

# DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

**Manufacturer's Name:** Agilent Technologies Japan, Ltd.

**Manufacturer's Address:** 1-3-2, Murotani, Nishi-ku, Kobe-shi,  
Hyogo, 651-2241 Japan

Declares, that the product:

**Product Name:** Network / Spectrum / Impedance Analyzer

**Model Number:** 4395A

**Product Options:** This declaration covers all options of the above product

Conforms with the following product standards:

EMC:	Standard	Limit
	IEC 61326-1:1997 +A1:1998 / EN 61326-1:1997 +A1:1998	
	CISPR 11:1997 / EN 55011:1998 / AS/NZS 2064.1/2	Group 1, Class A <sup>[1]</sup>
	IEC 61000-4-2:1995 / EN 61000-4-2:1995 +A1:1998	4 kV CD, 4 kV AD
	IEC 61000-4-3:1995 / EN 61000-4-3:1996 +A1:1998	3 V/m 80% AM 80 - 1000 MHz
	IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV signal lines, 1 kV power lines
	IEC 61000-4-5:1995 / EN 61000-4-5:1995	0.5 kV line-line, 1 kV line-ground
	IEC 61000-4-6:1996 / EN 61000-4-6:1996	3 V 80% AM 0.15 - 80 MHz
	IEC 61000-4-11:1994 / EN 61000-4-11:1994	1 cycle, 100%
	Canada: ICES-001	
<b>Safety:</b>	IEC 61010-1:1990 +A1:1992 +A2:1995 / EN 61010-1:1993 +A2:1995	
	CAN / CSA C22.2 No. 1010.1-92	

## Conformity / Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE-marking accordingly (European Union).

LEDs in this product are Class 1 in accordance with EN 60825-1:1994.

<sup>[1]</sup> The product was tested in a typical configuration with Agilent Technologies test systems.

Kobe, Japan      Dec. 15, 2000

Date

  
Name Koichi Yanagawa / Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.



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## **Safety Summary**

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When you notice any of the unusual conditions listed below, immediately terminate operation and disconnect the power cable.

Contact your local Agilent Technologies sales representative or authorized service company for repair of the instrument. If you continue to operate without repairing the instrument, there is a potential fire or shock hazard for the operator.

- Instrument operates abnormally.
- Instrument emits abnormal noise, smell, smoke or a spark-like light during the operation.
- Instrument generates high temperature or electrical shock during operation.
- Power cable, plug, or receptacle on instrument is damaged.
- Foreign substance or liquid has fallen into the instrument.



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## **Herstellerbescheinigung**

### GERÄUSCHEMISSION

LpA < 70 dB  
am Arbeitsplatz  
normaler Betrieb  
nach DIN 45635 T. 19

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## **Manufacturer's Declaration**

### ACOUSTIC NOISE EMISSION

LpA < 70 dB  
operator position  
normal operation  
per ISO 7779



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## Caution

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Do not exceed the operating input power, voltage, and current level and signal type appropriate for the instrument being used, refer to your instrument's Operation Manual.



Electrostatic discharge(ESD) can damage the highly sensitive microcircuits in your instrument. ESD damage is most likely to occur as the test fixtures are being connected or disconnected. Protect them from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any static charge built-up by touching the outer shell of any grounded instrument chassis before touching the test port connectors.





# Agilent 4395A Network/Spectrum/Impedance Analyzer

# Operation Manual

## **SERIAL NUMBERS**

This manual applies directly to instruments which have the serial number prefix JP1KE and MY411. For additional important information about serial numbers, read “Serial Number” in Appendix D of this Manual.



**Agilent Technologies**

**Agilent Part No. 04395-90040**  
**Printed in JAPAN May 2003**

**Sixth Edition**

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Agilent Technologies Japan, Ltd.  
Component Test PGU-Kobe  
1-3-2, Murotani, Nishi-ku, Kobe-shi,  
Hyogo, 651-2241 Japan

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## Manual Printing History

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates that are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

September 1997 .....	First Edition (part number: 04395-90000)
September 1998 .....	Second Edition (part number: 04395-90010)
March 2000 .....	Third Edition (part number: 04395-90010)
July 2001 .....	Fourth Edition (part number: 04395-90020)
December 2002 .....	Fifth Edition (part number: 04395-90030)
May 2003 .....	Sixth Edition (part number: 04395-90040)

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## Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institution's calibration facility, or to the calibration facilities of other International Standards Organization members.

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## Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of one year from the date of shipment, except that in the case of certain components listed in *General Information* of this manual, the warranty shall be for the specified period. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent Technologies from another country.

Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instruction when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

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## Limitation Of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

*No other warranty is expressed or implied. Agilent Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.*

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## **Exclusive Remedies**

*The remedies provided herein are buyer's sole and exclusive remedies. Agilent Technologies shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.*

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## **Assistance**

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

For any assistance, contact your nearest Agilent Technologies Sales and Service Office. Addresses are provided at the back of this manual.

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## Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific **WARNINGS** elsewhere in this manual may impair the protection provided by the equipment. In addition it violates safety standards of design, manufacture, and intended use of the instrument.

*The Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.*

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### Note



4395A comply with INSTALLATION CATEGORY II and POLLUTION DEGREE 2 in IEC1010-1. 4395A are INDOOR USE product.

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### Note



LEDs in this product are Class 1 in accordance with IEC825-1.  
CLASS 1 LED PRODUCT

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## Ground The Instrument

To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade.

## DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

## Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

## DO NOT Service Or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

## DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

## **Dangerous Procedure Warnings**

**Warnings** , such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

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### **Warning**



**Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.**

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## Safety Symbols

General definitions of safety symbols used on equipment or in manuals are listed below.



Instruction manual symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.



Alternating current.



Direct current.



On (Supply).



Off (Supply).



In position of push-button switch.



Out position of push-button switch.



Frame (or chassis) terminal. A connection to the frame (chassis) of the equipment which normally include all exposed metal structures.

### Warning



This **Warning** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

### Caution



This **Caution** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

### Note



This **Note** sign denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.



Affixed to product containing static sensitive devices use anti-static handling procedures to prevent electrostatic discharge damage to component.



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## Typeface Conventions

**Bold** Boldface type is used when a term is defined. For example: **icons** are symbols.

*Italics* Italic type is used for emphasis and for titles of manuals and other publications.

Italic type is also used for keyboard entries when a name or a variable must be typed in place of the words in italics. For example: copy *filename* means to type the word copy, to type a space, and then to type the name of a file such as file1.

Computer Computer font is used for on-screen prompts and messages.

**HARDKEYS** Labeled keys on the instrument front panel are enclosed in **□**.

**SOFTKEYS** Softkeys located to the right of the LCD are enclosed in **▣**.

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## Documentation Map

The following manuals are available for the analyzer.

### **Operation Manual (Option ABA only) (Agilent Part Number 04395-900x0)**

The Operation Manual describes all function accessed from the front panel keys and softkeys. It also provides information on options and accessories available, specifications, system performance, and some topics about the analyzer's features.

### **Programming Manual (Option ABA only) (Agilent Part Number 04395-900x1)**

The Programming Manual shows how to write and use BASIC program to control the analyzer and describes how Instrument BASIC works with the analyzer.

### **Instrument BASIC Users Handbook (Option ABA only) (Agilent Part Number 04155-9015x)**

The Instrument BASIC User's Handbook introduces you to the Instrument BASIC programming language, provide some helpful hints on getting the most use from it, and provide a general programming reference. It is divided into three books, *Instrument BASIC Programming Techniques*, *Instrument BASIC Interface Techniques*, and *Instrument BASIC Language Reference*.


### **Service Manual (Option 0BW only), (Agilent Part Number 04395-901x0)**

The Service Manual explains how to adjust, troubleshoot, and repair the instrument. This manual is option 0BW only.

The number indicated by "x" in the part number of each manual, is allocated for numbers increased by one each time a revision is made. The latest edition comes with the product.

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## Introduction

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### About the 4395A Network/Spectrum/Impedance Analyzer

The 4395A Network/Spectrum/Impedance Analyzer provides excellent vector network and spectrum measurement performance from 10 Hz to 500 MHz. Providing both network and spectrum measurement capabilities, the 4395A is a cost effective solution for the development and production testing of electronic devices.

Optionally, the 4395A can serve as an impedance analyzer as well. This requires Option 010 and the 43961A Impedance Test Kit.

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### About This Guide

This guide is the Operation Manual for the 4395A. It includes the following chapters/appendixes:

“Chapter 1 Introduction”	This chapter.
“Chapter 2 Installation Guide”	Provides procedures needed to install the 4395A.
“Chapter 3 Quick Start Guide”	Provides a quick-start tutorial which lets you learn the basics of network, spectrum, and impedance analyzer modes.
“Chapter 4 Front and Rear Panels”	Illustrates and describes the 4395A’s front and rear panel features.
“Chapter 5 Preparations for Measurement”	Provides the procedures needed to prepare for a measurement.
“Chapter 6 Setting and Optimizing Measurement Conditions”	Provides the procedures for setting and optimizing measurement conditions of 4395A.
“Chapter 7 Calibration”	Provides general procedures for using the 4395A as an impedance analyzer.
“Chapter 8 Analyzing the Measurement Results”	Explains how to analyze and process the measurement results obtained in each analyzer mode.
“Chapter 9 Advanced Techniques for Optimizing Measurement Tasks”	Provides advanced measurement techniques that can be used to optimize your measurement tasks.
“Chapter 10 Examples of Applications”	Contains example applications of the 4395A for each of network, spectrum, and impedance analyzer modes.
“Chapter 11 Specifications and Supplemental Characteristics”	Provides detailed information on the 4395A’s specifications.
“Chapter 12 Accessories and Options”	Lists options and accessories available with the 4395A.

“Appendix A Analyzer Features”	provides additional information on analyzer features beyond the basics covered in the previous chapters.
“Appendix B Softkey Reference”	Shows the hierarchy of softkeys that appear on the 4395A’s display.
“Appendix C Input Range and Default Settings”	Lists the valid ranges and initial settings of the various functions of the 4395A.
“Appendix D Manual Changes”	Provides information on changes to the manual and on the product serial number.

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## Document Guide

For information on using GPIB commands to program the 4395A, refer to *Programming Manual*, which contains a complete command reference with ready-to-use sample programs.

## Installation Guide

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This chapter provides installation and setup instructions. It contains the following information:

- Incoming Inspection
- Replacing Fuse
- Power Requirements
- Operation Environment
- Providing clearance to dissipate heat at installation site
- Instruction for Cleaning
- Rack/Handle Installation
- Connecting Cables
- Connecting a Test Set for Network Analyzer Mode
- Connecting an Active Probe
- Connecting an Impedance Test Kit and a Test Fixture
- Connecting a Keyboard
- Setting Up a 75  $\Omega$  Measurement For Spectrum Analyzer Mode

### Incoming Inspection

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#### Warning



**To avoid hazardous electrical shock, do not turn on the 4395A when there are signs of shipping damage to any portion of the outer enclosure (for example, covers, panel, or display)**

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Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the 4395A has been checked mechanically and electrically. The contents of the shipment should be as listed in Table 2-1. If the contents are incomplete, if there is mechanical damage or defect, or if the 4395A does not pass the power-on selftests, notify the nearest Agilent Technologies office. If the shipping container is damaged, or the cushioning material shows signs of unusual stress, notify the carrier as well as the Agilent Technologies office. Keep the shipping materials for the carrier's inspection.

Table 2-1. Contents

Description	Agilent Part Number	Quantity
Network/Spectrum/Impedance Analyzer	4395A	1
CD-ROM (Manuals)	04395-905xx <sup>1</sup>	1
Sample Program Disk (2 disks)	04395-180x0	1
Power Cable <sup>2</sup>	-	1
Option ABA only		
Operation Manual	04395-900x0 <sup>1</sup>	1
Programming Manual	04395-900x1 <sup>1</sup>	1
Instrument BASIC Users HandBook	04155-90151	1
Option 810 only		
mini-DIN Keyboard	-	1
Option 010 only		
BNC(m)-BNC(m) Cable	8120-1839	1
Option 0BW only		
Service Manual	04395-901x0 <sup>1</sup>	1
Option 1D5 only		
BNC Adapter	1250-1859	1
Option 1D7 only		
50Ω/75Ω Minimum Loss Pad	11852B option 004	1
Option 1CN Handle Kit		
Handle Kit	5062-3991	1
Option 1CM Rack Mount Kit		
Rack Mount Kit	5062-3979	1
Option 1CP Rack Mount & Handle Kit		
Rack Mount & Handle Kit	5062-3985	1

<sup>1</sup> The number indicated by “x” in the part number of each manual, is allocated for numbers increased by one each time a revision is made. The latest edition comes with the product.

<sup>2</sup> The power cable depends on where the instrument is used, see Figure 2-1.

## Replacing Fuse

---

## Replacing Fuse

### Fuse Selection

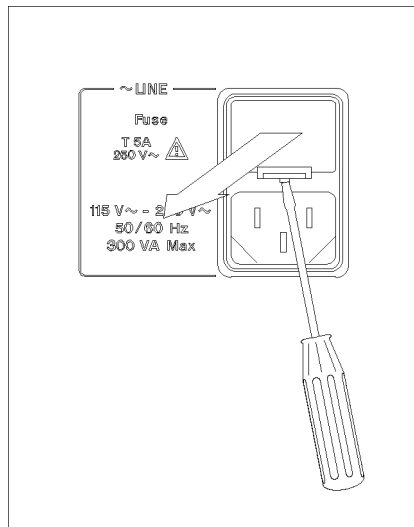
Select proper fuse according to the Table 2-2.

**Table 2-2. Fuse Selection**

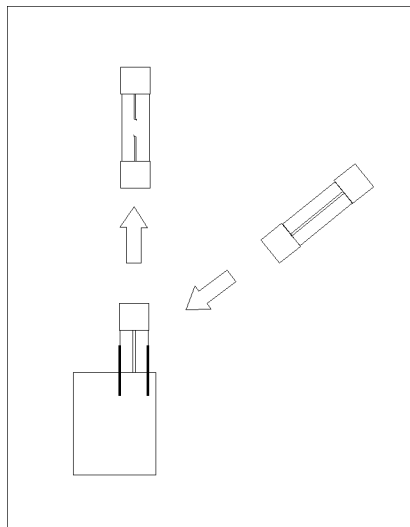
Fuse Rating/Type	Fuse Part Number
5A 250Vac UL/CSA type Time Delay	2110-0030

For ordering the fuse, contact your nearest Agilent Technologies Sales and Service Office.

### Procedure



Lever a small minus screwdriver to dismount the fuse holder above the AC line receptacle on the rear panel.



To check or replace the fuse, pull the fuse holder and remove the fuse. To reinstall the fuse, insert a fuse with the proper rating into the fuse holder.

---

### Caution



Use the proper fuse for the line voltage selected. Use only fuses with the required current rating and of the specified type as replacements. DO NOT use a mended fuse or short-circuit the fuse-holder in order to by-pass a blown fuse. Find out what caused the fuse to blow!

---



## Power Requirements

The 4395A requires the following power source:

Voltage : 90 to 132 Vac, 198 to 264 Vac

Frequency : 47 to 63 Hz

Power : 300 VA maximum

## Power Cable

In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument frame.

The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-1 for the part numbers of the power cables available.

---

### Warning

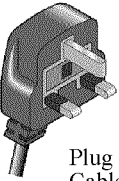
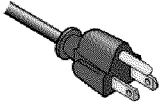
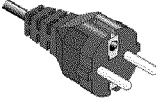
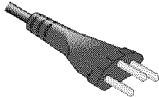

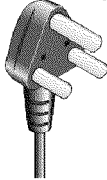
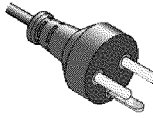

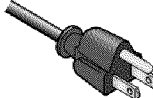

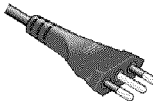
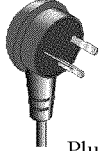

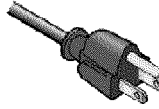


**For protection from electrical shock, the power cable ground must not be defeated.**

**The power plug must be plugged into an outlet that provides a protective earth ground connection.**

---

## Power Requirements

<p>OPTION 900</p>  <p>United Kingdom</p> <p>Plug : BS 1363/A, 250V, 10A Cable: 8120-1351</p>	<p>OPTION 903</p>  <p>U.S./ Canada</p> <p>Plug : NEMA 5-15P, 125V, 10A Cable: 8120-1378</p>
<p>OPTION 902</p>  <p>Continental Europe</p> <p>Plug : CEE 7 Standard Sheet VII, 250V, 10A Cable: 8120-1689</p>	<p>OPTION 906</p>  <p>Switzerland</p> <p>Plug : SEV Type 12, 250V, 10A Cable: 8120-2104</p>
<p>OPTION 904</p>  <p>U.S./ Canada</p> <p>Plug : NEMA 6-15P, 250V, 6A Cable: 8120-0698</p>	<p>OPTION 917</p>  <p>India/ Republic of S.Africa</p> <p>Plug : IEC 83-B1, 250V, 10A Cable: 8120-4211</p>
<p>OPTION 912</p>  <p>Denmark</p> <p>Plug : SR 107-2-D, 250V, 10A Cable: 8120-2956</p>	<p>OPTION 920</p>  <p>Argentina</p> <p>Plug : Argentine Resolution 63, Annex IV, 250V, 10A Cable: 8120-6870</p>
<p>OPTION 918</p>  <p>Japan</p> <p>Plug : JIS C 8303, 125V, 12A Cable: 8120-4753</p>	<p>OPTION 922</p>  <p>China</p> <p>Plug : GB 1002, 250V, 10A Cable: 8120-8376</p>
<p>OPTION 921</p>  <p>Chile</p> <p>Plug : CEI 23-16, 250V, 10A Cable: 8120-6978</p>	<p>OPTION 919</p>  <p>Israel</p> <p>Plug : Israel SI 32, 250V, 10A Cable: 8120-5182</p>
<p>OPTION 901</p>  <p>Australia/ New Zealand</p> <p>Plug : AS 3112, 250V, 10A Cable: 8120-1369</p>	<p>OPTION 927</p>  <p>Thailand</p> <p>Plug : NEMA 5-15P, 250V, 10A Cable: 8120-8871</p>
<p>NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90° etc.).</p>	

**Figure 2-1. Power Cable Supplied**

## Operation Environment

The 4395A must be operated under within the following environment conditions, and sufficient space must be kept behind the 4395A to avoid obstructing the air flow of the cooling fans.

Temperature: 10°C to 40°C

Humidity: less than 80% RH

**Note** The 4395A must be protected from temperature extremes which could cause condensation within the instrument.



## Providing clearance to dissipate heat at installation site

To ensure the specifications and measurement accuracy of the product, you must keep ambient temperature around the product within the specified range by providing appropriate cooling clearance around the product or, for the rackmount type, by forcefully air-cooling inside the rack housing. For information on ambient temperature to satisfy the specifications and measurement accuracy of the product, refer to Chapter 11, Specifications and Supplemental Characteristics.

When the ambient temperature around the product is kept within the temperature range of the operating environment specification (refer to “Operating Conditions” in Chapter 11), the product conforms to the requirements of the safety standard. Furthermore, under that temperature environment, it has been confirmed that the product still conforms to the requirements of the safety standard when it is enclosed with cooling clearance as follows:

**Table 2-3.**

	Conditions
Rear	180 mm
Side	60 mm

## Instruction for Cleaning

To prevent electrical shock, disconnect the 4395A power cable from the receptacle before cleaning. Wipe with a dry cloth or a soft cloth that is soaked with water and wrung tightly without undue pressure to clean the casing. Do not attempt to clean the 4395A internally.

## Rack/Handle Installation

The 4395A can be rack mounted and used as a component in a measurement system. Figure 2-2 shows how to rack mount the 4395A.

Table 2-4. Rack Mount Kits

Option	Description	Agilent Part Number
1CN	Handle Kit	5062-3991
1CM	Rack Mount Kit	5062-3979
1CP	Rack Mount & Handle Kit	5062-3985

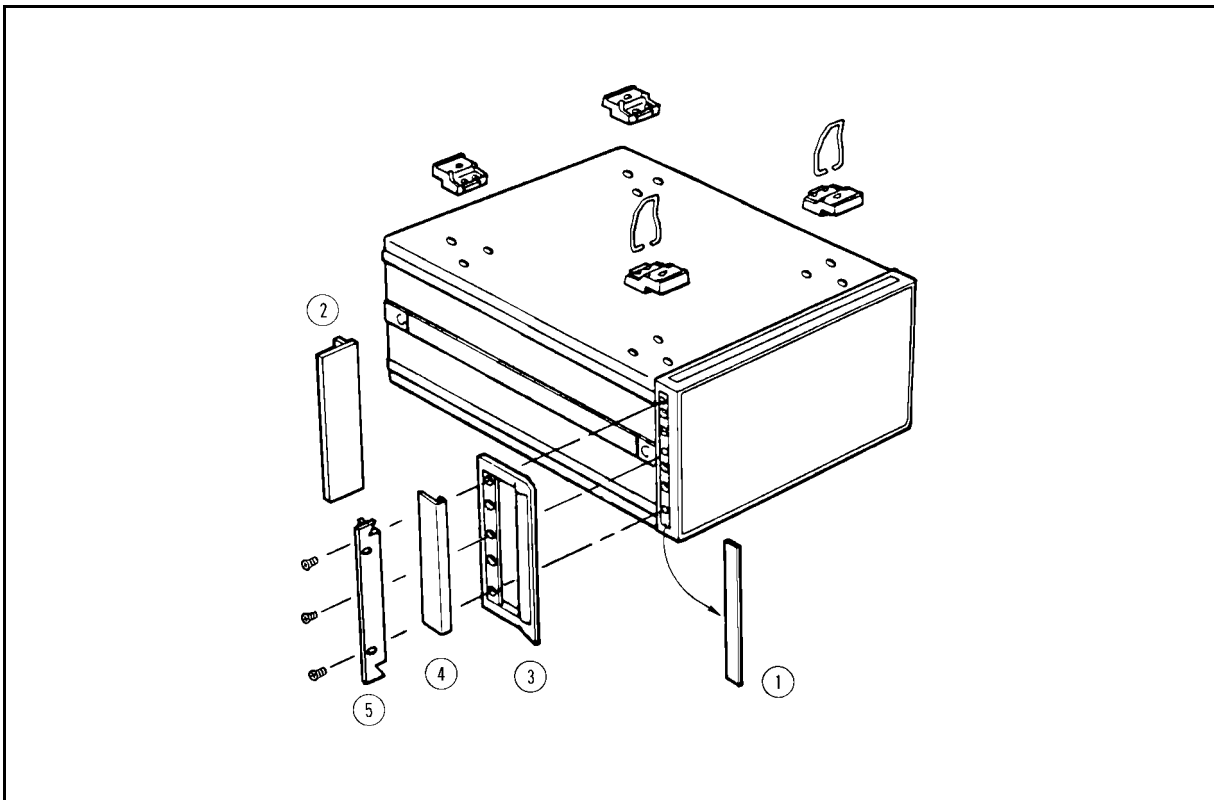


Figure 2-2. Rack Mount Kits Installation

### Option 1CN Handle Kit

Option 1CN is a handle kit containing a pair of handles and the necessary hardware to attach them to the instrument.

#### Installing the Handle

1. Remove the adhesive-backed trim strips ① from the left and right front sides of the 4395A.
2. Attach the front handles ③ to the sides using the screws provided.
3. Attach the trim strips ④ to the handles.

### **Option 1CM Rack Mount Kit**

Option 1CM is a rack mount kit containing a pair of flanges and the necessary hardware to mount them to the instrument in an equipment rack with 482.6 mm (19 inches) horizontal spacing.

#### **Mounting the Rack**

1. Remove the adhesive-backed trim strips ① from the left and right front sides of the 4395A.
2. Attach the rack mount flange ② to the left and right front sides of the 4395A using the screws provided.
3. Remove all four feet (lift bar on the inner side of the foot, and slide the foot toward the bar).

### **Option 1CP Rack Mount & Handle Kit**

Option 1CP is a rack mount kit containing a pair of flanges and the necessary hardware to mount them to an instrument which has handles attached, in an equipment rack with 482.6 mm (19 inches) spacing.

#### **Mounting the Handle and Rack**

1. Remove the adhesive-backed trim strips ① from the left and right front sides of the 4395A.
2. Attach the front handle ③ and the rack mount flange ⑤ together on the left and right front sides of the 4395A using the screws provided.
3. Remove all four feet (lift bar on the inner side of the foot, and slide the foot toward the bar).

---

## **Connecting Cables**

Use shielded cables when you connect the DUT and accessories for testing.

For more information about the cables, see chapter 12.

## Connecting a Test Set for Network Analyzer Mode

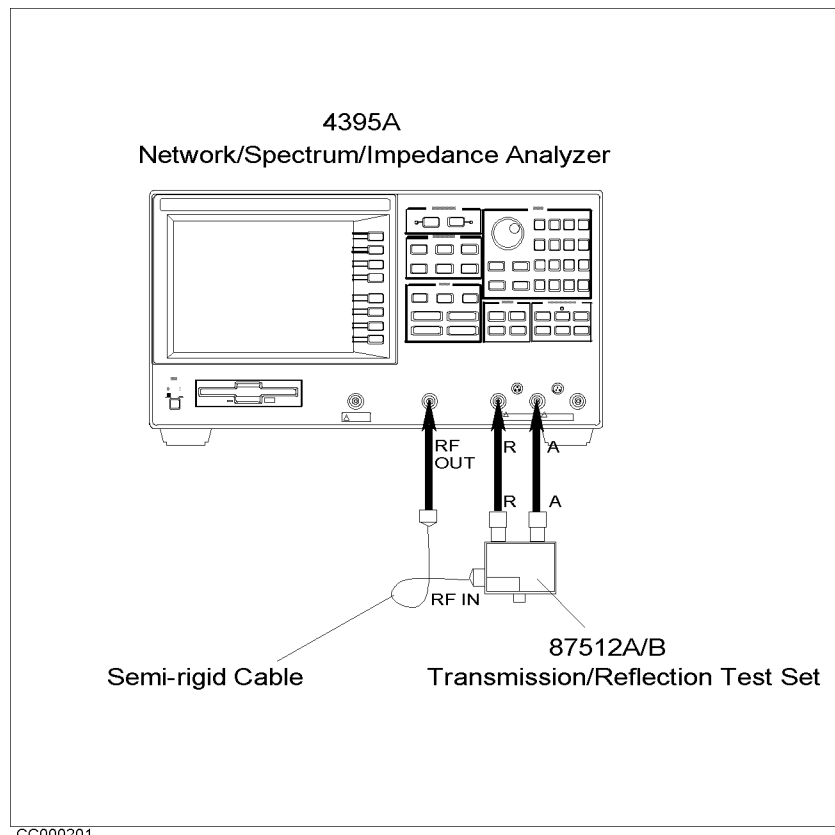
### Connecting a Test Set for Network Analyzer Mode

To use the network analyzer mode of the 4395A, a test set is required to measure the transmission and reflection characteristics of the device under test (DUT).

You can use either the 87512A/B transmission/reflection (T/R) test set or the 87511A/B S-parameter test set. The 87512A/B T/R test set measures reflection and transmission in the forward direction only. The 87511A/B S-parameter test set measures both the forward and reverse directions without reconnection.

For more information about the test sets, see Chapter 12.

### Connecting a Transmission/Reflection Test Set



**Figure 2-3. Connecting a Transmission/Reflection Test Set**

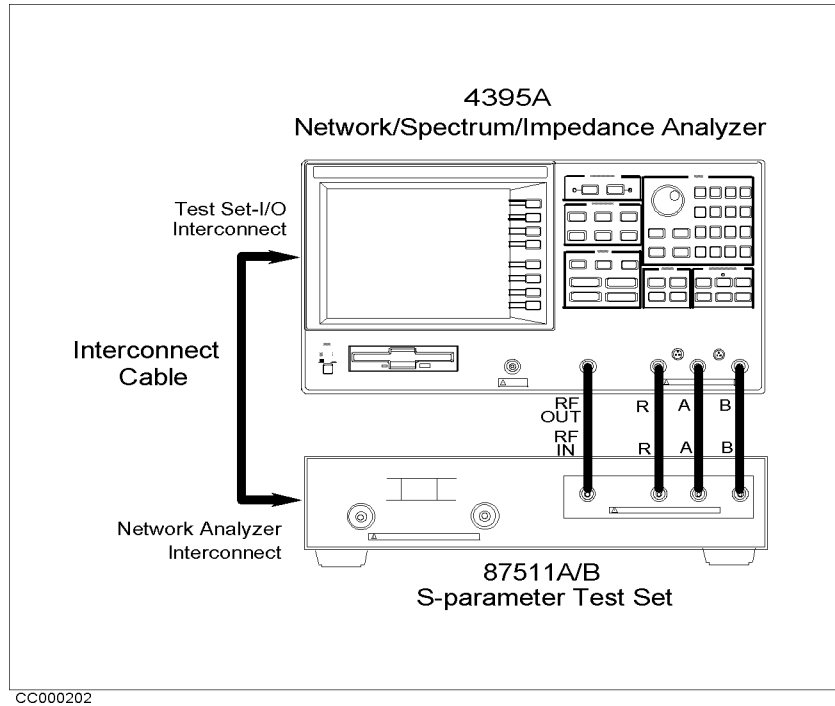
1. Place the transmission/reflection (T/R) test set in front of the 4395A.
2. Connect the R and A ports of the 4395A and the T/R test set to each other.
3. Connect the RF OUT port of the 4395A and the RF IN port of the T/R test set with a semi-rigid cable.

#### Note



When you use the 87512B, press **(Cal) MORE SET Z<sub>0</sub>**. Then press **(7) (5) (X1)** to set the characteristic impedance ( $Z_0$ ) to 75  $\Omega$ .

Connecting an S-parameter Test Set



CC000202

Figure 2-4. Connecting an S-parameter Test Set

1. Place the 4395A on the S-parameter test set.
2. Connect the TEST SET-I/O INTERCONNECT interface on the rear panel of the 4395A and the NETWORK ANALYZER-I/O INTERCONNECT interface of the test set using the cable furnished with the test set.
3. Connect the RF OUT, R, A, and B inputs of the 4395A to the S-parameter test set to each other.

**Note**



When you use the 87511B, press **[Cal]** MORE SET Z0 . Then press **[7]** **[5]** **[X1]** to set the characteristic impedance ( $Z_0$ ) to 75  $\Omega$ .

### Connecting an Active Probe

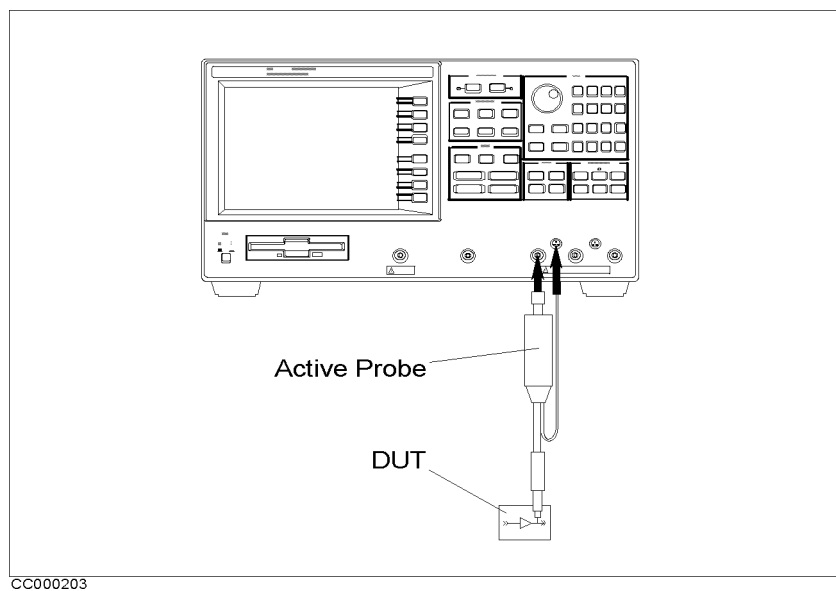
The active probe allows you to analyze an in-circuit signal or device that has no port for connecting to the test set. The active probe can be used for both spectrum and network measurements.

The 4395A can use the following active probes:

- 41800A Active Probe (5 Hz to 500 MHz)
- 41802A 1 M $\Omega$  Input Adapter (5 Hz to 100 MHz)

For more information about these active probes, see Chapter 12.

### For Spectrum Analyzer Mode



**Figure 2-5. Spectrum Analyzer Mode (One Active Probe)**

1. Connect the output connector of the active probe to the R, A, or B port of the 4395A.
2. Plug the probe power plug into the PROBE POWER connector.

### For Network Analyzer Mode

#### Using One Active Probe



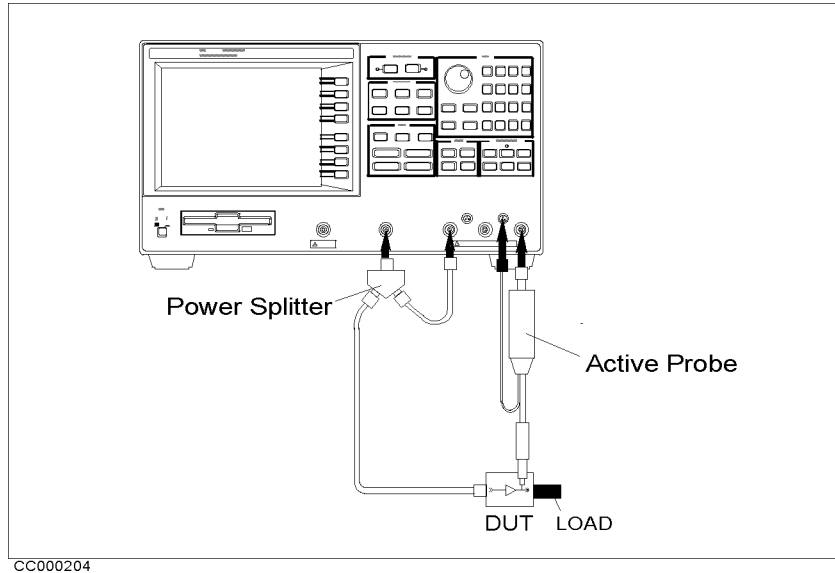


Figure 2-6. Network Analyzer Mode (One Active Probe)

1. Connect the power splitter to the RF OUT port.
2. Connect one output from the power splitter to the R input.
3. Connect the other output of the power splitter to the DUT.
4. Connect the active probe to the B input and plug the probe plug into the PROBE POWER connector.
5. If necessary, terminate the DUT with a load.

**Note**

The following power splitters are available for the 4395A:

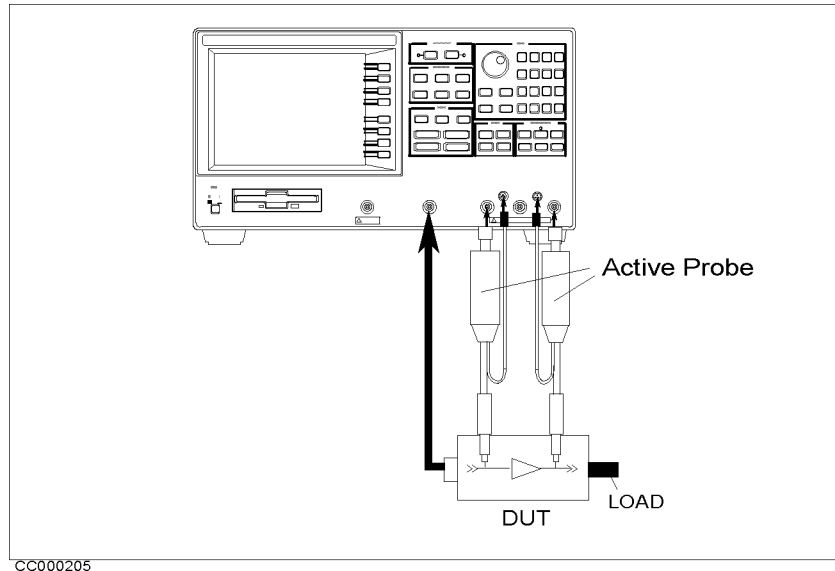


- 11850C,D Three-way Power Splitter
- 11667A Two-way Power Splitter

For more information about these power splitters, see Chapter 12.

## Connecting an Active Probe

### Using Two Active Probes



**Figure 2-7. Network Analyzer Mode (Two Active Probes)**

1. Connect one active probe to the R input.
2. Connect the other active probe to the B input.
3. Connect the RF OUT port to the DUT.
4. If necessary, terminate the DUT with a load.

Using a Transmission/Reflection Test Set

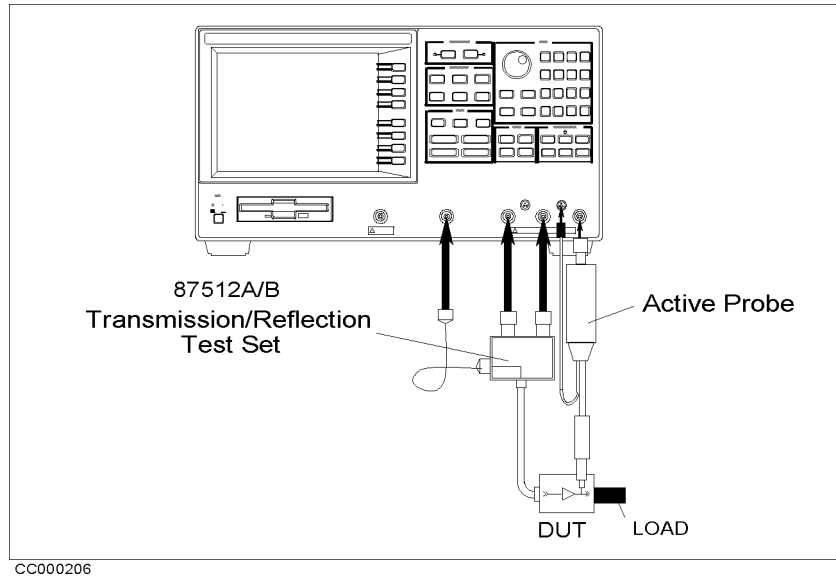


Figure 2-8. Using a Transmission/Reflection Test Set

1. Connect the 87512A/B T/R test set.
2. Connect the active probe to the B input.
3. If necessary, terminate the DUT with a load.

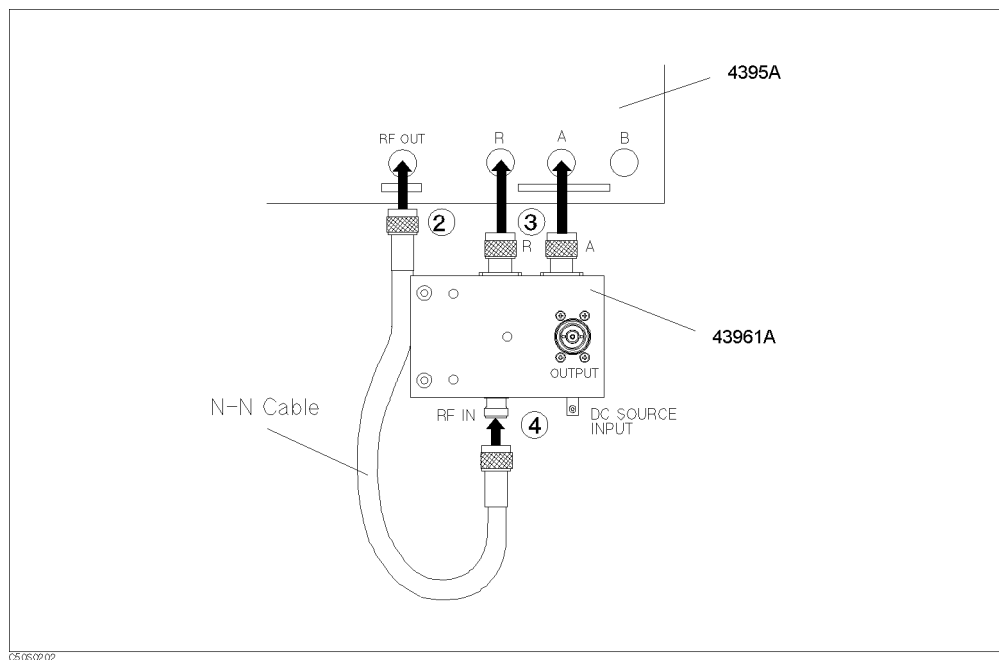
## Connecting an Active Probe

### Connecting an Impedance Test Kit and a Test Fixture for Impedance Analyzer Mode

#### Connecting an Impedance Test Kit

To start the impedance measurement, you need to connect the 43961A Impedance Test Kit to the 4395A. See Figure 2-9.

1. Verify the 4395A is turned off.
2. Connect the N-cable to the RF OUT port of the 4395A.
3. Connect two connectors of the 43961A to the R and A ports of the 43961A.
4. Connect the other connector of the N-cable to the RF IN port of the 43961A.
5. Turn on the 4395A.



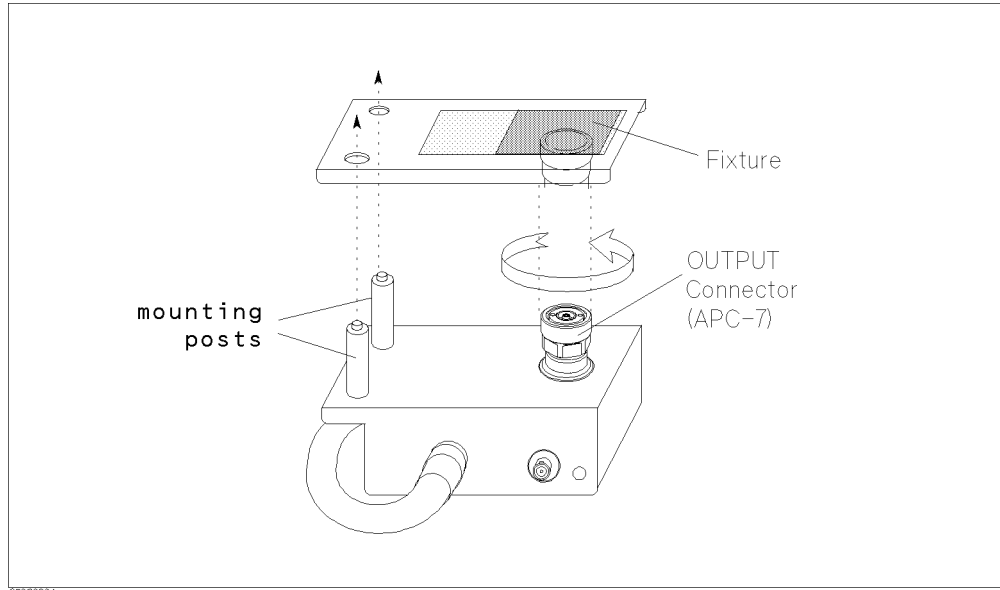
**Figure 2-9. Connecting the Impedance Test Kit**

#### Connecting a Test Fixture to the Impedance Test Kit

To connect the test fixture to the impedance test kit, see the applicable test fixture manual for instructions. The following is a general procedure:

1. Turn the APC-7 connector of the impedance test kit OUTPUT port.
2. Verify that the connector sleeve is retracted fully.
3. Set the mounting posts of the test station into the twin locating holes at the corner of the test fixture.
4. Connect the connector on the underside of the test fixture to the OUTPUT port of the impedance test kit.

## Connecting an Active Probe

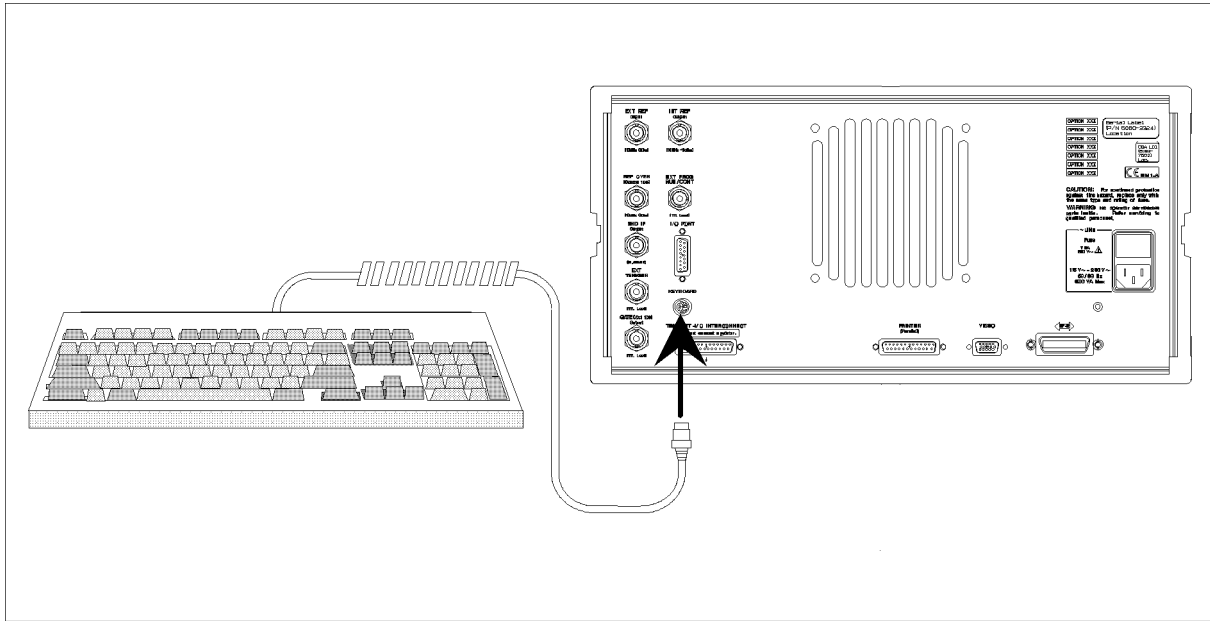


**Figure 2-10. Connecting Test Fixture**

## Connecting a Keyboard

### Connecting a Keyboard

An mini-DIN keyboard can be connected to the mini-DIN connector on the rear panel of the 4395A. The mini-DIN keyboard provides an easier way to enter characters for the file names, display titles, and Instrument BASIC programs. It can also access the 4395A softkey functions by using keyboard function keys. For more information on the mini-DIN keyboard, see *Programming Manual*.



CB10A016

Figure 2-11. Connecting a Keyboard

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## Setting Up a 75 Ω Measurement For Spectrum Analyzer Mode

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**Note**



This operation requires the option 1D7 50Ω to 75Ω Input Impedance Conversion. For detail information about option 1D7, see Chapter 12.

---

1. Attach the 11852B Option 004 50 ΩN(m)/75 Ω N(f) minimum loss pad to R, A, or B input.
2. Press **Cal**.
3. Press **INPUT Z**.
4. Press **75** to set the impedance of the source (75 Ω). Then press **Entry Off**.
5. Select the input port:

**Attached to**

**Press**

Input R

LVL CAL DATA R

Input A

LVL CAL DATA A

Input B

LVL CAL DATA B

6. Enter the insertion loss of the minimum loss pad in dB and press **X1**.

---

**Note**



Perform this procedure each time the 4395A is preset because the 4395A does not retain this setting in memory.

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## Quick Start Guide

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### Network Analyzer Tour

In this section, you explore the network analyzer mode of operation. Before starting this tour, verify that the 4395A is correctly installed (see chapter 2, “Installation Guide,” if you need additional information).

---

### Before You Leave On The Tour

On this tour, you will learn how to make a basic network analyzer measurement by measuring the transmission characteristics of a bandpass filter.

#### Overview

The following is a short summary of the tour:

1. Preparing for a measurement
  - Turning ON the 4395A
  - Connecting the DUT
2. Setting up the 4395A
  - Selecting the analyzer type
  - Setting the active channel
  - Setting the input port
  - Setting the frequency range
  - Performing the automatic scaling
3. Making a calibration
4. Reading a measurement result
  - Reading a measured value by using marker
5. Printing out the measurement result
  - Configuring and connecting a printer
  - Making a hardcopy of the display

After you finish this tour, you will understand how to make a basic measurement in the network analyzer mode of operation.

## Before You Leave On The Tour

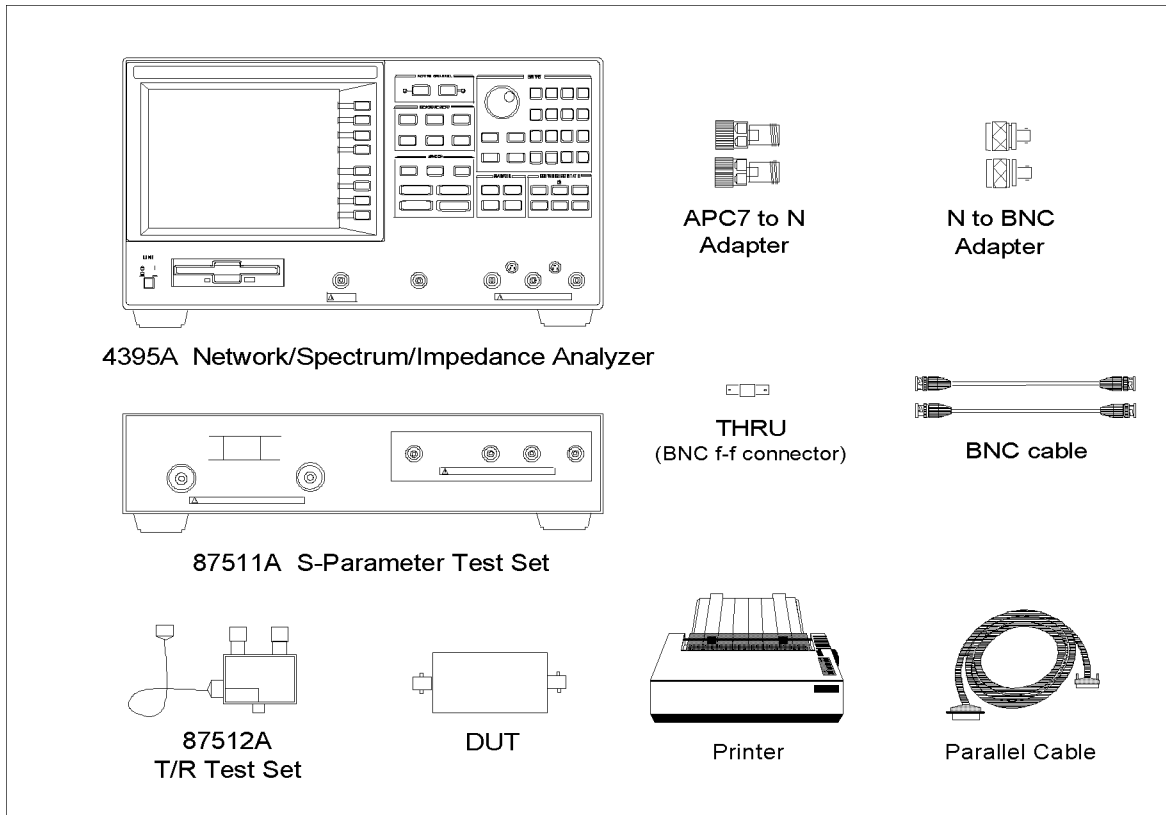
### Required Equipments

To perform all the steps in this tour, you must have the following equipments:

- 4395A Network/Spectrum/Impedance Analyzer
- Measurement Device:
  - This tour assumes the device under test (DUT) is a 70 MHz bandpass filter
- THRU (BNC female-to-female connector)
- Two BNC cables
- Test Set (use either of the following)
  - Transmission/Reflection (T/R) Test Set
    - Two N-to-BNC adapters
  - S-Parameter Test Set
    - Two APC7-to-N adapters
    - Two N-to-BNC adapters
- HP DeskJet Printer \*
- Parallel Interface Cable \*

\* If you wish to test some other device, you will need to change particular measuring conditions, such as the frequency range, according to the general characteristics of the DUT.

\* If you do not have an HP DeskJet printer and cable, skip step 5, “Printing Out the Measurement Results”.



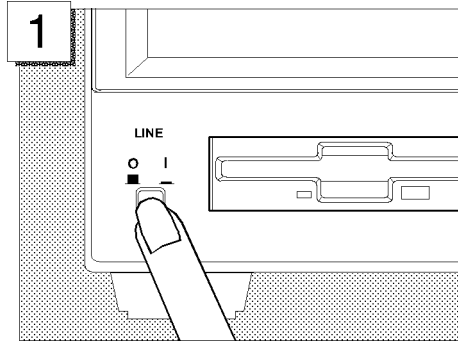
CB102015

**Figure 3-1. Required Equipment**

## Step 1: Preparing for the Measurement

You must set up the test set before you turn ON the 4395A. The setup procedure for the test set is described in “Connecting a Test Set for Network Analyzer Mode” in Chapter 2.

### Turning ON the 4395A



Press the LINE switch.

The 4395A performs a power on self-test. About 20 seconds later, the model name, revision number, and other information should appear on the LCD to indicate that the 4395A has normally started up.

### Connecting the DUT

Connect the DUT as shown in Figure 3-2 or Figure 3-3.

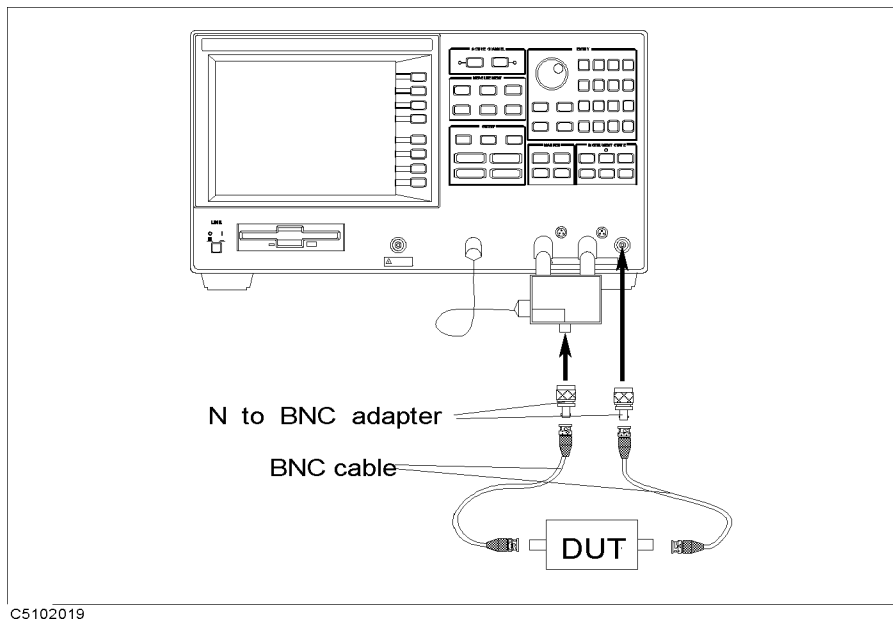
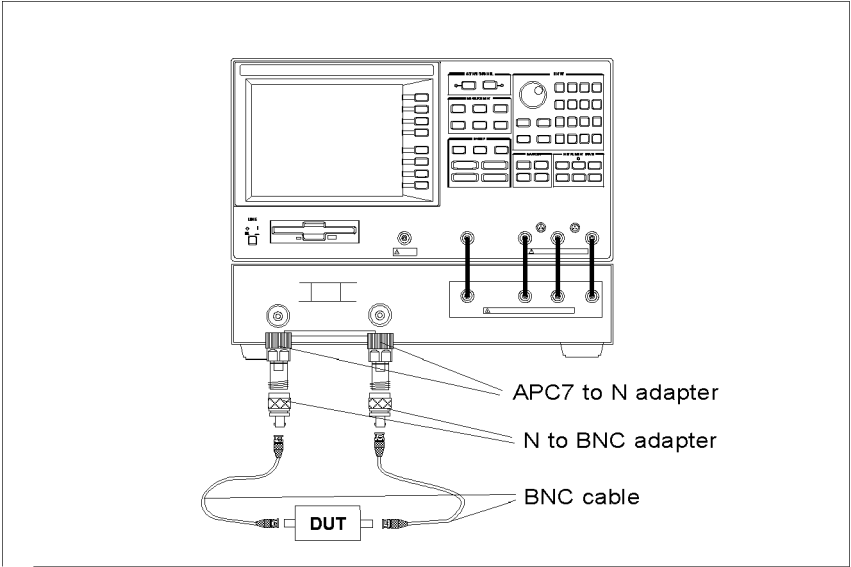


Figure 3-2. Transmission/Reflection Test Set Setup

**Step 1: Preparing for the Measurement**



C5102020

**Figure 3-3. S-Parameter Test Set Setup**

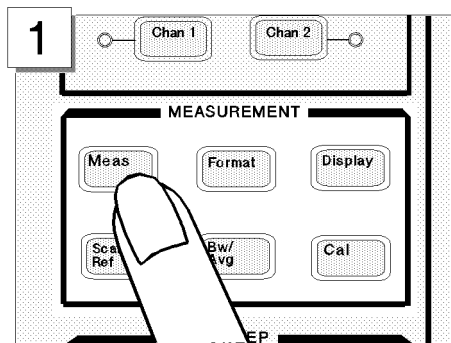
## Step 2: Setting up the 4395A

Before you start the measurement, you must set up the 4395A to fit your measurement requirements. For example, you must set the frequency range of the measurement. In this step, you will set the following parameters:

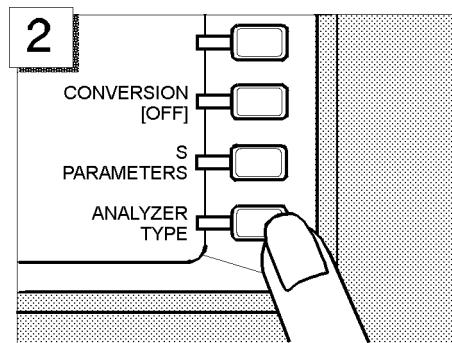
<b>Analyzer type</b>	Network analyzer mode
<b>Active channel</b>	Channel 1
<b>Inputs</b>	B/R or $S_{21}$ (depending on the test set)
<b>Format</b>	Log magnitude (default)
<b>Frequency Range</b>	Center 70 MHz, Span 500 kHz

### Setting the Analyzer Type

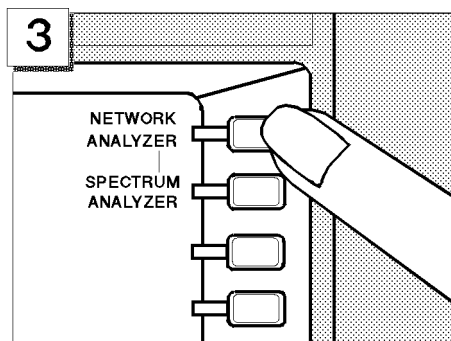
To use the 4395A in the network analyzer mode, you must set the analyzer type to the network analyzer mode after selecting the active channel.



In the MEASUREMENT block, press **Meas**.



Press **ANALYZER TYPE**.

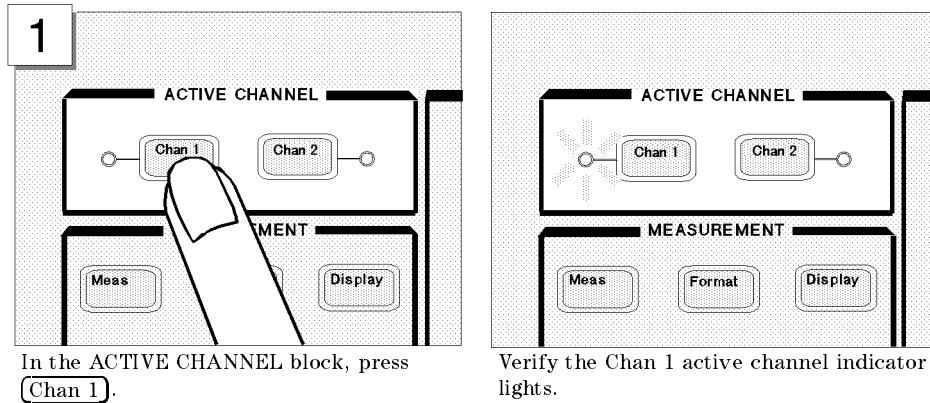


Press **NETWORK ANALYZER**.

## Step 2: Setting up the 4395A

### Setting the Active Channel

Because the 4395A has two measurement channels you can have two different measurement setups at the same time. To change the active channel to channel 1:



#### Note



Changing the analyzer type presets the 4395A for the active channel. If you want to keep the current measurement settings when changing the analyzer type, first set the other channel to active.

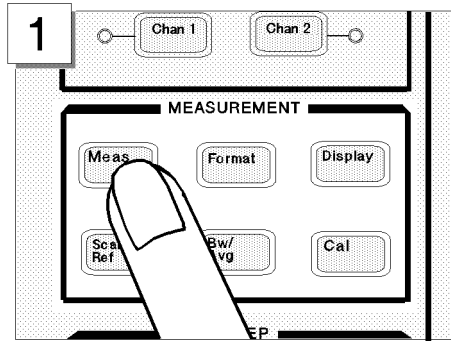
### Selecting the Input

The 4395A uses three inputs for network measurements (R, A, and B). Usually, the R input is connected to the RF OUT signal directly, the A input measures the reflected signal from the DUT, and the B input measures the signal through the DUT.

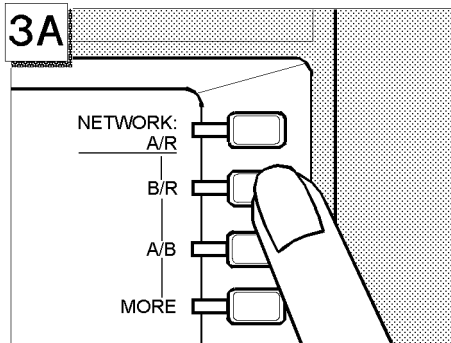
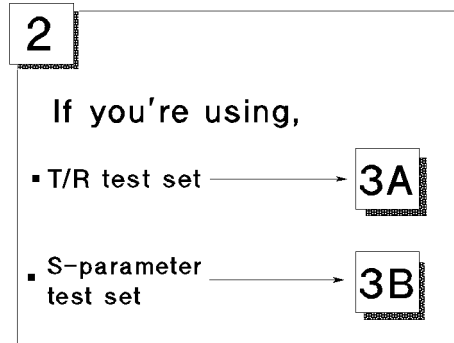
This example assumes you are using the T/R test set. Therefore, because you are going to measure the transmission characteristics of the DUT, select B/R to measure the ratio of B and R inputs.

When you use the S-parameter test set, you can measure the forward and reverse characteristics of a 2-port device without reconnecting the inputs. In that case, select  $S_{21}$  for a transmission measurement in the forward direction.

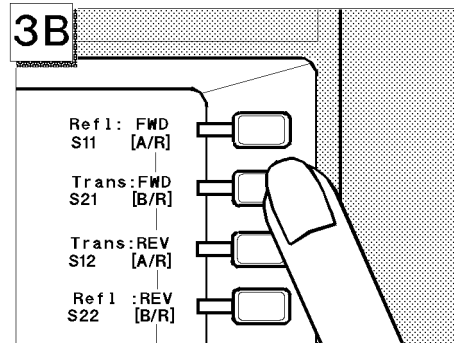
## Step 2: Setting up the 4395A



In the MEASUREMENT block, press **Meas**.



Press **B/R**.

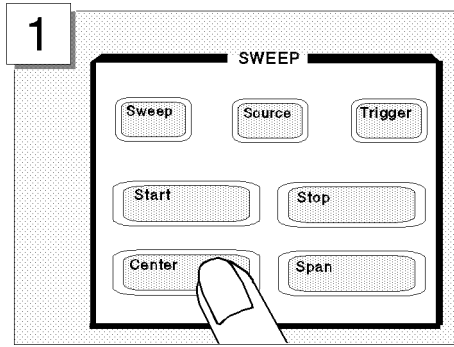


Press **Trans: FWD S21 [B/R]** to select B/R for the forward direction.

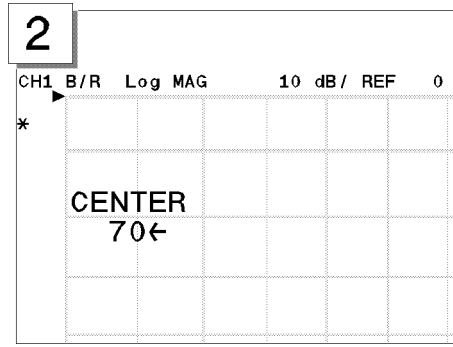
### Setting the Frequency Range

To display the transmission characteristics of the 70 MHz bandpass filter, you should specify the frequency range for the measurement. In this example, set the 4395A to a 70 MHz center frequency with a 500 kHz span.

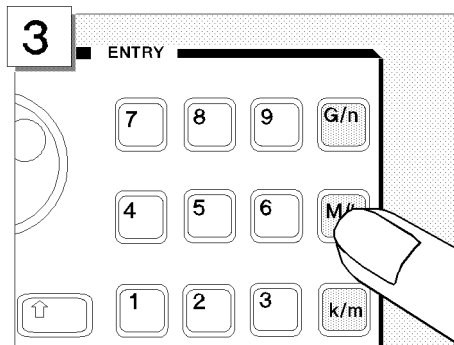
## Step 2: Setting up the 4395A



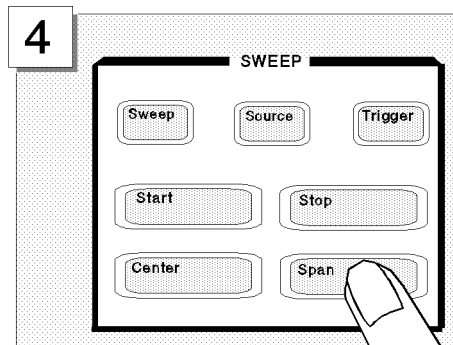
In the SWEEP block, press **Center**.



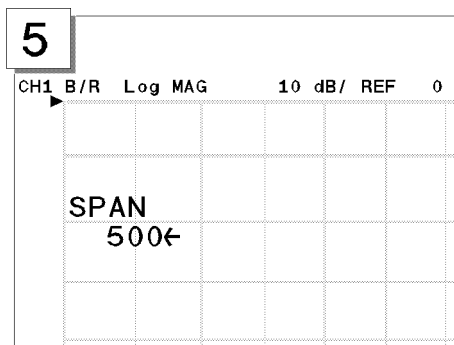
Press **7 0**.



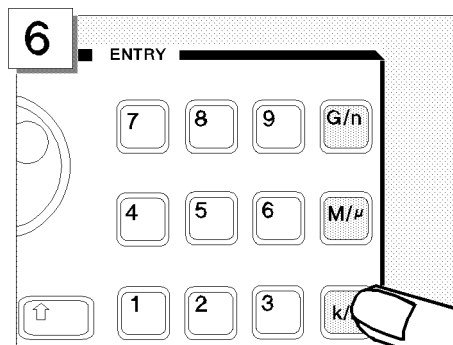
Press **M/μ**.



In the SWEEP block, press **Span**.



Press **5 0 0**.



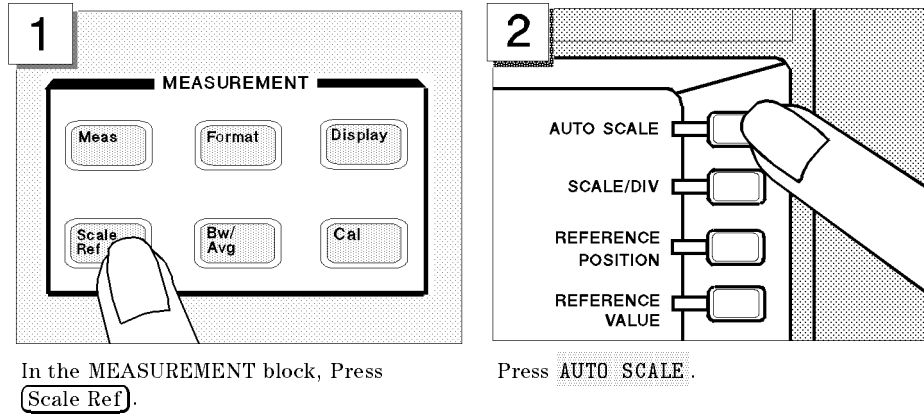
Press **k/m**.

## Performing the Automatic Scaling

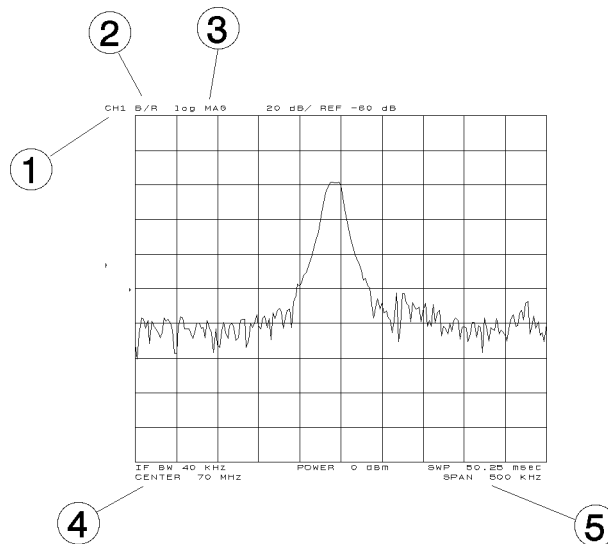
Often, the trace obtained after specifying the frequency range is too large or too small vertically for the grid. However, by using the automatic scaling function, you can obtain the optimum vertical setting automatically.



## Step 2: Setting up the 4395A



The transmission characteristics trace of the filter is displayed as shown below:



All the settings are displayed on the LCD.

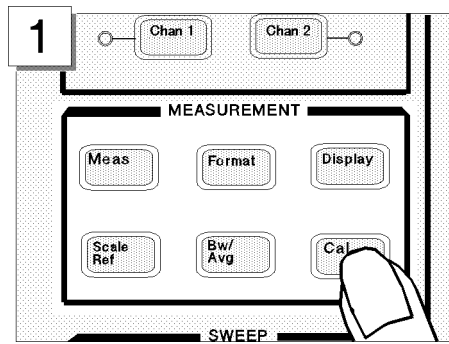
1. Active channel is set to channel 1.
2. Inputs are set to B/R.
3. Format is set to log magnitude mode.
4. Center frequency is set to 70 MHz.
5. Frequency span is set to 500 kHz.

### Step 3: Making a Calibration

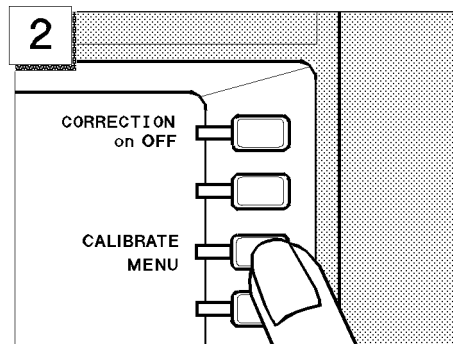
## Step 3: Making a Calibration

To ensure accurate measurement results, calibrate the 4395A before making a measurement. Calibration reduces error factor due to uncertainty. In this example, you perform the response calibration to cancel a frequency response error. A THRU (BNC female-to-female connector) is necessary to perform a response calibration for the transmission measurement.

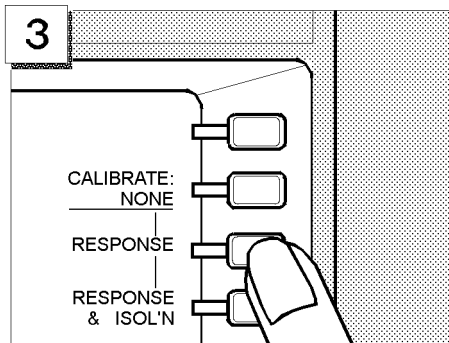
### Performing a Response Calibration (for the Transmission Measurement)



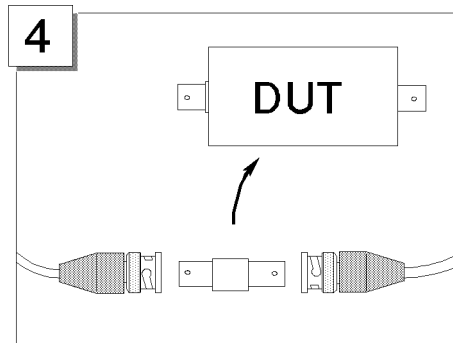
Press **Cal**.



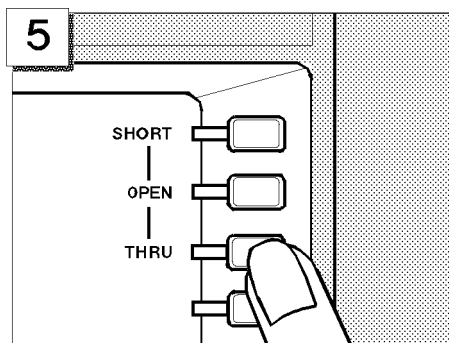
Press **CALIBRATE MENU**.



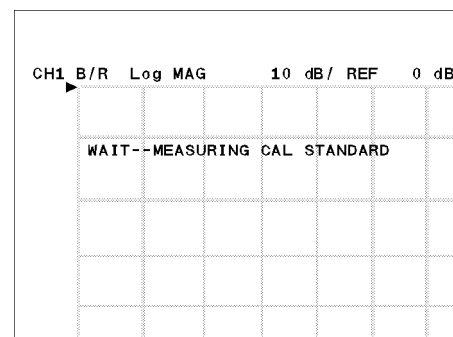
Press **RESPONSE**.



Disconnect the DUT then, connect the THRU.

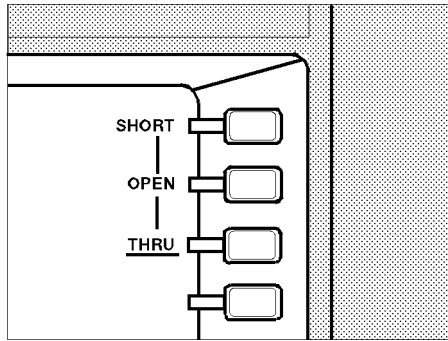


Press **THRU**.

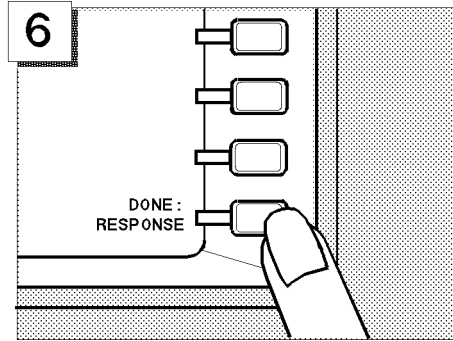


WAIT - MEASURING CAL STANDARD is displayed.

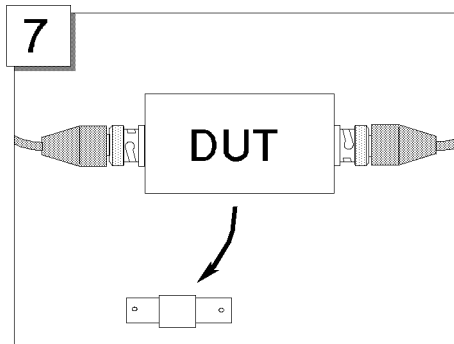
### Step 3: Making a Calibration



The THRU softkey label is underlined when the measurement is completed.



Press DONE: RESPONSE.



Disconnect the THRU and reconnect the DUT.

“Cor” is displayed on the left side of the display to show that the frequency response error is corrected.

The measured value is now corrected for the frequency response error.

#### Note



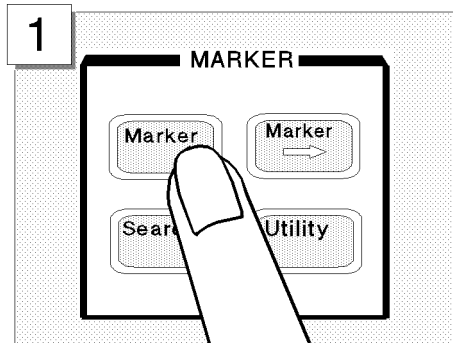
If the trace is changed, it requires an adjustment of the scale. Perform the automatic scaling again by pressing (Scale Ref) AUTO SCALE.

## Step 4: Reading a Measurement Result

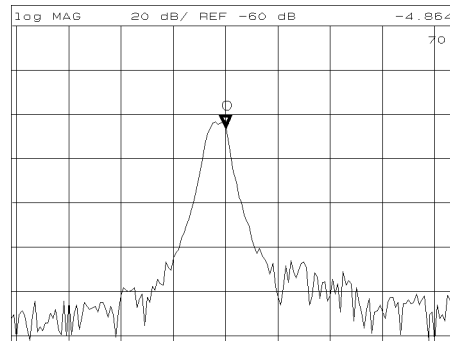
### Step 4: Reading a Measurement Result

You may want to readout the measured values on the displayed trace. You can use the marker function for this purpose. The marker shows the frequency and response value at the marker point.

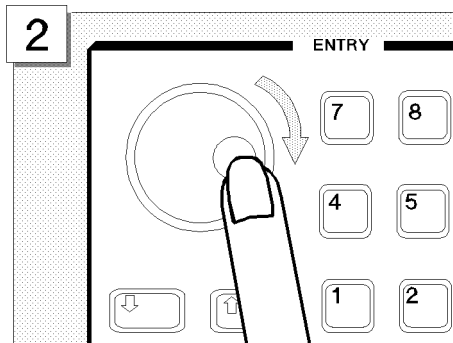
#### Reading a Measured Value by Using Marker



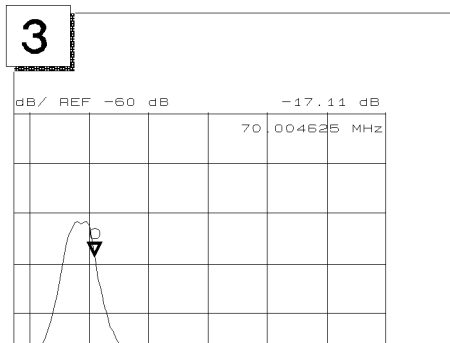
In the MARKER block, press **Marker**.



Verify a marker appears on the trace.

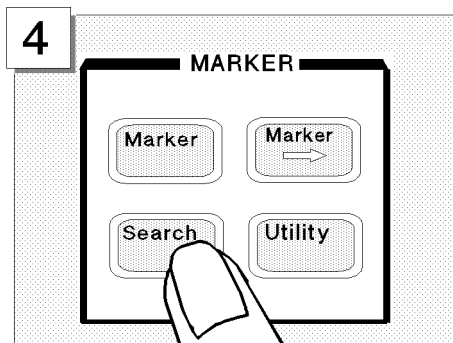


Turn the knob to the right to move the marker toward the right.

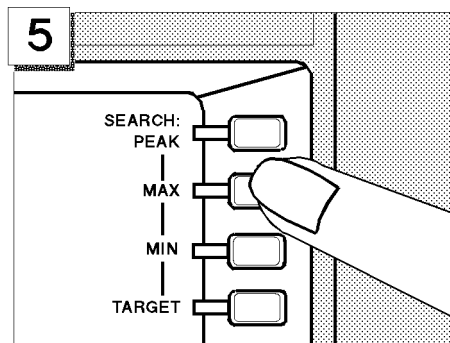


Read the values at the right top of the display.

The marker has a search function that makes it easier and faster to evaluate the trace results. For example, to search for the maximum value and its frequency on the trace:

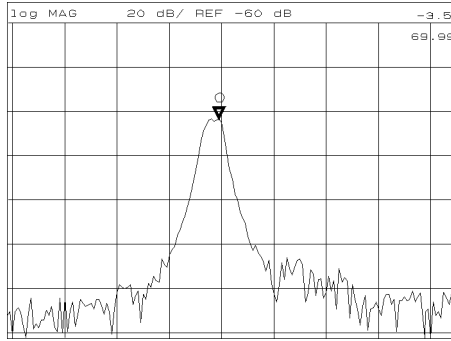


In the MARKER block, press **Search**.

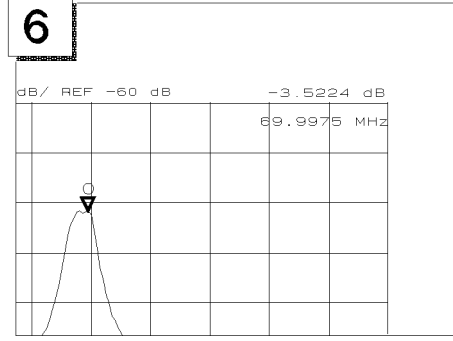


Press **MAX**.

## Step 4: Reading a Measurement Result



The marker immediately moves to the maximum point on the displayed trace.



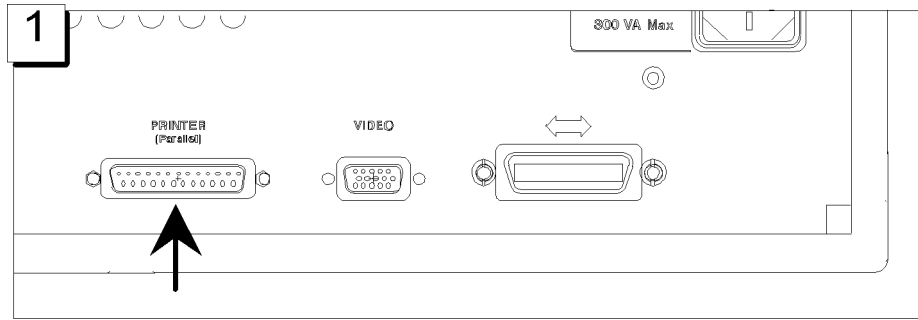
Read the frequency and response values displayed at the upper right of the display.

## Step 5: Printing Out the Measurement Result

### Step 5: Printing Out the Measurement Result

You may want a hardcopy of the measured results for a permanent record of the measurement. The 4395A can print out the data as a snapshot of the display or as a list of values without using any external controller.

#### Configuring and Connecting a Printer



Locate the parallel interface connector on the back of the 4395A.

#### Caution



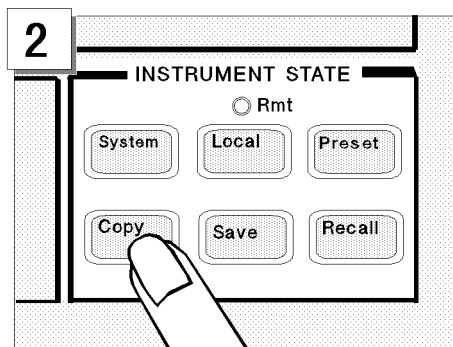
Do not connect a printer to “TEST SET - I/O INTERCONNECT”. Doing so could damage the printer.

#### Note

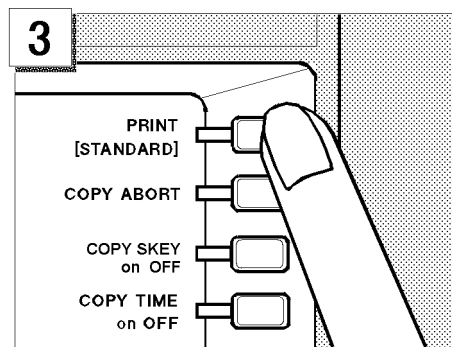


For more information about printer, see the chapter 12.

#### Making a Hardcopy of the LCD Display



Press **Copy**.



Press **PRINT [STANDARD]** to execute the printing.

## Spectrum Analyzer Tour

In this section, you explore the spectrum analyzer mode of operation. Before starting this tour, verify the 4395A is correctly installed (see chapter 2, “Installation Guide,” if you need additional information).

---

### Before You Leave On The Tour

On this tour, you will learn how to make a basic spectrum analyzer measurement by measuring the output signal of a signal generator.

#### Overview

The following is a short summary of the tour:

1. Preparing for a measurement
  - Turning ON the 4395A
  - Connecting the test signal source
2. Setting up the 4395A
  - Selecting the analyzer type
  - Setting the active channel
  - Selecting the input
  - Setting the frequency range
3. Making a Measurement
  - Reading the peak level using the marker
  - Setting the resolution bandwidth to see low level signals
  - Searching for harmonics using the search function
4. Saving and recalling the 4395A settings
  - Preparing the disk
  - Saving 4395A settings
  - Entering the file name
  - Recalling the 4395A settings

After you finish this tour, you will understand how to make a basic measurement in the spectrum analyzer mode of operation.

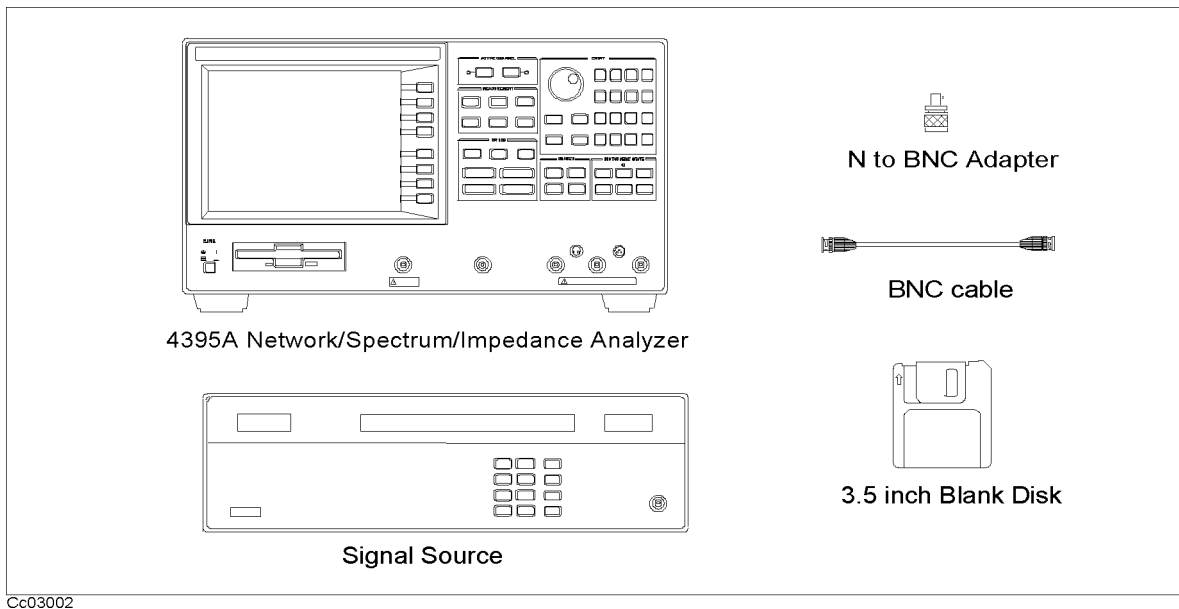
## Spectrum Analyzer Tour

### Required Equipments

To perform all the steps in this tour, you must have the following equipments:

- 4395A Network/Spectrum/Impedance Analyzer
- Test signal source (-20dBm, 20MHz, sine wave)\*\*
- N to BNC Adapter (50  $\Omega$ )
- BNC cable
- 3.5 inch 2HD Blank Disk

\*\* If you wish to test some other test signal, you will need to change particular measuring conditions, such as the frequency range, according to the general characteristics of the signal.



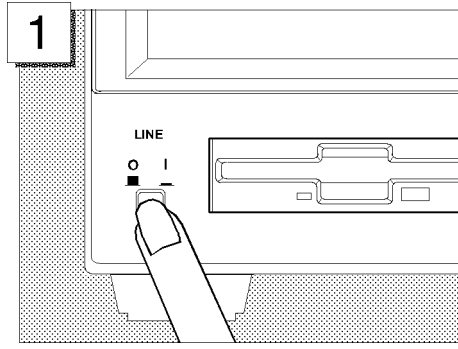
**Figure 3-4. Required Equipments**



## Step 1: Preparing for a Measurement

### Turning ON the 4395A

Verify the power source setting is correct before you turning ON the 4395A. If necessary, see chapter 2, “Installation Guide.”

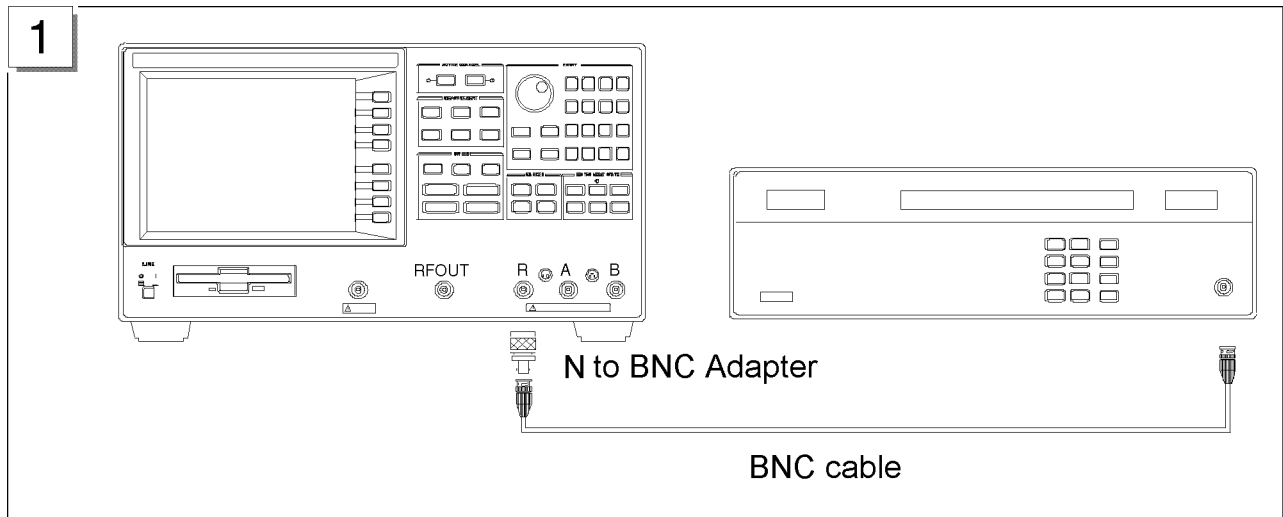


Press the LINE switch

The 4395A performs a power on self-test. About 20 seconds later, the model name, revision number, and other information should appear on the LCD to indicate that the 4395A has normally started up.

### Connecting the DUT

Connect the test signal source ( $-20$  dBm, 20 MHz) to Input R of the 4395A.



## Step 2: Setting Up the 4395A

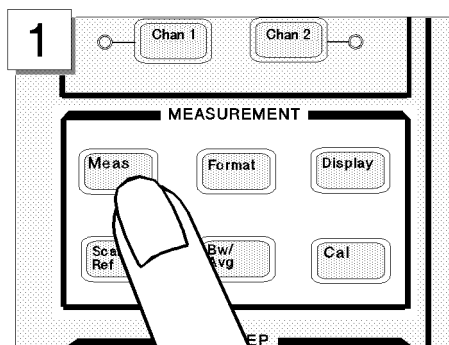
### Step 2: Setting Up the 4395A

In this step, you will set the following parameters:

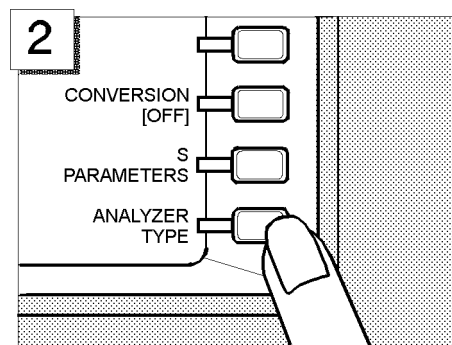
<b>Active channel</b>	Channel 2
<b>Analyzer type</b>	Spectrum analyzer mode
<b>Input</b>	R input
<b>Frequency Range</b>	0 Hz to 80 MHz

#### Setting the Analyzer Type

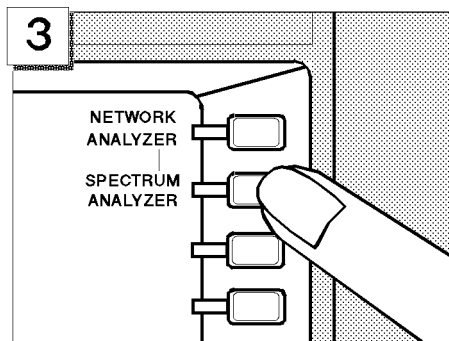
To use the spectrum analyzer mode, you must set the analyzer type to the spectrum analyzer mode after selecting an active channel.



In the MEASUREMENT block, press **Meas**.



Press **ANALYZER TYPE**.



Press **SPECTRUM ANALYZER**.

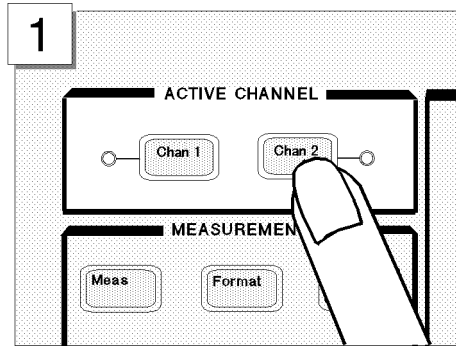
#### Note



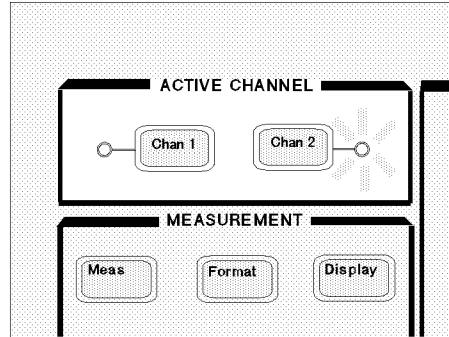
Changing the analyzer type presets the 4395A for the active channel. If you want to keep the current measurement settings when changing the analyzer type, first set the other channel to active.

## Setting the Active Channel

The 4395A has two measurement channels. This allows you to have two different measurement setups. Other selections you make on the front panel affect only the active channel. To set the active channel to channel 2:



1 In the ACTIVE CHANNEL block, press Chan 2.



Verify the Chan 2 active channel indicator lights.

### Note

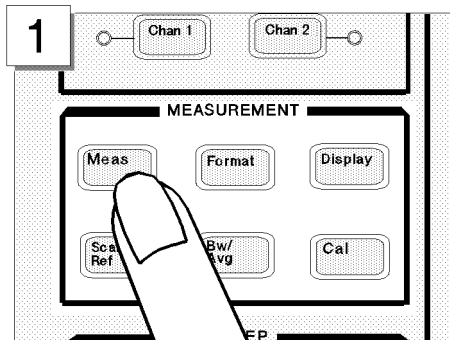


All selected settings are stored separately for each channel. You must select an active channel (1 or 2) before you can change the measurement setup for that channel.

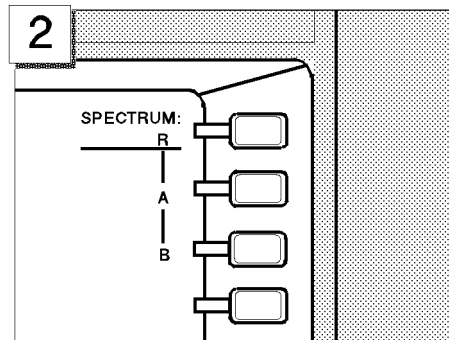
## Selecting the Input

The 4395A has three inputs; R, A, and B. Any of the inputs (R, A, or B) can be used for a spectrum measurement.

In the spectrum analyzer mode, the R input is selected by default. In the following steps, you verify the R input is selected.



1 In the MEASUREMENT block, press Meas.

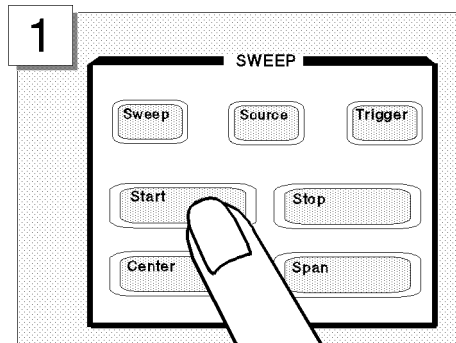


2 Verify the R in SPECTRUM: R is underlined. (This shows that the R input is selected for a spectrum analyzer measurement.)

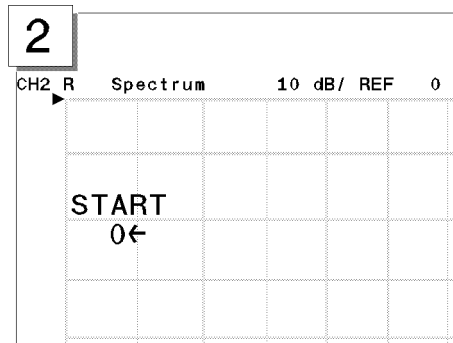
## Step 2: Setting Up the 4395A

### Setting the Frequency Range

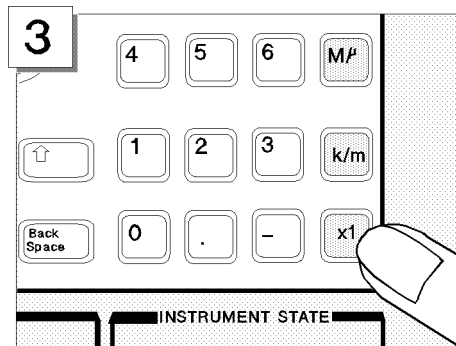
The CAL OUT signal (20 MHz at -20 dBm) is connected as test signal source. To see this signal on display, you must set the appropriate frequency range (in this case, 0 to 80 MHz):



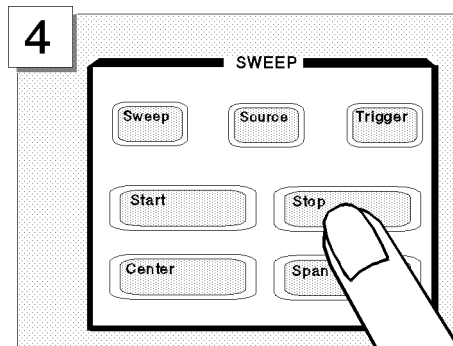
In the SWEEP block, press **(Start)**.



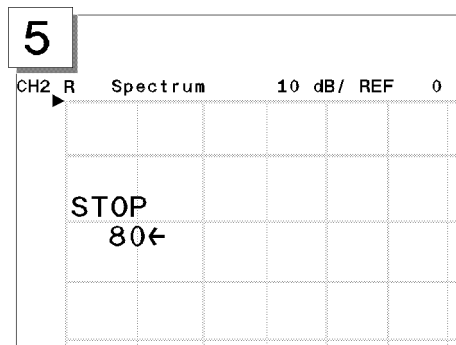
Press **(0)**.



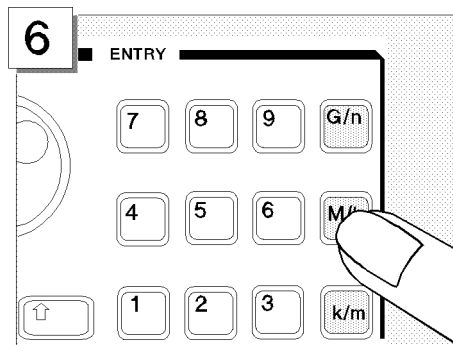
Press **(x1)**.



Press **(Stop)**.



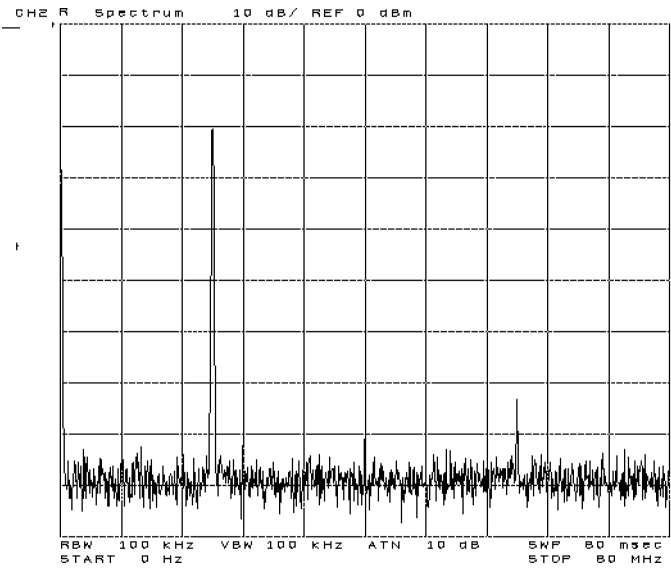
Press **(8) (0)**.



Press **(M/μ)**.

Verify the 20 MHz signal is displayed as shown below:

Step 2: Setting Up the 4395A

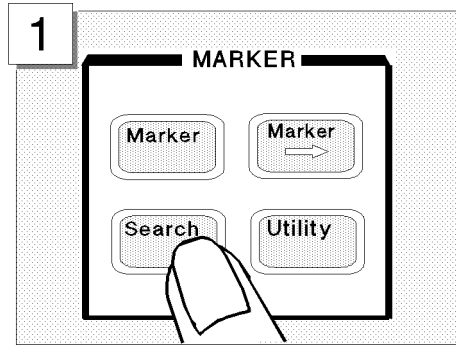


### Step 3: Making a Measurement

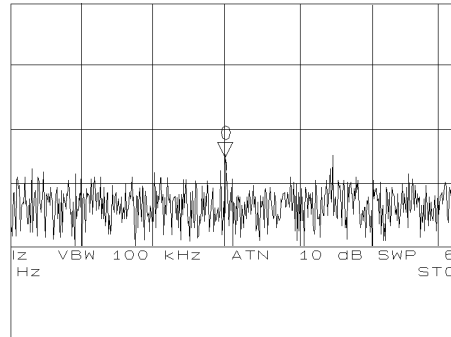
## Step 3: Making a Measurement

### Reading the Peak Level Using the Marker

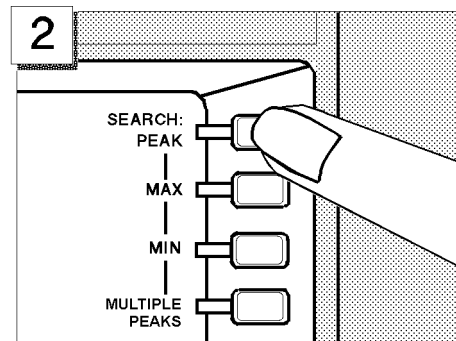
Let's try to read peak signal level by using the marker:



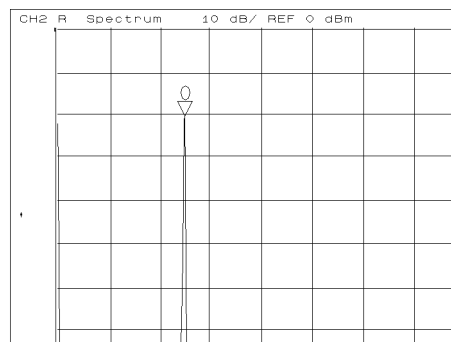
Press **Search**.



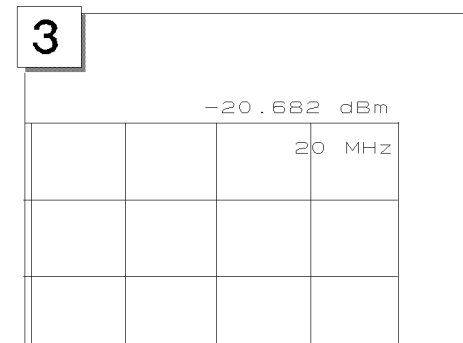
Marker appears on trace.



Press **SEARCH:PEAK**.



Marker moves to the top of the CAL OUT signal.



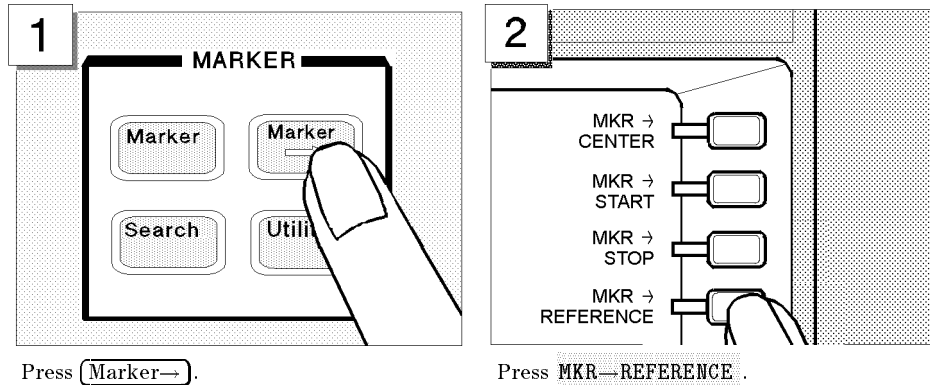
Read the marker value shown at the upper right of grid.

### Step 3: Making a Measurement

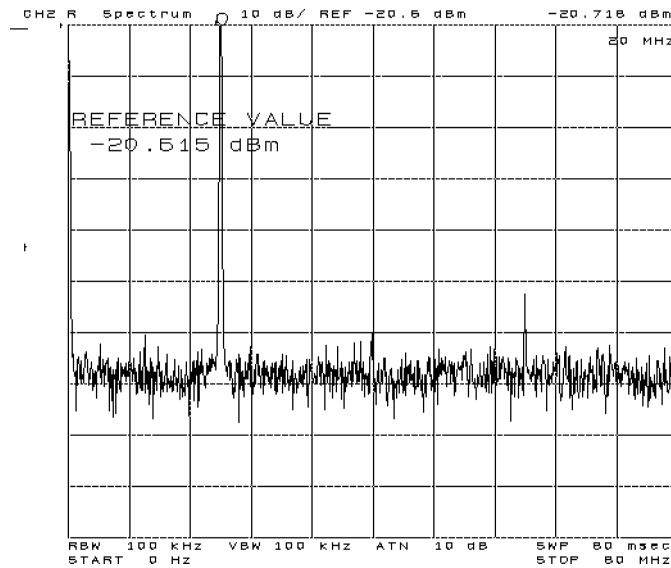
#### Setting the Resolution Bandwidth to See Low Level Signals

To see lower level signals that are approximately the same level as the noise floor, use a narrow resolution bandwidth (RBW) setting.

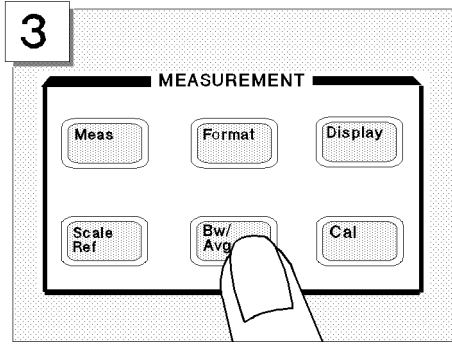
Before you set the RBW, set the maximum peak level as the reference level. This increases the visibility of the lower level signal. This technique is useful when you are measuring two signals and one is very close to the noise level.



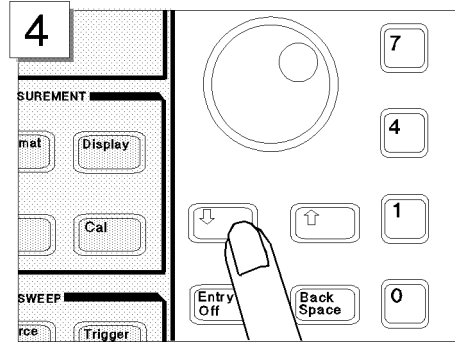
The trace moves upward to place the tip of the maximum peak at the top line of the grid.



### Step 3: Making a Measurement

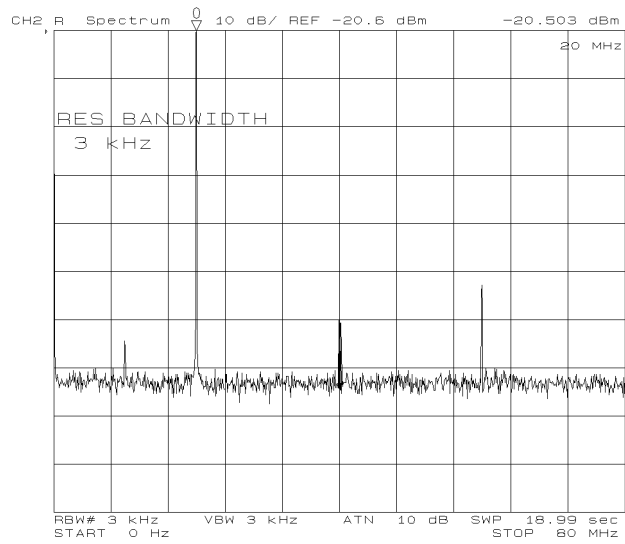


Press **Bw/Avg**.



Press **3** to narrow RBW setting to 3 kHz.

Now, with the noise floor level lowered by narrowing the resolution bandwidth, the second and third harmonics can be seen as shown below:

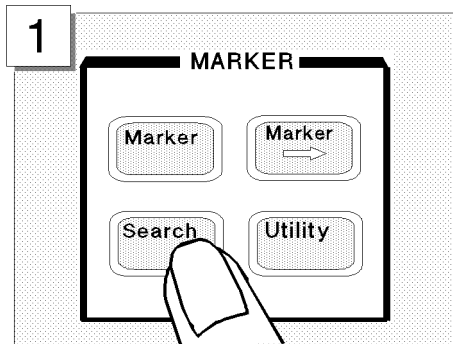




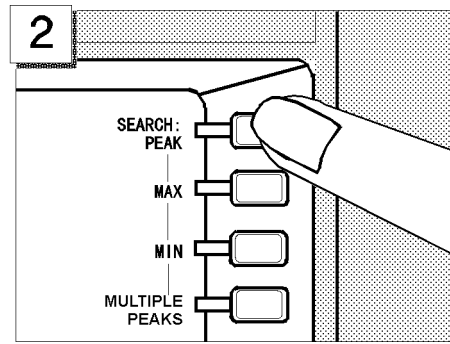
## Step 3: Making a Measurement

### Searching for Harmonics Using the Search Function

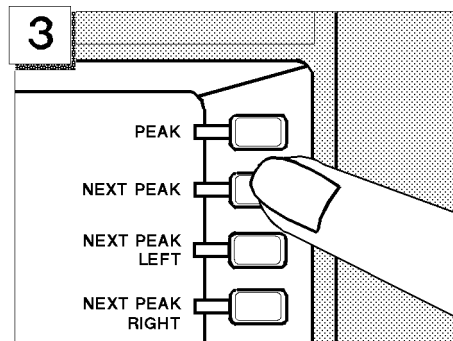
You can easily readout a harmonic's frequency and level by using the peak search function:



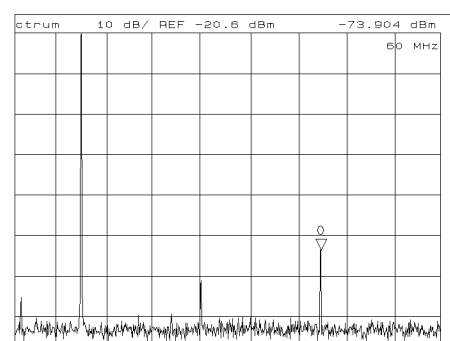
Press **Search**.



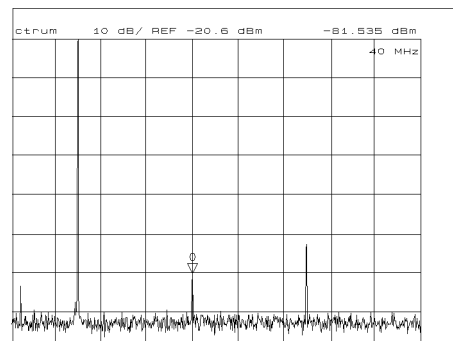
Press **SEARCH:PEAK**.



Press **NEXT PEAK**.



The marker moves to the third (or second) harmonic.



To move the marker to the second (or third) harmonic, press **NEXT PEAK** again.

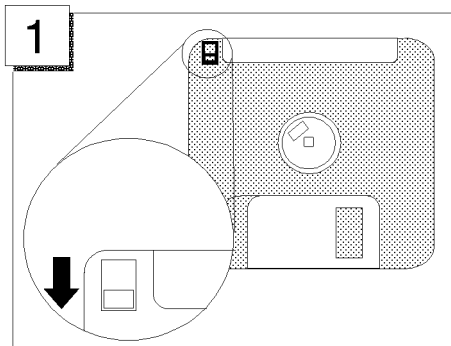
## Step 4: Saving and Recalling 4395A Settings

### Step 4: Saving and Recalling 4395A Settings

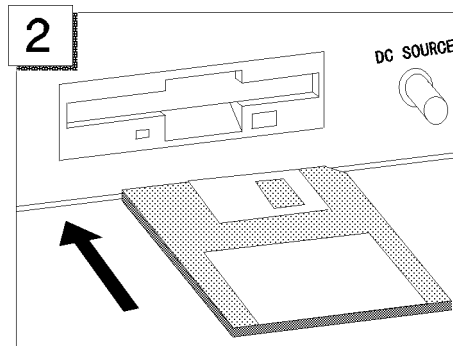
You can store the settings or measurement data on a 3.5 inch disk using the 4395A's disk drive. In this tour, you save and recall the settings that you selected previously in this tour.

#### Preparing the Disk

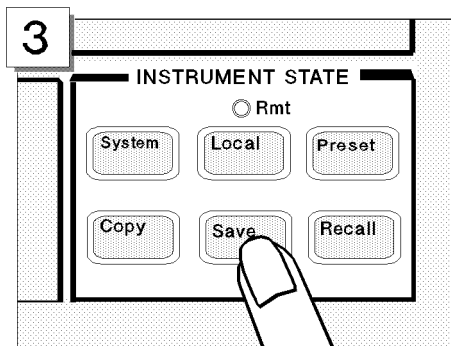
To use a disk, you must first initialize it by performing the following steps:



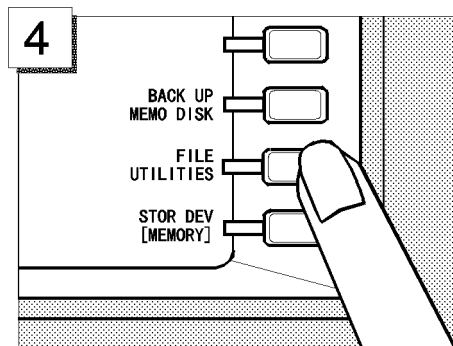
Verify the disk is not write protected.



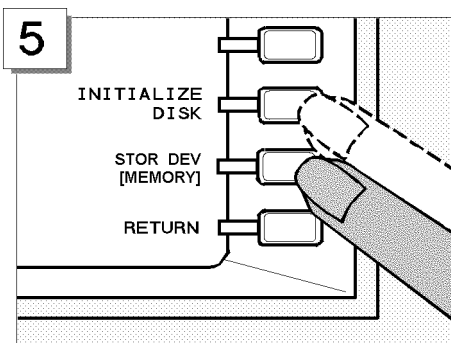
Insert the disk into the disk drive



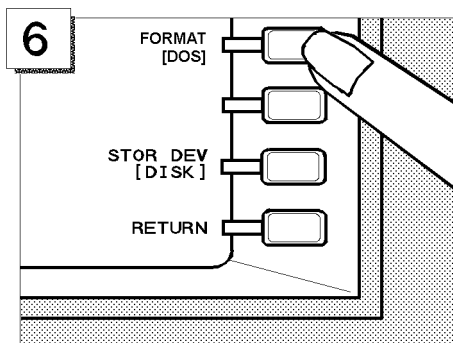
Press **Save**.



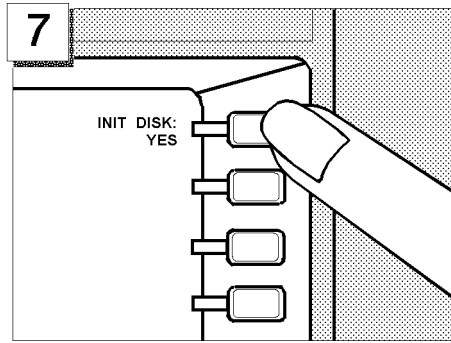
Press **FILE UTILITIES**.



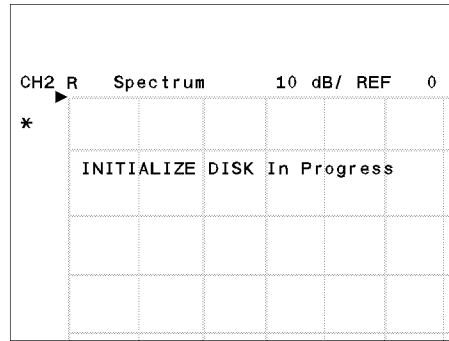
Toggle **STOR DEV [MEMORY]** to **[DISK]**, and Toggle **FORMAT [DOS]** to **[LIF]**.  
press **INITIALIZE DISK**



## Step 4: Saving and Recalling 4395A Settings



Press **INIT DISK: YES**.



The message, "INITIALIZE DISK In Progress," is displayed. After the disk is initialized, this message is turned off.

### Note



The 4395A can use either a LIF (Logical Interchange Format) or a MS-DOS (Disk Operating System) format disk.

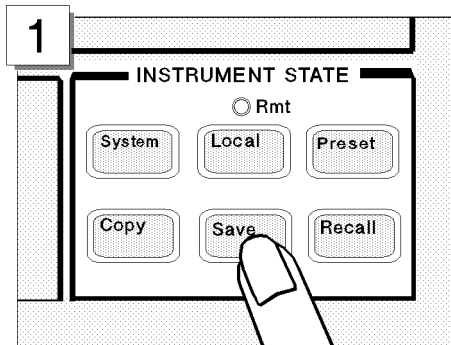
### Note



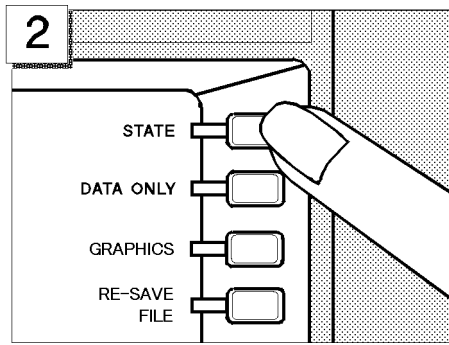
The 4395A can initialize a 1.44 MB 3.5 inch flexible disk only.

## Saving 4395A Settings

In the following example, use "SATOUR" as the file name of the 4395A settings you want to save.



Press **Save**.



Press **STATE**.

The 4395A requests the file name you want to use for the saved settings.

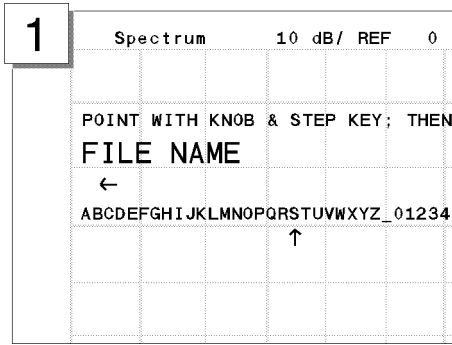
## Entering the File Name

### Note

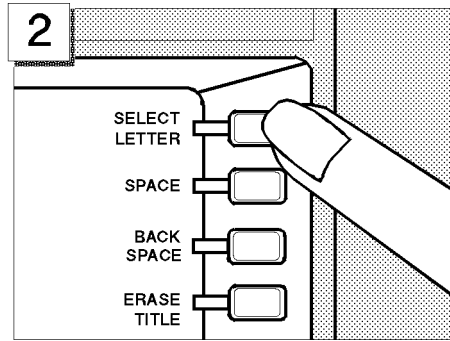


If a keyboard is connected, you can use it for file name entry. If not, use the front-panel controls as described in the following steps.

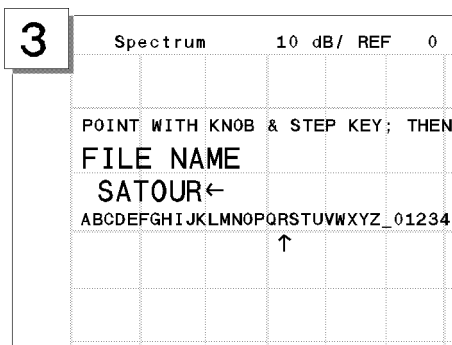
## Step 4: Saving and Recalling 4395A Settings



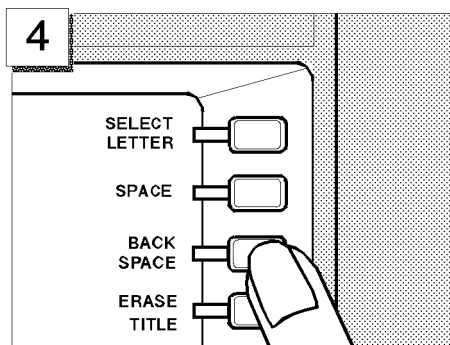
Turn the rotary knob to move the arrow below the first character, S.



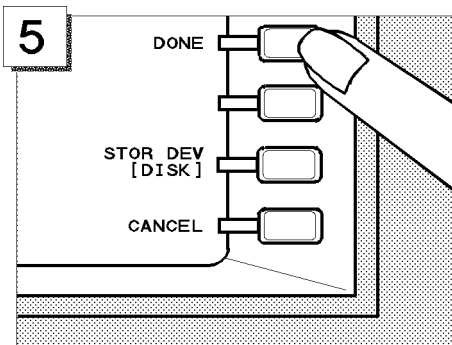
Press **SELECT LETTER**.



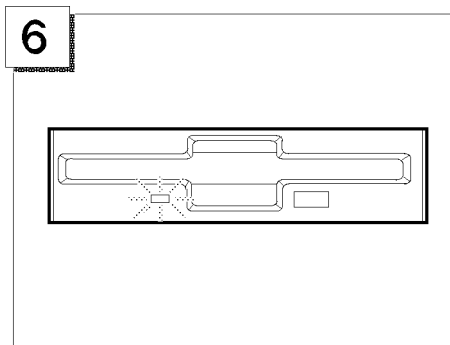
Keep entering characters until SATOUR is entered.



If you enter a wrong character, press **BACK SPACE** to erase the character.



To complete the file name entry, press **DONE**.



Verify the disk access indicator lights (this shows that the 4395A is saving the settings to the disk).

### Note



The file name for a LIF format can be up to 10 characters long. However, with the 4395A, the last 2 characters are reserved for a suffix. Therefore, you can enter a file name of up to 8 characters. Either upper or lower case is recognized in the LIF format.

A file name for a MS-DOS(DOS) format consists of a file name and an extension. The file name can be up to 8 characters long and the extension contains up to 3 characters. A period separates the extension from the file name. The extension

## Step 4: Saving and Recalling 4395A Settings

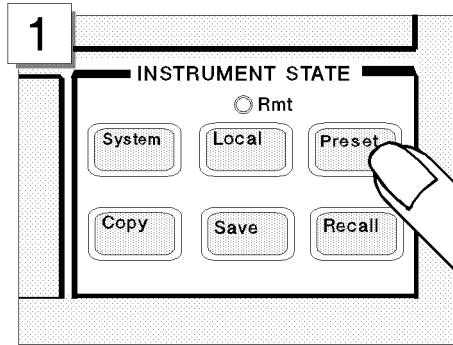
part reserved by the 4395A. Therefore, you can enter a file name of up to 8 characters. The file name is not case sensitive in the DOS format.

---

### Recalling the 4395A Settings

You can recall the file containing the saved 4395A settings anytime you want. This is true, even if you change the current 4395A settings. In this example, you will preset the 4395A and then recall the settings in the SATOUR file.

#### Presetting

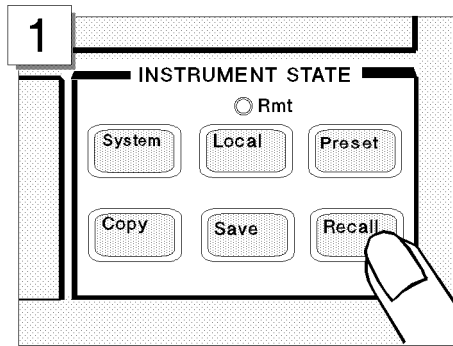


Press **Preset**.

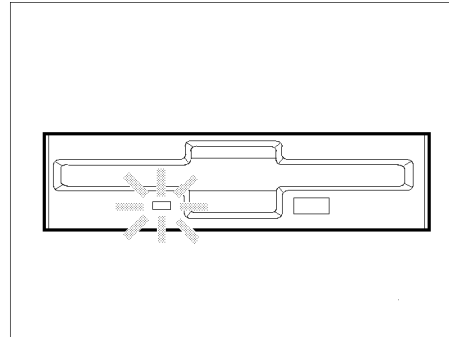
The 4395A is set to the preset conditions. However, the 4395A settings from the previous examples are stored in the SATOUR file on the disk.

## Step 4: Saving and Recalling 4395A Settings

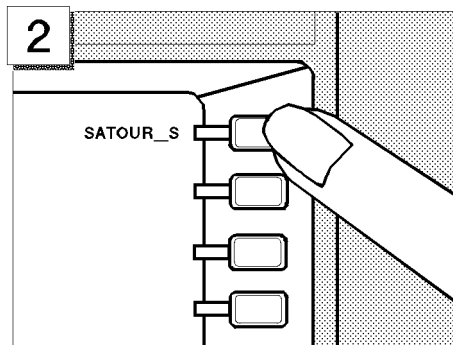
### Recalling the SATOUR file.



Press **Recall**.



The disk access lamp lights.



The stored file is listed in the softkey label area. Press **SATOUR\_S** to recall the 4395A settings that you saved.

---

### Note



Suffix, “\_S,” means the 4395A settings are saved. If you save the 4395A settings in a DOS format, an extension, “.sta,” is appended to the file name.

---

After the disk access lamp goes out, all 4395A settings that you set are recalled. You can verify them on the display. If you want to know what settings are saved, see chapter 8.

---

## Impedance Analyzer Tour

In this section, you explore the impedance analyzer mode of operation. Before starting this tour, make sure that your 4395A is correctly installed (see chapter 1, “Installation and Setup Guide,” if you need additional information).

---

**Note**

Your 4395A must be equipped with option 010 to serve as an impedance analyzer. Otherwise, impedance analyzer mode is not available.

---

### Before You Leave On The Tour

Through this tour, you will learn how to make a basic impedance analyzer measurement by measuring the impedance characteristics of a chip capacitor.

#### Overview

The following is a short summary of the tour:

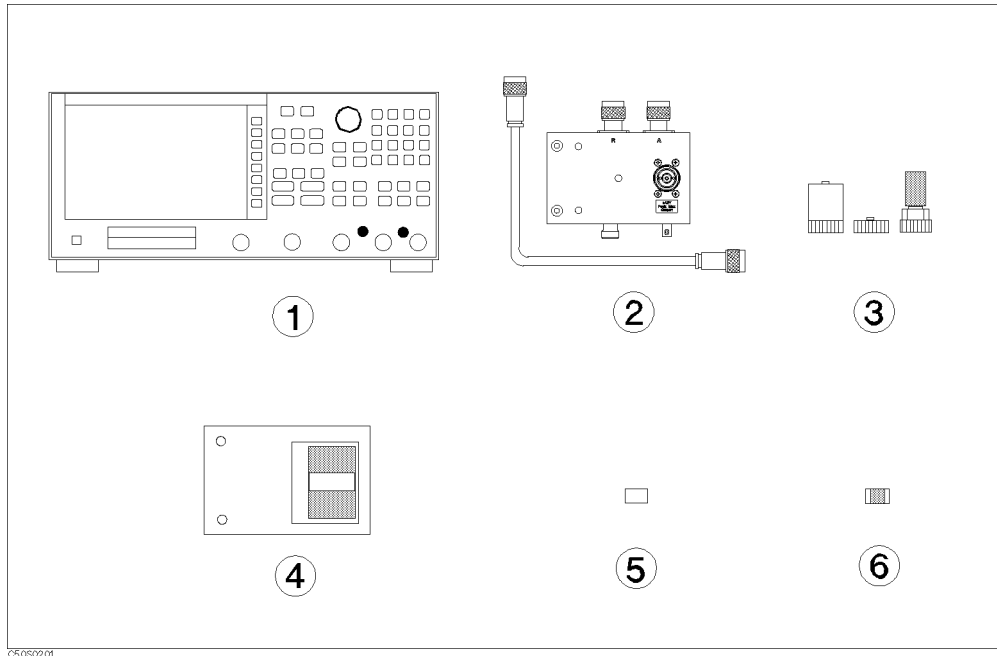
1. Preparing for a measurement
  - Connecting the impedance test kit
  - Turning ON the 4395A
2. Setting up the 4395A
  - Selecting the analyzer type
  - Activating Channel 1
  - Setting the sweep parameters
  - Setting the output level
  - Setting the IF bandwidth
3. Calibrating the 4395A
  - OPEN calibration
  - SHORT calibration
  - LOAD calibration
4. Connecting and setting up a test fixture
  - Connecting the fixture
  - Setting the electrical length
  - Fixture compensation
5. Carrying out impedance measurement
  - Selecting the measurement parameters for Channel 1
  - Connecting the DUT
  - Performing the Automatic Scaling
6. Switching from Channel 1 to Channel 2
7. Selecting the measurement parameters for Channel 2
8. Dual channel display

## Impedance Analyzer Tour

After you finish this tour, you will understand how to make a basic measurement in impedance analyzer mode. If you want to learn how to perform more complex tasks, refer to Chapters 5 through 9.

### Required Equipments

To perform all the steps in this tour, you must have the following equipments:



**Figure 3-5. Required Equipments**

1. 4395A Network/Spectrum/Impedance Analyzer with Option 010 equipped
2. 43961A Impedance Test Kit
3. Calibration kit (included in the 43961A)
4. Test fixture of your choice
5. Short device for the test fixture
6. DUT (chip capacitor)\*

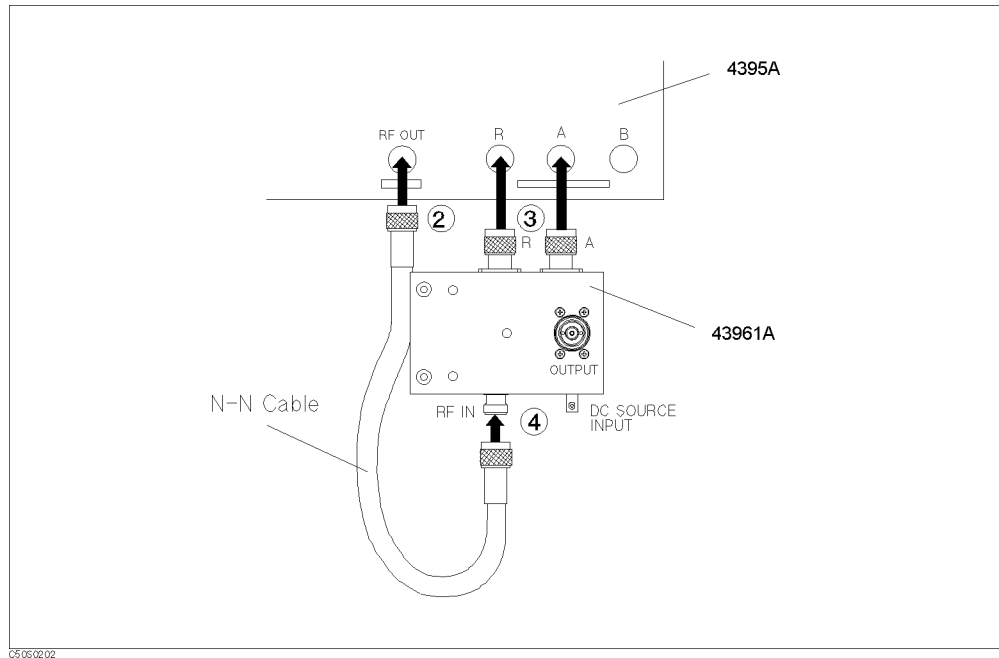
If you wish to test some other device instead of a chip capacitor, you will need to change particular measuring conditions, such as the frequency range, according to the general characteristics of the DUT.



## Step 1: Preparing for the Measurement

### Connecting the Impedance Test Kit

The 4395A requires the 43961A Impedance Test Kit to apply signals to, and measure the impedance characteristics of, a DUT (see Figure 3-6). To connect the 43961A Impedance Test Kit, follow these steps:



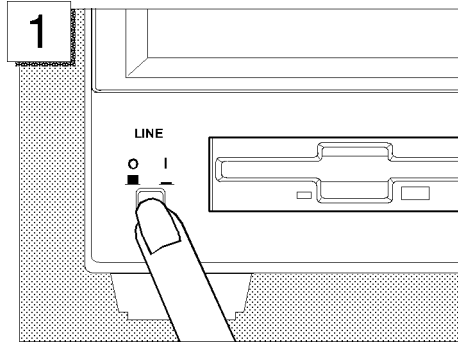
**Figure 3-6. Connecting the Impedance Test Kit**

1. Make sure that the power to the 4395A is OFF.
2. Connect the N-N cable to the 4395A's RF OUT port.
3. Make sure that the 43961A's APC7 connector sleeve is completely exposed.
4. Connect the two connectors of the 43961A to the R and A ports of the 4395A, by tightening the two connectors little by little alternately while holding the test kit.
5. Connect the other end of the N-N cable to the RF IN port of the 43961A.

### Turning ON the 4395A

Verify the power source setting is correct before you turning ON the 4395A. If necessary, see chapter 2, "Installation Guide."

## Impedance Analyzer Tour

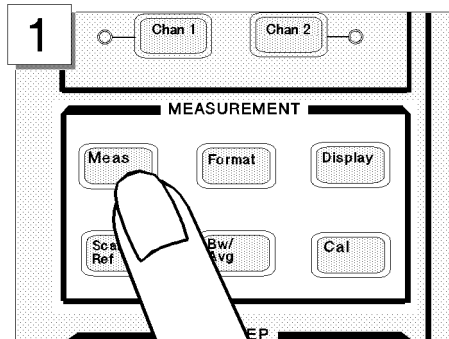


Press the power switch.

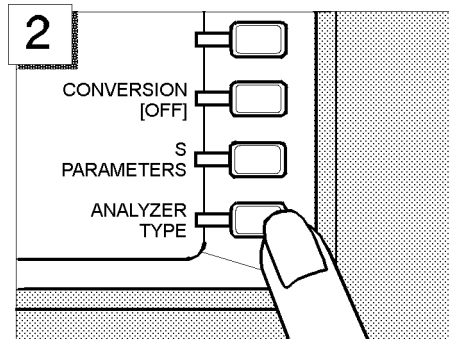
The 4395A performs a power on self-test. About 20 seconds later, the model name, revision number, and other information should appear on the LCD to indicate that the 4395A has normally started up.

### Setting Up the 4395A Setting the Analyzer Type

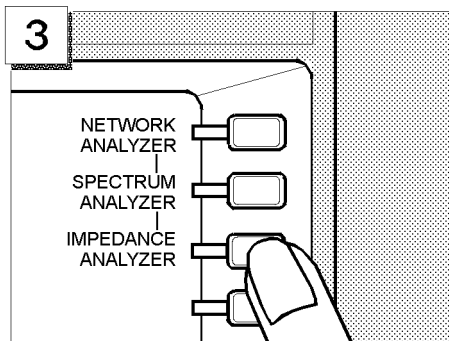
Available analyzer modes are listed in the menu under the **ANALYZER TYPE** softkey. You can use the 4395A as an impedance analyzer by selecting the corresponding analyzer mode from that menu. Follow these steps:



Press the **Meas** key in the MEASUREMENT block.



Choose **ANALYZER TYPE**.



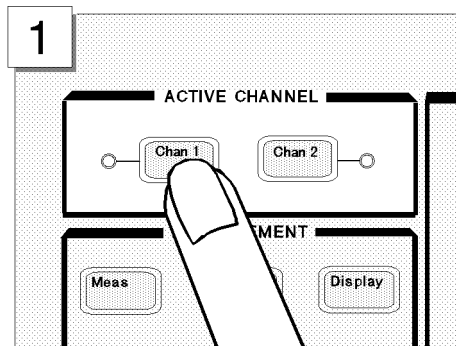
Choose **IMPEDANCE ANALYZER**.

### Activating Channel 1

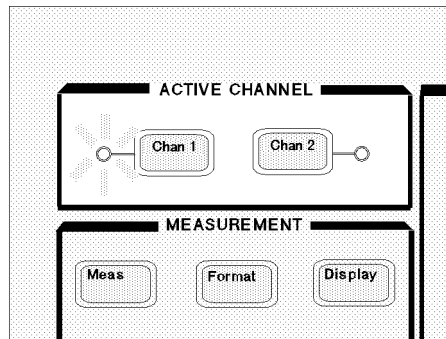
The 4395A has two channels, each of which can retain different measuring conditions. To demonstrate how effectively you can use these two channels to perform impedance measurement, this tour uses the following scenario:

1. Activate Channel 1, and set the parameters that apply to Channel 1
2. Switch to Channel 2, and set the parameters that apply to Channel 2 (see “Step 6: Switching from Channel 1 to Channel 2”)
3. Display both channels in parallel (see “Step 8: Dual Channel Display”)

First, activate Channel 1 through these steps:



Press the **Chan 1** key in the ACTIVE CHANNEL block.



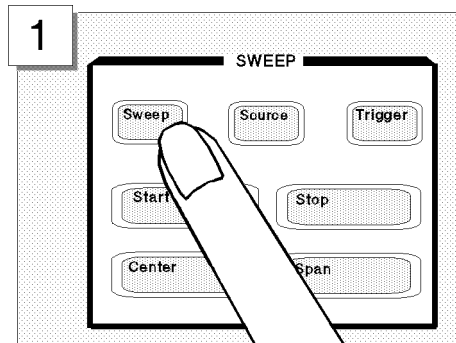
Make sure that the indicator lamp beside the **Chan 1** key is ON.

## Impedance Analyzer Tour

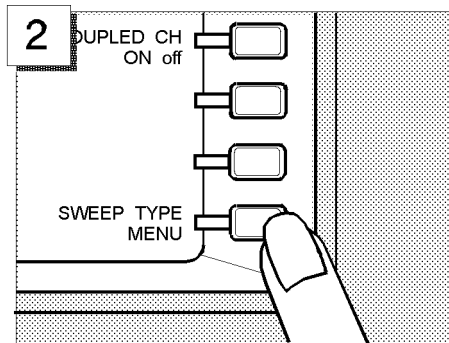
### Setting the Sweep Parameters

This tour assumes that the frequency is being swept from 100 kHz to 500 MHz.

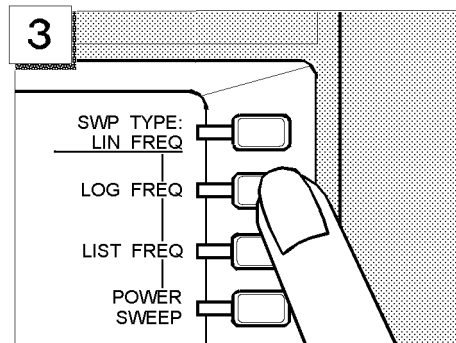
Follow these steps:



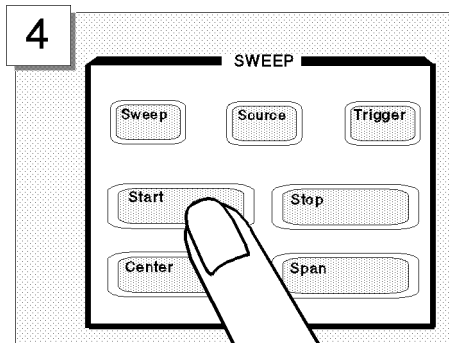
Press the **Sweep** key.



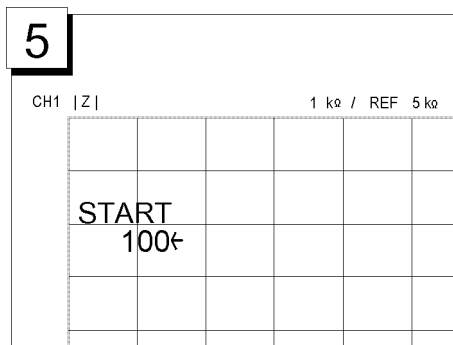
Choose **SWEEP TYPE MENU** to access the sweep type menu.



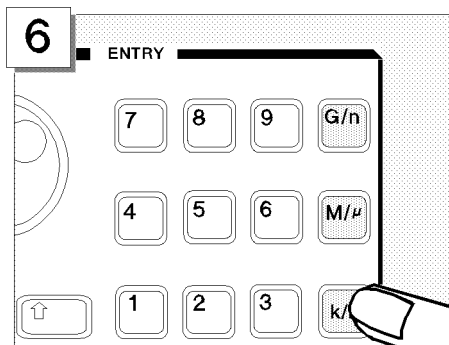
Choose **LOG FREQ** to have the 4395A accept log frequency settings.



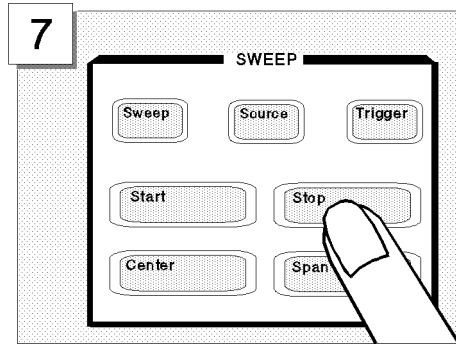
Press the **Start** key.



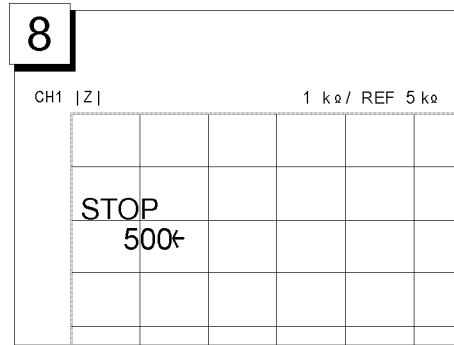
To specify the frequency at which to start the sweep, enter **1 0 0** using the numeric keys.



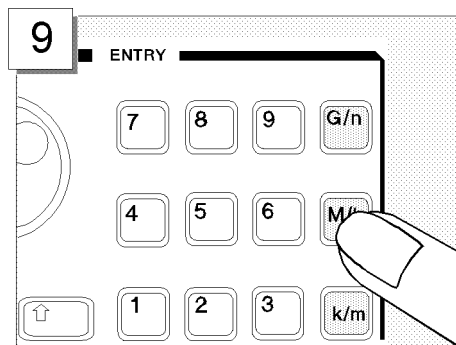
Press the **(k/m)** key to indicate that the unit is kHz.



Press the **STOP** key.



To specify the frequency at which to stop the sweep, enter **5 0 0** using the numeric keys.



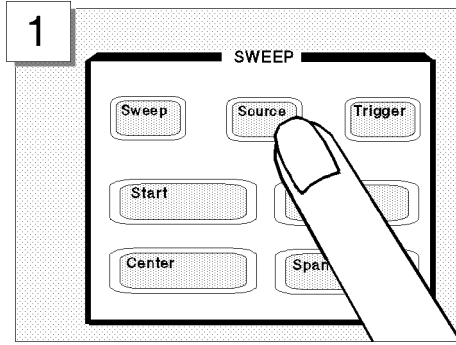
Press the **M/μ** key to indicate that the unit is MHz.

### Setting the Output Level

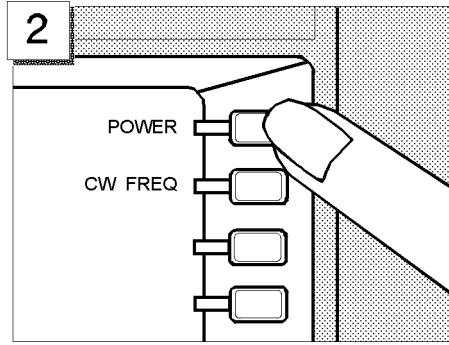
This tour assumes an output level of +0.5 dBm.

Follow these steps:

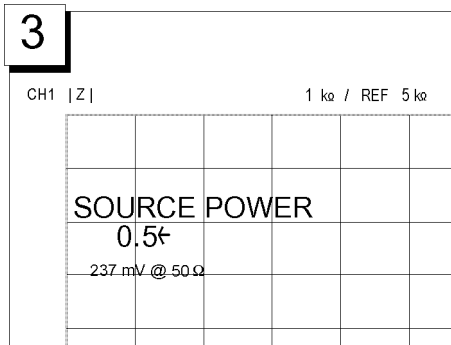
## Impedance Analyzer Tour



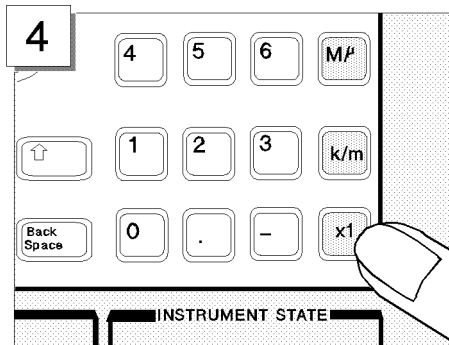
Press the **Source** key.



Choose **POWER**.



Enter **0 . 5** using the numeric keys.

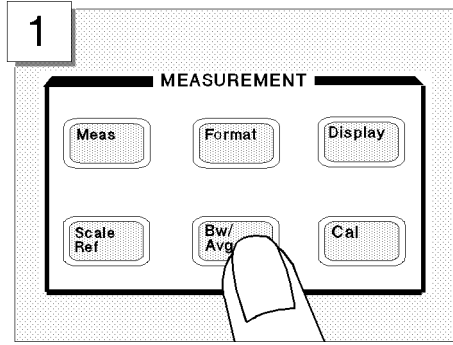


Press the **x1** key.

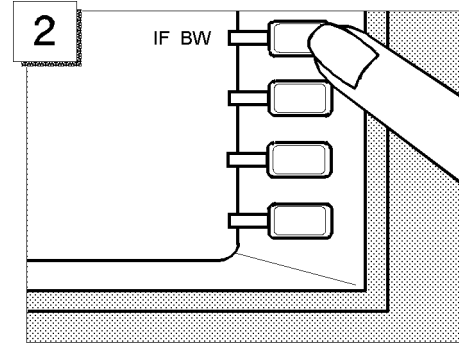
### Setting the IF Bandwidth

This tour assumes an IF bandwidth of 300 Hz.

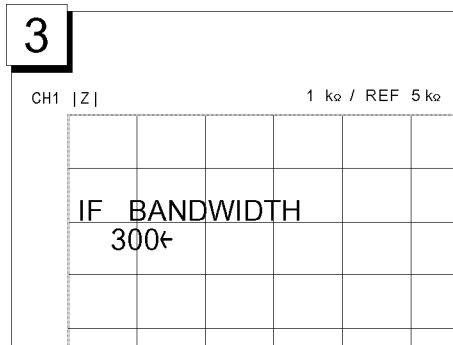
Follow these steps:



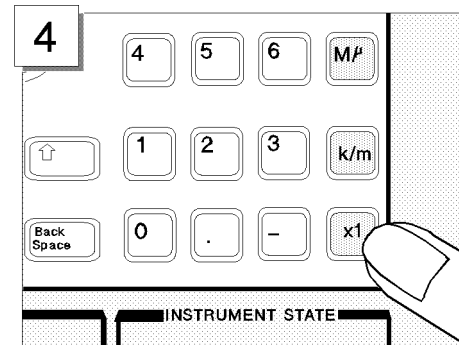
Press the **Bw/Avg** key.



Choose **IF BW**.



Enter **3 0 0** using the numeric key.



Press the **x1** key.

**Note** A smaller IF bandwidth reduces trace noise, but increases measuring time.

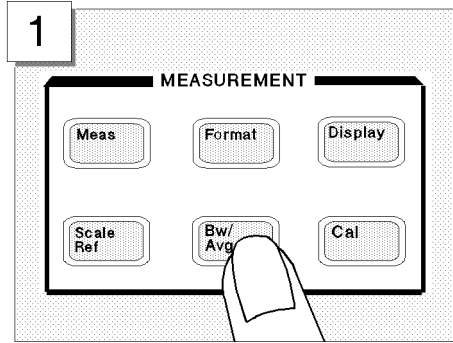


### Setting the Averaging Factor

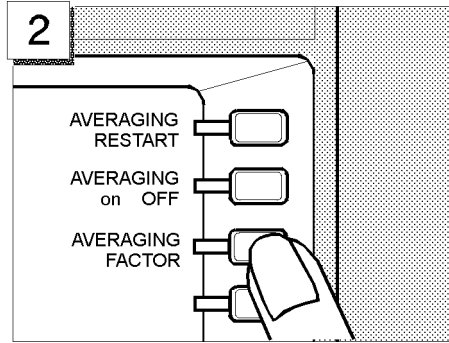
This tour assumes the averaging factor of 8.

Follow these steps:

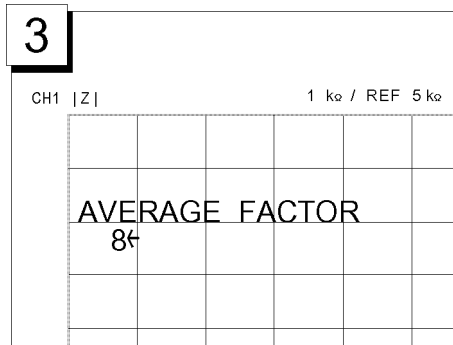
## Impedance Analyzer Tour



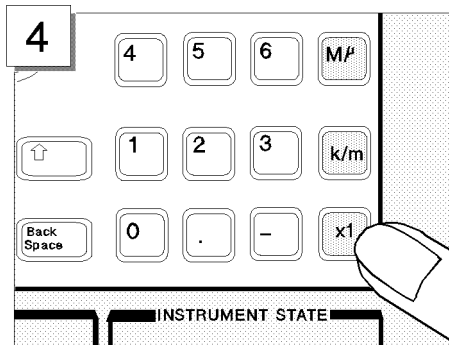
Press the **[Bw/Avg]** key.



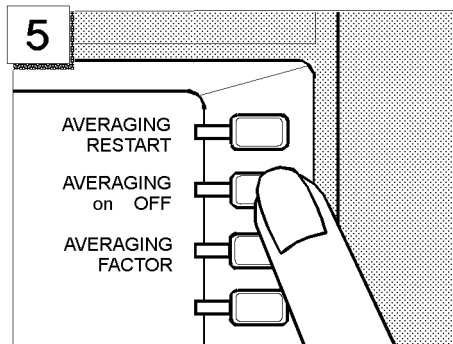
Choose **AVERAGING FACTOR**.



Enter **[8]** using the numeric key.



Press the **[x1]** key.



Toggle **AVERAGING on OFF** to **ON off**.

### Note



When you perform impedance measurement with the 43961A, you must set IF bandwidth equal to or less than 300 Hz and averaging factor equal to or greater than 8.



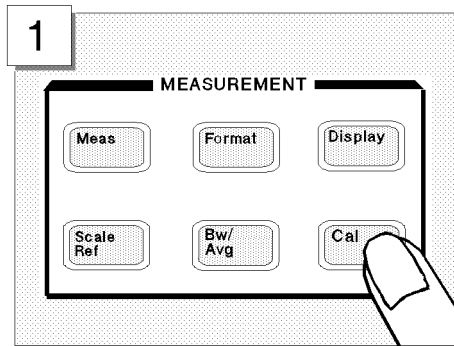
### Step 3: Making a Calibration

Calibrating the 4395A in impedance analyzer mode requires that the 4395A be connected with the 43961A impedance test kit. A proper calibration is required for the 4395A to perform measurements within the guaranteed accuracy range.

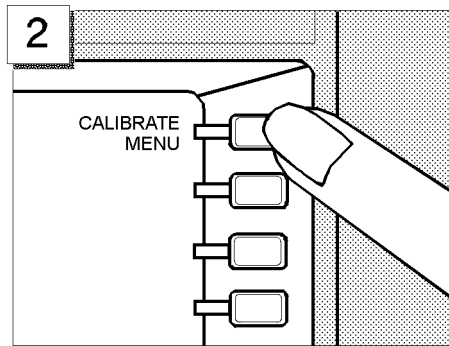
For impedance analyzer mode, the 4395A must be calibrated for each of the following three circuit states:

- OPEN (0 S termination)
- SHORT (0  $\Omega$  termination)
- LOAD (50  $\Omega$  termination)

To calibrate the 4395A, access the calibration menu through these steps:



Press the **Cal** key.



Choose **CALIBRATE MENU**.

With the calibration menu displayed on the LCD screen, calibrate the 4395A for the OPEN, SHORT, and LOAD states in order.

---

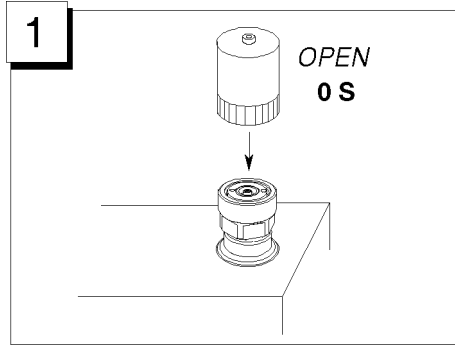
**Note** Be sure to use the calibration kit included in the 43961A package.



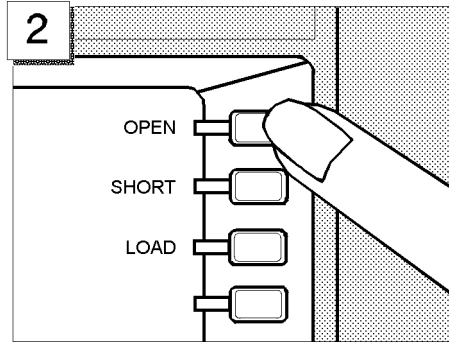
#### OPEN Calibration

Follow these steps:

## Impedance Analyzer Tour

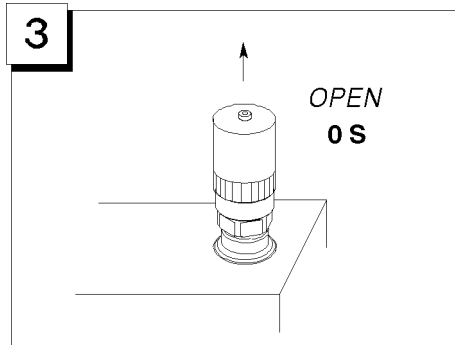


Connect the 0 S termination to the 43961A's OUTPUT port.



Choose OPEN.

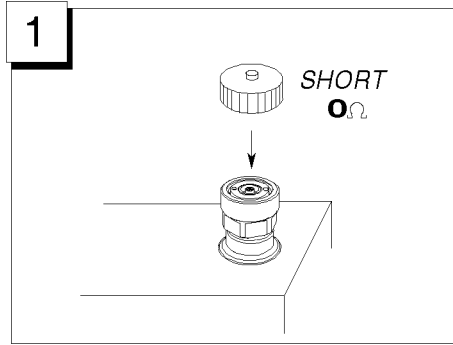
Wait until the OPEN softkey's label is underlined to indicate that the OPEN calibration is complete.



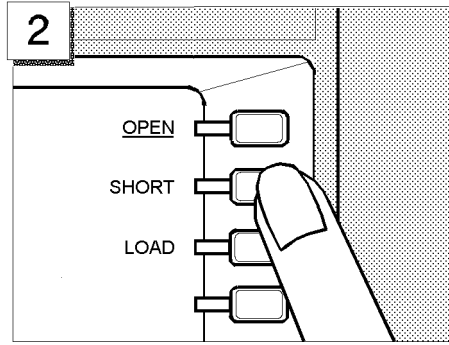
Remove the 0 S termination.

## SHORT Calibration

Follow these steps:

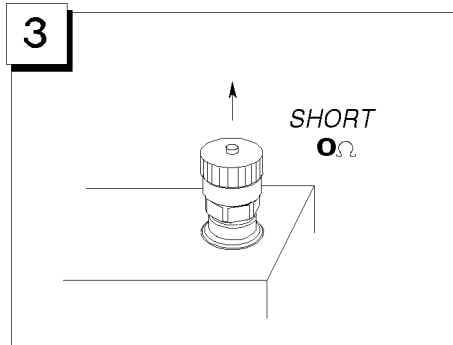


Connect the 0  $\Omega$  termination to the 43961A's OUTPUT port.



Press **SHORT**.

Wait until the **SHORT** softkey's label is underlined to indicate that the SHORT calibration is complete.

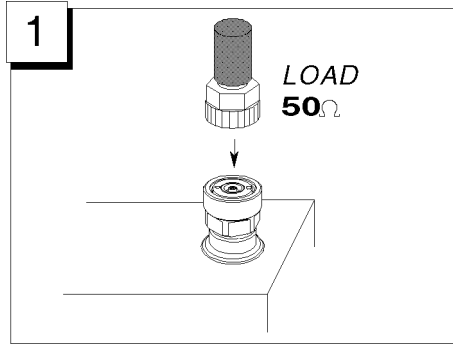


Remove the 0  $\Omega$  termination.

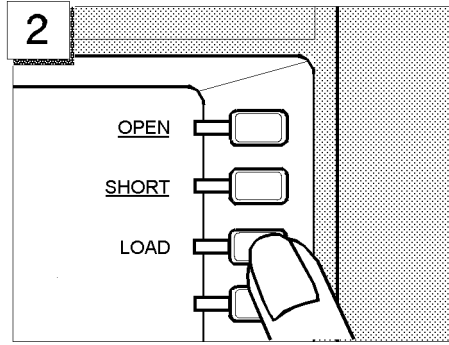
### LOAD Calibration

Follow these steps:

## Impedance Analyzer Tour

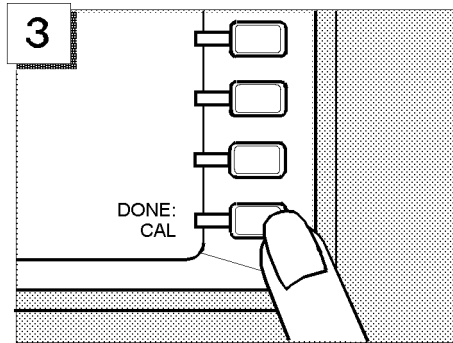


Connect the 50 Ω termination to the 43961A's OUTPUT port.

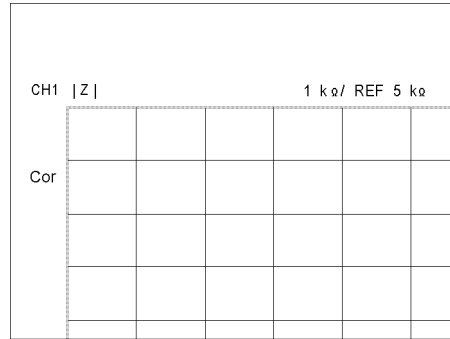


Press **LOAD**.

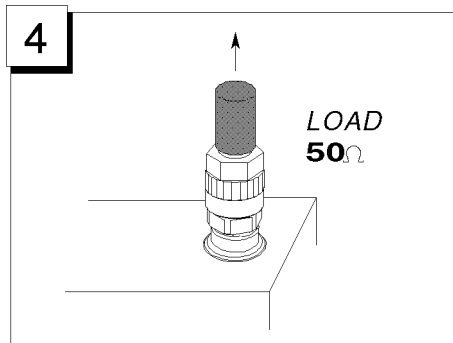
Wait until the **LOAD** softkey's label is underlined to indicate that the LOAD calibration is complete.



Choose **DONE: CAL**.



Make sure that a "Cor" marker is displayed at the left-hand edge of the screen.



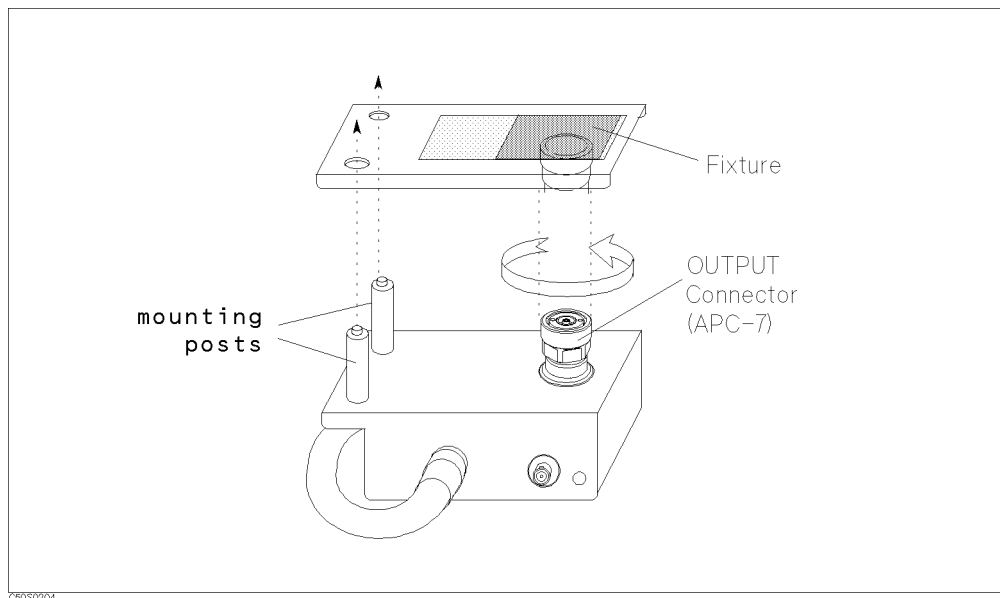
Remove the 50Ω termination.

## Step 4: Connecting and Setting Up a Test Fixture

### Connecting the fixture

This tour does not assume any specific test fixture. You can use a test fixture of your choice. For how to connect your test fixture to the impedance test kit, refer to the documentation that comes with the test fixture. A typical test fixture can be installed in such a procedure as shown below:

1. Turn the OUTPUT port APC-7 connector of the impedance test kit.
2. Make sure that the connecting sleeve is completely retracted.
3. Set the test station's mount post to the pair of holes located at one corner of the test fixture.
4. Turn the fixing ring counterclockwise until it is fully tightened.
5. Connect the impedance test kit's OUTPUT port to the connector located on the back side of the test fixture.



**Figure 3-7. Connecting the test fixture**

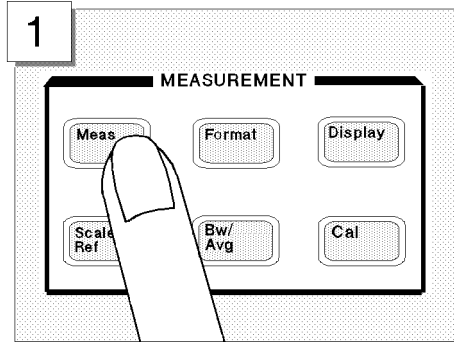
### Setting the Electrical Length

Connecting a test fixture adds an extra electrical length to the test circuit. This electrical length, which is specific to the test fixture you use, must be known to the 4395A so that it can compensate for the extra electrical length and eliminate errors due to phase shifts.

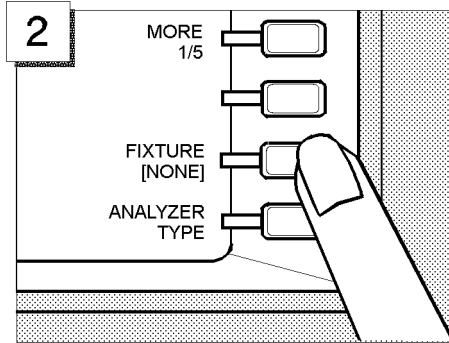
The 4395A incorporates a database of Agilent test fixtures with their own electrical lengths.

For example, if the model number of your test fixture is 16192, you would set the electrical length as follows:

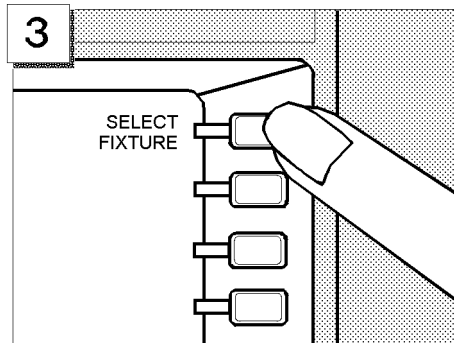
## Impedance Analyzer Tour



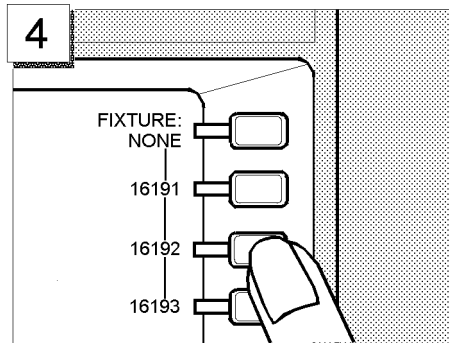
Press the **Meas** key.



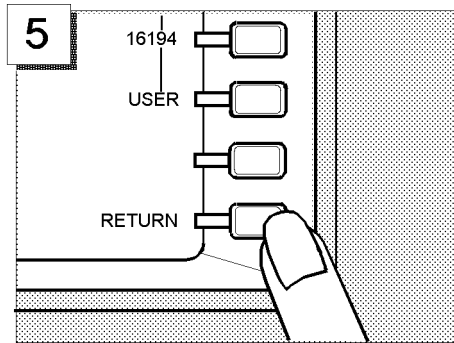
Choose **FIXTURE**.



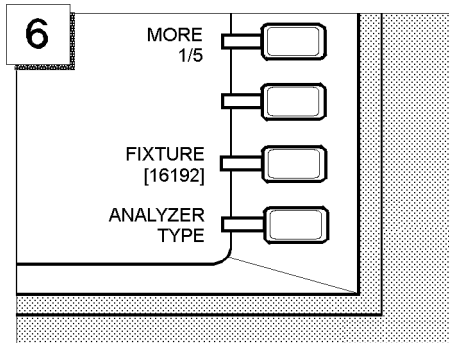
Choose **SELECT FIXTURE**.



Select **16192**.



Press **RETURN** twice.



Make sure that the **FIXTURE** label on the screen is followed by your selected model number (16192, in this case).

## Fixture Compensation

Fixture compensation is a process that calibrates the 4395A with a test fixture installed, thereby eliminating errors produced between the test fixture electrode and the impedance test kit's OUTPUT port. Normally, the 4395A must be fixture-compensated for the OPEN and SHORT circuit states. It can optionally be fixture-compensated for the LOAD state.

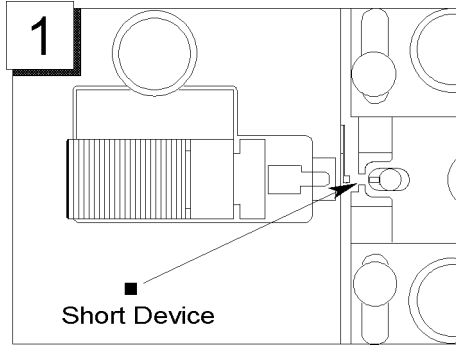
---

### Note

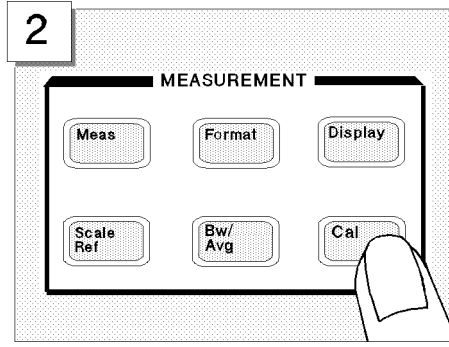
For how to connect standards, refer to the documentation that comes with the test fixture you use.



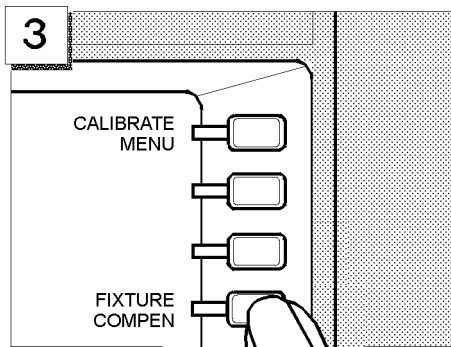
## Impedance Analyzer Tour



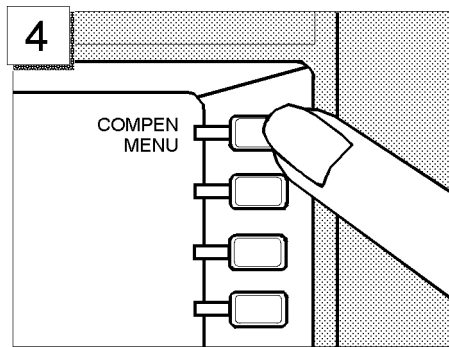
1  
Connect the appropriate short device to the fixture.



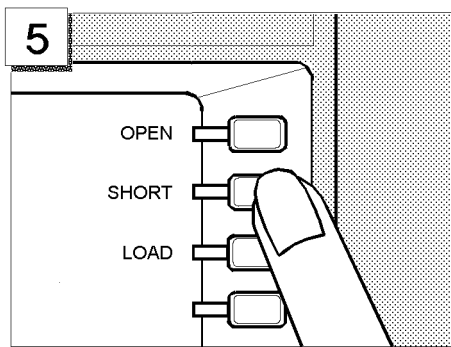
2  
Press the **Cal** key.



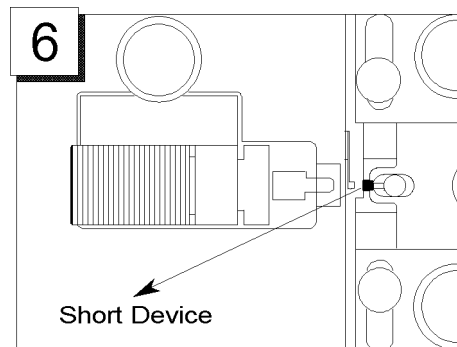
3  
Choose **FIXTURE COMPEN**.



4  
Choose **COMPEN MENU**.

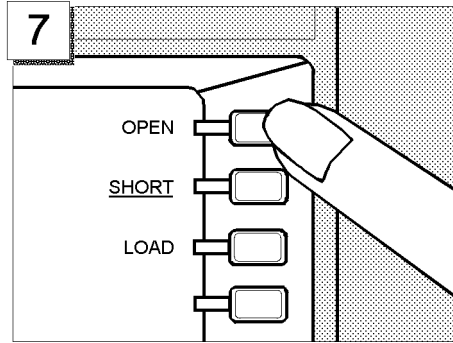


5  
Choose **SHORT**.  
Wait until the **SHORT** softkey's label is underlined to indicate that the SHORT compensation is complete.



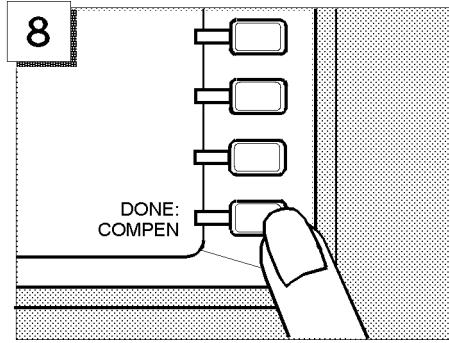
6  
Remove the short device to put the circuit into the OPEN state.



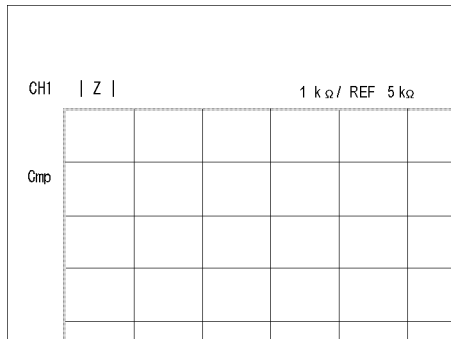


Choose **OPEN**.

Wait until the **OPEN** softkey's label is underlined to indicate that the OPEN compensation is complete.



Choose **DONE: COMPEN**.



Make sure that a “Cmp” marker is displayed in place of the “Cor” marker.

## Step 5: Carrying Out Impedance Measurement

### Selecting the Measurement Parameters for Channel 1

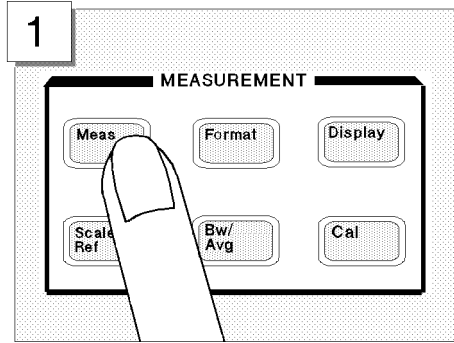
To begin impedance measurement, the 4395A must know which characteristics it should measure and how it should report the measured values. This tour assumes that the following measurement parameters are specified for Channel 1.

Characteristic Absolute value of impedance ( $|Z|$ )  
value

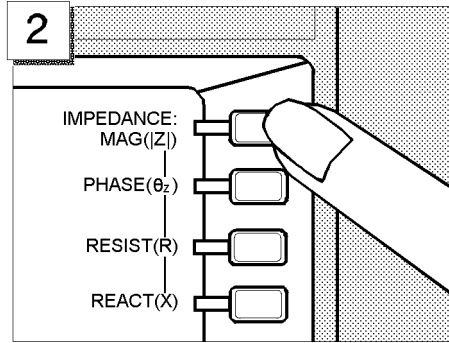
Format Log

To set the parameters listed above, follow these steps:

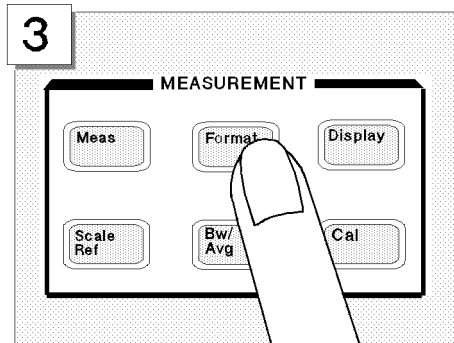
## Impedance Analyzer Tour



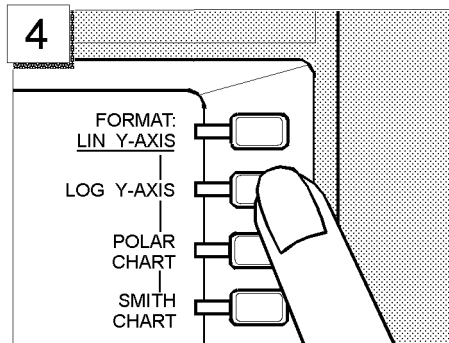
Press the **Meas** key.



Choose **IMPEDANCE: MAG (Z)**.



Press the **Format** key.



Choose **LOG Y-AXIS**.

These settings are applied to Channel 1, which has been the active channel in the scenario of this tour. Note that, in Steps 6 and 7, you will switch from Channel 1 to Channel 2, and assign different settings to Channel 2.

### Connecting the DUT

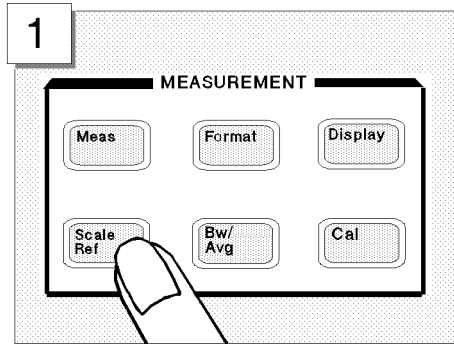
How to connect a DUT differs depending on which test fixture you use. For more information, refer to the documentation that comes with your test fixture.

As soon as you have connected the DUT, the 4395A will measure and display the impedance characteristics.

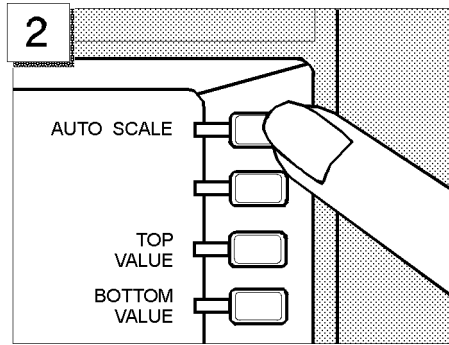
### Performing the Automatic Scaling

Often, the trace obtained after specifying the frequency range is too large or too small vertically for the grid. However, by using the automatic scaling function, you can obtain the optimum vertical setting automatically.

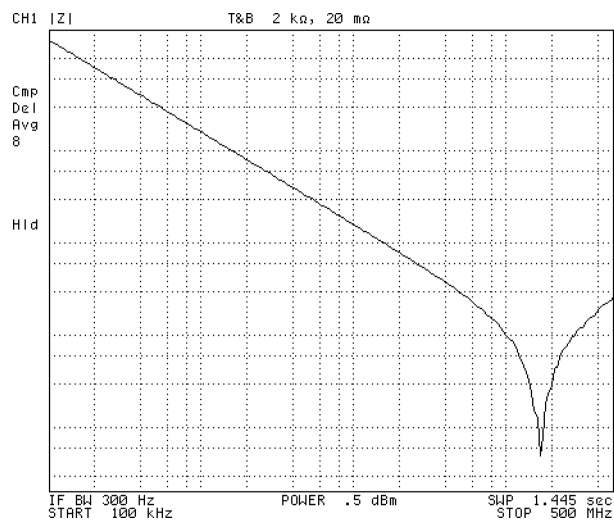
Follow these steps:



Press the **Scale Ref** key.



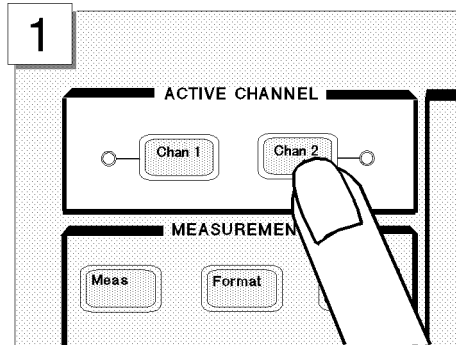
Choose **AUTO SCALE**.



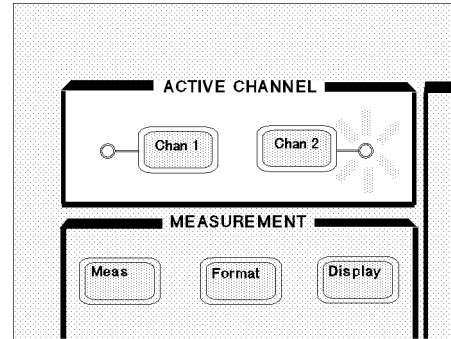
## Impedance Analyzer Tour

### Step 6: Switching from Channel 1 to Channel 2

All the settings you have made so far are assigned to Channel 1. Now, activate Channel 2 instead of Channel 1.



Press the **Chan 2** key in the ACTIVE CHANNEL block.

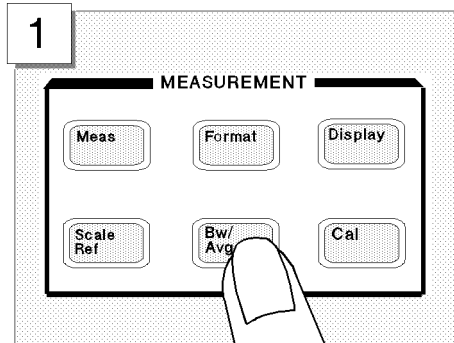


Make sure that the indicator lamp beside the **Chan 2** key is ON.

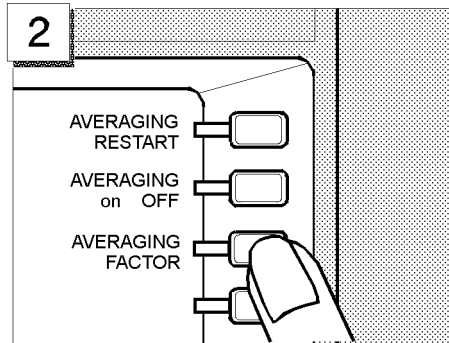
### Setting the Averaging Factor for Channel 2

This tour assumes the averaging factor of 8.

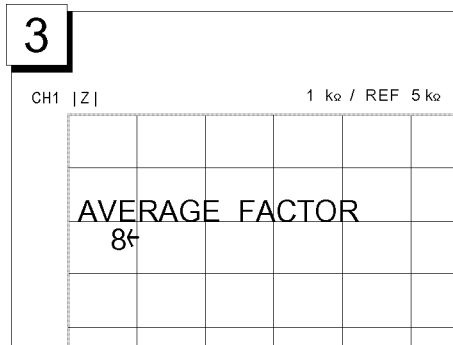
Follow these steps:



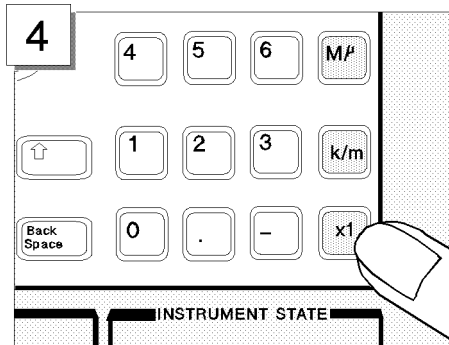
Press the **Bw/Avg** key.



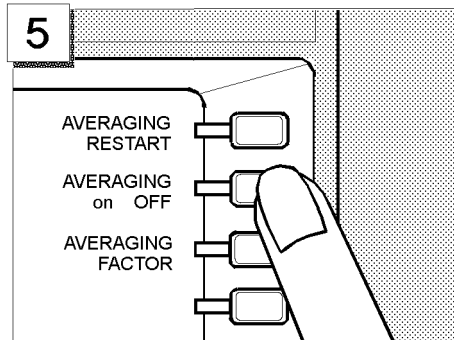
Choose **AVERAGING FACTOR**.



Enter **8** using the numeric key.



Press the **x1** key.



Toggle **AVERAGING on OFF** to **ON off**.

## Impedance Analyzer Tour

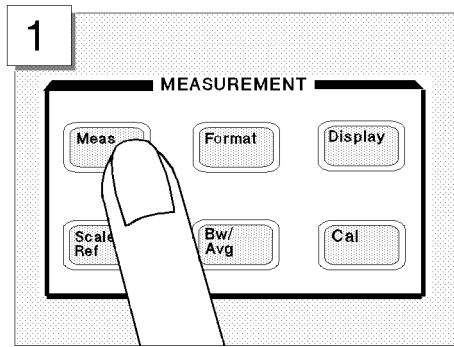
### Step 7: Selecting the measurement parameters for Channel 2

This tour assumes that the following measurement parameters be specified for Channel 2.

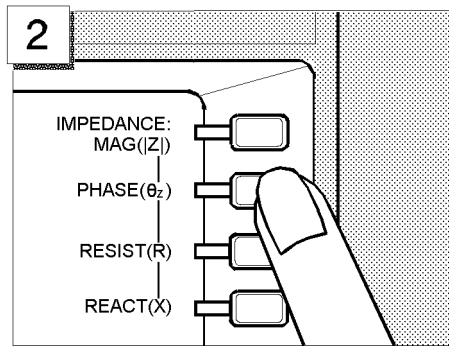
Characteristic Phase ( $\theta_z$ )  
value

Format Linear

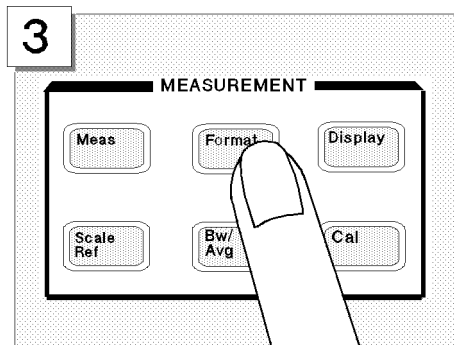
To set the parameters listed above, follow these steps:



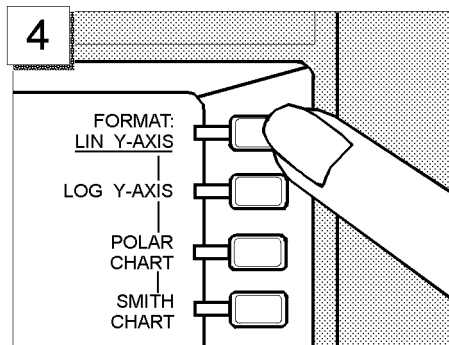
Press the **Meas** key.



Choose **PHASE:  $\theta_z$** .

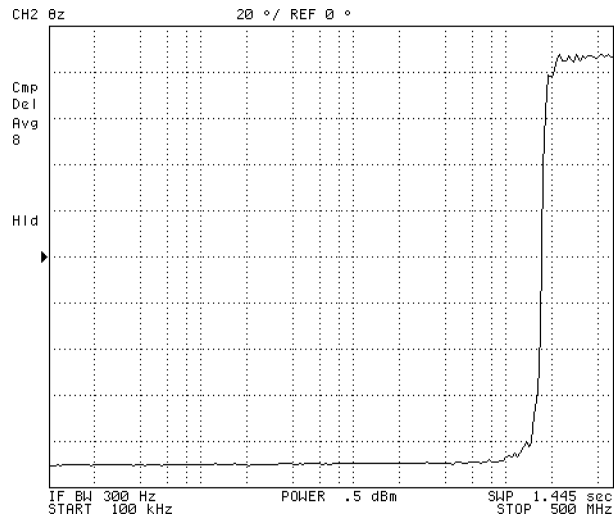


Press the **Format** key.



Choose **LIN Y-AXIS**.

## Impedance Analyzer Tour



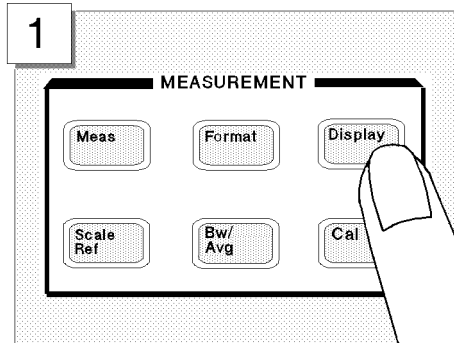
Now both Channels 1 and 2 are assigned specific settings. You can not only have one of the two channels displayed at a time, but also have both channels displayed in parallel, as you will learn in the next step.

## Impedance Analyzer Tour

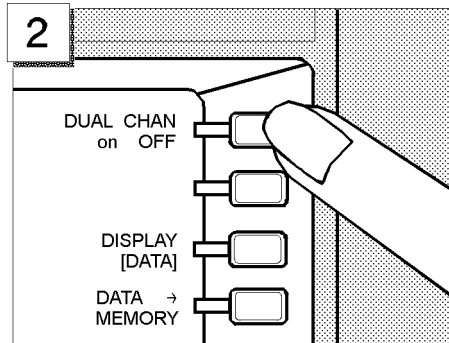
### Step 8: Dual Channel Display

The 4395A provides a feature that displays the measurement results for both channels at the same time. This feature is called “dual channel display.”

Follow these steps:

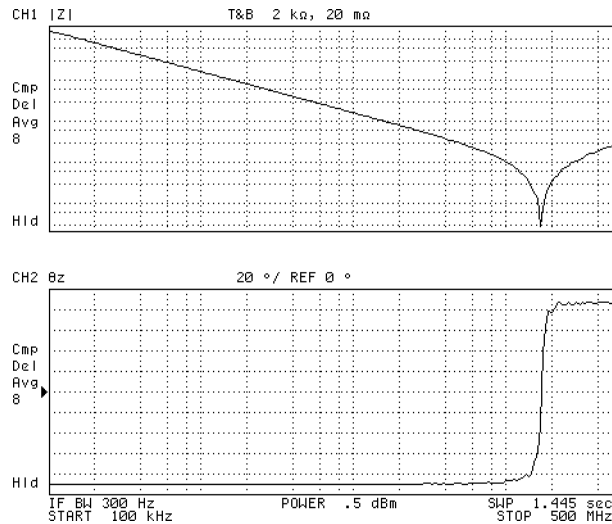


Press the **Display** key.



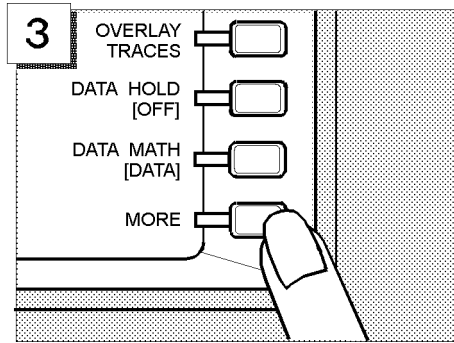
Choose **DUAL CHAN on OFF** so that the label changes to **DUAL CHAN ON off**.

The screen is split into upper and lower halves. The upper half shows the absolute impedance value while the lower half shows the phase.

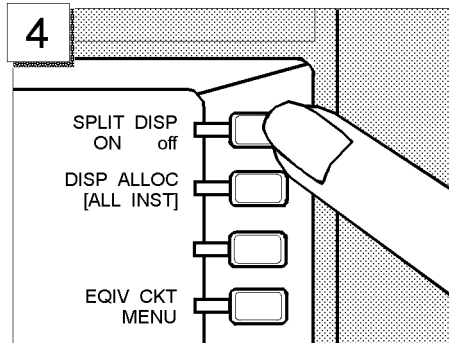




## Impedance Analyzer Tour

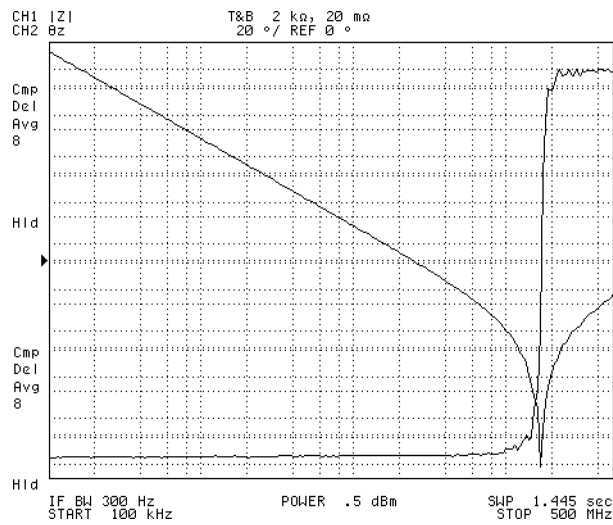


Choose **MORE**.



Choose **SPLIT DISP ON off** so that the label changes to **SPLIT DISP on OFF**.

Two graphs are merged into a single coordinate plane.





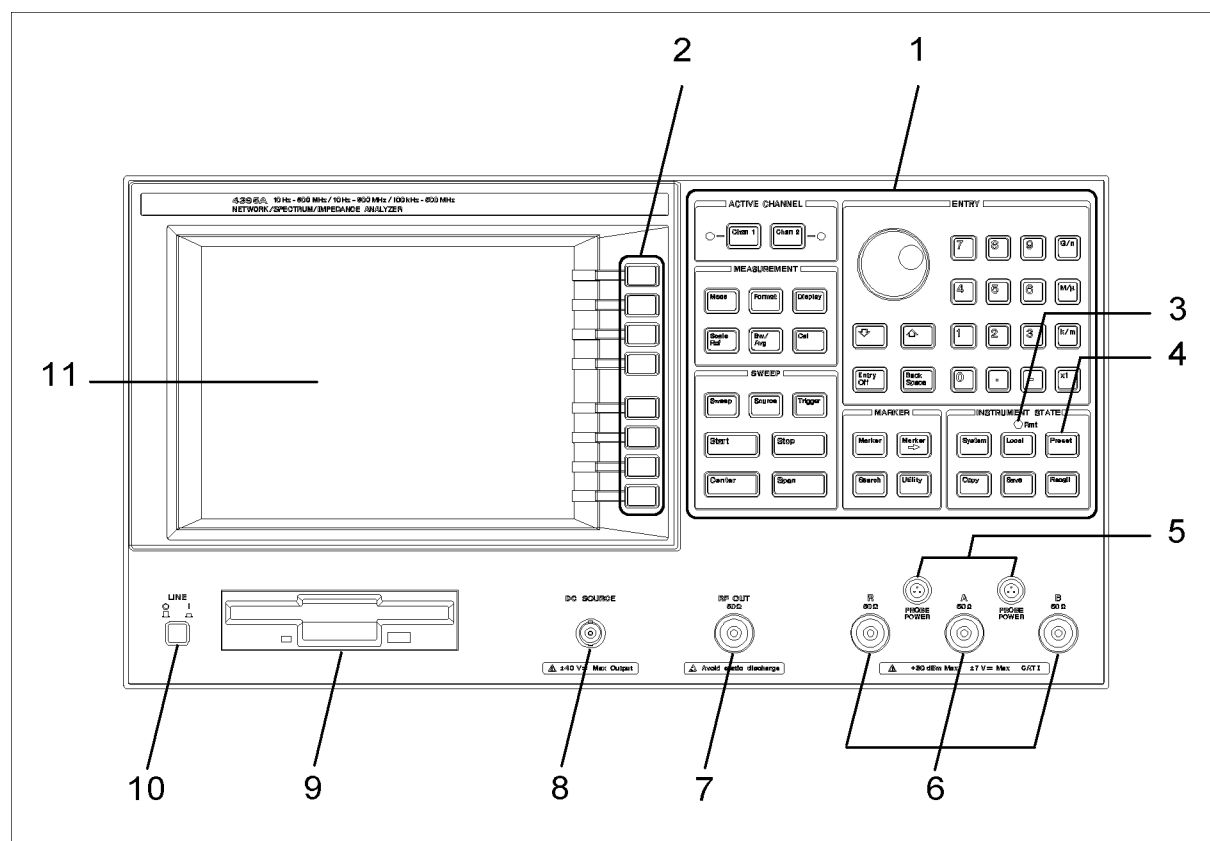
## Front and Rear Panels

### Features of 4395A

This chapter describes the features of the front and rear panels of 4395A. It provides illustrations and descriptions of the front panel features, the LCD display and its labels, and the rear panel features and connectors.

### Front Panel

The front panel provides a number of hardkeys (physical keys) and softkeys (menu items displayed on the LCD), which allow you to activate various analyzer functions (Figure 4-1).



CB002001

Figure 4-1. Front Panel Layout

## Front Panel

### 1. Hardkeys

The hardkeys (physical keys) located on the front panel are divided into 6 blocks—labeled “ACTIVE CHANNEL”, “MEASUREMENT”, “SWEEP”, “MARKER”, “INSTRUMENT STATE”, and “ENTRY”, respectively. Some of the front panel hardkeys control instrument functions directly while others provide access to softkey menus.

#### ACTIVE CHANNEL Block

The ACTIVE CHANNEL block contains two hardkeys: **Chan 1** and **Chan 2**. By pressing either of these two keys, you can make the channel 1 or 2 **active**.

All measuring conditions you specify through the front panel, such as sweep settings, are assigned to the currently **active channel**. Once you have assigned your desired settings to each channel, you can instantly switch between the two different sets of measuring conditions by simply pressing the **Chan 1** or **Chan 2** key.

#### MEASUREMENT Block

The MEASUREMENT block contains hardkeys associated with measuring parameters, display formats, and calibration.

#### SWEEP Key Block

The SWEEP block contains hardkeys associated with sweep settings.

#### MARKER Block

The MARKER block contains hardkeys associated with the marker function that facilitates reading values on the measurement trace.

#### INSTRUMENT STATE Block

The INSTRUMENT block contains hardkeys that affect the instrument state of 4395A.

#### ENTRY keys

The ENTRY block contains the following:

- numeric keys
- a rotary knob
- step keys for incrementing or decrementing your entered values
- edit keys
- unit terminator keys

You can use the rotary knob to change the value of the currently active parameter.

### 2. Softkeys

Softkey menus are lists of up to eight related functions that can be displayed in the softkey label area at the right-hand side of the display. The eight keys to the right of the LCD are the softkeys. Pressing one of the softkeys selects the adjacent menu function. This either executes the labeled function and makes it the active function, causes instrument status information to be displayed, or presents another softkey menu.

Some of the softkey menus are accessed directly from front panel keys and some from other menus. For example, the sweep menu accessed by pressing the **Sweep** key presents all the sweep functions such as sweep type, number of points, and sweep time. Pressing

**NUMBER of POINTS** allows the required number of points displayed per sweep to be entered directly from the number pad. **RETURN** softkeys return to previous menus. **DONE** indicates completion of a specific procedure and then returns to an earlier menu.

### Softkeys that are Joined by Vertical Lines

When several possible choices are available for a function, the softkeys are joined by vertical lines. For example, in the spectrum input port menu under the **(Meas)** key, the available inputs are listed: **R**, **A**, **B** with a vertical line between them. Note that only one softkey can be selected at a time. When a selection has been made from the listed alternatives, that selection is underlined until another selection is made.

### Softkeys That Toggle Between On and Off States

Some softkey functions can be toggled **ON** or **OFF**, for example averaging. This is indicated in the softkey label. The current state, **ON** or **OFF**, is capitalized in the softkey label.

Example:

AVERAGING ON off  
AVERAGING on OFF

The word on is capitalized, showing that averaging is currently on.

The word off is capitalized, showing that averaging is currently off.

### Softkeys that Show Status Indications in Brackets

Some softkey labels show the current status of a function in brackets. These include simple toggle functions and status-only indicators. An example of a toggled function is the **PRINT [STANDARD]** or **PRINT [COLOR]** softkey. The **DATA MATH[ ]** softkey is an example of a status-only indicator, where the selected equation of the data math function is shown in brackets in the softkey label.

## 3. GPIB “REMOTE” Indicator

The “REMOTE” Indicator turns on when the analyzer is in the remote state.

## 4. **(Preset)** Key

This key returns the instrument to a known standard preset state from any step of any manual procedure. A complete listing of the instrument preset conditions is provided in Appendix C.

## 5. PROBE POWER Connector

This connector (fused inside the instrument) supplies power to an active probe for in-circuit measurements of AC circuits. Applicable active probes are described in Chapter 12.

## Front Panel

### 6. Analyzer Input Terminals R, A, and B

These are input terminals through which the 4395A receives signals output from the RF OUT terminal and then fed through the test circuit. How to use these input terminals differs depending on which analyzer mode you use:

In network analyzer mode, use the A and B terminals to receive signals output from the RF OUT terminal and then fed through the device under test (DUT), and use the R terminal to directly feed back the signal output from the RF OUT terminal to provide the reference input signal. You may want to use a power splitter to split the RF OUT signal among the input terminals.

In spectrum analyzer mode, you can use any of these three terminals to monitor the spectrum of the input signals.

In impedance analyzer mode, which is available with option 010, use the R and A terminals to monitor the voltage and current across the DUT being fed with the signals output from the RF OUT terminal.

These terminals comply with INSTALLATION CATEGORY I of IEC 1010-1.

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#### Note



Do not exceed the operating input power, voltage, and current level and signal type appropriate for the instrument being used, refer to your instrument's operation manual.

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#### Note



Electrostatic discharge(ESD) can damage the highly sensitive microcircuits in your instrument. ESD damage is most likely to occur as the test fixtures are being connected or disconnected. Protect them from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any static charge built-up by touching the outer shell of any grounded instrument chassis before touching the test port connectors.

---

### 7. RF OUT Connector

Connects the RF output signal from the analyzer's internal source to a test set or power splitter. The output impedance at this connector is 50  $\Omega$ .

Note that, in spectrum analyzer mode, the RF output is disabled by default. When you perform zero span measurement in spectrum analyzer mode, you can turn the RF output on.

### 8. DC SOURCE (DC Voltage/Current Output) Connector (Option 001)

This connector, located on the front panel, supplies up to  $\pm 40$  V /  $\pm 100$  mA of DC voltage/current.

## 9. Built-in Flexible Disk Drive

You can use this disk drive to store your measurement data, instrument , list sweep tables, and HP Instrument BASIC programs. Supported data formats include the LIF (logical interchange format) and DOS (disk operating system) format.

## 10. LINE Switch

Turns on/off the power to the 4395A.

## 11. Liquid Crystal Display (LCD)

Displays measurement results, softkey menus, instrument settings, system or error messages

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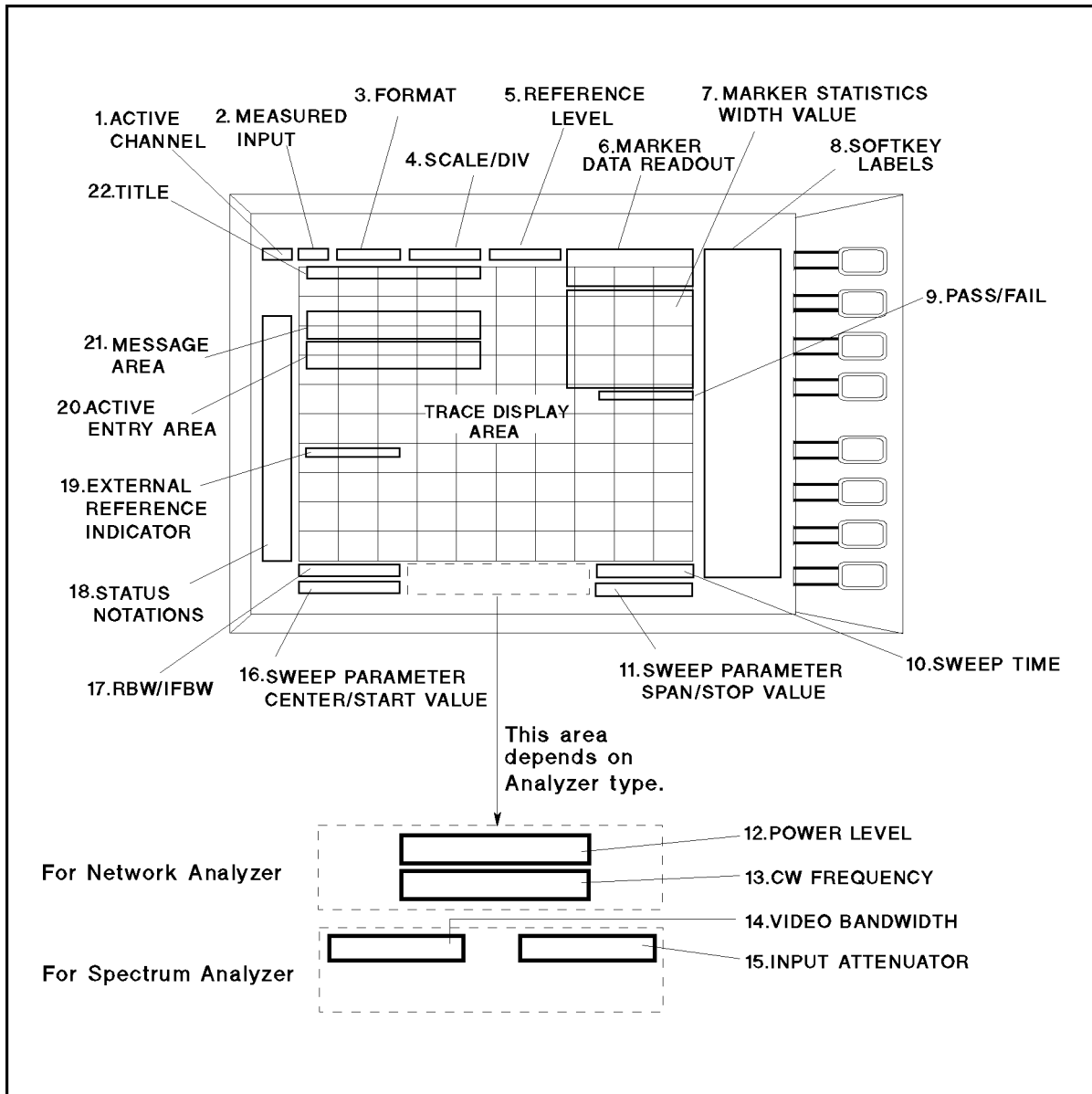
## Screen Display

The LCD displays a grid on which the measurement data is plotted, the currently selected measurement traces, and other information describing the measurement. Figure 4-2 shows the locations of the different information labels.

In addition to the full-screen display shown in Figure 4-2, a split display is available (see “Dual Channel Display” in Chapter 6). In this case, information labels are provided for each half of the display.

The screen can also be used as the HP Instrument BASIC display. HP Instrument BASIC uses either a full-screen display or a half-screen display below the graphic display as a text screen.

## Screen Display



CS002002

Figure 4-2. Screen Display (Single Channel, Cartesian Format)

### 1. Active Channel

Displays either “CH1” or “CH2” to indicate the number of the currently active channel (one that was selected keys in the ACTIVE CHANNEL block). When the dual channel function is enabled and traces for the two channels are overlaid, both “CH1” and “CH2” appear in this area.



## 2. Measured Input(s)

Shows the input terminals currently in use, the values of the S parameters, or ratio of inputs (such as A/R ratio). Use the **(Meas)** key to select the item to appear in this area.

## 3. Format

Shows the currently selected display format. Use the **(Format)** key to select your desired display format.

## 4. SCALE/DIV

Shows the currently selected scale in the unit appropriate to the ongoing measurement. Use the **(Scale Ref)** key to select your desired scale.

## 5. Reference Level

Displays the value of a reference line in Cartesian formats or the outer circle in polar formats. It is selected using the **(Scale Ref)** key. However, the reference line is invisible (it is indicated by a small triangle adjacent to the graticule at the left). The position of the reference line for the spectrum analyzer is fixed at the top of the Cartesian format.

## 6. Marker Data Readout

Displays the values of the marker in the unit appropriate to the current measurement (see Chapter 8). The status of the marker is also displayed under the marker values. The following status notations are used:

Cpl	Marker couple is tuned on. (When single channel is displayed, this notation is not displayed even if the marker couple is on.)
Xch	Cross channel is turned on.
Sgnl	Signal tracking is turned on. (When both signal tracking and search tracking are turned on, only Sgnl is displayed because search tracking is not allowed in this case.)
Peak	PEAK search tracking is turned on.
Max	MAX search tracking is turned on.
Min	MIN search tracking is turned on.
Targ	TARGET search tracking is turned on.
PksA	PEAK ALL search tracking is turned on.
PksL	PEAK LEFT ALL search tracking is turned on.
PksR	PEAK RIGHT ALL search tracking is turned on.

## 7. Marker Statistics and Width Value

Displays the statistical marker values determined by using the menus accessed with the **(Utility)** key, and the width value determined by using the menus accessed with the **(Search)** key. See Chapter 8.

## Screen Display

### 8. Softkey Labels

Displays the menu labels that define the function of the softkeys immediately to the right of the label.

### 9. PASS/FAIL

Indicates the values used for limit testing using limit lines. See “Limit Line Concept” in Appendix A.

### 10. Sweep Time

Displays the sweep time. When sweep time is manually changed, # is displayed between SWP and the sweep time value.

### 11. Sweep Parameter Span/Stop Value

Displays the stop frequency of the sweep range in frequency domain measurements or the upper limit of a power sweep if 4395A is in network analyzer mode or impedance analyzer mode. When the sweep parameter is in center/span mode, however, this area indicates the span instead. You can suppress the display of the sweep parameter values (see Chapter 6).

### 12. Power Level

Displays the power level of RF output if the 4395A is in network analyzer mode or impedance analyzer mode and frequency sweep is selected. When power sweep is selected or the 4395A is in another mode, this area is blank.

### 13. CW Frequency

Displays the measured frequency if the 4395A is in network analyzer mode or impedance analyzer mode and power sweep is being performed. When frequency sweep is selected or the 4395A is in another mode, this area is blank.

### 14. Video Bandwidth (VBW)

Displays the video bandwidth if the 4395A is in spectrum analyzer mode.

### 15. Input Attenuator

Displays the input attenuator value at the inputs R, A, B if the 4395A is in spectrum analyzer mode.

### 16. Sweep Parameter Center/Start Value

Displays the start frequency of the sweep range in frequency domain measurements or the lower power value in power sweep if the 4395A is in network analyzer mode or impedance analyzer mode. When the sweep parameter is in center/span mode, this area shows the sweep center value instead.

## 17. RBW/IFBW

Displays the RBW (in spectrum analyzer mode) or IFBW (in network analyzer mode or impedance analyzer mode). When RBW or IFBW is manually changed, a sharp sign (#) is displayed between RBW or IFBW and the value.

## 18. Status Notations

Displays the current status of various functions for the active channel. The following notations are used:

*	Sweep parameters changed: measured data in doubt until a complete fresh sweep has been taken.
P	RF output is ON (zero span in spectrum analyzer mode only).
Cor	Error correction is ON (network analyzer mode and impedance analyzer mode). Level correction is ON (spectrum analyzer mode only).
C2	Two-port error correction is ON (network analyzer mode only).
Cmp	Fixture compensation is ON (impedance analyzer mode only).
C?	Sweep parameters have changed <sup>1</sup> and interpolated error correction is ON (network analyzer mode and impedance analyzer mode).
C2?	Sweep parameters have changed <sup>1</sup> and interpolated two-port correction is ON (network analyzer mode only).
Cm?	Sweep parameters have changed <sup>1</sup> and interpolated fixture compensation is ON (impedance analyzer mode only).
C!	Sweep parameters have changed <sup>2</sup> and extrapolated error correction is ON (network analyzer mode and impedance analyzer mode).
C2!	Sweep parameters have changed <sup>2</sup> and extrapolated two-port correction is ON (network analyzer mode only).
Cm!	Sweep parameters have changed <sup>2</sup> and extrapolated fixture compensation is ON (impedance analyzer mode only).
Cm*	Fixture compensation is ON when error correction is C? or C! (impedance analyzer mode only).
Del	Electrical delay, port extension, or phase offset has been added or subtracted (network analyzer mode and impedance analyzer mode).
Neg	Negative peak detection is ON (spectrum analyzer mode only).
Smp	Sample detection is ON (spectrum analyzer mode only).
Avg	Sweep-by-sweep averaging is ON. The averaging count is shown below.
Max	Maximum hold is ON.
Min	Minimum hold is ON.
G*	Data math Gain is ON.
-O	Data math Offset is ON.
G&O	Data math Gain is ON and data math Offset is ON.
D-M	Data math ( Data Trace - Memory Trace ) is ON.
D+M	Data math ( Data Trace + Memory Trace ) is ON.
D/M	Data math ( Data Trace / Memory Trace ) is ON.
Hld	Hold sweep.
↑	Sweep indicator. (When sweep time is longer than 2 seconds, it appears on the trace).
ext	Waiting for external trigger (BNC in rear panel).
man	Waiting for manual trigger.
bus	Waiting for GPIB trigger.
Svc	A service mode is turned on. If this notation is shown, the measurement data will be out of specifications. (See <i>Service Manual</i> .)

1 Frequency span reduced, etc.

2 Frequency span expanded, etc.

---

**Note** No status notation is displayed when Gate trigger is used.



## **Screen Display**

### **19. External Reference**

ExtRef is displayed when an external reference signal is connected to the external reference input on the rear panel. This applies even if the phase is not locked to the external reference signal.

### **20. Active Entry Area**

Displays the name of the currently active input parameter with its current value.

### **21. Message Area**

Displays prompts or error messages. See “Error Messages” for more information on error messages.

### **22. Title**

Displays a user-defined title which can consist of alphanumeric characters.

## Rear Panel Features and Connectors

Figure 4-3 shows the features and connectors on the rear panel. Requirements for the input signals to the rear panel connectors are provided in Chapter 11.

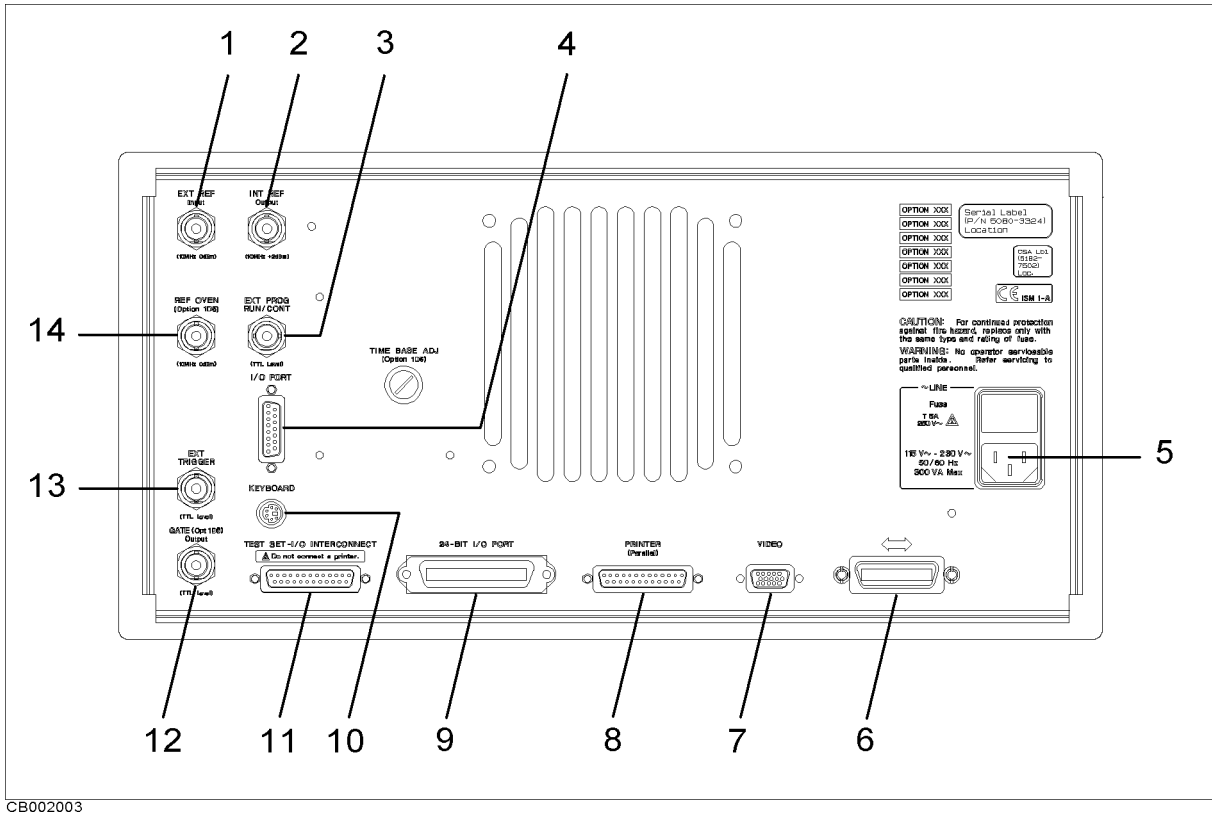


Figure 4-3. Rear panel

### 1. External Reference Input Connector

Connects an external frequency reference signal to the analyzer that is used to phase lock the analyzer for increased accuracy in frequency.

When the 4395A is equipped with the external oven (Option 1D5), this connector must be connected to REF OVEN connector (14). The external frequency reference function is automatically enabled when a signal is connected to this input. When the signal is removed, the analyzer automatically switches back to its internal frequency reference.

### 2. Internal Reference Output Connector

Connects to the frequency reference input of an external instrument to phase lock it to the 4395A for stable synchronization with the internal frequency of the 4395A.

## Rear Panel Features and Connectors

### 3. External Program RUN/CONT Input

Externally triggers RUN or CONT of the HP Instrument BASIC program. The positive edge of a pulse whose width is 20  $\mu$ s or larger in the LOW state triggers RUN or CONT. The signal is TTL-compatible.

### 4. I/O Port

This is a 12-bit data communications port that connects to external devices such as a handler on a production line. It can communicate 8 bits of output data and 4 bits of input data at a time. For more information, see Chapter 11 and *Programming Manual*.

### 5. Power Cable Receptacle

This receptacle accommodates the main power cable. Insert the main-power cable plug only into a socket outlet that has a protective ground contact. Note that the fuse that protects the power line is located inside the rear panel cover.

### 6. GPIB Interface

Connects the analyzer to an external controller and other instruments to configure an automated system. This connector is also used when the analyzer itself serves as the controller of compatible peripherals. For more information, see *Programming Guide*.

### 7. External Monitor Terminal

This terminal outputs measurement results to an external color monitor. Color monitors supporting VGA (scan rate of 31.5 kHz) can be connected to this terminal.

### 8. Parallel Interface

This interface can be used to redirect the displayed results to a printer. It complies with the Centronics parallel interface standard. See “Printer” in Chapter 12 for supported printers.

### 9. 24-bit I/O Port

In addition to the 12-bit I/O port (described in item 4 above), the 4395A is equipped with a 24-bit data communications port that connects to external devices such as a handler on a production line. This port can communicate 2 sets of 8-bit output data and 2 sets of 4-bit bidirectional data at a time. For more information, see *Programming Guide*.

### 10. mini-DIN Keyboard Connector

Connect a mini-DIN keyboard to this connector usually when using Instrument BASIC.

---

**Note**

Be sure to use the specified PS/2, 101 keyboard. Using any other keyboard can cause failure.



## 11. Test Set I/O Interface

You can use this interface to establish a connection between the 4395A and the test set using the cable included in the S-parameter test set package to control the test set from the 4395A. See Chapter 12 for the test set that can be connected. This interface is not used for the 87512A/B transmission/reflection test set.

---

**Caution** Do not connect a printer to this interface. Doing so could damage the printer.



## 12. Gate Output (Option 1D6 Only)

Outputs a signal that indicates the status of the gate when the 4395A is performing gate trigger in EDGE mode. The signal is TTL-compatible; high indicates gate ON, low indicates gate OFF.

## 13. External Trigger Input

Triggers a measurement sweep. The positive (or negative) edge of a signal in the LOW (or HIGH state) starts a measurement. The signal is TTL-compatible. To use this connector, set the trigger mode to external using softkey functions.

## 14. Reference Oven Output (Option 1D5 Only)

Connects to the EXT REF INPUT connector when Option 1D5 is installed. Option 1D5 improves the frequency accuracy and stability of the 4395A.





## Preparations for Measurements

---

This chapter provides the each procedure needed to prepare for network , spectrum, and impedance (with Option 010) measurements. The procedures are:

- Selecting an appropriate connection of DUT
- Presetting 4395A

If you are using the 4395A for the first time, it is recommended to get started by reading Chapter 1 through Chapter 3 of this manual.

---

### Selecting an appropriate connection of DUT

#### For Network Measurement

Connections of DUT in the network measurement varies depending upon your measurement parameters as described in this section.

#### Connecting DUT for Directional Transmission Characteristic Measurement

When you measure the transmission characteristic supplying a signal to your DUT from one direction, connect the DUT to the analyzer with the power splitter and the cables as shown in Figure 5-1.

You should manually change cabling when measuring the characteristic for reverse direction.

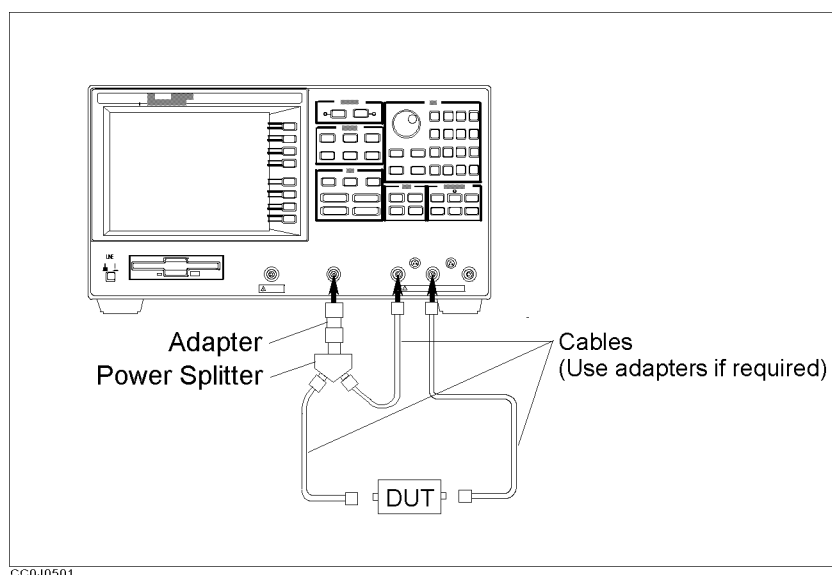


Figure 5-1. Connecting DUT for Directional Transmission Characteristic Measurement

## Selecting an appropriate connection of DUT

### Connecting DUT for Directional Transmission and Reflection Characteristics Measurement

When you measure the transmission and reflection characteristics supplying a signal to your DUT from one direction, connect the DUT to the analyzer with the transmission/reflection test set.

You should manually change cabling when measuring the characteristics for reverse direction.

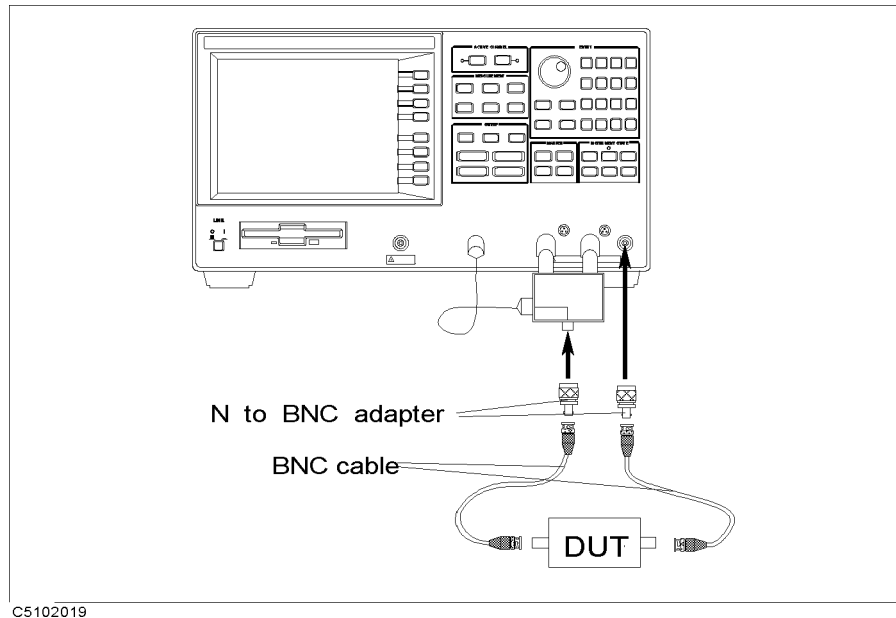


Figure 5-2.

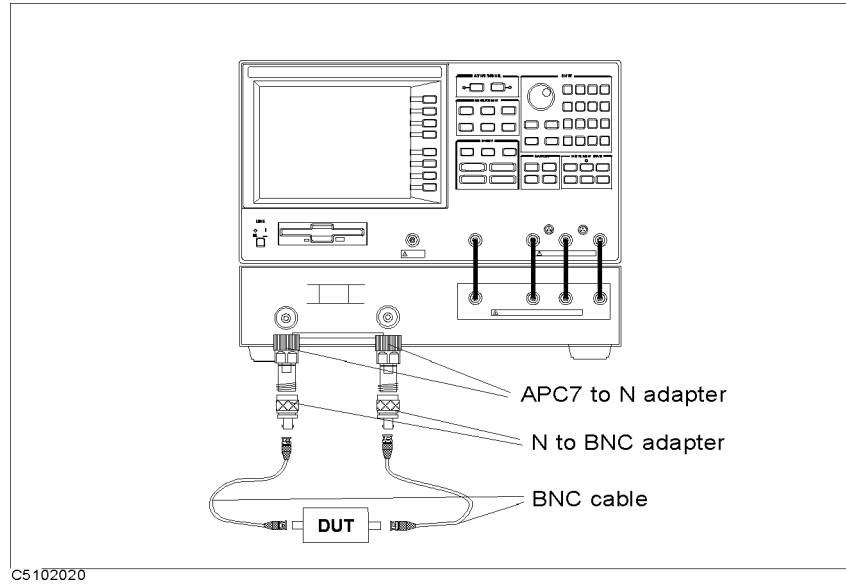
### Connecting DUT for Directional Transmission and Reflection Characteristics Measurement

### Connecting DUT for Bi-directional Transmission and Reflection Characteristics (Four S Parameters) Measurement

Bi-directional transmission and reflection characteristics, or all four S parameters, can be measured effectively with the S parameter set.

The device allows you to measure all the four parameters without changing cable connection manually at each measurement.

## Selecting an appropriate connection of DUT

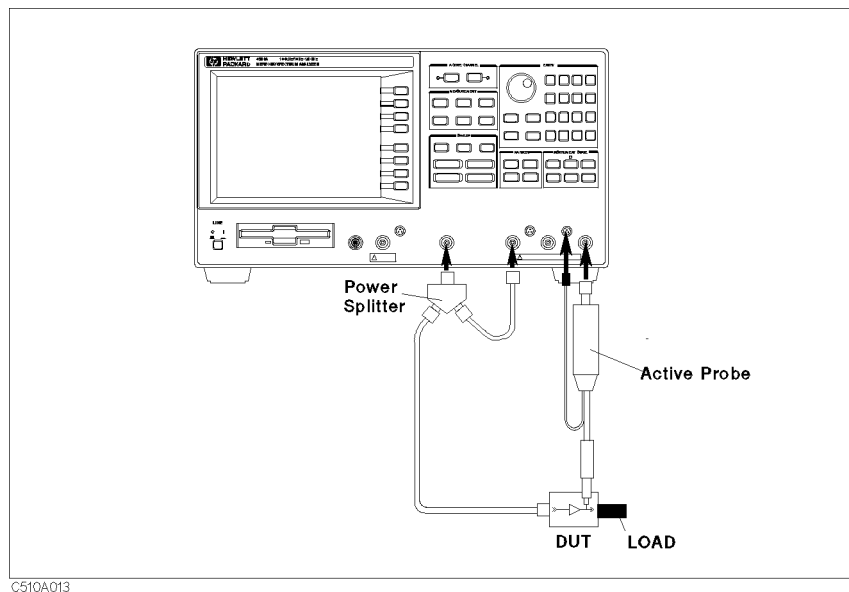


**Figure 5-3.**

**Connecting DUT for Bi-directional Transmission and Reflection Characteristics (Four S Parameters) Measurement**

### Connecting DUT for Transmission Characteristic Measurement When the Output Signal is in a Circuit

If the output signal of DUT is in a circuit, use the active probe to capture a signal from the test channel as shown in Figure 5-4.

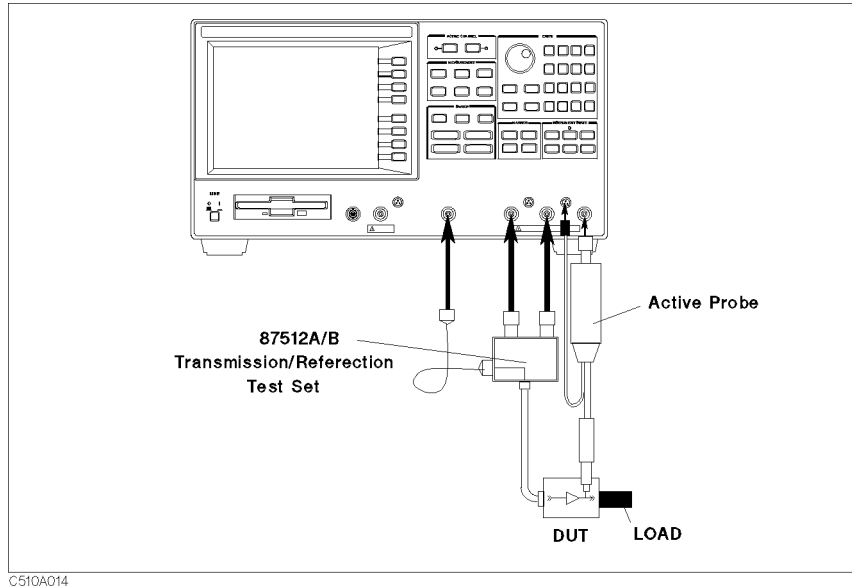


**Figure 5-4.**

**Connecting DUT for Transmission Characteristic Measurement When the Output Signal is in a Circuit**

Use the transmission/reflection test set with the active probe, when measuring the reflection characteristic at the input lead simultaneously. See Figure 5-5.

## Selecting an appropriate connection of DUT

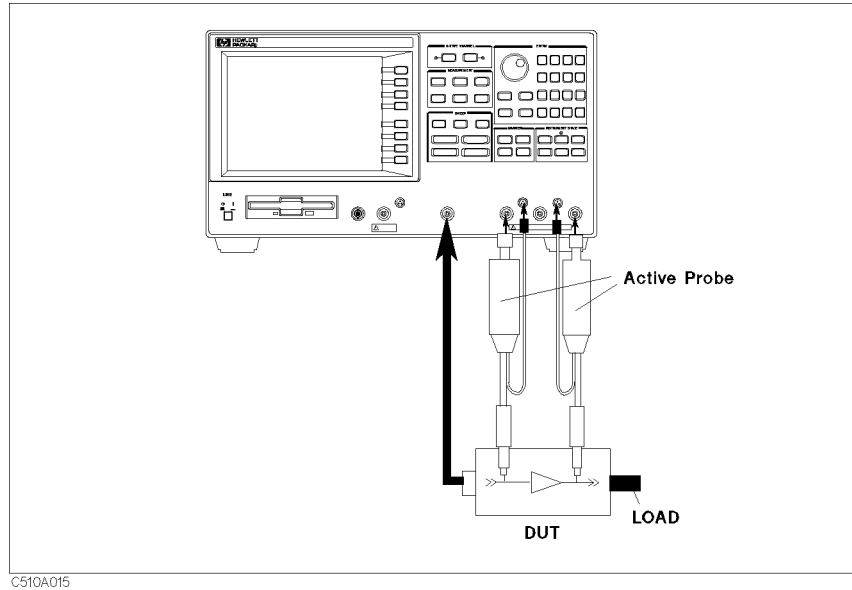


**Figure 5-5.**  
**Connecting DUT for Transmission and Reflection Characteristics Measurement When the Output Signal is in a Circuit**

## Selecting an appropriate connection of DUT

### Connecting DUT for Transmission Characteristic Measurement When the Input and Output Signals are in a Circuit

If both of the input and output signals of DUT are in a circuit, attach the active probes to both of the reference channel and the test channel, as shown in Figure 5-6.



**Figure 5-6.**  
**Connecting DUT for Transmission Characteristic Measurement When the Input and Output Signals are in a Circuit**

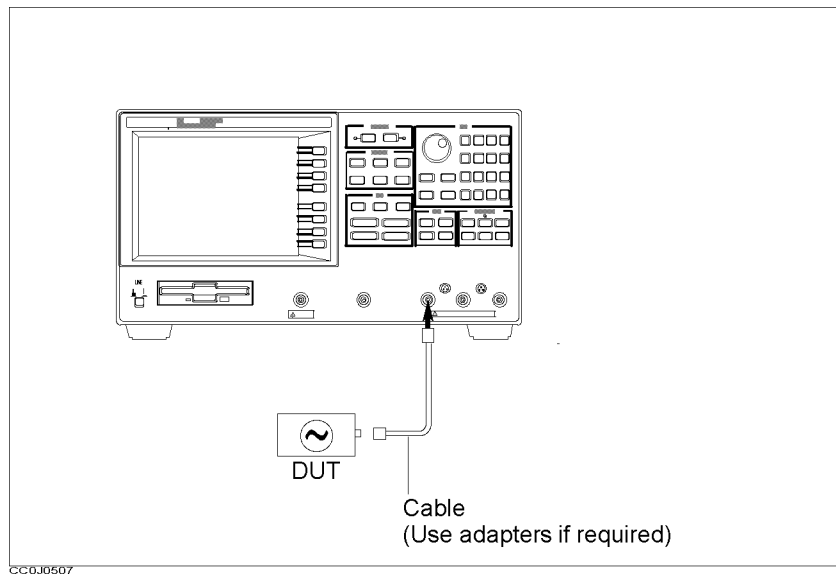
## Selecting an appropriate connection of DUT

### For Spectrum Measurement

Connections of DUT in the spectrum measurement varies depending upon how the measurement signal can be obtained as described in this section.

#### Connecting DUT When Directly Measuring the Signal

When you measure a signal which is directly supplied from the DUT to 4395A, connect the DUT as shown in Figure 5-7.

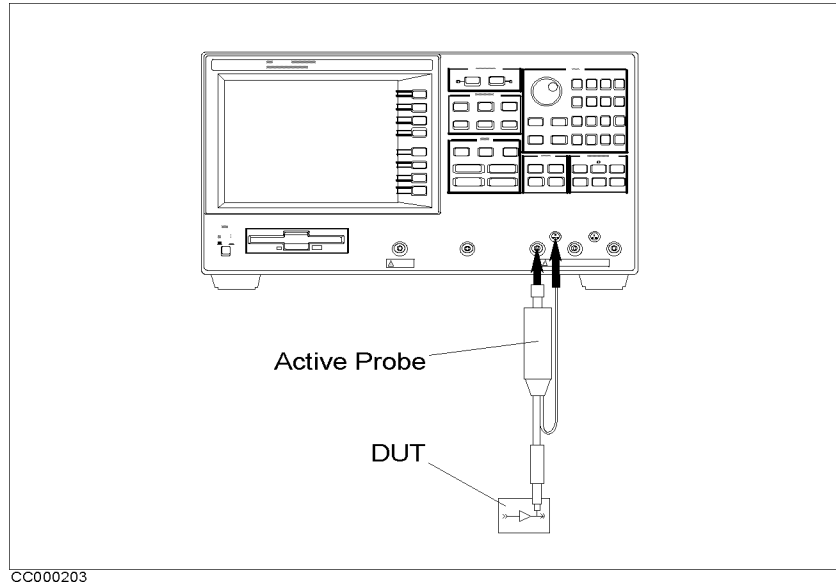


**Figure 5-7. Connecting DUT When Directly Measuring the Signal**

#### Connecting DUT When Measuring the Signal in a Circuit

Use the active probe to capture the measurement signal which is in a circuit as shown in Figure 5-8.

## Selecting an appropriate connection of DUT



**Figure 5-8. Connecting DUT When Measuring the Signal in a Circuit**

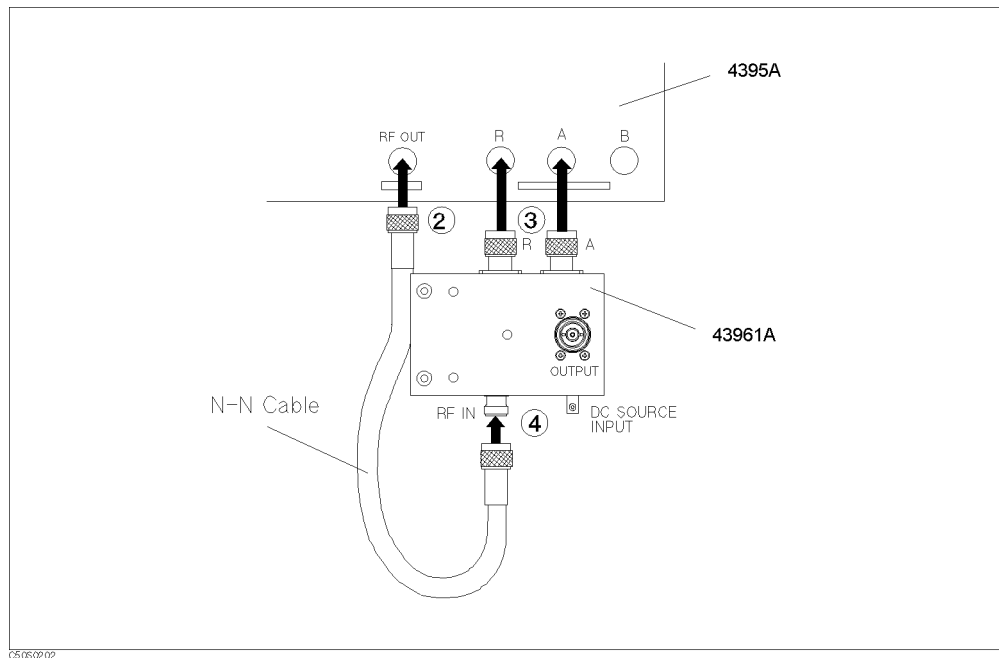
## Selecting an appropriate connection of DUT

### For Impedance Measurement (Option 010)

#### Connecting the Impedance Test Kit

In the impedance measurement, the 43961A Impedance Test Kit is required to connect your DUT to the analyzer. See Figure 5-9.

1. Verify the 4395A is turned off.
2. Connect the N-cable to the RF OUT port of the analyzer.
3. Connect two connectors of the 43961A to the R and A ports of the 43961A.
4. Connect the other connector of the N-cable to the RF IN port of the 43961A.
5. Turn on the 4395A.



**Figure 5-9. Connecting the Impedance Test Kit**

#### Note



The connection between DUT and the analyzer is accomplished when a test fixture is mounted on the impedance test kit. Note that all the measurement settings and calibrations should be completed before you mount the test fixture. Follow the steps described in Chapter 6 and Chapter 7.



## **Presetting 4395A**

Before starting measurement, press the green **Preset** key in the INSTRUMENT STATE block to set the 4395A to the preset state.

For additional information about the preset state, see Appendix C.



## Setting and Optimizing Measurement Conditions

---

This chapter provides following procedures for setting and optimizing measurement conditions:

- Select the analyzer mode
- Select the active channel
- Set up the trigger system
- Set the sweep conditions
- Select the input port/measurement parameter
- Select the measurement format
- Select the display unit
- Set the frequency range
- Set the vertical scale
- Set the IF/resolution/video bandwidth (IFBW/RBW/VBW)

## Selecting the Active Channel

---

### Selecting the Analyzer Mode

1. Press **Meas**.
2. Press **ANALYZER TYPE**.
3. Select one of the following analyzer modes:

<b>Analyzer Mode</b>	<b>Softkey</b>
Network Analyzer	<b>NETWORK ANALYZER</b>
Spectrum Analyzer	<b>SPECTRUM ANALYZER</b>
Impedance Analyzer <sup>1</sup>	<b>IMPEDANCE ANALYZER</b>

<sup>1</sup> Option 010 only.

---

#### Note



When you change the analyzer mode (operating mode), the analyzer is set to the preset state. So, when you want to change the analyzer mode, you must select it before you set up the other settings.

---

#### Note



In this manual, the following abbreviations are used:

- **NA mode:** Network analyzer mode
- **SA mode:** Spectrum analyzer mode
- **ZA mode:** Impedance analyzer mode

---

## Selecting the Active Channel

- In the ACTIVE CHANNEL block, press **Chan 1** (channel 1) or **Chan 2** (channel 2) to select the active channel.

The 4395A has two independent channels. You can assign a different set of measurement conditions to each channel and switch between the two channels with just a single keystroke, provided that you use both channels for the same analyzer mode. By switching between the channels, you can effectively evaluate the DUT's characteristics under different measurement conditions.

---

#### Note



- Be sure to select the active channel before you set measurement conditions. Once you have activated either channel, all the settings you make are assigned to the active channel.
- These two channels can only be assigned different measurement conditions within the same analyzer mode. You cannot use them across two different analyzer modes. For example, it is not possible to assign network measurement conditions to one channel while assigning spectrum measurement conditions to the other channel.

## Dual Channel Display

1. Press **Display**.
2. Toggle **DUAL CHAN** on **OFF** to **ON** off.
3. Press **MORE**.
4. Select one of the following options:

### Display Mode

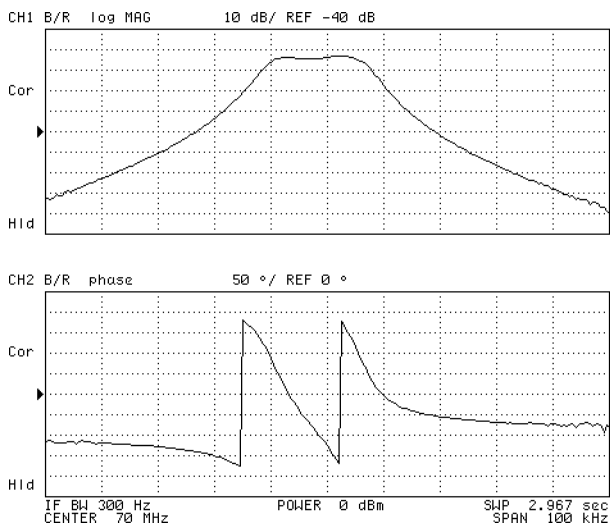
### Toggle

Split the screen into the two channels

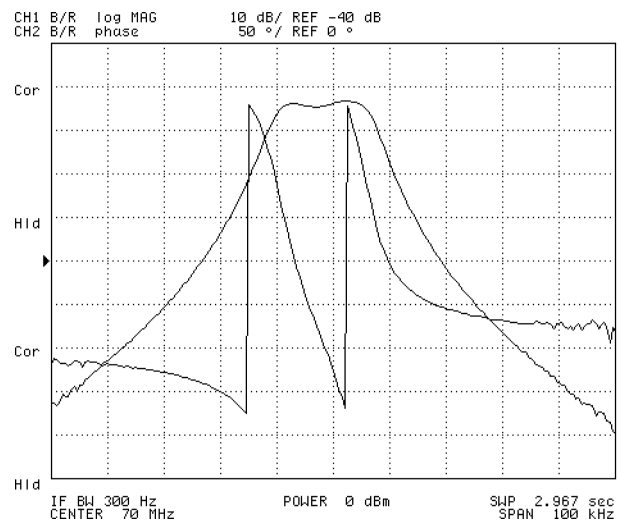
**SPLIT CHAN** on **OFF** → **ON** off

Merge the channels into one screen

**SPLIT CHAN** **ON** off → **on** **OFF**



Split the screen into the two channels



Merge the channels into one screen

**Figure 6-1. Dual Channel Display**

## Setting Up the Trigger System

---

### Setting Up the Trigger System

This section provides procedures for setting the trigger system.

- Setting up the trigger system
  - Using the external trigger

### Setting Up the Trigger System

1. Press **Trigger**.
2. Press **TRIGGER: [ ]**.
3. Select one of the following options:

<b>Trigger Mode</b>	<b>Softkey</b>
Internal trigger source	<b>FREE RUN</b>
External trigger source <sup>1</sup>	<b>EXTERNAL</b>
Manual trigger	<b>MANUAL</b>
Gate trigger <sup>2</sup>	<b>GATE [ ]</b>

<sup>1</sup> See “Using the External Trigger” that follows.

<sup>2</sup> Option 1D6 and SA (spectrum analyzer) mode only. Chapter 8 describes how to use this trigger mode.

### Using the External Trigger

1. Connect the trigger source to the EXT TRIGGER connector on the rear panel of the 4395A.
2. Press **Trigger**.
3. Press **TRIGGER: [ ]**.
4. Press **EXTERNAL**.
5. Input a trigger signal to the analyzer.

The external trigger signal level must be TTL Level.

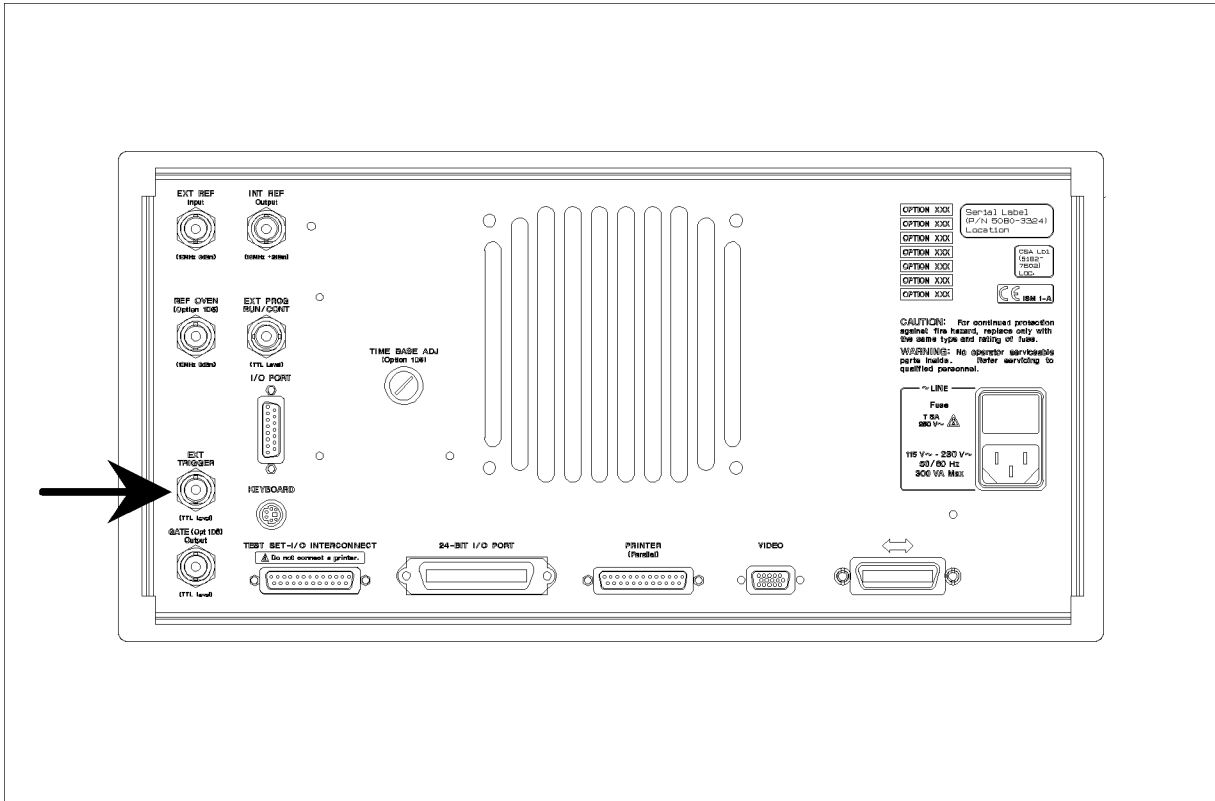


Figure 6-2. Location of EXT TRIGGER Connector

### Setting the Trigger Signal Polarity

1. Press **Trigger**.
2. Press **TRIGGER: [ ]**.
3. Toggle **TRIG PLRTY POS neg** to **pos NEG** to turn the trigger polarity to the negative logic.

### Generating a Trigger Event on Each Measurement Point (NA, ZA Mode)

1. Press **Trigger**.
2. Press **TRIGGER: [ ]**.
3. Select one of the following options:

Trigger Source	Softkey
Manual	Press <b>MANUAL</b> .
External	Press <b>EXTERNAL</b> .

4. Toggle **TRIG EVENT [ON SWEEP]** to **[ON POINT]**.
5. To generate a trigger event, press **MANUAL** (for manual) or input the external trigger signal (for external).

## Setting the Sweep Conditions

The sweep indicator (“↑”) moves to each point every time a trigger event is generated. You can select this mode only after you have selected **MANUAL** or **EXTERNAL** as the trigger source, or activated the bus trigger mode. For more information about the bus trigger mode, see the *Programming Manual*.

---

## Setting the Sweep Conditions

The 4395A controls the sweep process based on the following conditions:

- Sweep mode
- Sweep type
- Sweep parameters

This section describes how to select the sweep mode and sweep type. For how to set the sweep parameters, see “Setting the Frequency Range”. For how to use the power sweep function, see “Using the Power Sweep Function (NA, ZA Mode)”.

In addition, the 4395A is capable of automatically controlling the sweep process in accordance with a user-specified sweep list. For more information on the list sweep function, refer to Chapter 9 of this manual.

## Selecting the Sweep Mode

Select one of the following options

Sweep Mode	Keystrokes
Continuous	Press <b>(Trigger)</b> , then choose <b>CONTINUOUS</b> .
Single	Press <b>(Trigger)</b> , then choose <b>SINGLE</b> .
Specified times	Press <b>(Trigger)</b> , choose <b>NUMBER of GROUPS</b> , enter the number of times, and then press <b>(x1)</b> .

## Selecting the Sweep Type

1. Press **(Sweep)** and choose **SWEEP TYPE MENU**.
2. Select one of the following options:

Sweep Type	Softkey
Linear Frequency	Press <b>LIN FREQ</b> .
Log Frequency <sup>1</sup>	Press <b>LOG FREQ</b> .
List Frequency	Press <b>LIST FREQ</b> (See “Reducing Sweep Time (Using List Sweep)” in Chapter 9).
Power Sweep <sup>1</sup>	Press <b>POWER SWEEP</b> . See “Using the Power Sweep Function (NA, ZA Mode)” that follows.

<sup>1</sup> NA, ZA mode.



### Using the Power Sweep Function (NA, ZA Mode)

1. Press **Source** **CW FREQ**. Then enter the CW frequency.
2. Press **Sweep**.
3. Press **SWEEP TYPE MENU**.
4. Press **POWER SWEEP**.
5. Enter the start and stop power levels.

For example, to sweep from  $-5$  dBm to  $+15$  dBm, press **Start** **-** **5** **x1**, **Stop** **1** **5** **x1**.

**Note**



- You can set the sweep power in increments of 0.1 dB.
- Maximum power sweep range (start to stop) is 20 dB within range of  $-50$  dBm to  $+15$  dBm.

### Selecting the Input Port/Measurement Parameter

This step provides following procedures:

- To select the input port in NA mode
- To select the input port in SA mode
- To select the measurement parameter in ZA mode

#### To Select the Input Port in NA Mode

##### With the T/R Test Set

- Press **Meas**.

To measure	Type	Press
Reflection	Ratio	<b>A/R</b>
Transmission	Ratio	<b>B/R</b>
A port/B port	Ratio	<b>A/B</b>
Reflection	Absolute	<b>MORE A</b>
Transmission	Absolute	<b>MORE B</b>
Source	Absolute	<b>MORE R</b>

##### With the S-Parameter Test Set

- Press **Meas**.

### Selecting the Input Port/Measurement Parameter

To measure	Direction	Press
Reflection	Forward	S-PARAMETERS Refl:FWD S11 [A/R]
Transmission	Forward	S-PARAMETERS Trans:FWD S21 [B/R]
Transmission	Reverse	S-PARAMETERS Trans:REV S12 [B/R]
Reflection	Reverse	S-PARAMETERS Refl:REV S22 [A/R]

### To Select the Input Port in SA Mode

The 4395A has three input ports: R, A, and B. You can use any of these input ports for spectrum measurements.

In the preset state, the 4395A uses the R input port for spectrum measurements. To explicitly specify the input port, choose one of the following softkeys:

To select	Softkey
R input port	R
B input port	B
A input port	A

### To Select the Measurement Parameter in ZA mode

## Selecting the Measurement Format (NA,ZA Mode)

To measure	Press
Absolute magnitude value of impedance	IMPEDANCE: MAG( Z )
Phase value of impedance	PHASE( $\theta_z$ )
Resistance value	RESIST(R)
Reactance value	REACT(X)
Absolute magnitude value of admittance	MORE 1/5 ADMITTANCE: MAG( Y )
Phase value of admittance	MORE 1/5 $\theta_y$
Conductance value	MORE 1/5 CONDUCT(G)
Susceptance value	MORE 1/5 SUSCEPT(B)
Absolute magnitude value of reflection coefficient	MORE 1/5 MORE 2/5 MAG(  $\Gamma$  )
Phase value of reflection coefficient	MORE 1/5 MORE 2/5 PHASE( $\theta_\Gamma$ )
Real part of reflection coefficient	MORE 1/5 MORE 2/5 REAL( $\Gamma_x$ )
Imaginary part of reflection coefficient	MORE 1/5 MORE 2/5 IMAG( $\Gamma_y$ )
Parallel capacitance	MORE 1/5 MORE 2/5 MORE 3/5 CAPCITANCE: PRL( $C_p$ )
Series capacitance	MORE 1/5 MORE 2/5 MORE 3/5 SER( $C_s$ )
Parallel inductance	MORE 1/5 MORE 2/5 MORE 3/5 INDUCTANCE: PRL( $L_p$ )
Series inductance	MORE 1/5 MORE 2/5 MORE 3/5 SER( $L_s$ )
Parallel resistance	MORE 1/5 MORE 2/5 MORE 3/5 MORE 4/5 RESISTANCE: PRL( $R_p$ )
Series resistance	MORE 1/5 MORE 2/5 MORE 3/5 MORE 4/5 SER( $R_s$ )
Dissipation factor	MORE 1/5 MORE 2/5 MORE 3/5 MORE 4/5 D FACTOR: (D)
Quality factor	MORE 1/5 MORE 2/5 MORE 3/5 MORE 4/5 Q FACTOR: (Q)

## Selecting the Measurement Format (NA,ZA Mode)

---

### Selecting the Measurement Format (NA, ZA Mode)

#### Selecting the Measurement Format in NA Mode


1. Press **[Format]**.
2. Select one of the following options:

<b>Measurement Format</b>	<b>Softkey</b>
LOG Magnitude	LOG MAG
Phase	PHASE
Group Delay <sup>1</sup>	DELAY
Smith Chart <sup>2</sup>	SMITH CHART
Polar Chart	POLAR CHART
Liner Magnitude	MORE LIN MAG
Standing Wave Ratio (SWR)	MORE SWR
Real Part Only	MORE REAL
Imaginary Part Only	MORE IMAGINARY
Admittance Chart	MORE ADMITTANCE CHART
Phase Unit (degree or radian)	PHASE UNIT [ ] ( [DEG] or [RAD] )
Expanded Phase	EXP PHASE on OFF (toggle to ON off)

<sup>1</sup> See “Group Delay” in Chapter 8.

<sup>2</sup> See “Displaying the Trace as a Smith Chart (NA, ZA Mode)”.

#### Displaying the Trace as a Smith Chart (NA, ZA Mode)

1. Press **[Format]**.
2. Press **SMITH CHART** to display the trace as a smith chart.
3. Use the marker to read a measured value, by pressing **[Marker]** and turning .

## Selecting the Measurement Format (NA,ZA Mode)

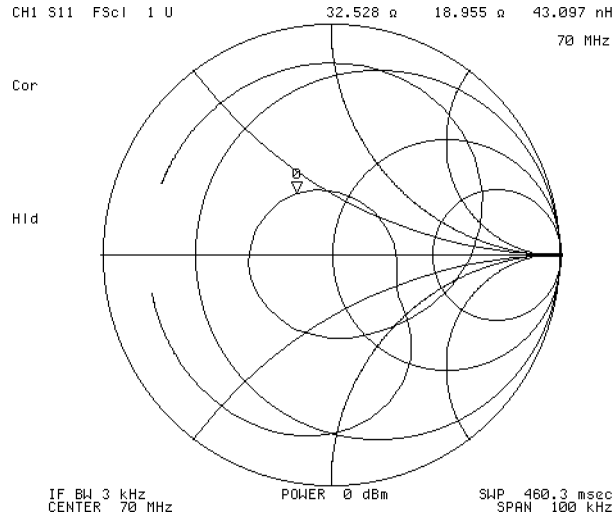


Figure 6-3. Smith Chart

### Note



To display the Smith Chart in the ZA mode, set the measurement parameter to **MAG(|Γ|)** in the measurement menu.

To change the marker readout format, use the following procedure:

### How To Change Marker Readout Format (NA, ZA Mode)

1. Press **(Utility)** **SMTH/POLAR MENU**.
2. Select one of the following options by pressing the corresponding softkey:

Format	Softkey
Real and Imaginary	REAL IMAG
Linear Magnitude and Phase	LIN MAG PHASE
Log Magnitude and Phase	LOG MAG PHASE
Impedance	R+jX
Admittance	G+jB
SWR and Phase	SWR PHASE

### Using the Impedance Conversion Function (NA Mode)

1. Press **(Meas)**.
2. Press **CONVERSION [ ]**.
3. Select one of the following options:

## Selecting the Measurement Format (NA,ZA Mode)

Convert To	Selected Port	Softkey
Impedance	A/R, S11, S12	Z:Refl
	B/R, S21, S22	Z:Trans
Admittance	A/R, S11, S12	Y:Refl
	B/R, S21, S22	Y:Trans

The marker readout value is a linear impedance or admittance value even if the LOG MAG format is selected.

## To Display Phase beyond $\pm 180$ Degrees (NA, ZA Mode)

By default, the 4395A wraps the trace around at  $\pm 180$  degree phases. However, there are occasions when it is more convenient to display the trace without  $\pm 180$  degree wrap-around. If this is the case, you can use the **Expanded Phase Format**, which displays phases beyond  $\pm 180$  degrees as shown in Figure 10-6.

To select the expanded phase format, follow these steps:

1. Press **Format**.
2. Toggle **EXP PHASE** on **OFF** to **ON** off.

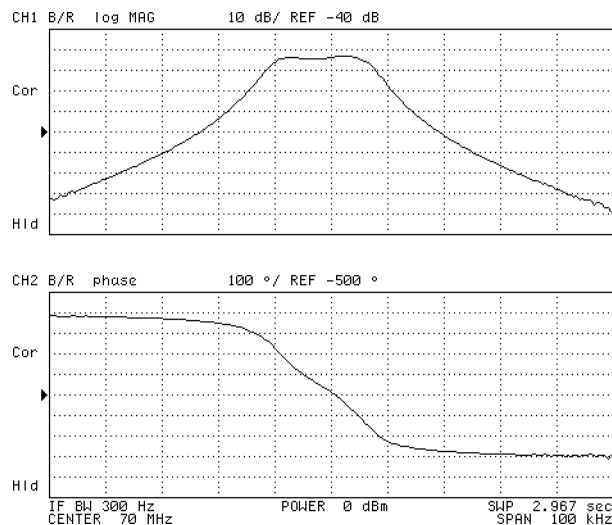


Figure 6-4. Expanded Phase Format

## Using the Complex Plane Format (ZA Mode)

### Displaying R-X in the Complex Plane

1. Press **Meas** and choose **IMPEDANCE: MAG(|Z|)**.
2. Press **Format** and choose **COMPLEX PLANE** to select the complex plane format.
3. Press **Scale Ref** and choose **AUTO SCALE** to adjust the scale.

In the complex plane, the measurement parameter is always a complex number even if you select a scalar parameter (such as  $|Z|$ ).

### Using the Marker

1. Press **Marker**. Then move the marker using the rotary knob.

The marker displays the real and imaginary value of the marker position at the upper-right corner of the grid as shown in Figure 6-5.

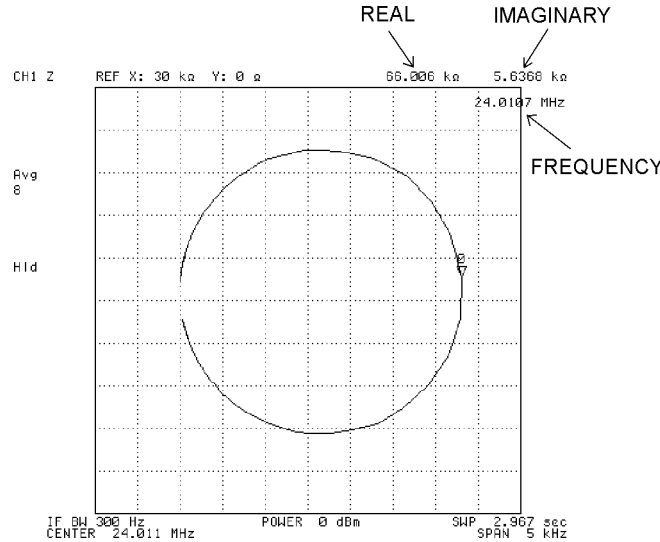


Figure 6-5. Marker Readout of Complex Plane

### Adjusting the Scale Setting

1. Press **Scale Ref**.
2. Change the following settings to adjust the scale of the complex plane:

Scale Setting	Keystrokes
Scale/Div	Choose <b>SCALE/DIV</b> . Then enter the scale per division value.
Reference X Value	Choose <b>REFERENCE X VALUE</b> . Then enter the reference X value.
Reference Y Value	Choose <b>REFERENCE Y VALUE</b> . Then enter the reference Y value.

The reference position of the complex plane is always at the center of the grid. You can adjust the scale by changing the scale per division setting or the reference coordinate value.

## Selecting the Display Unit (SA, ZA Mode)

---

### Selecting the Display Unit

#### Selecting the Display Unit in SA Mode

1. Press **Format**.
2. Select one of the following options by choosing the corresponding softkey:

Display Format	Unit	Softkey
Power	dBm	dBm
	W	WATT
Voltage	dBV	dBV
	dB $\mu$ V	dBuV
	V	VOLT

You can change the unit of a displayed value anytime you want. The 4395A automatically converts values into your specified format (unit) using the internally stored data. This eliminates the need of re-sweeping. Also, the 4395A can convert values even when it is in the held state.

In spectrum analyzer mode, marker readout unit can be selected apart from the display unit. See “To Select Marker Readout Unit (SA Nide)” in Chapter 8 for details.

If you want to perform a noise measurement instead of a spectrum measurement, see “Measuring the Noise Level” in Chapter 8.

#### Selecting the Phase Unit (NA, ZA Mode)

You can display the phase in either degrees or radians. To switch between the two units, follow these steps:

1. Press **Format**.
2. Do one of the following:
  - To switch from degrees to radians, toggle **PHASE UNIT [DEG]** to **[RAD]**.
  - To switch from radians to degrees, toggle **PHASE UNIT [RAD]** to **[DEG]**.






## Setting the Frequency Range



The 4395A has some useful features for setting the frequency range. This section provides the following procedures that are related to setting the frequency range.

- Setting the center frequency
  - Setting the marker position to center
  - Setting the maximum peak to center
  - Changing the center with the specified step size
- Setting the frequency span
  - Narrowing the span setting (SA mode)
  - Setting the frequency range to full span
  - Setting the sweep parameters using **Start** and **Stop**
- Zooming to a part of the trace
  - Changing the zooming factor
  - Displaying a zoomed trace on the other channel
  - Zooming between the marker and the  $\Delta$ marker

## Setting the Center Frequency

1. Press **Center** to activate the center frequency function.
2. Change the center frequency to place the target signal in the center of the grid by using the following keys:

To	Use
Set directly	<b>0</b> ... <b>9</b> and units terminator keys
Change continuously	
Change with 1-2-5 steps <sup>1</sup>	 

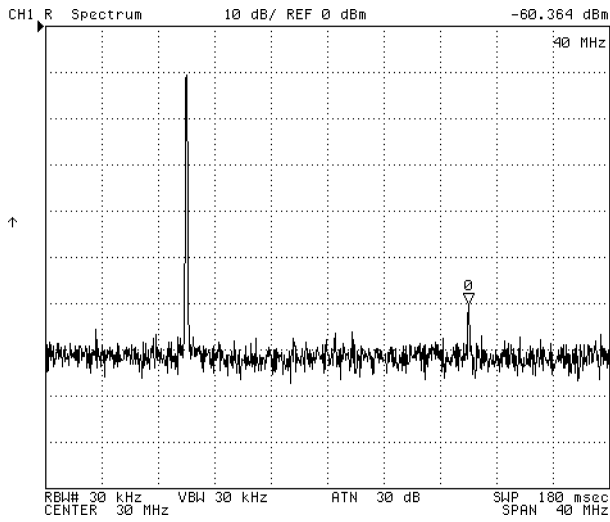
<sup>1</sup> You can change the step size of  . See “Change the Center Frequency by the Specified Step Size” in this section.

## Setting the Marker Position to Center

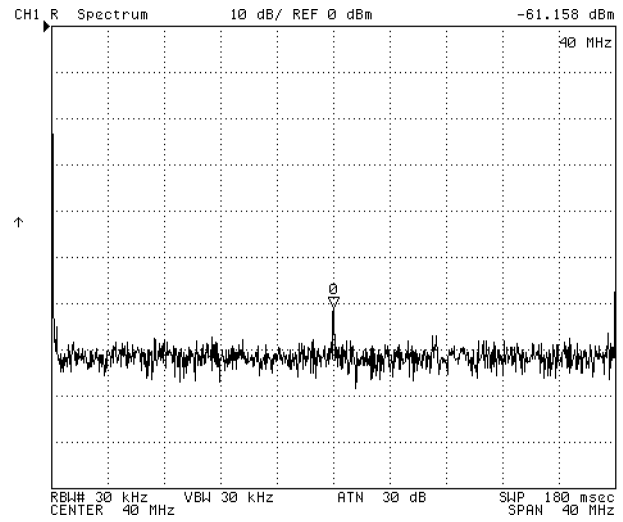
1. Press **Marker→**. A reverse-triangle shaped marker appears.
2. Place the marker on the position you want to set to the center by using the rotary knob.
3. Press **MKR→CENTER**.
4. Press **Entry Off**.

The above procedure causes the 4395A to immediately use the marker-pointed frequency as the center frequency. If you are measuring an unknown signal, display the signal in full span first. Then move the signal to the center using this function.

## Setting the Frequency Range



Move the marker



Press **MKR→CENTER**

**Figure 6-6. Marker to Center**

## Setting the Maximum Peak to Center

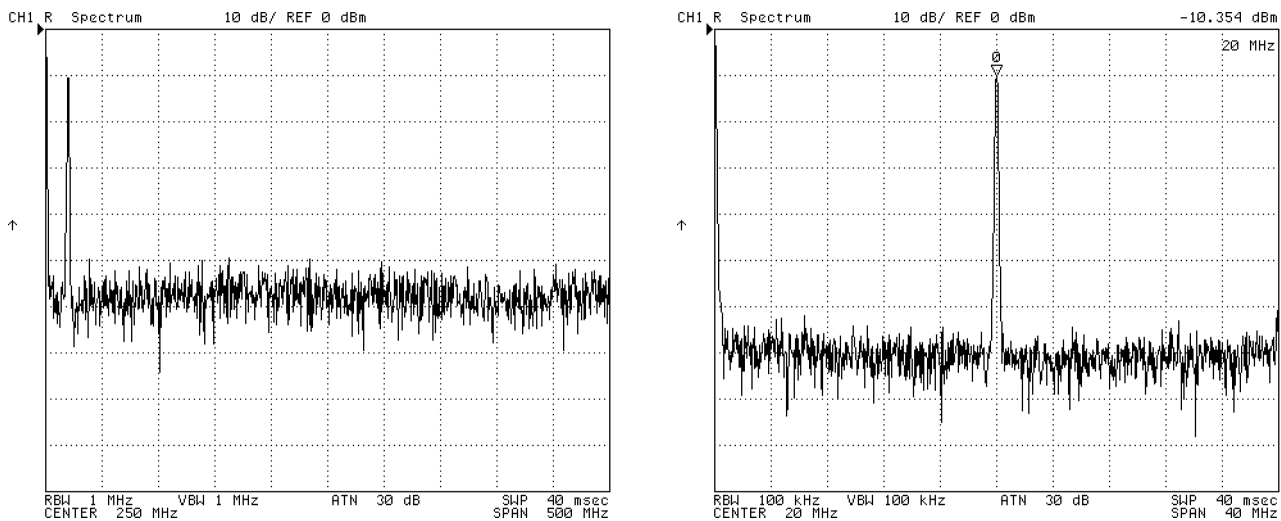
1. Press **Marker→**.
2. Press **PEAK→CENTER**.
3. Press **Entry Off**.

This function changes the center frequency to display the maximum peak at the center of the grid.

### Note



A large frequency span may prevent the peak from appearing accurately at the center of the grid. If this is the case, press **PEAK→CENTER** again so that the peak is redisplayed in the middle.



Display the peak

at the center of the screen

Figure 6-7. Peak to Center

## Change the Center Frequency by the Specified Step Size

1. Do one of the following:
  - Choose **Center** **CENTER STEP SIZE**. Then directly enter your desired step size using **0** ... **9** and the units terminator keys.
  - Press **Marker** and move the marker to the point you want to use as the step size frequency. Then choose **Center** **MKR→CNTR STEP**.
2. Toggle **STEP SIZE AUTO** man to **auto MAN**.
3. Press **Center**.
4. Press **↑** to increment (or **↓** to decrement) the center frequency setting by the specified step size.

This function is useful to display peaks that have a constant interval (such as harmonics) one after another. The following is an example of using this function to display harmonics.

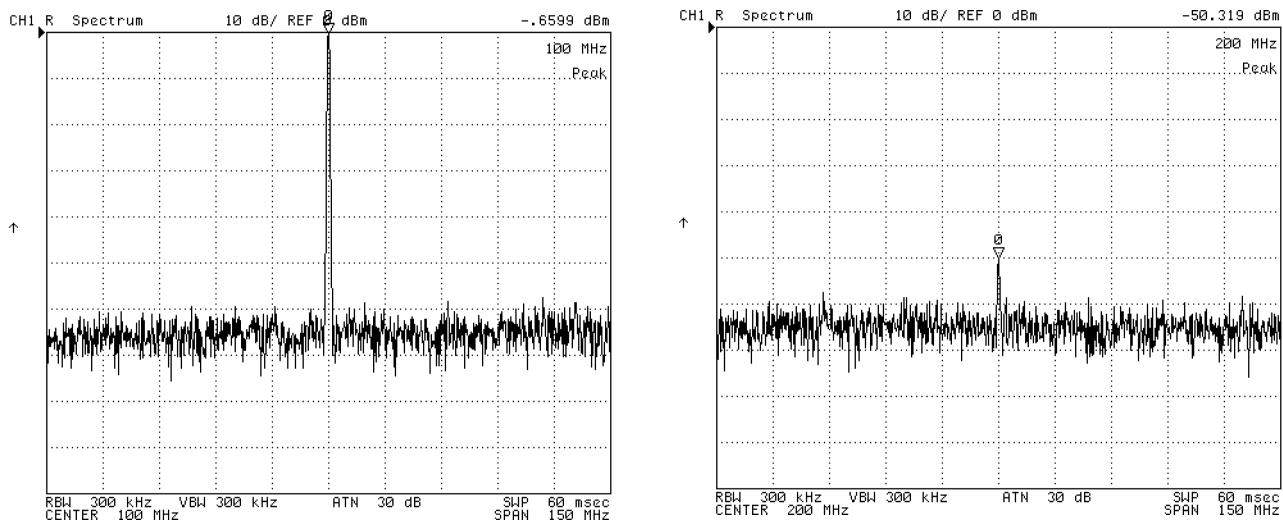
## Setting the Frequency Range

### Example: Displaying Harmonics (SA Mode)

To display the fundamental and harmonics of a 100 MHz signal, follow these steps:

1. Press **Center** 100 **(M/μ)**. Then set the span to display the fundamental at the center of the grid.
2. Press **Span** 150 **(M/μ)**.
3. Press **Search** and toggle **SEARCH TRK on OFF** to **ON off** to enable the search track function.
4. Choose **SEARCH: PEAK** to move the marker on the fundamental.
5. Press **Center** and choose **MKR—CNTR STEP**. Enter 100 MHz (so the step size matches the fundamental frequency).
6. Toggle **STEP SIZE AUTO man** to **auto MAN** to enable the specified step size.
7. Press **Center**. Then press **(↑)** to display the second harmonic.
8. To display higher order harmonics, press **(↑)** as required.

The marker searches for the next harmonic each time you change the center frequency using the search track function.





Fundamental

Second Harmonics

Figure 6-8. Displaying Harmonics

Setting the Frequency Span

- 1. Press **[Span]**.
- 2. Enter the frequency span to display the target peak in the optimum grid setting.

<b>To</b>	<b>Use</b>
Set directly	<b>[0]</b> ... <b>[9]</b> and units terminator keys
Change continuously	
Change with 1-2-5 steps	

## Setting the Frequency Range

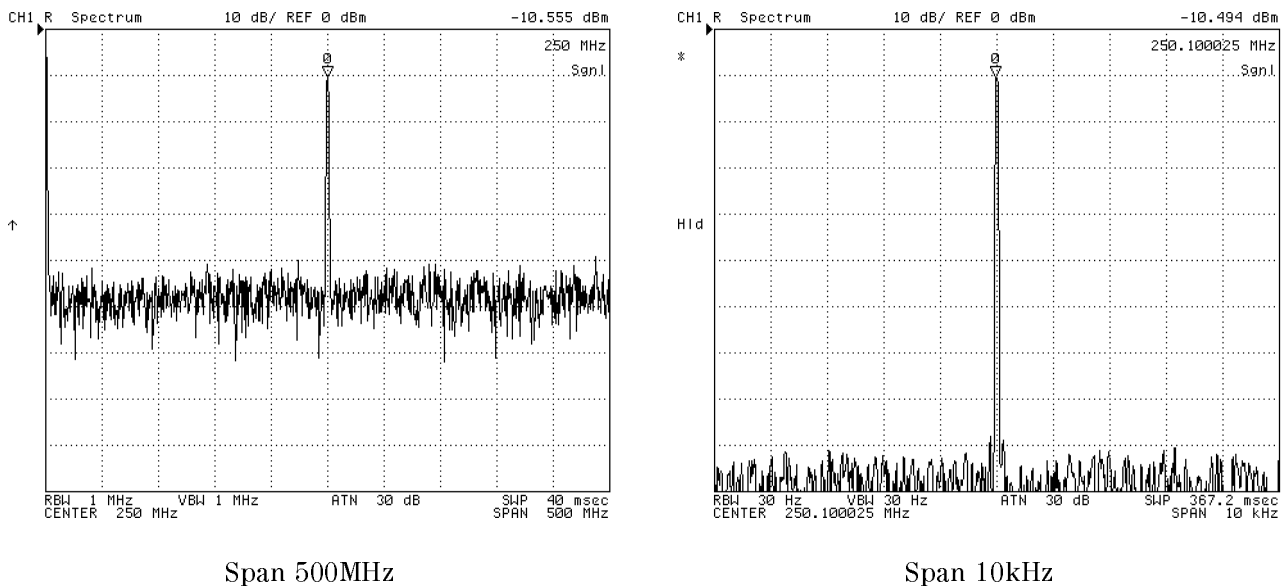
### Narrowing the Span Setting (SA Mode)

1. Press **Search**.
2. Choose **SEARCH: PEAK** to place the marker on the carrier.
3. Toggle **SIGNAL TRK on OFF** to **ON off**.
4. Narrow the span setting. See the “Setting the Frequency Span” procedure.

An extremely small span setting may cause the test signal to disappear from display. This happens because of the difference between the displayed and actual frequencies. For example, when the span setting is set to full span, the displayed test signal frequency has an error of approximately 600 kHz because of its resolution (500 MHz/800). A span setting smaller than the error frequency can cause the test signal to disappear from the screen depending on the error range.

The signal track function allows you to avoid this situation. When signal track is enabled, the analyzer narrows the span setting while centering the test signal as you narrow the span setting. Therefore, the test signal is placed at the center of the grid.

The following figure shows an example of narrowing the span with the signal track function. The actual signal frequency is 250.100025 MHz. When the center is fixed and the span is 10 kHz, the signal is out of display. The signal track function tracks the signal by changing the center frequency, and keeps displaying the signal at the center of the display.



**Figure 6-9. Narrowing Span with Signal Track**

### Setting the Frequency Range to Full Span.

1. Press **Span**.
2. Press **FULL SPAN**

This function is useful when you want to get a general view of the spectrum after you have obtained the detailed view of a specific signal.

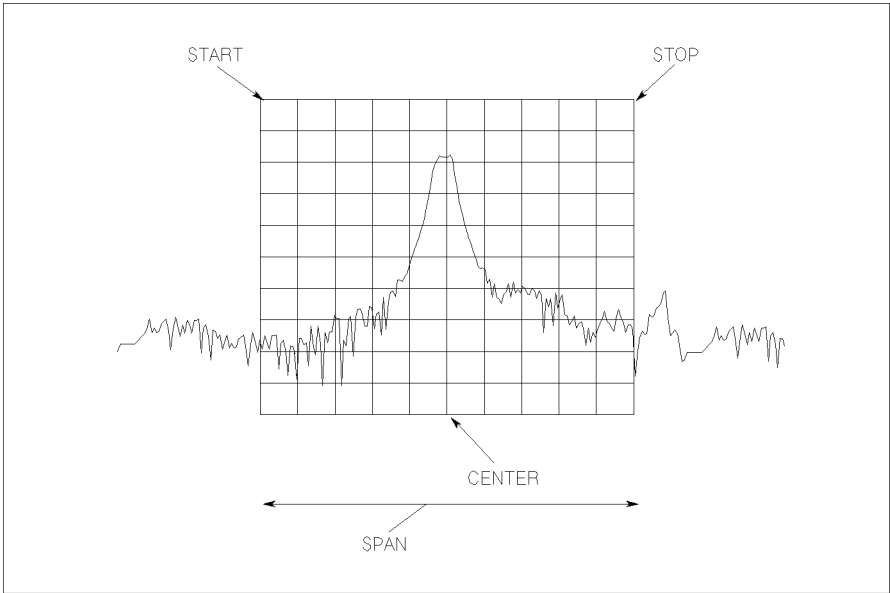
Setting the Sweep Parameters Using (Start) and (Stop)

You can set the sweep parameters using (Start) and (Stop) instead of (Center) and (Span):

- 1. Press (Start) to put the 4395A into a mode where it accepts your entered value as the frequency at which to start the sweep process.
- 2. Set the start frequency using the following keys:

To	Use
Set directly	(0) ... (9) and units terminator keys
Change continuously	(Circular arrow icon)
Change with 1-2-5 steps	(Up arrow icon) (Down arrow icon)

- 3. Press (Stop) to put the 4395A into a mode where it accepts your entered value as the frequency at which to stop the sweep process.
- 4. Set the stop frequency using the keys listed in the previous table.



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Figure 6-10. Setting the Sweep Parameters

## Setting the Frequency Range

### Zooming To a Part of the Trace

1. Move the marker to the point where you want to observe the signal details.
2. Press **Marker→**.
3. Press **MKR ZOOM**.
4. To zoom more, press **MKR ZOOM** again.

### Change the Zooming Factor.

1. Press **Marker→** **ZOOMING APERTURE**.
2. Enter your desired zooming aperture as a percentage of the span.

If you want to obtain a 20-fold zoom, for example, enter 5% for as the zooming factor.

### Displaying a Zoomed Trace on the Other Channel.

1. Press **Display** and toggle **DUAL CHAN** on **OFF** to **ON** off to display two channels on the LCD.
2. Move the marker to the point where you want to observe the signal details.
3. Press **Marker→**.
4. Choose **MKR—XCH MENU**.
5. Choose **MKR XCH ZOOM**.

The other channel displays the zoomed trace.

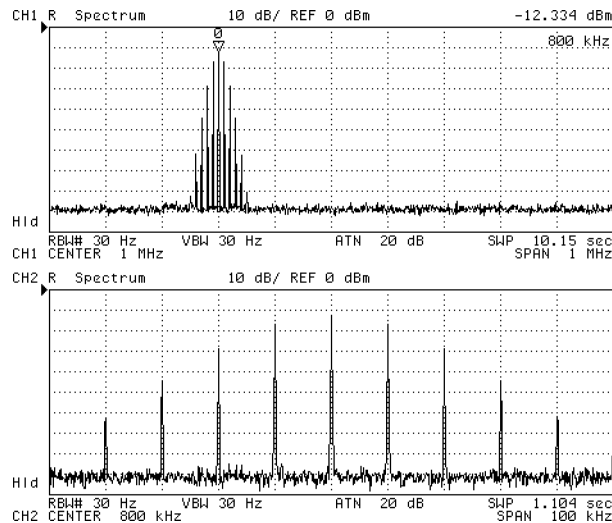


Figure 6-11. Zooming the Trace



## Adjusting the Scale and Reference

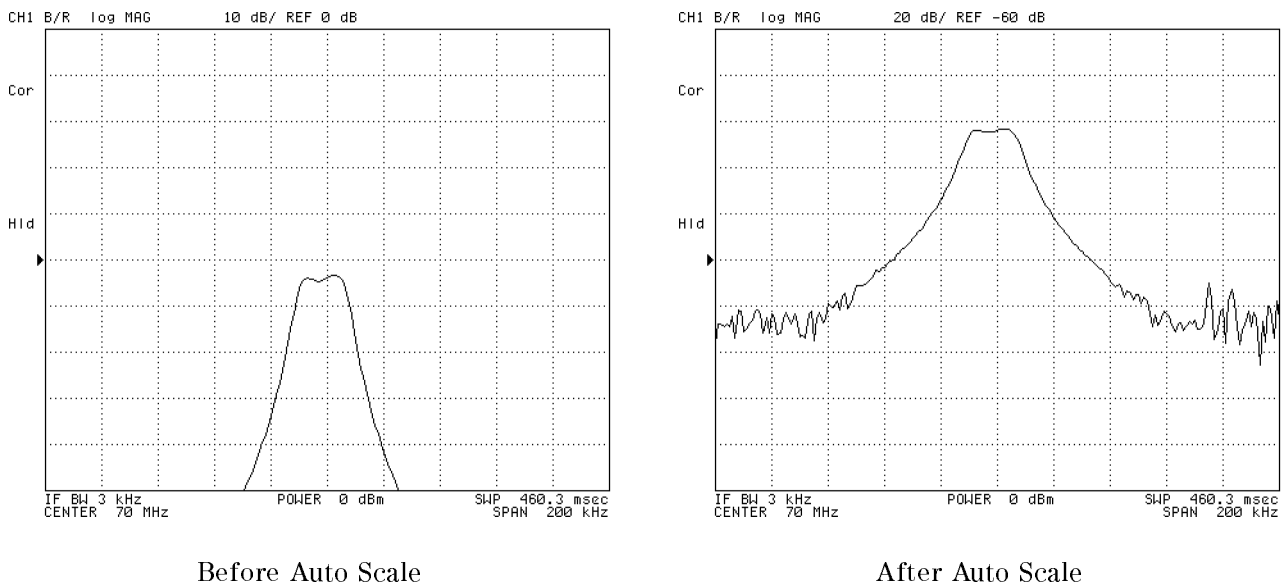
The 4395A provides you with several means to adjust the scale and reference of the trace so that the entire trace is displayed within the grid area. For example, when the trace is out of the grid or is too flat to see the required characteristics, you can adjust the trace settings by adjusting the reference or the scale.

- Automatically adjusting the scale and reference
- Manually adjusting the scale and reference
- Setting the reference
- Changing the scale per division

### Automatically Adjusting the Scale and Reference (NA, ZA Mode)

1. Press **Scale Ref**.
2. Press **AUTO SCALE** to fit the trace within the grid.

The scale and reference settings are automatically adjusted to provide an optimum trace display.



**Figure 6-12. Autoscale Function**

### Manually Adjusting the Scale and Reference (NA, ZA Mode)

If you want to manually adjust the scale and reference settings, the following functions are available:

- To change the scale per division setting, press **SCALE/DIV**.
- To change the reference position that is shown as “▶”, use **REFERENCE POSITION** and **↑** **↓** keys.
- To change the reference value, use **REFERENCE VALUE**.

If you are displaying a data trace and a memory trace together, you need to consider whether you want to change the scale for one or both traces. You can change the traces as follows:





## Adjusting the Scale and Reference

- If you want to change the scale setting for the data trace only, set **SCALE FOR [DATA]** and **D&M SCALE [UNCOUPLE]** under **Scale Ref** key.
- If you want to change the scale setting for the memory trace only, set **SCALE FOR [MEMORY]** and **D&M SCALE [UNCOUPLE]**.
- If you want to change the scale settings for the both traces, set **D&M SCALE [COUPLE]**.

## Setting the Reference (SA Mode)

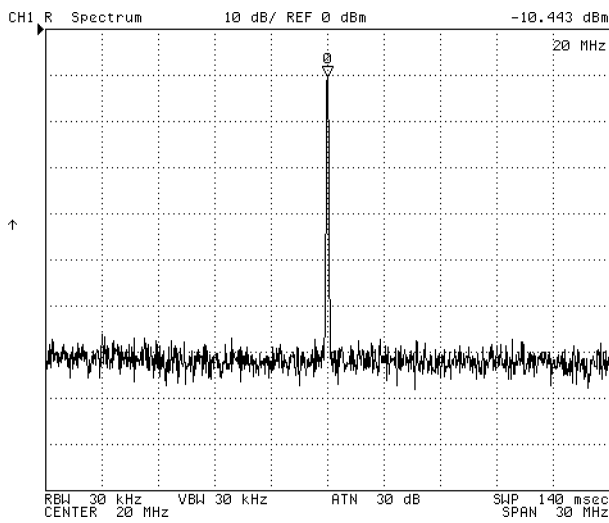
### Using the Numeric Keys.

1. Press **Scale Ref**.
2. Choose **REFERENCE VALUE**.

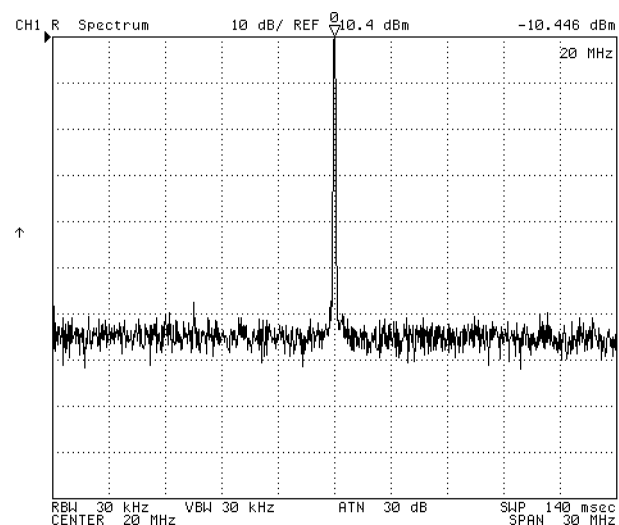
To	Use
Move trace upward	 or 
Move trace downward	 or 
Set reference value directly	<b>0</b> ... <b>9</b> and unit keys

### Using the Marker.

1. Press **Search** and choose **SEARCH: PEAK** to move the marker to the peak.
2. Press **Scale Ref**.
3. Choose **MKR→REFERENCE**.



Move the marker to the top of the peak






Press **Scale Ref** **MKR→REFERENCE**

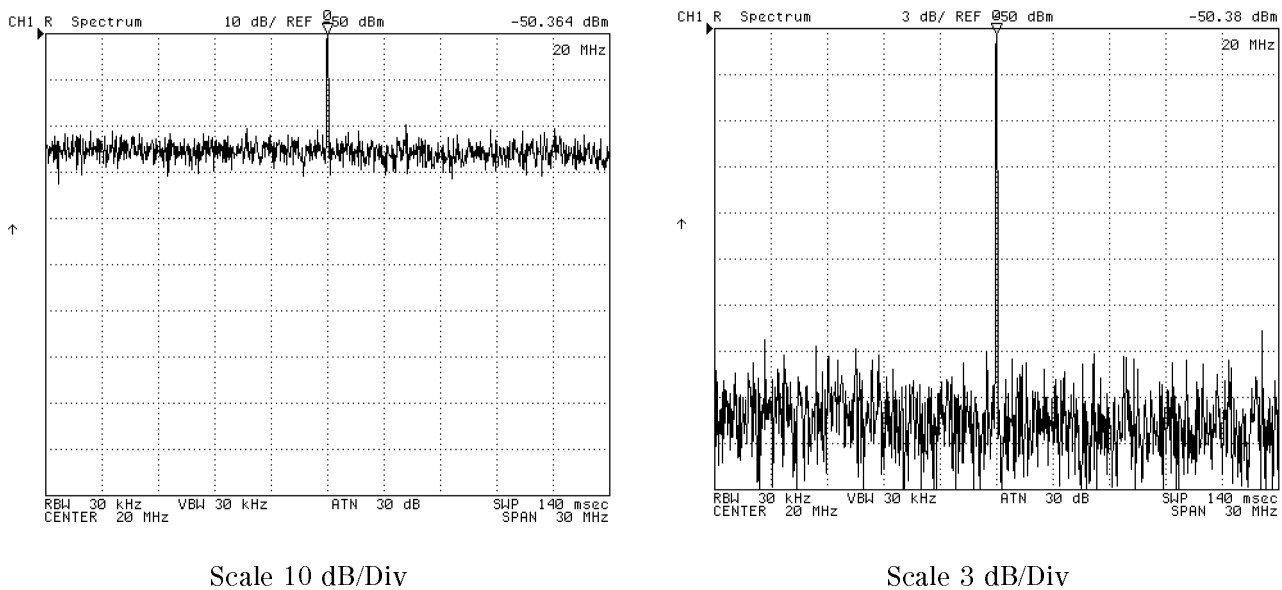
Figure 6-13. Marker to Reference

**Changing the Scale per Division (SA Mode)**

1. Set the reference level to the peak level of the target signal. See the “Using the Marker” procedure.
2. Press **[Scale Ref]**.
3. Choose **SCALE/DIV**.
4. Change the scale/division setting to display additional details using the following keys:

To	Use
Change continuously	
Change by 1-2-5 steps	 
Set Scale/Div directly	<b>[0]</b> ... <b>[9]</b> and unit keys

This function can be used to display a small peak on a full grid.



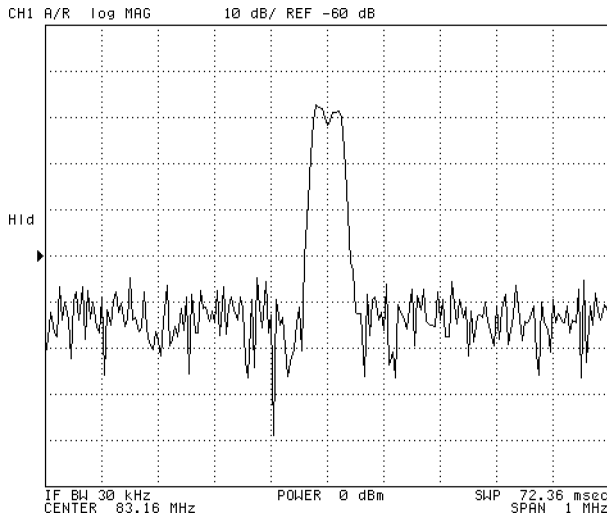
**Figure 6-14. Changing Scale/Div.**

## Setting the IF/Resolution/Video Bandwidth

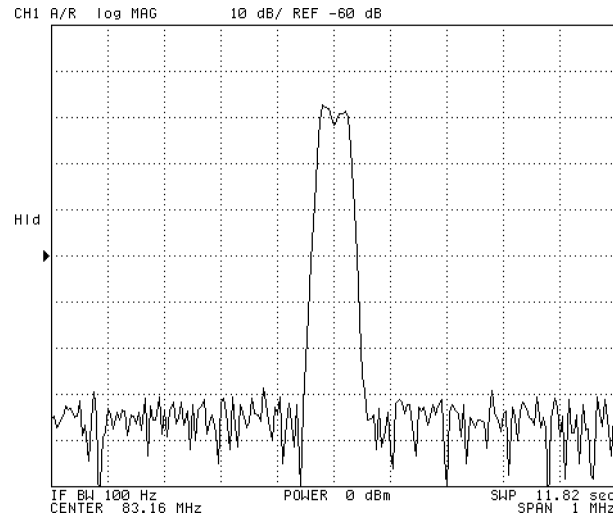
### Setting the IF Bandwidth (NA, ZA Mode)

1. Press **[Bw/Avg]**.
2. Choose **IF BW**.
3. Press **[↑]** or **[↓]**, or enter an IF bandwidth value directly from the numeric keypad.

A smaller IF bandwidth increases the dynamic range but slows down the sweep process.



IF Bandwidth 30 kHz



IF Bandwidth 100 Hz

**Figure 6-15. Setting IF Bandwidth (IFBW)**

#### Note



- The IF bandwidth should be set equal to or less than 1/5 of the measurement frequency.
- When making impedance measurements with the 43961A, you must set the IF bandwidth equal to or less than 300 Hz and set the averaging factor equal to or greater than 8.

### Setting the IF Bandwidth to Auto Mode

If the sweep type is log frequency, the IF bandwidth can be set to auto mode.

1. Press **[Bw/Avg]**.
2. Toggle **IF BW auto MAN** to **AUTO man**.

In auto mode, the IF bandwidth is automatically set equal to or less than 1/5 of each measurement frequency. If you want to set an upper limit of IF bandwidth in auto mode, press **AUTO IFBW LIMIT** and enter the upper limit with entry keys.

### Setting the Resolution Bandwidths (SA Mode)

Adjusting the RBW can improve the resolution of the frequency and lower the displayed noise floor.

1. Press **[Bw/Avg]**.
2. Choose **RES BW**.
3. Change the RBW setting using **[↑]**, **[↓]**, or the **[↻]**.

Measuring two or more mutually adjusting signals requires special considerations on the width of the 4395A's internal IF filter. If the internal IF filter is wider than the difference between the signals, the analyzer cannot separate them. To avoid this problem, you must provide a resolution bandwidth (RBW) small enough for the 4395A to identify the respective signals.

A small RBW can reduce the noise power per display point, thereby lowering the displayed noise floor and making it possible to display lower level signals.

For example, the trace of a 400 Hz amplitude modulated signal conceals sidebands in the skirt of the carrier trace when the RBW is 300 Hz. In this case, you can split the carrier and sidebands completely and lower the displayed noise floor by setting the RBW to 10 Hz.

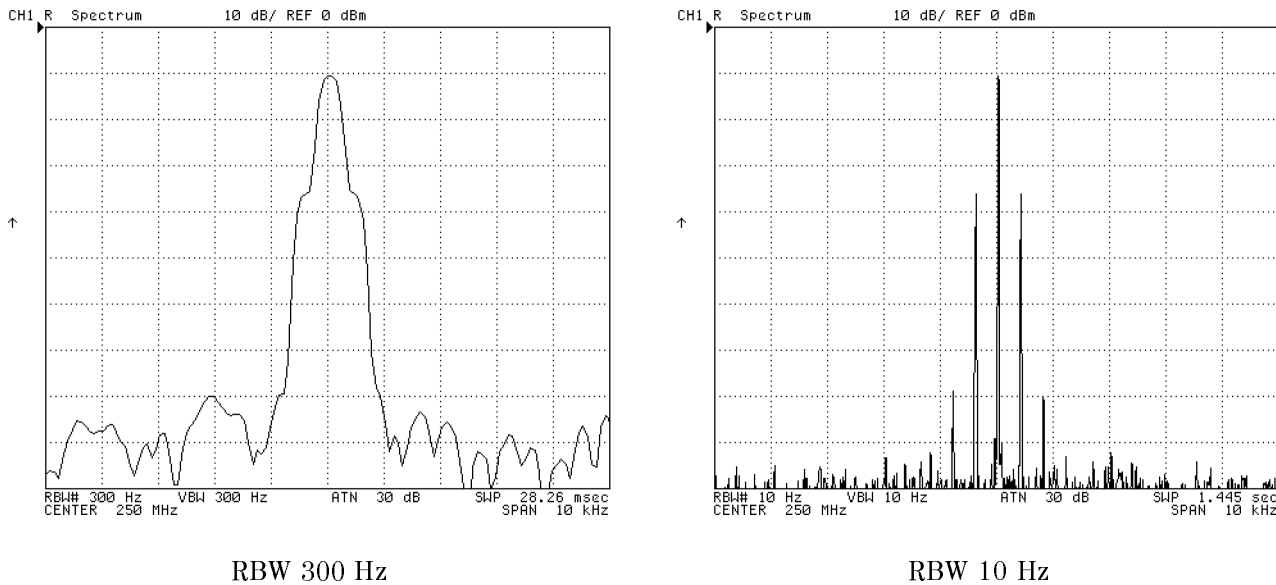


Figure 6-16. Setting Resolution Bandwidth (RBW)

### Setting the Resolution Bandwidth to Auto Mode



You can automatically set the resolution bandwidth in accordance with the percentage of the sweep span.

1. Press **[Bw/Avg]**.
2. Press **RBW/SPAN RATIO** and enter the percentage of the sweep span with entry keys.
3. Toggle to **AUTO man**.

## Setting the IF/Resolution/Video Bandwidth

### Setting the Video Bandwidth (SA Mode)

1. Press **[Bw/Avg]**.
2. Choose **VIDEO BW**.
3. Set the video bandwidth using the following keys:

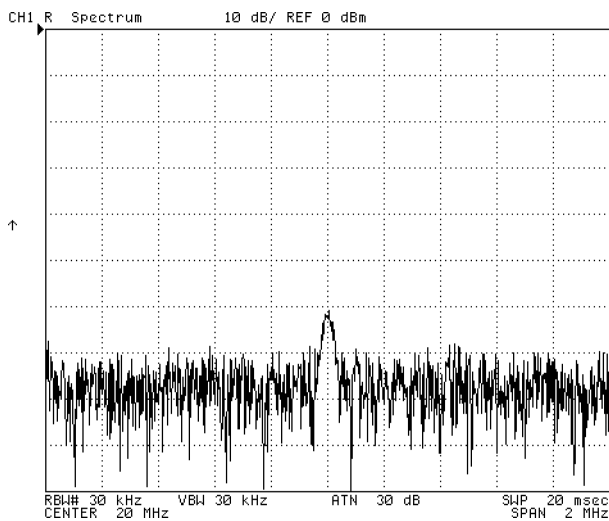
<b>To</b>	<b>Use</b>
Lower noise level	<b>[↓]</b> , or 
Shorten sweep time	<b>[↑]</b> , or 
Set bandwidth directly	<b>[0] ... [9]</b> and unit keys

When the target signal and the noise are hard to distinguish because of noise variation, narrow the video bandwidth. This reduces the noise variations and makes the signal clearly visible. Note, however, that reducing the video bandwidth slows down the sweep process.

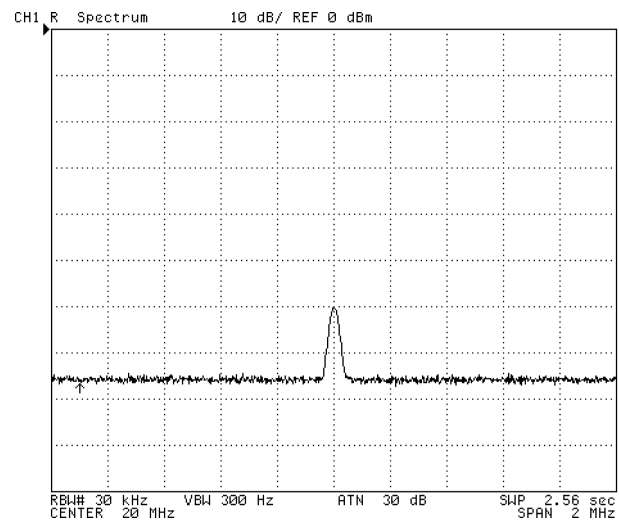
You can set the VBW to a value that is 1/1, 1/3, 1/10, 1/30, 1/100, or 1/300 of the RBW setting currently in effect.

#### Resetting the Video Bandwidth.

1. Press **[Bw/Avg]** **VIDEO BW**.
2. Enter the same value as the RBW setting.



Video BW 30 kHz



Video BW 300 Hz

**Figure 6-17. Setting Video Bandwidth (VBW)**

## Calibration

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This chapter describes calibration procedures required for measurement in the network analyzer mode and the impedance analyzer mode. For details about calibration procedures, see Appendix A.

In the spectrum analyzer mode, the 4395A requires no calibration procedure in the measurement.

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**Note** When performing the 75 $\Omega$  measurement in the spectrum analyzer mode, see Chapter 2 to set the 4395A properly.



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### Calibration Required for the Network Analyzer Mode

This section provide procedures for performing calibration. The calibration eliminates the errors and improves the measurement accuracy. The analyzer has six different methods of calibration. You can select the method that fits your measurement requirement by reading “To Select an Appropriate Calibration Method” procedure. This section also contains a procedure to customize a calibration kit.

- Selecting an appropriate calibration method
- Performing a response calibration
- Performing a response & isolation calibration
- Performing an S11 1-port calibration
- Performing an S22 1-port calibration
- Performing a full 2-port calibration
- Performing a 1-path 2-port calibration
- Selecting the calibration kit
- Customizing the user defined calibration kit

#### To Select an Appropriate Calibration Method

The analyzer has six calibration methods. You can choose the appropriate calibration method to fit your measurement by using Table 7-1.

## Calibration Required for the Network Analyzer Mode

Table 7-1. Calibration Method Selection Table

Measurement Type	Calibration Method	Complexity	See
Transmission or reflection measurement when the highest accuracy is not required.	Response	simple	“Performing a Response Calibration”
Transmission of high insertion loss devices or reflection of high return loss devices. Not as accurate as 1-port or 2-port calibration.	Response & isolation	simple	“To Perform a Response & Isolation Calibration”
Reflection of any one-port device or well terminated two-port device.	S <sub>11</sub> 1-port	slightly complex	“Performing an S11 1-Port Calibration”
Reflection of any one-port device or well terminated two-port device.	S <sub>22</sub> 1-port	slightly complex	“Performing an S22 1-Port Calibration”
Transmission or reflection of highest accuracy for two-port devices. S-parameter Test Set is required.	Full 2-port	complex	“Performing a Full 2-Port Calibration”
Transmission or reflection of highest accuracy for two-port devices. (Reverse test device between forward and reverse measurements.)	One-path 2-port	complex	“Performing a 1-Path 2-Port Calibration”

### Performing a Response Calibration

1. Press **Cal** **CALIBRATE MENU** **RESPONSE** to display the response calibration menu.
2. Connect one of following standards. Then press the corresponding key.

Measurement Type	Connect Standard	Press
Transmission Measurement	THRU	<b>THRU</b>
Reflection Measurement	OPEN	<b>OPEN</b>
	SHORT	<b>SHORT</b>

3. Press **DONE: RESPONSE**.

### Performing a Response & Isolation Calibration

1. Press **Cal** **CALIBRATE MENU** **RESPONSE & ISOL'N** to display the response and isolation calibration menu.
2. Press **RESPONSE**.
3. See 2 of the “Performing a Response Calibration” procedure.
4. Press **DONE: RESPONSE**.
5. Connect isolation standard (LOAD).



## Calibration Required for the Network Analyzer Mode

6. Press ISOL'N.
7. Press DONE RESP ISOL'N CAL.

## Calibration Required for the Network Analyzer Mode

### Performing an S11 1-Port Calibration

#### Step 1: Opening the S-11 1-Port Calibration Menu

1. Press **Cal**.
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the **CAL KIT** softkey label is not the same as the calibration you are going to use, follow the “Selecting the Calibration Kit” procedure.
3. Press **CALIBRATE MENU S11 1-PORT**.

#### Step 2: Measuring the OPEN

1. Connect OPEN standard to port 1.
2. Press **(S11): OPEN** (for the 7 mm or 3.5 mm cal kit) or **(S11): OPENS** (for the type-N cal kit).

When the 7 mm or 3.5 mm calibration kit is selected, the message “WAIT - MEASURING CAL STANDARD” is displayed while the OPEN data is measured. The softkey label **OPEN** is then underlined. Skip to step 3.

3. If the type-N calibration kit is selected, do the following:
  - a. Press **OPEN [M]** (for a male port connector) or press **OPEN [F]** (for a female port connector).  
The OPEN data is measured and the softkey label is then underlined.
  - b. Press **DONE: OPENS**.

#### Step 3: Measuring the SHORT

1. Disconnect the OPEN. Then connect a SHORT standard to port 1.
2. Press **SHORT** (for the 7 mm or 3.5 mm calibration kit) or **SHORTS** (for the type-N calibration kit).

When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label is underlined.

3. If the type-N calibration kit is selected, do the following:
  - a. Press **SHORT [M]** (for a male port connector) or press **SHORT [F]** (for a female port connector).  
The SHORT data is measured and the softkey label is then underlined.
  - b. Press **DONE: SHORTS**.

#### Step 4: Measuring the LOAD

1. Disconnect the SHORT, and connect an impedance-matched LOAD (usually 50 or 75  $\Omega$ ) at port 1.
2. Press **LOAD**. Then wait the LOAD is measured and the **LOAD** softkey is underlined.

### Step 5: Completing the Calibration

1. Press **DONE 1-PORT CAL** to complete the calibration.

The 4395A calculates the error coefficients, and then redisplay the correction menu with a **CORRECTION ON off** label. A corrected S11 trace is displayed, and “Cor” appears at the left side of the screen.

If you press **DONE** without measuring all the required standards, the message “CAUTION: ADDITIONAL STANDARDS NEEDED” is displayed.

### Performing an S22 1-Port Calibration

This calibration is similar to the S11 1-port calibration except that S22 is selected automatically. It is used only with an S-parameter test set.

For S-parameter measurements in the reverse direction with a transmission/reflection test kit, use the S11 1-port or 1-path 2-port calibration and reverse the DUT between measurement sweeps.

## Calibration Required for the Network Analyzer Mode

### Performing a Full 2-Port Calibration

#### Step 1: Opening the Full 2-Port Calibration Menu

1. Press **Cal**.
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the **CAL KIT** softkey label is not the same as the calibration kit to be used, see the “Selecting the Calibration Kit” procedure.
3. Press **CALIBRATE MENU FULL 2-PORT REFLECT'N**.

#### Step 2: Measuring the Reflection

1. Connect a shielded OPEN to port 1.
2. Press **(S11): OPEN** (for the 7 mm or 3.5 mm calibration kit) or **(S11): OPENS** (for the type-N calibration kit).  
When the 7 mm or 3.5 mm calibration kit is selected in step 1, the OPEN data is measured and the softkey label **OPEN** is underlined.
3. If the type-N calibration kit is selected, do the following:
  - a. Press **OPEN [M]** (for a male port connector) or press **OPEN [F]** (for a female port connector).  
The OPEN data is measured. The softkey label is then underlined.
  - b. Press **DONE: OPENS**.
4. Disconnect the OPEN and connect the SHORT to port 1.
5. Press **(S11): SHORT** (for the 7 mm or 3.5 mm calibration kit) or **(S11): SHORTS** (for the type-N calibration kit).  
When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label **SHORT** is underlined.
6. If the type-N calibration kit is selected, do the following:
  - a. Press **SHORT [M]** (for a male port connector) or press **SHORT [F]** (for a female port connector).  
The SHORT data is measured and the softkey label is then underlined.
  - b. Press **DONE: SHORTS**.
7. Disconnect the SHORT and connect an impedance-matched LOAD (usually 50 or 75  $\Omega$ ) at port 1.
8. Press **(S11): LOAD**. Then confirm the **LOAD** softkey label is underlined.
9. Repeat the OPEN-SHORT-LOAD measurements described above, connecting the devices in turn to port 2 and using the (S22) softkeys.
10. Press **REFLECT'N DONE**.

The reflection calibration coefficients are computed and stored. The two-port calibration menu is displayed (with the **REFLECT'N** softkey underlined).

### Step 3: Measuring the Transmission

1. Press **TRANSMISSION**.
2. Connect a THRU connection between port 1 and port 2 at the points where the test device is connected.
3. When the trace settles, press **FWD. TRANS. THRU**. Then wait the S21 frequency response is measured and the softkey label is underlined.
4. Press **FWD. MATCH THRU**. Then wait the S11 load match is measured and the softkey label is underlined.
5. Press **REV. TRANS. THRU**. Then wait the S12 frequency response is measured and the softkey label is underlined.
6. Press **REV. MATCH THRU**. Then wait the S22 load match is measured and the softkey label is underlined.
7. Press **TRANS. DONE**.

The transmission coefficients are computed and stored. The two-port calibration menu is displayed (with the **TRANSMISSION** softkey underlined).

### Step 4: Measuring the Isolation

1. If correction for isolation is not required, press **ISOLATION OMIT ISOLATION ISOLATION DONE**. Then skip to step 5.
2. If correction for isolation is required, connect impedance-matched LOADs to port 1 and port 2.
3. Press **FWD ISOL'N ISOL'N STD**. Then wait the S21 isolation is measured and the softkey label is underlined.
4. Press **REV ISOL'N ISOL'N STD**. Then wait the S12 isolation is measured and the softkey label is underlined.
5. Press **ISOLATION DONE**.

The isolation error coefficients are stored. The two-port calibration menu is displayed (with the **ISOLATION** softkey underlined).

### Step 5: Completing the Calibration

1. Press **DONE: 2-PORT CAL** to complete the calibration.

The error coefficients are computed and stored. The correction menu is displayed (with **CORRECTION ON off**). A corrected trace is displayed. The notation “C2” at the left of the screen indicates that two-port error correction is ON.

Now the test device can be connected and measured. Save the calibration data on the built-in disk drive.

## Calibration Required for the Network Analyzer Mode

### Performing a 1-Path 2-Port Calibration

#### Step 1: Opening the 1-Path 2-Port Calibration Menu

1. Press **Cal**.
2. Select the proper calibration kit. If the connector type or calibration kit name shown in the **CAL KIT** softkey label is not the same as the calibration kit to be used, see the “Selecting the Calibration Kit” procedure.
3. Press **CALIBRATE MENU ONE-PATH 2-PORT REFLECT’N**.

#### Step 2: Measuring the Reflection

1. Connect a shielded OPEN to the test port.
2. Press **(S11): OPEN** (for the 7 mm calibration kit) or **(S11): OPENS** (for the type-N calibration kit).

The OPEN data is measured, and the softkey label **OPEN** is underlined.

3. If the type-N calibration kit is selected, do the following:
  - a. Press **OPEN [M]** (for a male port connector) or press **OPEN [F]** (for a female port connector).

The OPEN data is measured and the softkey label is then underlined.

- b. Press **DONE: OPENS**.
4. Disconnect the OPEN and connect a SHORT to the test port.
5. Press **SHORT** (for the 7 mm or 3.5 mm calibration kit) or **SHORTS** (for the type-N calibration kit).

When the 7 mm or 3.5 mm calibration kit is selected, the SHORT data is measured and the softkey label **SHORT** is underlined.

6. If the type-N calibration kit is selected, do the following:
  - a. Press **SHORT [M]** (for a male port connector) or press **SHORT [F]** (for a female port connector).

The SHORT data is measured and the softkey label is then underlined.

- b. Press **DONE: SHORTS**.
7. Disconnect the SHORT and connect an impedance-matched LOAD (50 or 75  $\Omega$ ) to the test port.
8. Press **LOAD**. Then wait the LOAD is measured and the softkey label **LOAD** is underlined.
9. Press **REFLECT’N DONE**.

The reflection calibration coefficients are computed and stored. The two-port calibration menu is displayed (with the **REFLECT’N** softkey underlined).

### Step 3: Measuring the Transmission

1. Connect a THRU between the test port and the return cable to the analyzer (connect to the points at which the test device is connected).
2. Press **TRANSMISSION**.
3. Press **FWD**, **TRANS**, **THRU**. Then wait the S21 frequency response is measured and the softkey label is underlined.
4. Press **FWD**, **MATCH THRU**. Then wait the S11 load match is measured and the softkey label is underlined.
5. Press **TRANS**, **DONE**.

The transmission coefficients are computed and stored. The two-port calibration menu is displayed (with the **TRANSMISSION** softkey underlined).

### Step 4: Measuring the Isolation

1. If correction for isolation is not required, press **ISOLATION**, **OMIT ISOLATION**, **ISOLATION DONE**. Skip to step 5.
2. If correction for isolation is required, connect impedance-matched LOADs to the test port and the return port.
3. Press **FWD**, **ISOL'N**, **ISOL'N STD**. Then wait the S21 isolation is measured and the softkey label is underlined.
4. Press **ISOLATION DONE**.

The isolation error coefficients are stored. The two-port calibration menu is displayed (with the **ISOLATION** softkey underlined).

### Step 5: Completing the Calibration

1. Press **DONE 2-PORT CAL** to complete the calibration.

The error coefficients are computed and stored. The correction menu is displayed with **CORRECTION ON off**. A corrected trace is displayed. The notation "C2" at the left of the screen indicates that 2-port error correction is ON.

### Step 6: Performing the Measurement

1. Connect the test device in the reverse direction. Then press **PRESS to CONTINUE**.
2. Reconnect the test device in the forward direction. Then press **PRESS to CONTINUE**.

Now the error corrected trace is displayed. If you measure the other test device, press **Trigger**, **MEASUREMENT RESTART**. Then perform the procedure of step 6.

Save the calibration data on a floppy disk or memory disk.

For additional information about calibration, see Appendix A.

## Calibration Required for the Network Analyzer Mode

### Selecting the Calibration Kit

1. Press **Cal**.
2. Press **CAL KIT [ ]**.
3. Select one of the following options by pressing the corresponding key:

Calibration Kit	Softkey
7 mm calibration kit	CAL KIT: 7mm
3.5 mm calibration kit	3.5mm
50 Ω N type	N 50Ω
75 Ω N type	N 75Ω
User defined calibration kit	USER KIT

### Customizing the User Defined Calibration Kit

#### Defining the Standard Definition

##### Step 1: Preparation.

1. Prepare the “*Standard Definitions*” table of the standard kit you want to use. Table 7-2 is an example of a standard definition table.

**Table 7-2. Example of the Standard Definitions**

STANDARD		C0 ×10 <sup>-15</sup> F	C1 ×10 <sup>-27</sup> F	C2×10 <sup>-36</sup> F/Hz	C3×10 <sup>-45</sup> F/Hz	FIXED OR SLIDING	OFFSET			FREQ. (GHz)		COAX or WAVEGUIDE	STANDARD LABEL
NO.	TYPE						DELAY ps	LOSS MΩ/s	Z <sub>0</sub> Ω	MIN.	MAX.		
1	SHORT						0	700	50	0	999	COAX	SHORT (M)
2	OPEN	108	55	130	0		0	700	50	0	999	COAX	OPEN (M)
3	LOAD					FIXED	0	700	50	0	999	COAX	BROADBAND
4	DELAY/ THRU						0	700	50	0	999	COAX	THRU
5													
6													
7	SHORT						17.544	700	50	0	999	COAX	SHORT (F)
8	OPEN	62	17	28	0		17.544	700	50	0	999	COAX	OPEN (F)

##### Step 2: Opening the Define Standard Menu.

1. Press **Cal**.
2. Press **CAL KIT [ ]**.
3. Press **MODIFY [ ]**.
4. Press **DEFINE STANDARD**.
5. Select standard number.



## Calibration Required for the Network Analyzer Mode

6. Select standard type.

If you did not select standard type as OPEN in step 2, skip to step 4.

### Step 3: Entering C Parameters.

1. Press **C0**. Then enter C0 ( $\times 10^{-15}$ F).
2. Press **C1**. Then enter C1 ( $\times 10^{-27}$ F/Hz).
3. Press **C2**. Then enter C2 ( $\times 10^{-36}$ F/Hz<sup>2</sup>).

### Step 4: Entering OFFSET Parameters.

1. Press **SPECIFY OFFSET**.
  - Press **OFFSET DELAY**. Then enter the offset delay value.
  - Press **OFFSET LOSS**. Then enter the offset loss value.
  - Press **OFFSET Z0**. Then enter  $Z_0$ .
2. Press **STD OFFSET DONE**.

### Step 5: Entering a Standard Class Label.

1. Press **LABEL STD**.
2. Enter a standard label (up to 10 characters).
3. Press **DONE**.

### Step 6: Completing the Definition of a Calibration Kit.

1. Press **STD DONE (DEFINED)**.
2. Press **KIT DONE (MODIFIED)**.

## Calibration Required for the Network Analyzer Mode

### Defining a Class Assignment

#### Step 1: Preparing for the Class Assignment.

1. Prepare the standard class assignment table for your calibration kit.

**Table 7-3. Example: Standard Class Assignment of the 85032B**

	A	B	C	D	E	F	G	STANDARD CLASS LABEL
S <sub>11</sub> A	2	8						OPENS
S <sub>11</sub> B	1	7						SHORTS
S <sub>11</sub> C	3							LOAD
S <sub>22</sub> A	2	8						OPENS
S <sub>22</sub> B	1	7						SHORTS
S <sub>22</sub> C	3							LOAD
Forward Transmission	4							Fwd. Trans Thru
Reverse Transmission	4							Rev. Trans Thru
Forward Match	4							Fwd. Match Thru
Reverse Match	4							Rev. Match Thru
Response	1	7	2	8	4			RESPONSE
Response & Isolation	1	7	2	8	4			Response & Isol'n

#### Step 2: Specifying the Standard Class.

1. Press **SPECIFY CLASS**.
2. Select standard class.

To Select	Press
S <sub>11</sub> A	<b>SPECIFY: S11A</b>
S <sub>11</sub> B	<b>S11B</b>
S <sub>11</sub> C	<b>S11C</b>
S <sub>22</sub> A	<b>SPECIFY: S22A</b>
S <sub>22</sub> B	<b>S22B</b>
S <sub>22</sub> C	<b>S22C</b>
Forward Transmission	<b>MORE SPECIFY: FWD. TRANS.</b>
Reverse Transmission	<b>MORE REV. TRANS.</b>
Forward Match	<b>MORE FWD. MATCH</b>
Reverse Match	<b>MORE REV. MATCH</b>
Response	<b>MORE RESPONSE</b>
Response & Isolation	<b>MORE RESPONSE &amp; ISOL'N</b>

3. Enter the standard number from A to G.
4. Press **CLASS DONE (SPEC'D)**.

## Calibration Required for the Network Analyzer Mode

### Step 3: Creating the Standard Class Label.

1. Press **LABEL CLASS** to label the standard class.
2. Select the standard class.  
See 2 of Step 2.
3. Enter or modify the correspondent standard class label.
4. Press **LABEL DONE**.

### Labeling and Saving Calibration Kit.

1. Press **LABEL KIT**.
2. Enter label.
3. Press **DONE KIT DONE (MODIFIED)**.
4. Press **CAL KIT [ ] SAVE USER KIT USER KIT**.
5. Press **RETURN**.

Once you have defined your own calibration kit, you can verify the definition using the copy function that lists standard parameters and class assignment.

### Verifying the Definition of the User-Defined Calibration Kit.

1. Press **(Cal) CAL KIT [ ] USER KIT** to specify the calibration kit as a user-defined kit.
2. Press **(Copy) MORE CAL KIT DEFINITION**.
  - To display the standard parameters defined, press **STANDARD DEFINITION**. Then press the softkey whose label corresponds to the standard number if you want to list the defined parameters.
  - To display the defined class assignment, press **CLASS ASSIGNMENT**.
3. To make a hardcopy, press **PRINT [STANDARD]**.
4. To return to the normal display, press **RESTORE DISPLAY**.

### Calibration Required for the Impedance Analyzer Mode

This section provide procedures for performing the calibration when measuring in the impedance analyzer mode. This section also covers how to customize the user defined calibration kit.

#### OPEN/SHORT/LOAD Calibration

In the impedance analyzer mode, 4395A should be calibrated with the 43961A impedance test kit attached. Calibration defines the measurement accuracy at the OUTPUT port on the impedance test kit. After calibration, the analyzer can measure within its specified measurement accuracy.

The calibration is performed in terms of the three items:

- OPEN (using 0 S termination)
- SHORT (using 0  $\Omega$  termination)
- LOAD (using 50  $\Omega$  termination)

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#### Note

You must use the calibration kit that is furnished to the 43961A for the standard calibration kit.



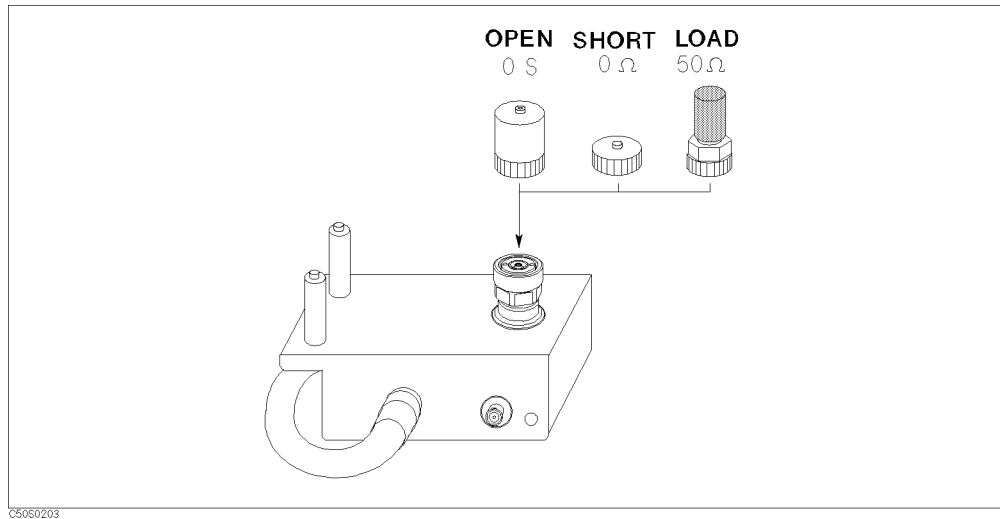
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#### Calibration Procedure

Follow the steps below to perform the OPEN/SHORT/LOAD calibrations.

1. Press **Cal**.
2. Press **CALIBRATE MENU**.
3. Connect the 0 S termination to the OUTPUT port.
4. Press **OPEN**.  
After an open calibration sequence is completed, the **OPEN** softkey label is underlined.
5. Disconnect the 0 S termination, then connect the 0  $\Omega$  termination to the OUTPUT port.
6. Press **SHORT**.  
After a short calibration sequence is completed, the **SHORT** softkey label is underlined.
7. Disconnect the 0  $\Omega$  termination, then connect the 50  $\Omega$  termination.
8. Press **LOAD**.  
After a load calibration sequence is completed, the **LOAD** softkey label is underlined.
9. Press **DONE: CAL**.
10. Verify the “Cor” notation is displayed on the left of the screen.

## Calibration Required for the Impedance Analyzer Mode



**Figure 7-1. Connecting Calibration Standards**

### Note



The OUTPUT port of the impedance test kit and the calibration standards have APC-7 connectors. The APC-7 connector is very sensitive to damage and dirt. You need to do the following when handling and storing APC-7 connectors:

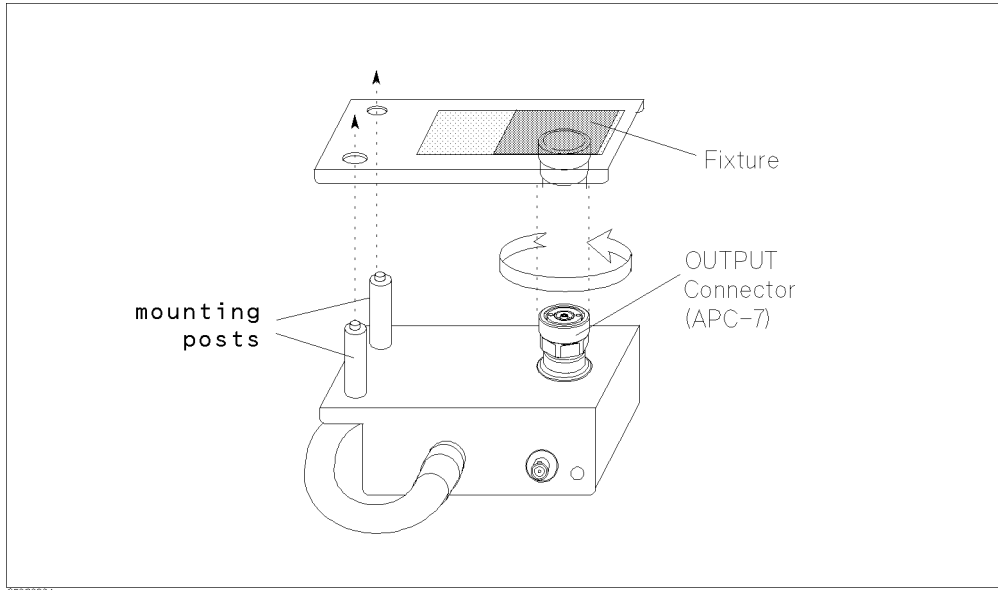
- Keep the connectors clean.
- Do not touch the mating plane surfaces.
- Do not set the connectors contact-end down.
- Before storing, extend the sleeve or connector nut.
- Use end caps over the mating plane surfaces.
- Never store connectors loose in a box or a drawer.

### Connecting the Test Fixture

To connect the test fixture to the impedance test kit, see the applicable test fixture manual for instructions. The following is a general procedure:

1. Turn the APC-7 connector of the impedance test kit OUTPUT port.
2. Verify that the connector sleeve is retracted fully.
3. Set the mounting posts of the test station into the twin locating holes at the corner of the test fixture.
4. Connect the connector on the underside of the test fixture to the OUTPUT port of the impedance test kit.

## Calibration Required for the Impedance Analyzer Mode



**Figure 7-2. Connecting Test Fixture**

### Setting the Electrical Length of the Test Fixture

After connecting the test fixture, you need to enter the extended electrical length of the fixture. This is required to eliminate a phase shift error caused by the extended electrical length.

The analyzer has electrical length data for some fixtures as preset data.

1. Press **Meas**.
2. Press **FIXTURE SELECT FIXTURE**.
3. Select the fixture model number that you are using.
4. Press **RETURN**.
5. Verify that “Del” notation appears on the left side of the display.

If your fixture is not listed on the softkey label in the fixture selection menu, use the user fixture setting menu. (See “Setting the User Defined Fixture ”.)

### Setting the User Defined Fixture

Selecting **FIXTURE [NONE] SELECT FIXTURE** under **Meas** displays the list containing Agilent fixtures. To use a fixture that is not listed in the fixture list, perform the following procedure:

1. Determine the following parameters before defining the user fixture:
  - Port Extension**            The equivalent electrical length of the fixture [m].
  - Label**                        The fixture identification that is displayed in the softkey label.
2. Press **Meas FIXTURE [NONE] MODIFY [NONE]** to display the user fixture setting menu.
3. Press **DEFINE EXTENSION**. Then enter an equivalent electrical length by using the numerical keys.
4. Press **LABEL FIXTURE**. Enter a label by using the rotary knob and then press **DONE**. Pressing **↑** **↓** changes the character set for entry. Up to 8 characters are allowed.
5. Press **KIT DONE**.
6. To store the setting data into the non-volatile memory, press **SAVE USER FXTR KIT**.

To use the user fixture setting, select **USER** under **Meas FIXTURE [NONE] SELECT FIXTURE**.

## Calibration Required for the Impedance Analyzer Mode

### Performing Fixture Compensation

Fixture compensation reduces the parasitic error existing between the test fixture electrode and the impedance test kit OUTPUT port. Fixture compensation consists of OPEN, SHORT and LOAD compensations. For basic measurements, the OPEN and SHORT compensations are required.

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**Note**

For the instructions on how to connect the standards, see the applicable test fixture manual.

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1. Connect the SHORT bar to the fixture.
2. Press **Cal** **FIXTURE COMPEN** **COMPEN MENU**.
3. Press **SHORT**.  
After the short compensation sequence is done, the **SHORT** softkey label is underlined.
4. Remove the SHORT bar and set the OPEN condition.
5. Press **OPEN**.  
After the open compensation sequence is done, the **OPEN** softkey label is underlined.
6. Press **DONE: COMPEN**.
7. Verify that “Cor” changes to “Cmp” notation.



### Selecting the Calibration Kit

See “Selecting the Calibration Kit” in “Calibration Required for the Network Analyzer Mode” for selecting the calibration kit.

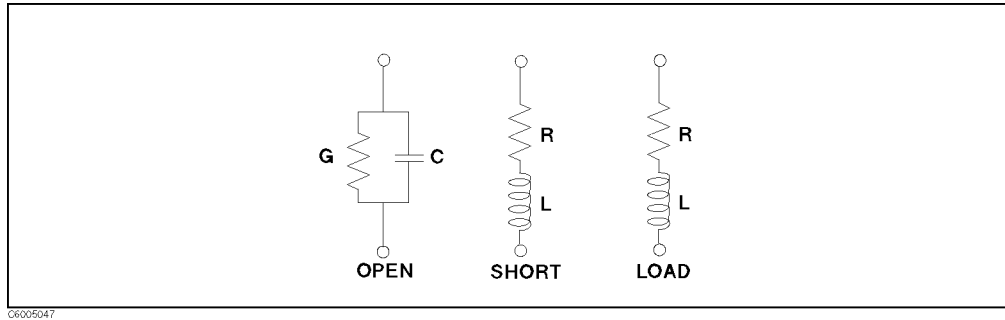
### Defining a Custom Fixture Compensation Kit

This section explains how to define a custom fixture compensation kit.

The 4395A incorporates a database of Agilent’s genuine test fixtures and their specific compensation coefficients. Therefore, as long as you use an Agilent’s genuine test fixture, you can use the fixture without defining an associated compensation kit.

If you use your custom test fixture to meet your actual needs, however, you must define the compensation kit associated with the fixture before you can use your custom test fixture. Once you have defined a fixture compensation kit, the 4395A preserves the definitions so you can select the compensation kit whenever you need to use it.

The 4395A uses the following equivalent circuit to perform fixture compensation for each of the OPEN, SHORT, and LOAD circuit states:



**Figure 7-3. Model of Fixture Compensation Kit**

Defining a fixture compensation kit involves the following steps:

1. Opening the fixture compensation kit modification menu
2. Specifying parameter values
3. Specifying the standard label

The above steps are described in the following subsections in order.

#### Step 1: Opening the Fixture Compensation Kit Modification Menu

To open the fixture compensation kit modification menu, do the following:

1. Press **Cal**.
2. Choose **COMPEN KIT [USER]**.
3. Choose **MODIFY [USER]**.
4. Choose **DEFINE STANDARD**.

## Calibration Required for the Impedance Analyzer Mode

### Step 2: Specifying Parameter Values

In this step, you specify 2 parameters for each of the OPEN, SHORT, and LOAD circuit states; thus 6 parameters in all. While the parameters for OPEN and SHORT are required, those for LOAD are optional.

To specify the parameter values, do the following:

1. Choose **OPEN: CONDUCT(G)**, and enter the conductance value (G) for OPEN.
2. Choose **CAP. (C)**, and enter the capacitance value (C) for OPEN.
3. Choose **SHORT: RESIST. (R)**, and enter the resistance value (R) for SHORT.
4. Choose **INDUCT. (L)**, and enter the inductance value (L) for SHORT.
5. Choose **LOAD: RESIST. (R)**, and enter the resistance value (R) for LOAD.
6. Choose **INDUCT. (L)**, and enter the reactance value (L) for LOAD.
7. Choose **STD DONE (DEFINED)**.

### Step 3: Specifying the Standard Label

1. Choose **LABEL KIT**.
2. Enter the standard label (up to 10 characters).
3. Choose **DONE**.
4. Choose **KIT DONE (MODIFIED)**.

## Analyzing the Measurement Results

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The 4395A provides various analyzer functions that allow you to output, save, or further analyze measurement results obtained through the 4395A's measurement functions. The first half of this chapter provides these analyzer functions which are not dependent on a particular analyzer mode. In the latter half, typical measurement techniques for each analyzer mode are described.

Topics covered include:

- Interpreting the trace
- Storing the trace data in memory
- Using the trace math functions
- Overlaying traces
- Outputting the data to a printer
- Saving and recalling the settings and data
- Typical network measurement techniques
- Typical spectrum measurement techniques
- Typical Impedance measurement techniques

## Interpreting the Trace

### Interpreting the Trace

Once you have successfully displayed the correct trace on the screen, you can use the marker to interpret the trace. The 4395A provides you with powerful search functions that allow you to search for specific points (like peaks or ripples). This section provides procedures for reading values using the marker and the marker search functions.

- To read a value using the marker
- To use the sub-markers
- To use the  $\Delta$ marker
- To search for a point that has a target value
- To search for the peak-to-peak of ripples using the statistics function
- To search for a single peak on the trace
- To search for multiple peaks
- To define the peak for search (to ignore unnecessary peaks)
- To specify the search range

### To Read a Value Using the Marker

1. Press **Marker**.
2. Move the marker by performing the following steps:
  - Turn the rotary knob until the marker moves to the point where you want to read the measured value.
  - Enter the target frequency by using numerical keys.
3. Read the marker value displayed on the upper right of the display.

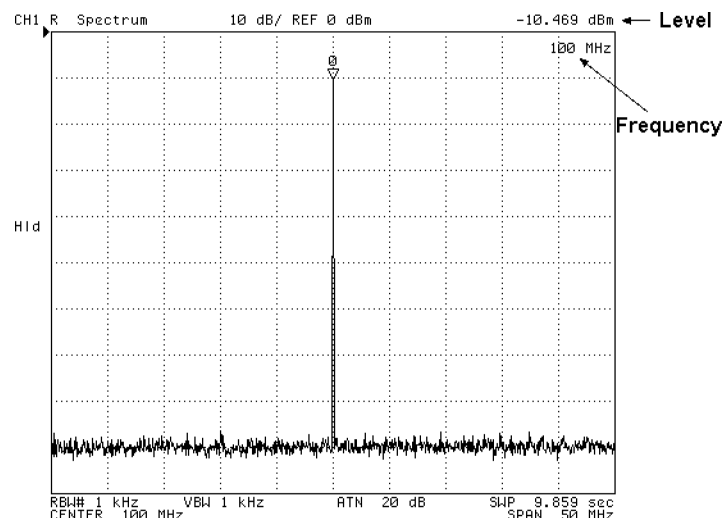


Figure 8-1. Marker Readout

### Improving the Readout Resolution (SA Mode)

If you want a more accurate frequency reading of the target signal, set the span and the RBW as narrow as possible.

#### Note



The readout resolution of the frequency is determined by the setting of the frequency span, the number of points (NOP), and the resolution bandwidth (RBW). The resolution is the sum value of  $\text{SPAN}/(\text{NOP}-1)$  and RBW. For example, when the frequency span is 10 MHz, the NOP is 801, and the RBW is 10 kHz, the readout resolution is approximately 22.5 kHz.

### To Select Marker Readout Unit (SA Mode)

Marker readout unit can be selected as follows:

1. press **Utility**.
2. Press **MKR UNIT { }**.
3. Select one of the following options:

Format	Unit	Softkey
Power	dBm	dBm
	W	WATT
Voltage	dBV	dBV
	dB $\mu$ V	dB $\mu$ V
	V	VOLT

## Interpreting the Trace

### To Use the Sub-markers

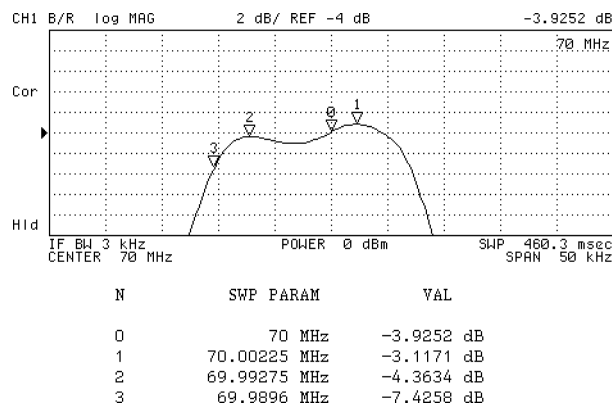
1. Press **Marker**.
2. Move the marker to the point where you want to set the sub-marker.
3. Press **SUB MKR**.
4. Select the sub-marker from **SUB MKR 1** to **7**.
5. Press **Utility**.
6. Toggle **MKR LIST** on **OFF** to **ON off** to display the marker list on the bottom of the display.

The sub-marker appears at the point of that the marker is displayed. Sub-markers are fixed horizontally and you cannot move them.

The sub-marker value can only be displayed by using the marker list.


To clear a sub-marker, press **Marker** **CLEAR SUB MKR**. Then press the sub-marker number that you want to erase from the display.

To clear all of the markers, press **Marker** **PRESET MKRS**.



**Figure 8-2. Sub-marker and Marker List**

### To Use the $\Delta$ Marker

1. Press **Marker**.
2. Place the marker at the point you want use as the reference point by using the .
3. Press  **$\Delta$ MODE MENU**.
4. Press  **$\Delta$ MKR**.
5. The reference marker appears at the marker point.
6. To move the marker:
  - Enter an offset frequency by using the numerical keys.
  - Turn the rotary knob until the marker moves to the point you want to read the value.
7. Read the level and the frequency differences from the reference marker that are displayed on the upper right of the grid.

The marker value on the upper right of the grid shows the frequency and the level differences between the reference marker and the marker.

When you use the sub-markers, use the marker list to display the difference between reference the marker and the sub-markers. (Press **Utility** and then toggle **MKR LIST on OFF** to **ON off**.)

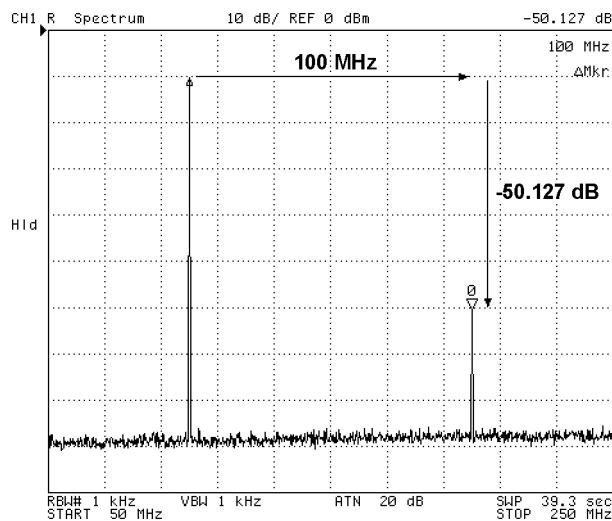


Figure 8-3.  $\Delta$ Marker

### To Search for a Point that has the Target Value (NA, SA Mode)

1. Press **Search**.
2. Press **TARGET**.
3. Enter the target value using **0** ... **9** and the unit terminator keys.

## Interpreting the Trace

To search for a target on	Press
All of the display	TARGET
Left side of the marker	SEARCH LEFT
Right side of the marker	SEARCH RIGHT

When the  $\Delta$ marker is active, the target value becomes the difference from the reference marker, not an absolute value. For example, you can search for the  $-3$  dB cutoff point of a filter by mixing the  $\Delta$ marker and the target search function.



## To Search for the Peak-to-Peak of Ripples Using the Statistics Function

### Step 1: To Specify the Search Range

1. Press **(Marker)**. Then move the marker to the start point of the range.
2. Press **ΔMODE MENU ΔMKR** to place the reference marker on the start point of the range.
3. Move the marker to the end point of the range.
4. Press **(Search) SEARCH RANGE MENU**.
5. Toggle **PART SRCH on OFF** to **ON off**.
6. Press **MKRΔ—SEARCH RNG** to set the range defined by the reference marker and the marker as the search range.

Triangle-shaped indicator ( $\Delta$ ) at the bottom of the grid shows current search range.

### Step 2: To Search For the Ripple

1. Press **(Utility)**.
2. Toggle **STATISTICS on OFF** to **ON off**.

**STATISTICS** displays the mean value (mean), the standard deviation (s.dev), and the peak-to-peak value (p-p) of the ripple within the specified range of the active channel. This information is displayed on the upper right of the display (see Figure 8-4). If you did not specify the search range, the analyzer searches within the displayed area.

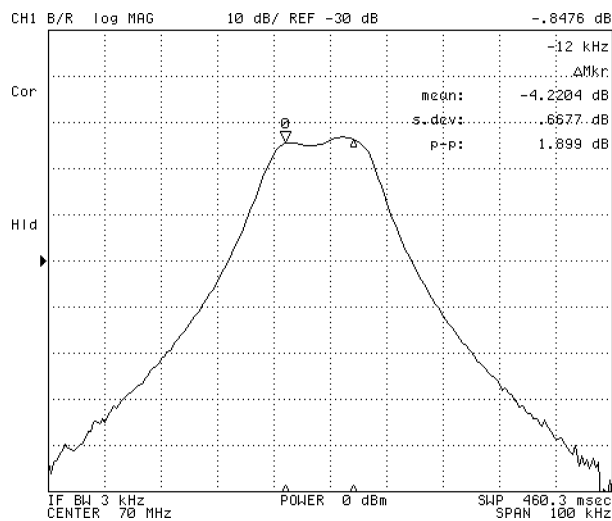


Figure 8-4. Ripple Parameters Readout

## Interpreting the Trace

### To Search for a Single Peak on the Trace

1. Press **Search**.
2. Press **SEARCH: PEAK** to search a maximum peak.
3. If you want to search for another peak:

To search next peak for	Press
2nd highest peak	<b>NEXT PEAK</b>
Peak just to the left	<b>NEXT PEAK LEFT</b>
Peak just to the right	<b>NEXT PEAK RIGHT</b>

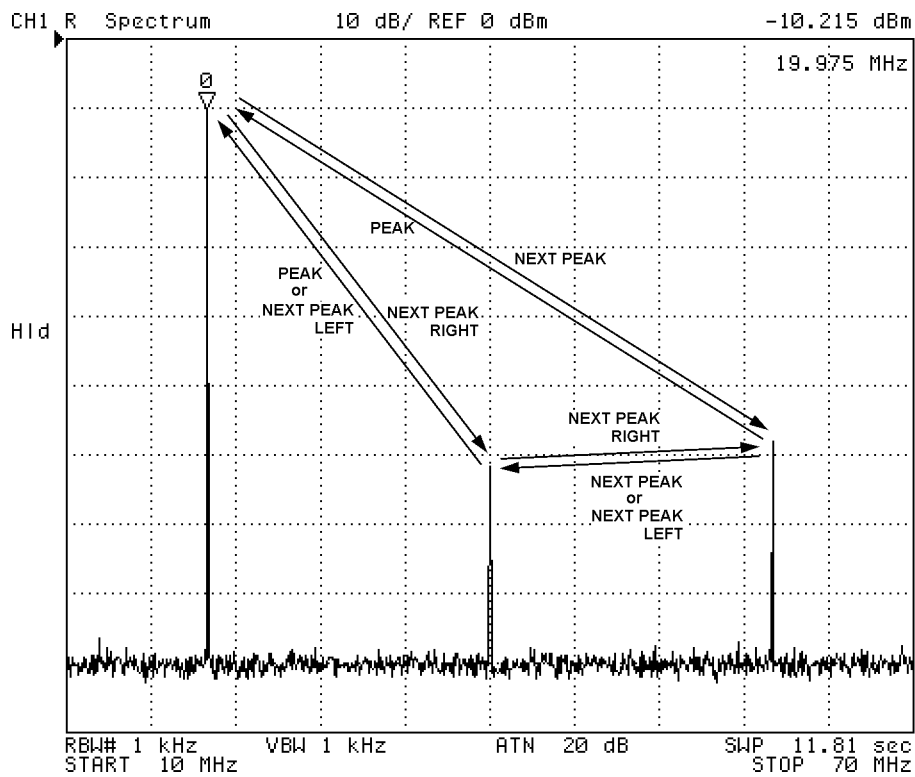


Figure 8-5. Peak Search

### To Search for Multiple Peaks

1. Press **Search** **MULTIPLE PEAKS**.
2. Do any of the following:

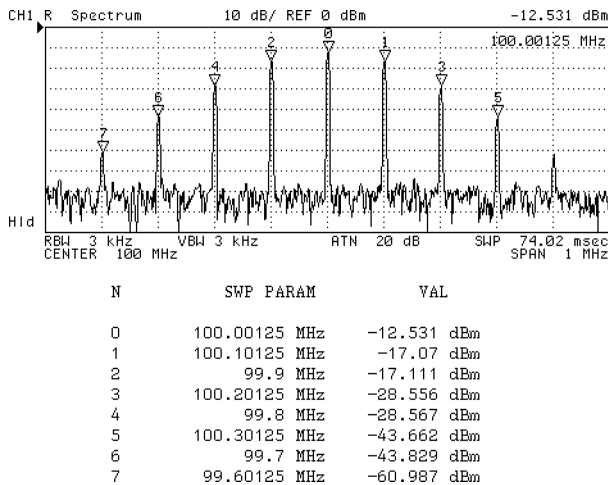
To search for peaks	Press
For all the peaks	<b>SEARCH: PEAKS ALL</b>
For peaks on the right	<b>PEAKS RIGHT</b>
For peaks on the left	<b>PEAKS LEFT</b>

3. Press **Utility**. Toggle **MKR LIST** on **OFF** to **ON** off to list all marker values.

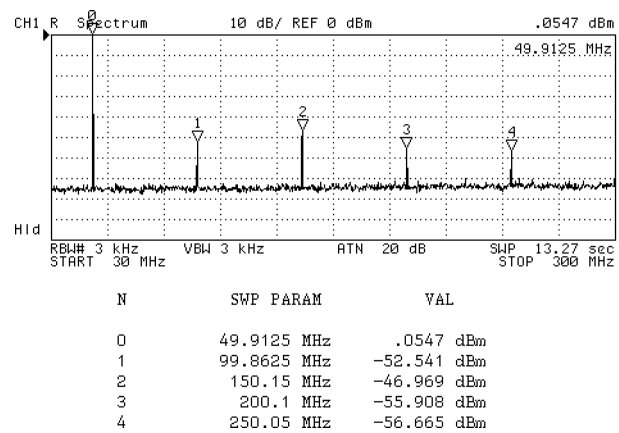
When this function is enabled, the marker is placed on the maximum peak and the sub-markers are placed on up to seven other peaks. **PEAKS ALL** searches for all the peaks and places the sub-markers in the order of peak level.

**PEAKS RIGHT** and **PEAKS LEFT** search only to the right or left side of the peak and place the sub-markers on peaks in the order found.

If the marker is to search for peaks other than harmonics, specify the peak threshold for the search function. This makes the search function ignore the peaks that have a lower level than the threshold level. See the “To Define the Peak for Search (To Ignore Unnecessary Peaks)” procedure.



**PEAKS ALL**



**PEAKS RIGHT**

Figure 8-6. Searching for Multiple Peaks

## Interpreting the Trace

### To Define the Peak for Search (To Ignore Unnecessary Peaks)

You can define the target peak for the search function using the following techniques:

- Defining the peak slope to ignore the relatively broad peaks.
- Specifying the peak threshold to ignore the absolutely small peaks.

### Defining the Peak Slope to Ignore the Relatively Broad Peaks (NA, ZA Mode)

#### Entering Directly.

1. Press **[Search]** **SEARCH: PEAK**.
2. Press **PEAK DEF MENU**.
3. Press **PEAK DEF: ΔX**. Then enter a width of the peak.
4. Press **PEAK DEF: ΔY**. Then enter a height of the peak.

#### Using the Marker.

1. Press **[Marker]**. Then move the marker on the local maximum you want to search.
2. Press **ΔMODE MENU ΔMKR**.
3. Press **[Search]** **SEARCH: PEAK PEAK DEF MENU**.
4. Move the marker to the foot of the peak.
5. Press **MKR→PEAK DELTA**.

This parameter defines the slope of the peak. The definition is made by defining ΔX and ΔY as shown in Figure 8-7. The search function searches only for peaks that are steeper than the specified slope. Use this function when the search function searches for a peak that has a gentle slope.

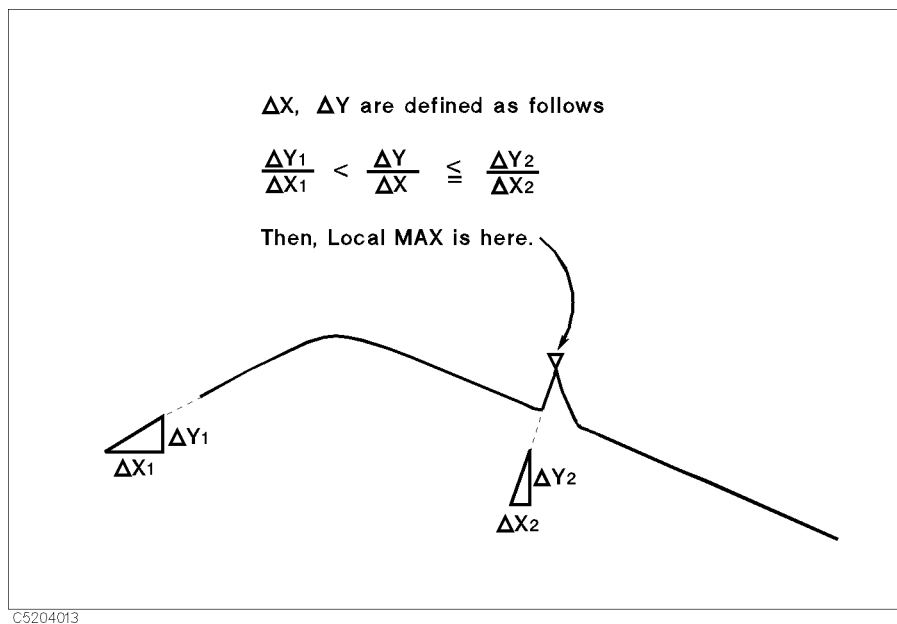


Figure 8-7. Peak Definition

**Defining Peak Height (SA Mode)**

1. Press **[Search]**.
2. Press **SEARCH: PEAK PEAK DEF MENU**.
3. Press **PEAK DEF: ΔY**.
4. Enter a peak height using the numerical keys and the units terminator keys.
5. Press **RETURN**.

**Specifying the Peak Threshold to Ignore the Absolutely Small Peaks**

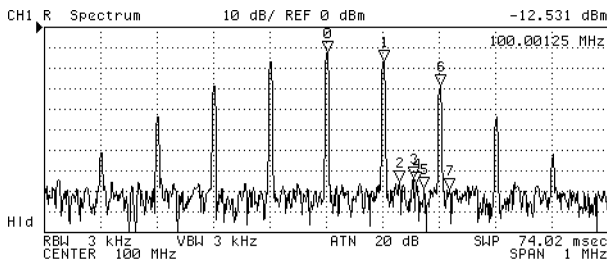
**Entering Directly.**

1. Press **[Search]** **SEARCH: PEAK PEAK DEF MENU**.
2. Press **THRESHOLD VALUE**.
3. Enter a threshold value.
4. Toggle **THRESHOLD on OFF to ON off**.

The red threshold line is displayed. The all search function searches for only the upper side of the threshold line.

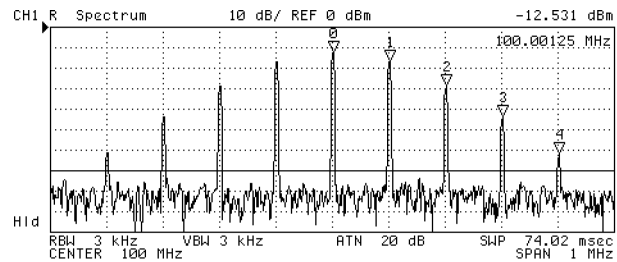
**Using the Marker.**

1. Press **[Search]**.
2. Press **SEARCH: PEAK PEAK DEF MENU**.
3. Move the marker to the point you want to set as the threshold value.
4. Press **MKR—THRESHOLD**.
5. Toggle **THRESHOLD on OFF to ON off**.



N	SWP PARAM	VAL
0	100.00125 MHz	-12.531 dBm
1	100.10125 MHz	-17.07 dBm
2	100.12875 MHz	-75.848 dBm
3	100.15375 MHz	-73.96 dBm
4	100.16 MHz	-76.535 dBm
5	100.17375 MHz	-79.036 dBm
6	100.20125 MHz	-28.556 dBm
7	100.21875 MHz	-79.069 dBm

Before Defining the Threshold



N	SWP PARAM	VAL
0	100.00125 MHz	-12.531 dBm
1	100.10125 MHz	-17.07 dBm
2	100.20125 MHz	-28.556 dBm
3	100.30125 MHz	-43.662 dBm
4	100.40125 MHz	-61.854 dBm

After Defining the Threshold

**Figure 8-8. Threshold Function**

## Interpreting the Trace

### To Specify the Search Range

You can set the search function to search within a specified range. To specify the search range, use one of the following two procedures:

- Using the marker
- Using the  $\Delta$ marker

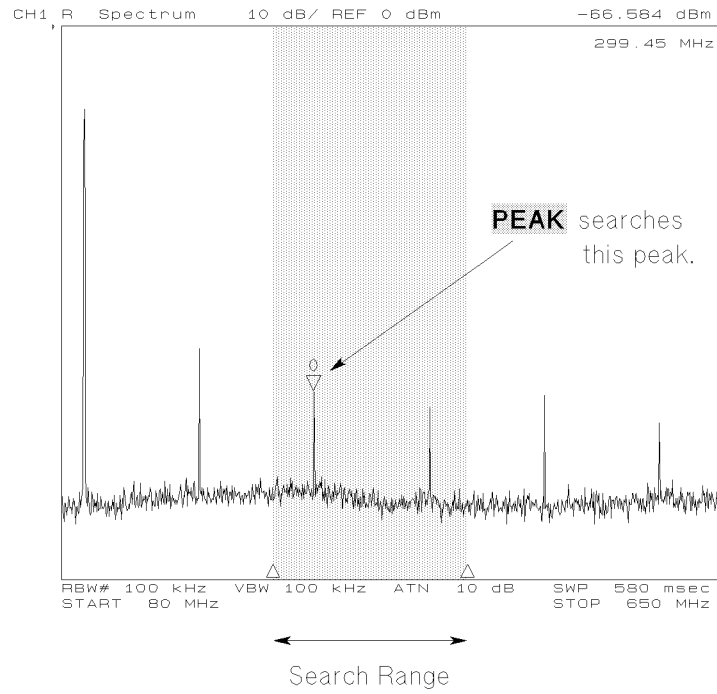
#### Using the Marker

1. Press **Search**.
2. Press **SEARCH RANGE MENU**.
3. Toggle **PART SRCH** on **OFF** to **ON off**.
4. Move the marker to the start point of the search range.
5. Press **MKR→LEFT RNG** to set the marker position as the left edge of the range.
6. Move the marker to the end point of the search range.
7. Press **MKR→RIGHT RNG** to set the marker position to the right edge of the range.
8. Press **RETURN**.

#### Using the $\Delta$ Marker

1. Press **Marker**.
2. Move the marker to the start point of the search range.
3. Press  **$\Delta$ MODE MENU**.
4. Press  **$\Delta$ MKR**.
5. Move the marker to the end point of the search range.
6. Press **Search**.
7. Press **SEARCH RANGE MENU**.
8. Toggle **PART SRCH** on **OFF** to **ON off** to enable the search range.
9. Press **MKRA→SEARCH RNG**.

All the search functions search within a specified search range. You can specify the search range for each channel individually. The triangle-shaped indicator at the bottom of the grid shows the current search range (see Figure 8-9). In this figure, **Search SEARCH: PEAK** searches for the highest peak within the specified range. It does not search all of the grid.



**Figure 8-9. Search Range**

To turn off the part search, press **Search** **SEARCH RANGE MENU**, and then toggle **PART SRCH ON** off to **on OFF**.

## To Use the Trace Memory

---

## To Use the Trace Memory

### To Store the Trace into the Trace Memory

1. Display the trace you want to store into the trace memory.
2. Press **Display**.
3. Press **DATA→MEMORY**.

This operation only stores the digitized trace data into the trace memory (not the display on LCD). You can store the trace data for the trace memory of each channel individually. The stored trace data is retained until new data is stored, the 4395A is preset, or power is turned off.

### To Display Memory Traces

1. Press **Display** **DISPLAY [ ]**.
2. Select the display trace:

To display	Press
Memory trace	<b>MEMORY</b>
Data and memory trace together	<b>DATA and MEMORY</b>
Data trace	<b>DISPLAY: DATA</b>

Memory traces are displayed as green (channel 1) or red (channel 2) to distinguish between the two traces. You can change this color by using the modify colors menu under **Display** **MORE** **ADJUST DISPLAY**.

If the trace memory of the active channel is empty, the error message (CAUTION: NO VALID MEMORY TRACE) is displayed.

### Notes

The scale of the memory trace is coupling with the data trace. If you want to change the scale setting for only the data or memory trace, toggle **Scale Ref** **D&M SCALE [COUPLE]** to **[UNCUPLE]**. Then toggle **SCALE FOR [DATA]** or **[MEMORY]** before you change the settings.



## To Use the Trace Math Function

1. Press **[Display]**.
2. Press **DATA MATH [ ]**.
3. Do one of the following:




To	Press
Add Trace with Memory Trace	<b>DATA+MEM</b>
Subtract Trace with Memory Trace	<b>DATA-MEM</b>
Divide Trace with Memory Trace	<b>DATA/MEM</b>

## To Turn Off the Data Math Function

1. Press **[Display]**.
2. Press **DATA MATH [ ]**.
3. Press **DATA MATH: DATA**.

## To Multiply the Trace

1. Press **[Display]**.
2. Press **DATA MATH [ ]**.
3. Press **GAIN**. Then enter a multiplication factor:

To	Use
Change value continuously	
Change value with 1-2-5 steps	 
Enter value directly	<b>[0] ... [9]</b> and unit keys

**Note** For more information about the settings of gain and offset value, see Appendix B.



## To Clear a Multiplied Trace

1. Press **[Display]**.
2. Press **DATA MATH [ ]**.
3. Press **DEFAULT GAIN & OFS**.

## To Overlay Multiple Traces

---

## To Overlay Multiple Traces

### To Store the Trace into the Overlay Trace

1. Press **Display**.
2. Press **OVERLAY TRACES**.
3. Press **SELECT PEN COLOR** and select one of the colors:

Overlay Trace Color <sup>1</sup>	Press
White	PEN 1
Red	PEN 2
Yellow	PEN 3
Green	PEN 4
Light Blue	PEN 5
Blue	PEN 6

<sup>1</sup> Power ON default.

4. Press **DATA→OVERLAY**.
5. Repeat steps 1 through 4 above to store different traces.

---

### Note



You cannot change the scale setting for the overlay traces. It is also impossible to read the overlay trace data with markers or to save the data into a floppy disk or memory disk. For those applications, use the data trace or memory trace.

---

### To Clear the Overlay Traces

1. Press **Display**.
2. Press **OVERLAY TRACES**.
3. Press **CLEAR GRAPHICS**.

---

## To Print

This step provides the following procedures for printing:

- To print out a display image
- To see or print a measured value list
- To print an analyzer setting

### To Print Out a Display Image

1. Connect the printer to the analyzer with a cable.
2. Press **(Copy)** **PRINT [STANDARD]** to print out a display image.  
To abort printing, press **(Copy)** **COPY ABORT**.

### To See or Print a Measured Value List

1. Press **(Copy)**.
2. Press **MORE LIST VALUES** to display the measured value list.
  - To see all of the measured value list, press **NEXT PAGE** or **PREV PAGE** to turn the pages.
  - To print out the measured value list, press **PRINT [STANDARD]**.
  - To return to the measurement display, press **RESTORE DISPLAY**.

### To Print an Analyzer Setting

1. Press **(Copy)**.
2. Press **MORE OPERATING PARAMETERS** to display the analyzer setting table as shown below.
3. Press **PRINT [STANDARD]** to print out the settings.
4. To return to the measurement display, press **RESTORE DISPLAY**.

To Print

Analyzer Setting Table

OPERATING PARAMETER	CH1	CH2
ANALYZER TYPE	NA	NA
SWEEP TYPE	LIN FREQ	LIN FREQ
NUMBER of POINTS	201	201
PORT 1 ATTEN.	0 dB	0 dB
PORT 2 ATTEN.	0 dB	0 dB
INPUT R ATTEN.	20 dB	20 dB
INPUT A ATTEN.	20 dB	20 dB
INPUT B ATTEN.	20 dB	20 dB
GROUP DELAY APERTURE	1 % SPAN	1 % SPAN
PHASE OFFSET	0 °	0 °
PORT 1 EXTENSION	0 s	0 s
PORT 2 EXTENSION	0 s	0 s
INPUT R EXTENSION	0 s	0 s
INPUT A EXTENSION	0 s	0 s
INPUT B EXTENSION	0 s	0 s
	OFF	OFF
VELOCITY FACTOR	1	1
CAL KIT	7mm	7mm
Z0	50 ohm	50 ohm
CAL TYPE	NONE	NONE

## To Save and Recall the Settings and Data

This step provides the following procedures for saving and recalling:

- To save an analyzer setting or measurement data
- To recall a saved analyzer setting
- To save a display image to a TIFF file
- To save measured data for a spreadsheet
- To copy a file between floppy disk and memory disk
- To initialize a disk for use
- To initialize the memory disk for use
- To back up the memory disk

### To Save an Analyzer Setting or Measurement Data

The 4395A supports two storage devices, a built-in flexible disk drive and a 512KB memory disk. The flexible disk drive should be used to store large numbers of files and for long term data storage. Memory disk should be used for temporary data and instrument states and to store or get data quickly.

**Note**



When you store important data into the memory disk, perform the memory disk backup operation described in “To Back Up the Memory Disk”. Otherwise, the memory disk data is lost when the power is turned off.

1. Insert a LIF or DOS formatted 3.5 inch disk into the built-in disk drive (if you are recalling an instrument state file from the memory disk, skip this step).
2. Press **Save**.
3. Select a save data type:

Save Data Type	Press
Instrument states only	STATE
Measurement data only <sup>1</sup>	DATA ONLY (binary)

<sup>1</sup> You can specify a data array type. See the “Specifying a Data Array Type” procedure.

4. Select where the file is stored by pressing either **STOR DEV [DISK]** (for the built-in disk drive) or **STOR DEV [MEMORY]** (for the memory disk).
5. Enter a filename. Then press **DONE**.

The analyzer automatically detects the disk format as either the LIF (Logical Interchange Format) or DOS (Disk Operating System). If you insert an any other format type disk, an error message is displayed.

For more information, Appendix A provides a complete list of the instrument state to be saved.

## To Save and Recall

### Specifying the Data Format

To save only the measurement data in the ASCII or binary format, follow these steps:

1. Press **Save**.
2. Choose **DATA ONLY**. Then select one of the following options by choosing the corresponding softkey:

<b>Data Format</b>	<b>Softkey</b>
ASCII	<b>SAVE ASCII</b>
Binary	<b>SAVE BINARY</b>

### Specifying a Data Array Type

To save only the measurement data by specifying the data array to save, follow these steps:

1. Press **Save**.
2. Choose **DATA ONLY**.
3. Press **DEFINE SAVE DATA**.
4. Choose the softkey associated with the data array to save so that the last two words of the key label are toggle from **on OFF** to **ON off**.

<b>Data Array</b>	<b>Toggle</b>
Raw data array	<b>RAW on OFF to ON off</b>
Calibration data array	<b>CAL on OFF to ON off</b>
Data array	<b>DATA on OFF to ON off</b>
Memory array	<b>MEM on OFF to ON off</b>
Data Trace array	<b>DATA TRACE on OFF to ON off</b>
Memory Trace array	<b>MEM TRACE on OFF to ON off</b>

5. Choose **RETURN** to return to the top menu.

See Appendix A for the definition of each array.

### To Recall a Saved Analyzer Setting

1. Insert a disk (if you are recalling an instrument state file from the memory disk, skip this step).
2. Press **Recall**.
3. Select where the file is stored by pressing either **STOR DEV [DISK]** (for a built-in disk drive) or **STOR DEV [MEMORY]** (for a memory disk).
4. Search for the filename you want to recall (the files are listed on the softkey label).
5. If a target file is not listed on the softkey label, turn the label page by pressing **PREV FILES** or **NEXT FILES**.

6. Press the softkey corresponding to the filename label.

### To Save a Display Image to a TIFF File

1. Press **(Save)** **GRAPHICS** .
2. Select where to store the file by pressing either **STOR DEV [DISK]** (for a built-in disk drive) or **STOR DEV [MEMORY]** (for a memory disk).
3. Enter filename. Then press **DONE** .

---

**Note**

A display image is saved according to the color setup you have done on the print setup menu (**(Copy)** **PRINT SETUP** ). You can choose from **PRINT:STANDARD** (black and white), **PRINT COLOR [FIXED]** (color against white background), and **PRINT COLOR [VARIABLE]** (color against black background).

---

The analyzer saves a TIFF file with an extension, “.TIF” for a DOS format, or a suffix, “\_T” for a LIF format.

If there is a file that has the same name you entered on the disk, the error message, “filename error” will be displayed. To save the file, use the other filename to save or purge the old file. To purge a file, press **(Save)** **FILE UTILITIES PURGE FILE** then select the displayed filename by pressing the associated softkey.

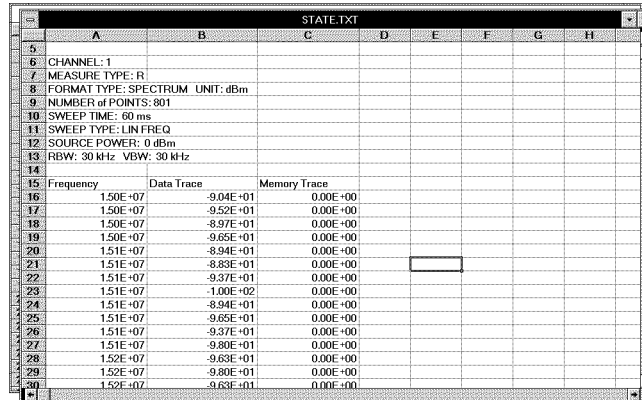
### To Save Measured Data for a Spreadsheet

1. Insert a DOS format disk into the built-in disk drive.
2. Press **(Save)** **DATA ONLY** .
3. Press **SAVE ASCII** .
4. Select the built-in disk drive as the storage device by toggling to **STOR DEV [DISK]** .
5. Enter a filename. Then press **DONE** .

The analyzer saves an ASCII file with a “.TXT” extension.

The measured data is saved as ASCII text. Each value is separated by a tab. When you open this file from the spreadsheet software, specify the file format as the “TEXT with TAB delimiter”.

## To Save and Recall



	A	B	C	D	E	F	G	H
5								
6	CHANNEL: 1							
7	MEASURE TYPE: R							
8	FORMAT TYPE: SPECTRUM UNIT: dBm							
9	NUMBER of POINTS: 801							
10	SWEEP TIME: 60 ms							
11	SWEEP TYPE: LIN FREQ							
12	SOURCE POWER: 0 dBm							
13	RBW: 30 kHz VBW: 30 kHz							
14								
15	Frequency	Data Trace	Memory Trace					
16	1.50E+07	-9.04E+01	0.00E+00					
17	1.50E+07	-9.52E+01	0.00E+00					
18	1.50E+07	-8.97E+01	0.00E+00					
19	1.50E+07	-9.65E+01	0.00E+00					
20	1.51E+07	-8.94E+01	0.00E+00					
21	1.51E+07	-8.83E+01	0.00E+00					
22	1.51E+07	-9.37E+01	0.00E+00					
23	1.51E+07	-1.00E+02	0.00E+00					
24	1.51E+07	-8.94E+01	0.00E+00					
25	1.51E+07	-9.65E+01	0.00E+00					
26	1.51E+07	-9.37E+01	0.00E+00					
27	1.51E+07	-9.80E+01	0.00E+00					
28	1.52E+07	-9.63E+01	0.00E+00					
29	1.52E+07	-9.80E+01	0.00E+00					
30	1.52E+07	-9.63E+01	0.00E+00					

Figure 8-10. Reading Saved Data from Spreadsheet Software

## To Copy a File between Floppy Disk and Memory Disk

1. Press **(Save)** **FILE UTILITIES** .
2. Press **COPY FILE** .
3. Select a storage device where the file is stored by toggling either **STOR DEV [DISK]** (for the build-in disk drive) or **STOR DEV [MEMORY]** (for the memory disk).
4. Search for the filename you want to recall (the files are listed on the softkey label).
5. If a target file is not listed on the softkey labels, turn the label page by pressing **PREV FILES** or **NEXT FILES** .
6. Press the softkey corresponding to the filename label.
7. Enter the filename of the target file.
8. Select the target storage device by toggling **STOR DEV [DISK]** or **[MEMORY]** .
9. Press **DONE** to copy the file.

You cannot copy a file between the LIF and DOS formats. When you want to copy a file on a DOS formatted disk to the memory disk, you must initialize the memory disk to the DOS format.

## To Initialize a Disk for Use

### Note

- Initializing the disk erases all data on the disk.
- The 4395A can initialize a 1.44 MB 3.5 inch flexible disk only.



1. Verify that the disk is not write protected.
2. Insert the disk.
3. Press **(Save)**.
4. Choose **FILE UTILITIES** .
5. Choose **INITIALIZE DISK** .



6. Select the disk format (either DOS or LIF) by toggling `FORMAT [DOS]` or `[LIF]`.
7. Toggle to `STOR DEV [DISK]` to select the disk drive.
8. Press `INIT DISK: YES` to initialize the disk.

## To Initialize the Memory Disk for Use

---

### Note



Initializing the memory disk erases all data on the memory disk. Copy important files on the memory disk to a flexible disk before initializing the memory disk.

---

1. Press `(Save) FILE UTILITIES`.
2. Press `INITIALIZE DISK`.
3. Select the disk format (either DOS or LIF) by toggling `FORMAT [DOS]` or `[LIF]`.
4. Toggle to `STOR DEV [MEMORY]` to select the memory disk.
5. Press `INIT DISK: YES`.

The files on the memory disk are lost when the 4395A is turned off unless the memory disk is backed up using `BACK UP MEMO DISK`.

## To Back Up the Memory Disk

The data (files and disk format) on the memory disk can be copied to a non-volatile memory (flash memory) by memory disk backup operation. The backup copy data is recalled to the memory disk every time the 4395A is turned on.

1. Press `(Save)`.
2. Press `BACK UP MEMO DISK`.

---

### Note



- When you store important data into the memory disk, You must back up the memory disk using `BACK UP MEMO DISK`. Otherwise, the data on the memory disk is lost when the 4395A is turned off.
  - Backup is also important as a means of recovering your precious data in the event of a power interruption or misoperation. For example, even if you inadvertently formatted the memory disk while using the 4395A, you could easily recover the data (files and disk format) from the backup copy; all you have to do is turn OFF and ON the 4395A.
  - The memory disk can endure approximately 100,000 cycles of backup operation.
-

## Typical Network Measurement Techniques

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### Typical Network Measurement Techniques

This section provides the following typical measurement techniques using the network analyzer mode of operation:

- Measuring 3 dB bandwidth using the width function
- Measuring electrical length
- Measuring phase deviation
- Compensating for the electrical delay caused by an extension cable

## Measuring 3 dB Bandwidth Using the Width Function

1. Do one of the following:

Reference Point	Keystrokes
Maximum value	Press <b>[Search]</b> <b>MAX</b> .
Nominal frequency	Press <b>[Marker]</b> and enter the nominal frequency through the numerical keypad.

2. Press **[Marker]** **ΔMODE MENU** **ΔMKR** to make the marker a reference.

3. Press **[Search]** **WIDTH [OFF]** **WIDTH VALUE**.

4. Press **[−]** **[3]** **[×1]** to enter −3 dB.

5. Toggle **WIDTH on OFF** to **ON off**.

As shown in Figure 8-11, a pair of sub-markers appear on both sides of the reference marker, being lowered by the specified number of levels; also, another sub-marker is displayed in the middle between the two sub-markers. The bandwidth (BW), center frequency of the bandwidth (cent), Q factor (Q), insertion loss (loss), and left and right hand bandwidth (ΔL.F and ΔR.F) are displayed at the upper right corner of the grid.

Figure 8-12 shows a typical example of a band pass filter measurement trace and describes each parameter. 0 will be returned for all parameters when two cutoff points can not be found.

Parameter	Description
Bandwidth (BW)	The stimulus width between two cutoff points ( $f_1$ and $f_2$ )
Center frequency of the bandwidth (cent)	The center point ( $f_{cent}$ ) of the two cutoff points ( $f_1$ and $f_2$ )
Q factor (Q)	$Q = \frac{\sqrt{f_1 \times f_2}}{BW}$
Insertion loss (loss)	The absolute value of the difference of the maximum value within a specified range and 0 dB
Left hand bandwidth (ΔL.F)	The stimulus difference between the left hand cutoff point ( $f_1$ ) and the center point of a specified range.
Right hand bandwidth (ΔR.F)	The stimulus difference between the right hand cutoff point ( $f_2$ ) and the center point of a specified range.

You can move the reference marker using the rotary knob. When you enable the width function, the reference marker automatically turns into a tracking Δmarker that allows you to move the reference marker.

For more information on the width function, see Appendix A.

## Measuring 3 dB Bandwidth Using the Width Function

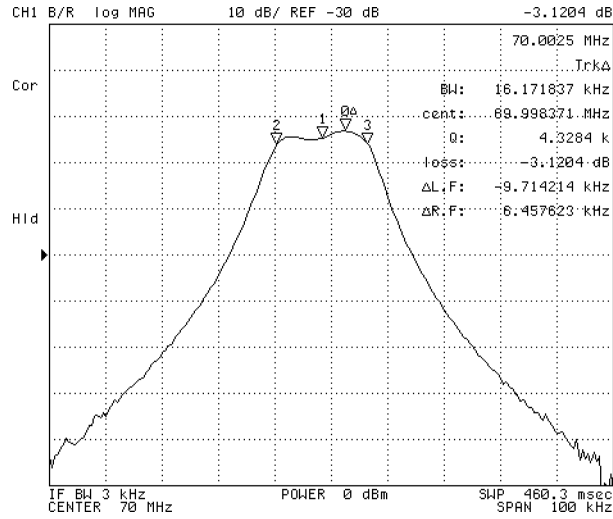


Figure 8-11. Bandwidth Measurement Using Width Function

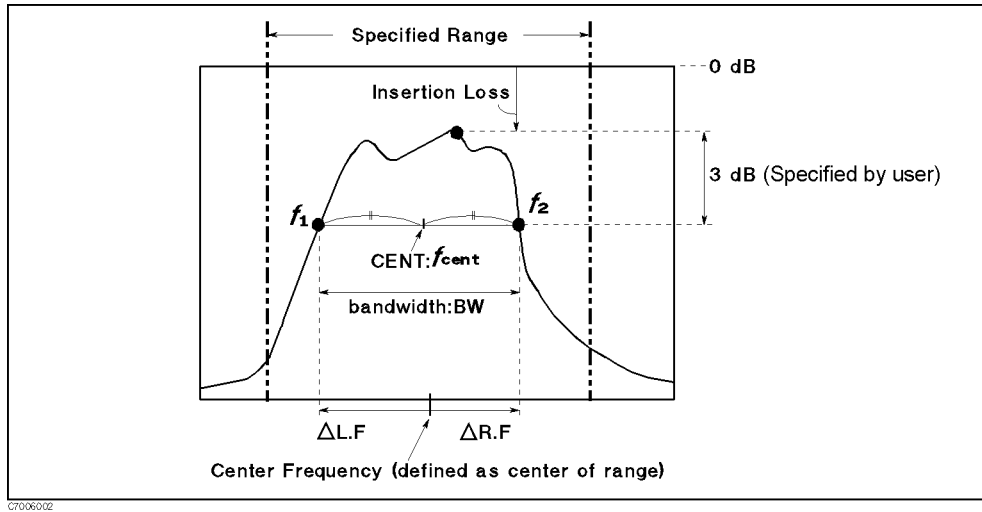


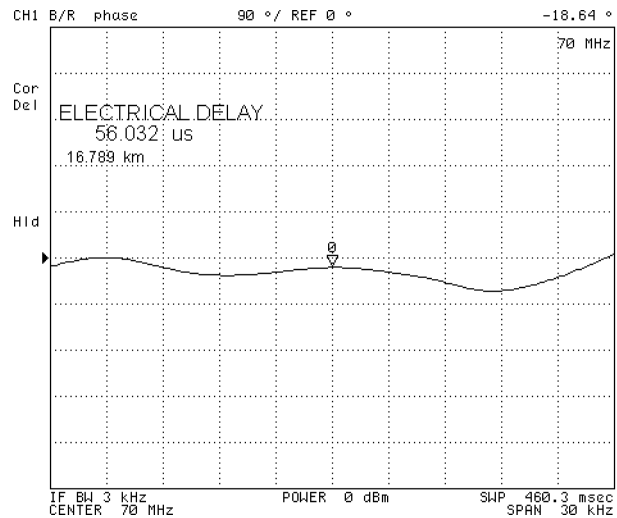
Figure 8-12. Parameters of a Band Pass Filter Measurement

### Measuring Electrical Length

1. Press **[Format]** **PHASE**, and then select the desired phase format.
2. Do one of the following procedures:
  - Using the marker:
    - a. Press **[Marker]**.
    - b. Turn the rotary knob to move the marker to the center of the display.
    - c. Press **[Cal]** **MORE ELEC DELAY MENU**.
    - d. Press **MKR→DELAY**.
  - Using the rotary knob:
    - a. Press **[cal]** **MORE ELEC DELAY MENU**.
    - b. Press **ELECTRICAL DELAY**.
    - c. Turn the rotary knob until the trace becomes flat at the specified frequency.
3. Press **ELECTRICAL DELAY**. Then read the electrical length that is displayed under the electrical delay time.



Before Adding the Electrical Length



After Adding the Electrical Length

**Figure 8-13. Measuring Electrical Length**

If the average relative permittivity ( $\epsilon_R$ ) of the DUT is known over the frequency span, the length calculation can be adjusted to better indicate the actual length of the DUT. This can be done by entering the relative velocity factor for the DUT.

## Measuring Electrical Length

### Setting the Velocity Factor of a Cable

1. Press **Cal**.
2. Press **MORE**.
3. Press **VELOCITY FACTOR**.
4. Enter a new value. Then press **(x1)**.

The relative velocity factor for a given dielectric can be calculated by:

$$V_f = \frac{1}{\sqrt{\epsilon_R}}$$

The velocity factor defaults to 1.

## Measuring Phase Deviation

### Deviation from the Linear Phase

1. Specify the frequency range.
2. Display the phase trace by pressing **[Format]** **PHASE**.
3. Adjust the scale settings by pressing **[Scale Ref]** **AUTO SCALE**.
4. Press **[Marker]**. Then move the marker to any of the points where the sloping trace crosses the center (place the marker on the sloping portion of the trace, not the vertical phase “wrap-around”).
5. Press **[cal]** **MORE ELEC DELAY MENU MKR→DELAY** to add enough electrical length to match the phase slope present at the marker frequency.
6. Read the phase value as a deviation from the linear phase.

By adding the electrical length to flatten the phase response, the linear phase shift caused by the DUT is removed. The displayed response is the deviation from the linear phase.

To turn off the electrical length function, press **[cal]** **MORE ELEC DELAY MENU ELECTRICAL DELAY** **[0]** **[X1]**.

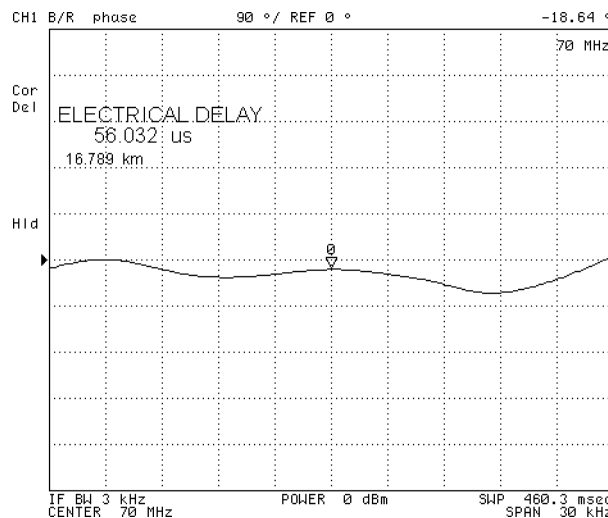


Figure 8-14. Deviation from the Linear Phase

### Group Delay

The phase linearity of many devices is specified in terms of group delay or envelope delay. This is especially true of telecommunications components and systems.

Group delay is the difference in propagation time through a device as a function of frequency. It is measured as a ratio of phase change over a sample delta frequency as follows:

$$Group\ Delay = -\frac{\Delta\phi}{360\Delta F}$$

Where:  $\Delta\phi$  is phase change [deg]  
 $\Delta F$  (commonly called the “aperture”) is the frequency difference that gives  $\Delta\phi$

1. Press **[Format]**.

## Measuring Phase Deviation

2. Press **DELAY**.
3. Press **Scale Ref** **AUTO SCALE**.

The group delay format displays the phase deviation to the group delay aperture. Therefore, setting the group delay aperture affects the trace shape. Setting a wider aperture makes the trace smoother. The aperture defaults to 1% of the span.

### Setting the Group Delay Aperture.

1. Press **Bw/Avg**.
2. Press **GROUP DELAY APERTURE**.
3. Enter group delay aperture value as a percentage of the span.

The group delay aperture is based on the number of points, not the real aperture. For example, if the number of points is 201, a 1% group delay aperture causes the 4395A to calculate the group delay using the adjacent measurement points on both sides. Therefore, the group delay trace may differ depending on the specified number of points.

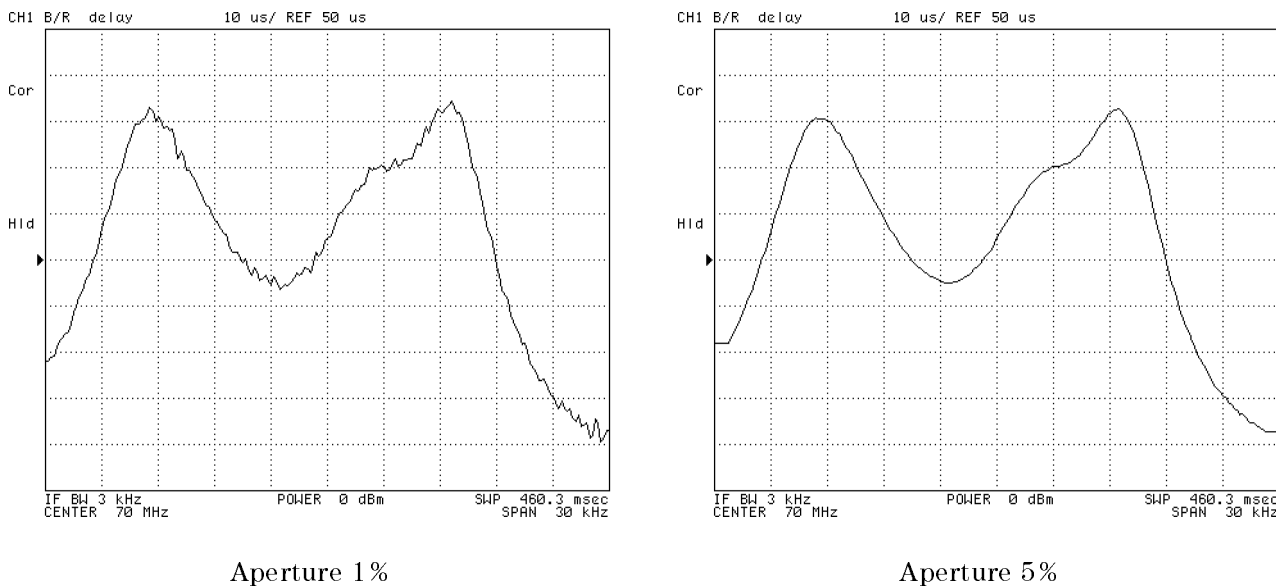


Figure 8-15. Setting Group Delay Aperture

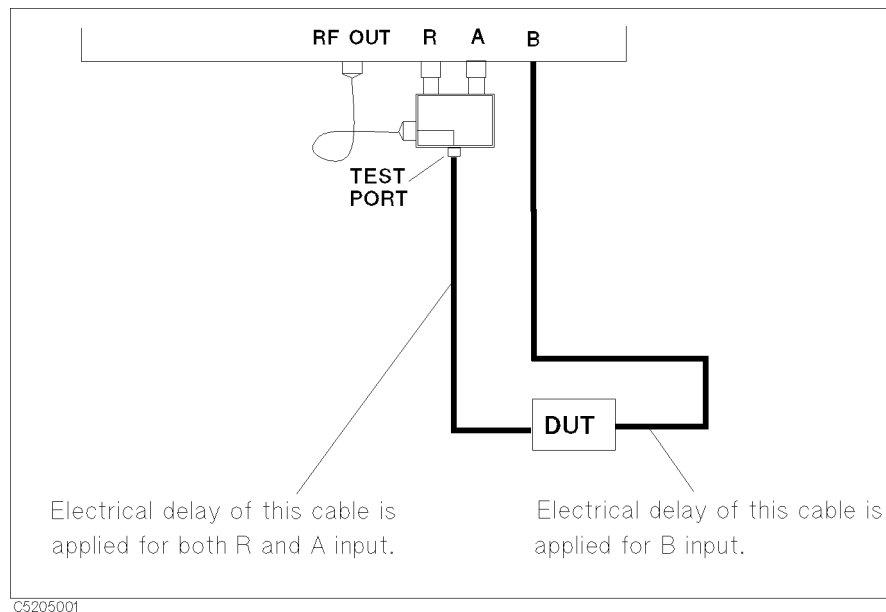


## Compensating for the Electrical Delay Caused by an Extension Cable

### If the Electrical Delay of the Extension Cable is Known

1. Press **Cal** **MORE** **PORT EXTENSIONS** to open the port extension menu.
2. Enter the electrical delay values for the respective input ports.
  - If you do not use the S-parameter test set, follow these steps:
    - Press **EXTENSION INPUT R**. Then enter the electrical delay of the cable that is connected to the R input.
    - Press **EXTENSION INPUT A**. Then enter the electrical delay of the A input.
    - Press **EXTENSION INPUT B**. Then enter the electrical delay of the B input.

If you use the transmission/reflection (T/R) test set, enter the electrical delay of the cable that is connected to the TEST PORT (for the R and A inputs).



**Figure 8-16. Port Extension With the T/R Test Set**

- If you use the S-parameter test set, follow these steps:
  - Enter "0" for **EXTENSION INPUT R**, **EXTENSION INPUT A** and **EXTENSION INPUT B** to clear the port extension of the R, A and B inputs.
  - Press **EXTENSION PORT 1**. Then enter the electrical delay of the PORT 1.
  - Press **EXTENSION PORT 2**. Then enter the electrical delay of the PORT 2.
- 3. Toggle **EXTENSION on OFF** to **ON off** to enable the port extension.

## Compensating for the Electrical Delay Caused by an Extension Cable

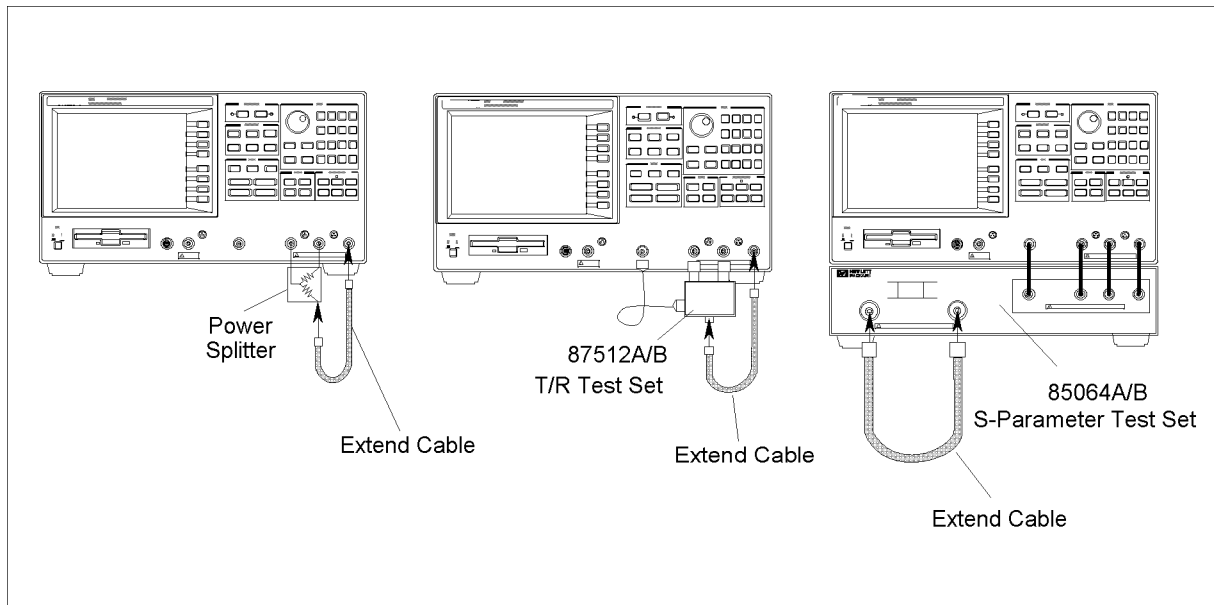
### If the Electrical Delay of the Extension Cable is Unknown

You can determine the electrical delay of the extension cable by:

- Measuring the electrical delay of the cable
- Measuring the cable's reflection in the OPEN or SHORT circuit state.

### Measuring the Electrical Length of a Cable.

1. Connect the cable as shown in Figure 8-17.
2. Define the frequency range according to the measurement conditions.
3. Press **[Meas]** **B/R** (or **S PARAMETERS** **Trns: FWD S21 [B/R]**) to select the transmission measurement.
4. Press **[Format]** **PHASE** to select the phase format.
5. Press **[Marker]**. Then move the marker to the sloping trace that crosses the center of the display.
6. Press **[Cal]** **MORE ELEC DELAY MENU** **MKR→DELAY ELECTRICAL DELAY**, then read the electrical delay of the cable.
7. Press **[0]** **[X1]** to clear the electrical delay offset.
8. Enter a measured electrical delay as described in the “If the Electrical Delay of the Extension Cable is Known” procedure.



**Figure 8-17. Cable Measurement Configuration (Transmission)**

### Reflection of a Opened or Shorted Cable.

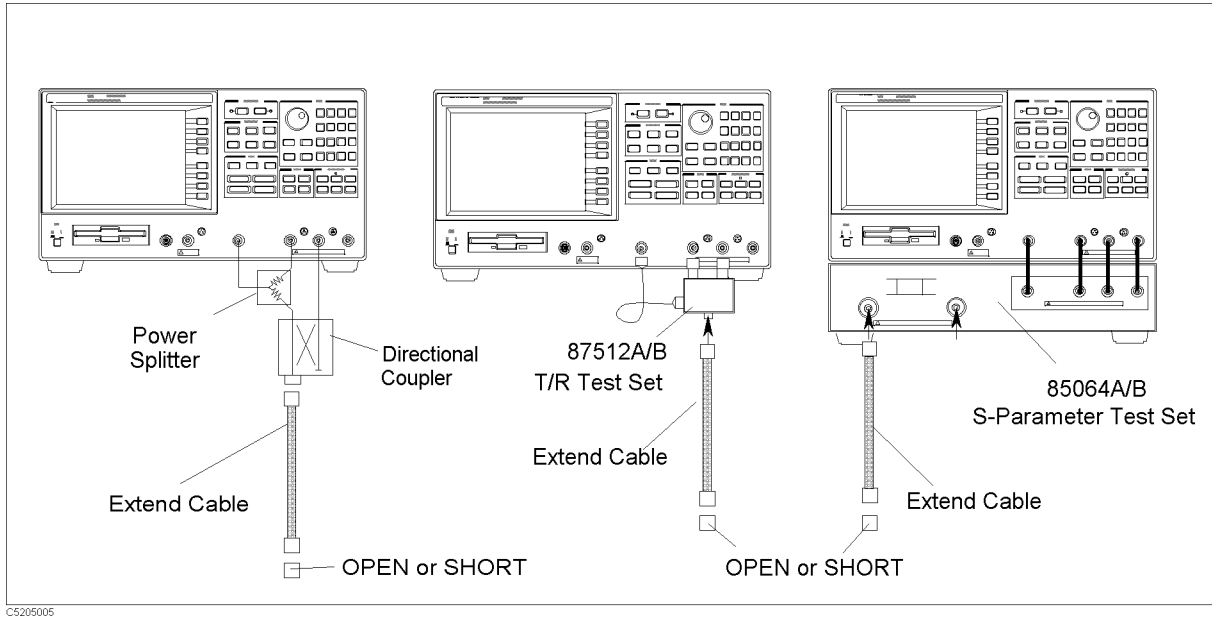
1. Connect the cable as shown in Figure 8-18.
2. Define the frequency range according to the measurement conditions.
3. Press **[Meas]** **A/R** (or **S PARAMETERS** **Ref1:FWD S11 [A/R]**) to select the reflection measurement.
4. Press **[Format]** **PHASE** to select the phase format.

## Compensating for the Electrical Delay Caused by an Extension Cable

5. Press **(Marker)**. Then move the marker to the sloping trace that crosses the center of the display.
6. Press **(Cal)** **MORE** **ELEC DELAY MENU** **MKR→DELAY** **ELECTRICAL DELAY**, then read the electrical delay of the cable.

Note that this value is twice the real delay because there are both output and return paths.

7. Press **(0)** **(X1)** to clear the electrical delay offset.
8. Enter *half the value* of the measured electrical delay as described in the “If the Electrical Delay of the Extension Cable is Known” procedure.




**Figure 8-18. Cable Measurement Configuration (Reflection)**

### Typical Spectrum Measurement Techniques

This section describes typical spectrum measurement techniques. The topics covered include:

- Measuring the noise level
- Measuring the carrier to noise ratio
- Performing the time gated spectrum analysis
- Measuring zero span (time domain measurement)
- Tracking unstable harmonics using the search track function

### Measuring the Noise Level

1. Press **Format**.
2. Choose **NOISE**.
3. Press **Scale Ref**. Then press **↓** until the noise trace gets close to the reference level.
4. Press **Bw/Avg**. Then press **VIDEO BW**.
5. Press **↓** to flatten the noise trace.
6. Press **Marker**. Then turn the  and read the normalized noise level.

The marker readout unit becomes “dBm/Hz” and is normalized by the 1 Hz equivalent noise bandwidth (ENBW). To convert the ENBW, see the “Converting to a Different Unit of Equivalent Noise Bandwidth” procedure.

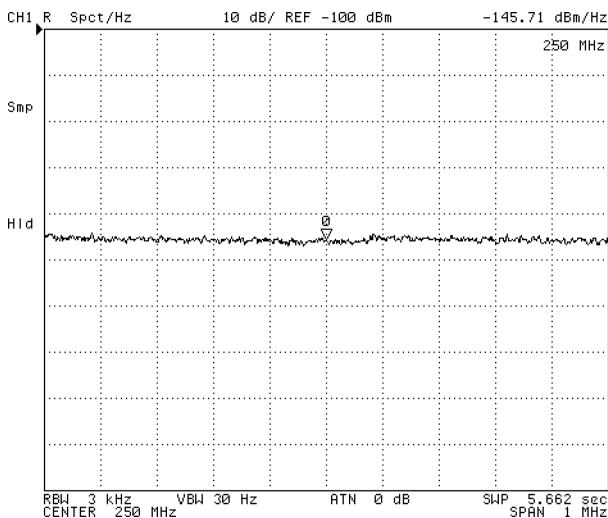


Figure 8-19. Noise Readout

**Note**



Switching the display to a noise format causes the 4395A to perform detection in sample detection mode. Subsequently returning the format to **Format** **SPECTRUM** causes the 4395A to perform detection in positive peak detection mode. This is true even if you have selected the negative detection mode before switching to the noise format.

### Converting to a Different Unit of Equivalent Noise Bandwidth

1. Calculate the conversion factor using the following equations with displayed units:

Unit	Use
$dBm/Hz$	$K = 10 \log BW$
$dBV/\sqrt{Hz}$ , $dB\mu V/\sqrt{Hz}$	$K = 20 \log BW$
$W/Hz$	$K = 1/BW$
$V/\sqrt{Hz}$	$K = 1/\sqrt{BW}$

2. Where,  $BW$  is the target equivalent noise bandwidth.

## Measuring the Noise Level

3. Press **Display** and choose **DATA MATH [ ]**.
  - Choose **OFFSET** for  $dBm/Hz$ ,  $dBV/\sqrt{Hz}$ , and  $dB\mu V/\sqrt{Hz}$ .
  - Choose **GAIN** for  $V/\sqrt{Hz}$  and  $W/Hz$ .
4. Enter  $K$ , then press **(x1)**.

---

**Note**

The 4395A displays  $dBV/\sqrt{Hz}$ ,  $dB\mu V/\sqrt{Hz}$ ,  $V/\sqrt{Hz}$  as  $dBV/Hz$ ,  $dB\mu V/Hz$ ,  $V/Hz$  respectively.



## Measuring the Carrier to Noise Ratio

1. Set up the frequency range within which to measure a carrier signal.
2. Press **Marker** to place the marker on the trace.
3. Press **Scale Ref** and choose **PEAK→REFERENCE** to set the reference level to the carrier signal level.
4. Adjust the scale/div to display the carrier and noise floor. Use **Scale Ref** **SCALE/DIV**.
5. Press **Marker** and choose **ΔMODE MENU ΔMKR** to place the reference marker on the carrier signal.
6. Press **Bw/Avg**. Then choose **VIDEO BW**.
7. Enter an appropriate video bandwidth to reduce the variation.
8. Press **Marker**. Then do either of the following:
  - Enter the offset frequency using the numeric keys.
  - Move the marker into the noise level of the trace using the rotary knob.
9. If you want to normalize the marker readout with the RBW filter, press **Utility** and toggle **NOISE FORM on OFF** to **ON off**.
10. Read the difference from the reference marker.

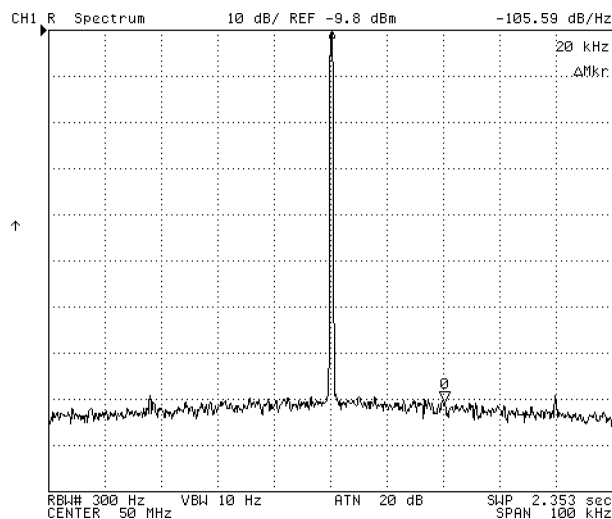


Figure 8-20. C/N Measurement

## Measuring the Carrier to Noise Ratio

### Time Gated Spectrum Analysis

The time gated spectrum analysis function can be used to measure any one of several signals separated in time (for example, burst modulated, pulsed RF, and time multiplexed). Using the gated sweep function allows the analyzer to measure the spectrum of a specific part of the signal or separate signals, and mask out interfering or transient signals. In the gated sweep mode, the analyzer is triggered to start and interrupt sweep selectively by an external trigger signal. By controlling the external trigger signal, the analyzer measures only the signals that are present when the analyzer sweeps.

The gate sweep is controlled by the following factors:

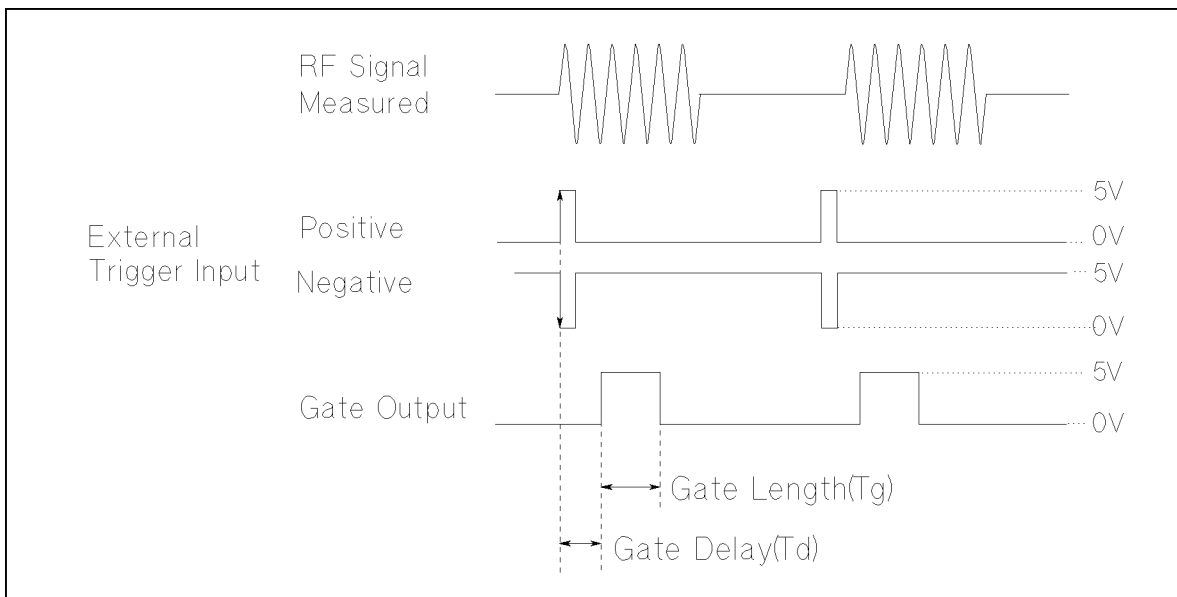
- Trigger polarity, which determines which positive or negative edge (level) causes triggering
- Gate trigger mode, which selects one of two modes (EDGE or LEVEL)
- Gate Delay, which determines how long after the trigger signal the gate actually becomes active.
- Gate Length, which determines how long the gate is on.

### Gate Trigger Mode

Two gate trigger modes (EDGE and LEVEL) are provided for the gate trigger to match the trigger signal used.

**Edge Mode.** The edge mode allows you to position the gate relative to either the rising or falling edge of a TTL trigger signal. The edge initiates the gate delay. For the edge mode, the gate sweep is controlled by the following factors:

- Trigger polarity, which selects the edge (positive or negative) to initiate the start point of the gate sweep. At the start point, the edge initiates the gate delay.
- Gate Delay, which determines how long after the trigger signal the gate actually becomes active.
- Gate Length, which determines how long the gate is on.



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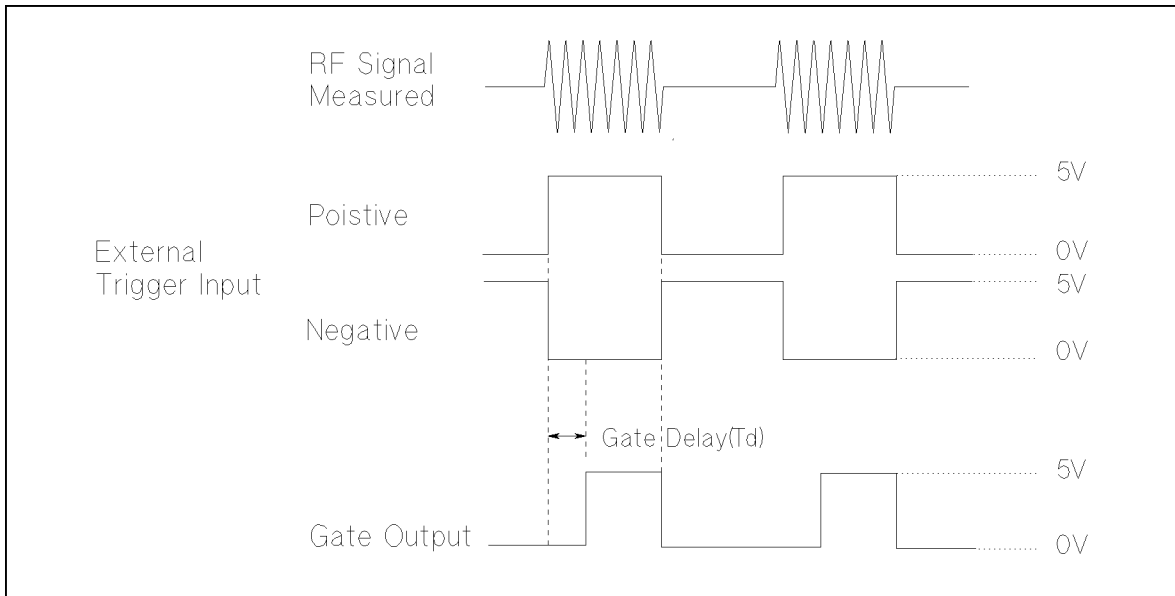
**Figure 8-21. Edge Mode**



## Measuring the Carrier to Noise Ratio

**Level Mode.** The level mode allows the external trigger signal to open and close the gate directly, without a programmed gate length. The level mode also provides the gate delay. For the level mode, the gate sweep is controlled by the following factors:

- Trigger polarity, which selects the polarity of TTL the level (+5 V or 0 V) to open gate.
- Gate Delay, which determines how long after the trigger signal the gate becomes active.



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**Figure 8-22. Level Mode**

## **Measuring the Carrier to Noise Ratio**

### **RBW Filter Response Time**

You don't need to care about the setting time for the RBW filter because the 4395A implements the RBW filter using digital processing.

Video bandwidth (VBW) can be set without concern for the gate length setting. The analyzer implements the video filter using digital processing. The video filter of the analyzer requires no settling time for normal operation. Therefore, it is not affected by the gate length setting.

### Performing Time Gated Spectrum Analysis

Time gated spectrum analysis involves the following steps:

1. Determining the Gate Trigger Parameters
2. Connecting the Gate Trigger Source
3. Setting the Center and Span Frequency
4. Adjusting the Gate Trigger
5. Setting the RBW/VBW and Using the Averaging Function
6. Measuring the Spectrum

---

**Note** Performing this measurement requires Option 1D6.



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#### Step 1: Determining the Gate Trigger Parameters.

1. Connect the target signal and the trigger signal to the input port of an oscilloscope (see Figure 8-23).

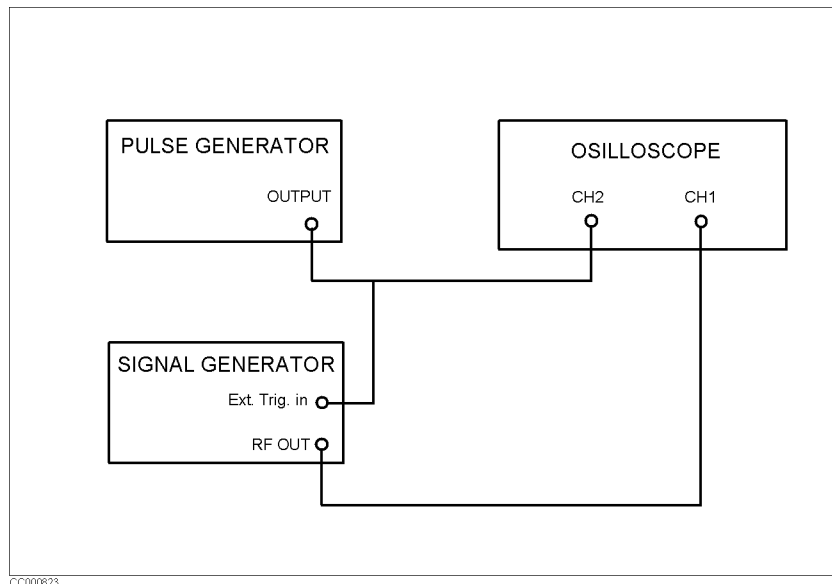
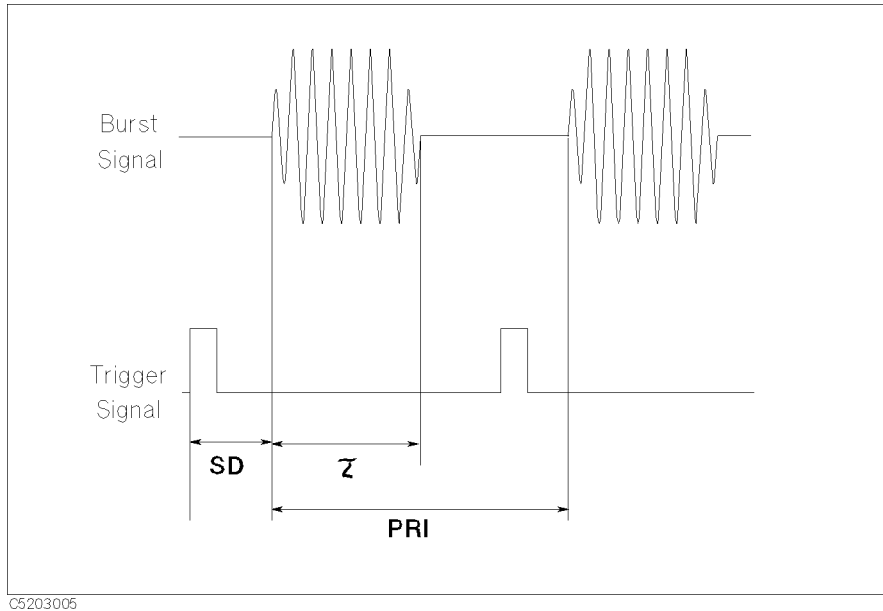


Figure 8-23. Time Domain Measurement Configuration

2. Adjust the oscilloscope to display the two signals.
3. Using the oscilloscope, check the following parameters:
  - For the target signal:
    - Pulse repetition width (PRI)
    - Signal width ( $\tau$ )
    - Signal delay (SD)
  - For the trigger signal:
    - Pulse width (if you use the level trigger mode)

## Performing Time Gated Spectrum Analysis

The signal delay (SD) is the delay inherent in the signal (that is, SD is the length of time after the trigger, but before the signal of interest occurs and becomes stable).



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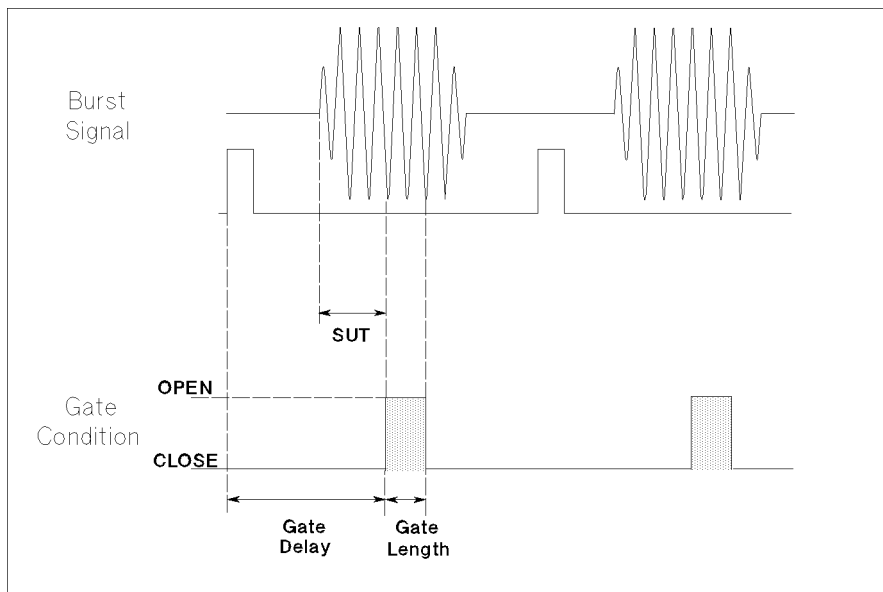
**Figure 8-24. Target and Trigger Signal Timing on the Oscilloscope**

4. Determine the gate parameters using the following equations:

- Gate delay = SUT + SD

Figure 8-25 shows the scheme of these parameters.

Open the “gate” during the time the signal is in a stable condition. The time from the start time of a signal and the open time of a gate is the “set up time” (SUT).



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**Figure 8-25. Gate Parameters**

### Step 2: Connecting the Gate Trigger Source.

1. Connect the RF signal source to the R input of the 4395A.
2. Connect the trigger output from the signal source to the EXT TRIGGER connector on the rear panel of the 4395A.

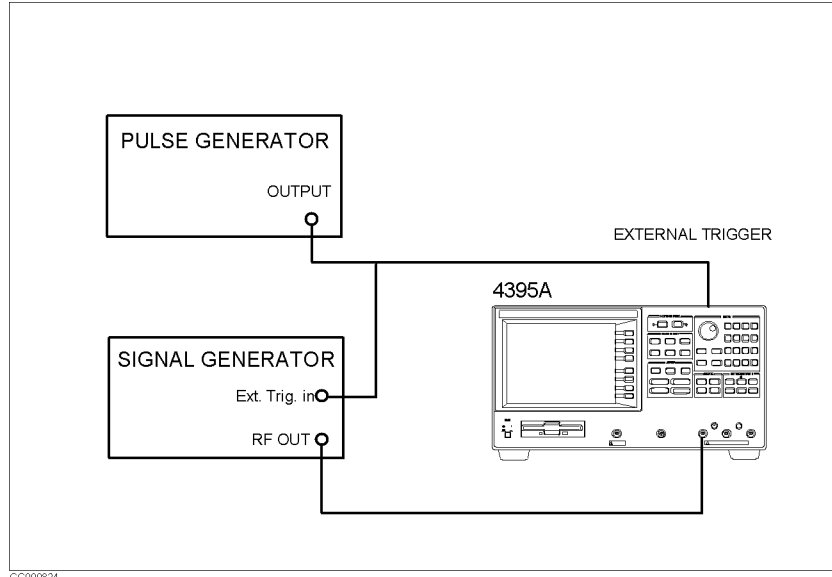


Figure 8-26. Time Gated Measurement Configuration

### Step 3: Setting the Center and Span Frequency.

- Set up the center and span frequency of the 4395A to display the target signal.

### Step 4: Adjusting the Gate Trigger.

1. Press **Trigger** **CONTINUOUS** to activate a gate trigger.
2. Choose **TRIGGER: [ ]**.
3. Choose **GATE [ ]**.
4. Select the gate control mode. Select LEVEL or EDGE by toggling **GATE CTL: LEVEL** and **EDGE** to the required mode.
5. If you have selected the LEVEL trigger mode, set the trigger polarity for starting the gate. Press **RETURN**. And then toggle **TRIG PLRTY** to **POS neg** (positive) or **pos NEG** (negative).
6. Choose **GATE [ ] GATE DELAY**.
7. Set a gate delay time.
8. If you have selected the EDGE trigger mode, choose **GATE LENGTH**. Then set the gate open length.

You can see the gate trigger status by monitoring the GATE Output terminal using an oscilloscope. The GATE Output terminal is located on the 4395A's rear panel.

## Performing Time Gated Spectrum Analysis

### Setting the RBW/VBW and Using the Averaging Function

#### Setting the Resolution Bandwidth.

1. Press **BW/Avg**.
2. Press **RES BW** and set the resolution bandwidth in accordance with Table 8-1.

## Performing Time Gated Spectrum Analysis

You must specify a gate length longer than the minimum gate length listed in Table 8-1. Otherwise, the sweep does not start.

**Table 8-1. Allowable RBW Settings and Minimum Gate Length**

RBW	Minimum Gate Length <sup>1</sup>
1 MHz	6 $\mu$ sec
300 kHz	22 $\mu$ sec
100 kHz	44 $\mu$ sec
30 kHz	170 $\mu$ sec
10 kHz	660 $\mu$ sec
3 kHz	1.4 msec
1 kHz	5.3 msec
300 Hz	22 msec
100 Hz	43 msec
30 Hz	170 msec
10 Hz	680 msec
3 Hz	1.4 sec
1 Hz	Gated sweep is not available. <sup>2</sup>

<sup>1</sup> If the gate control mode is "level", add the gate delay setting to the listed value.

<sup>2</sup> 5.5 sec when the gate control mode is "level".

### Setting the Video Bandwidth (VBW).

1. Choose **VIDEO BW**.
2. Set the video bandwidth.

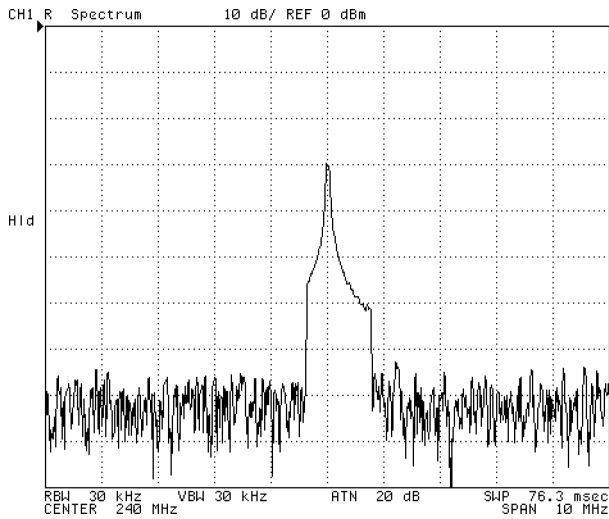
You can set any video bandwidth (VBW) without concern for the gate length setting. The 4395A implements the video filter using digital processing. The video filter of the 4395A requires no settling time for normal operation. Therefore, it is not affected by the gate length setting.

You can also use the averaging function to reduce the variation of the trace.

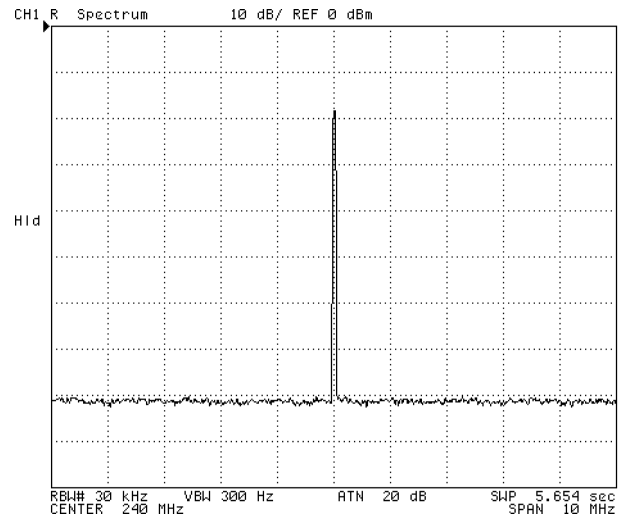
## Performing Time Gated Spectrum Analysis

### Measuring the Spectrum.

1. Adjust the span setting to fit the trace to your requirement.
2. Perform your measurement.



Before Time Gating (VBW = 30 kHz)



After Time Gating (VBW = 300 Hz)

Figure 8-27. Time Gated Spectrum Analysis



## Measuring Zero Span

1. Determine the following parameters:
  - Sweep Time
  - Number of Display Points (NOP)
2. Press **Center**. Then enter the frequency of the target signal.
3. Press **Span** and choose **ZERO SPAN** to set the frequency span to 0 Hz.
4. Press **Sweep**.
5. Press **Sweep** and choose **SWEEP TIME**, and then enter the sweep time.
6. Press **Sweep** and choose **NUMBER of POINTS**. Then enter your desired number of points (NOP).

**Note**



- Table 8-2 lists default settings when the span is switched to normal span or zero span in spectrum analyzer mode.

**Table 8-2.**  
**Default Settings When Switched to Normal Span or Zero Span**

	Switched to Normal Span	Switched to Zero Span
RBW mode	Auto	Manual
RBW	Automatically determined	3 MHz
Sweep time mode	Auto (Fixed <sup>1</sup> )	Manual (Fixed <sup>1</sup> )
Sweep time	Automatically determined	32 $\mu$ sec
NOP <sup>2</sup>	Automatically determined	801
Detection mode	Positive peak	Sample

1 Sweep time mode can not be changed in spectrum analyzer mode.

2 Number of display points

- You must specify an RBW equal to or greater than 3 kHz. If your specified value is smaller than 3 kHz, the 4395A automatically sets the RBW to 3 kHz.
- When you change the sweep time in zero span measurement of spectrum analyzer mode, the sweep time is limited by the number of display points. If you want to set a shorter sweep time than the limited sweep time, reduce the number of display points with **Sweep NUMBER of POINTS**, and then set a desired sweep time with **SWEEP**. If you want to set a longer sweep time than the limited sweep time, increase the number of display points, and then set a desired sweep time.
- The minimum time resolution and maximum sweep time in measuring zero span are listed in Table 8-3.

## Measuring Zero Span


**Table 8-3. Minimum Time Resolution**

<b>RBW</b>	<b>Min. Time Resolution</b>	<b>Max. Sweep Time (NOP = 801)</b>
5 MHz	40 nsec	1.28 msec
3 MHz	40 nsec	2.56 msec
1.5 MHz	80 nsec	5.12 msec
800 kHz	160 nsec	10.24 msec
400 kHz	320 nsec	20.48 msec
200 kHz	640 nsec	40.96 msec
100 kHz	1.28 $\mu$ sec	81.9 msec
40 kHz	2.56 $\mu$ sec	163.8 msec
20 kHz	5.12 $\mu$ sec	327.7 msec
10 kHz	10.24 $\mu$ sec	655.4 msec
5 kHz	20.48 $\mu$ sec	1.311 sec
3 kHz	40.96 $\mu$ sec	2.621 sec

- The 4395A uses an exclusive filter for 5 MHz resolution bandwidth to improve the response time. Accurate measurements with a 5 MHz RBW require the center frequency to be equal to the signal frequency.

---

### Reading Transition Time Using the Marker

1. Press **Utility**.
2. Toggle **MKR TIME** on **OFF** to **ON** off.
3. Move the marker using the .
4. Read the transition time that is displayed on the upper right of the grid.

When you are measuring the zero span, the marker displays the same frequency on every point of trace. Using the marker time function, you can change have the 4395A display time values instead of frequency. The marker displays transition time from the left end of the grid.

## Measuring Zero Span

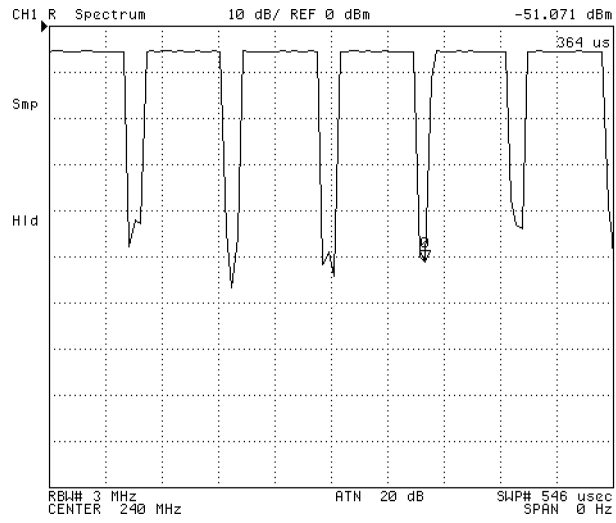


Figure 8-28. Marker Time

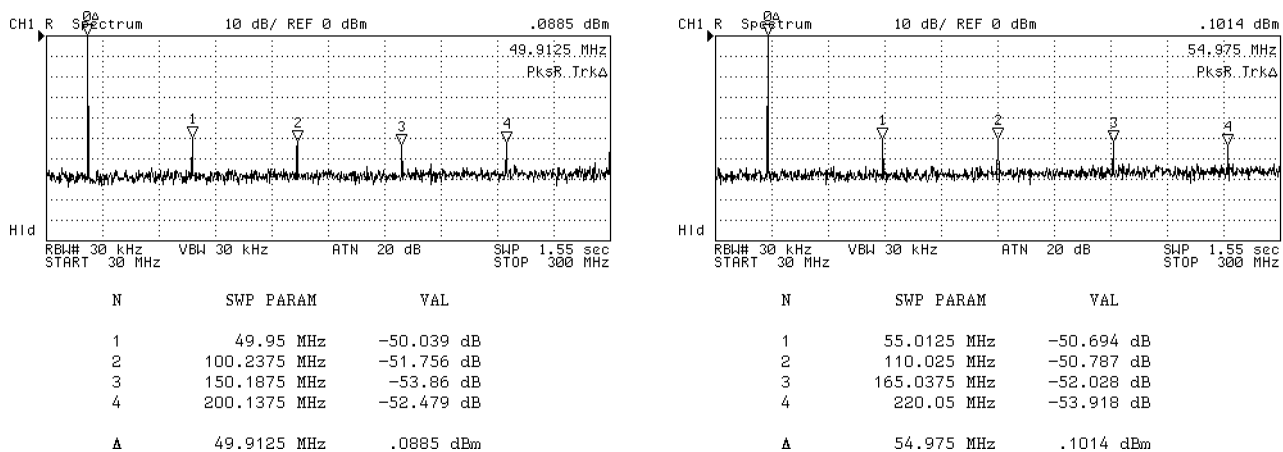
## Tracking Unstable Harmonics Using the Search Track Function

### Tracking Unstable Harmonics Using the Search Track Function

1. Set the frequency range to display the carrier and the harmonics.
2. Press **Search** and choose **SEARCH: PEAK** to move the marker to the peak.
3. Press **Marker** and choose **ΔMODE MENU TRACKING ΔMKR** to set up the marker as a reference Δmarker that can move with the carrier.
4. Press **Search** and toggle **SEARCH TRK on OFF** to **ON off** to cause the search function to be activated every time the 4395A performs a sweep process.
5. Choose **MULTIPLE PEAKS PEAKS RIGHT** to search for the carrier and harmonics under the search track.
6. Press **Utility**. Then toggle **MKR LIST on OFF** to **ON off**.

Even if the frequency of a carrier changes, the 4395A automatically tracks the carrier and the harmonics at the end of the sweep. Then the analyzer lists the difference between the carrier and the harmonics in the lower half of the screen.

If you wish to ignore the peaks other than the harmonics, you can use the peak threshold. For more information, See “To Define the Peak for Search (To Ignore Unnecessary Peaks)”.



Carrier Frequency: 50 MHz

55 MHz

**Figure 8-29. Tracking Unstable Harmonics Using Search Track**

## Typical Impedance Measurement Techniques

This section describes typical impedance measurement techniques. The topics covered include:

- Applying DC bias
- Equivalent circuit analysis
- Determining Q value using the width search function
- Port extension

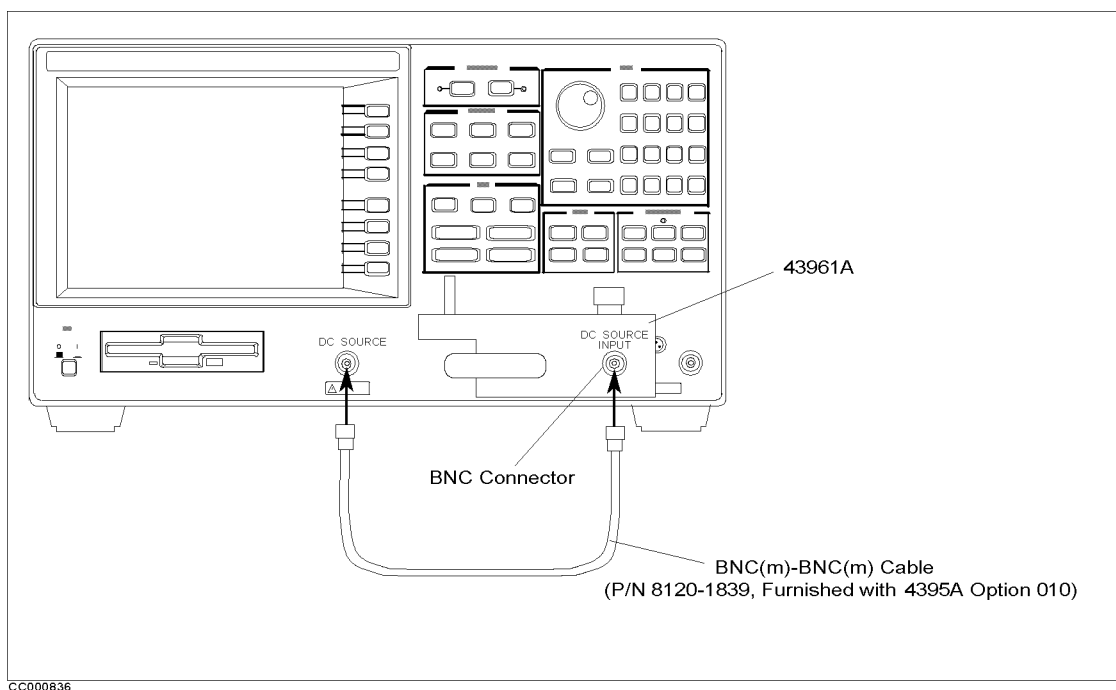
### Applying DC Bias

The 4395A option 001 DC source can be used to supply up to  $\pm 40$  V /  $\pm 100$  mA of DC voltage/current to external circuit or DUT through the DC SOURCE port on the front panel.

This section explains how to supply DC bias to the DUT on impedance measurement mode.

1. Make sure that the 4395A's DC SOURCE port is inactive. (The softkey label under **Source** should be **DC OUT on OFF**.)
2. Connect a BNC cable between the DC SOURCE port and the impedance test kit's DC SOURCE INPUT port (see Figure 8-30).

The 4395A can apply DC voltage bias up to  $\pm 40$ V or dc current bias up to  $\pm 20$  mA.



**Figure 8-30. Connecting DC SOURCE to Impedance test kit**

### Caution



Do not attempt to perform calibration or fixture compensation while the 4395A is applying DC bias. Doing so could damage the calibration or fixture compensation standard.

## Typical Impedance Measurement Techniques

### Setting the Upper Limit for DC Bias

The 4395A can control DC bias so that a user-specified upper limit (current or voltage) is not exceeded. This feature ensures that the device under DC bias is protected from excessively high voltage or current.

DC bias can be applied in one of two modes: current control and voltage control. You can set the upper limit voltage for current control mode, or the upper limit current for voltage control mode.

---

**Caution** Before applying DC bias, you must set the upper limit to protect the DUT.



---

To set the DC bias upper limit, follow these steps:

1. Press **Source**.
2. Select one of the following two options:
  - To apply DC bias in voltage control mode, toggle **DC SRC [CURRENT]** to **DC SRC [VOLTAGE]**.
  - To apply DC bias in current control mode, toggle **DC SRC [VOLTAGE]** to **DC SRC [CURRENT]**.
3. Set the upper limit voltage or current.
  - For voltage control mode, choose **DC CURRENT LIMIT** and enter the upper limit current using the numeric keys.
  - For current control mode, choose **DC VOLTAGE LIMIT** and enter the upper limit voltage using the numeric keys.

### Setting up and Applying Output Voltage/Current

1. Press **Source**.
2. Press **DC VOLTAGE** (for voltage control mode) or **DC CURRENT** (for current control mode), and enter output DC voltage or current using the numeric keys.
3. Toggle **DC OUT on OFF** to **ON off** to apply the DC voltage or current to the DUT.

## Equivalent Circuit Analysis

The 4395A provides a function that automatically calculates approximate values of specific parameters of an equivalent circuit that corresponds to a DUT. This function supports five circuit models. In addition, the resulting parameter values can be used to simulate the frequency-based characteristics of the equivalent circuit; this allows you to compare the simulated characteristics with the actually measured characteristics.

### Menus Associated with Equivalent Circuit Analysis

To use the equivalent circuit analysis function, open the *Equivalent Circuit Menu* by pressing **Display** and choosing **EQUIV KIT MENU**. The *Equivalent Circuit Menu* provides access to two submenus: *Select Equivalent Circuit Menu* and *Define Equivalent Circuit Parameter Menu*.

These three menus are described in this section.

**Equivalent Circuit Menu.** You can open the *equivalent circuit analysis menu* by pressing **Display** and choosing **MORE EQUIV KIT MENU**. This menu provides such options as for calculating the equivalent circuit parameters or simulating the equivalent circuit's characteristics under swept frequency.

Softkey Label	Description
<b>SELECT EQV CKT [ ]</b>	Opens the <i>Select Equivalent Circuit Menu</i> , which lets you to select one of the five supported circuit models.
<b>DISP EQV PARM [ ]</b>	Shows or hides the equivalent circuit constants.
<b>DEFINE EQV PARAMS</b>	Opens the <i>Define Equivalent Circuit Parameter Menu</i> , which lets you enter the equivalent circuit parameter values.
<b>CALCULATE EQV PARAMS</b>	Calculates the equivalent circuit parameters. While the calculation is being performed, a message <i>Calculating EQV parameters</i> is displayed. After the calculation is completed, the values of the equivalent parameters are displayed.
<b>SIMULATE F-CHRST</b>	Simulates the frequency characteristics by using the current equivalent circuit parameters and shows simulation results on the screen using memory trace. In other words, simulation results are stored into the memory trace.
<b>RETURN</b>	Returns to the previous menu.

## Typical Impedance Measurement Techniques

**Select Equivalent Circuit Menu.** This menu lets you to select one of the five supported circuit models. The 4395A calculates the parameter values within the range you specified using the marker search function.

Softkey Label	Description
CKT A	Selects equivalent circuit A, which is used to simulate inductors with high core loss.
B	Selects equivalent circuit B, which is used to simulate inductors in general and resistors.
C	Selects equivalent circuit C, which is used to simulate high-value resistors.
D	Selects equivalent circuit D, which is used to simulate capacitors.
E	Selects equivalent circuit E, which is used to simulate resonators.
CALCULATE EQV PARAMS	Same as CALCULATE EQV PARAMS in the <i>Equivalent Circuit Menu</i> .
SIMULATE F-CHRST	Same as SIMULATE F-CHRST in the <i>Equivalent Circuit Menu</i> .
RETURN	Returns to the <i>Equivalent Circuit Menu</i> .

**Define Equivalent Circuit Parameter Menu.** This menu lets you enter the equivalent circuit parameter values.

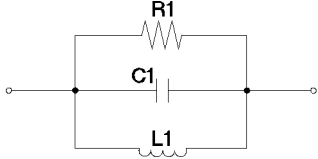
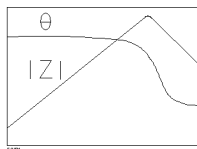
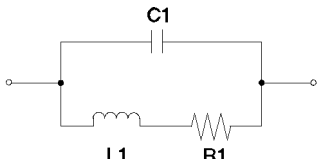
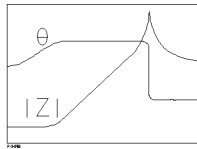
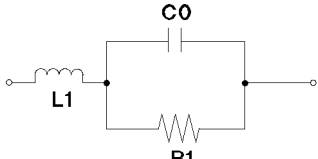
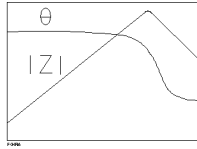
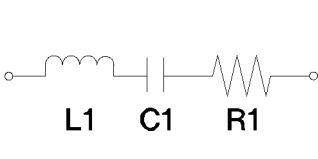
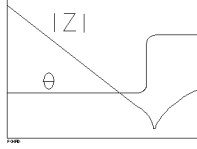
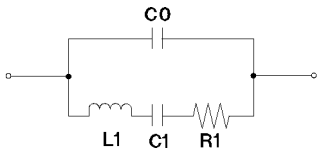
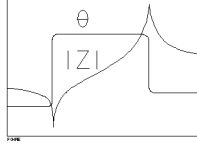
Softkey Label	Description
PARAMETER R1	Sets $R_1$ value.
C1	Sets $C_1$ value.
L1	Sets $L_1$ value.
C0	Sets $C_0$ value.
SIMULATE F-CHRST	Same as SIMULATE F-CHRST in the <i>Equivalent Circuit Menu</i> .
RETURN	Returns to the <i>Equivalent Circuit Menu</i> .

As shown in Table 8-4, each equivalent circuit model is suitable for analyzing specific type(s) of device.



## Typical Impedance Measurement Techniques

**Table 8-4. Equivalent Circuit Selection Guide**

	Equivalent Circuit	Type of Devices	Typical Frequency Characteristics
A		Inductors with high core loss	
B		Inductors and resistors	
C		High-value resistors	
D		Capacitors	
E		Resonators	

## Typical Impedance Measurement Techniques

### Using the Equivalent Circuit Analysis Function

#### Calculating Approximate Values of Equivalent Circuit Constants.

1. Press **[Display]** and choose **MORE EQUIV CKT MENU** to display the equivalent circuit menu.
2. Choose **SELECT CKT [ ]** to display the equivalent circuit models.
3. Select one of the following:

Type of DUT	Softkey
Coils with high core loss	<b>CKT A</b>
Coils in general / Resistors	<b>B</b>
High-value resistors	<b>C</b>
Capacitors	<b>D</b>
Resonators	<b>E</b>

4. Choose **CALCULATE EQV PARAM** to calculate the equivalent circuit parameters.

After a beep, the calculated equivalent parameters are displayed on the screen. To hide the equivalent parameters, press **[Display]** and choose **MORE EQUIV CKT MENU**. Then toggle **DISP EQV PARM [ON]** to **[OFF]**.

You can simulate a frequency characteristic trace from the equivalent circuit parameters obtained and compare it with the measured trace.

5. Press **[Display]** **MORE EQUIV CKT MENU**.
6. Choose **SIMULATE F-CHRST**.

After a beep, the simulated trace is displayed. The simulated trace is stored in the memory trace. To turn off the simulated trace, press **[Display]** and choose **DISPLAY [ ] DISPLAY: DATA**.

**Simulating a Trace from the Equivalent Circuit Parameters.** You can also simulate the frequency characteristics of an equivalent circuit by entering its parameters.

1. Press **[Display]** and choose **MORE EQUIV CKT MENU** to display the equivalent circuit menu.
2. Choose **SELECT EQV CKT [ ]** to display the equivalent circuit models.
3. Select the equivalent circuit model. Then choose **RETURN**.
4. Choose **DEFINE EQV PARAMS**.
5. Enter the equivalent circuit parameter value for the activated parameters.
6. Choose **SIMULATE F-CHRST** to simulate the frequency characteristics.

After a beep, the simulated frequency characteristics are displayed.

## Determining Q Value Using the Width Search Function

The width search function analyzes a resonator and displays the center point, width, and quality factor (Q) for the specified bandwidth.

To use the width search function, open the *Widths Menu* by pressing **Search** and choosing **WIDTH [ ]**. The *Widths Menu* provides access to a submenu called *Width Value Menu*, which lets you specify the bandwidth search criteria.

These two menus are described in this section.

### Widths Menu

This menu controls the width search function.

Softkey Label	Description
<b>SEARCH IN</b>	Searches for the cut-off point on the trace that is within the current cut-off points.
<b>SEARCH OUT</b>	Searches for the cut-off point on the trace outside the current cut-off points.
<b>WIDTHS on OFF</b>	Turns on the width search feature and calculates the center frequency of a lobe on the trace, width, Q, and cut-off point deviation from the center stimulus value. The cut-off point that defines the width parameters is set using the <b>WIDTH VALUE</b> softkey.  The $\Delta$ marker is automatically changed to the tracking $\Delta$ marker when <b>WIDTHS</b> is turned on. When <b>WIDTHS</b> is ON, the (normal) $\Delta$ marker cannot be selected.
<b>WIDTH VALUE</b>	Sets a measurement value of a cut-off point that defines the start and stop points for a width search. The width search feature analyzes the center point and the width between the trace down from (or up to) the anti-resonance point or resonance point and the quality factor (Q) for the resonator. Width units are in the units of the current format.
<b>RETURN</b>	Returns to the <i>Search Menu</i> .

### Width Value Menu

This menu lets you specify the search criteria for the width search function.

## Typical Impedance Measurement Techniques

Softkey Label	Description
MKRVAL/(\(\sqrt{2}\))	Sets the width value to the value that equals the marker value divided by square root of 2.
MKRVAL*(\(\sqrt{2}\))	Sets the width value to the value that equals the marker value multiplied by square root of 2.
MKRVAL/2	Sets the width value to the value that equals the marker value divided by 2.
FIXD VALUE	Makes the width value the active function and sets the width value to the value specified by this softkey.
RETURN	Returns to the <i>Widths Menu</i> .

Figure 8-31 shows an example of using the bandwidth search function.

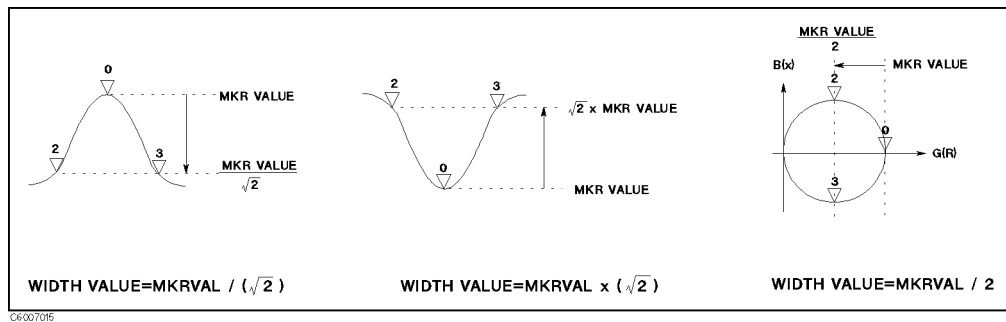


Figure 8-31. Q Measurement Examples

### Using the Anti-Resonance Point

1. Press **Search** to make the marker active.
2. Toggle **SEARCH TRK on OFF** to **ON off**. Then choose **MAX** to move the marker to the anti-resonance point on the trace.
3. Press **Search** and choose **WIDTH [ ] WIDTH VALUE MKRVAL/(\(\sqrt{2}\)) RETURN**.
4. Toggle **WIDTH on OFF** to **ON off**. The width value, Q factor, and several parameters are displayed on the screen.

### Using the Resonance Point

1. Press **Search** to make the marker active.
2. Toggle **SEARCH TRK on off** to **ON off**. Then choose **MIN** to move the marker to the resonance point on the trace.
3. Press **Search** and choose **WIDTH [ ] WIDTH VALUE MKRVAL\*(\(\sqrt{2}\)) RETURN**.
4. Toggle **WIDTH on OFF** to **ON off**. The width value, Q factor, and several parameters are displayed on the screen.

### Using the Admittance Chart

1. Press **Utility** to make the marker active. Then choose **SMTH/POLAR MENU G+jB** to read conductance and susceptance (assuming that the admittance circle has been displayed on the admittance chart).

## Typical Impedance Measurement Techniques

2. Press **(Search)** and toggle **SEARCH TRK** on **OFF** to **ON off**. Then choose **MAX** to move the marker to the point where the G value is maximum on the trace (resonance point).
3. Press **(Search)** and choose **WIDTH [ ] WIDTH VALUE MKRVAL/2 RETURN**
4. Toggle **WIDTH** on **OFF** to **ON off**. The width value, Q factor, and several parameters are displayed on the screen.

The 4395A searches half of the maximum conductance points on the admittance circle.

### Port Extension

The 43961A impedance test kit has APC-7 connectors that are intended for direct connection with a test fixture. However, you can use the 4395A's port extension feature to connect an extension cable between the test kit and fixture.

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**Note** You must determine the electrical length of the extension cable before using it with the aid of the port extension feature.



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Follow these steps:

1. Connect the cable to the APC-7 connector of the 43961A impedance test kit.
2. Press **(Cal)** and choose **MORE PORT EXTENSION**
3. Choose **EXTENSION VALUE** and enter the equivalent electrical length using the numeric keys.
4. Toggle **EXTENSION** on **OFF** to **ON off**.
5. If the cable's velocity factor is known, you can set the cable length more accurately. To set the velocity factor, press **(Cal)** and choose **MORE VELOCITY FACTOR**.



## Advanced Techniques for Optimizing Measurements

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This chapter introduces you to advanced measurement techniques on using the 4395A that have not been covered in the previous chapters. It explains how to use these techniques to optimize your measurement tasks.

Topics covered include:

- Reducing sweep time (using list sweep)
- Improving dynamic range
  - Adjusting the IF bandwidth
  - Using list sweep function
- Performing GO/NO-GO test of a filter (using limit line)
- Simultaneous measurement with different settings (using dual channel)
- Stabilizing the trace

### Reducing Sweep Time (Using List Sweep)

The analyzer has a list sweep function that can sweep frequency according to a predefined sweep segment list. Each sweep segment is independent. For the network/impedance analyzer mode, each segment can have a different number of sweep points, power level, and IF bandwidth value. For the spectrum analyzer mode, each segment can have a different number of points and RBW. Furthermore, the output voltage or current at DC SOURCE port can be set for each segment in all analyzer modes (option 001 only). This section covers:

- Planning the sweep list
- Editing a sweep list
- Executing the List Sweep

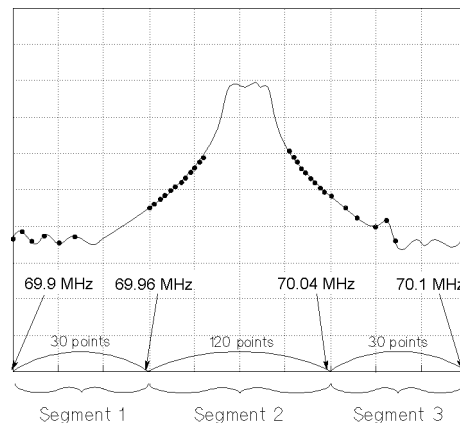
#### Planning the sweep list

1. Specify sweep segments.

A segment looks like a normal sweep setting. The list sweep function can combine up to 51 segments settings for network or impedance analyzer mode and 15 segments settings for spectrum analyzer mode into 1 sweep.

You may want to use the list sweep function primarily to reduce the time required for the sweep process. The 4395A does not require that the sweep segments be contiguous. Therefore, you can speed up the sweep process using the following strategy:

- Differentiate the sweep range of interest from other sweep ranges in terms of the number of points (Figure 9-1).



**Figure 9-1. Reducing Sweep Time by Optimizing the Number of Display Points**

2. Determine the following parameters before editing the sweep list.

Parameter	Description
Sweep Parameter	Frequency of each segment. Each segment cannot be continuous. Zero span can be set.
Number of points	Number of display points. You can adjust the display area for each segment by setting this parameter. Total number of points for all segments is 801 points maximum.



## Reducing Sweep Time (Using List Sweep)

RBW	This parameter is for the spectrum analyzer mode. You can set the resolution bandwidth for the each segment individually. This is useful if you want to display higher resolution only for the specific segment.
IF BW	This parameter for the network analyzer and impedance analyzer mode. You can set the IF bandwidth for each segment individually. This is useful if you want to display higher dynamic range only for the specific segment.
Output Power	Output power from the RF OUT port of each segment. The allowable range is $-50$ dBm to $+15$ dBm. (NA, ZA mode only)
DC Voltage or Current(Option 001)	DC output voltage or current from the DC SOURCE port on the front panel.

### Editing a Sweep List

1. Press **Sweep** **SWEEP TYPE MENU** **EDIT LIST** to call the sweep list editor.
2. Press **EDIT** to edit the sweep list.

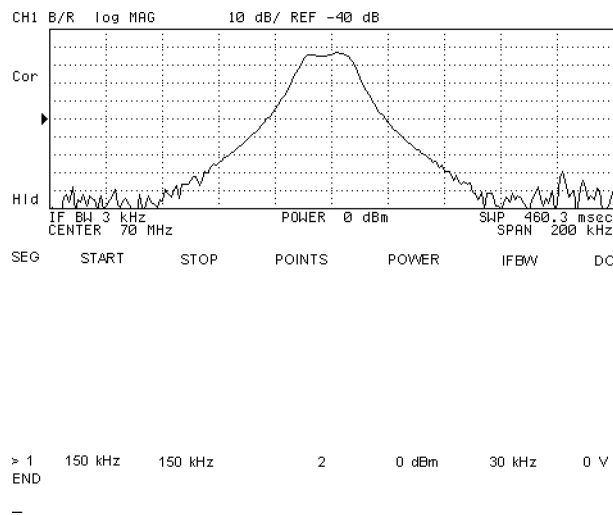


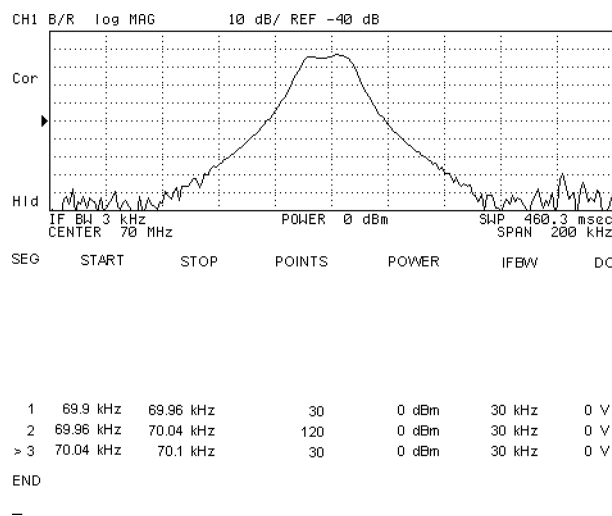
Figure 9-2. List Sweep Editor

3. Enter the frequency range of the segment.
  - Move the marker to the start point. Then press **SEGMENT: MKR→START**.
  - Move the marker to the stopping point. Then press **MKR→STOP**.
  - Press **Start** to enter the start sweep parameter. Then press **Stop** to enter the stop sweep parameter.
4. Press **MORE** **NUMBER of POINTS**. Then enter the number of points for the segment.
5. Press **POWER**. Then enter the output power level for the segment. (NA, ZA mode only)
6. Set the internal filter bandwidth:
  - When in spectrum analyzer mode, press **RES BW** to set the resolution bandwidth.

## Reducing Sweep Time (Using List Sweep)

- When in network or impedance analyzer mode, press **IF BW** to set the IF bandwidth.
7. Press **DC VOLTAGE** or **DC CURRENT** and enter DC output voltage or current.
  8. Press **RETURN** **SEGMENT DONE** to complete editing the segment.
  9. Press **ADD** to edit the next segment.
  10. Repeat steps 3 through 9 until you complete editing of all required segments.
  11. When you finish editing all the segments, press **LIST DONE** to complete the sweep list.

The segments do not have to be entered in any particular order. The analyzer automatically sorts them in increasing order of sweep parameter value.



**Figure 9-3. Sweep List Edit Display**

### To Modify or Delete the Segment

1. Press **(Sweep)** **SWEEP TYPE MENU** **EDIT LIST** **SEGMENT**.
2. Select the segment you want to delete or modify:
  - Enter the segment number you want to modify. Then press **(x1)**.
  - Move the cursor, ">", to the segment you want to modify by using the **(↑)**, the **(↓)**, or the **(↻)**.

3. Do either of the following:

To	Press
Modify specified segment	<b>EDIT</b>
Delete specified segment	<b>DELETE</b>

4. When you finish editing, press **LIST DONE**.

### Executing the List Sweep

1. Press **(Sweep)**.
2. Press **SWEEP TYPE MENU**.
3. Press **LIST FREQ**.
4. If you use the DC output, press **(Source)**. Then toggle **DC OUT on OFF** to **ON off**.

### Notes

If you want to delete an edited sweep list, press **(Sweep)** **SWEEP TYPE MENU** **EDIT LIST** **CLEAR LIST** **CLEAR LIST YES** **LIST DONE**.

You can save and recall the edited sweep list with all other instrument settings by pressing **(Save)** **STATE**. See “To Save an Analyzer Setting or Measurement Data” in Chapter 8 for more information.

### Improving Dynamic Range (NA Mode)

This section introduces you two techniques for enhancing the dynamic range of 4395A. These are:

- Adjusting the IF Bandwidth
- Using List Sweep

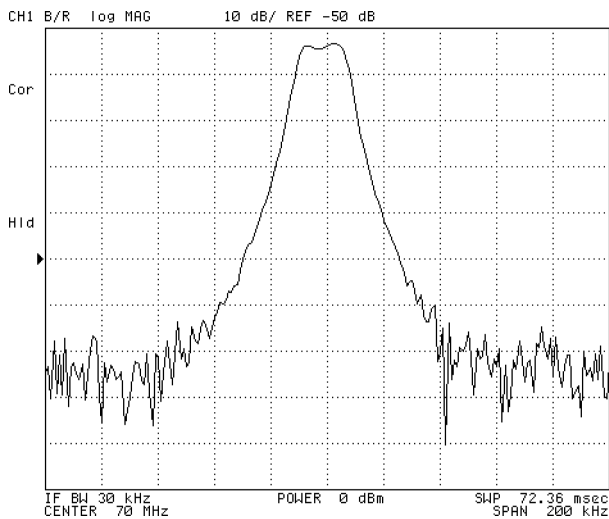
You can increase the dynamic range by applying the highest allowable power. The output power can be set by pressing **[Source] POWER**.

Averaging can also enhance the dynamic range. See “To Use the Averaging Function” for further information.

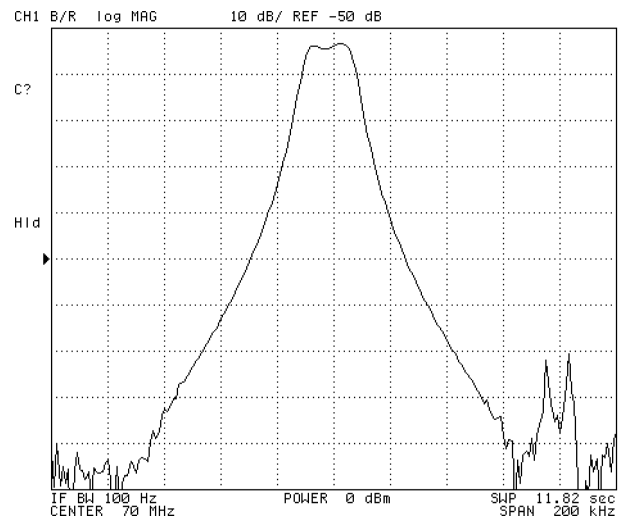
#### Adjusting the IF Bandwidth

Adjusting the IF bandwidth can lower the noise floor. For example, if you changed the IF bandwidth to 1/10 of the current setting (say, 100 Hz instead of 1 kHz), the measurement noise floor would lower by approximately 10 dB. This technique increases the dynamic range, but slows down the sweep process.

1. Press **[Bw/Avg]**.
2. Press **[IF BW]**.
3. Press **[↑]** or **[↓]**, or enter an IF bandwidth value directly from the numeric keypad.



IF Bandwidth 30 kHz



IF Bandwidth 100 Hz

Figure 9-4. Setting IF Bandwidth (IFBW)

### Using List Sweep

Figure 9-5 shows the sweep list modified from the list of the previous example(Figure 9-3) to improve dynamic range. Segments 1 and 3 have a narrow IF bandwidth and a higher power level for the stopband of the filter. Segment 2 has a wide IF bandwidth and lower power level for passband.

1. Press **[Sweep]** **SWEEP TYPE MENU** **EDIT LIST**.
2. To modify segment 1, press **SEGMENT** **[1]** **[X1]** **EDIT**.
3. Press **POWER** **15** **[X1]** **IFBW** **30** **[X1]** **SEGMENT DONE**.
4. To modify segments 2 and 3, see Figure 9-5 for the values and modify them in a manner similar to steps 2 and 3.
5. Press **LIST DONE**.
6. Press **LIST FREQ**.

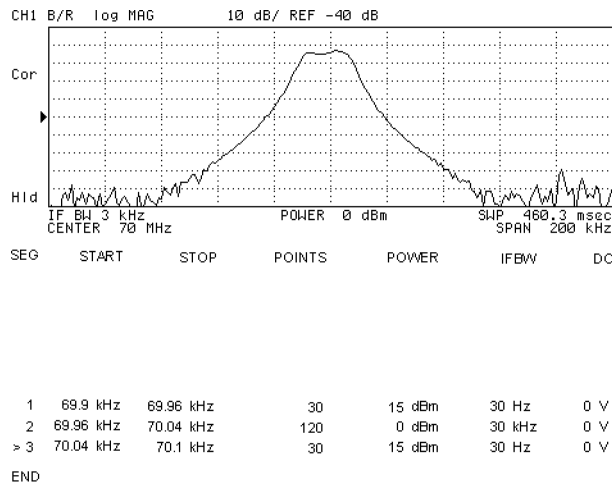
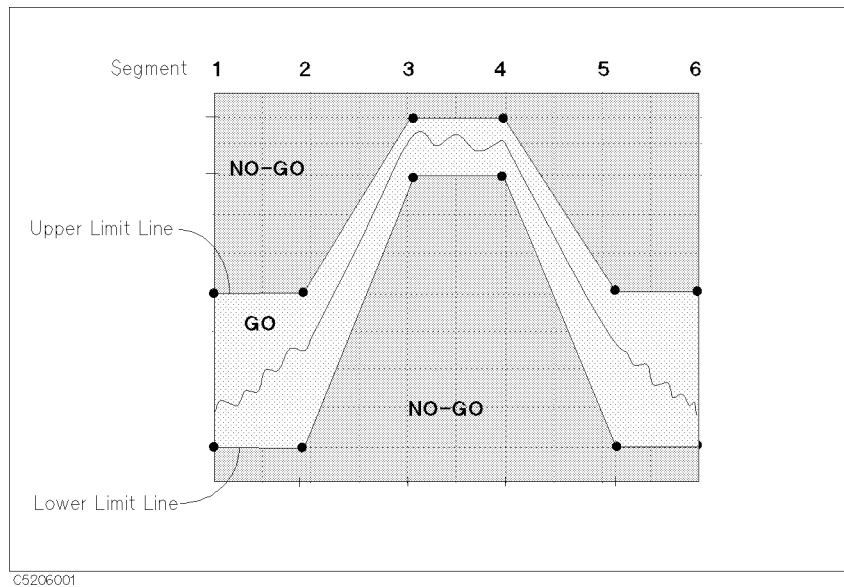


Figure 9-5. Dynamic Range Enhancement

## Performing GO/NO-GO Test of a Filter (using limit line)

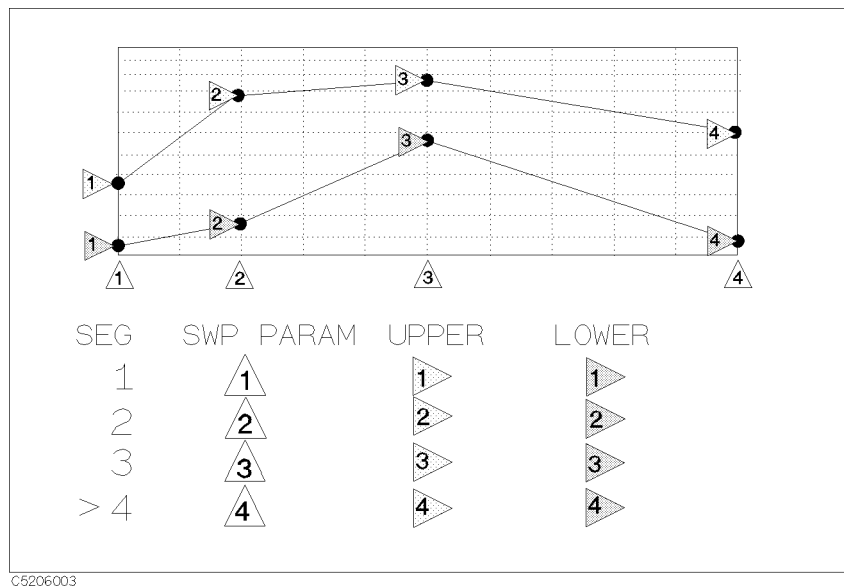
### Performing GO/NO-GO Test of a Filter (using limit line)

The limit line is constructed by connecting the segment points as shown in Figure 9-6.



**Figure 9-6. Limit Line Image**

For example, if you want to specify four points for the limit test, the limit line image is as shown in Figure 9-7. Each point has frequency information and an upper and a lower limit value. Enter these values as described in the “Editing a Limit Line Table” procedure.



**Figure 9-7. Frequency, Upper and Lower Limit**

In this example, the limit line connects four limit points. If a measured trace exceeds the upper or lower limit line, the limit test fails.

## Performing GO/NO-GO Test of a Filter (using limit line)

This section covers:

- Planning the Limit Line
- Editing a Limit Line Table
- Executing a Limit Line Test
- To Offset the Limit Line

### Planning the Limit Line

1. Determine the following parameters before editing the limit line:

Parameter	Description
Sweep Parameter	Frequency of each segment.
Upper Limit	Upper limit level of each segment.
Lower Limit	Lower limit level of each segment.

### Editing a Limit Line Table

1. Set up the frequency range of the grid before starting the limit line edit.
2. If you want to use marker to set the segment, press **Marker**.
3. Press **System**.
4. Press **LIMIT MENU**. Then toggle **LIMIT LINE** on **OFF** to **ON**. This makes it easier to understand the status of the limit line while you are editing it.
5. Press **EDIT LIMIT LINE** to call the limit line editor.
6. If an old limit line table is still in the limit line editor, press **CLEAR LIST** **CLEAR LIST YES** to clear it.
7. Press **EDIT** to edit the first segment.

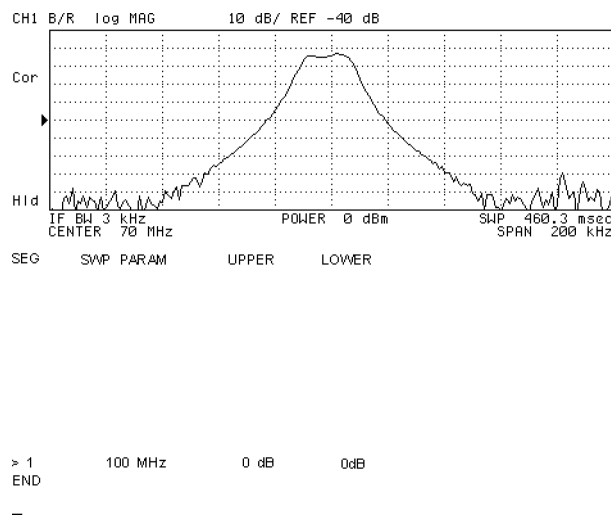


Figure 9-8. Limit Line Editor

8. Enter the frequency of the segment in one of the following ways:

## Performing GO/NO-GO Test of a Filter (using limit line)

- Press **SWP PARAM**. Then enter the frequency of the segment.
  - Move the marker to the point you want to use as the frequency of the segment. Then press **MKR—SWP PARAM**.
9. Press **UPPER LIMIT**. Then enter a upper limit value.
  10. Press **LOWER LIMIT**. Then enter a lower limit value.
  11. Press **DONE** to end editing the segment.
  12. Press **ADD** to edit the next segment.
  13. Repeat steps 7 through 11 until all segments are defined.
  14. When you finish editing all segments, press **DONE** to complete editing the limit line table.

You can enter the limit value using the middle and width method by pressing **MIDDLE VALUE** and **DELTA LIMIT**. You then enter the amplitude value as a middle amplitude value with a delta limit. The upper and lower limit lines appear at an equal positive and negative distance from the specified middle amplitude.

## To Modify or Delete the Segment

1. Press **(System) LIMIT MENU EDIT LIMIT LINE SEGMENT**.
2. Select the segment you want to delete or modify:
  - Enter the segment number you want to modify. Then press **(x1)**.
  - Move cursor, “>”, to the segment you want to modify by using the **(↑)**, the **(↓)**, or the **(↻)**.
3. Do either of the following:

To	Press
Modify specified segment	<b>EDIT</b>
Delete specified segment	<b>DELETE</b>

## Executing a Limit Line Test

### To Make a Limit Line Test Active

1. Press **(System)**.
2. Press **LIMIT MENU**.
3. Toggle **LIMIT TEST** on **OFF** to **ON** off.

If the limit line test passes, a green PASS message appears on the right of the grid. If it fails, a red FAIL message is displayed. You can set the analyzer to beep if the limit line test fails. (See the “To Beep When the Limit Test is Failed” procedure.)



## Performing GO/NO-GO Test of a Filter (using limit line)

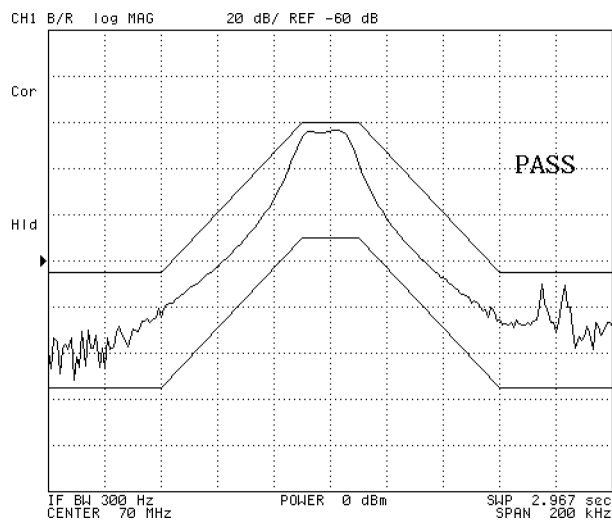


Figure 9-9. Limit Line Test

### To Beep When the Limit Test is Failed

1. Press **System**.
2. Press **LIMIT MENU**.
3. Toggle **BEEP FAIL on OFF** to **ON off**.



## To Offset the Limit Line

### To Offset the Limit Line

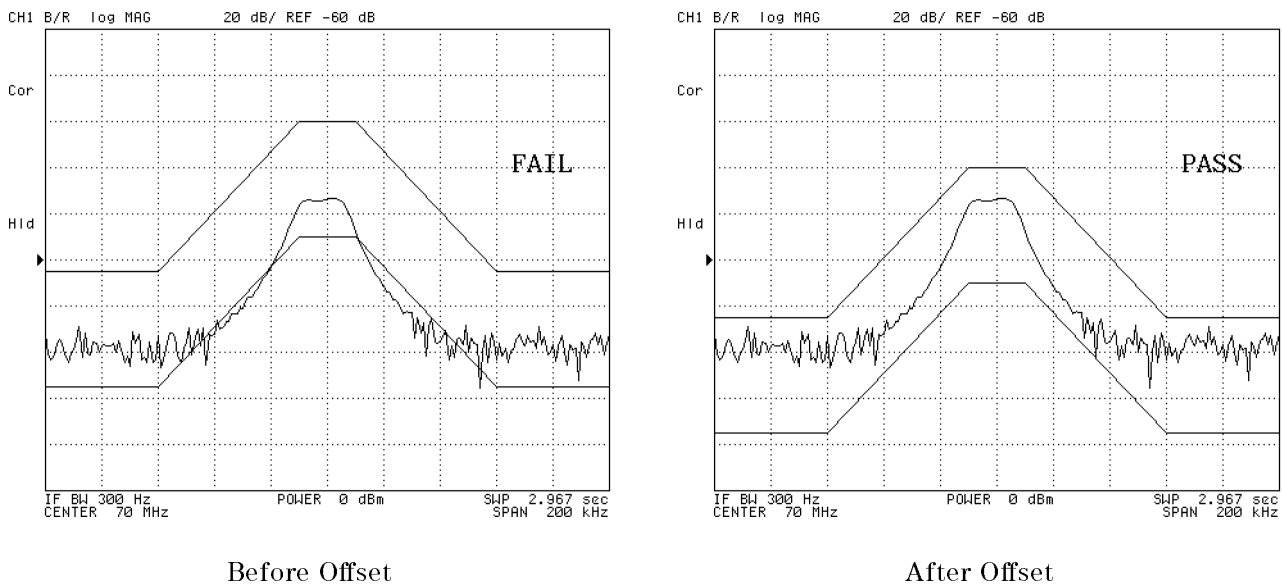
1. Press **(System)** **LIMIT MENU**.
2. Press **LIMIT LINE OFFSETS**.
3. Press the following keys:

To move line	Press
Horizontally	<b>SWP PARAM OFFSET</b>
Vertically	<b>AMPLITUDE OFFSET</b>

4. Then move the limit line by entering an offset value using one of the following:

To	Use
Move continuously	
Move with steps	
Enter offset value directly	<b>0</b> ... <b>9</b> and unit keys

5. To move the limit line vertically to the marker position:
  - a. Press **(Marker)** Then move the marker to the point you want to set as the offset value.
  - b. Press **(System)** **LIMIT MENU** **LIMIT LINE OFFSETS** **MKR→ AMP. OFS..**
6. When you are finished offsetting the limit line, press **RETURN**.



**Figure 9-10. Offsetting Limit Lines**

To clear the offset, enter 0 for all the offset values.

## Stabilizing the Trace

When the trace is not stable and the marker value changes frequently, it is difficult to read the measured value. You can use the following techniques to stabilize the trace:

- Stop the sweep.
- Use the averaging function.
- Use the maximum or minimum hold function.
- Capture the unstable signal using signal track.

### To Stop the Sweep

1. Press **Trigger**.
2. Press **SWEEP: HOLD**.

The sweep is stopped immediately (even if the sweep is in progress). If you want to restart the sweep, press **CONTINUOUS** to start a free-run sweep or press **SINGLE** to make a single sweep.

### To Use the Averaging Function

1. Press **Bw/Avg**.
2. Press **AVERAGING FACTOR**.
3. If needed, enter the averaging factor (number of times). Then press the **×1**. Default averaging factor is 16.
4. Toggle **AVERAGING on OFF** to **ON off**.

The averaging notation (Avg) appears on left side of the grid when averaging is turned on. The averaging notation indicates the number of times averaging has been performed. When averaging is completed, the counter stops incrementing. However, the trace continues updating with each sweep.

Averaging requires a sweep with a specified number of times that is enough for an averaging factor to complete the averaging. You can set the number of sweeps by using the number of groups function.

If you want to change the setting of any parameter when averaging, you can restart averaging from the 0 count.

To restart the averaging, press **Bw/Avg** **AVERAGING RESTART**. This resets averaging counter to 0.

### To Use Maximum or Minimum Hold Function

1. Press **Display**.
2. Press **DATA HOLD [OFF]**.

To Hold	Press
Maximum Level	<b>MAX</b>
Minimum Level	<b>MIN</b>

## Stabilizing the Trace

“Max” (or “Min”) appears on the right of the grid when the maximum (minimum) hold function is activated.

To turn off the maximum or minimum hold, press **Display** **DATA HOLD [ ]** **HOLD: OFF**.

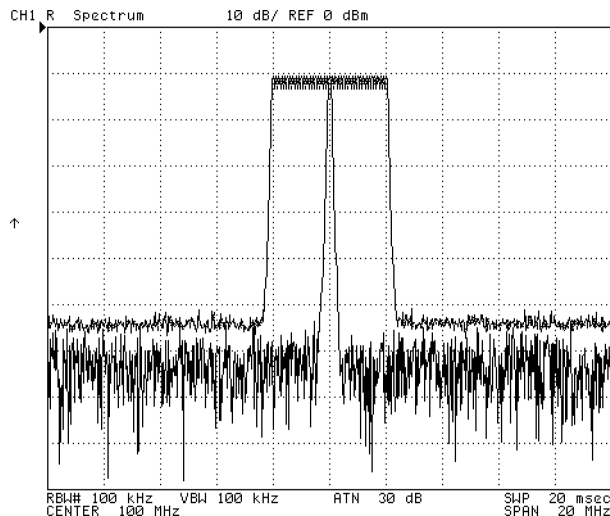


Figure 9-11. Maximum Holding the Drifting Signal

## To Capture an Unstable Signal Using Signal Track

1. Press **Display** **DUAL CHAN** on **OFF** to **ON** off.
2. Press **Chan 1**.
3. Press **Search**.
4. Press **SEARCH: PEAK** to move the marker to the peak of the drifting test signal.
5. Toggle **SIGNAL TRK** on **OFF** to **ON** off.

The signal track function captures the peak that is indicated by the marker and places it in the center of the grid for each sweep. If the peak is unstable horizontally, use this function. The analyzer automatically changes the center frequency to keep the peak in the center of the grid.

Figure 9-12 shows a display when signal track is ON at channel 1. Figure 9-13 shows a display after the analyzer sweeps a few times. At channel 1, the center frequency has been changed to maintain the drifting signal at the center of the display. Channel 2 shows that signal frequency has drifted to a higher frequency.

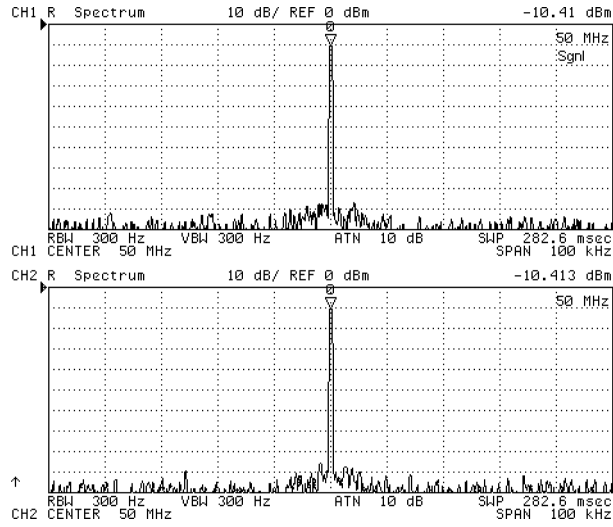


Figure 9-12. Display When Starting Signal Track

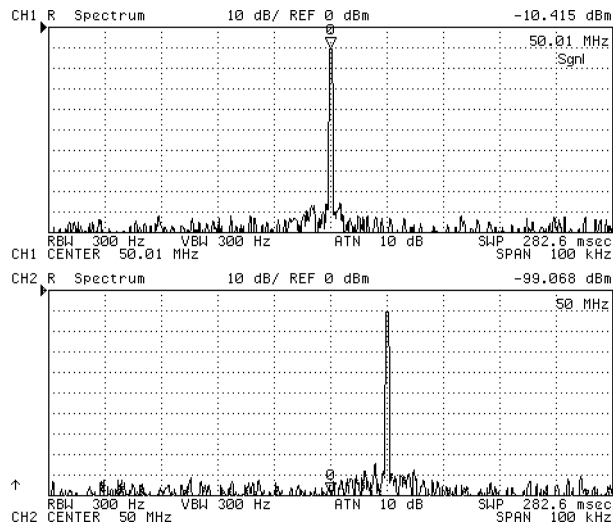


Figure 9-13. Display After Signal Has Drifted



## Examples of Applications

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This chapter contains example applications of the 4395A for each of network, spectrum, and impedance analyzer modes.

### Note



In this manual, the following abbreviations are used:

- **NA mode:** Network analyzer mode
  - **SA mode:** Spectrum analyzer mode
  - **ZA mode:** Impedance analyzer mode
- 

### Network Measurement (NA Mode)

- Filter transmission measurement
  - 6 dB bandwidth
  - Ripple
  - Magnitude and phase characteristics
  - Expanded phase characteristics
- Reflection measurement
  - Return loss and reflection coefficient
  - Standing wave ratio (SWR)
  - S-parameters measurement
  - Impedance measurement
  - Admittance measurement
- Gain compression measurement
  - Absolute output level measurement

### Spectrum Measurement (SA Mode)

- AM signal measurement
  - Carrier amplitude and frequency measurement using the marker
  - Modulating frequency and modulation index measurement using  $\Delta$ Marker
- FM Signal Measurement
  - Frequency deviation of wide band FM signal

### Impedance Measurement (ZA Mode)

- Evaluation of a chip capacitor
  - Capacitance (C) and dissipation factor (D) under swept frequency
  - $|Z|$  and  $\theta$  (Phase) under swept frequency
  - Equivalent circuit analysis
- Evaluation of a crystal resonator
  - Readout of resonance frequency ( $F_r$ ) and crystal impedance (CI)
  - Equivalent circuit analysis
  - Admittance chart
  - Using the marker
- Evaluation of a varactor diode - DC bias sweep using list sweep function
  - Measuring capacitance under DC bias conditions

## Measuring Transmission Characteristics of a Filter (NA Mode)

### Measuring Transmission Characteristics of a Filter (NA Mode)

Insertion loss and gain are ratios of the output to input signals. The following procedure measures the insertion loss and gain of a 83.16 MHz SAW bandpass filter. This measurement can be used to obtain the key filter parameters.

#### Measurement Setup

##### Connection

Set up the 4395A as shown in Figure 10-1.

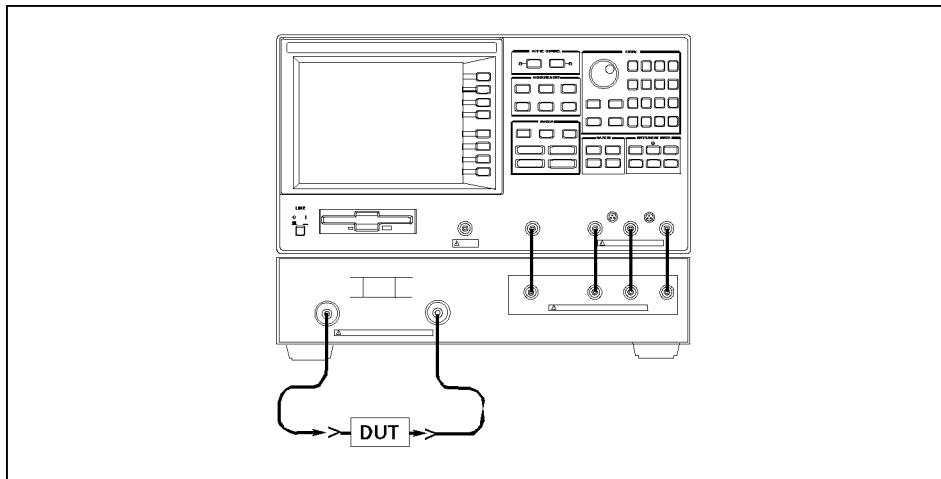


Figure 10-1. Transmission Measurement Setup

##### Analyzer Settings

Press **[Preset]**. Then set the analyzer's controls as follows:

	Desired Settings	Key Strokes
MEASUREMENT block	Select Network Analyzer	<b>[Meas]</b> ANALYZER TYPE NETWORK ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	Select S <sub>21</sub> (or B/R) measurement  IF BW 3 kHz	<b>[Meas]</b> S-PARAMETERS Trans:FWD S21 [B/R]  <b>[Format]</b> FORMAT:LOG MAG (default)  <b>[Bw/Avg]</b> <b>[3]</b> <b>[k/m]</b>
SWEEP block	Center frequency 83.16 MHz Span frequency 500 MHz	<b>[Center]</b> <b>[8]</b> <b>[3]</b> <b>[.]</b> <b>[1]</b> <b>[6]</b> <b>[M/μ]</b>  <b>[Span]</b> <b>[5]</b> <b>[0]</b> <b>[0]</b> <b>[k/m]</b>



## Measuring Transmission Characteristics of a Filter (NA Mode)

### Performing Calibration

Perform a frequency response calibration for this measurement as follows:

1. Press **Cal** **CALIBRATE MENU** **RESPONSE**.
2. Connect a THRU calibration standard between the measurement cables in place of the DUT.
3. Press **THRU** to perform a frequency response calibration data measurement.
4. Press **DONE: RESPONSE**. (**CORRECTION** on **OFF** is automatically set to **ON off**.)

### Measurement

Replace the THRU standard with the DUT. Press **Scale Ref** **AUTO SCALE** if the trace needs to be rescaled. Note that the display shows the complete response of the bandpass filter under test.

### Read Out Insertion Loss Using the Marker

1. Press **Search** **MAX** to move the marker to the maximum value of trace. The marker reads out the insertion loss and displays it at the upper right of the display.
2. Press **Marker** **ΔMODE MENU** **ΔMKR** to turn on the ΔMarker (at the position of the marker).
3. Enter **1** **5** **0** **(k/m)** to move the marker to the point offset from the Δmarker. The Δmarker value shows the relative attenuation at the offset position (see Figure 10-2).

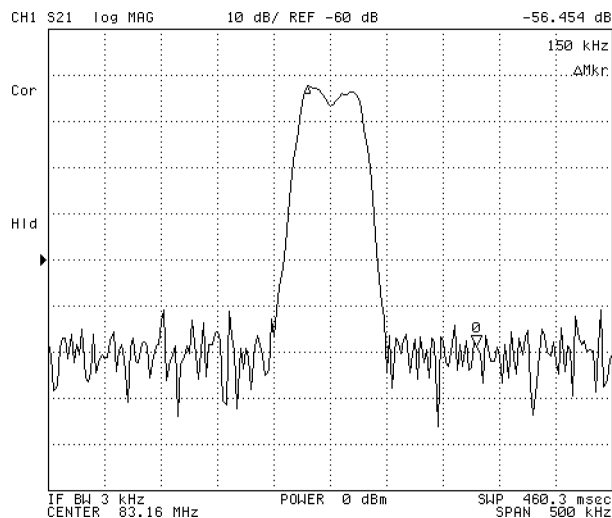


Figure 10-2. Response of a SAW Filter

### 6 dB Bandwidth

The analyzer calculates the bandwidth of the DUT between two equal power levels. In this example, it calculates the -6 dB bandwidth relative to the filter center frequency.

1. Press **Search** **MAX** to move the marker to the maximum value of the trace.
2. Press **WIDTHS** **[OFF]** **(-)** **6** **(X1)**.
3. Press **WIDTHS** on **OFF** to **ON off**. The analyzer calculates the -6 dB bandwidth, center frequency, Q (Quality Factor), insertion loss, and differences between the center frequency and the cutoff frequencies of the DUT. It then lists the results at the upper right hand of the

## Measuring Transmission Characteristics of a Filter (NA Mode)

display. Sub-marker 1 on the trace shows the passband center frequency while sub-markers 2 and 3 show the location of the  $-6$  dB cutoff points.

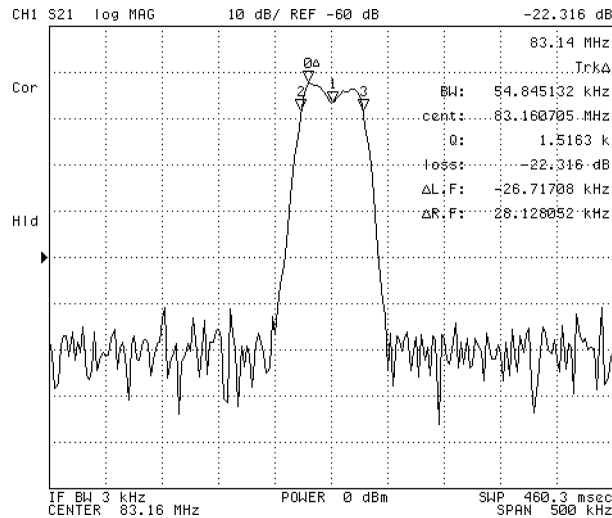


Figure 10-3. Using the Marker to Determine 6 dB Bandwidth

To have the 4395A calculate the bandwidth between other power levels, select **WIDTH VALUE** and enter the number (for example, enter  $-3$   $(\times 1)$  for  $-3$  dB).

Press **Marker** **PRESET MKRS** when you are finished with this measurement.

## Ripple

Passband ripple is the variation in insertion loss over a specified portion of the passband.

1. Press **Display** **DUAL CHAN** on **OFF** to **ON** off to display channel 2 below channel 1.
2. Press **Sweep** **COUPLED CH** ON off to on **OFF**.
3. Press **Marker** **8** **3** **1** **6** **(M/μ)**.
4. Press **Marker** **MKR**→**XCH MENU ZOOMING APERTURE** **1** **0** **(×1)**.
5. Press **MKR XCH ZOOM**.
6. Press **Chan 2** **Search** **MAX**. Then press **Marker** **MKR**→**REFERENCE** **Scale Ref** **SCALE/DEV** **1** **(×1)** to magnify the trace and resolve the ripple.
7. Press **Search** **SEARCH: PEAK**. Then press **Marker** **ΔMODE MENU ΔMKR**.
8. Press **Search** **SEARCH: PEAK** **PEAK DEF MENU** **PEAK PLRITY** POS neg to pos **NEG**. Then press **RETURN** **RETURN** **SEARCH: PEAK**. The passband ripple is automatically given as the peak-to-peak variation between the markers. The ripple value is displayed at the upper right of the display. Depending on the peak size, you may need to define the peak size using the peak definition feature of the 4395A.

## Measuring Transmission Characteristics of a Filter (NA Mode)

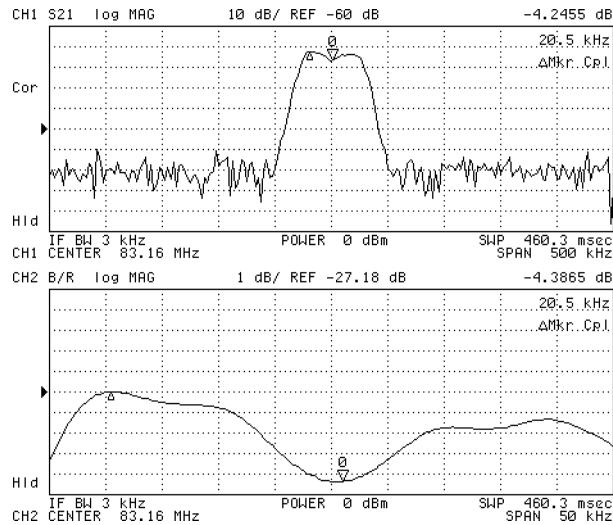


Figure 10-4. Using Peak Search to Determine Ripple

Press **Chan 1** **Marker** **PRESET MKRS**, and **Chan 2** **Marker** **PRESET MKRS** when you are finished with this measurement.

### Measuring Phase Response

A two input ratio measurement can also provide information about the phase shift of a network. The analyzer can translate this information into a related parameter, group delay.

With the same connection, instrument settings, and calibration used in the previous example (see “Measurement Setup” in “Measuring Transmission Characteristics of a Filter (NA Mode)”), make the following changes:

1. Press **Chan 1** **Sweep** **COUPLED CH on OFF** to **ON off** to couple sweep parameters of channel 2 to channel 1.
2. Press **Chan 2** **Format** **PHASE** to display the phase response on channel 2.

If the trace needs to be rescaled, press **Scale Ref** and **AUTO SCALE**.

Figure 10-5 shows the phase response of the bandpass filter. Notice the linear phase shift through the passband and the rapid fluctuations that occur outside this region. The random phase of the broadband noise floor causes the spurious out-of-band response.

This format displays phase over the range of  $-180$  to  $+180$  degrees. As phase increases beyond these values, a sharp 360 degree transition occurs in the display as the trace “wraps” between  $+180$  and  $-180$  degrees. This wrap causes the characteristic “sawtooth” display usually seen on devices with linearly increasing (or decreasing) phase responses.

## Measuring Transmission Characteristics of a Filter (NA Mode)

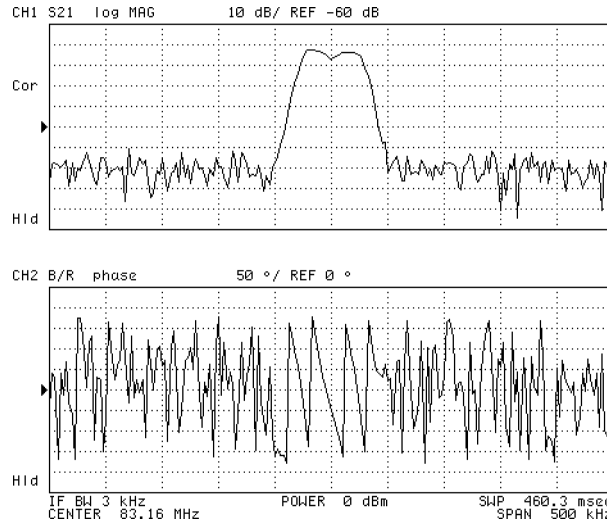


Figure 10-5. Amplitude and Phase Response of a SAW Filter

## Using the Expanded Phase Mode

The 4395A can display phase beyond  $\pm 180$  degrees. Press **[Format]** **EXP PHASE** on **OFF** to **ON off**. Then press **[Scale Ref]** **AUTO SCALE**. The phase is displayed with “no wrap” (see Figure 10-6).

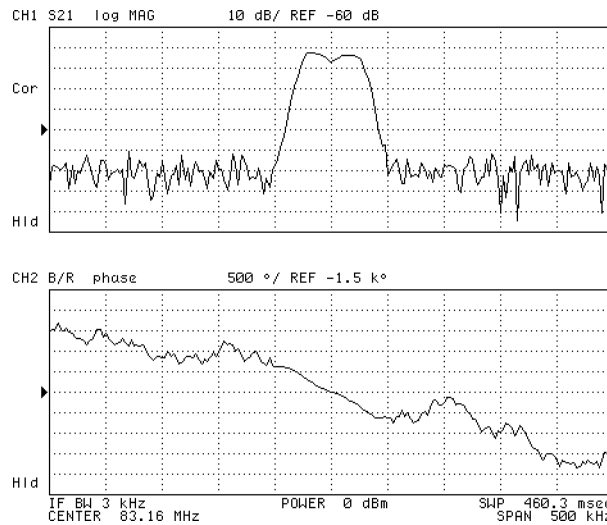


Figure 10-6. Expanded Phase Mode

Press **[Format]** **EXP PHASE** **ON off** to **on OFF** to turn off the expanded phase mode.

## Reflection Measurement (NA)

When making a reflection measurement, the 4395A monitors the signal going to the DUT and uses it as the reference. It compares the reflected signal from the DUT to the reference signal. The ratio of the incident and reflected signals is the reflection coefficient of the DUT or, when expressed in decibels, the return loss.

Reflection measurements require the connection of a directional device, such as a directional coupler, to separate the power reflected from the DUT. This separation is necessary so that it can be measured independently of the incident power (see Figure 10-7).

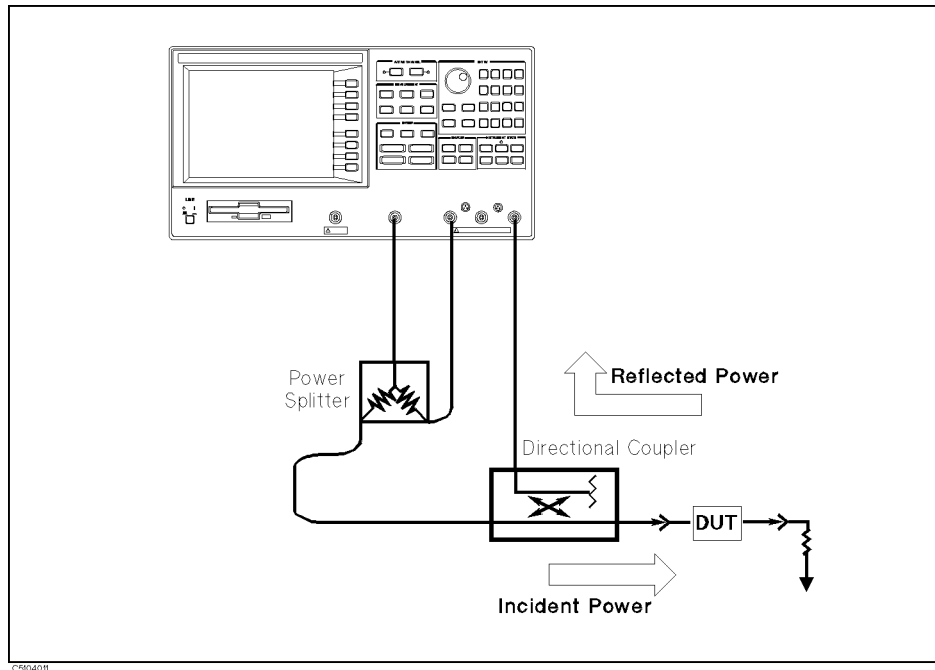


Figure 10-7. Reflection Measurement

### Multi-Port Test Devices

When the device has more than one port, connect high-quality terminations (loads) to all unused DUT ports to terminate them into their characteristic impedance (usually 50 or 75  $\Omega$ ). If this is not done, reflections off the unused ports will cause measurement errors.

The S-parameter test set automatically switches the termination at the unused port for each S-parameter measurement. When using a transmission/reflection test set, terminate the unused input port of the analyzer with a high quality load.

The signal reflected from the DUT is measured as a ratio with the incident signal. It can be expressed as a reflection coefficient, a return loss, or as SWR. These measurements are mathematically defined as:

## Reflection Measurement (NA)

$$\text{return loss(dB)} = -20 \log(\rho)$$

$$\begin{aligned} \text{reflection coefficient} &= \frac{\text{reflected power}}{\text{incident power}} \\ &= \rho \text{ (magnitude only)} \\ &= \Gamma \text{ (magnitude and phase)} \\ &= S_{11} \text{ or } S_{22} \text{ (magnitude and phase)} \end{aligned}$$

$$\text{SWR} = \frac{1 + \rho}{1 - \rho}$$

## Measurement Setup

### Connection

Set up the 4395A as shown in Figure 10-8.

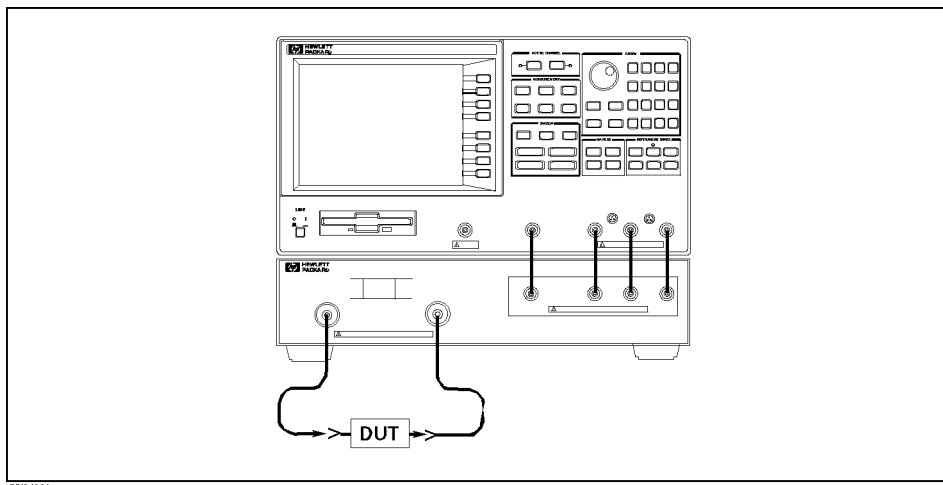


Figure 10-8. Reflection Measurement Setup

### Analyzer Settings

Press **[Preset]**. Then set the 4395A's controls as follows:

	Desired Setting	Key Strokes
MEASUREMENT block	Select network analyzer	<b>[Meas]</b> ANALYZER TYPE NETWORK ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	Select $S_{11}$	<b>[Meas]</b> S-PARAMETERS Ref1:FWD S11 [A/R] (default)
	Select LOG MAG format	<b>[Format]</b> FORMAT: LOG MAG (default)
SWEEP block	Center frequency 70 MHz	<b>[Center]</b> <b>[7]</b> <b>[0]</b> <b>[M/μ]</b>
	Span frequency 100 kHz	<b>[Span]</b> <b>[1]</b> <b>[0]</b> <b>[0]</b> <b>[k/m]</b>

### Performing Calibration

Perform an  $S_{11}$ , 1-port calibration for this measurement. The following procedure is for using 7 mm standards.

## Reflection Measurement (NA)

1. Press **Cal** **CALIBRATE MENU S11 1-PORT**.
2. Connect the OPEN standard to port 1. Then press **[S11]: OPEN**. (The softkey label **OPEN** is underlined when the measurement is complete.)
3. Connect the SHORT standard to port 1. Then press **SHORT**. (The softkey label **SHORT** is underlined when the measurement is complete.)
4. Connect the LOAD standard to port 1. Then press **LOAD**. (The softkey label **LOAD** is underlined when the measurement is complete.)
5. Press **DONE: 1-PORT CAL**. (**CORRECTION** on **OFF** is automatically set to **ON off**.)

### Note



The next example “S-Parameters Measurement” uses the calibration corrections you just completed. Do not change the calibration settings before doing the example.

### Measurement

Connect the DUT to the test set. Press **Scale Ref** **AUTO SCALE** if the trace needs to be rescaled.

### Return Loss and Reflection Coefficient

The return loss characteristics are displayed in the Log Mag format in Figure 10-9. The value inside the passband is greater than outside the passband. A large value for return loss corresponds to a small reflected signal just as a large value for insertion loss corresponds to a small transmitted signal.

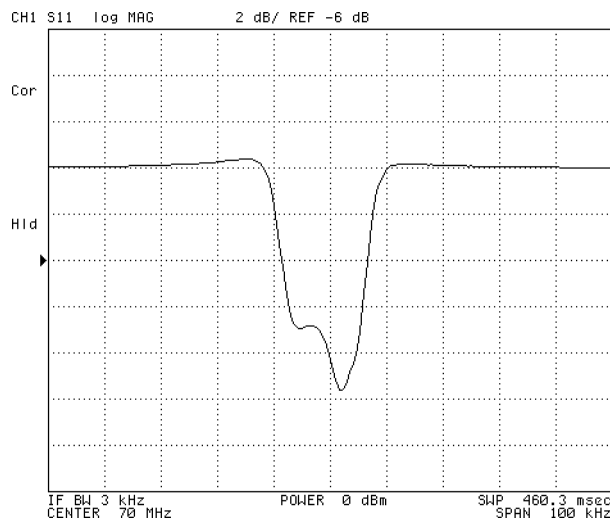


Figure 10-9. Return Loss

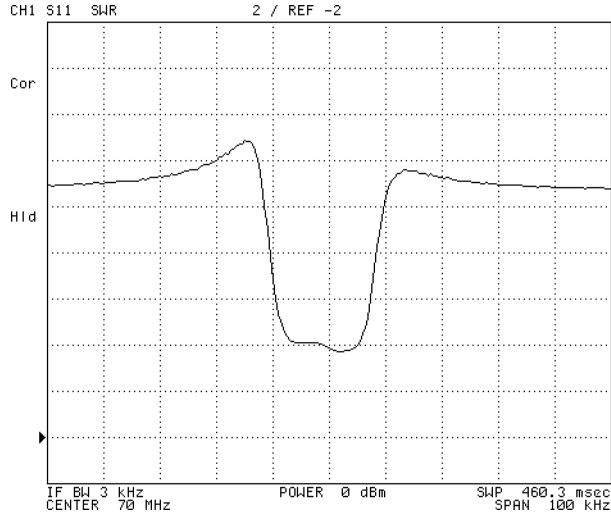
To display the same data in terms of reflection coefficient, press **Format** **MORE**

**FORMAT: LIN MAG**. This redisplay the existing measurement in a linear magnitude format that varies from  $\Gamma=1.00$  at the top of the display (100% reflection) to 0.00 at the bottom of the display (perfect match).

## Reflection Measurement (NA)

### Standing Wave Ratio (SWR)

To display the reflection measurement data as standing wave ratio (SWR), press **Format** **MORE** **SWR**. The analyzer reformats the display in the non-unit measure of SWR (with SWR = 1, a perfect match, at the bottom of the display).



**Figure 10-10. SWR**



### S-Parameters Measurement

S-parameters  $S_{11}$  and  $S_{22}$  are no different from the measurements made in the previous section.  $S_{11}$  is the complex reflection coefficient of the DUT's input.  $S_{22}$  is the complex reflection coefficient of the DUT's output. In both cases, all unused ports must be properly terminated. To display the trace on the polar chart, press **[Format]** POLAR CHART. The results of a typical  $S_{11}$  measurement is shown in Figure 10-11. Each point on the polar trace corresponds to a particular value of both magnitude and phase.

Polar Chart Shows Magnitude and Phase	
■ Magnitude	
□	The center of the circle represents a reflection coefficient $\Gamma$ of 0, that is, a perfect match or no reflected signal.
□	The outermost circumference of the scale represents a $\Gamma = 1.00$ , or 100 % reflection.
■ Phase	
□	The 3 o'clock position corresponds to zero phase angle, that is, the reflected signal is at the same phase as the incident signal.
□	Phase differences of 90, 180, and 270 degrees correspond to the 12, 9, and 6 o'clock positions on the polar display, respectively.

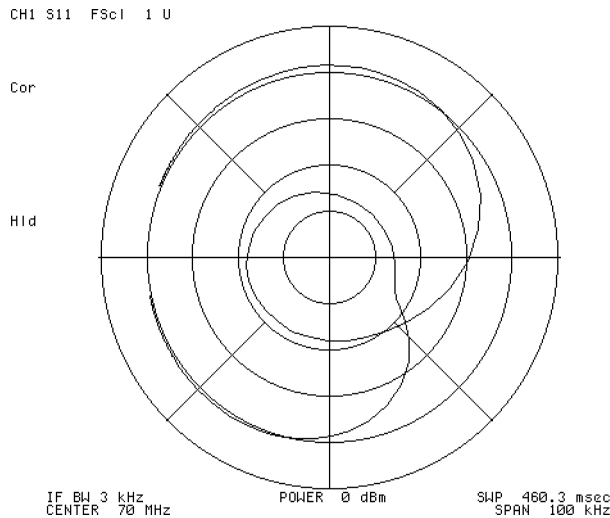


Figure 10-11.  $S_{11}$  on Polar Chart

### Data Readout Using the Marker

Press **[Marker]** and use the knob to position the marker at any desired point on the trace. Then read the frequency, magnitude, and phase in the upper right hand corner of the display. Or, enter the frequency of interest from the data entry key pad to read the magnitude and phase at that point.

To read the marker data in logarithmic, linear, real/imaginary, impedance ( $R+jX$ ), admittance ( $G+jB$ ), or SWR/phase formats, press **[Utility]** SMTH/POLAR MENU and select the desired format.

## Reflection Measurement (NA)

### Impedance Measurement

The amount of power reflection from a device is directly related to the impedance values of both the device and the measuring system. In fact, each value of the reflection coefficient ( $\Gamma$ ) uniquely defines a device impedance. For example:

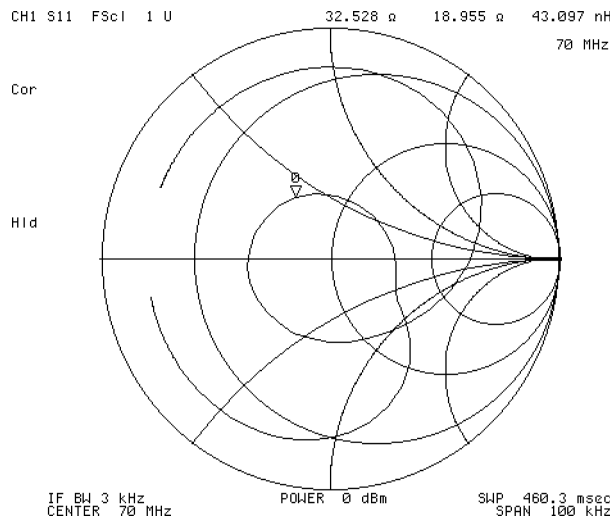
- $\Gamma=0$  occurs when the device and test set impedance are the same.
- A short circuit has a reflection coefficient of  $\Gamma=1 \angle 180^\circ (= -1)$ .
- An open circuit has a reflection coefficient of  $\Gamma=1 \angle 0^\circ (= 1)$ .

Every other value for  $\Gamma$  also corresponds uniquely to a complex device impedance, according to the equation:

$$Z_n = \frac{1 + \Gamma}{1 - \Gamma}$$

Where  $Z_n$  is the DUT impedance normalized to (that is, divided by) the measuring system's characteristic impedance (usually 50 or 75  $\Omega$ ). The network analyzer has a default impedance of 50  $\Omega$ . To set the impedance to 75  $\Omega$ , press **[Cal] MORE SET Z0**. The network analyzer uses the formula above to convert the reflection coefficient measurement data to impedance data.

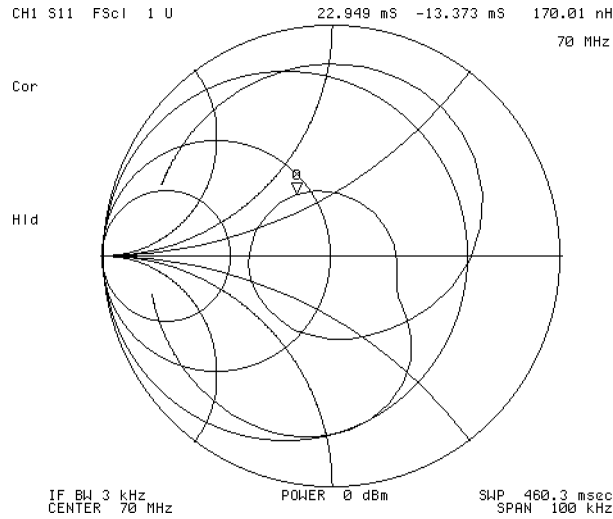
1. Press **[Format] SMITH CHART**. The display shows the complex impedance of the DUT over the frequency range selected.
2. Press **[Marker]** to turn on the marker. Then use the knob to read the resistive and reactive components of the complex impedance at any point along the trace. The marker displays a complex impedance readout.



**Figure 10-12. Impedance Measurement**

### Admittance Measurement

1. Press **Format** **MORE** **ADMITTANCE CHART**. The display shows the complex impedance of the DUT over the frequency range selected.
2. Use the knob to read the resistive and reactive components of the complex impedance at any point along the trace. The marker displays complex impedance readout.



**Figure 10-13. Admittance Measurement**

## Gain Compression Measurement (NA)

### Gain Compression Measurement (NA)

An important measure of active circuits is how well they handle a signal frequency with a varying input amplitude. By using the power sweep function in the network analyzer mode, measurements such as gain compression or automatic gain control slope can be made.

#### Measurement Setup

##### Connection

Set up the 4395A as shown in Figure 10-14.

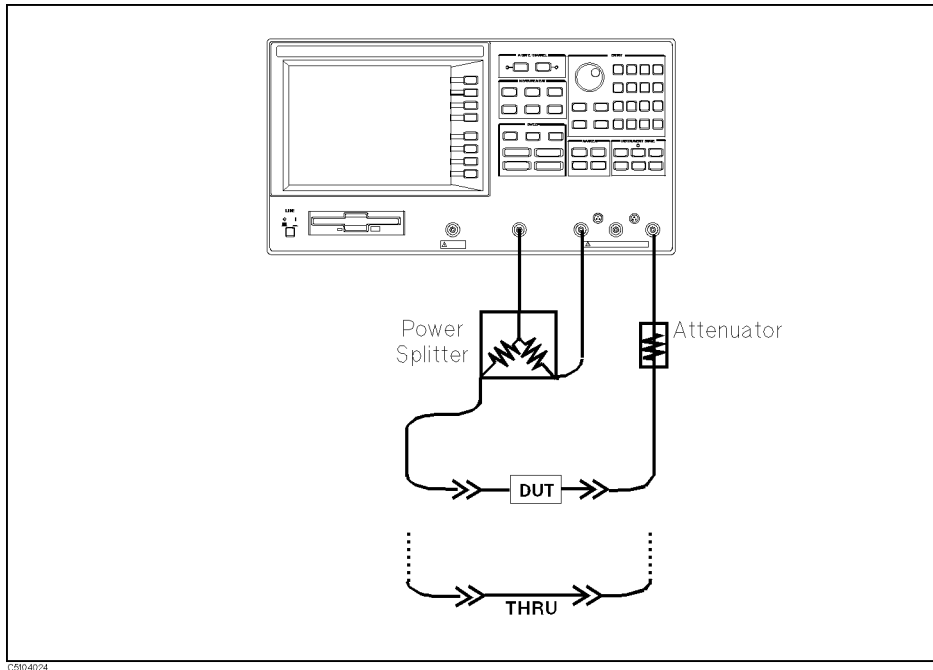


Figure 10-14. Gain Compression Measurement Setup

**Analyzer Settings**

Press **[Preset]**. Then set the 4395A's controls as follows:

	Desired Settings	Key Strokes
MEASUREMENT block	Select network analyzer	<b>[Meas]</b> ANALYZER TYPE NETWORK ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	Select S <sub>21</sub> (or B/R) measurement	<b>[Meas]</b> S-PARAMETERS Trans: FWD S21 [B/R]
	Select LOG MAG format	<b>[Format]</b> FORMAT: LOG MAG (default)
	IF BW 1 kHz	<b>[Bw/Avg]</b> <b>[1]</b> <b>[k/m]</b>
SWEEP block	Select power sweep	<b>[Sweep]</b> SWEEP TYPE MENU POWER SWEEP
	CW frequency 250 MHz	<b>[Source]</b> CW FREQ <b>[2]</b> <b>[5]</b> <b>[0]</b> <b>[M/μ]</b>
	Start power -5 dBm	<b>[Start]</b> <b>[-]</b> <b>[5]</b> <b>[x1]</b>
	Stop power 15 dBm	<b>[Stop]</b> <b>[1]</b> <b>[5]</b> <b>[x1]</b>

**Performing Calibration**

Perform a power response calibration for this measurement as follows:

1. Press **[Cal]** CALIBRATION MENU RESPONSE .
2. Connect a THRU calibration standard between the measurement cables in place of the DUT (see Figure 10-14).
3. Press **[THRU]** to perform a power response calibration data measurement.
4. Press **[DONE: RESPONSE]** . (**[CORRECTION on OFF]** is automatically set to **[ON off]** .)

**Measurement**

5. Replace the THRU standard with the DUT.
6. Press **[Scale Ref]** AUTO SCALE if the trace needs rescaling.
7. Press **[Search]** MAX to move the marker to the maximum point on the trace.
8. Press **[Marker]** ΔMODE MENU ΔMKR to set the Δmarker to the maximum point.
9. Press **[Search]** TARGET **[-]** **[1]** **[x1]** to search for the point of the gain compression. (See Figure 10-15.)

## Gain Compression Measurement (NA)



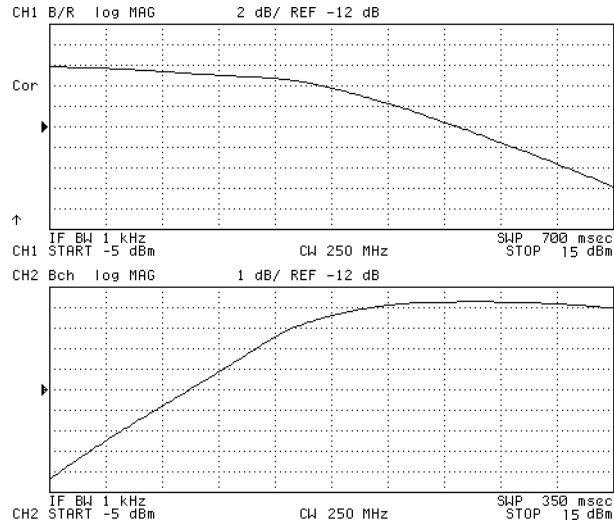
Figure 10-15. Gain Compression

### Absolute Output Level Measurement

The analyzer can show the characteristics input level versus output level by using the absolute measurement capability in the network analyzer mode.

1. Press **Marker** **MKR [UNCOUPLE]** to **MKR [COUPLE]** to couple the marker between both channels.
2. Press **Chan 2** **Meas** **MORE** **B** to select the absolute measurement at the B input.
3. Press **Display** **DATA MATH [DATA]** **OFFSET**. Then input the value of the attenuator that is connected between the DUT and the B input. In this example measurement, a 30 dB attenuator is used. Therefore, enter 30 **(x1)**.
4. The 4395A displays the input versus output power levels. The marker shows the input and output power levels at the -1 dB gain compression point.
5. Press **Display** **DUAL CHAN** on **OFF** to **ON off** to display both channel (see Figure 10-16). Note that you must subtract 6 dB from the input value readout. This is necessary because the input signal is attenuated by the power splitter that is between the RF OUT and the DUT.

## Gain Compression Measurement (NA)



**Figure 10-16.**

**Input vs. Output Power Level at the -1 dB Gain Compression Point**

## AM Signal Measurement (SA)

### AM Signal Measurement (SA)

In this example, the following parameters for AM signal measurement are derived:

- Carrier amplitude ( $E_c$ ) and frequency ( $f_c$ )
- Modulating frequency ( $f_m$ ) and modulation index ( $m$ )

#### Test Signal

The following test signal is used in this example:

- AM Signal
  - Frequency ( $f_c$ ): 100 MHz
  - Modulating signal frequency ( $f_m$ ): 10 kHz

#### Measurement Setup

##### Connection

Connect the test signal source to the R input port.

##### Analyzer Settings

Press **[Preset]**. Then set the 4395A's controls as follows:

	Desired Setting	Key Strokes
MEASUREMENT block	Select Spectrum Analyzer	<b>[Meas]</b> ANALYZER TYPE SPECTRUM ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	Select R input port	<b>[Meas]</b> SPECTRUM: R (default)
SWEEP block	Center frequency 100 MHz	<b>[Center]</b> <b>[1]</b> <b>[0]</b> <b>[0]</b> <b>[M/μ]</b>
	Span frequency 200 kHz	<b>[Span]</b> <b>[2]</b> <b>[0]</b> <b>[0]</b> <b>[k/m]</b>

#### Carrier Amplitude and Frequency Measurement Using the Marker

Press **[Scale Ref]** and enter the reference value if the trace needs rescaling.

1. Press **[Search]** to turn the marker on.
2. Press **[MAX]** to search for the carrier signal. The carrier amplitude and frequency are displayed in the upper right corner as shown in Figure 10-17.



## AM Signal Measurement (SA)

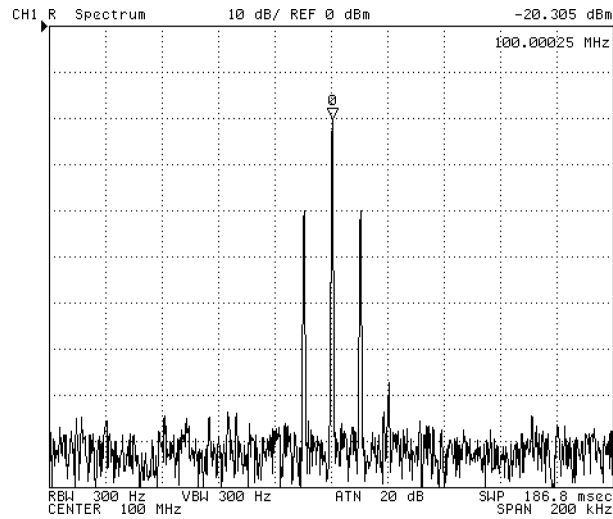


Figure 10-17. Carrier Amplitude and Frequency of AM Signal

The marker shows that the carrier amplitude ( $E_c$ ) is  $-20.305$  dBm and frequency ( $f_c$ ) is  $100$  MHz.

### Modulating Frequency and Modulation Index Measurement Using $\Delta$ Marker

3. Press **Marker**  $\Delta$ MODE MENU  $\Delta$ MKR.
4. Press **Search** SEARCH: PEAK NEXT PEAK to search for a sideband. The offset value from the carrier is displayed as the marker sweep parameter value shown in Figure 10-18. This value is the modulation frequency.

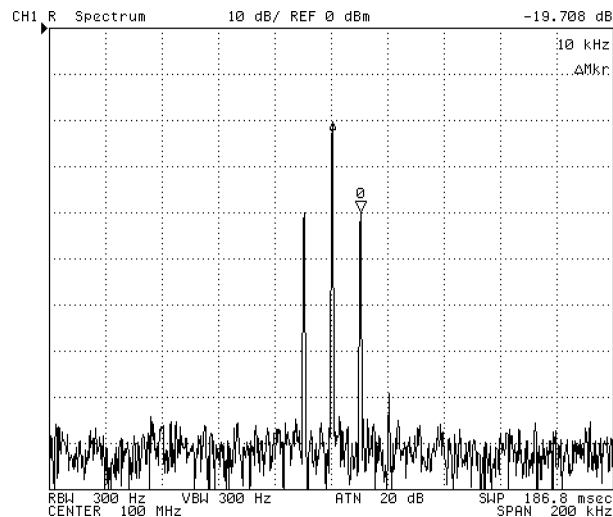


Figure 10-18. Modulating Frequency of AM Signal

The  $\Delta$ marker shows that the sideband amplitude value relative to the carrier is  $-19.708$  dB (see Figure 10-18). The modulation index ( $m$ ) can be derived from the following equation:

$$\begin{aligned} m &= 2 \times 10^{\frac{\Delta Mkr}{20}} \\ &= 20.68\% \end{aligned}$$

### **AM Signal Measurement (SA)**

where  $\Delta Mkr$  is the  $\Delta$ marker value shown in Figure 10-18.

## FM Signal Measurement (SA)

This example describes how to derive the frequency deviation ( $\Delta f_{\text{peak}}$ ) value.

### Test Signal

The following test signal is used in this example:

- **Wide band FM Signal**
  - Carrier frequency: 100 MHz.
  - Modulating frequency: 1 kHz.
  - Frequency deviation: 1 MHz.

### Measurement Setup

#### Connection

Connect the test signal to the R input port.

#### Analyzer Settings

Press **[Preset]**. Then set the 4395A's controls as follows:

	Desired Setting	Key Strokes
MEASUREMENT block	Select Spectrum Analyzer	<b>[Meas]</b> ANALYZER TYPE SPECTRUM ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	Select R input port Reference scale level -10 dBm	<b>[Meas]</b> SPECTRUM: R (default) <b>[Scale/Ref]</b> <b>[-]</b> <b>[1]</b> <b>[0]</b> <b>[x1]</b>
SWEEP block	Center frequency 100 MHz Span frequency 5 MHz RBW 300 Hz	<b>[Center]</b> <b>[1]</b> <b>[0]</b> <b>[0]</b> <b>[M/μ]</b> <b>[Span]</b> <b>[5]</b> <b>[M/μ]</b> <b>[Bw/Avg]</b> <b>[3]</b> <b>[0]</b> <b>[0]</b> <b>[x1]</b>

### Frequency Deviation of Wide Band FM Signal

Press **[Scale Ref]** and enter reference value if the trace needs rescaling.

#### Frequency Deviation

1. Press **[Search]** SEARCH: PEAK .
2. Press **[Marker]** ΔMODE MENU ΔMKR .
3. Press **[Search]** SEARCH: PEAK NEXT PEAK .

## FM Signal Measurement (SA)

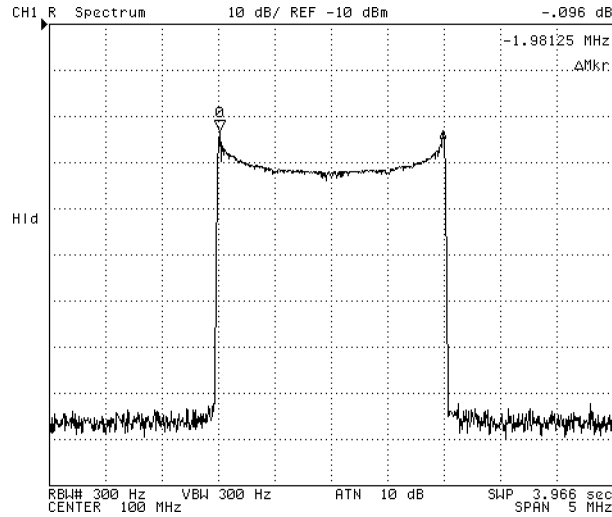


Figure 10-19. Wide Band FM Signal Measurement

The frequency deviation ( $\Delta f_{peak}$ ) can be derived roughly from the following equation:

$$\Delta f_{peak} = \frac{|\Delta Mkr|}{2}$$

where  $\Delta Mkr$  is the marker sweep parameter value shown in Figure 10-19. In this example, the frequency deviation is about 987.5 kHz.

Press **Marker** **PRESET MKRS** when you are finished with this measurement.

### Carrier Level and Modulating Frequency

The carrier level and modulating frequency can be derived using a method similar to the AM signal measurement. In this example, the zooming function is used to measure the carrier and the adjacent signal.

1. Press **Marker** **1** **0** **0** **(M/μ)** to put the maker on the carrier frequency.
2. Press **Marker** **ZOOMING APERTURE** **0** **0** **2** **(×1)**.
3. Press **MKR ZOOM** to zoom up to the carrier signal.
4. Press **Bw/Avg** **1** **0** **(×1)**.
5. Press **Scale Ref** and enter reference vale if the trace needs rescaling.
6. Press **Marker** **1** **0** **0** **(M/μ)** to move the marker to the career frequency. The carrier amplitude can be read as the marker value.
7. Press **Marker** **ΔMODE MENU** **ΔMKR** to put the Δmaker on the carrier.
8. Press **Search** **SEARCH: PEAK** **NEXT PEAK LEFT** (or **NEXT PEAK RIGHT**) to move the marker to the sideband.

## FM Signal Measurement (SA)

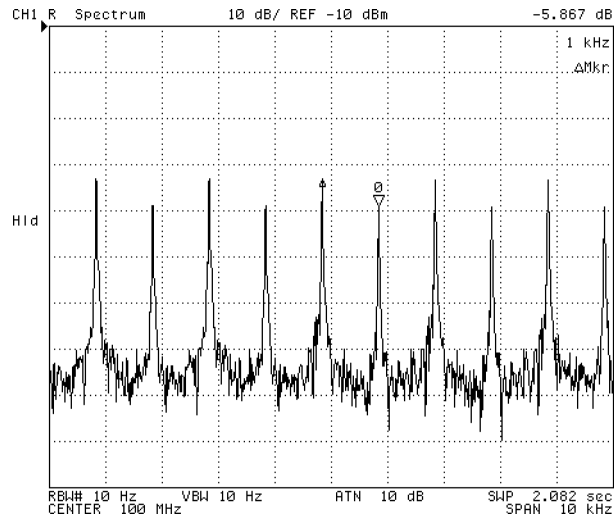


Figure 10-20. Zooming Carrier Signal of FM Signal

## Evaluation of a Chip Capacitor (ZA Mode)

### Evaluation of a Chip Capacitor (ZA Mode)

As a typical application of impedance analyzer mode, this example shows how to evaluate the impedance characteristics of a chip under swept frequency. Also, it shows how to determine the equivalent circuit parameters of a chip capacitor using the equivalent circuit analysis function of the 4395A. Note that using the 4395A as an impedance analyzer requires the 43961A Impedance Test Kit as well as Option 010.

### Measurement Setup

#### Connection

Set up the 4395A as shown in Figure 10-21.

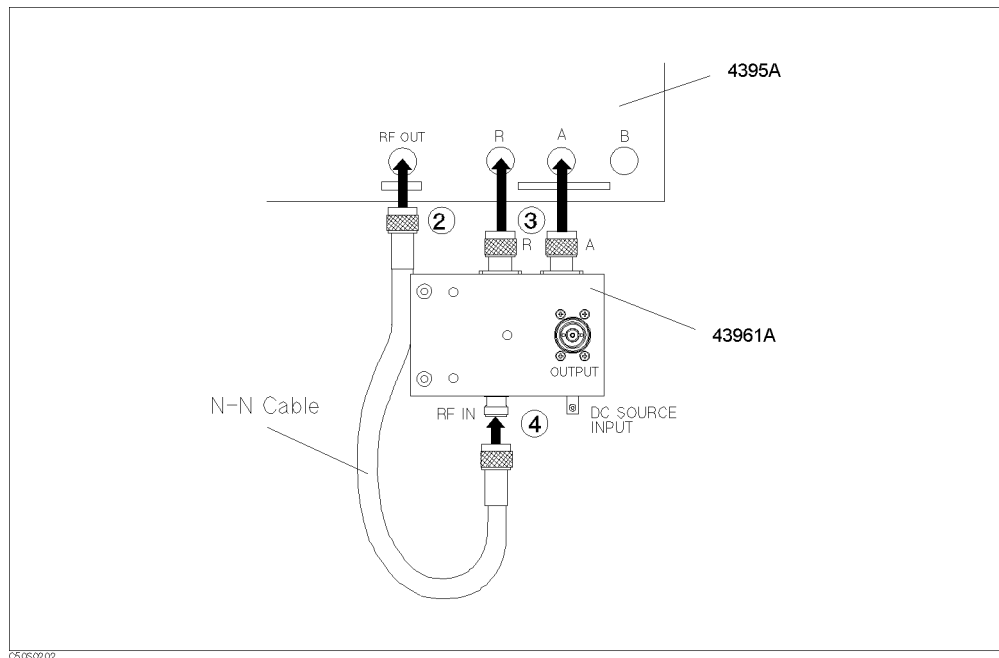


Figure 10-21. Connecting the Impedance Test Kit

#### Analyzer Settings

Press **[Preset]**. Then set the 4395A's controls as follows:

## Evaluation of a Chip Capacitor (ZA Mode)

	Desired Settings	Key Strokes
<b>MEASUREMENT</b> block	Select impedance analyzer mode	<b>Meas</b> ANALYZER TYPE IMPEDANCE ANALYZER
<b>ACTIVE CHANNEL</b> block	Select channel 1	<b>Chan 1</b> (default)
<b>SWEEP</b> block	Select LOG FREQ mode.  Sweep start frequency 100 kHz Sweep stop frequency 500 MHz Output level 0.5 dBm IF bandwidth 300 Hz Averaging factor 8	<b>Sweep</b> SWEEP TYPE MENU SWEEP TYPE: LOG FREQ <b>Start</b> 1 0 0 k/m <b>Stop</b> 5 0 0 M/ $\mu$ <b>Source</b> POWER . 5 $\times$ 1 <b>Bw/Avg</b> IF BW 3 0 0 $\times$ 1 AVERAGING FACTOR 8 $\times$ 1 AVERAGING on OFF (to ON off)

### Calibration

A proper calibration is requisite for the 4395A to perform measurements within the guaranteed accuracy range. Calibrating the 4395A for impedance analyzer mode requires three different terminations: 0 S (OPEN), 0  $\Omega$  (SHORT), and 50  $\Omega$  (LOAD).

---

**Note** Be sure to use the calibration kit included in the 43961A package.

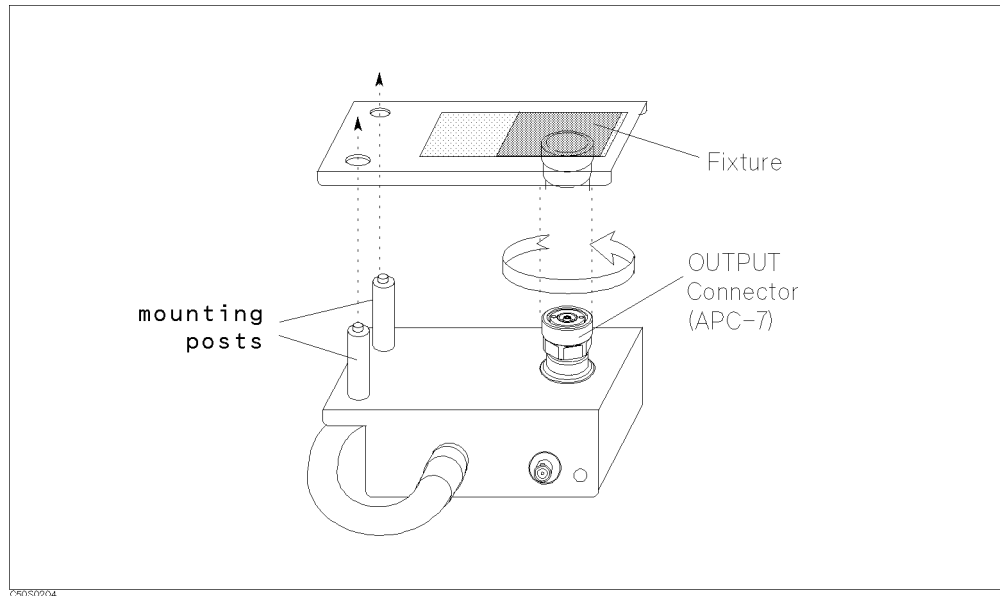


1. Press **Cal** and choose **CALIBRATE MENU**.
2. Connect the 0S termination to the OUTPUT port, and choose **OPEN**. Wait until the **OPEN** softkey's label is underlined to indicate that the OPEN calibration is complete.
3. Remove the 0S termination.
4. Connect the 0  $\Omega$  termination to the OUTPUT port, and choose **SHORT**. Wait until the **SHORT** softkey's label is underlined to indicate that the SHORT calibration is complete.
5. Remove the 0  $\Omega$  termination.
6. Connect the 50  $\Omega$  termination to the OUTPUT port, and choose **LOAD**. Wait until the **LOAD** softkey's label is underlined to indicate that the LOAD calibration is complete.
7. Choose **DONE: CORRECTION**.
8. Make sure that a "Cor" marker is displayed at the left-hand edge of the screen.

### Connecting the Test Fixture

The test fixture used in this example is the 16192A Parallel Electrode SMD Test Fixture. Connect the test fixture to the test kit referring to the documentation for the 16192A Parallel Electrode SMD Test Fixture.

## Evaluation of a Chip Capacitor (ZA Mode)



**Figure 10-22. Connecting the Test Fixture**

### Setting the Electrical Length of the Test Fixture

Connecting a test fixture adds an extra electrical length to the test circuit. This electrical length, which is specific to the test fixture you use, must be known to the 4395A so that it can compensate for the extra electrical length and eliminate errors due to phase shifts.

The 4395A incorporates a database of Agilent test fixtures with their own electrical lengths. This database contains the electrical length of the 16192A test fixture.

To set the electrical length of the test fixture, follow these steps:

1. Press **Meas**.
2. Choose **FIXTURE [NONE] SELECT FIXTURE**.
3. As the model number for the test fixture you are going to use, select **16192**.
4. Choose **RETURN**.
5. A “Del” marker appears at the left edge of the screen.

### Fixture Compensation

Fixture compensation is a process that calibrates the 4395A with a test fixture installed, thereby eliminating errors produced between the test fixture electrode and the impedance test kit's OUTPUT port.

Normally, the 4395A must be fixture-compensated for the OPEN and SHORT circuit states. It can optionally be fixture-compensated for the LOAD state.

---

#### Note

For how to connect standard devices, refer to the documentation that comes with the test fixture you use.



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To carry out fixture compensation, follow these steps:



## Evaluation of a Chip Capacitor (ZA Mode)

1. Press **[Cal]** and choose **FIXTURE COMPEN COMPEN MENU**.
2. Make sure that the test circuit is in the open state.
3. Choose **OPEN**. Wait until the **OPEN** softkey's label is underlined to indicate that the OPEN compensation is complete.
4. Connect the appropriate short device to the test fixture.
5. Choose **SHORT**. Wait until the **SHORT** softkey's label is underlined to indicate that the SHORT compensation is complete.
6. Choose **DONE: COMPEN**.
7. Check that a "Cmp" marker is displayed in place of the "Cor" marker.

## Capacitance and Dissipation Factor under Swept Frequency

### Setting Measurement Parameters

To begin impedance measurement, the 4395A must know which characteristics it should measure and how it should report the measured values.

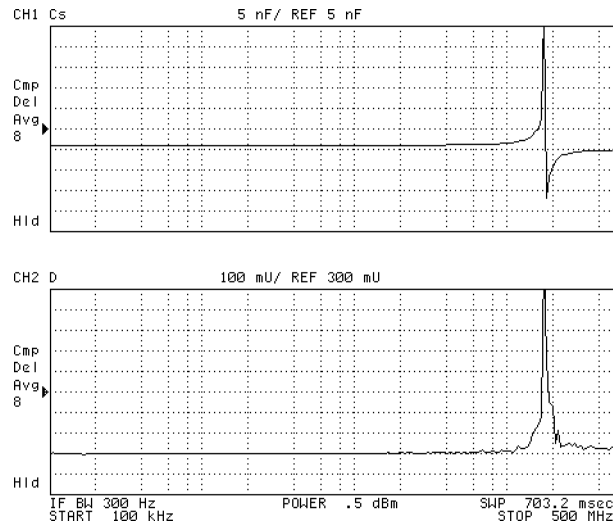
1. Press **[Chan 1]** to activate Channel 1.
2. Press **[Meas]** and choose **MORE 1/5 MORE 2/5 MORE 3/5 SER(C<sub>s</sub>)** to instruct the 4395A to measure C<sub>s</sub>(serial capacitance) for Channel 1.
3. Press **[Chan 2]** to activate Channel 2.
4. Press **[Meas]** and choose **MORE 4/5 D FACTOR(D)** to instruct the 4395A to measure D (dissipation factor) for Channel 2.
5. Press **[Bw/Avg] AVERAGING FACTOR [8] [x1]**.
6. Toggle **AVERAGING on OFF to ON off**.
7. Press **[Display]** and toggle **DUAL CHAN on OFF to ON off** to turn ON the dual channel function.

### Measurement

Connect the DUT to the test fixture referring to the documentation that comes with the 16192A test fixture.

Press **[Chan 1] [Scale Ref] AUTO SCALE**, **[Chan 2] [Scale Ref] AUTO SCALE** if the trace needs rescaling.

## Evaluation of a Chip Capacitor (ZA Mode)



**Figure 10-23.**  
 **$C_s$  and D Characteristics of a Chip Capacitor under Swept Frequency**

### **$|Z|$ and $\theta$ (Phase) under Swept Frequency**

Follow these steps:

1. Press **Chan 1** to activate Channel 1.
2. Press **Meas** and choose **MORE 5/5 IMPEDANCE:  $|Z|$**  to instruct the 4395A to measure  $|Z|$  for Channel 1.
3. Press **Format** and choose **FORMAT: LOG Y-AXIS**.
4. Press **Scale Ref** and choose **AUTO SCALE**.
5. Press **Chan 2** to activate Channel 2.
6. Press **Meas** and choose  **$\theta_z$** .
7. Press **Scale Ref** and choose **AUTO SCALE**.

The 4395A displays the  $|Z|$  and  $\theta$  characteristics under swept frequency, as shown in Figure 10-24.

## Evaluation of a Chip Capacitor (ZA Mode)

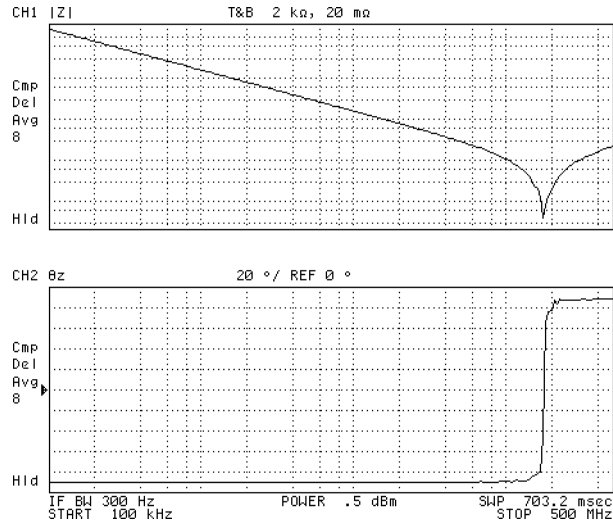


Figure 10-24.

$|Z|$  and  $\theta$  Characteristics of a Chip Capacitor under Swept Frequency

### Equivalent Circuit Analysis

The 4395A provides a function that automatically calculates approximate values of specific parameters of an equivalent circuit that corresponds to a DUT. This function supports five circuit models. In addition, the resulting parameter values can be used to simulate the frequency-based characteristics of the equivalent circuit; this allows you to compare the simulated characteristics with the actually measured characteristics.

To analyze equivalent circuit parameters, follow these steps:

1. Press (Display) and choose MORE EQUIV CKT MENU to access the equivalent circuit menu.
2. Choose SELECT EQV CKT [A] and select D as the equivalent circuit model to use.
3. Choose CALCULATE EQV PARAMS to calculate the parameters of the equivalent circuit.

Preceded by a beep, the values of the equivalent circuit parameters appear at the bottom of the screen.

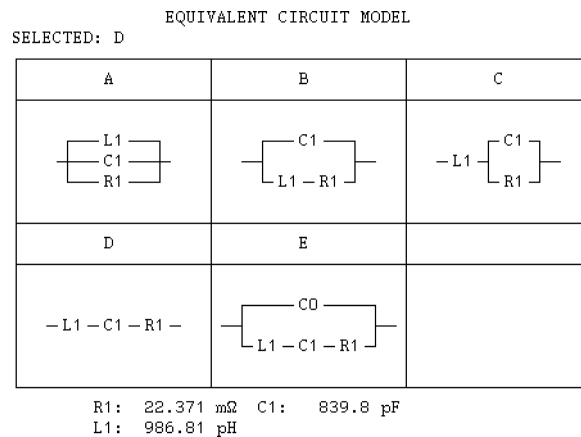


Figure 10-25. Equivalent Circuit Parameters

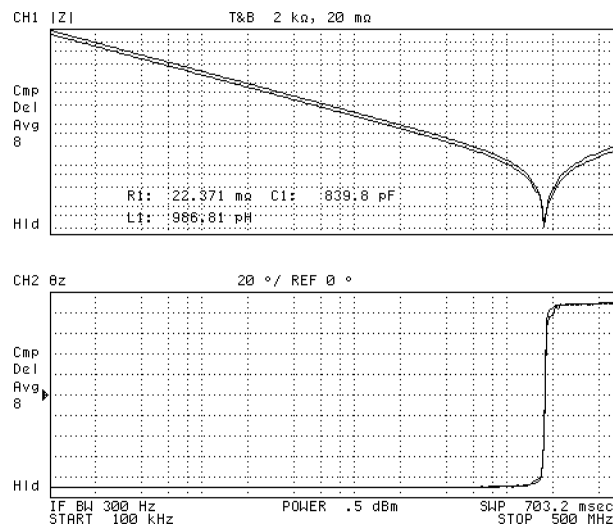
## Evaluation of a Chip Capacitor (ZA Mode)

To hide the equivalent circuit parameters from the screen, press **[Display]**, choose **MORE EQUIV CKT MENU**. Then choose **DISP EQV PARM [ON]** so that the softkey label changes to **[OFF]**.

You may wish to use the resulting parameter values to simulate the frequency-based characteristics of the equivalent circuit and compare them with the actually measured characteristics. To do so, follow these steps:

4. Press **[Display]**.
5. Choose **MORE EQUIV CKT MENU SIMULATE F-CHRST**.

Preceded by a beep, the simulation results appear on the screen. They are also stored in the trace memory.



**Figure 10-26.**  
**Simulation of Frequency-based Characteristics Using Resulting Equivalent Circuit Parameters**

You can simulate the frequency-based characteristics with desired parameter values you defined. Press **[Display]** **MORE EQUIV CKT MENU DEFINE EQV PARAMS**, enter each parameter values using **R1**, **C1**, **L1**, and **C0**, and then press **SIMULATE F-CHRST**.

To hide the simulation results from the screen, press **[Display]** and choose **DISPLAY [DATA&MEM]** **DISPLAY: DATA** for both **[Chan 1]** and **[Chan 2]**.

## Evaluation of a Crystal Resonator (ZA Mode)

### Measurement Setup

#### Connection

Connect the 4395A with the 43961A Impedance Test Kit in the same procedure as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

#### Analyzer Settings

Press **[Preset]**. Then set the 4395A’s controls as follows:

	Desired Settings	Key Strokes
<b>MEASUREMENT block</b>	Select impedance analyzer mode	<b>[Meas]</b> ANALYZER TYPE IMPEDANCE ANALYZER
<b>ACTIVE CHANNEL block</b>	Select channel 1	<b>[Chan 1]</b> (default)
<b>SWEEP block</b>	Center frequency 24 MHz Span frequency 200 kHz Output level 0.5 dBm IF bandwidth 300 Hz Averaging factor 8	<b>[Center]</b> <b>[2]</b> <b>[4]</b> <b>[M/μ]</b> <b>[Span]</b> <b>[2]</b> <b>[0]</b> <b>[0]</b> <b>[k/m]</b> <b>[Source]</b> POWER <b>[.]</b> <b>[5]</b> <b>[x1]</b> <b>[Bw/Avg]</b> IF BW <b>[3]</b> <b>[0]</b> <b>[0]</b> <b>[x1]</b> AVERAGING FACTOR <b>[8]</b> <b>[x1]</b> AVERAGING on OFF (to ON off)

#### Calibration

Calibrate the 4395A as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

#### Connecting the Test Fixture

The test fixture used in this example is the 16092A Spring Clip Test Fixture. Connect the test fixture to the test kit referring to the documentation for the 16092A Spring Clip Test Fixture.

#### Setting the Electrical Length of the Test Fixture

Connecting a test fixture adds an extra electrical length to the test circuit. This electrical length, which is specific to the test fixture you use, must be known to the 4395A so that it can compensate for the extra electrical length and eliminate errors due to phase shifts.

Although the 4395A incorporates a database of Agilent test fixtures with their own electrical lengths, the 16092A test fixture is not contained in this database. Therefore, you need to manually set its electrical length.

Follow these steps:

1. Press **[Meas]**.
2. Choose **FIXTURE [NONE] MODIFY [NONE] DEFINE EXTENSION**.
3. The 16092A test fixture has an electrical length of 0.0034 m. To enter this electrical length, press **[.] [0] [0] [3] [4] [x1]**.

## Evaluation of a Crystal Resonator (ZA Mode)

4. Choose LABEL FIXTURE ERASE TITLE. Press (1) (6) (0) (9) (2), and then choose DONE.
5. Choose KIT DONE (MODIFIED).
6. A “Del” marker appears at the left edge of the screen.

## Fixture Compensation

Carry out fixture compensation as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

## Setting Measurement Parameters

1. Press (Chan 1) to activate Channel 1.
2. Press (Meas) and check that IMPEDANCE: MAG(|Z|) is currently selected.
3. Press (Format) and choose LOG Y-AXIS.
4. Press (Chan 2) to activate Channel 2.
5. Press (Meas) and check that  $\theta_z$  is currently selected.
6. Press (Format) and check that FORMAT: LIN Y-AXIS is currently selected.
7. Press (Bw/Avg) AVERAGING FACTOR (8) (x1).
8. Toggle AVERAGING on OFF to ON off.
9. Press (Display) and toggle DUAL CHAN on OFF to ON off to turn OFF the dual channel display.

## Measurement

Connect the DUT to the test fixture referring to the documentation that comes with the 16092A Spring Clip Test Fixture.

If the trace needs rescaling, press (Scale Ref) and choose enter AUTO SCALE after activating Channel 1 with (Chan 1) key.

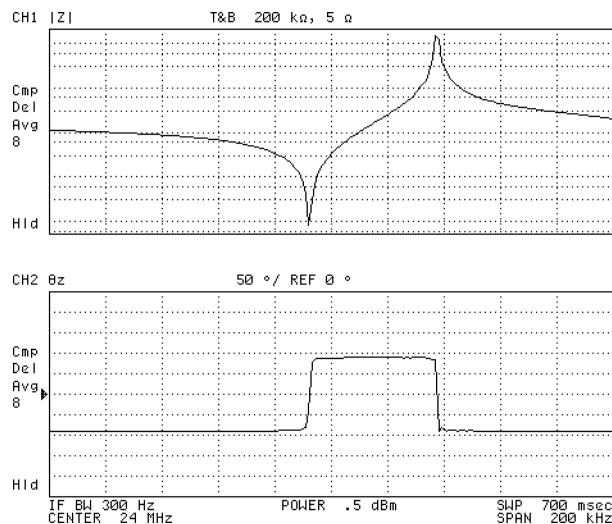


Figure 10-27. Frequency-based Characteristics of a Crystal Resonator

### Readout of Resonance Frequency ( $F_r$ ) and Crystal Impedance (CI)

1. Press **[Chan 2]** to activate Channel 2.
2. Press **[Search]** and toggle **SEARCH TRK on OFF** to **ON off** to turn ON the search track function.
3. Choose **TARGET**.
4. Press **[0] [x1]** and choose **SEARCH LEFT**.  
The marker moves to the zero phase ( $0^\circ$ ) point on the lower-frequency side. This is the point at which the resonance frequency ( $F_r$ ) and crystal impedance (CI) occur.

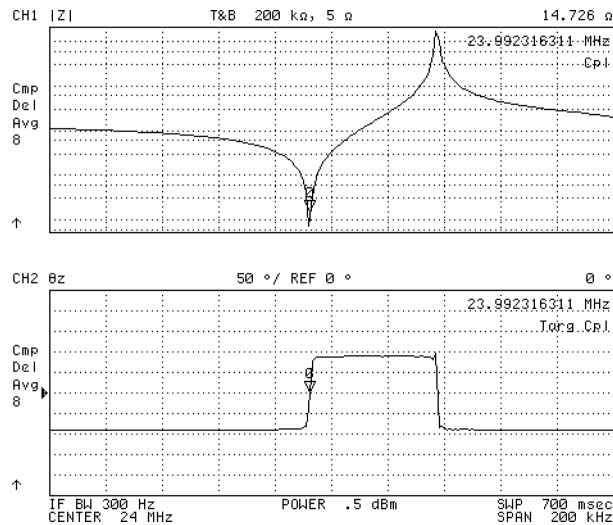


Figure 10-28. Readout of the  $F_r$  and CI Values of a Crystal Resonator

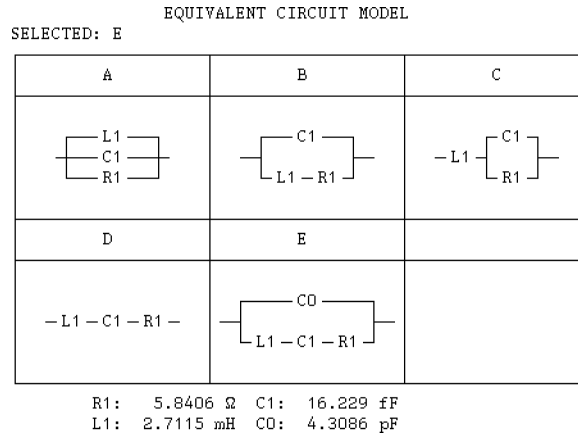
### Equivalent Circuit Analysis

The 4395A supports the 4-element equivalent circuit model, which is suitable for evaluating crystal resonator.

1. Press **[Display]** and choose **MORE EQUIV CKT MENU** to access the equivalent circuit menu.
2. Choose **SELECT EQV CKT [A]** and select **E** as the equivalent circuit model to use.
3. Choose **CALCULATE EQV PARAMS** to calculate the parameters of the equivalent circuit.

Preceded by a beep, the values of the equivalent circuit parameters appear at the bottom of the screen.

## Evaluation of a Crystal Resonator (ZA Mode)



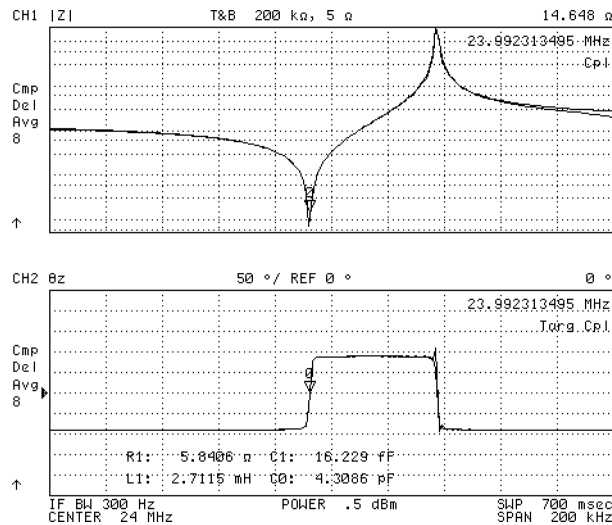
**Figure 10-29. Equivalent Circuit Parameters**

To hide the equivalent circuit parameters from the screen, press **[Display]** **MORE EQV CKT MENU** and toggle **DISP EQV PARM [ON]** to **[OFF]**.

You may wish to use the resulting parameter values to simulate the frequency-based characteristics of the equivalent circuit and compare them with the actually measured characteristics. To do so, follow these steps:

4. Press **[Display]** and choose **MORE EQUIV CKT MENU SIMULATE F-CHRST**.

To hide the simulation results from the screen, press **[Display]** and choose **DISPLAY [DATA&MEM]** **DISPLAY: DATA** for both channels.



**Figure 10-30. Simulation of Frequency-based Characteristics Using Resulting Equivalent Circuit Parameters**



## Admittance Chart

1. If the results of equivalent circuit simulation are currently displayed for Channel 1, hide the results by pressing (Chan 1) (Display) and choosing DISPLAY [DATA&MEM] DISPLAY: DATA RETURN MORE EQUIV CKT MENU DISP EQV PARM [ON].
2. With the marker located at the resonance frequency ( $F_r$ ) point, press (Marker→) and choose MKR→CENTER to set the sweep center frequency to the resonance frequency.
3. Press (Chan 1) (Meas) and choose MORE [1/5] ADMITTNCE: MAG(|Y|).
4. Press (Format) and choose COMPLEX PLANE to select the complex plane format.
5. Press (Display) and choose DUAL CHAN ON off to on OFF to turn OFF the dual channel display.
6. Press (Scale Ref) and choose AUTO SCALE to rescale the trace.
7. Adjust the span by pressing (Span) and then (↓) or (↑). If the number of sweep points is so small that the admittance chart does not form a circular shape, increase the number of sweep points by pressing (Sweep) and choosing NUMBER OF POINTS then pressing (↑). (Press (Scale Ref) AUTO SCALE if required.)

On a complex plane, the measurement parameters are always expressed as complex numbers even if you have selected a scalar parameter such as  $|Y|$ .

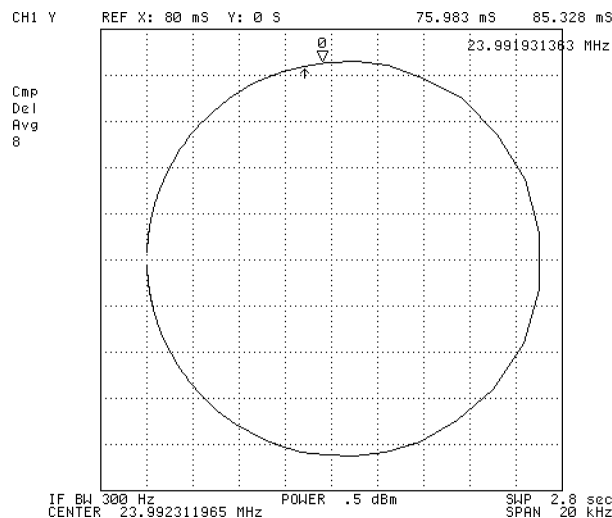


Figure 10-31. Admittance Chart for a Crystal Resonator

## Using the Marker

1. To move the marker, press (Marker) and turn the rotary knob.

The real and imaginary parts of the complex number that corresponds to the marker position are shown at the upper left corner of the grid area (see Figure 10-31).

If necessary, press (Scale Ref) and rescale the trace.

## Evaluation of a Varactor Diode - DC Bias Sweep Using List Sweep Function (ZA Mode)

This section provides an example application of impedance analyzer mode in which the 4395A's internal DC source (Option 001) is controlled through the list sweep function to evaluate the characteristics of a varactor diode under DC bias conditions.

### Measurement Setup

#### Connection

Connect the 4395A with the 43961A Impedance Test Kit in the same procedure as described in "Evaluation of a Chip Capacitor (ZA Mode)". Connect the BNC(m)-BNC(m) cable included in the 43961A package between the 4395A's DC SOURCE connector and the 43961A's DC SOURCE Input connector.

#### Analyzer Settings

Press **[Preset]**. Then set the 4395A's controls as follows:

	Desired Settings	Key Strokes
MEASUREMENT block	Select impedance analyzer mode	<b>[Meas]</b> ANALYZER TYPE IMPEDANCE ANALYZER
ACTIVE CHANNEL block	Select channel 1	<b>[Chan 1]</b> (default)
MEASUREMENT block	C <sub>p</sub> (parallel capacitance)  Averaging factor 8	<b>[Meas]</b> MORE 1/5 MORE 2/5 MORE 3/5 CAPACITANCE: PRL(C <sub>p</sub> )  <b>[Bw/Avg]</b> AVERAGING FACTOR <b>[8]</b> <b>[x1]</b> AVERAGING on OFF (to ON off)
SWEEP block	Hold trigger	<b>[Trigger]</b> SWEEP: HOLD

#### Defining the Sweep List

The list sweep function controls the sweep process in accordance with a user-defined sweep list. To define the sweep list, follow these steps:

1. Press **[Source]** and check that DC source output is turned off. (Softkey label must be DC OUT on OFF).
2. Check that DC SRC [VOLTAGE] (voltage mode) is currently selected.
3. Choose DC CURRENT LIMIT and press **[1]** **[0]** **[k/m]** to set the upper limit current to 10 mA . (Note that you may need to specify a greater or smaller value depending on the specifications of the actual DUT).
4. Press **[Sweep]** and choose SWEEP TYPE MENU EDIT LIST to begin editing the sweep list. First, you define segment 1 of the sweep list.
5. Choose ADD SEGMENT: START and press **[3]** **[0]** **[0]** **[M/μ]**. This defines both start and stop frequency for segment 1 to be 300 MHz, and instructs the 4395A to keep the frequency for segment 1 constant at 300 MHz.
6. Do not change the number of points. (default value is 2)

## Evaluation of a Varactor Diode - DC Bias Sweep Using List Sweep Function (ZA Mode)

7. Choose **MORE POWER** and press  $\boxed{-}$   $\boxed{1}$   $\boxed{3}$   $\boxed{\times 1}$  to set the power for segment 1 to  $-13$  dBm.
8. Choose **DC VOLTAGE** and press  $\boxed{-}$   $\boxed{2}$   $\boxed{8}$   $\boxed{\times 1}$  to set the DC bias voltage for segment 1 to  $-28$  V.
9. Choose **RETURN SEGMENT DONE** to finish defining segment 1.
10. Repeat steps 4 through 8 above for each of segments 2 through 15, increasing the DC bias voltage in 2 V increments from one segment to another. Note that, when you add a new segment by choosing **ADD**, the new segment inherits the definitions for the immediately preceding segment. Therefore, you can create the sweep list by just changing the DC SOURCE setting for each subsequent segment.

**Table 10-1. Sweep List for Evaluating a Varactor Diode**

Segment Number	Start Frequency	Stop Frequency	Measuring Point	Power	IF Bandwidth	DC Bias Voltage
1	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-28$ V
2	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-26$ V
3	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-24$ V
4	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-22$ V
5	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-20$ V
6	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-18$ V
7	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-16$ V
8	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-14$ V
9	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-12$ V
10	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-10$ V
11	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-8$ V
12	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-6$ V
13	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-4$ V
14	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$-2$ V
15	300 MHz	300 MHz	2	$-13$ dBm	2 Hz	$0$ V

11. When you have finished defining segment 15, choose **LIST DONE** to exit from edit mode.
12. Choose **LIST FREQ** to set the sweep mode to list sweep.

### Calibration

Calibrate the 4395A as described in "Evaluation of a Chip Capacitor (ZA Mode)".

#### Caution



Do not attempt to perform calibration or fixture compensation while the 4395A is applying external DC bias. Doing so could damage the calibration or fixture compensation standard.

## Evaluation of a Varactor Diode - DC Bias Sweep Using List Sweep Function (ZA Mode)

### Connecting the Test Fixture

Connect the 4395A with the 16192A Test Fixture as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

### Setting the Electrical Length of the Test Fixture

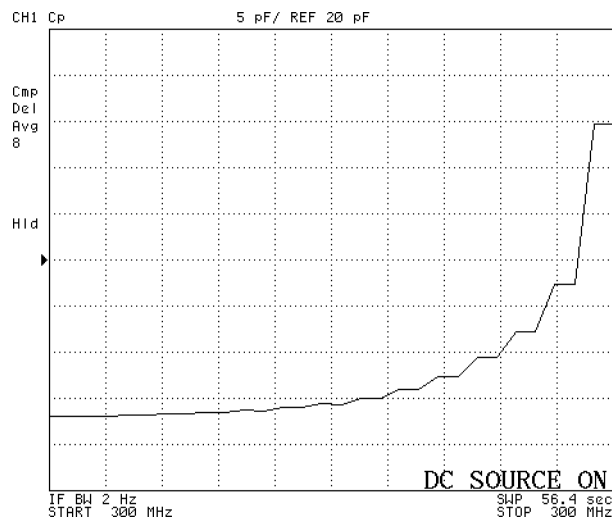
Set the electrical length of the 16192A Test Fixture as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

### Fixture Compensation

Carry out fixture compensation as described in “Evaluation of a Chip Capacitor (ZA Mode)”.

### Measuring Capacitance under DC Bias Conditions

1. Connect the DUT.
2. Press **Source** and toggle **DC OUT on OFF** to **ON off**.



**Figure 10-32. Characteristics of a Varactor Diode under DC Bias Sweep**

In this example, you learned how to evaluate the capacitance characteristics of a varactor diode under DC voltage bias conditions using the list sweep function. Other possible applications of the list sweep function include evaluating the capacitance of a capacitor under DC voltage bias conditions and evaluating the characteristics of a coil under DC current bias conditions.

## Specifications and Supplemental Characteristics

---

These specifications are the performance standards or limits against which the instrument is tested. When shipped from the factory, the 4395A meets the specifications listed in this section. The performance test procedures are covered in the *4395A Service Manual*.

Specifications describe the instrument's warranted performance over the temperature range of 0°C to 40°C (except as noted). Supplemental characteristics are intended to provide information that is useful in applying the instrument by giving non-warranted performance parameters. These are denoted as *SPC (supplemental performance characteristics), typical* or *nominal*. Warm up time must be greater than or equal to 30 minutes after power on for all specifications.

---

### Network Measurement

#### Source Characteristics

##### Frequency Characteristics

<b>Range</b> .....	10 Hz to 500 MHz
<b>Resolution</b> .....	1 mHz
<b>Frequency reference</b>	
<b>Accuracy</b>	
at 23±5°C, referenced to 23°C .....	<±5.5 ppm
<b>Aging</b> .....	<±2.5 ppm/year (SPC)
<b>Initial achievable accuracy</b> .....	<±1.0 ppm (SPC)
<b>Temperature stability</b>	
at 23±5°C, referenced to 23°C .....	<±2ppm (SPC)
<b>Precision frequency reference (option 1D5)</b>	
<b>Accuracy</b>	
at 0°C to 40°C, referenced to 23°C .....	<±0.13 ppm
<b>Aging</b> .....	<±0.1 ppm/year (SPC)
<b>Initial achievable accuracy</b> .....	<±0.02 ppm (SPC)
<b>Temperature stability</b>	
at 0°C to 40°C, referenced to 23°C .....	<±0.01 ppm (SPC)

##### Output Characteristics

<b>Power range</b> .....	-50 dBm to +15 dBm
<b>Level accuracy</b>	
at 0 dBm output, 50 MHz, 23±5°C, .....	±1.0 dB
<b>Level linearity</b>	

## Network Measurement

Output Power	Linearity <sup>1</sup>
≥ -40 dBm	±1.0 dB
< -40 dBm	±1.5 dB

1 at relative to 0 dBm output, 50 MHz, 23±5°C

### Flatness

at 0 dBm output, relative to 50 MHz, 23±5°C ..... ±2 dB

**Resolution** ..... 0.1 dB

### Spectral Purity Characteristics

#### Harmonics

at +10 dBm output ..... <-30 dBc

#### Non-harmonics spurious

at +10 dBm output ..... <-30 dBc

#### Noise sidebands

at ≥10 kHz offset from carrier ..... <-95 dBc/Hz

**Power sweep range** ..... 20 dB max.

#### Power sweep linearity

deviation from linear power referenced to the stop power level ..... ±0.5 dB

**Impedance** ..... 50 Ω nominal

#### Return loss

frequency ≤ 200 MHz ..... >15 dB (SPC)

frequency > 200 MHz ..... >7 dB (SPC)

**Connector** ..... Type N female

**Receiver Characteristics**

**Input Characteristics**

**Frequency range** ..... 10 Hz to 500 MHz  
**Input attenuator** ..... 0 to 50 dB, 10 dB step  
**Full scale input level (R,A,B)**

Attenuator setting [dB]	Full scale input level <sup>1</sup> [dBm]
0	-10
10	0
20	+10
30	+20
40	+30
50	+30

<sup>1</sup> Note that it is different from the full scale input level in spectrum measurement.

**IF bandwidth (IFBW)** ..... 2, 10, 30, 100, 300, 1 k, 3 k, 10 k, 30 kHz

Note: The IFBW should be set equal to or less than 1/5 of the lowest frequency in the sweep range.

**Noise level (referenced to full scale input level, 23±5°C)**

at 10 Hz ≤ frequency < 100 Hz, IFBW = 2 Hz ..... -85 dB (SPC)  
 at 100 Hz ≤ frequency < 100 kHz, IFBW = 10 Hz ..... -85 dB  
 at 100 kHz ≤ frequency, IFBW = 10 Hz ..... (-115 + f/100 MHz)dB

**Input crosstalk**

for input R ... +10 dBm input, input attenuator: 20 dB  
 for input A, B ... input attenuator: 0 dB  
 at frequency < 100 kHz  
     R through A, B ..... < -100 dB  
     others ..... < -100 dB (SPC)  
 at frequency ≥ 100 kHz  
     R through A, B ..... < -120 dB  
     others ..... < -120 dB (SPC)

**Source Crosstalk (for input A, B)(typical for input R)**

at +10 dBm output, <100 kHz, input attenuator: 0 dB ..... < -100 dB  
 at +10 dBm output, ≥100 kHz, Input attenuator: 0 dB ..... < -120 dB

**Impedance change by multiplexer switching**

at Input attenuator 0 dB ..... < 0.5 % (SPC)  
 at Input attenuator 10 dB and above ..... < 0.1 % (SPC)

**Connector** ..... Type N female

**Impedance** ..... 50 Ω nominal

**Return loss**

	Input attenuator		
	0 dB	10 dB	20 dB to 50 dB
10 Hz ≤ frequency < 100 kHz	25 dB <sup>1</sup>	25 dB <sup>1</sup>	25 dB <sup>1</sup>
100 kHz ≤ frequency ≤ 100 MHz	25 dB <sup>1</sup>	25 dB	25 dB <sup>1</sup>
100 MHz < frequency	15 dB <sup>1</sup>	15 dB	15 dB <sup>1</sup>

<sup>1</sup> SPC

**Maximum input level** ..... +30 dBm (at input attenuator: 40 dB or 50 dB)

**Network Measurement**

**Maximum safe input level** ..... + 30 dBm or  $\pm 7$  Vdc (SPC)

**Magnitude Characteristics**

**Absolute amplitude accuracy (R, A, B)**

at -10 dBm input, input attenuator: 10 dB, frequency  $\geq 100$  Hz, IFBW  $\leq 3$  kHz,  $23 \pm 5^\circ\text{C}$ ,  
 .....  $< \pm 1.5$  dB

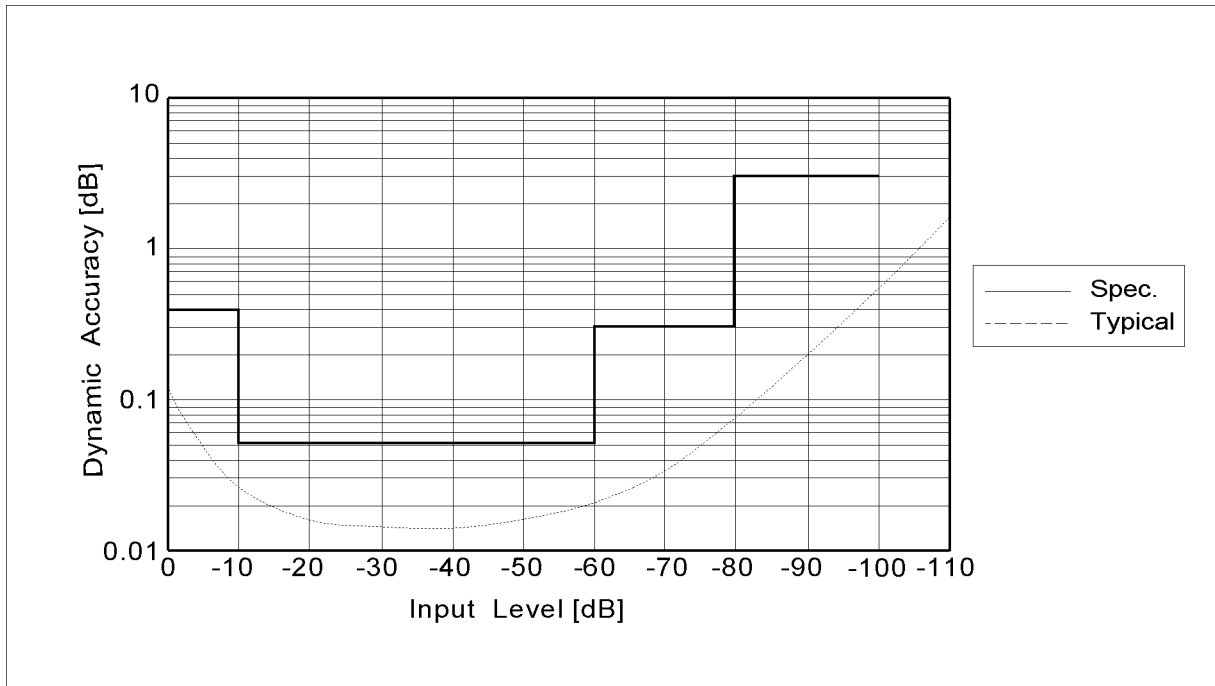
**Ratio accuracy (A/R, B/R) (typical for A/B)**

at -10 dBm input, input attenuator: 10 dB, IFBW  $\leq 3$  kHz,  $23 \pm 5^\circ\text{C}$ ,  
 .....  $< \pm 2$  dB

**Dynamic accuracy (A/R, B/R) (typical for A/B)**

Input Level (relative to full scale input level)	Dynamic Accuracy <sup>1</sup> frequency $\geq 100$ Hz
0 dB $\geq$ input level $> -10$ dB	$\pm 0.4$ dB
-10 dB $\geq$ input level $\geq -60$ dB	$\pm 0.05$ dB
-60 dB $>$ input level $\geq -80$ dB	$\pm 0.3$ dB
-80 dB $>$ input level $\geq -100$ dB	$\pm 3$ dB

<sup>1</sup> A input level (B input level for B/R) = full scale input level - 10 dB, R input level (B input level for A/B) = full scale input level - 10 dB, IFBW = 10 Hz,  $23 \pm 5^\circ\text{C}$   
 At the following points, measurement error may exceed the specifications:  
 124.0 MHz, 136.0 MHz, 415.0 MHz



**Figure 11-1. Magnitude Dynamic Accuracy**



**Residual responses** ..... < -80 dB full scale input level (SPC)  
**Trace noise (A/R, B/R, A/B)**  
 at 50 MHz, -20 dBm input, both inputs: full scale input level -10 dB, IFBW = 300 Hz  
 ..... < 0.005 dB rms (SPC)  
**Stability (A/R, B/R, A/B)** ..... < ±0.01 dB/°C (SPC)

**Phase Characteristics**

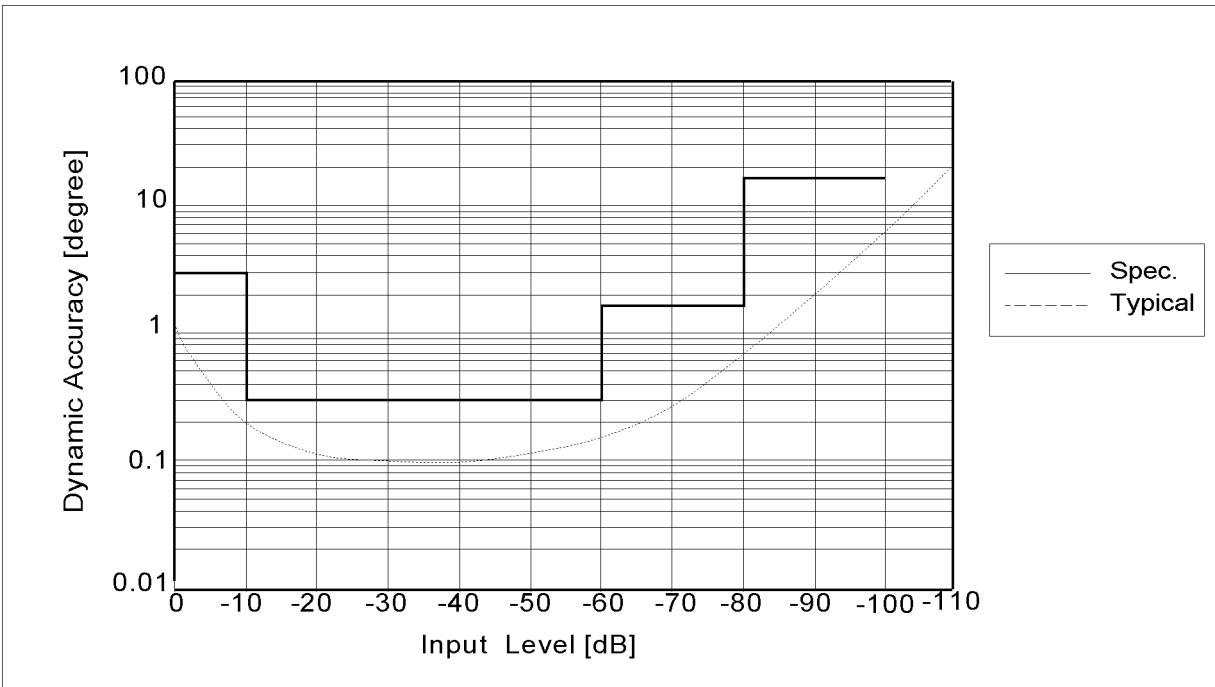
**Measurements format** ..... Standard format, Expanded phase format  
**Frequency response (deviation from linear phase) (A/R, B/R) (SPC for A/B)**  
 at -10 dBm input, input attenuator: 10 dB, IFBW ≤ 3 kHz, 23±5°C  
 ..... < ±12°

**Dynamic accuracy (A/R, B/R) (SPC for A/B)**

Input Level (relative to full scale input level)	Dynamic Accuracy <sup>1</sup> frequency ≥ 100 Hz
0 dB ≥ input level > -10 dB	±3°
-10 dB ≥ input level ≥ -60 dB	±0.3°
-60 dB > input level ≥ -80 dB	±1.8°
-80 dB > input level ≥ -100 dB	±18°

1 A input level (B input level for B/R) = full scale input level -10 dB, R input level (B input level for A/B) = full scale input level -10 dB, IFBW = 10 Hz, 23±5°C

At the following points, measurement error may exceed the specifications:  
 124.0 MHz, 136.0 MHz, 415.0 MHz



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**Figure 11-2. Phase Dynamic Accuracy**

**Trace noise (A/R, B/R, A/B)**  
 at 50 MHz, -20 dBm input, both inputs: full scale input level -10 dB, IFBW = 300 Hz  
 ..... < 0.04° rms (SPC)  
**Stability (A/R, B/R, A/B)** ..... < ±0.1 °/°C (SPC)

**Network Measurement**

**Group Delay Characteristics**

**Aperture [Hz]** ..... 0.25 % to 20 % of span  
**Accuracy**

In general, the following formula can be used to determine the accuracy, in seconds, of a specific group delay measurement:

$$\dots\dots\dots \frac{PhaseAccuracy[degree]}{Aperture[Hz] \times 360[degree]}$$

**Sweep Characteristics**

**Sweep type** ..... Linear frequency, Log frequency, Power, List frequency  
**Trigger type** ..... Hold, Single, Number of groups, Continuous  
**Trigger source** ..... Internal (free run), External, Manual, GPIB (bus)  
**Event trigger** ..... On point, On sweep  
**NOP(Number of Points)** ..... 2 to 801

**Measurement Throughput <sup>1</sup>**

(msec, SPC, IFBW = 30 kHz, after through calibration)

Measurement points	51	201	401	801
Amplitude	75	165	305	580
Amplitude/Phase	75	215	400	770

<sup>1</sup> Includes system retrace time and RF switching time. Add 80 msec at start frequency < 5 MHz.

# Spectrum Measurement

## Frequency Characteristics

**Frequency range** ..... 10 Hz to 500 MHz

**Frequency readout accuracy**  
 .....  $\pm((freq\ readout[Hz]) \times (freq\ ref\ accuracy) + RBW[Hz] + \frac{SPAN[Hz]}{(NOP-1)})$

where NOP means number of display points

### Frequency reference

**Accuracy**  
 at 23±5°C, referenced to 23°C ..... <±5.5 ppm

**Aging** ..... <±2.5 ppm/year (SPC)

**Initial achievable accuracy** ..... <±1.0 ppm (SPC)

**Temperature stability**  
 at 23±5°C, referenced to 23°C ..... <±2 ppm (SPC)

### Precision frequency reference (option 1D5)

**Accuracy**  
 at 0°C to 40°C, referenced to 23°C ..... <±0.13 ppm

**Aging** ..... <±0.1 ppm/year (SPC)

**Initial achievable accuracy** ..... <±0.02 ppm (SPC)

**Temperature stability**  
 at 0°C to 40°C, referenced to 23°C ..... <±0.01 ppm (SPC)

### Resolution bandwidth (RBW)

**Range**  
 3 dB RBW at span > 0 ..... 1 Hz to 1 MHz, 1-3 step  
 3 dB RBW at span = 0

..... 3k, 5k, 10k, 20k, 40k, 100k, 200k, 400k, 800k, 1.5M, 3M, 5MHz

**Selectivity** (60 dB BW / 3 dB BW)  
 at span > 0 ..... <3

**Mode** ..... Auto or Manual

**Accuracy**  
 at span > 0 ..... <±10%  
 at span = 0 ..... <±30%

### Video bandwidth (VBW)

**Range**  
 at span > 0 ..... 3 mHz to 3 MHz, 1-3 step,  $0.003 \leq VBW/RBW \leq 1$

### Noise sidebands

(Carrier Frequency: 10 MHz, 100 MHz, 500 MHz)

Offset from Carrier	Noise Sidebands
≥ 1 kHz	< -97 dBc/Hz
≥ 100 kHz	< -110 dBc/Hz

## Spectrum Measurement

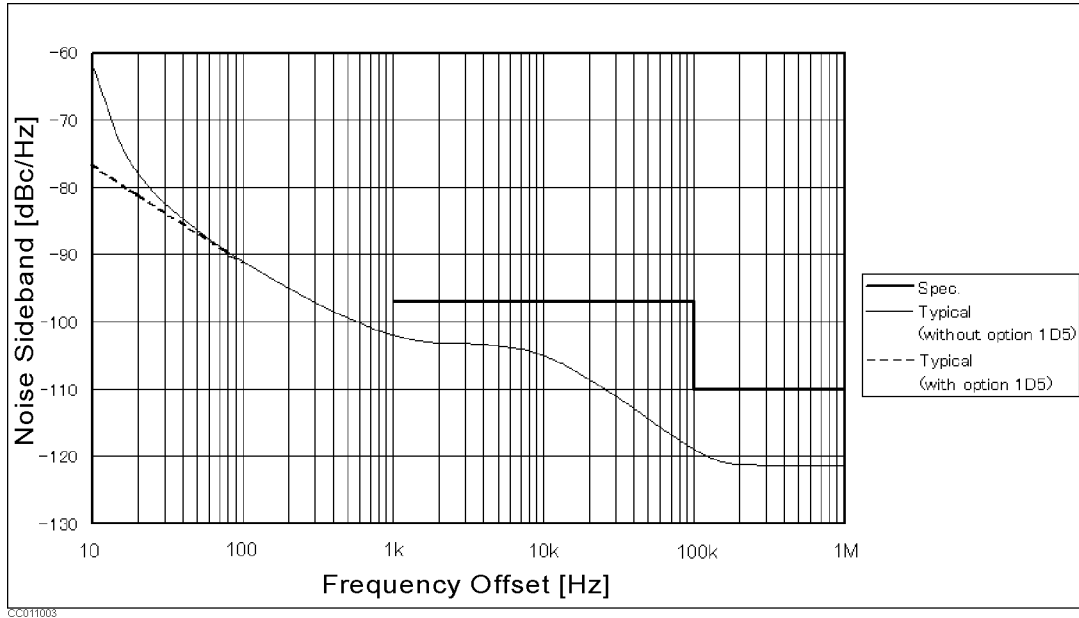


Figure 11-3. Noise Sidebands

## Amplitude Characteristics

**Amplitude range** ..... displayed average noise level to +30 dBm

**Reference value setting range** ..... -100 dBm to +30 dBm

**Level accuracy**

at -20 dBm input, 50MHz, input attenuator: 10 dB, 23±5°C ..... <±0.8 dB

**Frequency response**

at -20 dBm input, input attenuator: 10 dB, referenced to level at 50 MHz, 23±5°C

frequency ≥ 100 Hz ..... <±1.3 dB

frequency < 100 Hz ..... <±3.0 dB

**Amplitude fidelity<sup>1</sup>**

**Log scale<sup>2</sup>**

Input level (dB to full scale input level)	Amplitude Fidelity
0 to -30 dB	±0.05 dB
-30 to -40 dB	±0.07 dB
-40 to -50 dB	±0.15 dB
-50 to -60 dB	±0.35 dB
-60 to -70 dB	±0.8 dB
-70 to -80 dB	±1.8 dB

**Linear scale**<sup>2</sup> ..... <±3%

<sup>1</sup> Amplitude fidelity shows an extent of nonlinearity referenced to the full scale input level -10 dB.

<sup>2</sup> RBW = 10 Hz, -20 dBm ≤ reference value ≤ +30 dBm, referenced to full scale input level -10 dB, input attenuator: auto, 23±5°C

Note: Refer to *Input attenuator* part for the definition of full scale input level.

**Displayed average noise level**

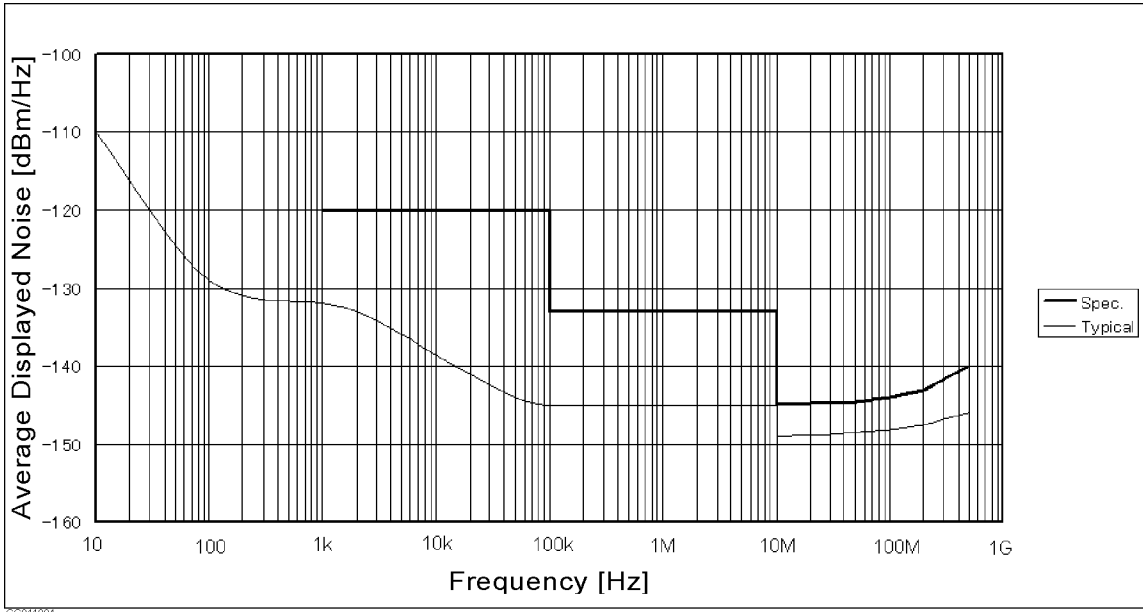
at reference value ≤ -40 dBm, input attenuator: auto or 0 dB

at frequency ≥ 1 kHz ..... -120 dBm/Hz

at ≥ 100 kHz ..... -133 dBm/Hz

at ≥ 10 MHz<sup>1</sup> ..... (-145 + frequency/100 MHz) dBm/Hz

<sup>1</sup> at start frequency ≥ 10 MHz



**Figure 11-4. Typical Displayed Average Noise Level**

**On-screen dynamic range**

## Spectrum Measurement

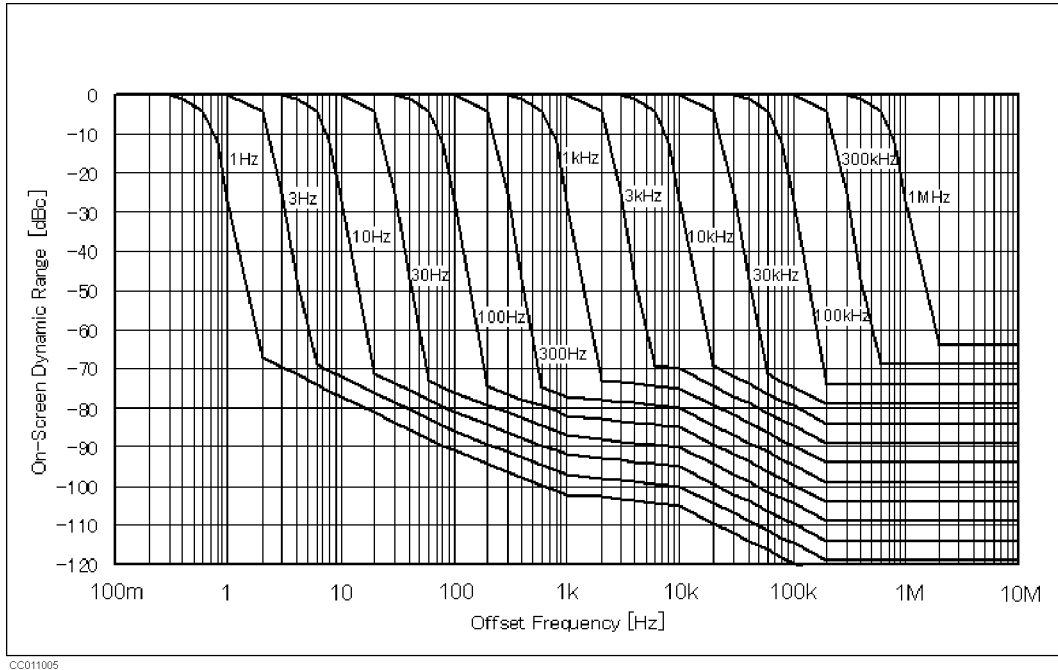


Figure 11-5. Typical On-screen Dynamic Range (Center: 50 MHz)

### Spurious responses

#### Second harmonic distortion ( $23 \pm 5^\circ\text{C}$ )

at single tone input with full scale input level  $-10$  dB, input signal frequency  $\geq 100$  kHz

.....  $< -70$  dBc

#### Third order inter-modulation distortion ( $23 \pm 5^\circ\text{C}$ )

at two tones input with full scale input level  $-16$  dB, separation  $\geq 100$  kHz

.....  $< -70$  dBc

#### Other spurious ( $23 \pm 5^\circ\text{C}$ )

at single tone input with full scale input level  $-10$  dB, input signal frequency  $\leq 500$  MHz,  
RBW  $\leq 100$  kHz,  $1\text{ kHz} \leq$  frequency offset  $\leq 300\text{ MHz}$

.....  $< -70$  dBc

( $< -60$  dBc (SPC) if there are input signals in the following frequency range:

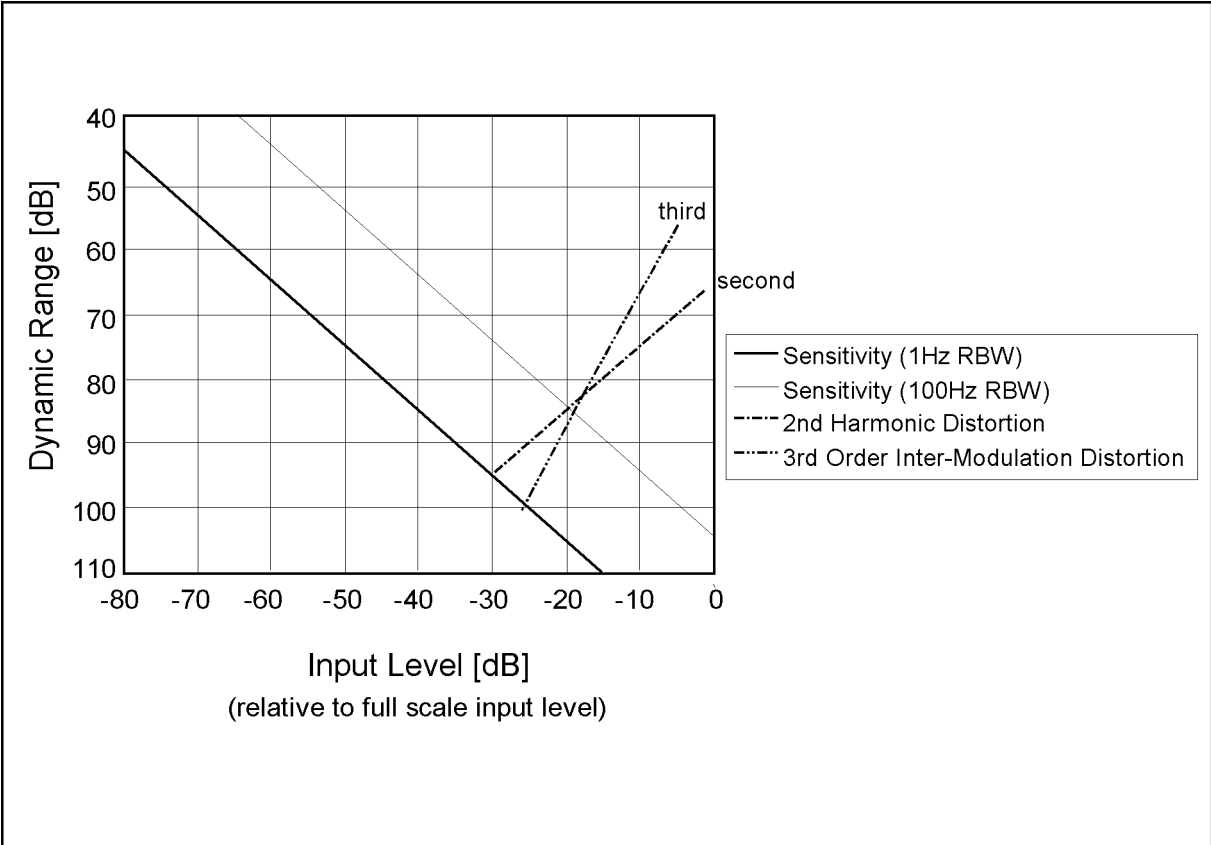
14.7 MHz to 15.9 MHz, 29.5 MHz to 31.7 MHz, 414.7 MHz to 415.9 MHz)

### Residual response

at reference value setting  $\leq -40$  dBm, input attenuator: auto or 0 dB .....  $< -108$  dBm

See “EMC” under “Others” in “Common to Network/Spectrum/Impedance Measurement”.

### Typical dynamic range



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Figure 11-6. Typical Dynamic Range at Inputs R, A, and B

**Input attenuator**  
**Setting range** ..... 0 dB to 50 dB, 10 dB step

Attenuator Setting	Full Scale Input Level <sup>1</sup>
0 dB	-20 dBm
10 dB	-10 dBm
20 dB	0 dBm
30 dB	+10 dBm
40 dB	+20 dBm
50 dB	+30 dBm

<sup>1</sup> Note that it is different from the full scale input level in network measurement.

**Mode** ..... Auto or Manual  
 (In auto mode, the attenuator is set to minimum value which ensures full scale input level  $\geq$  reference level)

**Input attenuator switching uncertainty**  
 at attenuator:  $\leq 30$  dB, referenced to 10 dB .....  $<\pm 1.0$  dB  
 at attenuator:  $\geq 40$  dB, referenced to 10 dB .....  $<\pm 1.5$  dB

**Temperature drift** .....  $<\pm 0.05$  dB/°C (SPC)

## Spectrum Measurement

### Scale

<b>Log</b> .....	0.1 dB/div to 20 dB/div
<b>Linear</b>	
at watt .....	$1.0 \times 10^{-12}$ W/div
at volt .....	$1.0 \times 10^{-9}$ V/div
<b>Measurement format</b> .....	Spectrum or Noise (/Hz)
<b>Display unit</b> .....	dBm, dBV, dB $\mu$ V, V, W

## Sweep Characteristics

<b>Sweep type</b> .....	Linear frequency, List frequency
<b>Trigger type</b> .....	Hold, Single, Number of groups, Continuous,
<b>Trigger source</b> .....	Internal (free run), External, Manual, Level gate(Option 1D6), Edge gate(Option 1D6), GPIB (bus)
<b>Sweep time</b> (excluding each sweep setup time)	

RBW	SPAN	Typical Sweep Time
1 MHz	500 MHz	180 ms
100 kHz	100 MHz	300 ms
10 kHz	10 MHz	240 ms
1 kHz	1 MHz	190 ms
100 Hz	100 kHz	270 ms
10 Hz	10 kHz	2.0 s
1 Hz	1 kHz	11 s
—	Zero Span	— <sup>1</sup>

<sup>1</sup> See the next item for sweep time at zero span

### Zero span

RBW	Minimum Resolution	Maximum Sweep Time
5 MHz	40 ns	1.28 ms
100 kHz	1.28 $\mu$ s	81.92 ms
3 kHz	40.96 $\mu$ s	2.62 s

### Number of display points

at span > 0 .....	2 to 801 points (automatically set)
at span = 0 .....	2 to 801 points (selectable)

## Input Characteristics

<b>Input Port</b> .....	R, A, B
<b>Crosstalk</b>	
from any input to other inputs, at the same input attenuator settings	
.....	< -100 dB (SPC)
<b>Connector</b> .....	Type N female
<b>Impedance</b> .....	50 $\Omega$ nominal
<b>Return Loss</b>	

	Input Attenuator		
	0 dB	10 dB	20 dB to 50 dB
10 Hz $\leq$ frequency < 100 kHz	25 dB <sup>1</sup>	25 dB <sup>1</sup>	25 dB <sup>1</sup>
100 kHz $\leq$ frequency $\leq$ 100 MHz	25 dB <sup>1</sup>	25 dB	25 dB <sup>1</sup>
100 MHz < frequency	15 dB <sup>1</sup>	15 dB	15 dB <sup>1</sup>

<sup>1</sup> (SPC)



## Spectrum Measurement

**Input Level** ..... +30 dBm max. at input attenuator: 50 dB  
**Maximum safe input level** ..... +30 dBm or  $\pm 7$  Vdc (SPC)

### Specifications when Option 1D6 Time-Gated spectrum analysis is installed

All specifications are identical to the standard 4395A except the following items.

#### Gate length

**Range** ..... 6  $\mu$ s to 3.2 s  
**Resolution**

Range of Gate Length( $T_1$ )	Resolution
$6 \mu\text{s} \leq T_1 \leq 25 \text{ ms}$	0.4 $\mu$ s
$25 \text{ ms} < T_1 \leq 64 \text{ ms}$	1 $\mu$ s
$64 \text{ ms} < T_1 \leq 130 \text{ ms}$	2 $\mu$ s
$130 \text{ ms} < T_1 \leq 320 \text{ ms}$	5 $\mu$ s
$320 \text{ ms} < T_1 \leq 1.28 \text{ s}$	20 $\mu$ s
$1.28 \text{ s} < T_1 \leq 3.2 \text{ s}$	100 $\mu$ s

#### Gate delay

**Range** ..... 0.8  $\mu$ s to 3.2 s  
**Resolution**

Range of Gate Delay ( $T_d$ )	Resolution
$0.8 \mu\text{s} \leq T_d \leq 25 \text{ ms}$	0.4 $\mu$ s
$25 \text{ ms} < T_d \leq 64 \text{ ms}$	1 $\mu$ s
$64 \text{ ms} < T_d \leq 130 \text{ ms}$	2 $\mu$ s
$130 \text{ ms} < T_d \leq 320 \text{ ms}$	5 $\mu$ s
$320 \text{ ms} < T_d \leq 1.28 \text{ s}$	20 $\mu$ s
$1.28 \text{ s} < T_d \leq 3.2 \text{ s}$	100 $\mu$ s

#### Additional Amplitude Error

**Log scale** ..... < 0.3 dB (SPC)  
**Linear scale** ..... < 3% (SPC)

**Gate Control Modes** ..... Edge (positive/negative) or Level

#### Gate Trigger Input (External Trigger Input is used)

**Connector** ..... BNC female  
**level** ..... TTL

#### Gate Output

**Connector** ..... BNC female  
**level** ..... TTL

### Specifications when Option 1D7 50 to 75 $\Omega$ Input Impedance Conversion is installed

**Insertion loss for Conversion Pad** ..... 5.7 dB nominal

## 4395A Option 010 Impedance Measurement

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### 4395A Option 010 Impedance Measurement

The following specifications are applied when the 43961A Impedance Test Kit is connected to the 4395A.

#### Measurement Functions

Measurement parameters	Z, Y, L, C, Q, R, X, G, B, $\theta$
Display parameters	$ Z , \theta_z, R, X,  Y , \theta_y, G, B,  \Gamma , \theta_\gamma, \Gamma_x, \Gamma_y, C_p, C_s, L_p, L_s, R_p, R_s, D, Q$

#### Display Formats

- Vertical lin/log scale
- Complex plane
- Polar/Smith/admittance chart

#### Sweep Parameters

- Linear frequency sweep
- Logarithmic frequency sweep
- List frequency sweep
- Power sweep (in dBm unit)

#### IF Bandwidth

2, 10, 30, 100, 300, 1k, 3k, 10k, 30k [Hz]

#### Calibration

- OPEN/SHORT/LOAD 3 term calibration
- Fixture compensation
- Port extension correction

#### Measurement Port Type

- APC-7

#### Output Characteristics

Frequency range ..... 100 kHz to 500 MHz

Frequency resolution ..... 1 mHz

Output impedance ..... 50  $\Omega$  nominal

Output Level

when the measurement port is terminated by 50  $\Omega$ <sup>1</sup> ..... -56 to +9 dBm

when the measurement port is open ..... 0.71 mVrms to 1.26 Vrms

<sup>1</sup> Note: When the measurement port is terminated with 50  $\Omega$ , the signal level at the measurement port is 6 dB lower than the signal level at the RF OUT port.

## 4395A Option 010 Impedance Measurement

Resolution .....0.1 dB

Level accuracy

frequency < 1 MHz ..... $\pm(A + 3)$  [dB]

frequency  $\geq$  1 MHz ..... $\pm(A + 1)$  [dB]

where, A is the sum total of level accuracy, level linearity, and level flatness specifications for output characteristics of network measurement.

## Measurement Basic Accuracy (Supplemental Performance Characteristics)

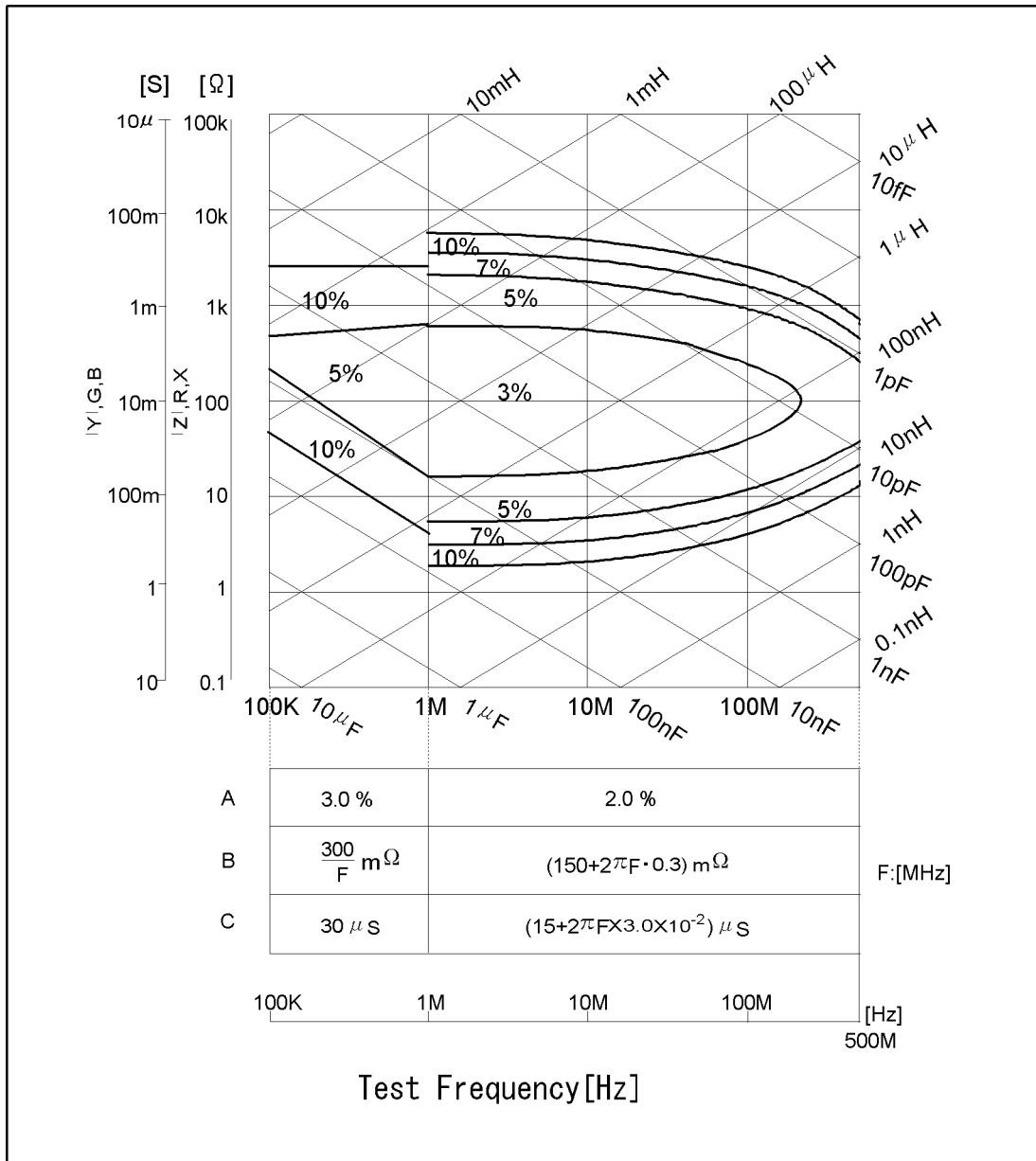
Measurement accuracy is specified at the connecting surface of the APC-7 connector of the 43961A under the following conditions: <sup>1</sup>

Warm up time .....	> 30 minutes
Ambient temperature .....	23°C ± 5°C, within ±1°C from the temperature at which calibration is performed
Signal level (setting) .....	0 to +15 dBm
Correction .....	ON
IFBW (for calibration and measurement).....	≤ 300 Hz
Averaging factor (for calibration and measurement) .....	≥ 8

<sup>1</sup> At the following points, measurement error may exceed the performance described in this section:

124.0 MHz, 136.0 MHz, 415.0 MHz

## Measurement Basic Accuracy (Supplemental Performance Characteristics)



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Figure 11-7. Impedance Measurement Accuracy

### $|Z| - \theta$ Accuracy

$$|Z| \text{ accuracy} \quad Z_a = A + (B/|Z_m|) + C \times |Z_m| \times 100 [\%]$$

$$\theta \text{ accuracy} \quad \theta_a = \sin^{-1}(Z_a/100)$$

Where,  $|Z_m|$  is  $|Z|$  measured. A, B, and C are obtained from Figure 11-7.

## Measurement Basic Accuracy (Supplemental Performance Characteristics)

### **|Y| - $\theta$ Accuracy**

$$|Y| \text{ accuracy} \quad Y_a = A + (B \times |Y_m| + C/|Y_m|) \times 100 [\%]$$

$$\theta \text{ accuracy} \quad \theta_a = \sin^{-1}(Y_a/100)$$

Where,  $|Y_m|$  is  $|Y|$  measured. A, B, and C are obtained from Figure 11-7.

### **R - X Accuracy (Depends on D)**

Accuracy	$D \leq 0.2$	$0.2 < D \leq 5$	$5 < D$
$R_a$	$\pm X_m \times X_a/100 [\Omega]$	$R_a/\cos\theta [\%]$	$R_a [\%]$
$X_a$	$X_a [\%]$	$X_a/\sin\theta [\%]$	$\pm R_m \times R_a/100 [\Omega]$

Where,

$$D \text{ can be calculated as: } \quad R/X, \text{ or}$$

$$R/(2\pi f \times L_s), \text{ or}$$

$$R \times 2\pi f \times C_s$$

$$\theta \text{ can be calculated as: } \quad \tan^{-1}(X/R), \text{ or}$$

$$\tan^{-1}(2\pi f \times L_s/R), \text{ or}$$

$$\tan^{-1}(1/(R \times 2\pi f \times C_s))$$

$$R_a = A + (B/|R_m| + C \times |R_m|) \times 100 [\%]$$

$$X_a = A + (B/|X_m| + C \times |X_m|) \times 100 [\%]$$

$R_m$  and  $X_m$  are the measured R and X, respectively. A, B, and C are obtained from Figure 11-7.

### **G - B Accuracy (Depends on D)**

Accuracy	$D \leq 0.2$	$0.2 < D \leq 5$	$5 < D$
$G_a$	$\pm B_m \times B_a/100 [S]$	$G_a/\cos\theta [\%]$	$G_a [\%]$
$B_a$	$B_a [\%]$	$B_a/\sin\theta [\%]$	$\pm G_m \times G_a/100 [S]$

Where,

$$D \text{ can be calculated as: } \quad G/B, \text{ or}$$

$$G/(2\pi f \times C_p), \text{ or}$$

$$G \times 2\pi f \times L_p$$

$$\theta \text{ can be calculated as: } \quad \tan^{-1}(B/G), \text{ or}$$

$$\tan^{-1}(2\pi f \times C_p/G), \text{ or}$$

$$\tan^{-1}(1/(G \times 2\pi f \times L_p))$$

$$G_a = A + (B \times |G_m| + C/|G_m|) \times 100 [\%]$$

$$B_a = A + (B \times |B_m| + C/|B_m|) \times 100 [\%]$$

### Measurement Basic Accuracy (Supplemental Performance Characteristics)

$G_m$  and  $B_m$  are the measured  $G$  and  $B$ , respectively. A, B, and C are obtained from Figure 11-7.

#### D Accuracy

Accuracy	$D \leq 0.2$	$0.2 < D$
$D_a$	$Z_a/100$	$(Z_a/100) \times (1 + D^2)$

Where,  $Z_a$  is  $|Z|$  accuracy.

#### L Accuracy (Depends on D)

Accuracy	$D \leq 0.2$	$0.2 < D$
$L_a$	$L_a/100$	$L_a(1 + D)$

Where,  $L_a = A + (B/|Z_l| + C \times |Z_l|) \times 100$  [%]

$|Z_l| = 2\pi f \times L_m$ ,  $f$  is frequency in Hz, and  $L_m$  is measured L. A, B, and C are obtained from Figure 11-7.

#### C Accuracy (Depends on D)

Accuracy	$D \leq 0.2$	$0.2 < D$
$C_a$	$C_a$	$C_a(1 + D)$

Where,  $C_a = A + (B/|Z_c| + C \times |Z_c|) \times 100$  [%]

$|Z_c| = (2\pi f \times C_m)^{-1}$ ,  $f$  is frequency in Hz, and  $C_m$  is measured C. A, B, and C are obtained from Figure 11-7.

## Common to Network/Spectrum/Impedance Measurement

### Display

#### LCD

Size/Type	8.4 inch color LCD
Number of pixels	640 × 480
Effective Display Area	160 mm × 115 mm(600 × 430 dots)
Number of display channels	2
Format	single, dual (split or overwrite)
Number of traces	
For measurement	2 traces
For memory	2 traces
Data math	$gain \times data - offset$ , $gain \times (data - memory) - offset$ , $gain \times (data + memory) - offset$ , $gain \times (data/memory) - offset$
Data hold	Maximum hold, Minimum hold

### Marker

#### Number of markers

Main marker	1 for each channel
Sub-marker	7 for each channel
Δmarker	1 for each channel

### Hard copy

Mode	Dump mode only (including color dump mode)
------	--------------------------------------------

### Storage

#### Built-in flexible disk drive

Type	3.5 inch, 1.44 MByte or 720 KByte, 1.44 MByte format is used for disk initialization
Memory	512 KByte, can be backed up by flash memory
Backup Memory	
Charge time	1 hour Typical
Operating time of the battery backup	72 hours Typical

### GPIB

Interface	IEEE 488.1-1987, IEEE 488.2-1987, IEC 625, and JIS C 1901-1987 standards compatible.
Interface function	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C1, C2, C3, C4, C11, E2
Data transfer formats	ASCII, 32 and 64 bit IEEE 754 Floating point format, DOS PC format (32 bit IEEE with byte order reversed)



## Common to Network/Spectrum/Impedance Measurement

### Printer parallel port

<b>Interface</b> .....	IEEE 1284 Centronics standard compliant
<b>Printer control language</b> .....	HP PCL3 Printer Control Language
<b>Connector</b> .....	D-SUB (25-pin)

### Option 001 DC Voltage/Current Source

The setting of option 001 DC voltage/current source is independent of Channel 1 and Channel 2 settings.

#### Voltage

**Range** ..... -40 V to +40 V

**Resolution** ..... 1 mV

#### Current limitation

at Voltage setting = -25 V to +25 V .....  $\pm 100$  mA

at Voltage setting = -40 V to -25 V, 25 V to 40 V .....  $\pm 20$  mA

#### Current

**Range** ..... -20  $\mu$ A to -100 mA, 20  $\mu$ A to 100 mA

**Resolution** ..... 20  $\mu$ A

#### Voltage limitation

at Current setting = -20 mA to +20 mA .....  $\pm 40$  V

at Current setting = -100 mA to -20 mA, 20 mA to 100 mA .....  $\pm 25$  V

#### Accuracy

##### Voltage

at  $23 \pm 5^\circ\text{C}$  .....  $\pm(0.1\% + 4 \text{ mV} + I_{dc}^1 [\text{mA}] \times 5 [\Omega] \text{ mV})$

##### Current

at  $23 \pm 5^\circ\text{C}$  .....  $\pm(0.5\% + 30 \mu\text{A} + V_{dc}^2 [\text{V}] / 10 [\text{k}\Omega] \text{ mA})$

<sup>1</sup> current at DC source connector

<sup>2</sup> voltage at DC source connector

### Probe Power

**Output voltage** ..... +15 V (300 mA), -12.6 V (160 mA), GND nominal

### Specifications When HP Instrument BASIC Is Operated

**Keyboard** ..... PS/2 style 101 English keyboard

**Connector** ..... mini-DIN

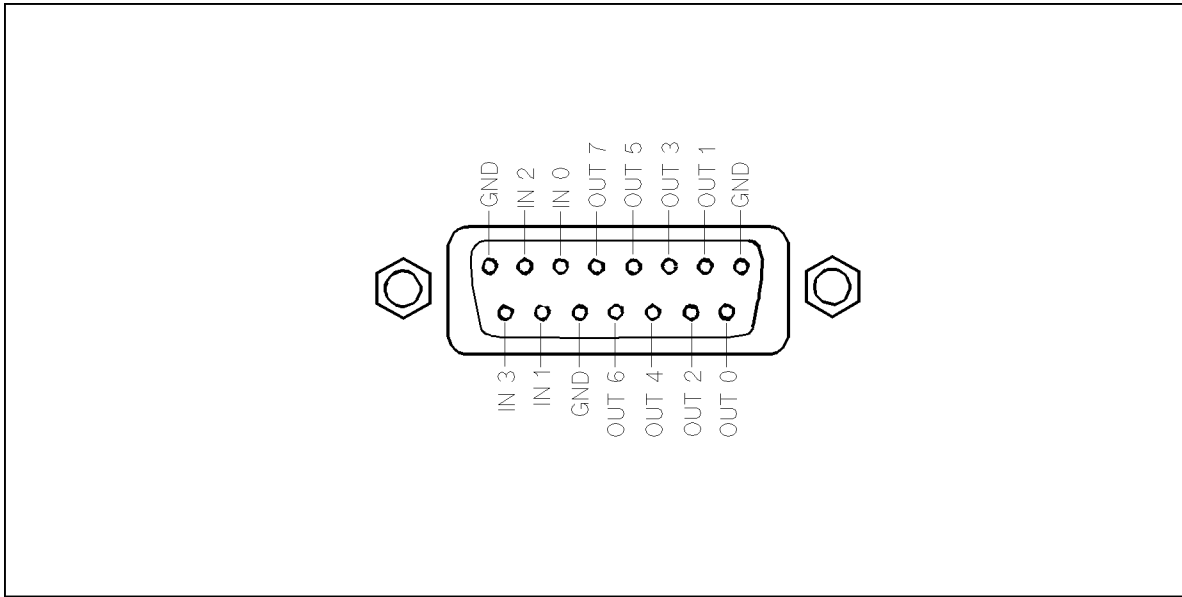
#### 8 bit I/O port

**Connector** ..... D-SUB (15-pin)

**Level** ..... TTL

**Number of Input/Output bit** ..... 4 bit for Input, 8 bit for Output

**Common to Network/Spectrum/Impedance Measurement**

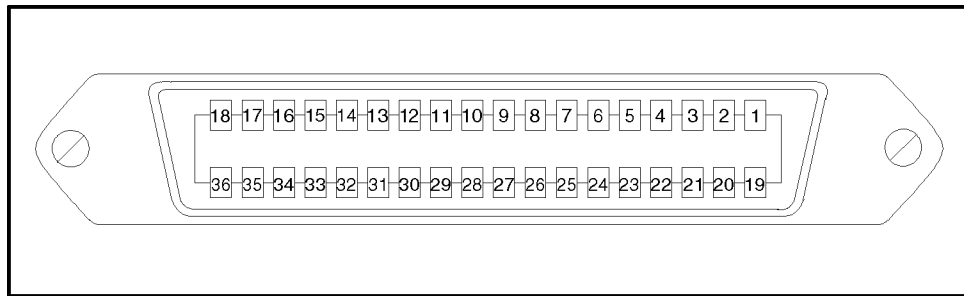


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**Figure 11-8. 8 bit I/O Port Pin Assignments**

**24-bit I/O Interface**

<b>Connector</b> .....	D-SUB (36-pin)
<b>Level</b> .....	TTL
<b>I/O</b> .....	8-bit for input or output, 16-bit for output



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**Figure 11-9. 24-bit I/O Interface Pin Assignment**

**Common to Network/Spectrum/Impedance Measurement**

**Table 11-1. Signal Source Assignment**

<b>Pin No.</b>	<b>Signal Name</b>	<b>Signal Standard</b>
1	GND	0 V
2	INPUT1	TTL level, pulse input (pulse width: 1 $\mu$ s or above)
3	OUTPUT1	TTL level, latch output
4	OUTPUT2	TTL level, latch output
5	OUTPUT PORT A0	TTL level, latch output
6	OUTPUT PORT A1	TTL level, latch output
7	OUTPUT PORT A2	TTL level, latch output
8	OUTPUT PORT A3	TTL level, latch output
9	OUTPUT PORT A4	TTL level, latch output
10	OUTPUT PORT A5	TTL level, latch output
11	OUTPUT PORT A6	TTL level, latch output
12	OUTPUT PORT A7	TTL level, latch output
13	OUTPUT PORT B0	TTL level, latch output
14	OUTPUT PORT B1	TTL level, latch output
15	OUTPUT PORT B2	TTL level, latch output
16	OUTPUT PORT B3	TTL level, latch output
17	OUTPUT PORT B4	TTL level, latch output
18	OUTPUT PORT B5	TTL level, latch output
19	OUTPUT PORT B6	TTL level, latch output
20	OUTPUT PORT B7	TTL level, latch output
21	I/O PORT C0	TTL level, latch output
22	I/O PORT C1	TTL level, latch output
23	I/O PORT C2	TTL level, latch output
24	I/O PORT C3	TTL level, latch output
25	I/O PORT D0	TTL level, latch output
26	I/O PORT D1	TTL level, latch output
27	I/O PORT D2	TTL level, latch output
28	I/O PORT D3	TTL level, latch output
29	PORT C STATUS	TTL level, input mode: LOW, output mode: HIGH
30	PORT D STATUS	TTL level, input mode: LOW, output mode: HIGH
31	WRITE STROBE SIGNAL	TTL level, active low, pulse output (width: 10 $\mu$ s; typical)
32	+5V PULLUP	
33	SWEEP END SIGNAL	TTL level, active low, pulse output (width: 20 $\mu$ s; typical)
34	+5V	+5V, 100 mA MAX
35	PASS/FAIL SIGNAL	TTL level, PASS: HIGH, FAIL: LOW, latch output
36	PASS/FAIL WRITE STROBE SIGNAL	TTL level, active low, pulse output (width: 10 $\mu$ s; typical)

## Common to Network/Spectrum/Impedance Measurement

### General Characteristics

#### Input and Output Characteristics

##### External reference input

Frequency	10 MHz $\pm$ 10 ppm (SPC)
Level	-5 dBm to +5 dBm (SPC)
Input impedance	50 $\Omega$ nominal
Connector	BNC female

##### Internal Reference Output

Frequency	10 MHz nominal
Level	0 dBm (SPC)
Output Impedance	50 $\Omega$ nominal
Connector	BNC female

##### Reference oven output (Option 1D5)

Frequency	10 MHz nominal
Level	0 dBm (SPC)
Output impedance	50 $\Omega$ nominal
Connector	BNC female

##### External trigger input

Level	TTL
Pulse width ( $T_p$ )	$\geq 2 \mu s$ Typically
Polarity	positive/negative selective
Connector	BNC female

##### External program Run/Cont input

Connector	BNC female
Level	TTL

##### Gate output (Option 1D6)

Level	TTL
Connector	BNC female

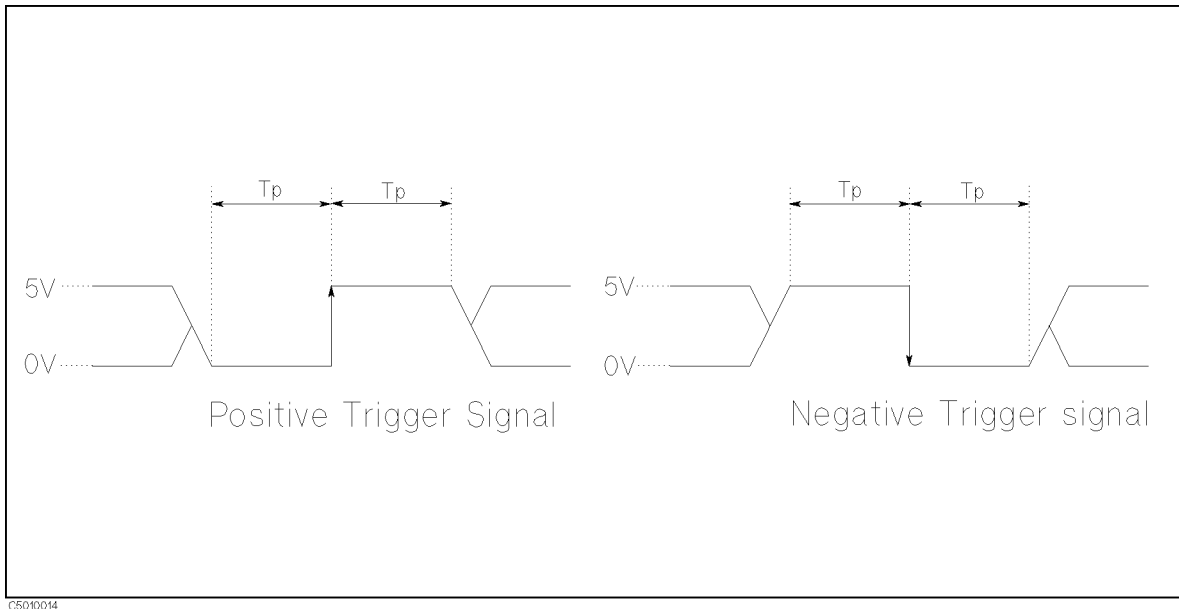


Figure 11-10. Trigger Signal (External trigger input)

#### S-parameter test set interface

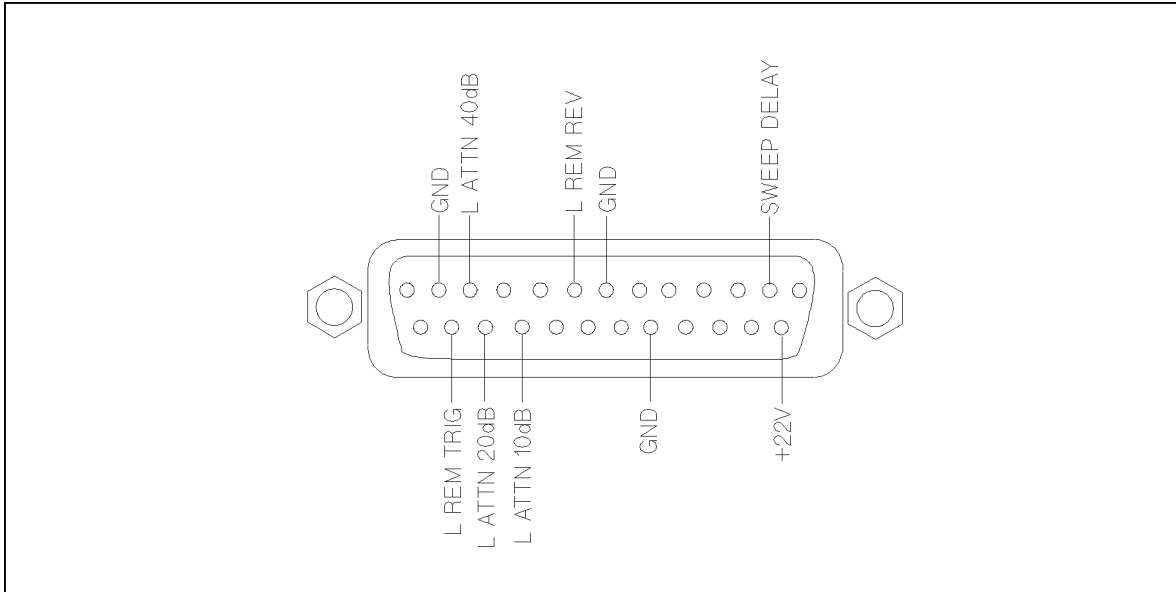
**Common to Network/Spectrum/Impedance Measurement**

**Connector** ..... D-SUB (25-pin)

**Caution**



Do not connect a printer to this connector. If you connect a printer with the S-parameter test set interface connector (TEST SET-I/O INTERCONNECT), it may cause damage to the printer.



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**Figure 11-11. S-Parameter Test Set Interface Pin Assignments**

**External monitor output**

**Connector** ..... D-SUB (15-pin HD)  
**Display resolution** ..... 640 × 480 VGA

**Internal Clock**

**Charge time** ..... 1 hour (SPC)  
**Capacity** ..... 72 hours (SPC)

**Operation Conditions**

**Temperature**

Disk drive non-operating condition ..... 0°C to 40°C  
 Disk drive operating condition ..... 10°C to 40°C

**Humidity**

at wet bulb temperature  $\leq 29^\circ\text{C}$ , without condensation

Disk drive non-operating condition ..... 15% to 95% RH  
 Disk drive operating condition ..... 15% to 80% RH

**Altitude** ..... 0 to 2,000 m

**Warm up time** ..... 30 minutes

**Common to Network/Spectrum/Impedance Measurement**

**Non-operation Conditions**

- Temperature** ..... -20°C to 60°C
- Humidity**  
at wet bulb temperature  $\leq 45^\circ\text{C}$ , without condensation ..... 15% to 95% RH
- Altitude** ..... 0 to 4,572 m

**Others**

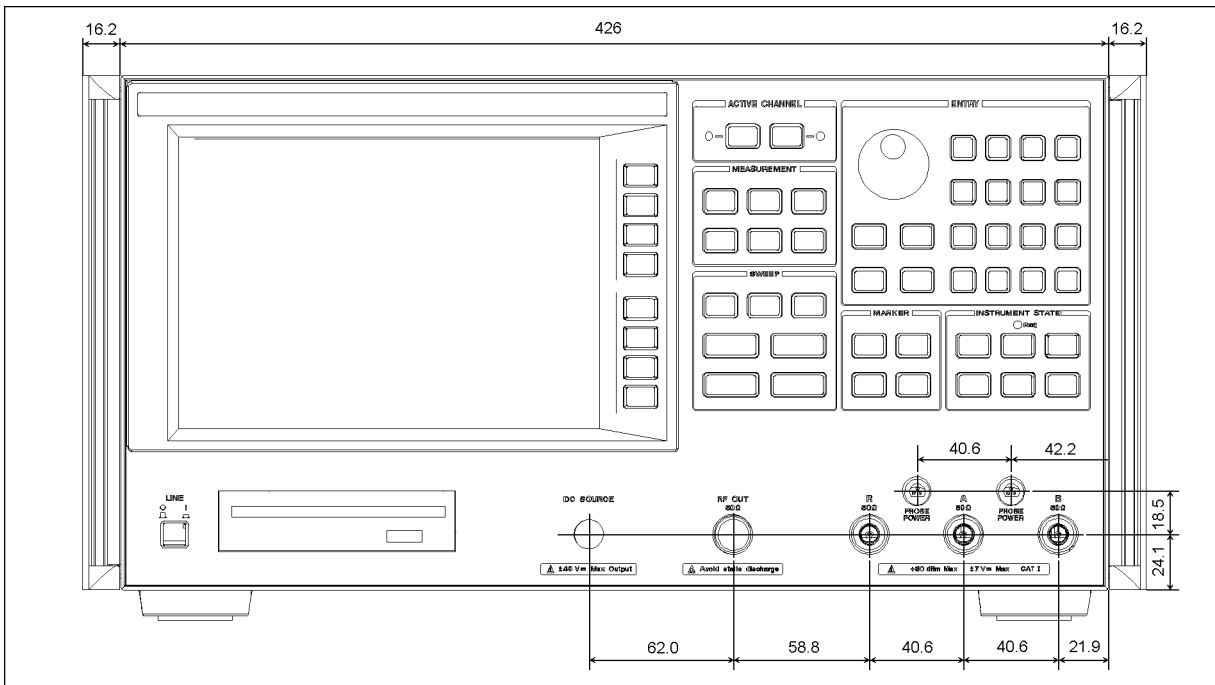
- EMC** ..... Complies with CISPR 11 (1990) / EN 55011 (1991) : Group 1, Class A  
Complies with EN 50082-1 (1992) / IEC 1000-4-2 (1995) : 4 kV CD, 8 kV AD  
Complies with EN 50082-1 (1992) / IEC 1000-4-3 (1995) : 3 V/m, 27 MHz to 1 GHz  
Complies with EN 50082-1 (1992) / IEC 1000-4-4 (1995) : 1 kV / Main, 0.5kV / Signal Line  
Complies with IEC 1000-3-2 (1995) / EN 61000-3-2 (1995)  
Complies with IEC 1000-3-3 (1994) / EN 61000-3-3 (1995)

Note: When tested at 3 V/m according to IEC 801-3/1984, the residual response will be within specifications over the full immunity test frequency range of 27 MHz to 1000 MHz except when the analyzer frequency is identical to the transmitted interference signal test frequency.

This ISM device complies with Canadian ICES-001.  
Cet appareil ISM est conforme à la norme NMB-001 du Canada.

- Safety** ..... Complies with IEC 1010-1 (1990), Amendment 1 (1992), Amendment 2 (1995)  
Certified by CSA-C22.2 No.1010.1-92

- Power requirements**  
..... 90 V to 132 V, or 198 V to 264 V (automatically switched), 47 to 63 Hz, 300 VA max.
- Weight** ..... 21 kg (SPC)
- Dimensions (with Option 001, 1CN, 1D5, and 1D7) (SPC)**



**Figure 11-12. Front View**

# Common to Network/Spectrum/Impedance Measurement

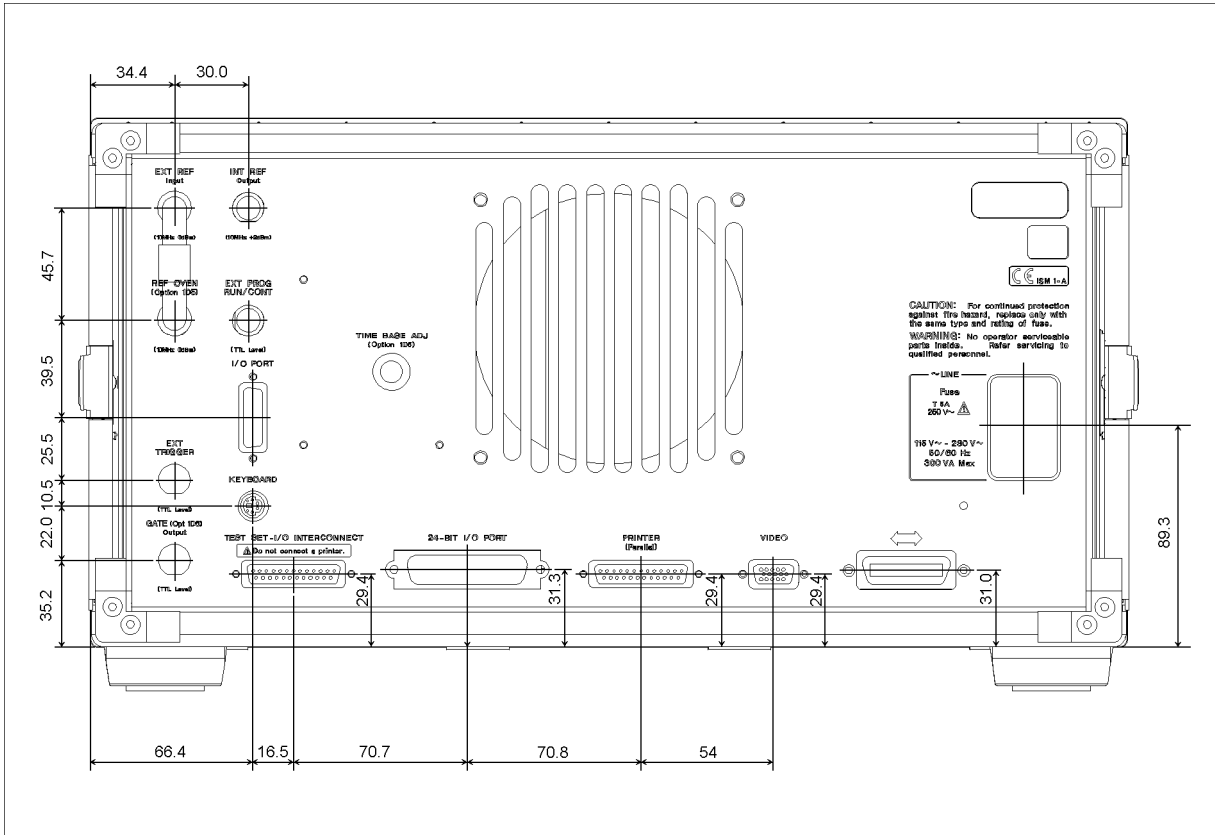


Figure 11-13. Rear View



Figure 11-14. Side View

# System Performance at Network Measurement

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## Typical System Performance

### Introduction

The performance of the 4395A Network/Spectrum Analyzer (analyzer) depends not only on the performance of the analyzer but also on the configuration, the user-selected operating conditions, and the measurement calibration.

This section explains the residual errors remaining in a measurement system after accuracy enhancement. It provides information to calculate the total measurement uncertainty of different configurations. Graphs at the beginning of the section show examples of the performance that can be calculated using the methods in this section.

The sources of measurement errors are explained, with an error model flowgraph and uncertainty equations. Information is provided for conversion of the dynamic accuracy error (in dB) to a linear value for use in the uncertainty equations. The effects of temperature drift on measurement uncertainty are illustrated with graphs.

Typical system performance tables are provided for an 7 mm and 3.5mm systems using an 85046A test set, for 50  $\Omega$  type-N systems using the 85046A and 87512A test sets, and 75  $\Omega$  type-N systems using the 85046B and 87512B test sets.

Procedure and blank worksheets are supplied to compute the total error-corrected measurement uncertainty of a system. These procedures combine the terms in the tables, the uncertainty equation, and the nominal S-parameter data of the device under test.

### Comparison of Typical Error-Corrected Measurement Uncertainty

Figure 11-15 through Figure 11-22 are examples of the measurement uncertainty data that can be calculated using the information provided in this section. These figures compare the reflection and transmission measurement uncertainty of a 7 mm system using different levels of error correction. Each figure shows uncorrected values and residual uncertainty values after response calibration, response and isolation calibration, and full one or two port calibration. The data applies to a frequency range of 300 kHz to 500 MHz with a stable temperature (no temperature drift), using compatible 7 mm calibration devices from the 85031B calibration kit.

The results shown in Figure 11-15 through Figure 11-22 can be obtained using the 85046A. Different measurement calibration procedures provide comparable measurement improvement for the following compatible connector types and test sets (using the compatible calibration kits):

- 3.5 mm connectors
- 87511A and 87511A with 50  $\Omega$  type-N connectors
- 87511B and 87511B with 75  $\Omega$  type-N connectors



Reflection Uncertainty of a One-Port Device

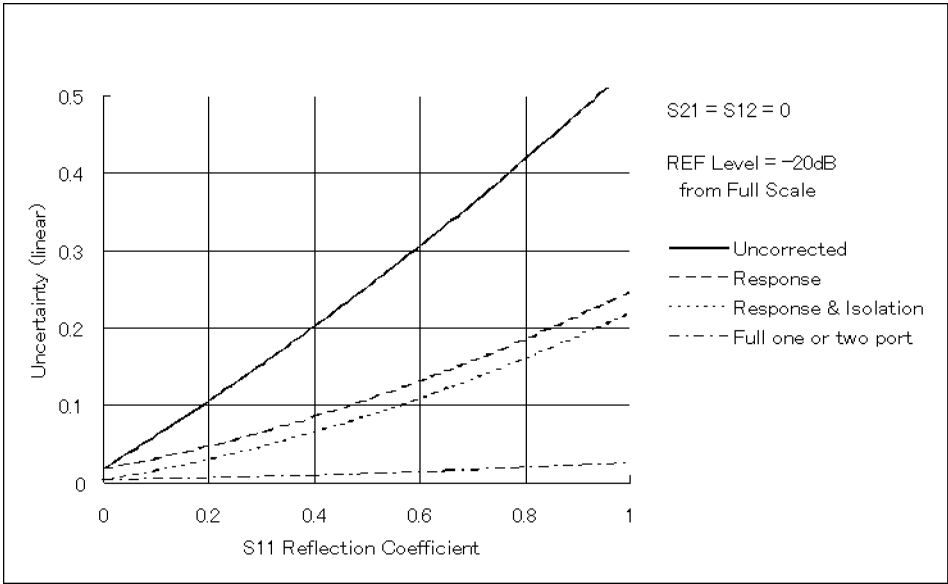


Figure 11-15. Total Reflection Magnitude Uncertainty of One-Port Device

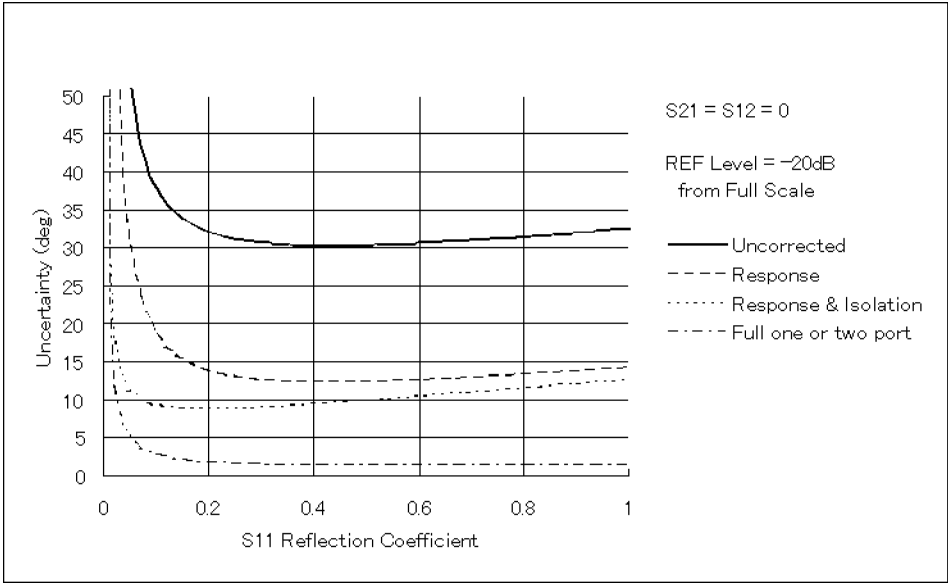


Figure 11-16. Total Reflection Phase Uncertainty of One-Port Device

## Typical System Performance

### Reflection Uncertainty of a Two-Port Device

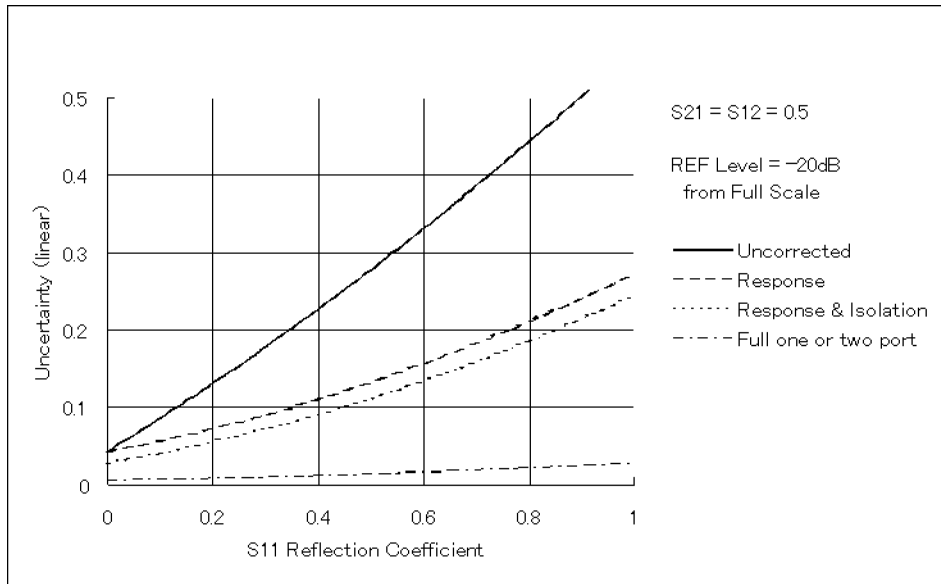


Figure 11-17. Total Reflections Magnitude Uncertainty of Two-Port Device

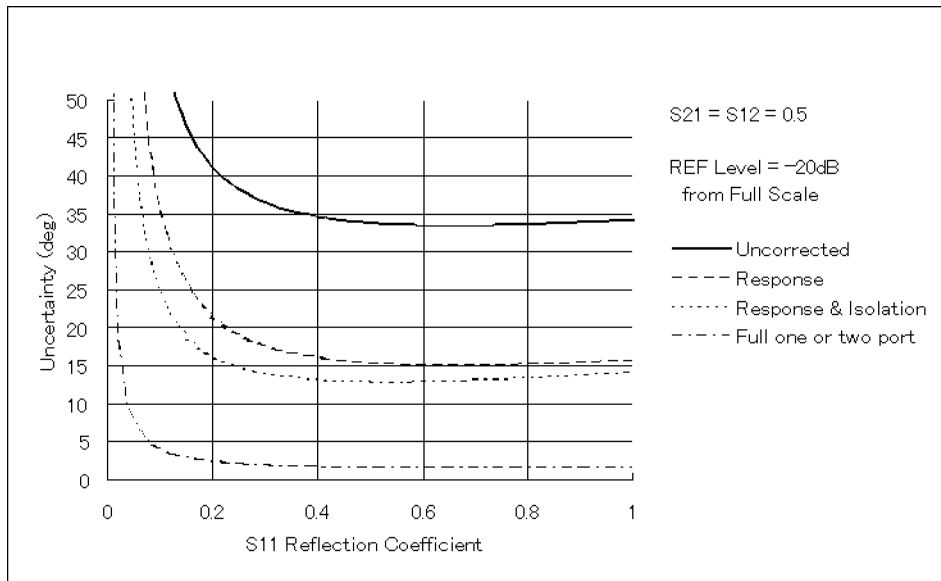


Figure 11-18. Total Reflection Phase Uncertainty of Two-Port Device

Transmission Uncertainty of a Low-Loss Device

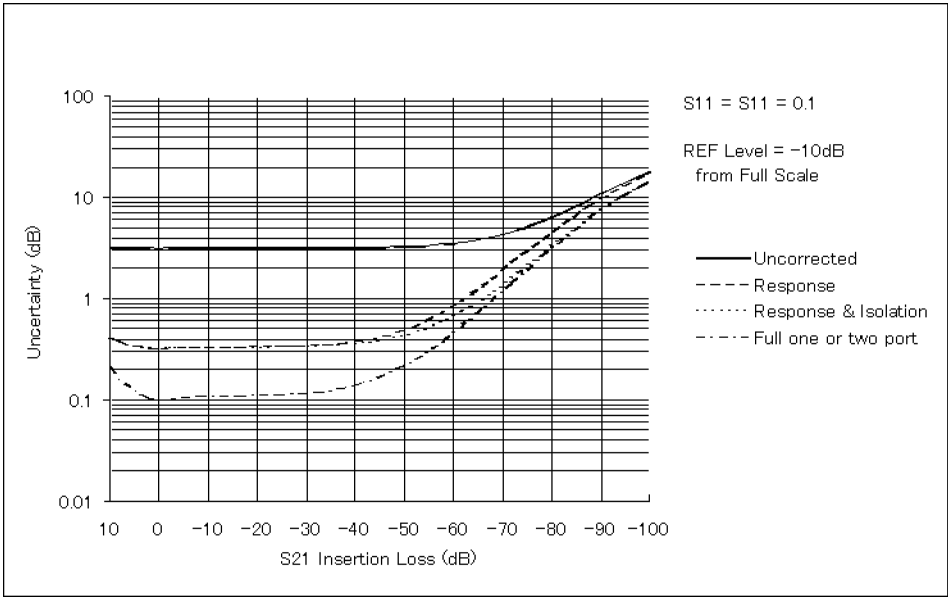


Figure 11-19. Total Transmission Magnitude Uncertainty of a Low-Loss Device

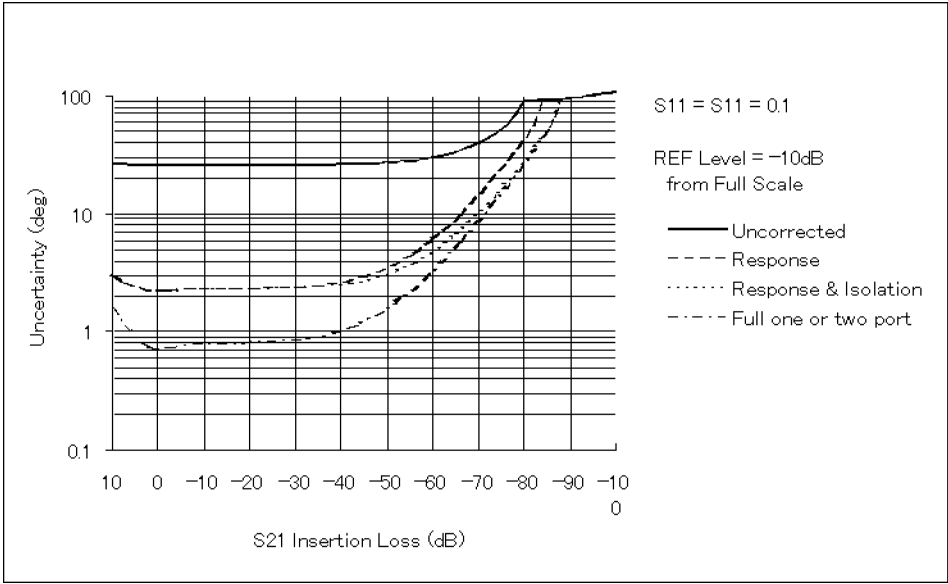
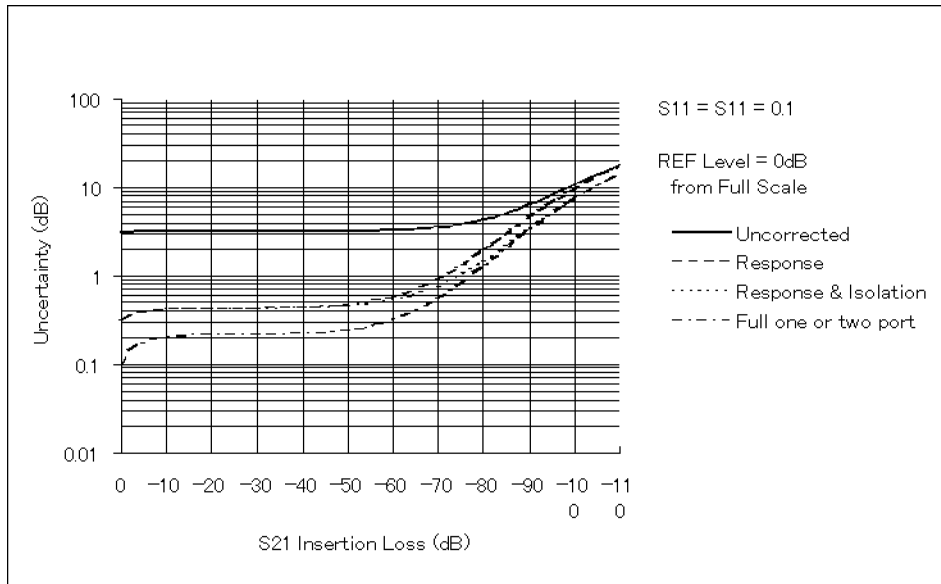


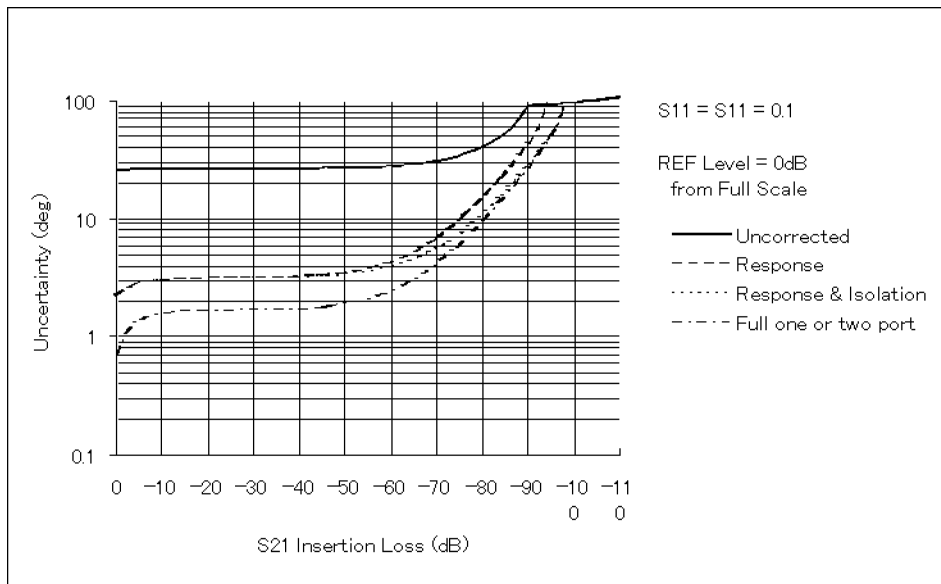
Figure 11-20. Total Transmission Phase Uncertainty of a Low-Loss Device

## Typical System Performance

### Transmission Uncertainty of a Wide Dynamic Range Device



**Figure 11-21.**  
**Total Transmission Magnitude Uncertainty of a Wide Dynamic Range Device**



**Figure 11-22. Total Transmission Phase Uncertainty of a Wide Dynamic Range Device**

## Types of Residual Measurement Errors

Network analysis measurement errors can be separated into three types: systematic, random, and drift errors. Measurement errors that remain after measurement calibration are called residual measurement errors. See “Calibration for Network Measurement” in Appendix A for a detailed description of the systematic errors corrected by measurement calibration.

### Residual Systematic Errors

These errors result from imperfections in the calibration standards, connector standards and interface, interconnecting cables, and instrumentation. These are the errors that affect transmission and reflection measurements.

Transmission Measurements	Reflection Measurements
Dynamic accuracy Effective switch port match Effective load match Effective source match Switch tracking Multiplexer switching Uncertainty Frequency error	
Effective crosstalk Effective transmission tracking Cable stability	Effective directivity Effective reflection tracking

### Residual Random Errors

These non-repeatable errors are due to trace noise, noise floor, and connector repeatability. They affect both transmission and reflection measurements.

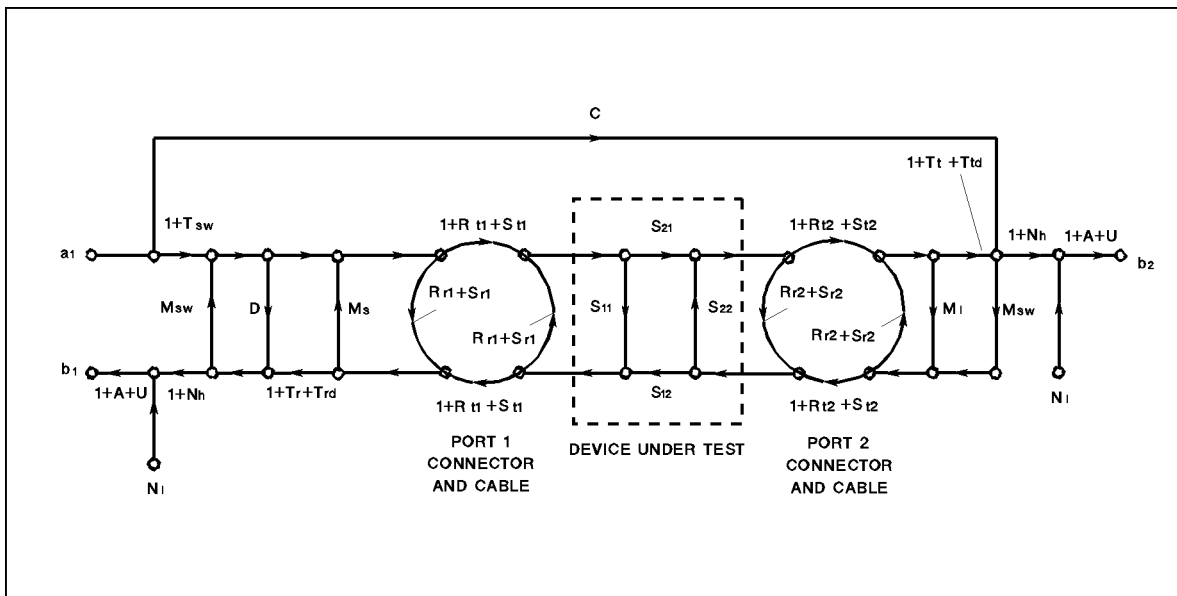
### Residual Drift Errors

These errors stem from frequency drift and instrumentation drift. They affect both kinds of measurements. Instrumentation drift is primarily temperature related.

## System Error Model

Any measurement result is the vector sum of the actual test device response plus all error terms. The precise effect of each error term depends upon its magnitude and phase relationship to the actual test device response. When the phase of an error response is not known, phase is assumed to be worst case (0 or 180 degrees). Random errors such as noise and connector repeatability are generally combined in a root-sum-of-the squares (RSS) manner. The error term related to thermal drift is combined on a typical basis as shown in each uncertainty equation given in the following paragraphs.

Figure 11-23 shows the error model for the analyzer with the 85046A/B S-parameter test set. This error model shows the relationship of the various error sources in the forward direction and can be used to analyze overall measurement performance. The model for signal flow in the reverse direction is similar. Note the appearance of the dynamic accuracy, noise errors, switch errors, and connector repeatability terms in both the reflection and transmission portions of the model.



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Figure 11-23. 4395A/85046A System Error Model

Table 11-2. Parameters of System error Model

<b>A</b>	= Dynamic Accuracy ( <b>A<sub>m</sub></b> = Magnitude Dynamic Accuracy)  ( <b>A<sub>p</sub></b> = Phase Dynamic Accuracy)	<b>U</b>	= Multiplexer Switching Uncertainty ( <b>U<sub>m</sub></b> = Magnitude Multiplexer Switching Uncertainty) ( <b>U<sub>p</sub></b> = Phase Multiplexer Switching Uncertainty)
<b>N<sub>1</sub></b>	= Noise Floor	<b>M<sub>s</sub></b>	= Residual Source Match
<b>N<sub>h</sub></b>	= High Level Noise	<b>M<sub>1</sub></b>	= Residual Load Match
<b>T<sub>sw</sub></b>	= Switch Tracking	<b>C</b>	= Residual Crosstalk
<b>M<sub>sw</sub></b>	= Switch Port Match	<b>T<sub>r</sub></b>	= Residual Reflection Tracking
<b>R<sub>r1</sub></b>	= Port 1 Reflection Repeatability	<b>T<sub>t</sub></b>	= Residual Transmission Tracking
<b>R<sub>r2</sub></b>	= Port 2 Reflection Repeatability	<b>S<sub>r1</sub></b>	= Port 1 Cable Reflection Stability
<b>R<sub>t1</sub></b>	= Port 1 Transmission Repeatability	<b>S<sub>r2</sub></b>	= Port 2 Cable Reflection Stability
<b>R<sub>t2</sub></b>	= Port 2 Transmission Repeatability	<b>S<sub>t1</sub></b>	= Port 1 Cable Transmission Stability
<b>T<sub>rd</sub></b>	= Reflection Tracking Drift	<b>S<sub>t2</sub></b>	= Port 2 Cable Transmission Stability
<b>T<sub>td</sub></b>	= Transmission Tracking Drift	<b>D</b>	= Residual Directivity

For measurement of one-port devices, set the crosstalk (C), load match (M<sub>1</sub>), transmission tracking (T<sub>t</sub>), transmission tracking drift (T<sub>td</sub>), port 2 connector repeatability (R<sub>r2</sub>, R<sub>t2</sub>), and port 2 cable stability (S<sub>r2</sub>, S<sub>t2</sub>) error terms to zero.

## Reflection Uncertainty Equations

### Total Reflection Magnitude Uncertainty ( $E_{rm}$ )

An analysis of the error model yields an equation for the reflection magnitude uncertainty. The equation contains all of the first order terms and the significant second order terms. The error term related to thermal drift is combined on a worst case basis with the total of systematic and random errors. The four terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms and the S-parameters are treated as linear absolute magnitudes.

$$E_{rm(\text{linear})} = V_r + S_{11} T_{rd(\text{magnitude})}$$

and

$$E_{rm(\text{log})} = 20 \log \left( 1 \pm \frac{E_{rm}}{S_{11}} \right)$$

where

$$V_r = S_r + \sqrt{W_r^2 + X_r^2 + Y_r^2 + Z_r^2}$$

$S_r$  = systematic error

$$= (1 + T_{sw})(D + S_{r1}) + (T_{sw} + T_r)S_{11} + (M_{sw} + M_s + S_{r1})S_{11}^2 \\ + (M_l + S_{r2} + M_{sw})S_{21}S_{12} + (A_m + U_m)S_{11}$$

$W_r$  = random low-level noise

$$= 3N_l$$

$X_r$  = random high-level noise

$$= 3N_h S_{11}$$

$Y_r$  = random port1 repeatability

$$= R_{r1} + 2R_{t1}S_{11} + R_{r1}S_{11}^2$$

$Z_r$  = random port2 repeatability

$$= R_{r2}S_{21}S_{12}$$

### Total Reflection Phase Uncertainty ( $E_{rp}$ )

Reflection phase uncertainty is determined from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to thermal drift of the total system, port 1 cable stability, phase dynamic accuracy, and phase multiplexer switching uncertainty.

$$E_{rp} = \arcsin \left( \frac{V_r - (A_m + U_m)S_{11}}{S_{11}} \right) + T_{rd(\text{phase})} + 2S_{t1} + A_p + U_p$$

## Transmission Uncertainty Equations

### Total Transmission Magnitude Uncertainty ( $E_{tm}$ )

An analysis of the error model in Figure 11-23 yields an equation for the transmission magnitude uncertainty. The equation contains all of the first order terms and some of the significant second order terms. The error term related to thermal drift is combined on a worst case basis with the total of systematic and random errors. The four terms under the radical are random in character and are combined on an RSS basis. The terms in the systematic error group are combined on a worst case basis. In all cases, the error terms are treated as linear absolute magnitudes.

$$E_{tm(\text{linear})} = V_t + S_{21} T_{td(\text{magnitude})}$$

and

$$E_{tm(\text{log})} = 20 \log \left( 1 \pm \frac{E_{tm}}{S_{21}} \right)$$

where

$$V_t = S_t + \sqrt{W_t^2 + X_t^2 + Y_t^2 + Z_t^2}$$

$S_t$  = systematic error

$$= C + (T_{sw} + T_t)S_{21} + (M_{sw} + M_s + S_{r1})S_{11}S_{21} + (M_{sw} + M_l + S_{r2})S_{21}S_{22} + (A_m + U_m)S_{21}$$

$W_t$  = random low-level noise

$$= 3N_l$$

$X_t$  = random high-level noise

$$= 3N_h S_{21}$$

$Y_t$  = random port1 repeatability

$$= R_{t1}S_{21} + R_{r1}S_{11}S_{21}$$

$Z_t$  = random port2 repeatability

$$= R_{t2}S_{21} + R_{r2}S_{22}S_{21}$$

### Total Transmission Phase Uncertainty ( $E_{tp}$ )

Transmission phase uncertainty is calculated from a comparison of the magnitude uncertainty with the test signal magnitude. The worst case phase angle is computed. This result is combined with the error terms related to phase dynamic accuracy, cable phase stability, thermal drift of the total system, and phase multiplexer switching uncertainty.

$$E_{tp} = \arcsin \left( \frac{V_t - (A_m + U_m)S_{21}}{S_{21}} \right) + T_{td(\text{phase})} + S_{t1} + S_{t2} + A_p + U_p$$



## Dynamic Accuracy

The dynamic accuracy value used in the system uncertainty equations is obtained from the analyzer's dynamic accuracy typical values. The typical value for magnitude dynamic accuracy is in dB, and it must be converted to a linear value to be used in the uncertainty equations. In addition, the analyzer's dynamic accuracy typical values are given for an input signal level from full scale in dB. This must be converted to a relative error (relative to the power at which the measurement calibration occurs) to be used in the system uncertainty equations.

$$\text{Dynamic Accuracy (linear)} = 10^{\frac{\pm \text{DynAcc(dB)}}{20}} \mp 1$$

$$\text{Dynamic Accuracy (dB)} = 20 \log(1 \pm \text{Dynamic Accuracy (linear)})$$

## Magnitude Dynamic Accuracy

Typical magnitude dynamic accuracy can be expressed in the following equations:

$$\text{Magnitude Dynamic Accuracy} = E_{d1m} + E_{d2m} + E_{d3m}$$

$$E_{d1m} = 1.39 \times 10^{-2} L^2$$

$$E_{d2m} = 1.73 \times 10^{-3}$$

$$E_{d3m} = \frac{6.95 \times 10^{-7}}{L}$$

where,

L = Measurement level (linear, relative to full scale level)

$E_{d1m}$  = Magnitude compression error (dominant at high measurement level range)

$E_{d2m}$  = Magnitude residual error (dominant at middle measurement level range)

$E_{d3m}$  = Magnitude A/D converter differential nonlinearity error (dominant at low measurement level range)

## Determining Relative Magnitude Dynamic Accuracy Error Contribution

Typical magnitude dynamic accuracy error contribution to system performance is expressed below:

$$\begin{aligned} \text{Magnitude dynamic accuracy error} &= |E_{d1m\text{MEAS}} - E_{d1m\text{REF}}| \\ &+ \max(E_{d2m\text{MEAS}}, E_{d2m\text{REF}}) \\ &+ E_{d3m\text{MEAS}} + E_{d3m\text{REF}} \end{aligned}$$

where,

Suffix REF means errors at calibration

Suffix MEAS means errors at DUT measurement

## Dynamic Accuracy

### Phase Dynamic Accuracy

Typical phase dynamic accuracy can be expressed by the following equations:

$$\text{Magnitude Dynamic Accuracy} = E_{d1p} + E_{d2p} + E_{d3p}$$

$$E_{d1p} = 1.00L^2$$

$$E_{d2p} = 0.10$$

$$E_{d3p} = \frac{6.13 \times 10^{-5}}{L}$$

where,

L = Measurement level (linear, relative to full scale level)

$E_{d1p}$  = Phase compression error (dominant at high measurement level range)

$E_{d2p}$  = Phase residual error (dominant at middle measurement level range)

$E_{d3p}$  = Phase A/D converter differential nonlinearity error (dominant at low measurement level range)

### Determining Relative Phase Dynamic Accuracy Error Contribution

Typical dynamic accuracy error contribution to system performance is expressed below:

$$\begin{aligned} \text{Phase dynamic accuracy error} = & |E_{d1p\text{MEAS}} - E_{d1p\text{REF}}| \\ & + \max(E_{d2p\text{MEAS}}, E_{d2p\text{REF}}) \\ & + E_{d3p\text{MEAS}} + E_{d3p\text{REF}} \end{aligned}$$

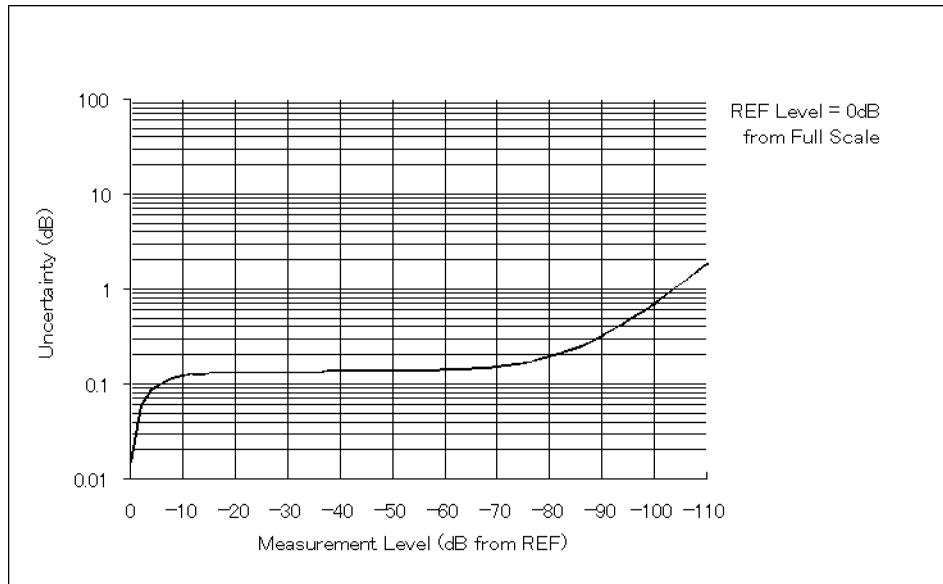
where,

Suffix REF means errors at calibration

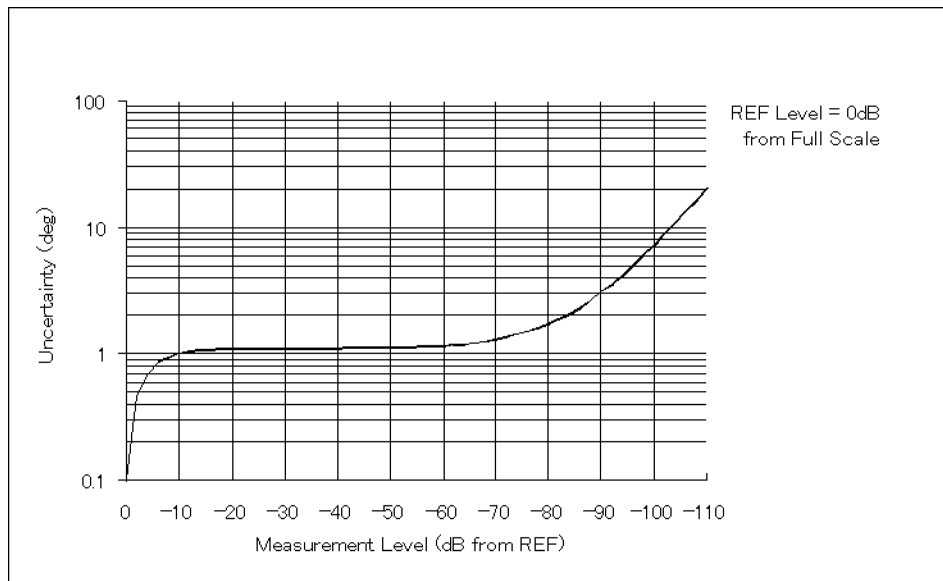
Suffix MEAS means errors at DUT measurement

Six example graphs are provided: Figure 11-24 and Figure 11-25 show the typical magnitude and phase dynamic accuracy error with a reference power level of full scale, Figure 11-26 and Figure 11-27 with a reference power level of  $-20$  dB from full scale, and Figure 11-28 and Figure 11-29 with a reference power level of  $-60$  dB from full scale.

Dynamic Accuracy Error Contribution



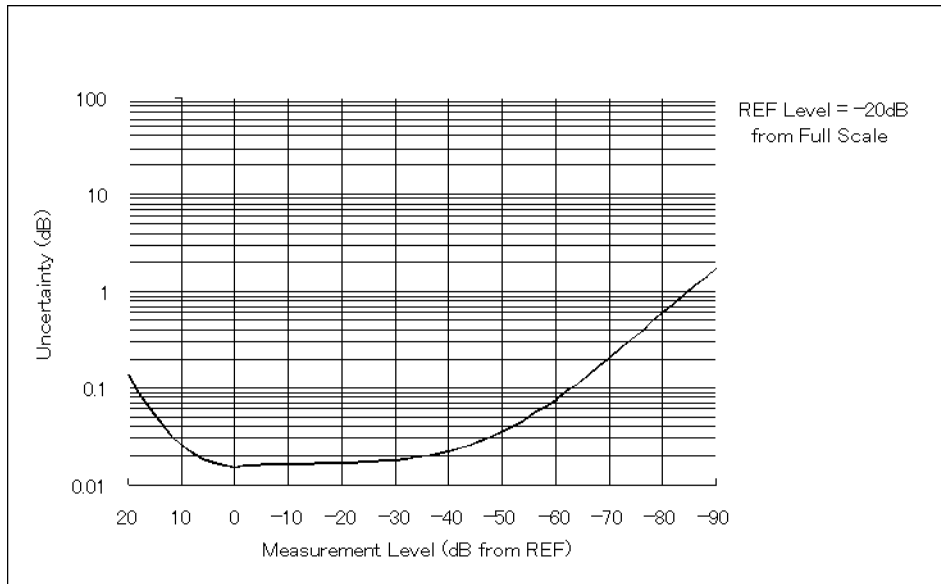
**Figure 11-24.**  
**Typical Magnitude Dynamic Accuracy Error**  
**(@Reference Power Level = Full Scale)**



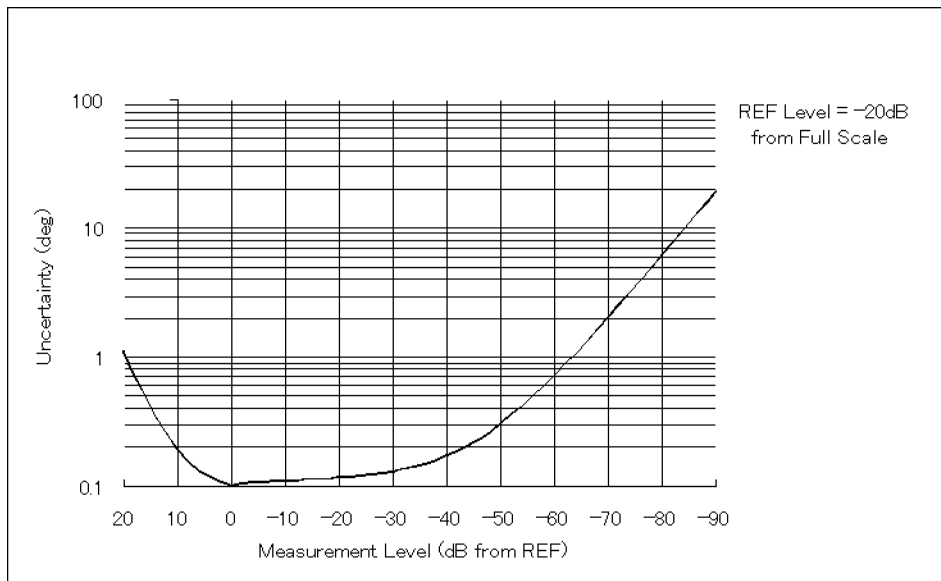
**Figure 11-25.**  
**Typical Phase Dynamic Accuracy Error**  
**(@Reference Power Level = Full Scale)**

## Dynamic Accuracy

### Dynamic Accuracy Error Contribution

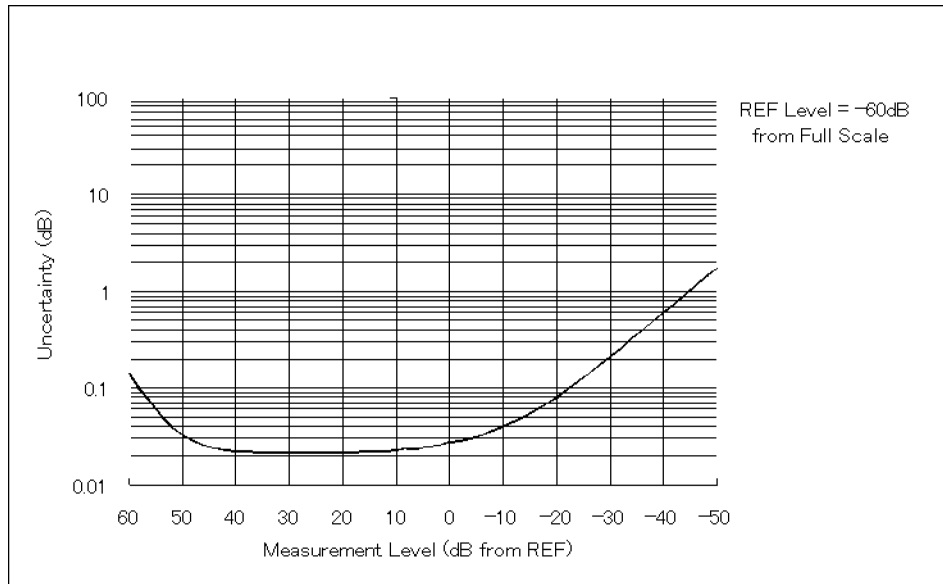


**Figure 11-26.**  
**Typical Magnitude Dynamic Accuracy Error**  
**(@Reference Power Level = -20 dB from Full Scale)**

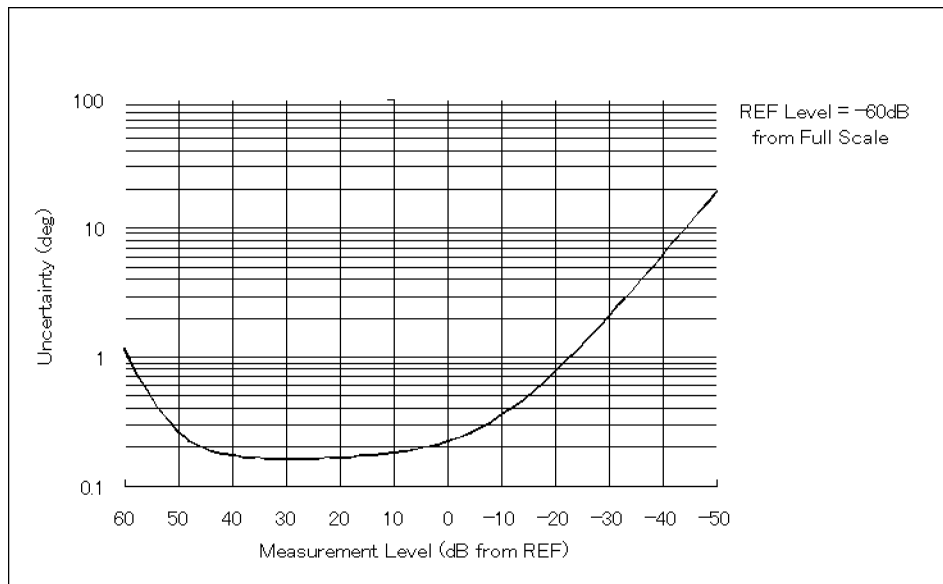


**Figure 11-27.**  
**Typical Phase Dynamic Accuracy Error**  
**(@Reference Power Level = -20 dB from Full Scale)**

Dynamic Accuracy Error Contribution



**Figure 11-28.**  
**Typical Magnitude Dynamic Accuracy Error**  
**(@Reference Power Level = -60 dB from Full Scale)**



**Figure 11-29.**  
**Typical Phase Dynamic Accuracy Error**  
**(@Reference Power Level = -60 dB from Full Scale)**

### Effects of Temperature Drift

Figure 11-30 to Figure 11-33 are graphs showing the effects of temperature drift on error-corrected measurement uncertainty values. Values are shown for changes of  $\pm 1^\circ\text{C}$ ,  $\pm 3^\circ\text{C}$  and  $\pm 5^\circ\text{C}$  from the ambient temperature. Figure 11-30 and Figure 11-31 show total reflection magnitude and phase uncertainty with temperature drift following an  $S_{11}$  one-port calibration. Figure 11-32 and Figure 11-33 shows the total transmission magnitude and phase uncertainty with temperature drift following a full two-port error correction. The graphs apply to measurements up to 500 MHz.

Temperature Drift with S<sub>11</sub> One-Port Calibration

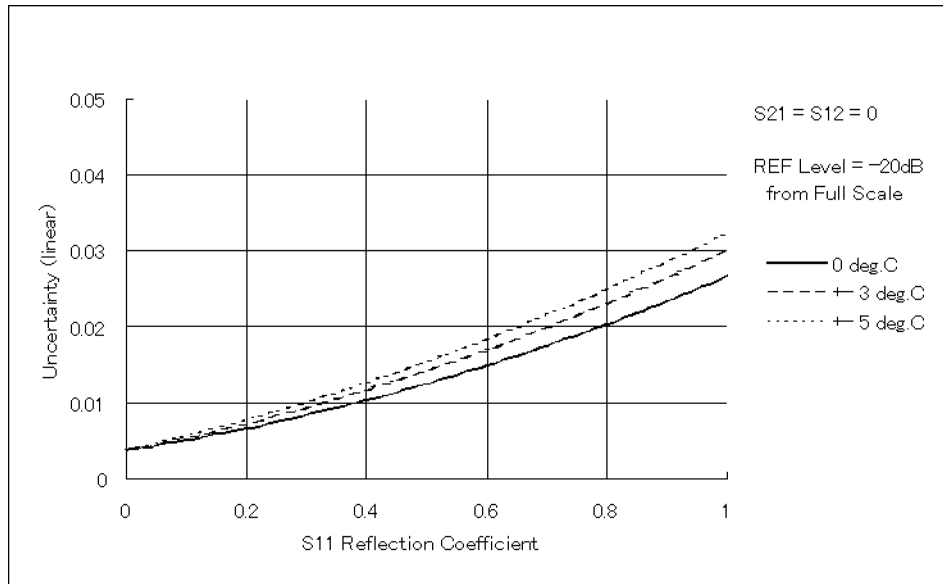


Figure 11-30. Total Reflection Magnitude Uncertainty (@One-Port Cal)

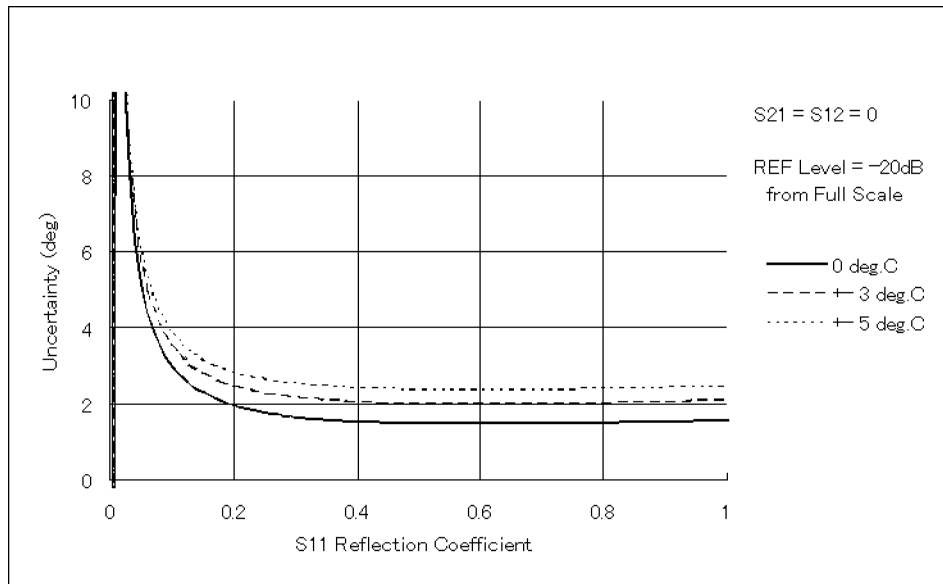


Figure 11-31. Total Reflection Phase Uncertainty (@One-Port Cal)

## Effects of Temperature Drift

### Temperature Drift with Full Two-Port Calibration

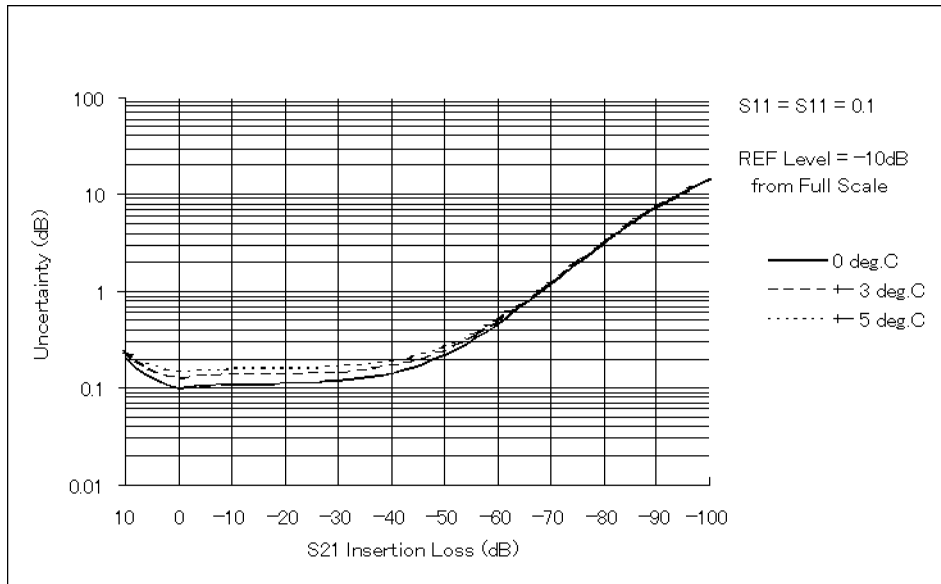


Figure 11-32. Total Transmission Magnitude Uncertainty (@Full Two-Port Cal)

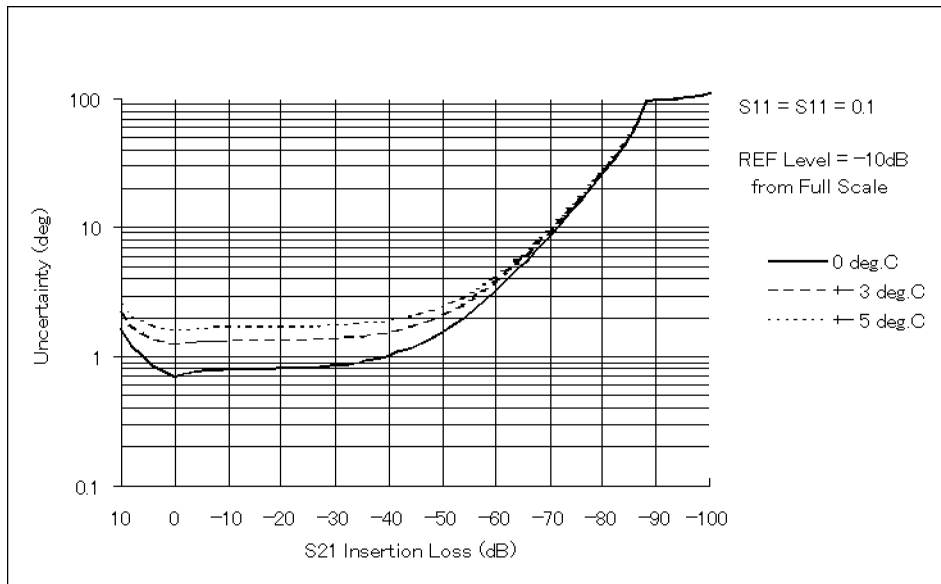


Figure 11-33. Total Transmission Phase Uncertainty (@Full Two-Port Cal)



## System performance with Different Test Sets and Connector Types

The tables in the following pages provides typical system performance for sytems using different test sets and different connector types. The values listed are for uncorrected measurements and for corrected measurements after measurement calibration. The linear value is shown in parenthesis with the dB value.

## System performance with Different Test Sets and Connector Types

**Table 11-3.**  
**Typical System Performance for Devices with 7 mm Connectors**  
**4395A with 87511A Test Set (300 kHz to 500 MHz)**

Symbol	Error Terms	Uncorrected	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>			
			Response Only	Response and Isolation	One-Port	Full two port
D	Directivity	-35 dB ( $1.8 \times 10^{-2}$ )	-35 dB ( $1.8 \times 10^{-2}$ )	-50 dB <sup>3</sup> ( $3.2 \times 10^{-3}$ )	-50 dB ( $3.2 \times 10^{-3}$ )	-50 dB ( $3.2 \times 10^{-3}$ )
M <sub>s</sub>	Source Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-40 dB (0.01)	-40 dB (0.01)
T <sub>r</sub>	Reflection Tracking	±3 dB (0.41)	±1 dB (0.12)	±0.9 dB (0.11)	±0.05 dB ( $5.8 \times 10^{-3}$ )	±0.05 dB ( $5.8 \times 10^{-3}$ )
M <sub>l</sub>	Load Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-	-42 dB ( $7.9 \times 10^{-3}$ )
T <sub>t</sub>	Trans. Tracking	±3 dB (0.41)	±0.1 dB (0.01)	±0.1 dB (0.01)	-	±0.03 dB ( $5.8 \times 10^{-3}$ )
C	Cross Talk	-100 dB ( $1.0 \times 10^{-5}$ )	-100 dB ( $1.0 \times 10^{-5}$ )	-110 dB ( $3.2 \times 10^{-6}$ )	-	-110 dB ( $3.2 \times 10^{-6}$ )
R <sub>r1</sub>	Port1 Refl. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>t1</sub>	Port1 Trans. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>r2</sub>	Port2 Refl. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>t2</sub>	Port2 Trans. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-110 dB from full scale ( $3.2 \times 10^{-6}$ )				
N <sub>h</sub>	High Level Noise <sup>2, 4</sup>	Magnitude: 0.001 dB ( $1.2 \times 10^{-4}$ )				
A <sub>m, A<sub>p</sub></sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.				
U <sub>m, U<sub>p</sub></sub>	Multiplexer Switching Uncertainty	Magnitude: ±0.002 dB ( $2.3 \times 10^{-4}$ ) Phase: 0.015 degrees				
S <sub>t1</sub>	Port1 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r1</sub>	Port1 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
S <sub>t2</sub>	Port2 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r2</sub>	Port2 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
T <sub>td</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1 + 0.15 × f(GHz)]degrees/°C				
T <sub>rd</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1 + 0.15 × f(GHz)]degrees/°C				
T <sub>sw</sub>	Switch Tracking	±0.03 dB ( $3.5 \times 10^{-3}$ )				
M <sub>sw</sub>	Switch Port Match	-70 dB ( $3.2 \times 10^{-4}$ )				

1 Accuracy enhancement procedures are performed using 85031B 7 mm calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valid measurement calibration.

2 With IF bandwidth of 10 Hz.

3 With impedance matched load.

4 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

5 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

6 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without cables and with 1-port calibration. For this case, drift typically is [0.1 + 0.05 × f (GHz)] × Δ°C, degrees.

## System performance with Different Test Sets and Connector Types

**Table 11-4.**  
**Typical System Performance for Devices with 3.5 mm Connectors**  
**4395A with 87511A Test Set (300 kHz to 500 MHz)**

Symbol	Error Terms	Uncorrected	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>			
			Response Only	Response and Isolation	One-Port	Full two port
D	Directivity	-35 dB ( $1.8 \times 10^{-2}$ )	-35 dB ( $1.8 \times 10^{-2}$ )	-40 dB <sup>3</sup> (0.01)	-40 dB (0.01)	-40 dB (0.01)
M <sub>s</sub>	Source Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-36 dB (0.02)	-36 dB (0.02)
T <sub>r</sub>	Reflection Tracking	±3 dB (0.41)	±1 dB (0.12)	±1 dB (0.12)	±0.14 dB (0.016)	±0.14 dB (0.016)
M <sub>l</sub>	Load Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-	-38 dB (0.013)
T <sub>t</sub>	Trans. Tracking	±3 dB (0.41)	±0.1 dB (0.01)	±0.1 dB (0.01)	-	±0.05 dB ( $1.6 \times 10^{-2}$ )
C	Cross Talk	-100 dB ( $1.0 \times 10^{-5}$ )	-100 dB ( $1.0 \times 10^{-5}$ )	-110 dB ( $3.2 \times 10^{-6}$ )	-110 dB ( $3.2 \times 10^{-6}$ )	-110 dB ( $3.2 \times 10^{-6}$ )
R <sub>r1</sub>	Port 1 Refl. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>t1</sub>	Port 1 Trans. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>r2</sub>	Port 2 Refl. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
R <sub>t2</sub>	Port 2 Trans. Connector Repeatability	-70 dB ( $3.2 \times 10^{-4}$ )				
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-110 dB from full scale ( $3.2 \times 10^{-6}$ )				
N <sub>h</sub>	High Level Noise <sup>2, 4</sup>	Magnitude: 0.001 dB ( $1.2 \times 10^{-4}$ )				
A <sub>m, A<sub>p</sub></sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.				
U <sub>m, U<sub>p</sub></sub>	Multiplexer Switching Uncertainty	Magnitude: ±0.002 dB ( $2.3 \times 10^{-4}$ ) Phase: 0.015 degrees				
S <sub>t1</sub>	Port 1 Cable Trans. Phase Stability <sup>5</sup>	$0.05 \times f$ (GHz) degrees				
S <sub>r1</sub>	Port 1 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
S <sub>t2</sub>	Port 2 Cable Trans. Phase Stability <sup>5</sup>	$0.05 \times f$ (GHz) degrees				
S <sub>r2</sub>	Port 2 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
T <sub>td</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1+0.15×f(GHz)]degrees/°C				
T <sub>rd</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1+0.15×f(GHz)]degrees/°C				
T <sub>sw</sub>	Switch Tracking	±0.03 dB ( $3.5 \times 10^{-3}$ )				
M <sub>sw</sub>	Switch Port Match	-70 dB ( $3.2 \times 10^{-4}$ )				

1 Accuracy enhancement procedures are performed using 85033C 3.5 mm calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valid measurement calibration.

2 With IF bandwidth of 10 Hz.

3 With impedance matched load.

4 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

5 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

6 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without calbes and with 1-port calibration. For this case, drift typically is  $[0.1 + 0.05 \times f \text{ (GHz)}] \times \Delta^\circ\text{C}$ , degrees.

## System performance with Different Test Sets and Connector Types

**Table 11-5.**  
**Typical System Performance for Devices with 50 Ω Type-N Connectors**  
**4395A with 87511A Test Set (300 kHz to 500 MHz)**

Symbol	Error Terms	Uncorrected	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>			
			Response Only	Response and Isolation	One-Port	Full two port
D	Directivity	-35 dB ( $1.8 \times 10^{-2}$ )	-35 dB ( $1.8 \times 10^{-2}$ )	-47 dB <sup>3</sup> ( $4.5 \times 10^{-3}$ )	-47 dB ( $4.5 \times 10^{-3}$ )	-47 dB ( $4.5 \times 10^{-3}$ )
M <sub>s</sub>	Source Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-35 dB (0.02)	-35 dB (0.02)
T <sub>r</sub>	Reflection Tracking	±3 dB (0.41)	±1 dB (0.12)	±0.9 dB (0.11)	±0.06 dB ( $6.9 \times 10^{-3}$ )	±0.06 dB ( $6.9 \times 10^{-3}$ )
M <sub>l</sub>	Load Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-	-42 dB ( $7.9 \times 10^{-3}$ )
T <sub>t</sub>	Trans. Tracking	±3 dB (0.41)	±0.1 dB (0.01)	±0.1 dB (0.01)	-	±0.05 dB ( $6.9 \times 10^{-3}$ )
C	Cross Talk	-100 dB ( $1.0 \times 10^{-5}$ )	-100 dB ( $1.0 \times 10^{-5}$ )	-110 dB ( $3.2 \times 10^{-6}$ )	-	-110 dB ( $3.2 \times 10^{-6}$ )
R <sub>r1</sub>	Port1 Refl. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>t1</sub>	Port1 Trans. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>r2</sub>	Port2 Refl. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>t2</sub>	Port2 Trans. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-110 dB from full scale ( $3.2 \times 10^{-6}$ )				
N <sub>h</sub>	High Level Noise <sup>2, 4</sup>	Magnitude: 0.001 dB ( $1.2 \times 10^{-4}$ )				
A <sub>m</sub> , A <sub>p</sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.				
U <sub>m</sub> , U <sub>p</sub>	Multiplexer Switching Uncertainty	Magnitude: ±0.002 dB ( $2.3 \times 10^{-4}$ ) Phase: 0.015 degrees				
S <sub>t1</sub>	Port1 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r1</sub>	Port1 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
S <sub>t2</sub>	Port2 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r2</sub>	Port2 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
T <sub>td</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1 + 0.15 × f(GHz)]degrees/°C				
T <sub>rd</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1 + 0.15 × f(GHz)]degrees/°C				
T <sub>sw</sub>	Switch Tracking	±0.03 dB ( $3.5 \times 10^{-3}$ )				
M <sub>sw</sub>	Switch Port Match	-70 dB ( $3.2 \times 10^{-4}$ )				

1 Accuracy enhancement procedures are performed using 85032B 50 Ω type-N calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valid measurement calibration.

2 With IF bandwidth of 10 Hz.

3 With impedance matched load.

4 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

5 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

6 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without cables and with 1-port calibration. For this case, drift typically is [0.1 + 0.05 × f (GHz)] × Δ°C, degrees.

## System performance with Different Test Sets and Connector Types

**Table 11-6.**  
**Typical System Performance for Devices with 75 Ω Type-N Connectors**  
**4395A with 87511B Test Set (300 kHz to 500 MHz)**

Symbol	Error Terms	Uncorrected	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>			
			Response Only	Response and Isolation	One-Port	Full two port
D	Directivity	-33 dB ( $2.2 \times 10^{-2}$ )	-33 dB ( $2.2 \times 10^{-2}$ )	-44 dB <sup>3</sup> ( $6.3 \times 10^{-3}$ )	-44 dB ( $6.3 \times 10^{-3}$ )	-44 dB ( $6.3 \times 10^{-3}$ )
M <sub>s</sub>	Source Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-35 dB (0.02)	-35 dB (0.02)
T <sub>r</sub>	Reflection Tracking	±3 dB (0.41)	±1 dB (0.12)	±0.9 dB (0.11)	±0.06 dB ( $6.9 \times 10^{-3}$ )	±0.06 dB ( $6.9 \times 10^{-3}$ )
M <sub>l</sub>	Load Match	-20 dB (0.10)	-20 dB (0.10)	-20 dB (0.10)	-	-42 dB ( $7.9 \times 10^{-3}$ )
T <sub>t</sub>	Trans. Tracking	±3 dB (0.41)	±0.1 dB (0.01)	±0.1 dB (0.01)	-	±0.05 dB ( $6.9 \times 10^{-3}$ )
C	Cross Talk	-100 dB ( $1.0 \times 10^{-5}$ )	-100 dB ( $1.0 \times 10^{-5}$ )	-104 dB ( $6.3 \times 10^{-6}$ )	-	-104 dB ( $6.3 \times 10^{-6}$ )
R <sub>r1</sub>	Port 1 Refl. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>t1</sub>	Port 1 Trans. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>r2</sub>	Port 2 Refl. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
R <sub>t2</sub>	Port 2 Trans. Connector Repeatability	-65 dB ( $5.6 \times 10^{-4}$ )				
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-104 dB from full scale ( $6.3 \times 10^{-6}$ )				
N <sub>h</sub>	High Level Noise <sup>2, 4</sup>	Magnitude: 0.001 dB ( $1.2 \times 10^{-4}$ )				
A <sub>m, A<sub>p</sub></sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.				
U <sub>m, U<sub>p</sub></sub>	Multiplexer Switching Uncertainty	Magnitude: ±0.002 dB ( $2.3 \times 10^{-4}$ ) Phase: 0.015 degrees				
S <sub>t1</sub>	Port 1 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r1</sub>	Port 1 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
S <sub>t2</sub>	Port 2 Cable Trans. Phase Stability <sup>5</sup>	0.05 × f (GHz) degrees				
S <sub>r2</sub>	Port 2 Cable Refl. Stability <sup>5</sup>	-70 dB ( $3.2 \times 10^{-4}$ )				
T <sub>td</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1+0.15×f(GHz)]degrees/°C				
T <sub>rd</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C ( $1.2 \times 10^{-3}$ /°C) Phase: <sup>6</sup> ±[0.1+0.15×f(GHz)]degrees/°C				
T <sub>sw</sub>	Switch Tracking	±0.03 dB ( $3.5 \times 10^{-3}$ )				
M <sub>sw</sub>	Switch Port Match	-70 dB ( $3.2 \times 10^{-4}$ )				

1 Accuracy enhancement procedures are performed using 85036B 75 Ω type-N calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valid measurement calibration.

2 With IF bandwidth of 10 Hz.

3 With impedance matched load.

4 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

5 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

6 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without cables and with 1-port calibration. For this case, drift typically is [0.1 + 0.05 × f (GHz)] × Δ°C, degrees.

## System performance with Different Test Sets and Connector Types

**Table 11-7.**  
**Typical System Performance for Devices with 50 Ω Type-N Connectors**  
**4395A with 87512A Test Set (100 Hz to 500 MHz)**

Symbol	Error Terms	Uncorrected	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>			
			Response Only <sup>3</sup>	Response and Isolation <sup>3</sup>	One-Port	one pass two port
D	Directivity	-	-	-	-40 dB (0.01)	-40 dB (0.01)
M <sub>s</sub>	Source Match	-24 dB (0.063)	-24 dB (0.063)	-24 dB (0.063)	-25 dB (0.056)	-25 dB (0.056)
T <sub>r</sub>	Reflection Tracking	-	-	-	±0.83 dB (0.1)	±0.83 dB (0.1)
M <sub>l</sub>	Load Match	-22 dB (0.079)	-22 dB <sup>4</sup> (0.079)	-22 dB (0.079)	-	-40 dB (0.01)
T <sub>t</sub>	Trans. Tracking	±0.8 dB (0.096)	±0.2 dB (0.023)	±0.2 dB (0.023)	-	±0.05 dB (5.8×10 <sup>-3</sup> )
C	Cross Talk	-	-	-	-	-110 dB (3.2×10 <sup>-6</sup> )
R <sub>r1</sub>	Port1 Refl. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )				
R <sub>t1</sub>	Port1 Trans. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )				
R <sub>r2</sub>	Port2 Refl. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )				
R <sub>t2</sub>	Port2 Trans. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )				
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-110 dB from full scale at ≥100 kHz (3.2×10 <sup>-6</sup> ) -90 dB from full scale at <100 kHz (3.2×10 <sup>-5</sup> )				
N <sub>h</sub>	High Level Noise <sup>2, 5</sup>	Magnitude:0.003 dB (3.5×10 <sup>-4</sup> )				
A <sub>m</sub> ,A <sub>p</sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.				
U <sub>m</sub> ,U <sub>p</sub>	Multiplexer Switching Uncertainty	Magnitude:±0.017 dB (2.0 ×10 <sup>-3</sup> ) Phase:0.1 degrees				
S <sub>t1</sub>	Port1 Cable Trans. Phase Stability <sup>6</sup>	0.05 × f (GHz) degrees				
S <sub>r1</sub>	Port1 Cable Refl. Stability <sup>6</sup>	-70 dB (3.2×10 <sup>-4</sup> )				
S <sub>t2</sub>	Port2 Cable Trans. Phase Stability <sup>6</sup>	0.05 × f (GHz) degrees				
S <sub>r2</sub>	Port2 Cable Refl. Stability <sup>6</sup>	-70 dB (3.2×10 <sup>-4</sup> )				
T <sub>td</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C (1.1×10 <sup>-3</sup> /°C)		Phase: <sup>7</sup> ±[0.1 + 0.15×f(GHz)]degrees/°C		
T <sub>rd</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C (1.1×10 <sup>-3</sup> /°C)		Phase: <sup>7</sup> ±[0.1 + 0.15×f(GHz)]degrees/°C		

1 Accuracy enhancement procedures are performed using 85032B 50 Ω type-N calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valid measurement calibration.

2 With IF bandwidth of 10 Hz.

3 Transmission Only

4 @ f ≥500 kHz.

5 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

6 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

7 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without calbes and with 1-port calibration. For this case, drift typically is [0.1 + 0.05 ×f (GHz)] × Δ°C, degrees.

## System performance with Different Test Sets and Connector Types

**Table 11-8.**  
**Typical System Performance for Devices with 75 Ω Type-N Connectors**  
**4395A with 87512B Test Set (100 Hz to 500 MHz)**

Symbol	Error Terms	Typical Residual after Accuracy Enhancement <sup>1, 2</sup>	
		One-Port	
D	Directivity	-40 dB (0.01)	
M <sub>s</sub>	Source Match	-25 dB (0.056)	
T <sub>r</sub>	Reflection Tracking	±0.83 dB (0.1)	
M <sub>l</sub>	Load Match	-	
T <sub>t</sub>	Trans. Tracking	-	
C	Cross Talk	-	
R <sub>r1</sub>	Port1 Refl. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )	
R <sub>t1</sub>	Port1 Trans. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )	
R <sub>r2</sub>	Port2 Refl. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )	
R <sub>t2</sub>	Port2 Trans. Connector Repeatability	-65 dB (5.6×10 <sup>-4</sup> )	
N <sub>l</sub>	Low-Level Noise <sup>2</sup>	-104 dB from full scale at ≥100 kHz (6.3×10 <sup>-6</sup> ) -84 dB from full scale at <100 kHz (6.3×10 <sup>-5</sup> )	
N <sub>h</sub>	High Level Noise <sup>2, 3</sup>	0.003 dB (3.5×10 <sup>-4</sup> )	
A <sub>m</sub> , A <sub>p</sub>	Dynamic Accuracy Error	See "Dynamic Accuracy" in Chapter 11.	
U <sub>m</sub> , U <sub>p</sub>	Multiplexer Switching Uncertainty	Magnitude:0.017 dB (2×10 <sup>-3</sup> ) Phase:0.1 degrees	
S <sub>t1</sub>	Port1 Cable Trans. Phase Stability <sup>4</sup>	[0.05×f(GHz)] degrees	
S <sub>r1</sub>	Port1 Cable Refl. Stability <sup>4</sup>	-70 dB (3.2×10 <sup>-4</sup> )	
S <sub>t2</sub>	Port2 Cable Trans. Phase Stability <sup>4</sup>	[0.05×f(GHz)] degrees	
S <sub>r2</sub>	Port2 Cable Refl. Stability <sup>4</sup>	-70 dB (3.2×10 <sup>-4</sup> )	
T <sub>t,d</sub>	Trans. Tracking Drift	Magnitude: 0.01 dB/°C (1.1×10 <sup>-3</sup> /°C)	Phase: <sup>5</sup> ±[0.1+0.15×f(GHz)] degrees/°C
T <sub>r,d</sub>	Refl. Tracking Drift	Magnitude: 0.01 dB/°C (1.1×10 <sup>-3</sup> /°C)	Phase: <sup>5</sup> ±[0.1+0.15×f(GHz)] degrees/°C

1 Accuracy enhancement procedures are performed using 85036B 75 Ω type-N calibration kit. Environmental temperature is 23°C ±3°C at calibration: ±1°C from calibration temperature must be maintained for valied measurement calibration.

2 With IF bandwidth of 10 Hz.

3 High-level noise is the RMS of a continuous measurement of a short circuit or thru.

4 Arrived at by bending 11857D cables out perpendicular to front panel and reconnecting. Stability is much better with less flexing.

5 Arrived at using 11857D cables and full 2-port calibration. Drift is much better without calbes and with 1-port calibration. For this case, drift typically is [0.1 + 0.05 × f (GHz)] × Δ°C, degrees.

### Determining Expected System performance

The uncertainty equations, dynamic accuracy calculations, and tables of system performance values provided in the preceding pages can be used to calculate the expected system performance. The following pages explain how to determine the residual errors of a particular system and combine them to obtain total error-corrected residual uncertainty values, using worksheets provided. The uncertainty graphs at the beginning of this *System performance* section are examples of the results that can be calculated using this information.

#### Procedures

Table 11-9 is a worksheet used to calculate the residual uncertainty in reflection measurements. Table 11-10 is a worksheet for residual uncertainty in transmission measurements. Determine the linear values of the residual error terms and the nominal linear S-parameter data of the device under test as described below and enter these values in the worksheets. Then use the instructions and equations in the worksheets to combine the residual errors for total system uncertainty performance.

**S-parameter Values.** Convert the S-parameters of the test device to their absolute linear terms.

**Noise Floor.** See the *Receiver Noise Level Performance Test* in the *Service Manual* to determine the actual noise floor performance of your measurement setup.

**Crosstalk.** See the *Input Crosstalk Performance Test*. Connect an impedance-matched load to each of the test ports and measure  $S_{21}$  or  $S_{12}$  after calibration. Turn on the marker statistics function, and measure the mean value of the trace. Use the mean value plus one standard deviation as the residual crosstalk value of your system.

**Dynamic Accuracy.** Determine the absolute linear magnitude dynamic accuracy as described under *Dynamic Accuracy* in this chapter.

**Other Error Terms.** See Table 11-3 through Table 11-8, depending on the test set and connector type in your system. Find the absolute linear magnitude of the remaining error terms.

**Combining Error Terms.** Combine the above terms using the reflection or transmission uncertainty equation in the worksheets.



## Determining Expected System performance

### Table 11-9. Reflection Measurement Uncertainty Worksheet

In the columns below, enter the appropriate values for each term.    Frequency: _____			
Error Term	Symbol	dB Value	Linear Value
Directivity	D	_____	_____
Reflection tracking	$T_r$	_____	_____
Source match	$M_s$	_____	_____
Load match	$M_l$	_____	_____
Dynamic accuracy (magnitude) <sup>1</sup>	$A_m$	_____	_____
Dynamic accuracy (phase) <sup>1</sup>	$A_p$	_____	_____
Multiplexer Switching Uncertainty (magnitude)	$U_m$	_____	_____
Multiplexer Switching Uncertainty (phase)	$U_p$	_____	_____
$S_{11}$	$S_{11}$	_____	_____
$S_{21}$	$S_{21}$	_____	_____
$S_{12}$	$S_{12}$	_____	_____
Noise floor	$N_l$	_____	_____
High level noise	$N_h$	_____	_____
Connector reflection repeatability	$R_{r1}, R_{r2}$	_____	_____
Connector transmission repeatability	$R_{t1}, R_{t2}$	_____	_____
Magnitude drift due to temperature	$T_{rd}(\text{mag})$	_____	_____
Phase drift due to temperature	$T_{rd}(\text{phase})$	_____	_____
Cable reflection stability	$S_{r1}, S_{r2}$	_____	_____
Cable transmission phase stability	$S_{t1}, S_{t2}$	_____	_____
Switch Tracking	$T_{sw}$	_____	_____
Switch Port Match	$M_{sw}$	_____	_____
<b>Magnitude</b>			
<b>Combine Systematic Errors.</b> In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors to obtain the total sum of systematic errors.			
$(1 + T_{sw}) \times (D + S_{r1})$	( _____ + _____ ) × ( _____ + _____ ) = _____	(k)	
$(T_{sw} + T_r) \times S_{11}$	( _____ + _____ ) × _____ = _____	(l)	
$(M_{sw} + S_{r1} + M_s) \times S_{11} \times S_{11}$	( _____ + _____ + _____ ) × _____ × _____ = _____	(m)	
$(M_{sw} + S_{r2} + M_l) \times S_{21} \times S_{12}$	( _____ + _____ + _____ ) × _____ × _____ = _____	(n)	
$(A_m + U_m) \times S_{11}$	( _____ + _____ ) × _____ = _____	(o)	
<b>Subtotal: k + l + m + n + o</b>	_____ + _____ + _____ + _____ + _____ = _____	(S)	
<b>Combine Random Errors.</b> In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors in an RSS fashion to obtain a total sum of the random errors.			
$3 \times N_l$	_____	$3 \times$ _____ = _____	(w)
$3 \times N_h \times S_{11}$	_____	$3 \times$ _____ × _____ = _____	(x)
$R_{r1} + 2 \times R_{t1} \times S_{11} + R_{r1} \times S_{11} \times S_{11}$	_____ + $2 \times$ _____ × _____ + _____ × _____ × _____ = _____	(y)	
$R_{r2} \times S_{21} \times S_{12}$	_____ × _____ × _____ = _____	(z)	
$\sqrt{w^2 + x^2 + y^2 + z^2}$	$\sqrt{_____ \times _____ + _____ \times _____ + _____ \times _____ + _____ \times _____} =$ _____	(R)	
<b>Subtotal: S + R</b>	_____ + _____ = _____	(V <sub>r</sub> )	
<b>Total Magnitude Errors:</b>			
$E_{rm}(\text{linear}) = V_r + T_{rd}(\text{mag}) \times S_{11}$	_____ + ( _____ × _____ ) = _____		
$E_{rm}(\text{log}) = 20 \text{ Log}(1 \pm E_{rm}/S_{11})$	$20 \text{ Log}(1 \pm \frac{_____}{_____} / \frac{_____}{_____}) =$ _____ dB		
<b>Phase</b>			
$E_{rp} = \text{Arcsin}[(V_r - (A_m + U_m) \times S_{11})/S_{11}] + T_{rd}(\text{phase}) + 2 \times S_{t1} + A_p + U_p$	$\text{Arcsin}[(\frac{_____}{_____} - (\frac{_____}{_____} + \frac{_____}{_____}) \times \frac{_____}{_____}) / \frac{_____}{_____}] +$ _____ + $2 \times$ _____ + _____ + _____ = $\pm$ _____ deg.		

<sup>1</sup> With IF bandwidth of 10 Hz.

# Determining Expected System performance

**Table 11-10. Transmission Measurement Uncertainty Worksheet**

In the columns below, enter the appropriate values for each term. Frequency: _____			
Error Term	Symbol	dB Value	Linear Value
Crosstalk	C	_____	_____
Transmission tracking	T <sub>t</sub>	_____	_____
Source match	M <sub>s</sub>	_____	_____
Load match	M <sub>l</sub>	_____	_____
Dynamic accuracy (magnitude) <sup>1</sup>	A <sub>m</sub>	_____	_____
Dynamic accuracy (phase) <sup>1</sup>	A <sub>p</sub>	_____	_____
Multiplexer Switching Uncertainty (magnitude)	U <sub>m</sub>	_____	_____
Multiplexer Switching Uncertainty (phase)	U <sub>p</sub>	_____	_____
S <sub>11</sub>	S <sub>11</sub>	_____	_____
S <sub>21</sub>	S <sub>21</sub>	_____	_____
S <sub>12</sub>	S <sub>12</sub>	_____	_____
S <sub>22</sub>	S <sub>22</sub>	_____	_____
Noise floor	N <sub>l</sub>	_____	_____
High level noise	N <sub>h</sub>	_____	_____
Connector reflection repeatability	R <sub>r1</sub> , R <sub>r2</sub>	_____	_____
Connector transmission repeatability	R <sub>t1</sub> , R <sub>t2</sub>	_____	_____
Magnitude drift due to temperature	T <sub>td</sub> (mag)	_____	_____
Phase drift due to temperature	T <sub>td</sub> (phase)	_____	_____
Cable reflection stability	S <sub>r1</sub> , S <sub>r2</sub>	_____	_____
Cable transmission phase stability	S <sub>t1</sub> , S <sub>t2</sub>	_____	_____
Switch Tracking	T <sub>sw</sub>	_____	_____
Switch Port Match	M <sub>sw</sub>	_____	_____
<b>Magnitude</b>			
<b>Combine Systematic Errors.</b> In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors to obtain the total sum of systematic errors.			
C			= _____ (k)
(T <sub>sw</sub> + T <sub>t</sub> ) × S <sub>21</sub>	(_____ + _____) × _____		= _____ (l)
(M <sub>sw</sub> + S <sub>r1</sub> + M <sub>s</sub> ) × S <sub>11</sub> × S <sub>21</sub>	(_____ + _____ + _____) × _____ × _____		= _____ (m)
(M <sub>sw</sub> + S <sub>r2</sub> + M <sub>l</sub> ) × S <sub>21</sub> × S <sub>22</sub>	(_____ + _____ + _____) × _____ × _____		= _____ (n)
(A <sub>m</sub> + U <sub>m</sub> ) × S <sub>21</sub>	(_____ + _____) × _____		= _____ (o)
<b>Subtotal: k + l + m + n + o</b>	_____ + _____ + _____ + _____ + _____		= _____ (S)
<b>Combine Random Errors.</b> In the space provided, enter the appropriate linear values from the list of errors. Then combine these errors in an RSS fashion to obtain a total sum of the random errors.			
3 × N <sub>l</sub>		3 × _____	= _____ (w)
3 × N <sub>h</sub> × S <sub>21</sub>		3 × _____ × _____	= _____ (x)
R <sub>t1</sub> × S <sub>21</sub> + R <sub>r1</sub> × S <sub>11</sub> × S <sub>21</sub>	_____ × _____ + _____ × _____ × _____		= _____ (y)
R <sub>t2</sub> × S <sub>21</sub> + R <sub>r2</sub> × S <sub>22</sub> × S <sub>21</sub>	_____ × _____ + _____ × _____ × _____		= _____ (z)
√w <sup>2</sup> + x <sup>2</sup> + y <sup>2</sup> + z <sup>2</sup>		√(_____ × _____ + _____ × _____ + _____ × _____ + _____ × _____)	= _____ (R)
S + R		_____ + _____	= _____ (V <sub>t</sub> )
<b>Total Magnitude Errors:</b>			
E <sub>tm</sub> (linear) = V <sub>t</sub> + T <sub>td</sub> (mag) × S <sub>21</sub>		_____ + (_____ × _____)	= _____
E <sub>tm</sub> (log) = 20 Log(1 ± E <sub>tm</sub> /S <sub>21</sub> )		20 Log(1 ± _____ / _____)	= _____ dB
<b>Phase</b>			
E <sub>tp</sub> = Arcsin[(V <sub>t</sub> - (A <sub>m</sub> + U <sub>m</sub> ) × S <sub>21</sub> )/S <sub>21</sub> ] + T <sub>td</sub> (phase) + S <sub>t1</sub> + S <sub>t2</sub> + A <sub>p</sub> + U <sub>p</sub>		Arcsin[(_____ - (_____ + _____) × _____) / _____] + _____ + _____ + _____ + _____ + _____	= ± _____ deg.

<sup>1</sup> With IF bandwidth of 10 Hz.

## Accessories and Options

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### Options Available

#### **DC SOURCE (Option 001)**

DC SOURCE supplies up to  $\pm 40$  V /  $\pm 100$  mA of DC voltage/current.

#### **High Stability Frequency Reference (Option 1D5)**

This option, a 10 MHz crystal in temperature stabilized oven, improves the source signal frequency accuracy and stability. This option can be retrofitted using the 4395U Upgrade Kit Option 1D5.

#### **Time-Gated Spectrum Analyzer (Option 1D6)**

This option allows the capability of intermittent or burst signal spectrum measurement. This option can be retrofitted using the 4395U Upgrade Kit Option 1D6.

#### **50 to 75 $\Omega$ Input Impedance Conversion (Option 1D7)**

This option offers 75  $\Omega$  input impedance for the spectrum measurement. The 11852B option 004 50 to 75  $\Omega$  minimum loss pads and 50  $\Omega$  to 75  $\Omega$  Supplemental characteristics are supplied with this option. This option can be retrofitted using the 4395U Upgrade Kit Option 1D7.

#### **Impedance Measurement Function (Option 010)**

This option allows the capability of impedance measurement function. This option can be retrofitted using the 43961A Impedance Test Kit. This option can be retrofitted using the 4396U Upgrade Kit Option 010.

#### **Handle Kit (Option 1CN)**

This option is a rack mount kit containing a pair of handles and the necessary hardware to mount the instrument.

#### **Rack Mount Kit (Option 1CM)**

This option is a rack mount kit containing a pair of flanges and the necessary hardware to mount the instrument, with handles detached, in an equipment rack with 482.6 mm (19 inches) horizontal spacing.

#### **Rack Mount and Handle Kit (Option 1CP)**

This option is a rack mount kit containing a pair of flanges, and the necessary hardware to mount the instrument with handles attached in an equipment rack with 482.6 mm (19 inches) horizontal spacing.

## Measurement accessories available

### Test Sets

#### 87511A/B S Parameter Test Set

These test sets contain the hardware required to measure all four S-parameters of a two-port 50 or 75  $\Omega$  device. An RF switch in the test set is controlled by the analyzer so that reverse measurement can be made without changing the connections to the DUT (device under test). Each test set also contains two internal dc bias tees for biasing active devices. The test port connectors for the 87511A are precision 7 mm connectors, and the 87511B test port connectors are 75  $\Omega$  type-N(f).

#### 87512A/B Transmission/Reflection Test Set

These test sets contain the hardware required to measure simultaneous transmission and reflection characteristics of a 50 or 75  $\Omega$  device in one direction only. The test port connector is 50  $\Omega$  type-N(f) on the 87512A and 75  $\Omega$  type-N(f) on the 87512B.

### Active Probes

#### 41800A Active Probe (5 Hz to 500 MHz)

This is a high input impedance probe for in-circuit measurements that cover the frequency range of 5 Hz to 500 MHz.

#### 41802A 1 M $\Omega$ Input Adapter (5 Hz to 100 MHz)

This adapter allows use of a high impedance probe. It has a frequency range of 5 Hz to 100 MHz.

#### 1141A Differential Probe

This is an FET differential probe with 200 MHz bandwidth and 3000:1 CMRR. The 1141A must be used with the 1142A Probe Control and Power Module.

### Power Splitters

#### 11850C,D Three-way Power Splitters

These are four-port, three-way power splitters. One output arm is used as the reference for the network analyzer in making ratio measurements and the other two output arms are test channels. The 11850C has a frequency range of DC to 3 GHz and an impedance of 50  $\Omega$ . The 11850D has a frequency range of DC to 2 GHz and an impedance of 75  $\Omega$ .

#### 11667A Power Splitter

This is a two-way power splitter with one output arm used for reference and one for test. It has a frequency range of DC to 18 GHz and an impedance of 50  $\Omega$ .

## Calibration Kits

The following calibration kits contain the precision standards (and the required adapters) for the indicated connector types. The standards facilitate measurement calibration (also called vector error correction). Refer to the applicable data sheet and ordering guide for additional information. Part numbers for the standards are in their respective manuals.

- 85033D 3.5 mm Calibration Kit
- 85031B 7 mm Calibration Kit
- 85032B 50  $\Omega$  Type-N Calibration Kit
- 85036B 75  $\Omega$  Type-N Calibration Kit

## Cables

The following RF cables are used to return the transmitted signal to the test set when measuring two-port devices. These cables provide shielding for high dynamic range measurements.

### 11857D 7 mm Test Port Return Cable Set

These are a pair of test port return cables for use with the 87511A Option 001 S-parameter test set. The cables can be used when measuring devices with connectors other than 7 mm by using the appropriate precision adapters.

### 11857B 75 $\Omega$ Type-N Test Port Return Cable Set

These are a pair of test port return cables for use with the 87511B S-parameter test set.

### 11851B 50 $\Omega$ Type-N RF Cable Set

This kit contains the three phase-matched 50  $\Omega$  type-N cables necessary to connect the 87512A transmission/reflection test kits or a power splitter to the analyzer. It also contains an RF cable used to return the transmitted signal of a two-port device to the network analyzer.

## BNC Cables

- P/N 8120-1838 50 $\Omega$  BNC Cable (30 cm)
- P/N 8120-1839 50 $\Omega$  BNC Cable (61 cm)
- P/N 8120-1840 50 $\Omega$  BNC Cable (122 cm)

## Adapters

### 11852B 50 $\Omega$ to 75 $\Omega$ Minimum Loss Pad (DC to 2 GHz)

This device converts the impedance from 50  $\Omega$  (type-N, female) to 75  $\Omega$  (type-N, male) or from 75  $\Omega$  to 50  $\Omega$ . It provides a low SWR impedance match between a 75  $\Omega$  DUT and the analyzer or a 50  $\Omega$  measurement accessory. An 11852B pad is included with the 87512B 75  $\Omega$  transmission/reflection test kit. Three 11852B pads are included with the 11850D 75  $\Omega$  power splitter and one is included with the 4395A Option 1D7.

## Adapter Kits

The following adapter kits contain the connection hardware required for making measurements on devices of the indicated connector type.

- 11853A 50  $\Omega$  Type-N Adapter Kit
- 11854A 50  $\Omega$  BNC Adapter Kit

### **Measurement accessories available**

- 11855A 75  $\Omega$  Type-N Adapter Kit
- 11856A 75  $\Omega$  BNC Adapter Kit

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## System accessories available

### Printer

The analyzer can output displayed measurement results directly to supported peripherals, not using external computers. Supported printers are as follows.

**Table 12-1. Supported Printers and Printing Modes**

Printer	Monochrome Printing	Fixed Color Printing	Variable Color Printing
HP DeskJet 340J	✓	✓	
HP DeskJet 505	✓		
HP DeskJet 560C	✓	✓	
HP DeskJet 694C	✓	✓	
HP DeskJet 850C	✓	✓	
HP DeskJet 1200	✓	✓	✓
HP DeskJet 1600CM	✓	✓	✓

### GPIB cable

An GPIB cable is required to interface the analyzer with a computer, or other external instrument. The following cables are available:

- 10833A (1 m)
- 10833B (2 m)
- 10833C (3 m)
- 10833D (0.5 m)

### External Monitors

The analyzer can control the built-in LCD and an external monitor simultaneously. Color monitors supporting VGA can be used as an external monitor.





## Basic Measurement Theory

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This chapter provides additional information on analyzer features beyond the basics covered in the previous chapters. It deals with the following topics:

- System Overview
- Data Processing Flow
- Network Analyzer Basic
  - Network Measurement Basic
  - S-parameters
  - Conversion
  - Smith Chart
  - Polar Chart
  - Electrical Delay
  - Averaging
  - IF Band Reduction
  - Group Delay
- Spectrum Analyzer Basic
  - Detection Mode
  - Swept and FFT Mode
  - Resolution Bandwidth (RBW)
  - Selectivity of the RBW
  - Noise Measurement
  - Gated Sweep for Spectrum Measurement
- Measurement and Display Points
- Limit Line Concept
- Marker
- GPIB
- Calibration for Network Measurement

## System Overview

### System Overview

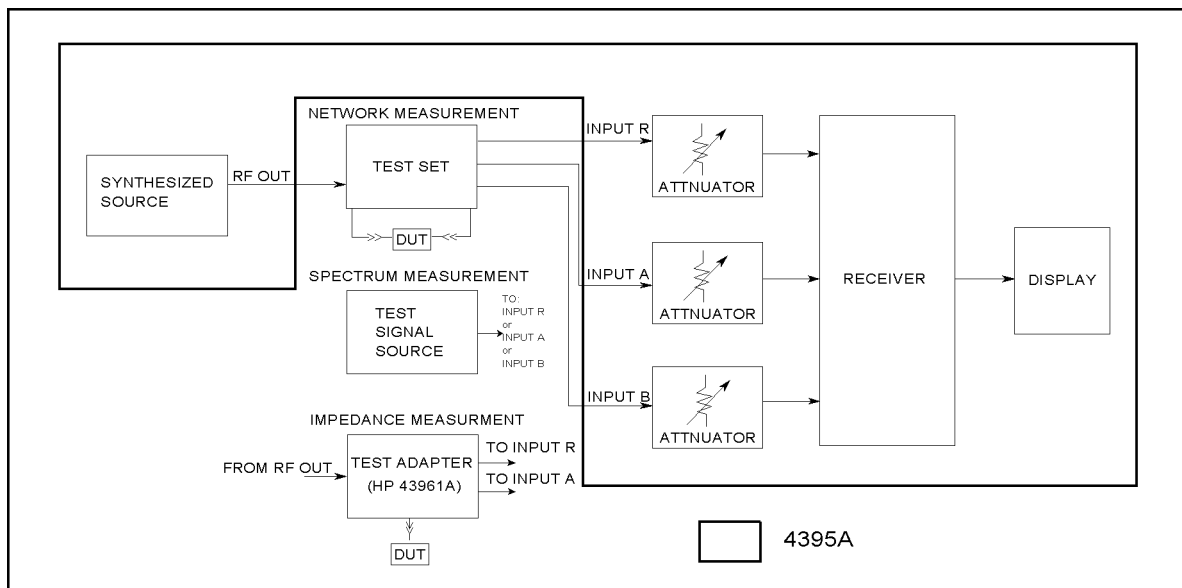
The 4395A has three analyzer modes; **network**, **spectrum**, and **impedance** (available with option 010).

In network analyzer mode, the 4395A measures the reflection and transmission characteristics of devices and networks by applying a known swept signal and measuring the response of the test device. The signal transmitted through the device or reflected from its input is compared with the incident signal generated by a swept RF source. The signals are applied to a receiver for measurement, signal processing, and display. The network analyzer system consists of a source, signal separation devices, a receiver, and a display.

In spectrum analyzer mode, the 4395A measures the amplitude and frequency of a signal spectral line by sweeping the tuning frequency of the receiver. The test signal is applied to a receiver through an input attenuator. The spectrum analyzer consists of an input attenuator, a receiver, and a display.

Impedance analyzer mode is available with option 010, and requires the 43961A RF impedance test kit as well. In impedance analyzer mode, the 4395A applies test signals to the DUT through the impedance test kit, and determines the impedance characteristics of the DUT by a method called the I-V analysis method, that is, by measuring the voltage (V) and current across the DUT. The 4395A's impedance analyzer system consists of a signal source, a test kit (the 43961A RF impedance test kit), a receiver, and a data display device.

Figure A-1 is a schematic block diagram that briefly illustrates the 4395A's principle of operation. For more information, refer to *Service Manual (English)* (Agilent part number: 04395-90100), which describes the 4395A's principle of operation in greater detail with a complete block diagram.



**Figure A-1. Schematic block diagram**

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## Data Processing

### Overview

The 4395A's receiver converts the R, A, and B input signals into useful measurement information. This conversion occurs in two main steps. First, the high frequency input signal is translated to fixed low frequency IF signals using analog mixing techniques (see the "Theory of Operation" in the *Service Manual* for details). Second, the IF signals are converted into digital data by an analog-to-digital converter (ADC). From this point on, all further signal processing is performed mathematically by the analyzer microprocessor and digital signal processor. The following paragraphs describe the sequence of math operations and the resulting data arrays as the information flows from the ADC to the display. They provide a good foundation for understanding most of the measurement functions and the order in which they are performed.

The 4395A has three data processing flow paths: one is for network analyzer mode, another for spectrum analyzer mode, and the other is for impedance analyzer mode. The data flow is automatically changed when analyzer mode is changed.

Figure A-2, Figure A-3, and Figure A-4 provide data processing flow diagrams that represent the flow of numerical data from IF detection to display. The data passes through several math operations (shown as single-line boxes). Most of these operations can be selected and controlled through the front panel MEASUREMENT block menus. The data is also stored in data arrays (shown as double-line boxes). These arrays are places in the flow path where the data is accessible via GPIB or using the internal disk drive or the memory disk.

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#### Note

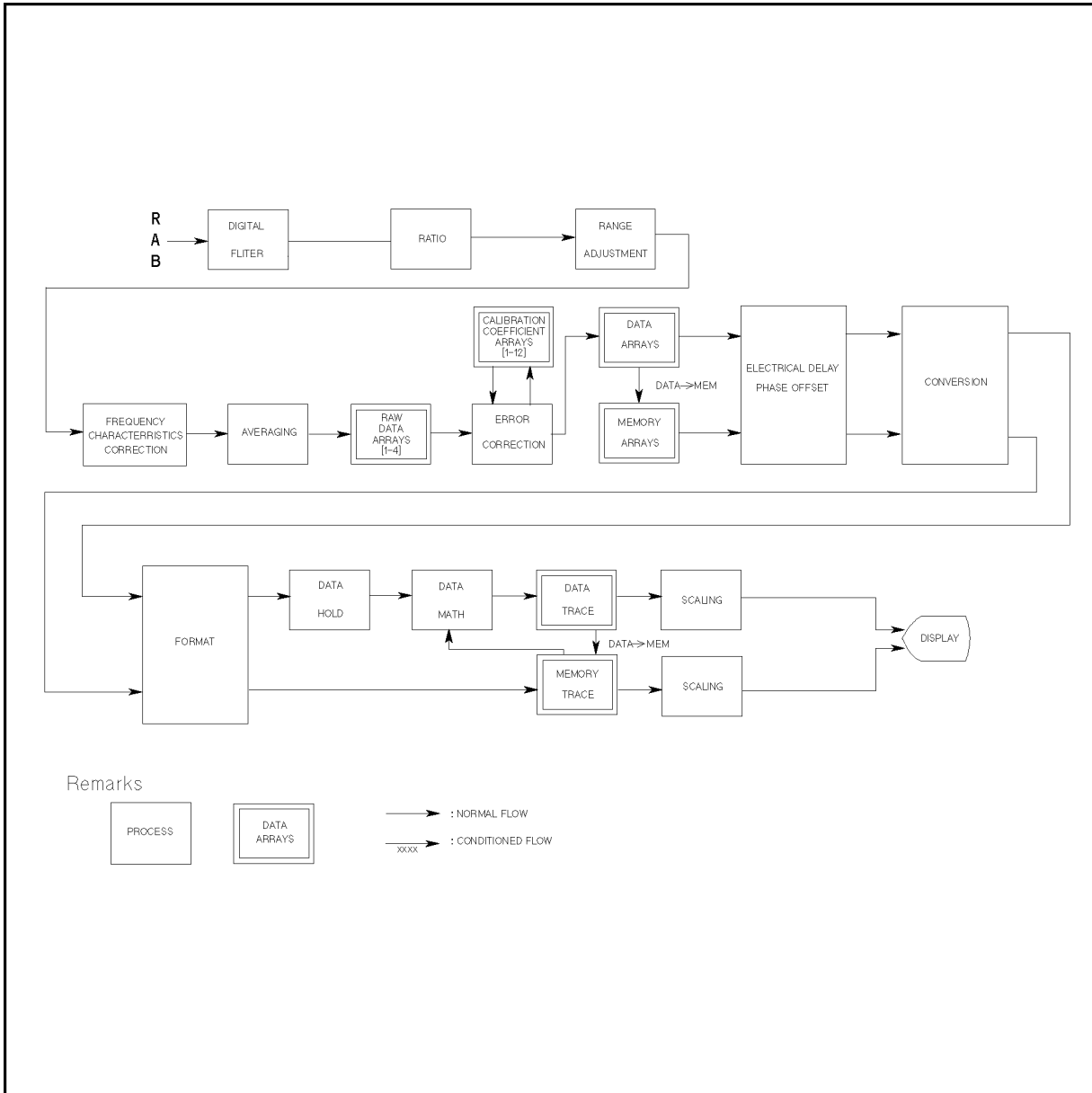


While only a single flow path is shown, two identical paths are available that correspond to channel 1 and channel 2. When the channels are uncoupled, each channel can be independently controlled so that the data processing operations for one can be different from the other.

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### Data Processing for Network Measurement

## Data Processing



CS012020

**Figure A-2. Data Processing for Network Measurement**

### Digital Filter

The digital filter detects the IF signal by performing a discrete Fourier transform (DFT) on the digital data. The samples are converted into complex number pairs (real plus imaginary,  $R+jI$ ) that represent both the magnitude and phase of the IF signal. The filter shape can be altered by selecting the IF bandwidth in Hz from the 10, 30, 100, 300, 1 k, 3 k, 10 k, and 40 k choices. Changing the filter shape is a highly effective technique for noise reduction.

### Ratio Calculations

These calculations are performed if the selected measurement is a ratio of two inputs (for example,  $A/R$  or  $B/R$ ). This is simply a complex divide operation. If the selected measurement is absolute (for example,  $A$  or  $B$ ), no operation is performed. The  $R$ ,  $A$ , and  $B$  values are also split into channel data at this point.

### A-4 Basic Measurement Theory

### Frequency Characteristics Correction by Corrective Data Arrays

This corrects the frequency response for absolute measurement value, using corrective data arrays. If the selected measurement is ratio (for example, A/R or B/R), no operation is performed.

### Averaging

This is one of the noise reduction techniques. This calculation involves taking the complex exponential average of up to 999 consecutive sweeps. See “Averaging (Sweep Averaging)” under the heading “Network Measurement Basics” in this chapter.

### Raw Data Arrays

These arrays store the results of all the preceding data processing operations. When full 2-port error correction is on, the raw data arrays contain all four S-parameter measurements required for accuracy enhancement. When the channels are uncoupled (coupled channels OFF), there may be as many as eight raw data arrays. These arrays are directly accessible via GPIB, or using the internal disk drive or the memory disk. Note that the numbers here are still complex pairs.

### Calibration Coefficient Arrays

When a measurement calibration has been performed and correction is turned on, error correction removes the repeatable systematic errors (stored in the calibration coefficient arrays) from the raw data arrays. This can vary from simple vector normalization to full 12-term error correction.

The calibration coefficient arrays themselves are created during a measurement calibration using data from the raw data arrays. These are subsequently used whenever correction is on, and are accessible via GPIB, or using the internal disk drive or the memory disk.

### Data Arrays

The results of error correction are stored in the data arrays as complex number pairs. These arrays are accessible via GPIB or by using the internal disk drive or the memory disk.

### Memory Arrays

If the data-to-memory operation is performed (using the **DATA—MEMORY** softkey), the data arrays are copied into the memory arrays (data trace arrays are also copied into the memory trace array at same time). These arrays are accessible using the internal disk drive or the memory disk. When accessed via GPIB, these arrays are read-only.

If memory is displayed, the data from the memory arrays goes through the same data processing flow path as the data from the data arrays.

### Electrical Delay and Phase Offset

This involves adding or subtracting a linear phase in proportion to frequency. This is equivalent to “line-stretching” or artificially moving the measurement reference plane. For more information, see “Electrical Delay” under the heading “Network Measurement Basics” in this chapter. .

### Conversion

Transforms S-parameter measurement data into equivalent complex impedance (Z) or admittance (Y) values, to inverse S-parameters (1/S), or to phase multiples of 4, 8, or 16. See “Conversion Function” under the heading “Network Measurement Basics” in this chapter. .

## **Data Processing**

### **Format**

This converts complex number pairs into a scalar representation for display, according to the selected format. This includes group delay calculations. Note that, once complex data has been formatted, it cannot be restored. See “Group Delay” for information on group delay principles.

### **Data Hold**

This keeps the maximum or minimum value at each display point when the data hold function is turned ON.

### **Data Math**

This calculates the complex ratio of the two (data/memory), the difference (data–memory), or summation (data+memory) when the data math function is selected. In addition, this function multiplies the ratio, difference, or summation by a constant, or subtracts a constant from them.

### **Data Trace Arrays**

The results are stored in the data trace arrays. It is important to note those marker values and marker functions are all derived from the data trace arrays. Limit testing is also performed on this array. The data trace arrays are accessible via GPIB, or using the internal disk drive or the memory disk.

### **Memory Trace Arrays**

If the data-to-memory operation is performed, the data trace arrays are copied into the memory trace arrays (data arrays are also copied into the memory array at same time). These arrays are accessible using the internal disk drive or the memory disk. When accessed via GPIB, these arrays are read-only.

### **Scaling**

These operations prepare the formatted data for display on the LCD. This is where the appropriate reference line position, reference line value, and scale calculations are performed.

## Data Processing for Spectrum Measurement

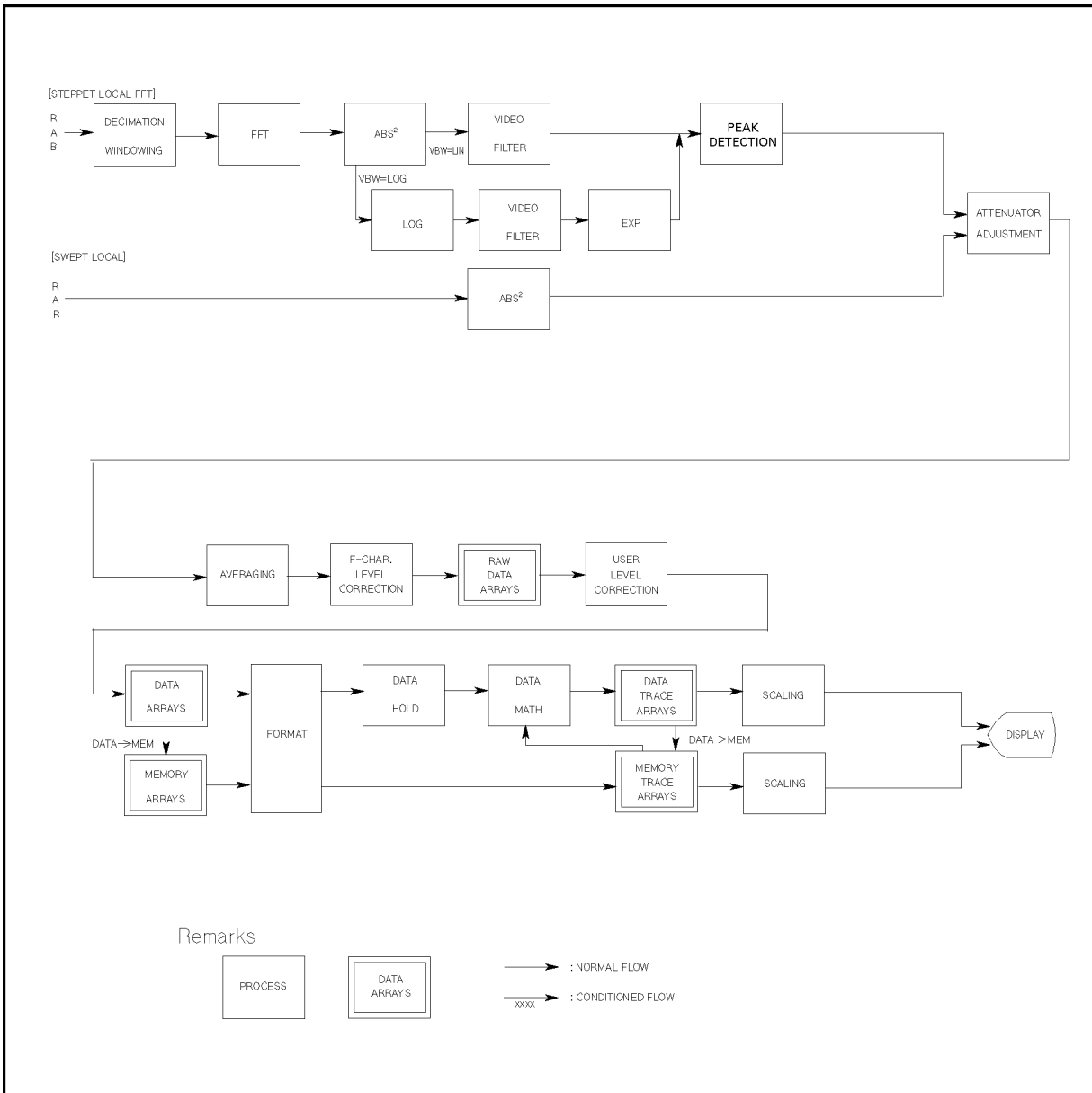


Figure A-3. Data Processing for Spectrum Measurement

### Decimation Windowing

This function reduces the sampling rate to resolve the spectrum closer than the frequency resolution (which is decided by an inherent sampling rate and finite sampling number).

### Fast Fourier Transform (FFT)

This operation transforms a time domain signal into a frequency domain data using the Fast Fourier Transform.

## **Data Processing**

### **Absolute Squared (ABS<sup>2</sup>)**

This calculates the power of the spectrum.

### **Video Averaging**

Video Averaging is one of the noise reduction techniques. The video bandwidth can be selected to be RBW/1, RBW/3, RBW/10, RBW/100, or RBW/300.

### **Detection**

This detects the value of a given display point in one of three modes: positive, negative, and sample. For more information, see “Detection Modes” under the heading “Network Measurement Basics” in this chapter.

### **Attenuator Adjustment**

This adjustment corrects the value to what it was before being attenuated.

### **Averaging**

Refer to “Averaging” under “Data Processing for Network Measurement” in this chapter.

### **Frequency Characteristics Level Correction**

This process digitally corrects for frequency response errors in the analog down-conversion path.

### **Raw Data Arrays**

These arrays store the results of all the data produced by the peak detector. These arrays are directly accessible via GPIB or by using the internal disk drive or the memory disk. In spectrum analyzer mode, row data arrays hold only the real number part of values.

### **Memory Arrays**

If the data-to-memory operation is performed (using the **DATA—MEMORY** softkey), the data arrays are copied into the memory arrays (data trace arrays are also copied into the memory trace arrays at same time). These arrays are accessible using the internal disk drive or the memory disk. When accessed via GPIB, these arrays are read-only. are also output via GPIB, but data cannot be input into them via GPIB.

If memory is displayed, the data from the memory arrays goes through the same data processing flow path as the data from the data arrays.

### **Format/Unit conversion**

This converts the measured values (dB value) to other unit (dBV, dB $\mu$ V, watt, an d volt). When noise measurement is selected, this divides measured values by the equivalent noise bandwidth to measure noise level directly.

### **Data Hold**

Refer to “Data Hold” under “Data Processing for Network Measurement” in this chapter.

### **Data Math**

Refer to “Data Math” under “Data Processing for Network Measurement” in this chapter.



### Data Trace Array

Refer to “Data Trace Array” under “Data Processing for Network Measurement” in this chapter. Note that, in spectrum analyzer mode, data trace arrays hold only the real number part of data.

### Memory Trace Array

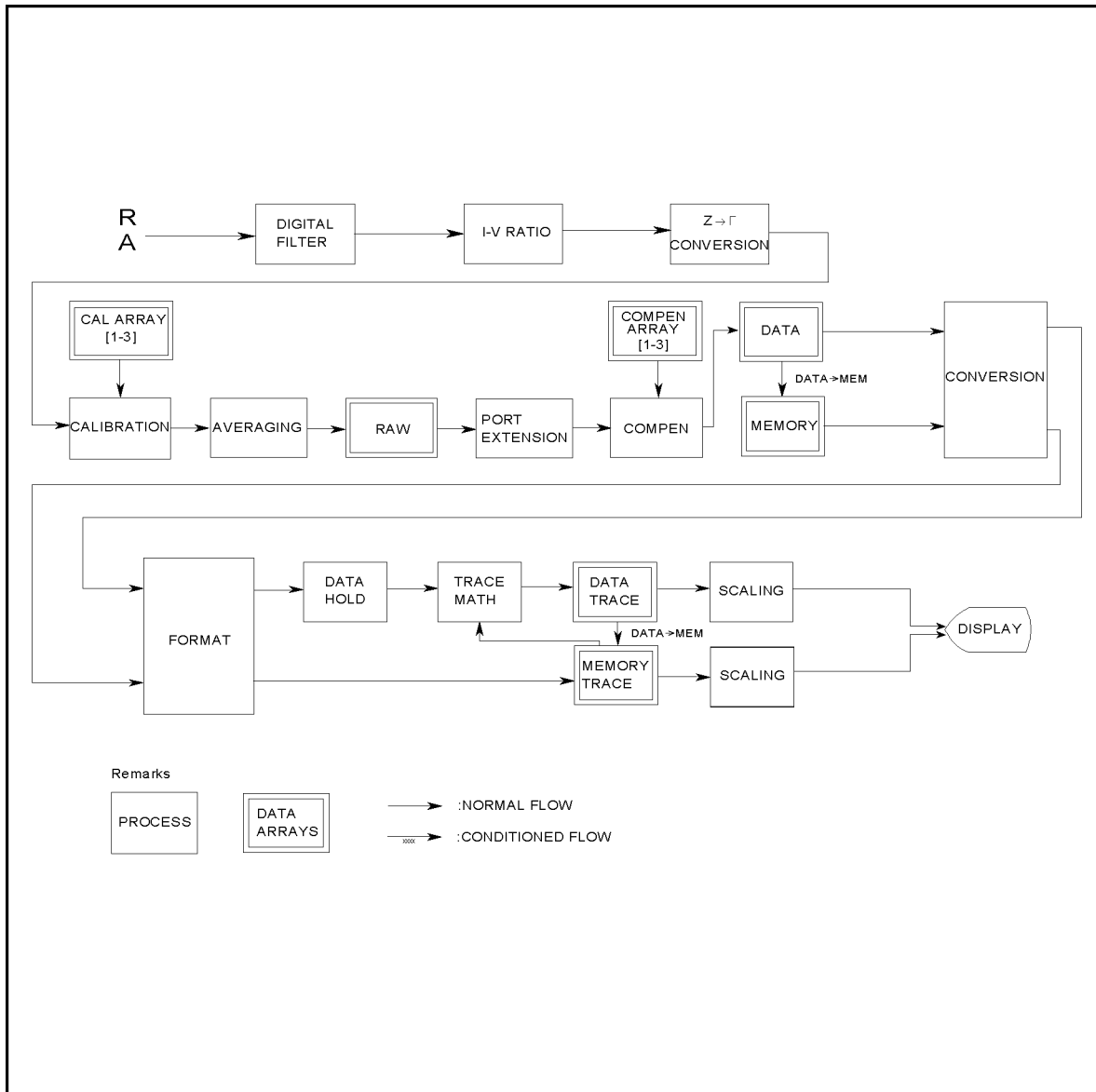
Refer to “Memory Trace Array” under “Data Processing for Network Measurement” in this chapter. Note that, in spectrum analyzer mode, memory trace arrays hold only the real number part of data.

### Scaling

Refer to “Scaling” under “Data Processing for Network Measurement” in this chapter.

## Data Processing

### Data Processing for Impedance Measurement



CC00A004

Figure A-4. Data Processing for Impedance Measurement

#### Digital Filter

Refer to “Digital Filter” under “Data Processing for Network Measurement” in this chapter.

#### Voltage/Current Ratio

This is simply a complex divide operation. The R and A values are split into channel data at this point.

### **I-V to Reflection Coefficient Conversion**

Converts the calculated  $V/I$  (voltage/current ratio) into  $\Gamma$  (reflection coefficient) data. The 4395A uses the reflection coefficient as its internal data.

### **Calibration Coefficient Arrays/Calibration**

During calibration, the 4395A measures three types of standards and stores them in the calibration coefficient arrays. This data is used to carry out  $S_{11}$  1 port calibration against the  $\Gamma$  value determined through the  $I-V \rightarrow \Gamma$  conversion and to determine the APC-7 calibration level of the 43961A.

### **Averaging**

Refer to “Averaging” under “Data Processing for Network Measurement” in this chapter.

### **Raw Data Arrays**

These arrays store the results of all the preceding data processing operations as reflection coefficients ( $\Gamma$ ). These arrays are directly accessible via GPIB, or using the internal disk drive or the memory disk. Note that the numbers here are still complex pairs.

### **Fixture Compensation Coefficient Arrays/Fixture Compensation**

During fixture compensation, 4395A measures three types of standards and stores them in the fixture compensation coefficient arrays. This data is used to remove errors attributable to the fixture. These arrays are directly accessible via GPIB, or using the internal disk drive or the memory disk.

### **Data Arrays**

The results of fixture compensation are stored in the data arrays as complex number pairs. These arrays are accessible via GPIB or by using the internal disk drive or the memory disk.

### **Memory Arrays**

If the data-to-memory operation is performed (using the `DATA—MEMORY` softkey), the data arrays are copied into the memory arrays (data trace arrays are also copied into the memory trace arrays at same time). These arrays are accessible using the internal disk drive or the memory disk. When accessed via GPIB, these arrays are read-only.

If memory is displayed, the data from the memory arrays goes through the same data processing flow path as the data from the data arrays.

### **Conversion**

When impedance or admittance is specified as a measurement parameter, the 4395A converts the corresponding reflection coefficient into the impedance or admittance value. In this case, however, the raw data, data, and memory arrays store the data as reflection coefficients, not as an impedance value.

### **Format**

Refer to “Format” under “Data Processing for Network Measurement” in this chapter.

### **Data Hold**

Refer to “Data Hold” under “Data Processing for Network Measurement” in this chapter.

**Data Processing****Data Math**

Refer to “Data Math” under “Data Processing for Network Measurement” in this chapter.

**Data Trace Array**

Refer to “Data Trace Array” under “Data Processing for Network Measurement” in this chapter.

**Memory Trace Array**

Refer to “Memory Trace Array” under “Data Processing for Network Measurement” in this chapter.

**Scaling**

Refer to “Scaling” under “Data Processing for Network Measurement” in this chapter.

## Network Measurement Basics

### S-parameters

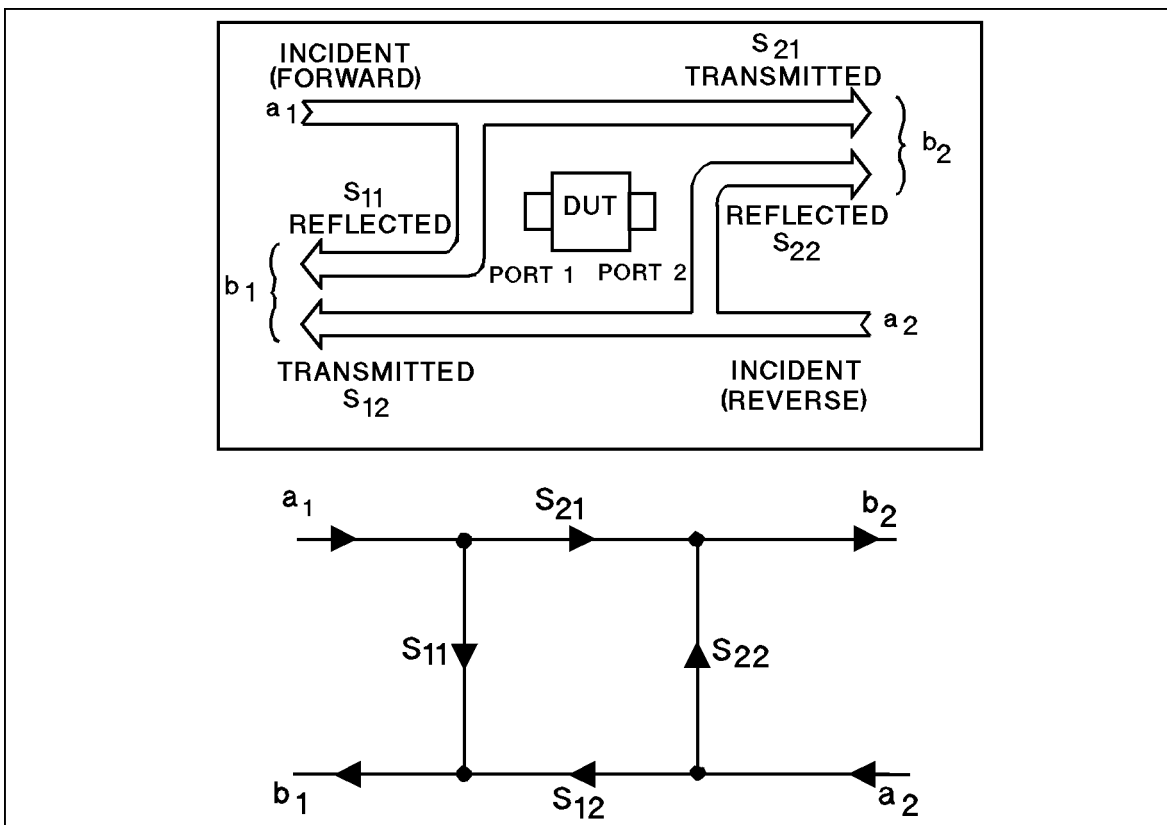
**S-parameters (scattering parameters)** are a convention that characterizes the way a device modifies signal flow. A brief explanation is provided here of the S-parameters of a two-port device. For additional details see Agilent Technologies Application Notes *A/N 95-1* and *A/N 154*.

S-parameters are always a ratio of two complex (magnitude and phase) quantities. S-parameter notation identifies these quantities using the numbering convention:

$$S_{\text{out in}}$$

Where the first number (**out**) refers to the port where the signal is emerging and the second number (**in**) is the port where the signal is incident. For example, the S-parameter  $S_{21}$  identifies the measurement as the complex ratio of the signal emerging at port 2 to the signal incident at port 1.

Figure A-5 is a representation of the S-parameters of a two-port device, together with an equivalent flow graph. In the illustration, “a” represents the signal entering the device and “b” represents the signal emerging. Note that a and b are not related to the A and B input ports on the analyzer.



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Figure A-5. S-Parameters of a Two-Port Device

S-parameters are exactly equivalent to the more common description terms below, requiring only that the measurements are taken with all DUT ports properly terminated.

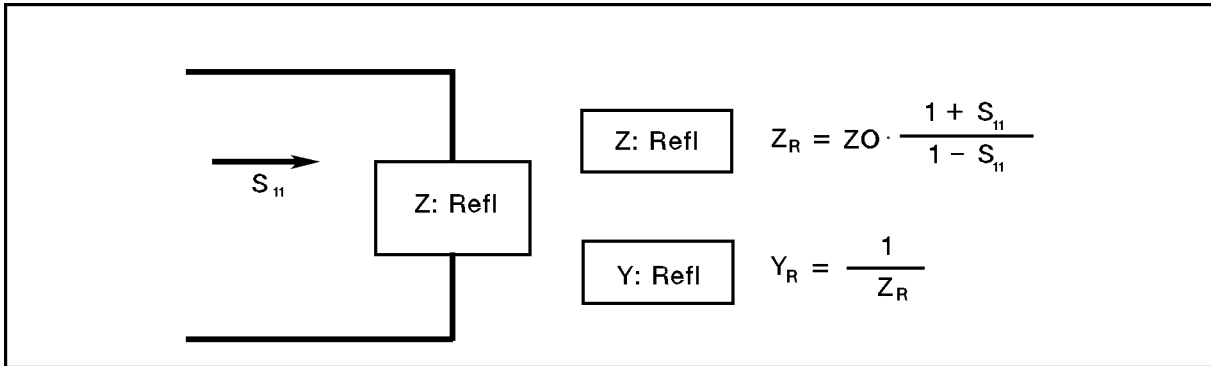
## Network Measurement Basics

S-Parameter	Definition	Test Set Description	Direction
$S_{11}$	$\frac{b_1}{a_1}  _{a_2=0}$	Input reflection Coefficient	FWD
$S_{21}$	$\frac{b_2}{a_1}  _{a_2=0}$	Forward gain	FWD
$S_{12}$	$\frac{b_1}{a_2}  _{a_1=0}$	Reverse gain	REV
$S_{22}$	$\frac{b_2}{a_2}  _{a_1=0}$	Output reflection coefficient	REV

### Conversion Function

This function converts the measured reflection or transmission data to the equivalent complex impedance (Z) or admittance (Y) values. This is not the same as a two-port Y or Z parameter conversion, as only the measured parameter is used in the equations. Two simple one-port conversions are available, depending on the measurement configuration.

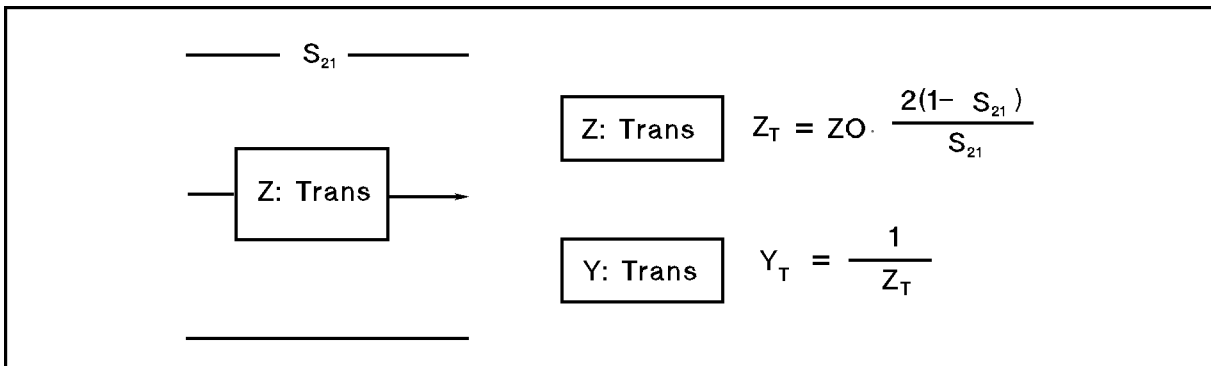
An  $S_{11}$  or  $S_{22}$  trace measured as reflection can be converted to an equivalent parallel impedance or admittance using the model and equations shown in Figure A-6.



C5012023

**Figure A-6. Reflection Impedance and Admittance Conversions**

In a transmission measurement, the data can be converted to its equivalent series impedance or admittance using the model and equations shown in Figure A-7.



C5012024

**Figure A-7. Transmission Impedance and Admittance Conversions**

Avoid using Smith chart, SWR, and delay formats for displaying Z and Y conversions, as these formats are not easily interpreted. Marker values are impedance values in  $\Omega$  units for Z conversions, or admittance values in S units for Y conversions in any format.

### Smith Chart

A Smith chart is used in reflection measurements to provide a readout of the data in terms of impedance. The intersecting lines on a Smith chart represent constant resistance and constant reactance values, normalized to the characteristic impedance,  $Z_0$ , of the system. Reactance values in the upper half of the Smith chart circle are positive (inductive) reactance, and in the lower half of the circle are negative (capacitive) reactance.

### Polar Chart

Each point on the polar format corresponds to a particular value of both magnitude and phase. Quantities are read vectorally: the magnitude at any point is determined by its displacement from the center (which has zero value), and the phase by the angle counterclockwise from the positive x-axis. Magnitude is scaled in a linear fashion, with the value of the outer circle usually set to a ratio value of 1. Because there is no frequency axis, frequency information is read from the markers.

### Electrical Delay

The electrical delay function simulates a variable length loss-free transmission line that can be added to or removed from a receiver input to compensate for interconnecting cables, etc. This function is similar to the mechanical or analog “line stretchers” of conventional network analyzers. Delay is annotated in units of time with secondary labeling in electrical length, associated with equivalent length of the transmission line if a value for **VELOCITY FACTOR** (see below) is specified.

To obtain the characteristics of the DUT itself free of the influence of interconnecting cables, use **ELECTRICAL DELAY** under **ELECTRICAL DELAY MENU**, and enter the following setting:

$$\text{Electrical delay } \Delta t = \frac{\Delta\theta}{F \times 360} [\text{sec}]$$

where:

- $F$  (Hz)                      Measuring frequency
- $\Delta\theta$  (degree)              Difference between measuring frequency without cables and that with the cables connected

In this case, the 4395A displays the electrical length of the interconnecting cable to compensate for, along with the value of electrical delay:

$$\Delta l = v_0 \times \Delta t [m]$$

where:

- $v_0$  (=2.997925E8) (m/sec)              light velocity in vacuum

If the average relative permittivity ( $\epsilon_r$ ) of the DUT is known over the frequency span, the length calculation can be adjusted to reflect the actual length of the DUT more closely. This can be done by entering the relative velocity factor for the DUT using **VELOCITY FACTOR** under the **(Cal)** key:

$$\frac{1}{\sqrt{\epsilon_r}}$$

assuming a relative permeability of 1.

## Network Measurement Basics

### Averaging (Sweep Averaging)

Averaging computes each data point based on an exponential average of consecutive sweeps weighted by a user-specified averaging factor. Each new sweep is averaged into the trace until the total number of sweeps is equal to the averaging factor, for a fully averaged trace. Each point on the trace is the vector sum of the current trace data and the data from the previous sweep. A high averaging factor gives the best signal-to-noise ratio, but slows the trace update time. Doubling the averaging factor reduces the noise by 3 dB. The algorithm used for averaging is:

$$A_{(n)} = \frac{S_{(n)}}{n} + \left(1 - \frac{1}{n}\right) \times A_{(n-1)}$$

where:

A(n) = current average ( $1 \leq n \leq F$ )

S(n) = current measurement ( $1 \leq n \leq F$ )

F = average factor

### IF Band Reduction

IF bandwidth reduction lowers the noise floor by reducing the receiver input bandwidth. It has an advantage over averaging in reliably filtering out unwanted responses such as spurs, odd harmonics, higher frequency spectral noise, and line-related noise. Sweep-to-sweep averaging, however, is better at filtering out very low frequency noise. A tenfold reduction in IF bandwidth (from 200 Hz to 20 Hz, for example) lowers the measurement noise floor by about 10 dB.

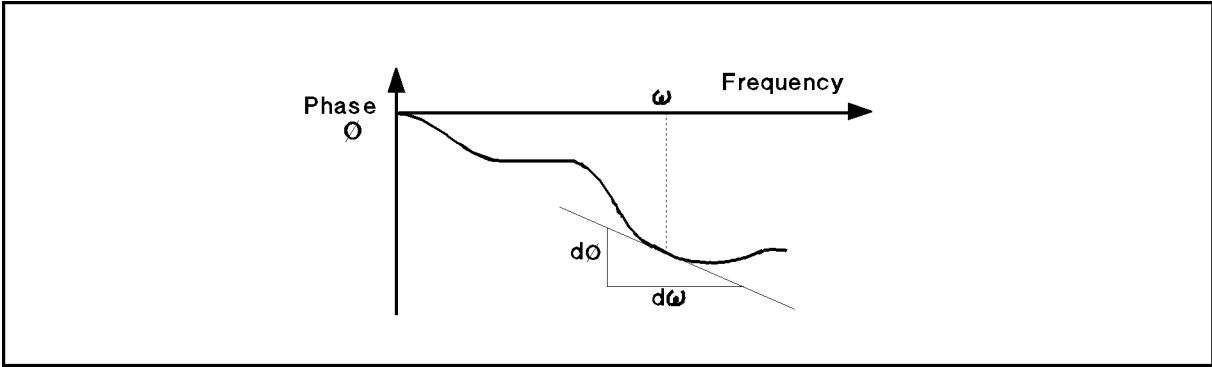
Another difference between sweep-to-sweep averaging and variable IF bandwidth is the sweep time. Averaging displays the first complete trace faster but takes several sweeps to reach a fully averaged trace. IF bandwidth reduction lowers the noise floor in one sweep, but the sweep time may be slower.

### Group Delay

For many networks, the linearity of the phase shift over a range of frequencies is an important parameter.

Group delay is the measurement of signal transmission time through a test device. It is defined as the derivative of the phase characteristic with respect to frequency. Because the derivative is the instantaneous slope (or rate of change of phase with frequency), a perfectly linear phase shift results in a constant slope, and therefore a constant group delay (Figure A-8).

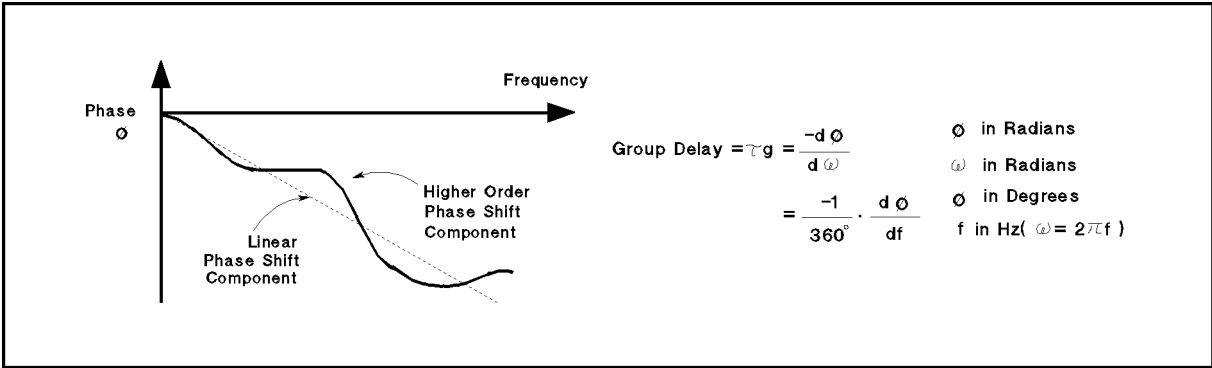




C5012001

Figure A-8. Constant Group Delay

Note, however, that the phase characteristic typically consists of both linear (first order) and higher order (deviations from linear) components. The linear component can be attributed to the electrical length of the test device and represents the average signal transit time. The higher order components are interpreted as variations in transit time for different frequencies, and represent a source of signal distortion (Figure A-9).

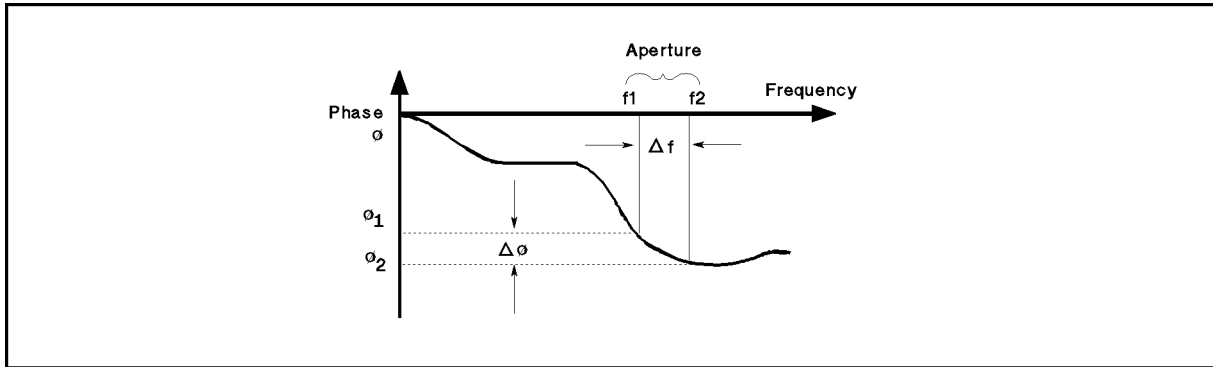


C5012002

Figure A-9. Higher Order Phase Shift

The 4395A computes group delay from the phase slope. Phase data is used to find the phase deviation,  $\Delta\phi$ , at the center point of a specified frequency aperture,  $\Delta f$ , to obtain an approximation for the rate of change of phase with frequency (Figure A-10). This value,  $\tau_g$ , represents the group delay in seconds assuming linear phase change over  $\Delta f$ .

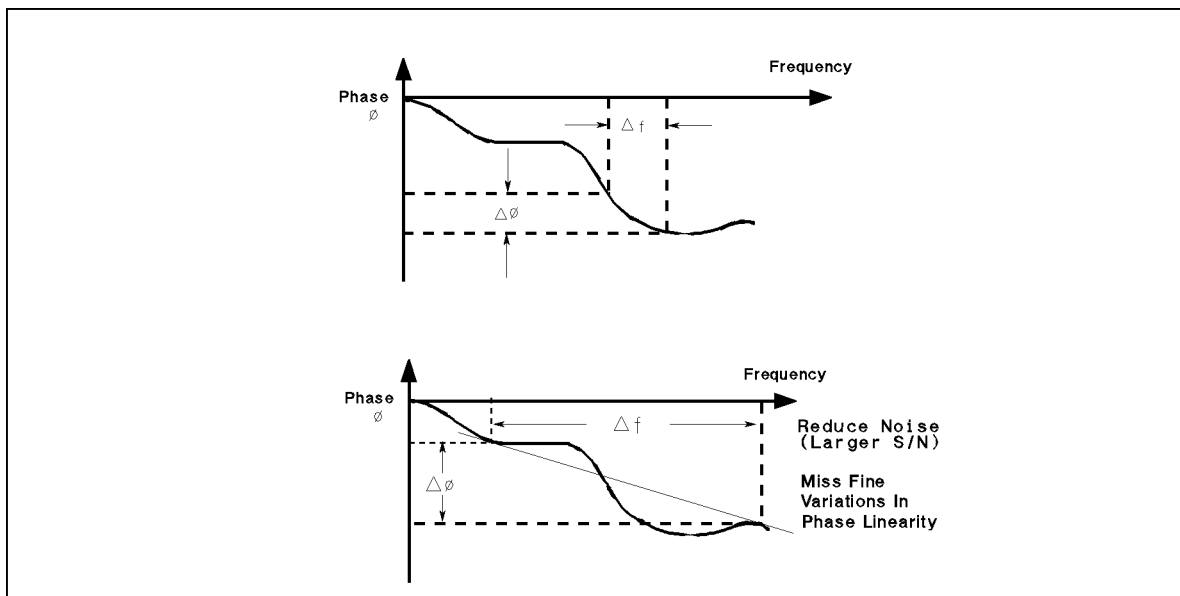
## Network Measurement Basics



CS012003

**Figure A-10. Rate of Phase Change Versus Frequency**

When deviations from linear phase are present, changing the frequency step can result in different values for group delay. Note that in this case the computed slope varies as the aperture  $\Delta f$  is increased (Figure A-11). A wider aperture results in loss of the fine grain variations in group delay. This loss of detail is the reason that in any comparison of group delay data it is important to know the aperture used to make the measurement.



CS012004

**Figure A-11. Variations in Frequency Aperture**

In determining the group delay aperture, there is a tradeoff between resolution of fine detail and the effects of noise. Noise can be reduced by increasing the aperture, but this will tend to smooth out the fine detail. More detail will become visible as the aperture is decreased, but the noise will also increase, possibly to the point of obscuring the detail. A good practice is to use a smaller aperture to assure that small variations are not missed, then increase the aperture to smooth the trace.

---

## Spectrum Measurement Basics

### Detection Modes

The analyzer displays the value measured at the display point specified by NOP. However, analyzer sweeps with the resolution specified by RBW. Detection chooses one level measured between display points for displaying the trace. One of three detection modes can be selected:

- Positive Peak Mode
- Negative Peak Modes
- Sample Mode

These modes are as described in the following subsections.

### Positive and Negative Peak Modes

Positive and negative peak modes store signal maximums and minimums between the display points, respectively, in a data array.

### Sample Mode

In the sample mode, the signal value at the display point is placed in a data array. Sample mode is used to measure noise level.

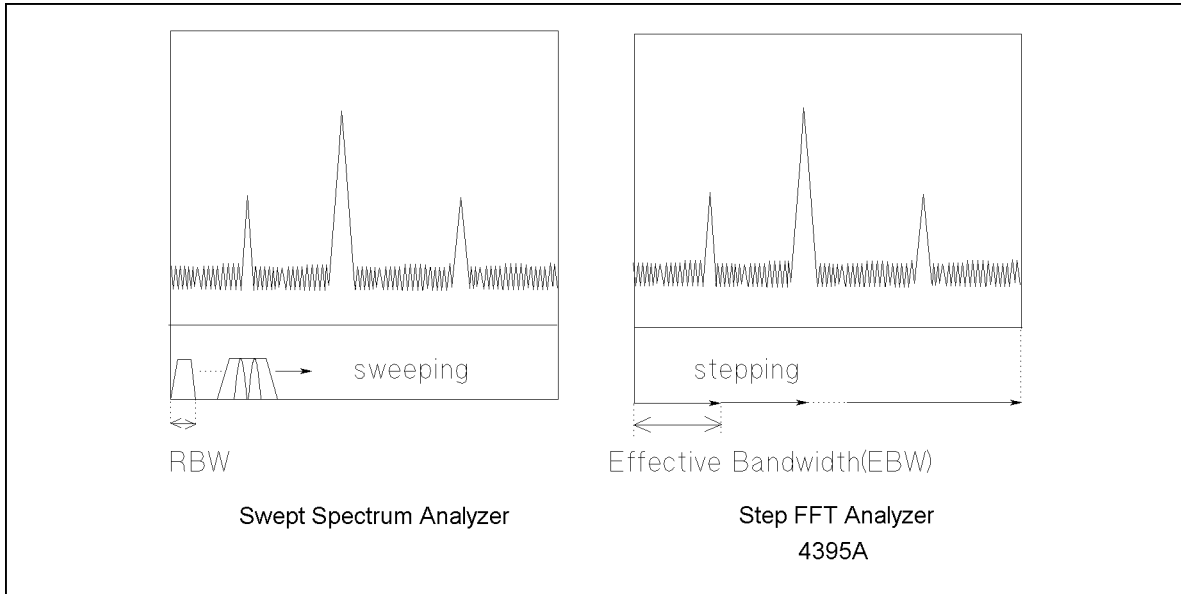
### Swept Spectrum Analyzers versus FFT Analyzers

Usually, two analyzers are used to analyze waveforms transformed from the time domain test signal to the frequency domain; one is a swept spectrum analyzer and the other is an FFT analyzer.

When measuring signals over a wide frequency span with a wide RBW, swept spectrum analyzers are better than FFT analyzers. This is true because the FFT analyzer requires a large memory and a fast AD converter to measure the signal and therefore, is not practical. When measuring signals with narrow RBW, FFT analyzers are better than swept spectrum analyzers because the swept spectrum analyzer requires much more time to measure (sweep) the signal. The FFT analyzer can measure the signal in very short time.

In spectrum analyzer mode, the 4395A operates as a step FFT analyzer which supports high-speed sweep throughout the entire RBW.

## Spectrum Measurement Basics

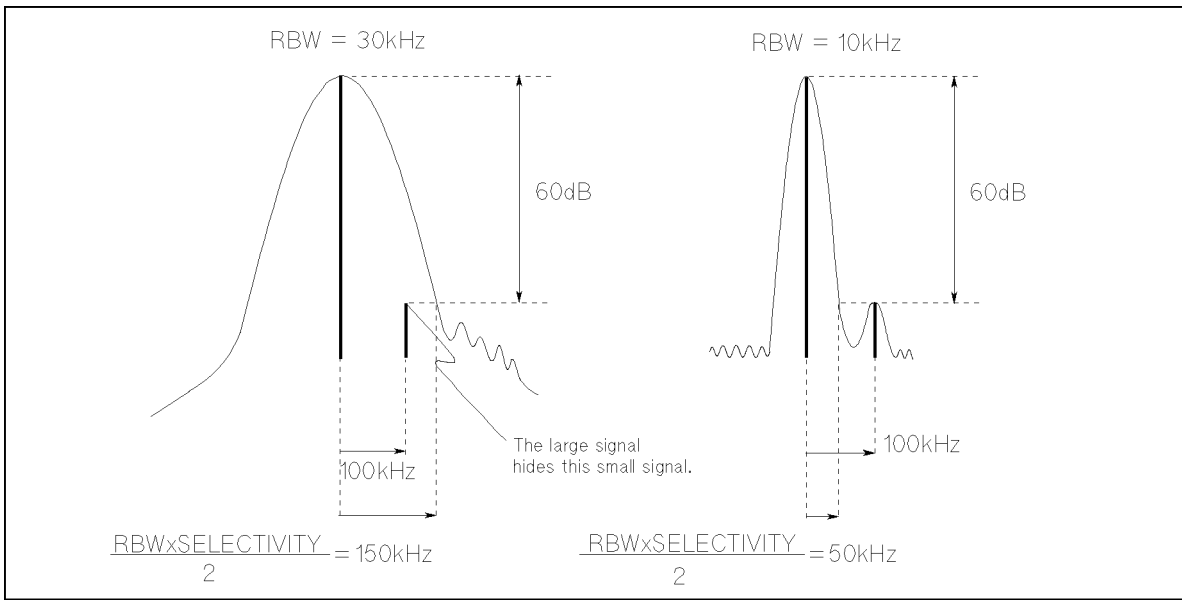


CS012032

**Figure A-12. Swept Spectrum Analyzers versus Step FFT Analyzers**

### Selectivity of the RBW

The selectivity of the RBW is the ratio of the 60 dB bandwidth to 3 dB bandwidth (RBW) of the filter. The selectivity defines the shape of the filter. This factor is important when resolving small signal that is adjacent to a large signal. The small adjacent signal is hidden by the large signal even when the resolution bandwidth is set to smaller than the difference of frequency between the signals. To resolve small adjacent signals, the resolution bandwidth must be set so that the small signal is not hidden by the large signals as shown in Figure A-13.



**Figure A-13. Resolving Small Adjacent Signal**

Because the 4395A uses a digital filter technique, the selectivity of the analyzer is better (smaller) than a conventional spectrum analyzer (which uses analog filter technique). This means the 4395A can detect a small signal that could not be detected by a conventional spectrum analyzer.

## **Spectrum Measurement Basics**

### **Noise measurement**

#### **Noise Format and Marker Noise Form**

When a spectrum analyzer measures noise, the power shown by an analyzer is in proportion to RBW (because spectrum analyzers measure total power coming thorough RBW). For noise measurement, the measurement value is usually normalized by an equivalent noise bandwidth of an RBW filter (frequency). The noise format automatically normalizes noise power by the equivalent noise bandwidth and displays the trace on the screen. The marker noise form also reads out the noise level normalized, even if the format is the spectrum.

#### **Sample Detection Mode for Noise Measurement**

For noise measurement, the sample detection mode is best. Because the power of noise is uniformly distributed over frequency, it is not necessary to measure all the frequencies between the display points. It is sufficient to measure only the display points. This is why the sample detection mode is used for noise measurement.

#### **VBW for Noise Measurement**

You should specify a smaller VBW when using the 4395A to measure noise levels.

To obtain accurate noise level measurements, it is essential to determine the average value over a relatively long period. With a smaller VBW, the 4395A can determine the average time domain at each measurement point.

## Impedance Measurement Basics

### I-V Measurement Method

#### Basic Concept of I-V Method

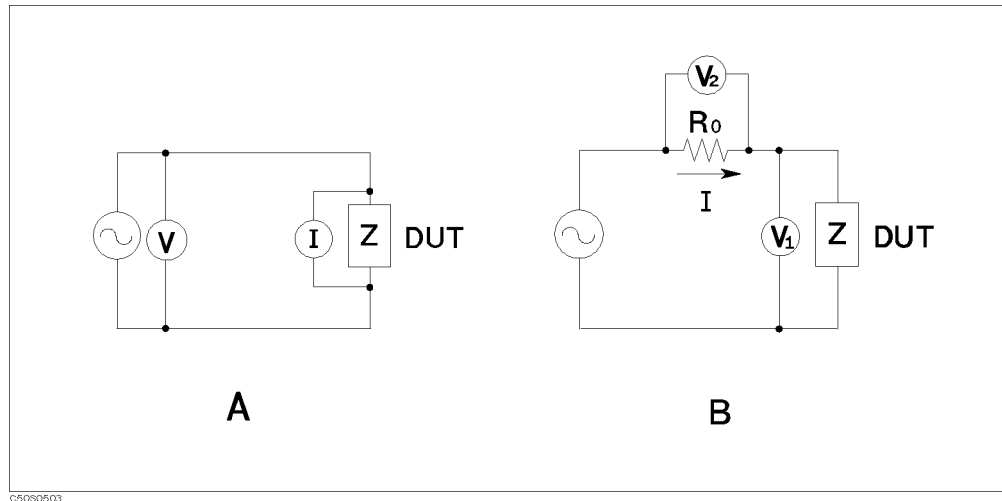


Figure A-14. I-V Measurement Method

The unknown impedance,  $Z$ , can be calculated from the measured voltage and current using Ohm's law: (See circuit A in Figure A-14.)

$$Z = \frac{V}{I}$$

The current,  $I$ , can be also obtained by the voltage level of the known resistance,  $R_0$ .

$$Z = \frac{V_1}{I} = \frac{V_1}{V_2} R_0$$

See circuit B in Figure A-14.

The 4395A uses circuit B to determine the unknown impedance.

#### How This Is Different From Impedance Conversion in the Network Analyzer Mode

The network analyzer part of the 4395A has an impedance conversion feature that converts the reflection coefficient to impedance. The reflection is determined by the impedance of the DUT.

$$Z = R_0 \frac{1 - \Gamma}{1 + \Gamma} \quad (-1 \leq \Gamma \leq 1)$$

If the DUT impedance is equal to the characteristic impedance, there is no reflection. When the impedance is an infinite value like OPEN, the all input signal is reflected.

When the impedance is greater than characteristic impedance, the measurement error is increased. For example, for an impedance of 2 k $\Omega$ , a 1 percent error in the reflection coefficient is converted to a 24 percent error in impedance.

## **I-V Measurement Method**

However, with the I-V method, the measurement error does not depend on the impedance of the DUT because the I-V method measures the impedance directly from the ratio of the voltage and current. Using the I-V method, you can measure a wide range impedance with constant accuracy. This is the major advantage of the I-V method.

The 4395A, when combined with the 43961A, uses a RF I-V measurement method to measure the impedance of a DUT at higher frequencies. While the RF I-V measurement method is based on the same principal as the I-V measurement method, it is possible to operate at higher frequencies by using an impedance matched measurement circuit (50  $\Omega$ ) and a precision coaxial test port.



## Impedance Measurement Scheme

### Measurement Block Diagram

With the 43961A connected, the measurement circuit is as shown in Figure A-15.

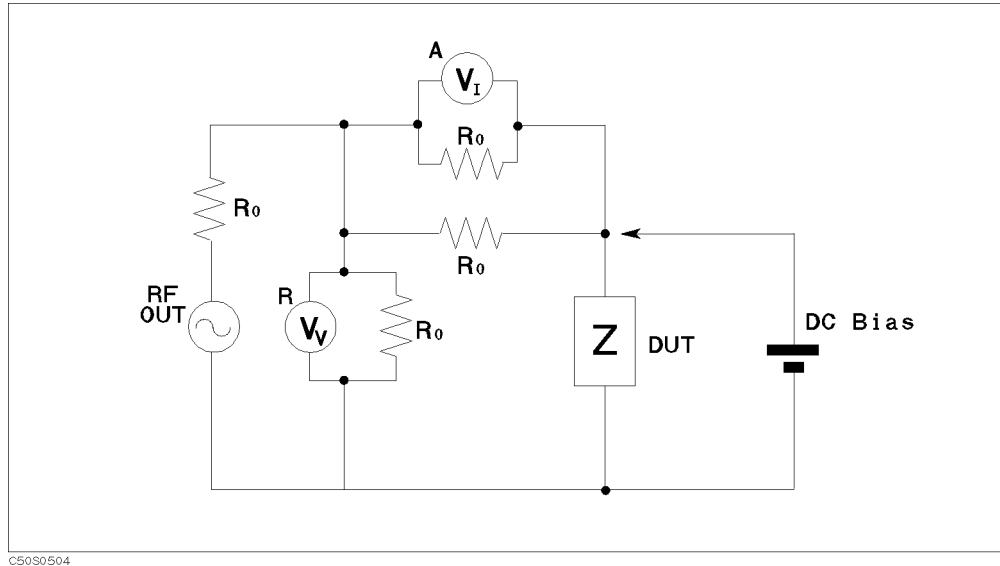


Figure A-15. Impedance Test Kit Block Diagram

The source signal is output from RF OUT port.  $V_V$  voltmeter is R port receiver that measures a voltage.  $V_I$  voltmeter is A port receiver that measures a voltage of  $R_0$  to obtain a current.

### Test Signal Level at DUT

The test signal level actually applied to the DUT depends on the test signal level from the 4395A, the output impedance, the insertion loss of the Impedance Test Kit, and the impedance of the DUT.

Figure A-16 shows the simplified equivalent circuit of the 4395A and 43961A.

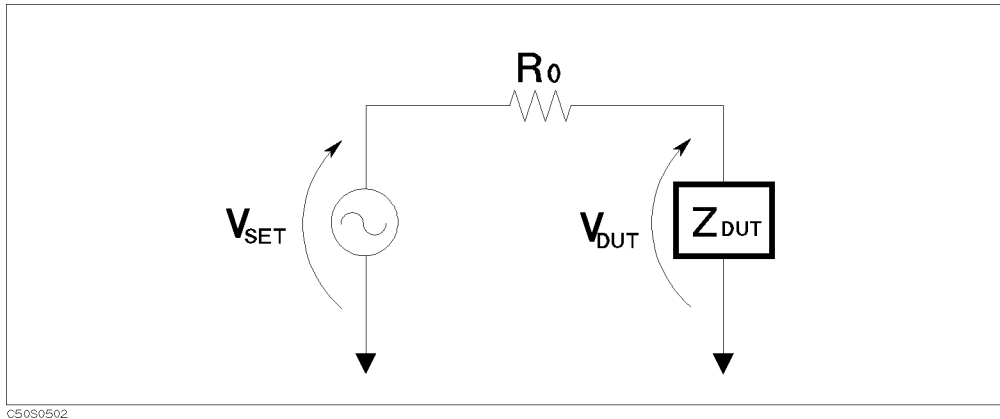


Figure A-16. Test Signal Level

## Impedance Measurement Scheme

The output signal is divided by the input impedance ( $R_0$ ) and the impedance of the DUT. You can use the following equation to determine the signal level actually applied to the DUT:

$$V_{DUT} = V_{SET} \times \frac{Z_{DUT}}{(Z_{DUT} + R_0)} [V]$$

Where,

$V_{DUT}$  Voltage level that is actually applied to the DUT.

$V_{SET}$  Voltage level that is set. See below.

$Z_{DUT}$  Impedance of the DUT.

$R_0$  Input impedance, 50  $\Omega$ .

The 4395A defines the output level as the level when the RF OUT port is 50  $\Omega$  terminated. Therefore, you can calculate the voltage from dBm,

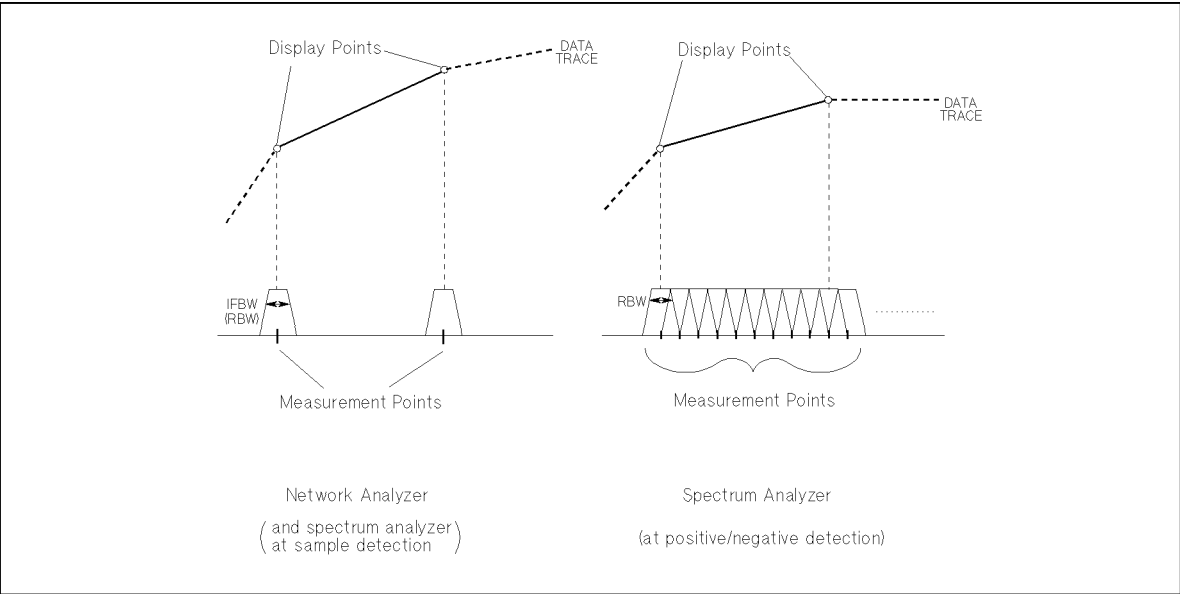
$$V_{SET} = \sqrt{10^{\frac{P_{SET}}{10}} \times 0.001 \times R_0}$$

Where,

$P_{SET}$  Output power setting level. [dBm]

### Measurement Points and Display Points

In a network measurement, the analyzer measures at only the display points specified by NOP. In a spectrum measurement, the analyzer measures all the frequencies between the display points (except for sampling detection mode). This is done so that the analyzer can detect spectrums existing between the display points



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Figure A-17. Measurement Points and Display Points

### Channel Coupling

When the 4395A is operating in network analyzer mode, you can couple the two channels so that the sweep parameters are linked across the two channels. But, when one channel measures a ratio measurement and the other one measures an absolute measurement (for example A/R and B), sweep parameters can not be linked.

In channel coupling mode, the following parameters are linked:

- Frequency
- Number of points
- Source power level
- Number of groups
- IF bandwidth
- Sweep time
- Trigger type
- Sweep type

In addition, if both channels have the same input parameter (such as  $S_{11}$  or A/R), the following parameters are linked:

- Calibration type
- Calibration coefficient

The following parameters always have the same value between the two channels, whether or not the channels are coupled:

- Trigger source
- List sweep table
- Calibration kit type and data

The following parameters are always set for each channel independently, whether or not the channels are coupled:

- Measurement parameter
- Display Format
- Title
- Traces displayed
- Scale value
- Electrical delay
- Phase offset
- Averaging (on/off, factor)

Linking of sweep parameter values for the two channels is independent of the `DUAL CHAN on OFF` softkey under the `(Display)` key and of the `MKR [UNCOUPLED] / [COUPLED]` softkey under the `(Marker)` key. `COUPLED CH OFF` becomes an alternate sweep function when dual channel display is on. In this mode, the 4395A alternates between the two sets of sweep parameter values for measurement of data and both are displayed.

## Limit Line Concept

These are lines drawn on the display to represent upper and lower limits or device specifications with which to compare the DUT. Limits are defined by specifying several segments, where each segment is a portion of the sweep parameter span. Each limit segment has an upper and a lower starting limit value.

Limits can be defined independently for the two channels with up to 18 segments for each channel (a total of 36 for both channels). These can be in any combination of the two limit types.

Limit testing compares the measured data with the defined limits, and provides pass or fail information for each measured data point. An out-of-limit test condition is indicated in the following ways:

- Displaying a FAIL message on the screen
- Emitting a beep
- Displaying an asterisk in tabular listings of data
- Writing a bit into GPIB event status register B (for more information on GPIB event status registers, refer to *4395A Programming Guide*)

Limits are entered in tabular form. Limit lines and limit testing can be either ON or OFF while limits are defined. As new limits are entered, the tabular columns on the display are updated, and the limit lines (if on) are modified to the new definitions. The complete limit set can be offset in either sweep parameter or amplitude value.

### How Limit Lines are Entered

Before limit lines can be explained, the concept of “segments” must be understood. A segment is the node of two limit lines.

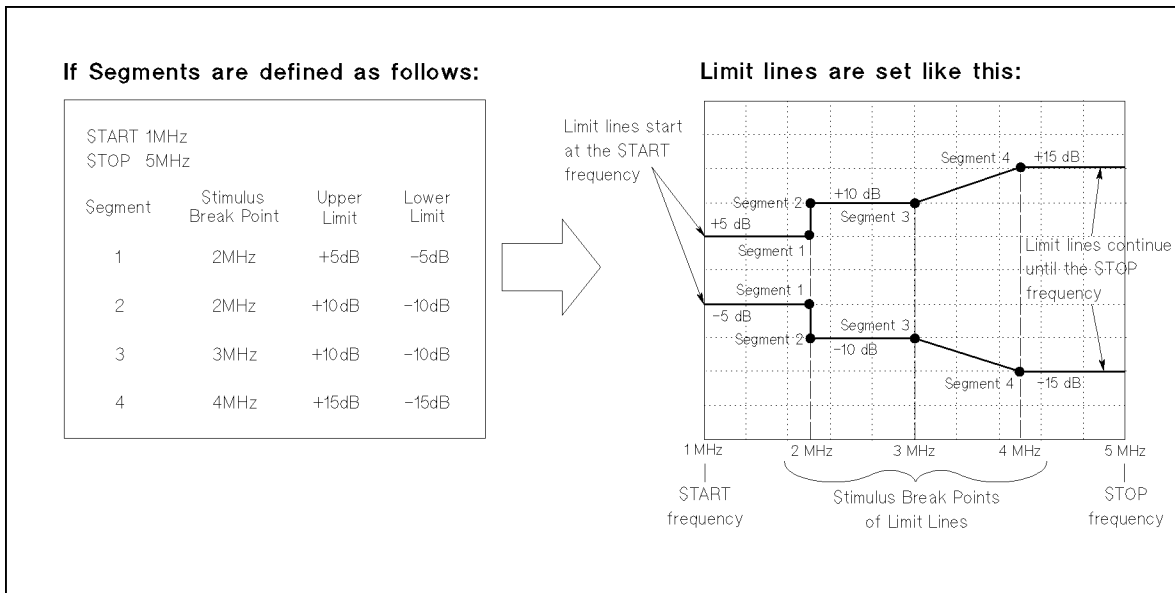


Figure A-18. The Concept of Segments as a Point between Two Sets of Limit Lines

## Limit Line Concept

As you can see in Figure A-18, segments are distinct points that define where limit lines begin or end. Limit lines span the distance between segments and represent the upper and lower test limits. Figure A-18 shows another important aspect of limit lines. The far left hand side of a set of limit lines will continue from the minimum sweep parameter value (*START*) and the far right hand side of a set of limit lines will continue until the maximum sweep parameter value (*STOP*).

A segment is placed at a specific sweep parameter value (a single frequency for example). The first segment defines the limit line value from the minimum sweep parameter value. Once its sweep parameter value is entered, the upper and lower test limit (+5 dB and -5 dB for example) need to be supplied.

Defining a second segment defines where the first set of limit lines ends. This process is repeated to create different sets of limit lines, each having new upper and lower limits. Up to 18 segments can be entered.

Limits can be defined independently for the two channels.

The example in Figure A-18 shows a combination of limit lines that change instantly and gradually.

Segment 1 is at 2 MHz and has an upper and lower limit of +5 and -5 dB, respectively. Notice the upper and lower limit lines start at the *START* frequency (1 MHz) and end at segment 1.

Segment 2 is also at 2 MHz with different upper and lower limits of +10 dB and -10 dB, changing the limit values instantly.

Segment 3 is at 3 MHz with the same limit value as segment 2 to obtain a flat limit lines.

Segment 4 is at 4 MHz with upper and lower limit values of +15 dB and -15 dB, changing the limit values gradually. Notice the upper and lower limit lines start at the segment and continue until the *STOP* frequency (5 MHz).

---

### Note



Limit lines cannot be cut. Therefore, when limit lines are needed partially along the sweep parameter axis, the non-limit-testing portion must also be entered. Set the non-limit-testing portion by forcing the upper and lower limit values out of range (+500 dB and -500 dB for example).

Both an upper limit and a lower limit (or delta limits) must be defined. If only one limit is required for a particular measurement, force the other limit out of range (+500 dB or -500 dB for example).

---

## Turning ON/OFF Limit Line/Limit Test

Limit lines and limit testing features are *OFF* unless explicitly turned *ON* by the user. After entering the limit line information, you can turn *ON* the limit line feature and optionally the limit testing features. Turning these features *OFF* has no effect on the entered limit line information.

## Segments Entering Order Needs Notice

Generally, the segments do not have to be entered in any particular order. The analyzer automatically sorts them and lists them on the display in increasing order of sweep parameter value.

One exception is when two segments have the same sweep parameter value as described in Figure A-18. If the same sweep parameter values exist, the analyzer draws the limit lines according to entered segment order. For example, in Figure A-18, segment 1 should be entered in advance of segment 2.

## Saving the Limit Line Table

Limit line information is lost if the LINE switch is turned off. However, the **(Save)** and **(Recall)** keys can save limit line information along with all other current analyzer settings. Limit line table information can be saved on a disk.

## Offsetting the Sweep Parameter or Amplitude of the Limit Lines

All limit line entries can be offset in either sweep parameter or amplitude values. The offset affects all segments simultaneously.

## Supported Display Formats

Limit lines are displayed only in Cartesian format. In polar and Smith chart formats, limit testing of one value is available. The value tested depends on the marker mode and is the magnitude or the first value in a complex pair. The message “NO LIMIT LINES DISPLAYED” is shown on the display in polar and Smith formats.

## Use a Sufficient Number of Points or Errors May Occur

Limits are checked only at the actual measured data points. If you do not select a sufficient number of points, it is possible for a device to be out of specification without a limit test failure indication.

To avoid this, be sure to specify a high enough number of points. In addition, if specific sweep parameter points must be checked, use the list sweep features described in “Reducing Sweep Time (Using List Sweep)” in Chapter 9 so that the actual measured data points are checked.

## Displaying, Printing, or Plotting Limit Test Data

The “list values” feature in the copy menu prints or displays a table of each measured sweep parameter value. The table includes limit line and limit test information (if these functions are turned on). If limit testing is ON, an asterisk “\*” is listed next to any measured value that is out of limits.

If the limit lines are ON, and other listed data allows sufficient space, the following information is also displayed:

- Upper limit and lower limit
- The margin by which the device passes or fails the nearest limit

## Results of Plotting or Printing the Display with Limit Lines ON

If limit lines are on, they are shown when you print or plot the display. If limit testing is ON, the PASS or FAIL message is included as well.

# Markers

### Three Types of Markers

Three types of markers are provided for each channel. The first is the movable marker that is displayed on the screen (as  $\nabla$ ) when **Marker**, **Marker→**, **Search**, or **Utility** is pressed. When a marker is turned on and no other function is active, the marker can be controlled with the knob, or the step keys.

The second is the sub-markers that appear at the present marker position when a softkey in the sub-marker menu is pressed. The seven sub-markers can be displayed for each channel at same time (a total of 14).

The third is the  $\Delta$ marker that defines a reference position of the delta mode. This type of marker includes three variations:  $\Delta$ marker(normal), tracking  $\Delta$ marker, and fixed  $\Delta$ marker.

### Marker Value

Markers have a sweep parameter value (the x-axis value in a Cartesian format) and a measurement value (the y-axis value in a Cartesian format). In a polar, Smith, or admittance chart format, the second part of a complex data pair is also provided as an auxiliary measurement value.

The marker can be moved to any point on the trace, Its measurement and sweep parameter values are displayed at the top right corner of the graticule for each displayed channel (in units appropriate to the display format). The displayed marker measurement values are valid even when the measured data is above or below the range displayed on the graticule. When marker list is turned on, sweep parameter values and measurement values of all markers are listed on the graticule. In a polar, Smith, or admittance chart format, auxiliary measurement values of all markers are also listed.

### Marker Time Mode

When marker time mode is turned on, the x-axis is changed to the time scale. The start point of the x-axis is 0 seconds and the stop point indicates the sweep time. The markers have a time instead of a sweep parameter value.

### Continuous/Discrete Mode

Marker values of the network analyzer are normally continuous (that is, they are interpolated between measured points). Alternatively, they can be set to read only discrete measured points. The marker of the spectrum analyzer always reads only the discrete measured point.

### Marker on the Data Trace or on the Memory Trace

If both data and memory are displayed, you can select which marker values apply to the data trace or the memory trace. If data or memory is displayed (not both), the marker values apply to the trace displayed. In a data math display (data+memory, data–memory, or data/memory), the marker values apply to the trace resulting from the memory math function.



## $\Delta$ Mode

With the use of a delta marker, a delta marker mode is available that displays both the sweep parameter and measurement values of the marker relative to the reference. Any position on the trace or a fixed point can be designated as the delta marker. The  $\Delta$ marker can be put on a current position of the marker. If the delta reference is the fixed  $\Delta$ marker, both its sweep parameter value and its magnitude value (y-axis value) can be set arbitrarily anywhere in the display area (not necessarily on the trace). If the delta marker is the tracking  $\Delta$ marker, its sweep parameter value can be controlled and its measurement value is the value of the trace at that sweep parameter value.

## Marker Search Function

Markers can search for the trace maximum/minimum, mean point, any other point, peak maximum/minimum or peak-to-peak value of all or part of the trace. The marker and sub-markers can be used together to search for specified bandwidth cutoff points and calculate the bandwidth. Statistical analysis uses markers to provide a readout of the mean, standard deviation, and peak-to-peak values of all or part of the trace.

## Width Function

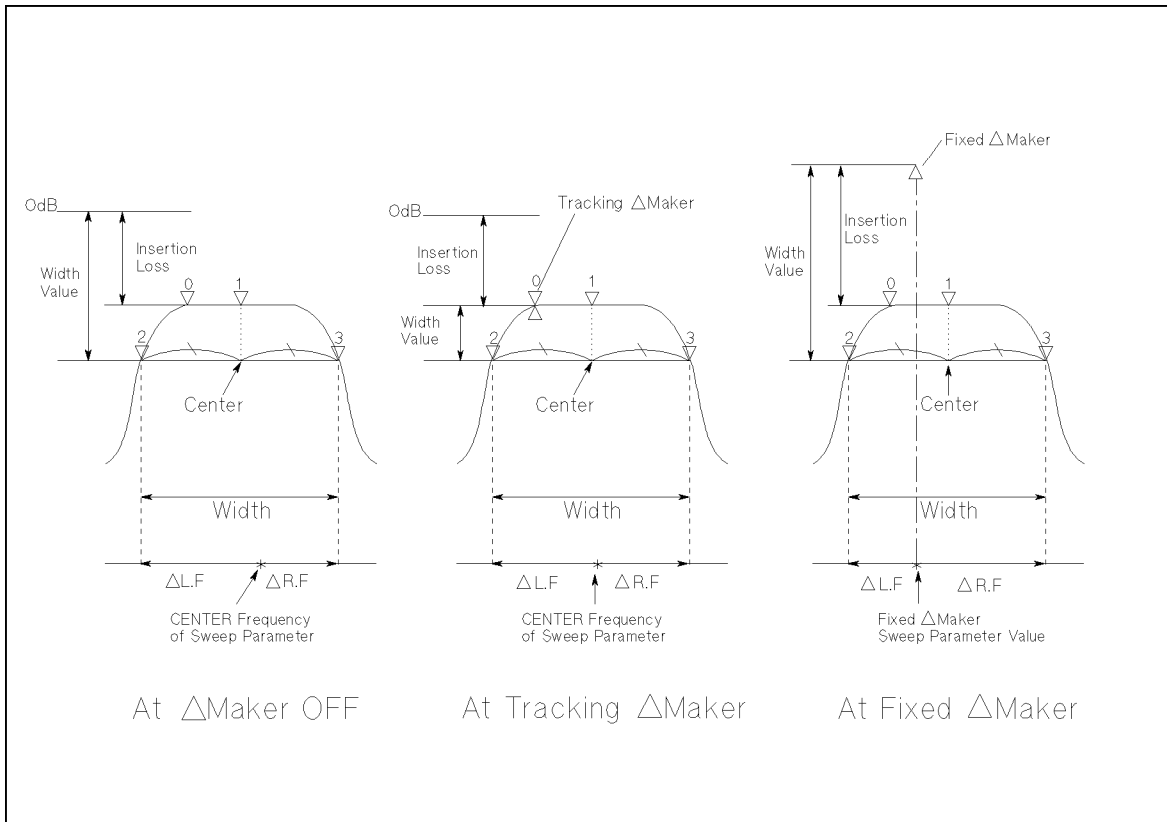
The bandwidth search feature analyzes a bandpass or band reject trace and calculates the center point, bandwidth, and Q (quality factor) for the specified bandwidth. These parameters depend on the  $\Delta$ marker mode. The following table shows how each parameter is determined for each  $\Delta$ marker mode.

**Table A-1. Obtaining Parameters in  $\Delta$  Marker Mode**

Parameter	Tracking $\Delta$ marker	Fixed $\Delta$ marker
<b>BW</b>	Displays the bandwidth value set by <b>WIDTH VALUE</b> .	
<b>center</b>	Displays the center sweep parameter value between the cutoff points (this is marked by sub-marker 1).	
<b>Q</b>	Displays the Q value (= cent/BW) of the trace.	
<b>Insertion Loss</b>	Displays the absolute value of the marker.	Displays the difference between the marker and the fixed $\Delta$ marker.
<b><math>\Delta F</math> (Left)</b>	Displays the sweep parameter value difference between marker 2 and the center frequency specified by the <b>Center</b> key.	Displays the sweep parameter value difference between marker 2 and the fixed $\Delta$ marker.
<b><math>\Delta F</math> (Right)</b>	Displays the sweep parameter value difference between marker 3 and center frequency specified by the <b>Center</b> key.	Displays the sweep parameter value difference between marker 3 and the fixed $\Delta$ marker.

Figure A-19 shows an example of the bandwidth search feature.

## Markers



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**Figure A-19. Bandwidth Search Example**

### Peak Definition

The search function provides the define peak feature, which specifies the properties of the peaks searched for by the peak search function. The define peak feature also allows the peak search function to discriminate peaks from noise.

The peak definitions are different for the network analyzer mode and the spectrum analyzer mode.

### Peak Definition for Network Analyzer Mode

The following parameters are used in the peak definition for the network measurement:

- Peak polarity (positive or negative)
- $\Delta X, \Delta Y$  (gradient)
- Threshold value

The search functions search for a peak where the parameters of the peak match the following conditions:

The search functions search for a peak where the parameters of the peak match the following conditions:

$$\frac{\Delta Y}{\Delta X} \times SPAN \leq \min(\Delta y_L, \Delta y_R)$$

and

$$Threshold \leq Peak Amplitude Value$$

where:

$\Delta y_L, \Delta y_R$  are the difference in amplitude value between a peak and the adjacent measurement points on both sides.

That is, the search functions search for a peak where, the gradient is greater than  $\Delta Y/\Delta X$ , and the amplitude is greater than the threshold value. The search functions ignore a peak when the amplitude value is less than the threshold even if the peak polarity is set to negative.

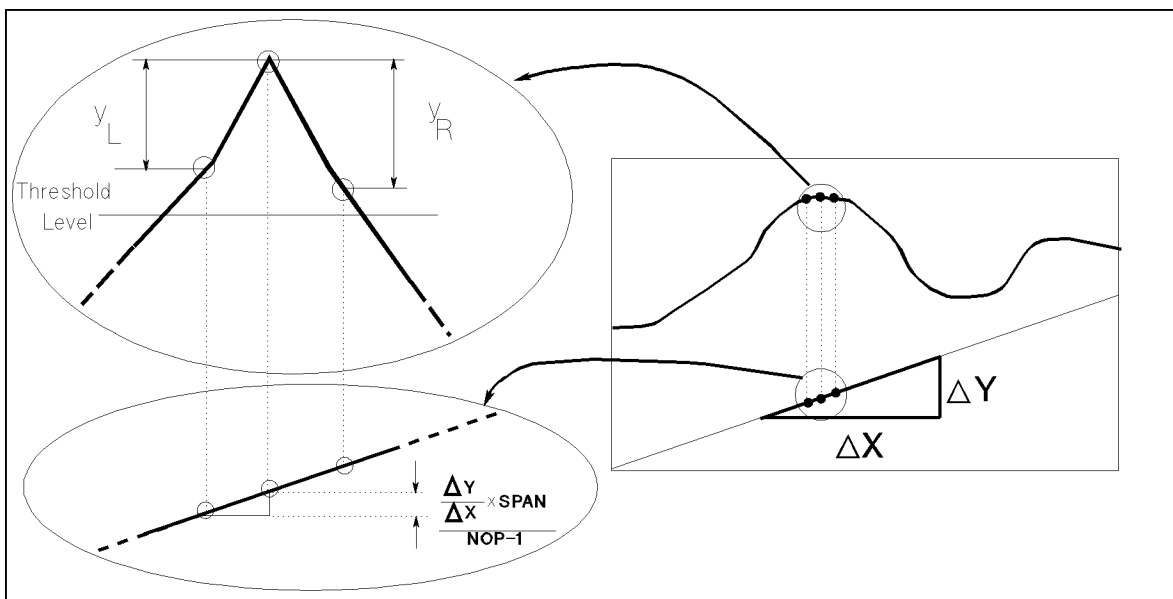


Figure A-20. Peak Definition for Network Analyzer Mode

## Markers

### Peak Definition for Spectrum Analyzer Mode

The following parameters are used in the peak definition for the spectrum measurement:

- $\Delta Y$  (difference of amplitude between a peak and an adjacent local minimum point)
- Threshold value

The search functions search for a peak where the parameters of the peak match the following conditions:

$$\Delta Y \leq \min(\max(\Delta y_L, \Delta y_R), \Delta y_{TH})$$

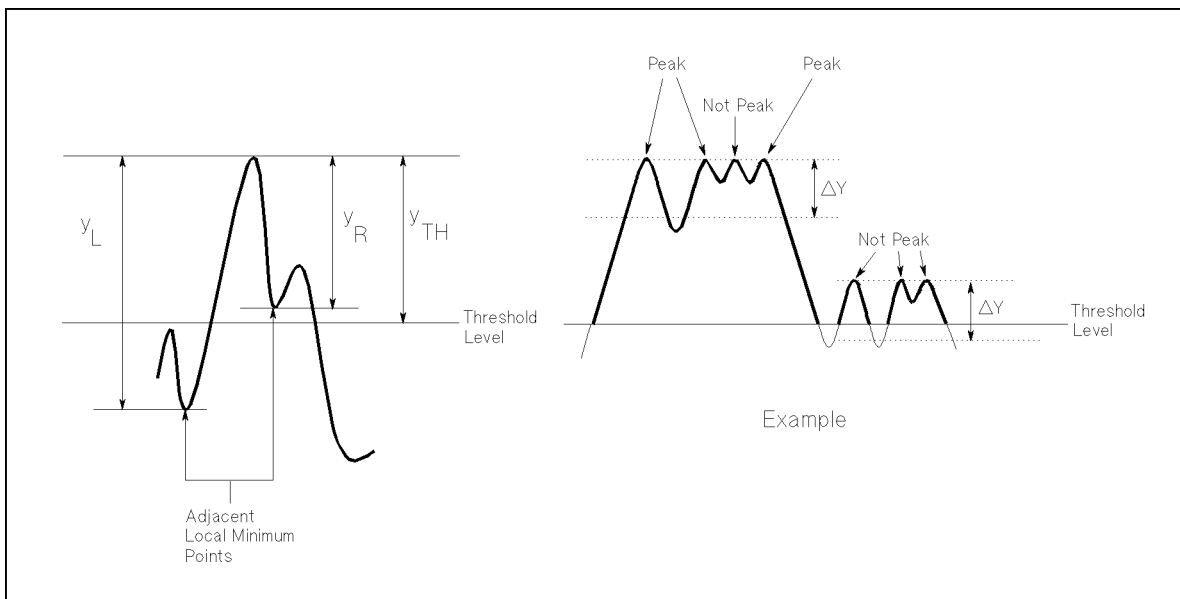
where:

$\Delta y_L, \Delta y_R$  are the difference in amplitude value between a peak and the adjacent local minimum point.

$\Delta y_{TH}$  is the difference between a peak and the threshold value.

That is, the search functions search for a peak where the difference of amplitude between the peak and the smaller of the adjacent local minimum points is greater than  $\Delta Y$ , and the difference between the peak and the threshold is greater than  $\Delta Y$ .

The peak polarity is always positive for the spectrum analyzer peak search functions.



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**Figure A-21. Peak Definition for Spectrum Analyzer Mode**

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## GPIB

The analyzer is factory-equipped with a remote programming digital interface using the General Purpose Interface Bus (GPIB). This allows the analyzer to be controlled by an external computer that sends commands or instructions to and receives data from the analyzer using the GPIB. In this way, a remote operator has the same control of the instrument available to a local operator from the front panel, except for the line power switch.

In addition, the analyzer itself can use GPIB to directly control compatible peripherals, without the use of an external controller. It can output measurement results directly to a compatible printer or plotter.

This section provides an overview of GPIB operation. More complete information on programming the analyzer remotely over GPIB is provided in *Programming Manual*. The *Programming Manual* includes examples of remote measurements using an HP 9000 series 200 or 300 computer with BASIC programming. The *Programming Manual* assumes familiarity with front panel operation of the instrument.

A complete general description of the GPIB is available in *Tutorial Description of the General Purpose Interface Bus*, Agilent publication 5952-0156. For more information on the IEEE 488.1 standard, see *IEEE Standard Digital Interface for Programmable Instrumentation*, published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York 10017, USA.

### How GPIB Works

The GPIB uses a party-line bus structure in which up to 15 devices can be connected on one contiguous bus. The interface consists of 16 signal lines and 6 grounded lines in a shielded cable. With this cabling system, many different types of devices including instruments, computers, plotters and printers can be connected in parallel.

Every GPIB device must be capable of performing one or more of the following interface functions:

#### Talker

A talker is a device capable of sending device-dependent data when addressed to talk. There can be only one active talker at any given time. Examples of this type of device are voltmeters, counters, and tape readers. The analyzer is a talker when it sends trace data or marker information over the bus.

#### Listener

A listener is a device capable of receiving device-dependent data when addressed to listen. There can be any number of active listeners at any given time. Examples of this type of device are printers, power supplies, and signal generators. The analyzer is a listener when it is controlled over the bus by a computer.

#### Controller

A controller is a device capable of managing the operation of the bus and addressing talkers and listeners. There can be only one active controller at any time. Examples of controllers include desktop computers and minicomputers. In a multiple-controller system, active control can be passed between controllers, but there can only be one *system controller* that acts as the master, and can regain active control at any time. The analyzer is an active controller when it plots or prints in the addressable mode. The analyzer is a system controller when it is in the system controller mode.

## **GPIB**

### **GPIB Requirements**

Number of Interconnected Devices:	15 maximum.
Interconnection Path/ Maximum Cable Length:	20 meters maximum or 2 meters per device, whichever is less.
Message Transfer Scheme:	Byte serial/bit parallel asynchronous data transfer using a 3-line handshake system.
Data Rate:	Maximum of 1 megabyte per second over limited distances with tri-state drivers. Actual data rate depends on the transfer rate of the slowest device involved.
Address Capability:	Primary addresses: 31 talk, 31 listen. A maximum of 1 active talker and 14 active listeners at one time.
Multiple Controller Capability:	In systems with more than one controller (like the analyzer system), only one can be active at any given time. The active controller can pass control to another controller, but only one system controller is allowed.

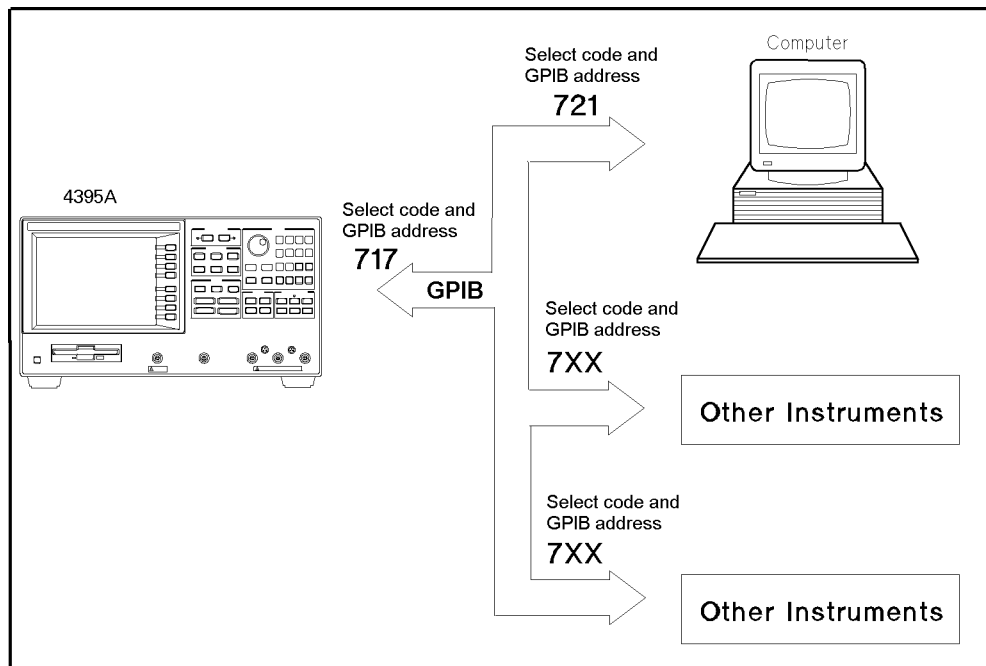
### **GPIB Capabilities of the 4395A**

As defined by the IEEE 488.1 standard, the analyzer has the following capabilities:

SH1	Full source handshake.
AH1	Full acceptor handshake.
T6	Basic talker, answers serial poll, unaddresses if MLA is issued. No talk-only mode.
TE0	Does not have extended address of talker.
L4	Basic listener, unaddresses if MTA is issued. No listen-only mode.
LE0	Does not have extended address of listener.
SR1	Complete service request (SRQ) capabilities.
RL1	Complete remote/local capability including local lockout.
PP0	Does not respond to parallel poll.
DC1	Complete device clear.
DT1	Responds to a group execute trigger.
C1, C2, C3, C4	System controller capabilities in system controller mode.
C11	Pass control capabilities in addressable mode.
E2	Tri-state drivers.

## Bus Mode

The analyzer uses a single-bus architecture. The single bus allows both the analyzer and the host controller to have complete access to the peripherals in the system.



**Figure A-22. Analyzer Single Bus Concept**

Two different modes are possible, system controller and addressable.

System Controller	This mode allows the analyzer to control peripherals directly in a stand-alone environment (without an external controller). This mode can only be selected manually from the analyzer front panel. Use this mode for operation when no computer is connected to the analyzer. Printing and plotting use this mode.
Addressable	This is the traditional programming mode, in which the computer is involved in all peripheral access operations. When the external controller is connected to the analyzer through GPIB (as shown in Figure A-22), this mode allows you to control the analyzer over GPIB in the talker mode in order to send data, and in the listener mode to receive commands. It also allows the analyzer to take or pass control in order to plot and print.

## Setting Addresses

In GPIB communications, each instrument on the bus is identified by an GPIB address. This address code must be unique to each instrument on the bus. These addresses are not affected when you press **Preset** or cycle the power. For more information on how to set the address, refer to the description of the **Local** key in Appendix B “Softkey Reference”.

# Calibration for Network Measurement

## Introduction

Network measurement calibration is an accuracy enhancement procedure that effectively reduces the system errors that cause uncertainty in measuring a DUT. It measures known standard devices, and uses the results of these measurements to characterize the system.

This section explains the theoretical fundamentals of accuracy enhancement and the sources of measurement errors. It describes the different measurement calibration procedures available in the analyzer, which errors they correct, and the measurements for which each should be used. The later part of this section provides further information on characterizing systematic errors and using error models to analyze the overall measurement performance.

## Accuracy Enhancement

If it were possible for a perfect measurement system to exist, it would have infinite dynamic range, isolation, and directivity characteristics, no impedance mismatches in any part of the test setup, and flat frequency response. Vector accuracy enhancement, also known as measurement calibration or error correction, provides the means to simulate a perfect measurement system.

In any high frequency measurement, there are measurement errors associated with the system that contribute uncertainty to the results. Parts of the measurement setup such as interconnecting cables and signal separation devices (as well as the analyzer itself) all introduce variations in magnitude and phase that can mask the actual performance of the DUT.

For example, crosstalk due to the channel isolation characteristics of the analyzer can contribute an error equal to the transmission signal of a high-loss test device. For reflection measurements, the primary limitation of dynamic range is the directivity of the test setup.

The measurement system cannot distinguish the true value of the signal reflected by the DUT from the signal arriving at the receiver input due to leakage in the system. For both transmission and reflection measurements, impedance mismatches within the test setup cause measurement uncertainties that appear as ripples superimposed on the measured data.

Measurement calibration simulates a perfect analyzer system. It measures the magnitude and phase responses of known standard devices, and compares the measurement with actual device data. It uses the results to characterize the system and effectively remove the system errors from the measurement data of a test device, using vector math capabilities internal to the analyzer.

When measurement calibration is used, the dynamic range and accuracy of the measurement are limited only by system noise and stability, connector repeatability, and the accuracy to which the characteristics of the calibration standards are known.

## Sources of Measurement Errors

Network analysis measurement errors can be separated into systematic, random, and drift errors.

Correctable systematic errors are the repeatable errors that the system can measure. These are errors due to mismatch and leakage in the test setup, isolation between the reference and test signal paths, and system frequency response.

The system cannot measure and correct for the non-repeatable random and drift errors. These errors affect both reflection and transmission measurements. Random errors are measurement variations due to noise and connector repeatability. Drift errors include frequency drift,



temperature drift, and other physical changes in the test setup between calibration and measurement.

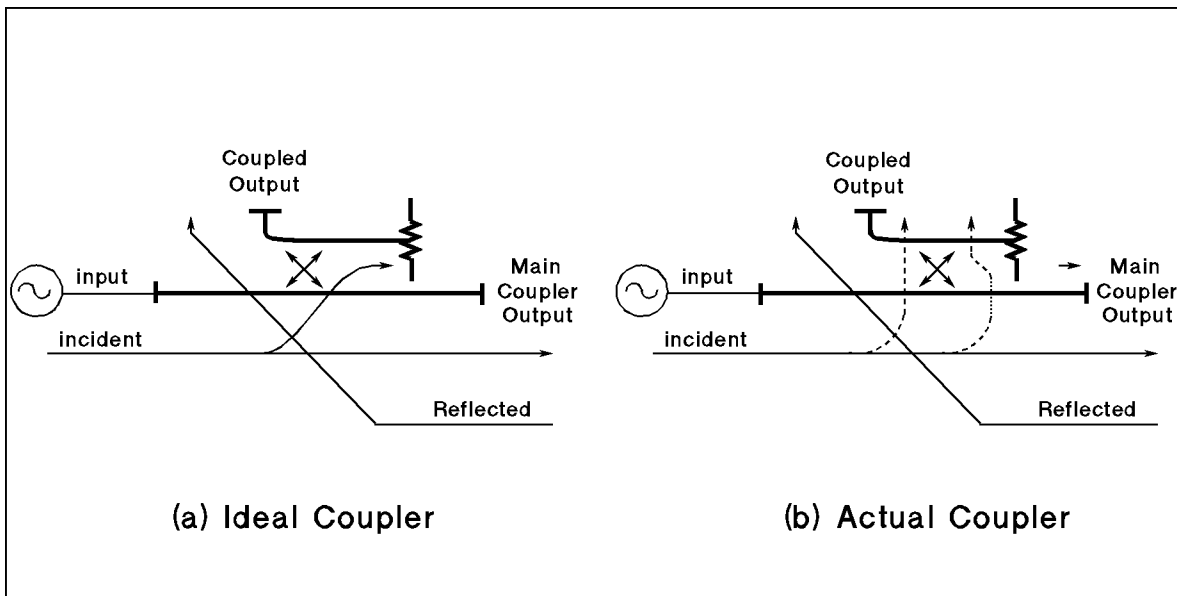
The resulting measurement is the vector sum of the DUT response plus all error terms. The precise effect of each error term depends upon its magnitude and phase relationship to the actual test device response.

In most high frequency measurements the systematic errors are the most significant source of measurement uncertainty. Because each of these errors can be characterized, their effects can be effectively removed to obtain a corrected value for the test device response. For the purpose of vector accuracy enhancement these uncertainties are quantified as directivity, source match, load match, isolation (crosstalk), and frequency response (tracking). Each of these systematic errors is described below.

Random and drift errors cannot be precisely quantified, so they must be treated as producing a cumulative uncertainty in the measured data.

### Directivity

Normally a device that can separate the reverse from the forward traveling waves (a directional bridge or coupler) detects the signal reflected from the DUT. Ideally the coupler would completely separate the incident and reflected signals, and only the reflected signal would appear at the coupled output (Figure A-23-a).



C5012036

Figure A-23. Directivity

However, an actual coupler is not perfect (Figure A-23-b). A small amount of the incident signal appears at the coupled output due to leakage as well as to reflection from the termination in the coupled arm. Also, reflections from the main coupler output connector appear at the coupled output, adding uncertainty to the signal reflected from the device. The figure of merit for how well a coupler separates forward and reverse waves is directivity. The greater the directivity of the device, the better the signal separation. Directivity is the vector sum of all leakage signals appearing at the analyzer receiver input due to the inability of the signal separation device to separate incident and reflected waves, and to residual reflection effects of test cables and adapters between the signal separation device and the measurement

## Calibration for Network Measurement

plane. The error contributed by directivity is independent of the characteristics of the test device and it usually produces the major ambiguity in measurements of low reflection devices.

### Source Match

Source match is defined as the vector sum of signals appearing at the analyzer receiver input due to the impedance mismatch at the test device looking back into the source. Source match is degraded by adapters and extra cables. A non-perfect source match leads to mismatch uncertainties that affect both transmission and reflection measurements. Source match is most often given in terms of return loss in dB (therefore, the larger the number, the smaller the error).

- In a reflection measurement, the source match error signal is caused by some of the reflected signal from the DUT being reflected from the source back toward the DUT and re-reflected from the DUT (Figure A-24).
- In a transmission measurement, the source match error signal is caused by reflection from the test device that is re-reflected from the source.

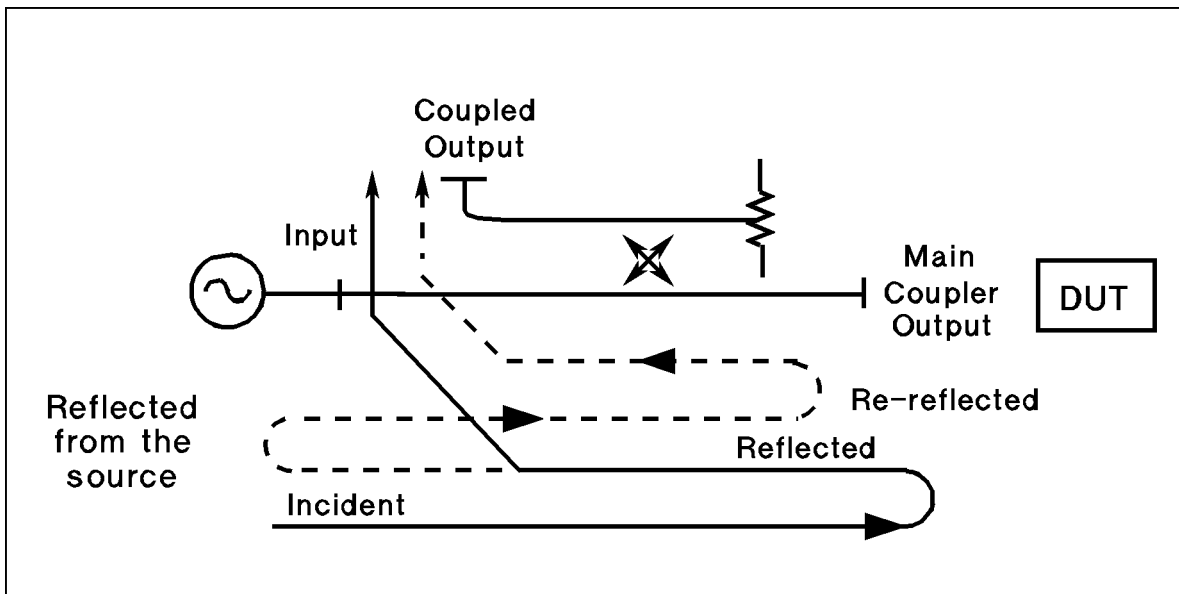


Figure A-24. Source Match

The error contributed by source match is a mismatch error caused by the relationship between the actual input impedance of the test device and the equivalent match of the source. It is a factor in both transmission and reflection measurements. Mismatch uncertainty is particularly a problem in measurements where there is a large impedance mismatch at the measurement plane.

### Load Match

Load match error results from an imperfect match at the output of the test device. It is caused by impedance mismatches between the test device output port and port 2 of the measurement system. As illustrated in Figure A-25, some of the transmitted signal is reflected from port 2 back to the test device. A portion of this wave can be re-reflected to port 2, or part can be transmitted through the device in the reverse direction to appear at port 1. If the DUT has low insertion loss (for example a transmission line), the signal reflected from port 2 and re-reflected from the source causes a significant error because the DUT does not attenuate the signal significantly on each reflection. Load match is usually given in terms of return loss in dB (therefore, the larger the number, the smaller the error).

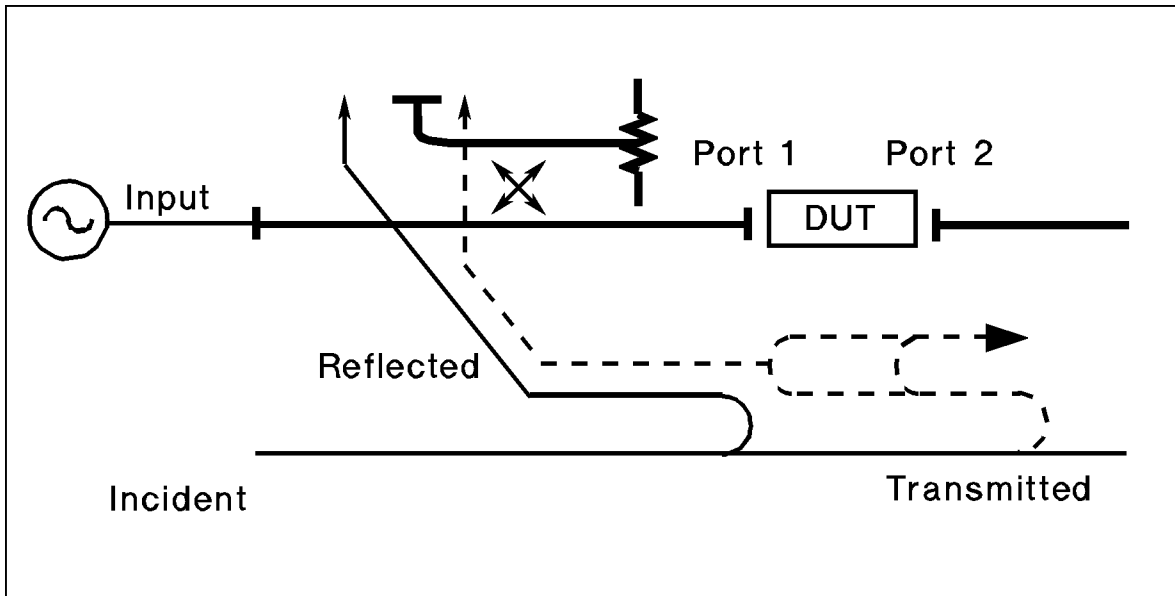


Figure A-25. Load Match

The error contributed by load match depends on the relationship between the actual output impedance of the test device and the effective match of the return port (port 2). It is a factor in all transmission measurements and in reflection measurements of two-port devices. Load match and source match are usually ignored when the test device insertion loss is greater than about 6 dB. This happens because the error signal is greatly attenuated each time it passes through the DUT. However, load match effects produce major transmission measurement errors for a test device with a highly reflective output port.

### Isolation (Crosstalk)

Leakage of energy between analyzer signal paths contributes to error in a transmission measurement much as directivity does in a reflection measurement. Isolation is the vector sum of signals appearing at the analyzer receivers due to crosstalk between the reference and test signal paths, including signal leakage within the test set and in both the RF and IF sections of the receiver.

The error contributed by isolation depends on the characteristics of the DUT. Isolation is a factor in high-loss transmission measurements. However, analyzer system isolation is more than sufficient for most measurements, and correction for it may be unnecessary. For measuring devices with high dynamic range, accuracy enhancement can provide improvements in isolation that are limited only by the noise floor.

## Calibration for Network Measurement

### Frequency Response (Tracking)

This is the vector sum of all test setup variations in which magnitude and phase change as a function of frequency. This includes variations contributed by signal separation devices, test cables, and adapters, and variations between the reference and test signal paths. This error is a factor in both transmission and reflection measurements.

For further explanation of systematic error terms and the way they are combined and represented graphically in error models, see the later section, titled Accuracy Enhancement Fundamentals - Characterizing Systematic Errors.

### Compensation for Measurement Errors

There are twelve different error terms for a two-port measurement that can be corrected by accuracy enhancement in the analyzer. These are directivity, source match, load match, isolation, reflection tracking, and transmission tracking, each in both the forward and reverse direction. The analyzer has several different measurement calibration routines to characterize one or more of the systematic error terms and remove their effects from the measured data. The procedures range from a simple frequency response calibration to a full two-port calibration that effectively removes all twelve error terms.

The **Response Calibration** effectively reduces the frequency response errors of the test setup for reflection or transmission measurements. This calibration procedure may be adequate for measurement of well-matched low-loss devices. This is the simplest error correction to perform, and should be used when extreme measurement accuracy is not required.

The **Response and Isolation Calibration** effectively removes frequency response and crosstalk errors in transmission measurements, or frequency response and directivity errors in reflection measurements. This procedure may be adequate for measurement of well-matched high-loss devices.

The **S<sub>11</sub> and S<sub>22</sub> One-Port Calibration** procedures provide directivity, source match, and frequency response vector error correction for reflection measurements. These procedures provide high accuracy reflection measurements of one-port devices or properly terminated two-port devices.

The **Full Two-Port Calibration** provides directivity, source match, load match, isolation, and frequency response vector error correction, in both forward and reverse directions, for transmission and reflection measurements of two-port devices. This calibration provides the best magnitude and phase measurement accuracy for both transmission and reflection measurements of two-port devices, and requires an S-parameter test set.

The **One-Path Two-Port Calibration** provides directivity, source match, load match, isolation, and frequency response vector error correction in one direction. It is used for high accuracy transmission and reflection measurements using a transmission/reflection test kit, such as the 87512A, B. (The DUT must be manually reversed between sweeps to accomplish measurements in both the forward and reverse directions.)

All the calibration procedures described above are accessed from the **CAL** key.

### Modifying Calibration Kits

For most applications, use the default cal kit models. Modifying calibration kits is necessary only if unusual standards are used or the very highest accuracy is required. Unless a cal kit model is provided with the calibration devices used, a solid understanding of error correction and the system error model are essential to making modifications. Read all of this section.

During measurement calibration, the analyzer measures actual, well-defined standards and mathematically compares the results with ideal “models” of those standards. The differences are separated into error terms which are later reduced during error correction. Most of the differences are due to systematic errors - repeatable errors introduced by the analyzer, test set, and cables - which are correctable. However, the difference between the standard’s mathematical *model* and its *actual performance* has an adverse affect; it reduces the system’s ability to remove systematic errors, and thus degrades error-corrected accuracy. Therefore, in addition to the default cal kit models, a “user kit” is provided that can be modified to an alternate calibration standards model.

Several situations exist that may require a user-defined cal kit:

- You use a connector interface different from the four built-in cal kits. (Examples: SMA, or BNC.)
- You are using standards (or combinations of standards) that are different from the predefined cal kits. (For example, using three offset SHORTs instead of an OPEN, SHORT, and LOAD to perform a 1-port calibration.)
- You want to improve the built-in standard models for predefined kits. Remember that the more closely the model describes the actual performance of the standard, the better the calibration. (Example: The 7 mm LOAD is determined to be 50.4  $\Omega$  instead of 50.0  $\Omega$ .)
- Unused standards for a given cal type can be eliminated from the default set, to eliminate possible confusion during calibration. (Example: A certain application requires calibrating a male test port. The standards used to calibrate a female test port can be eliminated from the set, and will not be displayed during calibration.)

### Glossary

This section provides a glossary of terms related to calibration.

- A **standard** is a specific, well-defined, physical device used to determine systematic errors.
- A standard **type** is one of five basic types that define the form or structure of the model to be used with that standard (for example, a SHORT or a LOAD).
- Standard **coefficients** are numerical characteristics of the standards used in the model selected.
- A standard **class** is a grouping of one or more standards that determines which standards are used in a particular calibration procedure.

### Defining the Standards

Standard definition is the process of mathematically modeling the electrical characteristics (delay, attenuation, and impedance) of each calibration standard. These electrical characteristics (coefficients) can be mathematically derived from the physical dimensions and material of each calibration standard, or from its actual measured response. The parameters of the standards can be listed in Standards Definitions, Table A-2.

## Calibration for Network Measurement

**Table A-2. Standard Definitions**

NO.	Standard Type	C0 $\times 10^{-15} \text{ F}$	C1 $\times 10^{-27} \text{ F/Hz}$	C2 $\times 10^{-36} \text{ F/Hz}^2$	Offset Delay ps	Offset Loss MΩ/s	Offset $Z_0$ Ω	Standard Label
1								
2								
3								
4								
5								
6								
7								
8								

Each standard must be identified as one of five “types”: OPEN, SHORT, LOAD, DELAY/THRU, or arbitrary impedance.

### Standard Types

#### ■ OPEN

OPENs assigned a terminal impedance of infinite ohms, but delay and loss offsets may still be added. For information of the delay and loss offsets, see the “Offset and Delay” paragraph.

As a reflection standard, an OPEN offers the advantage of broadband frequency coverage. However, an OPEN rarely has perfect reflection characteristics because fringing (capacitance) effects cause phase shift that varies with frequency. This can be observed in measuring an OPEN termination after calibration, when an arc in the lower right circumference of the Smith chart indicates capacitive reactance. These effects are impossible to eliminate, but the calibration kit models include the OPEN termination capacitance at all frequencies for compatible calibration kits. The capacitance model is a second order polynomial (squared term), as a function of frequency, where the polynomial coefficients are user-definable. The capacitance model equation is:

$$C = C_0 + C_1 \times F + C_2 \times F^2$$

where F is the measurement frequency.

#### ■ SHORT

SHORTs are assigned a terminal impedance of 0 Ω, but delay and loss offsets may still be added.

#### ■ LOAD

LOADs are assigned a terminal impedance equal to the system characteristic impedance  $Z_0$ , but delay and loss offsets may still be added. If the LOAD impedance is not  $Z_0$ , use the arbitrary impedance standard definition.

#### ■ DELAY/THRU

DELAY/THRUs are assigned a transmission line of specified length, for calibrating transmission measurements.

#### ■ ARBITRARY IMPEDANCE

ARBITRARY IMPEDANCES are assigned a standard type (LOAD), but with an arbitrary impedance (different from system  $Z_0$ ).

**Offset and Delay**

Offsets may be specified with any standard type. This means defining a uniform length of transmission line to exist between the standard being defined and the actual measurement plane. For reflection standards, the offset is assumed to be between the measurement plane and the standard (one-way only). For transmission standards, the offset is assumed to exist between the two reference planes (in effect, the offset is the THRU). Three characteristics of the offset can be defined: its delay (length), loss, and impedance.

- **Offset Delay** specifies the one-way electrical delay from the measurement (reference) plane to the standard, in seconds (s). (In a transmission standard, offset delay is the delay from plane to plane.) Delay can be calculated from the precise physical length of the offset, the permittivity constant of the medium, and the speed of light.
- **Offset Loss** specifies energy loss, due to skin effect, along a one-way length of coaxial cable offset. The value of loss is entered as ohms/nanosecond (or Giga ohms/second) at 1 GHz.
- **Offset  $Z_0$**  specifies the characteristic impedance of the coaxial cable offset. This is not the impedance of the standard itself.

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**Note** Numerical data for most Agilent Technologies calibration kits is provided in the calibration kit manuals.



**Specifying the Standard Class**

Once a standard is specified, it must be assigned to a standard *class*. This is a group of from one to seven standards that is required to calibrate for a single error term. The standards within a single class are assigned to locations A through G as listed on the Standard Class Assignments Table (Table A-3). A class often consists of a single standard, but may be composed of more than one standard.

**Table A-3. Standard Class Assignments Table**

Class	A	B	C	D	E	F	G	Standard Class label
S <sub>11A</sub>								
S <sub>11B</sub>								
S <sub>11C</sub>								
S <sub>22A</sub>								
S <sub>22B</sub>								
S <sub>22C</sub>								
Forward Transmission								
Reverse Transmission								
Forward Match								
Reverse Match								
Response								
Response & Isolation								

## Calibration for Network Measurement

The number of standard classes required depends on the type of calibration being performed, and is identical to the number of error terms corrected. (Examples: A response cal requires only one class, and the standards for that class may include an OPEN, or SHORT, or THRU. A 1-port cal requires three classes. A full 2-port cal requires 10 classes, not including two for isolation.)

The number of standards that can be assigned to a given class may vary from none (class not used) to one (simplest class) to seven. When a certain class of standards is required during calibration, the analyzer will display the labels for all the standards in that class (except when the class consists of a single standard). This does not, however, mean that all standards in a class must be measured during calibration. Only a single standard per class is required. Note that it is often simpler to keep the number of standards per class to the bare minimum needed (often one) to avoid confusion during calibration.

Standards are assigned to a class simply by entering the standard's reference number (established while defining a standard) under a particular class.

Each class can be given a user-definable label.

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### Note



The class assignments table can be displayed on screen and printed using **COPY** function.

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### Note



Agilent Technologies strongly recommends that you read application note 8510-5A before attempting to view or modify calibration standard definitions. The part number of this application note is 5956-4352. Although the application note is written for the 8510 family of network analyzers, it also applies to the 4395A.

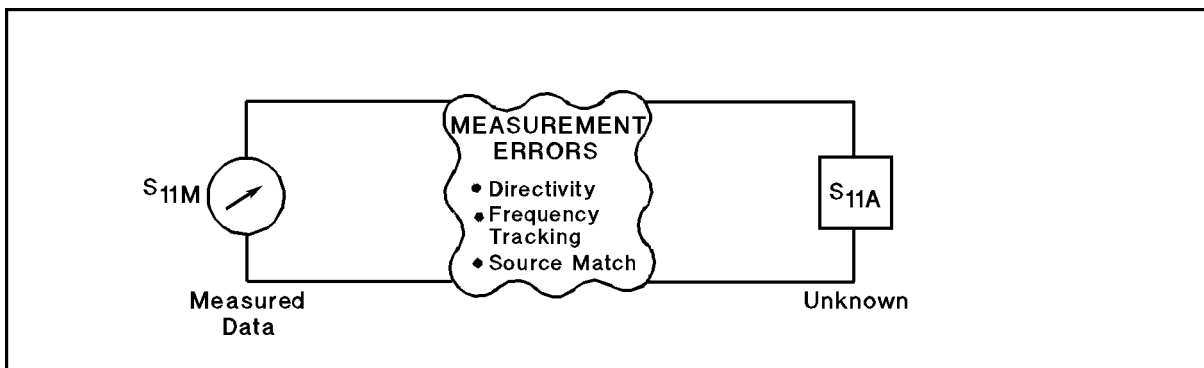
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## Accuracy Enhancement Fundamentals-Characterizing Systematic Errors

### One-Port Error Model

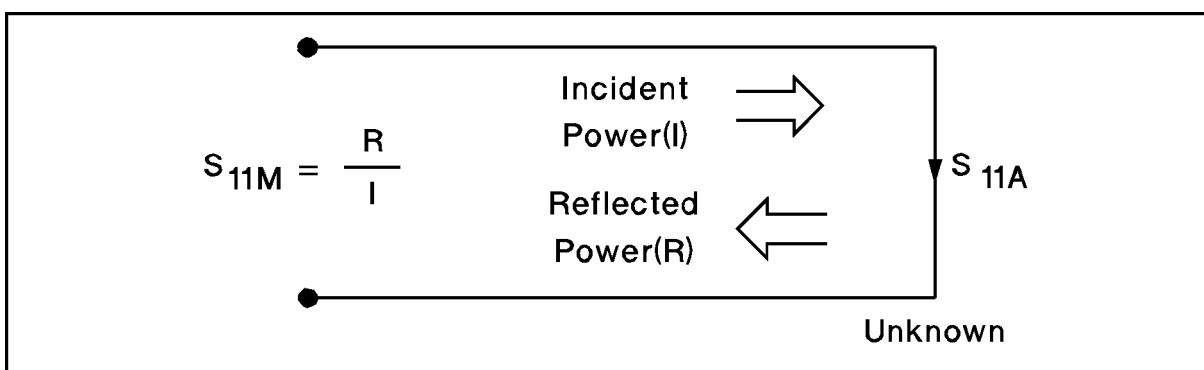
In a measurement of the reflection coefficient (magnitude and phase) of an unknown device, the measured data differs from the actual, no matter how carefully the measurement is made. Directivity, source match, and reflection signal path frequency response (tracking) are the major sources of error (Figure A-26).



C5012005

**Figure A-26. Sources of Error in a Reflection Measurement**

**Measuring reflection coefficient.** The reflection coefficient is measured by first separating the incident signal (I) from the reflected signal (R), then taking the ratio of the two values (Figure A-27). Ideally, (R) consists only of the signal reflected by the test device ( $S_{11A}$ ).

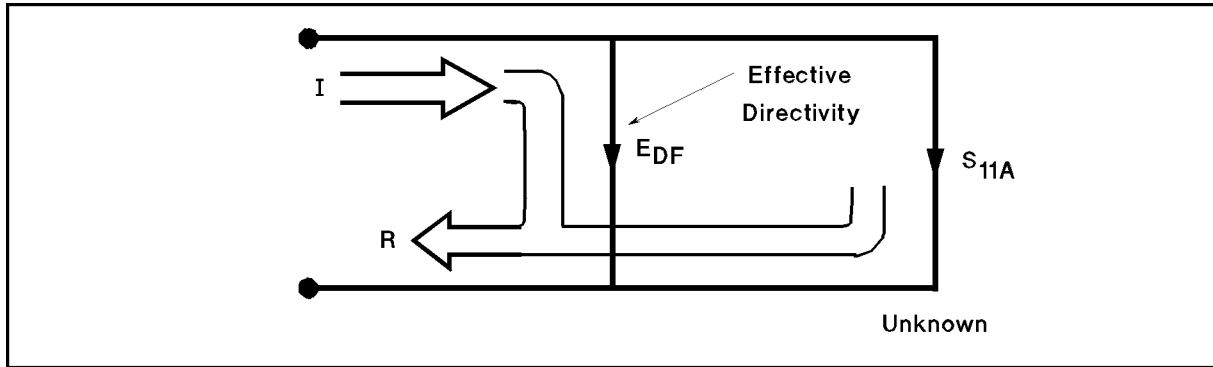


C5012006

**Figure A-27. Reflection Coefficient**

**Directivity Error.** However, all of the incident signal does not always reach the unknown (see Figure A-28). Some of (I) may appear at the measurement system input due to leakage through the test set or other signal separation device. Also, some of (I) may be reflected by imperfect adapters between signal separation and the measurement plane. The vector sum of the leakage and miscellaneous reflections is directivity,  $E_{DF}$ . Understandably, the measurement is distorted when the directivity signal combines vectorally with the actual reflected signal from the unknown,  $S_{11A}$ .

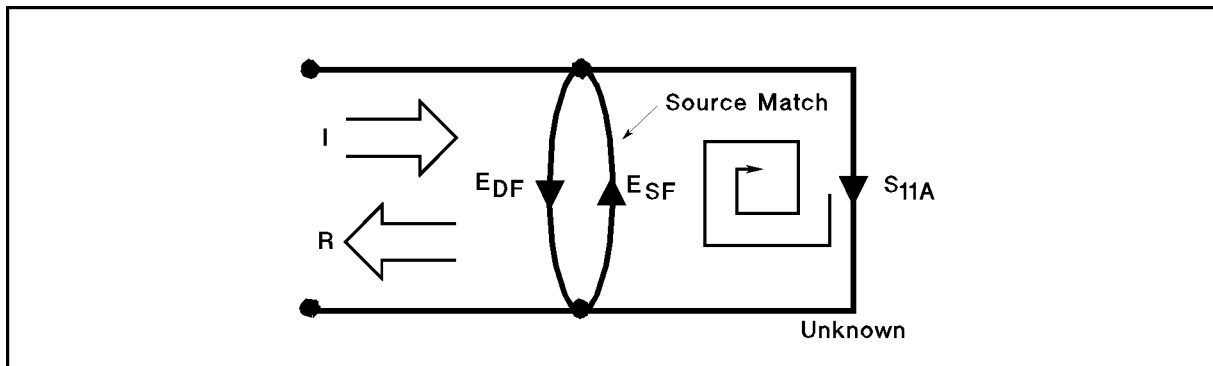
## Calibration for Network Measurement



C5012007

**Figure A-28. Effective Directivity  $E_{DF}$**

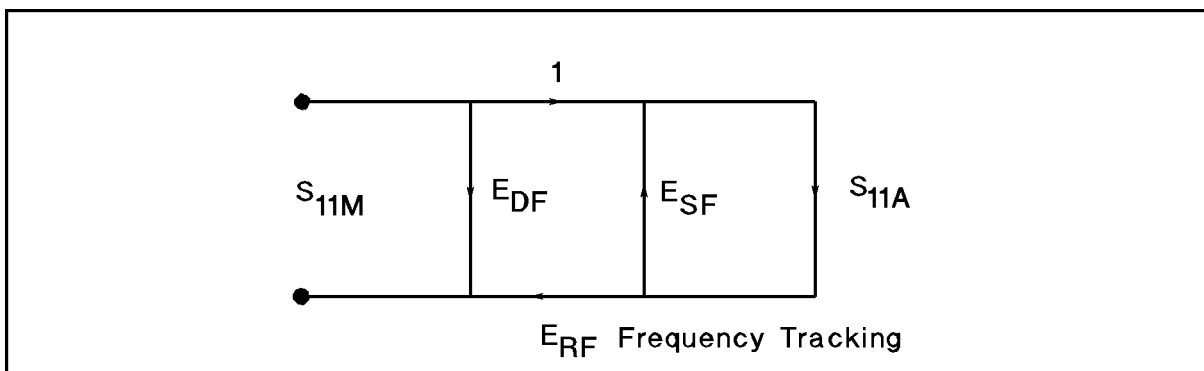
**Source match error.** Because the measurement system test port is never exactly the characteristic impedance ( $50\ \Omega$  or  $75\ \Omega$ ), some of the reflected signal is re-reflected off the test port, or other impedance transitions further down the line, and back to the unknown, adding to the original incident signal ( $I$ ). This effect causes the magnitude and phase of the incident signal to vary as a function of  $S_{11A}$  and frequency. Leveling the source to produce constant ( $I$ ) reduces this error, but because the source cannot be exactly leveled at the test device input, leveling cannot eliminate all power variations. This re-reflection effect and the resultant incident power variation are caused by the source match error,  $E_{SF}$  (Figure A-29).



C5012008

**Figure A-29. Source Match  $E_{SF}$**

**Frequency response error.** Frequency response (tracking) error is caused by variations in magnitude and phase flatness versus frequency between the test and reference signal paths. These are due mainly to imperfectly matched receiver circuits and differences in length and loss between incident and test signal paths. The vector sum of these variations is the reflection signal path tracking error,  $E_{RF}$  (Figure A-30).



C5012009

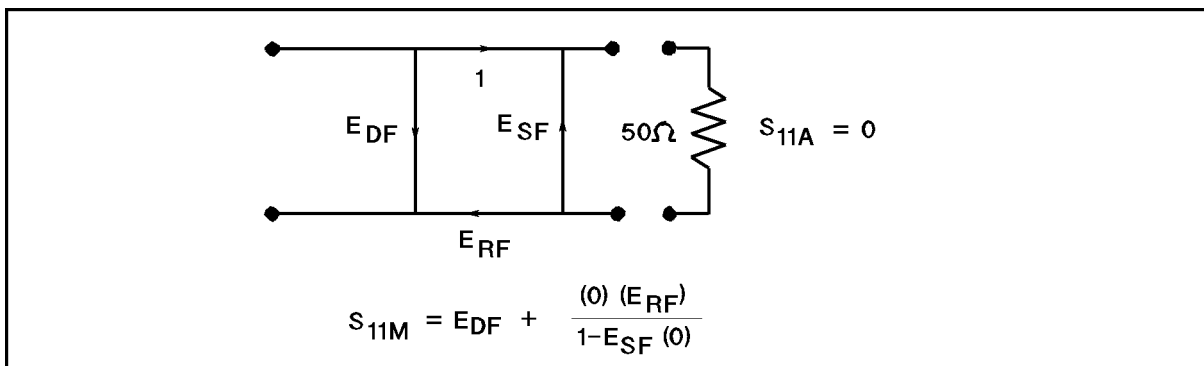
Figure A-30. Reflection Tracking  $E_{RF}$

**How calibration standards are used to quantify these error terms.** It can be shown that these three errors are mathematically related to the actual data,  $S_{11A}$ , and measured data,  $S_{11M}$ , by the following equation:

$$S_{11M} = E_{DF} + \frac{S_{11A}(E_{RF})}{1 - E_{SF}S_{11A}}$$

If the value of these three “ $E$ ” errors and the measured test device response were known for each frequency, the above equation could be solved for  $S_{11A}$  to obtain the actual test device response. Because each of these errors changes with frequency, their values must be known at each test frequency. These values are found by measuring the system at the measurement plane using three independent standards whose  $S_{11A}$  is known at all frequencies.

The first standard applied is a “perfect load” that makes  $S_{11A} = 0$  and essentially measures directivity (Figure A-31). “Perfect load” implies a reflection-free termination at the measurement plane. All incident energy is absorbed. With  $S_{11A} = 0$  the equation can be solved for  $E_{DF}$ , the directivity term. In practice, of course, the “perfect load” is difficult to achieve, although very good broadband LOADs are available in the 4296A compatible calibration kits.

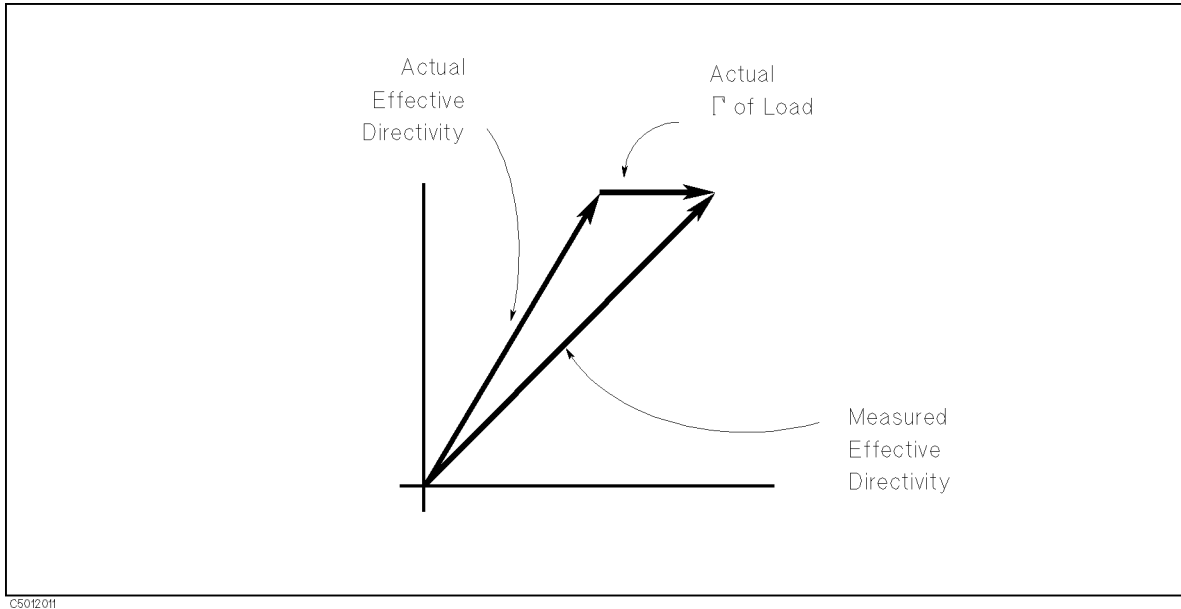


C5012010

Figure A-31. “Perfect Load” Termination

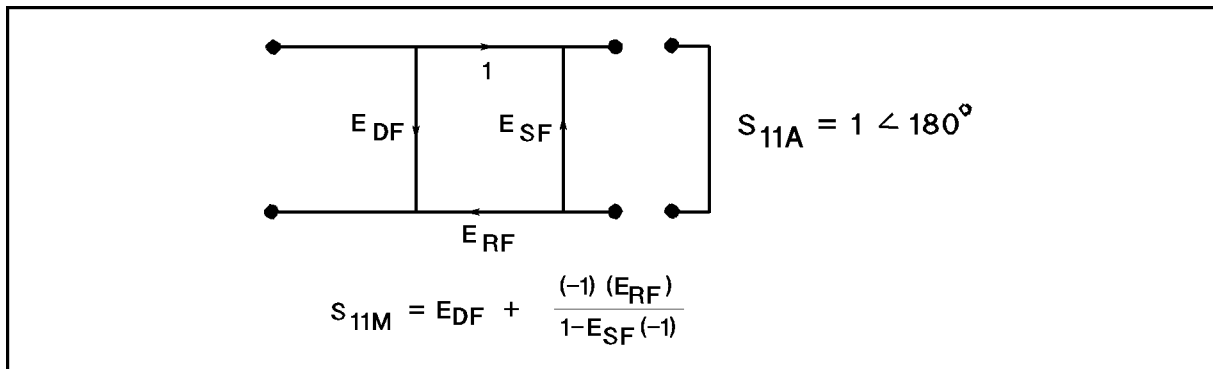
Because the measured value for directivity is the vector sum of the actual directivity plus the actual reflection coefficient of the “perfect load,” any reflection from the termination represents an error. System effective directivity becomes the actual reflection coefficient of the “perfect load” (Figure A-32). In general, any termination having a return loss value greater than the uncorrected system directivity reduces reflection measurement uncertainty.

## Calibration for Network Measurement



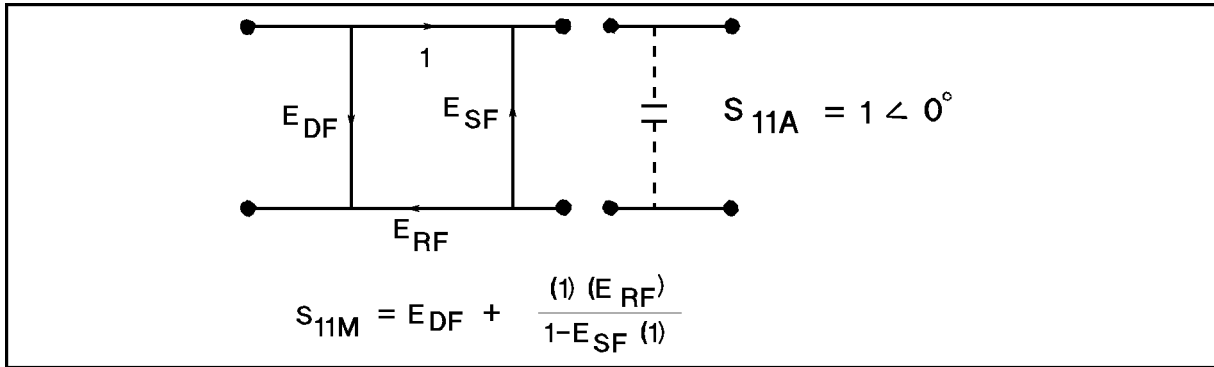
**Figure A-32. Measured Effective Directivity**

Next, a SHORT termination whose response is known to a very high degree establishes another condition (Figure A-33).



**Figure A-33. Short Circuit Termination**

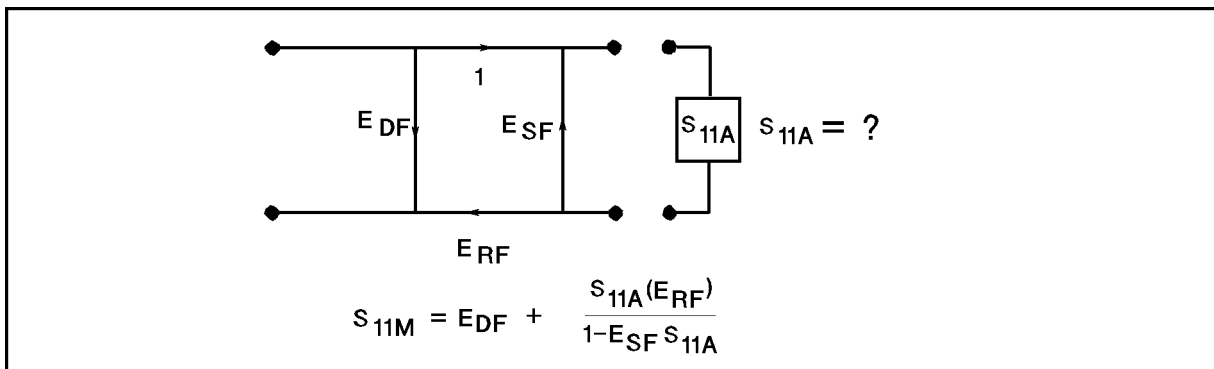
The OPEN gives the third independent condition. In order to accurately model the phase variation with frequency due to radiation from the OPEN connector, a specially designed shielded OPEN is used for this step. (The OPEN capacitance is different with each connector type). Now the values for  $E_{DF}$ , directivity,  $E_{SF}$ , source match, and  $E_{RF}$ , reflection frequency response, are computed and stored (Figure A-34).



C5012013

Figure A-34. Open Circuit Termination

Now the unknown is measured to obtain a value for the measured response,  $S_{11M}$ , at each frequency (Figure A-35).



C5012014

Figure A-35. Measured  $S_{11}$

This is the one-port error model equation solved for  $S_{11A}$ . Because the three errors and  $S_{11M}$  are now known for each test frequency,  $S_{11A}$  can be computed as follows:

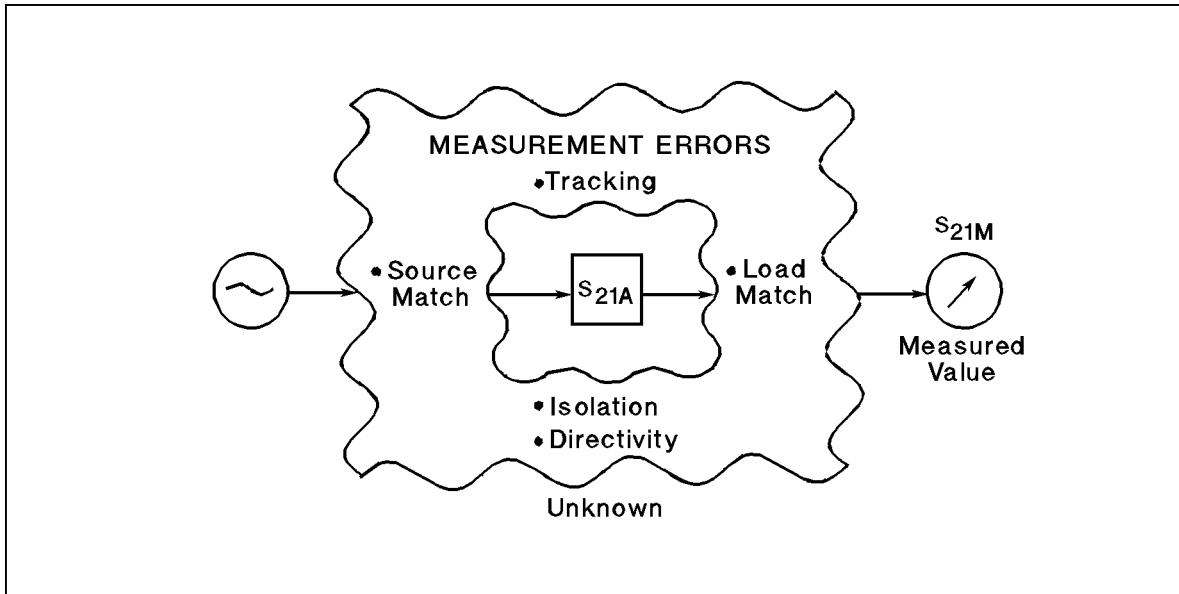
$$S_{11A} = \frac{S_{11M} - E_{DF}}{E_{SF}(S_{11M} - E_{DF}) + E_{RF}}$$

For reflection measurements on two-port devices, the same technique can be applied, but the test device output port must be terminated in the system characteristic impedance. This termination should be at least as good (have as low a reflection coefficient) as the LOAD used to determine directivity. The additional reflection error caused by an improper termination at the test device output port is not incorporated into one-port error model.

## Calibration for Network Measurement

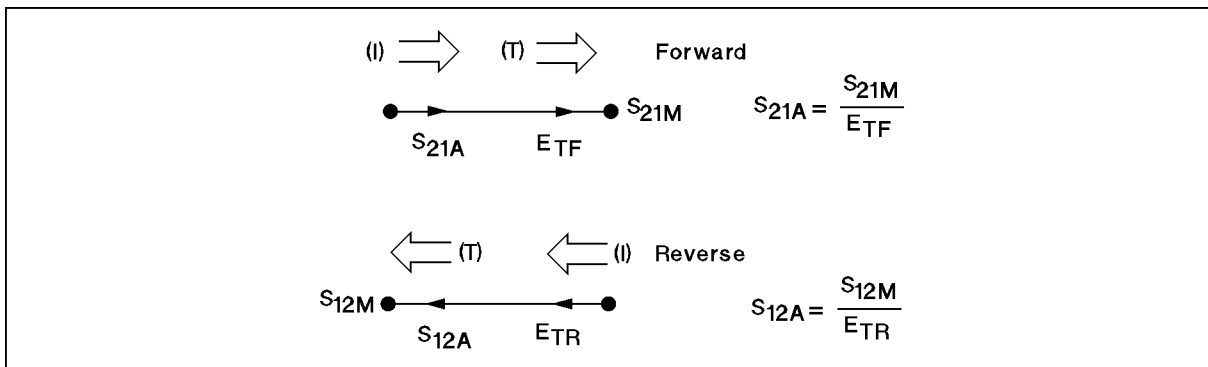
### Two-Port Error Model

The error model for measurement of the transmission coefficients (magnitude and phase) of a two-port device is derived in a similar manner. The major sources of error are frequency response (tracking), source match, load match, and isolation (Figure A-36). These errors are effectively removed using the full two-port error model



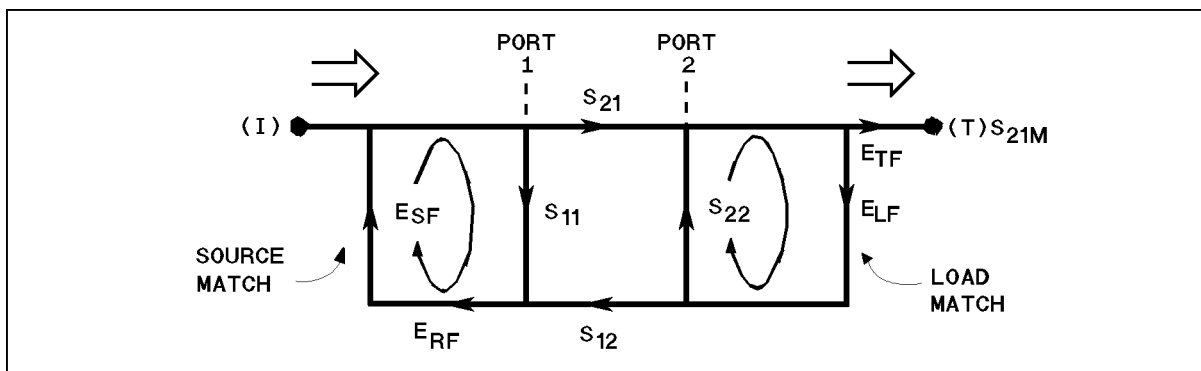
**Figure A-36. Major Sources of Error**

**Measuring Transmission Coefficient.** The transmission coefficient is measured by taking the ratio of the incident signal (I) and the transmitted signal (T) (Figure A-37). Ideally, (I) consists only of power delivered by the source, and (T) consists only of power emerging at the test device output.



**Figure A-37. Transmission Coefficient**

**Load Match Error.** As in the reflection model, source match can cause the incident signal to vary as a function of test device  $S_{11A}$ . Also, because the test setup transmission return port is never exactly the characteristic impedance, some of the transmitted signal is reflected from the test set port 2, and from other mismatches between the test device output and the receiver input, to return to the test device. A portion of this signal may be re-reflected at port 2, thus affecting  $S_{21M}$ , or part may be transmitted through the device in the reverse direction to appear at port 1, thus affecting  $S_{11M}$ . This error term, which causes the magnitude and phase of the transmitted signal to vary as a function of  $S_{22A}$ , is called load match,  $E_{LF}$  (Figure A-38).



C5012017

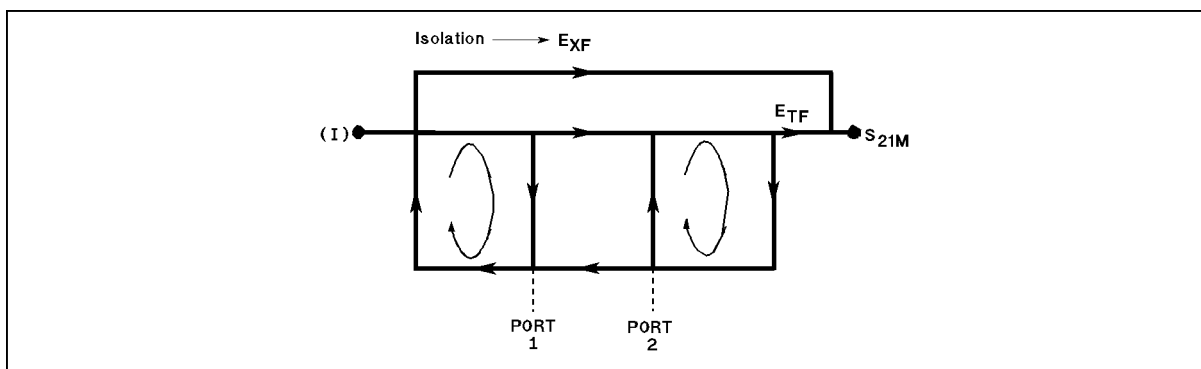
Figure A-38. Load Match  $E_{LF}$

The measured value,  $S_{21M}$ , consists of signal components that vary as a function of the relationship between  $E_{SF}$  and  $S_{11A}$  as well as  $E_{LF}$  and  $S_{22A}$ , so the input and output reflection coefficients of the test device must be measured and stored for use in the  $S_{21A}$  error correction computation. Thus, the test setup is calibrated as described above for the reflection to establish the directivity,  $E_{DF}$ , source match,  $E_{SF}$ , and reflection frequency response,  $E_{RF}$ , terms for the reflection measurements.

Now, that a calibrated port is available for reflection measurements, the THRU is connected and load match,  $E_{LF}$ , is determined by measuring the reflection coefficient of the THRU connection.

Transmission signal path frequency response is then measured with the THRU connected. The data is corrected for source and load match effects, then stored as transmission frequency response,  $E_{TF}$ .

**Isolation Errors.** Isolation,  $E_{XF}$ , represents the part of the incident signal that appears at the receiver without actually passing through the test device (Figure A-39). Isolation is measured with the test set in the transmission configuration and with terminations installed at the points where the test device will be connected.



C5012018

Figure A-39. Isolation  $E_{XF}$

**Error Terms the 4395A Can Reduce.** Thus there are two sets of error terms, forward and reverse, with each set consisting of six error terms, as follows:

- Forward
  - Directivity,  $E_{DF}$
  - Isolation,  $E_{XF}$
  - Source Match,  $E_{SF}$
  - Load Match,  $E_{LF}$
  - Transmission Tracking,  $E_{TF}$

## Calibration for Network Measurement

- Reflection Tracking,  $E_{RF}$
- Reverse
  - Directivity,  $E_{DR}$
  - Isolation,  $E_{XR}$
  - Source Match,  $E_{SR}$
  - Load Match,  $E_{LR}$
  - Transmission Tracking,  $E_{TR}$
  - Reflection Tracking,  $E_{RR}$

The 87511A, B S-parameter Test sets can measure both the forward and reverse characteristics of the test device without the need to manually remove and physically reverse it. With these test sets, the full two-port error model illustrated in Figure A-40 effectively removes both the forward and reverse error terms for transmission and reflection measurements.

The 87512A, B Transmission/Reflection Test kits cannot switch between forward and reverse directions, so the reverse error terms cannot be automatically measured. Therefore, with the one-path two-port calibration, the forward error terms are duplicated and used for both forward and reverse measurements by manually reversing the test device.

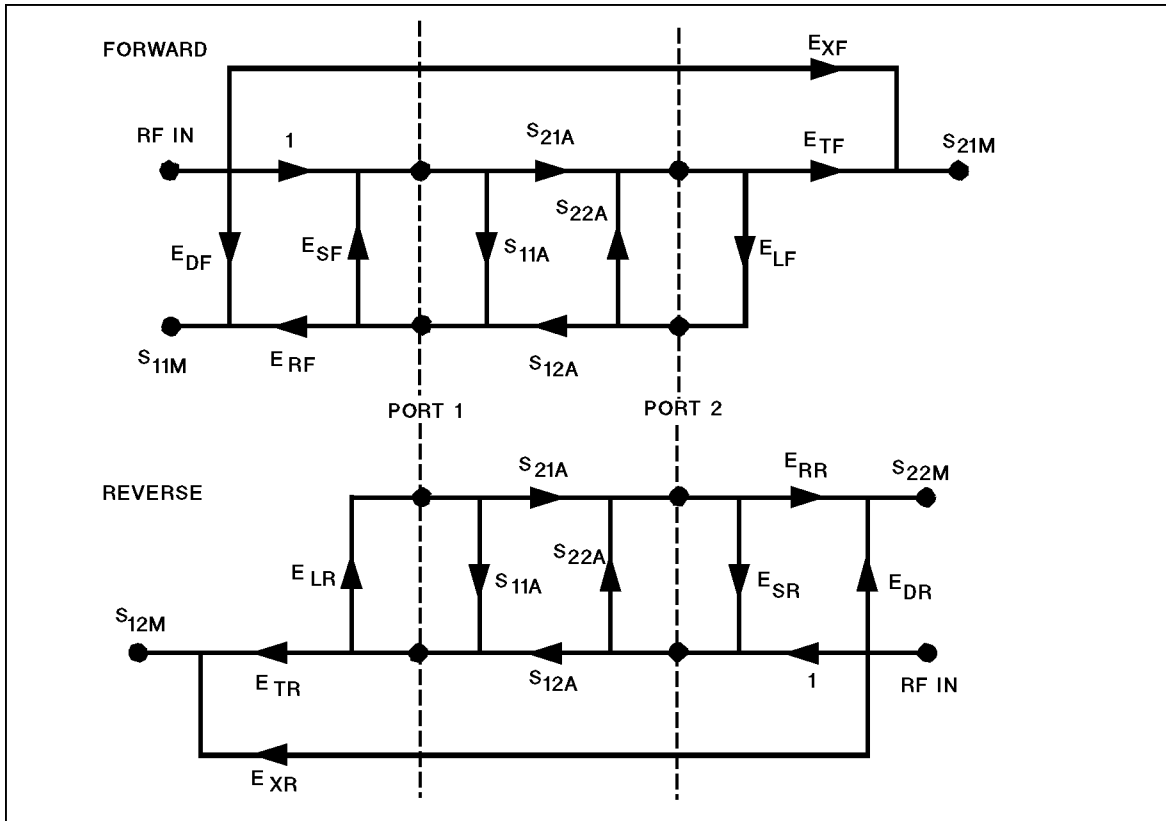


Figure A-40. Full Two-Port Error Model

The following equations show the full two-port error model equations for all four S-parameters of a two-port device. Note that the mathematics for this comprehensive model use all forward and reverse error terms and measured values. Thus, to perform full error correction for any one parameter, all four S-parameters must be measured.



$$\begin{aligned}
 S_{11A} &= \frac{\left[ \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) \left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) E_{SR} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LF} \right] \right]}{\left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) E_{SF} \right] \left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) E_{SR} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LF} E_{LR} \right]} \\
 S_{21A} &= \frac{\left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) (E_{SR} - E_{LF}) \right] \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right)}{\left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) E_{SF} \right] \left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) E_{SR} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LF} E_{LR} \right]} \\
 S_{12A} &= \frac{\left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) (E_{SF} - E_{LR}) \right] \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right)}{\left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) E_{SF} \right] \left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) E_{SR} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LF} E_{LR} \right]} \\
 S_{22A} &= \frac{\left[ \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) \left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) E_{SF} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LR} \right] \right]}{\left[ 1 + \left( \frac{S_{11M} - E_{DF}}{E_{RF}} \right) E_{SF} \right] \left[ 1 + \left( \frac{S_{22M} - E_{DR}}{E_{RR}} \right) E_{SR} \right] - \left[ \left( \frac{S_{21M} - E_{XF}}{E_{TF}} \right) \left( \frac{S_{12M} - E_{XR}}{E_{TR}} \right) E_{LF} E_{LR} \right]}
 \end{aligned}$$

In addition to the errors removed by accuracy enhancement, other systematic errors exist due to limitations of dynamic accuracy, test set switch repeatability, and test cable stability. These, combined with random errors, also contribute to total system measurement uncertainty. Therefore, after accuracy enhancement procedures are performed, residual measurement uncertainties remain.

### Saving and Recalling Instrument States and Data

This section describes storage devices, the save and recall functions, and the information you need to save instrument states and data into files.

Additional information on how to save and recall instrument states is provided in the “To Save and Recall the Settings and Data” in Chapter 8.

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**Note**

The **(Save)** and **(Recall)** keys do not access Instrument BASIC programs. Instrument BASIC has its own menus (under the **(System)** key) for accessing the built-in disk drive and the memory disk. See *Programming Manual* for detail.

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### Storage Devices

The analyzer supports two storage devices, a built-in flexible disk drive and a memory disk. The flexible disk drive should be used to store large numbers of files and long term data storage. The memory disk should be used to store temporary tentative data and instrument states and to store or retrieve data quickly.

---

**Note**

Use the built-in flexible disk to store important data because the memory disk data is lost when the power is turned off.

---

### Disk Requirements

The analyzer's disk drive uses a 720 Kbyte , or 1.44 Mbyte 3.5 inch micro-flexible disk.

### Disk Formats

The analyzer's built-in disk drive can access both LIF (logical interchange format) and DOS formatted disks. The disk drive and the memory disk can also initialize a new disk in either LIF or DOS format. Note that the analyzer can initialize 1.44 Mbyte disks only.

The following list shows the applicable DOS formats for the analyzer.

- 720 Kbyte, 80 tracks, double-sided, 9 sectors/track
- 1.44 Mbyte, 80 tracks, double-sided, 18 sectors/track

### Memory Disk Capacity

The memory disk capacity is 512 Kbyte. The memory disk capacity can be changed. This capacity includes the directory area. The capacity of data area depends on the disk format type.

## Copy Files Between the Memory Disk and the Flexible Disk

A copy function is provided to copy files between the memory disk and the flexible disk. **FILE UTILITIES** in the SAVE menu displays the softkeys used to copy files. The GPIB command FILC is also available to copy files.

### Note



When you copy files using this function, use the same disk format type for both the memory disk and the flexible disk. This copy function cannot copy files when the format of the memory disk is different from the format of the flexible disk.

## File Types And Data Saved

### Binary Files and ASCII Files

The analyzer supports two file formats, binary and ASCII, that are used to save data on a disk. Binary files are used to save measurement conditions and data using the SAVE function and to retrieve binary data using the RECALL function. External controllers and Instrument BASIC can read measurement data from binary data files. ASCII measurement data or screen image files can be read by commonly available IBM PC based software for data analysis or other secondary functions. The RECALL function cannot read ASCII files.

### Note



When saving internal data arrays, note that ASCII data files cannot be recalled on the analyzer. If you need to recall the data, save the file in binary format. This binary data can be recalled and saved as an ASCII file at any time.

## Data Groups

### Instrument States and Internal Data Arrays (STATE)

This group consists of the instrument states that include raw calibration coefficients (network analyzer only), the data arrays, and the memory arrays. (Binary Files Only)

### Internal Data Arrays (DATA ONLY)

The internal data arrays that are stored in the analyzer's memory consists of the following six data arrays. See "Data Processing" for complete information on each data array and their relationships.(Binary and ASCII Files)

- *Raw data arrays* contain raw, uncalibrated measurement data.
- *Calibration Coefficients arrays* contain the expanded calibration coefficients obtained by calibration of the network analyzer.
- *Data arrays* contain the calibrated data obtained using the calibration coefficients.
- *Memory arrays* contain the memory data arrays obtained using the DATA→MEM operation.
- *Data Trace arrays* contain the formatted data.
- *Memory Trace arrays* contain the formatted data of the "memory arrays."

These arrays can be saved selectively to suit the application. For example, when measuring several devices with the same measurement settings, you may need to save only the *trace*

## File Types And Data Saved

*arrays* for each device. Saving only the necessary arrays reduces the disk space required and the disk access time. In addition, saving internal data also allows the analysis of the measurement results using an external controller. See “File Structure of Internal Data Arrays File for Binary Files” for more information.

### Graphics image (GRAPHICS)

The analyzer saves the graphics image of the screen as a graphics file in the TIFF (Tagged Image File Format) format. The TIFF format is used in a wide range of drawing software programs (in binary format only).

## File Type and Data Group Combinations

You can select and save to a disk one of the following four combinations of the two file types and the four data groups.

- Binary File
  - Instrument states and internal data arrays (STATE)
  - Internal data arrays (DATA ONLY binary)
  - Graphics image (GRAPHICS)
- ASCII File
  - Internal data arrays (DATA ONLY ascii)

---

### Note



DATA ONLY does not save instrument settings such as start and stop frequencies. BE CAREFUL! Always make sure that you save the existing STATE if you want to use the setup again.

---

## File Names

All data saved using the built-in disk drive and the memory disk has an identifying file name. A file name consists of the lower and upper case alphabet, numbers, and valid symbol characters. Up to 8 characters can be used for a file name. The following table shows the valid characters for LIF and DOS file names.

**Table A-4. Valid Characters for File Names**

Valid Characters		Description
LIF	DOS Format	
A - Z	A - Z	Upper case alphabet
a - z	a - z	Lower case alphabet
0 - 9	0 - 9	Numeric characters
_	\$ & # % ' ! ( ) - _ @ ^ { } ~	Symbol characters

One of the following suffixes or extensions is automatically added to the file name depending on the data group type stored in the file.

**Table A-5. Suffixes and Extensions Added Automatically**

Data Groups	Suffixes for LIF	Extensions for DOS
Instrument States and Internal Data Arrays ( STATE )	_S	.STA
Internal Data Arrays ( DATA ONLY (binary) )	_D	.DTA
Internal Data Arrays as an ASCII File ( DATA ONLY (ASCII) )	_I	.TXT
Graphics Image as an TIFF File ( GRAPHICS )	_T	.TIF

## Auto Recall Function

When the 4395A is turned on, it looks for a file named "AUTOREC" from the built-in flexible disk or memory disk, and if found, the 4395A automatically reads the file to retrieve its data.

### Note



- When you save the AUTOREC file into the memory disk, you must perform memory disk backup operation. Otherwise, the AUTOREC file is lost when the power is turned off.
- When the 4395A is turned ON, the 4395A looks for the AUTOREC file on the flexible disk first. If there is no AUTOREC file on the flexible disk, the 4395A looks for it on the memory disk.

## File Structure

### File Structure of Internal Data Arrays File for Binary Files

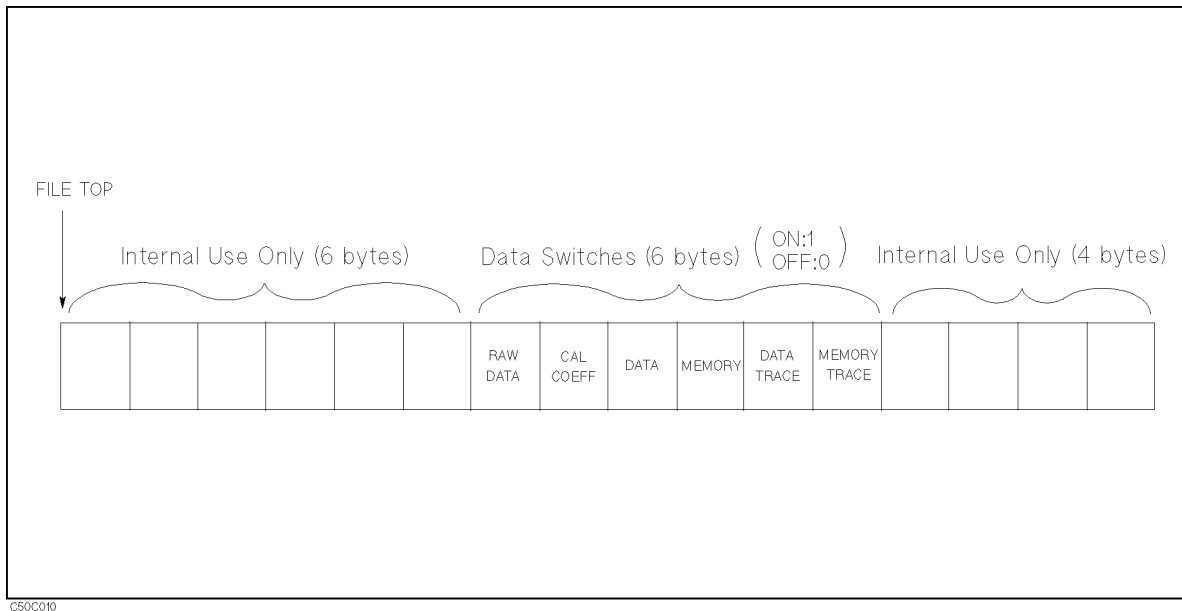
**Note** Binary and ASCII file structures are not compatible.



When internal data arrays are saved as a binary file, the arrays' file consists of a file header at the top of the file and the data groups following the file header.

#### File Header

Every internal data array file begins with a file header. Figure A-41 shows the header structure.



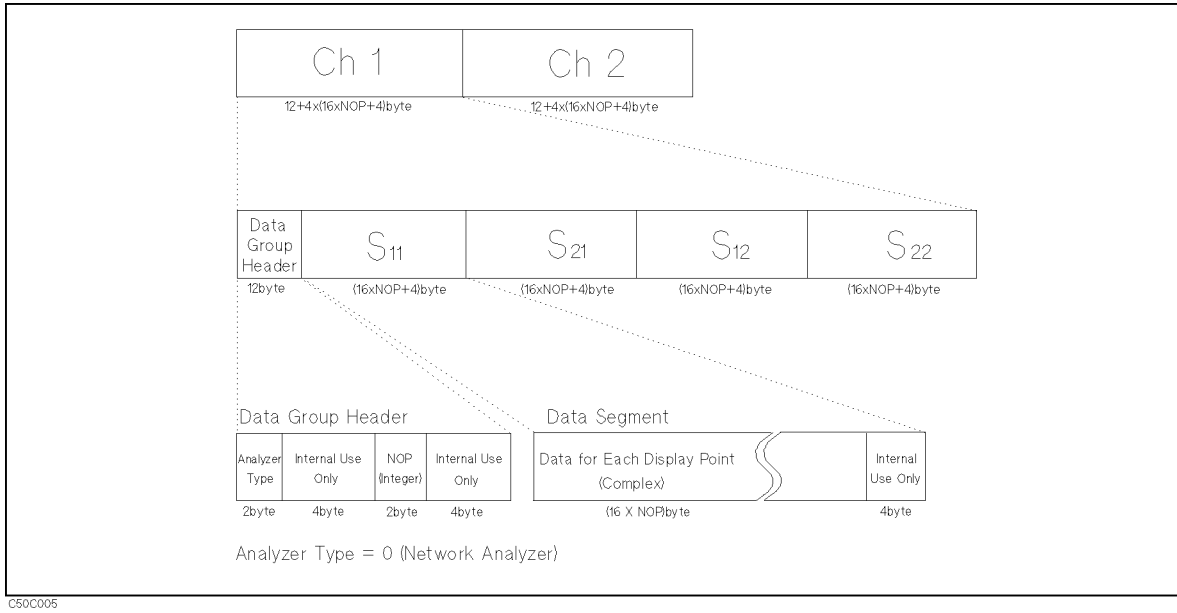
**Figure A-41. File Header Structure**

Six data switches define the data groups that follow the file head. Each one-byte switch is either 1 or 0 (decimal value) if the applicable data group exists or not, respectively. The data group to be followed is in the same order of these switches. For example, when the data switches, RAW DATA and DATA TRACE are 1 (ON), while the others are OFF, only the RAW DATA and DATA TRACE (in this order) groups will follow the header.

#### Data Group

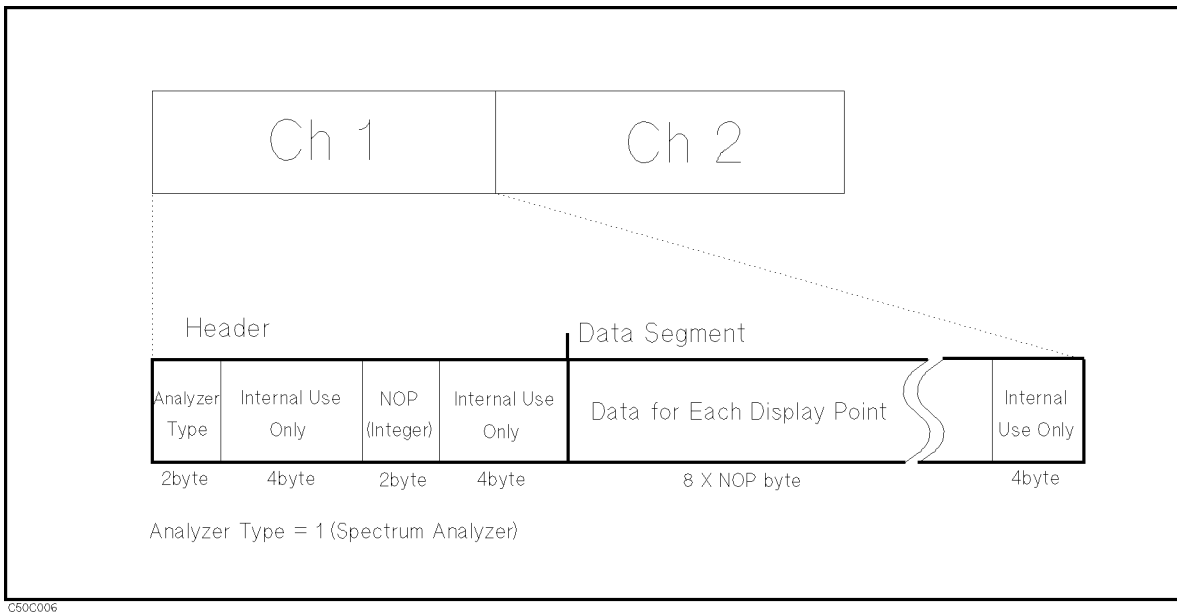
Data group of each channel begins with a header and consists of the same structured data segments. The number of data segments depends on the data group type as follows:

- RAW DATA of the network analyzer consists of a header and four data segments per channel as shown in Figure A-42. They will follow the file header in this order:



**Figure A-42. RAW Data Group Structure for the Network Analyzer**

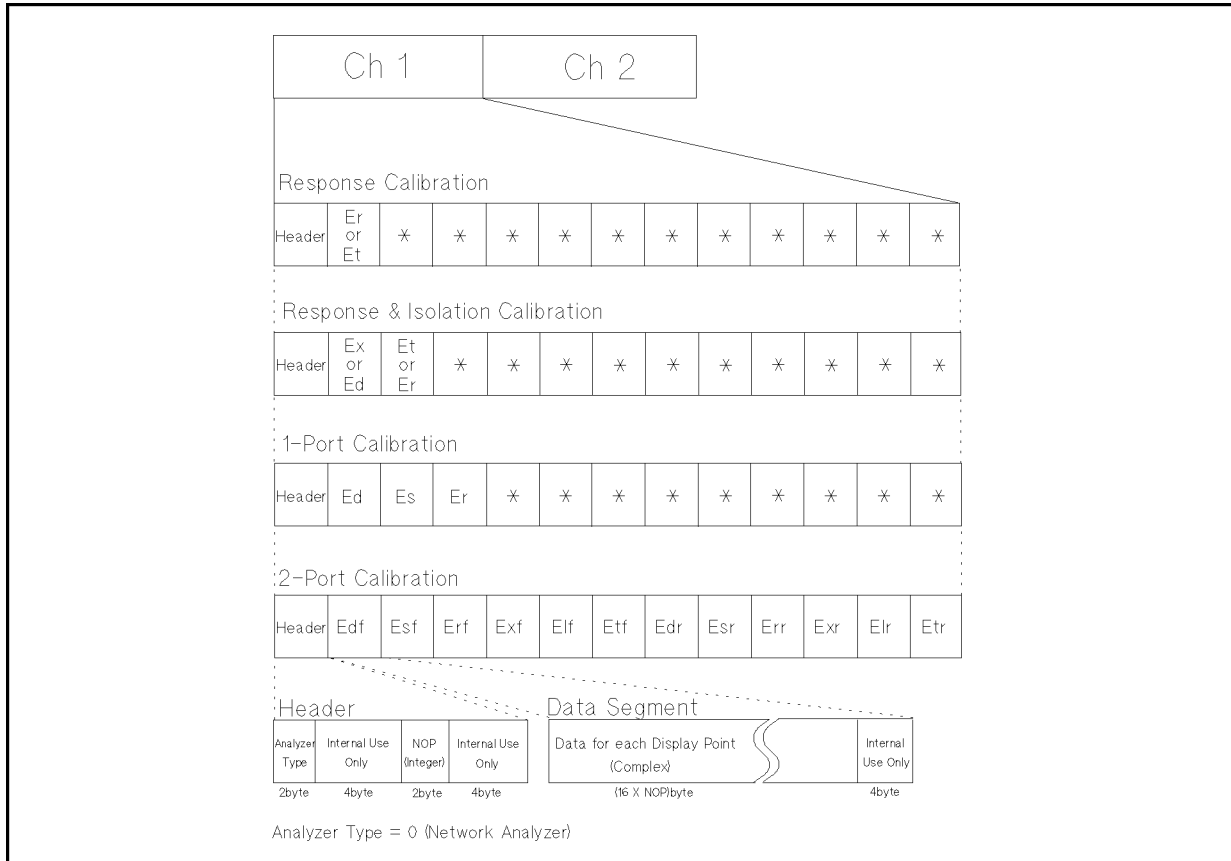
- **RAW DATA** of the spectrum analyzer consists of a header and a data segment by a channel as shown in Figure A-43. They will follow the file header in this order:



**Figure A-43. RAW Data Group Structure for the Spectrum Analyzer**

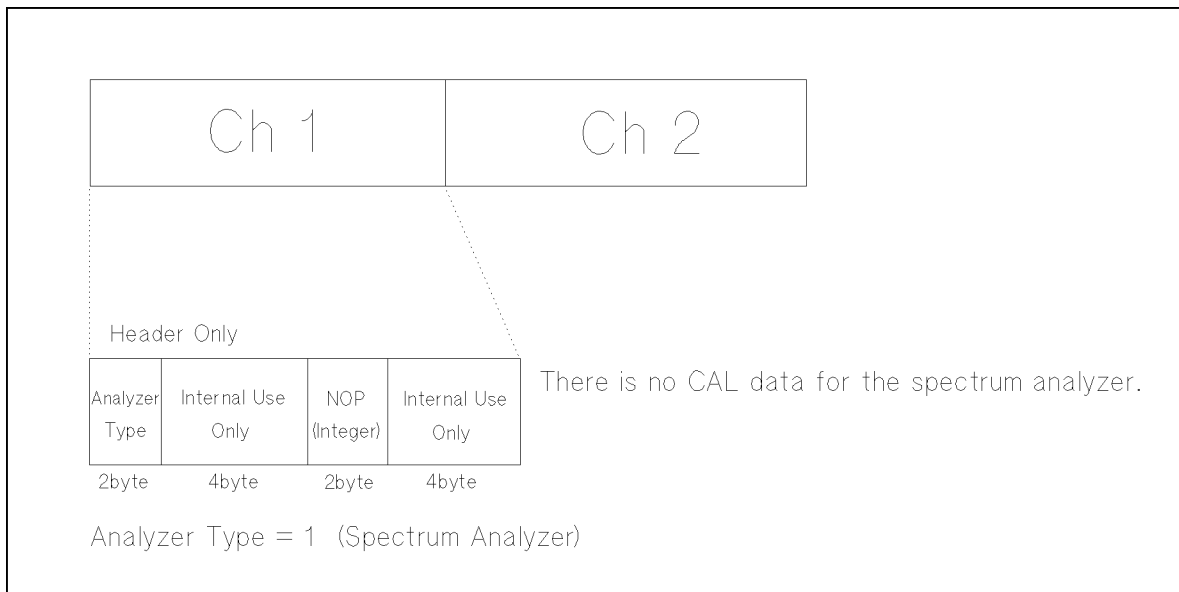
- **CAL** of the network analyzer consists of 12 data segments by a channel as shown in Figure A-44. The first half of the segments are for channel 1 and the second half of the segments are for channel 2. The contents of each segment depend on the type of calibration performed. CAL data is available for only the network analyzer.

## File Structure



C50C007

**Figure A-44. CAL Data Group Structure for the Network Analyzer**



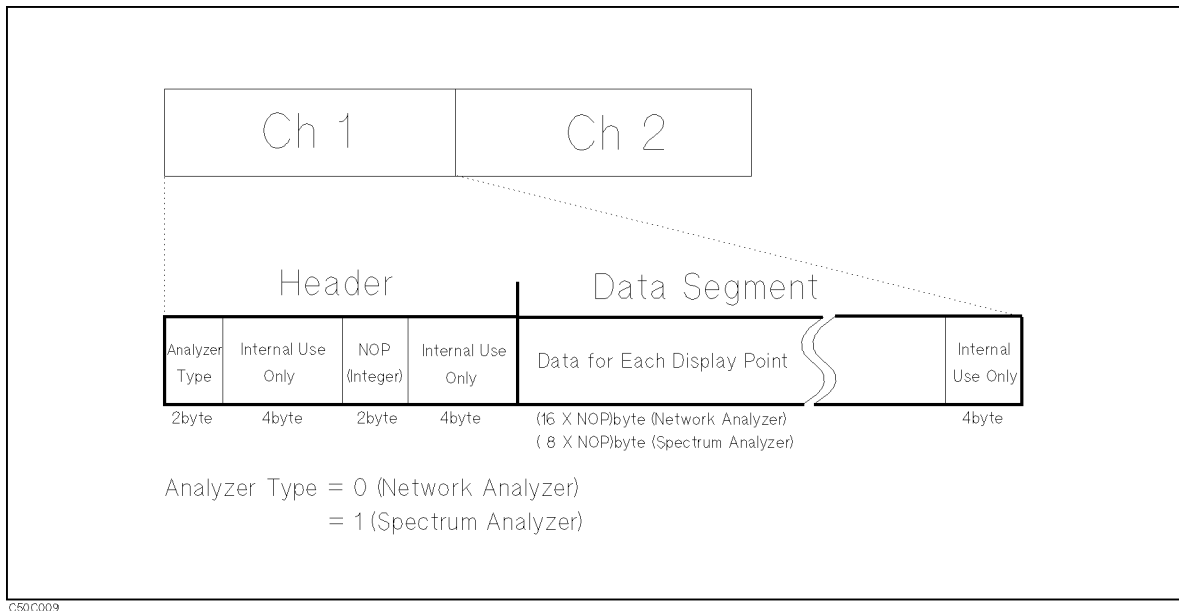
C50C008

**Figure A-45. CAL Data Group Structure for the Spectrum Analyzer**

- **DATA** consists of a header and a data segment by a channel.
- **MEMORY** consists of a header and a data segment by a channel.
- **DATA TRACE** consists of a header and a data segment by a channel.



- *MEMORY TRACE* consists of a header and a data segment by a channel.



**Figure A-46. DATA, MEMORY, DATA TRACE and MEMORY TRACE Data Group Structure**

- *Analyzer Type* is a two-byte INTEGER value. This shows the analyzer type of each channel. “0” is set when the network analyzer is selected and “1” is set when the spectrum analyzer is selected.
- *Number Of Points (NOP)* is a two-byte INTEGER value. This number is equal to the number of complex or real data that follows the NOP.
- *DATA* is a set of the values for each measurement point. The values are IEEE 754 double precision floating number. When the network analyzer mode is selected, the values are two numbers (the first value is the real part, the second value is the imaginary part). The data size in bytes can be determined by  $16 \times \text{NOP}$ . When the spectrum analyzer mode is selected, the values are one number and the data size in bytes can be determined by  $8 \times \text{NOP}$ .

## **File Structure**

### **File Structure of Internal Data Arrays File for ASCII File**

Numerical data and strings in an ASCII data file are separated by a tab, and a string is bound by double quotation marks.

#### **Status Block and Data Block**

An ASCII data file consists of a status block and data blocks. The status block consists of two lines, the revision number and the date code. The data block consists of three parts, the state part, the title line, and the data part.

##### ■ State

The state part consists of the following instrument states:

- Channel number
- Title on the screen
- Measurement type
- Format type (and Unit)
- Number of points
- Sweep time
- Sweep type
- Source power or CW frequency
- IF, or RBW and VBW bandwidth

##### ■ Title

The title part consists of the data array names saved. Data array names are described in the next section.

##### ■ Data

The data part consists of sweep parameter and numerical data of data arrays.

Table A-6 shows an example of an ASCII data file.

**Table A-6. Contents of ASCII Files**

Block Names		Contents
Status Block		"4395A REV1.00" "DATE: mmm dd yyyy" <sup>1</sup>
Data Block	State	"CHANNEL: 1" "TITLE: This is a title." <sup>2</sup> "MEAS TYPE: A/R" "FORMAT TYPE: LOG MAG" "NUMBER of POINTS: 201" "SWEEP TIME: 12.2 ms" "SWEEP TYPE: LIST FREQ" "SOURCE POWER: 0 dBm" <sup>3</sup> "BANDWIDTH: 3 kHz"
	Title	"Frequency"→"Raw [S11] Real"→"Raw [S11] Imag"→... <sup>4,5</sup>
	Data <sup>6,7</sup>	3.00000E+5→8.20007E-1→4.09729E-1→... <sup>4</sup> 1.52238E+7→9.32143E-1→-4.1914E-2→... : :

1 This is the date when the file is saved.

2 This line is listed when the title is defined (displayed).

3 Shows the power level of the source for a frequency sweep. If power sweep is selected, the CW frequency is listed (for example "CW FREQ: 100 MHz").

4 "→" means tab code. Data is separated by the tab code.

5 This line lists the names of the data array saved in this file. Titles used in the ASCII files are shown in Table A-7 through Table A-10.

6 Each line lists the measurement data at each measurement point. The number of lines in the data block is the same as the number of points.

7 In the network analyzer mode, complex data is saved. In the spectrum analyzer mode, only real data is saved.

## File Structure

### File Structure for Single Channel and Dual Channel

If you save an ASCII file when DUAL CHANNEL is turned OFF, the ASCII data file consists of the active channel's data. If DUAL CHANNEL is turned ON, the ASCII data file consists of the data of both channels 1 and 2. The channel 2 data follows the channel 1 data as follows:

#### File Structures for Single and Dual Channels

Dual Channel OFF	Dual Channel ON
Status Block	Status Block
Data Block of Active Channel	Data Block of Channel 1
(end of file)	Status Block
	Data Block of Channel 2

### Data Array Names for the Spectrum Analyzer

Data array names are used in the title line of the data block. Each data array of the spectrum analyzer has one name, Table A-7 lists all names.

**Table A-7. Data Groups and Data Array Names for Spectrum Analyzer**

Data Groups	Data Array Names	Descriptions
Raw Data	Raw	Raw data array.
Data	Data	Corrected Data arrays
Memory	Memory	Corrected Memory arrays
Data Trace	Data Trace	Data Trace arrays
Memory Trace	Memory Trace	Memory Trace arrays

## Data Array Names for the Network Analyzer

Data array names are used in the title line of the data block. Each real and imaginary part of the internal data array of the network analyzer has one name, Table A-8 lists all names.

**Table A-8.**  
**Data Groups and Data Array Names for the Network Analyzer Mode**

Data Groups	Data Array Names		Descriptions
	Real Part	Imaginary Part	
Raw Data	Raw[S11] Real	Raw[S11] Imag	Raw data arrays for S11 meas.
	Raw[S21] Real	Raw[S21] Imag	Raw data arrays for S21 meas.
	Raw[S12] Real	Raw[S12] Imag	Raw data arrays for S12 meas.
	Raw[S22] Imag	Raw[S22] Imag	Raw data arrays for S22 meas.
Calibration Data <sup>1</sup>	Cal[1] Real	Cal[1] Imag	Er, <sup>2</sup> Et, <sup>2</sup> Ex, <sup>3</sup> Ed, <sup>3,4</sup> or Edf <sup>5</sup>
	Cal[2] Real	Cal[2] Imag	Et, <sup>3</sup> Er, <sup>3</sup> Es, <sup>4</sup> or Est <sup>5</sup>
	Cal[3] Real	Cal[3] Imag	Er <sup>4</sup> or Erf <sup>5</sup>
	Cal[4] Real	Cal[4] Imag	Exf <sup>5</sup>
	Cal[5] Real	Cal[5] Imag	Elr <sup>5</sup>
	Cal[6] Real	Cal[6] Imag	Etr <sup>5</sup>
	Cal[7] Real	Cal[7] Imag	Edr <sup>5</sup>
	Cal[8] Real	Cal[8] Imag	Esr <sup>5</sup>
	Cal[9] Real	Cal[9] Imag	Err <sup>5</sup>
	Cal[10] Real	Cal[10] Imag	Exr <sup>5</sup>
	Cal[11] Real	Cal[11] Imag	Elr <sup>5</sup>
	Cal[12] Real	Cal[12] Imag	Etr <sup>5</sup>
Data	Data Real	Data Imag	Corrected Data arrays
Memory	Memory Real	Memory Imag	Corrected Memory arrays
Data Trace	Data Trace Real	Data Trace Imag	Data Trace arrays
Memory Trace	Memory Trace Real	Memory Trace Imag	Memory Trace arrays

1 For more information on calibration, see "Calibration for Network Measurement". Calibration data is available for only network analyzer mode.

2 When response calibration is used.

3 When response and isolation calibration are used.

4 When 1 port calibration is used.

5 When 2 port calibration is used.

## Data Groups of the Spectrum Analyzer

Every data group of the spectrum analyzer consists of one data array.

## Data Groups of the Network Analyzer

Every data group of the network analyzer consists of data arrays. The number of data arrays depends on the data group types. The saved data arrays RAW and CAL depend on the instrument state.

- RAW DATA of the network analyzer consists of eight data arrays. The data arrays saved depend on the calibration type and the measurement type. If RAW DATA is saved in an ASCII data file when 2-port calibration is used, all eight RAW data arrays will be saved in the ASCII data file for any measurement type. If another calibration type is used, the data arrays saved depend on the measurement type. Table A-9 lists the RAW data array combinations that are saved for each measurement type selected.

## Save Data Format

**Table A-9. Network Measurement Type Versus Raw Data Saved**

Measurement Type	Raw Data Arrays Saved <sup>1</sup>
A/R	"Raw[S11] Real", "Raw[S11] Imag"
B/R	"Raw[S21] Real", "Raw[S21] Imag"
A/B	"Raw[S12] Real", "Raw[S12] Imag"
A	"Raw[S11] Real", "Raw[S11] Imag"
B	"Raw[S21] Real", "Raw[S21] Imag"
R	"Raw[S12] Real", "Raw[S12] Imag"
S11	"Raw[S11] Real", "Raw[S11] Imag"
S12	"Raw[S12] Real", "Raw[S12] Imag"
S21	"Raw[S21] Real", "Raw[S21] Imag"
S22	"Raw[S22] Real", "Raw[S22] Imag"

<sup>1</sup> When 2-port calibration is turned ON, all Raw Data is saved.

- CAL DATA of the network analyzer consists of twenty data arrays. The data arrays saved depend on the calibration type used. Table A-10 lists the CAL data arrays that are saved for each calibration type selected.

**Table A-10. Calibration Type for Network Measurement Versus CAL Data Saved**

Calibration Type	CAL Data Saved	Error Terms <sup>1</sup>
Response	"Cal[1] Real", "Cal[1] Imag"	Er or Et
Response and Isolation	"Cal[1] Real", "Cal[1] Imag" "Cal[2] Real", "Cal[2] Imag"	Ex or Ed Et or Er
1 port Calibration	"Cal[1] Real", "Cal[1] Imag" "Cal[2] Real", "Cal[2] Imag" "Cal[3] Real", "Cal[3] Imag"	Ed Es Er
2 port Calibration	"Cal[1] Real", "Cal[1] Imag" "Cal[2] Real", "Cal[2] Imag" "Cal[3] Real", "Cal[3] Imag" "Cal[4] Real", "Cal[4] Imag" "Cal[5] Real", "Cal[5] Imag" "Cal[6] Real", "Cal[6] Imag" "Cal[7] Real", "Cal[7] Imag" "Cal[8] Real", "Cal[8] Imag" "Cal[9] Real", "Cal[9] Imag" "Cal[10] Real", "Cal[10] Imag" "Cal[11] Real", "Cal[11] Imag" "Cal[12] Real", "Cal[12] Imag"	Edf Esf Erf Exf Elf Etf Edr Esr Err Exr Elr Etr

<sup>1</sup> For more information on error terms, refer to "Calibration for Network Measurement".

- DATA of the network analyzer consists of two data arrays.
- MEMORY of the network analyzer consists of two data arrays.
- DATA TRACE of the network analyzer consists of two data arrays.
- MEMORY TRACE of the network analyzer consists of two data arrays.

## Save Data Format

When you store the internal data array by **(Save) DATA ONLY**, the stored binary file format is same as the network/spectrum analyzer except for the calibration and fixture compensation coefficients. This section provides the information about the save file format of the calibration and the fixture compensation coefficients.

### CAL Data Group

This group consists of the calibration and the fixture compensation coefficients data segments by a channel as shown in Figure A-47. The first half of the segments are for channel 1 and the second half of the segments are for channel 2. The contents of each segment depend on the type of calibration performed.

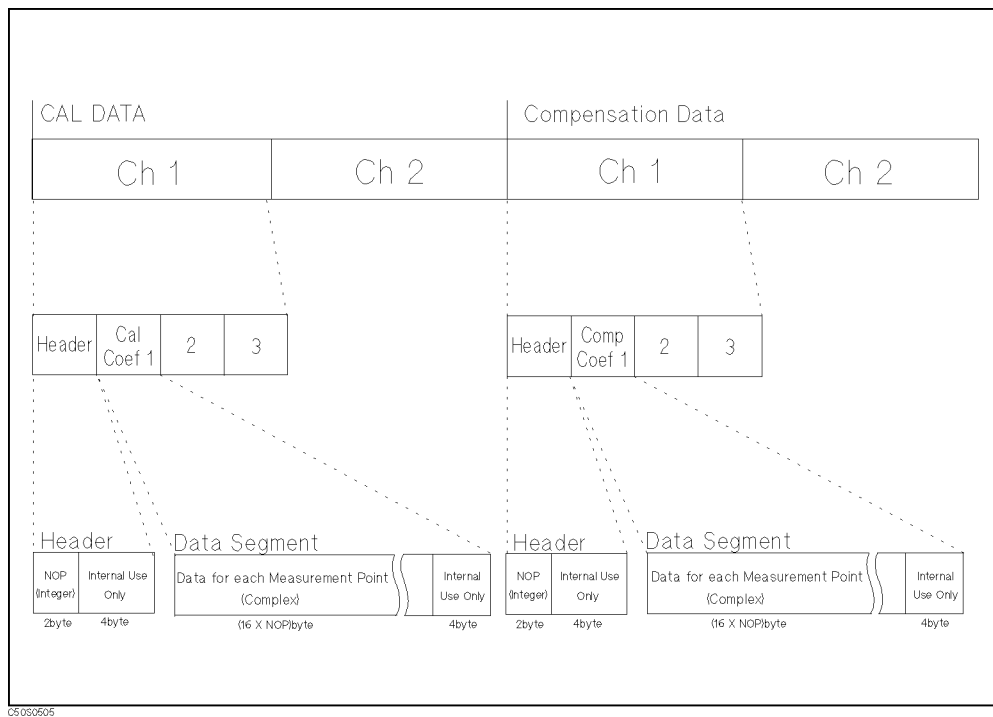


Figure A-47. CAL Data Group Structure





## **Softkey Reference**

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Chan 1   Chan 2   Meas

Front Panel Key	Description
Chan 1	Select the channel 1 for an active channel.
Chan 2	Select the channel 2 for an active channel.
<p>Meas</p> <p>Network Analyzer</p> <p>NETWORK: A/R</p> <p>B/R</p> <p>A/B</p> <p>MORE</p> <p>NETWORK: R</p> <p>A</p> <p>B</p> <p>MORE</p> <p>CONVERSION [OFF] → See Conversion menu</p> <p>S-PARAMETERS → See S-parameters menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p> <p>CONVERSION [OFF] → See Conversion menu</p> <p>S-PARAMETERS → See S-parameters menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Calculates and displays the complex ratio of the signal at input A to the reference signal at input R.</p> <p>Calculates and displays the complex ratio of the signal at input B to the reference signal at input R.</p> <p>Calculates and displays the complex ratio of input A to input B.</p> <p>Measures the absolute power amplitude at input R.</p> <p>Measures the absolute power amplitude at input A.</p> <p>Measures the absolute power amplitude at input B.</p>
<p>NA S-parameters menu</p> <p>Ref: FWD S11 [A/R]</p> <p>Trans:FWD S21 [B/R]</p> <p>Trans:REV S12 [A/R]</p> <p>Ref: REV S22 [B/R]</p> <p>INPUT PORTS → See Input port menu</p> <p>CONVERSION [OFF] → See Conversion menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p> <p>Conversion menu</p> <p>CONVERSION OFF</p> <p>Z:Ref</p> <p>Z:Trans</p> <p>Y:Ref</p> <p>Y:Trans</p> <p>i S</p> <p>MORE</p>	<p>Configures the S-parameter test set to measure <math>S_{11}</math> (the complex reflection coefficient, magnitude and phase, of the DUT input).</p> <p>Configures the S-parameter test set for measurement of <math>S_{21}</math> (the complex forward transmission coefficient, magnitude and phase, of the DUT).</p> <p>Configures the S-parameter test set to measure <math>S_{12}</math> (the complex reverse transmission coefficient, magnitude and phase, of the DUT).</p> <p>Defines the measurement as <math>S_{22}</math> (the complex reflection coefficient, magnitude, and phase, of the output of the DUT)</p> <p>Turns off all parameter conversion operations.</p> <p>Converts reflection data to its equivalent impedance values.</p> <p>Converts transmission data to its equivalent impedance values.</p> <p>Converts reflection data to its equivalent admittance values.</p> <p>Converts transmission data to its equivalent admittance values.</p> <p>Expresses the data in inverse S-parameter values.</p>

Front Panel Key	Description
<p><b>Meas</b> Continued</p> <p>CONVERSION 4xPHASE</p> <p>8xPHASE</p> <p>16xPHASE</p> <p>RETURN</p> <p>RETURN</p>	<p>Multiplies phase data by a factor of 4.</p> <p>Multiplies phase data by a factor of 8.</p> <p>Multiplies phase data by a factor of 16.</p>
<p>Analyzer type menu</p> <p>NETWORK ANALYZER</p> <p>SPECTRUM ANALYZER</p> <p>IMPEDANCE ANALYZER</p> <p>RETURN</p>	<p>Selects the network analyzer mode as the analyzer type.<sup>1</sup></p> <p>Selects the spectrum analyzer mode as the analyzer type.<sup>1</sup></p> <p>Selects the impedance analyzer mode as the analyzer type.<sup>1</sup></p>
<p>Spectrum Analyzer</p> <p>SPECTRUM: R</p> <p>A</p> <p>B</p> <p>DETECTION [POSITIVE]</p> <p>DETECTION:POS PEAK</p> <p>NEG PEAK</p> <p>SAMPLE</p> <p>RETURN</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Measures the spectrum at input R.</p> <p>Measures the spectrum at input A.</p> <p>Measures the spectrum at input B.</p> <p>Displays the <i>detection menu</i> that is used to select the type of detection mode (positive, negative, or sample mode). The detection mode defined is shown in brackets under the softkey label.</p> <p>Selects positive peak mode as the detection technique for displaying trace information.</p> <p>Selects negative peak mode for detection technique.</p> <p>Selects sample mode for detection technique.</p>

1 Changing analyzer type will preset all the parameters for the active channel.

Front Panel Key	Description
<p><b>Meas</b> Continued</p> <p>Impedance Analyzer</p> <p>ZA More menu 1/5</p> <p>IMPEDANCE: MAG(—Z—)</p> <p>PHASE(<math>\theta_z</math>)</p> <p>RESIST(R)</p> <p>REACT(X)</p> <p>MORE 1/5</p> <p>FIXTURE [NONE] → See Fixture menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Measures absolute magnitude value of impedance.</p> <p>Measures absolute phase value of impedance.</p> <p>Measures resistance value (R).</p> <p>Measures reactance value (X).</p> <p>Displays the <i>Impedance Measurement Menu</i> (2/5).</p> <p>Displays the <i>Fixture Menu</i> that is used to select a test fixture connected with the analyzer. The selected test fixture is displayed in brackets ([]).</p> <p>Displays the <i>Analyzer Type Menu</i> that selects the network, spectrum, or impedance analyzer mode of operation.</p>
<p>ZA More menu 2/5</p> <p>ADMITTANCE: MAG(—Y—)</p> <p>PHASE(<math>\theta_y</math>)</p> <p>CONDUCT(G)</p> <p>SUSCEPT(B)</p> <p>MORE 2/5</p> <p>FIXTURE [NONE] → See Fixture menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Selects an admittance parameter as the measurement parameter.</p> <p>Measures absolute magnitude value of admittance (<math> Y </math>).</p> <p>Measures phase value of admittance (<math>\theta_y</math>).</p> <p>Measures conductance value (G).</p> <p>Measures susceptance value (B).</p> <p>Displays the <i>Impedance Measurement Menu</i> (3/5).</p>
<p>ZA More menu 3/5</p> <p>REFL.COEF: —<math>\Gamma</math>—</p> <p>PHASE(<math>\theta_\Gamma</math>)</p> <p>REAL(<math>\Gamma_x</math>)</p> <p>IMAG(<math>\Gamma_y</math>)</p> <p>MORE 3/5</p> <p>FIXTURE [NONE] → See Fixture menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Selects a reflection coefficient as the measurement parameter.</p> <p>Measures absolute magnitude value of reflection coefficient (<math> \Gamma </math>).</p> <p>Measures phase value of reflection coefficient (<math>\theta_\gamma</math>).</p> <p>Measures real part of reflection coefficient (<math>\Gamma_x</math>).</p> <p>Measures imaginary part of reflection coefficient (<math>\Gamma_y</math>).</p> <p>Displays the <i>Impedance Measurement Menu</i> (4/5).</p>
<p>ZA More menu 4/5</p> <p>CAPCITNCE: PRL(<math>C_p</math>)</p> <p>SER(<math>C_s</math>)</p> <p>INDUCTNCE: PRL(<math>L_p</math>)</p> <p>SER(<math>L_s</math>)</p> <p>MORE 4/5</p> <p>FIXTURE [NONE] → See Fixture menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Selects a capacitance or inductance as the measurement parameter.</p> <p>Measures parallel capacitance (<math>C_p</math>), which is used for small capacitance measurement.</p> <p>Measures series capacitance (<math>C_s</math>), which is used for large capacitance measurement.</p> <p>Measures parallel inductance (<math>L_p</math>), which is used for large inductance measurement.</p> <p>Measures series inductance (<math>L_s</math>), which is used for small inductance measurement.</p> <p>Displays the <i>Impedance Measurement Menu</i> (5/5).</p>
<p>ZA More menu 5/5</p> <p>RESISTNCE: PRL(<math>R_p</math>)</p> <p>SER(<math>R_s</math>)</p> <p>D FACTOR(D)</p> <p>Q FACTOR(Q)</p> <p>MORE 5/5</p> <p>FIXTURE [NONE] → See Fixture menu</p> <p>ANALYZER TYPE → See Analyzer type menu</p>	<p>Selects a resistance, D, and Q as the measurement parameter.</p> <p>Measures parallel resistance (<math>R_p</math>), which is used for large resistance, large inductance, or small capacitance.</p> <p>Measures series resistance (<math>R_s</math>), which is used for small resistance, small inductance, or large capacitance.</p> <p>Measures dissipation factor (D).</p> <p>Measures quality factor (Q).</p> <p>Displays the <i>Impedance Measurement Menu</i> (1/5).</p>

## B-4 Softkey Reference

Front Panel Key	Description
<p>Meas Continued</p> <p>Fixture menu</p> <p>SELECT FIXTURE</p> <p>    FIXTURE: NONE</p> <p>    16191</p> <p>    16192</p> <p>    16193</p> <p>    16194</p> <p>    USER</p> <p>    RETURN</p> <p>SAVE USER FXTR KIT</p> <p>MODIFY [NONE]</p> <p>    DEFINE EXTENTION</p> <p>    LABEL FIXTURE</p> <p>    KIT DONE (MODIFIED)</p> <p>RETURN</p>	<p>Displays the <i>Select Fixture Menu</i>.</p> <p>Sets zero as electrical length value.</p> <p>Sets the electrical length that is suitable for the 16191A.</p> <p>Sets the electrical length that is suitable for the 16192A.</p> <p>Sets the electrical length that is suitable for the 16193A.</p> <p>Sets the electrical length that is suitable for the 16194A.</p> <p>Sets the electrical length, which is a user defined value.</p> <p>Saves electrical length and label as a user defined fixture.</p> <p>Displays the <i>Modify User Fixture Menu</i>, which are used to define the electrical length and label of a selected fixture.</p> <p>Sets the extension value of the user fixture.</p> <p>Sets the label name of the user fixture.</p> <p>Completes the procedure of the user fixture definition.</p>

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Format

Front Panel Key	Description
<p><b>Format</b></p> <p>Network Analyzer</p> <p>FORMAT:LOG MAG</p> <p>PHASE</p> <p>DELAY</p> <p>SMITH CHART</p> <p>POLAR CHART</p> <p>MORE</p> <p>  FORMAT:LIN MAG</p> <p>  SWR</p> <p>  REAL</p> <p>  IMAGINARY</p> <p>  ADMITTANCE CHART</p> <p>  RETURN</p> <p>  PHASE UNIT [DEG]</p> <p>  EXP PHASE ON off</p> <p>PHASE UNIT [DEG]</p> <p>EXP PHASE ON off</p>	<p>Displays the log magnitude format.</p> <p>Displays a Cartesian format of the phase portion of the data (measured in degrees). This format displays the phase shift versus frequency.</p> <p>Selects the group delay format. Activated markers give values in seconds.</p> <p>Displays a Smith chart format.</p> <p>Displays a polar format.</p> <p>Displays the linear magnitude format.</p> <p>Reformats a reflection measurement into its equivalent SWR (standing wave ratio) value.</p> <p>Displays only the real (resistive) portion of the measured data on a Cartesian format. This is similar to the linear magnitude format, but can show both positive and negative values.</p> <p>Displays only the imaginary (reactive) portion of the measured data on a Cartesian format. This format is similar to the real format except that reactance data is displayed on the trace instead of impedance data.</p> <p>Displays an admittance Smith chart format and displays the <i>circle data menu</i>.</p> <p>Selects the unit for phase measurement as DEG (degree) or RAD (radian). The unit selected is shown in brackets.</p> <p>Turns the expanded phase ON or OFF.</p> <p>Selects the unit for phase measurement as DEG (degree) or RAD (radian). The unit selected is shown in brackets.</p> <p>Turns the expanded phase ON or OFF.</p>
<p>Spectrum Analyzer</p> <p>FORMAT:SPECTRUM</p> <p>NOISE</p> <p>UNIT: dBm</p> <p>VOLT</p> <p>dBV</p> <p>dBuV</p> <p>WATT</p> <p>VOLT</p>	<p>Activates a spectrum measurement.</p> <p>Activates a noise level measurement. If the marker is placed in the noise, the rms noise level is read out normalized to a 1 Hz noise power bandwidth.</p> <p>Selects dBm as amplitude unit.</p> <p>Selects volt as amplitude unit.</p> <p>Selects dBV as amplitude unit.</p> <p>Selects dB<math>\mu</math>V as amplitude unit.</p> <p>Selects watt as amplitude unit.</p> <p>Selects volt as amplitude unit.</p>
<p>Impedance Analyzer</p> <p>FORMAT:LIN Y-AXIS</p> <p>LOG Y-AXIS</p> <p>POLAR CHART</p> <p>SMITH CHART</p> <p>ADMITTANCE CHART</p> <p>COMPLEX PLANE</p> <p>PHASE UNIT [DEG]</p> <p>EXP PHASE ON off</p>	<p>Displays the linear magnitude format.</p> <p>Displays the logarithmic scale format.</p> <p>Displays a polar format.</p> <p>Displays a Smith chart format.</p> <p>Displays an admittance Smith chart format.</p> <p>Displays a complex plane format.</p> <p>Selects the unit for phase measurement as DEG (degree) or RAD (radian). The unit selected is shown in brackets.</p> <p>Turns the expanded phase ON or OFF.</p>

## Display

Front Panel Key	Description
<b>Display</b>	
DUAL CHAN on OFF	Toggles between the display of both measurement channels or the active channel only. This is used in conjunction with SPLIT DISP ON off to display both channels.
DISPLAY[DATA]	Displays the current measurement data trace for the active channel.
DISPLAY: DATA	Displays the current measurement data trace for the active channel.
MEMORY	Displays the trace memory for the active channel. If no data is stored in memory for this channel, a warning message is displayed.
DATA and MEMORY	Displays both the current data and the memory traces.
DATA→MEMORY	Stores the current active measurement data in the memory of the active channel. It then becomes the memory trace (for use in subsequent math manipulations or display). When NOP is changed, the memory trace can no longer be used and the data trace will be displayed.
OVERLAY TRACES	
DATA→OVERLAY	Displays the current data trace on the LCD. The displayed trace is treated as an image and is not updated when measurement sweep newly occurs. Also, marker cannot be used to read measurement data at each display point.
SELECT PEN COLOR	Specifies the pen to be used in displaying a overlay trace by DATA→OVERLAY.
CLEAR GRAPHICS	Erases the image of all overlay traces displayed using DATA→OVERLAY.
RETURN	
DATA HOLD [OFF]	Displays the following menu to specify the data hold function setting. The selected option is shown in brackets in the softkey label. Changing the option will clear the data which is currently held.
HOLD: OFF	Turns off the hold function.
MAX	Holds the maximum values at each display point.
MIN	Holds the minimum values at each display point.
RETURN	
DATA MATH [DATA]	Displays the following softkeys and the OFFSET softkey to define the offset value using the data math function. The data math function selected is shown in brackets ([DATA] shows that the data math function selected DATA).
DATA MATH: DATA	Turns off all data math functions.
DATA+MEM	Adds the memory to the data.
DATA-MEM	Subtracts the memory from the data.
DATA/MEM	Divides the data by the memory.
DEFAULT GAIN & OFS	Returns gain and offset value back to the default values (gain=1, offset=0).
OFFSET	
MKR→OFFSET	Enters the marker's amplitude value into the offset value.
OFFSET VALUE	Defines the imaginary part of the offset value when using the Smith, Polar, and admittance chart format. If the format is not one of the above formats, this softkey performs no function.
AUX OFFSET VALUE	Defines the imaginary part of the offset value when using the Smith, Polar, and admittance chart format. If the format is not one of the above formats, this softkey performs no function.
RETURN	
GAIN	Defines the gain value for the data math function.
RETURN	
MORE → Display more menu	

Front Panel Key	Description
<p><b>Display</b> Continued</p> <p>NA/SA Display more menu</p> <p><b>SPLIT DISP ON off</b></p> <p><b>DISP ALLOC [ALL INST]</b></p> <p><b>ALL INSTRUMENT</b></p> <p><b>HALF INSTR HALF BASIC</b></p> <p><b>ALL BASIC</b></p> <p><b>BASIC STATUS</b></p> <p><b>RETURN</b></p> <p><b>TITLE</b> → See Enter text menu</p> <p><b>ADJUST DISPLAY</b> → See Adjust display menu</p> <p><b>FREQUENCY BLANK</b></p> <p><b>RETURN</b></p>	<p>Toggles between a full-screen single graticule display of one or both channels, and a split display with two half-screen graticules one above the other. The split display can be used in conjunction with <b>DUAL CHAN ON</b> to show the measured data of each channel simultaneously on separate graticules.</p> <p>Selects a full screen single screen or two half-screen graticules.</p> <p>Selects two half-screens, one graticule display above the HP Instrument BASIC display.</p> <p>Selects a full screen single HP Instrument BASIC display.</p> <p>Selects a full screen graticule and three status lines for HP Instrument BASIC under the graticule.</p> <p>Displays the title menu in the softkey labels and the character set in the active entry area to display the title in the active channel title area on the screen.</p> <p>Blanks the displayed frequency notation for security purposes. Frequency labels cannot be restored except by pressing <b>Preset</b> or by turning the power off and then on.</p>
<p>ZA Display more menu</p> <p><b>SPLIT DISP ON off</b></p> <p><b>DISP ALLOC [ALL INST]</b></p> <p><b>ALL INSTRUMENT</b></p> <p><b>HALF INSTR HALF BASIC</b></p> <p><b>ALL BASIC</b></p> <p><b>BASIC STATUS</b></p> <p><b>RETURN</b></p>	<p>Toggles between a full-screen single graticule display of one or both channels, and a split display with two half-screen graticules one above the other. The split display can be used in conjunction with <b>DUAL CHAN ON</b> to show the measured data of each channel simultaneously on separate graticules.</p> <p>Displays the following menu to allocate the BASIC screen area on the display.</p> <p>Selects a full screen single screen or two half-screen graticules.</p> <p>Selects two half-screens, one graticule display above the HP Instrument BASIC display.</p> <p>Selects a full screen single HP Instrument BASIC display.</p> <p>Selects a full screen graticule and three status lines for HP Instrument BASIC under the graticule.</p>



Front Panel Key	Description
<b>Display</b> Continued	
EQUIV CKT MENU	Displays the <i>Equivalent Circuit Menu</i> .
SELECT EQV CKT [A]	Displays the <i>Select Equivalent Circuit Menu</i> .
CKT A	Selects equivalent circuit A, which is used for inductors with high core loss.
B	Selects equivalent circuit B, which is used for inductors in general and resistors.
C	Selects equivalent circuit C, which is used for high-value resistors.
D	Selects equivalent circuit D, which is used for capacitors.
E	Selects equivalent circuit E, which is used for resonators.
CALCULATE EQV PARAMS	Calculates the equivalent circuit parameters. While the calculation is being performed, the message Calculating EQV parameters is displayed. After the calculation is completed, the values of the equivalent parameters are displayed.
SIMULATE F-CHRST	Simulates the frequency characteristics by using the current equivalent circuit parameters and shows simulation results on the screen using memory trace. In other words, simulation results are stored into the memory trace.
RETURN	
DISP PARM on OFF	Calculates and displays the equivalent circuit parameters.
DEFINE EQV PARAMS	Shows the menu below to specify parameters for the selected equivalent circuit.
PARAMETER R1	Sets $R_1$ value.
C1	Sets $C_1$ value.
L1	Sets $L_1$ value.
C0	Sets $C_0$ value.
SIMULATE F-CHRST	Simulates the frequency characteristics by using the current equivalent circuit parameters and shows simulation results on the screen using memory trace. In other words, simulation results are stored into the memory trace.
RETURN	
CALCULATE EQV PARAMS	Calculates the equivalent circuit parameters. While the calculation is being performed, the message Calculating EQV parameters is displayed. After the calculation is completed, the values of the equivalent parameters are displayed.
SIMULATE F-CHRST	Simulates the frequency characteristics by using the current equivalent circuit parameters and shows simulation results on the screen using memory trace. In other words, simulation results are stored into the memory trace.
RETURN	Returns to the <i>Equivalent Circuit Menu</i> .
TITLE → See Enter text menu	Displays the title menu in the softkey labels and the character set in the active entry area to display the title in the active channel title area on the screen.
ADJUST DISPLAY → See Adjust display menu	
FREQUENCY BLANK	Blanks the displayed frequency notation for security purposes. Frequency labels cannot be restored except by pressing <b>Preset</b> or by turning the power off and then on.
RETURN	

Front Panel Key	Description
<p><b>Display</b> Continued</p> <p>Adjust display menu</p> <p><b>INTENSITY</b></p> <p><b>BACKGROUND INTENSITY</b></p> <p><b>MODIFY COLORS</b></p> <p><b>CH1 DATA</b></p> <p><b>CH1 MEM/ LIMIT LINE</b></p> <p><b>CH2 DATA</b></p> <p><b>CH2 MEM/ LIMIT LINE</b></p> <p><b>GRATICULE</b></p> <p><b>WARNING</b></p> <p><b>MORE</b></p> <p><b>TEXT</b></p> <p><b>IBASIC</b></p> <p><b>MORE</b></p> <p><b>PEN 1</b></p> <p><b>PEN 2</b></p> <p><b>PEN 3</b></p> <p><b>PEN 4</b></p> <p><b>PEN 5</b></p> <p><b>PEN 6</b></p> <p><b>RETURN</b></p> <p><b>RETURN</b></p> <p><b>RETURN</b></p> <p><b>DEFAULT COLORS</b></p> <p><b>SAVE COLORS</b></p> <p><b>RECALL COLORS</b></p> <p><b>RETURN</b></p>	<p>Sets the display intensity as a percentage of the brightest setting.</p> <p>Sets the background intensity of the display as a percentage of the white level.</p> <p>Displays the menu used for color modification of the display elements.</p> <p>Selects channel 1 data trace for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects channel 1 memory trace and limit line for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects channel 2 data trace for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects channel 2 memory and the reference line and limit line for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects the graticule and a portion of softkey text (where there is a choice of a feature being ON or OFF) for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects the warning annotation for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects all the non-data text for color modification (for example: softkey labels) and displays the <i>color adjust menu</i>.</p> <p>Selects the text on the BASIC screen for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 1 for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 2 for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 3 for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 4 for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 5 for color modification and displays the <i>color adjust menu</i>.</p> <p>Selects pen 6 for color modification and displays the <i>color adjust menu</i>.</p> <p>Returns all the color settings back to the factory-set default values.</p> <p>Saves the modified version of the color set to the non-volatile memory.</p> <p>Recalls the previously saved modified version of the color set from the non-volatile memory. <b>RECALL COLORS</b> appears only when a color set has been saved.</p>
<p>Color adjust menu</p> <p><b>TINT</b></p> <p><b>BRIGHTNESS</b></p> <p><b>COLOR</b></p> <p><b>RESET COLOR</b></p> <p><b>RETURN</b></p>	<p>Adjusts the hue of the chosen attribute.</p> <p>Adjusts the brightness of the color being modified.</p> <p>Adjusts the degree of whiteness of the color being modified.</p> <p>Resets the color being modified to the default color.</p>

Scale Ref

Front Panel Key	Description
<p>Scale Ref</p>	
<p>Network Analyzer</p>	
<p>AUTO SCALE</p>	<p>Brings the trace data (defined by the SCALE FOR key) in view on the display with one keystroke. Sweep values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto the vertical graticule.</p>
<p>SCALE/DIV</p>	<p>Changes the response value scale per division of the displayed trace. In Smith, polar, and admittance chart formats, this refers to the full scale value at the outer circumference and is identical to the reference value.</p>
<p>REFERENCE POSITION</p>	<p>Sets the position of the reference line on the graticule of a Cartesian display (with 0 at the bottom line of the graticule and 10 at the top line). It has no effect on a Smith, polar or admittance chart format. The reference position is indicated with a small triangle just outside the graticule, on the left.</p>
<p>REFERENCE VALUE</p>	<p>Changes the value of the reference line, moving the measurement trace correspondingly. In Smith, polar and admittance chart formats, the reference value is the same as the scale and is the value of the outer circle.</p>
<p>MKR→REFERENCE</p>	<p>Makes the reference value equal to the marker's absolute value (regardless of the delta marker value). The marker is effectively moved to the reference line position. In Smith, polar and admittance chart formats this function makes the full scale value at the outer circle equal to the marker response value.</p>
<p>SCALE FOR [DATA]</p>	<p>Selects one of the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu.</p>
<p>D&amp;M SCALE [COUPLE]</p>	<p>Couples or uncouples the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu. This is valid only for those traces obtained by the <i>display menu</i> accessed from the <b>Display</b> key.</p>
<p>ATTENUATOR MENU</p>	<p>Displays the menu to control the attenuation at the following ports.</p>
<p>ATTEN R</p>	<p>Controls the attenuation at port R.</p>
<p>ATTEN A</p>	<p>Controls the attenuation at port A.</p>
<p>ATTEN B</p>	<p>Controls the attenuation at port B.</p>
<p>TEST SET ATTEN PT1</p>	<p>Controls the attenuation at port 1 of an S-parameter test set that is connected to the analyzer.</p>
<p>TEST SET ATTEN PT2</p>	<p>Controls the attenuation at port 2 of an S-parameter test set that is connected to the analyzer.</p>
<p>RETURN</p>	

Front Panel Key	Description
<p><b>Scale Ref</b> Continued</p> <p>Spectrum Analyzer</p> <p><b>PEAK</b>→<b>REFERENCE</b></p> <p><b>SCALE/DIV</b></p> <p><b>REFERENCE VALUE</b></p> <p><b>SCALE FOR [DATA]</b></p> <p><b>D&amp;M SCALE [COUPLE]</b></p> <p><b>ATTENUATOR MENU</b></p> <p><b>ATTEN R</b></p> <p><b>ATTEN A</b></p> <p><b>ATTEN B</b></p> <p><b>ATT AUTO on OFF</b></p> <p><b>RETURN</b></p>	<p>Searches for a peak using the marker and applies a sweep parameter at the marker to the reference value of the sweep parameters for the destination channel. The sweep parameter specified is an absolute value; not a difference even if a Δmarker is used.</p> <p>Changes the response value scale per division of the displayed trace.</p> <p>Changes the value of the reference line, moving the measurement trace correspondingly. In Smith, polar and admittance chart formats, the reference value is the same as the scale and is the value of the outer circle.</p> <p>Selects one of the “DATA” and “MEMORY” traces to be scaled by prior functions in this menu.</p> <p>Couples or uncouples the “DATA” and “MEMORY” traces to be scaled by prior functions in this menu. This is valid only for those traces obtained by the <i>display menu</i> accessed from the <b>Display</b> key.</p> <p>Displays the menu to control the attenuation at the following ports.</p> <p>Controls the attenuation at port R.</p> <p>Controls the attenuation at port A.</p> <p>Controls the attenuation at port B.</p> <p>Sets the automatic and manual spectrum analyzer input attenuator of an input port.</p> <p>When the automatic attenuator is selected, the value selected ensures that the level meets the following equation:</p> $\text{Attenuator value(dB)} = (\text{Reference value}) - (20\text{dB})$
<p>Impedance Analyzer</p> <p><b>AUTO SCALE</b></p> <p><b>SCALE/DIV</b></p> <p><b>REFERENCE POSITION</b></p> <p><b>REFERENCE VALUE</b></p> <p><b>MKR</b>→<b>REFERENCE</b></p> <p><b>SCALE FOR [DATA]</b></p>	<p>Brings the trace data (defined by the <b>SCALE FOR</b> key) in view on the display with one keystroke. Sweep values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto the vertical graticule.</p> <p>Changes the response value scale per division of the displayed trace. In Smith, polar, and admittance chart formats, this refers to the full scale value at the outer circumference and is identical to the reference value.</p> <p>Sets the position of the reference line on the graticule of a Cartesian display (with 0 at the bottom line of the graticule and 10 at the top line). It has no effect on a Smith, polar or admittance chart format. The reference position is indicated with a small triangle and a dashed line just outside the graticule, on the left.</p> <p>Changes the value of the reference line, moving the measurement trace correspondingly. In Smith, polar and admittance chart formats, the reference value is the same as the scale and is the value of the outer circle.</p> <p>Makes the reference value equal to the marker’s absolute value (regardless of the delta marker value). The marker is effectively moved to the reference line position. In Smith, polar and admittance chart formats this function makes the full scale value at the outer circle equal to the marker response value.</p> <p>Selects one of the “DATA” and “MEMORY” traces to be scaled by prior functions in this menu.</p>

Front Panel Key	Description
<p><b>Scale Ref</b> Continued</p>	
<p><b>MORE</b></p>	
<p><b>AUTO SCALE</b></p>	<p>Brings the trace data (defined by the <b>SCALE FOR</b> key) in view on the display with one keystroke. Sweep values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto the vertical graticule.</p>
<p><b>SCALE/DIV</b></p>	<p>Changes the response value scale per division of the displayed trace. In Smith, polar, and admittance chart formats, this refers to the full scale value at the outer circumference and is identical to the reference value.</p>
<p><b>TOP VALUE</b></p>	<p>Changes the value at the top line of the graticule, moving the measurement trace correspondingly.</p>
<p><b>BOTTOM VALUE</b></p>	<p>Changes the value at the bottom line of the graticule, moving the measurement trace correspondingly.</p>
<p><b>MKR→REFERENCE</b></p>	<p>Makes the reference value equal to the marker's absolute value (regardless of the delta marker value). The marker is effectively moved to the reference line position. In Smith, polar and admittance chart formats this function makes the full scale value at the outer circle equal to the marker response value.</p>
<p><b>SCALE FOR [DATA]</b></p>	<p>Selects one of the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu.</p>
<p><b>D&amp;M SCALE [COUPLE]</b></p>	<p>Couples or uncouples the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu. This is valid only for those traces obtained by the <i>display menu</i> accessed from the <b>Display</b> key.</p>
<p><b>MORE</b></p>	
<p><b>AUTO SCALE</b></p>	<p>Brings the trace data (defined by the <b>SCALE FOR</b> key) in view on the display with one keystroke. Sweep values are not affected, only scale and reference values. The analyzer determines the smallest possible scale factor that will put all displayed data onto the vertical graticule.</p>
<p><b>SCALE/DIV</b></p>	<p>Changes the response value scale per division of the displayed trace. In Smith, polar, and admittance chart formats, this refers to the full scale value at the outer circumference and is identical to the reference value.</p>
<p><b>REFERENCE X VALUE</b></p>	<p>Changes the value of the center position of the X axis, moving the measurement trace correspondingly.</p>
<p><b>REFERENCE Y VALUE</b></p>	<p>Changes the value of the center position of the Y axis, moving the measurement trace correspondingly.</p>
<p><b>MKR→REFERENCE</b></p>	<p>Makes the reference value equal to the marker's absolute value (regardless of the delta marker value). The marker is effectively moved to the reference line position. In Smith, polar and admittance chart formats this function makes the full scale value at the outer circle equal to the marker response value.</p>
<p><b>SCALE FOR [DATA]</b></p>	<p>Selects one of the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu.</p>
<p><b>D&amp;M SCALE [COUPLE]</b></p>	<p>Couples or uncouples the "DATA" and "MEMORY" traces to be scaled by prior functions in this menu. This is valid only for those traces obtained by the <i>display menu</i> accessed from the <b>Display</b> key.</p>
<p><b>MORE</b></p>	

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Bw/Avg

Front Panel Key	Description
<p><b>Bw/Avg</b></p> <p>Network Analyzer</p> <p>AVERAGING RESTART</p> <p>AVERAGING on OFF</p> <p>AVERAGING FACTOR</p> <p>IF BW auto MAN</p> <p>IF BW</p> <p>AUTO IFBW LIMIT</p> <p>GROUP DELY APERTURE</p>	<p>Resets the sweep-to-sweep averaging and restarts the sweep count at 1 at the beginning of the next sweep. The sweep count for averaging is displayed at the left of the display.</p> <p>Turns the averaging function on or off for the active channel.</p> <p>Makes the averaging factor the active function. Any value up to 999 can be used.</p> <p>When the sweep type is log frequency (LOG FREQ), you can choose automatic mode or manual mode for IF bandwidth. (In other sweep types, IF bandwidth is fixed to manual mode.) In auto mode, IF bandwidth is automatically set equal to or less than 1/5 of each measurement frequency. If you want to set an upper limit of IF bandwidth in auto mode, press AUTO IFBW LIMIT and enter the upper limit with entry keys.</p> <p>Selects the bandwidth value for IF bandwidth reduction.</p> <p>Sets an upper limit for IF bandwidth when IF bandwidth is set to auto mode.</p> <p>Sets the aperture for the group delay measurements as a percentage of the span.</p>
<p>Spectrum Analyzer</p> <p>AVERAGING RESTART</p> <p>AVERAGING on OFF</p> <p>AVERAGING FACTOR</p> <p>RES BW AUTO man</p> <p>RES BW</p> <p>RBW/SPAN RATIO</p> <p>VBW TYPE [LIN]</p> <p>VIDEO BW</p>	<p>Resets the sweep-to-sweep averaging and restarts the sweep count at 1 at the beginning of the next sweep. The sweep count for averaging is displayed at the left of the display.</p> <p>Turns the averaging function on or off for the active channel. Whenever an instrument state change affecting the measured data is made, the sweep count for averaging is reset to 1.</p> <p>Makes averaging factor the active function. Any value up to 999 can be used.</p> <p>Toggles between automatic and manual resolution bandwidth settings. The automatic resolution bandwidth specifies the resolution bandwidth from SPAN and RBW/SPAN ratio. Selecting the automatic setting in the zero span can fail, showing an error message.</p> <p>Selects the bandwidth value for resolution bandwidth reduction.</p> <p>Makes the RBW/SPAN ratio the active function. The RBW/SPAN ratio specifies resolution bandwidth in AUTO mode.</p> <p>Selects one of the Linear and logarithm types of the post detection filter (VBW).</p> <p>[LIN] The Linear type of VBW is selected. The analyzer enters the power (linear value) to be measured to the post-detection filter. In other words, the analyzer calculates logarithms of power after the post-detection filter.</p> <p>[LOG] The logarithm type of VBW is selected. The analyzer enters the logarithm value of power to be measured to the post-detection filter, as same as a conventional analog spectrum analyzer, which uses a log-amplifier. (The analyzer calculates logarithms of power before the post-detection filter.) The logarithm VBW makes measurement result 2.5 dB lower than the actual value.</p> <p>Changes the spectrum analyzer's post-detection filter.</p>
<p>Impedance Analyzer</p> <p>AVERAGING RESTART</p> <p>AVERAGING on OFF</p> <p>AVERAGING FACTOR</p> <p>IF BW auto MAN</p> <p>IF BW</p> <p>AUTO IFBW LIMIT</p>	<p>Resets the sweep-to-sweep averaging and restarts the sweep count at 1 at the beginning of the next sweep. The sweep count for averaging is displayed at the left of the display.</p> <p>Turns the averaging function on or off for the active channel. Whenever an instrument state change affecting the measured data is made, the sweep count for averaging is reset to 1.</p> <p>Makes averaging factor the active function. Any value up to 999 can be used.</p> <p>When the sweep type is log frequency (LOG FREQ), you can choose automatic mode or manual mode for IF bandwidth. (In other sweep types, IF bandwidth is fixed to manual mode.) In auto mode, IF bandwidth is automatically set equal to or less than 1/5 of each measurement frequency. If you want to set an upper limit of IF bandwidth in auto mode, press AUTO IFBW LIMIT and enter the upper limit with entry keys.</p> <p>Selects the bandwidth value for resolution bandwidth reduction.</p> <p>Sets an upper limit for IF bandwidth when IF bandwidth is set to auto mode.</p>

Cal

Front Panel Key	Description
Cal	
Network Analyzer	
CORRECTION on OFF	Turns error correction on or off. The analyzer uses the most recent calibration data for the displayed parameter.
CALIBRATE MENU → See NA Cal menu	Displays the menu that provides several accuracy enhancement procedures ranging from a simple frequency response calibration to a full two-port calibration. At the completion of a calibration procedure, correction is automatically turned on, and the notation “Cor” or “C2” is displayed at the left of the screen.
RESUME CAL SEQUENCE	Eliminates the need to restart a calibration sequence that was interrupted to access some other menu. Goes back to the point where the calibration sequence was interrupted.
CAL KIT [7mm] → See NA Cal kit menu	Displays the menu that selects one of the default calibration kits available for different connector types. This in turn displays additional softkeys used to define calibration standards other than those in the default kits (see “Modifying Calibration Kits” in Appendix A). When a calibration kit has been specified, its connector type is displayed in brackets in the softkey label.
MORE	
PORT EXTENSIONS	Goes to the <i>reference plane</i> menu that extends the apparent location of the measurement reference plane or input.
EXTENSIONS on OFF	Toggles the reference plane extension mode. When this function is on, all extensions defined below are enabled; when off, none of the extensions are enabled.
EXTENSION INPUT R	Adds electrical delay in seconds to extend the reference plane at input R to the end of the cable. This is used for all R input measurements (including S-parameters).
EXTENSION INPUT A	Adds electrical delay to the input A reference plane for all A input measurements (including S-parameters).
EXTENSION INPUT B	Adds electrical delay to the input B reference plane for all B input measurements (including S-parameters).
EXTENSION PORT 1	Extends the reference plane for measurements of $S_{11}$ , $S_{21}$ , and $S_{12}$ .
EXTENSION PORT 2	Extends the reference plane for measurements of $S_{22}$ , $S_{12}$ , and $S_{21}$ .
RETURN	
VELOCITY FACTOR	Enters the velocity factor used by the analyzer to calculate equivalent electrical length.
SET Z <sub>0</sub>	Sets the characteristic impedance used by the analyzer in calculating measured impedance with Smith chart markers and conversion parameters. If the test set used is an 85046B test set, or an 87512B Transmission/Reflection Test Kit, set $Z_0$ to 75 $\Omega$ . Characteristic impedance must be set correctly before calibration procedures are performed.
ELECTRICAL DELAY MENU	Displays softkeys to add or subtract a linear phase slope relative to frequency or a constant phase.
MKR→DELAY	Enters the group delay at the marker point of a fixed frequency aperture, 20 % of the span, to the electrical delay to balance the phase of the DUT. This effectively flattens the phase trace around the marker and can measure electrical length or deviation from linear phase. Additional electrical delay adjustment is required for DUTs without constant group delay over the measured frequency span. Because this feature adds phase to a variation in phase versus frequency, it is applicable only for ratioed input
ELECTRICAL DELAY	Adjusts the electrical delay to balance the phase shift of the DUT.
PHASE OFFSET	Adds or subtracts a phase offset that is constant with frequency (rather than linear). This is independent of <u>MARKER→DELAY</u> and <u>ELECTRICAL DELAY</u>
RETURN	
RETURN	



Front Panel Key	Description
<u>Cal</u> Continued	
NA Cal menu	
<u>CALIBRATE:NONE</u>	This softkey is underlined if no calibration has been performed or if the calibration data has been cleared. Unless a calibration is saved on the internal disk, the calibration data is lost when <u>Preset</u> is pressed, power is cycled on and off, or if an instrument state is recalled.
<u>RESPONSE</u>	Displays the frequency response calibration. This is the simplest and fastest accuracy enhancement procedure. However, it should only be used when extreme accuracy is not required. It effectively removes the frequency response errors of the test setup for reflection or transmission measurements.
<u>SHORT</u>	Measures SHORT standard of 7 mm or 3.5 mm cal kit for the response calibration.
<u>OPEN</u>	Measures OPEN standard of 7 mm or 3.5 mm cal kit for the response calibration.
<u>THRU</u>	Measures THRU standard of 7 mm or 3.5 mm cal kit for the response calibration.
<u>DONE: RESPONSE</u>	Completes the response calibration and computes and stores the error coefficients. The correction menu is displayed with <u>CORRECTION ON</u> .
<u>RESPONSE &amp; ISOL'N</u>	Displays the menus used to perform a response and isolation measurement calibration (used to measure devices with wide dynamic range). This procedure effectively reduces the same errors as the response calibration. In addition, it effectively reduces the isolation (crosstalk) error in transmission measurements or the directivity error in reflection measurements. In addition to the devices required for a simple response calibration, an isolation standard is required. The standard normally used to correct for isolation is an impedance-matched LOAD (usually 50 $\Omega$ or 75 $\Omega$ ) standard. Response and directivity calibration procedures for reflection and transmission measurements are provided in the "Performing a Response & Isolation Calibration" in Chapter 7.
<u>RESPONSE</u>	Displays the <i>response standard menu</i> that measures the standard for response calibration.
<u>ISOL'N STD</u>	Displays the menu that performs an isolation measurement calibration.
<u>DONE RESP ISOL'N CAL</u>	Completes the response and isolation calibration and computes and stores the error coefficients. The correction menu is displayed with <u>CORRECTION ON</u> .
<u>S11 1-PORT</u>	Provides a measurement calibration for reflection-only measurements of one-port devices or properly terminated two-port devices, at port 1 of an S-parameter test set or the test port of a transmission/reflection test kit. This procedure effectively reduces the directivity, source match, and frequency response errors of the test setup. It provides a higher level of measurement accuracy than the response and isolation calibration. It is the most accurate calibration procedure for reflection-only measurements. Three standard devices are required: a SHORT, an OPEN, and an impedance-matched LOAD. The procedure for performing an $S_{11}$ one-port calibration is described in the "Performing an S11 1-Port Calibration" in Chapter 7.
<u>(S11): OPEN</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the OPEN standard and then the softkey label is underlined. Or, this softkey displays the <i>open standard menu</i> that selects an OPEN standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>SHORT</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the SHORT standard and then the softkey label is underlined. Or, this softkey displays the <i>short standard menu</i> that selects a SHORT standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>LOAD</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the LOAD standard and then the softkey label is underlined. Or, this softkey displays the <i>load standard menu</i> that selects a LOAD standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>DONE: 1-PORT CAL</u>	Completes the 1-port calibration. The error coefficients are computed and stored. The correction menu is displayed with <u>CORRECTION ON</u> . If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
<u>S22 1-PORT</u>	This softkey is similar to <u>S11 1-PORT</u> . It is used for reflection-only measurements of one-port devices or properly terminated two-port devices in the reverse direction (that is, for devices connected to port 2 of the S-parameter test set).
<u>(S22): OPEN</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the OPEN standard and then the softkey label is underlined. Or, this softkey displays the <i>open standard menu</i> that selects an OPEN standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>SHORT</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the SHORT standard and then the softkey label is underlined. Or, this softkey displays the <i>short standard menu</i> that selects a SHORT standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>LOAD</u>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the LOAD standard and then the softkey label is underlined. Or, the softkey displays the <i>load standard menu</i> that selects a LOAD standard and measures the standard when the cal kit is 50 $\Omega$ or 75 $\Omega$ type-N.
<u>DONE: 1-PORT CAL</u>	Completes the 1-port calibration. The error coefficients are computed and stored. The correction menu is displayed with <u>CORRECTION ON</u> . If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.

Front Panel Key	Description
<b>Cal</b> Continued	
<b>FULL 2-PORT</b>	Displays the series of menus used to perform a complete calibration to measure all four S-parameters of a two-port device. This is the most accurate calibration for measurements of two-port devices. It effectively reduces all correctable systematic errors (directivity, source match, load match, isolation, reflection tracking, and transmission tracking) in both the forward and the reverse direction. Isolation correction can be omitted for measurements of devices with limited dynamic range.
<b>REFLECT'N</b>	Start the reflection calibration for full 2-port calibration and displays the menu that measures one port standards for reflection calibration.
<b>(S11): OPEN</b>	When the cal kit is a 7 mm or 3.5 mm cal kit this softkey measures the OPEN standard and then the softkey label is underlined. Or, this softkey displays the <i>open standard menu</i> that selects an OPEN standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>SHORT</b>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the short standard and then the softkey label is underlined. Or, the softkey displays the <i>short standard menu</i> that selects a SHORT standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>LOAD</b>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the load standard and then the softkey label is underlined. Or, this softkey displays the <i>load standard menu</i> that selects a LOAD standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>(S22): OPEN</b>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the OPEN standard and then softkey label is underlined. Or, this softkey displays the <i>OPEN standard menu</i> that selects an the OPEN standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>SHORT</b>	When the cal kit is a 7 mm or 3.5 mm cal kit, this softkey measures the short standard and then the softkey label is underlined. Or, this softkey displays the <i>short standard menu</i> that selects a SHORT standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>LOAD</b>	When the cal kit is a 7 mm or 3.5 mm cal kit this softkey measures the load standard and then the softkey label is underlined. Or, this softkey displays the <i>load standard menu</i> that selects a LOAD standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
<b>REFLECT'N DONE</b>	Completes the reflection calibration for the full 2-port calibration. The error coefficients are computed and stored. Full 2-Port menu is displayed, with the <b>REFLECT'N</b> softkey underlined. If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
<b>TRANSMISSION</b>	Starts the transmission calibration and displays the menu that measures frequency response and load match for transmission calibration.
<b>FWD. TRANS. THRU</b>	Measures S <sub>21</sub> frequency response, and then <b>FWD. TRANS. THRU</b> is underlined. If the cal kit is a user kit and two or more standards are assigned to the forward transmission class, <b>FWD. TRANS. THRU</b> displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
<b>FWD. MATCH THRU</b>	Measures S <sub>11</sub> load match, and then <b>FWD. MATCH THRU</b> is underlined. If the cal kit is a user kit and two or more standards are assigned to the forward match class, <b>FWD. MATCH THRU</b> displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
<b>REV. TRANS. THRU</b>	Measures S <sub>12</sub> frequency response, and then <b>REV. TRANS. THRU</b> is underlined. If the cal kit is a user kit and two or more standards are assigned to the reverse transmission class, <b>REV. TRANS. THRU</b> displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
<b>REV. MATCH THRU</b>	Measures S <sub>22</sub> load match, and then <b>REV. MATCH THRU</b> is underlined. If the cal kit is a user kit and two or more standards are assigned to the reverse match class, <b>REV. MATCH THRU</b> displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
<b>TRANS. DONE</b>	Completes transmission calibration. The error coefficients are calculated and stored. Full 2-Port menu is displayed, with <b>TRANSMISSION</b> underlined. If <b>TRANS. DONE</b> is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
<b>ISOLATION</b>	Starts the isolation calibration and displays the menu that measures isolation.
<b>OMIT ISOLATION</b>	Omits correction for isolation from the calibration when it is not required.
<b>FWD.ISOL'N ISOL'N STD</b>	Measures S <sub>21</sub> isolation and then <b>FWD.ISOL'N ISOL'N STD</b> is underlined.
<b>REV.ISOL'N ISOL'N STD</b>	Measures S <sub>12</sub> isolation and then <b>REV.ISOL'N ISOL'N STD</b> is underlined.
<b>ISOLATION DONE</b>	Completes isolation calibration. The error coefficients are calculated and stored. The full 2-port menu is displayed, with <b>ISOLATION</b> underlined. If <b>ISOLATION DONE</b> is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.

Front Panel Key	Description
<b>Cal</b> Continued	
DONE: 2-PORT CAL	Completes the full 2-port calibration. The error coefficients are computed and stored. The correction menu is displayed with <b>CORRECTION ON</b> and the notation C2 is displayed at the left of the screen. If <b>DONE: 2-PORT CAL</b> is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed
ONE PATH 2-PORT	Displays the series of menus used to perform a high-accuracy, two-port calibration without an S-parameter test set. This calibration procedure effectively reduces directivity, source match, load match, isolation, reflection tracking, and transmission tracking errors in one direction only. Isolation correction can be omitted for measurements of devices with limited dynamic range. (The DUT must be manually reversed between sweeps to accomplish measurement of both input and output responses.) The required standards are a SHORT, an OPEN, a THRU, and an impedance-matched LOAD. The procedure for performing a one-path 2-port calibration is described in the “Performing a 1-Path 2-Port Calibration” in Chapter 7.
REFLECT'N	Start the reflection calibration for full 2-port calibration and displays the menu that measures one port standards for reflection calibration.
(S11): OPEN	When the cal kit is a 7 mm or 3.5 mm cal kit this softkey measures the OPEN standard and then the softkey label is underlined. Or, this softkey displays the <i>open standard menu</i> that selects an OPEN standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
SHORT	When the cal kit is a 7 mm or 3.5 mm cal kit this softkey measures the SHORT standard and then the softkey label is underlined. Or, this softkey displays the <i>short standard menu</i> that selects a SHORT standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
LOAD	When the cal kit is a 7 mm or 3.5 mm cal kit this softkey measures the LOAD standard and then the softkey label is underlined. Or, this softkey displays the <i>load standard menu</i> that selects a load standard and measures the standard when the cal kit is 50 Ω or 75 Ω type-N.
REFLECT'N DONE	Completes the reflection calibration for the one-path 2-port calibration. The error coefficients are computed and stored. One-path 2-Port menu is displayed, with the <b>REFLECT'N</b> softkey underlined. If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
TRANSMISSION	Starts the transmission calibration and displays the menu that measures frequency response and load match for transmission calibration.
FWD. TRANS. THRU	Measures $S_{21}$ frequency response, and then the softkey is underlined. If the cal kit is user kit and two or more standards are assigned to the forward transmission class, this softkey displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
FWD. MATCH THRU	Measures $S_{11}$ load match, and then the softkey is underlined. If the cal kit is user kit and two or more standards are assigned to the forward match class, this softkey displays the <i>THRU standard menu</i> that selects the THRU standard and measures it.
TRANS. DONE	Completes transmission calibration. The error coefficients are calculated and stored. The one-path, 2-Port menu is displayed, with the <b>TRANSMISSION</b> softkey underlined. If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
ISOLATION	Starts the isolation calibration and displays the menu that measures isolation.
OMIT ISOLATION	Omits correction for isolation from the calibration when it is not required.
FWD.ISOL'N ISOL'N STD	Measures $S_{21}$ isolation and then the softkey label is underlined.
REV.ISOL'N ISOL'N STD	Measures $S_{12}$ isolation and then the softkey label is underlined.
ISOLATION DONE	Completes isolation calibration. The error coefficients are calculated and stored. One-path 2-port menu is displayed, with the <b>ISOLATION</b> softkey underlined. If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.
DONE: 2-PORT CAL	Completes the one-path 2-port calibration. The error coefficients are computed and stored. The correction menu is displayed with <b>CORRECTION ON</b> , and the notation C2 is displayed at the left of the screen. If this key is pressed without measuring all the required standards, the message CAUTION:ADDITIONAL STANDARDS NEEDED is displayed.

Front Panel Key	Description
<b>Cal</b> Continued	
Response standard menu	
SHORT	Measures SHORT standard of 7 mm or 3.5 mm cal kit for the response calibration.
OPEN	Measures OPEN standard of 7 mm or 3.5 mm cal kit for the response calibration.
THRU	Measures THRU standard of 7 mm or 3.5 mm cal kit for the response calibration.
DONE:RESPONSE	Completes the response calibration and computes and stores the error coefficients. The correction menu is displayed with <b>CORRECTION ON</b> .
SHORT[M]	Measures SHORT standard of type-N cal kits connected to the type-N male test port connector for the response calibration. [M] indicates that the test port connector is male, it does not indicate the connector type of the standard.
SHORT[F]	Measures SHORT standard of type-N cal kits connected to the type-N female test port connector for the response calibration. [F] indicates that the test port connector is female, it does not indicate the connector type of the standard.
OPEN[M]	Measures OPEN standard of type-N cal kits connected to the type-N male test port connector for the response calibration. [M] indicates that the test port connector is male, it does not indicate the connector type of the standard.calibration.
OPEN[F]	Measures OPEN standard of type-N cal kits connected to the type-N female test port connector for the response calibration. [F] indicates that the test port connector is female, it does not indicate the connector type of the standard.
THRU	Measures THRU standard of type-N cal kits for the response calibration.
DONE:RESPONSE	Completes the response calibration and computes and stores the error coefficients. The correction menu is displayed with <b>CORRECTION ON</b> .
defined std 1	These softkeys measure the standard defined by the user for the response calibration. When only one standard is assigned to the response calibration, this softkey menu is not displayed and the standard is measured immediately.
defined std 2	
defined std 3	
defined std 4	
defined std 5	
defined std 6	
defined std 7	
DONE:RESPONSE	Completes the response calibration and computes and stores the error coefficients. The correction menu is displayed with <b>CORRECTION ON</b> .

Front Panel Key	Description
<p><b>Cal</b> Continued</p> <p>OPEN standard menu</p> <p>OPEN[M]</p> <p>OPEN[F]</p> <p>DONE:OPEN</p> <p>defined std 1</p> <p>defined std 2</p> <p>defined std 3</p> <p>defined std 4</p> <p>defined std 5</p> <p>defined std 6</p> <p>defined std 7</p> <p>DONE:OPEN</p>	<p>Measures OPEN standard of type-N cal kits connected to the type-N male test port connector for the response calibration. [M] indicates that the test port connector is male, it does not indicate the connector type of the standard.</p> <p>Measures OPEN standard of type-N cal kits connected to the type-N female test port connector for the response calibration. [F] indicates that the test port connector is female, it does not indicate the connector type of the standard.</p> <p>Completes the OPEN calibration and computes and stores the error coefficients. The correction menu is displayed with CORRECTION ON .</p> <p>These softkeys measure the standard defined by the user for the OPEN calibration. When only one standard is assigned to the OPEN calibration, this softkey menu is not displayed and the standard is measured immediately.</p> <p>Completes the OPEN calibration and computes and stores the error coefficients. The correction menu is displayed with CORRECTION ON .</p>
<p>SHORT standard menu</p> <p>SHORT[M]</p> <p>SHORT[F]</p> <p>DONE:SHORT</p> <p>defined std 1</p> <p>defined std 2</p> <p>defined std 3</p> <p>defined std 4</p> <p>defined std 5</p> <p>defined std 6</p> <p>defined std 7</p> <p>DONE:SHORT</p>	<p>Measures SHORT standard of type-N cal kits connected to the type-N male test port connector for the response calibration. [M] indicates that the test port connector is male, it does not indicate the connector type of the standard.</p> <p>Measures SHORT standard of type-N cal kits connected to the type-N female test port connector for the response calibration. [F] indicates that the test port connector is female, it does not indicate the connector type of the standard.</p> <p>Completes the SHORT calibration and computes and stores the error coefficients. The correction menu is displayed with CORRECTION ON .</p> <p>These softkeys measure the standard defined by the user for the SHORT calibration. When only one standard is assigned to the SHORT calibration, this softkey menu is not displayed and the standard is measured immediately.</p> <p>Completes the SHORT calibration and computes and stores the error coefficients. The correction menu is displayed with CORRECTION ON .</p>

Front Panel Key	Description
<p> <span style="border: 1px solid black; border-radius: 50%; padding: 2px;">Cal</span> Continued            LOAD standard menu             defined std 1            defined std 2            defined std 3            defined std 4            defined std 5            defined std 6            defined std 7            DONE:LOAD         </p>	<p>           These softkeys measure the standard defined by the user for the LOAD calibration. When only one standard is assigned to the LOAD calibration, this softkey menu is not displayed and the standard is measured immediately.                     Completes the LOAD calibration and computes and stores the error coefficients. The correction menu is displayed with <b>CORRECTION ON</b> .         </p>
<p>           THRU standard menu             defined std 1            defined std 2            defined std 3            defined std 4            defined std 5            defined std 6            defined std 7            DONE:THRU         </p>	<p>           These softkeys measure the standard defined by the user for the THRU calibration. When only one standard is assigned to the THRU calibration, this softkey menu is not displayed and the standard is measured immediately.                     Completes the THRU calibration and computes and stores the error coefficients. The correction menu is displayed with <b>CORRECTION ON</b> .         </p>

Front Panel Key	Description
<b>Cal</b> Continued	
NA Cal kit menu	
CAL KIT:7mm	Selects the 7 mm cal kit model.
3.5mm	Selects the 3.5 mm cal kit model.
N 50 Ω	Selects the 50 Ω type-N model.
N 75 Ω	Selects the 75 Ω type-N model.
USER KIT	Selects a cal kit model defined or modified by the user. For information, see “Modifying Calibration Kits” in Appendix A.
SAVE USER KIT	Stores the user-modified or user-defined kit into memory, after it has been modified.
MODIFY [7mm]	Displays the modify cal kit menu, where a default cal kit can be user-modified.
DEFINE STANDARD	Makes the standard number the active function and brings up the define standard number menus.
The standard number (1 to 8) is an arbitrary reference number used to reference standards when specifying a class. Each number is similar to a register in that it holds specific information. Each contains the selected type of device (OPEN, SHORT, or THRU) and the electrical model for that device.	
STD NO.1 [SHORT] →	Selects standard No.1 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
NA/ZA Standard type menu	
STD NO.2 [OPEN] → NA/ZA	Selects standard No.2 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
Standard type menu	
STD NO.3 [LOAD] → NA/ZA	Selects standard No.3 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
Standard type menu	
STD NO.4 [DEL/THRU] →	Selects standard No.4 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
NA/ZA Standard type menu	
STD NO.5 [LOAD] → NA/ZA	Selects standard No.5 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
Standard type menu	
STD NO.6 [LOAD] → NA/ZA	Selects standard No.6 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
Standard type menu	
STD NO.7 [SHORT] →	Selects standard No.7 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
NA/ZA Standard type menu	
STD NO.8 [OPEN] → NA/ZA	Selects standard No.8 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
Standard type menu	
SPECIFY CLASS	Displays softkeys that assign a standard to a standard class. After the standards are modified, use SPECIFY CLASS to specify that a class consists of specific standards.
SPECIFY: S11A	Enters the standard numbers for the first class required for an S <sub>11</sub> 1-port calibration. (For predefined cal kits, this is OPEN (for the 7 mm) or OPENS (for type-N).)
S11B	Enters the standard numbers for the second class required for an S <sub>11</sub> 1-port calibration. (For predefined cal kits, this is SHORT (for the 7 mm) or SHORTS (for the type-N) .)
S11C	Enters the standard numbers for the third class required for an S <sub>11</sub> 1-port calibration. (For predefined kits, this is LOAD.)
SPECIFY: S22A	Enters the standard numbers for the first class required for an S <sub>22</sub> 1-port calibration. (For predefined cal kits, this is OPEN (for the 7 mm) or OPENS (for the type-N).)
S22B	Enters the standard numbers for the second class required for an S <sub>22</sub> 1-port calibration. (For predefined cal kits, this is SHORT (for the 7 mm) or SHORTS (for the type-N).)
S22C	Enters the standard numbers for the third class required for an S <sub>22</sub> 1-port calibration. (For predefined kits, this is LOAD.)
MORE	

Front Panel Key	Description
<b>Cal</b> Continued	
SPECIFY:FWD.TRANS.	Enters the standard numbers for the forward transmission (THRU) calibration. (For predefined kits, this is THRU.)
REV.TRANS.	Enters the standard numbers for the reverse transmission (THRU) calibration. (For predefined kits, this is THRU.)
FWD.MATCH	Enters the standard numbers for the forward match (THRU) calibration. (For predefined kits, this is THRU.)
REV.MATCH	Enters the standard numbers for the reverse match (THRU) calibration. (For predefined kits, this is THRU.)
RESPONSE	Enters the standard numbers for a response calibration. This calibration corrects for frequency response in either reflection or transmission measurements (depending on the parameter being measured when a calibration is performed). (For predefined kits, the standard is either OPEN or SHORT for reflection measurements or THRU for transmission measurements.)
RESPONSE & ISO'N	Enters the standard numbers for a response and isolation calibration. This calibration corrects for frequency response and directivity in reflection measurements or frequency response and isolation in transmission measurements.
RETURN	
CLASS DONE (SPEC'D)	Completes the class assignment and stores it.
CLASS DONE (SPEC'D)	Completes the class assignment and stores it.
LABEL CLASS	Displays softkeys that give the class a meaningful label for future reference. These labels become softkey labels during a measurement calibration. A label can be up to ten characters long.
LABEL: S11A	Displays the <i>letter menu</i> to define the label for the first class required for an S <sub>11</sub> 1-port calibration.
S11B	Displays the <i>letter menu</i> to define the label for the second class required for an S <sub>11</sub> 1-port calibration.
S11C	Displays the <i>letter menu</i> to define the label for the third class required for an S <sub>11</sub> 1-port calibration.
LABEL: S22A	Displays the <i>letter menu</i> to define the label for the first class required for an S <sub>22</sub> 1-port calibration.
S22B	Displays the <i>letter menu</i> to define the label for the second class required for an S <sub>22</sub> 1-port calibration.
S22C	Displays the <i>letter menu</i> to define the label for the third class required for an S <sub>22</sub> 1-port calibration.
MORE	
LABEL:FWD.TRANS.	Displays the <i>letter menu</i> to define the label for the forward transmission (THRU) calibration.
REV.TRANS.	Displays the <i>letter menu</i> to define the label for the reverse transmission (THRU) calibration.
FWD.MATCH	Displays the <i>letter menu</i> to define the label for the forward match (THRU) calibration.
REV.MATCH	Displays the <i>letter menu</i> to define the label for the reverse match (THRU) calibration.
RESPONSE	Displays the <i>letter menu</i> to define the label for the response calibration.
RESPONSE & ISO'N	Displays the <i>letter menu</i> to define the label for the response and isolation calibration.
LABEL DONE	Completes the procedure to define labels and store them.
LABEL DONE	Completes the procedure to define labels and store them.
LABEL KIT	Displays the <i>letter menu</i> to define a label for a new calibration kit. This label appears in the CAL KIT softkey label in the correction menu and the MODIFY label in the select cal kit menu. It is saved with calibration data.
KIT DONE (MODIFIED)	Completes the procedure to define user cal kit.
RETURN	



Front Panel Key	Description
<b>Cal</b> Continued	
NA/ZA Standard type menu	
STD TYPE: OPEN	Defines the standard type as an OPEN (used for calibrating reflection measurements). OPENs are assigned a terminal impedance of infinite ohms (but delay and loss offsets can still be added). Pressing this key also displays a menu for defining the OPEN (including its capacitance).
C0	Enters the $C_0$ term, which is the constant term of the quadratic equation and is scaled by $10^{-15}$ Farads.
C1	Enters the $C_1$ term, expressed in F/Hz (Farads/Hz) and scaled by $10^{-27}$ .
C2	Enters the $C_2$ term, expressed in F/Hz <sup>2</sup> and scaled by $10^{-36}$ .
SPECIFY OFFSET → NA/ZA Specify offset menu	Displays the <i>specify offset menu</i> that defines offsets in delay, loss, and standard impedance ( $Z_0$ ) for each standard type.
LABEL STD	Displays the <i>letter menu</i> to define a label for each standard.
STD DONE (DEFINED)	Terminates the standard definition. Press this after each standard is defined (including offsets).
SHORT	Defines the standard type as a SHORT, for calibrating reflection measurements. SHORTs are assigned a terminal impedance of 0 $\Omega$ . However, delay and loss offsets can still be added.
SPECIFY OFFSET → NA/ZA Specify offset menu	Displays the <i>specify offset menu</i> that defines offsets in delay, loss, and standard impedance ( $Z_0$ ) for each standard type.
LABEL STD	Displays the <i>letter menu</i> to define a label for each standard.
STD DONE (DEFINED)	Terminates the standard definition. Press this after each standard is defined (including offsets).
LOAD	Defines the standard type as a LOAD (termination). LOADs are assigned a terminal impedance equal to the system characteristic impedance $Z_0$ . However, delay and loss offsets can still be added. If the LOAD impedance is not $Z_0$ , use the arbitrary impedance standard definition.
SPECIFY OFFSET → NA/ZA Specify offset menu	Displays the <i>specify offset menu</i> that defines offsets in delay, loss, and standard impedance ( $Z_0$ ) for each standard type.
LABEL STD	Displays the <i>letter menu</i> to define a label for each standard.
STD DONE (DEFINED)	Terminates the standard definition. Press this after each standard is defined (including offsets).
DELAY/THRU	Defines the standard type as a transmission line of specified length, for calibrating transmission measurements.
SPECIFY OFFSET → NA/ZA Specify offset menu	Displays the <i>specify offset menu</i> that defines offsets in delay, loss, and standard impedance ( $Z_0$ ) for each standard type.
LABEL STD	Displays the <i>letter menu</i> to define a label for each standard.
STD DONE (DEFINED)	Terminates the standard definition. Press this after each standard is defined (including offsets).
ARBITRARY IMPEDANCE	Defines the standard type to be a LOAD with an arbitrary impedance (different from system $Z_0$ ).
TERMINAL IMPEDANCE	Specifies the (arbitrary) impedance of the standard in ohms.
SPECIFY OFFSET → NA/ZA Specify offset menu	Displays the <i>specify offset menu</i> that defines offsets in delay, loss, and standard impedance ( $Z_0$ ) for each standard type.
LABEL STD	Displays the <i>letter menu</i> to define a label for each standard.
STD DONE (DEFINED)	Terminates the standard definition. Press this after each standard is defined (including offsets).
RETURN	

Front Panel Key	Description
<p><b>Cal</b> Continued</p> <p>See NA/ZA Specify offset menu</p> <p>OFFSET DELAY</p> <p>OFFSET LOSS</p> <p>OFFSET Z0</p> <p>STD OFFSET DONE</p>	<p>Specifies the one-way electrical delay from the measurement (reference) plane to the standard in seconds (s). (In a transmission standard, offset delay is the delay from plane to plane.) Delay can be calculated from the precise physical length of the offset, the permittivity constant of the medium, and the speed of light.</p> <p>Specifies energy loss, due to skin effect, along a one-way length of coaxial cable offset. The value of loss is entered as <math>\Omega</math>/second at 1 GHz.</p> <p>Specifies the characteristic impedance of the coaxial cable offset.</p> <p>Completes procedure to specify offset value of standard.</p>
<p>Impedance Analyzer</p> <p>CALIBRATE MENU</p> <p>OPEN</p> <p>SHORT</p> <p>LOAD</p> <p>DONE: CORRECTION</p> <p>RESUME CAL SEQUENCE</p> <p>FIXTURE COMPEN</p> <p>COMPEN MENU</p> <p>OPEN</p> <p>SHORT</p> <p>LOAD</p> <p>DONE: COMPEN</p> <p>RESUME COMP SEQ</p> <p>OPEN on OFF</p> <p>SHORT on OFF</p> <p>LOAD on OFF</p> <p>RETURN</p> <p>CAL KIT [IMP 7mm]</p> <p>CAL KIT: IMP 7mm</p> <p>3.5mm</p> <p>N 50 <math>\Omega</math></p> <p>N 75 <math>\Omega</math></p> <p>USER KIT</p> <p>SAVE USER KIT</p> <p>MODIFY [7mm]</p>	<p>Displays the <i>Calibration Operation Menu</i> that is used to perform a calibration measurement.</p> <p>Measures OPEN standard of the cal kit for calibration.</p> <p>Measures SHORT standard of the cal kit for calibration.</p> <p>Measures LOAD standard of the cal kit for calibration.</p> <p>Completes calibration and then computes and stores the error coefficients.</p> <p>Eliminates the need to restart a calibration sequence that was interrupted to access some other menu. Goes back to the point where the calibration sequence was interrupted. This key also displays the <i>Calibrate Menu</i> which are used to perform a resumed calibration measurement.</p> <p>Displays the <i>Fixture Compensation Menu</i> that is used to perform the fixture compensation measurement in order to reduce measurement errors existing in the test fixture.</p> <p>Displays the <i>Compensation Operation Menu</i> which are used to perform a fixture compensation measurement.</p> <p>Measures OPEN for the fixture compensation.</p> <p>Measures SHORT standard for the fixture compensation.</p> <p>Measures LOAD standard for the fixture compensation.</p> <p>Completes the fixture compensation measurement and then computes and stores the compensation coefficients.</p> <p>Goes back to the point where the fixture compensation sequence was interrupted when that was interrupted to access some other menu.</p> <p>Turns OPEN fixture compensation ON or OFF.</p> <p>Turns SHORT fixture compensation ON or OFF.</p> <p>Turns LOAD fixture compensation ON or OFF.</p> <p>Returns to the <i>Calibration Menu</i>.</p> <p>Displays the <i>Cal Kit Menu</i> that selects the default calibration kit and a user kit. This key displays additional softkeys used to define calibration standards other than those in the default kits. When a calibration kit has been specified, its label is displayed in brackets in the softkey label.</p> <p>Selects the 7 mm cal kit model.</p> <p>Selects the 3.5 mm cal kit model.</p> <p>Selects the 50 <math>\Omega</math> type-N model.</p> <p>Selects the 75 <math>\Omega</math> type-N model.</p> <p>Selects a cal kit model defined or modified by the user. For information, see “Modifying Calibration Kits” in Appendix A.</p> <p>Stores the user-modified or user-defined kit into memory, after it has been modified.</p> <p>Displays the modify cal kit menu, where a default cal kit can be user-modified.</p>

Front Panel Key	Description
<b>Cal</b> Continued	
DEFINE STANDARD	Makes the standard number the active function and brings up the define standard number menus. The standard number (1 to 8) is an arbitrary reference number used to reference standards when specifying a class. Each number is similar to a register in that it holds specific information. Each contains the selected type of device (OPEN, SHORT, or THRU) and the electrical model for that device.
STD NO.1 [SHORT]	Selects standard No.1 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.2 [OPEN]	Selects standard No.2 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.3 [LOAD]	Selects standard No.3 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.4 [DEL/THRU]	Selects standard No.4 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.5 [LOAD]	Selects standard No.5 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.6 [LOAD]	Selects standard No.6 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.7 [SHORT]	Selects standard No.7 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
STD NO.8 [OPEN]	Selects standard No.8 as the standard definition. The standard type you selected is shown in the softkey label enclosed with brackets.
SPECIFY CLASS	Displays <i>Specify Class Menu</i> .
SPECIFY: IMP A	Enters the standard numbers for the first class required for an impedance calibration.
IMP B	Enters the standard numbers for the second class required for an impedance calibration.
IMP C	Enters the standard numbers for the third class required for an impedance calibration.
CLASS DONE (SPEC'D)	Completes the class assignment and stores it.
LABEL CLASS	Displays <i>Label Class Menu</i> .
LABEL: IMP A → See Enter text menu	Defines a label for the first class required for an impedance calibration. (For predefined cal kits, this is OPEN.)
IMP B → See Enter text menu	Defines a label for the second class required for an impedance calibration. (For predefined cal kits, this is SHORT.)
IMP C → See Enter text menu	Defines a label for the third class required for an impedance calibration. (For predefined cal kits, this is LOAD.)
LABEL DONE	Completes setting the label of class.
LABEL KIT	Displays the <i>letter menu</i> to define a label for a new calibration kit. This label appears in the CAL KIT softkey label in the correction menu and the MODIFY label in the select cal kit menu. It is saved with calibration data.
KIT DONE (MODIFIED)	Completes the procedure to define user cal kit.
RETURN	

Front Panel Key	Description
<p><b>Cal</b> Continued</p> <p>COMPEN KIT [USER]</p> <p>SAVE COMPEN KIT</p> <p>MODIFY [USER]</p> <p>DEFINE STANDARD</p> <p>OPEN: CONDUCT(G)</p> <p>CAP.(C)</p> <p>SHORT: RESIST.(R)</p> <p>INDUCT.(L)</p> <p>LOAD: RESIST.(R)</p> <p>INDUCT.(L)</p> <p>STD DONE (DEFINED)</p> <p>LABEL KIT</p> <p>KIT DONE (MODIFIED)</p> <p>RETURN</p> <p>MORE</p> <p>PORT EXTENSION</p> <p>EXTENSION ON off</p> <p>EXTENSION VALUE</p> <p>RETURN</p> <p>VELOCITY FACTOR</p> <p>SET Z<sub>0</sub></p> <p>RETURN</p>	<p>Displays the <i>Compensation Kit Menu</i> that is used to define user-defined OPEN, SHORT, and LOAD for fixture compensation measurement. When a set of user-defined OPEN, SHORT, and LOAD values has been specified, its label is displayed in brackets in the softkey label.</p> <p>Stores the user-modified or user-defined OPEN, SHORT, and LOAD for fixture compensation into memory, after it has been modified.</p> <p>Displays the <i>Modify Compensation Kit Menu</i>.</p> <p>Displays the <i>Define Compensation Standard Menu</i>.</p> <p>Sets a conductance value (G) of OPEN.</p> <p>Sets a capacitance value (C) of OPEN.</p> <p>Sets a resistance value (R) of SHORT.</p> <p>Sets an inductance value (L) of SHORT.</p> <p>Sets a resistance value (R) of LOAD.</p> <p>Sets an inductance value (L) of LOAD.</p> <p>Completes the procedure to define user-defined OPEN, SHORT, and LOAD.</p> <p>Displays the <i>Letter Menu</i> to define a label for a new set of user-defined OPEN, SHORT, and LOAD. This label appears in the COMPEN KIT softkey label in the <i>Calibration Menu</i> and the MODIFY label in the <i>Compensation Kit Menu</i>. It is saved with the data of OPEN, SHORT, and LOAD.</p> <p>Completes the procedure to define user-defined OPEN, SHORT, and LOAD for fixture compensation.</p> <p>Displays the <i>Port Extensions Menu</i> that is used to extend the apparent location of the measurement reference plane.</p> <p>Turns port extension ON or OFF. When this function is ON, all extensions defined below are enabled; when OFF, none of the extensions are enabled.</p> <p>Makes the port extension value the active function. This function is used to add electrical delay in seconds to extend the reference plane at the APC-7 connector on the test head to the end of the cable.</p> <p>Enters the velocity factor used by the analyzer to calculate equivalent electrical length.</p> <p>Sets the characteristic impedance used by the analyzer in calculating measured impedance with Smith chart markers and conversion parameters. If the test set used is an 85046B test set, or an 87512B Transmission/Reflection Test Kit, set Z<sub>0</sub> to 75 Ω. Characteristic impedance must be set correctly before calibration procedures are performed.</p>
<p>Spectrum Analyzer</p> <p>LVL CAL DATA R</p> <p>LVL CAL DATA A</p> <p>LVL CAL DATA B</p> <p>SET Z<sub>0</sub></p>	<p>Set the level calibration data for the input port R.</p> <p>Set the level calibration data for the input port A.</p> <p>Set the level calibration data for the input port B.</p> <p>Set the input impedance to either 50 Ω or 75 Ω.</p>

**Sweep**

Front Panel Key	Description
<b>Sweep</b>	
Network/Impedance Analyzer	
SWEEP TIME AUTO man	Toggles between automatic and manual sweep time. The automatic sweep time selects the optimum sweep time automatically.
SWEEP TIME	Activates the sweep time function and displays the :h:m:s softkey.
: h:m:s	Enters ":" for the manual sweep time entry.
RETURN	
NUMBER OF POINTS	Sets the number of data points per sweep. Using fewer points allows a faster sweep time but the displayed trace shows less horizontal detail. Using more points gives greater data density and improved trace resolution, but slows the sweep.
COUPLED CH ON off	Toggles channel coupling of the sweep parameter values. With COUPLED CH ON (the preset condition), both channels have the same sweep parameter values (the inactive channel takes on the sweep parameter values of the active channel). If the channel's analyzer modes are different, the channels cannot be coupled.
SWEEP TYPE MENU	
SWEEP TYPE:LIN FREQ	Activates linear frequency sweep mode.
LOG FREQ	Activates logarithmic frequency sweep mode. The source is stepped in logarithmic increments and the data is displayed on a logarithmic graticule.
LIST FREQ	Activates frequency list mode. If the list is not defined, this softkey performs no function.
POWER SWEEP	Activates power sweep mode. Used to characterize power-sensitive DUTs. In this mode, power is swept at a single frequency from a start power value to a stop power value. Values are selected using the <b>START</b> and <b>STOP</b> keys and the entry block.
EDIT LIST	Displays the following softkeys to define or modify the frequency sweep list.
SEGMENT	Determines a segment on the list to be modified. Enter the number of a segment in the list, or use the step keys to scroll the pointer "i" at the left to the required segment number. The indicated segment can then be edited or deleted.
EDIT — See NA/ZA segment menu	Displays the <i>segment menu for spectrum analyzer</i> . The segment indicated by the pointer "i" at the left can be modified.
DELETE	Deletes the segment indicated by the pointer "i".
ADD — See NA/ZA segment menu	Adds a new segment to be defined with the <i>segment menu for spectrum analyzer</i> . If the list is empty, a default segment is added and the edit segment menu is displayed so it can be modified. If the list is not empty, the segment indicated by the pointer "i" is copied and the edit segment menu is displayed.
CLEAR LIST	Displays the <i>clear list menu</i> .
LIST DONE	Defines the frequency sweep list and returns to the sweep type menu.
SEGMENT WAIT	Specifies the time to keep the analyzer waiting for measurement start after the setting for each segment is completed.
LIST DISP [FREQ BS]	When the sweeping mode is set to the frequency list sweep, displays contents of the trace based on either rules:
FREQ BS	The trace is sorted based on the sweep parameter.
ORDER BS	The trace is sorted the order of acquisition.
RETURN	

Front Panel Key	Description
<b>Sweep</b> Continued	
NA/ZA segment menu	
SEGMENT: START	Sets the start frequency of a segment.
STOP	Sets the stop frequency of a segment.
CENTER	Sets the center frequency of a segment.
SPAN	Sets the frequency span of a segment about a specified center frequency.
MKR→MENU	
MKR→START	Sets the sweep parameter start value to the sweep parameter value of the marker.
MKR→STOP	Sets the sweep parameter stop value to the sweep parameter value of the marker.
MKR→CENTER	Changes the CENTER to the marker's sweep parameter value.
RETURN	
MORE	
NUMBER of POINTS	Sets the number of data points per sweep.
POWER	Sets the power level segment by segment.
IF BW	Sets the IF bandwidth segment by segment.
DC VOLTAGE	Sets DC voltage for the DC SOURCE port segment by segment.
DC CURRENT	Sets DC current for the DC SOURCE port segment by segment.
RETURN	
SEGMENT QUIT	Returns to the previous softkey menu without saving the modified segment.
SEGMENT DONE	Saves the modified segment and returns to the previous softkey menu.

Front Panel Key	Description
<p><b>Sweep</b> Continued</p> <p>Spectrum Analyzer</p> <p><b>SWEEP TIME AUTO man</b></p> <p><b>SWEEP TIME</b></p> <p><b>: h:m:s</b></p> <p><b>RETURN</b></p> <p><b>NUMBER OF POINTS</b></p> <p><b>SWEEP TYPE MENU</b></p> <p><b>SWEEP TYPE:LIN FREQ</b></p> <p><b>LIST FREQ</b></p> <p><b>EDIT LIST</b></p> <p><b>SEGMENT</b></p> <p><b>EDIT</b> — See SA segment menu</p> <p><b>DELETE</b></p> <p><b>ADD</b> — See SA segment menu</p> <p><b>CLEAR LIST</b></p> <p><b>LIST DONE</b></p> <p><b>SEGMENT WAIT</b></p> <p><b>LIST DISP [FREQ BS]</b></p> <p><b>RETURN</b></p>	<p>Shows sweep time mode setting. Sweep time mode in spectrum analyzer mode is fixed to auto mode in normal span measurement, and to manual mode in zero span measurement. You cannot change the sweep time mode. The automatic sweep time selects the optimum sweep time automatically.</p> <p>Activates the sweep time function and displays the <b>:h:m:s</b> softkey.</p> <p>Enters “:” for the manual sweep time entry.</p> <p>Sets the number of data points per sweep. Using fewer points allows a faster sweep time but the displayed trace shows less horizontal detail. Using more points gives greater data density and improved trace resolution, but slows the sweep.</p> <p>Displays the <i>sweep type menu</i>. Using the softkeys on this menu, one of the following four sweep types can be selected for the network analyzer mode:</p> <p>Activates linear frequency sweep mode.</p> <p>Activates frequency list mode. If the list is not defined, this softkey performs no function.</p> <p>Displays the following softkeys to define or modify the frequency sweep list:</p> <p>Determines a segment on the list to be modified. Enter the number of a segment in the list, or use the step keys to scroll the pointer “<b>⏏</b>” at the left to the required segment number. The indicated segment can then be edited or deleted.</p> <p>Provides the <i>segment menu for network analyzer</i>. The segment indicated by the pointer “<b>⏏</b>” at the left can be modified.</p> <p>Deletes the segment indicated by the pointer “<b>⏏</b>”.</p> <p>Adds a new segment to be defined with the <i>segment menu for network analyzer</i>. If the list is empty, a default segment is added and the edit segment menu is displayed so it can be modified. If the list is not empty, the segment indicated by the pointer “<b>⏏</b>” is copied and the edit segment menu is displayed.</p> <p>Displays the <i>clear list menu</i>.</p> <p>Defines the frequency sweep list and returns to the sweep type menu.</p> <p>Specifies the time to keep the analyzer waiting for measurement start after the setting for each segment is completed.</p> <p>When the sweeping mode is set to the frequency list sweep, displays contents of the trace based on either rules:</p> <p><b>FREQ BS</b>                    The trace is sorted based on the sweep parameter.</p> <p><b>ORDER BS</b>                    The trace is sorted the order of acquisition.</p>

Front Panel Key	Description
<b>Sweep</b> Continued	
SA segment menu	
SEGMENT: START	Sets the start frequency of a segment.
STOP	Sets the stop frequency of a segment.
CENTER	Sets the center frequency of a segment.
SPAN	Sets the frequency span of a segment about a specified center frequency.
MKR→MENU	Displays the menu below to set the sweep parameters using the marker.
MKR→START	Sets the sweep parameter start value to the sweep parameter value of the marker.
MKR→STOP	Sets the sweep parameter stop value to the sweep parameter value of the marker.
MKR→CENTER	Changes the CENTER to the marker's sweep parameter value.
RETURN	
MORE	
NUMBER of POINTS	Sets the number of data points per sweep.
RES BW	Sets the IF bandwidth segment by segment.
DC VOLTAGE	Sets DC voltage for the DC SOURCE port segment by segment.
DC CURRENT	Sets DC current for the DC SOURCE port segment by segment.
RETURN	
SEGMENT QUIT	Returns to the previous softkey menu without saving the modified segment.
SEGMENT DONE	Saves the modified segment and returns to the previous softkey menu.

**Source**



Front Panel Key	Description
<p><b>Source</b></p> <p>Network/Impedance Analyzer</p> <p>POWER</p> <p>CW FREQ</p> <p>DC SRC [VOLTAGE]</p> <p>POWER</p> <p>CW FREQ</p> <p>DC SRC [CURRENT]</p> <p>DC CURRENT</p> <p>DC VOLTAGE LIMIT</p> <p>DC OUT ON off</p> <p>DC VOLTAGE</p> <p>DC CURRENT LIMIT</p> <p>DC OUT ON off</p>	<p>Activates the power level function.</p> <p>Sets the frequency for the power sweep.</p> <p>Sets the DC SOURCE port to control either voltage or current.</p> <p>VOLTAGE           The DC SOURCE port controls voltage (voltage control mode).</p> <p>CURRENT           The DC SOURCE port controls current (current control mode).</p> <p>Activates the power level function.</p> <p>Sets the frequency for the power sweep.</p> <p>Sets the DC SOURCE port to control either voltage or current.</p> <p>VOLT                The DC SOURCE port controls voltage (voltage control mode).</p> <p>CURR                The DC SOURCE port controls current (current control mode).</p> <p>Sets DC current for the DC SOURCE port.</p> <p>Sets the upper limit of the current for the DC SOURCE port when DC SRC [CURRENT] is selected. This command also defines the upper limit value for altered polarity because the specified value is regarded as an absolute value.</p> <p>Turns the DC SOURCE port ON or OFF.</p> <p>Sets DC voltage for the DC SOURCE port.</p> <p>Sets the upper limit of the voltage for the DC SOURCE port when DC SRC [VOLTAGE] is selected. This command also defines the upper limit value for altered polarity because the specified value is regarded as an absolute value.</p> <p>Turns the DC SOURCE port ON or OFF.</p>
<p>Spectrum Analyzer</p> <p>POWER</p> <p>RF OUT off ON</p> <p>DC VOLTAGE</p> <p>DC CURRENT LIMIT</p> <p>DC SRC [VOLTAGE]</p> <p>POWER</p> <p>CW FREQ</p> <p>DC CURRENT</p> <p>DC VOLTAGE LIMIT</p> <p>DC SRC [CURRENT]</p> <p>DC OUT ON off</p> <p>DC OUT ON off</p>	<p>Activates the power level function and sets the RF output power level of the analyzer's internal source. The allowable range is -70 dBm to +20 dBm.</p> <p>Toggles the signal output on the RF OUT port ON or OFF. In the network analyzer mode, if the RF output is turned OFF, the status notation "P↓" is displayed.</p> <p>The signal output setting is changed after the 4395A detects the trigger signal.</p> <p>Sets DC voltage for the DC SOURCE port.</p> <p>Sets the upper limit of the voltage for the DC SOURCE port when DC SRC [VOLTAGE] is selected. This command also defines the upper limit value for altered polarity because the specified value is regarded as an absolute value.</p> <p>Sets the DC SOURCE port to control either voltage or current.</p> <p>Activates the power level function.</p> <p>Sets the frequency for the power sweep.</p> <p>Sets DC current for the DC SOURCE port.</p> <p>Sets the upper limit of the current for the DC SOURCE port when DC SRC [CURRENT] is selected. This command also defines the upper limit value for altered polarity because the specified value is regarded as an absolute value.</p> <p>Sets the DC SOURCE port to control either voltage or current.</p> <p>Turns the DC SOURCE port ON or OFF.</p> <p>Turns the DC SOURCE port ON or OFF.</p>

Trigger

Front Panel Key	Description
<p><b>Trigger</b></p> <p>Network/Impedance Analyzer</p> <p><b>SWEEP:HOLD</b></p> <p><b>SINGLE</b></p> <p><b>NUMBER of GROUPS</b></p> <p><b>CONTINUOUS</b></p> <p><b>TRIGGER:[FREE RUN]</b></p> <p><b>FREE RUN</b></p> <p><b>EXTERNAL</b></p> <p><b>MANUAL</b></p> <p><b>TRIG EVENT[ON SWEEP]</b></p> <p><b>TRIG PLRTY POS neg</b></p> <p><b>RETURN</b></p> <p><b>MEASURE RESTART</b></p>	<p>Freezes the data trace on the display and the analyzer stops sweeping and taking data. The notation “Hld” is displayed at the left of the graticule. If the “*” indicator is on (at the left side of the display), trigger a new sweep by pressing <b>SINGLE</b>.</p> <p>Makes one sweep of data and returns to the hold mode.</p> <p>Triggers a user-specified number of sweeps and returns to the hold mode. If averaging is on, set the number of groups at least equal to the averaging factor selected to allow measurement of a fully averaged trace. Entering the number of groups resets the averaging counter to 1.</p> <p>Triggers the sweep automatically and continuously (the trace is updated with each sweep). This is the standard sweep mode.</p> <p>Displays the menu used to select the trigger source. The trigger source is common to both channels.</p> <p>Selects the internal trigger.</p> <p>Selects the external trigger input from the BNC on the rear panel.</p> <p>Selects the manual trigger.</p> <p>Toggles the trigger event mode. This function is available in the network analyzer mode only. When in the spectrum analyzer mode, this softkey does not appear on the menu.</p> <p><b>[ON POINT]</b> Shows the analyzer triggers each data point in a sweep.</p> <p><b>[ON SWEEP]</b> Shows the analyzer triggers a sweep.</p> <p>Selects the trigger signal polarity of an externally generated signal connected to the rear panel EXT TRIGGER input.</p> <p><b>POS neg</b> (positive) Shows the sweep is started with a low-to-high transition of a TTL signal.</p> <p><b>pos NEG</b> (negative) Shows the sweep is started with a high-to-low transition of a TTL signal.</p> <p>Aborts the sweep in progress and then restarts the measurement. This can be used to update a measurement following an adjustment of the DUT or test signal source.</p> <p>When a full two-port calibration is in use in the network analyzer mode, <b>MEASURE RESTART</b> initiates an update of both the forward and reverse S-parameter data.</p> <p>If the analyzer is measuring a number of groups, the sweep counter is reset to 1. If averaging is on, <b>MEASURE RESTART</b> resets the sweep-to-sweep averaging and is effectively the same as <b>AVERAGING RESTART</b>.</p> <p>If the sweep trigger is in the <b>HOLD</b> mode, <b>MEASURE RESTART</b> executes a single sweep. If <b>DUAL CHAN</b> is on (screen displays both measurement channels), <b>MEASURE RESTART</b> executes a single sweep of both channels even if <b>COUPLED CH</b> is off.</p>

Front Panel Key	Description
<p><b>Trigger</b> Continued</p> <p>Spectrum Analyzer</p> <p>SWEEP:HOLD</p> <p>SINGLE</p> <p>NUMBER of GROUPS</p> <p>CONTINUOUS</p> <p>TRIGGER:[FREE RUN]</p> <p>FREE RUN</p> <p>EXTERNAL</p> <p>MANUAL</p> <p>GATE [LEVEL]</p> <p>GATE CTL:LEVEL</p> <p>EDGE</p> <p>GATE DELAY</p> <p>GATE LENGTH</p> <p>RETURN</p> <p>TRIG PLRTY POS neg</p> <p>RETURN</p> <p>MEASURE RESTART</p>	<p>Freezes the data trace on the display and the analyzer stops sweeping and taking data. The notation "Hld" is displayed at the left of the graticule. If the "*" indicator is on (at the left side of the display), trigger a new sweep by pressing SINGLE.</p> <p>Makes one sweep of data and returns to the hold mode.</p> <p>Triggers a user-specified number of sweeps and returns to the hold mode.</p> <p>Triggers the sweep automatically and continuously (the trace is updated with each sweep). This is the standard sweep mode.</p> <p>Displays the menu used to select the trigger source. The trigger source is common to both channels.</p> <p>Selects the internal trigger.</p> <p>Selects the external trigger input from the BNC on the rear panel.</p> <p>Selects the manual trigger.</p> <p>Displays the menu used specify the gate trigger mode, the gate delay, and the gate length. To select the gate trigger mode, the following two softkeys are provided: (Option 1D6 only)</p> <p>Selects the level gate trigger mode.</p> <p>Selects the edge gate trigger mode.</p> <p>Sets the gate delay. (Option 1D6 only)</p> <p>Sets the gate length. (Option 1D6 only)</p> <p>Selects the trigger signal polarity of an externally generated signal connected to the rear panel EXT TRIGGER input.</p> <p>POS neg (positive) Shows the sweep is started with a low-to-high transition of a TTL signal.</p> <p>pos NEG (negative) Shows the sweep is started with a high-to-low transition of a TTL signal.</p> <p>Aborts the sweep in progress and then restarts the measurement. This can be used to update a measurement following an adjustment of the DUT or test signal source.</p>

Center Span Start Stop

Front Panel Key	Description
<p><b>Center</b></p> <p>STEP SIZE AUTO man</p> <p>CENTER STEP SIZE</p> <p>MKR→CNTR STEP</p> <p>MKRA→CNTR STEP</p> <p>MKR→CENTER</p> <p>MKRA→CENTER</p> <p>PEAK→CENTER</p>	<p>Toggles CENTER step policy.</p> <p><b>AUTO</b> Sets the step policy to be 1-2-5 step.</p> <p><b>MAN</b> Sets the step policy to linear step specified with <b>CENTER STEP SIZE</b>. (frequency sweep only)</p> <p>Changes the step size for the center frequency function.</p> <p>Changes the CENTER step size to the marker's sweep parameter value.</p> <p>Changes the CENTER step size to the difference between the marker and the delta-marker values.</p> <p>Changes the CENTER to the marker's sweep parameter value.</p> <p>Changes the CENTER to the difference between the marker and the delta-marker values.</p> <p>Searches for a peak using the marker and then changes the CENTER to the sweep parameter value of that peak.</p>
<p><b>Span</b></p> <p>FULL SPAN</p> <p>ZERO SPAN</p> <p>MKRA→SPAN</p>	<p>Sets the SPAN to the maximum range. The maximum range depends on the analyzer mode. The following table shows the maximum range of SPAN for each condition:</p> <p>Sets the SPAN to zero.</p> <p>Changes the SPAN to the difference between the marker and the delta-marker values.</p>
<p><b>Start</b></p>	<p>Defines the start value of the frequency range or power range of the sweep parameter. When pressed, its function becomes the active function. The value is displayed in the active entry area and can be changed with the knob, step keys, or numeric keypad. Current sweep parameter values for the active channel are also displayed along the bottom of the graticule. In power sweep, the sweep parameter value is in dBm.</p>
<p><b>Stop</b></p>	<p>Defines the stop value of the frequency range or power range of the sweep parameter. When pressed, its function becomes the active function. The value is displayed in the active entry area and can be changed with the knob, step keys, or numeric keypad. Current sweep parameter values for the active channel are also displayed along the bottom of the graticule. In power sweep, the sweep parameter value is in dBm.</p>

**Marker**   **Marker→**

Front Panel Key	Description
<b>Marker</b>	
Network/Impedance Analyzer	
SUB MKR → See Sub-marker menu	Displays the <i>sub-marker menu</i> that is used to turn on sub-markers.
CLEAR SUB MKR → See Sub-marker menu	Displays the <i>sub-marker menu</i> that is used to turn off sub-markers.
PRESET MKRS	Turns off all markers and cancels all setting of the marker functions.
MKR ON [DATA]	Selects a trace from data or memory to be applied for the marker values.
	[DATA] Shows that the data trace is selected.
	[MEM] Shows that the memory trace is selected.
MKR [UNCOUPLE]	Toggles between the coupled and uncoupled marker mode.
	[COUPLE] Couples the marker sweep parameter values for the two display channels. Even if the sweep parameter is uncoupled and two sets of sweep parameter values are shown, the markers track the same sweep parameter values on each channel as long as they are within the displayed sweep parameter range.
	[UNCOUPLE] Allows the marker sweep parameter values to be controlled independently on each channel.
MKR [CONT]	Toggles between the continuous and discontinuous marker mode. This softkey appears only in the network analyzer mode. <sup>1</sup>
	[DISCRETE] Places markers only on the measured trace points as determined by the sweep parameter settings.
	[CONT] Interpolates between the measured points to allow the markers to be placed at any point on the trace. Displayed marker values are also interpolated. This is the default marker mode (network analyzer only).
ΔMODE MENU	Displays the <i>delta mode menu</i> that is used to define the difference in values between the marker and a Δmarker.
ΔMKR	Puts the delta-maker on the current position of the marker.
FIXED ΔMKR	Sets a user-specified fixed reference marker, and turns on the Δmarker mode.
TRACKING ΔMKR	Puts a Δmarker at the present active marker position and turns on the tracking Δmarker.
ΔMODE OFF	Turns off the delta marker mode.
FIXED ΔMKR VALUE	Changes the amplitude value of the fixed Δmarker. Fixed Δmarker amplitude values are always uncoupled in the two channels.
FIXED ΔMKR AUX VALUE	Changes the auxiliary amplitude value of the fixed Δmarker (used only with a polar, Smith, or admittance format in the network analyzer mode). Fixed Δmarker auxiliary amplitude values are always uncoupled in the two channels. When the spectrum analyzer mode is selected, this softkey does not appear in this menu.
RETURN	

<sup>1</sup> In the spectrum analyzer mode, the marker is always in the discontinuous mode.

Front Panel Key	Description
<p><b>Marker</b> Continued</p> <p>Spectrum Analyzer</p> <p>SUB MKR → See Sub-marker menu</p> <p>CLEAR SUB MKR → See Sub-marker menu</p> <p>PRESET MKRS</p> <p>MKR ON [DATA]</p> <p>[DATA]</p> <p>[MEM]</p> <p>MKR [UNCOUPLE]</p> <p>[COUPLE]</p> <p>[UNCOUPLE]</p> <p>ΔMODE MENU</p> <p>ΔMKR</p> <p>FIXED ΔMKR</p> <p>TRACKING ΔMKR</p> <p>ΔMODE OFF</p> <p>ΔMKR SWP PRM</p> <p>FIXED ΔMKR VALUE</p> <p>FIXED ΔMKR AUX VALUE</p> <p>RETURN</p>	<p>Displays the <i>sub-marker menu</i> that is used to turn on sub-markers.</p> <p>Displays the <i>sub-marker menu</i> that is used to turn off sub-markers.</p> <p>Turns off all markers and cancels all setting of the marker functions.</p> <p>Selects a trace from data or memory to be applied for the marker values.</p> <p>Shows that the data trace is selected.</p> <p>Shows that the memory trace is selected.</p> <p>Toggles between the coupled and uncoupled marker mode.</p> <p>Couples the marker sweep parameter values for the two display channels. Even if the sweep parameter is uncoupled and two sets of sweep parameter values are shown, the markers track the same sweep parameter values on each channel as long as they are within the displayed sweep parameter range.</p> <p>Allows the marker sweep parameter values to be controlled independently on each channel.</p> <p>Displays the <i>delta mode menu</i> that is used to define the difference in values between the marker and a Δmarker.</p> <p>Puts the delta-maker on the current position of the marker.</p> <p>Sets a user-specified fixed reference marker. The sweep parameter and amplitude values can be set arbitrarily and can be anywhere in the display area. Unlike other markers, the fixed Δmarker need not be on the trace. The fixed Δmarker is indicated by a small triangle Δ, and the marker sweep parameter and measurement values are shown relative to this point. The notation ΔMkr is displayed at the top right corner of the graticule.</p> <p>Puts a Δmarker at the present active marker position and turns on the tracking Δmarker.</p> <p>Turns off the delta marker mode.</p> <p>Changes the sweep parameter value of the fixed Δmarker. Fixed Δmarker sweep parameter values can be different for the two channels if the channel markers are uncoupled.</p> <p>Changes the amplitude value of the fixed Δmarker. Fixed Δmarker amplitude values are always uncoupled in the two channels.</p> <p>Changes the auxiliary amplitude value of the fixed Δmarker (used only with a polar, Smith, or admittance format in the network analyzer mode). When the spectrum analyzer mode is selected, this softkey does not appear in this menu.</p>
<p>Sub-marker menu</p> <p>SUB MKR 1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>RETURN</p>	<p>These keys put a sub-marker at the present marker position.</p>

Front Panel Key	Description
Marker→	
MKR→CENTER	Changes the sweep parameter center value of the destination channel to the sweep parameter value of the marker and centers the new span about that value.
MKR→START	Changes the sweep parameter start value of the destination channel to the sweep parameter value of the marker.
MKR→STOP	Changes the sweep parameter stop value of the destination channel to the sweep parameter value of the marker.
MKR→REFERENCE	Sets the reference value of the destination channel to the marker's amplitude value. The reference position is not changed even the network analyzer mode is selected. In the polar, Smith, or admittance chart format of the network analyzer mode, the full scale value at the outer circle is changed to the marker amplitude value.
PEAK→CENTER	Changes the sweep parameter center value of the destination channel to the sweep parameter value of the peak.
MKR ZOOM	Moves the marker to the center and changes the sweep parameter span value of the destination channel to the value specified by the zooming aperture. Performing this function is similar to zooming in on the signal in the center of the sweep range.
ZOOMING APERTURE	Sets the zooming aperture value as a percentage of the span.
MKR→XCH MENU	
MKR→XCH CENTER	Applies a sweep parameter at the marker to the center value of the sweep parameters for the channel that is not active.
MKR→XCH START	Applies a sweep parameter at the marker to the start value of the sweep parameters for the channel that is not active.
MKR→XCH STOP	Applies a sweep parameter at the marker to the stop value of the sweep parameters for the channel that is not active.
PEAK→XCH CENTER	Searches for a peak using the marker and applies a sweep parameter at the marker to the center value of the sweep parameters for the channel that is not active.
MKR XCH ZOOM	Applies a sweep parameter at the marker to the center value of the sweep parameters for the channel that is not active, and changes the sweep parameter span value of the channel to "sweep parameter span × zooming aperture."
ZOOMING APERTURE	Sets the zooming aperture value as a percentage of the span.
RETURN	

Search

Front Panel Key	Description
<p><b>Search</b></p> <p>Network/Impedance Analyzer</p> <p><b>SEARCH: PEAK</b> → See Peak menu</p> <p><b>MAX</b></p> <p><b>MIN</b></p> <p><b>TARGET</b></p> <p><b>TARGET</b></p> <p><b>SEARCH LEFT</b></p> <p><b>SEARCH RIGHT</b></p> <p><b>SUB MKR</b> → See Sub-marker menu</p> <p><b>RETURN</b></p> <p><b>MULTIPLE PEAKS</b> → See Print setup menu</p> <p><b>WIDTHS [OFF]</b></p> <p><b>SEARCH IN</b></p> <p><b>SEARCH OUT</b></p> <p><b>WIDTHS on OFF</b></p> <p><b>WIDTH VALUE</b></p> <p><b>MKRVAL/√2</b></p> <p><b>MKRVAL*√2</b></p> <p><b>MKRVAL/2</b></p> <p><b>RETURN</b></p> <p><b>RETURN</b></p> <p><b>SRCH TRACK on OFF</b></p> <p><b>SRCH RANGE MENU</b> → See Search range menu</p>	<p>Moves the marker to the maximum or minimum peak and displays the <i>peak menu</i> that is used to search for the next peak.</p> <p>Moves the marker to the maximum amplitude point on the trace.</p> <p>Moves the marker to the minimum amplitude point on the trace.</p> <p>Moves the marker to a specified target point on the trace and displays to the target menu that is used to search right and search left to resolve multiple solutions. This softkey appears in the network analyzer mode only.</p> <p>Makes the target value to the active function to enter a value and moves the marker to a specified target point on the trace.</p> <p>The target value is in units appropriate to the current format. The default target value is <math>-3</math> dB.</p> <p>In delta marker mode, the target value is the value relative to the <math>\Delta</math>marker. If no <math>\Delta</math>marker is on, the target value is an absolute value.</p> <p>Searches the trace for the next occurrence of the target value to the left.</p> <p>Searches the trace for the next occurrence of the target value to the right.</p> <p>Displays softkeys that are used to search multiple peaks and to define peaks to be searched.</p> <p>Searches for the cutoff point on the trace that is within the current cutoff points.</p> <p>This softkey searches for the cutoff point on the trace outside of the current cutoff points.</p> <p>Turns on the bandwidth search feature and calculates the center sweep parameter value, bandwidth, Q, insertion loss, and cutoff point deviation from the center of a bandpass or band reject shape on the trace. The amplitude value that defines the passband or reject band is set using the <b>WIDTH VALUE</b> softkey.</p> <p>The <math>\Delta</math>marker is automatically changed to the tracking <math>\Delta</math>marker when <b>WIDTHS</b> is turned on. When <b>WIDTHS</b> is ON, the (normal) <math>\Delta</math>marker cannot be selected.</p> <p>Sets an amplitude parameter (for example, <math>-3</math> dB) that defines the start and stop points for a bandwidth search. The bandwidth search feature analyzes a bandpass or band reject trace and calculates the center point, bandwidth, and Q (quality factor) for the specified bandwidth. Bandwidth units are in the units of the current format. When the tracking <math>\Delta</math>marker or the fixed <math>\Delta</math>marker is on, the bandwidth value specified is the difference from the <math>\Delta</math>marker. For more information on the width function, see “Width Function” in Appendix A.</p> <p>Sets the width value to the value that equals the marker value divided by square root of 2.</p> <p>Sets the width value to the value that equals the marker value multiplied by square root of 2.</p> <p>Sets the width value to the value that equals the marker value divided by 2.</p> <p>Toggles the search tracking. This is used in conjunction with other search features to track the search of each new sweep.</p> <p><b>ON</b> Makes the analyzer search every new trace for the specified target value and puts the active marker on that point.</p> <p><b>OFF</b> When the target is found on the current sweep, it remains at the same sweep parameter value regardless of changes in trace amplitude values in subsequent sweeps.</p> <p>Displays the <i>Search Range Menu</i>.</p>



Front Panel Key	Description
<p><b>Search</b> Continued</p> <p>Peak menu</p> <p><b>PEAK</b></p> <p><b>NEXT PEAK</b></p> <p><b>NEXT PEAK LEFT</b></p> <p><b>NEXT PEAK RIGHT</b></p> <p><b>PEAK DEF MENU</b> → See Peak definition menu</p> <p><b>SUB MKR</b> → See Sub-marker menu</p> <p><b>RETURN</b></p>	<p>Moves the marker to the maximum or minimum peak.</p> <p>Moves the marker to the next peak.</p> <p>Moves the marker to the peak on the left of the present marker position.</p> <p>Moves the marker to the peak on the right of the present marker position.</p> <p>Displays the <i>peak definition menu</i>.</p> <p>Displays the <i>sub-marker menu</i> that is used to turn on sub-markers.</p>
<p>Print setup menu</p> <p><b>SEARCH: PEAKS ALL</b></p> <p><b>PEAKS RIGHT</b></p> <p><b>PEAKS LEFT</b></p> <p><b>PEAK DEF MENU</b> → See Peak definition menu</p> <p><b>SRCH TRACK on OFF</b></p> <p><b>ON</b></p> <p><b>OFF</b></p> <p><b>RETURN</b></p>	<p>Searches for eight maximum or minimum peaks using the marker and the sub-markers.</p> <p>Searches to the right of the peak for the nearest seven peaks from the maximum or minimum peak.</p> <p>Searches to the left of the peak for the nearest seven peaks from the maximum or minimum peak.</p> <p>Displays the <i>peak definition menu</i>.</p> <p>Toggles the search tracking. This is used in conjunction with other search features to track the search of each new sweep.</p> <p><b>ON</b> Makes the analyzer search every new trace for the specified target value and puts the active marker on that point.</p> <p><b>OFF</b> When the target is found on the current sweep, it remains at the same sweep parameter value regardless of changes in trace amplitude values in subsequent sweeps.</p>
<p>Search range menu</p> <p><b>PART SRCH on OFF</b></p> <p><b>MKR→SEARCH RNG</b></p> <p><b>MKR→LEFT RNG</b></p> <p><b>MKR→RIGHT RNG</b></p> <p><b>RETURN</b></p>	<p>Turns partial search on or off. The search range is displayed by two small triangles, “Δ”, at the bottom of the graticule. If no search range is defined, the search range is the entire trace.</p> <p>Sets the partial search range to the range between the marker and Δmarker.</p> <p>Sets the left (lower) border of the partial search range at the current position of the marker.</p> <p>Sets the right (higher) border of the partial search range at the current position of the marker.</p>
<p>NA/ZA Define peak menu</p> <p><b>THRESHOLD on OFF</b></p> <p><b>THRESHOLD VALUE</b></p> <p><b>MKR→THRESHOLD</b></p> <p><b>PEAK PLRTY POS neg</b></p> <p><b>POS</b></p> <p><b>NEG</b></p> <p><b>PEAK DEF: ΔX</b></p> <p><b>PEAK DEF: ΔY</b></p> <p><b>MKR→PEAK DELTA</b></p> <p><b>RETURN</b></p>	<p>Toggles the threshold on and off. When turning on, the analyzer will search a peak whose amplitude value is greater than or equal to the threshold.</p> <p>Sets the threshold values.</p> <p>Changes the threshold value to the amplitude value of the present marker position.</p> <p>Selects the peak polarity for the marker search functions.</p> <p><b>POS</b> Selects a positive peak</p> <p><b>NEG</b> Selects a negative peak</p> <p>Sets the peak delta ΔX value that is used to define the peak.</p> <p>Sets the peak delta ΔY value that is used to define the peak.</p> <p>Changes the peak delta value to the smaller value of the difference of amplitude values between the present maker position and both side display points of the marker.</p>

Front Panel Key	Description
<p><b>Search</b> Continued</p> <p>Spectrum Analyzer</p> <p>SEARCH: PEAK → See Peak menu</p> <p>MAX</p> <p>MIN</p> <p>MULTIPLE PEAKS → See Print setup menu</p> <p>SGNL TRACK on OFF</p> <p>SRCH TRACK on OFF</p> <p>SRCH RANGE MENU → See Search range menu</p>	<p>Moves the marker to the maximum or minimum peak.</p> <p>Moves the marker to the maximum amplitude point on the trace.</p> <p>Moves the marker to the minimum amplitude point on the trace.</p> <p>Displays softkeys that are used to search multiple peaks.</p> <p>Toggles signal tracking on and off.</p> <p>[ON] Moves the signal that is nearest to the marker to the center of the screen and keeps the signal there.</p> <p>[OFF] Turns off the signal tracking.</p> <p>Toggles the search tracking. This is used in conjunction with other search features to track the search of each new sweep.</p> <p>ON Makes the analyzer search every new trace for the specified target value and puts the active marker on that point.</p> <p>OFF When the target is found on the current sweep, it remains at the same sweep parameter value regardless of changes in trace amplitude values in subsequent sweeps.</p> <p>Displays the search range menu.</p>
<p>SA Define peak menu</p> <p>THRESHOLD on OFF</p> <p>THRESHOLD VALUE</p> <p>MKR→ THRESHOLD</p> <p>PEAK DEF: ΔY</p> <p>RETURN</p>	<p>Toggles the threshold on and off. When turning on, the analyzer will search a peak whose amplitude value is greater than or equal to the threshold.</p> <p>Sets the threshold values.</p> <p>Changes the threshold value to the amplitude value of the present marker position.</p> <p>Sets the peak delta ΔY value that is used to define the peak.</p>

**Utility**

Front Panel Key	Description
<p><b>Utility</b></p> <p>Network/Impedance Analyzer</p> <p>MKR LIST on OFF</p> <p>STATISTICS on OFF</p> <p>MKR TIME on OFF</p> <p>SMTH/POLAR MENU</p> <p>REAL IMAG</p> <p>LIN MAG PHASE</p> <p>LOG MAG PHASE</p> <p>R+jX</p> <p>G+jB</p> <p>SWR PHASE</p> <p>RETURN</p>	<p>Toggles the marker list function on and off. In <math>\Delta</math> mode, this also lists <math>\Delta</math>marker.</p> <p>Calculates and displays the mean, standard deviation, and peak-to-peak values of the section of the displayed trace in the search range. If Partial Search is off, the statistics are calculated for the entire trace. The statistics are absolute values.</p> <p>Sets the x-axis units to time, (the start point is zero and the stop point is the value of the sweep time). The marker indicates the elapsed time since the sweep started. This function is useful for testing a DUT's time transition characteristics at a certain fixed frequency by setting the span to zero.</p> <p>Displays softkeys to select a form of complex marker value on Smith, polar, and admittance chart.</p> <p>Displays the values of the marker on a Smith chart as a real and imaginary pair.</p> <p>Displays a readout of the linear magnitude and the phase of the marker.</p> <p>Displays the logarithmic magnitude value and the phase of the marker.</p> <p>Converts the marker values into rectangular form. The complex impedance values of the active marker are displayed in terms of resistance, reactance, and equivalent capacitance or inductance.</p> <p>Displays the complex admittance values of the marker in rectangular form. The marker values are displayed in terms of conductance (in Siemens), susceptance, and equivalent capacitance or inductance.</p> <p>Displays the SWR and phase of the marker. Magnitude values are expressed in dB and phase values in degrees.</p>
<p>Spectrum Analyzer</p> <p>MKR LIST on OFF</p> <p>STATISTICS on OFF</p> <p>MKR TIME on OFF</p> <p>NOISE FORM on OFF</p> <p>MKR UNIT MENU</p> <p>UNIT:dBm</p> <p>dBV</p> <p>dBuV</p> <p>WATT</p> <p>VOLT</p> <p>RETURN</p>	<p>Toggles the marker list function on and off. In <math>\Delta</math> mode, this also lists <math>\Delta</math>marker.</p> <p>Calculates and displays the mean, standard deviation, and peak-to-peak values of the section of the displayed trace in the search range. If Partial Search is off, the statistics are calculated for the entire trace. The statistics are absolute values.</p> <p>Sets the x-axis units to time, (the start point is zero and the stop point is the value of the sweep time). The marker indicates the elapsed time since the sweep started. This function is useful for testing a DUT's time transition characteristics at a certain fixed frequency by setting the span to zero.</p> <p>Toggles the noise marker on and off. This marker reads out the average noise level (referenced to a 1 Hz noise power bandwidth) at the marker position.</p> <p><math>\Delta</math>Marker reads out spectrum value even if the noise form is turned on.</p> <p>Selects dBm for the marker readout unit.</p> <p>Selects dBV for the marker readout unit.</p> <p>Selects dB<math>\mu</math>V for the marker readout unit.</p> <p>Selects watt for the marker readout unit.</p> <p>Selects volt for the marker readout unit.</p>

System

Front Panel Key	Description
System	
IBASIC	Displays the menu used to operate HP Instrument BASIC.
Step	Allows you to execute one program line at a time.
Continue	Resumes program execution from the point where it paused.
Run	Starts a program from its beginning.
Pause	Pauses program execution after the current program line is executed.
Stop	Stops program execution after the current line. To restart the program, press <b>Run</b> .
Edit	Enters into the EDIT mode. In the EDIT mode, the following softkeys are displayed on the softkey menu area.
ASSIGN @Hp4395	Produces the command ASSIGN @Hp4395 TO 800 at the cursor's current position.
OUTPUT @Hp4395	Produces the command OUTPUT @Hp4395;" at the cursor's current position.
ENTER @Hp4395	Produces the command ENTER @Hp4395; at the cursor's current position.
END	Produces the command END.
GOTO LINE	Allows you to move the cursor to any line number or to a label. After pressing GOTO LINE, type a line number or a label and then press <b>Return</b> . The cursor moves to the specified line or label.
RECALL LINE	Recalls the last deleted line.
END EDIT	Exits the edit mode.
COMMAND ENTRY	Displays the softkeys that are used to enter BASIC commands. The active entry area displays the letters, digits, and some special characters. Three sets of letters can be scrolled using the step keys, <b>↑</b> and <b>↓</b> .
SELECT LETTER	Selects the character pointed to by "↑".
SPACE	Inserts a space.
BACK SPACE	Deletes the last character entered.
ERASE TITLE	Deletes all characters entered.
DONE	Terminates command entry and executes the command you entered.
CANCEL	Cancels command and returns to the previous menu.
ON KEY LABELS	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	

Front Panel Key	Description
<b>System</b> Continued	
PROGRAM MENU	Display the list of the executable programs. Pressing the key with a program name aside will executing the corresponding program.
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
[USER DEFINE]	
NEXT FILES	
STOR DEV [DISK]	Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.
LIMIT MENU — See Limit test menu	Displays the series of menus that defines limits or specifications used to test a DUT.
RECALL MESSAGE	Recalls error messages displayed in the message area. Last 32 messages maximum can be hold in the memory.
MORE	
SET CLOCK	Displays the series of menus that set an internal clock.
TIME HH:MM:SS	Displays the current time on the active entry area and displays the next page to adjust time.
HOUR	Enables changing the hour setting using the knob or the numeric entry keys. <sup>1</sup>
MIN	Enables changing the minute setting using the knob or the numeric entry keys. <sup>1</sup>
SEC	Enables changing the second setting using the knob or the numeric entry keys. <sup>1</sup>
ENTER	Displays the current time on the active entry area and displays the next page to adjust time.
CANCEL	Returns to the previous page. Pressing this key does not affect the internal clock setting.
DATE DD/MM/YY	Displays the current date on the active entry area to adjust date.
MONTH	Enables changing the month setting using the knob or the numeric entry keys. <sup>1</sup>
DAY	Enables changing the day setting using the knob or the numeric entry keys. <sup>1</sup>
YEAR	Enables changing the year setting using the knob or the numeric entry keys. <sup>1</sup>
ENTER	Displays the current date on the active entry area to adjust date.
CANCEL	returns to the previous page. Pressing this key does not affect the internal clock setting.
DATE MODE: MonDayYear	Changes the displayed date to the “month:day:year” format.
DayMonYear	Changes the displayed date to the “day:month:year” format.
RETURN	
BEEP DONE ON off	Toggles an annunciator that sounds to indicate the completion of operations such as calibration or instrument state save.
BEEP WARN on OFF	Toggles the warning annunciator. When the annunciator is on it sounds a warning when a cautionary message is displayed.
FIRMWARE VERSION	Displays the firmware revision in the message area.
RETURN	

<sup>1</sup> After you change the hour setting, press **ENTER** to restart the clock.

Front Panel Key	Description
<p><b>System</b> Continued</p>	
<p>Limit test menu</p>	
<p>LIMIT LINE on OFF</p>	<p>Turns limit lines on or off. If limits have been defined and limit lines are turned on, the limit lines are displayed for visual comparison of the measured data in all Cartesian formats.</p>
<p>LIMIT TEST on OFF</p>	<p>Turns limit testing on or off. When limit testing is on, the data is compared with the defined limits at each measured point. Limit tests occur at the end of each sweep, whenever the data is updated, and when limit testing is first turned on.</p> <p>Limit testing is available for both magnitude and phase values in Cartesian formats. In the polar, Smith, and admittance chart formats of the network analyzer, the value tested depends on the marker mode and is the magnitude or the first value in a complex pair. The message "NO LIMIT LINES DISPLAYED" is displayed in polar, Smith, and admittance chart formats if limit lines are turned on.</p>
<p>BEEP FAIL on OFF</p>	<p>Turns the limit fail beeper on or off. When limit testing is on and the fail beeper is on, a beep is emitted each time a limit test is performed and a failure detected.</p>
<p>EDIT LIMIT LINE</p>	<p>Displays a table of limit segments on the lower half of the display. The edit limits menu is displayed so that limits can be defined or changed.</p>
<p>SEGMENT</p>	<p>Specifies which limit segment in the table to edit. A maximum of eight sets of segment values are displayed at one time and the list can be scrolled up or down to show other segment entries. The pointer "ζ" shows the segment that can be edited or deleted. The pointer can be moved using the entry block. If the table of limits is designated EMPTY, new segments can be added using <b>ADD</b> or <b>EDIT</b>.</p>
<p>EDIT</p>	<p>Displays the <i>limit line entry</i> menu that defines or modifies the sweep parameter value and limit values of a specified segment. If the table is empty, a default segment is displayed.</p>
<p>DELETE</p>	<p>Deletes the segment indicated by the pointer "ζ."</p>
<p>ADD</p>	<p>Displays the edit segment menu and adds a new segment to the end of the list. The new segment is initially a duplicate of the segment indicated by the pointer "ζ" and selected using <b>SEGMENT</b>. If the table is empty, a default segment is displayed. The maximum number of segments is 18.</p>
<p>CLEAR LIST</p>	<p>Displays the following softkeys and clears all the segments in the limit test.</p>
<p>CLEAR LIST YES</p>	<p>Clears all the segments in the limit line and returns to the previous menu.</p>
<p>NO</p>	<p>Cancel clearing the segment and returns to the edit limit menu.</p>
<p>DONE</p>	<p>Sorts the limit segments and displays them on the display in increasing order of sweep parameter values.</p>
<p>LIMIT LINE OFFSETS</p>	<p>Displays the following three softkeys that offset the complete limit set in either sweep parameter or amplitude value.</p>
<p>SWP PARAM OFFSET</p>	<p>Adds to or subtracts an offset from the sweep parameter value. This allows limits already defined to be used for testing in a different sweep parameter range.</p>
<p>AMPLITUDE OFFSET</p>	<p>Adds or subtracts an offset in amplitude value. This allows previously defined limits to be used at a different power level.</p>
<p>MKR→AMP.OFS.</p>	<p>Move the limits so that they are centered an equal amount above and below the marker at that sweep parameter value.</p>
<p>RETURN</p>	
<p>RETURN</p>	

Front Panel Key	Description
<p><b>System</b> Continued</p> <p>Limit line entry menu</p> <p>SWP PARAM</p> <p>MKR→SWP PARAM</p> <p>UPPER LIMIT</p> <p>LOWER LIMIT</p> <p>DELTA LIMIT</p> <p>MIDDLE VALUE</p> <p>MKR→MIDDLE</p> <p>DONE</p>	<p>Sets the starting sweep parameter value of a segment using the entry block controls.</p> <p>Changes the segment sweep parameter value to the present marker sweep parameter value.</p> <p>Sets the upper limit value for the segment. Upper and lower limits must be defined. If no upper limit is required for a particular measurement, force the upper limit value out of range (for example + 500 dB).</p> <p>When <b>UPPER LIMIT</b> or <b>LOWER LIMIT</b> is pressed, all the segments in the table are displayed in terms of upper and lower limits, even if they were defined as delta limits and middle value.</p> <p>If you attempt to set an upper limit that is lower than the lower limit, or vice versa, both limits will be automatically set to the same value.</p> <p>Sets the limits an equal amount above and below a specified middle value, instead of setting upper and lower limits separately. If no upper lower is required for a particular measurement, force the lower limit value out of range (for example - 500 dB).</p> <p>Sets the limits an equal amount above and below a specified middle value, instead of setting upper and lower limits separately. This is used in conjunction with <b>MIDDLE VALUE</b> or <b>MARKER → MIDDLE</b>, to set limits for testing a device that is specified at a particular value plus or minus an equal tolerance.</p> <p>When <b>DELTA LIMITS</b> or <b>MIDDLE VALUE</b> is pressed, all the segments in the table are displayed in these terms, even if they were defined as upper and lower limits.</p> <p>Sets the midpoint for <b>DELTA LIMITS</b>. It uses the entry controls to set a specified amplitude value vertically centered between the limits.</p> <p>Sets the midpoint for <b>DELTA LIMITS</b> using the marker to set the middle amplitude value of a limit segment. Move the limits so that the limits are automatically set an equal amount above and below the present marker amplitude value.</p> <p>Terminates a limit segment definition and returns to the last menu.</p>

**Local** **Preset**

Front Panel Key	Description
<p><b>Local</b></p> <p>SYSTEM CONTROLLER</p> <p>ADDRESS-ABLE ONLY</p> <p>SET ADDRESSES</p> <p>ADDRESS:INSTR</p> <p>ADDRESS:CONTROLLER</p> <p>RETURN</p>	<p>Sets the analyzer as the system controller. This mode is used when peripheral devices are to be used and there is no external controller.</p> <p>This mode can only be selected manually from the analyzer's front panel and can be used only if no active system controller is connected to the system through GPIB. If you try to set system controller mode when another system controller is present, the message "CAUTION: CAN'T CHANGE - ANOTHER CONTROLLER ON BUS" is displayed.</p> <p>Sets the analyzer as addressable only. This mode is used when an external controller controls peripheral devices or the analyzer. This mode is also used when the external computer passes control of the bus to the analyzer.</p> <p>Displays the following softkeys:</p> <p>Sets the GPIB address of the analyzer using the entry controls. There is no physical address switch to set in the analyzer.</p> <p>Sets the GPIB address the analyzer will use to communicate with the external controller.</p>
<p><b>Preset</b></p>	<p>Presets the instrument state to the preset default value. The preset default values are listed in Appendix C. <b>Preset</b> has no effect on the following states:</p> <ul style="list-style-type: none"> <li>■ Analyzer Type</li> <li>■ Display Allocation</li> <li>■ Title</li> <li>■ Display Adjustment</li> <li>■ Color Adjustment</li> <li>■ Clock Time/Date</li> <li>■ Limit Line Table</li> <li>■ GPIB Address</li> <li>■ GPIB Mode (system controller and addressable)</li> <li>■ User Cal Kit Definition</li> </ul>

**Copy**



Front Panel Key	Description
<p><b>Copy</b></p> <p>PRINT [STANDARD]</p> <p>COPY ABORT</p> <p>COPY TIME on OFF</p> <p>PRINT SETUP → See Print setup menu</p> <p>ORIENT [PORTRAIT]</p> <p>FORM FEED ON off</p> <p>MORE → See Copy more menu</p>	<p>Copies one page of the tabular listings to a printer. Either STANDARD, for a black and white printer, or COLOR, for a color printer, is shown in brackets("[ ]"). This identifies which printer is selected as the default in the print setup menu. The default setting at power on is standard. Default text for a color printer is black.</p> <p>Aborts printing in progress.</p> <p>Turns the "time stamp" on or off for a print. The time and date are printed out first, followed by the information shown on the display.</p> <p>Displays the <i>print setup menu</i>. This menu allows you to copy the display to a printer capable of graphics or tabular listing. For information on compatible printers, see Chapter 12.</p> <p>Specifies the orientation of printer sheets. If your printer does not support landscape printing, this setting is ignored.</p> <p>PORTRAIT           Portrait orientation</p> <p>LANDSCAPE        Landscape orientation</p> <p>Specifies whether to deliver a sheet after one screen is printed out by switching on/off. When the sheet orientation is specified to LANDSCAPE, the FORMFEED setting is ignored and sheets are always ejected after each screen printout.</p>
<p>Copy cal kit menu</p> <p>STANDARD DEFINITION → See Copy standard no. menu</p> <p>CLASS ASSIGNMENT</p> <p>RETURN</p>	<p>Displays the menu that selects which standard settings are to be hard copied.</p> <p>Shows the tabular listing of the cal kit class assignment and provides the screen menu to prepare for hard copy.</p>
<p>Copy limit test menu</p> <p>DISPLAY LIST</p> <p>DISP MODE: UPR &amp; LWR</p> <p>MID &amp; DLT</p> <p>RETURN</p>	<p>Displays the limit testing table and the screen menu to prepare for hard copy.</p> <p>Selects the upper and lower formats that display the upper limit and lower limit values.</p> <p>Selects the middle and delta formats that display the middle value and the maximum deviation (limit value) from the middle value.</p>
<p>Copy list sweep menu</p> <p>DISPLAY LIST</p> <p>DISP MODE: ST &amp; SP</p> <p>CTR &amp; SPAN</p> <p>RETURN</p>	<p>Displays the limit testing table and leads to the screen menu to prepare for hard copy.</p> <p>Selects the start/stop format to list the sweep parameter.</p> <p>Selects the center/span format to list the sweep parameter.</p>
<p>Copy standard no. menu</p> <p>STD NO.1</p> <p>STD NO.2</p> <p>STD NO.3</p> <p>STD NO.4</p> <p>STD NO.5</p> <p>STD NO.6</p> <p>STD NO.7</p> <p>STD NO.8</p>	<p>These softkeys provide the tabular listing of the standard definitions of the standard number 1 to 8 and provide the screen menu to prepare for hard copy.</p>

Front Panel Key	Description										
<p><b>Copy</b> Continued</p> <p>Print setup menu</p> <p><b>PRINT STANDARD</b></p> <p><b>COLOR</b></p> <p><b>PRINT COLOR [FIXED]</b></p> <p><b>DPI</b></p> <p><b>TOP MARGIN</b></p> <p><b>LEFT MARGIN</b></p> <p><b>DEFAULT SETUP</b></p> <p><b>RETURN</b></p>	<p>Sets the print command to the default selection (a standard printer that prints in black only or a PaintJet color printer to yield a black-only print).</p> <p>Sets the print command to a default of color.</p> <p>Toggles the printing color between <b>[FIXED]</b> and <b>[VARIABLE]</b>. If <b>FIXED</b> is selected, the analyzer prints a hard copy with default colors. If <b>VARIABLE</b> is selected, the analyzer prints a hard copy with colors as similar as possible to the display colors (that can be adjusted).<sup>1</sup></p> <p>Specifies the resolution of a printer used for printing by dpi. The range of settable resolution is between 75 and 600 dpi.</p> <p>Specifies the top margin of printing by inch. The settable margin range is between 0 and 5 inches in step of 0.1 inch.</p> <p>Specifies the resolution of a printer used for printing by dpi. The range of settable resolution is between 75 and 600 dpi.</p> <p>Resets the printing parameters to their default values. These defaults are as follows:</p> <table border="0"> <tr> <td>Form feed:</td> <td>ON</td> </tr> <tr> <td>Sheet orientation:</td> <td>Portrait</td> </tr> <tr> <td>Softkey label printing:</td> <td>OFF</td> </tr> <tr> <td>Top margin:</td> <td>1.0 inch</td> </tr> <tr> <td>Left margin:</td> <td>1.0 inch</td> </tr> </table>	Form feed:	ON	Sheet orientation:	Portrait	Softkey label printing:	OFF	Top margin:	1.0 inch	Left margin:	1.0 inch
Form feed:	ON										
Sheet orientation:	Portrait										
Softkey label printing:	OFF										
Top margin:	1.0 inch										
Left margin:	1.0 inch										
<p>Screen menu</p> <p><b>PRINT [STANDARD]</b></p> <p><b>COPY ABORT</b></p> <p><b>COPY TIME on OFF</b></p> <p><b>PRINT SETUP</b> → See Print setup menu</p> <p><b>NEXT PAGE</b></p> <p><b>PREV PAGE</b></p> <p><b>RESTORE DISPLAY</b></p>	<p>Copies one page of the tabular listings to a compatible HP graphics printer. Either <b>STANDARD</b>, for a black and white printer, or <b>COLOR</b>, for a color printer, is shown in brackets("[ ]"). This identifies which printer is selected as the default in the print setup menu. The default setting at power on is standard. Default text for a color printer is black.</p> <p>Aborts printing in progress.</p> <p>Turns printing time and date on or off. The time and date are printed first then the information displayed.</p> <p>Displays the <i>print setup menu</i>. This menu allows you to copy the display to a printer capable of graphics or tabular listing. For information on compatible printers, see Chapter 12.</p> <p>Displays the next page of information in a tabular listing .</p> <p>Displays the previous page of information in a tabular listing.</p> <p>Turns off the tabular listing and returns the measurement display to the screen.</p>										

<sup>1</sup> Because of the limited number of printer ink colors, the printed color is not always the same as the displayed color.

Front Panel Key	Description
<p><b>Copy</b> Continued</p> <p>NA Copy more menu</p> <p><b>LIST VALUES</b> → See Screen menu</p> <p><b>OPERATING PARAMETERS</b> → See Screen menu</p> <p><b>CAL KIT DEFINITION</b> → See Copy cal kit menu</p> <p><b>LIST SWEEP TABLE</b> → See Copy list sweep menu</p> <p><b>LIMIT TEST TABLE</b> → See Copy limit test menu</p> <p><b>RETURN</b></p>	<p>Displays the <i>screen menu</i>. This softkey provides a tabular listing of all the measured data points and their current values. When <b>DUAL CHAN</b> and <b>COUPLED CHAN</b> are <b>ON</b>, the measured values of both channels are listed at same time. When <b>LIMIT LINE</b> and <b>LIMIT TEST</b> are <b>ON</b>, the limit information is also listed together with the measured values. At the same time, the screen menu is displayed to enable hard copy listings and access new pages of the table.</p> <p>Displays the <i>screen menu</i>. Provides a tabular listing on the display of the key parameters for both channels. The screen menu is presented to allow hard copy listings and access new pages of the table.</p> <p><b>Parameters listed by <b>OPERATION PARAMETERS</b></b></p> <ul style="list-style-type: none"> <li>■ Number of points</li> <li>■ Sweep time</li> <li>■ Source power</li> <li>■ Port-1 and 2 attenuator</li> <li>■ Bandwidth</li> <li>■ Averaging factor</li> <li>■ Averaging switch</li> <li>■ Group delay aperture</li> <li>■ Calibration kit</li> <li>■ <math>Z_0</math></li> <li>■ Calibration type</li> <li>■ Sweep conditions when the calibration was performed</li> <li>■ Phase offset</li> <li>■ Port 1 and 2 extension</li> <li>■ Input R, A, and B extension</li> <li>■ Velocity factor</li> </ul> <p>Displays the <i>copy cal kit menu</i> that prints the calibration kit definitions.</p> <p>Displays the <i>copy list sweep menu</i> that can display a tabular listing of the list sweep table and print it.</p> <p>Displays the <i>copy limit test menu</i> that can display a tabular listing of the limit value for limit testing and print it.</p>

Front Panel Key	Description
<p><b>Copy</b> Continued</p> <p>SA Copy more menu</p> <p><b>LIST VALUES</b> → See Screen menu</p> <p><b>OPERATING PARAMETERS</b> → See Screen menu</p> <p><b>LIST SWEEP TABLE</b> → See Copy list sweep menu</p> <p><b>LIMIT TEST TABLE</b> → See Copy limit test menu</p> <p><b>RETURN</b></p>	<p>Displays the <i>screen menu</i>. This softkey provides a tabular listing of all the measured data points and their current values. When <b>DUAL CHAN</b> and <b>COUPLED CHAN</b> are <b>ON</b>, the measured values of both channels are listed at same time. When <b>LIMIT LINE</b> and <b>LIMIT TEST</b> are <b>ON</b>, the limit information is also listed together with the measured values. At the same time, the screen menu is displayed to enable hard copy listings and access new pages of the table.</p> <p>Displays the <i>screen menu</i>. Provides a tabular listing on the display of the key parameters for both channels. The screen menu is presented to allow hard copy listings and access new pages of the table.</p> <p>Displays the <i>copy list sweep menu</i> that can display a tabular listing of the list sweep table and print it.</p> <p>Displays the <i>copy limit test menu</i> that can display a tabular listing of the limit value for limit testing and print it.</p>
<p>ZA Copy more menu</p> <p><b>LIST VALUES</b> → See Screen menu</p> <p><b>OPERATING PARAMETERS</b> → See Screen menu</p> <p><b>CAL KIT DEFINITION</b> → See Copy cal kit menu</p> <p><b>COMPEN KIT DEFINITION</b> → See Copy compen kit menu</p> <p><b>LIST SWEEP TABLE</b> → See Copy list sweep menu</p> <p><b>LIMIT TEST TABLE</b> → See Copy limit test menu</p> <p><b>RETURN</b></p>	<p>Displays the <i>screen menu</i>. This softkey provides a tabular listing of all the measured data points and their current values. When <b>DUAL CHAN</b> and <b>COUPLED CHAN</b> are <b>ON</b>, the measured values of both channels are listed at same time. When <b>LIMIT LINE</b> and <b>LIMIT TEST</b> are <b>ON</b>, the limit information is also listed together with the measured values. At the same time, the screen menu is displayed to enable hard copy listings and access new pages of the table.</p> <p>Displays the <i>screen menu</i>. Provides a tabular listing on the display of the key parameters for both channels. The screen menu is presented to allow hard copy listings and access new pages of the table.</p> <p>Displays the <i>copy cal kit menu</i> that prints the calibration kit definitions.</p> <p>Displays the <i>copy compen kit menu</i> that prints the calibration kit definitions.</p> <p>Displays the <i>copy list sweep menu</i> that can display a tabular listing of the list sweep table and print it.</p> <p>Displays the <i>copy limit test menu</i> that can display a tabular listing of the limit value for limit testing and print it.</p>

**Save**

Front Panel Key	Description
<p><b>Save</b></p> <p>STATE</p> <p>DATA ONLY</p> <p>SAVE BINARY</p> <p>SAVE ASCII</p> <p>DEFINE SAVE DATA → See Define save data menu</p> <p>STOR DEV [DISK]</p> <p>RETURN</p> <p>GRAPHICS</p> <p>RE-SAVE FILE</p> <p>BACK UP MEMO DISK</p> <p>FILE UTILITIES</p> <p>PURGE FILE</p> <p>CREATE DIRECTORY</p> <p>CHANGE DIRECTORY</p> <p>COPY FILE → See Select file menu</p> <p>INITIALIZE DISK</p> <p>INIT DISK: YES</p> <p>FORMAT [LIF]</p> <p>STOR DEV [DISK]</p> <p>RETURN</p> <p>STOR DEV [DISK]</p> <p>RETURN</p> <p>STOR DEV [DISK]</p>	<p>Specifies saving the instrument states, the calibration coefficients and measurement data.</p> <p>Specifies saving the internal data arrays which are defined using the DEFINE SAVE DATA key.</p> <p>Specifies saving the internal data arrays as an ASCII file. The arrays saved are defined by the DEFINE SAVE DATA key.</p> <p>Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.</p> <p>Specifies the file format for saving the screen currently displayed as the TIFF format. The traces and background are saved in specified colors. Softkeys are also saved.</p> <p>Displays the Re-save File menu used to update a file that is already saved.</p> <p>Stores the contents of the memory disk in the backup memory</p> <p>Displays the Purge File menu used to remove a file saved on the disk.</p> <p>Specifies creating a new directory in a DOS format disk. This function is not available for LIF files.</p> <p>Specifies changing the current directory of a DOS format disk. This function is not available for LIF files.</p> <p>Copies files. When a file is copied between the flexible disk and the memory disk, the disk formats of the disk and the memory disk must be same format.</p> <p>Displays the Initialize menu.</p> <p>Initializes the disk or the memory disk. When the flexible disk is selected for initialization, [DISK] is displayed in the softkey label, When the memory disk is selected, [MEMORY] is displayed.</p> <p>Toggles the disk format between the LIF and DOS formats that are used when initializing a new disk.</p> <p>Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.</p> <p>Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.</p> <p>Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.</p>
<p>Define save data menu</p> <p>RAW on OFF</p> <p>CAL on OFF</p> <p>DATA on OFF</p> <p>MEM on OFF</p> <p>DATA TRACE on OFF</p> <p>MEM TRACE on OFF</p> <p>RETURN</p>	<p>Toggles saving or not saving the raw data arrays.</p> <p>Toggles saving or not saving the calibration coefficients arrays.</p> <p>Toggles saving or not saving the data arrays.</p> <p>Toggles saving or not saving the memory arrays.</p> <p>Toggles saving or not saving the trace arrays.</p> <p>Toggles saving or not saving the memory trace arrays.</p>

Front Panel Key	Description
<p><b>Save</b> Continued</p> <p>Purge file Yes/No menu</p> <p>PURGE: YES</p> <p>NO</p>	<p>Removes the file and returns to the previous menu.</p> <p>Returns to the previous menu without purging the file.</p>
<p>Select file menu</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>NEXT FILES</p> <p>RETURN</p>	<p>Displays the next file names in the softkey label.</p>

**Recall**

Front Panel Key	Description
<p><b>Recall</b></p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>file name</p> <p>NEXT FILES</p> <p>STOR DEV [DISK]</p>	<p>Selects a file to be loaded and loads the instrument state or data.</p> <p>Selects between the flexible disk drive and the memory disk as the storage device. [DISK] shows the built-in flexible disk is selected and [MEMORY] shows the memory disk is selected.</p>

## Input Range and Default Settings

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When the **Preset** key is pressed, or the analyzer is turned ON, the analyzer reverts to a known state. There are subtle differences between the preset state and the power-up state.

Some power-up states are recalled from non-volatile memory (battery backup memory). If power to the non-volatile memory is lost, the analyzer will have certain parameters set to factory settings. “Results of Power Loss to Battery Backup Memory (Factory Setting)” lists the factory settings. The operating time of the battery backup memory is approximately 72 hours(typical). The battery is automatically recharged while the instrument is ON. The recharge time (time required to fully recharge the battery) is approximately 1 hour(typical).

This appendix also contains Table C-2 to Table C-7 which provide descriptions of the calibration kits predefined for the calibraion functions of the network analyzer.

When line power is cycled the analyzer performs a self-test routine. Upon successful completion of the self-test routine, the instrument state is set to the following preset conditions. The same conditions are true following a “PRES” or “\*RST” command over the GPIB bus.

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### Active Channel Block

**Chan 1** and **Chan 2**

Function	Range	Preset Value	Power ON default
Active Channel	Chan 1, Chan2	Chan 1	Chan 1

## Measurement Block

### Measurement Block

Meas

Function	Range	Resolution	Preset Value	Power ON default
NA:Input Ports	A/R, B/R, A/B, R, A, B		Ch1:A/R, Ch2:B/R	Ch1:A/R, Ch2:B/R
NA:S-parameters	$S_{11}$ , $S_{21}$ , $S_{12}$ , $S_{22}$		$S_{11}$ <sup>1</sup>	Ch1: $S_{11}$ , Ch2: $S_{21}$ <sup>1</sup>
NA: Conversion	Off, Z:Refl, Z:Trans, Y:Refl, Y:Trans, 1/S, 4xPhase, 8 xPhase, 16xPhase		Off	Off
Analyzer Type	Network, Spectrum, Impedance		Analyzer type of the active channel before presetting <sup>2</sup>	Analyzer type of the active channel when the power is turned OFF <sup>2</sup>
SA:Input Ports	R, A, B		R	R
SA:Detection	POS PEAK, NEG PEAK, SAMPLE		POS PEAK	POS PEAK
ZA:Meas Parameter	$ Z $ , $\theta_z$ , R, X, $ Y $ , $\theta_y$ , G, B, $ \Gamma $ , $\theta_\Gamma$ , $\Gamma_x$ , $\Gamma_y$ , $C_p$ , $C_s$ , $L_p$ , $L_s$ , $R_p$ , $R_s$ , D, Q		Ch1: $ Z $ , Ch2: $\theta_z$	Ch1: $ Z $ , Ch2: $\theta_z$
ZA:Fixture	NONE, 16191, 16192, 16193, 16194, USER		NONE	NONE

1 When an S-parameter test set is connected to the analyzer.

2 Both channel 1 and 2

Format

Function	Range	Resolution	Preset Value	Power ON default
NA:Format	LOG MAG, PHASE, DELAY, SMITH CHART, POLAR CHART, LIN MAG, SWR, REAL, IMAGINARY, ADMITTANCE CHART		Ch1: LOG MAG Ch2: PHASE	Ch1: LOG MAG Ch2: PHASE
NA/ZA:Phase Unit	DEG, RAD		DEG	DEG
NA/ZA:Expand Phase	ON, OFF		OFF	OFF
SA: Format	SPECTRUM, NOISE		SPECTRUM	SPECTRUM
SA: Unit	dBm, dBV, $\text{dB}\mu\text{V}$ , WATT, WATT LOG Y-AXIS, VOLT, VOLT LOG Y-AXIS		dBm	dBm
ZA:Format	LIN Y-AXIS, LOG Y-AXIS, POLAR CHART, SMITH CHART, ADMITTANCE CHART, COMPLEX PLANE		LIN Y-AXIS	LIN Y-AXIS



Display

Function	Range	Resolution	Preset Value	Power ON default
Dual Channel	ON, OFF		OFF	OFF
Display	DATA, MEMORY, DATA & MEMORY		DATA	DATA
Data Hold	OFF, MAX, MIN		OFF	OFF
Data Math	DATA, DATA + MEM, DATA – MEM, DATA/MEM,		OFF	OFF
Gain	±100 to ±1/1000		1	1
Offset	±500 k to ±1p		0	0
Aux Offset	±500, 5 digits		0	0
Split Display	ON, OFF		ON	ON
Display Allocation	All INSTRUMENT, HALF INSTR HALF BASIC, All BASIC, BASIC STATUS		No effect	All INSTRUMENT
Title	Max 53 characters		No title	(No title)
Frequency Blank	ON (can not be turn Off until presetting)		OFF	OFF
Intensity	0 to 100 %		No effect	100 %
Background Intensity	0 to 100 %		No effect	0 %
Ch1 Data Color			No effect	Yellow
Ch1 Memory/Limit Line Color			No effect	Green
Ch2 Data Color			No effect	Cyan
Ch2 Memory/Limit Line Color			No effect	Salmon Pink
Graticule Color			No effect	Gray
Warning Color			No effect	Red
Text Color			No effect	White
IBASIC Text Color			No effect	Green
Pen 1 Color			No effect	White
Pen 2 Color			No effect	Red
Pen 3 Color			No effect	Yellow
Pen 4 Color			No effect	Green
Pen 5 Color			No effect	Cyan
Pen 6 Color			No effect	Modified Blue

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
Tint	0 to 100		Default settings for each colors	Default settings for each colors
Brightness	0 to 100		Default settings for each colors	Default settings for each colors
Color	0 to 100		Default settings for each colors	Default settings for each colors
ZA:Display Equivalent Circuit	ON, OFF		OFF	OFF
ZA:Equivalent Circuit	CKT A, CKT B, CKT C, CKT D, CKT E		CKT A	CKT A
ZA:Display Equivalent Parameter	ON, OFF		OFF	OFF
ZA:Parameter R1	$-1a^1$ to $+1a$	1a	0	0
ZA:Parameter C1	$-1a$ to $+1a$	1a	0	0
ZA:Parameter L1	$-1a$ to $+1a$	1a	0	0
ZA:Parameter C0	$-1a$ to $+1a$	1a	0	0

1 a =  $10^{-18}$

Scale Ref

Function	Range	Resolution	Preset Value	Power ON default
Scale / Div				
NA: Log Mag	0.001 to 500	0.001	10	10
NA: Phase	1 p to 500	1 p	90	90
NA: Delay	10 f to 10	10 f	10 n	10 n
NA: Smith Chart	10 p to 10 k	10 p	1	1
NA: Polar Chart	10 p to 10 k	10 p	1	1
NA: Lin Mag	1 f to 100 M	0.1f	100 m	100 m
NA: SWR	1 f to 100 M	0.1f	1	1
NA: Real	1 f to 100 M	0.1f	200 m	200 m
NA: Imaginary	1 f to 100 M	0.1f	200 m	200 m
NA: Exp Phase	1 f to 100 M	0.1f	90	90
NA: Admittance Chart	10 p to 10 k	10 p	1	1
SA: Unit dBm	0.1 to 20	0.1	10	10
SA: Unit dBV	0.1 to 20	0.1	10	10
SA: Unit dB $\mu$ V	0.1 to 20	0.1	10	10
SA: Unit WATT	1 f to 100 M	0.1 f	1	1
SA: Unit WATT Log Y-axis	0.001 to 100	0.00001	10	10
SA: Unit Volt	1 f to 100 M	0.1 f	1	1
SA: Unit Volt Log Y-axis	0.001 to 100	0.00001	10	10
ZA: Lin Y-axis	1 f to 100 M	1 f	100 m	100 m
ZA: Log Y-axis	1 f to 100 M	1 f	10	10
ZA: Polar Chart	10 f to 500 M	10 f	1	1
ZA: Smith Chart	10 f to 500 M	10 f	1	1
ZA: Admittance Chart	10 f to 500 M	10 f	1	1
ZA: Complex Plane	1 f to 100 M	1 f	50	50
ZA: Exp Phase	1 f to 100 M	1 f	90	90

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
Scale / Div (continued)				
ZA: IMPEDANCE: MAG( Z )	0 to 10	0.01	1 k	1 k
ZA: RESIST(R)	0 to 10	0.01	1 k	1 k
ZA: REACT(X)	0 to 10	0.01	1 k	1 k
ZA: RESISTNCE: PRL( $R_p$ )	0 to 10	0.01	100 k	100 k
ZA: SER: PRL( $R_s$ )	0 to 10	0.01	100 k	100 k
ZA: ADMITTNCE MAG ( Y )	0 to 10	0.01	0.1	0.1
ZA: CONDUCT(G)	0 to 10	0.01	0.1	0.1
ZA: SUSCEPT(B)	0 to 10	0.01	0.1	0.1
ZA: REFL.COEF:MAG(  $\Gamma$  )	0 to 10	0.01	0.2	0.2
ZA: REAL( $\Gamma_x$ )	0 to 10	0.01	0.2	0.2
ZA: IMAG( $\Gamma_y$ )	0 to 10	0.01	0.2	0.2
ZA: CAPCITNCE:PRL( $C_p$ )	0 to 10	0.01	100 $\mu$	100 $\mu$
ZA: SER( $C_s$ )	0 to 10	0.01	100 $\mu$	100 $\mu$
ZA: INDUCTNCE:PRL( $L_p$ )	0 to 10	0.01	1	1
ZA: SER( $L_s$ )	0 to 10	0.01	1	1
ZA: PHASE( $\theta_z$ )	0 to 10	0.01	36	36
ZA: PHASE( $\theta_y$ )	0 to 10	0.01	36	36
ZA: PHASE( $\theta_t$ )	0 to 10	0.01	36	36
ZA: D FACTOR(D)	0 to 10	0.01	0.1	0.1
ZA: Q FACTOR(Q)	0 to 10	0.01	100	100

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
Reference Value				
NA: Log Mag	-500 to 500	0.1 m	0	0
NA: Phase	-500 M to 500 M	0.1 m	0	0
NA: Delay	-0.5 to 0.5	1 f	0	0
NA: Smith Chart	10 n to 500	1 n	1	1
NA: Polar Chart	10 n to 500	1 n	1	1
NA: Lin Mag	-500 M to 500 M	0.1 m	0	0
NA: SWR	-500 M to 500 M	0.1 m	1	1
NA: Real	-500 M to 500 M	0.1 m	0	0
NA: Imaginary	-500 M to 500 M	0.1 m	0	0
NA: Exp Phase	-500 M to 500 M	0.1 m	0	0
NA: Admittance Chart	10 n to 500	1 n	1	1
SA: Unit dBm	-100 to 30	0.1	0	0
SA: Unit dBV(50Ω)	-113.0 to 17.0	0.1	0	0
SA: Unit dBV(75Ω)	-111.2 to 18.8	0.1	0	0
SA: Unit dB $\mu$ V(50Ω)	7.0 to 137.0	0.1	0	0
SA: Unit dB $\mu$ V(75Ω)	8.8 to 138.8	0.1	0	0
SA: Unit WATT	-10 p to 1.0	10 p	0	0
SA: Unit WATT Log Y-axis	-1000 to 1000	0.01 m	0	0
SA: Unit Volt(50Ω)	2.236 $\mu$ to 7.071	1 n	0	0
SA: Unit Volt(75Ω)	2.739 $\mu$ to 8.660	1 n	0	0
SA: Unit Volt Log Y-axis	-1000 to 1000	0.01 m	0	0
ZA: Lin Y-axis	-500 M to 500 M	1 f	0	0
ZA: Log Y-axis	-500 M to 500 M	1 f	0	0
ZA: Polar Chart	10 f to 500	1 p	1	1
ZA: Smith Chart	10 f to 500	1 p	1	1
ZA: Admittance Chart	-500 M to 500 M	1 f	1	1
ZA: Complex Plane	-500 M to 500 M	1 f	1	1
ZA: Exp Phase	-500 M to 500 M	1 f	0	0

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
Reference Value (continued)				
ZA: IMPEDANCE: MAG( Z )	-500 M to 500 M	1 f	5 k	5 k
ZA: RESIST(R)	-500 M to 500 M	1 f	5 k	5 k
ZA: REACT(X)	-500 M to 500 M	1 f	5 k	5 k
ZA: RESISTNCE: PRL( $R_p$ )	-500 M to 500 M	1 f	500 k	500 k
ZA: SER: PRL( $R_s$ )	-500 M to 500 M	1 f	500 k	500 k
ZA: ADMITTNCE MAG ( Y )	-500 M to 500 M	1 f	500 m	500 m
ZA: CONDUCT(G)	-500 M to 500 M	1 f	500 m	500 m
ZA: SUSCEPT(B)	-500 M to 500 M	1 f	500 m	500 m
ZA: REFL.COEF:MAG(  $\Gamma$  )	-500 M to 500 M	1 f	0	0
ZA: REAL( $\Gamma_x$ )	-500 M to 500 M	1 f	0	0
ZA: IMAG( $\Gamma_y$ )	-500 M to 500 M	1 f	0	0
ZA: CAPCITNCE:PRL( $C_p$ )	-500 M to 500 M	1 f	500 $\mu$	500 $\mu$
ZA: SER( $C_s$ )	-500 M to 500 M	1 f	500 $\mu$	500 $\mu$
ZA: INDUCTNCE:PRL( $L_p$ )	-500 M to 500 M	1 f	5	5
ZA: SER( $L_s$ )	-500 M to 500 M	1 f	5	5
ZA: PHASE( $\theta_z$ )	-500 M to 500 M	1 f	0	0
ZA: PHASE( $\theta_y$ )	-500 M to 500 M	1 f	0	0
ZA: PHASE( $\theta_t$ )	-500 M to 500 M	1 f	0	0
ZA: D FACTOR(D)	-500 M to 500 M	1 f	0.5	0.5
ZA: Q FACTOR(Q)	-500 M to 500 M	1 f	500	500

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
Reference Position				
NA: Log Mag	0 to 10	0.01	5	5
NA: Phase	0 to 10	0.01	5	5
NA: Delay	0 to 10	0.01	5	5
NA: Smith Chart	0 to 10	0.01	5	5
NA: Polar Chart	0 to 10	0.01	5	5
NA: Lin Mag	0 to 10	0.01	0	0
NA: SWR	0 to 10	0.01	1	1
NA: Real	0 to 10	0.01	5	5
NA: Imaginary	0 to 10	0.01	5	5
NA: Exp Phase	0 to 10	0.01	5	5
NA: Admittance Chart	0 to 10	0.01	5	5
SA: Unit dBm	10 (fixed)	—	10	10
SA: Unit dB $\mu$ V	10 (fixed)	—	10	10
SA: Unit WATT	10 (fixed)	—	10	10
SA: Unit WATT Log Y-axis	10 (fixed)	—	10	10
SA: Unit Volt	10 (fixed)	—	10	10
SA: Unit Volt Log Y-axis	10 (fixed)	—	10	10
ZA: <sup>1</sup>	0 to 10	0.01	5	5

<sup>1</sup> Except for Log Y-axis or Complex Plane.

Top Value Analyzer Mode:ZA, Format:Log Y-axis

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
IMPEDANCE: MAG( Z )	-1 G to 1 G	1 f	1 M	1 M
RESIST(R)	-1 G to 1 G	1 f	1 M	1 M
REACT(X)	-1 G to 1 G	1 f	1 M	1 M
RESISTNCE: PRL( $R_P$ )	-1 G to 1 G	1 f	1 M	1 M
SER: PRL( $R_s$ )	-1 G to 1 G	1 f	1 M	1 M
ADMITTNCE MAG ( Y )	-1 G to 1 G	1 f	1	1
CONDUCT(G)	-1 G to 1 G	1 f	1	1
SUSCEPT(B)	-1 G to 1 G	1 f	1	1
REFL.COEF:MAG(  $\Gamma$  )	-1 G to 1 G	1 f	1	1
REAL( $\Gamma_x$ )	-1 G to 1 G	1 f	1	1
IMAG( $\Gamma_y$ )	-1 G to 1 G	1 f	1	1
CAPCITNCE:PRL( $C_P$ )	-1 G to 1 G	1 f	1 m	1 m
SER( $C_s$ )	-1 G to 1 G	1 f	1 m	1 m
INDUCTNCE:PRL( $L_P$ )	-1 G to 1 G	1 f	10	10
SER( $L_s$ )	-1 G to 1 G	1 f	10	10
PHASE( $\theta_z$ )	-1 G to 1 G	1 f	200	200
PHASE( $\theta_y$ )	-1 G to 1 G	1 f	200	200
PHASE( $\theta_r$ )	-1 G to 1 G	1 f	200	200
D FACTOR(D)	-1 G to 1 G	1 f	1	1
Q FACTOR(Q)	-1 G to 1 G	1 f	1000	1000

Bottom Value Analyzer Mode:ZA, Mode:Log Y-axis



## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
IMPEDANCE: MAG( Z )	-1 G to 1 G	1 f	1	1
RESIST(R)	-1 G to 1 G	1 f	1	1
REACT(X)	-1 G to 1 G	1 f	1	1
RESISTNCE: PRL( $R_P$ )	-1 G to 1 G	1 f	1	1
SER: PRL( $R_s$ )	-1 G to 1 G	1 f	1	1
ADMITTNCE MAG ( Y )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
CONDUCT(G)	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
SUSCEPT(B)	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
REFL.COEF:MAG(  $\Gamma$  )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
REAL( $\Gamma_x$ )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
IMAG( $\Gamma_y$ )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
CAPCITNCE:PRL( $C_P$ )	-1 G to 1 G	1 f	1 n	1 n
SER( $C_s$ )	-1 G to 1 G	1 f	1 n	1 n
INDUCTNCE:PRL( $L_P$ )	-1 G to 1 G	1 f	10 p	10 p
SER( $L_s$ )	-1 G to 1 G	1 f	10 p	10 p
PHASE( $\theta_z$ )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
PHASE( $\theta_y$ )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
PHASE( $\theta_r$ )	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
D FACTOR(D)	-1 G to 1 G	1 f	1 $\mu$	1 $\mu$
Q FACTOR(Q)	-1 G to 1 G	1 f	1	1

Function	Range	Resolution	Preset Value	Power ON default
Reference X,Y Value				
ZA: Complex Plane	-1 G to 1 G	0.1 f	0	0

## Measurement Block

Function	Range	Resolution	Preset Value	Power ON default
NA: Scale for	Data, Memory		Data	Data
NA: Scale Couple	On, Off		On	On
NA: Electrical delay	-0.01 to 0.01	1 f	0	0
NA: Phase offset	$\pm 360^\circ$		0	0
SA: Attenuator mode	Manual, Auto		Auto	Auto
SA: Attenuator at R input	0, 10, 20, 30, 40, 50 dB	10 dB	20 dB	20 dB
SA: Attenuator at A input	0, 10, 20, 30, 40, 50 dB	10 dB	20 dB	20 dB
SA: Attenuator at B and B inputs	0, 10, 20, 30, 40, 50 dB	10 dB	20 dB	20 dB
SA: Scale for	Data, Memory		Data	Data
SA: Scale Couple	On, Off		On	On
SA: Max. mixer level	-100 to -10 dBm	10 dB	-10.0	-10.0
ZA: Scale for	Data, Memory		Data	Data
ZA: Scale Couple	On, Off		On	On

Bw/Avg

Function	Range	Resolution	Preset Value	Power ON default
NA: Band width	2, 10, 30, 100, 300, 1 k, 3 k, 10 k, 30 kHz		30 kHz	30 kHz
NA: Averaging	On, Off		Off	Off
NA: Averaging factor	1 to 999		16	16
NA: Group delay aperture	0.25 to 20 % of span		1 %	1 %
SA: Resolution Band width span=0	3 k, 5 k, 10 k, 20 k, 40 k, 100 k, 200 k, 400 k, 800 k, 1.5 M, 3 M		3 MHz	3 MHz
SA: Resolution Band width span>0	1 to $1 \times 10^6$ Hz 1-3 step, Auto		1 M (Auto)	1 M (Auto)
SA: Averaging	On, Off		Off	Off
SA: Averaging factor	1 to 999		16	16
SA: RBW/SPAN ratio	0.01 to 10 % of span		0.2 %	0.2 %
SA: Video Band Width	0.003 to $1 \times 10^6$ Hz 1-3 step		1 M	1 M
ZA: Band width	2, 10, 30, 100, 300, 1 k, 3 k, 10 k, 30 kHz		1 kHz	1 kHz
ZA: Averaging	On, Off		Off	Off
ZA: Averaging factor	1 to 999		16	16

Cal

## Sweep Block

Function	Range	Resolution	Preset Value	Power ON default
NA: Correction	On, OFF		Off	Off
NA: Calibration Type	None, Response, S11 1port, S22 1port, Full 2port, One path 2port		None	None
NA: Calibration Kit	7 mm, 3.5 mm, N50 $\Omega$ , N75 $\Omega$ , User kit		7 mm	7 mm
NA: System Impedance	1 m $\Omega$ to $5 \times 10^6$		50	50
NA: Velocity factor	0.0 to 10.0	1 f	1	1
NA: Port1 extension	-0.01 to 0.01	1 f	0	0
NA: Port2 extension	-0.01 to 0.01	1 f	0	0
NA: Input R extension	-0.01 to 0.01	1 f	0	0
NA: Input A extension	-0.01 to 0.01	1 f	0	0
NA: Input B extension	-0.01 to 0.01	1 f	0	0
SA: System Impedance	50, 75		50	50
SA: Input Z	50, 75		50	50
ZA: Correction	On, OFF		Off	Off
ZA: Calibration Kit	7 mm, 3.5 mm, N50 $\Omega$ , N75 $\Omega$ , User kit		7 mm	7 mm
ZA: System Impedance	50		50	50

---

## Sweep Block

Sweep

## Sweep Block

Function	Range	Resolution	Preset Value	Power ON default
NA: Sweep time mode	Auto, Man		Auto	Auto
NA: NOP	2 to 801		201	201
NA: Coupled Channel	On, Off		On	On
NA: Sweep type	Lin-Freq, Log-Freq, List-Freq, Power		Lin-Freq	Lin-Freq
NA: List edit mode (sweep range)	Start-stop, Center-Span		Start-stop	Start-stop
NA: List edit mode (resolution)	NOP, Step size		NOP	NOP
SA: Sweep time mode	Auto, Man		Auto	Auto
SA: NOP for zero span <sup>1</sup>	2 to 801		801	801
SA: Sweep type	Lin-Freq, List-Freq		Lin-Freq	Lin-Freq
SA: List edit mode	Start-stop, Center-Span		Start-stop	Start-stop
ZA: Sweep time mode	Auto, Man		Auto	Auto
ZA: NOP	2 to 801		201	201
ZA: Coupled Channel	On, Off		On	On
ZA: Sweep type	Lin-Freq, Log-Freq, List-Freq, Power		Lin-Freq	Lin-Freq

<sup>1</sup> NOP is automatically set and can not be changed by user, except for ZERO SPAN.

Source

Function	Range	Resolution	Preset Value	Power ON default
NA: Power	-50 to + 15 dBm	0.1 dB	0 dBm	0 dBm
NA: Attenuator port 1	0 to 70 dB	10 dB	0	0
NA: Attenuator port 2	0 to 70 dB	10 dB	0	0
NA: CW frequency	10 Hz to 510 MHz	1 mHz	250 MHz	250 MHz
SA: Power	- 50 to + 15 dBm	0.1 dB	0 dBm	0 dBm
SA: Power OUT	On, Off		Off	Off
ZA: Power	-50 to + 15 dBm	0.1 dB	0 dBm	0 dBm
ZA: CW frequency	10 Hz to 510 MHz	1 mHz	250 MHz	250 MHz

## Sweep Block

### Trigger

Function	Range	Resolution	Preset Value	Power ON default
Trigger type	Continuous, Number of groups, Single, Hold,		Continuous	Continuous
NA: Trigger Source	Free run, External, Manual, GPIB		Free run	Free run
NA: Trigger event	On point, On sweep		On sweep	On sweep
Trigger polarity	Positive, Negative		Positive	Positive
Gate type	Level, Edge		level	Level
Gate delay	0.8 $\mu$ s to 3.2 s		0.8 $\mu$ s	0.8 $\mu$ sec
Gate length	6 $\mu$ s to 3.2 s		100 $\mu$ s	100 $\mu$ sec
SA: Trigger Source	Free run, External, Manual, GPIB, Level Gate <sup>1</sup> , Edge Gate <sup>1</sup>		Free run	Free run

<sup>1</sup> With option 1D6.

### Center

Function	Range	Resolution	Preset Value	Power ON default
NA: Center Frequency	0 Hz to 510 MHz	1 mHz	250 MHz	250 MHz
NA: Step Size mode	On(1-2-5 step), Off(linear)		On	On
SA: Center Frequency	10 Hz to 510 MHz	1 mHz	250 MHz	250 MHz
SA: Step Size mode	On(1-2-5 step), Off(linear)		Off	Off
Center step size	1 mHz to 510 MHz	1 mHz	10 MHz	10 MHz
ZA: Step Size mode	On(1-2-5 step), Off(linear)		On	On

### Span

Function	Range	Resolution	Preset Value	Power ON default
NA: Span Frequency	0 Hz to 509.99999 MHz	1 mHz	499.99999 MHz	499.99999 MHz
NA: Span power	0 to 20 dB		20 dB	20 dB
SA: Span Frequency	0 Hz to 510 MHz	1 mHz	500 MHz	500 MHz
ZA: Span Frequency	0 Hz to 509.99999 MHz	1 mHz	499.99999 MHz	499.99999 MHz

## Marker Block

(Start) & (Stop)

Function	Range	Resolution	Preset Value	Power ON default
NA: Start Frequency	10 Hz to 510 MHz	1 mHz	10 Hz	10 Hz
NA: Stop Frequency	10 Hz to 510 MHz	1 mHz	500 MHz	500 MHz
NA: Start power	-50 to +15 dBm	0.1 dBm	-20 dBm	-20 dBm
NA: Stop power	-50 to +15 dBm	0.1 dBm	0 dBm	0 dBm
SA: Start Frequency	0 Hz to 510 MHz	1 mHz	0 Hz	0 Hz
SA: Stop Frequency	0 Hz to 510 MHz	1 mHz	500 MHz	500 MHz
ZA: Start Frequency	10 Hz to 510 MHz	1 mHz	100 kHz	100 kHz
ZA: Stop Frequency	10 Hz to 510 MHz	1 mHz	500 MHz	500 MHz

---

## Marker Block

(Marker)

## Marker Block

Function	Range	Resolution	Preset Value	Power ON default
Marker position	START to STOP		CENTER <sup>1</sup>	CENTER <sup>1</sup>
Number of Marker	1		Off	Off
Number of Sub-marker	7		All OFF	All OFF
Delta-marker	Off, On, FIX, TRAC		Off	Off
Marker on	Off, On		Off	Off
NA: Marker mode	Cont, Disc		Cont	Cont
NA: Fixed $\Delta$ mkr position(Sweep prmtr)	START to STOP		CENTER	CENTER
NA: Fixed $\Delta$ mkr position(Value)	The same as the reference value		(0)	(0)
NA: Fixed $\Delta$ mkr position(AUX value)	The same as the reference value		(0)	(0)
NA: Marker coupled	On, Off		On	On
SA: Fixed $\Delta$ mkr position(Sweep prmtr)	The same as the reference value		(0)	(0)
SA: Fixed $\Delta$ mkr position(Value)	The same as the reference value		(0)	(0)
SA: Marker coupled	On, Off		Off	Off
ZA: Marker coupled	On, Off		On	On

<sup>1</sup> Zero will be returned if the marker position is read using GPIB command after presetting and before the marker turn to ON.

Marker →

Function	Range	Resolution	Preset Value	Power ON default
Destination channel	Ch1, Ch2		Ch1	Ch1
Zooming aperture	0 to 100 % of SPAN	0.01	10 %	10 %

Search



## Marker Block

Function	Range	Resolution	Preset Value	Power ON default
Search range	START to STOP		Full SPAN	Full SPAN
NA: Peak polarity	Positive, Negative		Positive	Positive
NA: Width	On, Off		Off	Off
NA: Width value	$\pm 500$ dB		-3 dB	-3dB
SA: Signal track	On, Off		Off	Off
NA: Peak def: $\Delta X$	1 n to 1 G		10 MHz	10 MHz
NA: Peak def: $\Delta Y$	Depends on format		1 dB	1 dB
SA: Peak def: $\Delta Y$	Depends on format		15 dB	15 dB
Threshold	On, Off		Off	Off
NA: Threshold value	The same as the reference value		-100 dB	-100 dB
SA: Threshold value	The same as the reference value		-100 dBm	-100 dBm
Part search	On, Off		Off	Off
ZA: Peak polarity	Positive, Negative		Positive	Positive
ZA: Width	On, Off		Off	Off
ZA: Width value	$\pm 500$ dB		-3 dB	-3dB
ZA: Peak def: $\Delta X$	1 n to 1 G		10 MHz	10 MHz
ZA: Peak def: $\Delta Y$	Depends on format		1 dB	1 dB

### Utility

Function	Range	Resolution	Preset Value	Power ON default
Marker list	On, Off		Off	Off
NA: Statistics	On, Off		Off	Off
Marker time	On, Off		Off	Off
SA: Statistics	On, Off		Off	Off
SA: Noise form	On, Off		Off	Off

## Instrument State Block

## Instrument State Block

System

Function	Range	Resolution	Preset Value	Power ON default
Clock time	00:00:00 to 23:59:59		0:00:00	0:00:00
Clock date	1900 to 2099(year),01 to 12(month),01 to 31(day)		1997,01,01	1997,01,01
Date format	DAYMYEAR,MONDYEAR		MONDYEAR	MONDYEAR
Beeper done	On, Off		On	On
Beeper warning	On, Off		Off	Off
Limit Line	On, Off		Off	Off
Limit test	On, Off		Off	Off
Beep Fail	On, Off		Off	Off
Limit line table			No effect	Empty
Limit line offset (Sweep prmr)	-1 G to 1 GHz	1 mHz	0	0
Limit line offset (Amp)	-1 G to 1 G		0	0

Copy

Function	Range	Resolution	Preset Value	Power ON default
Print mode	Standard, Color		Standard	Standard
Copy time	On, Off		Off	Off
Print color	Fixed, Variable		Fixed	Fixed
Print resolution	75 to 600	5 dpi	75	75
Print margin(Left)	0 to 5	0.01 inch	1.0	1.0
Print margin(Top)	0 to 5	0.01 inch	1.0	1.0
Limit test table	UL, MDT		UL	UL
List sweep table (sweep prmr)	STSP, CTSP		STSP	STSP

## Predefined Calibration Kits

Save

Function	Range	Resolution	Preset Value	Power ON default
Initialize disk format	LIF, DOS		LIF	LIF
Graphics extension	3 characters		.TIF	.TIF
ASCII data extension	3 characters		.TXT	.TXT
Define Save:Raw	On, Off		Off	Off
Define Save:Cal	On, Off		Off	Off
Define Save:Data	On, Off		Off	Off
Define Save:Mem	On, Off		Off	Off
Define Save:Trace data	On, Off		On	On
Define Save:Trace mem	On, Off		On	On

Local

Function	Range	Resolution	Preset Value	Power ON default
GPIB address	0 to 30		No effect	No effect
GPIB mode	System controller, Addressable		No effect	No effect

## Results of Power Loss to Battery Backup Memory (Factory Setting)

Function	Factory Setting
GPIB address for 4395A	17
GPIB address for controller	21
Calibration kit definitions	Factory set default (See the following tables)
Real time clock date	09/01/1997
Analyser type	Network Analyzer mode

## Predefined Calibration Kits

**Table C-1. 3.5 mm Standard Cal Kit**

NO.	STANDARD TYPE	C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz <sup>2</sup>	OFFSET DELAY ps	OFFSET LOSS GΩ/s	OFFSET Z <sub>0</sub> Ω	STANDARD LABEL
1	SHORT				16.695	1.3	50	SHORT
2	OPEN	53	150	0	14.491	1.3	50	OPEN
3	LOAD				0	1.3	50	BROADBAND
4	DELAY/THRU				0	1.3	50	THRU
5	LOAD				0	1.3	50	SLIDING
6	LOAD				0	1.3	50	LOWBAND
7	SHORT				0	1.3	50	SHORT
8	OPEN	79.4	0	40	0	1.3	50	OPEN

**Table C-2. 7 mm Standard Cal Kit**

NO.	STANDARD TYPE	C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz <sup>2</sup>	OFFSET DELAY ps	OFFSET LOSS MΩ/s	OFFSET Z <sub>0</sub> Ω	STANDARD LABEL
1	SHORT				0	700	50	SHORT
2	OPEN	92.85	0	7.2	0	700	50	OPEN
3	LOAD				0	700	50	BROADBAND
4	DELAY/THRU				0	700	50	THRU
5	LOAD				0	700	50	SLIDING
6	LOAD				0	700	50	LOWBAND
7	SHORT				0	700	50	
8	OPEN	79.4	0	40	0	700	50	OPEN

**Table C-3. 50 Ω Type-N Standard Cal Kit**

NO.	STANDARD TYPE	C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz <sup>2</sup>	OFFSET DELAY ps	OFFSET LOSS MΩ/s	OFFSET Z <sub>0</sub> Ω	STANDARD LABEL
1	SHORT				0	700	50	SHORT[M]
2	OPEN	108	55	130	0	700	50	OPEN[M]
3	LOAD				0	700	50	BROADBAND
4	DELAY/THRU				0	700	50	THRU
5	LOAD				0	700	50	SLIDING
6	LOAD				0	700	50	LOWBAND
7	SHORT				17.544	700	50	SHORT[F]
8	OPEN	62	17	28	17.544	700	50	OPEN[F]

Table C-4. 75 Ω Type-N Standard Cal Kit

NO.	STANDARD TYPE	C0 × 10 <sup>-15</sup> F	C1 × 10 <sup>-27</sup> F/Hz	C2 × 10 <sup>-36</sup> F/Hz <sup>2</sup>	OFFSET DELAY ps	OFFSET LOSS MΩ/s	OFFSET Z <sub>0</sub> Ω	STANDARD LABEL
1	SHORT				0	1.13 × 10 <sup>3</sup>	75	SHORT[M]
2	OPEN	63.5	84	56	0	1.13 × 10 <sup>3</sup>	75	OPEN[M]
3	LOAD				0	1.13 × 10 <sup>3</sup>	75	BROADBAND
4	DELAY/THRU				0	1.13 × 10 <sup>3</sup>	75	THRU
5	LOAD				0	1.13 × 10 <sup>3</sup>	75	SLIDING
6	LOAD				0	1.13 × 10 <sup>3</sup>	75	LOWBAND
7	SHORT				17.544	1.13 × 10 <sup>3</sup>	75	SHORT[F]
8	OPEN	41	40	5	17.544	1.13 × 10 <sup>3</sup>	75	OPEN[F]

**Predefined Calibration Kits**

**Predefined Standard Class Assignments**

**Table C-5. Standard Class Assignments Table (7 mm and 3.5 mm)**

CLASS	A	B	C	D	E	F	G	STANDARD CLASS LABEL
S <sub>11A</sub>	2							OPEN
S <sub>11B</sub>	1							SHORT
S <sub>11C</sub>	3							LOAD
S <sub>22A</sub>	2							OPEN
S <sub>22B</sub>	1							SHORT
S <sub>22C</sub>	3							LOAD
Forward Transmission	4							THRU
Reverse Transmission	4							THRU
Forward Match	4							THRU
Reverse Match	4							THRU
Response	1	2	4					RESPONSE
Response & Isolation	1	2	4					RESPONSE

**Table C-6. Standard Class Assignments Table (50 Ω Type-N)**

CLASS	A	B	C	D	E	F	G	STANDARD CLASS LABEL
S <sub>11A</sub>	2	8						OPENS
S <sub>11B</sub>	1	7						SHORTS
S <sub>11C</sub>	3							LOAD
S <sub>22A</sub>	2	8						OPENS
S <sub>22B</sub>	1	7						SHORTS
S <sub>22C</sub>	3							LOAD
Forward Transmission	4							THRU
Reverse Transmission	4							THRU
Forward Match	4							THRU
Reverse Match	4							THRU
Response	1	7	2	8	4			RESPONSE
Response & Isolation	1	7	2	8	4			RESPONSE

**Table C-7. Standard Class Assignments Table (75  $\Omega$  Type-N)**

CLASS	A	B	C	D	E	F	G	STANDARD CLASS LABEL
S <sub>11A</sub>	2	8						OPENS
S <sub>11B</sub>	1	7						SHORTS
S <sub>11C</sub>	3							LOAD
S <sub>22A</sub>	2	8						OPENS
S <sub>22B</sub>	1	7						SHORTS
S <sub>22C</sub>	3							LOAD
Forward Transmission	4							THRU
Reverse Transmission	4							THRU
Forward Match	4							THRU
Reverse Match	4							THRU
Response	1	7	2	8	4			RESPONSE
Response & Isolation	1	7	2	8	4			RESPONSE





## Manual Changes

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### Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the analyzer than the current printing date of this manual. The information in this manual applies directly to the 4395A Network/Spectrum Analyzer serial number prefix listed on the title page of this manual.

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### Manual Changes

To adapt this manual to your 4395A, see Table D-1 and Table D-2, and make all the manual changes listed opposite your instrument's serial number and firmware version.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument's serial number is not listed on the title page of this manual or in Table D-1, it may be documented in a *yellow MANUAL CHANGES* supplement.

In additions to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Agilent Technologies recommends that you periodically request the latest *MANUAL CHANGES* supplement.

For information concerning serial number prefixes not listed on the title page or in the *MANUAL CHANGE* supplement, contact the nearest Agilent Technologies office.

Turn on the line switch or execute the \*IDN? command by GPIB to confirm the firmware version. See the *GPIB Command Reference* manual for information on the \*IDN? command.

**Table D-1. Manual Changes by Serial Number**

Serial Prefix or Number	Make Manual Changes
JP1KE	

**Table D-2. Manual Changes by Firmware Version**

Version	Make Manual Changes

## Serial Number

---

### Serial Number

Agilent Technologies uses a two-part, nine-character serial number that is stamped on the serial number plate (see Figure D-1) attached to the rear panel. The first five characters are the serial prefix and the last five digits are the suffix.



**Figure D-1. Serial Number Plate (sample)**

## Miscellaneous Changes

The option system of the 4395A has changed since June 2002. Apply the following changes.

New Option Number	Old Option Number	Remark
700 (No DC Bias Source)	Standard	1
001 (Add DC Bias Source)	same as the left number	
706 (No Time-gated Spectrum Analysis)	Standard	2
1D6 (Add Time-gated Spectrum Analysis)	same as the left number	
800 (Standard Frequency Reference)	Standard	3
1D5 (High Stability Frequency Reference)	same as the left number	
810 (Add Mini DIN Keyboard)	-	4
-	1A2 (Delete Mini DIN Keyboard)	
1CN (Handle Kit)	same as the left number	
1CM (Rack Mount Kit)	same as the left number	
1CP (Rack Mount & Handle Kit)	same as the left number	
0BW (Add Service Manual)	same as the left number	

- 1 In the previous system, an option for the DC bias source was available only for "Add". In the new option system, it is available for "Add" and "No", requiring the customer to select either of them.
- 2 In the previous system, an option for the time-gated spectrum analysis was available only for "Add". In the new option system, it is available for "Add" and "No", requiring the customer to select either of them.
- 3 In the previous system, an option for the frequency reference was available only for the high stability frequency reference. In the new option system, it is available for the high stability and standard references, requiring the customer to select either of them.
- 4 In the previous option system, the keyboard comes as one of standard accessories. In the new option system, it will be attached only when you choose option 810.

The option system of the 4395A has changed since May 2003. Apply the following changes.

New Option Number	Old Option Number	Remark
ABA (Add Manual set (English))	-	1
-	ABA (Include Manual set (English))	
ABJ (Add Manual set (Japanese))	-	1
-	ABJ (Include Manual set (Japanese))	
ABF (Add Manual set (French))	-	1
-	ABF (Include Manual set (French))	
-	0B1 (Delete Manual Sets)	2
-	0B1 (Add Manual Sets)	

- 1 In the previous system, the option number is used to choose the language of the operation manual set (standard accessory). In the new option system, it is used to add an operation manual set (optional accessory) of the language the customer desires.
- 2 No selection of addition/deletion is required for the operation manual set because it is only available as an optional accessory in the new option system. When 2 or more sets are required, specify option ABA,ABJ \* (number of required sets).



# Error Messages

---

This section lists the error messages that are displayed on the analyzer display or transmitted by the instrument over GPIB. Each error message is accompanied by an explanation, and suggestions are provided to help in solving the problem. Where applicable, references are provided to the related chapter of the appropriate manual.

When displayed, error messages are preceded with the word "CAUTION:." That part of the error message has been omitted here for the sake of brevity. Some messages without the "CAUTION:" are for information only, and do not indicate an error condition. The messages are listed first in alphabetical order because the displayed messages do not contain the message number. The messages are then listed in numerical order to make them easier to find if they are read over the GPIB.

In addition to error messages, The analyzer's status is indicated by status notations in the left margin of the display. Examples are \*, Cor, and Avg. Sometimes these appear together with error messages. A complete listing of status notations and their meanings is provided in Chapter 4 of this manual.

---

## Error Messages in Alphabetical Order

### A

#### 173 ACTIVE/SYSTEM CONTROLLER REQUIRED

When the 4395A and its peripherals are controlled using the Instrument BASIC, you must set the GPIB system's control mode to the system controller mode.

#### 10 ADDITIONAL STANDARDS NEEDED

Error correction for the selected calibration class cannot be computed until all the necessary standards have been measured.

#### 84 ANALYZER TYPE MISMATCH

The analyzer receives a command that is not available for the current analyzer type. Please confirm GPIB command or change analyzer type before sending the command.

### B

#### 17 BACKUP DATA LOST

Data checksum error on the battery backup memory has occurred. The battery is recharged for approximately 10 minutes after power was turned ON.

## **Error Messages in Alphabetical Order**

### **–160 Block data error**

This error, as well as errors –161 and –168, are generated when analyzing the syntax of a block data element. This particular error message is used if the analyzer cannot detect a more specific error.

### **–168 Block data not allowed**

A legal block data element was encountered but was not allowed by the analyzer at this point in parsing.

## **C**

### **13 CALIBRATION ABORTED**

The calibration in progress was terminated due to a change of the active channel or stimulus parameters.

### **11 CALIBRATION REQUIRED**

No valid calibration coefficients were found when you attempted to turn calibration ON.

### **126 CAN'T CHANGE NUMBER OF POINTS**

The number of points of the spectrum analyzer mode cannot be to change manually, except in zero span.

### **133 CAN'T CHANGE ON LIST SWEEP**

When list sweep is selected, the following parameters are not allowed to be changed:

- CENTER, SPAN, START, STOP
- NOP
- IFBW or RBW
- POWER
- DC SOURCE

Modify the list table to change these parameters in the list sweep.

### **97 CAN'T CHANGE WHILE DATA MATH ON**

The setting cannot be changed when the data math function is used.

### **99 CAN'T CHANGE WHILE DUAL CHAN OFF**

The Cross channel cannot be turned on when dual channel is off. Turn on the dual channel before the cross channel is turned on.

### **82 CAN'T CHANGE- ANOTHER CONTROLLER ON BUS**

The analyzer cannot assume the mode of system controller until the active controller is removed from the bus or relinquishes the bus. See *Programming Manual*.

### **134 CAN'T COUPLE IN CURRENT INPUTS**

When one channel measures a ratio measurement, and the other one measures an absolute measurement (for example: A/R and B), `COUPLED CH` can not be turned on.

**114 CAN'T SAVE GRAPHICS WHEN COPY IN PROGRESS**

If you attempt to save graphics when a print is in progress, this error message is displayed.

**1 CAN'T SET RBW AUTO IN ZERO SPAN**

The RBW AUTO mode cannot be selected in the zero span. The RBW must be specified manually in the zero span. (spectrum analyzer mode only).

**127 CAN'T SET SWEEP TIME AUTO IN ZERO SPAN**

The automatic sweep time cannot be in zero span of the spectrum analyzer mode. (The network analyzer mode allows that the automatic sweep time is turned on.)

**-281 Cannot create program**

Indicates that an attempt to create a program was unsuccessful. A reason for the failure might include not enough memory.

**-140 Character data error**

This error, as well as errors -141 through -148, are generated when analyzing the syntax of a character data element. This particular error message is used if the analyzer cannot detect a more specific error.

**-148 Character data not allowed**

A legal character data element was encountered where prohibited by the analyzer.

**-144 Character data too long**

The character data element contains more than twelve characters (see IEEE 488.2, 7.7.1.4).

**-100 Command error**

This is a generic syntax error that the analyzer cannot detect more specific errors. This code indicates only that a command error, as defined in IEEE 488.2, 11.5.1.1.4, has occurred.

**-110 Command header error**

An error was detected in the header. This error message is used when the analyzer cannot detect the more specific errors described for errors -111 through -119.

**75 COMMAND IGNORED - SEGMENT NOT DONE YET**

The GPIB command the analyzer received is ignored, because the segment is editing (*GPIB only*). Send LIMSDON (limit segment done) or SDON (segment done) to terminate editing segment. (See *Programming Manual*.)

**269 COMPENSATION ABORTED**

Compensation data acquisition process is aborted.

**267 COMPENSTATION REQUIRED**

Compensation is required. Perform compensation to obtain compensation data.

## **Error Messages in Alphabetical Order**

### **50 CONT SWITCHING MAY DAMAGE MECH SW**

RF output power switch, input attenuator switch at input R/A/B, or internal mechanical switch in the S-parameter test set is switching sweep by sweep, because RF power level or the input attenuator setting is different between two channels and the dual channel is turn on, or continuous trigger mode is selected after full 2-port calibration is performed when 4395A is used with the S-parameter test set. To avoid premature wearing out of the output power switch, input attenuator switch, or internal switch of the S-parameter test set, change trigger type to HOLD, SINGLE, or NUMBER of GROUP to hold sweep after measurement required. Or, for example, turn off the dual channel, or set the power level and the input attenuator of both channels to the same setting.

### **135 COUPLED CHAN - BETWEEN NA&NA OR ZA&ZA**

The analyzer types of both channels must be the network analyzer mode or impedance analyzer mode when the coupled channel is turned on. It is not possible to turn the coupled channel on in spectrum analyzer mode.

### **74 CURRENT EDITING SEGMENT SCRATCHED**

The current editing segment for the list table and the limit line is scratched when the following cases occur (*GPIB only*) :

- When EDITLIST (edit list table) command is received while editing a segment for the list table.
- When EDITLIML (edit limit line) command is received while editing a segment for the limit line.

Send LIMSDON (limit segment done) or SDON (segment done) to terminate editing segment.

### **16 CURRENT PARAMETER NOT IN CAL SET**

*GPIB only.* Correction is not valid for the selected measurement parameter.

## **D**

### **-230 Data corrupt or stale**

Possibly invalid data. New reading started but not completed since last access.

### **-225 Data out of memory**

The analyzer has insufficient memory to perform the requested operation.

### **-222 Data out of range**

A legal program data element was parsed but could not be executed because the interpreted value was outside the legal range as defined by the analyzer (see IEEE 488.2, 11.5.1.1.5).

### **-231 Data questionable**

Indicates that measurement accuracy is suspect.

### **-104 Data type error**

The parser recognized an unallowed data element. For example, numeric or string data was expected but block data was encountered.



**137 DC CURRENT LIMIT OCCURED**

The output current at DC SOURCE port is reached the upper limit; the output voltage is reduced so that the current does not exceed the upper limit. This message appears when the DC SOURCE port is used in voltage control mode.

**136 DC SOURCE OVERLOAD**

The DC SOURCE output is overloaded.

**138 DC VOLTAGE LIMIT OCCURED**

The output voltage at DC SOURCE port is reached the upper limit; the output current is reduced so that the voltage does not exceed the upper limit. This message appears when the DC SOURCE port is used in current control mode.

**37 DISPLAY BUFFER IS FULL**

The display buffer is filled with the overlay traces or traces drawn by IBASIC DRAW/MOVE commands, etc.

**117 DUPLICATE FILE EXTENSION**

The extension name entered is already used for other file types. Use other extension name.

**E**

**15 EXCEEDED 7 STANDARDS PER CLASS**

A maximum of seven standards can be defined for any class.

**-200 Execution error**

This is the generic syntax error that the analyzer cannot detect more specific errors. This code indicates only that an execution error as defined in IEEE 488.2, 11.5.1.1.5 has occurred.

**-123 Exponent too large**

The magnitude of the exponent was larger than 32000 (see IEEE 488.2, 7.7.2.4.1).

**F**

**-257 File name error**

Indicates that a legal program command or query could not be executed because the file name on the device media was in error. For example, an attempt was made to copy to a duplicate file name. The definition of what constitutes a file name error is device-specific.

**-256 File name not found**

A legal program command could not be executed because the file name on the device media was not found: for example, an attempt was made to read or copy a nonexistent file.

## **Error Messages in Alphabetical Order**

### **143 FLOATING POINT ERROR OCCURED**

Indicate that a floating point error occurred in the analyzer. Data processing may not be correct. This error message is used when an internal application was executed for illegal data sent from an external device, or when an internal software bug was detected. Contact your nearest Agilent Technologies office.

### **83 FORMAT NOT VALID FOR MEASUREMENT**

The conversion function except the 1/S and the multiple phase modes is not valid for the Smith, admittance, and SWR formats.

### **131 FREQUENCY SWEEP ONLY**

The sweep type must be frequency sweep when the center step size is set.

## **G**

### **-105 GET not allowed**

A Group Execute Trigger (GET) was received within a program message (see IEEE 488.2, 7.7).

## **H**

### **-240 Hardware error**

Indicates that a legal program command or query could not be executed because of a hardware problem in the analyzer. Definition of what constitutes a hardware problem is completely device-specific. This error message is used when the analyzer cannot detect the more specific errors described for errors -241 through -249.

### **-241 Hardware missing**

A legal program command or query could not be executed because of missing analyzer hardware. For example, an option was not installed.

### **-111 Header separator error**

A character that is not a legal header separator was encountered while parsing the header. For example, no white space followed the header, thus \*SRE4 is an error.

### **-114 Header Suffix out of range**

The value of a numeric suffix attached to a program mnemonic makes the header invalid.

## **I**

### **-224 Illegal parameter value**

Used where exact value, from a list of possibilities, was expected.

### –282 **Illegal program name**

The name used to reference a program was invalid. For example, redefining an existing program, deleting a nonexistent program, or in general, referencing a nonexistent program.

### –283 **Illegal variable name**

An attempt was made to reference a nonexistent variable in a program.

### –213 **Init ignored**

A request for a measurement initiation was ignored as another measurement was already in progress.

### 141 **INSUFFICIENT MEMORY**

If a lot of tasks is executed at same time, memory might be insufficient for a while. (For example, running HP Instrument BASIC program, printing a screen, and sending or receiving data array by GPIB are required at same time.) Please wait until finishing some tasks then execute the next task.

### –161 **Invalid block data**

A block data element was expected, but was invalid for some reason (see IEEE 488.2, 7.7.6.2). For example, an END message was received before the length was satisfied.

### –141 **Invalid character data**

Either the character data element contains an invalid character or the particular element received is not valid for the header.

### –121 **Invalid character in number**

An invalid character for the data type being parsed was encountered. For example, an alpha character in a decimal numeric or a “9” in octal data.

### –101 **Invalid character**

A syntax element contains a character that is invalid for that type. For example, a header containing an ampersand (SENSE&).

### 154 **INVALID DATE**

The date entered to set the real time clock is invalid. Reenter correct date.

### 112 **INVALID FILE NAME**

*GPIB only.* The file name for the RECALL, PURGE, or RE-SAVE function must have a “\_D” or “\_S” extension for LIF format.

### –103 **Invalid separator**

The parser was expecting a separator and encountered an illegal character. For example, the semicolon was omitted after a program message unit, \*RST:TRIG.

## **Error Messages in Alphabetical Order**

### **–151 Invalid string data**

A string data element was expected, but was invalid for some reason (see IEEE 488.2, 7.7.5.2). For example, an END message was received before the terminal quote character.

### **–131 Invalid suffix**

The suffix does not follow the syntax described in IEEE 488.2, 7.7.3.2, or the suffix is inappropriate for the analyzer.

## **L**

### **115 LIF-DOS COPY NOT ALLOWED**

If you try to copy a file between the memory disk and the flexible disk when the format of the memory disk is different from the format of the flexible disk, this message is displayed.

### **124 LIST TABLE EMPTY OR INSUFFICIENT TABLE**

The frequency list is empty. To implement the list frequency mode, add segments to the list table.

## **M**

### **–250 Mass storage error**

Indicates that a mass storage error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –257.

### **–311 Memory error**

An error was detected in the analyzer's memory.

### **–109 Missing parameter**

Fewer parameters were received than required for the header. For example, the \*SRE command requires one parameter, so receiving only \*SRE is not allowed.

## **N**

### **98 NO ACTIVE MARKER**

The marker→ command cannot be execute when no marker is displayed on the screen. Turn on the marker before executing the marker→ commands.

### **12 NO CALIBRATION CURRENTLY IN PROGRESS**

The **RESUME CAL SEQUENCE** softkey is not valid unless a calibration is in progress. Start a new calibration.

### **268 NO COMPENSATION CURRENTLY IN PROGRESS**

No compensation is currently in progress.

**119 NO DATA TRACE DISPLAYED**

The **SCALE FOR [DATA]** is selected when the data trace is not displayed.

**93 NO DATA TRACE**

The **MARKER ON [DATA]** is selected when the data trace is not displayed.

**+0 No error**

The error queue is empty. Every error in the queue has been read (OUTPERRO? query) or the queue was cleared by power-on or the \*CLS command.

**100 NO FIXED DELTA MARKER**

The **FIXED ΔMKR VALUE** and **FIXED ΔMKR AUX VALUE** softkey requires that fixed delta marker is turned ON.

**96 NO MARKER DELTA - RANGE NOT SET**

The **MKRA→SEARCH RNG** softkey requires that delta marker is turned ON.

**95 NO MARKER DELTA - SPAN NOT SET**

The **MKRA→SPAN** softkey requires that delta marker mode be turned ON.

**120 NO MEMORY TRACE DISPLAYED**

The **SCALE FOR [MEMORY]** is selected when the memory trace is not displayed.

**94 NO MEMORY TRACE**

The **MARKER ON [MEMORY]** is selected when the memory trace is not displayed.

**113 NO STATE/DATA FILES ON DISK**

There are no files on the flexible disk with extensions, “\_D” or “\_S” for LIF format, or “STA” or “.DTA” for DOS format.

**116 NO STATE/DATA FILES ON MEMORY**

There are no files on the memory disk with extensions, “\_D” or “\_S” for LIF format, or “.STA” or “.DTA” for DOS format.

**184 NOT ALLOWED IN SVC MODE**

The operation is not allowed in service mode.

**55 NOT ENOUGH DATA**

The amount of data sent to the analyzer is less than that expected (*GPIB only*).

**14 NOT VALID FOR PRESENT TEST SET**

The calibration requested is inconsistent with the test set present. This message occurs in the following situations:

## **Error Messages in Alphabetical Order**

- A full 2-port calibration is requested with a test set other than an S-parameter test set.
- A one-path 2-port calibration is requested with an S-parameter test set (this procedure is typically used with a transmission/reflection test set).

### **34 NO VALID MEMORY TRACE**

If a memory trace is to be displayed or otherwise used, a data trace must first be stored to memory.

### **–120 Numeric data error**

This error, as well as errors –121 through –129, are generated when parsing a data element that appears to be numeric, including the nondecimal numeric types. This particular error message is used if the analyzer cannot detect a more specific error.

### **–128 Numeric data not allowed**

A legal numeric data element was received, but the analyzer does not accept it in this position for a header.

## **O**

### **146 ON POINT NOT ALLOWD FOR THE CURRENT TRIG**

The trigger event mode cannot be changed to the ON POINT mode because the current trigger source setting does not allow the ON POINT mode. The ON POINT mode is available for only MANUAL, EXTERNAL, and BUS trigger sources of the network analyzer mode.

### **56 OPTION NOT INSTALLED**

This error occurs when an GPIB command which is optional command is sent and the analyzer is not installed the option (*GPIB only*). Please confirm options installed to the analyzer using \*OPT? command (see *Programming Manual*.)

### **45 OVERLOAD ON INPUT A**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

### **44 OVERLOAD ON INPUT B**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

### **46 OVERLOAD ON INPUT R**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

## **P**

### **–220 Parameter error**

Indicates that a program data element related error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –221 through –229.

–108 **Parameter not allowed**

More parameters were received than expected for the header. For example, the \*SRE command only accepts one parameter, so receiving \*SRE 4,16 is not allowed.

48 **PHASE LOCK LOOP UNLOCKED**

EXT REF Input of 10 MHz is not proper, or the instrument is needed to adjust or repair. Check the external reference signal first. Contact your nearest Agilent Technologies office for adjustment or repair.

193 **POWER ON TEST FAILED**

Power on test failed. Contact your nearest Agilent Technologies office.

26 **PRINTER: not on, not connected, out of paper**

The printer does not respond to control. Check the supply to the printer, online status, sheets, and so on.

–284 **Program currently running**

Certain operations dealing with programs may be illegal while the program is running. For example, deleting a running program might not be possible.

–280 **Program error**

Indicates that a downloaded program-related execution error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –281 through –289.

–112 **Program mnemonic too long**

The header contains more than twelve characters (see IEEE 488.2, 7.6.1.4.1).

–286 **Program runtime error**

A program runtime error of the HP Instrument BASIC has occurred. To get a more specific error information, use the ERRM\$ or ERRN command of the HP Instrument BASIC.

–285 **Program syntax error**

Indicates that a syntax error appears in a downloaded program. The syntax used when parsing the downloaded program is device-specific.

**Q**

–400 **Query errors**

This is the generic query error that the analyzer cannot detect more specific errors. This code indicates only that a query error as defined in IEEE 488.2, 11.5.1.1.7 and 6.3 has occurred.

–410 **Query INTERRUPTED**

A condition causing an interrupted query error occurred (see IEEE 488.2, 6.3.2.3). For example, a query followed by DAB or GET before a response was completely sent.

## **Error Messages in Alphabetical Order**

### **–420 Query UNTERMINATED**

A condition causing an unterminated query error occurred (see IEEE 488.2, 6.3.2.2). For example, the analyzer was addressed to talk and an incomplete program message was received by the controller.

### **–350 Queue overflow**

A specific code entered into the queue in lieu of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded.

## **R**

### **111 RECALL ERROR: INSTR STATE PRESET**

A serious error, for example corrupted data, is detected on recalling a file, and this forced the analyzer to be PRESET.

## **S**

### **110 SAVE ERROR**

A serious error, for example physically damaged disk surface, is detected on saving a file.

### **76 SEGMENT START/STOP OVERLAPPED**

Segments are not allowed to be overlapped. Reenter appropriate value for start or stop value of segments to avoid that segment is not overlapped.

### **–330 Self-test failed**

A self-test failed. Contact your nearest Agilent Technologies office or see the *Service Manual* for troubleshooting.

### **–221 Settings conflict**

A legal program data element was parsed but could not be executed due to the current device state (see IEEE 488.2, 6.4.5.3 and 11.5.1.1.5).

### **128 SPAN = 0 ONLY**

The setup must be zero span and spectrum analyzer mode when turning on the RF OUTPUT.

### **–150 String data error**

This error, as well as errors –151 and –158, are generated when analyzing the syntax of a string data element. This particular error message is used if the analyzer cannot detect a more specific error.

### **–158 String data not allowed**

A string data element was encountered but was not allowed by the analyzer at this point in parsing.



–130 **Suffix error**

This error, as well as errors –131 through –139, are generated when parsing a suffix. This particular error message is used if the analyzer cannot detect a more specific error.

–138 **Suffix not allowed**

A suffix was encountered after a numeric element that does not allow suffixes.

–134 **Suffix too long**

The suffix contained more than 12 characters (see IEEE 488.2, 7.7.3.4).

–102 **Syntax error**

An unrecognized command or data type was encountered. For example, a string was received when the analyzer was not expecting to receive a string.

–310 **System error**

Some error, termed “system error” by the analyzer, has occurred.

**T**

–124 **Too many digits**

The mantissa of a decimal numeric data element contains more than 255 digits excluding leading zeros (see IEEE 488.2, 7.7.2.4.1).

77 **TOO MANY SEGMENTS OR POINTS**

Frequency list mode is limited to 31 segments or 801 points.

64 **TOO MANY SEGMENTS**

The maximum number of segments for the limit line table is 18.

–223 **Too much data**

A legal program data element of block, expression, or string type was received that contained more data than the analyzer could handle due to memory or related device-specific requirements.

54 **TOO MUCH DATA**

Either there is too much binary data to send to the analyzer when the data transfer format is FORM 2, FORM 3 or FORM 5, or the amount of data is greater than the number of points.

78 **TOO SMALL POINTS OR TOO LARGE STOP**

STOP+SPAN/(NOP–1) is out of sweep range. Increase NOP or change STOP value to lower frequency to avoid this error.

–210 **Trigger error**

A trigger related error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –211 through –219.

## **Error Messages in Alphabetical Order**

### **-211 Trigger ignored**

A GET, \*TRG, or triggering signal was received and recognized by the analyzer but was ignored because of analyzer timing considerations. For example, the analyzer was not ready to respond.

## **U**

### **-113 Undefined header**

The header is syntactically correct, but it is undefined for the analyzer. For example, \*XYZ is not defined for the analyzer.

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## Error Messages in Numerical Order

### 0 - 100

#### +0 **No error**

The error queue is empty. Every error in the queue has been read (OUTPERR0? query) or the queue was cleared by power-on or the \*CLS command.

#### 1 **CAN'T SET RBW AUTO IN ZERO SPAN**

The RBW AUTO mode cannot be selected in the zero span. The RBW must be specified manually in the zero span. (spectrum analyzer mode only).

#### 10 **ADDITIONAL STANDARDS NEEDED**

Error correction for the selected calibration class cannot be computed until all the necessary standards have been measured.

#### 11 **CALIBRATION REQUIRED**

No valid calibration coefficients were found when you attempted to turn calibration on.

#### 12 **NO CALIBRATION CURRENTLY IN PROGRESS**

The **RESUME CAL SEQUENCE** softkey is not valid unless a calibration is in progress. Start a new calibration.

#### 13 **CALIBRATION ABORTED**

The calibration in progress was terminated due to a change of the active channel or stimulus parameters.

#### 14 **NOT VALID FOR PRESENT TEST SET**

The calibration requested is inconsistent with the test set present. This message occurs in the following situations:

- A full 2-port calibration is requested with a test set other than an S-parameter test set.
- A one-path 2-port calibration is requested with an S-parameter test set (this procedure is typically used with a transmission/reflection test set).

#### 15 **EXCEEDED 7 STANDARDS PER CLASS**

A maximum of seven standards can be defined for any class.

#### 16 **CURRENT PARAMETER NOT IN CAL SET**

*GPIB only.* Correction is not valid for the selected measurement parameter.

#### 17 **BACKUP DATA LOST**

Data checksum error on the battery backup memory has occurred. The battery is recharged for approximately 10 minutes after power was turned on.

## **Error Messages in Numerical Order**

### **26 PRINTER: not on, not connect, wrong address**

The printer does not respond to control. Check the supply to the printer, online status, sheets, and so on.

### **34 NO VALID MEMORY TRACE**

If a memory trace is to be displayed or otherwise used, a data trace must first be stored to memory.

### **37 DISPLAY BUFFER IS FULL**

The display buffer is filled with the overlay traces or traces drawn by IBASIC DRAW/MOVE commands, etc.

### **44 OVERLOAD ON INPUT B**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

### **45 OVERLOAD ON INPUT A**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

### **46 OVERLOAD ON INPUT R**

The power level at one of the four receiver inputs exceeds a certain level greater than the maximum input level.

### **48 PHASE LOCK LOOP UNLOCKED**

EXT REF Input of 10 MHz is not proper, or the instrument is needed to adjust or repair. Check the external reference signal first. Contact your nearest Agilent Technologies office for adjustment or repair.

### **50 CONT SWITCHING MAY DAMAGE MECH SW**

RF output power switch, input attenuator switch at input R/A/B, or internal mechanical switch in the S-parameter test set is switching sweep by sweep, because RF power level or the input attenuator setting is different between two channels and the dual channel is turn on, or continuous trigger mode is selected after full 2-port calibration is performed when 4395A is used with the S-parameter test set. To avoid premature wearing out of the output power switch, input attenuator switch, or internal switch of the S-parameter test set, change trigger type to HOLD, SINGLE, or NUMBER of GROUP to hold sweep after measurement required. Or, for example, turn off the dual channel, or set the power level and the input attenuator of both channels to the same setting.

### **54 TOO MUCH DATA**

Either there is too much binary data to send to the analyzer when the data transfer format is FORM 2, FORM 3 or FORM 5, or the amount of data is greater than the number of points.

### **55 NOT ENOUGH DATA**

The amount of data sent to the analyzer is less than that expected (*GPIB only*).

**56 OPTION NOT INSTALLED**

This error occurs when an GPIB command which is optional command is sent and the analyzer is not installed the option (*GPIB only*). Please confirm options installed to the analyzer using \*OPT? command (see *Programming Manual*.)

**64 TOO MANY SEGMENTS**

The maximum number of segments for the limit line table is 18.

**74 CURRENT EDITING SEGMENT SCRATCHED**

The current editing segment for the list table and the limit line is scratched when the following cases occur (*GPIB only*) :

- When EDITLIST (edit list table) command is received while editing a segment for the list table.
- When EDITLIML (edit limit line) command is received while editing a segment for the limit line.

Send LIMSDON (limit segment done) or SDON (segment done) to terminate editing segment.

**75 COMMAND IGNORED - SEGMENT NOT DONE YET**

The GPIB command the analyzer received is ignored, because the segment is editing (*GPIB only*). Send LIMSDON (limit segment done) or SDON (segment done) to terminate editing segment. (See *Programming Manual*.)

**76 SEGMENT START/STOP OVERLAPPED**

Segments are not allowed to be overlapped. Reenter appropriate value for start or stop value of segments to avoid that segment is not overlapped.

**77 TOO MANY SEGMENTS OR POINTS**

Frequency list mode is limited to 31 segments or 801 points.

**78 TOO SMALL POINTS OR TOO LARGE STOP**

STOP+SPAN/(NOP-1) is out of sweep range. Increase NOP or change STOP value to lower frequency to avoid this error.

**82 CAN'T CHANGE- ANOTHER CONTROLLER ON BUS**

The analyzer cannot assume the mode of system controller until the active controller is removed from the bus or relinquishes the bus. See *Programming Manual*.

**83 FORMAT NOT VALID FOR MEASUREMENT**

The conversion function except the 1/S and the multiple phase modes is not valid for the Smith, admittance, and SWR formats.

**84 ANALYZER TYPE MISMATCH**

The analyzer receives a command that is not available for the current analyzer type. Please confirm GPIB command or change analyzer type before sending the command.

## **Error Messages in Numerical Order**

### **93 NO DATA TRACE**

The **MARKER ON [DATA]** is selected when the data trace is not displayed.

### **94 NO MEMORY TRACE**

The **MARKER ON [MEMORY]** is selected when the memory trace is not displayed.

### **95 NO MARKER DELTA - SPAN NOT SET**

The **MKRD—SPAN** softkey requires that delta marker mode be turned ON.

### **96 NO MARKER DELTA - RANGE NOT SET**

The **MKRD—SEARCH RNG** softkey requires that delta marker is turned ON.

### **97 CAN'T CHANGE WHILE DATA MATH ON**

The setting cannot be changed when the data math function is used.

### **98 NO ACTIVE MARKER**

The **marker→** command cannot be execute when no marker is displayed on the screen. Turn on the marker before executing the **marker→** commands.

### **99 CAN'T CHANGE WHILE DUAL CHAN OFF**

The Cross channel cannot be turned on when dual channel is off. Turn on the dual channel before the cross channel is turned on.

### **100 NO FIXED DELTA MARKER**

The **FIXED ΔMKR VALUE** and **FIXED ΔMKR AUX VALUE** softkey requires that fixed delta marker is turned ON.

## **101 - 200**

### **110 SAVE ERROR**

A serious error, for example physically damaged disk surface, is detected on saving a file.

### **111 RECALL ERROR: INSTR STATE PRESET**

A serious error, for example corrupted data, is detected on recalling a file, and this forced the analyzer to be PRESET.

### **112 INVALID FILE NAME**

*GPIB only.* The file name for the RECALL, PURGE, or RE-SAVE function must have a “\_D” or “\_S” extension for LIF format.

### **113 NO STATE/DATA FILES ON DISK**

There are no files on the flexible disk with extensions, “\_D” or “\_S” for LIF format, or “STA” or “.DTA” for DOS format.

**114 CAN'T SAVE GRAPHICS WHEN COPY IN PROGRESS**

If you attempt to save graphics when a print is in progress, this error message is displayed.

**115 LIF-DOS COPY NOT ALLOWED**

If you try to copy a file between the memory disk and the flexible disk when the format of the memory disk is different from the format of the flexible disk, this message is displayed.

**116 NO STATE/DATA FILES ON MEMORY**

There are no files on the memory disk with extensions, “\_D” or “\_S” for LIF format, or “.STA” or “.DTA” for DOS format.

**117 DUPLICATE FILE EXTENSION**

The extension name entered is already used for other file types. Use other extension name.

**119 NO DATA TRACE DISPLAYED**

The **SCALE FOR [DATA]** is selected when the data trace is not displayed.

**120 NO MEMORY TRACE DISPLAYED**

The **SCALE FOR [MEMORY]** is selected when the memory trace is not displayed.

**124 LIST TABLE EMPTY OR INSUFFICIENT TABLE**

The frequency list is empty. To implement the list frequency mode, add segments to the list table.

**126 CAN'T CHANGE NUMBER OF POINTS**

The number of points of the spectrum analyzer mode cannot be to change manually, except in zero span.

**127 CAN'T SET SWEEP TIME AUTO IN ZERO SPAN**

The automatic sweep time cannot be in zero span of the spectrum analyzer mode. (The network analyzer mode allows that the automatic sweep time is turned on.)

**128 SPAN = 0 ONLY**

The setup must be zero span and spectrum analyzer mode when turning on the RF OUTPUT.

**131 FREQUENCY SWEEP ONLY**

The sweep type must be frequency sweep when the center step size is set.

**133 CAN'T CHANGE ON LIST SWEEP**

When list sweep is selected, the following parameters are not allowed to be changed:

- CENTER, SPAN, START, STOP
- NOP
- IFBW or RBW
- POWER
- DC SOURCE

## **Error Messages in Numerical Order**

Modify the list table to change these parameters in the list sweep.

### **134 CAN'T COUPLE IN CURRENT INPUTS**

When one channel measures a ratio measurement, and the other one measures an absolute measurement (for example: A/R and B), **COUPLED CH** can not be turned on.

### **135 COUPLED CHAN - BETWEEN NA&NA OR ZA&ZA**

The analyzer types of both channels must be the network analyzer mode or impedance analyzer mode when the coupled channel is turned on. It is not possible to turn the coupled channel on in spectrum analyzer mode.

### **136 DC SOURCE OVERLOAD**

The DC SOURCE output is overloaded.

### **137 DC CURRENT LIMIT OCCURED**

The output current at DC SOURCE port is reached the upper limit; the output voltage is reduced so that the current does not exceed the upper limit. This message appears when the DC SOURCE port is used in voltage control mode.

### **138 DC VOLTAGE LIMIT OCCURED**

The output voltage at DC SOURCE port is reached the upper limit; the output current is reduced so that the voltage does not exceed the upper limit. This message appears when the DC SOURCE port is used in current control mode.

### **141 INSUFFICIENT MEMORY**

If a lot of tasks is executed at same time, memory might be insufficient for a while. (For example, running HP Instrument BASIC program, printing a screen, and sending or receiving data array by GPIB are required at same time.) Please wait until finishing some tasks then execute the next task.

### **143 FLOATING POINT ERROR OCCURED**

Indicate that a floating point error occurred in the analyzer. Data processing may not be correct. This error message is used when an internal application was executed for illegal data sent from an external device, or when an internal software bug was detected. Contact your nearest Agilent Technologies office.

### **146 ON POINT NOT ALLOWD FOR THE CURRENT TRIG**

The trigger event mode cannot be changed to the ON POINT mode because the current trigger source setting does not allow the ON POINT mode. The ON POINT mode is available for only MANUAL, EXTERNAL, and BUS trigger sources of the network analyzer mode.

### **154 INVALID DATE**

The date entered to set the real time clock is invalid. Reenter correct date.

### **173 ACTIVE/SYSTEM CONTROLLER REQUIRED**

When the 4395A and its peripherals are controlled using the Instrument BASIC, you must set the GPIB system's control mode to the system controller mode.



**184 NOT ALLOWED IN SVC MODE**

The operation is not allowed in service mode.

**193 POWER ON TEST FAILED**

Power on test failed. Contact your nearest Agilent Technologies office.

**201 - 300**

**267 COMPENSTATION REQUIRED**

Compensation is required. Perform compensation to obtain compensation data.

**268 NO COMPENSATION CURRENTLY IN PROGRESS**

No compensation is currently in progress.

**269 COMPENSATION ABORTED**

Compensation data acquisition process is aborted.

**270 COMPENSATION STD LIST UNDEFINED**

Compensation standard list is undefined.

**-1 - -100**

**-100 Command error**

This is a generic syntax error that the analyzer cannot detect more specific errors. This code indicates only that a command error, as defined in IEEE 488.2, 11.5.1.1.4, has occurred.

**-101 - -200**

**-101 Invalid character**

A syntax element contains a character that is invalid for that type. For example, a header containing an ampersand (SENSE&).

**-102 Syntax error**

An unrecognized command or data type was encountered. For example, a string was received when the analyzer was not expecting to receive a string.

**-103 Invalid separator**

The parser was expecting a separator and encountered an illegal character. For example, the semicolon was omitted after a program message unit, \*RST:TRIG.

**-104 Data type error**

The parser recognized an unallowed data element. For example, numeric or string data was expected but block data was encountered.

## **Error Messages in Numerical Order**

### **–105 GET not allowed**

A Group Execute Trigger (GET) was received within a program message (see IEEE 488.2, 7.7).

### **–108 Parameter not allowed**

More parameters were received than expected for the header. For example, the \*SRE command only accepts one parameter, so receiving \*SRE 4,16 is not allowed.

### **–109 Missing parameter**

Fewer parameters were received than required for the header. For example, the \*SRE command requires one parameter, so receiving only \*SRE is not allowed.

### **–110 Command header error**

An error was detected in the header. This error message is used when the analyzer cannot detect the more specific errors described for errors –111 through –119.

### **–111 Header separator error**

A character that is not a legal header separator was encountered while parsing the header. For example, no white space followed the header, thus \*SRE4 is an error.

### **–112 Program mnemonic too long**

The header contains more than twelve characters (see IEEE 488.2, 7.6.1.4.1).

### **–113 Undefined header**

The header is syntactically correct, but it is undefined for the analyzer. For example, \*XYZ is not defined for the analyzer.

### **–114 Header Suffix out of range**

The value of a numeric suffix attached to a program mnemonic makes the header invalid.

### **–120 Numeric data error**

This error, as well as errors –121 through –129, are generated when parsing a data element that appears to be numeric, including the nondecimal numeric types. This particular error message is used if the analyzer cannot detect a more specific error.

### **–121 Invalid character in number**

An invalid character for the data type being parsed was encountered. For example, an alpha character in a decimal numeric or a “9” in octal data.

### **–123 Exponent too large**

The magnitude of the exponent was larger than 32000 (see IEEE 488.2, 7.7.2.4.1).

### **–124 Too many digits**

The mantissa of a decimal numeric data element contains more than 255 digits excluding leading zeros (see IEEE 488.2, 7.7.2.4.1).

## Error Messages in Numerical Order

### –128 **Numeric data not allowed**

A legal numeric data element was received, but the analyzer does not accept it in this position for a header.

### –130 **Suffix error**

This error, as well as errors –131 through –139, are generated when parsing a suffix. This particular error message is used if the analyzer cannot detect a more specific error.

### –131 **Invalid suffix**

The suffix does not follow the syntax described in IEEE 488.2, 7.7.3.2, or the suffix is inappropriate for the analyzer.

### –134 **Suffix too long**

The suffix contained more than 12 characters (see IEEE 488.2, 7.7.3.4).

### –138 **Suffix not allowed**

A suffix was encountered after a numeric element that does not allow suffixes.

### –140 **Character data error**

This error, as well as errors –141 through –148, are generated when analyzing the syntax of a character data element. This particular error message is used if the analyzer cannot detect a more specific error.

### –141 **Invalid character data**

Either the character data element contains an invalid character or the particular element received is not valid for the header.

### –144 **Character data too long**

The character data element contains more than twelve characters (see IEEE 488.2, 7.7.1.4).

### –148 **Character data not allowed**

A legal character data element was encountered where prohibited by the analyzer.

### –150 **String data error**

This error, as well as errors –151 and –158, are generated when analyzing the syntax of a string data element. This particular error message is used if the analyzer cannot detect a more specific error.

### –151 **Invalid string data**

A string data element was expected, but was invalid for some reason (see IEEE 488.2, 7.7.5.2). For example, an END message was received before the terminal quote character.

### –158 **String data not allowed**

A string data element was encountered but was not allowed by the analyzer at this point in parsing.

## **Error Messages in Numerical Order**

### **–160 Block data error**

This error, as well as errors –161 and –168, are generated when analyzing the syntax of a block data element. This particular error message is used if the analyzer cannot detect a more specific error.

### **–161 Invalid block data**

A block data element was expected, but was invalid for some reason (see IEEE 488.2, 7.7.6.2). For example, an END message was received before the length was satisfied.

### **–168 Block data not allowed**

A legal block data element was encountered but was not allowed by the analyzer at this point in parsing.

### **–200 Execution error**

This is the generic syntax error that the analyzer cannot detect more specific errors. This code indicates only that an execution error as defined in IEEE 488.2, 11.5.1.1.5 has occurred.

## **–201 - –300**

### **–210 Trigger error**

A trigger related error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –211 through –219.

### **–211 Trigger ignored**

A GET, \*TRG, or triggering signal was received and recognized by the analyzer but was ignored because of analyzer timing considerations. For example, the analyzer was not ready to respond.

### **–213 Init ignored**

A request for a measurement initiation was ignored as another measurement was already in progress.

### **–220 Parameter error**

Indicates that a program data element related error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –221 through –229.

### **–221 Settings conflict**

A legal program data element was parsed but could not be executed due to the current device state (see IEEE 488.2, 6.4.5.3 and 11.5.1.1.5).

### **–222 Data out of range**

A legal program data element was parsed but could not be executed because the interpreted value was outside the legal range as defined by the analyzer (see IEEE 488.2, 11.5.1.1.5).

–223 **Too much data**

A legal program data element of block, expression, or string type was received that contained more data than the analyzer could handle due to memory or related device-specific requirements.

–224 **Illegal parameter value**

Used where exact value, from a list of possibilities, was expected.

–225 **Data out of memory**

The analyzer has insufficient memory to perform the requested operation.

–230 **Data corrupt or stale**

Possibly invalid data. New reading started but not completed since last access.

–231 **Data questionable**

Indicates that measurement accuracy is suspect.

–240 **Hardware error**

Indicates that a legal program command or query could not be executed because of a hardware problem in the analyzer. Definition of what constitutes a hardware problem is completely device-specific. This error message is used when the analyzer cannot detect the more specific errors described for errors –241 through –249.

–241 **Hardware missing**

A legal program command or query could not be executed because of missing analyzer hardware. For example, an option was not installed.

–250 **Mass storage error**

Indicates that a mass storage error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –257.

–256 **File name not found**

A legal program command could not be executed because the file name on the device media was not found: for example, an attempt was made to read or copy a nonexistent file.

–257 **File name error**

Indicates that a legal program command or query could not be executed because the file name on the device media was in error. For example, an attempt was made to copy to a duplicate file name. The definition of what constitutes a file name error is device-specific.

–280 **Program error**

Indicates that a downloaded program-related execution error occurred. This error message is used when the analyzer cannot detect the more specific errors described for errors –281 through –289.

## **Error Messages in Numerical Order**

### **–281 Cannot create program**

Indicates that an attempt to create a program was unsuccessful. A reason for the failure might include not enough memory.

### **–282 Illegal program name**

The name used to reference a program was invalid. For example, redefining an existing program, deleting a nonexistent program, or in general, referencing a nonexistent program.

### **–283 Illegal variable name**

An attempt was made to reference a nonexistent variable in a program.

### **–284 Program currently running**

Certain operations dealing with programs may be illegal while the program is running. For example, deleting a running program might not be possible.

### **–285 Program syntax error**

Indicates that a syntax error appears in a downloaded program. The syntax used when parsing the downloaded program is device-specific.

### **–286 Program runtime error**

A program runtime error of the HP Instrument BASIC has occurred. To get a more specific error information, use the `ERRM$` or `ERRN` command of the HP Instrument BASIC.

## **–301 - –400**

### **–310 System error**

Some error, termed “system error” by the analyzer, has occurred.

### **–311 Memory error**

An error was detected in the analyzer’s memory.

### **–330 Self-test failed**

A self-test failed. Contact your nearest Agilent Technologies office or see the *Service Manual* for troubleshooting.

### **–350 Queue overflow**

A specific code entered into the queue in lieu of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded.

### **–400 Query errors**

This is the generic query error that the analyzer cannot detect more specific errors. This code indicates only that a query error as defined in IEEE 488.2, 11.5.1.1.7 and 6.3 has occurred.

## **–401 - –500**

## **Error Messages in Numerical Order**

### **–410 Query INTERRUPTED**

A condition causing an interrupted query error occurred (see IEEE 488.2, 6.3.2.3). For example, a query followed by DAB or GET before a response was completely sent.

### **–420 Query UNTERMINATED**

A condition causing an unterminated query error occurred (see IEEE 488.2, 6.3.2.2). For example, the analyzer was addressed to talk and an incomplete program message was received by the controller.





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