OPERATION MANUAL

NETWORK ANALYZER

MS3401A

CERTIFICATION

ANRITSU CORPORATION certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All parts of this product are warranted by Anritsu Corporation of Japan against defects in material or workmanship for a period of one year from the date of delivery. In the event of a defect occurring during the warranty period, Anritsu Corporation will repair or replace this product within a reasonable period of time after notification, free-of-charge, provided that: it is returned to Anritsu; has not been misused; has not been damaged by an act of God; and that the user has followed the instructions in the operation manual.

Any unauthorized modification, repair, or attempt to repair, will render this warranty void.

This warranty is effective only for the original purchaser of this product and is not transferable if it is resold.

ALL OTHER EXPRESSED WARRANTIES ARE DISCLAIMED AND ALL IMPLIED WARRANTIES FOR THIS PRODUCT, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF ONE YEAR FROM THE DATE OF DELIVERY. IN NO EVENT SHALL ANRITSU CORPORATION BE LIABLE TO THE CUSTOMER FOR ANY DAMAGES, INCLUDING LOST PROFITS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, ARISING OUT OF THE USE OR INABILITY TO USE THIS PRODUCT.

All requests for repair or replacement under this warranty must be made as soon as possible after the defect has been noticed and must be directed to Anritsu Corporation or its representative in your area.

Notes:

1. This instrument is operable on nominal voltages of 100 to 127 Vac or 200 to 250 Vac by changing the connections on the power transformer taps.

   The voltage and current ratings are indicated on the rear panel when the instrument is shipped from the factory.

   To operate on the other voltage, change the connections on the power supply transformer. The plate on the rear panel indicating the voltage and current ratings should be changed to the appropriate one. Order the plate from ANRITSU CORP. if needed.

2. In this manual, the power supply voltage and current ratings are represented by **Vac and ***A, respectively.

3. The relationship between power supply voltage and current rating is shown below.

**Vac	***A
100 to 127 V	5 A
200 to 250 V	3.15 A

COMPOSITION OF MS3401A OPERATION MANUAL

This manual is made up of the 12 sections and 10 appendices outlined below.

Composition			Use
SECTION 1	GENERAL		Sections 1 through 3 give the general preliminary information that is necessary to use the instrument.
SECTION 2	PREPARATIONS		
SECTION 3	START-UP PROCEDURE AND SIMPLE CHECKS		Sections 3 and 4 describe how to evaluate the MS3401A Network Analyzer system (simple checks and performance checks).
SECTION 4	PERFORMANCE CHECKS		
SECTION 5	OPERATING INSTRUCTIONS		SECTION 5 describes the front and rear panel (APPENDIX J) in detail. Beginners should read SECTION 3 before reading SECTION 5.
SECTION 6	MEASUREMENT		SECTION 6 describes typical measurement procedures.
SECTION 7	OVERVIEW OF GP-IB		These sections describe the GP-IB programming for building an automatic measuring system by combining the MS3401A Network Analyzer with a personal computer and other measuring instruments.
SECTION 8	GP-IB ADDRESS SETTING		
SECTION 9	DEVICE MESSAGES GENERAL FORMAT		Beginners should refer to the booklet "GP-IB BASIC GUIDE", available upon request from Anritsu.
SECTION 10	DEVICE MESSAGES DETAILS		
SECTION 11	GP-IB PROGRAMMING		
SECTION 12	MX3501A DIRECT PLOT (OPTION 02)		This section describes how to use the MX3501A Direct Plot software.
APPENDICES	A to I		Data for this manual
	J	FRONT AND REAR PANEL DESCRIPTIONS	A foldout of the MS3401A front and rear panel views and a description of the panels are provided at the end of this manual (APPENDIX J). Look at this foldout while reading the manual.

LEGENDS

WARNINGs, CAUTIONs, and NOTEs, and footnotes are used in this manual. Their meanings are given below:

(1) Hierarchy

The hierarchy priority is WARNING > CAUTION > Note > footnote.

(2) Definition

WARNING: WARNING is used when there is a personal injury hazard.

CAUTION: CAUTION is used when the equipment may be damaged.

NOTE: NOTE is used to provide information about exceptions, corrections, and restrictions.

Footnotes: Footnotes provide comments at the foot of the same page as the text. Footnotes are referenced by either an asterisk (*) or by combination of asterisk and numeral.

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SECTION 1

GENERAL

This section outlines the MS3401A Network Analyzer and describes its standard composition, options, accessories and peripheral devices, and specifications.

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1.1 Overview

The MS3401A Network Analyzer can measure magnitude, phase, and delay over a frequency range of 10 Hz to 30 MHz.

A fully synthesized system is used, which makes high-speed sweeping possible.

The options and accessories enable measurement of the transmission characteristics and impedance of various systems.

The Plug-in Memory Card (PMC), data knob incorporating four keys, DEFINE function, and AUTO function simplify front panel operation. PMC application software is also available. The PTA option facilitates use in factory automation (FA). Remore control by GP-IB is also possible.

The hard-copy function (video plotter, direct plotting) makes printing of results and data arrangement etc. very easy.

Applications

Ths MS3401A can measure the transmission characteristics and impedances of the following devices:

Coils, capacitors, resistors, transformers, resonators, delay lines, cables, diodes, transistors, FETs, operational amplifiers, general amplifiers, mechanical switches, semiconductor switches, magnetic heads, antennas, and optical devices.

1.2 Composition

Paragraphs 1.2.1 and 1.2.2 describe the MS3401A Network Analyzer standard composition and the options for expanding its range of functions.

1.2.1 Standard composition

Table 1-1 shows the standard composition of the MS3401A.

Table 1-1 Standard Composition

Item	Name	Qty.	Remarks
Instrument	MS3401A Network Analyzer	1	
Accessories	50 Ω coaxial cable	2	BNC [ ]—RG-55A/U 0.5m—[ ] BNC
	75 Ω coaxial cable	2	BNC [ ]—3C-2W 0.5m—[ ] BNC
	BNC(Fe)-BNC(Fe) Adapter	1	
	6.7 MHz bandpass filter	1	
	Power cord	1	
	Ac fuse	2	***A
	Operation manual	1	
	S.RAM 32KB	1	Capacity 32 kbytes

1.2.2 Options

Table 1-2 lists the options for the MS3401A.

Table 1-2 Options

Item	Name	Qty.	Remarks
01	PTA3PKG	1	PTA3 (Personal Test Automation) is a personal computer function for high-speed calculation and control. It can be programmed in the high level language PTL (Personal Test Automation Language).
	MS3401A Network Analyzer PTA3 operation manual	1	
	Keyboard	1	Program input and editing are performed via the keyboard.
02	MX3501A Direct Plot	1	Hard copy on X-Y plotter. Supplied on PMC (Plug-in Memory Card).

1.3 Accessories and Peripheral Devices

Table 1-3 lists the accessories available for the MS3401A. Table 1-4 lists the peripheral devices.

Table 1-3 Accessories

Name	Uses	Remarks
Accessory	Protection cover; Front handle kit; Rack mount kit	See APPENDIX D (1).
Transformer	Used in balanced circuit measurements and measurements other than 50 Ω or 75 Ω.	See APPENDIX D (2).
Ac probe	Used in-circuit measurements	See APPENDIX D (3).
Cable	Test cable, interface cable	See APPENDIX D (4).
PMC (Plug-in Memory Card)	32-kbyte and 128-kbyte SRAM (Static Random Access Memory) cards are provided.	——

Table 1-4 Peripheral Devices

Name	Uses	Remarks
Packet V Personal Technical Computer	Used to control an automatic measuring system via GP-IB	See APPENDIX E
BCD converter	Can be controlled by PTA3 or personal computer via GP-IB (Application) used in control of jigs etc.	See APPENDIX G
Multi function selector	Can be controlled by PTA3 or personal computer via GP-IB (Application) used as scanner.	See APPENDIX H
UA-455A video plotter	Used to hard-copy measured results displayed on MS3401A CRT	See APPENDIX I

1.4 Specifications

Measurement items	Magnitude, phase, delay time, magnitude/phase, magnitude/delay time
Frequency	
. Range	10 Hz to 30 MHz
. Resolution	0.01 Hz
. Accuracy	Calibrated 24 hours after starting (1) With one hour after starting as reference, $\pm 5 \times 10^{-8}$ (23° ±5°C) 15 minutes after starting (2) With 24 hours after starting as reference (23° ±5°C) $\pm 2 \times 10^{-8}$/day $\pm 1 \times 10^{-7}$/year (3) $\pm 5 \times 10^{-8}$ at 0° to 50°C
Input	
. No. of Input Channels	1
. Impedance	Switchable between 50/75 Ω, Return loss: $\geqq$30 dB (greater than IRG* -10 dBm)
. Range (IRG)	-20 to +20 dBm, 10 dB steps [0 dBm = 1 mW (50 Ω) or 1 mW (75 Ω)]
. Maximum input	+24 dBm AC, +1.5 Vdc or -3 Vdc
. Connector	BNC
. Spurious	No signal to input $\leqq$-80 dB (RBW**: 1 kHz)
. Probe Source	+12 V, 100 mA max. (equipped with short protection function)

*IRG: Input Range
**RBW: Resolution Bandwidth

Average Noise Level

RBW	Frequency	Value relative to IRG
10 Hz	100 Hz to 30 MHz	-80 dB
	200 kHz to 30 MHz	-95 dB
100 Hz	1 kHz to 30 MHz	-85 dB
	200 kHz to 30 MHz	-95 dB
1 kHz	10 kHz to 30 MHz	-85 dB
	200 kHz to 30 MHz	-100 dB
Wide	100 kHz to 30 MHz	-80 dB
	500 kHz to 30 MHz	-85 dB

Crosstalk	Between synthesizer input and output: ≥120 dB
Resolution Bandwidth	3 dB bandwidth: 3 Hz, 10 Hz, 100 Hz, 1 kHz, WIDE Accuracy: 10, 100, 1 kHz, ±20%, WIDE: ≥12 kHz
Video Bandwidth	10 Hz, 100 Hz, 1 kHz, 10 kHz, OFF

Magnitude Measurement

. Range	100 dB
. Resolution	0.01 dB
. Offset Error	Frequency response, level fluctuation, and RBW switching errors can automatically be corrected by memorizing the calibration data (usually based on the through connection).
. Linearity	0 to -10 dB, ±0.2 dB -10 to -50 dB, ±0.15 dB (-10 dB reference) -50 to -60 dB, ±0.5 dB -60 to -70 dB, ±1 dB -70 to -80 dB, ±2 dB (with RBW greater than 10 Hz)

Phase Measurement

. Range	±180 deg
. Resolution	0.1 deg
. Offset Error	Frequency response and RBW switching errors can automatically be corrected by memorizing the calibration data (usually based on the through connection).
. Level Characteristics	0 to -50 dB, ±15 deg (-10 dB reference) -50 to -70 dB, ±3 deg (with RBW of 1 kHz)

Delay Time Measurement

. Range	40 ns to 400 ms, 1,2,4 sequence
. Resolution	1/1000 of range
. Offset Error	Frequency response can automatically be corrected by memorizing the calibration data (usually based on the through connection).
. Level Characteristics	0 to -50 dB (0.5% of full scale) + (0.5% of reading) with RBW greater than 10 Hz at 1 μs range (1 to 30 MHz)

Synthesizer Output

. Output Level	0 dBm
. Impedance	Switchable between 50/75 Ω, Return loss: ≥25 dB (30 Hz to 30 MHz)
. Connector	BNC

Sweep Method

. Frequency	LIN: START/STOP, CENTER/SPAN LOG: START/STOP

Measurement Points (MP) — Number of points switchable between 501, 251, 101, 51, 21, and 11

Sweep Time (ST)

. Setting Range	10 ms to 27.5 h/SPAN
. Measurement Time	Maximum speed measurement time at RBW: WIDE, VBW: OFF, MP: 501. This does not include the response of the DUT. Amplitude measurement (M): 200 ms/SPAN Phase measurement (P): 200 ms/SPAN Delay time measurement (D): 800 ms/SPAN M/P measurement: 300 ms/SPAN M/D measurement: 1.0 s/SPAN

Sweep Function

. Sweep Range	FULL: sweeps full range MKR : sweeps only marker point or range between two markers
. Sweep Control	REPEAT START, SINGLE START, STOP, RESET

Automatic Settings

. Sweep time	Automatically set to fixed value according to measurement time, measurement frequency, number of measurement points, and RBW
. Resolution Bandwidth	Automatically set to fixed value according to start point of measurement frequency

. Video Bandwidth	Automatically set to fixed value according to resolution bandwidth
. Delay Range (DR)	Automatically set to fixed value according to delay time of the DUT

Calibration

. X→S	Correction of offset error

Calculation

. X-S	Automatic compensation of offset error
. MT-ST	Calculation between memories
. AVERAGE	Average of measurement values with set count of 2, 4, 8, 16, 32, 64, and 128

Display

. CRT	8-inch electromagnetic deflection (display color amber)
. Trace	Same as measurement item (orthogonal coordinates)
. Subtrace	Same as measurement item (orthogonal coordinates) ST, MT, MT-ST Cannot be used for amplitude/phase or amplitude/delay
. Overlap	Overwriting of trace waveform possible when ON
. Characters	Marker point data, trace conditions, measurement conditions, soft key functions
. Title	Maximum of 20 characters

Markers

. CURRENT	Indicates measurement value at marker point
. Δ (DELTA)	Indicates frequency difference between two markers or difference between measurement values on same sweep
. ZERO	Indicates difference between value of held reference marker value and measurement value
. MKR → MAX	Sets market at maximum point of measurement values
. MKR → MIN	Sets marker at minimum point of measurement values
. MKR CHANGE	Swaps CURRENT marker and reference marker
. MKR → CF	Sets frequency of CURRENT marker point to center frequency
. Δ → SPAN	Sets frequency of Δ marker to START and STOP frequencies

Function Memories

. Capacity	Up to ten types (measurement conditions, S data, measurement data, frequency table) except for power supply backup to PMC
. DEFINE	Five soft key functions can be defined in function memory saved to PMC memory After definition, functions can be recalled by pressing only soft keys

Rear Panel Input/Output

. Video Output	Separate signal for external video plotter (DIN 8-pin) Composite signal for external video plotter (BNC)

. 10 MHz Reference Output	TTL level (BNC)
. 10 MHz Reference Input	TTL level (BNC)
. 10 MHz Reference Buffer Output	TTL level (BNC)
. IF Output	Greater than -6 dBm with 0 dBm, 600 Ω (BNC)
. DET Output	Detector output (BNC) Greater than 1.5 V with 0 dBm, 1 kΩ
. GP-IB	Compatible with IEEE 488 (24-pin)
. I/O Port	For PTA 3 (option 01) (36-pin)

External Control

. Method	Control by GP-IB (IEEE 488, IEC625-1, 24-pin)
. GP-IB Functions	All functions on the front panel can be controlled except power supply switch, INTENSITY, GP-IB key, MANAGE key, and DEFINE key. Interface: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0

External Memory	SRAM card: one 32 kbyte card External dimensions: 35 H x 54 W x 85.6 D mm Connection method: Side panel perforated electrode method

General Specifications

. Usable Temperature Range	0° to 50°C
. Power Requirements	** Vac +10%, -15%, 50/60 Hz, ≤190 VA

. Dimensions and Weight — 177 H x 426 W x 451 D mm, $\leq$22 kg

Option 01

PTA3*1

. Software — PTL high-level language software: ROM based

. Keyboard — 1

Option 02

Direct plot — Hard copy on X-Y plotter
Supplied on PMC*2

*1 PTA: Personal Test Automation

*2 PMC: Plug-in Memory Card

PTA3 Option and PMC Specifications

Item		PTA3
Display	No. of Displayed Characters	56 characters x 28 lines = 1568 characters
	Font	7 x 11 dot matrix
	Graphic Display	4 screens, 512 x 400 dots
Keyboard	Character Keys	Upper and lower case English, numeric, special symbols
	Editing Keys	DEL, INS, <, >, ∨ , ^
	Command Keys	RUN, STE, EOL, RES

(cont'd)

	Item	PTA3
PTL	Program Area	128 kbytes
	Commands	Basic commands (8) and GP-IB statements (2)
	Functions	Mathematical functions, logical functions, and system functions
	System Subroutines	Display and GP-IB subroutines
	Variables	Numeric variables, character variables, and system variables
	Interfaces	GP-IB and I/O port
PMC	Memory Capacity	128 kbytes
	Program Files	70 programs

SECTION 2

PREPARATIONS

This section describes the preparations necessary before using the MS3401A Network Analyzer, and: (1) installation precautions; (2) power supply safety measures; and (3) storage and repacking, and shipping. For a description of the GP-IB cable connections, address setting, etc., see SECTION 8.

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2.1 Installation Precautions

This paragraph describes the MS3401A Network Analyzer general installation precautions and mechanical assembly when mounting it in a rack.

2.1.1 Installation site environmental conditions

The MS3401A operates normally at ambient temperatures of 0° to 50°C. However, for best performance, do not use or store it in locations:

- Where it may be subjected to strong vibrations
- Where it may be exposed to damp or dust
- Where it may be exposed to direct sunlight
- Where it may be exposed to active gases

To maintain stable operation for a long time, in addition to meeting the conditions listed above, the MS3401A should be used at stable room temperatures and where ac line voltage fluctuations are small.

CAUTION

If the MS3401A is used at room temperature after being used or stored at a low temperature for a long time, condensation may occur inside the instrument may cause short circuits. Always ensure that the analyzer is thoroughly dry before turning on the power.

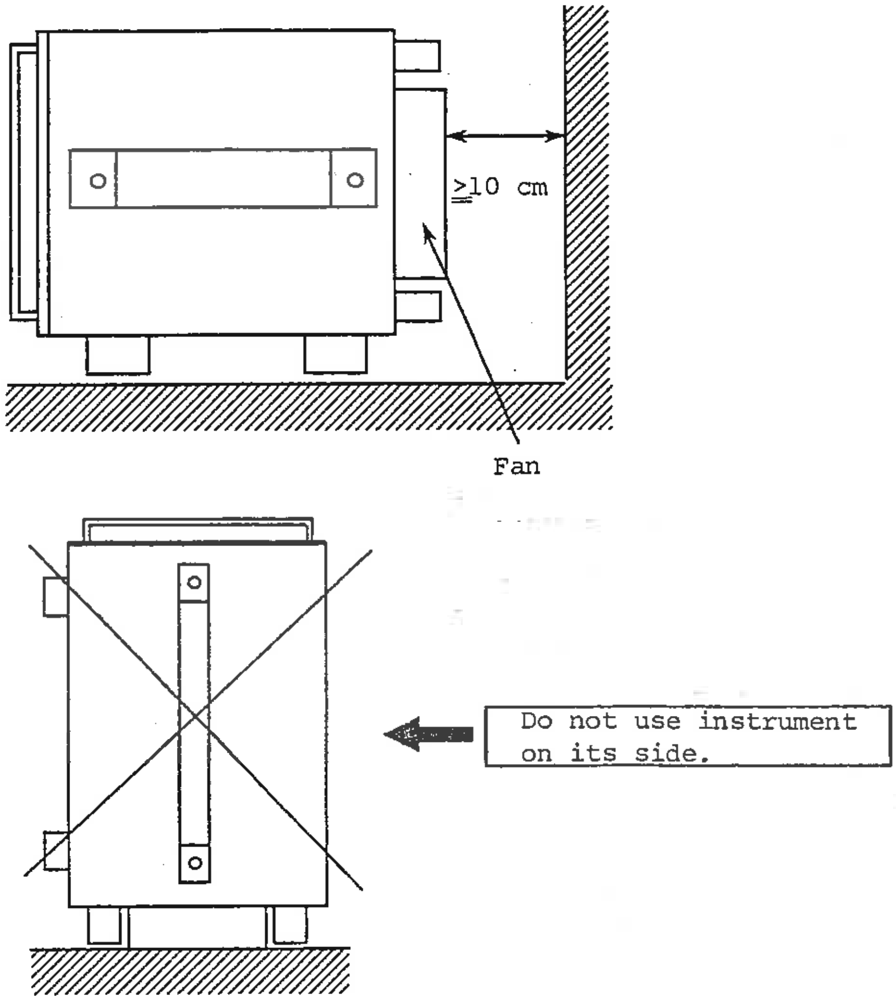

Fig. 2-1 Fan Clearance

(1) Fan clearance

To suppress any temperature increase inside the MS3401A, a cooling fan is mounted on the rear panel as shown in Fig. 2-1. Leave a space of at least 10 cm between the rear panel and walls, peripheral devices, obstructions, etc. so that the air flow is not obstructed.

2.1.2 Rack mounting

When mounting the MS3401A in a rack, the optional rack mounting kit is necessary. Order the rack mounting kit by using the order number given in APPENDIX D(1).

The mounting instructions are supplied with the kit.

2.2 Power Supply Safety Measures

The MS3401A Network Analyzer operates normally on a ** Vac +10% or -15%, 48 to 63 Hz power supply.

However, observe the following safety measures before supplying ac power.

2.2.1 Power cord polarity

Since the 3-pole (ground-type 2-pole) power cord is connected to the live line(L), neutral line(N), and ground line, the analyzer is designed so that the power supply polarity is always matched when the plug is inserted into a 3-pole (ground-type 2-pole) supply outlet.

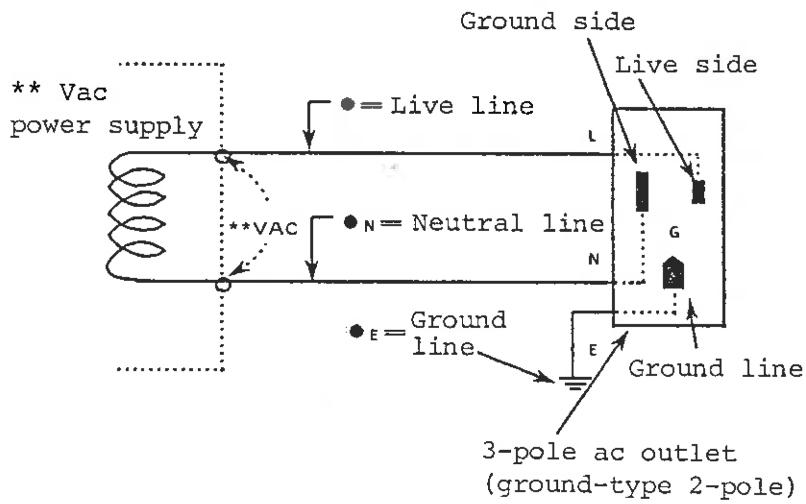

Fig. 2-2 Three-Pole Power Cord Plug and Outlet

2.2.2 Grounding

(1) Grounding frame ground (FG) terminal

When a 3-pole ac outlet (Fig. 2-2) is not available, ground the FG terminal (Fig. 2-3) directly to earth potential.

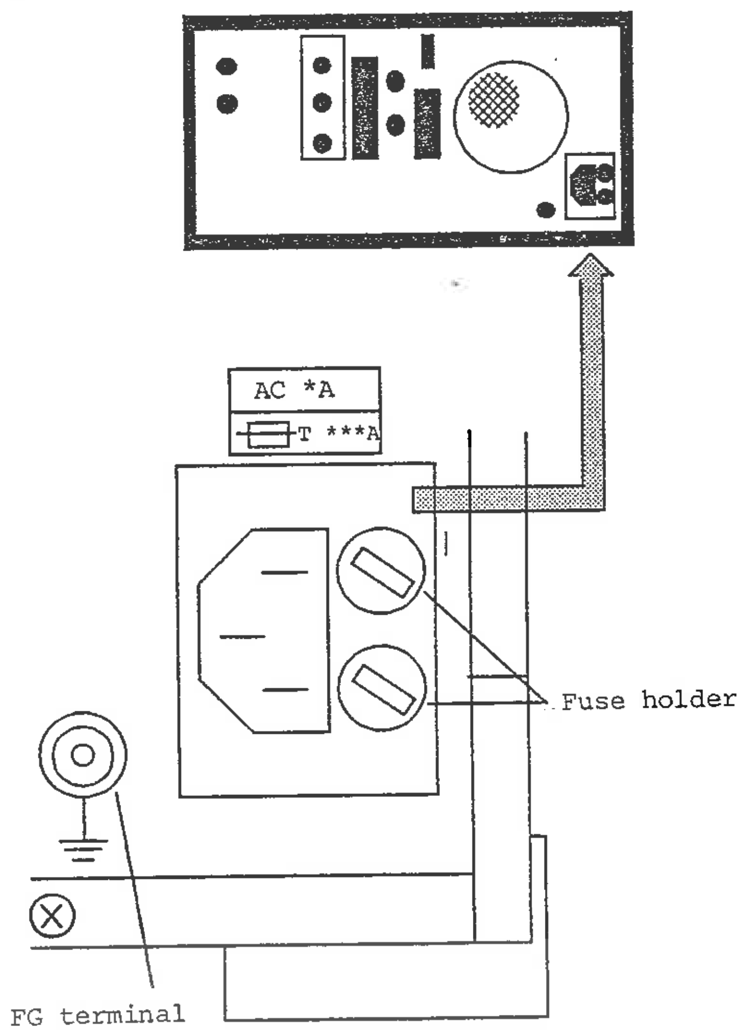

Fig. 2-3 Grounding (FG) Terminal

(2) Grounding by 3-pole ac outlet

If a 3-pole (ground type 2-pole) ac outlet is available, the MS3401A frame is connected to earth potential when the power cord is plugged into ac outlet and the FG terminal does not have to be grounded.

2.2.3 Fuse replacement

The standard system is supplied with the fuses shown in Table 1-1. The two fuses shown in Fig. 2-3 are rated at ***A.

When a fuse blows, located and correct the cause of the trouble before changing the fuse.

WARNING

1. Before replacing a fuse, turn off the power switch and unplug the power cord from the ac outlet.

   There an electric shock hazard if a fuse is replaced while the power is on.

2. Before turning on the power after replacing a fuse, check the protective grounding described in paragraph 2.2.2 and check that the ac supply voltage is suitable. There is an electric shock hazard if the power is turned on without the protective grounding.

   If the ac supply voltage is unsuitable, the equipment may be damaged.

The fuse replacement procecure (Fig. 2-3) based on the above safety measures, is described below.

Step	Procedure
1	Set the POWER switch on the front panel to OFF and unplug the power cord from the ac outlet.
2	Turn the fuse holder counterclockwise and remove the cap, together with the fuse.
3	Remove the blown fuse from the cap and replace it with the spare fuse.
4	Refit the cap and turn it clockwise until it will turn no further.

If the fuse blown again after replacing it, check that the replacement is of the same type, rated voltage and current, as the original.

If the fuse is not the same type, it may not fit the holder, contact may be poor, or the fusing time may be too long.

If the rated voltage and current of the replacement fuse are too high and trouble reoccur, the new fuse may not blow and the instrument may catch fire.

Set the power to ON after step 4 above.

For the power supply connection procedure, see Section 3.

2.3 Storage Precautions

This paragraph describes the precautions to take when storing the MS3401A Network Analyzer for a long time.

2.3.1 Precautions before storage

1. Wipe any dust and fingermarks off the cabinet.
2. Check the performance as described in SECTION 4 and check that the MS3401A operates normally.
3. The maximum and minimum storage temperature range is 60° to -20°C. The maximum humidity is 90%.

2.3.2 Recommended storage conditions

In addition to meeting the conditions listed in paragraph 2.3.1, the MS3401A should preferably be stored where:

1. Temperature is 0° to 30°C
2. Humidity is 40% to 80%
3. Temperature and humidity are stable

Before using the MS3401A after storage, check the performance as described in SECTION 4.

2.4 Repacking and Transportation

When transporting the MS3401A over long distances, observe the precautions described below.

2.4.1 Repacking

Use the original packing materials. If the original packing materials were thrown away or destroyed, repack the analyzer as follows:

1. Install the protective covers (34Y7326C) over the front and rear panels.

2. Wrap the MS3401A in plastic or similar material.

3. Obtain a cardboard, wood, or aluminum box 10 to 15 cm larger than the MS3401A on all sides.

4. Put the MS3401A in the center of the box and fill the surrounding space with shock absorbent material.

5. Secure the box with twine, tape, or bands.

Note:

It is easy to repack the MS3401A if the original packing materials are saved.

2.4.2 Transportation

Transport the MS3401A under the storage conditions recommended in paragraph 2.3.2.

SECTION 3

START-UP PROCEDURE AND SIMPLE CHECKS

This section describes the start-up procedure and simple checks for the MS3401A.

The start-up procedure describes how to turn the power and off and the initial CRT display.

The simple checks are part of the receiving inspection when the MS3401A is purchased.

If the simple check results are satisfactory, the performance checks described in SECTION 4 can be skipped and the MS3401A can be used immediately.

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3.1 Power-on and Initial State Setting

This paragraph describes:

1. The function of the power switch, and the power-on procedure
2. The initial CRT display after power-on
3. The setting of each automatically-initialized function when the power is turned on, and the CRT display

3.1.1 Power-on

Before turning on the power to the MS3401A ensure that the safety measures described in paragraph 2.2 have been followed, then plug the power cord into the MS3401A ac inlet.

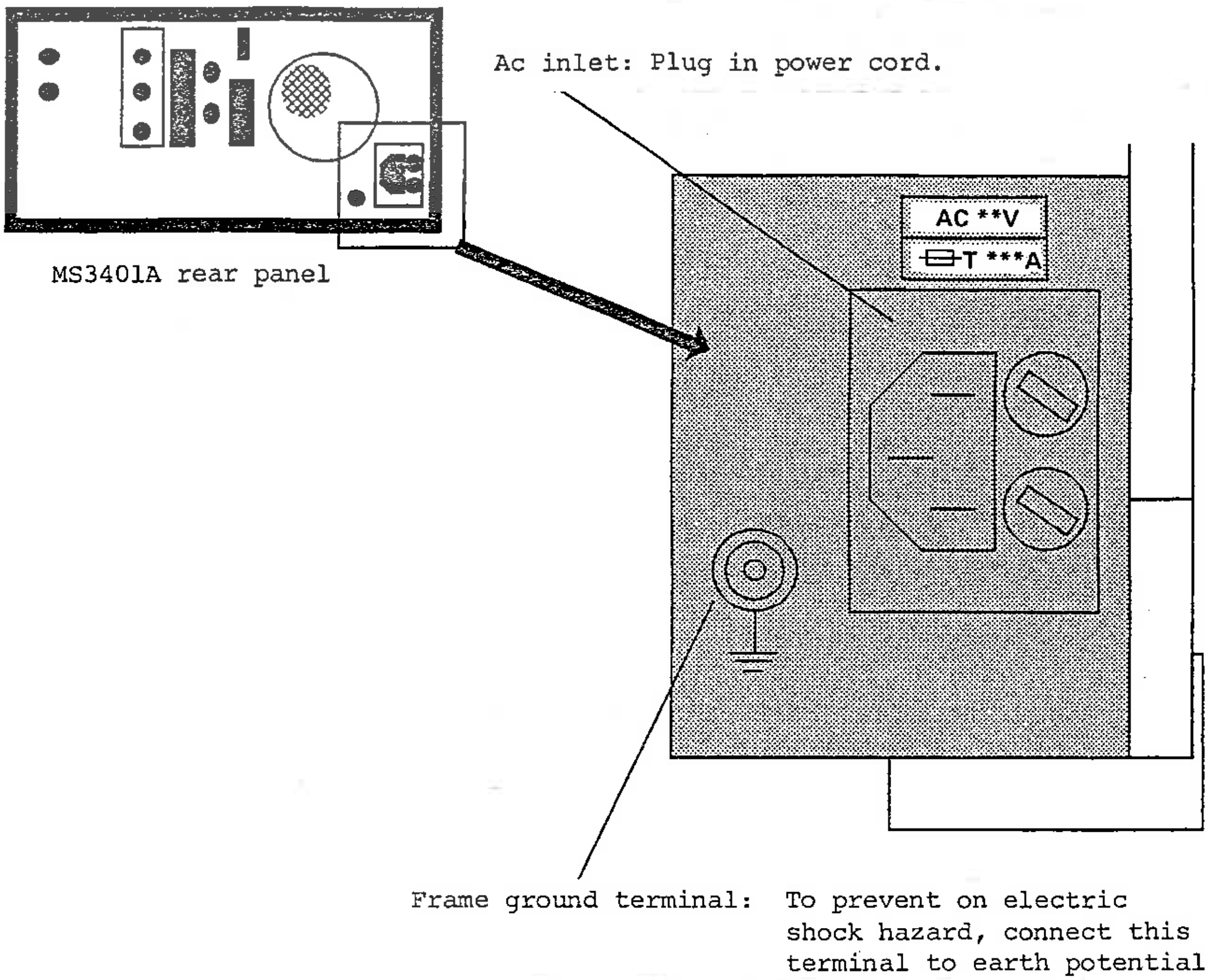


Fig. 3-1 Rear Panel

WARNING

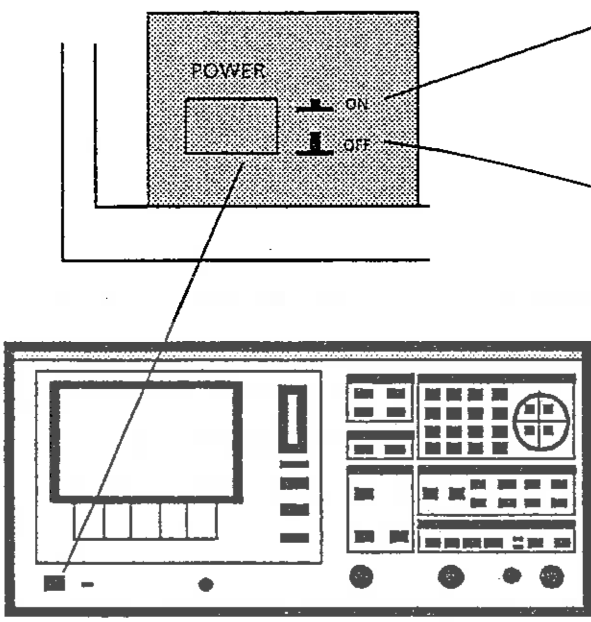
When a 3-pole (ground-type 2-pole) ac supply outlet is not available, before supplying power to the MS3401A, always connect the frame ground (FG) terminal on the rear panel to earth potential.

There is an electric shock hazard if the instrument is not grounded.

CAUTION

Before turning on the power to the MS3401A, check that the ac supply voltage is suitable (** V +10%, -15%).

If it is unsuitable, the instrument may be damaged.



ON: Press this button to set POWER ON; the button remains held and power is supplied to all the MS3401A circuits and it is now ready for use.

OFF: Press this button when it is set to POWER ON to set POWER OFF; it is released and the power is turned off.

Fig. 3-2 Front Panel POWER Pushbutton Switch

The standard procedure for connecting power to the MS3401A based on the above description is described below.

Power connection procedure:

Step	Procedure
1	Connect the rear panel FG terminal to earth potential.
2	Check that the ac supply voltage is correct.
3	Before plugging the power cord into the ac outlet, check that the front panel POWER switch is set to OFF.
4	Set the POWER switch to ON.

3.1.2 Initial CRT display

If the MS3401A either has no PMC* installed or the panel functions are not backed up when the PMC is installed, when the power is turned on, the CRT display is set to the initial state shown in Fig. 3-3 (nothing connected to input and output terminals) and the panel functions are initialized automatically.

For a description of the relationship between the parameters of each function and the initial CRT display, see paragraph 3.1.1.

Notes:

1. When the PMC is installed, the set final panel conditions (parameters of each function) are stored automatically when the power is turned off and reset when the power is turned on again.
2. The MS3401A can also be initialized by pressing the CONTROL section [INITIAL] key (Fig. 3-4 (b)).
3. When either the power is turned on, or the [INITIAL] key is pressed, the S memory is cleared.

A: Magnitude measurement measured value and set parameters data dislay line (Also called "trace A" for convenience)

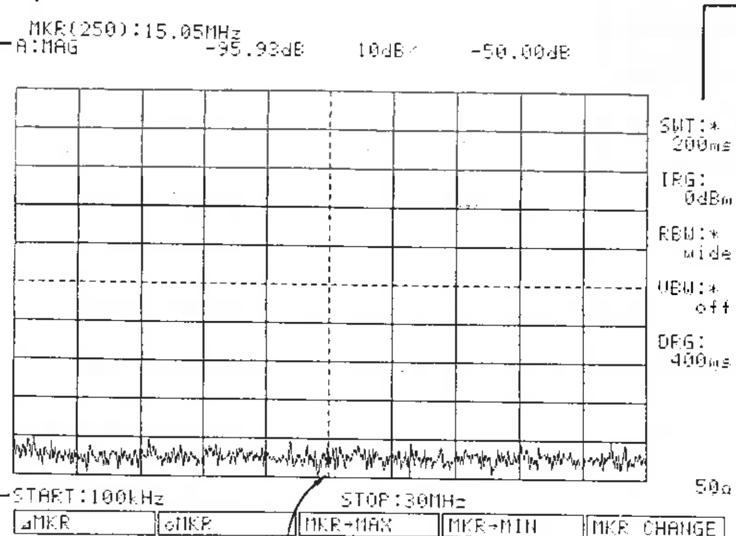
MAG: MAGnitude - shows that MS3401A is in magnitude measurement mode

-95.93dB: Value of magnitude measured at marker (with nothing connected to input and output terminals)

10dB/: Value of CRT vertical scaling per division LOG scale

-50.00dB: Center value of trace display vertical axis. Indicates horizontal dotted line (called offset line) at center of Y-axis of Cartesian coordinates of figure below.

Shows that there are 501 measurement points between sweep start point (left of CRT) and sweep stop point (right of CRT). Frequency of MKR (marker) at center of these points is 15.05 MHz.



SWT: Sweep time - shows that sweep time is 200 ms

: AUTO setting mode. - shows that SWT is set automatically by MS3401A

IRG: Input range - shows that upper limit of input signal applied to INPUT connector is 0 dBm

RBW: resolution bandwidth - shows that resolution bandwidth is WIDE

*: AUTO Setting mode - * shows that RBW is set automatically by MS3401A

VBW: Video Bandwidth - shows that video bandwidth is OFF

*: AUTO setting mode - * shows that VBW is selected automatically by MS3401A

Soft key display equivalent to pressing DISPLAY section [MARKER] key

Marker: shows marker point

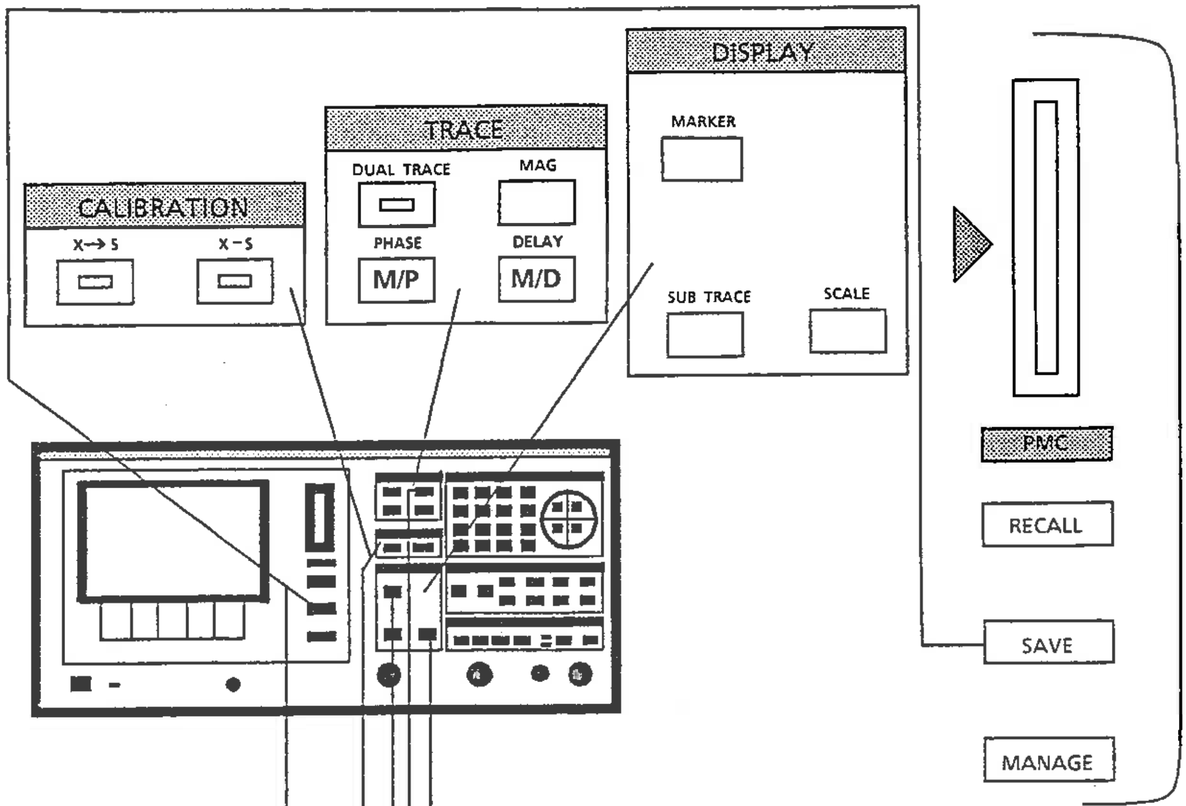
START: Linear mode sweep start frequency -100 kHz

STOP: Linear mode sweep stop frequency -30 MHz

DRG: Shows that Delay Rande (delay) range is 400 ms

Fig. 3-3 Initial CRT Display

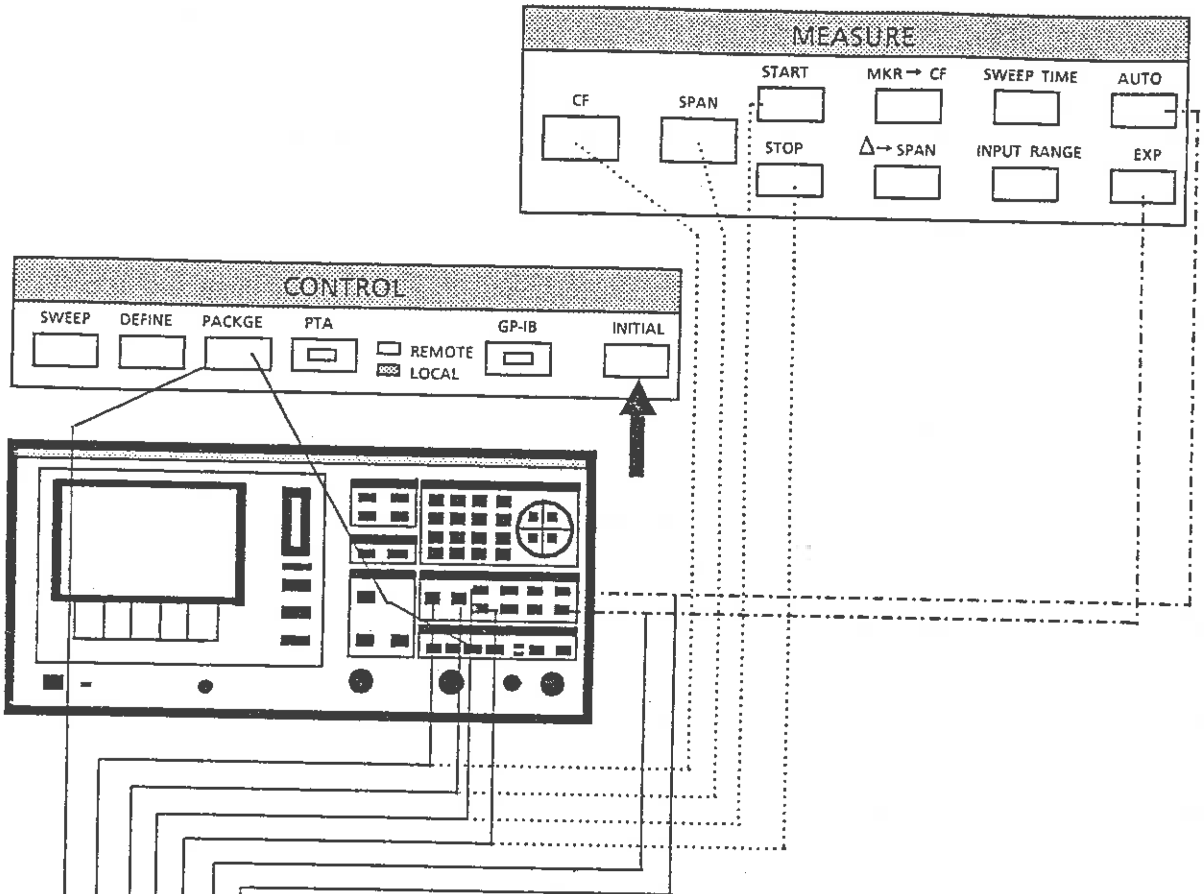
3.1.3 Initialization and CRT display



SCALE A	***10 dB / (MAG)***
OFFSET A	***-50.00 dB (MAG)***
SCALE B	50 deg / (PHASE)
OFFSET B	0.0 deg (PHASE)
SCALE B	100 ms / (DELAY)
OFFSET B	0.0 ms (DELAY)
MAG	***ON***
MARKER	***NORMAL***
X → S	OFF
X − S	OFF
FUNC	on
S	off
X	off
F.TBL	off

Fig. 3-4 (a) Initialization Parameters

Italicized parameters in Figs. 3-4 (a) and (b) correspond to the CRT display shown in Fig. 3-3.



RESOL· BW	***wide (AUTO)***
VIDEO BW	***off (AUTO)***
SWEEP TIME	***200 ms (AUTO)***
UNCAL	***on***
DLY RANGE	***400 ms***
50Ω/75Ω	*50Ω*
LOG/LIN	LIN
STOP	***30 MHz***
START	***100 KHz***
SPAN	10 MHz
CF	15 MHz
AVE	1
MP	501
OVERLAP	off
TITLE	off
PTA	off
GP-IB	off

Fig. 3-4 (b) Initialization Parameters

3.1.4 Abbreviations

The abbreviations on the panel and display are listed alphabetically below.

Abbreviation	Meaning
ADRS	Address
AUTO	Automatic Selection of Predefined Measurement Conditions
AVG	Averaging for S/N improvement
BUFF	Buffer
CAL	Calibration
CE	Clears Entry data
CF	Center Frequency during Linear Sweep
CHR	Character type Selection
COMP	Composite type Video signal
deg	Degree
DET	IF Output Detection
DLY	Delay
ΔMKR	ΔMarker
DRG	Delay Range
ENT	Enters Title Selected with knob
ERS	Erases Message Selected with Knob
EXP	Expansion of Measurement Capabilities
F.TBL	Frequency Table
F1 to F5	Function Keys No. 1 to No.5
FRMT	Format check
FUNC	Functions of Panel setting
IRG	Input Range
LIN	Linear sweep
LOG	Logarithmic sweep
M/D	Magnitude/Delay Measurement
M/P	Magnitude/Phase Measurement
MAG	Magnitude Measurement

(Cont'd)

Abbreviation	Meaning
MAX	Maximum
MIN	Minimum
MKR	Marker
MP	Measurement Point
MT	Main Trace
OMKR	Zero Marker
PHA	Phase Measurement
PMC	Plug-in Memory Card
PRTCT	Write Protect ON/OFF
RBW	Resolution Bandwidth
RES	Resets Sweep
RESOL.BW	Resolution Bandwidth
RSV	Request Service
RTL	Return to Local
RTN	Return
SEPA	Separated type Video Signal
SPAN	Frequency Span by Linear Sweep
ST	Sub trace or Start
START	Linear or Log Sweep Start Frequency
STOP	Linear or Log Sweep Stop Frequency
SWT	Sweep Time
VBW	Video Bandwidth

3.2 CRT Display in Each Mode

The setting parameters corresponding to the initial CRT display are shown in italics in Figs. 3-4 (a) and (b).

This paragraph explains how initial setting parameters other than those in italics are dislayed on the CRT.

3.2.1 Preparations

Connect the OUTPUT connector to the INPUT connector with the accessory 50 Ω coaxial cable as shown in Fig. 3-5.

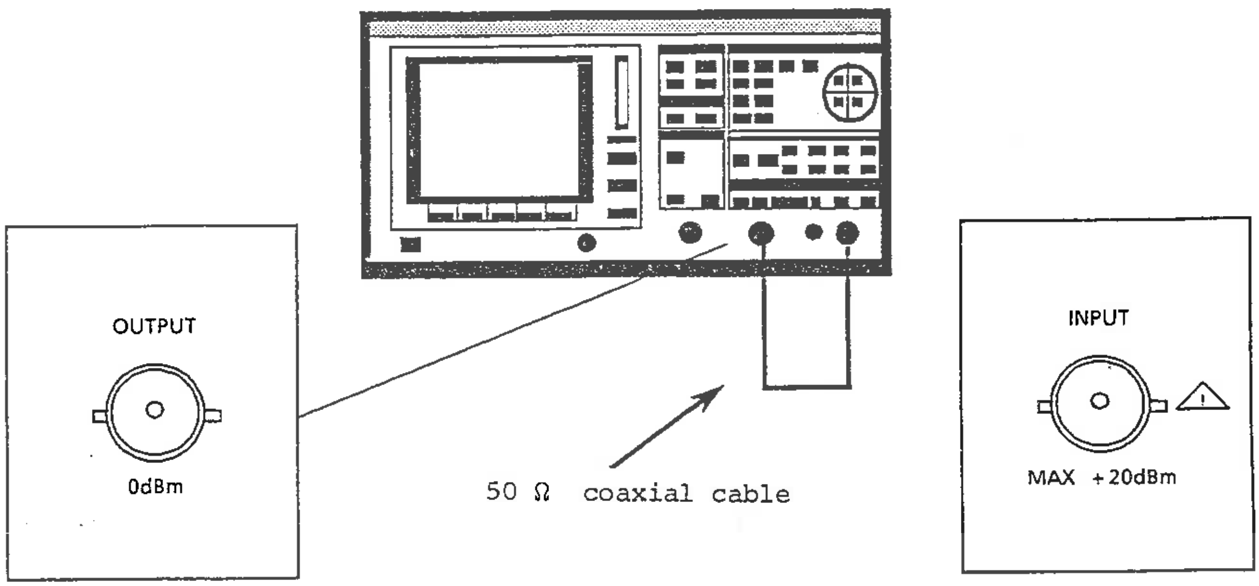


Fig. 3-5 Input and Output Terminal Connection

Note:

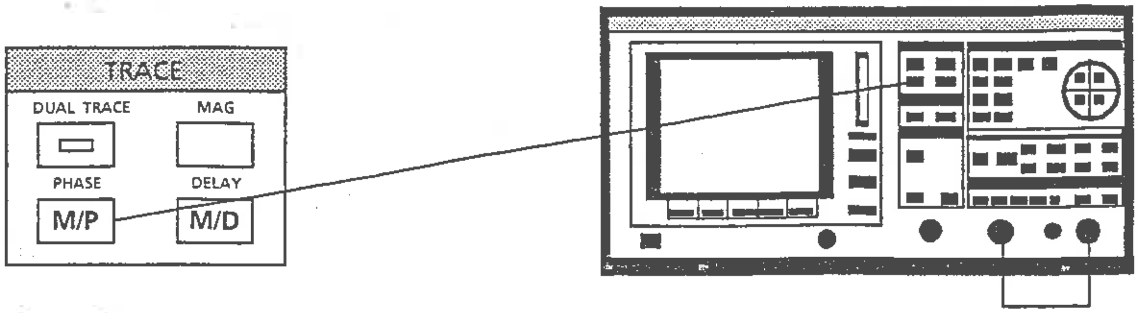
To check if the MS3401A is in the initial state, it is not always necessary to connect the input and output terminals with a cable. However, the accessory 50 Ω coaxial cable is used as a DUT (Device Under Test) with fixed impedance. The measured value of the trace waveform and marker on the CRT is also constant. This is convenient for comparing the magnitude, phase, delay, and other measurement modes.

The CRT displays in the initial states when the MS3401A is set to each of the following measurement modes are described below.

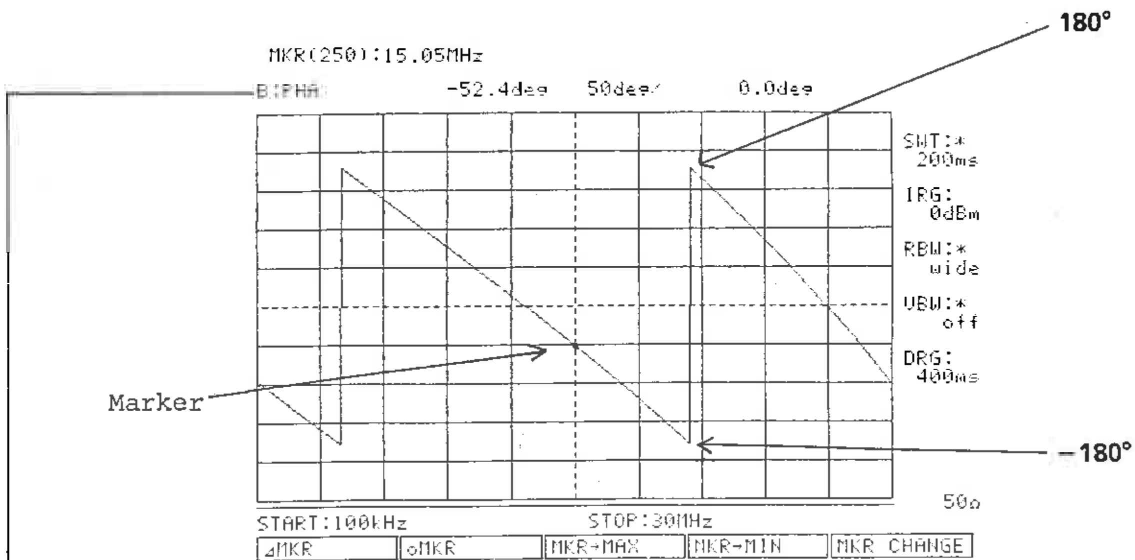
1. Phase measurement mode
2. Delay measurement mode
3. Delay measurement mode
4. Simultaneous magnitude/phase measurement mode
5. Simultaneous magnitude/delay measurement mode

3.2.2 Phase measurement mode

When the PHASE [M/P] key (Fig. 3-6 (a)) is pressed, the phase measurement trace waveform appears on the CRT as shown in Fig. 3-6(b). The trace A line on which the measured value and set parameters are displayed in the magnitude measurement mode is erased and the phase measurement mode measured value and set parameters are displayed on the next line.



(a) Phase Measurement Setting



(b) CRT Display

B: Phase measurement mode measured value and set parameters display line

PHA: Phase ... shows that the MS3401A is in the phase measurement mode

-52.4deg: Measured value at marker

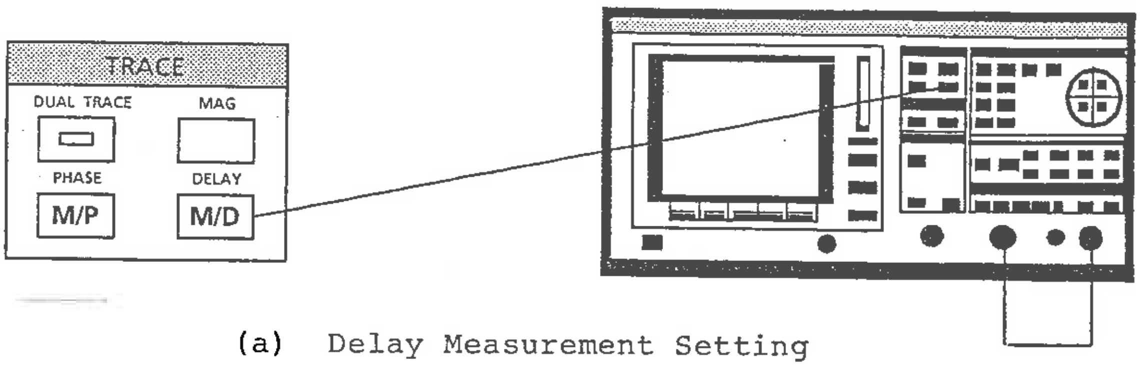
50deg/: Shows that the CRT vertical scale is 50 degrees/scale division

0.0deg: Offset value

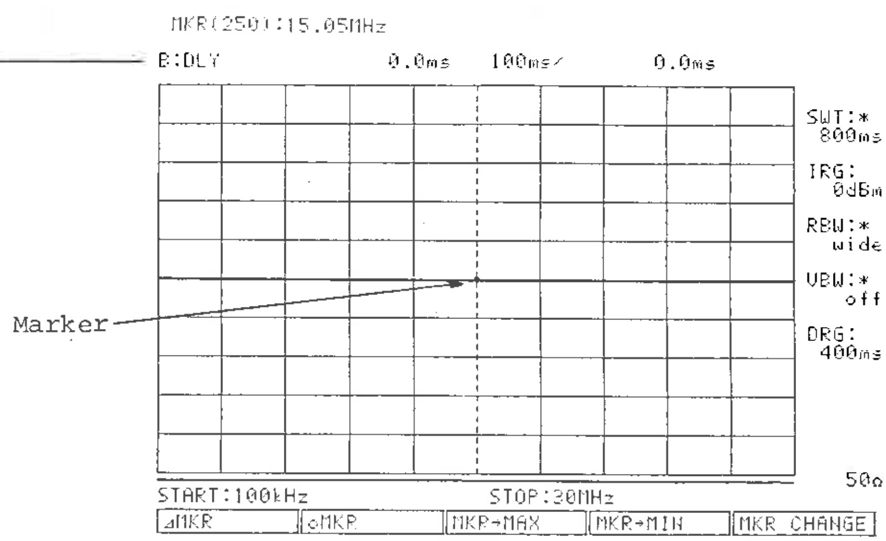
Fig. 3-6 Initial CRT Display at Phase Measurement

3.2.3 Delay measurement mode

When the DELAY [M/D] key (Fig. 3-7 (a)) is pressed, the delay trace waveform appears on the CRT as shown in Fig. 3-7 (b). The trace A line on which the measured value and set parameters are displayed in the magnitude measurement is erased, and the delay-measurement mode measured value and set parameters are displayed on the next line.



(a) Delay Measurement Setting



(b) CRT Display

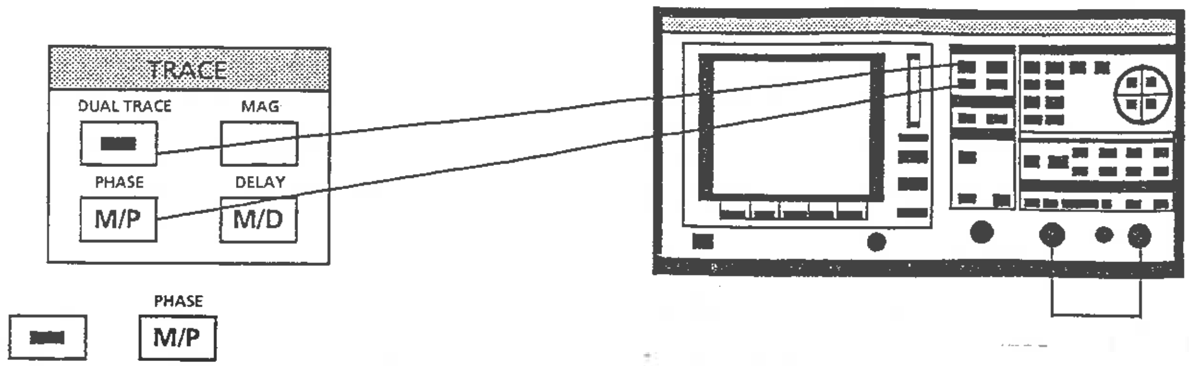
- B: Delay measurement mode measured value and set parameters display line
- DLY: Delay ... shows that the MS3401A is in the delay measurement mode
- 0.0ms: Measured value at marker
- 100ms/: Shows that the CRT vertical scale is 10 ms/scale division
- 0.0 ms: Offset

Fig. 3-7 Initial CRT Display at Delay Time Measurement

3.2.4 Magnitude/phase measurement mode

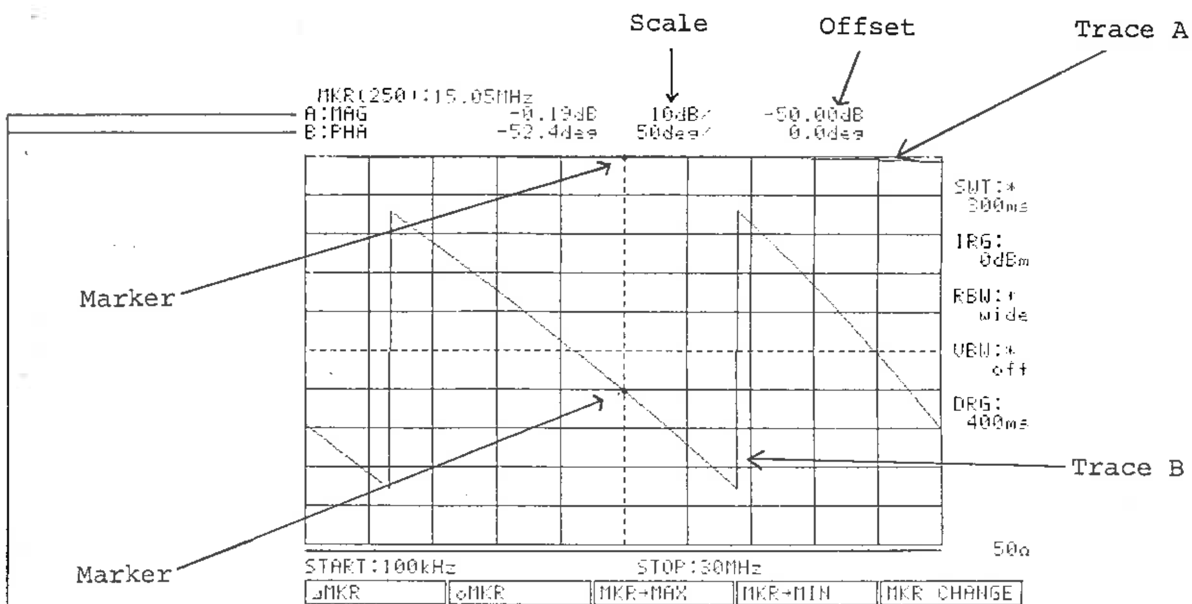
After the [DUAL TRACE] key internal LED is lit, when the PHASE [M/P] key (Fig. 3-8(a)) is pressed, the magnitude and phase trace waveforms appear on the CRT simultaneously as shown in Fig. 3-8(b).

The measured values and set parameters are displayed on the trace A line for magnitude measurement and on the trace B line for phase measurement.



Press [M/P] key after internal LED lights.

(a) Simultaneous Magnitude/Phase Measurement Setting



(b) CRT Display

A: Magnitude measurement measured value and set parameters display line

B: Phase measurement measured value and set parameters display line (trace B)

0.19 dB: Measured value at marker (magnitude)

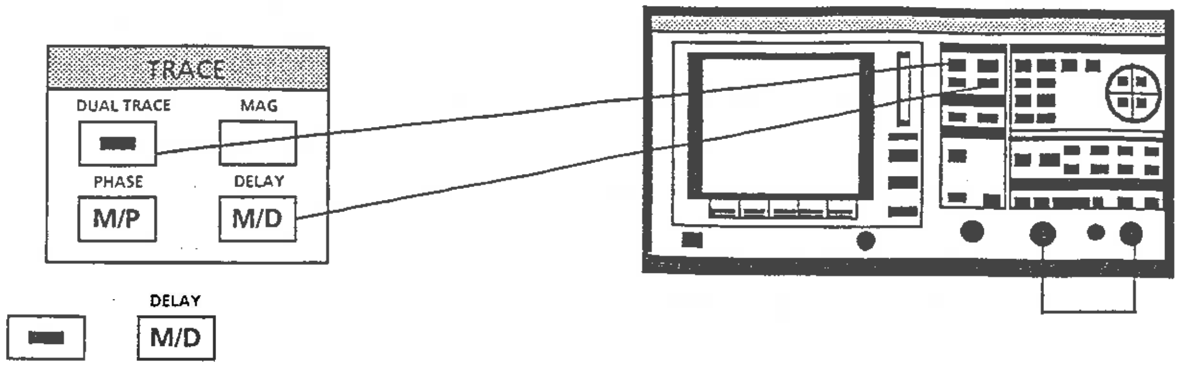
-52.4deg: Marker measured value at marker (phase)

Fig. 3-8 Initial CRT Display at Simultaneous Magnitude/Phase Measurement

3.2.5 Magnitude/delay measurement mode

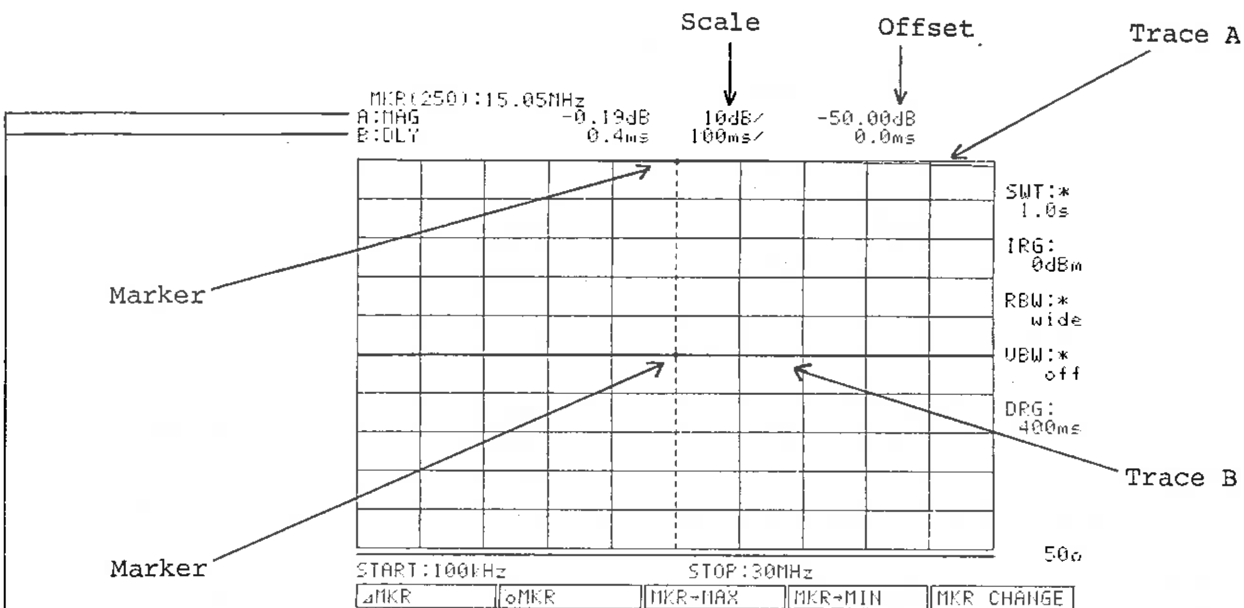
After the [DUAL TRACE] key internal LED is lit, when the PHASE [M/P] key (Fig. 3-9(a)) is pressed, the magnitude and delay trace waveform appear on the CRT simultaneously as shown in Fig. 3-9(b).

The measured value and parameters are displayed on the trace A line for magnitude measurement and on the trace B line for delay measurement.



Press the PHASE [M/D] key after internal LED lights.

(a) Simultaneous magnitude/delay measurement setting



(b) CRT Display

A: Magnitude measurement measured value and set parameters display line (trace A)

B: Delay measurement measured value and set parameters display line (trace B)

-0.19dB: Measured value at marker (magnitude)

0.4ms: Measured value at marker (delay)

Fig. 3-9 Initial CRT Display at Simultaneous Magnitude/Delay Measurement

3.2.6 Summary of measurement mode selection methods

Operations described in paragraphs 3.1.2, 3.1.3, 3.2.2 and 3.2.5 are also operations in which the items that can be measured with the MS3401A are selected.

Measurement items, key operations, and CRT displays are summarized in Table 3-1.

Table 3-1 Measurement Item Selection

Measurement item	TRACE key operation		CRT display
Magnitude	DUAL TRACE OFF	MAG	A : MAG
Phase	DUAL TRACE OFF	PHASE M/P	B : PHA
Delay	DUAL TRACE OFF	DELAY M/D	B : DLY
Magnitude/ phase	DUAL TRACE ON	PHASE M/P	A : MAG B : PHA
Magnitude/ delay	DUAL TRACE ON	DELAY M/D	A : MAG B : DLY

3.3 Simple Checks

This paragraph describes simple MS3401A Network Analyzer checks. The MS3401A is checked before it is shipped to ensure that it meets the catalog specifications in the ambient temperature range of 0° to 50°C. If the MS3401A passes the simple checks, it can be used immediately.

The following four items:

1. Initialization display at power-on
2. Magnitude measurement function
3. Phase measurement function
4. Delay measurement function

(1) Simple check adaptor

. 50 Ω coaxial cable (2) ... Length approx. 0.5 m (BNC.RG-55A/U.BNC)

. BNC (Fe)-BNC (Fe) adaptor .... Called "BNC adaptor" hereinafter.

(2) Setup

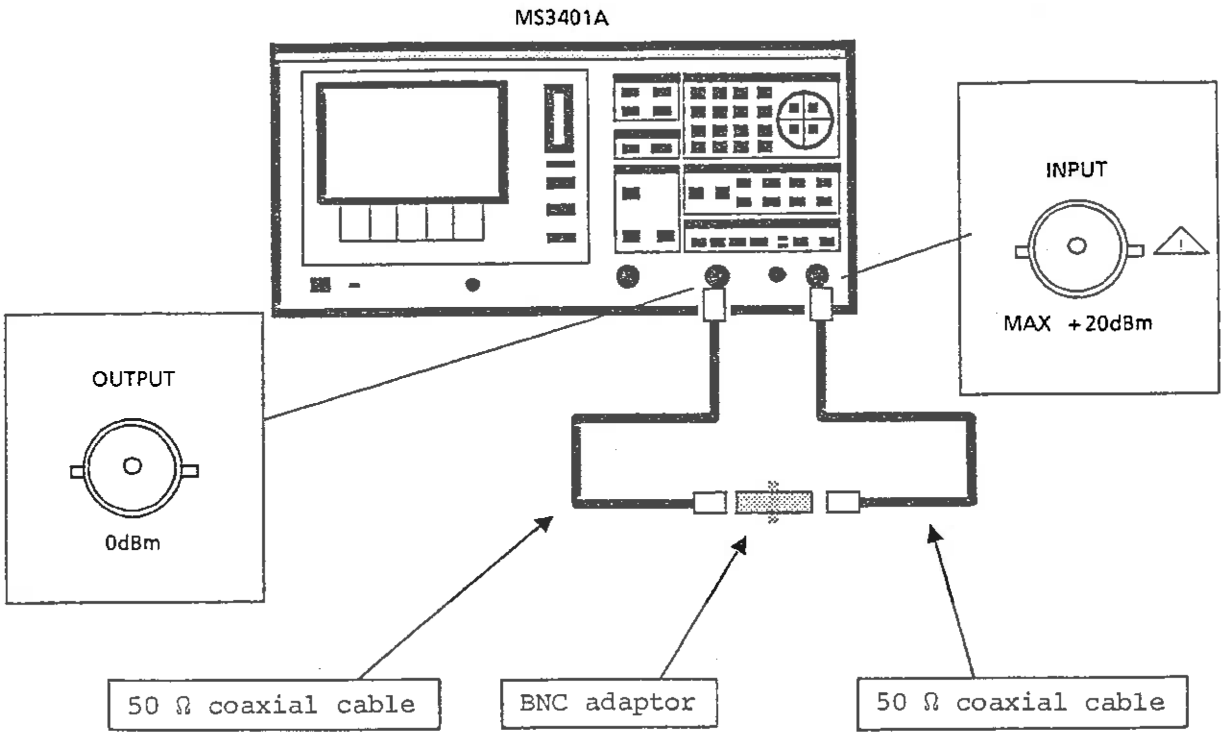
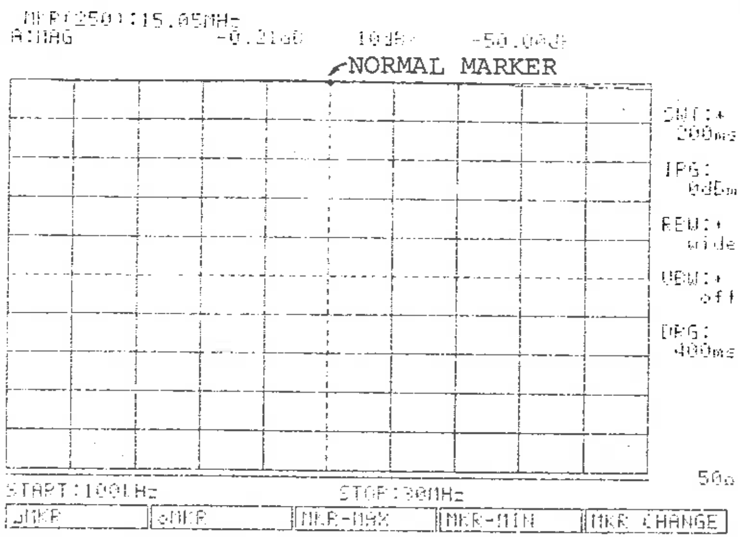
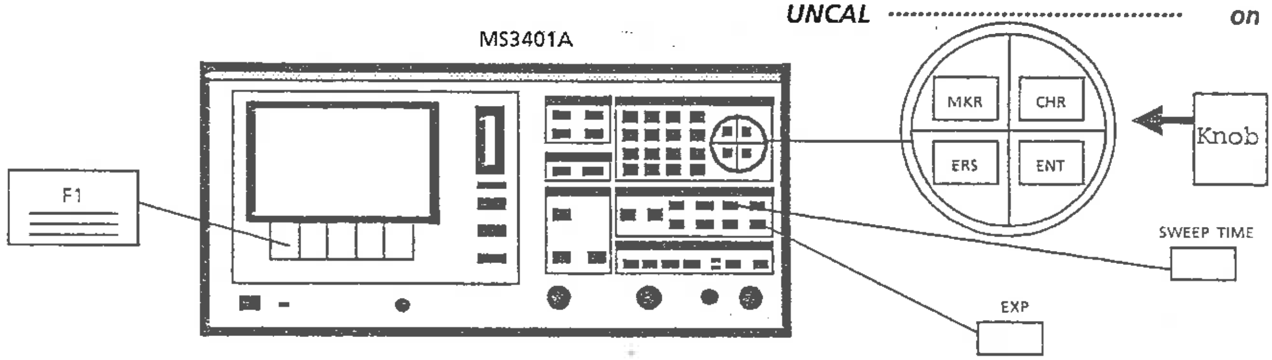


Fig. 3-10 Simple Checks



SCALE A	10 dB /
OFFSET A	−50 .00 dB
MAG	ON
INPUT RANGE	0 dBm
RESOL BW	wide (AUTO)
VIDEO BW	off (AUTO)
SWEEP TIME	200 ms (AUTO)
DLY RANGE	400 ms
50 Ω / 75 Ω	50 Ω
LOG / LIN	LIN
START	100 kHz
STOP	30 MHz
MARKER	NORMAL
CF	15 MHz
SPAN	10 MHz
MP	501
UNCAL	on



Initialization at Power-on (PMC Not Installed)

3.3.1 Initialization display at Power-on check

(1) Without PMC

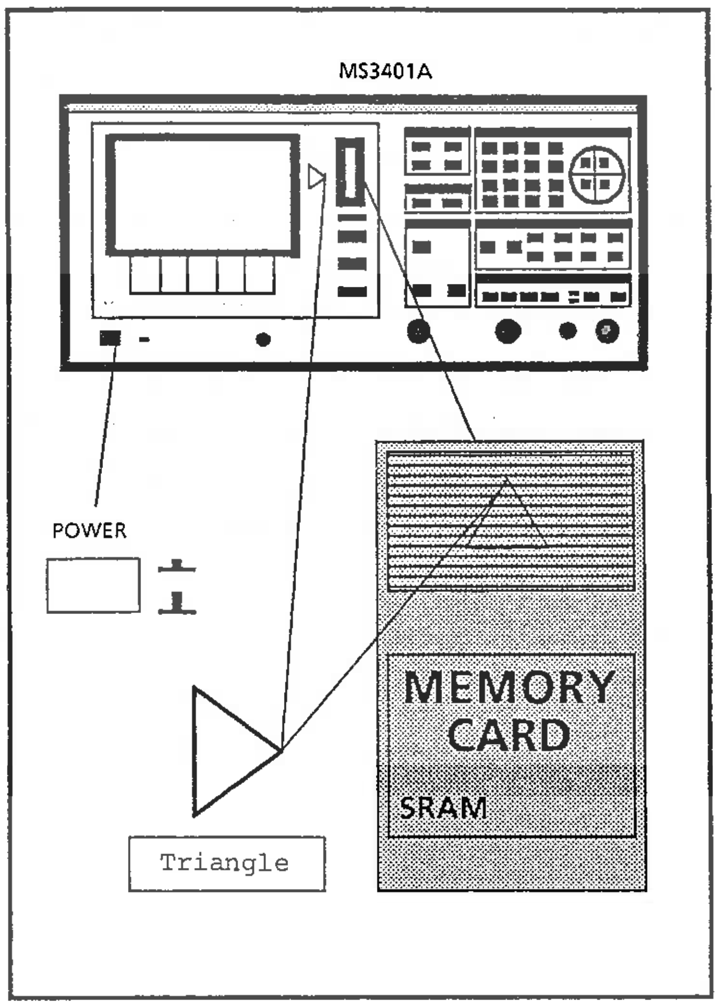
This checks the range (shown in figure above) from the initial CRT display. Without setting up the instrument, turn on the power in accordance with paragraph 3.3.1 and set the MS3401A as shown in the above figure. Check the MS3401A as follows:

Step	Procedure
1	Check that the parameters from SCALE A to STOP in the function parameter list at the top right of the above figure are displayed numerically at the right side of the linear-scale screen shown at the top left of the above figure.
2	Check the settings from MARKER to MP as follows: MARKER: Five markers are displayed at the bottom of the CRT. However, because no soft key ([F1] to [F5]) has been pressed, the current marker is the normal marker point. CF and MP: A CF setting of 15 MHz sets the center frequency to the center of the sweep span. MKR(250): 10.05 MHz displayed at the top of the CRT and the normal marker point displayed on the CRT show this. The sweep stop point (right end of CRT) is the 501 point MP setting.
3	Press the [SWEEP TIME] key and set the SWT: AUTO function displayed at the top right of the screen to manual. Then turn the knob until UNCAL is displayed at the bottom right of the CRT.

(2) With PMC (formatted)

This checks whether the parameter settings at the previous power-off are reset when the power is turned on when the PMC is installed.

The parameter setting at the previous power-off are assumed to be as in step 3 of 3.3.1(1).



Step	Procedure
4	Without turning off the MS3401A power, check the panel settings of step 3 of 3.3.1(1).
5	Plug PMC in the direction of the triangule into the PMC slot shown in the figure above.
6	Turn the power off.
7	Turn the power on and check that the parameter settings of step 3 of 3.3.1(1) are reset.

CAUTIONS

1. Plug the PMC into the PMC slot with the triangle on the PMC facing the triangle on the left side of the slot.

   The PMC must not be inserted with the triangle facing the right side of the PMC slot.
   If the PMC is forced into the slot, its electrodes may be damaged.

2. Before plugging-in the PMC, always discharge any static charge by touching the PMC on the OUTPUT or INPUT connector ground.

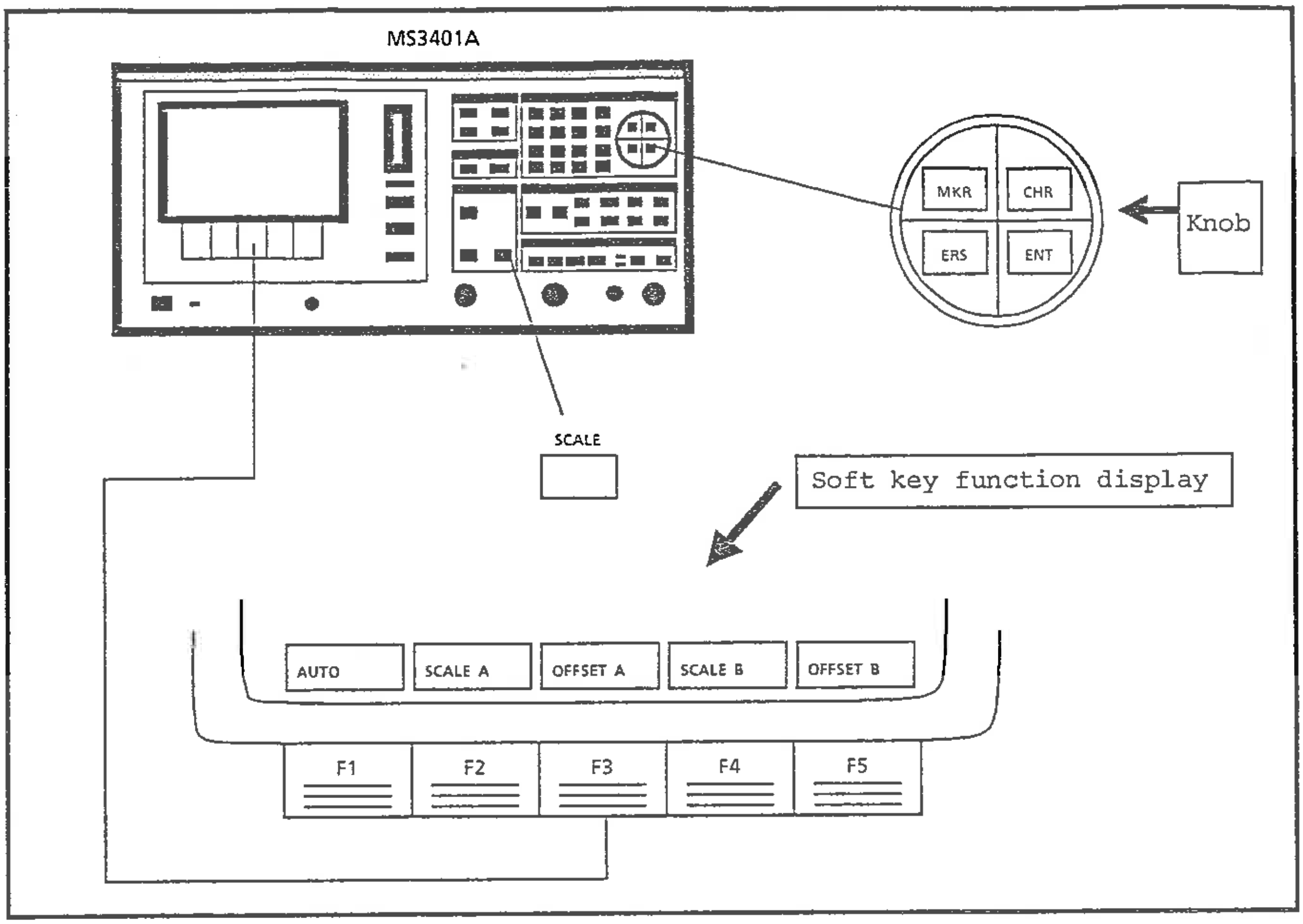
3.3.2 Magnitude measurement function check

This check starts after the power-on initialization check without PMC and checks the contents shown below.

The compare the contents before and after measuring the system frequency characteristic compensation on the same CRT, measurement starts after the measuring system frequency characteristic pre-compensation data is stored in the sub-memory.

Offset modification

Step	Procedure
1	Press the [SCALE] key to display the soft key functions at the bottom of the CRT.
2	Press the [F3] key (OFFSET A); offset -50.00 dB is reverse-displayed on trace A at the top of the CRT.
3	Turn the knob and set the offset value to 0.00 dB.
4	Press the [F2] key (SCALE A) and turn the knob and set the CRT vertical scale to 0.5 dB div.



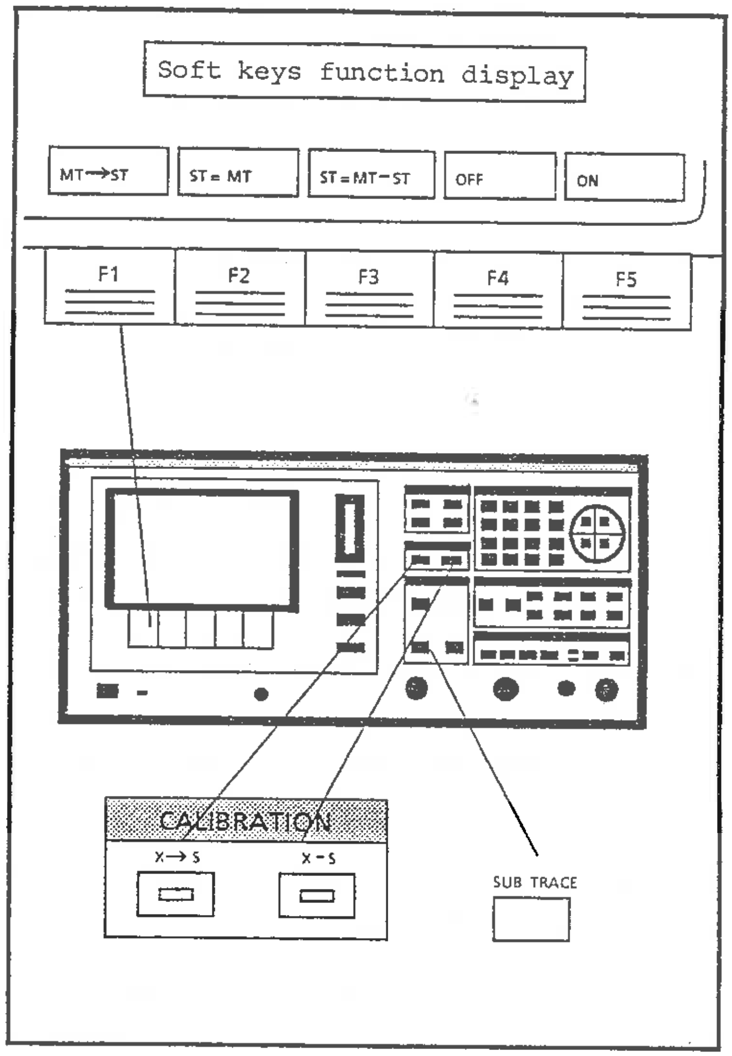
Storing pre-compensation data to sub-memory

(cont'd)

Step	Procedure
5	Connect a 50 Ω coaxial cable to both ends of the short adaptor as shown in Fig. 3-10. Trace waveform (B) is displayed on the CRT screen as shown in the figure below. The waveform shows the frequency response of the MS3401A itself.

(cont'd)

Step	Procedure
6	Press the [SUB TRACE] key to store this frequency characteristic in the sub-memory. The soft key function display shown below is displayed at the bottom of the CRT.



(cont'd)

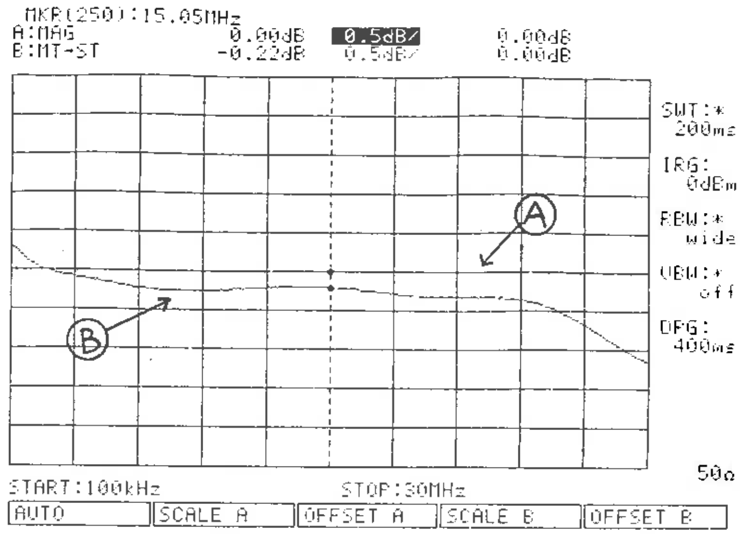
Step	Procedure
7	Press the [F1] key (MS→ST); the trace waveform B is stored in the sub-memory and both the sub-trace (ST) and main trace (MT) waveforms are displayed at the current trace waveform B. (The ST and MT waveforms overlap and appear as one waveform.)

Calibration and measurement

To remove the frequency response follow the steps below:

(cont'd)

Step	Procedure
8	Press the [X→S] key; the [X-S] key function is turned on automatically and the LEDs in both keys light.
9	Sweeping of the main trace begins simultaneously with lighting of the LEDs. The frequency response is stored in the S memory simultaneously with sweep. However, since the [X-S] key is also on, the difference between X (MS3401A frequency response) and the S memory contents (MS3401A frequency response) is calculated. Therefore, the frequency response is cancelled as the sweep progresses. At the end of the sweep, the LED in the [X→S] key goes off. As a result, no frequency response waveform over the entire frequency range is displayed at the main trace as shown by trace waveform A.



(cont'd)

Step	Procedure
	The LED in the [X-S] key remains on until the key is pressed again. Therefore, if the short adaptor shown in Fig. 3-10 is removed and the DUT is connected to the test cable, removed correct measurement (free from MS3401A frequency response) is performed from the next sweep.

Notes:

1. To expand or contract trace waveforms A and B, press the [SPACE] [F2] or [F4] keys, then change the scaling of the CRT vertical scale.

2. If the [X-S] lamp key is lit before the [X→S] key is pressed, incorrect data will be used for compensation.
   Therefore, always press the [X→S] key before the LED in the [X-S] lamp is lit.

3.3.3 Phase measurement function check

The phase measurement is checked after the magnitude measurement function check, and, therefore, the MS3401A will be preset as follows:

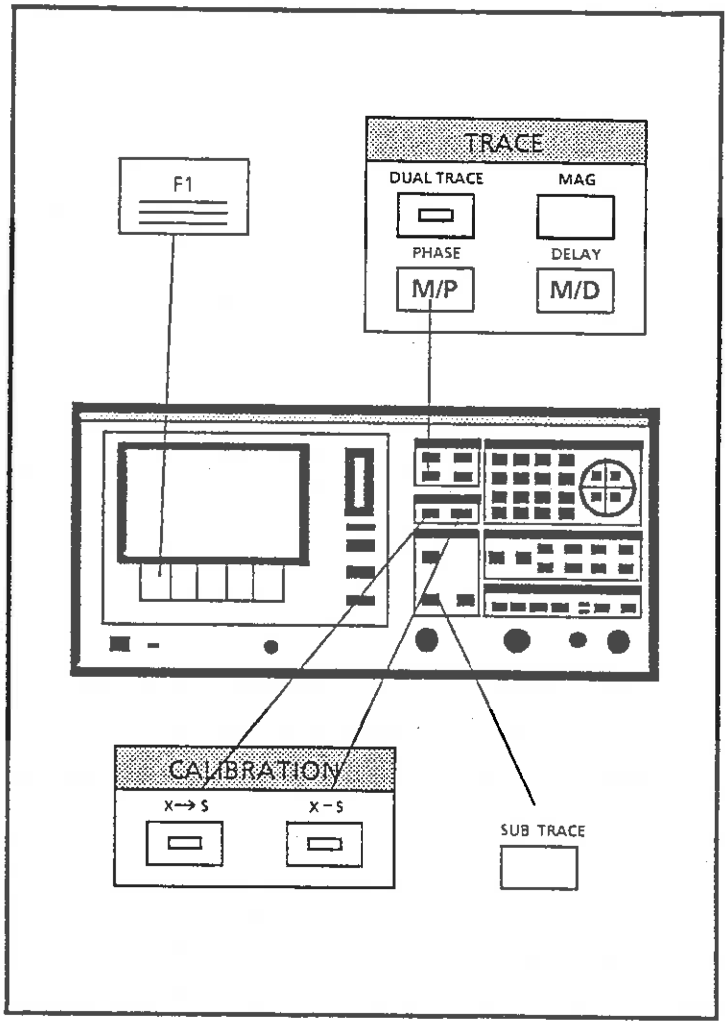
. OUTPUT/INPUT connector .... Connected (Fig. 3-8)

. Measurement mode .... Magnitude

. [X-S] LED .... On

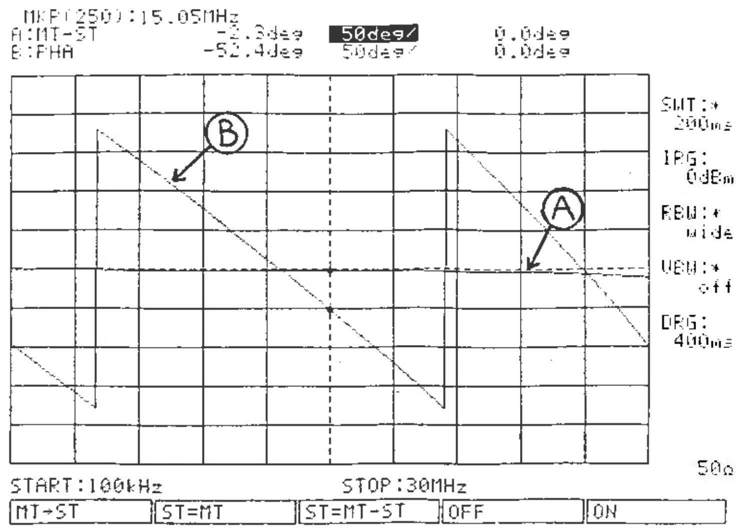
. Precompensation magnitude measurement data .... Stored in sub-memory and displayed on CRT

The precompensation phase measurement data is also stored in the sub-memory and displayed on the CRT. Operation is the same as for the magnitude measurement function check. The offset is initialized to 0.0 deg and does not have to be changed.



Storing precompensation data to sub-memory

Step	Procedure
1	Pressing the [X-S] key; the [X-S] LED goes off.
2	Press the PHASE [M/P] key; Phase measurement begins and trace waveform B is displayed. This is the phase characteristic of the MS3401A itself.



Note:

At this time, the trace B memory becomes the main memory and displays the phase measured data. The **old magnitude** measured data remains in the sub-memory (Trace (A)).

(cont'd)

Step	Procedure
3	Press the [SUB TRQCEW] key, then press the [F1] key (MT - ST); the trace (B) waveform is stored in the sub-memory.

Calibration and measurement

The phase characteristic currently displayed on the CRT includes the measuring system phase error as shown by trace waveform (B). To remove the measuring system phase error, proceed as described below.

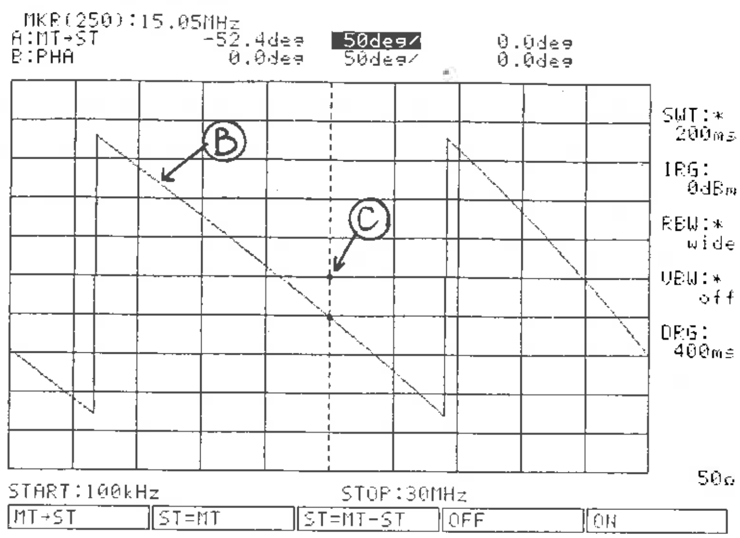
(cont'd)

Step	Procedure

4 Press the [X→S] key; the [X-S] key is turned on automatically and the LEDs in both keys light

The main trace sweep begins as soon as the LEDs light.

At the end of the sweep, the LED in the [X→S] key goes off. As a result, no phase error waveform over the entire frequency range is displayed at the main trace as shown by trace waveform C.



The LED in the [X-S] key remains on until the key is pressed again.

Therefore, if the short adaptor shown in Fig. 3-10 is removed and the DUT is connected, correct measurement free of MS3401A phase error is performed from the next sweep.

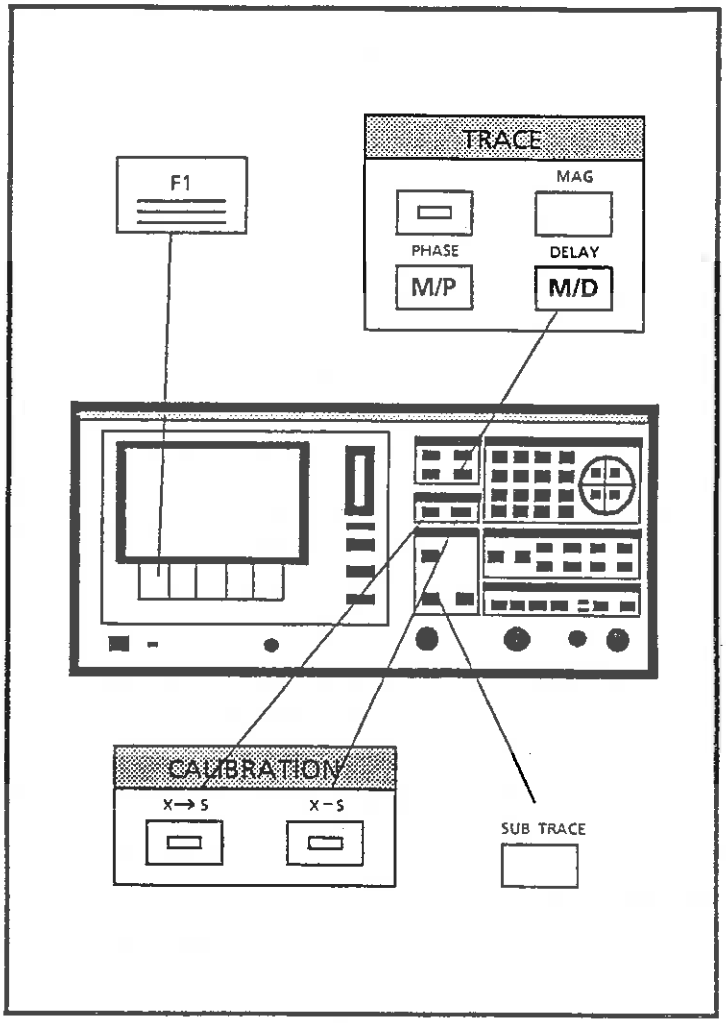
3.3.4 Delay measurement function check

This is checked after the phase measurement function check.

Therefore, the MS3401A will allready be preset as follows:

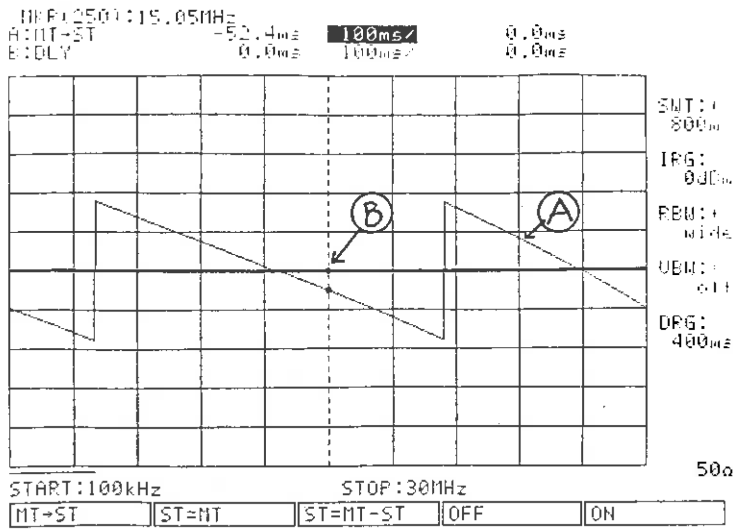
- Output - INPUT connectors ... Connected (Fig. 3-8)
- Measurement mode .... Phase
- [X→S] lamp .... ON
- Precompensation phase measurement data .... Stored in sub-memory and displayed on CRT

The precompensation delay measurement data is also stored in the sub-memory and displayed on the CRT. Operation is the same as for the magnitude measurement function check. Since the offset is initialized to 0.0ns, it does not have to be changed.



Storing precompensation data to sub-memory

Step	Procedure
1	Turn off the [X→S] LED by pressing the [X-S] key.
2	Press the [DELAY] key; delay measurement begins and trace waveform (B) is displayed. This is the delay of the MB3401A itself. The old phase measurement data remains in the sub-memory (Trace (A)).



(cont'd)

Step	Procedure
3	Press the [SUB TRACE] key, the press the [F1] key (MT-ST); then trace B waveform is stored in the sub-memory.

Calibration

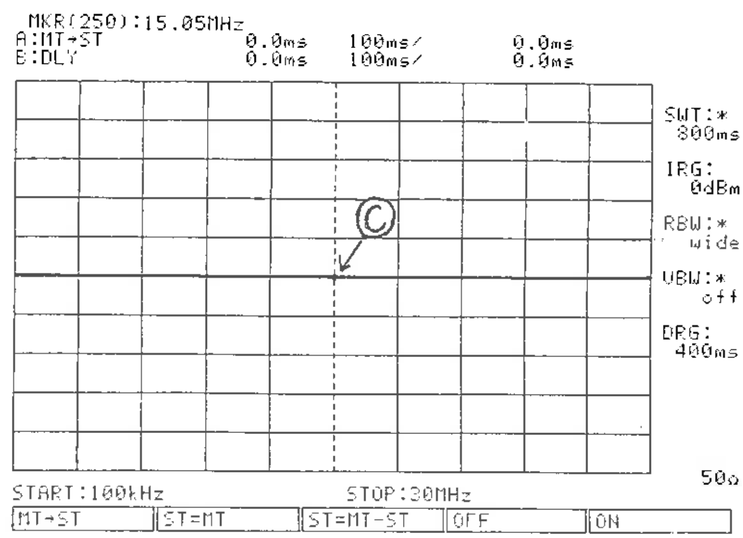
To remove the MS3401A delay, follow the steps below.

(cont'd)

Step	Procedure
4	Press the [X→S] key; the [X-S] key function comes on automatically and the LEDs in both keys lights.

(cont'd)

Step	Procedure
5	The main trace sweep begins as soon as both LEDs light. At the end of the sweep, the LED in the [X-S] key goes off. As a result, no delay waveform over the entire frequency range is displayed at the main trace as shown by trace waveform C.



Step	Procedure
6	The LED in the [X-S] key remains on until the key is pressed again. Therefore, if the short adaptor shown in Fig. 3-10 is removed and the DUT is connected correct measurement (free of MS3401A delay) is performed from the next sweep.

SECTION 4

CALIBRATION AND PERFORMANCE TESTS

This section describes MS3401A Network Analyzer routine calibration and performance tests.

(1) Routine calibration

To maintain the MS3401A performance, routine internal adjustment are necessary even if the MS3401A appears to be operating normally. Make these adjustments once or twice a year.

(2) Performance tests

Check that the MS3401A performs to specifications in any of the following cases.

1. When the results of the receiving inspection simple checks are incorrect
2. When Wanting to make a more detailed inspection than simple checks at receiving inspection
3. After parts replacement and adjustment
4. During routine calibration
5. Before or after long-term storage

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4.1 Regular Servicing and Preventive Maintenance

Calibration and performance tests can be used in preventive maintenance to prevent deterioration of the MS3401A performance.

When the MS3401A is in daily use, it must be operated correctly under the right environmental conditions (paragraph 2.1). Preventive maintenance should be based on the accumulative results of periodic performance and calibration tests.

The regular servicing methods and periods are listed in Table 4-1.

Table 4-1 Regular Servicing

	Period	Method
Soiling	• Before long-term storage • When used in dusty locations	Wipe with soapy water or cleaning solvent (DAIFLON)
Dust	• When noticeable dust and dirt have accumulated inside cabinet	Open cabinet and blow out dust with compressed air
Lubrication	None	
Loose screws	When detected	Retighten with recommended tool

* If acetone or benzene is used, the paint finish may be damaged.

When the MS3401A will not be used for a short or long time refer to paragraph 2.3.

4.2 Calibration and Performance Test Equipment

The calibration and performance test equipment are listed in Table 4-2.

Table 4-2 Calibration and Performance Test Equipment

Test item	Instrument	Main performance*	Recommended model	Reference
Standard oscillator frequency stability	Frequency counter 10 MHz standard oscillator	Frequency: 10 MHz Stability: $\leq 1 \times 10^{-9}$/day	MF57A	4.4.3
Frequency range	Frequency counter	Frequency range: 10 Hz to 30 Hz Resolution: $\leq$0.01 Hz	MF57A	4.4.2
Synthesizer output level	Level meter	Frequency range: 10 Hz to 20 MHz Measurement accuracy: $\leq\pm$0.3 dB Impedance: 50 or 75 Ω	ML424A	4.4.3
Input impedance Return loss	Reflection bridge Network analyzer	Frequency range: 10 Hz to 30 MHz Impedance: 50 or 75 Ω	MS3401A	4.4.4
Input unbalanced noise level	None			4.4.5
Crosstalk	Standard attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, 1 dB minimum steps Impedance: 50 or 75 Ω	MN1501J	4.4.6

Table 4-2 Calibration and Performance Test Equipment (Cont'd)

Test item	Instrument	Main performance*	Recommended model	Reference
Magnitude measurement linearity	Standard attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, 1 dB minimum steps Impdance: 50 or 75 Ω	MN1501J	4.4.7
Phase level charac-teristics	Standard attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, 1 dB minimum steps Impedance: 50 or 75 Ω	MN1501J	4.4.8
Delay level charac-teristic	Standard attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, 1 dB minimum steps Impedance: 50 or 75 Ω	MN1501J	4.4.9
	Standard delay cable	Delay: 100 ns Impedance: 50 Ω		

* Some of the performances covering the test item measurement ranges are omitted.

4.3 Calibration

Calibrate the frequency of the internal 10 MHz standard oscillator once every six months.

If there are any items that do not meet the specifications in the calibration or performance tests and adjustment, or repair is necessary, contact your ANRITSU service department.

4.3.1 Standard oscillator frequency accuracy

Although a very stable standard oscillator is installed, if the calibration accuracy is low, the accuracy of measured results will be low because the results accuracy cannot exceed the calibration accuracy.

Since the stability of the 10 MHz standard oscillator is $\pm 2 \times 10^{-8}$/day, a calibration standard oscillator of higher accuracy, which receives either a standard signal or a color television broadcast subcarrier (signal locked to a rubidium atomic standard), that generates a signal locked to this received signal, must be used.

(1) Calibration specifications

Standard oscillator

Accuracy	$\pm 2 \times 1^{-8}$/day	after calibration after 24 hours operation at 23° ±5°C
Frequency	10 MHz	

(2) Calibration equipment

. Oscilloscope

10 MHz measurement, external trigger

. Reference frequency standard

Standard signal receiver or equivalent instrument (accuracy: $\geq 1 \times 10^{-9}$/day)

(3) Setup

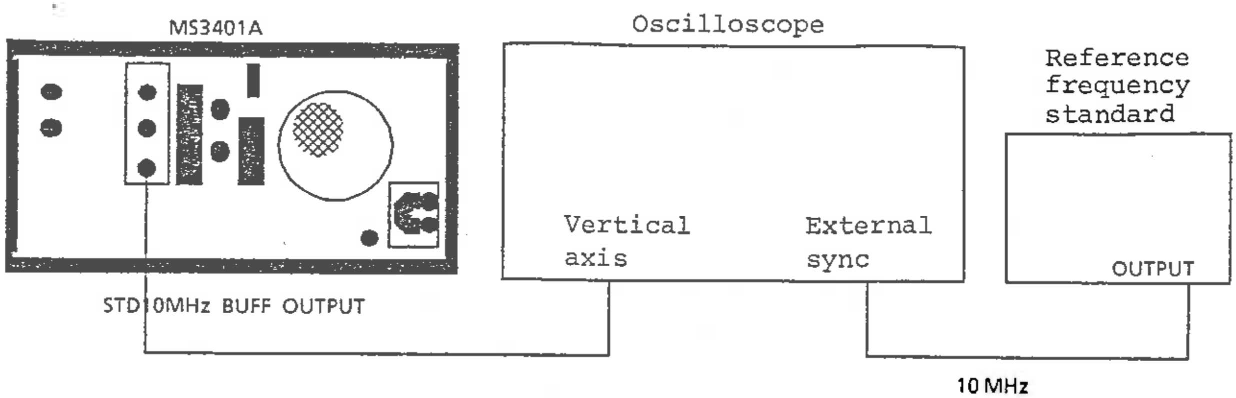


Fig. 4-1 Standard Oscillator Calibration

(4) Calibration procedure

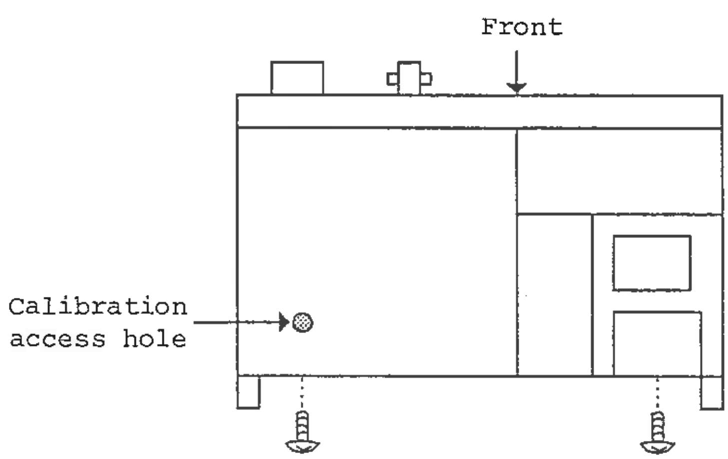


Fig. 4-2 Top View

Step	Procedure
1	Setup the equipment as shown in Fig. 4-1 with the MS3401A top cover recovered in a room at 23° ±5°C.
2	Warm up the MS3401A standard oscillator by leaving the instrument switched on for 24 hours.
3	Apply the signal from the reference frequency standard to the external sync input of the oscilloscope. Also, apply the signal from the STD 10 MHz BUFF OUTPUT connector on the rear panel of the MS3401A to the X-axis of the oscilloscope.
4	Adjust the oscilloscope and observe the displayed Lissajous waveform. If the waveform on the oscilloscope moves right and left, the MS3401A oscillator frequency and the reference standard frequency are not matched.
5	There is an access hole in the side of the MS3401A as shown in Fig. 4-2 for adjusting the standard oscillator. Adjust the potentiometer under this hole so that the Lissajous waveform on the oscilloscope does not move.

Note:

The reference frequency standard signal is 10 MHz; when it is applied to the oscilloscope Y-axis, a Lissajous waveform is displayed. Adjust the MS3401A standard oscillator frequency in step 5 so that the waveform becomes a stationary circle.

4.4 Performance Tests

When the MS3401A performance must be tested, follow the instruction in paragraphs 4.4.1 through 4.4.9.

CAUTION

Depending on the test item, the MS3401A warm up time may be as long as 24 hours. However, always warm up the MS3401A for at least 30 minutes before performing tests where no time is specified.
Also take account of the warm up times of the other test equipment before making any measurement.
For the higher accuracy, make measurements at the temperature specified in 4.3.1(1).
Also, the ac supply voltage fluctuations must be small, and there must be no noise, vibration, or dust.

4.4.1 Standard oscillator frequency stability

This test checks the frequency stability of the 10 MHz crystal oscillator used as the MS3401A standard oscillator. The frequency stability is checked by measuring the frequency change 24 hours after the power is turned on and at ambient temperatures between 0° and 50°C. Generally, the frequency of a crystal oscillator changes substantially for two or three minutes after the power is turned on, but stabilizes after seven or eight minutes. When measuring the frequency stability/day, measure the frequency 15 minutes after the power is turned on and again 24 hours later.

(1) Test specifications

Standard oscillator

. Frequency 10 MHz

. Aging rage $\leq +2 \times 10^{-8}$/day After 24 hours operation at 23° ±5°C

. Temperature stability $\leq 5 \times 10^{-8}$/day 0° to 50°C

(2) Test equipment

. MF57A Frequency Counter

. 10 MHz reference standard oscillator

stability $\leq 1 \times 10^{-9}$/day

(3) Setup

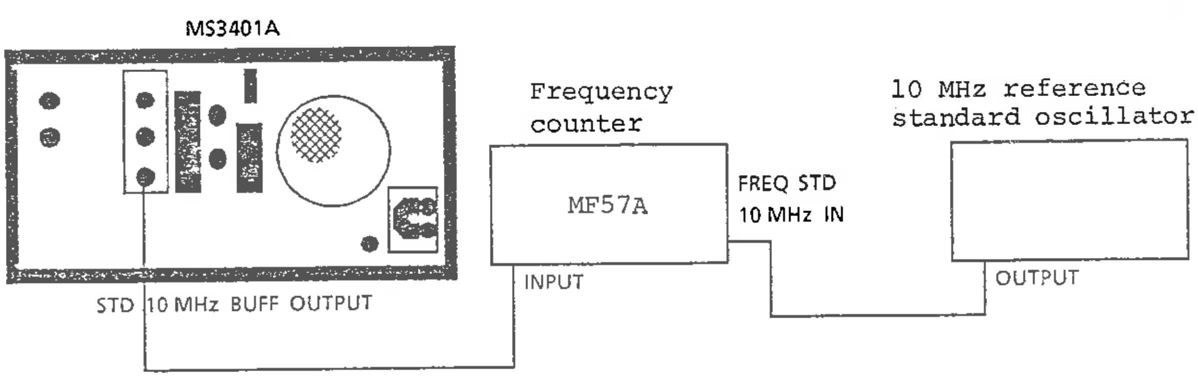


Fig. 4-3 Standard Oscillator Frequency Stability Test

(4) Test procedure

(a) Frequency stability/day

Perform this test where there is no vibration and where the ambient temperature change is ±2°C.

Step	Procedure
1	Setup the equipment as shown in Fig. 4-3.
2	Set the frequency selector switch (FREQ STD: INT/EXT) on the rear of the MF57A Frequency Counter to EXT.
3	Input the 10 MHz reference frequency to the MF57A Frequency Counter.
4	Turn on the MS3401A power.
5	Fifteen minutes after turning on the MS3401A power, measure the output frequency with the frequency counter.
6	Twenty-four hours later, measure the output frequency again.
7	Calculate the stability using the following equation: Frequency stability = (1st counter reading) - (2nd counter reading)/(2nd counter reading)

(b) Temperature stability

Perform this test in a constant-temperature chamber.

Step	Procedure
1	Setup the equipment as shown in Fig. 4-3 in a constant temperature chamber set to 0°C.
2	Turn on the MS3401A power and wait for the MS3401A internal temperature to stabilize.
3	When the MS3401A temperature has stabilized, measure the frequency with the MF57A Frequency Counter.
4	Set the chamber temperature to 50°C.
5	When the chamber temperature and the MS3401A internal temperature have stabilized, measure the frequency with the MF57A Frequency Counter.
6	Calculate the frequency temperature stability using the following equation: Frequency stability = (1st counter reading) - (2nd counter reading)/(2nd counter reading)

4.4.2 Frequency range

The network analyzer makes measurements by supplying the same local oscillator signal to the input and output circuit and linking the frequency.

Therefore, the frequency range can be checked at the input receiving frequency or output frequency.

This section describes a simple method for testing the output frequency

(1) Test specifications

. Frequency range 10 Hz to 30 MHz

(2) Test equipment

. Frequency counter:

Frequency counter:	Frequency range	10 Hz to 30 MHz
	Resolution	$\leqq$0.01 Hz
	Accuracy	$\leqq 2 \times 10^{-8}$

(3) Setup

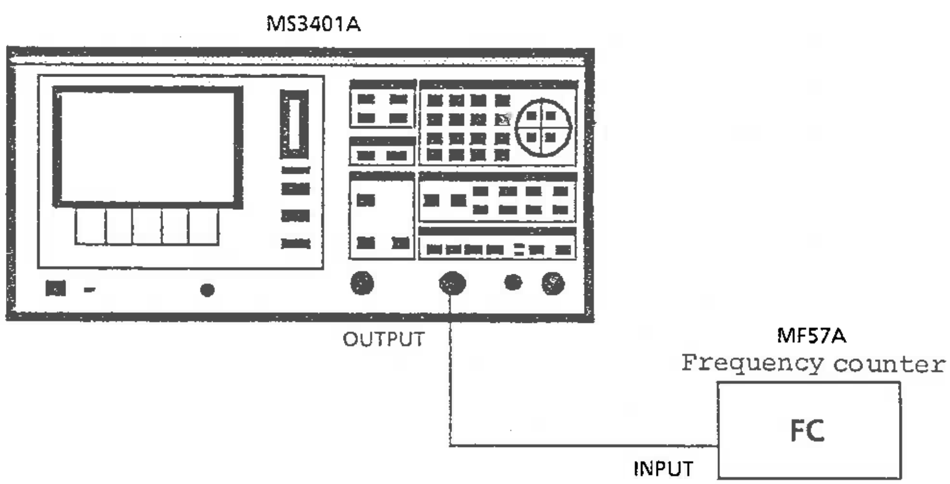
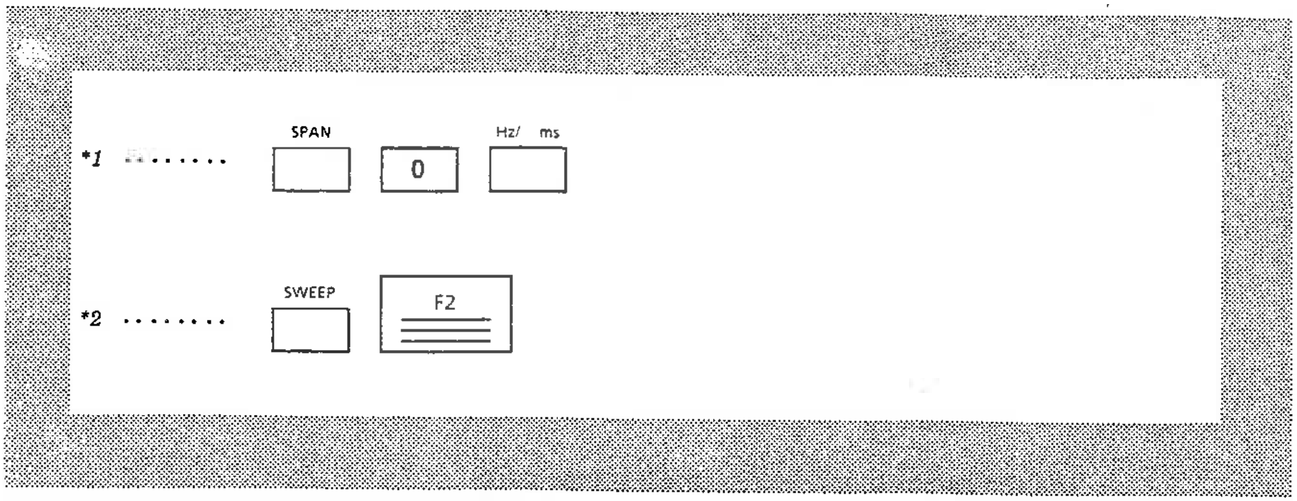


Fig. 4-4 Frequency Range Test

(4) Test procedure

Step	Procedure
1	Setup the MS3401A and frequency counter as shown in Fig. 4-4.
2	Press the MS3401A [INITIAL] key to initialize the instrument.
3	Set the MS3401A as follows: SPAN: 0 Hz (*1) SWEEP: MKR (*2)
4	Set each of the center frequencies listed below in succession and compare the set values with those displayed on the frequency counter for each frequency setting.

CF (Hz)	Frequency counter reading
10	
10 K	
1 M	
5 M	
10 M	
20 M	
30 M	



Note:

Warm up the frequency counter and MS3401A for at least 15 minutes before starting this test.

4.4.3 Synthesizer output level

The synthesizer outputs approximately 0 dBm for use at a test signal source.

There are two causes of output level error: (1) absolute value changes, and (2) frequency characteristics. The synthesizer uses a passive circuit for the latter and has almost no aging change.

This section describes testing only the absolute value at a selected frequency (2 MHz).

(1) Test specifications

Synthesizer output level 0 dBm

(2) Test equipment

Level meter Frequency range: 10 Hz to 20 MHz

Measurement accuracy: $\leq \pm 0.3$ dB (at 2 MHz)

Impedance: 50 or 75 Ω

(3) Setup

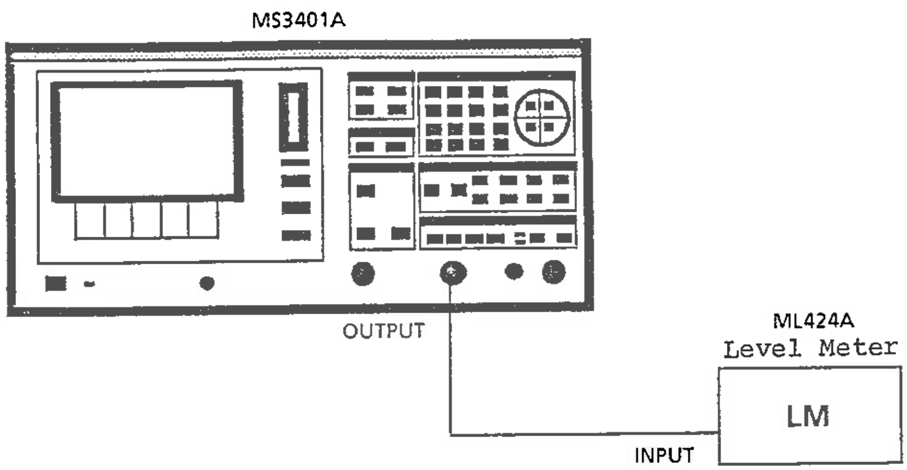
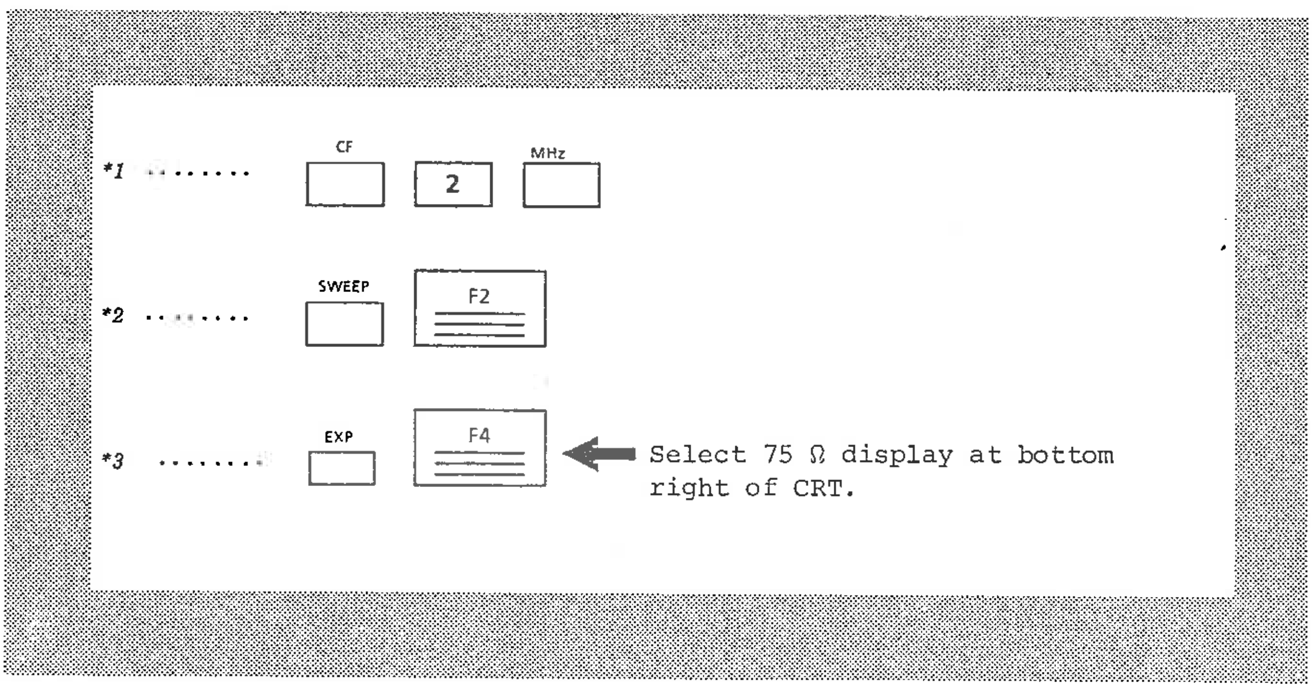


Fig. 4-5 Synthesizer Output Level Test

(4) Test procedure

Step	Procedure
1	Setup the equipment as shown in Fig. 4-5.
2	Initialize the MS3401A by pressing the [INITIAL] key.
3	Set the MS3401A as follow: CF: 2 MHz (*1) SWEEP: MKR (*2) Output impedance: 75 Ω (*3)
4	Read the level meter indication and check that it is approximately 0 dBm (±1 dB).



4.4.4 Input/output impedance

The input/output impedances are controlled to minimize mismatching with the DUT.

This paragraph describes testing the input/output impedances by using a reference MS3401A and a reflection bridge.

(1) Test specifications

Input impedance	Return loss $\geqq$30 dB (IRG = -10 dBm or more)
Output impedance	Return loss $\geqq$25 dB (30 Hz to 30 MHz)

(2) Test equipment

Reflection bridge	Frequency range	10 Hz to 30 MHz
MS3401A Analyzer	Impedance	50 or 75 Ω

(3) Setup

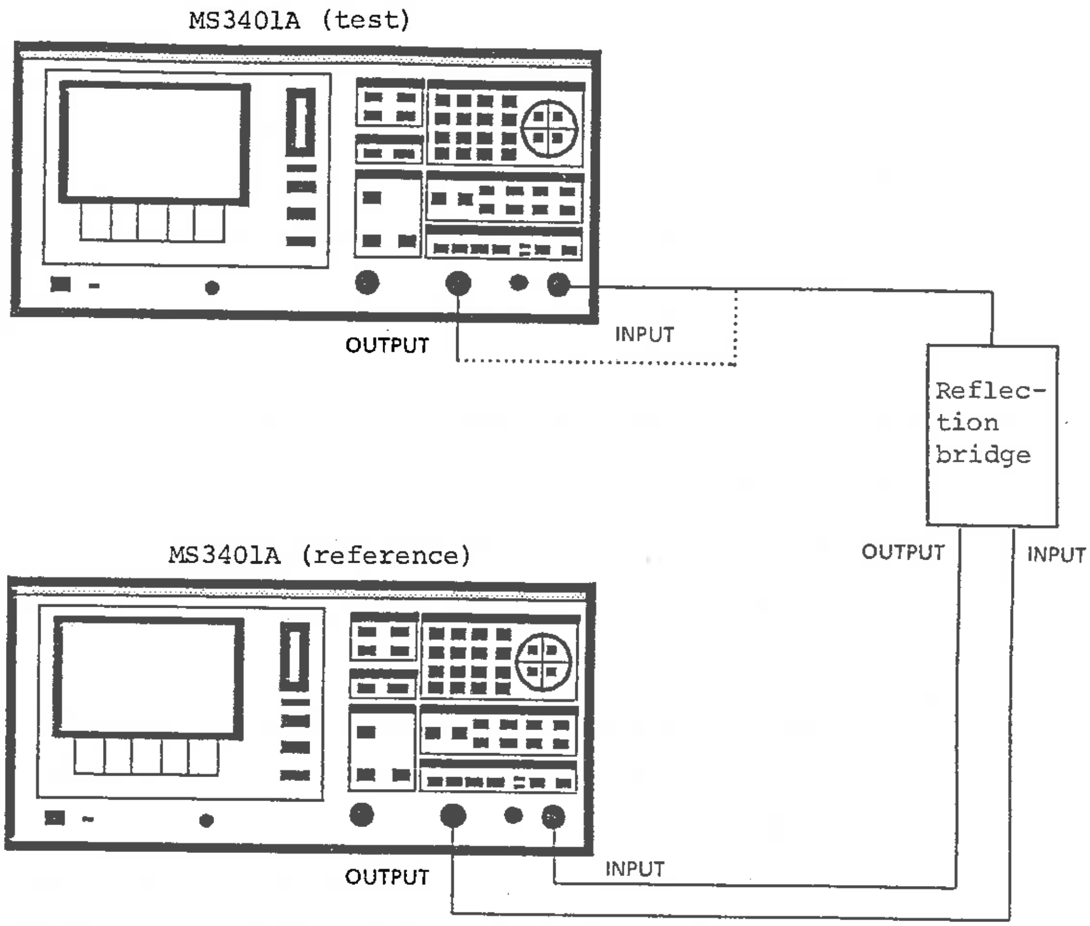


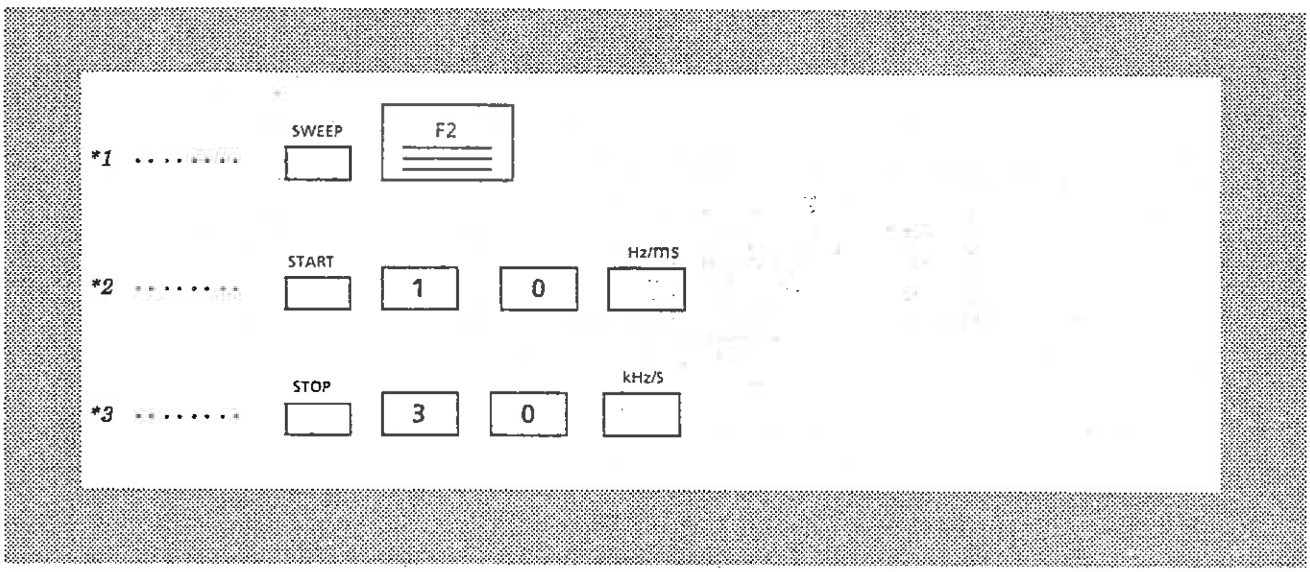
Fig. 4-6 Input/Output Impedance Test

(4) Test procedure

Step	Procedure
1	Setup the equipment as shown in Fig. 4-6.
2	Initialize the test MS3401A by pressing the [INITIAL] key
3	Set the test MS3401A sweep to MKR (*1)
4	Initialize the reference MS3401A by pressing the [INITIAL] key
5	Set the reference MS3401A as follows: START FREQ .... 10 Hz (*2) STOP FREQ .... 30 kHz (*3)
6	Set the reflection bridge frequency range to 10 Hz to 50 kHz.
7	Open the reflection birdge measurement terminals, press the network analyzer [X→S] key, and wait for one sweep.
8	Connect the reflection bridge measurement terminals to the reference MS3401A INPUT connector with the supplied cord.
9	Read the return loss directly from the reference MS3401A measured value. Read the worst value. Change the IRG and repeat the above measurement.
10	Connect the reflection bridge measurement terminals to the OUTPUT connector of the test MS3401A and measure the output impedance in the same way as step 9. Low frequency range measurement is complete.

(continued)

Step	Procedure
11	Change the frequency parameters set in step 5 and set the high frequency range as follows: START FREQ: 30 kHz STOP FREQ: 30 MHz
12	Set the reflection bridge frequency range to 30 kHz to 30 MHz.
13	Repeat steps 7 to 10 .



Note:

Testing for 50 or 75 Ω input/output impedance is identical.

4.4.5 Input average noise level

The input average noise level determines the lower limit of the magnitude measurement dynamic range.

When the attenuation of the DUT is infinite, since the detector measures its own noise level, signals lower than this noise level cannot be measured. The input average noise level is measured in the no-signal state with nothing connected to the input.

(1) Test specifications

. Average noise level

RBW	Frequency	Value relative to IRG
10 Hz	100 Hz to 30 MHz	-80 dB
	200 kHz to 30 MHz	-95 dB
100 Hz	1 kHz to 30 MHz	-85 dB
	200 kHz to 30 MHz	-95 dB
1 kHz	10 kHz to 30 MHz	-85 dB
	200 kHz to 30 MHz	-100 dB
Wide	100 kHz to 30 MHz	-80 dB
	500 kHz to 30 MHz	-85 dB

(2) Setup

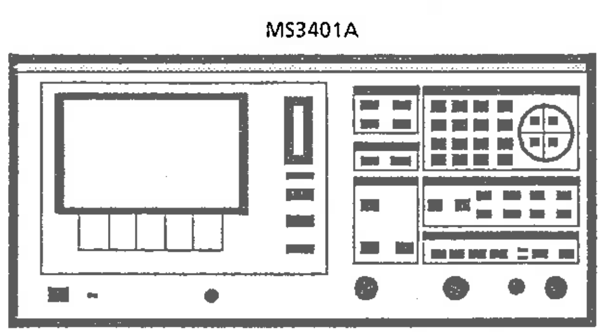


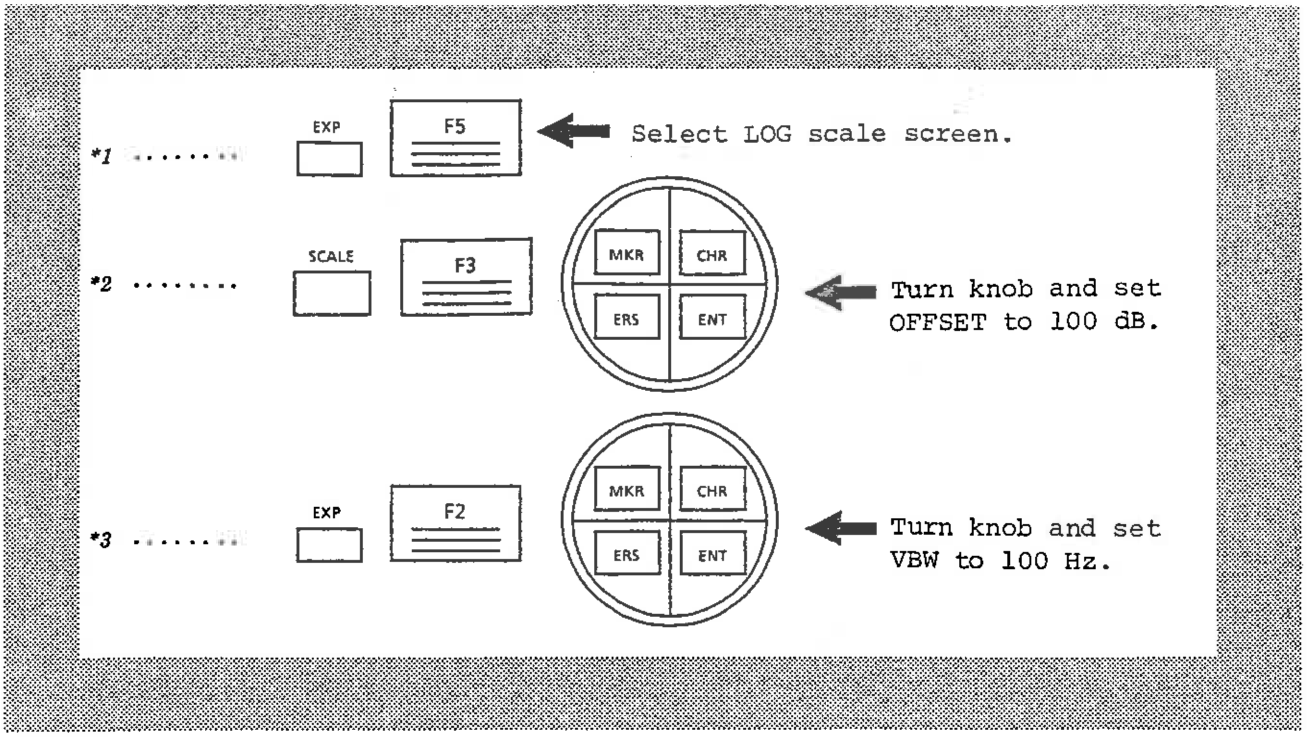
Fig. 4-7 Input Average Noise Level

(3) Test procedure

Step	Procedure
1	Input no signal to the MS3401A terminals as shown in Fig. 4-7.
2	Initialize the MS3401A by pressing the [INITIAL] key
3	Set the MS3401A as follows: Frequency: LOG sweep (*1) OFFSET A: -100 dB (*2) VBW: 100 Hz (*3)
4	Set the parameters according to the RBW as follows:

RBW	START FREQ	STOP FREQ	SWEEP TIME
10 Hz	100 Hz	30 MHz	75 s
100 Hz	1 kHz	30 MHz	7.5 s
1 kHz	10 kHz	30 MHz	5.0 s
WIDE	100 kHz	30 MHz	5.0 s

Step	Procedure
5	Press the [SWEEP] key, then press the [F4] (SINGLE START) key and wait for one sweep.



4.4.6 Crosstalk

Crosstalk is one cause of error at the lower limit of magnitude measurement. It is generated by a leak from the synthesizer output to the input via various routes (power supply, static coupling, etc.)

In the example, the attenuation of the DUT is made 100 dB and the crosstalk is found from the ripple generated by this signal S and the crosstalk signal.

(1) Test specifications

Crosstalk	Between synthesizer	Output and input: $\geq$120 dB

(2) Test equipment

Standard attenuator

Frequency range: 10 Hz to 30 MHz

Attenuation: 0 to 100 dB, minimum step 1 dB

Impedance: 50 or 75 Ω

(3) Setup

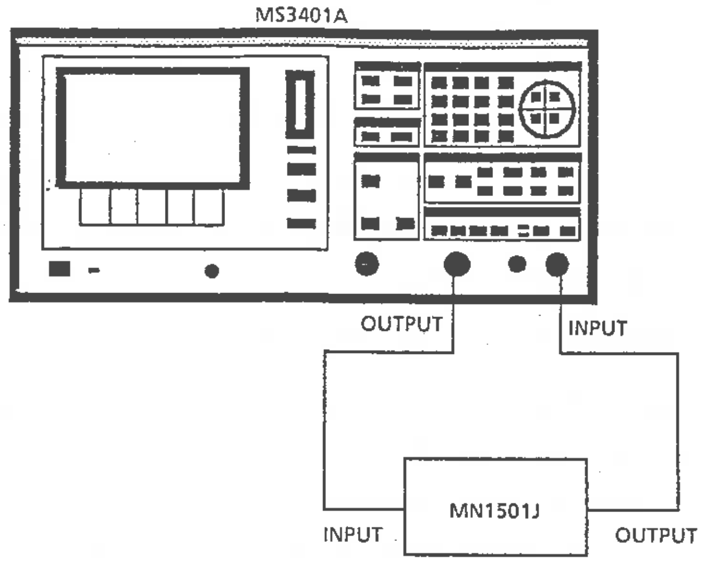


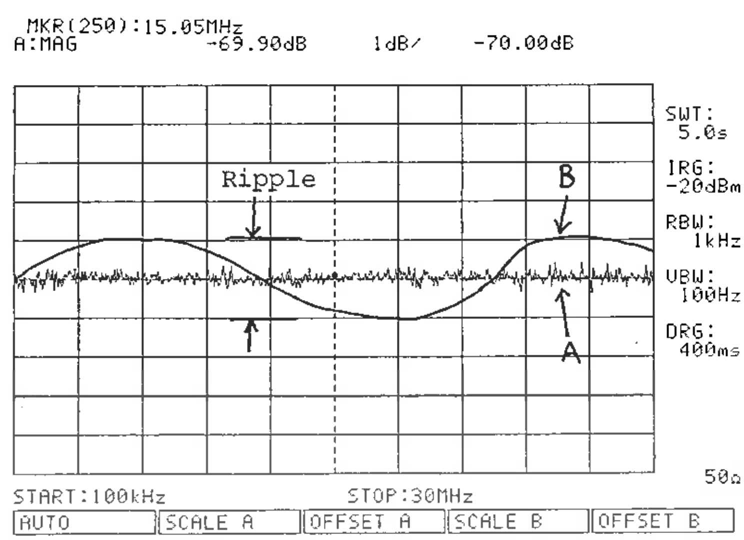
Fig. 4-8 Crosstalk Test

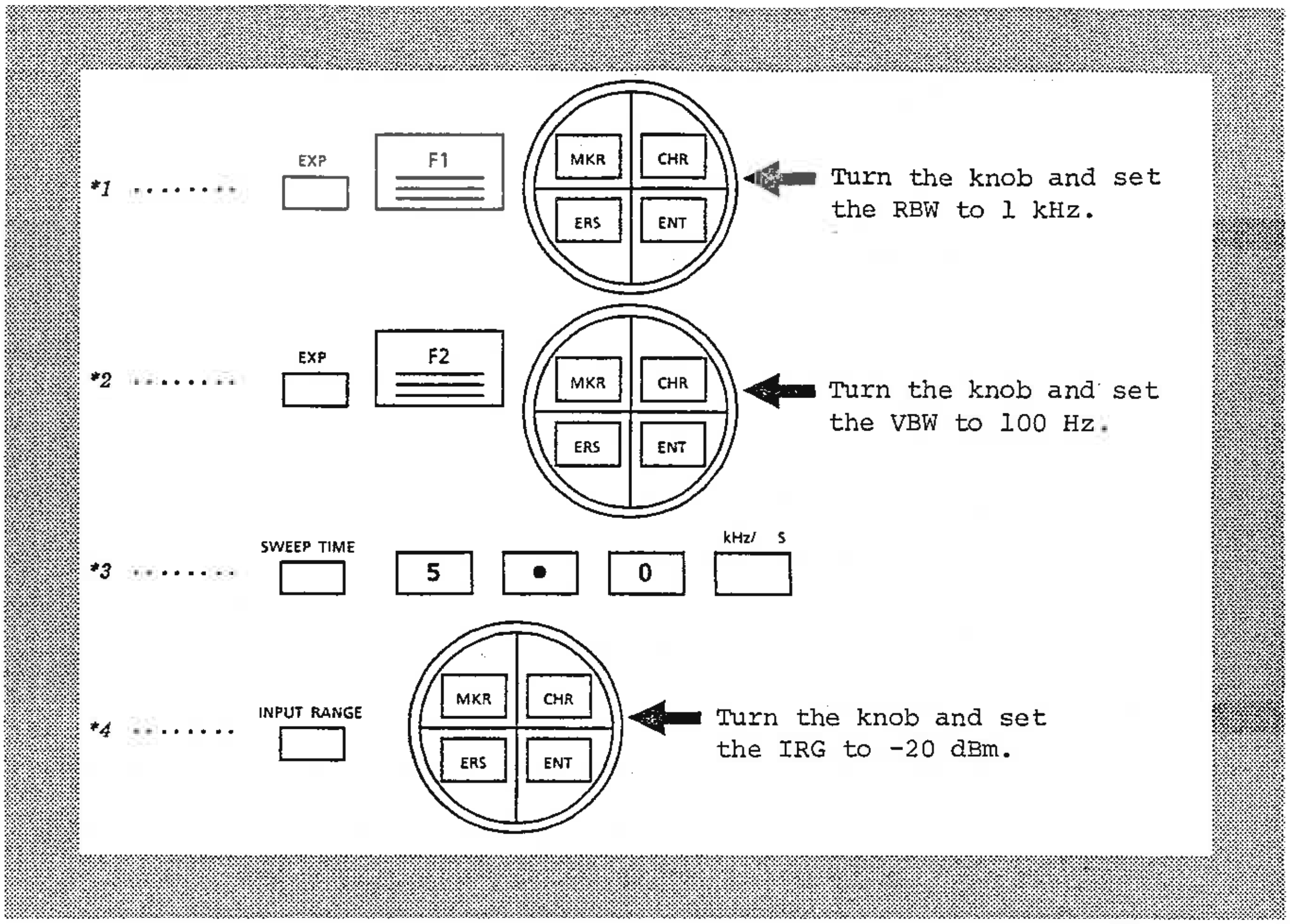
(4) Test procedure

Step	Procedure
1	Setup the equipment as shown in Fig. 4-8.
2	Initialize the MS3401A by pressing the [INITIAL] key.
3	Set the MS3401A as follows: RBW: 1 kHz (*1) VBW: 100 Hz (*2) SWEEP TIME: 5.0 s (*3) IRG: -20 dBm (*4)

(continued)

Step	Procedure
4	Set the attenuation of the standard attenuator to 30 dB.
5	Press the [X→S] key and wait for one sweep.
6	Set the attenuation of the standard attenuator to 100 dB and press [SWEEP] key, then press the [F4] (SINGLE START) key.
7	Set OFFSET A to -70 dB (*5).
8	If the crosstalk is within specification, the waveform will be flat like A in the figure below. If it is out of specification, the ripple will look like B. If the ripple peak value is 2 dB or less, the crosstalk is 120 dB or greater.





Note:

Connect the inputs and outputs with the supplied double-shielded cable.

4.4.7 Magnitude measurement linearity

This paragraph describes how to test the magnitude linearity error by using a standard attenuator.

(1) Test specifications

. Magnitude measurement linearity

0 to -10 dB: ±0.2 dB

-10 to -50 dB: ±0.15 dB (-10 dB standard)

-50 to -60 dB: ±0.5 dB

-60 to -70 dB: ±1 dB

-70 to -80 dB: ±2 dB

(RBW ≥10 Hz)

(2) Test equipment

Standard attenuator	Frequency range: 10 Hz to 130 MHz
	Attenuation: 0 to 100 dB, minimum step 1 dB
	Impedance: 50 or 75 Ω

(3) Setup

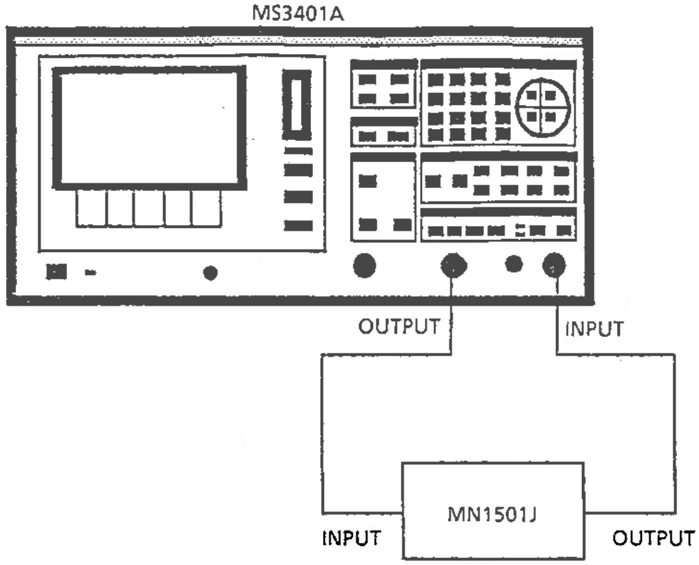


Fig. 4-9 Magnitude Measurement Linearity Test

(4) Test procedure

Step	Procedure
1	Setup the equipment as shown in Fig. 4-9.
2	Initialize the MS3401A by pressing the [INITIAL] key set it as follows:
3	Set the MS3401A as follows: CF: 2 MHz (*1) SPAN: 0 Hz (*2) RBW: 1 kHz (*3) VBW: 100 Hz (*4) SWEEP TIME: 3.0 s (*5) MP: 251 (*6)

(continued)

Step	Procedure
4	Set the attenuation of the standard attenuator to 10 dB, then press the [X→S] key and wait for one sweep.
5	Set the attenuation of the standard attenuator successively to each range listed below and record the measured value.

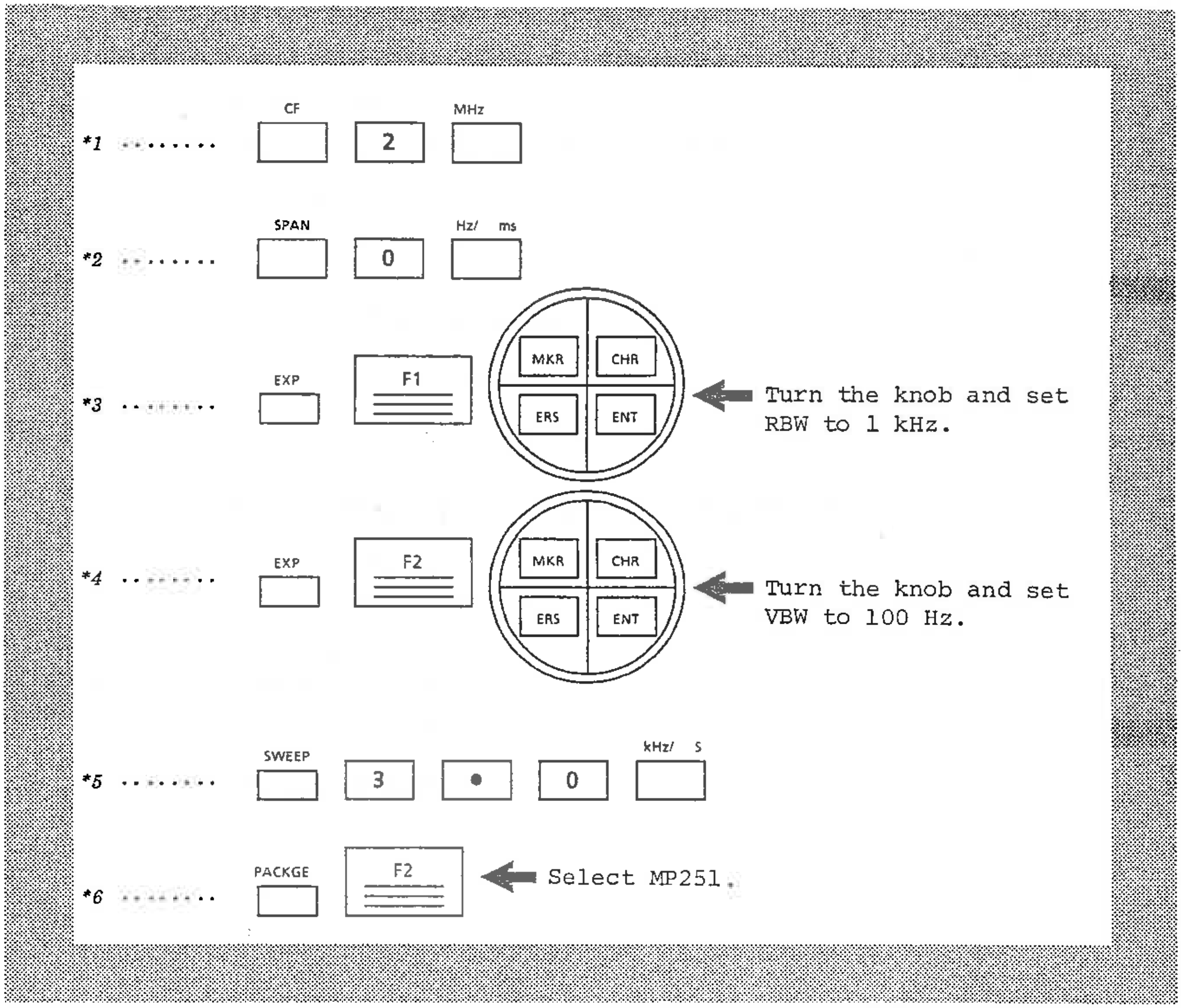
Range (dB)	Attenuation (dB)	Measured value (dB)	Linearity error (dB)
0	0		
-10	10		0 (standard)
-20	20		
-30	30		
-40	40		
-50	50		
-60	60		
-70	70		
-80	80		

Step	Procedure
6	At the end of measurement of each range, press the DISPLAY section [SCALE] key, then press the [F1] (AUTO) key. The displayed value OFFSET A shows the approximate average measured value (within 0.02 dB). Record these values in the above table. When the waveform deviates from the offset line, reset it to the offset line by adjusting OFFSET A. Read the OFFSET A value at this time.

Calculate the linearity error of each range from the following equations:

$\leq$10 dB: Linearity error (dB) = (true attenuation corresponding to range - 10 dB true value) - (measured value)

$\geq$-10 dB: Linearity error (dB) = 10 dB true value - measured value



Note:

The standard attenuator must have a calibration accuracy (10 dB/0.01 dB) traced to the national standard.

4.4.8 Phase level characteristics

The phase measured value varies slightly with input level because of the small nonlinear distortion of the internal amplifier or the limiter circuit level characteristics. Since the phase characteristic of the MN1501J Standard Attenuator is 0 in the low frequency region (250 kHz), it is used in the example of phase level characteristics measurement described in this paragraph.

(1) Test specifications

Phase level characteristics

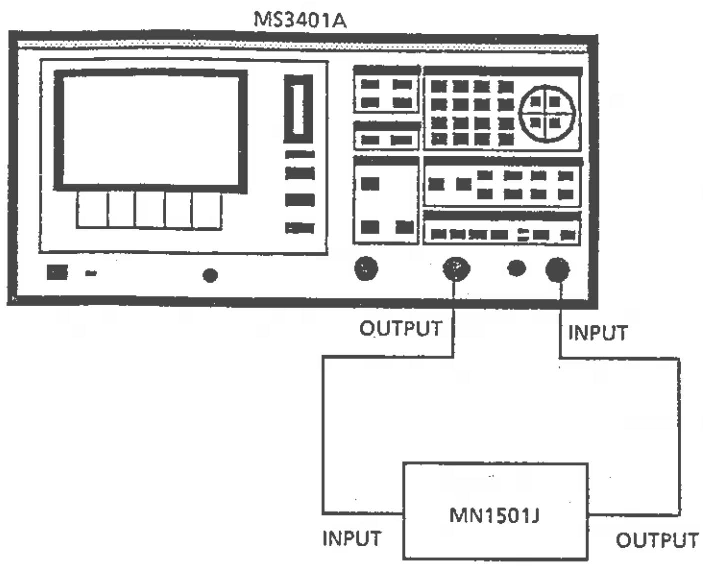
0 to -50 dB: ±1.5° (-10 dB standard)

-50 to -70 dB: ±3° (RBW 1 kHz)

(2) Test equipment

MN1501J Standard Attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, minimum step 1 dB Impedance: 50 or 75 Ω

(3) Setup



MN1501J Standard Attenuator

Fig. 4-10 Phase Level Characteristics Measurement

(4) Test procedure

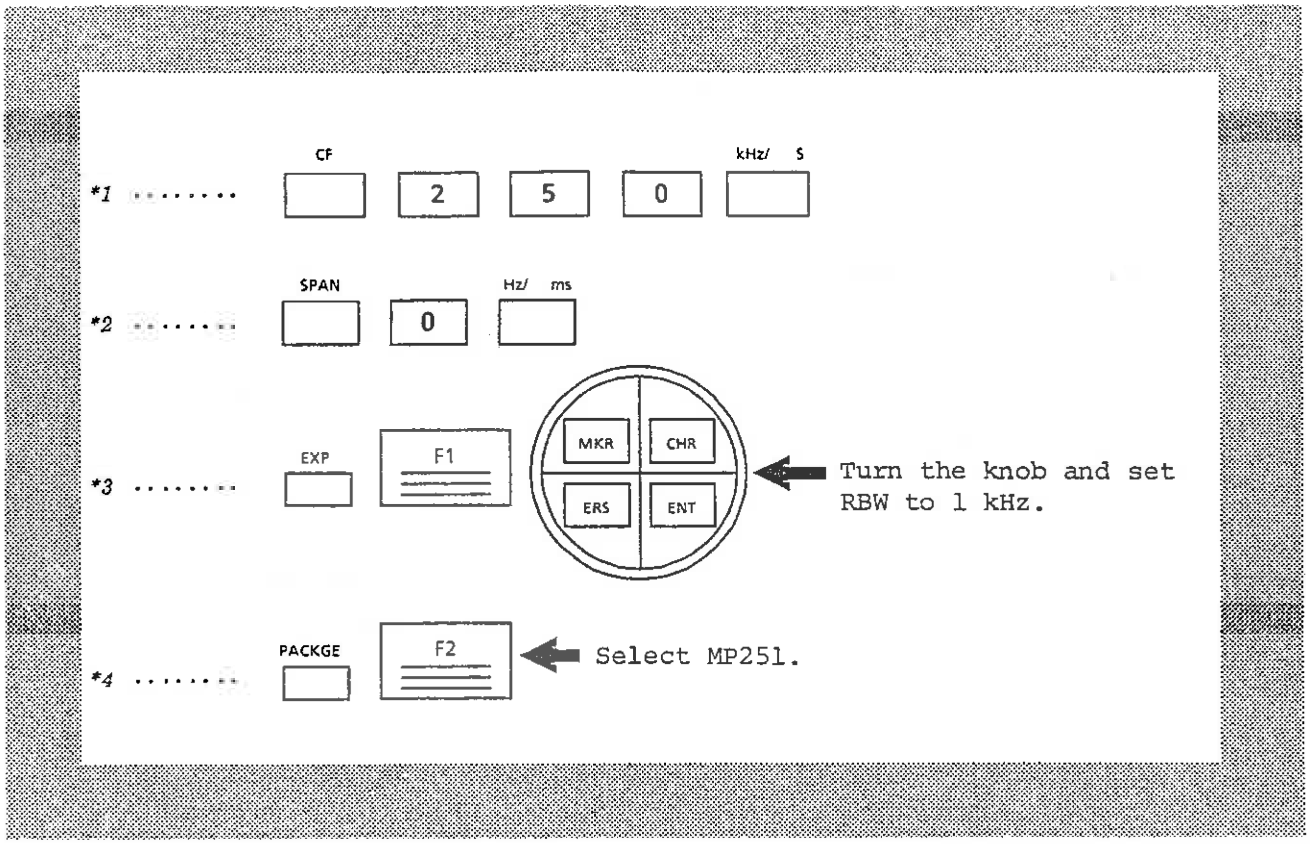
Step	Procedure
1	Setup the equipment as shown in Fig. 4-10.
2	Initialize the MS3401A by pressing the [INITIAL] key.

(continued)

Step	Procedure
3	Set the MS3401A as follows: CF: 250 kHz (*1) SPAN: 0 Hz (*2) RBW: 1 kHz (*3) MP: 251 (*4)
4	Set the attenuation of the standard attenuator to 10 dB and press the [X→S] key and wait for one sweep.
5	Set the attenuation of the standard attenuator successively to each range as shown below.

Range (dB)	Attenuation (dB)	Measured value (dB)
0	0	
-10	10	Standard [X→S]
-20	20	
-30	30	
-40	40	
-50	50	
-60	60	
-70	70	

Step	Procedure
6	At the end of measurement of each range, press the DISPLAY section [SCALE] key, then press the [F2] (AUTO) key. The displayed value OFFSET B shows the approximate average measured value (within 0.2°). Record these values in the above table. When the measurement graph has deviated from the offset line, reset it to the offset line by adjusting OFFSET B. Read the OFFSET B value at this time.



4.4.9 Delay level characteristics

If the phase level characteristics described in paragraph 4.4.8 meets the specifications, since the delay is the differential characteristic of the phase, the delay level also meets specifications. However, when only the delay level must be checked following repair and adjustment, test it as described in this paragraph.

(1) Test specifications

Delay level characteristic

0 to -50 dB: (0.5% of full scale) + (0.5% of reading)

RBW$\geq$10 Hz at DRG: 1 µs range (1 to 30 MHz)

(2) Test equipment

. Standard delay cable	100 ns
. MN1501J Standard Attenuator	Frequency range: 10 Hz to 30 MHz Attenuation: 0 to 100 dB, minimum step 1 dB Impedance: 50 or 75 Ω

(3) Setup

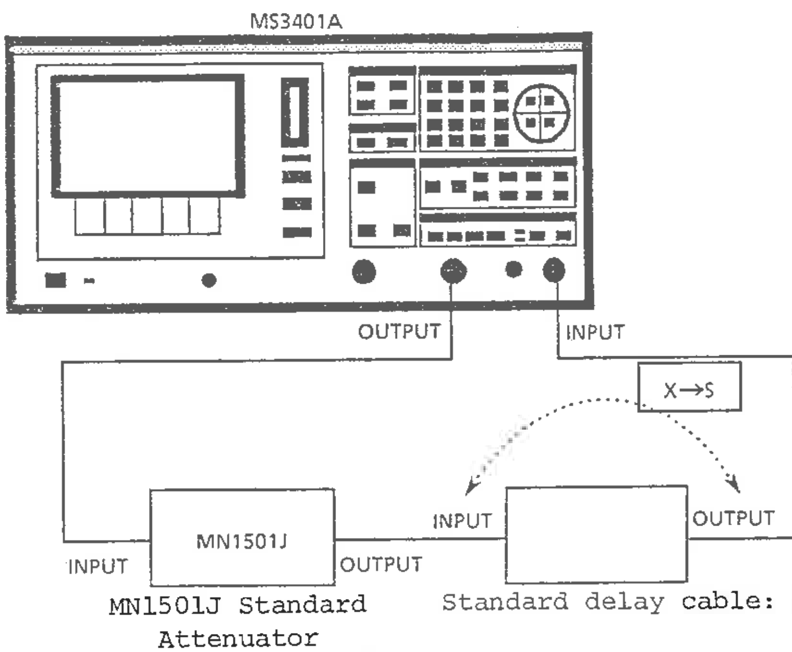


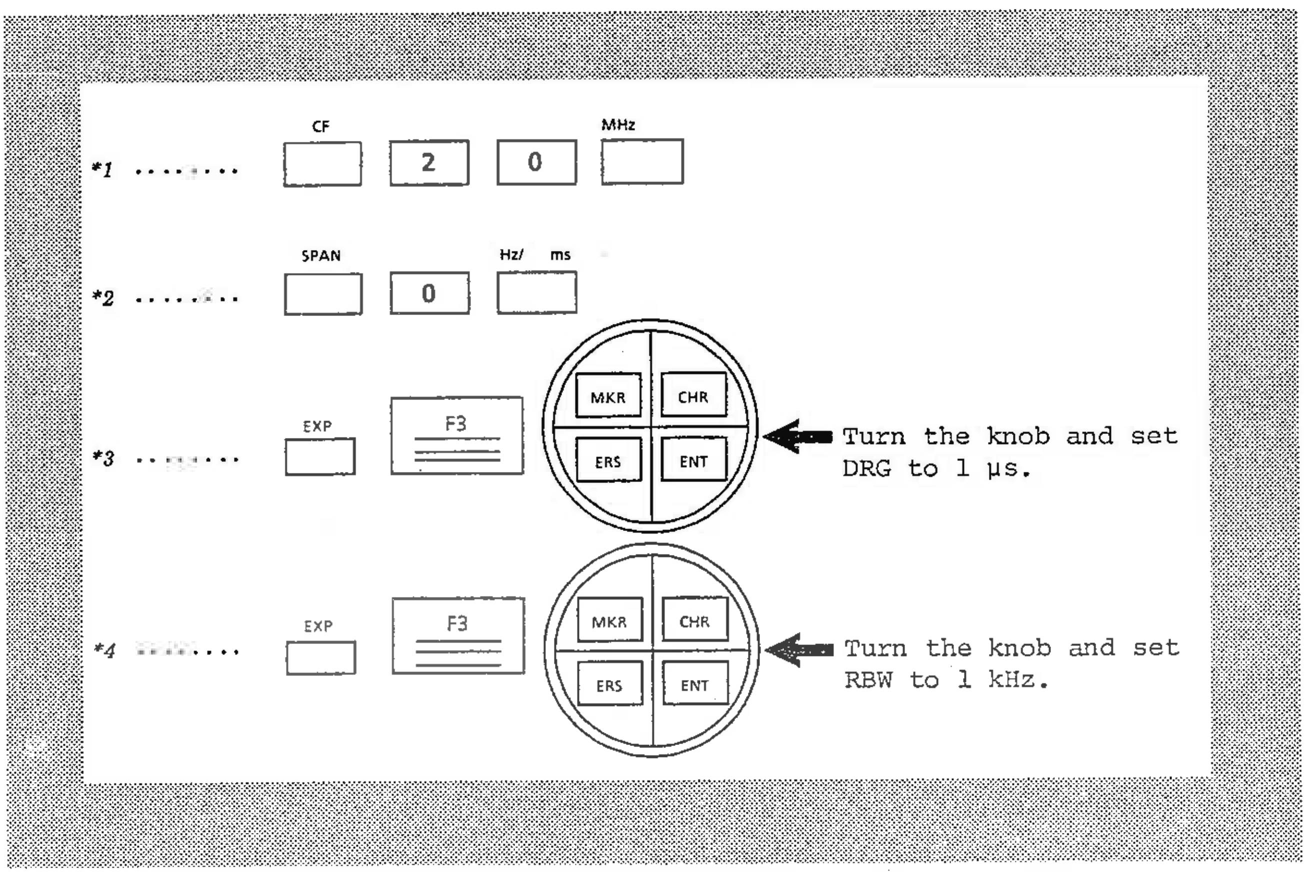
Fig. 4-11 Delay Level Characteristics

(4) Test procedure

Step	Procedure
1	Initialize the MS3401A by pressing the [INITIAL] key.
2	Set the MS3401A as follows: CF: 20 MHz (*1) SPAN: 0 Hz (*2) DRG: 1 μs (*3)
3	Set the attenuation of the standard attenuator to 0 dB and connect the inputs to the outputs with the standard delay cables (Fig. 4-11)
4	Press the [X→S] key and wait one sweep.
5	Connect the equipment as shown by the solid lines in Fig. 4-11.
6	Set the attenuation of the standard attenuator successively to each range as shown below.

Range (dB)	Attenuation (dB)	Measured value (dB)
0	0	
-10	10	
-20	20	
-30	30	
-40	40	
-50	50	

Step	Procedure
6	At the end of measurement of each range, press the DISPLAY section [SCALE] key, then press the [F1] (AUTO) key. The displayed value OFFSET B shows the approximate average measured value (within 0.2 ns). Record these values in the above table. When the waveform deviates from the offset line, reset it to the offset line by adjusting OFFSET B. Read the OFFSET B value at this time.



4.5 Service

In the MS3401A is damaged or malfunctions, contact Anritsu or your nearest ANRITSU dealer.

When requesting repair, please specify:

(a) Instrument name and the serial number on the rear panel.

(b) Problem

(c) Name of contact

SECTION 5

DETAILED OPERATING INSTRUCTIONS

The MS3401A Network Analyzer can be operated manually (local operation) or by remote control.

Read this section while referring to Appendix J Front and Rear panel Descriptions.

Remote control is described in sections 7 to 11.

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5.1 Impedance Switching and DUT Connection

The input/output impedances of the MS3401A Network Analyzer can be switched between 50 and 75 Ω so transmission characteristics (magnitude, phase, delay) of devices with either 50 or 75 Ω input/output impedances can also be measured.

5.1.1 Input/output impedance switching (EXP, 50 Ω/75 Ω)

Before connecting the device under test (DUT), between the MS3401A INPUT and OUTPUT connectors, the input/output impedances of the MS3401A must be matched to those of the DUT.

An initialization, the MS3401A input/output impedances are set automatically to 50 Ω. When the input/output impedances of the DUT are 50 Ω, nothing else has to be done.

This paragraph describes how to switch the MS3401A input/output to 75 Ω as shown in Fig. 5-1 when the DUT input/output impedances are 75 Ω.

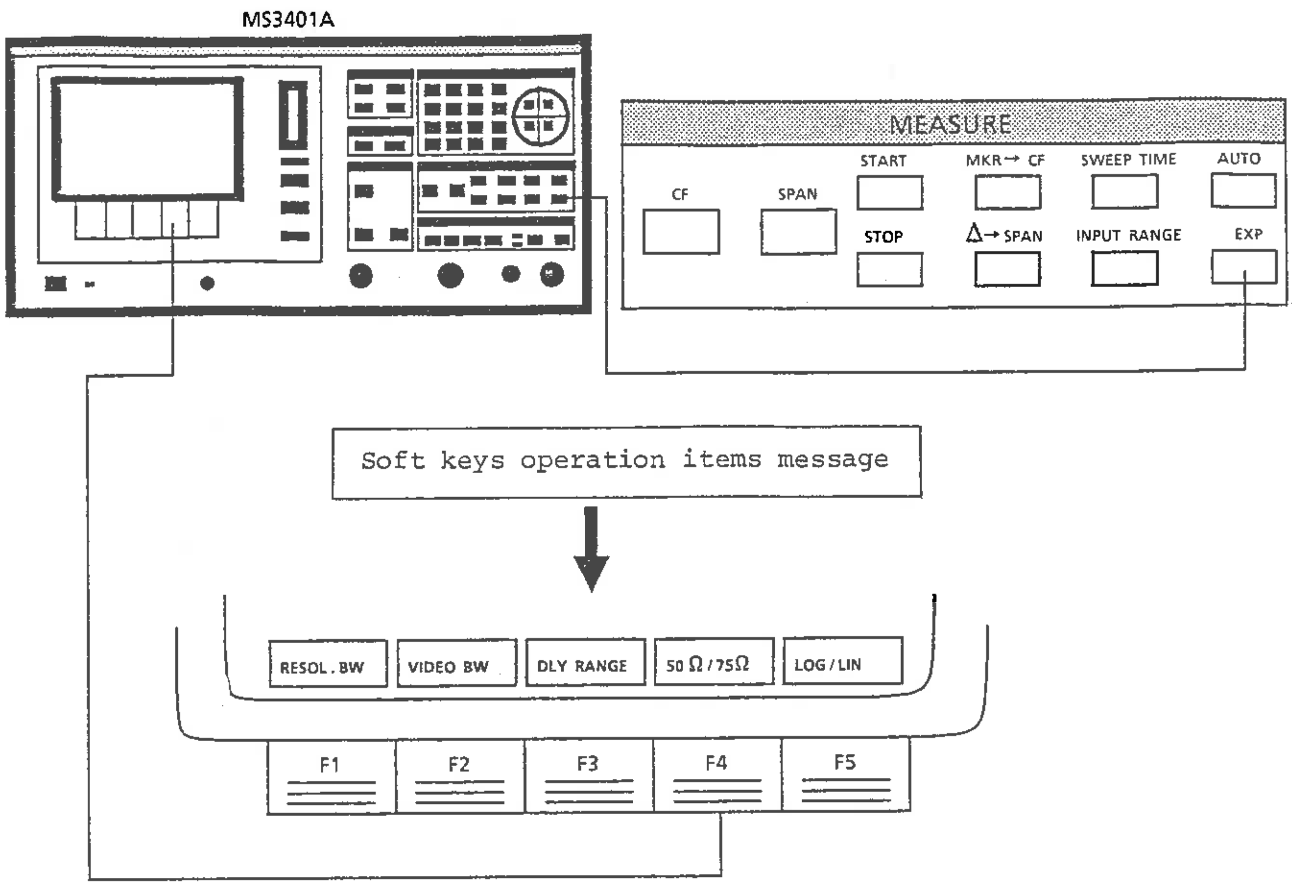
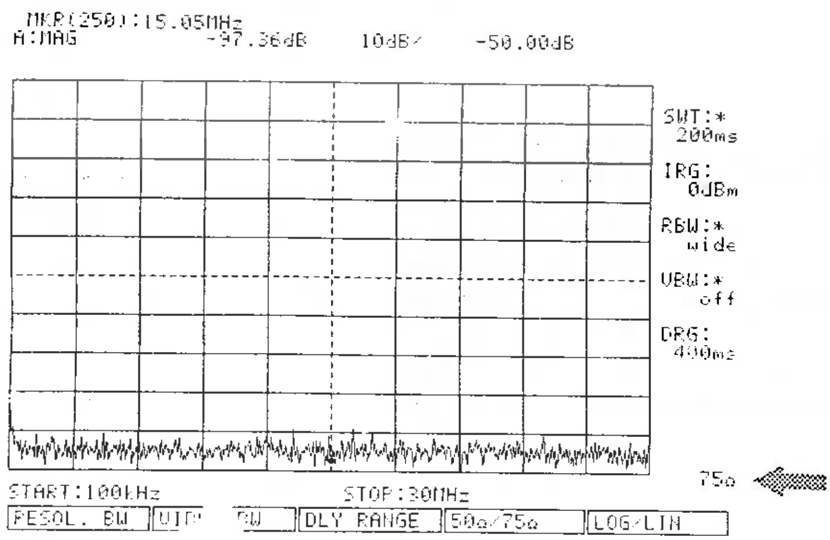


Fig. 5-1 Input/Output Impedance 50 Ω/75 Ω Switching

Step	Procedure
1	Press the [EXP] key (Fig. 5-1); the message "50 Ω/ 75 Ω is displayed at the bottom the CRT above the [F4] key.
2	Press the [F4] key; the characters (indicated by bold arrow) at the bottom right of the CRT change alternately between 50 Ω and 75 Ω each time the [F4] key is pressed. Stop pressing the [F4] key when 75 Ω is displayed.



Note:

Step 2 sets the MS3401A input/output impedances to 75 Ω. To switch the input/output impedances back to 50 Ω, press the [F4] key one to display 50 Ω.

5.1.2 DUT connection and input ATT setting (OUTPUT - INPUT/INPUT RANGE)

After setting the MS3401A input/output impedances to 75 Ω, connect the DUT between the MS3401A OUTPUT and INPUT connectors with a 75 Ω coaxial test cable. Fig. 5-2 shows the basic setup.

The general DUT connection procedure and input ATT setting are described below in accordance with Fig. 5-2.

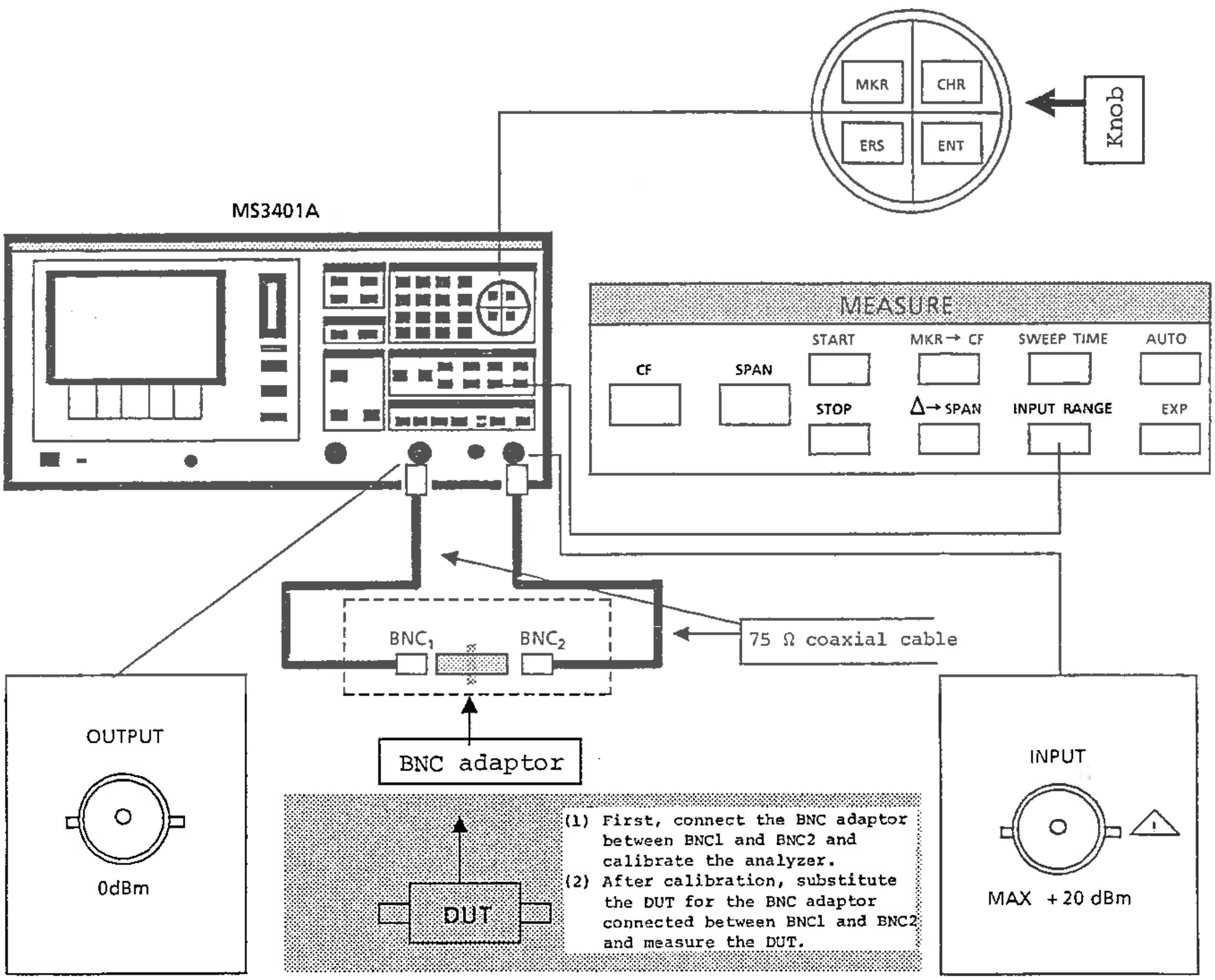
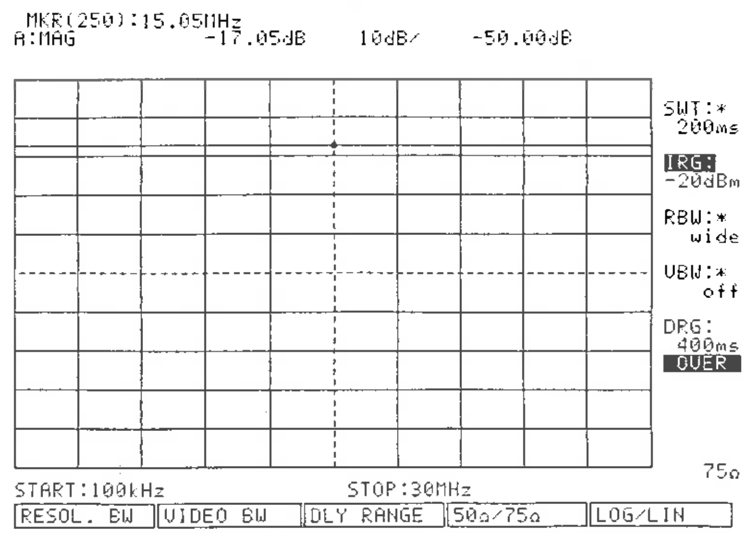


Fig. 5-2 DUT Connection Basic Setup

Step	Procedure
	BNC Adaptor Connection
1	Check that the MS3401A input/output impedances are 75 Ω and the IRG (INPUT RANGE) is 0 dBm using the messages on the CRT display. (See Fig. 5-1 of paragraph 5.1.1.)
2	Connect the two 75 Ω coaxial cables (length 0.5 m, BNC.3C-2W.BNC) to the BNC adaptor supplied with the analyzer as shown in Fig. 5-2.
3	Calibrate the analyzer at a calibration level of 0 dBm. For a detailed description of calibraton, see paragraph 3.3.2 or paragraph 5.3.2.
	DUT connection and input ATT setting
4	After calibration, substitute the DUT for the BNC adaptor.
5	Press the [INPUT RANGE] key (Fig. 5-2). The characters IRG: at the top right of the CRT are reverse-displayed.
6	Turn the knob (Fig. 5-2) until the message "OVER" appears at the top right of the CRT.

(continued)

Step	Procedure
	
7	Set the IRG to a value 10 dB higher than the value displayed when OVER is displayed.

When the input level to the analyzer exceeds the set IRG value, OVERLOAD is displayed on the CRT.

The IRG value shows the maximum allowable input level. The MS3401A is set to the optimum state by setting IRG to the value just before OVERLOAD is displayed.

The IRG is shown below:

IRG : +20 dBm
+10 dBm
0 dBm
−10 dBm
−20 dBm

CAUTION

If the OVERLOAD message does not disappear even when IRG is set to +20 dBm, immediately disconnect the test cable connected to the INPUT connector. Otherwise, overinput may damage the MS3401A input ATT.

If this happens, connect a variable attenuator in series with the DUT and use the variable attenuator to compensate for overinput before making any measurements.

5.2 CRT Display Control (DISPLAY)

The three keys [MARKER], [SUB TRACE], and [SCALE] in the DISPLAY section simplify reading of the measured result from the trace displayed on the CRT. The use of these three keys is outlined on the next page.

. Marker function .... Press [MARKER] key.
. Sub trace function .... Press [SUB TRACE] key.
. Scaling function ...... Press [SCALE] key.

↓

After key pressed,

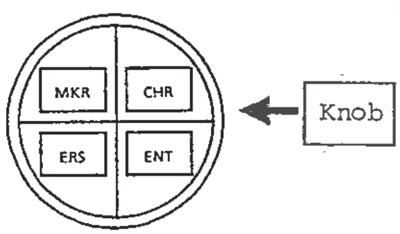
[Soft keys operation item message]

is displayed at the bottom of the CRT.
Select the desired item with the [F1] to [F5] keys corresponding to this message.

↓

For the marker function and scaling function, also

↓



Turn the knob shown at the left and set the marker position for the marker function and the parameters for the scaling function so that the measured result can be read easily.

5.2.1 Marker function (MARKER)

The marker function displays the measured frequency and value* at the marker on the CRT as a numeric value.

When the [MARKER] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown in Fig. 5-3.

The marker function at this stage is NORMAL MARKER.

At NORMAL MARKER, the position of the current marker can be moved by using the knob shown below.

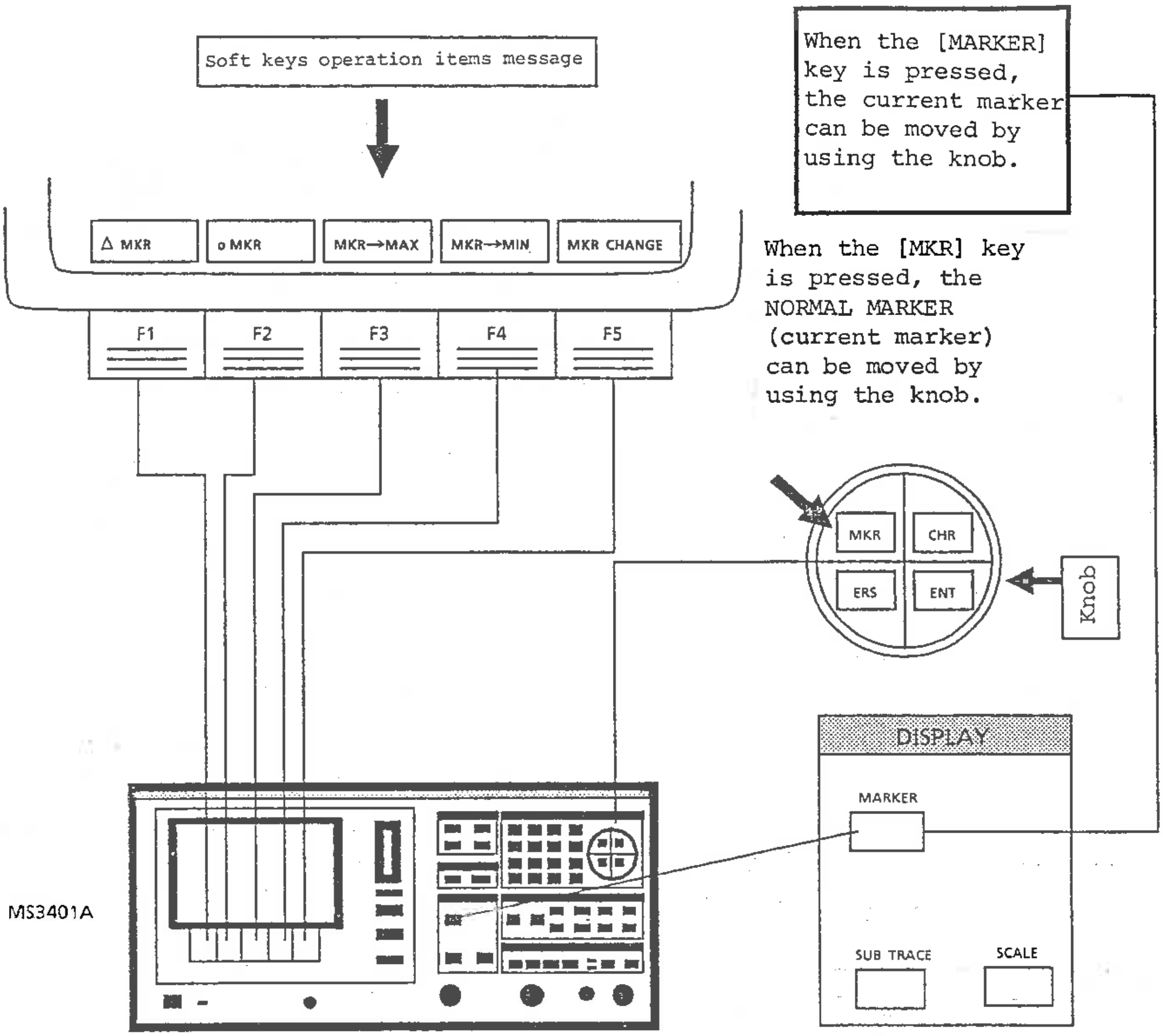


Fig. 5-3 Marker Function Setting

*: In this manual, "measured value" means the MAG, PHASE, DELAY, MAG/PHASE, or MAG/DELAY measured value.

Notes:

1. When the [MARKER] key is pressed, the ΔMKR and 0MKR functions are turned off. This is useful when wanting to temporarily stop the ΔMKR and 0MKR functions and return to the NORMAL MARKER function while the ΔMKR and 0MKR functions are in use.

2. Conversely, to move the NORMAL MARKER (current marker) without stopping the ΔMKR and 0MKR functions, press the [MKR] key on the knob shown in Fig. 5-3, and then turn the knob.

The functions of the operation items corresponding to soft keys [F1] to [F5] are described in Table 5-1 and Fig. 5-4.

Table 5-1 Functions of Marker Function and Soft Keys

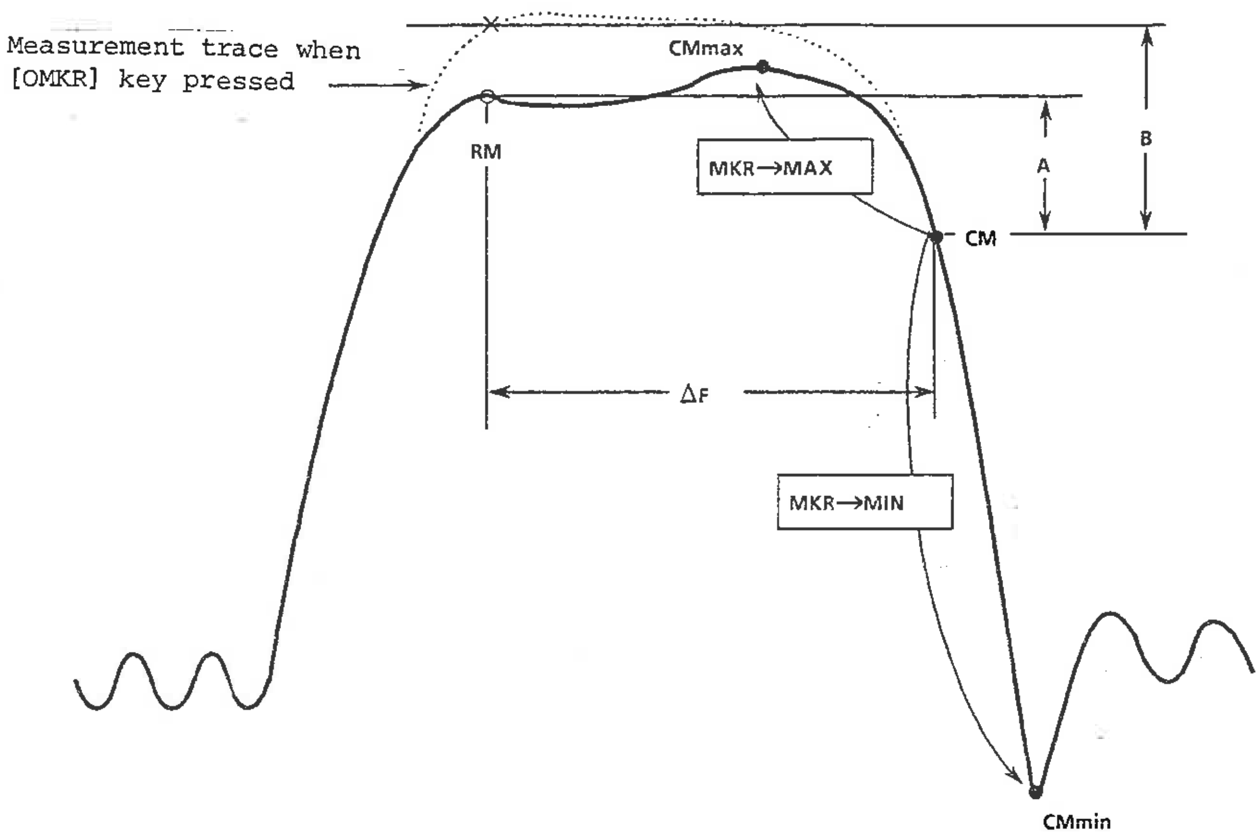
Soft key	Corres-ponding key	Explanation	Remarks
F1	Δ MKR	Displays the difference between the reference marker (RM) and current marker (CM) frequency and measured value. When the [F1] key is pressed, the current marker becomes the reference marker and the frequency and measured value differences become 0. Thereafter, the current marker is moved with the knob and the difference between the two points is found.	. When the [F1] key is pressed, the OMKR function is turned off. . When the trace waveform is moved at retrace, the RM is also moved.
F2	o MKR	Displays the difference between the reference marker (RM) reference value and current marker (CM) measured value. When the [F2] key is pressed, the current marker becomes the reference marker and the measured value is memorized as reference value 0. Thereafter, the current marker is moved with the knob and the difference between the reference value and measured value is found.	. When the [F2] key is pressed, the ΔMKR function is turned off. . When the trace waveform is moved at retrace, the RM is also moved.
F3	MKR→MAX	When the [F3] key is pressed, the current marker moves to the maximum value of the measurement trace and the frequency and measured value of that point are displayed.	
F4	MKR→MIN	When the [F4] key is pressed, the current marker moves to the minimum value of the measurement trace and the frequency and measured value of that point are displayed.	
F5	MKR CHANGE	When the [F5] key is pressed when the ΔMKR and OMKR functions are on, the reference marker (RM) and current marker (CM) are changed.	When the OMKR function is on, the measured value that was made the reference is memorized as the reference value.

Measurement Trace and Marker Functions

RM: Reference marker

CM: Current marker

X: Reference point



ΔF: Frequency displayed by ΔMKR

A: Measured value displayed by ΔMKR

B: Measured value displayed by OMKR

Fig. 5-4 Measurement Trace and Marker Functions

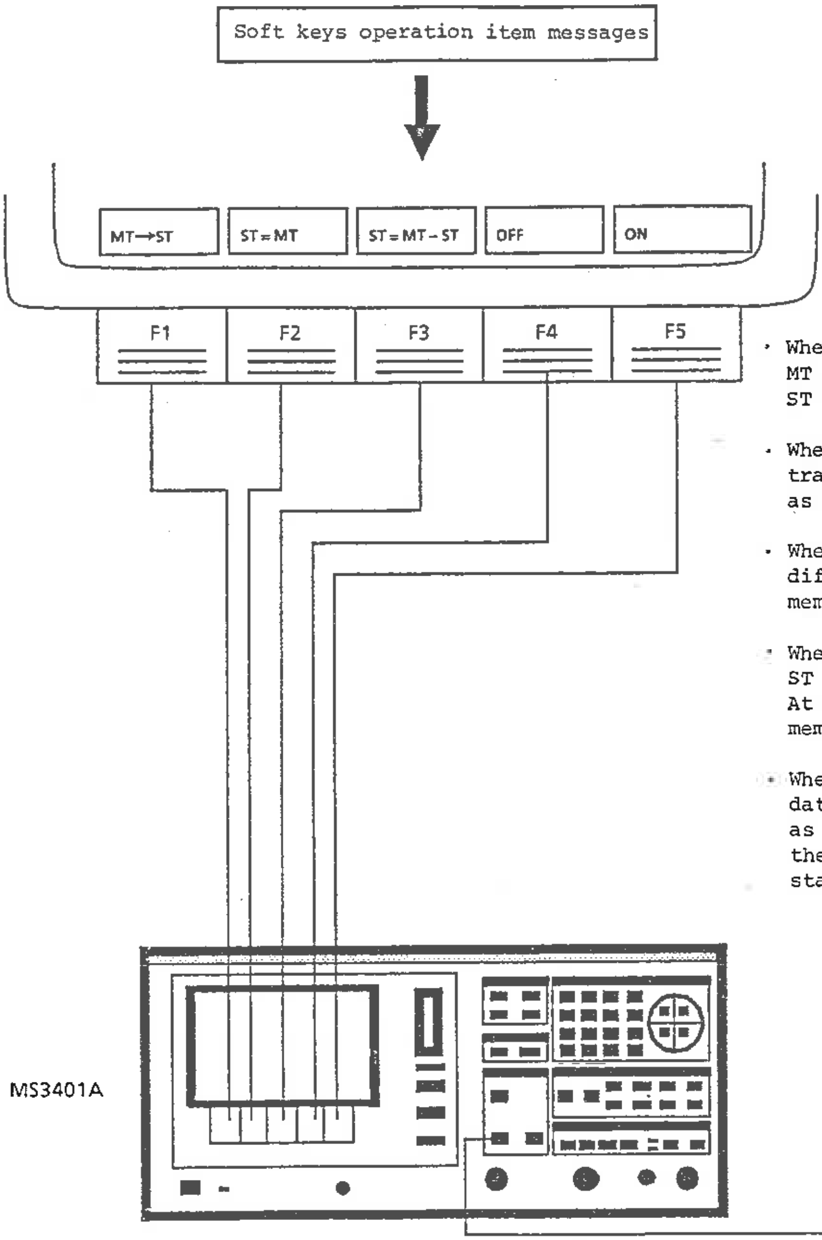
5.2.2 Sub trace function (SUB TRACE)

The sub trace function displays the measured result of one measurement item on the CRT as two traces: main trace (MT) and sub trace (ST).

CAUTION

This function cannot be used at MAG/PHASE and MAG/DELAY two-channel measurements. Therefore, when two-channel measurements are selected, the sub trace function is turned off.

When the [SUB TRACE] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown in Fig. 5-5.



Measurement item, MT, ST, and trace A and B lines display		
Measurement item	MT	ST
MAG	A	B
PHASE	B	A
DELAY	B	A

- When the [F1] key is pressed, the MT at that time is copied at the ST and the ST is held and displayed.
- When the [F2] key is pressed, the trace of the same measurement item as the MT is displayed at the ST.
- When the [F3] key is pressed, the difference between the MT and the memorized ST is displayed.
- When the [F4] key is pressed, the ST display is erased. At this time, the ST data remains memorized.
- When the [F5] key is pressed, the data held at the ST is displayed as the sub trace. At this time, the ST is displayed in the same state as $\boxed{\text{MT→ST}}$.

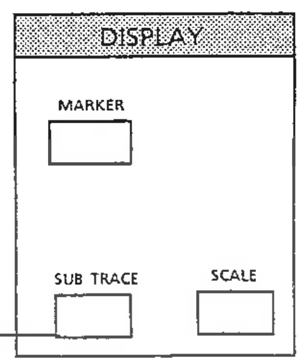
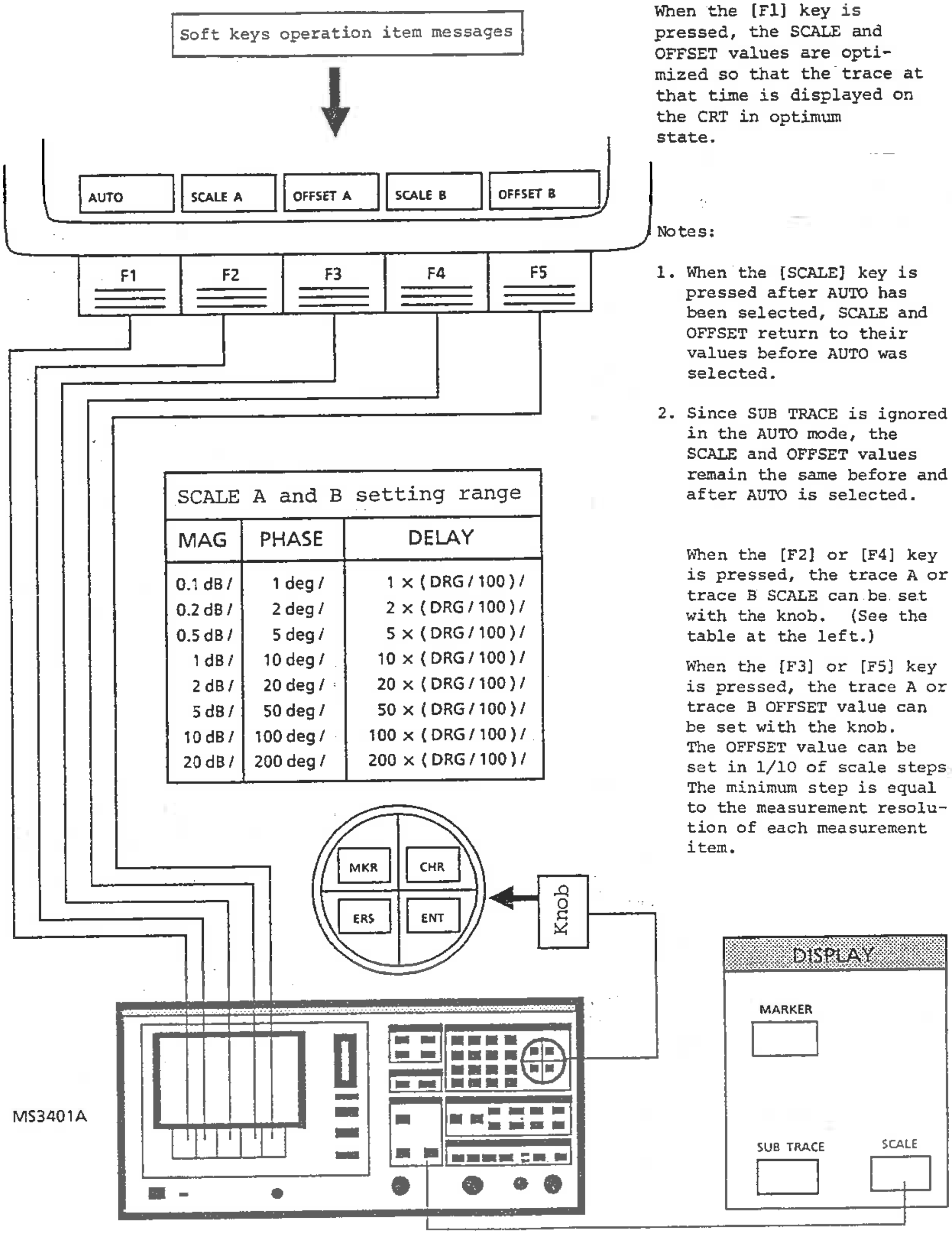


Fig. 5-5 Sub Trace Setting

5.2.3 Scaling function (SCALE)

The scaling function performs CRT trace scaling (value of one division of the CRT vertical scale) and offset setting (center value of vertical axis, that is, Y axis, of Cartesian coordinates).

When the [SCALE] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown in Fig. 5-6.



SCALE A and B setting range		
MAG	PHASE	DELAY
0.1 dB /	1 deg /	1 × (DRG / 100) /
0.2 dB /	2 deg /	2 × (DRG / 100) /
0.5 dB /	5 deg /	5 × (DRG / 100) /
1 dB /	10 deg /	10 × (DRG / 100) /
2 dB /	20 deg /	20 × (DRG / 100) /
5 dB /	50 deg /	50 × (DRG / 100) /
10 dB /	100 deg /	100 × (DRG / 100) /
20 dB /	200 deg /	200 × (DRG / 100) /

When the [F1] key is pressed, the SCALE and OFFSET values are optimized so that the trace at that time is displayed on the CRT in optimum state.

Notes:

1. When the [SCALE] key is pressed after AUTO has been selected, SCALE and OFFSET return to their values before AUTO was selected.

2. Since SUB TRACE is ignored in the AUTO mode, the SCALE and OFFSET values remain the same before and after AUTO is selected.

When the [F2] or [F4] key is pressed, the trace A or trace B SCALE can be set with the knob. (See the table at the left.)

When the [F3] or [F5] key is pressed, the trace A or trace B OFFSET value can be set with the knob. The OFFSET value can be set in 1/10 of scale steps. The minimum step is equal to the measurement resolution of each measurement item.

Fig. 5-6 Scaling Function Setting

5.3 Measurement Item Selection and Calibration

The basic operations for measuring transmission characteristics (magnitude, phase, delay) with the MS3401A Network Analyzer are selection of the measurement item at the front panel TRACE section, calibration at the front panel CALIBRATION section, and measurement based on lighting of the [X-S] lamp.

To measure a different item, once the [X-S] lamp that was lit during the preceding measurement is extinguished, the new measurement item can be selected at the front panel TRACE section to prepare for the next measurement. Figure 5-7 illustrates this.

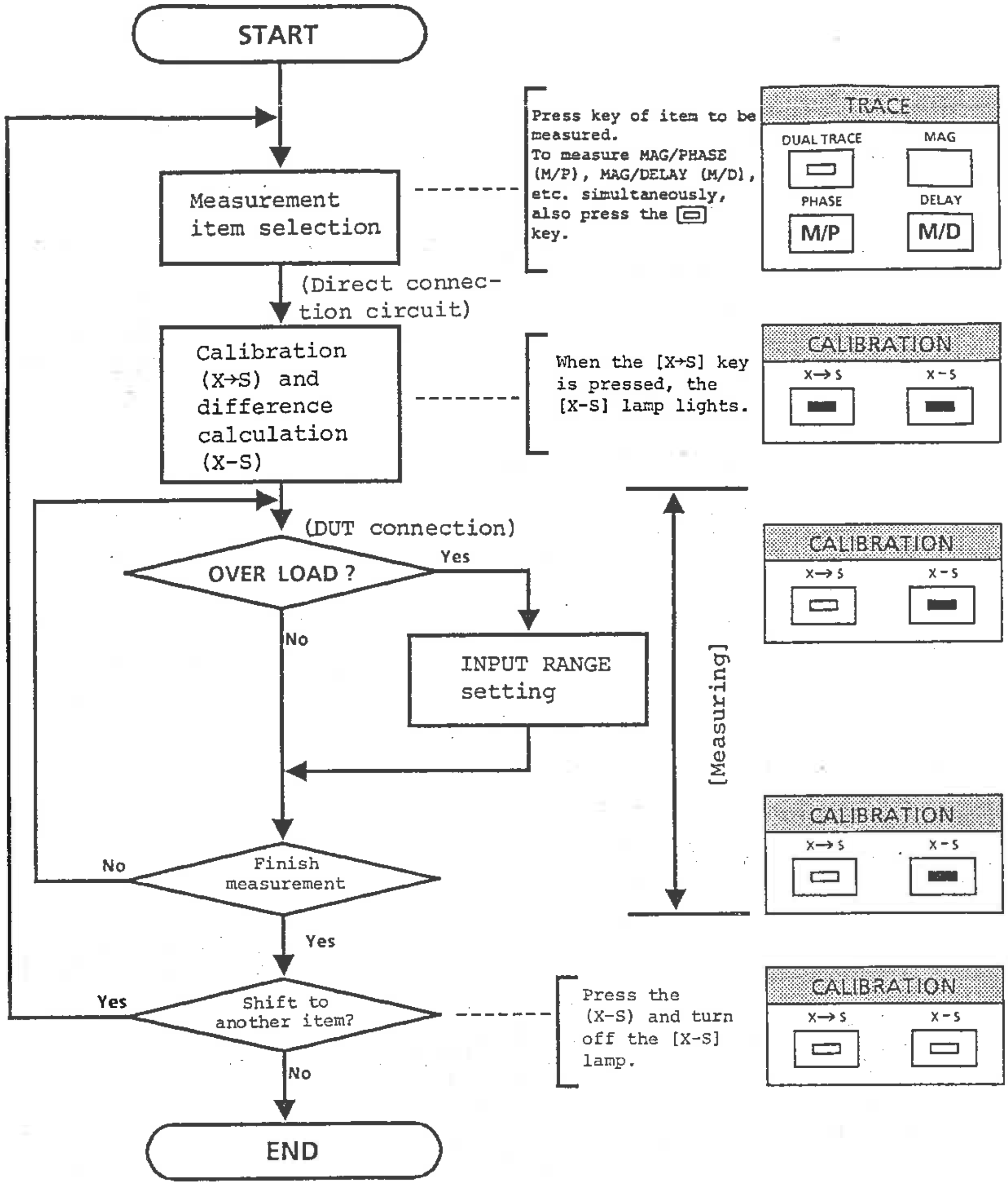
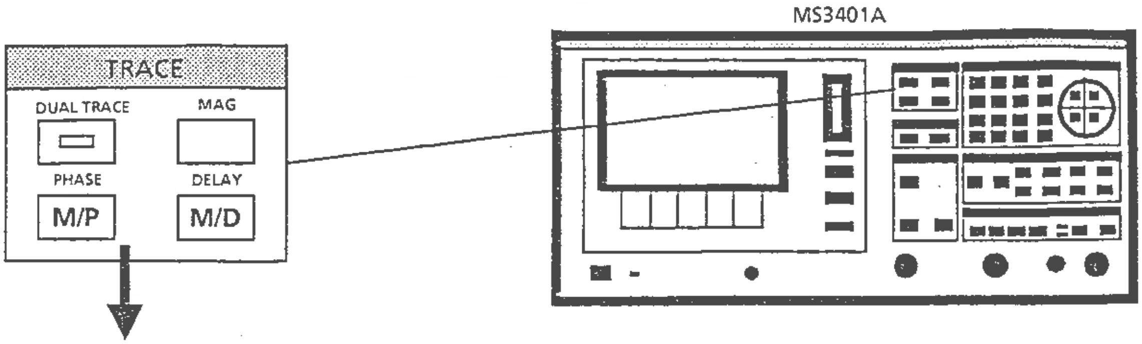


Fig. 5-7 Measurement Item Selection → Calibration → Measurement

5.3.1 Measurement item selection (TRACE)

A measurement item is selected as follows:

- At initialization, MAG (magnitude) is selected.
- The currently-selected measurement item is displayed by the trace A and B lines at the top of the CRT.
- At MAG, PHA (phase), or DLY (delay) single-item, single-channel measurement, the key lamp does not have to be lit. When the item to be measured is selected from the [MAG], [PHASE], and [DLY] keys and the selected key is pressed, the selected item is displayed on the trace A or B line at the top of the CRT.
- At M/P (magnitude/phase) or M/D (magnitude/delay) two channel measurement, when the item to be measured is selected from the [M/P] and [M/D] keys and the selected key is pressed after the lamp lights, MAG is displayed on the trace A line, and PHASE is displayed as PHA and DELAY is displayed as DLY on the trace B line at the top of the CRT.



Measurement item	TRACE key operation		CRT display
Magnitude	DUAL TRACE OFF	MAG	A : MAG
Phase	DUAL TRACE OFF	PHASE M/P	B : PHA
Delay	DUAL TRACE OFF	DELAY M/D	B : DLY
Magnitude/ phase	DUAL TRACE ON	PHASE M/P	A : MAG B : PHA
Magnitude/ delay	DUAL TRACE ON	DELAY M/D	A : MAG B : DLY

Fig. 5-8 Measurement Item Selection

5.3.2 Calibration (CALIBRATION)

Before making the first measurement, always calibrate the MS3401A to remove the measuring system frequency characteristic from the DUT frequency characteristic. The measuring system frequency characteristic for the direct connection is stored in the S-memory beforehand for this purpose. Since the measuring system frequency characteristic stored in the S-memory is subtracted from the measured value, even if the measured value includes the measuring system frequency characteristic, only the DUT frequency characteristic is measured.

Calibration is described below in accordance with Figs. 5-9 and 5-10.

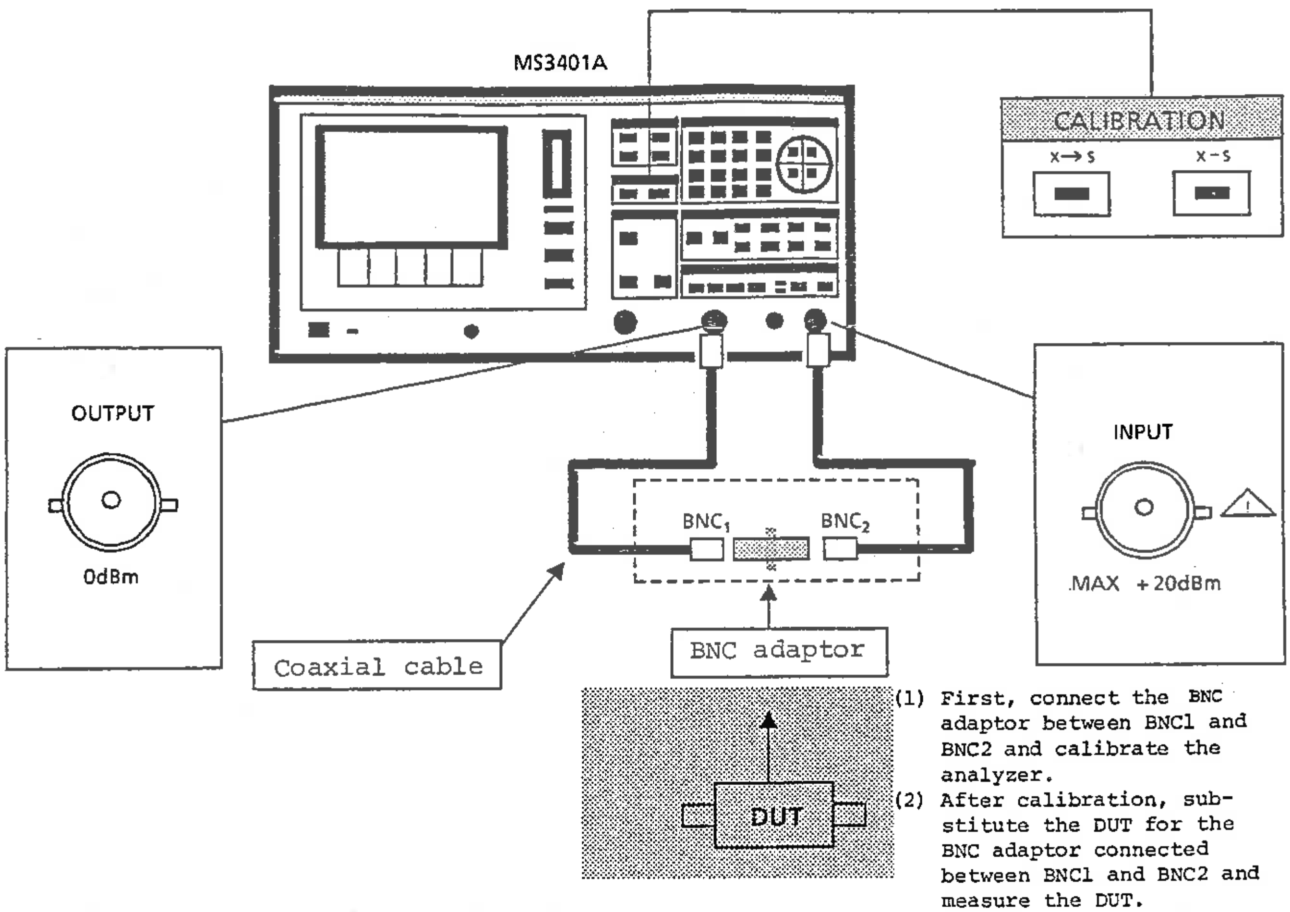


Fig. 5-9 Calibration and Measurement Connections

A measured result when the MS3401A is not calibrated and when it is calibrated using steps (1) and (2) of Fig. 5-9 are described in Fig. 5-10. The figure is slightly exaggerated to make it easier to understand.

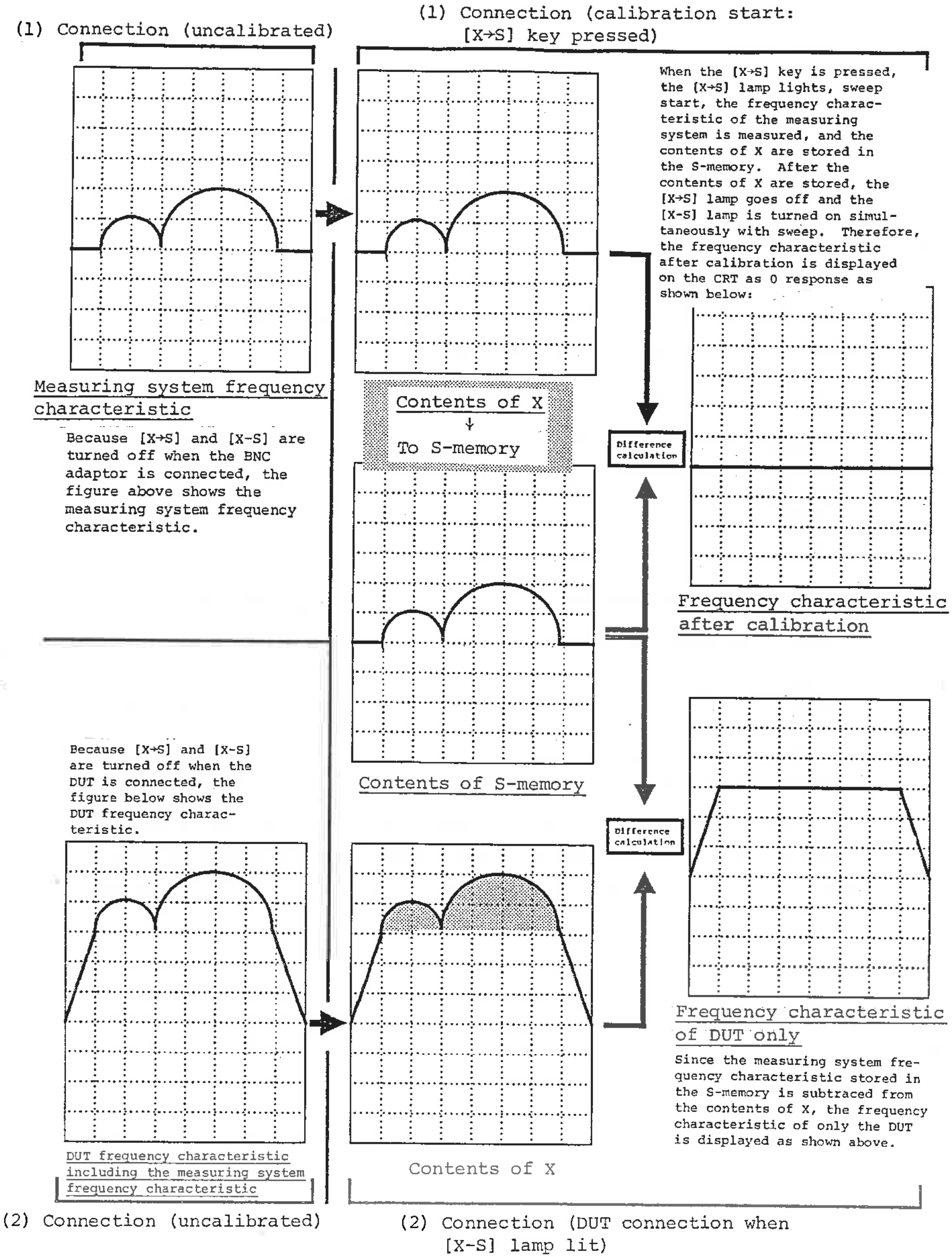


Fig. 5-10 Calibration and Measurement (X→S) and (X-S)

Note:

There is a separate S-memory for channel A and channel B. The memory corresponding to TRACE is used.

5.4 Setting by Data and Unit Keys (ENTRY)

The data and unit keys in the front panel ENTRY section are used to set the following:

. Horizontal frequency sweep width

center frequency CF .... Header key [CF]

. Horizontal frequency sweep width
SPAN .... Header key [SPAN]

. Sweep start frequency START .... Header key [START]

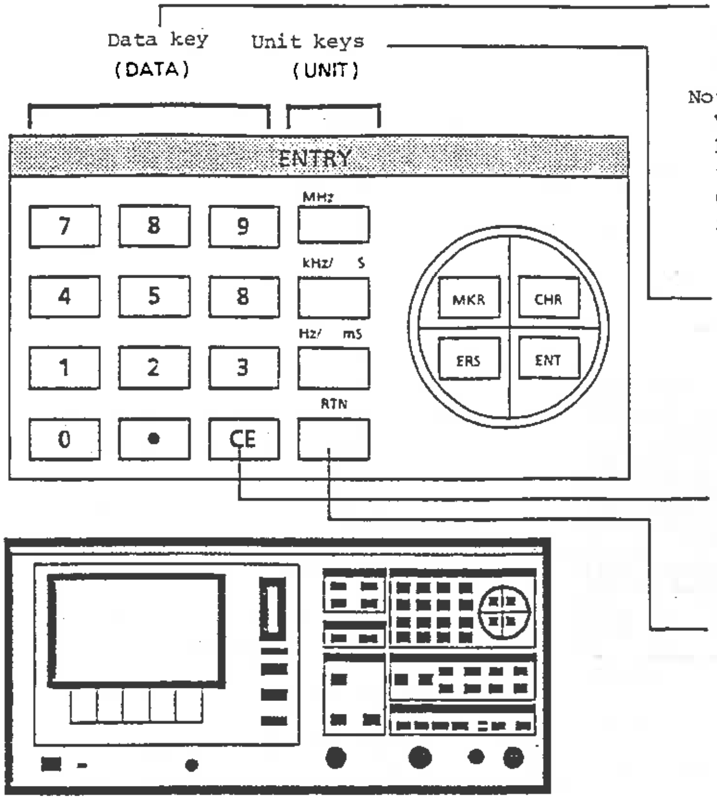
. Sweep stop frequency STOP .... Header key [STOP]

. Sweep stop time SWEEP .... Header key [SWEEP TIME]

. Address when saving data to
PMC .... Header key [SAVE]

. Address when recalling
data from PMC .... Header key [RECALL]

All the items above, except PMC, are set in HEADER (header key), DATA (data keys), UNIT (units keys) order. PMC is set in HEADER (header key), DATA (data keys) order.



The data keys are the 11 keys [0] to [9] and [.].

Note:
Values of 1 or less can also be entered without entering the leading 0. For example, 0.5 can be entered by keying in [0][.][5] or [.][5].

The units keys are the top three keys in the right column. The header key determines which unit is used. Data entry is completed by pressing a unit key.

The [CE] key clears the previously keyed-in contents. (CE: Clears Entry data)

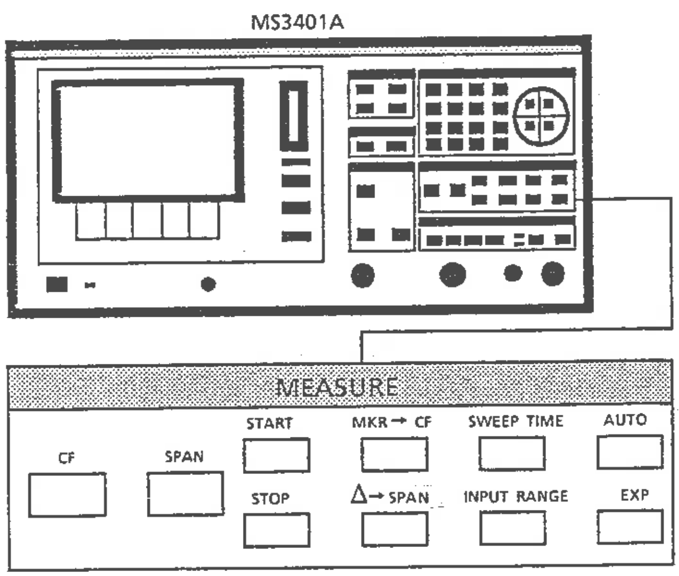
The [RTN] key is used as the RETURN key at PMC (plug-in Memory Card) write protection and formatting.

Setting example	Key operation
CF 12.4 MHz	[CF] [1] [2] [•] [4] [MHz]
SPAN 50 kHz	[SPAN] [5] [0] [kHz/ S]
Start frequency 1 MHz	[START] [1] [MHz]
Stop frequency 7 MHz	[STOP] [7] [MHz]
Sweep time 52 ms	[SWEEP TIME] [5] [2] [Hz/ mS]
Common setting order	HEADER key (HEADER) — Data keys (DATA) — Unit keys (UNIT)

Fig. 5-11 Setting by Keyboard (Data and Unit Keys)

5.5 Measurement Conditions Setting (MEASURE)

The front panel MEASURE section shown in Fig. 5-12 is used to set the MS3401A Network Analyzer measurement conditions.



The MEASURE Section has the following setting items:

- CF/SPAN
- START/STOP
- Special marker functions (MKR→CF, Δ→SPAN)
- SWEEP TIME
- INPUT RANGE (paragraph 5.1.2)
- AUTO (Automatic Measurement conditions setting)
- EXP (Expanded measurement conditions)

Fig. 5-12 MEASURE Functions

The last two items are set with soft keys [F1] to [F5] after the [AUTO] or [EXP] key is selected.

5.5.1 Center frequency and sweep span setting (CF/SPAN)

The two header keys [CF] and [SPAN] set the measurement frequency range center frequency (CF) and sweep span (SPAN).

After pressing the pertinent header key, set the data with the knob or ENTRY keys. When using the ENTRY keys, end data entry by pressing a unit key.

(HEADER → DATA → UNIT key operation order)

The CF and SPAN setting ranges are:

CF: 10.00 to 30000000.00 Hz

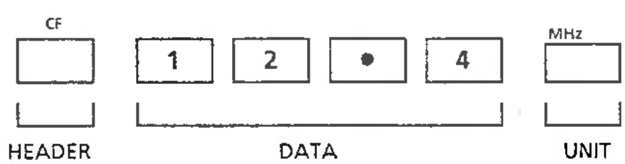
SPAN: 0.00 to 30000000.00 Hz

Notes:

1. SPAN $\leqq$2 x CF
2. CF and SPAN can be varied in 1/100 and 1/10 digit steps with the knob.

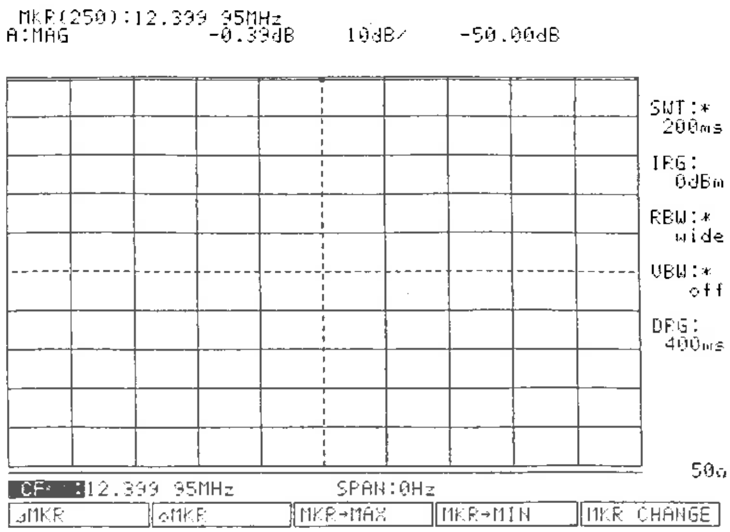
Example: Set the center frequency to 12.4 MHz using the ENTRY keys, and then change it to 12.39995 MHz using the knob.

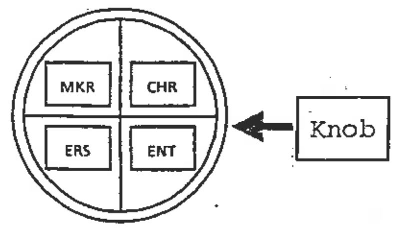
Step	Procedure
1	Press the [CF] HEADER key to reverse-display the characters "CF" at the bottom left corner of the CRT.
2	Enter the data 12.4 with the DATA keys.
3	Press the UNIT key [MHz]



(continued)

Step	Procedure
4	Turn the knob to set the cernter frequency to 12.39995 MHz.





Turn the knob so that 12.39995 MHz is displayed at the right side of the reverse displayed characters CF.

5.5.2 Sweep start and stop frequency setting (START/STOP)

The two keys [STOP] and [START] set the measurement frequency range LOG or LINEAR sweep start frequency (START) and sweep stop frequency (STOP). The start frequency and stop frequency values can be set with either the knob or ENTRY keys after pressing the [START] and [STOP] keys, respectively.

(1) LINEAR

START/STOP: 0.00 to 30000000.00 Hz

Notes:

1. START $\leq$STOP

2. The START and STOP frequencies can be changed in 1/10 digit steps with the knob.

(2) LOG

START: 10 Hz , 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz

STOP: 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, 10 MHz, 30 MHz

Notes:

1. START $\leq$STOP

2. The START and STOP frequencies can be set only with the knob.

3. LOG can be used only when the MEASURE POINT setting is 501.

Set the START and STOP frequencies for LOG sweep using steps 1 to 4 below (Fig. 5-13).

Step	Procedure
1	Press the [EXT] key.
2	Select LOG with the [F5] key (LOG/LIN).
3	Press the [START] or [STOP] key.
4	Set the sweep start frequency (START) or stop frequency (STOP) with the knob.

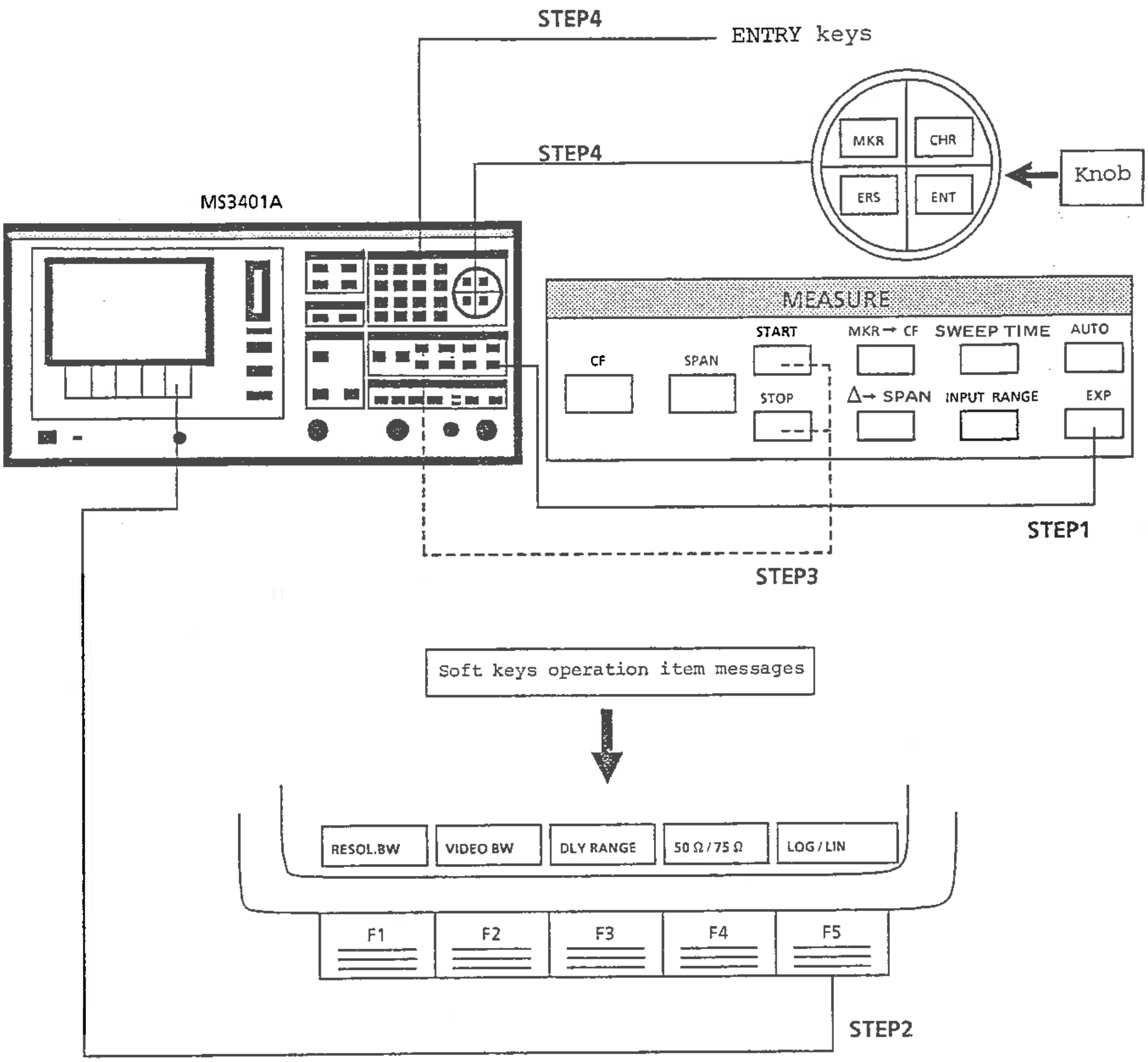
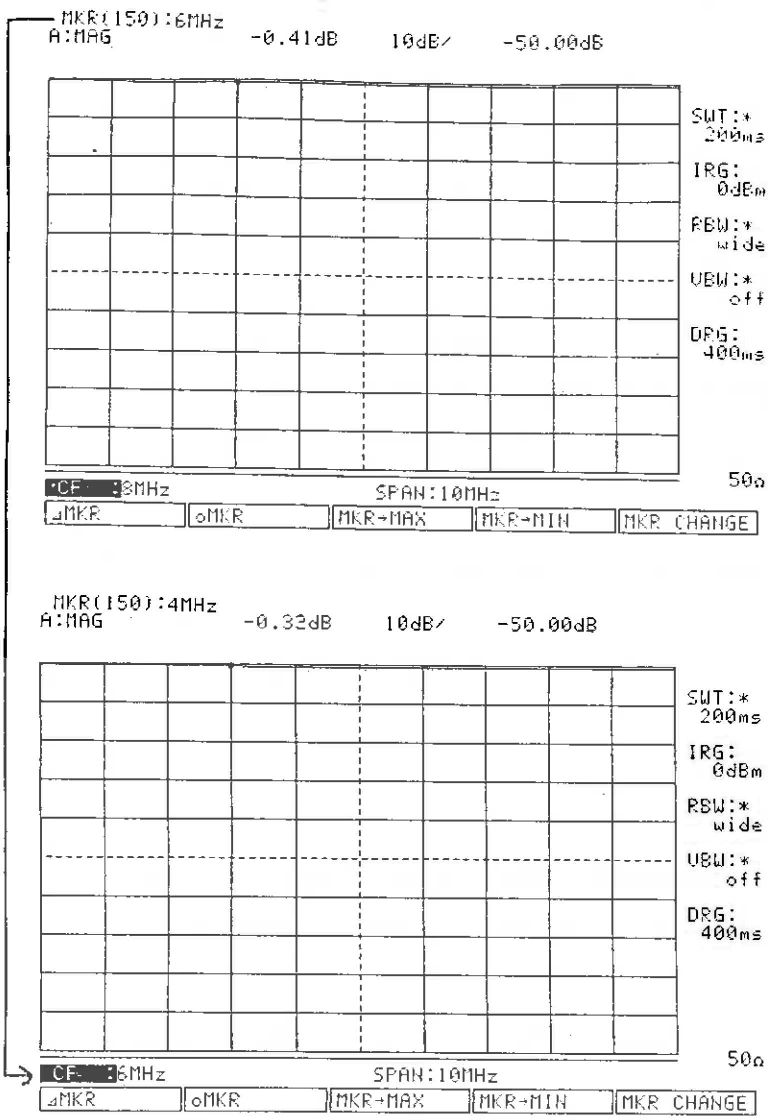


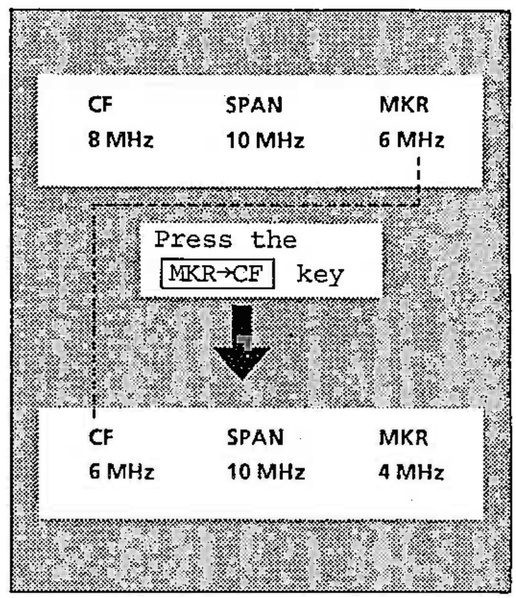
Fig. 5-13 LOG Sweep START-STOP Frequency Selection

To switch from LOG sweep to LINEAR sweep START-STOP frequency, select LIN with the [F5] key (Fig. 5-13), then press either the [START] or [STOP] key.

5.5.3 Setting current marker frequency to CF (MKR → CF)



To set the current marker frequency to CF without changing the position of the current marker as shown in the figure at the left, press the [MRK→CF].



- If the frequency setting mode is START/STOP, it is switched to CF/SPAN.
- The current marker does not move to the center.
- If SPAN>2.CF after MKR → CF is executed, SPAN=2xCF is set.

5.5.4 Setting Δ of Δmarker to span (Δ → SPAN)

When this key is pressed when the marker is ΔMKR, the current marker and reference marker frequency difference is set at SPAN without changing the position of the current marker and reference marker. If the frequency setting mode at this time is START/STOP, it is switched to CF/SPAN.

5.5.5 Sweep time setting (SWEEP TIME)

The sweep time is set with the [SWEEP TIME] key. After pressing the [SWEEP TIME] key, set the sweep time (SWEEP TIME-SWT) with the DATA and UNIT keys or knob.

The setting conditions are:

1. DATA keys: Sweep time set to two most significant digits (other digits are replaced with 0)
2. Knob: Sweep time set in 1/10 digit steps
3. Range: 10 ms to 99000 s

Note:

When the [AUTO] key is pressed, the sweep time is set automatically. However, this value is not always the optimum value.

Therefore, select the optimum value by considering the DUT response, etc.

5.5.6 RBW, VBW, DRG, 50 Ω/75 Ω, and LOG/LIN setting (EXP)

When the [EXP] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown in Fig. 5-14.

Select the desired item and set its measurement conditions with the [F1] to [F5] keys corresponding to this message.

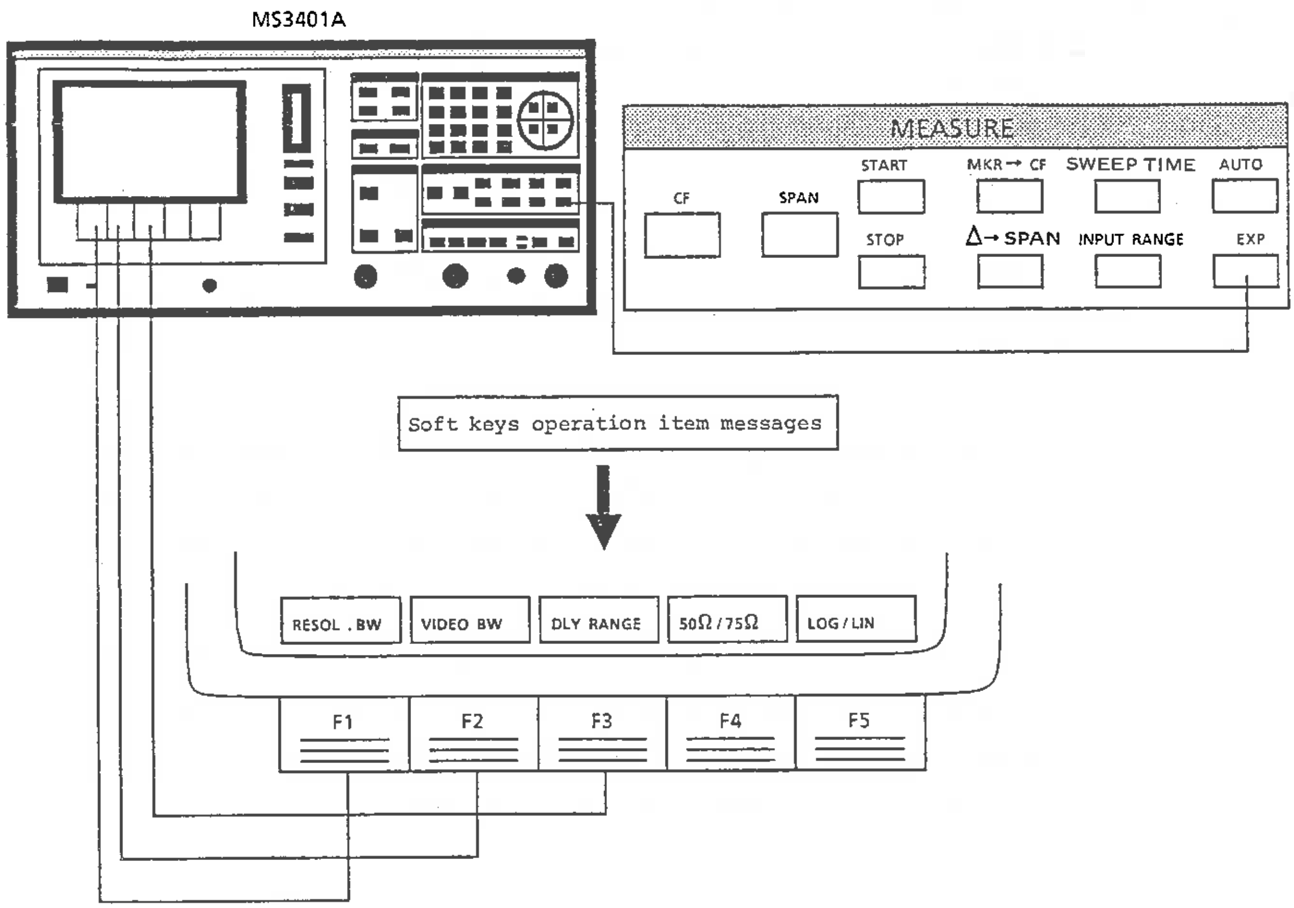


Fig. 5-14 Measurement Condition Expansion

Use of the 50 Ω/75 Ω soft key message corresponding to the [F4] key is described in paragraph 5.1.1 and use of the LOG/LIN soft key message corresponding to the [F5] key is described in paragraph 5.5.2. This paragraph describes F1 (RESOL.BW), F2 (VIDEO BW), F3 (DLY RANGE).

(1) RESOL.BW(RBW)

This key sets the receiving resolution bandwidth. When the [F1] key is pressed, RBW:AUTO is turned off and the RBW can be switched to 3 Hz, 10 Hz, 100 Hz, 1 kHz, or WIDE with the knob.

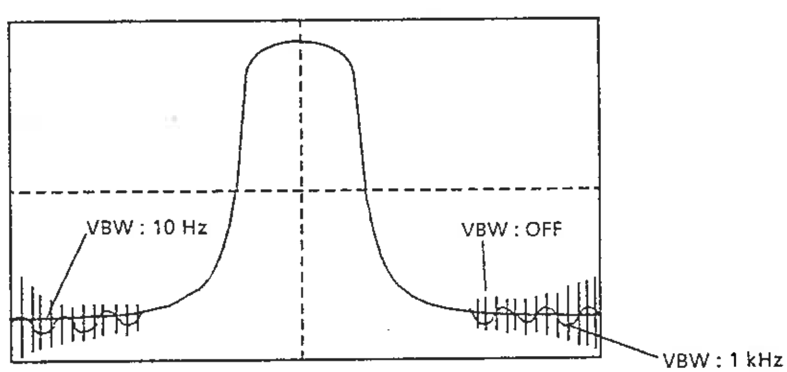
The normal RBW setting conditions are:

Lowest frequency of measurement frequency range	RBW
< 100 Hz	3 Hz
< 300 Hz	≦10 Hz
< 3 kHz	≦100 Hz
< 30 kHz	≦1 kHz
< 300 kHz	≦ Wide

(2) VIDEO BW (VBW)

This key sets the video bandwidth. When the [F2] key is pressed, VBW: AUTO is turned off and the VBW can be switched to 10 Hz, 100 Hz, 1 kHz, 10 kHz, or OFF with the knob.

Usually, the VBW is set wider than the RBW. When the VBW is narrow, as shown in the figure below, the average noise level is constant, but noise is compressed in proportion to the VBW.



(3) DLY RANGE (DRG)

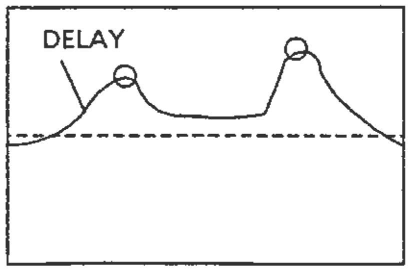
This key sets the DELAY measurement range. After the [F3] key is pressed, DRG can be set between 1 μs and 400 ms in 1, 2, 4 steps with the knob.

The normal DRG set conditions are:

DRG	Aperture (ΔF)	Measurement range	Resolution	Measurement frequency range
40 ns	10 MHz	±40 ns	0.04 ns	11 MHz to 22 MHz
100	4	±100	0.1	5 MHz to 28 MHz
200	2	±200	0.2	3 MHz to 30 MHz
400	1	±400	0.4	1.1 MHz to 30 MHz
1 μs	400 kHz	±1 μs	1	1 MHz to 30 MHz
2	200	±2	2	500 kHz to 30 MHz
4	100	±4	4	250 kHz to 30 MHz
10	40	±10	10	100 kHz to 30 MHz
20	20	±20	20	50 kHz to 30 MHz
40	10	±40	40	25 kHz to 30 MHz
100	4	±100	100	10 kHz to 30 MHz
200	2	±200	200	5 kHz to 30 MHz
400	1	±400	400	2.5 kHz to 30 MHz
1 ms	400 Hz	±1 ms	1 μs	1 kHz to 30 MHz
2	200	±2	2	500 Hz to 30 MHz
4	100	±4	4	250 Hz to 30 MHz
10	40	±10	10	100 Hz to 30 MHz
20	20	±20	20	50 Hz to 30 MHz
40	10	±40	40	25 Hz to 30 MHz
100	4	±100	100	12 Hz to 30 MHz
200	2	±200	200	11 Hz to 30 MHz
400	1	±400	400	10 Hz to 30 MHz

Note:

If DRG is set incorrectly, the measurement error will be large. To minimize the measurement error, set DRG to the lowest value at which the peak value (0 on diagram below) is maximum and the change is minimum.



5.5.7 Automatic setting of measurement conditions (AUTO)

The RBW, VBW, SWT, and DRG are set automatically according to the measuring frequency by using [AUTO] key.

When the [AUTO] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown in Fig. 5-15.

When the required item is selected with the [F1] to [F5] key corresponding to the message, the selected function is enabled.

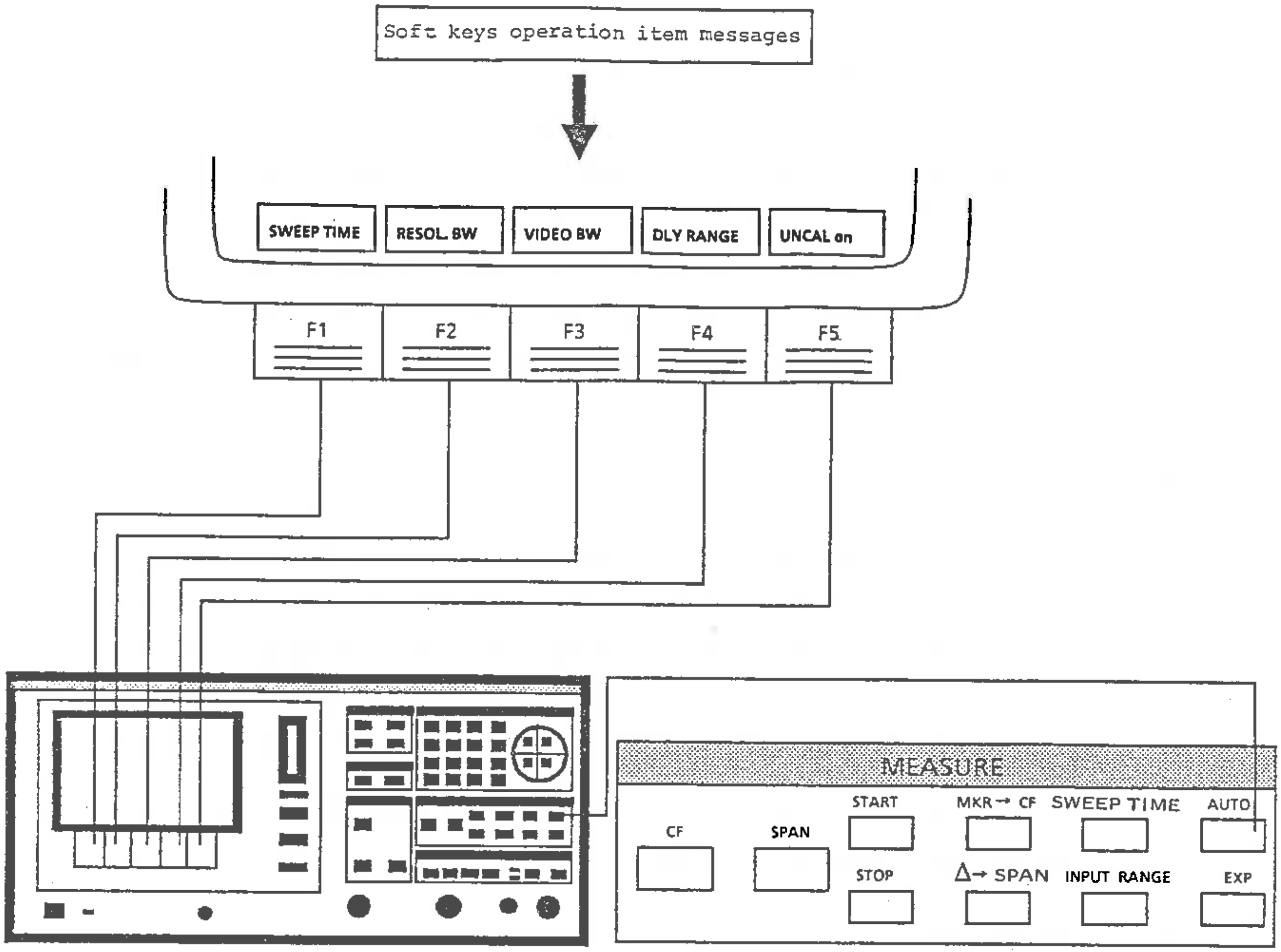


Fig. 5-15 Automatic Setting of Measurement Conditions

(1) SWEEP TIME

Each time the [F1] key is pressed in succession, SWEEP TIME AUTO (indicated by *) is alternately turned on and off. When it is on, SWT:* is displayed on the CRT and the set SWT is set for RBW and the set frequency. When FREQUENCY or RBW is switched in the AUTO mode, SWT is set automatically. The relationship between SWT, RBW, and FREQUENCY is shown in item (5) UNCAL.

(2) RESOL.BW

Each time the [F2] key is pressed in succession, RESOL.BW AUTO is alternately turned on and off. When it is on, RBW:* is displayed on the CRT and the set RBW is set at the set frequency. When FREQUENCY is switched in the AUTO mode, RBW is set automatically.

The relationship between RBW and FREQUENCY is shown in item (5) UNCAL.

(3) VIDEO BW

Each time the [F3] key is pressed in succession, VIDEO BW AUTO is alternately turned on and off. When it is on, VBW:* is displayed on the CRT and a VBW of 10 times the width of the set RBW is set.

(4) DLY RANGE

When the [F4] key is pressed, the DRG for the DUT is set automatically.

Notes:

1. Before pressing this key, connect the DUT.
2. The approximate DRG is set at this time. For the optimum value for the DUT, see the note in paragraph 5.6.6(3).

(5) UNCAL

Each time the [F5] key is pressed in succession, the function that displays UNCAL is alternately turned on and off.

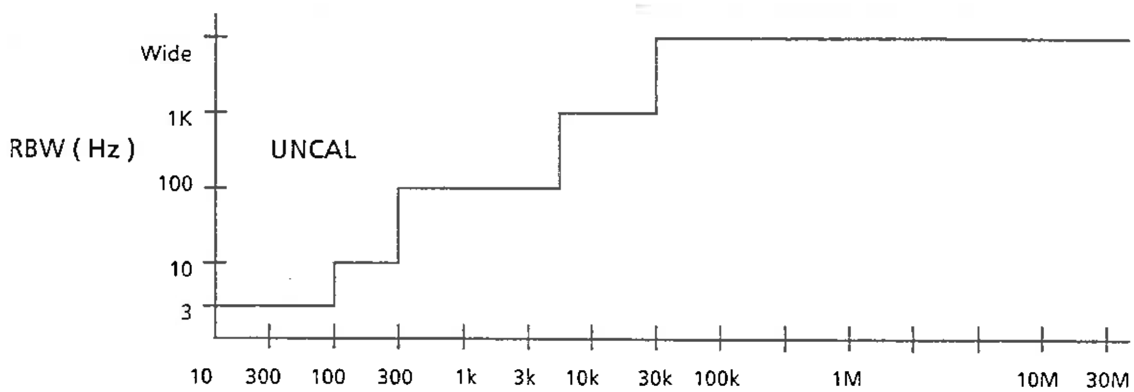
(a) UNCAL ON

If the measurement conditions (FREQUENCY, RBW, SWT) settings are not optimum, UNCAL is displayed on the CRT.

(b) UNCAL OFF

UNCAL is not displayed even if the set measurement conditions are not optimum.

The UNCAL conditions are shown below:



Lowest frequency (Hz)

UNCAL time at each measurement item and RBW

Item \ RBW	3 Hz	10 Hz	100 Hz	1 kHz	Wide
MAG	<230 s	<75 s	<7.5 s	<750 ms	<200 ms
PHA	<230 s	<75 s	<7.5 s	<750 ms	<200 ms
DLY	<600 s	<200 s	<20 s	<2 s	<800 ms
M / P	<460 s	<150 s	<15 s	<1.5 s	<300 ms
M / D	<850 s	<280 s	<28 s	<2.8 s	<1 s

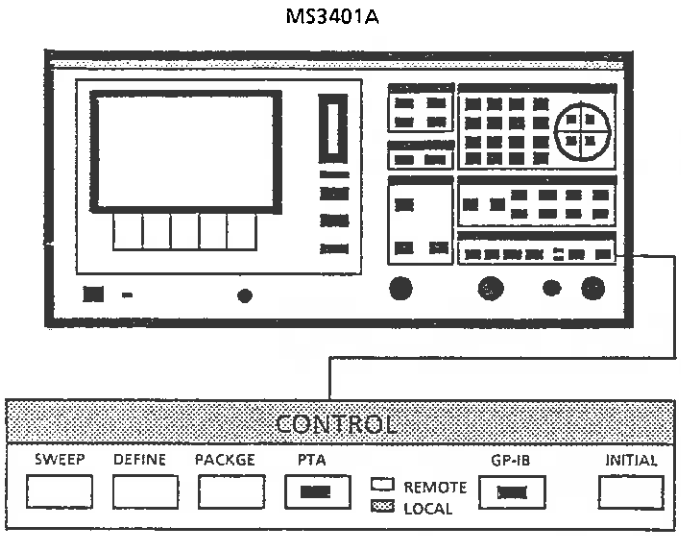
The table above shows the UNCAL times for 501 measurement points.

The UNCAL time becomes shorter corresponding to the number of measurement points when switching the number of measurement points.

5.6 Other Control Functions (CONTROL)

The front panel CONTROL section shown in Fig. 5-16 expands the measurement functions of the MS3401A Network Analyzer by adding "intelligent" functions to its measurement condition setting functions.

The CONTROL section has the following keys:



- SWEEP .... Sweep control
- DEFINE ... Memory recall by definition
- PACKGE ... Number of measurement points, etc. control
- PTA
- GP-IB ... Automatic measurement
- INITIAL .. Initialization

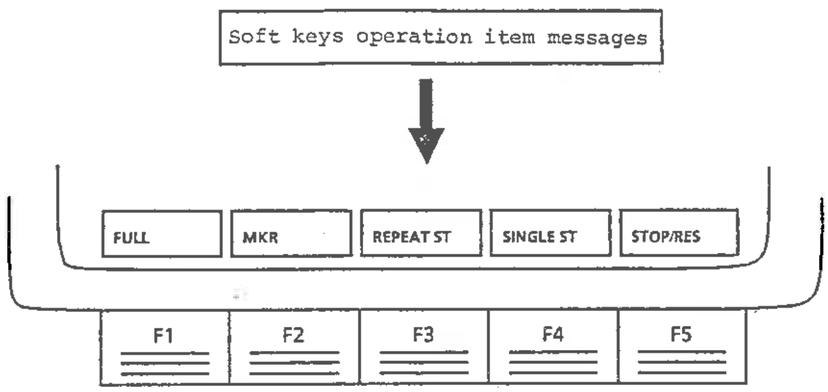
For a description of GP-IB, see Section 7 and succeeding sections, for a description of PTA, refer to the separate PTA Manual, and for a description of INITIAL, see paragraphs 3.1.3 and 3.1.3.

Fig. 5-16 CONTROL Functions

5.6.1 Sweep control (SWEEP)

When the [SWEEP] key shown in Fig. 5-16 is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown below:

When the required item is selected using the [F1] to [F5] key corresponding to the message, the selected function is enabled.



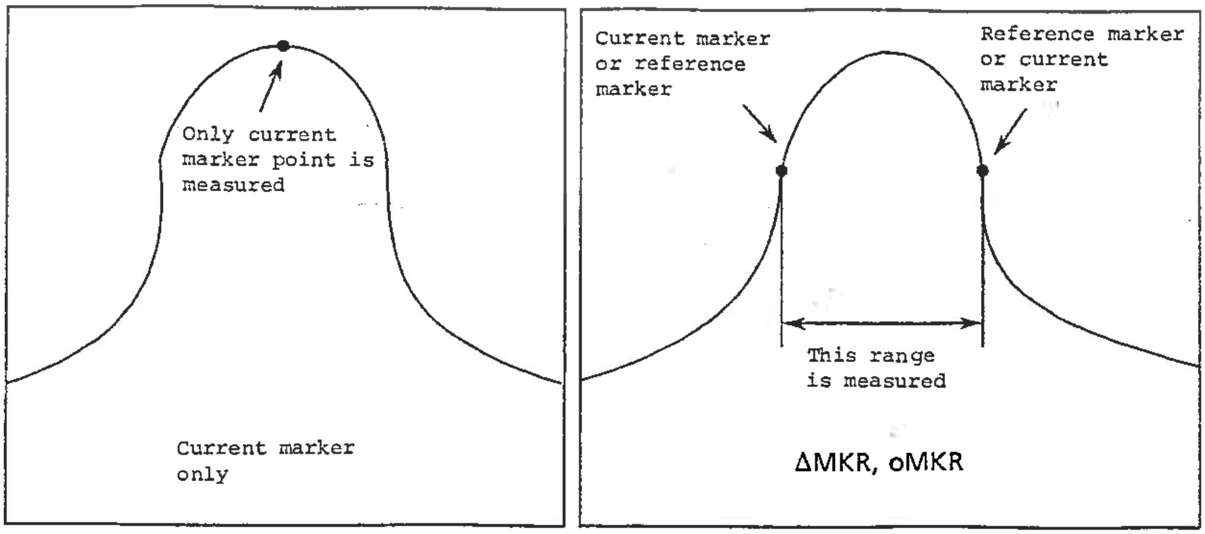
(1) FULL

When the [F1] key is pressed, full sweep is set.

(2) MKR

When the [F2] key is pressed, marker sweep is set and only the marker point is measured.

When ΔMKR or 0MKR is turned on at marker sweep, the range between the reference marker and current marker is measured.



Note:

When the current mark is moved at MKR sweep, sweep is performed again.

(3) REPEAT ST (START)

When the [F3] key is pressed, sweep is repeated. If the [F3] key is pressed during a sweep, a repeated sweep starts from the sweep start point. If the [F3] key is pressed while a sweep is stopped, a repeated sweep starts from the sweep stop point.

(4) SINGLE ST

When the [F4] key is pressed, sweep is performed once. If the [F4] key is pressed during a sweep, a single sweep starts from the sweep start point.
If the [F4] key is pressed while a sweep is stopped, a single sweep starts from the sweep stop point.

(5) STOP/RES

When the [F5] key is pressed, the sweep is stopped or reset. If the [F5] key is pressed during a sweep, the sweep is stopped. If the [F5] key is pressed while a sweep is stopped, the sweep is reset.

5.6.2 Calling function memory contents without using RECALL key (DEFINE)

To recall the contents of the function memory (2, for example), key in [RECALL][2] at the PMC and ENTRY sections (Fig. 5-17).
When the contents of the function memory are recalled by this method, they are identified by number only and the contents of the function memory of that number must be recorded separately beforehand.

The RECALL method described in this section recalls the panel functions for measuring a filter, for example, but by name, not number.

If FILTER-A, FILTER-B, and FILTER13 are defined for the memory numbers as shown below, the defined name becomes the recall key.

MEMORY	Defined name
0	FILTER-A
1	FILTER-B
2	FILTER13
⋮	⋮
9	FILTER-M

Defined names of up to 10 characters can be registered by the TITLE function of the PACKAGE functions described in this section

TITLE is registered by defining RECALL at soft keys [F1] to [F5] by DEFINE function. Thereafter, RECALL can be executed directly by pressing the [F1] to [F5] key corresponding to TITLE so that function memory management is easy.

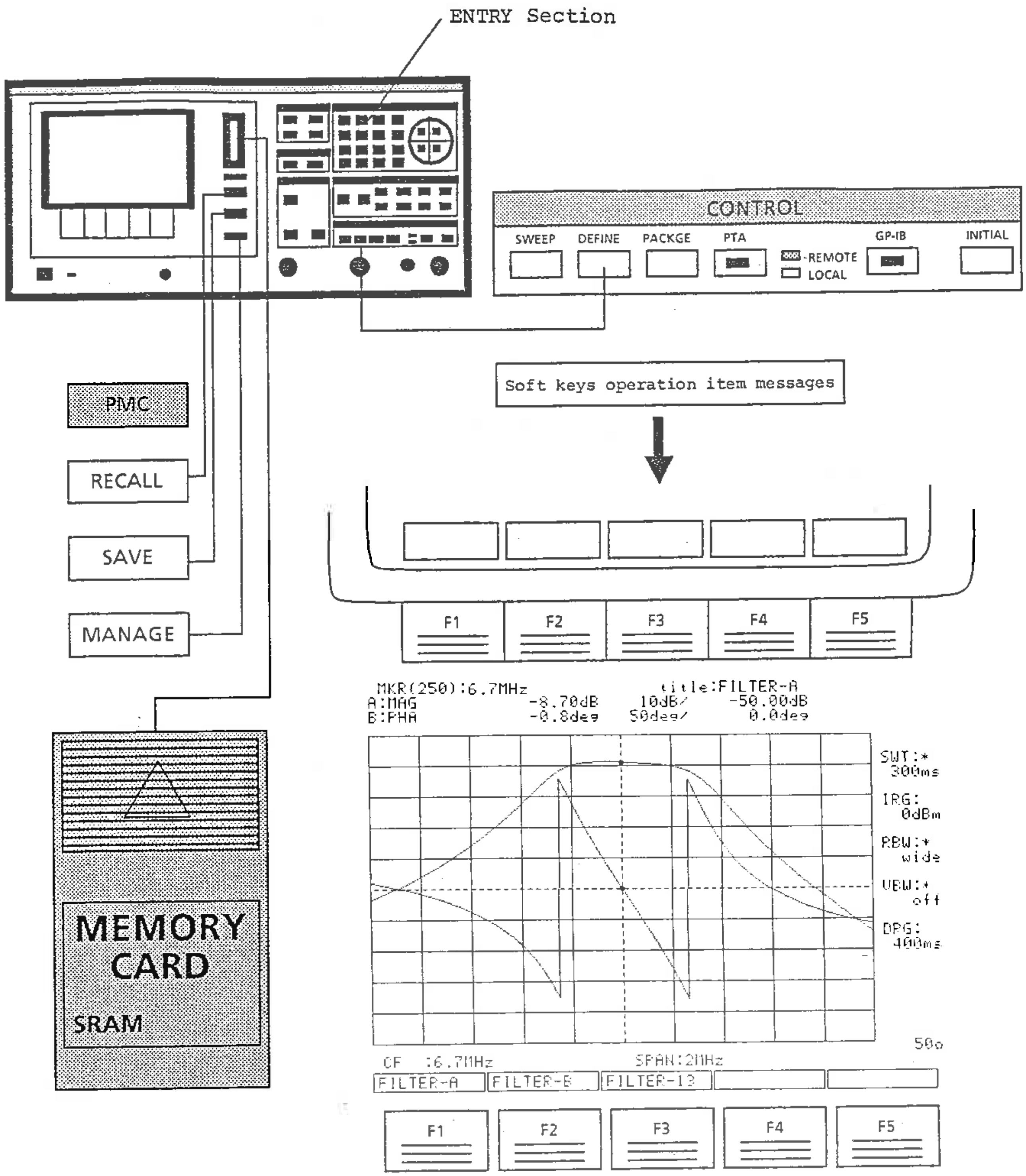


Fig. 5-17 RECALL by DEFINE Function

LIST ALL

memory	FUNC	S	X	F.TBL
0	○			
1	○			
2	○			
3	○			
4				
5				
6				
7				
8				
9				

To execute RECALL by DEFINE function, the setting data must be saved to the function memory beforehand. The method of defining and recalling the contents of address 0 at the left as FILTER-A is described below: (See Fig. 5-17)

Step	Procedure
1	Plug in the SRAM memory card (Fig. 5-17).
2	Press the [PACKAGE] key and enter the title FILTER-A. For a description of the title entry method, see paragraph 5.9.4.
3	Press the [DEFINE] key. If nothing is defined, nothing is displayed below the arrow mark (Fig. 5-17).
4	Press the [RECALL] key.
5	Select the memory number ([0] to [9]) to be registered. (The [0] key is pressed in this example.)
6	Press the soft key ([F1] to [F5]) to be defined. The title is displayed. Since the [F1] key was pressed in Fig. 5-17, FILTER-A is displayed at the corresponding soft key. After completing step 6, function memory RECALL is performed just by pressing the soft keys.

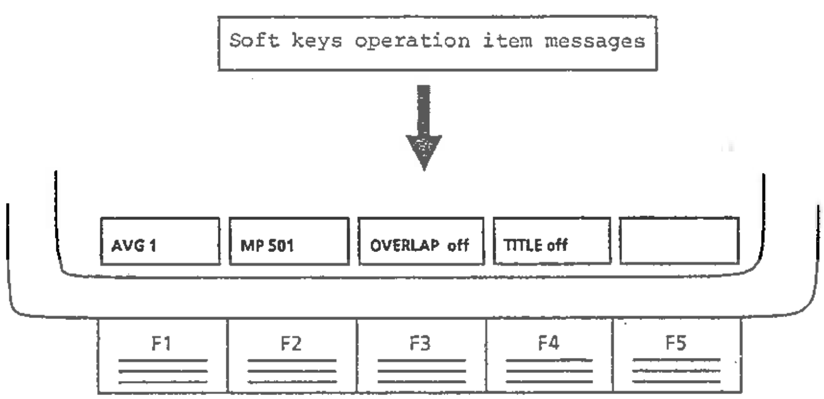
Note:

When the PMC is an SRAM, the operation associated with it can be defined by the user.

When the PMC is a PROM (Anritsu soft pack), operation associated with it is defined automatically. When the function memory using the SRAM-type PMC is RECALL, the function memory is managed by memory numbers 0 to 9.

5.6.3 Averaging, measurement points, OVERLAP, and title functions (PACKAGE)

The MS3401A Network Analyzer has averaging, measurement points, trace OVERLAP, and title functions. When the [PACKAGE] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F4] is displayed at the bottom of the CRT as shown below:
If the desired item is selected with the [F1] to [F4] keys corresponding to this message, the selected function can be controlled.



(1) AVG1

This key improves the S/N by averaging. Each time the [F1] key is pressed in succession, the averaging index (1, 2, 4, 8, 16, 32, 64, and 128) is set in succession.

Figure 5-18 shows how much averaging improves the S/N.

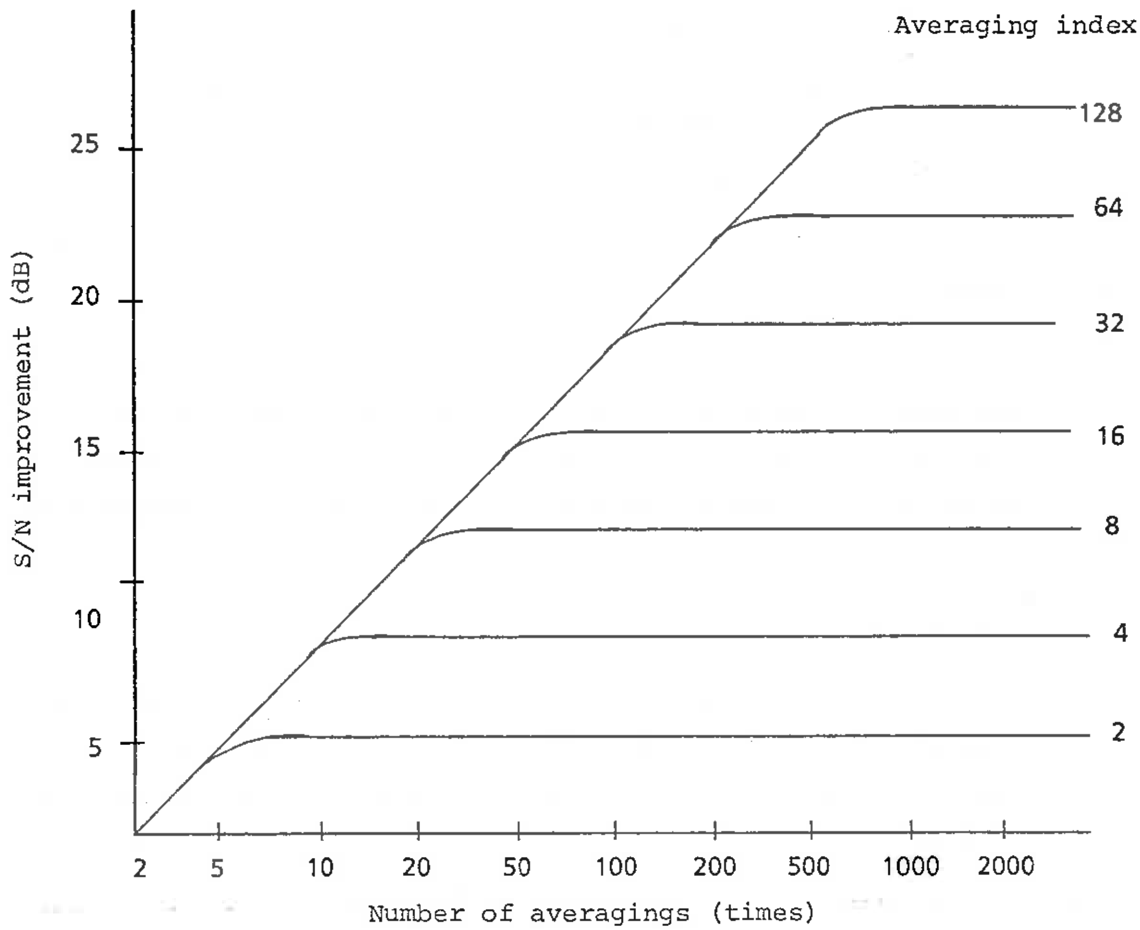


Fig. 5-18 Averaging

Note:

Averaging begins from the sweep after averaging index setting.

(2) MP (MEASURE POINT) 501

Each time the [F2] key is pressed in succession, the number of measuring points (501, 251, 101, 51, 21, 11) is set in succession.

Notes:

1. MP cannot be set in LOG sweep.
2. When MP is set, the following are automatically set simultaneously:

Function	Setting
ΔMKR	OFF
0MKR	OFF
Current marker	Center

(3) OVERLAP off

Each time the [F3] key is pressed in succession, OVERLAP is turned on and off alternately. When OVERLAP is on, the trace on the CRT is overlapped at each sweep. When OVERLAP is off, the overlapped trace is erased.

(4) TITLE on

A title of up to 20 characters can be input at the right side of the CRT. When the [F4] key is pressed, upper-case alphabetic characters, lower-case alphabetic characters, numerics, and special symbols can be scrolled and selected with the knob.

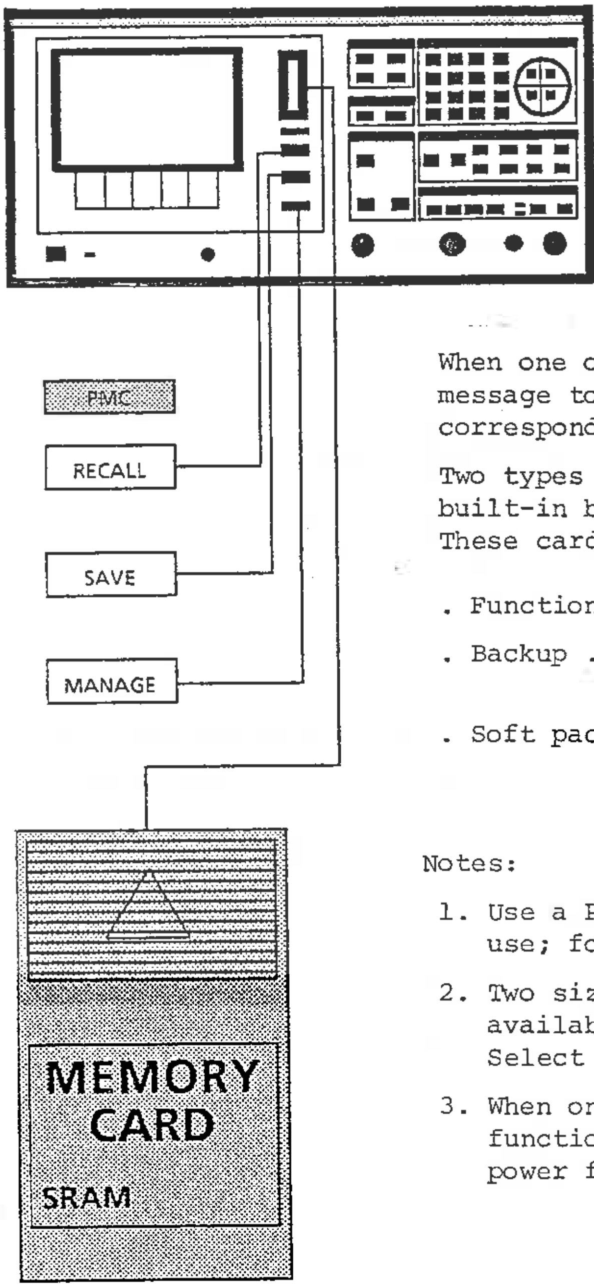
In Fig. 5-17, TITLE:FILTER-A is displayed at the top right of the CRT. In this case, TITLE on is displayed at the soft keys section.

When the [F4] key is pressed in this state, the title is erased.

For a description of the title entry method, see paragraph 5.9.4.

5.7 Plug-in Memory (PMC)

The three functions SAVE, RECALL, and MANAGE are performed at the front panel PMC section (Fig. 5-19) by plugging a PMC into the PMC slot.



Operation is outlined below:

- To save data, press the [SAVE] key.
- To recall saved data, press the [RECALL] key.
- To WRITE PROTECT or erase the card data, or format the card, etc., press the [MANAGE] key.

When one of these three keys is pressed, the message to be processed is displayed on the CRT corresponding to soft keys [F1] to [F5].

Two types of PMC are available: SRAMs with built-in battery, and EPROMs.
These cards have the following functions:

- Function memories .... 10 max.
- Backup .... SRAM functions retained at power failure
- Soft pack .... Software supplied (Refer to the soft pack manual.)

Notes:

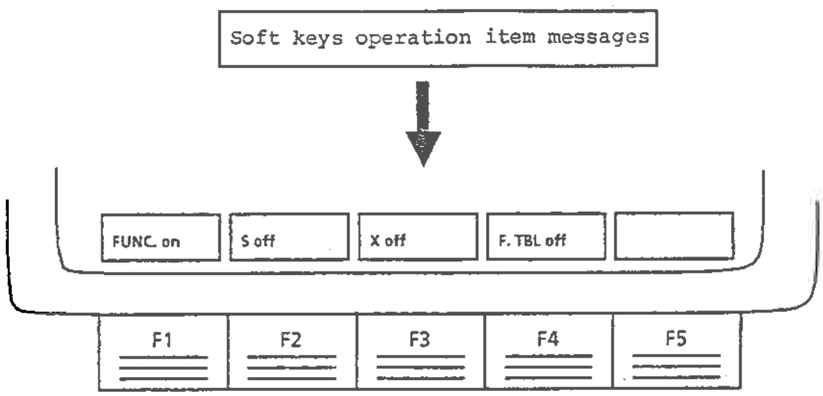
1. Use a PMC that has been formatted for MS3401A use; format the PMC before use.
2. Two sizes of PMC memory capacity are available: 32 kbyte, and 128 kbyte. Select according to the items to be saved.
3. When on EPROM PMC is installed, its functions are not backed-up if the primary power fails.

Fig. 5-19 PMC Section

5.7.1 SAVE function (SAVE)

When the [SAVE] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown below:

When the required item is selected with the [F1] to [F5] key corresponding to the message, the selected function is enabled.



The SAVE function saves the ON items of functions, S data, X data, and measurement frequency, to the SRAM PMC.

The memory size for each item is shown below:

Item	Memory (bytes)
FUNCTION	256
S	2 k
X	2 k
F. TBL	2.5 k

(1) SAVE procedure

Step	Procedure
1	Press the [SAVE] key. (In the SAVE mode, this key does not have to be pressed.)
2	Select the item to be saved with soft keys [F1] to [F4].
3	Press a data key [0] to [9].
4	If an error is not displayed, the selected item is saved.
5	If an error is displayed, see paragraph 5.8.

(2) FUNC on

This key sets saving of the set function on and off. When FUNC ON is displayed, the set function is saved. At initialization, FUNC is on.

(3) S off

This key sets saving of the contents of the S-memory used at CALIBRATION on and off. At initialization, S memory save is off.

(4) X off

This key sets saving of the main trace (MT) and sub trace (ST) data (X memory) on and off. At initialization, X memory save is off.

(5) F. TBL off

This key sets saving of the frequency table data of 501 points on and off. At initialization, frequency table save is off.

Note:

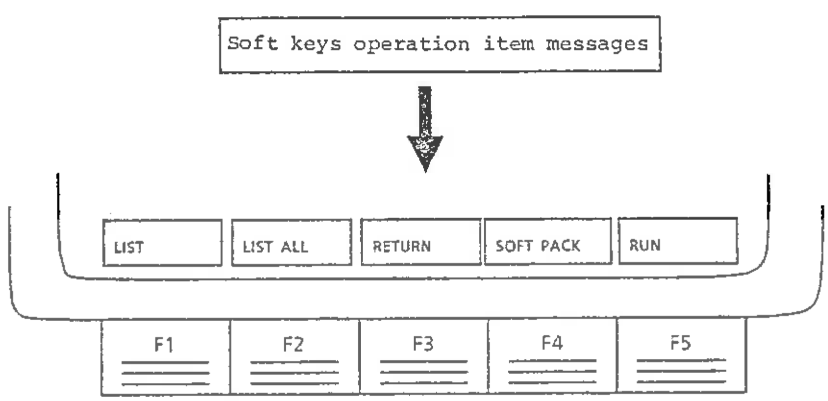
A write-protected PMC cannot be saved.

1 kbyte of the PMC capacity is for system use; only the remaining memory can be used.

5.7.2 RECALL function (RECALL)

The RECALL function recalls or lists the PMC function memory, or downloads the soft pack.
When the [RECALL] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown below:

When the required item is selected with the [F1] to [F5] key corresponding to the message, the selected function is enabled.



(1) Function memory RECALL

This function recalls the function, S data, X data, or measurement frequency saved as described in paragraph 5.7.1 and sets it in the MS3401A.

(a) RECALL method

Step	Procedure
1	Press the [RECALL] key. (In the RECALL mode, this key does not have to be pressed.)
2	Press a data key [0] to [9].
3	If an error is not displayed, the selected item is recalled.
4	If an error is displayed, see paragraph 5.8.

(2) LIST

This key displays the contents of Function Memories 0 to 9 on the CRT as shown below:

```
LIST
 memory 0
   FUNC:ON    S:OFF       X:OFF       F.TBL:OFF
   title
   trace:MAG              sub.trace:OFF          overlap:OFF
   marker:NORMAL
   START:100kHz           STOP:30MHz             LIN
   SWT:*200ms             RBW:*wide              VBW:*off
   IRG:0dBm               DRG:400ms              50Ω
   AVG:1                  MP:501                 UNCAL:ON
   sweep:FULL/RUN

[LIST        ][LIST ALL    ][RETURN      ][SOFT PACK   ][RUN         ]
```

(a) LIST method

Step	Procedure
1	Press the [RECALL] key. (In the RECALL mode, this key does not have to be pressed.)
2	Press the [F1] (LIST) key.
3	Press a data key [0] to [9].
4	If an error is displayed, see paragraph 5.8.

(3) LIST ALL

This key displays the usage state of the Function Memories as shown below:

The O mark indicates that the memory is used.

LIST ALL

memory	FUNC	S	X	F.TBL
0	O			
1	O	O		
2	O	O	O	
3	O			
4	O			
5				
6				
7				
8	O		O	
9	O	O	O	O

LIST	LIST ALL	RETURN	SOFT PACK	RUN

(a) LIST ALL method

Step	Procedure
1	Press the [RECALL] key.
2	Press the [F2] (LIST ALL) key.
3	If an error is displayed, see paragraph 5.8.

(4) RETURN

The LIST or LIST ALL mode is reset by using the [F3] (RETURN) key.

(5) SOFT PACK

This key loads the program from the EPROM PMC.

For more information, refer to the SOFT PACK manual.

(6) RUN

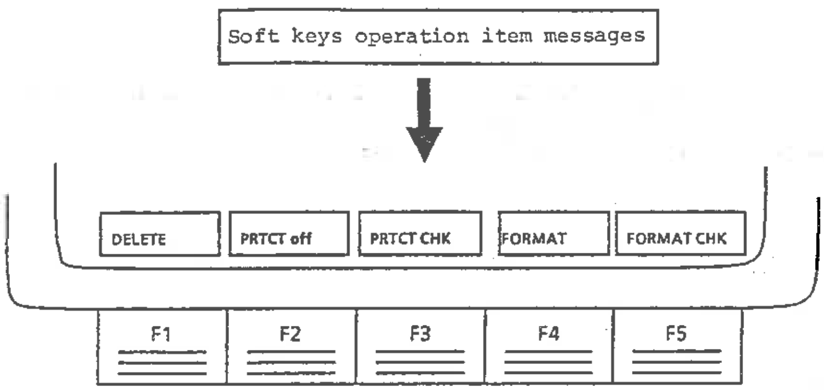
This key executes the program loaded at item (5).

For more information, refer to the SOFT PACK manual.

5.7.3 MANAGE function

This function messages the PMC.

When the [MANAGE] key is pressed, the soft keys operation item messages corresponding to soft keys [F1] to [F5] are displayed at the bottom of the CRT as shown below. When the required item is selected with the [F1] to [F5] key corresponding to the message, the selected function is enabled.



(1) DELETE

This key erases a function memory.

(a) DELETE method

Step	Procedure
1	Press the [MANAGE] key. (In the MANAGE mode, this key does not have to be pressed.)
2	Press the [F1] (DELETE) key.
3	Press a data key [0] to [9].
4	If an error is displayed, refer to paragraph 5.8.

(2) PRTCT off

This key switches PMC WRITE PROTECT.

(a) PROTECT method

Step	Procedure
1	Press the [MANAGE] key. (In the MANAGE mode, this key does not have to be pressed.)
2	Turn WRITE PROTECT on and or by pressing the [F2] (PRTCT) key.
3	Press the ENTRY section [RTN] key.
4	If an error is displayed, See paragraph 5.8.

(3) PRTCT CHK

This key checks the PMC PROTECT state, the PROTECT state is displayed at the error display position on the CRT.

(a) PROTECT CHECK method

Step	Procedure
1	Press the [MANAGE] key. (In the MANAGE mode, this key does not have to be pressed.)
2	Press the [F3] (PRTCT CHK) key.
3	If an error is displayed, see paragraph 5.8.

(4) FORMAT

This key formats the PMC for MS3401A use. Always format a new PMC.

(a) FORMAT method

Step	Procedure
1	Press the [MANAGE] key. (In the MANAGE mode, this key does not have to be pressed.)
2	Press the [F4] (FORMAT) key.
3	Press the ENTRY section [RTN] key.
4	If an error is displayed, see paragraph 5.8.

Notes:

1. A write-protected PMC cannot be formatted.
2. When formatted, the contents of the PMC are cleared.

(5) FORMAT CHK

This key checks the FORMAT state of the PMC. The instrument name that formatted the PMC is displayed at the error display position on the CRT.

(a) FORMAT CHECK method

Step	Procedure
1	Press the [MANAGE] key. (In the MANAGE mode, this key does not have to be pressed.)
2	Press the [F5] (FORMAT CHK) key.
3	If an error is displayed, see paragraph 5.8.

5.8 PMC Errors

If an error is generated at the PMC when a PMC function is executed, the contents of the error are displayed on the CRT.

ERROR MESSAGE	MEANING
no PMC	PCM not connected
no FORMAT	PCM not formatted
different FORMAT	Type of FORMAT incorrect
write protect	PMC write-protected
bad PMC	PMC damaged
memory over	Memory overflowed
not find file	Unregistered file or Function Memory read
different PMC type	PMC type incorrect
can't DEF	File to be defined not registered or soft key pressed

5.9 Knob Operation

The data functions listed below can be set with the knob. The four internal control keys [MKR], [ERS], [ENT], and [CHR] (Fig. 5-20) also make the MS3401A easier to operate.

5.9.1 Knob-settable functions

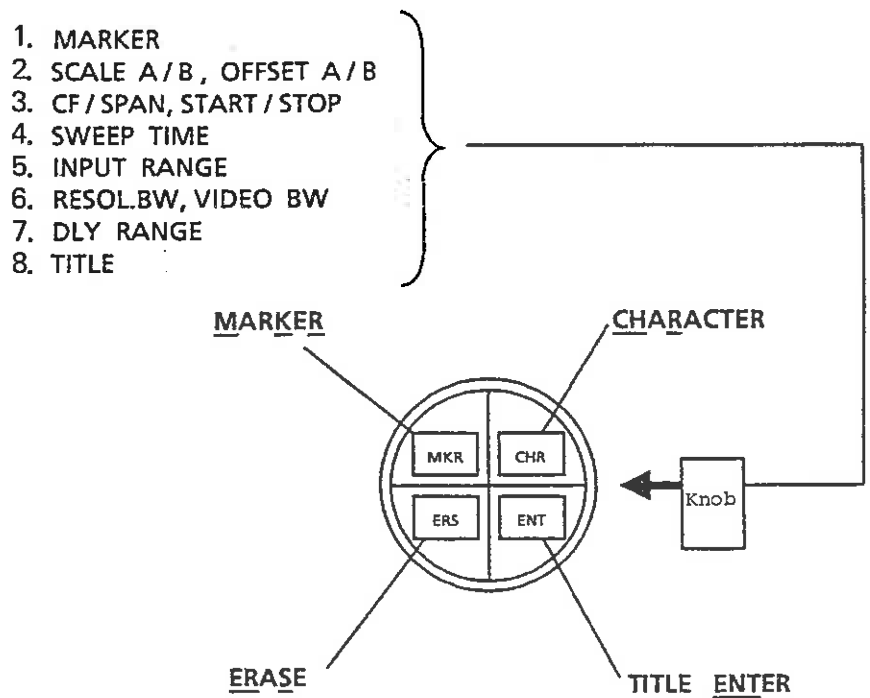
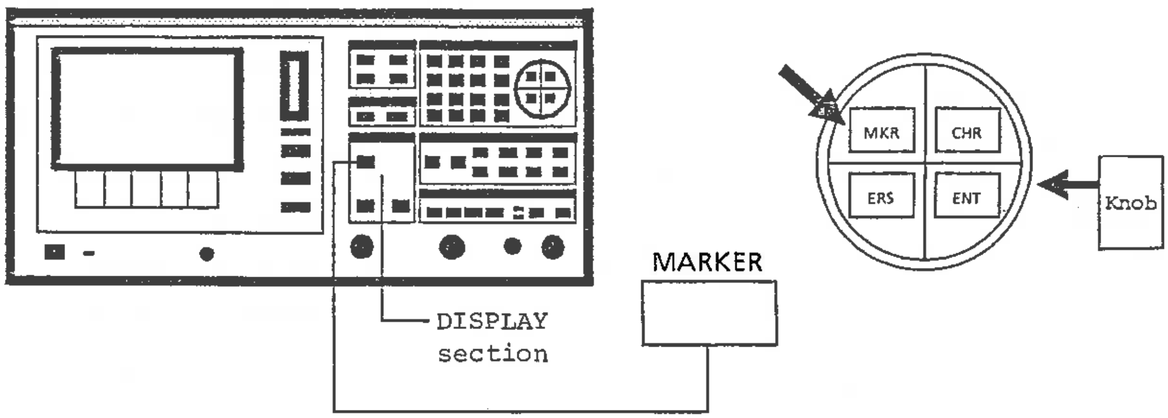


Fig. 5-20 Knob and Four Control Keys

5.9.2 MKR key (MKR)

When the [MKR] key is pressed, the NORMAL MARKER (current marker) can be moved with the knob, whether or not the DISPLAY section [MARKER] key is pressed.

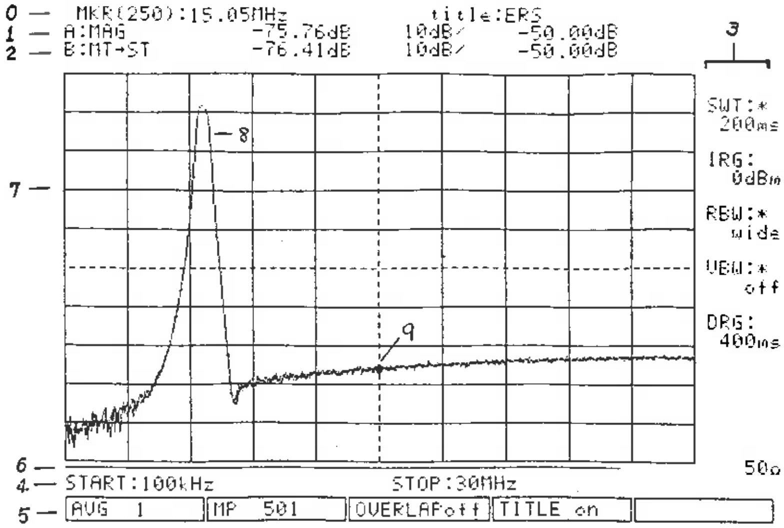


5.9.3 ERS key (ERS)

The ERS key erases a message displayed on the CRT.

(1) Erase method

Step	Procedure
1	Press the [ERS] key.
2	Select the item number of the message to be erased with the knob. The message is reverse-displayed.
3	Press the [ENT] key. The reverse-displayed selected message is erased.
4	Press the [RTN] key. The ERS function is reset.



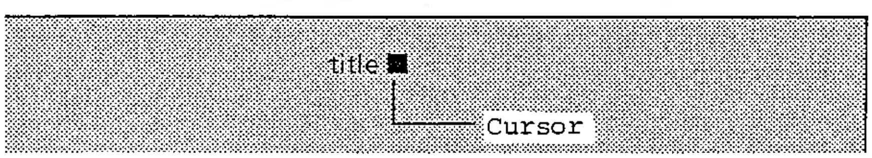
0. Marker title erase
1. Line A item erase
2. Line B item erase
3. Right item erase
4. Frequency setting item erase
5. Soft key item erase
6. Sweep marker item erase
7. Scale line
8. Waveform erase
9. Marker point erase

5.9.4 ENT (TITLE ENTER) key (ENT)

When this key is pressed, up to 20 characters selected with the knob can be entered as the title.

(1) Title entry method

Step	Procedure
1	Press the [PACKAGE] key.
2	Set TITLE by pressing the [F4] key. The following is displayed at the top right of the CRT:



(continued)

Step	Procedure
3	Select the type of characters (upper-case alphabetic, lower-case alphabetic, numeric/special symbols) by pressing the [CHR] key.
4	Select a character with the knob.
5	Enter the character by pressing the [ENT] key. When the character is entered, the cursor moves to the right.
6	Enter the title by repeating steps 3 to 5.
7	To end title entry, press the ENTRY section [RTN] key.

Note:

To erase the title, and make corrections, press the [F4] (TITLE off) key after pressing the [PACKAGE] key.

The title is erased. To make a correction, erase the title, then enter the new title as described above.

SECTION 6

MEASUREMENT

This section describes the measurement principle, examples of magnitude, phase, magnitude/phase, delay, and magnitude/delay measurement of a 6.7 MHz center frequency bandpass filter, and examples of sub trace use.

TABLE OF CONTENTS

6.1 Network Analysis

6.1.1 Principle

Transmission and reflection characteristics are often used to express the network's properties.

The MS3401A measures magnitude, phase, and delay frequency response and displays them on a CRT. The reflection characteristic can also be measured by combining the MS3401A with a reflection bridge.

(1) Transmission characteristics

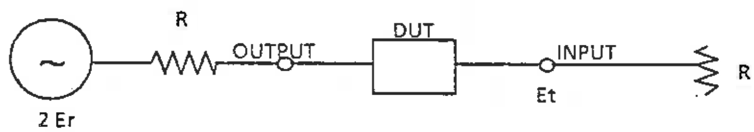


Fig. 6-1 Transmission Characteristics

In Fig. 6-1, the Er and Et relationship is:

$Et/Er = |K|.ej\phi$ .... (6.1)

($|K|$: Amplitude ratio (called MAGNITUDE),
θ: Phase shift (called PHASE) (rad))

From this, magnitude A, phase θ, and delay τ are found as follows:

$$A = 20 \log |K| \qquad \text{(dB)} \quad \ldots\ldots\ldots \quad (6.2)$$

$$0 = (360/2\pi)\phi \qquad \text{(deg)} \quad \ldots\ldots\ldots \quad (6.3)$$

$$\tau = -(d\phi/d\omega) \qquad \text{(s)}$$

$$-(\Delta\phi/\Delta\omega) = -(1/360)(\Delta\theta/\Delta F) \qquad \text{(s)} \quad \ldots \quad (6.4)$$

θ: Phase (deg), ω = Angular frequency, $\Delta\theta$: Phase difference (deg), ΔF: Frequency difference (Hz)

Magnitude and phase are measured directly and displayed on the CRT.

The delay can be obtained by measuring the phase difference $\Delta\theta$ between the two frequencies (fo + $\frac{\Delta F}{2}$) and (fo - $\frac{\Delta F}{2}$), and calculated from Eq. (6.4). This principle is shown in Fig. 6-2.

ΔF is called the aperture frequency. The relationship between aperture ΔF, range, resolution, and frequency range are shown in Table 6-1.

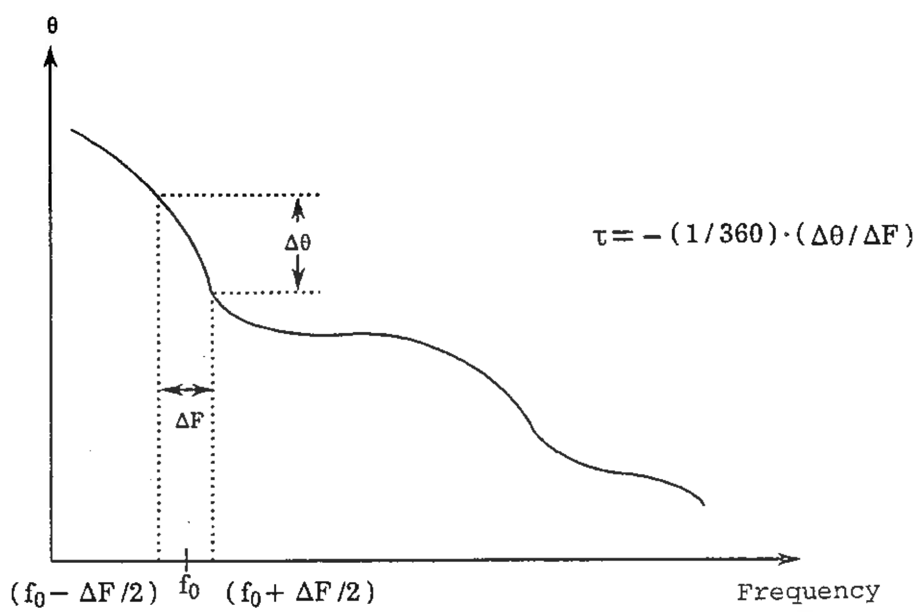


Fig. 6-2 Delay Time

Table 6-1 Delay Time

Range	Aperture ΔF	Resolution	Frequency range
40 ns	10 MHz	0.04 ns	11 MHz to 22 MHz
100 ns	4 MHz	0.1 ns	5 MHz to 28 MHz
200 ns	2 MHz	0.2 ns	3 MHz to 30 MHz
400 ns	1 MHz	0.4 ns	1.1 MHz to 30 MHz
1 μs	400 kHz	1 ns	1 MHz to 30 MHz
2 μs	200 kHz	2 ns	500 kHz to 30 MHz
4 μs	100 kHz	4 ns	250 kHz to 30 MHz
10 μs	40 kHz	10 ns	100 kHz to 30 MHz
20 μs	20 kHz	20 ns	50 kHz to 30 MHz
40 μs	10 kHz	40 ns	25 kHz to 30 MHz
100 μs	4 kHz	100 ns	10 kHz to 30 MHz
200 μs	2 kHz	200 ns	5 kHz to 30 MHz
400 μs	1 kHz	400 ns	2.5 kHz to 30 MHz
1 ms	400 kHz	1 μs	1 kHz to 30 MHz
2 ms	200 kHz	2 μs	500 Hz to 30 MHz
4 ms	100 Hz	4 μs	250 Hz to 30 MHz
10 ms	40 Hz	10 μs	100 Hz to 30 MHz
20 ms	20 Hz	20 μs	50 Hz to 30 MHz
40 ms	10 Hz	40 μs	25 Hz to 30 MHz
100 ms	4 Hz	100 μs	12 Hz to 30 MHz
200 ms	2 Hz	200 μs	11 Hz to 30 MHz
400 ms	1 Hz	400 μs	10 Hz to 30 MHz

(2) Reflection characteristic

If the impedance of the DUT is made Zx and the reference impedance is made Ro, the reflection coefficient S can be expressed by:

$$S = |S| \cdot e^{j\phi} = (Zx - Ro)/(Zx + Ro) \qquad (6.5)$$

$$\theta = (360/2\pi) \cdot \phi \text{ (deg)} \qquad (6.6)$$

$$\delta = 20 \log_{10} \frac{1}{|S|} \text{ (dB)} \qquad (6.7)$$

S is detected with a reflection bridge, and δ, ϕ are measured and displayed on a CRT by the MS3401A.

(3) Impedance characteristic

Two terminal impedances can be measured by using an impedance probe.

6.2 Magnitude (MAG), Phase (PHASE), and Magnitude/Phase (M/P) Measurement

The MS3401A Network Analyzer has an [AUTO] function that sets the RBW, VBW, SWT, and DRG automatically according to the measurement frequency. Therefore, the measurement operation is simple.

This paragraph describes the operating procedure for measuring the magnitude and phase, which are basic transmission characteristic measurement, of a 6.7 MHz center frequency bandpass filter as an example.

(1) Setup

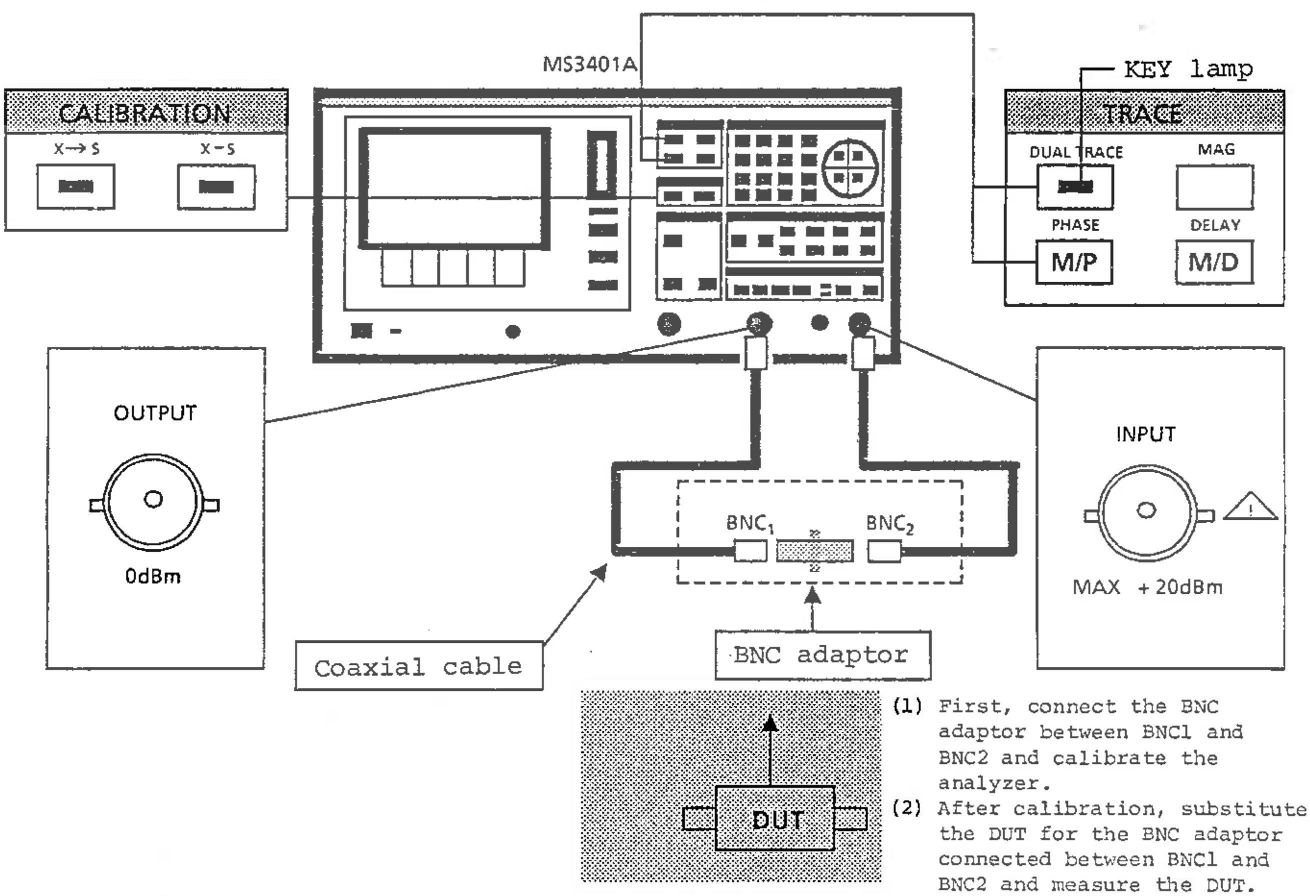


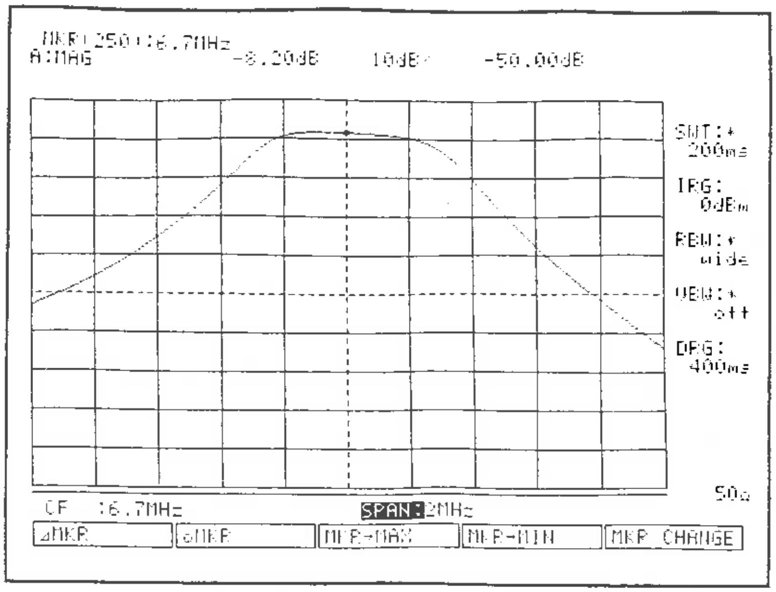
Fig. 6-2 MAG, PHA, and M/P Measurement

(2) Measurement procedure

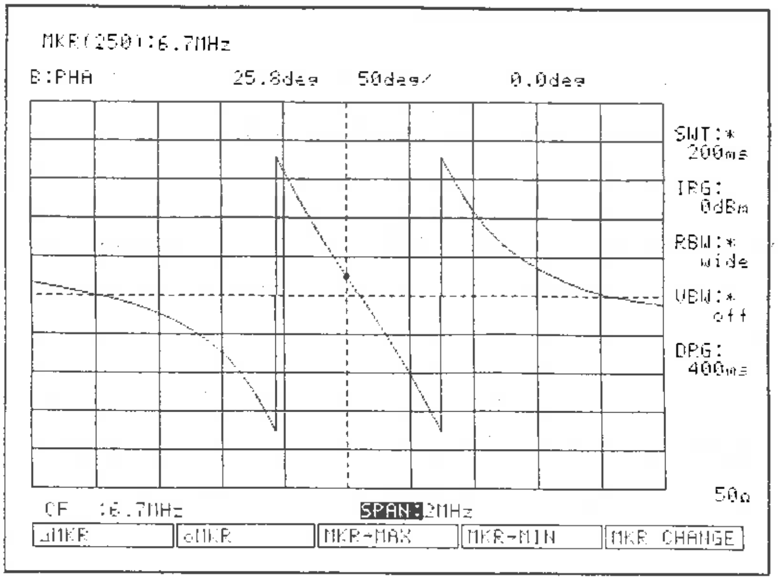
Step	Procedure	
1	Remove the PMC from the front panel socket. If a PMC is plugged into the socket, the instrument is initialized to the saved state at power on or when the [INITIAL] key is pressed after power on.	
2	Turn on the power. If the power is already on, press the [INITIAL] key. At this time, TRACE is set to [MAG] and magnitude can be measured.	
	To measure phase, press [PHASE] key.	
	To measure magnitude/phase, turn the [DUAL TRACE] lamp on and press the [M/P] key.	
3	Set the center frequency and span with the MEASURE section and ENTRY section key to:	
	CF:	6.7 MHz
	SPAN:	2.0 MHz
	<u>Calibration</u>	
4	Connect the BNC adaptor between the OUTPUT and INPUT connectors. (Between BNC1 and BNC2 in Fig. 6-2.)	
5	Press the CALIBRATION section [X→S] key and wait for the [X→S] lamp to go off and the [X-S] lamp to come on.	

(continued)

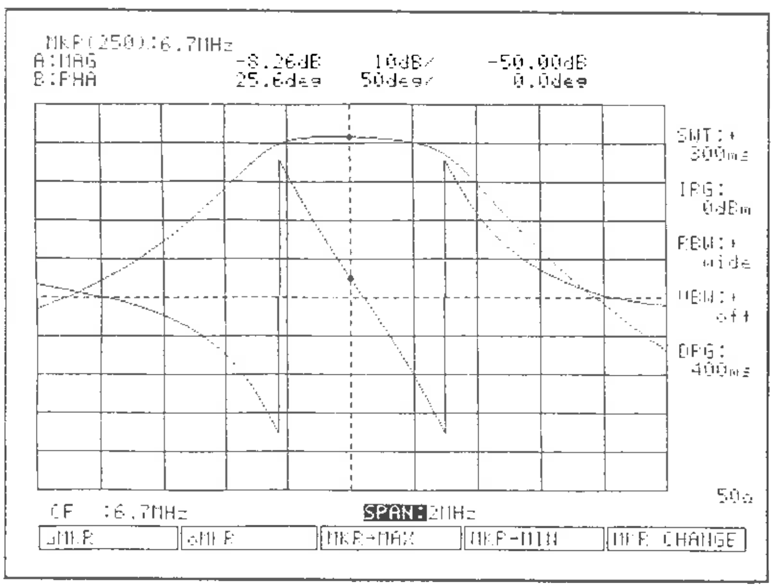
Step	Procedure
	Measurement
6	Substitute the DUT for the BNC adaptor connected between the OUTPUT and INPUT connectors.
7	Press the [SCALE] key, then press the soft key [F1] (AUTO).
8	Read the measured value from the CRT.
	Examples of measurement results are shown on the next page.



Magnitude measurement result



Phase measurement result



Magnitude/phase measurement result

Notes:

1. Depending on the DUT, the measurement result may change with the SWEEP TIME. If this happens, press the [SWEEP TIME] key and use the ENTRY section knob to adjust the SWEEP TIME to the lowest value at which the measurement result does not change.

2. When the DUT loss is high, press the [INPUT RANGE] key and set the lowest IRG by turning the knob. When there is a gain at the DUT, raise the IRG.

   At this time, adjust the IRG so that the OVERLOAD message does not appear at the bottom right of the CRT.

3. When the frequency, IRG, RBW, VBW, or measurement points are changed, repeat the procedure from step 4.

   When the IRG is -10 dBm or -20 dBm at calibration, insert an attenuator with a flat phase characteristic into the direct connection circuit.

6.3 Delay (DELAY) and Magnitude/Phase (M/D) Measurement

This paragraph describes an operating procedure example for measuring the delay of a 6.7 MHz center frequency bandpass filter.
The magnitude measurement procedure at magnitude/delay measurement is the same as that described in paragraph 6.2.

(1) Setup

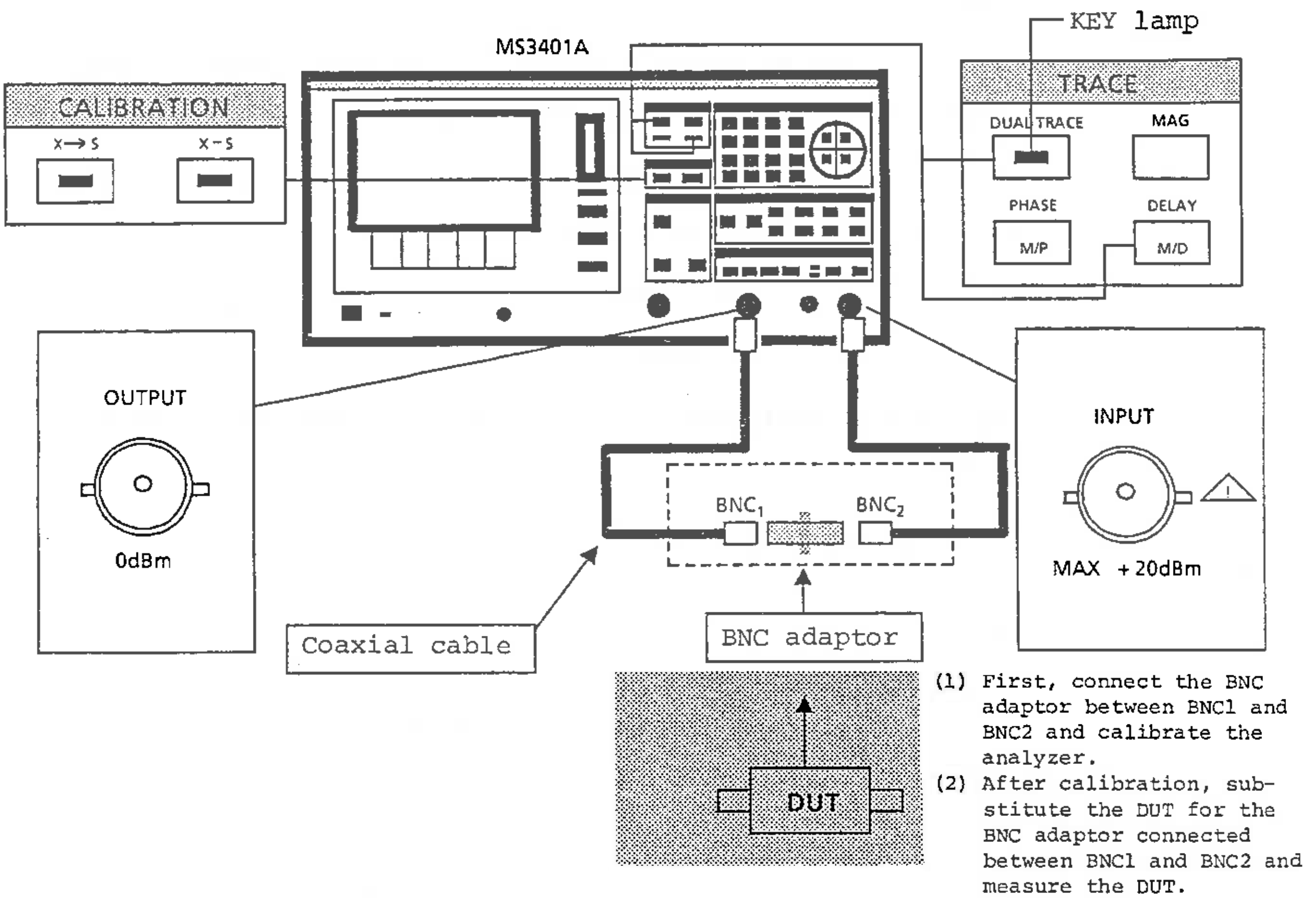


Fig. 6-3 DELAY and M/D Measurement

(2) Measurement procedure

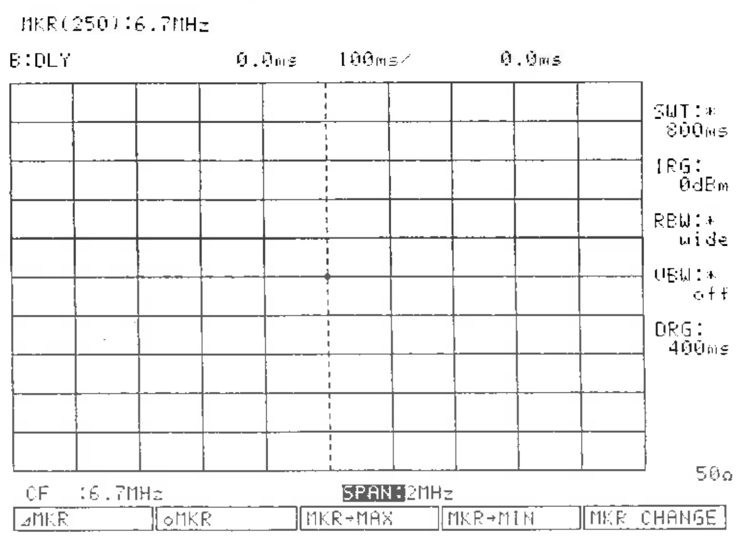
<table>
<tr><th>Step</th><th>Procedure</th></tr>
<tr><td>1</td><td>Remove the PMC from the front panel receptacle.</td></tr>
<tr><td>2</td><td>Turn on the power. If the power is already on, press the [INITIAL] key.

- To measure delay, press the TRACE section [DELAY] key.
- To measure magnitude/delay, turn the [DUAL TRACE] lamp on and press the [M/D] key.
</td></tr>
<tr><td>3</td><td>Set the center frequency and span with the MEASURE section and ENTRY section key to

CF: 6.7 MHz

SPAN: 2 MHz

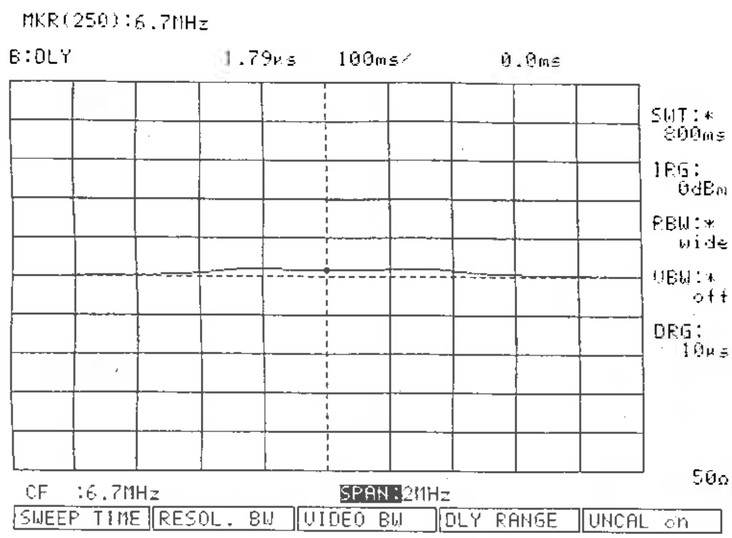
With these settings, the following display appears on the CRT.



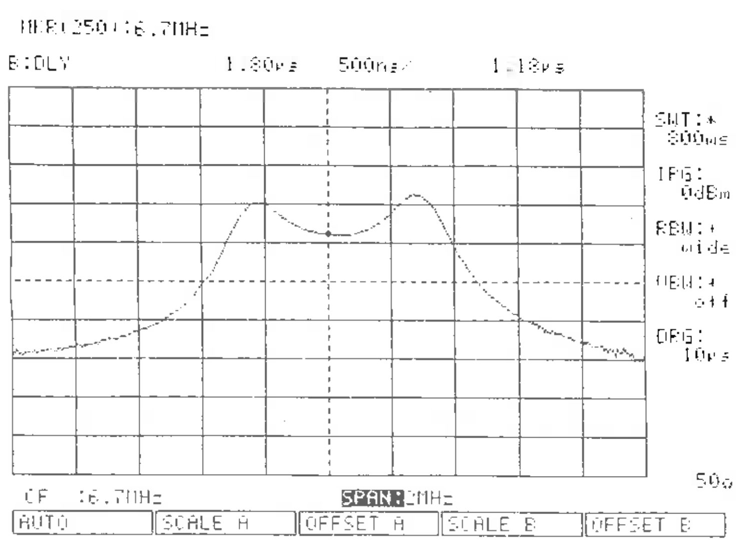
</td></tr>
</table>

(continued)

Step	Procedure
4	Connect the DUT between the OUTPUT and INPUT connectors.
5	Press the MEASURE section [AUTO] key, then press the soft key [F4] (DLY RANGE). The CRT display is shown below:

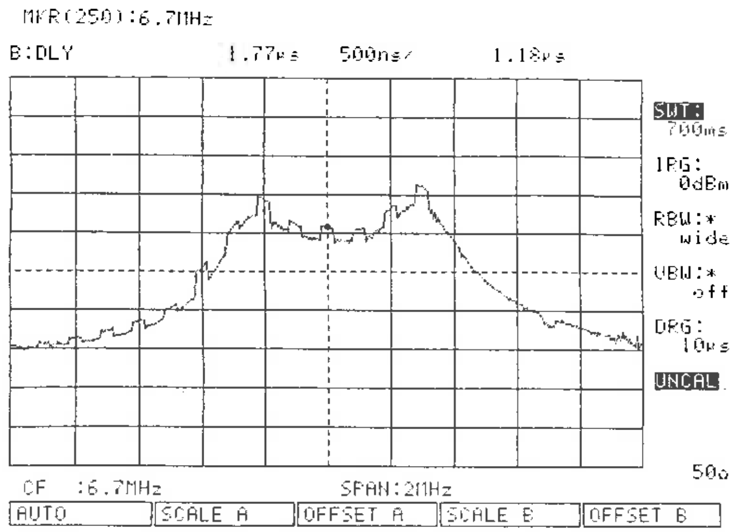


Step	Procedure
6	Press the DISPLAY section [SCALE] key, then press the soft key [F1] (AUTO). The CRT display is shown below:

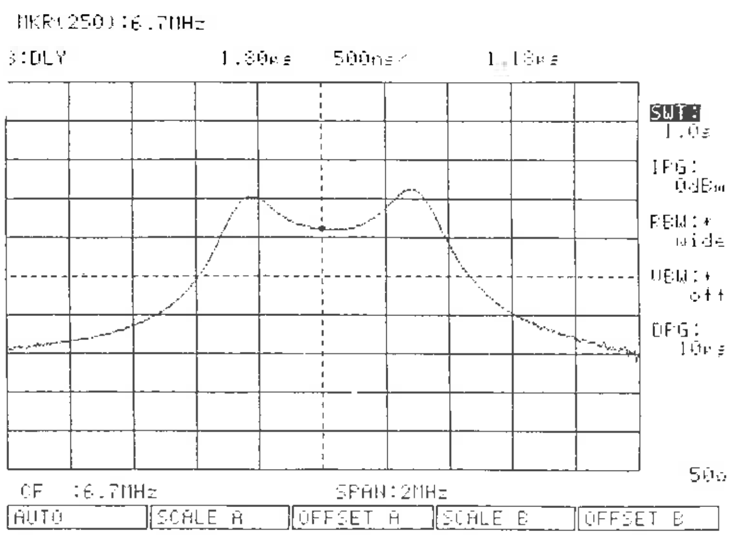


(continued)

Step	Procedure
7	Adjust the SWEEP TIME to the lowest value at which the measurement result does not change. The figure below is for SWT = 700 ms. 700 ms is too fast; 1 s is suitable.



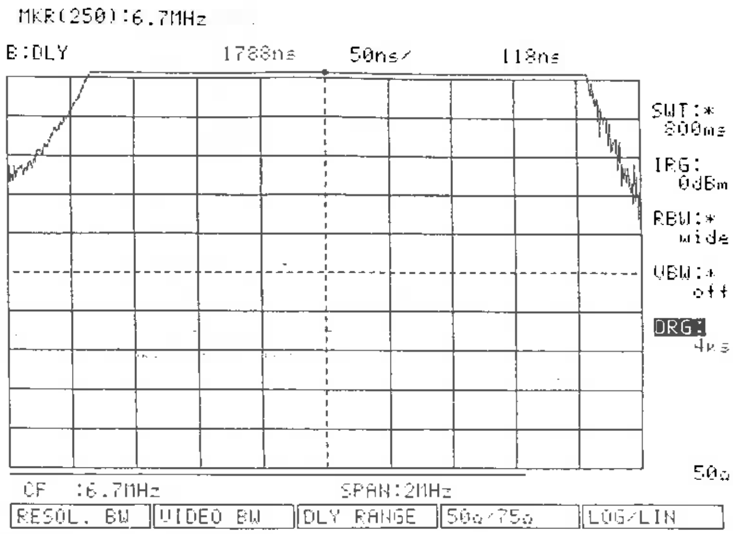
SWT = 700 ms
Unsuitable



SWT = 1 s
Suitable

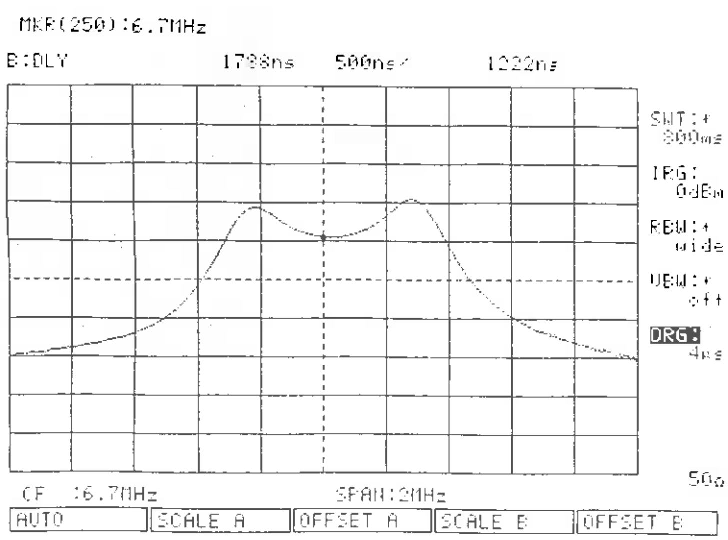
(continued)

Step	Procedure
	DELAY RANGE adjustment
8	Press the MEASURE section [EXP] key, then press the soft key [F3] (DLY RANGE) and adjust the DELAY RANGE with the ENTRY section knob. An example when the DRG is changed is shown below:



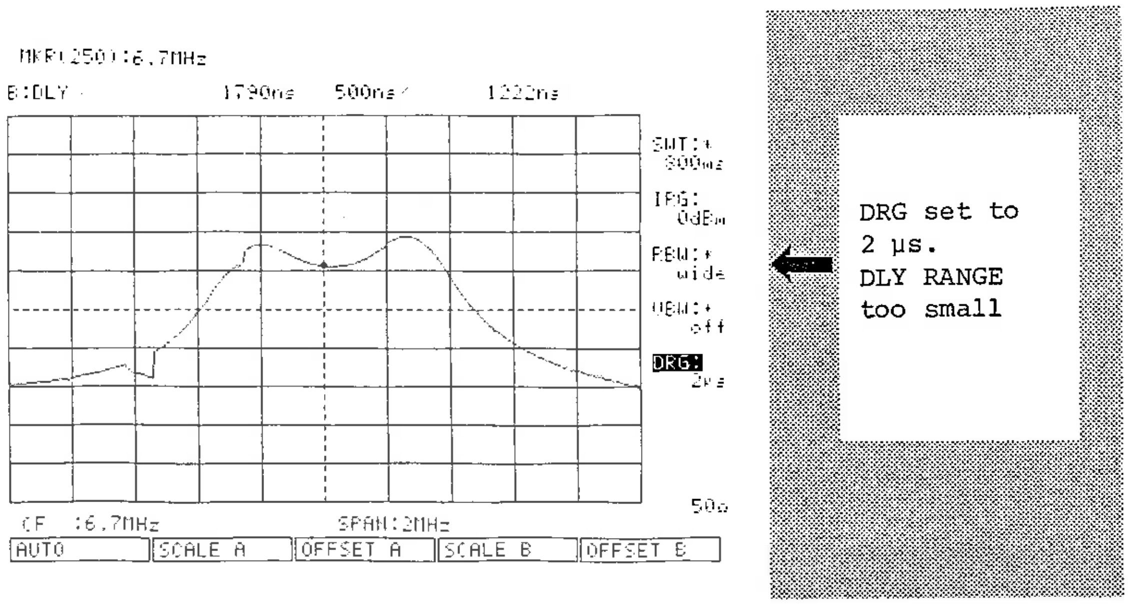
Display when DRG changed to 4 µs

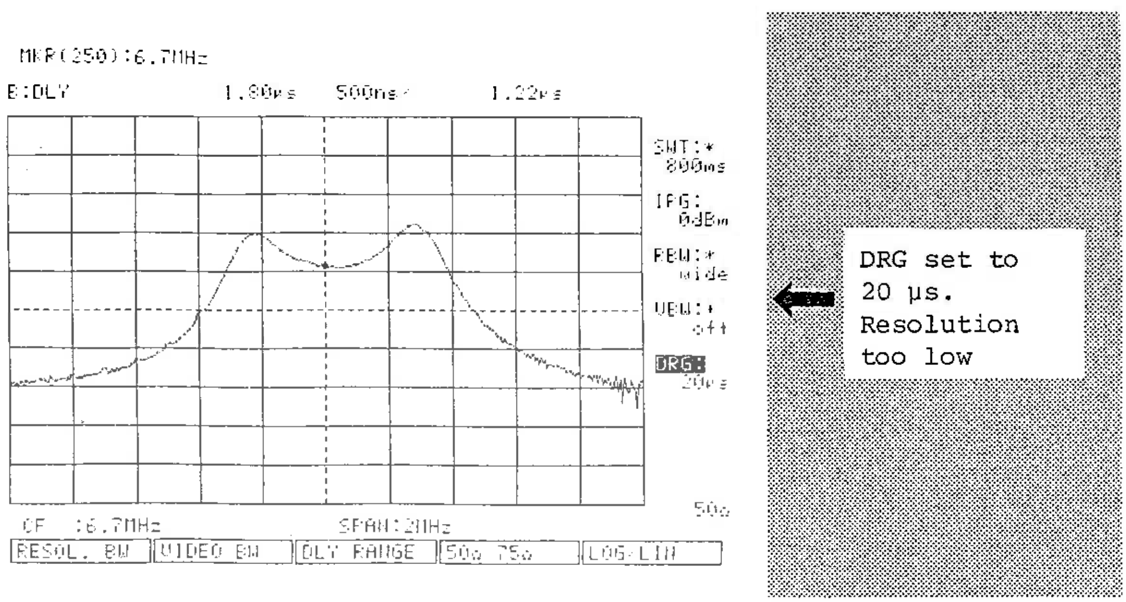
In this case, press the [SCALE] key, then press the soft key [F1] (AUTO) to obtain the figure below:



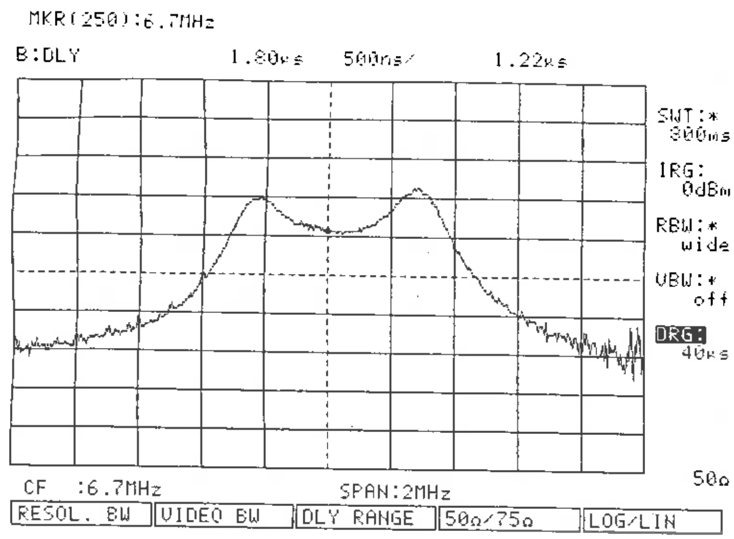
DRG set to 4 µs

Step	Procedure

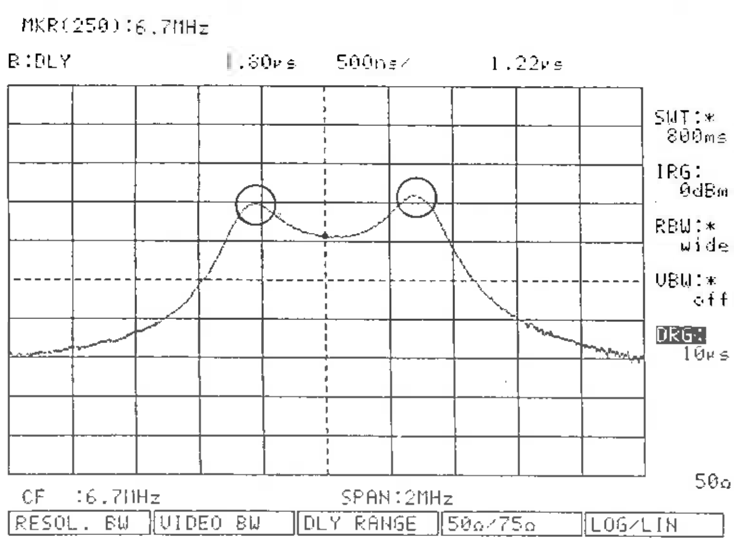




Step	Procedure



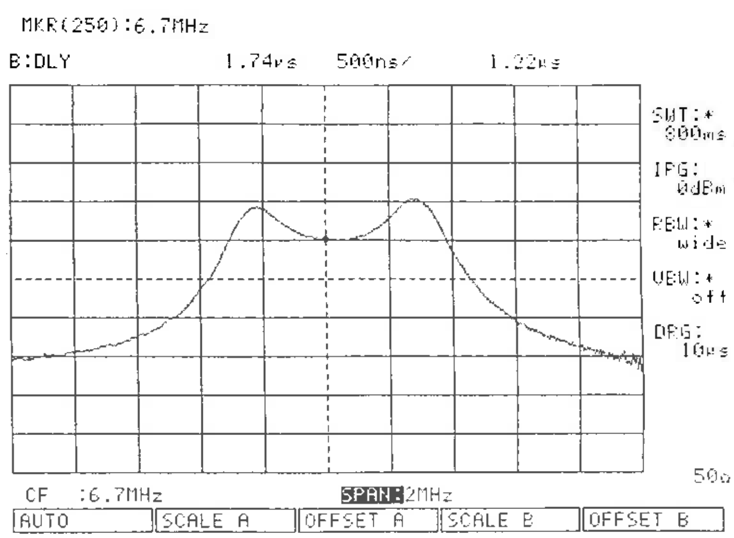
DRG set to 40 µs. Resolution too low



To minimize the measurement error, set DRG to the lowest value at which the peak value (0 part) becomes maximum and does not change.
If DLY RANGE is changed, readjust the SWEEP TIME.

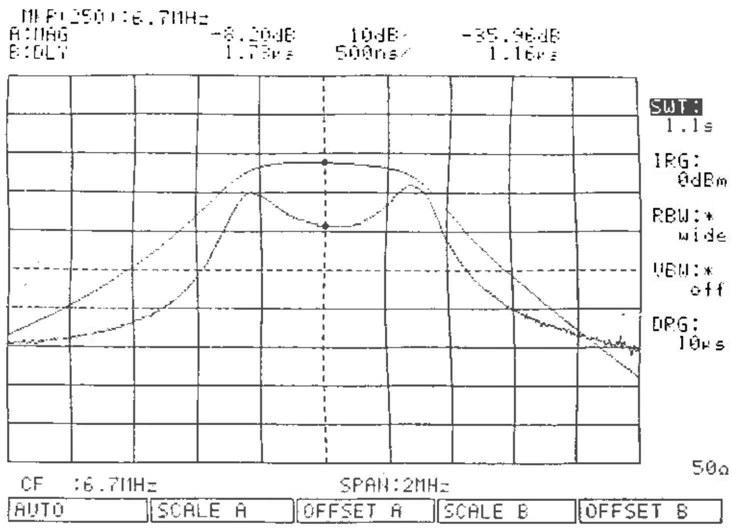
(continued)

Step	Procedure
	M/D measurement (description after measurement item selection of step 2)
	calibration
9	Connect the BNC adaptor between the OUTPUT and INPUT connectors.
10	Press the CALIBRATION section [X→S] key and wait for the [X→S] lamp to go off and the [X-S] lamp to come on.
	measurement
11	Substitute the DUT for the BNC adaptor connected between the OUTPUT and INPUT connectors.
12	Press the [SCALE] key, then press the soft key [F1](AUTO).
13	Read the measured value from the CRT (see figure below):



(continued)

Step	Procedure
	The MAG/DELAY measurement result is shown below:



Notes:

1. When the DUT loss is high, lower the IRG. When there is a gain at the DUT, raise the IRG.

   At this time, adjust the IRG so that the OVERLOAD message does not apear at the bottom right of the CRT.

2. When the frequency, IRG, RBW, VBW, or measurement points are changed, repeat the procedure from step 5.

   When the IRG is -10 dBm or -20 dBm at calibration, insert an attenuator with a flat phase characteristic in series with the direct connection circuit.

6.4 SUB TRACE Use

The [SUB TRACE] key can be used at single item measurement (TRACE other than M/P and M/D).

6.4.1 MT (MAIN TRACE) → ST (SUB TRACE)

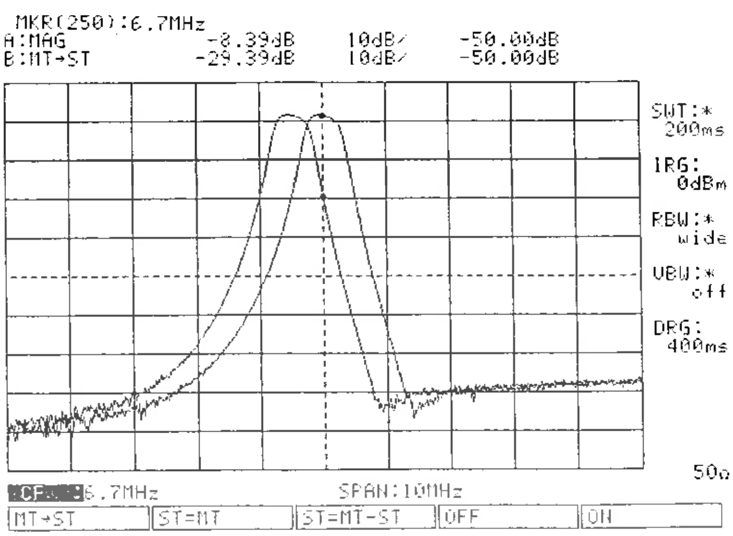
1. When the [F1] key is pressed, the newest MT contents are copied and held at the ST.

2. The ST SCALE and OFFSET are the same as those of the MT.

3. When TRACE is MAG, the ST waveform can be adjusted by using B-SCALE and OFFSET. When TRACE is PHASE or DELAY, the ST waveform can be adjusted by using A-SCALE and OFFSET.

4. The contents of the ST can also be backed-up at the PMC, the same as the contents of the MT.

5. This function can be used both as a preliminary when using the ST=MT-ST function described in paragraph 6.4.3, and also in the application shown below:



The waveforms of two filters are displayed simultaneously in the figure on the left. This is convenient when adjusting the characteristic to match a reference filter characteristic like this and in finding the correlation between two filters with different center frequencies.

6.4.2 MT=ST

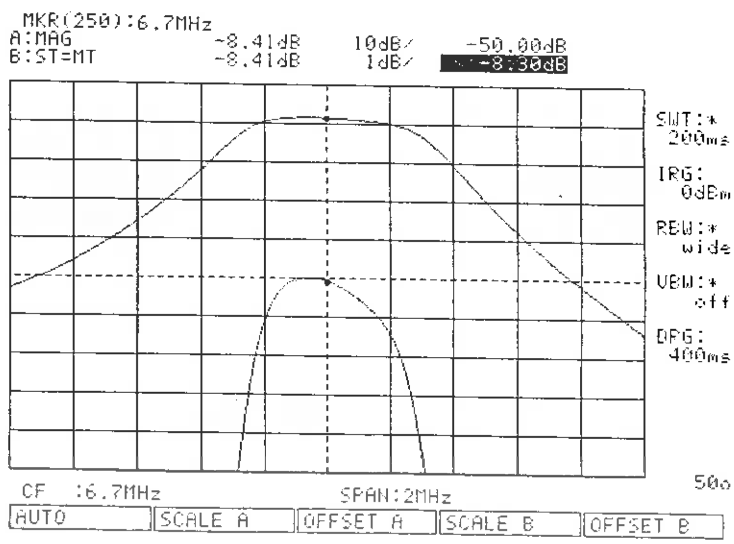
1. When the [F2] key is pressed, the trace of the same measurement item as the MT is displayed at the ST.

2. The ST SCALE and OFFSET are the same as those of the MT.

3. The ST waveform can be adjusted with SCALE and OFFSET, the same as paragraph 6.4.1.

3. This function is convenient for simultaneously observing the entire characteristic and the in-band ripple of a bandpass filter.

   See the figure below:



6.4.3 ST=MT-ST

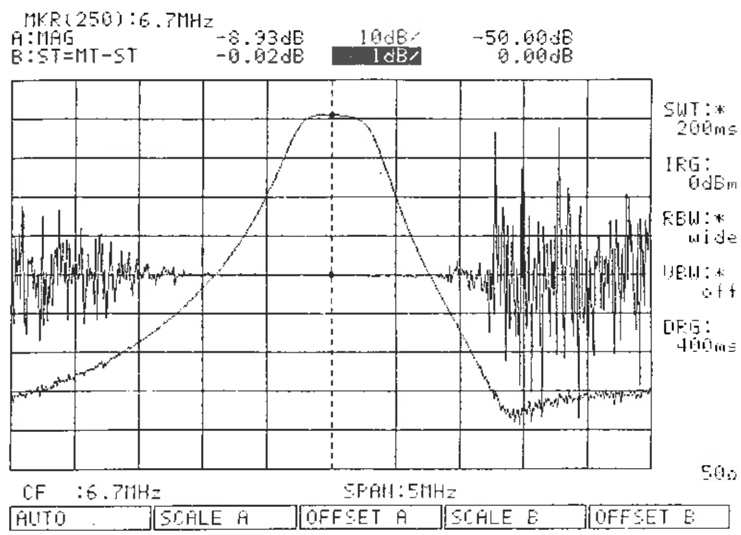
1. When the [F3] key is pressed, the difference between the MT and the memorized ST is displayed.

2. The SCALE and OFFSET are the same as those of the MT.

3. The waveform can be adjusted with SCALE and OFFSET, as described in paragraph 6.4.1.

4. This function is convenient for comparing two measured values.

   See the figure below:



6.4.4 OFF/ON

1. When the [F4] key is pressed, the ST display is erased. At this time, the data remains stored at the ST.

2. When the [F5] key is pressed, the data stored at the ST is displayed as SUB TRACE.

SECTION 7

OVERVIEW OF GP-IB

This section outlines the GP-IB (General Purpose Interface Bus) functions of the MS3401A Network Analyzer and describes the MS3401A specifications (interface function and device messages table).

TABLE OF CONTENTS

7.1 Introduction

The GP-IB interface is MS3401A standard equipment. The GP-IB is a standard measuring instrument interface bus as specified in IEEE-488 (Institute of Electrical and Electronic Engineers) and IEC-625 (International Electrotechnical Committee.) It can be used to remotely control all MS3401A function except the:

1. POWER switch
2. INTENSITY knob
3. [GP-IB] key
4. [MANGE] key
5. [DEFINE] key

The MS3401A CRT can be used as a personal computer terminal to display characters and graphics. Therefore, a flexible system can be easily built by connecting a personal computer and other measuring instruments to the MS3401A.

A flexible system can also be built without using a personal computer by adding a PTA3 (Personal Test Automation) option to the MS3401A.

The descriptions in this manual are based on sample programs for the ANRITSU Packet IIe/III/IIIs/V Personal Technical Computers.

7.2 Specifications

7.2.1 GP-IB interface functions

The GP-IB interface functions of the MS3401A Network Analyzer are listed in Table 7-1.

Table 7-1 MS3401A GP-IB Interface Functions

Symbol	Interface function	Remarks
SH1	All source handshake functions provided	Can send data
AH1	All accept handshake functions provided	Can receive data
T6	Basic talker functions provided Serial polling function provided Talk only function not provided Talker clear by MLA function provided	Talker functions
L4	Basic listener functions provided Listen only function not provided Listener clear by MTA function provided	Listener functions
TE0	Address expansion talker functions not provided	A function which explands the talker and lisdtener up to secondary address is not prodived
LE0	Address expansion listener functions not provided	
SR1	All service request functions provided	Interrupt function
RL1	All remote/local functions provided	Local lock-out function
PP0	Parallel polling function not provided	
DC1	Device clear function provided	Set all MS3401A functions to power-on state

Table 7-1 MS3401A GP-IB Interface Functions (Cont'd)

Symbol	Interface function	Remarks
DT1	Device trigger function provided	Controls start of measurement
C0	Control function not provided	No controller function

How to read the sub set is described in paragraph 1.4.2 of GP-IB BASIC GUIDE.

7.2.2 Device messages table

Table 7-2 Device Messages Table

Function			Control message	Data request message
TRACE			TRC△m(m:0~4)	TRC?
CAL	x → s		CAL	CAL?
	x − s		CXS△s(s:0,1)	CXS?
DISPLAY	MARKER		MKR△m(m:0~7)	MKR?
	Reference MARKER			RMK?
	Current MARKER		CMK△P(p:0~500)	CMK?
	SUB TRACE		STR△m(m:0~4)	STR?
	SCALE	AUTO	SAU	
		SCALE A	SCA△m(m:0~7)	SCA?
		SCALE B	SCB△m(m:0~7)	SCB?
		OFFSET A	OFA△ℓ(ℓ:+15000 ~−15000)	OFA?
		OFFSET B	OFB△ℓ(ℓ:+15000 ~−15000)	OFB?
MEASURE	FREQU-ENCY SET	CF	CNF△f(f:0~30MHz)	CNF?
		SPAN	SPF△f(f:0~30MHz)	SPF?
		START	STF△f(f:0~30MHz)	STF?
		STOP	SOF△f(f:0~30MHz)	SOF?
	FREQUENCY MODE		FRQ△s(s:0,1)	FRQ?
	SWEEP TIME		SWT△t(t:10ms ~99000sec)	SWT?
	INPUT RANGE		IRG△m(m:0~4)	IRG?
	AUTO	SWEEP TIME	AU1△s(s:0,1)	AU1?
		RESOL.BW	AU2△s(s:0,1)	AU2?
		VIDEO BW	AU3△s(s:0,1)	AU3?
		DRY RANGE	AU4	
		UNCAL	AU5△s(s:0,1)	AU5?
	EXP	RESOL.BW	RBW△m(m:0~4)	RBW?
		VIDEO BW	VBW△m(m:0~5)	VBW?
		DRY RANGE	DRG△m(m:0~17)	DRG?
		50Ω/75Ω	IMP△s(s:0,1)	IMP?
		LIN/LOG	LOG△s(s:0,1)	LOG?
CONTROL	SWEEP	FULL/MKR	SW1△s(s:0,1)	SW1?
		REPEAT/SINGLE	SW2△s(s:0,1)	SW2?
		STOP/RESET	SW3△s(s:0,1)	SW3?
	PACKA-GE	AVG	AVG△m(m:0~7)	AVG?
		MP	MEP△m(m:0~5)	MEP?
		OVERLAP	OVP△s(s:0,1)	OVP?
		TITLE	TTL△s(s:0,1)	TTL?
		Title input	TEN△text	TEN?
	PTA		PTA△s(s:0,1)	PTA?
	INITIAL		INI	

Function			Control message	Data request message
PMC	SAVE	FUNC	SV1△s(s:Ø,1)	SV1?
		S	SV2△s(s:Ø,1)	SV2?
		X	SV3△s(s:Ø,1)	SV3?
		F.TBL	SV4△s(s:Ø,1)	SV4?
		SAVE PMC	SVM△m(m:Ø~9)	
	RECALL	SOFT PACK	RC4	
		RUN	RC5	
		RECALL PMC	RCM△m(m:Ø~9)	
	PMC ERROR			PER?
SWEEP START/END			SWP△s(s:Ø,1)	SWP?
UNCAL				UCL?
OVERLOAD				OVL?
MKR DISPLAY VALUE	ₒMKR A			ZRA?
	ₒMKR B			ZRB?
	REF MKR A			RFA?
	REF MKR B			RFB?
	MKR VALUE A			MVA?
	MKR VALUE B			MVB?
	MKR FREQ			MVF?
MKR DISPLAY			MKD△s(s:Ø,1)	MKD?
MEASURE MEMORY	X-memory A		XMA△p(p:Ø~5ØØ)	XMA?△pØ,p1
	X-memory B		XMB△p(p:Ø~5ØØ)	XMB?△pØ,p1
	S-memory A		SMA△p(p:Ø~5ØØ)	SMA?△pØ,p1
	S-memory B		SMB△p(p:Ø~5ØØ)	SMB?△pØ,p1
	FREQ memory		FQM△p(p:Ø~5ØØ)	FQM?△pØ,p1
	BINARY/ASCII		BIN△s(s:Ø,1)	BIN?
BREAK POINT			BKP△p(p:1~5Ø1)	BKP?
SRQ			SRQ△s(s:Ø,1)	SRQ?
TERMINATOR			TRM△m(m:Ø~3)	TRM?
CRT CONTROL	Display item erase		CER△m(m:Ø~9)	
	Display item return		CRN△m(m:Ø~9)	
	Screen erase		CFL△m(m:Ø~4)	
	Character drawing		DCH△X,Y,text ,[,m][,n_0]	
	Straight line drawing		DLN△X_0,Y_0,X_1,Y_1 ,[,m][,n_1]	
	Square drawing		DRC△X_2,Y_2,X_3,Y_3 ,[,m][,n_1]	
	Circle drawing		DCR△X_4,Y_4,r,[,n_1]	
	Copy		VPT	

Notes:

1. △ indicates a space; do not confuse it with delta *Δ*.
2. For a detailed description of the device messages, see Section 10.

Table 7-3 MS3401A GP-IB Suffix Code

	Suffix unit	Suffix code	Remarks
Frequency	MHz kHz Hz	MZ KZ HZ	The MS3401A suffix codes are frequency units only. If the unit is not added, Hz is assumed.

Table 7-4 Status Message Line Assignment

Bit / Line / Value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
1	PMC errors	Service requested	OVER-LOAD, UNCAL (abnormal state)	End of sweep	Data key 7, 8, or 9, pressed	Data key 2 or 6, pressed	Data key 1, 5, or 6, pressed	Data key 0, 2, 4, 6, or 8, pressed
0	No PMC errors	Service not requested	Normal status		Data key 7, 8, or 9, not pressed	Data key 2 or 6, not pressed	Data key 1, 5, or 6, not pressed	Data key 0, 2, 4, 6, or 8 not pressed
Weight	128	64	32	16	8	4	2	1
Send	1 / 0	1 / 0	1 / 0	1 / 0	1 / 0	1 / 0	1 / 0	1 / 0

When data key pressed after [GP-IB] and [F3] keys pressed

SECTION 8

GP-IB PANEL CONTROL

This section describes: GP-IB cable connection and operation of the address switches on the rear panel, RETURN TO LOCAL, address setting and confirmation, service request, and GP-IB control status monitoring by [GP-IB] key.

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8.1 Precautions before Using GP-IB

To remotely control the MS3401A by GP-IB, the GP-IB cable must be connected and the GP-IB address must be set.

Figure 8-1 shows the location of the GP-IB address switches and the GP-IB connector on the rear panel.

Always connect or disconnect the GP-IB cable with the power off (read CAUTION below).

8.1.1 GP-IB cable connection and disconnection

CAUTION

Turn off the power switch and disconnect the power cord before connecting or disconnecting the GP-IB cable. This is because, depending on how the cable is connected or disconnected, the signal line may be disconnected before the other lines. If the ac power is on at this time, ac voltage leakage, etc. may be superimposed on the IC and components (IC, etc.) in the interface unit may be damaged.

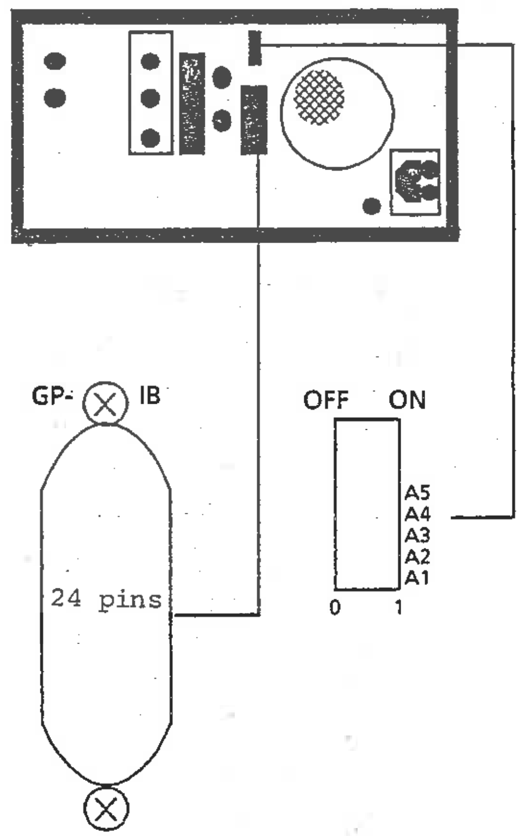


Fig. 8-1 GP-IB Address Switches and Cable Connector

8.1.2 Address setting before turning on the power

The MS3401A GP-IB address should be set before the power is turned on because the set address is read when the power is turned on.

The MS3401A GP-IB address is set to 1 at the factory.

The use an address other than 1, reset the address to any number, between 0 and 30 of Table 8-1.

An example of resetting the address to 26 is shown below (Fig. 8-2 (a) → Fig. 8-2 (b)).

Step	Procedure
1	Turn the power off and disconnect the power cable.
2	Disconnect the GP-IB cable from the GP-IB connector. <u>Description of address switches</u> Figure 8-2 is an enlarged diagram of the addresses switches shown in Fig. 8-1. The right side of each switch is bit-level 1 and the left side is bit-level 0. The most significant bit (MSB) is at the top (A5) and the least significant bit (LSB) is at the bottom (A1).
3	Table 8-1 shows that address 26 (decimal) is equivalent to the binary number 11010. Set the switches corresponding to bits 5, 4, and 2 to the level-1 side and the switches corresponding to bits 3 and 1 to the level-0 side (Fig. 8-2 (b))). Address 26 has now been set.
4	Reconnect the GP-IB cable.
5	The method for confirming the set address is given in paragraph 8.2.2.

Table 8-1 GP-IB Address Codes

Address character		Address switch setting					Primary address
Talk	Listen	5	4	3	2	1	
b_7 b_6	b_7 b_6	b_5	b_4	b_3	b_2	b_1	
1 0	0 1	↓	↓	↓	↓	↓	Decimal
@	SP	0	0	0	0	0	0
A	!	0	0	0	0	1	1
B	"	0	0	0	1	0	2
C	#	0	0	0	1	1	3
D	$	0	0	1	0	0	4
E	%	0	0	1	0	1	5
F	&	0	0	1	1	0	6
G	'	0	0	1	1	1	7
H	(	0	1	0	0	0	8
I	)	0	1	0	0	1	9
J	*	0	1	0	1	0	10
K	+	0	1	0	1	1	11
L	,	0	1	1	0	0	12
M	−	0	1	1	0	1	13
N	.	0	1	1	1	0	14
O	/	0	1	1	1	1	15
P	0	1	0	0	0	0	16
Q	1	1	0	0	0	1	17
R	2	1	0	0	1	0	18
S	3	1	0	0	1	1	19
T	4	1	0	1	0	0	20
U	5	1	0	1	0	1	21
V	6	1	0	1	1	0	22
W	7	1	0	1	1	1	23
X	8	1	1	0	0	0	24
Y	9	1	1	0	0	1	25
Z	:	1	1	0	1	0	26
[	;	1	1	0	1	1	27
\	<	1	1	1	0	0	28
]	=	1	1	1	0	1	29
↑	>	1	1	1	1	0	30

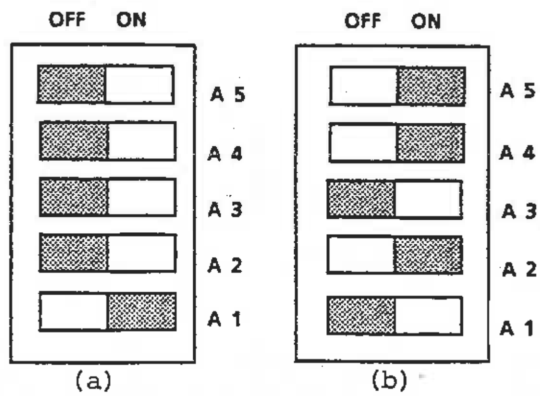


Fig. 8-2 Address Setting

8.2 [GP-IB] Key Operation

RETURN TO LOCAL, address setting and confirmation, service request, and GP-IB control status monitoring can be performed by operating the [GP-IB] key on the MS3401A front panel.

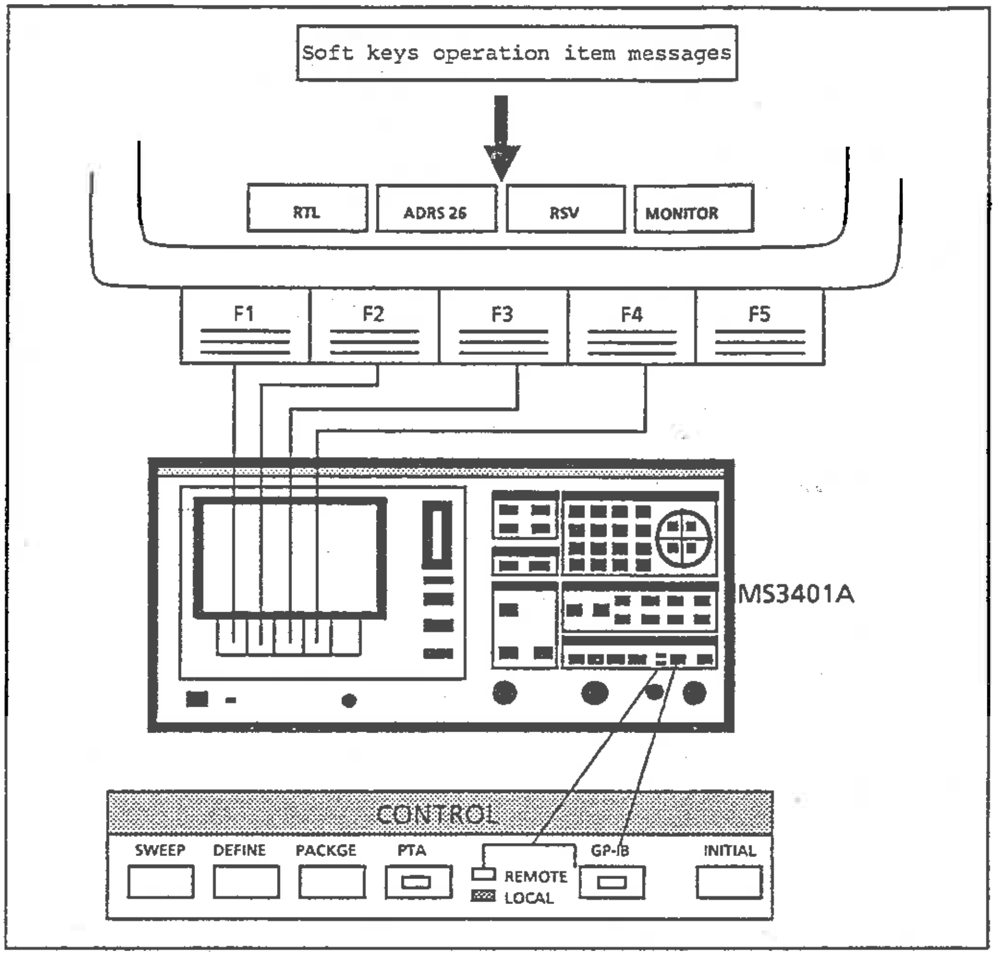


Fig. 8-3 [GP-IB] Key Operation

Note:

The [GP-IB] key is not remote-control table. Therefore, in the RWLS (Remote With Lockout Status), the soft keys operation item messages (Fig. 8-3) can be displayed by pressing the [GP-IB] key but soft keys [F1] to [F4] are locked.

8.2.1 RETURN TO LOCAL (RTL)

When the REMOTE status is specified by GP-IB control, the lamp inside the [GP-IB] key (Fig. 8-3) remains pit while the MS3401A is being remotely controlled. (To show this, is displayed at the right of "REMOTE".)

If the [F1] key is pressed at this time, the MS3401A returns to the LOCAL status, the REMOTE lamp goes off, and the front panel keys can be operated.

Note:

When the MS3401A is in the RWLS, it will not return to LOCAL status when the [F1] key is pressed. Return to the LOCAL status by pressing the [F1] key after clearing the LOCKOUT status by program.

8.2.2 Address confirmation and modification (ADRS)

When the [F2] key is pressed, the GP-IB address set by the rear panel switches is displayed and can be conformed without turning off the power.

Note:

The GP-IB address cannot be changed when the MS3401A is in REMOTE status. However, the set GP-IB address can be confirmed from the message corresponding to the [F2] key on the CRT when the MS3401A is in REMOTE or LOCAL status.

The MS3401A GP-IB address can be set before or after the power is turned on. However, if it is to be set after the power is turned on:

- Set the address in the LOCAL status.
- When the MS3401A is in the REMS (Remote Status), switch to the LOCAL status by pressing the [RTL] key.

  When the MS3401A is in the RWLS, switch to the LOCAL status by program execution.

Generally, when the power is turned on, the devices on the GP-IB are set to the LOCAL status.

Example:

Change address to 1 after switching from REMOTE status (REMS) to LOCAL status and confirming current address 26

Step	Procedure
	<u>Address confirmation</u>
1	Press the [GP-IB] key.
2	Confirm that the message on the CRT corresponding to the [F2] key is ADRS26.
	<u>Address modification</u>
3	Press the [F1] key corresponding to RTL and check that the [GP-IB] key REMOTE lamp goes off.
4	Change the rear panel address switches to address 1.
5	Press the [F2] key and check that the message on the CRT (Fig. 8-3) has changed from ADRS26 to ADRS1.

8.2.3 Service request transmission

The current status of the MS3401A can be sent to an external computer (controller) by pressing one of the data keys ([0] to [9] Fig. 8-4) after pressing the [F3] key corresponding to RSV (Request Service) on the CRT display. This is called a "status message".

The operator can interrupt the controller directly with this message. This function allows the construction of a measuring system with the MS3401A as the master controller.

Note:

The operation described above cannot be performed if the MS3401A SRQ function is off.

To turn the SRQ function on, send the device message "SRQΔ1" from the controller. (Δ indicates a space.)

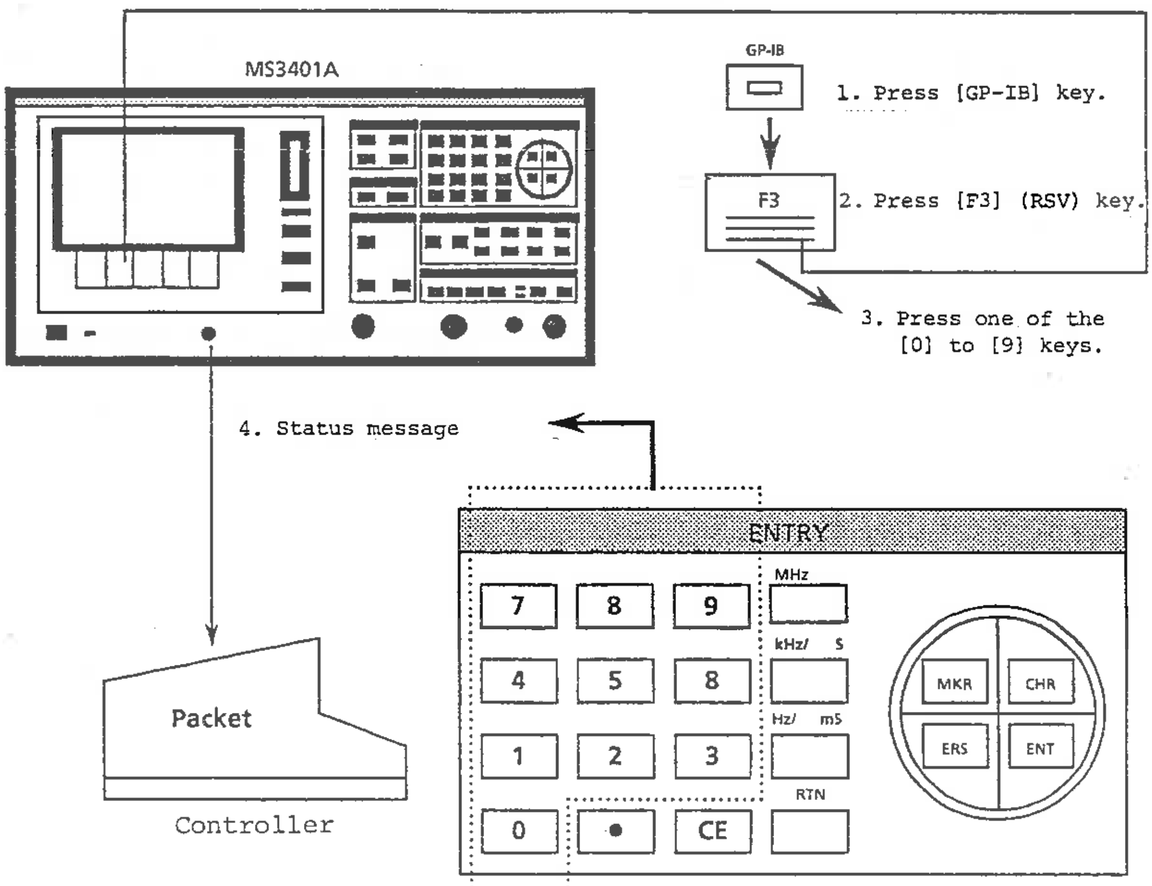


Fig. 8-4 Request Service (RSV) Transmission

Example:

Status message contents and operation

The contents of the status message are shown in Table 7-4. Status message transmission is described in Fig. 8-5.

Bit / Line / Value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
1	PMC errors	Service requested	OVER-LOAD, UNCAL (abnormal status)	Sweep end	Data key 7, 8, or 9 pressed	Data key 2, or 6 pressed	Data key 1, 5, or 6 pressed	Data key 0, 2, 4, 6, or 8 pressed
0	No PMC errors	Service not requested	Normal status		Data key 7, 8, or 9 not pressed	Data key 2, or 6 not pressed	Data key 1, 5 or 6 not pressed	Data key 0, 2, 4, 6, or 8 not pressed
Send	1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0

When data key pressed after [GP-IB] and [F3] keys pressed.

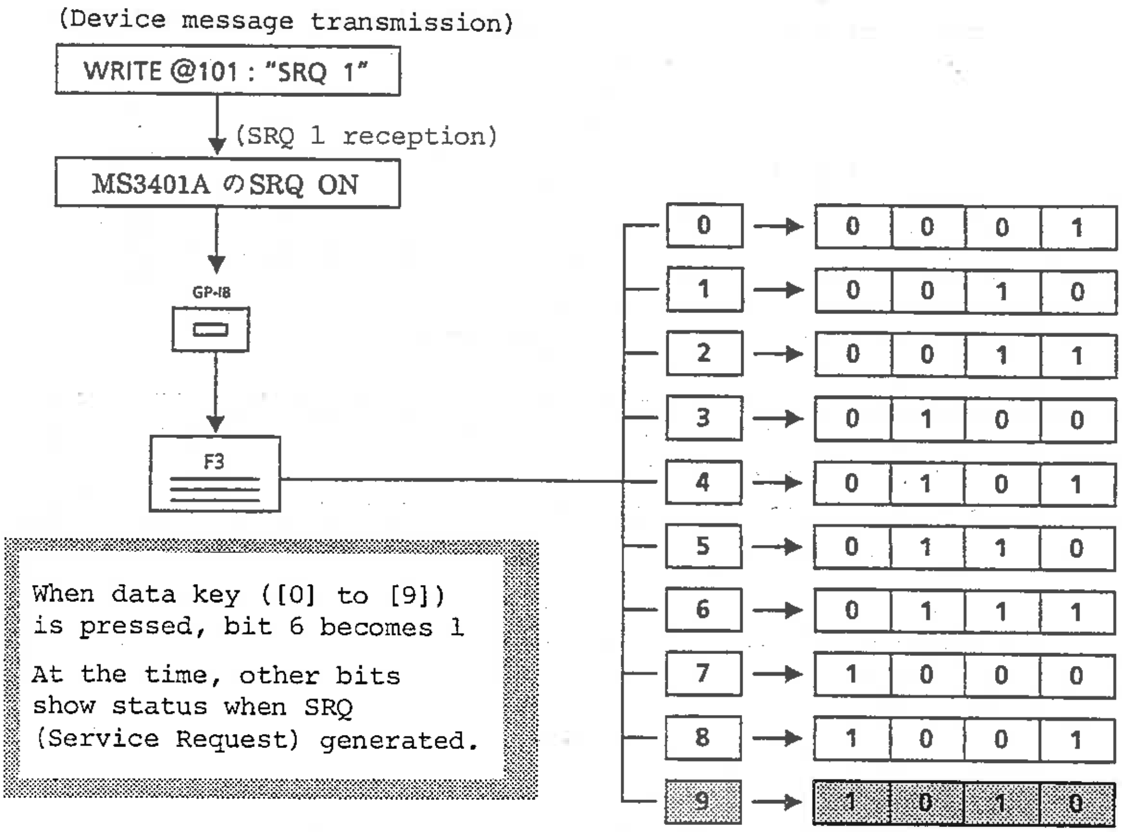


Fig. 8-5 Status Message Transmission

Example:

Perform process at controller when UNCAL generated

As shown in Fig. 8-5, the MS3401A SRQ does not have to be set to on each time. If SRQ is executed at the beginning, it remains on until it is set to off.

The status message when the pressed data key (Fig. 8-5) is assumed to be 9, is shown below.

9 key pressed

UNCAL generated

Bit / Line / Value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
Bit string	0	1	1	0	1	0	1	0
Weight	0	64	32	0	8	0	2	0

↓

SRQ line set to 1 (LOW level)

↓

Controller informed that interrupt signal coming

↓

SRQ lines LOW level, but when controller searches for device with 1 in DIO7 (bit 6), a status message is sent to controller.

↓

Status bits are 01101010 and weight value 64 + 32 + 8 + 2 = 106 received by controller.

↓

Controller finds that key 9 pressed at UNCAL generation from bit string and Weight value.

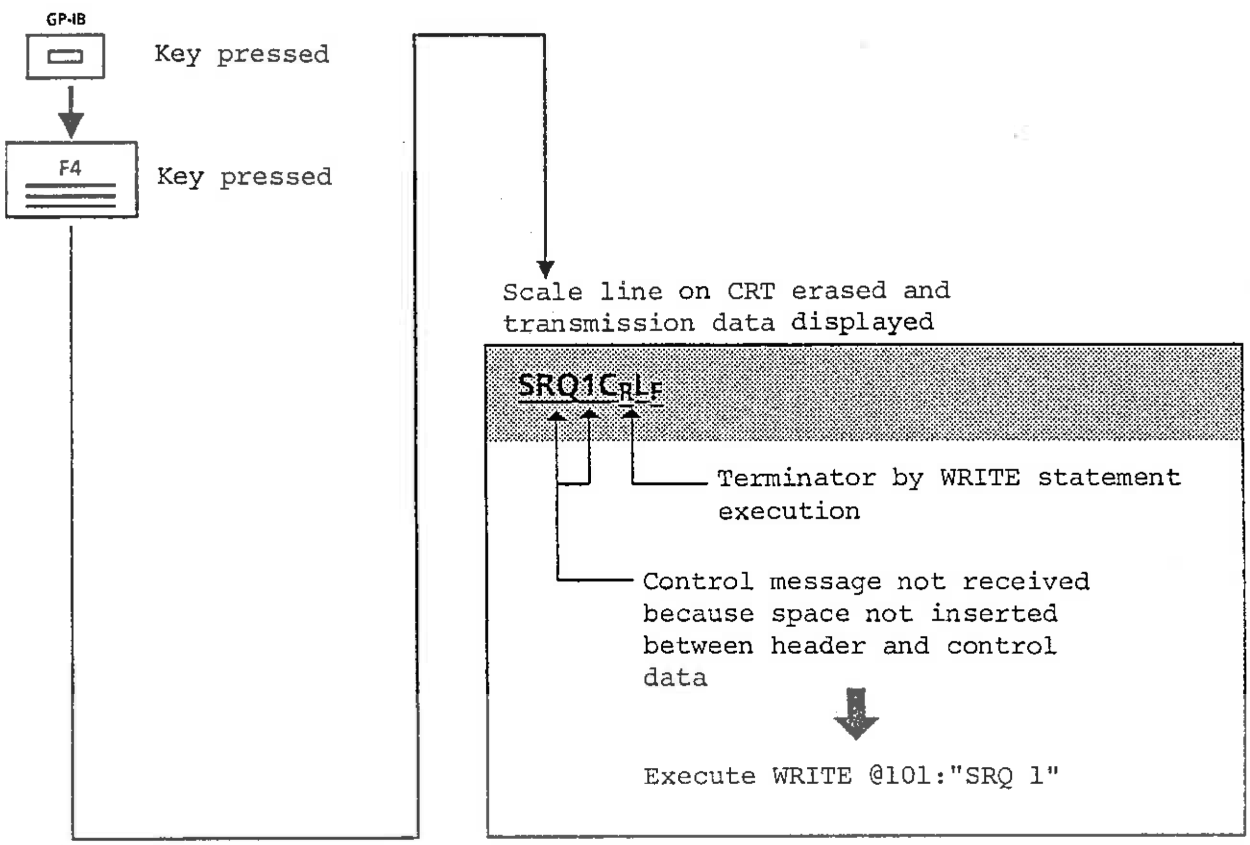
↓

Controller performs processing corresponding to UNCAL generation.

8.2.4 GP-IB control status monitor (MONITOR)

When the [F4] key corresponding to MONITOR (Fig. 8-3) is pressed, all the data (control message, data request message) sent from the controller (talker) to the MS3401A (listener) is displayed on the CRT. Since the data is displayed on the CRT even if incorrect data is sent, it is an effective way of dealing with software setting errors.

For example, assume that MS3401A SRQ is not turned on even through the operator intended to send SRQΔ1 first.



SECTION 9

GP-IB DEVICE MESSAGES GENERAL FORMAT

This section describes the device messages which contribute to the device functions.

Read this section while referring to the MS3401A device data specifications in paragraph 7.2.2. The interface functions conforming to IEEE-Std 488-1978 are described in the GP-IB Basic Guide. Refer to it as required.

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9.1 Device Message

When using the GP-IB system, actual control can be poor although the IEEE-488 Standard has been met mechanically and electrically. This is because device message conventions have not been observed.

Although interface messages are specified for use with any device, device messages are device-dependent and a device cannot be controlled skillfully if a program is not written in accordance with the device message specifications.

Therefore, a fixed standard has been established for the code and format of device messages within the range which hindered their universality. The first standard (publication 625-2) was issued by IEC in 1980 and was followed by IEEE-728-1982 Std. in 1982.

To minimize problems and to facilitate use, Anritsu standardized the code and format of its device messages by using these moves toward standardization.

9.2 Formatting of Device Messages

To set CF to 1 MHz and SPAN to 100 kHz by using the PACKET controller, after the MS3401A Network analyzer is initialized, write a program using WRITE @ statement (Fig. 9-1).

(Unless otherwise specified, interface select code = 1 and MS3401A address = 1 are assumed in the following descriptions.)

```
WRITE   @101: "INI ; CNF  1MZ ; SPF  100KZ" CR LF
```

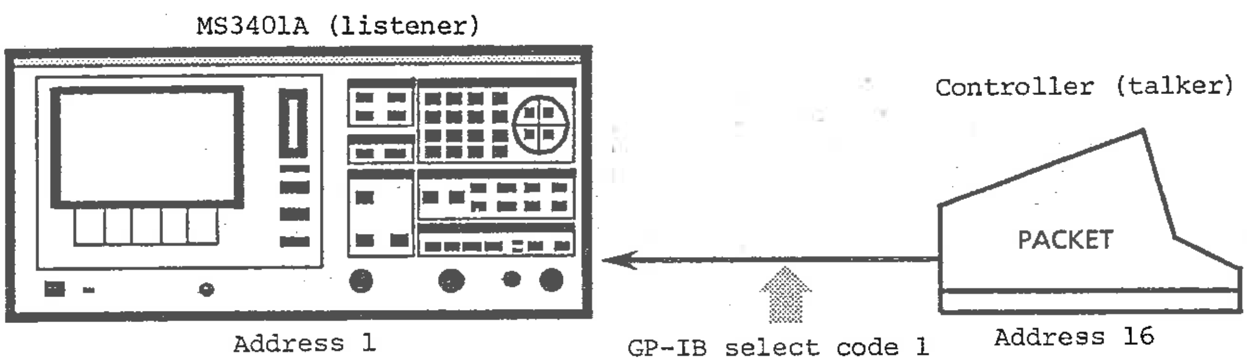


Fig. 9-1 Device Data Transmission

INI, CNF, and SPF in Fig. 9-1 correspond to the HEADER in Fig. 9-2. HEADER is the most device-dependent part of the device data. The header and the space + control data following the header can be used as one program code. However, these codes can also be used as data codes under the same standard for using ASCII code even if the type of device and manufacturer are different.

A standard has also been established for the message format when these program codes are sent from talker to listener. The message format is described with referrence to the example shown in Fig. 9-1.

The part on the left of the colon (:) of the WRITE @ statement is the interface message zone and the part on the right is the device message zone. On the right side.

1. Two or more upper-case alphabetic characters or upper-case alphabetic characters and numeric data from one set and comprise one message (data).

2. When two or more messages are sent consecutively, a semicolon is used after each message to separate it from the other messages.

3. The CR LF code is used at the end of the messages on one line to indicate the end. (Because the message shown in Fig. 9-1 is a WRITE @ statement, CR LF is added automatically.)

With reference to the two messages, CNF and SPF, shown in Fig. 9-1, each message always begins with an upper-case alphabetic character which determines what is to be set. When this character is followed by numeric data, it determines how the numeric data is to be used.

The upper-case alphabetic character at the beginning of each device message (data) represents the type and contents of the data and is called the header (HR).

The control data is called the numeric representation (NR) and the CR and LF are called the separator (SR).

A general description of how the four sections are used is shown in Fig. 9-2.

Device messages are made up of four elements: header, separator, data, and separator.

The separator between the header and data uses a space (SR) at the HR and NR delimiter.

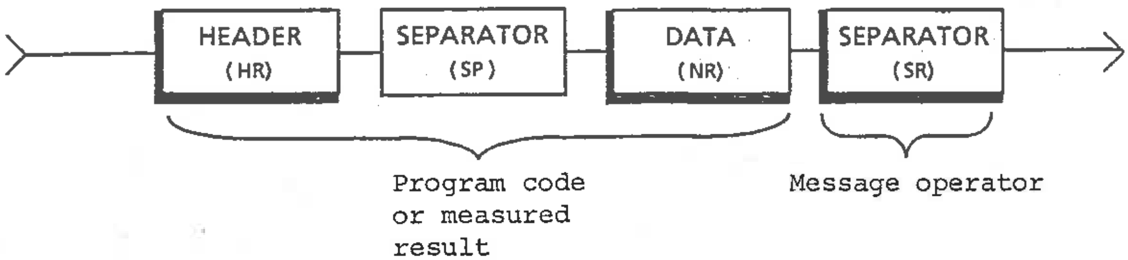


Fig. 9-2 Device Message General Format

9.2.1 Device message syntax notation

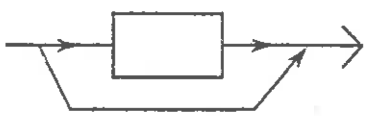
In the following message notations, a line pointing from right to left means that the message element is repeated, and an arrow pointing from right to left under a message element means that the message element can be deleted. Seven symbols are used in all. These symbols are shown in Fig. 9-3.

Message element that can be defined clearly

One ASCII character

Line showing connection order of message elements

Line pointing from right to left: Message element repeated two or more times



Line pointing from left to right under message element: Message element deletable

END message sent with device message

Bold line: Recommended path

Fig. 9-3 Message Notation

9.2.2 Description of each device message element

The device message elements are described with reference to Fig. 9-4.

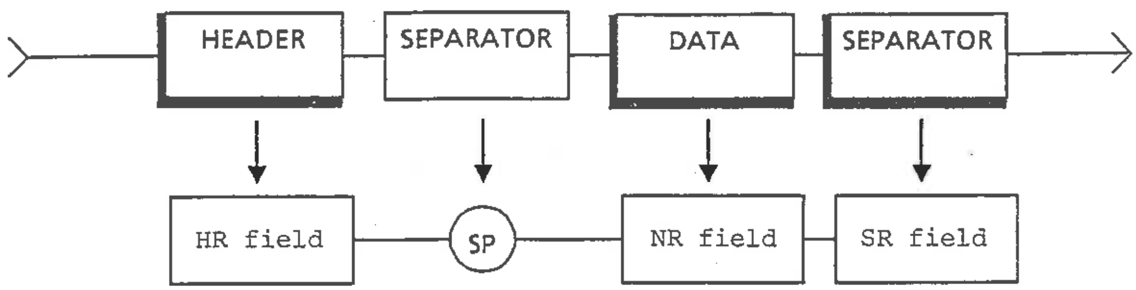


Fig. 9-4 Device Message Basic Syntax

(1) HR field

The HR field is used at the beginning of one device message. Generally, it represents the application and function of the data following it. When not followed by data, the application and function are represented by the header only.

Generally, an abbreviation made up of one to four upper-case alphabetic characters is used. Since the meaning of each character registered as a header is unique to each device, refer to the instruction manual for each device. The header description can be any combination of upper-case alphabetic characters, numerics and spaces but the first character must be an upper-case alphabetic character.

There are not length restrictions, but one to four characters is common.

Note:

The header of control messages that control the MS3401A (listener) from the controller (talker) is standardized at three characters. The header of data request messages is standardized at four characters by adding ? to the control message.

Examples:

. WRITE @101:"<u>INI</u>;<u>CNF</u>Δ<u>1MZ</u>;<u>SPF</u>Δ<u>100kZ</u>"

Span 100 kHz data

Span setting header (3 characters)

Center frequency 1 MHz data

Center frequency setting header

Header only, showing that MS3401A is initialized

. WRITE @101:"TRC 0" .... Set measurement item to MAG (control message)

. WRITE @101:"TRC?" ..... Data request message (4 characters formed by adding ? to control message)

. READ @101:A$ .... Store end data from MS3401A as TRC0. Shows that MS3401A currently in MAG measurement mode

. Space SP .... In programming examples, Δ represents one character space

One space is always used between the HR and NR delimiter.

A space following NR field can be used at the beginning of the data. In this case, two or more spaces may be placed between HR and NR.

An HR can be investigated easily by always using a space delimiter after the HR field.

Example:

One character space and two or more spaces
WRITE @101:"INI;CNFΔ1MZ;SPFΔ100kZ" ....
Same as example above.

WRITE @101:"INI;CNFΔΔ1MZ;SPFΔΔΔ100kZ"

(2) NR field

The NR field is the control data for performing the function indicated by the header. A numeric or character string is used. When a numeric is used, the NR field is represented by an integer, real, or floating point (exponent) number.

A suffix can also be used at the end of each format. The general format described above is shown in Fig. 9-5.

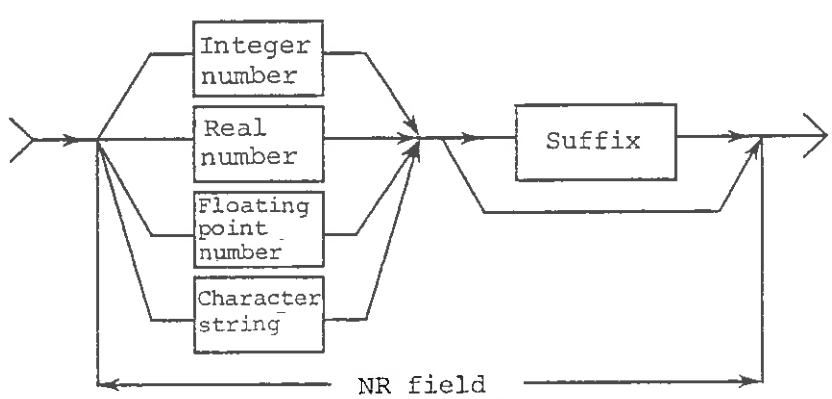


Fig. 9-5 NR Field Format

NR of range in Table 9-1 used with MS3401A

Table 9-1 NR Field Usage Range

Numeric value	Character string	Suffix
ASCII (integer number, real number) Binary	Title characters displayed on CRT	Frequency data units MHz → MZ kHz → KZ Hz → HZ

The numeric (integer, real) description rules are:

Integer number

1. DIGIT: Numerals 0 to 9
2. Space insertable at beginning
3. Plus sign representable by space, or omittable
4. Minus not used with 0

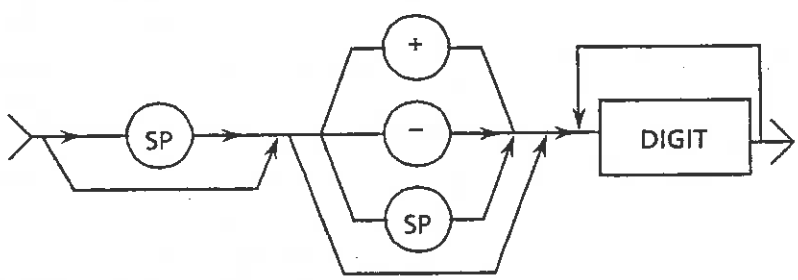
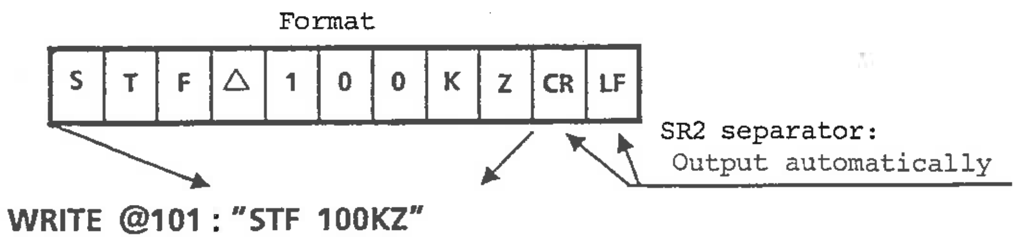


Fig. 9-6 Integer Number Format Syntax

Example:

Set MS3401A sweep start frequency to 100 kHz



Real number

1. Decimal point must be included
2. Left side of decimal point same as integer number format
3. No spaces at right of decimal point

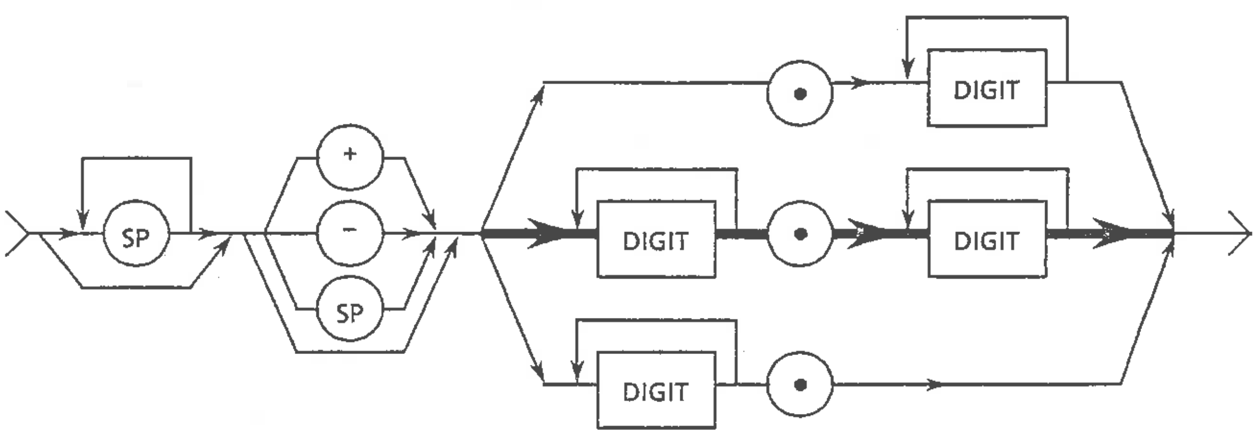


Fig. 9-7 Integer Number Format Syntax

Example:

Set sweep start frequency to 3.5 kHz and sweep stop frequency to 13.5 kHz.

Format	Program
① STF △3.5 KZ CR LF V V V HR NR SR	WRITE @101:"STF 3.5 KZ"
② SOF △13.5 KZ CR LF V V V HR NR SR	WRITE @101:"SOF 13.5 KZ"

(3) SR field

The SR (separator) field is used to identify the message elements as separate data when one message (record) contains two or more message elements (data). It is also used to show the end of one message (record).

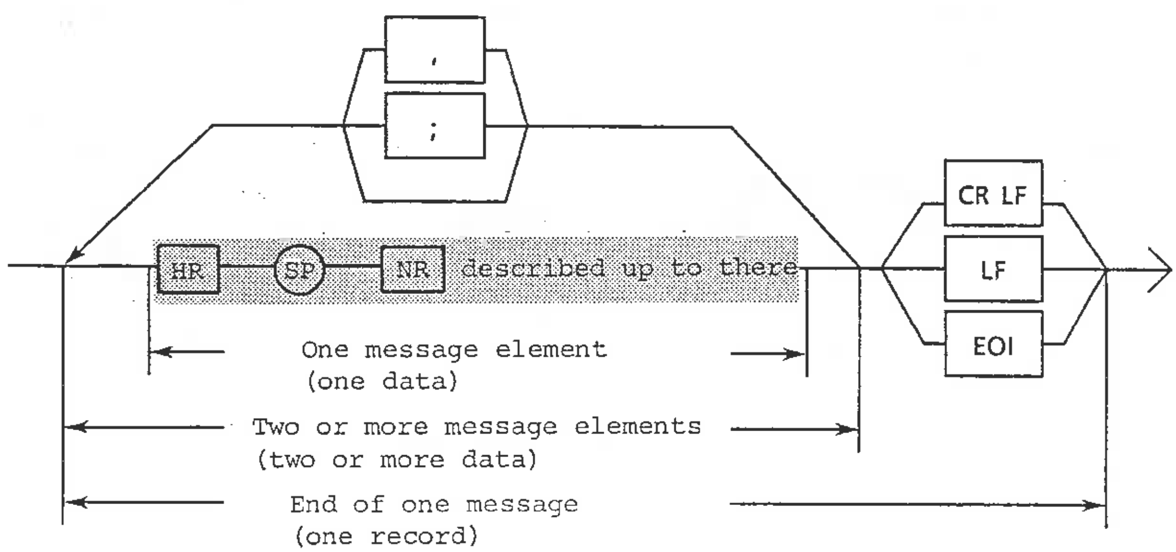


Fig. 9-8 SR Field

Figure 9-8 and Table 9-2 show how the separator is used with the MS3401A.

Table 9-2 Separator Hierarchy

Level	ASCII code	Single line signal	Meaning and use	
1	,		. Data delimiter	
	;		. Delimits data in one record	
2	CR LF		End of record	Sent last after DAB
	LF			
3		EOI		Send last simul- taneously with DAB

Comma and semicolon

The comma and semicolon are used to delimit one message element (one data) and two or more message elements (two or more data).

Generally, the comma is recommended as shown in Fig. 9-9 (a). However, the semicolon is used with the MS3401A.

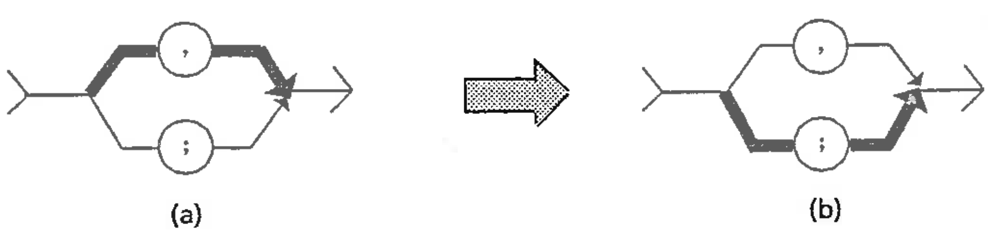


Fig. 9-9 Comma and Semicolon

With MS3401A:

1. Comma ...... Used to identify each data when two or more data used in NR field

2. Semicolon .. Used to delimit messages when two or more messages with (HR - HR) as one set

Example:

- WRITE @101:"INI;CNFΔ1MZ;SPFΔ100kZ"

- Draw straight line between coordinates (2, 3) and (20, 10)

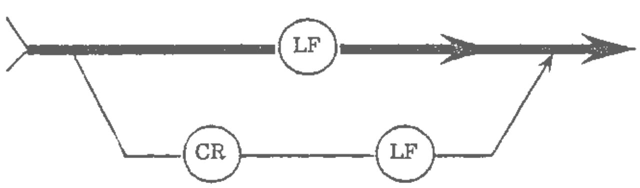
  WRITE @101:"DLNΔ2,3,20,10"

CRLF, LF, EOI

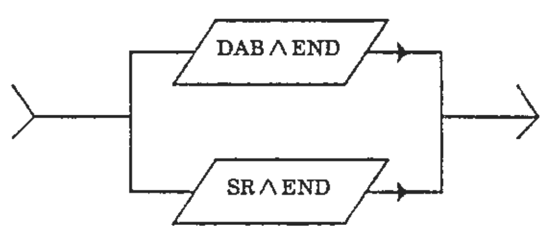
These codes generally show the end of one message, that is, one record, written on one line. It is recommended that the LF (Line Feed) code be used as shown in Fig. 9-10(a). However, use of the CR code will be recognized for some time for the following reasons:

- Many existing products use the CR-LF code. (Establishment of compatibility)

- Generally, the CR code can be ignored and only the last LF identified as the separator. However, when the CR code is actually used, such as with a printer, it is necessary.



(a)



(b)

Fig. 9-10 CRLF, LF, EOI

EOI is the highest level delimiter. An END message using an EOI line is transferred simultaneously with the last data byte (DAB) as shown in Fig. 9-10(b).

EOI is also used to show the end of binary data and the end of transmission of two or more messages.

When DAB is sent from the MS3401A (talker) to a listener,

. LF code is added at the end of DAB

. EOI is sent simultaneously with DAB.

When the MS3401A (listener) receives DAB from the talker, it also receives the carriage return (CR), line feed (LF), or EOI.

9.2.3 Types of device messages

Device messages are classified by application in Table 9-3. The panel settings and memory storage contents are controlled by control messages. Sometimes, these results must be read. In this case, before reading the controller (talker) must tell the listener what results it wants to read. Such a message is called a data request message.

The types of device messages are described in Table 9-3.

Table 9-3 Types of Device Messages (1)

Type	Application	Device status	Example
Control message	Message for remotely controlling operation of a device In the manual mode, the device operating conditions are set at the front panel. However, in the remote mode, they are set by sending this message from the controller.	Listener	Set and read center frequency 10 WRITE @101:"CNFΔ1MZ" 20 WRITE @101:"CNF?" 30 READ @101"A$ 40 PRINT A$ 50 END Line 10: Control message Line 20: Data request message Line 30: Reads data sent from MS3401A (talker) by talker output message at character string A at controller (listener). Line 40: Displays message Center frequency 1 MHz display
Measured value message	Message showing result of measurement by device. Sends measured result from device (talker) to controller (listener) in the prescribed format	Talker	
Status message	Message output by device on request (polling) from controller to show operating status	Talker	For message contents, see Table 7-4.
Display message	Additional information for interaction between operator and measuring instrument. Message format same as that of measured value message.	Talker/ listener	Message sent from controller (talker) to CRT, printer, or similar device (listener) Message displayed on CRT of controller (listener) from device (talker)

Table 9-4 Types of Device Messages (2)

Message	Talker	Listener	Description
Control	Controller	Device (MS3401A)	Message that controls the device (MS3401A) panel setting and memory storage contents, from controller
Data request	Controller	Device (MS3401A)	Message that prepares device (MS3401A) for reading of set values, frequency memory, function memory, and other data. Controller must send data request messages to device (MS3401A) immediately before reading data from device
Talker output	Device (MS3401A)	Controller	Message that sends data of function specified by data request message from device (MS3401A - talker) to controller in prescribed format

9.3 MS3401A Device Message General Format

Of the device message general formats described in paragraph 9.2, the following are used by the MS3401A and are described in this paragraph:

1. Control message general format
2. Data request message general format
3. Talker output message general format ... Except status message

9.3.1 Control message general format

Control messages are used to control the MS3401A. There are four formats. Packet V Personal Technical Computer instructions will be used to describe each format.

In the Packet V WRITE statement, SR (CF LF) is output automatically at the end of the message.

(1) Control message format 1

Example:

Initialize MS3401A settings

WRITE @1 01 : "INI"

- "INI" — INITIALIZE HR
- 01 — MS3401A GP-IB address
- @1 — Packet V interface select code

CR LF is sent automatically at the end of the above instruction.

(2) Control message format 2

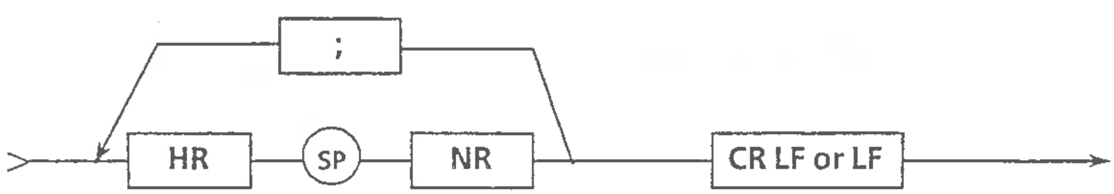
Example:

Set center frequency to 10 MHz

WRITE @101 : "CNFΔ10MZ"

(3) Control message format 3

This format transmits two or more control messages at one time.



WRITE @101: "INI;CNFΔ10MZ;SPFΔ1MZ"

- "INI;CNFΔ10MZ;SPFΔ1MZ" — Setting initialization, center frequency 10 MHz, span 1 MHz

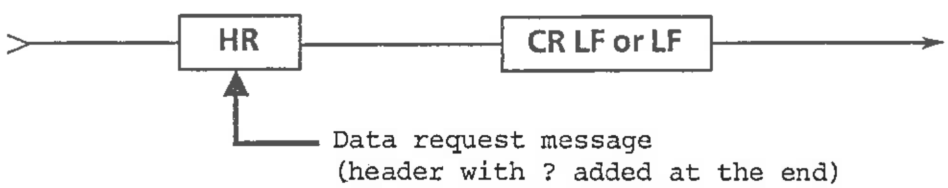
9.3.2 Data request message general format

Data request messages are used to read the MS3401A settings (CF, SPAN, SWT, etc.) and frequency memory, function memory, and other data.

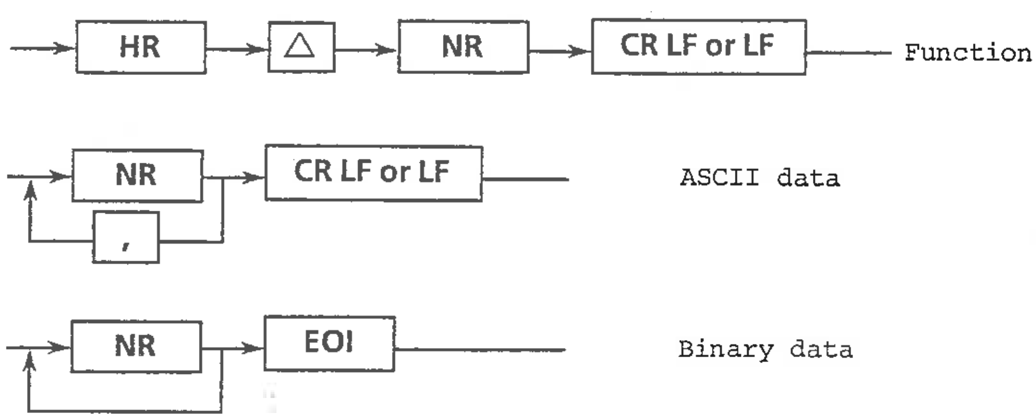
A data request message must be sent to the MS3401A immediately before reading data from it.

When the MS3401A becomes the talker, it sends the data, followed by CR LF and an END message (EOI). (See paragraph 9.3.3.)

The data format uses the control message with ? added at the end.



9.3.3 Talker send message general format



SECTION 10

GP-IB DEVICE MESSAGES DETAILS

The device messages listed in Table 7-2 are described in detail in Table 10-1.

This table lists the header and data control method for control messages, headers for data request messages, and the prescribed send format and data for talker output messages for each control item of each parameter.

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10.1 Device Messages Table

Table 10-1 Device Messages

Parameter			Device message		
	Item	Control item	Control	Data request	Talker send
	TRACE	MAG	TRC△Ø	TRC?	TRC△Ø
		PHA	TRC△1	TRC?	TRC△1
		DLY	TRC△2	TRC?	TRC△2
		M/P	TRC△3	TRC?	TRC△3
		M/D	TRC△4	TRC?	TRC△4
	CAL	X→S	CAL	CAL?	
		X→S end			Ø
		X→S executing			1
		X-S OFF	CXS△Ø	CXS?	CXS△Ø
		X-S ON	CXS△1	CXS?	CXS△1
DISPLAY	MARKER (1)	NORMAL	MKR△Ø	MKR?	MKR△Ø
		ΔMKR	MKR△1	MKR?	MKR△1
		o MKR	MKR△2	MKR?	MKR△2
		MKR→MAX	MKR△3	MKR?	
		MKR→MIN	MKR△4	MKR?	
		MKR CHANGE	MKR△5	MKR?	
		MKR→CF	MKR△6	MKR?	
		Δ →SPAN	MKR△7	MKR?	
	MARKER (2)	Reference		RMK?	RMK△P
	MARKER (3)	Current	CMK△P P:0~500	CMK?	RMK△P P: 3 characters fixed format from 000 to 500
	SUB TRACE	OFF	STR△Ø	STR?	STR△Ø
		MT→ST	STR△1	STR?	STR△1
		ST=MT	STR△2	STR?	STR△2
		ST=MT-ST	STR△3	STR?	STR△3
		ON	STR△4	STR?	
	SCALE	AUTO	SAU		
		SCALE A			
		10× minimum resolution	SCA△Ø	SCA?	SCA△Ø
		20× minimum resolution	SCA△1	SCA?	SCA△1
		50× minimum resolution	SCA△2	SCA?	SCA△2
		100× minimum resolution	SCA△3	SCA?	SCA△3
		200× minimum resolution	SCA△4	SCA?	SCA△4
		500× minimum resolution	SCA△5	SCA?	SCA△5
		1000× minimum resolution	SCA△6	SCA?	SCA△6
		2000× minimum resolution	SCA△7	SCA?	SCA△7

Note: △ in the table (and elsewhere) means one character space.
Do not confuse it with Δ (delta).

Table 10-1 Device Messages (Continued)

Parameter			Device message		
	Item	Control item	Control	Data request	Talker send
DISPLAY	SCALE	SCALE B 10× minimum resolution 20× minimum resolution 50× minimum resolution 100× minimum resolution 200× minimum resolution 500× minimum resolution 1000× minimum resolution 2000× minimum resolution	 SCB△Ø SCB△1 SCB△2 SCB△3 SCB△4 SCB△5 SCB△6 SCB△7	 SCB? SCB? SCB? SCB? SCB? SCB? SCB? SCB?	 SCB△Ø SCB△1 SCB△2 SCB△3 SCB△4 SCB△5 SCB△6 SCB△7
		OFFSET A OFFSET B	OFAℓ OFBℓ ℓ=15000 to −15000 OFFSET=1× minimum resolution	OFA? OFB?	OFAℓ OFBℓ ℓ: Signed 6 characters fixed format. + sign is space Example: A OFFSET A=10dB OFA 01000
MEASURE	FREQUENCY SET	CF SPAN START STOP	CNF△f SPF△f STF△f SOF△f f: 0Hz to 30MHz Data example For CF=1MHz (1)CMF 1MZ (2)CNF 1000KZ (3)CNF 1000000HZ (4)CNF 1000000	CNF? SPF? STF? SOF?	CNF△f SPF△f STF△f SOF△f f: 11 characters fixed format Data example For CF=1MHz CNF 1000000.00
	FREQUENCY MODE	CF/SPAN START/STOP	FRQ△Ø FRQ△1	FRQ? FRQ?	FRQ△Ø FRQ△1
	SWEEP TIME	SWEEP TIME	SWT t t: 10 ms to 99000 s (However, 2 significant digits. Input in ms)	SWT?	SWT t t: 8 characters fixed format For SWT=1 s SWT 00001000
	INPUT RANGE	+20 dBm +10 dBm 0 dBm −20 dBm −20 dBm	IRG△Ø IRG△1 IRG△2 IRG△3 IRG△4	IRG? IRG? IRG? IRG? IRG?	IRG△Ø IRG△1 IRG△2 IRG△3 IRG△4

Table 10-1 Device Message (Continued)

Parameter			Device message		
Item		Control item	Control	Data request	Talker send
MEASURE	AUTO	SWEEP TIME			
		OFF	AU1△Ø	AU1?	AU1△Ø
		ON	AU1△1	AU1?	AU1△1
		RESOL.BW			
		OFF	AU2△Ø	AU2?	AU2△Ø
		ON	AU2△1	AU2?	AU2△1
		VIDEO BW			
		OFF	AU3△Ø	AU3?	AU3△Ø
		ON	AU3△1	AU3?	AU3△1
		DLY RANGE	AU4		
		UNCAL OFF	AU5△Ø	AU5?	AU5△Ø
		ON	AU5△Ø	AU5?	AU5△Ø
	EXP	RESOL.BW			
		3 Hz	RBW△Ø	RBW?	RBW△Ø
		10 Hz	RBW△1	RBW?	RBW△1
		100 Hz	RBW△2	RBW?	RBW△2
		1 kHz	RBW△3	RBW?	RBW△3
		WIDE	RBW△4	RBW?	RBW△4
		VIDEO BW			
		10 Hz	VBW△1	VBW?	VBW△1
		100 Hz	VBW△2	VBW?	VBW△2
		1 kHz	VBW△3	VBW?	VBW△3
		10 kHz	VBW△4	VBW?	VBW△4
		OFF	VBW△5	VBW?	VBW△5
		DLY RANGE			
		40 ns	DRG△Ø	DRG?	DRG△S
		100 ns	DRG△1	DRG?	
		200 ns	DRG△2	DRG?	
		400 ns	DRG△3	DRG?	
		1 µs	DRG△4	DRG?	
		2 µs	DRG△5	DRG?	
		4 µs	DRG△6	DRG?	S: 2 characters fixed format
		10 µs	DRG△7	DRG?	
		20 µs	DRG△8	DRG?	
		40 µs	DRG△9	DRG?	
		100 µs	DRG△1Ø	DRG?	
		200 µs	DRG△11	DRG?	
		400 µs	DRG△12	DRG?	
		1 ms	DRG△13	DRG?	
		2 ms	DRG△14	DRG?	
		4 ms	DRG△15	DRG?	
		10 ms	DRG△16	DRG?	
		20 ms	DRG△17	DRG?	
		40 ms	DRG△18	DRG?	
		100 ms	DRG△19	DRG?	
		200 ms	DRG△2Ø	DRG?	
		400 ms	DRG△21	DRG?	

Table 10-1 Device Message (Continued)

Parameter			Device message		
Item		Control item	Control	Data request	Talker send
MEASURE	EXP	50 Ω/75 Ω 50 Ω 75 Ω	 IMP△Ø IMP△1	 IMP? IMP?	 IMP△Ø IMP△1
		LIN/LOG LIN LOG	 LOG△Ø LOG△1	 LOG? LOG?	 LOG△Ø LOG△1
CONTROL	SWEEP	FULL/MKR FULL MKR	 SW1△Ø SW1△1	 SW1? SW1?	 SW1△Ø SW1△1
		REPEAT /SINGLE REPEAT SINGLE	 SW2△Ø SW2△1	 SW2? SW2?	 SW2△Ø SW2△1
		STOP/RESET STOP RESET	 SW3△Ø SW3△1	 SW3? SW3?	 Ø 1 Ø: Sweep end 1: Sweeping
	PACKAG	AVG 1 2 4 8 16 32 64 128	AVG△Ø AVG△1 AVG△2 AVG△3 AVG△4 AVG△5 AVG△6 AVG△7	AVG? AVG? AVG? AVG? AVG? AVG? AVG? AVG?	AVG△Ø AVG△1 AVG△2 AVG△3 AVG△4 AVG△5 AVG△6 AVG△7
		MP11 21 51 101 251 501	MEP△Ø MEP△1 MEP△2 MEP△3 MEP△4 MEP△5	MEP? MEP? MEP? MEP? MEP? MEP?	MEP△Ø MEP△1 MEP△2 MEP△3 MEP△4 MEP△5
		OVERLAP OFF ON	 OVP△Ø OVP△1	 OVP? OVP?	 OVP△Ø OVP△1
		TITLE OFF ON	 TTL△Ø TTL△1	 TTL? TTL?	 TTL△Ø TTL△1
		Title input	TEN△text Text: Max 20 characters* *: first character of text must not be ?.	TEN?	TEN△text

Table 10-1 Device Messages (Continued)

Parameter			Device message		
	Item	Control item	Control	Data request	Talker send
CONTROL	PTA	PTA OFF PTA ON	PTA△Ø PTA△1	PTA? PTA?	PTA△Ø PTA△1
	INITIAL	INITIAL	INI		
PMC	SAVE	FUNC OFF FUNC ON S OFF S ON X OFF X ON F.TBL OFF F.TBL ON SAVE PMC	SV1△Ø SV1△1 SV2△Ø SV2△1 SV3△Ø SV3△1 SV4△Ø SV4△1 SVM△m m:Memory number 0 to 9	SV1? SV1? SV2? SV2? SV3? SV3? SV4? SV4?	SV1△Ø SV1△1 SV2△Ø SV2△1 SV3△Ø SV3△1 SV4△Ø SV4△1
	RECALL	LIST LIST ALL RETURN SOFT PACK RUN RECALL PMC	RC1△m m:Memory number 0 to 9 RC2 RC3 RC4 RC5 RCM△m m:Memory number 0 to 9		
	PMC ERROR	PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR PMC ERROR		PER? PER? PER? PER? PER? PER? PER? PER? PER? PER?	Ø (no ERROR) 1 (no PMC) 2 (no FORMAT) 3 (d.f. FORMAT) 4 (wrt PROTECT) 5 (bad PMC) 6 (memory over) 7 (not find) 8 (d.f.PMC type) 9 (can't DEF) ☆ For details, see paragraph 5.8.

Table 10-1 Device Message (Continued)

Parameter			Device message		
Item		Control item	Control	Data request	Talker send
SWEEP	START/ END	REPEAT START	SWP△Ø	SWP?	Ø
		SINGLE START	SWP△1	SWP?	1
					Ø: Sweep end 1: Sweeping
UNCAL		NORMAL		UCL?	Ø
		UNCAL		UCL?	1
OVERLOAD		NORMAL		OVL?	Ø
		OVER		OVL?	1
					☆ Read after sweep complete
MKR display value		o MKR A		ZRA?	ℓ
		o MKR B		ZRB?	ℓ
		REF MKR A		RFA?	ℓ
		REF MKR B		RFB?	ℓ
		MKR VALUE A		MVA?	ℓ
		MKR VALUE B		MVB?	ℓ
		MKR FREQ		MKF?	f
MKR erase		MKR erase OFF	MKD△Ø	MKD?	MKD△Ø
		ON	MKD△1	MKD?	MKD△1
MEASURE MEMORY		X-memory A	XMA△P	XMA?△PØ,P1	b
		X-memory B	XMB△P	XMB?△PØ,P1	b
		S-memory A	SMA△P	SMA?△PØ,P1	ℓ
		S-memory B	SMB△P	SMB?△PØ,P1	ℓ
		FREQ memory	FQM△P	FQM?△PØ,P1	f
			P: Memory address 0 to 500	PØ: Send start address 0 to 500 P1: Number of send data 1 to 501	b: 2 bytes binary data or 6 characters ASCII data ℓ: 6 characters ASCII data f: 11 characters ASCII data
		ASCII data	BIN△Ø	BIN?	BIN△Ø
		BINARY data	BIN△1	BIN?	BIN△1
			☆ Effective only for XMA?PO, P1 and XMB?PO, P1		

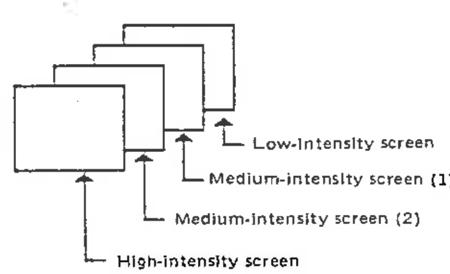
Table 10-1 Device Message (Continued)

Parameter		Device message		
Item	Control item	Control	Data request	Talker send
BREAK POINT	BREAK POINT	BKP△P P:1~5Ø1 ☆ BREAK POINT means sweep stop measurement point	BKP?	BKP△P P:ØØ1~5Ø1
SRQ	SRQ OFF SRQ ON	SRQ△Ø SRQ△1	SRQ? SRQ?	SRQ△Ø SRQ△1
TERMINATOR	LF CR CR/LF	TRM△Ø TRM△1 TRM△2	TRM? TRM? TRM?	TRM△Ø TRM△1 TRM△2

Table 10-1 Device Messages (Continued)

Parameter			Device message
Item		Control item	Control
CRT CONTROL	Display item erase*	Marker title item erase	CER△Ø
		A line item erase	CER△1
		B line item erase	CER△2
		Right item erase	CER△3
		Frequency setting item erase	CER△4
		Soft key item erase	CER△5
		Sweep marker erase	CER△6
		Scale line erase	CER△7
		Waveform erase	CER△8
		Marker erase	CER△9
	Display item return	Marker title item return	CRN△Ø
		A-line item return	CRN△1
		B-line item return	CRN△2
		Right item return	CRN△3
		Frequency setting item return	CRN△4
		Soft key item return	CRN△5
		Sweep marker return	CRN△6
		Scale line return	CRN△7
		Waveform return	CRN△8
		Marker return	CRN△9
	Screen erase	Low-intensity screen erase	CFL△Ø
		Medium-intensity screen(1) erase	CFL△1
		Medium-intensity screen(2) erase	CFL△2
		High-intensity screen erase	CFL△3
		Entire screen erase	CFL△4

☆ The MS3401A has the following four screens.



*: For a description of erasing of display items, also see paragraph 5.9.3.

Table 10-1 Device Message (Continued)

Parameter			Device message
Item		Control item	Control
CRT ※ CONTROL	Draw characters	X, Y coordinates of first character	DCH△X,Y,text[,m][,n_0] X : X coordinate of first character of text Y : Y coordinate of first character of text text : Display characters m : Screen m Screen 0 Low intensity 1 Medium intensity 1 2 Medium intensity 2 3 High intensity n_0 : Character mode n Mode 0 Normal display 1 Reverse display Parameters in [ ] can be omitted. When omitted, 0 is assumed.
	Draw straight line	Start point X, Y coordinates End point X, Y coordinates	DLN△X_0,Y_0,X_1,Y_1[,m][,n_1] X_0 : Straight line start point X coordinate Y_0 : Straight line start point Y coordinate X_1 : Straight line end point X coordinate Y_1 : Straight line end point Y coordinate m : Screen m Screen 0 Low intensity 1 Medium intensity 1 2 Medium intensity 2 3 High intensity n_1 : Graphic mode n Mode 0 Display solid line 1 Erase solid line 2 Display broken line 3 Erase broken line Parameters in [ ] can be omitted. When omitted, 0 is assumed.

* For the coordinates, see paragraph 10.2.

10.2 CRT Coordinates

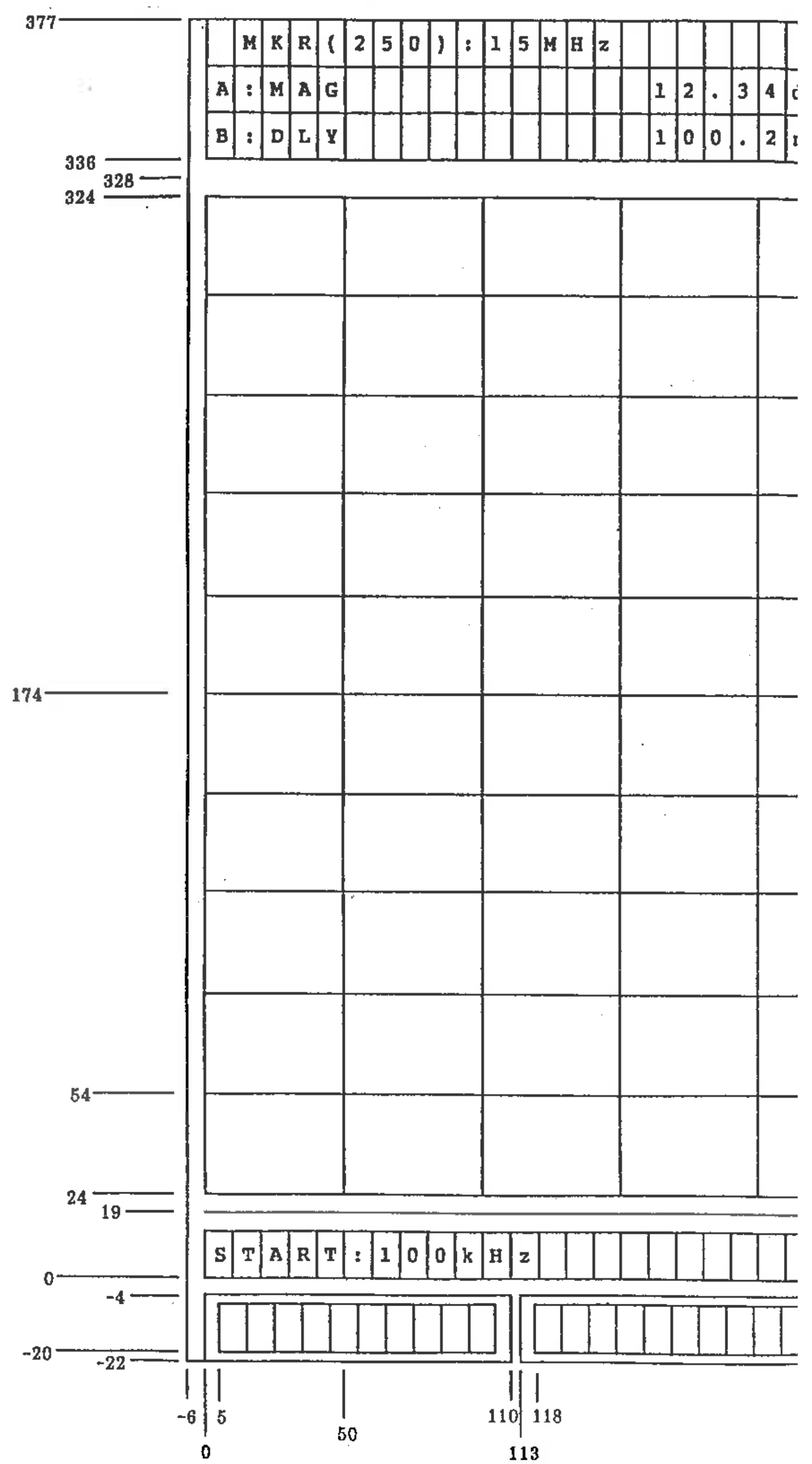


Fig. 1

Table 10-1 Device Message (Continued)

Parameter			Device message
	Item	Control item	Control
CRT CONTROL	Draw square	Start angle X, Y coordinates Opposite angle X, Y coordinates	DRC△X_2,Y_2,X_3,Y_3[,m][,n_1] X_2 : X coordinate of start angle of square Y_2 : Y coordinate of start angle of square X_3 : X coordinate of opposite angle of square Y_3 : Y coordinate of opposite angle of square m : Screen m Screen 0 Low intensity 1 Medium intensity 1 2 Medium intensity 2 3 High intensity n_1 : Graphic mode n Mode 0 Display solid line 1 Erase solid line 2 Display broken line 3 Erase broken line Parameters in [ ] can be omitted. When omitted, 0 is assumed.
	Draw circle	Center X, Y coordinates	DCR△X_4,Y_4,r[,n_1] X_4 : X coordinate of center of circle Y_4 : Y coordinate of center of circle r : Radius n_1 : Graphic mode n Mode 0 Display solid line 1 Erase solid line 2 Display broken line 3 Erase broken line Parameters in [ ] can be omitted. When omitted, 0 is assumed.
	Copy		VPT

SECTION 11

PROGRAMMING

The first half of this section describes programming centered about the status message. A status message is an instruction that interrupts the controller and is especially effective in parallel processing.

The last half of this section gives a number of sample programs as GP-IB programming references.

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11.1 Interrupt by Status Message

The GP-IB has a function which allows a device to interrupt the controller by using an SRQ signal. The controller searches for the device which generated the interrupt. This process is called polling.

There are two types of polling: serial polling and parallel polling. The MS3401A has the serial polling function. This function is summarized in Fig. 11-1.

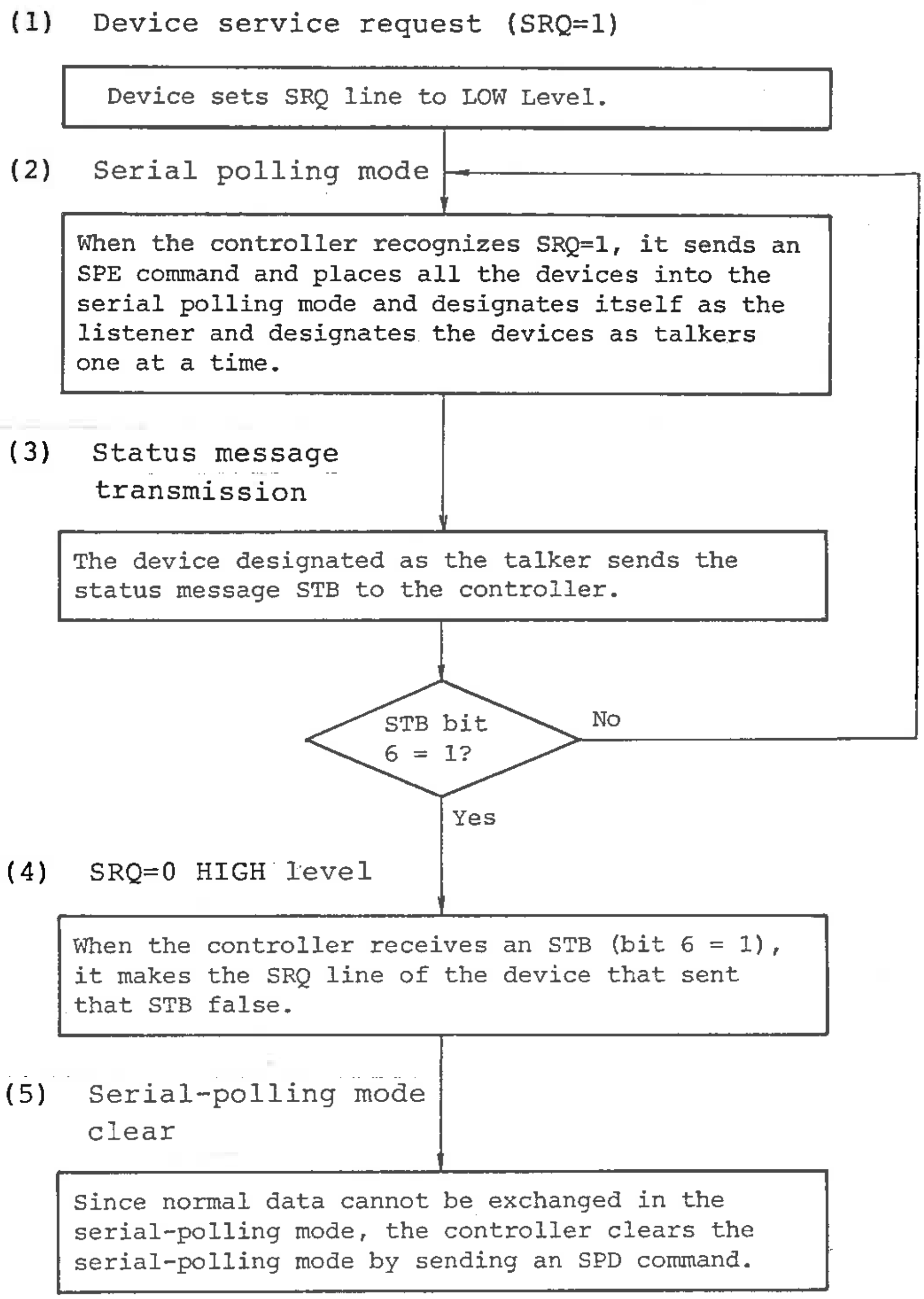
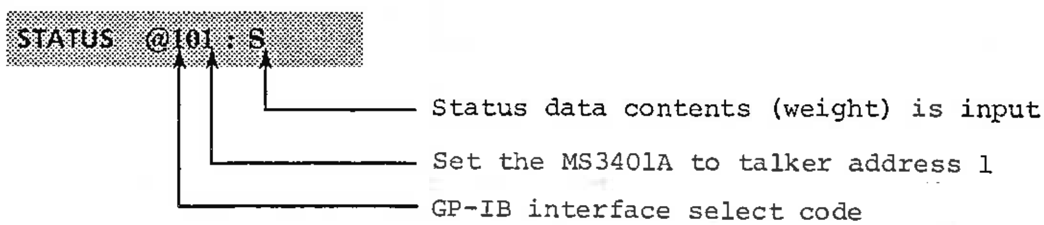


Fig. 11-1 Serial-Polling Mode

The Packet V Personal Technical Computer uses the following statement to perform the processing of steps (2) to (5) in Fig. 11-1.

```
STATUS @device number; numeric variable
```

MS3401A of address 1 is serially-polled as follows:



Each bit of the status data has a meaning. Table 7-4 is reproduced here as Table 11-1.

Table 11-1 Status Message Line Assignment

Bit / Line / Value	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	DI08	DI07	DI06	DI05	DI04	DI03	DI02	DI01
1	PMC error	Service requested	OVER-LOAD, UNCAL (abnormal state)	Sweep end	Data key 7, 8, or 9 pressed	Data key 2 or 6. pressed	Data key 1, 5, or 6 pressed	Data key 0, 2, 4, 6, or 8 pressed
0	No PMC error	Service not requested	Normal state		Data key 7, 8, or 9 not pressed	Data key 2 or 6 not pressed	Data key 1, 5, or 6 not pressed	Data key 0, 2, 4, 6, or 8 not pressed
Weight	128	64	32	16	8	4	2	1
Send	1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0

When data key pressed after [GP-IB] and [F3] keys pressed

Serial polling is a method by which the controller requests the status byte from each device and judges which device generated SRQ from the contents of this byte. The device that generated SRQ sets bit 6 (RQS message) of the status byte to 1. The other bits show the state that generated SRQ.

In the program, the SRQ command, which turns the SRQ function on and off, is used as shown in the following table before serial polling is performed.

Parameter		Device message		
Item	Control item	Control	Data request	Talker send
SRQ control	SRQ OFF SRQ ON	SRQ△Ø SRQ△1	SRQ? SRQ?	SRQ△Ø SRQ△1

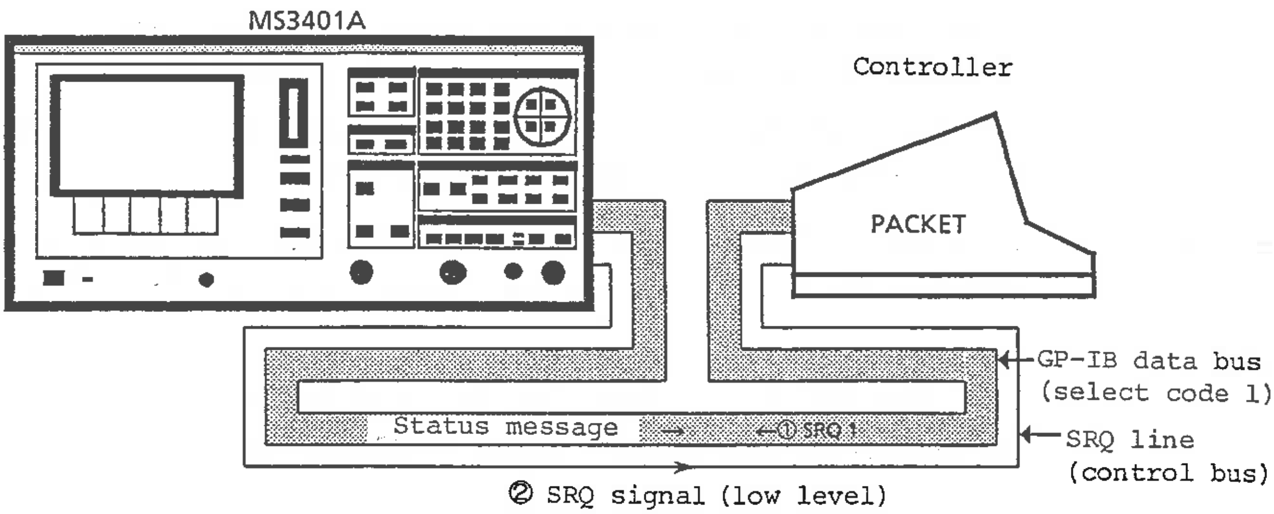


Fig. 11-2 Status Message Transmission

(1) To turn on the MS3401A SRQ function, the controller executes WRITE @101:"SRQ 1" (Fig. 11-2 ← 1 SRQ 1).

(2) When the MS3401A receives SRQ△1, the operation indicated by the shaded part of Table 1-1 is performed. That is, bit 6 is set to 1 and a service request is sent to the controller only when one of the following events takes place [Fig. 11-2, 2 SRQ signal (LOW level)].

- Data key pressed after [GP-IB] and [F3] keys pressed .... 1 set in bit 1, 2, or 3
- End of sweep .... 1 set in bit 4

. OVERLOAD, UNCAL, or other abnormal state generated .... 1 set in bit 5

. PCM error generated ... 1 set in bit 7

End of sweep (sweep ended by no abnormal state, no error generation, no data key operated) is used as an example in the following description.

To turn on the MS3401A SRQ function, SRQ 1 is executed from the controller. At the end of sweep, bit 6 is set to 1 and a service request is sent to the controller only when bit 4 was set to 1.

When STATUS @101:S is executed, the contents of S are bit 6=1, bit 4=1 and the value of S is $2^6 + 2^4 = 80$.

The BIT (N,S) function is used for bit-position detection at the binary value ($\leqq$65535) of numeric variable S.

(here, N = bit position N of expression S)

Function	Function name	Simple example	Meaning (value of function)
BIT(N,S)	Bit check	HSTR$(16385,4)=4001 4001=0100000000000001, BIT (15,16385) = 0 BIT (0,16385) = 1	Checks if bit position N of value of expression S is 0 or 1

A device uses the service request to request service without regard to what processing the controller is currently performing. This is called interrupt processing. However, depending on the program, the controller may set the serial-polling mode and check the device status messages beforehand.

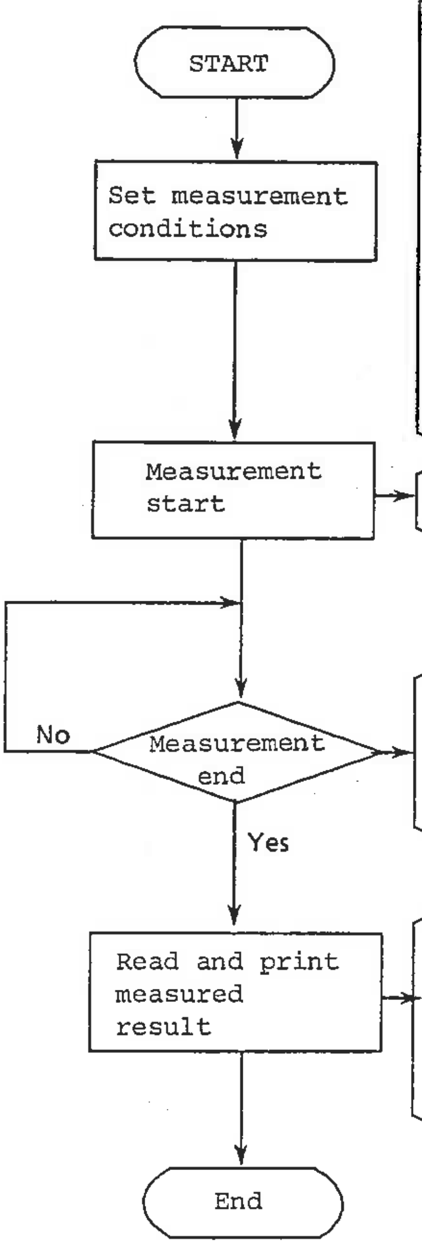
In the first half of this paragraph, programming is performed from this level. Interrupt processing and programming using parallel processing is performed from the last half.

11.1.1 Basic programming (1)

This paragraph describes basic programming using status messages by using the program of the Packet Series computer.

Example:

If SWEEP end SRQ generated, read MAG measured results




```
10 DIM MAG (500) ········· Register variable area

20 IFC @1 ·········· Initialize interface function of all
                     devices on GP-IB
30 DCL @1 ············ Initialize all devices on GP-IB to state
                       prescribed for each
                       To initializer only the MS3401A, program
                       DCL @101 or WRITE @101:"INT"
40 WRITE @101:"SRQ 1" ······ Turn on MS3401A SRQ
                             function

50 WRITE @101:"SW2 1" ······ Start measurement by single sweep
                             and clearly specify relationship
                             between measurement and data in
                             measurement memory

60 STATUS @101:S ···· Serial poll if MS3401A
                      requested service
70 IF NOT (BIT(6,S) = 1 AND BIT(4,S) = 1) THEN 60······
                      If contents of STB not AND of
                      service request (bit 6=1) and
                      measurement end (bit 4=1),
                      return to line 60 serial polling

80 WRITE @101:"XMA?0,501" ······ Request measured
                                 results
90 FOR I=0 TO 500
100 READ @101:MAG(I) ················ Read measured results
110 PRINT MAG(I) ···························· Print measured result
120 NEXT I
130 GOTO 50
140 END
```

Fig. 11-3 Basic GP-IB Programming

```
70 IF NOT (BIT(6,S)=1 AND BIT(4,S)=1) THEN 60
```

Judgement (line 70) can also be performed by Weight value as follows:

```
70 IF S><80 THEN 60   or,   70 IF S=70 THEN 80 ELSE 60
```

11.1.2 Interrupt processing

The program described in paragraph 11.1.1 performed serial polling from the controller. This paragraph describes a program that interrupts execution until the event specified by the WAIT EVENT statement is generated and resumes execution and reads the measured value when an interrupt is generated.

"EVENT" specifies generation of SRQ. The program processes events by giving them a name. Generally, external I/O interrupts generated through an external I/O interface are called external events.

WAIT EVENT* statement format

WAIT EVENT	Internal event flag name External event flag name	TIMEOUT	Numeric expression Character string expression

Note:

Internal event name External event name	....	Upper-case alphabetic characters, numerics, or underbars (_) can be used. However, the first character must be an upper-case alphabetic. The number of characters is optional. All the characters are effective.

*: The program is placed into the execution wait state until the event declared by the PROCESS EVENT statement or SIGNAL statement is generated.

"Internal event flag name" is the name given to an event that can be arbitrarily defined in the program. Paragraph 11.1.3 describes how it is used.

Since the external event flat name appearing here is given for SRQ generation, it is made GSRQ. (Another name can be given from NOTE of the format above.)

```
PROCESS  EVENT  GSRQ"@01,02"
CONNECT  EVENT  GSRQ
```

An event name is declared for an external event by the PROCESS EVENT statement beforehand. Since an external event cannot be generated by event declaration only, it is enabled by the CONNECT EVENT statement so that it can be generated.

WAIT EVENT GSRQ — Interrupts execution until event GSRQ generated

Describes contents to be processed after event GSRQ generated (after execution interrupted)

PROCESS EVENT* statement format

```
PROCESS  EVENT  External event flag name  "KEYkk"
                                          "@SS,nn"
```

Note:

External event flag name .	Upper-case alphabetic characters, numerics, and underbars ( ) can be used. However, the first character must be upper-case alphabetic. The number of characters is arbitrary. All the characters are effective.
KEYkk	Specifies interrupt by function key kk: 2 digit number 00≤kk≤23
@SS,nn	Specifies interrupt cause generated from interface unit SS: Interface unit select code, 2 digit number 00≤SS≤17
nn:	Specifies the interrupt cause bit No. 2 digit number 00≤nn≤15

*: Declares name of external event generated by interface unit or function key.

nn is the bit No. showing the interrupt cause from the I/O interface. For SRQ reception, 02 is specified. see Appendix B.

CONNECT EVENT* statement format

CONNECT EVENT event flag name [,event flag name...]

Note:

Event flag name ...... Upper-case alphabetic characters, numerics, or underbars (_) can be used. However, the first character must be upper-case alphabetic. The number of characters is arbitrary. All the characters are effective.

*: Enables generation of an event declared by PROCESS EVENT statement

Example:

SRQ interrupt from GP-IB interface

```
● 10  PROCESS EVENT GSRQ"01,02
● 20  CONNECT EVENT GSRQ
  30  DO
● 40  WAIT EVENT GSRQ
        }
  50  PRINT"SRQ received";
  60  LOOP**
```

External event name

Since 1 is used as the GP-IB interface select code, @01 is specified. Because 2 of the bit numbers showing the interrupt cause from GP-IB interface indicates SRQ reception, 02 is specified.

**: Block between DO and LOOP is looped. The program exits from the loop when the condition of the EXIT IF statement is satisfied.

EXIT IF condition expression Condition expression = Resolution expression/ logic expression

Note:

The PROCESS EVENT and CONNECT EVENT statements for SRQ interrupts assess that an external event was generated when the SRQ line is made High level (false) beforehand and changed to Low level (True) at that point. Therefore, when the SRQ line is true from the beginning, external event generation cannot be assessed. Thus, the SRQ line must be made false before executing these statements. This is done by reading the MS3401A status data once and clearing the previous service request status.

This can be understood by referring to (4) of Fig. 11-1 or the GP-IB Basic guide Fig. 1-12.

An SRQ interrupt handling routine using the PROCESS EVENT, CONNECT EVENT, and WAIT EVENT statements described above is shown below.

Example 2

Write program of Example 1 as SRQ interrupt handling routine

```
10  LET  MAD=101! ...................................... MS3401A Address
20  !
30  !  ---------Initialization---------
40  IFC  @1
50  DCL  @1
60  !  ---------Device set---------
70  WRITE @MAD:"SRQ 1"
100 !
110 !  ---------SRQ Event---------
120 !
130 STATUS  @MAD:S! ........................ Dummy SRQ reset
140 PROCESS  EVENT  GSRQ"@01,02"! .......... GSRQ event declaration
150 CONNECT  EVENT  GSRQ! .................. Enables GSRQ event
160 !
170 !*******MEASUREMENT*******
180 !
190 WRITE @MAD:"SW2 1" ..................... Single sweep
200 !
210 WAIT  EVENT  GSRQ! ..................... Waits Sweep End
220 WRITE @101:"XMA?0,251" ...... Requests measured result
230 FOR  I=0 TO 250
240 READ @101:MAG (I) ........... Reads measured result
250 PRINT MAG (I) ............... Prints measured result
260 NEXT  I
270 GOTO 50
280 END
```

Line 210 interrupts execution until even GSRQ is generated. When SRQ is received, since event GSRQ is generated, line 210 clears event wait and reads the measured value.

The next program sends effective bits 4, 5, and 7 of the status message. It is added to the program of Example 2 above.

Example 3

STB effective bits 4, 5, and 7 interrupt handling routine

```
10  LET  MAD=101! ------------------------------ M53401A Address
20  !
30  ! ------------Initialization------------
40  IFC  @1
50  DCL  @1
60  ! ------------Device set------------
70  WRITE @MAD:"SRQ 1"
100 !
110 ! ------------SRQ Event------------
120 !
130 STATUS  @MAD:S! -------------------- Dummy SRQ reset
140 PROCESS  EVENT  GSRQ"@01,02"! ---------- GSRQ event declaration
150 CONNECT  EVENT  GSRQ! ---------------- Enables GSRQ event
160 !
170 !*******MEASUREMENT*******
180 !
190 WRITE @MAD:"SW2 1" ------------------------ Single sweep
200 !
210 WAIT  EVENT  GSRQ! ------------------ Waits Sweep End
220 WRITE @101:"XMA?0,251" ---- Requests measured results
230 FOR  I=0 TO 250
240 READ @101:MAG(I) -------- Reads measured results
250 PRINT MAG(I) ------------ Prints measured data
260 NEXT  I
270 GOTO 50
230  DO
240    WAIT  EVENT  GSRQ! - - - - - - - - - - - - Waits  STB(bit6=1)
250    STATUS @MAD:S
260    IF  BIT(4,S)=1  THEN  GO  SUB  SWEEP
270    IF  BIT(5,S)=1  THEN  GO  SUB  ABNOR
280    IF  BIT(7,S)=1  THEN  GO  SUB  ERROR
290    EXIT  IF  BIT(4,S)=1
300  LOOP
310  !
320  READ  @MAD:A! - - - - - - - - - - - - - Reads measured result
330  PRINT  "FM  Deviation=";A/1000;"kHz"
340  GO  TO  530
350  350  !
360  ERROR:  ! ------------ERROR  sub-routine ------------
370  !
380  !
390  !
400  RETURN
410  !
420  BUSY:  ! ------------BUSY  sub-routine------------
430  !
440  !
450  !
460  RETURN
470  !
480  LIMIT:  ! ------------LIMIT  sub-routine------------
490  !
500  !
510  !
520  RETURN
530  END
```

Line 240: Since WAIT EVENT SRQ is assumed to have the same meaning as the side on the right of the equal sign in the program below, this program does not perform bit 6=1 assessment.

```
WAIT EVENT GSRQ   =   10 DO
                      20   STATUS @105:S
                      30   EXIT IF BIT(6,S)=1
                      40 LOOP
```

Line 250: As a result of serial polling at line 250, each bit is tested by lines 260 to 290. All the bits except 4 jump to the subroutine line and are processed there. (Only the block is shown in this program.)

Bit 4 is set to 1 and the program exits from DO - LOOP only when the sweep is ended and MAG is measured.

11.1.3 Interrupt and parallel processing

The interrupt handling routine described in paragraph 11.1.2 only interrupts execution by the WAIT EVENT statement until event GSRQ is generated by the WAIT EVENT statement. It does not perform any other processing.

The aim of parallel processing is processing during the event wait by the WAIT EVENT statement.

(1) Interrupt parallel processing by function key

The PROCESS EVENT statement format described in paragraph 11.1.2 contains a parameter called KEYkk.

This parameter means that a function key of the Packet series personal computer can be used as an interrupt key by specifying its number at kk by a two digit number. For instance, to use function key 1 as an interrupt key, 01 is specified at kk.

The program shown below performs interrupt parallel processing when function key 0 is pressed.

(Event declaration for entire program)

```
10 PROCESS EVENT GOTOB"KEY00"
20 !
```

(Normal processing)

```
30 !-----Task A-----
40 !
50 SET FN 0,"^","INTERRUPT"
60 CONNECT EVENT GOTOB
70 START B
80 DO
90 PRINT "Interrupt key No.?"
100 LOOP
110 END
```

(Interrupt routine)

```
120 !-----Task B-----
130 PARACT B URGENCY 50
140 WAIT EVENT GOTOB
150 PRINT "************"
160 PRINT " F";KEYNO;"pressed"
170 PRINT "************"
180 GO TO 140
190 END PARACT
```

```
           Interrupt key No.?
           Interrupt key No.?
           Interrupt key No.?
           *****************
Interrupt  F0 pressed
           *****************
           Interrupt key No.?
           Interrupt key No.?
Processing Interrupt key No.?
restart    Interrupt key No.?
           Interrupt key No.?
           Interrupt key No.?
           Interrupt key No.?
           *****************
Interrupt  F0 pressed
           *****************
           Interrupt key No.?
           Interrupt key No.?
           Interrupt key No.?
```

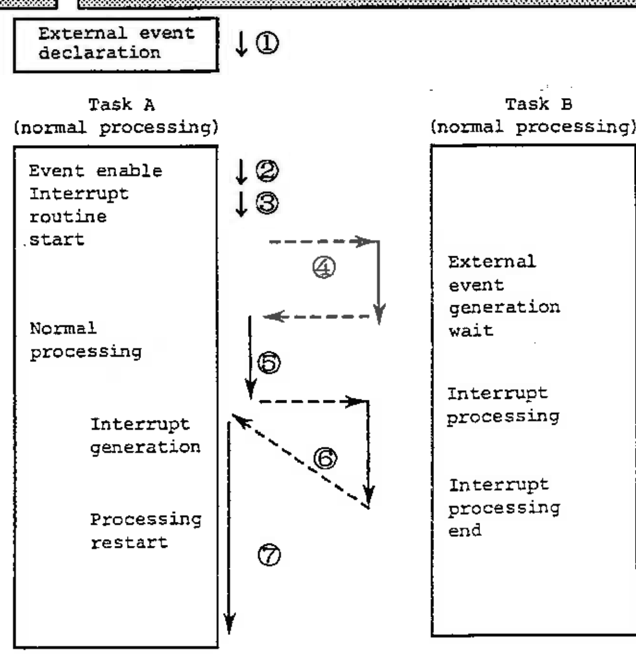


Fig. 11-4 Interrupt Parallel Processing by Function Key

Line 50: Defines function key 0 as interrupt key

Line 80 to 100: DO-LOOP has same function as GO TO 140 of line 180, both perform loop processing

Line 160: When function key 0 pressed, KEYNO output as 0. KEYNO is a function without as argument.

Steps 1 to 7 of Fig. 11-4 are described below:

1. The execute the task B interrupt routine, first, event GOTOB is declared for the entire program by line 10.

   If it is not declared, lines 50, 60, and 140 are meaningless even if executed.

   Lines 10 and 60 are executed for the entire program.

2. Line 50 declares key FNO as the interrupt source and enables the event declared by line 60.

3. When the interrupt routine (task B) is started by line 70, because of the priority (task A < task B).

4. Execution shifts to task B and the program waits for generation of an interrupt at line 140.

5. Then, execution returns to task A and normal processing is resumed.

6. Each time an interrupt is generated by pressing key N0, normal processing (Interrupt key No?) is interrupted and interrupt processing (F0 pressed) is performed.

7. When the system enters the wait state and the end of interrupt processing, normal processing is resumed.

(2) Program that displays status value at interrupt parallel processing

A program that displays the status value of the MS3401A is shown below:

```
 10 COM MAD
 20 LET MAD=105¥IFC @1
 30 WRITE @MAD:
 40 STATUS @MAD:S
 50 PROCESS EVENT GSRQ"01,02"
 60 START GPIBSRQ
 70 CONNECT EVENT GSRQ
 80 DO
 90 PRINT "Next status value?"
100 LOOP
110 END
```

Main program
(task A)

```
120 PARACT GPIBSRQ URGENCY 50
130 COM MAD
140 DO
150 WAIT EVENT GSRQ
160 STATUS @MAD:S
170 PRINT"STATUS=";S
180 LOOP
190 END PARACT
```

Parallel processing
(task GPIBSRQ)

When program execution reaches line 60, it encounters a START statement. GPIBSRQ described at the right of the START statement is the name of the parallel section.

Function of line 60 START statement

Therefore, GPIBSRQ is also described at the right of PARACT of line 120 of the parallel section. When the name of the parallel section is specified by the START statement, the specified parallel section enters the Ready or Running state. The main program (program ended by END line) and parallel section (routine beginning with PARACT and ending with END PARACT) are independent programs and are called program units. A processing priority can be specified for each program unit.

The priority is specified by a number from 0 to 255. The lower the mumber, the higher the priority. The priority of the main program is recognized implicitly as 100.

Functions of line 60 START statement (cont'd)	The priority of the parallel section is indicated by the number at the right of URGENCY, as shown in line 120; in this example it is 50. Therefore, the processing priority is parallel section GPIBSRQ >main program. If the priority of the parallel section is specified as 100, since it is the same as the priority of the main program, URGENCY is omitted. However, the execution flow is from low line number to high line number. When the parallel section is specified by the START statement, if it has the same priority as the main program, it is set to the Ready state. However, since the priority of the parallel section in this example is higher than that of the main program, the program is executed in line 60 → line 120 → line 130 → line 140 → line 150 order.
Line 150 event wait	Since the CONNECT EVENT statement of line 70 has not been executed yet, external event GSRQ cannot be generated at line 150. Therefore, the program waits at line 150 for event generation. Generally, when a program unit enters the event generation wait state, execution shifts to the program unit with the next higher priority. Up to eight program units, including the main program, are possible. Since there are only two program units in this example, execution shifts to line 70 of the main program.
Normal processing and interrupt processing	Line 70 enables event generation. If event GSRQ was not generated yet, the processing of lines 80 to 100 is continued. When event GSRQ is generated during this time, the event GSRQ wait state of line 150 is cleared and execution shifts to lines 160 and 170 of the parallel section. Therefore, the status value can be displayed by an interrupt. When re-execution by the next DO-LOOP reaches line 150, the program waits for the next event and normal processing is resumed, the same as in the program of (1).

(3) Structure and functions of program containing parallel section

For details, refer to the Packet Series personal computer manual. This paragraph describes the range required by GP-IB programming as a supplement of (1) and (2).

<Program unit 1 Main program>

```
20   COM  A,B(100),C$

80   PROCESS  EVENT   External event name
90   START  Parallel section to be started
100  CONNECT  EVENT External event name
          ∫
   Main program processing part
          ∫
500  (STOP)
          ∫
520  END
```

<Program unit 2 Parallel section>

```
530  PARACT  Parallel section name
540  COM  A, B(100), C$
          ∫
600  WAIT  EVENT External event name
          ∫
700  (STOP)
          ∫
710  END  PARACT
```

- Since each program unit can be handled as an independent program, even if the variable names used by each program unit are the same, they are processed as separate variables. When variables are used as common variables among program units, they are declared by the COM statement, like lines 20 and 540.
- Up to eight parallel sections, including the main program, can be used.
- External event declaration of line 80 is used in common by all the program units. External event declaration is written near the beginning of the first program unit.
- If two or more parallel sections are to be started, the START statement of line 90 specifies the name of each parallel section.
- The parallel section beginning with PARACT and ending with END PARACT is placed after the main program.
- A parallel section can be written even if there is no main program. For example, part of the main program at programs (1) and (2) can be replaced by a parallel section.

  That is, the PARACT parallel section name is described before line 10 and END PARACT is described before line 110.
- The priority is specified by 0≤numeric≤255 at URGENCY at the right side of the PARACT parallel section name.

- If a program unit is waiting to be executed, execution of the entire program is not ended even if all processing is complete. For example, if main program loop processing at programs (1) and (2) is limited, since a parallel section is waiting to be executed at the WAIT EVENT line, the main program END line is not executed even if this loop processing is complete.

  To avoid this, the program must be ended forcibly by the STOP statement, such as line 500 or line 700.

START* statement format

START Parallel section name

Note:

1. Parallel section name Upper-case alphabetic characters, numerics, and underbars (_) can be used.
   However, the first character must be an upper-case alphabetic. The number of characters is arbitrary.
   All the characters are effective.

*: A parallel section is placed into the Ready state or Running state by specifying the name of a parallel section currently in the stopped state from the parallel section currently executing.

PARACT* statement format

PARACT parallel section name [ΔURGENCY numeric] [CHANNEL numeric] [ΔEXTENSION numeric]

Notes:

1. Interrupt routine name ... Upper-case alphabetic characters, numerics, and underbars (_) can be used. However, the first character must be an upper-case alphabetic. The number of characters is arbitrary. All the characters are effective.

2. URGENCY .... Specifies the executing priority. The numeric is a positive integer number from 0 to 255. The smaller the numeric, the higher the priority ($0 \leq priority \leq 255$).

3. CHANNEL .... Specifies the maximum number of files that can be opened simultaneously in the parallel section ($0 \leq numeric \leq 4$: positive integer).

4. EXTENSION .... Specifies the maximum value of the variable storage area used by subprograms, defined functions, and pictures in parallel section. (The numeric is 0 or a positive integer.)

*: Specifies the beginning of a parallel section. Also specifies the execution priority, number of channels of files, and extension memory size.

END PARACT* statement format

```
END PARACT
```

*: Specifies the end of a parallel section. When END PARACT is executed, the executing parallel section is placed into the stop state.

STOP* statement format

STOP

*: When the STOP statement is executed, execution of not only the program unit containing the STOP statement, but execution of all the parallel sections which belong to other program units is stopped.

END * statement format

END

*: Specifies the end of the program.

When a program is divided into two or more program units, the END statement does not indicate the end of the entire unit, but the end of the main program part.

SIGNAL* statement format ... This item appears from the program of Example 2

SIGNAL Internal event flag name

Note:

Internal event flag name - Names a software event (control only in the program)

(1) Event flag naming

Usable characters	Upper-case alphabetic characters, numerics, and underbars (_). However, the first character must be an upper-case alphabetic.
Even flag name length ...	Arbitrary All characters are effective.

(2) Use with WAIT EVENT statement

Each SIGNAL statement must correspond to a WAIT EVENT statement of the same event name. When N SIGNAL statements are executed, N WAIT EVENT statements of the same event name must be executed. The internal event ends when received by WAIT EVENT statement.

*: Generates the internal event of the specified event flag name, and clears the wait state of other parallel sections waiting for the same internal event flag name by the WAIT EVENT statement and returns them to the Ready or Running state.

Example 1

Modify paragraph 11.1.2 Example 2 program for parallel processing (I sweep measurement)

```
10  COM  MEANSFLAG, MAG(250)
20  LET  MAD=101
30  !---------Initialization---------
40  IFC  @1
50  DCL  @1
60  !---------Device SRQ ON set-----------
70
80  WRITE  @MAD:"SRQ 1"
90  !
100 !---------SRQ Event---------
110 STATUS  @MAD:S!.................. Dummy SRQ reset
120 PROCESS  EVENT  GSRQ"@01,02"!.... Event declaration
130 START  GPIBSRQ!.......... Activates GPIBSRQ Block
140 !
150 !********MEASUREMENT***********
160 !
170 CONNECT  EVENT  GSRQ!......... Enables GSRQ Event
180 !
190 !---------Measure  Start---------
200 !
210 LET  MEANSFLAG=0
220 WRITE  @MAD:"SW2 1"
230 !
240 DO  UNTIL  MEANSGLAG=1
250 LOOP
260 !-------Measured Result-------
270 WRITE  @MAD:"XMA? 0,251"
280 FOR  I=0 TO 250
290 READ  @MAD:MAG (I)
300 PRINT MAG (I)
310 NEXT I
320 STOP!........ Stops parallel block execution wait
330 END
340 !
350 !***GPIB SRQ interrupt routine***
360 !
370 PARACT  GPIBSRQ  URGENCY  50
380   COM  MEANSFLAG
390 !
400   DO
410     WAIT  EVENT  GSRQ
420     LET  MEANSFLAG=1
430   LOOP
440 !
450 END  PARACT
```

Main program

Parallel section

(D1:MAGPIB 10)

(1) Lines 20 to 120 are the same as the program of paragraph 11.1.2 Example 2.

Line 10 COM MEANSFLAG, MAG(280), together with line 380, declares common variables so that variables MEANSFLAG and MAG (250) have the same contents and can be used by both the main program and the parallel section.

(2) When parallel section GPIBSRQ is specified by line 130, since its priority is high, execution shifts to it.

(3) Since even GSRQ has not been generated yet, the program waits at line 410 for event generation. Thus, execution shifts to the main program and advances in line 140 → line 240 order.

(4) Since the contents of MEANSFLAG become 0 at line 210 until event GSRQ is generated, the program remains in the loop until MEANSFLAG=1 at line 240.

(5) When the MS3401A issues a service request, the line 410 wait state in which the program is waiting for an event is cleared and MEANSFLAG=1.

(6) When MEANSFLAG=1, main program lines 240 and 250 loop processing ends, execution advances to lines 270 and 280, and the measured value is read and printed at the printer.

(7) At the parallel section, after MEANSFLAG=1 is defined at (5), the program waits for event GSRQ to be generated again. Therefore, steps (5) to (7) are repeated infinitely.

(8) If the state of (7) above, execution shifts to the main program without executing END PARACT each time event GSRQ is generated.

(9) If the STOP statement of line 290 is omitted from the main program, since the parallel section remains in the active state for the reasons given in (7) and (8) above, line 300 END of the main program is not executed. To end execution of the entire program, a STOP statement is placed at line 290 and MAG is measured once by one sweep and program execution is ended.

Example 2

Parallel processing combining internal event and external event (applicable to Example 1)

```
10  COM  MEANSFLAG, MAG(250)
20  LET  MAD=101
30  !—————————Initialization————————
40  IFC  @1
50  DCL  @1
60  !—————————Device SRQ ON set——————————
70
80  WRITE  @MAD:"SRQ 1"
90  !
100 !—————————SRQ Event————————
110 STATUS  @MAD:S!···················Dummy SRQ reset
120 PROCESS  EVENT  GSRQ"@01,02"!····Event declaration
130 START  GPIBSRQ!···········Activates GPIBSRQ Block
140 !
150  !*******MEASUREMENT**********
160 !
170 CONNECT  EVENT  GSRQ!·········Enables GSRQ Event
180 !
190 !—————————Measure  Start————————
200 !
210 !
220 WRITE  @MAD:"SW2 1"
230 !
240 WAIT EVENT MEANSFLAG!—————————Measure  end wait
250 !
260 !———————Measured Result———————
270 WRITE  @MAD:"XMA? 0,251"
280 FOR  I=0 TO 250
290 READ  @MAD:MAG (I)
300 PRINT MAG (I)
310 NEXT I
320 STOP!········Stops parallel block execution wait
330 END
340 !
350  !***GPIB SRQ interrupt routine***
360  !
370 PARACT  GPIBSRQ  URGENCY  50
380   COM  MEANSFLAG
390 !
400   DO
410     WAIT  EVENT  GSRQ
420     SIGNAL MEANSFLAG
430   LOOP
440 !
450 END  PARACT
```

Main program

Parallel section

Line 210 is equivalent to line 240 of Example 1. This line places the program into the wait state until internal event MEANSFLAG is generated.

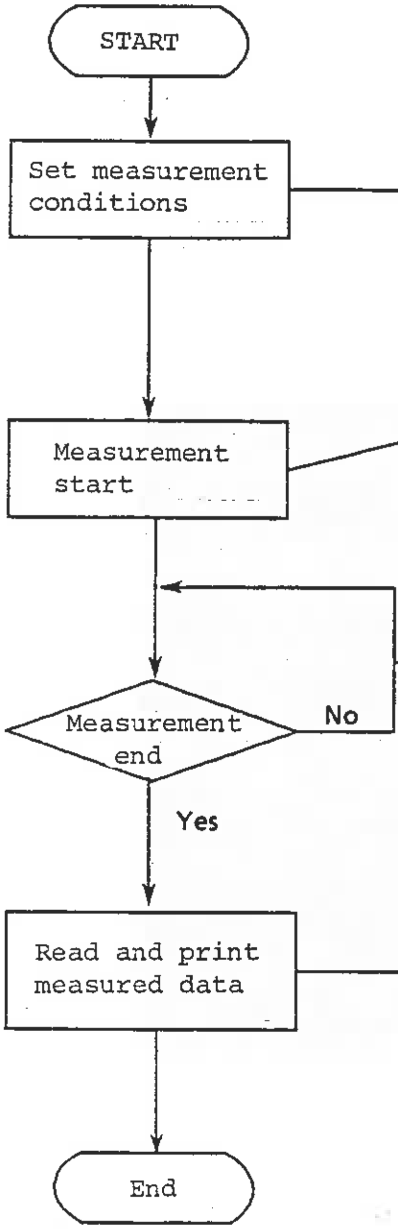
Internal event MEANSFLAG is generated when the MS3401A issued a service request and the line 410 wait state was cleared. MEANSFLAG named by line 420 SIGNAL statement is the internal event name. When the SIGNAL statement is executed, internal event MEANSFLAG is generated. This clears the line 240 wait state.

11.2 Program

This paragraph describes a sample program which controls the MS3401A Network Analyzer by using the Packet V Personal Technical Computer (ANRITSU) and the precautions to be observed when writing programs.

11.2.1 Basic programming (2)

This paragraph describes the basic approach to controlling the MS3401A. (Δ in the program below indicates one character space.)

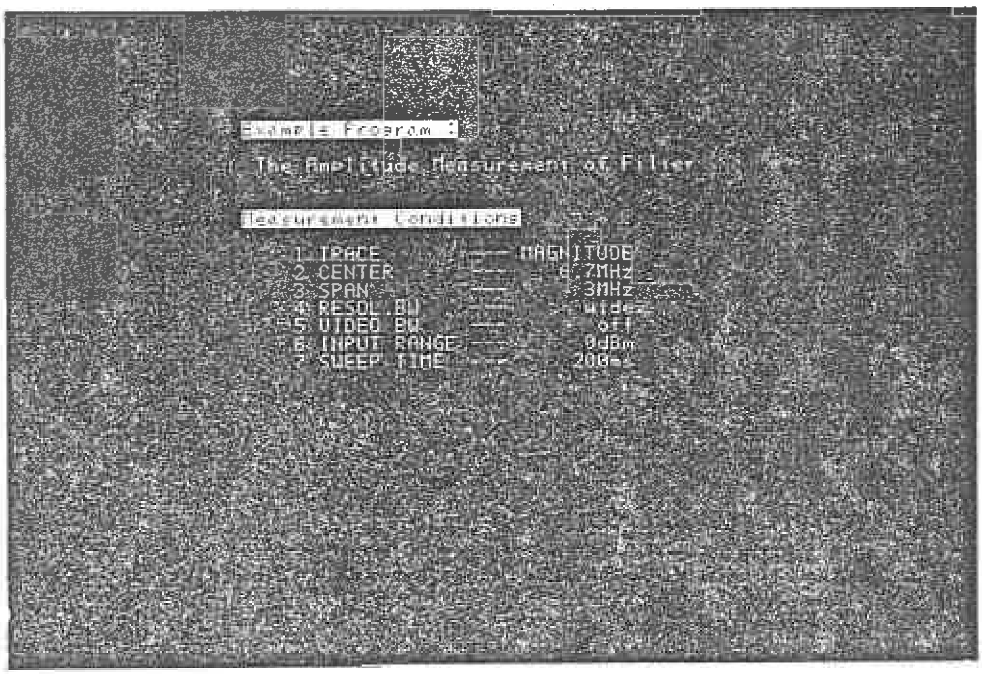



```
DIM MAG (500)
LET-MAD = 101
WRITE @ MAD : "TRC△0" ....... Set TRACE of MAG
WRITE @ MAD : "STF△1 Mz ; SOF△10 Mz" ... Set start
                    frequency to 1 MHz and stop
                    frequency to 10 MHz
WRITE @ MAD : SRQ△1" .......... Set SRQ to ON

WRITE @ MAD : SW2△1" .......... Active single
                                start

☆ STAUS @ MAD : S .......... Serial polling
                             execution
READ @ MAD : S .......... Read measurement end
                          status
IF S = 80 THEN ☆ ELSE ☆ ...... Determine measurement
                               end

WRITE @ 101 : "XMA ?△0, 501 "..... Request measured
                                   data
FOR I = 0 TO 500
READ @ MAD : MAG(I) ........ Read measured data
PRINT MAG (I) ......   Print measured data
NEXT I
```

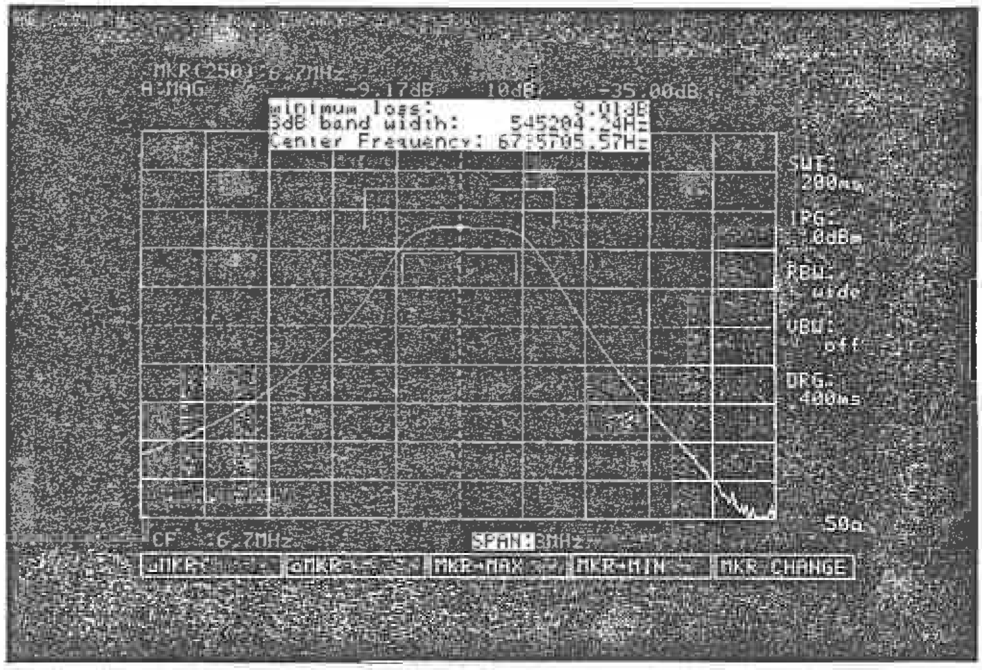
11.2.2 6.7 MHz filter measurement program

This program measures the magnitude of a 6.7 MHz filter and finds the filter constant loss, 3 dB bandwidth, and measurement center frequency.

The figure below is a video plotter white/black inverted printout of the filter measurement conditions described by the program.

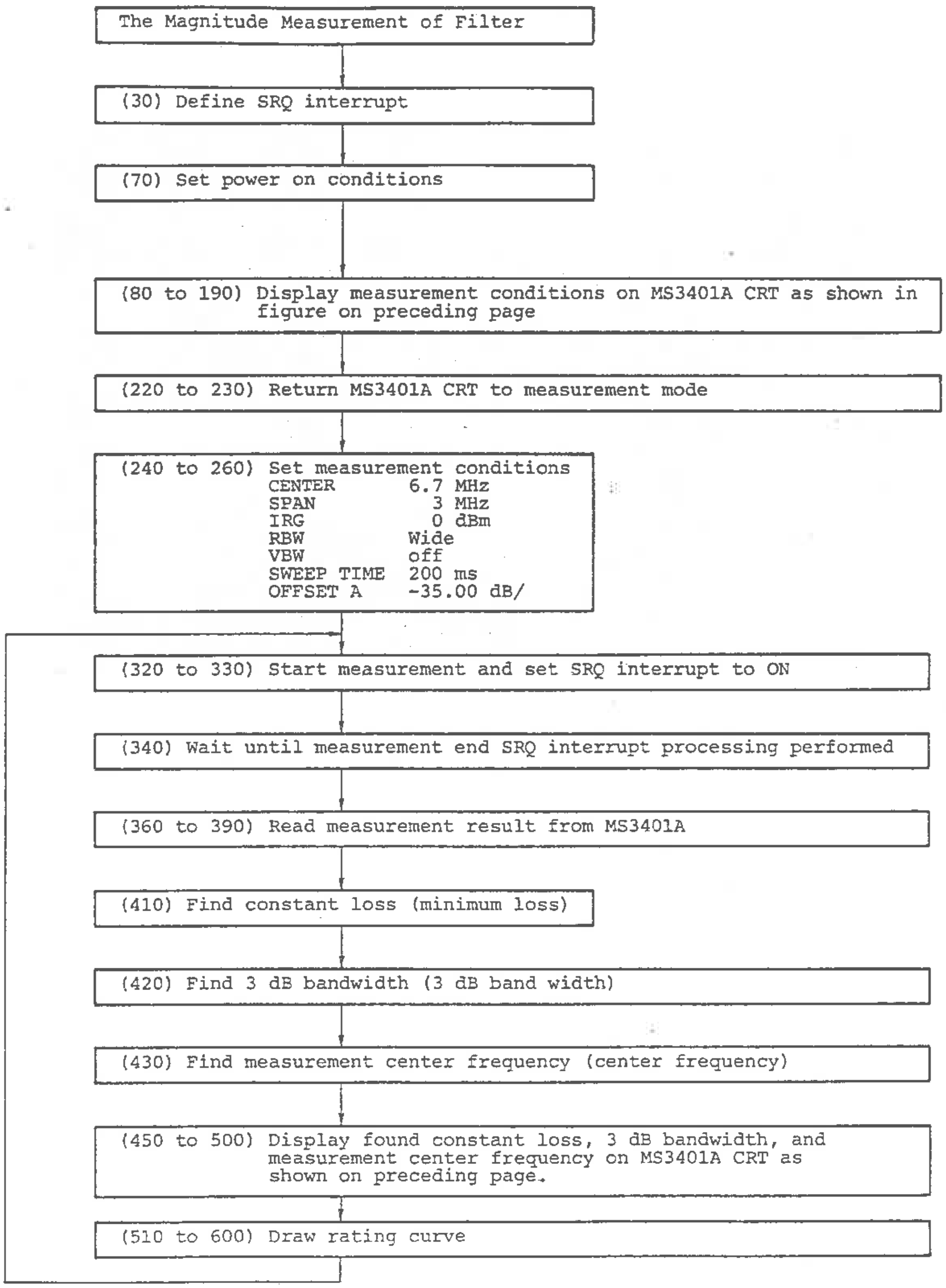


The figure below is a video plotter reversed white/ black printout of the results of measurement by the program.



The program is shown in items (1) and (2) below.

(1) Flowchart



(900 to 960) SRQ interrupt processing subprogram

(2) Program

```
10  !--- Filter Measurement ---
20  DIM FREQ (500), MAG (500), A$*100, B$*100
30  PROCESS EVENT GPIB "@01, 02"
40  START GP IBSRQ
50  CONNECT EVENT GPIB
60  !
70  WRITE @101 : " INI "
80  WRITE @101 : " SW3 0 "
90  WRITE @101 : " CFL 4 "
100 WRITE @101 : " DCH 80, 324, Example Program : ,3, 1 "
110 WRITE @101 : " DCH 90, 296, The Amplitude Measurement of Filter, 3, 0 "
120 WRITE @101 : " DCH 80, 254, Measurement Conditions, 2, 1 "
130 WRITE @101 : " DCH 120, 226,1 TRACE          --- MAGNITUDE, 2, 0 "
140 WRITE @101 : " DCH 120, 212,2 CENTER         ---     6.7 MHz, 2, 0 "
150 WRITE @101 : " DCH 120, 198,3 SPAN           ---       3 MHz, 2, 0 "
160 WRITE @101 : " DCH 120, 184,4 RESOL. BW      ---        Wide, 2, 0 "
170 WRITE @101 : " DCH 120, 170,5 VIDEO BW       ---         off, 2, 0 "
180 WRITE @101 : " DCH 120, 156,6 INPUT RANGE    ---       0 dBm, 2, 0 "
190 WRITE @101 : " DCH 120, 142,7 SWEEP TIME     ---      200 ms, 2, 0 "
200 !
210 WAIT DELAY 2
220 WRITE @101 : " CFL 4 "
230 WRITE @101 : " INI "
240 WRITE @101 : " OFA -3500 "
250 WRITE @101 : " SWT 200 ; IRG 2 ; RBW 4 ; VBW 5 "
260 WRITE @101 : " CNF 6.7MZ ;SPF 3MZ "
270 LET FREQ (0) = 5200000 ¥ LET STEP = 60000
280 FOR I = 1 TO 50
290 LET FREQ (I) = FREQ (I - 1) + STEP
300 NEXT I
310 !---    measure start    ---
320 WRITE @101 : " SW2 1 "
330 WRITE @101 : " SRQ 1 "
340 WAIT EVENT NEXT
350 !--- read measurement data ---
360 WRITE @101 : " BIN 1 "
370 WRITE @101 : " XMA ? 0, 501 "
380 MAT READ @101 USING " WH " : MAG
390 WRITE @101 : " BIN 0 "
400 !---    DATA PROCESSING    ---
410 GO SUB 630
420 GO SUB 710
430 GO SUB 850
440 !---    DISPLAY PROCESSING DATA    ---
450 LET A$ = " DCH 100, 336, minimum loss :          " ¥ LET B$ = " dB, 3, 1 "
460 WRITE @101 USING " C30, F10.2, C6 " : A$, MIN * .01, B$
470 LET A$ = " DCH 100, 324, 3 dB band width :       " ¥ LET B$ = " Hz, 3, 1 "
480 WRITE @101 USING " C30, F10.2, C6 " : A$, BAND , B$
490 LET A$ = " DCH 100, 310, Center Frequency :      " ¥ LET B$ = " Hz, 3, 1 "
500 WRITE @101 USING " C30, F10.2, C6 " : A$, CENT , B$
```

```
510  !
520  WRITE @ 101 DLN " 175, 280, 225, 280, 1, 0 "
530  WRITE @ 101 DLN " 175, 280, 225, 250, 1, 0 "
540  WRITE @ 101 DLN " 325, 280, 275, 280, 1, 0 "
550  WRITE @ 101 DLN " 325, 280, 325, 250, 1, 0 "
560  !
570  WRITE @ 101 DLN " 205, 231, 245, 231, 1, 0 "
580  WRITE @ 101 DLN " 205, 231, 205, 207, 1, 0 "
590  WRITE @ 101 DLN " 295, 231, 255, 237, 1, 0 "
600  WRITE @ 101 DLN " 295, 231, 295, 207, 1, 0 "
610  INPUT  PROMPT " next measurement ? " ;IN$
620  GO TO 320
630  !—      MINIMUM LOSS      —
640  LET MIN = −15000
650  FOR I = 0 TO 500
660  IF  MAG (I) <MIN THEN 680
670  LET MIN = MAG (I) ¥ LET PMIN = I
680  NEXT I
690  LET MIN = MIN* (−1)
700  RETURN
710  !—      3 dB BAND WIDTH      —
720  LET LSTD = MIN* (−1) −300
730  FOR I = PMIN TO 0 STEP −1
740  IF MAG (I) <LSTD THEN 760
750  NEXT I
760  LET P0 = I
770  FOR I = PMIN TO 500 STEP 1
780  IF MAG (I) <LSTD THEN 800
790  NEXT I
800  LET P1 = I − 1
810  LET FQL = FREQ (P0) + (FREQ (P0 + 1) − FREQ (P0)*(MAG (P0) − LSTD) / (MAG (P0) − MAG
     (P0 + 1))
820  LET FQH = FREQ (P1) + (FREQ (P1 + 1) − FREQ (P1)*(MAG (P1) − LSTD) / (MAG (P1) − MAG
     (P1 + 1))
830  LET BAND = FQH − FQL
840  RETURN
850  !—      CENTER FREQUENCY      —
860  LET CENT = FQL + BAND/2
870  RETURN
880  END
890  !—      GP-IB SRQ SOUBROUTINE      —
900  PARACT GPIBSRQ URGENCY 50
910  WAIT EVENT GPIB
920  STATUS @ 101 : STA
930  IF STA <> 80 THEN 950
940  SIGNAL NEXT
950  GO TO 910
960  END PARACT
```

SECTION 12

MX3501A DIRECT PLOT (OPTION 02)

This section describes how to use the MX3501A Direct Plot software.

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12.1 Outline

The MX3501A Direct Plot software, which is supplied on a PMC (Plug-in Memory Card), provides the hardcopying functions for plotting the MS3401A Network Analyzer CRT screen directly on an external X-Y plotter.

It can be used to directly plot the screen onto an HP, Graphtec, or Matsushita X-Y plotter, or Actronics color printer, via GP-IB.

In addition, when directly plotting the screen, the MX3501A Direct Plot software can select either the entire screen, scale only, or trace only.

12.2 Operating Procedures

Step	Procedure
1	Set the X-Y plotter to be used to LISTEN ONLY.
2	Insert the MX3501A PMC into the MS3401A.
3	Press the [RECALL] key of the PMC function and then the soft key [F4] (SOFT PACK). The program is loaded in the MS3401A internal memory.
4	Press soft key [F5] (RUN). The following soft key function display is displayed at the bottom of the CRT. (The MX3501A can be removed in this state). [HP-GL] [ALL ITEM] [1/1] [PLOT START] [RESET]

(continued)

Step	Procedure
	. [HP-GL] Selects X-Y plotter control command Whenever the [F1] key is pressed, the display is alternately switched between [GP-GL] and [HP-GL]. HP-GL is the HP standard control command for controlling the X-Y plotter. GP-GL is the Graphtec X-Y plotter control comamnd. Note: When using the Actronics color printer, select HP-GL. . [ALL ITEM] Selects item to be plotted Whenever the [F2] key is pressed, the display is alternately switched between [TRACE], [SCALE], and [ALL ITEM]. ALL ITEM enables plotting of all items (excluding the soft key menu) displayed on the MS3401A CRT. TRACE enables plotting of only the measured trace; SCALE enables plotting of only the scale.

(continued)

Step	Procedure
	. $\boxed{1/1}$ Selects plot size Whenever the [F3] key is pressed, the display is alternately switched between $\boxed{1/2}$ and $\boxed{1/1}$. For 1/1, plotting is approximately A3 size. For 1/2, plotting is approximately A4 size.
5	Select the required modes using soft keys [F1] to [F3] and then press the [F4] key. . $\boxed{\text{PLOT START}}$ Starts plotting When the [F4] key is pressed, the screen contents are output to the X-Y plotter in the selected modes.
6	To interrupt plotting, press the [F5] key. . $\boxed{\text{RESET}}$ Interrupts plotting If the [F5] key is pressed during plotting, plotting is interrupted. Note: If the X-Y plotter has a buffer that stores the transfer command, plotting will continue for a while even after the [F5] key has been pressed.

12.3 Plotter Output Examples

1. ALL ITEM

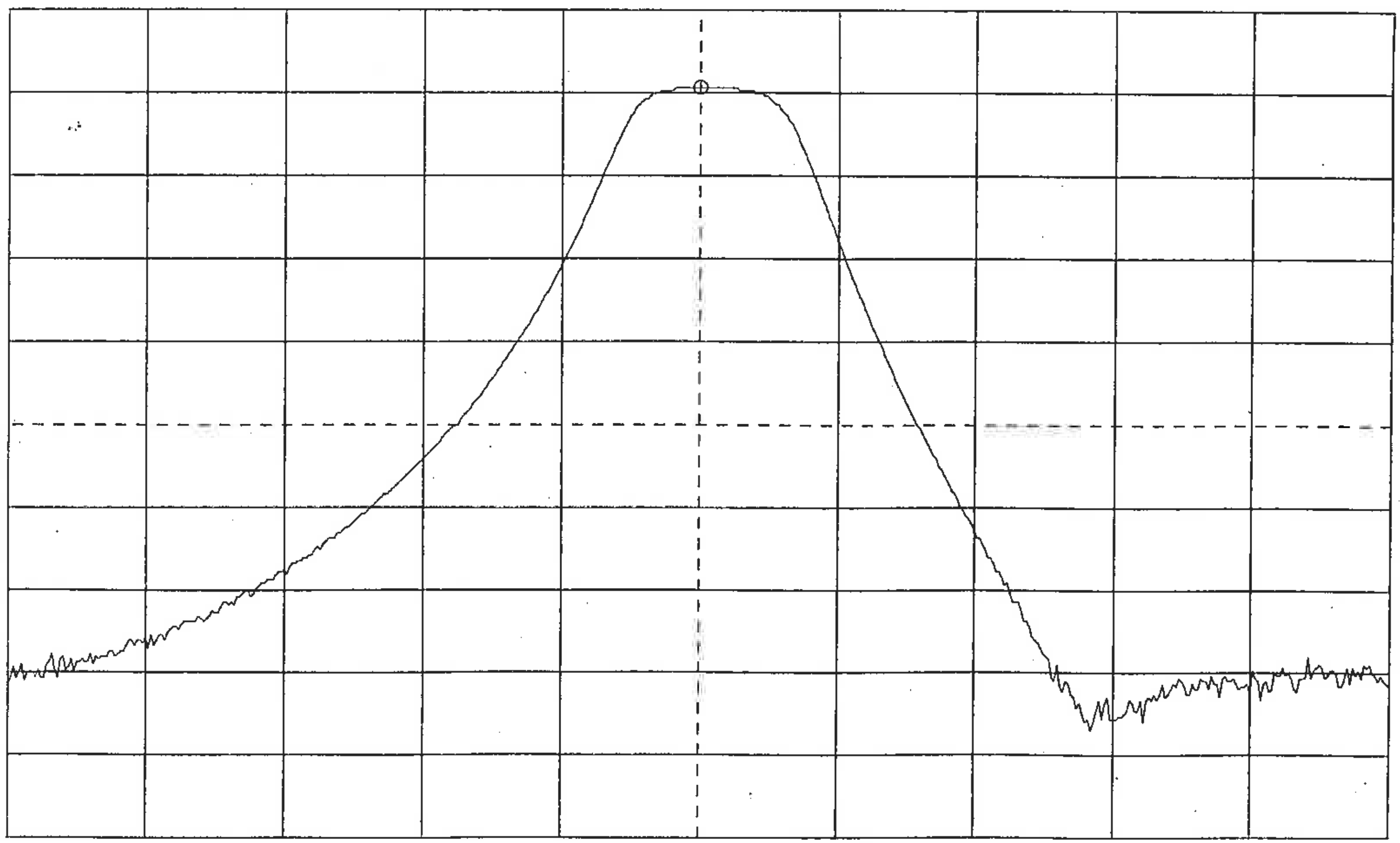
2. TRACE

3. SCALE

4. ALL ITEM and TRACE (TRACE overwrite)

(1) ALL ITEM

MKR(250):6.7MHz title:MS3401A X-YPLOTTER
A:MAG -9.17dB 10dB/ -50.00dB

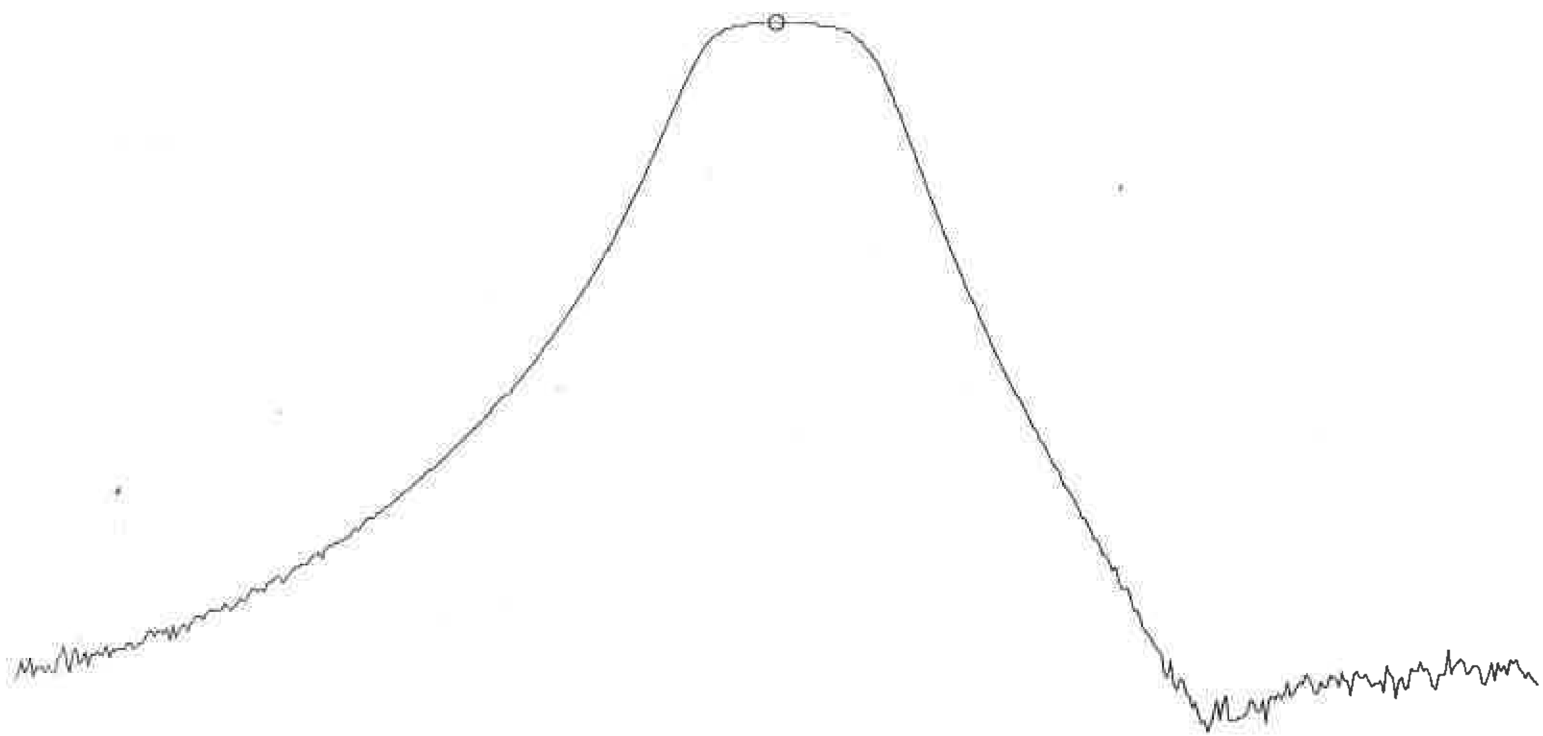


SWT: 300ms
IRG: 0dBm
RBW:* wide
VBW:* off
DRG: 400ms

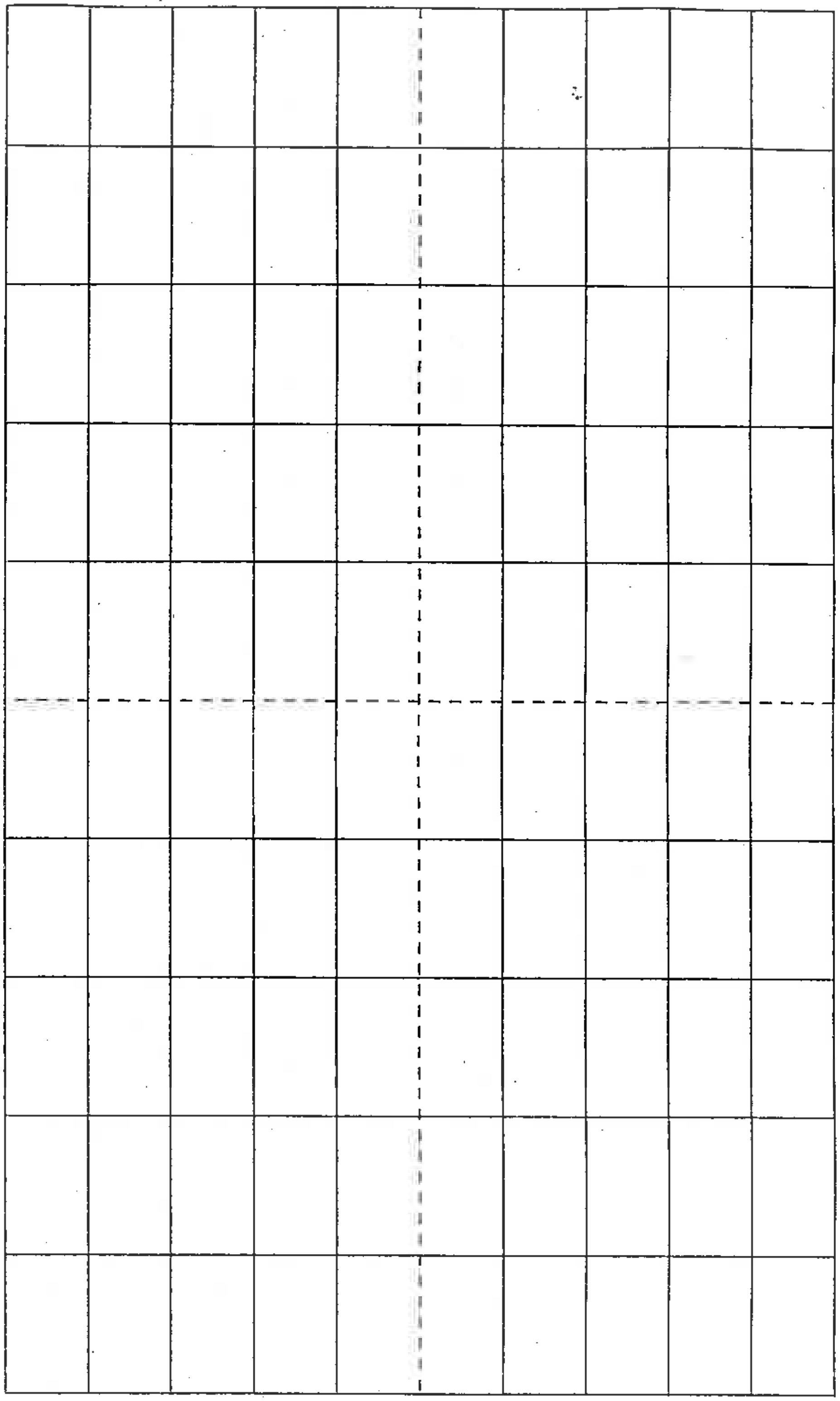
50Ω

CF :6.7MHz SPAN:5MHz

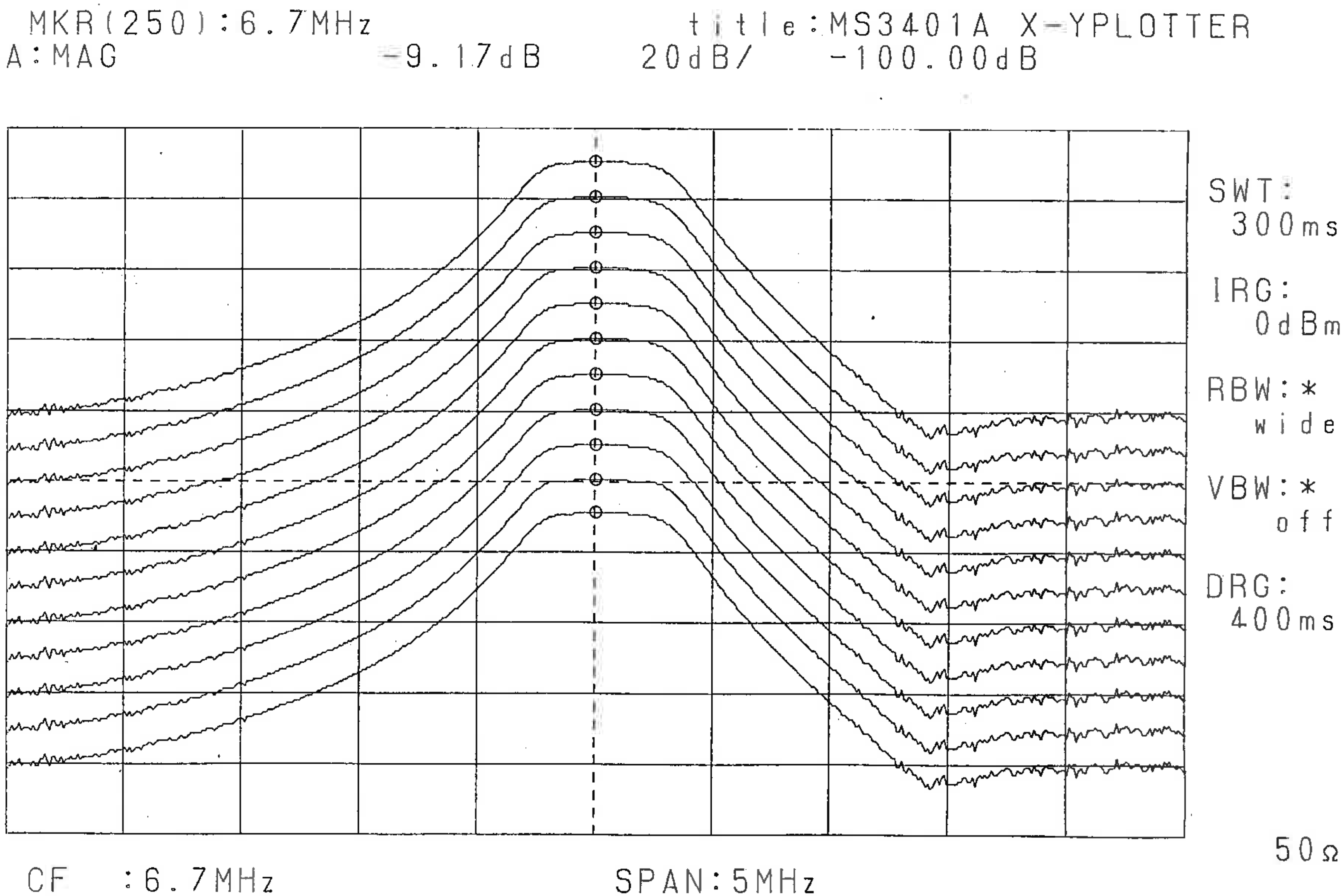
(2) TRACE



(3) SCALE



(4) ALL ITEM and TRACE (TRACE overwrite)



APPENEIX

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APPENDIX A

UNIVERSAL ASCII* CODE TABLE

B7 B6 B5	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
BITS B4B3B2B1	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 10 16	40 SP 20 32	60 0 30 48	100 @ 40 64	120 P 50 80	140 ` 60 96	160 p 70 112
0 0 0 1	1 SOH GTL 1 1	21 DC1 LLO 11 17	41 ! 21 33	61 1 31 49	101 A 41 65	121 Q 51 81	141 a 61 97	161 q 71 113
0 0 1 0	2 STX 2 2	22 DC2 12 18	42 " 22 34	62 2 32 50	102 B 42 66	122 R 52 82	142 b 62 98	162 r 72 114
0 0 1 1	3 ETX 3 3	23 DC3 13 19	43 # 23 35	63 3 33 51	103 C 43 67	123 S 53 83	143 c 63 99	163 s 73 115
0 1 0 0	4 EOT SDC 4 4	24 DC4 DCL 14 20	44 $ 24 36	64 4 34 52	104 D 44 68	124 T 54 84	144 d 64 100	164 t 74 116
0 1 0 1	5 ENQ PPC 5 5	25 NAK PPU 15 21	45 % 25 37	65 5 35 53	105 E 45 69	125 U 55 85	145 e 65 101	165 u 75 117
0 1 1 0	6 ACK 6 6	26 SYN 16 22	45 & 26 38	65 6 36 54	106 F 46 70	126 V 56 86	146 f 66 102	166 v 76 118
0 1 1 1	7 BEL 7 7	27 ETB 17 23	47 ' 27 39	67 7 37 55	107 G 47 71	127 W 57 87	147 g 67 103	167 w 77 119
1 0 0 0	10 BS GET 8 8	30 CAN SPE 18 24	50 (28 40	70 8 38 56	110 H 48 72	130 X 58 88	150 h 68 104	170 x 78 120
1 0 0 1	11 HT TCT 9 9	31 EM SPD 19 25	51) 29 41	71 9 39 57	111 I 49 73	131 Y 59 89	151 i 69 105	171 y 79 121
1 0 1 0	12 LF A 10	32 SUB 1A 26	52 * 2A 42	72 : 3A 58	112 J 4A 74	132 Z 5A 90	152 j 6A 106	172 z 7A 122
1 0 1 1	13 VT B 11	33 ESC 1B 27	53 ÷ 2B 43	73 ; 3B 59	113 K 4B 75	133 [5B 91	153 k 6B 107	173 { 7B 123
1 1 0 0	14 FF C 12	34 FS 1C 28	54 , 2C 44	74 < 3C 60	114 L 4C 76	134 \ 5C 92	154 l 6C 108	174	7C 124
1 1 0 1	15 CR D 13	35 GS 1D 29	55 − 2D 45	75 = 3D 61	115 M 4D 77	135] 5D 93	155 m 6D 109	175 } 7D 125
1 1 1 0	15 SO E 14	36 RS 1E 30	56 . 2E 46	76 > 3E 62	116 N 4E 78	136 ∧ 5E 94	156 n 6E 110	176 ~ 7E 126
1 1 1 1	17 SI F 15	37 US 1F 31	57 / 2F 47	77 ? UNL 3F 63	117 O 4F 79	137 — UNT 5F 95	157 o 6F 111	177 RUBOUT (DEL) 7F 127
	Address command	Universal command	Listen address		Talk address		Secondary address or command	

KEY

octal	25 NAK PPU	GP-IB code
		ASCII character
hex	15 21	decimal

* U S A Standard Code for Information Interchange

APPENDIX B

GP-IB INTERFACE INTERRUPT CAUSE BIT ASSIGNMENT

Bit No.	Cause
0	Set at controller
1	EIO detected Packet was controller and interrupt generated when not talker or listener
2	SRQ received
3	Remote/local state changed
4	MTA received
5	MLA received
6	GET received
7	Device clear received
8	IFC received
11	Parity error during data read
12	MLA/MTA cleared
13	
14	
15	

APPENDIX C

IEEE STANDARD ABBREVIATIONS INDEX

A

AC ----- Address Command
ACDS ----- Accept Date State
ACG ----- Addressed Command Groop
ACRS ----- Accepter Ready State
AD ----- Address
AH ----- Accepter Handshake
AIDS ----- Accepter IDle State
ANRS ----- Accepter Not Ready State
APRS ----- Affirmative Poll Response State
ATN ----- Attention
AWNS ----- Accepter Wait for New cycle State

C

C ----- Controller
CACS ----- Controller Active State
CADS ----- Controller Addressed State
CAWS ----- Controller Active Wait State
CIDS ----- Controller Idle State
CPWS ----- Controller Parallel Poll Wait State
CSBS ----- Controller Standby State
CSNS ----- Controller Service not Requested State
CPPS ----- Controller Parallel Poll State
CSRS ----- Controller Service Requested State
CSWS ----- Controller Synchronaus Wait State
CTRS ----- Controller Transfer State

D

DAB ----- Data Byte
DAC ----- Data Accepted
DAV ----- Data Valid
DC ----- Device Clear
DCAS ----- Device Clear Active State
DCIS ----- Device Clear Idle State
DCL ----- Device Clear
DD ----- Device Data
DIO ----- Data input/output
DT ----- Device Trigger
DTAS ----- Device Trigger Active State
DTIS ----- Device Trigger Idle State

E

END ----- End
EOI ----- End Or Identify
EOS ----- End of String

G

GET ----- Group execute Trigger
GTL ----- Go to Local
gts ----- go to stanby

I

IDY ----- Identify
IFC ----- Interface Clear
ist ----- individual Status

L

L ----- Listener
LACS ----- Listener Active State
LAD ----- Listener Address
LADS ----- Listener Addressed State
LAG ----- Listen Address Group
LE ----- Extended Listener
LIDS ----- Listener Idle State
LLO ----- Local Lock Out
LOCS ----- Local State
lon ----- Listen only
LPAS ----- Listener Primary Addressed State
lpe ----- Local Poll enabled
LPIS ----- Listener Primary Idle State
ltn ----- Listen
LWLS ----- Local with Lockout State
lun ----- Local unlisten

M

MLA ----- My Listen Address
MSA ----- My Secondary Address
MTA ----- My Talk Address

N

nba ----- new byte available
NDAC ----- Not Data Accepted

NPRS ····· Negative Poll Responce State
NRFD ····· Not Ready For Data
NR ····· Numeric Representation
NUL ····· Null Byte

O

OSA ····· Other Secondary Address
OTA ····· Other Talk Address

P

PACS ····· Parallel Poll Addressed to Configure State
PCG ····· Primary Command Group
pof ····· Power-off
pon ····· Power-on
PP ····· Parallel Poll
PPAS ····· Parallel Poll Active State
PPC ····· Parallel Poll Configure
PPD ····· Parallel Poll Disable
PPE ····· Parallel Poll Enable
PPIS ····· Parallel Poll Idle State
$PPR_{1\sim8}$ ····· Parallel Poll Response 1 ~ 8
PPSS ····· Parallel Poll Standby State
PPU ····· Parallel Poll Unconfigure
PUCS ····· Parallel Poll Unaddressed to Configure State

R

rdy ····· ready for next message
REMS ····· Remote State
REN ····· Remote Enable
RFD ····· Ready For Data
RL ····· Remote Local
rPP ····· request Parallel Poll
RQS ····· Request Seervice
rsc ····· request system Control
rsv ····· request service
rtl ····· return to local
RWLS ····· Remote With Lockout state

S

SACS ····· System Control Active State
SCG ····· Secondary Command Group
SDC ····· Selected Device Clear
SDYS ····· Source Delay State
SE ····· Secondary Message
SGNS ····· Source Generate State
SH ····· Source Handshake
SIAS ····· System Control Interface Clear Active State
sic ····· Send interface clear
SIDS ····· Source IDle State
SIIS ····· System Control Interface Clear Idle State
SINS ····· System Control Interface Clear Not Active State
SIWS ····· Source Idle Wait State
SNAS ····· System Control Not Active State
SPAS ····· Serial Poll Active State
SPD ····· Serial Poll Disable
SPE ····· Serial Poll Enable
SPIS ····· Serial Poll Idle State
SPMS ····· Serial Poll Mode State
SR ····· Service Request
SRAS ····· System Control Remote Enable Active State
sre ····· Send remote enable
SRIS ····· System Control Remote Enable Idle State
SRNS ····· System Control Remote Enable not active State
SRQ ····· Service Request
SRQS ····· Service Request State
ST ····· Status
STB ····· Status Byte
STRS ····· Source Transfer State DAV to Low
SWNS ····· Source Wait for New cycle State
SACS ····· System Control Active State

T

T ····· Talker
TACS ····· Talker Active State
TAD ····· Talk Address
TADS ····· Talker Addressed State
TAG ····· Talker Addressed Group
tca ····· take Control asynchronously
tcs ····· take Control synchronously
TCT ····· Take Control
TE ····· Extended Talker
TIDS ····· Talker Idle State
ton ····· talk only
TPAS ····· Talker Primary Addresed State
TPIS ····· Talker Primary Idle State

U

U ····· Uniline Message
UC ····· Universal Command
UCG ····· Universal Command Group
UNL ····· Unlisten
UNT ····· Untalk

APPENDIX D

OPTIONS

(1) Accessories

Ordering No.	Name	Remarks
34Y73726C	Protective covers	Protects front panel and rear panels, one-touch installation
34Y73731C	Front handle kit	Two handles
34Y73732C	Rack mounting kit	Handle + rack angle : 2

(2) Transformer

Model	Impedance		Frequency range
	Input	Output	
MA29J	50 Ω	600 Ω	30 Hz to 150 kHz
MA313J	50 Ω	75 Ω	4 kHz to 2 MHz
MA314J	50 Ω	135 Ω	4 kHz to 2 MHz
MA315J	50 Ω	150 Ω	4 kHz to 2 MHz

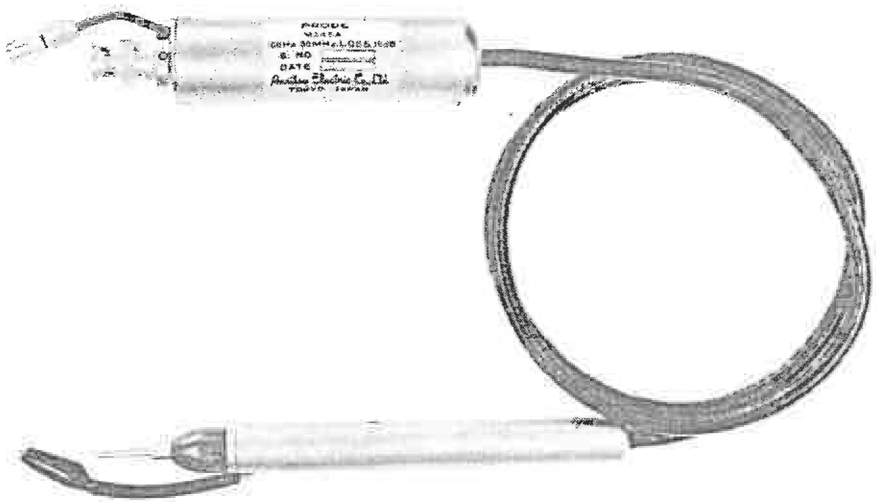
. Input connector: BNC

. Output connector: Fits M-214

. Frequency characteristic: $\leqq$0.3 dB

. Return loss: $\geqq$25 dB

(3) AC probe (MA45A)



Item	Specifications
Frequency	100 Hz to 30 MHz
Input level	2.74 Vrms max
Input capacitance	$\leqq$20 pF
Input impedance	$\leqq$3 MΩ
Loss	10 dB

(4) Cables

Name	Details
Coaxial cable	BNC-BNC 0.5 m, 1 m, 2 m
I/O port cable	36 pins-36 pins 2 m
GP-IB cable	24 pins-24 pins 1 m, 2 m

APPENDIX E

PACKET V PERSONAL TECHNICAL COMPUTER

Main unit

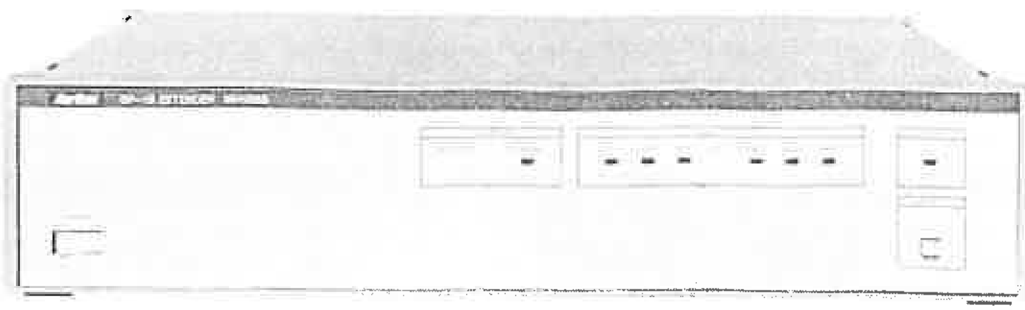
Item		Packet V_F (MC1201A)	Packet V_H (MC1202A)	Packet V_B (MC1203A)
CPU		68000 (clock frequency 8 MHz)		
Memory	ROM	32 KB		
	RAM	512 KB (no-wait) 14 MB maximum (with expansion box, 1 clock wait added)		
	VRAM	• 128 KB for graphics • 16 KB for characters		
	CMOS RAM	1 K × 4 bits (battery backup)		
Display functions	Interface	Separate video outputs (one connector for both color and monochrome displays)		
	Resolution	640 × 400 dots		
	Character fonts	Alphanumeric 6 × 10 dots		
	Character screen	80 characters × 25 lines		
	Graphics screen	• Page mode 4 screens (can be superimposed) • RGBI mode 1 screen Both character and graphics screens can be superimposed.		
	Monochrome display	16 gradations		
	Colors	• RGBI mode: 15 colors • Page mode: 2 colors (for each graphics screen)		
Clock		Year / month / day / hour / minute / second / day-of-week (backed up by a lithium battery for longer than 7 years)		
Timer		10 ms resolution		
Counter		1 ms resolution		
Tone generator		Frequency: 200 Hz to 15 kHz Duration: 2 ms to 32.767 s Volume control: 0 to 30 dB (relative value) with triad and noise generators		
Auxiliary storage		• One 3.5″ floppy disk drive (640 KB) (Additional drive is available as option.)	• One 3.5″ hard disk drive (20 MB) • One 3.5″ floppy disk drive (640 KB)	• One bubble cassette drive (128 KB) • One bubble memory board (512 KB)
Expansion slots		3 slots (VME bus type)		
Operating conditions	Temperature	5° to 45°C		0° to 50°C
	Humidity	20% to 80% (no condensation)		
Power		85 to 132 V or 170 to 250 V, 47 to 63 Hz		
		130 VA	170 VA	150 VA
Dimensions		132.5H × 390W × 400D mm		
Weight		8.5 kg	10.0 kg	9.0 kg
Option 01		Additional 3.5″ floppy dusk drive (640 KB)	—	
Option 03		1 MB RAM		

CRT display

Item		Monochrome display monitor (MC3601A)	Color display monitor (MC3602A)
Screen size		12 inches	12 inches
Color		Amber	15 colors (RGBI)
Resolution		640 dots (horizontal) × 400 dots (vertical)	
Tilt		0° to 20° (vertical)	
Swivel		±45° (horizontal)	
Horizontal sync. frequency		24.83 kHz	
Vertical sync. frequency		56.4 Hz	
Operating conditions	Temperature	0° to 50°C	5° to 45°C
	Humidity	20% to 80% (no condensation)	
Power consumption		85 to 264 V, <50 VA	90 to 130 V or 180 to 250 V, <100 VA
Dimensions		341H × 326W × 363D mm	
Weight		9 kg	11.2 kg

APPENDIX F

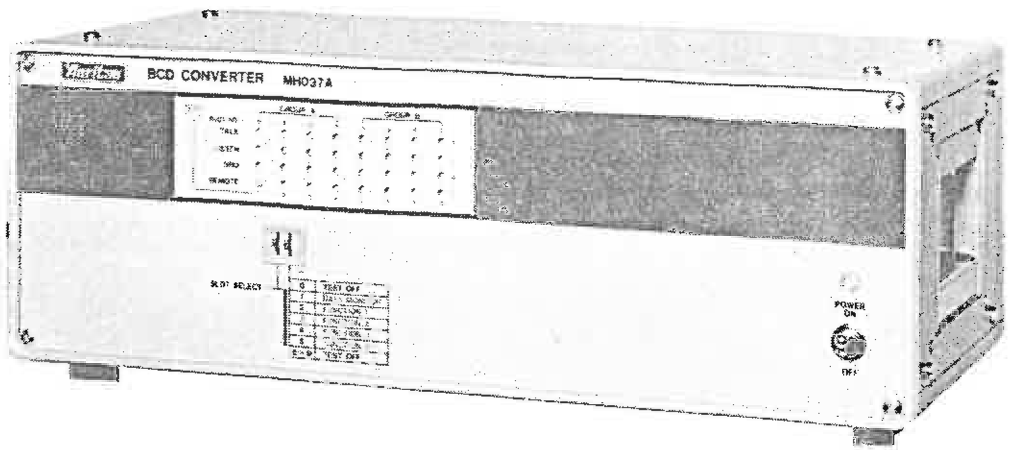
GP-IB EXTENDER (MH055B)



Item	Specifications
GP-IB interface transfer	GP-IB interface status can be sent to the opposite extender.
Serial interface	. Modem interface (JISC6361, RS232C) . Current loop interface (20 mA) . Internal modem (Option)
Communication system	. Full duplex . Asynchronous
Communication speed	110,300,600,1200,2400,4800,9600 bit/s
Character format	. Start bit 1 . Data bits 8 . Parity bit Even/odd/none . Stop bit 1/2
Serial interface connector	DB-25P

APPENDIX G

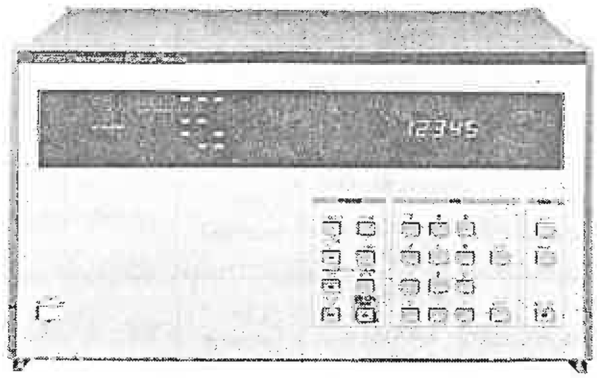
BCD CONVERTER (MH037A)



Interface	GP-IB 2 types of primary addresses; 2 types of ONLY mode can be set. SH1,AH1,TE5,LE3,SR1,RL2,PP0,DC1,DT1,C0
Input/output slot	Up to 8 units in any combination can be mounted on the rear panel.
Conversion of BCD code apart from 0 to 9	Any ASCII Code (except C_R and L_F codes) can be set respectively at the primary addresses
SRQ Mask	Can be set for each unit.
Checking	Data monitor, switch displays, status displays, display of input unit data line, lamp test, test pattern and timing pulse transmission to the output unit.
Units	MH038A Parallel Input Unit: 32 bit TTL MH039A Parallel Output Unit: 32 bit TTL MH044A Parallel Input Unit: 20 bit photocoupler MH054A Parallel Output'Unit: 16 bit relay contact

APPENDIX H

MULTIFUNCTION SELECTOR (MS010A)



Item	Specifications
Slots units	23 slots, multiple slots used according to the kind of unit
Interface	GP-IB SH1,AH1,T6,L4,SR1,RL1,PP0,CD1,PT0,C0
Channel combination setting	60
Collection data setting	60
Self-check function	SELF TEST key, executed when power turned on

Model	Number of channels (connector)	Common channel (connector)	Frequency range	Impedance	Insertion loss	Return loss	Crosstalk attenuation	Passband noise
MH356A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz	75Ω balanced	≦0.2dB	≧35dB	≧100dB	≦−120dBm
			650kHz to 2MHz				≧90dB	
MH357A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz	110Ω balanced	≦0.2dB	≧35dB	≧100dB	≦−120dBm
			650kHz to 2MHz				≧90dB	
MH358A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz	135Ω balanced	≦0.2dB	≧35dB	≧100dB	≦−120dBm
			650kHz to 2MHz				≧90dB	
MH359A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz	150Ω balanced	≦0.2dB	≧35dB	≧100dB	≦−120dBm
			650kHz to 2MHz				≧100dB	
MH220A	6 (57-40500)	1 (HR10-10R-12S)	DC to 150kHz	600Ω balanced	≦0.2dB	≧35dB	≧115dB	≦−120dBm
MH483A	6 (BNC)	1 (BNC)	DC to 10MHz	75Ω unbalanced	≦0.2dB	≧30dB	≧80dB	≦−120dBm
MH494AB	6 (BNC) (SP2.5CPS)	1 (BNC) (SP2.5CPS)	DC to 13MHz	75Ω unbalanced	≦0.2dB	≧35dB	≧115dB	≦−120dBm
			13 to 30MHz		≦0.3dB	≧33dB	≧105dB	
			30 to 100MHz		≦0.5dB	≧22dB	≧95dB	
MH655A	4 (BNC)	4 (BNC)	DC to 100kHz	50Ω unbalanced	≦0.2dB	≧25dB	≧90dB	≦−100dBm
			100 to 500MHz		≦0.5dB	≧22dB	≧80dB	

APPENDIX I

CONNECTION TO UA-455A VIDEO PLOTTER

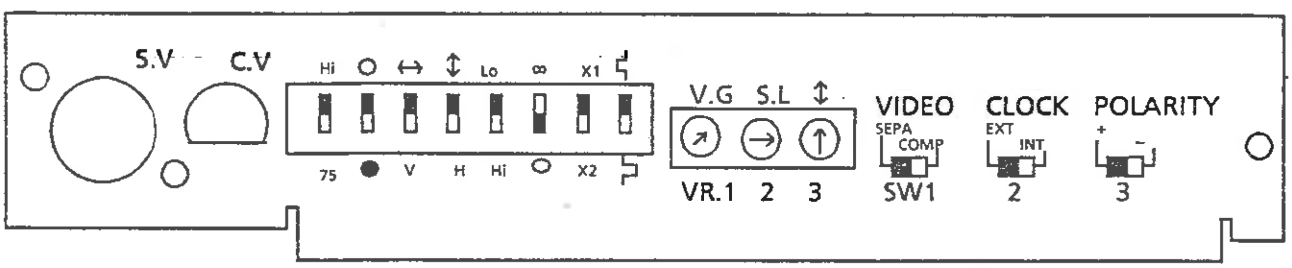
When connecting the MS3401A to the UA-455A Video Plotter to copy the screen, select the connection cable and set the UA-455A rear panel switches and controls as described below.

Connection cable: DIN-8P cable

Two kinds of connection cables are supplied with the UA-455A:

DIN-8P cable (1 m) and BNC coaxial cable (2 m)

Setting of switches and controls



CAUTION

Before turning on the UA-455A power, check that the ac line voltage is correct.

If the ac line voltage is unsuitable, the instrument may be damaged.

Notes:

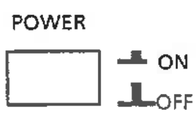
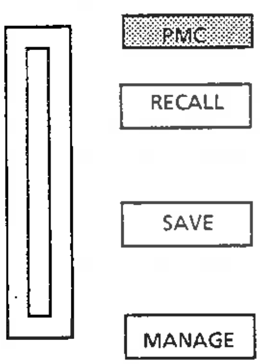
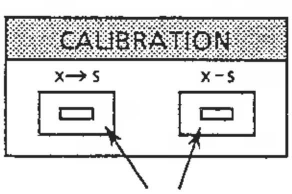
1. Set the switch to the black side.
2. Set the controls to the average position.

For a detailed description of adjustment, refer to the UA-455A operation manual.

APPENDIX J

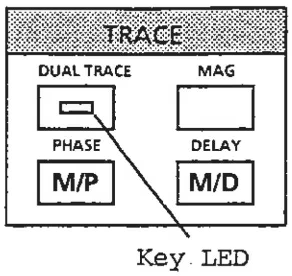
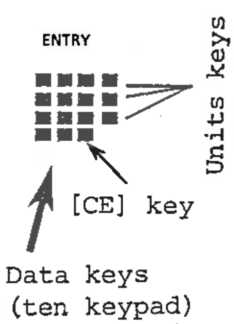
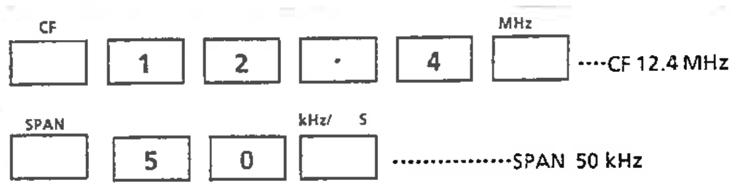
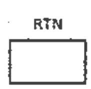
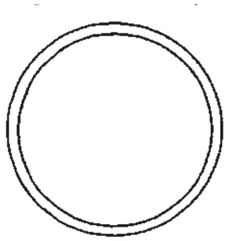
FRONT AND REAR PANELS DESCRIPTION TABLE

The front panel is shown in Fig. J-1 and the rear panel is shown in Fig. J-2. The functions of the keys, connectors, and displays on these panels are described according to the numbers in the table below. For further information, see SECTION 3 and SECTION 5.

No.	Panel marking	Function
1		Power switch: Set the switch to the POWER ON position, to supply ac power to the MS3401A. Set the switch to the POWER OFF position, to turn off the ac power.
2		CRT display: Displays the result of DUT circuit network magnitude, phase, group delay, and other measurements by Cartesian coordinates system. Also displays the measurement conditions, etc. graphically.
3		PMC (Plug-in Memory Card) slot and keys: A memory card plugs into the PMC slot. Press the [SAVE] key to save data; the [RECALL] key to recall saved data; and the [MANAGE] key to WRITE PROTECT and erase the card data, format the card, etc. Press one of these three keys to display messages on the CRT correspond to soft keys [F1] to [F5] functions. (See Table J-2.)
4	 Key LED*	CALIBRATION: These keys are used to make meaure-ments by removing the error (offset error) caused by the measuring system frequency characteristic. Press the [X→S] key to measure the measuring system frequency characteristic and store the result in the S-memory. When the [X-S] key is pressed, the internal LED lights and the frequency characteristic of only the DUT is measured.

*LED (Light-Emitting Diode)

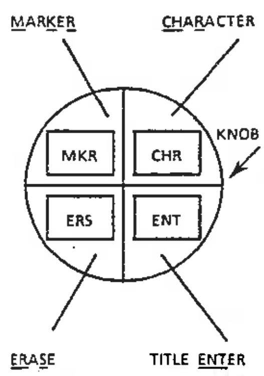
(cont'd)

No.	Panel marking	Function
5		TRACE: These keys select the measurement item: magnitude (MAG), phase (PHASE), delay (DELAY), simultaneous magnitude/phase (M/P), or magnitude/delay (M/D). To measure magnitude, phase, and delay singly, press either the [MAG], [PHASE], or [DELAY] key respectively, with the [DUAL TRACE] key set to OFF (internal LED off). For M/P measurement, press the [M/P] key with the [DUAL TRACE] key set to ON (internal LED on). For M/D measurement, press the [M/D] key with the [MAG] and [PHASE] keys set to ON.
6		Use these keys to enter the sweep time (SWEEP) or measurement frequency range center frequency (CF) and sweep span (SPAN). The [CE] key clears previous data entries. (CE: Clears Entry Data) 
7		RETURN key (RTN: RETURN) at PMC (Plug-in Memory Card) WRITE PROTECT and formatting MS3401A formatting example: 1. Plug a new PMC into the PMC slot. 2. [MANAGE] [F4] [RTN]
8		Knob: Set the functions shown below to the prescribed data by turning this knob. (1) MARKER (2) SCALE A/B, OFFSET A/B (3) CF/SPAN, START/STOP (4) SWEEP TIME (5) INPUT RANGE (6) RESOL. BW, VIDEO BW (7) DLY RANGE (8) TITLE

(cont'd)

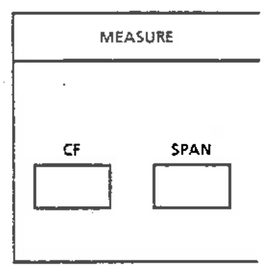
No. | **Panel marking** | **Function**

9

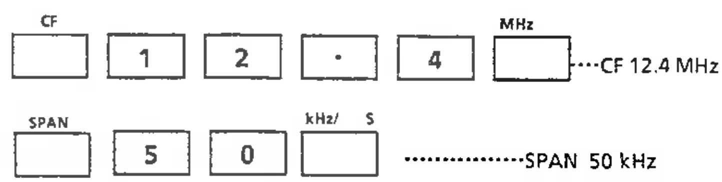


Press the [MKR] key to move the current marker with the knob.
Press the [ENT] key to input the character selected with the knob as the title.
Press the [CHR] key to select the type of characters (upper-case alphabetic, lower-case alphabetic, numeric/symbol).
Press the [RES] key to erase the message selected with the knob by pressing the [ENT] key.

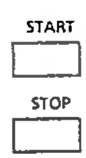
10



MEASURE: These keys set the MS3401A measurement conditions.
Press the [CF] key to set the measurement frequency range center frequency.
Press the [SPAN] key to set the sweep bandwidth.

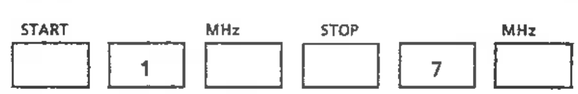


11



These keys set the measurement frequency range LOG or LINEAR sweep start frequency (START) and sweep stop frequency (STOP).
Start frequency 1 MHz, stop frequency 7 MHz setting example:

1. After pressing the [EXP] key, select LINEAR using the [F5] key.

2. 

(cont'd)

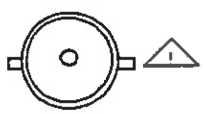
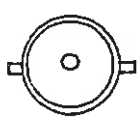
No.	Panel marking	Function
12	MKR→ CF Δ→ SPAN	Press the [MKR→CF] key to set the current marker frequency to the measurement range center frequency (CF). When the [Δ→SPAN] key is pressed, the measurement frequency range sweep span (SPAN) is set to the difference between the current marker frequency and reference marker frequency.
13	SWEEP TIME	Press the [SWEEP TIME] key then set the sweep time with the [ENTRY] keys or the knob. Sweep time 52 ms setting example: SWEEP TIME | 5 | 2 | Hz/ mS
14	AUTO	When the [AUTO] key is pressed, the message show below is displayed on the CRT. Optimise the measurement conditions automatically by selecting the items corresponding to this message by using the [F1] to [F5] keys. SWEEP TIME | RESOL.BW | VIDEO BW | DLY RANGE | UNCAL on
15	EXP	When the [EXT] key is pressed, the message shown below is displayed on the CRT. Set the measurement conditions by selecting the desired items corresponding to this message by using the [F1] to [F5] keys. RESOL.BW | VIDEO BW | DLY RANGE | 50 Ω/75 Ω | LOG/LIN
16	INPUT RANGE	This key sets the MS3401A input ATT. When the input level is higher than INPUT RANGE, OVERLOAD is displayed on the CRT. Measurements can be made in the optimum state by setting the input ATT immediately before this message is displayed.

(cont'd)

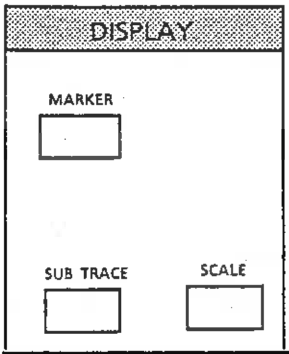
No.	Panel marking	Function
17	CONTROL SWEEP	CONTROL: This key controls the sweep (SWEEP), PMC operation (DEFINE), measurement points etc. (PACKAGE), automatic measurement (PTA and GP-IB), and initialization (INITIAL) functions. When the [SWEEP] key is pressed, the message shown below is displayed on the CRT. Select the required item corresponding to this message and the sweep function is by using the [F1] to [F5] keys. FULL | MKR | REPEAT ST | SINGLE ST | STOP/RES
18	DEFINE	This key defines the PMC operation. SRAM* type PMC operation can be defined by user. PROM** type PMC (ANRITSU soft pack) operation is defined automatically. (see Table J-2.)
19	GP-IB INITIAL REMOTE LOCAL Key LED When the GP-IB is in the remote mode, the key LED lights.	Press the [INITIAL] key to initialize the MS3401A. When the [GP-IB] key is pressed, the message shown below is displayed on the CRT. Select the required item corresponding to this message and the GP-IB function of that item by using the [F1] to [4] keys. RTL | ADRS 1 | RSV | MONITOR |
20	PTA	Press this key to turn the PTA on and off when Option 01 PTA is installed. PTA (Personal Test Automation) performs measuring system high-speed calculation and control by using the high level language PTL (Personal Test Language), which resembles BASIC, through a controller inside the MS3401A.

*SRAM (Static Random Access Memory)
**PROM (Programmable Read Only Memory)

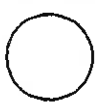
(cont'd)

No.	Panel marking	Function
21	PACKAGE	When the [PACKAGE] key is pressed, a message showing the averaging, measurement points, trace OVERLAP, and title functions is displayed as shown below. Select the desired item this message and the function by using the [F1] to [F4] keys. AVG 1 | MP 501 | OVERLAP off | TITLE off |
22	INPUT  MAX +20 dBm	The 10 Hz to 30 MHz signal passed through the DUT is input from this connector. The maximum permitted input level is +20 dBm; overinput may damage the input ATT. Select the input impedance from 50 Ω or 75 Ω by using the [EXP] key and soft key [F4].
23	PROBE SOURCE  +12 V 100 mA	This connector supplies +12 V, 100 mA power to the MA45A High Input Impedance Probe. A high input impedance probe is necessary for in-circuit measurements (transmission wave input measurement by parallel connection for the DUT circuit network). Connect the MA45A power supply terminal to this connector before turning on the MA3401A power.
24	OUTPUT  0 dBm	This connector outputs a 10 Hz to 30 MHz signal at a constant 0 dBm output level. Select the output impedance from 50 Ω or 75 Ω by using the [EXP] key and soft key [F4].

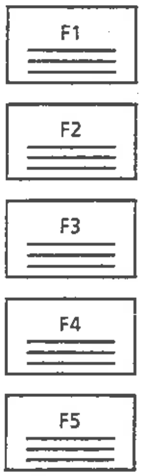
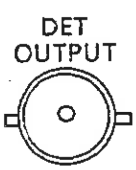
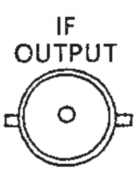
(cont'd)

No.	Panel marking	Function
25		DISPLAY: These keys provide a marker function and trace function for reading the measured results on the CRT display. When the either the [MARKER], [SUB TRACE], or [SCALE] key is pressed, the message shown in the shaded area below is displayed. Select each function by using soft keys [F1] to [F5].

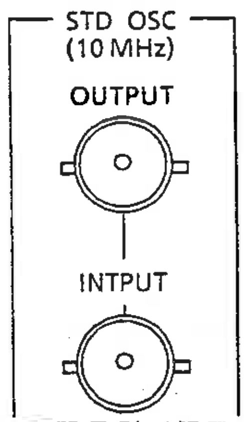
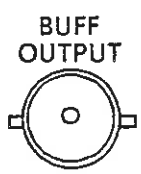
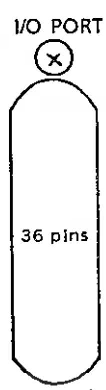
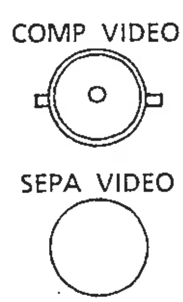
DISPLAY \ Soft key	F1	F2	F3	F4	F5
MARKER	ΔMKR	oMKR	MKR→MAX	MKR→MIN	MKR CHANGE
SUB TRACE	MT→ST	ST=MT	ST=MT-ST	OFF	ON
SCALE	AUTO	SCALE A	OFFSET A	SCALE B	OFFSET B

No.	Panel marking	Function
26	TO KEYBOARD 	The keyboard for controlling PTA when Option 01 PTA is installed connects to this connector.
27	INTENSITY 	This control adjusts the intensity of the CRT display. Turn it clockwise to brighten the entire screen; turn it counterclockwise, to darken the screen.

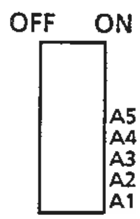
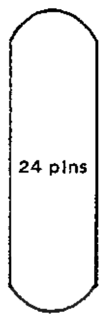
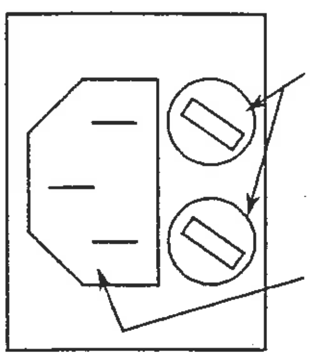
(cont'd)

No.	Panel marking	Function
28		When one of the panel keys shown in Table J-2 Soft Keys Functions Table is pressed, a message corresponding to soft keys [F1] to [F5] is displayed at the bottom of the CRT. Press the soft key corresponding to the message for the function. Example: GP-IB address check 1. Press the front panel CONTROL section [GP-IB] key. 2. The message shown below is displayed at the bottom of the CRT.  3. [ADRS 1] corresponds to the [F2] key and shows that the MS3401A address is 1.
29		Pull this operation card (MS3401A operating instructions summary) out to use it.
30		In the Cartesian coordinates system, the vertical axis of CRT represents the IF-signal detected output. Another detected output can be taken from the DET OUTPUT connector at approximately 0.4 to MAX 4 Vdc.
31		This connector outputs the 100 kHz IF signal at +6 dBm level. The output impedance is 600 Ω.

(cont'd)

No.	Panel marking	Function
32		STD OSC: Standard oscillator (10 MHz) input/output OUTPUT: Outputs the 10 MHz internal standard signal at TTL level. To use this signal with the MS3401A, connect this connector to the INPUT connector below it with a U-link. INPUT: Inputs the internal standard signal above or a 10 MHz external standard signal at TTL level.
33		This connector outputs the 10 MHz internal or external standard signal applied to the INPUT connector of No. 32 at TTL level.
34		This connector is used to control external device by PTA (Personal Test Automation - Option) function or control PTA function by external device. All input signals for control are negative logic. Control can be programmed by PTL language (Personal Test Language).
35		Connect the connectors to a video plotter to hard-copy the information on the MS3401A CRT. COMP VIDEO: Composite video output SEPA VIDEO: Separate video output

(cont'd)

No.	Panel marking	Function
36		These switches set the GP-IB address of the MS3401A. The MSB (most significant bit) of the bits is A5 and the LSB (least significant bit) is A1. Set bit level 1 by setting the switch to the right (ON) side, and bit level 0 by setting the switch to the left (OFF) side.
37		To remotely-control the MS3401A by GP-IB, connect the GP-IB interface bus to this connector. In the remote mode, the LED in the front panel CONTROL section [GP-IB] key lights.
38		This fan cools the MS3401A. Leave at least 10 cm between the MS3401A and walls, surrounding equipment, obstructions, etc. so that the air flow is not blocked.
39		Fuse holder. Contains *** A fuses. Ac inlet for the accessory power cord.
40		Connect this FG (Frame Ground) terminal to earth potential to prevent electric shock.