MS4662A
Network Analyzer
Operation Manual
Vol.1
Panel Operations

Fourth Edition

Read this manual before using the equipment.
Keep this manual with the equipment.

Measuring Instruments Division
Measurement Group

ANRITSU CORPORATION

MAR.
1997

Document No.: M-W0997AE-4.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Insure that you clearly understand the meanings of the symbols BEFORE using the equipment.

Symbols used in manual

DANGER	This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.
WARNING	This indicates a hazardous procedure that could result in serious injury or death if not performed properly.
CAUTION	This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

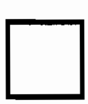
Safety Symbols Used on Equipment and in Manual

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

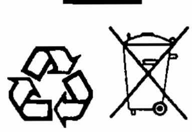
This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.

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



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



These indicate that the marked part should be recycled.

MS4662A Network Analyzer
Operation Manual Vol.1 Panel Operations

September 1995 (First Edition)
January 1997 (Fourth Edition)

Printed in japan

For Safety

WARNING

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

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

Repair

WARNING ⚠

3. This equipment cannot be repaired by the user. DO NOT attempt to open the cabinet or to disassemble internal parts. Only Anritsu-trained service personnel or staff from your sales representative with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision parts.

Falling Over

4. This equipment should be used in the correct position. If the cabinet is turned on its side, etc., it will be unstable and may be damaged if it falls over as a result of receiving a slight mechanical shock.

Battery Fluid

5. DO NOT short the battery terminals and never attempt to disassemble it or dispose of it in a fire. If the battery is damaged by any of these actions, the battery fluid may leak.

   This fluid is poisonous.

   DO NOT touch it, ingest it, or get in your eyes. If it is accidentally ingested, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, irrigate them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash if off carefully and thoroughly.

For Safety

WARNING

LCD

6. This instrument uses a Liquid Crystal Display (LCD); DO NOT subject the instrument to excessive force or drop it. If the LCD is subjected to strong mechanical shock, it may break and liquid may leak.

   This liquid is very caustic and poisonous.

   DO NOT touch it, ingest it, or get in your eyes. If it is accidentally ingested, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, irrigate them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash if off carefully and thoroughly.

CAUTION

Changing Fuse

CAUTION ⚠

1. Before changing the fuses, ALWAYS remove the power cord from the poweroutlet and replace the blown fuses. Always use new fuses of the type and rating specified on the fuse marking on the rear panel of the cabinet.

   T 6.3A indicates a time-lag fuse.

   There is risk of receiving a fatal electric shock if the fuses are replaced with the power cord connected.

Cleaning

2. Keep the power supply and cooling fan free of dust.
   - Clean the power inlet regularly. If dust accumulates around the power pins, there is a risk of fire.
   - Keep the cooling fan clean so that the ventilation holes are not obstructed. If the ventilation is obstructed, the cabinet may overheat and catch fire.

⚠ CAUTION/注意

>18kg

HEAVY WEIGHT/重量物

3. Use two or more people to lift and move this equipment, or use a trolley. There is a risk of back injury, if this equipment is lifted by one person.

Check Terminal

4. Never input a signal of more than +24dBm RF ±40V DC MAX. Input of an excessive signal may damage the equipment.

Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories including the Electrotechnical Laboratory, the National Research Laboratory and the Communication Research laboratory, and was found to meet the published specifications.

Anritsu Warranty

Anritsu Corporation will repair this equipment free-of-charge if a malfunction occurs within 1 year after shipment due to a manufacturing fault, provided that this warranty is rendered void under any or all of the following conditions.

- The fault is outside the scope of the warranty conditions described in the operation manual.
- The fault is due to misoperation, misuse, or unauthorized modification or repair of the equipment by the customer.
- The fault is due to severe usage clearly exceeding normal usage.
- The fault is due to improper or insufficient maintenance by the customer.
- The fault is due to natural disaster including fire, flooding and earthquake, etc.
- The fault is due to use of non-specified peripheral equipment, peripheral parts, consumables, etc.
- The fault is due to use of a non-specified power supply or in a non-specified installation location.

In addition, this warranty is valid only for the original equipment purchaser. It is not transferable if the equipment is resold.

Anritsu Corporation will not accept liability for equipment faults due to unforeseen and unusual circumstances, nor for faults due to mishandling by the customer.

Anritsu Corporation Contact

If this equipment develops a fault, contact the head office of Anritsu Corporation at the address in the operation manual, or your nearest sales or service office listed on the following pages.

'IBM' is a registered trademark of the IBM Corporation.
'HP' is a registered trademark of the Hewlett-Packard Company.
'MS-DOS' is a registered trademark of the Microsoft Corporation.
'NEC' is a registered trademark of the NEC Corporation.

Replacing the Memory Backup Battery

This unit uses a graphite fluoride lithium battery as a memory backup battery. It is replaceable only by our service personnel. Request its replacement from the nearest Anritsu office or your dealer.

Storage Media

This unit uses a plug-in memory card (PMC) and backup memory as external storage media for data and programs.

Valuable data and programs stored on the storage media could be lost if the media are handled incorrectly or fail.
Backup is recommended to guard against this risk.

Anritsu will not indemnify the user for the loss of stored data and programs.

Please take full notice of the instructions below. Especially, be careful not to remove the plug-in memory card (PMC) from the unit while it is being accessed. For more details refer to Chapter 2 of the manual.

(PMC)

- Damage to the PMC could result if it is exposed to static electricity.
- The SRAM plug-in memory card (PMC) has a limited battery life. Remember to replace the battery periodically.

(Memory with battery backup)

- Damage to the memory could result if it is exposed to static electricity.

Note: The battery used in the unit has a life of about seven years. Replace the battery before this time expires.

Disposal

The unit uses compound semiconductors that contain arsenic. Observe the relevant local regulations in disposing of the semiconductors.

CE Marking

Anritsu affix the CE Conformity Marking on the following product (s) accordance with the Council Directive 93/68/EEC to indicate that they conform with the EMC directive of the European Union (EU).

CE Conformity Marking

CE

1. Product Name/Model Name

Product Name: Network Analyzers

Model Name: MS4661A/E and MS4662A

2. Applied Directive

EMC: Council Directive 89/336/EEC

Safety: Council Directive 73/23/EEC

3. Applied Standards

EMC:

Electromagnetic radiation:

EN55011 (ISM, Group 1, Class A equipment)

Immunity:

EN50082-1

		Performance Criteria*
IEC801-2 (ESD)	4 kVCD, 8 kVAD	B
IEC801-3 (Rad.)	3 V/m	A
IEC801-4 (EFT)	1 kV	B

*: Performance Criteria

A: No performance degradation or function loss

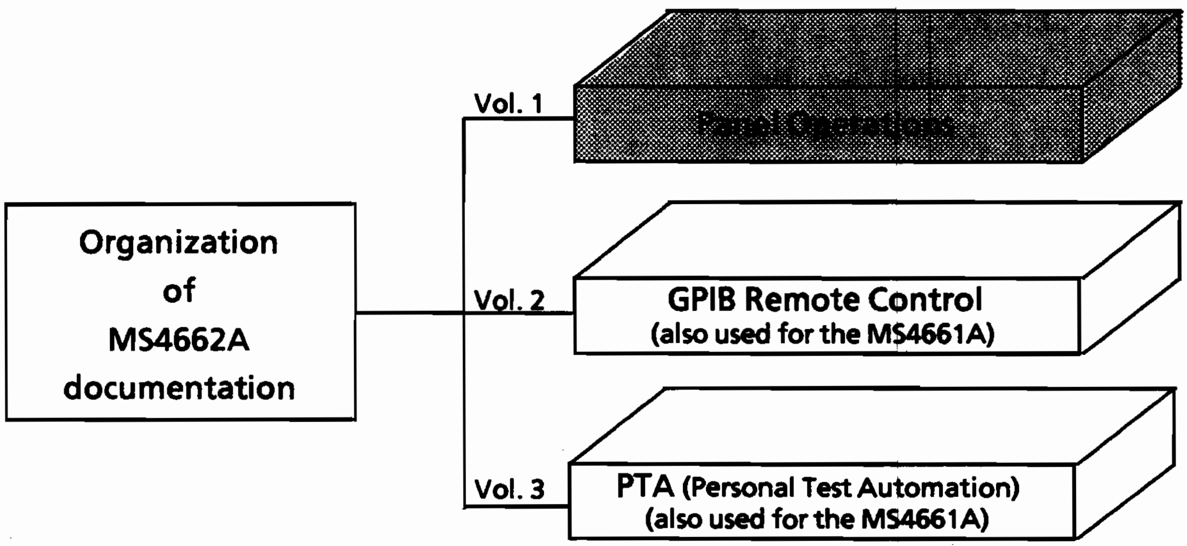
B: Self-recovered temporary degradation of performance or temporary loss of function

Safety: EN61010-1 (Installation Category II, Pollution Degree 2)

PREFACE

(1) Organization of documentation

The documentation supplied with the MS4662A Network Analyzer is divided into three manuals (Vol. 1, Vol. 2, and Vol. 3). Read these manuals as needed.



Panel Operations: Presents summary information about the MS4662A, including preparations and basic panel operations, and proceeds to introduce panel operations other than automatic measurement, such as performance testing.

GPIB Remote Control: Explains the concepts of GPIB remote control pursuant to the specifications of IEEE-488.2, with which the MS4662A is compliant. Sample programs written with reference to our PACKET V Series technical computer are provided.

PTA (Personal Test Automation): Explains how to program high-speed control and high-speed arithmetic operations that are directly linked to a testing system in the high-level language PTL. The programmed operations are executed by the personal computer built in the MS4662A. Called PTA (Personal Test Automation), this scheme of programming promotes the progress of test automation, together with GPIB remote control mentioned above.

(2) GPIB Basic Guide (sold separately)

In addition to the three volumes listed above, the GPIB Basic Guide is available as a separately sold manual. It provides a basic insight into the concepts of GPIB and contains GPIB control statements written in our PACKET V computer language.

TABLE OF CONTENTS

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SECTION 1
GENERAL

This chapter gives summary information about the MS4662A Network Analyzer, describes how this manual is organized, what hardware requirements must be met to use the MS4662A on a standard configuration, what application components and peripherals are available to enhance its performance, and its specifications.

TABLE OF CONTENTS

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1.1 Product Overview

The MS4662A is a network analyzer designed to test the S-parameters of electronic components and circuit networks over a frequency range of 100 kHz to 3 GHz.

Its 8.9-inch flat-screen, active matrix-driven color LCD, organized into 640 by 400 dots, displays color images in 4,096 colors.

The M4662A permits setting and running parameters by displaying softkey menus and data type-specific display coordinate graphs on screen, displaying test results, and hard-copying them to printers or plotters as needed.

Its internal R, TA, and TB test channels enable the MS4662A to measure the ratio between the Ta and Tb channels and also the absolute level of each channel during S-parameter measurement.

In addition to S-parameter measurement in a frequency axis domain, the MS4662A is capable of converting it to a time (distance) axis domain for impulse or step response measurement. Full 12-term error correction adds to the measurement precision of time-domain analyses by the network analyzer over the conventional TDR process.

The MS4662A supports a GPIB interface as standard. Building an automatic testing system is just a matter of connecting a personal computer or any other instrumentation to the network analyzer. Built-in PTA (Personal Test Automation) facilities in the MS4662A also make it possible to build an automatic testing system by using the MS4662A as a controller, without needing a personal computer.

■ Applications

The MS4662A is recommended for use in the development, adjustment, inspection, and maintenance of electronic components and devices in the telecommunications markets, including mobile telecommunication and fiber optics communications, and the AV markets represented by high-definition TV and satellite communications.

1.2 Manual Organization

This manual is divided into 12 chapters and three appendixes. A brief description of each of the chapters is given below.

Chapter		Description
Chapter 1	General	Product overview, organization of documentation, standard analyzer configuration, options, application components and peripherals, and standards.
Chapter 2	Preparations	Preparations to be completed before starting to use (turning on) the unit.
Chapter 3	Basic Operating Instructions	Basic operating instructions for first-time users of the MS4662A.
Chapter 4	Selecting Methods of Displaying Measurement Data	Methods of selecting data types for measurement data and the corresponding graph formats, and displaying the graphs at optimal positions on screen, and marker function.
Chapter 5	Selecting Measurement Parameters	Selecting measurement parameters with the FREQ, SWEEP, PORT POWER, and AVG keys in the MEASURE section.
Chapter 6	Package Functions	Functions designed to simplify the workflow of measurement, such as displaying titles, setting dates and times, changing measurement points, and isolating and calculating characteristic points in traced waveforms.
Chapter 7	Limit Testing Function	Evaluation of measurement results as PASS or FAIL.
Chapter 8	Hard-Copying and Save/Recall Functions	Copy function that hard-copies display images to printers or plotters, and PMC file save/recall functions.
Chapter 9	Calibrating Measurement Values	Explanations of the methods of calibrating measurement values, and practical examples (X-S method, single-port OSL method, two-port OSL method, and single-path two-port method).
Chapter 10	Testing	Typical examples of S-parameter and time-domain measurement.
Chapter 11	Unit Performance Testing	Instruments and apparatus needed to executed MS4662A performance testing, their setup, and performance testing procedures
Chapter 12	Storage and Transportation	Daily care, long-term storage, and repacking and transportation
Appendixes	A to C	Appendix C contains foldout front and rear panel views at the end of the VOLUME. Open the foldouts to read this manual while observing the panel operator side.

1.3 Hardware Configuration

The standard configuration of the MS4662A Network Analyzer is described below.

1.3.1 Standard configuration

The table below breaks down the standard configuration of the MS4662A Network Analyzer.

Item	Type and symbol (†)	Description (†)	Quantity	Remarks
Unit	MS4662A	Network analyzer	1	
Components	J0017F	Power cord	1	About 2.5 m long
	J0266	Power cord adapter	1	Three-pole - Two-pole
	F0014	Fuse	2	6.3 A, 2, AC line use T6.3A250V
	F0043	Fuse	2	1 A, 2, DC bias use MF51NN250V1ADC01
	Z0280A	Wrist band	1	
	W0997AE	Operation Manual	1 set	Panel Operations
	W0998AE			GPIB Remote Control
	W0999AE			PTA

† Specify the type, symbol, description, and quantity when ordering.

1.4 Application Components and Peripherals

The table below lists the application components and peripherals that can be used with the MS4662A. All these components and peripherals are options.

Application components and peripherals

Type and symbol (†)	Description (†)	Remarks
J0007	GPIB connecting cable, 1 m	408JE-101
J0008	GPIB connecting cable, 2 m	408JE-102
P0005	Memory card (32 K bytes)	BS32F1-C-172; battery life: about 5 years
P0006	Memory card (64 K bytes)	BS641-C-173; battery life: about 5 years
P0007	Memory card (128 K bytes)	BS128F1-C-174; battery life: about 4.3 years
P0008	Memory card (256 K bytes)	BS256F1-C-1175; battery life: about 2.2 years
P0009	Memory card (512 K bytes)	BS32F1-C-1176; battery life: about 1.1 years
J0079	High-power fixed attenuator	DC to 8 GHz, 30 dB, 25 W
J0395	High-power fixed attenuator	DC to 9 GHz, 30 dB, 30 W
B0334C	Carrying case	With a protective cover and casters
B0329C	Protective cover	
B0331C	Front handles	Two in a set
B0333C	Rack-mount kit	
MC3305A	PTA keyboard	JIS type
MC3306A	PTA keyboard	ASCII type
UA-455A	Video plotter	
Z0047	UA-455A forms	5 rolls in a set
VP-870	Printer	Equivalent to the VP800
MC8104A	Data storage unit	

† Specify the type, symbol, description, and quantity when ordering.

1.5 Specifications

The table below summarizes the specifications of the MS4662A.

Measurement item				Specification
Measurement items	S-parameter characteristics			S_{11}, S_{21}, S_{12}, S_{22}, R, TA, TB
	Time domain characteristics			Display of impulse or step responses of the characteristics mentioned above
Display	Monitor	Dot pattern		640 × 400 dots
		Display unit		8.9-inch color LCD
		Operation terminal		Drawing by GPIB and PTA
	Display screen			Single- or dual-screen (front/back, split) display
	Measurement and display items	S-parameters	S_{11}	LOG MAG, PHASE, LIN MAG, REAL, IMAG, POLAR (MAG/PHASE), VSWR IMPD (Z ∠ PHASE, Q/D, Rs/Cs, Ls, R+jX) ADMT (Y ∠ PHASE, Q/D or Rp/Cp, Lp, G+jB)
			S_{21}	LOG MAG, PHASE, LIN MAG, REAL, IMAG, POLAR (MAG/PHASE), HSDELAY
			S_{12}	LOG MAG, PHASE, LIN MAG, REAL, IMAG, POLAR (MAG/PHASE), HSDELAY
			S_{22}	LOG MAG, PHASE, LIN MAG, REAL, IMAG, POLAR (MAG/PHASE), VSWR IMPD (Z ∠ PHASE, Q/D, Rs/Cs, Ls, R+jX) ADMT (Y ∠ PHASE, Q/D or Rp/Cp, Lp, G+jB)
		Time domain	BAND PASS	LOG MAG, PHASE, LIN MAG, REAL, IMAG
			LOW PAS	LOG MAG, PHASE, LIN MAG, REAL, IMAG
	Waveform storage			Waveform data retained in storage screens

<table>
<tr><th>Measurement item</th><th>Specification</th></tr>
<tr><td>Test port characteristics</td><td>
After error correction

<table>
<tr><td>Directivity</td><td>≧38 dB</td></tr>
<tr><td>Source matching</td><td>≧35 dB</td></tr>
<tr><td>Load matching</td><td>≧35 dB</td></tr>
<tr><td>Transmission frequency characteristic</td><td>≦±0.02 dB</td></tr>
<tr><td>Reflection frequency characteristic</td><td>≦±0.02 dB</td></tr>
<tr><td>Crosstalk</td><td>≧105 dB</td></tr>
</table>

Connector: 3.5 mm (SMA), RBW: 10 Hz; at room temperature

Before error correction

<table>
<tr><td>Directivity</td><td>≧30 dB (300 kHz to 3 GHz)
≧22 dB (100 kHz to 300 kHz)
(at temperatures ranging from 23 to 35 °C)</td></tr>
<tr><td>Source matching</td><td>≧10 dB (300 kHz to 1.5 GHz)
≧8 dB (100 kHz to 3 GHz)</td></tr>
<tr><td>Load matching</td><td>≧15 dB (300 kHz to 1.5 GHz)
≧10 dB (100 kHz to 3 GHz)</td></tr>
<tr><td>Transmission frequency characteristic</td><td>≦2 dB (300 kHz to 80 MHz)
≦5 dB (100 kHz to 3 GHz)</td></tr>
<tr><td>Reflection frequency characteristic</td><td>≦2 dB (300 kHz to 80 MHz)
≦5 dB (100 kHz to 3 GHz)</td></tr>
<tr><td>Crosstalk</td><td>≧90 dB (100 kHz to 1 GHz)
≧80 dB (1 GHz to 3 GHz)</td></tr>
</table>
</td></tr>
</table>

Measurement item			Specification
Test port output characteristics	Frequency range		100 kHz to 3 GHz (0.1-Hz resolution)
	Internal reference oscillator	Frequency	10 MHz
		Aging characteristics	With reference to 15 minutes after power-on ≦ ±1 × 10^{-6}/day With reference to 24 hours after power-on (option) ≦ ±2 × 10^{-8}/day
		Temperature characteristics	≦ ±5×10^{-6} (0 to 50 °C), ≦ ±5×10^{-8} (0 to 50 °C) (option)
	Output level range		−70 to +10 dBm
	Output level accuracy		±1.0 dB or less (output frequency 100 MHz, output level 0 dBm)
	Output level linearity		±0.5 dB or less (0 dBm frequency, output frequency 100 MHz, output level −10 dBm to +8 dBm)
	Output level deviations		With reference to an output frequency of 100 MHz and an output level of 0 dBm −0.5 to +2.5 dB (output frequency 100 to 500 kHz) −1.5 to +1.5 dB (output frequency 500 kHz to 2 GHz) −2.0 to +2.0 dB (output frequency 2 to 3 GHz)
	Output connector		GPC-7
	Signal purity	SSB phase noise	Output level +0 dBm SSB phase noise (offset frequency 10 kHz): −90 dBc/Hz (output frequency 100 kHz to 80 MHz) −85 dBc/Hz (output frequency 80 MHz to 1 GHz) −80 dBc/Hz (output frequency 80 MHz to 1 GHz)
		Nonharmonic spurious output	≦ −30 dBc
		Harmonic distortion	≦ −25 dBc
Test port input characteristics	Frequency range		100 kHz to 3 GHz
	Input connector		GPC-7
	Test port attenuator		0 dB, +20 dB (switching error ±1 dB)
	Resolution bandwidth		3 Hz to 10 kHz, AUTO (set automatically according to the sweep time)
	Noise level		≦ −90 dBm (100 kHz to 80 MHz, resolution bandwidth 1 kHz) ≦ −80 dBm (80 MHz to 3 GHz, resolution bandwidth 1 kHz)

<table>
<tr><th colspan="2">Measurement item</th><th>Specification</th></tr>
<tr><td rowspan="4">Amplitude characteristics measurement</td><td>Measuring range</td><td>≧100 dB</td></tr>
<tr><td>Display</td><td>0.01 dB/div to 50 dB/div (1-2-5 sequence)</td></tr>
<tr><td>Measuring resolution</td><td>0.001 dB</td></tr>
<tr><td>Dynamic accuracy</td><td>At an RBW of 10 Hz with reference to a test port level of −10 dBm
<table>
<tr><th rowspan="2">Test port level</th><th colspan="2">Measuring accuracy</th></tr>
<tr><th>≦1.0 GHz</th><th>>1.0 GHz</th></tr>
<tr><td>+10 dB to 0 dB</td><td>±0.30 dB</td><td>±0.30 dB</td></tr>
<tr><td>0 dB to −40 dB</td><td>±0.05 dB</td><td>±0.05 dB</td></tr>
<tr><td>−40 dB to −50 dB</td><td>±0.05 dB</td><td>±0.10 dB</td></tr>
<tr><td>−50 dB to −60 dB</td><td>±0.10 dB</td><td>±0.30 dB</td></tr>
<tr><td>−60 dB to −70 dB</td><td>±0.30 dB</td><td>±1.20 dB</td></tr>
<tr><td>−70 dB to −80 dB</td><td>±1.20 dB</td><td>±4.00 dB</td></tr>
<tr><td>−80 dB to −90 dB</td><td>±4.00 dB</td><td>———</td></tr>
</table>
</td></tr>
<tr><td rowspan="4">Phase characteristics measurement</td><td>Measuring range</td><td>±180°</td></tr>
<tr><td>Display</td><td>0.01 deg/div to 50 deg/div (1-2-5 sequence)</td></tr>
<tr><td>Measuring resolution</td><td>0.001 deg</td></tr>
<tr><td>Dynamic accuracy</td><td>At an RBW of 10 Hz with reference to a test port level of −10 dBm
<table>
<tr><th rowspan="2">Test port level</th><th colspan="2">Measuring accuracy</th></tr>
<tr><th>≦1.0 GHz</th><th>>1.0 GHz</th></tr>
<tr><td>+10 dB to 0 dB</td><td>±6.0 deg</td><td>±6.0 deg</td></tr>
<tr><td>0 dB to −40 dB</td><td>±0.3 deg</td><td>±0.3 deg</td></tr>
<tr><td>−40 dB to −50 dB</td><td>±0.3 deg</td><td>±0.8 deg</td></tr>
<tr><td>−50 dB to −60 dB</td><td>±0.8 deg</td><td>±2.0 deg</td></tr>
<tr><td>−60 dB to −70 dB</td><td>±2.0 deg</td><td>±6.0 deg</td></tr>
<tr><td>−70 dB to −80 dB</td><td>±6.0 deg</td><td>±20.0 deg</td></tr>
<tr><td>−80 dB to −90 dB</td><td>±20.0 deg</td><td>———</td></tr>
</table>
</td></tr>
</table>

Measurement item			Specification
Calibration	Measurement value calibration		X-S Single-port vector error correction Two-port vector error correction Single-path two-port
	Calibration data interpolation		Calibration data can be altered with changing measuring frequencies (CF, SPAN, START, STOP, LOG/LIN) and measuring points (if two-port calibration is executed with 501 or fewer measuring points).
	Electrical length correction	Range	0 to ±999 999.999 999 9 m
		Resolution	100 nm
	Phase offset		Range: −180 deg to +180 deg
Delay time measurement	Measuring range		High-speed mode (HSDELAY) $\tau = \Delta\theta / (360 \times \text{Aperture frequency})$ $\Delta\theta$: Phase measuring range Aperture frequency: Span × Smoothing aperture (%) (The smoothing aperture is set between 20 to 2/MEP × 100 %.)
	Dynamic accuracy		Phase characteristics measurement dynamic accuracy/360 × Aperture frequency
Sweeps	Frequency sweep		LIN (CENTER/SPAN, START/STOP), LOG (START/STOP)
	Level sweep		LIN (START/STOP/STEP)
	Measuring points		11, 21, 51, 101, 251, 501, 1001
	Sweep time		10 ms to 27.5 H
	Sweep function	Sweep range	Total sweep, partial sweep, list frequency sweep
		Sweep control	REPEAT, SINGLE, STOP/CONT
Markers	Markers		Up to 10 independent markers allow in each trace.
	Marker functions		NORMAL MKR ΔMKR 0 MKR MKR→MAX MKR→MIN MKR→CF ΔMKR→SPAN MKR→OFFSET MKR→+PEAK MKR→−PEAK MKR TRACK +PEAK MKR TRACK −PEAK
	Frequency markers		Marker points is set with frequencies.

Measurement item			Specification
Markers	Feature extraction		Pressing measuring point keys allows the following features to be extracted: 0: OFF 1: MIN 2: MAX 3: P−P 4: MEAN 5: σ (Sigma) 6: 1st +PEAK 7: 1st−PEAK 8: NEXT+PEAK 9: NEXT−PEAK 10: Total POWER 11: CMP (ZONE) 12: CMP (MKR) 13: PEAK FREQ 14: 1 dB COMP 15: X dB BW 16: X dB FREQ 17: X deg FREQ 18: Ripple 1 19: Ripple 2 20: Ripple 3 21: Ripple 4
Others	Averaging	Method	SUM, MAX, MIN
		Times	1 to 1000
	Measurement data memory		Trace A memory (XMA): 1,001-point complex data Trace B memory (XMB): 1,001-point complex data Trace A submemory (SMA): 1,001-point complex data Trace B submemory (SMB): 1,001-point complex data
	Auto-scaling		Independent traces A/B
General electrical specifications	Automatic setting		Resolution bandwidth, Sweep time
	Calculations		Complex number I/O arithmetic operations Conjugate complex numbers
	Function memory		Up to 10 functions are stored in PMC.
	Hard-copying	Video plotting	Display images are copied to a video plotter using separate video output.
		Direct plotting	Display images are copied to a plotter or printer via GPIB.
	Probe power supply		+12 V, 200 mA max. (with a protective circuit against shorts)
	Rear panel I/O		Reference oscillator input Frequency: 10 MHz ± 10 Hz Level: TTL level Input terminal: BNC female Reference oscillator buffer output: 10 MHz GPIB: Conforming to IEEE-488.2. (24-pole connector) I/O port: PTA-α use (36-pole connector) Module bus: Used for external module control. Video output: Separate (DIN 8-pole) Digital RGB (9-pole D-subconnector)
	External control		GPIB: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C1 (All front-panel functions, except for the power switch, are controllable.)
	Internal controller		PTA
	Power supply		100 to 240 Vac +10 %/−15 %, ≦220 VA

Measurement item	Specification
Dimensions	222 (H) × 426 (W) × 450 (D) mm (excluding projections)
Mass	≦24 kg
Rated operating temperature range	0 to 50 °C

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SECTION 2
PREPARATIONS

This chapter explains the preparations to be completed before starting to use the MS4662A Network Analyzer, and safety precautions that need to be observed to safeguard both human bodies and equipment in completing the preparatory work and that are prerequisite to using the MS4662A. Refer to the GPIB Remote Control volume for information on GPIB cabling, address setting, etc. among the preparations.

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2.1 Installation Environmental Conditions

2.1.1 Sites to avoid

The MS4662A Network Analyzer operates normally at ambient temperatures of 0 °C to 50 °C. For optimum performance, do not use or store this equipment in the following locations:

- Where it may be subjected to strong vibrations
- Where it may be exposed to humidity or dust
- Where it may be exposed to direct sunlight
- Where it may be exposed to reactive gases

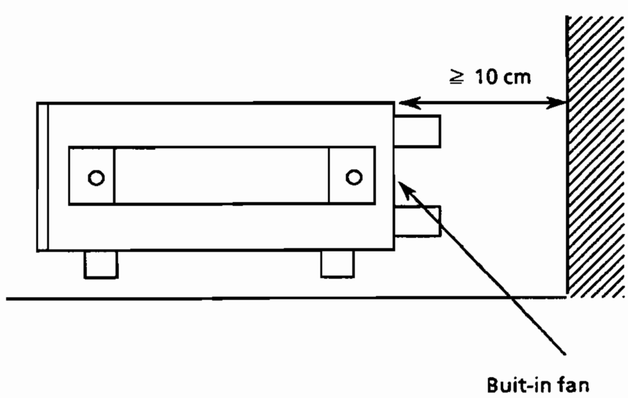
To maintain reliable operation over an extended period, in addition to meeting the conditions listed above, the MS4662A should be used at stable room temperatures and where AC line voltage fluctuations are small.

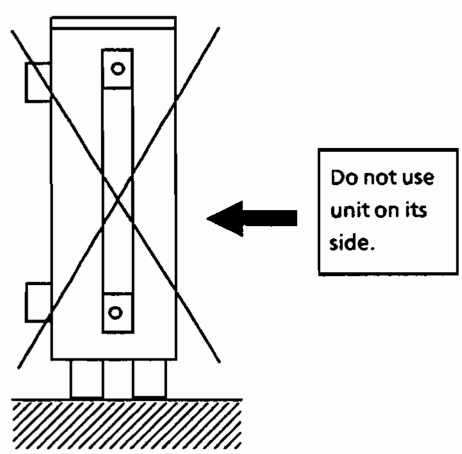
CAUTION

If the MS4662A is returned to room temperature after it been used or stored at a low temperature, such as 0℃, for a long period, condensation may occur inside the unit, causing shorts. Always ensure that the unit is thoroughly dry before turning on the power.

2.1.2 Fan clearance

To prevent any temperature increase inside the MS4662A, a cooling fan is mounted on the rear panel as shown in the following figure. Leave a space of at least 10 cm between the rear panel and walls, peripheral devices, obstructions, etc. so that air flow is not obstructed.





2.2 Safety Precautions

This subsection describes the safety precautions to be observed to protect human bodies and to avoid damage to the equipment and serious interruptions in service.

2.2.1 General safety precautions on power supplies

WARNING

- *Before turning on power: Be sure to complete protective grounding for the MS4662A. If power is turned on without protective grounding, electrical shock hazards could occur that threaten human lives or cause injuries. It is also important to check the supply voltage. The presence of any abnormal voltage in excess of the tolerable level could cause damage to the equipment or result in fire.*
- *While power is on : The unit may have to be internally checked or adjusted with the top, bottom or side cover open while it is powered on. Hazardous voltages are present inside the unit. Inadvertent contact with these voltages could cause electrical shock hazards to occur, threatening human lives or injuries. Refer servicing of the unit to qualified service personnel.*

Some of the remarks on safety precautions found in later chapters are reproduced below. Read these remarks beforehand to help prevent accidents.

2.2.2 Electrostatic effects on I/O connectors

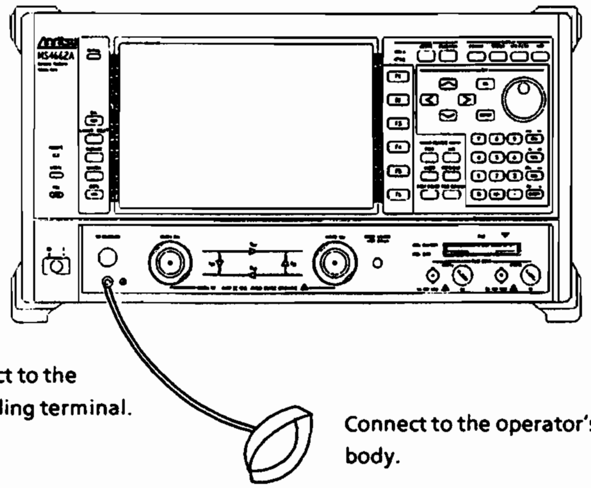
Protect those test port connectors labeled **AVOID STATIC DISCHARGE** against electrostatic effects.

CAUTION

Touching the central conductor in a connector by hand could damage the internal part through electrostatic discharge. Allow the central conductor in a cable or tester to be discharged before connecting them to a test port connector. Use of a wrist band supplied with the MS4662A is recommended to ensure that the internal circuitry is positively protected. (See "Connecting the wrist band.")

Connecting the wrist band

MS4662A front panel



Connect to the grounding terminal.

Connect to the operator's wrist or any other part of the operator's body.

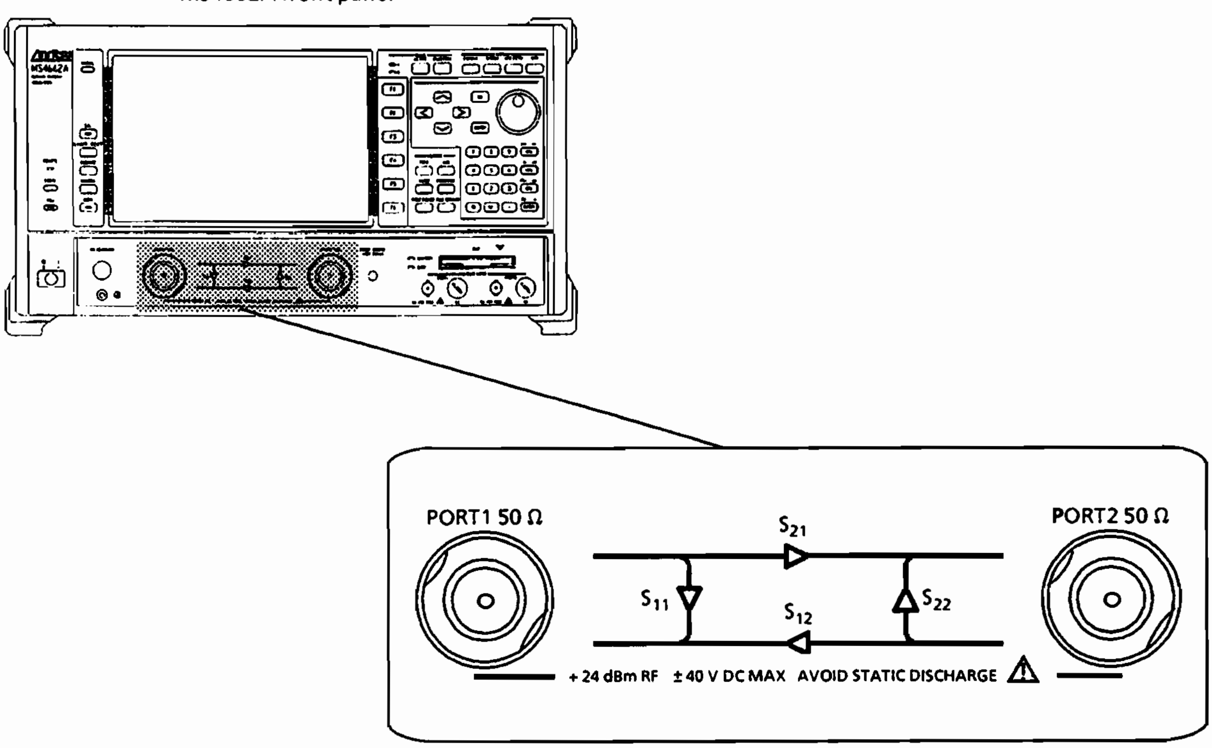
2.2.3 Test port 1 and 2 damage level

The damage level of the front-panel ports 1 and 2 is **+24 dBm RF ±40 VDC max**. Use them below this level.

CAUTION

The damage level of ports 1 and 2 is +24 dBm, ±40 VDC (1 A). The application of a signal above this level could burn the input attenuator or mixer. ⚠ is a warning mark to help prevent such damage. The test ports incorporate a DC blocking capacitor to test signals that contain DC components. In tests conducted under a high DC bias, such as 40 V, damage to the internal circuitry could also result if a spiky, momentary signal above this level, such as one occurring abruptly in the presence of load shorts or at connector attachment, is applied to the test ports. Be sure to apply the bias slowly after the measurement setup is complete. Watch also for load shorts.

MS4662A front panel



2.3 Assembly and Coupling

2.3.1 Rack mounting

When mounting the MS4662A in a rack, the optional mounting rack mounting kit B0333C is necessary. Mounting instructions are supplied with the kit.

2.3.2 Using multiple units stacked on top of each other

When units having the same width and depth as the MS4662A are stacked on top of the MS4662A, the optional connecting plate B0332 is available to ensure their coupling.

The legs of the stacked units are furnished with an automatic lock mechanism to lock the units in position automatically.

2.4 Preparations for Turning On Power

The MS4662A operates normally when it is plugged into a *** VAC ±10 % or −15 %. Before turning on the AC power to the MS4662A, take precautions to prevent:

- Electrical shock hazards
- Damage to the internal circuitry of the unit due to abnormal voltage
- Trouble caused by grounding current

WARNING and CAUTION labels are placed on the rear panel to alert users about possible hazards to protect them.

WARNING ⚠

NO OPERATOR SERVICE-ABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL.

CAUTION ⚠

FOR CONTINUED FIRE PROTECTION REPLACE ONLY WITH SPECIFIED TYPE AND RATED FUSE.

WARNING

This instrument is not customer-serviceable. Do not attempt to open the cover and tamper with internal components. Refer servicing to Anritsu trained service engineers who are familiar with the possible hazards of fires, electrical shocks and other risks. Hazardous voltages inside. Inadvertent contact or injury and damage precision components.

CAUTION

Be sure to replace with a fuse of the specified type and ratings. Use of a substandard fuse could lead to fires.

Take notice of the instructions given on the pages that follow.

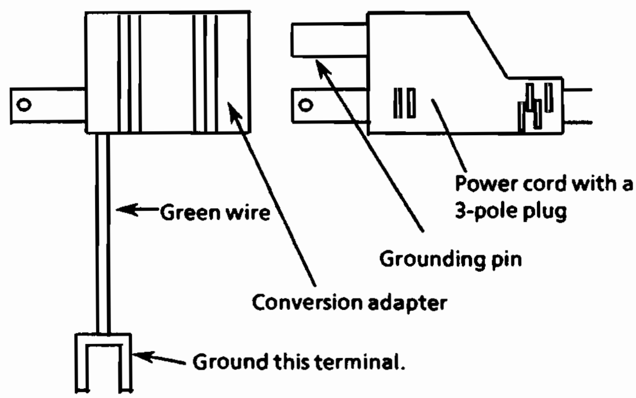
2.4.1 Protective grounding

(1) Grounding by 3-pole AC outlet

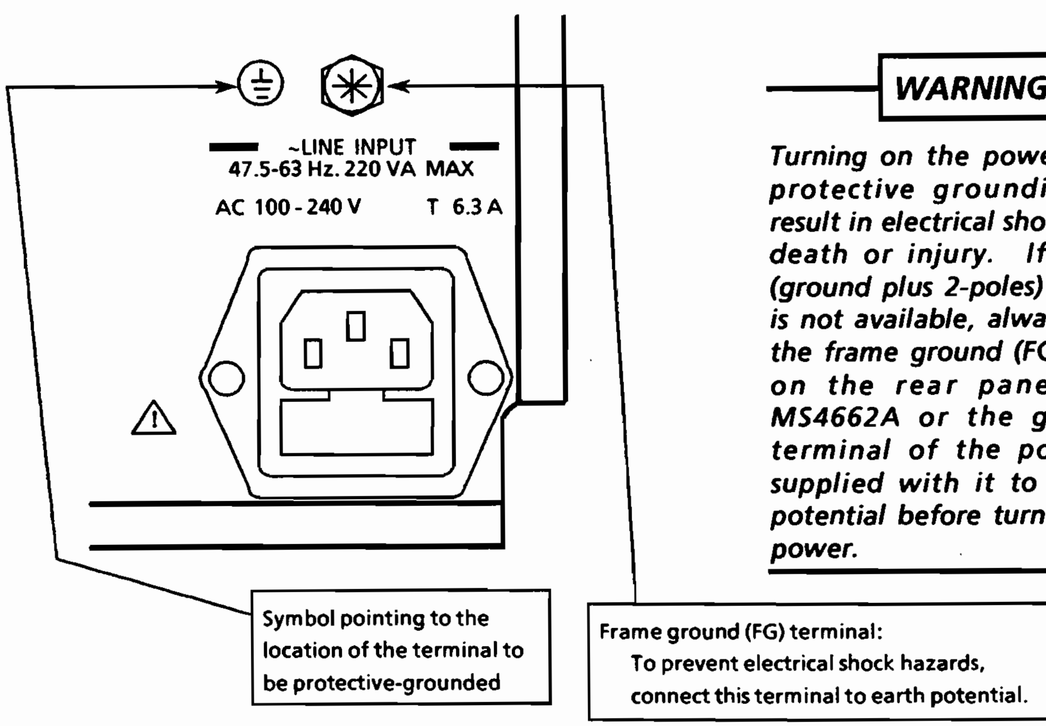
If a 3-pole (ground plus 2-poles) AC outlet is available, the MS4662A frame is connected to the earth potential when the 3-pole power cord is plugged into an AC outlet, since the plug of the power cord and the power supply match in polarity. Hence, there is no need to ground the FG terminal and use a 3-to-2-pole conversion plug.

(2) Grounding by conversion adapter

If a 3-pole AC outlet is not available, ground the tip of the green wire extending from the 3-to-2-pole conversion plug shown below.



(3) Grounding frame ground (FG) terminal



WARNING

Turning on the power without protective grounding could result in electrical shock, causing death or injury. If a 3-pole (ground plus 2-poles) AC outlet is not available, always connect the frame ground (FG) terminal on the rear panel of the MS4662A or the grounding terminal of the power cord supplied with it to the earth potential before turning on the power.

If a 3-pole AC outlet is not available and grounding by the green grounding wire is difficult to achieve, ground the frame ground (FG) terminal directly to the earth potential.

2.4.2 Fuse replacement

WARNING

- *There is an electrical shock hazard if a fuse is replaced with the power on. Before replacing a fuse, turn off the power switch and unplug the power cord from the AC outlet.*
- *There is also an electrical shock hazard if the power is turned on without protective grounding. Further, if an incorrect AC supply voltage is used, it may cause unit damage. Before turning on the power after replacing a fuse, execute protective grounding in one of the methods described earlier and check that the AC supply voltage available is correct.*

CAUTION

If a spare fuse is not available, replace with a fuse of the same type and voltage and current ratings as the one currently inserted in the fuse holder.

- *A fuse of the incorrect type may be difficult to insert into or remove from the fuse holder, or cause defective contact, delays in fusing time, and so on.*
- *A fuse of excessive voltage and current ratings may fail to blow when the unit fails, threatening fire damage to the unit.*

The MS4662A is supplied with two fuses, rated at 6.3 A, as listed in the standard configuration table (☞P.1-5) on a standard configuration. These fuses are used enclosed in fuse holders.

Before replacing a fuse after the occurrence of a failure, determine and remove the cause of the failure first.

Only after these precautions are taken, replace the fuse by following the steps below.

Step	Procedure
1	Set the front panel POWER switch to OFF and unplug the power cord from the AC outlet.
2	Turn the fuse holder counterclockwise with a slotted screwdriver. Remove the cap from the fuse holder, together with the fuse.
3	Remove the blown fuse from the cap and replace it with the spare (the fuse may be inserted in any direction).
4	Refit the cap into the fuse holder and turn it clockwise until it will turn no further.

2.5 Storage Medium Handling Precautions

CAUTION

*Never remove the plug-in memory card, floppy disk or any other storage medium while the unit (MS4662A/MC8104A) is accessing them. The unit **BUSY** lamp lights to indicate that access is in progress. If the storage media being accessed are removed, stored data could be lost.*

The MS4662A uses a plug-in memory card (PMC) to store data and programs. Further, a floppy disk drive is used as an MC8104A data storage unit.

Valuable data and programs stored on the storage media could be lost if the media are handled incorrectly or fail. Backup is recommended to guard against this risk.

Anritsu will not indemnify users for the loss of stored data and programs.

Please take careful note of the instructions below in handling floppy disks and plug-in memory cards.

2.5.1 Floppy disks

CAUTION

- *Observe the specified environmental conditions. Avoid using floppy disks in a dusty place.*
- *Do not bring magnetized materials close to floppy disks nor bend disks.*

Handle floppy disks with care, because failure to observe these instructions could disable reading from or writing to the disks.

2.5.2 Plug-in memory cards (PMCs)

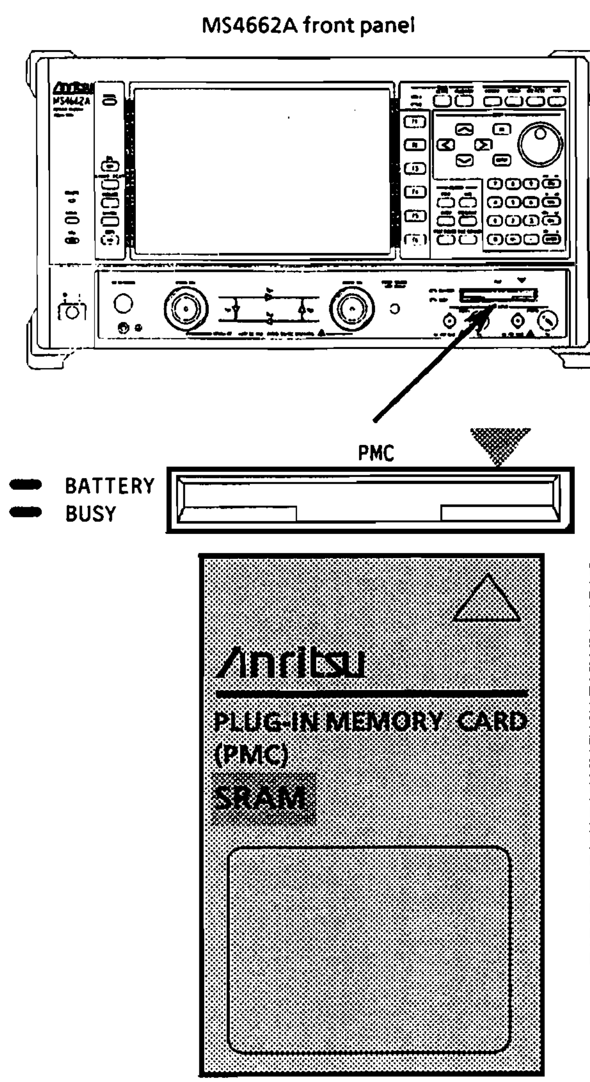
Plug-in memory cards (PMCs) are described below with regard to:

- Insertion into the MS4662A unit slot
- Care in handling
- Cap handling
- Battery loading and replacement
- Write protect switch handling

(1) Insertion into the unit slot

CAUTION

- *An attempt to force a PMC into the slot could cause damage to the PMC connector. Insert a PMC as shown below.*



① Keep the PMC with the side bearing a green triangle facing up.

② Hold the PMC level and bring it closer straight to the slot in the direction of the triangle on the PMC, making sure that it faces the triangle on the MS4662A panel.

③ Insert the PMC into the slot straight and slowly until it won't go any further.

Note: Forcing the PMC into position could damage the PMC connector.

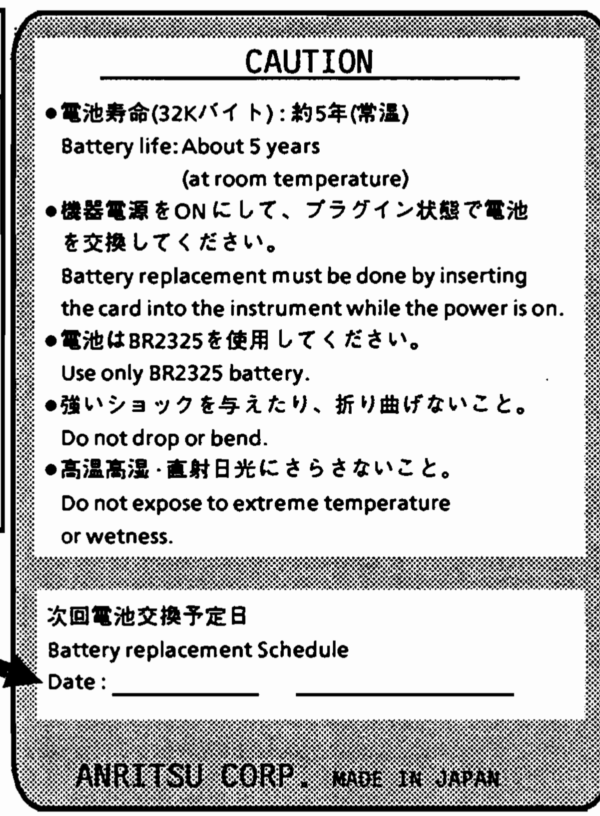
Insert the PMC into the MS4662A unit slot correctly as shown above.

(2) Care in handling PMCs

1) Do not subject the PMC to strong impacts, dropping or bending.
2) Do not expose the PMC to water.
3) Do not expose the PMC to extreme temperatures, humidity, or direct sunlight.
4) Do not insert tweezers or similar objects into the connector of the PMC.
5) Do not allow dirt or dust to enter the connector of the PMC.
6) Insert only a PMC into the unit slot and nothing else.
7) The 128 K, 256 K, and 512 K byte PMCs are not loaded with a battery when shipped. Load them with the battery supplied before using them.
8) The service lives of batteries at room temperature are listed below. When the battery is exhausted, the data stored on the PMC is lost. Be sure to replace the battery before it is exhausted. On the back of each PMC is a space for entering the date on which battery replacement is due, as shown below. After loading a battery for the first time, enter the scheduled date of battery replacement in this space.

PMC type	Memory size	Battery life	Battery used
BS32F1-C-172	32 KB	About 5 years	BR2325
BS64F1-C-173	64 KB	About 5 years	
BS128F1-C-174	128 KB	About 4.3 years	
BS256F1-C-1175	256 KB	About 2.2 years	
BS512F1-C-1176	512 KB	About 1.1 years	

After loading a battery, enter the scheduled date of battery replacement in this space.

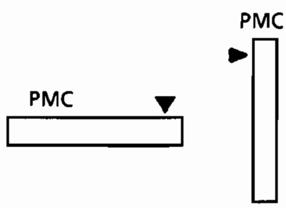


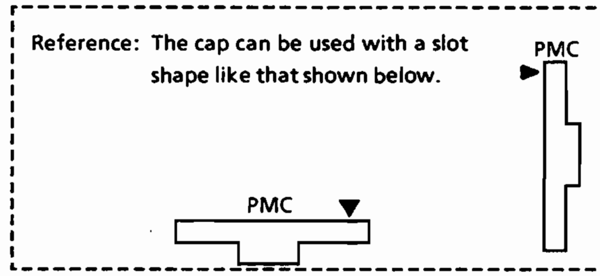
The MS4662A has a red **"Battery"** lamp to monitor the voltage of the built-in battery. When this lamp lights, replace the battery immediately.

(3) Cap handling

Keep the cap normally on, since it serves to prevent the insertion of a PMC in the wrong direction. The cap, however, must be removed in the following situations:

- When the PMC insertion slot on the unit side has the shape shown below.

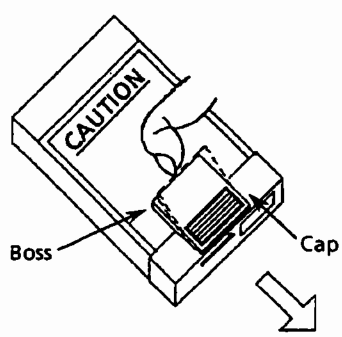




- Remove the cap temporarily when loading or replacing the battery.

[Removing the cap]

The cap can be easily removed with the back of the PMC (labeled with CAUTION) facing up.



Move the cap in the direction of the arrow while lifting up the boss on the cap slightly (along the dotted lines).

(4) Battery loading and replacement

■ Loading the battery (for SRAM only)

Before using a PMC, be sure to load the lithium battery supplied.

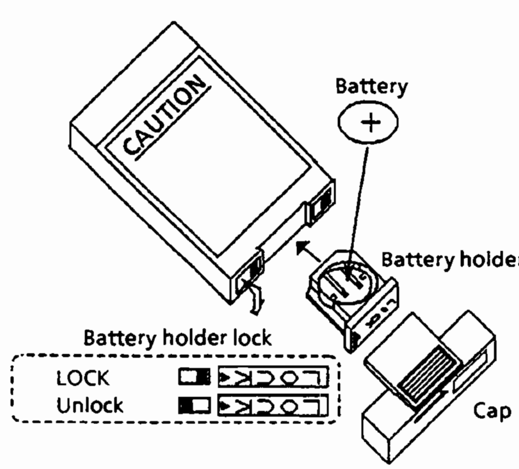
Load the battery with the back of the PMC (labeled with CAUTION) facing up.

① Remove the cap from the PMC.

② Unlock and pull out the battery holder.

③ Set the battery in the battery holder with the + side facing up.

④ Insert the battery holder into the PMC and lock it, then attach the cap to the PMC.

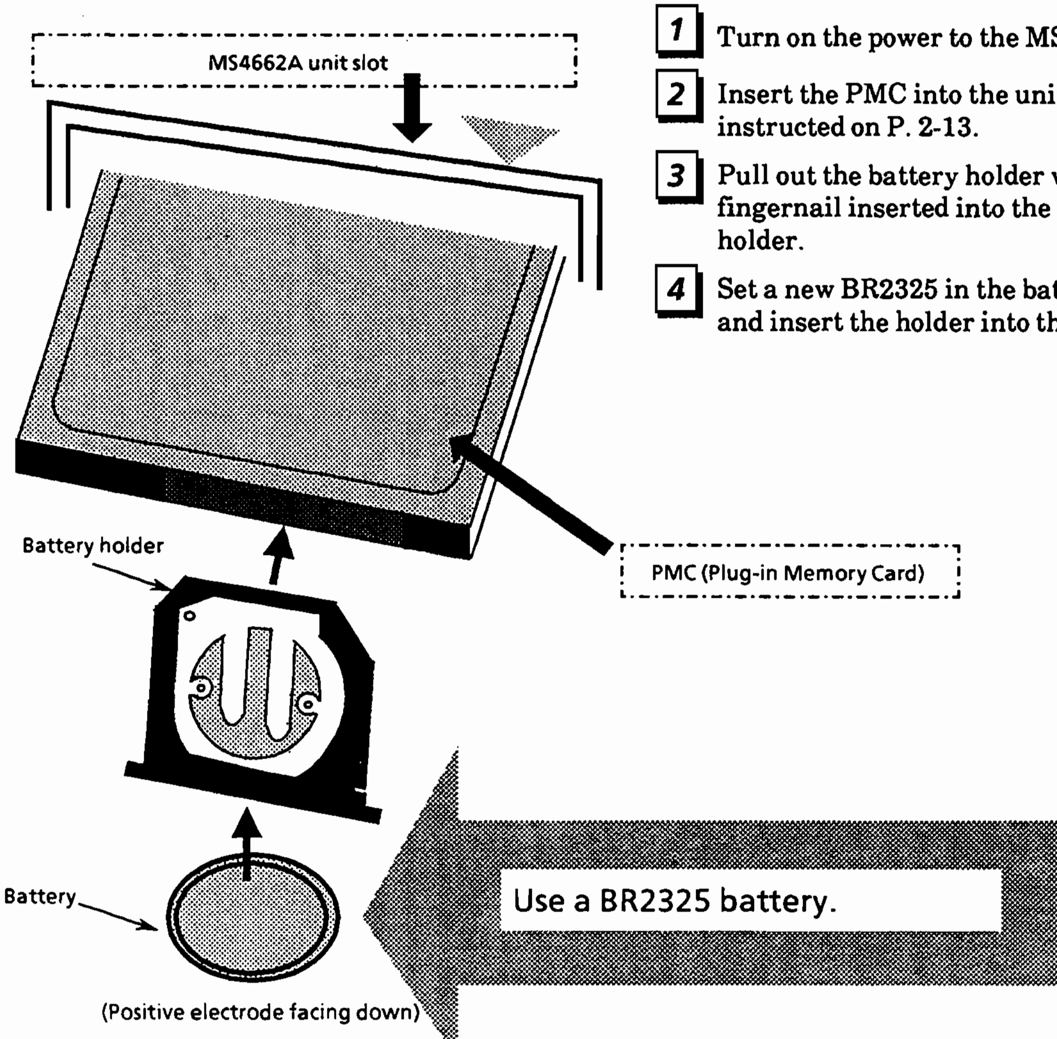


■ Replacing the battery (for SRAM only)

<u>Turn on the power to the unit and insert the PMC in the unit when replacing the battery.</u>

Data stored on the PMC will be lost if the battery is replaced in any other way.

Step	Procedure
1	Prepare a lithium battery.
2	Turn on the power to the unit.
3	Remove the cap from the PMC and insert the PMC into the unit (aligning the ▼ marks with each other).
4	Unlock the battery holder.
5	Pull out the battery holder and replace with a new battery.
6	Insert the battery holder into the PMC and lock it.
7	Take out the PMC from the unit and then attach the cap to it.



1 Turn on the power to the MS4662A.

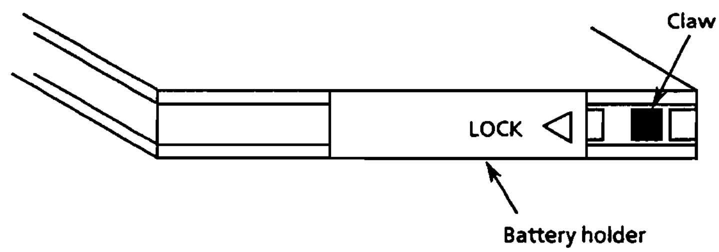
2 Insert the PMC into the unit as instructed on P. 2-13.

3 Pull out the battery holder with a fingernail inserted into the groove in the holder.

4 Set a new BR2325 in the battery holder and insert the holder into the PMC.

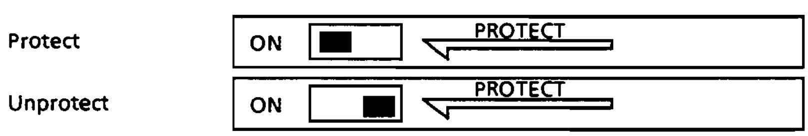
■ Locking the battery holder

The PMC battery holder has a lock claw as shown below. Slide the claw to the left with the tip of a ballpoint or similar object to lock the battery holder.



(5) Write protect switch handling (for SRAM only)

The unit is shipped with the write protect switch set to the unprotect position. To enable protection, move the switch to the ON position with the tip of a ballpoint or similar object.
Keep the write protect switch set to the unprotect position if protection is enabled by software installed in the unit.



SECTION 3
BASIC OPERATING INSTRUCTIONS

This chapter provides basic operations on the MS4662A Network Analyzer for those users who use the unit for the first time. The scope of these basic operating instructions is limited to a minimum necessary to allow the users to develop a quick, easy understanding of the basic operations and performance of the MS4662A.

More detailed operating instructions can be found in Section 4 and later.

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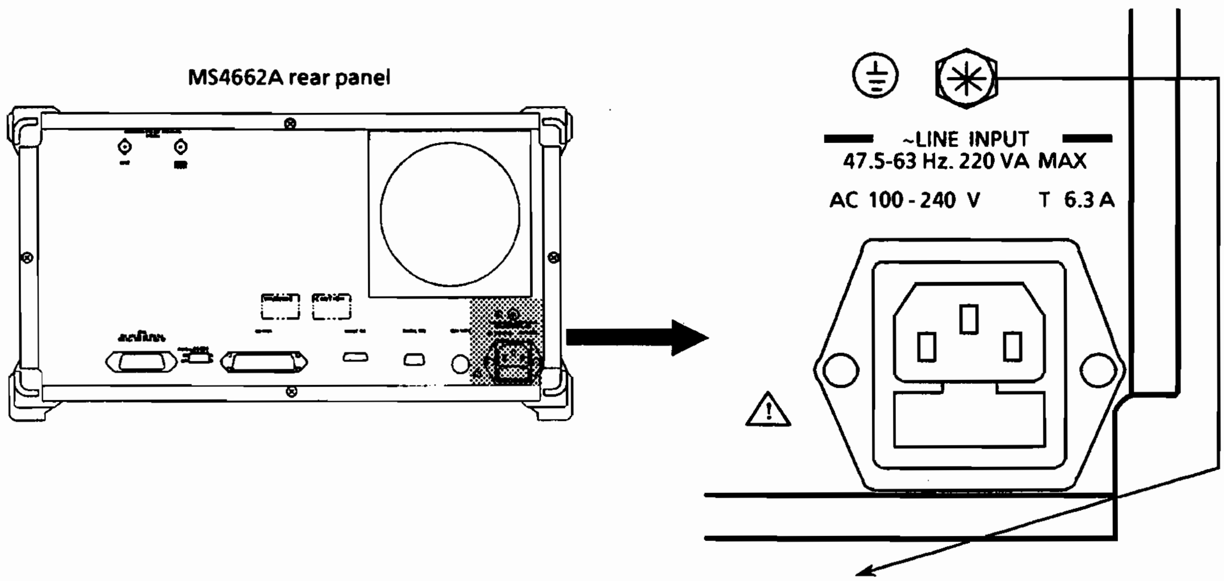
3.1 Initial Power-on

Before turning on power to the MS4662A Network Analyzer, provide protective grounding as a safety precaution as directed in Section 2.2 (→P.2-4) and then insert the power cord supplied into an AC outlet.

WARNING

Turning on the power without protective grounding could result in electrical shock, causing death or injury. If a 3-pole (ground plus 2-poles) AC outlet is not available, always connect the frame ground (FG) terminal on the rear panel of the MS4662A or the grounding terminal of the power cord supplied with it to the earth potential before turning on the power.

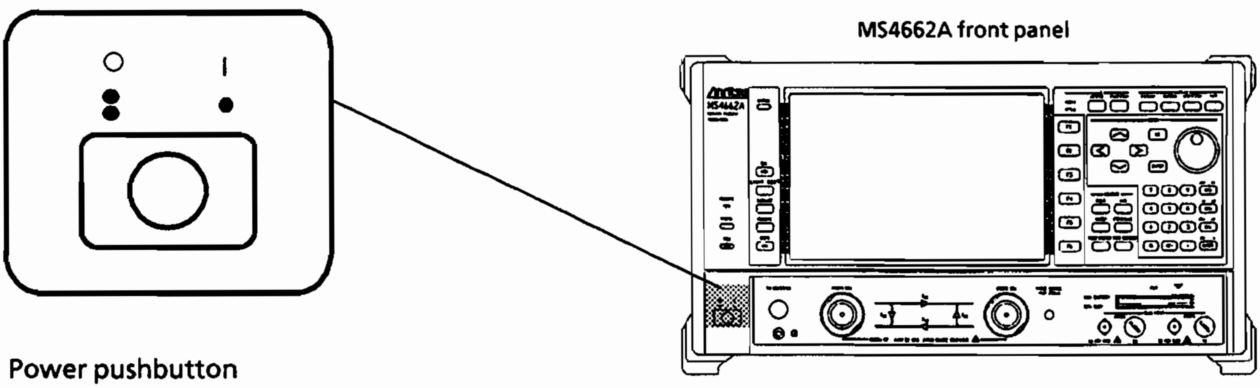


Frame ground (FG) terminal:
To prevent electrical shock hazards, connect this terminal to earth potential.

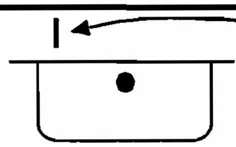
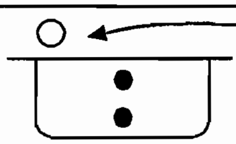
CAUTION

An improper AC supply voltage could cause damage to internal circuitry of the unit due to abnormal voltages. Before turning on the power to the MS4662A, check that the AC supply voltage is suitable (nominal + 10 %, − 15 %; not exceeding 250 V).

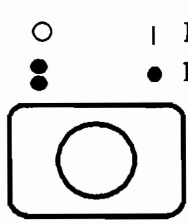
The MS4662A power switch is located at the position shown below. It has two symbols, **I** and **O**, to indicate that the power is on and off, respectively.

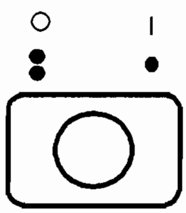


Power pushbutton

	**ON** symbol	Power is turned on when the pushbutton is depressed. Power is available to all the circuits in the MS4662A, making it ready for use.
	**OFF** symbol	Power is turned off when the pushbutton is ejected, turning off the AC power to the MS4662A.

<Initial power-on procedure>

Step	Procedure	Point to check
1	Connect the rear-panel FG terminal to earth potential.	• There is no need for grounding if a 3-pole power cord with a grounding terminal is used.
2	Measure the AC supply voltage at the AC outlet with an AC voltmeter.	• Check that the AC voltage is in the range of the rated voltage +10 % or −15 %.
3	 Push the front-panel power switch to **OFF**.	• Power is turned on when the pushbutton is depressed. Press the pushbutton again in this state to eject it.

Step	Procedure	Point to check
4	Insert the jack of the power cord into the rear-panel **AC inlet**.	• Insert the jack of the power cord until it won't go any further.
5	Insert the plug of the AC cord into the **AC outlet**.	
6	 Turn **ON** the front-panel pushbutton switch.	• Power is turned on when the pushbutton is recessed. Power is available to all the circuits in the MS4662A, making it ready for use. • The display brightens up, showing a power-on initial setup screen (see the next page). • Either the TRACE-A or TRACE-B indicator lamp lights. • The rear-panel fan starts running to discharge heat output from inside the MS4662A.

3.2 Screen Display

The MS4662A, when powered on, runs a self-test, with the screen displaying the status and result of the self-test. If the MS4662A succeeds in the self-test, it reproduces the same screen and setup panel with which the MS4662A was powered off the last time.

- Screen display self-test .... Execution of self-diagnostics and result display
- Initial setup trace screen .... Default setup screen
- Power-on display screen .... Reproduction of the status in which the MS4662A was powered off the last time.
- Measurement mode selection screen .... Measurement mode selection (power-on screen used for mode selection)

3.2.1 Screen display self-test

(1) When the MS4662A succeeds in the self-test

"RUNNING" is displayed to the right of every → symbol.

All panel lamps are on.

```
     MS4662A SELF TEST

   MAIN CPU → RUNNING
   DISP CPU → RUNNING
   MEAS CPU → RUNNING
```

(2) When the MS4662A fails the self-test

"STOPPED" is displayed to the right of any → symbol. Even if the display CPU is abnormal, nothing appears on the screen display. Hence, the screen appears in any one of the following ways when the MS4662A fails the self-test:

```
     MS4662A SELF TEST

   MAIN CPU → STOPPED
   DISP CPU → RUNNING
   MEAS CPU → RUNNING
```

```
MS4662A SELF TEST

MAIN CPU → RUNNING
DISP CPU → RUNNING
MEAS CPU → STOPPED
```

```
MS4662A SELF TEST

MAIN CPU → STOPPED
DISP CPU → RUNNING
MEAS CPU → STOPPED
```

Note: If "STOPPED" is displayed or nothing appears on the screen display, call the Anritsu head office, a branch, office, representative office, or the Service Section, Inspection Department, Measuring Instrument Division, Atsugi Office for repair. Their addresses and telephone numbers are found on the back of this volume.

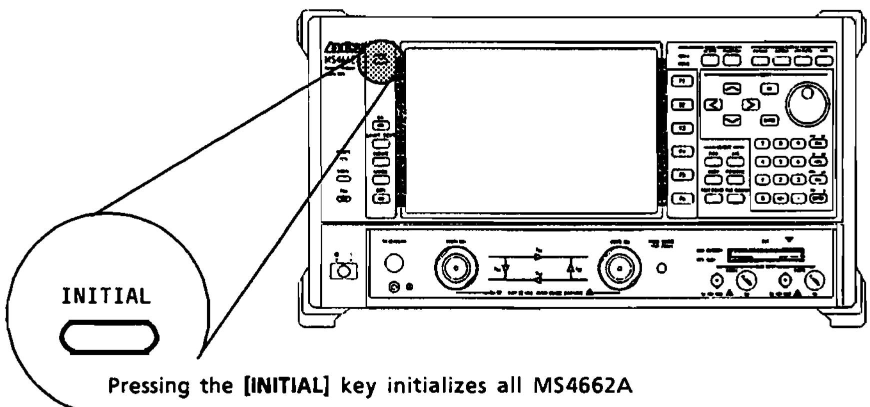
When requesting service, please state:

- The name of the unit and the serial number indicated on the rear panel
- A description of the failure
- The name of the representative, and the contact confirming the conditions of the failure and receiving a notice of completion of repair.

3.2.2 Initial setup trace screen

If the MS4662A succeeds in the self-test, it reproduces the backup trace panel and parameters with which the MS4662A was powered off the last time. Here, the initial setup screen is displayed. Pressing the INITIAL key in the circle shown below initializes the MS4662A measurement parameters to their defaults.

MS4662A front panel



Pressing the [INITIAL] key initializes all MS4662A measurement parameters to their defaults, except for certain backup parameters.

Initial Setup Operation

Initialization by the INITIAL key does not affect the parameters listed below. All these parameters are backed up.

(1) GPIB interface conditions

- Unit GPIB address
- MC8104A data storage unit GPIB address
- GPIB port timeout value
- GPIB port terminator

(2) Printer/plotter setup conditions

- Paper size (A3/A4)
- Output position (center, upper left, upper right, lower left, lower right)
- Output items (all items, trace only, scale only)
- Equipment address
- Model selection (HP-GL, GP-GL, UA-455A, VP-800, 2225, DSU)

Note: DSU = Digital storage unit MC8104A

(3) Storage unit drive selection

- Internal PMC
- DSU PMC1, DSU PMC2
- DSU FD

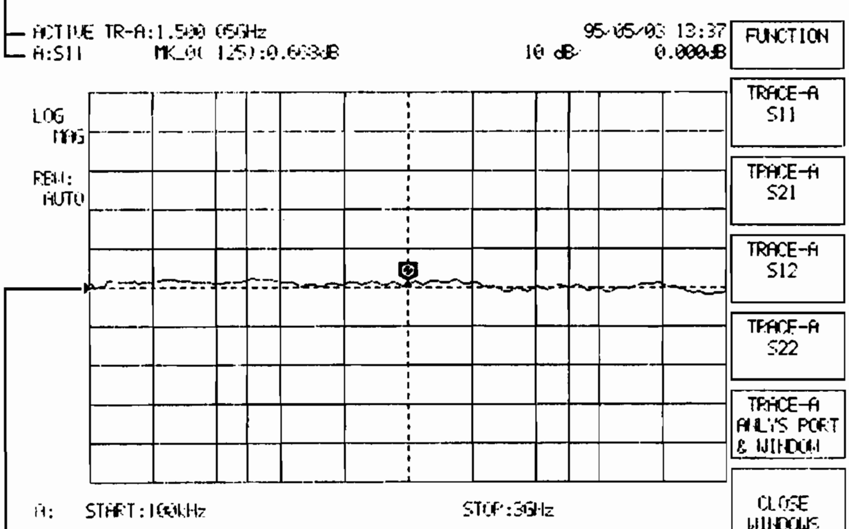
(4) Color specification parameters

(5) External module parameters

In the initial setup trace screen, channel A is active, with the S parameter S11 trace screen on display. Hereafter, the S parameter S11 trace screen is referred to as a standard initial setup trace screen. (For details on the initial setup parameters, see Appendix A, "Default List".)

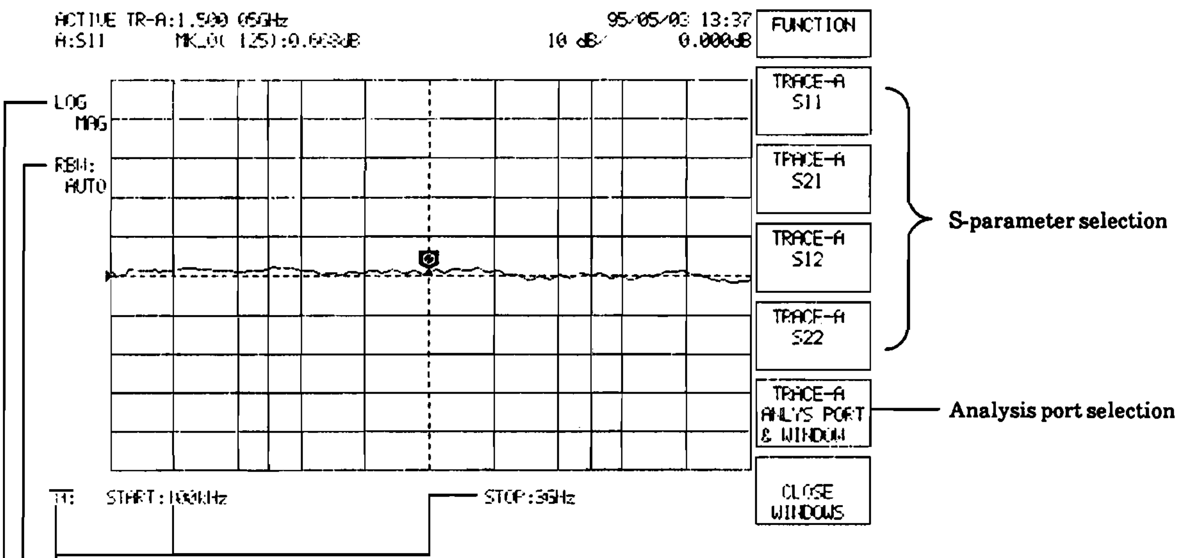
Lamp A lights, indicating that the channel trace is active.

- **ACTIVE TR-A:** Indicates that the frequency of the active marker point associated with active trace A is 1.5005 GHz. Pressing the ACTIVE key switches the display to trace B (see the next page).
- Indicates date and time. Does not indicate when title is on (described later).
- **A: S_{11}** —— Indicates that the channel A measurement mode is S_{11}.
- **MK_0 (125): 0.668 dB** —— Ten different markers, numbered from 0 to 9, are available. Among them, marker 0 is currently active. MK-0 at point 125, with the S11 measurement value being 0.668 dB.
- **10dB/:** Indicates that the vertical screen scale is 10 dB per division.
- Upper right **0.000 dB:** Offset value, indicating that the centerline on the Y-axis scale is 0 dB, which is called the offset line. The ▸ mark points to the location of the offset line.



▸ indicates the location of the offset line. In initial status, ▸ is positioned at the center of the Y-axis, with an initial offset line of 0 dB and a Y-axis scale division of 10 dB. Hence, the screen is at 50 dB at the top and −50 dB at the bottom.

Initial Setup Trace A Screen (1/2)



Indicate that the START sweep frequency and the STOP sweep frequency in trace A are 100 KHz and 3 GHz, respectively. Press the FREQ key in the panel MEASURE section to enable sweep frequency setting.

RBW: AUTO: Resolution bandwidth setting. AUTO sets an optimal resolution bandwidth automatically to suit the sweep time. Press the AVG key in the panel MEASURE section and select the softkey TRACE-A, B RBW. Then, turning the ENTRY knob permits selecting a resolution bandwidth between 3 and 10 kHz in 1-3 step.

LOG MAG: Indicates that the data graph is in a LOG MAG (logarithmic magnitude graph) format. Press the FORMAT key in the panel DISPLAY section to change the data graph to any other format (LOG MAG, PHASE, IMPD, ADMT, LIN MAG, REAL, IMAG, POLAR, and VSWR).

Initial Setup Trace A Screen (2/2)

3.3 Abbreviations Appearing on the Panel and Screen

The full spellings and meanings of the abbreviations appearing on the panel and display screen are listed alphanumerically below.

Abbreviation	FULL
ADMT	Admitance
ADRS	Address
AMP	Amplitude
AUTO	Automatic Setting of Predefined Measurement Conditions
AVG	Averaging for S/N Improvement
BAT, CHK	Battery Check
BS	Back Space
BUFF	Buffer
CF	Center Frequency
CHR. ENT	Character entry
CMP	Compare
COMP	Compression
COMP	Composite type Video signal
CONJ	Conjugate
D	Destination
deg	degree
DET	IF Detection Output
DLY	Delay
DRG	Delay Range
DSP	Digital Signal Processing
DSU	Data Storage Unit
E_{DF}	Dirctivity Error in Forward direction
E_{DR}	Dirctivity Error in Reverse direction
EL	Electro Luminesence
EL	Electric length
E_{LF}	Load match Error in Forward direction
E_{LR}	Load match Error in Reverse direction
E_{RF}	Reflection frequency response Error in Forward direction
ERR	Error
E_{RR}	Reflection frequency response Error in Reverse direction
E_{SF}	Source match Error in Forward direction
E_{SR}	Source match Error in Reverse direction
E_{TF}	Transmission frequency response Error in Forward direction
E_{TR}	Transmission frequency response Error in Reverse direction
EU	Engineering Unit
E_{XF}	Isolation Error in Forward direction
E_{XR}	Isolation Error in Reverse direction
F. TBL	Frequency Table
F1~F5	Function Keys No.1~No.5
FFT	Fast Fourier Transform
FORMAT CHK	Format check
FRMR	Former
FUNC	Functions of Panel setting
GND	Ground
GP DLY	Group Delay
IFT	Inverse Fourier Transform
IMAG	Imaginary
IMPD	Impedance
INT	Internal
IRG	Input Range
L. TBL	Level Table
LIN	Linear sweep
LOG	Logarithmic sweep
LWR	Lower

Abbreviation	FULL
M/D	Magnitude/Delay Measurement
M/P	Magnitude/Phase Measurement
MAG	Magnitude Measurement
MAX	Maximum
MEAS	Measure
MIN	Minimum
MK	Marker
MKR	Marker
MP	Measurement Point
MT	Main Trace
NWA	Network Analyzer
OFS	Offset
OFS	OFFSET
oMKR	Zero Marker
OSL	Open-Short-Load
OVRLP	Over lap
PHA	Phase Measurement
PMC	Plug-in Memory Card
PRM	Parameter
PRTCT	Write Protect ON/OFF
PTA	Personal Test Automation
PW	Power
PWR	Power
R	Reference signal (Reference channel)
RBW	Resolution Bandwidth
RES	Resets Sweep
RESOL. BW	Resolution Bandwidth
RSV	Request Service
rtl	Return to local
RTL	Return to Local
RTN	Return
S	Source
SCA	Scalar
SEPA	Separated type Video Signal
SPAN	Frequency Span by Linear Sweep
ST	Sub trace or Start
START	Linear or Log Sweep Start Freqrency
STOP	Linear or Log Sweep Stop Freqrency
SWT	Sweep Time
T	Top
T	Test signal (Test channel)
TA	Test port A
TB	Test port B
TR-A	Trace-A
TR-B	Trace-B
TRK	Tracking
UNL	Unlisten
UNT	Untalk
UPR	Upper
VBW	Video Bandwidth
VSWR	Voltage Standing-Wave Ratio
ZMKL	Zone Marker Left
ZMKR	Zone Marker Right
ΔMKR	ΔMarker

(Blank)

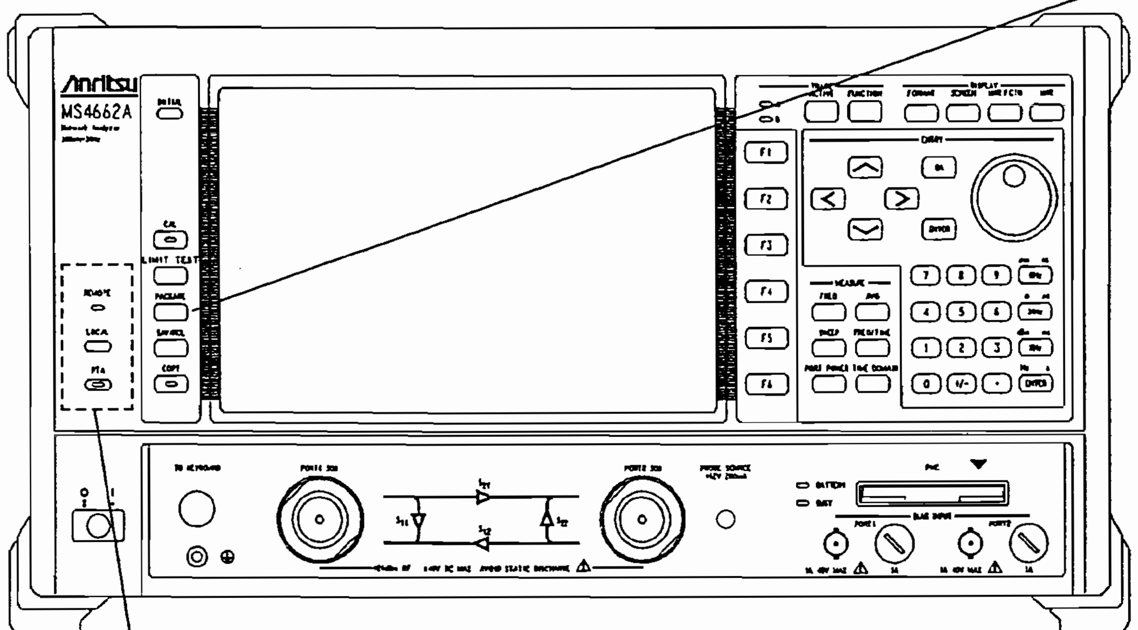
3.4 Operator Panel Function Guide

The functions available from the F1 to F6 function softkey menus are listed below (1/2).

Symbols

(1) Softkey labels with the following symbols may be changed from their present marking to the following:
- ◎ : TRACE-A, B
- ○ : TRACE-A, B, TRACE-A, or TRACE-B
- ● : TRACE
- ▲ : TRACE-A or TRACE-B
- ◇ : TRACE-A
- ◆ : TRACE-B

(2) Softkeys with the following symbols are marked with the following status characters:
- ▽ : FRMR DATA, MEASURING or CREATED
  - ① When the panel CAL key is pressed .... Frmr Data
  - ② When the softkey is pressed and executed .... Measuring
  - ③ When the execution is completed .... Created
  - ④ None of the above .... Default



<CAL, LIMIT TEST, PACKAGE, SAV/RCL>

Panel key	Function	Softkey menu F1	F2	F3	F4	F5	F6
CAL	Calibration in the X-S method • Reads CAL data (F1). • Generates final CAL data (F6).	◎TRACE-A,B X→S ▽				◎TRACE-A,B CAL PRM & WINDOW	◎TRACE-A,B CAL START
	Calibration in the single-port OSL method • Reads CAL data (F1 to F3). • Selects connector parameters (F5). • Generates final CAL data (F6).	◎TRACE-A,B OPEN ▽	◎TRACE-A,B SHORT ▽	◎TRACE-A,B LOAD ▽		◎TRACE-A,B CAL PRM & WINDOW	◎TRACE-A,B CAL START
	Calibration in the two-port OSL method • Reads CAL data (F1 to F4). • Selects connector parameters (F5). • Generates final CAL data (F6).	◎TRACE-A,B THRU ▽	◎TRACE-A,B LOAD/LOAD ▽	◎TRACE-A,B OPEN/SHORT ▽	◎TRACE-A,B SHORT/OPEN ▽	◎TRACE-A,B CAL PRM & WINDOW	◎TRACE-A,B CAL START
	Calibration in the single-path two-port method • Reads CAL data (F1 to F4). • Selects connector parameters (F5). • Generates final CAL data (F6).	◎TRACE-A OPEN ▽	◎TRACE-A SHORT ▽	◎TRACE-A LOAD ▽	◎TRACE-B THRU ▽	◎TRACE-A,B CAL PRM & WINDOW	◎TRACE-A,B CAL START
LIMIT TEST	Sets a limit line, turns on or off limit testing, turns on and off the beep, and displays evaluation results.	TRACE-A LMT SET UP & WINDOW	TRACE-A,B LIMIT TEST ON/OFF	TR-A	TR-B	BEEP ON/OFF	CLOSE WINDOW
PACKAGE	Displays a title character string, sets measurement points and breakpoints, extracts features, executes memory calculations and initialization, specifies color palette colors, and so on.	TITLE & WINDOW	○TRACE-A,B MEAS POINT & WINDOW	◎TRACE-A,B READ OUT & WINDOW	CALCULATE & WINDOW	OPTION & WINDOW	CLOSE WINDOWS
SAV/RCL	Displays the PMC file directory, and selects the recall and save formats, media, and access drives.	INDEX RCL & WINDOW	PRM RECALL & WINDOW	PRM SAVE & WINDOW	FILE MGT & WINDOW	DRIVE SEL & WINDOW	CLOSE WINDOWS
COPY	Executes and cancels hard copying.			———			

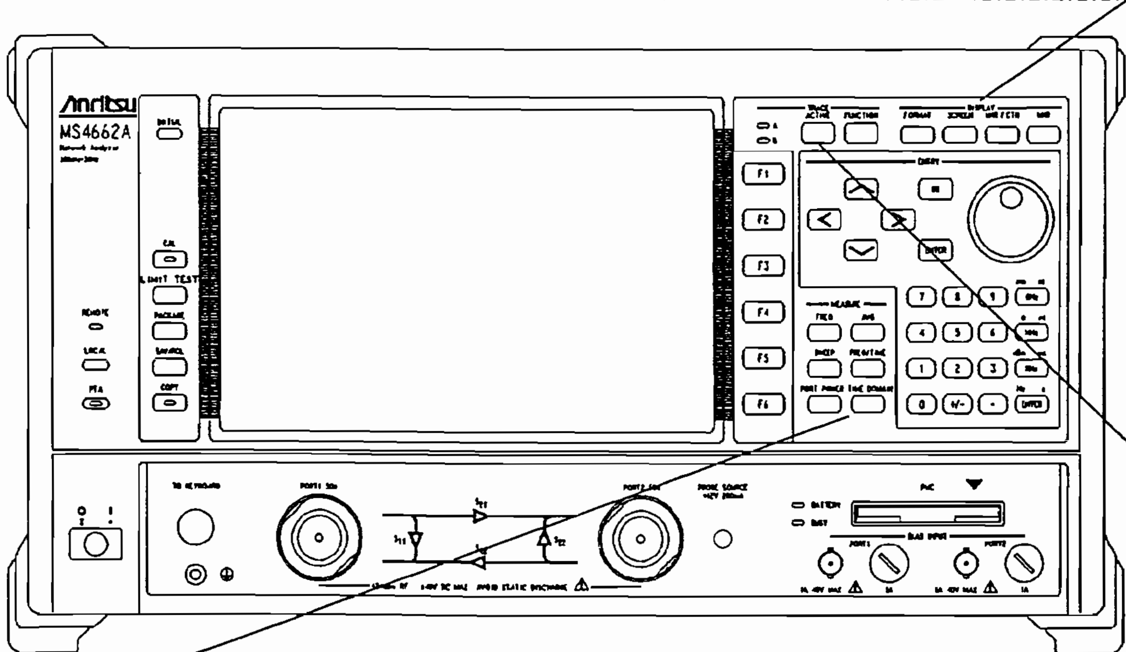
<LOCAL, PTA>

Panel key	Function	Softkey menu F1	F2	F3	F4	F5	F6
LOCAL	Sets special GPIB parameters from a panel, select copying conditions, and selects copy devices.	GPIB PORT1 & WINDOW			COPY MODE & WINDOW	COPY DVC & WINDOW	CLOSE WINDOWS
PTA	Runs, stops, restarts, and cancels a program, turns off PTA, and displays the next menu.	RUN	STOP	CONTINUE	RESET	PTA OFF	etc
	Displays a PTA file list, moves the cursor up, loads a program, runs a program, and displays the next menu.	PROG LIST	CURSOR UP	CURSOR DWN	LOAD	RUN	etc
	Defines the characters to be displayed for each function key with a DEF subroutine.	F1	F2	F3	F4	F5	etc
	Enters a YES and a NO character string, and returns to the initial menu.	YES	NO				etc

The functions available from the F1 to F6 function softkey menus are listed below (2/2).

Symbols

(1) Softkey labels with the following symbols may be changed from their present marking to the following:
◎: TRACE-A, B
○: TRACE-A, B, TRACE-A, or TRACE-B
●: TRACE
▲: TRACE-A or TRACE-B
◇: TRACE-A
◆: TRACE-B



<DISPLAY section>

Panel key	Function	Softkey menu F1	F2	F3	F4	F5	F6
MKR	Generates, moves, and turns off an active marker, expands and contracts zone markers, and turns on and off trace A and B coupling.	○TRACE-A MKR SET & MOVE	○TRACE-A ACTIVE SCROLL	○TRACE-A ACTIVE MKR OFF	○TRACE-A ZONE LEFT/RIGHT		○TRACE-A,B COUPLE ON/OFF
MKR FCTN	Sets a normal marker, displays and runs preprogrammed user-defined marker functions, and selects marker functions.	○TRACE-A NORMAL	○TRACE-A *1	○TRACE-A *2	○TRACE-A *3	○TRACE-A OTHER & WINDOW	CLOSE WINDOWS
SCREEN	Sets the Y-axis scale automatically or manually, varies the offline value, sets an electrical length, selects display styles, and erases or restores display items.	○TRACE-A AUTO SCALE	○TRACE-A SCALE	○TRACE-A OFFSET	▲TRACE-A,B EL	◎TRACE-A,B FORM & WINDOW	TRACE-A,B STORAGE ON/OFF
FORMAT	Selects the display format when TRANSFER, S21, or S12 is selected from the FUNCTION menu as a SUBFUNCTION.	▲TRACE-A LOG MAG	▲TRACE-A PHASE	▲TRACE-A POLAR	▲TRACE-A HSDLY	▲TRACE-A OTHER & WINDOW	CLOSE WINDOWS
	Selects display formats when REFLECTION, S11, or S22 is selected from the FUNCTION menu as a SUBFUNCTION.	▲TRACE-A LOG MAG	▲TRACE-A PHASE	▲TRACE-A IMPD	▲TRACE-A ADMIT	▲TRACE-A OTHER & WINDOW	CLOSE WINDOWS
	Selects the display format when BAND PASS or LOW PASS is selected from the FUNCTION menu as a SUBFUNCTION.	▲TRACE-A LOG MAG	▲TRACE-A PHASE	▲TRACE-A LIN MAG	▲TRACE-A REAL	▲TRACE-A IMAG	

<MEASURE section>

Panel key	Function	Softkey menu F1	F2	F3	F4	F5	F6
FREQ	Sets the sweep center frequency, frequency span, start frequency, and stop frequency, and selects the sweep mode.	○TRACE-A,B CENTER	○TRACE-A,B SPAN	○TRACE-A,B START	○TRACE-A,B STOP	○TRACE-A,B OTHER & WINDOW	CLOSE WINDOWS
SWEEP	Sets a continuous sweep, a single sweep, stops and restarts a sweep, and the sweep time, and turns on or off coupling.	○TRACE-A,B REPEAT	○TRACE-A,B SINGLE	○TRACE-A,B STOP/CONT	○TRACE-A,B SWEEP TIME AUTO		○TRACE-A,B COUPLE ON/OFF
PORT POWER	Selects between the port and 2 input attenuators, sets test port output, and sets power sweep parameters.	○TRACE-A,B PORT 1 INPUT ATT	○TRACE-A,B PORT 2 INPUT ATT	○TRACE-A,B TEST PORT POWER	TEST PORT PWR SETUP & WINDOW	○TRACE-A,B PWR SWEEP & WINDOW	CLOSE WINDOWS
AVG	Sets an averaging count, smoothing, group delay parameters (aperture and delay), RBW, TRACE-A, B COUPLE, AVERAGE TYPE, and so on.	○TRACE-A,B AVG NO	○TRACE-A,B SMOOTHING	○TRACE-A,B DLY	○TRACE-A,B RBW	○TRACE-A,B AVG FORMAT & WINDOW	CLOSE WINDOWS
FREQ/TIME	Selects between frequency and time domains; operable in trace A.	———					
TIME DOMAIN	Sets the display start time/distance, sets the display time/distance span, impulse/step response, gate and filter shapes, and the time/distance units.	TRACE-A GATE ON/OFF	◇TRACE-A START	◇TRACE-A SPAN		OTHER & WINDOW	CLOSE WINDOWS

<TRACE section>

Panel key	Function	Softkey menu F1	F2	F3	F4	F5	F6
FUNCTION	Selects the display format group for S-parameter measurement.	▲TRACE-A S11	▲TRACE-A S21	▲TRACE-A S12	▲TRACE-A S22		
	Selects the display format group for time-domain measurement.	▲TRACE-A BAND PASS	▲TRACE-A LOW PASS			ANLYS PORT & WINDOW	CLOSE WINDOWS
ACTIVE	Selects the display format group for the active channel (A/B).	———					

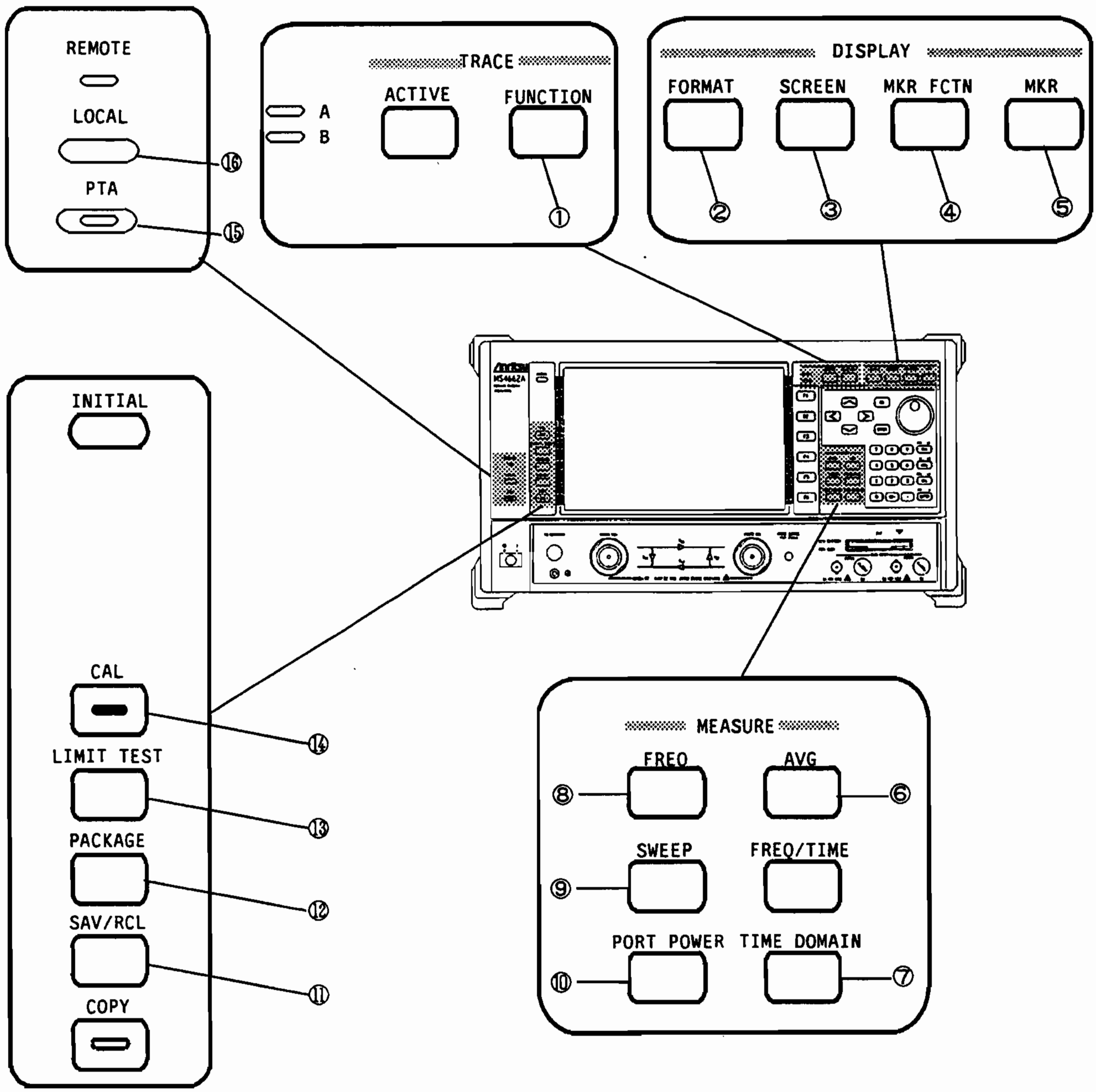
3.5 Selecting and Accepting/Executing Parameters

Parameters are displayed in the softkey labels associated with the F1 to F6 softkeys. Softkeys labeled &WINDOW have also parameters listed in the window. Desired measurement functions can be executed by selecting and accepting the relevant measurement parameters from the window with the ENTRY knob or numeric keys. The following topics are covered in this subsection:

- Menu call keys
- Example of displaying a lower-level menu and selecting parameters
- Rules of window parameter listing
- Selecting and accepting/executing parameters
- Opening and closing a window
- Using direct entry response areas
- Using entry response areas

3.5.1 Menu call keys

Pressing a menu call key on the MS4662A front panel displays the corresponding softkey menu onscreen. A total of 16 menu call keys (① to ⑯ as shown below) are placed on the panel. When one of the softkeys [F1] to [F6] associated with the softkey labels is pressed, the function defined in that label is set or executed. Window parameters are selectable from lower-level menus.



3.5.2 Changing softkey labels (TRACE-A, TRACE-B, TRACE A, B) with coupling on/off

Among the softkeys that are displayed by pressing the panel keys ① to ⑮ as described in Section 3.5.1, most softkey labels begin with TRACE-A, TRACE-B, or TRACE A, B.

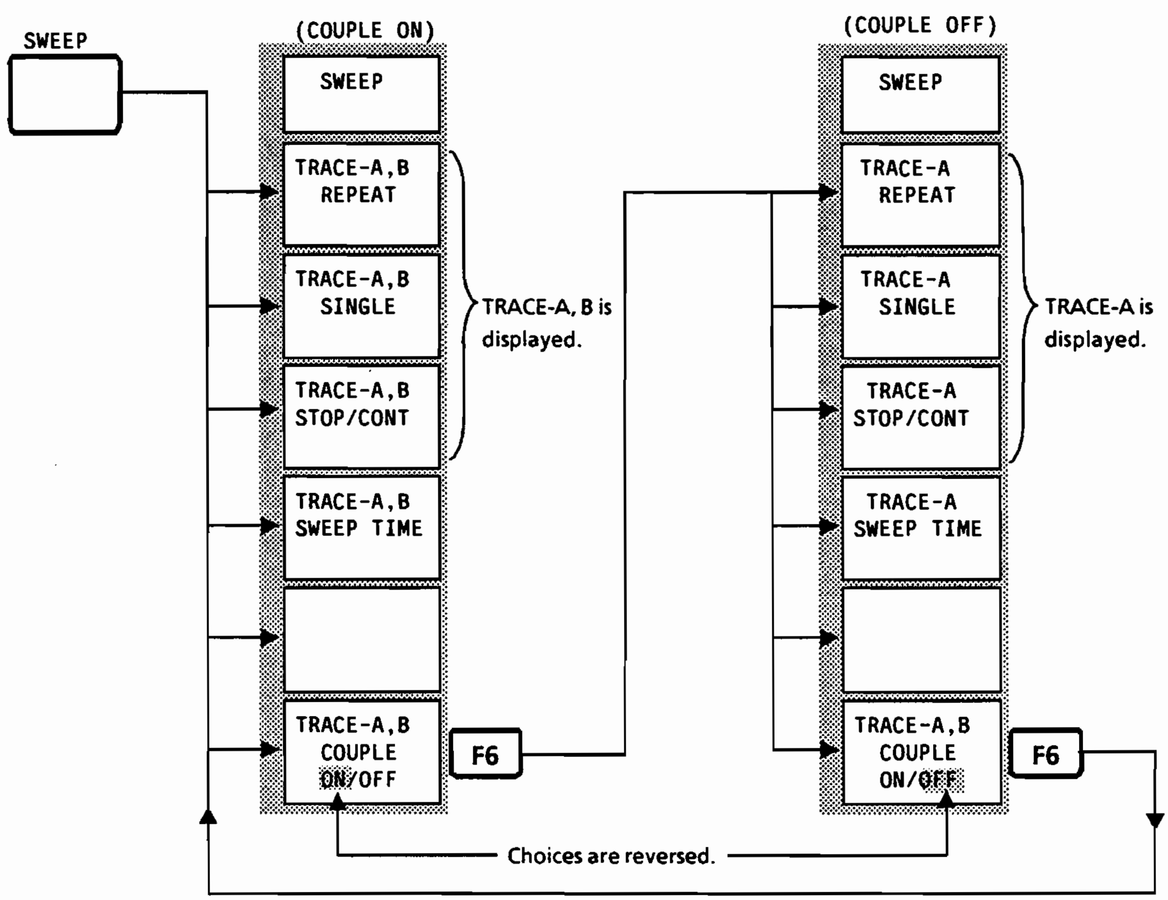
An example explains how the coupling on/off procedure determines the label from among these choices.

In menus with the softkey label TRACE-A, B COUPLE ON/OFF, the coupling function that sets trace A and B parameters to the same values can be turned on or off.

The default mode is TRACE-A, B COUPLE ON. The TRACE-A, B COUPLE OFF mode is set to set TRACE-A or TRACE-B to different parameter values as needed.

The TRACE-A, B COUPLE ON/OFF applies to other menus as well.

<Example 1: SWEEP menu for active trace A>



Note: In addition to the SWEEP menu, the FREQ and PORT POWER menus are coupled on or off.

Menus with the softkey label TRACE-A, B COUPLE ON/OFF (Panel keys)	Other menus that are coupled on or off in sync coupling with the menu at left
MKR	MKR FCTN
SWEEP	FREQ, PORT POWER
AVG	PACKAGE (MEAS POINT only), SCREEN (EL only)

3.5.3 Example of displaying a lower-level menu and selecting parameters

<Example> In S_{11} measurement, change the graph format of the display coordinate system from a magnitude graph (LOG MAG) to a polar coordinate graph (POLAR). It is assumed that the MS4662A was in the initialize mode when it was last powered off.

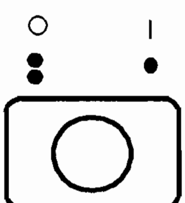
Procedural flow

STEP 1 Turn on the power switch

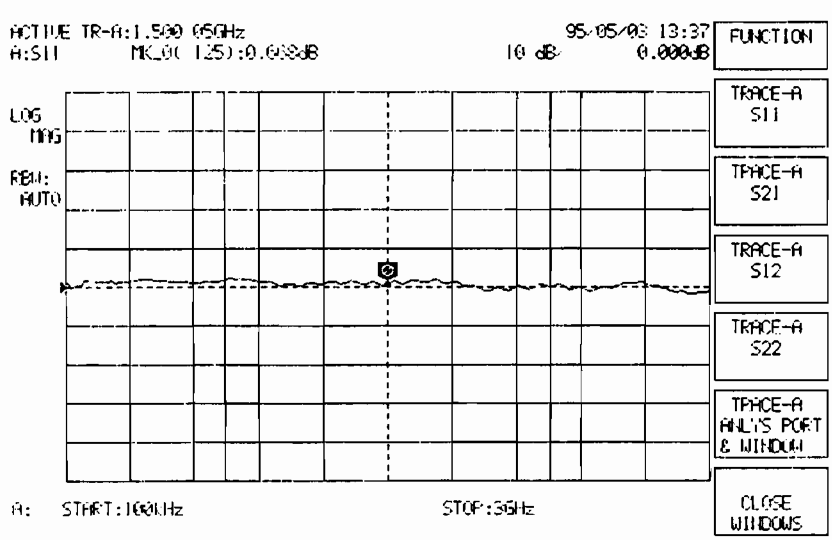
STEP 2 Display the FORMAT menu

STEP 3 Select polar coordinate display (POLAR)

STEP 1 Turn on the power switch.

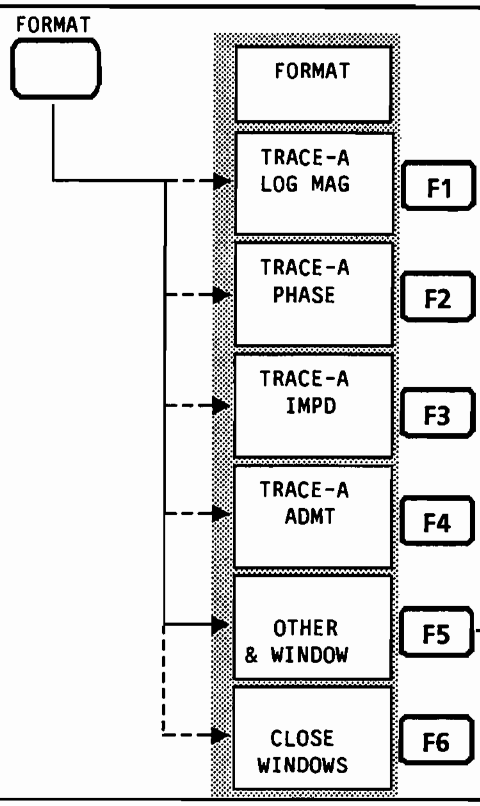


Press the power switch and a backup parameter screen (initialize screen) is displayed as shown below.

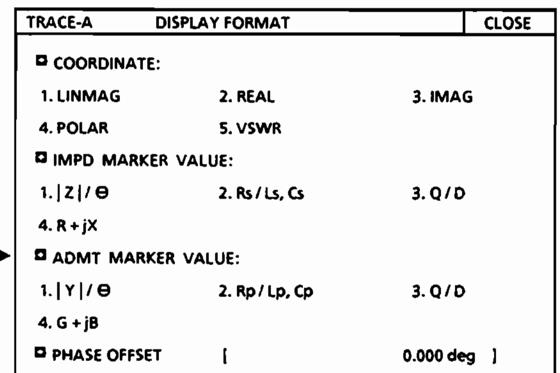


Go to next page

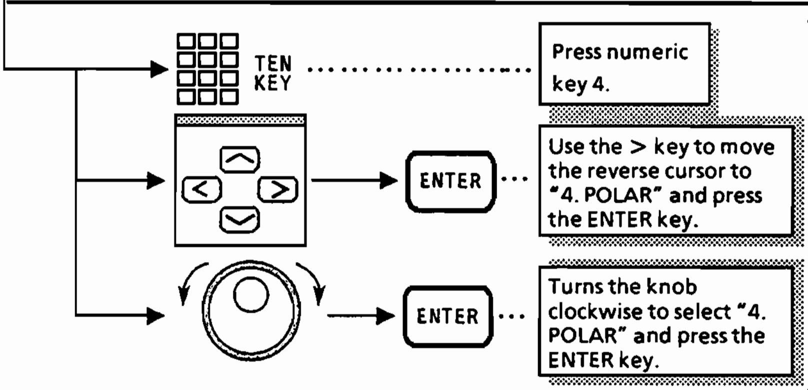
STEP 2 Display the FORMAT menu.



Press F5. The DISPLAY FORMAT window opens as shown below.

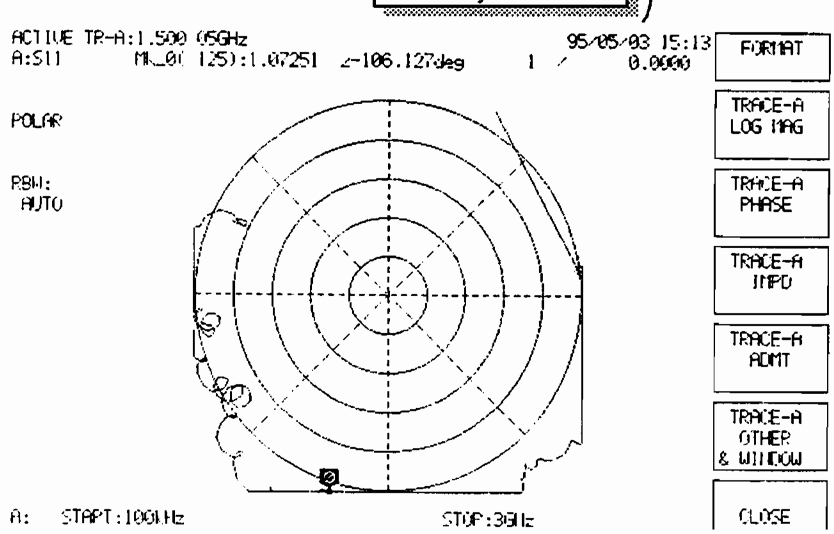


STEP 3 Select polar coordinate display (POLAR).



(1) Perform one of the three procedures described at left to select and accept "4. POLAR" in the DISPLAY FORMAT window.

(2) A polar coordinate graph (POLAR) is then displayed across the screen as shown below.

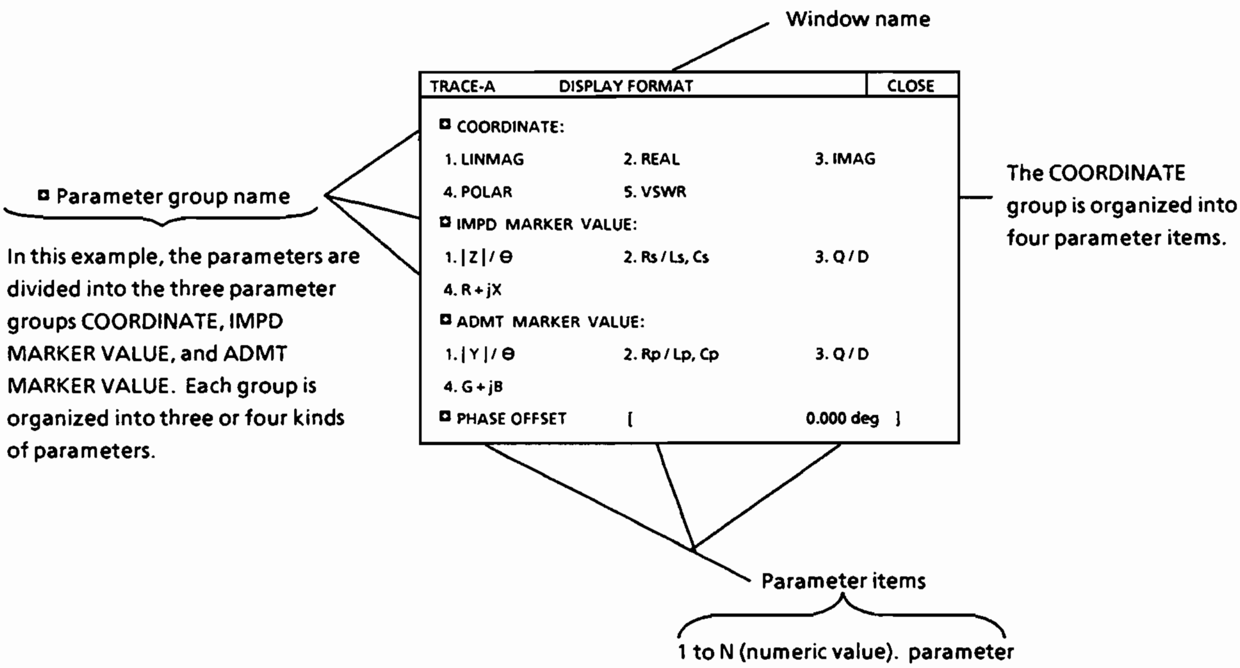


3.5.4 Rules of window parameter listing

An example window is shown below. It consists of a table of two lines, with the window title on the first line and a parameter list on the second line.

(1) Parameter group name (Grouping)

Parameters in a window are divided into several groups. Each parameter group name is headed by ◘ and terminated by a colon (:). A title that begins with ◘ is called a parameter group name or grouping.



(2) Parameter items

Each parameter group name (grouping) is organized into several parameters as explained above. If it is organized into three parameters, for example, items 1 to 3 are assigned a parameter name each; if it is organized into eight parameters, items 1 to 8 are assigned a parameter name each.

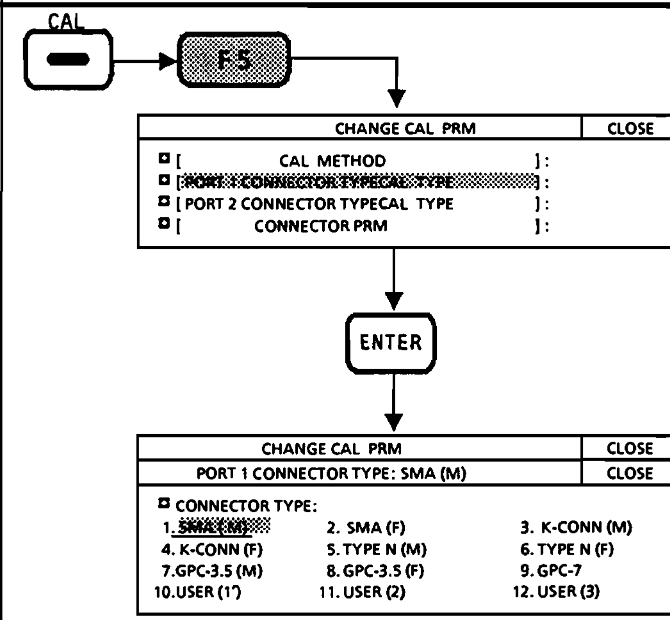
(3) Identifying accepted and nonaccepted parameters

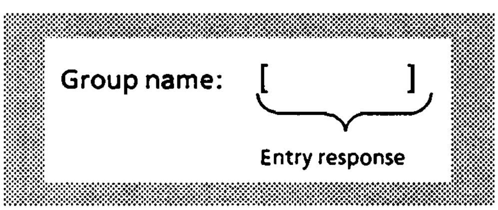
Accepted parameters are identified by an underbar under them. Parameters without an underbar under them are not accepted even if the reverse cursor points to them.

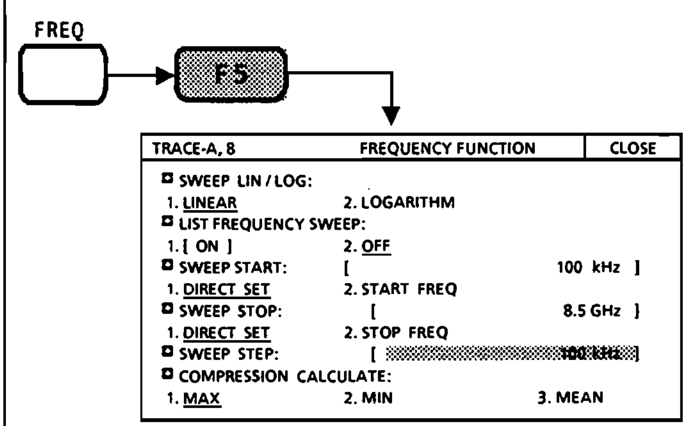
(4) Parameters enclosed in symbols

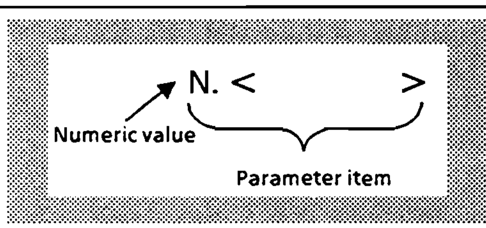
<table>
<tr><th>Symbol</th><th>Example</th></tr>
<tr><td>
Reverse cursor

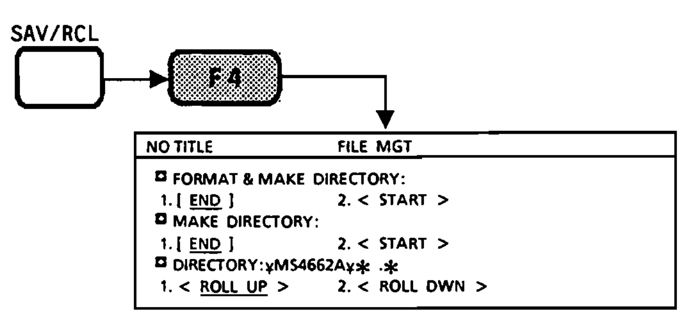
□ [Parameter group name]

When a parameter group name is enclosed in square brackets ([ ]) and the reverse cursor can be moved to it, pressing the ENTER key will open a lower-level window. In the example shown at right, press the ENTER key after moving the reverse cursor to the parameter group name [PORT1 CONNECTION TYPE], and a second-level window opens. If there is only one parameter group window in the window, a direct entry area is displayed at the lower right corner of the screen.
</td><td>


</td></tr>
<tr><td>


The space enclosed in square brackets ([ ]) that follows the colon (:) at the end of a parameter group name is called an entry response area, because numeric data is entered into that space. After selecting a parameter, accept its choice by pressing a unit key or the ENTER key.
</td><td>


</td></tr>
<tr><td>


Executable parameters that are enclosed in angle brackets (< >) are not executed until the ENTER key is pressed. These parameters cannot be executed with the ∧ and ∨ keys even when the reverse cursor points to them.
</td><td>


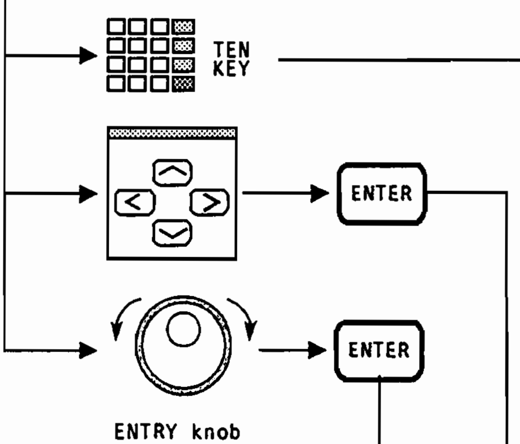
</td></tr>
</table>

3.5.5 Selecting and accepting/executing parameters

To accept and execute a parameter, move the reverse cursor to the desired parameter by using the cursor keys (<, >, ∨, ∧) , the ENTRY knob, or numeric keys in the ENTRY section and press the ENTER key. When a choice of the parameter is accepted, an underbar is drawn under it, so the parameter can be identified wherever the reverse cursor is positioned. Referring to the window introduced on the preceding page, this process is explained below.

CHANGE CAL PRM			CLOSE
PORT 1 CONNECTOR TYPE: SMA (M)			CLOSE
◘ CONNECTOR TYPE:			
1. SMA (M)	2. SMA (F)	3. K-CONN (M)	
4. K-CONN (F)	5. TYPE N (M)	6. TYPE N (F)	
7. GPC-3.5 (M)	8. GPC-3.5 (F)	9. GPC-7	
10. USER (1)	11. USER (2)	12. USER (3)	

NO TITLE	FILE MGT
◘ FORMAT & MAKE DIRECTORY:	
1. [END]	2. < START >
◘ MAKE DIRECTORY:	
1. [END]	2. < START >
◘ DIRECTORY: ¥MS4662A¥* .*	
1. < ROLL UP >	2. < ROLL DWN >



(1) One-digit parameter item numbers (upper right)
Enter a parameter item number with a numeric key and that parameter is selected and accepted without having to press the ENTER key.

(2) Two-digit parameter item numbers (upper left)
If two-digit parameter item numbers are involved, use a two-digit sequence to specify a one-digit parameter item number, from 0 to 9. To select parameter item 8, for example, type the numeric keys [0] and [8] in this order, and the choice is accepted with the reverse cursor moving to it. Enter two-digit parameter item number 10 and higher the same way as explained in (1).

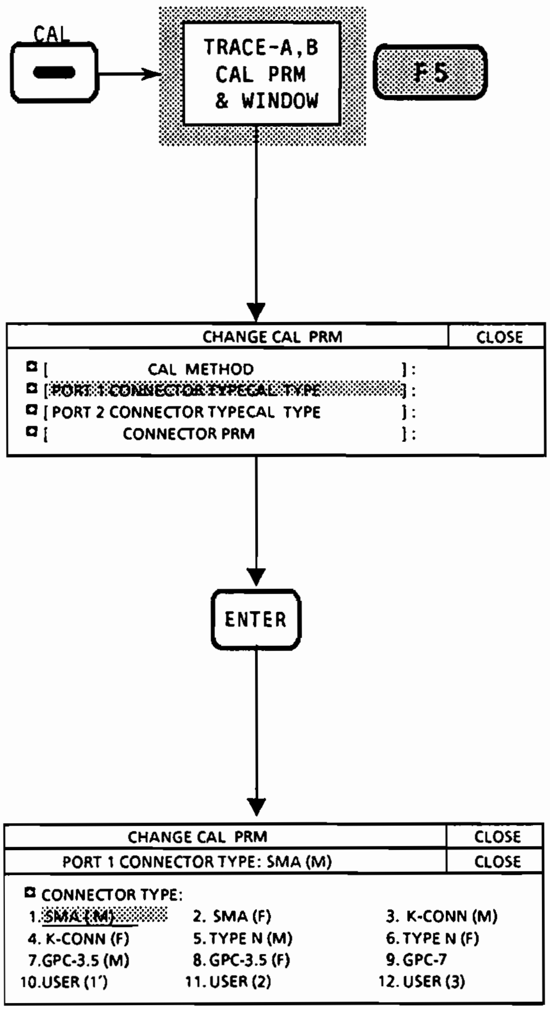
- ▼ Turn the ENTRY knob counterclockwise to move the reverse cursor to the left.
- ▼ Turn the ENTRY knob clockwise to move the reverse cursor to the right.
- ▼ When the desired parameter is selected, press the ENTER key to accept the choice.

(1) [<] and [>] keys
- ▼ Move the < key to move the reverse cursor to the left.
- ▼ Move the > key to move the reverse cursor to the right.
- ▼ When the desired parameter is selected, press the ENTER key to accept the choice.

(2) [∨] and [∧] keys
The ∧ and ∨ keys, when pressed, execute two functions as follows:
① Move the reverse cursor up or down across different groups of parameters.
② Accepts the choice of the parameter pointed by the reverse cursor. An underbar is then drawn under the parameter and the reverse cursor exist from its position.

Note: Parameters enclosed in angle brackets (< >) cannot be executed by pressing the ∧ or ∨ key. To execute these parameters, press the ENTER key or specify their parameter item number with numeric keys.

3.5.6 Opening a window



(1) Opening a window with a softkey

- To open a window with a softkey, press the softkey labeled &WINDOW.
- When the softkey labeled &WINDOW is pressed, a window having a name similar to the softkey label opens. When the new window opens:
  - Any window that has already been open closes.
  - Accepted parameters in the closed window remain, with all other parameters being canceled.

(2) Opening a lower-level window by setting parameters in a window

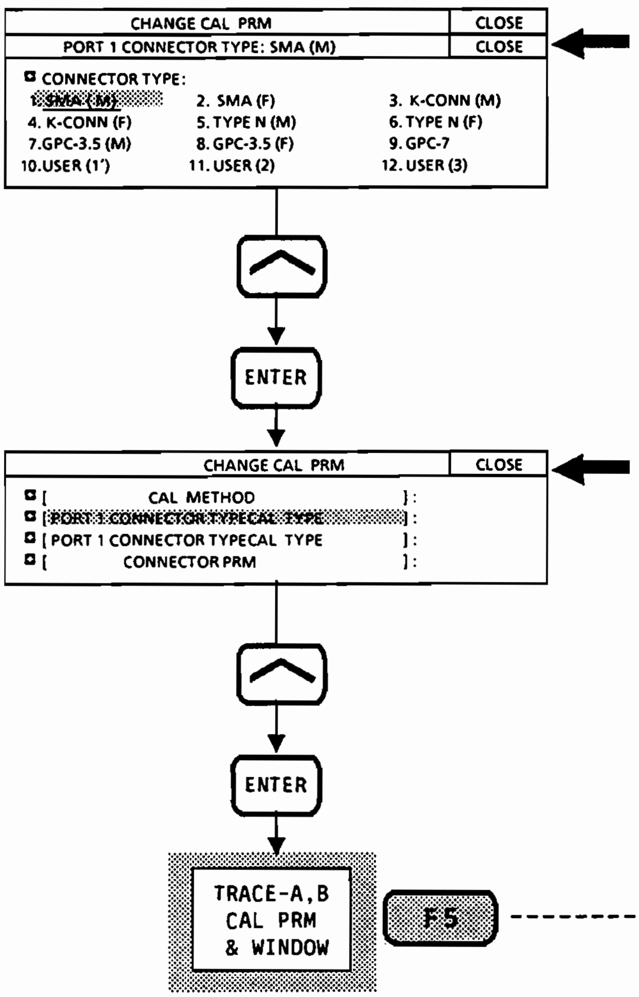
The reverse cursor is movable through the parameter group items in the CHANGE CAL PRM window shown in the figure at left, thus permitting lower-level windows to be opened from those items.

To open the PORT 1 CONNECTOR TYPE window, move the reverse cursor to the second group item from the top and press the ENTER key.

The upper-level window is cleared with only its label (CHANGE CAL PRM) appearing above the lower-level window label (PORT 1 CONNECTOR TYPE: SMA (M)).

Note: When the reverse cursor is at a group item enclosed in square brackets [ ], a choice of the parameter item selection is not accepted even when the ∧ or ∨ key is pressed. The ∧ and ∨ keys simply serve to exit from the group item and make a choice of the function. The ∧ and ∨ keys do not open a lower-level window until the ENTER key is pressed.

(3) Closing a window with the CLOSE parameter



Move the reverse cursor to CLOSE with the ∧ key and press the ENTER key to close the PORT 1 CONNECTOR TYPE: SMA (M) window.

Move the reverse cursor to CLOSE with the ∧ key and press the ENTER key to close the CHANGE CAL PRM window.

Control returns to the CAL X-S menu composed of the F1 to F6 softkeys.

Notes:
- To close all open windows and exit from them at once, press a panel key, which will display a menu that is available from invocation from the panel key.
- Windows that do not have a CLOSE parameter can be closed by selecting the CLOSE WINDOWS label (F6 softkey) in the panel key menu.

3.5.7 Using direct entry response areas

A direct entry response area is a numeric entry field that is displayed at the lower right corner of the screen, not within the current window, when a panel key or softkey is pressed. Numeric values can be directly entered into the direct entry response area by using the numeric keys or ENTRY knob. With the ENTRY knob, there is no need to press the ENTER key to conclude the entry of a numeric value in the direct entry response area.

Windows also have fields into which numeric values can be directly entered by using the numeric keys or ENTRY knob. These fields are simply called entry response areas, as opposed to the direct entry response area. (See Section 3.5.8 for more information on entry response areas.)

There are three kinds of direct entry response areas as follows:

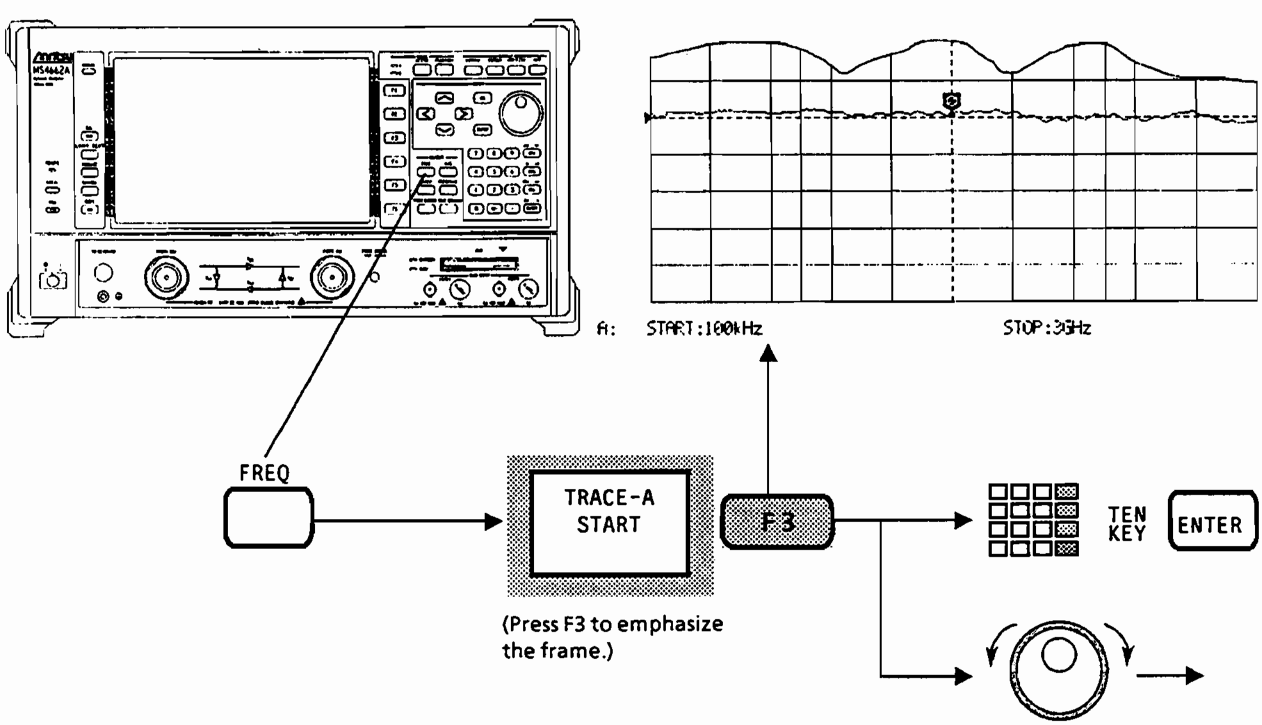
- Numeric entry field with a reverse header
- Reverse numeric entry field without a header
- Reverse numeric entry field with a header

Note: If a direct entry area has already been defined as a softkey when a panel key is pressed, the direct entry area that has been operated upon earlier is ready to accept entries. If a window is closed by selecting the CLOSE WINDOWS label, the direct entry area that has been operated upon earlier is ready to accept entries.

Examples of direct entry response areas are described below.

(1) Numeric entry field with a reverse header

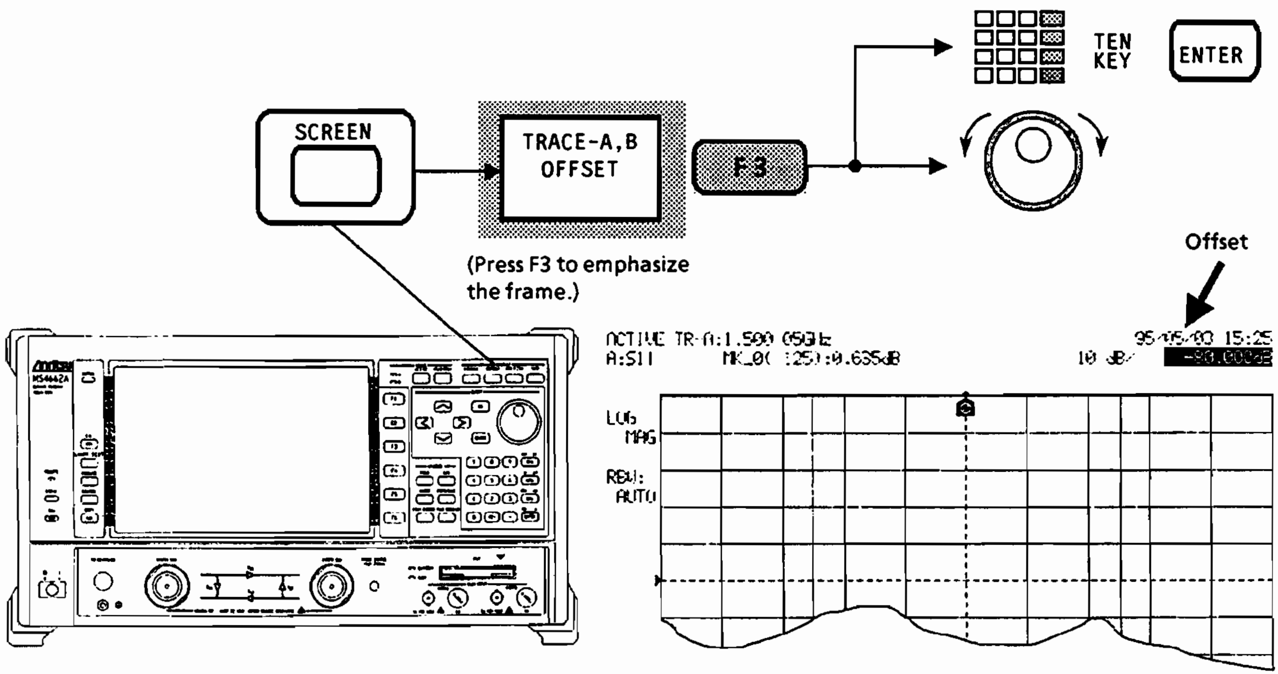
Start frequency setting: The procedure shown below reverses the START header. After updating the data directly with the ENTRY knob or entering new data with numeric keys, press a unit key to conclude the setting.



(Press F3 to emphasize the frame.)

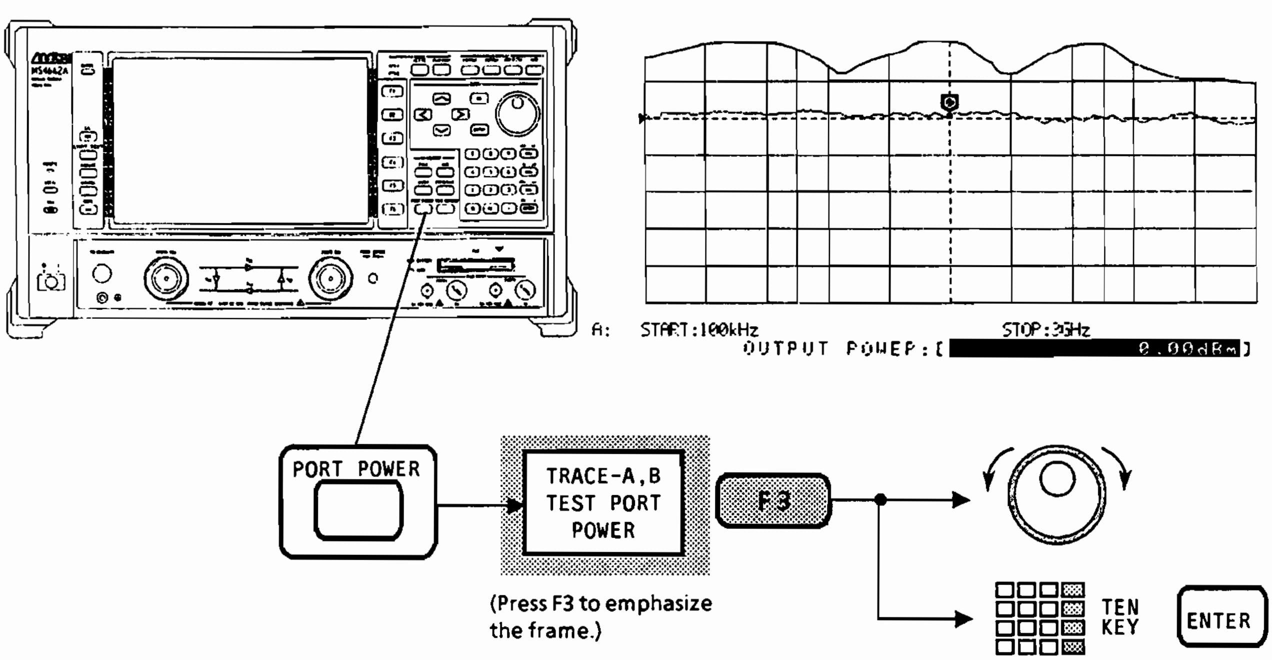
(2) Reverse numeric entry field without a header

Offset setting: The procedure shown below reverses the offset value display. After updating the data directly with the ENTRY knob or entering new data with numeric keys, press the ENTER key.



(3) Reverse numeric entry field with a header

Test port power setting: The procedure shown below displays a reverse numeric entry field with a header.
After updating the data directly with the ENTRY knob or entering new data with numeric keys, press a unit key to conclude the setting.



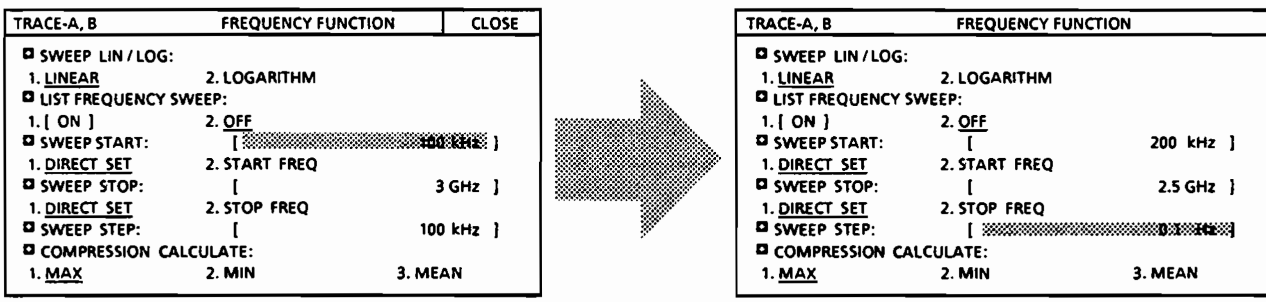
3.5.8 Using entry response areas

Entry response areas may also be used in windows. They are available to parameter group items mainly to enter numeric data.

(1) Selecting group items

<Example> Enter the following settings into the FREQUENCY FUNCTION window explained in Section 3.5.4 (4):

- Sweep start frequency .... 200 kHz
- Sweep stop frequency .... 2.5 GHz
- Sweep step .... 0.1 Hz



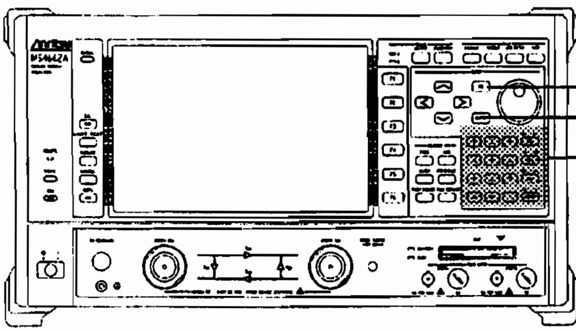
Assume that the reverse cursor has been positioned in the entry response area for SWEEP START prior to the setting as shown at left above.

No.	Example setting	Key-in sequence
1	Sweep start frequency 200 kHz	[2] [0] [0] [kHz] (dBm ms)
2	Cursor movement	[﹀] [﹀]
	Sweep stop frequency 2.5 GHz	[2] [•] [5] [GHz] (mm/ns)
3	Cursor movement	[﹀] [﹀]
	Sweep step 0.1 Hz	[0] [•] [1] [ENTER] (Hz/s)
		Cursor movement keys (HEADER) — Numeric keys (DATA) — Unit key (UNIT)

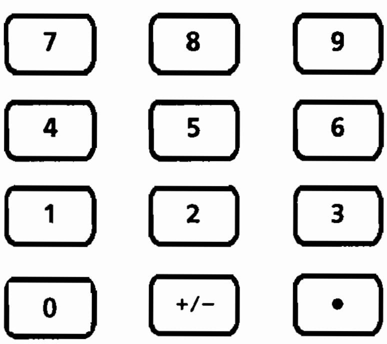
(2) Entering and correcting data with the numeric/unit keys

After verifying a group item as a header (HEADER), set data by pressing the numeric keys (DATA) and unit key (UNIT) in this order. The numeric/unit keys are shown below. To correct data entry errors, use the BS (backspace) key.

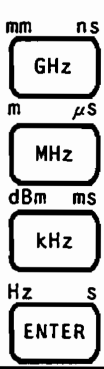
MS4662A front panel



Numeric/unit keys



Numeric data is entered by using the numeric/unit keys, which comprise the numeric keys [0] to [9], the decimal point key [.], and the sign key [+/−]. To enter a numeric value with these keys, press numeric keys from among the [0] to [9] keys, the decimal point key [.], and then the unit key for the unit specified by the group item (header). Leading zeros may be omitted in entering values less than 0. For example, 0.5 may be entered in either key-in sequence of [0] [.] [5] or [.] [5].



The unit keys are arranged in one vertical column at the right end. They are used for units of distance, time (delay), frequency, and amplitude. The choice of the unit depends on the condition setting of the group item to function as a header or the header key. Pressing the unit key completes data entry. To complete the entry of data that does not have a unit, press the ENTER key. The ENTER key adjacent to the cursor direction key (>) may also be pressed.

Unit key/ENTER key

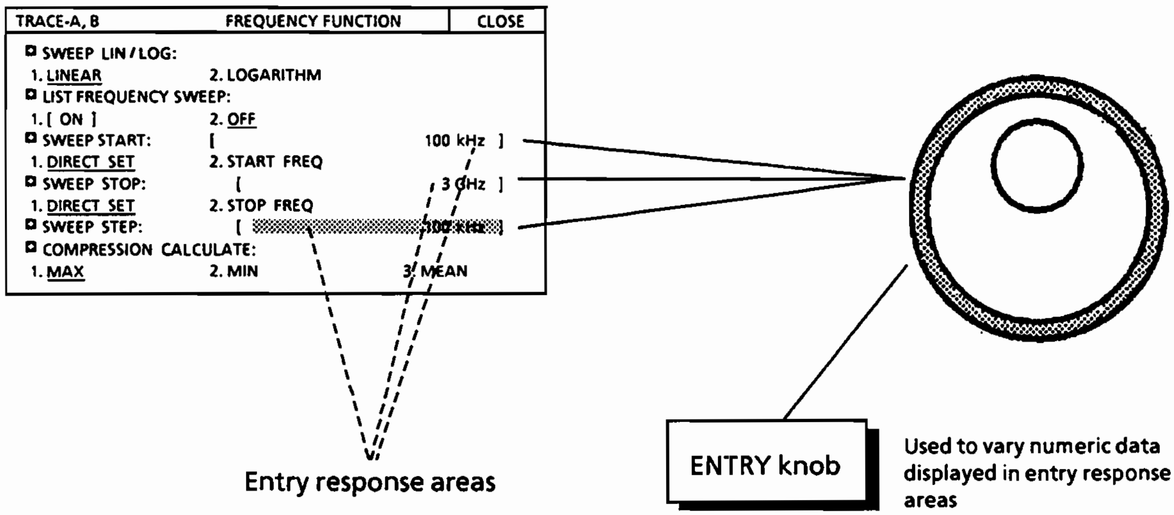
[BS] When the entry response area had been selected and value or title input become available by numeric key or ENTRY key, BS key can be used as the backspace key to revise wrong input.

<Example> You noticed that 100.25 was input where 100.36 should be input.

[1] [0] [0] [•] [2] [5] [BS] [BS] [3] [6]

(3) Entering data with the ENTRY knob

The method of using the ENTRY knob to vary numeric data in an entry response area is described below. Part of the FREQUENCY FUNCTION window explained in Section 3.5.4 (4) is shown below.



The ENTRY knob is used to vary the current value of data displayed in an entry response area continuously. Turn the knob clockwise to increase the current value, and counterclockwise to reduce it.

- There is no need to press the ENTER key to accept the current value in an entry response area as it is altered. The current value is accepted automatically each time it is changed by turning the ENTRY knob.
- Turn the ENTRY knob clockwise or counterclockwise to search for the character string in the TITLE window for title entry.

Note: In areas other than entry response areas, the ENTRY knob does the following:

- Turn the ENTRY knob clockwise to move the cursor to the right, and counterclockwise to move to the left.
- When the menu label MKR MOVE has been selected by pressing the MKR key, turn the ENTRY knob clockwise to move the active and zone markers to the right, and counterclockwise to move to the left.
- When the menu label ZONE LEFT has been selected by pressing the MKR key, turn the ENTRY knob clockwise to move the left-side zone marker to the right, and counterclockwise to move it to the left.
- When the menu label ZONE RIGHT has been selected by pressing the MKR key, turn the ENTRY knob clockwise to move the right-side zone marker to the right, and counterclockwise to move it to the left.
- When the menu label SCALE has been selected by pressing the SCREEN key, turn the ENTRY knob clockwise to vary the vertical scale in 1-2-5 steps, and counterclockwise to vary it in 5-2-1 steps.

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SECTION 4
SELECTING METHODS OF DISPLAYING MEASUREMENT DATA

This chapter explains how to select the data types of measurement data and the graph formats suited to them, and to display the data at an optimal position onscreen. These functions can be accessed by menu selections from the softkeys that are displayed by pressing FORMAT, SCREEN, MKR FCTN, and MKR assigned in the front-panel DISPLAY section.

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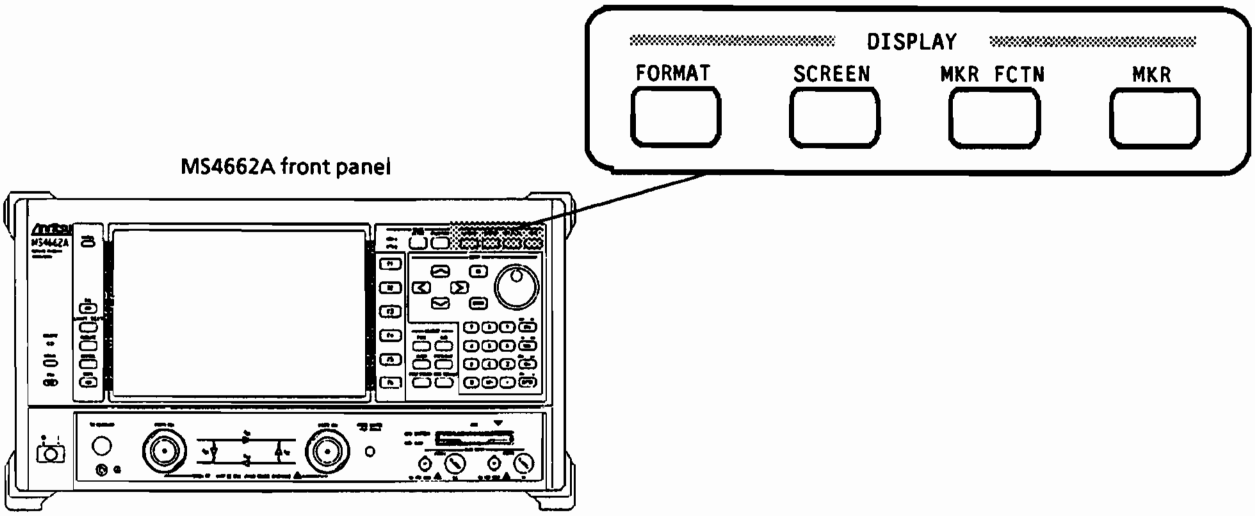
(Blank)

To select the method of displaying measurement data, operate the keys in the DISPLAY section shown below.



FUNCTION

Select a measurement mode from the FUNCTION menu.

FORMAT

Select the types of data of interest (such as the amplitude, phase, impedance, real , and imaginary) and the optimal graph format from the FORMAT menu.

SCREEN

After having selected a graph format suited to the types of data of interest, set scales and adjust offsets to optimize the location of trace waveforms onscreen and also set up the mode of display, which includes selecting between single and dual displays or displaying only desired items. These display items are selectable from the SCREEN menu.

MKR FCTN

MKR

Following the trace waveform setup, set marker points. The MS4662A provides multimarker features that permit up to 10 markers to be displayed at the same time. One of these markers can be designated as an active or delta reference marker. These marker features are selectable from the MKR and MKR FCTN menus.

4.1 Selecting Formats of Measurement Data Display .... FORMAT

Pressing the FORMAT key displays a menu for selecting the format of measurement data display. The menu contains a choice of graph formats that are determined by the S-parameter from the FUNCTION menu. Select the graph format best suited to display the types of data of interest from the FORMAT menu, which is displayed by pressing the FORMAT key.

4.1.1 Classifications of data types used with graph formats

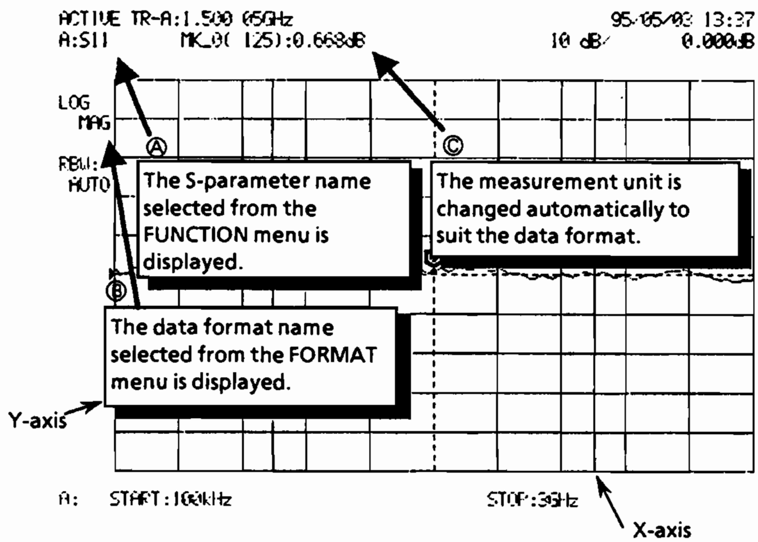
The FORMAT menu displays the data types available in graph formats. The types of data that are displayed are determined by the upper-level measurement mode and the S-parameter from the FUNCTION menu. See Table 4-1.

Table 4-1 Selecting Data Types through Measurement Mode, S-Parameter, and FORMAT Menu

Measurement mode	FUNCTION menu S-parameter	What is displayed in the FORMAT menu	
		Data type	Graph format
S-PARAMETER (Transmission measurement)	S_{21} S_{12}	LOG MAG (logarithmic magnitude)	Rectangular coordinate graph
		PHASE (phase)	Rectangular coordinate graph
		Simultaneous magnitude and phase measurement	POLAR (polar coordinate graph)
		HSDLY (high-speed group delay)	Rectangular coordinate graph
		LIN MAG (linear magnitude)	Rectangular coordinate graph
		REAL (real)	Rectangular coordinate graph
		IMAG (imaginary)	Rectangular coordinate graph
S-PARAMETER (Reflection measurement)	S_{11} S_{22}	LOG MAG (logarithmic magnitude)	Rectangular coordinate graph
		PHASE (phase)	Rectangular coordinate graph
		IMPD (impedance)	Smith chart
		ADMIT (admittance)	Admittance chart
		LIN MAG (linear magnitude)	Rectangular coordinate graph
		REAL (real)	Rectangular coordinate graph
		IMAG (imaginary)	Rectangular coordinate graph
		Simultaneous magnitude and phase measurement	POLAR (polar coordinate graph)
		VSWR	Rectangular coordinate graph
S-PRM-TIME (S-parameter domain)	BAND PASS or LOW PASS	LOG MAG (logarithmic magnitude)	Rectangular coordinate graph
		PHASE (phase)	Rectangular coordinate graph
		LIN MAG (linear magnitude)	Rectangular coordinate graph
		REAL (real)	Rectangular coordinate graph
		IMAG (imaginary)	Rectangular coordinate graph

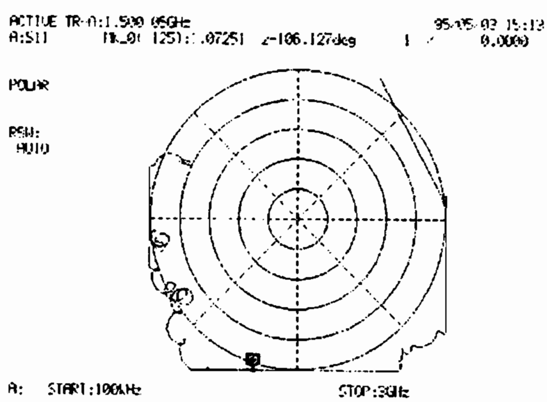
Graph formats (1/2)

Rectangular coordinate graph



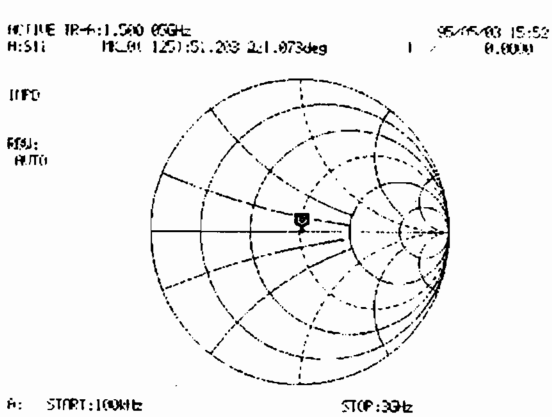
A graph that has its Y-axis rectangular to the X-axis as a frequency axis is called an rectangular coordinate graph. In rectangular coordinate graphs, the Y-axis is labeled with a magnitude ratio (dB) or phase difference (DEG) as a transmission or reflection characteristic, with a time (ms) as a group delay characteristic, and so on. The X-axis is represented in linear or log form as a function of the frequency on the Y-axis. The X-axis serves as a timebase in the time domain. ⓐ, Ⓑ, and Ⓒ shown at left apply to the graph introduced below as well.

Polar coordinate graph



In polar coordinate graphs, each set of coordinates represents one complex impedance, which is read as a vector. The magnitude is represented as a distance from the center of a circle, or as its radius, on a linear scale relative to the outermost circle as 1 (0 dB). The phase is represented by an angle measured in the direction of rotation around the circle, or counterclockwise from the X-axis. The reflection coefficient $\rho\angle\theta$ can be conveniently measured in a polar coordinate graph (ρ: magnitude, θ: deviation angle).

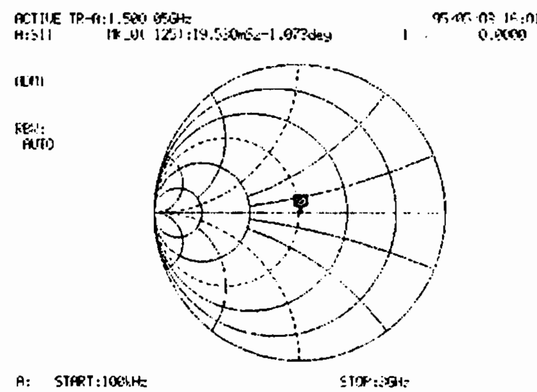
Smith chart



A Smith chart represents a set of circles of resistance r and reactance X normalized with the characteristic impedance Z_0. The resistance and reactance components can be directly read in the form of r ±jx at each intersection of a circle and a radial in the Smith chart, for example, under a characteristic impedance of 50 Ω, as (0.2 × 50 = 10 Ω) at point A, as (j0.5 × 50 = j25 Ω) at point B, and as (0.2 + j0.5) × 50 = (10 + j25) Ω at point C. The upper half of the Smith chart indicates an inductive impedance, while the lower half indicates a capacitive impedance. Marker point parameters are selectable from the following:

1. z/θ (absolute impedance value/impedance phase angle)
2. Rs/Ls and Cs (serial resistance/serial impedance or serial capacitance)
3. Q/D (Q = x/r, tanδ)

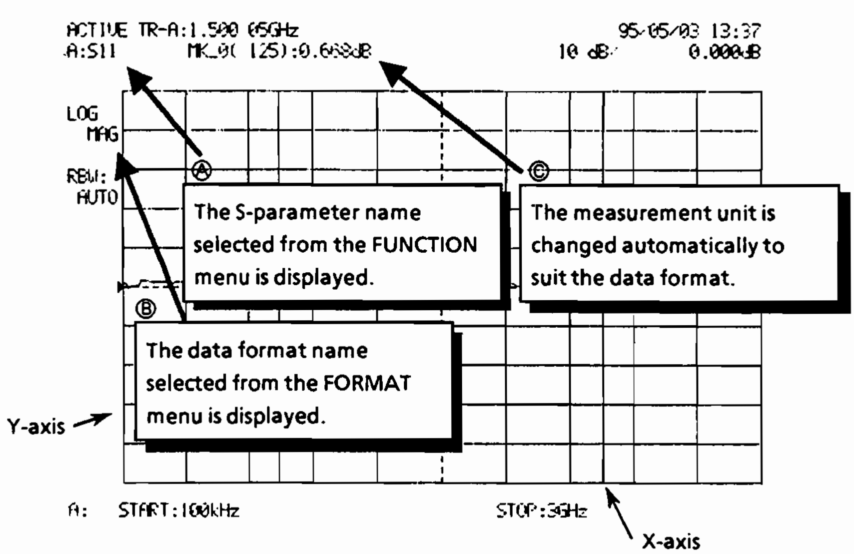
Graph formats (2/2)

Admittance chart		An admittance chart is a Smith chart rotated by 180°. It is used for admittance measurement. Marker values are represented by a conductance (reciprocal of the resistance), stated in a unit called Siemens (S), and an angle measured counterclockwise from the X-axis. Marker point parameters are selectable from the following: 1. $\|y\|/\theta$ (absolute admittance value/admittance phase angle) 2. Rp/Lp and Cp (parallel resistance/parallel admittance or parallel capacitance) 3. Q/D ($Q = x/r$, $\tan\delta$)

Since, among the data types used in graph formats, those used in polar coordinate graphs, Smith charts, and admittance charts have been explained in the graph formats (1/2 and 2/2 above), the data types used in rectangular coordinate graphs are defined below on the basis of Table 4-1. The parameter values given in the graphs are defaults. Ⓐ, Ⓑ, and Ⓒ used in the rectangular coordinate graph in "Graph formats (1/2)" apply to (1) to (6) below as well.

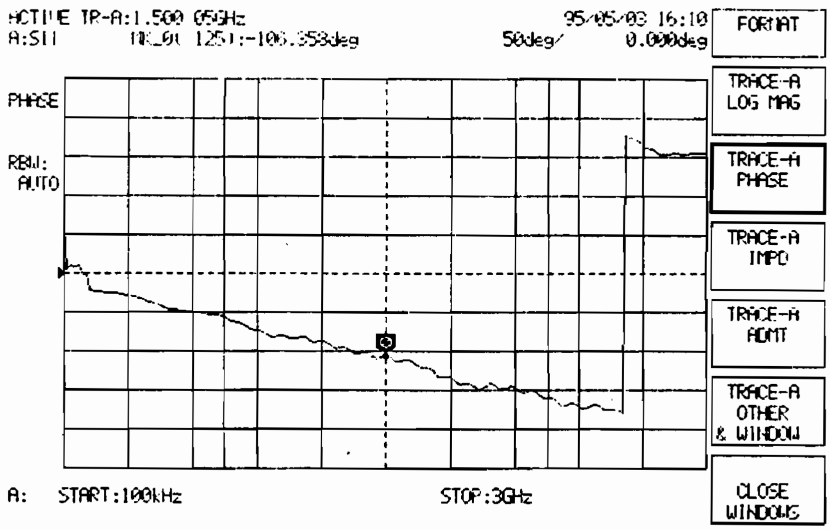
(1) LOG MAG (logarithmic magnitude)

LOG MAG plots magnitude ratios on the Y-axis in dB with respect to the frequency on the X-axis. Ⓐ, Ⓑ, and Ⓒ below apply to (1) to (6) below as well.



(2) PHASE (phase)

PHASE plots phase ratios on the Y-axis in deg with respect to the frequency on the X-axis.

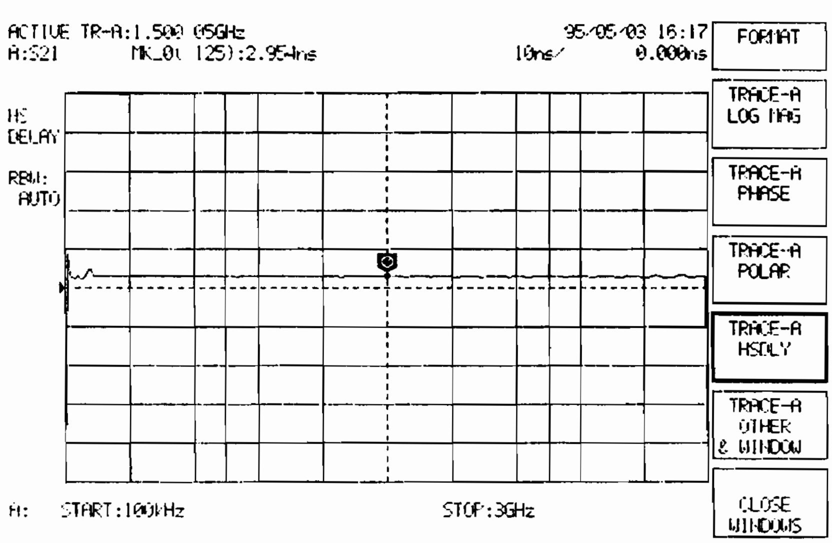


(3) HSDLY (high-speed group delay)

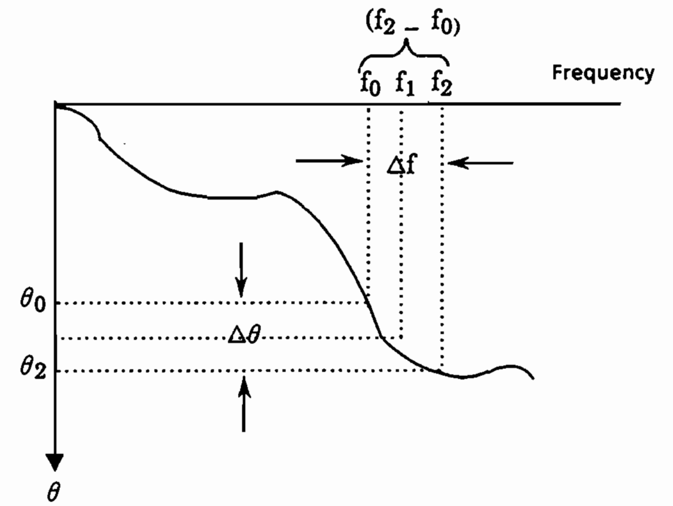
HSDLY represents plots group delays on the Y-axis with respect to the frequency on the X-axis. The group delay τ indicates the change $\Delta\theta$ in phase characteristics relative to the frequency change Δf and is stated in an equation as:

$$\tau = (1/2\pi)(\Delta\theta/\Delta f)$$

In this equation, Δf is termed an aperture frequency and is set in % in the frequency span range of 1 % to 10 %. (In HSDLY terms, this aperture frequency is called a smoothing aperture. It is set by using the DLY softkey from the AVG menu, which is displayed by pressing the AVG key in the MEASURE section.)

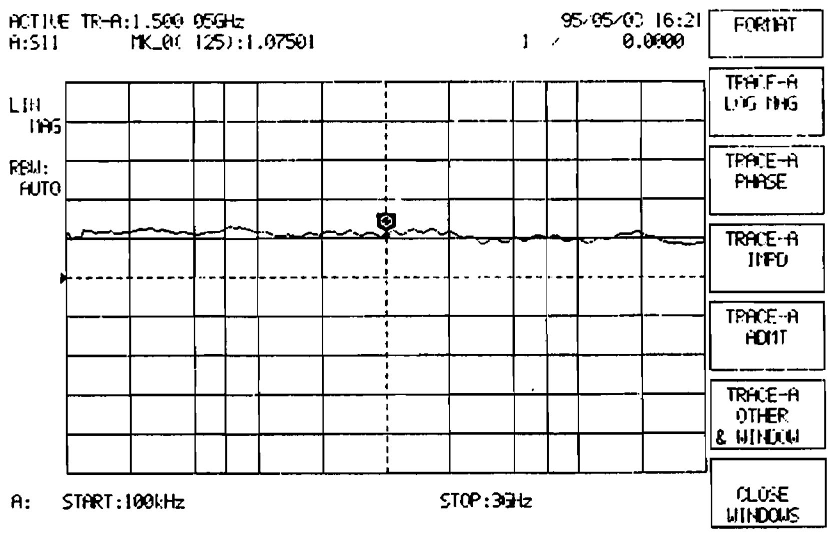


Aperture setting



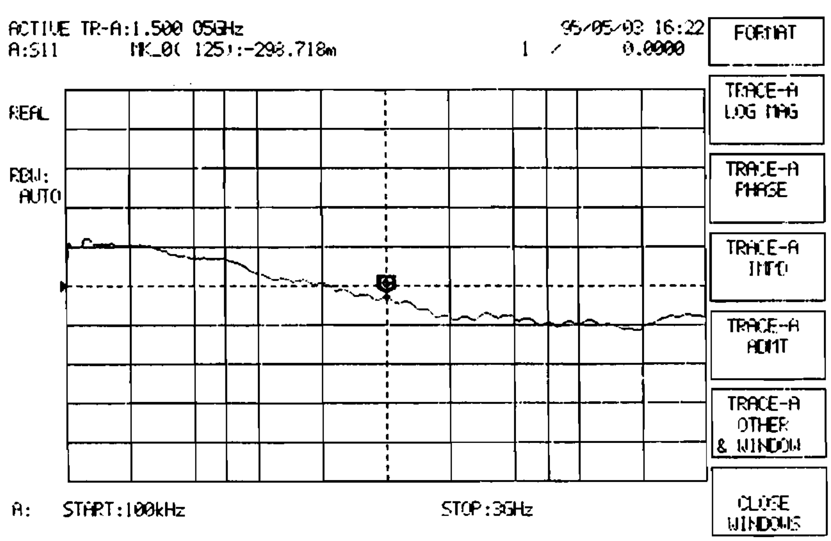
(4) LIN MAG (linear magnitude)

LIN MAG plots magnitude ratios on the Y-axis on a linear scale without a measurement unit, with respect to the frequency on the X-axis.



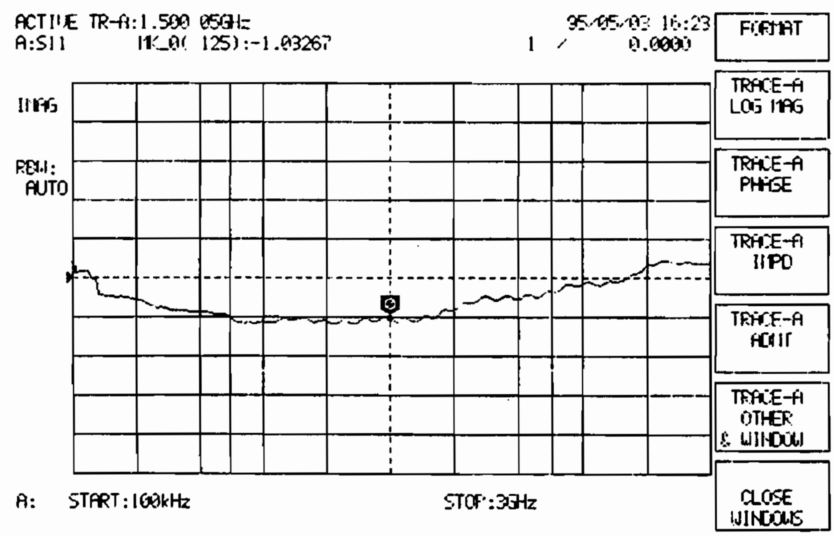
(5) REAL (real)

REAL plots real ratios on the Y-axis without a measurement unit, with respect to the frequency on the X-axis. It is similar to LIN MAG but differs in that it handles both positive and negative numbers.



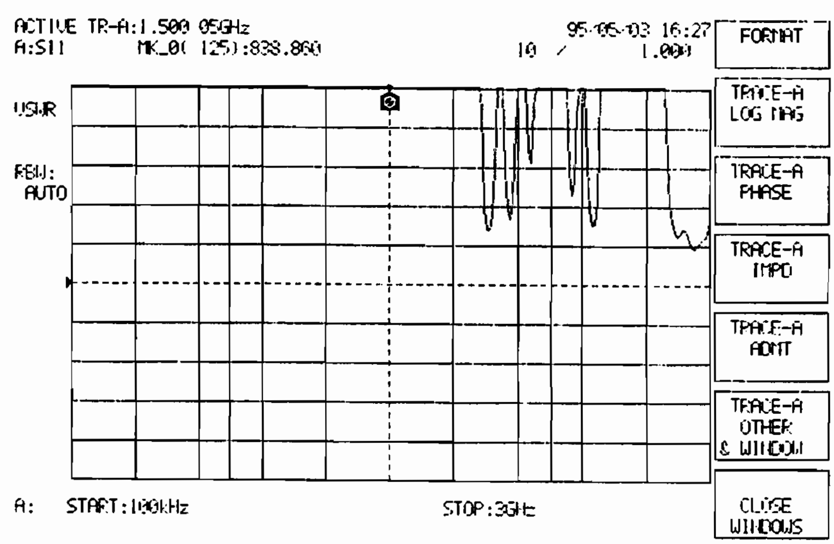
(6) IMAG (imaginary)

IMAG plots imaginary ratios on the Y-axis without a measurement unit, with respect to the frequency on the X-axis. Among measurement data, only reactances are covered.



(7) VSWR (voltage standing-wave ratio)

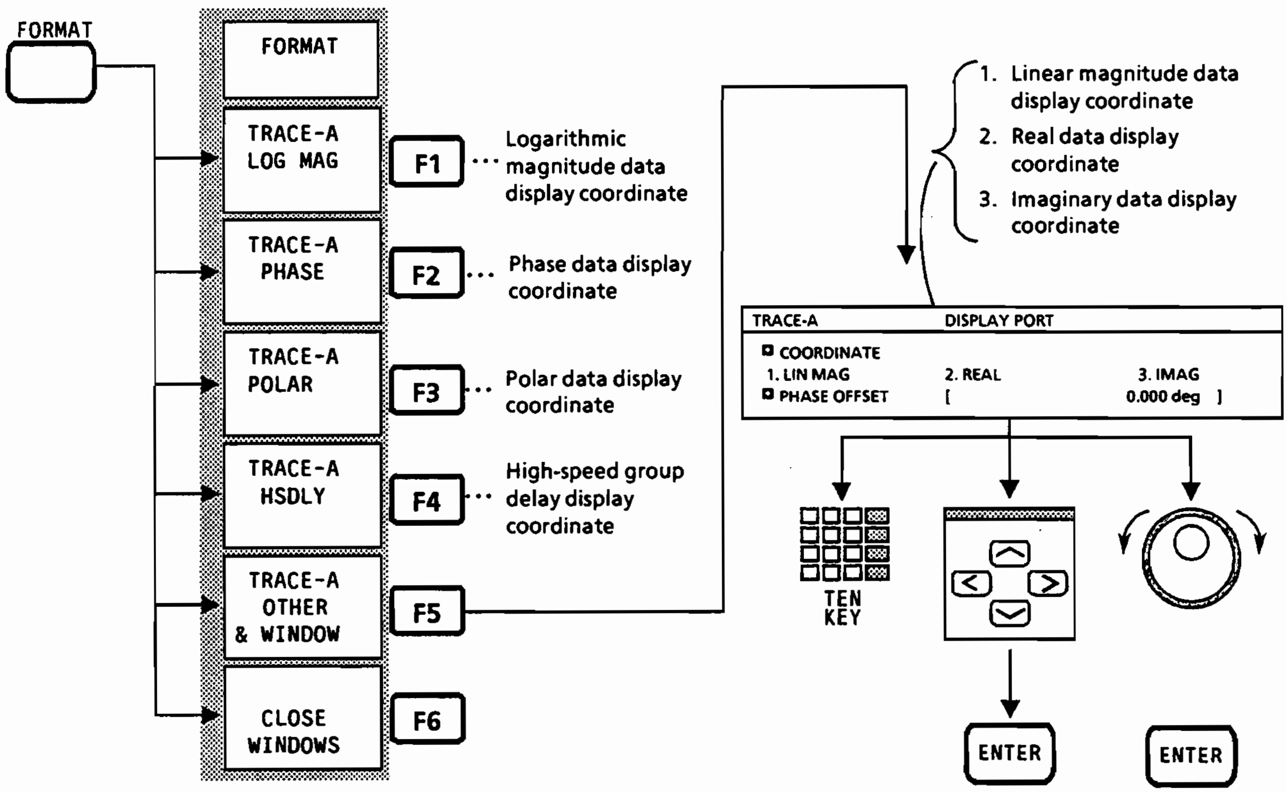
VSWR plots VSWRs on the Y-axis without a measurement unit, with respect to the frequency on the X-axis.



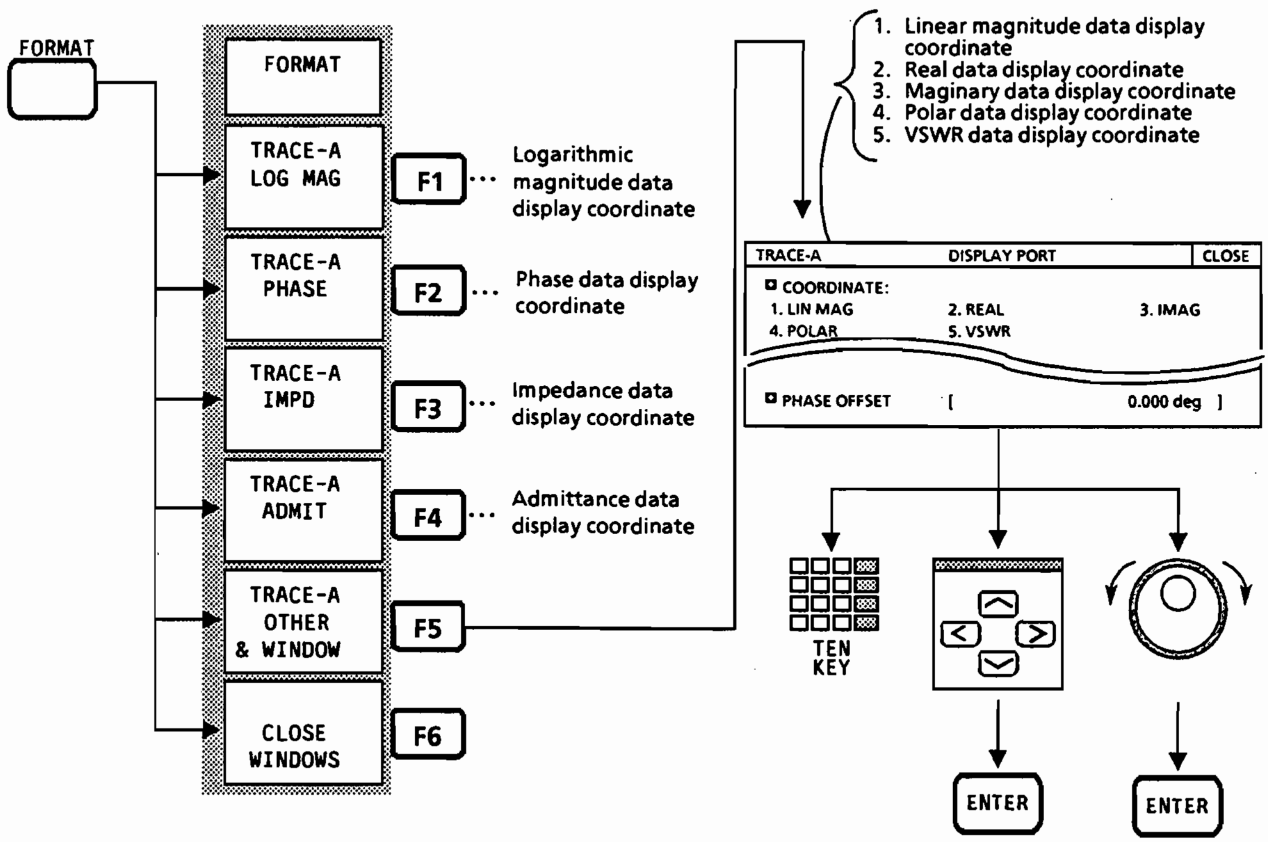
4.1.2 Graph data format selection flow: Frequency domain

The key-in sequences used to select graph data formats on the basis of Table 4-1 are shown below.

(1) When FUNCTION menu S_{21} or S_{12} is selected



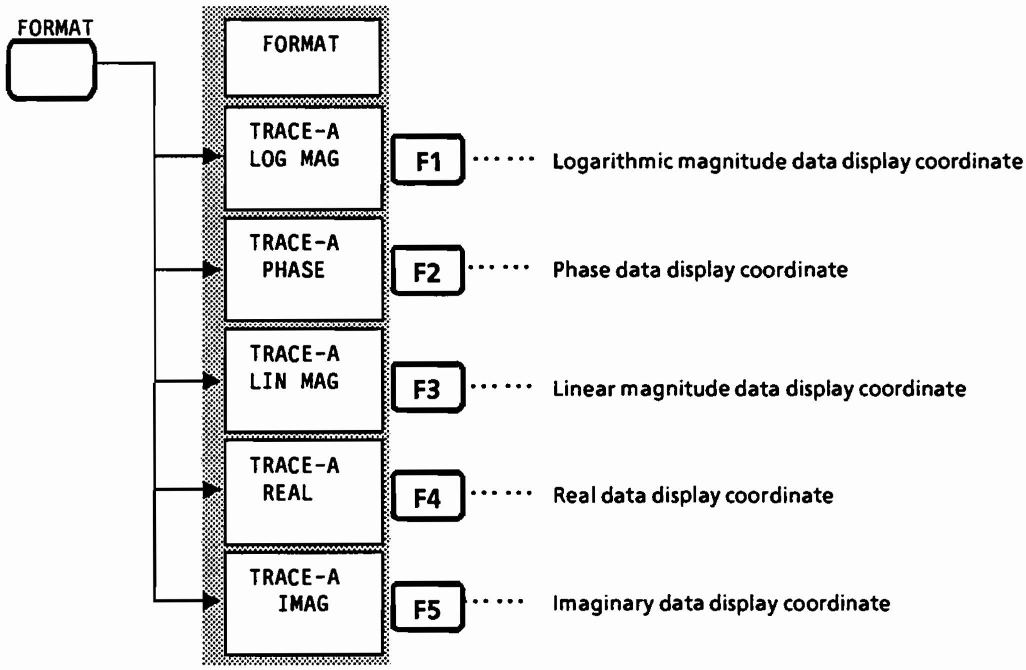
(2) When FUNCTION menu S_{11} or S_{22} is selected



4.1.3 Graph data format selection flow: Time domain

[ACTIVE] After setting active trace A, press the [FREQ/TIME] key.

(1) When FUNCTION menu BAND PASS or LOW PASS is selected



Note: If active trace B is set by pressing the ACTIVE key in Section 4.1.2 (1) and (2) and in Section 4.1.3 (1), the label TRACE-A in each menu is changed to TRACE-B.

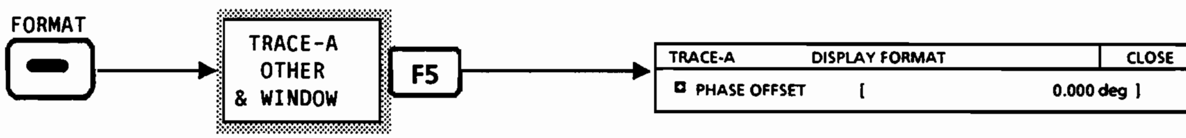
While time-domain measurement is executed by setting active trace A, set active trace B to monitor frequency domain data as needed.

4.1.4 Setting a phase offset

A waveform that folds from −180 [deg] to +180 [deg] could not be enlarged for detailed measurement in its present form. Any offset may be applied to such waveforms to observe them shifted from their display position.

(1) Operating procedure

Perform the following key-in sequence:

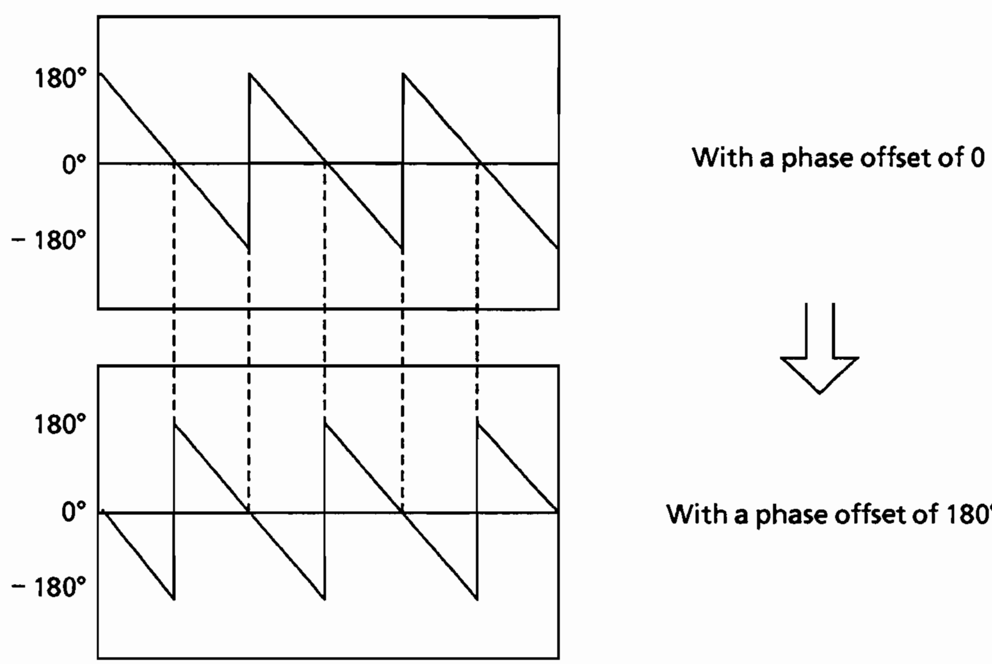


Offsets can be set by using the numeric keys or ENTRY knob.

Phase offsets are variable in the range of −838.8608 to + 838.8608 [deg].

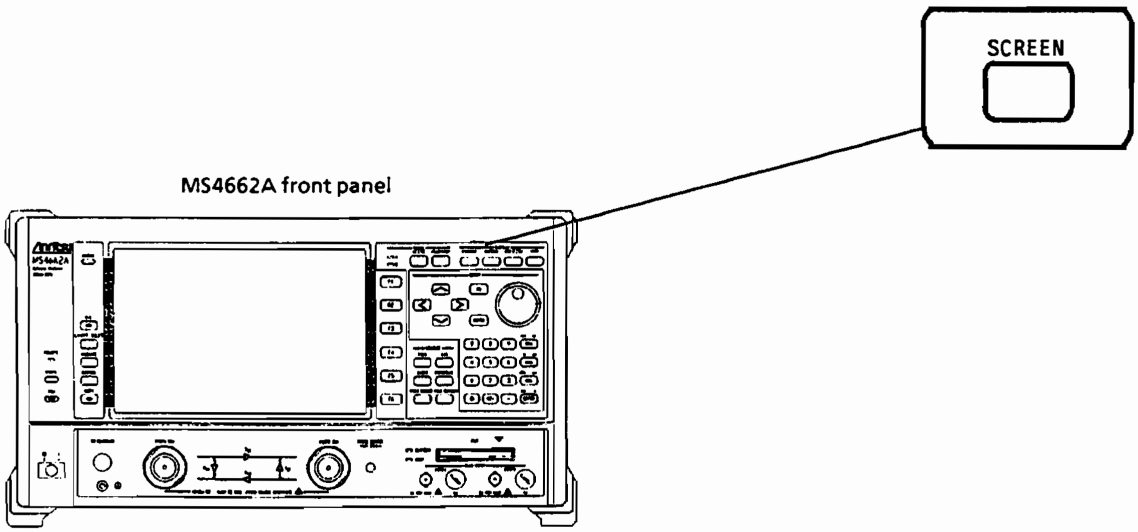
<Example>

Measurement values around ±180° can be moved to around 0° to make the waveform easier to observe.

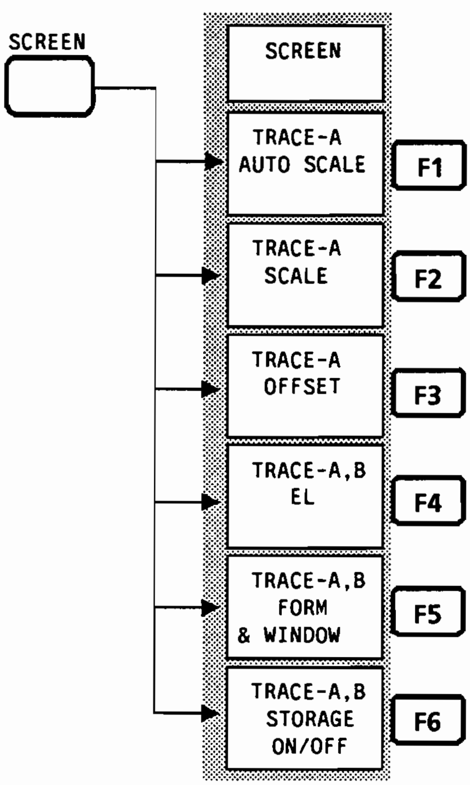


4.2 Selecting Trace Waveform Display Methods .... SCREEN

Once the graph format for displaying the desired type of data is established, the next step is to select display function items from the SCREEN menu, which is displayed by pressing the SCREEN key, optimize the location of trace waveforms onscreen, and, if necessary, select the style in which trace waveforms appear, such as displaying trace waveforms A/B in dual channels and superposing multiple traces on one another. Specific items may also be displayed onscreen by using the display item erase function.



Pressing the SCREEN key displays the SCREEN menu shown below.



F1 ...... Selects the optimal value of the Y-axis magnitude scale automatically

F2 ...... Hand-selects the value of the Y-axis magnitude scale

F3 ...... Changes the value of the Y-axis offset line

F4 ...... Sets an electrical length

F5 ...... Selects a trace waveform display style and erases or restores display screen items

F6 ...... Stores trace waveforms

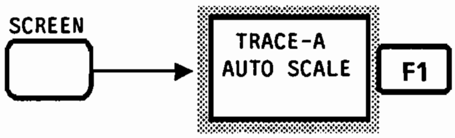
Note: If active trace B is set by pressing the ACTIVE key, the label TRACE-A in the SCREEN changes to TRACE-B.

4.2.1 Setting a scale .... AUTO SCALE, SCALE

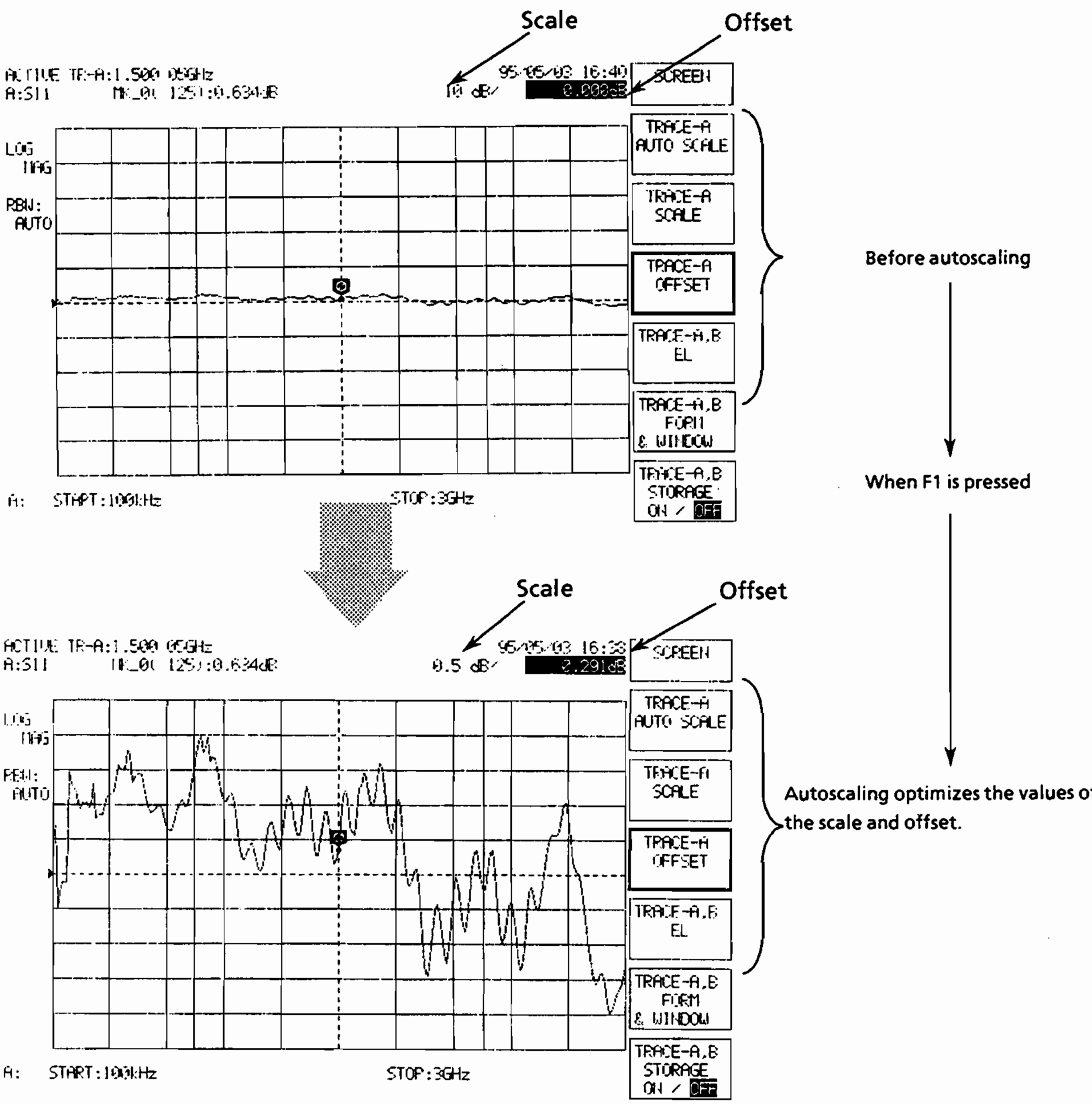
Scales can be set both automatically and manually.

(1) Automatic setting

Press keys in the following sequence:



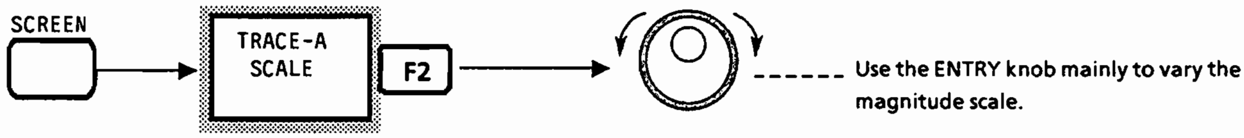
When F1 is pressed, the scale and offset are set automatically to optimize the trace waveform display.



Note: The scaling information is stored in memory, regardless of changes in the function or format setting, and is recalled from memory when the setting is changed back to the original function or format.

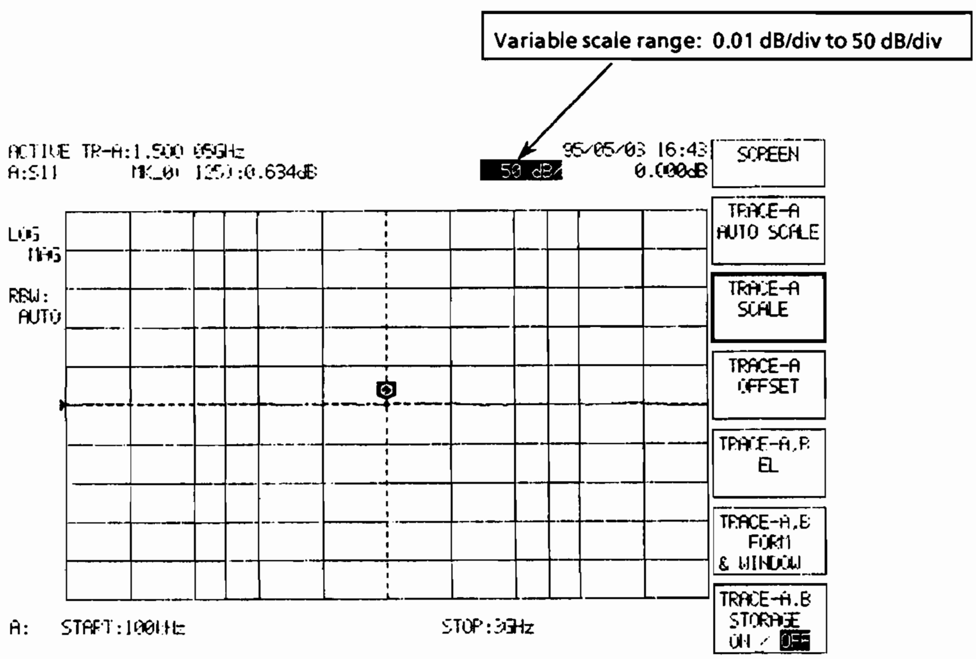
(2) Manual setting

Press keys in the following sequence:



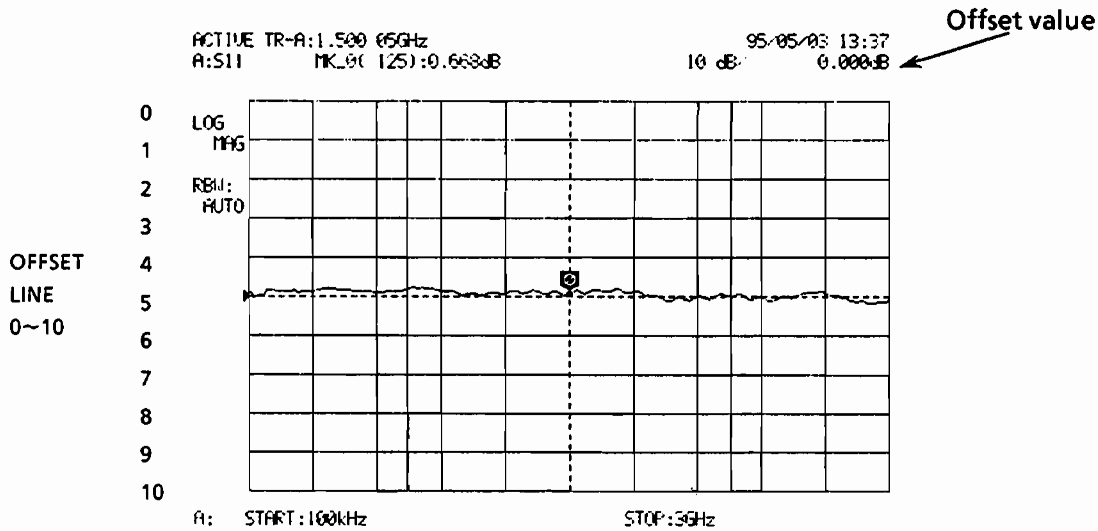
The magnitude scale is variable from 0.01 dB/div to 50 dB/div.

Turning the ENTRY knob clockwise varies the magnitude scale up to 50 dB/div in 1-2-5 steps; turning it counterclockwise varies the magnitude scale up to 0.01 dB/div.



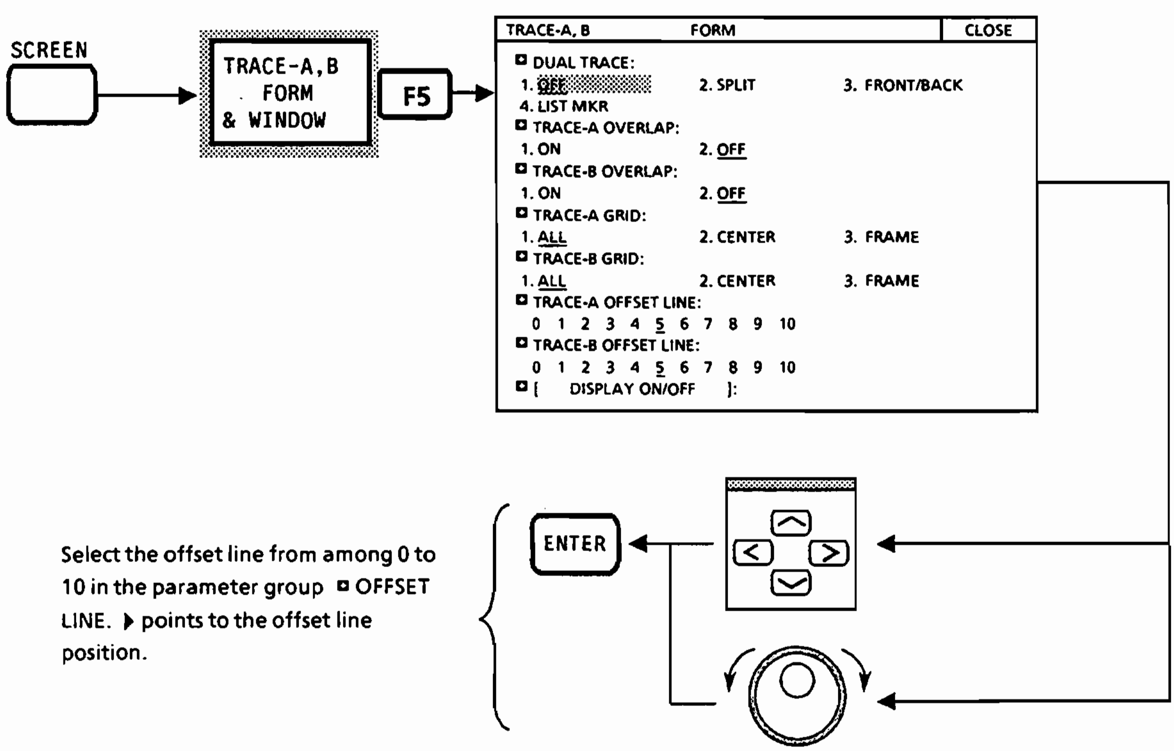
4.2.2 Changing an offset line .... OFFSET

Offset lines in the rectangular coordinate graph shown below can be changed by performing the procedural steps explained below.



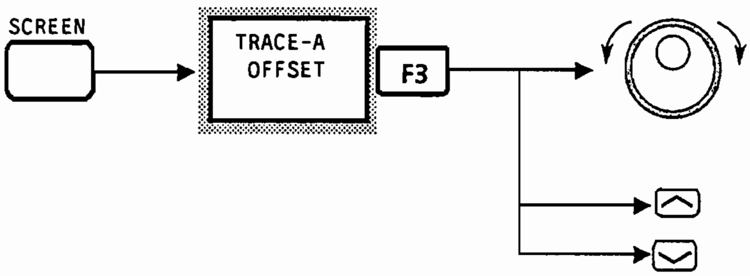
(1) Selecting an offset line

Select the desired offset line to change. If it is not necessary to select an offset line, go to (2).



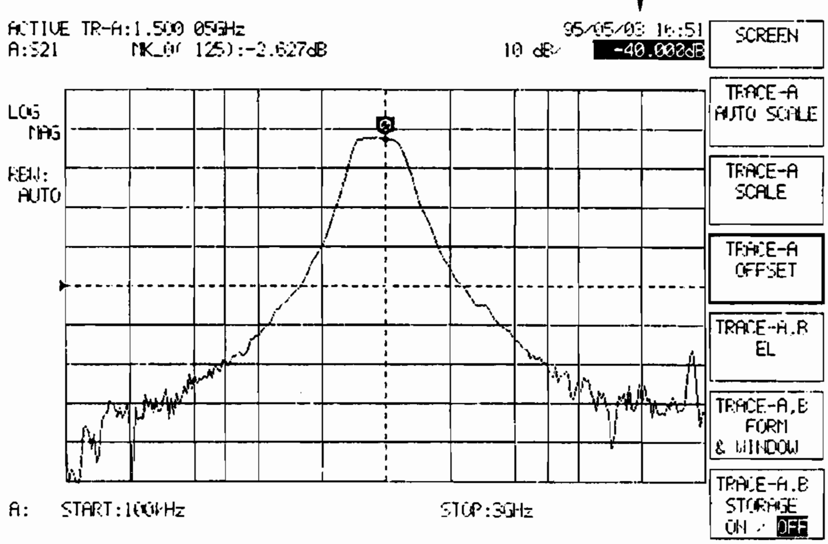
Note: The default offset line position is 5.

(2) Changing an offset value



The value can be set in the range from −800 to 800 in LIN MAG and PHASE graphs. In other graphs, it can be set in the range from −80 to 80. Whether unit is added or not depends on the data format.

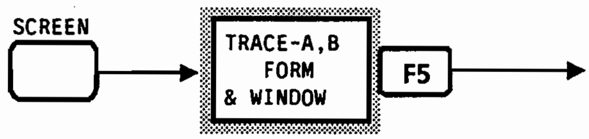
The (up) key decreases the OFFSET value by 1 div.
The (down) key decreases the OFFSET value by 1 div.

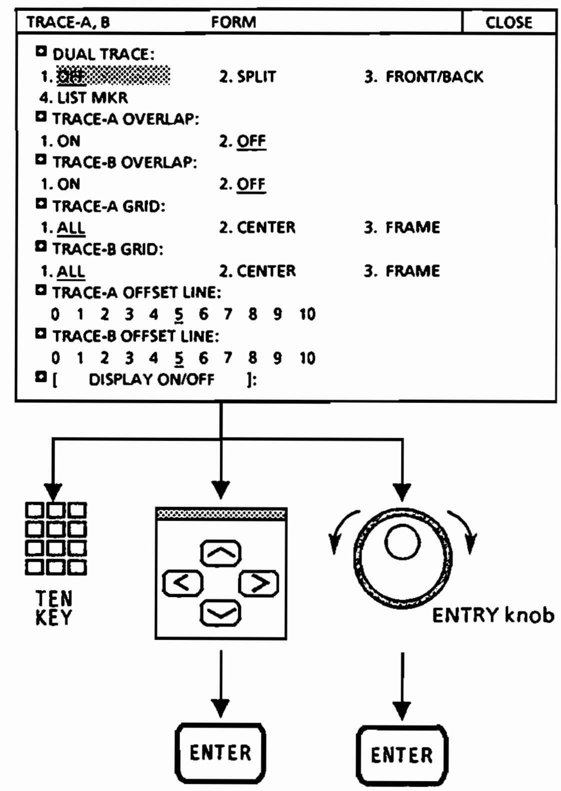


Note: Though the subfunction format has once been changed, the former scaling information remains. Therefore, if the subfunction format has been switched to the previous one, the previous scaling remains set.

4.2.3 Selecting a trace waveform display style .... FORM

To select a trace waveform display style (dual trace display, overlapping, scaling, and offset line), press keys in the following sequence (for information on offset lines, see 4.2.2):





① Choose from among the parameter groups ◘DUAL TRACE, ◘TRACE-A OVERLAP, ◘TRACE-B OVERLAP, and ◘GRID using the ∨ or ∧ key.

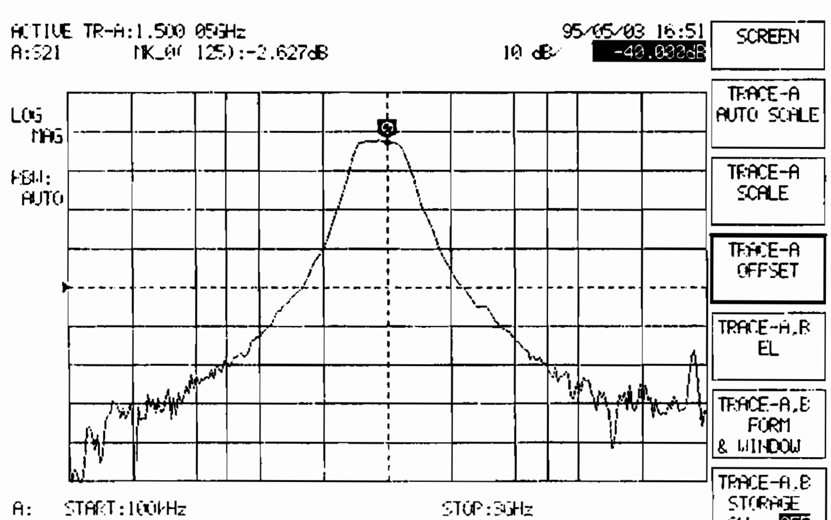
② Select the desired parameter from the parameter group with the < or > key or with the ENTRY knob, and press the ENTER key.

To make a choice with numeric keys, simply type in the parameter number; there is no need to press the ENTER key.

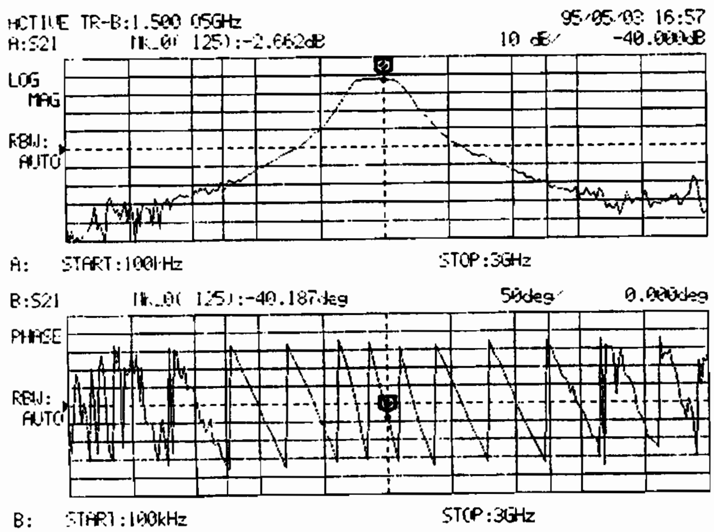
(1) Displaying trace A or B in a single channel .... DUAL TRACE: OFF

Select the OFF parameter for DUAL TRACE to display trace A or B in a single channel. The default setting is DUAL TRACE OFF.

An example display of trace A in a single channel is shown below.

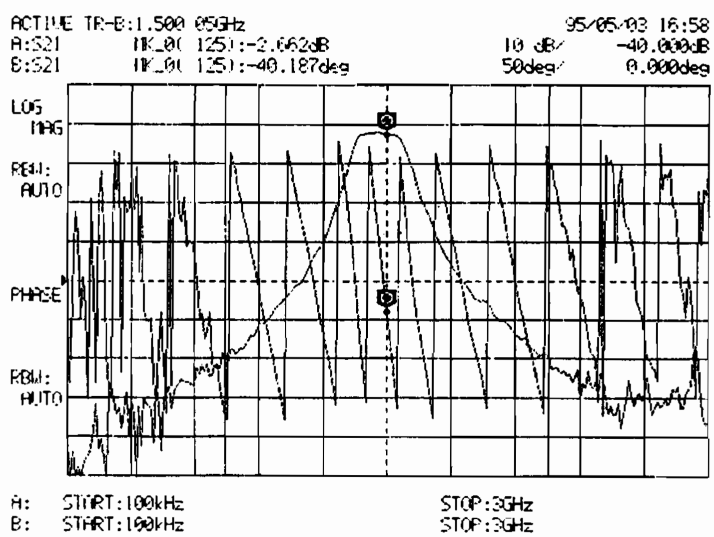


(2) Displaying traces A and B in dual channels .... DUAL TRACE: SPLIT



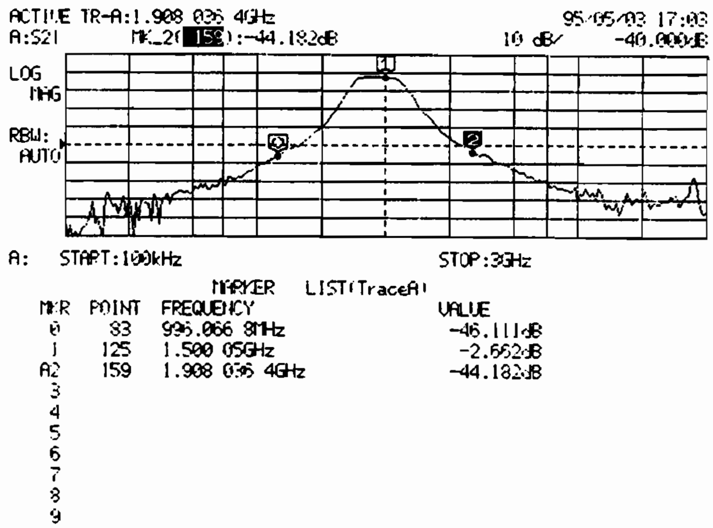
Select the SPLIT parameter for DUAL TRACE to display trace A or B in dual channels. Traces A and B appear in the upper and lower parts of the screen shown at left, respectively. Trace A is used as a time domain, while trace B is used as a frequency domain.

(3) Overlaying dual traces .... DUAL TRACE: FRONT/BACK



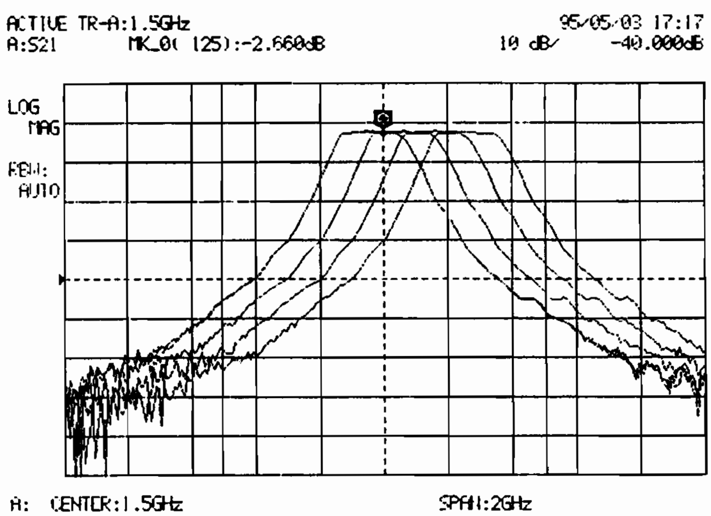
Select the FRONT/BACK parameter for DUAL TRACE to overlay trace A with trace B.

(4) Displaying a marker list .... LIST MRK



Select LIST MRK from DUAL TRACE to produce a list of the numbers, points, frequencies, and measurement values at the marker points displayed on the active trace in the lower half of the screen.

(5) Superposing multiple traces .... OVERLAP: ON



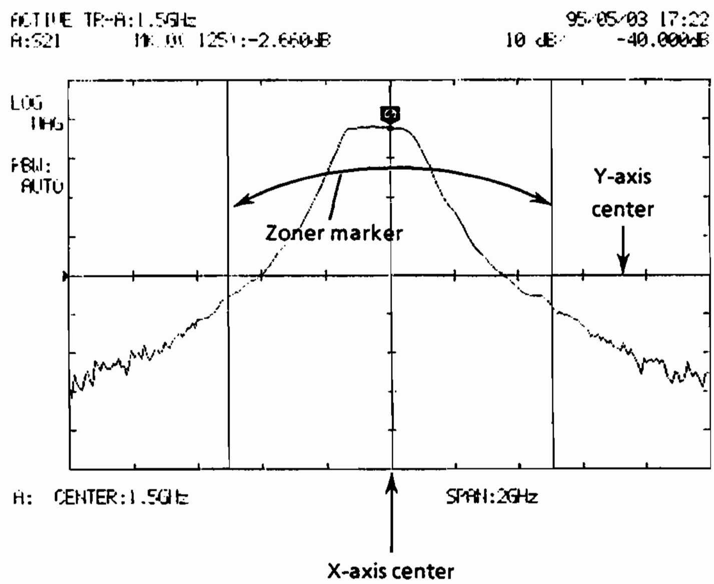
To superpose one trace on another without erasing earlier traces, select TRACE-A: OVERLAP: ON for trace A or TRACE-B: OVERLAP: ON for trace B.

In most measurement applications, use the OVERLAP: OFF setting. The default setting is OFF.

Typical application: The OVERLAP: ON setting is useful for observing changes in characteristics with changes in temperature or with time.

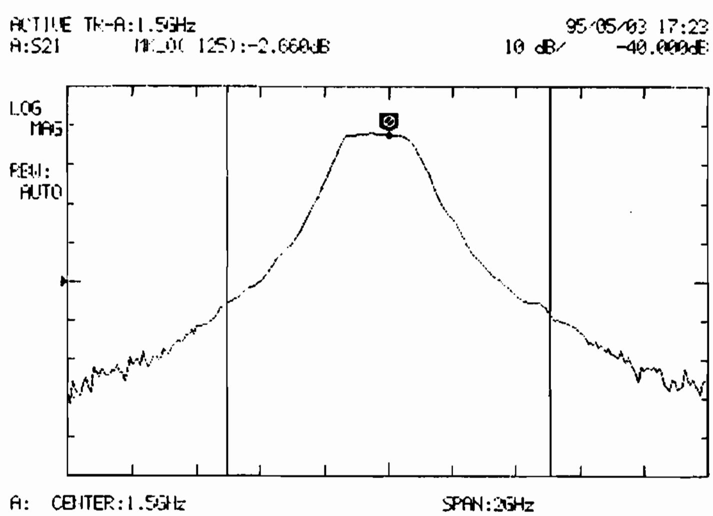
(6) Displaying only grid centerline .... GRID: CENTER

Select GRID: CENTER to display only grid centerlines as shown below.



(7) Displaying only a frame .... GRID: FRAME

Select GRID: FRAME to display only a frame as shown below.

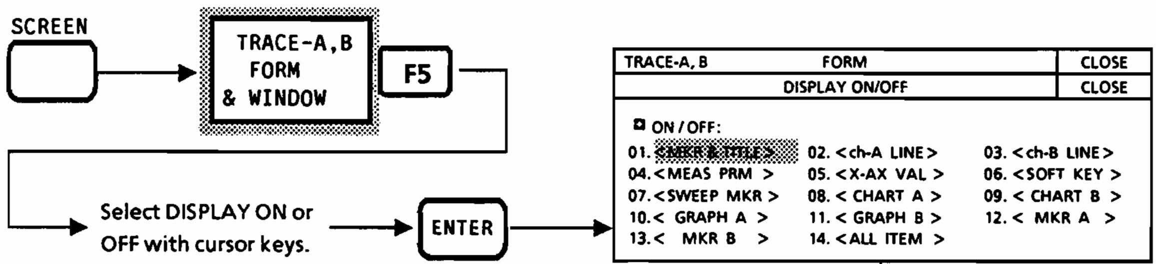


Note: The default setting is GRID: ALL, allowing all scales to be displayed.

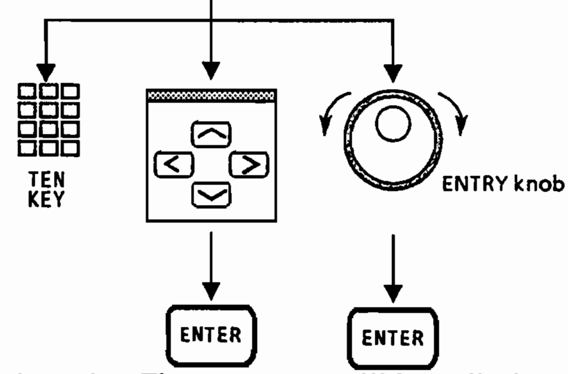
4.2.4 Erasing and restoring display screen items

Items selected onscreen is erased and restored for redisplay.

Press keys in the following sequence:

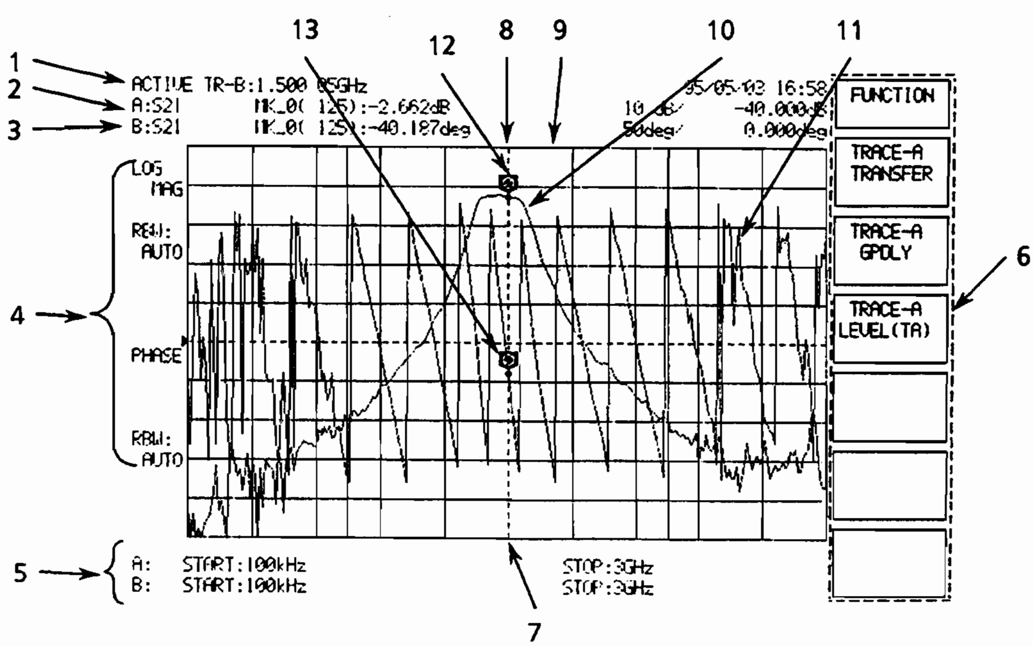


Select the parameter to erase from among 1 to 14 in the ON/OFF parameter group in the DISPLAY ITEM group with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key. When a parameter is erased, an underbar is drawn under it. (For single-digit parameter numbers, type 0 first. To erase <SOFT KEY>, for example, type 06.)



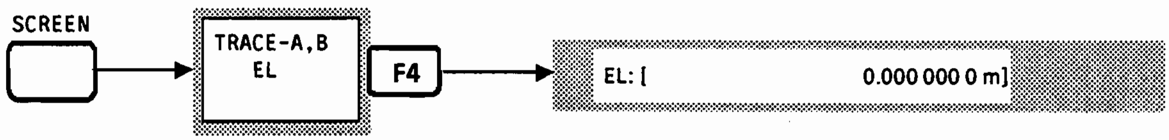
To redisplay a parameter that has been erased, specify it again. The parameter will be redisplayed with its underbar removed.

All the display screen items that is erased are shown by number, excluding <ALL ITEM> in 14.



4.2.5 Setting an electrical length

The following-key in sequence sets an electrical length (EL) in the direct entry area:

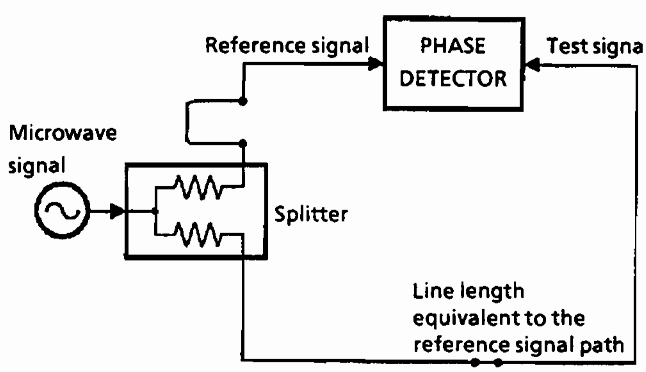


An electrical length may be set to:

- Electrical length adjustment
- Measure the phase of a DUT alone

(1) Electrical length adjustment

An electrical length set to adjust phase delay. If the reference signal path and the test signal path are equal in their length as shown below and the transmission line and the splitter are normal, a constant phase is measurable even while the frequency is varied. One drawback of this method, however, is that the line length must be varied from one measurement setup to another.



Phase change that produces an equivalent electrical length

In reality, however, the reference signal path and the test signal path typically are unequal in their length. To convert the physical length of the test signal path to an electrical length equivalent to the length of the reference signal path:

① First, measure the delay τ to determine the length difference between the reference signal path and the test signal path. Then, solve the following equation to calculate the corrected electrical length:

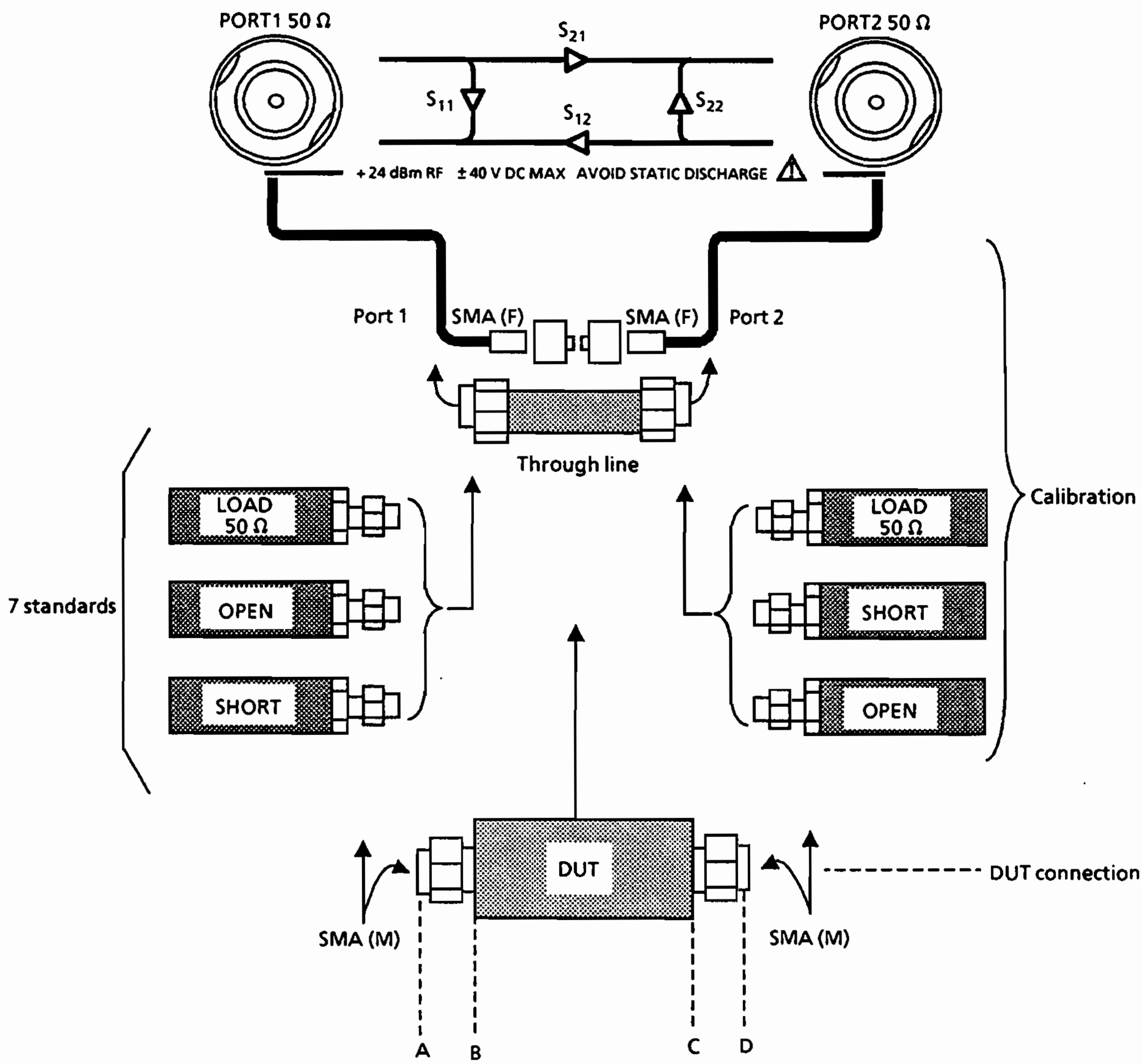
$$\text{Corrected electrical length} = (-360 \times \tau)/(1.2 \times 10^{-8})$$

② Set the corrected electrical length in the direct entry area.

③ Adjust the electrical length in the direct entry area to make the phase trace straight with an inclination of 0° in the display format phase screen.

(2) Measuring the phase of a DUT alone

An example of typical calibration using seven standards involving a through line is shown below. When a DUT is inserted between ports 1 and 2 after calibration, it produces a phase change relative to the frequency. This phase change represents a phase delay in the DUT between A and D.

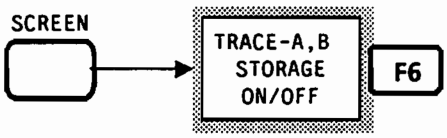


If a phase delay only in the DUT between B and C is of interest, set the electrical length converted on the basis of connector length A − B = C − D in the direct entry area. By so doing, the phase lag associated with the connectors can be canceled. This conversion technique may be extended not only to connector lengths but also to the cable supplied with the DUT that is not included as part of the measurement system during calibration.

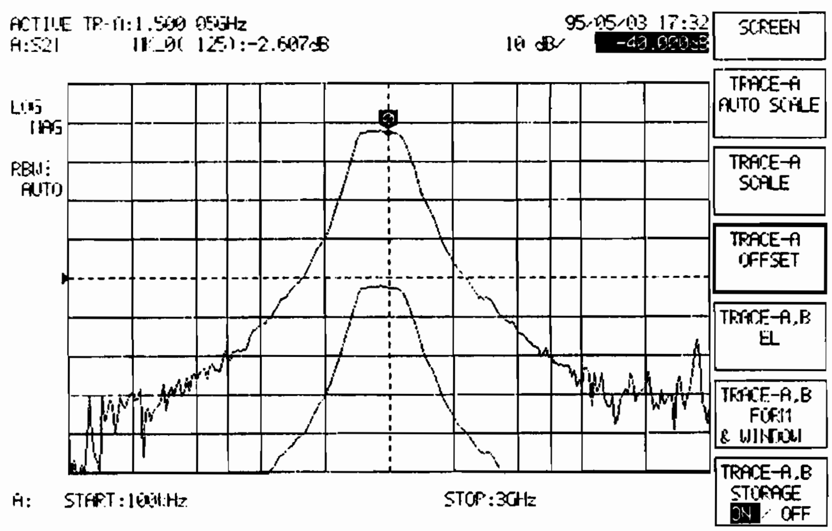
4.2.6 Storing trace waveforms

When STORAGE is turned on, the trace waveform data then in effect is retained onscreen until STORAGE is turned off.

Press keys in the following sequence:

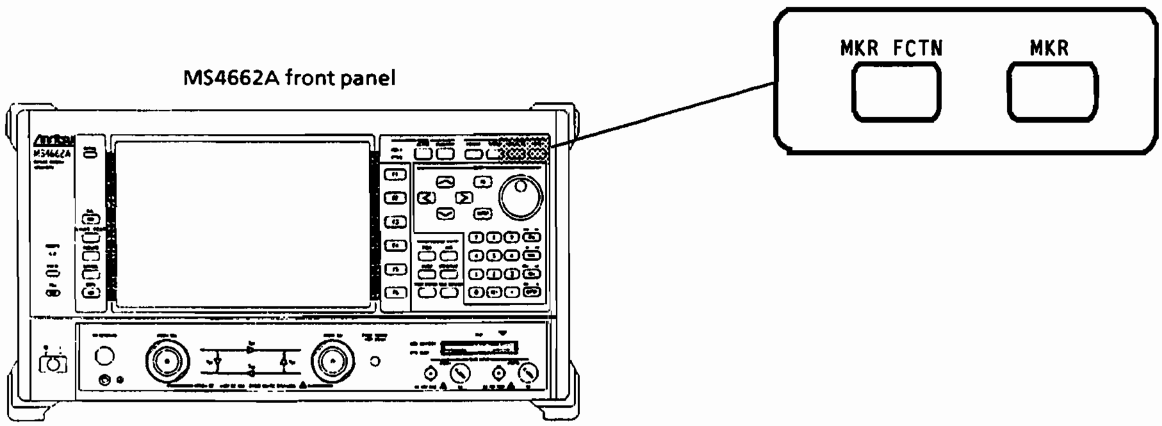


STORAGE is initially off. Press F6 to turn it on.
Press F6 again to turn it off.

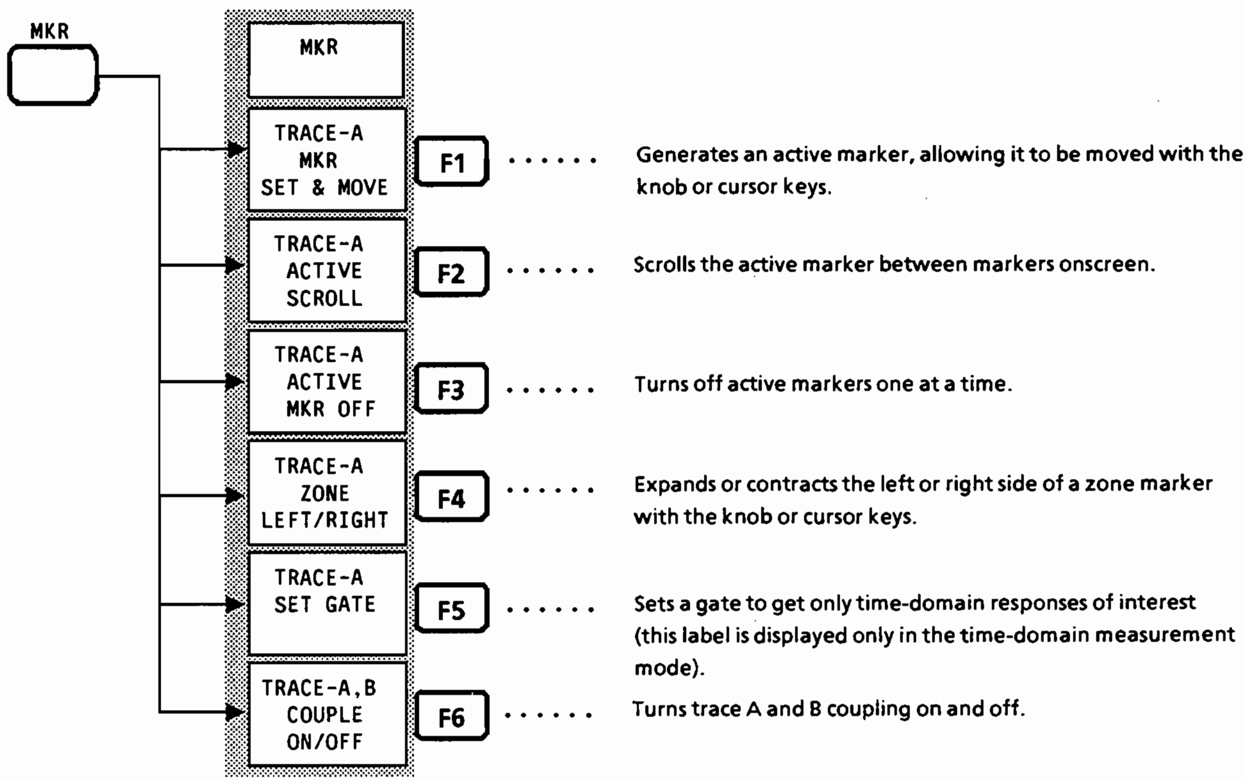


4.3 Selecting Measuring Functions by Marker Displays .... MKR, MKR FCTN

When markers are placed on a trace waveform using the marker functions, the frequencies and measurement values (*) at the marker points are displayed at the upper left corner of the screen. The marker functions are selectable from the MKR or MKR FCTN menu, which is displayed by pressing the MKR or MKR FCTN key.



Pressing the MKR key causes the appearance of the MKR menu shown below. The MKR menu is described below.

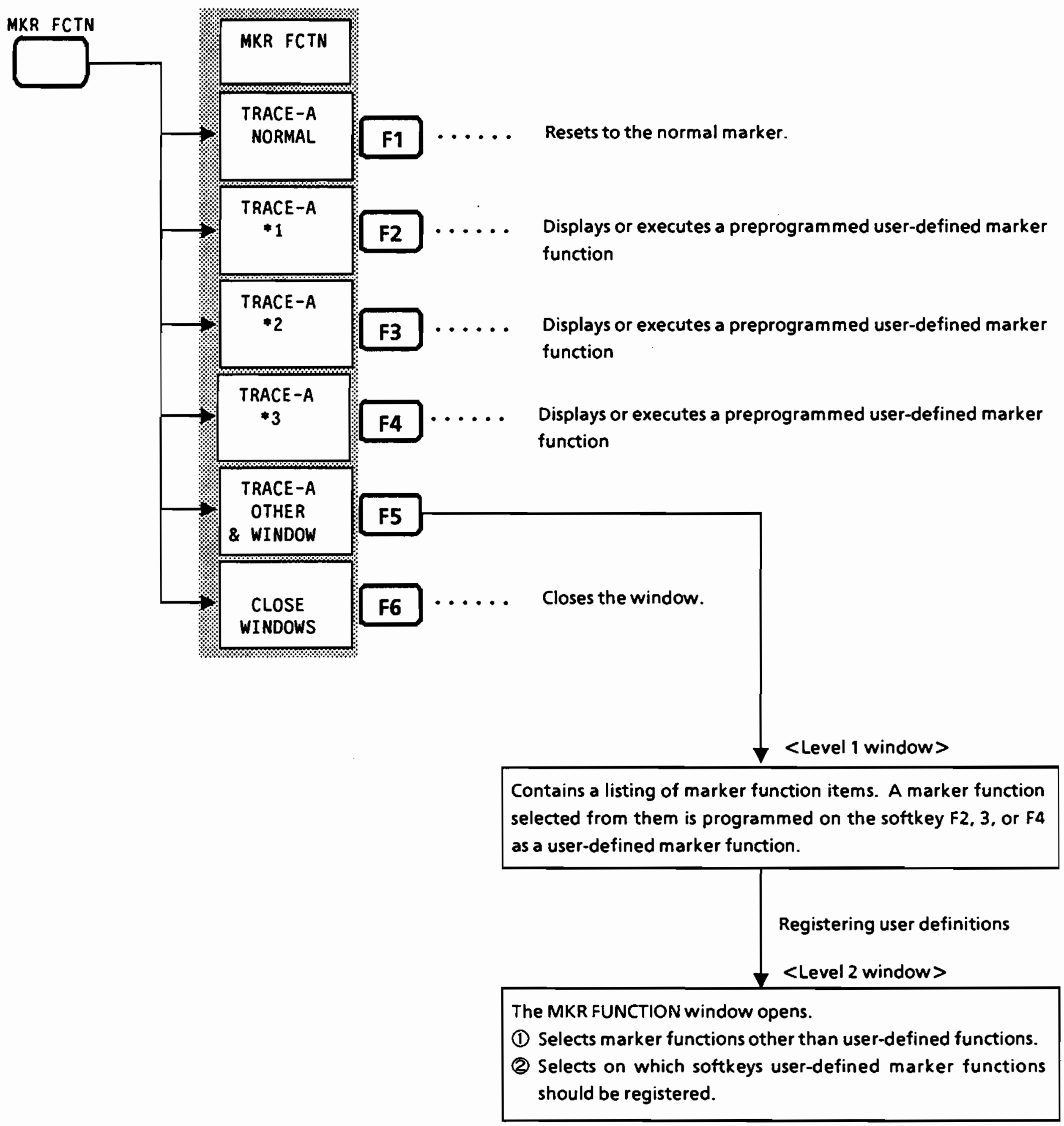


Note: If active trace B is set by pressing the ACTIVE key, the label TRACE-A in the MKR changes to TRACE-B. TRACE-A, B is displayed if TRACE-A, B COUPLE in the MKR menu is on.

---

* The term "measurement value" in this manual implicitly refers to any measurement value in an orthogonal coordinate graph, polar coordinate graph, or Smith chart.

Pressing the MKR FCTN key causes the appearance of the MKR FCTN menu shown below:



Note: If active trace B is set by pressing the ACTIVE key, the label TRACE-A in the MKR FCTN changes to TRACE-B. TRACE-A, B is displayed if TRACE-A, B COUPLE in the MKR FCTN menu is on.

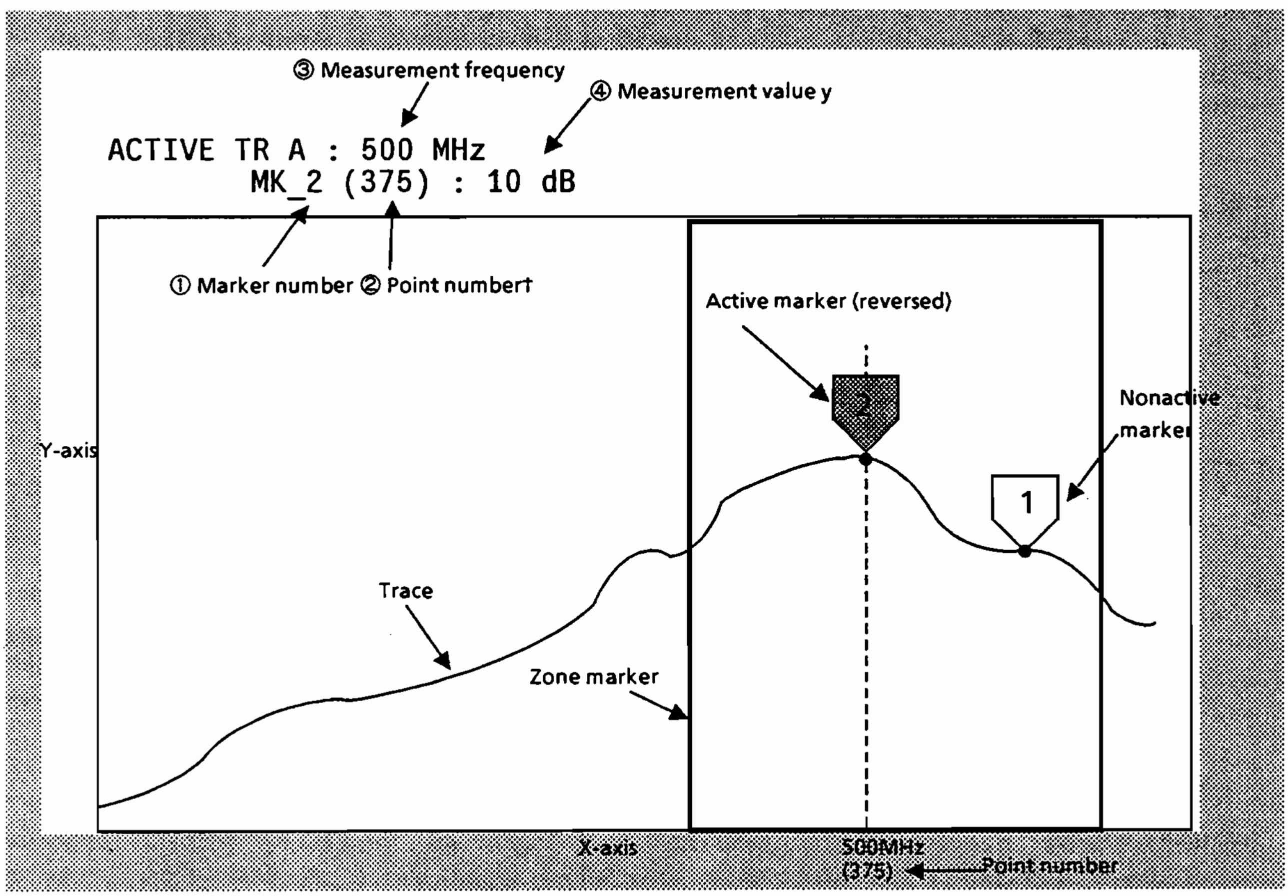
4.3.1 Marker function summary

When a marker placed on a trace waveform is specified as an active marker, it is reversed. The MS4662A:

① Displays the marker number of the active marker,
② Displays the measuring point number in ( ),
③ Displays the measurement frequency f at the point number, and
④ Displays the measurement value at the point number.

When the measurement value mentioned above is a relative value between two markers, the reference marker is called a delta (Δ) marker, or called a 0 marker, depending on how the reference is set.

A marker that points to a unique measurement value, not a relative value, is called a normal marker.



The part of the display surface enclosed in bold lines above is called a zone marker. The frame width is variable on both sides. A zone marker can be used not only as a reference marker but also to specify a zone for the feature extraction function.

Note: The designation of MK_2 above applies to a normal marker. A Δ or 0 marker would be designated in the following ways:
Δ marker designation → Δ* – #
0 marker designation → 0 MK *
(* denotes an active marker 0 to 9, #, a reference marker 0 to 9, L or R.)

* May also be designated in terms of X-axis frequencies.

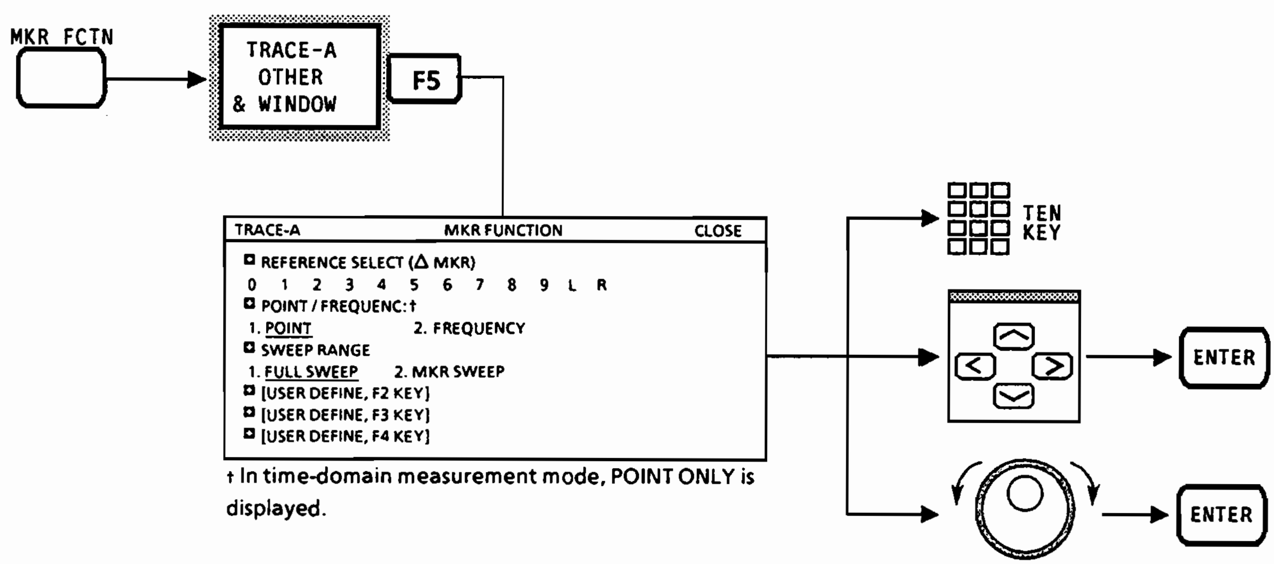
4.3.2 Generating markers and changing the active marker position

The MS4662A provides a multimarker function to display up to 10 markers simultaneously. These markers are numbered from 0 to 9.

Instructions on generating markers, designating a particular marker as an active marker, and controlling its marker position are given below. To use the default marker position setup parameter POINT, begin with (2).

(1) Selecting the marker position setup parameter

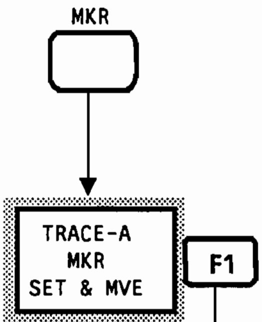
The marker position setup parameter can be selected by pressing keys in the sequence described below. As indicated in the POINT/FREQUENCY parameter group in the MKR FUNCTION window, two alternative parameters are available for setting the marker position: POINT and FREQUENCY. The default is POINT. The key-in sequence below also explains how to change the marker position setup parameter from POINT to FREQUENCY or vice versa. In time-domain measurement, in which the timebase is used, POINT ONLY is displayed as a parameter choice because frequency setting is not available.



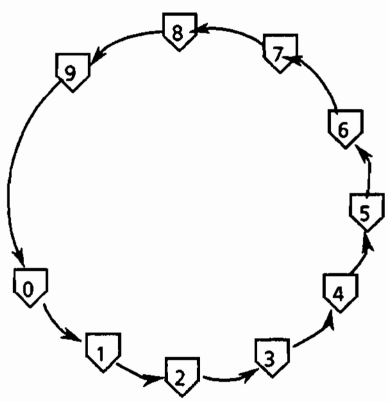
① Select the POINT/FREQUENCY parameter group with the ∧ or ∨ key.

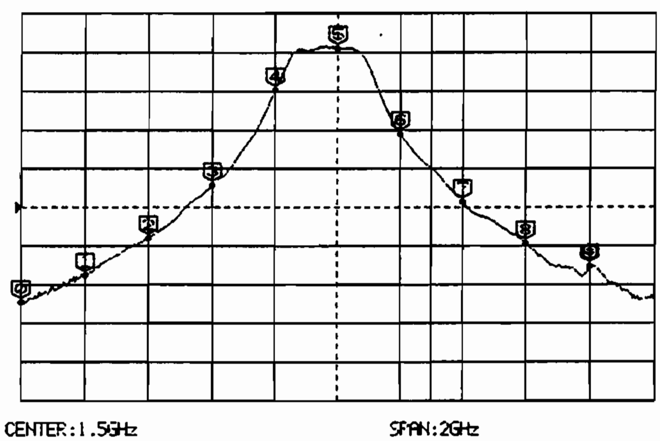
② Select 1. POINT or 2. FREQUENCY with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply type in the parameter number; there is no need to press the ENTER key.

(2) Generating a marker, and setting and repositioning the active marker

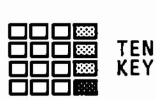


① Pressing the F1 softkey (MKR SET & MOVE) displays the softkey label frame in bold lines, generating a new marker in ascending number order to work as an active marker. If an active marker already exists, the marker with the next higher number is designated as an active marker in its place. When marker 9 is already active, however, marker 0 is designated as an active marker. An active marker is generated cyclically each time MKR SET & MOVE is pressed.





② While the softkey label frame of the F1 softkey (MKR SET & MOVE) is displayed in bold lines, the number and marker position of the active marker are displayed in the direct entry area at the lower right corner of the screen. If the marker position setup parameter POINT has been selected and the current marker position is 250, with active marker number 1, then the active marker is designated as MK_1 (250). This format indicates that the marker position is variable, permitting the active marker to be moved from the left edge of the frequency axis (timebase) onscreen to the right edge, along with the zone marker. An example of moving an active marker each time it is generated is shown above.



...... Type in the point number or frequency of the destination X-axis coordinate. Then, press the ENTER key to that point.

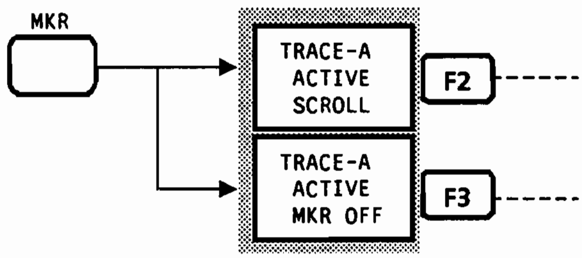
Cursor keys

...... Move in steps of one division.
(The > key moves to the right, the < key to the left.)

...... Moves in steps of one point.
(Turn clockwise to move to the right, counterclockwise to move to the left.)

4.3.3 Selecting and deselecting the active marker by scrolling

To select and deselect the active marker by scrolling, press keys in the following sequence:

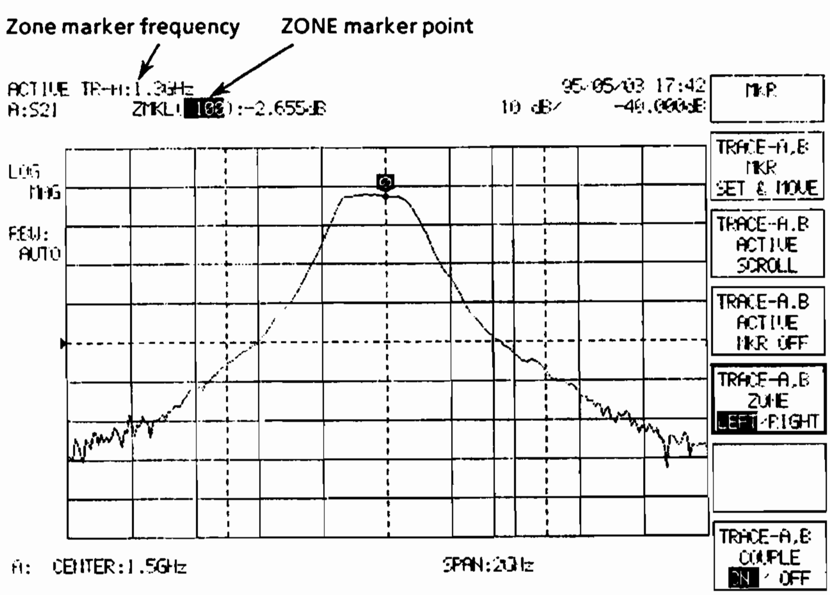


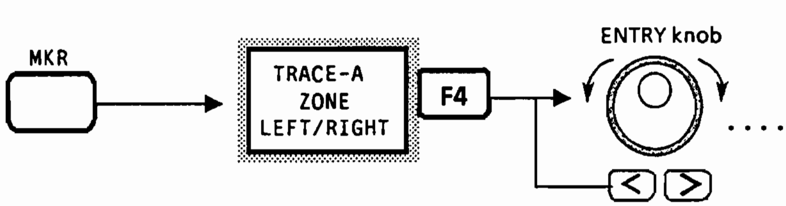
Each time the key is pressed, the active marker moves from one marker to the next displayed. Press F1 after the key.
<Example> 1→5→7→8→1→5→ ········

Each time the key is pressed, the active marker is deleted between the markers displayed. Press F1 after the key.
<Example: Marker 5 active > 5→7→8→1

4.3.4 Changing the width and position of the zone marker

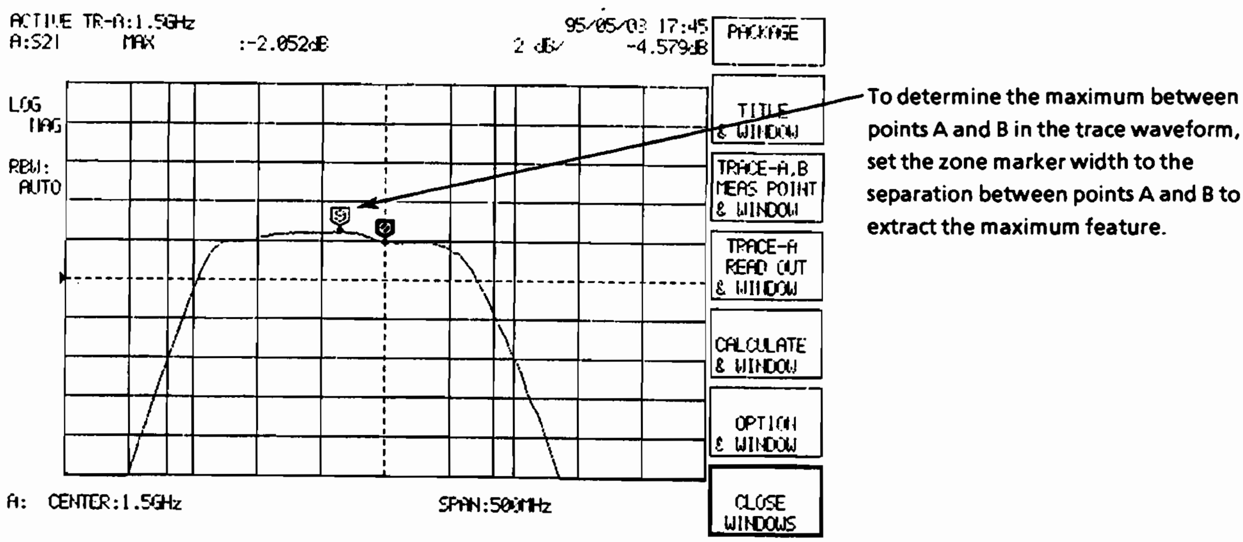
The part of the display surface enclosed in bold lines is called a zone marker. The zone marker is positioned at the dotted lines by default.



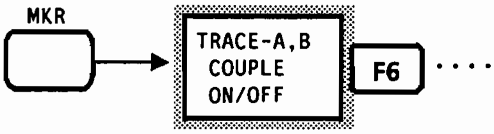


Either LEFT or RIGHT is always reversed. Use the < or > key or with the ENTRY knob to vary the zone marker on the selected side. Reverse the LEFT and RIGHT toggle each time the key is pressed.

The zone marker is used to get a selected range of a trace waveform onscreen and to determine characteristic points, such as the maximum and minimum, within that range. This process is called target data search. (→For more details on feature extraction, see Section 6, "Package Functions.")

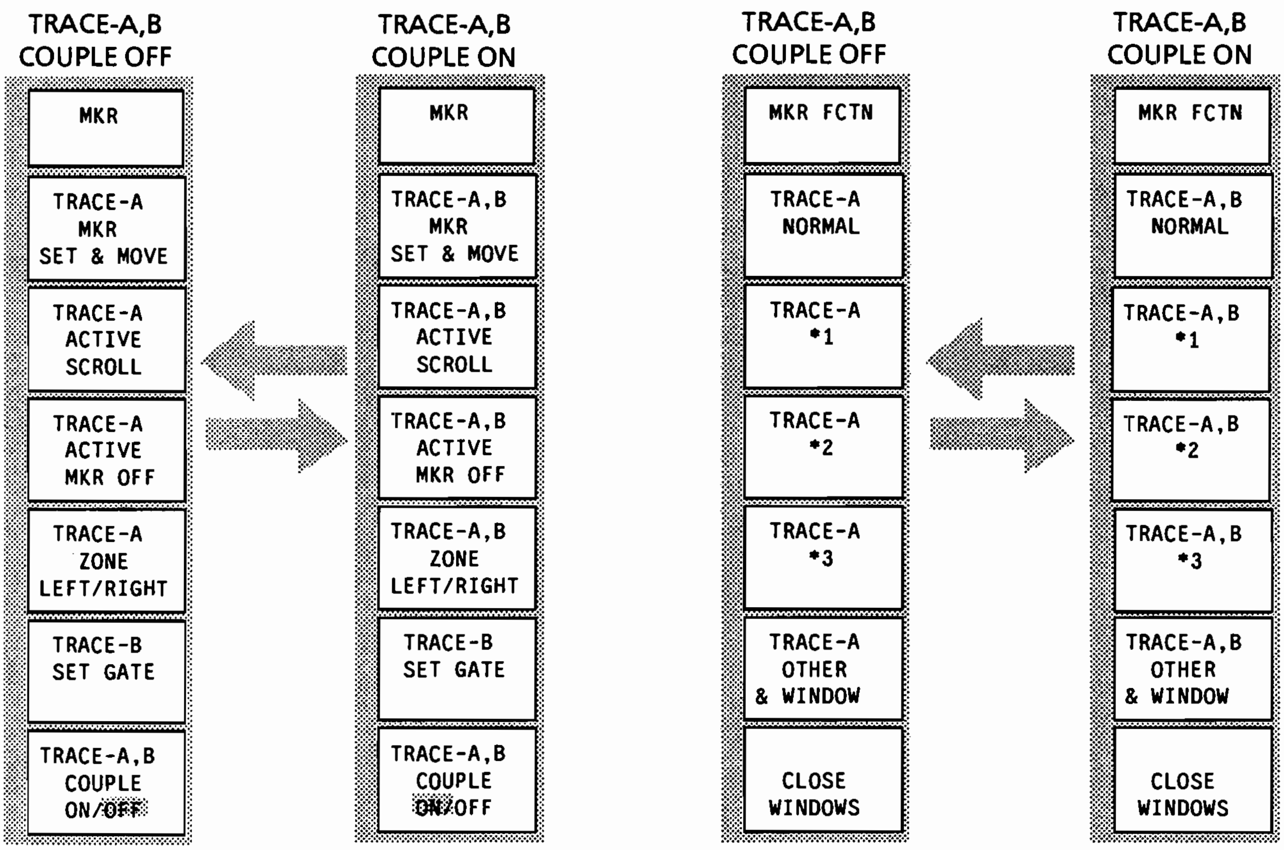


4.3.5 Marker function trace A/B coupling



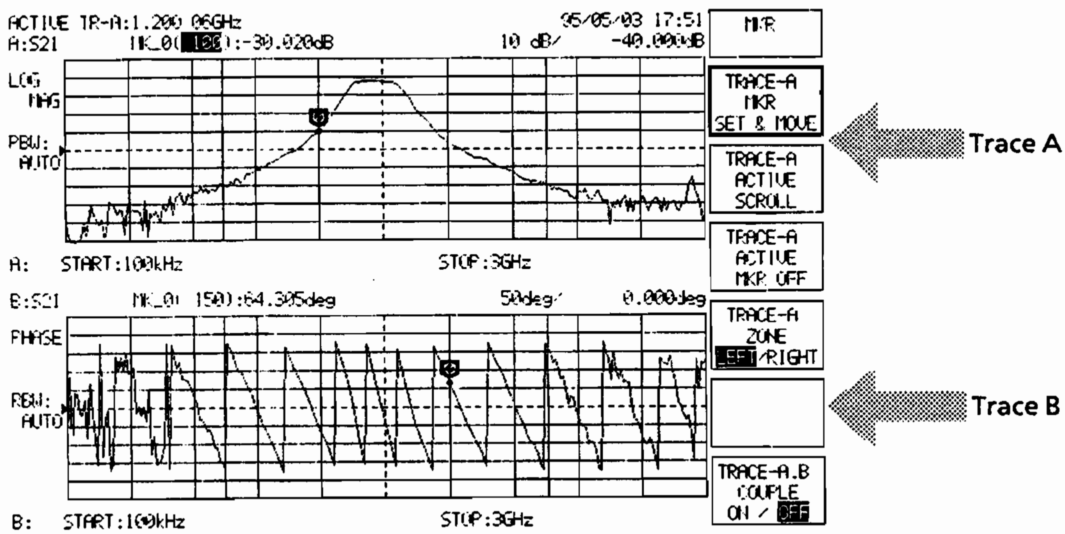
. . . . The key toggles between ON and OFF each time it is pressed. The current setting is reversed.

The softkey indications in the marker coupling ON/OFF states are shown below.



Note: TRACE-B SET GATE on F5 is displayed only in the time-domain measurement mode.

An operation in the TRACE-A, B COUPLE OFF mode is illustrated below. The active marker displayed on trace A or B can be moved independently by pressing F1, then operating the < or > key or with the ENTRY knob.



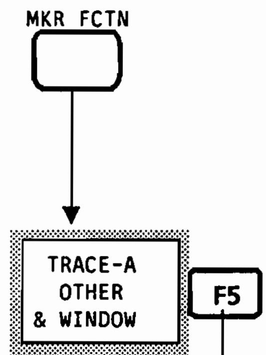
Example operation in the TRACE-A, B COUPLE OFF mode

4.3.6 User programming and execution of marker functions

User programming and execution of marker functions consists in selecting desired marker functions from the 12 choices listed in the USER DEFINE level 2 window (→see (2) for explanations of the individual functions) and programming them on the F2, F3, or F4 softkeys. If a marker function is thus programmed, it can be executed by simply pressing the F2, F3, or F4 softkey without having to open the F5 softkey window. When ΔMKR is selected, however, F5 must be pressed to open the MKR FUNCTION level 1 window to change the reference marker number.

(1) Marker function user programming flow

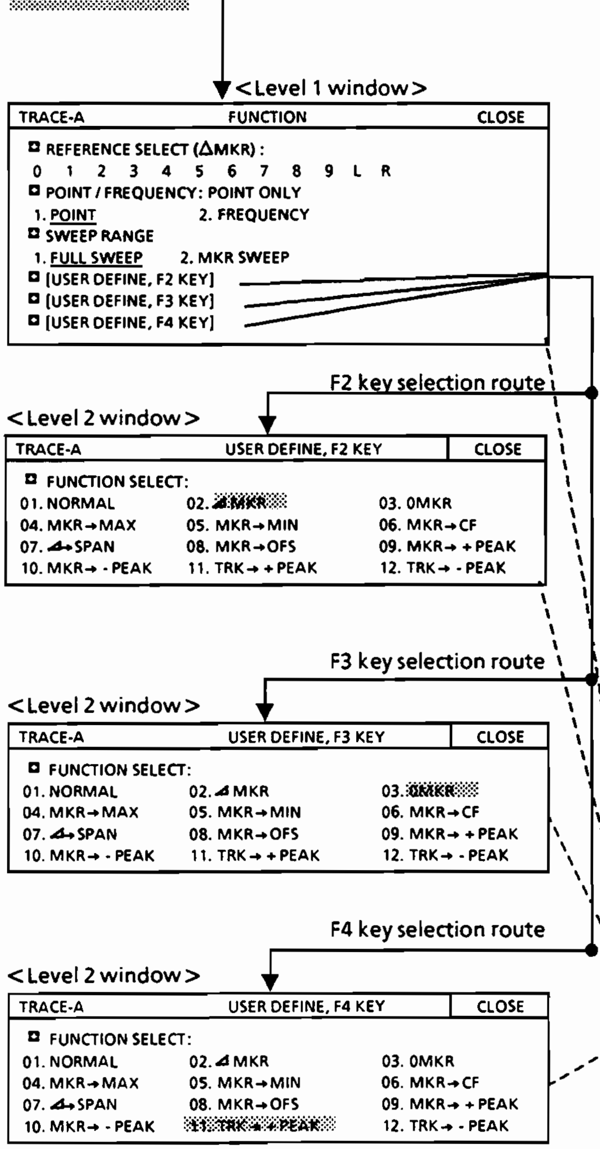
Examples of programming the ΔMKR, 0MKR, and TRK → +PEAK functions on F2, F3, and F4, respectively, are given below.

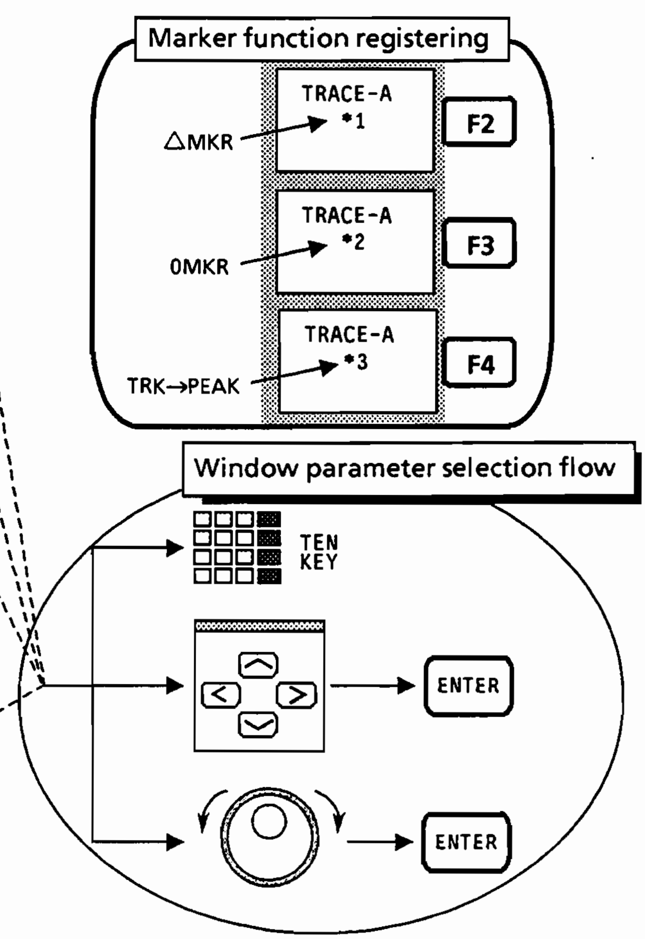


①Select [USER DEFINE, F2 KEY] from the MKR FUNCTION level 1 window with the ∧ or ∨ key or with the ENTRY knob, and press the ENTER key. The USER DEFINE, F2 KEY level 2 window opens.

②Select 2. ΔMKR from the MKR FUNCTION SELECT parameter group with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key. (For single-digit parameter numbers, type 0 first. In this example, type 02.)

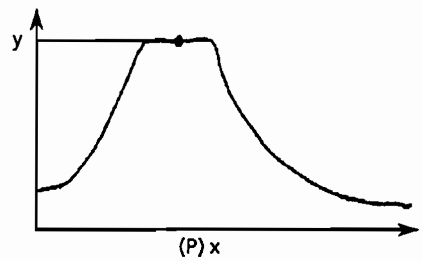
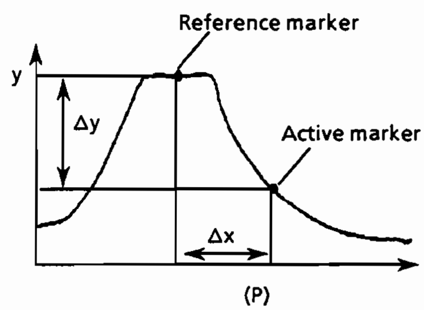
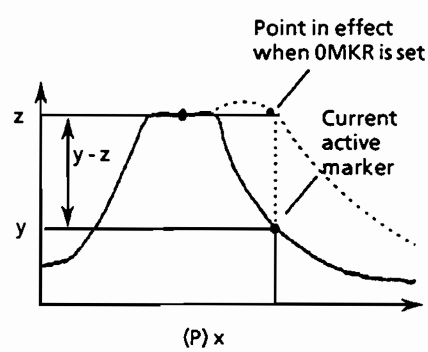
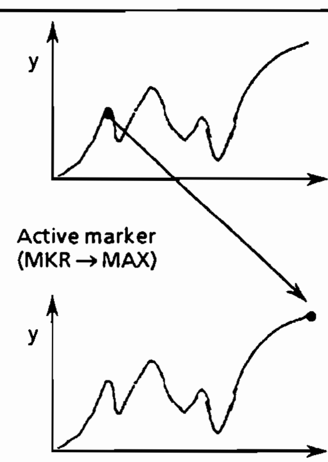
③Do the same as steps ① and ② for the 0MKR and TRK → +PEAK functions as well. To program 0MKR, open the USER DEFINE, F3 KEY level 2 window. To program TRK → +PEAK, open the USER DEFINE, F4 KEY level 2 window.

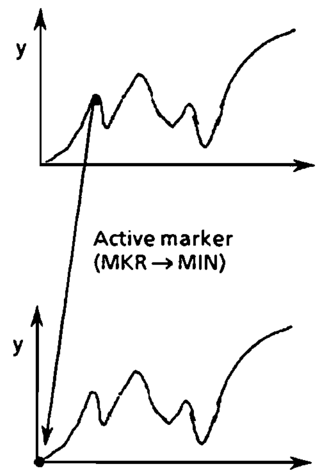
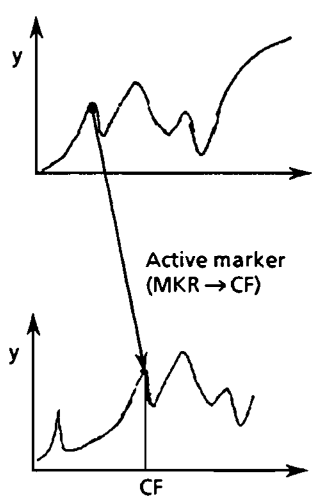
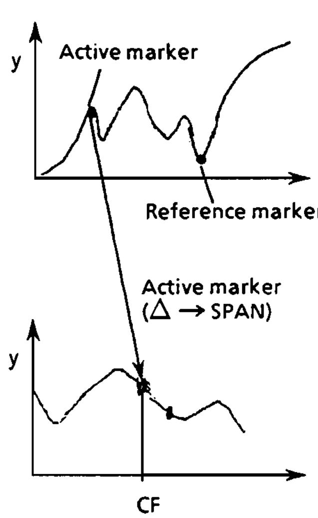


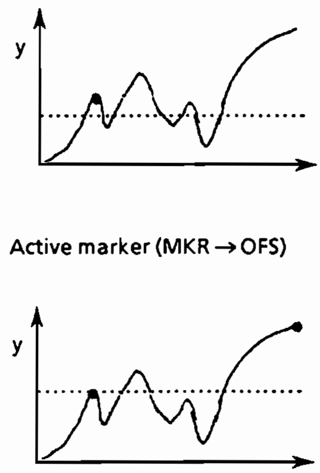
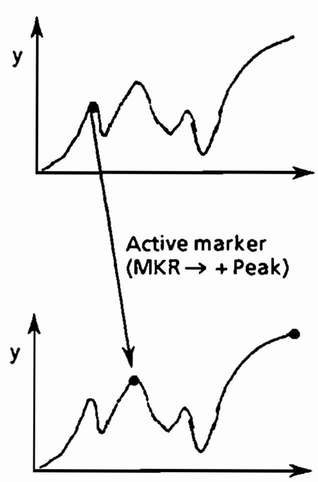
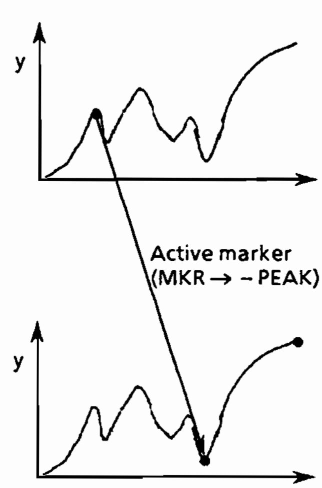


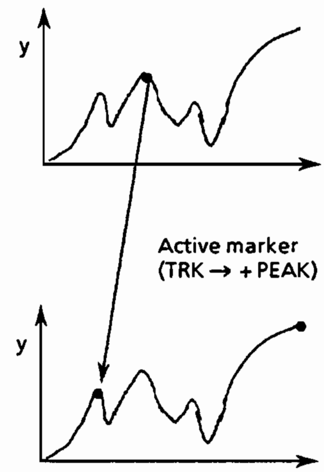
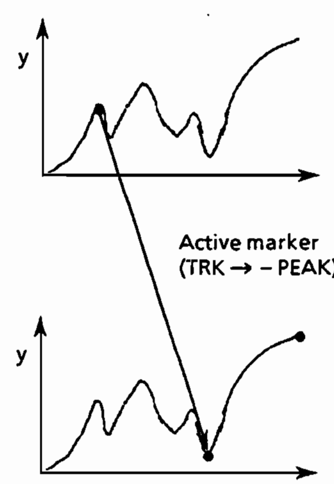
(2) Descriptions of marker functions

The table below gives explanations of the 12 marker functions listed in the USER DEFINE window.

No.	Function name	Explanatory drawing	Description
1	NORMAL		Marker function: NORMAL Indicates the position of the active marker in terms of the number of points p (0 to 1,000) and the coordinate value X of that point as marker position information. Further, the measurement value y at the point p pointed by the active marker point is displayed.
2	ΔMKR (Delta marker)		Marker function: ΔMKR Indicates the position of the active marker in terms of the number of points p (0 to 100) and displays the difference Δx between the active marker coordinate value and the reference marker coordinate value. Further, the difference Δy between the measurement value pointed to by the active marker and that pointed by the reference marker is displayed.
3	0MKR (Zero marker)		Marker function: 0MKR Indicates the position of the active marker in terms of the number of points p (0 to 1,000) and the coordinate value X of that point as marker position information. When the 0MKR mode is set, the measurement value pointed to by the active marker is stored as a reference value z, and the difference from the measurement value y pointed to by the current active marker (y − z) is displayed.
4	MKR → MAX		Marker function: MKR → MAX Moves the active marker to the point that indicates the maximum measurement value in the waveform onscreen and resets the marker function choice to NORMAL.

No.	Function name	Explanatory drawing	Description
5	MKR → MIN		Marker function: MKR → MIN Moves the active marker to the point that indicates the minimum measurement value in the waveform onscreen and resets the marker function choice to NORMAL.
6	MKR → CF		Marker function: MKR → CF Sets the coordinate value (frequency) pointed to by the active marker as a center frequency (CF) and resets the marker function choice to NORMAL. If an iterative sweep has been executed, the measurement result that reflects the new center frequency is displayed.
7	Δ → SPAN		Marker function: Δ → SPAN Sets the absolute difference between the coordinate value (frequency) pointed to by the active marker and the coordinate value (frequency) pointed to by the reference marker as a span environment (SPAN) and resets the marker function choice to NORMAL. The active marker moves to the center frequency (CF) point. If an iterative sweep has been executed, the measurement result that reflects the new span frequency is displayed.

No.	Function name	Explanatory drawing	Description
8	MKR → OFS		Marker function: MKR → OFS Sets an offset to move the measurement value pointed to by the active marker to offset line and resets the marker function choice to NORMAL. An offset line center is shown at left.
9	MKR → + PEAK		Marker function: MKR → + PEAK Moves the active marker to the point that gives the maximum measurement value at the peak in the waveform onscreen and resets the marker function choice to NORMAL.
10	MKR → - PEAK		Marker function: MKR → - PEAK Moves the active marker to the point that gives the minimum measurement value at the bottom in the waveform onscreen and resets the marker function choice to NORMAL.

No.	Function name	Explanatory drawing	Description
11	TRK → + PEAK		Marker function: TRK → PEAK Searches for the maximum measurement value at the peak in the waveform onscreen at the completion of each sweep and moves the active cursor to that point.
12	TRK → − PEAK		Marker function: TRK → − PEAK Searches for the minimum measurement value at the bottom in the waveform onscreen at the completion of each sweep and moves the active cursor to that point.

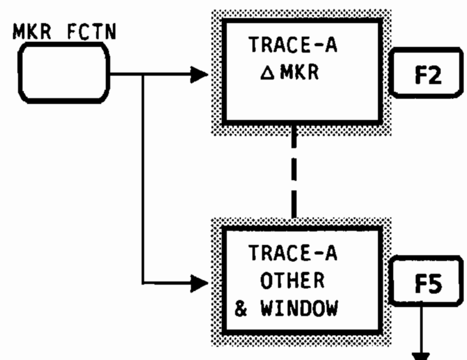
Note: If NORMAL, ΔMRK, 0MRK, TRK → +PEAK, or TRK → − PEAK is selected with feature extraction on, feature extraction is turned off.

4.3.7 Measuring frequency and level differences with a Δ marker

The frequency and level differences between two points can be measured with a Δ marker. For explanation's sake, it is assumed that the ΔMKR function is preprogrammed on the F2 softkey that is displayed by pressing the MKR FCTN key and that the marker position setup parameter POINT has been selected. In Δ marker measurement, one of the two points of interest is designated as an active marker point (x1, y1), and the other as a reference marker point (x2, y2). $x1-x2 = \Delta x$ is taken as a frequency difference, and $y1-y2 = \Delta y$ is taken as a level difference. The key-in sequences are explained below.

(1) Setting a reference marker

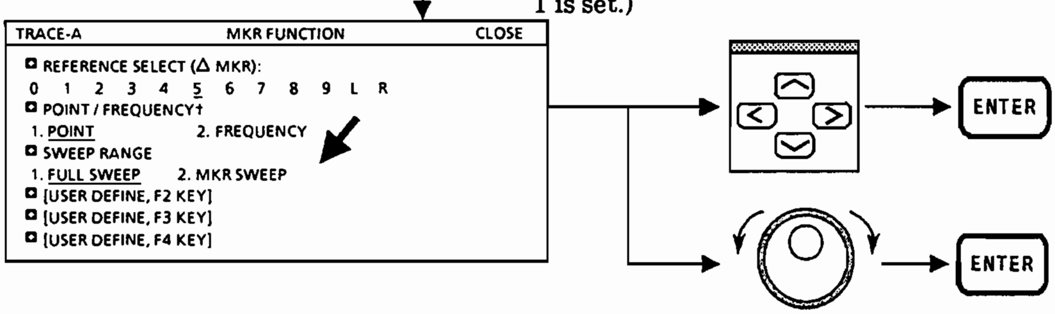
Pressing the SCREEN key displays the SCREEN menu shown below. Press keys in the following sequence:



① Press F2 to set the ΔMKR mode.

② Select the REFERENCE SELECT (ΔMKR) parameter group with the ∧ or ∨ key or with the ENTRY knob.

③ Select a reference marker from among the reference marker numbers 0 to 9 and the leftmost end L and the rightmost end R of the zone marker with the < or > key or with the ENTRY knob, and press the ENTER key. A reference marker, when so established, has an underbar drawn under it. (In the example below, reference marker 1 is set.)

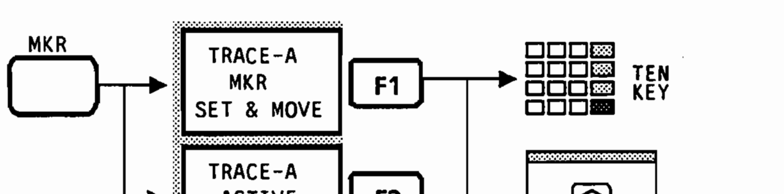


(2) Setting and moving an active marker

To set and move an active marker, press keys in the following sequence:

① Press F1 to generate two markers.

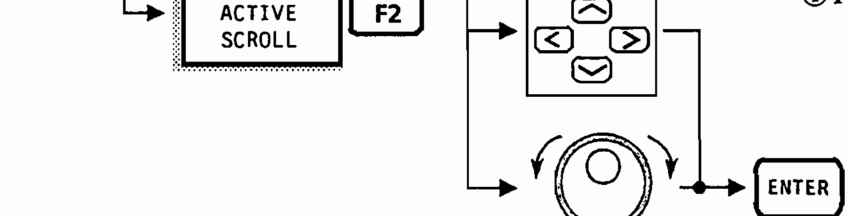
② Move the active marker to a desired point with the < or > key or with the ENTRY knob.



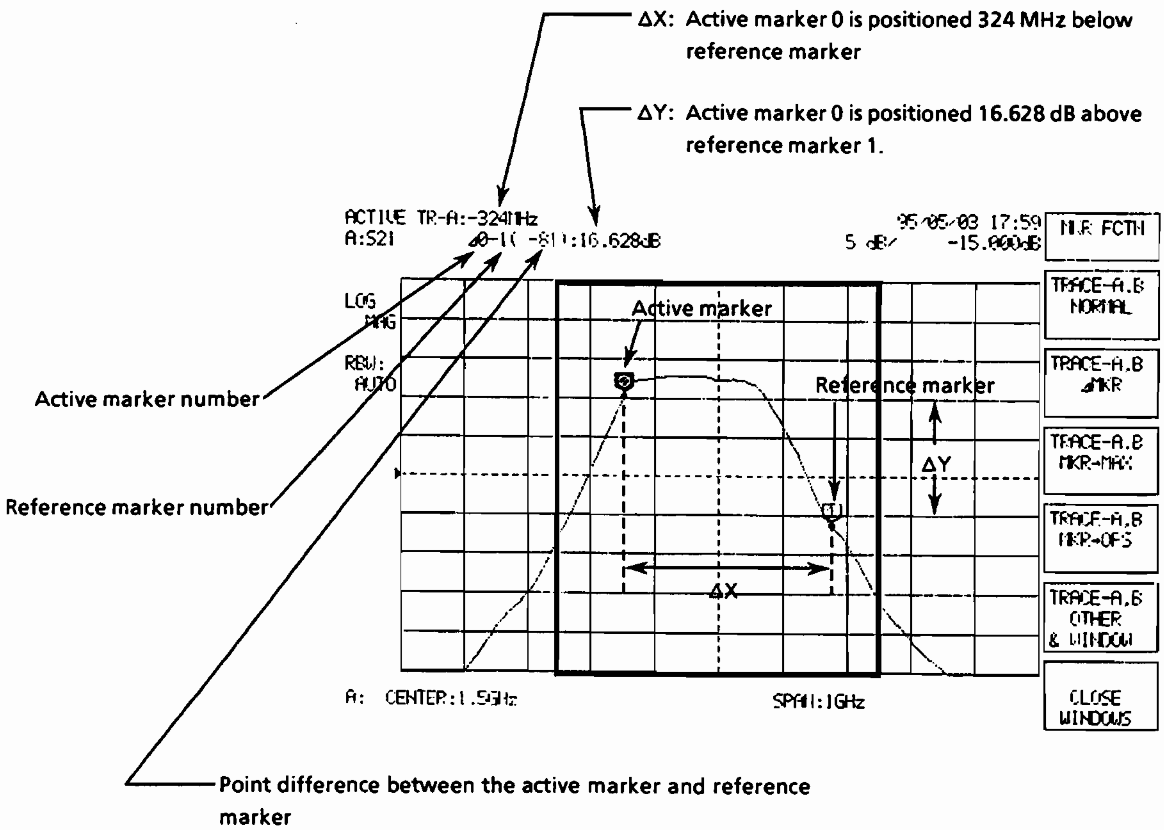
When using numeric keys, type in the destination point number and press the ENTER key.

③ Press F2 to make the other marker active.

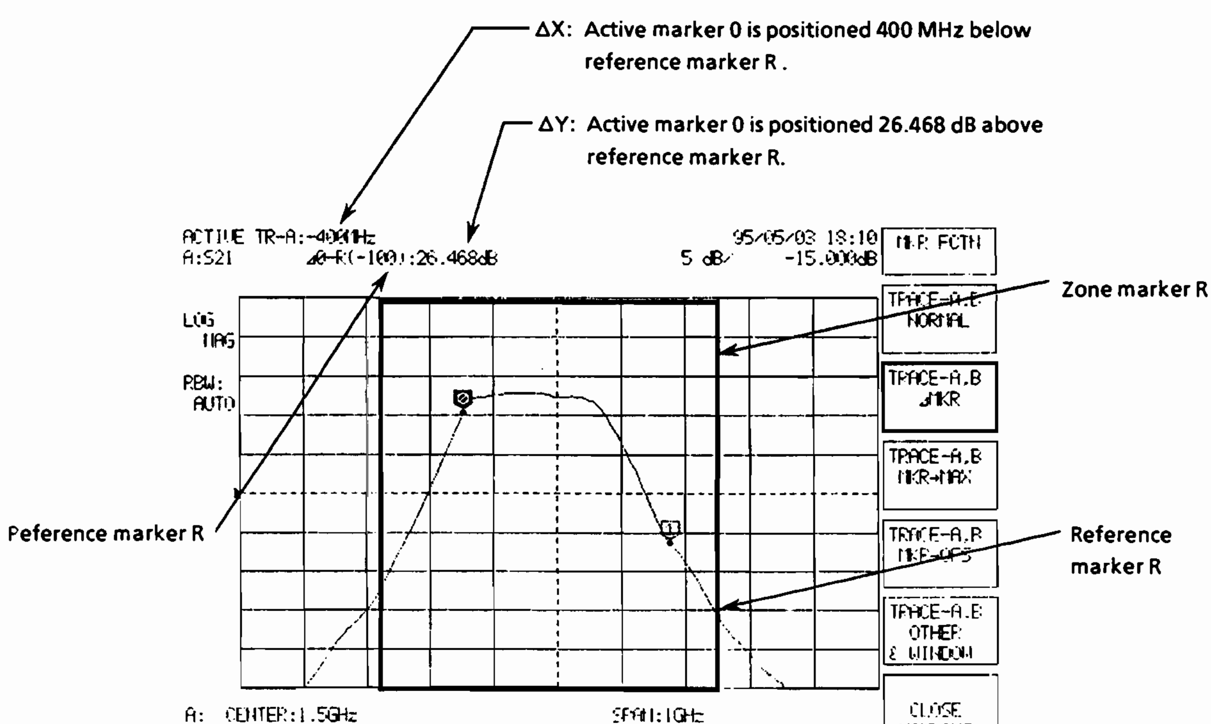
④ Perform step ②.



An example of measuring the frequency difference ΔX and the level difference ΔY between active marker 0 at point 163 and reference marker 1 is illustrated below.



An example of measuring the frequency difference ΔX and the level difference ΔY between active marker 0 at point 163 and reference marker R at the rightmost end of the zoner marker is illustrated below.



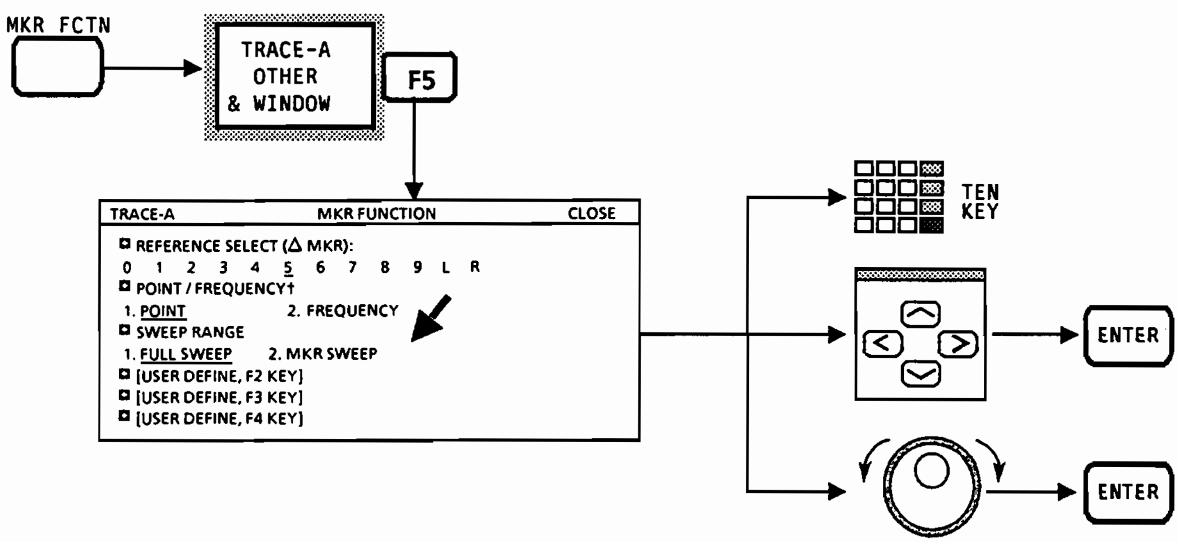
4.3.8 Marker sweep

In the normal sweep mode, a sweep begins at the center or start frequency and scans a specified frequency span or specified interval between the start and stop frequencies. In the MS4662A, this is called a full sweep. In contrast to a full sweep, a marker sweep is available to scan the interval between the active and reference markers. Marker sweeps provide a convenient means of analyzing a selected portion of the onscreen sweep area at large and at high speed. The key-in sequences are explained below.

(1) Selecting the MKR SWEEP parameter

① Select the SWEEP RANGE parameter group with the ∧ or ∨ key.

② Select 2. MKR SWEEP with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

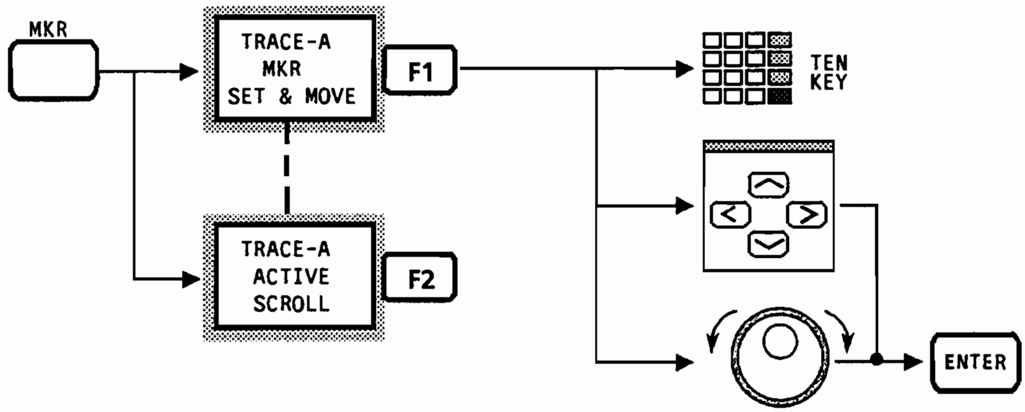


(2) Setting a reference marker

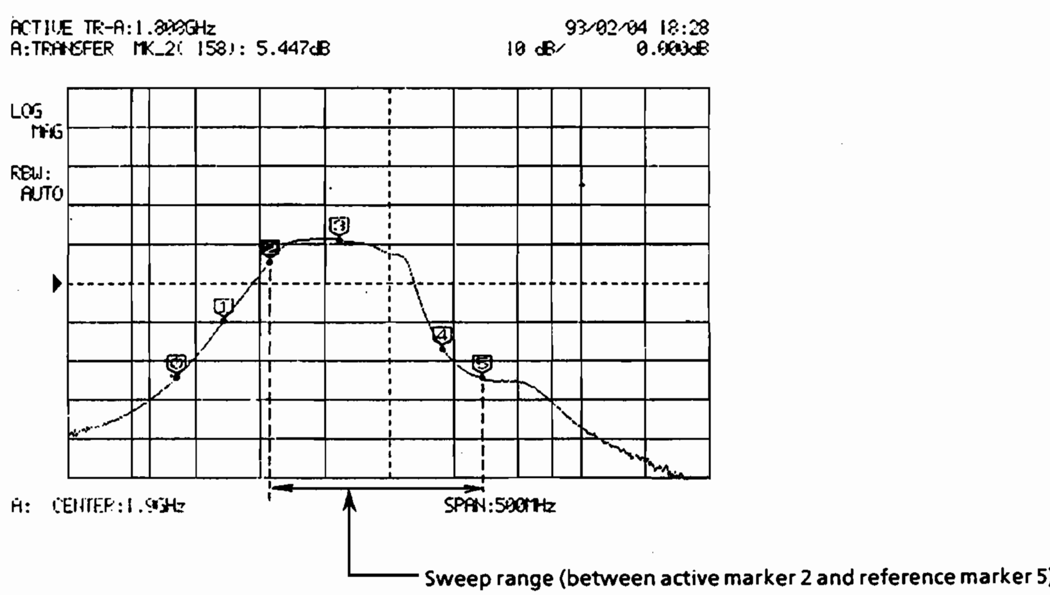
Set a reference marker as instructed in Section 4.3.7 (1). Normally, a reference marker is set in the ΔMKR mode, but it can also be set in any other mode as well. Bypass the ΔMKR selection procedure if a marker sweep is not executed in the ΔMKR mode. To execute a marker sweep in the ΔMKR mode, set the ΔMKR mode as instructed in Section 4.3.7 (1). (Reference marker 5 is set in the example below.)

(3) Setting and moving an active marker

Set an active marker as instructed in Section 4.3.7 (2). Place the active marker and the reference marker at the ends of the sweep range.

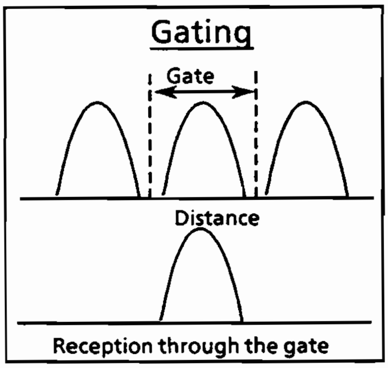


In the example below, a marker sweep is executed between marker 5 set as a reference marker on one hand and active marker 2 on the other.



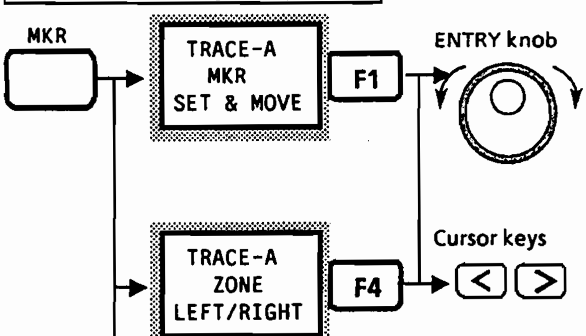
4.3.9 Gating in time-domain measurement

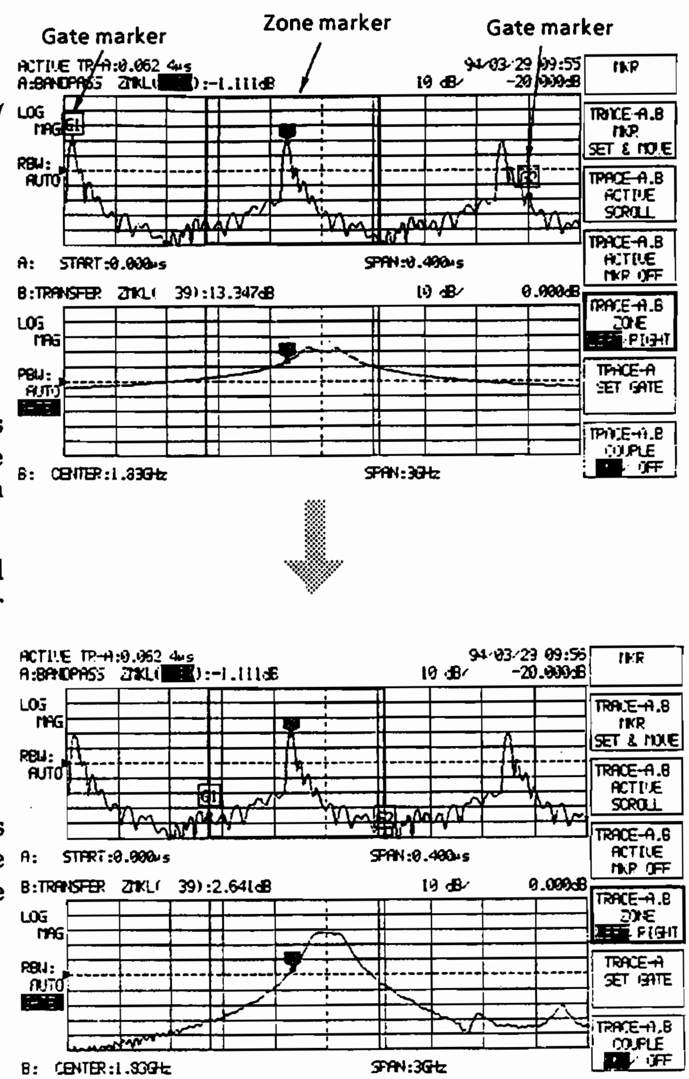
The MS4662A executes time-domain measurement in trace A and converts the time domain to a frequency domain in trace B. In time-domain measurement, a gate is set to receive only the responses of interest, with undesired waves removed. The gating start and stop points are set using the marker functions. When the gate is turned on, responses located outside the gate are removed from the time-domain trace through a mathematical calculation process. Such time filtering is called gating.



Gated time-domain responses can be directed back to trace B for conversion to a frequency domain.

The gating procedure is explained below.





① Press F1.

② Move the active and zone markers to the time-domain responses to be gated with the < or > key or with the ENTRY knob.

③ Press F4 to adjust the leftmost and rightmost ends of the zone marker to the gating start and stop points.

④ Press F5 to fix the gate markers G1 and G2 in association with the leftmost and rightmost ends of the zone marker, respectively.

Note: The F5 softkey label is displayed only in the time-domain measurement mode (see Chapter 5). If gating is turned on by pressing the TIME DOMAIN key, the frequency waveform associated with the range of gating set on trace A is displayed on trace B.

SECTION 5
SELECTING MEASUREMENT PARAMETERS

This chapter explains how to select measurement parameters to set up measurement conditions. The measurement parameters are selectable from the softkey menus that are displayed by pressing the FREQ, SWEEP, PORT POWER, AVG, and TIME DOMAIN keys in the front-panel MEASURE section.

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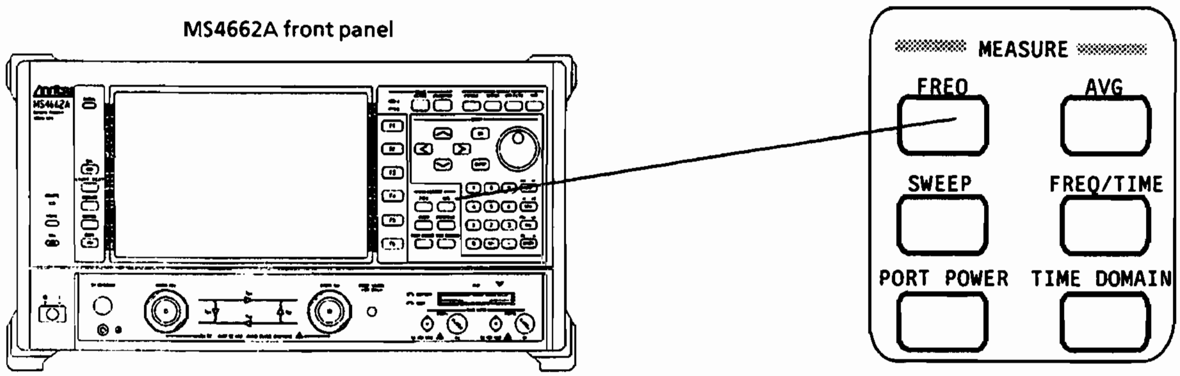
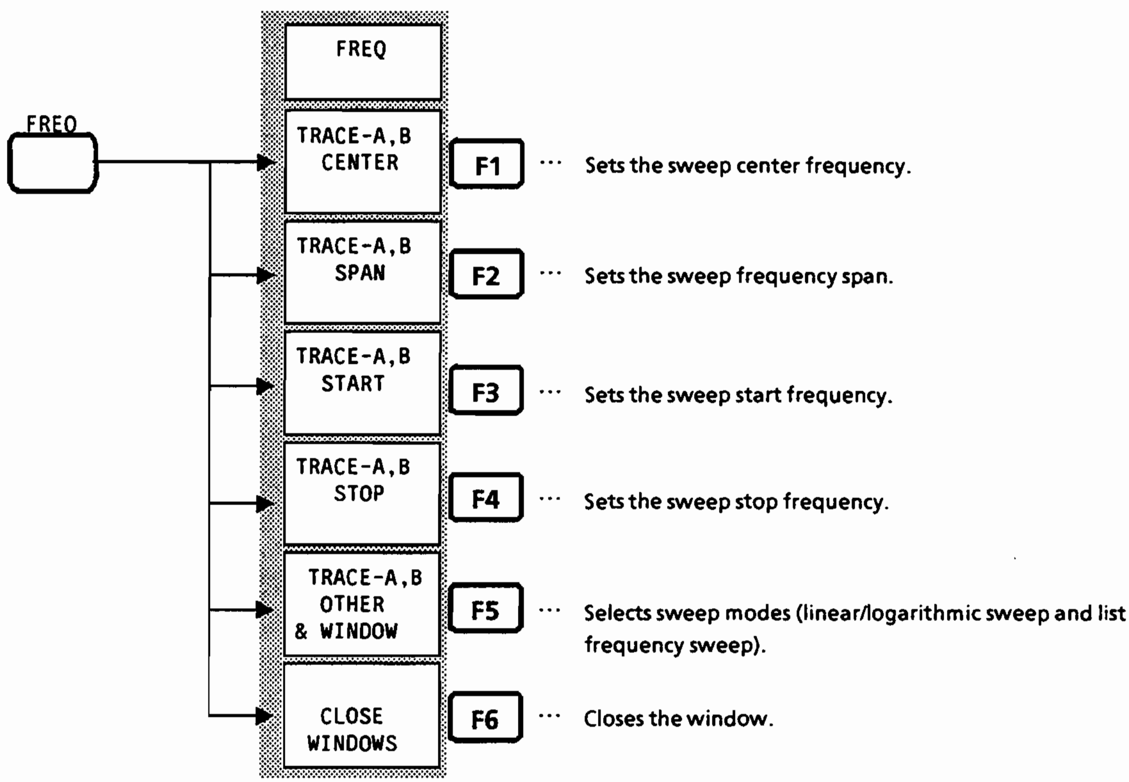
5.1 Selecting Frequency Setup Parameters .... FREQ

Pressing the FREQ key displays the FREQ softkey menu for selecting frequency setup parameters.

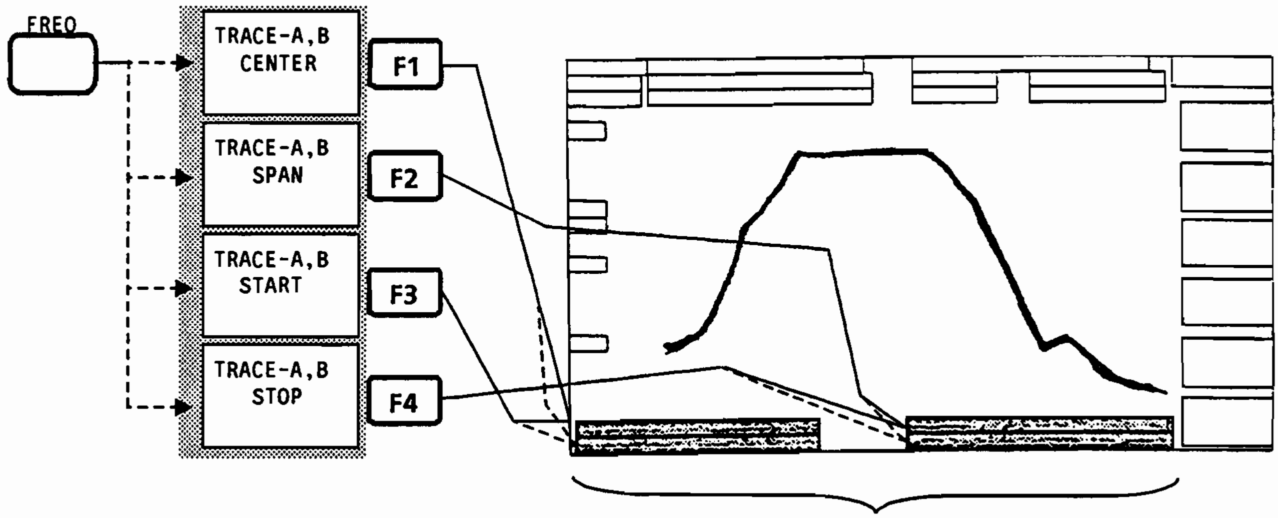




Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the SWEEP menu, which is displayed by pressing the SWEEP key. When TRACE-A, B COUPLE OFF (which appears onscreen as TRACE-A, B COUPLE ON/OFF) is set by pressing F6 in the SWEEP menu, each softkey label TRACE-A, B displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active.

5.1.1 Setting sweep frequencies .... CENTER, SPAN, START, STOP

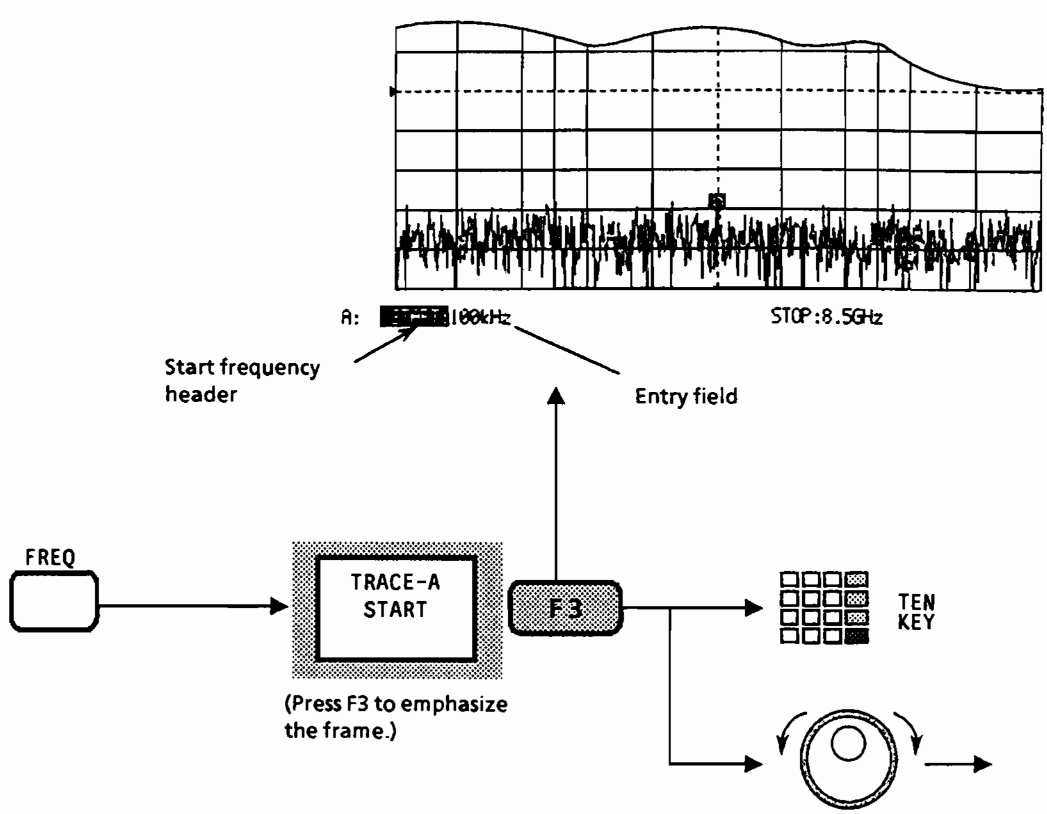
The sweep frequencies, CENTER, SPAN, START, and STOP, are set directly in direct entry areas at the bottom of the screen by using the ENTRY knob or numeric keys.



Direct entry areas (upper: TRACE-A; lower: TRACE-B)

<Example of setting the start frequency>

The procedure shown below reverses the START header. After updating the data directly with the ENTRY knob or entering new data with numeric keys, press a unit key to conclude the setting.



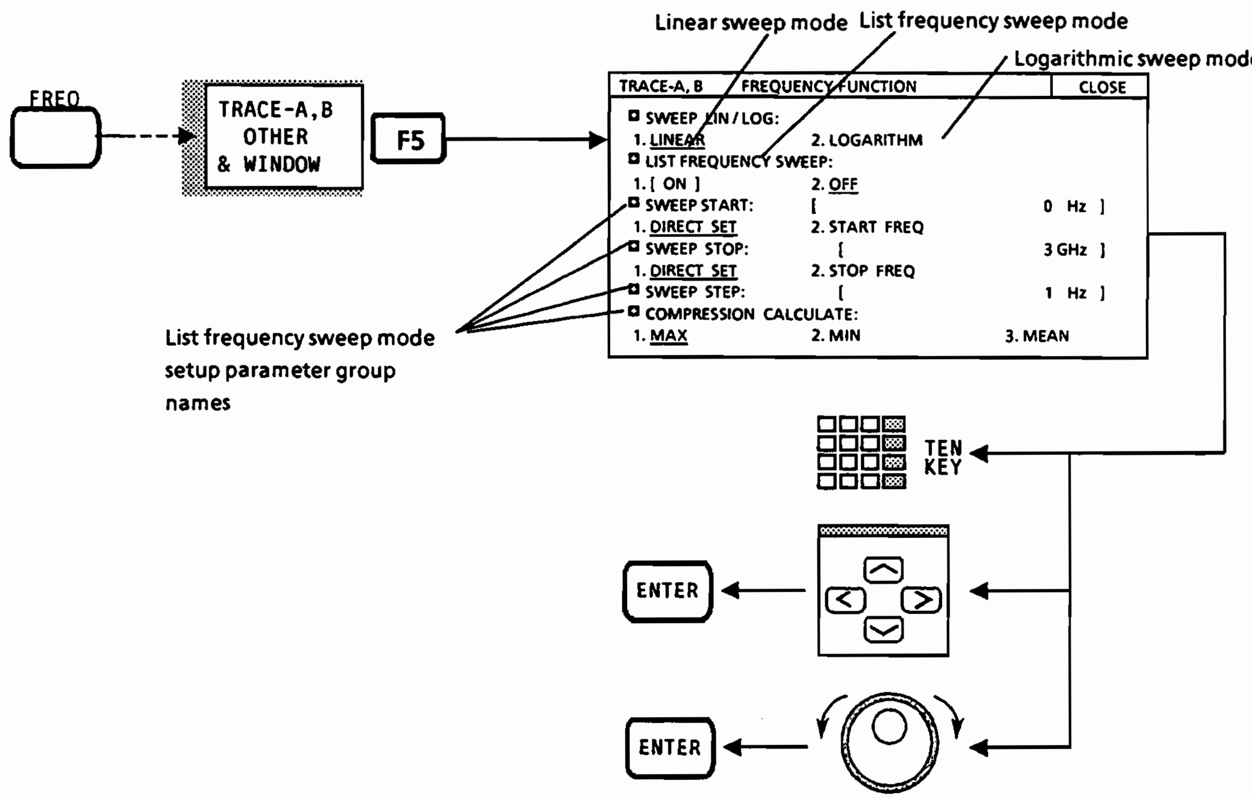
(Press F3 to emphasize the frame.)

Set the other frequency parameters (CENTER, SPAN, and STOP) the same way. When a frequency parameter is selected, its frame is displayed in bold lines. The entry field header is reversed.

5.1.2 Selecting sweep modes

Press F5 to open the FREQUENCY FUNCTION window to select one of the following sweep modes:

- Linear sweep mode
- Logarithmic sweep mode
- List frequency sweep mode



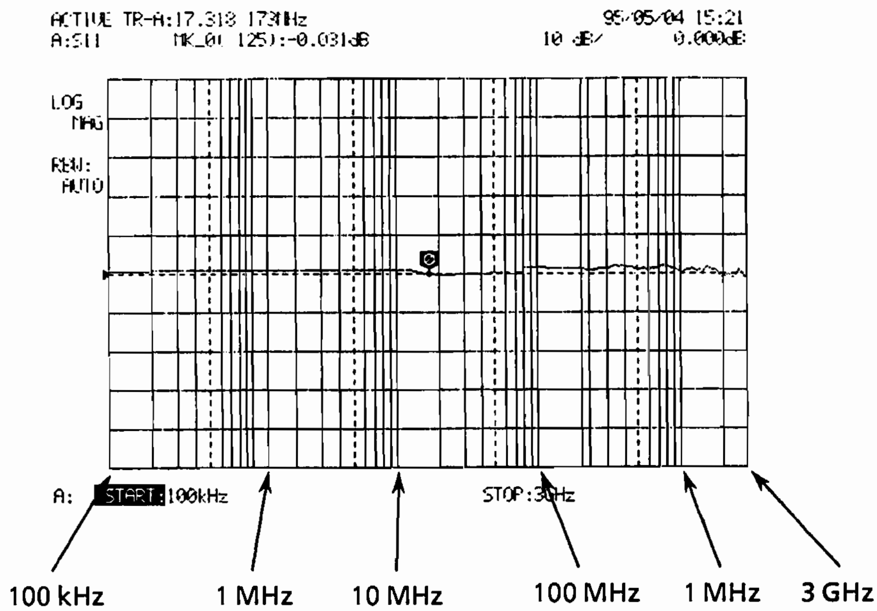
(1) Setting the logarithmic sweep mode .... LOGARITHM

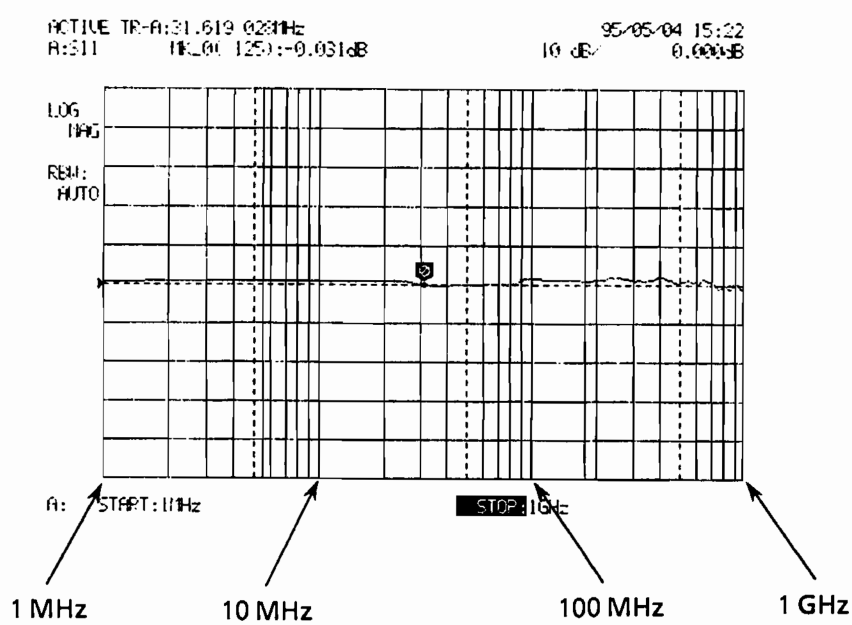
The linear mode (LINEAR), in which the frequency divisions on the X-axis are spaced equally, is selected by default. To run a logarithmic sweep, perform the following key-in procedures:

① Select the SWEEP LIN/LOG parameter group with the ∧ or ∨ key.

② Select 2. LOGARITHM with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply type in the parameter number 2; there is no need to press the ENTER key.

The low-limit start frequency for a logarithmic sweep is 100 kHz. Five settings - 100 kHz, 1 MHz, 10 MHz, 100 MHz, and 1 GHz - are available for selection as the start and stop frequencies, except for points other than f = 3 GHz for the stop frequency. Set the start and stop frequencies to meet the relation Fstop > Fstart. Examples of setting a start frequency and a stop frequency are given below.

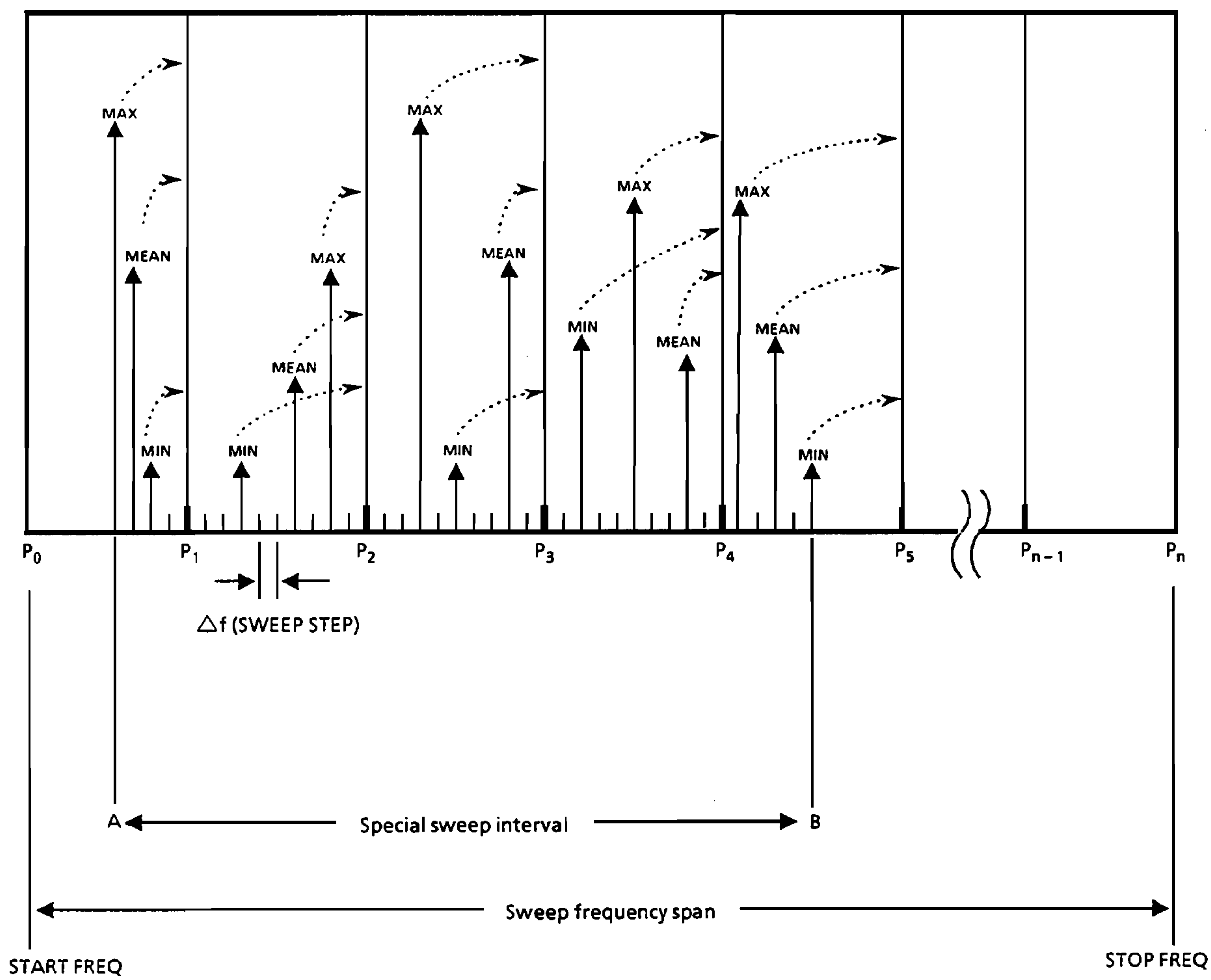




(2) Setting the list frequency sweep mode .... LIST FREQUENCY SWEEP

A special sweep interval, A through B, may be specified between the normal start frequency (START FREQ) and the stop frequency (STOP FREQ) to get more detailed data from that frequency range than from elsewhere. This is called the list frequency sweep mode.

In the list frequency sweep mode, the interval between one measurement value display point and the next is swept in a more detailed step Δf (SWEEP STEP) and the maximum (MAX), minimum (MIN) or mean value (MEAN) of the resultant data is held. When the sweep reaches the next measuring point P indicated by dotted lines, the maximum (MAX), minimum (MIN) or mean value (MEAN) that has been held is retained in memory and the measurement value is displayed as waveform data. The list frequency sweep mode is set off by default.



<Example settings>

In measurement up to 10 MHz at 10 measuring points, measure the maximum, minimum or mean value in a list frequency range of 500 kHz to 4.4 MHz in steps of 100 kHz.

- START FREQ .... 0 MHz
- STOP FREQ .... 10 MHz
- START LIST FREQUENCY .... 500 kHz
- STOP LIST FREQUENCY .... 4.4 MHz
- SWEEP STEP (Δf) .... 100 kHz

<1> Setting SWEEP START

① Select ON in the LIST FREQUENCY SWEEP parameter group with the ∧ or ∨ key, and press the ENTER key.

② Select DIRECT SET in the SWEEP START parameter group with the ∧ or ∨ key, and press the ENTER key.

③ Select the SWEEP START entry field with the ∧ or ∨ key.

④ Type 500 with numeric keys and press the kHz unit key.

⑤ Select START FREQ in the SWEEP START parameter group with the ∧ or ∨ key, and press the ENTER key.

⑥ Select the SWEEP START entry field with the ∧ or ∨ key.

⑦ Type 0 with a numeric key and press the MHz unit key.

<2> Setting SWEEP STOP and SWEEP STEP

① Select DIRECT SET in the SWEEP STOP parameter group with the ∧ or ∨ key, and press the ENTER key.

② Select the SWEEP STOP entry field with the ∧ or ∨ key.

③ Type 4.4 with numeric keys and press the MHz unit key.

④ Select STOP FREQ in the SWEEP STOP parameter group with the ∧ or ∨ key, and press the ENTER key.

⑤ Select the SWEEP STOP entry field with the ∧ or ∨ key.

⑥ Type 10 with numeric keys and press the MHz unit key.

⑦ Select the SWEEP STEP entry field with the ∧ or ∨ key.

⑧ Type 100 with numeric keys and press the kHz unit key.

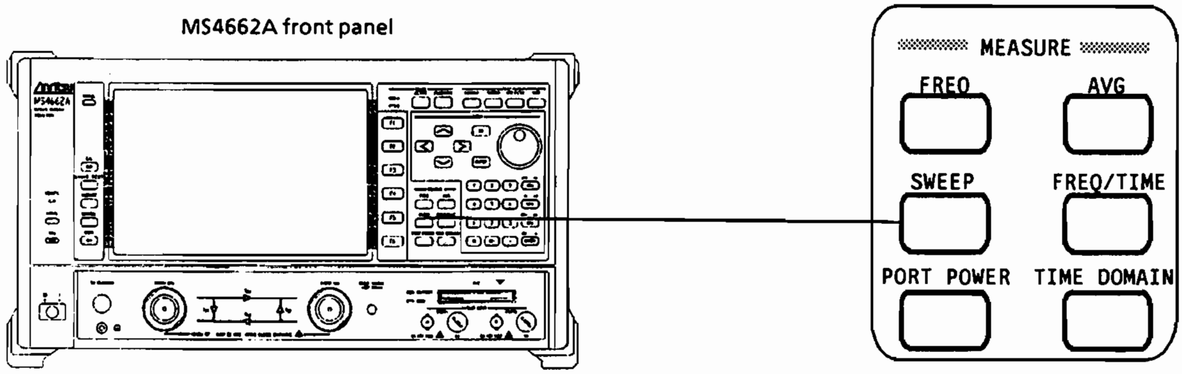
<3> Selecting COMPRESSION CALCULATE

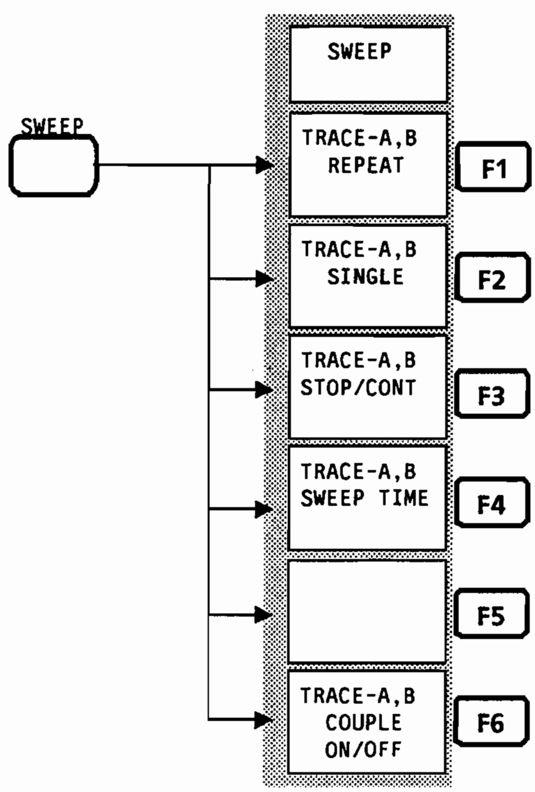
① Select the COMPRESSION CALCULATE parameter group with the ∧ or ∨ key.

② Select the desired item from among 1. MAX, 2. MIN, and 3. MEAN with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number 2; there is no need to press the ENTER key.

5.2 Selecting Sweep Setup Parameters .... SWEEP

Pressing the SWEEP key in the front-panel MEASURE section displays the SWEEP softkey menu for selecting sweep setup parameters.





F1 ··· Sweeps repetitively and continuously.

F2 ··· Sweeps once.

F3 ··· Pauses a sweep in progress, or starts a sweep from a paused state.

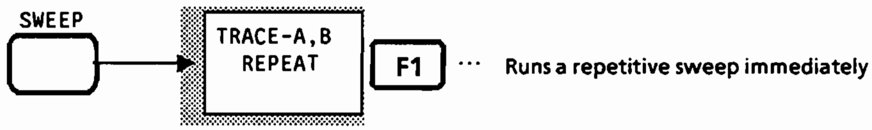
F4 ··· Sets a sweep time in a direct entry area.

F6 ··· Toggles between ON and OFF each time the key is pressed. The current setting is reversed.

5.2.1 Staring, stopping, and restarting a sweep

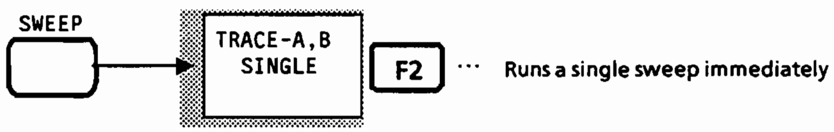
(1) Repetitive sweep

Press F1 in the operation shown below to run a repetitive, continuous sweep, from the sweep start point if one is already in progress or if one has been halted.



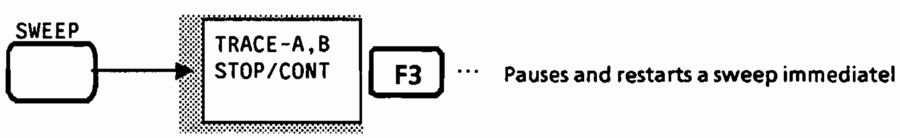
(2) Single sweep

Press F2 in the operation shown below to run a single sweep, from the sweep start point if one is already in progress or if one has been halted.



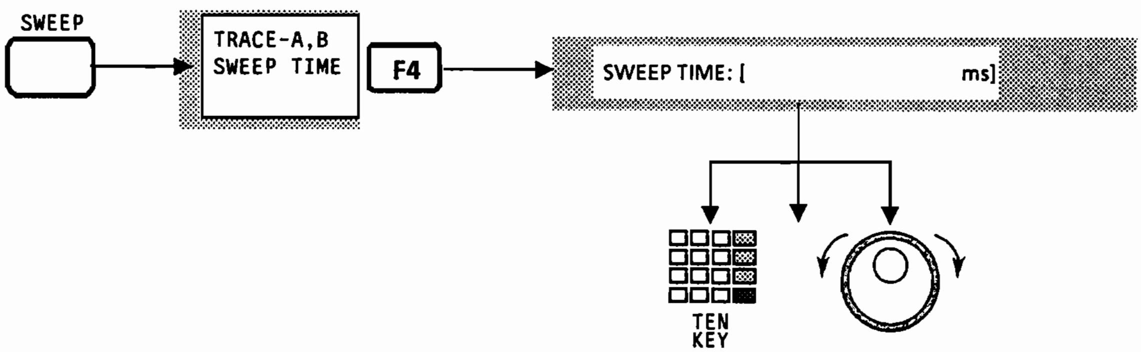
(3) Pausing and restarting a sweep

Press F3 in the operation shown below to pause a repetitive or single sweep in progress. Press F3 again to restart the sweep.



5.2.2 Setting the sweep time

The default sweep time setting is AUTO. To set a sweep time slower than the default value, press F4 first. As a direct entry area opens at the lower right corner of the screen, select the desired sweep time from among 10 ms to 3,500 s and from 1.00 to 27.5 hr (lower limits depend on the number of measuring points (11 to 1,001)) by turning the ENTRY knob clockwise or counterclockwise. When setting a sweep time with numeric keys, press a unit key to conclude the setting.



Type "0" ms, s to reset the sweep time to AUTO. The value that is set by AUTO includes only the sweep time in the frequency domain and does not include the full two-port calibration calculation time and the time-domain conversion time.

Note: Lower limits to the sweep time are listed below:

Lower limits to the sweep time

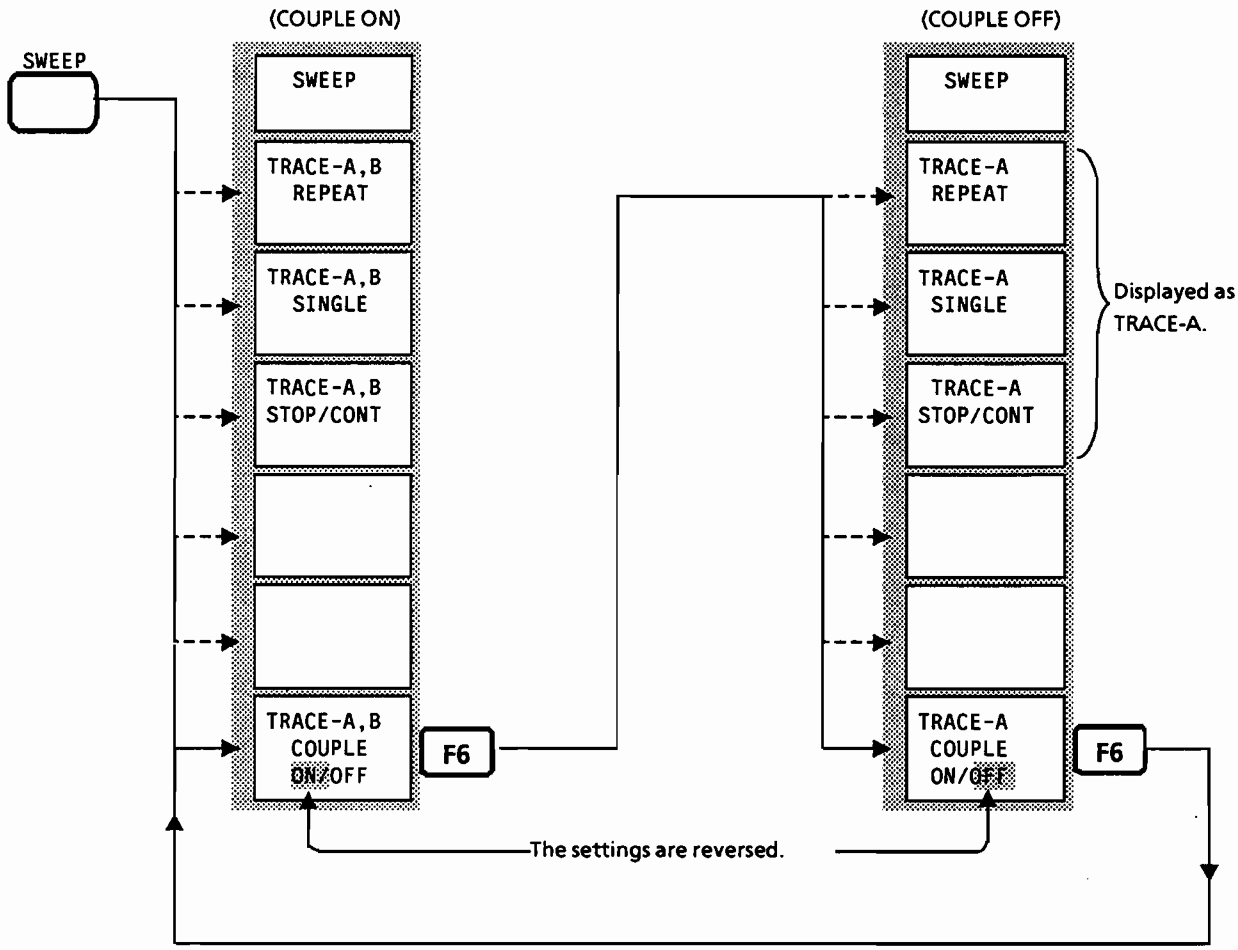
Measuring point	Lower limit to the sweep time
11	5 ms
21	8 ms
51	20 ms
101	40 ms
251	100 ms
501	200 ms
1001	400 ms

5.2.3 Turning the TRACE-A, B COUPLE ON/OFF parameter on and off

The TRACE-A, B COUPLE ON/OFF parameter toggles between ON and OFF each time the F6 softkey in the SWEEP menu is pressed. The reversed setting is either ON or OFF

- If ON is reversed, trace A and B parameters can be set to identical values.
- If OFF is reversed, trace A and B parameters can be set independently.
- Setting COUPLE OFF when trace A is active causes the menu label TRACE-A, B to appear as TRACE-A.
- Setting COUPLE OFF when trace B is active causes the menu label TRACE-A, B to appear as TRACE-B.

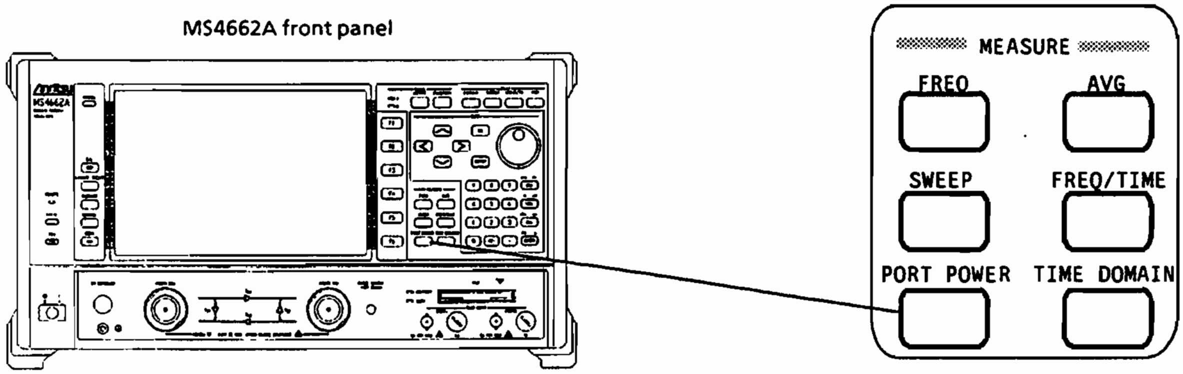
<Example: SWEEP menu in effect when trace A is active>

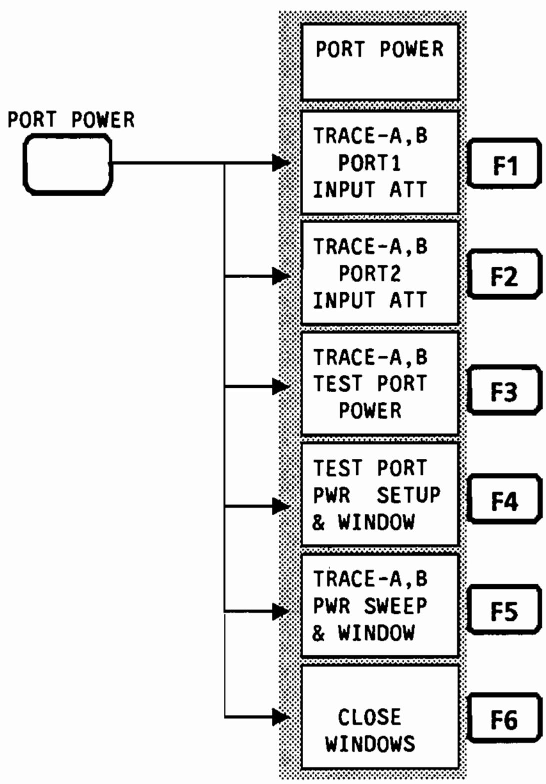


Note: In addition to the SWEEP menu, the FREQ and PORT POWER menus are also set to COUPLE OFF or COUPLE ON as shown above.

5.3 Selecting Test Port Parameters .... PORT POWER

Pressing the PORT POWER key displays a softkey menu for setting test port parameters.





F1 ··· Changes the test port 1 input attenuator (0 dBm, +20 dBm).

F2 ··· Changes the test port 2 input attenuator (0 dBm, +20 dBm).

F3 ··· Sets the test port power. Continuously variable by 20 dB.

F4 ··· Sets the source power, output attenuator, and output offset.

F5 ··· Sets power sweep parameters.

F6 ··· Closes the window.

Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the SWEEP menu. When TRACE-A, B COUPLE OFF (which appears onscreen as TRACE-A, B COUPLE ON/OFF) is set by pressing F6 in the SWEEP menu, each softkey label TRACE-A, B displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active.

5.3.1 Test port considerations and power setting

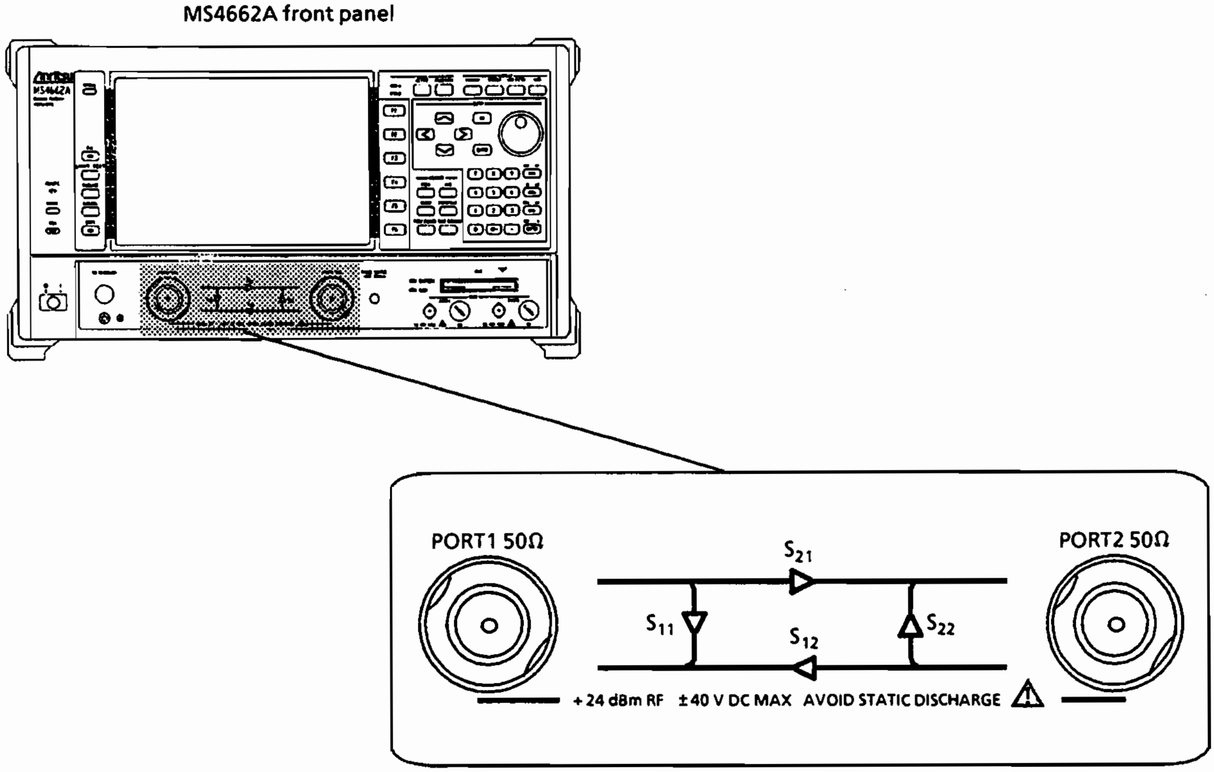
(1) Electrostatic effects on the test ports

Protect those test port connectors labeled **AVOIDE STATIC DISCHARGE** against electrostatic effects.

CAUTION

Touching the central conductor in a connector by hand could damage internal parts through electrostatic discharge. Allow the central conductor in a cable or tester to be discharged before connecting them to a test port connector. Use of the wrist band supplied with the MS4662A is recommended to ensure that the internal circuitry is positively protected.

MS4662A front panel



(2) Test port 1 and 2 damage level

The damage level of the front-panel ports 1 and 2 is **+24 dBm RF ±40 VDC max.** Use them below this level.

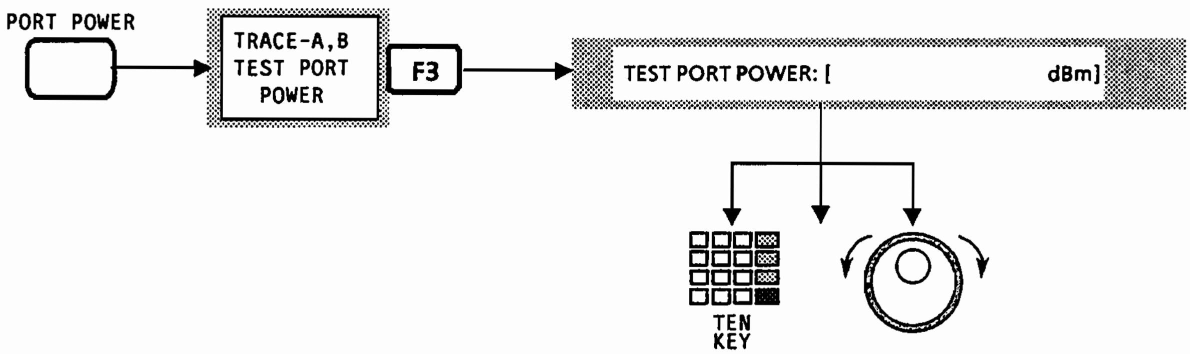
CAUTION

The test ports are not protected against signals in excess of their damage level. The application of a signal above this level could burn the input attenuator or mixer. ⚠ is a warning mark to help prevent such damage. The test ports incorporate a DC blocking capacitor to test signals that contain DC components. In tests conducted under a high DC bias, such as 40 V, damage to the internal circuitry could also result if a spiky, momentary signal above this level, such as one occurring abruptly in the presence of load shorts or at connector attachment, is applied to the test ports. Be sure to apply the bias slowly after the measurement setup is complete. Watch also for load shorts.

(3) Setting the test port power and I/O attenuators

▼Test port power setting

Press keys in the sequence described below. Pressing F3 opens a direct entry area at the lower right corner of the screen. Set the test port power by using the ENTRY knob or numeric keys.



The test port power setting depends on the output attenuator setting. Set the test port power according to the table below (output offset: −13 dB).

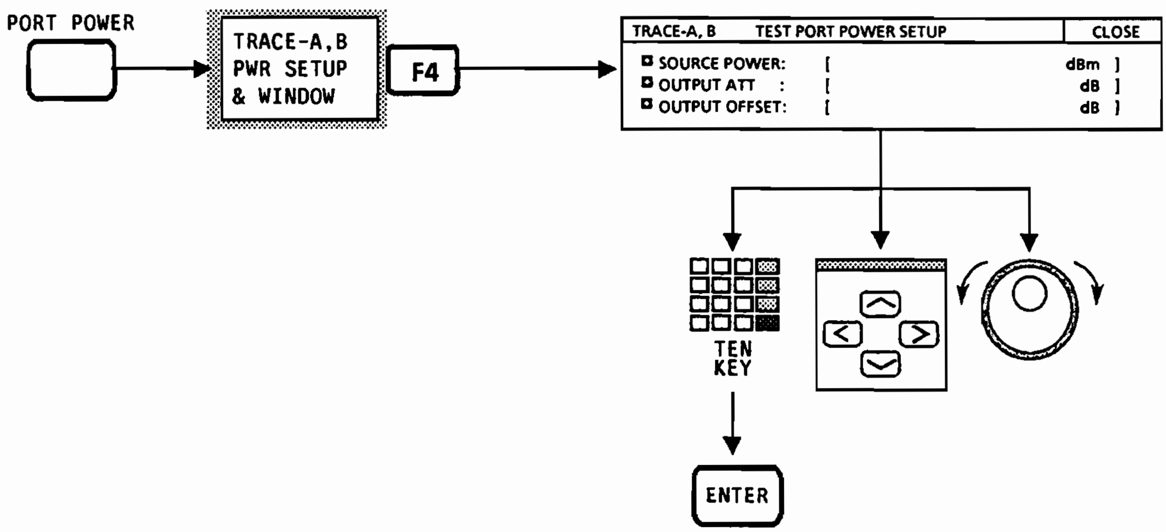
Output attenuator value	Test port level
0 dB	−10 to 10 dBm
10 dB	−20 to 0 dBm
20 dB	−30 to −10 dBm
30 dB	−40 to −20 dBm
40 dB	−50 to −30 dBm
50 dB	−60 to −40 dBm
60 dB	−70 to −50 dBm

▼Test port power parameter setup

The test port power is set up by the following three parameters:

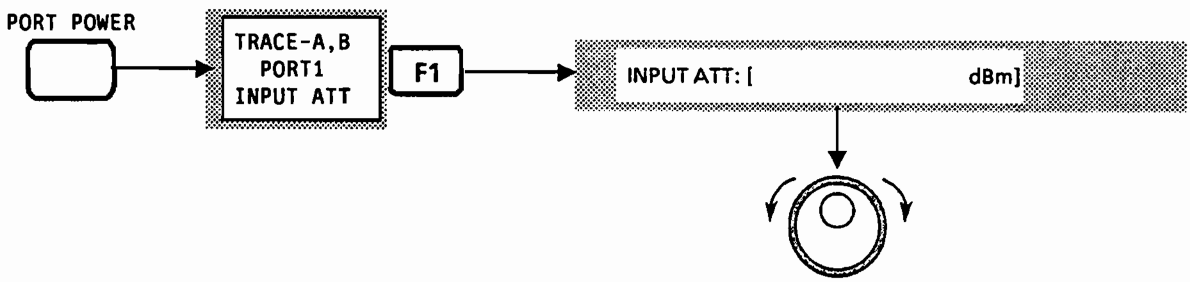
- Source power: Output level of the test signal source.
- Output attenuator
- Output offset: Gain (+) or loss (−) in the path from the test signal source to the test ports. The default is −13 dB, since the MS4662A involves an internal loss of 13 dB. If an amplifier or attenuator intervenes between the test ports of the MS4662A and the DUT, the power at the input end of the DUT is indicated by altering the value of the output offset.

Test port power = (Source power) − (Output attenuator) + (Output offset)

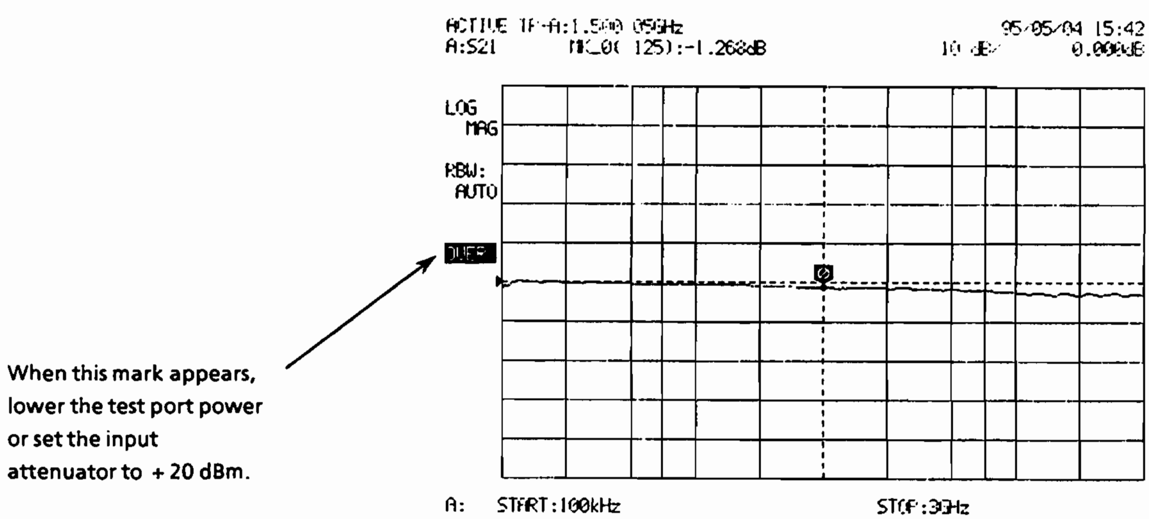


▼Port 1 and 2 input attenuator setting

Referring to port 1 as an example, press F1 in the key-in sequence below to a direct entry area at the lower right corner of the screen. Set the input attenuator by turning the ENTRY knob clockwise or counterclockwise.

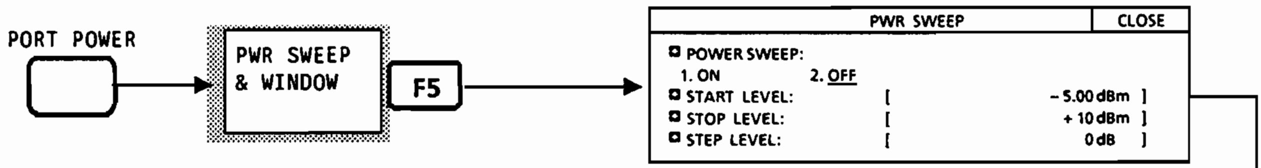


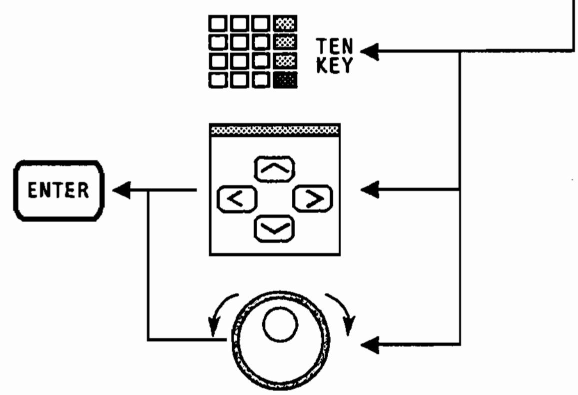
OVER appears when the output level of the DUT is too high. Set the input attenuator to +20 dBm in this case.



5.3.2 Setting power sweep parameters

Press F5 in the key-in sequence below to open the POWER SWEEP window for setting power sweep parameters. An example of setting power sweep parameters is given below:





① Select the POWER SWEEP parameter group with the ∧ or ∨ key.

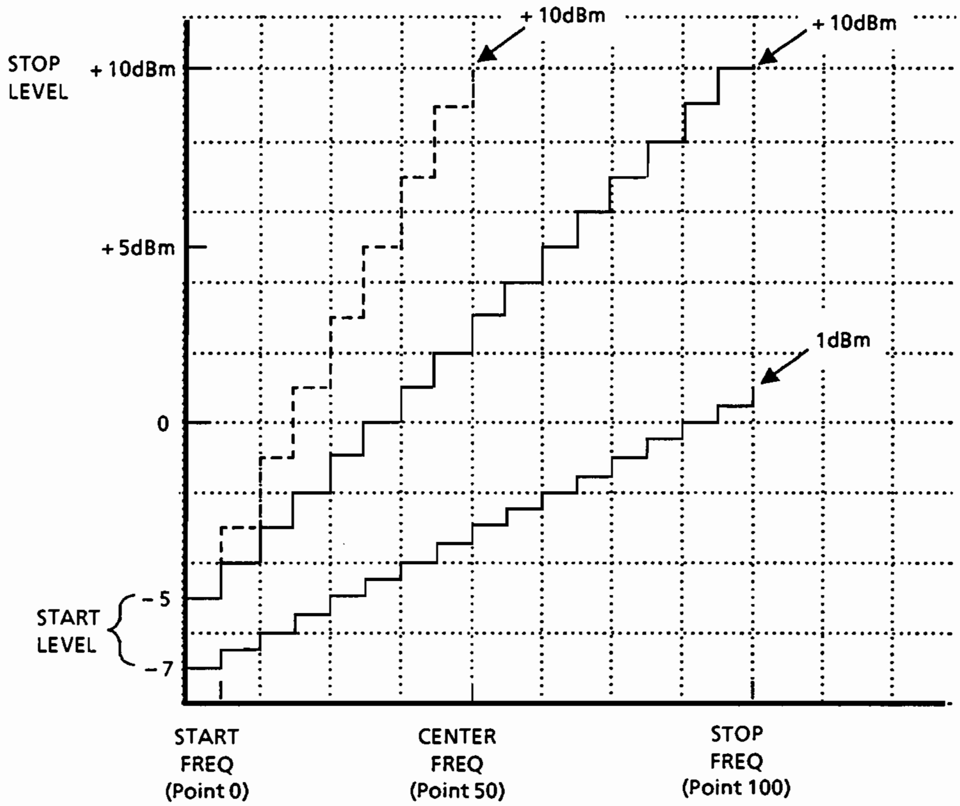
② Select 1. ON with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply type in the parameter number 1; there is no need to press the ENTER key.

③ Select START LEVEL, STOP LEVEL, and STEP level with the ∧ or ∨ key to set their parameter data to −5 dBm, +10 dBm, and 0 dB, respectively.

When setting a numeric value with numeric keys, press the dBm unit key to conclude the setting. The ENTER key may be pressed instead for the dB unit. It is unnecessary with the ENTRY knob to press the ENTER key or a unit key after selecting a numeric value.

In normal sweep applications, START LEVEL and STOP LEVEL are equal. Given 101 measuring points, the sweep time interval between the sweep start point (START FREQ, point 0) and the sweep stop point (STOP FREQ, point 1000) is swept at a constant level.

An example power sweep is given on the next page. Power sweeps require setting START LEVEL, STOP LEVEL, and STEP to meet specific needs.



In the diagram above, a scan starting at START LEVEL = −5 dBm, proceeding in steps of STEP LEVEL = 0.3 dB, and stopping at STOP LEVEL = +10 dBm reaches +10 dBm at point 50, which is halfway in the sweep time interval.

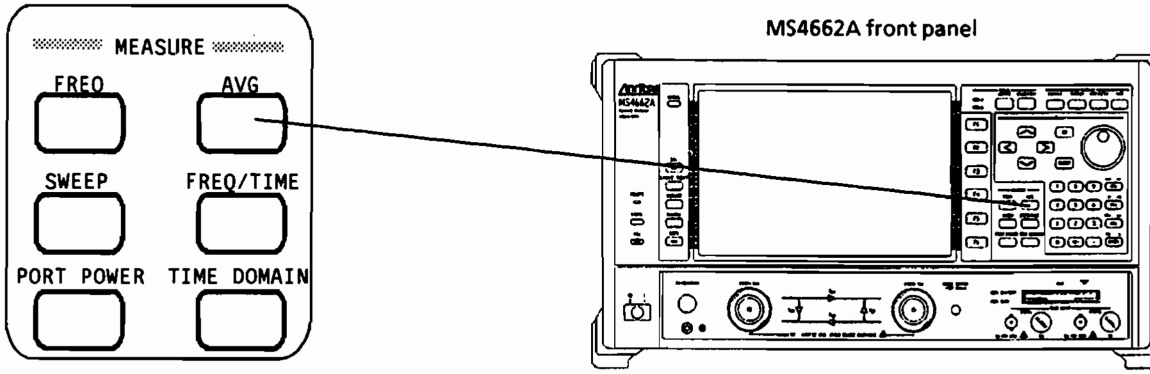
With START LEVEL = −7 dBm, STOP LEVEL = +10 dBm, and STEP LEVEL = 0.08 dBm, however, the scan fails to reach +10 dBm at point 500, which is the sweep time interval. To let the scan reach STOP LEVEL at the end of the sweep interval, make the following setting:

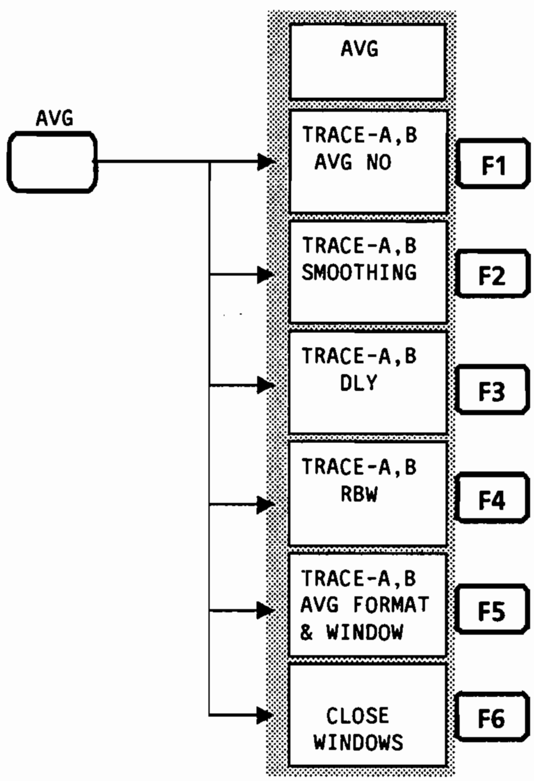
- **STEP LEVEL = 0 dB**

This setting will select the value of STEP LEVEL to allow the scan to reach STOP LEVEL at the end of the sweep interval.

5.4 Improving the S/N Ratio and Selecting Group Delay Parameters .... AVG

Pressing the AVG key in the front-panel MEASURE section displays the AVG softkey menu, which contains a list of parameters designed to improve the S/N ratio - averaging, smoothing, a resolution bandwidth (RBW), and a smoothing aperture, which sets the aperture frequency during group delay measurement as a percentage ratio of the frequency span.





F1 ··· Selects an averaging count between 1 and 1,000.

F2 ··· Selects a smoothing ratio between 0 and 50 % of the frequency span.

F3 ··· Sets a group delay parameter (aperture).

F4 ··· Selects a resolution bandwidth (RBW) between 3 Hz and 10 kHz.

F5 ··· Selects an AVG menu format (TRACE-A, B COUPLE ON/OFF, AVERAGE TYPE, and GPDLY PARAMETER TYPE).

F6 ··· Closes the window.

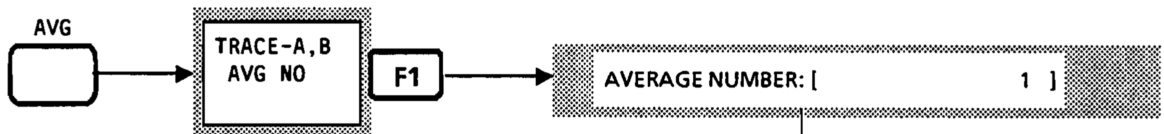
Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the AVERAGE FORMAT menu, which is displayed by pressing the AVG FORMAT & WINDOW label. EL (electrical length) from the SCREEN menu and MEAS POINT (measuring point) from the PACKAGE menu are controlled at the same time. See Section 5.4.3 for more details.

5.4.1 Improving the S/N ratio

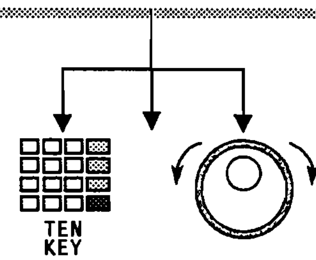
The S/N ratio is improved by selecting one of the three parameters - an averaging count (1 to 1,000), smoothing % (0 to 50 %), and an RBW (3 Hz to 10 kHz). Use an RBW in combination with averaging or smoothing as needed.

(1) Averaging count

Press keys in the sequence described below. Pressing F1 opens a direct entry area for AVERAGE NUMBER at the lower right corner of the screen.



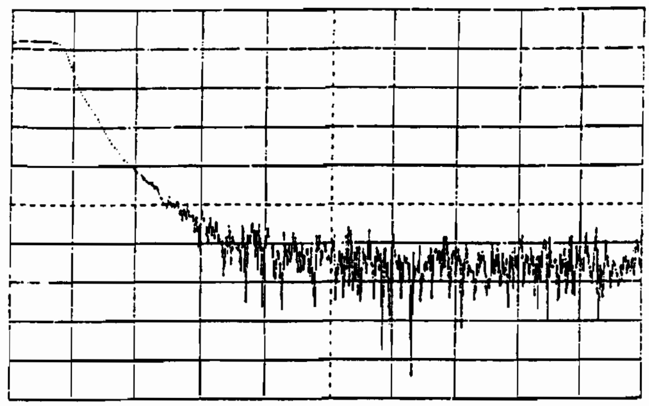
Turn the ENTRY knob clockwise or counterclockwise to select an averaging count between 1 and 1,000. When setting a count with numeric keys, press the ENTER key to conclude the setting. An averaging count of 1 will execute a normal run of measurement, without averaging calculations. The default is AVERAGE NUMBER 1.



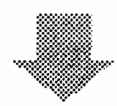
To ensure data stability with signals containing noises, the measurement values from repeated sweeps may be averaged by vector averaging with a specified averaging count.

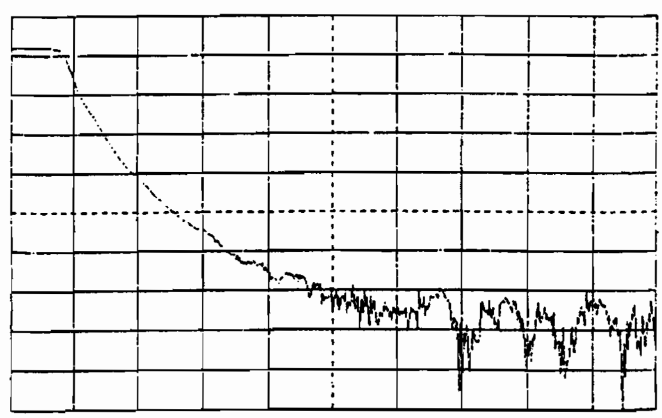
Notes:
- The degree of improvement in the S/N ratio is proportional to the square root of the averaging count. (For example, doubling averaging count will lessen noises by 3 dB.)
- The higher the averaging count, the better becomes the S/N ratio, with the result of a longer sweep time.

The charts below illustrate the benefits of averaging.



AVERGE NUMBER: 1

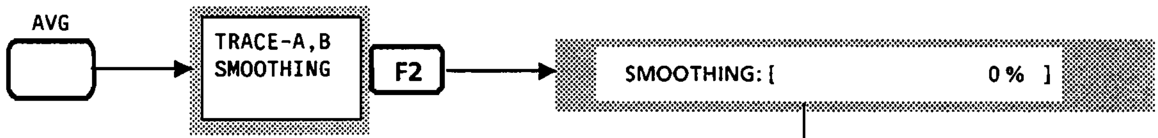




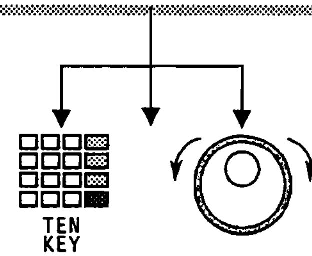
AVERGE NUMBER: 100

(2) Smoothing

Press keys in the key-in sequence described below. Pressing F2 opens a direct entry area for SMOOTHING at the lower right corner of the screen.

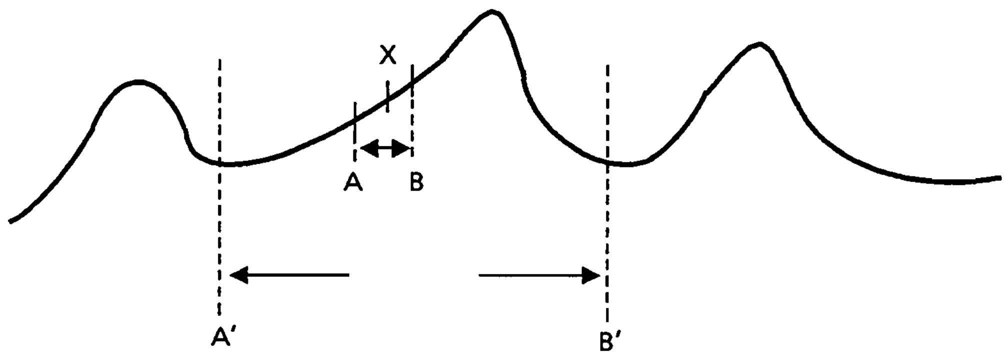


Turn the ENTRY knob clockwise or counterclockwise to select a smoothing ratio between 0 and 50 % of the frequency span. When setting a smoothing ratio with numeric keys, press the ENTER key to conclude the setting. A smoothing ratio of 0 % will execute a normal run of measurement, without averaging calculations. The default is SMOOTHING 0 %.



Smoothing is similar to averaging in that it averages data at frequency points. The difference is that smoothing calculates the data before and after each point within a specified percentage range, whereas averaging calculates a vector mean at each point.

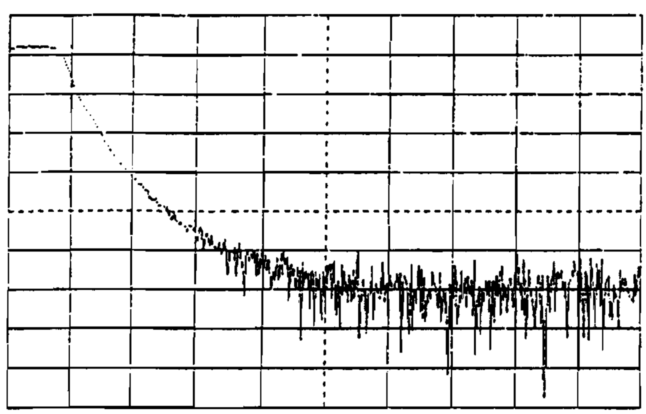
In the graph shown below, if the interval between A and B represents N % of the frequency span, averaging moves towards the right edge of the screen while calculating a mean at every data point between A and B, or a moving average.



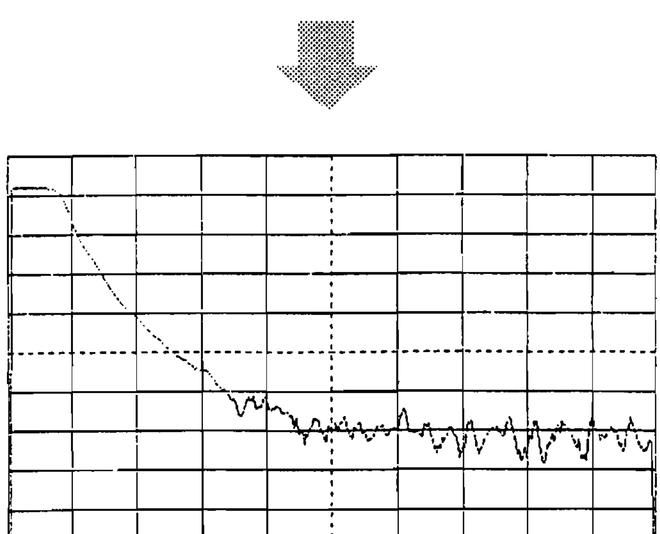
A moving average is calculated by solving:

Moving average = (Sum total of means at data points between A and B)/(Number of points between A and B)

If the range of smoothing is taken too wide as in A' to B' above than in A to B, the smoothed waveform will not resemble the original waveform. In most situations, a percentage ratio of smoothing is selected to ease the job of reading trace data waveforms influenced by noises. The charts below illustrate the effects of smoothing.



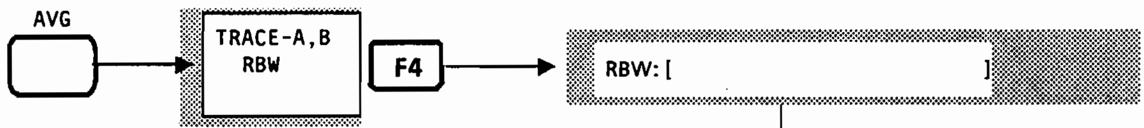
SMOOTHING: 0 %



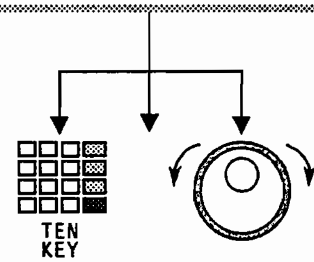
SMOOTHING: 1 %

(3) Selecting a resolution bandwidth (RBW)

Press keys in the key-in sequence described below. Pressing F4 opens a direct entry area for setting an RBW at the lower right corner of the screen.



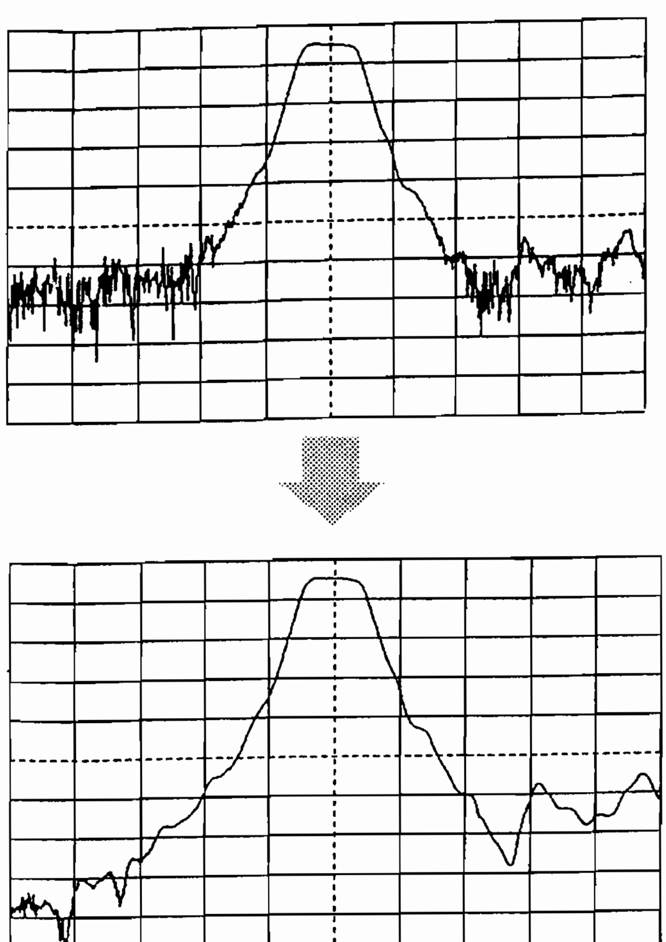
Turn the ENTRY knob clockwise or counterclockwise to select an RBW between 3 Hz and 10 kHz in 1-3 or 3-1 steps. When setting an RBW with numeric keys, press the ENTER key to conclude the setting. The default is AUTO, which sets an optimal RBW matched to the sweep time automatically.



Determine the value of the RBW to meet a sweep rate of practical use, because a narrower IF band would lessen noise effects but prolong the sweep time.

- Noise level: Reducing the RBW by 90 % lessens the noise level by 10 dB.
- Sweep time: The sweep time increases in reverse proportion to the RBW.

Differences in floor noise effects between a trace waveform measured with an RBW of 3 kHz and that measured with an RBW of 10 Hz are shown below.

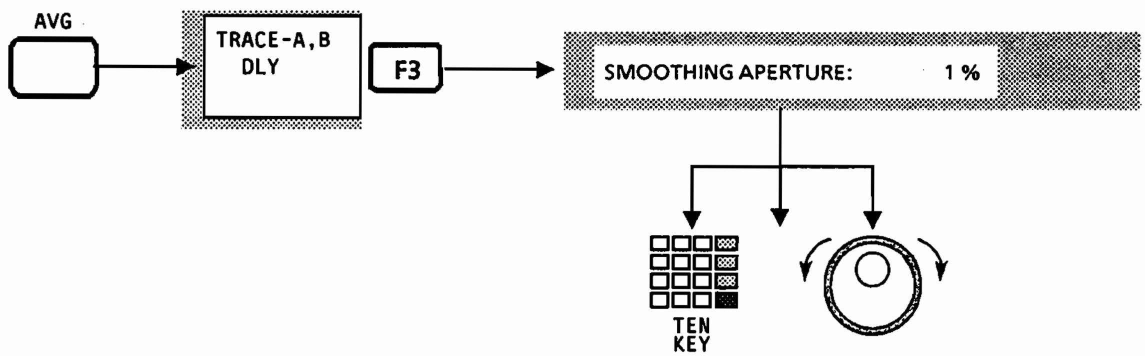


RBW 10 kHz

RBW 3 Hz

5.4.2 Setting an aperture frequency in group delay measurement

To perform group delay measurement, press keys in the key-in sequence described below to set a group delay parameter (smoothing aperture). Pressing F3 opens a direct entry area for setting a smoothing aperture at the lower right corner of the screen.



Set an aperture frequency (smoothing aperture) as apercentage ratio of the frequency span. Turn the ENTRY knob clockwise or counterclockwise to select a smoothing aperture between 0.2 % and 20 % of the frequency span. The minimum ratio that can be set is given by solving the equation:

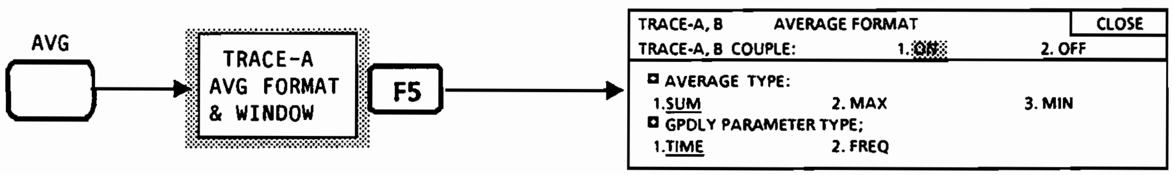
$$\text{Minimum \%} = \frac{2}{\text{Measuring points}} \times 100\,\%$$

5.4.3 Selecting AVG menu formats

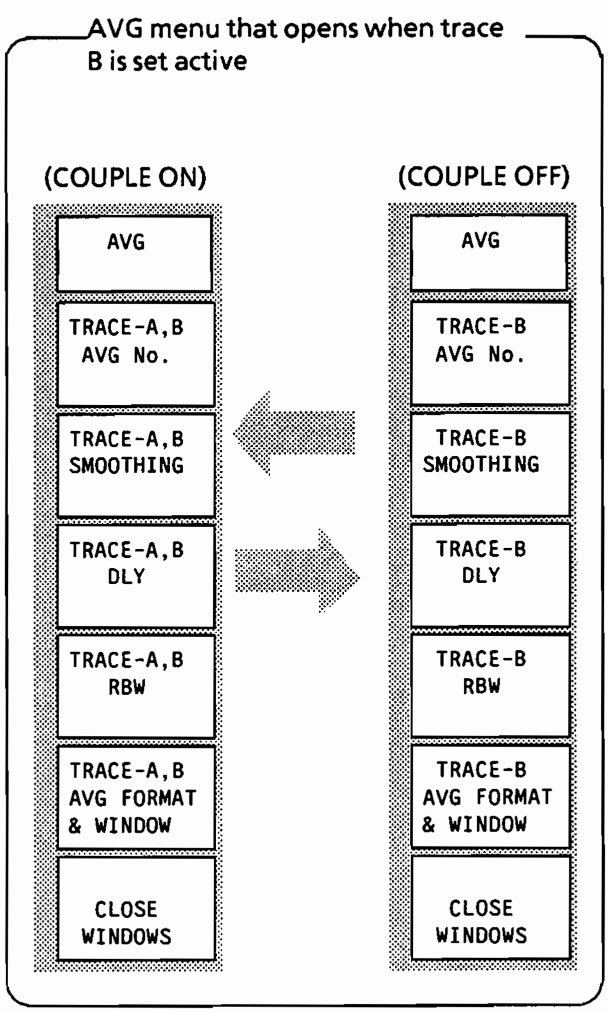
Three averaging formats are available for selection from the AVG menu as follows:

- TRACE-A, B COUPLE ON/OFF
- AVERAGE TYPE
- GPDLY PARAMETER TYPE

These choices are displayed in the AVERAGE FORMAT window by pressing F5 in the key-in sequence described below.



1 TRACE-A, B COUPLE ON/OFF



Turn the TRACE-A, B COUPLE ON/OFF parameter on or off with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number.

- If ON is selected, trace A and B parameters can be set to identical values.
- If OFF is selected, trace A and B parameters can be set independently.
- Setting COUPLE OFF when trace A is active causes the menu label TRACE-A, B to appear as TRACE-A.
- Setting COUPLE OFF when trace B is active causes the menu label TRACE-A, B to appear as TRACE-B.

Note: The EL (electrical length) label from the SCREEN menu and the MEAS POINT (measuring point) label from the PACKAGE menu are set to COUPLE ON or OFF at the same time.

(2) AVERAGE TYPE

Select the AVERAGE TYPE parameter group with the ∧ or ∨ key. Then, select the desired parameter with the < or > key or numeric keys.

- Select 1. SUM to perform averaging measurement. The default is SUM.
- To measure the maximum magnitude of the trace waveform at each measuring point, select 2. MAX.
- To measure the minimum magnitude of the trace waveform at each measuring point, select 3. MIN.

(3) GPDLY PARAMETER TYPE

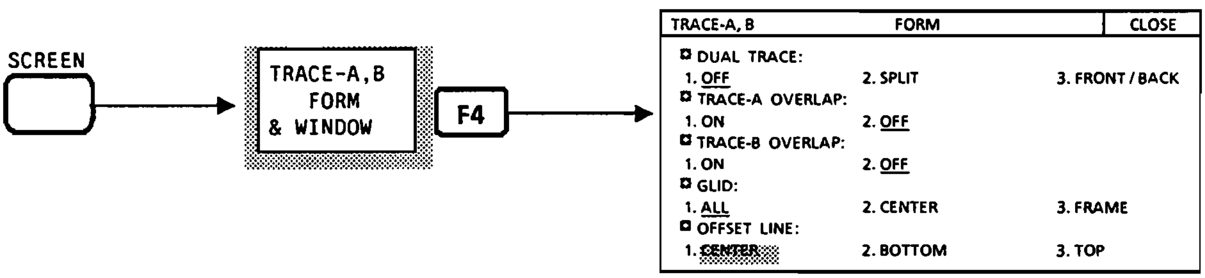
This function is inoperable, because the MS4662A does not support a GPDLY measurement function.

5.5 Selecting the Time-Domain Measurement Mode .... FREQ/TIME

Press the FREQ/TIME key to select the time-domain measurement mode. The key, when pressed a second time, toggles back to the frequency-domain measurement mode.

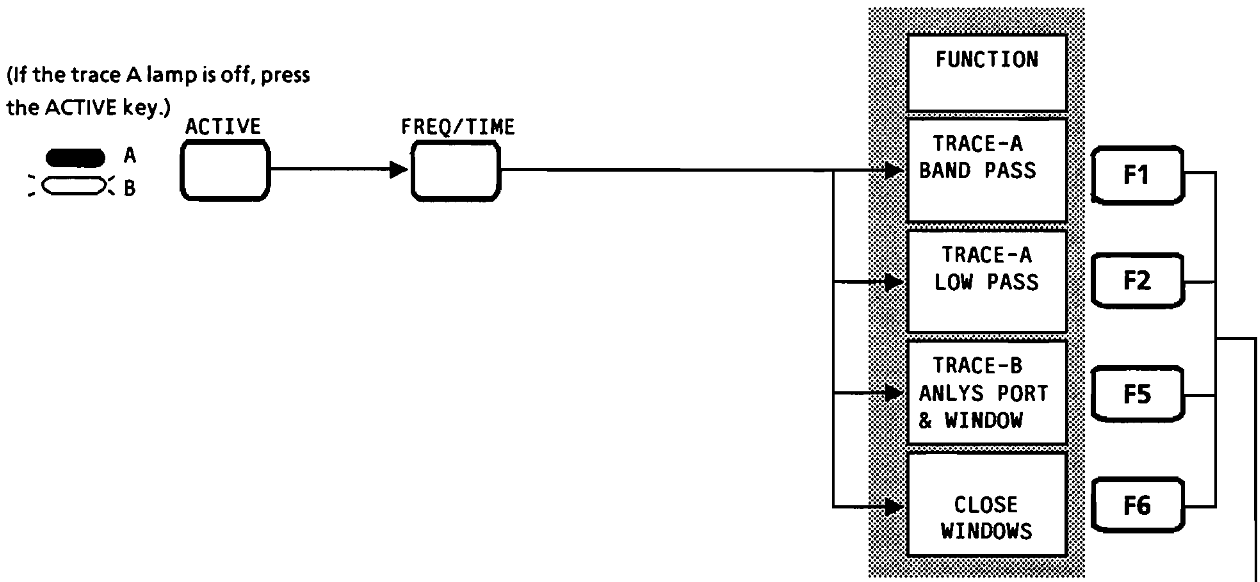
In the simultaneous time-domain and frequency-domain measurement mode, the MS4662A displays frequency-domain waveforms on trace B. The impulse or step responses calculated in the time domain on the basis of analyses of the frequency domain are displayed on trace A. This subsection explains in what display formats traces A and B are observed.

Note: Select the SPLIT parameter from DUAL TRACE in the key-in sequence described below to observe trace A (time-domain waveform) and trace B (frequency-domain waveform) simultaneously.

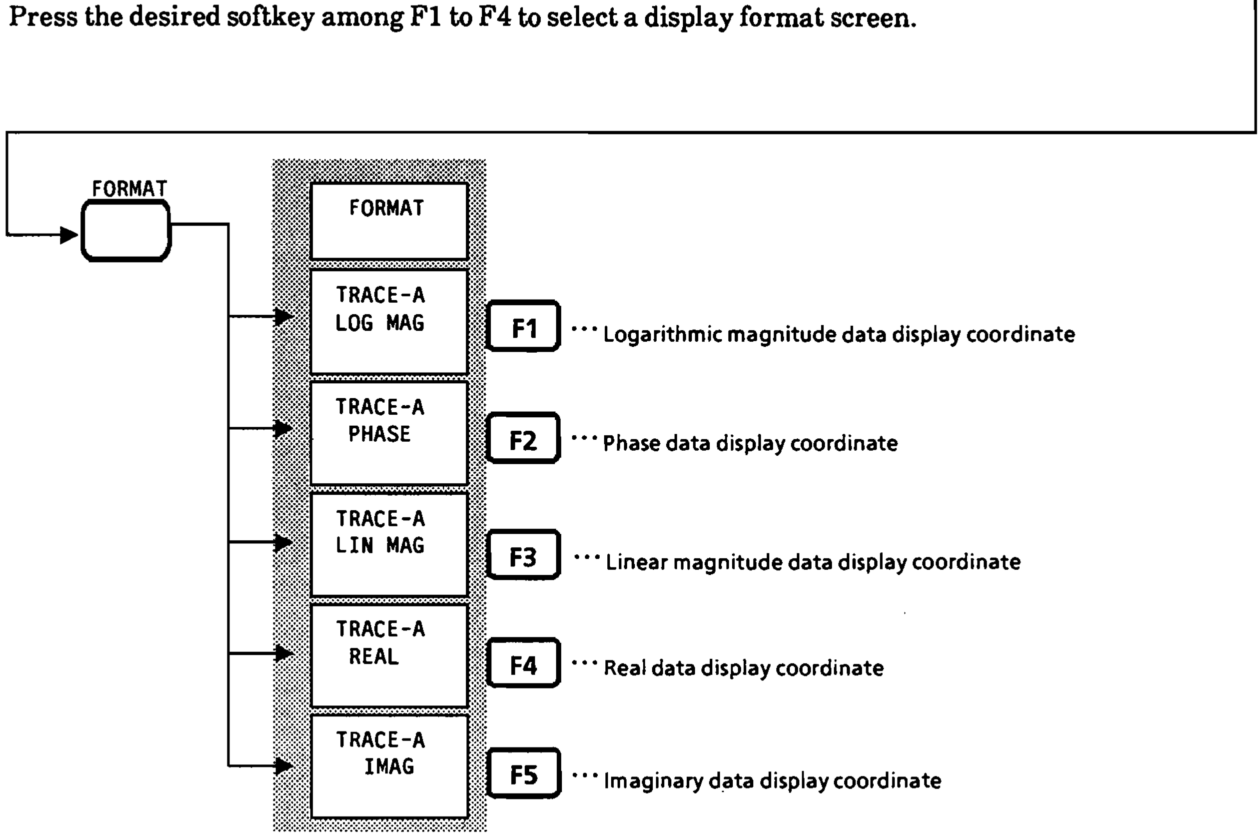


5.5.1 Selecting display formats for time-domain measurement

The band-pass mode or the low-pass mode is used in MS4662A time-domain measurement. (See 5.5.3 and 5.6 for more details.)

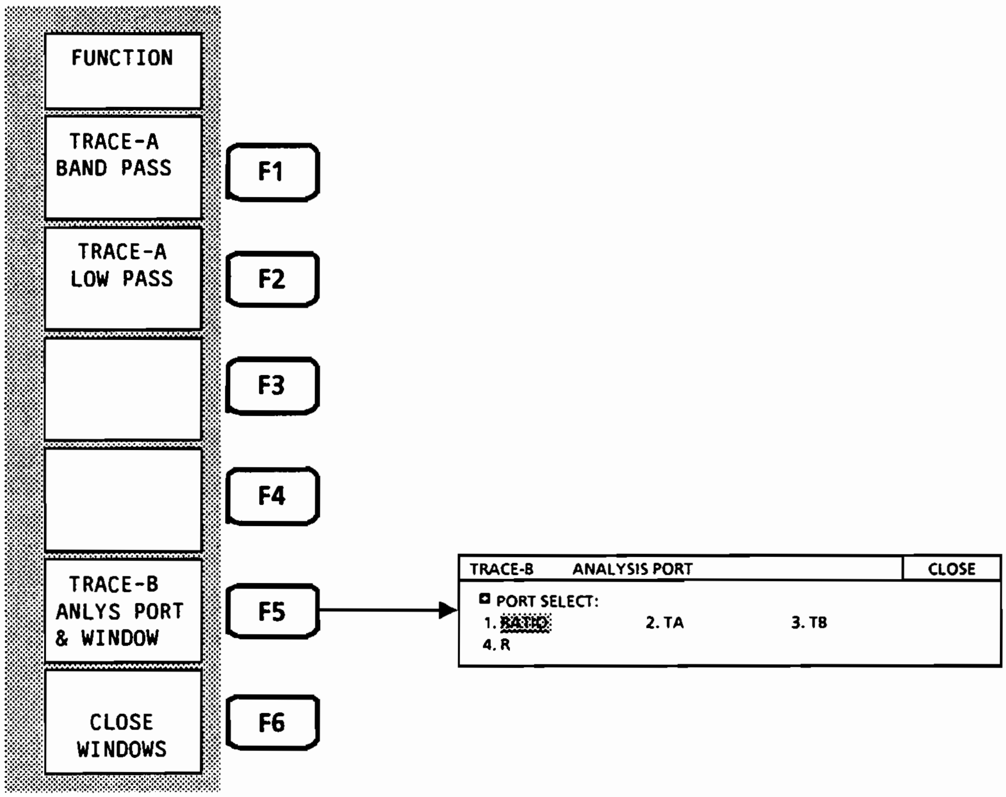


Press the FORMAT key with BAND PASS or LOW PASS selected from the FUNCTION menu as a subfunction, and the FORMAT menu will open for selecting display formats. Press the desired softkey among F1 to F4 to select a display format screen.



5.5.2 Selecting analysis ports

Press FUNCTION menu F5 to select measurement ports from the ANALYSIS PORT window that opens subsequently.

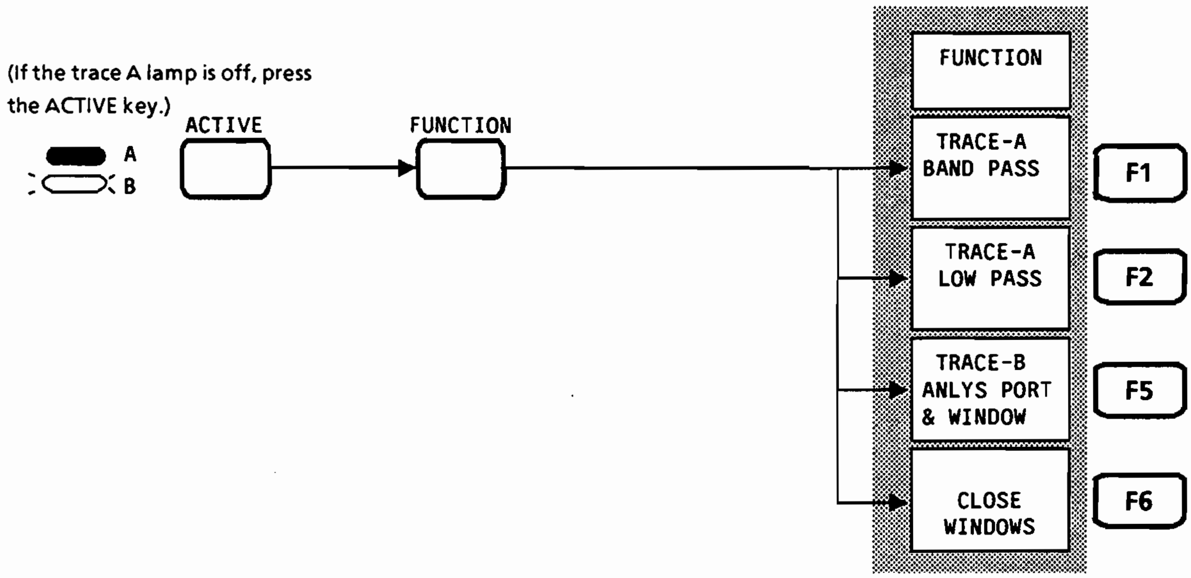


1. RATIO executes the following comparative measurements on the basis of the S-parameter settings:

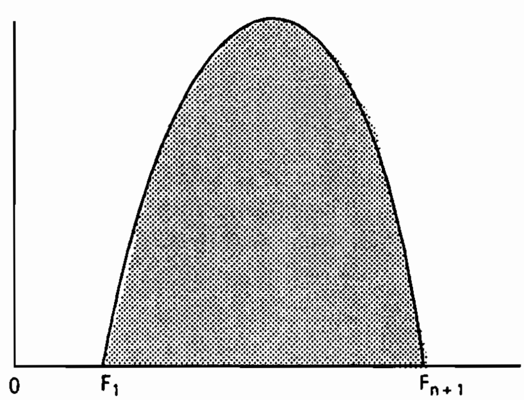
- S_{21}, S_{12}: TB/R
- S_{11}, S_{22}: TA/R

5.5.3 Selecting between the band-pass mode and the low-pass mode

The band-pass mode or the low-pass mode is used in MS4662A time-domain measurement.



(1) Band-pass mode

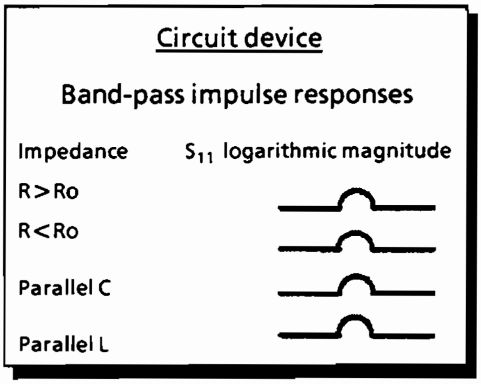


Band-pass impulse responses

- Magnitude measurement only
- Discrete point positions
- No discrete point type information

The band-pass mode permits measurement with band-pass characteristics, such as those of a band-pass filter. It provides impulse response measurement, but not step response measurement because it does not contain DC components. Only magnitude measurement is available. The resultant band-pass impulse responses are used to represent discrete point positions in time or distance terms.

As different from the low-pass mode, the band-pass mode does not yield discrete point type information. A typical application of this mode is the testing of devices that are not responsive to low frequencies, such as filters, waveguides, high-pass networks, and band-pass networks.



As can be seen from the band-pass impulse responses to various impedances at discrete points shown at left, no discrete point type information is available.

(2) Low-pass mode

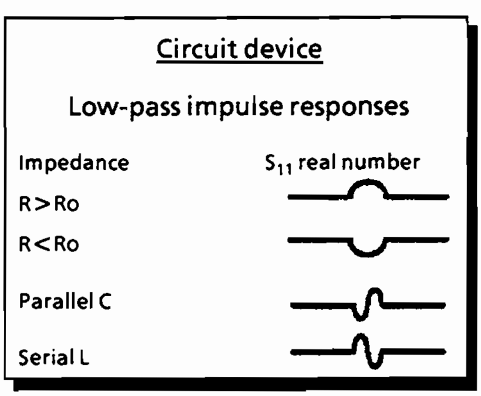
The low-pass mode offers an equivalent of the measurement by time-domain reflectometry. It requires low pass limits down to negative frequencies, as well as DC components, but the negative frequency range is calculated by the system automatically. The low-pass mode is thus used to test devices that respond to both DC components and low frequencies.

■ Low-pass impulse responses

Low-pass impulse responses

- Discrete point positions
- Discrete point type information

Low-pass impulse responses provide not only useful information that determines the impedance (R, L, or C) at each discrete point but also locate that point.

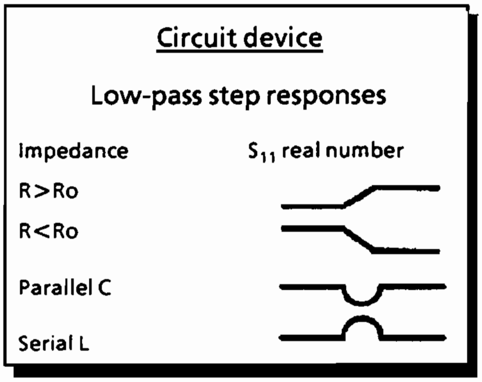


Impulse responses have a positive or negative peak as R is greater than or less than Z_0. The response peak is uniform to the reflection coefficient as expressed in the equation:

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

The impulse response of a parallel capacitance peaks from negative to positive, while that of a serial inductance peaks from positive to negative.

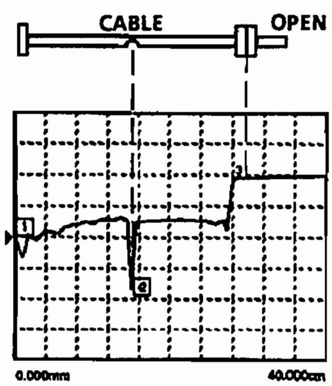
■ Low-pass step responses



Low-pass step responses provide not only useful information that determines the impedance (R, L, or C) at each discrete point but also locate that point. The low-pass step response of a resistive impedance is shifted at the positive or negative level as R is greater than or less than Z_0. The response peak is uniform to the reflection coefficient as expressed in the equation:

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

The step response of a parallel capacitance has a negative peak, while that of a serial inductance has a positive peak.

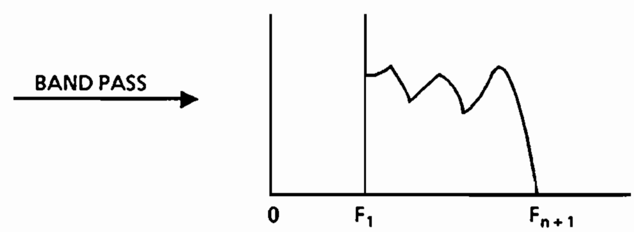


Cable fault location measurement is an example of low-pulse step response measurement. A faulty cable would demonstrate far worse matching characteristics in the frequency domain than a normal cable. Low-pass step responses not only locate discrete points but provide discrete point type information. In the example shown at left, the fall in the trace represents a response from a parallel capacitance caused by a crack in the cable. Because the cable is open-ended, a steep rise in the trace is typically observed at the end of the cable as shown.

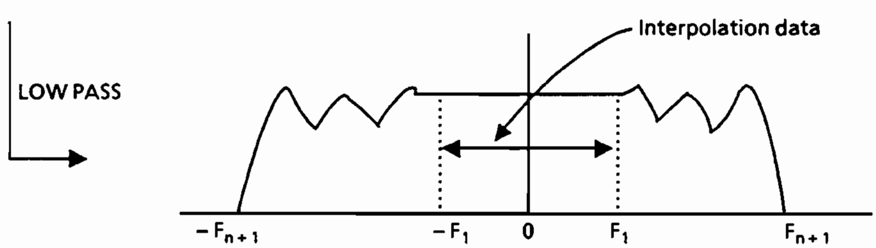
(3) Setting a measuring frequency range

The preceding pages have explained the need to define waveforms observed in a frequency domain as a low-pass or band-pass characteristic when converting them to those in a time domain. Among the frequencies that have been set by center, span, start and stop frequencies in both the low- pass mode and the band-pass mode, if the first measuring frequency is F_1, the next is F_2, and the last measuring frequency at measuring point n + 1 is F_{n+1}, the interval F1 ($F_i = F_i - F_i$-1, i = 2, 3, ... n + 1) between measuring frequencies must be uniform. If LOW PASS has been selected, the interval between DC and the first measuring frequency $\Delta F_0 = (F_1 - F_0)$ must also be uniform. In this case, F_0 is 0 or DC. The test frequency must be equivalent to the higher harmonics in an integer multiple of the start frequency.

(a) Measurement result



(b) Band-pass characteristic



(c) Low-pass characteristic

<Example> When the calibrated maximum frequency is 3 GHz and there are 501 measuring data points, determine the start frequency.

Divide the calibrated maximum frequency by 501, the number of measuring data points. The quotient gives the start frequency. Since the maximum frequency is 3 GHz, the calibrated start frequency is 5.98 MHz (3000/501).

Note: If the start and stop frequencies are set to make the measuring frequency interval variable, the system would use an interpolated value to make the measuring frequency interval uniform. Users can, therefore, set the measuring frequency range at their discretion. The interpolation process, however, is prone to error.

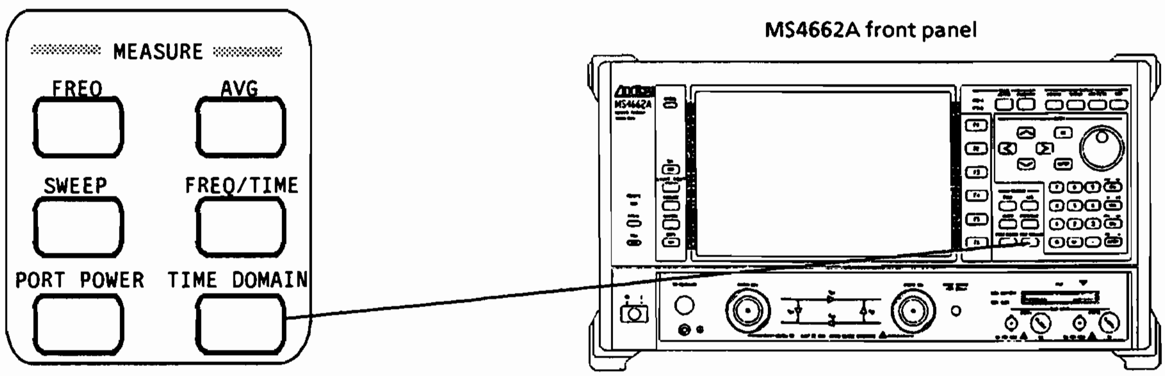
(4) Setting measuring points

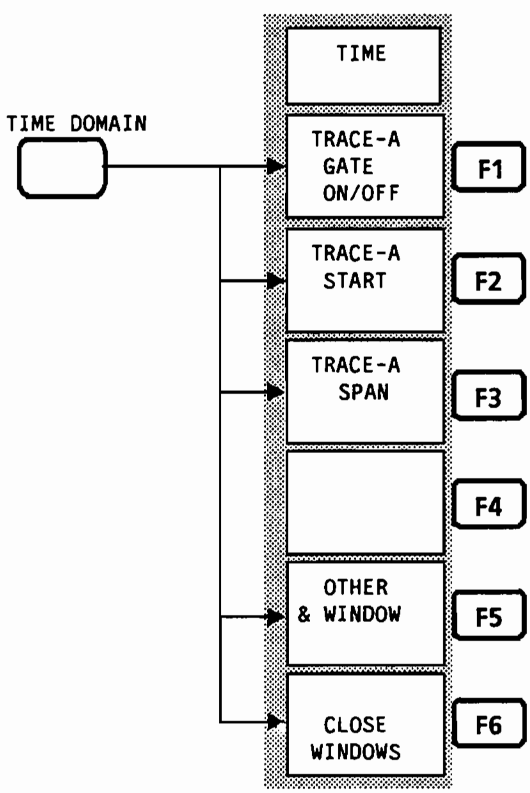
Waveforms measurement in a time domain is set to trace B, with 501 measuring points. If waveform measurement has been performed at points other than 501 points, a waveform at the preset measuring points is displayed before a frequency waveform at the 501 points is generated internally by interpolation.

5.6 Time-Domain Operations

In 5.5, the MS4662A was set in the band-pass or low-pass mode for time-domain measurement, with a display format and an analysis port being selected. A frequency range was set in trace B. All these were preparatory steps time-domain measurement. This subsection explains how to select time-domain-specific parameters required by time-domain measurement in the time-domain mode.

Press the TIME DOMAIN key shown below to open the TIME softkey menu.





F1 ··· Turns the gate on or off. The setting is reversed. When the gate is on, the result of gating is displayed on trace B.

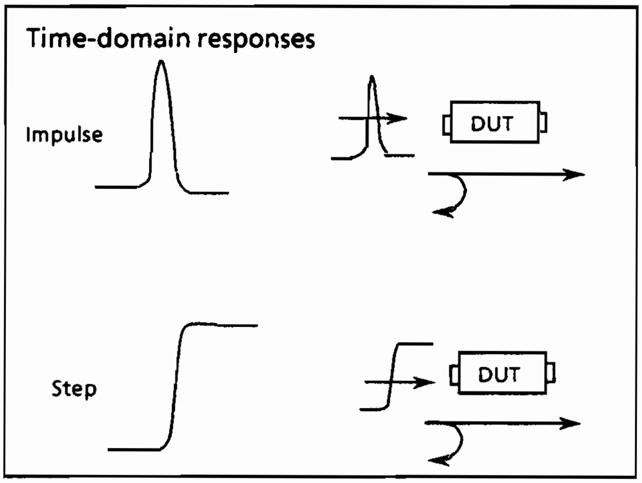
F2 ··· Sets a display start time or distance (the time or span is set in the OTHER window).

F3 ··· Sets a display start span or distance span (the time or span is set in the OTHER window).

F5 ··· Selects ① impulse/step response, ② gate shape, ③ filter shape, and ④ distance/time time-domain parameters.

F6 ··· Closes the window.

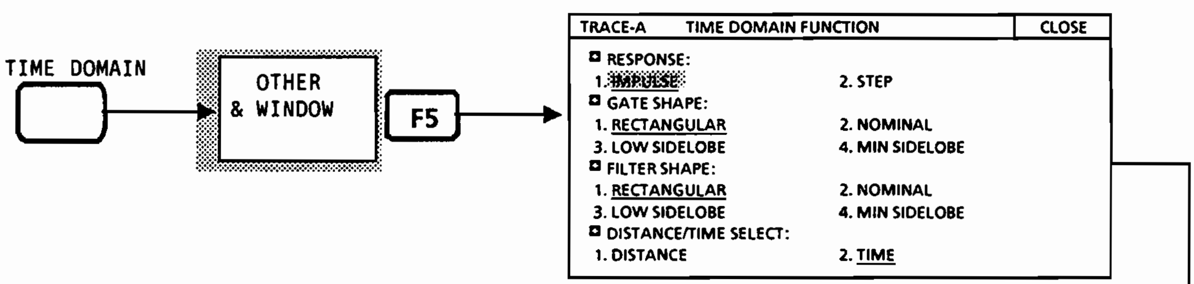
5.6.1 Selecting impulse and step responses



An impulse or step signal like that shown in the figure is selected as an input to the device under test (DUT) to collect a time-domain response (time response waveform). The impulse or step signal as mentioned here is not generated actually, but time-domain responses are collected through a mathematical simulation process.

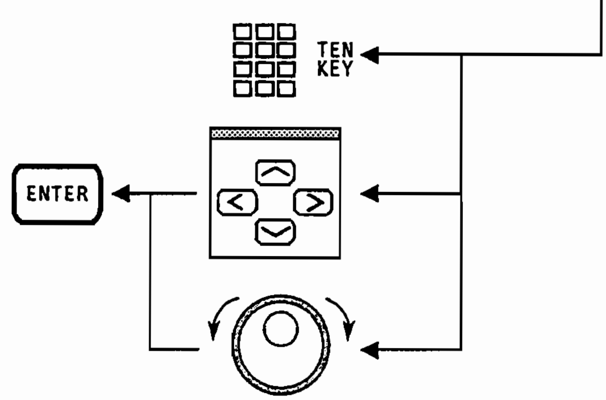
The impulse mode simulates a response that would result from impulse signal input; the step mode simulates a response that would result from step signal input.

Press F5 in the key-in sequence described below to open the TIME DOMAIN FUNCTION window to specify whether the time- domain waveform derived from the results of measurement in the frequency domain should be displayed as an impulse or step response.



① Select the RESPONSE TYPE parameter group with the ∧ or ∨ key.

② Select 1. IMPULSE or 2. STEP with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.



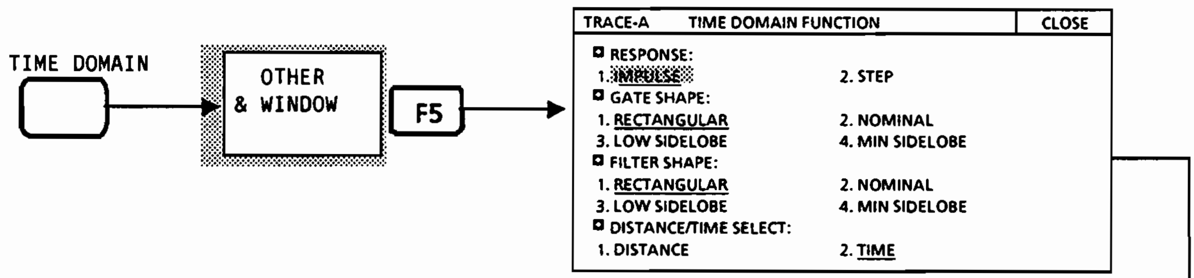
In the low-pass mode, two different responses, impulse and step, can be used for DUTs. The band-pass mode does not allow step response measurement because it does not contain DC components.

5.6.2 Setting time/distance area ranges

Set the start time (distance) or span time (distance) to determine the time-domain waveform from the results of measurement in the frequency domain. If the time (TIME) is T (seconds) and the distance (DISTANCE) is L (meters), the following relationship exists between the time and distance:

$L = 3 \times 10^8 \times T$

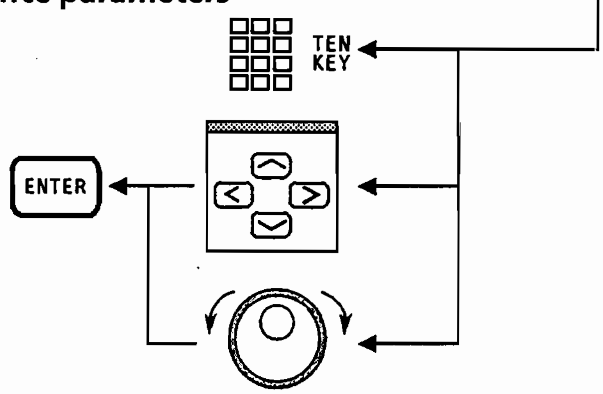
To select between the time and distance parameters, press F5 in the key-in sequence described below to open the TIME DOMAIN FUNCTION window.



(1) Selecting between the time and distance parameters

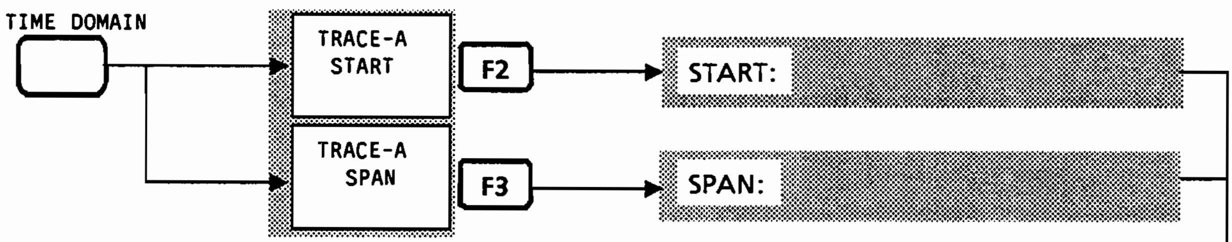
① Select the DISTANCE/TIME SELECT parameter group with the ∧ or ∨ key.

② Select 1. DISTANCE or 2. TIME with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

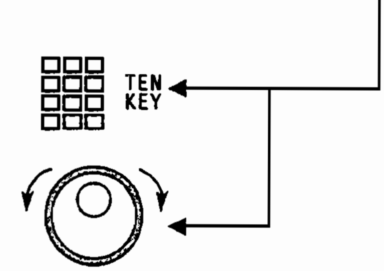


(2) Setting the start (time/distance) and span (time/distance)

Press F2 or F3 in the key-in sequence described below to open a direct entry area for setting the time or distance display start time and the display span.



Set both the START and SPAN data with the < or > key or with the ENTRY knob. With the ENTRY knob, there is no need to press the ENTER key to conclude the setting. After entering the data, press a unit key appropriate to the type of the data; u, ms, or ns for the time, or m or mm for the distance.



Note: The span time that can be set to collect a time-domain waveform from the results of measurement in a frequency domain. The span time must meet the following relation:

$0 <$ Span time $\leqq$ 1000/Measuring frequency span

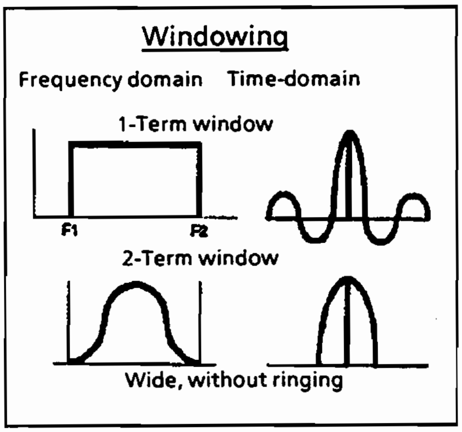
For example, if the measuring frequency span is 1 GHz, a span time up to $1000/10^9 = 1\ \mu s$ can be set. The allowable distance is up to $3 \times 10^{11}/10^9 = 300$ m.

Note: The following relationship exists between the time setting (T) and the distance setting (X):

V: Light velocity (3×10^8 m/s)
X = {X limit or V × T} .... When converting from a time to a distance
T = {T limit or X/V} .... When converting from a distance to a time

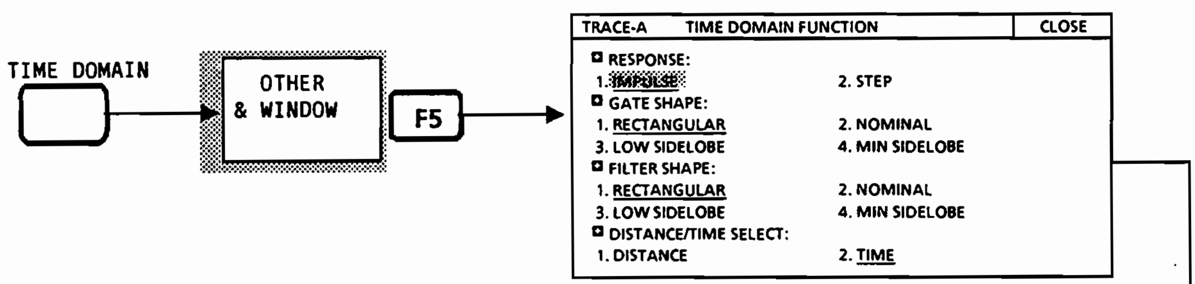
5.6.3 Windowing

Windowing (FILTER SHAPE) needs to be selected to suppress ringing that arises when a time-domain waveform is derived from the results of measurement in a frequency domain. Windowing is a variation of frequency filtering that is used in converting frequency-domain data to time-domain data.



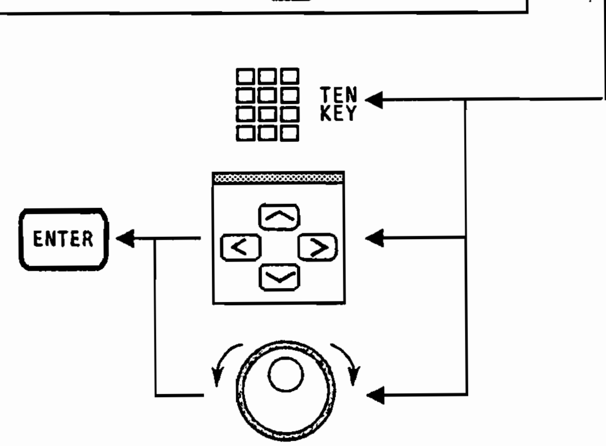
Windowing removes steep changes at F1 and F2, thereby keeping the sidelobe low during time-domain measurement. Windowing suppresses ringing in the pulse width (sidelobe) because it is capable of controlling a whole pulse waveform to some extent. Without windowing, a sin x/x response would manifest in the time domain. Therefore, data in the frequency domain is windowed before it is converted to a time domain to minimize the ringing in the time domain.

To select window filtering, press F5 in the key-in sequence described below to open the TIME DOMAIN FUNCTION window.



① Select the FILTER SHAPE parameter group with the ∧ or ∨ key.

② Select desired windowing from among 1. RECTANGULAR to MIN SIDELOBE with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.



Windowing, inverse to the resolution (impulse signal width) in a time domain, makes it possible to observe impulse signals with ringing suppressed or observe signals with short rise and fall times. In the FILTER SHAPE parameter group, RECTANGLE provides the least ringing (least sidelobe) with the narrowest pulse width available.

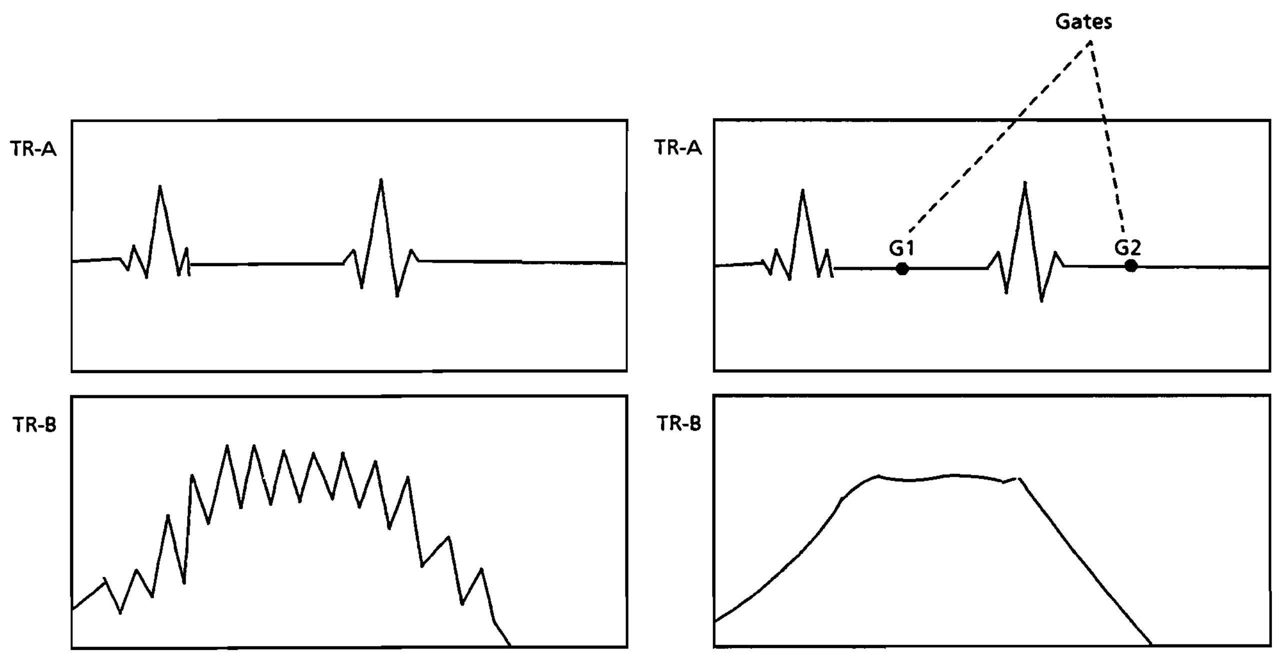
FILTER SHAPE	Object of selection	Resolution coefficient	SIDE LOBE
RECTANGULAR	1-term rectangular type	1.21	−13 dB
NOMINAL	2-term Hamming type	1.81	−43 dB
LOW SIDELOBE	3-term Blackman-Harris type	1.81	−67 dB
MIN SIDELOBE	4-term Blackman-Harris type	2.72	−92 dB

High ringing ↕ Low ringing

Impulse signal width (50 %) = 0.6 (LOW PASS) × Resolution coefficient/Resolution span 1.2 (BAND PASS)

5.6.4 Gating

Gating is a variation of bandpass filtering (time filtering), which is set in a time domain to take out only a specified range of responses from a time-domain waveform and analyze characteristics of these responses in a frequency domain. Gating (partial time-domain waveform selection function), when turned on, allows the frequency-domain waveform having impulse pulses in the range of gating set on trace A o be displayed on trace B.



(a) Gating off (b) Gating on

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SECTION 6
PACKAGE FUNCTIONS

This chapter focuses on the package functions, which include title entry, measuring point setting, and measurement data calculations. They also extract feature points, such as maximums and minimums, on trace waveforms. The package functions thus greatly ease the workflow of measurement.

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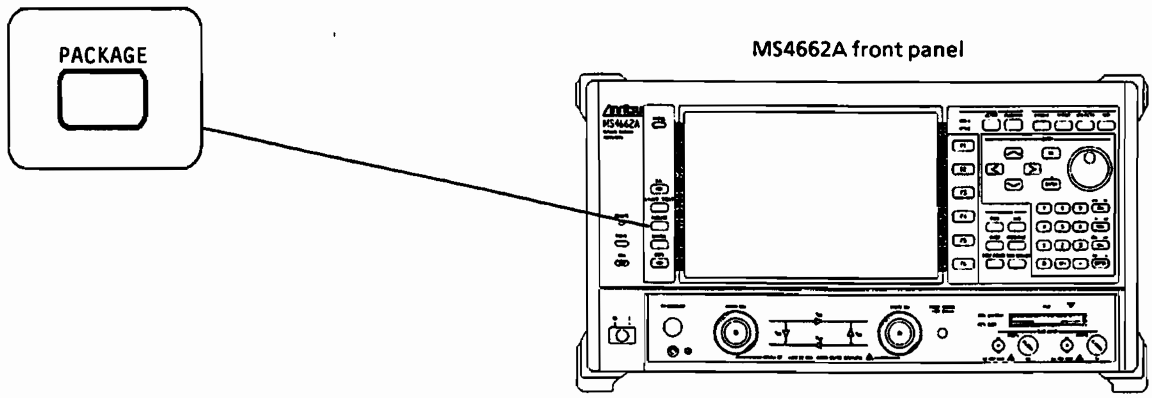
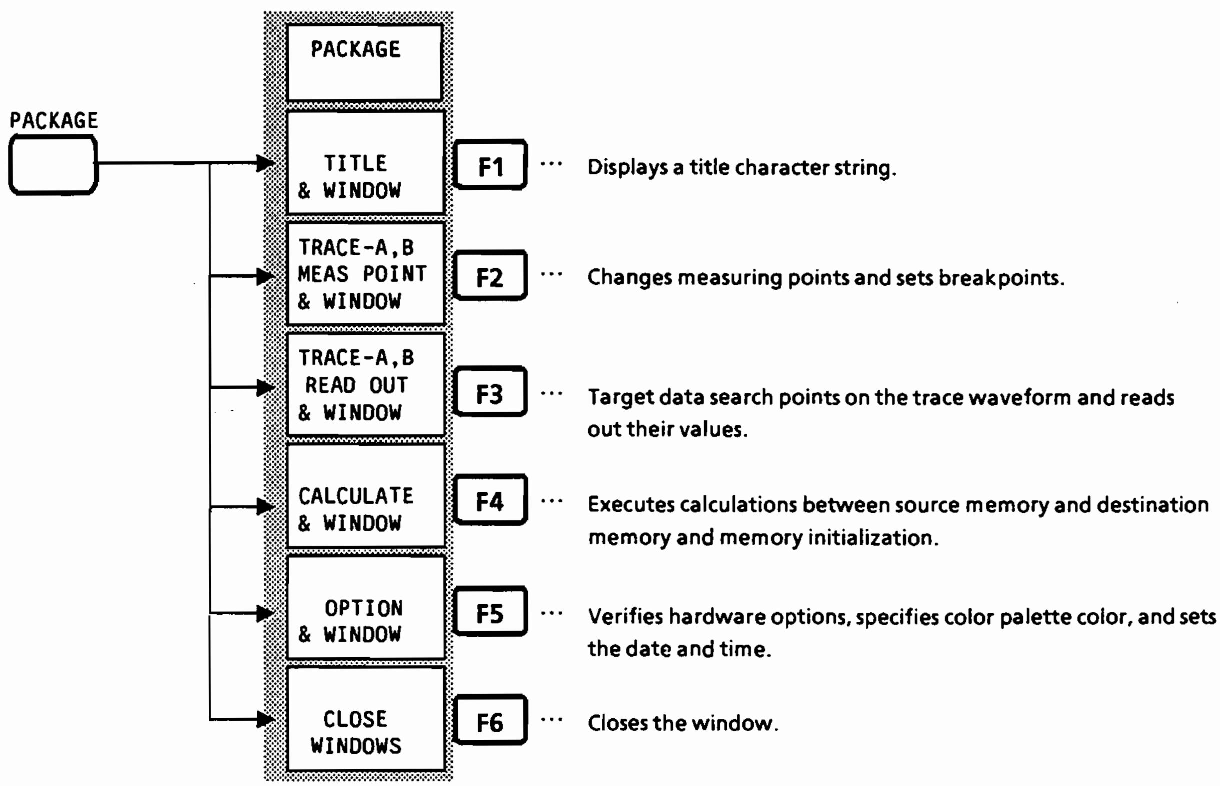
Press the PACKAGE key in the left-hand side of the front panel to display the PACKAGE softkey menu.



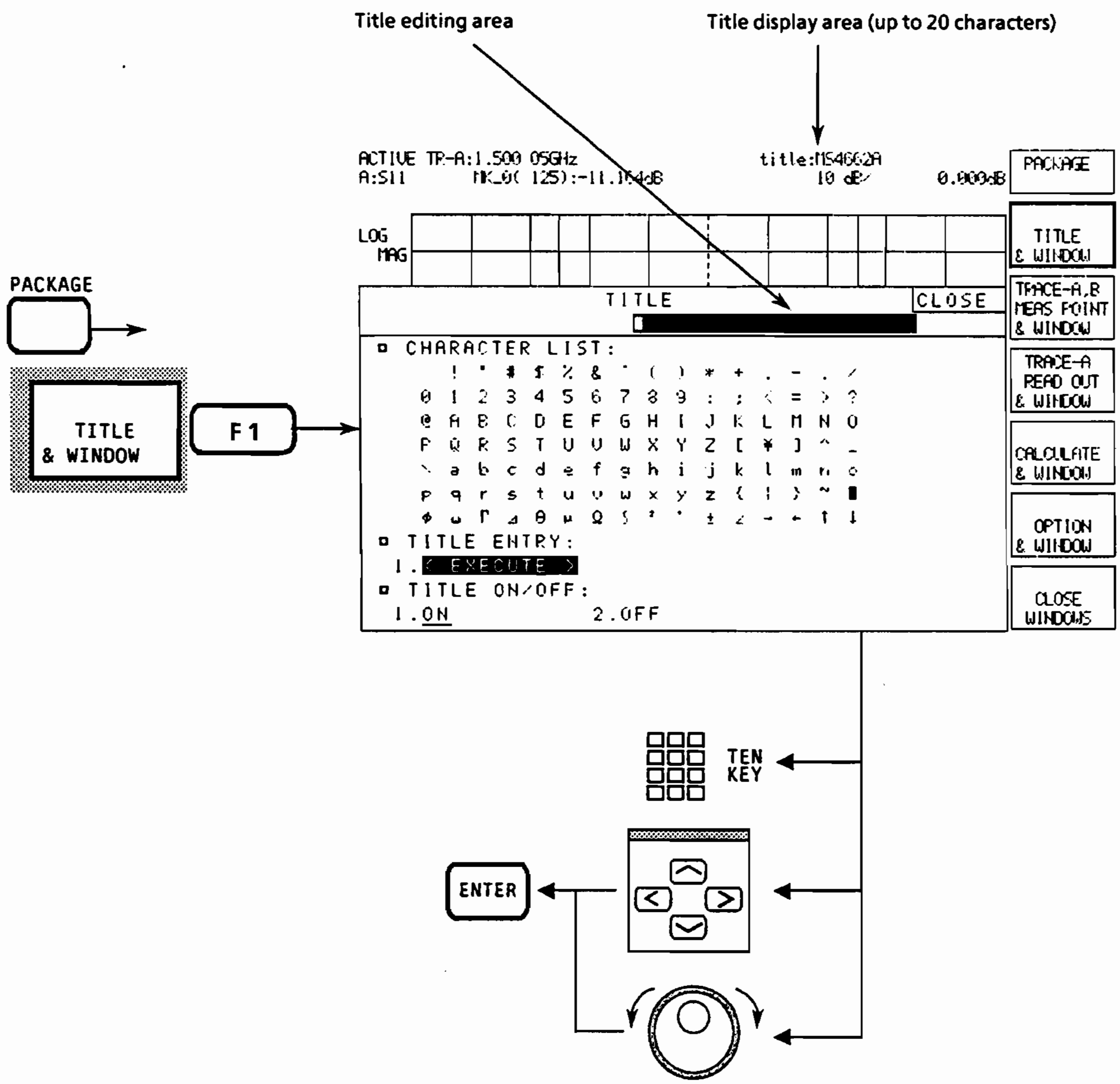


Note: TRACE-A, B in TRACE-A,B MEAS POINT in the PACKAGEmenu is controlled by the TRACE-A, B COUPLE ON/OFF function from the AVG menu. When TRACE-A, B COUPLE OFF is set in the AVERAGE FORMAT window, which is displayed by pressing F5 in the AVG menu, the softkey label TRACE-A, B MEAS POINT displays as TRACE-A MEAS POINT if TRACE-A is active or as TRACE-B MEAS POINT if TRACE-B is active. TRACE-A, B in TRACE-A, B READ OUT always displays as TRACE-A, B, regardless of the on/off status of the TRACE-A, B COUPLE ON/OFF parameter.

6.1 Displaying a Title Character String

A title character string, up to 20 characters long, is displayed in the title display area in the top of the display screen shown below.

To display a title character string, press keys in the following sequence:



Since TITLE OFF has been set by default, the date and time normally display in the top of the display screen. Pressing F1 in the procedure above displays the TITLE window.

In the procedure described below, select the parameter group with the ∧ or ∨ key. To select parameters from the group, use the < or > key or the ENTRY knob, and press the ENTER key to conclude the setting. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key. To correct data entry errors, use the BS (backspace) key.

① Select the TITLE ON/OFF parameter group.

② Select 1. ON. The date/time display area in the top of the display screen is cleared and a title display area is created instead.

③ Select the CHARACTER LIST group.

④ Move the cursor to the character to edit and press the ENTER key to select that character, and that character is displayed in the title editing area.

⑤ Repeat Step ④ for each additional character to be included in the title.

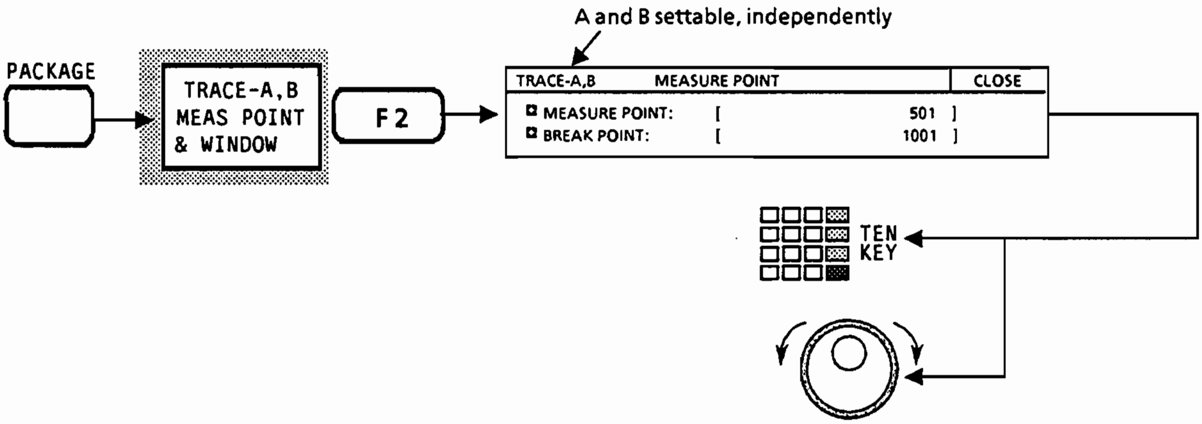
⑥ Select the TITLE ENTRY parameter group. Press the ENTER key to move the contents of the title editing area into the title display area.

Note: To erase the character string already displayed as a title, execute Step ⑥ with the title editing area being blank. To edit the title, simply overwrite it.

6.2 Changing Number of Measuring Points and Setting Breakpoints

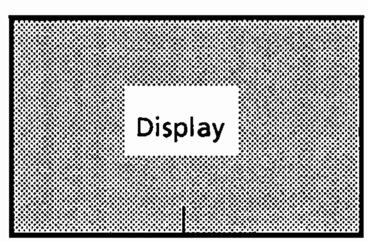
Press F2 in the key-in sequence described below to open the MEASURE POINT window.

- Changing number of measuring points 11, 21, 51, 101, 251, 501, 1001
- Setting breakpoints .... Set breakpoints between 1 and 1001.



(1) Changing number of measuring points

Fewer measuring points speed up the total sweep time. The number of measuring points is selectable from among seven choices: 11, 21, 51, 101, 251, 501, and 1001. Use the ENTRY knob to select them.



START	CENTER	STOP	Measuring points
0	5	10	 11
0	10	20	 21
0	25	50	 51
0	50	100	 101
0	125	250	 251
0	250	500	 501
0	500	1000	 1001

(2) Setting breakpoints

A breakpoint has been set at point 1001 by default. When a breakpoint is set at point N, a sweep extends from point 0 to point N, and not thereafter.

Select point N between 1 and 1001 with the < or > key or numeric keys. When setting a point number with numeric keys, press the ENTER key to conclude the setting.

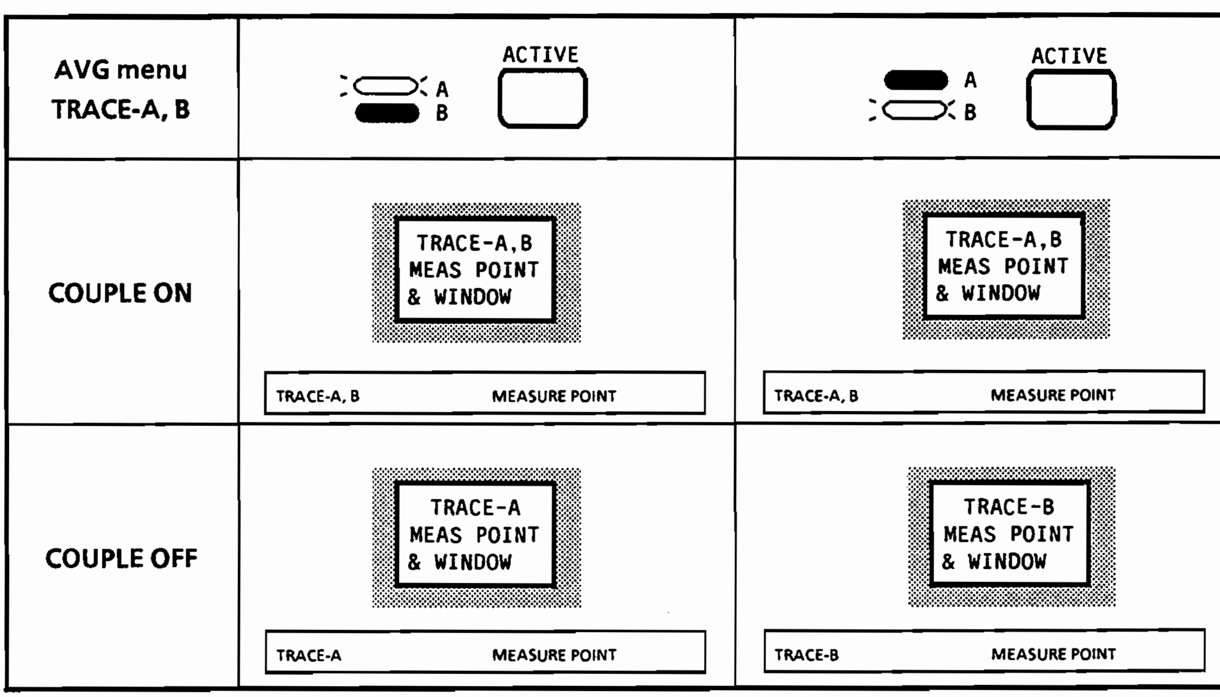
Note: Setting a breakpoints makes it unnecessary to scan all the measuring points on the horizontal axis, thus making for a shorter total sweep time. Run a marker sweep to make even the sweep start point variable.

(3) TRACE-A, B COUPLE ON/OFF

The relationships of the parameters in the MEASURE POINT window with TRACE-A, B is controlled by the TRACE-A, B COUPLE ON/OFF function from the AVG menu.

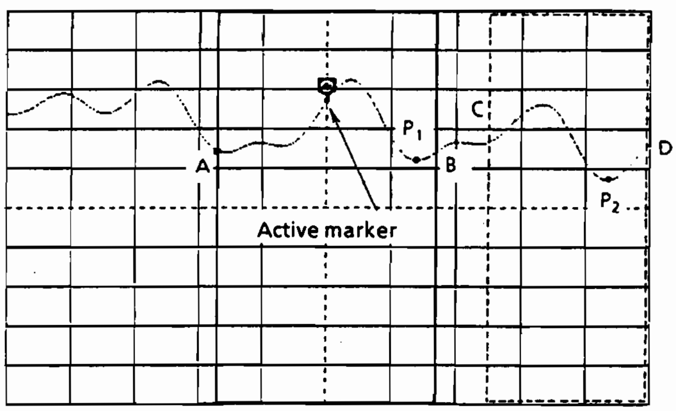
When TRACE-A, B COUPLE ON in the AVG menu, the trace label displays as TRACE-A, B, allowing trace A and B parameters to be set to identical values.

When TRACE-A, B COUPLE OFF is set, the trace label displays as TRACE-A or TRACE-B, allowing trace A and B parameters to be set independently. The softkey label TRACE-A, B displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active.



6.3 Target data search

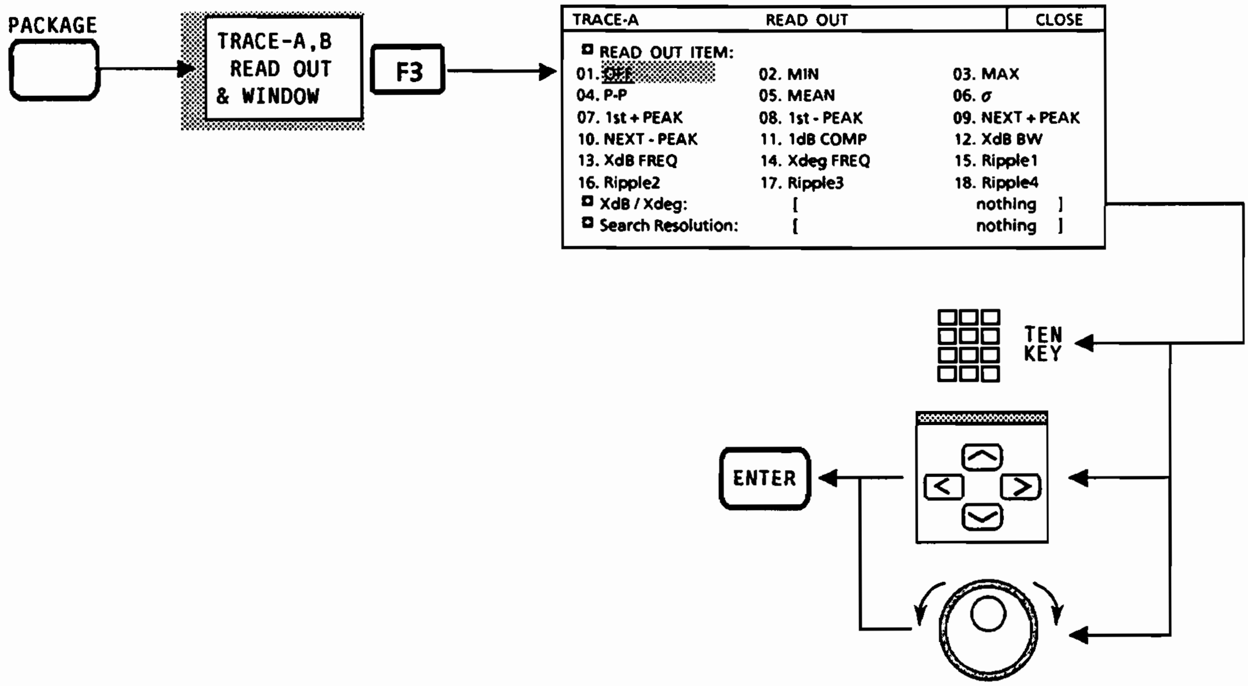
To read out the minimal value of point P2 in the trace waveform shown below, execute the marker function MKR → MIN to move the active marker to point P2 to read out the minimal value. The minimal value of point P1 between A and B can be read out by moving the active marker to point P1 with the ENTRY knob.



The values of points P1 and P2 may also be read out using the target data search function. If MIN has been previously selected as an object of feature extraction and the zone marker is moved with its width being adjusted to the distance between A and B, the minimal value of P_1 between A and B is read out. If the zone marker is moved with its width being adjusted to the distance between C and D, the minimal value of P_2 between C and D can be read out. Feature extraction extracts feature points (such as the maximum and minimum) in a zone marker range and displays the results of their calculation.

6.3.1 Target data search procedure

Press F3 in the key-in sequence described below to open the READ OUT window, which displays a list in of READ OUT times as objects of target data search.



The OFF parameter in the READ OUT ITEM group has been selected by default. While the OFF parameter is selected, the active marker is active, and the measurement values (magnitude and frequency) observed at the active marker point can be read out.

Execute target data search in the following procedural steps:

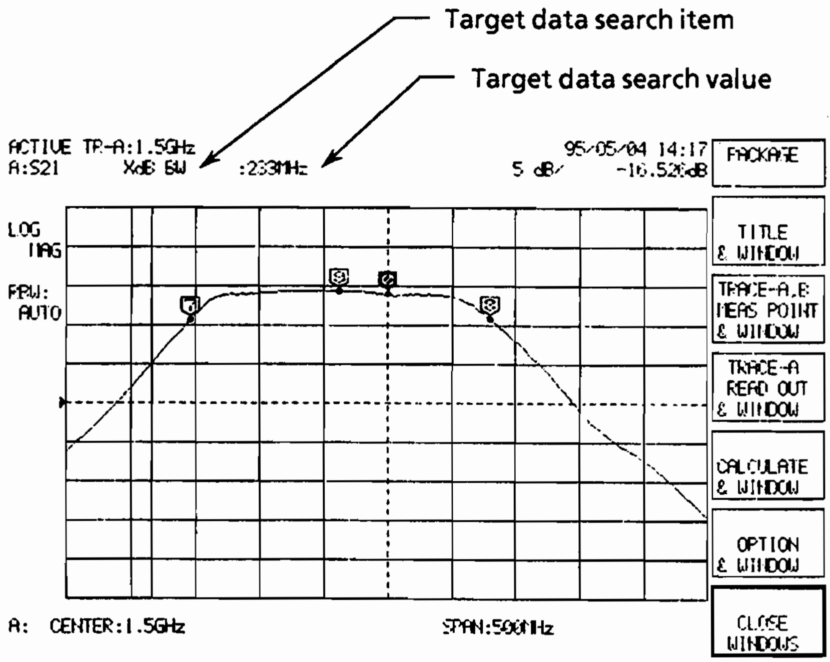
① Select the READ OUT ITEM parameter group with the ∧ or ∨ key.

② Select the desired read-out item from among 2. MIN to 18. Ripple 4. with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

③ Adjust the width and position of the zone marker with the ENTRY knob to cover the target data search point.

④ The read-out item selected in Step ② is calculated and displayed.

Note: If READ OUT ITEM has been selected from among 12. X dB BW, 13. X dB FREQ, and 14. X deg FREQ, select the X dB/X deg parameter group with the ∧ or ∨ key, set a numeric value with numeric keys, and press the ENTER keys. If READ OUT ITEM has been selected from among 07. 1st + PEAK to 10. NEXT-PEAK and from 15. Ripple 1 to 18. Ripple 4, set a search resolution likewise. Target data of any values higher than this resolution are searched.



Note: The marker function is turned off (normal) when target data search is turned on.

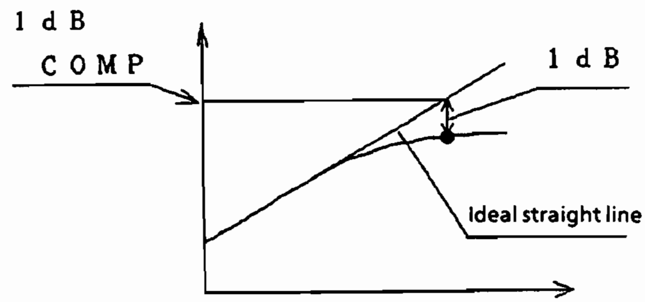
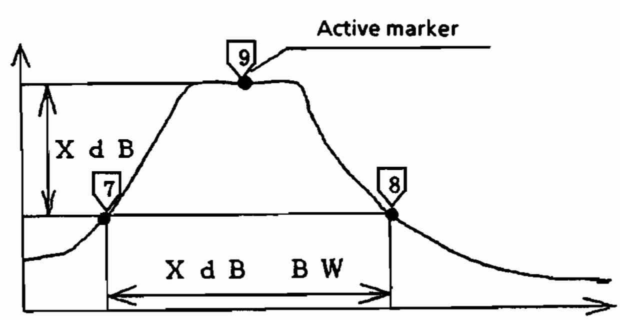
6.3.2 Definitions of target data search items

The table below gives definitions of the read-out items, 1. OFF through 18. Ripple 4, listed in the READ OUT window.

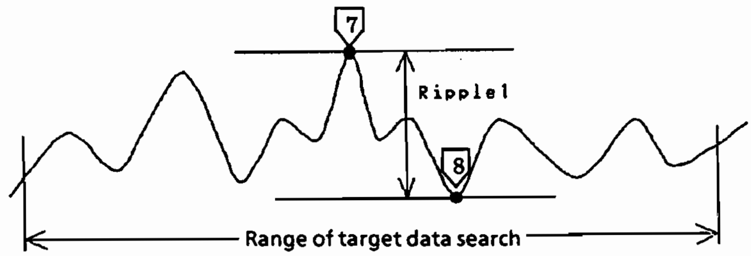
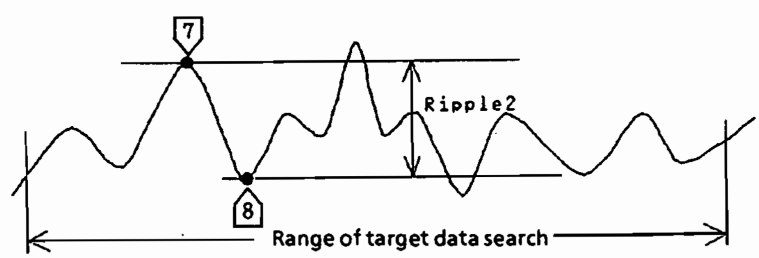
Target data search (1/4)

Target data search item	Definition
1. OFF	The target data search function is turned off. While the OFF parameter is selected, the active marker is active, and the measurement values (magnitude and frequency) observed at the active marker point can be read out.
2. MIN 3. MAX 4. P − P 5. MEAN 6. δ	The following items of measured values in the interval specified by the range of target data search (zone marker range) are calculated and output: Minimum : MIN Maximum: MAX Marker [9] moves to the position of the target data search value. Maximum − Minimum: P-P Marker [7] points to the left-side frequency that meets the condition, and the point value.Marker [8] points to the right-side frequency that meets the condition, and the point value. Weighted mean: MEAN Standard deviation: δ
7. 1st + PEAK 8. 1st − PEAK	The maximum value (+PEAK) or minimal value (−PEAK) in the interval specified by the range of target data search (zone marker range) are calculated and output. Marker [9] moves to the position of the target data search value.
9. NEXT + PEAK 10. NEXT − PEAK	When the maximal values of the measurement results in the interval specified by the range of target data search (zone marker range) are sorted in descending order, the N-th maximal value (+PEAK) from the highest is output; when the minimal values are sorted in ascending order, the M-th minimal value (−PEAK) from the lowest is output. N is set to 1 on initialization and on execution of the first target data search run + PEAK and is incremented by 1 on execution of each next target data search run + PEAK. Likewise, M is incremented or decremented on execution of the first target data search run − PEAK and each next target data search run − PEAK. Marker [9] moves to the position of the target data search value.

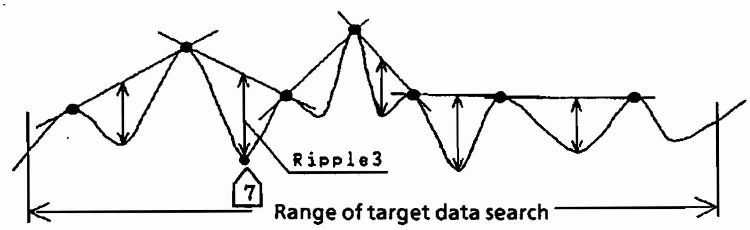
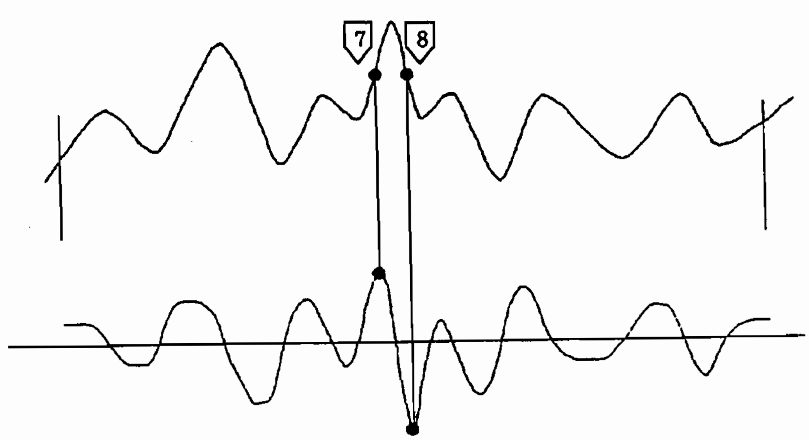
Target data search (2/4)

Target data search item	Definition
11. 1 dB COMP	The power measured at the leftmost end of the zone is conceived, along with an ideal straight line that passes the power that is measured at the active marker point. Then, the power on the ideal straight line at such point that it is lower by 1 dB than the measured value of the power is calculated and output. +130 dBm is output when there is no such point. 
12. X dB BW	The measured value at the active marker point is noted as a reference level, and the difference between the reference level and each measurement level in the zone is calculated. Then, a search is made on both sides of the active marker to output the difference between the first left- and right-side measuring frequencies that equal X dB. The right-side zone frequency is output when no such measuring frequencies are found.  Marker 7 points to the left-side frequency that meets the condition, and the point value. Marker 8 points to the right-side frequency that meets the condition, and the point value. Marker 9 moves to the arithmetic mean of the left- and right side values above.
13. X dB FREQ	The interval specified by the range of target data search (zone marker range) is surveyed from the left end to output the measuring frequency that yields a measurement value of X dB (dBm). 0 Hz is output when no such measuring frequency is found.
14. X deg FREQ	The interval specified by the range of target data search (zone marker range) is surveyed from the left end to output the measuring frequency that yields a measurement value of X deg. 0 Hz is output when no such measuring frequency is found.

Target data search (3/4)

Target data search item	Definition
15. Ripple 1	The difference between the maximal value having the maximum value and the minimal value having the minimum value beyond the ripple resolution in the interval specified by the range of target data search (zone marker range) is calculated and output. If ripple 1 is not found, a ripple of 0 is output, with markers 7 and 8 moving to the right-side marker point.  Marker 7 points to the left-side frequency that meets the condition, and the point value. Marker 8 points to the right-side frequency that meets the condition, and the point value.
16. Ripple 2	The difference between the maximal and minimal values that adjoin each other beyond the ripple resolution in the interval specified by the range of target data search (zone marker range) is calculated and the maximum value is output. If ripple 2 is not found, a ripple of 0 is output, with markers 7 and 8 moving to the right-side marker point.  Marker 7 points to the left-side frequency that meets the condition, and the point value. Marker 8 points to the right-side frequency that meets the condition, and the point value.

Target data search (4/4)

Target data search item	Definition
17. Ripple 3	A line segment that connects two maximal values that adjoin each other beyond the ripple resolution in the interval specified by the range of target data search (zone marker range) is assumed. Then, the maximum difference between the line segment and the minimal value is output. If ripple 3 is not found, a ripple of 0 is output, with markers [7] and [8] moving to the right-side marker point.  Marker [7] points to the left-side frequency that meets the condition, and the point value. Marker [8] points to the right-side frequency that meets the condition, and the point value.
18. Ripple 4	A differential waveform is generated from the difference between two measuring points that adjoin each other beyond the ripple resolution in the interval specified by the range of target data search (zone marker range) is assumed. Then, the measuring point in the differential waveform at which the difference between the adjoining maximal and minimal values is determined and the difference in the measured value from the original waveform at that measuring point is output as ripple 4. If ripple 4 is not found, a ripple of 0 is output, with markers [7] and [8] moving to the right-side marker point.  Marker [7] points to the left-side frequency that meets the condition, and the point value. Marker [8] points to the right-side frequency that meets the condition, and the point value.

6.4 Memory Calculations and Initialization

The MS4662A performs inter-memory calculations, such as addition and subtraction, on the data stored in source memory and destination memory, and stores the results in destination memory. Complex data is handled. Calculation results are stored in destination memory divided into real and imaginary numbers.

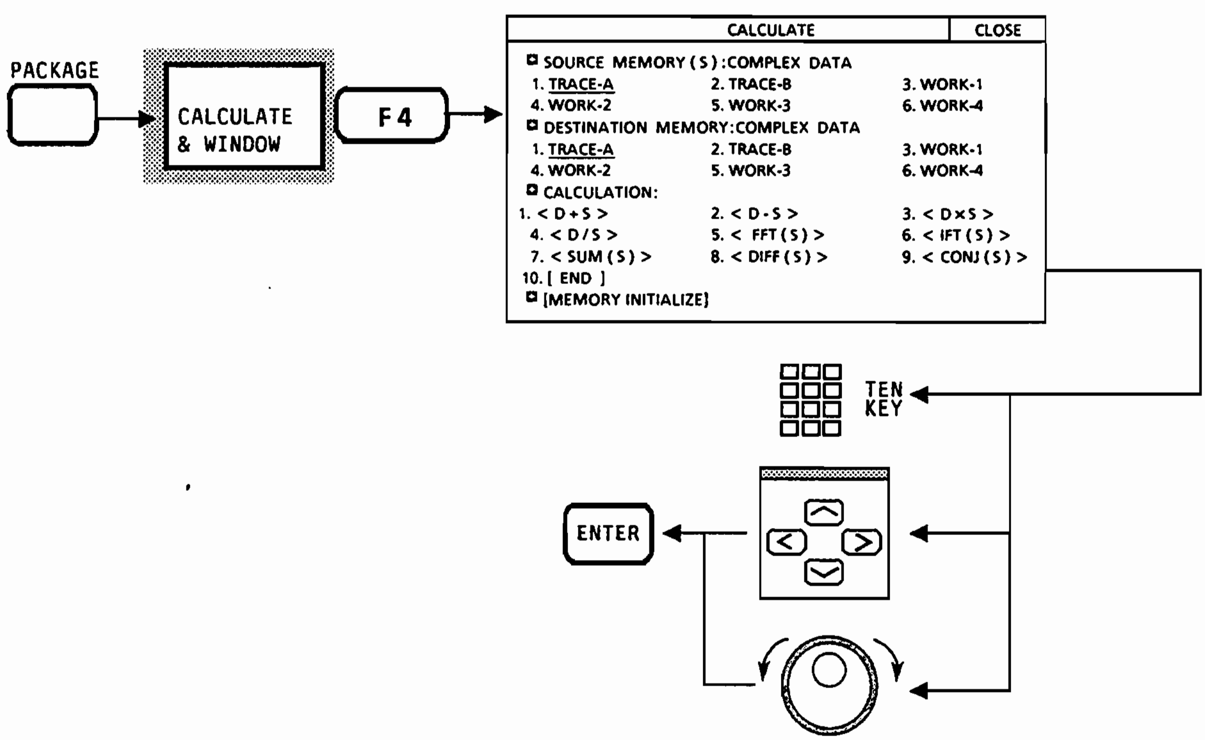
Trace memory and work memory are subjected to memory calculations. Memory calculations are performed on two locations of trace memory, two locations of work memory, or between one location of trace memory and one location of work memory. Two trace memory locations are available: TRACE-A and TRACE-B. Four work memory locations are available: WORK-1, WORK-2, WORK-3, and WORK-4. Each memory location has a size of 8 KB.

A memory initialization menu is available to initialize memory contents to certain values before inter-memory calculations are executed.

6.4.1 Inter-memory calculations

Press F4 in the key-in sequence below to open the CALCULATE window.

Use the ∧ or ∨ key to select parameter groups from this window. Select parameters from each group with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.



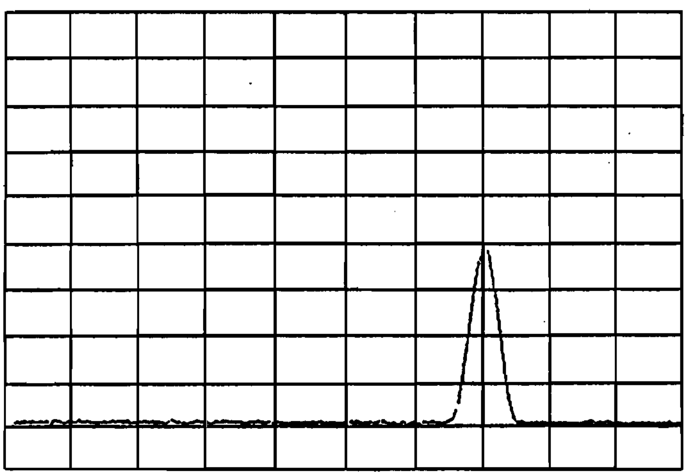
(1) Parameter selection procedure

① Select the SOURCE MEMORY(S) parameter group with the ∧ or ∨ key.
② Specify one of the six different locations as source memory.
③ Select the DESTINATION MEMORY parameter group with the ∧ or ∨ key.
④ Specify one of the six different locations as destination memory.
⑤ Select the CALCULATION parameter group with the ∧ or ∨ key.
⑥ Choose from among the nine different calculation items. A calculation begins. The reverse cursor moves to 10. [END] when the calculation is complete.

(2) Example calculation

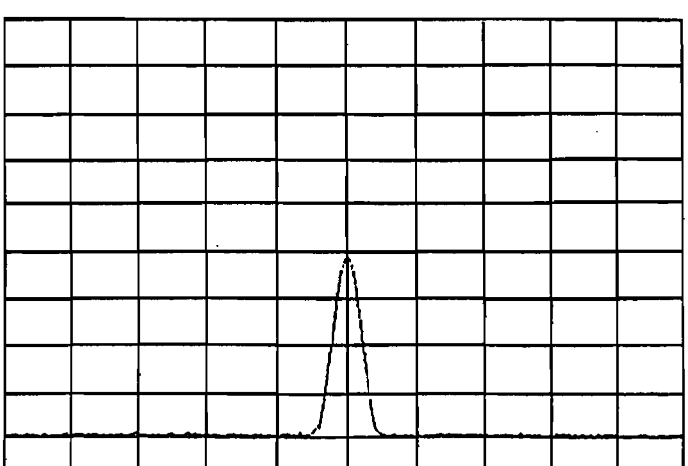
As an example of a trace memory calculation, D − S → D is explained below in which TRACE-B is specified as source memory and TRACE-A is specified as destination memory.

TRACE-B ······Source (S)

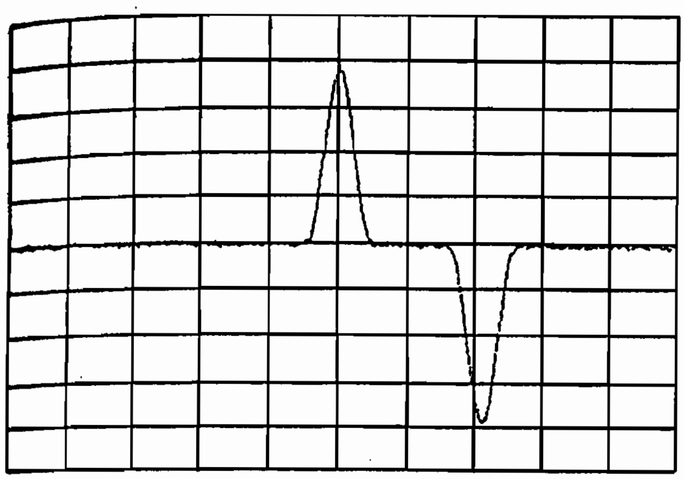


<Source memory specification>
① Select the SOURCE MEMORY(S) parameter group with the ∧ or ∨ key.
② Press the numeric key 2 to specify 2. TRACE-B as source memory.

TRACE-A ······Destination (D)



<Destination memory specification>
③ Select the DESTINATION MEMORY parameter group with the ∧ or ∨ key.
④ Press the numeric key 1 to specify 1. TRACE-A as destination memory.



<Calculating TRACE-A − TRACE-B → TRACE-A (D-S → D)>

⑤ Select the CALCULATION parameter group with the ∧ or ∨ key.

⑥ Press the numeric key 2 to select the calculation item A calculation begins. The reverse cursor moves to 10. [END] when the calculation is complete.

⑦ To make the result of the calculation D-S → D easier to view, apply an offset to get the trace screen (TRACE-A) shown at left.

(3) Calculation items

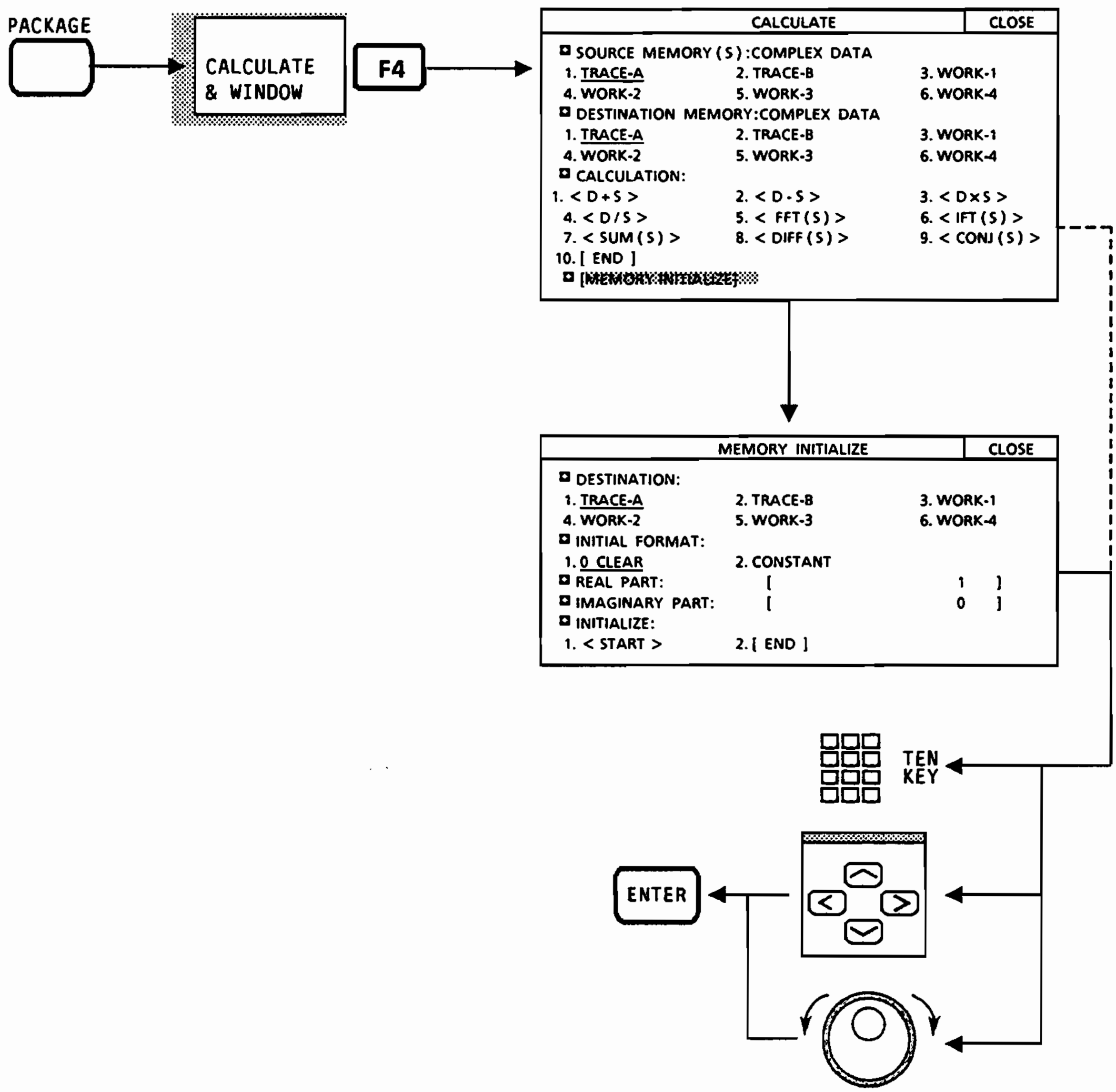
Complex data can be subjected to calculation by the calculation items selectable from the CALCULATION parameter group as listed below. Calculation results are stored in destination memory divided into real and imaginary numbers.

(D: destination, S: source, C: complex, R: real)

1. <D+S> .... Addition D (C) + S (C) → Destination (Complex)
2. <D−S> .... Subtraction D (C) − S (C) → Destination (Complex)
3. <DxS> .... Multiplication D (C) × S (C) → Destination (Complex)
4. <D/S> .... Division D (C)/S (C) → Destination (Complex)
5. <FFT (S) .... Fast Fourier transform FFT {Source (R)} → Destination (Complex)
6. <IFT (S) .... Inverse Fourier transform IFT {Source (R)} → Destination (Complex)
7. <SUM (S) .... Cumulative addition S (C) 0 + ... + S (C) n → Destination (Complex)
8. <DIFF (S)> ...... Differential S (C) n − S (C) n-1 → Destination (Complex)
9. <CONJ (S)> ..... Conjugate complex number S (C) n → Destination (Complex)

6.4.2 Memory initialization

Opening the CALCULATE window in the key-in sequence below, select the MEMORY INITIALIZE parameter group with the ∧ or ∨ key and press the ENTER key to open the MEMORY INITIALIZE window.



Use the ∧ or ∨ key to select parameter groups from this window. Select parameters from each group with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

① Select the DESTINATION parameter group with the ∧ or ∨ key.

② Select the memory location to initialize.

③ Select the INITIAL FORMAT parameter group with the ∧ or ∨ key.

④ To clear memory, select 1.0 CLEAR. To enter a constant, select 2. CONSTANT.

⑤ Select the REAL PART parameter group with the ∧ or ∨ key.

Enter data with numeric keys according to INITIAL FORMAT and press the ENTER key. To clear memory, type 0.

⑥ Select the IMAGINARY PART parameter group with the ∧ or ∨ key.

Enter data with numeric keys according to INITIAL FORMAT and press the ENTER key.

To clear memory, type 0.

⑦ Select the INITIALIZE parameter group with the ∧ or ∨ key.

Select 1. <START> and press the ENTER key to start initialization. The cursor moves to 10. [END] when the initialization is complete.

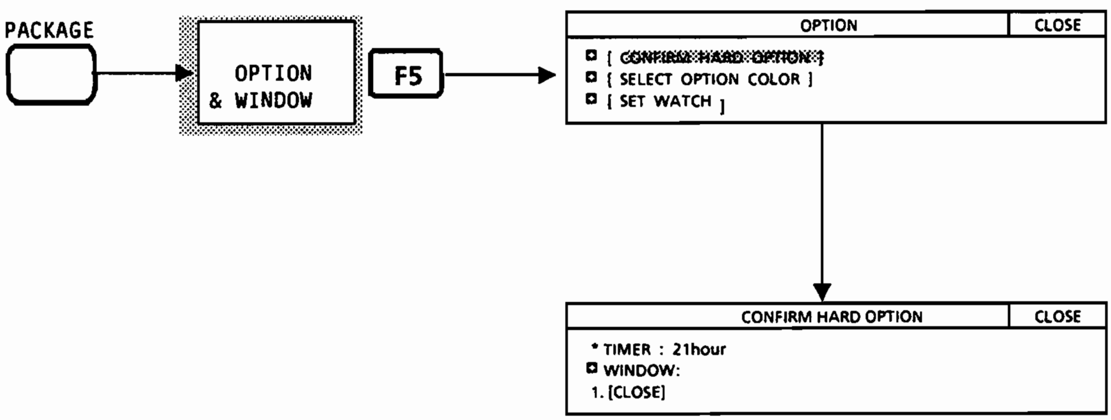
6.5 Verifying Hardware, Specifying Colors, and Setting the Date and Time

Press the F5 softkey associated with the OPTION & PACKAGE label in the PACKAGE menu. Pressing F5 provides the following three functions:

- CONFIRM HARD OPTION .... MS4662A and peripherals connection status check
- SELECT OPTION COLOR ..... Color palette color specification
- SET WATCH .... Date and time setting

6.5.1 Verifying the connection of peripherals

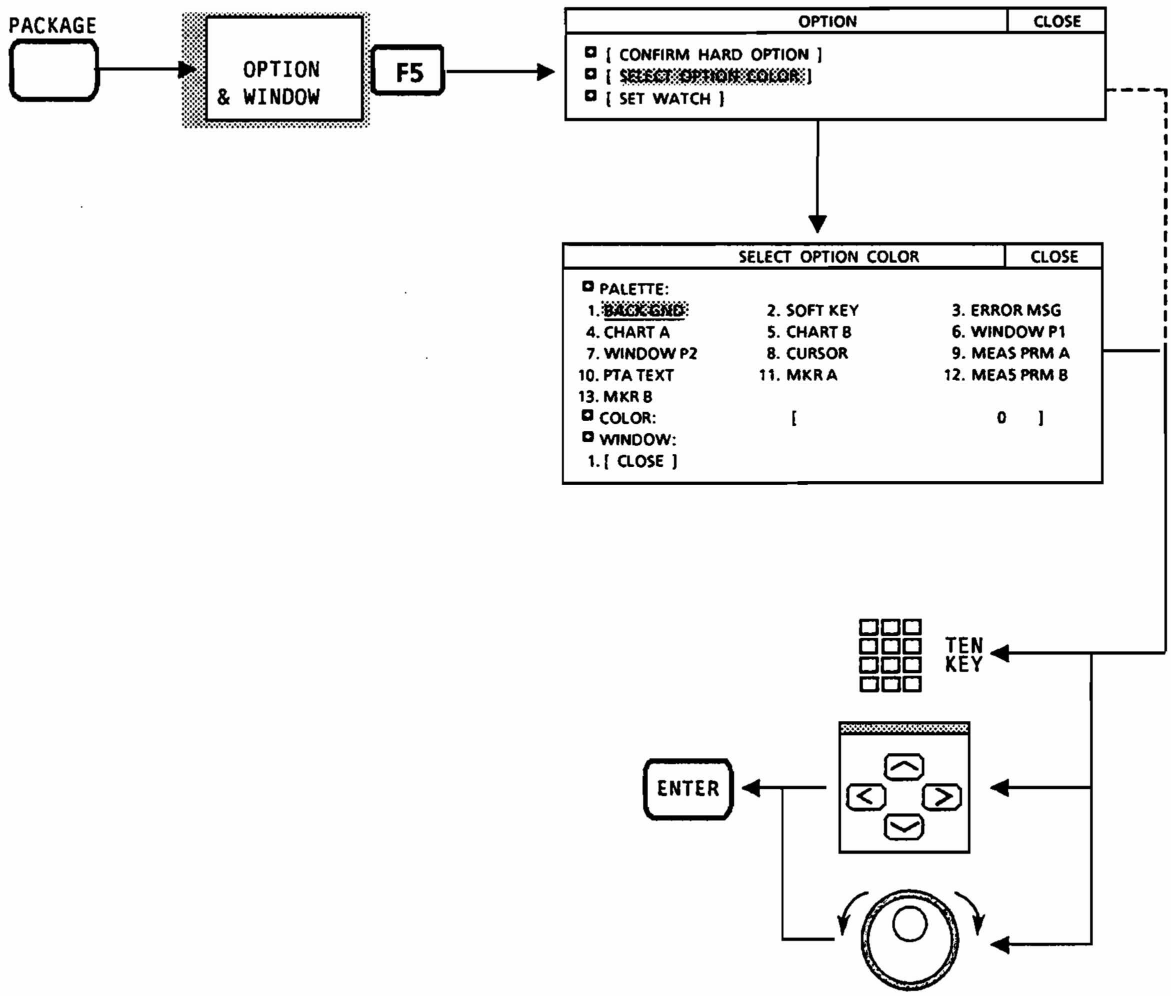
Select the CONFIRM HARD OPTION parameter group with the ∧ or ∨ key in the key-in sequence below, and the CONFIRM HARD OPTION window opens.



Because the MS4662A features built-in S-parameter testing and does not require special peripherals, only a timer is displayed in this window to indicate the duration of its usage.

6.5.2 Specifying color palette colors

Select the SELECT OPTION COLOR parameter group with the ∧ or ∨ key in the key-in sequence below, and the SELECT OPTION COLOR window open opens.



① Select the PALETTE parameter group with the ∧ or ∨ key.

② Select the number of the item to be colored with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

③ Select the COLOR parameter group with the ∧ or ∨ key.

④ Select a color number from among 0 to 15 in the table at left below with the ENTRY knob. The color associated with the number is displayed under the COLOR entry field. The table at right below lists the default colors in the color palette.

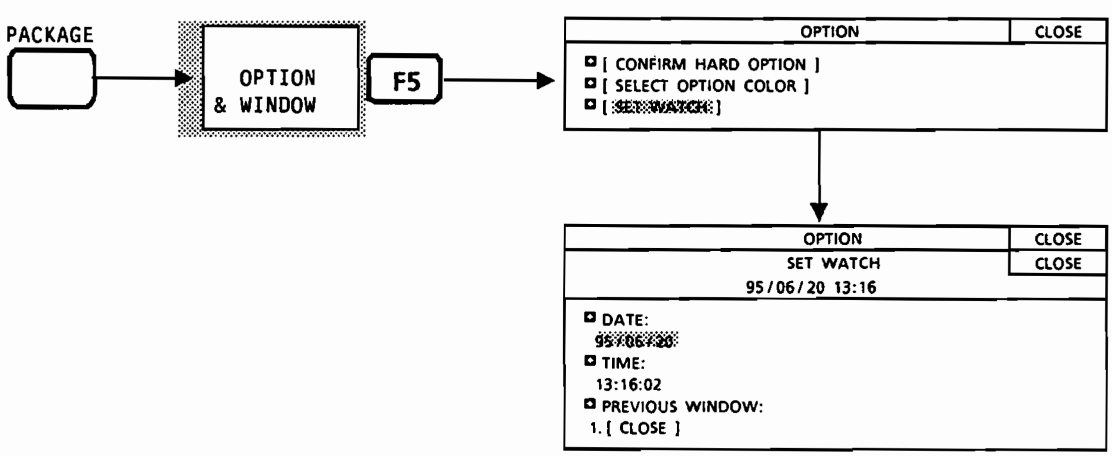
<Number-color correspondence table>

n = 0: Black
= 1: Dark blue
= 2: Dark red
= 3: Dark purple
= 4: Dark green
= 5: Dark turquoise
= 6: Dark yellowyellow
= 7: Dark white
= 8: Black
= 9: Light blue
= 10: Light red
= 11: Light purple
= 12: Light green
= 13: Light turquoise
= 14: Light
= 15: Light white

Screen number	Name	Default (color)
01	BACK GND	0 (black)
02	SOFT KEY	7 (dark white)
03	ERROR MSG	9 (light red)
04	CHART A	13 (light purple)
05	CHART B	15 (light yellow)
06	WINDOW P1	15 (light white)
07	WINDOW P2	15 (light white)
08	CURSOR	15 (light white)
09	MEAS PRM A (GRAPH A)	10 (light green)
10	PTA TEXT	15 (light white)
11	MKR A	15 (light white)
12	MEAS PRM B (GRAPH B)	14 (light turquoise)
13	MKR B	9 (light red)

6.5.3 Setting the date and time

Select the SET WATCH parameter group with the ∧ or ∨ key in the key-in sequence below, and the SET WATCH window opens.



① Select the DATE parameter group with the ∧ or ∨ key.
② Set the year, month, and data with numeric keys, and press the ENTER key.
③ Select the TIME parameter group with the ∧ or ∨ key.
④ Set the hour, minute, and second with numeric keys, and press the ENTER key.

SECTION 7
LIMIT TESTING FUNCTIONS

This chapter concerns the limit testing functions of the MS4662A. The MS4662A provides two types of limit lines (single and segmented).

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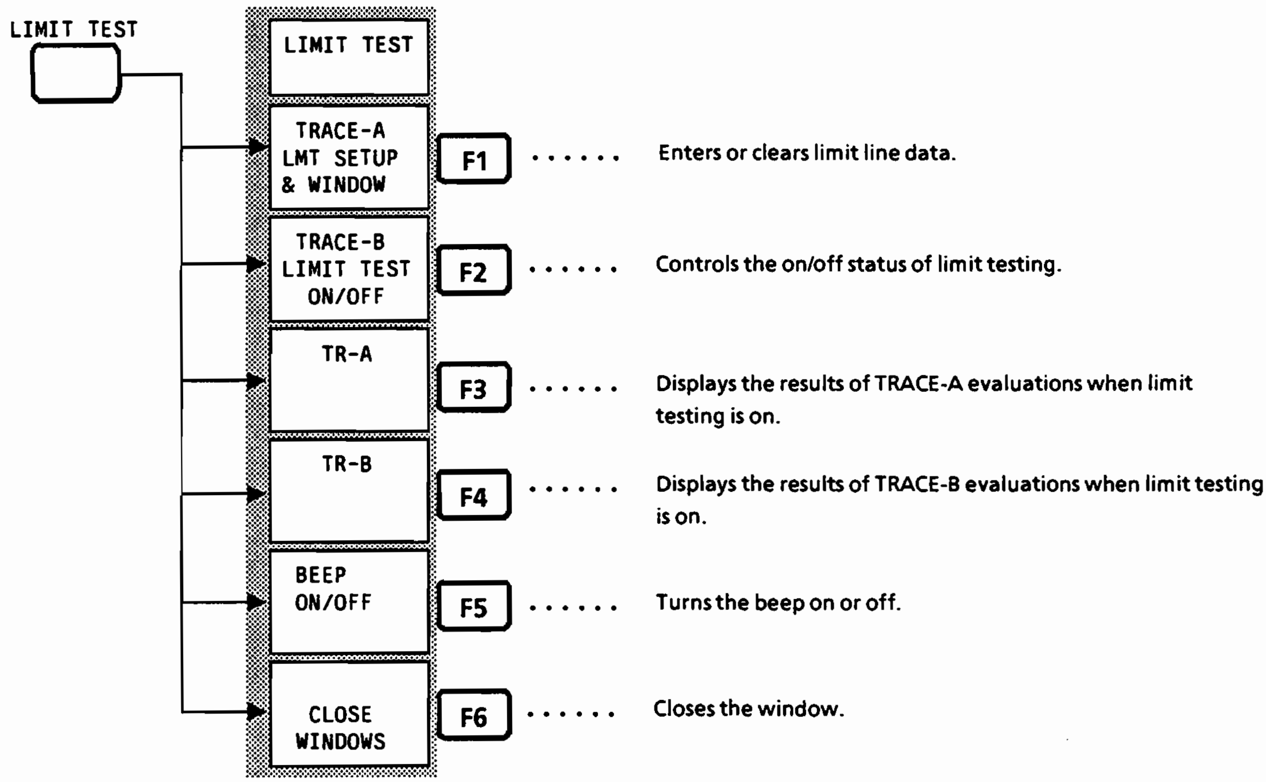
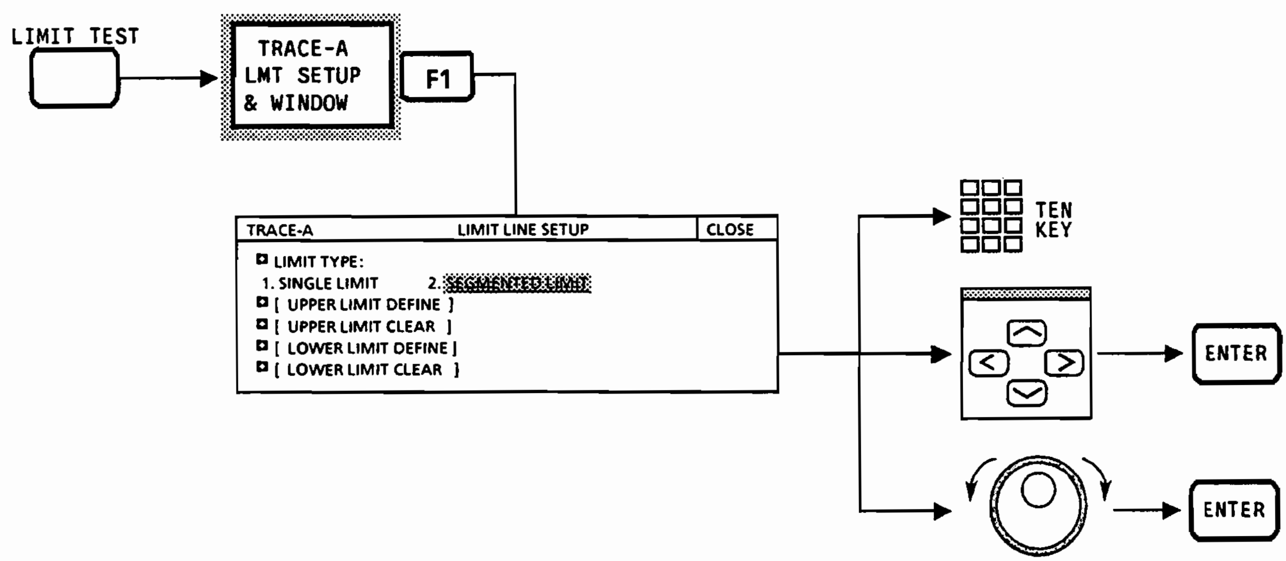
7.1 Setting Limit Testing Parameters

The MS4662A's limit testing functions include entering limit line data, controlling the on/off status of limit testing, and turning the beep on or off. The LIMIT TEST key, when pressed, comes up with the following softkey menu:

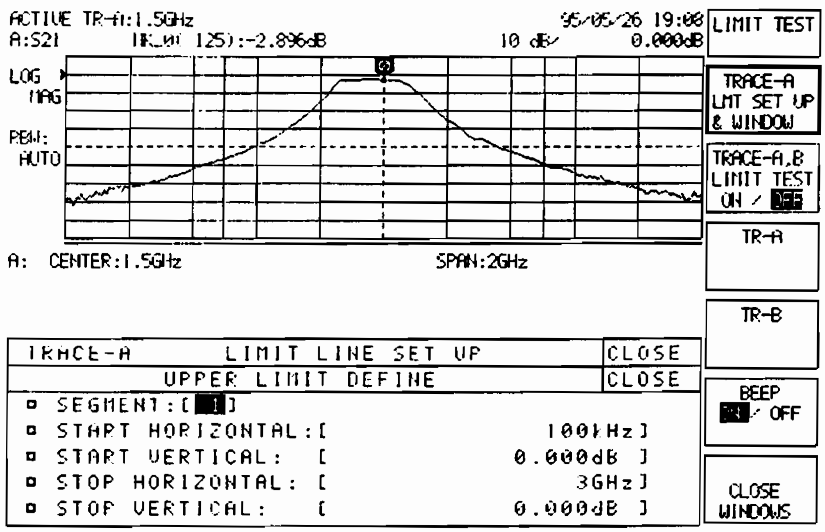


7.1.1 Entering and clearing limit line data

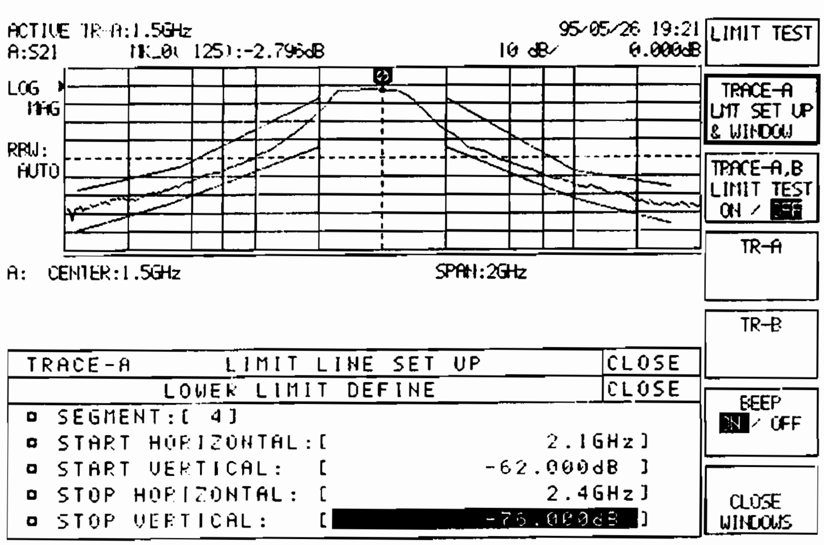


(1) Entering a segmented limit

After selecting SEGMENTED LIMIT from the LIMIT LINE SETUP window, position the cursor on UPPER/LOWER LIMIT DEFINE and press the ENTER key. An entry screen like that shown below appears.



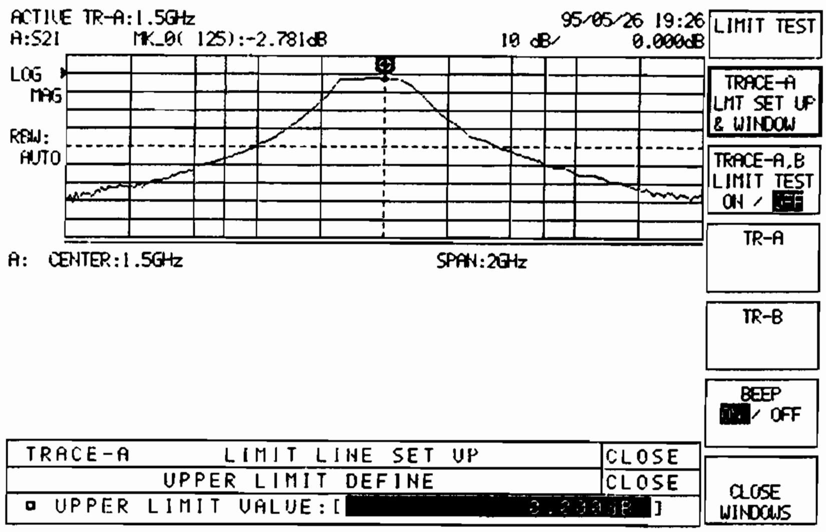
Beginning with segment 1, enter X-axis data (frequency and time) and Y-axis data (dB and deg) with the ENTRY knob or numeric keys. When STOP data for segment 1 is entered, segment data is automatically set to the same data.



Limit line entry example

(2) Entering a single limit

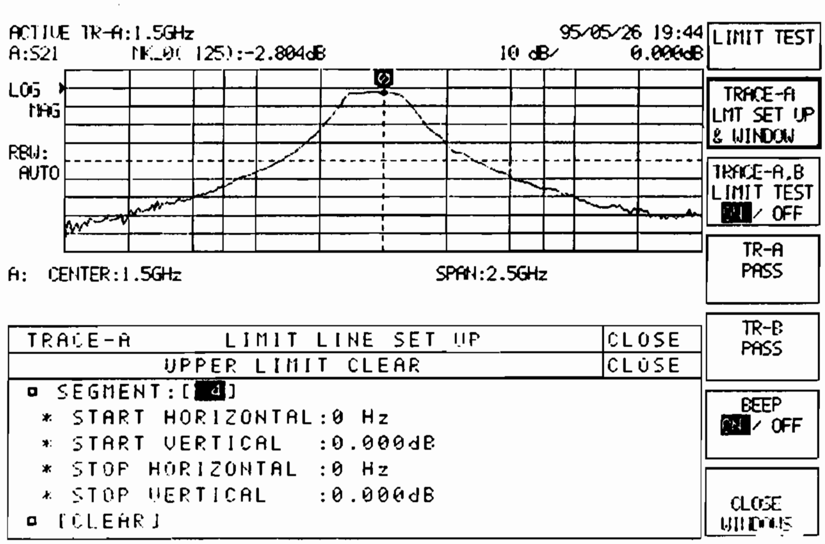
After selecting SINGLE LIMIT from the LIMIT LINE SETUP window, position the cursor on UPPER/LOWER LIMIT DEFINE and press the ENTER key. An entry screen like that shown below appears.



A single limit has Y-axis data (dB and deg) only. Enter the data with the ENTRY knob or numeric keys.

(3) Clearing limit data and limit lines

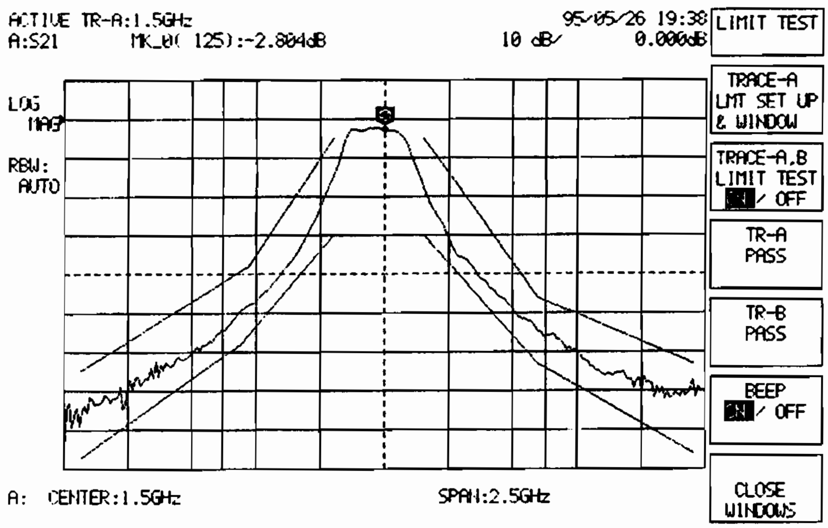
Position the cursor on UPPER/LOWER LIMIT DEFINE in the LIMIT LINE SETUP window, and press the ENTER key. A limit clear screen like that shown below appears.



Position the cursor on CLEAR and press the ENTER key to clear the current settings of the limit data and limit line.

7.1.2 Controlling the on/off status of limit testing

Press LIMIT TEST menu F2 and limit testing toggles between ON and OFF. The results of PASS/FAIL evaluations are displayed in place of the F4 and F5 softkeys when LIMIT TEST is ON.



Limit test on example

7.1.3 Turning the beep on or off

Press LIMIT TEST menu F5 and the beep toggles between ON and OFF. If BEEP is ON, the beep sounds when the result of an evaluation is FAIL while LIMIT TEST is ON.
If BEEP is OFF, no beep sounds to report the result of an evaluation or to relay a message, such as CAL OFF.

SECTION 8
HARD-COPYING AND SAVE/RECALL FUNCTIONS

This chapter describes the copy function that hard-copies display images to printers or plotters, and the functions for saving and recalling PMC files of measurement data and measurement parameter data. Refer to Chapter 2, "Preparations," for the precautions to be observed in handling PMCs.

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8.1 Hard-copying Display Images

The MS4662A supports the following methods of hard-copying display images:

- Copying to a video plotter (UA-455A)
- Copying to a printer or plotter via a GPIB interface

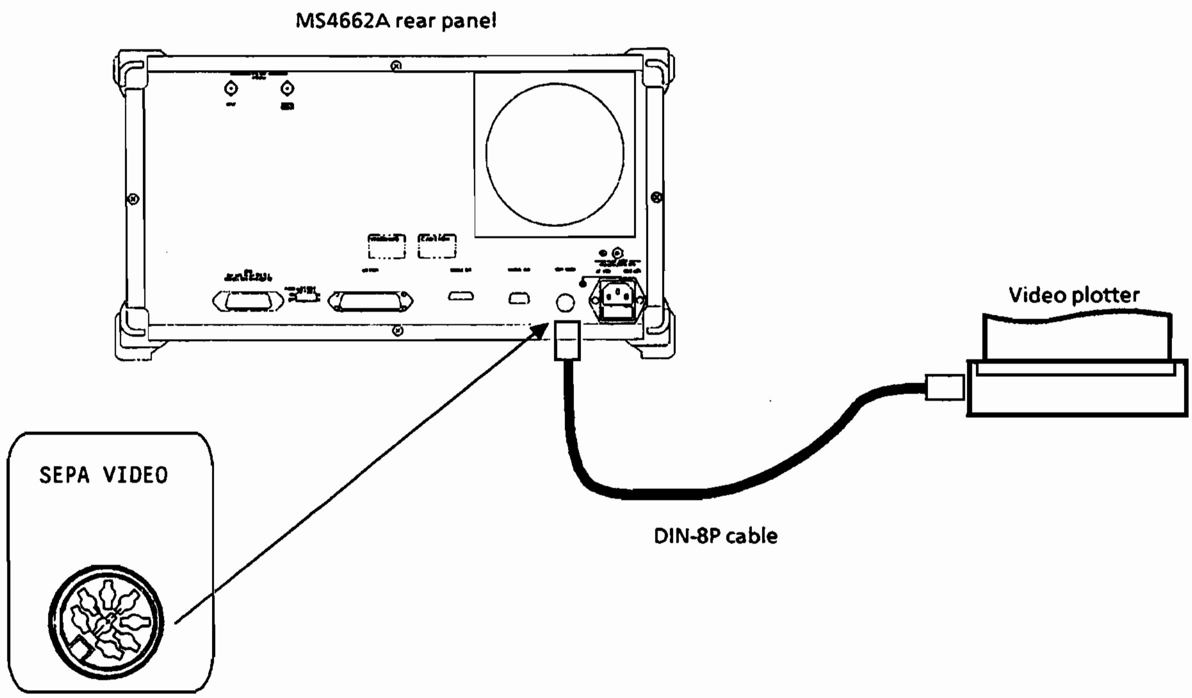
The hard-copying procedures are described below.

8.1.1 Connecting hard-copying devices

Instructions on connecting hard-copying devices to the MS4662A follow.

(1) Connecting the UA-455A video plotter without a GPIB interface

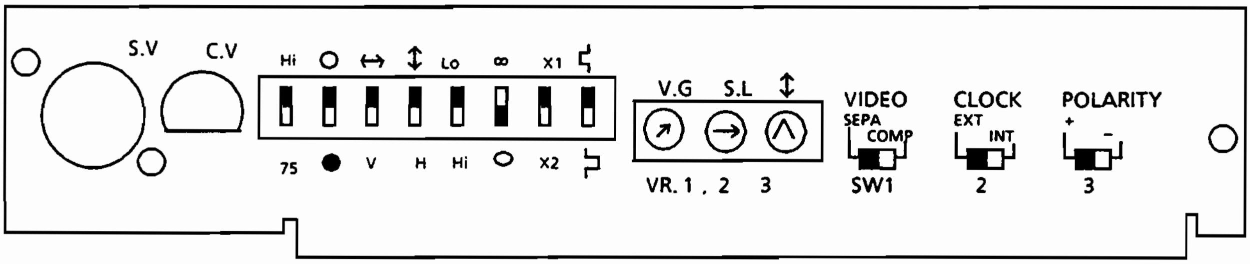
The UA-455A video plotter can be connected to the MS4662A without a GPIB interface for hard-copying display devices. Attach the cable shown below and set the switches and controls on the back of the UA-455A as appropriate.



■ Connecting cable

The UA-455A comes supplied with a DIN-8P cable (1 m). Plug one end of the cable to the MS4662A rear-panel SEPA VIDEO connector and the other end into the S.V connector of the video plotter.

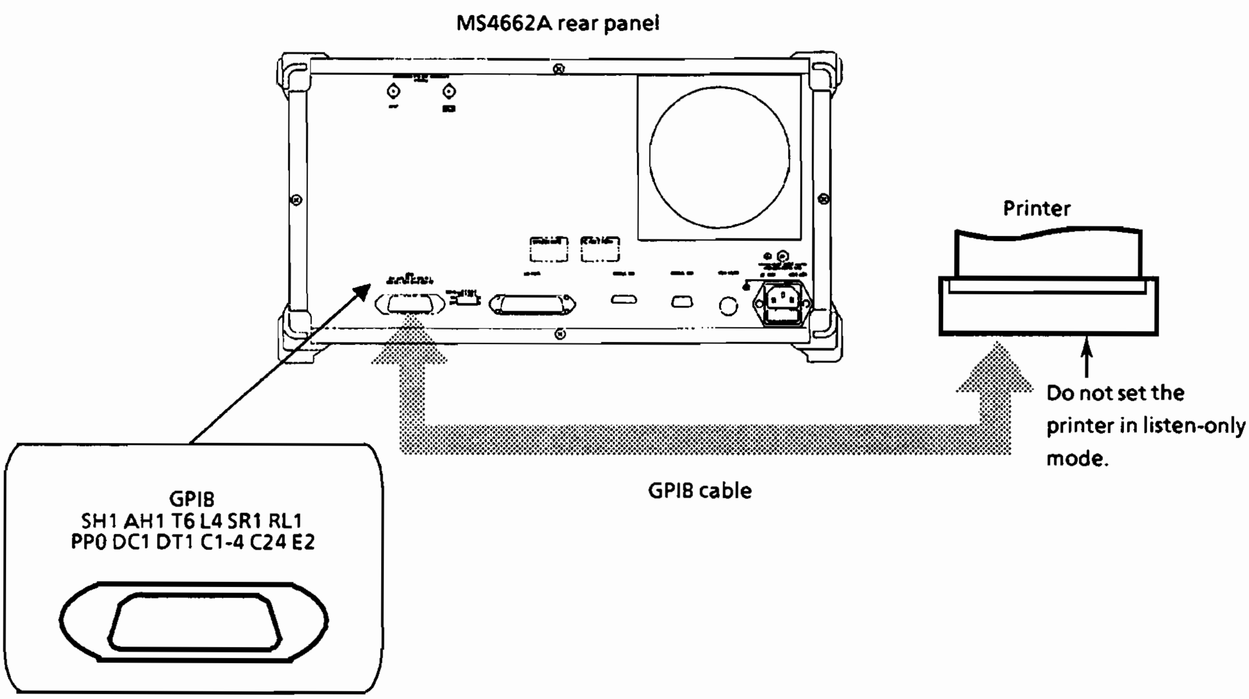
■ Setting switches and controls



- Set each switch at the black position.
- The control positions shown are typical.
- Refer to the UA-455A operation manual for more detailed adjustment instructions.

(2) Connecting printers and plotters via GPIB

Connect those hard-copying devices that are controlled via a GPIB interface to the GPIB bus.



The MS4662A supports the following kinds of plotters and printers:

	HG-GL plotter	GP-GL plotter	Printer
Type	7475A (Hewlett Packard)	GD9411 (Graphtech)	VP-800 (Epson) 2225A (Hewlett Packard) Built-in DSU (†) printer (MC8104A)

† Data storage unit

(3) Connecting a data storage unit

Set the rear-panel DIP switches, S_1 and S_2, of the data storage unit as shown below.

S_1

	LON	5	4	3	2	1	
ON		●			●	●	1
OFF	●		●	●			0

(Switches 5 to 1:) Data storage unit GPIB address

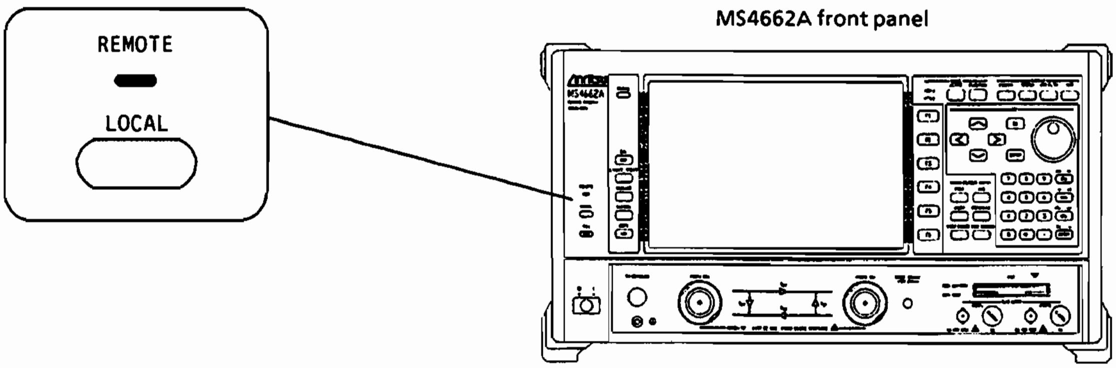
S_2

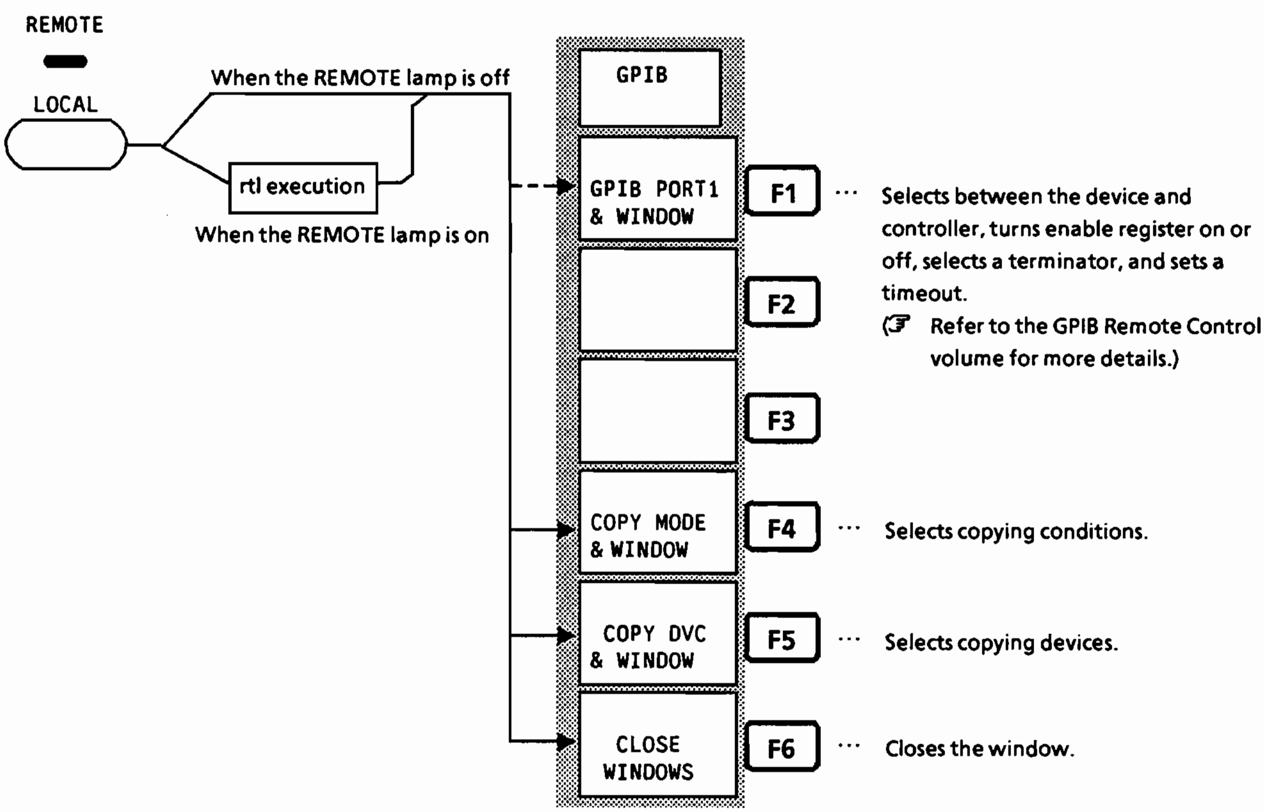
	8	7	6	5	4	3	2	1	
ON		●				●	●		1
OFF	●		●	●	●			●	0

8.1.2 Selecting copying conditions and devices (via GPIB)

Follow the key-in sequences marked by continuous lines below to select copying conditions, such as where to copy to on the paper and in what size, and copying devices.

MS4662A front panel

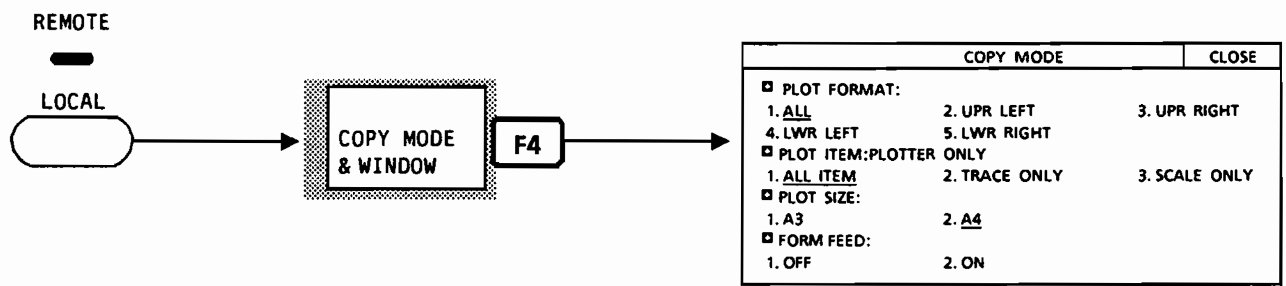




Note: In the operation above,if the MS4662A has been local lockout from the controller with the REMOTE lamp on, the GPIB menu will not display even when the LOCAL key is pressed. If the REMOTE lamp is on, execute rtl (return to local) by programming to turn off the REMOTE lamp and then press the LOCAL key.

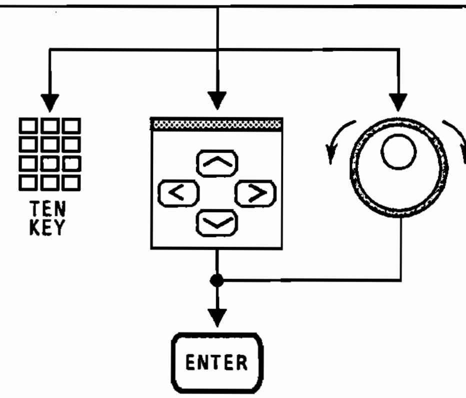
(1) Selecting copying conditions

Press keys in the sequence described below to select copying conditions. It is assumed that the REMOTE lamp is off.



① Select the desired parameter group with the ∧ or ∨ key.

② Select the desired parameter with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.



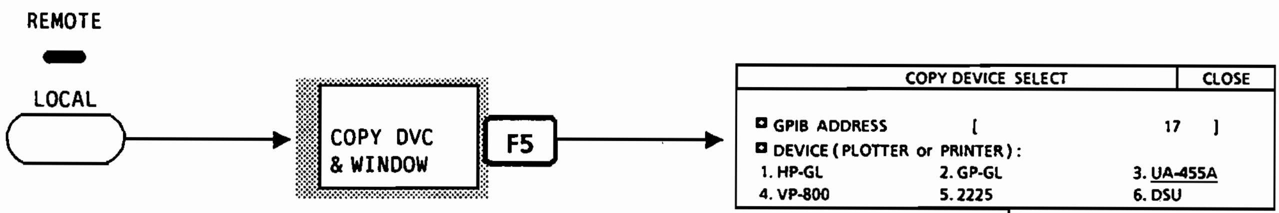
<Parameter definitions>

Parameter group name	Parameter	Explanation
PLOT FORMAT	ALL	Plots the display image throughout the center of the paper.
	UPR LEFT	Plots the display image at the upper left corner of the paper.
	UPR RIGHT	Plots the display image at the upper right corner of the paper.
	LWR LEFT	Plots the display image at the lower left corner of the paper.
	LWR RIGHT	Plots the display image at the lower right corner of the paper.
PLOT ITEM	ALL ITEM	Plots all items in the display image.
	TRACE ONLY	Plots trace waveforms only.
	SCALE ONLY	Plots scales only.
PLOT SIZE	A3	Plots in the A3 size.
	A4	Plots in the A4 size.
FORM FEED	ON	Plots the display image by feeding forms.
	OFF	Plots the display image without feeding forms.

Note: These parameters are not selectable for the UA-455A video plotter and printer. The display image output position, items, and size are fixed with the UA-455A video plotter and printer.

(2) Selecting copying devices

Press keys in the sequence described below to select copying devices. It is assumed that the REMOTE lamp is off.

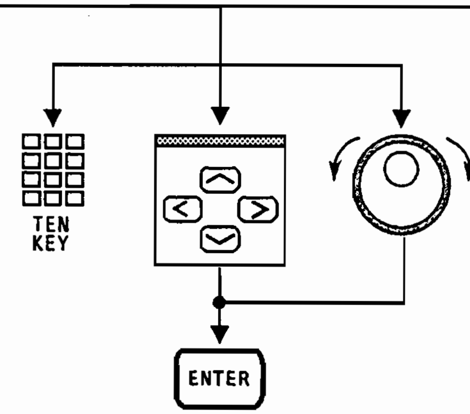


① Select the GPIB ADDRESS parameter group with the ∧ or ∨ key.

② Set the desired copying device address with numeric keys and press the ENTER key.

③ Select the DEVICE (PLOTTER or PRINTER) parameter group with the ∧ or ∨ key.

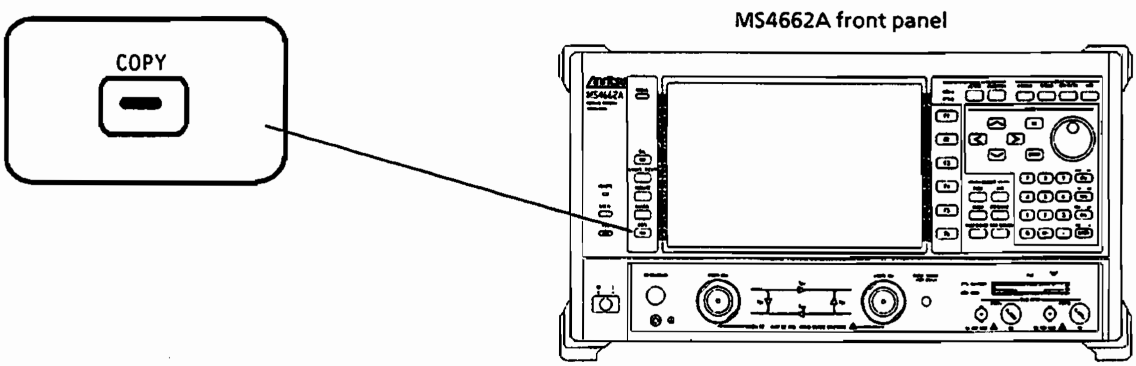
④ Select the desired copying device from among 1 to 6 with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.



Notes:
- See (2) in 8.1.1, "Connecting hard-copying devices," for the kinds of plotters and printers supported by the MS4662A.
- The GPIB address can be set between 0 and 30.
- The UA-455A plotter does not support a GPIB interface, so its address setting has no effect. If the UA-455A plotter has been selected, press the front-panel COPY key to transmit display image data to the UA-455A via the DIN-8P cable. If any other device has been selected, display image data is transmitted to the addressed device via the GPIB interface.

8.1.3 Executing and canceling hard-copying

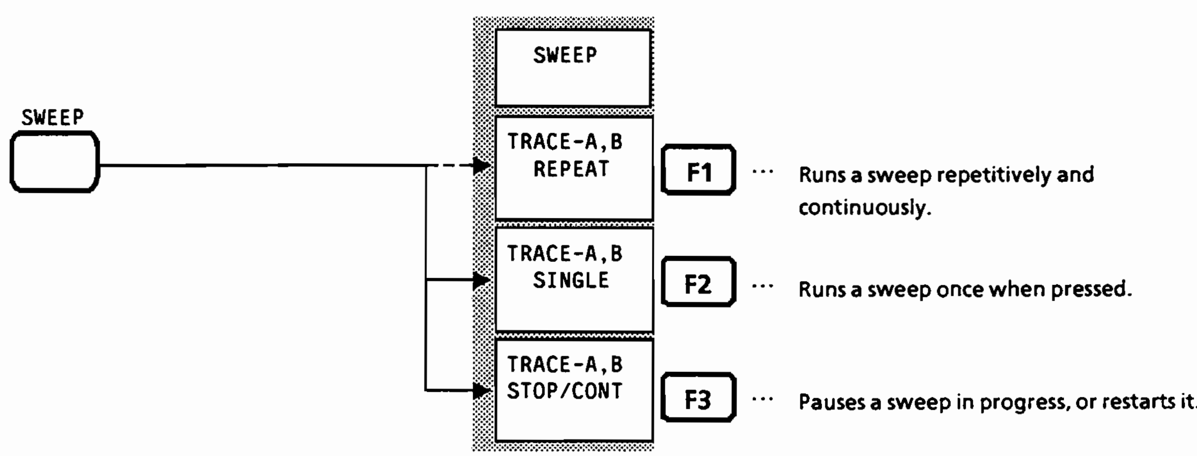
To execute hard-copying, press the COPY key and copying begins according to the copying conditions explained in 8.1.2, with the COPY lamp being on at the same time.



If a problem occurs with the printer or plotter while copying, press the COPY key a second time to cancel copying.

Note: With the UA-455A plotter, hard-copying can be executed by pressing both the UA-455A PRINT key and the COPY key. To execute hard-copying by pressing the COPY key, however, the UA-455A must have been selected as a copying condition as instructed in 8.1.2.

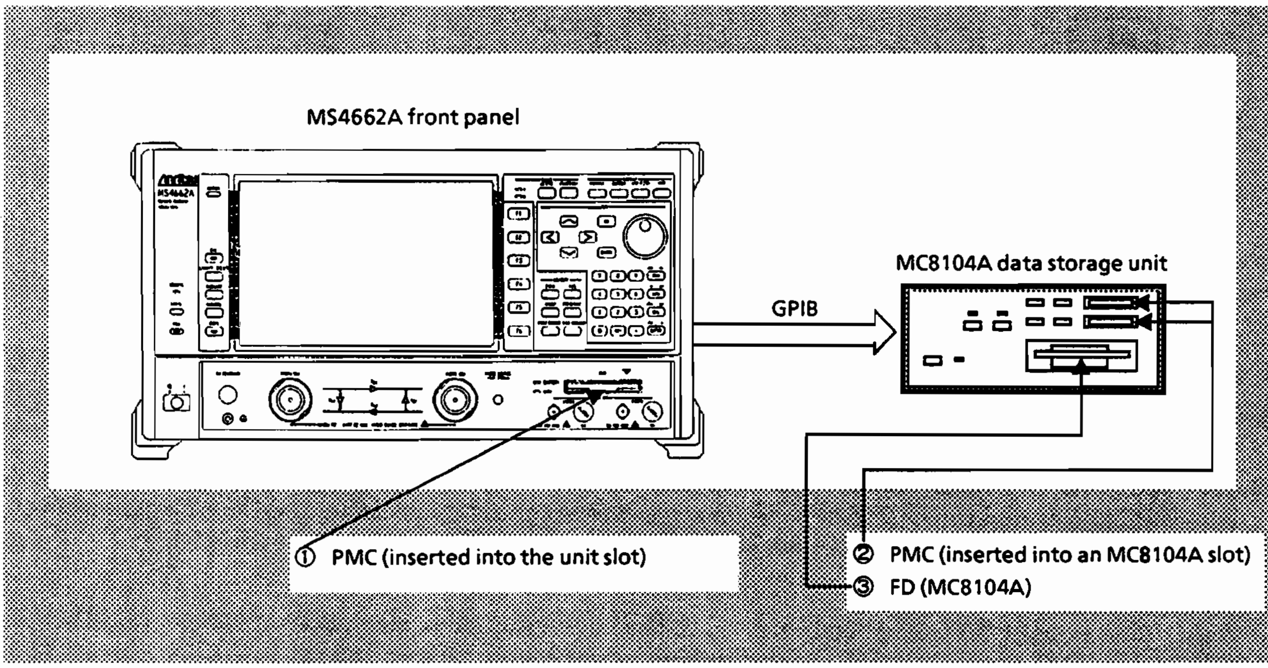
If the F1 softkey, REPEAT, has been selected in the key-in sequence marked by the dotted line below, waveforms or marker levels may be varied during hard-copying, disrupting the resultant copies. This problem can be avoided by pressing the COPY key after running a single sweep with F2 or pausing a sweep with F3.



8.2 Saving, Recalling, and Managing PMC Files

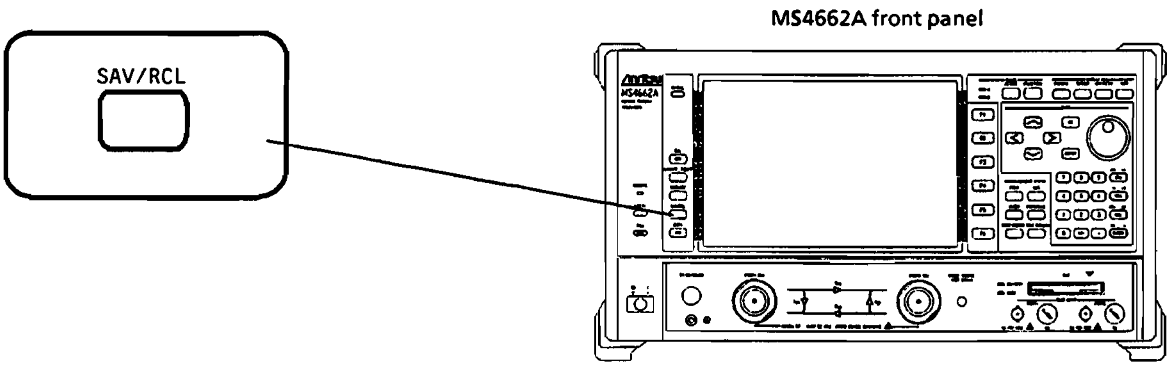
Measurement conditions and values can be saved into PMC (plug-in card) memory and recalled for reuse at a later time.

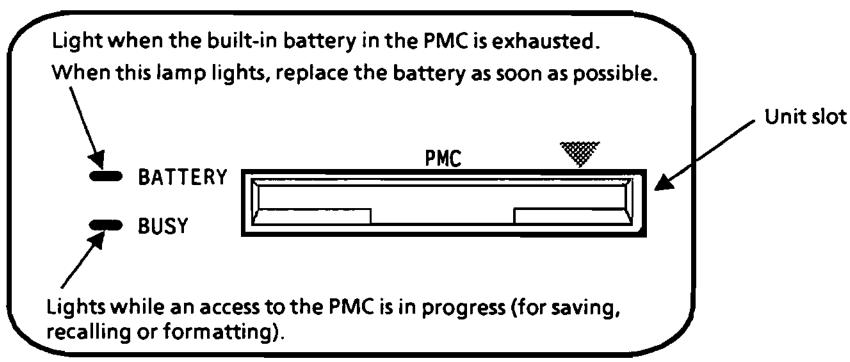
The MS4662A supports three kinds of storage media: internal PMC (inserted into the unit slot), external PMC (inserted into an MC8104A slot), and external floppy disk (MC8104A).



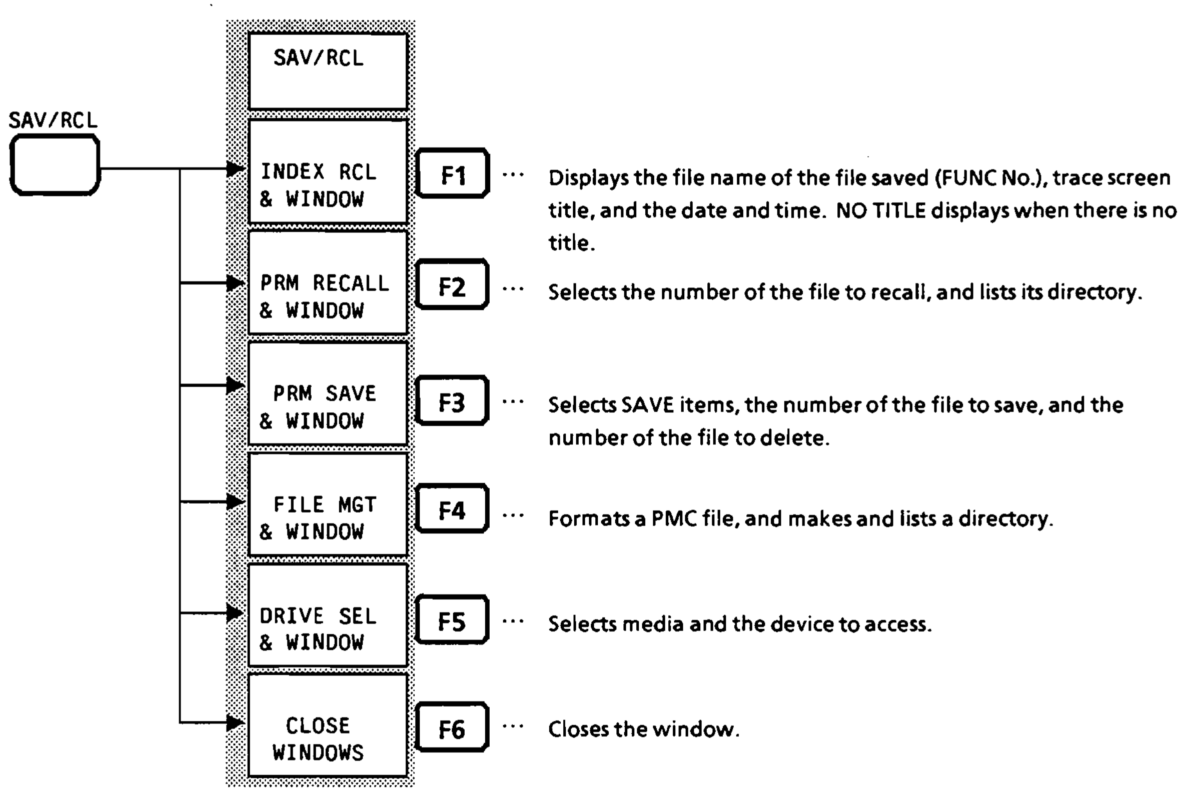
For ② and ③, refer to the MC8104A operation manual.
① is highlighted here.

To save, recall, and manage PMC files, press keys in the sequence described below.





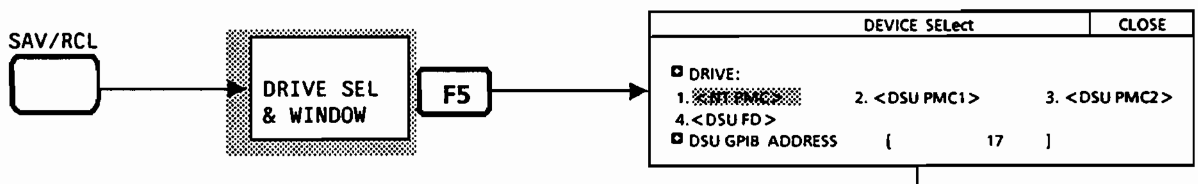
Press the SAV/RCL panel key to open the SAV/RCL menu.

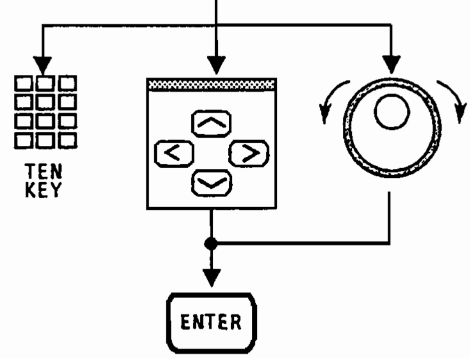


8.2.1 Selecting media loading drives

(1) Selecting the unit drive

Before saving a PMC file to the PMC or recalling one from the PMC, the drive must be selected in the key-in sequence below. The drive houses media (PMCs or floppy disks) for access for save or recall.





① Select the DRIVE parameter group with the ∧ or ∨ key.

② Select the desired parameter with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key. To use the PMC inserted in the unit slot, select 1. <INT PMC>. To use an external data storage unit (DSU), select 2, 3, or 4 before proceeding to Steps ③ and ④.

③ Select the DSU GPIB ADDRESS parameter group with the ∧ or ∨ key.

④ Select an address with the ENTER knob or set it with numeric keys.

Note: The GPIB address can be set between 0 and 30.

(2) Using a data storage unit

Set the rear-panel DIP switches, S1 and S2, of the data storage unit as shown below.

S_1

	LON	5	4	3	2	2	
ON		●			●	●	1
OFF	●		●	●			0

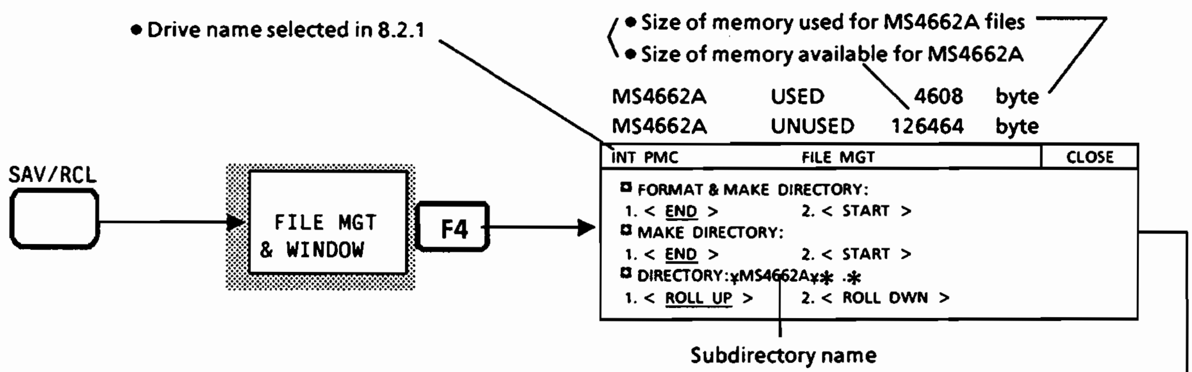
Columns 5 to 2 → Data storage unit GPIB address

S_2

	8	7	6	5	4	3	2	1	
ON							●		1
OFF	●	●	●	●	●	●		●	0

8.2.2 Formatting PMC files and making directory

New SRAM PMCs or SRAM PMCs having a nonstandard format require formatting before they can be used. It is assumed that the PMC has been properly inserted in the unit slot.



(1) Formatting and making a directory

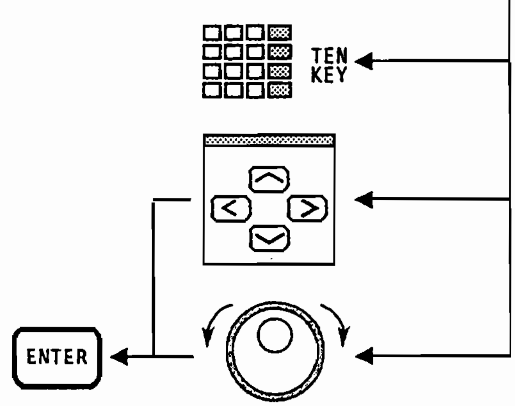
① Select the FORMAT & MAKE DIRECTORY parameter group with the ∧ or ∨ key.

② Select the START parameter with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key.

③ The BUSY lamp to the left of the front-panel PMC slot lights while formatting and directory making is in progress. When this lamp goes off, the cursor moves from 2. <START> to 1. <END>, indicating that formatting is complete and a type name directory having MS4662 as its subdirectory name has been automatically created right under the root directory.

While the root directory is provided to store common files that are available to all analyzer types, it is not accessed since no common files are available at present. The MS4662 subdirectory stores analyzer-specific files.

A 128 KB SRAM PMC, when just formatted, provides a system memory area of 4608 bytes, or 4.5 KB, if MS4662A files have not yet been saved onto it. The remaining size of 126,464 bytes, or 123.5 KB, is available as a user area.



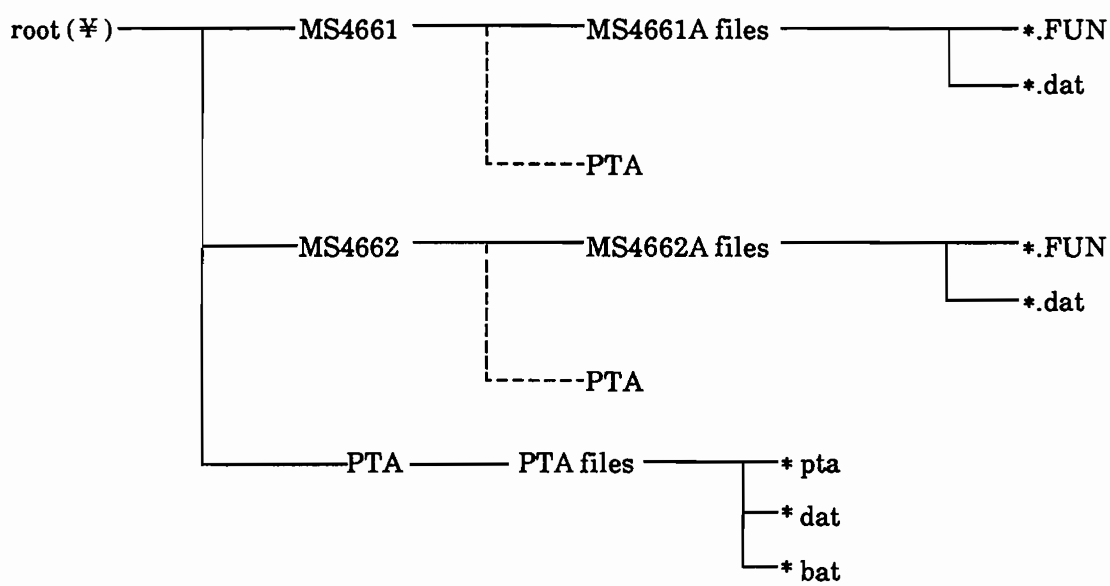
CAUTION

Formatting a PMC will erase all the files that have been stored on it.

(2) Making an additional directory MS4662 on the PMC in another type of analyzer

With the MS4662A, a type name directory having MS4662 as its subdirectory name has been made as explained in (1), without the upgrade designator, such as A, B, or C.

A formatted PMC that has been used in another type of analyzer, for example, MS4661A, contains a subdirectory named MS4661. To be able to use this PMC in the MS4662A as well, a subdirectory named MS4662 must be additionally made. This is accomplished by selecting and accepting 2. <START> in the MAKE DIRECTORY parameter group in the FILE MGT window. The subdirectory MS4662 has been made when the cursor moves back to 1.



PTA programs and data are stored in the PTA subdirectory right after the root directory when PTA runs.

While an analyzer runs, only the corresponding analyzer-specific directory is accessed; while PTA runs, only the PTA directory is accessed. In file listing, therefore, only the files stored in the directory file accessed are listed.

(3) File types and extensions

Analyzer files are classified into five types:

- Measurement data
- Measurement parameter
- PTA program
- PTA data
- PTA startup

The following extensions identify these types of files:

File type	Extension
Measurement data	.dat
Measurement parameter	.fun
PTA program	.pta
PTA data	.dat
PTA startup	.bat

With the MS4662A, files are named @FUNC.0, @FUNC.1, @FUNC.2, @FUNC.3, ... and @FUNC.9. File names are assigned by selecting the numbers.

If there is a title in the top of the trace screen, it is stored as a file name header when the file is saved. (See 8.2.3 and 8.2.4 for more details.)

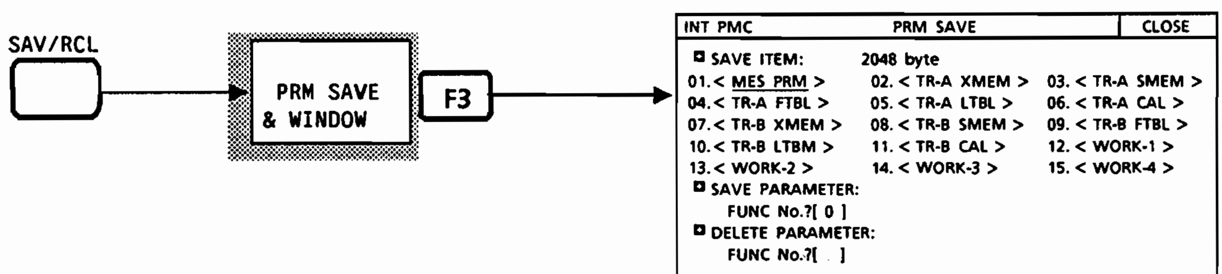
Extensions are assigned automatically when the files are saved.

8.2.3 Saving a PMC file

CAUTION

When a file is saved, the data that has been stored on the file with the same file number is erased completely. As a safeguard, recalling a file with a header before saving is recommended. (See 8.2.4.)
Valuable files may be write-protected to prevent writing. (See Chapter 2.)

Press keys in the key-in sequence described below to save the current measurement data and parameters to the PMC.



(1) Saving a file

① Select the SAVE ITEM parameter group with the ∧ or ∨ key.

② Select the desired SAVE ITEM parameter with the < or > key or with the ENTRY knob, and press the ENTER key. To make a choice with numeric keys, simply key in the parameter number; there is no need to press the ENTER key. For single-digit parameter numbers, type 0 first. To save 3. <TR-A SMEM> (trace A S-memory contents), for example, type 03.

③ Select SAVE PARAMETER: FUNC No.? [ ] with the ∧ or ∨ key.

④ Select the desired number from among 0 through 9 with numeric keys, and press the ENTER key.

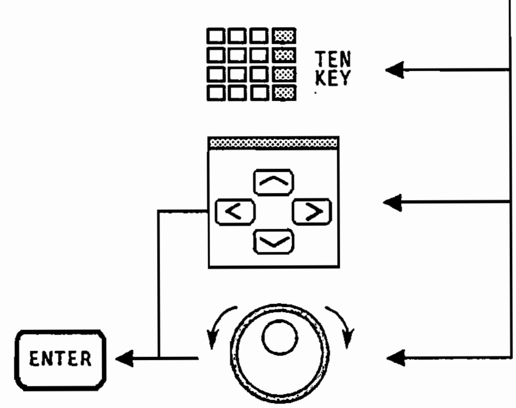
③ The BUSY lamp to the left of the front-panel PMC slot lights while an access to the PMC for saving is in progress. Saving is complete when the BUSY lamp goes off.

(2) Deleting a file

① Select DELETE PARAMETER: FUNC No.? [ ] with the ∧ or ∨ key.

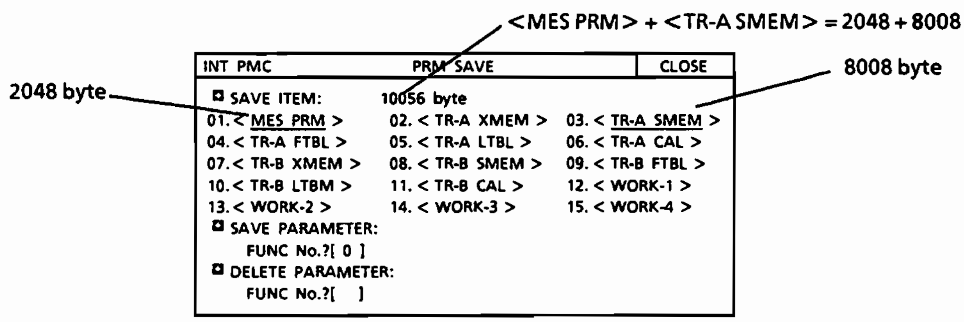
② Select the desired number to delete from among 0 through 9 with numeric keys, and press the ENTER key.

③ The BUSY lamp to the left of the front-panel PMC slot lights while an access to the PMC for deletion is in progress. Deletion is complete when the BUSY lamp goes off.



(3) PRM SAVE window save items

The sum total of the SAVE item memory sizes selected is displayed to the right of the SAVE ITEM parameter group: in the PRM SAVE window. In the PRM SAVE window shown below, 10,056 bytes is displayed since MES PRM (2048 bytes) and TR-A SMEM (8008 bytes) have been selected.



The table below describes each save item listed in the PRM SAVE window and the saved contents.

PRM SAVE window save items (1/2)

No.	SAVE ITEM	Saved contents
01	MES PRM	Saves the parameters that have been set on the measurement screen as measurement conditions using panel keys (such as FORMAT, SCALE, FREQ, and SWEEP). These measurement parameters can be recalled in the same testing system to reproduce the same trace waveform.
02	TR-A XMEM	Saves the contents of XMEM (X memory), which stores testing system data X in TR-A (trace A), including the DUT, or the measurement value X resulting from data calibration (X-S).
03	TR-A SMEM	Saves the contents of SMEM (S memory), which stores CAL (calibration) data from TR-A (trace A) based on the X-S method.
04	TR-A FTBL	Saves frequency table (F.TBL) data at up to 1,001 points in TR-A (trace A).
05	TR-A LTBL	Saves level table (L.TBL) data at up to 1,001 points in TR-A (trace A).
06	TR-A CAL	Saves the contents of CAL memory, which stores CAL data from TR-A (trace A) based on the OSL (open-short-load) method.
07	TR-B XMEM	Saves the contents of XMEM (X memory), which stores testing system data X in TR-B (trace B), including the DUT, or the measurement value X resulting from data calibration (X-S).
08	TR-B SMEM	Saves the contents of SMEM (S memory), which stores CAL (calibration) data from TR-B (trace B) based on the X-S method.
09	TR-B FTBL	Saves frequency table (F.TBL) data at up to 1,001 points in TR-B (trace B).
10	TR-B LTBL	Saves level table (L.TBL) data at up to 1,001 points in TR-B (trace B).

PRM SAVE window save items (2/2)

No.	SAVE ITEM	Saved contents
11	TR-B CAL	Saves CAL data from TR-B (trace B) based on the OSL (open-short-load) method.
12	WORK-1	Saves the contents of the memory WORK-1, which stores calculation data used in the CALCULATE window, which is opened by selecting the F4 softkey (CALCULATE & WINDOW) displayed by pressing the PACKAGE key.
13	WORK-2	Saves the contents of the memory WORK-2, which stores calculation data used in the CALCULATE window, which is opened by selecting the F4 softkey (CALCULATE & WINDOW) displayed by pressing the PACKAGE key.
14	WORK-3	Saves the contents of the memory WORK-3, which stores calculation data used in the CALCULATE window, which is opened by selecting the F4 softkey (CALCULATE & WINDOW) displayed by pressing the PACKAGE key.
15	WORK-4	Saves the contents of the memory WORK-4, which stores calculation data used in the CALCULATE window, which is opened by selecting the F4 softkey (CALCULATE & WINDOW) displayed by pressing the PACKAGE key.

PMC type	Memory size	Battery life	Battery used
BS32F1-C-172	32KB	About 5 years	BR2325
BS64F1-C-173	64KB	About 5 years	
BS128F1-C-174	128KB	About 4.3 years	
BS256F1-C-1175	256KB	About 2.2 years	
BS512F1-C-1176	512KB	About 1.1 years	

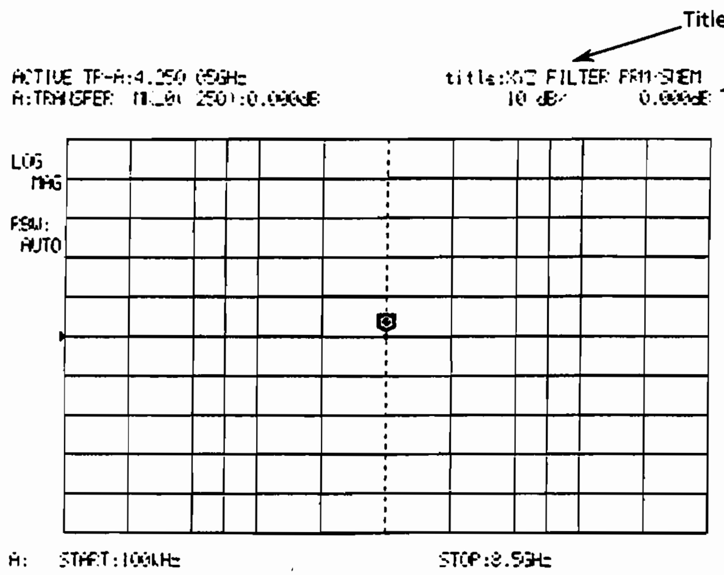
PMC memory size list

Unit: byte

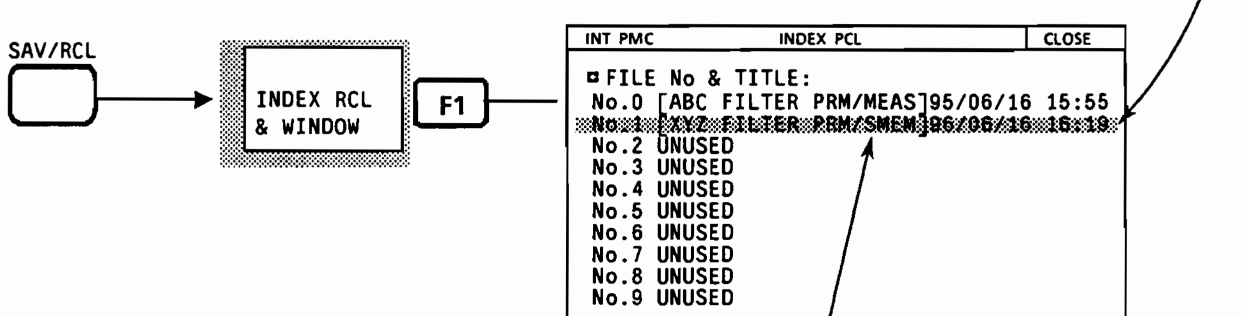
No.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
SAVE ITEM / MEAS POINT	MES PRM	TR-A XMEM	TR-A SMEM	TR-A FTBL	TR-A LTBL	TR-A CAL	TR-B XMEM	TR-B SMEM	TR-B FTBL	TR-B LTBL	TR-B CAL	WORK-1	WORK-2	WORK-3	WORK-4
1001	2048	8008	8008	8008	2002	96096	8008	8008	8008	2002	96096	8008	8008	8008	8008
501	2048	4008	4008	4008	1002	48096	4008	4008	4008	1002	48096	4008	4008	4008	4008
251	2048	2008	2008	2008	502	24096	2008	2008	2008	502	24096	2008	2008	2008	2008
101	2048	808	808	808	202	9696	808	808	808	202	9696	808	808	808	808
51	2048	408	408	408	102	4896	408	408	408	102	4896	408	408	408	408
21	2048	168	168	168	42	2016	168	168	168	42	2016	168	168	168	168
11	2048	88	88	88	22	1056	88	88	88	22	1056	88	88	88	88

8.2.4 Recalling a file with a header

If there is a title in the top of the trace screen as shown below, it is stored as a file name header when the file is saved.



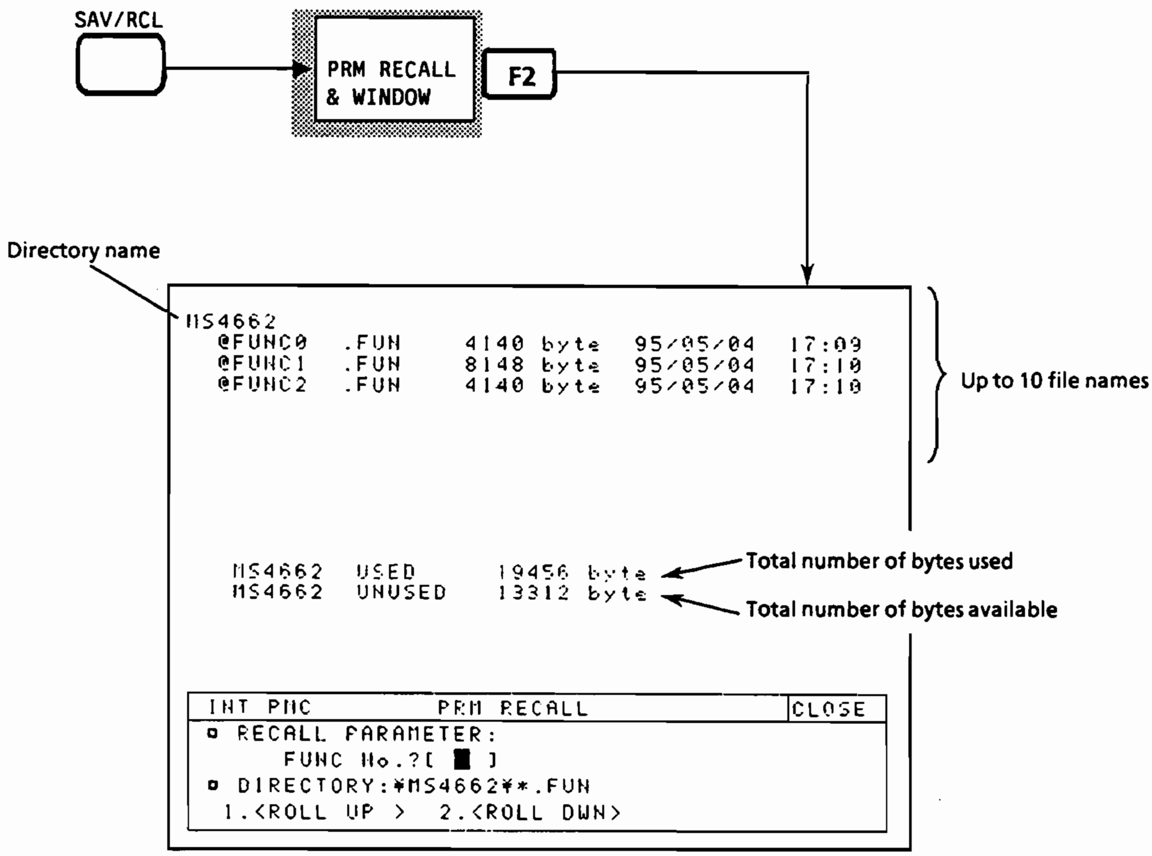
After having saved setup parameters (for example, as FUNC No. 1) from a trace screen with a title like that shown above by selecting MES PRM from the SAVE ITEM parameter group, press keys in the following sequence to list a file having that header as shown below.



The title of the file as saved is displayed in [ ] as a file name header. NO TITLE is displayed when there is no title.

8.2.5 Recalling a PMC file and listing its directory

Press keys in the sequence below to read and set the measurement data and parameters that have already been saved. The directory name and the used and unused sizes of memory are listed at the same time.



To recall a file, follow these steps:

① Select RECALL PARAMETER: FUNC No.? [ ] with the ∧ or ∨ key.

② Select the desired number to recall from among 0 through 9 with numeric keys, and press the ENTER key.

③ The BUSY lamp to the left of the front-panel PMC slot lights while an access to the PMC for recalling is in progress. Recalling is complete when the BUSY lamp goes off.

Note: Files without numbered file names in the directory list can be read by entering a LOAD command under PTA in the format LOAD"file-name."

8.3 PMC Error Messages

If errors occur in the PMC while executing PMC functions, the following error messages are displayed onscreen:

No.	Error message	Explanation
1	NO PMC OR FLOPPY	No PMC or floppy disk is connected.
2	NO FORMAT	The medium (PMC or floppy disk) is unformatted.
3	DIFFERENT FORMAT	The format type does not match.
4	WRITE PROTECT	The medium is write-protected
5	BAD PMC	The PMC has failed.
6	MEMORY OVER	A memory overflow occurred.
7	NOT FIND FILE	An attempt was made to read an undefined file or function memory location.
8	DIFFERENT PMC TYPE	The PMC type does not match.
9	CAN'T DEFINE	An attempt was made to define an unknown file, or an unknown softkey was pressed.
10	PMC ERROR	A PMC error, which is none of the above.
11	NO BATTERY	The built-in battery in the PMC is exhausted.

SECTION 9

CALIBRATING MEASUREMENT VALUES

This chapter explains how to calibrate measurement values and provides practical examples of their calibration. A calibration kit and a calibration accuracy verification kit are available as options. See Appendix B for additional details on the CAL softkey menu functions. Descriptions of the key operations in the ENTRY section are not covered in this chapter. See Chapter 3 as needed.

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9.1 Notes on Calibrating Measurement Values

Measurement values collected on a testing system always involve indeterminate values due to its incompleteness. Each measurement value represents an actual value combined with a measurement error specific to the testing system. Calibrating a networkanalyzer is to determine the causes of invariably reproducible system errors and give them an error model rendering to collect real values from the measurement values, less measurement errors.

9.1.1 Vector error correction

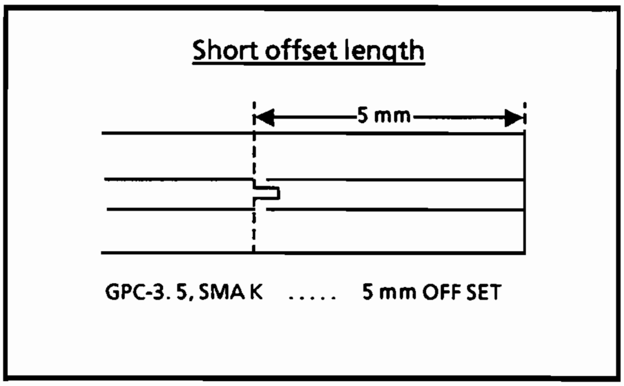
The MS4662A, capable of measuring both the magnitude and phase of microwave signals, permits correcting the following six categories of error items:

- Source test port matching (source matching)
- Load test port matching (load matching)
- Directivity
- Isolation
- Transmission frequency characteristics (tracking)
- Reflection frequency characteristics (tracking)

9.1.2 Calibration standards

Four kinds of calibration standards are available: shorts, opens, loads, and through lines.

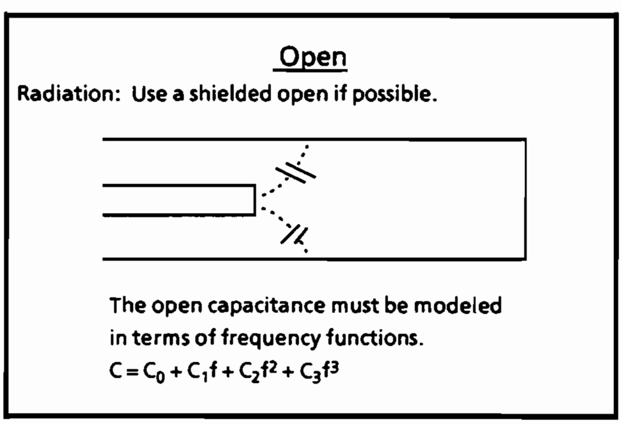
(1) Short



A short provides a reference value for total reflection. It allows complete reflection of the entire incident RF energy in a precise phase. Requirements for an RF short are an impedance of 0 Ω, a voltage of 0, and a phase of 180°.

GPC-3.5, SMA, and K connectors have an offset length of 5 mm relative to the depth of the pin in the central conductor. This value is preprogrammed in the MS4662A as a default.

(2) Open



An open provides a reference value for total reflection. An open is similar to a short but has a more complex response. Requirements for a full open are a maximum voltage, an infinite impedance, and a phase of 0°. All these requirements, however, are theoretical. Real opens have a slight capacitance.

Because the impedance is presumed free from reflection at a 0° reference point, the phase response is varied by using coefficients that precisely represent the open capacitance. Assign the values of C_0, C_1, C_2, and C_3 in the equation above. These values are preprogrammed in the MS4662A as defaults.

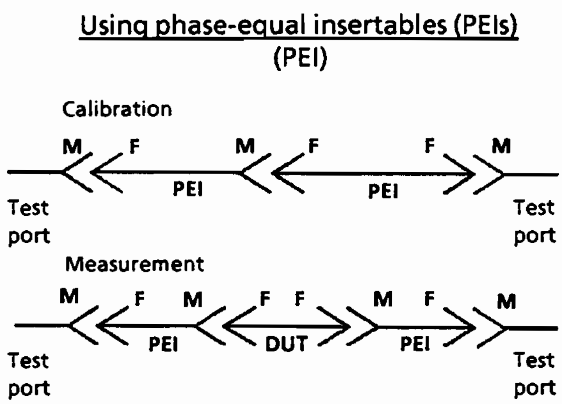
(3) Load

An ideal load meets two requirements. One is a perfect connector. The other is an infinitely long, complete transmission line that can absorb all of the incident RF energy (reflection-free).

Because an infinitely long transmission line would be impracticable to handle, a load short of this goal is used in practical applications. Two types of calibration loads generally available are broad-band loads and sliding loads. The MS4662A uses a broad-band load (50 Ω).

Broad-band loads support a broad range of calibration applications, in addition to being easy to handle as calibration tools.

(4) Through line



Using PEIs

At calibration, a through line connection with a through offset length of 0 mm is accomplished by connecting a pair of conversion adapters that are equal in electrical length, called phase-equal insertables (PEIs), to the test ports. Shown at left is an example of using PEIs where each test port has male (M) connectors at both ends and the DUT has female (F) connectors at both ends.

- Female – male
- Female – female
- Male – female
- Male – male

All these four PEIs are made to have an equal electrical length.

9.1.3 Choosing from among the methods of calibration

The MS4662A offers a choice of four softkey menus, which are labeled X-S, 1 PORT OSL, 2 PORT OSL, and 1 PATH 2 PORT. These different methods of calibration are outlined below.

- X-S
- 1 PORT OSL
- 2 PORT OSL
- 1 PATH 2 PORT

Method of calibration	Explanation
X-S method	Provides frequency response correction by using through lines and opens as standards.
1 PORT OSL method	Provides single-port vector error correction by using opens, shorts, and loads.
2 PORT OSL method	Provides forward and backward full 12-term vector error correction by using opens, shorts, loads, and through lines as standards.
1 PATH 2 PORT method	Provides forward vector error correction, except for load matching, by using opens, shorts, loads, and through lines as standards.

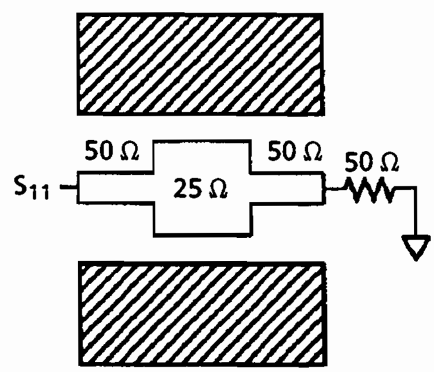
9.1.4 Evaluating calibration performance and verification kit

The best way to evaluate the performance of a calibration is to verify the results of measurement using a verification kit with known data.

Verification kit

- Used in calibration rooms or standards management rooms

Model 3666, 3667, 3668 and 3669 verification kits are available in association with the 3.5-mm, GPC-7 connector, K-connector, and V-connector precision component kits, respectively. Each kit is supplied with one attenuator for 20 dB and 50 dB each, one 10-cm air line with one bead-welded end, and one 10-cm Beatty standard. The Beatty standard has a central conductor in the middle with a discrete point that generates a two-port mismatch similar to one generated by a beadless air line.



Beatty standard

These verification kits are typically used in calibration rooms or standards management rooms. Each kit is furnished with a number of precision components each with known characteristics at 20 selected frequencies.

> One precaution worthy of special notice about the verification kits is that they should be handled with extreme care not to alter the known original characteristics of the verification components. Frequent, day-to-day use should therefore be avoided. Their use should be limited to accuracy verification checks conducted every 12 months or to situations where system accuracy is questionable.

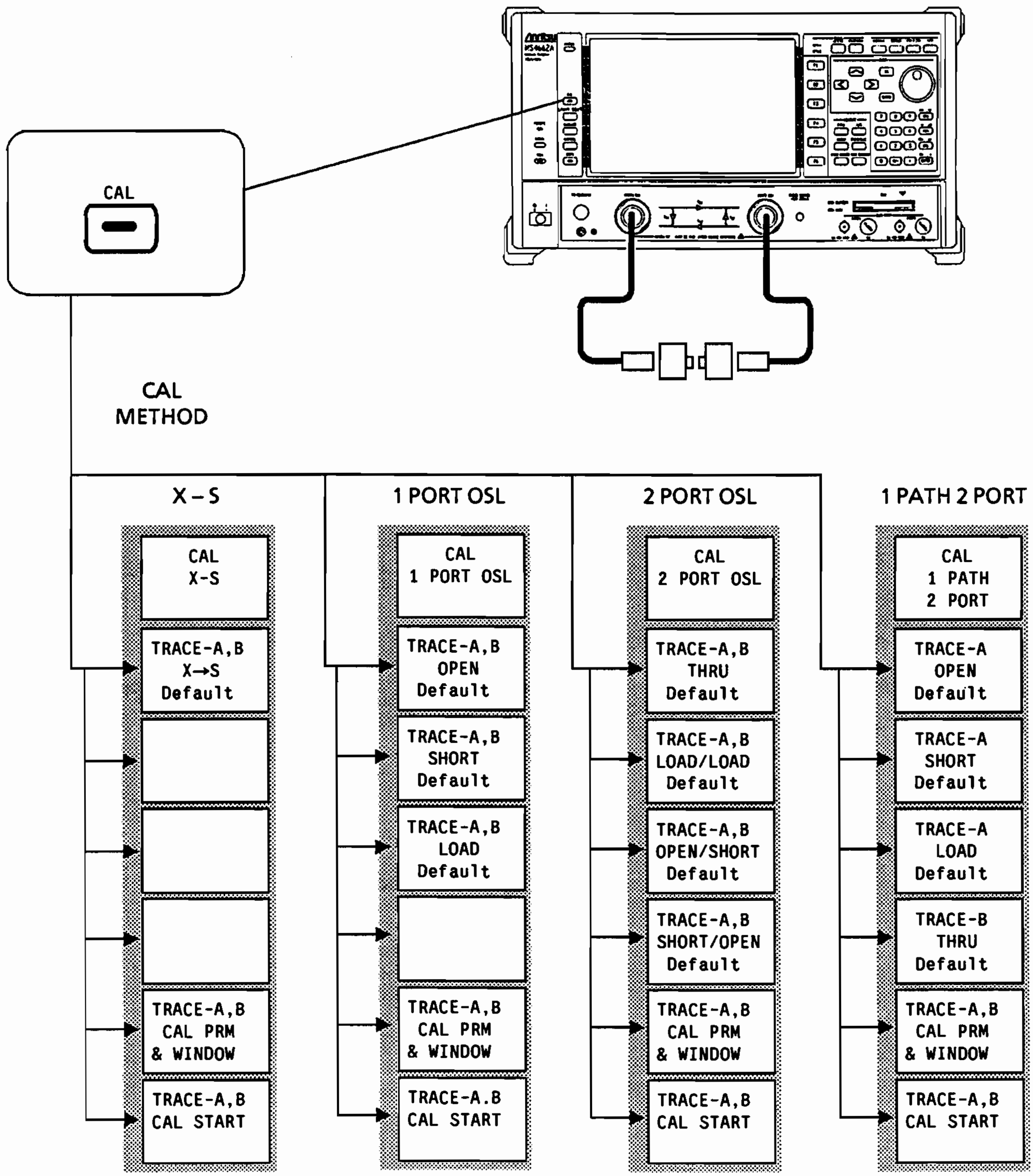
9.2 Preparations for Calibration

General considerations for getting prepared for loading calibration data are as follows:

- The MS4662A uses GPC-7 connectors (18 GHz) as its test ports. DUTs and standards cannot be directly plugged into the GPC-7 connectors. Use GPC-X conversion adapters (X: N male, N female, SMA male, SMA female, 3.5-mm male, 3.5-mm female, K male, K female, V male, or V female) and plug DUTs and standards into the GPC-7 connectors by way of these adapters.
- To ensure measurement accuracy, calibrate the MS4662A about 60 minutes after it is powered on.

9.3 Procedures for Calibration through CAL Menu Selections

Pressing the CAL key opens one of the four different CAL menus below depending on the method of calibration (CAL METHOD) that has already been selected.

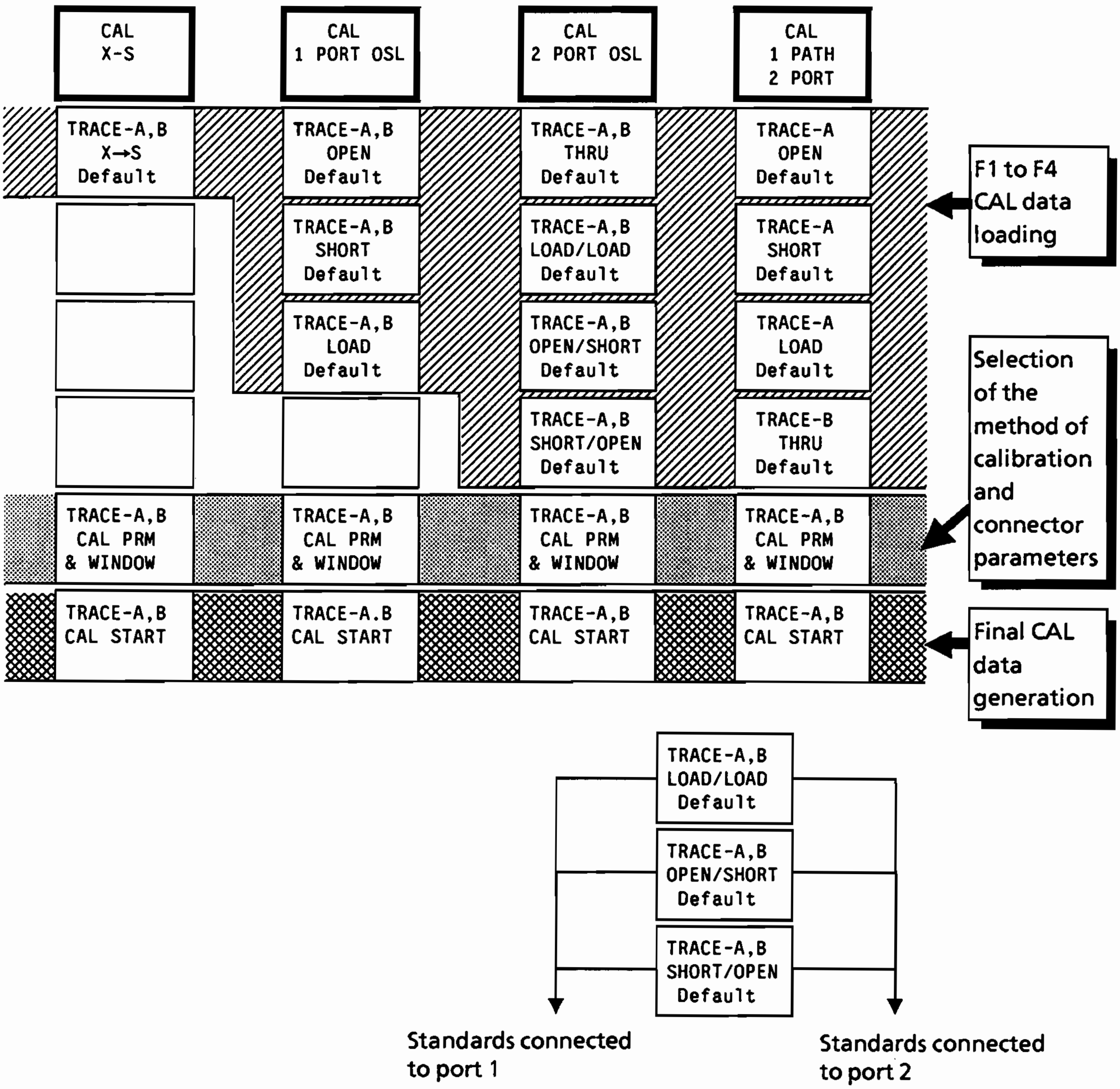


X-S:	Provides frequency response correction only.
1 PORT OSL:	Provides 1 port vector error correction.
2 PORT OSL:	Provides forward and backward full 12-term vector error correction.
1 PATH 2 PORT:	Provides forward vector error correction, except for load matching.

9.3.1 Organization and functions of CAL menus

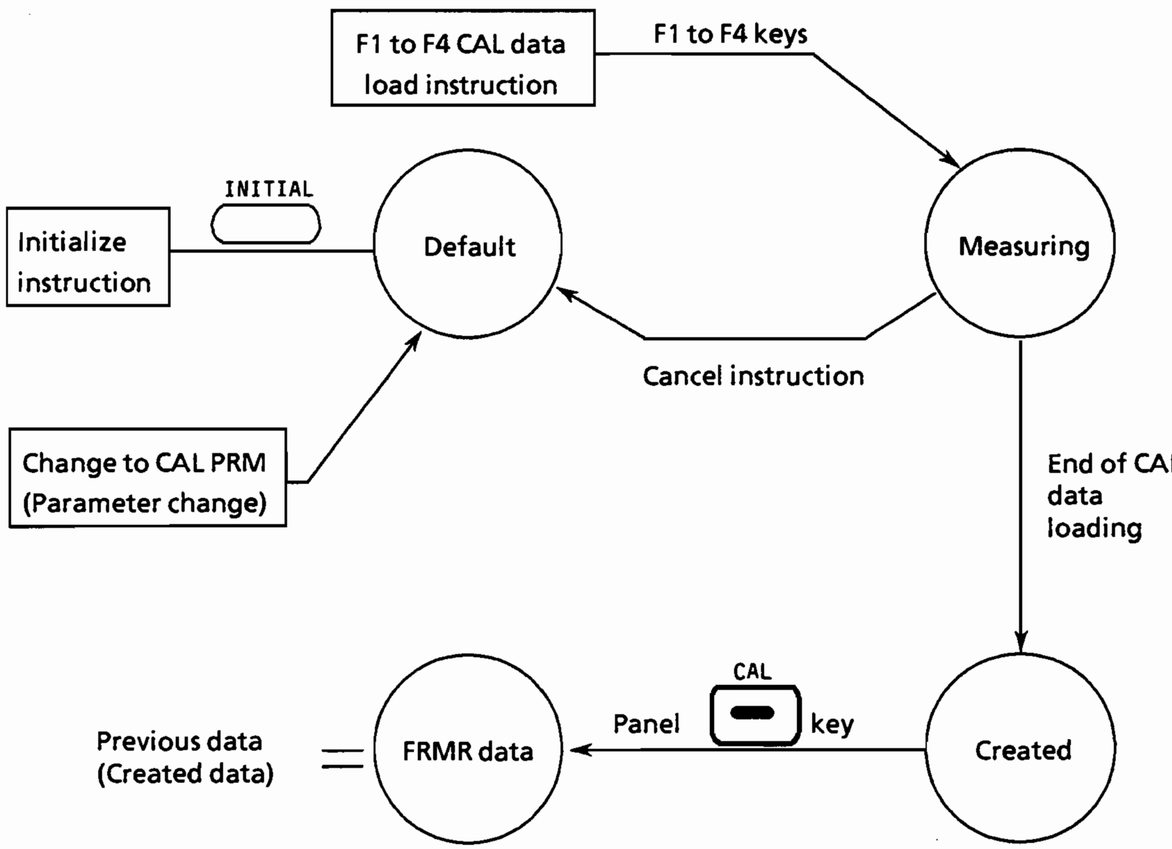
The method of calibration classifies the CAL menus into four kinds: X-S, 1 PORT OSL, 2 PORT OSL, and 1 PATH 2 PORT. Each menu is organized into three functional parts as follows:

- F1 to F4 CAL data loading
- Selection of the method of calibration and connector parameters
- Final CAL data generation



(1) F1 to F4 CAL data loading

The CAL menu labels (F1 to F4) change according to CAL data generated in the sequences shown below.



CAL menu label state transitions

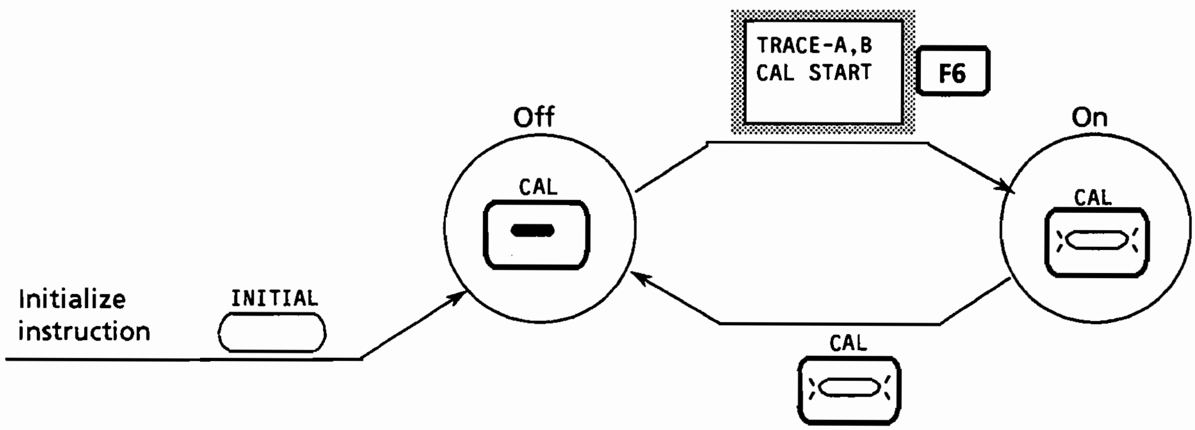
- **Default:** Pressing the INITIAL key generates CAL data having a default value (clear 0), which displays "Default." In this state, press CAL PRM F5 to select the method of calibration and connector parameters from the softkey menu that opens subsequently.
- **Measuring:** Pressing F1 to F4 displays "Measuring," loading testing system CAL complex data into X memory, then into S memory if the data has been collected by the X-S method or into CAL memory if it has been collected by the OSL method. "Measuring" lasts while loading is in progress.
- **Created:** "Created" displays when testing system data loading is complete.
- **FRMR Data:** Pressing the CAL key will normally open a CAL menu. If the CAL key is pressed in the Created state, it would display "FRMR Data" (former data). Created CAL data is available, therefore, to CAL menus labeled FRMR Data.

(2) Selection of the method of calibration and connector parameters

The MS4662A supports the X-S method, which corrects frequency responses only, and the single-port OSL method, two-port OSL method, and single-path two-port method, which correct vector errors. The X-S method can be used in simple measurement applications in which critical accuracy is not required. Where accuracy is important, the single-port OSL method, two-port OSL method, or single-path two-port method comes as a better choice.
To correct errors in the OSL methods, it is necessary to predefine connector parameter data, such as offset lengths and open capacitances of the connectors connected to the test ports.

(3) Final CAL data generation

The CAL data in effect upon CAL menu label state transitions from Measuring to Created is data on the testing system alone, excluding the DUT, that aids in error correction.

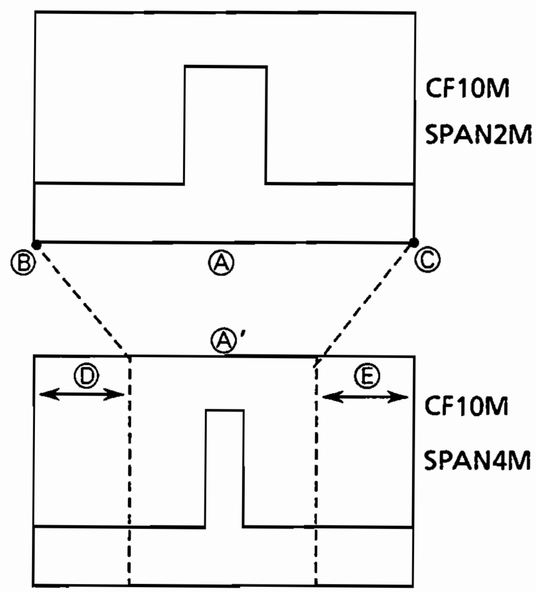


After connecting a DUT to the test ports to set up a testing system inclusive of the DUT, press CAL START F6 to generate final CAL data as corrected to eliminate errors, or measurement values. Final CAL data generation is followed by the start of sweeps according to preset sweep parameters (such as REPEAT/SINGLE, LOG/LIN, and AVERAGE counts).

9.3.2 Interpolating calibration data

Once CAL data (OPEN, SHORT, LOAD, or THRU) is collected, the CAL START key executes calibration data interpolation with changing frequencies (CF, SPAN, START, STOP) and measuring points to generate new calibration data.

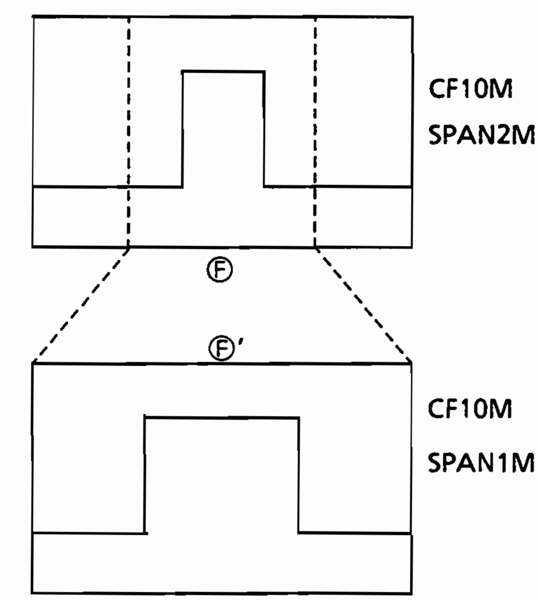
<Example> If the SPAN frequency has been changed



Execute calibration at a center frequency of 10 MHz, with a span of 2 MHz.

The upper chart represents the result of measurement of the filter after CAL START. The span frequency is then set to 4 MHz (lower chart).

Pressing the CAL START key changes calibration data Ⓐ to Ⓐ'. Calibration data Ⓓ is an extension of the calibration data at point Ⓑ; calibration data Ⓔ is an extension of the calibration data at point Ⓒ.



Execute calibration at a center frequency of 10 MHz, with a span of 2 MHz.

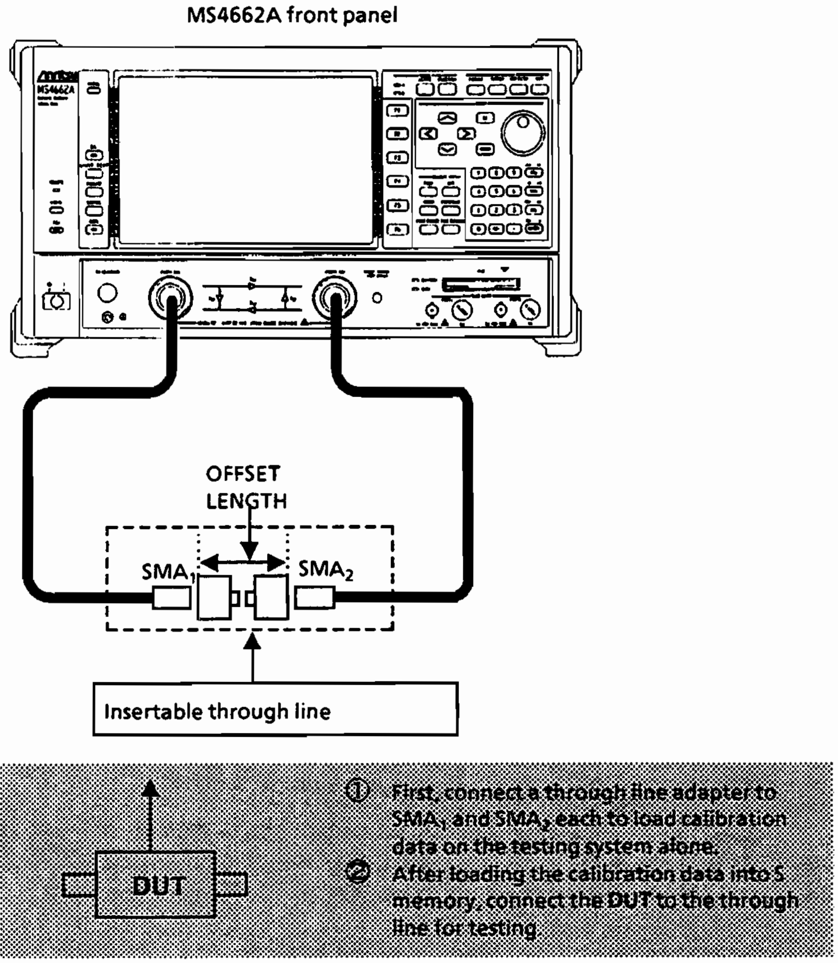
The upper chart represents the result of measurement of the filter after CAL START. The span frequency is then set to 1 MHz (lower chart).

Pressing the CAL START key generates CAL data Ⓕ' from Ⓕ through interpolation.

Note: Calibration data interpolation is not available with 1,001 measuring points and during log frequency sweeps.

9.3.3 X-S method: Calibration for S_{21} and S_{12} measurement

Calibration in the X-S method for S_{21} and S_{12} measurement corrects frequency responses only.



Have the frequency characteristics of the whole testing system stored in S memory in a directly coupled circuit beforehand. Then, connect a DUT to the through line to determine the frequency characteristics of the DUT alone by subtracting those of the testing system stored in S memory from the contents of X memory.

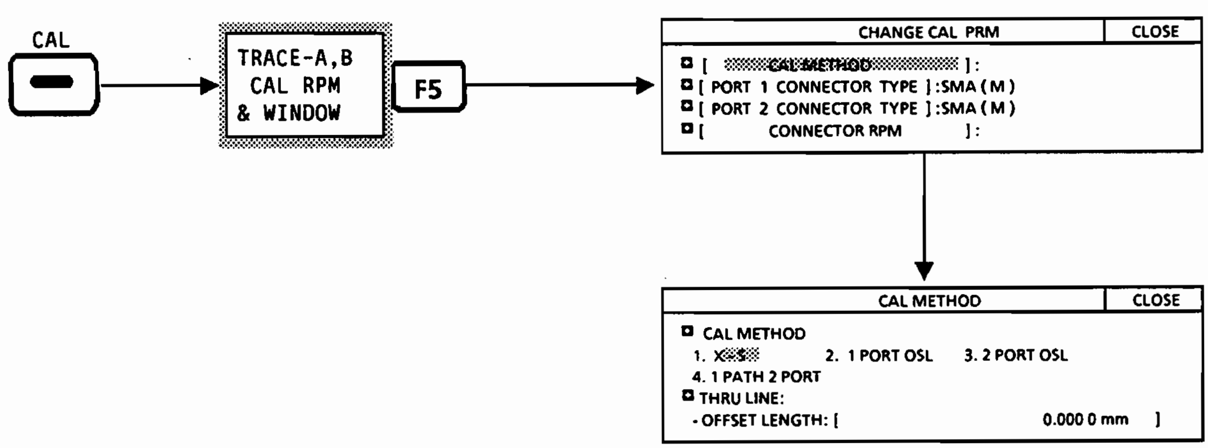
When the connection of an insertable through line in the setup diagram is complete, proceed with calibration along the following flow of CAL X-S menu operations:

Operational flow

- **STEP 1** Select CAL METHOD
- **STEP 2** Load CAL data from X into S
- **STEP 3** CAL START (run X→ S)

STEP 1 Select the method of calibration.

If the X-S method is not the current choice, select it in the following key-in sequence:



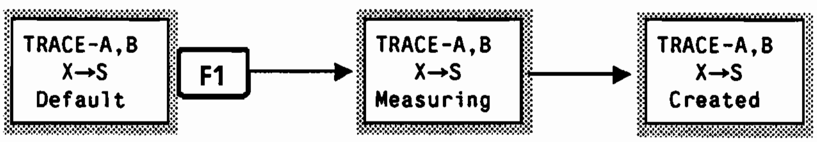
① Select the CAL METHOD group and press the ENTER key to open the CAL METHOD window.

② Select 1. X-S from the CAL METHOD group.

③ Close the CAL METHOD and the CHANGE CAL PRM window.

STEP 2 Load CAL data into S memory.

Press X → S Default F1 in the key-in sequence described below, and loading of CAL data (frequency characteristics of the testing system alone) into S memory begins, with the X → S Default label changing to "X-S Measuring." "X → S Measuring" lasts while loading is in progress. The X → S Measuring label changes to "X →S Created" when data loading in S memory is complete.

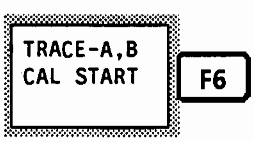


··· Load X (measurement values) into S memory.

STEP 3 CAL START (run X - S).

① Adjust the connector type (male or female) of the insertable through line to the DUT in the setup diagram, and connect the DUT to it.

② Press CAL START F6 and the panel CAL key lamp lights. The subsequently collected measurement value is subjected to a calculation to yield a new measurement value of X.

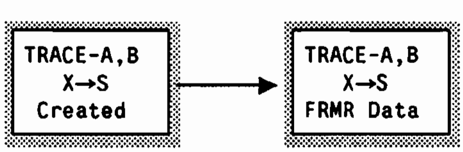


The panel CAL key lamp lights.

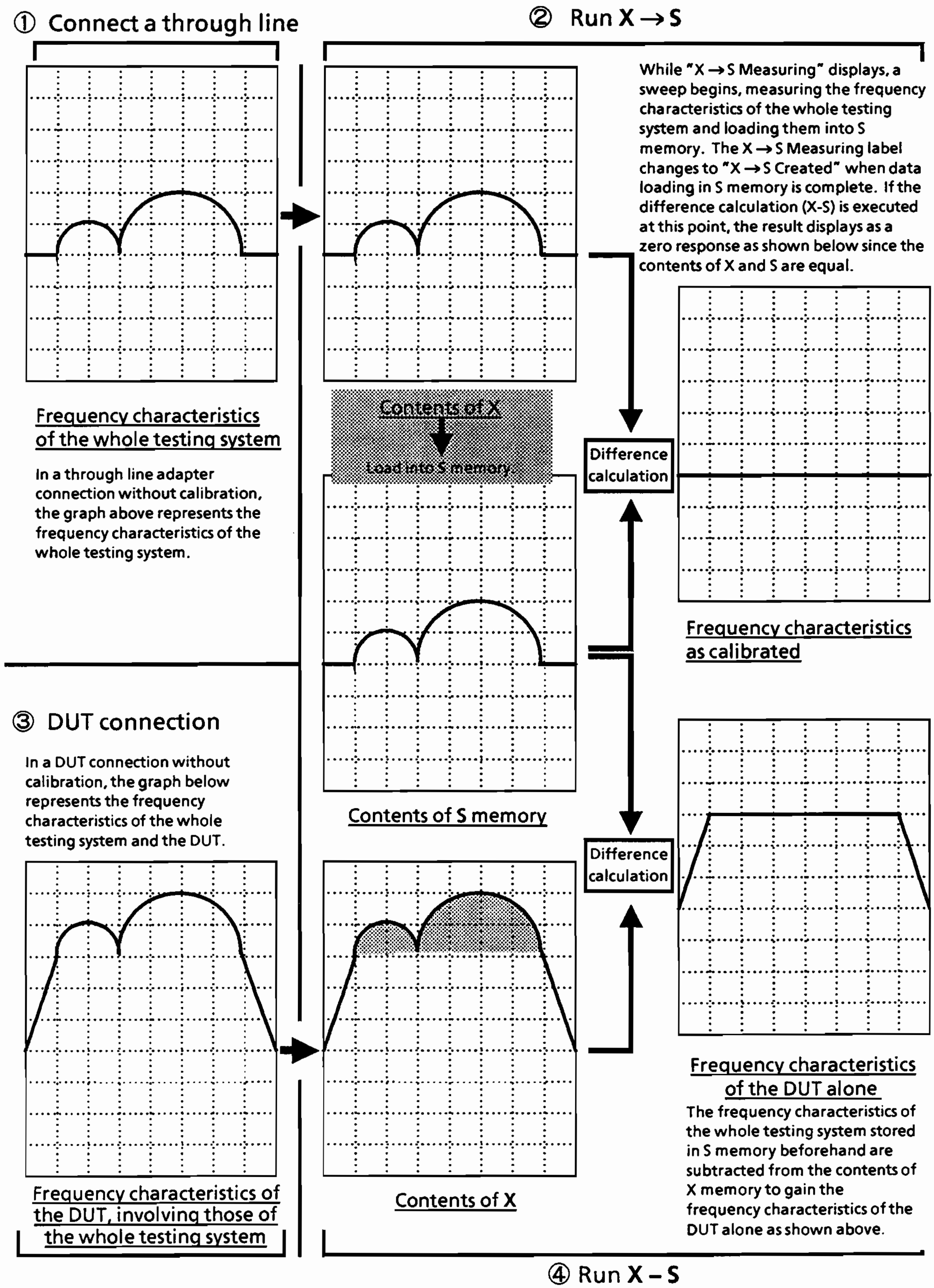
$X' \leftarrow X-S$

X: Measurement value
S: S memory loaded with CAL data in STEP2.
X': Measurement value resulting from calculation

- The difference provides the measurement value of the DUT.
- When the CAL panel key is pressed, the X → S Created label changes to "X → S FRMR Data." The calculation X' ← X−S is not performed on subsequently collected measurement values until the CAL START key is pressed again.

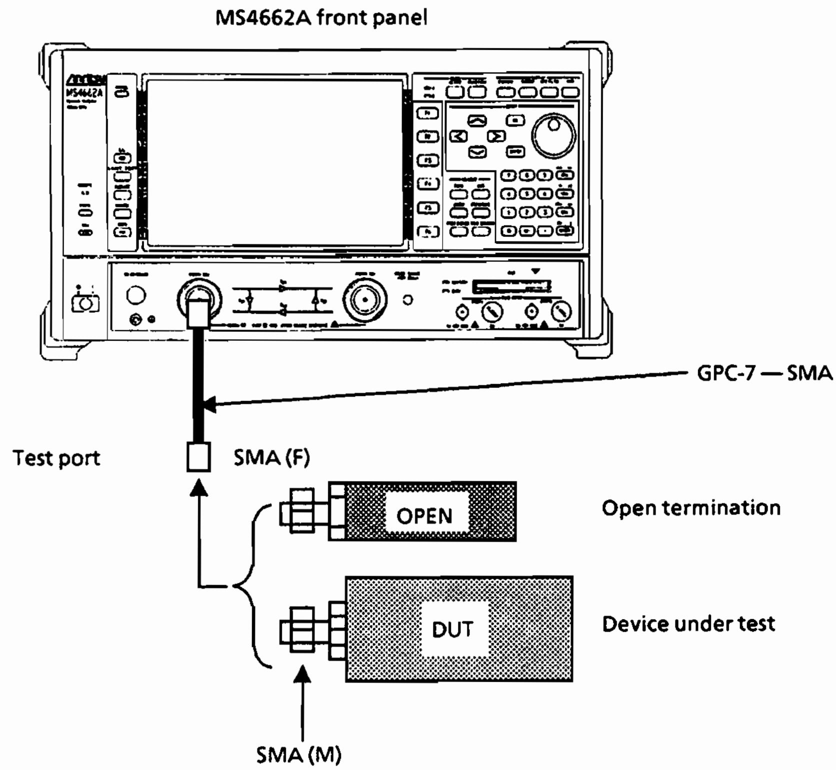


The principles of operation of the X-S calibration method are illustrated below.



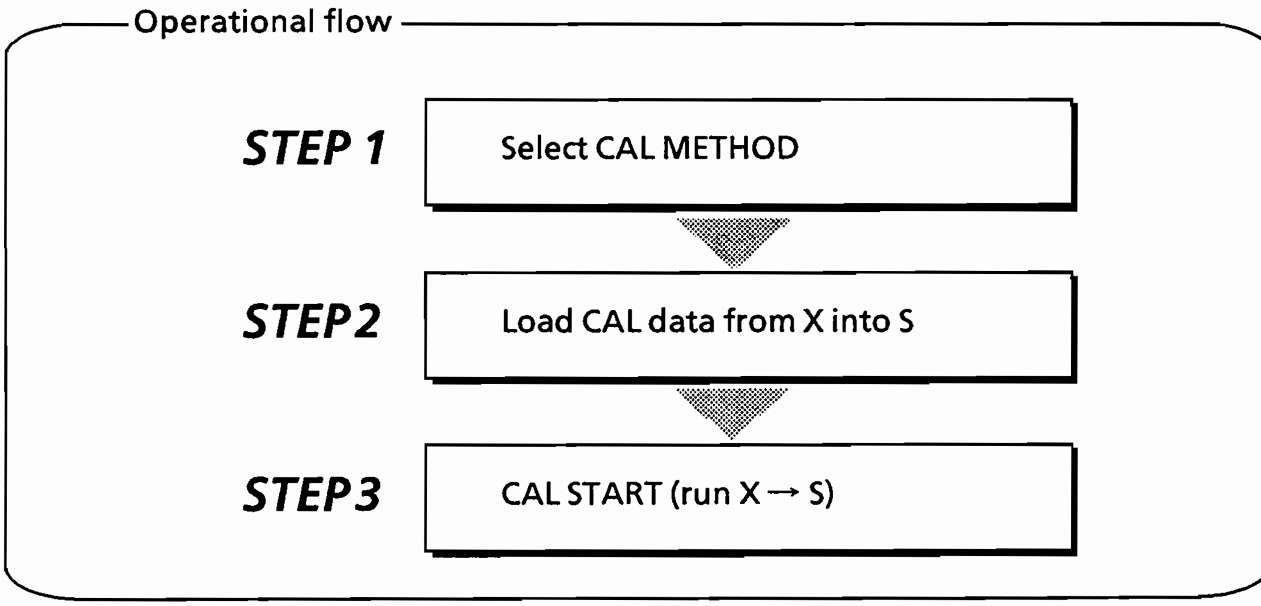
9.3.4 X-S method: Calibration for S_{11} and S_{22} measurement

Calibration in the X-S method for S_{11} and S_{22} measurement corrects frequency responses only.



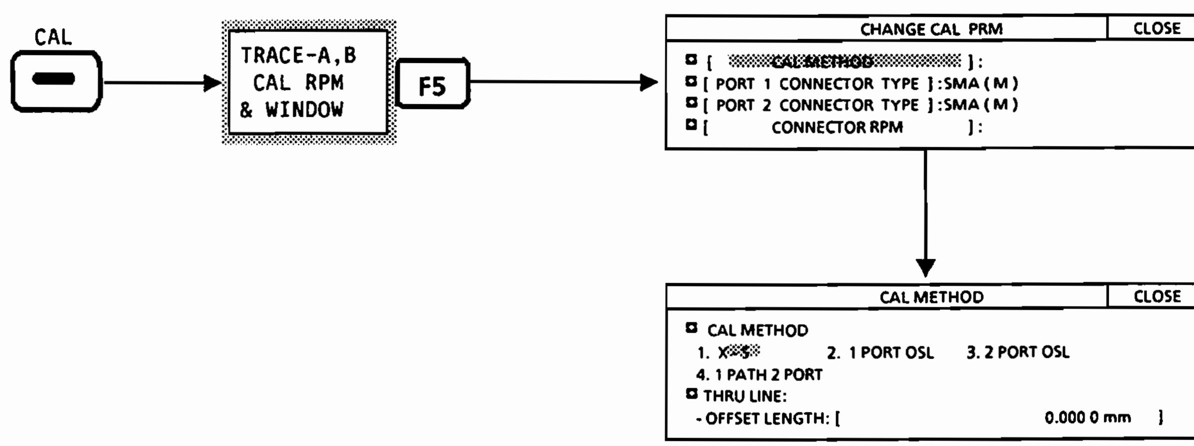
Calibration in the X-S method for S_{11} and S_{22} measurement serves the same goal and offers the same benefit as calibration in the X-S method for S_{21} and S_{12} measurement, and differs only in cabling and in that the end of the DUT in the reflection bridge is left open, when compared with the connection of a through line in place of the DUT in the latter method.

When the connection of an open termination in the setup diagram is complete, proceed with calibration along the following flow of CAL X-S menu operations:



STEP 1 Select the method of calibration.

If the X-S method is not the current choice, select it in the following key-in sequence:

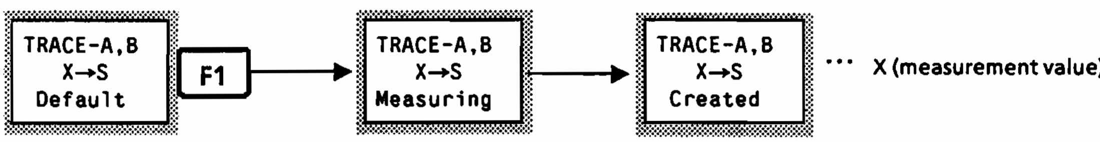


① Select the CAL METHOD group and press the ENTER key to open the CAL METHOD window.

② Select 1. X-S from the CAL METHOD group.

STEP 2 Load CAL data into S memory.

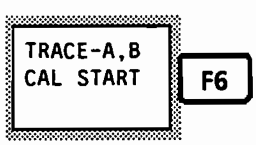
Press F1 X → S Default F1 in the key-in sequence described below, and loading of CAL data (frequency characteristics of the testing system alone) into S memory begins, with the X → S Default label changing to "X-S Measuring." "X → S Measuring" lasts while loading is in progress. The X → S Measuring label changes to "X → S Created" when data loading in S memory is complete.



STEP 3 CAL START (run X - S).

① Adjust the connector type (male or female) of the open termination to the DUT in the setup diagram, and connect the DUT to it.

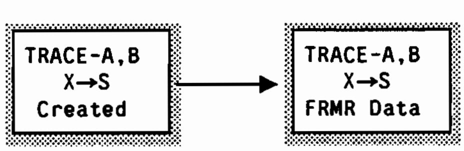
② Press CAL START F6 and the panel CAL key lamp (green) lights. The subsequently collected measurement value is subjected to a calculation to yield a new measurement value of X.



X' ← X − S

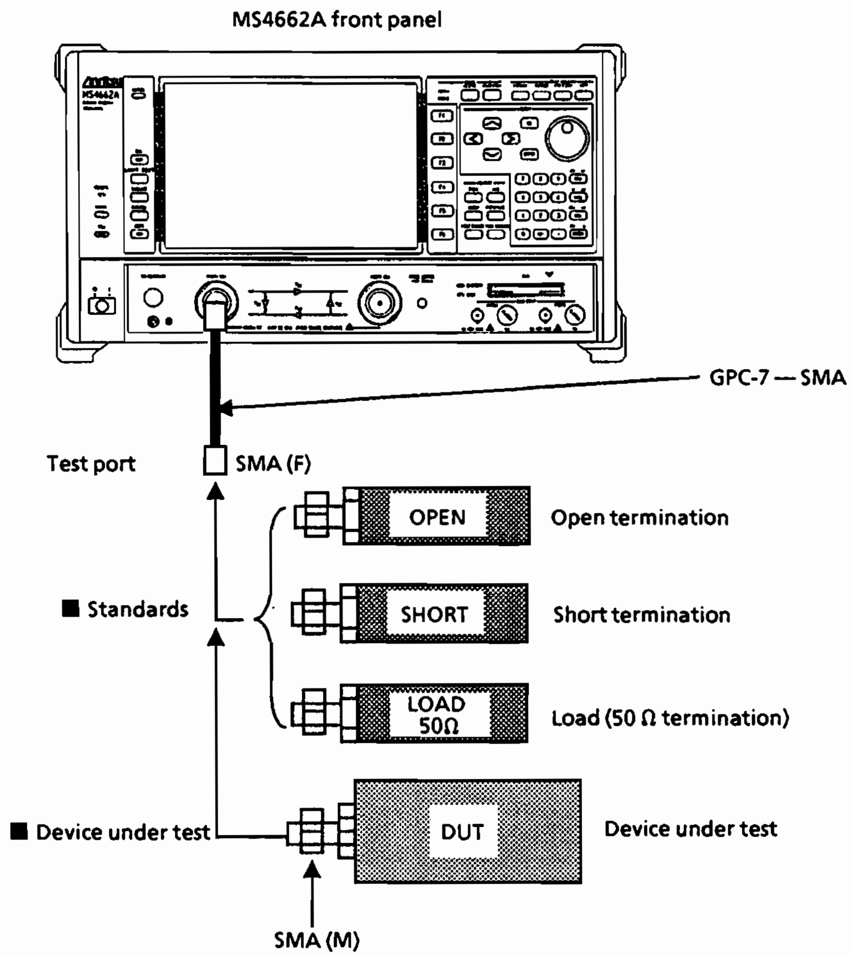
X: Measurement value
S: S memory loaded with CAL data in STEP 2.
X': Measurement value resulting from calculation

- The difference provides the measurement value of the DUT.
- When the CAL panel key is pressed, the X → S Created label changes to "X → S FRMR Data." The calculation X' ← X-S is not performed on subsequently collected measurement values until the CAL START key is pressed again.



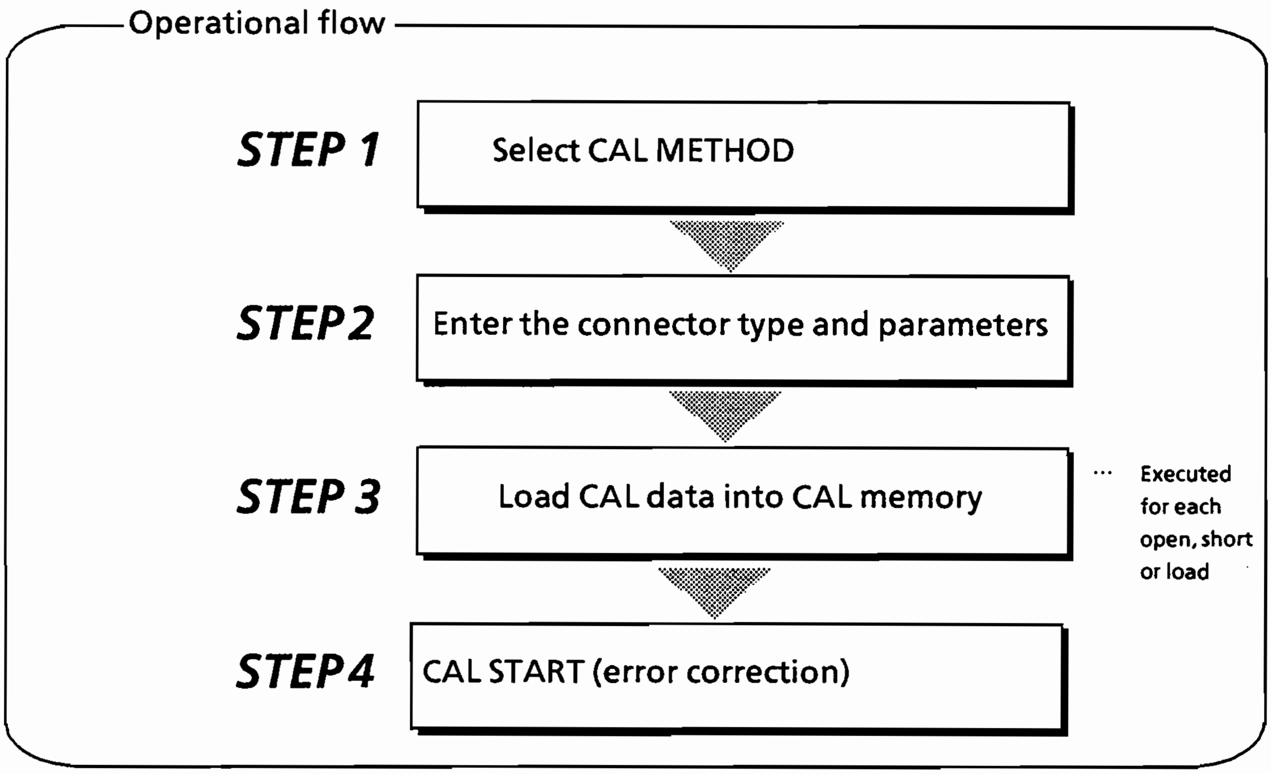
9.3.5 1 PORT OSL method: Calibration for S_{11} and S_{22} measurement

In S_{11} and S_{22} measurement, the 1 port OSL method corrects port reflection errors. It uses three kinds of calibration standards: opens, shorts, and loads (50 Ω termination).



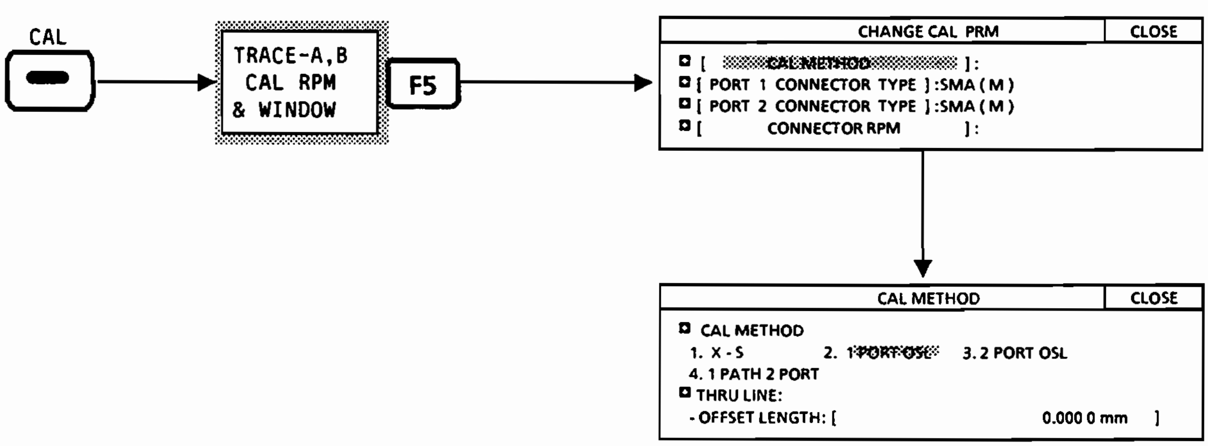
The end of the cable plugged into port 1 or 2 serves as a test port. It is assumed that the test port has an SMA (F) connector and that each standard and the DUT have an SMA (M) connector each. Connector parameter data on the SMA (M) connectors is subject to correction.

When required cabling in the setup diagram, except for the test ports, is complete, proceed with calibration along the following flow of CAL 1 PORT OSL menu operations:



STEP 1 Select the method of calibration.

If the 1 PORT OSL method is not the current choice, select it in the following key-in sequence:



① Select the CAL METHOD group and press the ENTER key to open the CAL METHOD window.

② Select 2. 1 PORT OSL from the CAL METHOD group.

STEP 2 Enter the connector type and parameters.

① Select CLOSE from the CAL METHOD window to close the CAL METHOD window.

② Select the PORT 1 CONNECTOR TYPE group from the CHANGE CAL PRM window and press the ENTER key to open the PORT 1 CONNECTOR TYPE window.

```
CHANGE CAL PRM                                   | CLOSE
□ [        CAL METHOD          ]:
□ [ PORT 1 CONNECTOR TYPE ]:SMA (M)
□ [ PORT 2 CONNECTOR TYPE ]:SMA (M)
□ [        CONNECTOR RPM       ]
```

↓

```
PORT 1 CONNECTOR TYPE:SMA (M)                    | CLOSE
□ CONNECTOR TYPE:
 1. SMA (M)        2. SMA (F)        3. K-CONN (M)
 4. K-CONN (F)     5. TYPE N (M)     6. TYPE N (F)
 7. GPC-3.5 (M)    8. GPC-3.5 (F)    9. GPC-7
10. USER (1)      11. USER (2)      12. USER (3)
```

③ Having selected 1. SMA (M), close the PORT 1 CONNECTOR TYPE window.

For the 3750 (3.5 mm), 3753 (N), and 3751 (GPC-7) calibration kits recommended for use with the MS4662A, default connector parameters are preprogrammed in the MS4662A, so the procedures that follow may be bypassed.

④ Select the CONNECTOR PRM group from the CHANGE CAL PRM window and press the ENTER key to open the CONNECTOR PRM window.

```
CHANGE CAL PRM                                   | CLOSE
□ [        CAL METHOD          ]:
□ [ PORT 1 CONNECTOR TYPE ]:SMA (M)
□ [ PORT 2 CONNECTOR TYPE ]:SMA (M)
□ [        CONNECTOR RPM       ]
```

↓

```
CONNECTOR PRM                                    | CLOSE
□ CONNECTOR TYPE:SMA (M)
□ OPEN DEVICE:
 ------ C0 (E-15) : [          28.000    ]
 ------ C1 (E-27) : [        -400.000    ]
 ------ C2 (E-36) : [          10.000    ]
 ------ C3 (E-45) : [           0.500    ]
 - OFFSET LENGTH : [           5.000 mm  ]
□ SHORT DEVICE:
 - OFFSET LENGTH: [            5.000 mm  ]
```

⑤ Turn the ENTRY knob to select the OPEN DEVICE GROUP and enter four different open capacitance coefficients and an offset length. (These values are listed in the test report supplied with the calibration kit.)

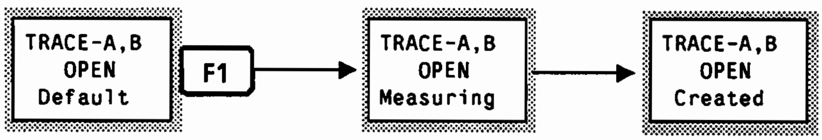
⑥ Select the SHORT DEVICE group and enter the offset length of a short termination. (This value is listed in the test report supplied with the calibration kit.)

⑦ Close the CONNECTOR PRM and the CHANGE CAL PRM window.

STEP 3 Load CAL data into CAL memory.

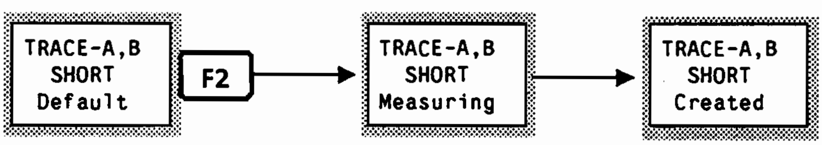
① Connect an open termination (OPEN) to port 1.

② Press OPEN Default F1 in the key-in sequence described below, and loading of CAL data into CAL memory begins, with the OPEN Default label changing to "OPEN Measuring." "OPEN Measuring" lasts while loading is in progress. The OPEN Measuring label changes to "OPEN Created" when data loading in CAL memory is complete.



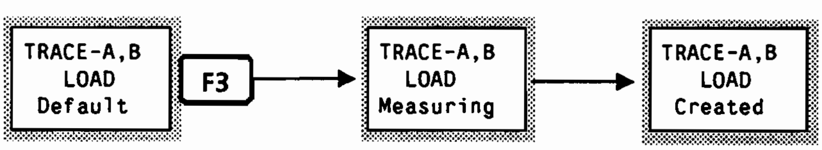
③ Remove the open termination (OPEN) from port 1 and connect a short termination (SHORT) in its place.

④ Press SHORT Default F2 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for OPEN, with the CAL data being loaded into CAL memory.



⑤ Remove the short termination (SHORT) from port 1 and connect a load (50 Ω termination) in its place.

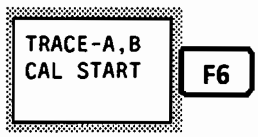
⑥ Press LOAD Default F3 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for SHORT, with the CAL data being loaded into CAL memory.

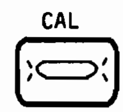


STEP 4 Execute CAL START to start error correction.

① Remove the load and connect a DUT in its place.

② Press CAL START F6 and the panel CAL key lamp (green) lights.



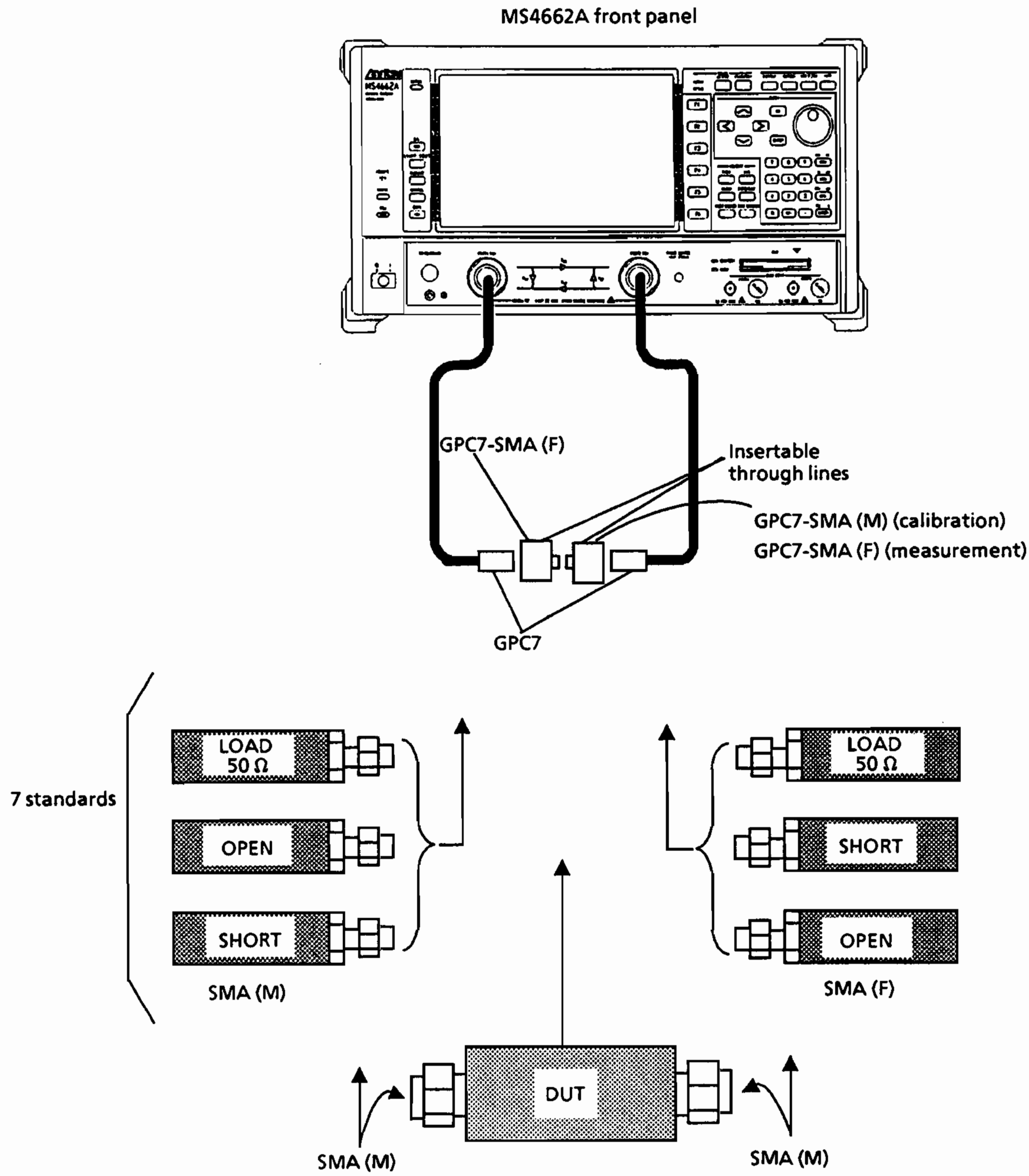


The CAL START lamp lights.

The subsequently collected measurement value is subjected to vector error correction for reflection errors. The result of the error correction provides a measurement value of the DUT.

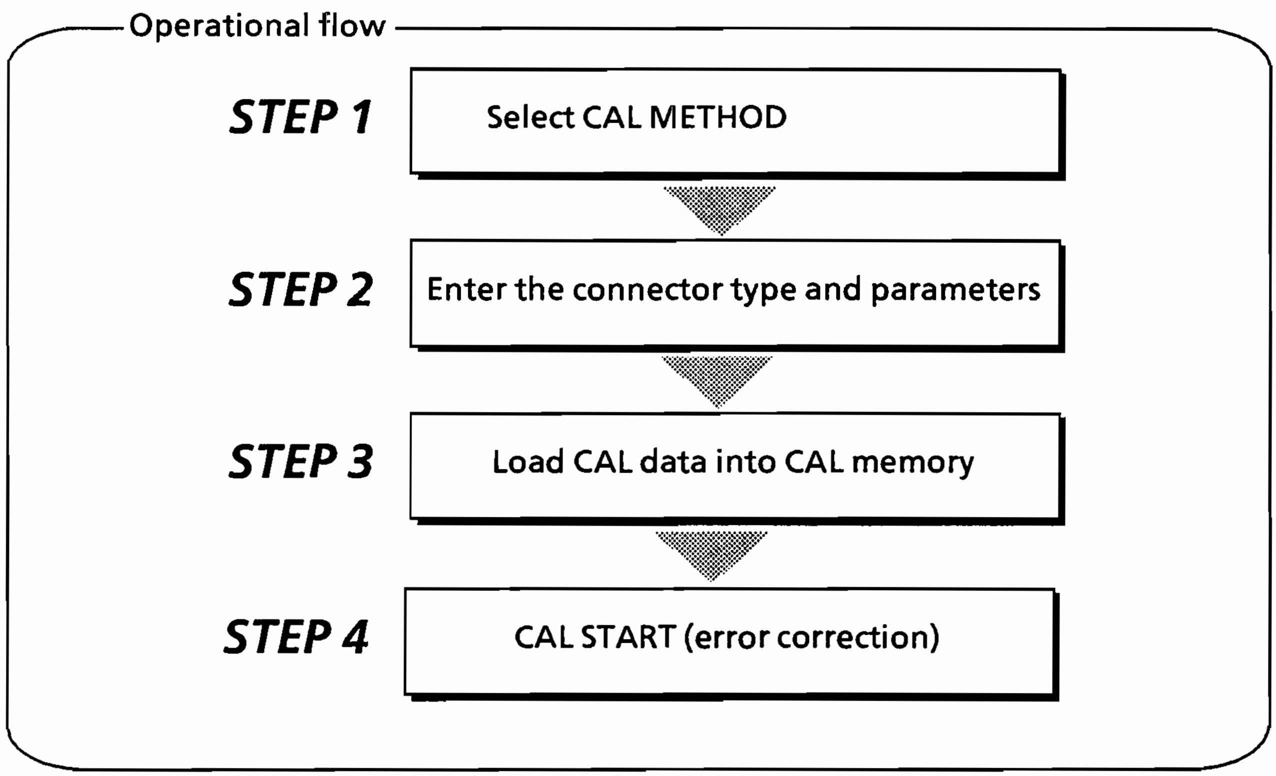
9.3.6 2 PORT OSL method: Calibration for S_{11}, S_{22}, S_{21}, and S_{12} measurement

The two-port OSL (2 PORT OSL) method corrects forward and backward full 12-term vector errors associated with two-port measurement by using opens, shorts, loads (50 Ω), and through lines as standards.



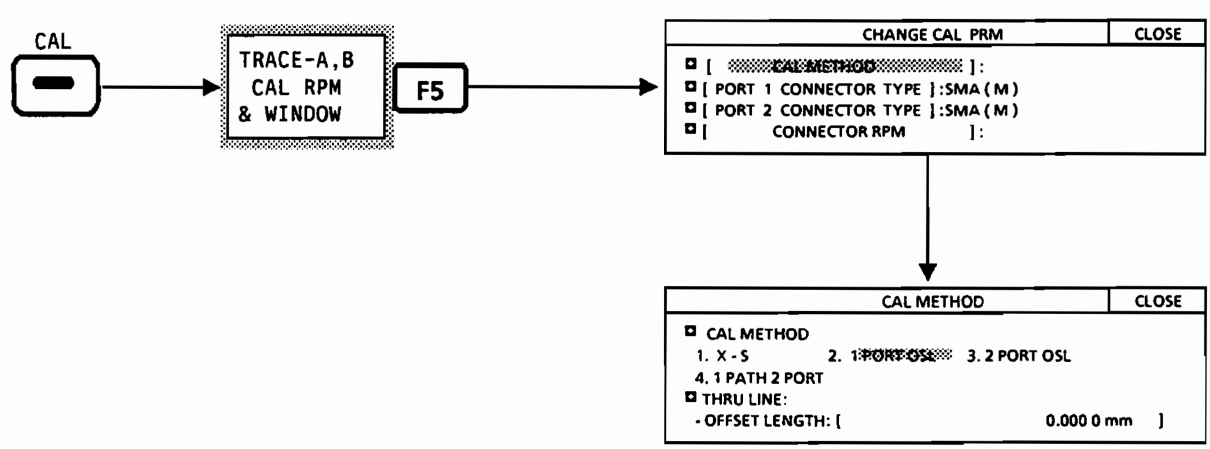
Make connections to ports 1 and 2 as shown above. The connector of each standard is subject to connector parameter correction.

When required cabling in the setup diagram, except for the test ports, is complete, proceed with calibration along the following flow of CAL 2 PORT OSL menu operations:



STEP 1 Select the method of calibration.

If the 2 PORT OSL method is not the current choice, select it in the following key-in sequence:



① Select the CAL METHOD group and press the ENTER key to open the CAL METHOD window.

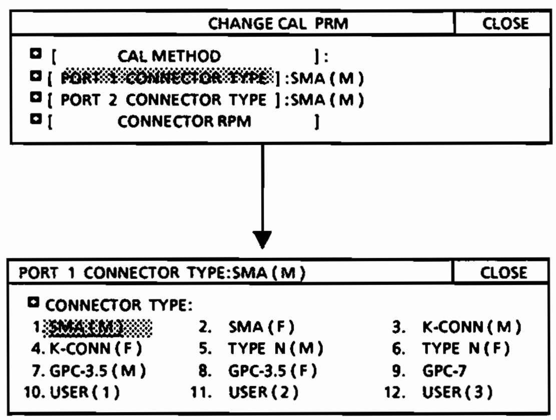
② Select 3. 2 PORT OSL from the CAL METHOD group.

③ Select the THRU LINE group and enter the offset length of a 0-mm through line as an insertable through line.

STEP 2 Enter the connector type and parameters.

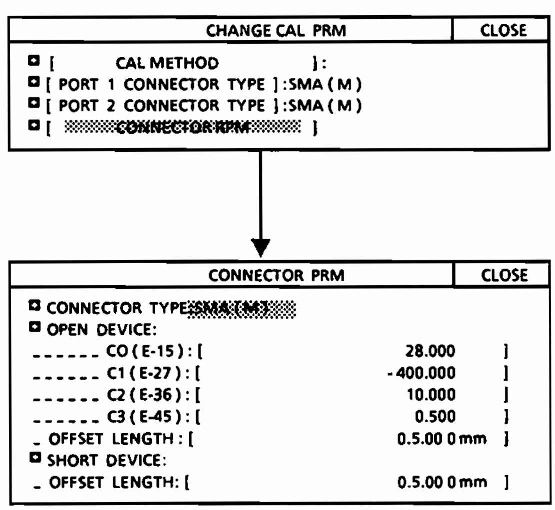
① Select CLOSE from the CAL METHOD window to close the CAL METHOD window.

② Select the PORT 1 CONNECTOR TYPE group from the CHANGE CAL.
PRM window and press the ENTER key to open the PORT 1 CONNECTOR TYPE window.



③ Having selected 1. SMA (M), close the PORT 1 CONNECTOR TYPE window.For the 3750 (3.5 mm), 3753 (N), and 3751 (GPC-7) calibration kits recommended for use with the MS4662A, default connector parameters are preprogrammed in the MS4662A, so the procedures that follow may be bypassed.

④ Select the CONNECTOR PRM group from the CHANGE CAL PRM window and press the ENTER key to open the CONNECTOR PRM window.



⑤ Turn the ENTRY knob to select the OPEN DEVICE grouping and enter four different open capacitance coefficients and an offset length. (These values are listed in the test report supplied with the calibration kit.)

⑥ Select the SHORT DEVICE grouping and enter the offset length of a short termination. (This value is listed in the test report supplied with the calibration kit.)

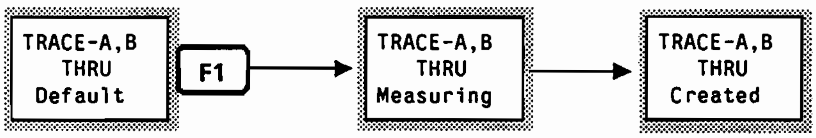
⑦ Close the CONNECTOR PRM window.

⑧ Likewise, select the connector type and parameters for port 2.

STEP 3 Load CAL data into CAL memory.

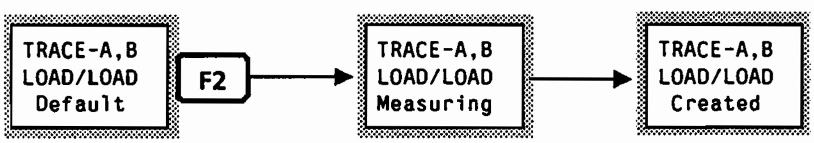
① Connect ports 1 and 2 with through lines.

② Press THRU Default F1 in the key-in sequence described below, and loading of CAL data into CAL memory begins, with the THRU Default label changing to "THRU Measuring." "THRU Measuring" lasts while loading is in progress. The THRU Measuring label changes to "THRU Created" when data loading in CAL memory is complete.



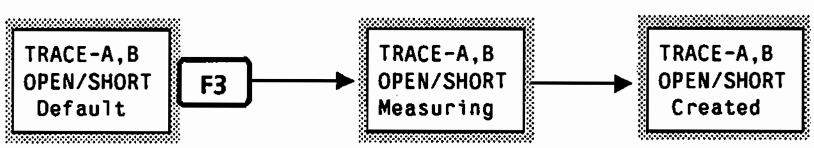
③ Remove the through lines from ports 1 and 2 and connect loads in their place.

④ Press LOAD/LOAD Default F2 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for THRU, with the CAL data being loaded into CAL memory.



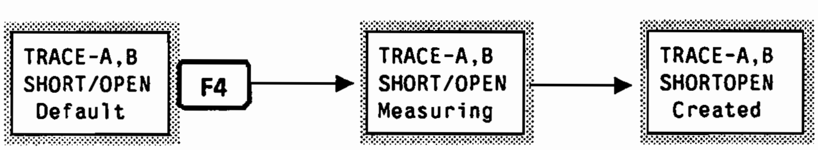
⑤ Remove the termination and connect an open termination to port 1 and a short termination to port 2.

⑥ Press OPEN/SHORT Default F3 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for LOAD, with the CAL data being loaded into CAL memory.



⑦ Interchange the open termination connected to port 1 and the short termination connected to port 2.

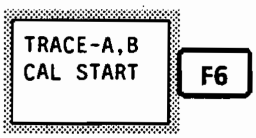
⑧ Press SHORT/OPEN Default F4 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for OPEN/SHORT, with the CAL data being loaded into CAL memory.

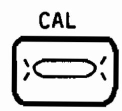


STEP 4 Execute CAL START to start error correction.

① Remove the open termination from port 1 and the short termination from port 2. Then, adjust the connector type of the insertable through lines to the DUT in the setup diagram, and connect the DUT to them.

② Press CAL START F6 and the panel CAL key lamp (green) lights.





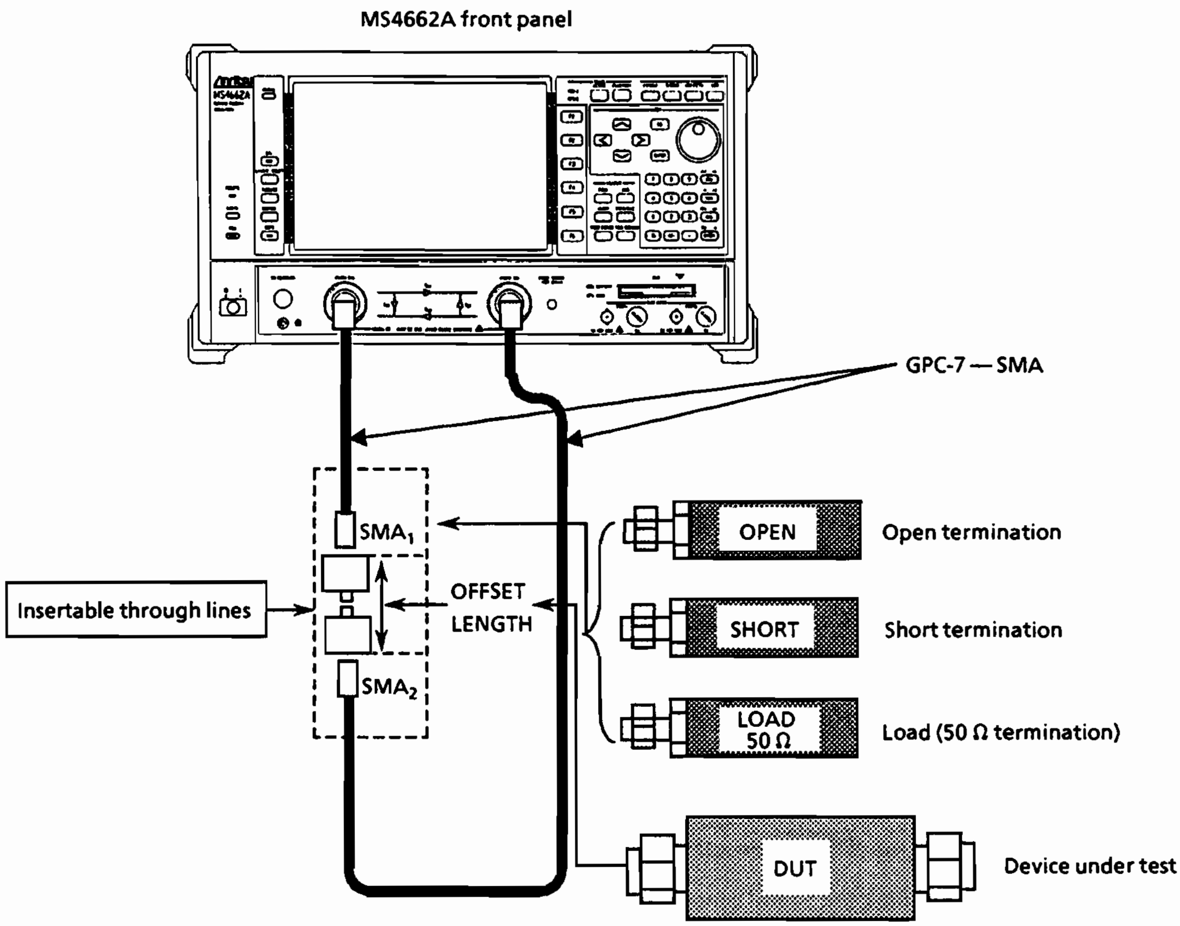
The CAL START lamp lights.

The lighting of the CAL key lamp is followed by the start of calibration by full 12-term vector error correction to provide a true, error-free value of S_{11}. True, error-free values of S_{22}, S_{21}, and S_{12} can be obtained by simply selecting the subfunctions of S_{22}, S_{21}, and S_{12} from the FUNCTION menu, respectively.

Note: Executing CAL START initiates sweeps for measurement. The first sweep performs forward measurement for errors, the second, backward measurement for errors. True measurement values resulting from concurrent full 12-term vector error correction are displayed. In forward or backward measurement, true measurement values are not collected until after two sweeps. In combined forward and backward measurement or measurement with SWEEP COUPLE OFF, true measurement values are not collected until after four sweeps.

9.3.7 1 PATH 2 PORT method: Calibration for transmission/reflection transmission characteristics measurement

The 1 PATH 2 PORT method provides forward vector error correction, except for load matching.



When required cabling in the setup diagram, except for the test ports, is complete, proceed with calibration along the following flow of CAL 1 PATH 2 PORT menu operations:

Operational flow

STEP 1 Select CAL METHOD

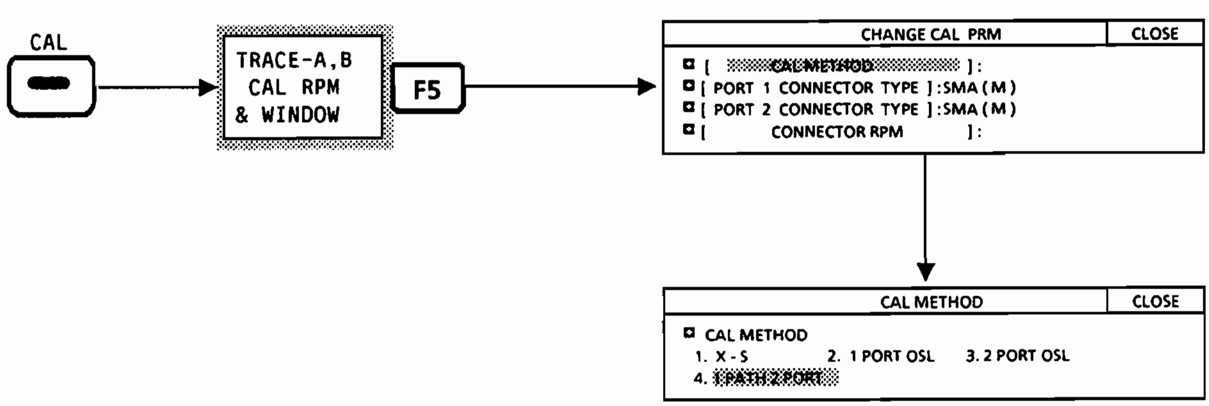
STEP 2 Enter the connector type and parameters

STEP 3 Load CAL data into CAL memory

STEP 4 CAL START (error correction)

STEP 1 Select the method of calibration.

If the 1 PATH 2 PORT method is not the current choice, select it in the following key-in sequence:



① Select the CAL METHOD grouping and press the ENTER key to open the CAL METHOD window.

② Select 4. 1 PATH 2 PORT from the CAL METHOD grouping.

③ Select the THRU LINE grouping and enter the offset length of a 0-mm through line as an insertable through line.

STEP 2 Enter the connector type and parameters.

① Select CLOSE from the CAL METHOD window to close the CAL METHOD window.

② Select the PORT 1 CONNECTOR TYPE group from the CHANGE CAL PRM window and press the ENTER key to open the PORT 1 CONNECTOR TYPE window.

```
CHANGE CAL PRM                                | CLOSE
□ [         CAL METHOD            ]:
□ [ PORT 1 CONNECTOR TYPE ]:SMA(M)
□ [ PORT 2 CONNECTOR TYPE ]:SMA(M)
□ [         CONNECTOR RPM         ]
                      ↓
PORT 1 CONNECTOR TYPE:SMA(M)                  | CLOSE
□ CONNECTOR TYPE:
1. SMA(M)         2. SMA(F)         3. K-CONN(M)
4. K-CONN(F)      5. TYPE N(M)      6. TYPE N(F)
7. GPC-3.5(M)     8. GPC-3.5(F)     9. GPC-7
10. USER(1)       11. USER(2)       12. USER(3)
```

③ Having selected 1. SMA (M), close the PORT 1 CONNECTOR TYPE window.

For the 3750 (3.5 mm), 3753 (N), and 3751 (GPC-7) calibration kits recommended for use with the MS4662A, default connector parameters are preprogrammed in the MS4662A, so the procedures that follow may be bypassed.

④ Select the CONNECTOR PRM grouping from the CHANGE CAL PRM window and press the ENTER key to open the CONNECTOR PRM window.

```
CHANGE CAL PRM                                | CLOSE
□ [         CAL METHOD            ]:
□ [ PORT 1 CONNECTOR TYPE ]:SMA(M)
□ [ PORT 2 CONNECTOR TYPE ]:SMA(M)
□ [         CONNECTOR RPM         ]
                      ↓
CONNECTOR PRM                                 | CLOSE
□ CONNECTOR TYPE:SMA(M)
□ OPEN DEVICE:
------ CO(E-15):[              28.000     ]
------ C1(E-27):[            -400.000     ]
------ C2(E-36):[              10.000     ]
------ C3(E-45):[               0.500     ]
- OFFSET LENGTH:[              5.000 mm   ]
□ SHORT DEVICE:
- OFFSET LENGTH:[              5.000 mm   ]
```

⑤ Turn the ENTRY knob to select the OPEN DEVICE grouping and enter four different open capacitance coefficients and an offset length. (These values are listed in the test report supplied with the calibration kit.)

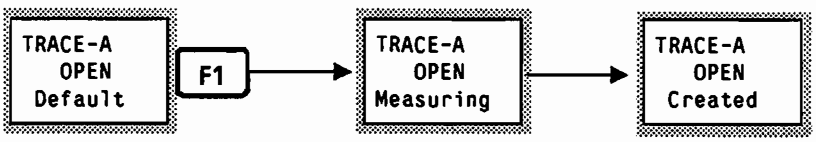
⑥ Select the SHORT DEVICE group and enter the offset length of a short termination. (This value is listed in the test report supplied with the calibration kit.)

⑦ Close the CONNECTOR PRM window.

STEP 3 Load CAL data into CAL memory.

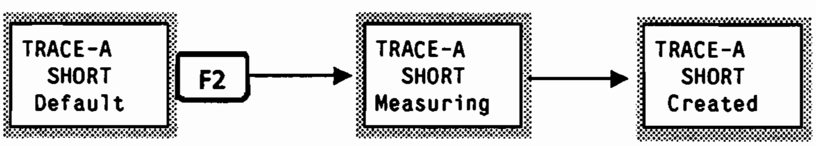
① Connect an open termination (OPEN) to port 1.

② Press OPEN Default F1 in the key-in sequence described below, and loading of CAL data into CAL memory begins, with the OPEN Default label changing to "OPEN Measuring." "OPEN Measuring" lasts while loading is in progress. The OPEN Measuring label changes to "OPEN Created" when data loading in CAL memory completes.



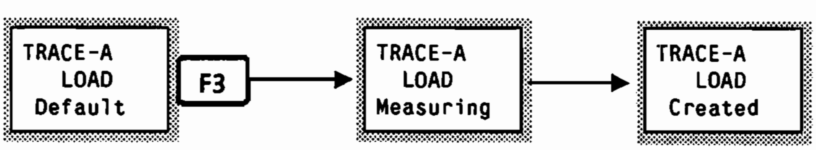
③ Remove the open termination (OPEN) from port 1 and connect a short termination (SHORT) in its place.

④ Press SHORT Default F2 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for OPEN, with the CAL data being loaded into CAL memory.

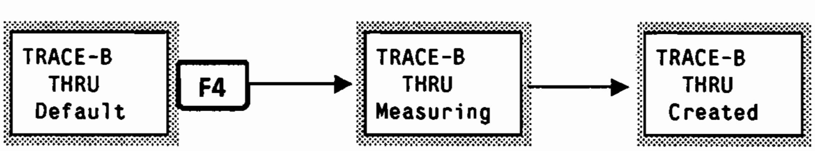


⑤ Remove the short termination (SHORT) from port 1 and connect a load (50 Ω termination) in its place.

⑥ Press LOAD Default F3 in the key-in sequence described below, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for SHORT, with the CAL data being loaded into CAL memory.



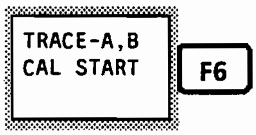
⑦ Press THRU Default F4 in the key-in sequence described below, and loading of CAL data into CAL memory begins, with the THRU Default label changing to "THRU Measuring." "THRU Measuring" lasts while loading is in progress. The THRU Measuring label changes to "THRU Created" when data loading in CAL memory completes.

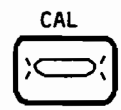


STEP 4 Execute CAL START to start error correction.

① Adjust the connector type of the insertable through lines to the DUT in the setup diagram, and connect the DUT to them.

② Press CAL START F6 and the panel CAL key lamp (green) lights.





The panel CAL key lamp lights.

The subsequent measurement value is subjected to vector error correction, excluding mismatch loading error. The value after error correction provides a measurement value of the DUT.

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SECTION 10
MEASUREMENT

This chapter introduces typical examples of transmission characteristics measurement, reflection characteristics measurement, and time-domain measurement. For information on calibration prerequisite to measurement, see Chapter 9. For key-in operations in the ENTRY section, see Chapter 3.

TABLE OF CONTENTS

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All operations explained in this section are assumed to begin by pressing the INITIAL key. Defaults of typical parameters are listed below. For details on other defaults, see Appendix A, "Default List."

- Trace A .... Active
- Measuring points 251
- RBW .... AUTO setting
- Measurement mode .... S_{11}
- Trace A display format .... LOG MAG
- Trace B display format .... LOG MAG

Measurement mode	FUNCTION menu	Measurement item	Display format
Transmission characteristics measurement	S_{21}, S_{12}	Logarithmic magnitude	LOG MAG
		Logarithmic magnitude	LOG MAG
		Magnitude and phase	LOG MAG, PHASE
		High-speed group delay	HSDLY
Reflection characteristics MS4662A Network Analyzer	S_{11}, S_{22}	Return loss	LOG MAG
		Reflection coefficient	LIN, MAG, polar coordinates
		Impedance	Smith chart
		75 Ω to 50 Ω conversion	———
Level measurement	TA, TB, R	S_{21}, S_{11}	LOG MAG, LIN MAG
		S_{12}, S_{22}	LOG MAG, LIN MAG
Time-domain measurement	BAND PASS	S-parameter time-domain analysis	LOG MAG (S_{21})
	LOW PASS	Cable fault location measurement	REAL

The principles of measurement are explained first to aid in the understanding of the concepts of measurement that follow.

10.1 Circuit Network Analysis

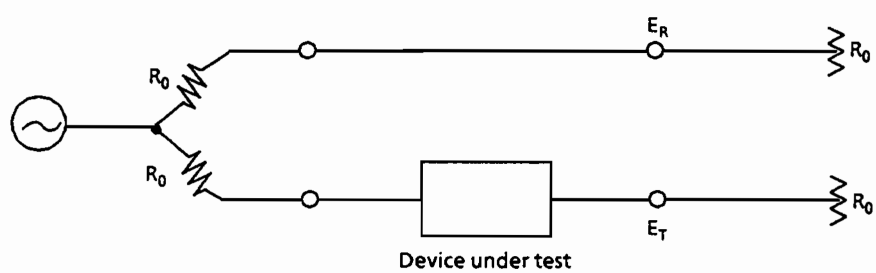
Circuit network analysis by a network analyzer is accomplished by measuring the transmission and reflection characteristics of the circuit network of interest in a frequency domain by using sinusoidal waves. Transmission characteristics are expressed by Etr/Ein, where Ein is the incident voltage on the circuit network and Etr is the transmitted voltage; reflection characteristics are expressed by Ere/Ein, where Ein is the incident voltage on the circuit network and Ere is the reflected voltage. Hence, the transmission and reflection characteristics of a circuit network can be determined by measuring the magnitude ratio and phase difference of Etr/Ein and Ere/Ein.

The characteristics of a circuit network are represented by using the magnitudes and phases of its basic transmission and reflection characteristics, plus the items listed below as derived from these characteristics. The MS4662A features a built-in S-parameter testing set to permit measurement of all these items.

Transmission characteristics: Magnitude
Phase
Group delay
Transmission coefficient

Reflection characteristics: Magnitude
Phase
Reflection coefficient
VSWR
Impedance
Admittance

10.1.1 Transmission characteristics



Transmission characteristics measurement

In the diagram above, R_0 denotes the characteristic impedance of the testing system, E_R, the reference end voltage, and E_T, the test end voltage. The transmission coefficient K can be stated in an equation as

$$K = |K| \cdot e^{j\phi} = \frac{E_T}{E_R} \quad \text{①}$$

where |K|: Magnitude ratio, ϕ: Phase difference (rad)

The magnitude A, phase ϕ, and group delay τ can thus be determined as follows:

$A = 20 \log_{10} |K|$ (dB) .... ②

$\theta = \frac{360}{2\pi} \phi$ (deg) .... ③

$\tau = -\frac{d\phi}{d\omega}$

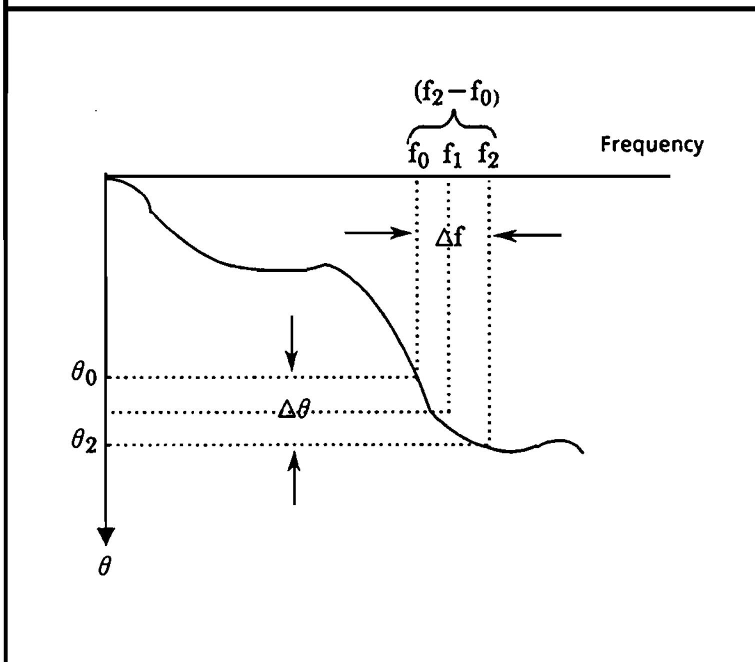
$\simeq -\frac{\Delta\phi}{\Delta\omega} = -\frac{1}{360} \cdot \frac{\Delta\theta}{\Delta f}$ (S) .... ④

where, θ: Phase (deg), ω: Angular frequency (rad/s)
$\Delta\theta$: Phase difference (rad), Δf: Frequency difference (Hz)

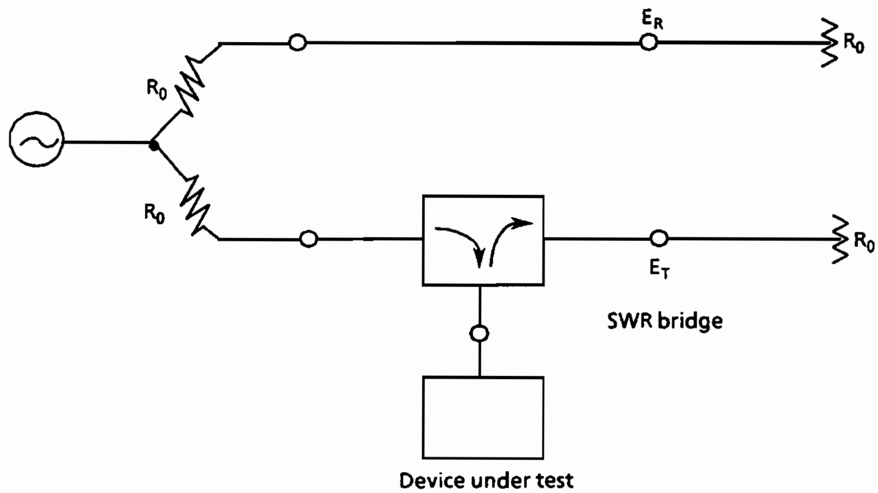
The magnitude and phase are measured directly and displayed onscreen. The absolute value of the transmission coefficient is determined from Eq. ② by calculation.

The group delay is calculated from Eq. ④ by measuring the phase difference $\Delta\theta$ between the frequency $f_0 + \frac{\Delta f}{2}$ and $f_0 - \frac{\Delta f}{2}$.

Aperture setting for group delay measurement



10.1.2 Reflection characteristics



Reflection characteristics measurement

In the diagram above, R_0 denotes the characteristic impedance of the testing system, E_R, the reference end voltage, and E_T, the test end voltage. The reflection coefficient Γ can be stated in an equation as

$$\Gamma = |\Gamma| \cdot e^{j\phi} = \frac{E_T}{E_R} \quad \text{①}$$

where |Γ|: Magnitude ratio, ϕ: Phase difference (rad)

The return loss can thus be determined as follows:

$$\delta = 20 \log |\Gamma| \text{ (dB)} \quad \text{②}$$

$$\theta = \frac{360}{2\pi} \phi \text{ (deg)} \quad \text{③}$$

The reflection loss and the phase are measured directly and displayed onscreen. The absolute value of the reflection coefficient is determined from Eq. ② by calculation.

The impedance and admittance are calculated from the reflection coefficient Γ by using the equation

$$Z_X = |Z_X| e^{j\theta'} = \frac{1+\Gamma}{1-\Gamma} \cdot R_O = R_X + jX_X \quad \text{④}$$

$R_X = \mathrm{Re}(Z_X)$

$X_X = \mathrm{Im}(Z_X)$

The impedance is represented in serial equivalent circuits like those shown below.

Impedance serial equivalent circuits

The values of Q and D of the inductance or capacitance in these circuits are expressed in equations as

$$Q = \frac{X_X}{R_X} \quad \cdots\cdots\cdots\cdots \quad ⑤$$

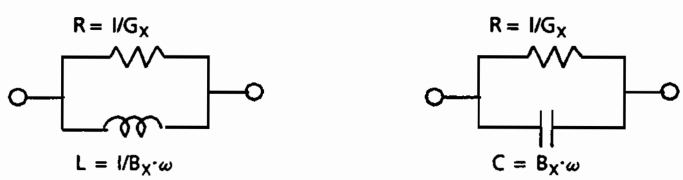
$$D = \frac{1}{Q} \quad \cdots\cdots\cdots\cdots \quad ⑥$$

$$Y_x = |Y_x| e^{j\theta''} = \frac{1}{Z_X} = \frac{1-\Gamma}{1+\Gamma} \cdot \frac{1}{R0} = G_X + jB_X \quad \cdots\cdots\cdots\cdots \quad ⑦$$

$G_X = \mathrm{Re}\,(Y_X)$

$B_X = \mathrm{Im}\,(Y_X)$

The admittance is represented in parallel equivalent circuits like those shown below.



Admittance parallel equivalent circuits

The values of Q and D of the inductance or capacitance in these circuits are expressed in equations as

$$Q = \frac{G_X}{B_X} \quad \cdots\cdots\cdots\cdots \quad ⑧$$

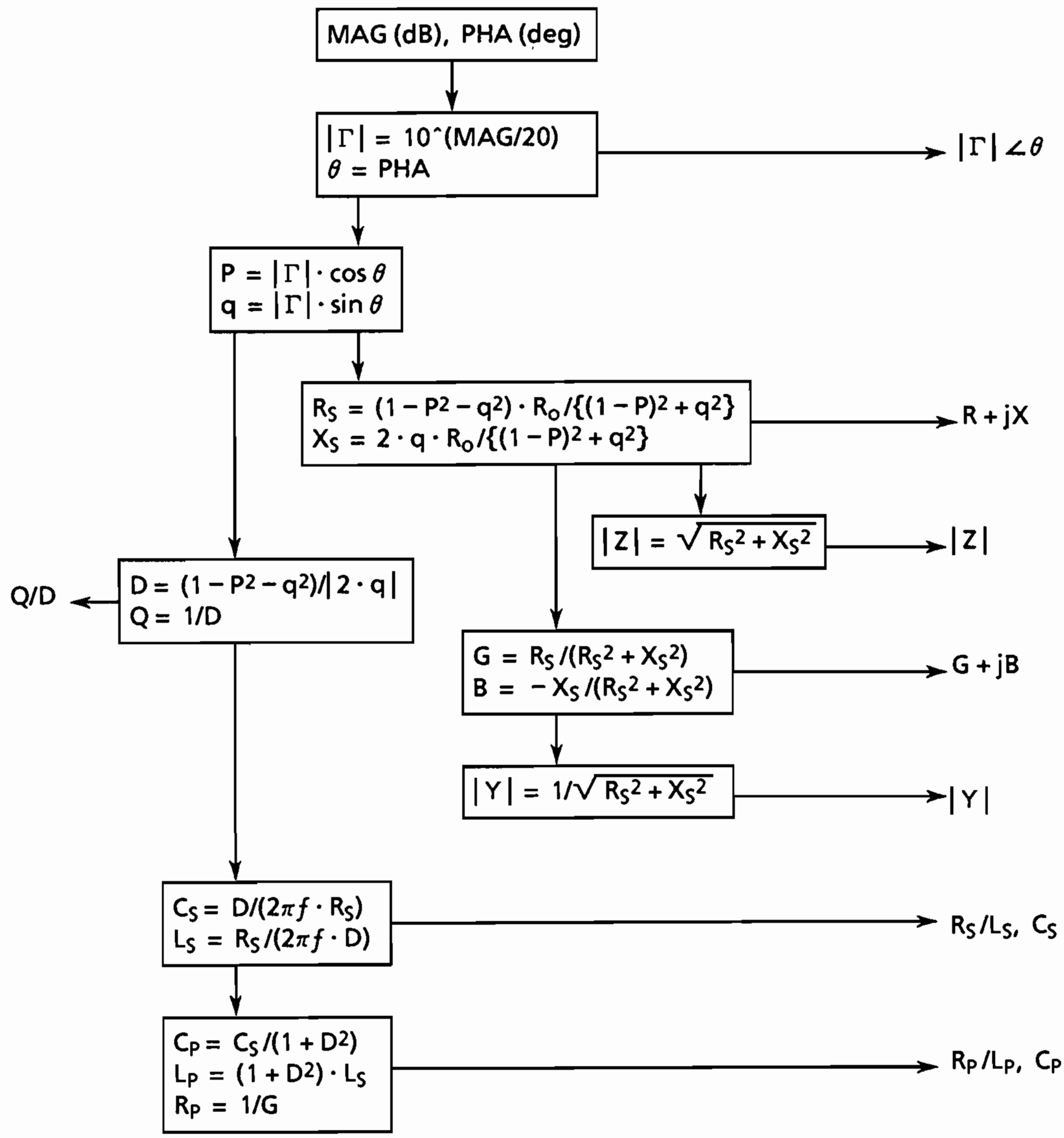
$$D = \frac{1}{Q} \quad \cdots\cdots\cdots\cdots \quad ⑨$$

If the negative resistance components of these values are measured, they are as follows:

- $|\Gamma| > 1$ ● $GX < 0$
- $Q < 0$
- $D < 0$ ● $|Z| \angle \theta'$ の θ' $90° < \theta' < 180°$ or $-90° > \theta' > -180°$
- $R_X < 0$ ● $|Y| \angle \theta''$ の θ'' $90° < \theta'' < 180°$ or $-90° > \theta'' > -180°$

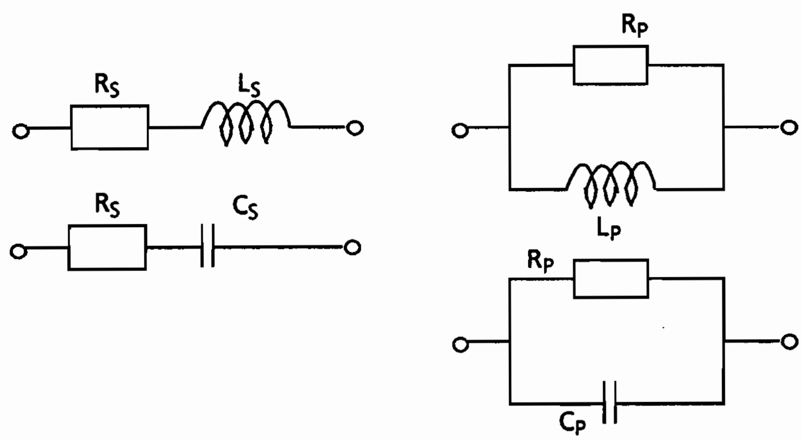
10.1.3 Impedance calculation flowchart

The MS4662A Network Analyzer, when in Smith chart mode, performs the following series of calculations upon the measurement values of the magnitude and phase and displays the calculation results onscreen:



The meanings of the parameters are as follows:

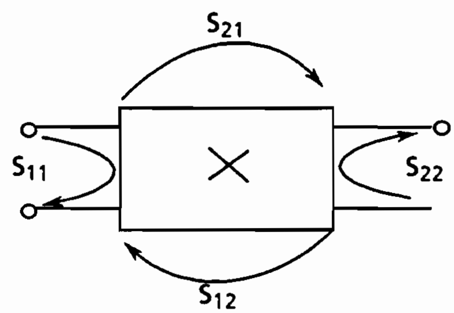
$\lvert\Gamma\rvert$	....	Reflection coefficient absolute value
θ	....	Reflection coefficient phase angle
$\lvert Z\rvert$	....	Impedance absolute value
$\lvert Y\rvert$	....	Admittance absolute value
R	....	Impedance resistance component
X	....	Impedance reactance component
G	....	Admittance conductance component
B	....	Admittance susceptance component
Q	....	Q=X/R.
D	....	tan δ
R_S	....	Serial resistance
L_S	....	Serial inductance
C_S	....	Serial capacitance
R_P	....	Parallel resistance
L_P	....	Parallel inductance
C_P	....	Parallel capacitance



10.2 Principles of S-Parameter Measurement

The S-parameters are commonly used to analyze high-frequency circuits as 4-terminal circuit network evaluation parameters. They consist of the following four individual parameters:

- S_{11}: Forward reflection coefficient
- S_{21}: Forward transmission coefficient
- S_{12}: Backward transmission coefficient
- S_{22}: Backward reflection coefficient



(1) Transmission coefficient (S_{21}, S_{12}) measurement

The transmission coefficient of a sample is calculated from the difference between the signal input with the sample left through at both ends and that with the sample inserted in position. If the input signal observed with the sample left through is e_s and the input signal observed with the sample in position is ex, then the transmission coefficient of the sample is expressed by the equation

where

$$\frac{e_x}{e_s} = |K| e^{j\phi}$$

$|K|$: Magnitude ratio ϕ: Phase difference (rad) e Base of natural logarithm

Further, magnitude A and phase θ are represented by

$$A = 20 \log_{10} |K| \quad (\text{dB})$$

$$\theta = \frac{360}{2\pi} \phi \quad (\text{deg})$$

(2) Reflection coefficient (S_{11}, S_{22}) measurement

The reflection coefficient of a sample is measured with a built-in reflection bridge. If the impedance of the sample is Z_X and the reference impedance is R_0, the reflection coefficient Γ, return loss δ, and phase θ are expressed by the following equations:

$$\Gamma = |\Gamma| e^{j\phi} = \frac{Z_X - R_0}{Z_X + R_0}$$

$$\delta = 20 \log_{10} |\Gamma| \text{ (dB)}$$

$$\theta = \frac{360}{2\pi}\phi \text{ (deg)}$$

Γ is detected at the test port to measure the values of δ and θ.

10.3 Fundamentals of Measurement

Fundamentals concepts of circuit network measurement of prime importance are covered here.

(1) Dynamic range

(a) Dynamic range

Dynamic range is defined as the difference between the maximum input level and the average noise level. The maximum input level is not the absolute maximum rating that protects equipment against damage but the maximum input level that maintains the linearity of the receiver portion of the equipment. It equals the value of the input attenuators at ports 1 and 2. Measurement accuracy benefits from providing a fully wide dynamic range for the device under test and from using the upper part of the dynamic range to the extent possible.

(b) Port output power and input attenuator

To use the upper part of the dynamic range, the port output power is adjusted to the attenuator in normal passive circuit testing applications. In passive circuit testing that requires a dynamic range because of a large insertion loss, the test port power is increased to such extent that it will not cause an overload. In this case, the output level must be reduced to equal the input attenuator during testing system calibration.

With devices under test having a gain, such as amplifiers, the test port power must be reduced to the point lower than the input attenuator by the gain. If the input range of the receiver portion is exceeded, the OVER indicator lights. When OVER lights, lower the test port power or increase the input attenuator.

(c) Resolution bandwidth

The average noise level of the receiver portion is determined by the resolution bandwidth. The resolution bandwidth should be selected to suit the dynamic range.

(2) Sweep time and measuring points

(a) Sweep time

A narrower resolution bandwidth results in a longer sweep time. The sweep time is normally set to an optimal value according to the resolution bandwidth.

(b) Measuring points

A shorter sweep time is useful in certain situations, such as when a device under test is adjusted. To fill this need, the number of measuring points is selectable from among seven choices: 11, 21, 51, 101, 251, 501, and 1,001. Use fewer measuring points to speed up the total sweep time.

10.4 Transmission Characteristics Measurement: S_{21}, S_{12}

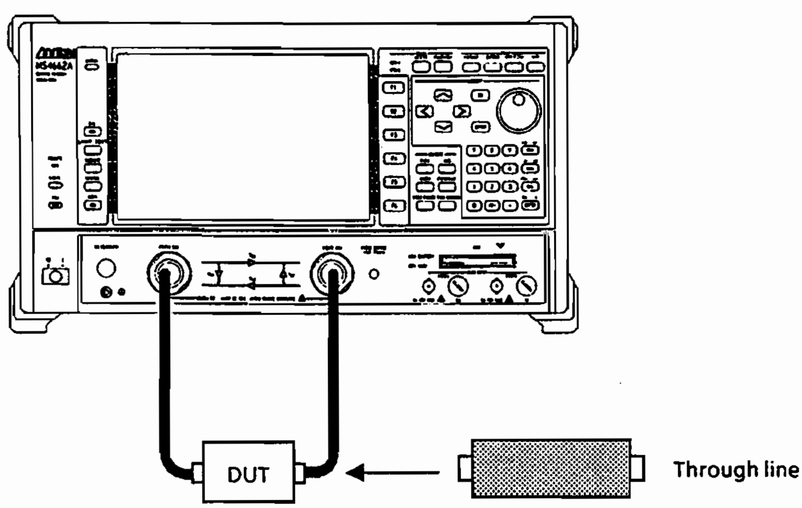
The measurement of transmission characteristics is the most basic part of a circuit network analysis task. This subsection explains how to make the following measurements by using a band-pass filter having a center frequency of 1.5 GHz:

- Logarithmic magnitude measurement: S_{21}, single trace
- Simultaneous magnitude and phase measurement: S_{21}, dual trace
- High-speed group delay measurement
- Level measurement

10.4.1 Logarithmic magnitude measurement: S_{21}, single trace

Measure the logarithmic magnitude in the display format LOG MAG, in which the magnitude ratio on the Y-axis is expressed in dB, in contrast to the frequency on the X-axis. The value of the magnitude ratio displays on both traces A and B. Begin operation by initialization and set parameters as required.

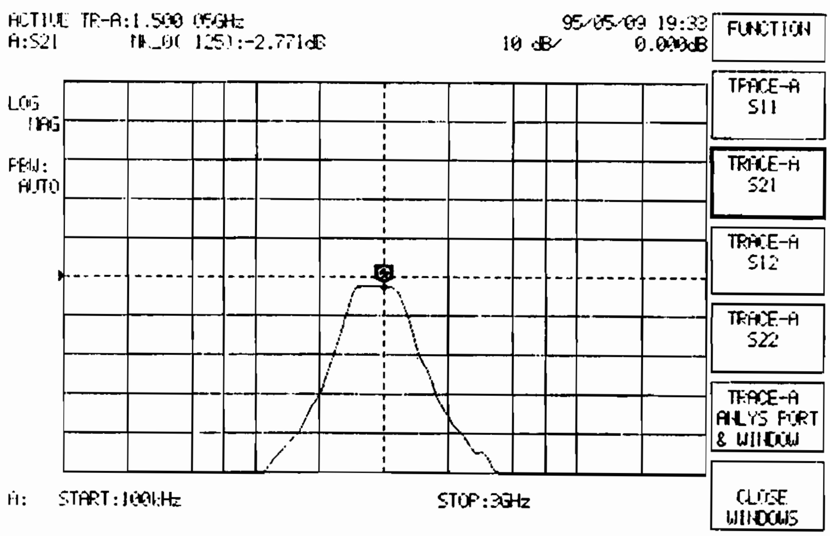
(1) Setup



(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press the [TRACE-A S21] [F2] key.

A LOG MAG display format screen with a FUNCTION menu appears.



Step	Operation

4 Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections:

- PORT 1 INPUT ATT .... +20 dBm
- PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)

In filter measurement, PORT 1 INPUT ATT allows more accurate measurement of the filter attenuation characteristics when it is set to +20 dBm than when it is set to 0 dBm.

5 Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections:

- CENTER .... 1.5 GHz
- SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)

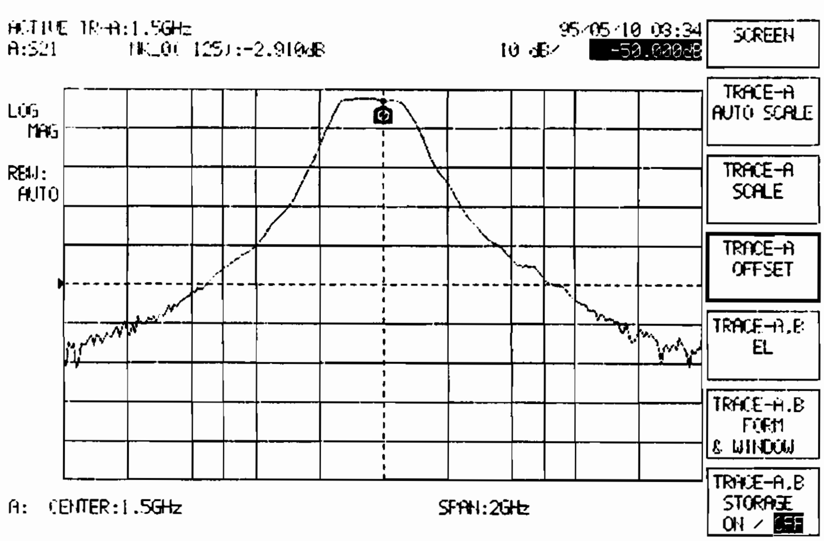
6 Remove the DUT from the testing system and connect through lines in its place.

7 Load CAL data into S memory in the X-S method.

8 Remove the through lines from the testing system and connect the DUT in their place.

9 Execute CAL START to collect the result of X-S.

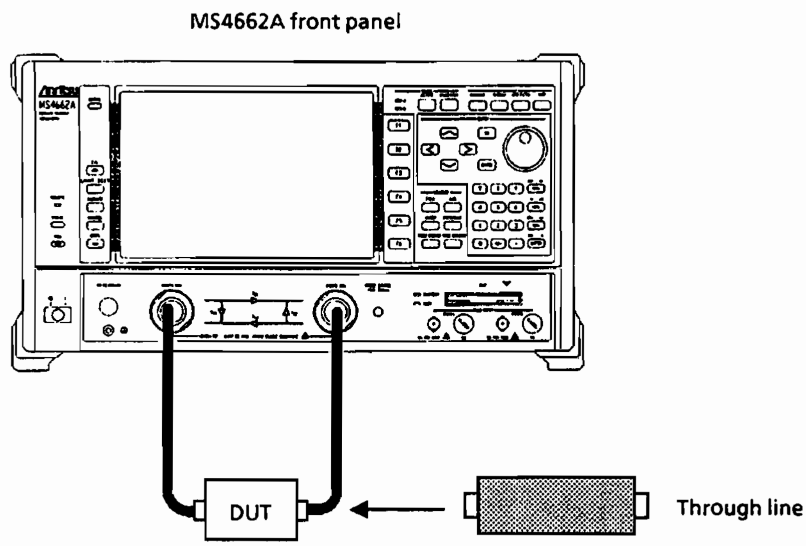
10 Press the DISPLAY section SCREEN key. Through the SCREEN menu, adjust the scale and offset to display the trace waveform at an optimal position onscreen. The active marker points to a measurement value.



10.4.2 Simultaneous magnitude and phase measurement: S_{21}, dual traces

Measure the magnitude on trace A in the display format LOG MAG. Measure the phase on trace B in the display format PHASE. Begin operation by initialization and vary parameters as required.

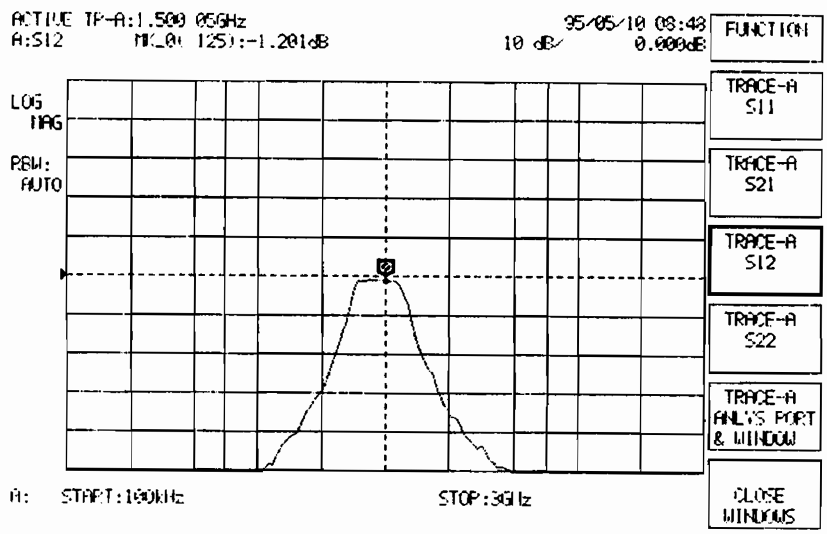
(1) Setup



(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press the [TRACE-A S21] [F2] key.

A LOG MAG display format screen with a FUNCTION menu appears.



4 Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections:

- PORT 1 INPUT ATT .... +20 dBm
- PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)

In filter measurement, PORT 1 INPUT ATT allows more accurate measurement of the filter attenuation characteristics when it is set to +20 dBm than when it is set to 0 dBm.

5 Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections:

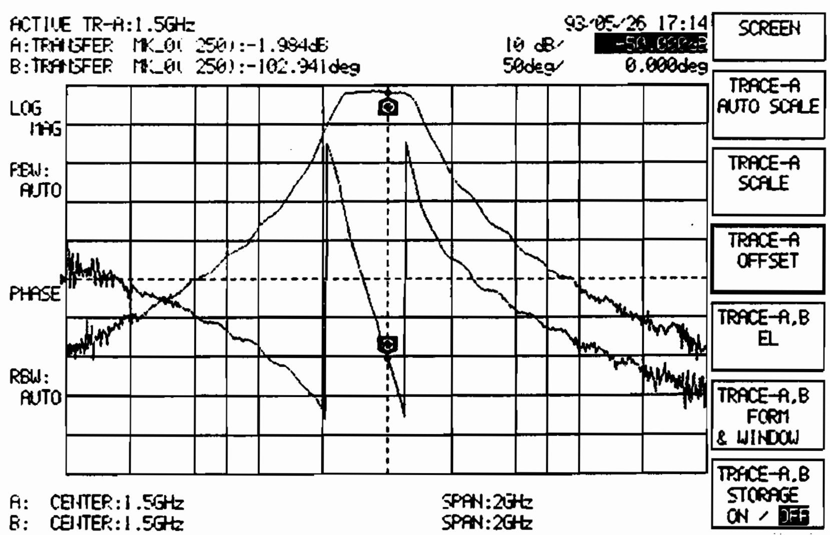
- CENTER .... 1.5 GHz
- SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)

6 Press the DISPLAY section SCREEN key. Select DUAL TRACE: FRONT/BACK from the SCREEN menu.

7 Set trace B active.

8 Set DISPLAY to B.

Step	Operation
9	Remove the through lines from the testing system and connect the DUT in their place.
10	Load CAL data into S memory in the X-S method.
11	Execute CAL START to collect the result of X-S.
12	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale and offset to display the trace waveform at an optimal position onscreen. The active marker points to a measurement value. For phases, the active marker points to a measurement value when the ACTIVE key is pressed to set trace B active.



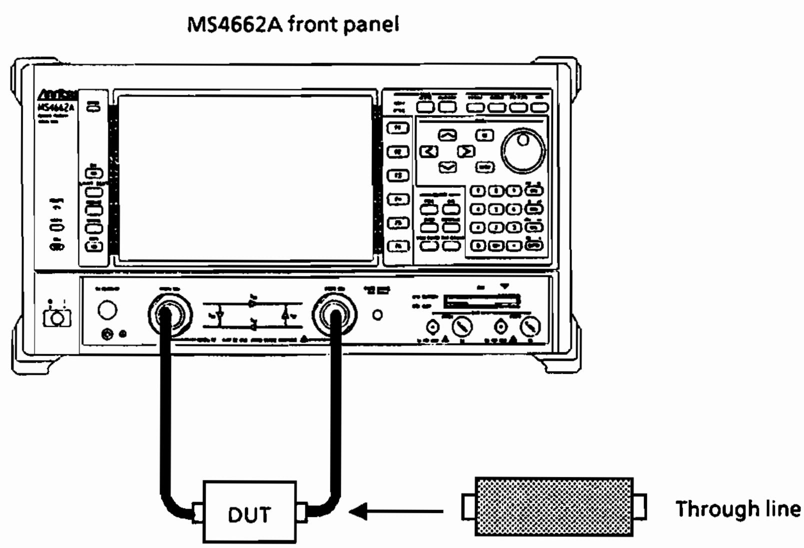
10.4.3 High-speed group delay measurement

High-speed group delay measurement (HSDLY) measures group delay τ by calculating phase changes in aperture frequency Δf with the following equation:

$$\tau = (1/2\pi)(\Delta\theta/\Delta f)$$

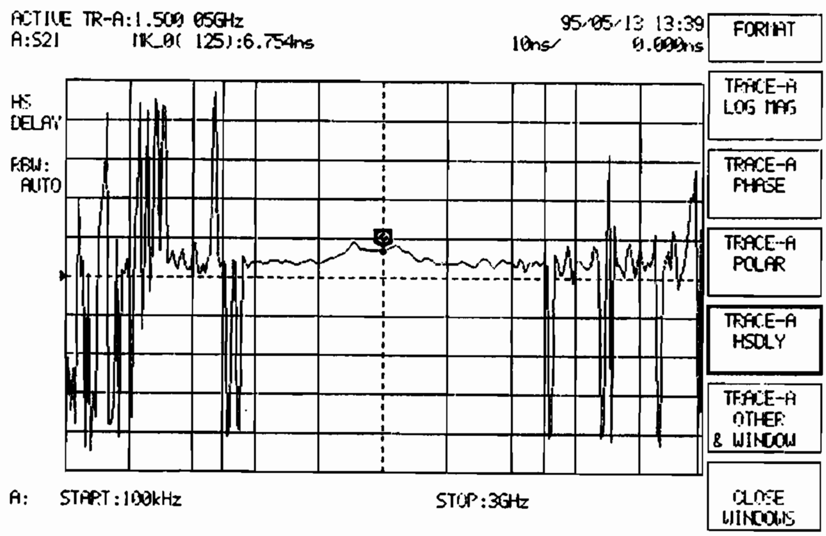
With HSDLY, Δf is called a smoothing aperture, which is set in % between 0.1 and 20 % of the frequency span. To minimize measurement errors, set τ to a minimum value to produce an optimal resolution and a maximum delay.

(1) Setup



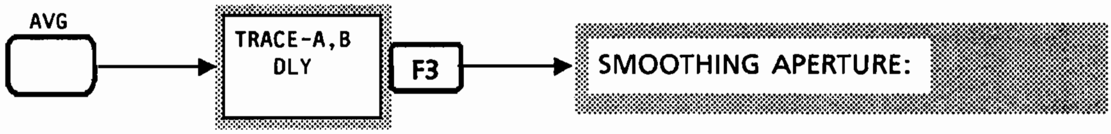
(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press the FUNCTION menu [TRACE-A S21] [F2] key, then the FORMAT key. Select HSDLY to display an HSDLY display format screen.

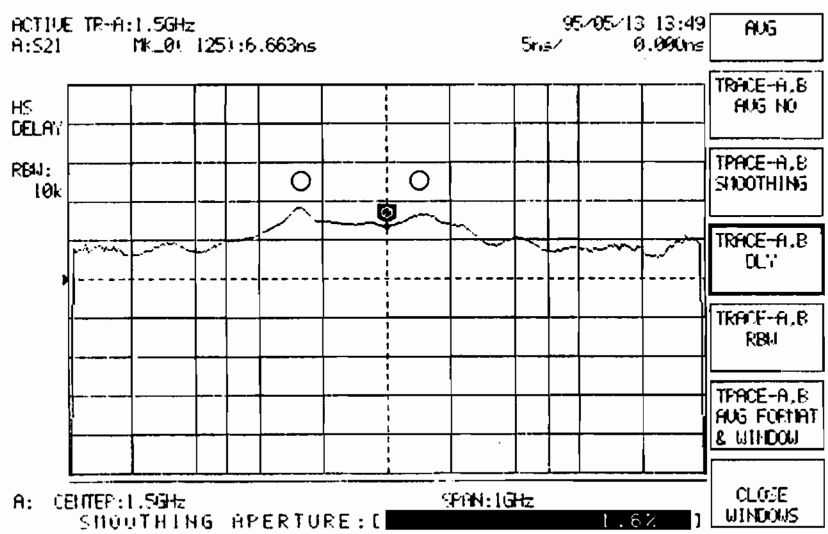


Step	Operation
4	Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections: • PORT 1 INPUT ATT .... +20 dBm • PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights) In filter measurement, PORT 1 INPUT ATT allows more accurate measurement of the filter attenuation characteristics when it is set to +20 dBm than when it is set to 0 dBm.
5	Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections: • CENTER .... 1.5 GHz • SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)
6	Remove the DUT from the testing system and connect through lines in its place.
7	Load CAL data into S memory in the X-S method.
8	Remove the through lines from the testing system and connect the DUT in their place.
9	Execute CAL START to collect the result of X-S.

Step	Operation
10	Press the DISPLAY section SCREEN key. Through the SCREEN menu, adjust the scale and offset to display the trace waveform at an optimal position onscreen.
11	Press the MEASURE section AVG key. Press the AVG menu DLY F3 key, and the SMOOTHING APERTURE direct entry area opens at the lower right corner of the screen.



Step	Operation
12	Turn the ENTRY knob clockwise or counterclockwise to select a smoothing aperture between 0.1 and 20 % of the frequency span. Set this % value as instructed below. To minimize measurement errors, set the smoothing aperture to a minimum value to maximize the peak (marked by ○) and keep it steady.



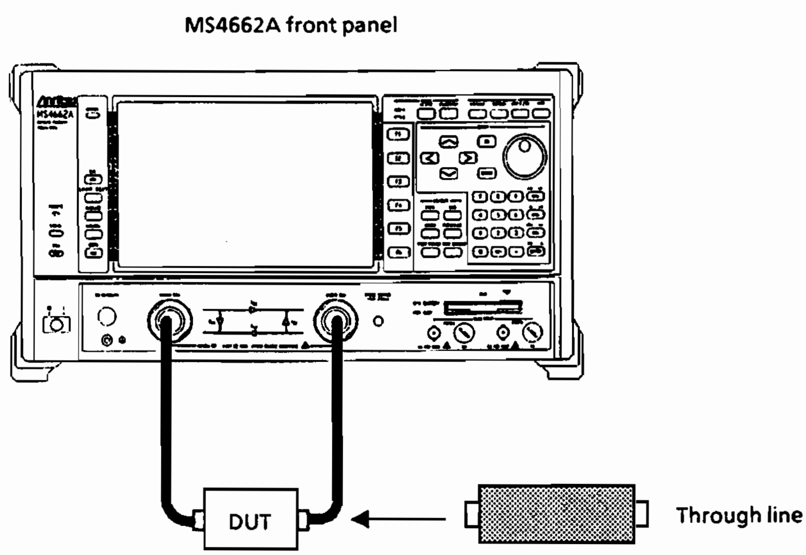
Note: The minimum smoothing aperture and the resolution setting depend on the number of measuring points available.

10.4.4 Level measurement: TA, TB, R

Selecting analysis ports permits level measurement at the measurement points. The measurement points are tested as in the table below according to the S-parameter settings.

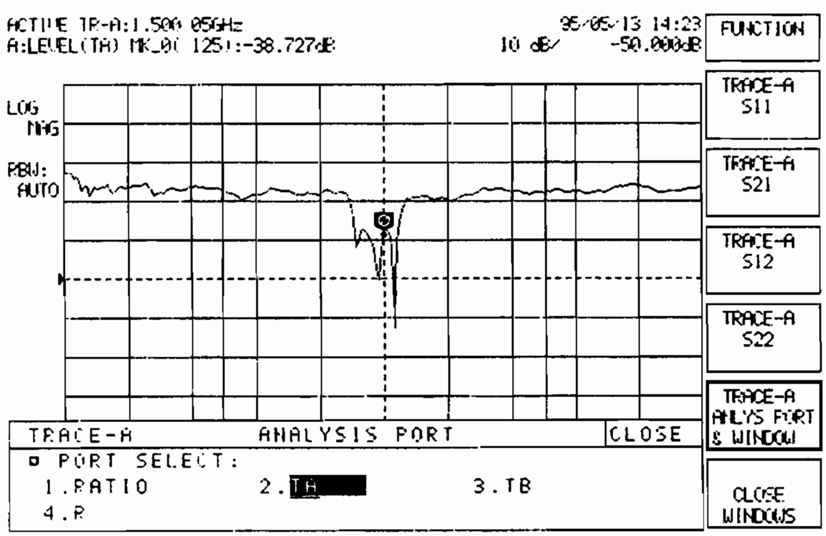
	R	TA	TB
S_{21}, S_{11}	Reference level	Reflection level	Transmission level
S_{12}, S_{22}	Reference level	Transmission level	Reflection level

(1) Setup



(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press FUNCTION menu [ANLYS PORT] [F5] Select measurement ports from the ANALYSIS PORT window.



10.5 Reflection Characteristics Measurement: S_{11}, S_{22}

When an incident energy is applied as input to a device under test, if its input impedance differs from the impedance of the testing system, part of the input energy would be reflected. The ratio of the reflected energy to the incident energy is called a reflection coefficient. This is the basic of reflection measurement. For example, the return loss can be measured from a logarithm of the absolute value of the reflection coefficient. If the reflection coefficient is known, the VSWR can be measured by calculating (1+absolute value of the reflection coefficient)/(1−absolute value of the reflection coefficient). In addition to the X−S method, the single-port OSL method applies to reflection measurement calibration. This subsection explains how to make the following measurements by using a band-pass filter having a center frequency of 1.5 GHz:

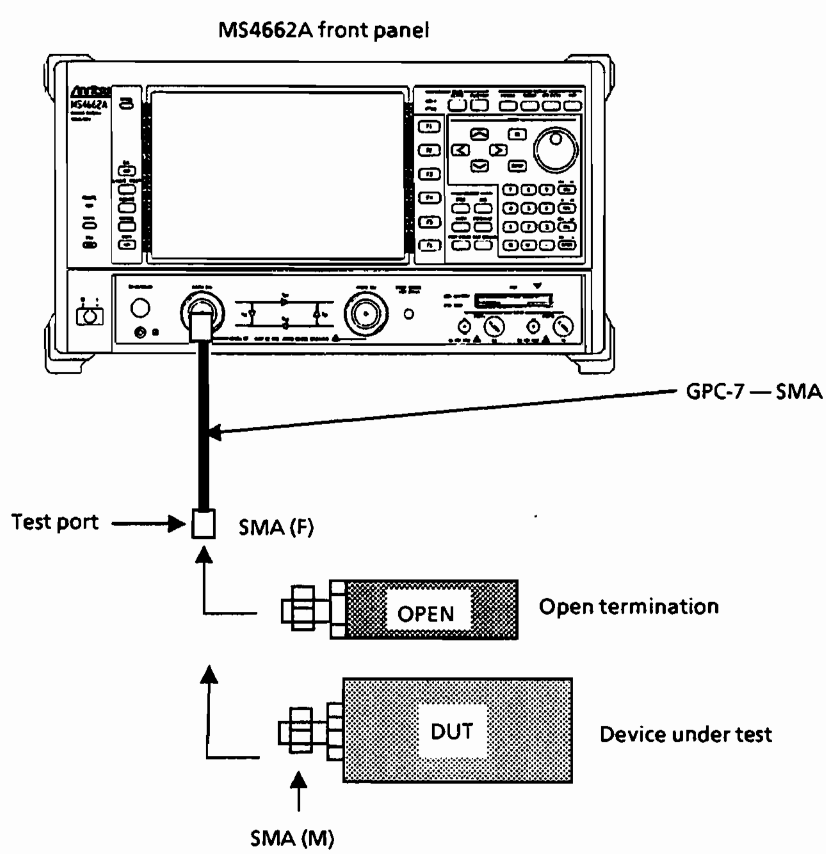
- Return loss measurement
- Reflection coefficient measurement
- Impedance measurement

10.5.1 Return loss measurement

Measure the return loss in the display format LOG MAG. In LOG MAG, the reflected versus incident energies are measured in dB, thereby allowing direct reading of the return loss.

Begin operation by initialization and vary parameters as required.

(1) Setup



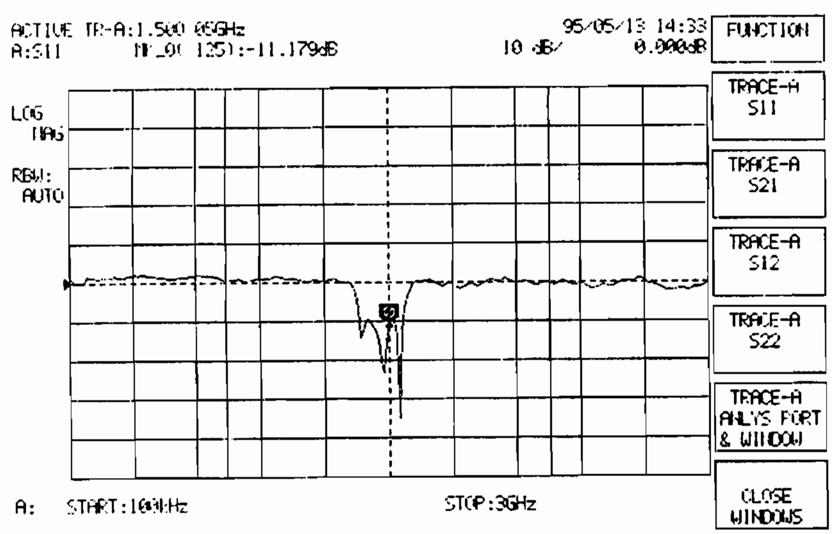
(2) Measurement procedure

Step **Operation**

1 Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.

2 Press the INITIAL key.

3 A LOG MAG display format screen with a FUNCTION menu appears.



4 Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections:

- PORT 1 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)
- PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)

5 Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections:

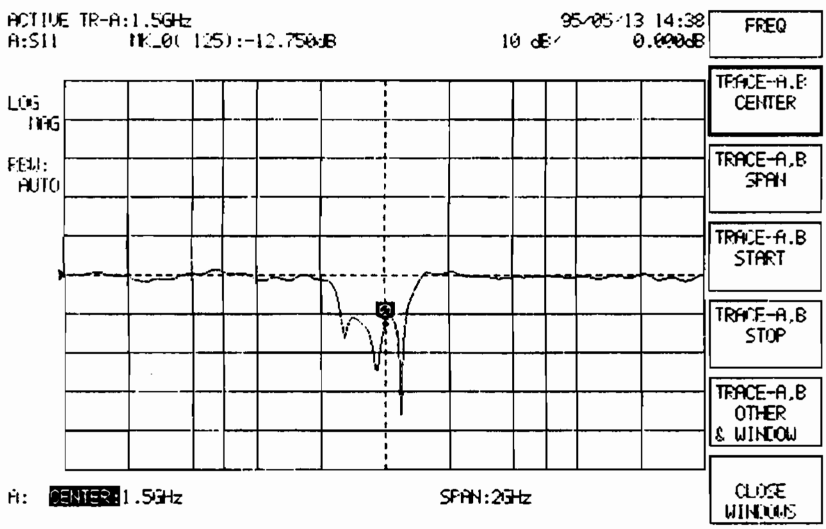
- CENTER .... 1.5 GHz
- SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)

6 Remove the DUT from the testing system and connect an open termination in its place.

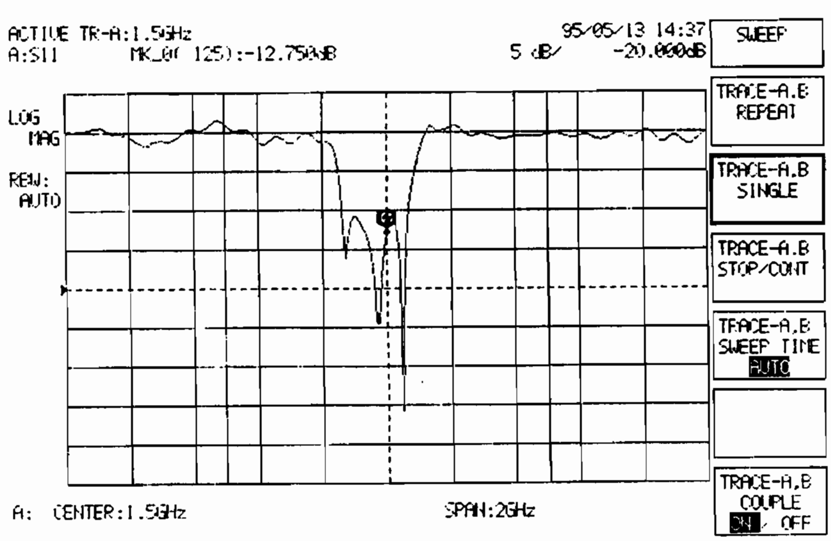
7 Load CAL data into S memory in the X-S method.

8 Remove the open termination from the testing system and connect the DUT in its place

Step	Operation
9	Execute CAL START to collect the result of X – S.



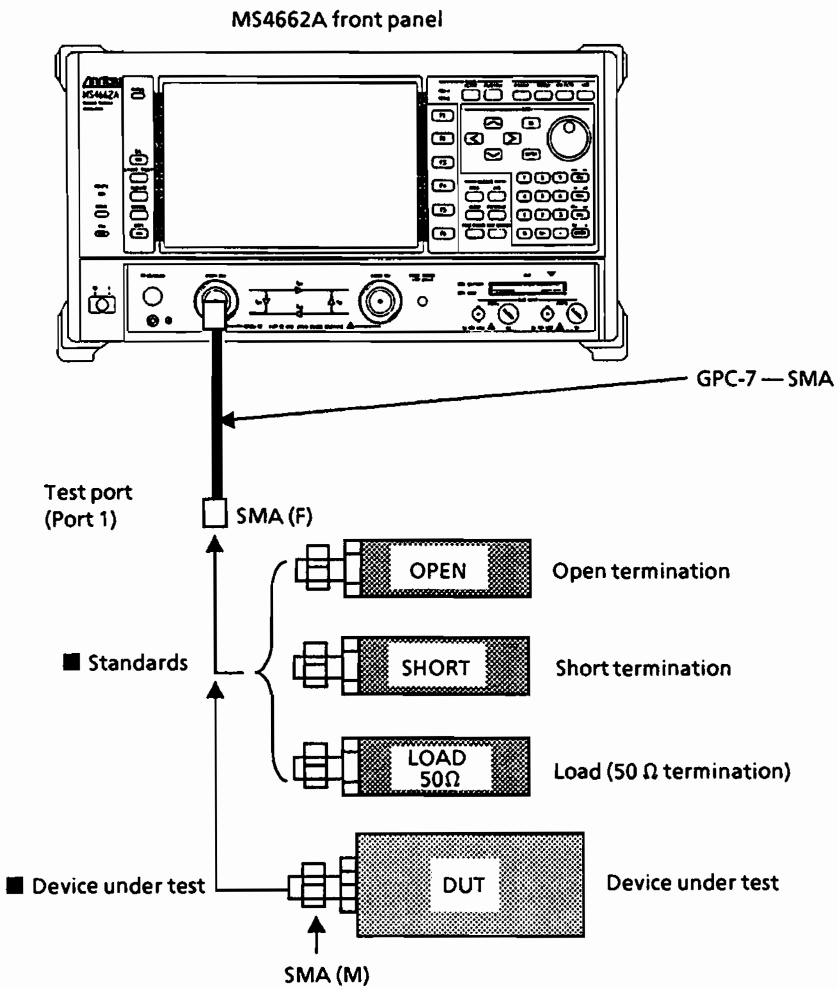
Step	Operation
10	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale and offset to display the trace waveform at an optimal position onscreen. The active marker points to a measurement value.



10.5.2 Reflection coefficient measurement

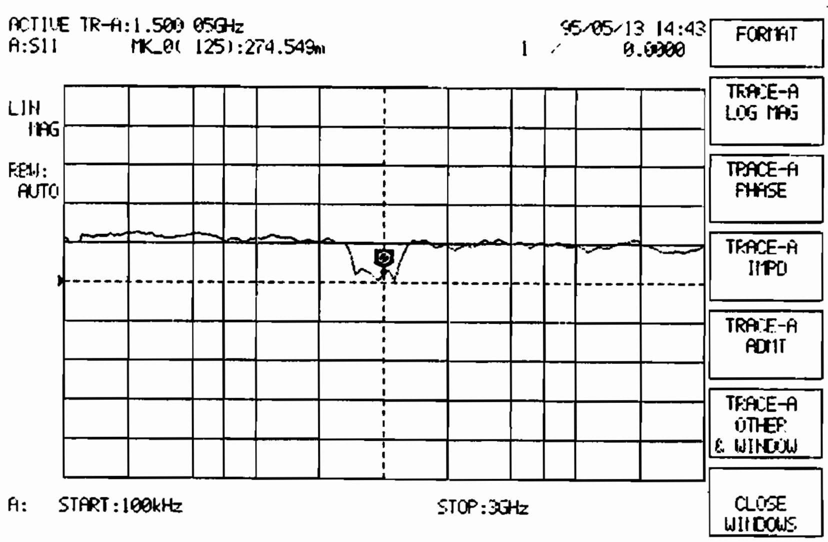
Measure the reflection coefficient in the display format LOG MAG and in a polar coordinate graph. In LIN MAG, the reflected versus incident energies are measured in linear form, thereby allowing direct reading of the absolute value of the reflection coefficient. Polar coordinate graphs permit concurrent measurement of the complex reflection coefficient $\Gamma=\rho<\theta$ (ρ: reflection coefficient absolute value, θ: phase angle). Because there is no frequency axis in a polar coordinate system, frequencies are read by means of a marker. Begin operation by initialization and set parameters as required. Calibration is accomplished in the measurement procedures explained here by using 1 port OSL method as an example.

(1) Setup



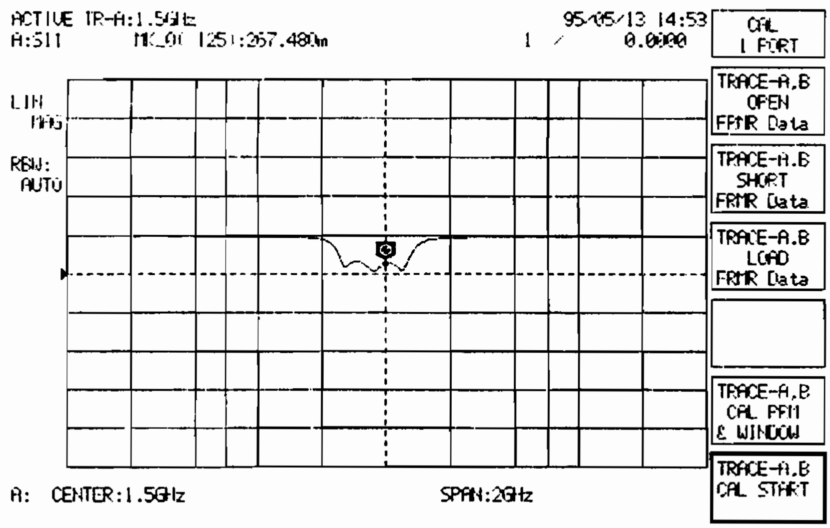
(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	A LOG MAG display format screen with a FUNCTION menu appears. Select OTHER & WINDOW from the FORMAT menu, which is opened by pressing the FORMAT key. Select LIN MAG as COORDINATE from the OTHER window.

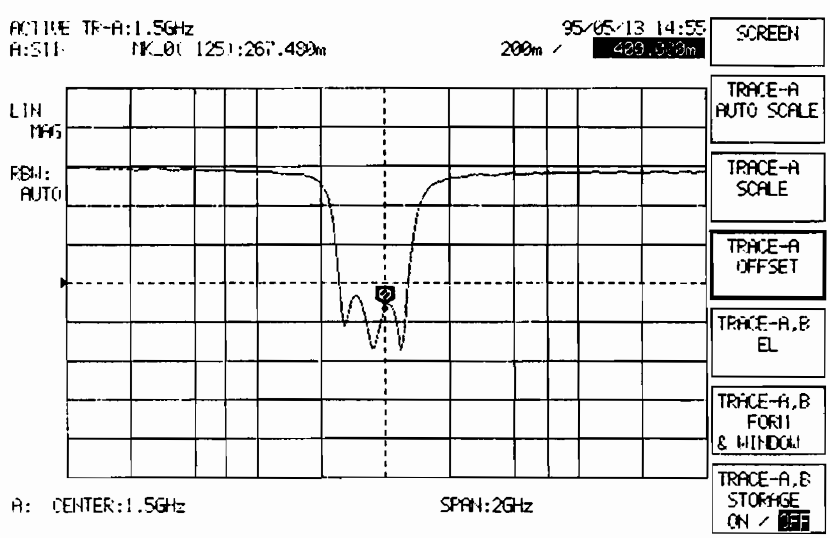


Step	Operation
4	Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections: • PORT 1 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights) • PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)
5	Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections: • CENTER .... 1.5 GHz • SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)
6	Remove the DUT from the test port and press the CAL key to select 1 PORT OSL.
7	Preparatory to running 1 PORT OSL, select the type of connector connected to the test port.
8	Load the reference CAL data with the open termination, short termination, and 50 Ω load connected to the test port into CAL memory.
9	Remove the standards from the test port and connect the DUT in their place.

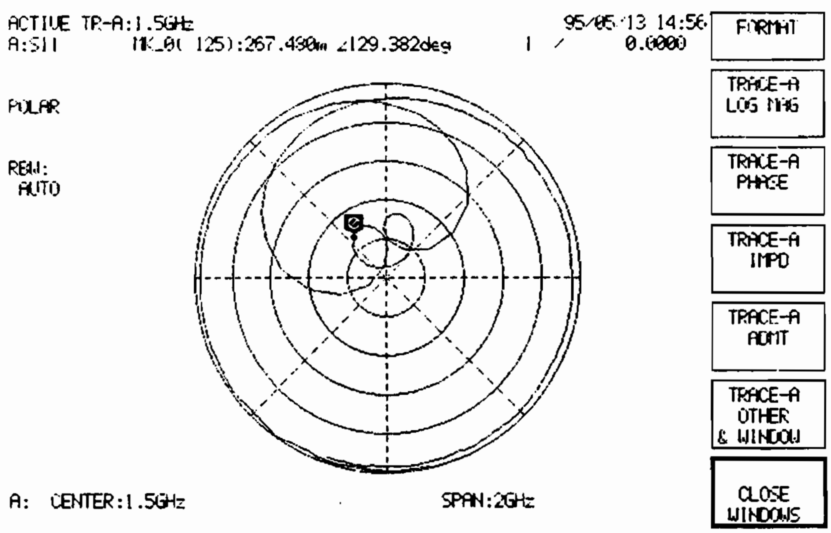
Step	Operation
10	Execute CAL START to correct vector errors.



11	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale to display the trace waveform at an optimal position onscreen. The active marker points to a measurement value.



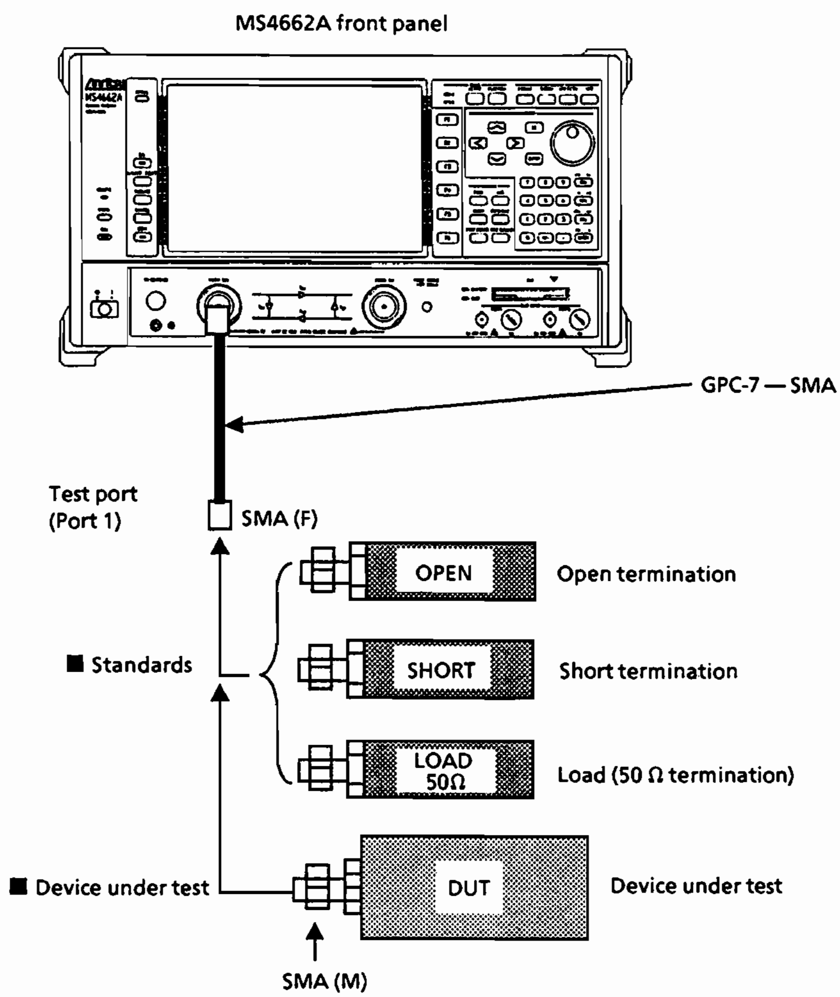
Step	Operation
12	Press the FORMAT key. Select OTHER & WINDOW from the FORMAT menu. Select POLAR as COORDINATE from the OTHER window. The active marker points to measurement values (ρ: reflection coefficient absolute value, θ: phase angle).



10.5.3 Impedance measurement

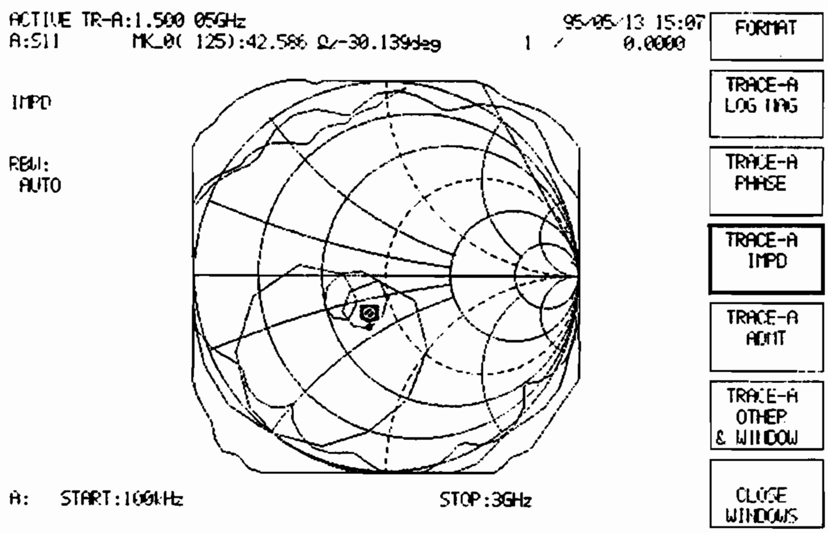
Measure the device impedance, which comprises a resistance and a reactance, in the display format IMPD (Smith chart). Select 1. |Z|/θ, 2. Rs/Ls, Cs, or 3. Q/D from the IMPD MARKER VALUE menu in the FORMAT menu (OTHER window), which is opened by pressing the FORMAT key, to display a measurement result at the active marker point. Begin operation by initialization and set parameters as required. Calibration is accomplished in the measurement procedures explained here by using 1 port OSL method as an example.

(1) Setup



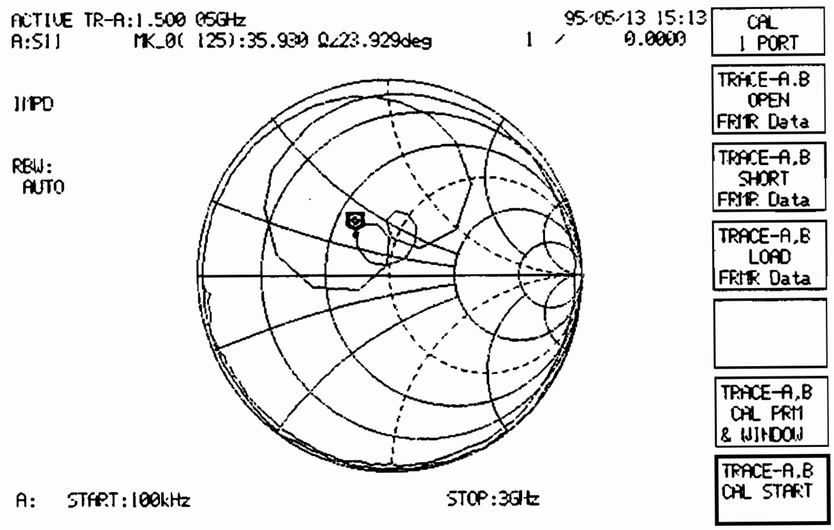
(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	A LOG MAG display format screen with a FUNCTION menu appears. Select IMPD from the FORMAT menu, which is opened by pressing the FORMAT key, to display a Smith chart.



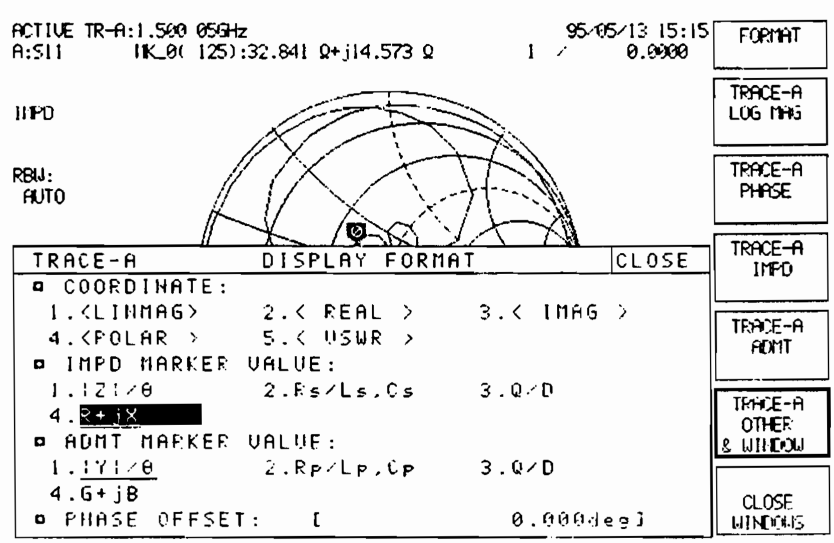
Step	Operation
4	Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections: • PORT 1 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights) • PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)
5	Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections: • CENTER .... 1.5 GHz • SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)
6	Remove the DUT from the test port and press the CAL key to select 1 PORT OSL.
7	Preparatory to running 1 PORT OSL, select the type of onnector connected to the test port.
8	Load the reference CAL data with the open termination, short termination, and 50 Ω load connected to the test port into CAL memory.
9	Remove the standards from the test port and connect the DUT in their place.

Step	Operation
10	Execute CAL START to correct vector errors.



Step	Operation
11	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale to display the trace waveform at an optimal position onscreen.
12	Press the FORMAT key. Select OTHER & WINDOW from the FORMAT menu. Select 1. |Z|/θ, 2. Rs/Ls, C2, or 3. Q/D from the IMPD MARKER VALUE menu in the OTHER window, to calculate the following characteristics and display the values in digital form:

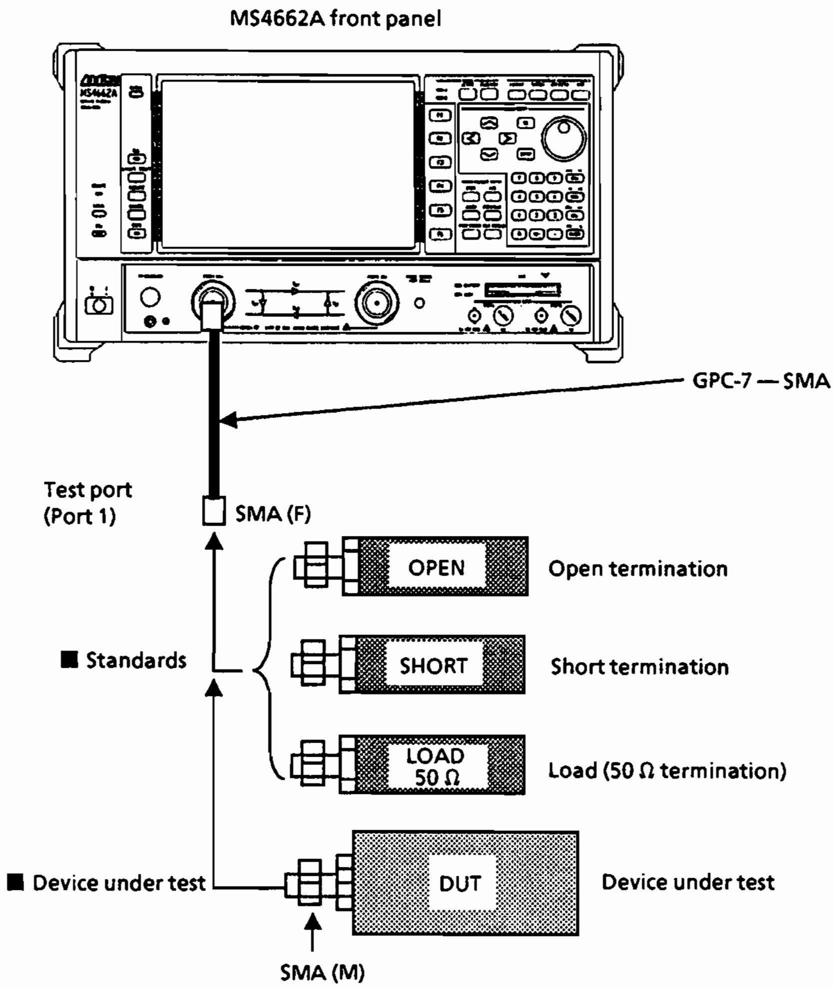
1. |Z|/θ .... Impedance absolute value/phase angle
2. Rs/Ls, Cs ... Serial resistance/serial inductance or serial capacitance
3. Q/D .... Q=X/R, tanδ
4. R+jX ...... Impedance resistance and reactance



10.5.4 VSWR measurement

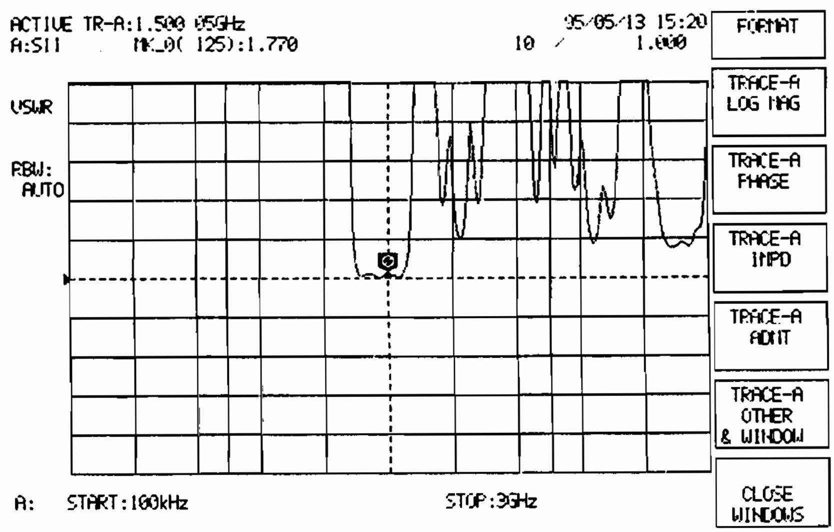
Measure the VSWR in the display format VSWR. Begin operation by initialization and set parameters as required. Calibration is accomplished in the measurement procedures explained here byusing the 1 port OSL method as an example.

(1) Setup



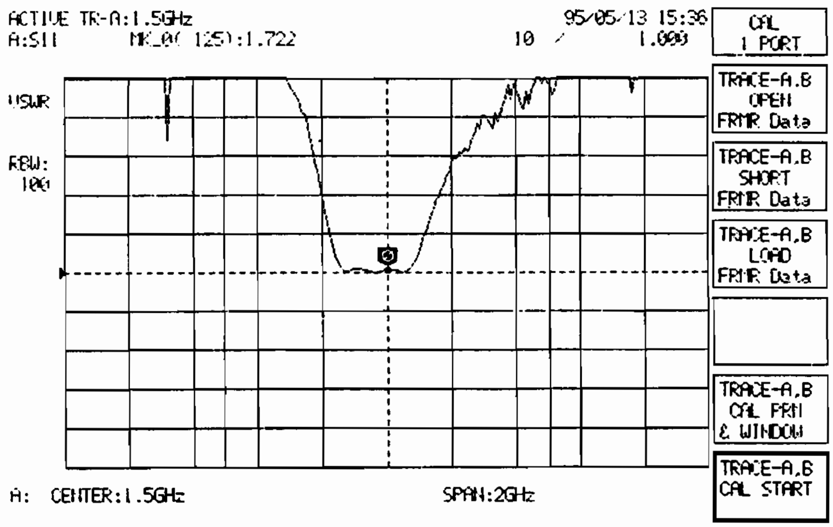
(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	A LOG MAG display format screen with a FUNCTION menu appears. Select OTHER & WINDOW from the FORMAT menu, which is opened by pressing the FORMAT key. Select VSWR as COORDINATE from the OTHER window.

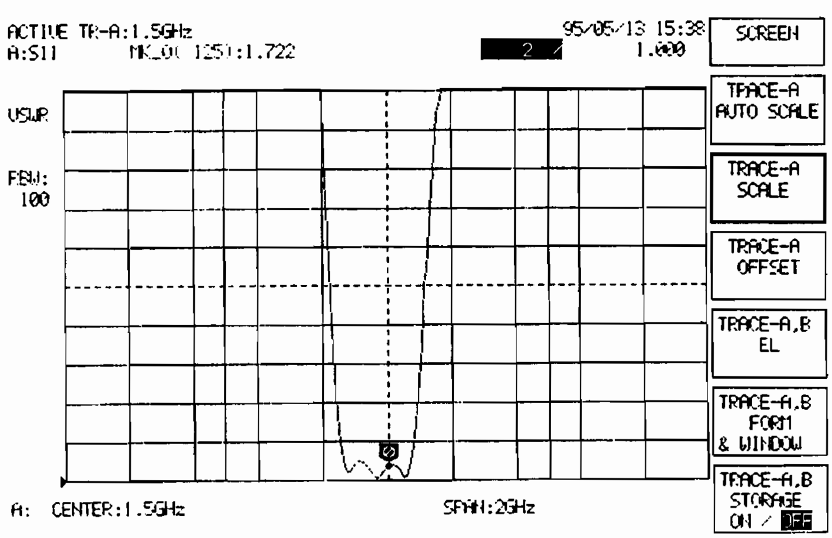


Step	Operation
4	Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections: • PORT 1 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights) • PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)
5	Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections: • CENTER .... 1.5 GHz • SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)
6	Remove the DUT from the test port and press the CAL key to select 1 PORT OSL.
7	Preparatory to running 1 PORT OSL, select the type of connector connected to the reflection bridge.
8	Load the reference CAL data with the open termination, short termination, and 50 Ω load connected to the reflection bridge into CAL memory.
9	Remove the standards from the test port and connect the DUT in their place.

Step	Operation
10	Execute CAL START to correct vector errors.



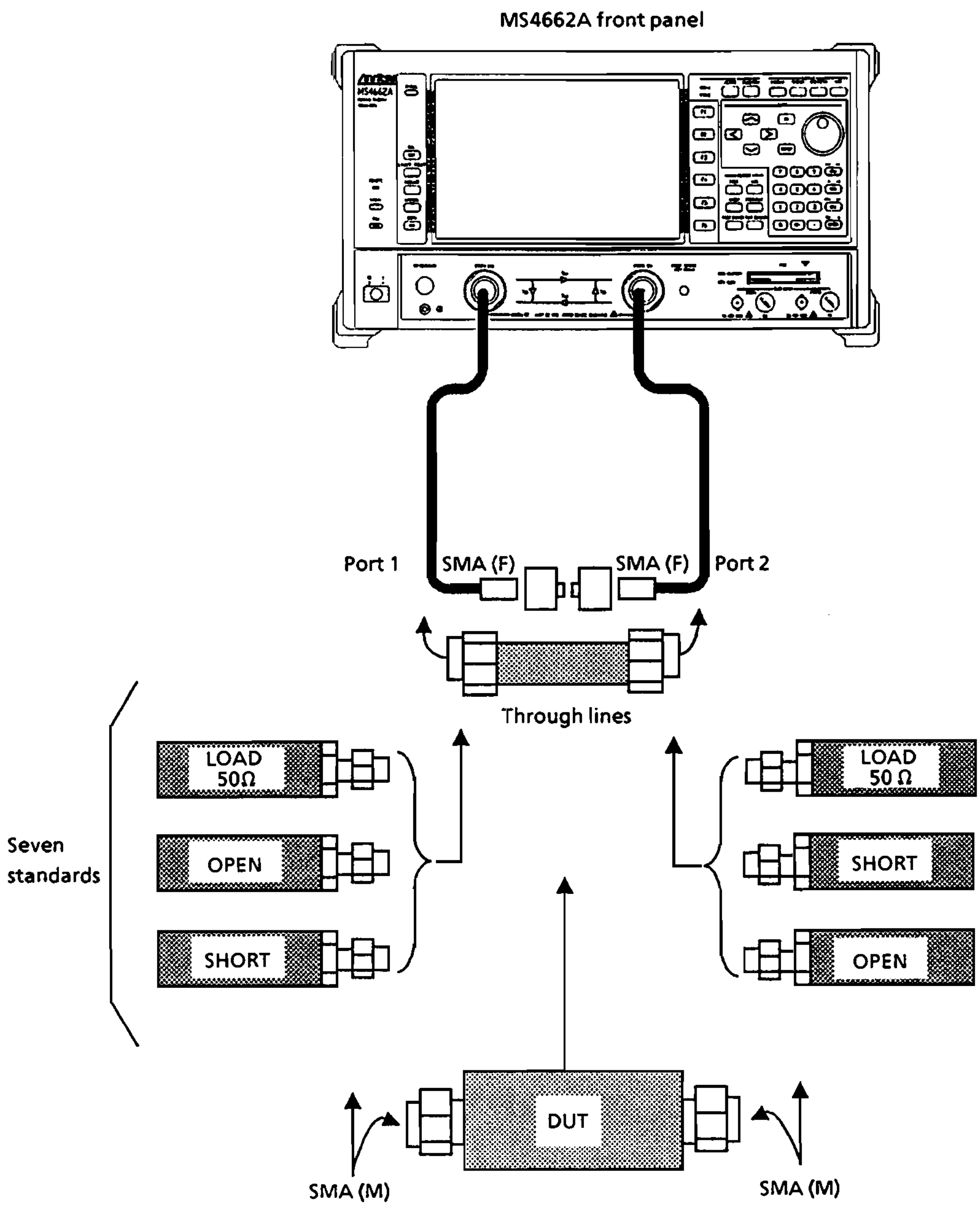
Step	Operation
11	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale to display the trace waveform at an optimal position onscreen. The active marker points to a measurement value.



10.6 S-Parameter Measurement

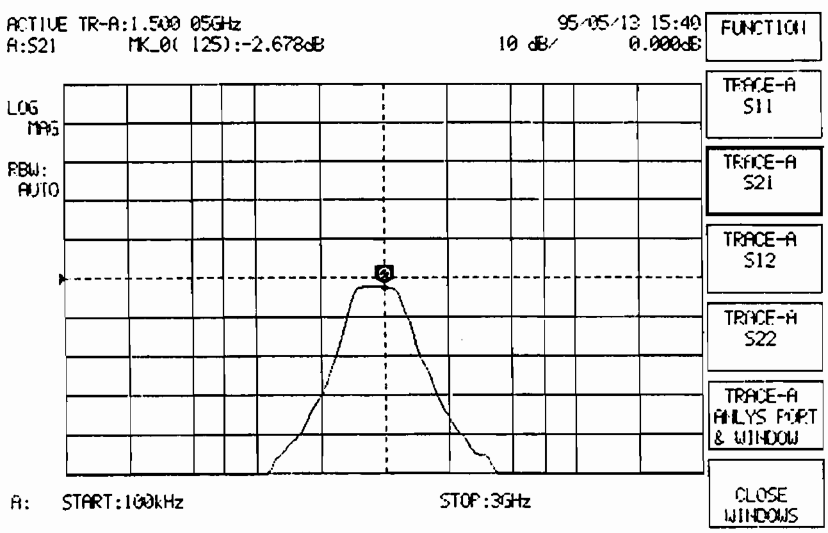
In the example measurement here, the forward transmission coefficient S_{21} and reflection coefficient S_{11} are separated into traces A and B for simultaneous measurement. The backward transmission coefficient S_{12} and reflection coefficient S_{22} are measured at the same time. Begin operation by initialization and set parameters as required. Full 12-term vector error correction allows the four different parameters of S_{11}, S_{21}, S_{22}, and S_{12} to be calibrated in a group at once.

(1) Setup

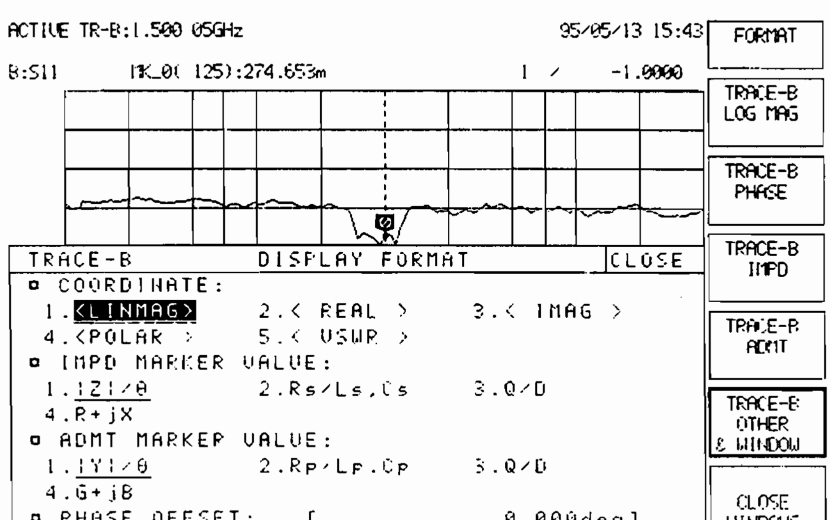


(2) Measurement procedure

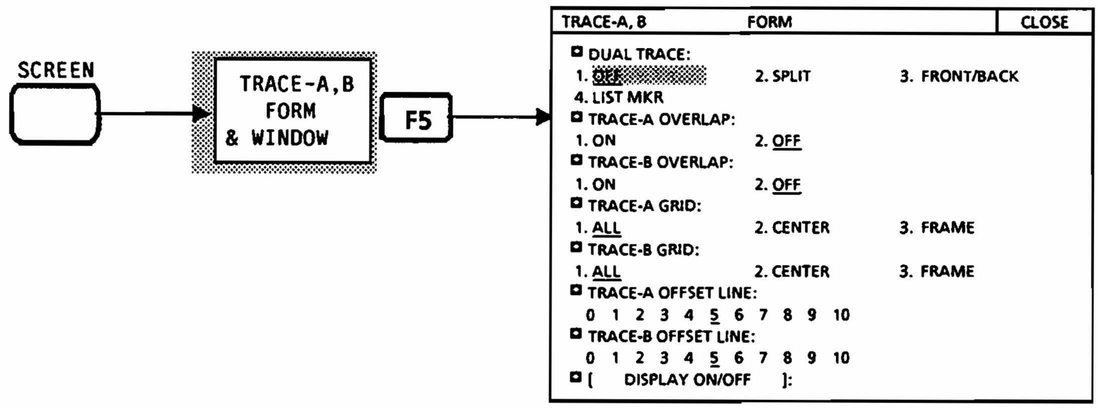
Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	The FUNCTION menu displays parameters for selecting S_{11}, S_{21}, S_{22}, and S_{12}. Select the forward transmission coefficient S_{21}.

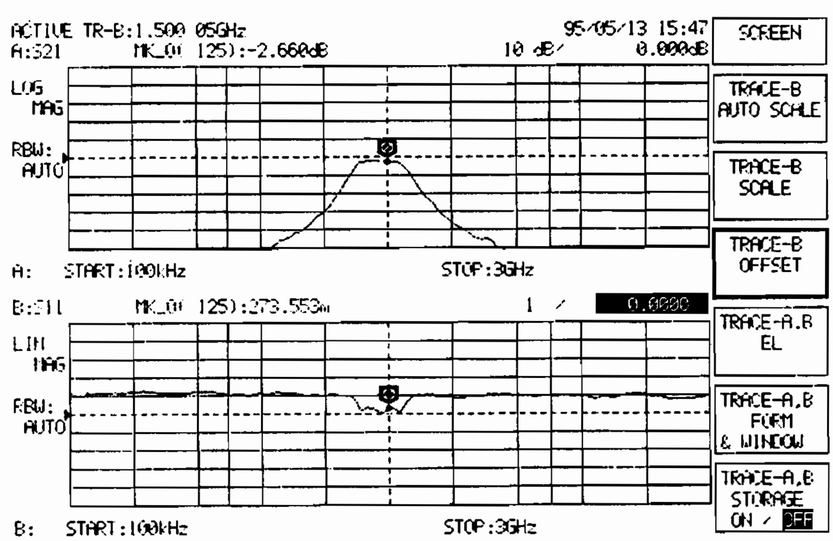


Step	Operation
4	Press the ACTIVE key to set trace B active.
5	Press the FUNCTION key. Select the forward reflection coefficient S_{11} from the S_{11}, S_{21}, S_{12}, and S_{22} S-parameter selection menu.
6	Press the FORMAT key to open OTHER & WINDOW, from which select the display format LIN MAG. A LIN MAG screen appears.



Step	Operation
7	Select SPLIT from DUAL TRACE in the key-in sequence below. Dual traces of TRACE-A (S_{21}) LOG MAG and TRACE-B (S_{11}) LIN MAG appear simultaneously.





8 Press the MEASURE section PORT POWER key. Set the following parameters through PORT POWER softkey menu selections:

- PORT 1 INPUT ATT .... +20 dBm
- PORT 2 INPUT ATT .... 0 dBm (or +20 dBm if the OVER indicator lights)

In filter measurement, PORT 1 INPUT ATT allows more accurate measurement of the filter attenuation characteristics when it is set to +20 dBm than when it is set to 0 dBm.

9 Press the MEASURE section FREQ key. Set the following parameters through FREQ softkey menu selections:

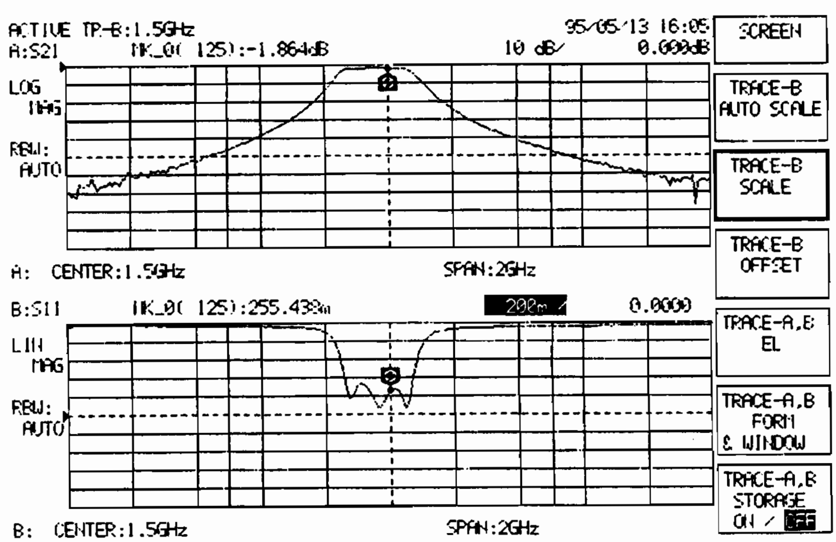
- CENTER .... 1.5 GHz
- SPAN .... About 2 GHz (as appropriate to make waveforms easier to view)

10 Remove the DUT from the testing system and press the CAL key to select 2 PORT OSL.

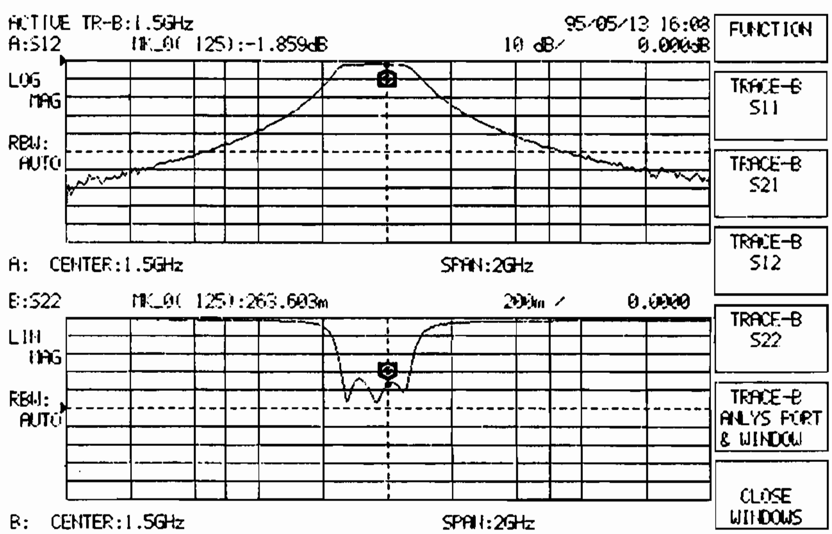
Step	Operation
11	Preparatory to running 2 PORT OSL, set the offset length of the through lines and select the type of connectors connected to ports 1 and 2.
12	Load into CAL memory the reference CAL data with the through lines connected between ports 1 and 2, with the termination connected to ports 1 and 2, with the open termination connected to port 1 and short termination connected to port 2, and with the open termination connected to port 2 and the short termination connected to port 1.
13	Remove the standards from the test port and connect the DUT in their place.
14	Execute CAL START to correct vector errors.

S_{21} and S_{11} measurement

15 Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale and offset to display the trace waveform at an optimal position onscreen. The active markers on traces A and B point to the forward transmission coefficient S_{21} and forward reflection coefficient S_{11}.



Step	Operation
	S_{12} and S_{22} measurement
16	Press the ACTIVE key to set trace A active.
17	Press the FUNCTION key. The parameter to select S_{11}, S_{21}, $S_1$2, and S_{22} appears.
18	Press the ACTIVE key to set trace B active.
19	Press the FUNCTION key. Select the backward reflection coefficient S_{22} from the S_{11}, S_{21}, S_{12}, and S_{22} S-parameter selection menu.
20	Press the FORMAT key to open OTHER & WINDOW, from which select the display format LIN MAG. A LIN MAG screen appears. The active markers on traces A and B point to the backward transmission coefficient S_{12} and backward reflection coefficient S_{22}.



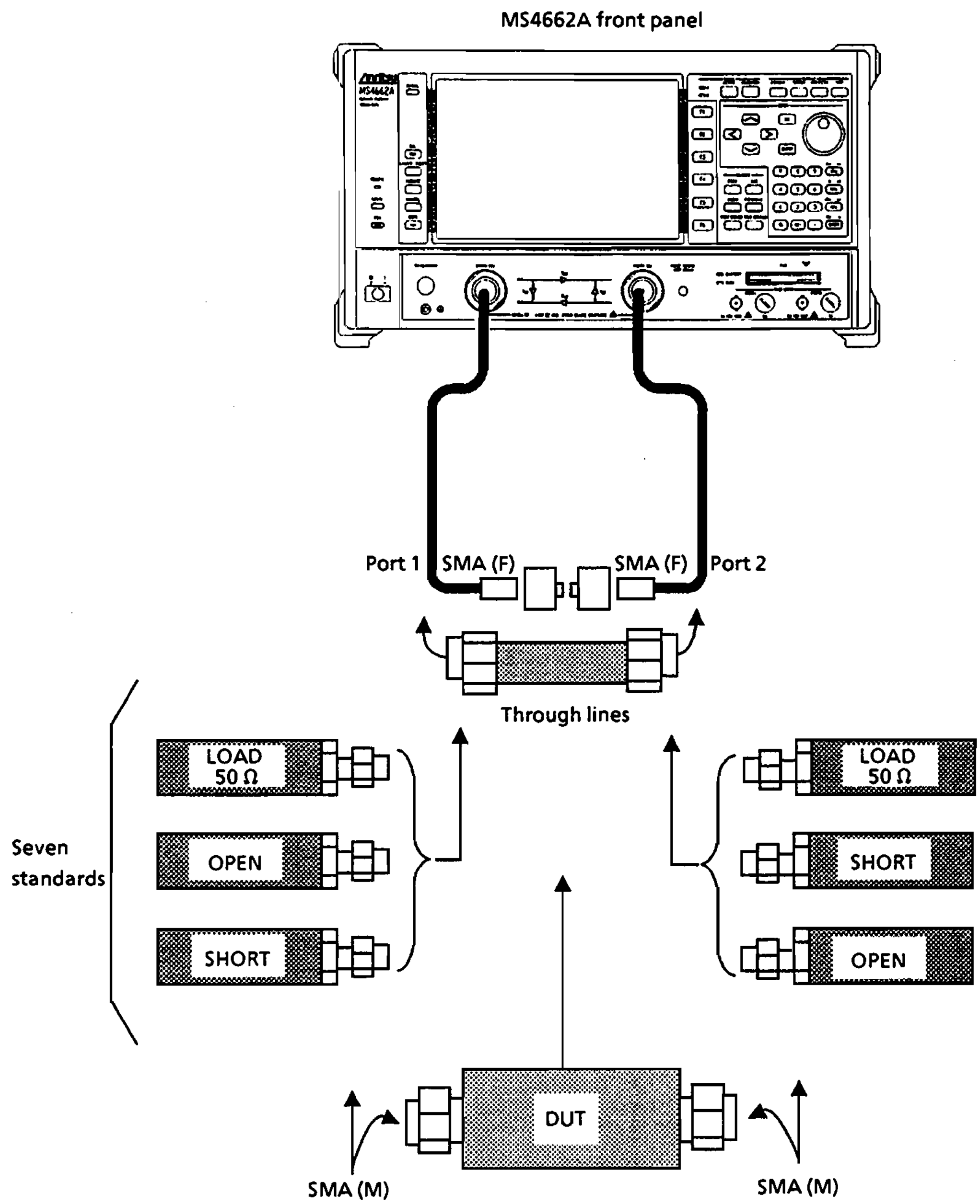
10.7 Time-Domain Measurement

In the time-domain measurement mode, the MS4662A displays frequency-domain waveforms on trace B. The impulse or step responses calculated in the time domain on the basis of analyses of the frequency domain are displayed on trace A. If there are 501 measuring points and the relation "start frequency = stop frequency/501" holds, frequency-domain measurement is free from interpolation errors. Hence, measurement at 501 measuring points is recommended for frequency-domain waveform measurement. This subsection focuses on the time-domain analyses of forward transmission coefficient S_{21} and cable fault location measurement.

10.7.1 S-parameter time-domain analysis (S_{21})

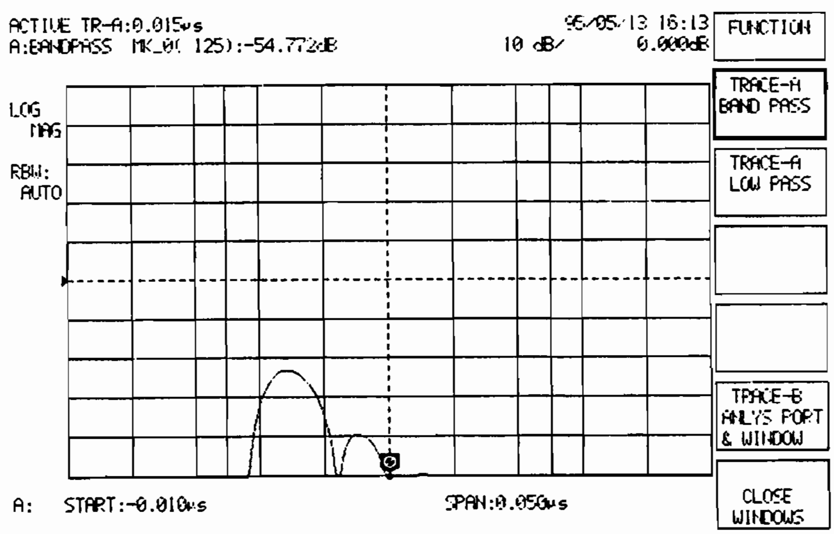
The time-domain of S_{21} is measured on trace A. The measurement mode of the time domain is band pass mode. In band pass mode, the time-domain waveform is displayed in impulse response.

(1) Setup

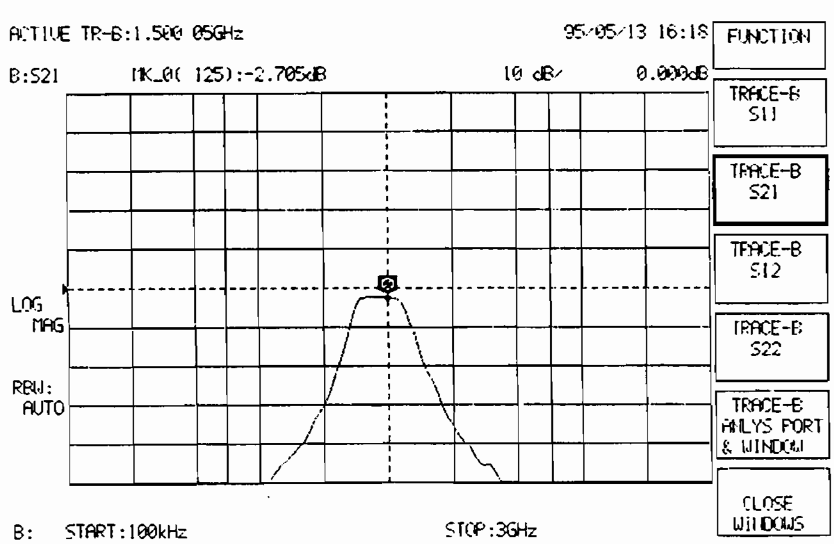

MS4662A front panel
Port 1
SMA (F)
SMA (F)
Port 2
Through lines
LOAD
50 Ω
OPEN
SHORT
Seven
standards
LOAD
50 Ω
SHORT
OPEN
DUT
SMA (M)
SMA (M)

(2) Measurement procedure

Step	Operation
1	Set up a testing system with a device under test (DUT) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press the MEASURE section FREQ/TIME key.
4	Select BAND PASS from the FUNCTION menu.

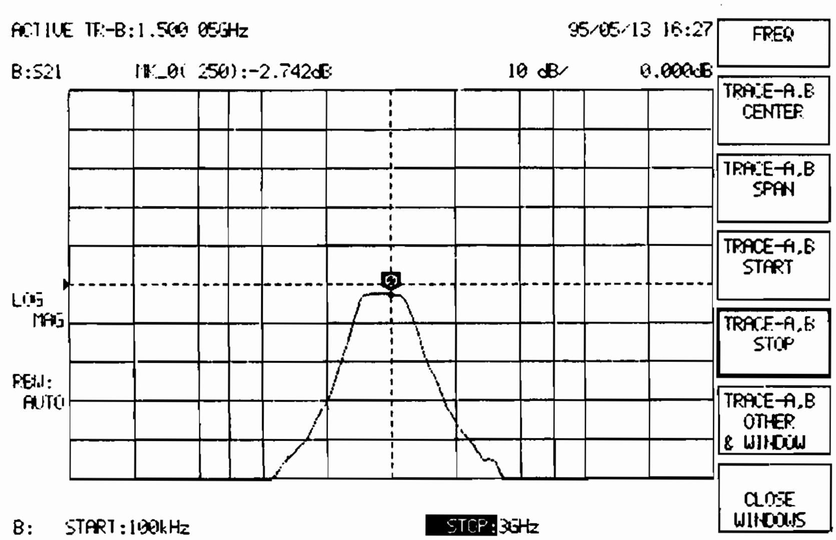


Step	Operation
5	Press the ACTIVE key to set trace B active. Select the forward transmission coefficient S_{21} from the S_{11}, S_{21}, S_{12}, and S_{22} S-parameter selection menu that displays in a LOG MAG display format.

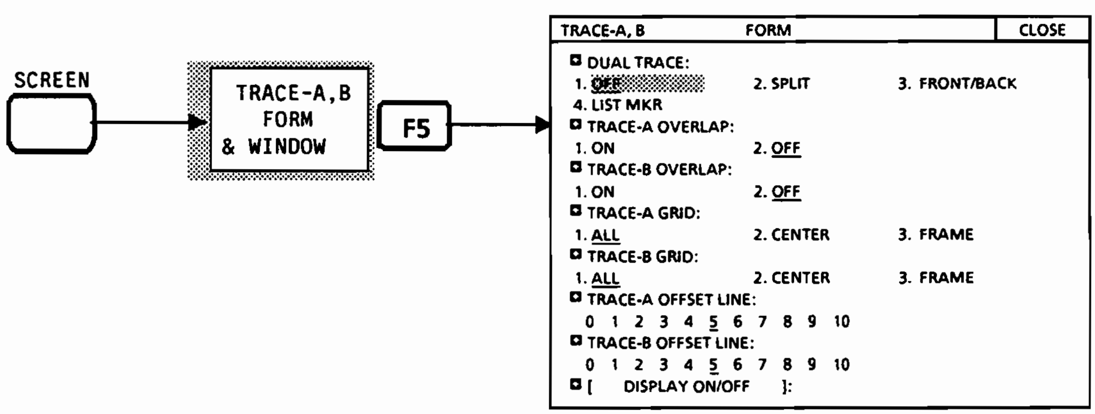


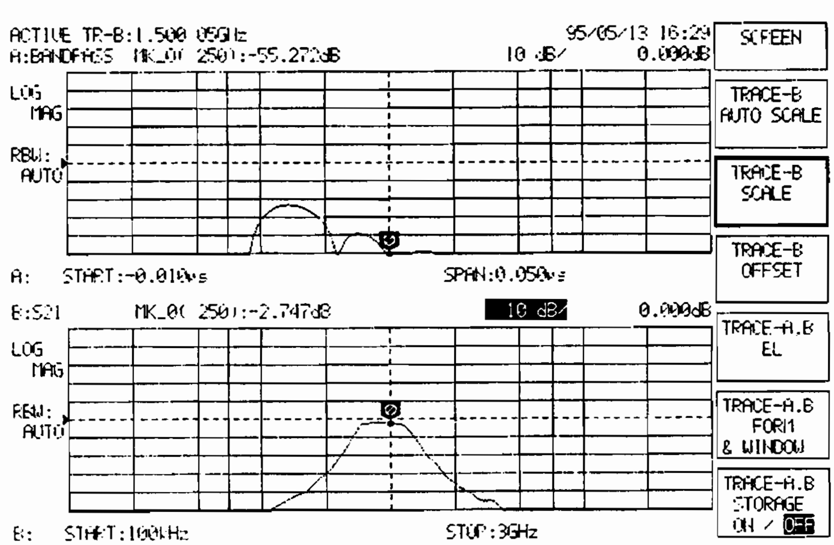
Step	Operation

6 Set 501 measuring points and measuring frequencies.



7 Select SPLIT from DUAL TRACE in the key-in sequence below. Dual traces of the TRACE-A time domain and the TRACE-B frequency domain appear simultaneously.

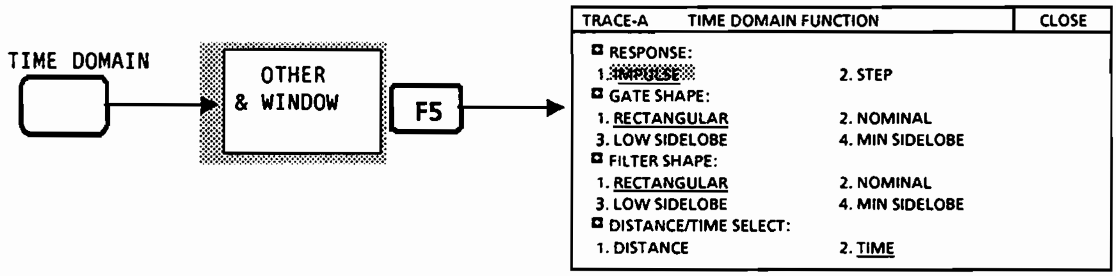




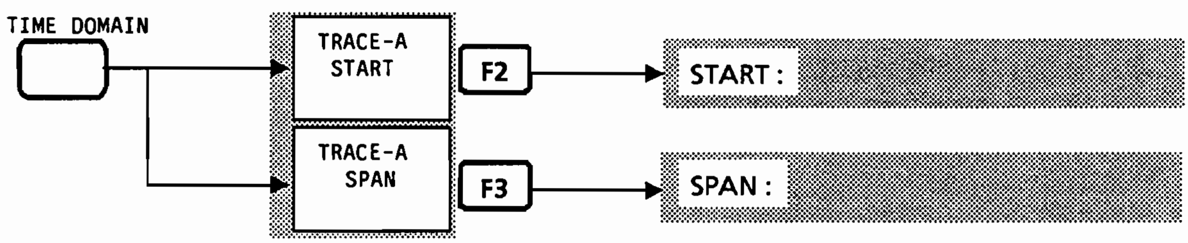
Step	Operation

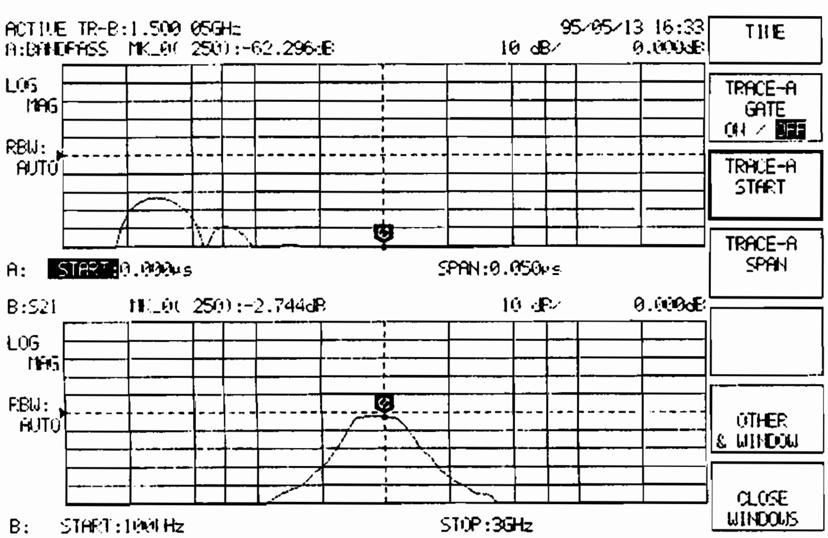
8 Press the ACTIVE key to set trace A active.

9 Select the IMPULSE parameter from the TIME DOMAIN FUNCTION window in the key-in sequence below.

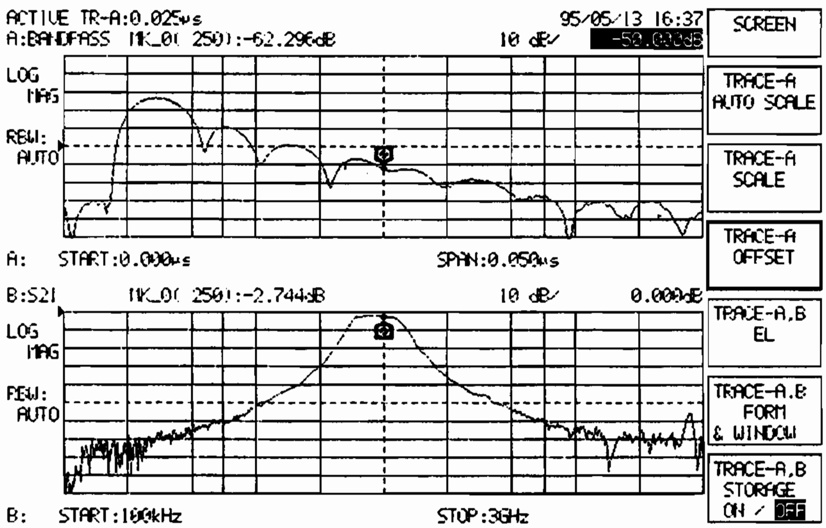


10 Set the display start time and the display span in the key-in sequence below as needed. If START has been set to a value other than 0, set it to 0.





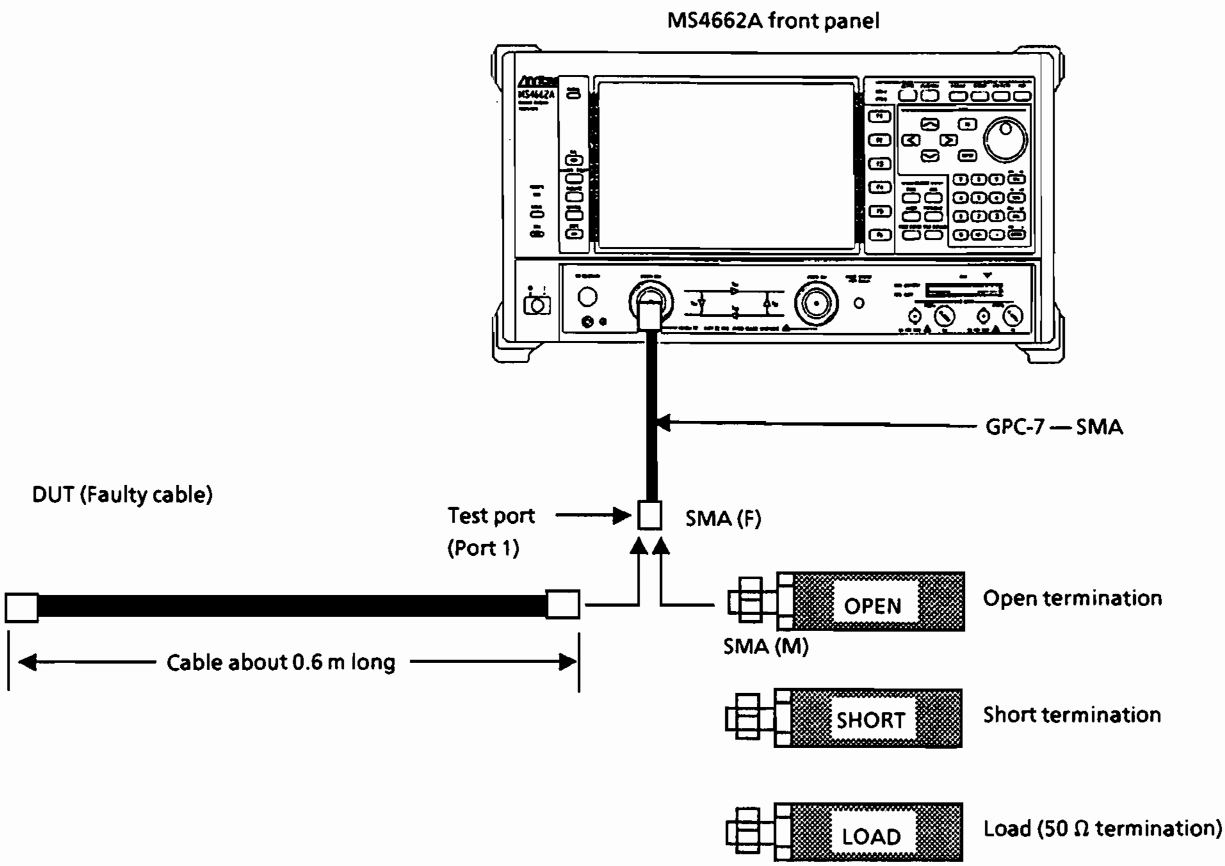
Step	Operation
11	Press the SCREEN key to set the scale.



10.7.2 Cable fault location measurement

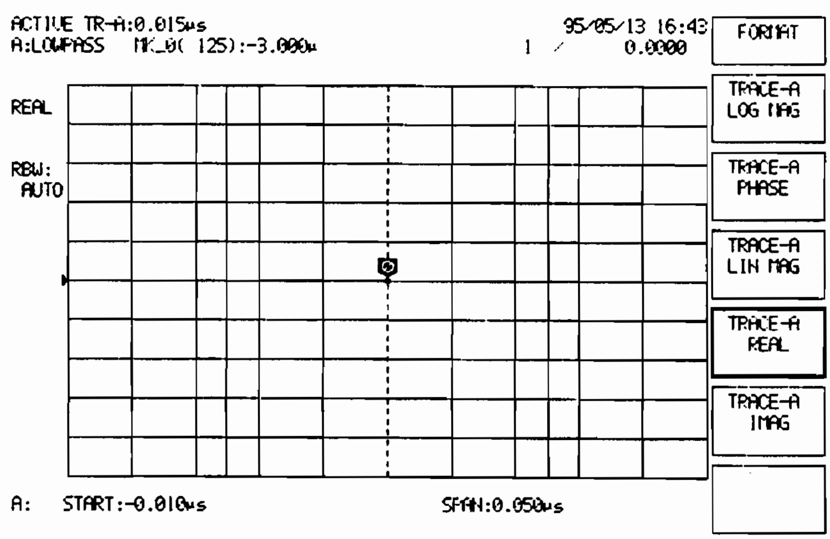
An example of typical time-domain analyses, cable fault location measurement allows measurement similar to the traditional practice of time-domain reflectometry. It measures S_{11} with the end of the cable left open. Cable fault location measurement locates faults (existing, in this example, at the end of the cable) from peaks of reflection characteristics produced by step responses in the low-pass time-domain measurement mode, with a distance parameter taken on the horizontal axis. Calibration is accomplished in the measurement procedures explained here by using the 1 port OSL method as an example. The frequency axis is 100 kHz to 3 GHz full span.

(1) Setup

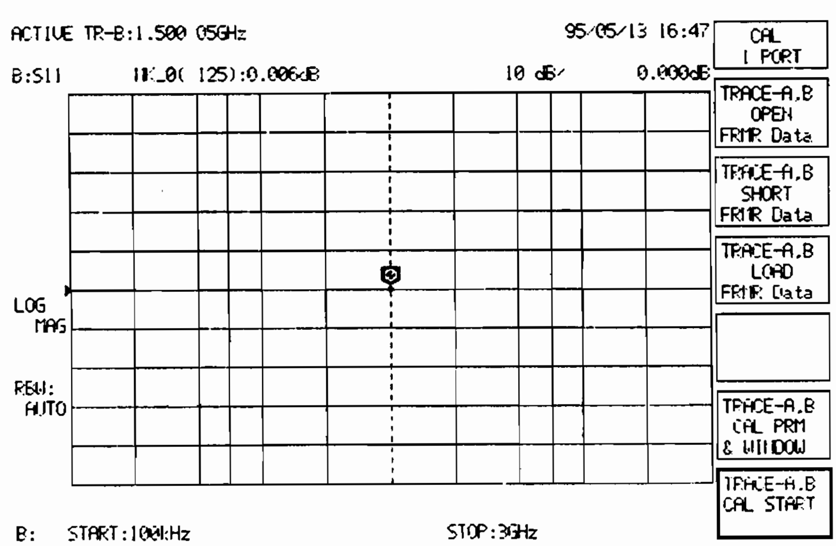


(2) Measurement procedure

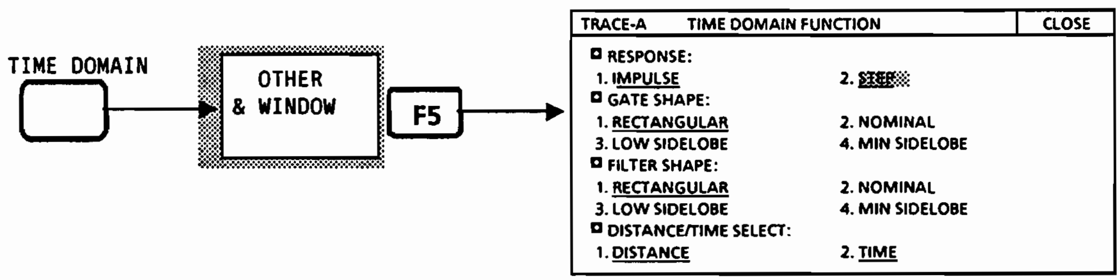
Step	Operation
1	Set up a testing system with a DUT (faulty cable) connected to it according to the setup diagram.
2	Press the INITIAL key.
3	Press the MEASURE section FREQ/TIME key.
4	Select LOW PASS from the FUNCTION menu.
5	Press the FORMAT key to select REAL. A real data display coordinate screen appears.



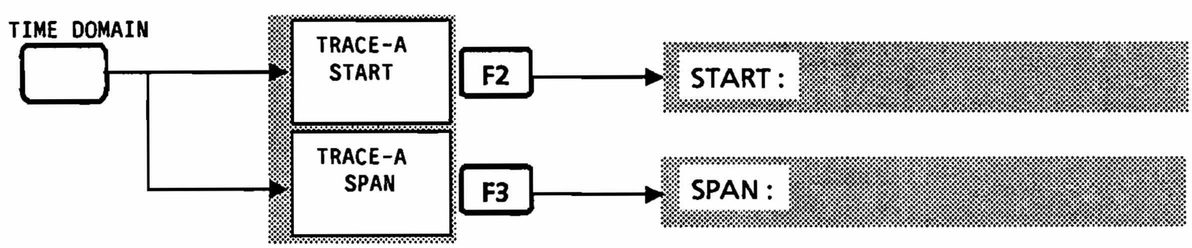
Step	Operation
6	Press the ACTIVE key to set trace B active. Select FUNCTION menu S_{11}.
7	Remove the DUT from the test port and run single-port correction according to the CAL key menu.
8	Press CAL START F6.



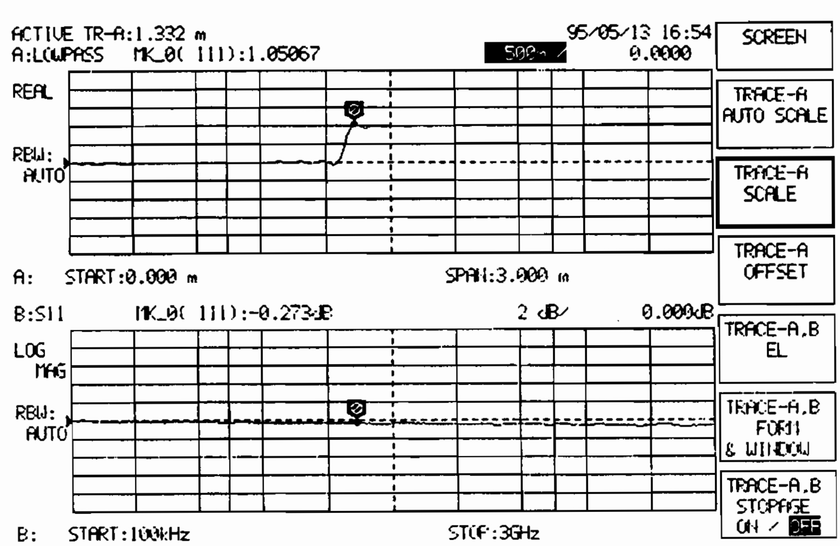
Step	Operation
9	Connect the DUT to the test port.
10	Press the ACTIVE key to set trace A active.
11	Select parameters from the TIME DOMAIN FUNCTION window in the key-in sequence below.



Step	Operation
12	Set a distance start distance of 0 mm and the display span to meet the total length of the cable in the key-in sequence below.



Step	Operation
13	Press the DISPLAY section SCREEN key. Through the SCREEN key, adjust the scale and offset to display the trace waveform at an optimal position onscreen.



SECTION 11
PERFORMANCE TESTING

This chapter explains what instruments and apparatus are needed to execute MS4662A performance testing, how to set them up, and how to proceed with performance testing. For information on calibration prerequisite to measurement, see Chapter 9. For key-in operations in the ENTRY section, see Chapter 3.

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11.1 Situations Requiring Performance Testing

Performance testing is conducted as part of preventive maintenance to preclude the deterioration of the MS4662A performance.

Performance testing may be conducted during MS4662A acceptance inspections, routine inspections, performance verifications following repairs, and all other situations where it is deemed useful. Check critical performance items from time to time for preventive maintenance. Conduct the following tests for MS4662A acceptance inspections, routine inspections, performance verifications following repairs:

- Reference oscillator frequency stability
- Test port output characteristics: Output frequency range
- Test port output characteristics: Output level accuracy
- Test port output characteristics: Output level linearity
- Test port output characteristics: Output level deviation
- Test port input characteristics: Average noise level
- Test port characteristics (before error correction): Directivity
- Test port characteristics (before error correction): Source matching
- Test port characteristics (before error correction): Load matching
- Test port characteristics (before error correction): Transmission frequency characteristics
- Test port characteristics (before error correction): Reflection frequency characteristics
- Test port characteristics (before error correction): Crosstalk
- Magnitude dynamic accuracy
- Phase dynamic accuracy

Perform performance testing periodically with regard to critical items for preventive maintenance. The recommended frequency of routine inspections is twice a year.

If any item is found to fail specifications during performance testing, call the Anritsu service department.

11.2 List of Performance Testing Instruments and Apparatus

List of performance testing instruments and apparatus.

List of Performance Testing Instruments and Apparatus

Recommended instrument name (Type)	Performance requirement †	Testing item
Frequency counter (MF1603A)	• Frequency range: 0.1 mHz to 3 GHz • Readout: 10 digits • External reference input: 10 MHz acceptable	Reference oscillator frequency stability Output frequency range
Power meter (ML4803A) Power sensor (MA4601A)	• Unit accuracy: ±0.02 dB • Frequency range: 100 kHz to 3 GHz (dependent on the power sensor used) • Frequency range: 100 kHz to 3 GHz • Measured power range: −30 to +20 dBm • Input connector: Type N	Output level accuracy Output level linearity Output level deviation Magnitude dynamic accuracy Phase dynamic accuracy
3750 calibration kit	• Frequency range: DC to 3 GHz	Average noise level Crosstalk Test port directivity
Standard attenuator	• ATT with its calibration accuracy traced to domestic standards (10 dB/0.01 dB)	Magnitude dynamic accuracy Phase dynamic accuracy
Frequency standard	• Frequency: 10 MHz • Stability: 1×10^{-9}/day or less	Reference oscillator frequency stability

† Part of the performance requirements for covering the specific ranges of test item measurement.

11.3 Performance Testing

Unless otherwise specified, allow both the device under test and the instrumentation to warm up for at least 30 minutes until they performance testing. Precise measurement accuracy also benefits from a room temperature environment completely free from excessive noise, vibration, dust, moisture, and other problems, as well as less AC supply voltage variations.

11.3.1 Reference oscillator frequency stability

Test the frequency stability of the 10 MHz crystal oscillator used as a reference oscillator by measuring frequency changes right after the power-on sequence and at ambient temperatures of 0 °C and 50 °C.

(1) Testing specifications

■ Reference oscillator

- Frequency: 10 MHz

<Standard>

- Aging rate: $\pm1\times10^{-6}$/day or less (15 minutes after power-on)
- Temperature stability: $\pm5\times10^{-6}$ or less (0 to 50 °C)

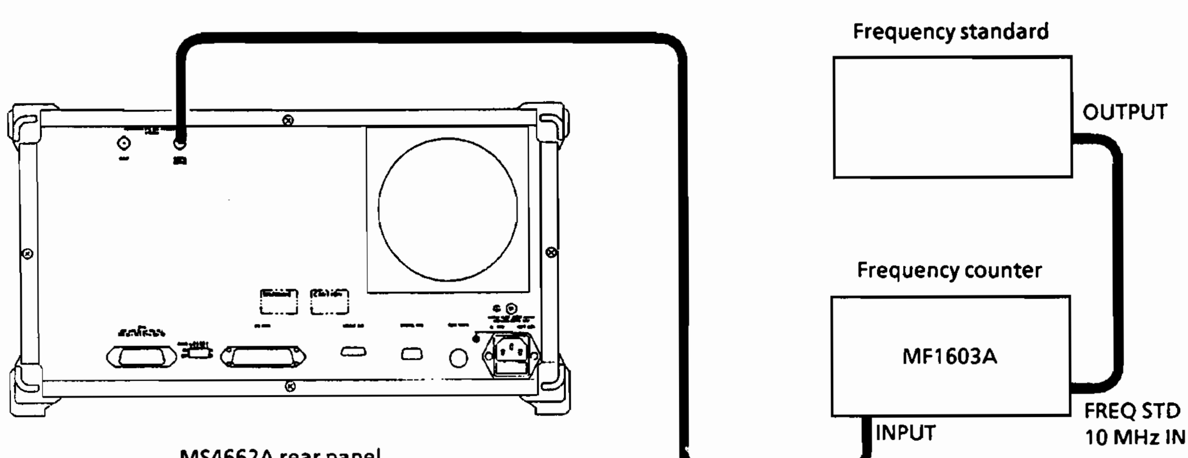
<Option>

- Aging rate: $\leqq2\times10^{-8}$/day, after 24 hours of operation, 23 °C ± 3 °C
  $\leqq2\times10^{-7}$/year, after 24 hours of operation, 23 C° ± 3 °C
- Temperature stability: $\pm5\times10^{-8}$ (0 to 50 °C)

(2) Testing instruments

- Frequency counter: MF1603A
- Frequency standard: One having $\pm1\times10^{-9}$/day or better stability

(3) Setup



Reference oscillator frequency stability test

(4) Testing procedures

Frequency stability/day: Perform this test in a place at ambient temperatures of 23 °C ± 3 °C, free from vibration.

Step	Operation
1	Set the MS4662A rear-panel reference oscillator selector switch (FREQ STD: INT/EXT) to EXT.
2	Turn on the MS4662A front-panel power switch.
3	When 15 minutes (standard) or 24 hours (option) have passed after the power was turned on, measure the frequency on a counter (down to the 0.1 Hz place; hereafter the same).
4	Then, measure the frequency on the counter 24 hours later.
5	Calculate the stability by solving: $$\text{Frequency stability} = \frac{\text{(Second counter reading)} - \text{(First counter reading)}}{\text{(First counter reading)}}$$

Temperature stability: Perform this test using a vibration-free thermostat.

Step	Operation
1	Place the MS4662A in a thermostat and set the thermostat temperature at 25 °C.
2	Turn on the MS4662A front-panel power switch. Wait until the MS4662A internal temperature is stabilized (about 1.5 hours after the thermostat temperature reaches stability).
3	When the MS4662A internal temperature is stabilized, measure the frequency on the counter (down to the 0.1 Hz place).
4	Set the thermostat temperature at 50 °C.
5	Measure the frequency on the counter when both the thermostat temperature and the MS4662A internal temperature are stabilized.
6	Calculate the stability by solving: $$\text{Frequency stability} = \frac{\text{(Counter reading at 50 °C)} - \text{(Counter reading at 25 °C)}}{\text{(Counter reading at 25 °C)}}$$
7	Set the thermostat temperature at 0 °C and perform **Steps 5** and **6**.

11.3.2 Test port output characteristics: Output frequency range

Network analyzers feed a uniform synthesizer local oscillator signal to I/O circuits for frequency-coupled measurement. Hence, the frequency range can be determined from the input received frequency or the output frequency. The method of testing output frequencies is described below.

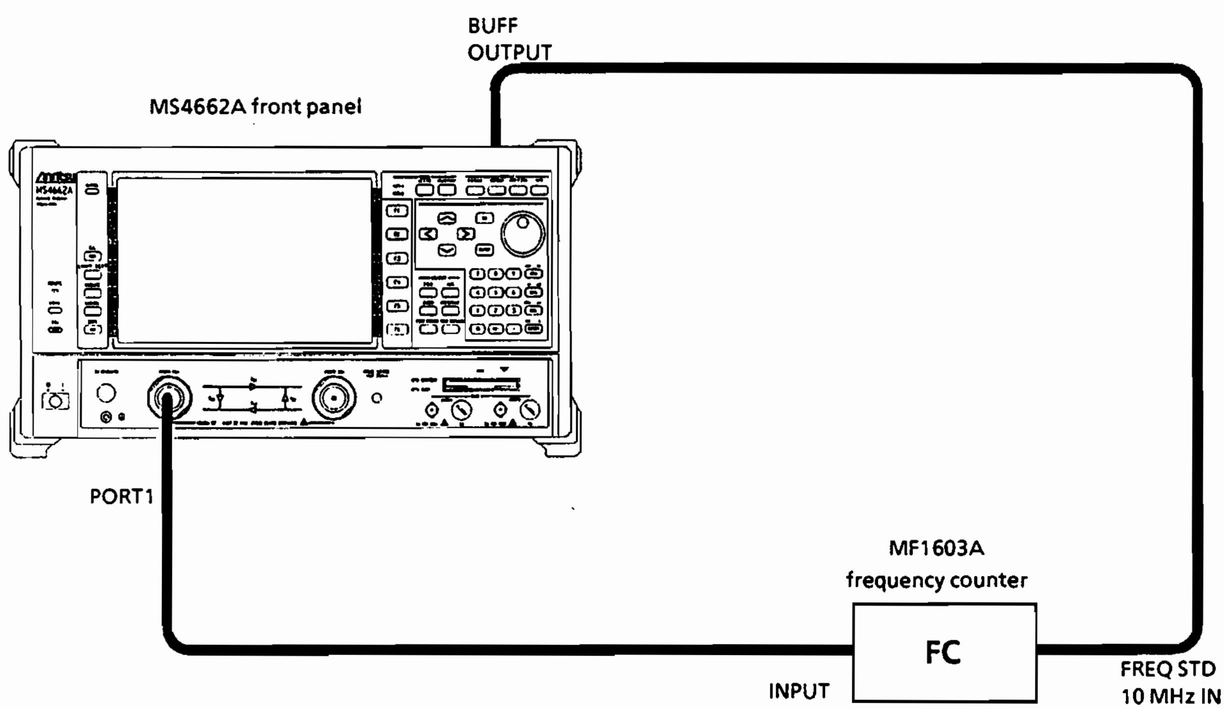
(1) Testing specifications

- Frequency range: 100 kHz to 3 GHz
- Minimum resolution: 0.1 Hz

(2) Testing instrument

- Frequency counter: MF1603A

(3) Setup



Output frequency range test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to set SPAN to 0 Hz.
3	Set the center frequency at each of the values listed below and read the corresponding frequency counter value.

Center frequency	Frequency counter reading
100 kHz	
10 MHz	
100 MHz	
300 MHz	
500 MHz	
1 GHz	
3 GHz	

11.3.3 Test port output characteristics: Output level accuracy

Output level errors are traceable to two sources: absolute value variations and step errors. The MS4662A, fabricated of passive circuitry, involves no or little secular change. Therefore, the method of testing absolute value variations at 0 dBm is described below.

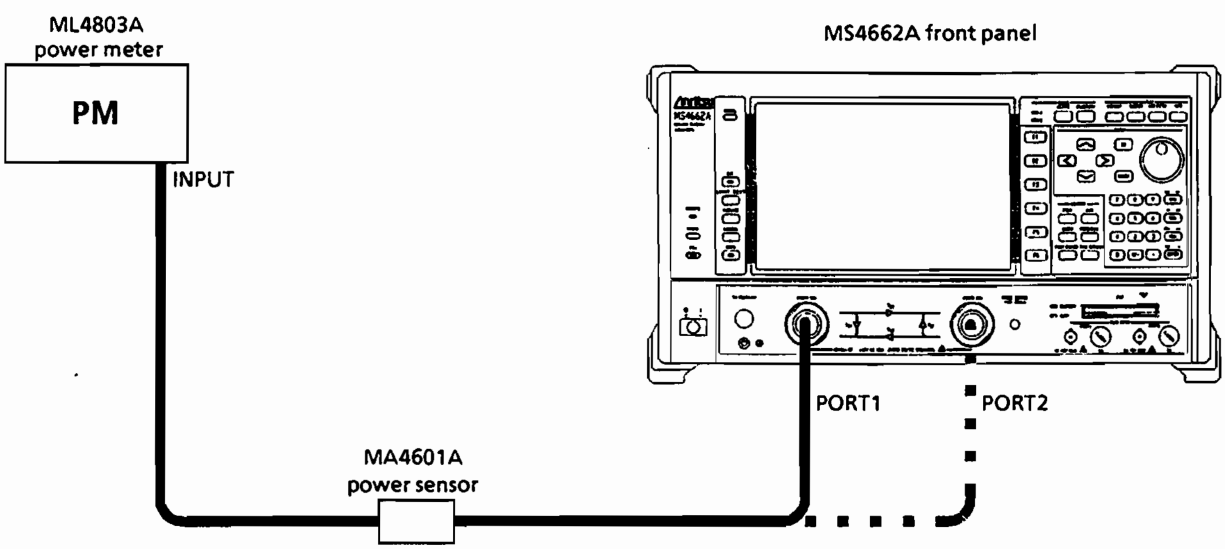
(1) Testing specification

- Output level accuracy: ±1.0 dB or less at an output frequency of 100 MHz and an output level of 0 dBm.

(2) Testing instrument

- Power meter: ML4803A
- Power sensor: MA4601A

(3) Setup for output accuracy test



Output level accuracy test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Set up the testing system as in 11.3.3.
3	Press the FREQ key to set CENTER FREQ to 100 MHz and SPAN to 0 Hz.
4	Read the ML4803A power meter, which indicates the output level of port 1.
5	Connect the MA4601A power sensor to port 2.
6	Press the FUNCTION key to select S22.
7	Read the ML4803A power meter, which indicates the output level of port 2.

11.3.4 Test port output characteristics: Output level linearity

Set the ML4803A power meter reading as a 0 dB reference point when TEST PORT POWER is set to 0 dBm in the output level accuracy test.

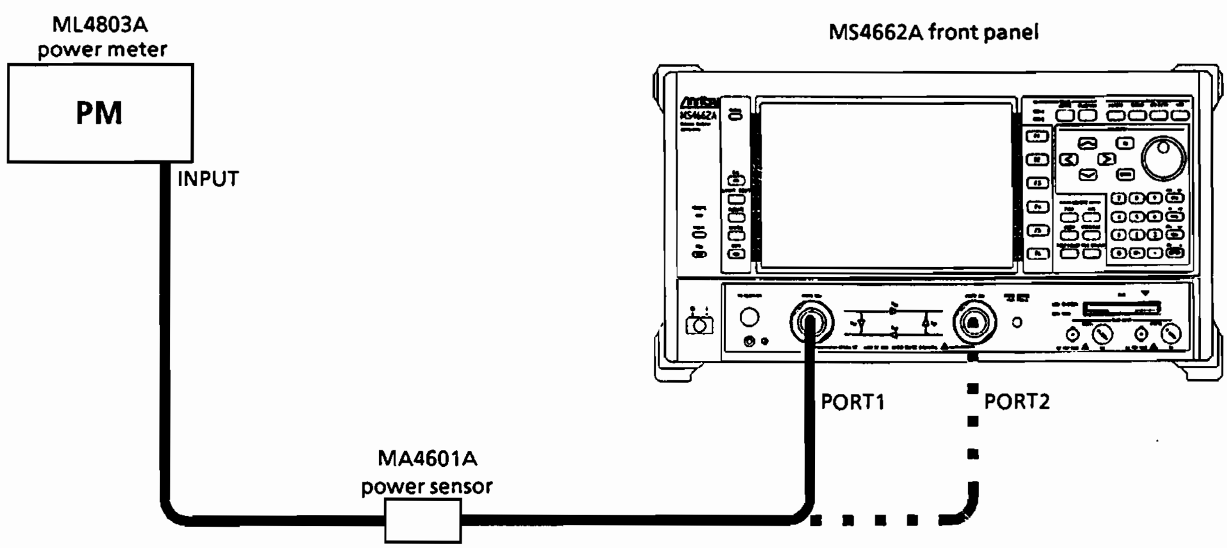
(1) Testing specification

- Output level linearity: ±0.5 dB or less at an output frequency of 100 MHz and a port output of −10 to +8 dBm (0 dBm reference).

(2) Testing instrument

- Power meter: ML4803A
- Power sensor: MA4601A

(3) Setup



Output level linearity test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to set CENTER FREQ to 100 MHz and SPAN to 0 Hz.
3	Set the ML4803 power meter reading as a 0 dB reference point.
4	Determine linearity errors (dB) from the ML4803A power meter reading that is observed as TEST PORT POWER is set to the levels listed below.

TEST PORT POWER (dBm)	0	1	2	3	4	5	6	7	8
Linearity error (dB)	0								

TEST PORT POWER (dBm)		−1	−2	−3	−4	−5	−6	−7	−8	−9	−10
Linearity error (dB)											

11.3.5 Test port output characteristics: Output level deviation

Set the ML4803A power meter reading as a 0 dB reference point when TEST PORT POWER is set to 0 dBm in the output level accuracy test. Next, measure the output level as the MS4662A output level is varied between 100 kHz and 3 GHz to calculate the deviation from the output level at 100 kHz.

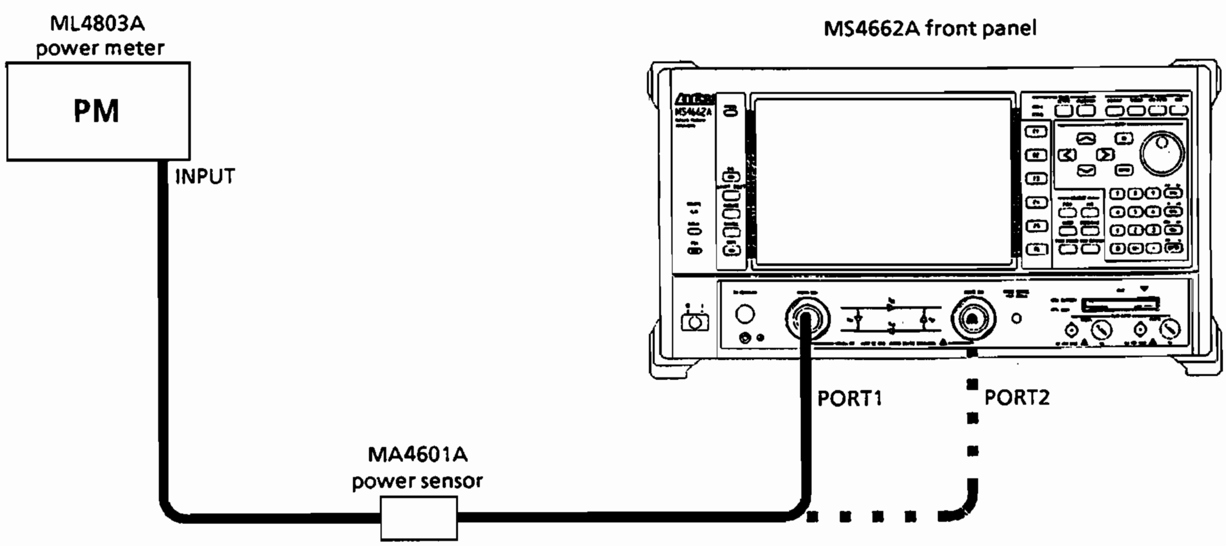
(1) Testing specifications

- Output level deviation: Relative to an output frequency of 100 MHz and an output level of 0 dBm
  −0.5 dB to +2.5 dB (output frequency: 100 to 500 kHz)
  −1.5 dB to +1.5 dB (output frequency: 500 kHz to 2 GHz)
  −2.0 dB to +2.0 dB (output frequency: 2 to 3 GHz)

(2) Testing instrument

- Power meter: ML4803A
- Power sensor: MA4601A (frequency range: 100 kHz to 3 GHz)

(3) Setup



Output level deviation test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to set CENTER FREQ to 100 MHz and SPAN to 0 Hz.
3	Set the ML4803 power meter reading as a 0 dB reference point.
4	Determine deviations from 100 MHz from the ML4803A power meter reading that is observed CENTER FREQ is set to the levels listed below.

CENTER FREQ (Hz)	100 k	200 k	300 k	400 k	500 k	1 M	10 M	100 M	1 G	2 G	3 G
Level deviation (dB)								0			

11.3.6 Test port input characteristics: Average noise level

The internal noise that is uniformly distributed throughout the measuring frequency band in proportion to the resolution bandwidth is called an average noise level. The average noise level determines the lower limit to the dynamic range mainly in magnitude measurement. Accordingly, when the device under test has an infinite attenuation, the detector measures the noise level of its own, unable to measure signals below this noise level. Measurement is conducted by connecting a 50 Ω termination to the test ports.

(1) Testing specification

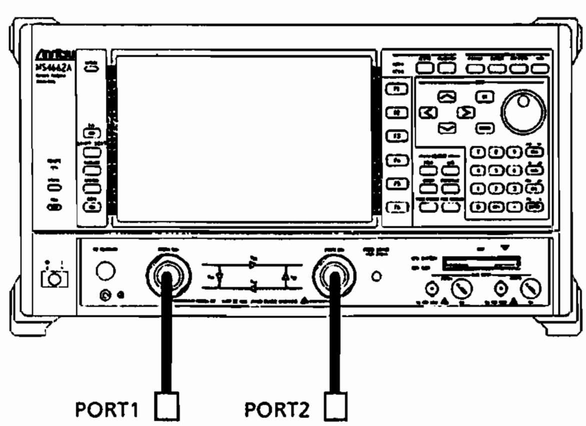
- Average noise level: ≦ −90 dBm (100 kHz to 80 MHz, reception bandwidth 1 kHz)
  ≦ −80 dBm (80 MHz to 3 GHz, reception bandwidth 1 kHz)

(2) Testing instrument

- 50 Ω termination: 3750 calibration kit 50 Ω termination

(3) Setup

MS4662A front panel

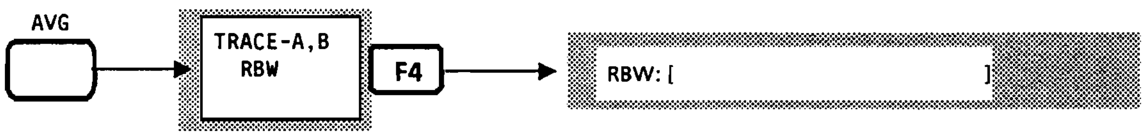


50 Ω termination

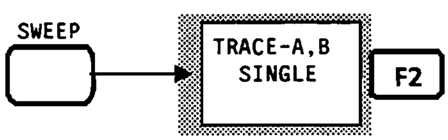
Average noise level test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to select the measurement mode S12 from the menu.
3	Press ANLYS PORT [F5] to set the analysis port to TA.
4	Set RBW to 1 kHz in the key-in sequence below.



Step	Operation
5	Press the FREQ key to set START FREQ to 100 kHz and STOP FREQ to 80 MHz.
6	Run CAL (X-S) by interconnecting ports 1 and 2.
7	Connect a 50 Ω termination to ports 1 and 2.
8	Run a single sweep in the key-in sequence below.



Step	Operation
9	Press the PACKAGE key to read the mean value by using the read-out function MEAN.
10	Press the FREQ key to set START FREQ to 80 MHz and STOP FREQ to 3 GHz.
11	Return to **Step 6** and perform measurement between 80 MHz and 3 GHz.
12	Select the measurement mode S21 in **Step 2**.
13	Set the analysis port to TB in **Step 3**.
14	Likewise, run a TB test from **Step 5** afterwards.

11.3.7 Test port characteristics (before error correction): Directivity

Measure the directivity of ports 1 and 2 before error correction.

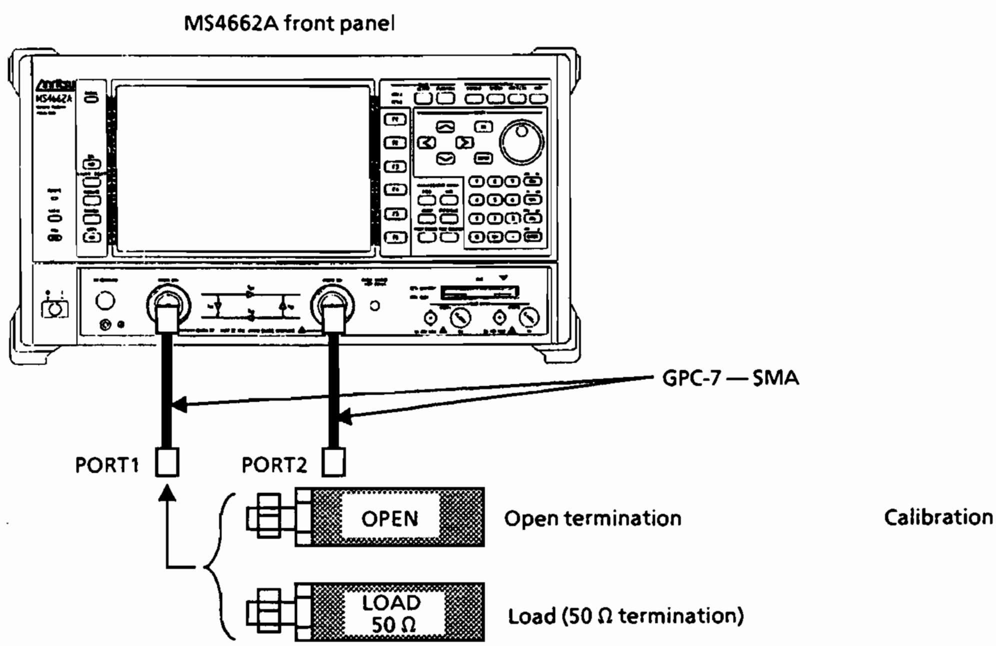
(1) Testing specification

- Directivity: ≧ 30 dB (300 kHz to 3 GHz)
  ≧ 22 dB (100 kHz to 300 kHz)

(2) Testing instrument

- Calibration kit: 3750

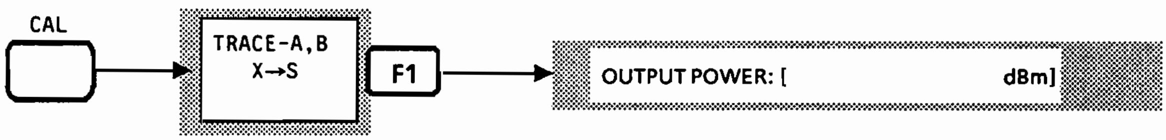
(3) Setup



Directivity test

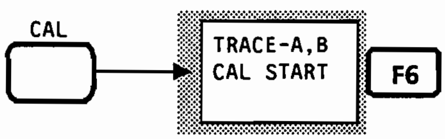
(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Connect an open termination to port 1.
3	Perform calibration (in the X → S method) in the key-in sequence below.



Press F1 to run one sweep.

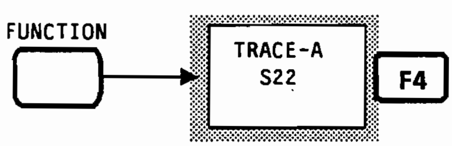
4 Start calibration in the key-in sequence below.



5 Connect a 50 Ω termination in place of the open termination.

6 Locate the maximum in the trace waveform with MKR and MKR FCTN. This value indicates the maximum directivity.

7 Select the measurement mode S22.



8 Connect an open termination to port 2, and test it the same way as in **Step 3** and afterwards.

11.3.8 Test port characteristics (before error correction): Source matching

Manage source matching to minimize mismatches with the device under test.

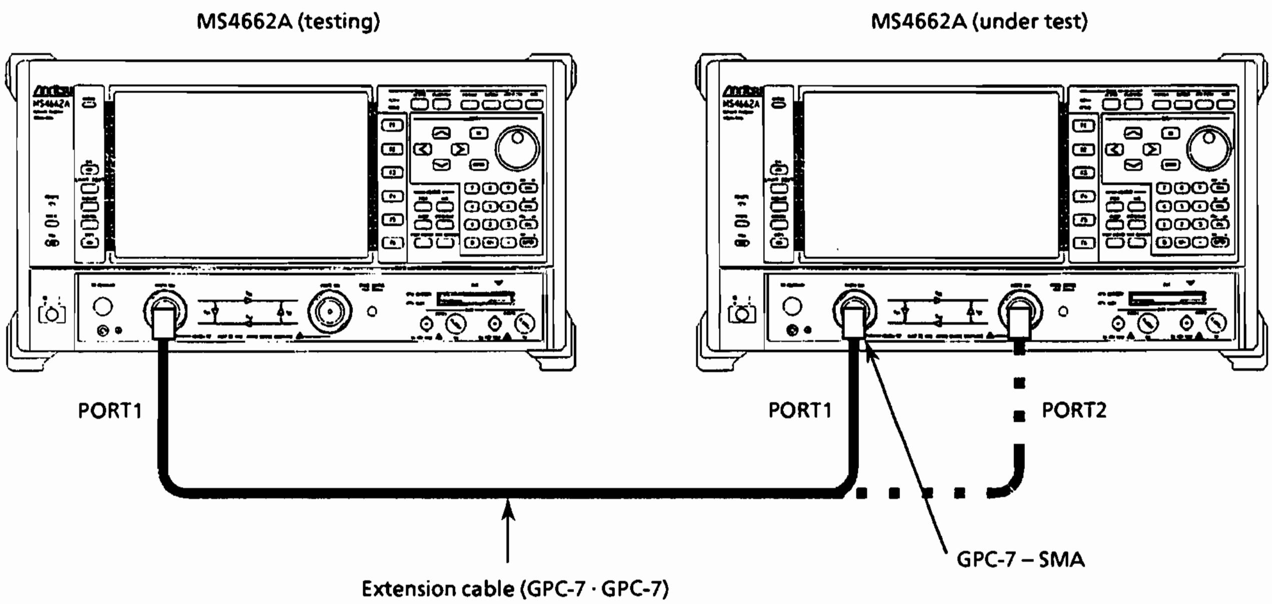
(1) Testing specification

- Source matching: ≧ 10 dB (300 kHz to 1.5 GHz)
  ≧ 8 dB (100 kHz to 3 GHz)

(2) Testing instruments

- Network analyzer: MS4662A
- Calibration kit: 3750

(3) Setup



Source matching test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key on each network analyzer.
	<u>Testing network analyzer</u>
2	Set RBW to 100 Hz or less.
3	Using a 3750 calibration kit (SMA, 3.5 mm), perform 1 port calibration at the end of the extension cable.
	<u>Network analyzer under test</u>
4	Select the measurement mode S21 through the FUNCTION menu.
5	Press SWEEP menu STOP/CONT [F3] to halt the sweep.
	<u>Testing network analyzer</u>
6	Connect the calibration end of the extension cable to port 1 of the network analyzer under test.
7	After completing one sweep, locate the maximum in the measurement data with MKR and MKR FCTN. This value indicates a source match for port 1.
8	Select the measurement mode S12 through the FUNCTION menu.
9	Connect the calibration end of the extension cable to port 2 of the network analyzer under test.
10	As in **Step** 7, locate the maximum in the measurement data with MKR and MKR FCTN. This value indicates a source match for port 2.

Note: The measurement data may be disturbed in spike form at the frequency at which the sweep by the analyzer under test is halted. Remove data at this point.

11.3.9 Test port characteristics (before error correction): Load matching

Manage load matching to minimize mismatches with the device under test.

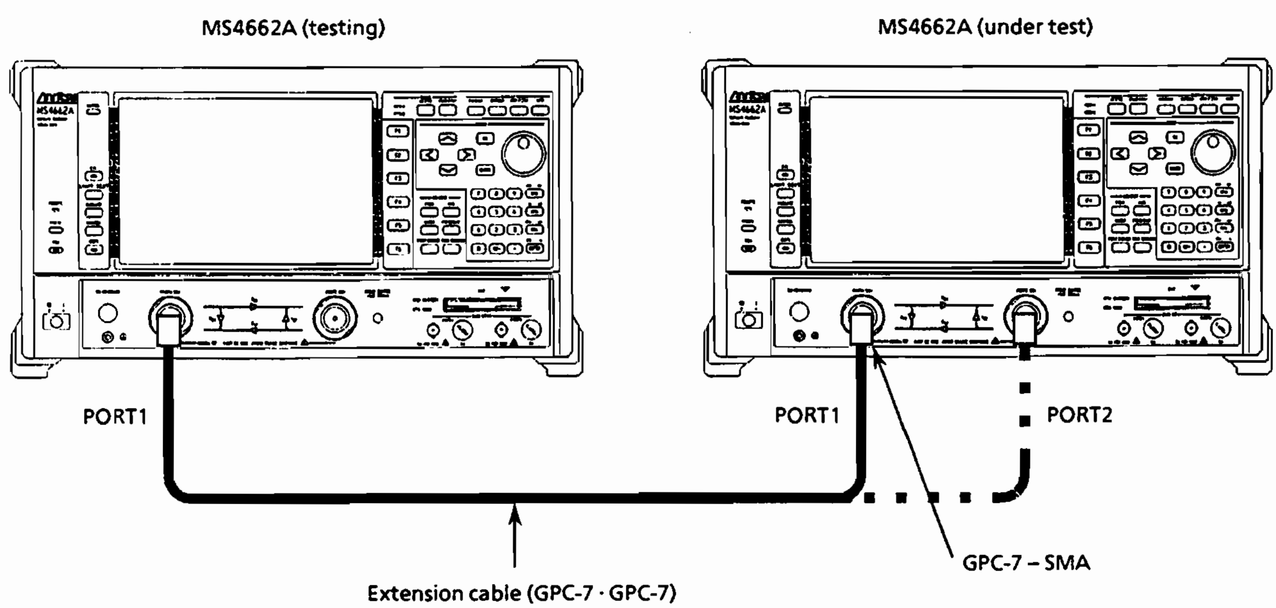
(1) Testing specification

- Load matching: ≧ 15 dB (300 kHz to 1.5 GHz)
  ≧ 10 dB (100 kHz to 3 GHz)

(2) Testing instruments

- Network analyzer: MS4662A
- Calibration kit: 3750

(3) Setup



Load matching test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key on each network analyzer.
	Testing network analyzer
2	Set RBW to 100 Hz or less.
3	Using a 3750 calibration kit (SMA, 3.5 mm), perform single-port calibration at the end of the extension cable.
	Network analyzer under test
4	Select the measurement mode S12 through the FUNCTION menu.
5	Press SWEEP menu STOP/CONT [F3] to halt the sweep.
	Testing network analyzer
6	Connect the calibration end of the extension cable to port 1 of the network analyzer under test.
7	After completing one sweep, locate the maximum in the measurement data with MKR and MKR FCTN. This value indicates a load match for port 1.
8	Select the measurement mode S21 from the FUNCTION menu.
9	Connect the calibration end of the extension cable to port 2 of the network analyzer under test.
10	As in **Step 7**, locate the maximum in the measurement data with MKR and MKR FCTN. This value indicates a load match for port 2.

11.3.10 Test port characteristics (before error correction): Transmission frequency characteristics

Interconnect ports 1 and 2 with a cable to run a transmission frequency characteristics test.

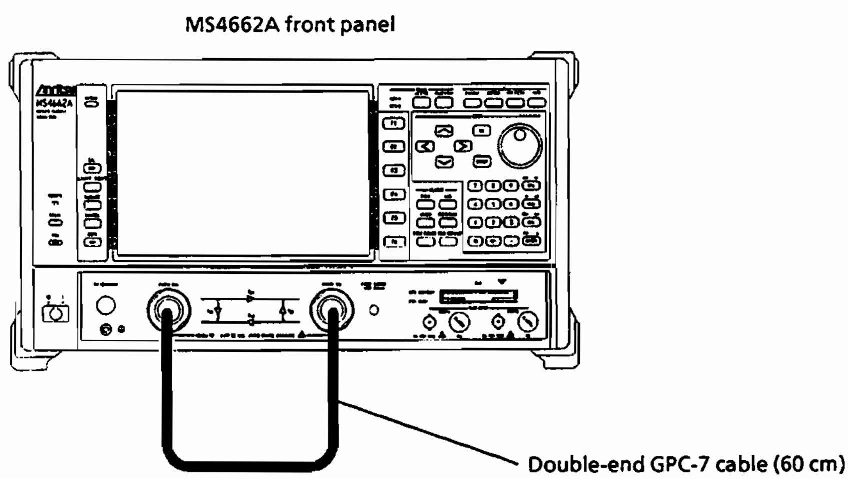
(1) Testing specification

- Transmission frequency characteristics: ≦ 2 dB (300 kHz to 80 MHz)
  ≦ 5 dB (100 kHz to 3 GHz)

(2) Testing instrument

- None

(3) Setup

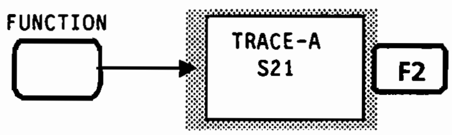


Transmission frequency characteristics test

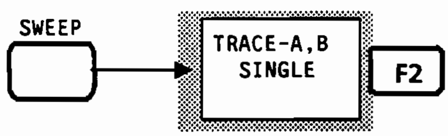
(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Interconnect ports 1 and 2 according to the setup diagram.
3	Select the measurement mode S21 in the key-in sequence below.
4	Run a single sweep in the key-in sequence below.
5	Locate the maximum or minimum in the measurement waveform with MKR and MKR FCTN.
6	Select the measurement mode S12 in **Step 3** and perform steps from **Step 4** downward.

Step 3 key-in sequence:



Step 4 key-in sequence:



11.3.11 Test port characteristics (before error correction): Reflection frequency characteristics

Interconnect ports 1 and 2 with a short termination to run a reflection frequency characteristics test.

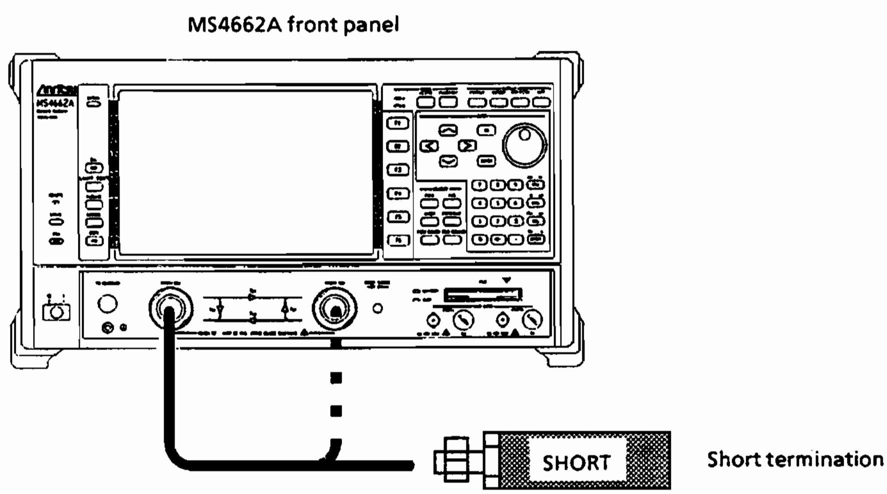
(1) Testing specification

- Reflection frequency characteristics: ≦ 2 dB (300 kHz to 80 MHz)
  ≦5 dB (100 kHz to 3 GHz)

(2) Testing instruments

- 3750 calibration kit, Short termination

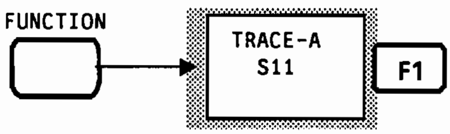
(3) Setup



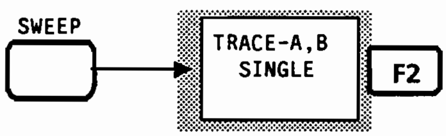
Reflection frequency characteristics test

(4) Testing procedure

Step	Operation
1	Press the INITIAL key.
2	Connect a short termination to port 1 according to the setup diagram.
3	Select the measurement mode S11 in the key-in sequence below.



Step	Operation
4	Run a single sweep in the key-in sequence below.



Step	Operation
5	Locate the maximum or minimum in the measurement waveform with MKR and MKR FCTN.
6	Select the measurement mode S22 in **Step 3** and perform steps from **Step 4** downward.

11.3.12 Test port characteristics (before error correction): Crosstalk

Crosstalk is a source of major error at the lower limit of magnitude measurement. It is induced by the disturbance of synthesizer output into the input in one route or another (pow supply, static coupling, and so on).

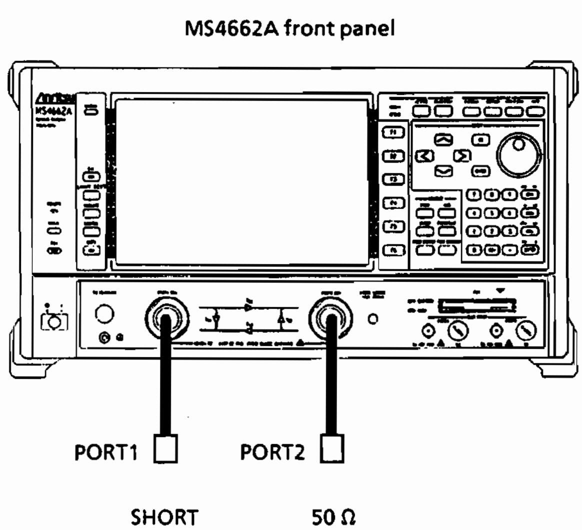
(1) Testing specification

- Load matching: ≧ 90 dB (100 kHz to 1 GHz)
  ≧ 80 dB (1 to 3 GHz)

(2) Testing instruments

- 3750 calibration kit, 50 Ω termination, Short termination

(3) Setup

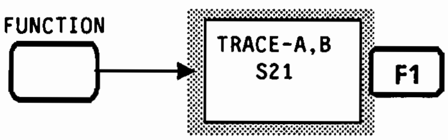


Crosstalk test

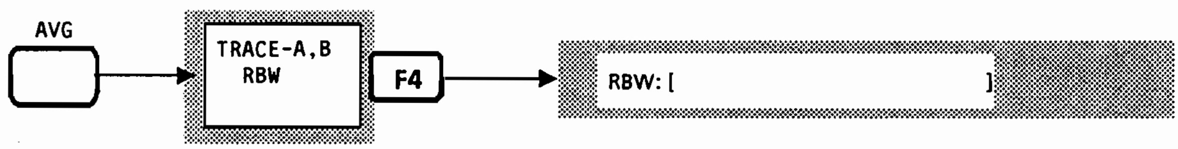
(4) Testing procedure: Signal source → TA/TB crosstalk

Step	Operation
1	Press the INITIAL key.
2	Connect a short termination to port 1 and a 50 Ω termination to port 2 according to the setup diagram.
3	Select the measurement mode S21 in the key-in sequence below.
4	Set RBW to 30 Hz in the key-in sequence below.
5	Run a single sweep in the key-in sequence below.
6	Locate the maximum in the measurement waveform with MKR and MKR FCTN. The maximum in the frequency ranges of 100 kHz to 1 GHz and from 1 GHz to 3 GHz each indicate a crosstalk.
7	Select the measurement mode S12 in **Step 3**.
8	Connect a 50 Ω termination to port 1 and a short termination to port 2.
9	As in the measurement mode S21, run an S12 crosstalk test from **Step 5** afterwards.

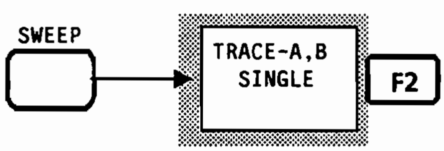
Step 3 key-in sequence:



Step 4 key-in sequence:



Step 5 key-in sequence:



11.3.13 Magnitude dynamic accuracy

Measure the magnitude ration linearity from the maximum input level that sustains the linearity of the receiver to a point close to the average noise level. Calculate the magnitude dynamic accuracy by comparison with the true value of a standard attenuator.

(1) Testing specification

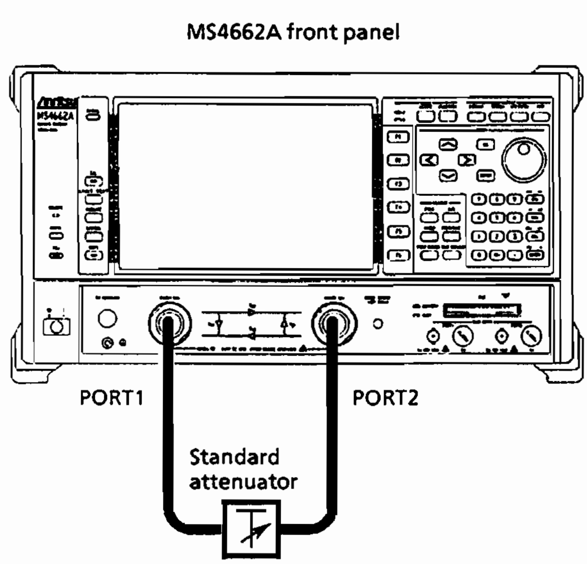
- Dynamic accuracy: 10 Hz RBW, relative to a test port level of −10 dBm.

Test port level	Measurement accuracy	
	≦1.0 GHz	>1.0 GHz
+10 dB to 0 dB	±0.30 dB	±0.30 dB
0 dB to −40 dB	±0.05 dB	±0.05 dB
−40 dB to −50 dB	±0.05 dB	±0.10 dB
−50 dB to −60 dB	±0.10 dB	±0.30 dB
−60 dB to −70 dB	±0.30 dB	±1.20 dB
−70 dB to −80 dB	±1.20 dB	±4.00 dB
−80 dB to −90 dB	±4.00 dB	———

(2) Testing instruments

- Standard attenuator: ATT with its calibration accuracy traced to domestic standards (10 dB/ 0.01 dB)
- Calibration kit: 3750

(3) Setup

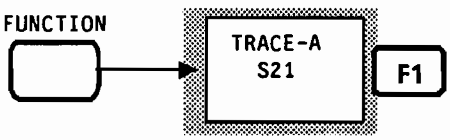


Magnitude dynamic accuracy test

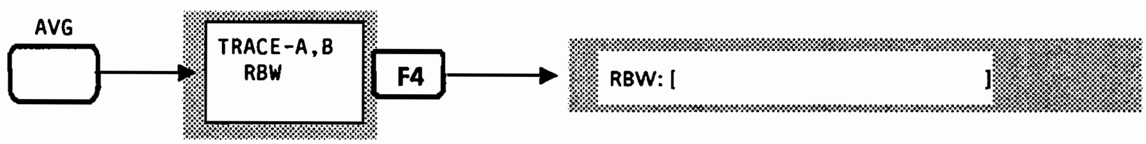
(4) Testing procedure

Between 0 dB and − 90 dB

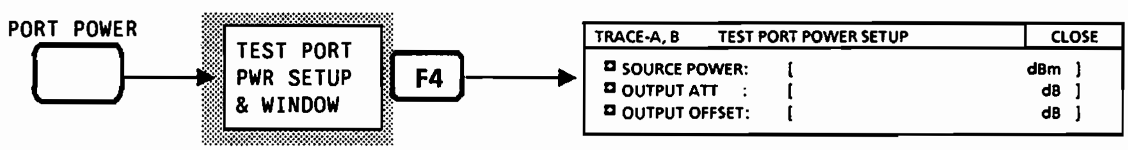
Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to select the measurement mode S21 from the menu.



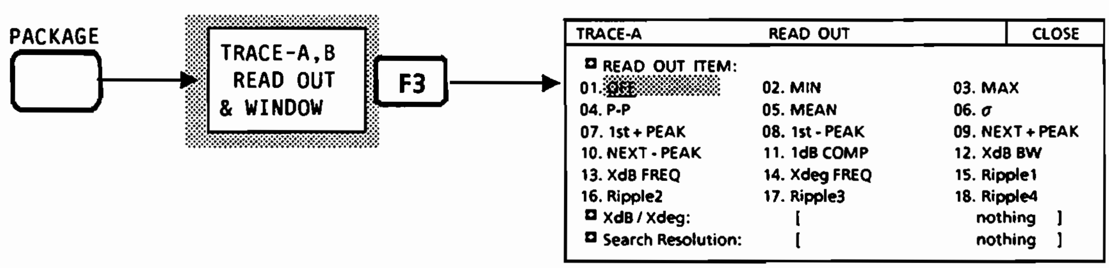
Step	Operation
3	Press the FREQ key to set CENTER FREQ to 10.1 MHz and SPAN to 0 Hz.
4	Set RBW to 10 Hz in the key-in sequence below.



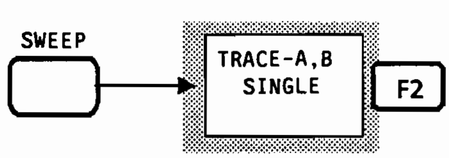
Step	Operation
5	Set OUTPUT ATT to 10 dB in the key-in sequence below.



Step	Operation
6	Using a 3750 calibration kit, run full two-port calibration.
7	Select 5. MEAN from the READ OUT parameter group in the key-in sequence below.



Step	Operation
8	Connect a standard attenuator according to the setup diagram and set it to 0 dB. Note the reading observed at this time as a reference number.
9	Run a single sweep in the key-in sequence below.

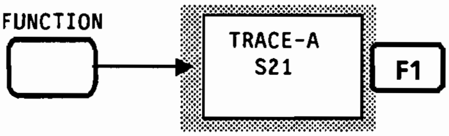


Step	Operation
10	Read the feature extraction value. Its difference from the reference number represents the dynamic accuracy.

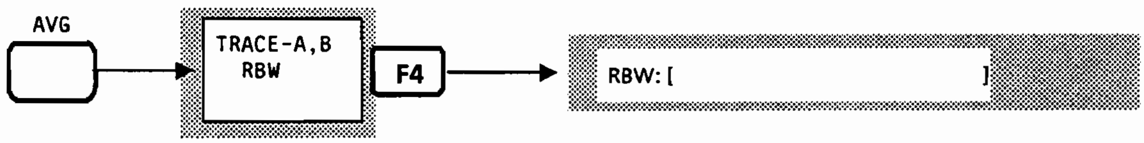
Step	Operation
11	Calculate the dynamic accuracy (feature extraction value − (N − N20)). where N: Calibration value of the standard attenuator at an attenuation setting N_0: Calibration value of the standard attenuator at 20 dB
12	Repeat **Steps 9** to **11** each time the standard attenuator is set to 10 to 90 dB.
13	Select the measurement mode S12 in **Step 2**.
14	Repeat **Steps 8** to **12**.

Between 0 dB and + 10 dB

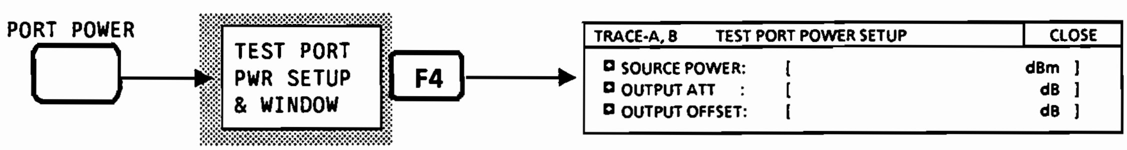
Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to select the measurement mode S21 from the menu.



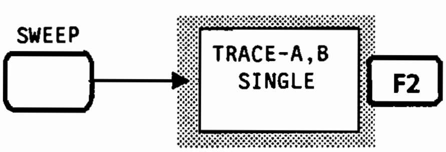
Step	Operation
3	Set RBW to 10 Hz in the key-in sequence below.



Step	Operation
4	Set OUTPUT ATT to 10 dB and SOURCE POWER to +23 dBm in the key-in sequence below.



Step	Operation
5	Using a 3750 calibration kit, run full two-port calibration.
6	Connect a standard attenuator according to the setup diagram and set it to 10 dB. Then, press STORAGE F6.
7	Run a single sweep in the key-in sequence below.



Step	Operation
8	Press the SCREEN key to set SCALE to 0.1 dB and press STORAGE [F6].
9	Set the standard attenuator to 10 to 0 dB.
10	Run a single-sweep as in **step 7**.
11	Press the SCREEN key to vary the offset by the value of the standard attenuator.
12	The maximum difference between the two waveforms represents the dynamic accuracy between 0 and +10 dBm.
13	Select the measurement mode S12 in **Step 2**.
14	Repeat **Steps 6** to **12**.

11.3.14 Phase dynamic accuracy

The slightest nonlinear distortion in the internal amplifier or level characteristics of the limiter circuit could vary the phase ration measurement by a negligible degree. Measure the phase dynamic accuracy by varying the test port level from +10 dB to −90 dB with a standard attenuator.

(1) Testing specification

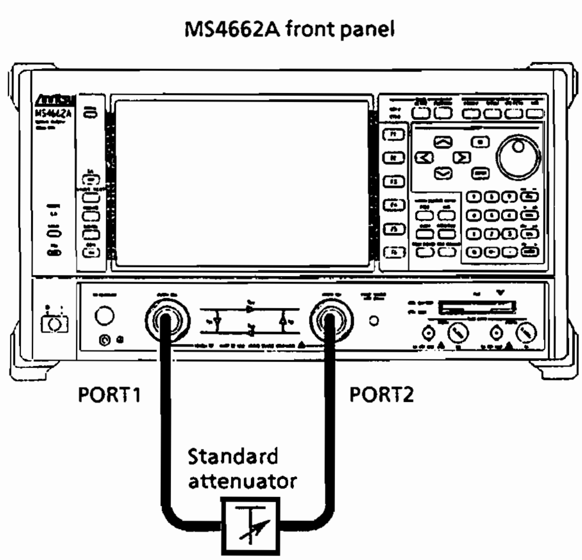
- Dynamic accuracy: 10 Hz RBW, relative to a test port level of −10 dBm.

Test port level	Measurement accuracy	
	≦1.0 GHz	>1.0 GHz
+10 dB to 0 dB	±6.0 deg	±6.0 deg
0 dB to −40 dB	±0.3 deg	±0.3 deg
−40 dB to −50 dB	±0.3 deg	±0.8 deg
−50 dB to −60 dB	±0.8 deg	±2.0 deg
−60 dB to −70 dB	±2.0 deg	±6.0 deg
−70 dB to −80 dB	±6.0 deg	±20.0 deg
−80 dB to −90 dB	±20.0 deg	———

(2) Testing instruments

- Standard attenuator: ATT with its calibration accuracy traced to domestic standards (10 dB/0.01 dB)
- Calibration kit: 3750

(3) Setup

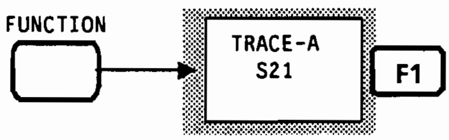


Phase dynamic accuracy test

(4) Testing procedure

Between 0 dB and − 90 dB

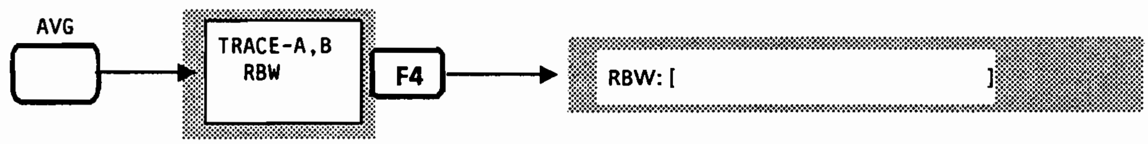
Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to select the measurement mode S21 from the menu.



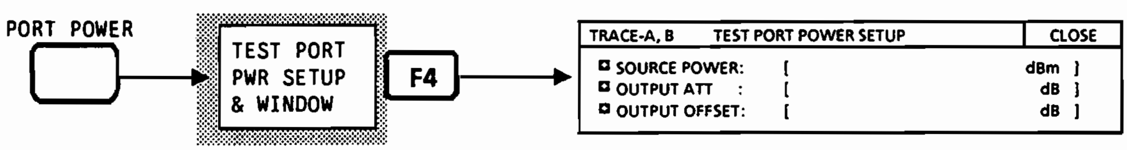
3 Press the FORMAT key to select the display format PHASE.

4 Press the FREQ key to set CENTER FREQ to 10.1 MHz and SPAN to 0 Hz.

5 Set RBW to 10 Hz in the key-in sequence below.

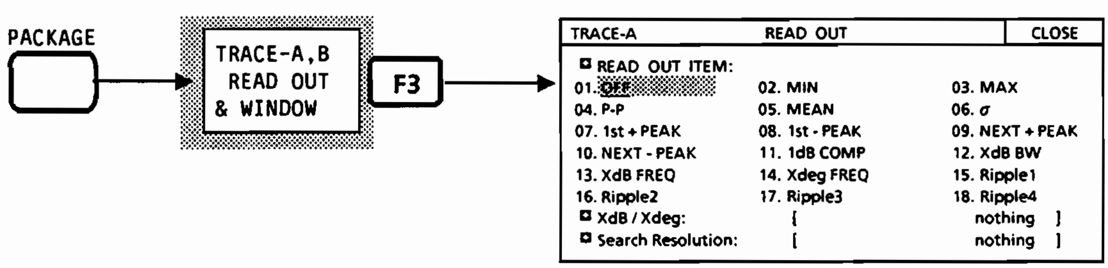


6 Set OUTPUT ATT to 10 dB in the key-in sequence below.



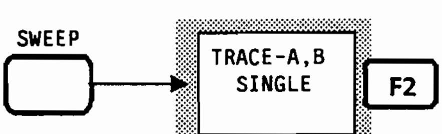
7 Using a 3750 calibration kit, run full two-port calibration.

8 Select 5. MEAN from the READ OUT parameter group in the key-in sequence below.



9 Connect a standard attenuator according to the setup diagram and set it to 0 dB. Note the reading observed at this time as a reference number.

10 Run a single sweep in the key-in sequence below.

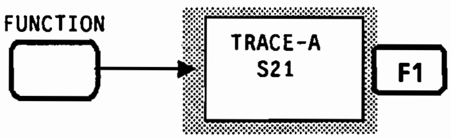


11 Read the feature extraction value. Its difference from the reference number represents the dynamic accuracy.

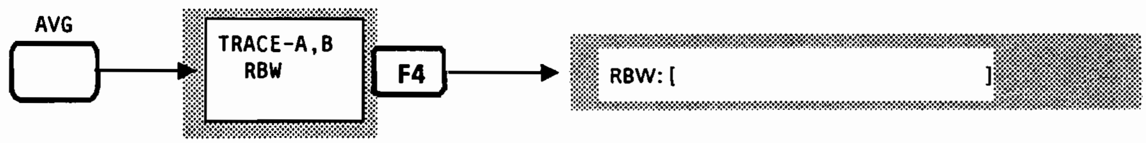
Step	Operation
12	Repeat **Steps 10** to **11** each time the standard attenuator is set to 10 to 90 dB.
13	Select the measurement mode S12 in **Step 2.**
14	Press the FORMAT key to select the display format PHASE.
15	Repeat **Steps 9** to **12**.

Between 0 dB and + 10 dB

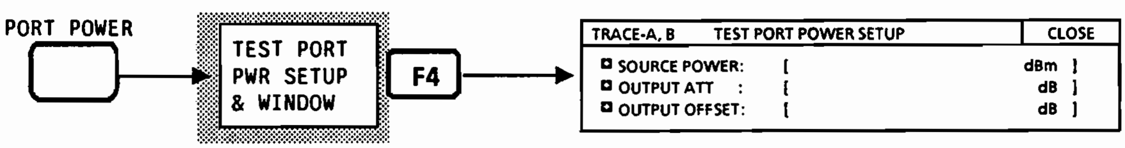
Step	Operation
1	Press the INITIAL key.
2	Press the FREQ key to select the measurement mode S21 from the menu.



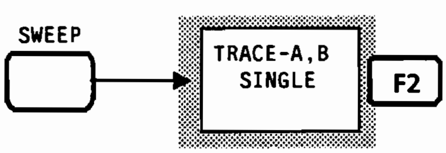
Step	Operation
3	Press the FORMAT key to select the display format PHASE.
4	Set RBW to 10 Hz in the key-in sequence below.



Step	Operation
5	Set OUTPUT ATT to 10 dB and SOURCE POWER to +23 dBm in the key-in sequence below.



Step	Operation
6	Using a 3750 calibration kit, run full two-port calibration.
7	Connect a standard attenuator according to the setup diagram and set it to 0 dB.
8	Run a single sweep in the key-in sequence below.



Step	Operation
9	Press the SCREEN key to set SCALE to 1 deg/ and press STORAGE F6 .
10	Set the standard attenuator to 10 to 0 dB.
11	Run a single sweep as in **Step 8**. The difference between the two waveforms represents the dynamic accuracy.
12	Select the measurement mode S12 in **Step 2**.
13	Press the FORMAT key to select the display format PHASE.
14	Repeat **Steps 7** to **11**.

SECTION 12
STORAGE AND TRANSPORTATION

This chapter explains how to take care of the MS4662A Network Analyzer during day-to-day use, store it over long periods of time, repack, and transport it.

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(Blank)

12.1 Cabinet Cleaning

Before cleaning, turn off the unit and unplug it.

- Clean the exterior surfaces of the cabinet with a dry, soft cloth.
- If dirt or dust noticeably adheres to the unit, after the unit has been used in a dusty environment, or before it is left out of service for a long period of time, wipe it with a cloth saturated with a diluted synthetic detergent solution. After cleaning, wipe dry with a dry, soft cloth.
- If components are found loose, clamp them again using specified tools.

CAUTION

Never use organic solvents, such as benzine, thinner, and alcohol, to clean the cabinet surfaces. The surface coat could be damaged or deformed or discolored.

12.2 Storage Precautions

Apply these precautions when storing the MS4662A Network Analyzer over extended periods of time.

12.2.1 Precautions before storage

(1) Wipe off dust, fingerprint marks, and other dirt and strains from the unit.

(2) Avoid storing the unit in these locations:

1) Exposed to direct sunlight or dusty.

2) Highly damp, threatening adherence of moisture drops or dew condensation.

3) Exposed to reactive gases or gases that could oxidize the unit.

4) Ambient

- Temperature >70 °C, < −40 °C
- Relative humidity ≧ 90 %

12.2.2 Recommended storage conditions

When the unit is left out of service for a long period of time, it should be stored to observe the following environmental conditions, as well as the storage conditions above:

- Temperature .... 0 to 30 °C
- Relative humidity ..... 40 to 80 %
- Little daily change in temperature in humidity

12.3 Repacking and Transportation for Return

When returning the MS4662A to Anritsu for repair, observe these precautions.

12.3.1 Repacking

Use the packaging material in which the unit had been delivered. If any other packaging material is used, take notice of these instructions:

(1) Wrap the unit in a vinyl sheet or the like.

(2) WProvide a corrugated fiberboard box, wooden box, or aluminum box large enough to place cushioning material on all sides of the unit.

(3) Place cushioning material in the box to protect all sides of the unit against shocks during transit and to secure it in firm position.

(4) Secure the outside the box with packaging strings, adhesive tap, bands or the like.

12.3.2 Transportation

Transport the MS4662A to avoid vibration to the extent possible and to meet the recommended storage conditions given in 12.2.2.

APPENDIXES

TABLE OF CONTENTS

(Blank)

Appendix A
Default List

Default list (1/5)

Group	Major parameter	Command	Initial data
ACTIVE A B; FUNCTION; FORMAT	ACTIVE TRACE	ACTR	TRACE-A
	S-PRM (Trace A)	SPRM	S_{11}
	S-PRM (Trace B)	SPRM	S_{21}
	S-PRM-TIME (Trace A)	TDMA	BAND PASS
	S-PRM-TIME (Trace B)	TDMA	S_{21}
	COORDINATE (Trace A)	COOR	LOG MAG
	COORDINATE (Trace B)	COOR	LOG MAG
	IMPD MARKER VALUE	IMV	$\lvert Z \rvert/\theta$
	ADMT MARKER VALUE	ADV	$\lvert Y \rvert/\theta$
MKR; MKR FCTN	ACTIVE MKR No.	MSET	MK␣0
	INACTIVE MKR No.		MK␣1 to 9
	ZONE (LEFT & RIGHT) MKR:	CPL␣ ZNAB	ON
	ZONE LEFT POINT width (Trace A)	ZNA␣Ø	(MEP† − 1)/4
	ZONE LEFT POINT width (Trace B)	ZNB␣Ø	(MEP† − 1)/4
	ZONE RIGHT POINT width (Trace A)	ZNA␣Ø	(MEP† − 1)/4
	ZONE RIGHT POINT width (Trace B)	ZNB␣Ø	(MEP† − 1)/4
	ZONE LEFT FREQUENCY (Trace A)	ZNA␣1	744 ··· MHz
	ZONE LEFT FREQUENCY (Trace B)	ZNB␣1	744 ··· MHz
	ZONE RIGHT FREQUENCY (Trace A)	ZNA␣1	2.25 ··· GHz
	ZONE RIGHT FREQUENCY (Trace B)	ZNB␣1	2.25 ··· GHz
	ACTIVE MKR TRACE-A, B COUPLE	CPL␣ MSET	ON
	MKR POINT MKR 0 to 9	MSET␣Ø	All 250 points for MKR 0 through 9
	MKR FUNCTION (Trace A/B)	MKR	NORMAL
	REFERENCE MKR No. (Trace A/B)	RMKR	OFF
	ACTIVE MKR FREQUENCY VALUE	MKF?	1.5 ··· GHz
	ACTIVE MKR DISTANCE VALUE	MKF?	Dependent on the setting

† Measurement Point

Default list (2/5)

Group	Major parameter		Command	Initial data
SCREEN	ACTIVE MKR TIME VALUE		MKF?	Dependent on the setting
	SCALE (Trace A)		SCAL	10 dB/(LOG MAG)
	SCALE (Trace B)		SCAL	10 dB/(LOG MAG)
	OFFSET (Trace A)		OFST	0.000 dB (LOG MAG)
	OFFSET (Trace B)		OFST	0.000 dB (LOG MAG)
	DUAL TRACE MODE		DF2	OFF (SINGLE)
	TRACE-A OVERLAP ON/OFF		OVPA OVP	OFF
	TRACE-B OVERLAP ON/OFF		OVPB OVP	OFF
	GRID MODE		DF1	ALL
	OFFSET LINE		OFS	5
	DISPLAY ITEM CODE		DF3 DF4	All items displayed
	TRACE-A, B STORAGE ON/OFF		STOR	OFF
FREQ	TRACE-A, B COUPLE ON/OFF	CENTER FREQUENCY	CPL␣SWP	ON, 1.5 GHz
		SPAN FREQUENCY	CPL␣SWP	ON, 2 GHz
		START FREQUENCY	CPL␣SWP	ON, 100 kHz
		STOP FREQUENCY	CPL␣SWP	ON, 3 GHz
		RBW	CPL␣AVG	ON, AUTO
	FREQUENCY SWEEP MODE		FRQ	START/STOP
	DISTANCE/TIME SELECT		TAMD	TIME
	START TIME		STTM	−0.010 μs
	SPAN TIME		SPTM	0.050 μs
SWEEP	REPEAT/SINGLE SWEEP (Trace A/B)		SW2 SWP	REPEAT SWEEP
	SWEEP TIME (Trace A/B)		SWT	AUTO: 125 ms
	SWEEP LOG/LIN MODE (Trace A/B)		LOG	LINEAR
	SWEEP RANGE MODE (FULL/MKR) (Trace A/B)		SW1	FULL SWEEP

Default list (3/5)

Group	Major parameter		Command	Initial data
PORT POWER	TRACE-A, B COUPLE ON/OFF	PORT1 INPUT ATT	CPL_SWP	ON, 0 dBm
		PORT2 INPUT ATT	CPL_SWP	ON, 0 dBm
		DELAY RANGE	CPL_SWP	ON, 400 ms
		HSDLY DISTANCE	CPL_SWP	ON, 1 %
	PORT1 INPUT		IATA	0 dB
	PORT2 INPUT		IATB	0 dB
	TEST PORT POWER		OPL	0 dBm
	SOURCE POWER		SPWR	+13 dBm
	OUTPUT ATT		OATT	0 dB
	OUTPUT OFFSET		OOFS	−13 dB
	POWER SWEEP ON/OFF		LSW	OFF
	POWER SWEEP START LEVEL (Trace A/B)		STL	0 dBm
	POWER SWEEP STOP LEVEL (Trace A/B)		SOL	+10 dBm
	POWER SWEEP STEP LEVEL (Trace A/B)		SEL	1.00 dB
	POWER LEVEL TRACE-A, B COUPLE ON/OFF		CPL_SWP	ON
	POWER LEVEL		CPL	+10 dBm
	APERTURE FREQUENCY (ATrace /B)		APF	24 MHz
	DELAY RANGE SETTING MODE (Trace A/B)		———	DELAY RANGE
FREQ/TIME	TIME DOMAIN ON/OFF		TMDM	TIME DOMAIN OFF
TIME DOMAIN	GATE ON/OFF			OFF
	RESPONSE		RSPS	IMPULSE
	GATE SHAPE		GSHP	RECTANGULAR
	FILTER SHAPE		FSHP	RECTANGULAR
AVG	AVERAGE TYPE (Trace A/B)		AVT	SUM
	AVERAGE NUMBER (Trace A/B)		AVG	1
	SMOOTHING (Trace A/B)		SMT	0 %

Default list (4/5)

Group	Major parameter	Command	Initial data
CAL	CAL ON/OFF (X → S, X-S)	CAL	X → S OFF
	X-S ON/OFF	CXS	X-S OFF
	CAL METHOD	ECL	X-S
PACKAGE	BREAK POINT (Trace A/B)	BKP	1001
	TITLE	TEN	All blank
	TITLE ON/OFF	TTL	OFF
	MEASURE POINT (Trace A/B)	MEP	251
	SOURCE MEMORY	CSCE	TRACE-A
	DISTINATION MEMORY	CDST	TRACE-A
	CALCULATION	CEXE	D+S
	INITIAL FORMAT	———	0 CLEAR
	REAL PART	CNST	1.00000
	IMAGINARY PART	CNST	0.00000
	INITIALIZE EXECUTED	———	END
	ELECTRIC LENGTH	CPL␣ELG	0.000 m
SAV/RCL	DATA STORAGE UNIT PORT SELECT	PMCA	PORT-2
	DATA STORAGE UNIT GPIB ADDRESS	PMCA	17
	DRIVE SELECT CODE	PMCS	INT PMC
	RECALL FUNCTION No. CODE	RCM	MEMORY 0
	SAVE FUNCTION No. CODE	SVM	MEMORY 0
	SAVE S-MEMORY ON/OFF	SV2	OFF
	SAVE X-MEMORY ON/OFF	SV3	OFF
	SAVE CALIBRATION MEMORY ON/OFF	SV6	OFF
	WORK MEMORY ON/OFF	SVDM␣m (m:1to4)	OFF

Default list (5/5)

Group	Major parameter	Command	Initial data
LOCAL	REMOTE/LOCAL FUNCTION	GTLT	LOCAL†
	GPIB OUTPUT TERMINATOR (PORT-1)	TRM	LF & EOI
	GPIB TIME OUT (PORT-1)	GTM	20s
	DEVICE SELECT (PRINTER or PLOTTER)	PLTD	PRINTER
	PRINTER ADDRESS	PRIA	17
	PRINTER DEVICE SELECT	PRIM	UA-455A
	PLOTTER ADDRESS	PLTA	17
	PLOTTER DEVICE SELECT	PLTM	GP-GL
	PLOT SIZE	PLF	A4 size
	FORM FEED	PFF	No FF output
	PLOT POSSION CODE	PLPS	ALL
	PLOT ITEM	PLI	ALL ITEM
	GPIB SRQ ON/OFF	SRQ	OFF
	GPIB OUTPUT TERMINATOR	TRM	LF & EOI
	GPIB TIME OUT	GTM	20s
PTA	PTA ON/OFF	PTA	OFF
	PTA PROGRAM INPUT/OUTPUT	PTL	OFF
	PTA BUSY/NORMAL	PTA?	NORMAL

† GTL is a bus command (interface message). To run this command and set the device local, use the LCL@ statement.

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Appendix B
Softkey Menu Function Guide

This appendix lists the softkey menus that are invoked by pressing panel keys in alphabetic order of the menu call keys and describes their functions by menu label. Consult the softkey menu function guide to expedite the work of softkey menu selections or to resolve questions in the use of particular functions.

The table below lists the menu cal key names, menu title names with subheaders, and the numbers of the pages on which the menus are covered.

Softkey Menu Function Guide

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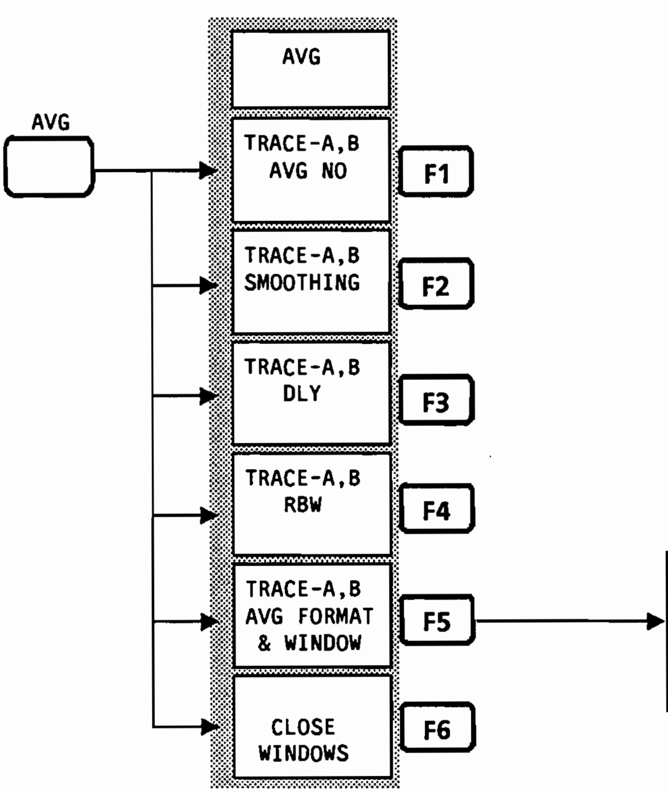
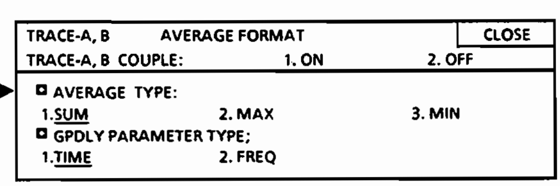
	AVG
Selects an averaging count between 1 and 1,000. An averaging count of 1 will execute a normal run of measurement, without averaging calculations. The default is AVERAGE NUMBER 1.	TRACE-A,B AVG NO
Selects a smoothing ratio between 0 and 50 % of the frequency span. A smoothing ratio of 0 % will execute a normal run of measurement, without averaging calculations. The default is SMOOTHING 0 %.	TRACE-A,B SMOOTHING
Sets a group delay parameter (aperture, delay).	TRACE-A,B DLY
Selects a resolution bandwidth (RBW) between 3 Hz and 10 kHz in 1-3 or 3-1 steps. The default is AUTO, which sets an optimal RBW matched to the sweep time automatically to remove measurement errors even when the frequency span or sweep time is altered.	TRACE-A,B RBW
Selects an AVG menu format (TRACE-A, B COUPLE ON/OFF, AVERAGE TYPE, and GPDLY PARAMETER TYPE).	TRACE-A,B AVG FORMAT & WINDOW
Closes the window.	CLOSE WINDOWS

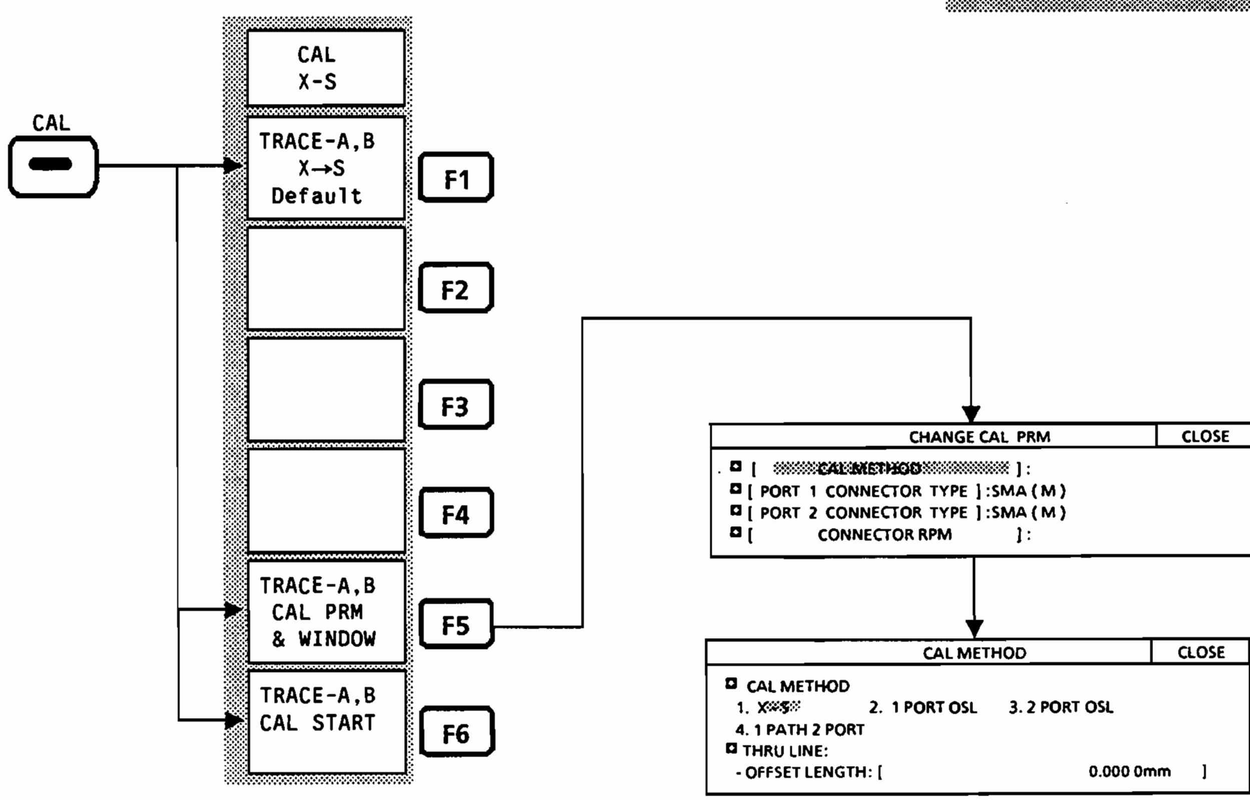
Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the AVERAGE FORMAT menu, which is displayed by pressing AVG FORMAT & WINDOW F5. EL (electrical length) from the SCREEN menu and MEAS POINT (measuring point) from the PACKAGE menu are controlled at the same time.





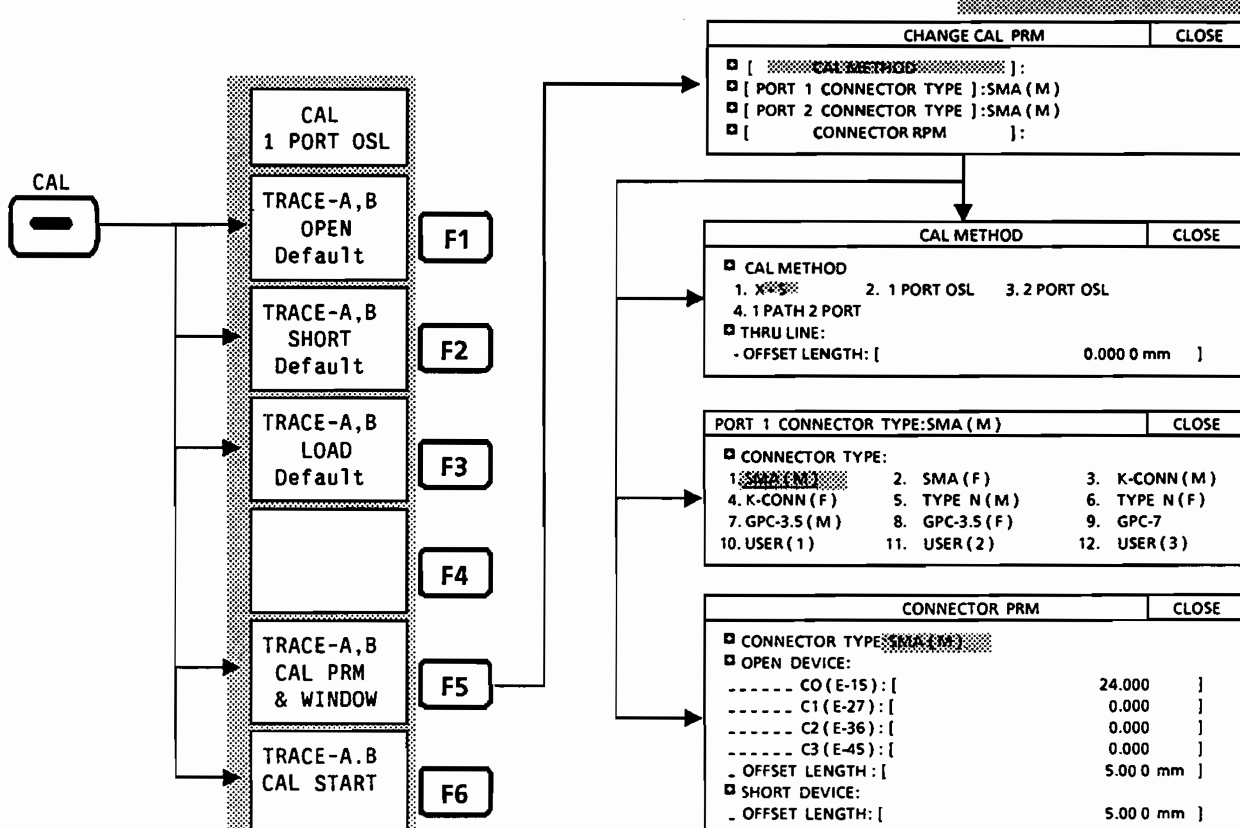
CAL X – S

	CAL X-S
Loads CAL data (frequency characteristics of the testing system alone) into X memory, with the X → S Default label changing to "X → S Measuring." "X → S Measuring" lasts while loading is in progress. The X → S Measuring label changes to "X → S Created" when data loading in S memory is complete.	TRACE-A,B X→S Default†
If the X-S method is not the current choice, open the CAL METHOD window by following the route marked in a continuous line below to select the X-S method.	TRACE-A,B CAL PRM & WINDOW
Press CAL START to start error correction, collecting a measurement value corrected after a single sweep.	TRACE-A,B CAL START



† Pressing the CAL key in the Created state would display "FRMR Data" (former data), meaning that created CAL data is available to CAL menus labeled FRMR Data.

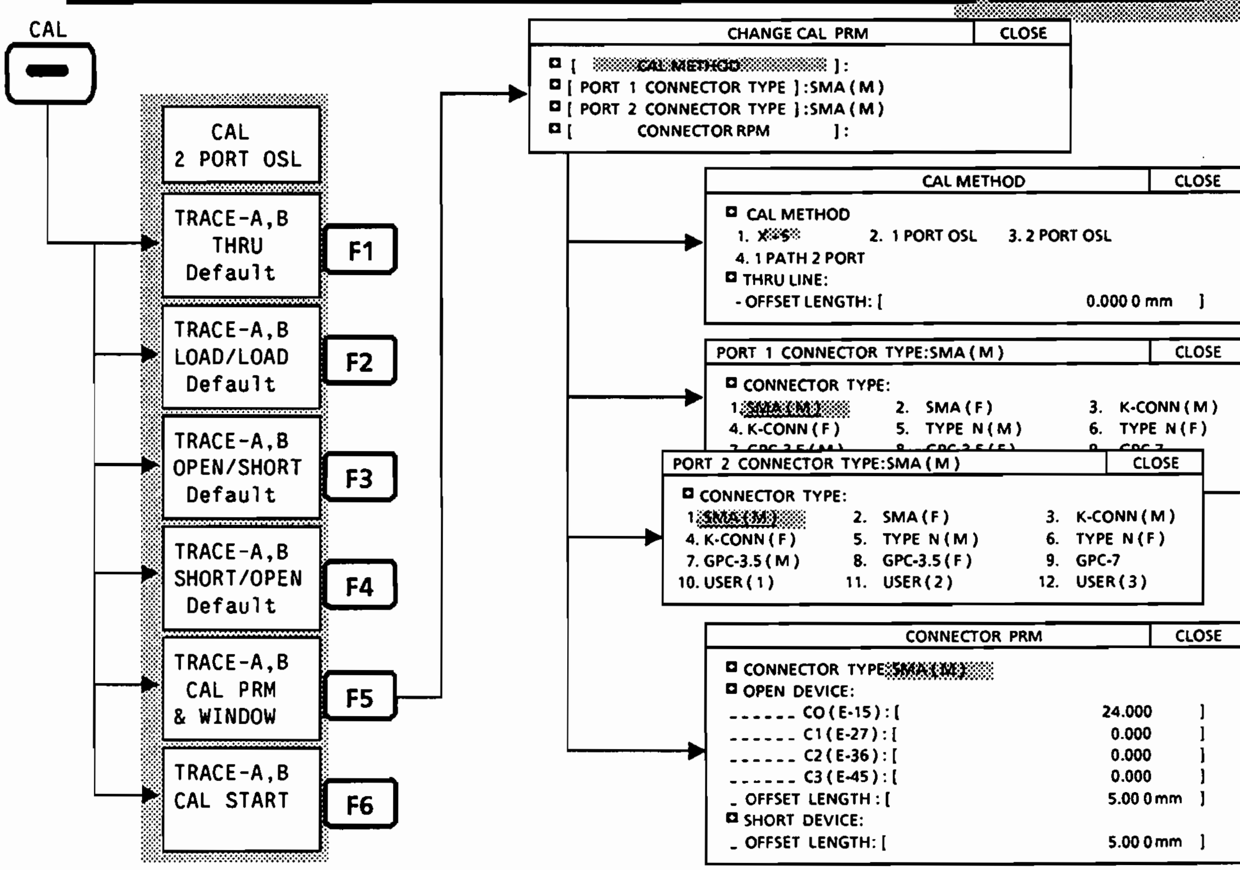
	CAL 1 PORT OSL
Connect an open device (OPEN) to port 1. Press OPEN Default to start a sweep, with the OPEN Default label changing to "OPEN Measuring." "OPEN Measuring" lasts while the sweep is in progress. The OPEN Measuring label changes to "OPEN Created" when CAL data loading in CAL memory is complete.	TRACE-A,B OPEN Default†
Connect a short device (SHORT) to port 1. Press SHORT Default to start a sweep, with the SHORT Default label changing to "SHORT Measuring." "SHORT Measuring" lasts while the sweep is in progress. The SHORT Measuring label changes to "SHORT Created" when CAL data loading in CAL memory is complete.	TRACE-A,B SHORT Default†
Connect a load device (LOAD) to port 1. Press LOAD Default to start a sweep, with the LOAD Default label changing to "LOAD Measuring." "LOAD Measuring" lasts while the sweep is in progress. The LOAD Measuring label changes to "LOAD Created" when CAL data loading in CAL memory is complete.	TRACE-A,B LOAD Default†
Open the CAL METHOD window to select 1 PORT OSL in the key-in sequence below. Select the type of connector attached to test port 1, set the open capacitance and offset length of the open device, and set the offset length of the short device.	TRACE-A,B CAL PRM & WINDOW
Press CAL START to start error correction, collecting a measurement value corrected after a single sweep.	TRACE-A,B CAL START



† Pressing the CAL key in the Created state would display "FRMR Data" (former data), meaning that created CAL data is available to CAL menus labeled FRMR Data.

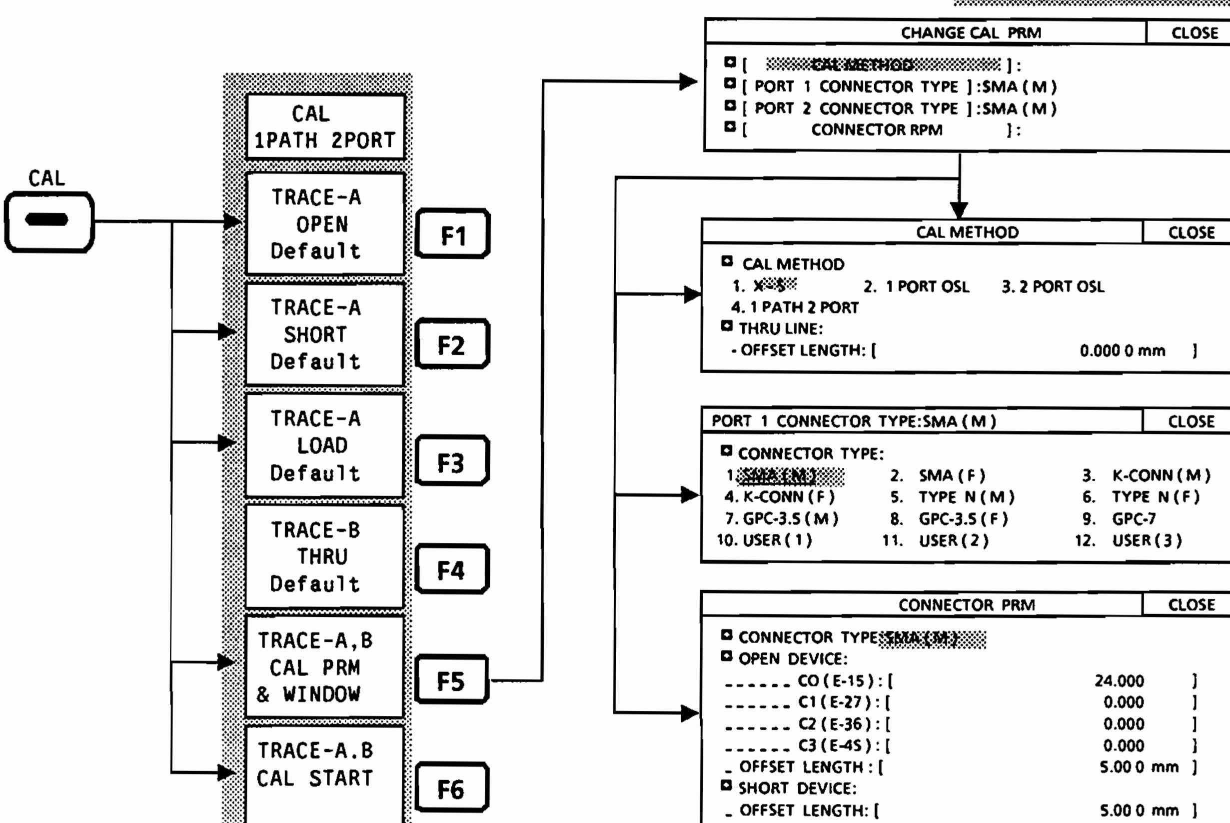
CAL 2 PORT OSL

	CAL 2 PORT OSL
Interconnect ports 1 and 2 with through lines. Press THRU Default to start a sweep, with the THRU Default label changing to "THRU Measuring." "THRU Measuring" lasts while the sweep is in progress. The THRU Measuring label changes to "THRU Created" when CAL data loading in CAL memory is complete.	TRACE-A,B THRU Default†
Connect loads to ports 1 and 2. Press LOAD/LOAD Default, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for THRU, with the CAL data being loaded into CAL memory.	TRACE-A,B LOAD/LOAD Default†
Connect OPEN to port 1 and SHORT to port 2. Press SHORT/OPEN Default, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for LOAD, with the CAL data being loaded into CAL memory.	TRACE-A,B OPEN/SHORT Default†
Connect SHORT to port 1 and OPEN to port 2. Press SHORT/OPEN Default, and the label changes from "Default," to "Measuring" and to "Created" in the same way as for OPEN/SHORT, with the CAL data being loaded into CAL memory.	TRACE-A,B SHORT/OPEN Default†
Open the CAL METHOD window to select 2 PORT OSL in the key-in sequence below. Select the type of connector attached to test port 1, set the open capacitance and offset length of the open device, and set the offset length of the short device.	TRACE-A,B CAL PRM & WINDOW
Press CAL START to start error correction, collecting a measurement value corrected after two sweeps.	TRACE-A,B CAL START



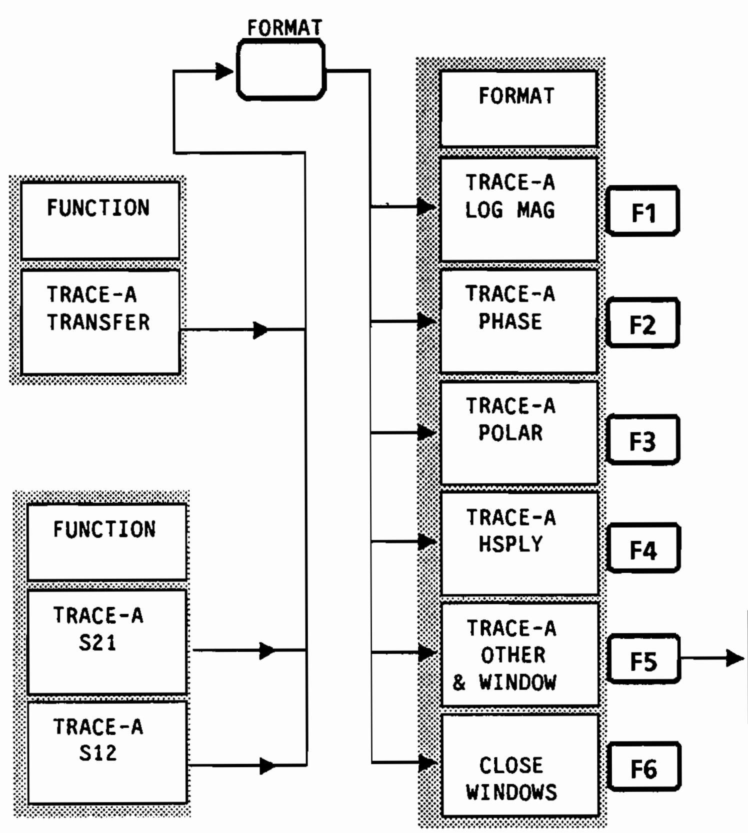
† Pressing the CAL key in the Created state would display "FRMR Data" (former data), meaning that created CAL data is available to CAL menus labeled FRMR Data.

	CAL 1PATH 2PORT
Connect an open device (OPEN) to port 1. Press OPEN Default to start a sweep, with the OPEN Default label changing to "OPEN Measuring." "OPEN Measuring" lasts while the sweep is in progress. The OPEN Measuring label changes to "OPEN Created" when CAL data loading in CAL memory is complete.	TRACE-A OPEN Default†
Connect a short device (SHORT) to port 1. Press SHORT Default to start a sweep, with the SHORT Default label changing to "SHORT Measuring." "SHORT Measuring" lasts while the sweep is in progress. The SHORT Measuring label changes to "SHORT Created" when CAL data loading in CAL memory is complete.	TRACE-A SHORT Default†
Connect a load device (LOAD) to port 1. Press LOAD Default to start a sweep, with the LOAD Default label changing to "LOAD Measuring." "LOAD Measuring" lasts while the sweep is in progress. The LOAD Measuring label changes to "LOAD Created" when CAL data loading in CAL memory is complete.	TRACE-A LOAD Default†
Connect through lines. Press THRU Default to start a sweep, with the THRU Default label changing to "THRU Measuring." "THRU Measuring" lasts while the sweep is in progress. The THRU Measuring label changes to "THRU Created" when CAL data loading in CAL memory is complete.	TRACE-B THRU Default†
Open the CAL METHOD window to select 1 PATH 2 PORT in the key-in sequence below. Select the type of connector attached to test port 1, set the open capacitance and offset length of the open device, and set the offset length of the short device.	TRACE-A,B CAL PRM & WINDOW
After connecting a DUT to the test ports to set up a testing system inclusive of the DUT, press CAL START F6 to collect a measurement value corrected after two sweeps.	TRACE-A,B CAL START

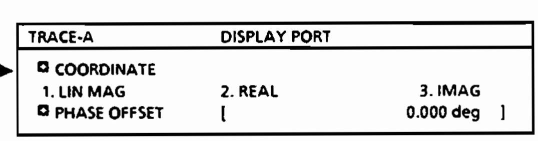


† Pressing the CAL key in the Created state would display "FRMR Data" (former data), meaning that created CAL data is available to CAL menus labeled FRMR Data.

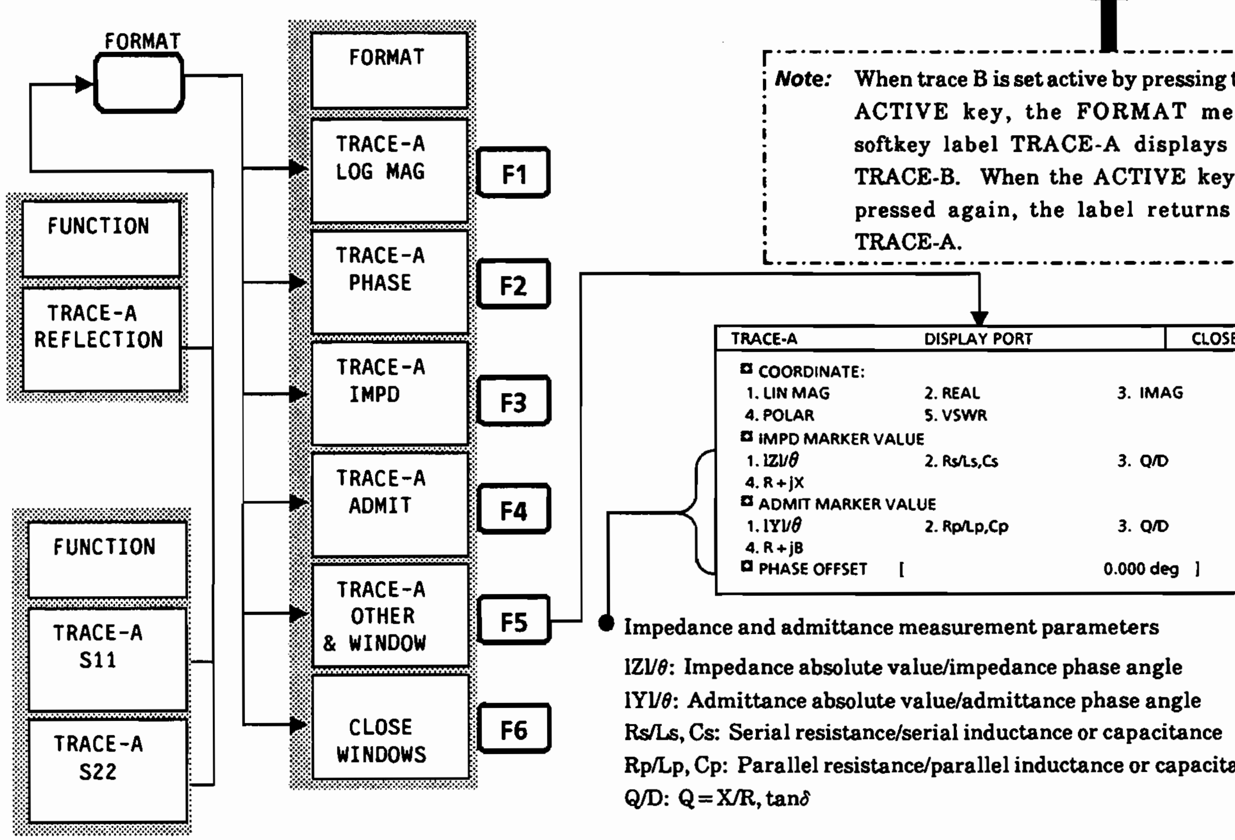
	FORMAT
When S21 or S12 is selected, press FORMAT menu F1 to select a logarithmic magnitude data display screen.	TRACE-A LOG MAG
When S21 or S12 is selected, press FORMAT menu F2 to select a phase data display screen.	TRACE-A PHASE
When S21 or S12 is selected, press FORMAT menu F3 to select a polar chart.	TRACE-A POLAR
When S21 or S12 is selected, press FORMAT menu F4 to select a high-speed group delay screen.	TRACE-A HSPLY
When S21 or S12 is selected, press FORMAT menu F5 to open the DISPLAY FORMAT window for choosing from among a linear magnitude data display screen (LIN MAG), a real number data display screen (REAL), and an imaginary number data display screen (IMAG) for changing the phase extension.	TRACE-A OTHER & WINDOW
Closes the window.	CLOSE WINDOWS



Note: When trace B is set active by pressing the ACTIVE key, the FORMAT menu softkey label TRACE-A displays as TRACE-B. When the ACTIVE key is pressed again, the label returns to TRACE-A.



	FORMAT
When S11 or S22 is selected, press FORMAT menu F1 to select a logarithmic magnitude data display screen.	TRACE-A LOG MAG
When S11 or S22 is selected, press FORMAT menu F2 to select a phase data display screen.	TRACE-A PHASE
When S11 or S22 is selected, press FORMAT menu F3 to select an impedance data display screen.	TRACE-A IMPD
When S11 or S22 is selected, press FORMAT menu F4 to select an admittance data display screen.	TRACE-A ADMIT
When S11 or S22 is selected, press FORMAT menu F5 to open the DISPLAY PORT window for choosing from among a linear magnitude data display screen (LIN MAG), a real number data display screen (REAL), an imaginary number data display screen (IMAG), and a polar chart or VSWR data display screen (VSWR) for changing the phase extension.	TRACE-A OTHER & WINDOW
Closes the window.	CLOSE WINDOWS



Note: When trace B is set active by pressing the ACTIVE key, the FORMAT menu softkey label TRACE-A displays as TRACE-B. When the ACTIVE key is pressed again, the label returns to TRACE-A.

● Impedance and admittance measurement parameters

|Z|/θ: Impedance absolute value/impedance phase angle

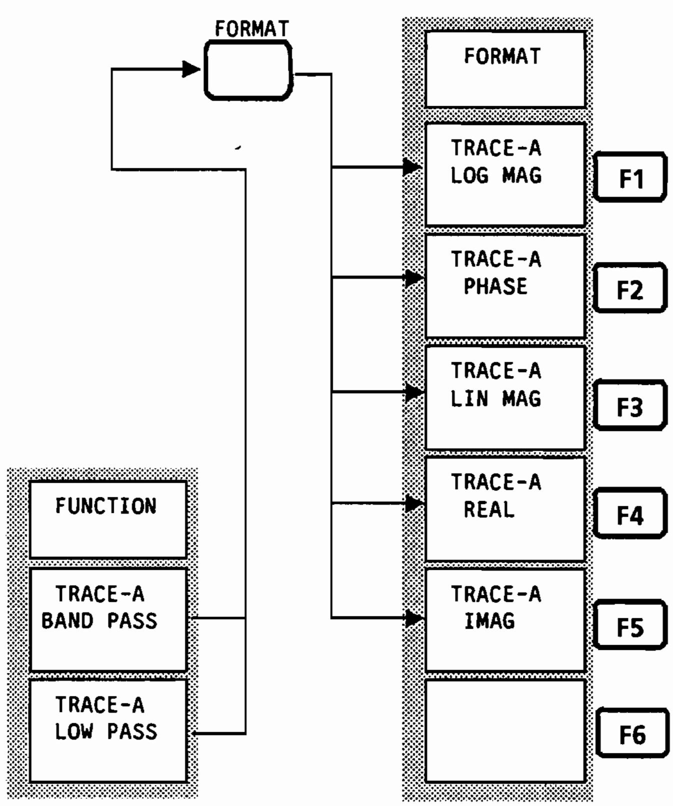
|Y|/θ: Admittance absolute value/admittance phase angle

Rs/Ls, Cs: Serial resistance/serial inductance or capacitance

Rp/Lp, Cp: Parallel resistance/parallel inductance or capacitance

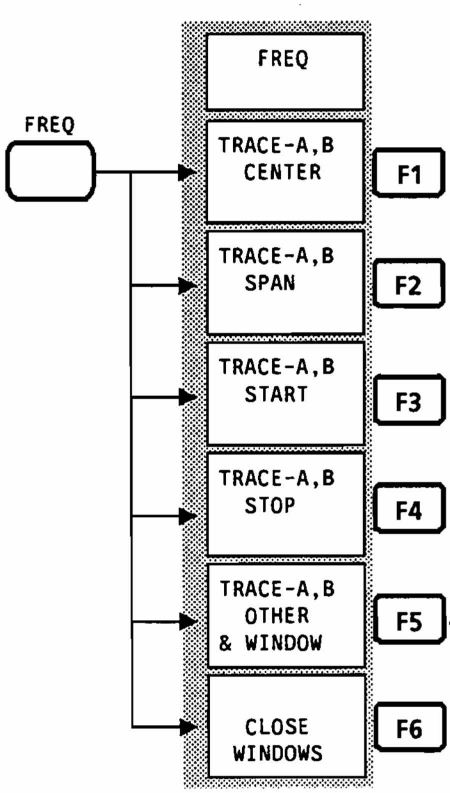
Q/D: Q = X/R, tanδ

	FORMAT
When BAND PASS or LOW PASS is selected, press FORMAT menu F1 to select a logarithmic magnitude data display screen.	TRACE-A LOG MAG
When BAND PASS or LOW PASS is selected, press FORMAT menu F2 to select a phase data display screen.	TRACE-A PHASE
When BAND PASS or LOW PASS is selected, press FORMAT menu F3 to select a linear magnitude data display screen.	TRACE-A LIN MAG
When BAND PASS or LOW PASS is selected, press FORMAT menu F4 to select a real data display screen.	TRACE-A REAL
When BAND PASS or LOW PASS is selected, press FORMAT menu F5 to select an imaginary data display screen.	TRACE-A IMAG

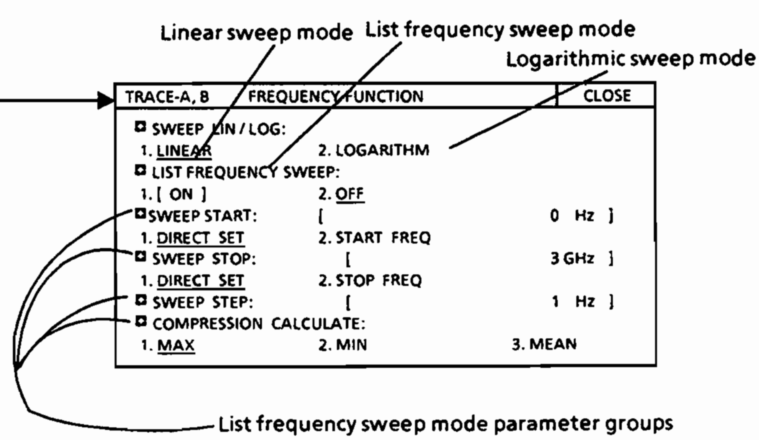


Note: When trace B is set active by pressing the ACTIVE key, the FORMAT menu softkey label TRACE-A displays as TRACE-B. When the ACTIVE key is pressed again, the label returns to TRACE-A.

Description	FREQ
Sets the sweep center frequency. The default is 1.5 GHz.	TRACE-A,B CENTER
Sets the seep frequency span. The default is 2 GHz.	TRACE-A,B SPAN
Sets the sweep start frequency. The default is 100 kHz.	TRACE-A,B START
Sets the sweep stop frequency. The default is 3 GHz.	TRACE-A,B STOP
Selects sweep modes (linear/logarithmic sweep and list frequency sweep). In the list frequency mode, select execution parameters (START LIST FREQUENCY, STOP LIST FREQUENCY, SWEEP STEP (Δf), and COMPRESSION CALCULATE).	TRACE-A,B OTHER & WINDOW
Closes the window.	CLOSE WINDOWS

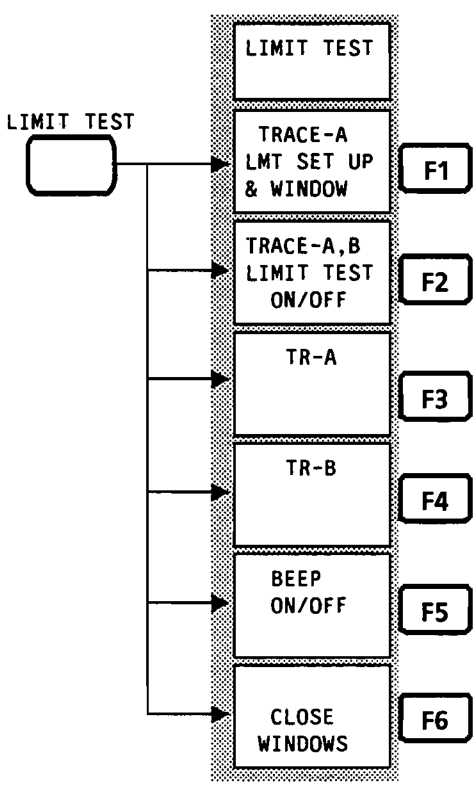


Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the SWEEP menu, which is displayed by pressing the SWEEP key. When TRACE-A, B COUPLE OFF (which appears onscreen as TRACE-A, B COUPLE ON/OFF) is set by pressing F6 in the SWEEP menu, each softkey label TRACE-A, B displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active.

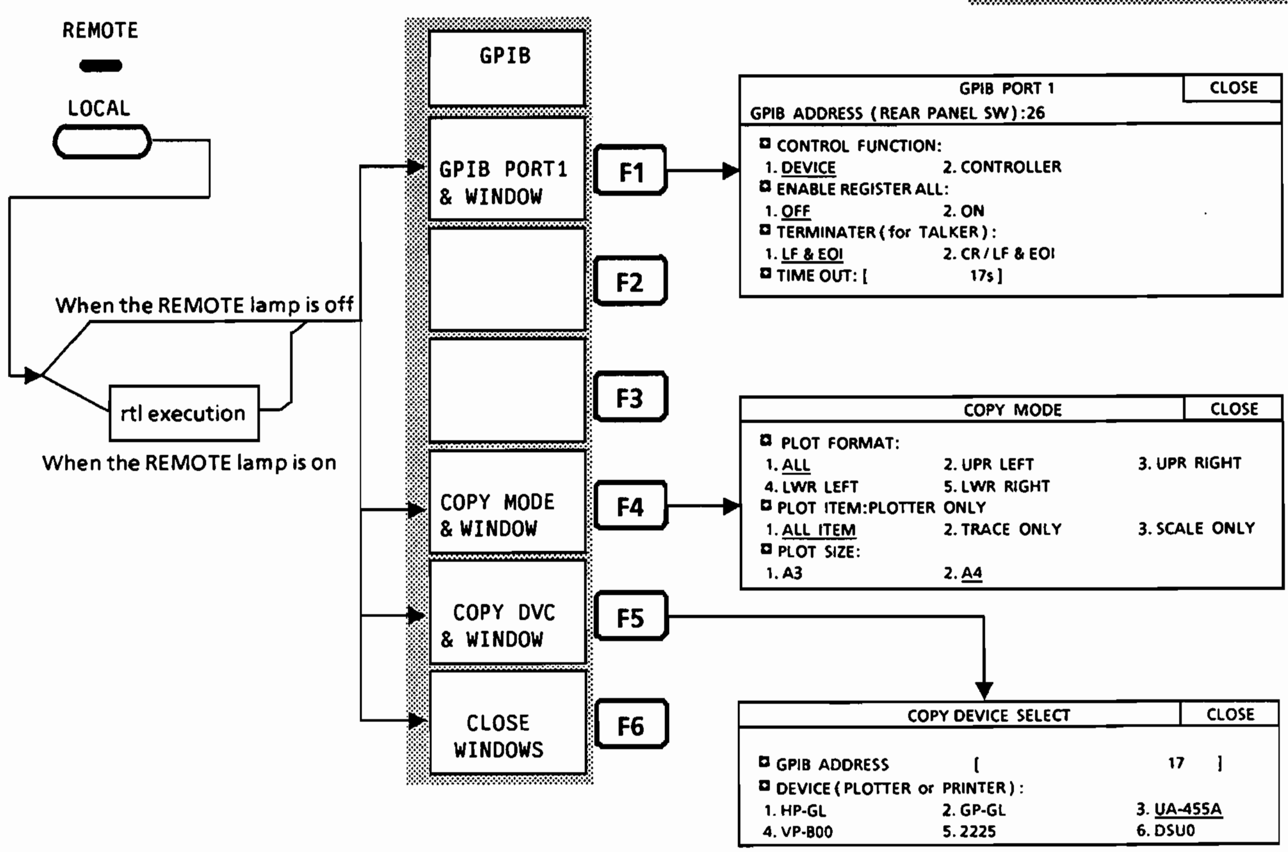


LIMIT TEST

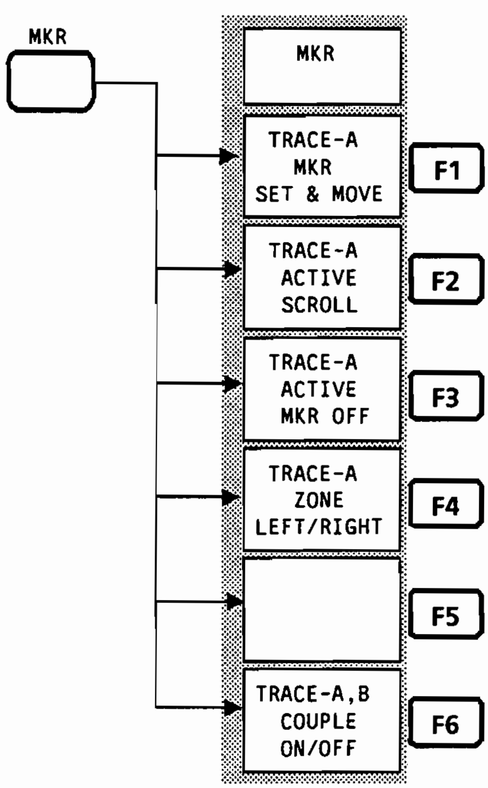
	LIMIT TEST
Enters or clears limit line data (such as single or segmented).	TRACE-A LMT SETUP & WINDOW
Controls the on/off status of limit testing (PASS/FAIL).	TRACE-A,B LIMIT TEST ON/OFF
Displays the results of TRACE-A limit testing.	TR-A
Displays the results of TRACE-B limit testing.	TR-B
Turn the beep on or off.	BEEP ON/OFF
Closes the window.	CLOSE WINDOWS



	GPIB
Checks the GPIB address, selects between the device and controller, turns enable register on or off, selects a terminator, and sets a timeout.	GPIB PORT1 & WINDOW
Selects the parameters in ( ) as copying conditions. ● PLOT FORMAT (ALL, UPR LEFT, UPR RIGHT, LWR LEFT, LWR RIGHT) ● PLOT ITEM (ALL ITEM, TRACE ONLY, SCALE ONLY) ● PLOT SIZE (A3, A4)	COPY MODE & WINDOW
Sets the copying device address (HP-GL, GP-GL, or UA-455A plotter, VP-800, 2225, or DSU printer).	COPY DVC & WINDOW
Closes the window.	CLOSE WINDOWS

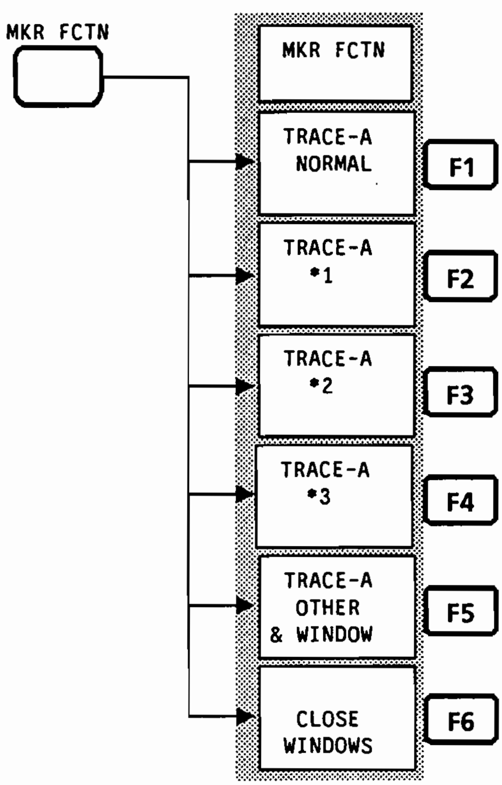


	MKR
Generates an active marker, allowing it to be moved with the knob or cursor keys. Ten different markers, numbered from 0 to 9, can be displayed concurrently.	TRACE-A MKR SET & MOVE
Scrolls the active marker between markers onscreen.	TRACE-A ACTIVE SCROLL
Turns off active markers one at a time.	TRACE-A ACTIVE MKR OFF
Expands or contracts the left or right side of a zone marker with the knob or cursor keys.	TRACE-A ZONE LEFT/RIGHT
Turns trace A and B coupling on and off.	TRACE-A,B COUPLE ON/OFF

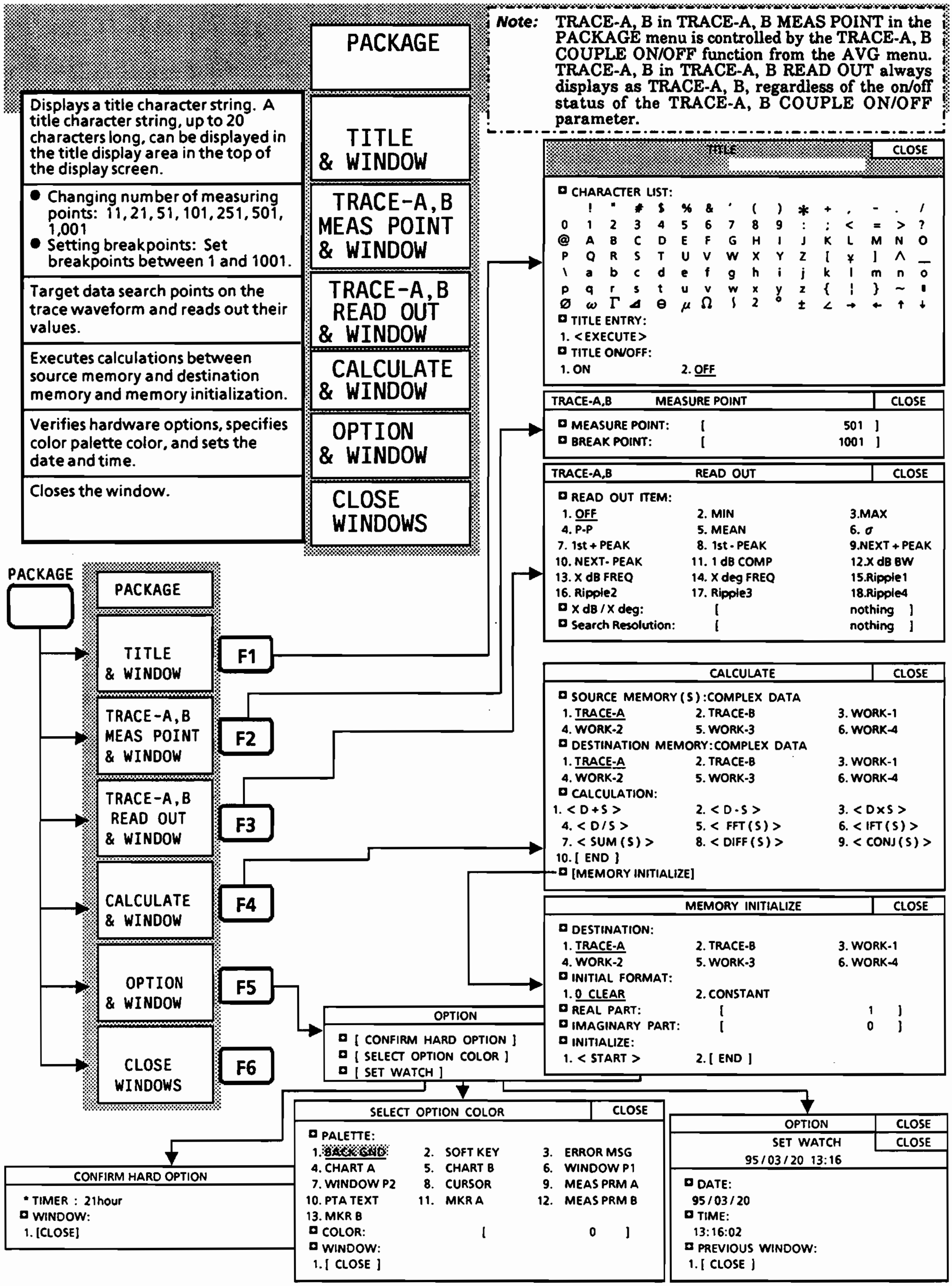


Note: If trace B is set active by pressing the ACTIVE key, the label TRACE-A in the MKR changes to TRACE-B. TRACE-A, B is displayed if TRACE-A, B COUPLE in the MKR menu is on.

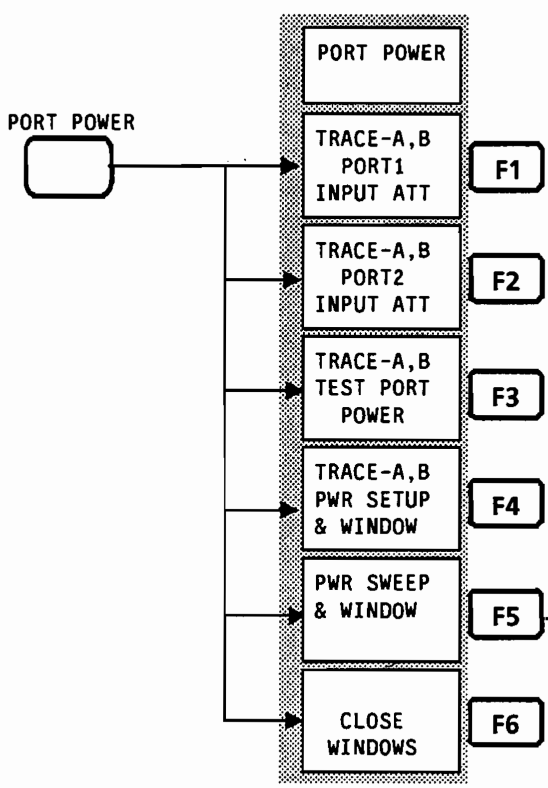
Description	Softkey
	MKR FCTN
Resets to the normal marker.	TRACE-A NORMAL
Displays or executes a preprogrammed user-defined marker function.	TRACE-A *1
Displays or executes a preprogrammed user-defined marker function.	TRACE-A *2
Displays or executes a preprogrammed user-defined marker function.	TRACE-A *3
(1) Contains a listing of marker function items. A marker function selected from them is programmed on the softkey F2, 3, or F4 as a user-defined marker function. (2) Opens the MKR FUNCTION window. ①Selects marker functions other than user-defined functions. ②Selects on which softkeys user-defined marker functions should be programmed.	TRACE-A OTHER & WINDOW
Closes the window.	CLOSE WINDOWS



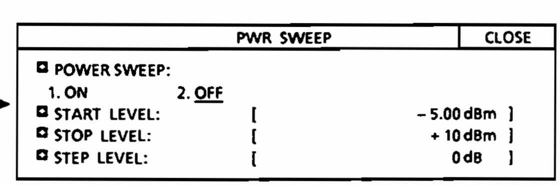
Note: If trace B is set active by pressing the ACTIVE key, the label TRACE-A in the MKR changes to TRACE-B. TRACE-A, B is displayed if TRACE-A, B COUPLE in the MKR menu is on.


Note: TRACE-A, B in TRACE-A, B MEAS POINT in the PACKAGE menu is controlled by the TRACE-A, B COUPLE ON/OFF function from the AVG menu. TRACE-A, B in TRACE-A, B READ OUT always displays as TRACE-A, B, regardless of the on/off status of the TRACE-A, B COUPLE ON/OFF parameter.
PACKAGE
Displays a title character string. A title character string, up to 20 characters long, can be displayed in the title display area in the top of the display screen.
TITLE & WINDOW
● Changing number of measuring points: 11, 21, 51, 101, 251, 501, 1,001
● Setting breakpoints: Set breakpoints between 1 and 1001.
TRACE-A,B MEAS POINT & WINDOW
Target data search points on the trace waveform and reads out their values.
TRACE-A,B READ OUT & WINDOW
Executes calculations between source memory and destination memory and memory initialization.
CALCULATE & WINDOW
Verifies hardware options, specifies color palette color, and sets the date and time.
OPTION & WINDOW
Closes the window.
CLOSE WINDOWS
PACKAGE
PACKAGE
TITLE & WINDOW
F1
TRACE-A,B MEAS POINT & WINDOW
F2
TRACE-A,B READ OUT & WINDOW
F3
CALCULATE & WINDOW
F4
OPTION & WINDOW
F5
CLOSE WINDOWS
F6
TITLE
CLOSE
CHARACTER LIST:
! " # $ % & ' ( ) * + , - . /
0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z [¥] ^ _
\ a b c d e f g h i j k l m n o
p q r s t u v w x y z { ¦ } ~ ▮
ø ω Γ ◢ ϴ μ Ω ∫ 2 ° ± ∠ → ← ↑ ↓
TITLE ENTRY:
1. <EXECUTE>
TITLE ON/OFF:
1. ON 2. OFF
TRACE-A,B MEASURE POINT
CLOSE
MEASURE POINT: [501]
BREAK POINT: [1001]
TRACE-A,B READ OUT
CLOSE
READ OUT ITEM:
1. OFF 2. MIN 3.MAX
4. P-P 5. MEAN 6. σ
7. 1st + PEAK 8. 1st - PEAK 9.NEXT + PEAK
10. NEXT- PEAK 11. 1 dB COMP 12.X dB BW
13. X dB FREQ 14. X deg FREQ 15.Ripple1
16. Ripple2 17. Ripple3 18.Ripple4
X dB / X deg: [nothing]
Search Resolution: [nothing]
CALCULATE
CLOSE
SOURCE MEMORY (S) :COMPLEX DATA
1. TRACE-A 2. TRACE-B 3. WORK-1
4. WORK-2 5. WORK-3 6. WORK-4
DESTINATION MEMORY:COMPLEX DATA
1. TRACE-A 2. TRACE-B 3. WORK-1
4. WORK-2 5. WORK-3 6. WORK-4
CALCULATION:
1. < D + S > 2. < D - S > 3. < D x S >
4. < D / S > 5. < FFT (S) > 6. < IFT (S) >
7. < SUM (S) > 8. < DIFF (S) > 9. < CONJ (S) >
10. [END]
[MEMORY INITIALIZE]
MEMORY INITIALIZE
CLOSE
DESTINATION:
1. TRACE-A 2. TRACE-B 3. WORK-1
4. WORK-2 5. WORK-3 6. WORK-4
INITIAL FORMAT:
1. 0 CLEAR 2. CONSTANT
REAL PART: [1]
IMAGINARY PART: [0]
INITIALIZE:
1. < START > 2. [END]
OPTION
[CONFIRM HARD OPTION]
[SELECT OPTION COLOR]
[SET WATCH]
CONFIRM HARD OPTION
* TIMER : 21hour
WINDOW:
1. [CLOSE]
SELECT OPTION COLOR
CLOSE
PALETTE:
1. BACK GND 2. SOFT KEY 3. ERROR MSG
4. CHART A 5. CHART B 6. WINDOW P1
7. WINDOW P2 8. CURSOR 9. MEAS PRM A
10. PTA TEXT 11. MKR A 12. MEAS PRM B
13. MKR B
COLOR: [0]
WINDOW:
1. [CLOSE]
OPTION
CLOSE
SET WATCH
CLOSE
95 / 03 / 20 13:16
DATE:
95 / 03 / 20
TIME:
13:16:02
PREVIOUS WINDOW:
1. [CLOSE]

	PORT POWER
Changes the test port 1 input attenuator (0 dBm, + 20 dBm).	TRACE-A,B PORT1 INPUT ATT
Changes the test port 2 input attenuator (0 dBm, + 20 dBm).	TRACE-A,B PORT2 INPUT ATT
Sets the test port power.	TRACE-A,B TEST PORT POWER
Sets the test port output parameters. ● Source power ● Output attenuator ● Output offset level	TRACE-A,B PWR SETUP & WINDOW
Sets power sweep parameters in the PSW SWEEP window.	PWR SWEEP & WINDOW
Closes the window.	CLOSE WINDOWS

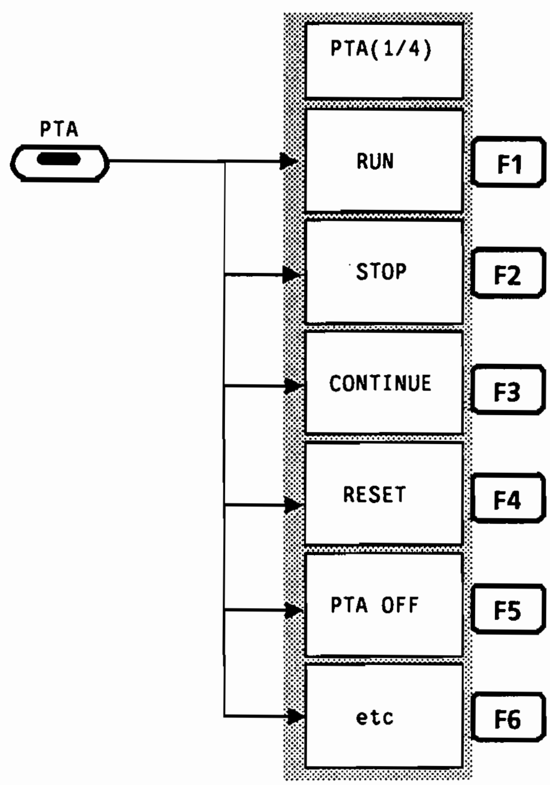


Note: The on/off status of the setup parameter TRACE-A, B COUPLE ON/OFF parameter is controlled from the SWEEP menu. When TRACE-A, B COUPLE OFF (which appears onscreen as TRACE-A, B COUPLE ON/OFF) is set by pressing F6 in the SWEEP menu, each softkey label TRACE-A, B displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active.



PTA (1/4)

	PTA(1/4)
Starts program execution.	RUN
Pauses program execution.	STOP
Restarts program execution from the paused state.	CONTINUE
Cancels program execution.	RESET
Turns off PTA.	PTA OFF
Selects the next PTA menu in sequence.	etc

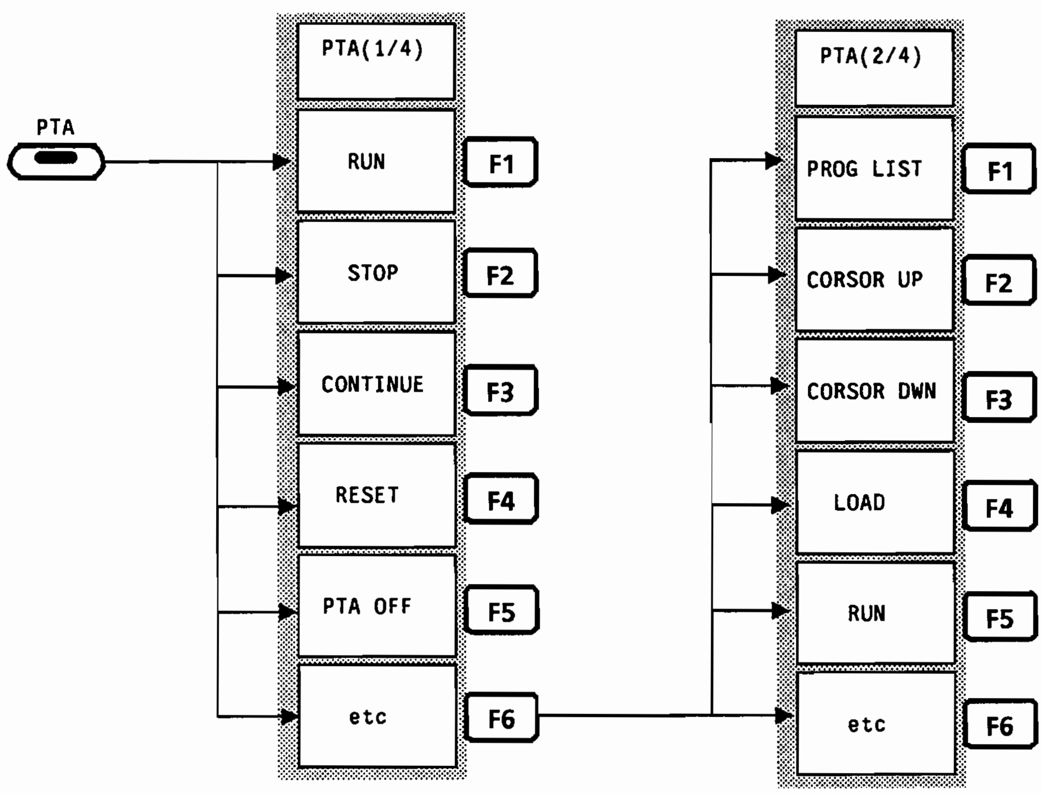


Press the front-panel **PTA** key to turn on PTA. The screen is cleared and a cursor appears at the HOME position (upper left corner of the screen). PTA menus open in association with the **F1** to **F6** softkeys.

Note:
- PTA memory is not cleared of the stored program even when PTA OFF F5 is pressed. When PTA is turned on by pressing the PTA key next time, the same program is ready to run.
- Loading a new program after turning on PTA will overwrite the existing program.

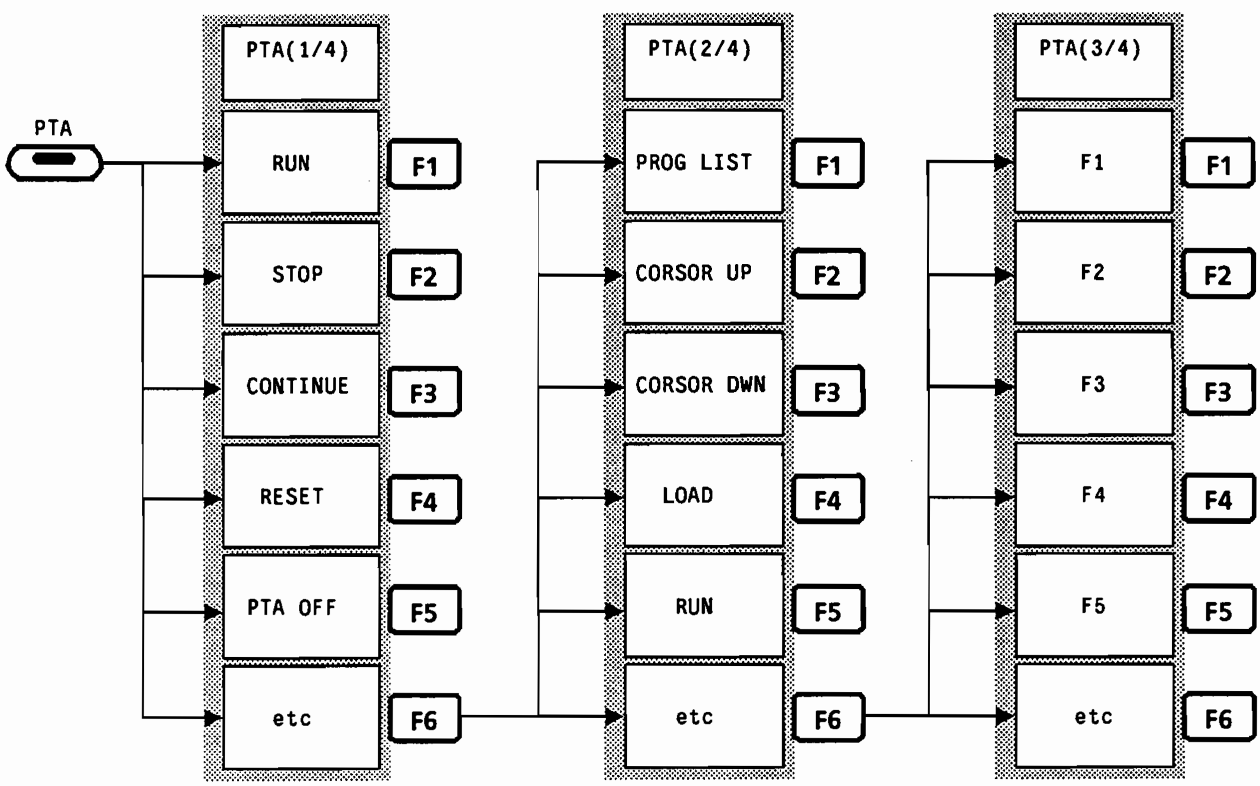
PTA (2/4)

	PTA(2/4)
Lists the names of the PTA files stored on the PMC.	PROG LIST
Moves the cursor up.	CORSOR UP
Moves the cursor down.	CORSOR DWN
Loads the program with the file name at the cursor.	LOAD
Restarts program execution.	RUN
Selects the next PTA menu in sequence.	etc

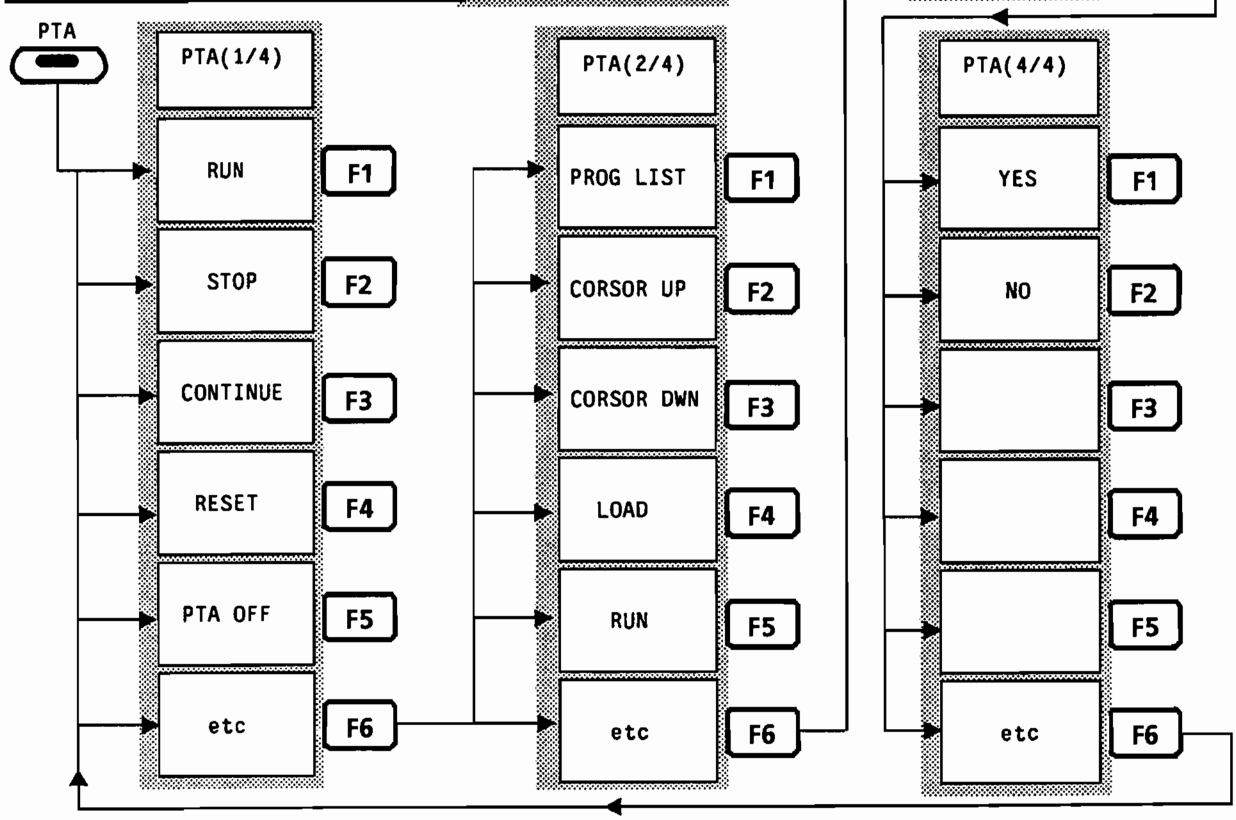


PTA (3/4)

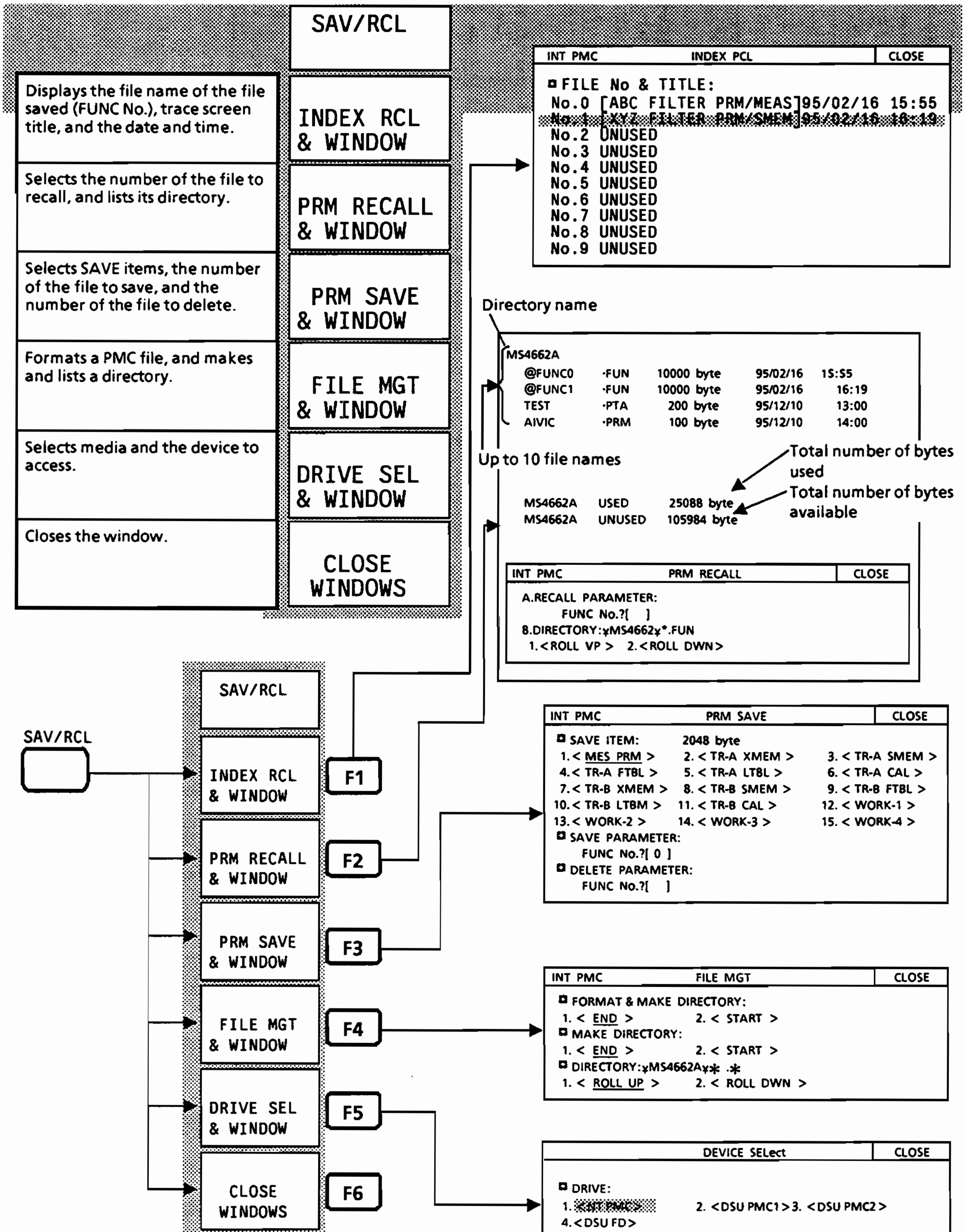
	PTA(3/4)
Function key to define display characters in the DEF subroutine.	F1
Function key to define display characters in the DEF subroutine.	F2
Function key to define display characters in the DEF subroutine.	F3
Function key to define display characters in the DEF subroutine.	F4
Function key to define display characters in the DEF subroutine.	F5
Selects the next PTA menu in sequence.	etc



	PTA(4/4)
Enters the character string "YES."	YES
Enters the character string "NO."	NO
None	
None	
None	
Returns to the first PTA menu.	etc



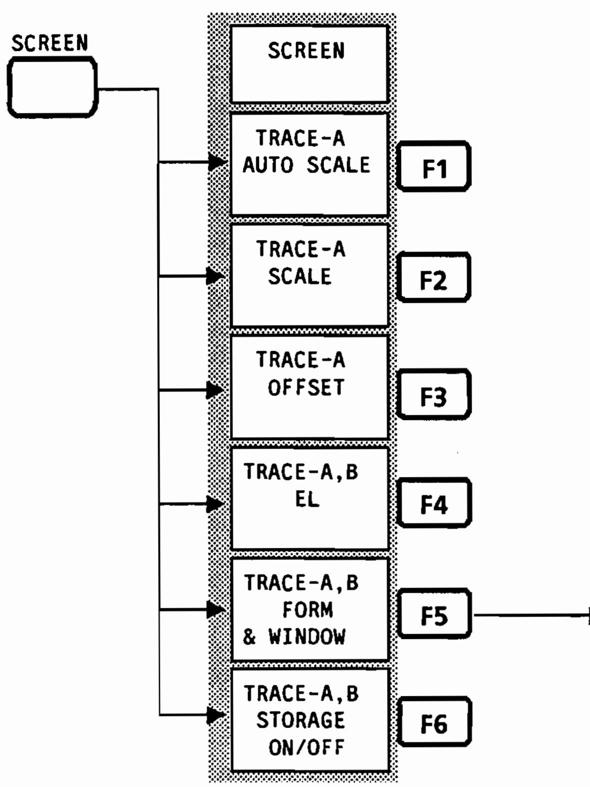
SAV/RCL



SAV/RCL
Displays the file name of the file saved (FUNC No.), trace screen title, and the date and time.
INDEX RCL & WINDOW
Selects the number of the file to recall, and lists its directory.
PRM RECALL & WINDOW
Selects SAVE items, the number of the file to save, and the number of the file to delete.
PRM SAVE & WINDOW
Formats a PMC file, and makes and lists a directory.
FILE MGT & WINDOW
Selects media and the device to access.
DRIVE SEL & WINDOW
Closes the window.
CLOSE WINDOWS
INT PMC INDEX PCL CLOSE
FILE No & TITLE:
No.0 [ABC FILTER PRM/MEAS]95/02/16 15:55
No.1 [XYZ FILTER PRM/SMEM]95/02/16 16:19
No.2 UNUSED
No.3 UNUSED
No.4 UNUSED
No.5 UNUSED
No.6 UNUSED
No.7 UNUSED
No.8 UNUSED
No.9 UNUSED
Directory name
MS4662A
@FUNC0 ·FUN 10000 byte 95/02/16 15:55
@FUNC1 ·FUN 10000 byte 95/02/16 16:19
TEST ·PTA 200 byte 95/12/10 13:00
AIVIC ·PRM 100 byte 95/12/10 14:00
Up to 10 file names
Total number of bytes used
Total number of bytes available
MS4662A USED 25088 byte
MS4662A UNUSED 105984 byte
INT PMC PRM RECALL CLOSE
A.RECALL PARAMETER:
FUNC No.?[ ]
B.DIRECTORY:¥MS4662¥*.FUN
1.<ROLL VP > 2.<ROLL DWN>
SAV/RCL
SAV/RCL
INDEX RCL & WINDOW
F1
PRM RECALL & WINDOW
F2
PRM SAVE & WINDOW
F3
FILE MGT & WINDOW
F4
DRIVE SEL & WINDOW
F5
CLOSE WINDOWS
F6
INT PMC PRM SAVE CLOSE
SAVE ITEM: 2048 byte
1.< MES PRM > 2.< TR-A XMEM > 3.< TR-A SMEM >
4.< TR-A FTBL > 5.< TR-A LTBL > 6.< TR-A CAL >
7.< TR-B XMEM > 8.< TR-B SMEM > 9.< TR-B FTBL >
10.< TR-B LTBM > 11.< TR-B CAL > 12.< WORK-1 >
13.< WORK-2 > 14.< WORK-3 > 15.< WORK-4 >
SAVE PARAMETER:
FUNC No.?[0]
DELETE PARAMETER:
FUNC No.?[ ]
INT PMC FILE MGT CLOSE
FORMAT & MAKE DIRECTORY:
1.< END > 2.< START >
MAKE DIRECTORY:
1.< END > 2.< START >
DIRECTORY:¥MS4662A¥* .*
1.< ROLL UP > 2.< ROLL DWN >
DEVICE SELect CLOSE
DRIVE:
1.<INT PMC> 2.<DSU PMC1>3.<DSU PMC2>
4.<DSU FD>
DSU GPIB ADDRESS [17]

Description	SCREEN
Selects the optimal value of the Y-axis magnitude automatically.	TRACE-A AUTO SCALE
Selects the value of the Y-axis magnitude manually. Variable scale range: 0.01 dB/div to 50 dB/div	TRACE-A SCALE
Changes the values of specific points in orthogonal coordinate graphs (offset line = top line, center line, bottom line).	TRACE-A OFFSET
Sets an electrical length (EL) in the direct entry area.	TRACE-A,B EL
Selects display styles, and erases or restores display items.	TRACE-A,B FORM & WINDOW
Stores trace waveforms.	TRACE-A,B STORAGE ON/OFF

Note: When trace B is set active by pressing the ACTIVE key, the SCREEN menu label TRACE-A changes to TRACE-B. TRACE-A, B always displays as TRACE-A, B, regardless of the ACTIVE key operation.

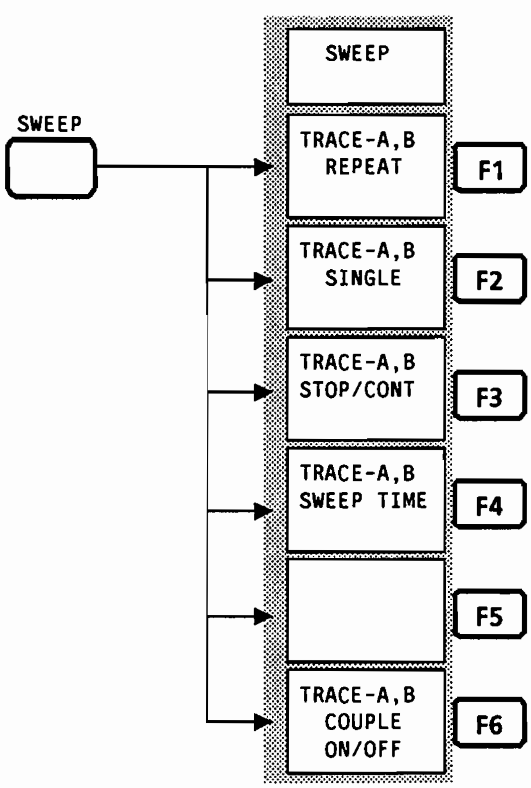


TRACE-A, B FORM | CLOSE

- DUAL TRACE
  1. OFF 2. SPLIT 3. FRONT/BACK 4. LIST MKR
- TRACE-A OVERLAP:
  1. ON 2. OFF
- TRACE-B OVERLAP:
  1. ON 2. OFF
- TRACE-A GRID
  1. ALL 2. CENTER 3. FRAME
- TRACE-B GRID
  1. ALL 2. CENTER 3. FRAME
- TRACE-A OFFSET LINE:
  0 1 2 3 4 5 6 7 8 9 10
- TRACE-B OFFSET LINE:
  0 1 2 3 4 5 6 7 8 9 10
- [DISPLAY ON / OFF]:

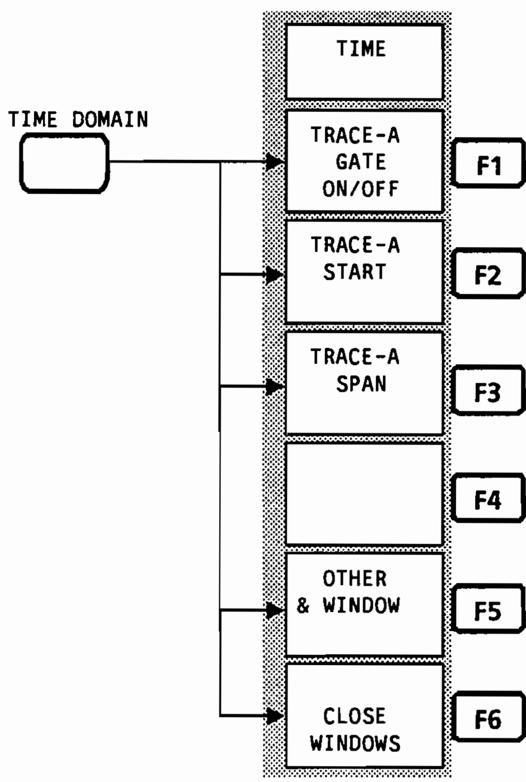
SWEEP

	SWEEP
Sweeps repetitively and continuously, from the sweep start point if one is already in progress or if one has been halted.	TRACE-A,B REPEAT
Sweeps once, from the sweep start point if one is already in progress or if one has been halted.	TRACE-A,B SINGLE
Pauses a repetitive sweep in progress, or restarts a sweep from a paused state. The pause and restart functions do not apply to single sweeps.	TRACE-A,B STOP/CONT
Sets a sweep time in a direct entry area. Setting range: 100 ms to 3500 s, 1.00 to 27.5 hr	TRACE-A,B SWEEP TIME
Toggles between ON and OFF each time F6 is pressed. The current setting is reversed.	TRACE-A,B COUPLE ON/OFF

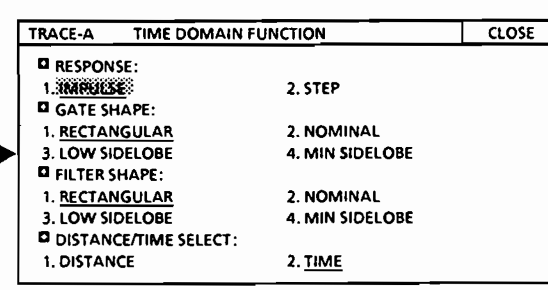


Note: When TRACE-A, B COUPLE OFF is set by pressing F6, the softkey label TRACE-A, B at the top of the menu above displays as TRACE-A if TRACE-A is active or as TRACE-B if TRACE-B is active. In sync with the TRACE-A, B COUPLE OFF function from the SWEEP menu, the FREQ and OUT/INPUT menus are set to COUPLE ON or OFF at the same time.

	TIME
Turns the gate on or off. The setting is reversed. When the gate is on, the result of gating is displayed on trace B.	TRACE-A GATE ON/OFF
Sets a display start time or distance (the time or span is set in the OTHER window).	TRACE-A START
Sets a display start span or distance span (the time or span is set in the OTHER window).	TRACE-A SPAN
Selects ① impulse/step response, ② gate shape, ③ filter shape, and ④ distance/time time-domain parameters.	OTHER & WINDOW
Closes the window.	CLOSE WINDOWS



Note: While time-domain measurement is executed by setting trace A active, set trace B active to monitor frequency domain data as needed.



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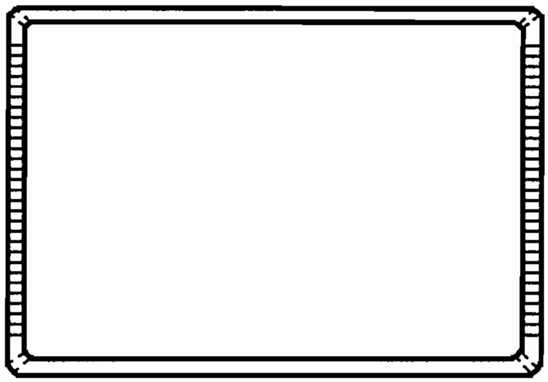
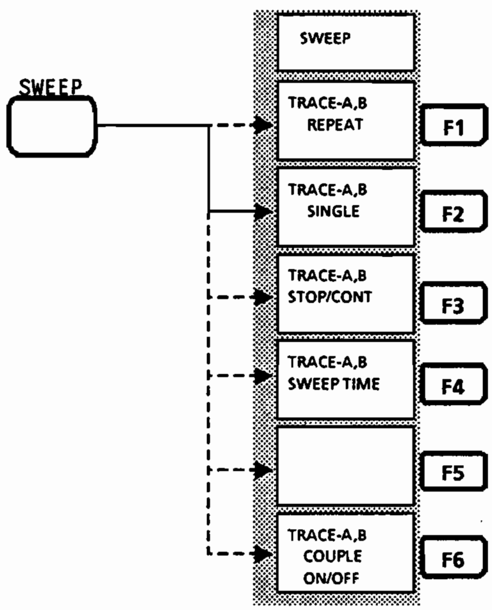
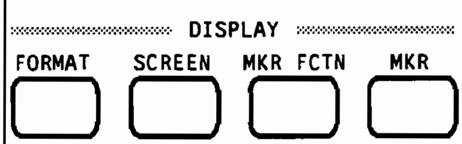
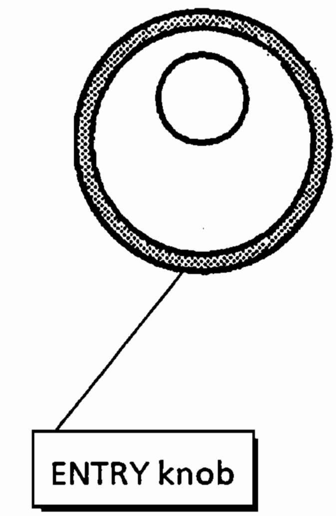
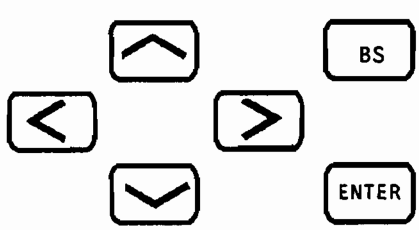
APPENDIX C
FRONT AND REAR PANEL LAYOUTS

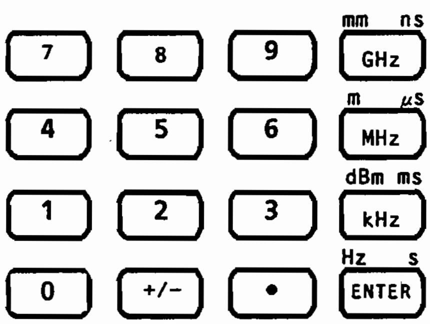
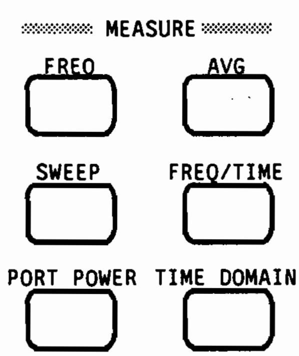
Front and rear panel layouts of the MS4662A Network Analyzer are shown in Figures C-1 and C-2. Operator panel keys, controls, and indicators are numbered. Panel functions are described below with reference to these numbers.

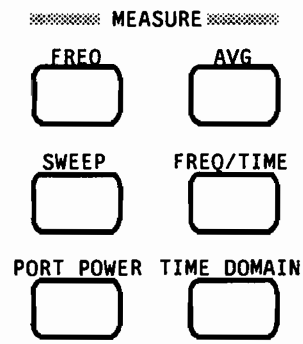
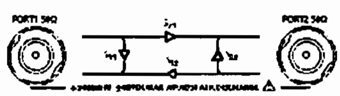
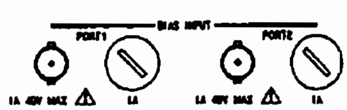
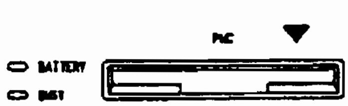
No.	Panel marking	Function
1	REMOTE LOCAL	Press the LOCAL key to release the unit from GPIB remote to manually control it from the front panel. If the unit has been manually locked out from the controller, it cannot be returned to local mode. The REMOTE LED lamp goes on when the unit is in the remote mode or off when it is in the local mode. A GPIB menu opens when the LOCAL key is pressed to permit setting special GPIB parameters from the panel and selecting copying conditions copying devices.
2	SAV/RCL	Press the SAV/RCL panel key to open the SAV/RCL menu for saving and recalling PMC files and managing them. To call a PMC file through this menu, for example, press PRM RECALL F2; to save to a PMC file, press PRM SAVE F3.
3	PACKAGE	Press the PACKAGE key to display the PACKAGE softkey menu. It contains a choice of functions for entering measurement data titles, setting measuring points, target data search (such as maximal and minimal values), and executing vector calculations.
4	LIMIT TEST	Press the LIMIT TEST key to display a limit menu for selecting limit lines (segmented or single), entering limit line data, turning limit testing on and off, and turning the beep on and off.
5	INITIAL	Press the INITIAL key initialize all MS4662A measurementparameters to their defaults, except for certain backup parameters, such as GPIB interface conditions, SAVE/RECALL data, and printer/plotter setup conditions.
6	CAL	Press the CAL key to open one of the four different CAL menus depending on the method of calibration: X-S:, 1 PORT OSL, 2 PORT OSL, and 1 PATH 2 PORT. All menus consist of three steps: ① reading CAL data (F1 to F4), ② selecting the method of calibration and connector parameters (F5) and ③ CAL start (F6). When CAL START F6 is pressed, the CAL key lamp lights.

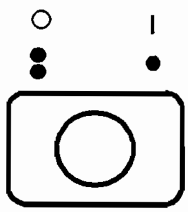
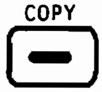
No.	Panel marking	Function
7		9-inch flat-screen organized into 640 by 400 dots, on which softkey menus, display coordinate graphs specific to data types, measurement parameters, and measurement results are displayed. The MS4662A is an active matrix-driven color LCD using amorphous silicon thin-film transistors (TFTs) as pixel electrodes.
8		Most of the front-panel keys have softkey menus. F1 to F6 are assigned in association with the softkey labels of these menus. Parameters can be set or run by selecting the relevant functions appearing as labels. The figure at left shows a single sweep in execution.
9		• **ACTIVE:** The ACTIVE key toggles, with the lamp indicating which trace is active. • **FUNCTION:** Press the FUNCTION key to open the FUNCTION menu. Its contents are updated according to the measurement mode choice.

No.	Panel marking	Function
10		• **FORMAT:** Press the FORMAT key to open a menu for selecting the format of measurement data display. Its contents are updated according to the subfunction selected when the FUNCTION key is pressed. • **SCREEN:** Press the SCREEN key to display the SCREEN menu. Select display function items from the menu to allow trace waveforms to appear at optimal location onscreen. Select the styles of trace form display as needed, such as displaying trace waveforms on the dual channels of A and B, and superposing multiple traces on one another. Use display item erase functions to display only items of interest onscreen. • **MKR FCTN:** Press the MKR FCTN key to display the MKR FCTN menu. The menu provides a choice of 12 marker functions. Commonly used marker functions are user-programmable on F2 to F4. If the ΔMKR (delta marker) function is preprogrammed on F3, for example, pressing F3 following the MKR FCTN key enables the ΔMKR function. • **MKR:** Press the MKR key to open the MKR menu. The menu generates markers, allowing them to be moved. In addition to generating up to 10 multmarkers, the menu permits their width and position to be varied. If a specified marker is an active marker, the frequency and the measurement point at that point are displayed digitally at the upper left corner of the screen.

No.	Panel marking	Function
11		The ENTRY knob (rotary knob) is used to vary the current value of data displayed in an entry response area continuously. In addition, it is used for the following purposes: ● Turn the ENTRY knob counterclockwise to move the cursor to the left and clockwise to move to the right. ● When the menu label MKR MOVE has been selected by pressing the MKR key, turn the ENTRY knob counterclockwise to move the active and zone markers to the left and clockwise to move to the right. ● When the menu label ZONE LEFT has been selected by pressing the MKR key, turn the ENTRY knob counterclockwise to increase the width of the zone marker and clockwise to decrease its width. ● When the menu label ZONE RIGHT has been selected by pressing the MKR key, turn the ENTRY knob counterclockwise to increase the width of the zone marker and clockwise to decrease its width. ● When the menu label SCALE has been selected by pressing the SCREEN key, turn the ENTRY knob clockwise to vary the vertical scale in 1-2-5 steps and counterclockwise to vary it in 5-2-1 steps.
12		● **BS:** Use the BS (backspace) key to correct data entry errors. Use it when entering numeric values or titles in entry response areas with numeric keys or the ENTRY knob. ● **ENTER:** Pressing the ENTER key completes the entry of data without a unit. The ENTER key beside the numeric keys does the same. ● < and > keys ▼ Move the < key to move the reverse cursor to the left. ▼ Move the > key to move the reverse cursor to the right. ▼ When the desired parameter is selected, press the ENTER key to accept the choice. ● ∨ and ∧ keys The ∧ and ∨ keys, when pressed, execute two functions. ① Move the reverse cursor up or down across different groups of parameters. ② Accepts the choice of the parameter pointed by the reverse cursor. An underbar is then drawn under the parameter and the reverse cursor exits from its position.

No.	Panel marking	Function
13		Generally called numeric keys, this group of 16 keys consists of numeric keys and unit keys. The numeric comprise the digit keys [0] to [9], the decimal point key [.], and the sign key [+/−]. Four unit keys are arranged in one vertical column at the right end. They are used to enter units for the distance, time (delay), frequency, and magnitude. The choice of the unit depends on the condition setting of the group item to function as a header or the header key. Pressing the unit key completes data entry. To complete the entry of data that does not have a unit, press the ENTER key. The ENTER key adjacent to the cursor movement key (>) does the same.
14		• **FREQ:** Press the FREQ key to open a FREQ softkey menu. The menu sets the sweep center frequency, frequency span, start frequency, and stop frequency, selects between linear and logarithmic sweeps, and selects sweep modes. • **SWEEP:** Press the SWEEP key to open the SWEEP softkey menu. The menu sets a continuous sweep (REPEAT), a single sweep (SINGLE), stops and restarts (STOP/CONT) a sweep, the sweep time (SWEEP TIME) and so on. • **PORT POWER:** Press the PORT POWER to open the PORT POWER softkey menu for selecting I/O level setup parameters. The menu sets the RF output level (OUT POWER), selects input ranges (TA/TB sets power sweep parameters, and so on. • **AVG:** Press the AVG key to open the AVG softkey menu. It provides two broad sets of functions: S/N improvement and group delay parameter selection. For the former set of functions, averaging, smoothing, and RBW menus are available to lessen noise. For the latter, the menu offers a choice of SMOOTHING APERTURE for setting the aperture frequency as a percentage value, APERTURE FREQUENCY for setting it directly as a frequency, and a delay range (DELAY RANGE) for setting it as a time.

No.	Panel marking	Function
14 (continued)	 MEASURE FREQ AVG SWEEP FREQ/TIME PORT POWER TIME DOMAIN	• **FREQ/TIME:** Press the FREQ/TIME key to select between frequency-domain and time-domain measurement. Since time-domain measurement results are displayed on trace A, set trace A active before pressing this key. • **TIME DOMAIN:** Press the TIME DOMAIN key to open the TIME softkey menu. The menu offers a choice of time-domain-specific parameters required in time-domain measurement. Pressing OTHER & WINDOW F5, for example, will open the TIME DOMAIN FUNCTION window for selecting ① impulse/step response, ② gate shape, ③ filter shape, and ④ distance/time time-domain parameters.
15		Test port connectors. ⚠ is a warning mark to prevent excessive input.
16	PROBE SOURCE +12V 200mA 	Supplies power to a high-input impedance probe, which is needed in in-circuit measurement (devices tested in a parallel setup).
17		Test port 1 and 2 bias terminals and protective fuses. ±40 A, 1A biases can be supplied.
18		**PMC (plug-in memory card)** insertion slot. Insert a PMC into this slot, its face facing the ▽ mark. PMCs are used as external memory and also as PTA program or data memory. The BUSY lamp lights while an access to the PMC is in progress. The BATTERY lamp lights when the voltage of the built-in battery in the PMC drops to its service limit.

No.	Panel marking	Function
19	TO KEYBOARD 	Connector to accommodate a PTA control keyboard.
20		Power is turned on when the pushbutton is recessed. Power is available to all the circuits in the MS4662A, making it ready for use. AC power is turned off the pushbutton pops up.
21	COPY 	Press the COPY key to execute copying under the copying conditions set by pressing the LOCAL key. Press again to cancel copying.
22	PTA 	Press the PTA key to open a PTA function menu at the right edge of the screen. A green lamp in the key lights while PTA is on.

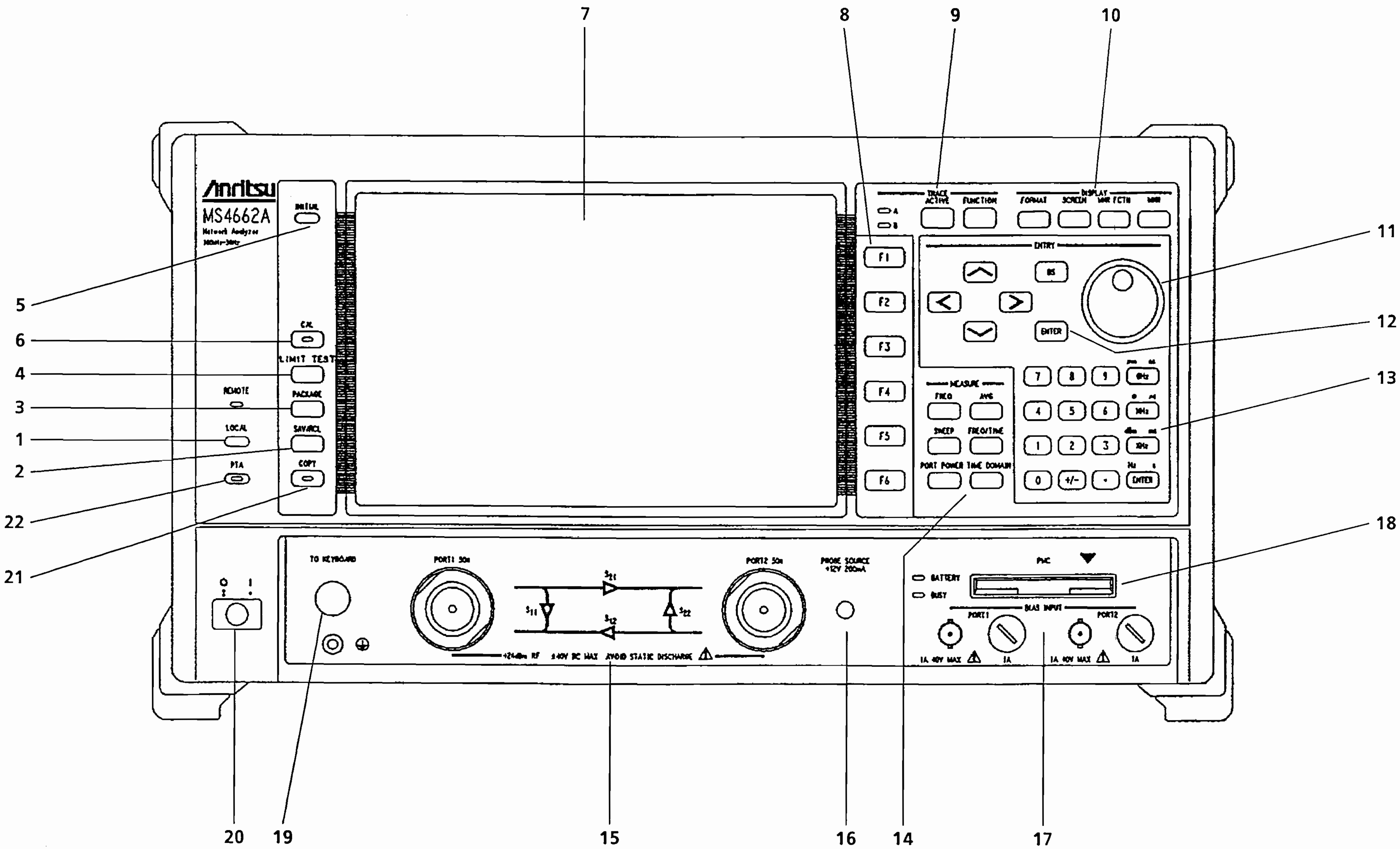
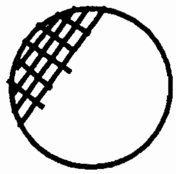
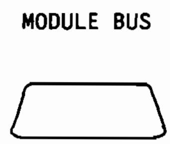
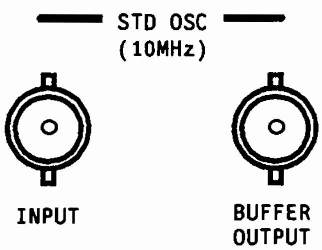
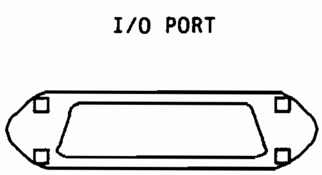
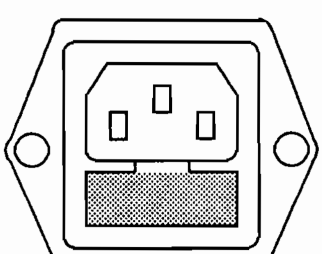
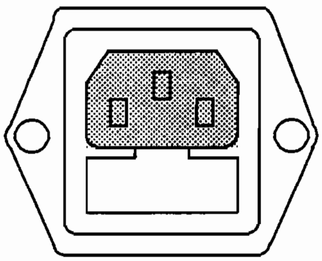
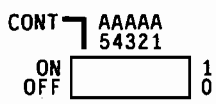
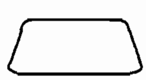


Figure C.1 Front panel

(Blank)

No.	Panel marking	Function
23		Fan to externally exit heat from inside the MS4662A. Keep the fan at least 10 cm from the nearest obstacle.
24		External module bus connector
25		• **INPUT:** Input connector for using an external reference oscillator. The internal reference oscillator is used if no external input is available to this connecter. • **BUFFER OUTPUT:** Connector that outputs reference signals externally via buffers.
26		Used to control external equipment with the PTA (Personal Test Automation) functions or control the PTA functions from external equipment. All control input signals have negative logic. Functions are controllable by programming in PTL (Personal Test Language).
27		Bus connector using the MS4662A as a talker or listener as directed by an external system controller. "SH1" to "E2" above the connector designate GPIB1 interface functions (subsets).
28		Fuse holder enclosing a 6.3 A fuse. "T" in the fuse marking designate the rating type, indicating that the fuse has a certain time lag before it blows. The fuse is compatible with the IEC specifications. Refer to IEC Pub 127 Sheet Ⅲ for more details.

No.	Panel marking	Function
29		Connect this FG (frame ground) terminal to the earth potential to prevent electrical shock hazards.
30		AC power inlet into which the power cord supplied with the MS4662A is inserted. The grounding wire in a three-conductor power cord is connected to the earth potential when inserted into this inlet.
31		**ADDRESS switch:** Used to set the GPIB address of the MS4662A. The MSB is A5; the LSB is A1. Bit level 1 means setting the switch to the upper position (1); bit level 0 means setting the switch to the lower position (0). Set CONT on to let the MS4662A come up as a controller when it is powered on.
32	DIGITAL RGB 	**DIGITAL RGB:** Accommodates a color monitor with digital RGB input. The relationships between the markings and default colors are given below. Numerals indicates the color numbers. Screen background .... 0 (black) Softkeys .... 7 (dark white) Error messages .... 9 (light red) Scale line A .... 13 (light purple) Scale line B .... 11 (light yellow) Window (page 1) .... 15 (light white) Window (page 2) .... 15 (light white) Cursor .... 15 (light white) Graph A and its parameters .... 10 (light green) PTA screen .... 15 (light white) Marker A .... 15 (light white) Graph b and its parameters ..... 10 (light turquoise) Marker B .... 15 (light red)
33	SEPA VIDEO 	**SEPA VIDEO:** Used to hard-copy display images with a plotter (UA-455A) having separate video input.

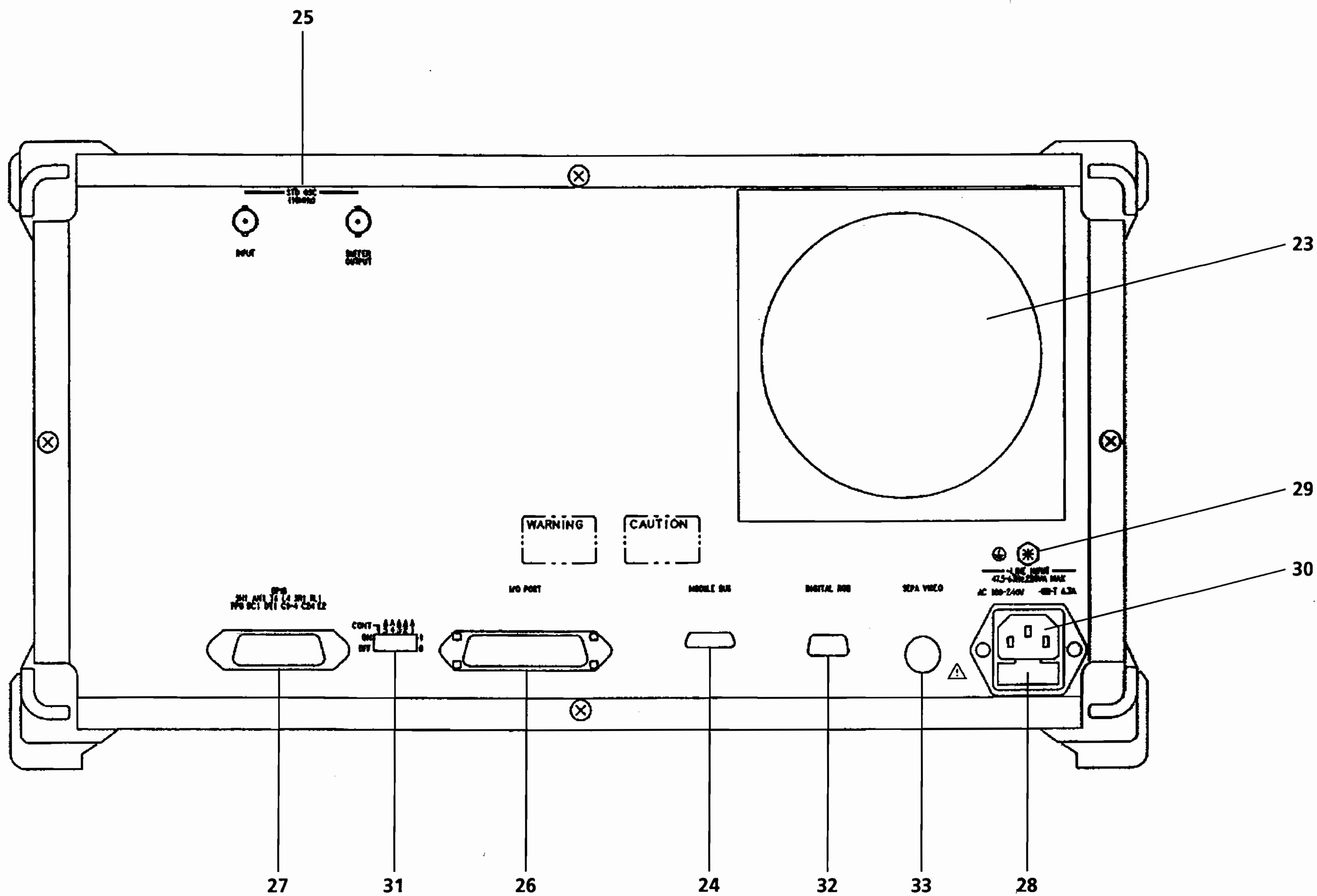


Figure C.2 Rear panel

(Blank)

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