
Caution



Do not exceed the operating input power level, voltage level, current level, and signal type that is appropriate for the instrument being used. Refer to your instrument's operation manual for safe operating practices and device limitations.



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.

MS462XX Series

SCORPION[®]

Vector Network Measurement Systems

MEASUREMENT GUIDE



Anritsu

Table of Contents

Chapter 1 General Information

SCOPE OF THIS MANUAL	1-1
INTRODUCTION	1-1
RELATED MANUALS	1-1
MS462XX MODELS	1-1
MS462XX OPTIONS	1-2
UPGRADEABILITY	1-3
CONFIGURATION	1-4

Chapter 2 System Overview

INTRODUCTION	2-1
CONVENTIONS	2-1
FRONT PANEL OVERVIEW	2-2
DISPLAY AREA	2-3
FRONT PANEL KEYS	2-4
LABELED KEYS	2-5
SOFT KEYS	2-7
MENU TREE	2-8
FOUR-CHANNEL DISPLAY	2-9

Chapter 3 Calibration

INTRODUCTION	3-1
CALIBRATION COEFFICIENTS	3-2
OSLT CALIBRATION	3-3
AUTOCAL TWO-PORT CALIBRATION	3-5
AUTOCAL FOUR-PORT CALIBRATION	3-11
THREE-PORT CALIBRATION	3-17
TWO-PATH, THREE-PORT CALIBRATION	3-18
FOUR-PORT CALIBRATION	3-19
DISCRETE FILL CALIBRATION	3-20
SEGMENTED SWEEP CALIBRATION	3-23
ADAPTER REMOVAL	3-25
FLEXIBLE CALIBRATION	3-28
ACCURACY ENHANCEMENT	3-31

Table of Contents (Continued)

Chapter 4 Applications

INTRODUCTION	4-1
NOISE FIGURE	4-2
INTERMODULATION DISTORTION	4-17
HARMONICS.	4-30
SPGC	4-41
SFGC	4-44
TIME DOMAIN	4-46
MIXER MEASUREMENTS	4-48
GLOBAL POWER SWEEP.	4-82

Chapter 5 Balanced Measurements

INTRODUCTION	5-1
THREE-PORT BALANCED MEASUREMENT	5-1
FOUR-PORT BALANCED MEASUREMENT	5-4
BALANCED PARAMETERS	5-6
IMPEDANCE TRANSFORMATION	5-7
EMBEDDING AND DE-EMBEDDING	5-9
GROUP	5-13
INTERCHANNEL MATH	5-15

Chapter 6 Features

INTRODUCTION	6-1
HARD COPY AND DISK OUTPUT	6-1
THREE-PORT DIPLEXER MEASUREMENTS	6-3
TUNE MODE	6-6
TEST SEQUENCE	6-8
EXTERNAL SCSI	6-11
MARKERS	6-14
LIMIT LINES.	6-19
ALTERNATE SWEEP	6-22
MARKER SWEEP	6-25
OTHER FEATURES	6-27

Table of Contents (Continued)

Chapter 7 Software Support

INTRODUCTION	7-1
SCORPION NAVIGATOR®	7-1
AUTOCAL TWO-PORT CHARACTERIZATION.	7-4
AUTOCAL FOUR-PORT CHARACTERIZATION	7-6
SCORPION COMMAND ENCYCLOPEDIA	7-8
DRIVERS AND POWER TOOLS	7-11
VNA DISPLAY CAPTURE.	7-13
NOISE FIGURE VENDOR ENR TABLE	7-15
NF ENR EXTENSION TABLE	7-17

Index

TRADEMARK ACKNOWLEDGMENTS

Scorpion is a registered trademark of ANRITSU company. ActiveX, Excel, Visual Basic, Visual C++, and Windows are registered trademarks of Microsoft Corporation. ThinkJet, DeskJet, and HP Vee are registered trademarks of Hewlett Packard Company. LabView and LabWindows are registered trademarks of National Instruments Corporation. Any and all other trademarks or trade names mentioned are the property of their respective owners. LRL/LRM calibration methods are patented in the name of Rohde & Schwarz, Germany. Some of the measurement examples used in this manual were accomplished with the cooperation of Sawtek, Inc.

NOTICE

ANRITSU Company has prepared this manual for use by ANRITSU Company personnel and customers as a guide for the proper installation, operation and maintenance of ANRITSU Company equipment and computer programs. The drawings, specifications, and information contained herein are the property of ANRITSU Company, and any unauthorized use or disclosure of these drawings, specifications, and information is prohibited; they shall not be reproduced, copied, or used in whole or in part as the basis for manufacture or sale of the equipment or software programs without the prior written consent of ANRITSU Company.

UPDATES

Updates to this manual, if any, may be downloaded from the Anritsu Internet site at: <http://www.us.anritsu.com>.

Chapter 1

General Information

1-1 SCOPE OF THIS MANUAL The purpose of this Measurement Guide is to introduce the basic operation of the Scorpion® MS462XX Vector Network Measurement System and help lessen the time required to become proficient at performing basic measurements. The procedures in this manual assume a working knowledge of, and a familiarity with, vector network analyzers. Refer to the other manuals supplied with the MS462XX for more detailed explanations and procedures.

1-2 INTRODUCTION This chapter provides information to familiarize the user with the basic MS462XX Vector Network Measurement System. Included is information about related manuals, and the available models and options.

1-3 RELATED MANUALS This manual is one of a six manual set consisting of this Measurement Guide, the *MS462XX Application Guide* (Anritsu part number 10410-00214), the *MS462XX Operation Manual* (Anritsu part number 10410-00203), the *MS462XX Programming Manual* (10410-00204), the *MS462XX Maintenance Manual* (10410-00205), and the *MS462XX GPIB Quick Reference Guide* (10410-00206).

1-4 MS462XX MODELS With four basic models and a number of powerful options to choose from, the MS462XX can be configured to address many measurement requirements. The following models are available as platforms.

	10 MHz to 3 GHz	10 MHz to 6 GHz	10 MHz to 9 GHz
2-Port T/R ¹	MS4622A	MS4623A	MS4624A
2-Port	MS4622B	MS4623B	MS4624B
3-Port	MS4622B + MS4600/3A	MS4623B + MS4600/3A	MS4624B + MS4600/3A
3-Port T/R ²	MS4622B + MS4600/6	MS4623B + MS4600/6	MS4624B + MS4600/6
4-Port	MS4622D	MS4623D	MS4624D
2-Port DRA ³	MS4622C	MS4623C	MS4624C
3-Port DRA ³	MS4622C + MS4600/3C	MS4623C + MS4600/3C	MS4624C + MS4600/3C

1. T/R is an economical Transmission/Reflection (or 1-path, two-port) configuration that measures S11 and S21 parameters.

2. 3-Port T/R measures 2-port S-parameters plus two-path, three-port measurements.

3. DRA is the Direct Receiver Access configuration for use in developing custom solutions.

1-5 MS462XX
OPTIONS

The following options are easily added to the MS462XX platform for increased measurement capabilities.

Option Number	Description	Availability
2	Time Domain	All Models
3A	Second Internal Source	3 GHz Source – 22B Models Only
3B	Second Internal Source	6 GHz Source – 23B Models Only
3C	Second Internal Source	3 GHz Source – 22C Models Only
3D	Second Internal Source	6 GHz Source – 23C Models Only
3E	Second Internal Source	9 GHz Source – 24B Models Only
3F	Second Internal Source	9 GHz Source – 24C Models Only
4	50 MHz to 3 GHz Noise Figure	22B, 23B, and 24B Models Only
4B	50 MHz to 6 GHz Noise Figure	23B and 24B Models Only
4D	50 MHz to 3 GHz Noise Figure	22C, 23C, and 24C Models Only
4E	50 MHz to 6 GHz Noise Figure	23C and 24C Models Only
4F	50 MHz to 3 GHz Noise Figure	22D, 23D, and 24D Models Only
4G	50 MHz to 6 GHz Noise Figure	23D and 24D Models Only
5	Frequency Translated Group Delay	MS4600B/C Series Only
6	Third Test Port	B and C Models Only
7	T/R Step Attenuator	A Models Only
8	Harmonic Measurement	All Models
10	AutoCal Control	All Models/Standard
11	Test Port Connector	All Models ¹
13	Intermodulation Distortion	All Models
24	Processing Upgrade	B and C Models

NOTES

- ¹ Standard Test Port Connector is N-female.
Option 11NM replaces N-female with N-male.
Option 11S replaces N-female with 3.5 mm male.
Option 11SF replaces N-female with 3.5 mm female.
Option 11A replaces N-female with GPC-7 male.

1-6 UPGRADEABILITY The following photo illustrates the manufacturing approach to the MS462XX system. The front panel and other modular subassemblies are easy to install, and replace when necessary. Options are added in the same manner. This approach ensures fast and reliable repairs and upgrades.



Figure 1-1. MS462XX Assembly

There is an MS462XX available to satisfy today's requirements with an upgrade path to support tomorrow's requirements.

1-7 CONFIGURATION

Record your MS462XX Vector Network Measurement System serial number, model number, and option configuration here for future reference.

NOTE

This information can be found on the rear panel of the instrument or by making the following front panel selection: Utility/Instrument State Parameters/System.

System Serial Number: _____

Firmware Version: _____

Model Number:

- | | | | |
|---------|--------------------------|---------|--------------------------|
| MS4622A | <input type="checkbox"/> | MS4624A | <input type="checkbox"/> |
| MS4622B | <input type="checkbox"/> | MS4624B | <input type="checkbox"/> |
| MS4622C | <input type="checkbox"/> | MS4624C | <input type="checkbox"/> |
| MS4622D | <input type="checkbox"/> | MS4624D | <input type="checkbox"/> |
| MS4623A | <input type="checkbox"/> | | |
| MS4623B | <input type="checkbox"/> | | |
| MS4623C | <input type="checkbox"/> | | |
| MS4623D | <input type="checkbox"/> | | |

Option Number:

- | | | | |
|--------|--------------------------|-------|--------------------------|
| 1 | <input type="checkbox"/> | 5 | <input type="checkbox"/> |
| 1A | <input type="checkbox"/> | 6 | <input type="checkbox"/> |
| 2 | <input type="checkbox"/> | 7 | <input type="checkbox"/> |
| 3A | <input type="checkbox"/> | 8 | <input type="checkbox"/> |
| 3B | <input type="checkbox"/> | 11NM | <input type="checkbox"/> |
| 3C | <input type="checkbox"/> | 11S | <input type="checkbox"/> |
| 3D | <input type="checkbox"/> | 11SF | <input type="checkbox"/> |
| 3E | <input type="checkbox"/> | 11A | <input type="checkbox"/> |
| 4 | <input type="checkbox"/> | 13 | <input type="checkbox"/> |
| 4B | <input type="checkbox"/> | 24 | <input type="checkbox"/> |
| 4D | <input type="checkbox"/> | 98 | <input type="checkbox"/> |
| 4E | <input type="checkbox"/> | 99 | <input type="checkbox"/> |
| 4F | <input type="checkbox"/> | _____ | <input type="checkbox"/> |
| 4G | <input type="checkbox"/> | _____ | <input type="checkbox"/> |
| NC346A | <input type="checkbox"/> | _____ | <input type="checkbox"/> |
| NC346B | <input type="checkbox"/> | _____ | <input type="checkbox"/> |

Chapter 2

System Overview

2-1 INTRODUCTION

The MS462XX provides an intuitive user interface based on measurement applications. The display area contains both data and menu selection information. The menu selection information is accessed with the eight soft keys adjacent to the display. The remaining front panel keys provide selection of the general system controls and settings. A menu tree overview (Section 2-8) provides a brief description of the selections associated with the major front panel keys.

2-2 CONVENTIONS

Throughout this Measurement Guide, path names may be used to represent the keystrokes for a desired action or procedure. The path name begins with a front panel key selection, followed by additional front panel or softkey selections, each separated by a forward slash (/). Front panel key names and soft keys are presented in the manual as they are on the system, that is, in initial caps or all uppercase letters as appropriate. For example, the following path name representation displays the system model number, serial number, current software version, and installed options:

Utility/INSTRUMENT STATE PARAMETERS/SYSTEM

Following the path above, the user would press the Utility front panel key, followed by the INSTRUMENT STATE PARAMETERS softkey, then the SYSTEM softkey to display the system information.

Individual steps within a procedure may also be presented as sequentially numbered steps for clarity. Again, front panel key names and soft keys are presented in the manual as they are on the system. For example, the following procedure displays the system model number, serial number, current software version, and installed options:

1. Press the Utility front panel key.
2. Select the menu soft keys as follows:

INSTRUMENT STATE PARAMETERS
SYSTEM

In some procedures, an optional or alternative step may be included and will be identified by the word optional in parenthesis, as below:

1. (optional) Perform a calibration for flatness using a power meter.

2-3 FRONT PANEL OVERVIEW

The MS462XX front panel is organized into three main areas: the display, the user interface, and the test port connector areas. The MS462XX front panel view is shown below for reference.

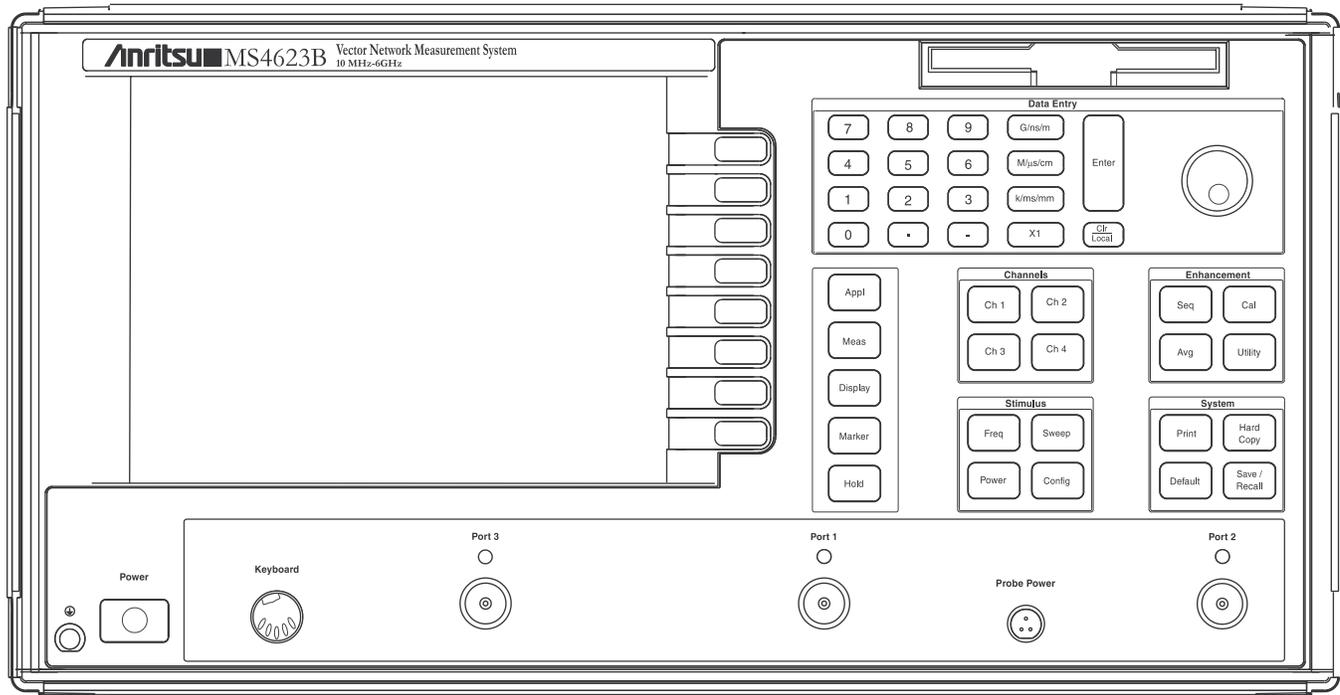


Figure 2-1. MS462XX Vector Network Measurement System

While the test port connector area is straightforward, the following sections provide more details about the display and user interface areas.

2-4 DISPLAY AREA

The display can be partitioned into data and menu display areas, separated by a vertical line. The menu display area provides the user interface for the MS462XX and is the focus of this Measurement Guide. The menu display area can be removed by pressing the Clr key in the Data Entry area on the front panel.

The MS462XX organizes measurement capabilities into applications accessible from the applications key (Appl) on the front panel of the system. The following illustration is a typical display following the selection of the Appl key.

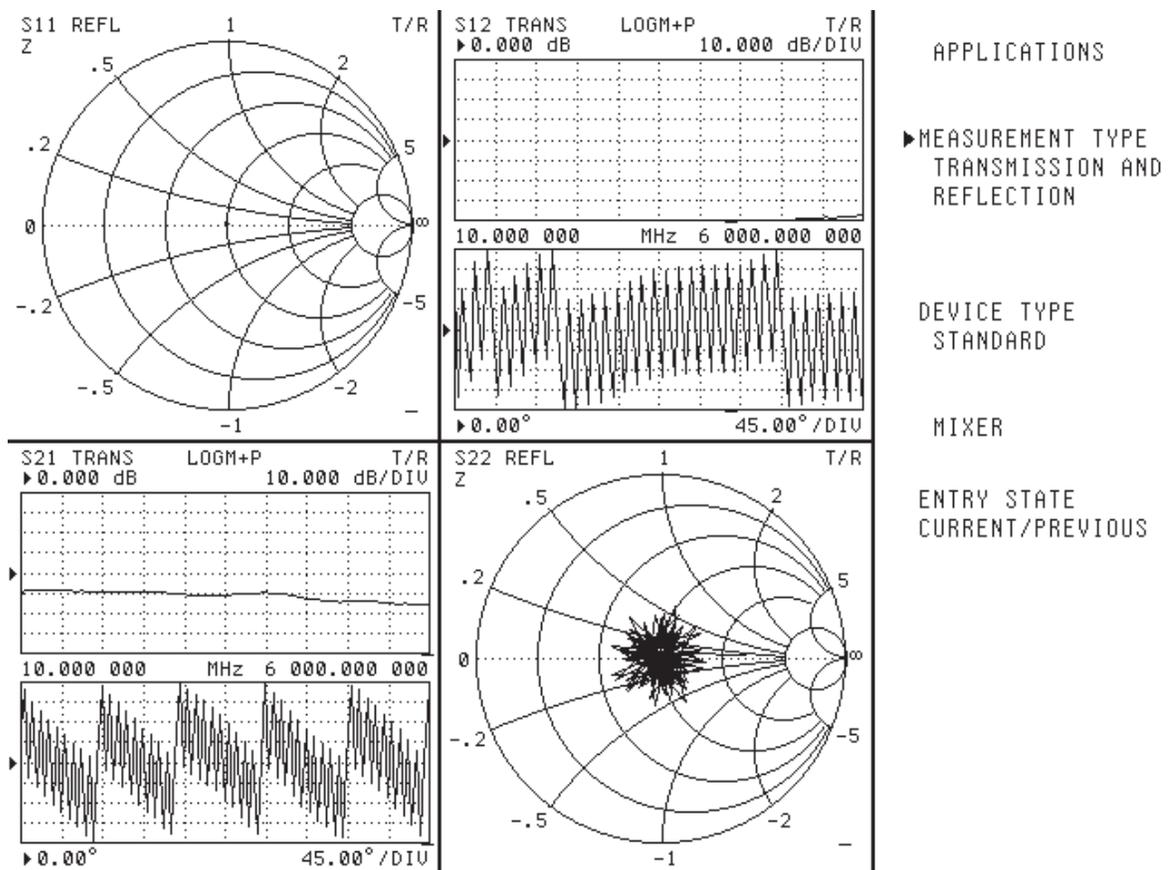


Figure 2-2. MS462XX Typical Display

2-5 FRONT PANEL KEYS

The MS462XX user interface area (Figure 2-3) consists of eight soft keys, next to the display, and six groups of labeled keys. The labeled key groups are Data Entry, Channels, Enhancement, Stimulus, System, and a group consisting of the Application, Measurement, Display, Marker, and Hold keys. Refer to the following front panel view.

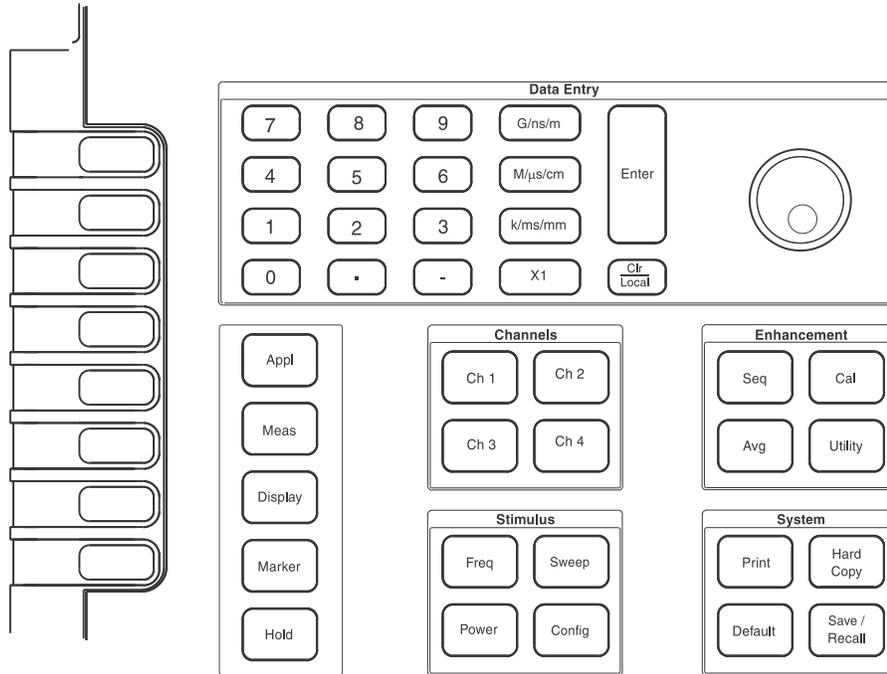


Figure 2-3. MS462XX Front Panel Keys

2-6 LABELED KEYS

The labeled keys provide access to the general system interface. These keys are organized into Data Entry, Channels, Enhancement, Stimulus, and System selections. Selection of the keys in this area typically provides choices in the menu display area. Figure 2-4 shows an example of these user interface keys.

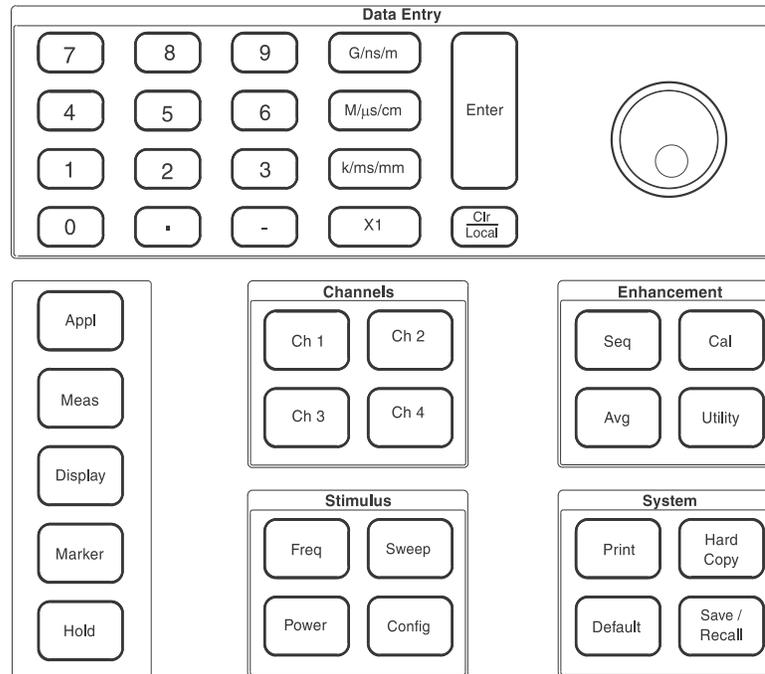


Figure 2-4. MS462XX Labeled Keys

The **Data Entry** keys are used to enter or clear numerical data for the active parameter.

The **Channel** keys, in conjunction with the Meas and Display keys, control the display of the measurement results. The currently active channel is indicated by the channel key LED in the upper left-hand corner of the key.

The **Enhancement** keys are used for sequencing menus, performing measurement calibrations, controlling the Average, Smoothing, and IF Bandwidth functions, and accessing system utilities.

The **Stimulus** keys provide frequency-sweep control, RF power control, and control over measurement configuration.

The **System** keys control printing, system reset to defaults, and saving and recalling stored system setups.

The **Application** key displays a series of menus that provide functions for measurement applications.

The **Measurement** key displays a series of menus used to select S-parameters.

The **Display** key displays a series of menus used to choose graph types, set scales, set the reference plane, store trace memory and manipulate limit lines.

The **Marker** key displays a series of menus used to set and manipulate marker frequency, power, time, and distance.

The **Hold** key toggles the system in and out of the hold mode, or triggers a sweep.

2-7 SOFT KEYS

The eight soft keys are used to make selections from the menu display area, just to the left of the keys. The reaction of the system to the selection of these soft keys depends on the choices in the menu display area. Figure 2-5 shows an example of this user interface.

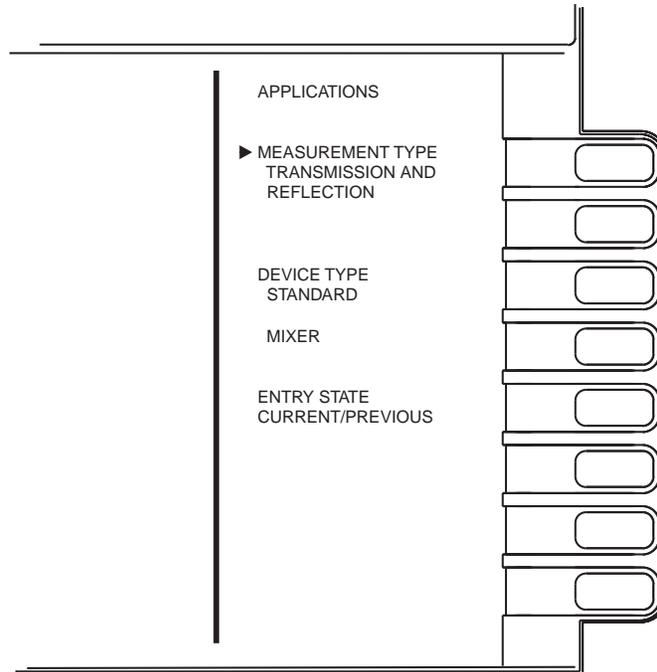
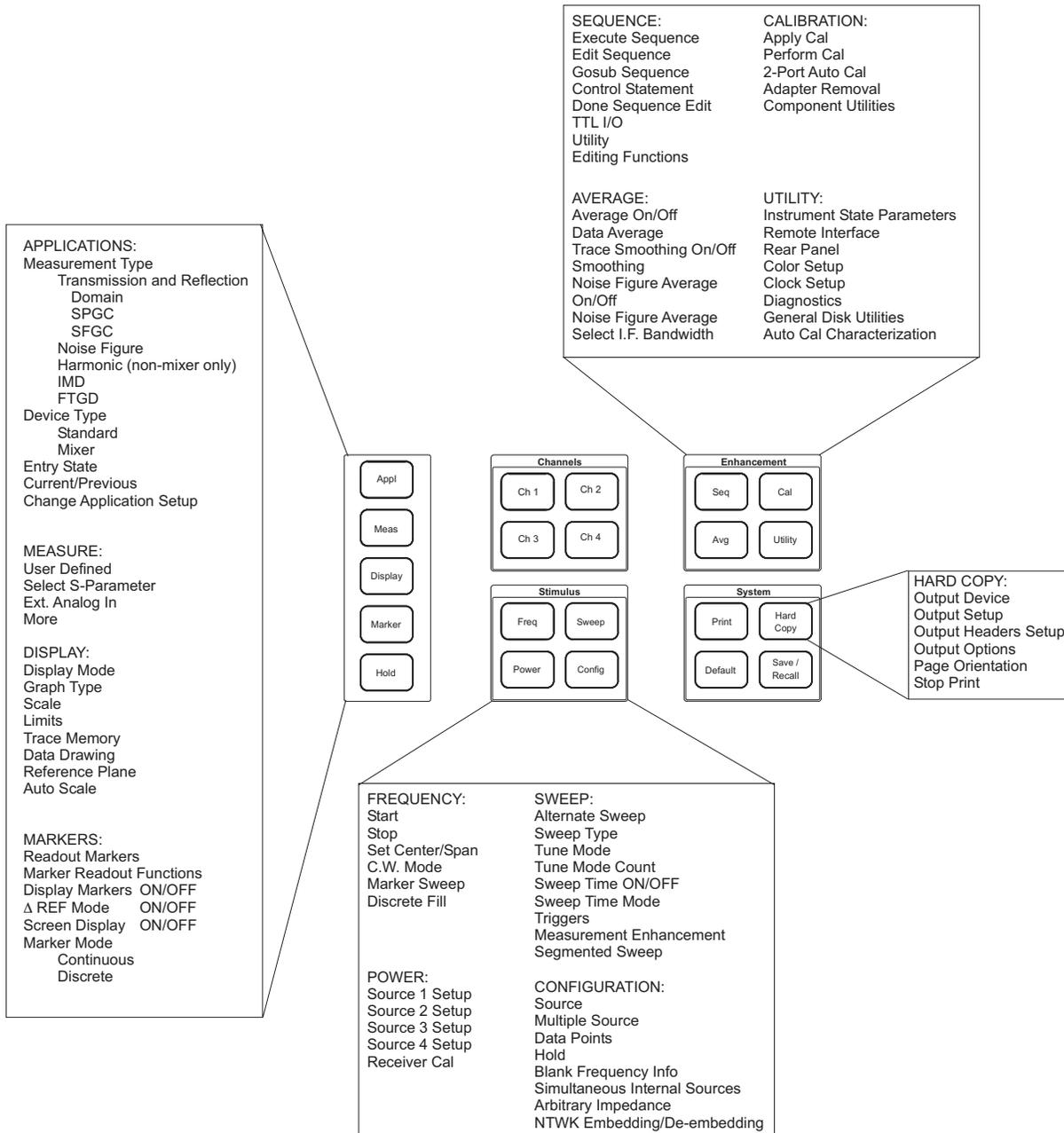


Figure 2-5. Softkey Example

Pressing a softkey executes the menu selection adjacent to that softkey. In some cases, the execution involves displaying another menu with further selections.

2-8 MENU TREE

The following diagram depicts the selections behind the major front panel keys.



2-9 **FOUR-CHANNEL DISPLAY**

The flexible four channel display of the MS462XX can be used by all applications to display the measurement results. This section explains how to take advantage of the four-channel display capability.

The four channel display is controlled by the selection of the Ch 1, Ch 2, Ch 3, or Ch 4 keys in the Channels area of the front panel. There is an LED in the upper left-hand corner of each of the four channel keys to easily identify the currently active channel.

The four Channel keys, in concert with the Meas and Display keys, provide the mechanism for controlling the display of the measurement results.

The Meas key allows the selection of the desired S-parameter. The S-parameters available for selection are:

USER DEFINED	S32	S10	SD1D2	SD2C1
S21	S33	SD1	SD2D1	SD2C2
S11	S14	SDD	SD2D2	SC1D1
S12	S24	S1C	SC1C1	SC2D2
S22	S41	SC1	SC1C2	SC2D1
EXT ANALOG IN	S42	SCC	SC2C1	SC2D2
S13	S34	SDC	SC2C2	
S23	S43	SCD	SD1C1	

The Display key allows the configuration of the display. The following Display selections are available:

- DISPLAY MODE
- GRAPH TYPE
- SCALE
- LIMITS
- TRACE MEMORY
- DATA DRAWING
- REFERENCE PLANE
- AUTO SCALE

NOTE

Overlay Dual Channels display mode requires Channels 1 & 3 (or Channels 2 & 4) be set for the same Graph Type.

The SCALE and AUTOSCALE selections configure the scales for the active channel. The most commonly used Display key selections are DISPLAY MODE, GRAPH TYPE, SCALE, and AUTO SCALE.

The DISPLAY MODE selection configures the presentation of the four channel results on the display. The display modes available for selection are:

- SINGLE CHANNEL
- DUAL CHANNELS 1 & 3
- DUAL CHANNELS 2 & 4
- SELECT DISPLAY GROUP
- OVERLAY DUAL CHANNELS 1 & 3
- OVERLAY DUAL CHANNELS 2 & 4
- FOUR CHANNELS
- OVERLAY ALL FOUR CHANNELS

The GRAPH TYPE selection configures the graph type for the active channel. The graph types available for selection are:

- LOG MAGNITUDE
- LINEAR MAGNITUDE
- PHASE
- REAL
- IMAGINARY
- LOG POLAR
- LINEAR POLAR
- SMITH CHART (IMPEDANCE)
- SMITH CHART (ADMITTANCE)
- GROUP DELAY
- POWER OUT
- SWR
- LOG MAGNITUDE AND PHASE
- LINEAR MAGNITUDE AND PHASE
- REAL AND IMAGINARY

Following is a typical procedure for configuring measurement results using the four-channel display capability.

1. Select the DISPLAY MODE for the measurement:

Display/DISPLAY MODE

If using Dual Channels, remember that the GRAPH TYPE must be the same for both channels.

2. Specify the Active Channel by selecting the Ch 1, Ch 2, Ch 3, or Ch 4 key.
3. Specify the S-parameter for Display:

Meas

4. Specify the Graph Type for the active channel:

Display/GRAPH TYPE

5. Adjust the Scale for the active channel:

Display/SCALE (or Display/AUTOSCALE)

6. As required, repeat steps 2 through 5 for the remaining measurement channels.

This procedure for configuring the display is demonstrated throughout the following measurement procedures.

NOTE

When using Dual Channels and Overlay Dual Channels for channels 1 & 3, the same dual channel display is configured for channels 2 & 4. Toggle between the two dual channel displays by selecting channel 1 (or channel 3) and then channel 2 (or channel 4).

Chapter 3

Calibration

3-1 INTRODUCTION

The MS462XX provides flexible calibration capabilities accessible from the calibration key (Cal) on the front panel of the system. This organization allows for straightforward and intuitive calibrations that provide the foundation for performing accurate S-parameter measurements by removing system errors preceding the actual measurements.

This chapter presents the primary calibration techniques available for the MS462XX. Typically, an application is chosen first (see Chapter 4, Applications) before performing a calibration. Following a calibration, the MS462XX is ready to perform accurate measurements. The front panel Cal key contains an LED that illuminates when a calibration is applied.

This chapter contains discussions, examples, and procedures related to the following calibrations:

- ❑ Calibration Coefficients
- ❑ OSLT Calibration
- ❑ AutoCal Two-Port Calibration
- ❑ AutoCal Four-Port Calibration
- ❑ Three-Port Calibration
- ❑ Two-Path, Three-Port Calibration
- ❑ Four-Port Calibration
- ❑ Discrete Fill Calibration
- ❑ Segmented Sweep Calibration
- ❑ Adapter Removal
- ❑ Flexible Calibration
- ❑ Accuracy Enhancement

Each calibration discussion shows a typical calibration procedure. Once a typical calibration is mastered, explore the different calibration options to become familiar with each calibration's powerful capability.

**3-2 CALIBRATION
COEFFICIENTS**

Standard Feature

NOTE

Once loaded, the calibration coefficients reside in memory until a Default-0 keyboard sequence is performed.

Every calibration kit contains calibration coefficients that help ensure the most accurate calibration. These coefficients must be loaded into the MS462XX before proceeding with a calibration. If these coefficients are not loaded, the MS462XX uses the default values contained in memory.

The following procedure loads and displays the calibration coefficients from a floppy disk into the MS462XX memory.

1. Place the calibration coefficients diskette into the floppy drive of the MS462XX.
2. Press the Cal front panel key.
3. Select the menu soft keys as follows:

MORE

COMPONENT UTILITIES

INSTALL KIT INFO FROM FLOPPY DISK

4. The MS462XX will install the calibration coefficients into memory.
5. Select: DISPLAY COAXIAL INFORMATION
6. Select either the male or female connector type of the calibration kit to view the corresponding calibration coefficients.

This completes the procedure for loading and displaying the calibration coefficients using the MS462XX.

**3-3 OSLT
CALIBRATION**

Standard Feature

NOTE

Pressing **Clr** in the Data Entry area of the Front Panel aborts the calibration process.

NOTE

Include Isolation when there is poor isolation (< 100 dB) in the test setup.

Calibration using the standard OSLT technique includes the measurement of an Open, a Short, a broadband Load, and a Throughline connection. These standards allow removal of system errors from the measurements that follow. This procedure calibrates the MS462XX using the OSLT technique.

1. Press the Cal front panel key.
2. Select the menu soft keys as follows:
 - PERFORM CAL/MANUAL CAL/2 PORT
 - CHANGE CAL METHOD AND LINE TYPE
 - STANDARD
 - NEXT CAL STEP
 - NEXT CAL STEP
 - FULL 12-TERM
 - EXCLUDE ISOLATION
 - NORMAL
3. Specify the Start Frequency:
 - START = 10 MHz
4. Specify the Stop Frequency:
 - STOP = 6000 MHz
5. Specify the Data Points:
 - DATA POINTS = 401 MAX PTS
 - NEXT CAL STEP
6. Specify the Port 1 Connector:
 - PORT 1 CONN = TYPE N (F)
7. Specify the Port 2 Connector:
 - PORT 2 CONN = TYPE N (M)
8. Specify the Test Signal Power Levels:
 - TEST SIGNALS
 - SOURCE 1 POWER = +7 dB
 - RESUME CAL
 - START CAL
9. Follow the directions for connecting calibration devices.

10. Press the Save/Recall front panel key, and the following soft keys:

SAVE

FRONT PANEL SETUP AND CAL DATA ON HARD DISK

CREATE NEW FILE

11. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the OSLT technique.

3-4 **AUTOCAL
TWO-PORT
CALIBRATION**
Standard Feature

The AutoCal module (36581XXF/1) is an automatic calibrator that provides fast, repeatable, and accurate coaxial two-port calibrations. The MS462XX AutoCal feature internally controls the AutoCal module to perform an OSLT calibration, thereby eliminating the requirement for an external computer and increasing the speed of the calibration.



Figure 3-1. MS462XX with Two-Port AutoCal Module

This section contains the following procedures for calibrating, characterizing, and assuring the two-port AutoCal module.

- AutoCal Characterization Files
- AutoCal Calibration
- AutoCal Characterization
- AutoCal Assurance

These powerful features support fast, repeatable, and accurate coaxial two-port calibrations.

***AutoCal
Characterization
Files***

The AutoCal Characterization Files contain the characterization data for the AutoCal module. The characterization data can be generated at either the factory or as a result of an AutoCal Characterization using the MS462XX. The following procedures show how to use the characterization files most effectively.

Using Characterization Files from the factory-supplied floppy diskette:

1. Insert the factory disk into the floppy drive on the MS462XX.
2. Copy the characterization file to the hard drive of the MS462XX.

Save/Recall/GENERAL DISK UTILITIES/FLOPPY DISK UTILITIES/COPY FILES TO HARD DISK

ALL TYPES (*.*)
3. The MS462XX retrieves the files from the disk and displays the files to copy.
4. Select the softkey beside the file with the *.ACD format.
5. The MS462XX copies the characterization file to the hard drive.

Loading Characterization Files before performing an AutoCal calibration:

1. Load the characterization file for the desired AutoCal module.

Save/Recall/RECALL/AUTO CAL CHARACTERIZATION ON HARD DISK
2. Select the softkey beside the file with the *.ACD format that corresponds to the desired AutoCal module. The MS462XX reads the characterization file for the desired AutoCal module.

Display AutoCal Characterization Information:

The AutoCal Characterization Information consists of Data Points, Switch Type, Serial Number, Start and Stop Frequency. This information provides important information regarding the calibration used to characterize the AutoCal module.

Once the characterization file is loaded, select the menu soft keys as follows:

Cal/MORE/COMPONENT UTILITIES/DISPLAY AUTO CAL CHARACTERIZATION INFORMATION

The MS462XX displays the AutoCal Characterization Information.

This completes the procedure for working with the AutoCal Characterization Files using the MS462XX.

***AutoCal Two-Port
Calibration***

The AutoCal Module (36581XXF/1) is an automatic calibrator that provides fast, repeatable, and accurate coaxial two-port calibrations. The MS462XX AutoCal feature internally controls the AutoCal module to perform an OSLT calibration, thereby eliminating the requirement for an external computer and increasing the speed of the calibration.

To calibrate the MS462XX using the AutoCal technique:

NOTE

The AutoCal module must be characterized with the MS462XX before attempting an AutoCal calibration (see Section 7-3, page 7-4).

3. Specify the Start Frequency:

Freq/START = 40 MHz

4. Specify the Stop Frequency:

STOP = 6000 MHz

5. Specify Data Points:

Config/DATA POINTS = 401 MAX PTS

6. Specify Test Signal Power Levels:

Power/SOURCE 1 SETUP/SOURCE 1 POWER = 7 dBm

7. Recall a stored characterization for the AutoCal module:

Save/Recall/RECALL/AUTOCAL CHARACTERIZATION ON HARD DISK

8. Select the AutoCal characterization file to read.

9. Begin the AutoCal calibration:

Cal/PERFORM CAL/AUTOCAL/SELECT BOX TYPE: 2 PORT
SELECT CAL TYPE/FULL 2 PORT
RETURN

10. As required, change the calibration setup (Steps 11 through 13):

CHANGE SETUP

11. Specify Port Configuration:

PORT CONFIG.
SELECT PORTS:
(L=1,R=2 or R=1,L=2 where L is for Left and R is for Right on the AutoCal Module)
RETURN

12. Specify Thru Type:

THRU ASSIGNMENT: AUTOCAL
RETURN

NOTE

Include Isolation when there is poor isolation (< 100 dB) in the test setup.

13. Specify Averaging Values:

AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
ISOLATION = 32
INCLUDE ISOLATION = NO
RETURN

14. Start the AutoCal two-port calibration.

START CAL
MEASURE DEVICES

15. Following the MEASURE DEVICE(S) selection, the MS462XX proceeds with the calibration using the characterized AutoCal Module.

16. Save the setup and cal data:

Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD DISK/CREATE NEW FILE

17. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the AutoCal technique.

***AutoCal Two-Port
Characterization***

The AutoCal Module should be re-characterized every six months. The MS462XX streamlines the characterization process by providing internal control of this process. This process requires a 12-term calibration in place before characterization can proceed. The following procedure characterizes the AutoCal module using the MS462XX.

1. Perform an OSLT two-port calibration (Section 3-3) in the desired frequency range with maximum data points and maximum source power.
2. Press the front panel keys and menu soft keys as follows:
Utility/AUTOCAL CHARACTERIZATION
3. Select the box type:
SELECT BOX TYPE – 2 PORT
4. Specify Port Configuration:
SELECT PORTS: (L=1,R=2 or R=1,L=2 where L is for Left and R is for Right on the AutoCal Module)
5. Specify the Averaging Values:
AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
RETURN
CONTINUE
6. Following the CONTINUE selection, the MS462XX proceeds to characterize the AutoCal Module using the previously performed OSLT calibration. This characterization process can be time-consuming, depending upon the averaging selections.
7. Save the characterized AutoCal data for later retrieval:
Save/Recall/SAVE/AUTOCAL CHARACTERIZATION ON HARD DISK/CREATE NEW FILE
8. Specify a name using the front panel knob, and select DONE.

This completes the procedure for characterizing the AutoCal module using the MS462XX.

AutoCal Two-Port Assurance

The AutoCal Module contains a reference standard that is characterized during the characterization process. This reference standard is separate from the elements used for the OSLT calibration and can be accessed to evaluate the quality of an AutoCal Calibration.

1. Following an AutoCal Calibration, leave the AutoCal Module connected and select the menu soft keys as follows:

Utility/DIAGNOSTICS/AUTOLOCAL ASSURANCE
SELECT BOX TYPE – 2 PORT
PERFORM ASSURANCE

2. (Optional) View and/or adjust the Assurance Limits for Directivity, Source Match, Reflection Tracking, Load Match, and Transmission Tracking.

ASSURANCE LIMITS SETUP
RETURN

3. Perform the AutoCal Assurance

MEASURE DEVICE(S)

4. The MS462XX performs the AutoCal Assurance. If AutoCal Assurance passes the Assurance Limits, a pass indication is provided. If not, a fail indication is provided. In the case of a fail indication, a brief summary of failure for the first five frequencies is available in the MS462XX service log.

5. Access the service log with the following menu soft keys.

CONTINUE
Utility/DIAGNOSTICS/SERVICE LOG

This completes the procedure for performing an AutoCal Assurance using the MS462XX.

3-5 **AUTOCAL
FOUR-PORT
CALIBRATION**
Standard Feature

The AutoCal module (36584XF) is an automatic calibrator that provides fast, repeatable, and accurate coaxial calibrations for two, three, and four-port measurements. The MS462XX AutoCal feature internally controls the AutoCal module to perform an OSLT calibration, thereby eliminating the requirement for an external computer and increasing the speed of the calibration.

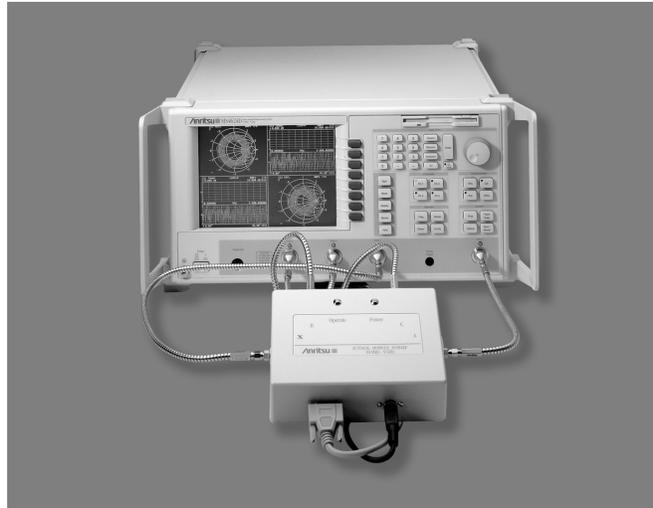


Figure 3-2. MS462XX with Four-Port AutoCal Module

This section contains the following procedures for calibrating, characterizing, and assuring the four-port AutoCal module.

- ❑ AutoCal Characterization Files
- ❑ AutoCal Calibration
- ❑ AutoCal Characterization
- ❑ AutoCal Assurance

These powerful features support fast, repeatable, and accurate coaxial two-port calibrations.

***AutoCal
Characterization
Files***

The AutoCal Characterization Files contain the characterization data for the AutoCal module. The characterization data can be generated at either the factory or as a result of an AutoCal Characterization using the MS462XX. The following procedures show how to use the characterization files most effectively.

Using Characterization Files from the factory-supplied floppy diskette:

1. Insert the factory disk into the floppy drive on the MS462XX.
2. Copy the characterization file to the hard drive of the MS462XX.

Save/Recall/GENERAL DISK UTILITIES/FLOPPY DISK UTILITIES/COPY FILES TO HARD DISK

ALL TYPES (*.*)
3. The MS462XX retrieves the files from the disk and displays the files to copy.
4. Select the softkey beside the file with the *.ACD format.
5. The MS462XX copies the characterization file to the hard drive.

Loading Characterization Files before performing an AutoCal calibration:

1. Load the characterization file for the desired AutoCal module.

Save/Recall/RECALL/AUTO CAL CHARACTERIZATION ON HARD DISK
2. Select the softkey beside the file with the *.ACD format that corresponds to the desired AutoCal module. The MS462XX reads the characterization file for the desired AutoCal module.

Display AutoCal Characterization Information:

The AutoCal Characterization Information consists of Data Points, Switch Type, Serial Number, Start and Stop Frequency. This information provides important information regarding the calibration used to characterize the AutoCal module.

Once the characterization file is loaded, select the menu soft keys as follows:

Cal/MORE/COMPONENT UTILITIES/DISPLAY AUTO CAL CHARACTERIZATION INFORMATION

The MS462XX displays the AutoCal Characterization Information.

This completes the procedure for working with the AutoCal Characterization Files using the MS462XX.

***AutoCal Four-Port
Calibration***

The AutoCal Module (36584XF) is an automatic calibrator that provides fast, repeatable, and accurate coaxial two-port calibrations. The MS462XX AutoCal feature internally controls the AutoCal module to perform an OSLT calibration, thereby eliminating the requirement for an external computer and increasing the speed of the calibration.

To calibrate the MS462XX using the AutoCal technique:

NOTE

The AutoCal module must be characterized with the MS462XX before attempting an AutoCal calibration (see Section 7-3, page 7-4).

1. Specify the Start Frequency:
Freq/START = 40 MHz
2. Specify the Stop Frequency:
STOP = 6000 MHz
3. Specify Data Points:
Config/DATA POINTS = 401 MAX PTS
4. Specify Test Signal Power Levels (Source 1 provides output power between Ports 1 and 2; Source 2 provides output power between Ports 3 and 4):
Power/SOURCE 1 SETUP/SOURCE 1 POWER = 7 dBm
Power/SOURCE 2 SETUP/SOURCE 2 POWER = 7 dBm
5. Recall a stored characterization for the AutoCal module:
Save/Recall/RECALL/AUTOCAL CHARACTERIZATION ON HARD DISK
6. Select the AutoCal characterization file to read.
7. Begin the AutoCal calibration:
Cal/PERFORM CAL/AUTOCAL/SELECT BOX TYPE: 4 PORT
SELECT CAL TYPE/FULL 4 PORT
RETURN
8. As required, change the calibration setup (Steps 11 through 13):
CHANGE SETUP
9. Specify Port Configuration:
PORT CONFIG.
SELECT PORTS:
(Match the port numbers of the MS462XX to the AutoCal module where X, A, B, and C are on the AutoCal module)
RETURN
10. Specify Thru Type:
THRU ASSIGNMENT: AUTOCAL (for each thru)
RETURN

NOTE

Include Isolation when there is poor isolation (< 100 dB) in the test setup.

11. Specify Averaging Values:

AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
ISOLATION = 32
INCLUDE ISOLATION = NO
RETURN

12. START AUTOCAL 4 PORT CALIBRATION

START CAL
MEASURE DEVICE(S)

13. Following the MEASURE DEVICE(S) selection, the MS462XX proceeds with the calibration using the characterized AutoCal Module.

14. Save the setup and cal data:

Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD DISK/CREATE NEW FILE

15. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the AutoCal technique.

***AutoCal Four-Port
Characterization***

The AutoCal Module should be re-characterized every six months. The MS462XX streamlines the characterization process by providing internal control of this process. This process requires a 40-term calibration in place before characterization can proceed. The following procedure characterizes the AutoCal module using the MS462XX.

1. Perform an OSLT four-port calibration (Section 3-8) in the desired frequency range with maximum data points and maximum source power.
2. Press the front panel keys and menu soft keys as follows:
Utility/AUTOCAL CHARACTERIZATION
3. Select the box type:
SELECT BOX TYPE – 4 PORT
4. Connect the four-port AutoCal module:
Connect Port 1 to X
Connect Port 2 to A
Connect Port 3 to B
Connect Port 4 to C
5. Specify the Averaging Values:
AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
RETURN
CONTINUE
6. Following the CONTINUE selection, the MS462XX proceeds to characterize the AutoCal Module using the previously performed OSLT calibration. This characterization process can be time-consuming, depending upon the averaging selections.
7. Save the characterized AutoCal data for later retrieval:
Save/Recall/SAVE/AUTOCAL CHARACTERIZATION ON HARD
DISK/CREATE NEW FILE
8. Specify a name using the front panel knob, and select DONE.

This completes the procedure for characterizing the AutoCal module using the MS462XX.

AutoCal Four-Port Assurance

The AutoCal Module contains a reference standard that is characterized during the characterization process. This reference standard is separate from the elements used for the OSLT calibration and can be accessed to evaluate the quality of an AutoCal Calibration.

1. Following an AutoCal Calibration, leave the AutoCal Module connected and select the menu soft keys as follows:

Utility/DIAGNOSTICS/AUTOCAL ASSURANCE
SELECT BOX TYPE – 4 PORT
PERFORM ASSURANCE

2. (Optional) View and/or adjust the Assurance Limits for Directivity, Source Match, Reflection Tracking, Load Match, and Transmission Tracking.

ASSURANCE LIMITS SETUP
RETURN

3. Perform the AutoCal Assurance

MEASURE DEVICE(S)

4. The MS462XX performs the AutoCal Assurance. If AutoCal Assurance passes the Assurance Limits, a pass indication is provided. If not, a fail indication is provided. In the case of a fail indication, a brief summary of failure for the first five frequencies is available in the MS462XX service log.

5. Access the service log with the following menu soft keys.

CONTINUE
Utility/DIAGNOSTICS/SERVICE LOG

This completes the procedure for performing an AutoCal Assurance using the MS462X

3-6 THREE-PORT CALIBRATION

MS462XD:
A four-port model can perform three-port calibrations.

Option 3X:
Adds a second internal source and an additional test port.

Option 6:
Use and external synthesizer for three-port calibrations.

NOTE
Pressing **Clr** in the Data Entry area of the Front Panel aborts the calibration process.

NOTE
The Offset Length for a 3.5 mm reflective device is 5 mm.

Calibration using the three-port calibration technique is available for selection on three and four-port configurations of the MS462XX.

The following procedure calibrates the MS462XX using the three-port technique.

A two-port calibration must be performed before proceeding with a three-port calibration. A two-port calibration can be one of the preceding OSLT or AutoCal calibrations. The frequency range and data points of the two-port calibration dictate the calibration configuration for the three-port calibration.

1. Specify Test Signal Power Levels (Source 1 provides output power between Ports 1 and 2; Source 2 provides output power between Ports 3 and 4):

Power/SOURCE 1 SETUP/SOURCE 1 POWER = 7 dBm
Power/SOURCE 2 SETUP/SOURCE 2 POWER = 7 dBm
Cal/PERFORM CAL/MANUAL CAL/3 PORT
CHANGE CAL METHOD/SOLT
NEXT CAL STEP
NEXT CAL STEP
CHANGE PARAMETERS
NEXT CAL STEP

2. Specify calibration parameters:

PORT 3 CONN = TYPE N(M)
DO PORT 2,3 THROUGH? = NO
START CAL

3. Follow the directions for connecting calibration devices.

4. Save the setup and cal data:

Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD DISK/CREATE NEW FILE

5. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the three-port calibration technique.

**3-7 TWO-PATH,
THREE-PORT
CALIBRATION**

Standard Feature
for Three-Port
Configurations

Two-path, three-port calibration can be used when only S11, S21, and S31 are required, or when load-match corrections are not critical.

The following procedure calibrates the MS462XX using the two-path, three-port technique.

1. Perform an OSLT calibration (Section 3-3).
2. Press the front panel keys and menu soft keys as follows:

```
Cal  
PERFORM CAL/MANUAL CAL/3 PORT  
CHANGE CAL METHOD/2 PATH 3 PORT (S11, S21, S31)  
NEXT CAL STEP  
NEXT CAL STEP  
START CAL
```

3. Connect the thru line between port 1 and port 3.

```
MEASURE DEVICE(S)  
NEXT CAL STEP  
ENTER TO PROCEED
```

This completes the procedure for calibrating the MS462XX using the two-path, three-port calibration technique.

NOTE

If the thru line length (port 1 to port 3) is not zero, enter the appropriate value.

3-8 **FOUR-PORT
CALIBRATION**

Model D Only

Calibration using the four-port calibration technique is available for D models only. The following procedure calibrates the MS462xD using the four-port technique.

A two-port calibration must be performed before proceeding with a four-port calibration. A two-port calibration can be one of the preceding OSLT or AutoCal calibrations. The frequency range and data points of the two-port calibration dictate the calibration configuration for the four-port calibration.

1. Perform an OSLT two-port calibration (Section 3-3) or a two-port AutoCal calibration (Section 3-4).

2. Specify Test Signal Power Levels (Source 1 provides output power between Ports 1 and 2; Source 2 provides output power between Ports 3 and 4):

Power/SOURCE 1 SETUP/SOURCE 1 POWER = 7 dBm

Power/SOURCE 2 SETUP/SOURCE 2 POWER = 7 dBm

Cal/PERFORM CAL/MANUAL CAL/4 PORT

CHANGE CAL METHOD/SOLT

NEXT CAL STEP

NEXT CAL STEP

3. Specify calibration parameters:

PORT 3 CONN = GPC-3.5 (M)

PORT 4 CONN = GPC-3.5 (M)

START CAL

4. Follow the directions for connecting calibration devices.

5. Save the setup and cal data:

Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD
DISK/CREATE NEW FILE

6. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462xD using the four-port calibration technique.

NOTE

To verify that the calibration is good, connect a through between Ports 1 and 2, 1 and 3 and 1 and 4 in consecutive order and check that S11, S22, S33 and S44 have a RL of 15 or better. Also verify transmission S-parameters are close to 0 dB.

3-9 DISCRETE FILL CALIBRATION

Standard Feature

A Discrete Fill calibration supports calibration requirements where the data point spacing is not uniform.

The following display shows a bandpass filter response after performing a discrete fill calibration.

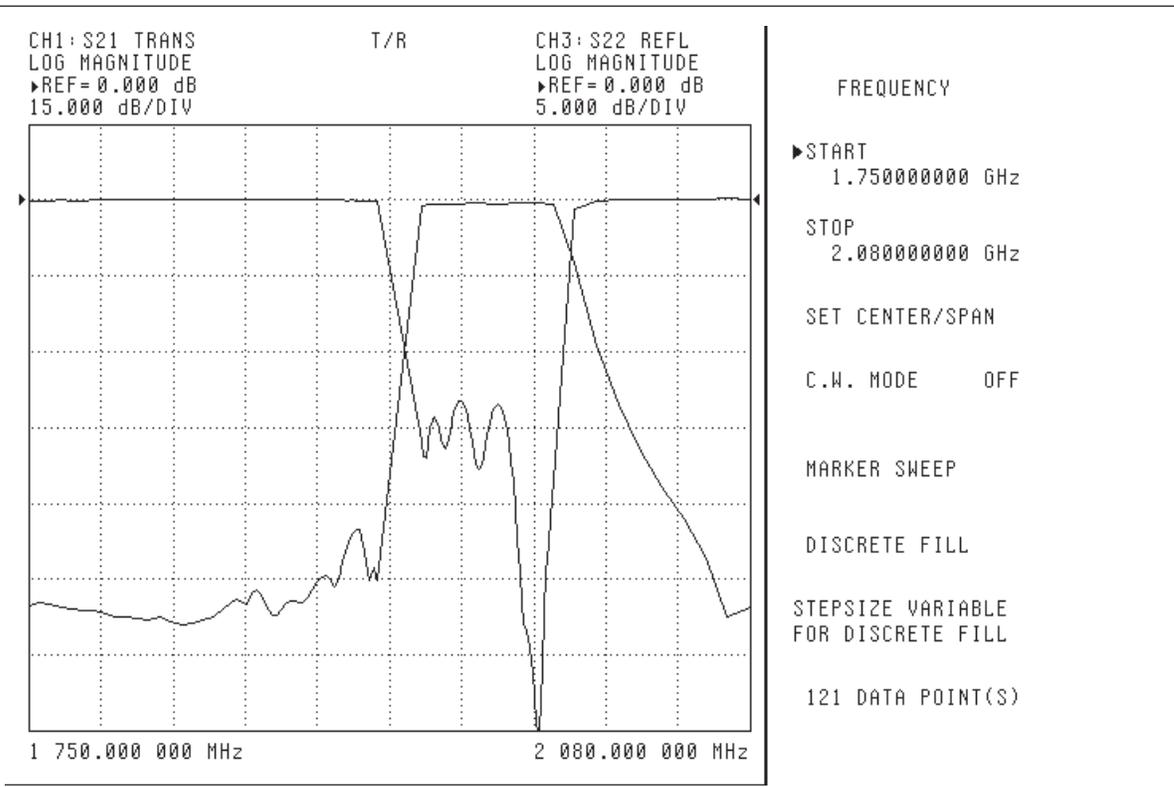


Figure 3-3. Discrete Calibration Example Display

In this example, more data points are required in the passband than in the rejection bands. In this way, measurement speed is optimized by limiting the amount of data points to only those of interest. The passband for this measurement is 1930 MHz to 1990 MHz.

The following table shows the requirements for this discrete fill calibration.

Start Frequency	Increment	Number of Points	Stop Frequency
1750 MHz	5 MHz	21 Points	1850 MHz
1850 MHz	2 MHz	31 Points	1910 MHz
1930 MHz	1 MHz	61 Points	1990 MHz
1990 MHz	10 MHz	10 Points	2080 MHz

The following procedure calibrates the MS462XX using the Discrete Fill technique.

NOTE

Pressing **Clr** in the Data Entry area of the Front Panel aborts the calibration process.

NOTE

Include Isolation when there is poor isolation (< 100 dB) in the test setup.

1. Press the Cal front panel key.
2. Select the menu soft keys as follows:
 - PERFORM CAL/MANUAL CAL/2 PORT
 - NEXT CAL STEP
 - FULL 12-TERM
 - EXCLUDE ISOLATION
 - N-DISCRETE FREQUENCIES (2 TO 1601 POINTS)
 - CLEAR ALL
3. Specify Start Frequency:
 - START FREQ = 1750 MHz
4. Specify Increment:
 - INCREMENT = 5 MHz
5. Specify Number of Points:
 - NUMBER OF POINTS = 21
 - FILL THE RANGE
6. Specify Start Frequency:
 - START FREQ = 1850 MHz
7. Specify Increment:
 - INCREMENT = 2 MHz
8. Specify Number of Points:
 - NUMBER OF POINTS = 31
 - FILL THE RANGE
9. Specify Start Frequency:
 - START FREQ = 1930 MHz
10. Specify Increment:
 - INCREMENT = 1 MHz
11. Specify Number of Points:
 - NUMBER OF POINTS = 61
 - FILL THE RANGE

12. Specify Start Frequency:

START FREQ = 1990 MHz

13. Specify Increment:

INCREMENT = 10 MHz

14. Specify Number of Points:

NUMBER OF POINTS = 10

FILL THE RANGE

NEXT CAL STEP

15. Specify Port 1 Connector:

PORT 1 CONN = TYPE N (F)

16. Specify Port 2 Connector:

PORT 2 CONN = TYPE N (M)

17. Specify Test Signal Power Levels:

TEST SIGNALS/SOURCE 1 POWER = + 7 dBm

RESUME CAL

START CAL

18. Follow the directions for connecting calibration devices.

19. Save the setup and cal data:

Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD
DISK/CREATE NEW FILE

20. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the Discrete Fill technique.

**3-10 SEGMENTED
SWEEP
CALIBRATION**

Option 24 Required

A segmented Sweep calibration supports measurement requirements where averaging, power, or IF bandwidth differ from frequency to frequency. The Segmented Sweep selection is available when a two-port calibration is performed.

Up to 16 segments can be defined with a total of up to 1601 data points per sweep. Each segment can have unique averaging, power, and IF bandwidth setups. If the data spacing is not uniform, a Discrete Fill setting may be used in each segment.

Before starting a Segmented Sweep calibration, sweep segments must be set up. The menus to set up a Segmented Sweep can be found under the SWEEP key on the front panel.

***Setting up a
Segmented
Sweep***

The following procedure illustrates how to set up a segmented sweep:

1. Press the Sweep front panel key.
2. Select the menu soft keys as follows:
 - MORE
 - SEGMENTED SWEEP
 - DEFINE
 - SEGMENT (to ON)
 - START (set the start frequency of the first segment)
 - STOP (set the stop frequency of the first segment)
 - DATA POINTS (set the number of data points in the first segment)
3. Add additional segments to the sweep by selecting the soft keys:
 - ADD NEXT SEGMENT
 - START (set the start frequency of the second segment)
 - STOP (set the stop frequency of the second segment)
 - DATA POINTS (set the number of data points in the second segment)
4. Repeat Step 3 to add up to 16 segments in the segmented sweep. Each segment must be toggled ON to be included.
5. Additional parameters, such as Discrete Fill, IFBW, Data Averaging, and Source Power can be uniquely set for each segment in the sweep. To access these additional parameters, select the MORE soft key.
6. After all segments are set up, select
 - RETURN
 - SEG. SWEEP MODE = APPLY

NOTE

Segmented Sweep mode must be applied before it will be active.

*Calibrating a
Segmented
Sweep*

The following procedure calibrates the MS462XX using a Segmented Sweep:

NOTE

Pressing **Clr** in the Data Entry area of the Front Panel aborts the calibration process.

NOTE

Include Isolation when there is poor isolation (< 100 dB) in the test setup.

1. Press the Cal front panel key.
2. Select the menu soft keys as follows:
 - PERFORM CAL/MANUAL CAL/2 PORT
 - CHANGE CAL METHOD AND LINE TYPE
 - STANDARD (NOT USED FOR WAVEGUIDE)
 - NEXT CAL STEP
 - NEXT CAL STEP
 - FULL 12-TERM
 - EXCLUDE ISOLATION
 - SEGMENTED SWEEP (1601 POINTS MAXIMUM)
 - NEXT CAL STEP
3. Specify Port 1 Connector:
 - PORT 1 CONN = TYPE N (F)
4. Specify Port 2 Connector:
 - PORT 2 CONN = TYPE N (M)
 - START CAL
5. Follow the directions for connecting calibration devices.
6. Save the setup and cal data by pressing the Save/Recall front panel key and selecting:
 - SAVE
 - MORE
 - SEGMENTED SWP ON HARD DISK
 - CREATE NEW FILE
7. Specify a name using the front panel knob. When complete, select DONE.

This completes the procedure for calibrating the MS462XX using the Segmented Sweep mode.

**3-11 ADAPTER
REMOVAL**

Standard Feature

While it is usually desired to perform a two-port calibration with mating connectors of the same type, this is sometimes not possible based on the connectors of the device to be tested. Examples of this include:

- ❑ The DUT has one N port and one GPC-3.5 port.
- ❑ The DUT has two female SMA ports and it is not desired to use a non-zero length thru.
- ❑ The DUT has one fixtured port and one SMA port.

What these examples share is that completing the thru line between the effective test ports requires some kind of adapter. Since the adapter has some phase length, loss, and mismatch, its effects should be removed for a high quality cal. Adapter removal is a utility to characterize this adapter and remove its effects.

The concept of the adapter removal relies on the existence of two related sets of reference planes—one set on either side of the adapter (see Figure 3-4). Assuming one can perform a full calibration at each set of reference planes, there is enough information to extract the behavior of the adapter itself. When the calibration is being performed at the reference planes on the left (between ports 1 and 2'), the adapter behavior is embedded in the characteristics of port 2'. Similarly, when the calibration is being performed between ports 1' and 2, the adapter behavior is embedded in that of port 1'. Since each of these two calibrations involve mating connector types, these are far easier to perform than the direct 1-2 calibration. It will not be shown here, but the use of the two calibrations provide nearly enough information to extract the parameters of the adapter itself.

Figure 3-4 shows the structure of the adapter removal calibration. Two calibrations are performed at the two sets of reference planes shown (between ports 1 and 2', and between 1' and 2), which allows a determination of the adapter behavior. After the adapter removal, the resulting calibration will be between Ports 1 and 2.

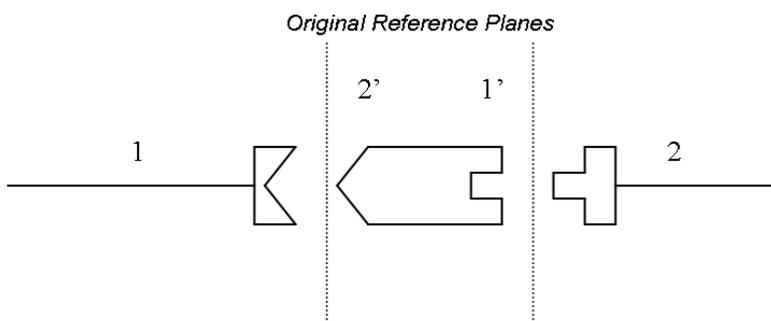


Figure 3-4. Adapter Removal Block Diagram

Example: The following example should help illustrate the use of the adapter removal utility. An adapter was constructed with about 3 dB of loss and 180 degrees of phase shift at 3 GHz. This leads to an estimate of the delay length of:

$$\phi = \omega\tau \qquad \tau = \frac{\phi}{\omega} = \frac{\pi}{2\pi(3 \times 10^9)} \approx 167\text{ps}$$

Since the loss of this adapter is substantial, one could not simply use reference plane extensions to remove the phase shift and hope for an accurate result.

The two calibrations described earlier were performed and stored to the hard disk and the adapter removal was executed. A thru was then connected without the adapter in place. Normally this would not be possible (since the whole reason for using the adapter removal was for situations when a thru would be difficult), but this example adapter was constructed just to show that the algorithm functions correctly. The results are shown in Fig. 3.

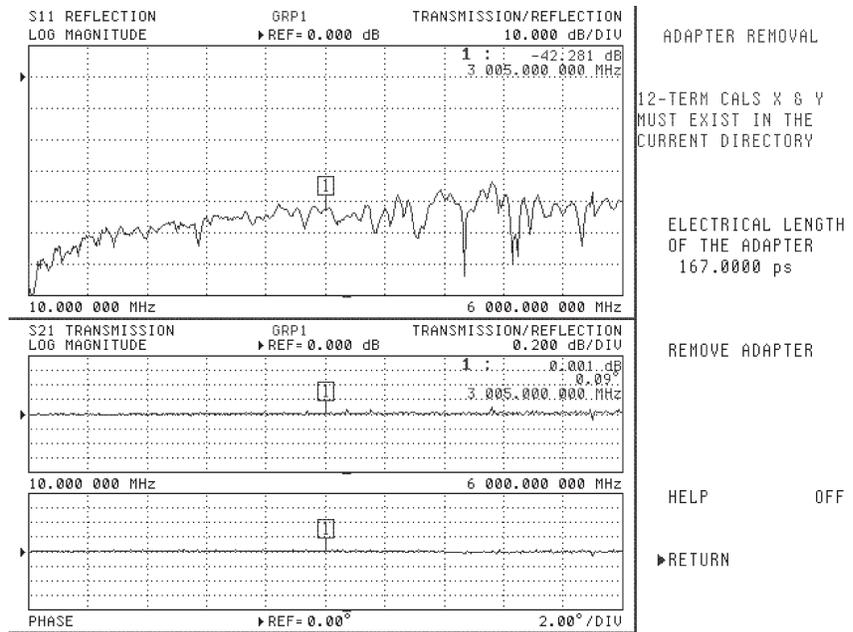


Figure 3-6. Result of the Adapter Removal

The thru without the adapter was connected after executing the adapter removal utility and the near-perfect thru values for S21 show that the algorithm successfully removed the adapter from the calibration. As expected, the thru without the adapter shows nearly zero insertion loss and phase shift, and a very good match. Any residuals are largely due to cable flex. Had this connection been made with one of the initial two calibrations applied, S21 would have shown about 3 dB of gain since the adapter had been built into each calibration.

3-12 FLEXIBLE CALIBRATION

Standard Feature

Using Flexible Calibration

Flexible Calibration mode allows an existing two, three, or four-port calibration to be quickly subdivided so that only the required measurements are used. This is accomplished by having all error coefficients available, but just enabling those that are needed. The configuration can be changed so that calibration setups do not need to be recalled from memory or disk.

Flexible Calibration requires that a single N-port (two, three, or four-port) calibration be performed (see application notes *AutoCal*, 11410-00258, or *4-Port AutoCal*, 11410-00298, for more information). Then, when a given measurement is to be performed, the user selects what portion of the calibration is to be used. The simplest case is when a full M-port calibration is enabled ($M \leq N$).

For example, a four-port VNA is used to measure a pair of two-port DUTs. While one DUT is being measured, the second DUT is being loaded on the remaining two ports. The user has two options:

- Use two, two-port calibrations and recall the setup between each measurement
- Use a four-port calibration

In each case, considerable time is lost due to reloading a two-port calibration between measurements or due to measuring 16 parameters each time when only four are needed.

With Flexible Calibration, you can perform a full four-port calibration (parent calibration) to start and then enable a two-port calibration for each of the measurement groups. Once the parent calibration has been performed, the Flexible Cal menu (left) can be used to select the appropriate measurement subsets as follows:

```

FLEXIBLE CAL
SELECT INPUT METHOD
(BY PORT)
FULL TERM CALS

REFLECTION ONLY
(BY S-PARAM)
▶ CUSTOMIZE CAL

FLEXIBLE CAL MODE
APPLY

DEFINE

HELP          OFF

RETURN
    
```

- FULL TERM CALS—If the parent calibration is a four-port calibration, use this to select a full two or three-port calibration or to re-enable the full four-port calibration; if the parent calibration is a three-port calibration, use this to select any two-port calibration or to re-enable the three-port calibration
- REFLECTION ONLY CALS—Use this to select one, or up to four, reflection-only one-port calibrations
- CUSTOMIZE CALS—Use this to select different combinations other than full-term or one-port calibrations

An important point is that the system will automatically determine which error terms must be included to perform the correction as best as possible within the constraints supplied. The rules for the system's decisions can be described as follows:

- ❑ If a reflection term (S_{ii}) is activated, include all reflectometer coefficients for that port. If S_{ii} is isolated, the calibration is treated like a one-port reflection-only calibration
- ❑ For each transmission term (S_{ji}), activate its tracking term. If done alone, the calibration is treated like a normalization calibration (similar to frequency response)
- ❑ If a transmission term is activated along with its matching reflection terms (e.g., S_{12} , S_{11} and S_{22}), activate the load match terms

The net effect is, if all four parameters associated with a two-port calibration are specified, a full two-port correction will be enabled. If only S_{ii} and S_{ji} are activated, then a 1-path, two-port calibration will be enabled.

NOTE

Although the system can be fairly intelligent in which terms it uses, it knows little about the DUT. You can help by specifying not only the measurements that are needed, but also the ones that are tightly connected to the desired measurement and are not on the measurement's list.

Example Using Flexible Calibration

Figure 3-7 shows a three-port device consisting of a one-port resonator/antenna and a two-port, sub-DUT. If leakage is not of interest, you would really want to measure only five parameters instead of nine. The idea is to avoid measuring more than is needed.

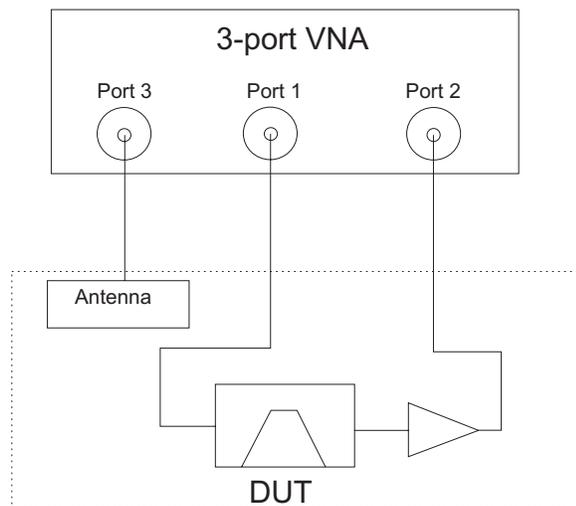


Figure 3-7. Three-Port VNA Measuring a Three-Port Device

The three-port DUT has an integrated antenna, to be treated as a single port, and an amplifier path, to be treated as a separate two-port device. The following will illustrate that in partially connected DUTs, such as this, there is no accuracy penalty in using the Flexible Calibration mode.

A full three-port calibration and measurements over the 700 MHz to 1000 MHz frequency range were performed. Both the full three-port calibration results and the Flexible Calibration results, defined as CUSTOM CAL with the S11, S12, S21, S22, and S33 parameters enabled, are compared on an overlay in Figure 3-8 below.

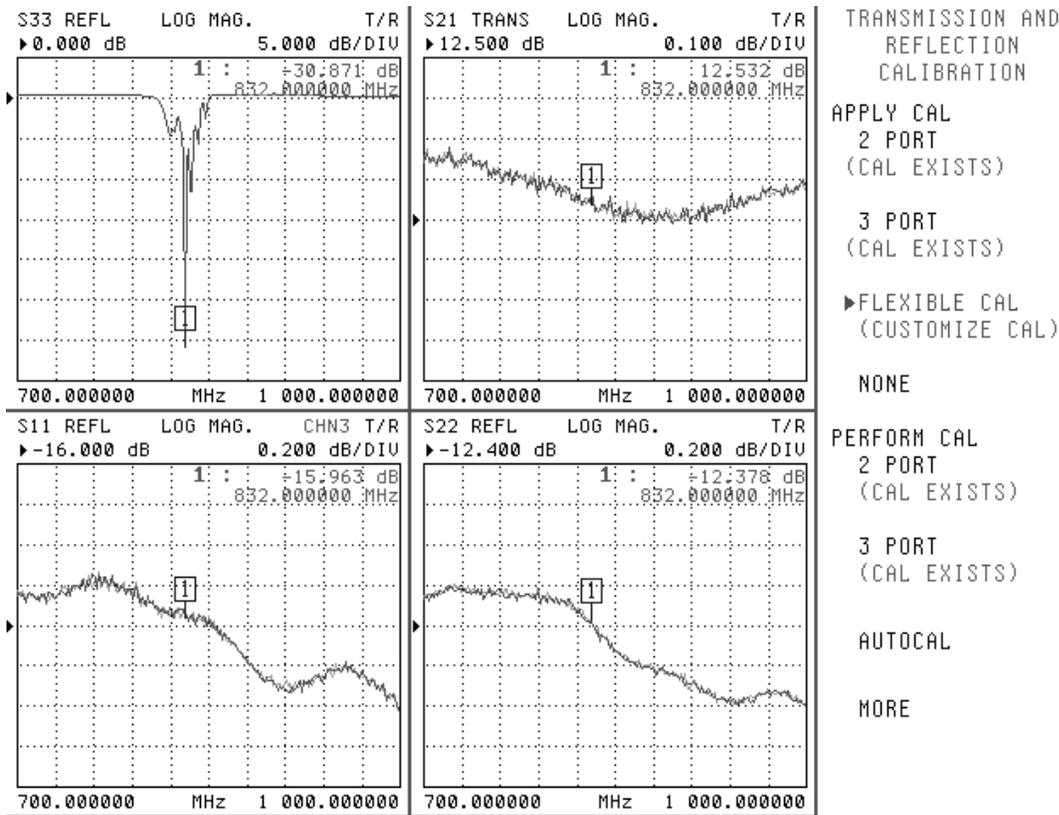


Figure 3-8. Example Comparing Flexible Calibration Results with Full Three-Port Calibration Results

The light trace is the full three-port calibration result while the dark trace uses the Flexible Calibration method. Aside from some minor differences due to trace noise (measurement done with a very wide IFBW with no averaging), the traces overlay completely. As expected there is no difference, but only five parameters were measured per cycle instead of nine. This method works for partially connected DUTs, such as those discussed previously.

Other application notes (e.g., *Three and Four Port S-parameter Measurements*, 11410-00279) or Anritsu customer service can be consulted for more information on the various types of calibrations possible.

**3-13 ACCURACY
ENHANCEMENT**

Standard Feature

***Flat Test Port Power
Calibration***

NOTE

If a network or cables are placed between Port x and the power sensor, the instrument will adjust the source power level to obtain the desired output power at the sensor input. Keep in mind that if the network is lossy, the source may not be able to achieve the leveled power desired at the sensor input resulting in ALC LVLD FAIL errors. The maximum leveled source output is typically +7 dBm.

While the MS462XX VNMS is a highly accurate measurement platform, there are calibration procedures which can be performed to further enhance the accuracy of the system. These strategies are detailed in this section.

This calibration is performed with a power meter connected to the dedicated GPIB bus of MS462XX. The power sensor is then connected to the appropriate test port and the measurement process can begin.

1. Press the Power front panel key
2. Select which source (source 1 or source 2) to perform the calibration with.

SOURCE 1 SETUP

3. Set the selected source to the desired power level.

SOURCE 1 POWER = 0 dBm

4. Select the flat test port power calibration

FLAT TEST PORT POWER CAL

5. Ensure that the power meter is calibrated and zeroed. Supported power meters include the Anritsu 2430A Series, the HP 437 and HP 438, and the Gigatronics Model 8540.
6. Connect the power sensor to the test port.
7. Select the number of power points to be measured. For best results, one power point should be measured per sweep point, otherwise interpolation will occur and accuracy will be reduced.

MEASURE 1 POWER POINT EVERY 1 POINT(S)

8. Enter the target source power. For best results, the target source power should be equal to the source power set previously.

POWER TARGET = 0 dBm

BEGIN CAL

9. Wait until the process is complete. This measurement may take a few minutes, especially with older power meters which are slower in the acquisition process.

10. Save the Calibration if desired.

This completes the flat test port power calibration.

Receiver Calibration

In order for the MS462XX to measure absolute power, a receiver calibration is necessary. If this step is performed following a flat test port power calibration, then the accuracy of the source is essentially being transferred to the receiver. This calibration is applicable to intermodulation distortion (IMD) and harmonics applications in standard and mixer device types.

To perform a receiver calibration:

11. Select the frequency range of interest by pressing the Freq front panel key.

START = 10 MHz

STOP = 6 GHz

12. Select the number of points by pressing the Config front panel key

DATA POINTS

POINTS

13. Press the Power front panel key.

RECEIVER CAL

RECEIVER CAL

14. Select the receiver port.

RECEIVER PORT = PORT 2

15. Select the source port.

SOURCE PORT = PORT 1

16. Connect a throughline between port 1 and port 2.

BEGIN CAL

This completes the receiver calibration procedure.

NOTE

Performing the receiver cal over the full frequency range allows one cal to satisfy many different frequency ranges without the need for multiple calibrations.

Chapter 4

Applications

4-1 INTRODUCTION

The MS462XX organizes measurement capabilities into applications accessible from the applications key (AppI) on the front panel of the system. This measurement organization allows for straightforward and intuitive measurement operation and a convenient method for switching between different measurement applications.

Following the application setup, it is best to perform a calibration to remove system errors before proceeding with actual measurements.

This chapter contains discussions, examples, and procedures related to the following applications:

- ❑ Noise Figure
- ❑ Intermodulation Distortion (IMD)
- ❑ Harmonic
- ❑ Swept Power Gain Compression (SPGC)
- ❑ Swept Frequency Gain Compression (SFGC)
- ❑ Time Domain
- ❑ Mixer Measurements
- ❑ Frequency Translated Group Delay
- ❑ Power Sweep

Each application discussion shows a typical measurement result. The procedures document the steps used to achieve this typical measurement result.

Once a typical measurement is mastered, explore the different measurement configurations for each application to become familiar with each application's powerful capabilities.

4-2 NOISE FIGURE

Option 4X:
50 MHz to 3 GHz
50 MHz to 6 GHz

This section contains information on three typical noise figure measurements, all performed on the same device under test (DUT). This approach allows for direct comparisons of measurement results. The procedures are presented so that each measurement builds on the setup of the previous measurement. The four sections are:

- ❑ External Scalar Noise Figure
- ❑ Internal Scalar Noise Figure
- ❑ Vector Error-Corrected Noise Figure
- ❑ External Attenuators and Networks

The External Scalar Noise Figure measurement produces noise figure values that can be used for comparisons to other approaches.

The Internal Scalar Noise Figure measurement is similar to the External Scalar Noise Figure measurement, but the noise source is connected to the rear panel of the MS462XX. These noise figure values will generally correspond to the External Scalar measurement; however, matching difference in the path between the noise source and the DUT can cause substantial differences.

The Vector Error-Corrected Noise Figure measurement combines the S-parameter and Noise Figure measurements to compensate for mismatching effects in the measurement.

The Internal measurement capability of the MS462XX allows switching between noise figure and other measurement applications, allowing more measurements to be made with fewer connections.

The External Attenuators and Networks section overviews the correction mechanisms to minimize error when using adapters, cables, or other networks between the noise source and the DUT.

For more information on noise figure measurements, refer to the following Anritsu Application Notes:

- ❑ Noise Figure (Anritsu part number: 11410-00210)
- ❑ Noise Figure Accuracy (Anritsu part number: 11410-00227)
- ❑ Noise Figure Corrections (Anritsu part number: 11410-00256)

**External Scalar
Noise Figure**

The following display shows a typical External Scalar Noise Figure measurement.

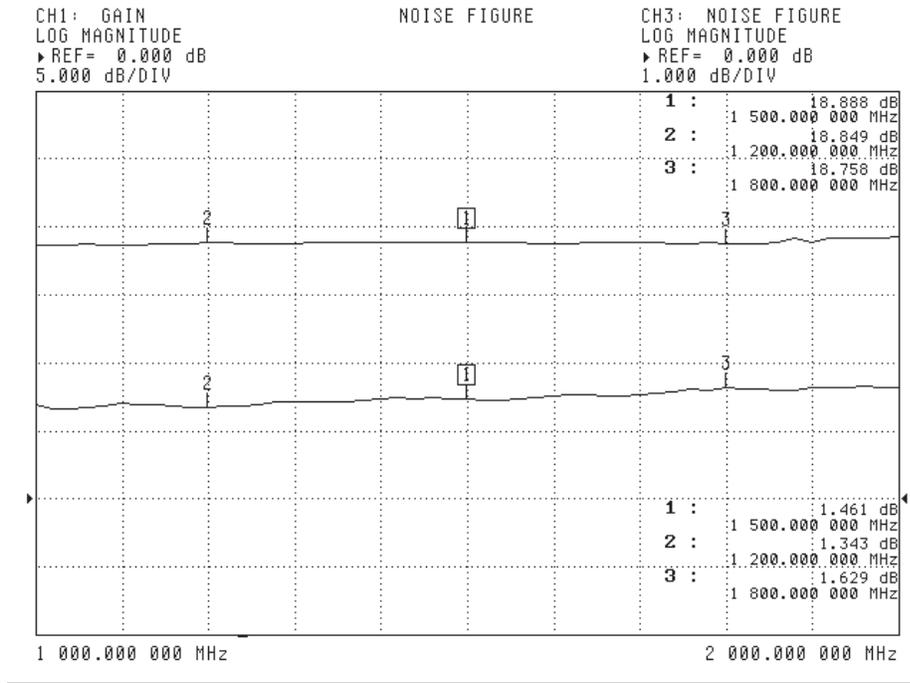


Figure 4-1. External Scalar Noise Figure Example Display

The following procedure outlines a typical External Scalar Noise Figure measurement.

1. Press the Appl front panel key.
2. Select the menu soft keys as follows:

NOTE

Noise Figure measurements are only available between 50 MHz and 6 GHz.

CHANGE APPLICATION SETUP
 ENTRY STATE: CURRENT
 MEASUREMENT TYPE/NOISE FIGURE

NOTE

Select DUT BANDWIDTH = NARROW for noise figure measurements of band limited devices. The WIDE selection provides faster measurements of broadband devices than the NARROW selection.

NOTE

Refer to Section 7-9 for information on formatting the noise source ENR values into a file and copying the file to the hard disk.

NOTE

The default noise figure average of 40 provides measurement speed and reasonable stability. Increasing the noise figure averaging provides more stable measurements, but decreases the measurement speed.

- Specify the DUT Bandwidth for the noise figure measurement.

DUT BANDWIDTH = WIDE

- Indicate the location of the noise source for the measurement.

NOISE FIGURE SETUP
NOISE SOURCE = EXTERNAL

- Load the appropriate noise source ENR values.

ENR TABLE OPERATION
LOAD ENR TABLE
FROM HARD DISK/VENDOR ENR TABLE

- Select the ENR file to read.

- Prepare the MS462XX for calibration.

Freq/START = 1 GHz
Freq/STOP = 2 GHz
Config/DATA POINTS = 51 MAX PTS

The following table shows some typical noise figure measurement sweep times for noise figure averaging = 40.

Data Points	Typical Sweep Time
101	3 minutes, 35 seconds
51	1 minute, 49 seconds
15	32 seconds
3	6.4 seconds
1	2.1 seconds

Avg/NOISE FIGURE AVERAGE = 40
NOISE FIGURE AVERAGE = ON

- Connect a through line between the noise source and Port 2 of the MS462XX.

Cal/PERFORM NOISE FIGURE ONLY
MEASURE DEVICE(S)

The MS462XX proceeds with the calibration.

EXIT

- Connect the DUT between the noise source and Port 2 of the MS462XX.

NOTE
OVERLAY DUAL CHANNELS requires that both channels have the same Graph Type.

10. Configure the 4-Channel display for the desired results.

Ch 1

Display/GRAPH TYPE/LOG MAGNITUDE

Appl//DISPLAY SELECTIONS/INSERTION GAIN

Ch 3

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/DISPLAY SELECTIONS/NOISE FIGURE

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

11. Adjust the scales for each channel display.

Ch 1

Display/SCALE

RESOLUTION = 5 dB/DIV

REFERENCE LINE = 2

Ch 3

Display/SCALE

RESOLUTION = 1 dB/DIV

REFERENCE LINE = 2

This completes the procedure for performing the External Scalar Noise Figure measurement using the MS462XX.

**Internal Scalar
Noise Figure**

The following display shows a typical Internal Scalar Noise Figure measurement for the same frequency range and data points as the previous external measurement. Note that these results are similar to the previous results. These noise figure values will generally correspond to the External Scalar measurement; however, a matching difference in the path between the noise source and the device under test (DUT) can cause substantial differences.

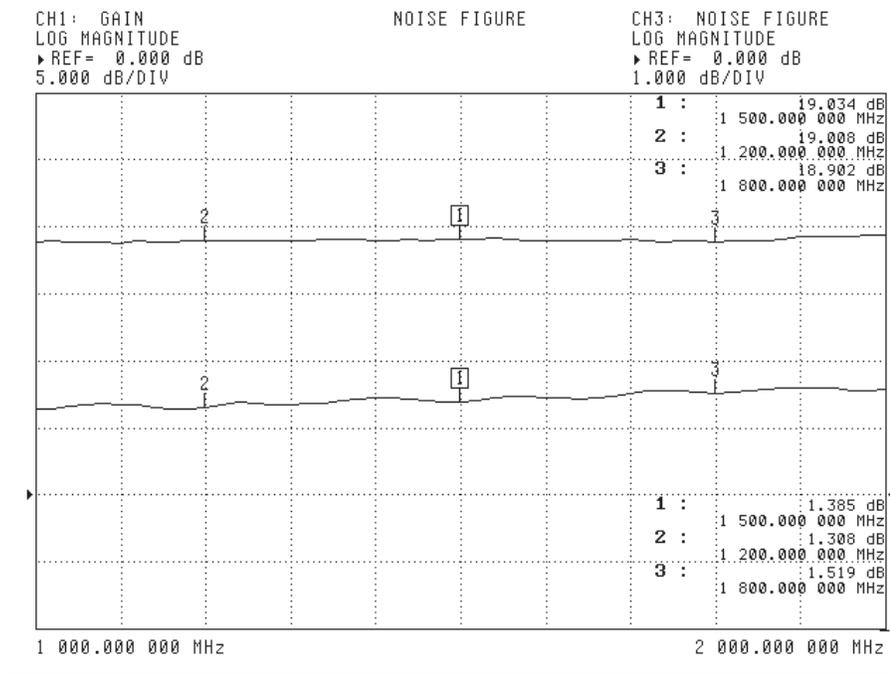


Figure 4-2. Internal Scalar Noise Figure Example Display



Figure 4-3. Internal Noise Source Configuration

NOTE

The internal ENR extension table is created at the factory by Anritsu and is installed on both the internal memory and the hard drive. Refer to Section 7-9 for information about creating a new ENR extension file and copying the file to the internal memory and hard disk.

1. Ensure that the noise source is connected to the rear panel of the MS462XX.

2. Indicate the location of the noise source for the measurement.

Appl/NOISE FIGURE SETUP

NOISE SOURCE = INTERNAL

3. Connect a through line between the noise source and Port 2 of the MS462XX. Note that the noise source for internal measurements is routed to Port 1. Proceed to calibrate for this configuration where the noise source location is internal.

Cal/PERFORM NOISE FIGURE ONLY

MEASURE DEVICE(S)

The MS462XX proceeds with the calibration.

EXIT

4. Connect the DUT between the noise source and Port 2 of the MS462XX.

Single Connection, Multiple Measurements

5. Switch between Noise Figure measurements and Transmission and Reflection measurements.

Appl/CHANGE APPLICATION SETUP

ENTRY STATE = PREVIOUS

MEASUREMENT TYPE/TRANSMISSION REFLECTION

Appl/CHANGE APPLICATION SETUP

MEASUREMENT TYPE/NOISE FIGURE

This completes the procedure for performing the Internal Scalar Noise Figure measurement using the MS462XX.

NOTE

Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next applications with the previous system settings. CURRENT uses the current system settings in the next applications.

Vector Error-Corrected Noise Figure

The following display shows a typical Vector Error-Corrected Noise Figure measurement for the same frequency range and data points as the previous measurements. The Vector Error-Corrected Noise Figure measurement combines the S-parameter and Noise Figure measurements to compensate for mismatching effects in the measurement.

The Vector Error-Corrected Noise Figure measurement requires a two-port calibration that dictates the frequency range and data points for this approach. Careful selection of system settings will help optimize both S-parameter and Noise Figure for both speed and accuracy.

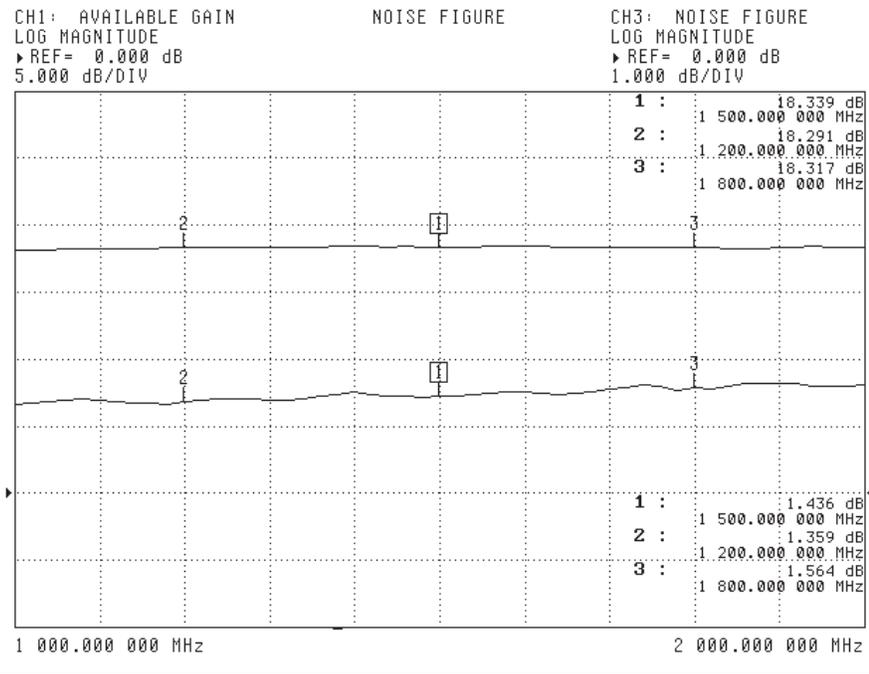


Figure 4-4. Vector Error-Corrected Noise Figure Example Display

The following procedure adds the two-port calibration to the previous Internal Scalar Noise Figure measurement. Performing the noise figure calibration with the 12-term calibration allows compensation for the mismatching effects in the measurement.

1. Switch from Noise Figure measurements to Transmission and Reflection measurements.

Appl/CHANGE APPLICATION SETUP
ENTRY STATE = CURRENT
MEASUREMENT TYPE/TRANSMISSION REFLECTION

2. Select Source Power to ensure S-parameter measurements are performed without compression.

Power/SOURCE 1 SETUP/SOURCE 1 POWER = -15 dBm

3. Perform a two-port calibration. Reference chapter 3 for calibrating the MS462XX.

4. Switch from Transmission and Reflection measurements to Noise Figure measurements.

Appl/CHANGE APPLICATION SETUP
ENTRY STATE = CURRENT
MEASUREMENT TYPE/NOISE FIGURE

5. Connect a through line between the noise source and Port 2 of the MS462XX. Note that the noise source for internal measurements is routed to Port 1. Proceed with calibration.

Cal/PERFORM NOISE FIGURE WITH 12-TERM
MEASURE DEVICE(S)

The MS462XX proceeds with the calibration.

EXIT

6. Connect the DUT between the noise source (Port 1) and Port 2 of the MS462XX.

7. Configure the 4-Channel display for the desired results.

Ch 1
Appl/DISPLAY SELECTIONS/AVAILABLE GAIN

<p>NOTE</p>

<p>This ENTRY STATE selection configures the Noise Figure application with the current settings (i.e., Frequency, Data Points, Source Power, Display Selections, etc.).</p>

The following display shows the difference between Insertion Gain and Available Gain for this measurement.

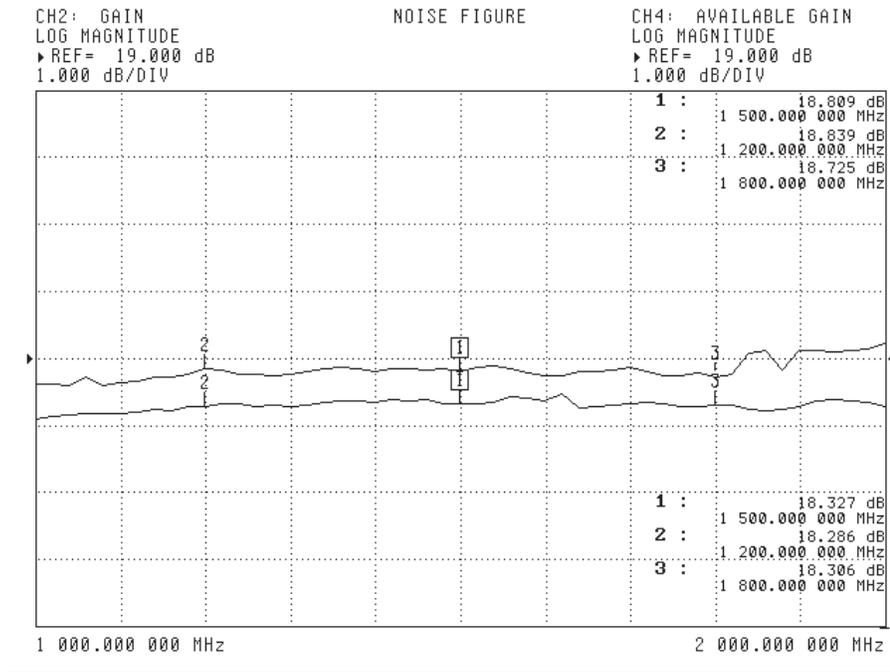


Figure 4-5. Insertion Gain vs. Available Gain Example Display

8. Configure channels 2 & 4 for this measurement

- Display/DISPLAY MODE/FOUR CHANNELS
- Ch 2
- Display/GRAPH TYPE/LOG MAGNITUDE
- Appl/DISPLAY SELECTION/INSERTION GAIN
- Ch 4
- Display/GRAPH TYPE/LOG MAGNITUDE
- Appl/DISPLAY SELECTION/AVAILABLE GAIN
- Display/DISPLAY MODE/ OVERLAY DUAL CHANNELS 2 & 4

9. Adjust the scales for each channel display.

Ch 2

Display/SCALE

RESOLUTION = 1 dB/DIV

REFERENCE VALUE = 19 dB

REFERENCE LINE = 4

Ch 4

Display/SCALE

RESOLUTION = 1 dB/DIV

REFERENCE VALUE = 19 dB

REFERENCE LINE = 4

This completes the procedure for performing the Vector Error-Corrected Noise Figure measurement using the MS462XX.

External Attenuators and Networks

Whenever an adapter, cable, or network is placed between the noise source and the DUT, a possible error in the resulting noise figure measurement can be introduced. While the possible error is small, when the utmost accuracy is desired, the following correction mechanisms can be implemented to minimize error.

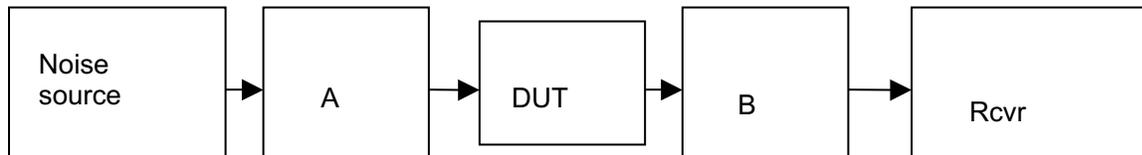


Figure 4-6. Loss Before DUT Schematic

NOTES

The internal ENR extension table is created at the factory by Anritsu and is installed on both the internal memory and the hard drive. Refer to Section 7-9 for information about creating a new ENR extension file and copying the file to the internal memory and hard disk.

Loss before DUT is used to correct the ENR for any losses between the ENR reference plane and the DUT plane. If those losses are present during the calibration, then the loss should be entered before the cal is performed. If the lossy network is not present during the cal, then a value of 0 dB should be entered until after the cal is done. Only enter a value for loss before the DUT when the lossy network is present in the measurement path.

Loss Before the DUT

If a network (attenuator) is placed between Port 1 and the input of the DUT, the contribution to ENR reduction can be entered in the noise figure setup menu. This method should only be used for networks which have flat frequency response (loss is constant over frequency). Figure 4-6 shows the network attenuator represented in general as A. Use the following procedure to insert the loss before the DUT.

10. Select the noise figure setup menu:

Appl/NOISE FIGURE SETUP

11. Select the ENR Table Operation menu and select the ENR Table for the noise diode being used.

ENR TABLE OPERATION/LOAD ENR TABLE
FROM HARD DISK/VENDOR ENR TABLE

12. For scalar, internal and vector corrected measurements, press the Application front panel key to return to the main NF menu:

Appl

13. Select the insertion loss before DUT option:

INSERT LOSS BEFORE THE DUT

14. Enter the loss of the input network and perform the noise figure calibration as usual.

Loss After the DUT

When a device has very high gain, the receiver may saturate during the measurement. This typically is a concern when measuring a device with >20 to 25 dB of gain with a 15 dB ENR noise diode. To prevent this, place attenuators after the DUT to reduce the power to manageable levels, as represented by B in Figure 4-7.

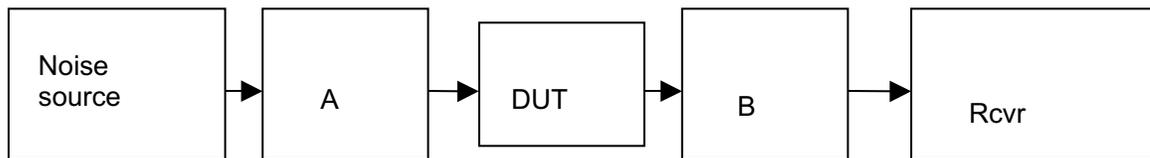


Figure 4-7. Loss After DUT Schematic

NOTES

Only use this setting when adding attenuation AFTER performing the noise figure calibration. If the instrument was calibrated with the attenuation in the path, then leave this setting zeroed out, as the instrument will already be compensating for the loss.

The internal ENR extension table is created at the factory by Anritsu and is installed on both the internal memory and the hard drive. Refer to Section 7-9 for information about creating a new ENR extension file and copying the file to the internal memory and hard disk.

1. Select the noise figure setup menu:

Appl/NOISE FIGURE SETUP

2. Select the ENR Table Operation menu and select the ENR Table for the noise diode being used.

ENR TABLE OPERATION/LOAD ENR TABLE
FROM HARD DISK/VENDOR ENR TABLE

3. For scalar, internal and vector corrected measurements, press the Application front panel key to return to the main NF menu:

Appl

4. Select the insertion loss after DUT option:

INSERT LOSS AFTER THE DUT

5. Enter the loss of the output network and perform the noise figure calibration as usual.

External Extension Files (Internal and Vector Measurements only)

When the network ahead of the DUT does not have a flat frequency response, the two-port S-parameters of the network can be measured, and the MS462XX can compute the correction file for the path from the rear panel of the instrument all the way to the DUT input connector. This method takes the factory generated .EXT file for the path within the instrument and concatenates it with a user generated .S2P file for the network between the port 1 connector and the DUT input connector. This is represented as A in Figure 4-8.

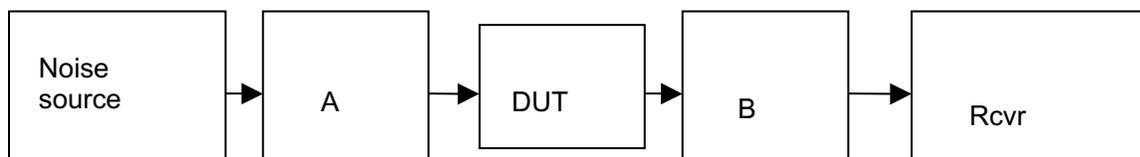


Figure 4-8. External Extension Files Schematic

Use the following procedure to make this type of measurement.

1. Select the noise figure setup menu:
 Appl/NOISE FIGURE SETUP
2. Select the ENR Table Operation menu and select the ENR Table for the noise diode being used.
 ENR TABLE OPERATION/LOAD ENR TABLE
 FROM HARD DISK/VENDOR ENR TABLE
3. Go to the external ENR extension table menu
 EXTERNAL ENR EXTENSION TABLE

NOTE

The internal ENR extension table is created at the factory by Anritsu and is installed on both the internal memory and the hard drive. Refer to Section 7-9 for information about creating a new ENR extension file and copying the file to the internal memory and hard disk.

6. Select the .NFX file for the characterization of the network between port 1 and the DUT. The .NFX file is a user created .S2P file renamed with the file extension .NFX.

Return

7. Enable the external ENR correction table:

EXTERNAL ENR EXTENSION TABLE

8. Return to the main NF menu:

Appl

9. Perform the noise figure calibration as usual.

Notes on creating an .NFX file:

The .NFX file which characterizes the network between the port 1 connector and the DUT input connector is a user generated .S2P file of the four S-parameters for the user inserted network. When creating this file, try to keep the frequency range consistent with the NF capabilities of the instrument, although the instrument will interpolate / extrapolate as necessary.

1. Perform a careful calibration and measure the S-parameters of your network
2. Use the frequency range from 50 MHz to 3 GHz with 101 points.
3. Create the .S2P file

HARD COPY
OUTPUT DEVICE = DISK FILE
OUTPUT SETUP
FORMAT = S2P

4. Press the Print front panel key to capture the output.
5. Rename the filename extension from *.S2P to *.NFX. This can be done using Windows Explorer or any other utility.
6. Copy the .NFX file back to the MS462XX.

NOTE

This will activate the user generated .NFX file. If this is not enabled, the results will be inaccurate, as the correction file will not be applied.

NOTE

The extension files are also used to correct for losses between the noise source and the DUT but with a higher level of accuracy. As with the LBD, if the network causing the loss is present during the cal, that extension file must be activated for the cal. If doing internal measurements, the internal extension file is automatically activated. The user manually activates the external extension file when appropriate.

Viewing Excess Noise Ratio (ENR) Tables

Excess noise ratio tables are unique for each noise diode and must be selected to match the diode in use for the noise figure measurement. The view ENR table function may be used to verify that the correct table is loaded, and that the table is free of errors.

- ENR TABLE -		DISPLAY ENR TABLE
FREQUENCY (GHz)	ENR (dB)	
0.0100	15.9800	▶FIRST PAGE
0.1000	15.8100	
1.0000	15.6200	PREVIOUS PAGE
2.0000	15.4900	
3.0000	15.4000	NEXT PAGE
4.0000	15.1500	
5.0000	14.8900	
6.0000	15.2000	
7.0000	14.9700	
8.0000	14.9300	
9.0000	14.6500	
10.0000	15.5400	
11.0000	14.9900	
12.0000	15.3900	
13.0000	15.5800	
14.0000	15.2200	
15.0000	14.8300	
16.0000	14.7300	
17.0000	14.7900	RETURN

PAGE 1 OF 1

PAGING: <0> FIRST, <1> PREVIOUS, <2> NEXT, <3> LAST

Figure 4-9. Excess Noise Ratio (ENR) Table

1. Select the noise figure setup menu:
 Appl/NOISE FIGURE SETUP
2. Select the ENR Table Operation menu and select DISPLAY ENR Table.
 ENR TABLE OPERATION/ DISPLAY ENR TABLE

NOTE

The displayed ENR table will be the one currently loaded into memory. This is the table which will be used during the noise figure measurement.

4-3 INTERMODULATION DISTORTION

Option 13

This section contains three typical intermodulation distortion (IMD) measurements, all performed on the same device under test (DUT). This approach allows for direct comparisons of measurement results. The procedures are presented so that each measurement builds on the setup of the previous measurement. The three measurements that can be done for third, fifth, seventh, and ninth order IMD are:

- ❑ Two-Tone IMD Products
- ❑ Swept Two-Tone IMD Products
- ❑ Swept Two-Tone Third Order Intercept (TOI)

These three measurements are typically performed using two synthesizers and a spectrum analyzer. The typical Two-Tone IMD Products measurement is a CW-type measurement in which two CW tones are combined and applied to the input of the DUT. The non-linear characteristics of the DUT generate the IMD products. The relative magnitude of the IMD products to the two tones defines the IMD distortion.

The MS462XX provides a more powerful measurement capability by sweeping the two tones while maintaining the offset between the two tones. The results displayed versus frequency provide more useful data regarding the IMD performance of the DUT.

A swept two-tone IMD Products measurement performs this CW-type measurement within a frequency range and displays the results as IMD products versus frequency.

A swept two-tone n -order intercept measurement performs the swept IMD Products measurement and displays the calculated intercept versus frequency.

For more information, refer to the Anritsu Intermodulation Distortion (IMD) Application Note (Anritsu part number 11410-00213).

NOTE

Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next application with the previous system settings. CURRENT uses the current system settings.

2. Press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
ENTRY STATE = CURRENT
MEASUREMENT TYPE/IMD

3. Configure the display for the Two-Tone IMD Products measurement.

Ch 1
Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE

4. Specify the frequency range and data points for the IMD measurements.

Appl/SWEEP MODE = SOURCE
IMD ORDER = 3
Freq/C.W. MODE = OFF
START = 1 GHz
STOP = 2 GHz
Config/DATA POINTS/51 MAX PTS

5. Perform a Receiver Cal for Port 2. Connect a through line between Port 1 and Port 2, including any attenuation that follows the DUT. This calibration gives the MS462XX the ability to measure absolute power in dBm.

Cal/PERFORM CAL/RECEIVER CAL
BEGIN CAL

The MS462XX proceeds with the calibration.

EXIT
Cal/APPLY CAL: RECEIVER CAL FOR PORT 2 = ON

6. Connect the combining network between the two sources (Port 1 and Port 3) on the front panel of the MS462XX.

7. Configure the MS462XX for the Two-Tone IMD Products measurement

Appl/SWEEP MODE = CW RCVR

8. Specify the CW Frequency for Tone 1.

Freq/C.W. MODE = 1.5 GHz

9. Specify the CW Frequency for Tone 2 by selecting an offset from Tone 1.

Appl/TONE 2 OFFSET = 1.01 MHz

10. Connect the DUT between the combining network and Port 2 of the MS462XX.

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

11. Specify the I.F. Bandwidth for the measurement. A selection of 10 Hz provides maximum dynamic range.

Avg/SELECT I.F. BANDWIDTH/I.F. BW 10 Hz

12. Adjust the Scale of the display for the measurement.

Display/SCALE
 RESOLUTION = 15 dB/DIV
 REFERENCE VALUE = 0 dB
 REFERENCE LINE = 7

13. Adjust Source 1 Power for +5 dBm at the output of the DUT.

Power/SOURCE 1 SETUP
 SOURCE 1 POWER = -5.5 dBm
 RETURN

14. Adjust Source 2 Power for +5 dBm at the output of the DUT.

Power/SOURCE 2 SETUP
 SOURCE 1 POWER = -5.5 dBm
 RETURN

For IMD orders equal to 5, 7, and 9, follow the above procedure choosing the higher appropriate IMD order in Step 4. The following figures present examples of higher order IMD measurements.

This completes the procedure for performing a Two-Tone IMD Products measurement using the MS462XX.

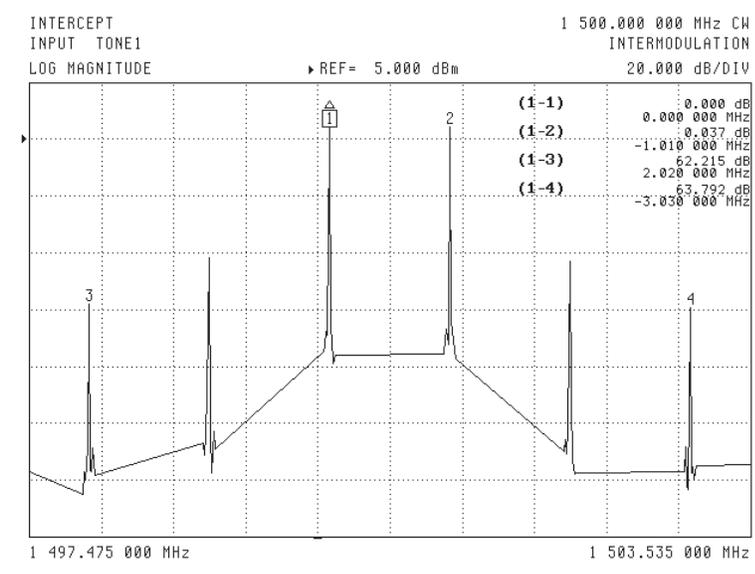


Figure 4-12. Two-Tone Fifth Order IMD Products Example Display

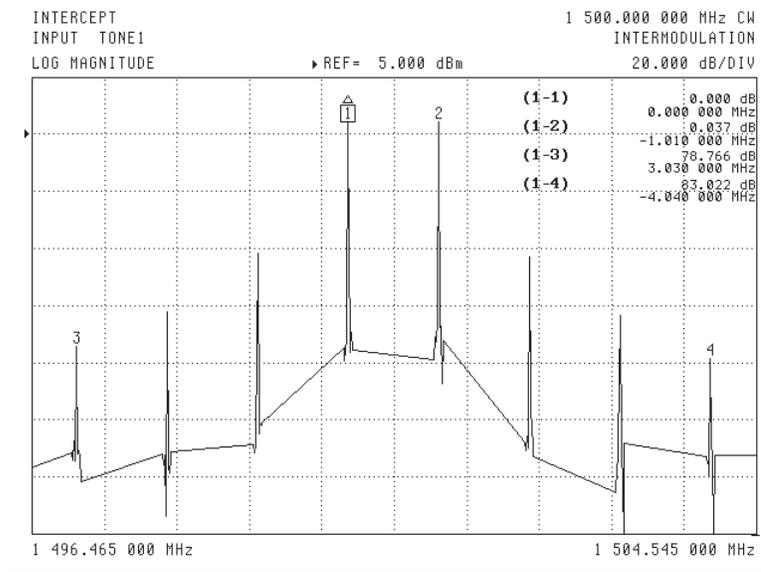


Figure 4-13. Two-Tone Seventh Order IMD Products Example Display

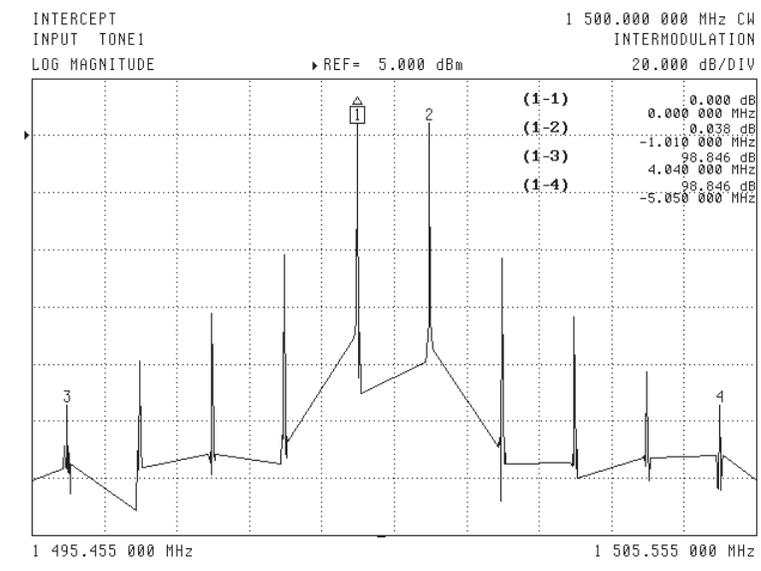


Figure 4-14. Two-Tone Ninth Order IMD Products Example Display

Swept Two-Tone IMD Products

The following display shows a typical Swept Two-Tone IMD Products measurement. A Swept Two-Tone IMD Products measurement performs the previous CW-type measurement within a frequency range and displays the results as IMD products versus frequency. This measurement shows the third order IMD Products for two output tones at +5 dBm. Example displays of higher order IMD products follow this procedure.

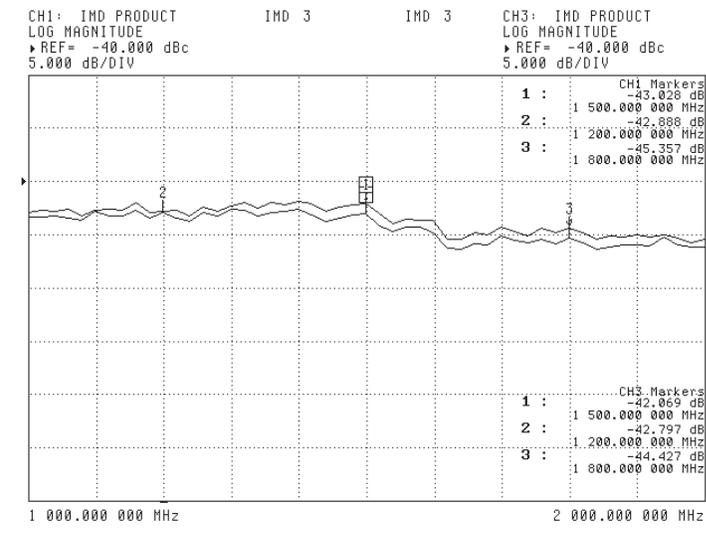


Figure 4-15. Swept Two-Tone Third Order IMD Products Example Display

1. Specify the frequency range and data points for the IMD measurements.

Appl/SWEEP MODE = SOURCE
 Freq/C.W. MODE = OFF
 START = 1 GHz
 STOP = 2 GHz
 Config/DATA POINTS/51 MAX PTS

2. Perform an IMD Cal. Connect a through line between the combining network and Port 2, including any attenuation that follows the DUT.

Cal/PERFORM CAL/IMD CAL
 Avg/SELECT I.F. BANDWIDTH/I.F. BW 100 Hz
 MEASURE DEVICE(S)

The MS462XX proceeds with the IMD calibration.

EXIT

3. Connect the DUT between the combining network and Port 2 of the MS462XX.

NOTE
 An IMD Cal allows input referred measurements. The source power should not be adjusted following an IMD Cal.

4. Configure the 4-channel display for the Swept Two-Tone Third Order IMD Products measurement.

Appl/IMD ORDER = 3

Ch 1

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/DISPLAY SELECTION

THIRD ORDER INTERMODULATION = PRODUCT

MEASURE RELATIVE TO = TONE 1 (UPPER PRODUCT)

MEAS. REFERENCE = OUTPUT

RETURN

Ch 3

Appl/IMD ORDER = 3

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/DISPLAY SELECTION

THIRD ORDER INTERMODULATION = PRODUCT

MEASURE RELATIVE TO = TONE 2 (LOWER PRODUCT)

MEAS. REFERENCE = OUTPUT

RETURN

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

5. Adjust the scales for the displays.

Ch 1

Display/SCALE

RESOLUTION = 1.0 dB/DIV

REFERENCE VALUE = - 40 dBc

REFERENCE LINE = 7

Ch 3

Display/SCALE

RESOLUTION = 1.0 dB/DIV

REFERENCE VALUE = - 40 dBc

REFERENCE LINE = 7

6. For higher order IMD products, select:

Appl/IMD ORDER = (5, 7, or 9)

NOTE

An Overlay Dual Channels display allows viewing of both upper and lower IMD products.

This completes the procedure for performing a Swept Two-Tone IMD Products measurement using the MS462XX.

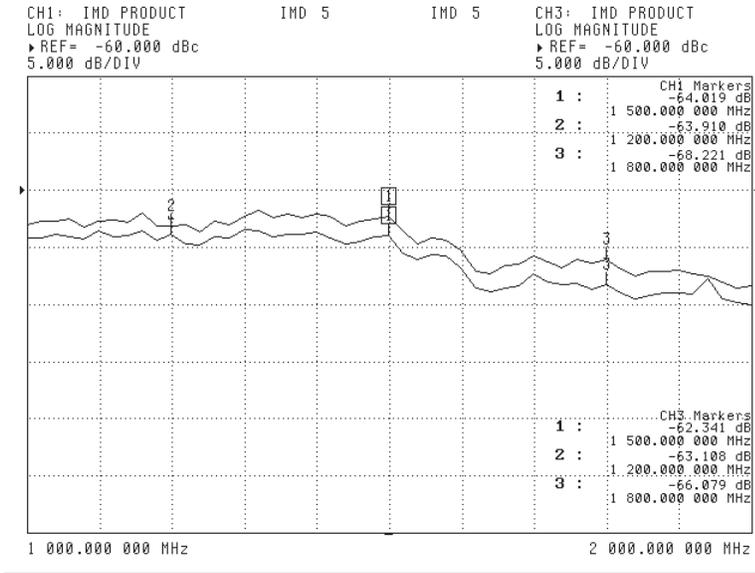


Figure 4-16. Swept Two-Tone Fifth Order IMD Products Example Display

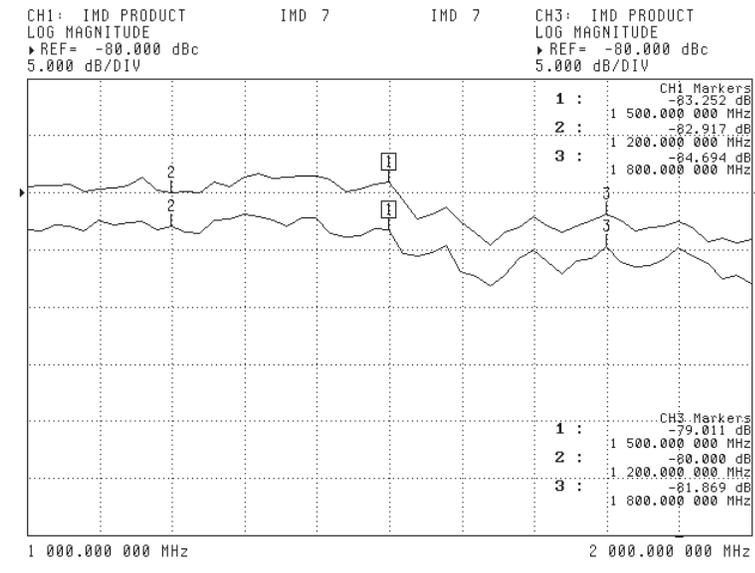


Figure 4-17. Swept Two-Tone Seventh Order IMD Products Example Display

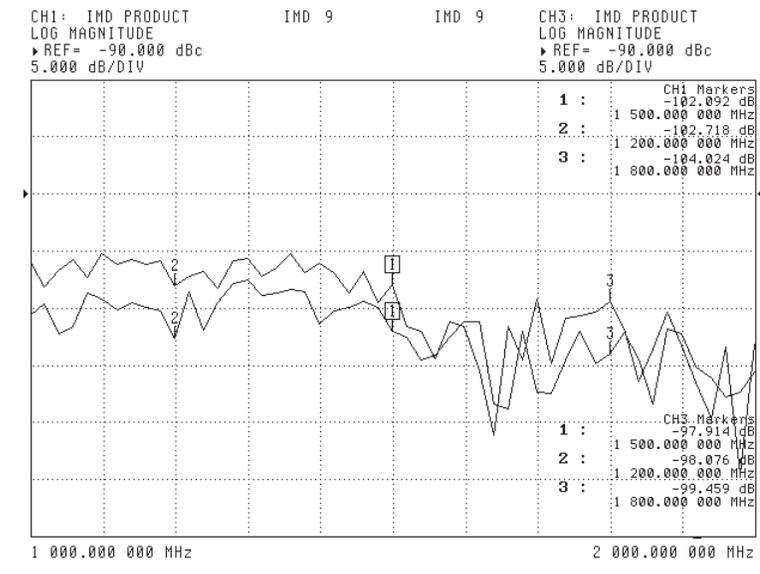


Figure 4-18. Swept Two-Tone Ninth Order IMD Products Example Display

Swept Two-Tone Intercept

A Swept Two-Tone Intercept measurement performs the swept IMD Products measurement and displays the calculated intercept versus frequency. The following display shows a typical Swept third order intercept (TOI) measurement. This measurement shows the TOI calculations for the two output tones at 5 dBm of the previous measurement. Similar calculations can be done for fifth, seventh, and ninth order intercepts. Example displays of higher order intercepts follow.

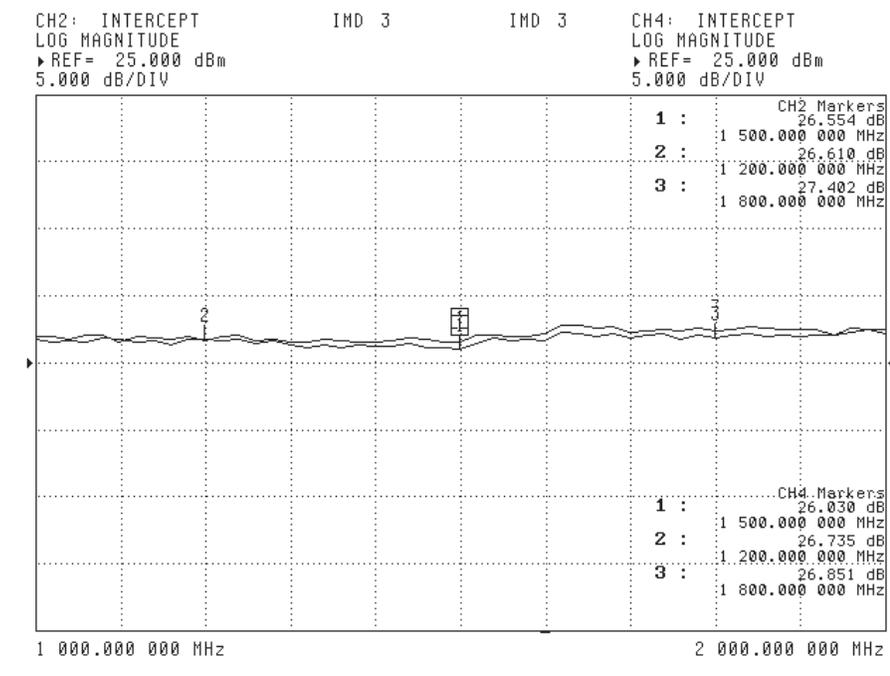


Figure 4-19. Swept Two-Tone Third Order Intercept Example Display

- Configure the 4-channel display for the Swept Two-Tone IMD Products measurement.

NOTE

The output TOI is calculated as:

$$\frac{3P_{TONE2} - P_{LOWER\ IMD}}{2}$$

or

$$\frac{3P_{TONE1} - P_{UPPER\ IMD}}{2}$$

where the tone powers are in dBm.

- Display/DISPLAY MODE/FOUR CHANNELS
- Ch 2
- Display/GRAPH TYPE/LOG MAGNITUDE
- Appl/IMD ORDER = 3
- Appl/DISPLAY SELECTION
- THIRD ORDER INTERMODULATION = INTERCEPT
- MEASURE RELATIVE TO = TONE 1 (UPPER PRODUCT)
- MEAS. REFERENCE = OUTPUT
- RETURN
- Ch 4

NOTE

In general, the n th order intercept is calculated as:

$$\frac{nP_{\text{TONE2}} - P_{\text{LOWER IMD}}}{n - 1}$$

or

$$\frac{nP_{\text{TONE1}} - P_{\text{UPPER IMD}}}{n - 1}$$

NOTE

An Overlay Dual Channels display allows viewing of both upper and lower calculated TOI.

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/IMD ORDER = 3

Appl/DISPLAY SELECTION

THIRD ORDER INTERMODULATION = INTERCEPT

MEASURE RELATIVE TO = TONE 2 (LOWER PRODUCT)

MEAS. REFERENCE = OUTPUT

RETURN

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 2 & 4

8. Adjust the scales for the displays.

Ch 2

Display/SCALE

RESOLUTION = 5.0 dB/DIV

REFERENCE VALUE = 25 dB

REFERENCE LINE = 4

Ch 4

Display/SCALE

RESOLUTION = 5.0 dB/DIV

REFERENCE VALUE = 25 dB

REFERENCE LINE = 4

9. For higher order intercepts, select:

Appl/IMD ORDER = (5, 7, or 9)

This completes the procedure for performing a Swept Two-Tone TOI measurement using the MS462XX.

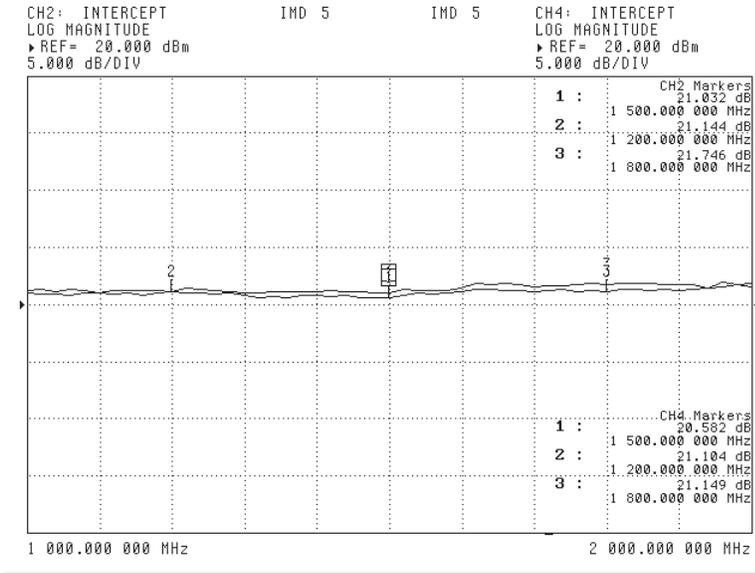


Figure 4-20. Swept Two-Tone Fifth Order Intercept Example Display

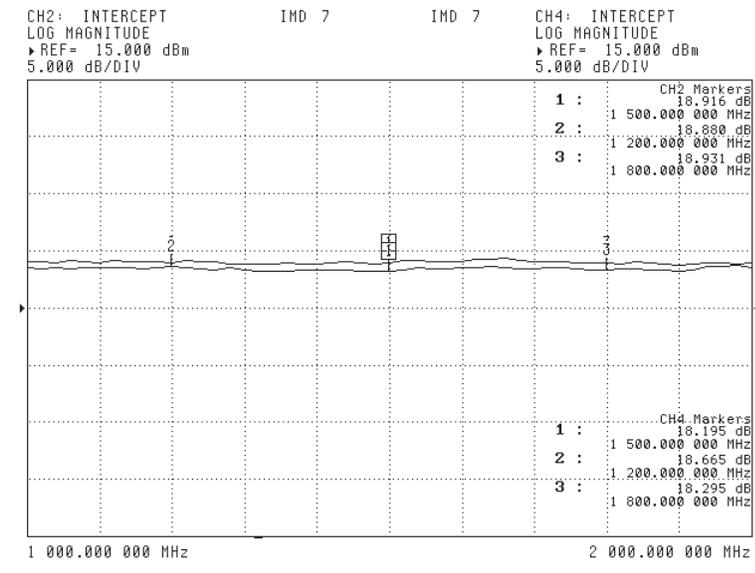


Figure 4-21. Swept Two-Tone Seventh Order Intercept Example Display

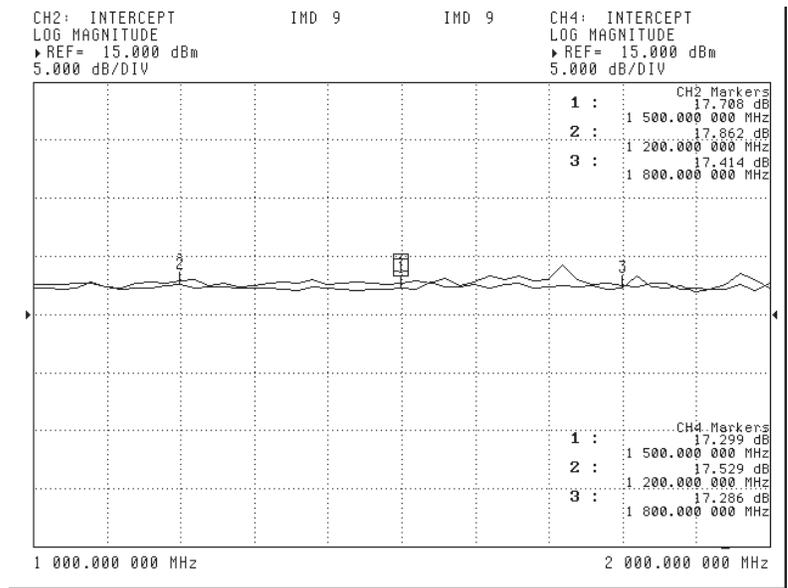


Figure 4-22. Swept Two-Tone Ninth Order Intercept Example Display

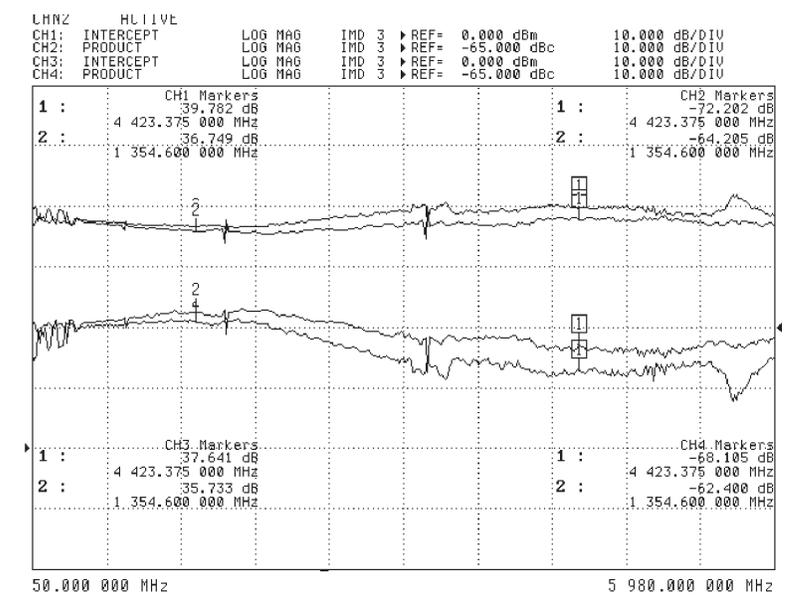


Figure 4-23. Upper and Lower Third Order IMD Products and Third Order Intercepts Example Display Using Four Channel Overlay Display Mode

4-4 HARMONICS

Option 8

This section contains four typical harmonic measurements, all performed on the same device under test (DUT). This approach allows for direct comparisons of measurement results. The procedures are presented so that each measurement builds on the setup of the previous measurement. The four measurements are:

- ❑ CW Scalar Harmonic
- ❑ Swept Scalar Harmonic
- ❑ Swept Vector Harmonic
- ❑ Swept Vector Harmonic Phase

These measurements are typically measured with a synthesizer and a spectrum analyzer. The CW Scalar Harmonic measurement produces comparable scalar results to that of a synthesizer and a spectrum analyzer. The Swept Scalar Harmonic provides a more comprehensive scalar harmonic performance versus frequency capability.

The Swept Vector Harmonic and the Swept Vector Harmonic Phase measurements provide a potentially more accurate, more integrated, and more flexible approach to measuring the DUT's harmonics using the MS462XX.

Vector Harmonic measurements remove the effects of the source harmonics in relatively linear measurements. In this way, Vector Harmonic measurements reveal more accurate harmonic measurements than the Scalar Harmonic measurements. This Vector Harmonic measurement capability is only available for the 2nd and 3rd harmonics.

For more information, refer to the Anritsu Harmonic Application Note (Anritsu part number 11410-00222).

CW Scalar Harmonic

The CW Scalar Harmonic measurement produces comparable scalar results to that of a synthesizer and a spectrum analyzer. The following display shows a typical CW Scalar Harmonic measurement. For this measurement, the MS462XX measures 9 data points in each area of interest until the 9th harmonic or until the Stop Frequency selection. Straight-line segments connect the data groups.

This measurement shows the harmonics for Source Power of -20 dBm applied to the DUT.

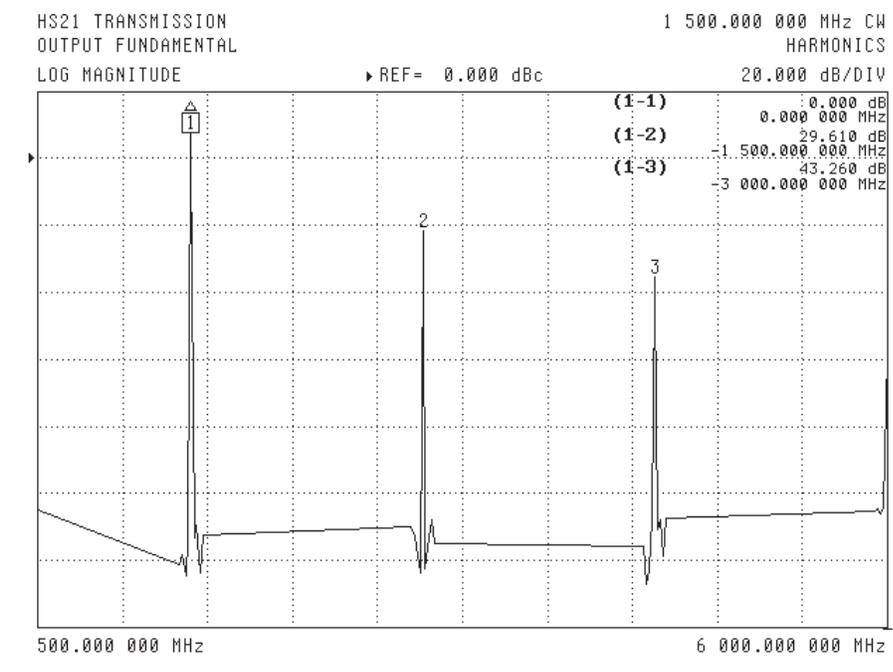


Figure 4-24. CW Scalar Harmonic Example Display

NOTE
Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next application with the previous settings. CURRENT uses the current system settings.

1. Press the Appl front panel key and select the menu soft keys as follows:
 CHANGE APPLICATION SETUP
 ENTRY STATE = CURRENT
 MEASUREMENT TYPE/HARMONIC
2. Configure the display for the CW Scalar Harmonic measurement.
 Ch 1
 Meas/S21
 Display/DISPLAY MODE/SINGLE CHANNEL
 Display/GRAPH TYPE/LOG MAGNITUDE

3. Specify the harmonic frequency range for the measurement.

Appl/SWEEP MODE = SOURCE
Freq/C.W. MODE = OFF
START = 500 MHz
STOP = 6 GHz
Config/DATA POINTS/201 MAX PTS

4. Perform a Receiver Cal for Port 2. Connect a through line between Port 1 and Port 2, including any attenuation that follows the DUT. This calibration gives the MS462XX the ability to measure absolute power in dBm.

Cal/RECEIVER SETUP/RECEIVER CAL
BEGIN CAL

The MS462XX proceeds with the calibration.

RETURN

5. Prepare the MS462XX for the CW Harmonic measurement by specifying the CW frequency to apply to the input of the DUT.

Appl/SWEEP MODE = CW RCVR
Freq/C.W. MODE = 1.5 GHz

6. Adjust Source 1 Power to -20 dBm (the desired level for input to the DUT).

Power/SOURCE 1 SETUP
SOURCE 1 POWER = 0 dBm
PORT 1 ATTN = 2

7. Connect the DUT between Port 1 and Port 2 of the MS462XX.

8. Specify the I.F. Bandwidth for the measurement. A selection of 10 Hz provides maximum dynamic range.

Avg/SELECT I.F. BANDWIDTH/I.F. BW 10 Hz

9. Adjust the Scale of the display for the measurement

Display/SCALE
RESOLUTION = 20 dB/DIV
REFERENCE VALUE = 0 dB
REFERENCE LINE = 7

This completes the procedure for performing the CW Scalar Harmonic measurement using the MS462XX.

Swept Scalar Harmonic

The following display shows a typical Swept Scalar Harmonic measurement. The Swept Scalar Harmonic measurement produces comparable scalar results to that of a synthesizer and a spectrum analyzer. The Swept Scalar Harmonic provides a more comprehensive scalar harmonic performance versus frequency capability.

This measurement also shows the harmonics for Source Power of -20 dBm.

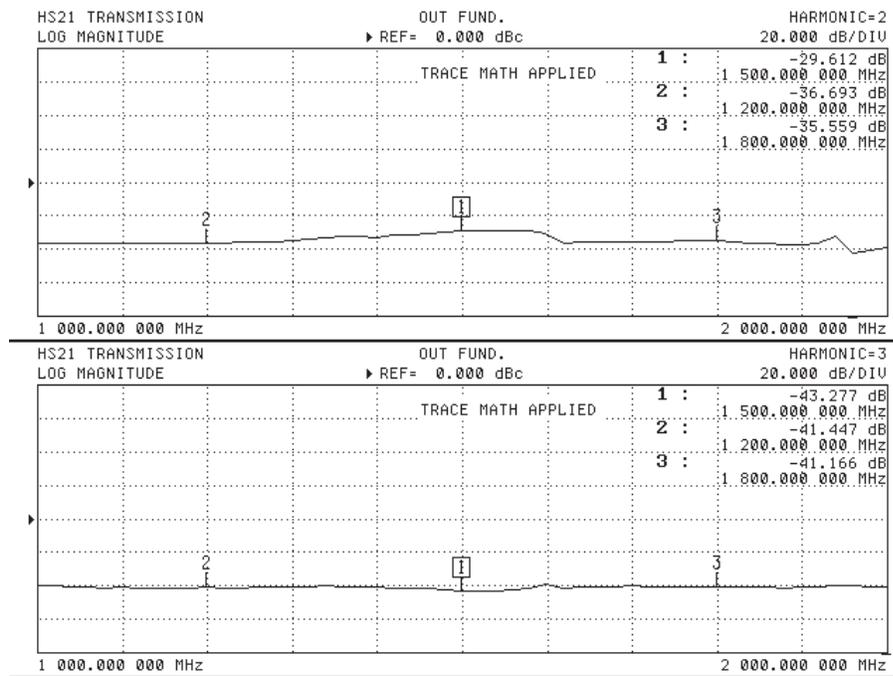


Figure 4-25. Swept Scalar Harmonic Example Display

1. Configure the 4-channel display to display the Swept Scalar Harmonic measurement for the 2nd and 3rd harmonic using Dual Channel display. Also adjust the Scale of Ch 3 to correspond to the Scale of Ch 1.

NOTE

The Dual Channels display mode allows simultaneous viewing of both the second and third harmonics.

Ch 3
 Meas/S21
 Display/GRAPH TYPE/LOG MAGNITUDE
 Display/DISPLAY MODE/DUAL CHANNELS 1 & 3
 Display/SCALE
 RESOLUTION = 20 dB/DIV
 REFERENCE VALUE = 0 dB
 REFERENCE LINE = 7

2. Change the measurement configuration to perform Swept Scalar Harmonic measurements.

Appl/SWEEP MODE = SOURCE
Freq/C.W. MODE = OFF
START = 1 GHz
STOP = 2 GHz
Config/DATA POINTS/51 MAX PTS

3. Use Trace Memory functions to show the difference between Harmonics (1 – 2) and between Harmonics (1 – 3). This process is required when performing Scalar measurements.

Ch 1
Appl/HARMONIC SETUP/HARMONIC = 1
Display/TRACE MEMORY/STORE DATA TO MEMORY
VIEW DATA (/) MEMORY
Appl/HARMONIC SETUP/HARMONIC = 2
Ch 3
Appl/HARMONIC SETUP/HARMONIC = 1
Display/TRACE MEMORY/STORE DATA TO MEMORY
VIEW DATA (/) MEMORY
Appl/HARMONIC SETUP/HARMONIC = 3

This completes the procedure for performing the Swept Scalar Harmonic measurement using the MS462XX.

Vector Harmonic Measurement Display Options

The following diagram shows the relationship between the vector harmonic output result formats.

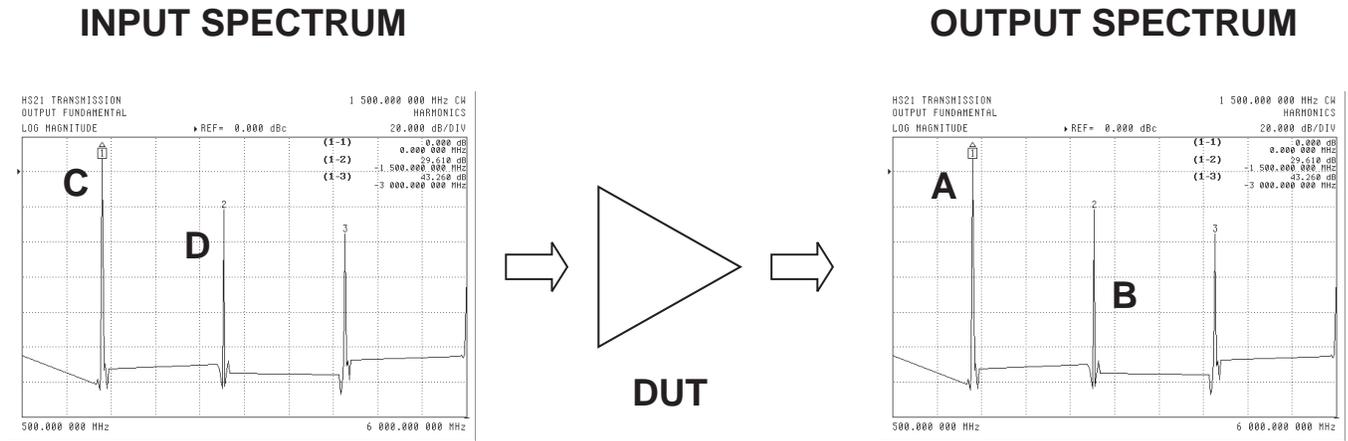


Figure 4-26. Vector Harmonic Measurement Display Options

These measurement results are only available when an enhancement calibration has been performed.

For Second Harmonic Measurements:

- ❑ Source Harmonic = B / D
- ❑ Source Fundamental = B / C
- ❑ Output Fundamental = B / A

Swept Vector Harmonic

Swept Vector Harmonic measurement provides a potentially more accurate, more integrated, and more flexible approach to measuring the DUT harmonics using the MS462XX. Vector Harmonic measurements remove the effects of the source harmonics in relatively linear measurements. In this way, Vector Harmonic measurements reveal more accurate harmonic measurements than the Scalar Harmonic measurements. This Vector Harmonic measurement capability is only available for the 2nd and 3rd harmonics. The following display shows a typical Swept Vector Harmonic measurement.

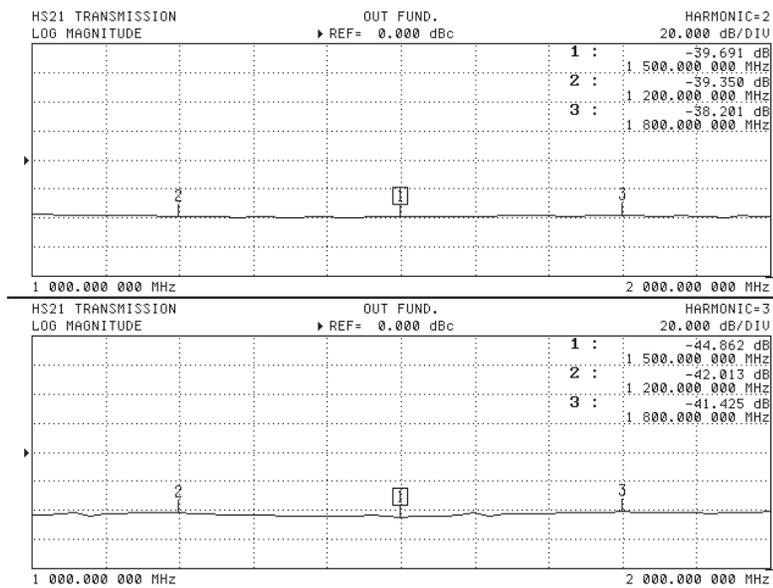


Figure 4-27. Swept Vector Harmonic Example Display

This measurement also shows the harmonics for Source Power of -20 dBm.

1. This measurement requires an Enhancement Cal. Connect a through line between Port 1 and Port 2, excluding any attenuation that follows the DUT.

```

Cal/SOURCE 1 SETUP
SOURCE 1 POWER = 0 dBm
PORT 1 ATTN = 0 (0 dB)
RETURN
CALIBRATE
ENHANCEMENT CAL
Avg/SELECT I.F. BANDWIDTH/I.F. BW 100 Hz
MEASURE DEVICE(S)
    
```

2. The MS462XX proceeds with the calibration. Follow the directions for connecting calibration devices.

EXIT

3. Adjust Source 1 Power to -20 dBm (the desired level for input to the DUT).

Power/SOURCE 1 SETUP

SOURCE 1 POWER = 0 dBm

PORT 1 ATTN = 2

4. Connect the DUT between Port 1 and Port 2 of the MS462XX. If required, add external pads following the DUT to avoid compressing the MS462XX receiver.

5. Specify the I.F. Bandwidth for the measurement. A selection of 10 Hz provides maximum dynamic range.

Avg/SELECT I.F. BANDWIDTH/I.F. BW 10 Hz

6. Configure the display for the Swept Vector Harmonic Phase measurement. This vector approach does not require Trace Match function to view the relative measurement.

Ch 1

Appl/HARMONIC SETUP/HARMONIC = 2

DISPLAY OUTPUT RELATIVE TO: OUTPUT FUNDAMENTAL

Ch 3

Appl/HARMONIC SETUP/HARMONIC = 3

DISPLAY OUTPUT RELATIVE TO: OUTPUT FUNDAMENTAL

This completes the procedure for performing the Swept Vector Harmonic measurement using the MS462XX.

NOTE

This calibration is strongly dependent on source power (since the source harmonics that are being removed are a strong function of source power). Once the Enhancement Cal is performed, the Source Power should not change. It is acceptable to increase or decrease the Source Step Attenuator or add external pads since these steps do not affect source harmonics.

Swept Vector Harmonic Phase

The Swept Vector Harmonic Phase measurement builds on the previous Swept Vector Harmonic measurement by also measuring harmonic phase relative to the source harmonic.

This measurement requires a separate phase calibration with a Harmonic Phase Standard (Anritsu part number 37SF50). Following calibration with this standard, the MS462XX calculates the absolute source harmonic phase and the relative 2nd and 3rd harmonic phases. The following display shows a typical Swept Vector Harmonic Phase measurement.

This measurement shows the Swept Vector Harmonic Phase measurement of the 2nd harmonic for Source Power of – 20 dBm.

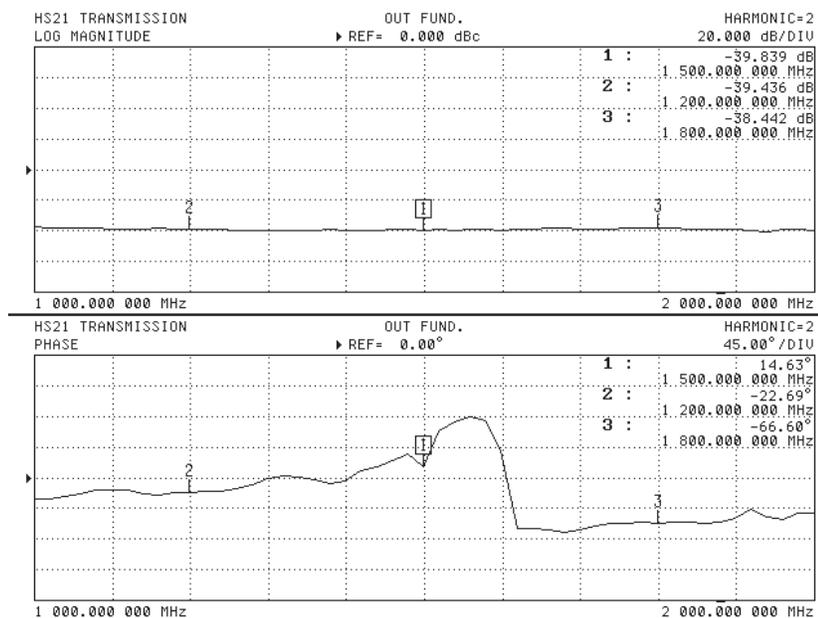


Figure 4-28. Swept Vector Harmonic (=2) Phase Example Display

1. This measurement requires a Phase Cal. Connect the Harmonic Phase Standard between Port 1 and Port 2, excluding any attenuation that follows the DUT.

```
Cal/SOURCE 1 SETUP
SOURCE 1 POWER = 0 dBm
PORT 1 ATTN = 0 (0 dB)
RETURN
CALIBRATE
PHASE CAL
Avg/SELECT I.F. BANDWIDTH/I.F. BW 100 Hz
MEASURE DEVICE(S)
```

NOTE

This calibration is strongly dependent on source power (since the source harmonics that are being removed are a strong function of source power). Once the Enhancement Cal is performed, the Source Power should not change. It is acceptable to increase or decrease the Source Step Attenuator or add external pads since these steps do not affect source harmonics.

The MS462XX proceeds with the calibration.

NEXT CAL STEP

EXIT

2. Adjust Source 1 Power to -20 dBm (the desired level for input to the DUT).

Power/SOURCE 1 SETUP

SOURCE 1 POWER = 0 dBm

PORT 1 ATTN = 2

3. Connect the DUT between Port 1 and Port 2 of the MS462XX. If required, add external pads following the DUT to avoid compressing the MS462XX receiver.

4. Specify the I.F. Bandwidth for the measurement. A selection of 10 Hz provides maximum dynamic range.

Avg/SELECT I.F. BANDWIDTH/I.F. BW 10 Hz

5. Configure the display for the Swept Vector Harmonic Phase measurement. This vector approach does not require Trace Match function to view the relative measurement.

Ch 3

Display/GRAPH TYPE/PHASE

6. Configure the display to display the 2nd and 3rd harmonic.

Ch 1

Appl/HARMONIC SETUP/HARMONIC = 2

DISPLAY OUTPUT RELATIVE TO: OUTPUT FUNDAMENTAL

Ch 3

Appl/HARMONIC SETUP/HARMONIC = 2

DISPLAY OUTPUT RELATIVE TO: OUTPUT FUNDAMENTAL

7. The following keystrokes modify the display for the Swept Vector Harmonic Phase measurement of the 3rd harmonic.

Ch 1

Appl/HARMONIC SETUP/HARMONIC = 3

Ch 3

Appl/HARMONIC SETUP/HARMONIC = 3

The following display shows the Swept Vector Harmonic Phase measurement for the 3rd harmonic.

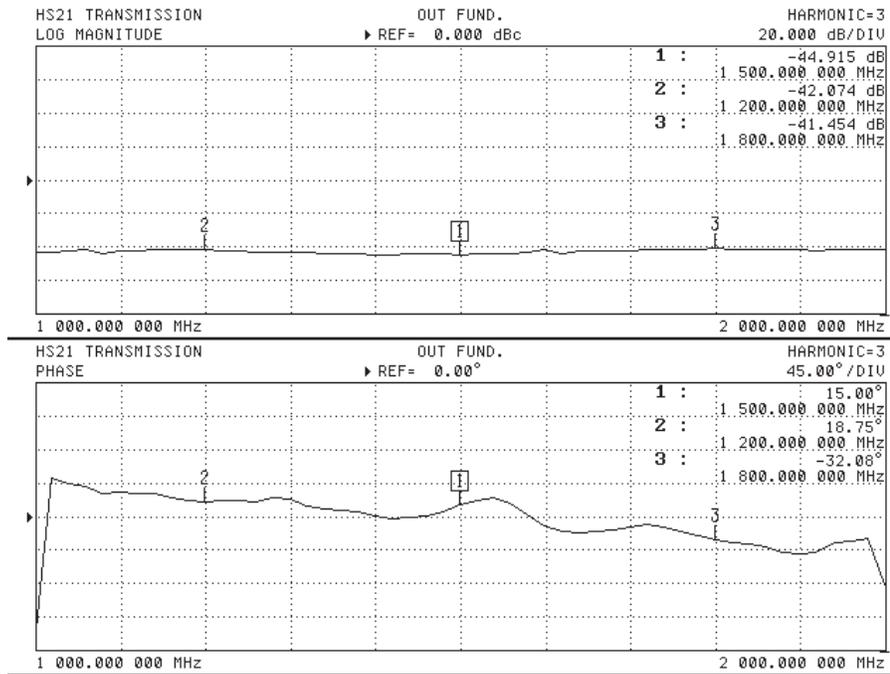


Figure 4-29. Swept Vector Harmonic (=3) Phase Example Display

This completes the procedure for performing the Swept Vector Harmonic Phase measurement using the MS462XX.

4-5 SPGC
Standard Feature

The following display shows a typical Swept Power Gain Compression (SPGC) measurement of an amplifier.

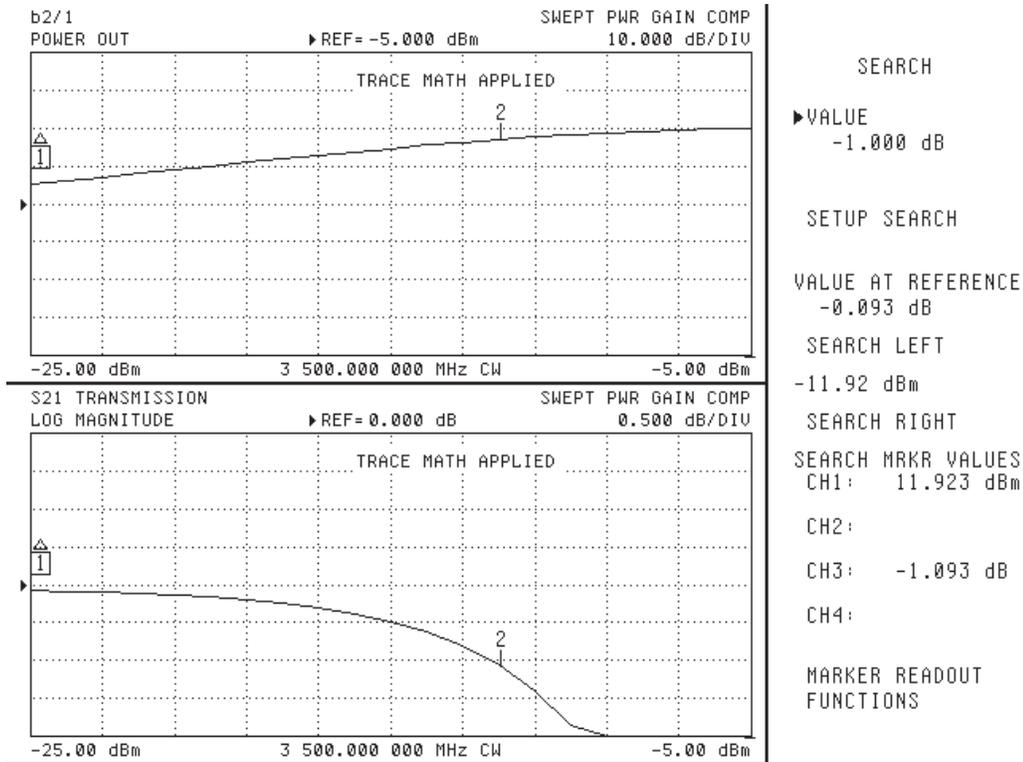


Figure 4-30. Swept Power Gain Compression Example Display

NOTE

Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next application with the previous system settings. CURRENT uses the current system settings.

The 0.1 dB compression point at Port 2 is +10 dBm

1. Press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
ENTRY STATE: PREVIOUS
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION/SWEPT POWER GAIN COMPRESSION
SET FREQUENCIES
CLEAR ALL FREQUENCIES

2. Repeat the following steps for 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, and 5000 MHz.

NEXT FREQUENCY = 500 MHz
INSERT NEXT FREQUENCY

3. Set up the power ranges to sweep each of these frequencies.

```
RETURN
SET ATTENUATION/PORT 1 ATTN = 1 (*10 dB)
RETURN
SET POWER
P START = -25 dBm
P STOP = -5 dBm
P SET = -25 dBm
```

4. Perform the necessary calibrations.

```
Cal
```

5. (optional) Perform a linear power calibration using a power meter.

```
LINEAR POWER
```

6. (optional) Follow directions on the display to set up for Linear Power Calibration and press:

```
BEGIN CAL
```

7. (optional) Following the BEGIN CAL selection, the MS462XX proceeds with the Linear Power Calibration with the Power Meter. Press:

```
RETURN
```

8. Perform the receiver calibration, include any pads following the AUT.

```
CALIBRATE RECEIVER
```

9. Connect a throughline between the test ports and wait for a complete sweep, then press:

```
STORE
```

10. Connect the amplifier between the test ports and wait for a complete sweep, then press:

```
NORMALIZE S21
```

11. Perform the SPGC measurement for a single frequency.

```
Appl/TEST AUT
SWEPT POWER FREQUENCY = 3.5 GHz
Marker/READOUT MARKER
```

The following display shows a typical Multiple Frequency Gain Compression (MFGC) measurement of an amplifier.

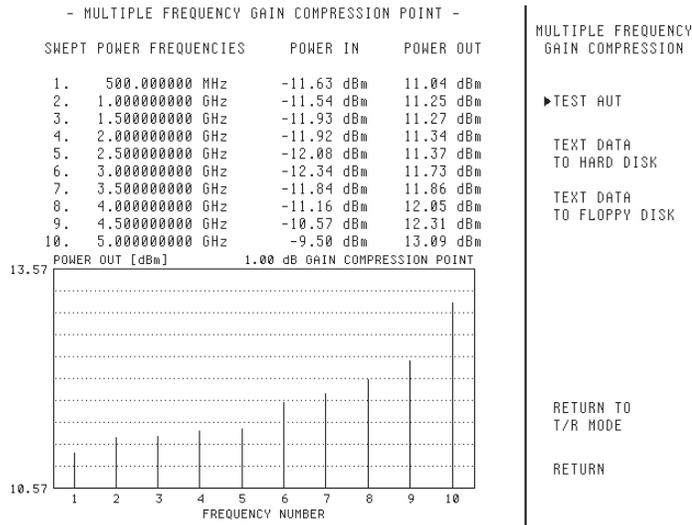


Figure 4-31. Typical Multiple Frequency Gain Compression Measurement

12. Perform the Multiple Frequency Gain Compression measurement.

AppI/MULTIPLE FREQ GAIN COMPRESSION /TEST AUT

13. Return to Transmission/Reflection by selecting:

RETURN TO T/R MODE

This completes the procedure for performing a Swept Power Gain Compression measurement of an amplifier using the MS462XX.

4-6 SFGC

Standard Feature

The following display shows a typical Swept Frequency Gain Compression (SFGC) measurement of an amplifier.

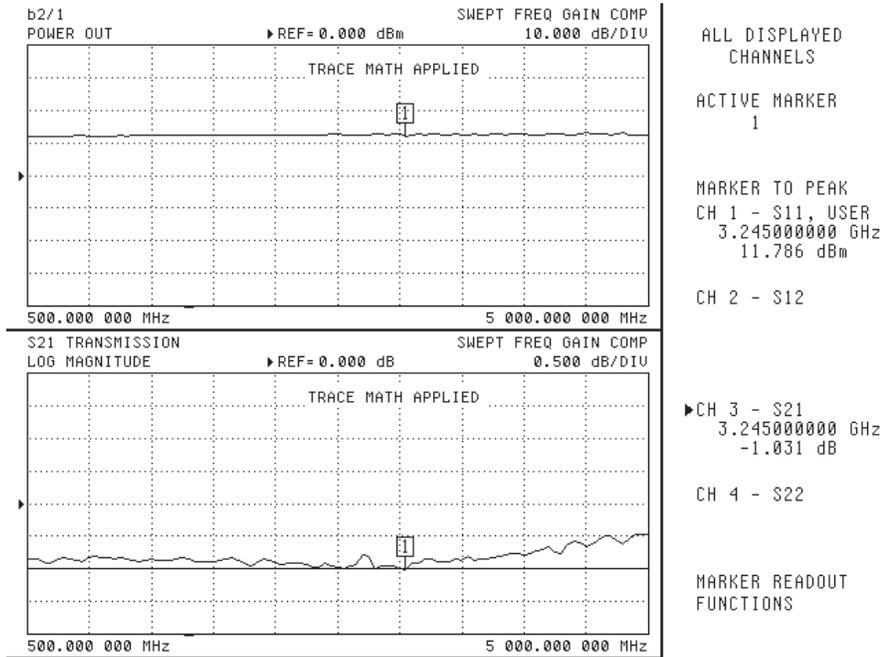


Figure 4-32. Swept Frequency Gain Compression Example Display

1. Press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
 ENTRY STATE: PREVIOUS
 MEASUREMENT TYPE
 TRANSMISSION AND REFLECTION
 SWEPT FREQUENCY GAIN COMPRESSION

2. Press the Freq front panel key.
3. Specify the Start Frequency:
 START = 500 MHz
4. Specify the Stop Frequency:
 STOP = 5000 MHz
5. Proceed to perform calibrations.
 Cal
6. (optional) Perform a calibration for flatness using a power meter.

CALIBRATE FOR FLATNESS

NOTE

Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next application with the previous system settings. CURRENT uses the current system settings.

7. (optional) Follow the directions on the display to set up for Linear Power Calibration.

8. (optional) Specify the number of power calibration points:

MEASURE 1 PWR POINT EVERY 1 POINT(S)

9. (optional) Specify the calibration power level near compression:

Power Target = 0 dBm

BEGIN CAL

10. (optional) Following the BEGIN CAL selection, the MS462XX proceeds with the Linear Power Calibration with the Power Meter. Press:

RETURN

11. Perform a receiver calibration, including any pads following the AUT.

Power/SOURCE 1 SETUP

SOURCE 1 POWER = 0 dBm

PORT 1 ATTN = 0 (*10 dB)

CALIBRATE RECEIVER

12. Connect a throughline between the test ports and wait for a complete sweep, then press:

STORE

13. Select a Source 1 power within the linear range of the AUT and perform a Normalize Calibration.

Power/SOURCE 1 SETUP

SOURCE 1 POWER = 0 dBm

PORT 1 ATTN = 1 (*10 dB)

14. Connect amplifier between the test ports and wait for a complete sweep, then press:

NORMALIZE S21

15. Perform the SFGC measurement.

Appl/TEST AUT

16. Using the front panel knob, adjust SOURCE 1 POWER until the S21 TRANSMISSION display shows compression. Compression is indicated when the data approaches the limit line. The limit line indicates the compression point.

17. Return to Transmission/Reflection by selecting:

RETURN TO T/R MODE

This completes the procedure for performing a Swept Frequency Gain Compression measurement of an amplifier using the MS462XX.

NOTE

The 0.1 dB compression point at Port 2 is +10 dBm.

4-7 TIME DOMAIN

The following display shows a typical time domain measurement.

Option 2

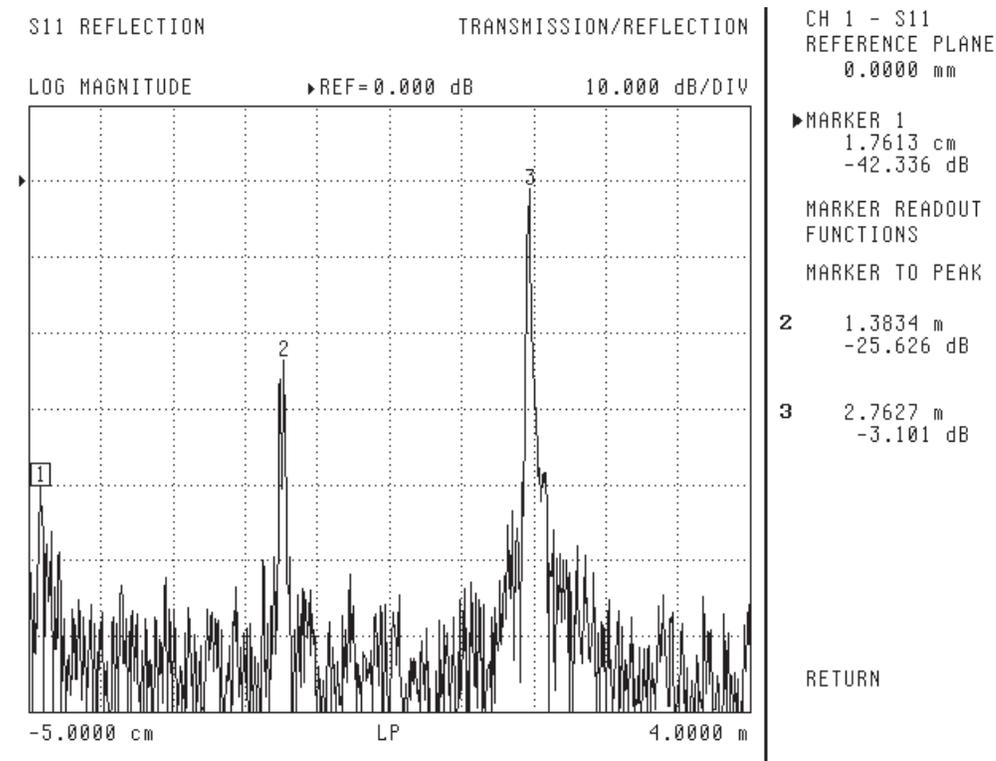


Figure 4-33. Time Domain Measurement Example Display

1. Press the Cal front panel key and select the menu soft keys as follows:

PERFORM CAL 2 PORT CHANGE CAL METHOD AND LINE
TYPE/STANDARD

NEXT CAL STEP

NEXT CAL STEP

FULL 12-TERM

EXCLUDE ISOLATION

TIME DOMAIN (HARMONIC)

2. Specify the Start Frequency:

START (STEP) = 10 MHz

3. Specify the Stop Frequency:

APPROXIMATE STOP = 6 GHz

NEXT CAL STEP

4. Specify the Port 1 Connector:
PORT 1 CONN = TYPE N (F)
5. Specify the Port 2 Connector:
PORT 2 CONN = TYPE N (M)
6. Specify the Test Signal Power Levels:
TEST SIGNALS/SOURCE 1 POWER = +7 dB
RESUME CAL
START CAL
7. Follow the directions for connecting calibration devices, then press:
Save/Recall/SAVE/FRONT PANEL SETUP AND CAL DATA ON HARD
DISK/CREATE NEW FILE
8. Specify a name using the front panel knob. When complete, select DONE,
then press:
Appl/CHANGE APPLICATION SETUP
ENTRY STATE: PREVIOUS
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION/DOMAIN
9. Specify the Domain Appl:
SELECT DOMAIN = TIME, LOWPASS
10. Specify the Display format:
DISPLAY = DISTANCE
Display/DISPLAY MODE/SINGLE CHANNEL
Ch 1
Meas/S11, REFL
Display/GRAPH TYPE/LOG MAGNITUDE
Appl/DOMAIN/SETUP/RANGE SETUP
11. Specify the Start distance:
START = -5 cm
12. Specify the Stop distance:
STOP = 4 m
13. Specify the Response:
RESPONSE = IMPULSE
14. Perform the measurement by connecting the DUT to Port 1 and using
markers to locate discontinuities.

NOTE

Specify the ENTRY STATE before selecting the next application. PREVIOUS configures the next application with the previous system settings. CURRENT uses the current system settings.

This completes the procedure for performing a time domain measurement using the MS462XX.

4-8 MIXER MEASUREMENTS

Standard Feature

The MS462XX organizes measurement capabilities into applications accessible from the applications key (Appl) on the front panel of the system. This measurement organization allows for straightforward and intuitive measurement operation and a convenient method for switching between different measurement applications.

More straightforward mixer measurements are possible because the MS462XX includes a selection for device type. This selection is available after the Appl/CHANGE APPLICATION SETUP keystrokes. For a selection of Device Type = Mixer, the MS462XX simplifies the setup for the selected measurement by:

- allowing the quick selection of which source is to be the DUT LO,
- allowing simple selection of a fixed LO or fixed IF measurement scenario (and specifying that LO or IF frequency), and
- informing the receiver of what kind of DUT conversion to expect (up conversion $|RF+LO|$, down conversion $|RF-LO|$, or no conversion as might be used for a quick leakage measurement).

Activating the Mixer device type also performs the important function of turning on both internal sources for front panel access (usually using ports 1 and 3 driving, port 2 being the receive port). Two ports are not allowed to drive simultaneously during normal S-parameter measurements.

This section contains discussions, examples, and procedures related to the following applications:

- Mixer Conversion Loss
- Mixer Noise Figure
- Mixer IMD
- Frequency Translated Group Delay (FTGD)

Each application discussion shows a typical measurement result. The procedures document the steps used to achieve this typical measurement result.

Once a typical measurement is mastered, explore the different measurement configurations for each application to become each application's powerful capabilities.

**Mixer Conversion
Loss**

This section contains two typical mixer conversion loss measurements. These measurements are performed on the same DUT so that comparisons are possible. Each subsequent measurement builds on the setup of the previous measurement.

- ❑ Mixer Conversion Loss, Fixed LO
- ❑ Mixer Conversion Loss, Fixed IF

More straightforward mixer measurements are possible because the MS462XX includes a selection for device type. For a selection of Device Type = Mixer, the MS462XX simplifies the setup for the selected measurement by:

- ❑ allowing the quick selection of which source is to be the DUT LO,
- ❑ allowing simple selection of a fixed LO or fixed IF measurement scenario (and specifying that LO or IF frequency), and
- ❑ informing the receiver of what kind of DUT conversion to expect (up conversion | RF+LO | down conversion | RF-LO | , or no conversion as might be used for a quick leakage measurement).

Activating the Mixer device type also performs the important function of turning on both internal sources for front panel access (usually using ports 1 and 3 driving, port 2 being the receive port). Two ports are not allowed to drive simultaneously during normal S-parameter measurements.

The measurement itself is quite straightforward, as it is just a simple T/R non-ratioed analysis. It is important to remember that since the RF and IF frequencies are unequal in up or down conversion, there is no reference signal available. As a result, the only display parameters that are normally used in a conversion loss measurement are the test channel values $b_1/1$.

If an external Anritsu 68XXX or 69XXX source is to be used as the LO, then the GPIB cable from the source must be connected to the dedicated GPIB port of MS462XX prior to applying power to the MS462XX. Refer to Figure 4- for a sample connection diagram.

Instrument Setup for External Synthesizer Supplied LO

Once both instruments are powered on, use the following procedure to verify that the GPIB address for the synthesizer is set correctly.

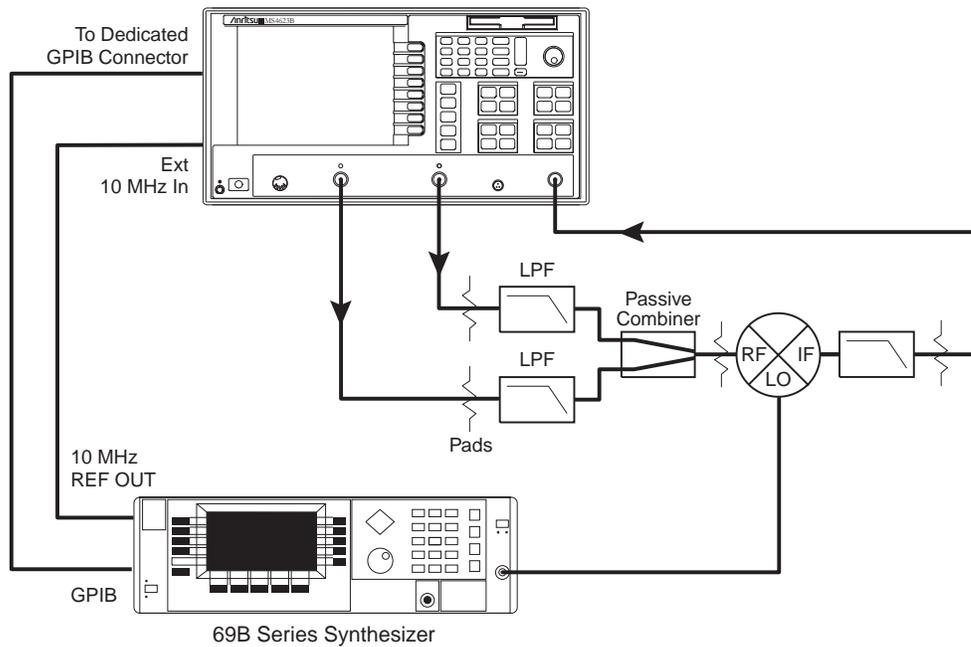


Figure 4-34. MS462XX and 68XXX /69XXX Connection Diagram

1. Press the Utility front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement:

REMOTE INTERFACE
 GPIB SETUP
 EXTERNAL SOURCE 3 = 9

2. On the 68XXX/69XXX press the System front panel key

CONFIG
 GPIB
 GPIB ADDRESS = 9 (Adrs/ns/Hz)
 GPIB ADDRESS

3. Connect the 10 MHz reference from the synthesizer to the MS462XX and transfer the reference frequency for the MS462XX from Internal to External by selecting the following menu keys:

Utility/REAR PANEL/REFERENCE FREQUENCY = EXTERNAL

This completes the setup of an external 68XXX/69XXX source for use with as an LO drive.

Mixer Conversion Loss, Fixed LO

The device to be tested has a fixed LO (at +7 dBm) of 3000 MHz and an RF range (at -10 dBm) of 3200 to 3800 MHz. The conversion loss in the IF range of 200 to 800 MHz will be measured. Internal Source 1 provides the RF signal and Internal Source 2 provides the LO for the mixer DUT.

The following display shows a typical Mixer Conversion Loss, Fixed LO measurement.

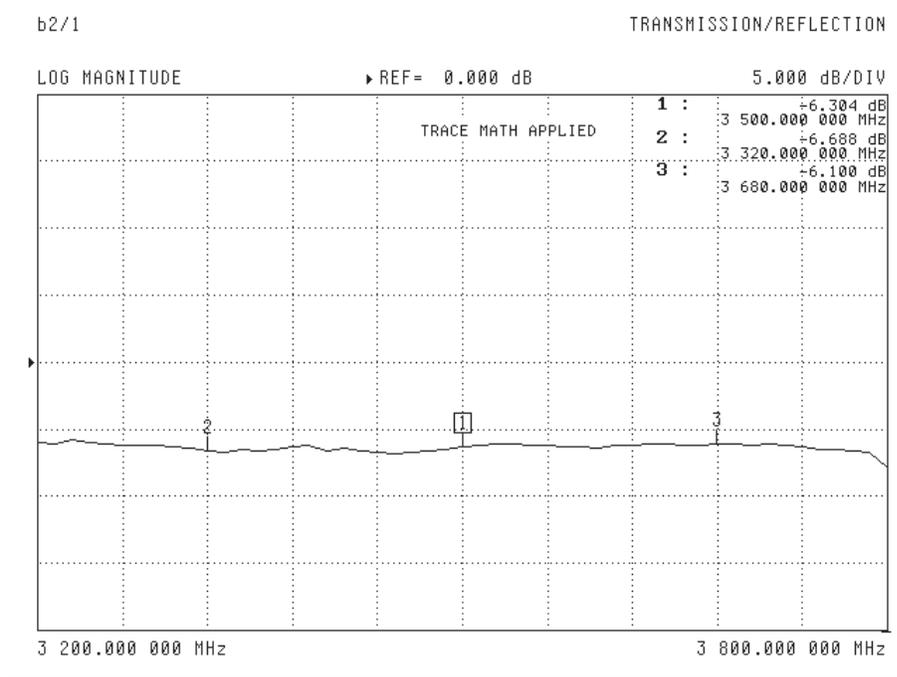


Figure 4-35. Mixer Conversion Loss, Fixed LO Example Display

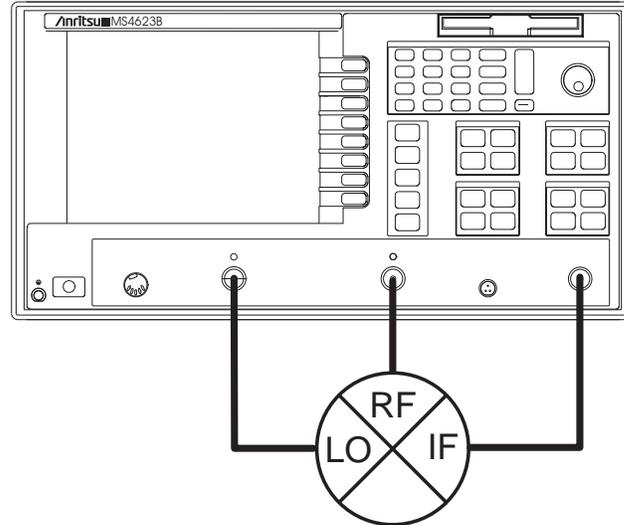


Figure 4-36. Mixer Conversion Loss, Fixed LO

NOTE

CAL must be OFF to use ratio measurements.

NOTE

By selecting Receiver Conversion = None, the receiver will track the source, which is necessary for proper calibrations. Essentially the unit will perform as if it were in Device Type = Standard.

1. Press the Appl front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement:

CHANGE APPLICATION SETUP
 DEVICE TYPE = MIXER
 ENTRY STATE = CURRENT
 MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. Press the Appl front panel key and select:

LO/RECEIVER SETUP
 RCVR CONVERSION=NONE
 Ch 3
 Meas/USER DEFINED/CHANGE RATIO
 b2/1
 USER 1
 Display/DISPLAY MODE/SINGLE CHANNEL
 Display/GRAPH TYPE/LOG MAGNITUDE

3. Connect a through line between Port 1 and Port 2 of the MS462XX, including any attenuation following the DUT.

NOTE

Be careful in the selecting the LO OFFSET FROM RF. The -500 MHz selection sets the LO range as 2700 to 3300 MHz. On the other hand, a +500 MHz selection would set the LO range as 3700 to 4300 MHz. Both of these frequency ranges produce the fixed IF of 500 MHz so careful selection of this setting ensures accurate measurements. The frequency display on the screen is still the RF frequency applied to the mixer DUT.

NOTE

This setup screen is a way to avoid using Multiple Source Control by simplifying some of the choices. The types of conversions are limited to Fixed LO and Fixed IF. Use Multiple Source Control if a more complicated frequency plan for the DUT is needed.

4. Perform a Receiver Cal over the entire frequency range of the system to correct for receiver slope between RF and IF frequencies.

```
Freq
START= 10 MHz
STOP = 6000 MHz
Config/DATA POINTS/401 MAX PTS
Avg/SELECT I.F. BANDWIDTH/I.F. BW 1 kHz
Power/RECEIVER CAL/RECEIVER CAL
BEGIN CAL
```

5. The MS462XX proceeds with the Receiver Cal.

```
RETURN
```

6. Specify the RF frequency range and data points for the measurement.

```
Freq
START= 3200 MHz
STOP = 3800 MHz
Config/DATA POINTS/51 MAX PTS
```

7. With the through line still connected, adjust Source 1 (RF applied to mixer DUT) to -10 dBm and use Trace Memory to save data to memory and to display data divided by memory. This has established the RF power level so that the display in later steps will be of direct conversion loss.

```
Power/SOURCE 1 SETUP
SOURCE 1 POWER = -10 dBm
PORT 1 ATTN = 0 (0 dB)
Display/TRACE MEMORY
STORE DATA TO MEMORY
DATA (/) MEMORY
```

8. Configure the MS462XX for a mixer measurement by pressing the Appl front panel key and select the menu soft keys as follows:

```
CHANGE APPLICATION SETUP
```

9. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```
LO / RECEIVER SETUP
```

10. Select either the internal second source (LO IS SOURCE=2) or an external Anritsu 68XXX or 69XXX synthesizer (LO IS SOURCE=3).

LO IS SOURCE = 2 or LO IS SOURCE = 3

LO CW MODE = ON

LO CW FREQUENCY = 3 GHz

RCVR CONVERSION/DOWN

RETURN

NOTE

The frequency display on the screen is the RF frequency applied to the mixer DUT.

11. Adjust Source Power to +7 dBm as is required for this DUT.

Power/SOURCE 2 (or 3) SETUP

SOURCE 2 (or 3) POWER = 7 dBm

PORT 3 ATTN = 0 (0 dB)

12. Connect the mixer DUT with the IF at Port 2, the RF at Port 1, and the LO at Port 3, or to the external synthesizer.

13. Adjust the Scale of the display for the measurement

Display/SCALE

RESOLUTION = 5 dB/DIV

REFERENCE VALUE = 0 dB

REFERENCE LINE = 4

This completes the procedure for performing the Mixer Conversion Loss, Fixed LO measurement using the MS462XX.

Mixer Conversion Loss, Fixed IF

The device to be tested has a fixed IF of 500 MHz and a RF range (at -10 dBm) of 3200 to 3800 MHz. The LO range (at +7 dBm) is set as a fixed offset (-500 MHz) from the RF or 2700 to 3300 MHz. The conversion loss for this fixed IF frequency will be measured. Internal Source 1 provides the RF signal and Internal Source 2 provides the LO for the mixer DUT.

The following display shows a typical Mixer Conversion Loss, Fixed IF measurement.

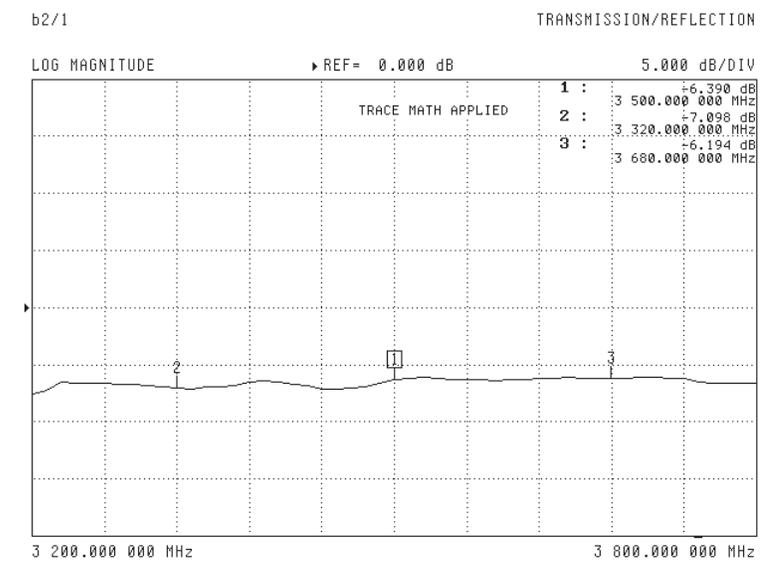


Figure 4-37. Mixer Conversion Loss, Fixed IF Example Display

NOTE
 When selecting the LO OFFSET FROM RF, the -500 MHz selection sets the LO range to 2700 to 3300 MHz. A +500 MHz selection sets the LO range to 3700 to 4300 MHz. Both of these frequency ranges produce the fixed IF of 500 MHz so careful selection of this setting ensures accurate measurements.

1. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:
 LO / RECEIVER SETUP
2. Select either the internal second source (LO IS SOURCE=2) or an external Anritsu 68XXX or 69XXX synthesizer (LO IS SOURCE=3).

LO IS SOURCE = 2 or LO IS SOURCE = 3

LO CW MODE = OFF

LO OFFSET FROM RF = -500 MHz

RCVR CONVERSION/DOWN

RETURN

3. The previously stored Trace Memory (steps 6 & 7) is the same since it is again the reference RF power that must be known for computing the conversion loss. Repeat steps 6 and 7 if changing the RF frequency range or RF power. The display shows the results of the fixed IF measurement.

This completes the procedure for performing the Mixer Conversion Loss, Fixed IF measurement using the MS462XX.

Mixer Noise Figure

Option 4X:
50 MHz to 3 GHz
50 MHz to 6 GHz

This section contains two typical mixer noise figure measurements. These measurements are performed on the same DUT so that comparisons are possible. Each subsequent measurement builds on the setup of the previous measurement.

- ❑ Mixer Scalar Noise Figure, Fixed LO
- ❑ Mixer Scalar Noise Figure, Fixed IF

More straightforward mixer measurements are possible because the MS462XX includes a selection for device type. For a selection of Device Type=Mixer, the MS462XX simplifies the setup for the selected measurement by:

- ❑ allowing the quick selection of which source is to be the DUT LO,
- ❑ allowing simple selection of a fixed LO or fixed IF measurement scenario (and specifying that LO or IF frequency), and
- ❑ informing the receiver of what kind of DUT conversion to expect (up conversion $|RF+LO|$, down conversion $|RF-LO|$, or no conversion as might be used for a quick leakage measurement).

The following three assumptions are made regarding mixer noise figure measurements using the MS462XX:

- ❑ The IF of the mixer DUT will be connected to Port 2 of the MS462XX and the IF will have a frequency range within the present system limits of 50 and 3000 MHz.
- ❑ The LO of the mixer DUT should be supplied by the optional Source 2. Source 1 cannot be used during mixer noise figure measurements.
- ❑ The frequency conversion in the mixer DUT cannot link to a 12-term calibration so mixer noise figure measurements are limited to the scalar approach.

The following measurements are performed externally; however, internal routing is permitted. In addition, wideband noise figure measurements are performed, but narrowband is also permitted.

Mixer Noise Figure, Fixed LO

The device to be tested has a fixed LO (at +7 dBm) of 700 MHz and a RF range of 920 to 1000 MHz. The noise figure in the IF range of 220 to 300 MHz will be measured. There is a low pass filter following the mixer DUT with a cutoff frequency of 550 MHz. The noise source provides the RF and Internal Source 2 provides the LO for the mixer DUT.

The following display shows a typical Mixer Noise Figure, Fixed LO measurement.

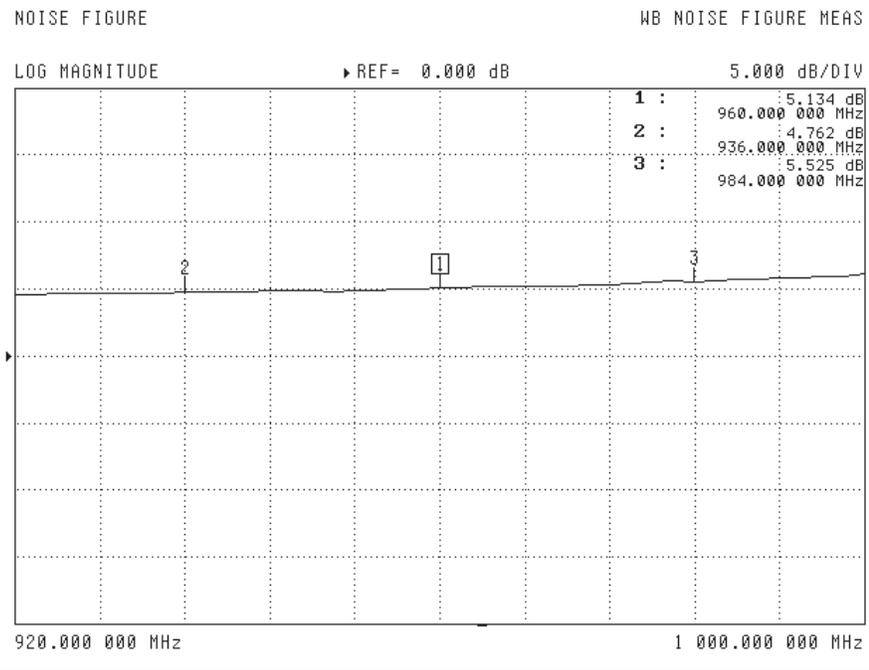


Figure 4-38. Mixer Noise Figure, Fixed LO Example Display

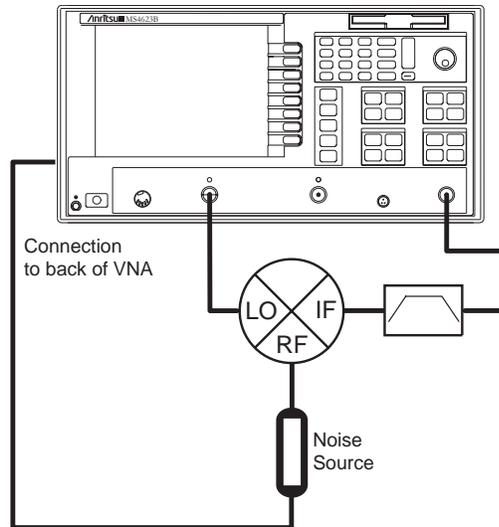


Figure 4-39. Mixer Noise Figure, Fixed LO

NOTE

The MS462XX may display a “RECEIVER FREQ OUT OF H/W RANGE.” This error condition subsides when the correct frequencies are specified for the measurement.

1. Press the Appl front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement:
 - CHANGE APPLICATION SETUP
 - DEVICE TYPE = MIXER
 - ENTRY STATE = CURRENT
 - MEASUREMENT TYPE/NOISE FIGURE
2. Configure the display for the measurement.
 - Ch 3
 - Display/DISPLAY MODE/SINGLE CHANNEL
 - Display/GRAPH TYPE/LOG MAGNITUDE
3. Specify the DUT Bandwidth for the noise figure measurement.
 - Appl
 - DUT BANDWIDTH = WIDE

NOTE

Select DUT BANDWIDTH = NARROW for noise figure measurements of band limited devices. The WIDE selection provides faster measurements of broadband devices than the NARROW selection.

NOTE

The frequency display on the screen is the RF frequency applied to the mixer DUT.

Select LO IS SOURCE = 3 if using an external synthesizer. Make sure to connect the 10 MHz line between the synthesizer and the MS462XX.

NOTE

The default noise figure average of 40 provides measurement speed and reasonable stability. Increasing the noise figure averaging provides more stable measurements, but decreases the measurement speed.

4. Indicate the location of the noise source for the measurement.

NOISE FIGURE SETUP
NOISE SOURCE = EXTERNAL

5. Load the appropriate noise source ENR values.

ENR TABLE OPERATION
LOAD ENR TABLE
FROM HARD DISK/VENDOR ENR TABLE

6. Select the ENR file to read. Refer to Section 7-8 for information on formatting the noise source ENR values into a file and copying the file to the hard disk.

7. Proceed with the LO / Receiver setup by selecting the Appl front panel key and the menu soft keys as follows:

LO / RECEIVER SETUP
LO IS SOURCE = 2 (or 3)
LO CW MODE = ON
LO CW FREQUENCY = 700 MHz
RCVR CONVERSION/DOWN
RETURN

8. Specify the RF frequency range and data points for the measurement.

Freq
START= 920 MHz
STOP = 1000 MHz
Config/DATA POINTS/51 MAX PTS

9. Specify the Noise Figure Averaging for the measurement

Avg/NOISE FIGURE AVERAGE = 40
NOISE FIGURE AVERAGE = ON

10. Adjust Source Power to +7 dBm as is required for this DUT.

Power/SOURCE 2 (or 3) SETUP
SOURCE 2 (or 3) POWER = 7 dBm
PORT 3 ATTN = 0 (0 dB)

11. Connect the Noise Source to Port 2 of the MS462XX, including any attenuation and filtering following the DUT. Make sure that Device Type=Mixer so the MS462XX knows to calibrate the IF frequencies at the receiver.

Appl/CHANGE APPLICATION SETUP/DEVICE TYPE = MIXER
Cal/PERFORM NOISE FIGURE ONLY
MEASURE DEVICE(S)

NOTE

The SSB correction is for use during mixer noise figure measurement when a SSB response is desired (e.g. when the DUT will be used in an application where only one sideband is used, the case in most radios). If not invoked, the calculated insertion gain will be a sum of the two sideband responses and may be higher than is practically useful. The SSB correction simply subtracts 3 dB from the calculated insertion gain before it is used in calculations. This assumes that the DUT conversion gain/loss is the same for the two sidebands and may be simplistic.

12. The MS462XX proceeds with the calibration.
13. Connect the noise source at the RF of the mixer DUT, the IF at Port 2, and the LO at Port 3.
14. Adjust the Scale of the display for the measurement

Display/SCALE
 RESOLUTION = 5 dB/DIV
 REFERENCE VALUE = 0 dB
 REFERENCE LINE = 4

The following display shows the SSB performance of this mixer DUT for this measurement.

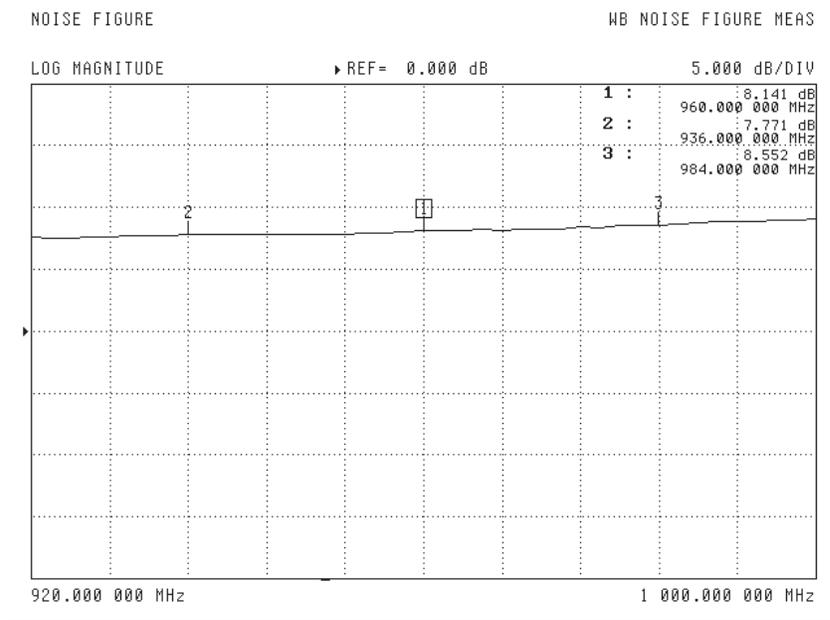


Figure 4-40. Mixer Noise Figure, Fixed LO with SSB Correction Example Display

15. Apply the SSB Correction. This correction decreases by 3 dB the calculated insertion gain.

Appl
 NOISE FIGURE SETUP
 SSB CORRECTION = ON

This completes the procedure for performing the Mixer Noise Figure, Fixed LO measurement using the MS462XX.

Mixer Noise Figure, Fixed IF

The device to be tested has a fixed IF of 200 MHz and a RF range of 920 to 1000 MHz. The LO frequency range (at +7 dBm) is set as a fixed offset (-200 MHz) from the RF or 720 to 800 MHz. The noise figure for this fixed IF frequency will be measured. There is a low pass filter following the mixer DUT with a cutoff frequency of 550 MHz. The noise source provides the RF and Internal Source 2 provides the LO for the mixer DUT.

The following display shows a typical Mixer Noise Figure, Fixed IF measurement.

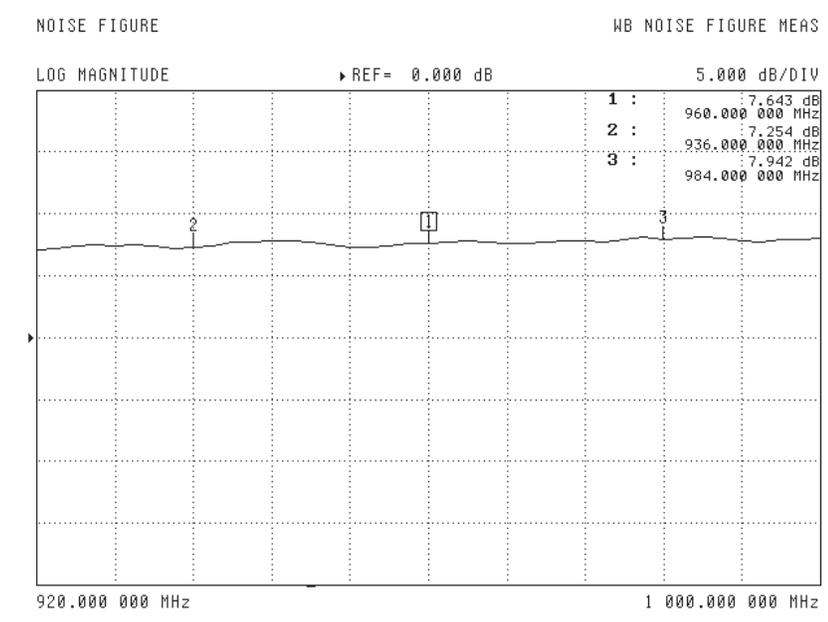


Figure 4-41. Mixer Noise Figure, Fixed IF Example Display

1. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```

LO / RECEIVER SETUP
LO IS SOURCE = 2
LO CW MODE = OFF
LO OFFSET FROM RF = -200 MHz
RCVR CONVERSION/DOWN
RETURN

```

When selecting the LO OFFSET FROM RF, the -200 MHz selection sets the LO range as 720 to 800 MHz. A +200 MHz selection sets the LO range as 1120 to 1200 MHz. Both of these frequency ranges produce the fixed IF of 200 MHz so careful selection of this setting ensures accurate measurements. The frequency display on the screen is still the RF frequency applied to the mixer DUT.

2. Connect the Noise Source to Port 2 of the MS462XX, including any attenuation and filtering following the DUT.

Cal/PERFORM NOISE FIGURE ONLY
MEASURE DEVICE(S)

3. The MS462XX proceeds with the calibration.
4. Connect the noise source at the RF of the mixer DUT, the IF at Port 2, and the LO at Port 3.

The following display shows the SSB performance of this mixer DUT for this measurement.

NOTE

The SSB correction is for use during mixer noise figure measurement when a SSB response is desired (e.g. when the DUT will be used in an application where only one sideband is used, the case in most radios). If not invoked, the calculated insertion gain will be a sum of the two sideband responses and may be higher than is practically useful. The SSB correction simply subtracts 3 dB from the calculated insertion gain before it is used in calculations. This assumes that the DUT conversion gain/loss is the same for the two sidebands and may be simplistic.

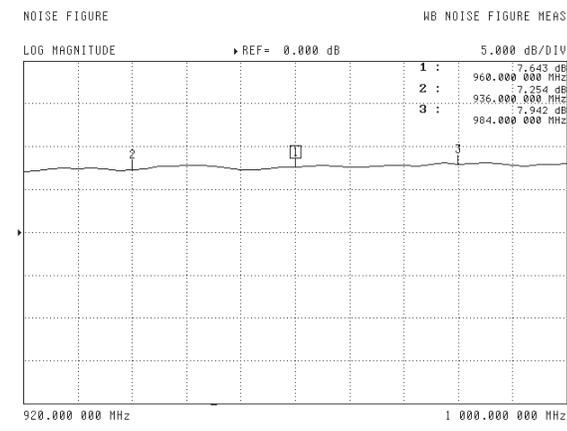


Figure 4-42. Mixer Noise Figure, Fixed IF with SSB Correction Example Display

5. Apply the SSB Correction. This correction decreases by 3 dB the calculated insertion gain.

Appl
NOISE FIGURE SETUP
SSB CORRECTION = ON

There are two ways the LO can degrade a mixer NF measurement:

- ❑ Direct LO leakage: Since mixer isolation is often less than 30 dB and a discrete signal of -90 dBm can affect a noise figure measurement, filtering of the LO on the output path is critical. If the LO is close to the output signal band, the filtering may need to be quite steep.
- ❑ LO noise conversion: If the LO is noisy or has spurs at an offset equal to the DUT output frequency, this noise/spur content can convert to the output frequency and impact the measurement. While spurs may be difficult to counteract, broadband noise effects can be reduced through power budgeting. In many sources, the broadband noise originates in the output amplifiers and the level control precedes these amplifiers. If the source is set for maximum power and the output padded externally, the absolute (and relative) level of the broadband noise can be reduced while keeping the LO drive at the correct level.

This completes the procedure for performing the Mixer Noise Figure, Fixed IF measurement using the MS462XX.

**Mixer
Intermodulation
Distortion (IMD)**

Option 13

This section contains four typical mixer IMD measurements. These measurements are performed on the same DUT so that comparisons are possible. Each subsequent measurement builds on the setup of the previous measurement.

- CW Mixer IMD
- Swept Mixer IMD, Fixed LO
- Swept Mixer IMD, Fixed IF
- Swept Mixer Third Order Intercept (TOI), Fixed IF

More straightforward mixer measurements are possible because the MS462XX includes a selection for device type. This selection is available after the Appl/CHANGE APPLICATION SETUP keystrokes. For a selection of Device Type = Mixer, the MS462XX simplifies the setup for the selected measurement by:

- allowing the quick selection of which source is to be the DUT LO,
- allowing simple selection of a fixed LO or fixed IF measurement scenario (and specifying that LO or IF frequency), and
- informing the receiver of what kind of DUT conversion to expect (up conversion |RF+LO|, down conversion |RF-LO|, or no conversion as might be used for a quick leakage measurement).

Activating the Mixer device type also performs the important function of turning on both internal sources for front panel access (usually using ports 1 and 3 driving, port 2 being the receive port). Two ports are not allowed to drive simultaneously during normal S-parameter measurements.

Setup Considerations**Time Base Synchronization**

This measurement requires an external synthesizer with the time bases of the instruments synchronized. The 10 MHz reference out from the synthesizer must be connected to the 10 MHz reference in on the MS462XX to synchronize the time bases. In addition, the MS462XX requires a manual selection to engage the external source (see Utility/REAR PANEL/REFERENCE FREQUENCY).

If this is not done, the tones and intermodulation products may not be exactly where the receiver expects them (particularly at smaller IF bandwidths) and poor results will be obtained. If the external 10 MHz is not connected but the reference selection is still external, the MS462XX may not sweep or an error message "PHASE LOCK FAIL DFCEBAKJ" (or similar random letters) may be displayed.

GPIB Considerations

Ideally, the synthesizer will be connected to the dedicated GPIB port and turned on prior to turning on the MS462XX and the synthesizer will not be turned off while the MS462XX is running. If it is necessary to activate the synthesizer after turning on the MS462XX, the following procedure may be used

1. Enter the multiple source menu (but go no further down that tree) AFTER the synthesizer has booted (this allows the system to recognize the existence of the synthesizer). Assuming the synthesizer is set to address 9 (default address for source 3), check under Config/Sources/Source3 to see that the source is ACTIVE. If the addresses are out of synch, review the setups and repeat.
2. Verify that the sources have been selected under the IMD application menu/SOURCE SELECTION. The default is sources 1 and 2 will be tones 1 and 2 while source 3 will be the LO. Ensure that the mode is APPLY.
3. Activate Mixer mode, usually the synthesizer will enter remote mode and will be programmed appropriately
4. If not done already, connect the 10 MHz lines as discussed above and switch the MS462XX to external reference.

If the synthesizer must be turned off or disconnected prior to shutting down the MS462XX (or the user will be later rebooting the MS462XX without a synthesizer connected), the following steps will help

1. Switch the MS462XX to INTERNAL reference and disconnect the 10 MHz line
2. Under Config/Sources, set the external source to INACTIVE
3. The external synthesizer can now be disconnected or turned off. Note that if a setup is to be saved, whether the external synthesizer is connected (and recognized) is critical. The setup can only be recalled with the same physical connections present.

These setup considerations can help with setup issues and general measurement flow.

CW Mixer IMD

The device to be tested has a fixed LO (of +7 dBm) at 3 GHz. The first tone is at 3500 MHz and the second tone is offset 1.01 MHz from the first tone (or at 3501.01 MHz). Both tones are applied to the combining network at 0 dBm. Only output-referred intermodulation products are of interest so no calibrations will be performed. Sources 1 and 2 of the MS462XX will be tones 1 and 2 while the external source (Source 3) will provide the LO to the mixer DUT.

The MS462XX has already been turned on with the synthesizer connected and is in Device Type = Standard mode.

The following display shows a typical Mixer IMD, CW measurement.

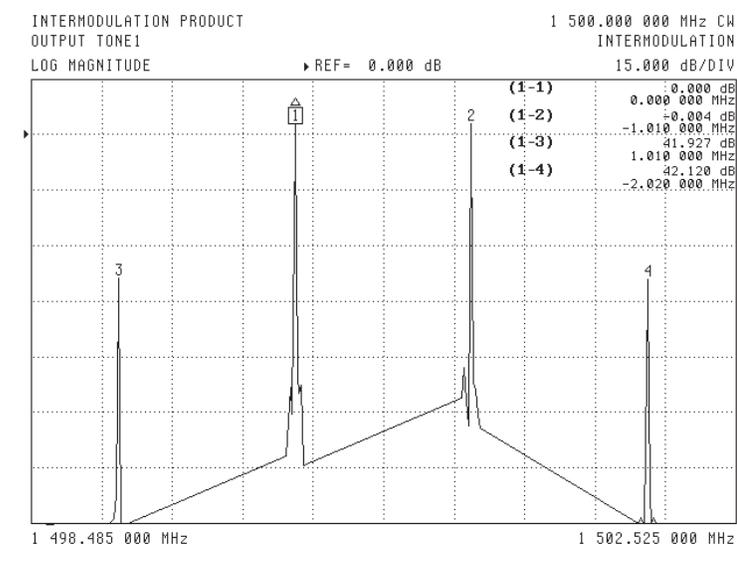


Figure 4-43. Mixer IMD, CW Example Display

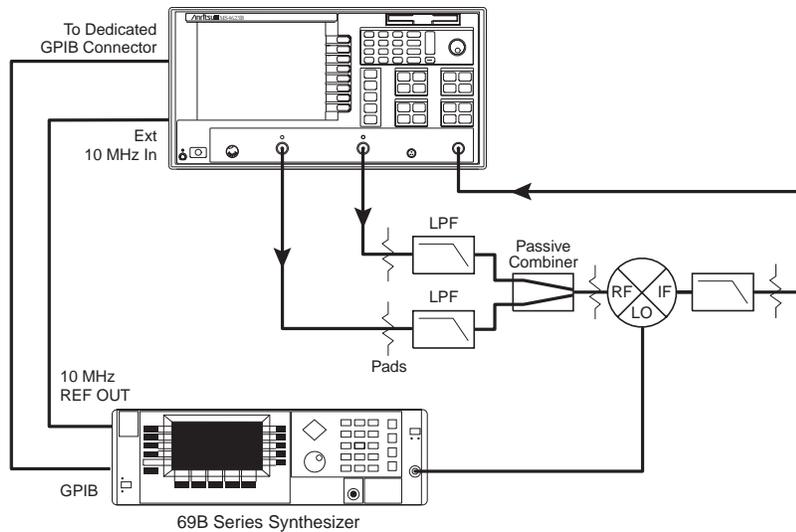


Figure 4-44. CW Mixer IMD

1. Verify Source 3 indicates ACTIVE configuration. This ACTIVE configuration requires a GPIB connection between the Dedicated GPIB of the MS462XX and the GPIB of the synthesizer. If Source 3 is not active, see the previous discussion for setup considerations.

Config/SOURCE/SOURCE 3 = ACTIVE

2. Connect 10 MHz reference from synthesizer to MS462XX. Transfer the Reference Frequency for the MS462XX from Internal to External

Utility/REAR PANEL/REFERENCE FREQUENCY = EXTERNAL

3. Press the Appl front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement.

CHANGE APPLICATION SETUP

DEVICE TYPE = MIXER

MEASUREMENT TYPE/IMD

4. Ensure that Tone 1 is Source 1, Tone 2 is Source 2, and LO is Source 3. In addition, verify that the Selection Mode is APPLY.

SOURCE SELECTION

TONE 1 IS SOURCE = 1

TONE 2 IS SOURCE = 2

LO IS SOURCE = 3

SELECTION MODE = APPLY

RETURN

5. Configure the display for the measurement.
Ch 3
Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE
6. Connect the combining network between the two sources (Port 1 and Port 3) on the front panel of the MS462XX.
7. Specify the frequency range and data points for the IMD measurements.
Appl/SWEEP MODE = SOURCE
Freq/C.W. MODE = OFF
START = 1 GHz
STOP = 2 GHz
Config/DATA POINTS/51 MAX PTS
8. Perform a Receiver Cal for Port 2 and connect a through line between Port 1 and Port 2, including any attenuation that follows the DUT. This calibration gives the MS462XX the ability to measure absolute power in dBm.
Cal/PERFORM CAL/RECEIVER CAL
BEGIN CAL
9. The MS462XX proceeds with the calibration.
EXIT
Cal/APPLY CAL: RECEIVER CAL FOR PORT 2 = ON
10. Connect the combining network between the two sources (Port 1 and Port 3) on the front panel of the MS462XX.
11. Configure the MS462XX for the Two-Tone IMD Products measurement.
Appl
SWEEP MODE = CW RCVR
12. Specify the CW Frequency for Tone 1.
Freq/C.W. MODE = 1500 MHz
13. Specify the CW Frequency for Tone 2 by selecting an offset from Tone 1.
Appl/TONE 2 OFFSET = 1.01 MHz
14. Specify the I.F. Bandwidth for the measurement. A selection of 10 Hz provides maximum dynamic range.
Avg/SELECT I.F. BANDWIDTH/I.F. BW 10 Hz

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

15. Adjust the Scale of the display for the measurement.

Ch 3
Display/SCALE
RESOLUTION = 20 dB/DIV
REFERENCE VALUE = 0 dB
REFERENCE LINE = 7

16. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

LO / RECEIVER SETUP
LO CW MODE = ON
LO CW FREQUENCY = 3 GHz
RCVR CONVERSION/DOWN
RETURN

17. Setup the Power for Tone 1 and Tone 2 for 0 dBm to the combining network.

Power/SOURCE 1 SETUP
SOURCE 1 POWER = 0 dBm
PORT 1 ATTN = 0 (0 dB)
RETURN
SOURCE 2 SETUP
SOURCE 2 POWER = 0 dBm
PORT 3 ATTN = 0 (0 dB)

18. Adjust Source 3 Power to +7 dBm as is required for this DUT.

Power/SOURCE 3 SETUP
SOURCE 3 POWER = 7 dB

19. Connect the mixer DUT with the IF at Port 2, the RF to the combining network, and the LO to the synthesizer.

This completes the procedure for performing the Mixer IMD, CW measurement using the MS462XX.

NOTE

This setup screen is a way to avoid using Multiple Source Control by simplifying some of the choices. The types of conversions are limited to Fixed LO and Fixed IF. Use Multiple Source Control if a more complicated frequency plan for the DUT is needed.

The frequency display on the screen is the RF frequency applied to the mixer DUT.

**Swept Mixer IMD,
Fixed LO**

A Swept Mixer IMD, Fixed Lo measurement performs the previous CW-type measurement within a frequency range and displays the results as IMD products versus frequency. This measurement shows the IMD Products for two input tones at 0 dBm to the combining network.

The device to be tested has a fixed LO (at +7 dBm) of 3000 MHz and a RF range (at 0 dBm to the combining network) of 3200 to 3800 MHz. The IMD products in the IF range of 200 to 800 MHz will be measured

The following display shows a typical Swept Mixer IMD, Fixed LO measurement.

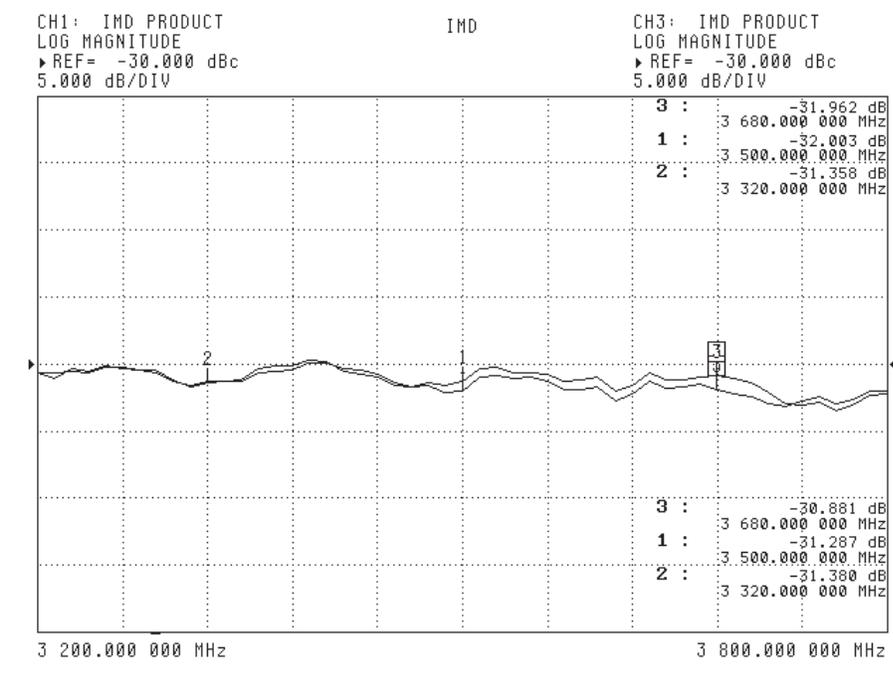


Figure 4-45. Swept Mixer IMD, Fixed LO Example Display

1. Begin this swept measurement by switching the sweep mode from CW RCVR to SOURCE.
 - Appl/SWEEP MODE = SOURCE
 - Freq/C.W. MODE = OFF
2. Specify the frequency range and data points for the IMD measurements.
 - Freq/START = 3200 MHz
 - STOP = 3800 MHz
 - Config/DATA POINTS/51 MAX PTS

NOTE

The frequency display on the screen is the RF frequency applied to the mixer DUT.

NOTE

An IMD Cal allows input referred measurements. The source power should not be adjusted following an IMD Cal.

3. Verify the following LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```
LO / RECEIVER SETUP
LO IS SOURCE = 3
LO CW MODE = ON
LO CW FREQUENCY = 3000 MHz
RCVR CONVERSION/DOWN
RETURN
```

4. Perform an IMD Cal. Connect a through line between the combining network and Port 2, including any attenuation that follows the DUT.

```
Appl/CHANGE APPLICATION SETUP/DEVICE TYPE=STANDARD
Cal/PERFORM CAL/IMD CAL
Avg/SELECT I.F. BANDWIDTH/I.F. BW 100 Hz
MEASURE DEVICE(S)
```

5. The MS462XX proceeds with the IMD Calibration.

```
EXIT
```

6. Return the Device Type Selection to Mixer for the measurement.

```
Appl/CHANGE APPLICATION SETUP/DEVICE TYPE=MIXER
```

7. Connect the mixer DUT with the IF at Port 2, the RF to the combining network, and the LO to the synthesizer.

8. Configure the 2-channel display for the Swept Mixer IMD measurement.

Display/DISPLAY MODE/DUAL CHANNELS 1&3

Ch 1

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/DISPLAY SELECTION

THIRD ORDER INTERMODULATION = PRODUCT

MEASURE RELATIVE TO = TONE 1 (UPPER PRODUCT)

MEAS. REFERENCE = OUTPUT

RETURN

Ch 3

Display/GRAPH TYPE/LOG MAGNITUDE

Appl/DISPLAY SELECTION

THIRD ORDER INTERMODULATION = PRODUCT

MEASURE RELATIVE TO = TONE 2 (LOWER PRODUCT)

MEAS. REFERENCE = OUTPUT

RETURN

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

9. Adjust the scales for the displays.

Ch 1

Display/SCALE

RESOLUTION = 5 dB/DIV

REFERENCE VALUE = -30 dBc

REFERENCE LINE = 4

Ch 3

Display/SCALE

RESOLUTION = 5 dB/DIV

REFERENCE VALUE = - 30 dBc

REFERENCE LINE = 4

NOTE

An Overlay Dual Channels display allows viewing of both upper and lower IMD products.

This completes the procedure for performing the Swept Mixer IMD, Fixed LO measurement using the MS462XX.

**Swept Mixer IMD,
Fixed IF**

A Swept Mixer IMD, Fixed IF measurement performs the measurement with the LO sweeping a fixed offset from the RF so that a fixed IF is observed. The results are displayed as IMD products versus frequency for a Fixed IF. This measurement shows the IMD Products for two input tones at 0 dBm to the combining network.

The device to be tested has a fixed IF of 500 MHz and a RF Range (at 0 dBm to the combining network) of 3200 to 3800 MHz. The LO range (at + 7 dBm) is set as a fixed offset (-500 MHz) from the RF or 2700 to 3300 MHz.

The following display shows a typical Swept Mixer IMD, Fixed IF measurement.

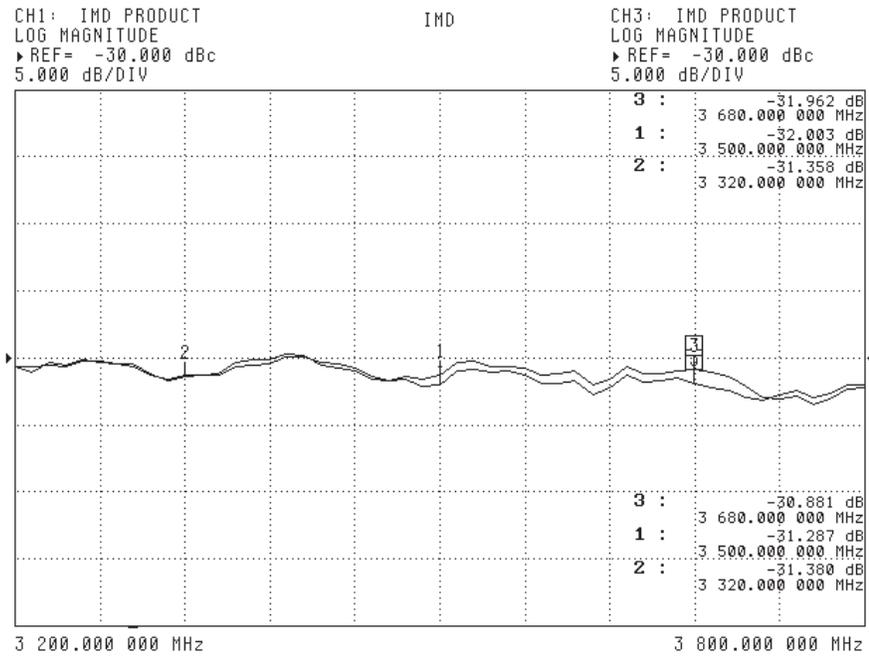


Figure 4-46. Swept Mixer IMD, Fixed IF Example Display

1. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```

LO / RECEIVER SETUP
LO IS SOURCE = 3
LO CW MODE = OFF
LO OFFSET FROM RF = -500 MHz
RCVR CONVERSION/DOWN
RETURN
    
```

NOTE

An IMD Cal allows input referred measurements. The source power should not be adjusted following an IMD Cal.

NOTE

Be careful in selecting the LO OFFSET FROM RF. The -500 MHz selection sets the LO range as 2700 to 3300 MHz. On the other hand, a +500 MHz selection would set the LO range as 3700 to 4300 MHz. Both of these frequency ranges produce the fixed IF of 500 MHz so careful selection of this setting ensures accurate measurements. The frequency display on the screen is still the RF frequency applied to the mixer DUT.

The frequency display on the screen is the RF frequency applied to the mixer DUT.

2. Perform an IMD Cal. Connect a through line between the combining network and Port 2, including any attenuation that follows the DUT.

```
Appl/CHANGE APPLICATION SETUP/DEVICE TYPE=STANDARD  
Cal/PERFORM CAL/IMD CAL  
Avg/SELECT I.F. BANDWIDTH/I.F. BW 100 Hz  
MEASURE DEVICE(S)
```

3. The MS462XX proceeds with the IMD Calibration.

```
EXIT
```

4. Return the Device Type Selection to Mixer for the measurement.

```
Appl/CHANGE APPLICATION SETUP/DEVICE TYPE=MIXER
```

5. Connect the mixer DUT with the IF at Port 2, the RF to the combining network, and the LO to the synthesizer.

This completes the procedure for performing the Swept Mixer IMD, Fixed IF measurement using the MS462XX.

2. Connect a through line between Port 1 and Port 2, including any attenuation that follows the DUT. The calibration gives the MS462XX the ability to measure absolute power in dBm.

Power/RECEIVER CAL/RECEIVER CAL
 BEGIN CAL
 RETURN

3. Return to the IMD application.

Appl/CHANGE APPLICATION SETUP/DEVICE TYPE = MIXER
 ENTRY STATE = PREVIOUS
 MEASUREMENT TYPE/IMD
 Power/RECEIVER CAL/RECEIVER CAL FOR PORT 2 = ON

4. Configure the 4-channel display for the Swept Two-Tone IMD Products measurement.

Display/DISPLAY MODE/FOUR CHANNELS
 Ch 1
 Appl/DISPLAY SELECTION
 THIRD ORDER INTERMODULATION = INTERCEPT
 MEASURE RELATIVE TO = TONE 1 (UPPER PRODUCT)
 MEAS. REFERENCE = OUTPUT
 RETURN
 Ch 3
 Appl/DISPLAY SELECTION
 THIRD ORDER INTERMODULATION = INTERCEPT
 MEASURE RELATIVE TO = TONE 2 (LOWER PRODUCT)
 MEAS. REFERENCE = OUTPUT
 RETURN

5. Adjust the scales for the displays.

Ch 1
 Display/SCALE
 RESOLUTION = 5 dB/DIV
 REFERENCE VALUE = 0 dBm
 REFERENCE LINE = 4
 Ch 3
 Display/SCALE
 RESOLUTION = 5 dB/DIV
 REFERENCE VALUE = 0 dBm
 REFERENCE LINE = 4

NOTE

The Reference Value of 0 dB actually represents 0 dBm due to the previously performed Receiver Cal.

NOTE

TOI is calculated as:

$$\frac{3P_{\text{TONE2}} - P_{\text{LOWER IMD}}}{2}$$

or

$$\frac{3P_{\text{TONE1}} - P_{\text{UPPER IMD}}}{2}$$

where the tone powers are in dBm.

**Frequency
Translated Group
Delay (FTGD)**

Option 5

Group delay is a common figure of merit used in determining how much distortion a given device will add to a communications system. Traditionally, this measurement was obtained from the change in phase over the change in frequency during a transmission measurement. While this method works well for non-frequency translating devices, it fails miserably with frequency translating devices as accurate and stable phase information is generally available.

FTGD, Fixed LO

In this example, the DUT is a mixer and a low pass filter functioning as a down converter. The RF frequency range for this test is 1900 MHz to 2150 MHz, the LO frequency is fixed at 1100 MHz resulting in an IF frequency range of 800 MHz to 1050 MHz. The RF power is -5 dBm while the LO power is $+7$ dBm. The corresponding conversion loss is roughly 6 dB.

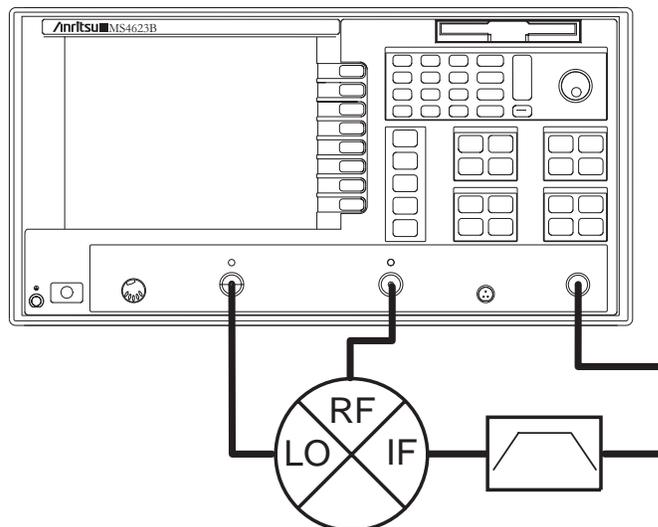


Figure 4-48. Mixer and LPF for FTGD Measurement

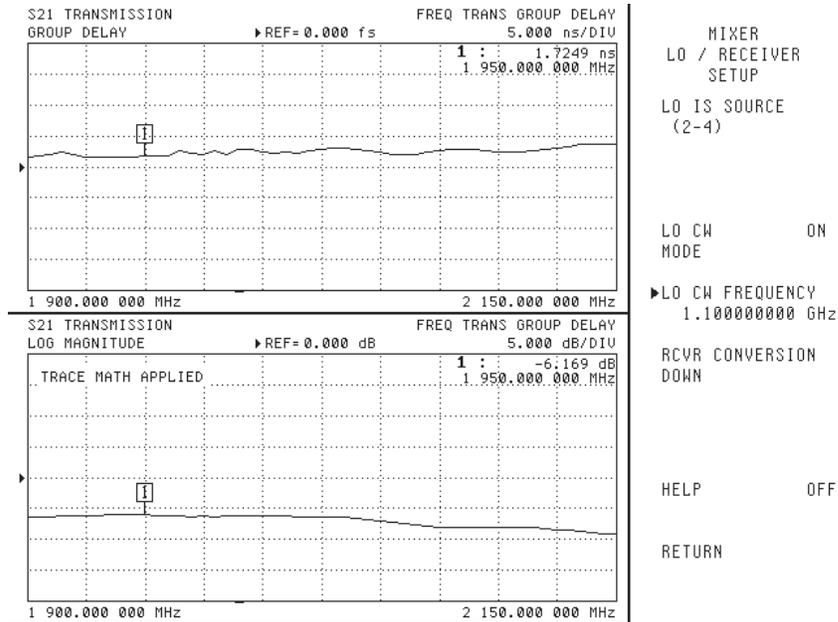


Figure 4-49. Frequency Translated Group Delay Measurement (Down conversion)

1. Press the Appl front panel key and select the menu soft keys as follows:
 - CHANGE APPLICATION SETUP
 - DEVICE TYPE / STANDARD
 - MEASUREMENT TYPE / FREQUENCY TRANSLATION GROUP DELAY
2. Press the Freq front panel key and select the menu soft keys as follows to set the RF frequency range for the mixer:
 - START = 1900 MHz
 - STOP = 2150 MHz
3. Press the Power front panel key and select the menu soft keys as follows. The resulting Port 1 output power should be -5 dBm.
 - SOURCE 1 SETUP
 - SOURCE 1 POWER = -5 dBm
 - PORT 1 ATTN = 0 dB
 - RETURN
4. Press the Config front panel key and select the menu soft keys as follows:
 - DATA POINTS
 - 51 MAX POINTS

NOTE

Ensure that the correct power levels are set before beginning the calibration. Altering levels after starting the calibration will invalidate the calibration.

NOTE

Wait for a sweep to complete before storing the trace to memory.

5. Press the Cal front panel key and select the menu soft keys as follows:

PERFORM CAL

6. Connect a through line between measurement ports 1 and 2 using the reference plane to which your DUT will be connected. A clicking sound may be heard during the calibration process. This is the instrument adjusting attenuator levels for optimum signal level, and is normal behavior. Select:

MEASURE DEVICE(S)

EXIT

7. Press the Avg front panel key and select the menu soft keys as follows:

SELECT I.F. BANDWIDTH

I.F. BW 100 Hz

8. Press the Ch3 front panel key.

9. This step normalizes the power seen at the receiver without the DUT connected, so that conversion loss can be directly read in the proceeding measurements. Press the Display front panel key and select the menu soft keys as follows:

TRACE MEMORY

STORE DATA TO MEMORY

DATA (/) MEMORY

RETURN

SCALE

RESOLUTION = 5 dB/DIV

RETURN

10. Press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP

DEVICE TYPE = MIXER

11. Press the Appl front panel key and select the menu soft keys as follows:

LO / RECEIVER SETUP

LO IS SOURCE = 2 (2ND internal source)

LO CW MODE = ON

LO CW FREQUENCY = 1100 MHz

RCVR CONVERSION = DOWN

RETURN

NOTE

The resulting Port 3 output power should be 7 dBm.

12. Press the Power front panel key and select the menu soft keys as follows:

SOURCE 2 SETUP
SOURCE 2 POWER = 7 dBm
PORT 3 ATTN = 0 dB
RETURN

13. Press the Ch1 front panel key.

14. Press the Display front panel key and select the menu soft keys as follows:

SCALE
RESOLUTION = 5 ns/DIV
RETURN

This completes a fixed LO frequency translated group delay measurement.

NOTE

As an alternative, phase can also be displayed by changing the graph type. In addition, quasi-absolute phase can be displayed (with firmware 1.17 and above) by selecting: Appl/ABSOLUTE PHASE = ON

4-9 GLOBAL POWER SWEEP

Standard Feature

NOTE

For more information, refer to the Anritsu Global Power Sweep Application Note (Anritsu part number: 11410-00243)

**Example 1:
AM/PM Measurement
of an Amplifier**

Standard Feature

The power sweep mode allows the following measurement possibilities:

- AM/PM measurements
- Gain compression measurements of mixers, sweeping the LO and/or the RF sources
- Reflection coefficients vs. power
- Mixer isolation vs. LO power
- Swept power harmonic measurements
- Swept power IMD and mixer IMD measurements

This section contains discussions, examples, and procedures related to the following applications:

- Standard T/R
- Mixer T/R
- Harmonic
- Non-mixer IMD and Mixer IMD

For a standard (non-mixer) T/R measurement, any of the usual calibration techniques may be applied (one-port, 12-term, etc.). If the power sweep is covering ranges close to +10 dBm, it may be desirable to perform the cal while in power sweep mode to remove some receiver compression effects (specified to be < 0.1-0.2 dB at +10 dBm port depending on model). In other situations, the calibration will be effectively power-independent assuming the step attenuator is not changed. Most of the measurements in this category will be akin to AM-AM or AM-PM conversion analysis and are useful for studying compression effects on linear parameters.

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

```
CHANGE APPLICATION SETUP
DEVICE TYPE = STANDARD
ENTRY STATE = CURRENT
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION
```

2. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

```
Freq/CW MODE=ON [1 GHZ]
Sweep/SWEEP TYPE = POWER SWEEP
Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +5 dBm
```

3. Press the Cal front panel key and select the menu soft keys as follows:
 - PERFORM CAL 2 PORT
 - NEXT CAL STEP
 - TRANSMISSION FREQUENCY RESPONSE
 - FORWARD PATH (S21)
 - EXCLUDE ISOLATION
 - NORMAL
 - NEXT CAL STEP
 - START CAL
4. Connect a thru line between port 1 and port 2 and select the menu soft keys as follows:
 - MEASURE DEVICE
 - NEXT CAL STEP
 - ENTER
5. To configure the display, select:
 - CH3
 - DISPLAY MODE/SINGLE CHANNEL
6. Press the Display front panel key and select the menu soft keys as follows:
 - GRAPH TYPE/LOG MAGNITUDE AND PHASE
7. Press the Meas front panel key and select the menu softkey:
 - S21
8. Connect the DUT between port 1 and port 2.
9. Press the Avg front panel key and select the appropriate IF bandwidth or averaging by selecting the following soft key:
 - SELECT IF BANDWIDTH

Figure 4-50 (page 4-84) shows an AM/PM measurement of an amplifier using a frequency response cal. Trace memory could be used to normalize the results to low power values if desired.

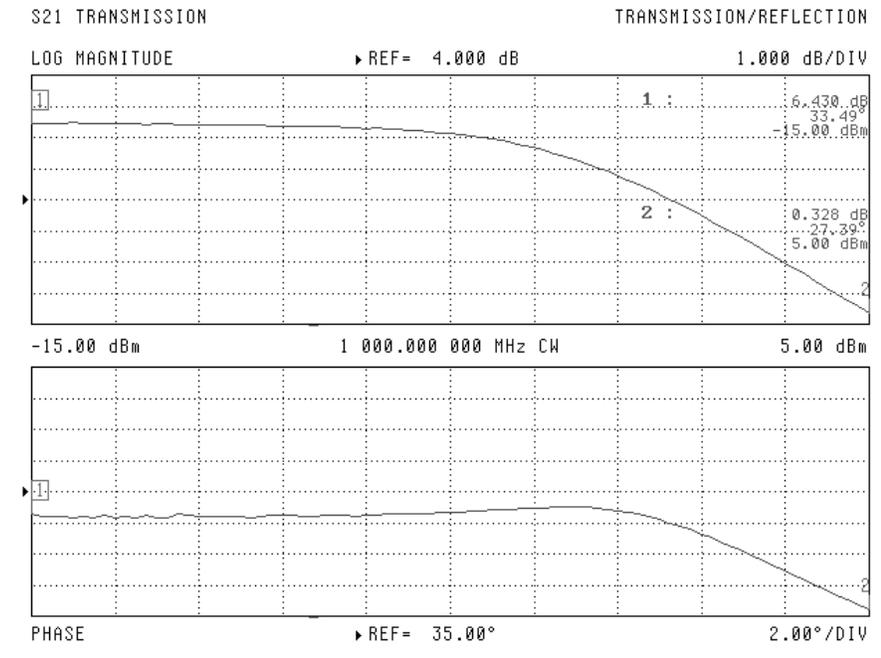


Figure 4-50. AM/PM Measurement of an Amplifier

*Example 2:
S21 and S11 vs.
Power of an
Amplifier*

Standard Feature

To enable this measurement, a full 12-term cal must be performed while in power sweep. The amplifier output should be padded to avoid compressing the receiver (normal specification for the MS462XX is 0.1 dB compression at 10 dBm receiver port power, depending on model).

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
DEVICE TYPE = STANDARD
ENTRY STATE = CURRENT
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

Freq/CW MODE=ON (0.994 GHz)
Sweep/SWEEP TYPE = POWER SWEEP
Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +10 dBm

3. Press the Cal front panel key and the following soft keys to perform a full 12-term cal excluding isolation:

PERFORM 2 PORT
NEXT CAL STEP
FULL 12 TERM/EXCLUDE ISOLATION/NORMAL
NEXT CAL STEP
START CAL

4. Follow the instructions on the screen. Refer to *Chapter 3, Calibration* for further details on calibration.

MEASURE DEVICE
NEXT CAL STEP
ENTER

5. Press the CH1 and Display front panel keys and the following soft keys to configure the display:

DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

6. Press the Display front panel key and the following soft keys:

GRAPH TYPE/LOG MAGNITUDE AND PHASE

7. Press the Meas front panel key and select the menu softkey:
S21
8. Press the Ch 3 and Display front panel keys and select the following menu soft keys:
GRAPH TYPE/LOG MAGNITUDE
9. Press the Meas front panel key and select the menu softkey:
S11
10. Connect the DUT between port 1 and port 2 and select the appropriate IF bandwidth or averaging by pressing:
Avg/SELECT IF BANDWIDTH

Figure 4-51 shows S11 and S21 for an amplifier during power sweep. A full 12-term cal was performed, while in power sweep, to enable this measurement. Again the amplifier output was padded to avoid compressing the receiver (normal specification for the MS462XX is 0.1 dB compression at 10 dBm receiver port power depending on model).

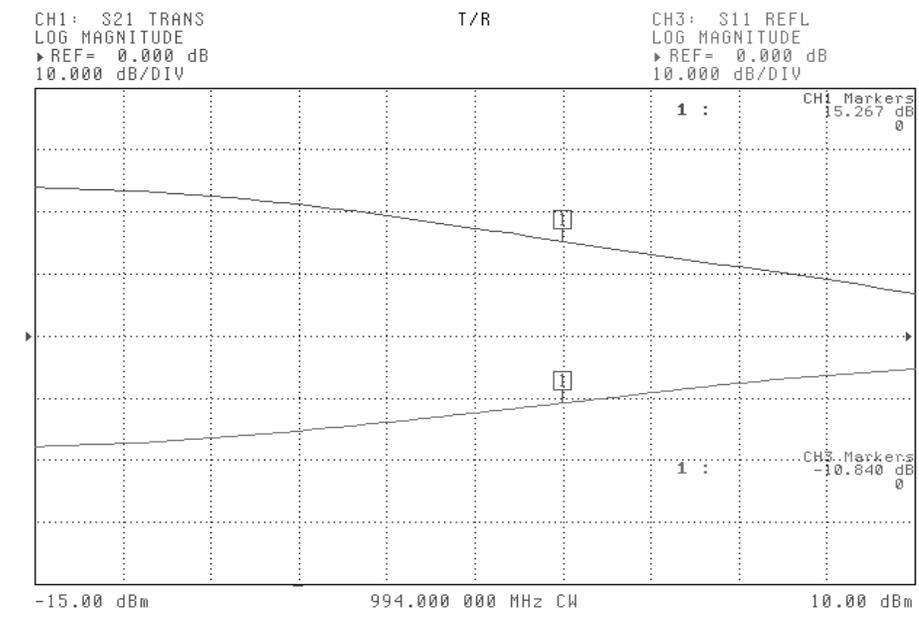


Figure 4-51. S21 and S11 for an Amplifier

**Example 3:
Mixer Conversion Loss with
RF Sweeping,
Fixed LO**
Standard Feature

The usual T/R calibrations apply to non-frequency translating mixer measurements and the receiver cal, discussed earlier, can apply to conversion gain measurements. It is important to note that the X-axis power variable always refers to source 1. Many of the measurements in this category are AM-AM in nature, although many effects of LO starvation/overdrive are also of interest. Since conversion measurements are un-ratioed, a direct AM-PM measurement cannot be made.

Figures 4-52 and 4-53 (pages 4-88 and 4-90) show the compression of conversion loss for a passive mixer with RF and LO sweeping, respectively. For these measurements, source 1 (1.1 GHz, driving port 1) is used as the RF, while source 2 (1.0 GHz, driving port 3) is used as the LO. The IF (100 MHz) receive port is port 2. In Figure 4-52, the LO is fixed at +10 dBm and the 1 dB compression point appears to occur when the RF is near +1 dBm.

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
 DEVICE TYPE = STANDARD
 ENTRY STATE = CURRENT
 MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. Press the Ch 3 and Meas front panel keys and select the following menu soft keys:

USER DEFINED/CHANGE RATIO
 B2/1
 USER 1
 Display/DISPLAY MODE/SINGLE CHANNEL
 Display/GRAPH TYPE/LOG MAGNITUDE

3. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

Freq/CW MODE=ON [1100 MHz]
 Sweep/POWER SWEEP
 Power/SELECT SOURCE = 1
 START = -15 dBm
 STOP = +5 dBm
 SELECT SOURCE = 2
 STOP = +10
 SINGLE POWER ON = +10 dBm

NOTE
 A receiver cal can be done here, even if a receiver cal was previously done. To do so, first disable CW mode and then enter a range between 100 and 1100 MHz.

4. Connect a thru line between port 1 and port 2.
5. Perform a thru normalization to trace memory while in standard mode by pressing the Display front panel key and the following soft keys:

TRACE MEMORY/STORE DATA TO MEMORY
DATA (/) MEMORY

6. Press the Appl front panel key and the following soft keys to enable mixer mode and set up the LO:

CHANGE APPLICATION SETUP
DEVICE TYPE = MIXER
Appl/LO/RECEIVER SETUP
LO IS SOURCE = 2
LO CW MODE = ON
LO CW FREQUENCY = 1000 MHz
RCVR CONVERSION = DOWN
RETURN

7. Connect the mixer to measure (IF to Port 2, RF to Port 1, LO to Port 3).
8. Select IFBW/Averaging to suit.

Figure 4-52 shows the mixer conversion loss compression with the RF sweeping. All frequencies are CW and the LO is fixed at +10 dBm. Receiver cal and trace memory normalization were used to make the measurement.

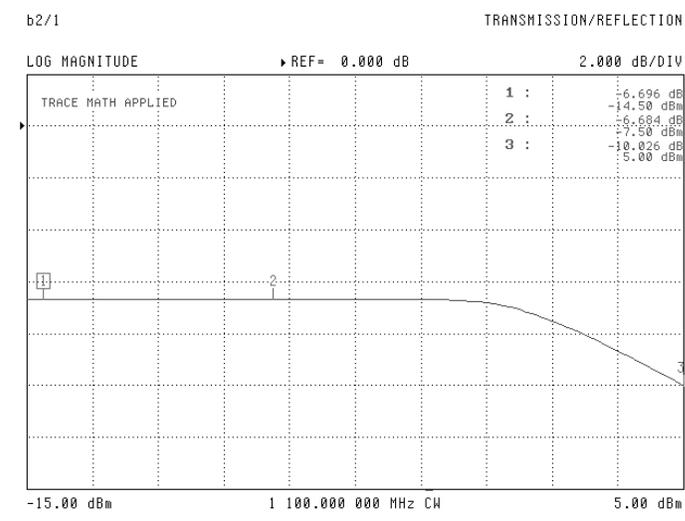


Figure 4-52. Mixer Conversion Loss with RF Sweeping

Example 4:
Mixer Conversion
Loss LO Sweeping,
Fixed RF
Standard Feature

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
DEVICE TYPE = STANDARD
ENTRY STATE = CURRENT
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. Press the Ch 3 and Meas front panel keys and select the following menu soft keys:

USER DEFINED/CHANGE RATIO
B2/1
USER 1
Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE

3. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

Freq/CW MODE=ON [1100 MHz]
Sweep/POWER SWEEP
Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +10 dBm
SELECT SOURCE = 2
STOP = +10
SINGLE POWER ON = +10 dBm

4. Connect a thru line between port 1 and port 2.
5. Perform a thru normalization to trace memory while in standard mode by pressing the Display front panel key and the following soft keys:

TRACE MEMORY/STORE DATA TO MEMORY
DATA (/) MEMORY

NOTE

A receiver cal can be done here, even if a receiver cal was previously done. To do so, first disable CW mode and then enter a range between 100 and 1100 MHz.

- Press the Appl front panel key and the following soft keys to enable mixer mode and set up the LO:

```

CHANGE APPLICATION SETUP
DEVICE TYPE = MIXER
Appl/LO/RECEIVER SETUP
LO IS SOURCE = 2
LO CW MODE = ON
LO CW FREQUENCY = 1000 MHz
RCVR CONVERSION = DOWN
RETURN
    
```

- Connect the mixer to measure (IF to Port 2, RF to Port 1, LO to Port 3).
- Select IFBW/Averaging to suit.

Figure 4-53 shows mixer conversion loss compression with the LO sweeping. The RF is fixed at -5 dBm and all frequencies are CW. The LO sweep range can be determined from the menu bar at the right (-15 dBm \rightarrow $+10$ dBm or 2.5 dB/div). As is consistent with Figure x, the mixer is only operating 'normally' when the LO power is approximately 10 dB greater than the RF power.

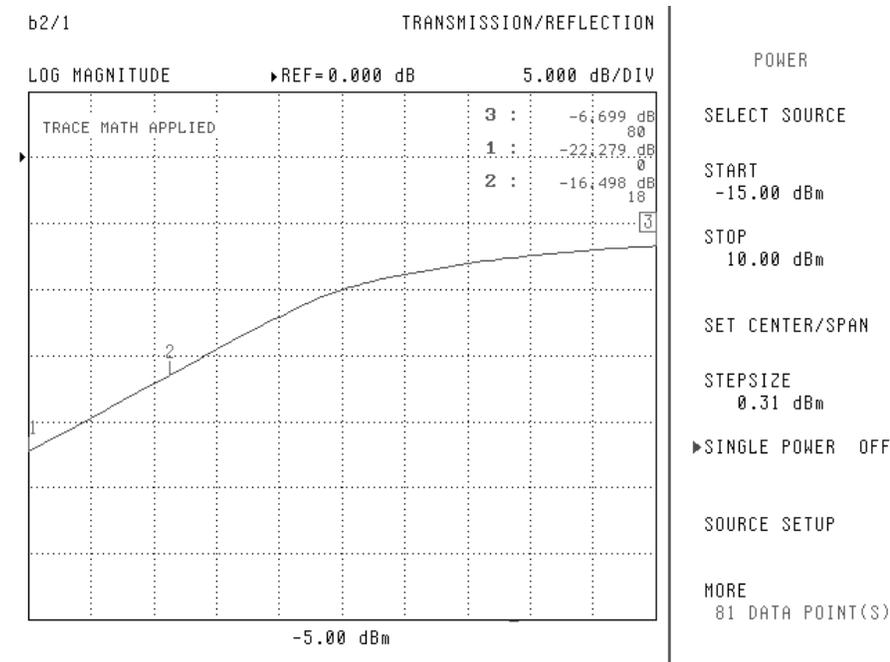


Figure 4-53. Mixer Conversion Loss Compression with the LO Sweeping

***Example 5:
Mixer Isolation
as a Function of
LO Drive***
Standard Feature

Another mixer measurement of interest is isolation. If the mixer output is weak, imbalances become more obvious and leakage can change. In the case of Figure 4-54, the RF is fixed and the LO power is swept (over the same -15 -> +10 dBm range as in Figure 4-53). The RF->IF isolation is a function of LO drive, and many other isolation measurement combinations are possible.

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
DEVICE TYPE = STANDARD
ENTRY STATE = CURRENT
MEASUREMENT TYPE/TRANSMISSION AND REFLECTION

2. Press the Ch 3 and Meas front panel keys and select the following menu soft keys:

Meas/S21, TRANS b2/a1
Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE

3. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

Freq/CW MODE=ON [1100 MHz]
Sweep/POWER SWEEP
Power/SELECT SOURCE = 2
START = -15 dBm
STOP = +10 dBm
SELECT SOURCE = 1
STOP = 0 dBm
SINGLE POWER ON = 0 dBm

4. Press the Cal front panel key and the following soft keys to perform a forward frequency calibration:

PERFORM CAL 2 PORT
NEXT CAL STEP
TRANSMISSION FREQUENCY RESPONSE
FORWARD PATH (S21)
EXCLUDE ISOLATION
SINGLE POWER (1 POINT)
NEXT CAL STEP
START CAL

5. Connect a thru line between port 1 and port 2.

MEASURE DEVICE
 NEXT CAL STEP
 ENTER

6. Press the Appl front panel key and the following soft keys to enable mixer mode and set up the LO:

CHANGE APPLICATION SETUP
 DEVICE TYPE = MIXER
 Appl/LO/RECEIVER SETUP
 LO IS SOURCE = 2
 LO CW MODE = ON
 LO CW FREQUENCY = 1000 MHz
 RCVR CONVERSION = NONE
 RETURN

7. Connect the mixer to measure (IF to Port 2, RF to Port 1, LO to Port 3).

8. Select IFBW/Averaging to suit.

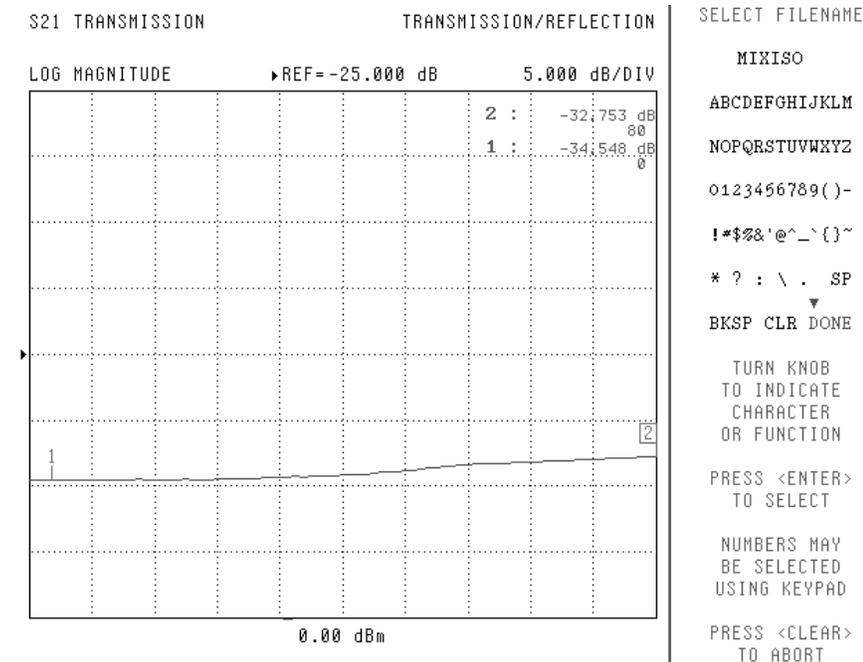


Figure 4-54. Mixer Isolation as a Function of LO Drive

**Example 6:
Swept Power
Harmonic
Measurements**
Option 8

Since harmonic output is often a strong function of drive power, this measurement may be used as a coarse analysis of distortion. Both scalar and enhanced measurements are possible where scalar measurements are often made with trace memory normalization to achieve values relative to the fundamental. The enhanced calibration removes the effects of source harmonics. Since the source harmonics are a function of power level, it is critical that this calibration be performed while in power sweep mode.

Figure 4-55 illustrates a simple scalar harmonic measurement. Trace memory normalization was used to produce the desired relative output (memory stored when harmonic=1, then switch to harmonic=2). As in frequency sweep, low level scalar harmonic measurements may be limited by source harmonics, but these are quick measurements to make.

1. To select transmission and reflection mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
MEASUREMENT TYPE
TRANSMISSION AND REFLECTION

2. Press the following front panel keys and select the following menu soft keys:

Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE
Meas/S21

3. To configure the MS462XX for Power Sweep, press the following front panel and soft keys:

Freq/CW MODE=ON [1 GHz]
Sweep/POWER SWEEP
Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +5 dBm

4. Press the Appl front panel key and the following soft keys to select swept harmonics:

CHANGE MEASUREMENT TYPE/HARMONIC
SWEEP MODE/SOURCE
HARMONIC SETUP/HARMONIC = 1

NOTE
Make sure SOURCE is selected in HARMONIC SWEEP mode, not CW RCVR.

5. With the DUT connected, press the following front panel and soft keys for normalization:

Display/TRACE MEMORY/STORE DATA TO MEMORY
DATA (/) MEMORY

6. Select Harmonic 2 by pressing the following front panel and soft keys:

Appl/HARMONIC SETUP/HARMONIC = 2

7. Select IF bandwidth or averaging by pressing the following front panel and soft keys:

Avg/SELECT IF BANDWIDTH

Figure 4-55 presents a scalar second harmonic measurement of an amplifier. The results are in dBc relative to the fundamental due to a trace memory normalization.

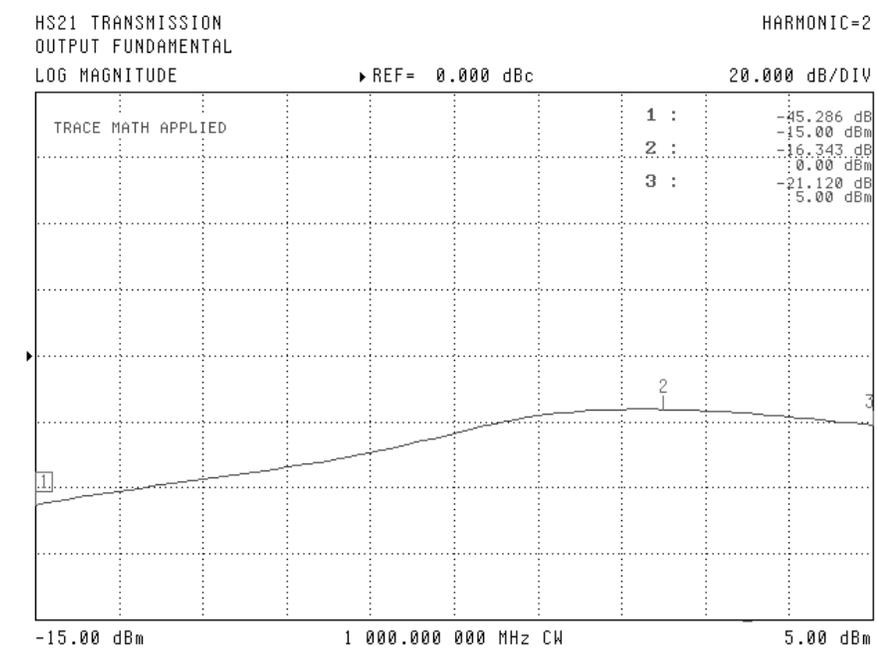


Figure 4-55. *Scalar Second Harmonic Measurement of an Amplifier*

*Example 7:
Enhanced Sec-
ond Harmonic
Measurement of
an Amplifier*

Option 8

This example shows the application of the harmonic enhancement cal within power sweep. As with the frequency sweep version, the enhancement cal removes the effects of source harmonics in a vector fashion. The second harmonic of an amplifier is shown in Figure 4-56. If a scalar measurement were used on this amplifier, the error would have been 2-3 dB at the low end. Approximately 60 dB of dynamic range is available when using this calibration.

This example builds on the previous example for Swept Power Harmonic Measurements and assumes the MS462XX is already in Power Sweep mode.

1. Press the following front panel and soft keys:

Freq/CW MODE=ON [1.120 GHz]

Appl/HARMONIC SETUP/DISPLAY OUTPUT RELATIVE TO OUTPUT FUNDAMENTAL

HARMONIC = 2

Meas/S21

2. To set the power sweep values, press the following front panel and soft keys:

Power/SELECT SOURCE = 1

START = -15 dBm

STOP = +5 dBm

3. For performance enhancement, press the following front panel and soft keys:

Cal/CALIBRATE/ENHANCEMENT CAL

4. Connect a thru line between port 1 and port 2.

MEASURE DEVICE

5. Connect a short to port 1 and port 2.

MEASURE DEVICE NEXT CAL STEP EXIT

6. Connect the DUT between port 1 and port 2 and select the appropriate IF bandwidth or averaging by pressing:

Avg/SELECT IF BANDWIDTH

Figure 4-56, page 4-96, shows an enhanced second harmonic measurement of an amplifier. The results are referenced, as is common, to the output fundamental.

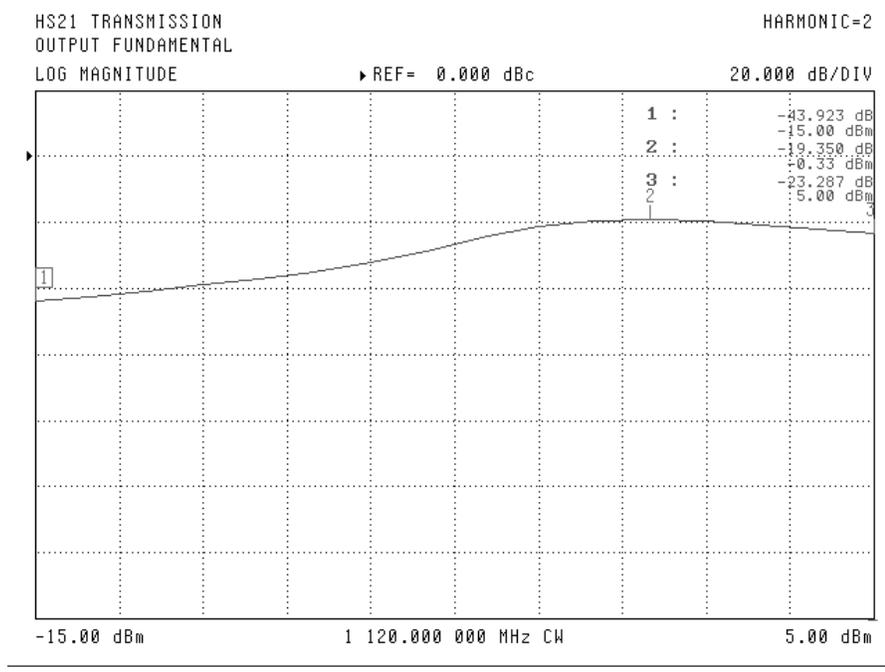


Figure 4-56. Enhanced Second Harmonic Measurement of an Amplifier

**Example 8:
Swept Power
IMD and Mixer
IMD
Measurements**

Option 8

All IMD products and intercepts can be computed during a power sweep and can provide a powerful tool for distortion analysis. Receiver cal and IMD cal are available for use in input-referred measurements. The IMD cal should be performed while in power sweep. It is often useful to examine IMD products versus power, since they rarely follow the simplistic linear power dependence due to the presence of multiple non-linearities of a given order and the interaction of different order non-linearities.

The first example in this section is of the third through ninth intermodulation products (odd orders only) of an amplifier. A receiver cal was used for this measurement. Above about -5 dBm input power, this amplifier is extremely non-linear as is evidenced by the magnitude of the intermodulation products. The shapes of the higher order product curves during power sweep are of particular interest in optimizing amplifier performance.

This example assumes the previous examples have been done and the MS462XX is in Power Sweep mode.

NOTE
Make sure SWEEP MODE is set to SOURCE, not CW RCVR.

NOTE
Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

1. To select IMD mode, press the Appl front panel key and select the menu soft keys as follows:

CHANGE APPLICATION SETUP
MEASUREMENT TYPE/IMD

2. To set the CW frequency, press the following front panel and soft keys:

Freq/CW MODE=ON [1 GHz]

3. Press the Appl front panel key and the following soft keys:

SWEEP MODE = SOURCE
DISPLAY SELECTION/PRODUCT
MEASURE RELATIVE TO TONE 1
OUTPUT = REFERENCE
RETURN
TONE 2 OFFSET = 1 MHz

4. Connect a combiner inputs to port 1 and port 3, and the DUT output to port 2.

5. To set up swept power, press the following front panel and soft keys:

Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +5 dBm

6. To configure the display, press the following front panel and soft keys:

Display/DISPLAY MODE/FOUR CHANNELS

7. Press the Ch 1 and Appl front panel keys and select the following menu soft keys:
 - IMD ORDER = 3
8. Press the Ch 2 then the Appl front panel keys and select the following menu soft keys:
 - IMD ORDER = 5
 - SWEEP MODE = SOURCE
 - DISPLAY SELECTION/PRODUCT
 - MEASURE RELATIVE TO TONE 1
 - OUTPUT = REFERENCE
 - RETURN
 - TONE 2 OFFSET = 1 MHz
9. Press the Ch 3 and Appl front panel keys and select the following menu soft keys:
 - IMD ORDER = 7
 - SWEEP MODE = SOURCE
 - DISPLAY SELECTION/PRODUCT
 - MEASURE RELATIVE TO TONE 1
 - OUTPUT = REFERENCE
 - RETURN
 - TONE 2 OFFSET = 1 MHz
10. Press the Ch 4 and Appl front panel keys and select the following menu soft keys:
 - IMD ORDER = 9
 - SWEEP MODE = SOURCE
 - DISPLAY SELECTION/PRODUCT
 - MEASURE RELATIVE TO TONE 1
 - OUTPUT = REFERENCE
 - RETURN
 - TONE 2 OFFSET = 1 MHz
11. Press the Display front panel key and select the following menu soft keys:
 - GRAPH TYPE/LOG MAGNITUDE
 - SCALE/RESOLUTION = 20 dB/div
12. Select IFBW/Averaging to suit.

Figure 4-57 shows the third through ninth (odd) order intermodulation products of an amplifier. Two equal tones were applied (X-axis refers to the power of tone 1) with a tone 1 frequency of 1 GHz.

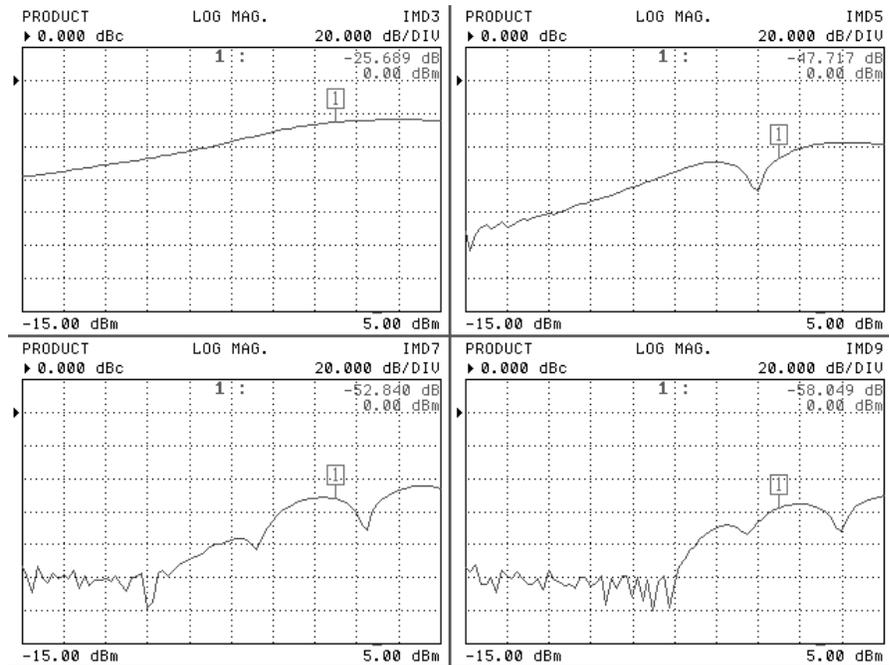


Figure 4-57. Third Through Ninth (odd) Order Intermodulation Products of an Amplifier

Example 9:
Input
Referenced IP3

Option 13

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

As is obvious, the curves in the previous example are not simple straight lines as expected from a naive analysis. This impacts the interpretation of an intercept calculation, which is a simple single point extrapolation, as shown in Figure 4-58. The displayed intercept is calculated from the intermodulation product (and main tone power) at that given power point using a linear model. For this reason, the intermodulation product curves of Figure 4-57 are often preferred for analysis.

1. To configure the display, press the following front panel and soft keys:

Display/DISPLAY MODE/SINGLE CHANNEL

Freq/CW MODE ON = 1 GHz

2. Press the Appl front panel key and select the following menu soft keys to set up the IP3 requirements:

TONE 2 OFFSET = 1 MHz

IMD ORDER = 3

DISPLAY SELECTION = INTERCEPT

RELATIVE TO TONE 1

MEASURE REFERENCE = INPUT

RETURN

3. Press the Power front panel key and select the following menu soft keys to configure power sweep:

SELECT SOURCE = 1

START = -15 dBm

STOP = +5 dBm

SELECT SOURCE = 2

START = -15 dBm

STOP = +5 dBm

4. Connect a thru line from the output of the combiner to port 2.
5. Press the Cal front panel key and select the following menu soft keys to perform an IMD cal:

PERFORM CAL

IMD CAL

MEASURE DEVICES

EXIT

6. Connect the DUT between the combiner and port 2.
7. Select IFBW/Averaging to suit.

Figure 4-58 shows an input-referred third order intercept point plot where the IMD calibration was done while in power sweep. If the amplifier was non-linear, this power sweep would be flat. As the power level increases, the extrapolation used in computing the intercept becomes increasingly power dependent.

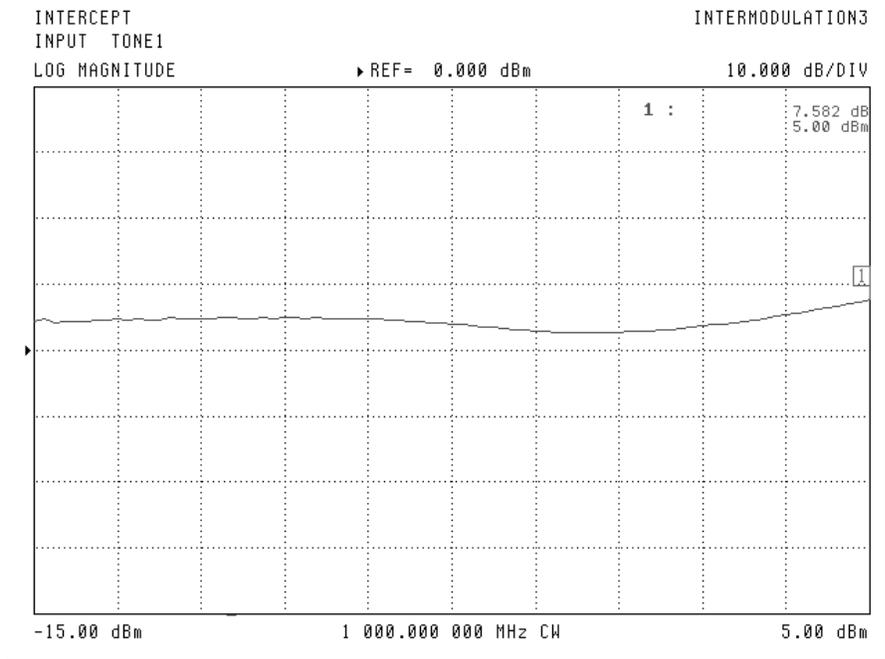


Figure 4-58. Input-Referred Third Order Intercept Point Plot

**Example 10:
IMD Products**

Option 13

In both of the previous examples, tone 1 and tone 2 swept over the exact same power ranges. Sometimes, a more general sweep is desired (may be required by a given standard) and almost any linear relationship is possible (as long as both sources remain in their respective ALC control ranges). Figure 4-59 contains a plot of the third order IMD product when source 2 sweeps at a fixed offset of -5 dB relative to source 1. It is possible for the sources to sweep over entirely different ranges, with different step sizes, as long as the number of power points are the same. Both IMD products are shown in Figure 4-59 since they will not be the same in this case. The upper curve is the upper sideband (relative to tone 1) while the lower curve is the lower sideband relative to tone 2. The effect of the asymmetry is quite clear in this example.

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

1. In IMD power sweep, configure the CW frequency to 1.12 GHz, and configure the IMD setup and display as follows:

```
Freq/CW MODE = ON (1.12 GHz)
Appl/TONE 2 OFFSET = 3 MHz
CH1
DISPLAY SELECTION = PRODUCT
RELATIVE TO TONE 2
MEAS REFERENCE = OUTPUT
CH3
DISPLAY SELECTION = PRODUCT
RELATIVE TO TONE 2
MEAS REFERENCE = OUTPUT
Display/DISPLAY MODE/DUAL CHANNELS 1&3
Display/GRAPH TYPE/LOG MAGNITUDE
CH1
Display/GRAPH TYPE/LOG MAGNITUDE
```

2. Configure power sweep by pressing:

```
Power/SELECT SOURCE = 1
START = -10 dBm
STOP = +5 dBm
SELECT SOURCE = 2
START = -15 dBm
STOP = 0 dBm
```

3. Connect combiner inputs to port 1 and port 3, and the DUT output to port 2.
4. Select IFBW/Averaging to suit.

Figure 4-59, page 4-103, shows the upper and lower IMD3 products for asymmetric drive. Tone 2 is swept at a -5 dB offset relative to tone 1, although any linear relationship is allowed.

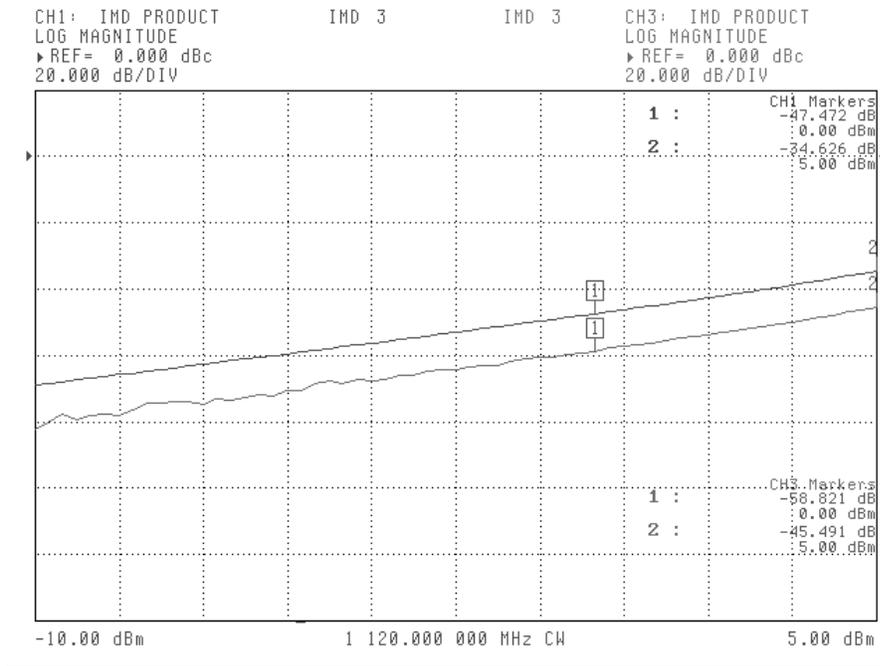


Figure 4-59. Upper and Lower IMD3 Products for Asymmetric Drive

Example 11:
IMD 3 for a Pas-
sive Mixer

Option 13

In mixer IMD measurements, the RF will usually be swept, and the corresponding IMD/IP products observed. Sometimes it may be interesting to sweep the LO alone (or in combination with sweeping the RF) to observe the effects of LO starvation or due to some power coupling of the practical signal sources. In all of the mixer examples to follow; a simple, passive doubly-balanced mixer was employed. Because of current control restrictions, the examples are set up so that the external synthesizer is not sweeping power.

Figure 4-60 shows the case of a fixed LO (source 3, an external synthesizer) at 900 MHz and +10 dBm. The two RF tones, from sources 1 and 2, are swept (equal amplitude this time) and the IMD3 product is plotted. As might be expected from the earlier conversion loss compression measurements, the distortion increases significantly as the RF power gets within about 10 dB of the LO power for this passive mixer.

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

NOTE

Verify that the 10 MHz cable to the external synthesizer is connected.

1. In IMD power sweep, configure the CW frequency to 1 GHz, configure the IMD setup and display as follows:

```
Freq/CW MODE = ON (1 GHz)
Appl/TONE 2 OFFSET = 3 MHz
CH1
IMD ORDER = 3
DISPLAY SELECTION = PRODUCT
RELATIVE TO TONE 1
MEAS REFERENCE = OUTPUT
Display/DISPLAY MODE/SINGLE CHANNEL
Display/GRAPH TYPE/LOG MAGNITUDE
```

2. Refer to the Mixer Setup Considerations on page 4-65, and Figure 4-44 on page 4-68.
3. Verify Source 3 indicates ACTIVE configuration. This ACTIVE configuration requires a GPIB connection between the Dedicated GPIB of the MS462XX and the GPIB of the synthesizer. If Source 3 is not active, see the previous discussion for setup considerations.

```
Config/SOURCE/SOURCE 3 = ACTIVE
```

4. Connect 10 MHz reference from synthesizer to MS462XX. Transfer the Reference Frequency for the MS462XX from Internal to External
5. Press the Appl front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement.

```
Utility/REAR PANEL/REFERENCE FREQUENCY = EXTERNAL
CHANGE APPLICATION SETUP
DEVICE TYPE = MIXER
```

6. Ensure that Tone 1 is Source 1, Tone 2 is Source 2, and LO is Source 3. In addition, verify that the Selection Mode is APPLY.

```
SOURCE SELECTION
TONE 1 IS SOURCE = 1
TONE 2 IS SOURCE = 2
LO IS SOURCE = 3
SELECTION MODE = APPLY
RETURN
```

7. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```
LO / RECEIVER SETUP
LO CW MODE = ON
LO CW FREQUENCY = 900 MHz
RCVR CONVERSION/DOWN
RETURN
```

8. Configure power sweep by pressing:

```
Power/SELECT SOURCE = 1
START = -15 dBm
STOP = +5 dBm
SELECT SOURCE = 2
START = -15 dBm
STOP = +5 dBm
SELECT SOURCE = 3
SINGLE POWER ON = +10 dBm
```

9. Connect the combiner output to the DUT RF, source 3 to DUT LO, and port 2 to DUT IF, as shown in Figure 4-44 on page 4-68.

10. Select IFBW/Averaging to suit.

Figure 4-60 shows the IMD3 product for a passive mixer with fixed LO drive (+10 dBm). The two RF tones are swept as shown (equal amplitude).

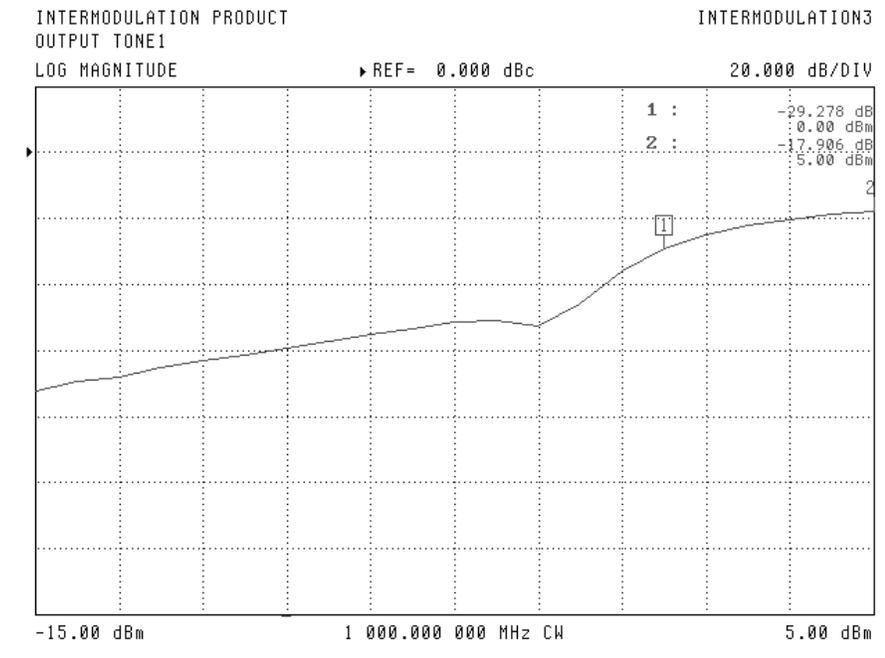


Figure 4-60. IMD3 Product for a Passive Mixer with Fixed LO Drive (+10 dBm)

**Example 12:
IMD 3 Product
for a Passive
Mixer with
Fixed RF Tones**

Another option is to fix the RF tones (at 1 GHz and 1.003 GHz respectively, -10 dBm each) and sweep the LO power. Sources 1 and 3 were used for the RF tones and source 2 was used as the LO in this case although that is not a requirement. Again an IF of 100 MHz is used for this example mixer. The LO sweep range is indicated in the menu at the right and although guaranteed port power is only +10 dBm for this instrument, 15 dBm was available at this frequency (maximum power and frequencies at which they occur may vary). The distortion asymptotes to a reasonably low value as the LO drive reaches a sufficiently high level.

NOTE

Avoid specifying offsets that are multiples of 125 kHz. These frequencies may create an image problem if the IMD products to be observed are very small. Verify IMD products before measurements by connecting a thru between the combining network and Port 2. Changing the offset frequency by as little as 1 kHz can improve the IMD performance.

NOTE

Verify that the 10 MHz cable to the external synthesizer is connected.

1. In IMD power sweep, configure the CW frequency to 16 GHz, configure the IMD setup and display as follows:
 - Freq/CW MODE = ON (1 GHz)
 - Appl/TONE 2 OFFSET = 3 MHz
 - CH1
 - IMD ORDER = 3
 - DISPLAY SELECTION = PRODUCT
 - RELATIVE TO TONE 1
 - MEAS REFERENCE = OUTPUT
 - Display/DISPLAY MODE/SINGLE CHANNEL
 - Display/GRAPH TYPE/LOG MAGNITUDE
2. Refer to the Mixer Setup Considerations on page 4-65, and Figure 4-44 on page 4-68.
3. Verify Source 3 indicates ACTIVE configuration. This ACTIVE configuration requires a GPIB connection between the Dedicated GPIB of the MS462XX and the GPIB of the synthesizer. If Source 3 is not active, see the previous discussion for setup considerations.
 - Config/SOURCE/SOURCE 3 = ACTIVE
4. Connect 10 MHz reference from synthesizer to MS462XX. Transfer the Reference Frequency for the MS462XX from Internal to External
 - Utility/REAR PANEL/REFERENCE FREQUENCY = EXTERNAL
5. Press the Appl front panel key and select the menu soft keys as follows to prepare the MS462XX for the measurement.
 - CHANGE APPLICATION SETUP
 - DEVICE TYPE = MIXER
 - MEASUREMENT TYPE/IMD

6. Ensure that Tone 1 is Source 1, Tone 2 is Source 2, and LO is Source 3. In addition, verify that the Selection Mode is APPLY.

```
SOURCE SELECTION
TONE 1 IS SOURCE = 1
TONE 2 IS SOURCE = 2
LO IS SOURCE = 3
SELECTION MODE = APPLY
RETURN
```

7. Proceed with LO / Receiver setup by selecting the Appl front panel key and select the menu soft keys as follows:

```
LO / RECEIVER SETUP
LO CW MODE = ON
LO CW FREQUENCY = 1003 MHz
RCVR CONVERSION/DOWN
RETURN
```

8. Configure power sweep by pressing:

```
Power/SELECT SOURCE = 2
START = -5 dBm
STOP = +15 dBm
SELECT SOURCE = 1
SINGLE POWER ON = -10 dBm
SELECT SOURCE = 3
SINGLE POWER ON = -10 dBm
```

NOTE

+15 dBm may not be possible with some models. Reduce the level as necessary.

9. Connect port 1 and Source 3 to the combiner inputs.
10. Connect the combiner output to the DUT RF.
11. Connect port 3 to the DUT LO.
12. Connect port 2 to the DUT IF.
13. Select IFBW/Averaging to suit.

Figure 4-61, page 4-109, shows the IMD3 product for a passive mixer with fixed RF tones (-10 dBm). The LO power is swept from -5 to +15 dBm and all frequencies are CW.

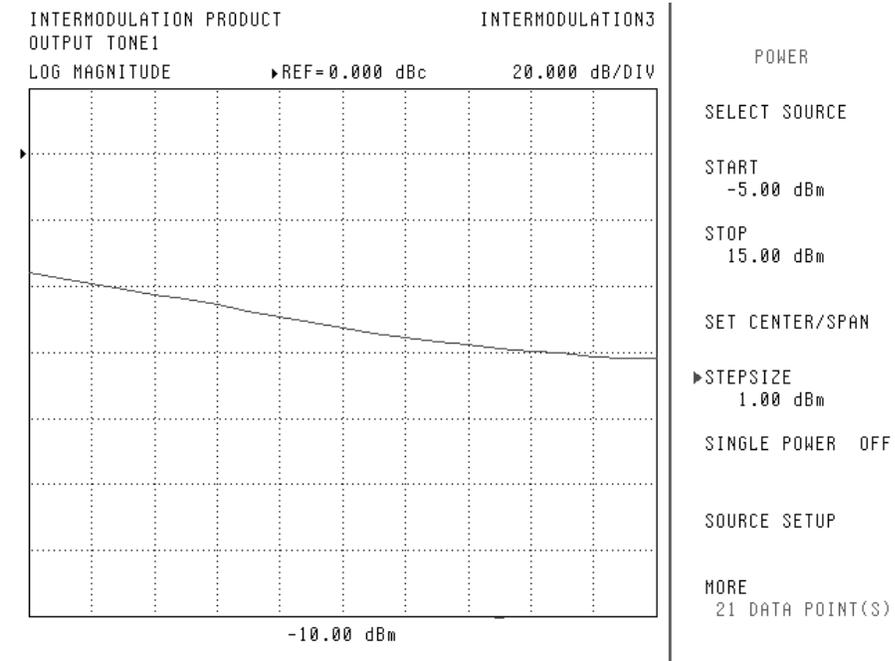


Figure 4-61. IMD3 Product for a Passive Mixer with Fixed RF Tones (-10 dBm)

Chapter 5

Balanced Measurements

5-1 INTRODUCTION

The MS462XX is capable of balanced S-parameter measurements for both three-port and four-port applications. This chapter contains discussions, examples, and procedures related to the following applications:

- ❑ Three-Port Balanced Measurement of Mixed Mode S-parameters
- ❑ Four-Port Balanced Measurement of Mixed Mode S-parameters

Each application discussion provides a typical measurement result and the procedures used to achieve this result. For more information, refer to the following Anritsu Application Notes:

- ❑ Three and Four Port S-parameter Measurements (11410-00279)
- ❑ Embedding/De-embedding (11410-00278)
- ❑ Arbitrary Impedance (11410-00284)

5-2 THREE-PORT BALANCED MEASUREMENT

This section shows how to extract Mixed Mode S-parameters from a three-port balanced device, in this case a balun. A balun is a network or device used for the transformation from a balanced transmission line or system to an unbalanced line or system, or vice versa.

It is important that the single-ended port of the device under test (DUT) be connected to Port 1 of the MS462XX and the remaining ports connected to Ports 2 and 3 of the MS462XX (see Figure 5-1).

The three-port Mixed Mode S-parameters are:

S1D S1C SD1 SC1 SDD SCC SDC SCD

For three-port balanced measurements, it is crucial that the unbalanced port of the DUT be connected to Port 1 of the VNA.

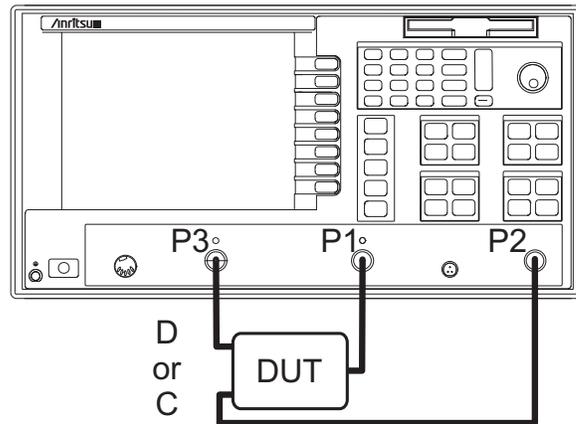


Figure 5-1. *Three-Port Balanced Measurement Setup
(Including differential and common-mode virtual-node designators)*

To perform a three-port balanced measurement of Mixed Mode S-parameters:

1. Perform a three-port calibration (refer to Section 3-6).
2. Connect the DUT as shown in Figure 5-1. Make sure that the unbalanced port of the device is connected to Port 1 of the MS462XD.
3. Select CH1 and press the Meas front panel key.
4. Select the menu soft keys as follows:
S21, TRANS b2/a1
5. Press the Display front panel key and the following menu soft keys:
GRAPH TYPE/MORE/LINEAR MAGNITUDE AND PHASE.
6. Select CH2 and press the Meas front panel key.
7. Select the menu soft keys as follows:
MIXED MODE S-PARAMETER/SD1 DIFF. MODE
8. Press the Display front panel key and the following menu soft keys:
GRAPH TYPE/MORE/LINEAR MAGNITUDE AND PHASE.
9. Select CH3 and press the Meas front panel key.
10. Select the menu soft keys as follows:
MORE/S31

BALANCED MEASUREMENTS THREE-PORT BALANCED MEASUREMENT

11. Press the Display front panel key and the following menu soft keys:
GRAPH TYPE/MORE/LINEAR MAGNITUDE AND PHASE.
12. Select CH4 and press the Meas front panel key.
13. Select the menu soft keys as follows:
MIXED MODE S-PARAMETER/SC1 COMMON MODE.
14. Press the Display front panel key and the following menu soft keys:
GRAPH TYPE/MORE/LINEAR MAGNITUDE AND PHASE.
15. Press the Marker front panel key and the following menu soft keys:
READOUT MARKERS/1 = ON
16. Enter 998.35 MHz for the frequency.
17. Press the Marker front panel key and the following menu soft keys:
SCREEN DISPLAY = ON

Figure 5-2 shows that S21 and S31 have nearly the same magnitude and are approximately 180 degrees out of phase, which is typical of baluns. As would be expected of a differential device, SD1 is large in magnitude and SC1 is small.

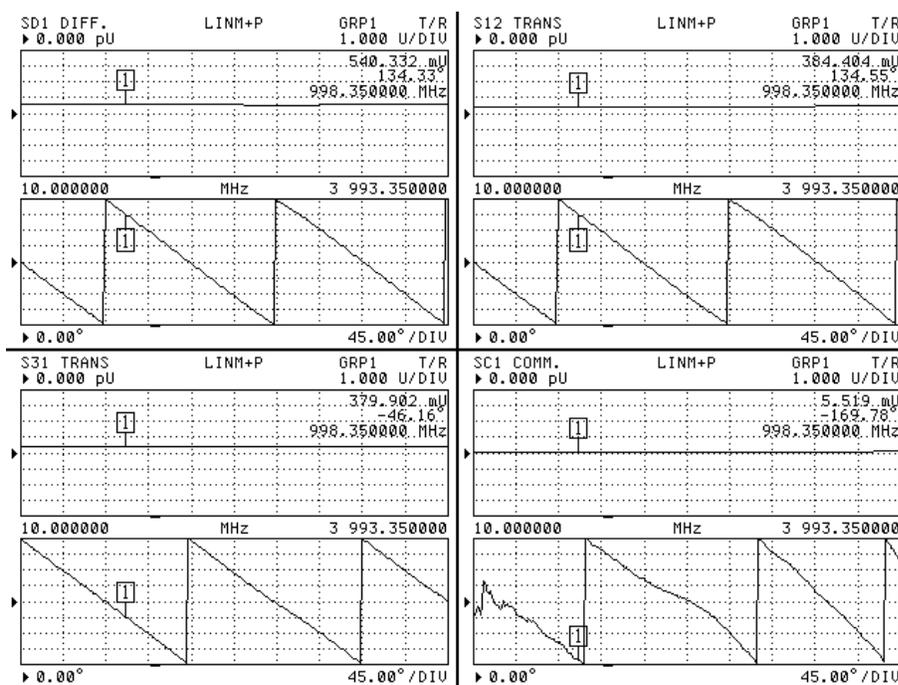


Figure 5-2. Three-Port Balanced Measurement Results

**5-3 FOUR-PORT
BALANCED
MEASUREMENT**

A four-port balanced measurement setup is similar to a three-port balanced measurement with the exception of the Mixed Mode S-parameter choices.

Connect the device under test as shown in Figure 5-3.

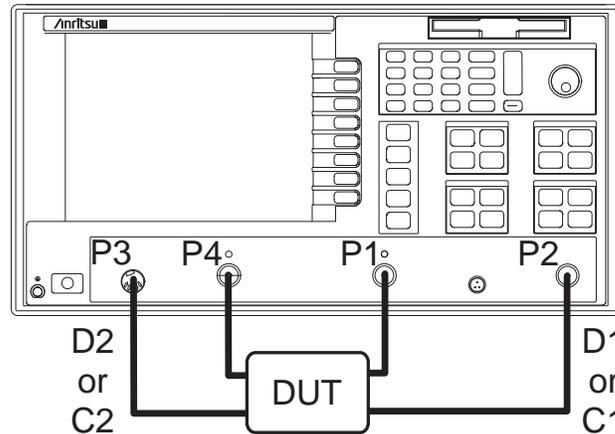


Figure 5-3. *Four-Port Balanced Measurement Setup
(Including differential and common-mode virtual-node designators)*

NOTE

In four-port balanced measurements, it is important that balanced Port 1 is connected to Ports 1 and 2 of the MS462XD, and balanced Port 2 is connected to Ports 3 and 4 of the MS462XD.

To perform a four-port balanced measurement of Mixed Mode S-parameters:

1. Perform a four-port calibration (refer to Section 3-8).
2. Connect the DUT as shown in Figure 5-1. Make sure that the unbalanced port of the device is connected to Port 1 of the MS462xD.
3. Select CH1 and press the Meas front panel key.
4. Select the menu soft keys as follows:
S21, TRANS b2/a1
5. Press the Display front panel key and the following menu soft keys:
GRAPH TYPE/MORE/LINEAR MAGNITUDE AND PHASE.
6. Select CH2 and press the Meas front panel key.
7. Select the menu soft keys as follows:
MIXED MODE S-PARAMETER/MORE

The four-port S-parameters begin with SD1D1 Differential Mode and end with SC2D2 Mode Conversion. There are 16 Mixed Mode S-parameters for a balanced four port as well as 16 unbalanced S-parameters. The 16 Mixed Mode S-parameters are:

SD1D1	SC1C1	SD1C1	SC1D1
SD1D2	SC1C2	SD1C2	SC1D2
SD2D1	SC2C1	SD2C1	SC2D1
SD2D2	SC2C2	SD2C2	SC2D2

**5-4 BALANCED
PARAMETERS**

Balanced Parameter data, designated MnP data, can be obtained in a similar manner as S-parameter data. To extract the Balanced Parameter data:

1. Press the Hard Copy front panel key and the following menu soft keys:

OUTPUT DEVICE/DISK FILE

RETURN

OUTPUT SETUP1

DESTINATION = FLOPPY DISK

FORMAT = SnP OPTIONS (S1P, S2P, S3P, S4P, M3P, or M4P)

RETURN

PRINT

Like SnP data, MnP data will result in magnitude and angle information for three-port balanced devices (M3P data) and four-port balanced devices (M4P).

5-5 IMPEDANCE TRANSFORMATION

The Impedance Transformation function addresses the reality that balanced devices may not have 50 Ohm impedances on each single-ended leg. A balanced impedance is considered to be divided equally between the ports. For example, a device with a balance impedance of 150 Ohms on balanced port 1 has 75 Ohms impedance on each leg of the balanced port. To apply Impedance Transformation to a three-port device with one balanced port of 150 Ohms:

1. Press the Config front panel key and the following menu soft keys:

```

IMPEDANCE TRANSFORMATION/ PORT = 1
RESISTIVE TERM = 50 Ohms
REACTIVE TERM (j) = 0 Ohms
IMPEDANCE TRANSFORMATION/ PORT = 2
RESISTIVE TERM = 75 Ohms
REACTIVE TERM (j) = 0 Ohms
IMPEDANCE TRANSFORMATION/ PORT = 3
RESISTIVE TERM = 75 Ohms
REACTIVE TERM (j) = 0 Ohms
COMPUTATION METHOD = PSEUDO-WAVE

```

2. To apply the define Impedance Transformation press the menu soft key:

```

IMPEDANCE TRANSFORMATION = ON

```

NOTE

Pseudo-wave and power wave are different S-parameter representations, each used in some simulators, that can affect the Impedance Transformation if the reference impedances Z_i are not real. The pseudo-wave representation is physical. The power wave representation is not physical, but is a visualization tool to help analyze power flows in some circuits. When Z is not real, the transformations can differ radically. For more detailed information on pseudo-wave and power wave, refer to the *Anritsu Arbitrary Impedance Application Note*, part number 11410-00284.

Figure 5-4 shows the same DUT as the previous example with Impedance Transformation applied.

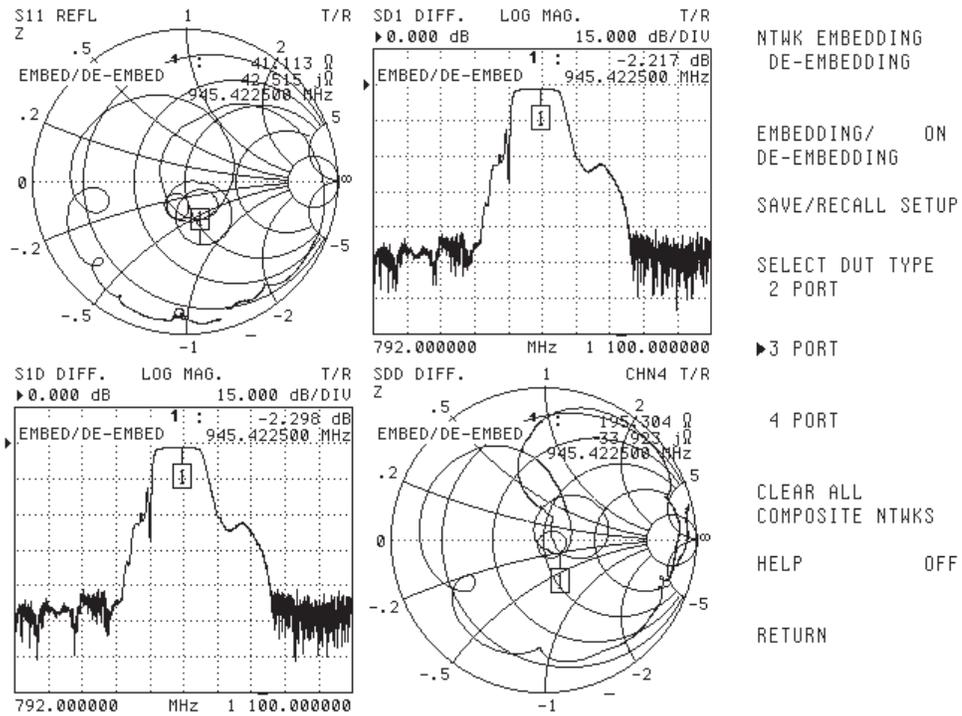


Figure 5-4. Impedance Transformation and Embedding/De-Embedding (see next section) Applied

5-6 EMBEDDING AND DE-EMBEDDING**NOTE**

Within the E/DE feature, press HELP = ON to view detailed instructions and information.

NOTE

E/DE networks are stored in dynamic memory and are not maintained if the VNMS is turned off. Select SAVE on the E/DE Function menu to save networks on a floppy disk.

NOTE

If the APPLY is successful, the screen will momentarily display the message:
"Apply Network Successful."

Because it is important to know the S-parameter data of the DUT, and the effects of adding or removing test fixtures or transmission lines to the DUT, the MS462XX has an Embedding and De-embedding (e/de) feature. This feature makes it possible to move the calibrated VNAs error reference plane(s) to a different position by mathematically adding (embedding) or removing (de-embedding) certain structures from the measured data. Multiple networks can be cascaded on any unbalanced or balanced port so it is crucial that order of entry be kept in mind. Networks are entered starting at the DUT planes and working out toward the MS462XX. Two-port networks are grouped together, as are four-port networks, and the two-port networks are placed closest to the DUT.

The following example illustrates how embedding and de-embedding is applied to a three-port balanced device. T-line segments are de-embedded from each port, then a circuit network is embedded onto the balanced port.

1. Perform an OSLT three-port calibration (refer to Section 3-6).
2. Set the screen to display the S-parameters that would be affected by embedding or de-embedding.
3. Press the Config front panel key and the following menu soft keys to set T-Line parameters for Port 1 of the DUT:

```
NTWK EMBEDDING/DE-EMBEDDING
SELECT DUT TYPE = 3 PORT
SELECT PORT P1
```

On the MS462XX display, ADD ON TO NTWKS should be highlighted in red since P1 has no existing network present.

```
DE-EMBEDDING
SELECT NTWK GENERATION METHOD/CIRCUIT TOPOLOGY =
T-LINE SECTION/ TIME = 100 PS
APPLY
RETURN
RETURN
```

4. To set T-Line parameters for Port 2 of the DUT, press the following menu soft keys:

```
NTWK EMBEDDING/DE-EMBEDDING
SELECT DUT TYPE = 3 PORT
SELECT PORT P2
DE-EMBEDDING
SELECT NTWK GENERATION METHOD/CIRCUIT TOPOLOGY =
T-LINE SECTION/ TIME = 92 PS
APPLY
RETURN
RETURN
```

5. To set T-Line parameters for Port 3 of the DUT, press the following menu soft keys:

```
NTWK EMBEDDING/DE-EMBEDDING
SELECT DUT TYPE = 3 PORT
SELECT PORT P3
```

Again, ADD ON TO NTWKS should be highlighted in red, as P3 has no existing network present.

NOTE

To check the embedding or de-embedding networks applied at each port, SELECT PORT = P1 and press EMBEDDING/DE-EMBEDDING LOG.

```
DE-EMBEDDING
SELECT NTWK GENERATION METHOD/CIRCUIT TOPOLOGY =
T-LINE SECTION/ TIME =92 PS
APPLY
RETURN
RETURN
RETURN
```

6. To apply the T-Line sections to the measured data, press the menu soft key:

```
EMBEDDING/DE-EMBEDDING = ON.
```

The system will take a moment to calculate and apply the Embedding/De-embedding correction to the measured data, and an indicator will be present on the screen.

To embed a circuit network onto the DUT follow the procedure below.

7. Press the following menu soft keys:

```
EMBEDDING/DE-EMBEDDING = OFF
SELECT DUT TYPE = 3 PORT
SELECT PORT P2-P3
```

NOTE

Selecting MODIFY LAST NTWK will allow changes to existing networks. ADD ON TO NTWKS will append a new network onto the last network added away from the DUT.

ADD ON TO NTWKS should be highlighted in red on the display as the balanced port P2-P3 has no existing network at this time.

EMBEDDING
 SELECT NTWK GENERATION METHOD/CIRCUIT TOPOLOGY
 INDUCTANCE = 30 nH
 CAPACITANCE 1 = IF
 CAPACITANCE 2 = IF
 APPLY
 RETURN
 RETURN
 RETURN

- To apply the circuit topology, press the menu soft key:
 EMBEDDING/DE-EMBEDDING = ON.

Figures 5-5 and 5-6 show the effects of applying the circuit and the T-line section de-embedded in the earlier example to the DUT.

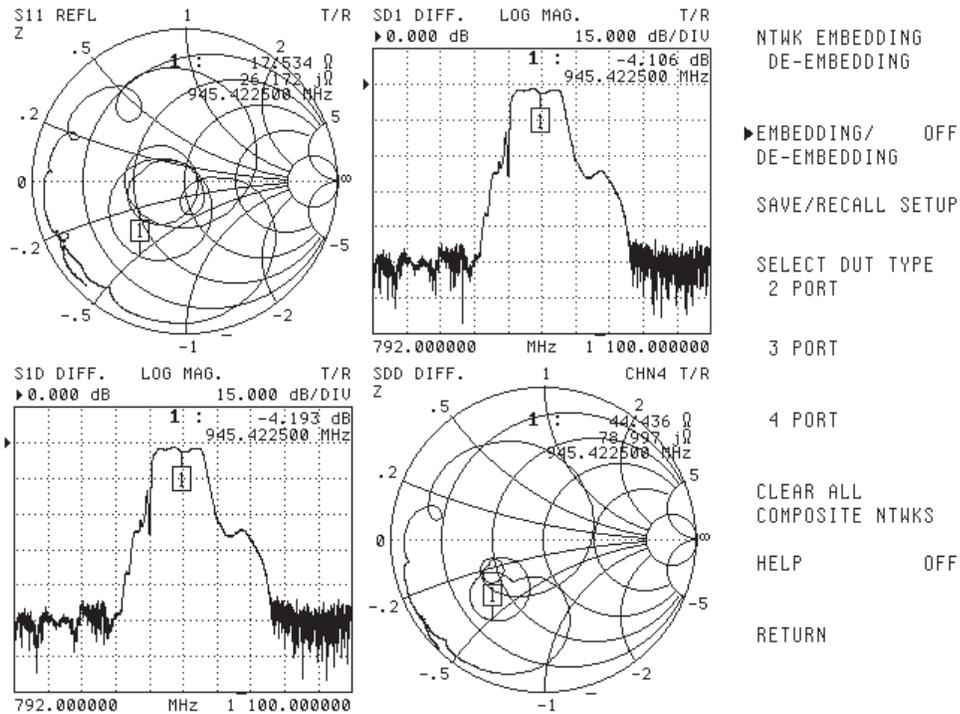


Figure 5-5. Em/De is turned off and no matching or impedance transformations are applied.

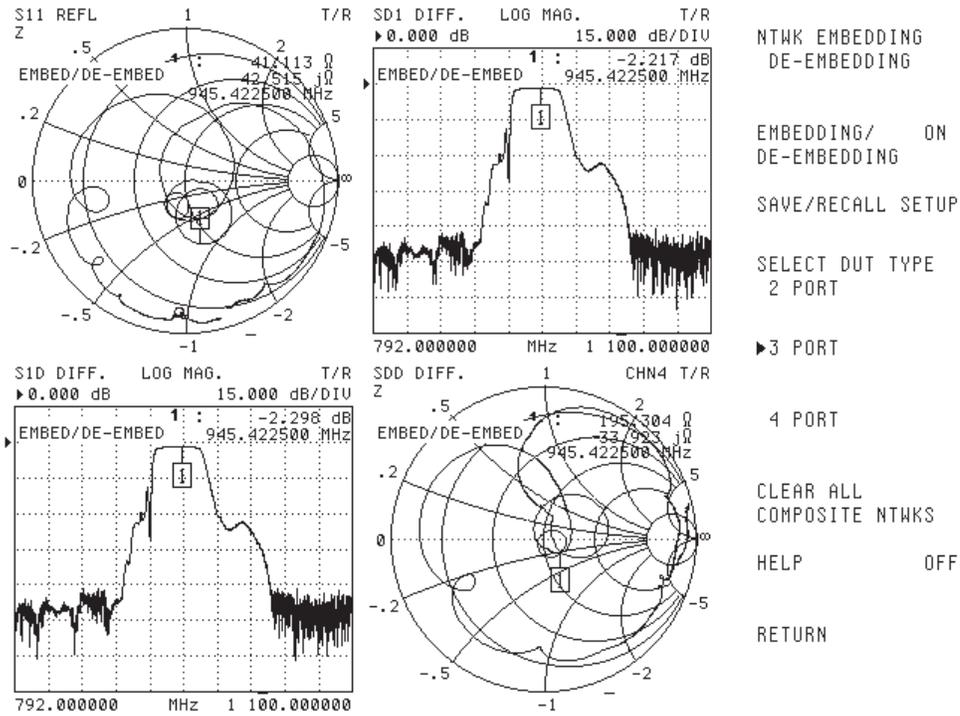


Figure 5-6. Matching network described in the text is applied, with Em/De turned on and impedance transformation applied

NOTE

Figure 5-6 is matched with E/DE and Impedance Transformations applied

Because several test fixtures may need to be used and characterized when measuring the DUT, each setup can be saved on the hard disk or a floppy disk for recall. To do this:

In the NTKW EMBEDDING/DE-EMBEDDING menu, press the menu soft keys :

- SAVE/RECALL SETUP
- SAVE or RECALL.

5-7 GROUP

D Models Only

The GROUP feature allows the definition of four separate screen views with up to four S-parameters each in any display or graph type available. See Section 2-9 of this manual for display choices. This allows access to viewing all 16 Mixed Mode S-parameters, or any other combination, by cycling through each screen. To define the active screen as a GROUP 1:

1. Press the Display front panel key and the following menu soft keys:

DISPLAY MODE/ SELECT DISPLAY GROUP/GROUP 1

Repeat until all the screens needed for quick access are defined as a group. For convenience, GROUP 1 through 4 are predefined into three categories called:

- SINGLE ENDED S-PARAMETERS
- BALANCED DIFFERENTIAL
- SINGLE ENDED BALANCED DIFFERENTIAL.

To select these categories:

2. Press the Display front panel key and the following menu soft keys:

DISPLAY MODE/SELECT DISPLAY GROUP/SETUP S-PARAMS IN ALL CHANNELS

To view the predefined S-parameter screen groupings:

3. Press the Display front panel key and the following menu soft keys:

DISPLAY MODE/SELECT DISPLAY GROUP/HELP = ON

If the Balanced Differential Group Setup has been selected, the HELP ON would show the 16 BALANCED DIFFERENTIAL S-parameters.

Any group can be redefined to fit specific preferences.

The CHANNEL KEYS can also be redefined to be GROUP keys for ease of

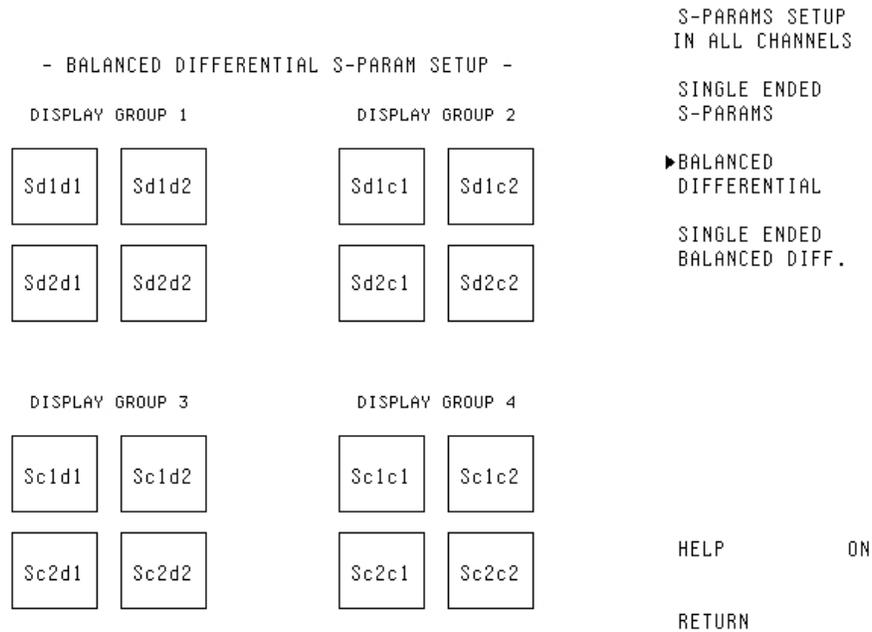


Figure 5-7. *Balanced Differential S-Parameter Groupings*

switching between screen groups. To redefine the CHANNEL KEYS:

4. Press the Display front panel key and the following menu soft keys:

DISPLAY MODE/ SELECT DISPLAY GROUP/ REDEFINE CHANNEL KEYS = GROUP.

Now CH1 is GROUP 1, CH2 is GROUP 2, CH3 is GROUP 3, and CH4 is GROUP4.

5-8 INTERCHANNEL MATH

Interchannel math is useful for amplitude and phase balance measurements. To perform division between channels:

1. Select CH 3 to view the results of the INTERCHANNEL MATH and change the graph type by pressing:

Display/GRAPH TYPE/ LOG MAGNITUDE AND PHASE

2. Press the Display front panel key and the following menu soft keys:

INTERCHAN MATH/CHANNEL NUM FOR OPERAND1 = 1

OPERAND 2 = 3

INTERCHANNEL MATH = ON

Once applied to the active channel, in this case CH 3, the results of the math with INTERCHAN MATH APPLIED will be shown on the active channel.

Figure 5-8 shows CH 2 with the results of S21/S31, which is 0 dB for a well balanced device and has 180 degrees phase.

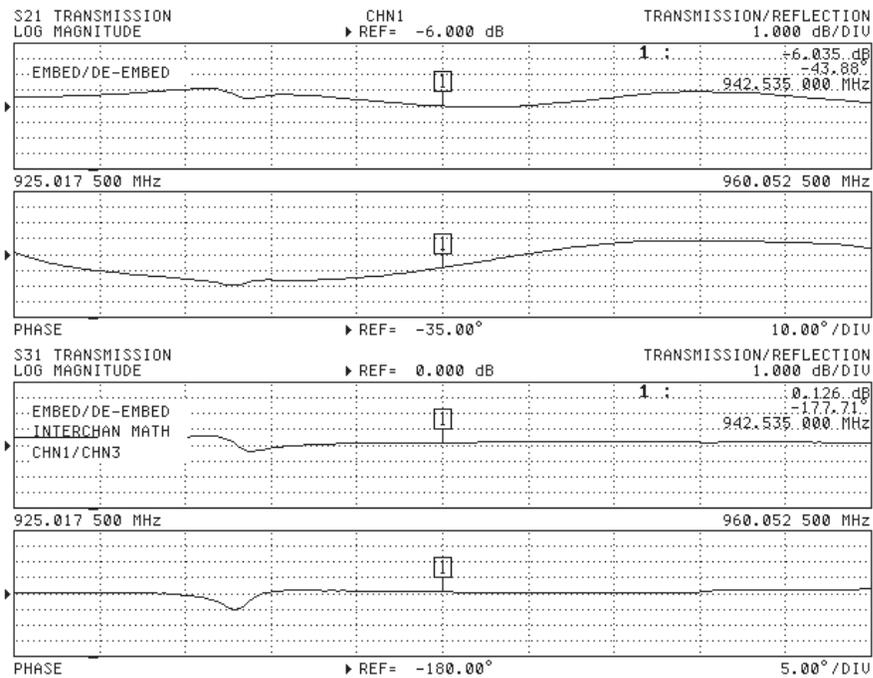


Figure 5-8. INTERCHANNEL MATH is ON

Chapter 6

Features

6-1 INTRODUCTION

This chapter contains discussions, examples, and procedures related to the following additional features:

- ❑ Hard Copy and Disk Output
- ❑ Three-Port Measurements of a Diplexer
- ❑ Tune Mode
- ❑ Test Sequences
- ❑ SCSI
- ❑ Markers
- ❑ Limit Lines
- ❑ Alternate Sweep
- ❑ Marker Sweep
- ❑ Other Features
 - Chop
 - Entry State
 - SnP Data Outputs

Many of the feature discussions present a typical measurement result, and the procedures document the steps used to achieve this typical measurement result.

6-2 HARD COPY AND DISK OUTPUT

Standard Feature

In addition to the front panel LCD display, the MS462XX is capable of outputting measurement data to printers, plotters, and disk files in a variety of convenient formats. Flexibility to choose between the desired output formats is provided by choosing the Hard Copy front panel key. Once the output format is chosen, the front panel Print key can be selected to format the data according to the Hard Copy selections.

Selecting the Hard Copy key from the front panel of the MS462XX will offer the following selections:

- Output Device: select between printer, plotter or disk file
- Output Setup: depending upon the device selection, a variety of options will be offered to further customize the output
- Output Headers Setup: offers flexibility to include additional information, comments and logos to the output
- Output Options: provides capability to route tabular data from the hard disk or floppy disk to the output device
- Page Orientation: choose between portrait or landscape
- Stop Print: aborts the current print activity

**Output Device:
Printer**

A connection between the printer and the MS462XX standard 25-pin parallel port printer is required. A variety of Thinkjet[®], Deskjet[®] and Epson printers are supported. When using the printer, options are provided to print both graphical and tabular data via the Output Setup menu selections.

**Output Device:
Plotter**

A GPIB connection between a plotter and the MS462XX Dedicated GPIB is required. The protocol used to control plotters is HP-GL (Hewlett-Packard Graphics Language), which is capable of drawing only the data trace(s) so that multiple traces may be drawn on a single sheet of paper. When using the plotter, options are provided to format plots in full or quarter sizes.

**Output Device:
Disk File**

When using the disk file as the output device, additional options are provided for specifying both the destination and the format. The options for destination choices include both hard disk and floppy disk, and the format choices include text, SnP, tabular data, bitmap, and HPGL.

A popular format for interacting with simulators is the SnP format, so there are additional options for this format to further customize this output for a variety of preferences:

- S1P, S2P, S3P, S4P, M3P and M4P, where SnP are standard formats and the MnP files contains Mixed Mode S-parameters
- SnP Setups that offer specifying the Frequency Units in GHz, MHz, kHz or Hz
- SnP Setups that offer specifying the Output Format. In Linear Magnitude and Phase, Log Magnitude and Phase, or Real and Imaginary outputs.

This completes the procedure for outputting measurements to printers, plotters and disk files using the MS462xx.

**6-3 THREE-PORT
DIPLEXER
MEASUREMENTS**

Calibration using the three-port calibration technique is available as Option 3A for 3 GHz Source (B Models only), Option 3B for 6 GHz Source (B Models only), and Option 6 (when using an external synthesizer).

Option 3A for 3 GHz
Option 3B for 6 GHz
Option 6 (when using an external synthesizer)

The following display shows a typical three-port measurement of a diplexer.

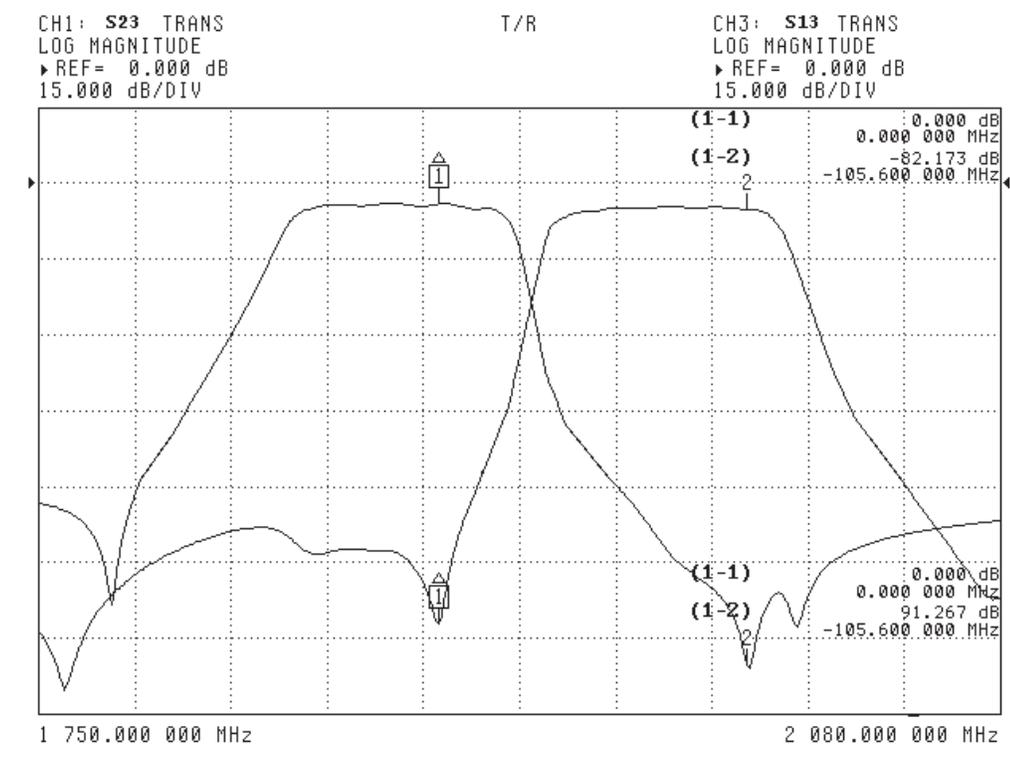


Figure 6-1. Typical Three-Port Measurement of a Diplexer Example Display

The photo below illustrates a typical three-port diplexer hookup.

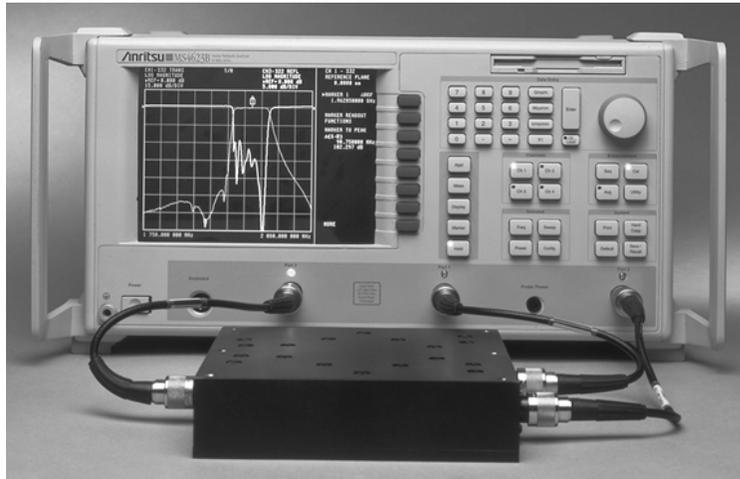


Figure 6-2. Three-Port Diplexer Hookup

To perform a three-port diplexer measurement:

1. Perform a three-port calibration for the desired frequency range (refer to Section 3-6).
2. Connect the three ports of the diplexer to the three ports of the MS462XX, then press the following keys:

Ch 1

Display/GRAPH TYPE/LOG MAGNITUDE

Ch 3

Display/GRAPH TYPE/LOG MAGNITUDE

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

Ch 1

Meas/S23

Ch 3

Meas/S13

Ch 1

Display/SCALE

3. Specify the resolution for the display:

RESOLUTION = 15 dB/DIV

4. Specify the reference line for the display:

REFERENCE LINE = 7

Ch 3

Display/SCALE

5. Specify the resolution for the display:

RESOLUTION = 15 dB/DIV

6. Specify the reference line for the display:

REFERENCE LINE = 7

NOTE

If measurement speed is the ultimate goal, increase the I.F. Bandwidth (Avg/SELECT I.F. BANDWIDTH), decrease the Data Points (Config/DATA POINTS) and use Tune Mode (Sweep/TUNE MODE). Select Sweep to show the actual sweep time performance for the measurement.

This completes the procedure for performing a three-port measurement of a diplexer with the MS462XX.

6-4 TUNE MODE

Standard Feature

Tune Mode can dramatically increase the speed of a measurement by updating forward S-parameters more frequently than reverse ones. A Tune Mode Count dictates the forward measurement count before the reverse measurement is performed, allowing for real-time tuning of a DUT. For the purpose of demonstration, the Tune Mode feature is presented for a diplexer, but this feature is also applicable for two-port measurements.

The following display shows a typical three-port measurement of a diplexer.

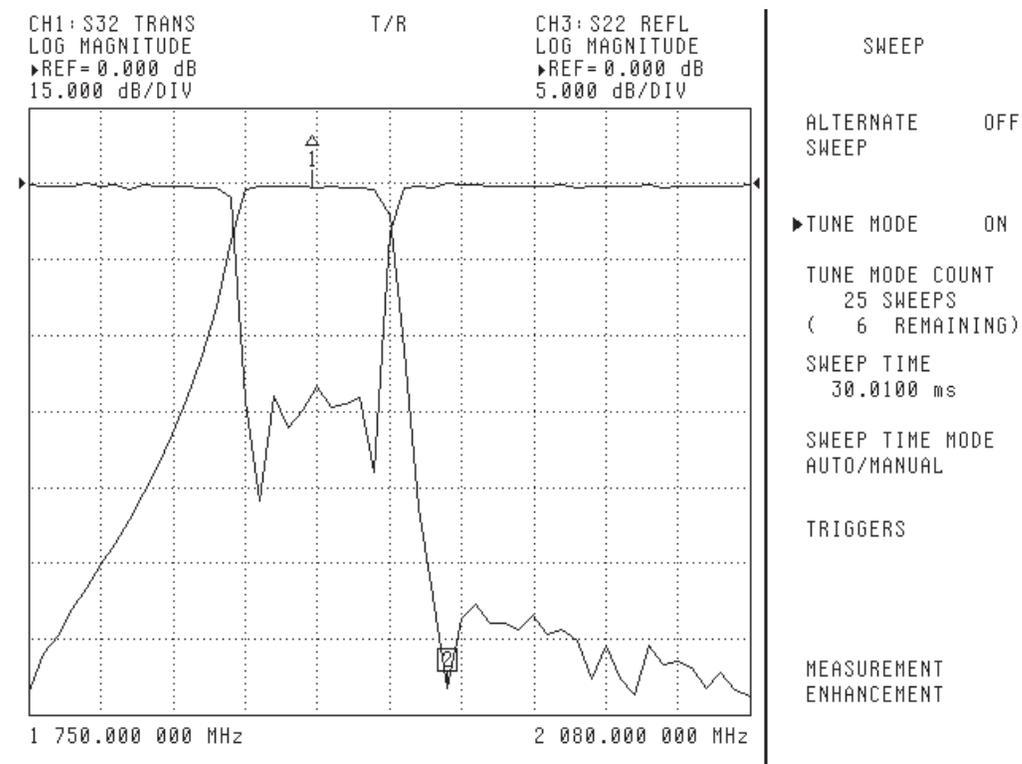


Figure 6-3. Typical Three-Port Measurement of a Diplexer Example Display

1. Perform a three-port calibration for the desired frequency range (refer to Section 3-6).

2. Connect the three ports of the diplexer to the three ports of the MS462XX, then press the following keys:

Ch 1

Display/GRAPH TYPE/LOG MAGNITUDE

Ch 3

Display/GRAPH TYPE/LOG MAGNITUDE

Display/DISPLAY MODE/OVERLAY DUAL CHANNELS 1 & 3

Ch 1

Meas/S32

Ch 3

Meas/S22

Ch 1

Display/SCALE

3. Specify the resolution for the display:

RESOLUTION = 15 dB/DIV

4. Specify the reference line for the display:

REFERENCE LINE = 7

Ch 3

Display/SCALE

5. Specify the resolution for the display:

RESOLUTION = 5 dB/DIV

6. Specify the reference line for the display:

REFERENCE LINE = 7

Sweep

TUNE MODE COUNT = 25

TUNE MODE = ON

NOTE

If measurement speed is the ultimate goal, increase the I.F. Bandwidth (Avg/SELECT I.F. BANDWIDTH), decrease the Data Points (Config/DATA POINTS). Select Sweep to show the actual sweep time performance for the measurement.

This completes the procedure for demonstrating Tune Mode on a three-port measurement of a diplexer using the MS462XX.

6-5 TEST SEQUENCE

Standard Feature

A sequence of keystrokes can be stored in memory or on disk for later playback, thus saving time on repetitive front panel operations. This feature is demonstrated by documenting a peak-to-peak ripple filter measurement. The following display shows the results of a peak-to-peak ripple filter measurement using a test sequence.

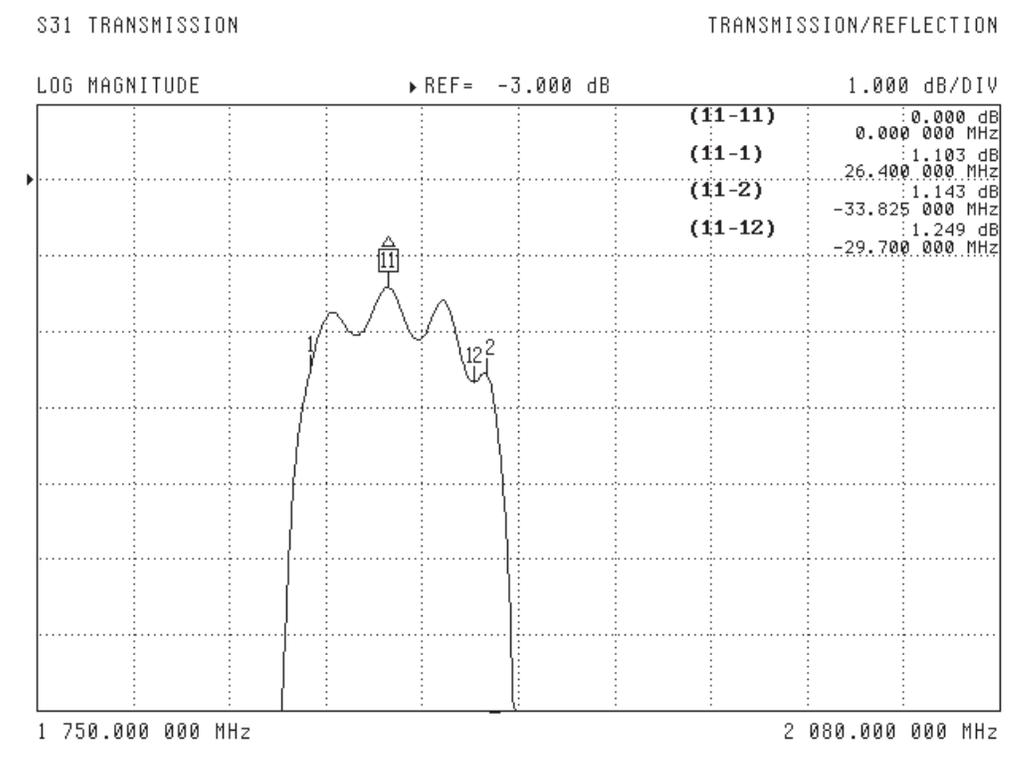


Figure 6-4. Results of a Peak-to-Peak Ripple Filter Measurement Example Display

The setup for this measurement requires markers 1 and 2 to represent the bandwidth where the peak-to-peak measurement is performed. Markers 11 and 12 are used to find the maximum and minimum values between markers 1 and 2. In addition, a manual measurement should be performed such that the above display is observable.

The following procedure documents the steps for creating a test sequence for the peak-to-peak measurement.

1. Press the Seq front panel key and select the front panel keys and menu soft keys as follows:

EDIT SEQUENCE/SEQUENCE 3

Marker/ Δ REF MODE OFF

Freq/MARKER SWEEP/START SWEEP MARKER = 1

Freq/MARKER SWEEP/STOP SWEEP MARKER = 2
 Seq/CONTROL STATEMENT/WAIT FOR SWEEP COMPLETE
 Marker/SELECT ΔREF MARKER/MARKER 12
 Marker/READOUT MARKER
 MARKER TO PEAK/MARKER TO MIN
 Marker/SELECT ΔREF MARKER/MARKER 11
 Marker/READOUT MARKER
 MARKER TO PEAK/MARKER TO MAX
 Freq/MARKER SWEEP/RESTORE FULL SWEEP
 Marker/READOUT MARKER
 Marker/ ΔREF MODE ON
 Seq/DONE SEQUENCE EDIT

2. Execute the peak-to-peak measurement by selecting:
 Seq/EXECUTE SEQUENCE/SEQUENCE 3

The following display shows the sequence editing window following a Seq/EDIT SEQUENCE/SEQUENCE 3 selection.

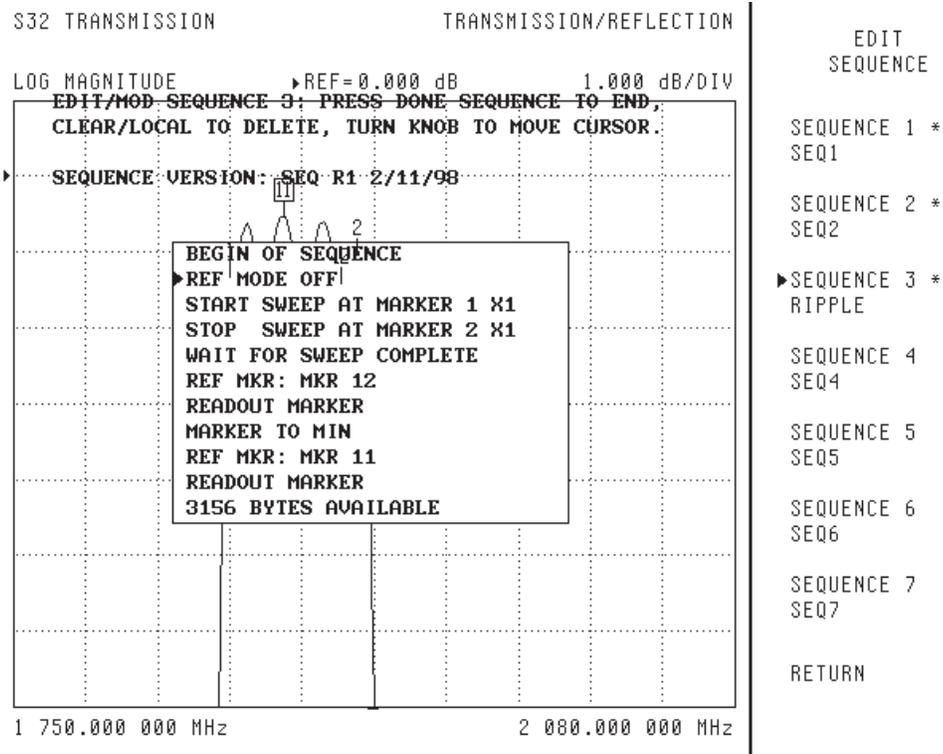


Figure 6-5. Sequence Editing Window Example Display

NOTES

- Seq/UTILITY/RENAME SEQUENCE allows names to be assigned to sequence numbers.
- While editing a sequence, Seq/EDITING FUNCTIONS/CLEAR EDITING WINDOW clears the editing window so that a command effect can be viewed. Seq/EDITING FUNCTIONS/RESTORE EDITING WINDOW restores the editing window so that more editing can be performed.
- While editing a sequence, Seq/EDITING FUNCTIONS/CANCEL SEQUENCE EDIT aborts the editing sequence. Remove the editing window by selecting Seq/DONE SEQUENCE EDIT.

The following table documents the contents of the Sequence Editing Window after completing the previous steps.

Keystrokes	Sequence Entry
Marker/ Δ REF MODE OFF	REF MODE OFF
Freq/MARKER SWEEP/START SWEEP MARKER = 1	START SWEEP AT MARKER 1 X1
Freq/MARKER SWEEP/STOP SWEEP MARKER = 2	STOP SWEEP AT MARKER 2 X2
Seq/CONTROL STATEMENT/WAIT FOR SWEEP COMPLETE	WAIT FOR SWEEP COMPLETE
Marker/SELECT Δ REF MARKER/MARKER 12	REF MKR: MKR 12
Marker/READOUT MARKER	READOUT MARKER
MARKER TO PEAK/MARKER TO MIN	MARKER TO MIN
Marker/SELECT Δ REF MARKER/MARKER 11	REF MKR: MKR 11
Marker/READOUT MARKER	READOUT MARKER
MARKER TO PEAK/MARKER TO MAX	MARKER TO MAX
Freq/MARKER SWEEP/RESTORE FULL SWEEP	RESTORE FULL SWEEP
Marker/ Δ REF MODE ON	REF MODE ON
Marker/READOUT MARKER	READOUT MARKER

This completes the procedure documenting the steps for creating, editing, and executing a sequence for the peak to peak measurement.

6-6 **EXTERNAL SCSI**
Standard Feature

The MS462XX contains approximately 2 MB of non-volatile memory that acts as a virtual internal hard drive. An external SCSI-2 interface on the MS462XX rear panel allows an external hard drive to be used in place of the internal non-volatile memory. When an external hard drive is used, the MS462XX storage capacity is limited only by the size of the SCSI-2 hard drive, rather than the non-volatile memory.

Figure 6-6 shows a typical directory of the MS462XX non-volatile memory.

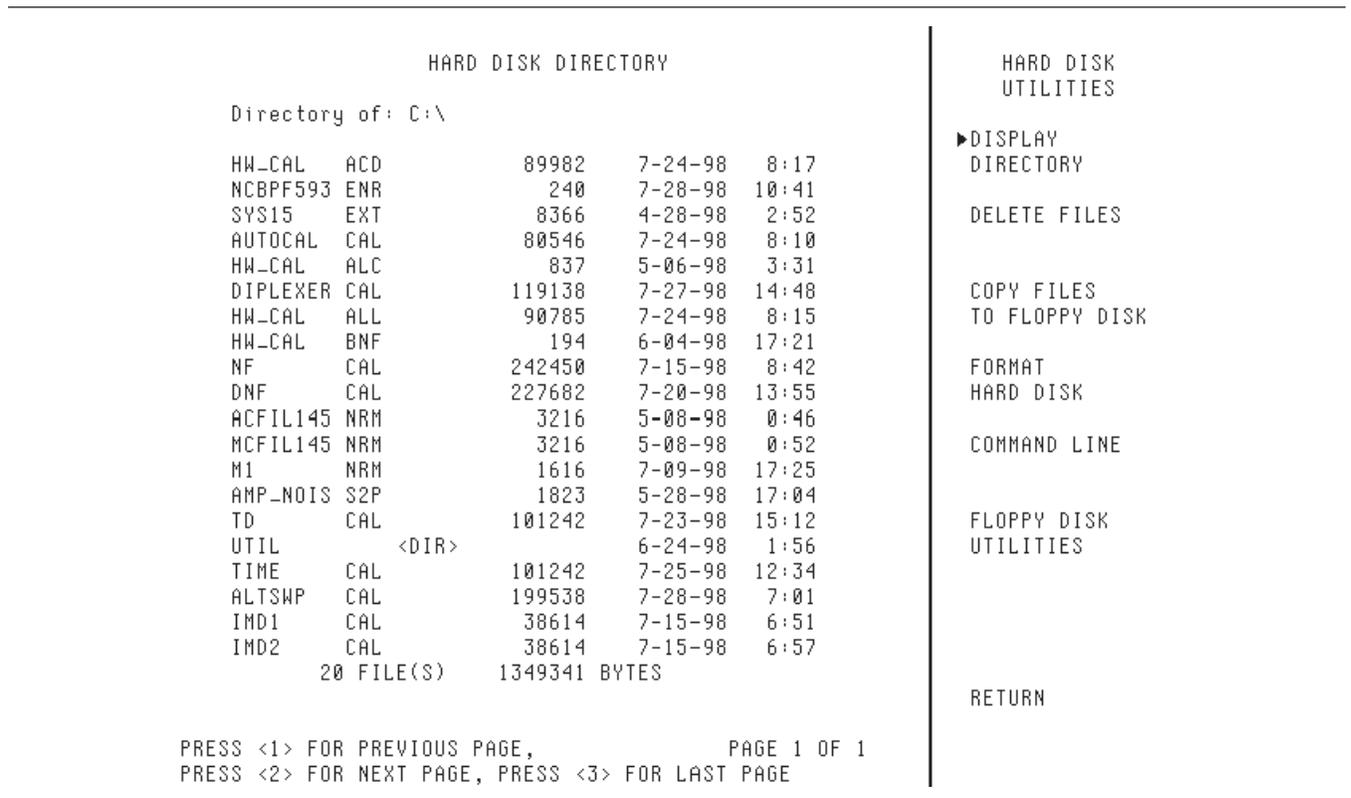


Figure 6-6. MS462XX Typical Hard Disk Directory

Figure 6-7 shows two typical hard disk directories of the MS462XX when an external SCSI-2 hard drive is attached to the external SCSI-2 interface.

HARD DISK DIRECTORY				HARD DISK UTILITIES			
Directory of: C:\				▶DISPLAY DIRECTORY			
UTIL	<DIR>			DELETE FILES			
HW_CAL	ACD	89982	7-29-98 10:09	COPY FILES			
NCBPF593	ENR	240	7-29-98 9:02	TO FLOPPY DISK			
SVS15	EXT	8366	7-29-98 9:02	FORMAT			
AUTOCAL	CAL	80546	7-29-98 9:02	HARD DISK			
HW_CAL	ALC	837	7-29-98 9:03	COMMAND LINE			
DIPLEXER	CAL	119138	7-29-98 9:03	FLOPPY DISK			
HW_CAL	ALL	90785	7-29-98 9:03	UTILITIES			
HW_CAL	BNF	194	7-29-98 9:03				
NF	CAL	242450	7-29-98 9:03	RETURN			
DNF	CAL	227682	7-29-98 9:04				
ACFIL145	NRM	3216	7-29-98 9:04				
MCFIL145	NRM	3216	7-29-98 9:04				
M1	NRM	1616	7-29-98 9:04				
AMP_NOIS	S2P	1823	7-29-98 9:04				
TD	CAL	101242	7-29-98 9:04				
TIME	CAL	101242	7-29-98 9:05				
ALTSNP	CAL	199538	7-29-98 9:05				
IND1	CAL	38614	7-29-98 9:05				
IND2	CAL	38614	7-29-98 9:05				
IP1BW_M	BMP	38462	7-29-98 9:14				
DSCTBW_M	BMP	38462	7-29-98 9:14				
GC2BW_M	BMP	38462	7-29-98 9:14				
PRESS <1> FOR PREVIOUS PAGE, PAGE 1 OF 2 PRESS <2> FOR NEXT PAGE, PRESS <3> FOR LAST PAGE				▶DISPLAY DIRECTORY			
				DELETE FILES			
				COPY FILES			
				TO FLOPPY DISK			
				FORMAT			
				HARD DISK			
				COMMAND LINE			
				FLOPPY DISK			
				UTILITIES			
				RETURN			
				PRESS <1> FOR PREVIOUS PAGE, PAGE 2 OF 2 PRESS <2> FOR NEXT PAGE, PRESS <3> FOR LAST PAGE			
				Directory of: C:\			
				H1BW_M BMP 38462 7-29-98 9:14			
				L1M1BW_M BMP 38462 7-29-98 9:14			
				L1M2BW_M BMP 38462 7-29-98 9:14			
				MKR1BW_M BMP 38462 7-29-98 9:15			
				NFBW_M BMP 38462 7-29-98 9:15			
				SF1BW_M BMP 38462 7-29-98 9:15			
				SP1BW_M BMP 38464 7-29-98 9:15			
				SP3BW_M BMP 38462 7-29-98 9:15			
				SQ1BW_M BMP 38462 7-29-98 9:15			
				SQ3BW_M BMP 38462 7-29-98 9:15			
				TD1BW_M BMP 38462 7-29-98 9:15			
				TYP_DSPB BMP 38462 7-29-98 9:16			
				PCS3PORT CAL 119138 7-29-98 9:33			
				HARMONIC CAL 242450 7-29-98 9:34			
				SCORPION CAL 242450 7-29-98 9:34			
				A970921 ACD 61440 7-29-98 9:38			
				A971102 ACD 89982 7-29-98 9:37			
				40 FILE(S) 2681749 BYTES			

Figure 6-7. MS462XX Typical Hard Disk Directory with External SCSI-2 Hard Drive

The 40 files shown in the hard disk directory use 2.68 MB of memory space, which is more than the approximately 2 MB of non-volatile memory supplied.

The following procedure describes how to use the external SCSI-2 interface when attaching a hard drive. The procedure begins by backing up the files in the internal non-volatile memory to a floppy disk. The SCSI-2 hard drive is then installed and the original files are transferred from the floppy to the SCSI-2 hard drive.

1. Press the front panel keys and menu soft keys as follows:

Utility/GENERAL DISK UTILITIES/DISPLAY DIRECTORY

Utility/GENERAL DISK UTILITIES/COMMAND LINE

2. Insert a blank formatted High Density (1.44 MB) diskette into the MS462XX floppy drive.

3. Use the front panel knob to enter the following command onto the command line:

COPY C:*.* A:

4. When complete, select DONE and the MS462XX will copy the contents of the hard drive to the floppy.
5. Press Clr on the front panel to quit the command line.
6. Turn the MS462XX OFF using the Power switch on the front panel.
7. Attach the SCSI-2 hard drive to the external SCSI-2 interface on the MS462XX rear panel.
8. Turn the MS462XX ON using the Power switch on the front panel.
9. Press the front panel keys and menu soft keys as follows:

Utility/GENERAL DISK UTILITIES/FORMAT HARD DISK/FORMAT DISK

Utility/GENERAL DISK UTILITIES/DISPLAY DIRECTORY

Utility/GENERAL DISK UTILITIES/COMMAND LINE

10. Enter the following command using the front panel knob onto the command line:

COPY A:*.* C:

11. When complete, select DONE and the MS462XX will copy the contents of the floppy to the hard drive.
12. Press Clr on the front panel to quit the command line.
13. Press the front panel keys and menu soft keys as follows:

Utility/GENERAL DISK UTILITIES/DISPLAY DIRECTORY

This completes the procedure describing the use of the MS462XX external SCSI-2 interface.

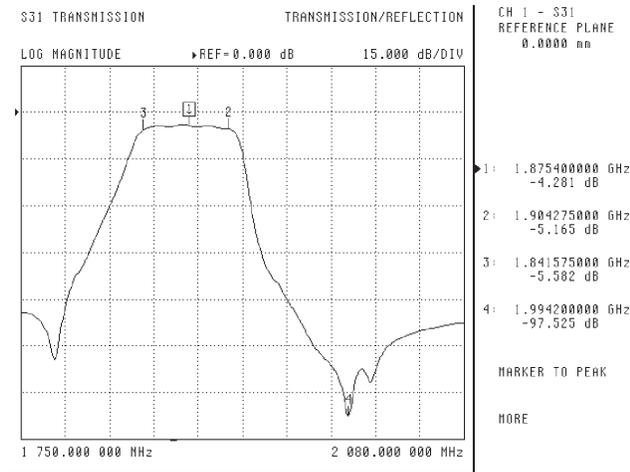
<p>NOTE</p>

<p>Formatting the hard disk will permanently erase all previous files.</p>
--

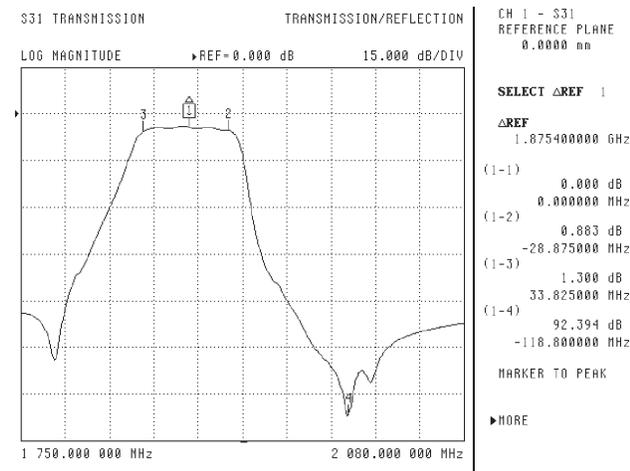
6-7 **MARKERS**
Standard Feature

The MS462XX supports the use of up to twelve independent markers. The following displays demonstrate some of the MS462XX marker capabilities.

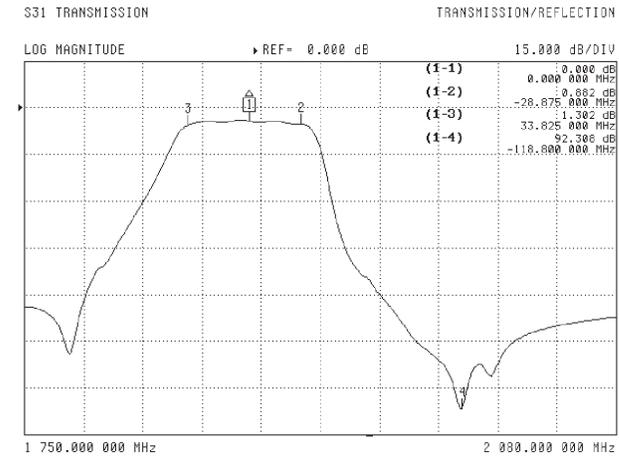
Each marker becomes the active marker upon selection. An active marker is indicated on the display as a marker number inside a square. **MARKER MODE = DISCRETE** limits the marker locations to only the calibration frequency points. **MARKER MODE = CONTINUOUS** allows marker locations other than calibration frequency points by performing interpolation between two calibration points.



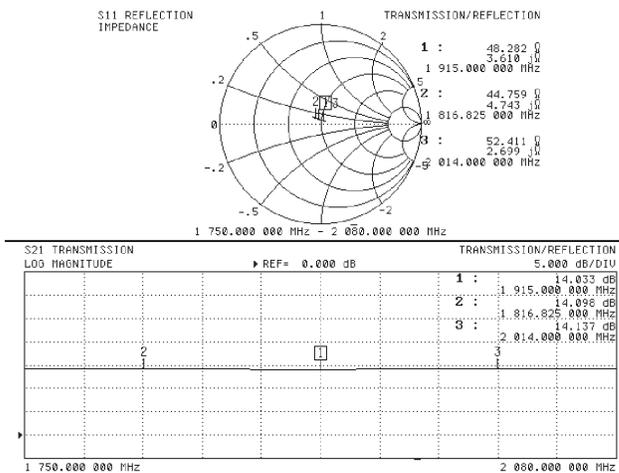
Single channel display with four markers shown on the active channel.



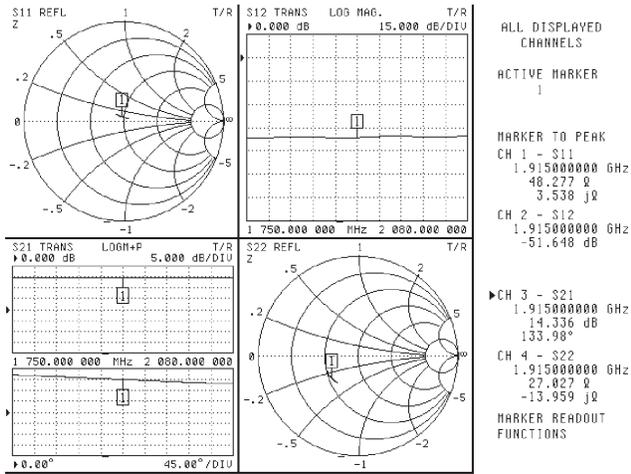
Single channel display with four markers shown on the active channel using differences between markers mode (ΔREF MODE).



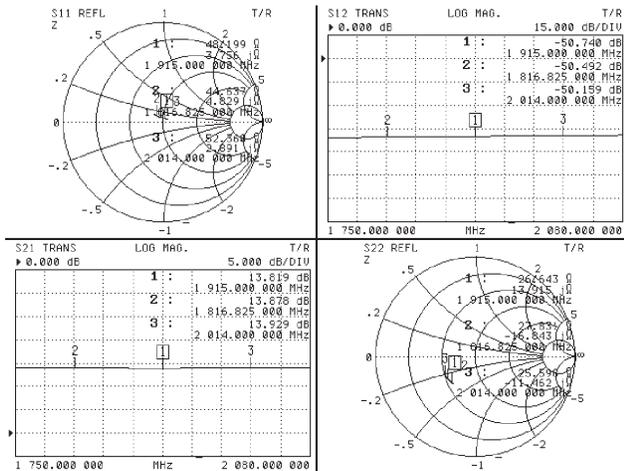
Single channel display with four markers shown on the active channel using differences between markers mode (Δ REF MODE). Here, the marker screen display is ON.



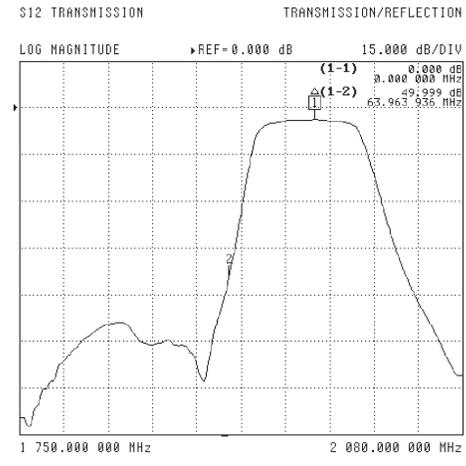
Dual channel display with three markers shown on the active channel. The marker screen display is ON.



Four channel display with one active marker's value is shown for all four channels.

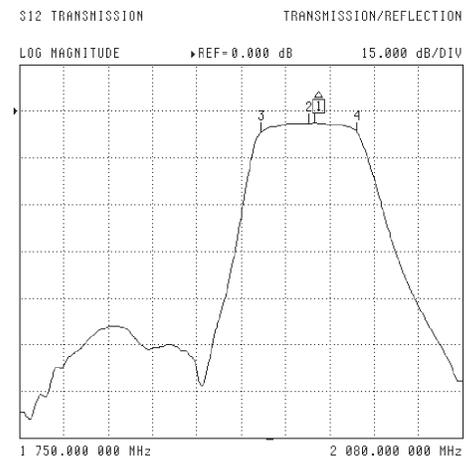


Four channel display where each channel has three marker values shown. Marker screen display is ON.



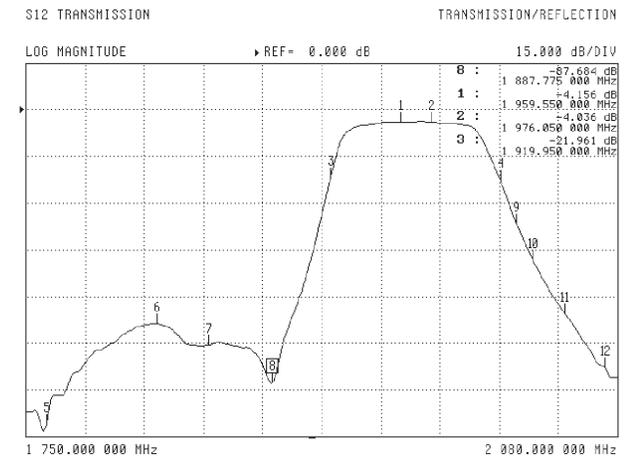
SEARCH
 VALUE -50.000 dB
 SETUP SEARCH
 VALUE AT REFERENCE -3.830 dB
 SEARCH LEFT 1.906311064 GHz
 SEARCH RIGHT
 SEARCH MKR VALUES
 CH1:
 CH2: -53.830 dB
 CH3:
 CH4:
 MARKER READOUT FUNCTIONS

Single channel display where the marker search mode is used to find the -50 dB point. Marker screen display is ON.



FILTER PARAMETERS
 CENTER FREQ 1.965843202 GHz
 BANDWIDTH 3.000 dB
 MAXIMUM VALUE 71.791483 MHz
 LOSS AT REF -3.832 dB
 Q 27.38
 SHAPE FACTOR 1.87
 FILTER SETUP
 MARKER READOUT FUNCTIONS

Single channel display where the marker filter parameter mode is used.



Single channel display with 12 markers viewed. Marker screen display is ON.

6-8 LIMIT LINES

Standard Feature

The MS462XX supports up to ten segmented limit lines. The following display shows a filter measurement using seven segmented limit lines.

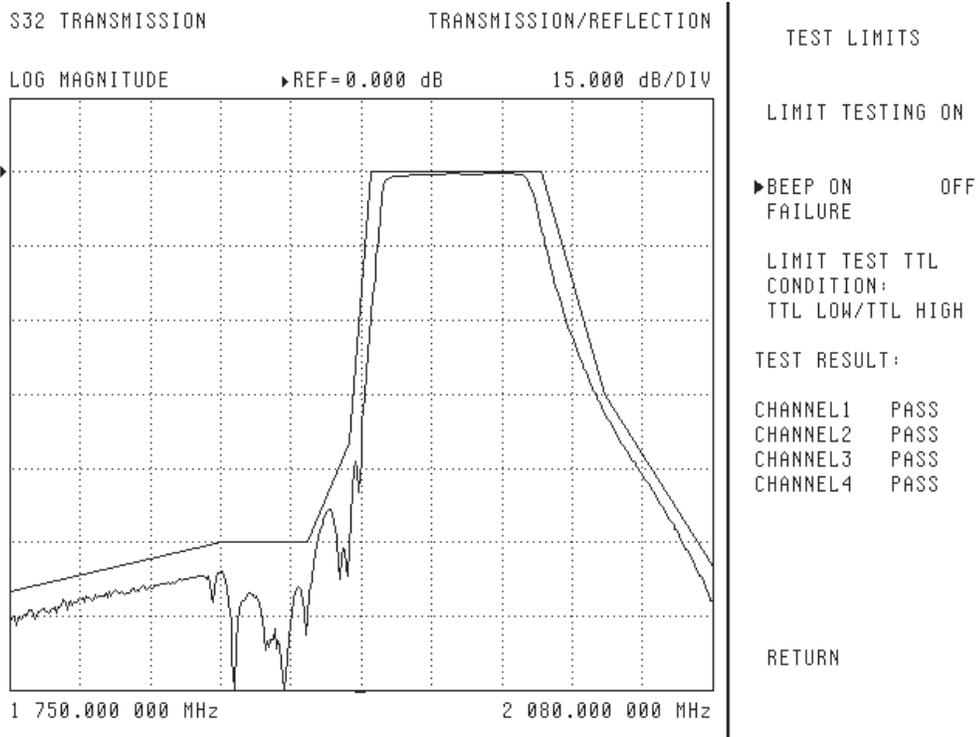


Figure 6-17. Seven Segmented Limit Lines Example Display

The following limit line requirements are prepared for the segmented limit line definitions.

Segment	Start Position Horizontal (MHz)	Start Position Vertical (dB)	Stop Position Horizontal (MHz)	Stop Position Vertical (dB)
1	1750	-85	1850	-75
2	1850	-75	1890	-75
3	1890	-75	1910	-55
4	1910	-55	1920	0
5	1920	0	2000	0
6	2000	0	2030	-45
7	2030	-45	2080	-80

1. Press the front panel keys and menu soft keys as follows:

Display/LIMITS
CLEAR ALL SEGMENTS
DISPLAY LIMITS = ON
UPPER LIMIT = ON
EDIT SEGMENTS/EDIT UPPER LIMITS
SEGMENT 1 = ON
START POSITION: HORIZONTAL = 1750 MHz
START POSITION: VERTICAL = -85 dB
STOP POSITION: HORIZONTAL = 1850 MHz
STOP POSITION: VERTICAL = -75 dB
ATTACH NEXT
SEGMENT 2 = ON
STOP POSITION: HORIZONTAL = 1890 MHz
STOP POSITION: VERTICAL = -55 dB
ATTACH NEXT
SEGMENT 3 = ON
STOP POSITION: HORIZONTAL = 1910 MHz
STOP POSITION: VERTICAL = -55 dB
ATTACH NEXT
SEGMENT 4 = ON
STOP POSITION: HORIZONTAL = 1920 MHz
STOP POSITION: VERTICAL = 0 dB
ATTACH NEXT
SEGMENT 5 = ON
STOP POSITION: HORIZONTAL = 2000 MHz
STOP POSITION: VERTICAL = 0 dB
ATTACH NEXT

NOTE

The front panel knob also allows selection of horizontal and vertical values.

NOTE

The START POSITION values of this new segment default to the STOP POSITION values of the previous segment.

SEGMENT 6 = ON
STOP POSITION: HORIZONTAL = 2030 MHz
STOP POSITION: VERTICAL = -45 dB
ATTACH NEXT
SEGMENT 7 = ON
STOP POSITION: HORIZONTAL = 2080 MHz
STOP POSITION: VERTICAL = -80 dB
RETURN
RETURN
TEST LIMITS
LIMIT TESTING = ON

This completes the procedure for using segmented limit lines on the MS462XX.

NOTE

In a similar way, segmented limit lines are available in power sweep setups.

6-9 ALTERNATE SWEEP

Standard Feature

The MS462XX provides the capability to decouple channels 1 and 2 from channels 3 and 4. In this way, channels 1 and 2 can have different system settings and calibrations than channels 3 and 4.

The following display shows the alternate sweep feature applied to the measurement of a bandpass filter.

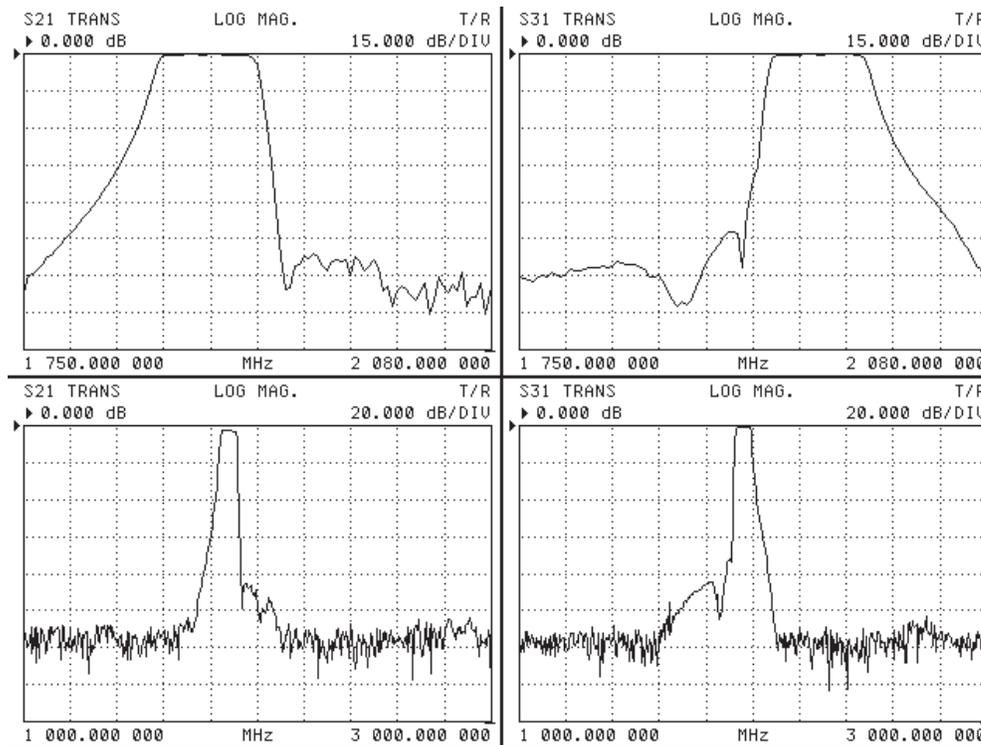


Figure 6-18. Alternate Sweep Example Display

Although not clear in the above display, the bottom two channels (the alternate sweep) are shown in a different color than the primary sweep (the top two channels). The default color for data traces while using the alternate sweep is yellow, whereas, the default color for data traces while using the primary sweep is red.

Note that the frequency range for the top two channels (channels 1 and 2) is 1750 to 2080 MHz while the frequency range for the bottom two channels (channels 3 and 4) is 1000 to 3000 MHz. The following display illustrates this difference with an overlay display.

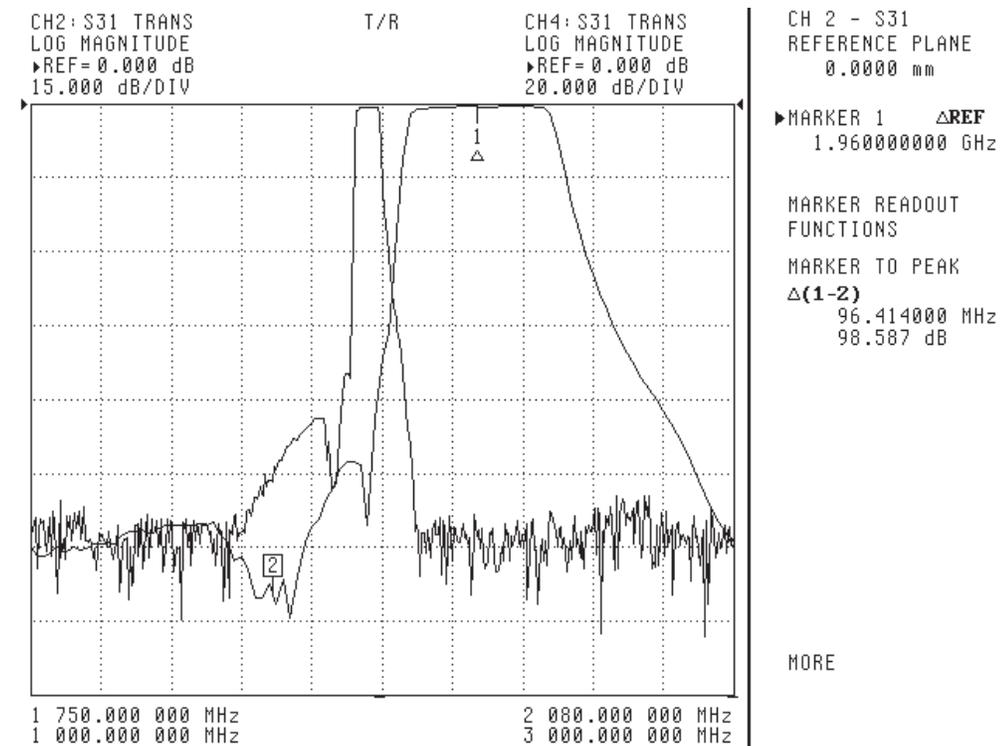


Figure 6-19. Alternate Sweep Overlay Example Display

In this display, the same bandpass filter response is shown, but the responses are shown on two difference frequency ranges (see the frequency range portion of display). When using alternate sweep, the system allows separate settings from the primary sweep. These different settings include Calibration, Frequency, I.F. Bandwidth, Data Points, Source Power, Markers, Limits, and Averaging.

1. Press the Appl front panel key and select the menu soft keys as follows:
 - CHANGE APPLICATION SETUP
 - MEASUREMENT TYPE
 - TRANSMISSION AND REFLECTION
2. Perform a three-port calibration (Section 3-6) between 1750 and 2080 MHz:
 - Freq/START = 1750 MHz
 - Freq/STOP = 2080 MHz
 - Config/DATA POINTS = 401 MAX PTS
 - Power/SOURCE 1 SETUP/SOURCE 1 POWER = +7 dB
 - Avg/SELECT I.F. BANDWIDTH/I.F. BW = 1 kHz

3. Select an alternate sweep channel before calibration:
Ch 3 (or Ch 4)
4. Initiate the alternate sweep:
Sweep/ALTERNATE SWEEP = ON
5. Perform a second three-port calibration between 1000 and 3000 MHz:
Freq/START = 1000 MHz
Freq/STOP = 3000 MHz
Config/DATA POINTS = 101 MAX PTS
Power/SOURCE 1 SETUP/SOURCE 1 POWER = +7 dB
Avg/SELECT I.F. BANDWIDTH/I.F. BW = 100 Hz
6. Configure the display according to the previous display.

The primary sweep is active for system setting changes when Ch 1 or Ch 2 is selected.

The alternate sweep is active for system setting changes when Ch 3 or Ch 4 is selected.

Another interesting feature involves switching between the primary and alternate sweep.

1. Select:
Ch 1 (or Ch 2)
2. Press the Sweep front panel key and select the menu soft keys as follows:
ALTERNATE SWEEP = OFF

Note that the four-channel display reverts to the primary sweep system settings. The following procedure allows a four channel display of the alternate sweep.

1. Select:
Ch 3 (or Ch 4)
2. Press the Sweep front panel key and select the menu soft keys as follows:
ALTERNATE SWEEP = ON
ALTERNATE SWEEP = OFF

Note that the four channel display reverts to the alternate sweep system settings. This is a convenient technique for switching the four channel display between the primary and alternate sweep system settings.

6-10 *MARKER SWEEP*
Standard Feature

The following displays show before and after results of a marker sweep using the MS462XX. Figure 6-20 shows a full sweep, while Figure 6-21 shows a marker sweep.

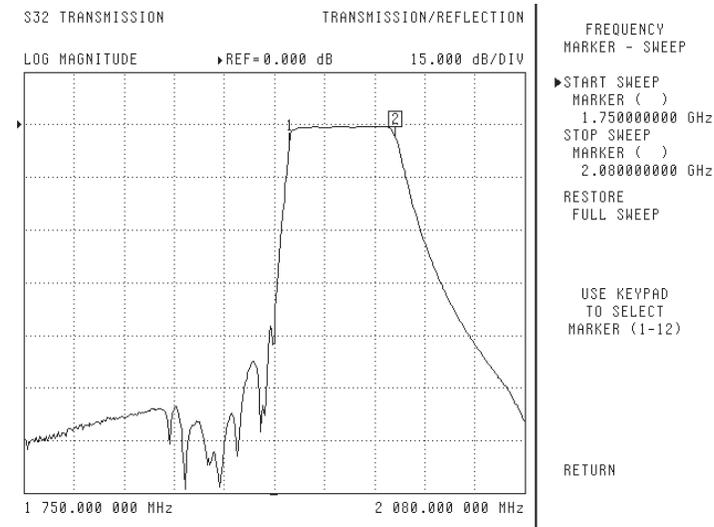


Figure 6-20. Results of a Full Sweep Example Display

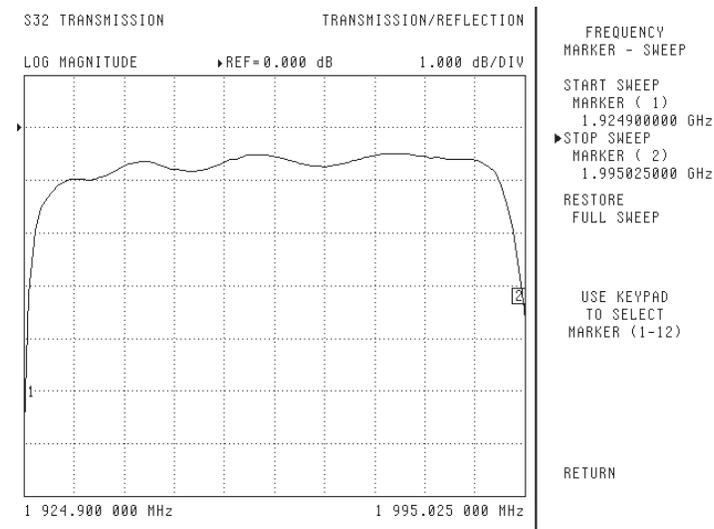


Figure 6-21. Results of a Marker Sweep Example Display

The following procedure documents the steps for performing a marker sweep.

1. Specify marker 1 location:

Marker/MARKER SETUP/MARKER 1 = 1.9249 MHz

2. Specify marker 2 location:

Marker/MARKER SETUP/MARKER 2 = 1.9950 MHz

Freq/MARKER SWEEP

3. Specify Start marker number:

START SWEEP MARKER = 1

4. Specify Stop marker number:

STOP SWEEP MARKER = 2

NOTE

To restore the original full sweep, select Freq/MARKER SETUP/RESTORE FULL SWEEP.

6-11 OTHER FEATURES This section contains information on other features available in the MS462XX.

Chop Sweep To access the Chop Sweep feature, select the following front panel key and menu soft keys:

Sweep/MORE/MEASUREMENT ENHANCEMENT
CHOP MODE TYPE = ALL S-PARAMETERS (or PER PORT)
CHOP SWEEP = ON (or OFF)

When CHOP MODE TYPE = ALL S-PARAMETERS is selected and CHOP SWEEP = ON, all S parameters are obtained in a single sweep. For a two-port instrument, all four S-parameters are measured in a single sweep; for a three-port instrument, all nine S-parameters are measured in a single sweep. The sweep time displayed is the approximate sweep time of a single sweep.

If CHOP MODE TYPE = PER PORT is selected and CHOP SWEEP = ON, each S-parameter associated with a port is obtained in a single sweep until all ports have been swept. For example, S11, S21, S31 are measured in a single sweep at port 1, then S12, S22 and S23 at Port 2 would require another sweep, and finally S13, S23, and S33 at Port 3 would require a third sweep. The sweep time value per port is the value times three for three-port, or times two for two-port (nine for three-port, four for two-port).

With CHOP SWEEP = OFF, the maximum number of sweeps would be required to obtain all S-parameters; one sweep per S-parameter. Time for completion would be sweep time times the number of S parameters.

Entry State To access the Entry State feature, select the following front panel key and menu soft keys:

Appl/CHANGE APPLICATION SETUP/ENTRY STATE

The Entry State feature specifies system settings when switching to the next application. Before changing applications, specify whether to use the Current or Previous system settings. For Entry State set to Current, the MS462XX configures the next application with the same existing system settings (i.e., display mode, graph type(s), frequency, etc.). In contrast, with Entry State set to Previous the MS462XX configures the next application with the previous system settings.

The following examples illustrate the use of Entry State. Consider a requirement to perform an S-parameter measurement and a Noise Figure measurement.

ENTRY STATE = CURRENT

The MS462XX is first configured for S-parameter measurements. The MS462XX is next configured for Noise Figure by setting the Entry State to

Current and selecting the Noise Figure application. For the Entry State of Current, the MS462XX uses the current system settings for the Noise Figure application.

ENTRY STATE = PREVIOUS

The MS462XX is first configured for S-parameter measurements. The MS462XX is next configured for Noise Figure measurements by setting the Entry State to Previous and selecting the Noise Figure application. For the Entry State of Previous, the MS462XX uses the system settings from the previous Noise Figure application entry.

Frequency Blanking

Frequency Blanking is typically used in secure environments to prevent frequency information from being displayed on the analyzer. When frequency blanking is activated, all frequency information is displayed as xxx.xxxx. Figure 6-22 shows a typical display with frequency blanking activated.

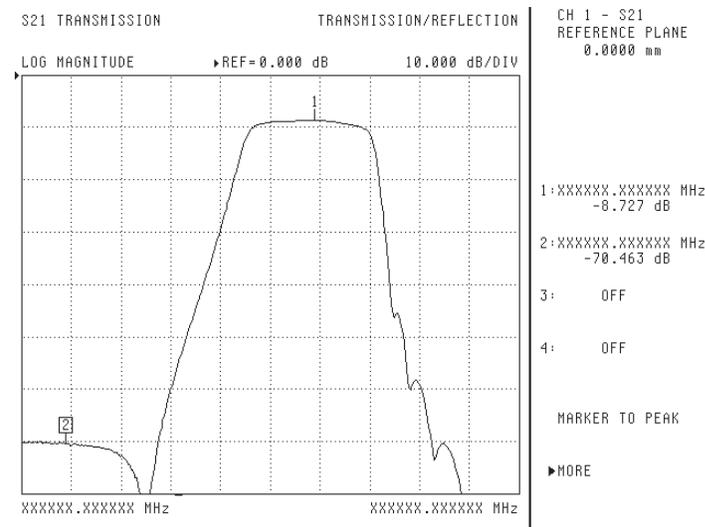


Figure 6-22. Filter Measurement with Frequency Blanking Activated

NOTE

Once activated, blanking can only be disabled by either resetting the instrument, or via GPIB command.

To activate frequency blanking, select the following front panel key and menu softkey:

Config/BLANK FREQUENCY INFO

To turn off frequency blanking via the front panel, select the following front panel key and menu softkey:

Default/CONTINUE

To turn off frequency blanking using GPIB, issue the GPIB command: FON.

***SnP Format
Data Outputs***

SnP-type data can be retrieved from the MS462XX. The data is in the format of magnitude and angle and can be viewed on any computer supporting text files. Before retrieving the data, all necessary Transmission and Reflection calibrations should be performed (see Chapter 3 for information on calibrations). To set up the MS462XX to obtain the SnP files:

1. Select the front panel Appl key and the following soft keys:
CHANGE APPLICATION SETUP
MEASUREMENT TYPE
TRANSMISSION AND REFLECTION
2. Press the front panel Hard Copy key and the following soft keys:
OUTPUT DEVICE/ DISK FILE
RETURN
OUTPUT SETUP
DESTINATION = FLOPPY DISK
FORMAT = SnP OPTIONS (choose between S1P, S2P, S3P, and S4P)
RETURN
3. Insert a disk into the MS462XX floppy disk drive and press the front panel PRINT key .
4. Enter a file name.

This completes the SnP data acquisition.

Chapter 7

Software Support

7-1 INTRODUCTION

This chapter contains information pertaining to drivers and other software used to support the applications on the MS462XX.

7-2 SCORPION NAVIGATOR®

Freeware

Scorpion Navigator (Anritsu part number: 2300-353) is a Windows-based GPIB (IEEE 488.2) controlled software program that contains easy to use modules for single connection setups, calibrations, measurements, and data capture. These building blocks provide a suite of unique, innovative and practical measurements for characterizing amplifiers and other active devices in both R&D and manufacturing using a Scorpion Vector Network Measurement System.

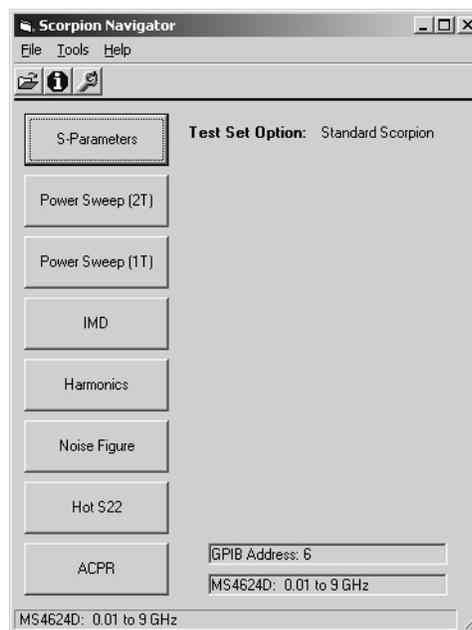


Figure 7-1. Scorpion Navigator Interface

Scorpion Navigator System Requirements

Scorpion Navigator required the following equipment:

- Pentium II PC 200 MHz or greater
- National Instruments GPIB Controller
- Windows Operating System
(Windows 2000 or Windows XP preferred)
- Scorpion BMS 1.16 or higher

***Scorpion Navigator
Description***

In R&D applications, Scorpion Navigator employs a standard user interface that provides easy-to-use navigation of Scorpion's powerful capabilities to measure S-parameters, Noise Figure, Harmonics, Single-Tone Compression and Two-Tone Intermodulation Distortion.

In manufacturing applications, the ActiveX® modules provide easy plug-n-play compatibility with most automation environments: HP Vee®, Visual Basic®, Microsoft Excel®/VBA™, VBScript™, JavaScript™, Visual C++®, National Instrument's LabView®, LabWindows® and TestStand™. In other words, these measurement ActiveX modules are instrument drivers that can seamlessly integrate into essentially any software development environment.

Scorpion Navigator was originally developed for the Power Amplifier Test System. Although many of the available measurements are important for amplifier testing. They also apply to a number of new measurement challenges for RF component designers and manufacturers.

The following table overviews the features, advantages, and benefits of using Scorpion Navigator:

Features	Advantages	Benefits
Standard ActiveX modules orchestrate common Scorpion measurements	Very little coding is required for basic measurements, including pass/fail testing	Increase productivity
Access the source code via a unique ActiveX auto-code generation feature	Easier to customize existing measurement capabilities when source code is provided	Possibility to automate custom requirements in about a week
Extensive single and two-tone testing for amplifier requirements	Comprehensive, accurate and fast test for next generation requirements	Improve time-to-market and time-to-volume
Windows graphical user interface (GUI)	Sophisticated displays and concise menus provide easy-to-use testing interface	Perform advanced measurements without long learning curves

The following table summarizes the various measurement capabilities available in Scorpion Navigator:

Measurements	Variations Supported	Notes
S-Parameter	2-Port S-Parameters K-factor	
Swept Power IMD (2-Tones)	P _{out} (or Gain), IM3, IM5, IM7, Drain Current, and Power Added Efficiency P _{out} (or Gain), IM3, IM5, IM7, Drain Current, and Power Added Efficiency P _{out} (or Gain), IM3, IM5, IM7, Drain Current, and Power Added Efficiency	Single Frequency Versus P _{in} or P _{out} Three Overlaid Frequencies Versus P _{in} or P _{out} Specify Start and Stop Frequencies or Start and Stop Offsets
Swept Power (1-Tone)	P _{out} versus P _{in} Gain versus P _{in} Gain versus P _{out} AM/PM P _{out} (or Gain) versus Multiple Frequencies	Single Frequency Single Frequency Single Frequency Single Frequency Up to 101 Frequencies
IMD, CW	P _{out} , IM3, IM5, IM7 and IM9 Swept Frequency Products, Input or output referred Swept Third Order Intercepts, Input or output referred	
Harmonics, CW	CW versus 2 nd , 3 rd , 4 th , 5 th , 6 th , 7 th , 8 th , 9 th	Single Frequency
Noise Figure	Noise Figure versus Frequency	Swept Frequency
Hot S22	Hot S22 and Hot K-factor	Reference New Application Note (11410-00295)
ACPR	CW for CDMA, W-CDMA Swept Power	Reference ACPR Application Note (11410-00264)

The Scorpion Navigator currently supports two-port AutoCal modules for auto-calibrations in addition to standard manual calibration kits (including user-defined). A future release of Scorpion Navigator will include support for the new four-port AutoCal modules.

7-3 AUTOCAL TWO-PORT CHARACTERIZATION The following procedure characterizes the two-port AutoCal module using the MS462XX.



Figure 7-2. Two-Port AutoCal System Setup

1. Perform a two-port OSLT calibration (Section 3-3) in the desired frequency range with the maximum data points and a 0 dBm source power.
2. Press the front panel keys and menu soft keys as follows:
Utility/AUTOCAL CHARACTERIZATION/SELECT BOX TYPE: 2 PORT
3. As required, change the characterization setup (Steps 4 through 5).
4. Connect the AutoCal module and specify the Port Configuration:
SELECT PORTS: (L=1,R=2 or R=1,L=2 where L is for Left and R is for Right on the AutoCal Module)
5. Specify the Averaging values:
AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
RETURN
6. Start the AutoCal characterization:
CONTINUE

7. Following the CONTINUE selection, the MS462XX proceeds to characterize the AutoCal Module using the previously performed OSLT calibration. This characterization process can be time-consuming, depending upon the averaging selections.
8. Save the characterized AutoCal data for later retrieval:

Save/Recall/SAVE/AUTOCAL CHARACTERIZATION ON HARD
DISK/CREATE NEW FILE
9. Specify a name using the front panel knob, and select DONE.

This completes the procedure for characterizing the AutoCal module using the MS462XX.

**7-4 AUTOCAL
FOUR-PORT
CHARACTERIZATION**

The following procedure characterizes the four-port AutoCal module using the MS462XX.



Figure 7-3. Four-Port AutoCal System Setup

1. Perform a four-port OSLT calibration (Section 3-8) in the desired frequency range with the maximum data points and a 0 dBm source power.
2. Press the front panel keys and menu soft keys as follows:
Utility/AUTOCAL CHARACTERIZATION/SELECT BOX TYPE: 4 PORT
3. Connect the AutoCal module as follows:
Port 1 to AutoCal X
Port 2 to AutoCal A
Port 3 to AutoCal B
Port 4 to AutoCal C
4. Specify the Averaging values:
AVERAGING
REFLECTION = 4
LOAD = 4
THRU = 4
RETURN
5. Start the AutoCal characterization:
CONTINUE

6. Following the CONTINUE selection, the MS462XX proceeds to characterize the AutoCal Module using the previously performed OSLT calibration. This characterization process can be time-consuming, depending upon the averaging selections.
7. Save the characterized AutoCal data for later retrieval:

Save/Recall/SAVE/AUTOCAL CHARACTERIZATION ON HARD
DISK/CREATE NEW FILE
8. Specify a name using the front panel knob, and select DONE.

This completes the procedure for characterizing the AutoCal module using the MS462XX

7-5 SCORPION COMMAND ENCYCLOPEDIA

The Scorpion Command Encyclopedia (SCE) is a fully integrated ATE programming environment. It has been designed as a rapid development tool to simplify the creation of MS462XX remote control applications. SCE provides everything necessary to create GPIB or Ethernet ATE programs.

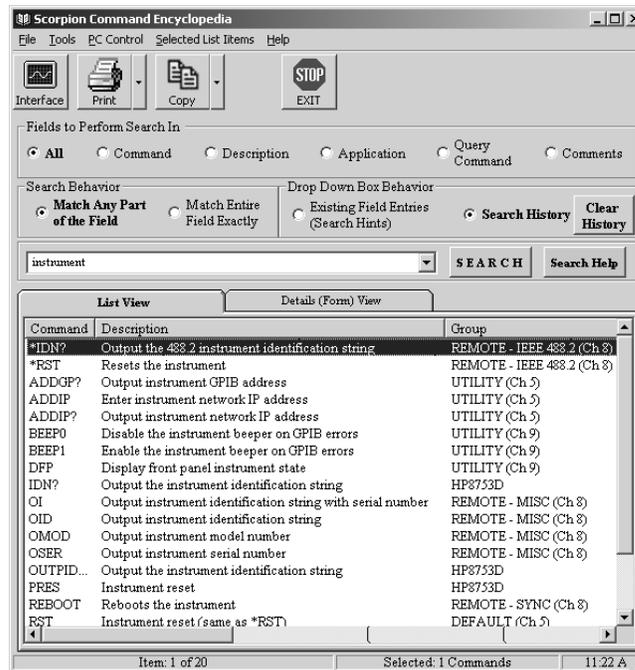


Figure 7-4. Scorpion Command Encyclopedia Main Screen

SCE Features

- A searchable command database can be accessed through the user-friendly computer interface. The database provides command mnemonic names, descriptions and usage information, and is searchable by mnemonic, description, query command, application and user comment.
- A programming manual link allows access to the Scorpion Programming Manual in Adobe Acrobat reader format.
- The programming interface allows selection of GPIB or Ethernet interfaces.
- The programming interface generates the code required to duplicate the command sequences exercised through the SCE interface. This feature currently supports the Visual Basic programming language.

Operation

The MS462XX command database can be accessed through the SCE graphical user interface (GUI). The command database is fully searchable and fully integrated into the SCE. For example, clicking on a command listed in the command list window will automatically open the Scorpion Interface screen and place the selected command in the execution box ready for execution over the selected remote interface.

For more detailed information on a particular command, go to the Help menu and select Spawn Manual. This will open the MS462XX Programming Manual in the provided Adobe Acrobat Reader.

Scorpion Interface Screen

The Scorpion Interface screen allows the use of any command mnemonic over either the GPIB or the Ethernet remote control interface.

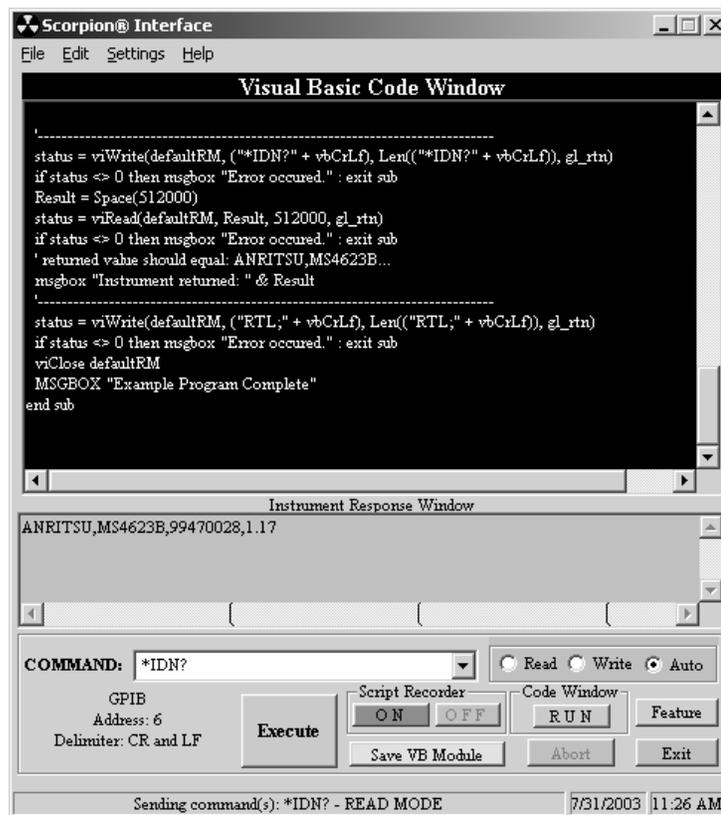


Figure 7-5. Scorpion Interface Screen

Scorpion Interface screen features include:

- ❑ Switch between interface types (GPIB or Ethernet).
- ❑ The “Auto Command Spell Check” option (located in the Options menu screen) verifies that a command is valid. It also verifies that the command Read or Write execution method is correctly selected. This option is selectable allowing advanced users the flexibility of turning this option off and executing commands freely over the GPIB/ Ethernet Interface.
- ❑ Automatic Code Generation can execute commands over the selected interface. The automatically generated code can then be copied into the ATE program to help speed up development.
- ❑ The Feature button allows selection of available features. Currently available features are:

The Get Trace feature performs a screen capture (supported in both GPIB and Ethernet interfaces). When a screen capture is executed the code required to duplicate it is generated automatically in the Code Generation window, to easily reproduce the result in another program.

The Get Sequence feature provides the ability to manipulate sequences remotely. As with the Get Trace feature, this feature also creates the code in the code window for use in other programs.

An important feature of the SCE Scorpion Interface is the ability to automatically generate the code required to duplicate the mnemonic commands sent. The SCE can send command mnemonics out over the GPIB or the Ethernet and then automatically generates the Visual Basic code required to duplicate the command sequence in the Visual Basic programming language.

The SCE Scorpion Interface also provides the ability to record and play back a sequence of commands. With scripting turned ON, all commands are recorded. The script can be run from the SCE environment and then cut and pasted into an ATE program. This provides the means to rapidly develop ATE applications by making it easy to experiment and learn programming requirements for each command.

7-6 DRIVERS AND POWER TOOLS

Freeware

Power Tools (Anritsu part number: 2300-218) is an instrument driver that replaces GPIB command mnemonics with meaningful function names. Since Power Tools is packaged as Dynamic Link Libraries (DLLs), it supports most Windows-based software development tools. In this way, Power Tools provides an intuitive and straightforward approach to controlling the MS462XX from Automatic Test Equipment (ATE) Application Programs.

The following block diagrams show the relationship between the MS462XX and the ATE Application Program.

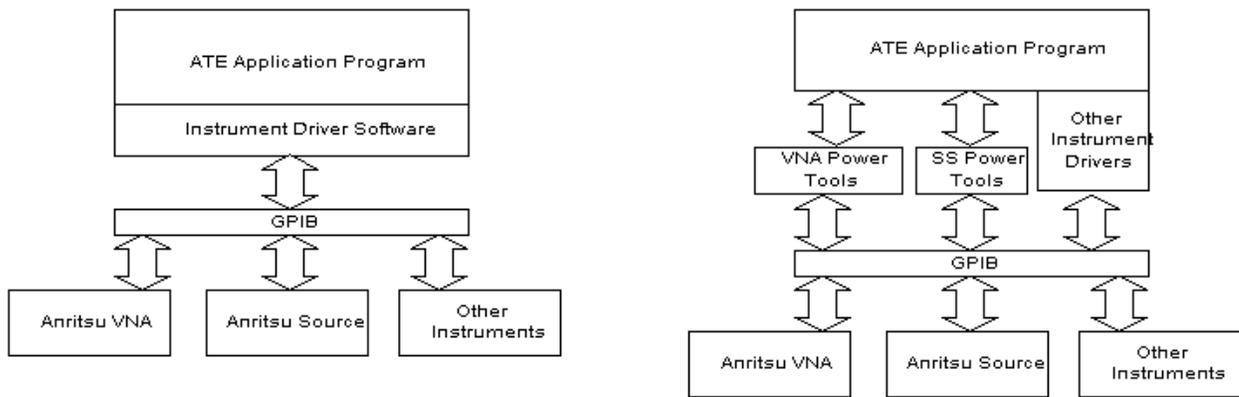


Figure 7-6. MS462XX and ATE Application Program Block Diagrams

The block diagram on the left shows a typical ATE System. In this case, the Instrument Driver Software is an integral part of the ATE Application Program.

The block diagram on the right shows a Power Tools Enabled ATE System. In this case, the Instrument Driver Software (or VNA Power Tools) is not an integral part of the ATE Application Program. This system configuration affords many advantages over the typical ATE System. Three of these advantages with explanations are shown in the following table.

Advantage	Explanation
Forward and Backward Compatibility	Anritsu provides updated instrument drivers guaranteed to be backward compatible while also providing forward compatible support for new instrument options and features.
Modular Software Design	Power Tools is separately compiled outside the Application Program. Update the instrument driver independently from the ATE Application Program.
Easier To Use	GPIB command mnemonics are replaced with meaningful function names.

This completes the discussion on Instrument Drivers and Power Tools.

7-7 VNA DISPLAY CAPTURE

Freeware

The VNA Display Capture program (Anritsu part number 2300-218) is a Windows-based program used to capture, display, save, and print display data from an Anritsu VNA. The available output formats include bitmaps (*.BMP), plotter graphics (*.HGL), printer graphics (*.PGR), and metafiles (*.WMF). In addition, the VNA Display Capture allows both color or black and white captures.

The following display shows a typical capture in a Windows environment.

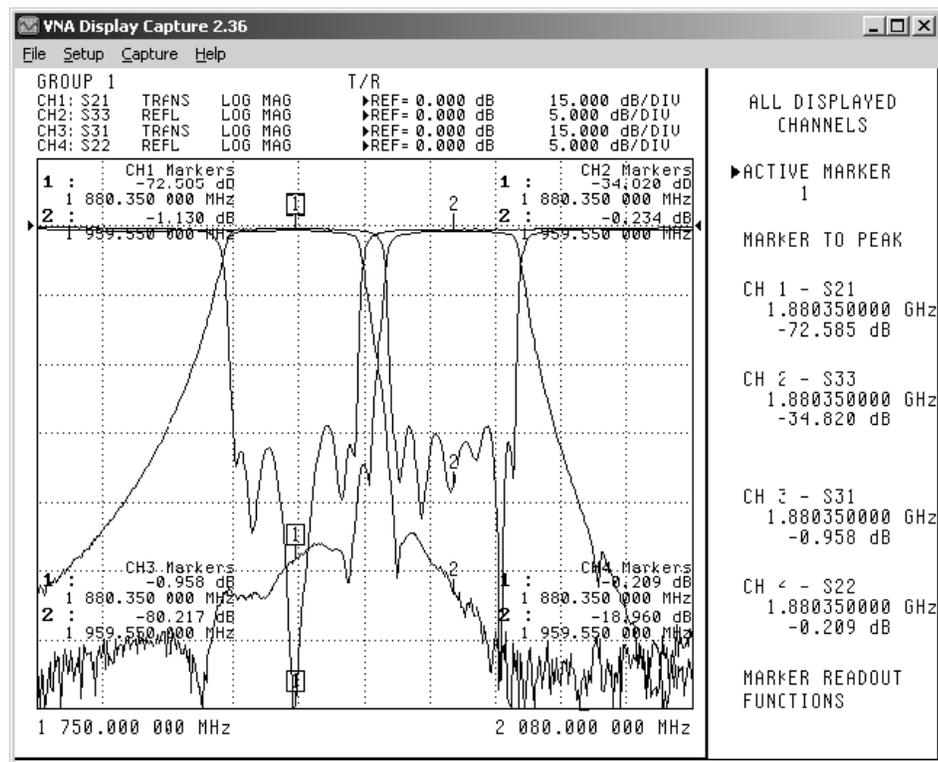


Figure 7-7. Typical Capture Display

The following procedure captures and stores an MS462XX display in a bitmap format using the VNA Display Capture software program.

1. Ensure a GPIB connection between the computer and the MS462XX.
2. Execute VNA DISPLAY CAPTURE.
3. Select Setup from the tool bar. The following menu is displayed when Setup is selected.

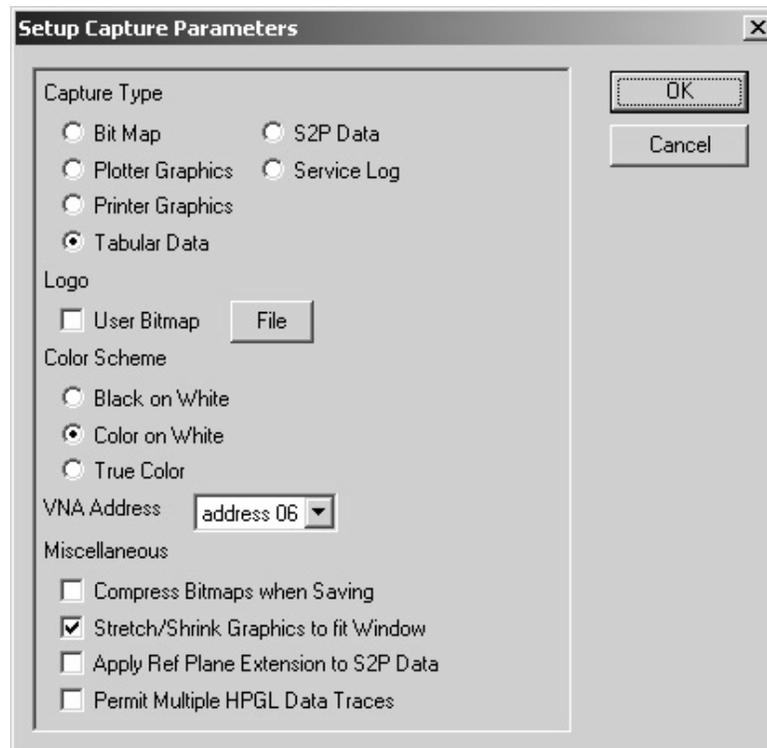


Figure 7-8. Setup Capture Parameters

4. Specify Capture Type = Bit Map
5. Specify Color Scheme = Black on White
6. Specify VNA Address = 06 (default GPIB address of MS462XX)
7. Select OK
8. Select Capture from the tool bar.

Following the Capture selection, the VNA Display Capture program will capture the front panel display from the MS462XX.

NOTE

The file name must include the .BMP or the .WMF extension.

9. Select File from the tool bar.
10. Select Save from pull-down menu.
11. Specify a file name = diplexer.bmp

This completes the procedure for capturing and storing an MS462XX display in a bitmap format using the VNA Display Capture software program.

**7-8 NOISE FIGURE
VENDOR ENR
TABLE**

Option 4

The noise figure measurement application requires the vendor ENR values for the noise source. These values are configured in a tab delimited ASCII file and stored on the hard disk of the MS462XX. The filename must be of the form *.enr and it is generally useful for the name to contain the noise source serial number. Once loaded on the hard drive, these values are loaded into memory for the noise figure measurement.

The ASCII file is generated using any text editor or word processor. No headers are necessary, begin immediately with the first frequency and ENR value on the first line separated by a tab. This file should not contain more than 101 points. The following example illustrates the contents of the vendor ENR table.

0.01	15.53
0.10	15.39
1.0	15.21
2.0	15.00
3.0	15.04
4.0	14.85
5.0	14.68
6.0	14.83
...	

The following figure illustrates the contents of the vendor ENR table.

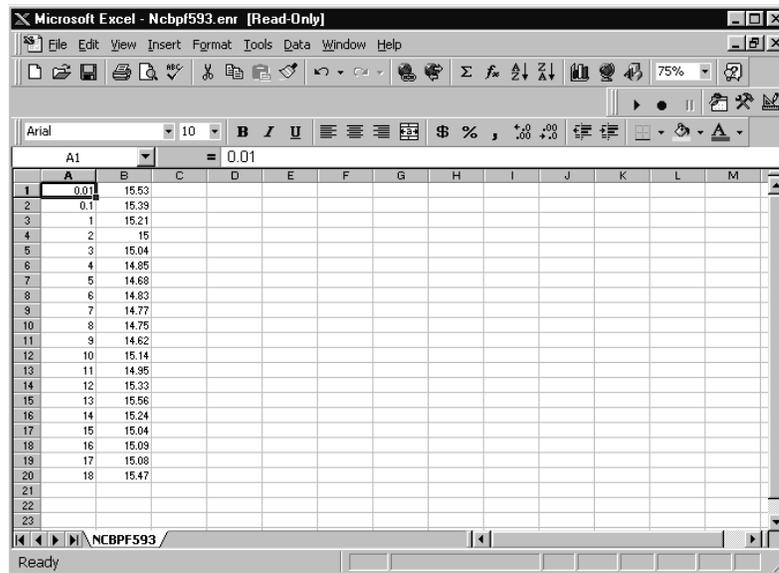


Figure 7-9. Example Vendor ENR Table

NOTE

Do not press return after the last pair.

When completed, save the file as text. Since most programs automatically append extensions to the filename, be sure to change the extension to *.enr. Copy this file to a high density (1.44 MB) floppy for transfer to the hard disk of the MS462XX.

The following procedure loads this file onto the hard disk of the MS462XX.

1. Insert the floppy into the MS462XX floppy disk drive.
2. Press the front panel keys and menu soft keys as follows:
Utility/GENERAL DISK UTILITIES/FLOPPY DISK UTILITIES
COPY FILES TO HARD DISK/ALL TYPES (*.*)
3. Specify the file to copy using the SELECT FILE TO COPY menu.
4. Following the SELECT FILE TO COPY file selection, the MS462XX will copy the specified file to the MS462XX hard disk.

This completes the description and the procedure for loading the Vendor ENR Table to the hard disk of the MS462XX.

7-9 NF ENR EXTENSION TABLE

Option 4

The noise figure measurement application requires the S-parameters of the path between the rear panel noise source connector and the Port 1 connector. These S-parameters are configured in a file and stored on the MS462XX hard disk. The filename must be of the form *.ext and it is generally useful for the name to contain the instrument serial number. Once loaded on the hard drive, these values are loaded into memory for the noise figure measurement.

This ASCII file is generated at the factory and stored on the hard disk. No headers are necessary, begin immediately with the first line containing the following data separated by tabs. This file should not contain more than 101 points.

NS refers to the match of the noise source alone. The following example illustrates the contents of a vendor ENR table:

freq Re(S11) Im(S11) Re(S21) Im(S21) Re(S12) Im(S12) Re(S22) Im(S22) Re(NS) Im(NS)

Figure 7-10. S-Parameters ASCII ENR File Format

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	0.05	0.0284	-0.0126	0.5264	-0.6237	0.5243	-0.6214	0.0246	0.0085	-0.019	-0.0011		
2	0.0795	0.0222	-0.0246	0.1272	-0.8008	0.1283	-0.7973	0.0274	0.0057	-0.0188	0.0038		
3	0.109	-0.0009	-0.0293	-0.2947	-0.7537	-0.2911	-0.75	0.0277	-0.0017	-0.0179	0.0067		
4	0.1385	-0.0247	-0.0086	-0.6395	-0.4994	-0.6317	-0.4992	0.0277	-0.0045	-0.0161	0.0089		
5	0.168	-0.0203	0.0296	-0.7959	-0.104	-0.7933	-0.1058	0.0348	-0.0071	-0.0138	0.0121		
6	0.1975	0.0299	0.0429	-0.7255	0.3031	-0.7242	0.3012	0.0448	-0.0295	-0.012	0.0159		
7	0.227	0.0461	-0.0179	-0.4911	0.6119	-0.4906	0.6095	0.0207	-0.0462	-0.0129	0.0182		
8	0.2565	0.0099	-0.0376	-0.1236	0.791	-0.1241	0.7879	0.0058	-0.0336	-0.0124	0.0168		
9	0.286	-0.0084	-0.0373	0.2977	0.748	0.2944	0.7456	0.0073	-0.027	-0.0074	0.0162		
10	0.3155	-0.013	-0.0252	0.6368	0.4954	0.6343	0.495	0.0052	-0.0342	-0.0015	0.0193		
11	0.345	-0.0086	-0.0046	0.7992	0.1046	0.7972	0.1058	-0.0096	-0.0329	-0.0017	0.0245		
12	0.3745	0.002	0.0085	0.742	-0.3126	0.7402	-0.3106	-0.014	-0.023	-0.0045	0.0234		
13	0.404	0.0199	0.0074	0.4818	-0.6454	0.4799	-0.6439	-0.0118	-0.0139	-0.001	0.0178		
14	0.4335	0.0263	0.0002	0.1002	-0.7948	0.1004	-0.7927	-0.0097	-0.0155	0.0077	0.0179		
15	0.463	0.0176	-0.0163	-0.3167	-0.7356	-0.315	-0.7339	-0.0151	-0.0135	0.0111	0.0238		
16	0.4925	0.0014	-0.0263	-0.6394	-0.4786	-0.6373	-0.4783	-0.0165	-0.0092	0.0074	0.0258		
17	0.522	-0.0184	-0.0237	-0.7912	-0.0888	-0.7899	-0.0889	-0.0163	-0.0078	0.0053	0.0195		
18	0.5515	-0.0308	-0.0107	-0.7287	0.3048	-0.7259	0.3044	-0.0204	-0.0078	0.0124	0.0132		
19	0.581	-0.0198	-0.0002	-0.4731	0.6299	-0.471	0.6283	-0.024	0.0035	0.0208	0.0139		
20	0.6105	-0.0037	0.0055	-0.0881	0.7861	-0.0881	0.7823	-0.0184	0.0139	0.0205	0.0197		
21	0.64	0.0096	-0.0044	0.3244	0.7271	0.3219	0.7245	-0.0056	0.0182	0.0175	0.0197		
22	0.6695	0.0164	-0.0175	0.6422	0.4622	0.6389	0.4609	0.002	0.0116	0.0152	0.0132		
23	0.699	0.0068	-0.0248	0.787	0.078	0.7841	0.0788	0.0016	0.0097	0.0199	0.006		

Figure 7-11 Example Internal Extension File

When completed, make sure to save the file as text. Since most programs automatically append extensions to the filename, make sure to change the extension to *.ext. Copy this file to a high density (1.44 MB) floppy for transfer to the MS462XX hard disk.

This file is generated at the factory by performing a measurement of the through path between the back panel and the Port 1 connector. The procedure involves a 101 point calibration between 50 MHz and 3 GHz. The four channel display is configured for real and imaginary output for S_{11} , S_{21} , S_{12} , and S_{22} . This data is output to disk using TEXT format.

Using this same technique, the noise source (no bias applied) measurement is also performed to obtain the real and imaginary performance between 50 MHz and 3 GHz. These two files are combined (typically using Excel) for the final file.

NOTE

Scientific notation is not supported, but any number of significant digits can be used up to the line length limit. Also, do not press return after the last line entry.

The following procedure loads this file onto the hard disk of the MS462XX.

1. Insert the floppy into the floppy drive of the MS462XX.
2. Press the front panel keys and menu soft keys as follows:
Utility/GENERAL DISK UTILITIES/FLOPPY DISK UTILITIES
COPY FILES TO HARD DISK/ALL TYPES (*.*)
3. Specify the file to copy using the SELECT FILE TO COPY menu.

Following the SELECT FILE TO COPY file selection, the MS462XX proceeds to copy the specified file to the MS462XX hard disk.

To move the internal ENR extension table into memory:

4. Press the front panel keys and menu soft keys as follows:
Appl/NOISE FIGURE SETUP
NOISE SOURCE = INTERNAL
ENR TABLE OPERATION/LOAD ENR TABLE FROM HARD DISK/INTERNAL ENR EXTENSION TABLE
INTERNAL ENR EXTENSION TABLE
5. Select the internal .EXE file (usually contains the instrument serial number) and press:
RETURN
RETURN

This completes the description and the procedure for loading the ENR Extension Table to the hard disk of the MS462XX.

Index

A

alternate sweep 6-22
 application key 2-6
 applications 4-1
 harmonic 4-31
 noise figure 4-2
 swept frequency gain compression 4-44
 swept power gain compression 4-41
 time domain 4-46
 AutoCal
 calibration 3-5, 3-11
 characterization 3-7, 3-9, 3-13, 3-15, 7-4, 7-6
 automatic test equipment 7-11
 autoscale 2-9

B

balanced measurements 5-1
 four-port 5-4, 5-5
 three-port 5-1, 5-2, 5-3
 balanced parameters 5-6
 bandpass filter 3-20, 6-22
 bandwidth 4-4

C

calibration 3-1
 aborting 3-3
 AutoCal 3-5, 3-11
 coefficients 3-2
 discrete fill 3-20
 four-port 3-19
 OSLT 3-3
 three-port 3-17, 6-3
 two-port 3-17
 calibration coefficients 3-2
 channel key 2-5, 2-9
 characterization
 AutoCal 3-5, 3-11

chop sweep 6-27
 command encyclopedia 7-8
 compression point 4-45
 connector 2-2, 3-2
 conventions 2-1
 conversion loss 4-49
 Customize Calibration, Flexible 3-28

D

data entry key 2-5
 decouple channels 6-22
 de-embedding 5-9, 5-10, 5-11, 5-12
 device type 4-48, 4-65
 diplexer 6-1
 directory 6-11
 discrete fill calibration 3-20
 disk output 6-2
 display 2-3
 four-channel 2-9, 2-10, 6-24
 key 2-6
 modes 2-9
 overlay 6-22
 display key 2-9
 drivers 7-11
 dual channels 2-10
 Dynamic Link Libraries 7-11

E

embedding 5-9
 enhancement key 2-5
 ENR 7-15, 7-16, 7-17, 7-18
 extension table 7-17, 7-18
 vendor table 7-15
 entry state 6-27
 Error Term, Determination 3-29
 Excel 7-18
 external SCSI 6-11

F		interchannel math	5-15
features.	6-1	intermodulation distortion	4-1, 4-82
Flexible Calibration		isolation	3-3, 3-8, 3-14, 3-21, 3-24
Customize Cals.	3-28	K	
Error Term Determinations	3-29	keys	
Example	3-29	channels	2-5
Full Term Cals	3-28	data entry	2-5
Measurement Subsets	3-28	enhancement.	2-5
Overview	3-28	front panel	2-5, 2-8
Reflection Only Cals	3-28	labeled.	2-4, 2-5
Using	3-28	soft keys	2-7
floppy disk	6-12	stimulus	2-5
four-channel display	2-9, 2-10, 6-24	system	2-5
four-port calibration	3-19	L	
frequency translated group delay	4-1	limit lines	6-19
front panel		M	
display	2-3	manuals	1-1
keys	2-4, 2-5	marker key	2-6
overview	2-2	marker sweep.	6-25
full sweep	6-26	markers	6-8, 6-14
Full Term Calibrations, Flexible.	3-28	measurement key	2-6
G		measurement speed.	6-5, 6-6
General Information.	1-1	mixer	4-48, 4-65, 4-82
global power sweep	4-82	mixer measurements	4-1
GPIB	7-11	models	1-1
graph type	2-10	N	
group	5-13	noise figure.	4-1, 6-27, 7-17
H		noise source.	7-15
hard drive.	6-11	non-volatile memory	6-11
harmonic		O	
CW scalar.	4-31	offset length.	3-17
swept scalar	4-33	options.	1-1, 2-1
swept vector	4-36	OSLT calibration.	3-3, 3-9, 3-15, 7-4, 7-6
harmonics	4-1, 4-30		
hold key	2-6		
I			
impedance transformation	5-7, 5-8		

output
 capture formats 7-13
 hard copy and disk 6-1, 6-2
 overlay dual channels 2-9, 2-10

P

peak-to-peak ripple filter 6-8
 phase 4-38
 plotting 6-2
 power sweep 4-1
 Power Tools 7-11
 primary sweep 6-22
 printing 2-5, 6-2, 7-13

R

Reflection Only Calibration, Flexible 3-28
 related manuals 1-1

S

saving. 2-5
 scale 2-9
 SCE. 7-8
 Segmented Sweep
 calibrating 3-24
 calibration 3-23, 3-24

setting up. 3-23
 serial number 2-1
 smoothing 2-5
 soft keys 2-7
 software support 7-1
 software version 2-1
 S-parameters 2-6, 2-9, 4-2, 6-6, 6-27, 7-17
 stimulus key 2-5
 sweep. 6-5
 swept frequency gain compression 4-1, 4-44
 swept power gain compression 4-1, 4-41
 system information 2-1
 system key 2-5
 System Overview 2-1

T

test sequence 6-8, 6-9, 6-10
 third order intercept 4-17
 three-port calibration 3-17, 6-6
 three-port measurement 6-1, 6-6
 time domain 4-1, 4-46
 transmission/reflection 1-1
 tune mode 6-1, 6-6

V

VNA Display Capture 7-13

Anritsu

Discover What's Possible®