MODEL
372XXA
VECTOR NETWORK ANALYZER

OPERATION MANUAL

Software Version: 1.04

Wiltron

490 JARVIS DRIVE ● MORGAN HILL, CA 95037-2809

P/N: 10410-00149
REVISION: B
PRINTED: JUNE 1995

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NOTICE

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Chapter 1 — General Information
This chapter provides a general description of the WILTRON Model 372XXA Vector Network Analyzer System and its major units: network analyzer, test set, and frequency source. It also provides descriptions for the precision component kits, and equipment options. Additionally, it contains the listing of recommended test equipment.

Chapter 2 — Installation
This chapter provides instructions for performing an initial inspection, preparing the equipment for use; setting up for operation over the IEEE-488.2 (GPIB) Bus, using a printer; and preparing the units for storage and/or shipment. It also provides a listing of WILTRON Customer Service Centers.

Chapter 3 — Network Analyzers, A Primer
This chapter provides an introduction to network analysis and the types of measurements that can be made using them. It provides general and introductory description.

Chapter 4 — Front Panel Operation
This chapter describes the front panel controls and provides flow diagrams for the menus called up using the front panel controls. It contains the following subchapters:

- Front Panel Control-Group Descriptions
- Calibration Keys and Indicators, Detailed Description
- Save/Recall Menu Key and Menus, Key Description and Menu Flow
- Measurement Keys and Menus, Key Descriptions and Menu Flow
- Channel Keys and Menu, Key Descriptions and Menu Flow
- Display Keys and Menus, Key Descriptions and Menu Flow
- Enhancement Keys and Menus, Key Descriptions and Menu Flow
- Output Keys and Menus, Key Descriptions and Menu Flow
- System State Keys and Menus, Key Descriptions and Menu Flow
- Markers/limits Keys and Menus, Key Descriptions and Menu Flow
- Disk Storage Interface, Detailed Description

Chapter 5 — Error And Status Messages
This chapter describes the type of error messages you may encounter during operation and provides a tabular listing. This listing describes and defines the error types.

Chapter 6 — Data Displays
This chapter provides a detailed description of the various data displays. It describes the graph types, frequency markers, measurement limit lines, status displays, and data display controls.

Chapter 7 — Measurement Calibration
This chapter provides a discussion and tutorial on measurement calibration. It contains step-by-step calibration procedures for the Standard (OSL), Offset-Short, and LRL/LRM methods. It also has a procedure for calibrating using a sliding termination.

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Chapter 8 — Measurements
This chapter discusses measurements with the 372XXA VNA. It contains subchapters that provide a detailed descriptions for the following measurement types.

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- Low Level and Gain
- Group Delay
- Active Device
- Dual Source Control

Chapter 9 — Time Domain
This chapter describes the Option 2, Time Domain feature. It provides an operational procedure and a flowchart of the time domain menus.

Chapter 10 — Operational Checkout Procedures
This chapter provides a procedure for operational checkout.

Appendix A — Front Panel Menus, Alphabetical Listing
This appendix shows all of the menus that are called up using the front panel controls. It provides a replica of the menu and descriptive text for all of the various menu choices. The listing is alphabetical by the menu call letters mentioned and/or illustrated in Chapter 4.

Appendix B — Model 372XXA VNA Rear Panel Connectors
This appendix describes the rear panel connectors. It also provides pinout listing.

Appendix C — Performance Specifications
This appendix provides system performance specifications.

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General Information

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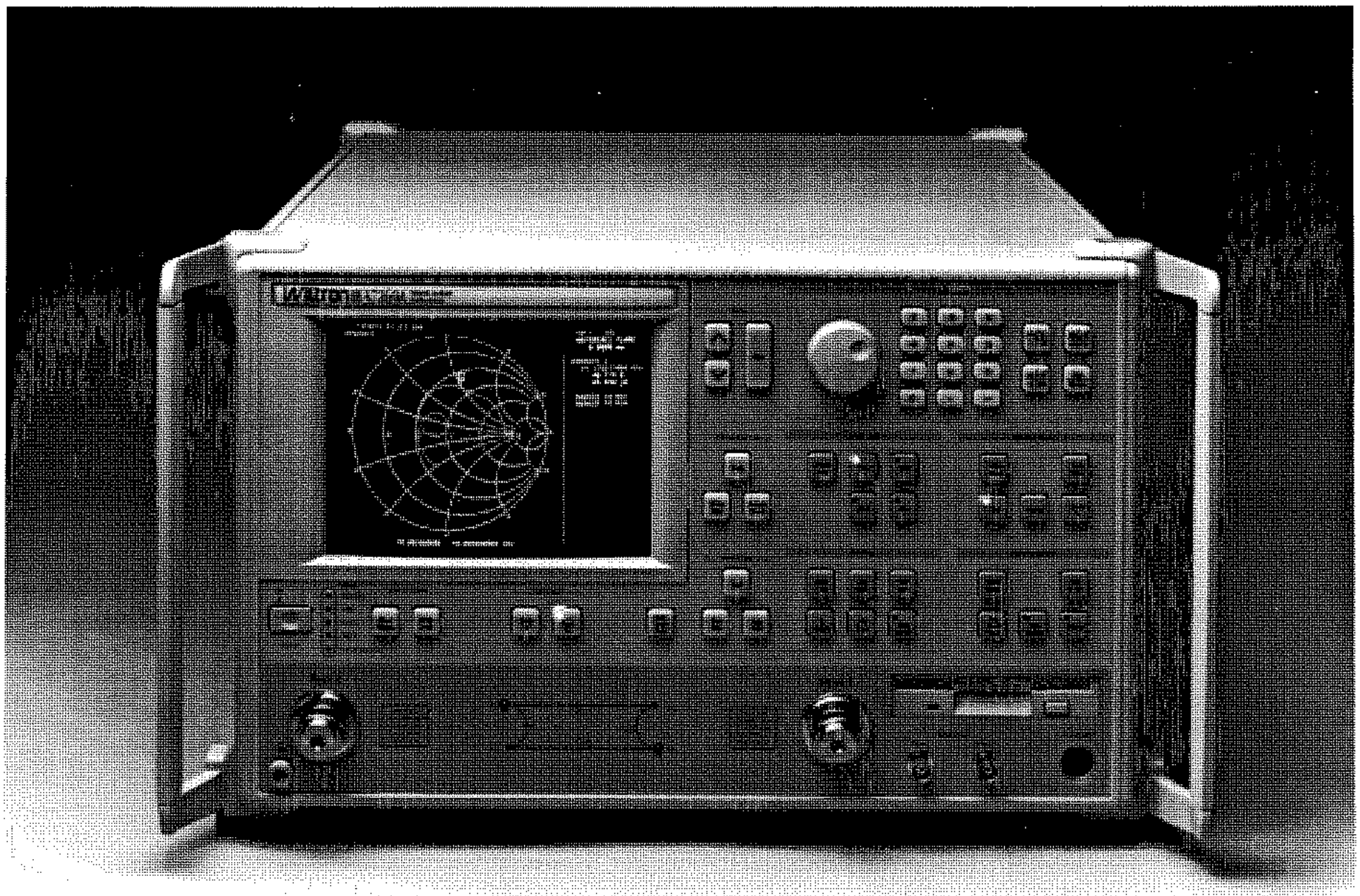

Figure 1-1. *Model 372XXA Vector Network Analyzer System*

Chapter 1
General Information

1-1 SCOPE OF MANUAL

This manual provides general information, installation, and operating information for the Model 372XXA Vector Network Analyzer (VNA) system. (Throughout this manual, the terms *372XXA VNA* and *372XXA* will be used interchangeable to refer to the system.) Manual organization is shown in the table of contents.

1-2 INTRODUCTION

This section provides general information about the 372XXA VNA system and one or more precision-component calibration or performance verification kits. The section also provides a listing of recommended test equipment.

1-3 IDENTIFICATION NUMBER

All WILTRON instruments are assigned a unique six-digit ID number, such as "401001." This number is affixed to a decal on the rear panel of each unit. In any correspondence with WILTRON Customer Service, please use this number.

1-4 SYSTEM DESCRIPTION

The 372XXA Network Analyzer (Figure 1-1) is a single-instrument system that contains a built-in source, test set, and analyzer. It is produced in five models that cover a range of from 22.5 MHz to 40 GHz. It provides up to 1601 measurement data points, a built-in hard-disk drive for storing and recalling front panel setups and measurement and calibration data. It provides an on-screen display of total operational time and date of last frequency and ALC calibration, and the number of power-off cycles since the last calibration. It supports operation over the IEEE 488.2 General Purpose Interface Bus (GPIB).

1-5 PRECISION COMPONENT KITS

Two types of precision-component kits are available: calibration and verification. Calibration kits contain components used to identify and separate error sources inherent in microwave test setups. Verification kits consist of components with characteristics traceable to the National Institute of Standards and Technology (NIST). This type of kit is usually kept in the metrology laboratory where it provides the most dependable means of checking system accuracy. Each of these kits contains a microfloppy disk providing coefficient or measurement data for each component. Details of these kits are described in the following paragraphs.

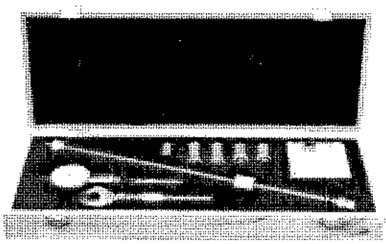

Figure 1-2. Typical Model 365X Calibration Kit

Model 3650 SMA/3.5 mm Calibration Kit

The 3650 Calibration Kit (Figure 1-2) contains all the precision components and tools required to calibrate the 372XXA VNA for 12-term error-corrected measurements of test devices with SMA or 3.5 mm connectors. Components are included for calibrating both male and female test ports. The kit supports calibration with broadband loads. Option 1 adds sliding loads. Kit consists of the following components:

- ☐ 23S50 Short, SMA/3.5 mm Male
- ☐ 23SF50 Short, SMA/3.5 mm Female
- ☐ 24S50 Open, SMA/3.5 mm Male
- ☐ 24SF50 Open, SMA/3.5 mm Female
- ☐ 28S50–2 Termination, SMA/3.5 mm Male, 2 ea. (dc–26.5 GHz)
- ☐ 28SF50–2 Termination, SMA/3.5 mm Female, 2 ea. (dc–26.5 GHz)
- ☐ 33SFSF50 Insertable, SMA/3.5 mm Female/Female, 2 ea.
- ☐ 33SS50 Insertable, SMA/3.5 mm Male/Male
- ☐ 33SSF50 Insertable, SMA/3.5 mm Male/Female, 2 ea.
- ☐ 34AS50–2 Adapter, GPC–7 to SMA/3.5 mm Male, 2 ea.
- ☐ 34ASF50-2 Adapter, GPC–7 to SMA/3.5 mm Female, 2 ea.
- ☐ 01–201 Torque Wrench
- ☐ 01–210 Reference Flat
- ☐ 01–222 Connector Gauge
- ☐ 01–223 Gauge Kit Adapter
- ☐ Data Disk

Option 1: Adds 17S50 Sliding Load, SMA/3.5 mm Male; 17SF50 Sliding Load, SMA/3.5 mm Female; 01–211 Female Flush Short; and 01–212 Male Flush Short.

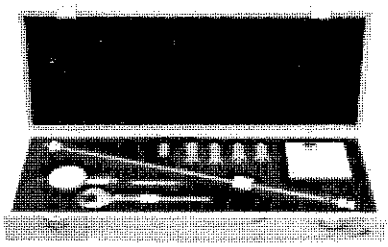

Figure 1-2. Typical Model 365X Calibration Kit (Repeated)

Model 3651 GPC–7 Calibration Kit

The 3651 Calibration Kit (Figure 1-2) contains all the precision components and tools required to calibrate the 372XXA for 12-term error-corrected measurements of test devices with GPC–7 connectors. The kit supports calibration with broadband loads. Option 1 adds a sliding load and a pin depth gauge. Kit consists of the following components:

- ☐ 23A50 Short, GPC–7
- ☐ 24A50 Open, GPC–7
- ☐ 28A50–2 Termination, GPC–7, 2 ea. (dc–18 GHz)
- ☐ 01–200 Torque Wrench
- ☐ 01–221 Collet Extractor Tool and Vial of 4 Collets
- ☐ Data Disk

Option 1: Adds 17A50 Sliding Load, GPC–7; and 01–220 GPCP–7 Connector Gauge; and 01–210 Reference Flat.

Model 3652 K Connector ® Calibration Kit

The 3652 Calibration Kit (Figure 1-2) contains all the precision components and tools required to calibrate the 372XXA for 12-term error-corrected measurements of test devices with K Connectors. Components are included for calibrating both male and female test ports. The kit supports calibration with broadband loads. Option 1 adds sliding loads. Kit consists of the following components:

- ☐ 23K50 Short, K Male
- ☐ 23KF50 Short, K Female
- ☐ 24K50 Open, K Male
- ☐ 24KF50 Open, K Female
- ☐ 28K50 Termination, K Male, 2 ea. (dc–40 GHz)
- ☐ 28KF50 Termination, K Female, 2 ea. (dc–40 GHz)
- ☐ 33KK50 Insertable, K Male/Male
- ☐ 33KFKF50 Insertable K Female/Female, 2 ea.
- ☐ 33KKF50 Insertable, K Male/Female, 2 ea.
- ☐ 34AK50 Adapter, GPC–7/K Male, 2 ea.
- ☐ 34AKF50 Adapter, GPC–7/K Female, 2 ea.
- ☐ 01–201 Torque Wrench
- ☐ 01–210 Reference Flat
- ☐ 01–222 Connector Gauge
- ☐ 01–223 Gauge Kit Adapter
- ☐ Data Disk

Option 1: Adds 17K50 Sliding Load, K Male; 17KF50 Sliding Load, K Female; 01–211 Female Flush Short; and 01–212 Male Flush Short.

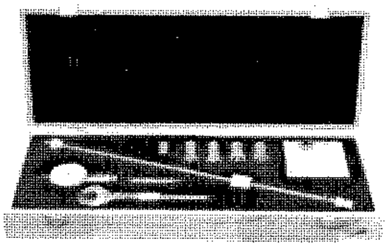

Figure 1-2. Typical Model 365X Calibration Kit (Repeated)

Model 3653 Type N Calibration Kit

The 3653 Calibration Kit (Figure 1-2) contains all the precision components and tools required to calibrate the 372XXA for 12-term error-corrected measurements of test devices with Type N connectors. Components are included for calibrating both male and female test ports. The kit supports calibration with broadband loads. Option 1 for sliding loads is not available in this calibration kit. Kit consists of the following components:

- ☐ 23N50 Short, N Male
- ☐ 23NF50 Short, N Female
- ☐ 24N50 Open, N Male
- ☐ 24NF50 Open, N Female
- ☐ 28N50–2 Termination, N Male, 2 ea. (dc–18 GHz)
- ☐ 28NF50–2 Termination, N Female, 2 ea. (dc–18 GHz)
- ☐ 34AN50–2 Adapter, GPC–7/N Male, 2 ea.
- ☐ 34ANF50–2 Adapter, GPC–7/N Female, 2 ea.
- ☐ 01–213 Type N Reference Gauge
- ☐ 01–224 Type N Connector Gauge
- ☐ Data Disk

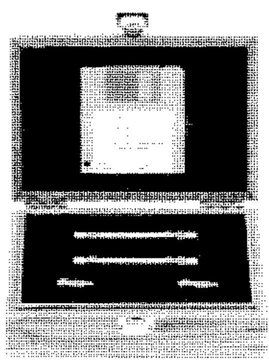

Figure 1-3. Model 3666 Verification Kit

Model 3666 3.5 mm Verification Kit

The 3666 Verification Kit (Figure 1-3) contains precision 3.5 mm components with characteristics that are traceable to the NIST. Used primarily by the metrology laboratory, these components provide the most dependable means of determining system accuracy. A disk containing factory-measured test data for all components is supplied for comparison with customer-measured data.

The 3666 consists of the following components:

- ☐ 19S50–7 7.5 cm Air Line
- ☐ 19S50–7B 7.5 cm Stepped Impedance Air Line (Beatty Standard)
- ☐ 42S–20 20 dB Attenuator
- ☐ 42S–50 50 dB Attenuator

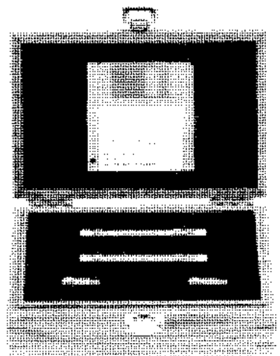

Figure 1-4. Model 3667 Verification Kit

Model 3667 GPC–7 Verification Kit

The 3667 Verification Kit (Figure 1-4) contains precision GPC–7 components with characteristics that are traceable to the NIST. Used primarily by the metrology laboratory, these components provide the most dependable means of determining system accuracy. A disk containing factory-measured test data for each component is supplied for comparison with customer-measured data. Kit consists of the following components:

- ☐ 18A50–10B 10 cm Stepped Impedance Air Line (Beatty Standard)
- ☐ 18A50–10 10 cm Air Line
- ☐ 42A–20 20 dB Attenuator
- ☐ 42A–50 50 dB Attenuator

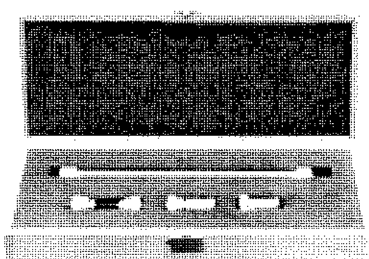

Figure 1-5. Model 3668 Verification Kit

Model 3668 K Connector® Verification Kit

The 3668 Verification Kit (Figure 1-5) contains precision K Connector components with characteristics that are traceable to the NIST. Used primarily by the metrology laboratory, these components provide the most dependable means of determining system accuracy. A disk containing factory-measured test data for each component is supplied for comparison with customer-measured data. Kit consists of the following components:

- ☐ 19K50–7 7.5 cm Air Line
- ☐ 19K50–7B 7.5 cm Stepped Impedance Air Line (Beatty Standard)
- ☐ 42K–20 20 dB Attenuator
- ☐ 42K–50 50 dB Attenuator

1-6 OPTIONS

The following options are available.

- ☐ Option 2: Time (Distance) Domain Measurement Capability.
- ☐ Option 3: 1 Hz Frequency Resolution
- ☐ Option 4: External SCSII Hard Disk
- ☐ Option 6: Port 2 Test Step Attenuator
- ☐ Option 10: Ovenized Timebase
- ☐ Option 11: Reference Loop Extension Cables

1-7 PERFORMANCE SPECIFICATIONS

System performance specifications are provided in Appendix C.

1-8 RECOMMENDED TEST EQUIPMENT

Table 1-1 lists the recommended test equipment for maintaining and servicing the 372XXA VNA system.

Table 1-1. Recommended Test Equipment

Instrument	Critical Specification	Recommended Manufacturer/Model
Spectrum Analyzer, with Diplexer and External Mixers	*Frequency:* 0.01 to 40 GHz *Resolution:* 10 Hz	Tektronix, Inc. Model 2794P,with External Mixers: WM 780K (18 to 26.5 GHz) WM 780A (26.5 to 40 GHz) Diplexer PN: 015-0385-00
Power Meter, with Power Sensors	*Range:* –30 to +20 dBm (1 µW to 100 mW) *Other:* GPIB-controllable	Hewlett-Packard Model 437B, with Power Sensors: HP 8487A (0.05 to 50 GHz)
Digital Multimeter	*Resolution:* 4-1/2 digits *DC Accuracy:* 0.002% +2 counts *DC Input Z:* 10 MΩ *AC Accuracy:* 0.07% +100 counts (to 20 kHz) *AC Input Z:* 1 MΩ	John Fluke, Inc. Model 8840A, with Option 8840A-09 (True RMS AC)
Frequency Counter, with External Mixers	*Range:* 0.01 to 40 GHz *Input Z:* 50Ω *Resolution:* 1 Hz *Other:* External Time Base Input	EIP Microwave, Inc. Model 578A, with External Mixers: Option 91 (26.5 to 40 GHz)
Oscilloscope	*Bandwidth:* DC to 150 MHz *Vertical Sensitivity:* 2 mV/division *Horiz Sensitivity:* 50 ns/division	Tektronix, Inc. Model 2445
Function Generator	*Output Voltage Range:* 300 mV to 10V *Functions:* 200 Hz Sine Wave 100 Hz Square Wave	Hewlett-Packard Model 3325B

Chapter 2
Installation

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Chapter 2
Installation

2-1 INTRODUCTION

This chapter provides information for the initial inspection and preparation for use of the 372XXA Vector Network Analyzer. Information for interfacing the 372XXA to the IEEE-488 General Purpose Interface Bus and reshipment and storage information is also included.

2-2 INITIAL INSPECTION

Inspect the shipping container for damage. If the container or cushioning material is damaged, retain until the contents of the shipment have been checked against the packing list and the instrument has been checked for mechanical and electrical operation.

If the 372XXA is damaged mechanically, notify your local sales representative or WILTRON Customer Service. If either the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as WILTRON. Keep the shipping materials for the carrier's inspection.

2-3 PREPARATION FOR USE

No initial setup is required. After unpacking, the 372XXA is ready for use. The 372XXA is equipped with automatic line-power sensing, and will operate with any of the following line voltages: 100V, 120V, 220V, 240V +5%, –10%, 48–63 Hz, 350 VA.

2-4 GPIB SETUP AND INTERCONNECTION

All functions of the 372XXA (except power on/off and initialization of the hard disk) can be controlled remotely by an external computer/controller via the IEEE-488.2 GPIB. The information in this section pertains to interface connections and cable requirements for the rear panel GPIB connector. Refer to the Model 372XXA Programming Manual, Wiltron Part Number 10410-00151, for information about remote operation of the 372XXA using the GPIB.

The 372XXA GPIB operates with any IBM XT, AT, or PS/2 compatible computer/controller equipped with a National Instruments GPIB-PCII/IIA interface card and NI-488 MS-DOS Handler Software.

Interface Connector

Interface between the 372XXA and other devices on the GPIB is via a standard 24-wire GPIB interface cable. This cable uses a double-sided connector; one connector face is a plug, the other a receptacle. These double-function connectors allow parallel connection of two or more cables to a single instrument connector. The pin assignments for the rear panel GPIB connector are shown in Figure B-1, located in Appendix B.

Cable Length Restrictions

The GPIB system can accommodate up to 15 instruments at any one time. To achieve design performance on the bus, proper timing and voltage level relationships must be maintained. If either the cable length between separate instruments or the accumulated cable length between all instruments is too long, the data and control lines cannot be driven properly and the system may fail to perform. Cable length restrictions are as follows:

- ☐ No more than 15 instruments may be installed on the bus.
- ☐ Total accumulative cable length in meters may not exceed two times the number of bus instruments or 20 meters—whichever is less.

NOTE

For low EMI applications, the GPIB cable should be a fully shielded type, with well-grounded metal-shell connectors.

2-5 SYSTEM GPIB INTERCONNECTION

There are two rear panel GPIB IEEE-488 connectors. The IEEE 488.2 connector used to interface the 372XXA to an external computer/controller via a standard GPIB cable. The dedicated GPIB connector is used to interface to plotters and a second source for multiple source operation via a standard GPIB cable. The WILTRON Part numbers for standard GPIB cables of various lengths are listed in Chapter 1.

GPIB Interface to an External Plotter

The 372XXA GPIB interface can be configured to control a suitable external plotter (refer to Chapter 6—Data Displays). In this mode of operation, the GPIB is dedicated to this application and only the 372XXA and the plotter are connected to the GPIB. Standard GPIB cables are used to interconnect to the plotter.

GPIB Addresses
The 372XXA leaves the factory with the default GPIB address set to 6. This address may be changed using the GP7 menu (see Appendix A).

2-6 EXTERNAL MONITOR CONNECTOR

The rear panel EXTERNAL MONITOR connector allows the internal display information of the 372XXA to be connected to an external VGA monitor (either color or monochrome). The pinout of this 15-pin Type D connector is shown in Figure B-4, located in Appendix B.

2-7 PREPARATION FOR STORAGE AND/OR SHIPMENT

The following paragraphs describe the procedure for preparing the 372XXA for storage or shipment.

Preparation for Storage
Preparing the 372XXA for storage consists of cleaning the unit, packing the inside with moisture-absorbing desiccant crystals, and storing the unit in a temperature environment that is maintained between −40 and +70 degrees centigrade (−40 to 156 degrees Fahrenheit).

Preparation for Shipment
To provide maximum protection against damage in transit, the 372XXA should be repackaged in the original shipping container. If this container is no longer available and the 372XXA is being returned to WILTRON for repair, advise WILTRON Customer Service; they will send a new shipping container free of charge. In the event neither of these two options is possible, instructions for packaging and shipment are given below.

Use a Suitable Container
Obtain a corrugated cardboard carton with a 275-pound test strength. This carton should have inside dimensions of no less than six inches larger than the instrument dimensions to allow for cushioning.

Protect the Instrument
Surround the instrument with polyethylene sheeting to protect the finish.

Cushion the Instrument
Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument. Provide at least three inches of dunnage on all sides.

Seal the Container

Seal the carton by using either shipping tape or an industrial stapler.

Address the Container

If the instrument is being returned to WILTRON for service, mark the WILTRON address and your return address on the carton in one or more prominent locations. For international customers, use the address of your local representative (Table 2-1). For U.S.A. customers, use the WILTRON address shown below:

WILTRON Company
ATTN: Customer Service
490 Jarvis Drive
Morgan Hill, CA 95037-2809

Table 2-1. WILTRON *Service Centers*

UNITED STATES
WILTRON COMPANY
490 Jarvis Drive
Morgan Hill, CA 95037-2809
Telephone: (408) 778-2000
Telex: 285227 WILTRON MH
FAX: 408-778-0239

ANRITSU WILTRON SALES COMPANY
685 Jarvis Drive
Morgan Hill, CA 95037-2809
Telephone: (408) 776-8300
FAX: 408-776-1744

ANRITSU WILTRON SALES COMPANY
10 Kingsbridge Road
Fairfield, NJ 07004
Telephone: (201) 227-8999
FAX: 201-575-0092

AUSTRALIA
WILTRON PTY. LTD.
Level 2, 410 Church Street
North Parramatta
NSW 2151 Australia
Telephone: 026-30-81-66
Fax: 026-83-68-84

BRAZIL
ANRITSU-WILTRON
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2225 Rio de Janeiro RJ Brazil
Telephone: 021-28-69-141
Fax: 021-53-71-456

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FAX: 08-10-51-700

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FAX: 011-91-22-202-9403

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FAX: 0462-25-8379

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Kangnam-ku, Seoul
Telephone: (02) 551-2250
FAX: (02) 551-4941

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S-127 25 Skarholmen
Telephone: (08) 74-05-840
Telex: (854) 81-35-089
FAX: (08) 71-09-960

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FAX: (02) 509-5519

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LU1 3LU, England
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Telex: (851) 826750
FAX: 05-82-31-303

Chapter 3
Network Analyzers, A Primer

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Chapter 3
Network Analyzers, A Primer

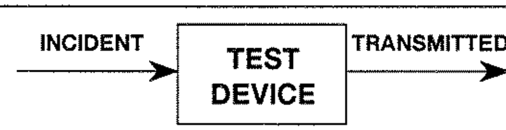
3-1 INTRODUCTION

This section provides front panel operating and measurement application information and data. It includes discussions on the following topics:

- System description
- General discussion about network analyzers
- Basic measurements and how to make them
- Error correction
- General discussion on test sets

3-2 GENERAL DESCRIPTION

The Model 372XXA Vector Network Analyzer System measures the magnitude and phase characteristics of networks: amplifiers, attenuators, and antennas. It compares the incident signal that leaves the analyzer with either the signal that is transmitted through the test device or the signal that is reflected from its input. Figures 3-1 and 3-2 illustrate the types of measurements that the 372XXA can make.



Gain (dB)
Insertion Loss (dB)
Insertion Phase (degrees)
Transmission Coefficients (S12, S21)
Separation of Transmission Components (Real and Imaginary)
Electrical Length (m)
Electrical Delay (s)
Deviation from Linear Phase (degrees)
Group Delay (s)

Figure 3-1. Transmission Measurements

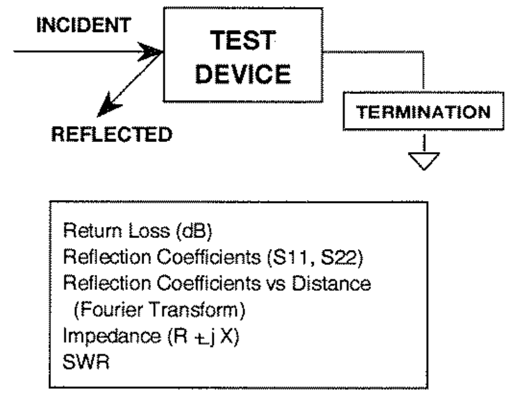


Figure 3-2. *Reflection Measurements*

The 372XXA is a self-contained, fully integrated measurement system that includes an optional time domain capability. The system hardware consists of the following:

- ☐ Analyzer
- ☐ Precision components required for calibration and performance verification.
- ☐ Optional use of WILTRON 67XXB or 681XXA/B as a second source.

The 372XXA internal system modules perform the following functions:

Source Module This module provides the stimulus to the device under test (DUT). The frequency range of the source and test set modules establish the frequency range of the system. The frequency stability of the source is an important factor in the accuracy (especially phase accuracy) of the network analyzer. Hence, the 372XXA always phase locks the source to an internal 10 MHz crystal reference.

Test Set Module The test set module routes the stimulus signal to the DUT and samples the reflected and transmitted signals. The type of connector used is important, as is the "Auto Reversing" feature. Auto Reversing means that it applies the stimulus signal in both the forward and reverse direction. The direction is reversed automatically. This saves you from having to reverse the test device physically to measure all four scattering parameters (S-parameters). Frequency conversion (1st and 2nd IFs) occurs in the test set.

Analyzer Module

The analyzer module down-converts, receives, and interprets the 3rd IF signal for phase and magnitude data. It then displays the results of this analysis on a large, 190 mm (7-1/2 inch) diagonal color display. This display can show all four S-parameters simultaneously. In addition to the installed display, you can also view the measurement results on an external color monitor.

3-3 NETWORK ANALYZERS

We will begin this discussion with a subject familiar to most WILTRON customers: scalar network analysis. After showing comparisons, we will proceed to the fundamentals of network analyzer terminology and techniques. This discussion serves as an introduction to topics presented in greater detail later in this section. This discussion will touch on new concepts that include the following:

- ☐ Reference Delay
- ☐ S-parameters: what they are and how they are displayed
- ☐ Complex Impedance and Smith Charts

Scalar Analyzer Comparison

Network Analyzers do everything that scalar analyzers do except display absolute power. In addition, they add the ability to measure the phase characteristics of microwave devices and allow greater dynamic range.

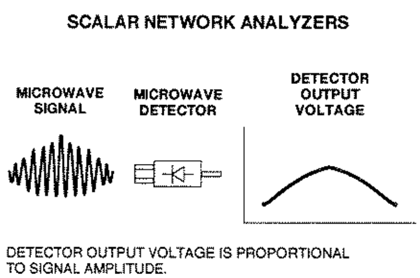


Figure 3-3. *Scalar analyzer detection*

If all a Network Analyzer added was the capability for measuring phase characteristics, its usefulness would be limited. While phase measurements are important in themselves, it is the availability of this phase information that unlocks many new features for complex measurements. These features include Smith Charts, Time Domain, and Group Delay. Phase information also allows greater accuracy through *vector error correction* of the measured signal.

First, let us look at scalar network analyzers (SNAs). SNAs measure microwave signals by converting them to a DC voltage using a diode detector (Figure 3-3). This DC voltage is proportional to the magnitude of the incoming signal. The detection process, however, ignores any information regarding the phase of the microwave signal.

In a network analyzer, access is needed to both the magnitude and phase of a microwave signal. There are several different ways to perform the measurement. The method WILTRON employs (called Harmonic Sampling or Harmonic Mixing) is to down-convert the signal to a lower intermediate frequency (IF). This signal can then be measured directly by a tuned receiver. The tuned receiver approach gives the system greater dynamic range. The system is also much less sensitive to interfering signals, including harmonics.

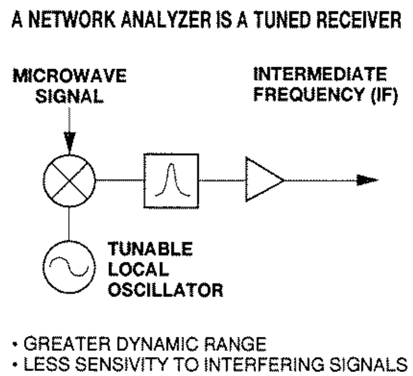


Figure 3-5. *Network analyzer is a tuned receiver*

Vector Network Analyzer Basics

The network analyzer is a tuned receiver (Figure 3-5, left). The microwave signal is down converted into the passband of the IF. To measure the phase of this signal, we must have a reference to compare it with. If the phase of a signal is 90 degrees, it is 90 degrees different from the reference signal (Figure 3-6, left). The network analyzer would read this as –90 degrees, since the test signal is delayed by 90 degrees with respect to the reference signal.

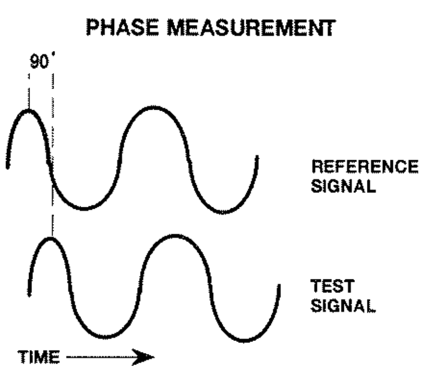


Figure 3-6. *Signals with a 90 degree phase difference*

This phase reference can be obtained by splitting off some of the microwave signal before the measurement (Figure 3-4, below).

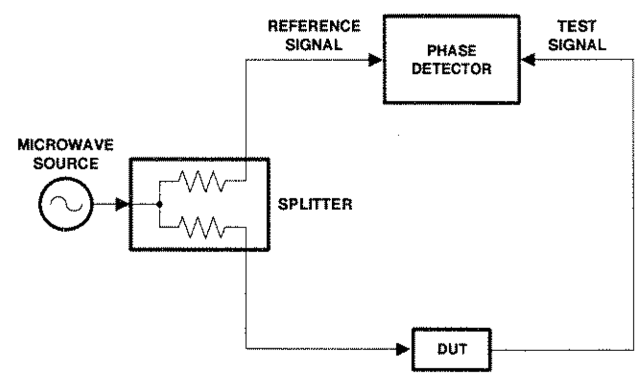


Figure 3-4. *Splitting the microwave signal*

The phase of the microwave signal after it has passed through the device under test (DUT) is then compared with the reference signal. A network analyzer test set automatically samples the reference signal, so no external hardware is needed.

Let us consider for a moment that you remove the DUT and substitute a length of transmission line (Figure 3-7, left). Note that the path length of the test signal is longer than that of the reference signal. Now let us see how this affects our measurement.

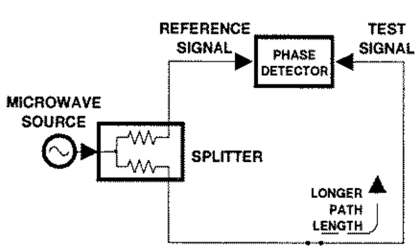


Figure 3-7. *Split signal where a length of line replaces the DUT*

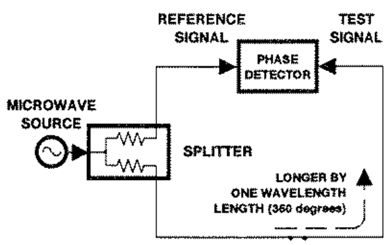


Figure 3-8. *Split signal where path length differs by exactly one wavelength*

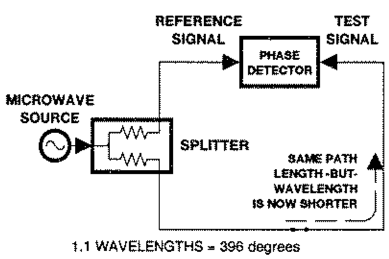


Figure 3-9. *Split signal where path length is longer than one wavelength*

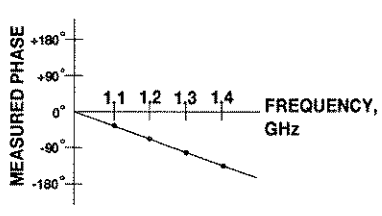


Figure 3-10. *Electrical Delay*

Assume that we are making a measurement at 1 GHz and that the difference in path-length between the two signals is exactly 1 wavelength. This means that test signal is lagging the reference signal by 360 degrees (Figure 3-8). We cannot really tell the difference between one sine wave maxima and the next (they are all identical), so the network analyzer would measure a phase difference of 0 degrees.

Now consider that we make this same measurement at 1.1 GHz. The frequency is higher by 10 percent so therefore the wavelength is shorter by 10 percent. The test signal path length is now 0.1 wavelength longer than that of the reference signal (Figure 3-9). This test signal is:

$$1.1 \times 360 = 396 \text{ degrees}$$

This is 36 degrees different from the phase measurement at 1 GHz. The network analyzer will display this phase difference as –36 degrees.

The test signal at 1.1 GHz is delayed by 36 degrees more than the test signal at 1 GHz.

You can see that if the measurement frequency is 1.2 GHz, we will get a reading of –72 degrees, –108 degrees for 1.3 GHz, etc. (Figure 3-10). There is an electrical delay between the reference and test signals. For this delay we will use the common industry term of reference delay. You also may hear it called phase delay. In older network analyzers you had to equalize the length of the reference arm with that of the test arm to make an appropriate measurement of phase vs. frequency.

To measure phase on a DUT, we want to remove this phase-change-vs.-frequency-due-to changes in the electrical length. This will allow us to view the actual phase characteristics. These characteristics may be much smaller than the phase-change-due-to-electrical-length difference.

There are two ways of accomplishing this. The most obvious way is to insert a length of line into the reference signal path to make both paths of equal length (Figure 3-11, below). With perfect transmission lines and a perfect splitter, we would then measure a constant phase as we change the frequency. The problem using this approach is that we must change the line length with each measurement setup.

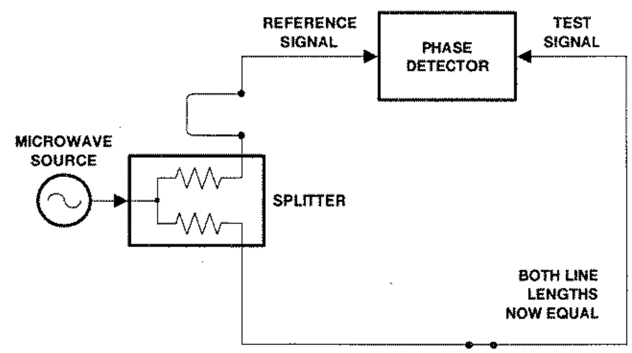


Figure 3-11. *Split signal where paths are of equal length*

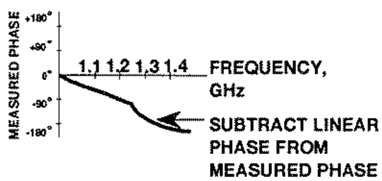


Figure 3-12. *Phase difference increases linearly with frequency*

Another approach is to handle the path length difference in software. Figure 3-12 (left) displays the phase-vs.-frequency of a device. This device has different effects on the output phase at different frequencies. Because of these differences, we do not have a perfectly linear phase response. We can easily detect this phase deviation by compensating for the linear phase. The size of the phase difference increases linearly with frequency so we can modify the phase display to eliminate this delay.

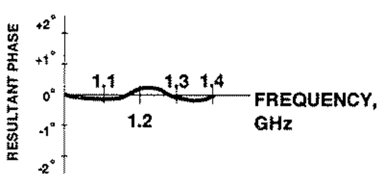


Figure 3-13. *Resultant phase with path length compensation in place*

The 372XXA offers automatic reference delay compensation with the push of a button. Figure 3-13 (left) shows the resultant measurement when we compensate path length. In a system application you can usually correct for length differences; however, the residual phase characteristics are critical.

Network Analyzer Measurements

Now let us consider measuring the DUT. Consider a two port device; that is, a device with a connector on each end. What measurements would be of interest?

First, we could measure the reflection characteristics at either end with the other end terminated into 50 ohms. If we designate one end as the normal place for the input that gives a reference. We can then define the reflection characteristics from the reference end as forward reflection, and those from the other end as reverse reflection (Figure 3-14).

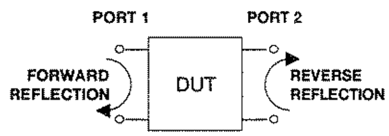


Figure 3-14. *Forward and reverse measurements*

Second, we can measure the forward and reverse transmission characteristics. However, instead of saying "forward," "reverse," "reflection," and "transmission" all the time, we use a shorthand. That is all that S-parameters are, a shorthand! The "S" stands for scattering. The first number is the port that the signal is being injected into, while the second is the port that the signal is leaving. S_{11}, therefore, is the signal being injected into port 1 relative to the signal leaving port 1. The four scattering parameters (Figure 3-15):

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

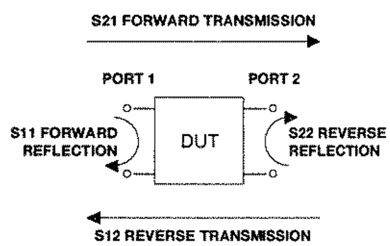


Figure 3-15. *S-parameters*

S-parameters can be displayed in many ways. An S-parameter consists of a magnitude and a phase. We can display the magnitude in dB, just like a scalar network analyzer. We often call this term *log magnitude.*

We can display phase as "linear phase" (Figure 3-16). As discussed earlier, we can't tell the difference between one cycle and the next. Therefore, after going through 360 degrees we are back to where we began. We can display the measurement from −180 to +180 degrees. The −180 to +180 approach is more common. It keeps the display discontinuity removed from the important 0 degree area used as the phase reference.

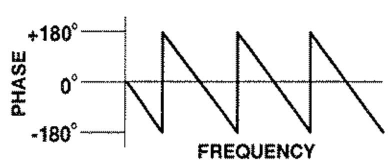


Figure 3-16. *Linear phase-with-frequency waveform*

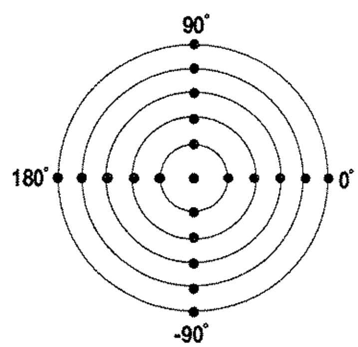


Figure 3-17. *Polar display*

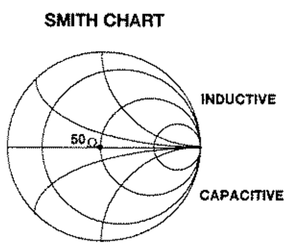


Figure 3-18. *Smith chart*

There are several ways in which all the information can be displayed on one trace. One method is a polar display (Figure 3-17). The radial parameter (distance from the center) is magnitude. The rotation around the circle is phase. We sometimes use polar displays to view transmission measurements, especially on cascaded devices (devices in series). The transmission result is the addition of the phase and log magnitude (dB) information of each device's polar display.

As we have discussed, the signal reflected from a DUT has both magnitude and phase. This is because the impedance of the device has both a resistive and a reactive term of the form $r+jx$. We refer to the r as the real or resistive term, while we call x the imaginary or reactive term. The j, which we sometimes denote as i, is an imaginary number. It is the square root of -1. If x is positive, the impedance is inductive, if x is negative the impedance is capacitive.

The size and polarity of the reactive component x is important in impedance matching. The best match to a complex impedance is the complex conjugate. This complex-sounding term simply means an impedance with the same value of r and x, but with x of opposite polarity. This term is best analyzed using a Smith Chart (Figure 3-18), which is a plot of r and x.

To display all the information on a single S-parameter requires one or two traces, depending upon the format we want. A very common requirement is to view forward reflection on a Smith Chart (one trace) while observing forward transmission in Log Magnitude and Phase (two traces). Let us see how to accomplish this in the 372XXA.

The 372XXA has four channels. Each channel can display a complete S-parameter in any format on either one or two traces. All four S-parameters can be seen simultaneously in any desired format. A total of eight traces can be viewed at the same time. While this is a lot of information to digest, the 372XXA's large color display makes recognizing and analyzing the data surprisingly easy.

Another important parameter we can measure when phase information is available is group delay. In linear devices, the phase change through the DUT is linear-with-frequency. Thus, doubling the frequency also doubles the phase change. An important measurement, especially for communications system users, is the rate of change-of-phase-vs.-frequency (group delay). If the rate of phase-change-vs.-frequency is not constant, the DUT is nonlinear. This nonlinearity can create distortion in communications systems.

Measurement Error Correction

Since we can measure microwave signals in both magnitude and phase, it is possible to correct for six major error terms:

- ☐ Source Test Port Match
- ☐ Load Test Port Match
- ☐ Directivity
- ☐ Isolation
- ☐ Transmission Frequency Response
- ☐ Reflection Frequency Response

We can correct for each of these six error terms in both the forward and reverse directions, hence the name 12-term error correction. Since 12-term error correction requires both forward and reverse measurement information, the test set must be *reversing.* "Reversing" means that it must be able to apply the measurement signal in either the forward or reverse direction.

To accomplish this error correction, we measure the magnitude and phase of each error signal (Figure 3-19). Magnitude and phase information appear as a vector that is mathematically applied to the measurement signal. This process is termed *vector error correction.*

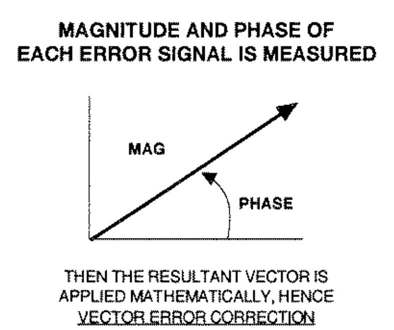


Figure 3-19. *Magnitude and phase measurements*

Summary

A network analyzer is similar to a scalar network analyzer. The major difference it that it adds the capability for measuring phase as well as amplitude. With phase measurements comes scattering, or S-parameters, which are a shorthand method for identifying forward and reverse transmission and reflection characteristics. The ability to measure phase introduces two new displays, polar and Smith Chart. It also adds vector error correction to the measurement trace. With vector error correction, errors introduced by the measurement system are compensated for and measurement uncertainty is minimized. Phase measurements also add the capability for measuring group delay, which is the rate of change-of-phase-vs.-frequency (group delay). All in all, using a network analyzer provides for making a more complete analysis of your test device.

Chapter 4
Front Panel Operation

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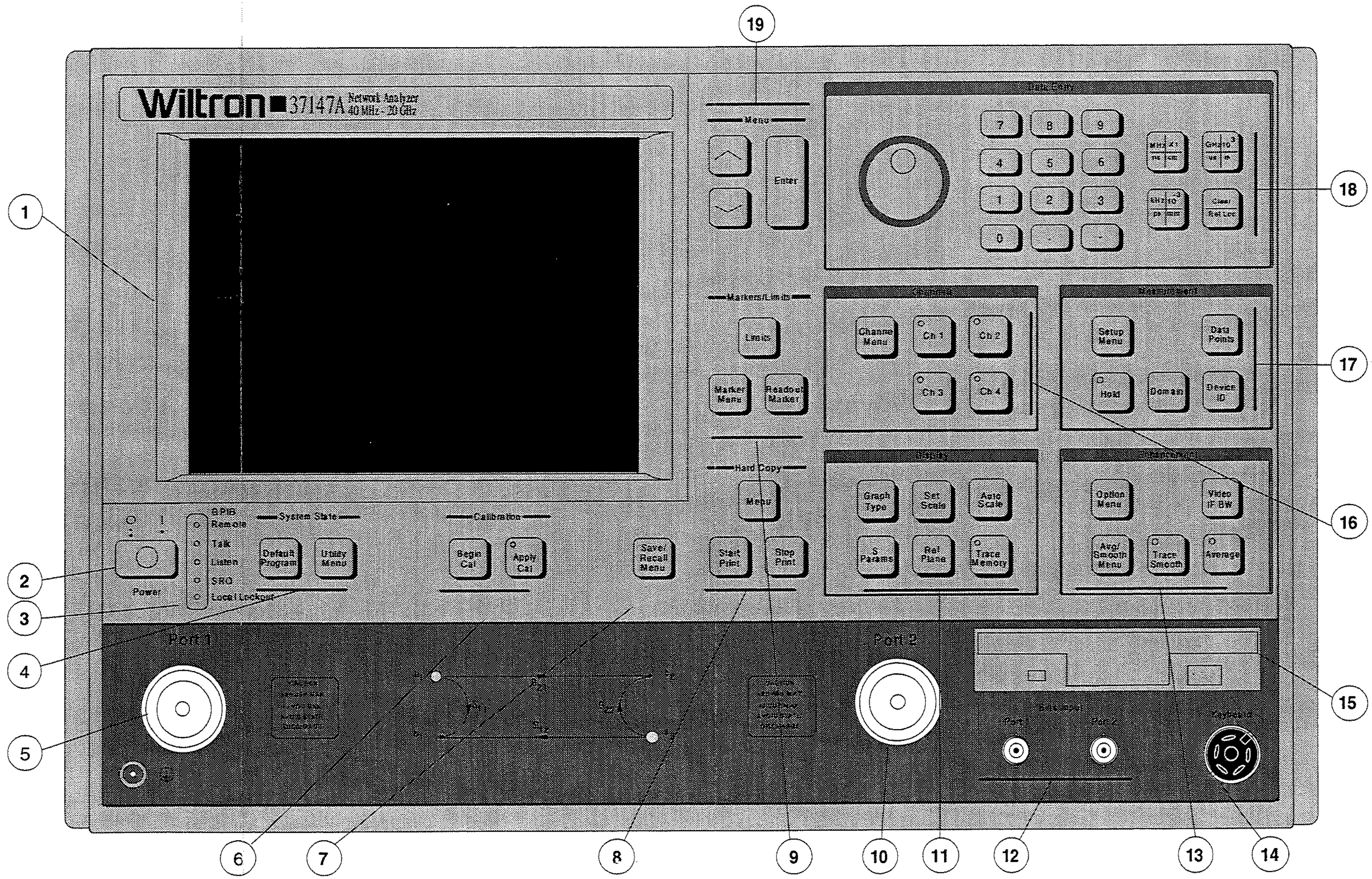


Figure 4-1. Model 37247A Vector Network Analyzer Front Panel

Chapter 4
Front Panel Operation

4-1 INTRODUCTION

This chapter describes the front panel keys, controls, and menus. The chapter is organized into an overall description of the front panel key-groups and detailed descriptions of individual keys within the key-groups.

4-2 FRONT PANEL KEY-GROUP DESCRIPTIONS

The following pages provide descriptions of the front panel key-groups.

Index 1. **CRT display:** Displays any or all of the four measurement channels, plus menus.

Index 2. **Power:** Turns the 372XXA on and off. When on, the operating program runs a self test then recalls the parameters and functions in effect when powered down last.

Index 3. **GPIB Indicators**

Remote: Lights when the 372XXA switches to remote (GPIB) control. It remains lit until the unit returns to local control.

Talk: Lights when you address the 372XXA to talk and remains lit until unaddressed.

Listen: Lights when you address the 372XXA to listen and remains lit until unaddressed.

SRQ: Lights when the 372XXA sends a Service Requests (SRQ) to the external controller. The LED remains lit until the 372XXA receives a serial poll or until the controller resets the SRQ function.

Local Lockout: Lights when a local lockout message is received. The LED remains lit until the message is rescinded. When lit, you cannot return the 372XXA to local control via the front panel.

Index 4. **System State keys**

Default Program: Resets the front panel to the factory-preset state and displays Menu SU1 or SU3. Pressing this key in conjunction with the "0" or "1" key resets certain internal memories and front panel key states (refer to paragraphs 4-5 and 4-10).

CAUTION

Use of this key will destroy front panel and calibration setup data, unless they have been saved to disk.

Utility Menu: Displays the first in a series of menus that let you perform diskette and other utility-type functions and operations.

Index 5. **Port 1 Test Connector:** Provides an input test connection for the device-under-test (DUT).

Index 6. **Calibration keys**

Begin Cal: Calls up the first in a sequence of menus that guide you through a measurement calibration. Refer to paragraph 4-3 for a detailed discussion of the calibration keys, indicators, and menus.

Apply Cal: Turns on and off the applied error correction and tune mode.

Index 7. **Save/Recall Menu key:** Displays the first of several menus that let you save the current calibration or front panel setup or recall a previously saved calibration or setup.

Index 8. **Hard Copy keys**

Menu: Displays option menus that let you define what will happen each time you press the Start Print key. The displayed menu also selects disk I/O operations.

Start Print: Tells the printer or plotter to start output based on the current selections or plotting.

Stop Print: Immediately stops printing the data, clears the print buffer, and sends a form-feed command to the printer.

Index 9. **Markers/Limits keys**

Marker Menu: Displays the first in a series of menus that let you set and manipulate marker frequencies, times, and distances.

Readout Marker: Displays a menu that lists all of the active markers. If no markers are active, the marker menu is displayed.

Limits: Displays one of the menus that let you manipulate the limit lines displayed on the CRT.

Index 10. **Port 2 Test Connector:** Provides an input test connection for the device-under-test (DUT).

Index 11. **Display keys**

Graph Type: Displays the two menus that let you choose the graph type for the active channel.

Set Scale: Displays the appropriate scaling menu, based on the graph type for the active channel.

Auto Scale: Automatically scales the active channel for optimum viewing.

S Params: Displays Menu SP (Appendix A), which lets you choose between S_{11}, S_{12}, S_{21}, or S_{22}. You may display the same parameter on two or more channels.

Ref Plane: Displays the first of two menus that let you set the reference plane for the active channel in time or distance. For a correct distance readout, you must set the dielectric constant to the correct value. Refer to the discussion in menu RD2 (Appendix A).

Trace Memory: Displays the menus that let you do any of the following. (1) Store the measured data in memory. (2) View the stored data. (3) Add, subtract, multiply, or divide the measured data from the stored data (normalize to the stored memory). (4) View both the measured and the stored data simultaneously on the active channel. (5) Store/Recall saved data to disk. Four memories exist — one for each channel. This lets you normalize the data in each channel independently. The LED on this button lights when the active channel is displaying memory data or measurement data normalized to memory.

Index 12. **Bias Input connectors**

Port 1: Provides for supplying a bias voltage for the Port 1 input.

Port 2: Provides for supplying a bias voltage for the Port 2 input.

Index 13. **Enhancement keys**

Option Menu: Displays a series of menus showing the choice of optional features.

Video IF BW: Displays a menu that lets you chose between 10 kHz, 1 kHz, 100 Hz, or 10 Hz intermediate frequency (IF) bandwidth filters.

Avg/Smooth Menu: Displays a menu that lets you enter values for Averaging and Smoothing.

Trace Smooth: Turns the trace smoothing function on and off.

Average: Turns the average function on and off.

Index 14. **Keyboard connector:** Provides for connecting an external IBM-AT-type keyboard. All alphanumeric field entries can be input from this keyboard. These inputs include Device ID, Model, Date, Operator Identification, frequencies, filenames, as well as comment-type entries. The analog knob and keypad input for these entries remains active.

Index 15. **Diskette Drive:** Provides a drive for the 3.5- inch, high-density (1.44 MB) floppy diskette used to store selected front panel setups and calibrations.

Index 16. **Channels keys**

Channel Menu: Displays a menu that lets you select the format for the number of channels displayed.

Ch 1: Makes Channel 1 the active channel. The active channel is the one acted on by the keys in the Display section. Only one channel can be active at any one time.

Ch 2: Makes Channel 2 the active channel.

Ch 3: Makes Channel 3 the active channel.

Ch 4: Makes Channel 4 the active channel.

Index 17. **Measurement keys**

Setup Menu: Displays the first of several menus that let you select functions affecting measurements.

Data Points: Displays a menu that lets you select between 1601, 801, 401, 201, 101, or 51 data points.

Hold: Toggles the instrument in and out of the hold mode; or it triggers a sweep, depending on the function selected in menu SU4 (Appendix A).

Domain: Displays the first in a series of menus that let you set the Time Domain display parameters. (This key is only active if your 372XXA is equipped with the Time Domain option.)

- If already in the Domain menus, pressing this key will return to the first menu in the sequence.
- If in the Domain menus and another (non-time domain) menu is displayed by pushing a menu key, the last displayed domain menu redisplays when the Domain key is next pressed.

Device ID: Displays a menu that lets you identify your test device.

Index 18. **Data Entry keys**

Rotary Knob: Used to alter measurement values for the *active parameter* (Start Frequency, Stop Frequency, Offset, etc.).

Keypad: Provides for entering values for the active parameter. The active parameter is the one to which the menu cursor is pointing.

MHz/X1/ns/cm: Terminates a value entered on the keypad in the units shown—that is; megahertz for frequency, unity for dimensionless or angle entries, nanoseconds for time, or centimeters for length.

GHz/10^3/µs/m: Terminates a value entered on the keypad in the units shown —that is; gigahertz for frequency, $1X10^3$ power for dimensionless or angle entries, microseconds for time, or meters for length.

kHz/10^{-3}/ps/mm: Terminates a value entered on the keypad in the units shown—that is; kilohertz for frequency, $1X10^{-3}$ for dimensionless or angle entries, picoseconds for time, or millimeters for length.

Clear/Ret Loc:

a. *Local (Non-GPIB) Mode:* (1) The key clears entries not yet terminated by one of the terminator keys above, which allows the previously displayed values to redisplay. Or (2) the key turns off the displayed menu, if you have not made any keypad entries needing termination.

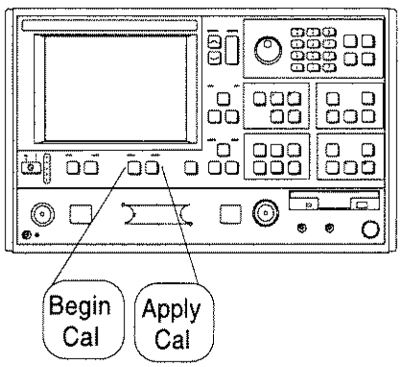
b. *GBIB Mode:* The key returns the instrument to local (front panel) control, unless the controller has sent a local lockout message (LLO) over the bus.

Index 19. **Menu keys**

Arrow keys: They move the menu cursor up and down to select items appearing in the menu area of the CRT.

Enter: Implements the menu selection chosen using the arrow keys.

4-3 CALIBRATION KEY-GROUP, DESCRIPTIONS AND MENU FLOW



The Calibration keys (Begin Cal and Apply Cal, left) are described below. The calibration menus are diagrammed according to the method of calibration performed: Standard, Offset-Short, or LRL/LRM. The menu sequencing is complex and looping and can be said to have two parts: setup and calibration. The setup flow for the three calibration methods is diagrammed in Figures 4-2 thru 4-4. Each setup flow chart leads to the main calibration sequence, which is diagramed in Figure 4-5. A full description of each menu is provided in Appendix A, where the menus are arranged in alphabetical order by call letter (C1, C2, C3, etc).

Begin Cal Key: This key displays a menu that lets you initiate the calibration sequence. That is, to begin a sequence of steps that corrects for errors inherent in a measurement setup.

Apply Cal Key: This key displays a menu (left) that lets you turn on and off the error correction that may be applied to the displayed channel(s) using the currently valid error-correction indicator. Additionally, the menu lets you turn tune mode on and off and change the number of forward sweeps between reverse sweeps (or reverse sweeps between forward sweeps).

MENU CAL_APPLIED
APPLY CALIBRATION
FULL 12-TERM (S11, S21 S22, S12)
APPLY ON (OFF) CALIBRATION
TUNE MODE ON (OFF)
NO. OF FWD (REV) SWEEPS BETWEEN REV (FWD) SWEEPS XXXXX SWEEPS (XXXXX REMAINING)
PRESS <APPLY CAL> TO TURN ON/OFF
PRESS <ENTER> TO TURN ON/OFF

NOTE

Pressing the Clear key while in a calibration setup or sequencing will let you abort the calibration and return to the first setup menu.

Standard Calibration Setup Flow– Description

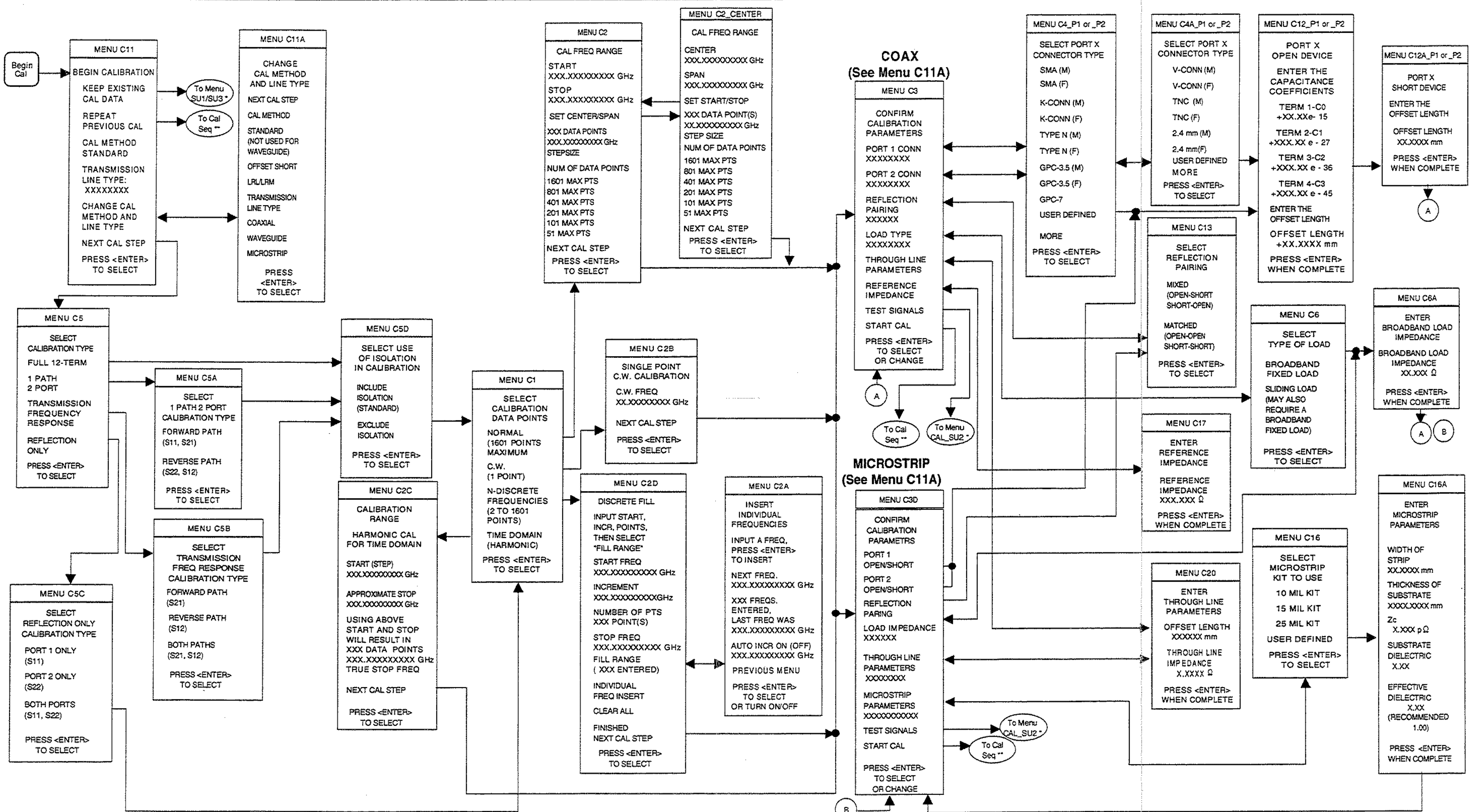
1. Pressing the Begin Cal key calls Menu C11.

2. With one exception, the flow is from left to right in the direction of the arrow head. The exception occurs in Menu C1, for the TIME DOMAIN choice. Here the flow direction reverses to Menu C2C then returns to a left-to-right flow on to Menu C3 or C3D.

3. Arrowheads that point both left and right indicate that the flow returns to the right-most menu after a choice had been made.

4. The group of menus to the left of Menu C3 and C3D are the initial selection set and are essentially the same for all three calibration types: Standard, Offset-Short, and LRL/LRM.

5. The group of menus that follow Menu C3 or C3D are, for the most part, type specific. The selection of Menu C3 or C3D depends upon the choice made in Menu C11A: COAXIAL or MICROSTRIP. For the Standard Calibration, the WAVEGUIDE selection in Menu C11A is not used.



* Setup Menu SU1/SU3 – See Figure 4-6
** Cal Seq (Calibration Sequence) – See Figure 4-5

Figure 4-2. *Menu Sequencing, Standard Calibration*

Offset-Short Calibration Setup Flow – Description

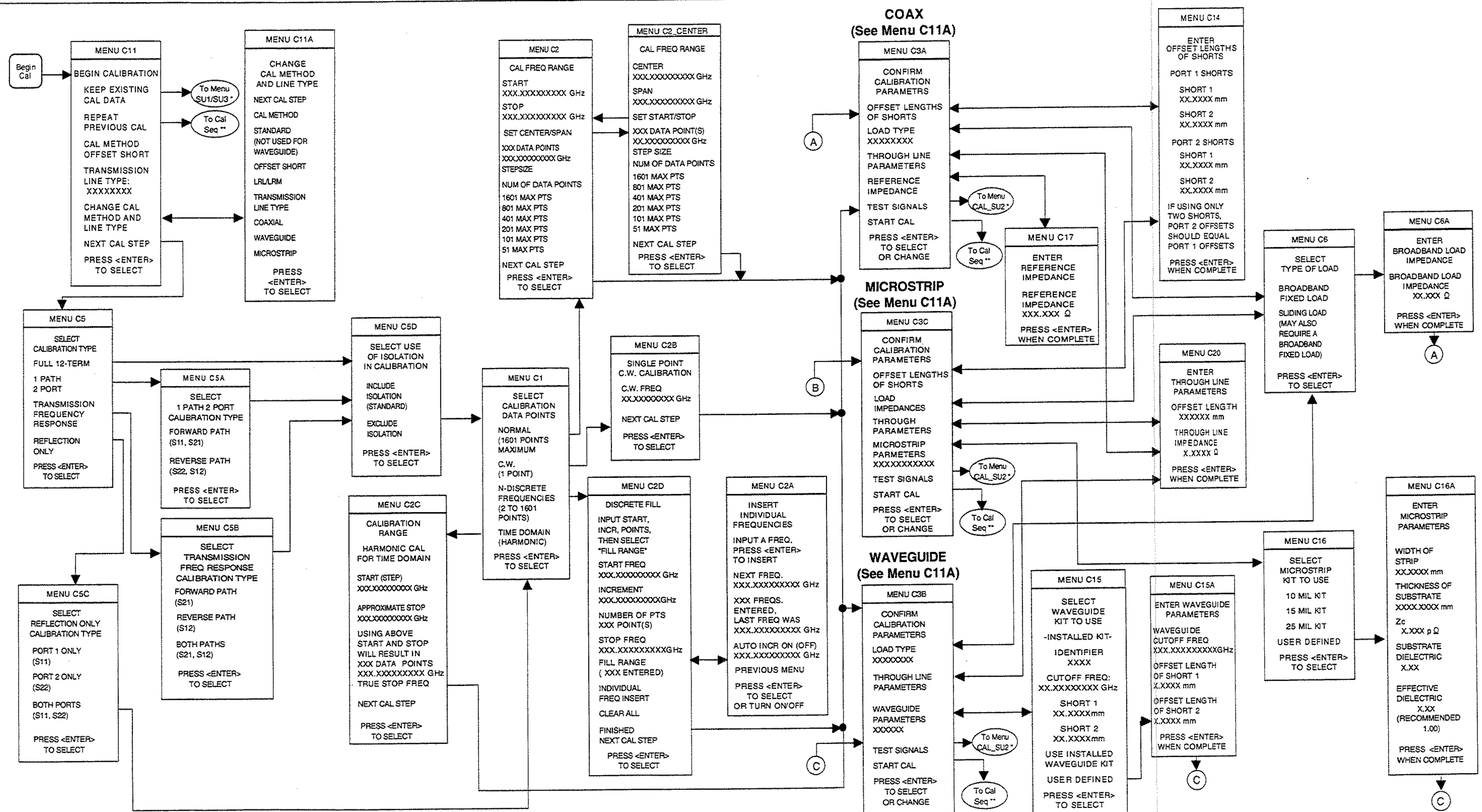
1. Pressing the Begin Cal key calls Menu C11.

2. With one exception, the flow is from left to right in the direction of the arrow head. The exception occurs in Menu C1, for the TIME DOMAIN choice. Here the flow direction reverses to Menu C2C then returns to a left-to-right flow on to Menu C3A, C3C, or C3B.

3. Arrowheads that point both left and right indicate that the flow returns to the right-most menu after a choice had been made.

4. The group of menus to the left of Menu C3A, C3C, or C3B are the initial selection set and are essentially the same for all three calibration types: Standard, Offset-Short, and LRL/LRM.

5. The group of menus that follow Menu C3A, C3C, or C3B are, for the most part, type specific. The selection of Menu C3A, C3C, or C3B depends upon the choice made in Menu C11A: COAXIAL, WAVEGUIDE, or MICROSTRIP.



* Menu SU1/SU3 – See Figure 4-6
** Cal Seq (Calibration Sequence) – See Figure 4-5

Figure 4-3. *Menu Sequencing, Offset-Short Calibration*

LRL/LRM Calibration Setup flow – Description

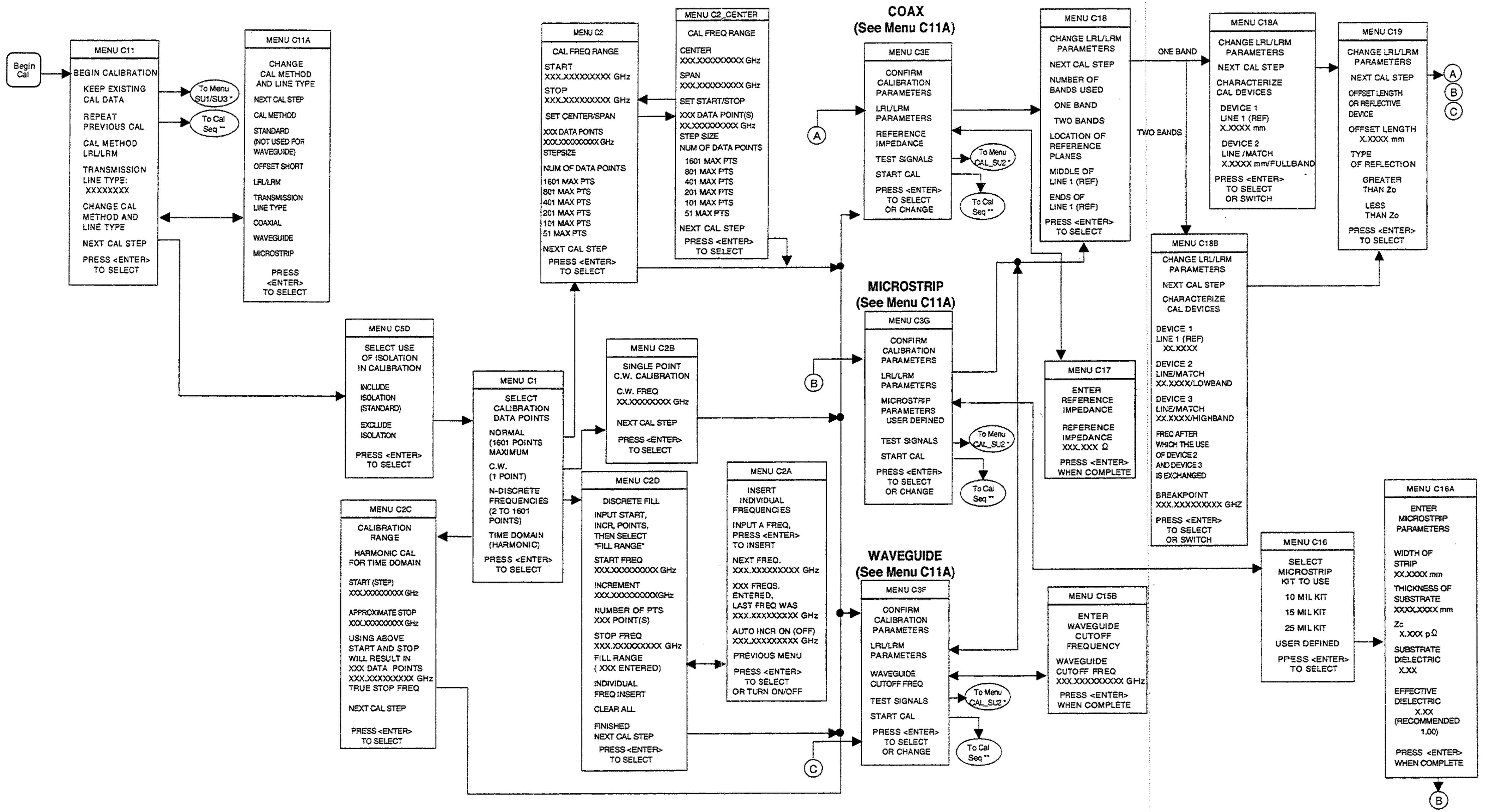
1. Pressing the Begin Cal key calls Menu C11.

2. With one exception, the flow is from left to right in the direction of the arrow head. The exception occurs in Menu C1, for the TIME DOMAIN choice. Here the flow direction reverses to Menu C2C then returns to a left-to-right flow on to Menu C3E, C3G, or C3F.

3. Arrowheads that point both left and right indicate that the flow returns to the right-most menu after a choice had been made.

4. The group of menus to the left of Menu C3E, C3G, or C3F are the initial selection set and are essentially the same for all three calibration types: Standard, Offset-Short, and LRL/LRM.

5. The group of menus that follow Menu C3E, C3G, or C3F are, for the most part, type specific. The selection of Menu C3E, C3G, or C3F depends upon the choice made in Menu C11A: COAXIAL, WAVEGUIDE, or MICROSTRIP.



* Menu SU1/SU3 – See Figure 4-6
** Cal Seq (Calibration Sequence) – See Figure 4-5

Figure 4-4. *Menu Sequencing, LRL/LRM Calibration*

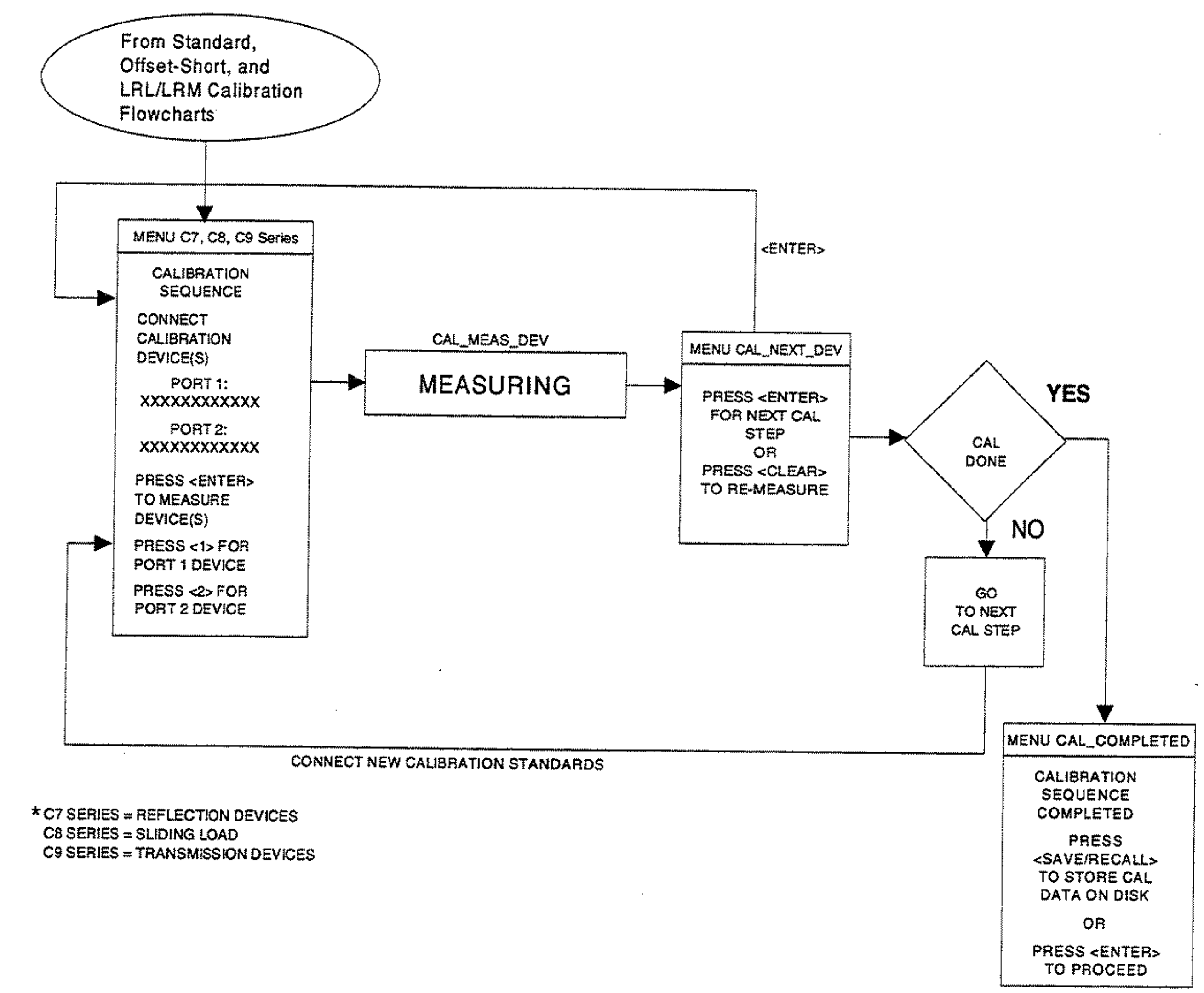
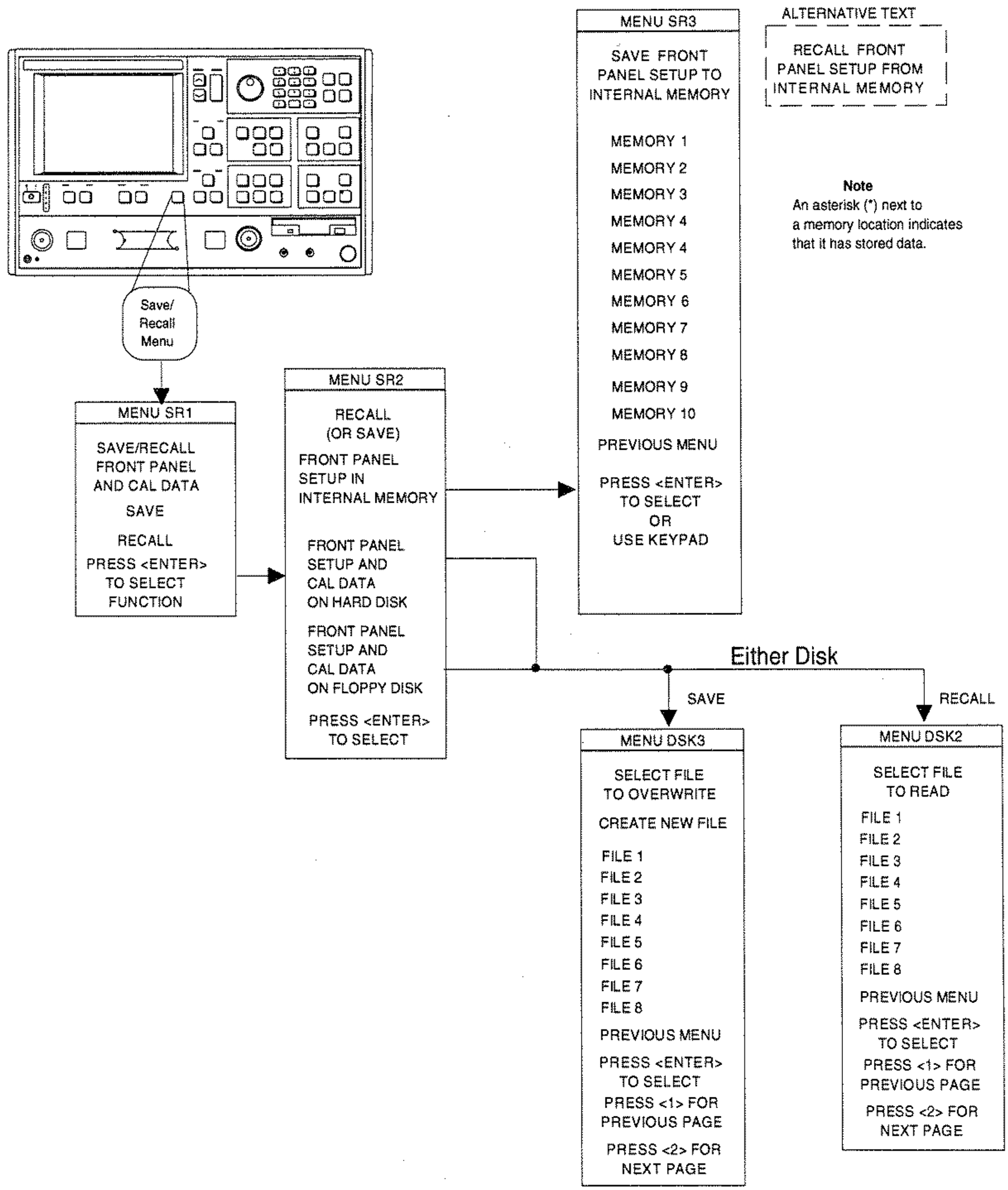


Figure 4-5. *Calibration Sequence Menus*

4-4 SAVE/RECALL MENU KEY, DESCRIPTION AND MENU FLOW

Pressing this key displays the first of a menu set (below) that lets you save or recall control panel setups and calibration data. Full menu descriptions can be found in the alphabetically ordered Appendix A under the menu's call letters (SR1, SR2, SR3, etc).



4-5 MEASUREMENT KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the Measurement key-group are described below. Flowcharts of the Setup Key and Data Points key menus are shown in Figure 4-6. As described for the calibration menus, the flow is left-to-right and the double arrowheaded lines indicate that the flow returns to the calling menu once a selection has been made.Full menu descriptions can be found in the alphabetically ordered Appendix A under the menu's call letters (SU1, SU2, DF, etc).

Setup Menu Key: Pressing this key calls Sweep Setup Menu SU1 or SU3. Depending upon which menu items you select, additional menus may also be called.

Data Points Key: Pressing this key calls Menu SU9 or SU9A. Menu SU9 provides for data point selection. Menu SU9A is called if the C.W. MODE selection in Menu SU1 is on.

Hold Key: If the instrument is sweeping, pressing this key results in an immediate halt of the sweep at the current data point. The LED on the button lights, indicating that the Hold Mode is active.

If you restart the sweep after performing any recall-from-disk operations in the Hold Mode (sweep stopped at some data point), the sweep restarts from the beginning. The instrument may be taken out of the hold mode as follows:

- By pressing the Default Program button. This causes the 372XXA to revert to a predefined state.
- By pressing the BEGIN CAL key. This causes the 372XXA to resume sweeping and begin the Calibration Menu sequence.

NOTE

See the description for Menu SU4 for a discussion of the interaction between the Hold Mode and the selection of "Single Sweep" or "Restart Sweep"

Domain Key: This key function is fully described in paragraph 4-2 (page 4-7). Additionally, if the Time Domain option is installed, making a selection other than "Frequency Domain" lets you display measured data in the time domain. It also calls a further sequence of Time Domain Menus. Refer to paragraph 9-2 for additional details.

Device ID Key: Pressing this key calls a menu that lets you enter a name for the test device. This key has the same effect as selecting "Device ID" in the PM2 menu.

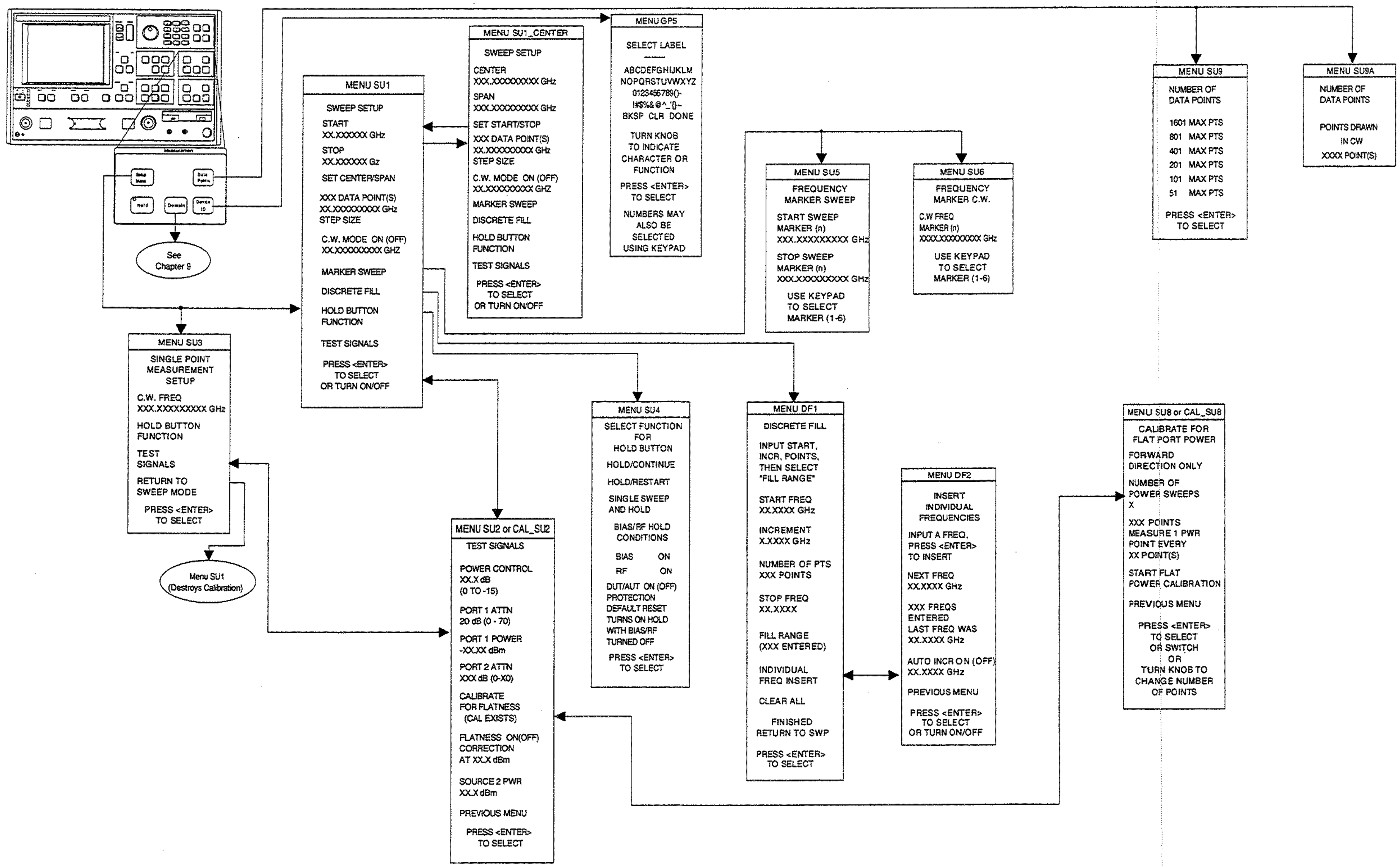


Figure 4-6. *Measurement Key-Group*

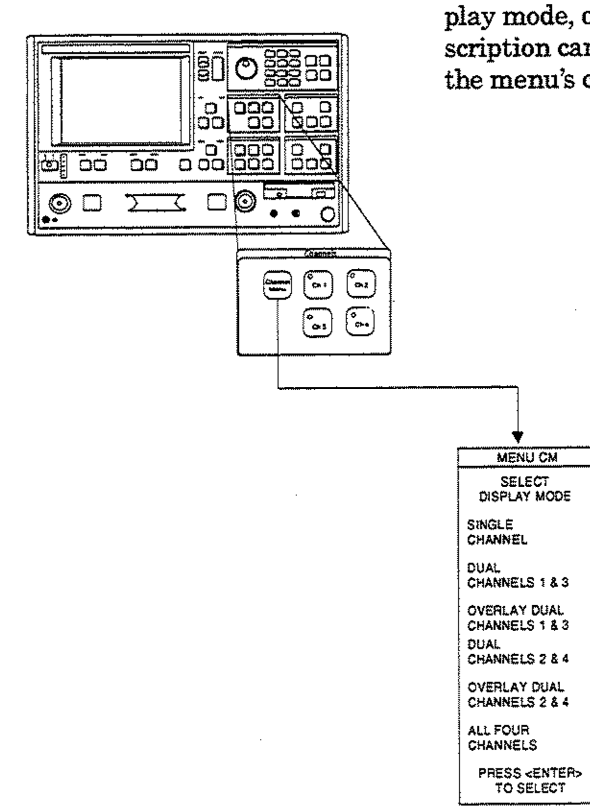
4-6 CHANNELS KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the Channels key-group are described below.

Ch 1-4 Keys: These keys (left) define the active channel. One (and only one) must always be active as indicated by the associated LED. Pressing a button makes the indicated channel active. If channel indicated by the key is already active, pressing the key has no effect.

The active channel will be the channel acted upon by the S Params, Graph Type, Ref Plane, Trace Memory, Set Scale, Auto Scale, Markers/Limits and Domain keys. When in the single channel display mode, the active channel will be the one displayed.

Channel Menu : Pressing this key calls menu CM (below). Here, you select the number of channels to be displayed. When in the single display mode, only the active channel will be displayed. Full menu description can be found in the alphabetical listing (Appendix A) under the menu's call letters (CM).



4-7 DISPLAY KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the Display key-group are described below. Menu flow diagrams are shown in Figure 4-7. Full menu description(s) for menu SP and all others mentioned below can be found in the Appendix A alphabetical listing under the menu's call letters (SP, GT1, RD1, etc).

Graph Type Key: Pressing this key calls menu GT1 or GT2. These menus let you select the type of display to appear on the active channel for the selected S-Parameter.

Set Scale Key: Pressing this key calls the appropriate scaling menu (SS1, SS2, SS3, etc.) depending upon the graph type being displayed on the active channel for the selected S-Parameter.

Auto Scale Key: Pressing this key autoscales the trace or traces for the active channel. The new scaling values are then displayed on the menu (if it is displayed) and graticule. The resolution will be selected from the normal sequence of values you have available using the knob. When the active channel has a Real and Imaginary type display, the larger of the two signals will be used to autoscale both the real and imaginary graphs. Both graphs will be displayed at the same resolution.

S Params Key: Pressing this key calls menu SP. This menu allows you to select the S-Parameter to be displayed by the active channel for the selected S-Parameter.

Ref Plane Key: Pressing this key calls menu RD1. This menu lets you input the reference plane in time or distance. You do this by selecting the appropriate menu item. For a correct distance readout, the dielectric constant must be set to the correct value. This is accomplished by selecting **SET DIELECTRIC**, which calls menu RD2.

On menu RD1, selecting **AUTO** automatically adjusts the reference delay to unwind the phase for the active channel.

The 372XXA unwinds the phase as follows:

- ☐ First, it sums the phase increments between each pair of measured data points, then it takes the average "Pdelta" over the entire set of points.
- ☐ Next, it corrects the phase data by applying the following formula:

$$P_{correct} = P_{measured} - NxP_{delta}$$

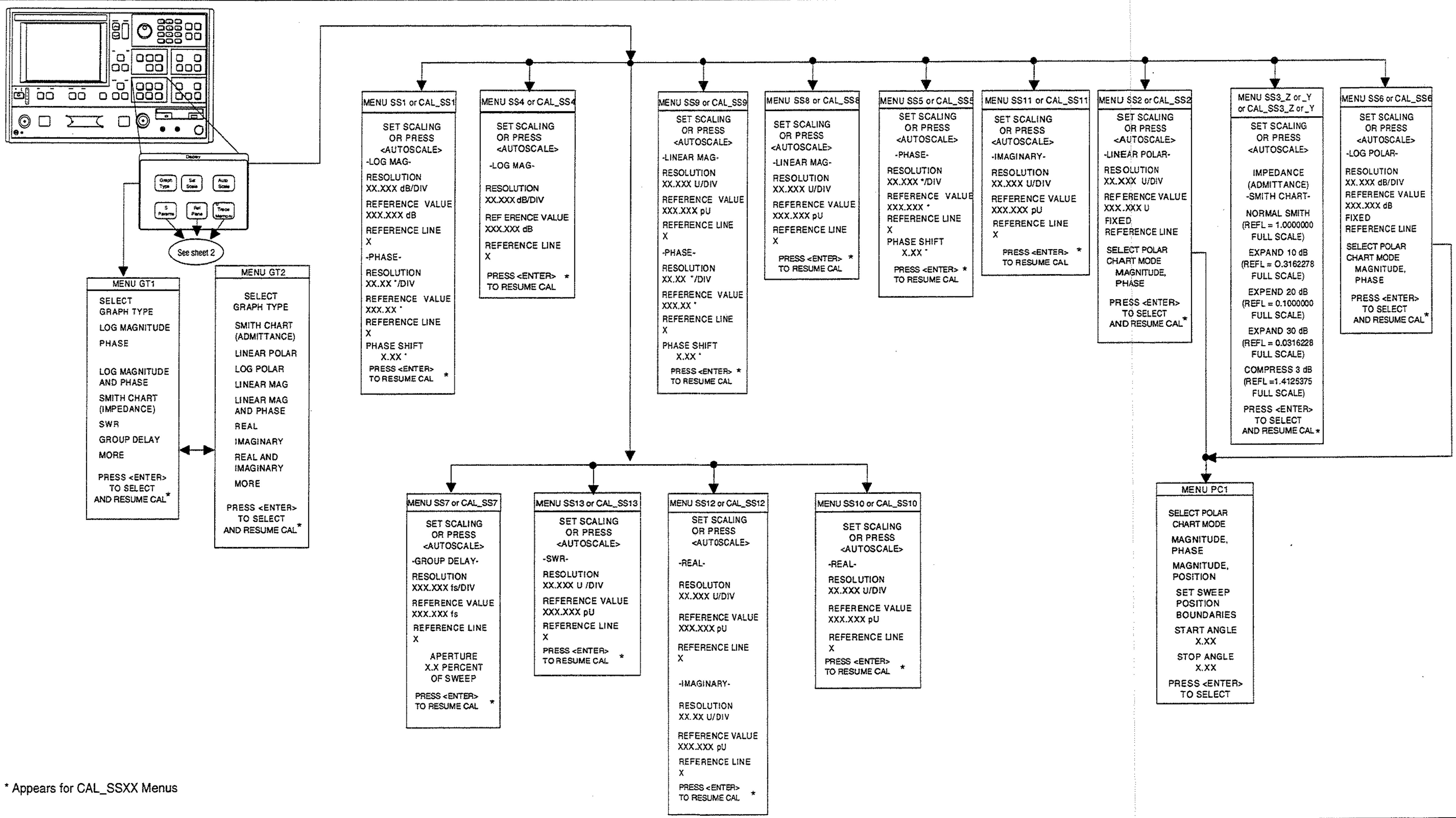
Where P = phase

Assuming there are fewer than 360 degrees of phase rotation between each data point, the operation described above removes any net phase offset. The endpoints of the phase display then fall at the same phase value.

Trace Memory Key: Pressing this key brings up menu NO1. This menu—which relates to the active channel—allows you to store data to memory, view memory, perform operations with the stored memory, and view both data and memory simultaneously. Four memories exist, one for each channel. This allows each channel to be stored and normalized independent of the other channels. Data from the trace memory may be stored on the disk or recalled from it.

NOTE

Trace memory will automatically be set to "VIEW DATA" (that is, turned off), if a sweep with a greater number of points is selected while operating on a stored trace.



* Appears for CAL_SSXX Menus

Figure 4-7. *Display Key-Group Menus (1 of 2)*

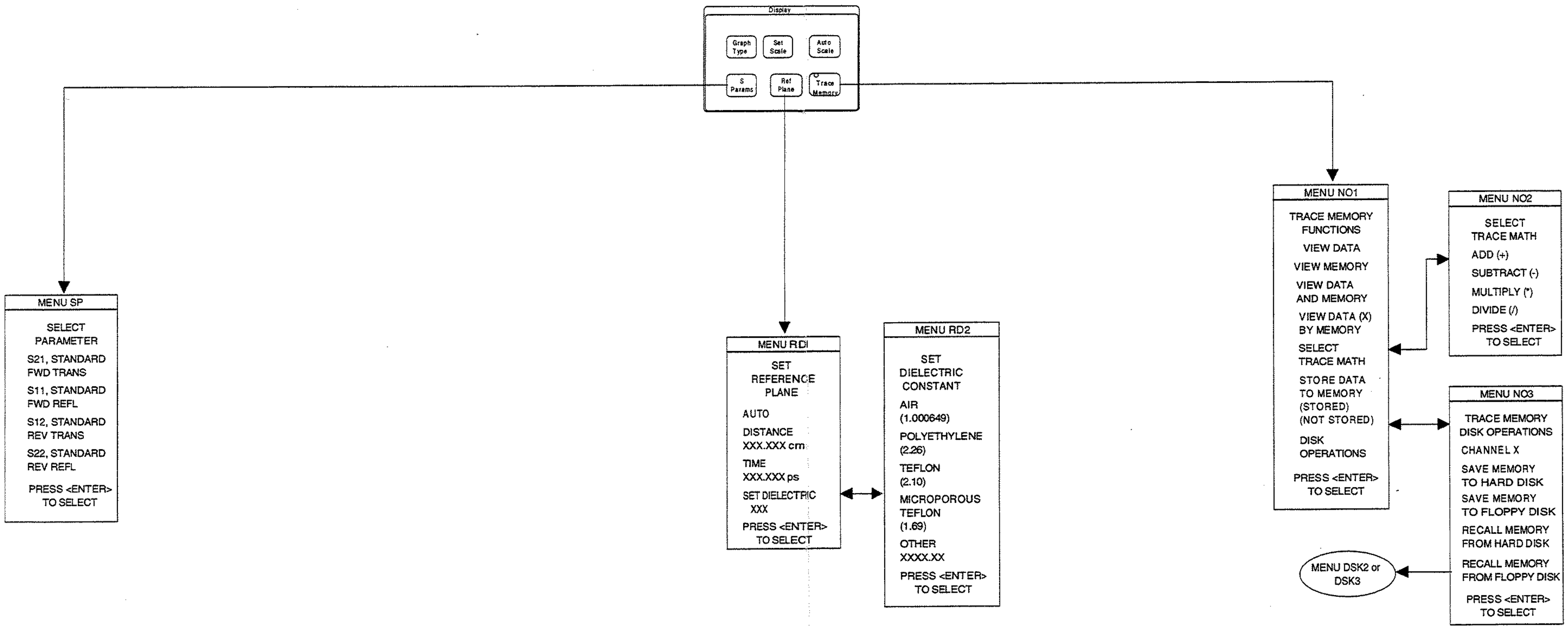


Figure 4-7. Display Key-Group Menus (2 of 2)

4-8 ENHANCEMENT KEY-GROUP, DESCRIPTION AND MENU FLOW

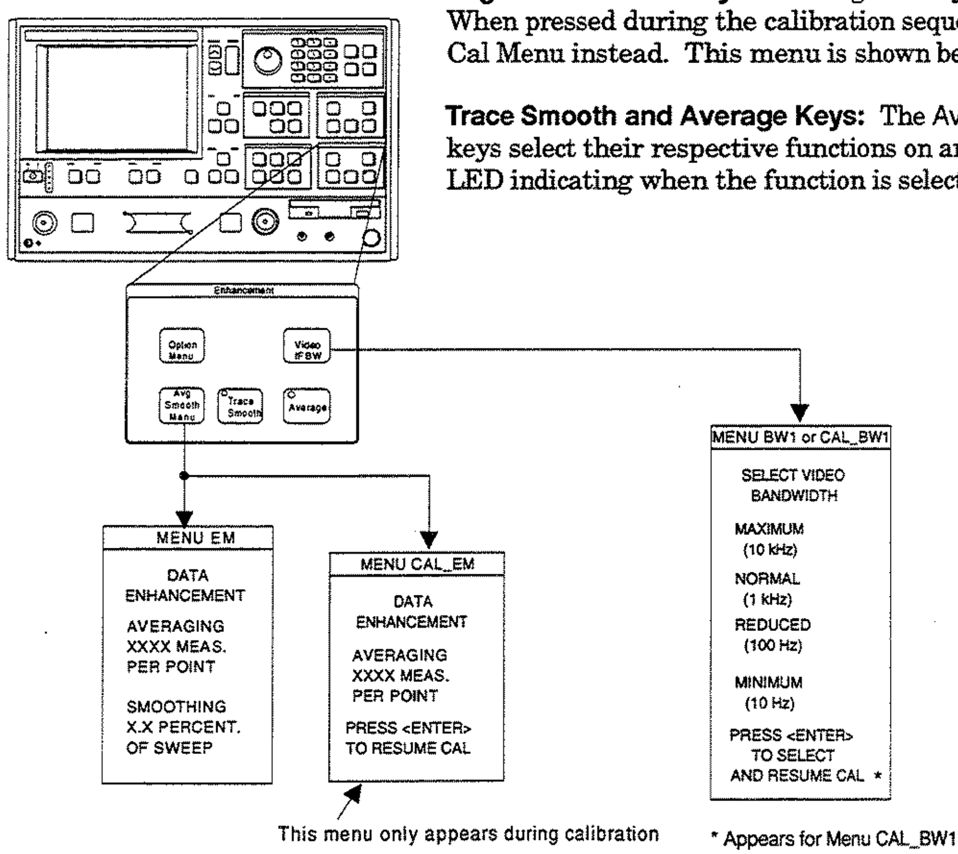
The individual keys within the Enhancement key-group are described below. Full menu description(s) for menu OPTNS and all others mentioned below can be found in the Appendix A alphabetical listing under the menu's call letters (SP, GT1, RD1, etc).

Option Menu Key: This key brings up the OPTNS menu. Depending on choices selected, this menu causes other menus to appear. A menu flow diagram for this key is shown in Figure 4-8.

Video IF BW Key: Pressing this produces a menu that lets you choose between four different IF bandwidths. This menu is shown below.

Avg/Smooth Menu Key: Pressing this key brings up the EM Menu. When pressed during the calibration sequence, it brings up the EM Cal Menu instead. This menu is shown below.

Trace Smooth and Average Keys: The Average and Trace Smooth keys select their respective functions on and off with the appropriate LED indicating when the function is selected.



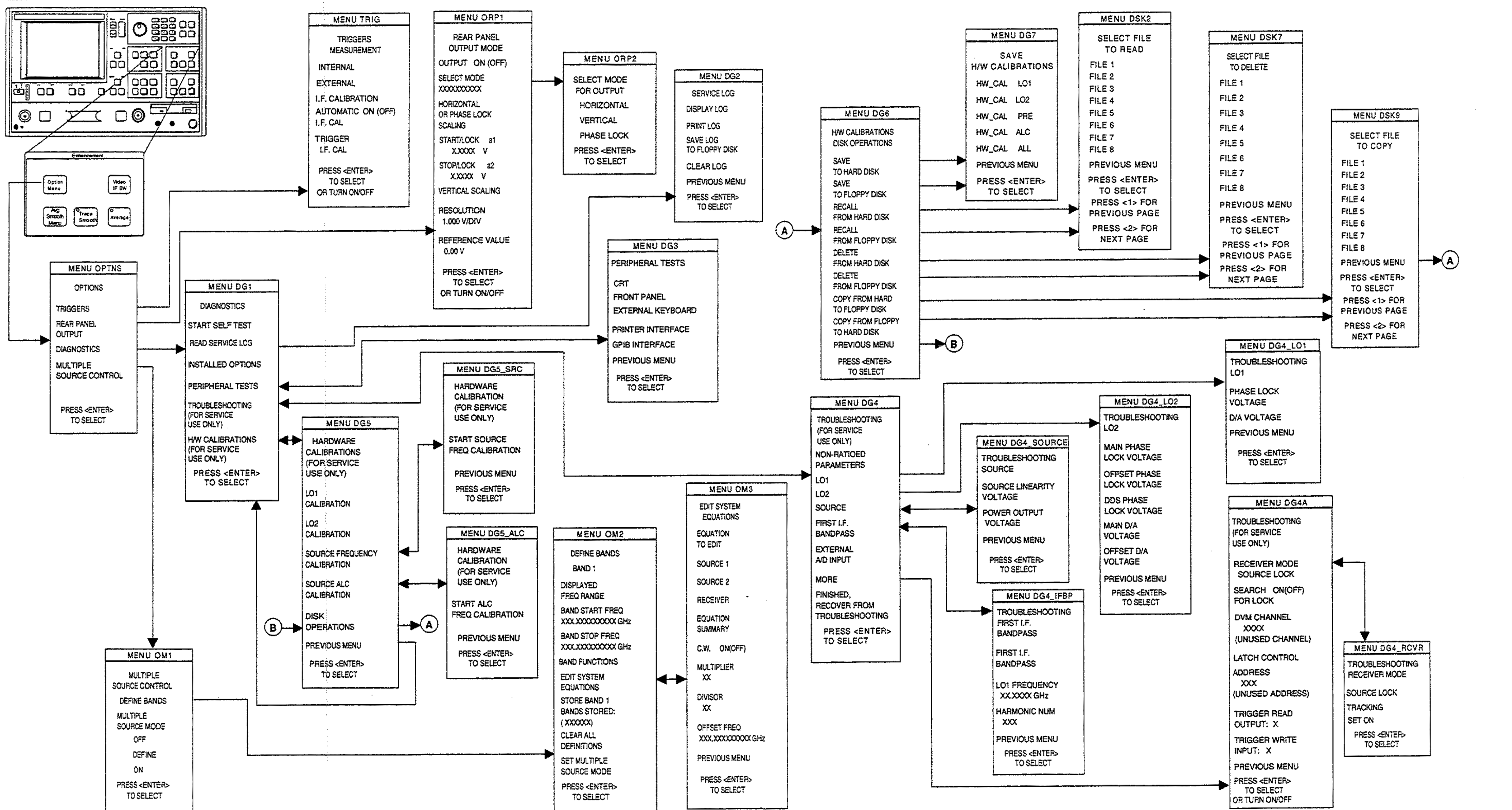


Figure 4-1. Enhancement Key-Group (Options Menu Key)

4-9 HARD COPY KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the Hard Copy key-group are described below. Full descriptions for menus can be found in the alphabetical listing (Appendix A) under the menu's call letters (PM1, PM2, PM3, etc.)

Menu Key: Pressing this key brings up menu PM1. This menu allows you to define what will happen every time you press the Start Print key. A menu flow diagram is shown in Figure 4-9.

Start Print Key: Pressing this key starts outputting the measured data as defined by the setup defined by the selected MENU key.

Stop Print Key: Pressing this key can result in any of the following actions if the printer is selected

- If the 372XXA is not outputting data, the key sends a form feed command to the printer.
- If the printer is active, the key aborts the printing and sends a form feed command to the printer. Aborting the printing clears the print buffer.
- If the printer is not selected and another form of output is active, Pressing this key aborts printing but *does not* send a form feed to the printer.

Plotting Functions The 372XXA can plot an image of either the entire screen or subsets of it. Plots can be either full size or they can be quarter size and located in any of the four quadrants. You can select different pens for plotting different parts of the screen. You cannot, however, plot tabular data.

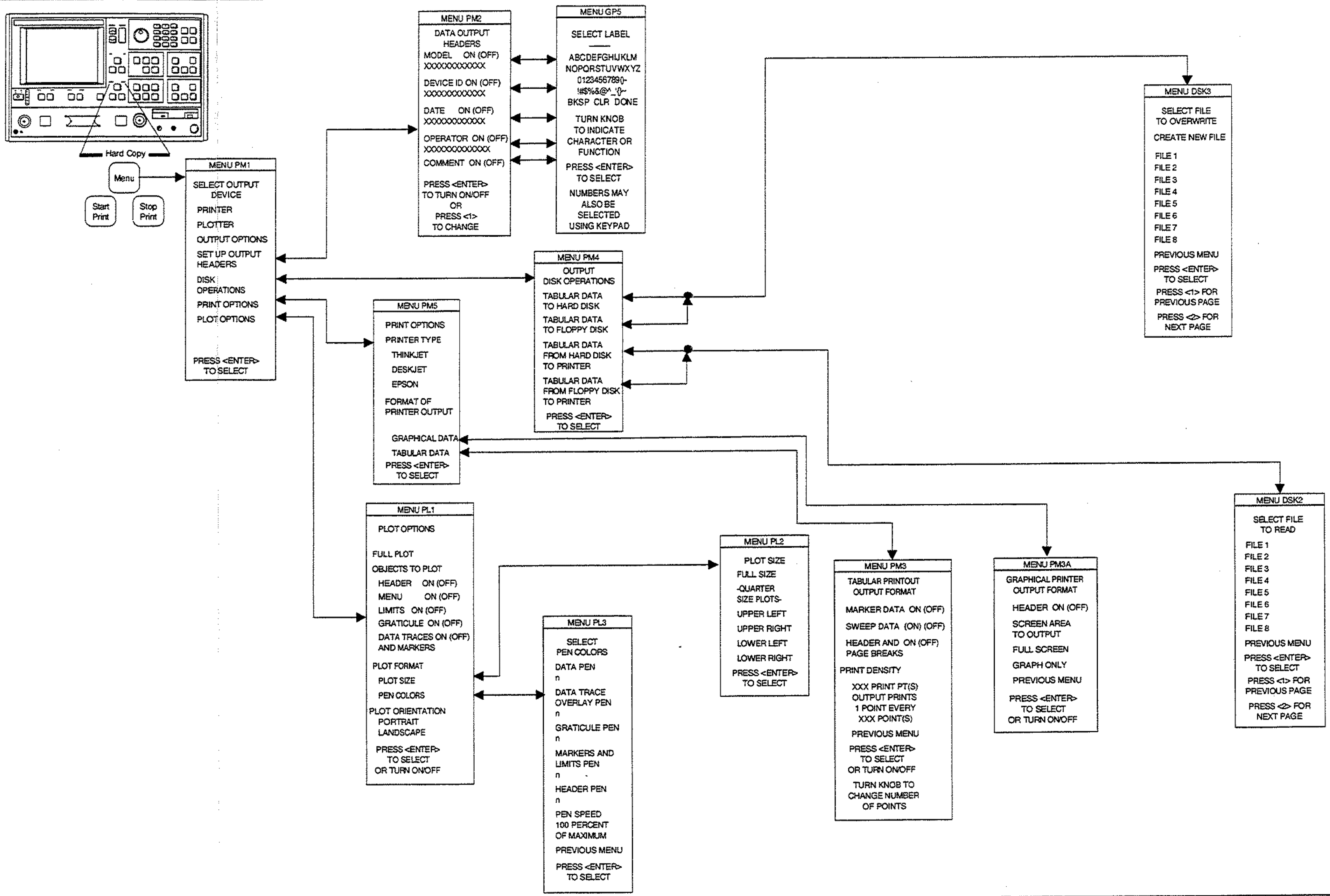


Figure 4-2. Hard Copy Key-Group Menus

4-10 SYSTEM STATE KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the System State key-group are described below. The menu flow for the Utility Menu key is shown in Figure 4-10. Full descriptions for menus can be found in the alphabetical listing (Appendix 1) under the menu's call letters (U1, U2, U3, etc.)

Default Program Key: Pressing this key brings up the default menu. If pressed again, it recalls the factory selected default values for the control panel controls. The values are defined in Table 4-1.

Pressing this key then the 1 key resets front panel key states and internal memories 1 thru 10.

Pressing this key then the 0 key resets front panel key states, internal memories 1 thru 10, and certain hardware settings. Refer to paragraph 4-5 for additional information on this function.

CAUTION

Use of this key will destroy control panel and calibration setup data, unless they have been saved to disk.

Utility Menu *Key*: Pressing this key calls menu U1. This menu accesses subordinate menus to perform system, disk, and service utilities. The only functions performed directly from the U1 Menu are "Blank Frequency Information." and "Data Drawing."

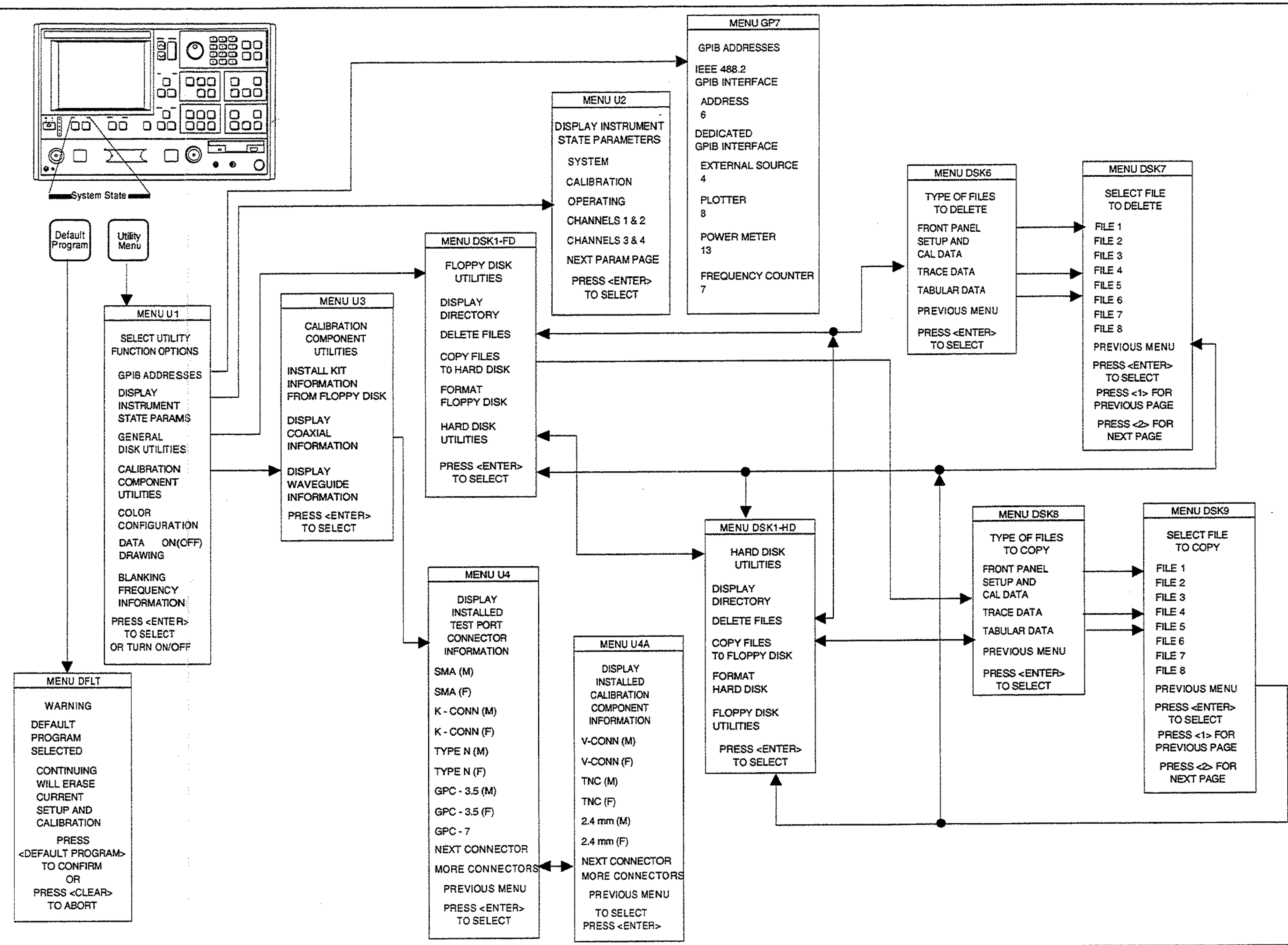


Figure 4-3. *System State Key-Group Menus*

Table 4-1. *Default Settings*

Function	Default Setting
Instrument State	Measurement Setup Menu Displayed
Measurement	Maximum sweep range of source and test set *Source Power:* Model Dependent *Resolution:* Normal (401 points)
Channel	Quad (four-channel) display Channel 1 active
Display	*Channel 1:* S11, 1:1 Smith Chart *Channel 2:* S12, Log Magnitude and Phase *Channel 3:* S21, Log Magnitude and Phase *Channel 4:* S22, 1:1 Smith Chart *Scale:* 10 dB/Division or 90/Division *Offset:* 0.000dB or 0.00 degree *Reference Position:* Midscale *Electrical Delay:* 0.00 seconds *Dielectric:* Air (1.000649) *Normalization:* Off *Normalization Sets:* Erased
Enhancement	*Video IF Bandwidth:* Normal *Averaging:* Off *Smoothing:* Off
Calibration	*Correction:* Off and Calibration erased *Connector:* Model dependent *Load:* Broadband
Markers/Limits	*Markers On/Off:* All off *Markers Enabled/Disabled:* All enabled Marker Frequency: All set to the start-sweep frequency (or start -time distance Δ *Reference:* Off *Limits:* All set to reference position value (all off all enabled)
System State	*GPIB Addresses:* Unchanged *Frequency Blanking :* Disengaged, *Error(s): GPIB SRQ errors are cleared, Service Log errors are not cleared* *Measurement:* Restarted

4-11 MARKERS/LIMITS KEY-GROUP, DESCRIPTION AND MENU FLOW

The individual keys within the Markers/Limits key-group are described below. The menu flow for the Marker Menu key is shown on the facing page. Full descriptions for these menus can be found in the alphabetical listing (Appendix 1) under the menu's call letters (M1, M2, M3, etc.)

Marker Menu Key: Pressing the Marker Menu key calls Menu M1. This menu lets you toggle markers on and off and set marker frequencies, times, or distances.

Readout Marker Key: Pressing this key calls different menus, depending upon front panel key selections, as described below.

- ☐ It calls menu M1 if there are no markers available within the selected frequency range.
- ☐ It calls menu M3 if no Delta ref marker has been selected.
- ☐ It calls menu M4 if the ΔReference mode is off and the selected marker is in the current sweep range (or time/distance).
- ☐ It calls menu M5 if the ΔReference mode and marker are both on and and the ΔReference marker is in the selected sweep range (or time/distance).
- ☐ It calls menu M6 if ACTIVE MARKER ON ALL CHANNELS has been previously selected in menu M9.
- ☐ It calls menu M7 if SEARCH has been previously selected in menu M9.
- ☐ It calls menu M8 if FILTER PARAMETER has been previously selected in menu M9.

Marker Readout Functions This menu choice, which appears on several marker menus, provides for several filter-related measurements. It also allows for performing a marker-value search and for reading the active marker value on all displayed channels.

Limit Frequency Readout Function The 372XXA has a Limit-Frequency Readout function. This function allows frequency values to be read at a specified level (such as the 3 dB point) on the data trace. This function is available for all rectilinear graph-types.

The graph-type and their menu call letters are listed below

- ☐ Log Magnitude, Menu LF1
- ☐ Phase, Menu LF2
- ☐ Group Delay, Menu LF3
- ☐ Linear Magnitude, Menu LF4
- ☐ SWR, Menu LF5
- ☐ Real, Menu LF6
- ☐ Imaginary, menu LF7

Full menu descriptions can be found in the alphabetical listing (Appendix 1) under the menu call letters (LF1, LF2, LF3, etc.)

Limits Key Pressing this key calls the appropriate Limit menu, based on the graph type selected using the Graph Type key and menu.

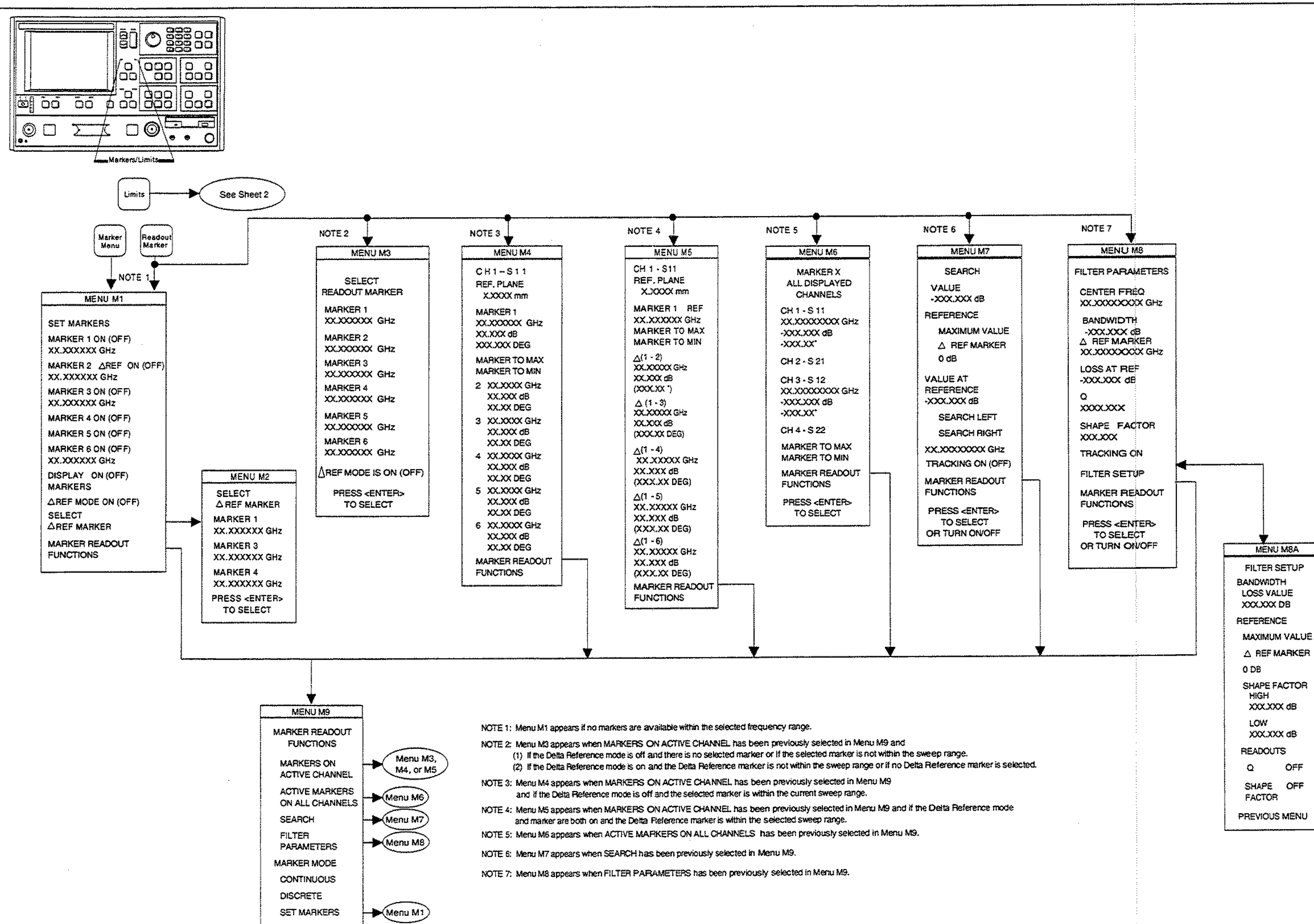


Figure 4-11. Markers/Limits Key-Group Menus (1 of 3)

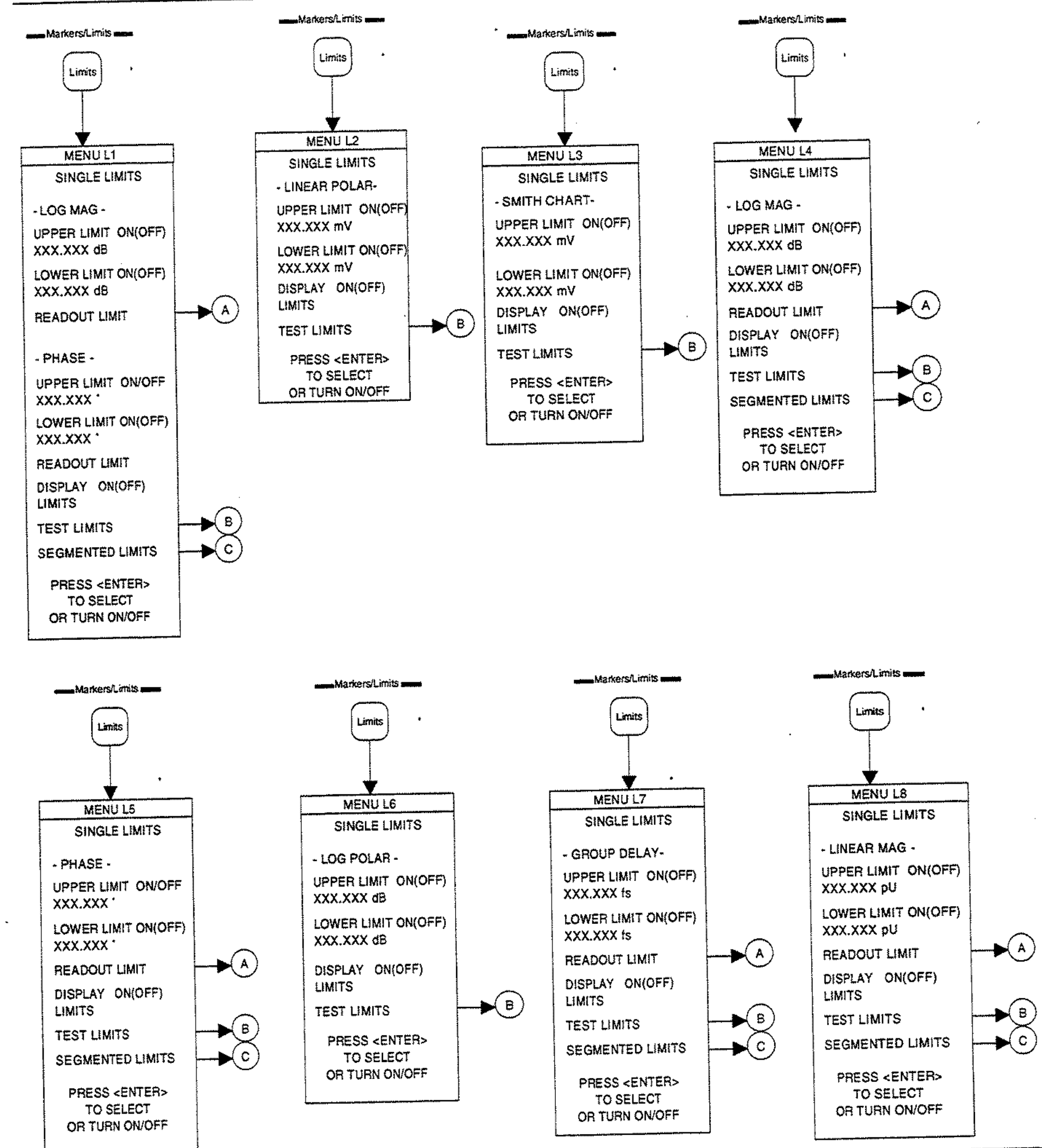


Figure 4-11. Markers/Limits Key-Group Menus (2 of 3)

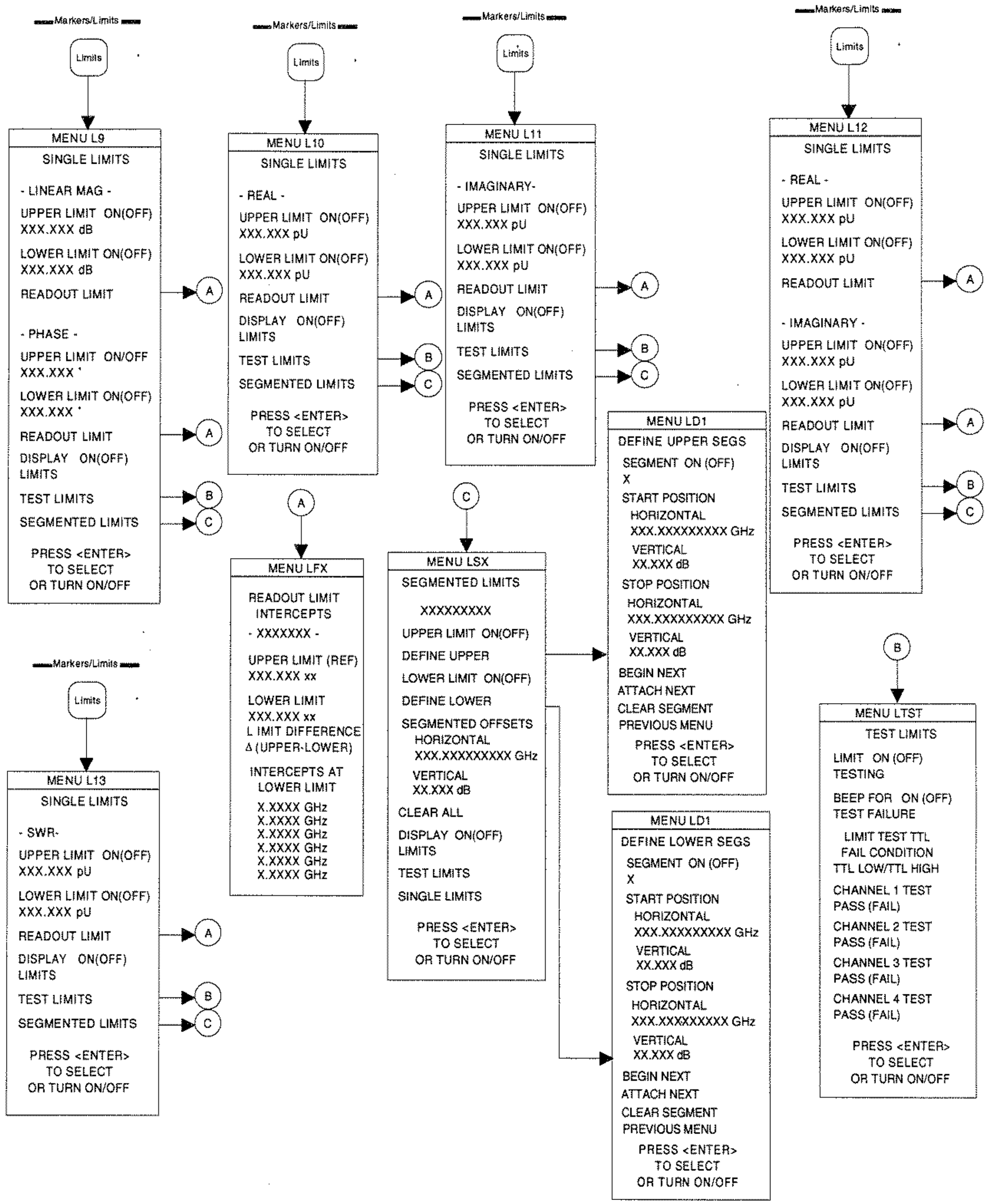


Figure 4-11. *Markers/Limits Key-Group Menus (3 of 3)*

4-12 DISK STORAGE INTERFACE

The 372XXA has two internally mounted disk drives: a 256 MB hard and a 3.5 inch floppy. The format, files, and directory are compatible with MS-DOS, Version 5.0.

Disk Format Floppy diskettes are MS-DOS compatible and have a 1.44 MByte capacity.

Disk Files You may find any of the following file-types on the 372XXA disk.

- ☐ **Program Files.** These are binary files used to load the operating program. They are provided on the hard drive, and a backup copy is provided on floppy diskettes. Applications programs cannot read them.
- ☐ **Calibration Data Files:** These are binary files used to store and retrieve calibration and other data. Applications programs cannot read them. File size depends on calibration type.
- ☐ **Tabular Measurement Data Files.** These are ASCII files used to store actual measurement data. They *can be read* by applications programs. File size depends on selected options.
- ☐ **Trace Memory Files.** These are binary files used to store trace data. Applications programs cannot read them. You use them to perform trace math operations on data.
- ☐ **Cal Kit File for Coax or Waveguide.**

Formatting a Data File Disk You may format additional diskettes to hold calibration, tabular measurement, and trace-memory data files. Do this using the **FORMAT DISK** selection on the "Floppy Disk Utilities" menu. Using this selection will format the target disk and overwrite any existing data it contains.

A format hard disk utility is provided in case of hard disk failure. Using this feature overwrites your system software and requires booting from the backup floppy diskettes.

Copying Data Files From Disk to Disk

Use the COPY FILES selection on the "Floppy Disk Utilities" and "Hard Disk Utilities" menus to copy data files between hard and floppy diskettes.

NOTE

For best disk performance and reliability, the target-data-files diskette should always be formatted in the 372XXA internal disk drive.

Recovering From Disk Write/Read Errors

If you experience a read or write error during a disk operation, you should:

- □ Verify that the diskette has been properly formatted.
- □ Verify that the diskette is high density (1.44 MB). *Low density (720 KB) diskettes are not supported.*
- □ Verify that the write-protect tab on the disk is engaged.
- □ Retry the disk operation.

Repeated disk errors may indicate a defective diskette and format.

Chapter 5
Error and Status Messages

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Chapter 5
Error and Status Messages

5-1 INTRODUCTION

This chapter lists, describes, and provides corrective action for the error messages that point to problems that the operator can correct. Any error messages that appear on the display but do not appear in this chapter will require action by a qualified service representative.

5-2 ERROR MESSAGES

Error messages are provides in Tables 5-1 and 5-2.

Table 5-1. *General Error Messages (1 of 4)*

Error Message	Description	Corrective Action
ATTENUATOR UNAVAILABLE	Option 6 Port 2 Test Step Attenuator is not installed.	Install Option 6 Step Attenuator,
BANDS MUST SEQUENCE	Frequency bands in Multiple Source mode must sequence in a 1-2-3-4-5 order.	None, no skipping is allowed.
BOTH LIMITS MUST BE ON	Must have both limits activated.	Turn on limits.
DIFFERENT H/W SETUP. RECALL ABORTED	Hardware is different from the recalled setup.	Reconfigure system to duplicate the hardware setup that was used to store the saved data.
DIFFERENT S/W VERSION, RE-CALL ABORTED	Saved state not compatible with hardware or software version.	Load compatible software (S/W) version and retry.
DISCRETE FREQS LOST	Change in frequency caused discrete fill frequencies to be lost.	None.
DISPERSIVE MEDIUM, ONLY TIME USED	Distance does not apply for dispersive media.	None.
FREQUENCIES HAVE REACHED UPPER LIMIT	Frequencies being defined in Multiple Source mode have reached upper limits of Sources.	Redefine frequencies to not exceed limits of Sources.
ILLEGAL IN C.W. MODE	Attempted to readout limit frequency.	None, no limit lines are permitted in CW mode.
ILLEGAL IN TIME DOMAIN	Attempted to readout limit frequency	None.
MEAS DATA NOT AVAILABLE FOR STORAGE	Measurement data is not available for storage.	None.

Table 5-1. General Error Messages (2 of 4)

Error Message	Description	Corrective Action
MEMORY LOCATION CORRUPTED	Requested memory location is corrupted.	None. If problem reoccurs after storing a new setup, contact WILTRON Customer Service.
NO BANDS ARE STORED	No frequency bands have been defined and stored.	Need to define and store frequency bands to turn on Multiple Source mode.
NO STORED MEMORY DATA	No data is stored in memory.	None.
OPTION NOT INSTALLED	Selected an option that is not installed.	None.
OUT OF CAL RANGE	Entered values out of the selected calibration range.	Change calibration range or re-enter values that are within the current range.
OUT OF H/W RANGE	Entered value is out of the instrument's hardware range.	Re-enter values that are within range.
OUT OF RANGE	Entered value is out of range.	Re-enter values that are within range.
OUT OF RANGE, 10 PERCENT MIN	Entered value is out of the instrument's range by greater than 10 percent.	Re-enter frequency or power value.
OUT OF RANGE, 20 PERCENT MAX	Entered smoothing or group delay value exceeds the range by greater than 20 percent.	Re-enter values that are within range, 0 to 20%.
OUT OF SWEEP RANGE	Entered a frequency that is out of the instrument sweep range.	Re-enter frequency.
OUT OF WINDOW RANGE	Attempted to set marker outside start to stop range.	Redefine marker to be within frequency start/stop range.
RECEIVER OUT OF RANGE BY EQUATION	Equation defined in Multiple Source mode places receiver frequency out of range when attempting to store band.	Redefine frequency.
SOURCE 1 OUT OF RANGE BY EQUATION	Equation defined in Multiple Source mode places Source 1 frequency out of range when attempting to store band.	Redefine frequency.
SOURCE 2 OUT OF RANGE BY EQUATION	Equation defined in Multiple Source mode places Source 2 frequency out of range when attempting to store band.	Redefine frequency.

Table 5-1. General Error Messages (3 of 4)

Error Message	Description	Corrective Action
STANDARD CAL NOT VALID FOR WAVEGUIDE	Cannot use waveguide when calibrating with the standard method.	Use the Offset Short method with waveguide.
START F FOLLOWS PREVIOUS STOP F	Start frequency of current band immediately follows stop frequency of previous band. Cannot be modified.	None.
START GREATER THAN STOP	Entered start frequency is greater than the stop frequency.	Re-enter frequency values such that the start frequency is lower than the stop frequency.
START MUST BE LESS THAN STOP	Entered start frequency is greater than the stop frequency.	Re-enter frequency values such that the start frequency is lower than the stop frequency.
STEP IS TOO LARGE	Entered discrete fill step extends the stop range.	Re-enter so that step is within range.
STOP IS OVER RANGE	Entered value exceeds the instrument's stop frequency.	Re-enter stop frequency.
SYSTEM BUS ADDRESSES MUST BE UNIQUE	GPIB address is being used by another bus instrument.	Select a different, unique GPIB address.
SYSTEM UNCALIBRATED	372XXA is uncalibrated for the selected measurement values.	Perform a measurement calibration.
TOO FEW POINTS, 2 MINIMUM	Entered too few discrete fill points, 2 is minimum.	Re-enter data points.
TOO MANY POINTS, 1601 MAXI-MUM	Entered too many discrete fill points, 1601 points are the maximum allowed.	Re-enter data points.
UNDEFINED DIVIDE BY ZERO	Denominator cannot be zero in equation.	Make denominator a value other than zero.
WARNING: NO GPIB CONTROL OF SOURCE SWEEP	Neither Source power nor flat-port power can be modified when receiver mode is user-defined with NO Source GPIB control.	None.
WARNING: SET ON RECEIVER MODE	Phase-lock setting is undefined when VNA in Set-On Receiver mode.	None.
WARNING: SOURCE 2 DOES NOT EXIST	2nd, external, frequency source is not present.	Connect frequency source.
WINDOW TOO SMALL	Attempted to set start greater than or equal to stop.	Re-enter frequency values.

Table 5-2. Disk Error Messages (1 of 1)

Error Message	Description	Corrective Action
7140: FLOPPY DISK GENERAL ERROR	Invalid disk media or format.	Use 1.44 MB diskette and format in the 372XXA.
7142: FLOPPY DISK READ ERROR	Read error when accessing disk file.	Use 1.44 MB diskette and format in the 372XXA.
7143: DISK WRITE ERROR	Error in writing to disk file.	Use 1.44 MB diskette and format in the 372XXA.
7147: FLOPPY DISK UNAVAILABLE	Floppy disk is not available.	Install floppy diskette or floppy disk drive.
7170: HARD DISK GENERAL ERROR	General error in accessing hard disk.	Retry and if still fails, reformat the hard disk drive.
7172: HARD DISK READ ERROR	Read error when accessing disk file.	Retry and if still fails, reformat the hard disk drive.
7173: HARD DISK WRITE ERROR	Error in writing to disk file.	Retry and if still fails, reformat the hard disk drive.
7177: HARD DISK UNAVAILABLE	Hard disk is not available.	Install hard disk drive circuit board.
8140: GENERAL DISK BUFFER ERROR	Out of RAM.	Press the System State, Default Program key and retry.
FILE NOT FOUND	Disk file not found.	None.
FLOPPY DISK HAS NO ROOM FOR FILE	Floppy diskette is full.	Delete files or install new diskette.
FLOPPY DISK NOT READY	Floppy disk is not ready (or not installed.).	Install diskette in floppy drive.

Chapter 6
Data Displays

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Chapter 6
Data Displays

6-1 INTRODUCTION

This chapter provides discussion and examples of the various types of data displays.

6-2 DISPLAY MODES AND TYPES

The 37XXA displays measurement data using a "Channel Concept". This means that each channel can display both a different S-Parameter and a different graph type for each. As you select each channel the graph type, scaling, reference delay, S-Parameter, etc. associated with that channel appear on the screen. You can display the same S-Parameter on two or more channels.

Several graph-types are possible: polar, rectilinear, or Smith chart. The rectilinear graph-type may be magnitude, phase, magnitude and phase, SWR, group delay, real, imaginary, and real and imaginary. The Smith chart graph-type is specifically designed to plot complex impedances.

Single Channel Display— Ch 1, 2, 3, 4 You select this display type (Figures 6-1 and 6-2) by choosing "Single Display" on Menu CM (Appendix A). Possible graph types are single, Smith, polar, rectilinear, or dual (split) rectilinear (magnitude and phase).

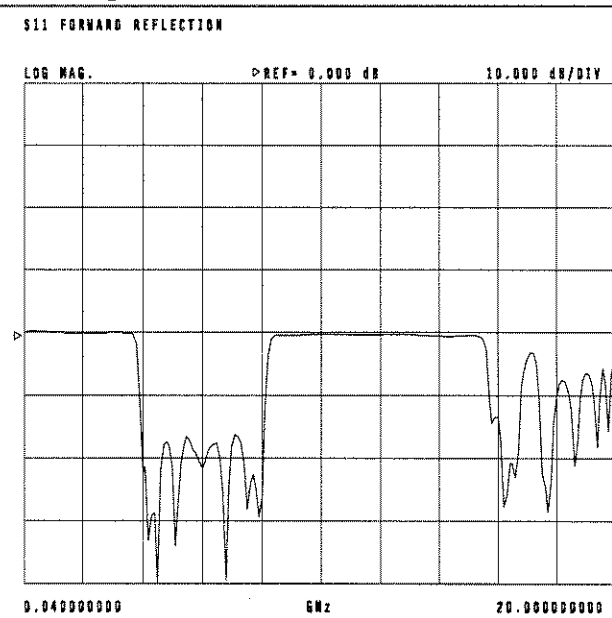


Figure 6-1. *Single Channel Display, Log Magnitude*

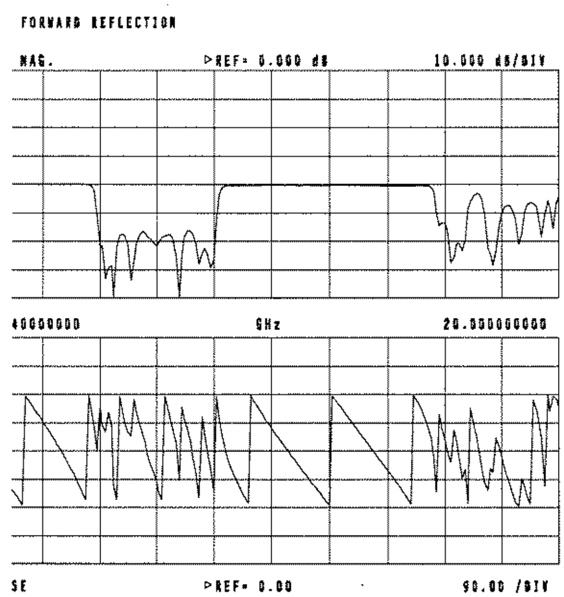


Figure 6-2. Single Channel Display, Magnitude and Phase

Dual Channel Display— Ch 1 and 3 or Ch 2 and 4

If you have chosen a dual display of magnitude and phase, the affected area of the CRT screen is subdivided into two smaller portions (Figure 6-3). You select this display type by choosing "Dual Display" in Menu CM (Appendix A).

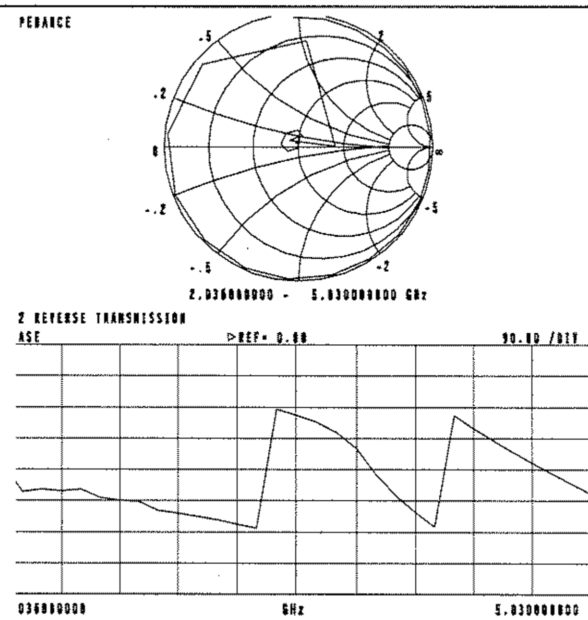


Figure 6-3. Dual Channel Display

Four Channel Display— Ch 1, 2, 3, 4

From four-to-eight graph types are displayed. In each quadrant, the graph type can be any of the possible choices listed in the GT menu (Appendix A). If you have chosen to display magnitude and phase on a channel, the quadrant displaying that channel is further subdivided as described above. You select this display type by choosing "All Four Channels" in Menu CM. An example of a four-channel display appears in Figure 6-4, below.

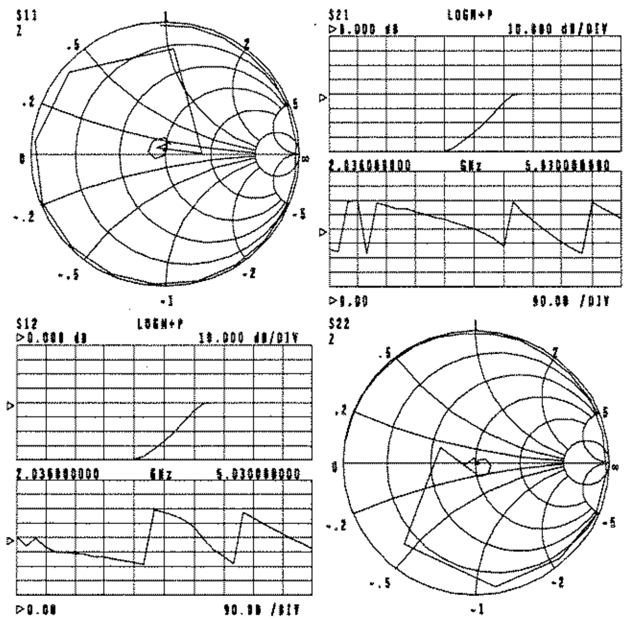


Figure 6-4. *Four Channel Display*

Dual Trace Overlay

For rectilinear graph types, two traces can be displayed, one overlaid (superimposed) on the other (Figure 6-5). By menu selection, the two traces can be Channel 1 overlaid on Channel 3 or Channel 2 overlaid on Channel 4. Each trace is in a different color. Channels 1 and 2 are displayed in red, while Channels 3 and 4 are displayed in yellow.

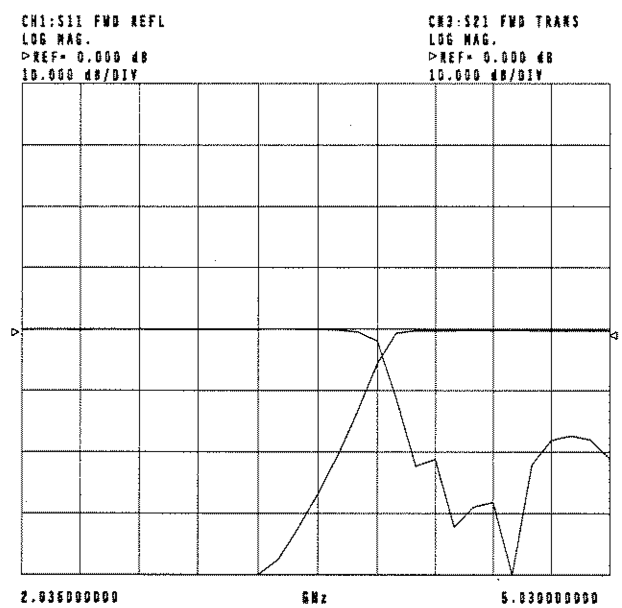


Figure 6-5. *Dual Trace Overlay*

Graph Data Types

The data types (real, imaginary, magnitude, phase) used in the displayed graph-types reflect the possible ways in which S-Parameter data can be represented in polar, Smith, or rectilinear graphs. For example: Complex data—that is, data in which both phase and magnitude are graphed—may be represented and displayed in any of the ways described below:

- ☐ Complex Impedance; displayed on a Smith chart graph.
- ☐ Real and imaginary; displayed on a real and imaginary graph.
- ☐ Phase and magnitude components; displayed on a rectilinear (Cartesian) or polar graph.
- ☐ In addition to the above, the 372XXA can display the data as a group delay plot. In this graph-type, the group-delay measurement units are time. Those of the associated aperture are frequency and SWR.

The quantity group delay is displayed using a modified rectilinear-magnitude format. In this format the vertical scale is in linear units of time (ps-ns-μs). With one exception, the reference value and reference line functions operate the same as they do with a normal magnitude display. The exception is that they appear in units of time instead of magnitude.

Examples of graph-data types are shown in Figure 6-6 through 6-11, on the following pages.

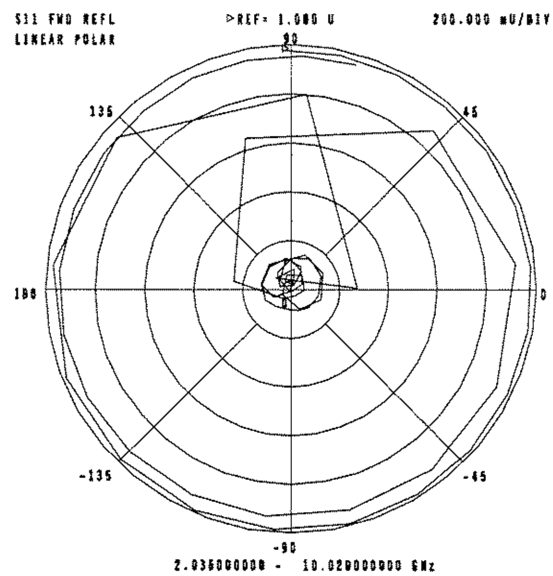


Figure 6-6. *Linear Polar Graticule*

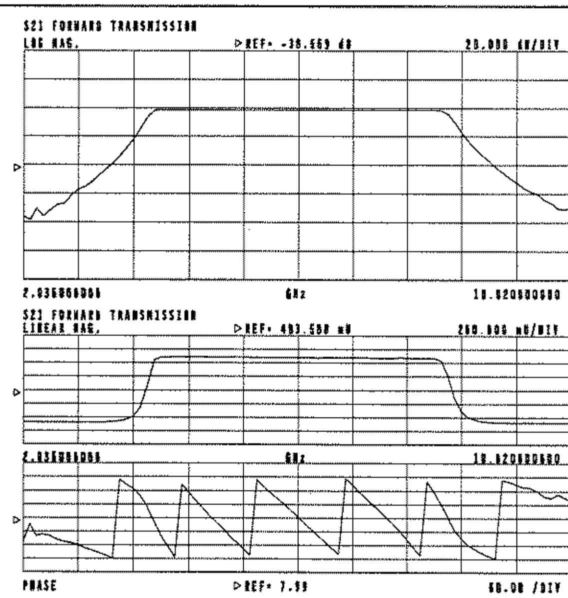


Figure 6-7. *Dual Channel Rectilinear Gratiule*

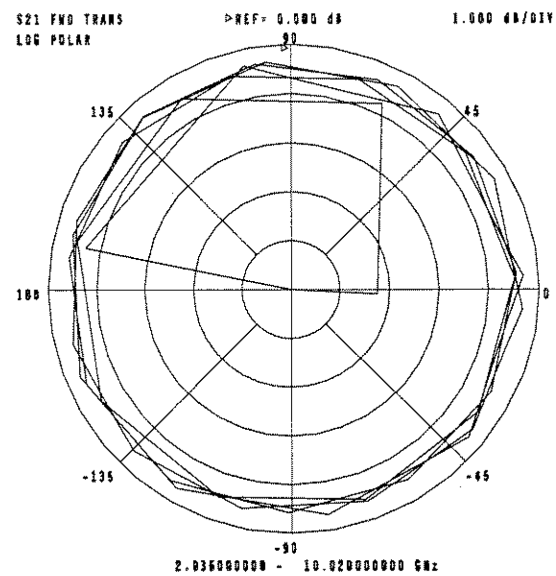


Figure 6-8. *Log Polar Graticule*

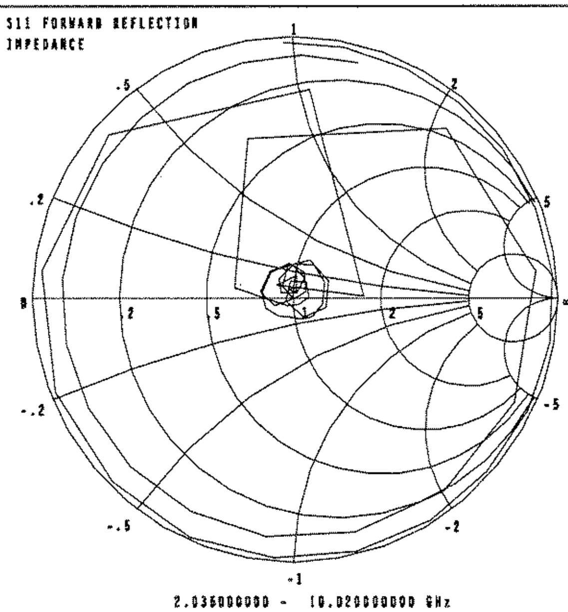


Figure 6-9. *Normal Smith Chart*

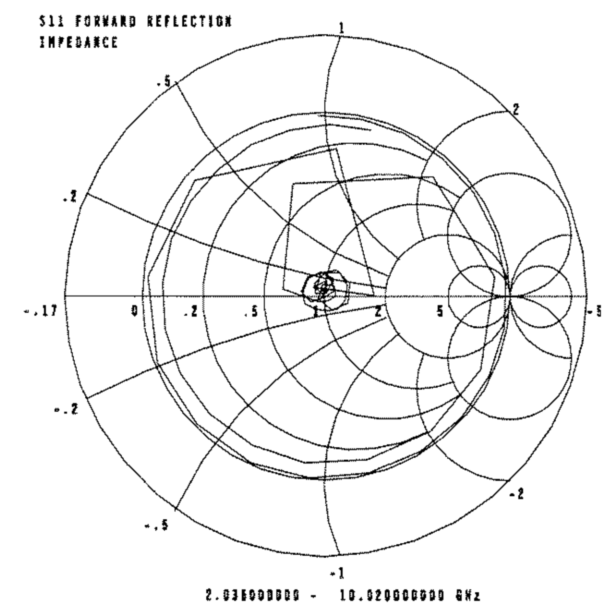


Figure 6-10. *3 dB Compressed Smith Chart*

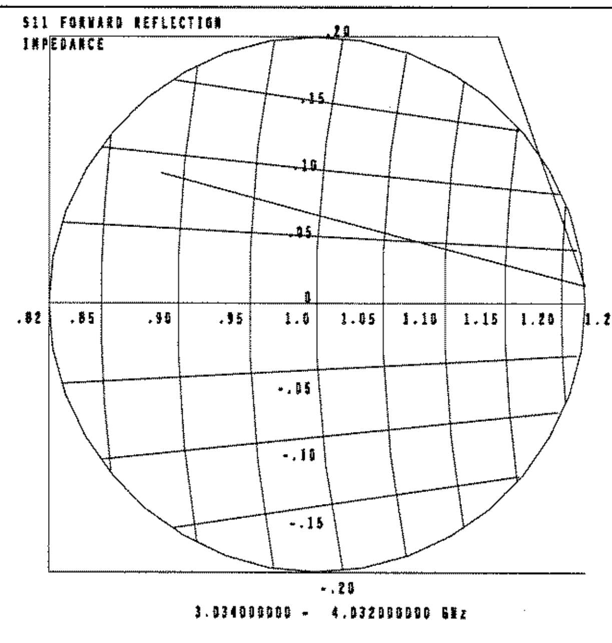
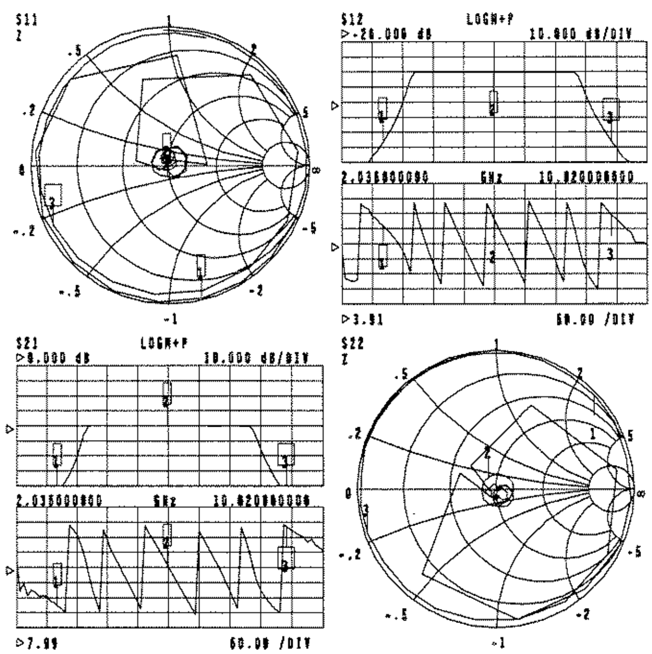


Figure 6-11. *20 dB Expanded Smith Chart*

6-3 FREQUENCY MARKERS

Marker Annotation

The example below shows how the 372XXA annotates markers for the different graph-types. Each marker is identified with its own number. When a marker reaches the top of its graticule, it will flip over and its number will appear below the symbol. When markers approach the same frequency, they will overlap. Their number will appear as close to the marker as possible without overlapping.



Marker Annotation

Marker Designation

Depending on menu selection, you may designate a marker as the "active" or the "delta reference" marker. If you choose a marker to be active—indicated by its number being enclosed in a square box—you may change its frequency or time (distance) (or point number in CW Draw) with the Data Entry keypad or knob. If you have chosen it to be the delta-reference marker, a delta symbol (Δ) appears on character space above the marker number (or one character space below a "flipped" marker). If the marker is both active and the delta reference marker, the number and the delta symbol appear above (below) the marker. The delta symbol appears above (below) the number.

6-4 LIMITS

Limit lines function as settable maximum and minimum indicators for the value of displayed data. These lines are settable in the basic units of the measurement on a channel-by-channel basis. If the display is rescaled the limit line(s) will move automatically and thereby maintain their correct value(s).

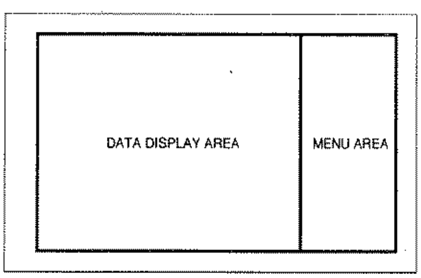
Each channel has two limit lines (four for dual displays), each of which may take on any value. Limit lines are either horizontal lines in rectilinear displays or concentric circles around the origin in Smith and polar displays.

Each channel can produce segmented limits. They allow different upper and lower limit values to be set at up to ten segments across the measurement range.

6-5 STATUS DISPLAY

In addition to the graticules, data, markers, and marker annotation, the 372XXA displays certain instrument status information in the data display area. This information is described below.

Reference Position Marker The Reference Position Marker indicates the location of the reference value. It is displayed at the left edge of each rectilinear graph-type. It consists of a green triangular symbol similar to the cursor displayed in the menu area. You can center this symbol on one of the vertical graticule divisions and move it up or down using the "Reference Position" option. When you do this, the data trace moves accordingly. If you also select the reference value option, the marker will remain stationary and the trace will move with the maximum allowable resolution. When changing from a full-screen display to half- or quarter-screen display, the marker will stay as close to the same position as possible.



Display screen showing the data display and menu areas

Scale Resolution Each measurement display is annotated with the scale resolution. For log-magnitude displays resolution ranges from 0.001 to 50 dB per division. Linear displays of magnitude range from 0.001 to 50 units per division. Cartesian phase displays can range from 0.01 to 90 degrees per division. The polar display is 45 degrees per display graticule.

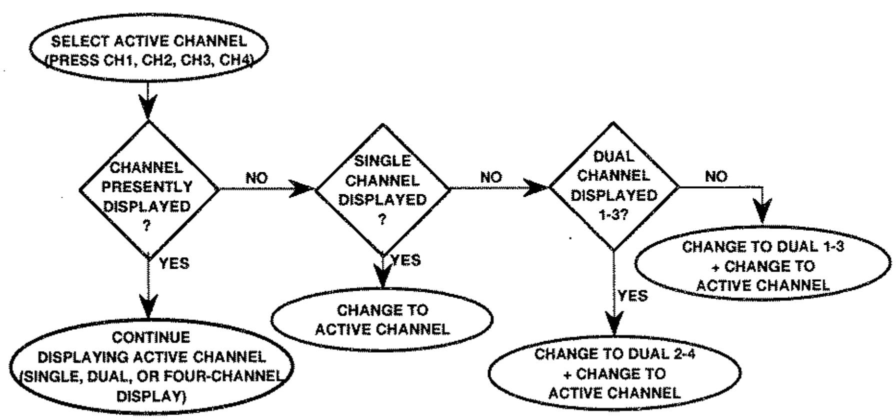
Frequency Range Each measurement display is annotated with the frequency range of the measurement.

Analog Instrument Status The 372XXA displays analog-instrument-status messages (in red when appropriate) in the upper right corner of the data-display area (left). They appear at the same vertical position as line 2 of the menu area. If more than one message appears, they stack up below that line.

Measurement Status The 372XXA displays measurement-status messages (in red when appropriate) in the upper-right corner of the graticule (channel) to which they apply.

Sweep Indicator Marker A blue sweep-indicator marker appears at the bottom of each displayed graph-type. It indicates the progress of the current sweep. When measuring quiet data—that is, data having few or no perturbations—this indicator assures that the instrument is indeed sweeping. Its position is proportional to the number of data points measured in the current sweep. If the sweep should stop for any reason, the position of the indicator will stop changing until the sweep resumes.

6-6 DATA DISPLAY CONTROL



Active Channel Algorithm

Active Channel Selection The following figure shows the algorithm that the 372XXA uses to display the active channel.

S-Parameter Selection

If you select a new S-Parameter using Menu SP (Appendix A), it appears on the then-active channel in the same graph-type in which it was last displayed. The following table shows the displayable S-Parameters based on the correction type you have in place. If you attempt to display other S-Parameters, an error message displays. In cases when there is no last-displayed S-Parameter stored, the display will default as shown. If an S-Parameter is selected for which there was no last-displayed graph-type, the display defaults to S_{21}, S_{12} Log Magnitude and Phase and S_{11}, S_{22} Smith.

Correction Type	Displayable S-Parameters	Default Display Position			
		CH1	CH2	CH3	CH4
None	All	S_{11}	S_{12}	S_{21}	S_{22}
Frequency Response					
Reverse Transmission	S_{12}		S_{12}		
Forward Transmission	S_{21}			S_{21}	
Both	S_{12}, S_{21}		S_{12}	S_{21}	
Port 1 Reflection Only	S_{11}	S_{11}			
Port 2Reflection Only	S_{22}				S_{22}
Reflection Only, Both	S_{11}, S_{22}	S_{11}			S_{22}
Forward 1-Path 2-Port	S_{11}, S_{21}	S11		S_{21}	
Reverse 1-Path 2-Port	S_{12}, S_{22}		S_{12}		S22
12-Term	All	S_{11}	S_{12}	S_{21}	S_{22}

Data Display Update

When you change a control panel parameter that affects the appearance of the display, the entire display changes immediately to reflect that change. For example, if you press Autoscale, the entire display rescales immediately. You do not have to wait for the next sweep to see the results of the change. The following parameters are supported for this feature: Reference Delay, Offset, Scaling, Auto Scale, Auto Reference Delay, Trace Math, IF BW, and Smoothing. In the case of Averaging, the sweep restarts.

If the knob is used to vary any of the above parameters, the change occurs as the measurement progresses–that is, the continuing trace will reflect the new setting(s).

When you change a marker frequency or time (distance), the readout parameters will change. This change reflects the changes in measurement data at the marker's new frequency, using data stored from the previous sweep.

Display of Markers

Once you have selected a marker to display, it will appear on the screen. It does not matter what resolution you have selected. When you set a marker to another calibrated frequency and then lower the resolution, that frequency and the marker will continue to display. It will display even if its frequency is not consistent with the data points in the lower-resolution sweep.

6-7 *HARD COPY AND DISK OUTPUT*

In addition to the CRT display, the Model 372XXA is capable of outputting measured data as a

- ☐ Tabular Printout
- ☐ Screen-Image Printout
- ☐ Pen Plot,
- ☐ Disk Image Of The Tabular Data Values

The selection and initiation of this output is controlled by the Hard Copy keys.

Tabular Printout

An example of a tabular format is shown in Figure 6-12. The tabular formats are used as follows:

- ☐ *Tabular Printout Format:* Used when printing three or four channels.
- ☐ *Alternate Data Format:* Used when printing one or two channels.

In tabular printouts, the 372XXA shifts the data columns to the left when an S-Parameter is omitted. Leading zeroes are always suppressed. The heading (Model, Device I/O, Date, Operator, Page) appears on each page. When using the WILTRON Model 2225C Ink Jet printer, place all of the rear panel MODE SELECT switches in the down (OFF) POSITION.

Screen-Image Printout

In a Screen-Image Printout, the exact data displayed on the screen is dumped to the printer. The dump is in the graphics mode, on a pixel-by-pixel basis.

Plotter Output

The protocol used to control plotters is "HP-GL (Hewlett-Packard Graphics Language). HP-GL contains a comprehensive set of vector graphics type commands. These commands are explained in the Interfacing and Programming Manual for any current model Hewlett-Packard plotter, such as the 7470A.

When the plotter is selected as the output device, it is capable of drawing the graph shown on the screen or of drawing only the data trace(s), so that multiple traces may be drawn on a single sheet of paper (in different colors, if needed). An example of a plotter output is shown in Figure 6-13.

Disk Output

The 372XXA can write-to or read-from the disk all measured data. This data is stored as an ASCII file in the exact same format as that shown for the tabular printout in Figure 6-12. If read back from the disk, the data is output to the printer. There, it prints as tabular data.

```
37247A

MODEL:                              DATE:
DEVICE ID:                          OPERATOR:


SWEEP DATA
START:       0.040000000 GHz  GATE START:          -
STOP:       20.000000000 GHz  GATE STOP:           -
STEP:        0.099800000 GHz  GATE:                -
                              WINDOW:              -
                   ------------CH1------------
PARAMETER:                       -S11-
NORMALIZATION:                    OFF
REFERENCE PLANE:              0.0000     mm
SMOOTHING:                    0.0 PERCENT
DELAY APERTURE:                    -

MARKERS:

MKR      FREQ              MAGNITUDE
#        GHz                  dB

FREQUENCY POINTS:

PNT      FREQ              MAGNITUDE
#        GHz                  dB

1        0.040000000       -54.881
2        0.139800000       -60.875
3        0.239600000       -59.163
4        0.339400000       -55.751
5        0.439200000       -53.856
6        0.539000000       -53.139
7        0.638800000       -51.019
8        0.738600000       -49.457
9        0.838400000       -48.807
10       0.938200000       -48.195

192     19.101800000       -41.057
193     19.201600000       -41.421
194     19.301400000       -42.988
195     19.401200000       -45.713
196     19.501000000       -47.747
197     19.600800000       -48.829
198     19.700600000       -49.502
199     19.800400000       -47.618
200     19.900200000       -46.288
```

Figure 6-12. Example of a Tabular Printout

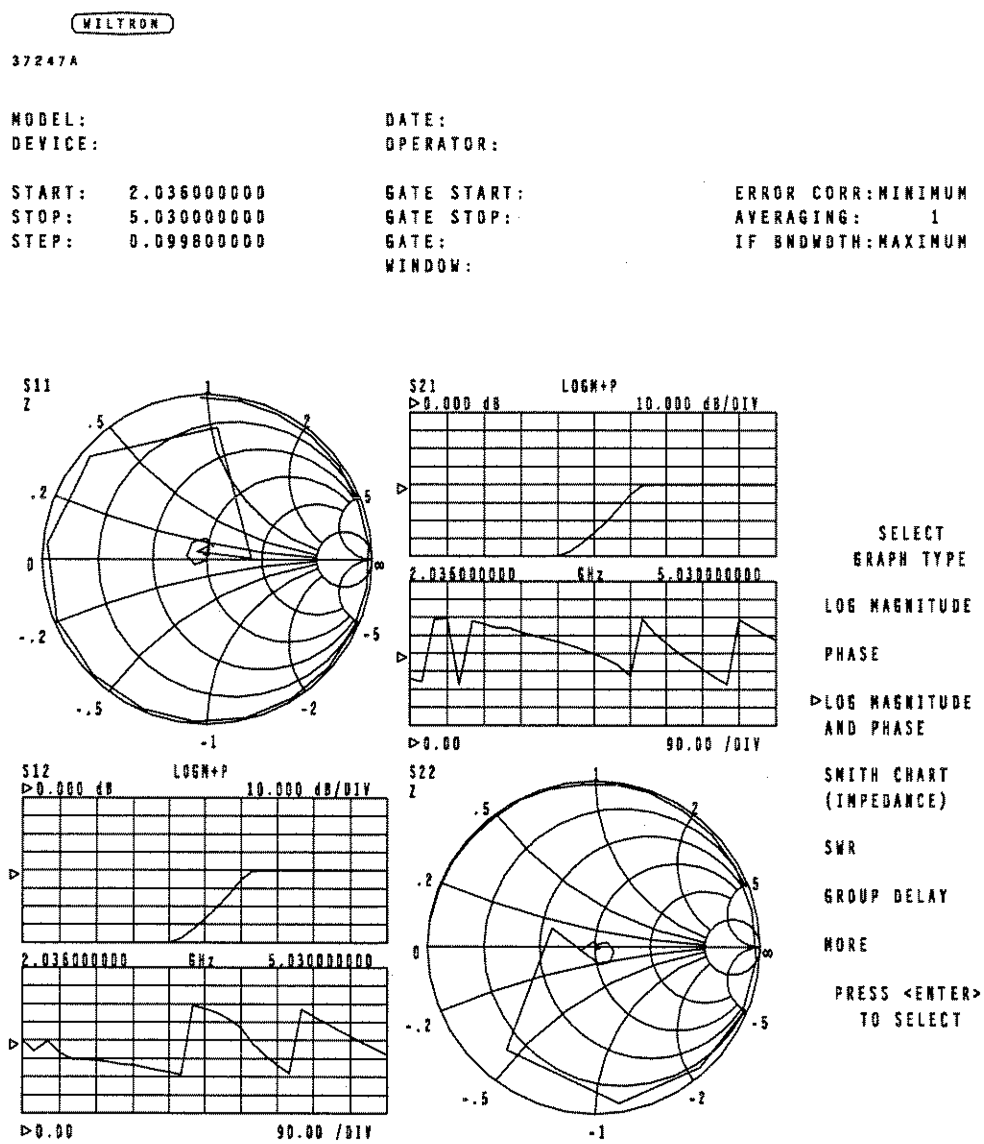


Figure 6-13. Example of a Plot

Chapter 7
Measurement Calibration

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7-6 MEASUREMENT CALIBRATION
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Chapter 7
Measurement Calibration

7-1 INTRODUCTION

This section provides discussion and examples for performing a measurement calibration. It also provides a detailed procedure for calibrating with a sliding termination.

7-2 MEASUREMENT CALIBRATION —DISCUSSION

Measurements always include a degree of uncertainty due to imperfections in the measurement system. The measured value is always a combination of the actual value plus the systematic measurement errors. Calibration, as it applies to network analysis, characterizes the systematic measurement errors and subtracts them from the measured value to obtain the actual value.

The calibration process requires that you establish the test ports, perform the calibration, and confirm its quality. Let us examine each of these steps.

Establishing the Test Ports Figures 7-1 and 7-2 are two of the most common approaches used to make measurements on two-port devices. In many cases, you may need adapters to change between connector types (N, SMA, GPC-7, etc) or between genders (male [M] or female [F]).

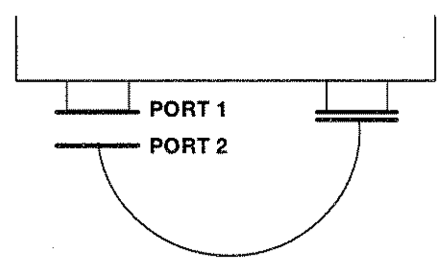


Figure 7-1. *Establishing the Test Port*

The use of cables and/or adapters does not effect the final measurement result, if they were in place for the calibration process. The vector error corrections established during the calibration process eliminates cable and/or adapter effects as long as the ports used are stable and exhibit good repeatability, which is the case if good quality components are used. Figure 7-2 shows such a configuration

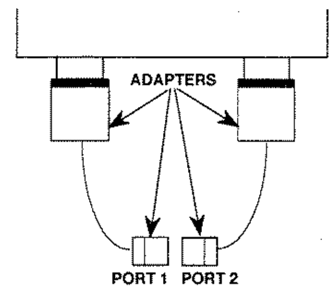


Figure 7-2. *Using Adapters on the Test Port*

Many calibration kits include adapters that are designed to have equal phase length. These parts are called phase equal adapters (PEA). Wiltron designs in-series adapters (e.g., K Connector M-M, M-F, F-F) to be phase insertable when technically possible.

When available, it is good practice to use PEAs to establish test ports (Figure 7-2A).

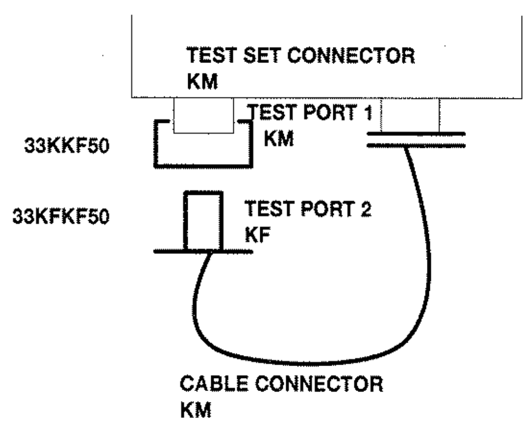


Figure 7-2A. *Use of PEAs to Establish Test Ports*

This approach offers two advantages:

- ☐ It minimizes wear on the more expensive test set and cable connectors.
- ☐ It provides a simple solution to measuring non-insertable devices (e.g., a filter with K female input and output connectors), by merely swapping PEAs after calibration. See Figure 7-3.

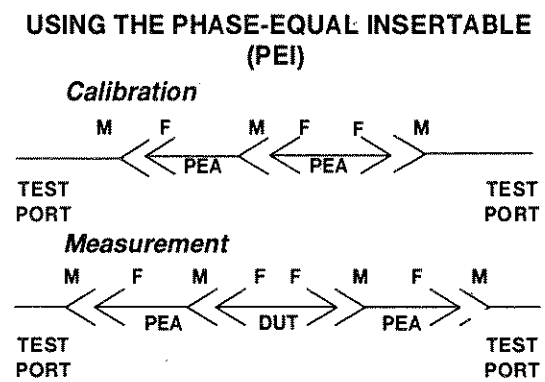


Figure 7-3. *Using Phase-Equal Insertables*

NOTE

In this and other discussions, we will talk about "insertable" and "non-insertable" devices. Insertable devices have an insertable connector pair (i.e., male input and female output connectors) and can be measured after a through calibration.. A non-insertable device has a non-insertable pair of connectors. This would be the case if it included female connectors on both ports or different connector types on each port. Therefore, "non-insertables" cannot be connected directly into the measurement path without an adapter.

ERRORS REDUCED BY CALIBRATION

- Directivity
- Source Match
- Load Match
- Frequency Sensitivity (Tracking)
- Internal System Errors

INTERNAL SYSTEM ERRORS

- RF Leakage
- IF Leakage
- System Interaction

RANDOM ERRORS

- Frequency
- Repeatability
- Noise
- Connector Repeatability
- Temperature/Environmental Changes
- Calibration Variables

TRANSMISSION MEASUREMENT ERRORS

- Source Match
- Load Match
- Tracking

Understanding the Calibration System

Measurement errors must be reduced by a process that uses calibration standards. The standards most commonly used are Opens, Shorts, and Z_0 (Characteristic Impedance) Loads. In conjunction with a through connection, these standards can correct for the major errors in a microwave test system. These errors are Directivity, Source Match, Load Match, Isolation, and Frequency Tracking (reflection and transmission).

Calibration also corrects for many internal system errors, such as RF leakage, IF leakage, and system component interaction.

Random errors such as noise, temperature, connector repeatability, DUT sensitive leakages, frequency repeatability, and calibration variables are not completely correctable. However, some of them can be minimized by careful control. For instance: temperature effects can be reduced by room temperature control, calibration variables can be reduced through improved technique and training, and frequency errors can be virtually eliminated by the fully synthesized internal source.

We know that adapters and cables degrade the basic directivity of the system, but these errors are compensated by vector error correction.

In general, transmission measurement errors are source match, load match, and tracking; while reflection measurement errors are source match, directivity, and tracking.

REFLECTION MEASUREMENT ERRORS

- Source Match
- Directivity
- Tracking

Error modeling and flowgraphs are techniques used to analyze the errors in a system. Error models describe the errors, while flowgraphs show how these errors influence the system. Error models (Figure 7-4, below) can become quite complex.

DIRECTIVITY, SOURCE MATCH, AND TRACKING ERRORS

DISTORTED MEASUREMENT

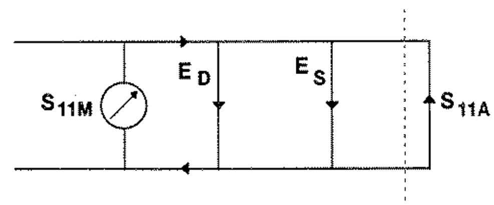


Figure 7-4. *Example of Error Modeling*

CALIBRATION TYPES

- Frequency Response
- Reflection Only—1 Port
- 1 Path, 2 Port
- 12 Term—2 Port, Both Directions

The 372XXA offers a selection of calibration possibilities depending on the user's needs. These possibilities are as follows:

- ☐ Frequency Response
- ☐ Reflection Only—1 Port
- ☐ 1 Path, 2 Port
- ☐ 12 Term—2 Port, Both Directions

These calibration types are described below.

Frequency Response: Corrects for one or both of the forward-direction-error terms associated with a measurement of S_{21} and S_{11}.

Reflection Only: Corrects for the three error terms associated with an S_{11} measurement (EDF, ESF, and ERF).

1 Path, 2 Port: Corrects for the four forward-direction error terms (EDF, ESF, ERF, and ETF).

Full 12 Term: Corrects for all twelve error terms associated with a two-port measurement. A 12-Term error model is shown in Figure 7-5.

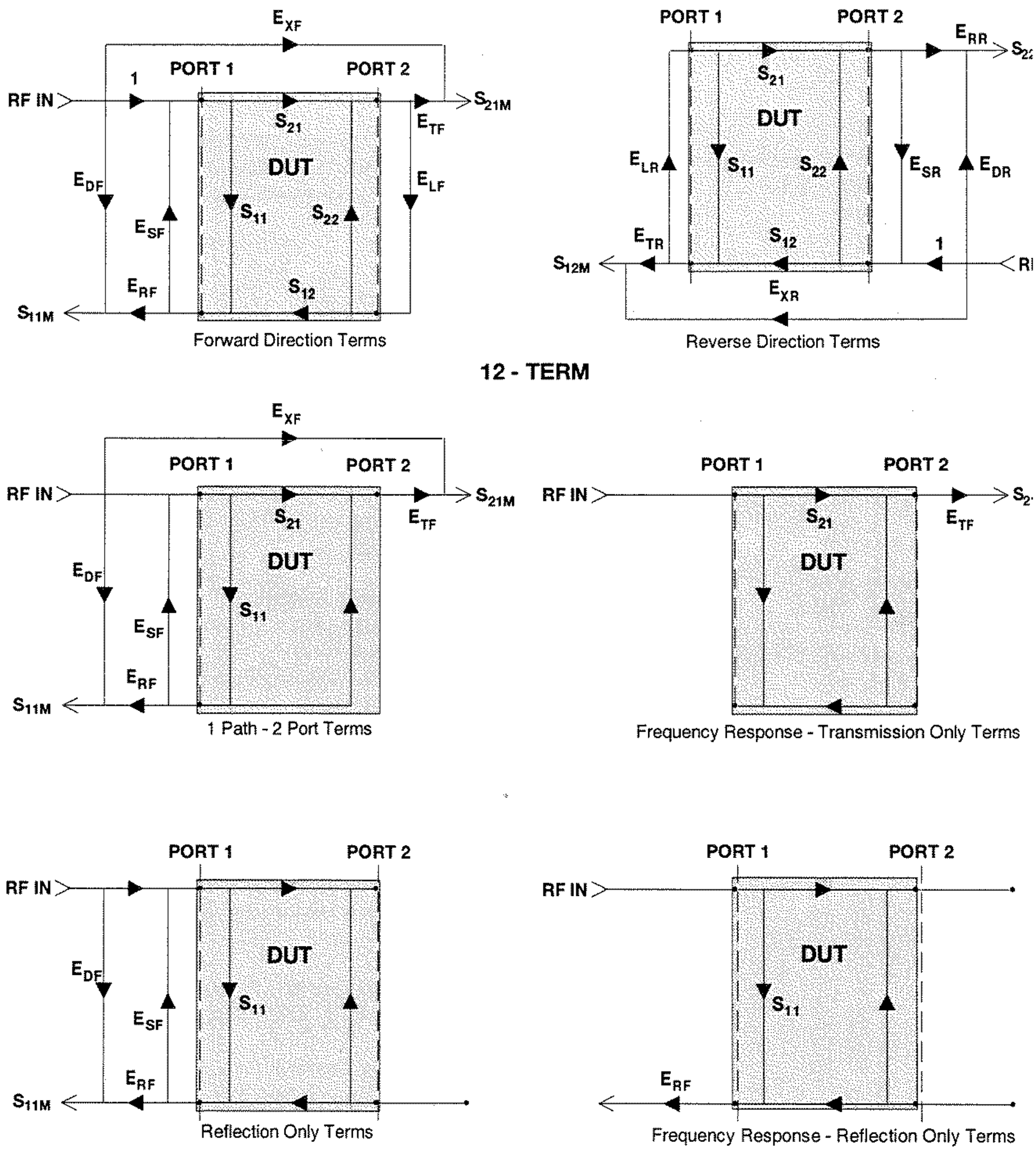


Figure 7-5. Error Models

Measurement calibration using the 372XXA is straightforward and menu directed. A short time spent in preparation and preplanning will make the process simple and routine. (Example: Adjusting the coaxial cables used in the measurement setup such that insertion of the DUT causes minimal flexing of these cables).

The screen prompts on the 372XXA guide you through the calibration process—a process that consists of connecting and disconnecting connectors and moving the slide on a sliding load (if one is used).

The most critical part of the calibration process is properly seating and torquing the connectors. Also, you will notice that the calibration takes longer when the ports are terminated with a load. This is intentional. It allows for more averaging during the isolation measurement.

CALIBRATING FOR A REFLECTION MEASUREMENT USES THREE STANDARDS:

- Short
- Open
- Termination

Calibrating for a Measurement

Let us assume that we want to correct for three errors in the reflection measurement: source match, directivity, and tracking. We accomplish this using three standards.

Shorts are the easiest to visualize. They totally reflect all of the incident RF energy output at a precise phase. The terms zero-ohms impedance, voltage null, and 180° phase all define an RF Short.

Opens are similar to Shorts, but their response is more complex. The terms voltage maximum, infinite impedance, and 0° phase all define a perfect Open. A perfect Open, however, is only a concept. In reality Opens always have a small fringing capacitance.

To account for the fact that the Open will not predictably reflect impedance at an exact 0° phase reference, we alter its response using coefficients that accurately characterize the fringing capacitance. The coefficients are different for each coaxial line size, since each size has a different fringing capacitance. To maximize accuracy, ensure that these coefficients are installed prior to the calibration (Menu U3).

As Opens and Shorts provide two references for a full reflection, Z_0 terminations provide a zero-reflection reference.

IDEAL TERMINATIONS

- Reflectionless
- Perfect Connector
- Infinite-Length, Dimensionally Exact, Reflectionless Transmission Line

Ideal Z_0 terminations must consist of two parts, a perfect connector and an infinite-length perfect transmission line that absorbs all of the RF energy that enters it (no reflections).

Infinite length transmission lines are unwieldy at best, so you must use less-than-ideal terminations. For calibration purposes there are two common types: broadband loads and sliding terminations.

PRACTICAL Z_0 TERMINATIONS

- Broadband Load
- Sliding Termination

Broadband loads are widely used. An example is the WILTRON 28 Series Termination. These terminations are easy to use as calibration tools, and they are adequate for most applications.

BROADBAND LOAD

- Easy to Use
- Inexpensive
- Adequate for Most Applications

Sliding Loads are the traditional vector network analyzer Z_0 calibration reference. They provide the best performance when the application requires high-precision return loss measurements. Sliding loads consist of a connector, a long section of precision transmission line, and a microwave load that is movable within the transmission line. One thing to remember with sliding loads is that they have a low-frequency limit and must be used with a fixed load below this cutoff frequency for full frequency coverage. WILTRON sliding loads cut off at 2 GHz. (V-connector sliding loads cut off at 4 GHz).

SLIDING LOAD

- Connector
- Long Transmission Line
- Movable Microwave Load

Pin depth—the relationship between the interface positions of the outer and center conductors—is the most critical parameter under your control in a sliding load. An example of its criticality is that an incorrect pin depth of 0.001 inch can cause a reflection return loss of 44 dB. And, since we are trying to calibrate to accurately measure a 40 dB return loss, correct pin depth makes a *big difference!*

Cables in the measurement system are another cause for concern. The main criteria for a cable are stability and repeatability. WILTRON offers two types of cables that meet these criteria: semi-rigid and flexible. Our semi-rigid cables provide maximum stability with limited flexibility of movement. Our flexible cables allow more freedom of movement (along with its associated degradation of phase stability).

Evaluating the Calibration

The 372XXA provides an accurate representation of complex data. However, it can only provide accuracy to the extent of the supplied calibration data. For this reason, it is necessary to periodically verify the calibration data and the 372XXA system performance.

Calibration verification reveals problems such as a poor contact with one of the calibration components, improper torquing, or a test port out of specification. Problems like these can easily occur during a calibration procedure. Anyone who has experienced one of these problems and stored bad data—after having performed a complete calibration procedure—knows the frustration it can cause. Additionally, it can be very costly to use incorrectly taken measurement data for design or quality assurance purposes.

The best way to confirm a calibration is to measure a precision, known-good device and confirm its specifications.

VERIFICATION KIT

- Used by Calibration and Metrology Labs

Verification Kits

WILTRON has developed several precision-component kits: for 3.5 mm connectors, for GPC-7 connectors, K Connectors® and V Connectors®. These are, respectively, the Models 3666, 3667, and 3668 and 3669 Verification Kits.

Each of the kits contain 20 dB and 50 dB attenuators, a 10 cm airline, and a 10 cm Beatty Standard. A Beatty Standard is a two-port mismatch similar to a beadless airline. It consists of a center conductor with a discontinuity in the middle providing the mismatch (Figure 7-6).

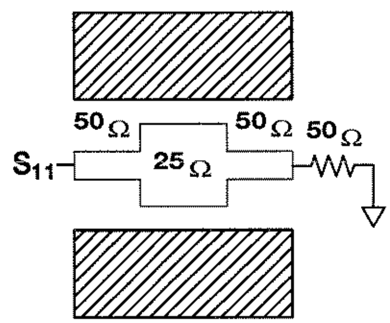


Figure 7-6. *The Beatty Standard*

Typically, these verification kits will be used by calibration or metrology labs. Each of the kits contain several precision components, all of which have been characterized at specified frequencies. The data on these components is stored on a disk provided with the verification kit.

The verification of the kit components is straight forward. The components are first measured with the 372XXA, then they are compared with the data recorded on the disk. If the measured data compares favorably with the recorded data (taking tolerances into consideration), then the system is known to be operating properly and providing accurate data.

There is one caution that you need to observe when using Verification Kits. Because the verification components have been characterized, you must handle them carefully so that you do not change their known characteristics. Consequently, you should not have them available for daily use. Rather, you should only use them for the accuracy verification checks taken every 6-to-12 months (or at any other time the system's integrity is in doubt).

This completes the discussion on calibration. Refer to paragraph 7-3 for a procedure showing how to calibrate the sliding load.

7-3 MEASUREMENT CALIBRATION —SLIDING TERMINATION

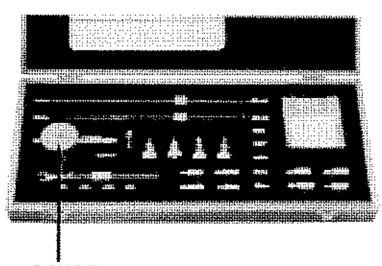
Sliding terminations (loads) are the traditional Z_0 calibration-reference devices for vector network analyzer calibration. When correctly used and perfectly aligned, they can be more accurate than precision fixed loads. However, sliding terminations have a 2 GHz (4 GHz for V-Connector sliding loads) low-frequency limit and must be used with a fixed load for full frequency-range coverage.

Sliding terminations consist of a connector, a long section of precision transmission line, and a microwave load that is movable within the transmission line. Pin depth—the relationship between the interface positions of the outer and center conductors—is the most critical parameter that you can control in a sliding termination. An example of its criticality is that an incorrect pin depth of 0.001 inch can cause a reflection return loss of 44 dB. Since you are usually calibrating to accurately measure a greater than 40 dB return loss, correct pin depth is essential.

Since setting an accurate pin depth is so important, this discussion centers on describing how to set the pin depth for male and female sliding terminations. Calibration with the sliding termination is essentially the same as described below for the broadband load.

The procedure below uses the Model 3652 Calibration Kit and its 17KF50 and 17K50 Sliding Terminations. Calibration is similar for the Model 3650 SMA/3.5mm, Model 3651 GPC-7 and Model 3654 V connector kits. For the 3651, the procedure is simpler: Because the GPC-7 connector is sexless, there is only one sliding termination.

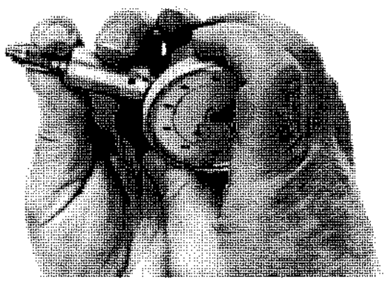
Procedure



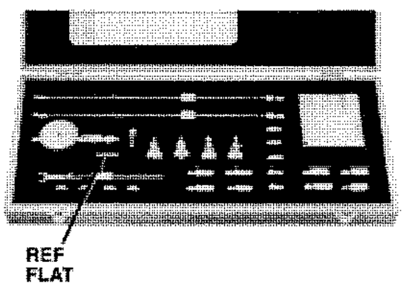
Step 1. Remove the Pin Depth Gauge from the kit, place it on the bench top.

NOTE

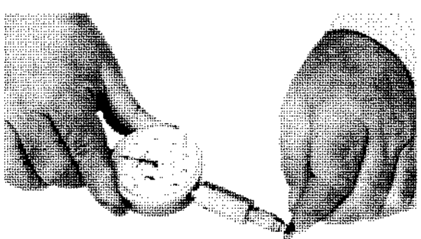
The meter is convertible between male and female. The following procedure describes the zeroing process for the female fitting. The procedure for the male fitting begins with step 16.



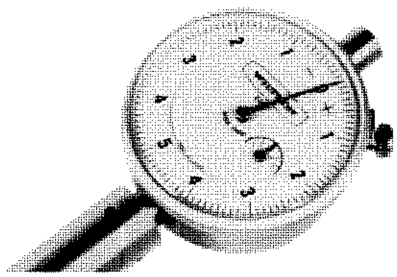
Step 2. Push the outer locking ring towards the gauge to expose the center pin.



Step 3. Take the 01-210 Ref Flat from the kit.



Step 4. While holding the gauge as shown, press the Ref Flat firmly against the end of the exposed center pin.

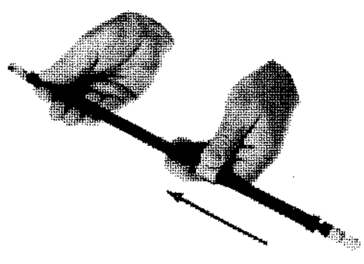


Step 5.

While pressing the Ref Flat against the center pin, check that the pointer aligns with the "0" mark. If it does not, loosen the bezel lockscrew and rotate the bezel to align the pointer with the "0" mark. Tighten the bezel lock screw.

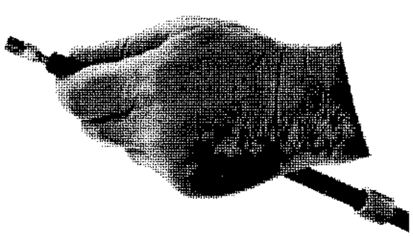
NOTE

Gently rock the Ref Flat against the center pin to ensure that it is fully depressed and you have accurately set the gauge for zero.



Step 6.

Remove the sliding termination with the female-connector (17KF50, for this example) from the kit, and slide the load all the way toward the end closest to the connector.

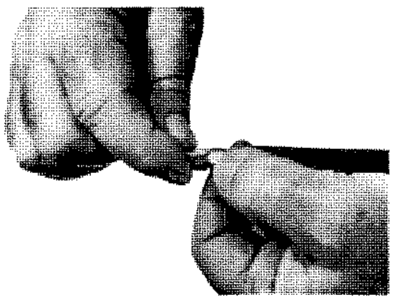


Step 7.

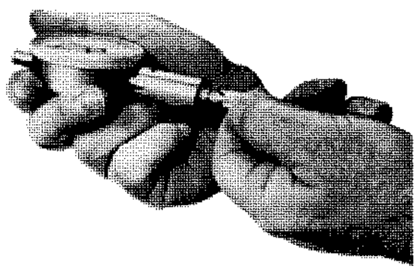
With either hand, pick up the sliding termination near its connector end.

Step 8.

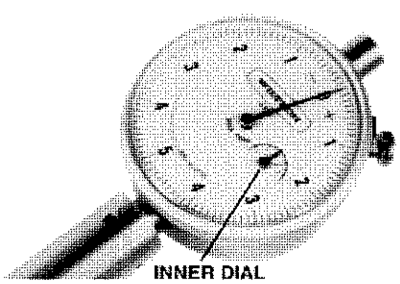
Cup the sliding termination in your palm, and support the barrel between your body and crooked elbow.



Step 9. Remove the flush short by holding its body and unscrewing its connector.



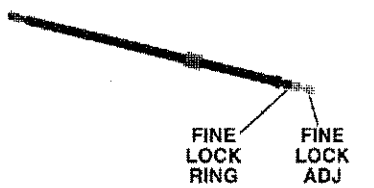
Step 10. Install the gauge onto the end of the sliding termination.



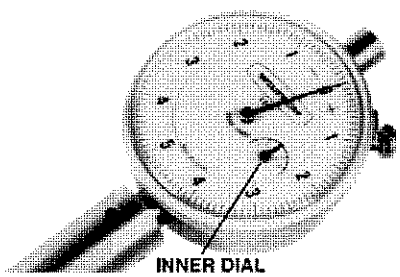
Step 11. If the COARSE SET adjustment—which has been set at the factory—has not moved, the inner dial on the gauge will read "0." If it doesn't, perform the Coarse Set Adjustment in step 15.

Step 12. Place the sliding termination, with the gauge attached, on the bench top.

Step 13. Loosen the FINE LOCK ring and turn the FINE ADJ ring to position the gauge pointer 2-3 small divisions on the "–" side of zero.



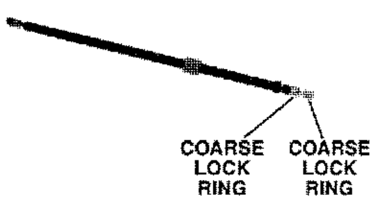
Step 14. Turn the FINE LOCK ring clockwise to both tighten the adjustment and place the pointer exactly to "0." The Sliding Termination is now ready to use.



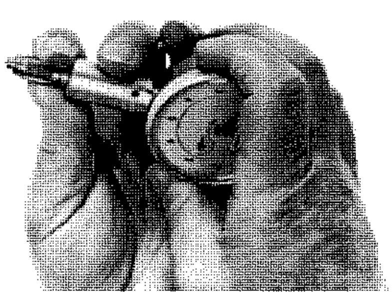
NOTES

- Ensure that the inner dial read "0."
- The following step is not normally necessary. It needs to be done only if the adjustment has changed since it was set at the factory.

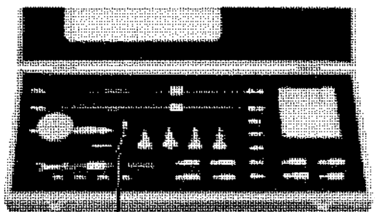
Step 15. With the 01-211 Flush Short installed, loosen the COARSE LOCK and gently push the COARSE SET adjustment rod in as far as it will go. This coarsely sets the center conductor to be flush against the attached short. Return to step 2.



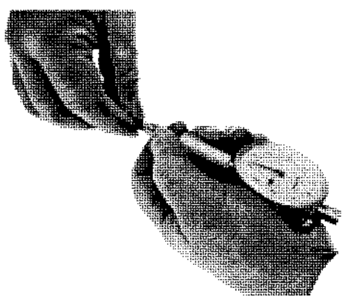
Step 16. The procedure for adjusting the male-connector sliding termination is essentially the same as that described above. The only difference is that you must install the female adapter on the end of the gauge shaft, over the center conductor. To install this adapter, proceed as follows:



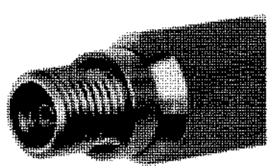
- ☐ Zero-set the gauge as described in step 2 above.
- ☐ Push the outer locking ring back toward the gauge and turn it clockwise onto the exposed threads.
- ☐ Loosen the lock ring one turn in a counterclockwise direction.



Step 17. Remove the 01-223 Female Adapter ("F ADAPTER FOR PIN GAUGE") from the kit.



Step 18. Install the female adapter over the center pin and screw it into the locking ring, and tighten the outer ring until it is snug against the housing.



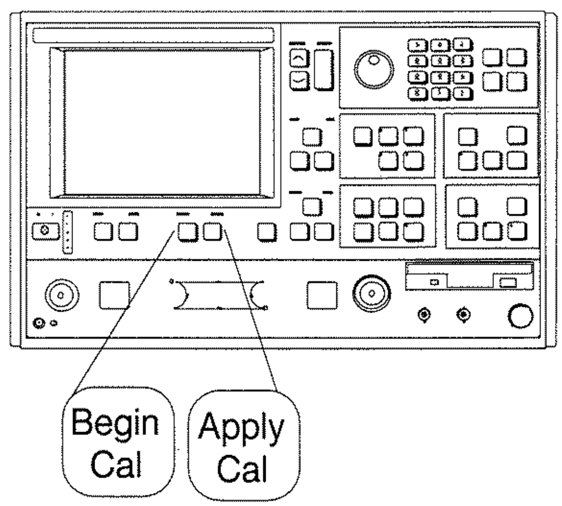
Step 19. Inspect the end of the adapter, you should see no more than two exposed threads. If so, repeat steps 7 thru 10, above.

Step 20. Connect the gauge to the sliding termination and zero set the center pin using the FINE ADJ as previously described in step 2 above.

7-4 STANDARD (OSL) CALIBRATION PROCEDURE

The standard calibration for the 372XXA Vector Network Analyzer system uses an Open, a Short, a Broadband and/or Sliding Load, and a throughline connection to categorize the inherent errors in the measurement system. These errors include those caused by connectors as well as internal system errors such as RF leakage, IF leakage, and component interaction. For maximum accuracy, install the capacitive coefficients (for the open device) using Menu U3.

Calibration Procedure A detailed, step-by-step procedure for performing a Open-Short-Load calibration is given below.



MENU C11
BEGIN CALIBRATION
KEEP EXISTING CAL DATA
REPEAT PREVIOUS CAL
CAL METHOD STANDARD
TRANSMISSION LINE TYPE: XXXXXXXX
CHANGE CAL METHOD AND LINE TYPE
NEXT CAL STEP
PRESS <ENTER> TO SELECT

Step 1. Press the Begin Cal key.

Step 2. Select **CHANGE CAL METHOD AND LINE TYPE**, in menu C11 (left). (This assumes STANDARD and COAXIAL are not presently shown in blue as being selected.)

MENU C11A	
CHANGE CAL METHOD AND LINE TYPE	
NEXT CAL STEP	c.
CAL METHOD	
STANDARD (NOT USED FOR WAVEGUIDE)	a.
OFFSET SHORT	
LRL/LRM	
TRANSMISSION LINE TYPE	
COAXIAL	b.
WAVE GUIDE	
MICROSTRIP	
PRESS <ENTER> TO SELECT	

Step 3. When menu C11A (left) appears, move cursor to the following:

a. **STANDARD**, then press Enter key. This selects Standard (OSL) as the calibration method.

b. **COAXIAL,** then press Enter key. This selects coaxial transmission line media.

c. **NEXT CAL STEP**, then press Enter key. This causes menu C11 to return to the screen.

Step 4. When menu C11 reappears, confirm that the **STANDARD** calibration method and **COAXIAL** line type have been selected. Select **NEXT CAL STEP** and press the Enter key to proceed. This brings up menu C5.

Step 5. Menu C5 (left) lets you select the type of calibration. For this example, move the cursor to **FULL 12-TERM** and press the Enter key. This selection calibrates for all twelve error terms.

MENU C5
CALIBRATION TYPE
FULL 12-TERM
1 PATH 2 PORT
TRANSMISSION FREQUENCY RESPONSE
REFLECTION ONLY
PRESS <ENTER> TO SELECT

Step 6. The next menu, C5D, lets you choose whether to include or exclude the error terms associated with leakage between measurement channels. For a normal calibration, you would choose to include these error terms. Therefore, move the cursor to **INCLUDE ISOLATION (STANDARD)** and press the Enter key.

MENU C5D
SELECT USE OF ISOLATION IN CALIBRATION
INCLUDE ISOLATION (STANDARD)
EXCLUDE ISOLATION
PRESS <ENTER> TO SELECT

MENU C1
SELECT CALIBRATION DATA POINTS
NORMAL (1601 POINTS MAXIMUM)
C.W. (1 POINT)
N-DISCRETE FREQUENCIES (2 TO 1601 POINTS)
TIME DOMAIN (HARMONIC)
PRESS <ENTER> TO SELECT

Step 7. Next, menu C1 appears. It lets you select the number of frequency points at which calibration data is to be taken. The choices are:

a. **NORMAL:** Data is taken at up to 1601 equally spaced frequencies across the calibration frequency range. *Use this selection for this example.*

b. **C.W. FREQ:** Data is taken at one point. This choice brings up menu C2B (below) that lets you select the single CW frequency point.

MENU C2B
SINGLE POINT CALIBRATION
C.W. FREQ XX.XXXX GHz
FINISHED ENTRY, NEXT CAL STEP
INPUT FREQ AND PRESS <ENTER> TO SELECT

MENU C2
FREQ RANGE OF CALIBRATION
START 0.0400000000GHz
STOP 20.000000000 GHz
201 DATA PTS 0.099800000 GHz STEPSIZE
MAXIMUM NUMBER OF DATA POINTS 1601 MAX PTS 801 MAX PTS 401 MAX PTS **201 MAX PTS** 101 MAX PTS 51 MAX PTS
NEXT CAL STEP
PRESS <ENTER> TO SELECT

c. **N-DISCRETE FREQUENCIES:** This selection lets you specify a discrete number of frequency points, from 2 to 1601.

d. **TIME DOMAIN:** This selection is the calibration mode for low-pass time-domain processing. It lets you select frequencies at integer (harmonic) multiples of the start frequency.

Step 8. The next menu, C2 (left), lets you set your start and stop frequencies. For this example, move cursor to **START,** press 40 on keypad, and hit the MHz terminator key. Perform like operations for the **STOP** choice, except make entry read 20 GHz. After setting the frequencies, select **NEXT CAL STEP** and press the Enter key.

MENU C3

CONFIRM
CALIBRATION
PARAMETERS

PORT 1 CONN
K CONN (M)

PORT 2 CONN
SMA (M)

REFLECTION
PAIRING
MIXED

LOAD TYPE
SLIDING

THROUGHLINE
PARAMETERS

REFERENCE
IMPEDANCE

TEST SIGNALS

START CAL

PRESS <ENTER>
TO SELECT
OR CHANGE

Step 9. When menu C3 (left) appears, if you want to change any of the parameters shown in blue letters, place the cursor on that parameter and press the Enter key. For this example, we will change them all, starting with the top one. Move the cursor to **PORT 1 CONN** and press the Enter key.

Step 10. In menu C4 (below), which appears next, move the cursor to **K CONN (M)** and then press the Enter key. This choice presumes that you have a K-Female connector on the device-under-test (DUT). Remember, in this menu you choose the connector type on the test port, or the connector type that *mates* with the DUT connector. When menu C3 returns, observe that **K CONN (M)** is now shown in blue for the **PORT 1 CONN** choice.

MENU C4

SELECT PORT 1
CONNECTOR TYPE

SMA (M)

SMA (F)

K-CONN (M)

K-CONN (F)

TYPE N (M)

TYPE N (F)

GPC-3.5 (M)

GPC-3.5 (F)

GPC-7

USER DEFINED

MORE

PRESS <ENTER>
TO SELECT

MENU C3
CONFIRM CALIBRATION PARAMETERS
PORT 1 CONN K CONN (M)
PORT 2 CONN K CONN (M)
REFLECTION PAIRING MIXED
LOAD TYPE SLIDING
THROUGH PARAMETERS
REFERENCE IMPEDANCE
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT OR CHANGE

Step 11. With menu C3 (left) displayed, move the cursor to **PORT 2 CONN** and press the Enter key. Following the procedure in step 10, select **K CONN (M)** for the Port 2 connector.

Step 12. When menu C3 returns:

a. Observe that **PORT 2 CONN** now reflects **K CONN (M)**.

b. Move cursor to **REFLECTION PARING** and press the Enter key. This brings up menu C13 (below).

MENU C13
SELECT REFLECTION PAIRING
MIXED (OPEN–SHORT SHORT–OPEN)
MATCHED (OPEN–OPEN SHORT–SHORT)
PRESS <ENTER> TO SELECT

Reflection Pairing lets you mix or match the Open and Short reflection devices in the Calibration Sequence menus. The **MIXED** choice lets you calibrate using first an Open on one port and a Short on the other, then a Short on one port and an Open on the other. Conversely, **MATCHED** lets you calibrate first using an Open on both ports then using a Short on both ports. For this example, choose **MIXED** and press the Enter key.

MENU C3
CONFIRM CALIBRATION PARAMETERS
PORT 1 CONN TYPE N (M)
PORT 2 CONN TYPE N (F)
REFLECTION PARING MIXED
LOAD TYPE BROADBAND
THROUGH PARAMETERS
REFERENCE IMPEDANCE
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT

Step 13. When menu C3 returns:

a. Observe that **REFLECTION PARING** now reflects **MIXED**.

b. Move cursor to **LOAD TYPE** and press the Enter key. This brings up menu C6 (below).

MENU C6
SELECT TYPE OF LOAD
BROADBAND FIXED LOAD
SLIDING LOAD (MAY ALSO REQUIRE BROADBAND FIXED LOAD)
PRESS <ENTER> TO SELECT

This menu lets you select either of two load types, broadband or sliding. Broadband loads are adequate for all but the most demanding reflection measurements. They are easier to use and less expensive than sliding loads. If you choose a sliding load, refer to paragraph 7-3 for a procedure on setting pin depth.

For this example, select **BROADBAND LOAD** and press the Enter key.

MENU C6A
ENTER BROADBAND LOAD IMPEDANCE
BROADBAND LOAD IMPEDANCE 50.000 Ω
PRESS <ENTER> TO SELECT

c. The next menu to appear, C6A (left), prompts you to enter an impedance value. For this example, use the rotary knob to change the displayed value to 50 Ω. Alternatively, you can key in 50 ohms. That is, press 50 on the keypad and the X1 terminator key. If the value were 1 μΩ, you would key in .001 and press 10^{-3}. Conversely, if the value was 1 MΩ, you would key in 1000 and press the 10^{3} terminator key.

MENU C20
ENTER THROUGH LINE PARAMETERS
OFFSET LENGTH 0.0000 mm
THROUGHLINE IMPEDANCE 50.000 Ω
PRESS <ENTER> WHEN COMPLETE

Step 14. When menu C3 again returns:

a. Observe that **LOAD TYPE** now shows **BROAD-BAND.**

b. Move cursor to **THROUGH PARAMETERS** and press the Enter key.

Step 15. Menu C20 (left) appears next. It lets you define the length of the offset and the impedance of the throughline. For this example, enter 0 mm for length and 50 ohms for impedance.

Step 16. When menu C3 reappears, move the cursor to **REFERENCE IMPEDANCE** and press the Enter key. This brings up menu C17 (left).

Step 17. Move cursor to **REFERENCE IMPEDANCE** and use the rotary knob to change the displayed value to 50 Ω.

Press the Enter key when you have completed your value entry.

MENU C17
ENTER REFERENCE IMPEDANCE
REFERENCE IMPEDANCE 50.000 Ω
PRESS <ENTER> WHEN COMPLETE

MENU SU2
TEST SIGNALS
POWER CONTROL 0.0 dB (0 TO -15)
PORT 1 ATTN 20 dB (0 - 70)
PORT 1 POWER XX.XX dBm
PORT 2 ATTN X0 dB (0-40)
CALIBRATE FOR FLATNESS (CAL EXISTS)
FLATNESS CORRECTION AT XX.X dBm
SOURCE 2 PWR XX.X dBm
PREVIOUS MENU
PRESS <ENTER> TO SELECT

Step 18. When menu C3 returns, select **TEST SIGNALS** to bring up menu SU2 (left).

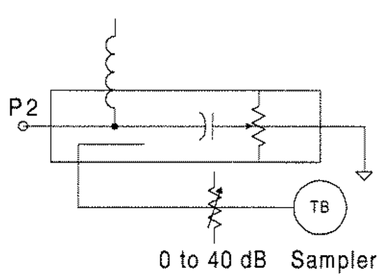
Step 19. Menu SU2 lets you define the power level of the signals at the two test ports. Power delivered to the DUT by the test set must be such that the measured signals are well above the noise floor but below the 0.1 dB compression level of the Test Set samplers. (Noise floor and maximum signal into Port 2 levels are specified in Appendix C.)

For active device Test Sets, an optional Port 2 attenuator in the forward transmission path allows up to 1 Watt of power (30 dBm) before 0.1 dB compression occurs.

Determine the required input power level and the expected output RF power level from the DUT. Ideally, the Port 2 step attenuator should be set so that the input to the test sampler (left) is –10 dBm. For example, if the input to the DUT is set for –20 dBm and the device gain is 40 dB, set the **PORT 2 ATTN** menu option for 20 dB.

(If you needed to calibrate the test port for power flatness, you would move the cursor to **FLATNESS CORRECTION** and press the Enter key.

Finally, move the cursor to **PREVIOUS MENU** and press the Enter key. This returns you to menu SU1. When you get there, press the Enter key to return to menu C3.



MENU C3
CONFIRM CALIBRATION PARAMETERS
PORT 1 CONN TYPE N (M)
PORT 2 CONN SMA (M)
REFLECTION PAIRING MIXED
LOAD TYPE SLIDING
THROUGH PARAMETERS
REFERENCE IMPEDANCE
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT OR CHANGE

Step 20.

When menu C3 reappears, select **START CAL** and press the Enter key to begin the calibration procedure.

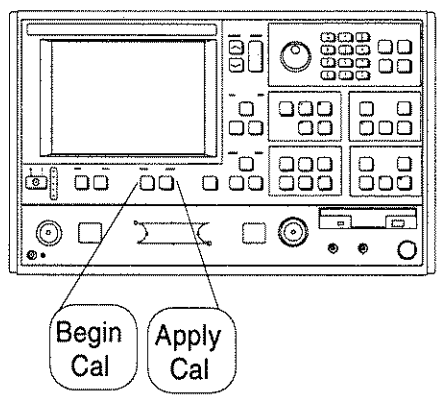
Continue the calibration sequence by following the prompts as they appear. Connect the appropriate Isolation Devices, Broadband Loads, Opens, Shorts, and Throughlines, when requested in the calibration sequence.

7-5 OFFSET-SHORT CALIBRATION PROCEDURE

The Offset-Short calibration is the standard technique for waveguide. It uses an offset Short and a flush Short to categorize the inherent errors in the waveguide measurement system. These errors include those caused by connectors as well as internal system errors such as RF leakage, IF leakage, and component interaction.

Calibration Procedure A detailed, step-by-step procedure for performing a Offset-Short calibration is given below.

Step 1. Press the Begin Cal key.



Step 2. Select **CHANGE CAL METHOD AND LINE TYPE**, in menu C11 (left). (This assumes OFFSET SHORT and WAVEGUIDE are not presently shown in blue as being selected.)

MENU C11
BEGIN CALIBRATION
KEEP EXISTING CAL DATA
REPEAT PREVIOUS CAL
CAL METHOD XXXXXXX
TRANSMISSION LINE TYPE: XXXXXXXX
CHANGE CAL METHOD AND LINE TYPE
NEXT CAL STEP
PRESS <ENTER> TO SELECT

MENU C11A
CHANGE CAL METHOD AND LINE TYPE
NEXT CAL STEP
CAL METHOD
STANDARD (NOT USED FOR WAVEGUIDE)
OFFSET SHORT
LRL/LRM
TRANSMISSION LINE TYPE
COAXIAL
WAVE GUIDE
MICROSTRIP
PRESS <ENTER> TO SELECT

Step 3. When menu C11A (left) appears, move cursor to the following:

a. **OFFSET SHORT**, then press the Enter key. This selects Offset Short as the calibration method.

b. **WAVEGUIDE,** then press the Enter key. This brings menu C5 (bottom left) to the screen.

c. **NEXT CAL STEP,** then press the Enter key. This causes menu C11 to return to the screen.

Step 4. When menu C11 reappears, confirm that the **OFFSET SHORT** calibration method and **WAVEGUIDE** line-type have been selected. Select **NEXT CAL STEP** and press the Enter key to proceed.

Step 5. Menu C5 appears next. This menu (bottom left) lets you select the type of calibration. For this example, move the cursor to **FULL 12-TERM** and press the Enter key.

MENU C5
SELECT CALIBRATION TYPE
FULL 12-TERM
1 PATH 2 PORT
TRANSMISSION FREQUENCY RESPONSE
REFLECTION ONLY
PRESS <ENTER> TO SELECT

Step 6. The next menu, C5D (below), lets you choose whether to include or exclude the error terms associated with leakage between measurement channels. For a normal calibration, you would choose to include these error terms. Therefore, move the cursor to **INCLUDE ISOLATION (STANDARD)** and press the Enter key.

MENU C5D
SELECT USE OF ISOLATION IN CALIBRATION
INCLUDE ISOLATION (STANDARD)
EXCLUDE ISOLATION
PRESS <ENTER> TO SELECT

MENU C1
SELECT CALIBRATION DATA POINTS
NORMAL (1601 POINTS MAXIMUM)
C.W. (1 POINT)
N-DISCRETE FREQUENCIES (2 TO 1601 POINTS)
TIME DOMAIN (HARMONIC)
PRESS <ENTER> TO SELECT

Step 7. Menu C1 (left), which appears next, lets you select the number of frequency points at which calibration data is to be taken. Of these choices, which were described in paragraph 7-4, choose **NORMAL (1601 POINTS MAXIMUM)** for this example.

Step 8. The next menu, C2 (below), lets you set your start and stop frequencies. For this example, move cursor to **START,** press 40 on keypad, and hit MHz terminator key. Perform like operations for the **STOP** choice, except make entry read 20 GHz. After setting the frequencies, select **NEXT CAL STEP** and press the Enter key.

MENU C2
FREQ RANGE OF CALIBRATION
START 0.0400000000GHz
STOP 20.000000000 GHz
201 DATA PTS 0.099800000 GHz STEPSIZE
MAXIMUM NUMBER OF DATA POINTS
1601 MAX PTS
801 MAX PTS
401 MAX PTS
201 MAX PTS
101 MAX PTS
51 MAX PTS
NEXT CAL STEP
PRESS <ENTER> TO SELECT

MENU C3B
CONFIRM CALIBRATION PARAMETERS
LOAD TYPE BROADBAND
THROUGH LINE PARAMETERS
WAVEGUIDE PARAMETERS XXXXXXXX
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT OR CHANGE

Step 9. When menu C3B (bottom left) appears, if you want to change any of the parameters shown in blue letters, place the cursor on that parameter and press the Enter key. (These choices operate the same as was described for menu C3 in paragraph 7-4.) For this example, we change the waveguide parameters. Move the cursor to **WAVEGUIDE PARAMETERS** and press the Enter key.

MENU C15
SELECT WAVEGUIDE KIT TO USE
—INSTALLED KIT—
IDENTIFIER XXXX
CUTOFF FREQ: XXX.XXXXXXXXX GHz
SHORT 1 XX.XXXX mm
SHORT 2 XX.XXXX mm
USE INSTALLED WAVEGUIDE KIT
USER DEFINED
PRESS <ENTER> TO SELECT

Step 10. When menu C15 (left) appears, move cursor to one of the two available choices and press the Enter key. These choices are described below.

a. USE INSTALLEDWAVEGUIDE KIT: Selecting this choice uses the values shown in blue for IDENTIFIER, CUTOFF FREQ, SHORT 1, and SHORT 2. Select this choice, for this example.

b. USER DEFINED: Selecting this choice brings up menu C15A (below), which lets you specify waveguide parameters. After defining your waveguide parameters, you are returned to menu C3B.

MENU C15A
ENTER WAVEGUIDE PARAMETERS
WAVEGUIDE CUTOFF FREQ: XXX.XXXXXXXXX GHz
OFFSET LENGTH OF SHORT 1 XX.XXXX mm
OFFSET LENGTH OF SHORT 2 XX.XXXX mm
PRESS <ENTER> WHEN COMPLETE

Step 11. Continue the calibration sequence by following the prompts as they appear. Connect the appropriate Isolation Devices, Broadband Loads, Shorts, and Throughlines, when requested in the calibration sequence.

7-6 LRL/LRM CALIBRATION PROCEDURE

The LRL/LRM (line-reflect-line/line-reflect-match) calibration* feature provides an enhanced capability for error compensation when making measurements in coaxial, microstrip and waveguide transmission media. Instead of using the standard Open, Short, and Load, the LRL/LRM calibration method uses two lines and a reflection or match. The difference in length between line 1 and line 2 creates the measurements necessary for the error solutions.

Because very high quality air lines are readily available, excellent directivity and source match are possible with this calibration. This calibration is excellent for measurements in transmission media, such as coax or waveguide, in which opens or precision terminations are difficult to realize.

The LRL/LRM calibration technique uses the characteristic impedance of a length of transmission line or a precision match as the calibration standard. A full LRL/LRM calibration consists of two transmission line measurements, a high reflection measurement, and an isolation measurement. Using this technique full 12-term error correction can be performed with the 372XXA.

Three line LRL/LRM calibration can also be selected. In a two-line LRL measurement, the difference in length between line 1 and line 2 is necessary for calibration but limits the frequency range to a 9:1 span. The use of three lines in the calibration extends the frequency range to an 81:1 span.

Through the use of LRL/LRM calibration and an external computer, in conjunction with ANACAT software, multiple-level de-embedding is possible. This calibration allows you to make semi-conductor chip measurements up to 60 GHz with a single test fixture.

In addition, any non-coaxial transmission media, including mixed media interconnects, can be accommodated. For example, a test device with a waveguide input and a coplanar microstrip output can be measured. Software automatically compensates for the microstrip dispersion.

A detailed procedure for calibrating for a measurement using the LRL/LRM method is provided in the following pages.

*LRMCalibrationMethodofRhode&Scharwz,Germany

LRL/LRM Calibration (Microstrip)

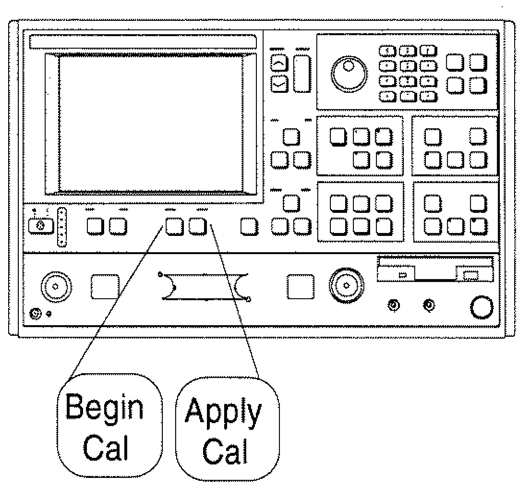
Microstrip is a dispersive media. The 372XXA applies dispersion compensation during calibration for microstrip measurements. Because the 37XX2A must know the specific microstrip parameters, during the calibration procedure menus are available for entering the

- width of the strip
- thickness of the substrate
- substrate dielectric constant
- effective dielectric constant Zc
- characteristic impedance (reference)

When testing microstrip devices it is necessary to launch from coax to microstrip. In production testing this launching must be temporary, so that the device can easily be installed in and be removed from the fixture. The requirement for launching to 60 GHz is met by the WILTRON Universal Test Fixture (UTF). The UTF provides accurate, repeatable launch to substrates from 5 to 70 mils thick, and from 0.15 to 2 inches long. Offset connections and right angles can be configured. DC bias probes can be mounted to the UTF to inject bias onto the substrate. UTF calibration/verification kits are available for alumina in 10 mil, 15 mil, and 25 mil microstrip, and for 25 mil coplanar waveguide. Although a UTF is not essential, the following calibration procedures presume its use.

Step 1. Select the desired LRL line substrates from the appropriate microstrip calibration kit. When called for in the calibration sequence, mount the LRL line substrates on the UTF following the procedure given in the 3680 OMM.

Step 2. Press the Begin Cal key.



MENU C11
BEGIN CALIBRATION
KEEP EXISTING CAL DATA
REPEAT PREVIOUS CAL
CAL METHOD XXXXXXXX
TRANSMISSION LINE TYPE: XXXXXXXX
CHANGE CAL METHOD AND LINE TYPE
NEXT CAL STEP
PRESS <ENTER> TO SELECT

Step 3. Select **CHANGE CAL METHOD AND LINE TYPE**, in menu C11 (left). (This assumes LRL and MICROSTRIP are not presently shown in blue as being selected.)

Step 4. When menu C11A (bottom left) appears, highlight the following selections.

a. **LRL/LRM** and press the Enter key.

b. **MICROSTRIP** and press the Enter key.

c. **NEXT CAL STEP** and press the Enter key.

Step 5. When menu C11 reappears, confirm that the **LRL/LRM** calibration method and **MICROSTRIP** line-type have been selected. Select **NEXT CAL STEP** and press the Enter key to proceed.

Step 6. Continue through the calibration sequence, and make the following selections from the menus that appear:

INCLUDE ISOLATION (STANDARD) (Menu C5D)
NORMAL (1601 POINTS MAXIMUM) (Menu C1)
START (Your start frequency) (Menu C2)
STOP (Your stop frequency) (Menu C2)

MENU C11A	
CHANGE CAL METHOD AND LINE TYPE	
NEXT CAL STEP	*c.*
CAL METHOD	
STANDARD (NOT USED FOR WAVEGUIDE)	
OFFSET SHORT	
LRL/LRM	*a.*
TRANSMISSION LINE TYPE	
COAXIAL	
WAVE GUIDE	
MICROSTRIP	*b.*
PRESS <ENTER> TO SELECT	

MENU C5D
SELECT USE OF ISOLATION IN CALIBRATION
INCLUDE ISOLATION (STANDARD)
EXCLUDE ISOLATION
PRESS <ENTER> TO SELECT

MENU C1
SELECT CALIBRATION DATA POINTS
NORMAL (1601 POINTS MAXIMUM)
C.W. (1 POINT)
N-DISCRETE FREQUENCIES (2 TO 1601 POINTS)
TIME DOMAIN (HARMONIC)
PRESS <ENTER> TO SELECT

MENU C2
FREQ RANGE OF CALIBRATION
START 0.0400000000GHz
STOP 20.000000000 GHz
201 DATA PTS 0.099800000 GHz STEPSIZE
MAXIMUM NUMBER OF DATA POINTS
1601 MAX PTS
801 MAX PTS
401 MAX PTS
201 MAX PTS
101 MAX PTS
51 MAX PTS
NEXT CAL STEP
PRESS <ENTER> TO SELECT

MENU C3G

CONFIRM
CALIBRATION
PARAMETERS

LRL/LRM
PARAMETERS

MICROSTRIP
PARAMETERS
USER DEFINED

TEST SIGNALS

START CAL

PRESS <ENTER>
TO SELECT
OR CHANGE

Step 7. When menu C3G appears, if you want to change microstrip parameters to be different from those shown in blue, place cursor on **MICROSTRIP PARAMETERS** and press the Enter key.

Step 8. When menu C16 (left) appears, move cursor to the WILTRON 3680 UTF calibration kit you wish to use or to **USER DEFINED**; then press the Enter key.

The calibration kit selections shown in menu C16 are for the following 3680 Connection Substrate Kits:
10 MIL KIT — 36804B-10M
15 MIL KIT — 36804B-15M
25 MIL KIT — 36804B-25M

If you choose **USER DEFINED**, the next menu that appears (C16A), lets you characterize your parameters. Move cursor to each selection, key in a value, then press the Enter key to return to menu C16.

MENU C16

SELECT
MICROSTRIP
KIT TO USE

10 MIL KIT

15 MIL KIT

25 MIL KIT

USER DEFINED

PRESS <ENTER>
WHEN COMPLETE

MENU C16A

ENTER
MICROSTRIP
PARAMETERS

WIDTH OF
STRIP
XX.XXXX mm

THICKNESS OF
SUBSTRATE
XXXX.XXXX mm

Zc
XXX.XXX pΩ

SUBSTRATE
DIELECTRIC
XX.XX

EFFECTIVE
DIELECTRIC
XX.XX
(RECOMMENDE D
0.00)

PRESS <ENTER>
WHEN COMPLETE

MENU C3G
CONFIRM CALIBRATION PARAMETERS
LRL/LRM PARAMETERS
CHANGE MICROSTRIP PARAMETERS XXXXXXXXX
START CAL
PRESS <ENTER> TO SELECT

Step 9. Select **LRL/LRM PARAMETERS**, when menu C3G returns.

Step 10. When menu C18 appears, you have two choices to make: whether your calibration is to be two-line or three-line, and where you want to have your reference plane.

a. *Select the reference plane:* Highlight **MIDDLE OF LINE 1 (REF)** or **ENDS OF LINE 1 (REF)** and press the Enter key.

b. *Select the type of LRL / LRM calibration:* Highlight **ONE BAND,** for a two-line calibration; or **TWO BANDS**, for a three-line calibration.

As mentioned earlier, in a two-line measurement, the difference in length between line 1 and line 2 is necessary for calibration but limits the frequency range to a 9:1 span. By using three lines in the calibration, you extend the frequency range to an 81:1 span.

If you select **TWO BANDS**, skip to Step 12.

MENU C18	
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	
NUMBER OF BANDS USED	
ONE BAND	***EITHER/OR***
TWO BANDS	
LOCATION OF REFERENCE PLANES	
MIDDLE OF LINE 1 (REF)	***EITHER/OR***
ENDS OF LINE 1 (REF)	
PRESS <ENTER> TO SELECT	

MENU C18A	
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	*e.*
CHARA CTERIZE CAL DEVICES	
DEVICE 1 LINE 1 (REF) X.XXXX mm	*a.*
DEVICE 2 LINE /MATCH X.XXXX mm	*b., c., d.*
PRESS <ENTER> TO SELECT OR SWITCH	

Step 11.

(2-Line Calibration)

When menu C18A (left) appears, make the following selections:

a. Move the cursor to **DEVICE 1 LINE 1 (REF)** and key in the value.

b. Move the cursor to **DEVICE 2 LINE/MATCH.** Here you have another decision to make: whether your calibration is to be LRL or LRM. For this selection, the Enter key acts as a toggle.

c. If you toggle such that **LINE** turns red, then key in the value for line 2. This value depends on your frequency range.

d. If you toggle **MATCH** red, observe that **FULL-BAND** appears. This indicates that your reflective device covers the full calibration range.

e. When you have made both selections, move the cursor to **NEXT CAL STEP** and press the Enter key to produce the next menu. Skip to step 13.

MENU C18B	
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	*g.*
CHARACTERIZE CAL DEVICES	
DEVICE 1 LINE 1 (REF) XX.XXXX	*a.*
DEVICE 2 LINE/MATCH XX.XXXX/LOWBAND	*b., c., d.*
DEVICE 3 LINE/MATCH XX.XXXX/HIGHBAND	*e.*
FREQ AFTER WHICH THE USE OF DEVICE 2 AND DEVICE 3 IS EXCHANGED	
BREAKPOINT XXX.XXXXXXXXXGHZ	*f.*
PRESS <ENTER> TO SELECT OR SWITCH	

Step 12. *(3-Line*

When menu C18B (left) appears, make the following selections:

a. Move the cursor to **DEVICE 1 LINE 1 (REF)** and key in the value (typically 1.00 cm). Press the ENTER key to select.

b. Move the cursor to **DEVICE 2 LINE/MATCH.** Both here, and for the next choice, you have another decision to make: whether your calibration is to be LRL or LRM. For this selection, the ENTER key acts as a toggle.

c. If you toggle such that **LINE** turns red, then key in the value for line 2. This value depends on your frequency range.

d. If you toggle **MATCH** red, observe that **LOWBAND** appears. This indicates that your reflection device is a low-band load. This load must have a passband such that it passes all frequencies from the start to the breakpoint (see below).

e. Move the cursor to **DEVICE 3 LINE/MATCH.** If device 3 is a line, key in the value. If it is a match, the term **HIGHBAND** will appear. This indicates that your match is a high-band load. This load must have a passband such that it passes all frequencies from the breakpoint to the stop frequency.

f. Move the cursor to **BREAKPOINT** and enter your breakpoint frequency. For two-line LRL calibrations, select a breakpoint equal to the upper frequency of the low frequency LRL line. For a combined LRL and LRM calibration, select a breakpoint equal to the top frequency of the calibration divided by six; for instance, to cover the frequency range 0.04 to 60 GHz, select 10 GHz as the breakpoint.

g. When you have made all selections, move the cursor to **NEXT CAL STEP** and press Enter to produce the next menu.

MENU C19	
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	c.
OFFSET LENGTH OF REFLECTIVE DEVICE	
OFFSET LENGTH X.XXXX mm	a.
TYPE OF REFLECTION	
GREATER THAN Zo	b.
LESS THAN Zo	EITHER/OR
PRESS <ENTER> TO SELECT	

Step 13. The next menu, C19, gives you choices for your reflective device.

a. Move the cursor to **OFFSET LENGTH** and key in a value (typically 0.0000 mm).

b. Move the cursor to **GREATER THAN Zo** or **LESS THAN Zo,** depending on whether your reflective device is an Open or a Short. Press the ENTER key to select.

NOTE

Choose **GREATER THAN Zo** for an Open and **LESS THAN Zo** for a Short.

c. When you complete your choices, move the cursor to **NEXT CAL STEP** and press the Enter key.

Step 14. When menu C3G reappears, move cursor to **START CAL** and press Enter.

MENU C3G
CONFIRM CALIBRATION PARAMETERS
CHANGE LRL/LRM PARAMETERS
CHANGE MICROSTRIP PARAMETERS XXXXXXXXX
START CAL
PRESS <ENTER> TO SELECT

Step 15. Continue the calibration sequence by following the prompts as they appear. Mount the appropriate LRL line substrates when requested in the calibration sequence.

For the **REFLECTIVE DEVICE** and **BROADBAND LOAD** prompts, remove all substrates from the UTF and allow the lower jaws to short the center conductor. Separate the connector blocks by at least an inch. (The BROADBAND LOAD prompt only appears if you selected to include isolation in menu C5B.)

Step 16. Store the calibration.

LRL/LRM Calibration (Coaxial)

An LRL cal kit is necessary to perform the coaxial calibration. Calibration kits for GPC-7 are available from Maury Microwave and Hewlett Packard.

Two line lengths are used as the impedance standard. The calibration frequency range is limited by the difference in the lengths of the two lines. Their length must be different by approximately 90 degrees at the mid-band frequency. A good calibration can be achieved over the range of 18 degrees to 162 degrees making it possible to calibrate LRL over a 9:1 frequency range.

MENU C3E
CONFIRM CALIBRATION PARAMETERS
LRL/LRM PARAMETERS
REFERENCE IMPEDANCE
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT OR CHANGE

LRL calibration is very sensitive to uncalibrated source match. If some padding is placed at the test ports, the directivity and source match will be improved. If the goal is high level measurements, then padding should be included. If low level measurements are being performed, then the padding must be left out.

Step 1. Same as Steps 1 through 6 in the Microstrip procedure, except choose **COAXIAL** in menu C11A.

Step 2. When menu C3E (left) appears, if you want to change line impedance, place cursor on **REFERENCE IMPEDANCE** and press the Enter key.

Step 3. When menu C17 (left) appears, move cursor to **REFERENCE IMPEDANCE,** key in the value, then press the Enter key.

Step 4. Same as Steps 9 through 16 in the microstrip procedure.

MENU C17
ENTER REFERENCE IMPEDANCE
REFERENCE IMPEDANCE 50.000 Ω
PRESS <ENTER> WHEN COMPLETE

In the coaxial, three-line calibration there are factors you need to be aware of. Note that it is the line length *differences* that are important to the LRL calibration, namely (L2–L1) and (L3–L1) where L1 is the length of line 1, L2 is the length of line 2, and L3 is the length of line 3.

Longer length differences are used for longer wavelengths (lower frequencies). For frequencies up to and including the breakpoint frequency, the larger absolute value of the (L2–L1) and (L3–L1) differences is used. At frequencies above the breakpoint, the smaller absolute value of the (L2–L1) and (L3–L1) differences is used.

Consideration must also be given to selecting the breakpoint frequency. Divide the frequency range to satisfy the 9:1 rule for any given pair of lines. The range is thus divided by the frequency breakpoint into the intervals [f1, f2] and [f2, f3]. Based on these intervals, next determine the appropriate length differences; the longer difference is associated with the lower interval [f1, f2]. Note that if the differences are equal to each other, concurrent frequency ranges are implied and only two lines need be used.

Select a line 1 reference (L1) around which to place these two differences. Use any combination of positive or negative differences around line 1. The software selects which interval is associated with either of line 2 or line 3 by comparing the absolute values of the differences with line 1. Data from the two lines, which make up the larger absolute difference, are used for the interval [f1, f2]. Data from the two lines, which make up the smaller absolute difference, are used for the interval [f2, f3].

LRL/LRM Calibration (Waveguide)

The waveguide procedure is very similar to the coaxial and microstrip procedures already described.

Step 1. Same as Steps 1 through 6 in the Microstrip procedure, except choose **WAVEGUIDE** in menu C11A.

MENU C3F
CONFIRM CALIBRATION PARAMETERS
LRL/LRM PARAMETERS
WAVEGUIDE CUTOFF FREQ
TEST SIGNALS
START CAL
PRESS <ENTER> TO SELECT OR CHANGE

The only difference is with menu C3F. For a waveguide calibration, move the cursor to **WAVEGUIDE CUTOFF FREQ** and press Enter. This action calls menu C15B, which lets you enter the waveguide cutoff frequency. After doing, so you are returned to menu C3F.

Step 2. When menu C3F reappears, place cursor on **CHANGE LRL/LRM PARAMETERS** and press the Enter key.

Step 3. Same as Steps 9 through 13 in the Microstrip procedure.

MENU C15B
ENTER WAVEGUIDE CUTOFF FREQUENCY
WAVEGUIDE CUTOFF FREQ XX.XXXX GHz
PRESS <ENTER> WHEN COMPLETE

Chapter 8
Measurements

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Chapter 8
Measurements

8-1 INTRODUCTION

This section discusses four typical measurements that can be made with the Model 372XXA Vector Network Analyzer.

8-2 TRANSMISSION AND REFLECTION MEASUREMENTS

This discussion provides information on general measurement considerations and transmission and reflection measurements using the 372XXA.

APPLY POWER TO THE SYSTEM

- Then, Turn On the Analyzer

SETUP

- System Should Be Warmed Up for At Least 60 to 80 Minutes

DEFAULT PARAMETERS

- Known-Good Starting Point
- Selected With the Default program Key

SWEEP TEST MENU

- Start and Stop Frequencies
- Source Power Level

Setup and Calibration

To get started, apply power to the system.

After turning on the power, allow the system to warm up for at least 60 minutes before operation.

In normal operation, the system comes on line in the state that it was in when last turned off. If you want to return the system to its default state, you can do so by pressing the Default Program key twice.

The default parameters provide a known starting point. For example, they reset the start and stop frequencies for maximum sweep width, the source control to 0 dB, and the display resolution to 401 data points.

The Sweep Setup menu should now appear on the display (it also can be displayed using the Setup Menu key). If you like, you can select a new start frequency, stop frequency, or source power.

You can further reduce the power level at Ports 1 and 2 with the built-in attenuators. Using the Reduced Test Signals option in the Sweep Setup menu, you can change the setting of the Port 1 source attenuator over a range of from 0 to 70 dB. The Port 2 test attenuator has a range of from 0 to 40 dB (in 10 dB steps) (if Option 6 is installed).

Install the calibration kit devices to the test ports as instructed by the U3 menu. Both the capacitance coefficients for the Open and the offset lengths for the Open and Short can be modified or defined.

Selecting the Begin Cal key starts the calibration process. The Calibration menus step you through the calibration process, as follows:

Select the type of calibration desired.

Select the frequency range of calibration. Using the Data Points key, you can choose between 1601 to 51 measurement data points.

When the calibration is completed, you can store the calibration data on a disk. You are now ready to install the test device and proceed with the measurement. At this point you have a number of measurement options to consider such as displays, markers, limits, outputs, sweeps, and enhancements.

You can select any of the available graph types and display them for any calibrated parameter on any of the four channels (if a 12-term calibration was performed).

SWEEP SETUP MENU

- Use the "Test Signals" Option to Add Attenuation

CALIBRATION

- Select Begin Cal Key
- Select Type of Calibration
- Select Frequency Range of Calibration
- Install Calibration Kit Devices As Instructed by the Menu
- Modify the Capacitance Coefficients and the Offset Lengths, If Required
- Store the Calibration Data Internally or to Disk

MEASUREMENT OPTIONS

- Displays
- Markers
- Limits
- Outputs
- Sweeps
- Enhancements

DISPLAYS

- Four Channels
- Each Channel Can Display Up to Two Graph Types
- Calibration Parameters Can Be Selected By Any Channel

MARKERS

- Selectable User Marker Menu
- 6 Markers Available
- Delta And Max/Min Modes

LIMITS

- Selectable Using Limits Key
- Two Limit Lines Available for Each Channel
- Limit lines can be flat, sloped, or segmented with up to 10 discrete frequency segments
- Functions With All Graph Types

OUTPUT

- Select Start Print key to Output Display
- Use the Hard Copy Menu to Choose Output Type and Output Device

OUTPUT HEADERS

- Selected With Device ID Key or From the Output Menu Under the Setup Output Headers Option
- Labels Output With Device/Serial Number, Date, Operator's Name, and comments

Up to six markers are available. Using the Marker Menu, you can set the frequency of each one, you can set each one in the delta marker mode, and you can set each marker's level to maximum or minimum.

In some cases—such as in a production environment—limit lines are desireable. Options within the menu called up using the Limits key, provide for one or two flat, sloped, or single-point-segmented limit lines for each channel. These limit lines function with all of the graph types, including Smith and admittance. The color of the limit lines (blue) differs from that of the measurement trace. This allows for easy analysis of results.

The Hard Copy Menu key menu (Figure 8-1) gives you a choice between a printer and a colored-pen plotter. It also lets you select menus from which you may chose from a variety of print or plot options.

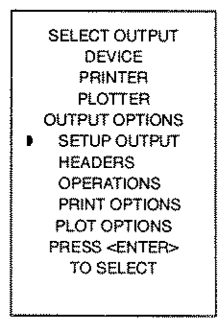


Figure 8-1. *Output Menu*

To output the display, press the Start Print key. The default setting provides for a full display printout from the associated printer.

To label the output, select Setup Output Headers in the Output Menu or press the Device ID key.

On the output to the printer, plotter, or disk. a menu then appears that lets you specify the device name/serial number, the date, the operator's name, and user comments (Figure 8-2).

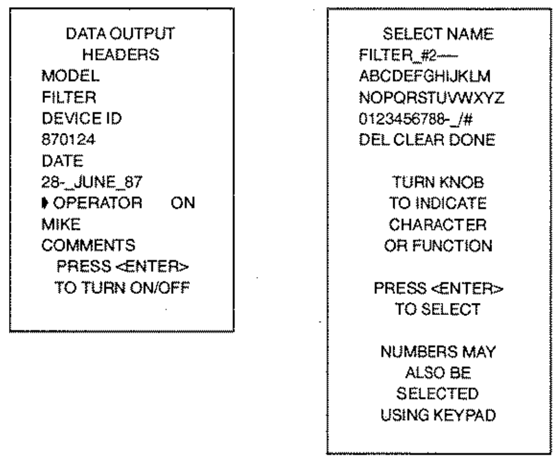


Figure 8-2. *Label Menus*

SWEEPS

- Start/Stop Frequencies Can Be Changed With Calibration Applied
- Marker Sweep Available From the Setup Menu
- Data Points Selectable Using the Data Points key

Sweep frequencies can be changed with the calibration applied as long as the frequencies are between the calibration start and stop frequencies.

Additionally, a marker sweep can be selected from the Setup Menu. This allows you to sweep between any two active markers as long as the frequency of each falls between the calibrated start and stop frequencies.

Using the Data Points key, you can select the number of data points for optimal resolution-vs-speed.

ENHANCEMENTS

- Intermediate Frequency Bandwidth Changed Using the Video IFBW Key
- Averaging and Smoothing Values Set Using Ave/Smooth Menu Key
- Averaging and Smoothing Turned On or Off Using Trace Smooth and Average keys

Finally, you can enhance the measurement data by reducing the IF bandwidth and using averaging and/or smoothing.

- ☐ Change the IF bandwidth by selecting the Video IF BW key.
- ☐ Set the averaging and smoothing values by selecting the Avg/Smooth Menu key.
- ☐ Turn on the averaging and smoothing using the Trace Smooth and Average keys, which have LED's to let you know that the enhancement is being applied.

Measurement Discussion

Before going any further, let us take a few moments to review some basic principles of network measurements. First, we apply incident energy to the input of a test device. If the device's input impedance differs from the measurement system's impedance, some of that energy is reflected. The remainder is transmitted through the device. We call the ratio of reflected-to-incident energy the reflection coefficient. The ratio of transmitted-to-incident energy we call the transmission coefficient (Figure 8-3).

BASIC MEASUREMENT PRINCIPLES

REFLECTION COEFFICIENT= REFLECTED ENERGY / INCIDENT ENERGY

TRANSMISSION COEFFICIENT= TRANSMITTED ENERGY / INCIDENT ENERGY

Figure 8-3. *Basic Measurement Principles*

These ratios are complex quantities that have magnitude and phase components. Using vector representation, the vector magnitude is the ratio of reflected-to-incident magnitude (or transmitted-to-incident magnitude), while the vector phase is the difference in phase between the incident energy and the reflected/transmitted energy (Figure 8-4).

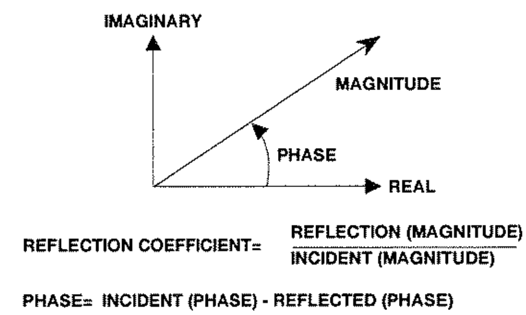


Figure 8-4. Magnitude/Phase Vector

REFERENCE PLANE

- Defined At the Test Port Measurement Plane As

  Magnitude = 1
  Phase = 0 Degrees

- Established During Calibration

The measurement reference for the incident energy is the point at which the device connects to the measurement system. We call this point the reference plane. The incident energy at the reference plane is defined as having a magnitude of 1 and a phase of 0 degrees. We establish this during the calibration.

The ratio of reflected and transmitted energy to the incident energy can be represented by a number of different measurements and units, as shown below.

MEASUREMENTS

- Log Magnitude
- Phase
- Smith Chart (Impedance)
- Group Delay (See paragraph 3-13)
- Admittance Smith Chart
- Linear Polar
- Log Polar
- Linear Magnitude
- Real and Imaginary

The default display for reflection measurements is the Smith chart. The default display for transmission measurements is the Log Magnitude and Phase graph.

The Smith chart is a convenient way to display device impedance and is a useful aid for the graphical design and analysis of microwave circuits (Figure 8-5).

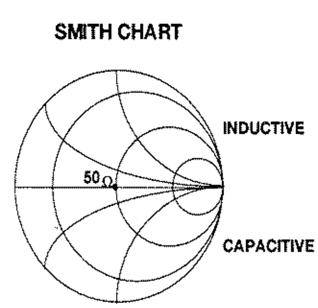


Figure 8-5 Smith Chart Display 1

DEFAULT DISPLAYS

Reflection

- Smith Chart

Transmission

- Log Magnitude and Phase Graph

Let us assume both that our system is already calibrated and that we have equalized the system for the test port in use. We would then

1. *Connect the Short.* A Short always appears as a dot at the left-most edge of the Smith chart's horizontal axis.

2. *Connect a Termination.* Now you will see another dot located at the center (1+j0) of the chart (this assumes a 50-ohm load).

3. *Connect the Open.* An Open appears as an arc on the chart's right edge. This is due to the fringing capacitance of the Open standard (Figure 8-6).

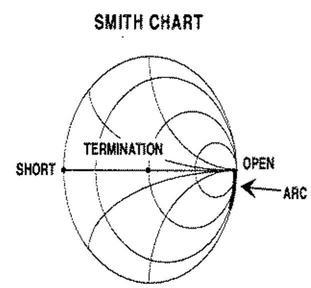


Figure 8-6 *Smith Chart Display 2*

Now let us perform a reflection measurement on a 20 dB attenuator over the 1-to-18 GHz range.

We need to determine the setup, calibration, and measurement requirements.

REFLECTION MEASUREMENT

Example: 20 dB Attenuator

- Setup
- Calibration
- Measurement

SETUP

- Reset With the Default Parameters Key
- Set the Start Frequency to 1 GHz
- Set the Stop Frequency to 18 GHz

CALIBRATION

- Begin Cal Key
- Reflection Only

MEASUREMENT

- Select Log Magnitude Display
- Install DUT
- Autoscale
- Set Marker 1 to Max, Marker 2 to Min

A known good starting point is to reset with Default Program parameters. Since our measurement lies between 1 and 18 GHz, set the Start and Stop frequencies using the Sweep Setup menu that appears on the display following system reset.

Let us perform a simple calibration, Reflection Only, which uses an open, a short, and a broadband load. To do this, press the Begin Cal key and follow the directions in the menu area.

When you complete the calibration, the "CHANNEL 1 WITH S11" Smith chart appears on the display. Now:

1. Select the Log Magnitude display and install the attenuator.
2. Select Auto Scale to optimize the display data.
3. Use Markers 1 and 2 to find the maximum and minimum impedance.

TRANSMISSION MEASUREMENT

Example: 20 dB Attenuator

- Setup
- Calibration
- Measurement

SETUP

- Use Default Program Settings

CALIBRATION

- Begin Cal Key
- Frequency Response (Transmission Response Only)

Now let us perform a transmission measurement on the same 20 dB attenuator over the same frequency range. We will follow the same steps as before, but this time we will use additional features.

Once again, reset the system using the Default Program key.

In this calibration we will select the N-Discrete Frequencies menu option and step all frequencies in increments of 50 MHz.

When the calibration is complete, Channel 1 will display "S21 FORWARD TRANSMISSION WITH LOG MAGNITUDE AND PHASE." You can use Markers 1 and 2 to find the maximum and minimum values of the attenuators insertion loss.

8-3 LOW LEVEL AND GAIN MEASUREMENTS

This discussion provides methods and techniques for making gain and low-signal-level measurements. It is divided into 372XXA system considerations and test device considerations.

DYNAMIC RANGE LIMITS

- High Level Accuracy Limited by the Compression of the Receiver
- Low Level Accuracy Limited by Noise and Leakage Signals

372XXA System Considerations

The 372XXA system is limited in its ability to test low-signal levels by its dynamic range and signal-to-noise-power ratio. First we will discuss receiver dynamic range, which is the difference between the maximum and minimum acceptable signal levels (Receiver Dynamic Range = Pmax – Pmin).

Receiver Dynamic Range

The dynamic range of the 372XXA is limited by the 0.1 dB compression level of the samplers at high signal levels. It is further limited at low signal levels by leakage signals and noise.

Figure 8-7 shows the detected output signal as a function of the power level at the sampler. The 0.1 dB compression level is on the order of –10 dBm. The 372XXA is designed such that all other conversions compress at a much greater level, which leaves the samplers as the main source of nonlinearity.

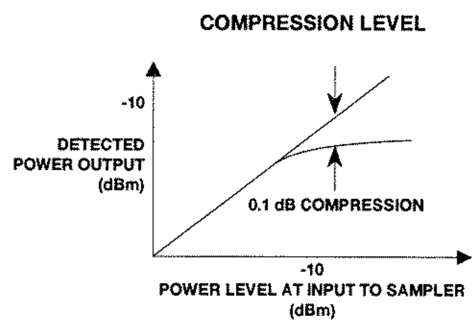


Figure 8-7. *Compression at 0.1 dB*

The small signal response is limited by errors due to noise and leakage signals. The leakage signals are both from within the 372XXA and at the device-under-test (DUT) connectors.

The detected signal is the vector sum of the desired signals, the noise signals, and the leakage signals. These signals introduce an error or uncertainty (Figure 8-8).

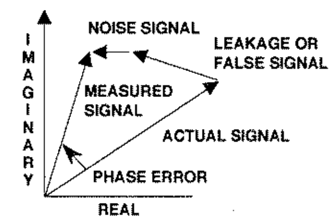


Figure 8-8. *Amplitude and Phase Uncertainty*

LEAKAGE PATHS

- Transfer Switch (120 db)
- Frequency Conversion Module
- DUT Leakage

Some of the possible leakage paths for the 372XXA are the transfer switch, the frequency conversion module, and the DUT. The system limits these leakages to greater than 100 dB. The 12-term error correction can reduce this leakage to better than 110 dB at 18 GHz and 90 dB at 40 GHz.

DUT LEAKAGE

- Should Be Greater Than 80 dB to Assure Accurate Measurements

The DUT connectors should have internally captivated center pins. Those connectors which use external pins to captivate the center conductor should have silver loaded epoxy on the pins to reduce radiation to better than 80 dB.

Signal-to-Noise-Power Ratio

The signal-to-noise-power ratio for each of the test or reference channels is as shown. The "signal power" is the power level of the 80 kHz IF signal at the internal synchronous detectors, and the "noise power" is the total power contained within the bandwidth of the bandpass filter at 80 kHz.

Signal To Noise

S/N Ratio For Test or Reference Channel

$$SN = \frac{SignalPower(dBm)}{NoisePower(dBm)}$$

The uncertainty, or error, in a measurement is a function of the amplitude of leakage signals and of the noise level. The uncertainty in the measurement of magnitude and phase of the S-parameters are calculable and shown below in Figures 8-9- and 8-10.

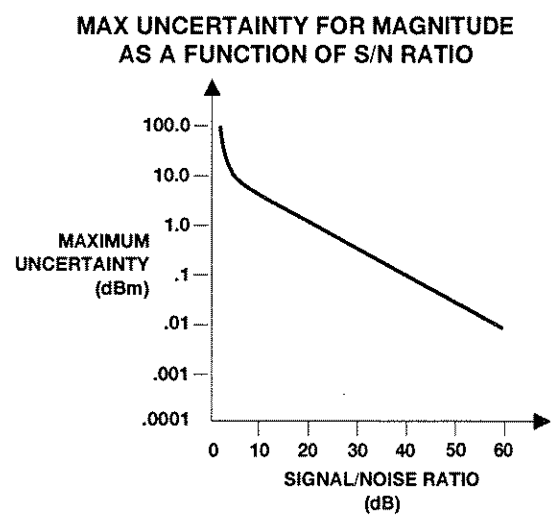


Figure 8-9. *The Effect of S/N Ratio On Magnitude Measurements (Noise Only)*

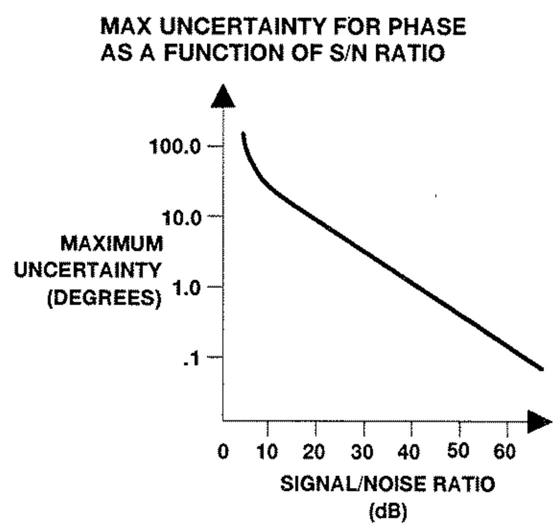


Figure 8-10. *The Effect of S/N Ratio On Phase Measurements (Noise Only)*

The most difficult types of measurements are those that exercise the full dynamic range of the 372XXA, such as filters (Figure 8-11). Filter measurements are examples of where one must observe both low-insertion loss (in the passband) and high attenuation (in the stop band).

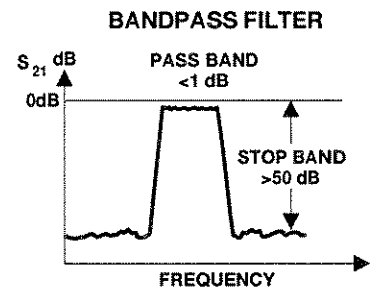


Figure 8-11. *Filter Measurements*

TECHNIQUES TO MAXIMIZE THE S/N RATIO

- Maximize RF Signal Level
- Signal Enhancement

There are two techniques that you can use to optimize the signal-to-noise ratio. They are (1) maximizing the RF signal level and (2) using signal enhancement.

MAXIMIZE RF SIGNAL LEVEL

- Maximum Dynamic Range
- Optimum Linearity

To maximize the RF signal level, use the default settings of the 372XXA.

ENHANCEMENTS

- IF Bandwidth Reduction
- Averaging

The 372XXA provides two enhancements for improving the signal-to-noise ratio: IF bandwidth reduction and averaging.

IF BANDWIDTH REDUCTION

- Four Bandwidths Available
- Noise is Decreased
- Faster Than Averaging

Reducing the IF bandwidth is a primary method for enhancing accuracy. The 372XXA has a choice of four bandwidths available from the front panel: Maximum (10 kHz), Normal (1 kHz), Reduced (100 Hz), and Minimum (10 Hz). The noise level should decrease by a factor equal to the square root of the IF bandwidth. Using IF Bandwidth reduction makes for faster measurements than with the use of an equivalent amount of averaging.

AVERAGING

- Up to 4096 Averages
- Reduces Noise
- Increases Sweep Time

Averaging is another way to improve accuracy. The improvement is proportional to the square root of the number of averages. The improvement from averaging, however, comes at the expense of increased sweep time.

Figure 8-12 shows the measured reduction in noise due to bandwidth and averaging.

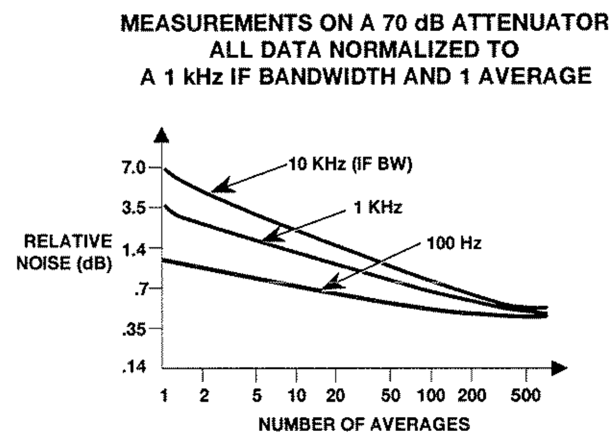


Figure 8-12. *Reduction in Noise Using Averaging*

Example: Using 1 kHz BW reduction and 10 averages, you would increase the signal-to-noise ratio by 7.6 dB but would lengthen the time required for the measurement by a factor of 4.3. This example assumes a constant signal power.

Test Device (DUT) Considerations

In order to test a device, the required input RF level and the expected device output RF level must be determined.

The RF level at Port 1 must be set for the device input RF power level required. Attenuation can be added in steps of 10 dB up to 70 dB using the built-in source attenuator.

The RF level into Port 2 should be kept to –10 dBm or less to ensure optimum linearity and to protect internal components from damage. The never-to-exceed RF level into either Port 1 or Port 2 is +20 dBm. You can add up to 40 dB of attenuation (in 10 dB steps) into Port 2 with Option 6.

If do not have the Option 6 built-in test attenuator, you should use external attenuators on Port 1 and Port 2 as needed. However, the use of external attenuators invalidates input and output match measurements; whereas, the built-in attenuator is compensated by the calibration and does not affect reflection measurements.

Before calibration, ensure that the test setup is correct by setting the power level and adding attenuation as needed.

PORT 1 RF OUTPUT LEVEL

- –10 dBm
- Can Add Up to 70db Attenuation in 10 dB Steps

PORT 2 RF INPUT LEVEL

- –10 dBm Maximum
- Can Add Up to 40 dB Attenuation in 10 dB Steps

EXTERNAL ATTENUATORS

- Use Only if Internal Attenuator Is Not Available—They Invalidate DUT Match Data

The 372XXA uses enhancements in the calibration to ensure a wide dynamic range. It automatically selects 1 kHz IF bandwidth and varies the number of averages with the calibration device. Terminations require the most averages.

CALIBRATION

- Set Desired RF Signal Level
- Include Attenuation As Needed

If desired, the Video IF bandwidth and number of averages can be specified for the calibration measurements. Using 100 averages (Avg = 100) appears to be sufficient for most measurements.

CALIBRATION

- Video IF Bandwidth Reduced Setting
- Number of Averages Varies With Calibration Device Measured

To obtain the maximum performance from the 372XXA for measurements of attenuation, you can use the capability of the N discrete frequency calibration to spot check measurements in the frequency band of interest.

CALIBRATION

- Can Select the Desired IF Bandwidth and Averaging

The measurement procedure is straight forward, as shown below.

TO MEASURE HIGH ATTENUATION

- 10 dBm Source Power
- 100 Averages in Calibration
- 100 Averages in Measurement

MEASUREMENT PROCEDURE

- Determine DUT I/O RF Levels
- Set Source RF Level
- Set Port 1 Source Attenuator and Port 2 Test Attenuator

EXAMPLE - FILTER

- No Attenuator Needed
- IF Bandwidth 1 kHz and 100 Averages

EXAMPLE - FET

- Set Port 1 Source Attenuator to 30 dB (for 37247A and below)
- No Port 2 Attenuator Is Needed
- Calibrate
- Use IF Bandwidth and Averaging As Desired

EXAMPLE - AMPLIFIER

- No Port 1 Attenuator
- Port 2 Test Attenuator to 10dB

Wide Dynamic Range Device - Filter

Since you do both low-insertion-loss and high-attenuation measurements simultaneously, use the maximum RF signal level and no attenuation. Selecting the 1 kHz Video IF BW setting and 100 averages will likely suffice for this kind of measurement.

High Gain Device - FET

This device has a typical 15 dB gain and requires an input level of about –30 dBm. Set the Port 1 Source Attenuator to 30 dB. Since the device RF output level is –15 dBm (–30 dBm + 15 dB[gain] = –15 dBm) no attenuation is needed at Port 2.

Medium Power Device - Amplifier

Measure the small signal parameters of a 10 dB gain device that requires an input power level of 0 dBm. Here, Port 1 will have no attenuation. The device RF output level is 10 dBm. This level equals 10 dBm (0 dBm + 10 dB[gain] = 10 dBm) into Port 2 and will cause compression in the measurement. At least 10 dB of test attenuation will be needed at Port 2, which will reduce the Port 2 RF level to 0 dB.

8-4 GROUP DELAY MEASUREMENTS

Group delay is the measure of transit time through a device at a particular frequency. Ideally, we want to measure a constant—or relatively constant—transit time over frequency. The top waveform shown in Figure 8-13 is measured at one frequency. The bottom waveform is identical to the first, simply delayed in time.

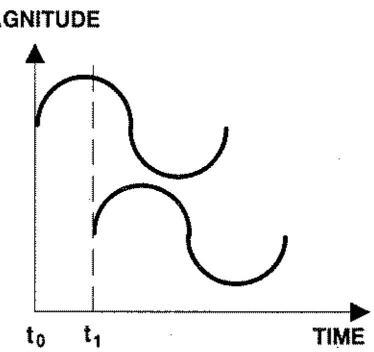


Figure 8-13. *Two Waveforms Delayed in Time*

Referring to Figure 8-14, the first waveform shown is the original waveform. It is made up of many frequency components. After traveling through a device the signal is delayed in time. Some frequencies are delayed more than others and thus our waveform does not have exactly the same shape as before.

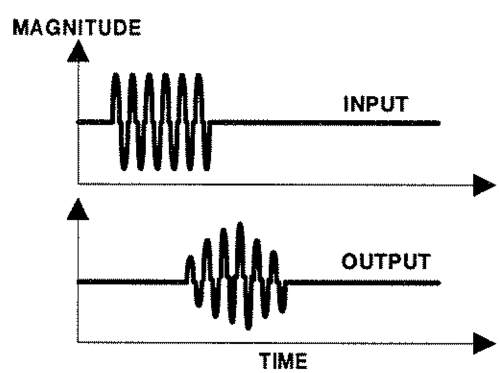


Figure 8-14. *Waveform with Frequency Differences*

NONLINEAR DELAY = DISTORTION

When delay is nonlinear, as shown above, distortion occurs. By measuring group delay with a network analyzer you can characterize the distortion that occurs from a signal traveling through your test device.

GROUP DELAY

- Measure During Design
- Avoid Distortion Later

When designing components it is important to measure group delay so that you can compensate for any distortion caused by the component. You may be able to tune the device so as to optimize the performance of group delay over the frequency range of interest. Outside of the specified frequency range, the group delay may or may not be linear.

GROUP DELAY

- Measure During Test
- Optimize Performance

So how is group delay measured? Signals travel too fast to enable measuring the input and output times of each frequency component. Consequently, we must use mathematical calculations to derive the group delay from the phase slope.

HOW IS GROUP DELAY MEASURED

Mathematical Representation of the Phase Slope

Group delay is mathematically represented by the following equations:

$$\tau = -\frac{-d\theta}{d\omega} = \frac{-1}{2\pi}\frac{d\theta}{df} = \frac{-1}{360}\frac{d\theta}{df} = \frac{1}{2\pi}\frac{\Delta\theta}{\Delta f}$$

What this equation shows is that group delay is a measure of the change in phase with relation to the change in frequency.

The change in frequency is referred to as an aperture.

$$\Delta f = Aperture$$

To measure group delay the frequency aperture must be selected. Depending on the size of aperture, different levels of precision can result for the measurement of group delay.

$$Aperture = \frac{Frequency\ Range}{\#\ Of\ Data\ Points}.$$

A wide aperture results in a loss of fine-grain variations but gives more sensitivity in the measurement of time delay. A small aperture gives better frequency resolution, but at the cost of lost sensitivity. Thus, for any comparison of group delay data you must know the aperture used to make the measurement (Figure 8-15).

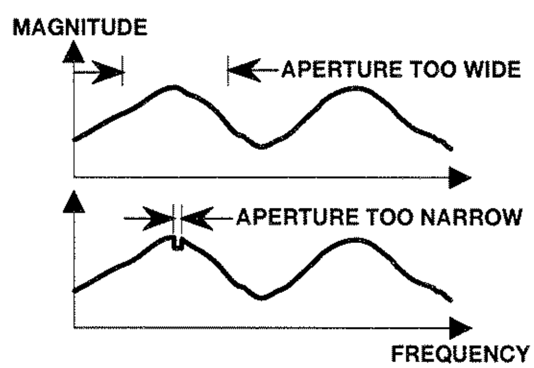


Figure 8-15. *Waveforms With Aperture Differences*

Let us take a look at a group delay measurement made on the WILTRON 372XXA Vector Network Analyzer. Group delay, as a measurement option, can be found in the Graph Type menu. After selecting the option, the 372XXA displays the data in a time-vs-frequency graph, or to be more exact, a group-delay-vs-frequency graph (Figure 8-16).

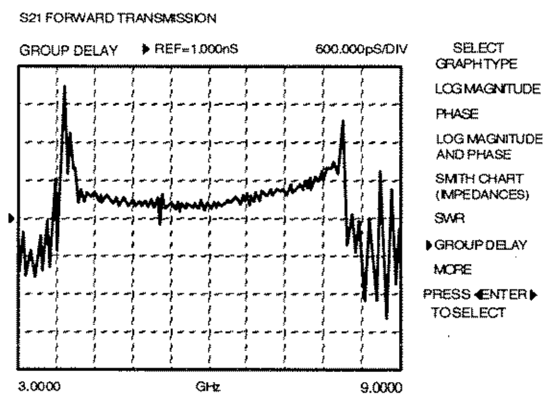


Figure 8-16. *Group Delay-vs-Frequency Graph*

The 372XXA automatically selects the frequency spacing between data points—that is, the aperture. Notice that this value is displayed on the screen with the measurement (Figure 8-17).

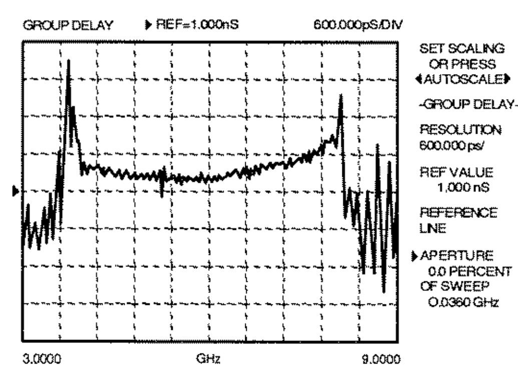


Figure 8-17. *Group Delay Screen Showing Aperture*

The aperture defaults to the smallest setting for the frequency range and number of data points selected. This value is displayed in the a Set Scale key menu when measuring group delay (Figure 8-18).

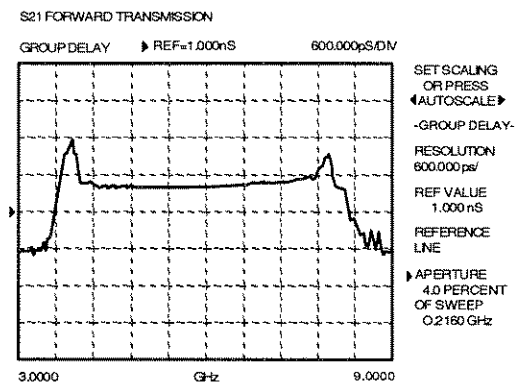


Figure 8-18. *372XXA Aperture*

GROUP DELAY APPLICATIONS

- Communications

Group delay applications are found throughout the microwave industry, although the majority of such measurements are made in the telecommunications area.

One occurrence of group delay that you may have experienced is with a long-distance telephone call. Occasionally a phone call can be disturbing because of the delay in time from when you speak and when the other person responds. If there is simply a delay, then time delay—or linear group delay—has occurred. But if the voices are also distorted, then non-linear group delay has occurred. It is this distortion that we must avoid. We can avoid linear group delay by measuring group delay both during the design and development stages and during recalibration in the field.

One final group-delay application is found in the development of components. In this application, group delay is measured for the transit time of a signal through the device. When time is of the essence in a fast switching system, as in a modern computer, the travel time through a device is critical.

8-5 ACTIVE DEVICE MEASUREMENTS

Active devices are key components in microwave systems.

The measurements that are made on active devices are similar to those made on passive devices.

Active devices come in many shapes and sizes. In most cases we are going to have to develop a fixture in which to mount the device.

Active devices require bias voltages, and in many cases they are easily damaged. High gain amplifiers may saturate with input signals of –50 dBm! With active devices, we have a new set of measurement requirements.

The 372XXA has been designed to help you make these types of measurements. It includes one 70 dB step attenuator used to adjust the Port 1 power level. A second 40 dB step attenuator is also included (with Option 6) in the forward transmission path to allow measurement of high gain devices without sacrificing reverse transmission and reflection measurements (S_{12}, S_{22}). Bias tees on each port are used to bias the device via the test port center conductor. This approach to bias is useful for testing transistors; however, MMIC's usually require bias injection at other points (Figure 8-19).

Test fixtures are necessary for mounting the device so that it can be measured in our coaxial (or waveguide) measuring system (Figure 8-20).

ACTIVE DEVICES

- FETs
- Amplifiers
- MMIC's

COMMON MEASUREMENTS

- S_{11} Input Match
- S_{21} Gain
- S_{12} Reverse Isolation
- S_{22} Output Match

WHAT'S DIFFERENT?

- Connectors
  - There May Not Be Any
  - Instead You Will See: Tabs-Leads-Pads

WHAT'S DIFFERENT?

- Voltage-Bias Requirements
- Signal Level Performance
  - Power Output
  - Max Input Level
- Non Linear
  - Gain Compression

ATTENUATORS
Bias Tees

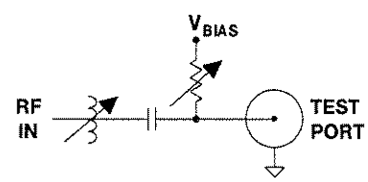


Figure 8-19. Bias Tee

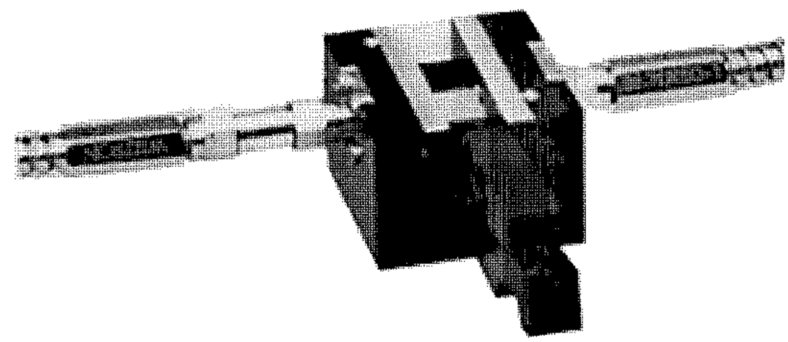


Figure 8-20. *Active Device Test Fixture*

Now we have an interesting situation. While we can measure the performance at the connector— which is the calibration plane— what we really want to know is how our device performs (Figure 8-21).

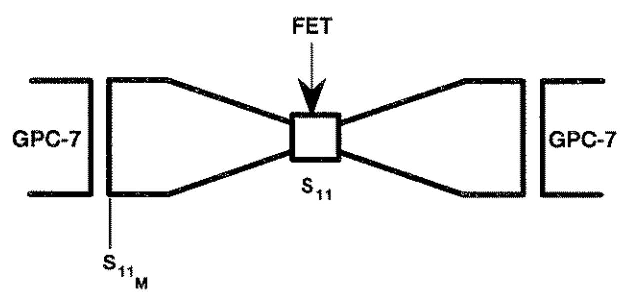


Figure 8-21. *Test Device, What It Looks Like*

DE-EMBEDDING

Remove or "De-embed" The Effects of the Fixture

You can consider the device embedded in the fixture and can measure the S-Parameters of the fixture with the device installed.

The most elementary situation is a system in which the test fixture is electrically ideal or transparent. In this case the solution is simple— merely move the reference plane out to the device (Figure 8-22).

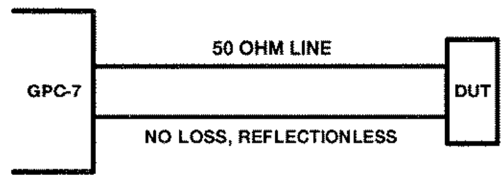


Figure 8-22. *Simple Example of De-Embedding*

In some cases—depending on the fixture or the device being measured—this is satisfactory. But when it is not, we need to employ other techniques.

One of the reasons that moving the reference plane out to the device does not always work, is that the test fixture includes a transition from coax to a structure such as microstrip, co-planer waveguide, or stripline (Figure 8-23).

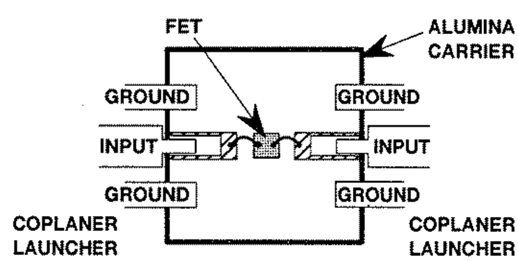


Figure 8-23. *Coax-to-Substrate Transition*

WHAT DO WE DO?
TWO APPROACHES ARE COMMON

- Calibrate the Fixture As "Part of the Analyzer"
- Characterize the Fixture and Compute the Desired Result

Engineers have come to grips with the general problem. However, there is no established standard approach. Two of the more common approaches are to calibrate the fixture as a part of the analyzer, and to characterize the fixture and compute the desired result.

APPROACH NUMBER 1 CALIBRATE THE FIXTURE

- Special Calibration Devices Required

In the discussion on calibration we saw that the calibration components establish the reference plane and determine the quality of the measurement. If we have a good Open, Short and Z_0 load to place at the end of a microstrip line, we can calibrate the system at the point of measurement.

Figure 8-24 shows some of the special test-fixture calibration standards that are available.

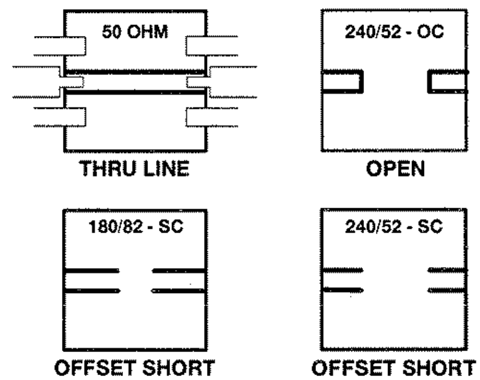


Figure 8-24. *Special Test Fixtures*

SPECIAL CALIBRATION DEVICES PROBLEMS

- Opens Are Difficult-Radiation Effects
- Good Terminations Are Hard to Find,
  20-30 db Is Often the Best That We Can Do and This Determines the "Effective Directivity"

These special calibration kits are far from perfect, but they are superior to our perfect transmission line assumption.

You may also have heard of the probe stations built to permit on-wafer calibration measurements.

ON-WAFER CALIBRATION

Calibration Standards Are on a Wafer

The Open, Short, termination approach provides three known standards that permit the analyzer to solve for three unknowns (Figure 8-25).

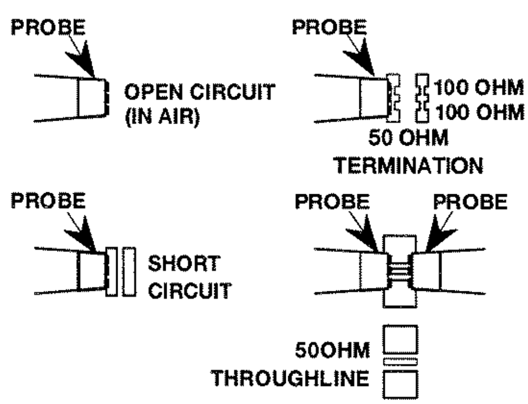


Figure 8-25. *Solving for Unknowns*

CAUTION

You should turn off or disconnect the bias supplies during the calibration, since you are using a Short as the calibration standard.

It is also possible to use three known impedances. For instance, a varactor with three voltages applied (Figure 8-26).

SPECIAL CALIBRATION KITS

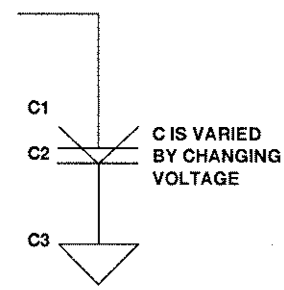


Figure 8-26. *Three Known Impedances*

APPROACH NUMBER 2
CHARACTERIZE THE FIXTURE

- Model
- Measure
- Compute the Desired Result

The second approach is to model the fixture. Modeling is elegant but of limited use due to the non-ideal characteristics of the fixture. Modeling can be accomplished in a CAD system like Touchstone or Compass.

In summary, there are quite a variety of approaches—all with their own characteristic pitfalls. Engineers try to choose the most appropriate technique for their application.

8-6 MULTIPLE SOURCE CONTROL

The Multiple Source Control mode permits independent control of the 372XXA source, receiver, and an external WILTRON synthesizer (67XXB, 68XXXB), without the need of an external controller (Figure 8-1).

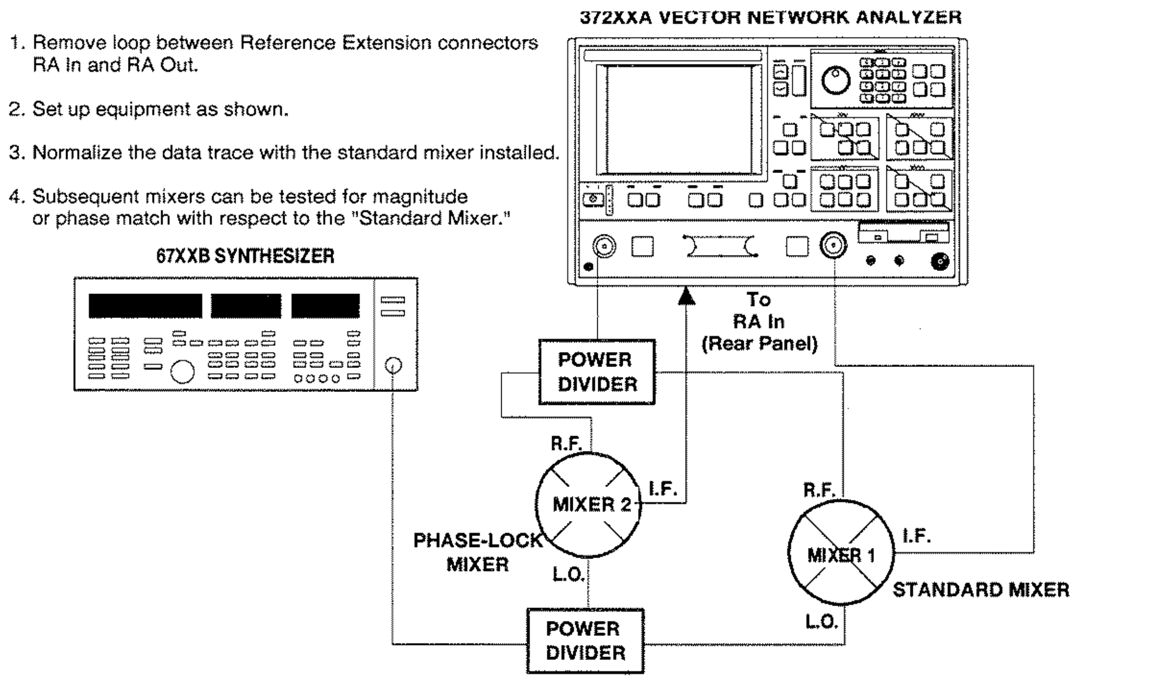


Figure 8-1. *Test Setup for Multiple Source Control Operation*

Operation in this mode requires Option 11. Removing the reference loop lets you isolate the receiver from the source. This permits testing of frequency converters such as mixers.

The software lets the frequency ranges and output powers of the two sources be specified. A frequency sweep can comprise up to five separate bands, each with independent source and receiver settings for convenient testing of frequency translation devices such as mixers. Up to five sub-bands (harmonics) can be tested in one sweep.

Control Formula

Multiple Source control is specified as a displayed frequency range partitioned into from one-to-five consecutive bands. For each band Source 1, Source 2, and receiver frequencies may be interdependently specified per the formula:

$$Frequency = \left(\frac{Multiplier}{Divisor}\right) \times \left(\frac{F}{Offset\ Frequency}\right)$$

Where:

- ☐ Multiplier and Divisor are integer constants
- ☐ F is the displayed frequency
- ☐ Offset Frequency is the offset frequency constant

The following rules apply:

- ☐ Multiplier, Divisor and Offset Frequency may be independently specified for each source and receiver.
- ☐ F is global, and is the same value in all formulas.
- ☐ Each source or receiver may, if desired, be set to a CW frequency, removing F from the equation.

NOTE

When a formula results in an unachievable frequency, such as 1/3 X 1 GHz, the result is rounded to the nearest achievable frequency, defined by the source frequency resolution. Frequency resolution is 1 kHz, except for 67XXB sources with a high-end frequency above 20 GHz. For these models, the resolution is 2 kHz.

Bands

The displayed frequency range may be divided into up-to five bands. Band 1 must start at the beginning of the frequency range and end at either the user-specified stop frequency or the end of the frequency range. Band 2 must begin at the next point after band 1 ends, and it must end at either the user-specified stop frequency or the end of the frequency range. Band 5 must end at the end of the frequency range. Independent source and receiver control formulas may be specified for each band.

Operation Procedures

Procedures for performing preoperation and operation are given on pages 8-31 thru 8-34.

MENU U1

SELECT UTILITY
FUNCTION OPTIONS

GPIB ADDRESSES

DISPLAY
INSTRUMENT
STATE PARAMS

GENERAL DISK
UTILITIES

CALIBRATION
COMPONENT
UTILITIES

COLOR
CONFIGURATION

DATA OFF
DRAWING

BLANKING
FREQUENCY
INFORMATION

PRESS <ENTER>
TO SELECT
OR TURN ON/OFF

MENU GP7

GPIB ADDRESSES

IEEE 488.2
GPIB INTERFACE

ADDRESS:
6

DEDICATED
GPIB INTERFACE

EXTERNAL SOURCE
4

PLOTTER
8

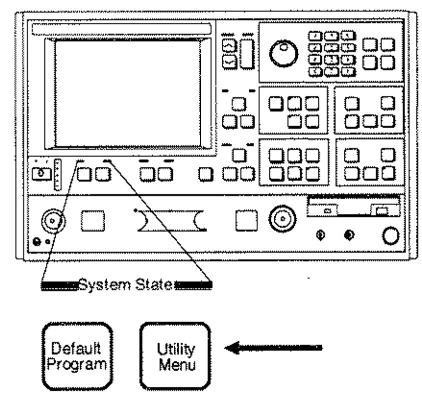
POWER METER
13

FREQUENCY COUNTER
7

Multiple Source Control Preoperational Setup
The two sources receive control information from the 372XXA VNA. The GPIB address assigned to the external source must be identical to the address contained in the data directed to the source by the 372XXA VNA. Assure source/VNA address compatibility as follows:

Step 1. Install Sources 1 and 2 on the GPIB (IEEE-488 bus).

Step 2. Press the Utility Menu key.



Step 3. Move cursor to **GPIB ADDRESSES** and press Enter, when menu U1 (left) appears.

Step 4. When menu GP7 (left) appears, observe that the address number is correct. If necessary, use keypad to enter new address.

MENU OPTNS

OPTIONS

TRIGGERS

REAR PANEL OUTPUT

DIAGNOSTICS

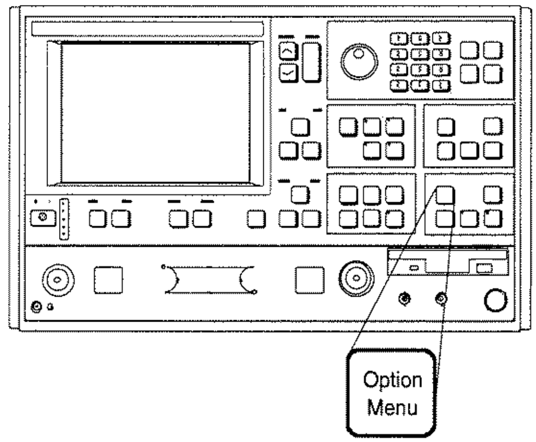
MULTIPLEXER CONTROL

MULTIPLE SOURCE CONTROL

PRESS <ENTER> TO SELECT

Multiple Source Control Operation

Step 5. Press the Option Menu key.



MENU OM1

MULTIPLE SOURCE CONTROL

DEFINE BANDS

MULTIPLE SOURCE MODE

OFF

STANDBY

ON

PRESS <ENTER> TO SELECT

Step 6. When menu OPTIONS (left) appears, move cursor to **MULTIPLE SOURCE CONTROL** and press Enter.

Step 7. When menu OM1(left) appears, move cursor to **DEFINE BANDS** and press Enter. This brings menu OM 1 to the screen.

MENU OM2
DEFINE BANDS
BAND 1
DISPLAYED FREQ RANGE
BAND START F XXX.XXXXXX XXX GHz
BAND STOP F XXX.XXXXXXXXX GHz
BAND FUNCTIONS
EDIT SYSTEM EQUATIONS
STORE BAND 1 BANDS STORED: (1 2 3 4 5)
CLEAR ALL DEFINITIONS
SET MULTIPLE SOURCE MODE
PRESS <ENTER> TO SELECT

MENU OM3
EDIT SYSTEM EQUATIONS
EQUATION TO EDIT
SOURCE 1
SOURCE 2
RECEIVER
EQUATION SUMMARY
C.W. OFF
MULTIPLIER XX
DIVISOR XX
OFFSET FREQ XXX.XXXXXXXXX GHz
PREVIOUS MENU
PRESS <ENTER> TO SELECT

Step 8. Coincident with menu OM2 (left), the data display area of the screen presents a chart entitled "RANGES OF BANDS STORED." This chart shows the band start and band stop frequencies that have been stored for each of five bands.

Using menu OM2, the displayed frequency range can be divided into one to five bands.

Band 1 must start at the beginning of the frequency range and end at either the user-specified stop frequency or the end of the frequency range.

Band 2 must begin at the next point after band 1 ends and end at either the user-specified stop frequency or the end of the frequency range.

Step 9. Move cursor to **BAND**; select **BAND 1** by entering "1" using the keypad or rotary knob.

Step 10. Move cursor to **BAND START F**, and use keypad or rotary knob to enter the band 1 start frequency.

Step 11. Move cursor to **BAND STOP F**, and enter the band 1 stop frequency.

Step 12. Move cursor to **EDIT SYSTEM EQUATIONS** and press Enter.

Step 13. When menu OM3 (left) appears, select **SOURCE 1**.

Step 14. Move cursor to **MULTIPLIER** and use keypad or rotary knob to enter desired multiplier for Source 1. This is the multiplier term in the following equation:

Freq. = (Multiplier/Divisor) X (F + Offset Frequency)

Step 15. Move cursor to **DIVISOR** and use keypad or rotary knob to enter desired **DIVISOR** for source 1. This is the divisor term given in the above equation.

Step 16. Move cursor to either **OFFSET FREQUENCY**, and use keypad or rotary knob to enter desired offset frequency for Source 1; or **C.W.** , and press Enter to toggle C.W. to OFF.

The Offset Frequency choice is the offset frequency given in the above equation. The C.W. choice removes F from the equation and places Source 1 in the CW mode.

MENU OM2
DEFINE BANDS
BAND 2
DISPLAYED FREQ RANGE
BAND START F XX.XXXXXX GHz
BAND STOP F XX.XXXXXX GHz
BAND FUNCTIONS
EDIT SYSTEM EQUATIONS
STORE BAND 1 BANDS STORED: (NONE)
CLEAR ALL DEFINITIONS
SET MULTIPLE SOURCE STATE
PRESS <ENTER> TO SELECT

MENU OM1
MULTIPLE SOURCE CONTROL
DEFINE BANDS
MULTIPLE SOURCE MODE
OFF
STANDBY
ON
PRESS <ENTER> TO SELECT

Step 17. Move the cursor to **PREVIOUS MENU** and press Enter. This returns you to menu OM2 (left).

Step 18. Move cursor to **STORE BAND 1** and press ENTER. This stores the band start frequency, the band stop frequency and the Source 1, Source 2 and Receiver equations.

Step 19. Note that the **BAND** number has incremented to 2.

Step 20. Repeat the above steps to define the start and stop frequencies for bands 2 thru 5. Set up the system equations for each band.

NOTE

Except for band 1, the system software constrains all start frequencies to follow the previous band's stop frequency. However, while frequency bands are being defined or the system equations are being edited, the system is automatically placed in the standby mode. In this mode, frequencies that may be entered are not supervised by the system software; any frequency can be entered and displayed. When the mode is switched to **ON** (in menu OM1, left), the system software restricts the frequencies to band limits. When the mode is switched to **OFF**, the frequencies are restricted to system limits.

Chapter 9
Time Domain

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Chapter 9
Time Domain

9-1 INTRODUCTION

This chapter describes the optional Time Domain feature.

9-2 TIME DOMAIN MEASUREMENTS

The Option 2, Time Domain feature provides a useful measurement tool for determining the location of impedance discontinuities. Some typical applications are identifying and analyzing circuit elements, isolating and analyzing a desired response, locating faults in cables, and measuring antennas.

TIME DOMAIN
A USEFUL TOOL FOR:

- Identifying and Analyzing Circuit Elements
- Isolating a Desired Response
- Locating Faults
- Making Antenna Measurements

The relationship between the frequency-domain response and the time-domain response of a network is described mathematically by the Fourier transform.

The 372XXA makes measurements in the frequency domain then calculates the inverse Fourier transform to give the time-domain response. The time-domain response is displayed as a function of time (or distance). This computational technique benefits from the wide dynamic range and the error correction of the frequency-domain data.

Let us examine the time-domain capabilities. Two measurement modes are available: lowpass and bandpass.

372XXA TIME DOMAIN MODES

- Lowpass Mode
- Bandpass Mode

We use the lowpass mode with devices that have a dc or low-frequency response. In the lowpass mode two responses to the device-under-test (DUT) are available: impulse or step response.

LOWPASS MODE

- Either Impulse or Step Response Available
- Displays Impedance Information
- Requires Harmonically Related Frequencies
- Used When Device Has a DC or Low Frequency Path

The frequencies used for the test must be harmonically related (interger multiples) to the start frequency. The simplest way to calculate this relationship is to divide the highest frequency in the calibration by 1600 (the default number-of-points available); this is the start frequency. For example if the highest frequency is 40 GHz, the calculated start frequency is 0.025 GHz (40/1600).

LOWPASS IMPULSE RESPONSE

- Location of Discontinuities
- Information on Type of Discontinuities

The lowpass impulse response displays the location of discontinuities as well as information useful in determining the impedance (R, L, or C) of each discontinuity.

The impulse response is a peak that goes positive for $R>Z_0$ and negative for $R<Z_0$. The height of the response is equal to the reflection coefficient

$$\rho = \frac{R - Z_0}{R + Z_0}$$

The impulse response for a shunt capacitance is a negative-then-positive peak and for a series inductance is a positive-then-negative peak (Figure 9-1).

CIRCUIT ELEMENTS
Lowpass Impulse Response

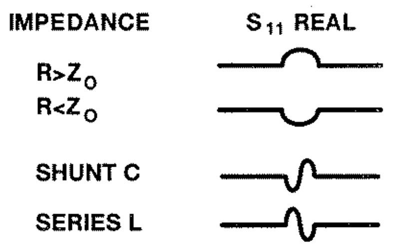


Figure 9-1. Lowpass Impulse Response

An example of using impulse response is circuit impedance analysis. With an impulse response, we can observe the circuit response of a passive device, such as a multielement step attenuator (Figure 9-2), and make final, realtime adjustments during the test.

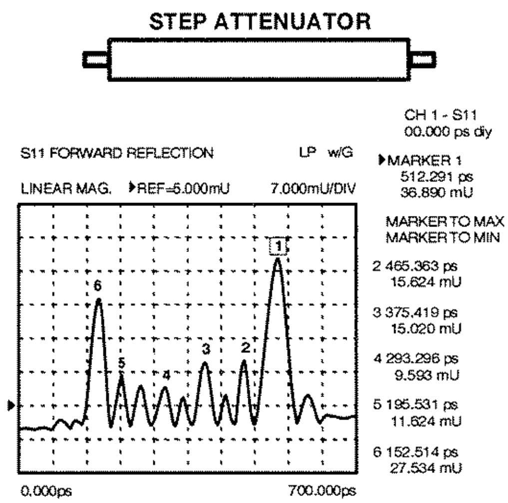


Figure 9-2. Example of Lowpass Impulse Response

In the above example, the connectors at each end have been gated out (page 9-12), which lets you better observe the internal circuit response. Each displayed marker has been manually set to the peak of the response at each adjustable circuit element. In this way, the data display lets you make the adjustment in realtime, while the marker menu shows the magnitude of the response at each marker.

The lowpass step response displays the location of discontinuities as well as information useful in determining the impedance (R, L, or C) of each discontinuity. If you are familiar with time-domain reflectometry

LOWPASS STEP RESPONSE

- TDR Measurement
- Location of Discontinuities
- Information on Type of Discontinuities

(TDR) you may feel more comfortable with step response, as the displays are similar.

The lowpass step response for a resistive impedance is a positive level shift for $R>Z_0$ and a negative level shift for $R<Z_0$. The height of the response is equal to the reflection coefficient

$$\rho = \frac{R - Z_0}{R + Z_0}$$

The step response for a shunt capacitance is a negative peak, and for a series inductance it is a positive peak (Figure 9-3).

CIRCUIT ELEMENTS
Lowpass Step Response

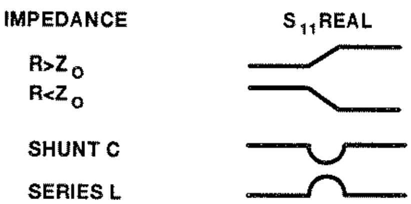


Figure 9-3. Lowpass Step Response

An example of using the lowpass step response is cable-fault location. In the frequency domain a cable with a fault exhibits a much worse match than a good cable. Using lowpass step response, both the location of the discontinuity and the information about its type are available (Figure 9-4).

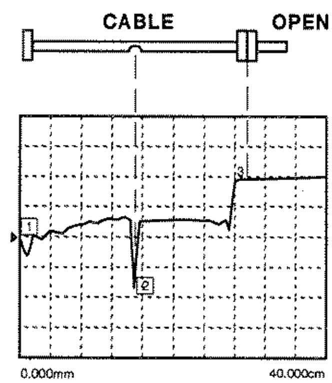


Figure 9-4. Example of Lowpass Step Response

In the above example, the dip in the display shows the shunt-capacitive response caused by a crimp in the cable. The response at the end of the cable shows the step-up that is typical of an open (Figure 9-3).

BANDPASS MODE

- Calculates Impulse or Phasor-Impulse Response
- Uses Any Frequency Range
- Used When Device Does Not Have a DC or Low-Frequency Path

The 372XXA bandpass mode gives the response of the DUT to an RF-burst stimulus. Two types of response are available: impulse and phasor-impulse. An advantage of the bandpass mode is that any frequency range can be used. Use this mode with devices that do not have a dc or low-frequency path.

BANDPASS IMPULSE RESPONSE

- Magnitude Measurement Only
- Location of Discontinuities
- No Information on Type of Discontinuities

Use the bandpass-impulse response to show the location of a discontinuity in time or distance, as indicated by changes in its magnitude. Unlike the lowpass mode, no information as to the type of the discontinuity is available. A typical use for this mode is to measure devices—such as, filters, waveguide, high-pass networks, bandpass networks—where a low-frequency response is not available.

The bandpass-impulse response for various impedance discontinuities is shown in Figure 9-5. As we can see, no information about the type of discontinuity is available.

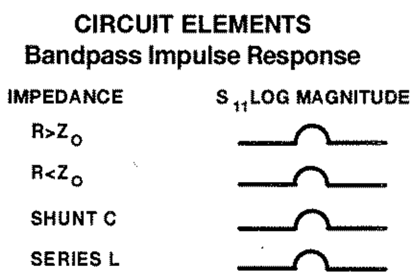


Figure 9-5. Bandpass Impulse Response

An example of using the bandpass-impulse response, is the pulse height, ringing, and pulse envelope of a bandpass filter (Figure 9-6).Use the phasor-impulse response with bandpass response to determine the type of an isolated impedance discontinuity.

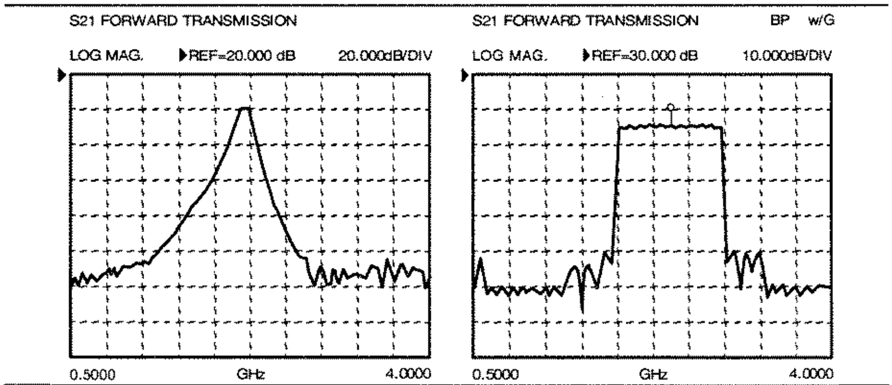


Figure 9-6. *Example of Bandpass-Impulse Response*

PHASOR IMPULSE BANDPASS RESPONSE

- Real and Imaginary Measurement
- Information On Type of Discontinuity

After the bandpass-impulse response has been isolated, the phasor-impulse response for a resistive-impedance-level change is a peak that goes positive ($R>Z_0$) for the real part of S_{11} and negative for $R<Z_0$. The imaginary part remains relatively constant. In each case the peak is proportional to the reflection coefficient. The phasor-impulse response for a shunt capacitance is a negative-going peak in the imaginary part of S_{11}. For a series inductance, it is a positive going peak (Figure 9-7).

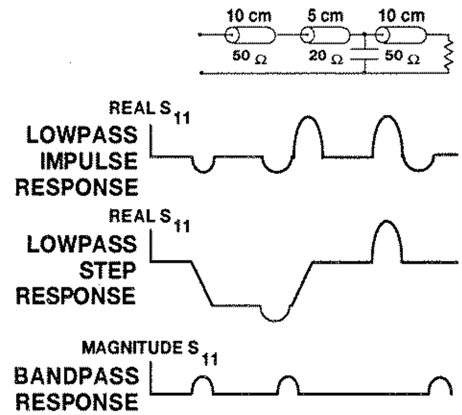


Figure 9-7. *Complex Impedances*

Next, let us look at a complex circuit. A resistive impedance change R<Zo and a shunt capacitance and series inductance. These impedance changes are shown in the time domain for the lowpass-impulse response, lowpass-step response, and bandpass-impulse response (Figure 9-8).

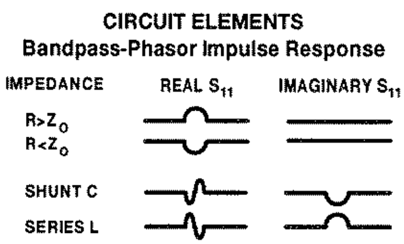


Figure 9-8. *Bandpass Phasor Response*

The 372XXA processes bandpass-impulse-response data to obtain phasor-impulse response. This becomes most advantageous where both a reactive reflection and an impedance change occur at the same location. The real part of the time-domain response shows the location of impedance level changes, while the imaginary part shows the type of reactive discontinuity. Phasor-impulse response displays one discontinuity at a time (Figure 9-9).

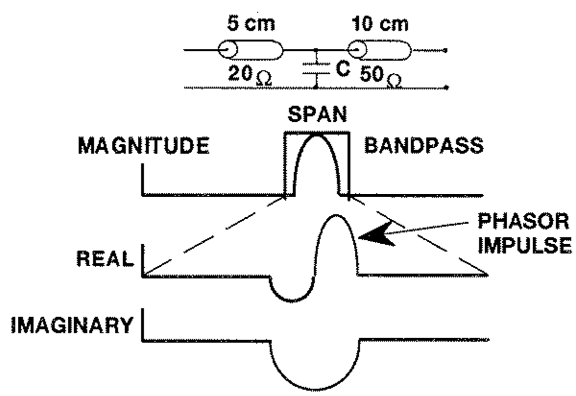
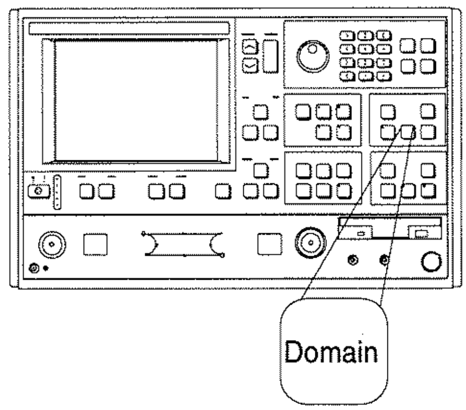


Figure 9-9. *Phasor-Impulse Response Data*

9-3 OPERATING TIME DOMAIN

To operate in the time domain mode, press the Domain key (below). A domain menu (Figure 9-10) lets you select the frequency- or time-domain modes by simple cursor selection. The 372XXA defaults to the frequency domain.

Select time or distance for the horizontal axis. The 372XXA defaults to time axis.



NOTE

If you select distance, be sure to set the dielectric constant in the Reference Delay menu (Figure 9-11).

SET
DIELECTRIC
CONSTANT
AIR
(1.000649)
POLYETHYLENE
(2.26)
TEFLON
(2.10)
MICROPOROUS
TEFLON
(1.69)
OTHER
XXXX.XX
PRESS <ENTER>
TO SELECT

Figure 9-11. *Reference Delay Menu*

DOMAIN
▸ FREQUENCY
FREQUENCY
WITH TIME
GATE
TIME
LOWPASS MODE
TIME
BANDPASS MODE
DISPLAY
TIME/DISTANCE
SET RANGE
SET GATE
GATE ON/OFF
HELP
PRESS <ENTER>
TO SELECT
OR SWITCH

DOMAIN
FREQUENCY
FREQUENCY
WITH TIME
GATE
▸ TIME
LOWPASS MODE
TIME
BANDPASS MODE
DISPLAY
TIME/DISTANCE
SET RANGE
SET GATE
GATE ON/OFF
HELP
PRESS <ENTER>
TO SELECT
OR SWITCH

DOMAIN
FREQUENCY
FREQUENCY
WITH TIME
GATE
TIME
LOWPASS MODE
▸ TIME
BANDPASS MODE
DISPLAY
TIME/DISTANCE
SET RANGE
SET GATE
GATE ON/OFF
HELP
PRESS <ENTER>
TO SELECT
OR SWITCH

Figure 9-10. *Domain Menu*

Select SET RANGE and use the START/STOP or GATE/SPAN selections to set the range (Figure 9-12).

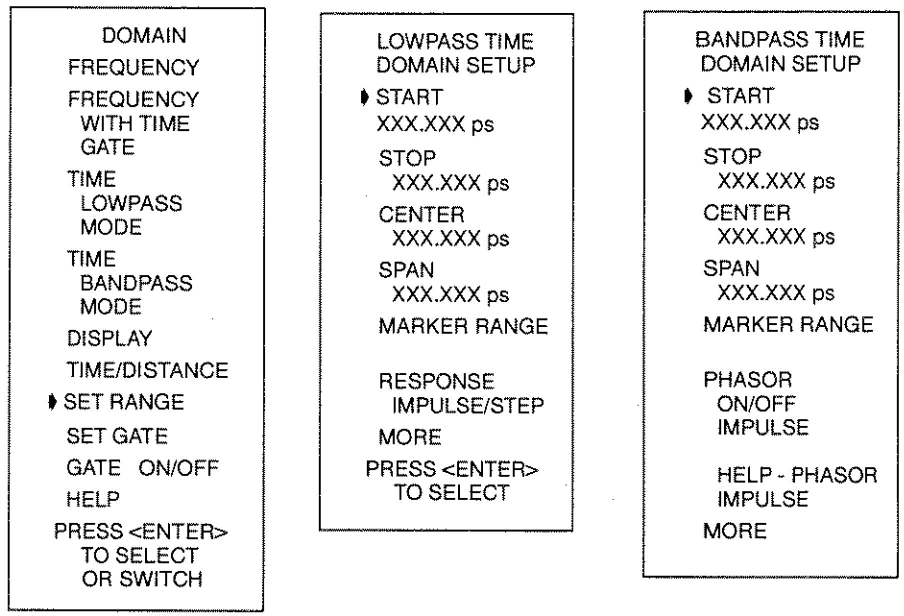


Figure 9-12. *Set Range Menu*

For the lowpass mode select either IMPULSE or STEP Response and set the DC term. The 372XXA defaults to the IMPULSE Response and the AUTO EXTRAPOLATE mode for the DC term (Figure 9-13).

NOTE

The bandpass mode displays Bandpass Impulse Response unless we select Phasor Impulse Response.

```
LOWPASS TIME
DOMAIN SETUP
START
  XXX.XXX ps
STOP
  XXX.XXX ps
CENTER
  XXX.XXX ps
SPAN
  XXX.XXX ps
MARKER RANGE

▶ RESPONSE
  IMPULSE/STEP
MORE
PRESS <ENTER>
  TO SELECT
```

```
SET D.C. TERM
FOR LOWPASS
PROCESSING
▶AUTO
 EXTRAPOLATE
LINE
  IMPEDANCE
OPEN
SHORT
OTHER
  –XXX.XXX #
  ABOVE VALUE
  REPRESENTS A
  REFLECTION
  COEFF. OF
  XX.XXX mU
PREVIOUS MENU
PRESS <ENTER>
  TO SELECT
```

```
BANDPASS TIME
DOMAIN SETUP
START
  XXX.XXX ps
STOP
  XXX.XXX ps
CENTER
  XXX.XXX ps
SPAN
  XXX.XXX ps
MARKER RANGE

▶ PHASOR ON/OFF
  IMPULSE

HELP-PHASOR
IMPULSE
MORE
PRESS <ENTER>
  TO SELECT
```

Figure 9-13. *Response Menus*

The Marker Range menu allows us to zoom in and display the range between two selected markers (Figure 9-14).

```
LOWPASS TIME
DOMAIN SETUP
START
  XXX.XXX ps
STOP
  XXX.XXX ps
CENTER
  XXX.XXX ps
SPAN
  XXX.XXX ps
▶ MARKER RANGE
RESPONSE
  IMPULSE/STEP
MORE
PRESS <ENTER>
  TO SELECT
```

```
TIME
MARKER SWEEP
▶START TIME
  MARKER ( )
  XXX.XXX nS
STOP TIME
  MARKER ( )
  XXX.XXX nS
RESTORE
  ORIGINAL
  RANGE
PREVIOUS MENU
USE KEYPAD
TO CHOOSE
MARKER (1 - 6)
OR
PRESS <ENTER>
TO SELECT
```

Figure 9-14. *Marker Range Menus*

9-4 WINDOWING

Windowing is a frequency filter that we apply to the frequency-domain data when we convert it to time-domain data. This filtering rolls off the abrupt transition at F1 and F2. This effectively produces a time-domain response with lower sidelobes. Windowing allows a limited degree of control over the pulse shape, trading off ringing (sidelobes) for pulse width (Figure 9-15).

We select windowing from the Time Domain Setup menu. Four different windows are available: RECTANGLE, NOMINAL, LOW SIDELOBE, and MINIMUM SIDELOBE. The RECTANGLE option provides the narrowest pulse width, while the MINIMUM SIDELOBE option provides the least ringing (fewest sidelobes). The 372XXA defaults to the NOMINAL option, which is acceptable for most measurements. Windowing menus are shown in Figure 9-16.

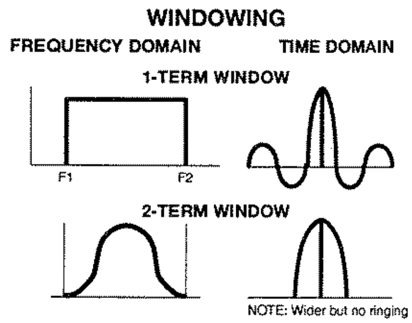


Figure 9-15. Windowing

LOWPASS TIME
DOMAIN SETUP
START
XXX.XXX ps
STOP
XXX.XXX ps
CENTER
XXX.XXX ps
SPAN
XXX.XXX ps
MARKER RANGE
RESPONSE
IMPULSE/STEP
▸ MORE
PRESS <ENTER>
TO SELECT

LOWPASS TIME
DOMAIN SETUP
▸ SET WINDOW
NOMINAL
SET GATE
SET D.C. TERM
XXX.XXX
PREVIOUS MENU
PRESS <ENTER>
TO SELECT

SHAPE
▸ RECTANGULAR
NOMINAL
LOW SIDELOBE
MIN SIDELOBE
HELP
PRESS <ENTER>
TO SELECT

Figure 9-16. Window Shape Menus

DOMAIN
FREQUENCY
FREQUENCY WITH TIME GATE
TIME LOWPASS MODE
▶ TIME BANDPASS MODE
DISPLAY
SET RANGE
▶ SET GATE
GATE ON/OFF
HELP
PRESS <ENTER> TO SELECT OR SWITCH

Step 1. Convert the frequency domain data into the time domain using TIME BANDPASS MODE (Figure 9-20).

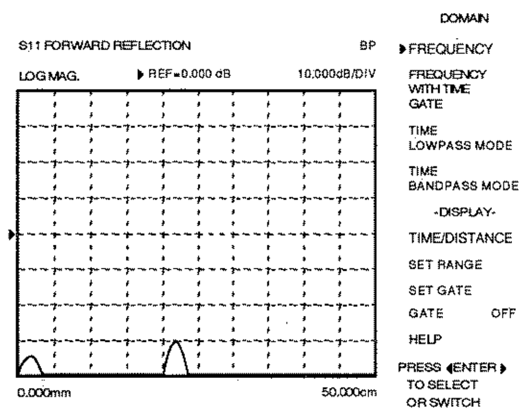


Figure 9-20. *Time Gating*

GATE
START XXX.XXX mm
STOP XXX.XXX mm
CENTER XXX.XXX mm
SPAN XXX.XXX mm
▶ SET SHAPE NOMINAL
GATE DISP
PREVIOUS MENU
PRESS <ENTER> TO SELECT

Step 2. Select SET GATE in the Domain menu (left) then GATE DISP in the Gate menu. This allows us to put the gate around the discontinuity of interest using the START, STOP, CENTER, or SPAN selections (Figure 9-21).

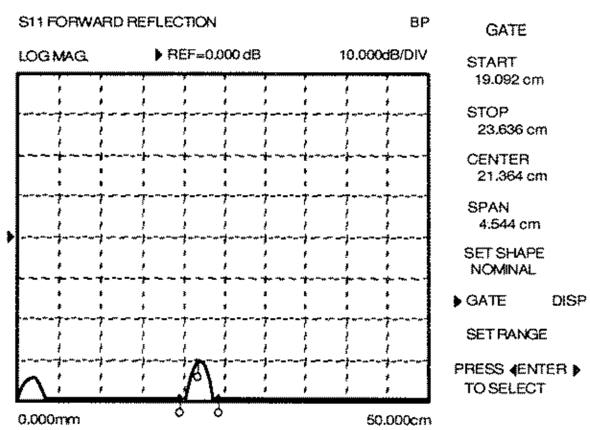


Figure 9-21. *Gate Display*

SHAPE
RECTANGULAR
▶ NOMINAL
LOW SIDELOBE
MIN SIDELOBE
HELP
PRESS <ENTER> TO SELECT

Step 3. Select GATE ON in the Gate menu and the unwanted responses are removed (Figure 9-22).

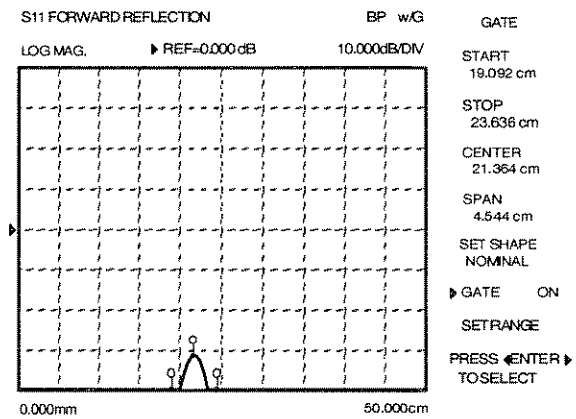


Figure 9-22. Response with GATE ON Selected

Step 4. Select PHASOR IMPULSE ON in the Bandpass menu. The real and imaginary responses of the Phasor Impulse Response are displayed. Based on the display, the device has a series inductance as well as resistance >50 ohms (Figure 9-23).

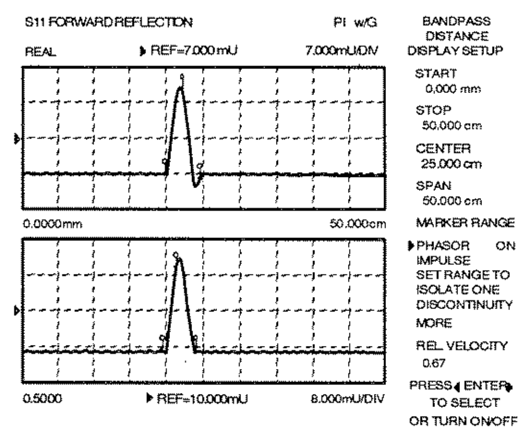


Figure 9-23. Response with PHASOR IMPULSE ON Selected

Step 5. Select FREQUENCY WITH TIME GATE in the Domain menu to display the frequency domain S_{11} forward reflection of the gated time domain response (Figure 9-24).

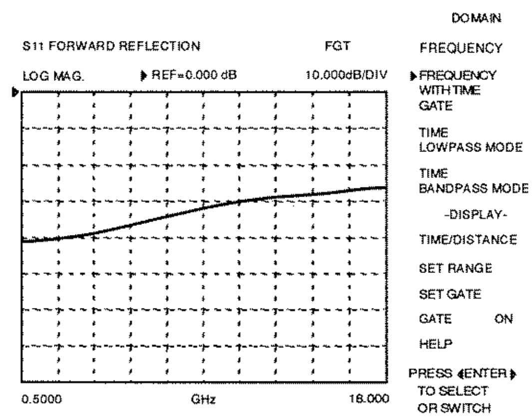


Figure 9-24. *Response FREQUENCY WITH TIME GATE Selected*

An example of gating a transmission measurement is making an antenna measurement. Gating can remove unwanted ground or chamber reflections that interfere with characterizing an antenna's pattern (Figure 9-25).

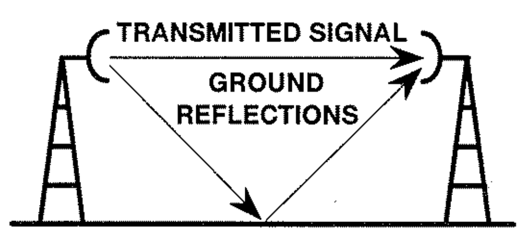


Figure 9-25. *Antenna Measurements*

MEASUREMENT CONSIDERATIONS

- Small Responses
- Close Responses
- Distant Responses

Finally, let's look at some measurement considerations and ways to optimize their time-domain results.

SMALL RESPONSES

- Small Impedance Changes
- Long Lossy Devices
- High Insertion Loss Paths

OPTIMIZE FOR SMALL RESPONSES

- Use Averaging
- Use 100 Hz IF Bandwidth
- Use Window With Least Ringing

CLOSE RESPONSES

- Physically Close Elements
- Similar Length Transmission Paths

OPTIMIZE FOR CLOSE RESPONSES

- Use Widest Sweep
- Use Window with Narrowest Pulse Shape

DISTANT RESPONSES

- Use 1601 Points
- Use Minimum Required Frequency Range

Optimizing Time Domain Results

Small impedance changes cause small responses that can be lost in the noise floor. This is also true of long cable and waveguide runs with high insertion loss.

To optimize for small responses:

- ☐ Use averaging and 100 Hz IF bandwidth to lower the noise floor.
- ☐ Use maximum power to provide maximum dynamic range.
- ☐ Use the window with the lowest sidelobes to reduce ringing.

Elements that are physically close or have similar length transmission paths can have minimal or overlapping time domain responses.

To optimize for close-response measurements and attain the best resolution:

- ☐ Use the widest sweep.
- ☐ Use the window with the narrowest pulse shape.

To maximize the distance measurement capability without causing aliasing (false information), use the minimum-frequency-step size by selecting 1601 points and the minimum-required-frequency range.

In summary, the 372XXA Time Domain capability is a powerful and versatile tool in performing network analyzer measurements.

Time Domain Menus

A flow diagram of the menus associated with the Time Domain Option is shown in foldout Figure 9-25. The menu choices are described in Appendix A. They appear in alphabetical order by their call letters: TD1, TD2, TD2dl, etc.

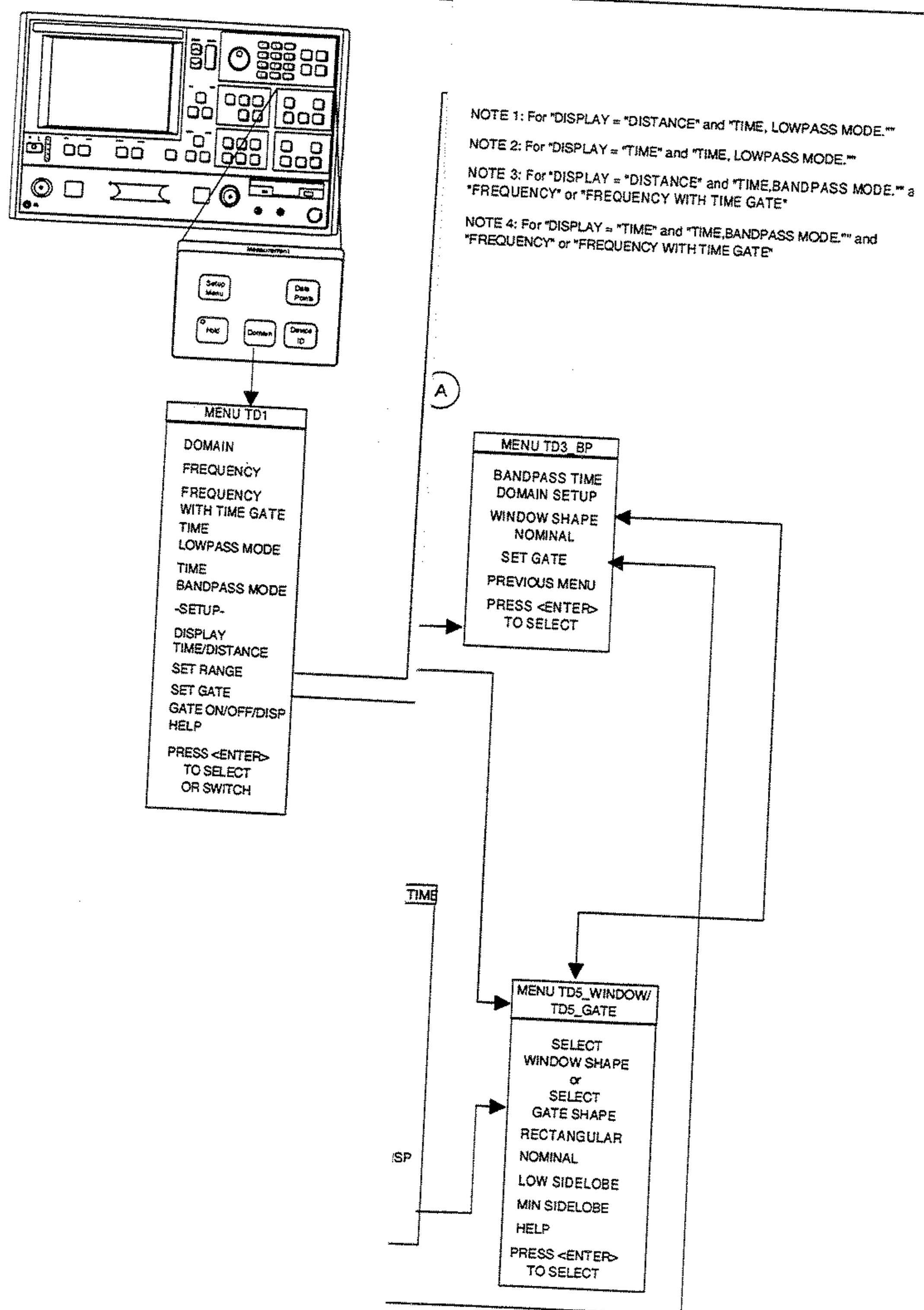


Figure 9-25. *Time Domain Menu Flow*

Chapter 10
Operational Checkout Procedures

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Chapter 10 Operational Checkout Procedures

10-1 INTRODUCTION

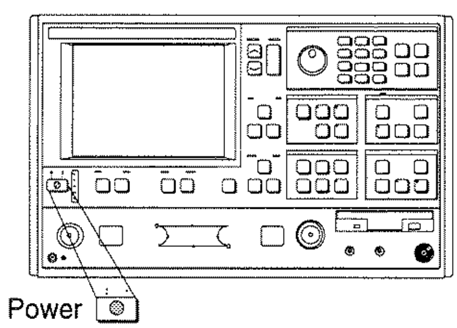
This chapter provides quick operational checkout procedures that may be used by incoming inspectors to ensure that the Model 372XXA Vector Network Analyzer is operational. This is a quick-check procedure. For the full performance verification procedure, refer to the Series 372XXA Maintenance Manual, Wiltron Part Number 10410-00153.

10-2 REQUIRED EQUIPMENT

Flexible microwave cable (through line).
Short, Open

10-3 INITIAL SETUP

Perform the following steps before starting the performance tests.



- ☐ Press Power key (left) to On.

NOTE

Allow the system to warm up for at least 60 minutes to ensure operation to performance specifications.

10-4 SELF TEST

Perform an instrument self test to ensure that the 372XXA is operating properly. To start a self test, Press Option Menu key and make the menu choices shown in Figure 10-1.

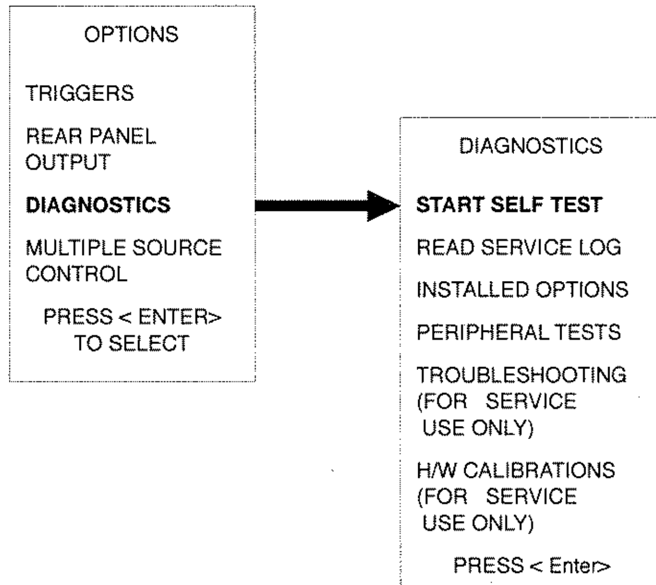
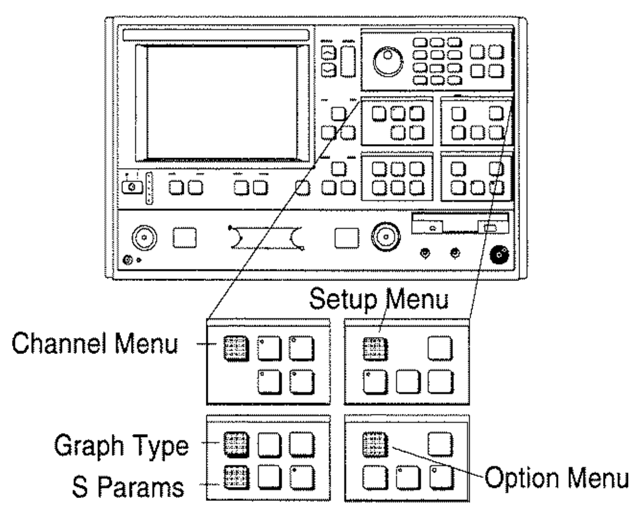


Figure 10-1. *Performing a Self Test*

10-5 SAMPLER EFFICIENCY TEST

This test verifies that each individual receiver channel operates properly. Measurement calibration of the system is *not* required for this test.

This test requires that you press specified front panel keys and make choices from the displayed menu(s). The keys used in this test are shown below.

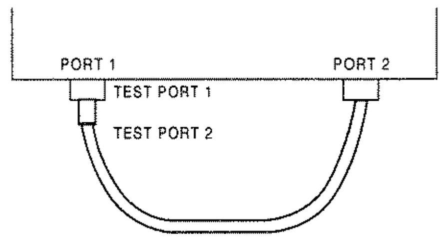


Key	Menu Choice
Options Menu	Non-Ratioed Parameters, see Figure 10-2
Setup Menu	START: 1 GHz STOP: Table 10-1, High-End Frequency
Channel Menu	FOUR CHANNELS
Graph Type	LOG MAGNITUDE (All channels)

Test Setup

Setup 372XXA as described below.

Step 1. Connect Test Ports 1 and 2 together using a high-quality through line (below).



Step 2. Reset the 372XXA using the Default Program key.

Step 3. Set up the 372XXA as shown in table at left.

Test Procedure

Perform test as described below.

Step 1. Observe sweep indicators and allow at least one complete sweep to occur on all four channels.

Step 2. Verify that the maximum-value to minimum-value amplitude slope (Figure 10-3, page 10-7) meets the specifications shown below.

Model	High-End Frequency	Reference Channel Slope	Test Channels Slope
37211A	3 GHz	<5 dB	<8 dB
37217A	8.6 GHz	<5 dB	<10 dB
37225A	13.5 GHz	<7 dB	<9 dB
37247A	20 GHz	<7 dB	<9 dB
37269A	40 GHz	<16 dB	<18 dB

Step 1. Press OPTION MENU key.

Step 2. Make menu choices as shown below.

Step 3. Press SETUP MENU key; set START frequency to 1 GHz.

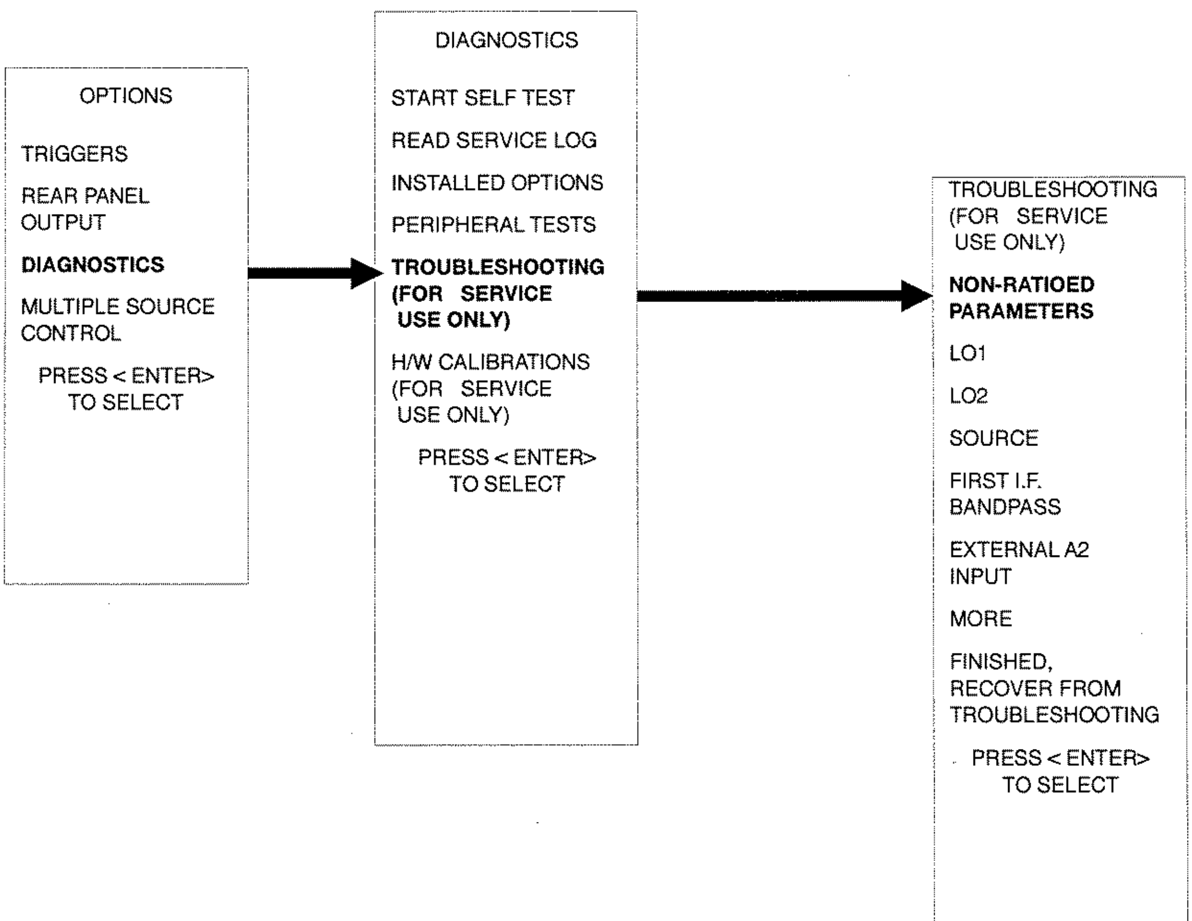
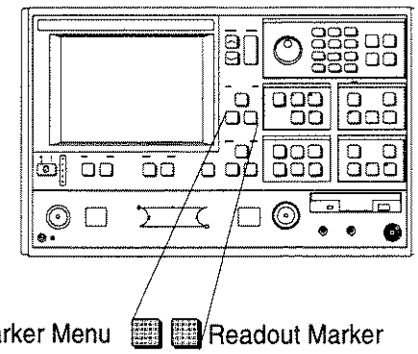


Figure 10-2. *Redefining Selected Parameter Automatically for Sampler Efficiency Testing*



Step 3. Verify that the minimum amplitude meets the specifications shown below.

Model	Test Channels	Reference Channel
37211A	–25	–20
37217A	–28	–22
37225A	–30	–24
37247A	–31	–25
37269A	–40	–40

NOTE
Use the Marker Menu and Readout Marker keys (left) and menus to obtain precise frequency and amplitude values.

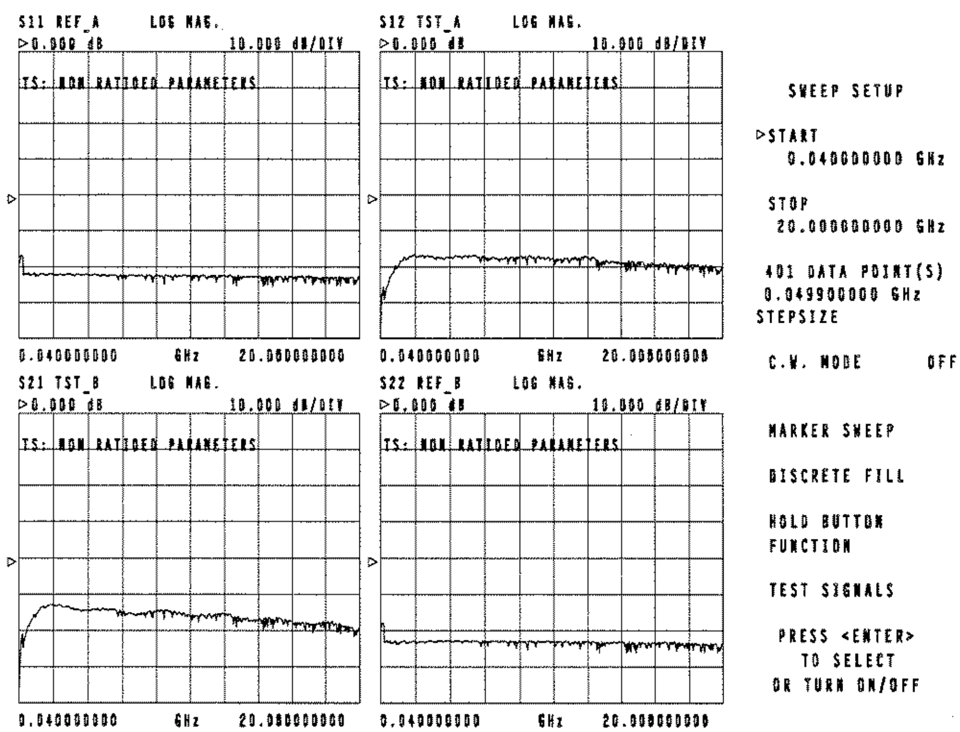


Figure 10-3. Sampler Efficiency Test Waveforms

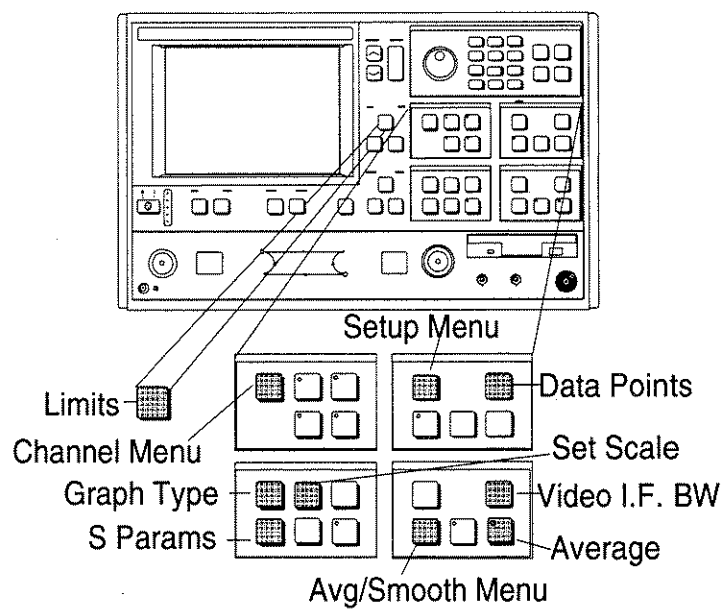
10-6 HIGH LEVEL NOISE TEST

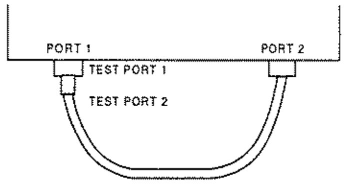
Key	Menu Choice
Setup Menu	START: 40 MHz STOP: High-end frequency
Channel Menu	DUAL CHANNELS 1-3
Graph Type	LOG MAGNITUDE (Both channels)
Set Scale	RESOLUTION: 0.020 dB/DIV REF VALUE: 0.0 dB (Both channels)
S-Params	Channel 1 – S12 Channel 3 – S21
Avg/ Smooth Menu	AVERAGING 128 MEAS. PER POINT
Average	ON
Data Points	401
Video IF BW	NORMAL (1 kHz)
Limits	UPPER LIMIT ON 0.020 dB 37247A & below), or: 0.040 dB (37269A) LOWER LIMIT ON –0.020 dB (37247A & below) or: –0.040 dB (37269A) DISPLAY LIMITS ON

The following test verifies that the high-level signal noise in the 372XXA will not significantly affect the accuracy of subsequent measurements. Calibration of the system is *not* required for this test.

This test requires that you press specified front panel keys and make choices from the displayed menu(s). The keys used in this test are highlighted below.

Test Setup Setup 372XXA as described in table at left.





Test Procedure

Perform test as described below.

Step 1. Connect Test Port 1 and Test Port 2 (top left) together.

Step 2. Press Ch 1 key.

Step 3. Press Trace Memory key.

Step 4. Choose **VIEW DATA** (Figure 10-4) from menu and press Enter key.

Step 5. While observing sweep indicators, allow at least two complete sweeps to occur.

Step 6. Choose **STORE DATA TO MEMORY** from menu and press Enter key.

Step 7. Choose **VIEW DATA / MEMORY** from menu and press Enter key.

Step 8. While observing sweep indicators, allow at least two complete sweeps to occur.

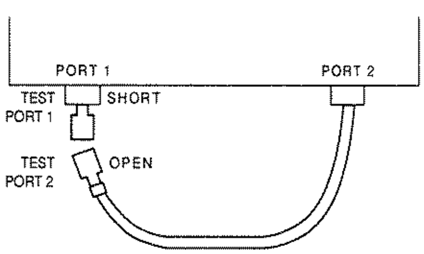
Step 9. Verify that the peak-to-peak High Level Noise falls within the area between the two limit lines (Figure 10-4).

Step 10. Press Ch 3 key.

Step 11. Repeat steps 4 thru 9 for channel 3.

Step 12. Press S Params key; set Ch 1 for S_{11} and Ch 3 for S_{22}.

Step 13. Connect a Short to Test Port 1 and an Open to Test Port 2 (left).



Step 14. Repeat steps 2 thru 9.

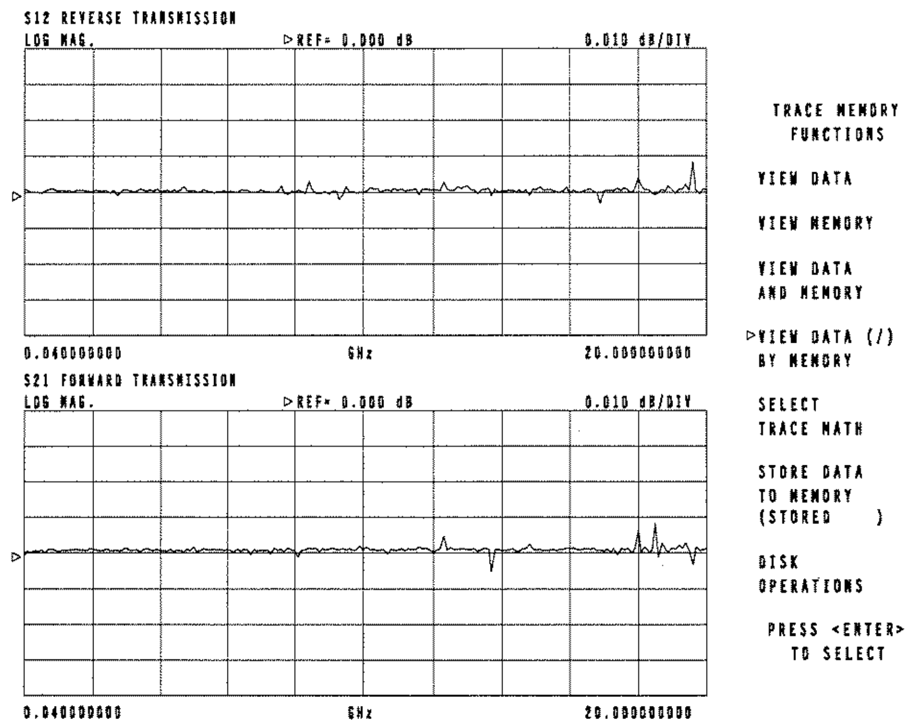


Figure 10-4. *High Level Noise Test Waveform*

APPENDIX A
FRONT PANEL MENUS, ALPHABETICAL LISTING

A-1 INTRODUCTION

This appendix provide description for all menu choices. Menus are arranged in alphabetical order by call sign (C1, SU2, DSK1, etc).

A-2 MENUS

A listing of all of the menus contained in this appendix is provided in the tabulation below. This listing gives the call sign, name, and page number of the menus.

Menu Call Letter and Name	Page Number
Menu BW1 or CAL_BW1, Select Video Bandwidth	A-6
Menu C1, Select Calibration Data Points	A-7
Menu C2, Frequency Range of Calibration	A-8
Menu C2A, Insert Individual Frequencies	A-9
Menu C2B, Single Point Calibration	A-10
Menu C2C, Calibration Range—Harmonic Cal for Time Domain	A-10
Menu C2D, Fill Frequency Ranges	A-11
Menu C3, Confirm Calibration Parameters	A-12
Menu C3A, Confirm Calibration Parameters	A-13
Menu C3B, Confirm Calibration Parameters	A-14
Menu C3C, Confirm Calibration Parameters	A-15
Menu C3D, Confirm Calibration Parameters	A-16
Menu C3E, Confirm Calibration Parameters	A-17
Menu C3F, Confirm Calibration Parameters	A-17
Menu C3G, Confirm Calibration Parameters	A-18
Menu C4_P1/C4_P2, Select Calibration Type	A-19
Menu C4A_P1/C4A_P2, Select Calibration Type	A-20
Menu C5, Select Calibration Type	A-21
Menu C5A, Select 1 Path 2 Port Calibration Type	A-22
Menu C5B, Select Transmission Freq Response Calibration Type	A-22
Menu C5C, Select Reflection Only Calibration Type	A-23
Menu C5D, Select Use of Isolation	A-23
Menu C6, Select Load Type	A-24
Menu C6A, Enter Broadband Load Impedance	A-24
Menu C7-Series, Begin Calibration Sequence	A-25
Menu C8, Slide Load to Position X	A-25
Menu C9, Connect Throughline	A-26

Menu Call Letter and Name	Page Number
Menu C9A, Connect Device 1, Line	A-26
Menu C9B, Connect Device 2, Line/Lowband	A-27
Menu C9C, Connect Device 2, Line	A-27
Menu C11, Begin Calibration	A-28
Menu C11A, Select Calibration Method	A-29
Menu C12_P1/C12_P2, Enter the Capacitance Coefficients for Open Devices	A-30
Menu C12A_P1/C12A_P2, Enter the Offset Length	A-31
Menu C13, Set Reflection Pairing Menu	A-31
Menu C14, Enter Offset Lengths (Shorts)	A-32
Menu C15, Select Waveguide Kit to Use	A-33
Menu C15A, Enter Waveguide Parameters	A-34
Menu C15B, Enter Waveguide Parameters	A-34
Menu C16, Select Microstrip Parameters	A-35
Menu C16A, Enter Microstrip Parameters	A-35
Menu C17, Enter Line Impedance	A-36
Menu C18, Change LRL/LRM Parameters	A-36
Menu C18A, Change LRL/LRM Parameters	A-37
Menu C18B, Change LRL/LRM Parameters—Two Band Calibration	A-38
Menu C19, Change LRL/LRM Parameters	A-39
Menu C20, Change Through Parameters	A-40
Menu Cal_Completed	A-40
Menu Cal_Applied	A-41
Menu Cal_EM, Enhancement Menu for Calibration	A-41
Menu CM, Select Display Mode	A-42
Menu DB1, PORT 1 or PORT 2 Select	A-43
Menu DF1, Discrete Fill	A-44
Menu DF2, Insert Individual Frequencies	A-45
Menu DFLT, Default Program Selected	A-46
Menu DG1, Diagnostics 1	A-47
Menu DG2, Troubleshooting	A-48
Menu DG3, Diagnostics 3	A-49
Menu DSK1-FD, Floppy Disk Utilities	A-51
Menu DSK1-HD, Hard Disk Utilities	A-51
Menu DSK2, Select File to Read	A-52
Menu DSK3, Select File to Overwrite	A-53
Menu DSK6, Type of Files to Delete	A-54
Menu DSK7, Select File to Delete	A-55
Menu DSK8, Type of Files to Copy	A-56
Menu DSK9, Select File to Copy	A-57
Menu DSK10, Capture Tabular Data	A-60

Menu Call Letter and Name	Page Number
Menu DSK11, Caution	A-60
Menu EM, Enhancement Menu	A-61
Menu GP5, Select Name	A-62
Menu GP7, Display GPIB Status	A-63
Menu GT1, Select Graph Type	A-64
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Menu L2, Set Limits—Linear Polar	A-67
Menu L3, Set Limits—Linear Polar/Smith Chart	A-68
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Menu L6, Set Limits—Log Polar	A-71
Menu L7, Set Limits—Group Delay	A-72
Menu L8, Set Limits—Linear Magnitude	A-73
Menu L9, Set Limits—Linear Magnitude and Phase	A-74
Menu L10, Set Limits—Real Values	A-75
Menu L11, Set Limits—Imaginary Values	A-76
Menu L12, Set Limits—Real and Imaginary Values	A-77
Menu L13, Set Limits—SWR	A-78
Menu LD1, Define Upper Limit	A-79
Menu LD2, Define Lower Limit	A-80
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Menu LF2, Set Limit Frequencies—Phase	A-82
Menu LF3, Set Limit Frequencies—Group Delay	A-83
Menu LF4, Set Limit Frequencies—Linear Mag	A-84
Menu LF5, Set Limit Frequencies—SWR	A-85
Menu LF6, Set Limit Frequencies—Real	A-86
Menu LF7, Set Limit Frequencies—Imaginary	A-87
Menu LSX, Segmented Limits	A-88
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Menu M1, Set Markers	A-90
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Menu NO1, Trace Memory Functions	A-94
Menu NO2, Select Trace Math	A-95
Menu NO3, Trace Memory Disk Functions	A-95
Menu OM1, Multiple Source Control Menu	A-96
Menu OM2, Define Bands Menu	A-97
Menu OM3, Edit System Equations	A-98

Menu Call Letter and Name	Page Number
Menu OPTNS, Select Options	A-99
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Menu PL1, Plot Options	A-103
Menu PL2, Select Plot Size	A-104
Menu PL3, Select Pen Colors	A-105
Menu PM1, Select Data Output Type	A-106
Menu PM2, Data Output Headers	A-107
Menu PM3, Tabular Printer Output Format	A-108
Menu PM3A, Graphical Printer Output Format	A-109
Menu PM4, Disk Output Operations	A-110
Menu PM5, Printer Type, Options	A-111
Menu RCV1, Receiver Mode	A-112
Menu RCV2, User Defined Receiver Mode Menu	A-112
Menu RCV3, Standard Receiver Mode Warning Menu	A-113
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Menu RD1, Set Reference Delay	A-114
Menu RD2, Set Dielectric Constant	A-115
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Menu SR2, Recall or Save	A-117
Menu SR3, Save to Internal memory	A-118
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Menu SS2 or CAL_SS2, Set Scaling 2	A-120
Menu SS3Z/SS3Y or CAL_SS3Z/CALSS3Y, Set Scaling 3	A-121
Menu SS4 or CAL_SS4, Set Scaling 4	A-122
Menu SS5 or CAL_SS5, Set Scaling 5	A-123
Menu SS6 or CAL_SS6, Set Scaling 6	A-124
Menu SS7 or CAL_SS7, Set Scaling 7	A-125
Menu SS8 or CAL_SS8, Set Scaling 8	A-126
Menu SS9 or CAL_SS9, Set Scaling 9	A-127
Menu SS10 or CAL_SS10, Set Scaling 10	A-128
Menu SS11 or CAL_SS11, Set Scaling 11	A-129
Menu SS12 or CAL_SS12, Set Scaling 12	A-130
Menu SS13 or CAL_SS13, Set Scaling 13	A-131
Menu SU1, Sweep Setup 1	A-132
Menu SU2 or CAL_SU2, Sweep Setup 2	A-133
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Menu SU5, Frequency Marker Sweep	A-136

Menu Call Letter and Name	Page Number
Menu SU6, Frequency Marker C.W.	A-136
Menu SU8 or CAL_SU8, Calibrate For Flat Test Port Power	A-138
Text Associated With Flat Power Calibation Menu SU8	A-139
Menu SU9, Number of Data Points	A-140
Menu SU9A, Number of Data Points 2	A-141
Menu TD1, Domain (Frequency/Display)	A-142
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Menu TD2dl, Lowpass Distance Display Setup	A-144
Menu TD2tb, Bandpass Time Domain Setup	A-145
Menu TD2db, Bandpass Distance Display Setup	A-146
Menu TD3b, Bandpass Time Domain Setup	A-147
Menu TD3l, Lowpass Time Domain Setup	A-147
Menu TD4d/t, Gate (Distance/Time)	A-148
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Menu TD6, Set D.C. Term for Low Pass Processing	A-150
Menu TD7t, Time Marker Sweep.	A-151
Menu TD7d, Distance Marker Range	A-152
Menu TRIG, Triggers Measurement	A-153
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Readout Text Associated With Menu U4	A-156
Menu U3, Calibration Component Utilities	A-157
Menu U4, Display Installed Calibration Components Information 1	A-158
Menu U4A, Display Installed Calibration Components Information 2	A-159
Menu U5, Color Configuration	A-159

MENU	DESCRIPTION
SELECT VIDEO BANDWIDTH	
MAXIMUM (10 kHz)	Selects video bandwidth to be 10 kHz.
NORMAL (1 kHz)	Selects video bandwidth to be 1 kHz.
REDUCED (100 Hz)	Selects video bandwidth to be 100 Hz.
MINIMUM (10 Hz)	Selects video bandwidth to be 10 Hz.
PRESS <ENTER> TO SELECT AND RESUME CAL	Pressing the ENTER key implements your selection. The "AND RESUME CAL" text appears when menu is accessed during calibration.

Menu BW1 or CAL_BW1, Select Video Bandwidth

MENU	DESCRIPTION
SELECT CALIBRATION DATA POINTS	
NORMAL (1601 POINTS MAXIMUM)	Selects the standard calibration from a start to a stop frequency that provides for up to 1601 equally spaced (except the last) points of data for the defined frequency range.
C.W. (1 POINT)	Selects the single frequency (C.W.) calibration sequence that provides for 1 data point at a selected frequency.
N-DISCRETE FREQUENCIES (2 TO 1601 POINTS)	Selects the discrete frequency calibration mode that lets you input a list of 2 to 1601 individual data point frequencies.
TIME DOMAIN (HARMONIC)	Selects the calibration mode for low-pass time-domain processing.
PRESS <ENTER> TO SELECT	Pressing the ENTER key implements your selection.

Menu C1, Select Calibration Data Points

MENU	DESCRIPTION
FREQUENCY RANGE OF CALIBRATION	
START XXX.XXXXXXXXXGHz	Enter the sweep-start frequency for calibration. If you desire, you can change this frequency for your measurement when you reach menu SU1, which follows the final calibration menu. The only restriction is that your start measurement frequency be greater than or equal to your start calibration frequency.
STOP XXX.XXXXXXXXX GHz	Enter the sweep-stop frequency for calibration. Like the start frequency, this too can be changed for your measurement. The stop frequency must be lower than or equal to your stop calibration frequency. In other words, your measurement frequency span must be equal to or smaller than your calibration frequency span.
SET CENTER/SPAN	Calls Menu C2_CENTER, which lets you enter a center frequency and span range.
XXX DATA POINTS XXX.XXXXXXXXXGHz STEPSIZE	The program automatically sets the step size, based on the selected start and stop frequencies. The step size will be the smallest possible (largest number of points up to a maximum of 1601), based on the chosen frequency span.
MAXIMUM NUMBER OF DATA POINT(S)	
1601 MAX PTS 801 MAX PTS 401 MAX PTS 201 MAX PTS 101 MAX PTS 51 MAX PTS	
NEXT CAL STEP	Displays the next menu in the calibration sequence.
PRESS <ENTER> TO SELECT	Pressing the ENTER key implements your menu selection.

Menu C2, Frequency Range of Calibration (Start/Stop)

MENU	DESCRIPTION
CAL FREQ RANGE	
CENTER XXX.XXXXXXXXXGHz	Enter the center frequency for calibration. If you desire, you can change this frequency for your measurement when you reach menu SU1_CENTER, which follows the final calibration menu.
SPAN XXX.XXXXXXXXX GHz	Enter the span width for calibration. Like the start frequency, this too can be changed for your measurement.
SET START/STOP	Calls Menu C2, which lets you enter a start and stop frequency.
XXX DATA POINTS XXX.XXXXXXXXXGHz STEPSIZE	The program automatically sets the step size, based on the selected center and span frequencies. The step size will be the smallest possible (largest number of points up to a maximum of 1601), based on the chosen frequency span.
MAXIMUM NUMBER OF DATA POINT(S)	
1601 MAX PTS 801 MAX PTS 401 MAX PTS 201 MAX PTS 101 MAX PTS 51 MAX PTS	
NEXT CAL STEP	Displays the next menu in the calibration sequence.
PRESS <ENTER> TO SELECT	Pressing the ENTER key implements your menu selection.

Menu C2_CENTER, Frequency Range of Calibration (Center/Span)

MENU	DESCRIPTION
INSERT INDIVIDUAL FREQUENCIES	
INPUT A FREQ, PRESS <ENTER> TO INSERT	
NEXT FREQ. XXX.XXXXXXXXXGHz	Move the cursor here and enter the next frequency for which you wish calibration data taken. If the AUTO INCR option is ON, pressing Enter automatically increments the calibration frequency by the interval in GHz that appears below the option.
XXXX FREQS. ENTERED, LAST FREQ WAS XXX.XXXXXXXXXGHz	Shows the number of frequencies that you have entered and reports the value of the last frequency entered.
AUTO INCR ON (OFF) XXX.XXXXXXXXXGHz	Move the cursor here and press ENTER to switch the Auto-Increment mode on or off. If AUTO INCR is on, you may enter the frequency spacing.
PREVIOUS MENU	Calls menu C2D.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing Enter will cause actions as described above.

Menu C2A, Insert Individual Frequencies

MENU	DESCRIPTION
SINGLE POINT C.W. CALIBRATION	
C.W. FREQ XXX.XXXXXXXXXGHz	Move cursor here and enter the frequency for which calibration is to be done.
NEXT CAL STEP	Move cursor here and press ENTER when finished.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C2B, Single Point Calibration

MENU	DESCRIPTION
CALIBRATION RANGE	
HARMONIC CAL FOR TIME DOMAIN	
START (STEP) XXX.XXXXXXXXXGHz	Move cursor here to enter the desired start frequency. This frequency also will be used as the frequency increment.
APPROXIMATE STOP XXX.XXXXXXXXX GHz	Move the cursor here to enter the approximate desired stop frequency. The frequency will be adjusted to the nearest harmonic multiple of the start frequency.
USING ABOVE START AND STOP WILL RESULT IN XXX DATA POINTS XXX.XXXXXXXXX GHz TRUE STOP FREQ	The program automatically indicates the number of data points and the true (harmonic) stop frequency.
NEXT CAL STEP	Move the cursor here and press Enter when finished.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C2C, Calibration Range—Harmonic Cal for Time Domain

MENU	DESCRIPTION
DISCRETE FILL	
INPUT START, INCR, POINTS, THEN SELECT "FILL RANGE"	This menu is used to create one or more ranges of discrete equally spaced frequency points for calibration.
START FREQ XXX.XXXXXXXXX GHz	Enter the first frequency of the range.
INCREMENT XXX.XXXXXXXXX GHz	Enter the increment (step size) between one frequency and the next.
NUMBER OF PTS XXXX POINT(S)	Enter the number of frequency points in the range.
STOP FREQ XXX.XXXXXXXXX GHz	Enter the stop frequency, in GHz.
FILL RANGE (XXXX ENTERED)	Moving the cursor here and pressing ENTER fills the range and shows the number of frequencies selected (in NUMBER OF PTS above).
INDIVIDUAL FREQ INSERT	Calls menu C2A, which allows you to set the individual frequencies.
CLEAR ALL	Clears all entries displayed above.
FINISHED NEXT CAL STEP	Calls menu C3, the next menu in the calibration sequence.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C2D, Fill Frequency Ranges

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for Standard OSL method, coaxial line type.
PORT 1 CONN XXXXXXXX	Calls Menu C4_P1 or C4A_P1, which displays the Port 1 test port connector type to be used during OSL calibration. This should agree with the connector type that both your calibration components and the test device mate with. Move cursor here and press Enter to display menu used to change connector type.
PORT 2 CONN XXXXXXXX	Calls Menu C4_P2 or C4A_P2, which displays the Port 2 test port connector type to be used during OSL calibration. This should agree with the connector type that both your calibration components and the test device mate with. Move cursor here and press Enter to display menu used to change connector type.
REFLECTION PAIRING XXXXXX	Calls menu C13, which lets you select the pairing (mixed or matched) for the types of reflection devices (open/short) that you will use on Ports 1 and 2 for calibration.
LOAD TYPE XXXXXXXX	Calls Menu C6, which displays type of load selected for calibration—broadband fixed or sliding. Move cursor here and press ENTER to display menu used to change load type.
THROUGH LINE PARAMETERS	Calls Menu C20, which lets you enter throughline parameters—including offset length and loss equation coefficients.
REFERENCE IMPEDANCE	Calls Menu C17, which lets you choose the reference impedance value (1 $\mu\Omega$ to 1 kΩ) for the devices connected to Ports 1 and 2 for calibration. Default value is 50Ω.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings.
START CAL	Starts the standard (OSL) calibration sequence using coaxial standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for Offset-Short method, coaxial line type.
OFFSET LENGTHS OF SHORTS	Calls Menu C4, which lets you change the offset lengths of the shorts used for coaxial calibration.
LOAD TYPE XXXXXXXX	Calls Menu C6, which displays type of load selected for calibration—broadband fixed or sliding. Move cursor here and press Enter to display menu used to change load type.
THROUGH LINE PARAMETERS	Calls Menu C20, which lets you enter throughline parameters—including offset length and loss equation coefficients.
REFERENCE IMPEDANCE	Calls Menu C15, which lets you choose the reference impedance value (1 μΩ to 1 MΩ) for the devices connected to Ports 1 and 2 for calibration. Default value is 50Ω.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings. .
START CAL	Starts the offset-short calibration sequence using coaxial standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3A, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for Offset-Short method, waveguide line type.
LOAD TYPE XXXXXXXX	Calls Menu C6, which displays type of load selected for calibration—broadband fixed or sliding.
THROUGH LINE PARAMETERS	Calls Menu C20, which lets you enter throughline parameters—including offset length and loss equation coefficients.
WAVEGUIDE PARAMETERS XXXXXX	Calls Menu C15, which lets you enter waveguide parameters.
TEST SIGNALS	Calls menu CAL_SU2, which lets you calibrate Flat Test Port Power or change source power(s) and attenuator settings. .
START CAL	Starts the offset-short calibration sequence using waveguide standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3B, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for Offset-Short method, microstrip line type.
OFFSET LENGTHS OF SHORTS	Calls Menu C14, which lets you change offset lengths of shorts used for microstrip calibration.
LOAD IMPEDANCES	Calls Menu C6A, which lets you select an impedance type and/or enter an impedance value.
THROUGH LINE PARAMETERS	Calls Menu C20, which lets you enter throughline parameters—including offset length and loss equation coefficients.
MICROSTRIP PARAMETERS XXXXXXXXXXX	Calls Menu C16, which lets you change microstrip parameters.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings. .
START CAL	Starts the offset-short calibration sequence using microstrip standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3C, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for Standard OSL method, microstrip line type.
PORT 1 OPEN/SHORT	Calls menu C12_P1, which is used to define the capacitive coefficients of the Open and offset length of the Short for Port 1.
PORT 2 OPEN/SHORT	Calls menu C12_P2, which is used to define the capacitive coefficients of the Open and offset length of the Short for Port 2.
REFLECTION PAIRING	Calls menu C13, which lets you select the pairing (mixed or matched) for the types of reflection devices (open/short) that you will use on Ports 1 and 2 for calibration.
LOAD IMPEDANCE XXXXXX	Calls Menu C6A, which lets you select an impedance type and/or enter an impedance value.
THROUGH LINE PARAMETERS XXXXXXXXXXXX	Calls Menu C20, which lets you enter throughline parameters—including offset length and loss equation coefficients.
MICROSTRIP PARAMETERS XXXXXXXXXXX	Calls Menu C16, which lets you change microstrip parameters.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings.
START CAL	Starts the standard calibration sequence using microstrip standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3D, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for LRL/LRM method, coaxial line type.
LRL/LRM PARAMETERS	Calls Menu C18, which lets you change LRL/LRM parameters.
REFERENCE IMPEDANCE	Calls Menu C17, which lets you change the reference impedance of the coaxial line standard to other than 50 ohms (default).
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings.
START CAL	Starts the LRL/LRM calibration sequence using coaxial standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3E, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for LRL/LRM method, waveguide line type.
LRL/LRM PARAMETERS	Calls Menu C18, which lets you change LRL/LRM parameters.
WAVEGUIDE CUTOFF FREQ	Calls Menu 15B, which lets you enter a waveguide cutoff frequency.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings.
START CAL	Starts the LRL/LRM calibration sequence using waveguide standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3F, Confirm Calibration Parameters

MENU	DESCRIPTION
CONFIRM CALIBRATION PARAMETERS	Used for LRL/LRM method, microstrip line type.
LRL/LRM PARAMETERS	Calls Menu C18, which lets you change LRL/LRM parameters.
MICROSTRIP PARAMETERS USER DEFINED	Calls Menu C16, which lets you change microstrip parameters.
TEST SIGNALS	Calls menu CAL_SU2, which lets you enter calibrate Flat Test Port Power or change source power(s) and attenuator settings.
START CAL	Starts the LRL/LRM calibration sequence using microstrip standards.
PRESS <ENTER> TO SELECT OR CHANGE	Pressing the Enter key implements your menu selection.

Menu C3G, Confirm Calibration Parameters

MENU	DESCRIPTION
SELECT PORT X CONNECTOR TYPE	
SMA (M)	Applies the four capacitance-coefficient values to the Open and offset length to the Short. These values are needed to correct for an SMA connector being installed on the test device (male or female).
SMA (F)	
K-CONN (M)	Same as above, except for K connector.
K-CONN (F)	
TYPE N (M)	Same as above, except for TYPE N connector.
TYPE N (F)	
GPC-3.5 (M)	Same as above, except for GPC-3.5 connector.
GPC-3.5 (F)	
GPC-7	Same as above, except for GPC-7 connector.
USER DEFINED	Calls menu C12, which lets you specify the connector coefficients.
MORE	Calls additional connector types to screen.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C4_P1/C4_P2, Select Connector Type

MENU	DESCRIPTION
SELECT PORT X CONNECTOR TYPE	
V-CONN (M) V-CONN (F)	Applies the four capacitance-coefficient values to the Open and offset length to the Short. These values are needed to correct for an SMA connector being installed on the test device (male or female).
TNC (M)	Same as above, except for TNC connector.
TNC (F)	
2.4 mm (M)	Same as above, except for 2.4 mm connector.
2.4 mm(F)	
USER DEFINED	Calls Menu C12, which lets you specify the connector coefficients.
MORE	Calls additional connector types to screen.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C4A_P1/C4A_P2, Select Connector Type

MENU	DESCRIPTION
SELECT CALIBRATION TYPE	
FULL 12-TERM	Select calibration using all 12 error terms EDF, ESF, ERF, ETF, ELF, (EXF), EDR, ESR, ERR, ETR, FLR, (EXR).
1 PATH 2 PORT	Calls Menu C5A, which lets select a correction for forward- or reverse-direction error terms.
TRANSMISSION FREQUENCY RESPONSE	Calls Menu C5B, which lets select a correction for frequency response error terms.
REFLECTION ONLY	Calls Menu C5C, which lets select a correction for reflection-only error terms.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C5, Select Calibration Type

MENU	DESCRIPTION
SELECT 1 PATH 2 PORT CALIBRATION TYPE	
FORWARD PATH (S11, S21)	For the calibration-correction of the forward transmission and reflection error term, ETF, EDF, ESF, ERF, (EXF).
REVERSE PATH (S12, S22)	For the calibration-correction of the reverse transmission and reflection error term, EDR, ESR, ERR, ETR, (EXR).
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your selection.

Menu C5A, Select 1 Path 2 Port Calibration Type

MENU	DESCRIPTION
SELECT TRANSMISSION FREQ RESPONSE CALIBRATION TYPE	
FORWARD PATH (S21)	For the calibration-correction of the forward transmission frequency-response error term, ETF. (EXF).
REVERSE PATH (S12)	For the calibration-correction of the reverse transmission-frequency-response error term, ETR, (EXR).
BOTH PATHS (S21, S12)	For the calibration-correction of the forward and reverse transmission-frequency-response error terms ETF, ETR, (EXF, EXR).
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C5B, Select Transmission Freq Response Calibration Type

MENU	DESCRIPTION
SELECT REFLECTION ONLY CALIBRATION TYPE	
PORT 1 ONLY (S11)	For the calibration-correction of the forward reflection-only error terms EDF, ESF, ERF.
PORT 2 ONLY (S22)	For the calibration-correction of the reverse reflection-only error terms EDR, ESR, ERR.
BOTH PORTS (S11, S22)	For the calibration-correction of the forward and reverse reflection-only error terms EDF, ESF, ERF, EDR, ESR, ERR.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C5C, Select Reflection Only Calibration Type

MENU	DESCRIPTION
SELECT USE OF ISOLATION IN CALIBRATION	
INCLUDE ISOLATION (STANDARD)	Includes isolation term(s).
EXCLUDE ISOLATION	Excludes isolation term(s).
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C5D, Select Use of Isolation

MENU	DESCRIPTION
SELECT TYPE OF LOAD	
BROADBAND FIXED LOAD	Selects calibration based on the broadband load being used, then calls menu C6A.
SLIDING LOAD (MAY ALSO REQUIRE BROADBAND FIXED LOAD)	Selects calibration based on the sliding load being used. If your low-end frequency is below 2 GHz (4 GHz for V Connector), a fixed broadband load is also required.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C6, Select Load Type

MENU	DESCRIPTION
ENTER BROADBAND LOAD IMPEDANCE	
BROADBAND LOAD IMPEDANCE XX.XXX Ω	Enter the impedance of the load..
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C6A, Enter Broadband Load Impedance

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
CONNECT CALIBRATION DEVICE(S)	
PORT 1: XXXXXXXXXXXX	Connect the required component to Port 1.
PORT 2: XXXXXXXXXXXX	Connect the required component to Port 2.
PRESS <ENTER> TO MEASURE DEVICE(S)	Pressing the Enter key sequentially measures the devices connected to Ports 1 and 2, beginning with Port 1.
PRESS <1> FOR PORT 1 DEVICE	Pressing the 1 key, on the keypad, measures the device connected to Port 1.
PRESS <2> FOR PORT 2 DEVICE	Pressing the 2 key, on the keypad, measures the device connected to Port 2.

Menu C7-Series, Begin Calibration Sequence

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
SLIDE LOAD TO POSITION X	Slide the load to the next position, then press the Enter key. Moving the slide to six different positions provides sufficient data for the program to accurately calculate the effective directivity of the system.
PRESS <ENTER> TO MEASURE DEVICE (S)	Pressing the Enter key begins the measurement.

Menu C8, Slide Load to Position X

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
CONNECT THROUGHLINE XXXXX BETWEEN TEST PORTS	Connect Ports 1 and 2 together using the Throughline standard (zero or non-zero length).
PRESS <ENTER> TO MEASURE DEVICE(S)	Pressing the Enter key begins the measurement.

Menu C9, Connect Throughline

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
CONNECT DEVICE 1 LINE 1 (REF) XXXXX BETWEEN TEST PORTS	Prompts you to connect reference line 1 between test ports.
PRESS <ENTER> TO MEASURE DEVICE(S)	Pressing the Enter key begins the measurement.

Menu C9A, Connect Device 1, Line

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
CONNECT DEVICE 2 LINE/ LOWBAND MATCHES BETWEEN TEST PORTS	Connect device 2 between the test ports. This will be a LINE for LRL measurements or LOWBAND MATCHES for LRM measurements.
PRESS <ENTER> TO MEASURE DEVICE(S)	Pressing the Enter key begins the measurement.

Menu C9B, Connect Device 2, Line/Lowband

MENU	DESCRIPTION
CALIBRATION SEQUENCE	
CONNECT DEVICE 2 LINE XXXXX BETWEEN TEST PORTS	Prompts you to connect the second line standard between the test ports.
PRESS <ENTER> TO MEASURE DEVICE(S)	Pressing the Enter key begins the measurement.

Menu C9C, Connect Device 2, Line

MENU	DESCRIPTION
BEGIN CALIBRATION	
KEEP EXISTING CAL DATA	Keep existing calibration data
REPEAT PREVIOUS CAL	Repeats the previous calibration.
CAL METHOD XXXXXXX	Displays the calibration method that you have selected—standard, offset short or LRL/LRM.
TRANSMISSION LINE TYPE: XXXXXXXX	Indicates type of transmission line currently selected, e. g. coaxial, waveguide, microstrip.
CHANGE CAL METHOD AND LINE TYPE	Calls menu C11A, which allows you to change calibration method and transmission line type.
NEXT CAL STEP	Selects the next calibration step.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C11, Begin Calibration

MENU	DESCRIPTION
CHANGE CAL METHOD AND LINE TYPE	
NEXT CAL STEP	Select next calibration step. Must move cursor to here after making below selections. Pressing the Enter key then moves you to the next step.
CAL METHOD	
STANDARD (NOT USED FOR WAVEGUIDE)	This option and the ones below allow you to select the method (procedure) to be used to calibrate. This method is independent of the calibration type, which may be 12 term, reflection only etc.
OFFSET SHORT	Selects offset-short method.
LRL/LRM	Selects LRL or LRM method
TRANSMISSION LINE TYPE	
COAXIAL	Selects coaxial cable as the transmission line type.
WAVEGUIDE	Selects waveguide as the transmission line type.
MICROSTRIP	Selects microstrip as the transmission line type.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C11A, Select Calibration Method

MENU	DESCRIPTION
PORT X OPEN DEVICE	Enter the capacitance-coefficient values needed to correct for your Open device. The capacitive phase shift of the Open is characterized by the equation: $C_{Open} = C_O + (C_1 \times f) + (C_2 \times f^2) + (C_3 \times f^3)$
ENTER THE CAPACITANCE COEFFICIENTS	
TERM 1-C0 ± XX.XXe- 15	Enter the term 1 coefficient value (x 10^{-15} F).
TERM 2-C1 ± XXX.XX e - 27	Enter the term 2 coefficient value (x 10^{-27} F/Hz).
TERM 3-C2 ±XXX.XX e - 36	Enter the term 3 coefficient value (x 10^{-36} F/Hz^2).
TERM 4-C3 ±XXX.XX e - 45	Enter the term 4 coefficient value (x 10^{-45} F/Hz^3).
ENTER THE OFFSET LENGTH	
OFFSET LENGTH ±XX.XXXX mm	Select to enter and display offset length of Open.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key calls C12A_P1/C12A_P2.

Menu C12_P1/C12_P2, Enter the Capacitance Coefficients for Open Devices

MENU	DESCRIPTION
PORT X SHORT DEVICE	
ENTER THE OFFSET LENGTH	
OFFSET LENGTH ± XX.XXXX mm	Select to enter the length that the Short is offset from the reference plane.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C12A_P1/C12A_P2, Enter the Offset Length

MENU	DESCRIPTION
SET REFLECTION PAIRING	
MIXED (OPEN–SHORT SHORT–OPEN)	Selects different reflection devices (open/short or short/open) to be connected to Ports 1 and 2 for the calibration sequencing.
MATCHED (OPEN–OPEN SHORT–SHORT)	Selects the same type of reflection device (open/open or short/short) to be connected to Ports 1 and 2 for the calibration sequencing.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C13, Set Reflection Pairing Menu

MENU	DESCRIPTION
ENTER OFFSET LENGTHS OF SHORTS	
PORT 1 SHORTS	
SHORT 1 XX.XXXX mm	Enter the length that Short 1 is offset from the reference plane.
SHORT 2 XX.XXXX mm	Enter the length that Short 2 is offset from the reference plane.
PORT 2 SHORTS	
SHORT 1 XX.XXXX mm	Enter the length that Short 1 is offset from the reference plane.
SHORT 2 XX.XXXX mm	Enter the length that Short 2 is offset from the reference plane.
IF USING ONLY TWO SHORTS, PORT 2 OFFSETS SHOULD EQUAL PORT 1 OFFSETS	
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C14, Enter Offset Lengths (Shorts)

MENU	DESCRIPTION
SELECT WAVEGUIDE KIT TO USE	
-INSTALLED KIT-	The lines below indicate the characteristics of the installed waveguide calibration kit, if applicable.
IDENTIFIER XXXX	Displays the type of waveguide used.
CUTOFF FREQ: XXX.XXXXXXXXX GHz	Displays the cutoff frequency of the waveguide.
SHORT 1 XX.XXXXmm	Displays the offset length of the first calibration short.
SHORT 2 XX.XXXXmm	Displays the offset length of the second calibration short.
USE INSTALLED WAVEGUIDE KIT	Move the cursor to this line and press Enter to use the displayed kit.
USER DEFINED	Calls menu C15A, which lets you modify the parameters.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C15, Select Waveguide Kit to Use

MENU	DESCRIPTION
ENTER WAVEGUIDE PARAMETERS	
WAVEGUIDE CUTOFF FREQ XXX.XXXXXXXXX GHz	Move cursor to this line then press Enter to bring up menu that allows you to enter waveguide cutoff frequency.
OFFSET LENGTH OF SHORT 1 X.XXXX mm	Move the cursor to this line and enter the offset length of Short 1.
OFFSET LENGTH OF SHORT 2 X.XXXX mm	Move the cursor to this line and enter the offset length of Short 2.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C15A, Enter Waveguide Parameters

MENU	DESCRIPTION
ENTER WAVEGUIDE CUTOFF FREQUENCY	
WAVEGUIDE CUTOFF FREQ XXX.XXXXXXXXX GHz	Enter waveguide cutoff frequency.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C15B, Enter Waveguide Parameters

MENU	DESCRIPTION
SELECT MICROSTRIP KIT TO USE	
10 MIL KIT	Selects parameters for 10 mil UTF kit.
15 MIL KIT	Selects parameters for 15 mil UTF kit.
25 MIL KIT	Selects parameters for 25 mil UTF kit.
USER DEFINED	Calls menu C16A, which lets you modify the parameters.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C16, Select Microstrip Parameters

MENU	DESCRIPTION
ENTER MICROSTRIP PARAMETERS	
WIDTH OF STRIP XX.XXXX mm	Move the cursor to this line and enter the width of the microstrip you are using.
THICKNESS OF SUBSTRATE XXXX.XXXX mm	Move the cursor to this line and enter the thickness of the substrate you are using.
Zc XXX.XXX Ω	Move the cursor to this line and enter the characteristic impedance of the microstrip.
SUBSTRATE DIELECTRIC XX.XX	Move the cursor to this line and enter the relative dielectric constant of the substrate you are using.
EFFECTIVE DIELECTRIC XX.XX (RECOMMENDED 1.00)	Move the cursor to this line and enter the effective dielectric constant of the microstrip. A recommended value will also be displayed.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C16A, Enter Microstrip Parameters

MENU	DESCRIPTION
ENTER REFERENCE IMPEDANCE	
REFERENCE IMPEDANCE XXX.XXXΩ	Enter the reference impedance (Z_0) of the coaxial reference line standard.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key implements your menu selection.

Menu C17, Enter Line Impedance

MENU	DESCRIPTION
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	Selects next calibration step. Must move cursor to here after making below selections. Pressing the Enter key then moves you to the next step. Calls menu C18A for one band or C18B for two bands.
NUMBER OF BANDS USED	
ONE BAND	Selects a one-band LRL or LRM calibration.
TWO BANDS	Selects a two-band LRL or LRM calibration (that is, a three-line LRL or concatenated LRL and LRM calibrations).
LOCATION OF REFERENCE PLANES	
MIDDLE OF LINE 1 (REF)	Select reference planes to be at middle of line 1.
ENDS OF LINE 1 (REF)	Select reference planes to be at end of line 1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu C18, Change LRL/LRM Parameters

MENU	DESCRIPTION
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	Selects next calibration step. Must move cursor to here after making below selections. Pressing the Enter key then moves you to the next step. Calls menu C19.
CHARACTERIZE CAL DEVICES	
DEVICE 1 LINE 1 (REF) X.XXXX mm	Enter length of line 1.
DEVICE 2 LINE /MATCH X.XXXX mm/FULLBAND	Select device 2—LINE or MATCH; if line is selected, enter length.
PRESS <ENTER> TO SELECT OR SWITCH	Press Enter to select. If DEVICE 2 is chosen, pressing the Enter key toggles between LINE and MATCH.

Menu C18A, Change LRL/LRM Parameters

MENU	DESCRIPTION
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	Selects next calibration step. Must move cursor to here after making below selections. Pressing the Enter key then moves you to the next step. Calls menu C19.
CHARACTERIZE CAL DEVICES	
DEVICE 1 LINE 1 (REF) XX.XXXX	Enter length of line 1.
DEVICE 2 LINE/MATCH XX.XXXX/LOWBAND	Press Enter to toggle between LINE and MATCH. If LINE is selected, enter line length. If match is selected, LOWBAND is displayed. This indicates that device 2 is the lowband match.
DEVICE 3 LINE/MATCH XX.XXXX/HIGHBAND	Press Enter to toggle between LINE and MATCH. If LINE is selected, enter line length. If match is selected, HIGHBAND is displayed. This indicates that device 3 is the high band match.
FREQ AFTER WHICH THE USE OF DEVICE 2 AND DEVICE 3 IS EXCHANGED	
BREAKPOINT XXX.XXXXXXXXXGHZ	Enter breakpoint frequency: end of band 1, beginning of band 2.
PRESS <ENTER> TO SELECT OR SWITCH	Pressing the Enter key implements your menu selection.

Menu C18B, Change LRL/LRM Parameters—Two Band Calibration

MENU	DESCRIPTION
CHANGE LRL/LRM PARAMETERS	
NEXT CAL STEP	Moves to the next calibration step. Must move cursor to here after making below selections. Pressing the Enter key then moves you to the next step.
OFFSET LENGTH OF REFLECTIVE DEVICE	
OFFSET LENGTH X.XXXX mm	Enter the offset length of the reflective device.
TYPE OF REFLECTION	
GREATER THAN Zo	Specifies the reflection to have an impedance value greater than the reference impedance (Z_0). This is typically an open device.
LESS THAN Zo	Selects the reflection to have an impedance value less than the reference impedance (Z_0). This is typically a short device.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements the selection.

Menu C19, Change LRL/LRM Parameters

MENU	DESCRIPTION
ENTER THROUGH LINE PARAMETERS	
OFFSET LENGTH X.XXXX mm	Enter offset length of through-line device.
THROUGHLINE IMPEDANCE X.XXXX Ω	Enter the impedance of the through-line device.
PRESS <ENTER> WHEN COMPLETE	Pressing the Enter key brings the next calibration menu.

Menu C20, Change Through Parameters

MENU	DESCRIPTION
CALIBRATION SEQUENCE COMPLETED	
PRESS <SAVE/RECALL> TO STORE CAL DATA ON DISK	Pressing the SAVE/RECALL MENU Key displays menu SR, which lets you save your calibration data onto a disk or recall previously saved calibration data from a disk. While this menu provides a convenient point at which to save the calibration data, it is not the only point allowed. You can use the SAVE/RECALL MENU key at any point in the measurement program.
OR	
PRESS <ENTER> TO PROCEED	Pressing the Enter key implements your menu selection.

Menu Cal_Completed

MENU	DESCRIPTION
APPLY CALIBRATION	
FULL 12-TERM (S11, S21 S22, S12)	Reflects the type of calibration presently stored in internal memory.
APPLY ON (OFF) CALIBRATION	Turns calibration on or off.
TUNE MODE ON (OFF)	For applied Full 12-Term calibration only. When turned off, the ratio of forward to reverse sweeps is set to the normal 1:1.When turned on, you can set the ratio of forward sweeps to reverse sweep from 1:1 to 10,000:1 (below).
NO. OF FWD (REV) SWEEPS BETWEEN REV (FWD) SWEEPS XXXXX SWEEPS (XXXXX REMAINING)	Lets you enter a value for the number of forward (or reverse) sweeps. Alternatively, this option displays the number of forward sweep (or reverse) remaining before a reverse sweep will occur.
PRESS <APPLY CAL> TO TURN ON/OFF	Press the Apply Cal key to apply the stored calibration.
PRESS <ENTER> TO TURN ON/OFF	Press the Enter key to turn selected mode on/off.

Menu Cal_Applied

MENU	DESCRIPTION
DATA ENHANCEMENT	
AVERAGING XXXX MEAS. PER POINT	Averages the measured data over time, as follows: 1. The sweep stops at the first frequency point and takes a number of readings, based on the selected number of points. 2. The program averages the readings and writes the average value for that frequency point in the displayed graph. 3. The sweep then advances to the next sequential frequency point and repeats the process.
PRESS <ENTER> TO RESUME CAL	Pressing the Enter key implements your menu selection and returns you to the calibration setup or sequence.

Menu Cal_EM, Enhancement Menu for Calibration

MENU	DESCRIPTION
SELECT DISPLAY MODE	
SINGLE CHANNEL	Selects a single channel for display. You select the type of display in menu GT1 or GT2.
DUAL CHANNELS 1 & 3	Selects Channels 1 and 3 for display. You select the type of display in menu GT1 or GT2.
OVERLAY DUAL CHANNELS 1 & 3	Lets you simultaneously view the Channel 1 data superimposed over the Channel 3 data on a single display. Channel 1 trace displays in red and Channel 3 in yellow.
DUAL CHANNELS 2 & 4	Selects Channels 2 and 4 for display. You select the type of display in menu GT1 or GT2.
OVERLAY DUAL CHANNELS 2 & 4	Lets you simultaneously view the Channel 2 data superimposed over the Channel 4 data on a single display. Channel 2 trace displays in red and Channel 4 in yellow.
ALL FOUR CHANNELS	Selects all four channels for display. You select the type of display in menu GT1 or GT2.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection. The menu remains on the screen until another menu is selected for display or until the CLEAR/RET LOC key is pressed.

Menu CM, Select Display Mode

MENU	DESCRIPTION
DISCRETE FILL	
INPUT START, INCR, POINTS, THEN SELECT "FILL RANGE"	This menu is used to create one or more ranges of discrete equally spaced frequency points.
START FREQ XXX.XXXXXXXXX GHz	Enter the first frequency of the range.
INCREMENT XXX.XXXXXXXXX GHz	Enter the increment (step size) between one frequency and the next.
NUMBER OF PTS XXXX POINT(S)	Enter the number of frequency points in the range.
STOP FREQ XXX.XXXXXXXXX GHz	Enter the stop frequency, in GHz.
FILL RANGE (XXXX ENTERED)	Moving the cursor here and pressing Enter fills the range and shows the number of frequencies selected (in NUM OF PTS above).
INDIVIDUAL FREQ INSERT	Calls menu DF2, which allows you to set the individual frequencies.
CLEAR ALL	Clears all entries displayed above.
FINISHED RETURN TO SWP	Closes this menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DF1, Discrete Fill

MENU	DESCRIPTION
INSERT INDIVIDUAL FREQUENCIES	
INPUT A FREQ, PRESS <ENTER> TO INSERT	Enter the start frequency, increment frequency, and number of points; then select the FILL RANGE menu option, below.
NEXT FREQ XXX.XXXXXXXXX GHz	Enter the sweep start frequency, in GHz.
XXXX FREQS ENTERED LAST FREQ WAS XXX.XXXXXXXXX GHz	Enter the frequency, in GHz, by which you want to increment the start frequency.
AUTO INCR ON (OFF) XXX.XXXXXXXXX GHz	Enter the number of points.
PREVIOUS MENU	Enter the stop frequency, in GHz.
PRESS <ENTER> THEN SELECT OR TURN ON/OFF	Press the Enter key to implements your menu selection or to turn a selection on or off.

Menu DF2, Insert Individual Frequencies

MENU	DESCRIPTION
WARNING DEFAULT PROGRAM SELECTED CONTINUING WILL ERASE CURRENT SETUP AND CALIBRATION	
PRESS <DEFAULT PROGRAM> TO CONFIRM	Pressing the DEFAULT PROGRAM key a second time resets the 372XXA to its default settings. Press the DEFAULT PROGRAM key, the "0" key, then the DEFAULT PROGRAM key again clears all internal memories. This keying method can be used to clear memories of data used for classified operations.
PRESS <CLEAR> TO ABORT	Pressing the CLEAR key implements your menu selection.

Menu DFLT, Default Program Selected

MENU	DESCRIPTION
DIAGNOSTICS	
START SELF TEST	Starts a self test of the 372XXA.
READ SERVICE LOG	Calls Menu DG2, which gives you options for using the Service Log.
INSTALLED OPTIONS	Displays the fitted options.
PERIPHERAL TESTS	Calls Menu DG3, which provides tests for peripherals such as the CRT, front panel, external keyboard, printer and GPIB interfaces.
TROUBLESHOOTING (FOR SERVICE USE ONLY)	Calls Menu DG4, which provides options for troubleshooting the 372XXA hardware. This menu is intended for use by a qualified service technician. Refer to the Model 372XXA Maintenance Manual for additional information.
H/W CALIBRATIONS (FOR SERVICE USE ONLY)	Calls Menu DG5, which provides for invoking calibration routines for use by a qualified service technician. Refer to the Model 372XXA Maintenance Manual for additional information.

Menu DG1, Diagnostics 1

MENU	DESCRIPTION
SERVICE LOG	
DISPLAY LOG	Displays the service log, which provides operational status information. The service log is a useful aid for troubleshooting a malfunctioning unit.
PRINT LOG	Sends the service log to a printer.
SAVE LOG TO FLOPPY DISK	Saves the service log to a floppy disk file service log.
CLEAR LOG	Clears the service log error list.
PREVIOUS MENU	Returns to Menu DG1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DG2, Troubleshooting

MENU	DESCRIPTION
PERIPHERAL TESTS	
CRT	Provideds a graphic display for evaluating screen colors and linearity.
FRONT PANEL	Provides for testing the front panel keys.
EXTERNAL KEYBOARD	Provides for testing the external keyboard connected to the Keyboard connector on the front panel
PRINTER INTERFACE	Provides for testing the printer interface.
GPIB INTERFACE	Provides for testing the GPIB interface.
PREVIOUS MENU	Returns to Menu DG1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DG3, Diagnostics 3

MENU	DESCRIPTION
FLOPPY DISK UTILITIES	
DISPLAY DIRECTORY	Directory displays in the screen's data area. Press <1> for previous page, <2> for next page, <0> for first page, and <3> for last page.
DELETE FILES	Calls DSK6, which lets you delete data files.
COPY FILES TO HARD DISK	Calls DSK8, which lets you copy files to the hard disk.
FORMAT FLOPPY DISK	Formats the floppy disk.
HARD DISK UTILITIES	Calls DSK1-HD, which provides hard disk utilities.
PRESS <ENTER> TO SELECT	Pressing Enter implements your menu selection. You will be returned to the previous menu when your selection is made.

Menu DSK1_FD, Floppy Disk Utilities

MENU	DESCRIPTION
HARD DISK UTILITIES	
DISPLAY DIRECTORY	Directory displays in the screen's data area. Press <1> for previous page, <2> for next page, <0> for first page, and <3> for last page.
DELETE FILES	Calls DSK6, which lets you delete data files.
COPY FILES TO FLOPPY DISK	Calls DSK8, which lets you copy files to the floppy disk.
FORMAT HARD DISK	Formats the hard disk.
FLOPPY DISK UTILITIES	Calls DSK1-FD, which provides floppy disk utilities.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DSK1_HD, Hard Disk Utilities

MENU	DESCRIPTION
SELECT FILE TO READ	
FILE 1	Displays the data stored in file number 1.
FILE 2	Displays the data stored in file number 2.
FILE 3	Displays the data stored in file number 3.
FILE 4	Displays the data stored in file number 4.
FILE 5	Displays the data stored in file number 5.
FILE 6	Displays the data stored in file number 6.
FILE 7	Displays the data stored in file number 7.
FILE 8	Displays the data stored in file number 8.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.
PRESS <1> FOR PREVIOUS PAGE	Pressing the "1" key on the keypad returns to the previous page.
PRESS <2> FOR NEXT PAGE	Pressing the "2" key on the keypad produces the next page.

Menu DSK2, Select File to Read

MENU	DESCRIPTION
SELECT FILE TO OVERWRITE	
CREATE NEW FILE	
FILE 1	Select file number 1 to be overwritten with new data.
FILE 2	Select file number 2 to be overwritten with new data.
FILE 3	Select file number 3 to be overwritten with new data.
FILE 4	Select file number 4 to be overwritten with new data.
FILE 5	Select file number 5 to be overwritten with new data.
FILE 6	Select file number 6 to be overwritten with new data.
FILE 7	Select file number 7 to be overwritten with new data.
FILE 8	Select file number 8 to be overwritten with new data.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.
PRESS <1> FOR PREVIOUS PAGE	Pressing the "1" key on the keypad returns to the previous page.
PRESS <2> FOR NEXT PAGE	Pressing the "2" key on the keypad produces the next page.

Menu DSK3, Select File to Overwrite

MENU	DESCRIPTION
TYPE OF FILES TO DELETE	
FRONT PANEL SETUP AND CAL DATA	Deletes the front panel and calibration data files.
TRACE DATA	Deletes the trace data files.
TABULAR DATA	Deletes the tabular data files.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DSK6, Type of Files to Delete

MENU	DESCRIPTION
SELECT FILE TO DELETE	
FILE 1	Selects file number 1 data to be deleted.
FILE 2	Selects file number 2 data to be deleted.
FILE 3	Selects file number 3 data to be deleted.
FILE 4	Selects file number 4 data to be deleted.
FILE 5	Selects file number 5 data to be deleted.
FILE 6	Selects file number 6 data to be deleted.
FILE 7	Selects file number 7 data to be deleted.
FILE 8	Selects file number 8 data to be deleted.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.
PRESS <1> FOR PREVIOUS PAGE	Pressing the "1" key on the keypad returns to the previous page.
PRESS <2> FOR NEXT PAGE	Pressing the "2" key on the keypad produces the next page.

Menu DSK7, Select File to Delete

MENU	DESCRIPTION
TYPE OF FILES TO COPY	
FRONT PANEL SETUP AND CAL DATA	Copy the front panel setup and calibration data files.
TRACE DATA	Copy the trace data files.
TABULAR DATA	Copy the tabular data files.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu DSK8, Type of Files to Copy

MENU	DESCRIPTION
SELECT FILE TO COPY	
FILE 1	Selects file number 1 data to be copied.
FILE 2	Selects file number 2 data to be copied.
FILE 3	Selects file number 3 data to be copied.
FILE 4	Selects file number 4 data to be copied.
FILE 5	Selects file number 5 data to be copied.
FILE 6	Selects file number 6 data to be copied.
FILE 7	Selects file number 7 data to be copied.
FILE 8	Selects file number 8 data to be copied.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.
PRESS <1> FOR PREVIOUS PAGE	Pressing the "1" key on the keypad returns to the previous page.
PRESS <2> FOR NEXT PAGE	Pressing the "2" key on the keypad produces the next page.

Menu DSK9, Select File to Copy

MENU	DESCRIPTION
CAPTURE TABULAR DATA	Captures the tabular data to a file when the Enter key is pressed.
PRESS <ENTER> TO CONTINUE	Pressing the Enter key implements your menu selection.

Menu DSK10, Capture Tabular Data

MENU	DESCRIPTION
CAUTION: ALL FLOPPY DISK DATA WILL BE ERASED	
INSERT DISK TO FORMAT	Ensure that you have the correct floppy diskette for formatting, then press the Enter key to begin the formatting process.
PRESS <ENTER> TO CONTINUE	Pressing the Enter key implements your menu selection.

Menu DSK11, Format Floppy Disk

MENU	DESCRIPTION
CAUTION: ALL HARD DISK DATA WILL BE ERASED	
ASSUME HARD DISK READY TO FORMAT	Assumes that the hard disk is ready to be formatted; press the Enter key to begin the formatting process.
PRESS <ENTER> TO CONTINUE	Pressing the Enter key implements your menu selection.

Menu DSK12, Format Hard Disk

MENU	DESCRIPTION
DATA ENHANCEMENT	
AVERAGING XXXX MEAS. PER POINT	Averages the measured data over time, as follows: 1. The sweep stops at the first frequency point and takes a number of readings, based on the selected number of points. 2. The program averages the readings and writes the average value for that frequency point in the displayed graph. 3. The sweep then advances to the next sequential frequency point and repeats the process.
SMOOTHING X.X PERCENT OF SWEEP	Lets you select a percentage of the sweep to receive smoothing. The smoothing process uses a raised Hamming window to average the data from a span of frequenccies.

Menu EM, Enhancement Menu

MENU	DESCRIPTION
SELECT LABEL - - - - - - - - - ABCDEFGHIJKLM NOPQRSTUVWXYZ 0123456789()- !#$%&'@^_'{}~	Name your file using the rotary knob to select letters, numbers, or both. A letter or number turns red to indicate that the letter/number has been chosen for selection. Pressing the Enter key selects the letter or number. the name you spell out displays in the area below "SELECT NAME." You are allowed up to eight characters for a file name and twelve characters for a label.
BKSP CLR DONE	Selecting "BKSP" deletes the last letter in the name displayed above. Selecting "CLR" deletes the entire name. Selecting "DONE" signals that you have finished writing the name.
TURN KNOB TO INDICATE CHARACTER OR FUNCTION	Use the rotary knob to indicate the letter or number you wish to select. You can use the up-arrow and down-arrow keys to move between rows.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection. The menu remains on the screen until another menu is selected for display or until the CLEAR/RET LOC key is pressed.
NUMBERS MAY ALSO BE SELECTED USING KEYPAD	You may also select numbers and decimals using the keypad.

Menu GP5, Select Name

MENU	DESCRIPTION
GPIB ADDRESSES	
IEEE 488.2 GPIB INTERFACE	
ADDRESS: 6	Selects the GPIB address for the 372XXA analyzer. The default address is 6.
DEDICATED GPIB INTERFACE	
EXTERNAL SOURCE 4	Selects the address for an external source. The default address is 4.
PLOTTER 8	Selects the address for a compatible plotter. The default address is 8.
POWER METER 13	Selects the address for an HP4370 Power Meter. The default address is 13.
FREQUENCY COUNTER 7	Selects the address for an external frequency counter. The default address is 7.

Menu GP7, Display GPIB Status

MENU	DESCRIPTION
SELECT GRAPH TYPE	
LOG MAGNITUDE	Selects a log magnitude graph for display on the active channel's selected S-parameter. The active channel is indicated by its key (CH1, CH2, CH3, CH4) being lit.
PHASE	Selects a phase graph for display on the active channel.
LOG MAGNITUDE AND PHASE	Selects log magnitude and phase graphs for display on the active channel.
SMITH CHART (IMPEDANCE)	Selects a Smith chart for display on the active channel.
SWR	Selects an SWR display for the active channel.
GROUP DELAY	Selects a Group Delay display for the active channel.
MORE	Takes you to additional graph type selections on menu GT2.
PRESS <ENTER> TO SELECT AND RESUME CAL	Pressing the Enter key implements your menu selection (and resumes the calibration from where it left off, if in the calibration mode).

Menu GT1/CAL_GT1, Select Graph Type

MENU	DESCRIPTION
SELECT GRAPH TYPE	
SMITH CHART (ADMITTANCE)	Selects an Admittance Smith chart for display on the active channel's S-parameter.
LINEAR POLAR	Selects a Linear Polar graph for display on the active channel's S-parameter.
LOG POLAR	Selects a Log Polar graph for display on the active channel's S-parameter.
LINEAR MAG	Selects a Linear Magnitude graph for display on the active channel's S-parameter.
LINEAR MAG AND PHASE	Selects Linear Magnitude and Phase graphs for display on the active channel's S-parameter.
REAL	Selects Real data for display on the active channel's s-parameter.
IMAGINARY	Selects Imaginary data for display on the active channel's s-parameter.
REAL AND IMAGINARY	Selects both Real and Imaginary data for display on the active channel's S-parameter.
MORE	Takes you to additional graph type selections.
PRESS <ENTER> TO SELECT AND RESUME CAL	Pressing the Enter key implements your menu selection (and resumes the calibration from where it left off, if in the calibration mode).

Menu GT2/CAL_GT2, Select Graph Type

MENU	DESCRIPTION
SINGLE LIMITS	
—LOG MAG—	
UPPER LIMIT ON (OFF) XXX.XXX dB	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Log Mag display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX dB	Turns the Lower Limit line on or off for the active channel on your Log Mag display.
READOUT LIMIT	Displays Menu LF1, which shows points where the current S-parameter intercepts the lower limit.
–PHASE–	
UPPER LIMIT ON (OFF) XXX.XXX °	Turns the Upper Limit line on or off for the active channel on your Phase display.
LOWER LIMIT ON(OFF) XXX.XXX °	Turns the Lower Limit line on or off for the active channel on your Phase display.
READOUT LIMIT	Displays Menu LF2, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both limit lines for the active channel on both the Log-Mag and Phase graphs.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L1, Set Limits—Magnitude and Phase

MENU	DESCRIPTION
SINGLE LIMITS	
–LINEAR POLAR–	
UPPER LIMIT ON (OFF) XXX.XXX mU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Linear Polar display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX mU	Turns the Lower Limit line on or off for the active channel on your Linear Polar display.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your polar display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L2, Set Limits—Linear Polar

MENU	DESCRIPTION
SINGLE LIMITS	
–SMITH CHART–	
UPPER LIMIT ON (OFF) XXX.XXX mU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Smith Chart display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX mU	Turns the Lower Limit line on or off for the active channel on your Smith Chart.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Smith Chart.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L3, Set Limits—Linear Polar/Smith Chart

MENU	DESCRIPTION
SINGLE LIMITS	
–LOG MAG–	
UPPER LIMIT ON (OFF) XXX.XXX dB	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Log Mag display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX dB	Turns the Lower Limit line on or off for the active channel on your Log Mag display.
READOUT LIMIT	Displays Menu LF1, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Log Mag display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L4, Set Limits—Log Magnitude

MENU	DESCRIPTION
SINGLE LIMITS	
–PHASE–	
UPPER LIMIT ON (OFF) XXX.XXX °	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Phase display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX °	Turns the Lower Limit line on or off for the active channel on your Phase display.
READOUT LIMIT	Displays Menu LF1, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both limit lines for the active channel on a phase graph.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L5, Set Limits—Phase

MENU	DESCRIPTION
SINGLE LIMITS	
–LOG POLAR–	
UPPER LIMIT ON (OFF) XXX.XXX dB	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Log Polar display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX dB	Turns the Lower Limit line on or off for the active channel on your Log Polar display.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Log Polar display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L6, Set Limits—Log Polar

MENU	DESCRIPTION
SINGLE LIMITS	
–GROUP DELAY–	
UPPER LIMIT ON (OFF) XXX.XXX fs	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Group Delay display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX fs	Turns the Lower Limit line on or off for the active channel on your Group Delay display.
READOUT LIMIT	Displays Menu LF1, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Group Delay display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L7, Set Limits—Group Delay

MENU	DESCRIPTION
SINGLE LIMITS	
–LINEAR MAG–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Linear Mag display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Linear Mag display.
READOUT LIMIT	Displays Menu LF1, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Linear Mag display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L8, Set Limits—Linear Magnitude

MENU	DESCRIPTION
SINGLE LIMITS	
–LINEAR MAG–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Linear Mag display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Linear Mag display.
READOUT LIMIT	Displays Menu LF4, which shows points where the current S-parameter intercepts the lower limit.
-PHASE-	
UPPER LIMIT ON (OFF) XXX.XXX °	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your polar display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX °	Turns the Lower Limit line on or off for the active channel on your Phase display.
READOUT LIMIT	Displays Menu LF2, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Phase display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L9, Set Limits—Linear Magnitude and Phase

MENU	DESCRIPTION
SINGLE LIMITS	
–REAL–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Real display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Real display.
READOUT LIMIT	Displays Menu LF6, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Real values display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L10, Set Limits—Real Values

MENU	DESCRIPTION
SINGLE LIMITS	
–IMAGINARY–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Imaginary display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Imaginary display.
READOUT LIMIT	Displays Menu LF7, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Imaginary values display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L11, Set Limits—Imaginary Values

MENU	DESCRIPTION
SINGLE LIMITS	
–REAL–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Real display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Real display.
READOUT LIMIT	Displays Menu LF6, which shows points where the current S-parameter intercepts the lower limit.
–IMAGINARY–	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your Imaginary display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your Imaginary display.
READOUT LIMIT	Displays Menu LF7, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel on your Imaginary values display.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L12, Set Limits—Real and Imaginary Values

MENU	DESCRIPTION
SINGLE LIMITS	
–SWR—	
UPPER LIMIT ON (OFF) XXX.XXX pU	Turns the Upper Limit line on or off for the active channel. For your convenience, the arbitrarily set limit lines allow you to delineate a go/no go line on your SWR display beyond which the measured values are unacceptable.
LOWER LIMIT ON(OFF) XXX.XXX pU	Turns the Lower Limit line on or off for the active channel on your SWR display.
READOUT LIMIT	Displays Menu LF5, which shows points where the current S-parameter intercepts the lower limit.
DISPLAY ON (OFF) LIMITS	Enables both previously set limit lines to appear for the active channel.
TEST LIMITS	Calls Menu LTST, which provides choices for testing the limits.
SEGMENTED LIMITS	Calls a menu in the LS series (LSX), which lets you set segmented limit lines.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu L13, Set Limits—SWR

MENU	DESCRIPTION
DEFINE UPPER SEGS	Define the upper limit segment.
SEGMENT ON (OFF) X	Enter the segment number that you want to define, and turn it on or off.
START POSITION	
HORIZONTAL XXX.XXXXXXXXX GHz	Enter the start horizontal value in GHz, seconds, meter, or points (domain dependent)
VERTICAL XX.XXXXX dB	Enter the start vertical value in dB, degrees, units, or seconds (graph-type dependent)
STOP POSITION	
HORIZONTAL XXX.XXXXXXXXX GHz	Enter the stop horizontal value in GHz, seconds, meter, or points (domain dependent)
VERTICAL XX.XXXXX dB	Enter the stop vertical value in dB, degrees, units, or seconds (graph-type dependent)
BEGIN NEXT	Turns the next segment on and sets its start and stop postions to the previous segment's stop position.
ATTACH NEXT	Turns the next segment on and sets its start postions to the previous segment's stop position.
CLEAR SEGMENT	Turns the current segment-to-define off and sets its start equal to its stop.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu LD1, Define Upper Limit Segment

MENU	DESCRIPTION
DEFINE LOWER SEGS	Define the upper limit segment.
SEGMENT ON (OFF) X	Enter the segment number that you want to define, and turn it on or off.
START POSITION	
HORIZONTAL XXX.XXXXXXXXX GHz	Enter the start horizontal value in GHz, seconds, meter, or points (domain dependent)
VERTICAL XX.XXXXX dB	Enter the start vertical value in dB, degrees, units, or seconds (graph-type dependent)
STOP POSITION	
HORIZONTAL XXX.XXXXXXXXX GHz	Enter the stop horizontal value in GHz, seconds, meter, or points (domain dependent)
VERTICAL XX.XXXXX dB	Enter the stop vertical value in dB, degrees, units, or seconds (graph-type dependent)
BEGIN NEXT	Turns the next segment on and sets its start and stop postions to the previous segment's stop position.
ATTACH NEXT	Turns the next segment on and sets its start postions to the previous segment's stop position.
CLEAR SEGMENT	Turns the current segment-to-define off and sets its start equal to its stop.
PREVIOUS MENU	Returns to the previous menu.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu LD2, Define Lower Limit Segment

MENU	DESCRIPTION
READOUT LIMIT INTERCEPTS	
–LOG MAG—	
UPPER LIMIT (REF) XXX.XXX dB	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMITdB XXX.XXX dB	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER) XXX.XXX dB	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF1, Set Limit Frequencies—Log Mag

MENU	DESCRIPTION
READOUT LIMIT INTERCEPTS	
–PHASE—	
UPPER LIMIT (REF) XXX.XXX °	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMITdB XXX.XXX °	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER)	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF2, Set Limit Frequencies—Phase

MENU	DESCRIPTION
READOUT LIMIT INTERCEPTS	
–GROUP DELAY—	
UPPER LIMIT (REF) XXX.XXX fs	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMIT XXX.XXX fs	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER)	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF3, Set Limit Frequencies—Group Delay

MENU	DESCRIPTION
READOUT LIMIT INTERCEPTS	
–LINEAR MAG—	
UPPER LIMIT (REF) XXX.XXX pU	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMIT XXX.XXX pU	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER) XXX.XXX pU	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF4, Set Limit Frequencies—Linear Mag

MENU	DESCRIPTION
SET LIMIT FREQUENCIES	
–SWR—	
UPPER LIMIT (REF) XXX.XXX pU	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMIT XXX.XXX pU	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER) XXX.XXX pU	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF5, Set Limit Frequencies—SWR

MENU	DESCRIPTION
SET LIMIT FREQUENCIES	
–REAL—	
UPPER LIMIT (REF) XXX.XXX pU	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMIT XXX.XXX pU	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER)	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF6, Set Limit Frequencies—Real

MENU	DESCRIPTION
SET LIMIT FREQUENCIES	
–IMAGINARY—	
UPPER LIMIT (REF) XXX.XXX pU	Lets you set the UPPER LIMIT (REF) limit line. Changing this value also moves the lower limit line by the LIMIT DIFFERENCE amount.
LOWER LIMIT XXX.XXX pU	Lets you set the LOWER LIMIT dB limit line. Changing this value also changes the LIMIT DIFFERENCE amount relative to the UPPER LIMIT (REF) value.
LIMIT DIFFERENCE (UPPER-LOWER)	Lets you set the LIMIT DIFFERENCE amount. Changing this value also changes the lower limit value relative to the UPPER LIMIT (REF) value.
INTERCEPTS AT LOWER LIMIT	Displays at which frequencies the data intercepts the lower limit. May be interpolated.
XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz XXX.XXXXXXXXX GHz	

Menu LF7, Set Limit Frequencies—Imaginary

MENU	DESCRIPTION
SEGMENTED LIMITS	
–XXXXXXX—	Displays the currently active channel's graph type.
UPPER LIMIT ON(OFF)	Turns the Upper Limit line on or off for the active channel.
DEFINE UPPER	Calls menu LD1, which lets you define an upper segment value.
LOWER LIMIT ON(OFF)	Turns the Lower Limit line on or off for the active channel.
DEFINE LOWER	Calls menu LD2, which lets you define a lower segment value.
SEGMENTED OFFSETS	
HORIZONTAL XXXX GHz	Enter the horizontal offset to be applied to all of the channel's segmented limits, in GHz, seconds, meters, or points (domain dependent)
VERTICAL XXXX dB	Enter the vertical offset to be applied to all of the channel's segmented limits, in dB, degrees, units, or seconds (graph-type dependent).
CLEAR ALL	Clears all segments.
DISPLAY ON (OFF) LIMITS	Toggle between on and off to display the active channel's limits.
TEST LIMITS	Calls menu LTST, which lets test for limits.
SINGLE LIMITS	Returns to the appropriate single limits menu.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu LSX, Segmented Limits

MENU	DESCRIPTION
TEST LIMITS	
LIMIT ON (OFF) TESTING	Turns limit testing for all displayed channels on or off.
BEEP FOR ON (OFF) TEST FAILURE	Turns beeper on or off when limit test fails.
LIMIT TEST TTL FAIL CONDITION TTL LOW/TTL HIGH	Selects between a TTL high or TTL low to indicate that the limit test has failed.
CHANNEL 1 TEST PASS (FAIL)	Displays result of Channel 1 limit test.
CHANNEL 2 TEST PASS (FAIL)	Displays result of Channel 2 limit test.
CHANNEL 3 TEST PASS (FAIL)	Displays result of Channel 3 limit test.
CHANNEL 4 TEST PASS (FAIL)	Displays result of Channel 4 limit test.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu LTST, Test Limits

MENU	DESCRIPTION
SET MARKERS	
MARKER 1 ON (OFF) XXX.XXXXXXXXX GHz	Turns Marker 1 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob. **NOTE** In this text, markers are referred to as being active and as being selected. Any marker that has been turned on and assigned a frequency is considered to be selected. The marker to which the cursor presently points is considered to be active. The active marker is the only one for which you can change the frequency.
MARKER 2 ΔREF ON (OFF) XXX.XXXXXXXXX GHz	Turns Marker 2 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob.
MARKER 3 ON (OFF) XXX.XXXXXXXXX GHz	Turns Marker 3 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob.
MARKER 4 ON (OFF) XXX.XXXXXXXXX GHz	Turns Marker 4 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob.
MARKER 5 ON (OFF) XXX.XXXXXXXXX GHz	Turns Marker 5 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob.
MARKER 6 ON (OFF) XXX.XXXXXXX GHz	Turns Marker 6 on or off (activates or deactivates). When on (active), the frequency, time, or distance may be set using the keypad or rotary knob.
DISPLAY ON (OFF) MARKERS	Displays selected markers.
ΔREF MODE ON (OFF)	Selects the ΔREF Mode to be on or off.
SELECT ΔREF MARKER	Calls Menu M2, which lets you select the ΔREF Marker.
READOUT MARKER FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.

Menu M1, Set Markers

MENU	DESCRIPTION
SELECT ΔREF MARKER	
MARKER 1 XXX.XXXXXXXXX GHz	Marker 1 only appears if it has been activated in Menu M1. Placing the cursor on Marker 1 and pressing the Enter key here selects it as the ΔREF marker. The ΔREF marker is the one from which the other active markers are compared and their difference frequency measured and displayed in Menu M3. The marker frequency may be set using the keypad or rotary knob.
MARKER 3 XXX.XXXXXXXXX GHz	Same as above, but for Marker 3. *This display is representative if Markers 1, 3, and 4 are selected. Markers 2, 5, and 6 would also show, if they had been selected.*
MARKER 4 XXX.XXXXXXXXXGHz	Same as above, but for Marker 4
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu M2, Select ΔREF Marker

MENU	DESCRIPTION
SELECT READOUT MARKER	
MARKER 1 XXX.XXXXXXXXX GHz	Displays the frequency and S-Parameter value(s) of Marker 1 on all CRT-displayed graphs and Smith Charts. The frequency of Marker 1 also displays here. If Marker 1 was activated in Menu M2 as the REF marker, REF appears as shown for Marker M5 below.
MARKER 2 XXX.XXXXXXXXX GHz	Same as above, but for Marker 2
MARKER 5 XXX.XXXXXXXXX GHz	Same as above, but for Marker 5 *This display is representative if Markers 1, 2, and 5 are selected. Markers 3, 4, and 6 would also show, if they had been selected.*
ΔREF MODE IS ON (OFF)	Indicates the status of the ΔREF mode.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu M3, Select Readout Marker

MENU	DESCRIPTION
C H 1 — S 1 1	Selects channel for readout
REFERENCE PLANE X.XXXX mm	
MARKER 1 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	The selected marker—that is, the one to which the cursor points in Menu M1—and its frequency, time, or distance display here. This could be any one of the six available markers: Marker 1 thru Marker 6.
MARKER TO MAX	Causes the active marker to go to the frequency with the *greatest* S-Parameter value on the active channel.
MARKER TO MIN	Causes the selected marker to go to the frequency with the *smallest* S-Parameter value on the active channel.
2 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Displays the frequency, magnitude, and phase of the active S-Parameter at marker 2, if the marker is enabled.
3 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Displays the frequency, magnitude, and phase of the active S-Parameter at marker 3, if the marker is enabled.
4 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Displays the frequency, magnitude, and phase of the active S-Parameter at marker 4, if the marker is enabled.
5 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Displays the frequency, magnitude, and phase of the active S-Parameter at marker 5, if the marker is enabled.
6 XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Displays the frequency, magnitude, and phase of the active S-Parameter at marker 6, if the marker is enabled.
MARKER READOUT FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.

Menu M4, Readout Marker

MENU	DESCRIPTION
CH 1 – S11 REFERENCE PLANE X.XXXX mm	
MARKER 1 ΔREF XXX.XXXXXXXXX GHz MARKER TO MAX MARKER TO MIN	The REF marker, as activated in Menu M2, its frequency, its reference delay, and the channel on which it appears display here. The REF marker could be any one of the six available markers: M1-M6. The frequency of the REF marker can be changed using the keypad or rotary knob.
Δ(1 - 2) XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	The marker numbers of the REF marker and the next lowest-numbered selected marker appear between the parentheses. This example assumes Marker 1 as the Ref marker and Marker 2 as the next lowest-numbered selected marker. The lines below display the difference frequency, (or time/distance) and trace value(s) between these two markers on the active channel.
Δ(1 - 3) XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Same as above, except Marker 3 is the next lowest-numbered selected marker.
Δ(1 - 4) XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Same as above, except Marker 4 is the next lowest-numbered selected marker.
Δ(1 - 5) XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Same as above, except Marker 5 is the next lowest-numbered selected marker.
Δ(1 - 6) XXX.XXXXXXXXX GHz XX.XXX dB XXX.XXX °	Same as above, except Marker 6 is the next lowest-numbered selected marker.
MARKER READOUT FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.

Menu M5, Set ΔREF Marker Readout

MENU	DESCRIPTION
MARKER X ALL DISPLAYED CHANNELS	Displays the active marker number. For each channel being displayed, the channel, S-Parameter, frequency, time, distance or point number, and the current readout value for the marker is shown (below). No marker information is provided for channels that arer not displayed .
CH 1 — S11 XX.XXXXXXXXX GHz –XXX.XXX dB –XXX.XX °	Displays the measured value for the active marker on all channels currently being displayed. You can set the marker on the active channel in this menu. The active channel is displayed in GREEN; when not active it is displayed in BLUE.
CH 2 — S21	See above.
CH 3 — S12 XX.XXXXXXXXX GHz –XXX.XXX dB –XXX.XX °	See above.
CH 4 — S22	See above.
MARKER TO MAX	Causes the active marker to go to the frequency with the *greatest* S-Parameter value on the active channel.
MARKER TO MIN	Causes the selected marker to go to the frequency with the *smallest* S-Parameter value on the active channel.
MARKER READOUT FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements menu selection.

Menu M6, Marker X All Displayed Channels

MENU	DESCRIPTION
SEARCH	This menu provides control and readout for the marker search function. When this function is selected, the graph type for the active channel is automatically set to LOG MAGNITUDE (other graph types are not allowed), and taken out of time domain low pass or band pass display. Frequency with time gate display is allowed
VALUE –XXX.XXX dB	Target search value. A value from -999.999 to 999.999 dB may be entered.
REFERENCE	These menu choices let you enter the reference value for the search. The reference may be: -Graticule "0 dB" -Position of Delta Ref. Marker (Marker 1 is used as the Δ Ref Marker) -Maximum value in Passband (default selection). Marker 1 is used to indicate maximum.
MAXIMUM VALUE	Selects maximum value as the reference.
Δ REF MARKER	Selects Δ Ref Marker (Marker 1) as the reference.
0 dB	Selects 0 dB as the reference.
VALUE AT REFERENCE –XXX.XXX dB	Displays the difference between the reference value and 0 dB.
SEARCH LEFT SEARCH RIGHT XX.XXXXXXXXX GHz	Goes to the next data point that is left (or right) of the search marker (Marker 2) and whose value is equal to VALUE plus the reference. If "TRACKING" is ON, Marker 2 will search both left and right, and go to the closest point whose value is equal to VALUE plus reference. If there is no such point, the message "VALUE NOT FOUND" is displayed in the data area. Otherwise the marker goes to that coordinate and the readout (under the search direction) is updated to reflect that frequency.
TRACKING ON (OFF)	When ON the active marker will change its frequency value after every sweep to maintain the user entered loss value. When OFF the marker stays at the same frequency and reads out the magnitude value at that frequency, except when a search is triggered.
MARKER READOUT FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements menu selection, or toggles selected option on or off.

Menu M7, Search

MENU	DESCRIPTION
FILTER PARAMETERS	Provides the readouts for the filter measurement functions, as well as some selections. When this function is selected, the graph type for the active channel is automatically set to LOG MAGNITUDE, and taken out of time domain low pass or band pass display. Frequency with time gate display is allowed
CENTER FREQ XX.XXXXXXXXX GHz	Displays the value of Marker 2. Marker 1 displays the reference value (maximum filter response, or its set value if delta ref).
BANDWIDTH XXX.XXX dB Δ REF MARKER XX.XXXXXXXXX GHz	Displays the difference between Markers 3 and 4.
LOSS AT REF –XXX.XXX dB	Displays the difference between the reference value and 0 dB.
Q XX.XXX	Displays the Q value. **NOTE** "Q" and "SHAPE FACTOR" are not displayed if they are toggled OFF in Menu M8A.
SHAPE FACTOR X.XXX	Displays the Shape Factor value.
TRACKING ON (OFF)	When ON the active marker will change its frequency value after every sweep to maintain the user entered loss value. When OFF the marker stays at the same frequency and reads out the magnitude value at that frequency, except when a search is triggered.
FILTER SETUP	Calls Menu M8A, which lets you set filter parameters.
MARKER READOUT FUNCTIONS	Calls Menu M9, which lets you select readout marker parameters.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements menu selection, or toggles selected option on or off.

Menu M8, Filter Parameters

MENU	DESCRIPTION
FILTER SETUP	
BANDWIDTH LOSS VALUE XXX.XXX dB	A "loss" is a positive number. A value of 0 to 999.999 dB may be entered. The search value for bandwidth will be REF minus (-) LOSS. By default, the loss value is set to 3 dB.
REFERENCE	These menu choices let you enter the reference value for the search. The reference may be: -Graticule "0 dB" -Position of Delta Ref. Marker. (Marker 1 is used as the Δ Ref Marker) -Maximum value in Passband (default selection). Marker 1 is used to indicate maximum.
MAXIMUM VALUE	Selects maximum value as the reference.
Δ REF MARKER	Selects Δ Ref Marker (Marker 1) as the reference.
0 dB	Selects 0 dB as the reference.
SHAPE FACTOR	
HIGH XXX.XXX dB LOW XXX.XXX dB	Enter high and low values for the Shape Factor. The LOW entry must be less than the HIGH entry. A value of 0 to 999.999 dB may be entered. The defaults are +6 dB for the HIGH, and +60 dB for the LOW value
READOUTS	
Q ON (OFF)	Toggles Q on or off.
SHAPE FACTOR ON (OFF)	Toggles the Shape Factor on or off.
	NOTE "Q" and "SHAPE FACTOR" are not displayed in Menu M8, if they are toggled to OFF.
PREVIOUS MENU	Returns to the M8 menu.

Menu M8A, Filter Setup

MENU	DESCRIPTION
MARKER READOUT FUNCTIONS	
MARKERS ON ACTIVE CHANNEL	Calls Menu M3 directly — or causes it to be displayed when the Readout Marker key is pressed — if there is no active marker. Or to it calls or causes Menu M4 to be displayed if there is an active marker. If in delta reference mod, Menu M5 menu is displayed.
ACTIVE MARKERS ON ALL CHANNELS	Calls Menu M6 directly —or causes it to be displayed when the Readout Marker key is pressed.
SEARCH	Calls Menu M7 directly —or causes it to be displayed when the Readout Marker key is pressed.
FILTER PARAMETERS	Calls Menu M8 directly —or causes it to be displayed when the Readout Marker key is pressed.
MARKER MODE	
CONTINUOUS	Marker values are interpolated between data points, Interpolated markers are allowed only when the horizontal axis of the display is FREQUENCY. Interpolated markers are not allowed in CW, Time Domain, or Power Sweep. If a channel has been set to interpolated markers and the sweep is changed to CW or Power Sweep, the markers will automatically revert to normal mode (DISCRETE). Time Domain will ignore CONTINUOUS mode. Interpolated markers are allowed in any graph type, as long as the sweep is by frequency.
DISCRETE	Markers are displayed only at actual measured data point values.
SET MARKERS	Calls Menu M1, which lets you set marker parameters.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements menu selection.

Menu M9, Marker Readout Functions

MENU	DESCRIPTION
TRACE MEMORY FUNCTIONS	
VIEW DATA	Displays measured data; that is, the data presently being taken.
VIEW MEMORY	Displays stored data; that is, data that was previously taken and stored in memory.
VIEW DATA AND MEMORY	Displays measured data superimposed over stored data.
VIEW DATA (/) MEMORY	Displays measured data combined with stored data using selected math.
SELECT TRACE MATH	Takes you to menu NO2 for selection of the type of math operation to be performed.
STORE DATA TO MEMORY (STORED) (NOT STORED)	Stores the measured data to internal memory.
DISK OPERATIONS	Brings up menu NO3, which allows data to be stored to or recalled from the disk.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu NO1, Trace Memory Functions

MENU	DESCRIPTION
SELECT TRACE MATH	
ADD (+)	Selects DATA + MEMORY as the math function.
SUBTRACT (–)	Selects DATA – MEMORY as the math function.
MULTIPLY (*)	Selects DATA X MEMORY as the math function.
DIVIDE (/)	Selects DATA ÷ MEMORY as the math function.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection. The menu returns to the NO1 menu.

Menu NO2, Select Trace Math

MENU	DESCRIPTION
TRACE MEMORY DISK OPERATIONS	
CHANNEL X	Indicates the channel to be used (active channel).
SAVE MEMORY TO HARD DISK	Calls menu DSK3, which lets you save memory to the hard disk.
SAVE MEMORY TO FLOPPY DISK	Calls menu DSK3, which lets you save memory to the floppy disk.
RECALL MEMORY FROM HARD DISK	Calls menu DSK2, which lets you recall memory from the hard disk.
RECALL MEMORY FROM FLOPPY DISK	Calls menu DSK2, which lets you recall memory from the floppy disk.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu NO3, Trace Memory Disk Functions

MENU	DESCRIPTION
MULTIPLE SOURCE CONTROL	
DEFINE BANDS	Calls menu OM1, which lets you define a frequency band.
MULTIPLE SOURCE MODE	
OFF	Turns multiple source operating mode off placing 372XXA VNA in normal operating mode.
DEFINE	
ON	Sets multiple source mode to ON.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu OM1, Multiple Source Control Menu

MENU	DESCRIPTION
DEFINE BANDS	
BAND 1	Displays the band number being defined.
DISPLAYED FREQ RANGE	
BAND START FREQ XX.XXXXXX GHz	Displays the start frequency for the band.
BAND STOP FREQ XX.XXXXXX GHz	Displays the stop frequency for the band.
BAND FUNCTIONS	
EDIT SYSTEM EQUATIONS	Calls menu OM2, which lets you edit system equations.
STORE BAND 1 BANDS STORED: (1 2 3 4 5)	Indicates the band that will be stored and, within the parenthesis, indicates the bands that have been stored.
CLEAR ALL DEFINITIONS	Clears all the band definitions that may have been previously stored.
SET MULTIPLE SOURCE STATE	Selects Multiple Source Control menu OM0.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu OM2, Define Bands Menu

MENU	DESCRIPTION
EDIT SYSTEM EQUATIONS	
EQUATION TO EDIT	
SOURCE 1	Selects source 1 frequency equation for change.
SOURCE 2	Selects source 2 frequency equation for change.
RECEIVER	Selects receiver frequency equation for change.
EQUATION SUMMARY	
C.W. ON (OFF)	Toggles frequency term (F) in equation ON or OFF.
MULTIPLIER XX	Enables changing multiplier term of frequency equation via key pad or rotary knob.
DIVISOR XX	Enables changing divisor term frequency equation via key pad or rotary knob.
OFFSET FREQ XXX.XXXXXXXXX GHz	Enables changing offset frequency term frequency equation via key pad or rotary knob.
PREVIOUS MENU	Recalls menu OM1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu OM3, Edit System Equations

MENU	DESCRIPTION
OPTIONS	
TRIGGERS	Calls menu TRIG, which lets you define trigger source.
REAR PANEL OUTPUT	Calls menu ORP1, which lets you select an output for the rear panel AUX I/O connector.
DIAGNOSTICS	Calls menu DG1, which lets you implement system diagonistics.
MULTIPLE SOURCE CONTROL	Calls menu OM1, which lets you use and define multiple sources.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu OPTNS, Select Options

MENU	DESCRIPTION
REAR PANEL OUTPUT CONTROL	
OUTPUT ON (OFF)	Turns the rear panel ANALOG OUT output on or off.
SELECT MODE XXXXXXXXXX	Calls menu ORP2, which lets you select an output mode.
HORIZONTAL OR PHASE LOCK SCALING	
START/LOCK a1 X.XXXX V	Lets you enter a voltage for the start/lock frequency. Value will be a frequency start voltage if SELECT MODE choice is HORIZONTAL. It will be a phase-lock voltage if SELECT MODE choice is PHASELOCK.
STOP/LOCK a2 X.XXXX V	Lets you enter a voltage for the start/lock frequency. Value will be a frequency stop voltage if SELECT MODE choice is HORIZONTAL. It will be a phase-lock voltage if SELECT MODE choice is PHASELOCK.
VERTICAL SCALING	
RESOLUTION 1.000 V/DIV	Shows fixed value for VERTICAL mode.
REFERENCE VALUE 0.000 V/DIV	Shows fixed value for VERTICAL mode.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu ORP1, Rear Panel Output Control

MENU	DESCRIPTION
SELECT MODE FOR OUTPUT	
HORIZONTAL	Pressing Enter key selects horizontal drive for external chart recorder connected to ANALOG OUT connector.
VERTICAL	Pressing Enter key selects vertical drive for external chart recorder connected to ANALOG OUT connector.
PHASE LOCK	Pressing Enter key selects phase-lock for external chart recorder connected to ANALOG OUT connector.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu ORP2, Select Output Mode

MENU	DESCRIPTION
SELECT POLAR CHART MODE	
MAGNITUDE, PHASE	Selects Polar Chart Display to show magnitude and phase for the full frequency range—from start frequency to stop frequency.
MAGNITUDE, SWP POSITION	Selects Polar Chart Display to show magnitude information only for the phase data that falls between the start and stop angles selected below.
SET SWEEP POSITION BOUNDARIES	Sets the start and stop angles for the data display.
START ANGLE X.XX°	
STOP ANGLE X.XX°	
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu PC1, Select Polar Chart Mode

MENU	DESCRIPTION
PLOT OPTIONS	
FULL PLOT	The plotter will plot everything displayed on the screen (data traces, graticule, menu text) when START PRINT is pressed.
OPTIONS TO PLOT	
HEADER ON (OFF)	The plot will include an information header if this option is on and START PRINT is pressed.
MENU ON (OFF)	The plot will include the menu text if this option is on and START PRINT is pressed.
LIMITS ON (OFF)	The plot will include any limit lines if this option is on and START PRINT is pressed.
GRATICULE ON (OFF)	The plot will include the graticule and annotation if this option is on and START PRINT is pressed. The plotter plots the graticule.
DATA TRACE(S) ON(OFF) AND MARKERS	The plot will include the data and any marker that are present if this option is on and START PRINT is pressed. The plotter plots the graticule.
PLOT FORMAT	
PLOT SIZE	Calls menu PL2, which lets you select the size and location of the plot.
PEN COLORS	Calls menu PL3, which lets you select pen colors for the various elements of the plot: graticule, data traces, menu text and header. Also lets you select the relative pen speed.
PLOT ORIENTATION PORTRAIT LANDSCAPE	Select the orientation for your plot, either portrait or landscape.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu PL1, Plot Options

MENU	DESCRIPTION
PLOT SIZE	
FULL SIZE	Selects a full size (page) plot.
–QUARTER SIZE PLOTS–	
UPPER LEFT	Selects a quarter-size plot, upper-left quadrant.
UPPER RIGHT	Selects a quarter-size plot, upper-right quadrant.
LOWER LEFT	Selects a quarter-size plot, lower-left quadrant.
LOWER RIGHT	Selects a quarter-size plot, lower-right quadrant.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu PL2, Select Plot Size

MENU	DESCRIPTION
SELECT PEN COLORS	
DATA PEN n	Selects the color in which the data will be plotted. The number of the pen displays where the "n" is shown.
DATA TRACE OVERLAY PEN n	Selects the color in which the 2nd trace in a dual trace overlay plot will be plotted. The number of the pen displays where the "n" is shown.
GRATICULE PEN n	Selects the color in which the graticule will be plotted. The number of the pen displays where the "n" is shown.
MARKERS AND LIMITS PEN n	Selects the color in which the markers and limits will be plotted. The number of the pen displays where the "n" is shown.
HEADER PEN n	Selects the color in which the header information will be plotted. The number of the pen displays where the "n" is shown.
PEN SPEED 100 PERCENT OF MAXIMUM	Selects the pen's speed as a percentage of the plotter's maximum speed. (Used to optimize plots on transparencies or with worn pens.)
PREVIOUS MENU	Recalls menu PL1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu PL3, Select Pen Colors

MENU	DESCRIPTION
SELECT OUTPUT DEVICE	
PRINTER	Selects the printer as your output device.
PLOTTER	Selects the plotter as your output device.
OUTPUT OPTIONS	
SET UP OUTPUT HEADERS	Calls menu PM2, which lets you define the output header information shown on printer/plotter output.
DISK OPERATIONS	Calls menu PM4, which lets you store/recall tabular data to/from disk.
PRINT OPTIONS	Calls menu PM5.
PLOT OPTIONS	Calls menu PL1.

Menu PM1, Select Data Output Type

MENU	DESCRIPTION
DATA OUTPUT HEADERS	
MODEL ON (OFF) XXXXXXXXXXXX	Selecting <1>displays menu GP5, which lets you select the letters and/or numbers in your model identifier.
DEVICE ID ON (OFF) XXXXXXXXXXXX	Selecting <1>displays menu GP5, which lets you select the letters and/or numbers in your Device I.D. identifier.
DATE ON (OFF) XXXXXXXXXXXX	Selecting <1>displays menu GP5, which lets you select the letters and/or numbers in the date.
OPERATOR ON (OFF) XXXXXXXXXXXX	Selecting <1> displays menu GP5, which lets you select the letters identifying the operator.
COMMENT ON (OFF) XXXXXXXXXXXX	Selecting <1> displays menu GP5, which lets you enter a comment.
PRESS <ENTER> TO TURN ON/OFF	Pressing the Enter key selects between menu selections. Pressing the CLEAR/RET LOC key lets you change the between ON and OFF states
PRESS < 1 > TO CHANGE	Pressing <1> lets you enter the desired label in menu GP5.

Menu PM2, Data Output Headers

MENU	DESCRIPTION
TABULAR PRINTER OUTPUT FORMAT	
MARKER DATA ON (OFF)	Provides for printing marker data.
SWEEP DATA ON (OFF)	Provides for printing sweep data. If you choose to print the sweep data, you can then choose how may points of the total sweep to print.
HEADER AND ON (OFF) PAGE BREAKS	Provides for printing header and page-break data.
PRINT DENSITY	
XXX PRINT PT(S) OUTPUT PRINTS 1 POINT EVERY XXX POINT(S)	Outputs one point every X points. Use the rotary knob to select total number of points to output. Skipping points will reduce the total number of printed points.
PREVIOUS MENU	Returns to menu PM5.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key selects between menu selections. Pressing the CLEAR/RET LOC key lets you change the between ON and OFF states.
TURN KNOB TO CHANGE NUMBER OF POINTS	

Menu PM3, Tabular Printer Output Format

MENU	DESCRIPTION
GRAPHICAL PRINTER OUTPUT FORMAT	
HEADER ON (OFF)	Provides for printing header data.
SCREEN AREA TO OUTPUT	
FULL SCREEN	Prints the full-screen data, including the menus.
GRAPH ONLY	Prints only the graph or Smith chart.
PREVIOUS MENU	Returns to menu PM5.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key selects between menu selections. Pressing the CLEAR/RET LOC key lets you change the between ON and OFF states.

Menu PM3A, Graphical Printer Output Format

MENU	DESCRIPTION
OUTPUT DISK OPERATIONS	
TABULAR DATA TO HARD DISK	Outputs tabular data to the disk and takes you to GP1-3 or DSK 11 for selection of a file name.
TABULAR DATA TO FLOPPY DISK	Outputs tabular data to the disk and takes you to DSK 11 for selection of a file name.
TABULAR DATA FROM HARD DISK TO PRINTER	Brings up DSK9 for selection of a measurement data file to be output to the printer.
TABULAR DATA FROM FLOPPY DISK TO PRINTER	Brings up DSK9 for selection of a measurement data file to be output to the printer.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu PM4, Disk Output Operations

MENU	DESCRIPTION
PRINT OPTIONS	
PRINTER TYPE	
THINKJET	Select when HP QuietJet or HP ThinkJet is connected to 372XXA VNA.
DESKJET	Select when HP DeskJet (B/W) or HP LaserJet II and III series is connected to 372XXA VNA.
EPSON	Select when Epson FX, Epson MX, or Epson 9-pin compatible is connected to 372XXA VNA.
FORMAT OF PRINTER OUTPUT	
GRAPHICAL DATA	Prints only the graph or Smith chart, including any and all data it contains.
TABULAR DATA	Prints a tabulation of the measured data
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu PM5, Printer Type, Options

MENU	DESCRIPTION
SET REFERENCE PLANE	
AUTO	Automatically sets the reference delay so that the cumulative phase shift is zero. This selection unwinds the phase in a Smith chart display or reduces the phase revolutions in a rectilinear display to less than one.
DISTANCE XXX.XXXX mm	Electrically repositions the measurement reference plane, as displayed on the active channel, by a distance value entered in millimeters. This selection lets you compensate for the phase reversals inherent in a length of transmission line connected between the test set's Port 1 connector and the device-under-test (DUT).
TIME XXX.XXXX ms	Electrically repositions the measurement reference plane by a distance value that corresponds to the time in milliseconds.
SET DIELECTRIC XXX	Displays menu RD2, which lets you enter a value for the dielectric constant of your transmission line.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu RD1, Set Reference Delay

MENU	DESCRIPTION
SET DIELECTRIC CONSTANT	
AIR (1.000649)	Calculates reference delay based on dielectric constant of air (1.000649).
POLYETHYLENE (2.26)	Calculates reference delay based on the dielectric constant of polyethylene (2.26).
TEFLON (2.10)	Calculates reference delay based on the dielectric constant of teflon (2.1).
MICROPOROUS TEFLON (1.69)	Calculates reference delay based on the dielectric constant of microporous teflon (1.69).
OTHER XXXX.XX	Calculates reference delay based on the value you enter. Terminate your entry using any terminator and select with the Enter key.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection and returns you to the RD1 menu.

Menu RD2, Set Dielectric Constant

MENU	DESCRIPTION
SELECT PARAMETER	
S21, STANDARD FWD TRANS	Selects the S_{21} parameter to be displayed on the active channel The parameter can be displayed in any of the available formats.
S11, STANDARD FWD REFL	Selects the S_{11} parameter to be displayed on the active channel. The parameter can be displayed in any of the available formats.
S12, STANDARD REV TRANS	Selects the S_{12} parameter to be displayed on the active channel. The parameter can be displayed in any of the available formats.
S22, STANDARD REV REFL	Selects the S_{22} parameter to be displayed on the active channel. The parameter can be displayed in any of the available formats.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu SP, Select S Parameter

MENU	DESCRIPTION
SAVE/RECALL FRONT PANEL AND CAL DATA	
SAVE RECALL	Displays menu SR2, which asks you to select a storage location—internal memory or disk.
PRESS <ENTER> TO SELECT FUNCTION	Pressing the Enter key implements your selection.

Menu SR1, Save/Recall Front Panel Information

MENU	DESCRIPTION
RECALL (OR SAVE)	
FRONT PANEL SETUP IN INTERNAL MEMORY	Calls menu SR3, which lets you save the front panel setup into or recall it from internal memory.
FRONT PANEL SETUP AND CAL DATA ON HARD DISK	Calls menu DKS2 or DSK3, which let you recall or save to hard disk memory.
FRONT PANEL SETUP AND CAL DATA ON FLOPPY DISK	Calls menu DKS2 or DSK3, which let you recall or save to floppy disk memory.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your selection. The menu remains on the screen until another menu is selected for display or until the Clear/Ret Loc key is pressed.

Menu SR2, Recall or Save

MENU	DESCRIPTION
SAVE FRONT PANEL SETUP TO (RECALL FRONT PANEL SETUP FROM) INTERNAL MEMORY	
MEMORY 1*	Causes the current front panel setup to be saved to memory location 1. If an asterisk appears beside the selection, the memory is full. Select a different memory location.
MEMORY 2	Same as above, except the setup saves to memory location 2.
MEMORY 3	Same as above, except the setup saves to memory location 3.
MEMORY 4*	Same as above, except the setup saves to memory location 4.
MEMORY 5*	Same as above, except the setup saves to memory location 5.
MEMORY 6	Same as above, except the setup saves to memory location 6.
MEMORY 7	Same as above, except the setup saves to memory location 7.
MEMORY 8	Same as above, except the setup saves to memory location 8.
MEMORY 9	Same as above, except the setup saves to memory location 9.
MEMORY 10	Same as above, except the setup saves to memory location 10.
PRESS <ENTER> TO SELECT OR USE KEYPAD	Pressing the Enter key implements your menu selection.

Menu SR3, Save to Internal memory

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LOG MAG–	
RESOLUTION XX.XXX dB/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX dB	Sets the value at the reference line for the active channel amplitude measurement on the log-magnitude graph. The value can be set in increments of 0.001 dB using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement on the log-magnitude graph. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
–PHASE–	
RESOLUTION XX.XX ° /DIV	Sets the resolution for the vertical axis of the active channel's displayed phase graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XX °	Sets the value at the reference line for the active channel amplitude measurement on the phase graph. The value can be set in increments of 0.001 dB using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's phase measurement on the phase graph. This is the line about which the phase expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PHASE SHIFT X.XX °	Sets the value by which the active channel's phase measurement is shifted on the phase graph. The shift can be set in increments of 0.01 degrees using the keypad or rotary knob. This is useful when phase data is near the 180 degree rollover value.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS1 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS1 or CAL_SS1, Set Scaling 1

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LINEAR POLAR–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob. The center is fixed at 0 units; therefore, changing the resolution also changes the reference value and vice versa
REFERENCE VALUE XXX.XXX U	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
FIXED REFERENCE LINE	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
SELECT POLAR CHART MODE MAGNITUDE PHASE	Calls menu PC1, which lets you define the phase angles between which your polar chart will display data.
PRESS <ENTER> TO SELECT AND RESUME CAL	Pressing the Enter key implements your menu selection and resumes the calibration from where it left off, if in the calibration mode.

Menu SS2 or CAL_SS2, Set Scaling 2

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
IMPEDANCE (ADMITTANCE) SMITH CHART	Scales an Impedance Smith chart for display in the active channel.
NORMAL SMITH (REFL = 1.0000000 FULL SCALE)	Selects a normal Smith chart for display in the active channel.
EXPAND 10 dB (REFL = 0.3162278 FULL SCALE)	Selects a 10 dB expansion of the Smith chart being displayed for the active channel.
EXPAND 20 dB (REFL = 0.1000000 FULL SCALE)	Selects a 20 dB expansion of the Smith chart being displayed for the active channel.
EXPAND 30 dB (REFL = 0.0316228 FULL SCALE)	Selects a 30 dB expansion of the Smith chart being displayed for the active channel.
COMPRESS 3 dB (REFL =1.425375 FULL SCALE)	Selects a 3 dB compression of the Smith chart being displayed for the active channel.
PRESS <ENTER> TO SELECT AND RESUME CAL	On the CAL_SS3Z or Y menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS3Z/SS3Y or CAL_SS3Z/CALSS3Y, Set Scaling 3

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LOG MAG–	
RESOLUTION XX.XXX dB/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX dB	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 dB using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement on the log-magnitude graph. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS4 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS4 or CAL_SS4, Set Scaling 4

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–PHASE–	
RESOLUTION XX.XXX °/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX °	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.01 ° using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PHASE SHIFT X.XX °	Sets the value by which the active channel's phase measurement is shifted on the phase graph. The shift can be set in increments of 0.01 degrees using the keypad or rotary knob. This is useful when phase data is near the 180 degree rollover value.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS5 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS5 or CAL_SS5, Set Scaling 5

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LOG POLAR–	
RESOLUTION XX.XXX dB/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX dB	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 dB using the keypad or rotary knob.
FIXED REFERENCE LINE	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
SELECT POLAR CHART MODE MAGNITUDE PHASE	Calls menu PC1, which lets you define the phase angles between which your polar chart will display data.
PRESS <ENTER> TO SELECT AND RESUME CAL	Pressing the Enter key implements your menu selection and resumes the calibration from where it left off, if in the calibration mode.

Menu SS6 or CAL_SS6, Set Scaling 6

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–GROUP DELAY–	
RESOLUTION XX.XXX fs/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REF VALUE XXX.XXX fs	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.0001 s using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
APERTURE X.X PERCENT OF SWEEP	Sets and displays the percent of frequency span over which group delay is calculated.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS7 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS7 or CAL_SS7, Set Scaling 7

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LINEAR MAG–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX pU	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS8 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS8 or CAL_SS8, Set Scaling 8

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–LINEAR MAG–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX pU	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
–PHASE–	
RESOLUTION XX.XX °/DIV	Sets the resolution for the vertical axis of the active channel's displayed phase graph. Resolution can by set incrementally using the keypad or rotary knob.
REF VALUE XXX.XX °	Sets the value by which the active channel's phase measurement is offset on the phase graph. The offset can be set in increments of 0.01 degrees using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's phase measurement on the phase graph. This is the line about which the phase expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PHASE SHIFT X.XX °	Sets the value by which the active channel's phase measurement is shifted on the phase graph. The shift can be set in increments of 0.01 degrees using the keypad or rotary knob. This is useful when phase data is near the 180 degree rollover value.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS9 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS9 or CAL_SS9, Set Scaling 9

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–REAL–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX pU	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS10 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS10 or CAL_SS10, Set Scaling 10

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–IMAGINARY–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX pU	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS11 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS11 or CAL_SS11, Set Scaling 11

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–REAL–	
RESOLUTION XX.XXX U/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX pU	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
–IMAGINARY–	
RESOLUTION XX.XX °/DIV	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XX °	Sets the value by which the active channel's phase measurement is offset on the phase graph. The offset can be set in increments of 0.01 degrees using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's phase measurement on the phase graph. This is the line about which the phase expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS12 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS12 or CAL_SS12, Set Scaling 12

MENU	DESCRIPTION
SET SCALING OR PRESS <AUTOSCALE>	
–SWR–	
RESOLUTION XX.XXX U /	Sets the resolution for the vertical axis of the active channel's displayed graph. Resolution can by set incrementally using the keypad or rotary knob.
REFERENCE VALUE XXX.XXX U	Sets the value at the reference line for the active channel amplitude measurement on the displayed graph. The value can be set in increments of 0.001 U using the keypad or rotary knob.
REFERENCE LINE X	Sets the reference line for the active channel's amplitude measurement. This is the line about which the amplitude expands with different resolution values. The reference line can be set to any vertical division using the rotary knob.
PRESS <ENTER> TO RESUME CAL	On the CAL_SS13 menu, pressing the Enter key returns you to the calibration setup or sequence.

Menu SS13 or CAL_SS13, Set Scaling 13

MENU	DESCRIPTION
SWEEP SETUP	
START XXX.XXXXXXXXX GHz	Enter the sweep-start frequency in GHz. The start frequency must be lower than the stop frequency.
STOP XXX.XXXXXXXXX GHz	Enter the sweep-stop frequency in GHz. The stop frequency must be higher than the start frequency.
SET CENTER/SPAN	Calls menu SU1_CENTER, which lets you set values for center frequency and span width.
XXX DATA POINTS XXX.XXXXXXXXX GHz STEPSIZE	Displays the number of frequency points and the spacing between points for the start and stop frequencies selected above. The number of points shown provides the finest frequency resolution possible, based on your Data Points key menu selection.
C.W. MODE ON (OFF) XXX.XXXXXXXXX GHZ	Move cursor here and press Enter to enable the CW mode. Enter CW frequency for measurements.
MARKER SWEEP	Move cursor here and press Enter to set the start and stop frequencies (menu SU5) of the CW frequency (menu SU6) to the values of any marker
DISCRETE FILL	Calls Discrete Fill Menu (menu DF1).
HOLD BUTTON FUNCTION	Calls menu SU4, which lets you set the action of the HOLD key.
TEST SIGNALS	Calls menu SU2, which lets you set the source power and the values for the attenuators in the 372XXA. It also provides entry into the Flat Test Port Power calibration.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the ENTER key implements your menu selection.

Menu SU1, Sweep Setup 1

MENU	DESCRIPTION
SWEEP SETUP	
CENTER XXX.XXXXXXXXX GHz	Enter the center frequency in GHz.
SPAN XXX.XXXXXXXXX GHz	Enter the span frequency in GHz.
SET START/STOP	Calls menu SU1, which lets you set values for start and stop frequencies.
XXX DATA POINT(S) XXX.XXXXXXXXX GHz STEPSIZE	Displays the number of frequency points and the spacing between points for the center and span frequencies selected above. The number of points shown provides the finest frequency resolution possible, based on your Data Points key menu selection.
C.W. MODE ON (OFF) XXX.XXXXXXXXX GHZ	Move cursor here and press Enter to enable the CW mode. Enter CW frequency for measurements.
MARKER SWEEP	Move cursor here and press Enter to set the start and stop frequencies (menu SU5) of the CW frequency (menu SU6) to the values of any marker
DISCRETE FILL	Calls Discrete Fill Menu (menu DF1).
HOLD BUTTON FUNCTION	Calls menu SU4, which lets you set the action of the HOLD key.
TEST SIGNALS	Calls menu SU2, which lets you set the source power and the values for the attenuators in the 372XXA. It also provides entry into the Flat Test Port Power calibration.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the ENTER key implements your menu selection.

Menu SU1_CENTER, Sweep Setup 1

MENU	DESCRIPTION
TEST SIGNALS	
POWER CONTROL +XX.X dB 0 TO -15.0 dB)	Enter the delta-power level for the Port 1 output in dB.
PORT 1 ATTN XX10 dB (0 - 70)	Attenuates the microwave source power at port 1 from 0 to 70 dB, in 10 dB steps. The power is attenuated before being applied to Port 1 for a forward transmission or reflection test (S_{21} or S_{11}, respectively).
PORT 1 POWER -XX.XX dBM	Displays the Port 1 power, in dBm.
PORT 2 ATTN XX10 dB (0-X0)	Attenuates from 0 to 40 dB (10 dB steps) the microwave power being input to Port 2 from the device-under-test (DUT).
CALIBRATE FOR FLATNESS (CAL EXISTS)	
FLATNESS ON(OFF) CORRECTION AT XX.X dBm	Calls menu SU8 or CAL_SU8, depending on whether valid Flat Test Port Power calibration data exists. Both of these menus provide selection control for the Flat Test Port Power feature.
SOURCE 2 POWER -XX.XX dBm	Enter the power level, in dBm, of the 2nd, external frequency source.
PREVIOUS MENU	Returns you to the previous menu. (RESUME CAL may be used instead of PREVIOUS MENU, when accessed during a calibration.)
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu SU2 or CAL_SU2, Sweep Setup 2

MENU	DESCRIPTION
SINGLE POINT MEASUREMENT SETUP	
C.W. FREQ XXX.XXXXXXXXX GHz	Enter the measurement frequency in GHz for continuous wave (CW) operation.
HOLD BUTTON FUNCTION	Calls menu SU4, which lets you set the action of the HOLD key.
TEST SIGNALS	Calls menu SU2, which lets you set values for the source power and attenuators. It also provides entry into the Flat Test Port Power calibration.
RETURN TO SWEEP MODE	Move cursor here and press Enter to return to the F1-F2 sweep mode (Menu SU1).
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu SU3, Single-Point Measurement Setup

MENU	DESCRIPTION
SELECT FUNCTION FOR HOLD BUTTON	
HOLD/CONTINUE	Causes the hold key (button) to stop and start the sweep.
HOLD/RESTART	Causes the hold key to stop and restart the sweep.
SINGLE SWEEP AND HOLD	Causes the hold key to trigger a single sweep and hold when finished. (Two sweeps, one from Port 1 to 2 and another from Port 2 to 1, are accomplished for a 12-Term measurement.)
BIAS/RF HOLD CONDITIONS	
BIAS ON (OFF)	Select bias to be on or off (test sets having bias input only) while system is in hold.
RF ON (OFF)	Selects RF to be on or off while system is in hold.
DUT/AUT ON (OFF) PROTECTION DEFAULT RESET TURNS ON HOLD WITH BIAS/RF TURNED OFF	When on, a default reset places the system in hold with RF and bias turned off. This choice is initialized to OFF when the software version changes or after a Default Program key press, so that the system comes up in the sweep mode.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu SU4, Select Function for Hold Button

MENU	DESCRIPTION
FREQUENCY MARKER SWEEP	
START SWEEP MARKER (n) XXX.XXXXXXXXX GHz	Pressing a number on the keypad causes the associated marker to be the start frequency of the sweep.
STOP SWEEP MARKER (n) XXX.XXXXXXXXX GHz	Pressing a number on the keypad causes the associated marker to be the stop frequency of the sweep.
USE KEYPAD TO SELECT MARKER (1-6)	Use the keypad to select markers 1, 2, 3, 4, 5, or 6.

Menu SU5, Frequency Marker Sweep

MENU	DESCRIPTION
FREQUENCY MARKER C.W.	
C.W FREQ MARKER (n) XXX.XXXXXXXXX GHz	Pressing a number on the keypad causes the associated marker to be the C.W. frequency.
USE KEYPAD TO SELECT MARKER (1-6)	Use the keypad to select markers 1, 2, 3, 4, 5, or 6.

Menu SU6, Frequency Marker C.W.

MENU	DESCRIPTION
CALIBRATE FOR FLAT PORT POWER	
FORWARD DIRECTION ONLY	
NUMBER OF POWER SWEEPS X	Select the number of times (1 – 5) that the power point for each frequency is to be measured (swept).
XXX POINTS MEASURE 1 PWR POINT EVERY XX POINT(S)	Displays the number of power points (0 – 50) to be skipped during the power sweep. The points not measured are interpolated to provide a flat sweep.
START FLAT POWER CALIBRATION	Begins the calibration. If calibration is successful, you are returned to menu SU8. If the calibration unsuccessful due to a fatal error (Source or power meter inoperable or not connected), this menus remains displayed. At any time, you can abort the calibration by pressing the DEFAULT PROGRAM or CLEAR/RET LOC keys. All other keys are locked out.
PREVIOUS MENU	Returns you to previous menu.
PRESS <ENTER> TO SELECT OR SWITCH	Pressing the Enter key implements your menu selection or turns the function on/off.
TURN KNOB TO CHANGE NUMBER OF POINTS	

Menu SU8 or CAL_SU8, Calibrate For Flat Test Port Power

–FLAT POWER CALIBRATION–

FLAT POWER CALIBRATION ADJUSTS THE SOURCE OUTPUT POWER AT EACH MEASUREMENT POINT ACROSS A FREQUENCY SPAN TO PROVIDE A CONSTANT POWER LEVEL AT THE SELECTED TEST PORT. (FORWARD DIRECTION ONLY)

–INSTRUCTIONS–

1. PRESET, ZERO, AND CALIBRATE THE POWER METER.
2. CREATE AND ACTIVATE THE POWER METER'S CAL FACTOR LIST FOR THE POWER SENSOR BEING USED.
3. CONNECT THE POWER METER TO THE DEDICATED GPIB INTERFACE BUS AND THE POWER SENSOR TO THE TEST PORT.
4. SELECT <START FLAT POWER CALIBRATION>.

%

–FOR BEST RESULTS–

1. SET THE POWER CONTROL TO MAXIMUM POWER.
2. SELECT AT LEAST 2 POWER SWEEP READINGS.
3. MEASURE 1 POWER POINT FOR EVERY DATA POINT.

Text Associated With Flat Power Calibration Menu SU8

MENU	DESCRIPTION
NUMBER OF DATA POINTS	
1601 MAX PTS'	Selects measurement data points to be 1601.
801 MAX PTS'	Selects measurement data points to be 801.
401 MAX PTS'	Selects measurement data points to be 401.
201 MAX PTS'	Selects measurement data points to be 201.
101 MAX PTS'	Selects measurement data points to be 101.
51 MAX PTS'	Selects measurement data points to be 51.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements you selection.

Menu SU9, Number of Data Points

MENU	DESCRIPTION
NUMBER OF DATA POINTS POINTS DRAWN IN C.W. XXXX POINT(S)	Displays the number of data point, when in the CW mode. This number can be between 1 and 1601.

Menu SU9A, Number of Data Points 2

MENU	DESCRIPTION
DOMAIN	
FREQUENCY	Displays the data in normal frequency domain format.
FREQUENCY WITH TIME GATE	Displays the data in the frequency domain after a specific time range has been sampled by the gate function.
TIME LOWPASS MODE	Displays the data in the time (distance) domain, using true lowpass processing. Data must be taken using a harmonic series calibration and sweep in order to use this mode.
TIME BANDPASS MODE	Displays the data in the time (distance) domain using bandpass processing. Any data sweep range using normal calibration can be used.
–SETUP–	
DISPLAY TIME/DISTANCE	Switches the mode of display between time and distance. This does not affect the actual displayed data, but only the annotation.
SET RANGE	Call a menu that lets you set range and other display parameters.
SET GATE	Calls a menu that lets you set gate parameters.
GATE ON/OFF/DISP	Switches the gate on or off each time Enter is pressed.
HELP	Displays an informational help menu.
PRESS <ENTER> TO SELECT OR SWITCH	Pressing the Enter key implements your menu selection.

Menu TD1, Domain (Frequency/Display)

MENU	DESCRIPTION
LOWPASS TIME DOMAIN SETUP	
START XXX.XXX ps	Sets the start time of the display.
STOP XXX.XXX ps	Sets the stop time of the display..
CENTER XXX.XXX ps	Sets the center time of the display.
SPAN XXX.XXX ps	Sets the span (Stop - Start) of the display.
MARKER RANGE	Takes you to a menu that lets you set the display to a range determined by two of the markers.
RESPONSE IMPULSE/STEP	Switches between Impulse and Step response each time Enter is pressed.
MORE	Takes you to a menu that contains additional selections for display setup.

Menu TD2_LP_TIME, Lowpass Time Domain Setup

MENU	DESCRIPTION
LOWPASS DISTANCE DISPLAY SETUP	
START XXX.XXX mm	Sets the start time of the display.
STOP XXX.XXX mm	Sets the stop time of the display.
CENTER XXX.XXX mm	Sets the center time of the display.
SPAN XXX.XXX mm	Sets the span (Stop - Start) of the display.
MARKER RANGE	Takes you to a menu that lets you set the display to a range determined by two of the markers.
RESPONSE IMPULSE/STEP	Switches between Impulse and Step response each time Enter is pressed.
MORE	Takes you to a menu that contains additional selections for display setup.
RELATIVE VELOCITY X.X	Indicates the relative velocity of light, as set by the dielectric constant in menu RD2.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD2_LP_DIST, Lowpass Distance Display Setup

MENU	DESCRIPTION
BANDPASS TIME DOMAIN SETUP	
START XXX.XXX ps	Sets the start time of the display.
STOP XXX.XXX ps	Sets the stop time of the display..
CENTER XXX.XXX ps	Sets the center time of the display.
SPAN XXX.XXX ps	Sets the span (Stop - Start) of the display.
MARKER RANGE	Takes you to a menu that lets you set the display to a range determined by two of the markers.
PHASOR ON/OFF IMPULSE	Switches Phasor Impulse processing on or off each time Enter is pressed.
HELP – PHASOR IMPULSE	Displays an informational help menu.
MORE	Takes you to a menu that contains additional selections for display setup.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu TD2_BP_TIME, Bandpass Time Domain Setup

MENU	DESCRIPTION
BANDPASS DISTANCE DISPLAY SETUP	
START XXX.XXX mm	Sets the start time of the display.
STOP XXX.XXX mm	Sets the stop time of the display.
CENTER XXX.XXX mm	Sets the center time of the display.
SPAN XXX.XXX mm	Sets the span (Stop - Start) of the display.
MARKER RANGE	Takes you to a menu that lets you set the display to a range determined by two of the markers.
PHASOR ON/OFF IMPULSE	Switches Phasor Impulse processing on or off each time Enter is pressed.
HELP – PHASOR IMPULSE	Displays an informational help menu.
MORE	Takes you to a menu that contains additional selections for display setup.
RELATIVE VELOCITY X.X	Indicates the relative velocity of light, as set by the dielectric constant in menu RD2.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu TD2_BP_DIST, Bandpass Distance Display Setup

MENU	DESCRIPTION
BANDPASS TIME DOMAIN SETUP	
WINDOW SHAPE NOMINAL	Takes you to a menu that lets you change the window type.
SET GATE	Takes you to a menu that lets you set the gate parameters.
PREVIOUS MENU	Returns you to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD3_BP, Bandpass Time Domain Setup

MENU	DESCRIPTION
LOWPASS TIME DOMAIN SETUP	
WINDOW SHAPE NOMINAL	Takes you to a menu that lets you change the window type.
SET GATE	Takes you to a menu that lets you set the gate.
D.C. TERM XXXXX XXXXXXXXXX	Takes you to a menu that lets you set the D.C. term for lowpass processing.
PREVIOUS MENU	Returns you to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD3_LP, Lowpass Time Domain Setup

MENU	DESCRIPTION
GATE	
START XXX.XXX xx	Sets the start time of the gate.
STOP XXX.XXX xx	Sets the stop time of the gate.
CENTER XXX.XXX xx	Sets the center time of the gate.
SPAN XXX.XXX xx	Sets the span (Stop - Start) of the gate.
SET SHAPE XXXXXXXXX	Takes you to a menu that lets you set the shape of the gate.
GATE ON/OFF/DISP	Switches the gate on or off each time Enter is pressed.
SET RANGE	Takes you back to menu TD2_XX_XXXX (LP_TIME, LP_DIST, BP_TIME, BP_DIST), depending on the type of measurement you selected in menu TD1.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD4_TIME & TD4_DIST, Gate (Distance/Time)

MENU	DESCRIPTION
SELECT WINDOW SHAPE	
RECTANGULAR	Selects a Rectangular (one-term) shape.
NOMINAL	Selects a two-term Hamming shape.
LOW SIDELOBE	.Selects a three-term Blackman-Harris shape.
MIN SIDELOBE	Selects a four-term Blackman-Harris shape.
HELP	Displays an informational help menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD5_WINDOW, Shape

MENU	DESCRIPTION
SELECT GATE SHAPE	
RECTANGULAR	Selects a Rectangular (one-term) shape.
NOMINAL	Selects a two-term Hamming shape.
LOW SIDELOBE	Selects a three-term Blackman-Harris shape.
MIN SIDELOBE	Selects a four-term Blackman-Harris shape.
HELP	Displays an informational help menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD5_GATE, Shape

MENU	DESCRIPTION
SET D.C. TERM FOR LOWPASS PROCESSING	Since it is impossible to measure the true D.C. term required for lowpass processing, a value must be estimated. This menu allows a choice between five different selections for this value.
AUTO EXTRAPOLATE	Sets the D.C. term to a value determined by extrapolating the data points near the zero frequency.
LINE IMPEDANCE	Sets the D.C. term to the characteristic impedance of the transmission medium (Z_0).
OPEN	Sets the D.C. term to correspond to an open circuit.
SHORT	Sets the D.C. term to correspond to a short circuit.
OTHER XXX.XXX (REFLECTION COEFFICIENT X.XXX pU)	Sets the D.C. term to the value entered.
PREVIOUS MENU	Returns you to the previous menu.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD6, Set D.C. Term for Low Pass Processing

MENU	DESCRIPTION
TIME MARKER SWEEP	
START TIME MARKER ( ) XXX.XXX ns	Sets the start time to the value of the selected marker.
STOP TIME MARKER ( ) XXX.XXX ns	Sets the stop time to the value of the selected marker.
RESTORE ORIGINAL RANGE	Returns the display to the original time range that was in effect before the marker range was selected.
PREVIOUS MENU	Returns you to the previous menu.
USE KEYPAD TO CHOOSE MARKER (1 - 6)	Select marker number from keypad.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD7_TIME, Time Marker Sweep.

MENU	DESCRIPTION
DISTANCE MARKER SWEEP	
START DIST MARKER ( ) XX.XXXX cm	Sets the start time to the value of the selected marker.
STOP DIST MARKER ( ) X.XXXX m	Sets the stop time to the value of the selected marker.
RESTORE ORIGINAL RANGE	Returns the display to the original time range that was in effect before the marker range was selected.
PREVIOUS MENU	Returns you to the previous menu.
USE KEYPAD TO CHOOSE MARKER (1 - 6)	Select marker number from keypad.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu TD7_DIST, Distance Marker Range

MENU	DESCRIPTION
TRIGGERS MEASUREMENT	
INTERNAL	Internally triggers a point-by-point measurement. Choosing this option always turns AUTOMATIC I.F. CALIBRATION off.
EXTERNAL	Provides for externally triggering a point-by-point measurement via the rear panel External Trigger connector. Choosing this option always turns AUTOMATIC I.F. CALIBRATION off.
I.F. CALIBRATION	
AUTOMATIC ON (OFF) I.F. CAL	Turns on or off the timer for I.F. calibration. The timer automatically triggers an I.F. calibration at regular intervals for internal hardware calibrations. If can be set on or off when in either INTERNAL or EXTERNAL trigger measuement mode.
TRIGGER I.F. CAL	Immediately triggers an I.F. calibration, which calibrates the internal hardware. A "CALIBRATING IF..." message is displayed.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu TRIG, Triggers Measurement

MENU	DESCRIPTION
SELECT UTILITY FUNCTION OPTIONS	
GPIB ADDRESSES	Calls menu GP7, which displays the current GPIB addresses of the various dedicated instruments.
DISPLAY INSTRUMENT STATE PARAMS	Calls menu U2, which lets you display the various instrument state parameters.
GENERAL DISK UTILITIES	Calls menu DSK1-FD, which lets you select between several disk utilities.
CALIBRATION COMPONENT UTILITIES	Calls menu U3, which lets you select between several calibration--component utilities.
COLOR CONFIGURATION	Calls menu U5, which lets you configure the screen colors.
DATA ON (OFF) DRAWING	Turns data drawing on or off for all channels.
BLANKING FREQUENCY INFORMATION	Blanks all frequency-identifier information from the 372XXA displays, if such information is presently being displayed. Hides the frequency value with X's, such as XXX.XXXXXXXXX GHz.
PRESS <ENTER> TO SELECT OR TURN ON/OFF	Pressing the Enter key implements your menu selection.

Menu U1, Utility Menu

MENU	DESCRIPTION
DISPLAY INSTRUMENT STATE PARAMETERS	
SYSTEM	Displays all of the system parameters (Readout Text for U2, on the following pages).
CALIBRATION	Displays the calibration parameters.
OPERATING	Displays the global operating parameters.
CHANNEL 1 & 2	Displays the Channel 1-2 operating parameters.
CHANNEL 3 & 4	Displays the Channel 3-4 operating parameters.
NEXT PARAM PAGE	Alternately displays Readout Text U3 a thru e.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu U2, Display Instrument State

Readout Text U2, Global Operating Parameters

Parameter	Display Format
Number of Points	
Power Control	xx.x dB
Port 1 Attenuation	xx.x dB
Porft 2 Attenuation	xx.x dB
Source 2 Power	xx.x dB
Reference Impedance	xx.xxx Ω
Averaging	xxx Meas. per point
Smoothing	Off/On
	x.x percent of sweep
	Off/On

Readout Text U2, Channel Parameters

Parameter	Display Format
Number of Points	
Power Control	xx.x dB
Port 1 Attenuation	xx.x dB
Porft 2 Attenuation	xx.x dB
Source 2 Power	xx.x dB
Reference Impedance	xx.xxx Ω
Averaging	xxx Meas. per point
Smoothing	Off/On
	x.x percent of sweep
	Off/On

Readout Text U2, System Parameters

Parameter	Display Format
WILTRON Model	xxxxxxxx
Serial Number	xxx
Software Version	xxxxxxxx
Options	xxxxxxxx
IEEE 488.2 GPIB Interface	
Address	xx
Enable Registers	xx
Service Request	xx
Standard Event Status	
Parallel Poll	
Extended Event Status	
Limits Testing Status	
Dedicated GPIB Interface	
External Source Address	xxxxx
Plotter Address	xxxxx
Power Meter Address	xxxxx
Frequency Counter	xxxxx
Measurement Trigger	xxxxxx
Automatic I.F. Calibration	xxxxxxx
Diagnostic Mode	
Troubleshooting	xxx
Receiver Mode	xxxxxxxxxxxx
Search for Lock	xxx

Readout Text U2, Calibration Parameters

Parameter	Display Format
Cal Method	xxxxxxxx
Line Type Medium	xxxxxxxx
Cal Type	xxxxxxxx
Number of Points	xxxxxxxx
Start Freq	xxxxxxxx
Stop Freq	xxxxxxxx
Power Control	xx.x dB
Port 1 Attenuator	xx.x dB
Port 2 Attenuator	xx.x dB
Source 2 Power	xx.x dB
Load Type	xxxxxxxx
Through Offset	xxxxxxxx

MENU	DESCRIPTION
CALIBRATION COMPONENT UTILITIES	
INSTALL KIT INFORMATION FROM FLOPPY DISK	Reads into memory the coefficient data from the calibration-components disk supplied with the calibration kits.
DISPLAY COAXIAL INFORMATION	Calls menu U4 and U4A, which lets you display the connector information for the various coaxial connectors supported.
DISPLAY WAVEGUIDE INFORMATION	Displays the waveguide information loaded from the floppy diskette.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu U3, Calibration Component Utilities

MENU	DESCRIPTION
DISPLAY INSTALLED TEST PORT CONNECTOR INFORMATION	This menu lets you view coefficient data on components. The data appears in the display area of the screen (See readout text on next page).
SMA (M)	Select to display coefficient data for the SMA male components.
SMA (F)	Select to display coefficient data for the SMA female components.
K – CONN (M)	Select to display coefficient data for the K Connector™ male components.
K – CONN (F)	Select to display coefficient data for the K Connector female male χομπονεντσ.
TYPE N (M)	Select to display coefficient data for the Type N male components.
TYPE N (F)	Select to display coefficient data for the Type N female components.
GPC - 3.5 (M)	Select to display coefficient data for the GPC-3.5 male components.
GPC - 3.5 (F)	Select to display coefficient data for the GPC-3.5 female components.
GPC - 7	Select to display coefficient data for the sexless GPC-7 components.
NEXT CONNECTOR	Cycles through selections SMA (M) to GPC 7.
MORE CONNECTORS	Calls up menu U4A and lets you select more connectors.
PREVIOUS MENU	Displays menu U3.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu U4, Display Installed Calibration Components Information 1

MENU	DESCRIPTION
DISPLAY INSTALLED CALIBRATION COMPONENT INFORMATION	This menu lets you view coefficient data for connectors. The data appears in the display area of the screen.
V-CONN (M)	Select to display coefficient data for the V Connector™ male components.
V-CONN (M)	Select to display coefficient data for the V Connector female components.
TNC (M)	Select to display coefficient data for the TNC male components.
TNC (F)	Select to display coefficient data for the TNC female male components.
2.4 mm (M)	Select to display coefficient data for the 2.4 mm male components.
2.4 mm (F)	Select to display coefficient data for the 2.4 mm female components.
NEXT CONNECTOR	Cycles through selections V Connector to 2.44 mm (F).
MORE CONNECTORS	Calls up menu U4A and lets you select more connectors.
PREVIOUS MENU	Returns you to menu U3.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu U4A, Display Installed Calibration Components Information 2

MENU	DESCRIPTION
COLOR CONFIGURATION	
DATA 10 RED	Sets the color for the data drawn on the CRT. Use rotary knob to cycle between the available colors. Default color is shown.
OVERLAY DATA 15 YELLOW	Sets the color for the overlay data drawn on the CRT. Use rotary knob to cycle between the available colors. Default color is shown.
MEMORY DATA 24 GREEN	Sets the color for the memory data drawn on the CRT. Use rotary knob to cycle between the available colors. Default color is shown.
MARKERS AND LIMITS 32 CYAN	Sets the color for the markers and limits drawn on the CRT. Use rotary knob to cycle between the available colors. Default color is shown.
GRATICULE 24 GREEN	Sets the color for the CRT graticule. Use rotary knob to cycle between the available colors. Default color is shown.
ANNOTATION AND MENU TEXT 24 GREEN	Sets the color for the annotation and menu text. Use rotary knob to cycle between the available colors. Default color is shown.
MENU HEADERS (TITLES & INFO) 32 CYAN	Sets the color for the menu headers and information. Use rotary knob to cycle between the available colors. Default color is shown.
RESET COLORS	Resets colors to the default values.
PRESS <ENTER> TO SELECT	Pressing the Enter key implements your menu selection.

Menu U5, Color Configuration

APPENDIX B
MODEL 372XXA VECTOR NETWORK ANALYZER
REAR PANEL CONNECTORS

B-1 INTRODUCTION

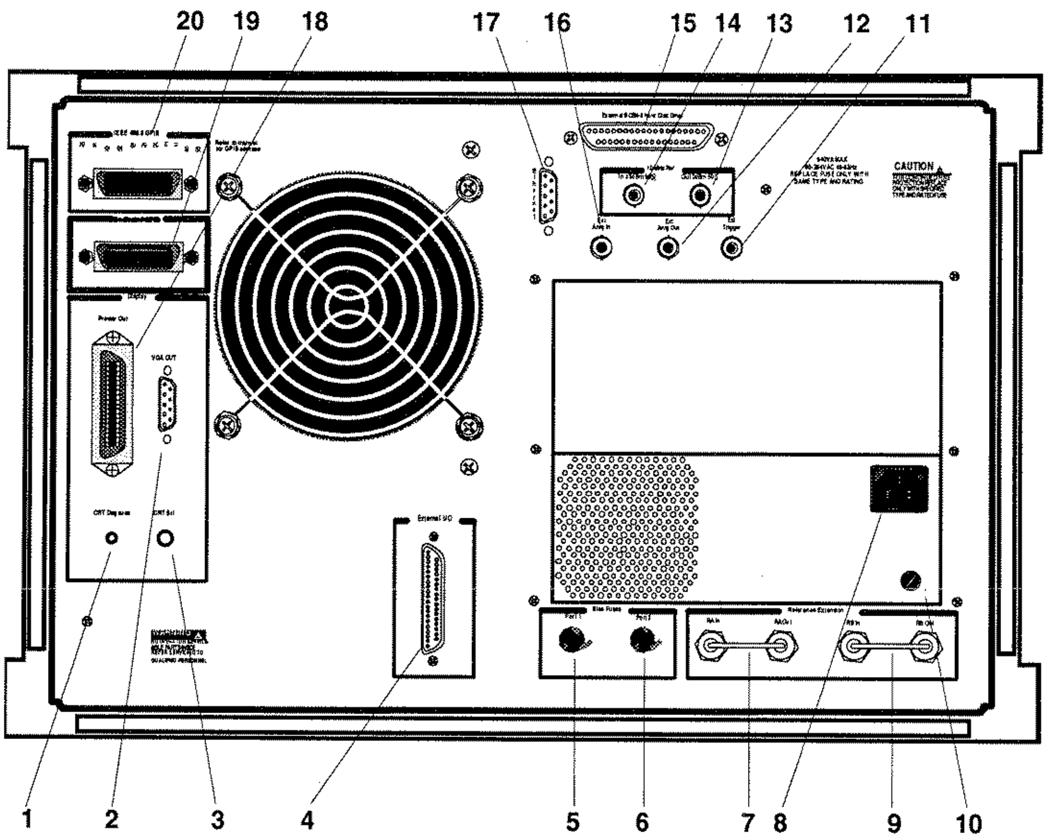
This appendix provides descriptions and pinout diagrams for the 372XXA rear panel connectors .

B-2 372XXA REAR PANEL

The 372XXA rear panel connectors are described on page B-2 and B-3.

B-3 CONNECTOR PINOUT DIAGRAMS

Figures B-1 through B-4 provide pinout diagrams for the rear panel connectors.



1 CRT Degauss: Momentary-on pushbutton that degausses the internal color monitor. It has no effect on an external monitor.

2 VGA OUT: 15-pin connector provides VGA output of 372XXA video display. Figure B-4 provides a pinout diagram.

3 CRT Brt: Adjustment for CRT brightness. Counterclockwise rotation increases brightness.

4 External I/O: Provide I/O access for Channel 1 through 4 limit and Port 1 and 2 bias voltages. Figure B-3 provides a pinout diagram.

5 Bias Fuses, Port 1: Fuse, 0.5A, 3AG, 250V, provides protection for external bias being applied to the active device connected to test port 1 without disturbing the accuracy of the 372XXA measurement.

6 Bias Fuses, Port 2: Fuse, 0.5A, 3AG, 250V, provides protection for external bias being applied to the active device connected to test port 2 without disturbing the accuracy of the 372XXA measurement.

7 Reference Extension, RA In to RA Out: Loop allows external reference to be used as a receiver. This provides for custom-defined user parameters with any combination of channels.

8 Line Voltage Input: Three-prong ac plug that provides input for the input-line power. The line voltage must be between 85 and 264 Vac rms, 43 to 63 Hz.

9 Reference Extension, RB In to RB Out: Loop allows external reference to be used as a receiver. This provides for custom-defined user parameters with any combination of channels.

10 Line Fuse: 3 AG fuse cartridge that protects for an input overcurrent condition. The fuse is slow blow, 8A, 250V.

11 **External Trigger:** Allows an external signal to sync the 372XXA measurements; ±1V trigger.

12 **External Anlg Out:** Provides an up-to-±10V signal for use in driving an external plotter or antenna (CW draw).

13 **10 MHz Ref OUT 0dBm 50Ω:** BNC connector that allows the internal 10 MHz reference to be used to phase lock an external counter or other measuring instrument. Level is typically 0 dBm into 50Ω impedance.

14 **10 MHz Ref IN 0dBm 50Ω:** BNC connector that allows an external 10 MHz signal (–5 to +5 dBm) to be used as the frequency reference for phase locking the source frequency. 50Ω impedance.

15 **External SCSII-2 Hard Disk Drive:** Provides for connecting an external SCSII-2 hard disk drive.

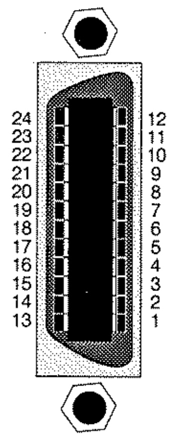
16 **Ext Anlg In:** Provides input to the A5 A/D Converter PCB. BNC connector allows an external dc voltage to be measured by the internal analog-to-digital converter circuit. Intended for use in troubleshooting by a qualified service technician.

17 **Eithernet:** Provides for connecting the 372XXA to a network using an Eithernet-type connector.

18 **Printer Out:** 36-pin connector that provides a parallel interface to the companion printer. Figure B-2 describes the signal lines and shows the connector pinout.

19 **Dedicated GPIB:** IEEE 488 standard 24-pin connector that allows the 372XXA to remotely control a 2nd frequency source, an external plotter, analyzer, or other peripheral. Figure B-1 provides a pinout diagram.

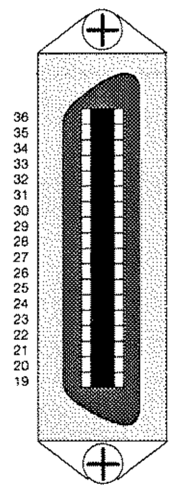
20 **IEEE 488.2 GPIB:** IEEE 488 standard 24-pin connector that provides for remotely controlling the 372XXA from an external computer/controller via the IEEE-488 bus (GPIB). Figure B-1 provides a pinout diagram.



Pinout Diagram

PIN	NAME	DESCRIPTION
1-4	DIO 1 thru DIO 4	*Data Input/Output.* Bits are HIGH with the data is logical 0 and LOW when the data is logical 1.
5	EOI	*End Or Identify.* A low-true state indicates that the last byte of a multibyte message has been placed on the line.
6	DAV	*Data Valid.* A low-true state indicates that the talker has (1) sensed that NRFD is LOW, (2) placed a byte of data on the bus, and (3) waited an appropriate length of time for the data to settle.
7	NRFD	*Not Ready For Data.* A high-true state indicates that valid data has not yet been accepted by a listener.
8	NDAC	*Not Data Accepted.* A high-false state indicates that the current data byte has been accepted for internal processing by a listener.
9	IFC	*Interface Clear.* A low-true state places all bus instruments in a known state—such as, unaddressed to talk, unaddressed to listen, and service request idle.
10	SRQ	*Service Request.* A low-true state indicates that a bus instrument needs service from the controller.
11	ATN	*Attention.* A low-true state enables the controller to respond to both it's own listen/talk address and to appropriate interface messages — such as, device clear and serial poll.
12	Shield	Chassis ground.
13-16	DIO 5 thru DIO 8	*Data Input/Output.* Bits are high with the data is logical 0 and LOW when the data is logical 1.
17	REN	*Remote Enable.* A low-true state enables bus instruments to be operated remotely, when addressed.
18-24	GND	Logic ground.

Figure B-1. Pinout Diagram, GPIB and Dedicated GPIB Connectors



Pinout Diagram

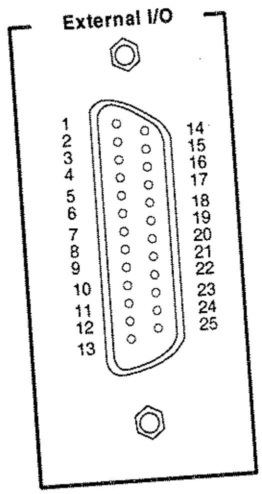
PIN	NAME	DESCRIPTION
1	$\overline{\text{STROBE}}$	*Printer Strobe.* A low-true pulse that tells the printer valid data has been placed on the bus.
2-9	DATA1 thru DATA8	*Data Lines.* Bits are HIGH when the data is logical 1 and LOW when the data is a logical 0.
10	$\overline{\text{ACK NLG}}$	*Printer Acknowledgement.* A low-true (it varies from printer to printer) pulse sent back by the printer to acknowledge that the data has been accepted and the printer is ready to accept more data.
11	BUSY	*Printer Busy.* High-true level sent by the printer to indicate that it is not available. This line is HIGH at the following times: (1) During data entry. (2) While printing. (3) When off-line. (4) When a printer-error has been signaled.
12	PE	*Printer Error.* High-true level sent by the printer to indicate that it is out of paper.
13	SLCT	*Select.* A high-true logic level.
14	$\overline{\text{AUTO FEED XT}}$	*Automatic Paper Feed.* A low-true level that tells the printer to feed the paper automatically.
15	NC	No Connection.
16	OV	Logic GND Level.
17	CHASSIS GND	Chassis ground, which is isolated from logic ground.
18	NC	No Connection.
19	$\overline{\text{STROBE}}$ RTN	Return line for $\overline{\text{STROBE}}$ signal.
20-27	DATA RTN	Return lines for DATA1 thru DATA8 lines.

Figure B-2. Pinout Diagram, Printer Connector (1 of 2)

PIN	NAME	DESCRIPTION
28	$\overline{\text{ACKNLG}}$ RTN	Return line for ACKNLG signal.
29	BUSY RTN	Return line for BUSY signal.
30	PE RTN	Return line for PE signal.
31	$\overline{\text{INIT}}$	*Printer Initial State.* A low-true pulse that tells the printer to assume its initial state and clear its print buffer.
32	$\overline{\text{ERROR}}$	*Printer Error.* A low-true signal that indicates the printer is (1) out of paper, (2) off-line, or (3) in an error state.
33	GND	Ground level.
34	NC	No Connection.
35	+5V	+5V dc level.
36	$\overline{\text{SLCT IN}}$	*Printer Select Input.* A low-true level that permits the printer to accept data.

***Figure B-2.** Pinout Diagram, Printer Connector (2 of 2)*

EXTERNAL I/O CONNECTOR PINOUT DIAGRAM



Pinout Diagram

PIN	NAME	DESCRIPTION
1	Channel 1 Limit	Signal indicating results of Channel 1 limit testing. User selectable TTL-high = Fail or TTL-low = Fail.
2	Limit 1 Rtn	Return for the Channel 1 limit signal
3	Channel 2 Limit	Signal indicating results of Channel 2 limit testing. User selectable TTL-high = Fail or TTL-low = Fail.
4	Limit 2 Rtn	Return for the Channel 1 limit signal
5	Channel 3 Limit	Signal indicating results of Channel 3 limit testing. User selectable TTL-high = Fail or TTL-low = Fail.
6	Limit 3 Rtn	Return for the Channel 3 limit signal
7	Channel 4Limit	Signal indicating results of Channel 4 limit testing. User selectable TTL-high = Fail or TTL-low = Fail.
8	Limit 4 Rtn	Return for the Channel 4 limit signal
9	Limit Fail	Signal indicating failure in any channel limit testing. User selectable TTL-high = Fail or TTL-low = Fail.
10	Spare	
11	Spare	
12	Limit Fail Rtn	Return for the Limit Fail signal
13	Spare	
14	Spare	
15	Ext Dig In	Allows an external signal to sync the 372XXA measurements; ±1V trigger.
16	Dig In Rtn	Return for External Dig In signal
17	Ext Ana Out	Provides an up-to-±10V signal for use in driving an external plotter or antenna (CW draw).

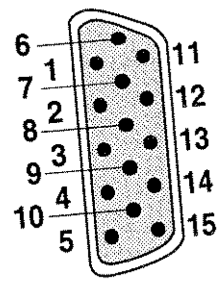
Figure B-3. Pinout Diagram, External I/O Connector (1 of 2)

EXTERNAL I/O CONNECTOR PINOUT DIAGRAM

PIN	NAME	DESCRIPTION
18	Ana Out Rtn	Return for Ext Ana Out signal
19	Spare	
20	Spare	
21	Spare	
22	Gnd 1	Return for Port 1 Bias.
23	Port 1 Bias	Provides for applying an external bias to the active device connected to test port 1.
24	Port 2 Bias	Provides for applying an external bias to the active device connected to test port 2.
25	Gnd 2	Return for Port 2 Bias.

***Figure B-3.** Pinout Diagram, External I/O Connector (2 of 2)*

VGA OUT CONNECTOR PINOUT DIAGRAM



PIN	NAME	DESCRIPTION
1	Red	Red signal
2	Green	Green signal
3	Blue	Blue signal
4	Not Used	
5	Not Used	
6	Red Return	Red return
7	Green Return	Green return
8	Blue Return	Blue return
9	Not Used	
10	Digital Ground	Sync ground
11	Not Used	
12	Not Used	
13	Hsync	Horizontal sync
14	Vsync	Vertical sync
15	Not Used	

Figure B-4. Pinout Diagram, VGA IN/OUT Connector

Appendix C
Performance Specifications

SYSTEM PERFORMANCE

Signal Source Characteristics Range:
37211A, 22.5 MHz to 3 GHz
37217A, 22.5 MHz to 8.6 GHz
37225A, 40 MHz to 13.5 GHz
37247A, 40 MHz to 20 GHz
37269A, 40 MHz to 40 GHz

Frequency Resolution: 1 kHz (1 Hz optional)

Power Range:
37211A, +10 to −85 dBm
37217A, +10 to −85 dBm
37225A, +10 to −85 dBm
37247A, +10 to −85 dBm
37269A, +5 to −97 dBm

Harmonics: <−35 dBc at maximum rated power

High Level Noise:
<0.03 dB and <0.4° peak-to-peak variation in a 1 kHz IF bandwidth up to 20 GHz.
<0.08 dB and <0.5° peak-to-peak variation up to 40 GHz.

Test Port Characteristics:
- **Standard Connector Type:** K (2.92 mm)
- **Impedance:** 50 ohms
- **Default Port Power Level (dBm):**
  37211A: 0 dBm
  37217A: 0 dBm
  37225A: 0 dBm
  37247A: 0 dBm
  37269A: −15 dBm
- **Maximum Input Level:** +20 dBm
- **DC Bias:** 0.5 A maximum, 40 VDC maximum
- **Raw (Uncorrected) Source Match:** 10 dB to 20 GHz
  8 dB to 40 GHz

GENERAL

Front Panel Connectors and Controls:
- **Keyboard Input:** An IBM-AT compatible keyboard can be connected to the front panel for navigating through front panel menus and disk directories, annotation of data files and display labels, printing displays and pausing instrument sweeps.
- **Bias Inputs:** 0.5 A maximum, 40 Vdc maximum through BNC connectors.

Rear Panel Connectors and Controls:
- **CRT Intensity:** Continuous control of CRT intensity.
- **CRT Degauss:** Pushbutton control degausses CRT.
- **Printer:** Centronics interface for an external printer.
- **VGA Out:** Provides VGA output of 372XXA video display.
- **10 MHz Ref. In:** Connects to external reference frequency standard, 10 MHz, +5 to −5 dBm, 50 ohms, BNC female.
- **10 MHz Ref. Out:** Connects to internal reference frequency standard, 10 MHz, 0 dBm, 50Ω, BNC female.
- **External Analog Out:** −10V to +10V with 5 mV resolution, varying in proportion to user-selected data (e.g., frequency, amplitude). BNC female.
- **External Trigger Control:** External triggering for 372XXA measurement, ±1V trigger. 10 kΩ input impedance. BNC female.
- **External I/O:** 25-pin DSUB connector with the following capabilities:
  - **External Analog Out:** −10V to +10V with 5 mV resolution, varying in proportion to user-selected data (e.g., frequency, amplitude).
  - **External Trigger Control:** External triggering for *372XXA* measurement, ±1V trigger. 10 kΩ input impedance.
  - **Bias In, Ports 1 and 2:** 0.5A, 40 Vdc maximum.
  - **Limits Pass/Fail:** 0 (pass) or +5V (fail) output for each channel's limit pass/fail status (4 lines); 0(all channels pass) or +5V (any one of 4 channels fail) output limit pass/fail status (1 line).
  - **External Analog Input:** ±50 Volt input for displaying external signals on the CRT in Diagnostics mode. BNC Female.
- **System Bus:** Dedicated IEEE-488.2 controller interface for the plotter, external power meter, and other peripheral instruments.
- **GPIB:** IEEE-488.2 interface
- **External SCSI:** Provides SCSI-2 connector for external SCSI hard drive connection.

ENVIRONMENTAL CHARACTERISTICS

Temperature Range:
- **Operating:** 0 to 50°C
- **Storage:** −40 to 75°C

Power Requirements: 85–264V, 48–63 Hz, 400 VA maximum
Dimensions: 267H x 432W x 585D mm (10.5 x 17 x 23 in.)
Weight: 34 kg (75 lb)

MEASUREMENT CAPABILITIES

Number of Channels: Four measurement channels.
Parameters: S_{11}, S_{21}, S_{22}, S_{12}; or *non-ratioed,* complex input and output impedance; complex input or output admittance; and complex forward and reverse transmission.
Domains: Frequency Domain, CW Draw, and optional Time (Distance) Domain.
Formats: Log Magnitude, Phase, Log Magnitude and Phase, Smith Chart (impedance), Inverse Smith Chart (Admittance), Linear Polar, Log Polar, Group Delay, Linear Magnitude, Linear Magnitude and Phase, Real, Imaginary, Real and Imaginary, SWR.
Data Points:
Can be switched to a value of 1601, 801, 401, 201, 101, or 51 data (frequency) points without recalibration. In addition, the system accepts an arbitrary set of N discrete data points where: *2<N<1601*.
CW mode permits selection of a single point without recalibration.
Reference Delay:
Can be entered in time or in distance (when the dielectric constant is entered). Automatic reference delay feature adds the correct electrical length compensation at the push of a button. Software compensation for the electrical length difference between reference and test is always accurate and stable since measurement frequencies are always synthesized. In addition, the system compensates reference phase delay for dispersive transmission media, such as waveguide and microstrip.
Number of Markers: Six independent markers can be used to read out measurement data.
Delta Markers: In delta-reference marker mode, any one marker can be selected as the reference for the other five.
Marker to Maximum/Minimum: Markers can be directed automatically to the minimum or maximum of a data trace.
Enhanced Markers: Marker search for a level or bandwidth, displaying an active marker for each channel, and discrete or continuou (interpolated) markers.
Marker Sweep: Sweeps upward in frequency between any two markers. Recalibration is not required.
Segmented Limit Lines: Two limit lines per channel, composed of flat, sloped, or single point segments, to indicate test limits. Each limit line may be made from up to 10 segments.
Pass/Fail Indication: When trace exceeds a limit line segment a "PASS" or "FAIL" message is displayed on the screen. A GPIB Pass/Fail SRQ is enabled.
Limit Frequency: Identifies the ±X dB bandwidth of amplifiers, filters and other frequency sensitive devices. Interpolation algorithm determines the exact intersection frequencies of test data and limit lines.
Measurement Frequency Range: Frequency range of measurement can be narrowed within calibration range without recalibration. CW mode permits single frequency measurements, also without recalibration.
Tune Mode: Tune Mode optimizes sweep speed in tuning applications by updating forward S-parameters more frequently than reverse ones. This mode allows the user to select the ratio of forward sweeps to reverse sweeps after a full 12-term calibration. The ratio of forward sweeps to reverse sweeps can be set anywhere between 1:1 to 10,000:1.

DISPLAY CAPABILITIES

Display Channels: Four, each of which can display any S-parameter or user-defined parameter in any format with up to two traces per channel for a maximum of eight traces simultaneously. A single channel, two channels (1 and 3, or 2 and 4), overlaid channels (1 and 3, or 2 and 4), or all four channels can be displayed simultaneously.
CRT: Color, 7.5-inch diagonal, VGA display.
Trace Overlay: Displays two data traces on the active channel's graticule simultaneously.
Trace Memory: A separate memory for each channel can be used to store measurement data for later display or subtraction, addition, multiplication or division with current measurement data.
Scale Resolution (minimum):
- **Log Magnitude:** 0.001 dB/div
- **Linear Magnitude:** 1 pU
- **Phase:** 0.01 degrees/div
- **Group Delay:** 0.001 ps
- **Time:** 0.001 ms
- **Distance:** 0.001 mm
- **SWR:** 1 pU
- **Autoscale:** Automatically sets Resolution and Offset to fully display measurement data.
- **Reference Position:** Can be set at any graticule line.
- **Annotation:** Type of measurement, vertical and horizontal scale resolution, start and stop frequencies, and reference position.

MEASUREMENT ENHANCEMENT

Vector Error Correction: There are four methods of calibration:

1) OSL (standard) calibration method using short circuits, open circuits, and terminations (fixed or sliding)
2) Offset-Short calibration
3) LRL (Line-Reflect-Line) calibration
4) LRM Line-Reflect-Match calibration

There are five vector error correction models available:

1) Full 12-Term
2) One Path/Two Port (Forward or Reverse)
3) Frequency Response (Forward or Reverse or both)
4) Frequency Response with Isolation
5) Reflection Only (Port 1 or Port 2 or both)

Full 12-term can always be used, if desired, since all 372XXA series models automatically reverse the test signal. A front-panel button selects whether calibration is applied and an LED lights when error correction is applied.

Calibration Standards: User selects SMA, GPC-3.5, GPC-7, Type N, 2.4 mm, TNC, or K Connector from the calibration menu. Use of fixed or sliding load can be selected for each connector type. Open circuit capacitance coefficients can be modified. In general, all calibration parameters may be modified manually or through the GPIB interface.

Reference Impedance: Modify the reference impedance of the measurement to other than 50 ohms (but not 0).

LRL/LRM Calibration Capability: The LRL calibration technique uses the charactersitic impedance of a length of transmission line as the calibration standard. A full LRL calibration consists merely of two transmission line measurements, a high reflection measurement, and an isolation measurement. The LRM calibration technique is a variation of the LRL technique that utilizes a precision termination rather that a second length of transmission line. A third optional standard, either Line or Match, may be measured in order to extend the frequency range of the calibration. This extended calibration is achieved by mathematically concatenating either two LRL, two LRM, or one LRL and one LRM calibration(s). Using these techniques, full 12-term error correction can be performed on the 372XXA VNA.

Dispersion Compensation: Selectable as Coaxial (non-dispersive), Waveguide, or Microstrip (dispersive).

Reference Plane: Selectable as Middle of line 1 or Ends of line 1.

Corrected Impedance: Determined by Calibration Standards.

Data Averaging: Averaging of 1 to 4096 averages can be selected. Averaging can be toggled on/off with front panel button. A front panel button turns data averaging on/off, and a front panel LED indicates when averaging is active.

Video IF Bandwidth: Front panel button selects four levels of video IF bandwidth. MAXIMUM (10 kHz), NORMAL (1 kHz), REDUCED (100 Hz) and MINIMUM (10 Hz).

Trace Smoothing: Functions similarly to Data Averaging but computes an average over a percentage range of the data trace. The percentage of trace to be smoothed can be selected from 0 to 20% of trace. Front panel button turns smoothing on/off, and front panel LED indicates when smoothing is active.

SOURCE CONTROL

Frequency Resolution: 1 kHz (1 Hz optional)

Test Port Power Level: The level at Port 1 may be controlled in fine increments of 0.1 dB or in 10 dB steps by using the internal 0 to 70 dB step attenuator.

Power Accuracy: ±0.5 dB at 2 GHz at default power.

Level Test Port Power: The power, at all sweep frequencies, is leveled to within ±2 dB (±3 dB for 20–40 GHz).

Flatness Correction: Further improves the test port power flatness using an external power meter to measure and correct for level variations.

Dual Source Control: Allows a user to separately control the frequency of both the internal and an external signal source and the receiver without the need for an external controller.

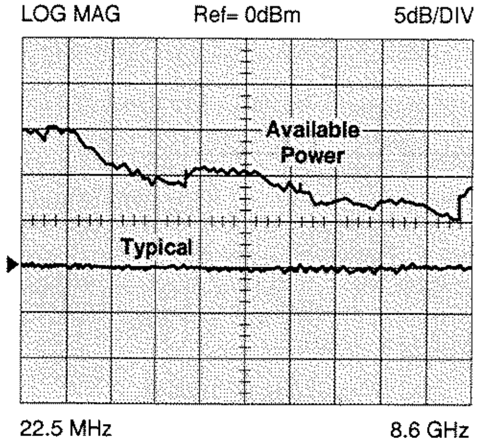
Sweep Type: Linear, CW, Marker, or N-Discrete point sweep.

Frequency Accuracy, Standard Time Base:
  Aging: $<1 \times 10^{-6}$/year
  Stability: $<1 \times 10^{-6}$ over +15 to +50°C range

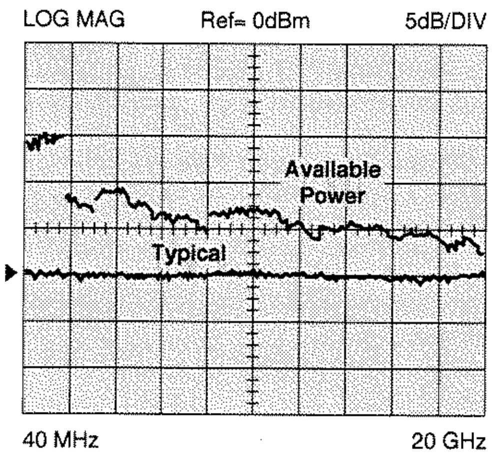
Frequency Accuracy, High Stability Time Base (Opt 10):
  Aging: $<1 \times 10^{-9}$/day
  Stability: $<1 \times 10^{-9}$ over 0 to +55°C range

Power Range:

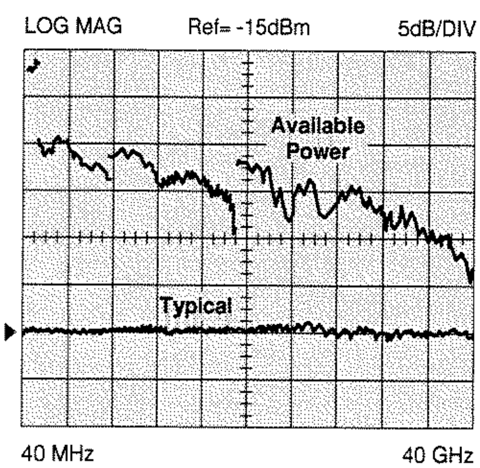
Model	Rated Power (dBm)	Minimum Power (dBm)	Resolution (dB)	Flatness (dB)
37211A	0	–85	0.1	±1.5
37217A	0	–85	0.1	±1.5
37225A	0	–85	0.1	±1.5
37247A	0	–85	0.1	±2
37269A	–15	–97	0.1	±3



Model 37211A and 37217A Port 1 Power



Model 37225A and 37247A Port 1 Power



Model 37269A Port 1 Power

GROUP DELAY CHARACTERISTICS

Group Delay is measured by computing the phase change in degrees across a frequency step by applying the formula:

$$\tau_g = -\frac{1}{360}\frac{d\Phi}{df}$$

Aperture: Defined as the frequency span over which the phase change is computed at a given frequency point. The aperture can be changed without recalibration. The minimum aperture is the frequency range divided by the number of points in calibration and can be increased to 20% of the frequency range without recalibration. The frequency width of the aperture and the percent of the frequency range are displayed automatically.

Range: The maximum delay range is limited to measuring no more than ±180 degrees of phase change within the aperture set by the number of frequency points. A frequency step size of 100 kHz corresponds to 10 ms.

Measurement Repeatability (sweep to sweep): For continuous measurement of a through connection, RSS fluctuations due to phase and FM noise are:

$$\frac{1.41\ [(\textit{Phase Noise in deg})^2 + (\tau_g \times \textit{Residual FM Noise in Hz})^2]\times 0.5}{360\ (\textit{Aperture in Hz})}$$

Accuracy:

$$\textit{Error in } \tau_g = \frac{\dfrac{\textit{Error in Phase}}{360} + [\tau_g \times \textit{Aperture Freq. Error (Hz)}]}{\textit{Aperture (Hz)}}$$

HARD COPY

Hardcopy Output Selection: Menu selects printer type, graphical or tabular data output, and plotter type, which allows portrait or landscape format. The number of data points of tabular data can be selected as well as data at markers only.

Compatible Printers:

- HP ThinkJet
- HP QuietJet
- HP DeskJet (b/w) (310/320, 500)
- HP LaserJet II & III Series
- Epson FX80

Compatible GPIB Plotters:

- HP Models 7440A,7470A, 7475A, and 7550A
- Tektronix Model HC100 plotters. The plotter is connected to the dedicated system GPIB bus.

Performance: After selecting the Start Print button, front panel operation and measurement capability is restored to the user within 2 seconds.

STORAGE

Internal Memory: Up to 10 front panel states can be stored and recalled from non-volatile memory locations. The current front panel setup is automatically stored in non-volatile memory at instrument power-down. When power is applied, the instrument returns to its last front panel setup (with no calibration data applied).
Internal Hard Disk Drive: A hard-disk drive is used to store and recall measurement and calibration data and front-panel setups.
External SCSI Interface: Option 4 deletes the internal hard disk drive and adds a SCSI Interface connector to the rear panel for connecting a SCSI-2 formatted hard disk drive.
Internal Disk Drive: A 3.5-inch microdiskette drive with 1.44 Mbytes formatted capacity is used to load measurement programs and to store and recall measurement and calibration data and front-panel setups.
Disk Storage Format: All files are MS-DOS Compatible. User-defined file names may be 1 to 8 characters long.
Data File Size:
Measurement: 20.5K bytes per 401 point S-parameter trace.
Calibration: 48.8K bytes per 401 point (12-term cal+setup). Trace Memory: 3.2Kbytes per 401 point data trace.

REMOTE PROGRAMMING

Interface: GPIB (IEEE-488.2)
Addressing: Address can be set from the front panel and can range from 0 to 30. Defaults to address 6.
Transfer Formats: ASCII, 32-bit floating point, or 64-bit floating point.
Speed: 40K bytes/s
Interface Function Codes: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DT1, DC0, C0.

MEASUREMENT ACCURACY

The graphs shown on pages C-8 through C-14 give measurement accuracy after 12-term vector error correction. These errors include the contributions of residual directivity, load and source match, frequency response, isolation, network analyzer dynamic accuracy, and connector repeatability. In preparing the following graphs, 100 Hz IF bandwidth and averaging of 1024 points were used. Changes in the video IF bandwidth or averaging can result in variations at low levels.

DYNAMIC RANGE SUMMARY

Dynamic range (Table C-1) is given in two manners. "Receiver Dynamic Range" is defined as the ratio of the maximum signal level at Port 2 for 0.1 dB compression to the noise floor at Port 2. "System Dynamic Range" is defined as the ratio of the power incident on Port 2 in a through line connection to the noise floor at Port 2 (forward measurements only) when both test ports are terminated in 50 Ohms. In preparing the Dynamic Range specifications, 100 Hz IF bandwidth and 1024 averages were used during calibration and measurement.

TEST PORT CHARACTERISTICS

The Test Port specifications (Table C-2) apply when the proper Model 34U or 34Y Universal Adapters are connected, with or without phase-equal insertables, to the test set ports and calibrated with the appropriate Wiltron or other designated calibration kit at 23°C ± 3°C using the OSL calibration method with a sliding load to achieve 12-term error correction. A 90 Minute minimum warm-up time is assumed.

TIME (DISTANCE) DOMAIN MEASUREMENT CAPABILITY (OPTION 2)

Option 2, Time (Distance) Domain software allows the conversion of reflection or transmission measurements from the frequency domain to the time domain. Measured S-parameter data is converted to the time domain by application of a Fast Fourier Transform (FFT) using the Chirp Z-Transform technique. Prior to conversion any one of several selectable windowing functions may be applied. Once the data is converted to the time domain, a gating function may be applied to select the data of interest. The processed data may then be displayed in the time domain with display start and stop times selected by the user, or in the distance domain with display start and stop distance selected by the user. The data may also be converted back to the frequency domain with a time gate to view the frequency response of the gated data.
Lowpass Mode: This mode displays a response equivalent to the classic (Time Domain Reflectometer) response of the device under test. Lowpass response may be displayed in either the impulse or step mode. This type of processing requires a sweep over a harmonic series of frequencies and an extrapolated or user-entered dc value.
Bandpass Mode: This mode displays a response equivalent to the time response of the device under test to a band limited impulse. This type of processing may be used with any arbitrary frequency sweep range, limited only by the test set range or device-under-test response.
Phasor Impulse Mode: This mode displays a response similar to the Lowpass impulse response, using data taken over an arbitrary (band limited) sweep range. Detailed information, similar to that contained in the lowpass impulse response, may be used to identify the nature of impedance discontinuities in the device under test. Now, with Phasor Impulse, it is possible to characterize complex impedances on band-limited devices.

Windowing: Any one of four window functions may be applied to the initial frequency data, to counteract the effects of processing data with a finite bandwidth. These windows provide a range of tradeoffs of main-lobe width vs. sidelobe level (ringing). The general type of function used is the Blackman-Harris window, with the number of terms being varied from one to four. Typical performance is shown below:

Type of Window (Number of Terms)	First Side Lobe Relative to Peak	Impulse Width[1]
Rectangular (1)	−13 dB	1.2W
Nominal-Hamming (2)	−43 dB	1.8W
Low Side Lobe Blackman-Harris (3)	−67 dB	2.1W
Minimum Side Lobe Blackman-Harris (4)	−67 dB	2.7W

1 W(Bin Width)=1/2 Δf sweep width

Gating: A selective gating function may be applied to the time domain data to remove the responses of all but one desired time range. This gating function may be chosen as the convolution of any of the above window types with a rectangular gate of user-defined position and width. The gate may be specified by entering start and stop times or center and span. The gated data may be displayed in the time domain, or converted back to the frequency domain.

Time Domain Display: Data processed to time domain may be displayed as a function of time or as a function of distance, provided the dielectric constant of the transmission media is entered correctly. In the case of dispersive media such as waveguide or microstrip, the true distance to a discontinuity is displayed in the distance mode. The time display may be set to any arbitrary range by specifying either the start and stop times or the center time and span.

Frequency with Time Gate: Data that has been converted to time domain and selected by the application of gating function may be converted back to the frequency domain. This allows the display of the frequency response of a single element contained in the device under test. Frequency response accuracy is a function of window and gate type, and gate width. For a full reflection, minimum gate and window accuracy is within 0.2 dB of the ungated response over a 40 GHz range.

OTHER OPTIONS

Option 1 & 1A-Rack & Slide Mounting Options
Option 1 provides slide mounts and associated hardware to install the 372XXA in a user-supplied rack. Option 1A provides hardware for mounting the 372XXA in a user-supplied rack where there is proper bottom support for the instrument.

Option 3 — 1 Hz Frequency Resolution
Option 3 adds 1 Hz frequency resolution to all *microwave* models (1 kHz is standard). *(1 Hz frequency resolution is standard on Models 37211A and 37217A.)*

Option 4 — External SCSI Interface
Option 4 adds a rear panel connector for connection of an external SCSI-2 Hard Disk Drive for use in applications where removable media is a requirement. In this situation, the internal hard disk drive is not installed.

Option 6 — Port 2 Test Step Attenuator
Option 6 adds a 0 to 70 dB step attenuator in the Forward Transmission signal path to allow for device output power of up to +30 dBm (1 Watt) into Port 2.

Option 7 — Test Port Connector

7A: Replaces Universal K connector with Universal GPC-7 connector

7N Replaces Universal K connector with Universal N male connector

7NF Replaces Universal K connector with Universal N female connector

Option 10 — Ovenized Timebase
Option 10 replaces the standard temperature compensated crystal oscillator (with a temperature stability of 1ppm over a +15 to 55°C range) with an ovenized crystal oscillator (aging stability of x 10^{-9}/day and temperature stability ± x 10^{-9} over 0 to 55°C range).

Option 11 — Reference Loop Extension Cables
Option 11 add extension to both Reference A and Reference B Sampler RF inputs allowing the user direct access to these channels.

MEASUREMENT SPEED SUMMARY

Measurement times will be on a per sweep basis including retrace, with a 12-term RF calibration applied, no averaging, 10 kHz IF bandwidth and two channels with one display trace each. The measurement times are as follows:
401 pts, .01-20 GHz sweep = 1.1 seconds
101 pts, .01-20 GHz sweep = .35 seconds
401 pts, 1 GHz sweep width = 1.0 seconds
101 pts, 1 GHz sweep width = .26 seconds

UNCERTAINTY CURVES (measured @23 ±3 deg C)

Uncertainty curves are provided on the following pages.

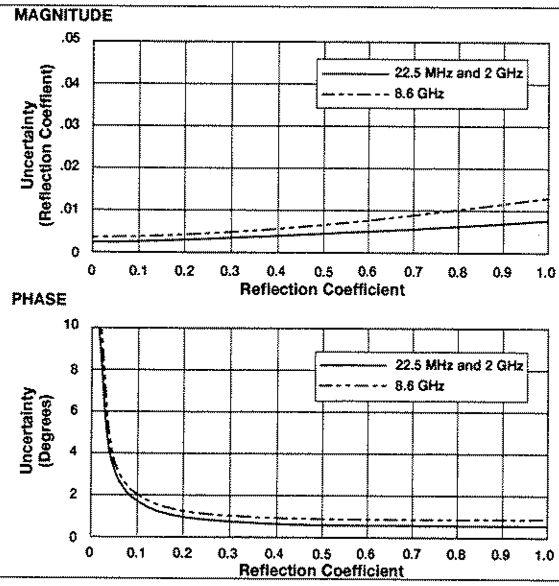
Table C-1. Dynamic Range Summary

Model	Freq (GHz)	Max Signal Into Port 2 (dBm)	Noise Floor (dBm)	Receiver Dynamic Range	Port 1 Power (dBm)	System Dynamic Range
37211A.	0.0225	+30	–95	125	0	95
	2	+30	–98	130	0	98
	3	+30	–98	130	0	98
37217A	0.0225	+30	–95	125	0	95
	2	+30	–98	130	0	98
	8.6	+30	–98	128	0	98
37225A	0.04	+30	–70	100	0	70
	2	+30	–98	128	0	98
	13.5	+30	–98	128	0	96
37247A	0.04	+30	–70	100	0	70
	2	+30	–98	128	0	98
	20	+30	–96	126	0	96
37269A	0.04	+30	–70	100	0	70
	2	+30	–98	128	0	98
	20	+30	–95	125	–5	90
	40	+30	–93	123	–15	78

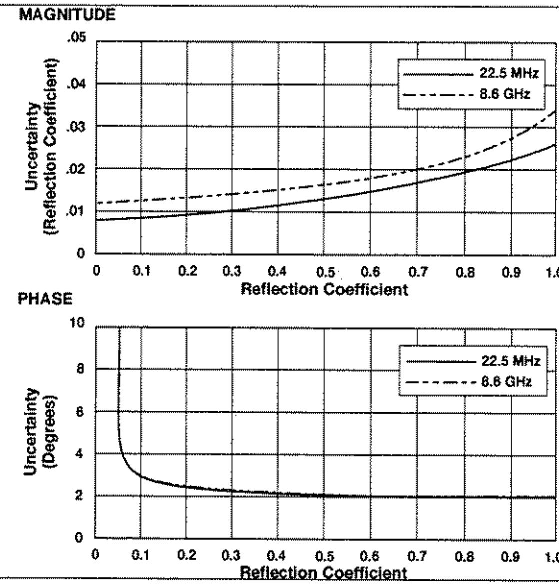
Table C-2. Test Port Characteristics

Connector	Frequency (GHz)	Directivity	Source Match	Load Match	Reflection Frequency Tracking	Transmission Frequency Tracking	Isolation
GPC-7	0.04	>52	>44	>52	±0.003	±0.004	>105
	1.0	>52	>44	>52	±0.003	±0.004	>115
	8.6	>52	>42	>52	±0.004	±0.012	>112
	18	>52	>42	>52	±0.004	±0.012	>112
GPC-7 LRL Calibration	2.0	>60	>60	>60	±0.001	±0.001	>115
	8.6	>60	>60	>60	±0.001	±0.001	>112
	18	>60	>60	>60	±0.001	±0.001	>112
3.5 mm	0.04	>44	>40	>44	±0.006	±0.006	>105
	1.0	>44	>40	>44	±0.006	±0.006	>115
	8.6	>44	>38	>44	±0.006	±0.050	>110
	20	>44	>38	>44	±0.015	±0.020	>110
	26.5	>44	>34	>44	±0.020	±0.030	>102
K	0.04	>42	>40	>42	±0.006	±0.006	>105
	1.0	>42	>40	>42	±0.006	±0.006	>115
	8.6	>42	>38	>42	±0.006	±0.070	>110
	20	>42	>38	>42	±0.015	±0.020	>110
	40	>38	>38	>38	±0.020	±0.030	>100

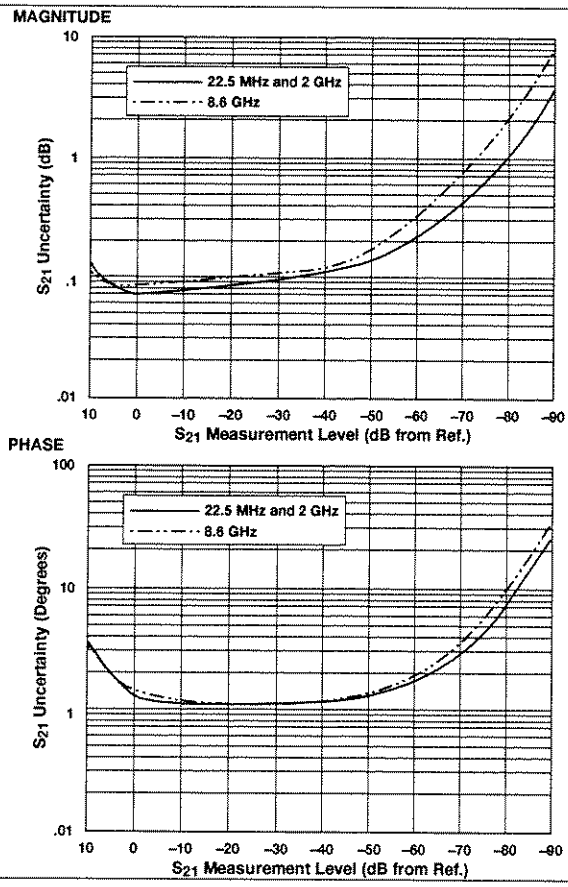
Models 37211A and 37217A (GPC-7 Connectors), Reflection Measurements



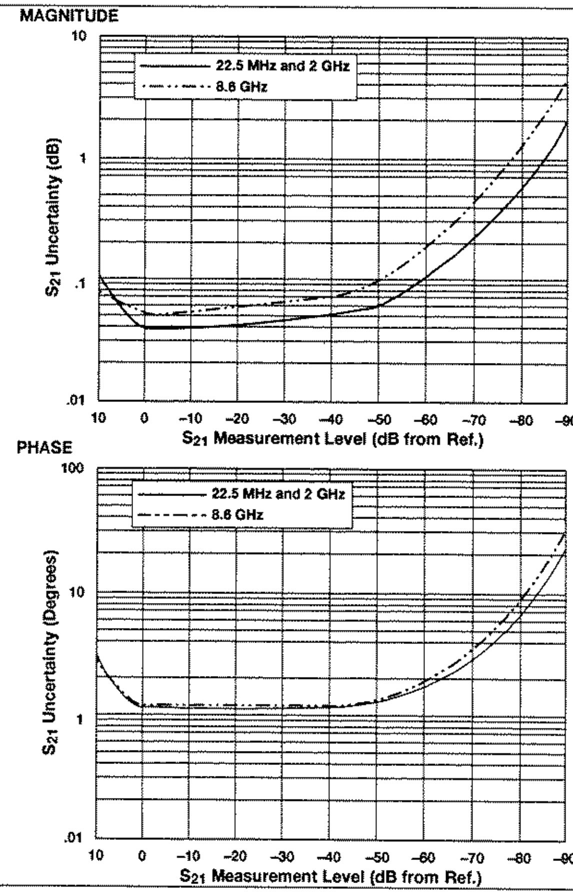
Models 37211A and 37217A (Type N Connectors) Reflection Measurements



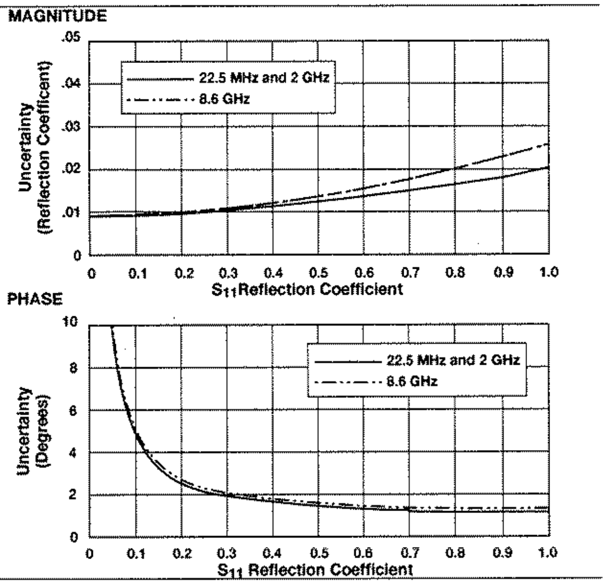
Models 37211A and 37217A (GPC-7 Connectors), Transmission Measurements



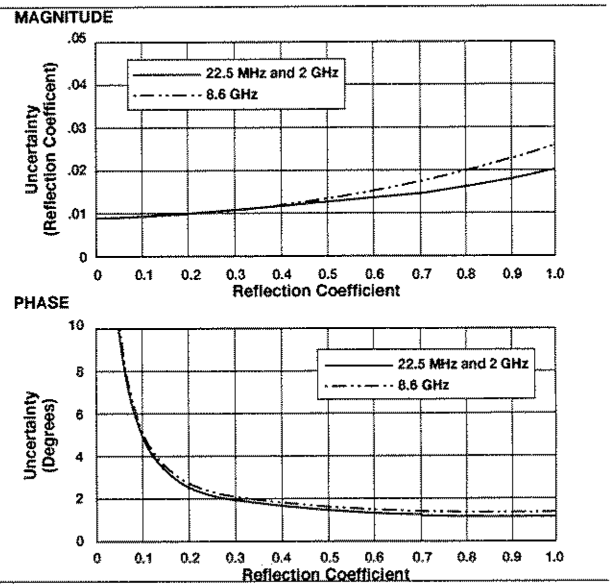
Models 37211A and 37217A (Type N Connectors) Transmission Measurements



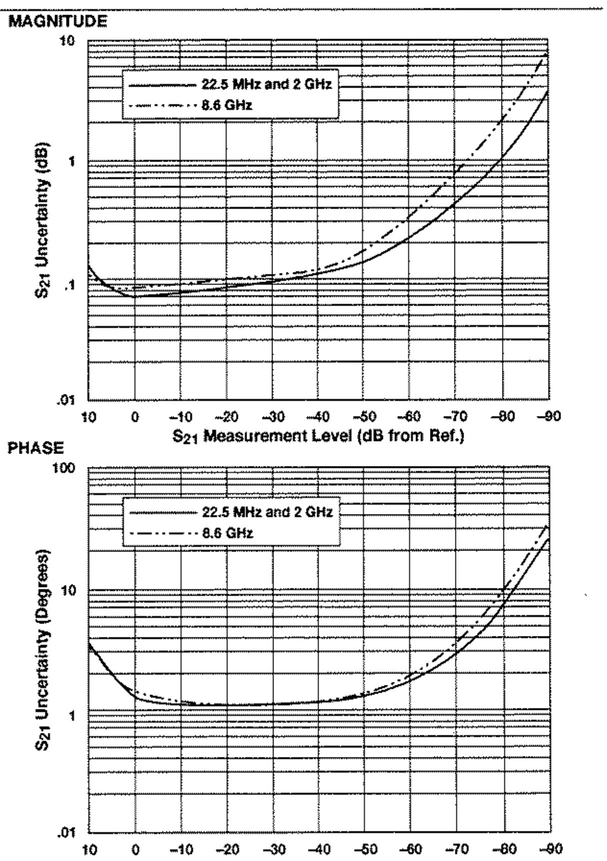
Models 37211A and 37217A (3.5mm Connectors),



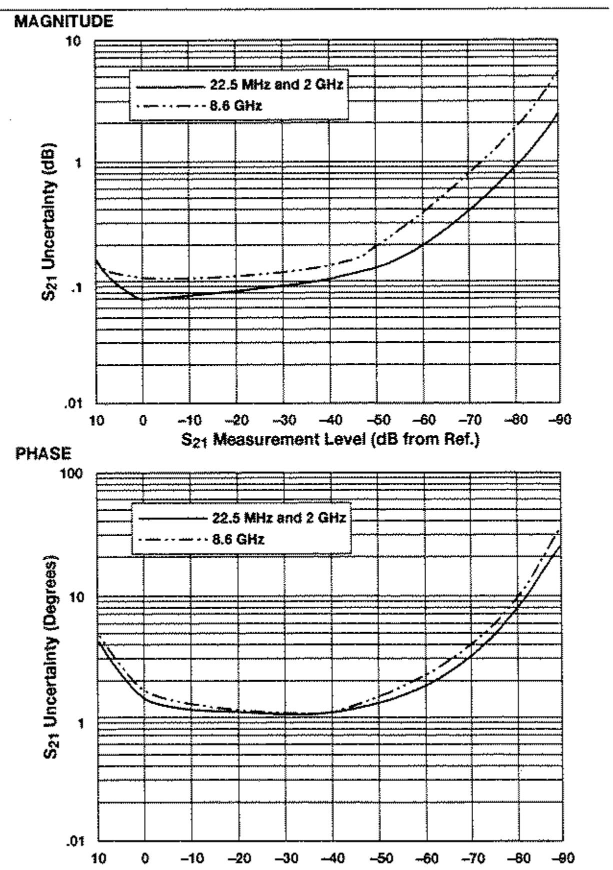
Models 37211A and 37217A (K Connectors)



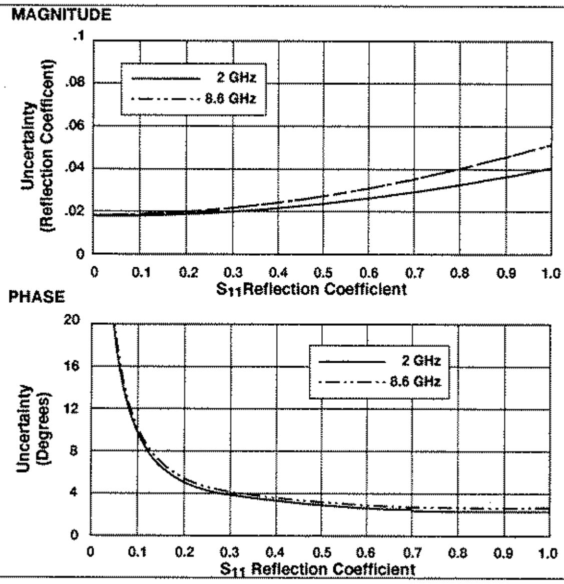
Models 37211A and 37217A (3.5mm Connectors), Transmission Measurements



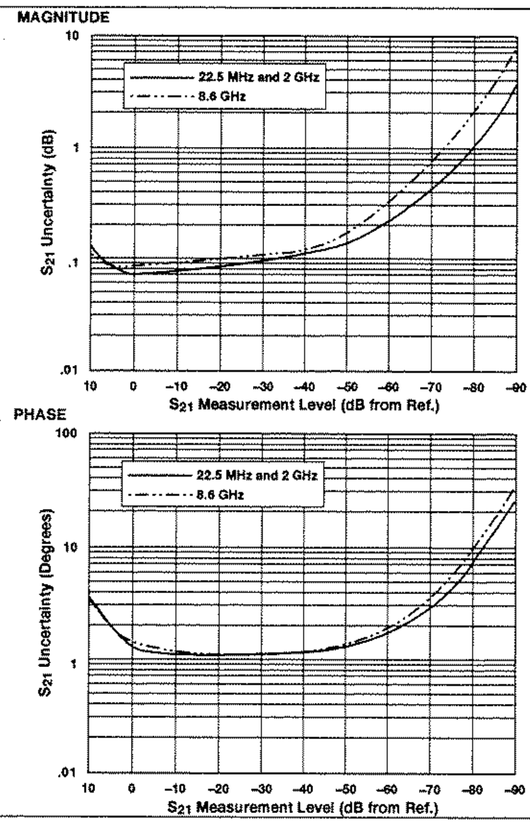
Models 37211A and 37217A (K Connectors) Transmission Measurements



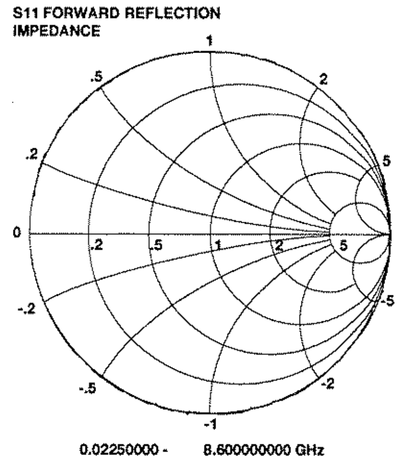
Model 37217A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-15, 15 mil Calibration Kit — Reflection Measurements



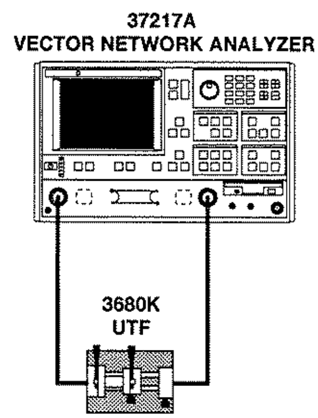
Model 37217A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-15, 15 mil Calibration Kit — Transmission Measurements



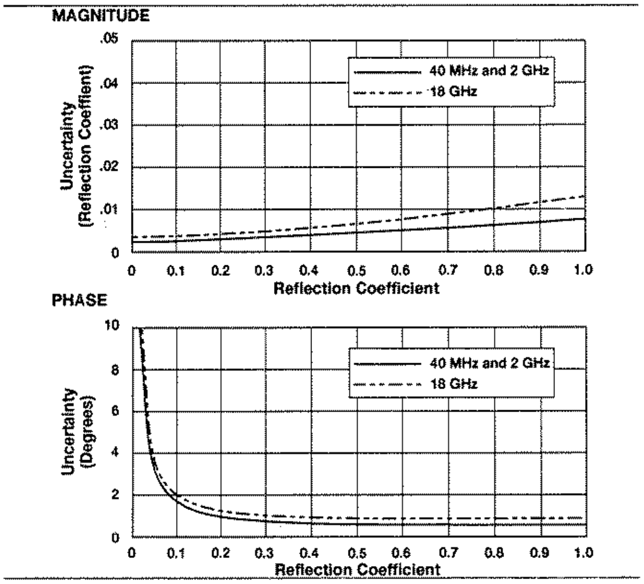
Model 37217A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-15, 15 mil Calibration Kit — LRLM Performance (typical)



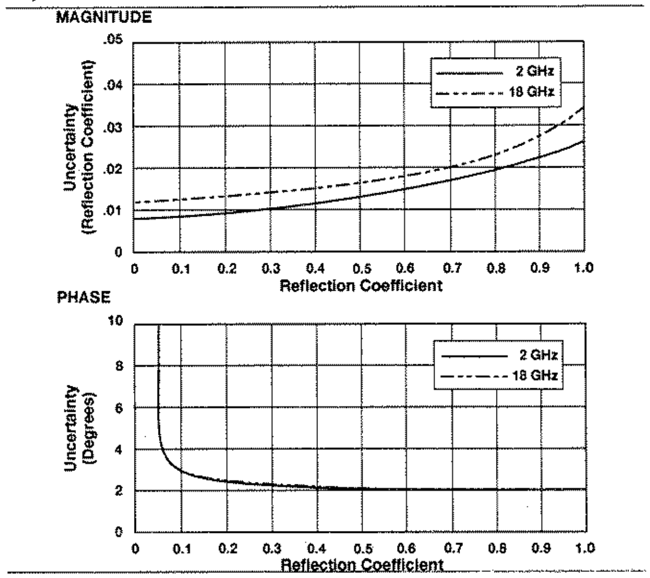
Measurement Setup



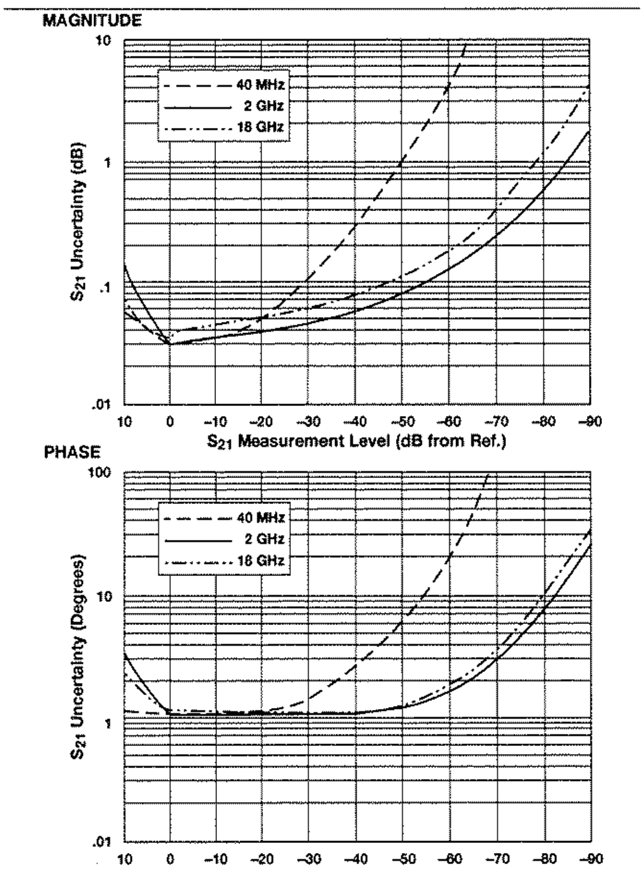
Models 37225A and 37247A (GPC-7 Connectors), Reflection Measurements



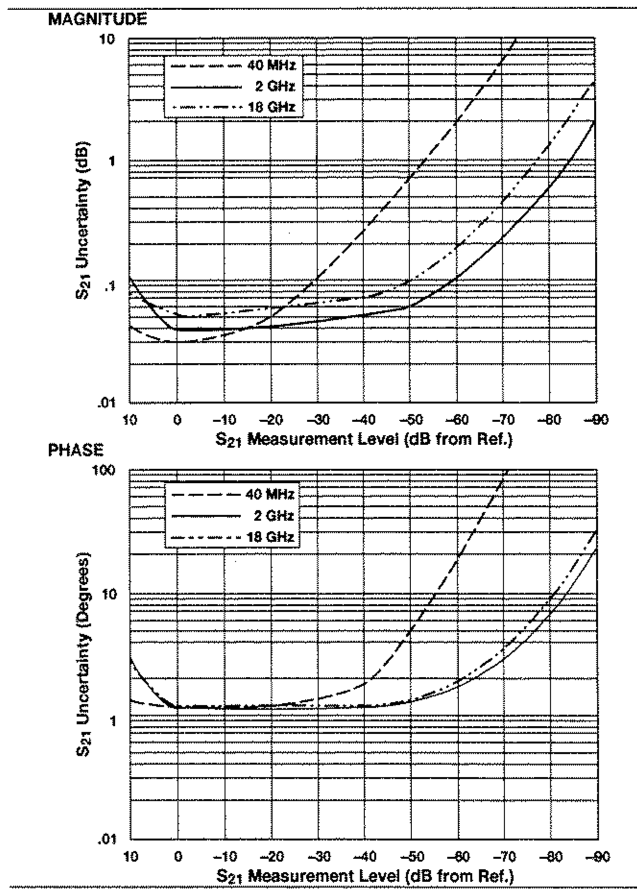
Models 37225A and 37247A (Type N Connectors), Reflection Measurements



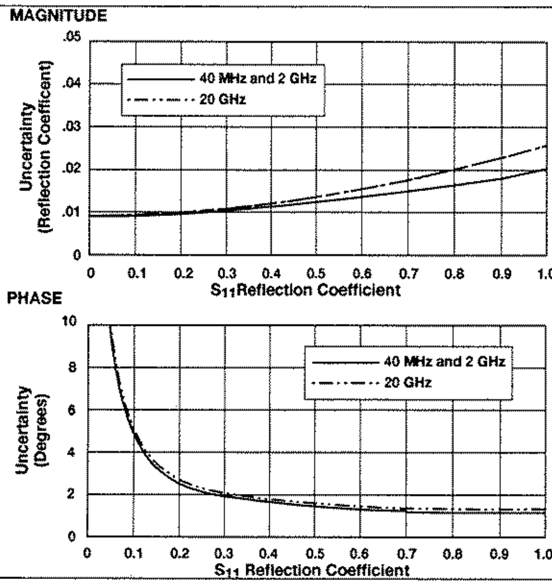
Models 37225A and 37247A (GPC-7 Connectors), Transmission Measurements



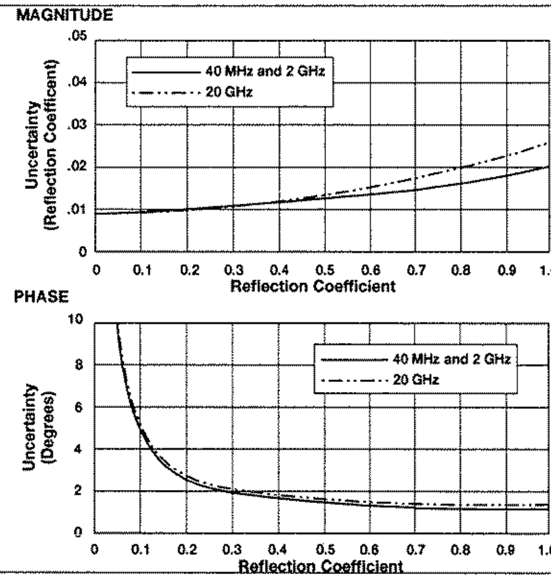
Models 37225A and 37247A (Type N Connectors), Transmission Measurements



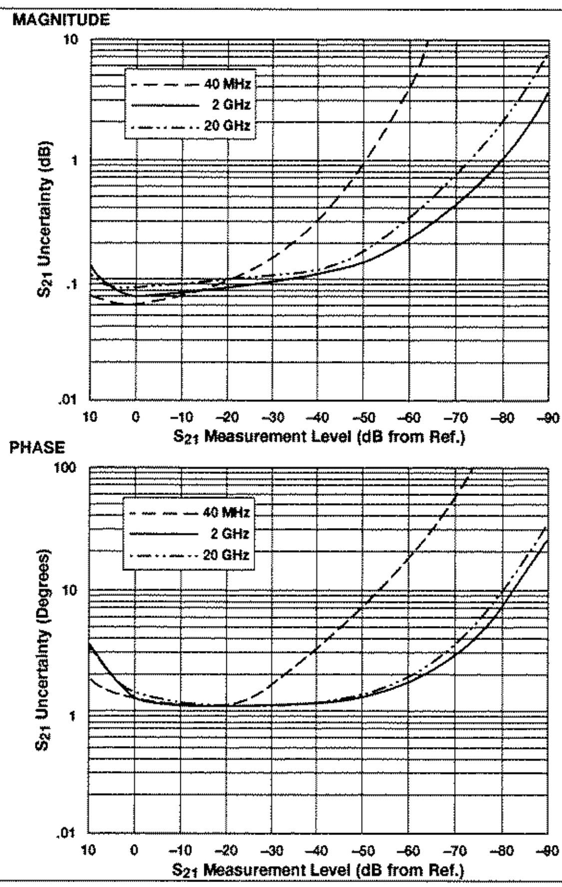
Models 37225A and 37247A (GPC-7 Connectors), Reflection Measurements



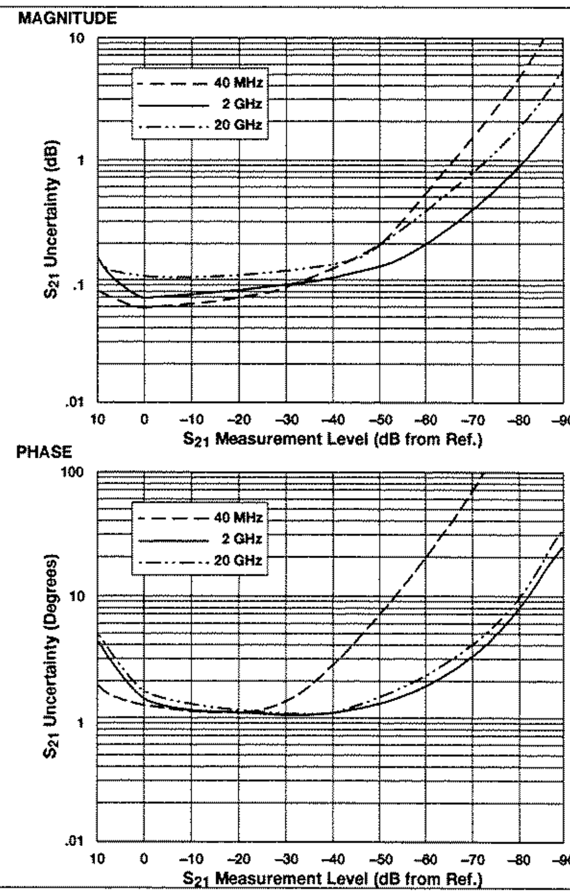
Models 37225A and 37247A (K Connectors), Reflection Measurements



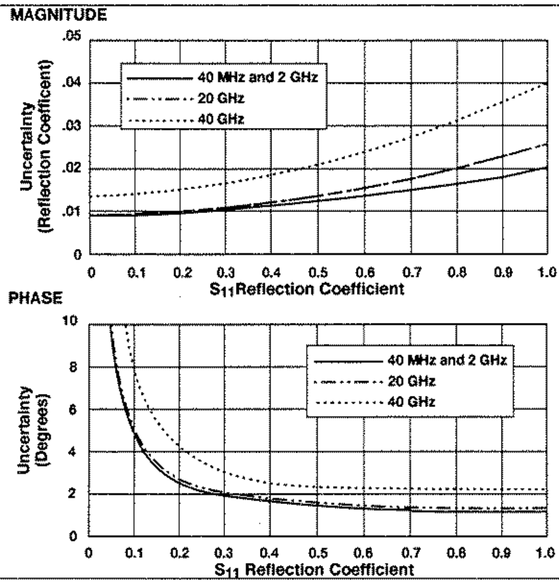
Models 37225A and 37247A (GPC-7 Connectors), Transmission Measurements



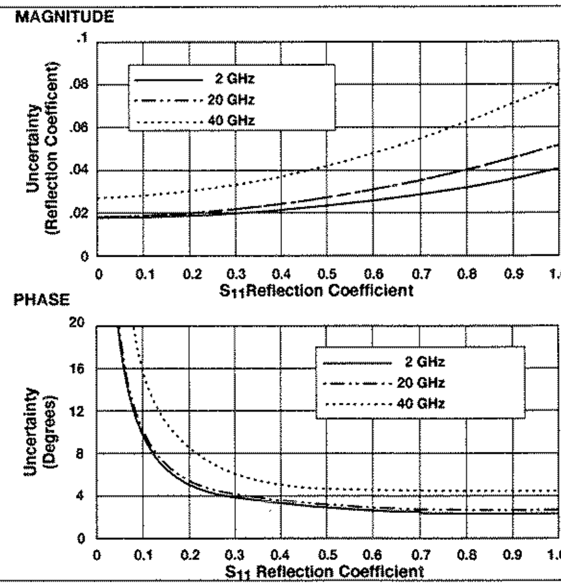
Models 37225A and 37247A (K Connectors), Transmission Measurements



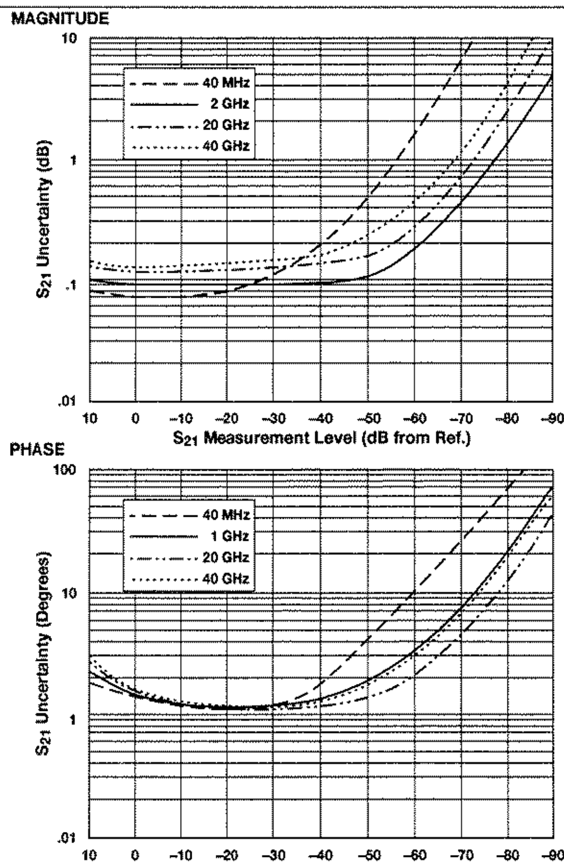
Model 37269A (K Connectors), Reflection Measurements



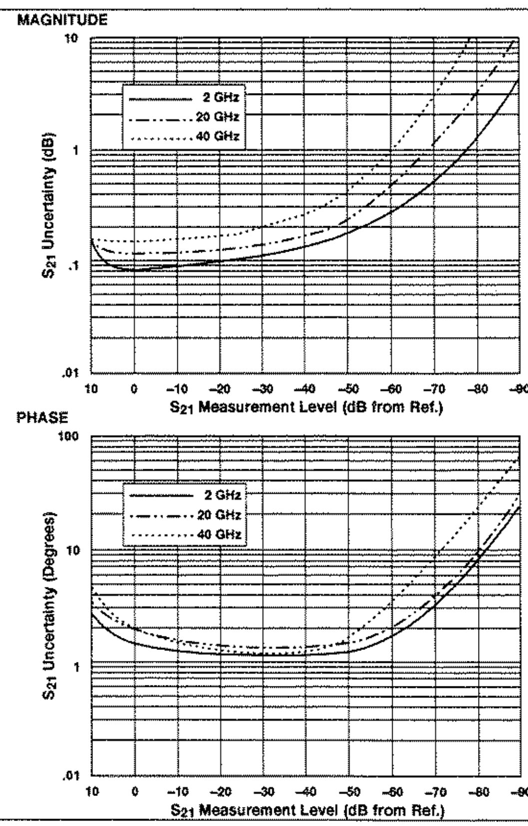
Model 37269A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-10, 10 mil Calibration Kit — Reflection Measurements



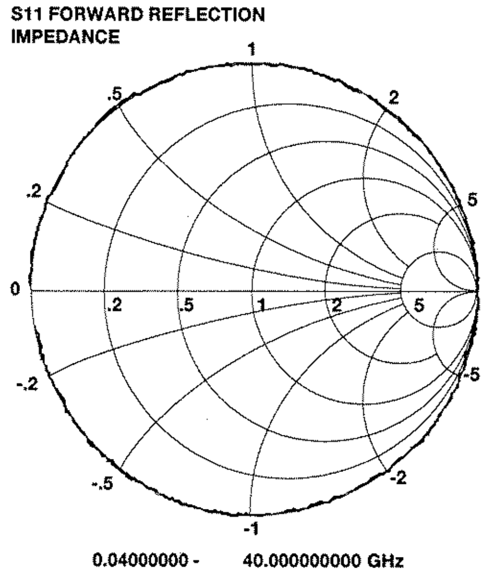
Model 37269A (K Connectors), Transmission Measurements



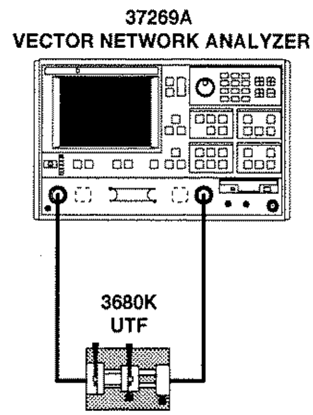
Model 37269A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-10, 10 mil Calibration Kit — Transmission Measurements



Model 37269A Universal Test Fixture (Model 3680K), Microstrip LRL Calibration (Model 36804-10, 10 mil Calibration Kit — LRLM Performance (typical)



Measurement Setup



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