CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

APPENDIX

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

APPENDIX

NOTES

(1) This instrument is operable on a voltage from 100 Vac to 130 Vac or from 200 Vac to 260 Vac by changing the connections of power supply circuit.

The voltage is indicated on the rear panel when the instrument is shipped from the factory.

*(2) In this manual, a power supply input voltage and current rating are represented by **Vac and ***A.*

(3) The relation between power supply input voltage and current rating is listed below.

***Vac*	****A*
100 to 130 V	*5A*
200 to 260 V	*3.15A*

SECTION 1 GENERAL

CONTENTS

SECTION 1 GENERAL

1.1 INTRODUCTION

The MS420[ ] Network/Spectrum Analyzer can measure a magnitude, a phase, a delay, a level and a spectrum in the frequency range of 10 Hz to 30 MHz. It has also a synthesizer as a test signal source and a built-in CRT for displaying measured values.

This analyzer can be used as an impedance analyzer in combination with a reflection bridge or impedance probe. There are available as separate accessories. Order from Anritsu Electric Co., Ltd.

Use of options, application parts and peripheral devices makes it possible to extend measuring functions and automatic measurements.

Principle Measurement Capabilities

(a) Frequency response

- Magnitude
- Phase
- Delay time
- Crosstalk
- Frequency spectrum
- Level
- Noise
- Frequency conversion loss (requiring an external synthesizer)
- End to end transmission characteristics (requiring two MS420[ ])
- Impedance (requiring an impedance measuring kit)

(b) Level response

- Linearity
- Companding characteristics

(c) Frequency count

(d) Time domain

- Envelope display

Table 1.1 indicates a list of components requiring measurement, parameters measured, required options, peripheral devices and the location of test description in this manual.

Note

Modeles MS420B and MS420K were designed respectively for 75 Ω and 50 Ω. The designation "MS420[ ]" represents both models.

Table 1-1 Measuring Components

Component	Type of measurement	Options, peripheral devices	Details
Coil Capacitor Resistance	◦ Impedance characteristics	Impedance measuring kit	
Transformer	• Impedance characteristics • Magnitude, Phase, Delay time • Crosstalk ◦ Distortion	Impedance measuring kit (Low distortion signal source)	 3.1 3.2.2
Resonator ◦ Crystal • Ceramic	◦ Impedance characteristics • Resonant frequency ◦ Antiresonance frequency • Spurious • Equivalent constant	Impedance measuring kit PTA option or personal computer	
Delay line	• Magnitude, Delay time • Impedance characteristics • Crosstalk	 Impedance measuring kit	3.1
Cable	• Magnitude, Phase, Delay time ◦ Impedance characteristics ◦ Crosstalk	 Impedance measuring kit	3.1
Mixer	• Conversion loss (magnitude) • Carrier leak • Spurious	Synthesizer	3.6.4 3.2.2
Diode	• Impedance characteristics	Impedance measuring kit	
Transistor FET	• S-parameter • Distortion • Noise	S-parameter test set (Low distortion signal source)	 3.2.4
Operational amplifier	◦ Open gain, phase • CMRR • Power rejection • I/O impedance • Distortion ◦ Noise • Maximum output level	 Impedance measuring kit (Low distortion signal source)	4.4

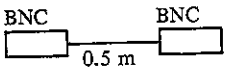
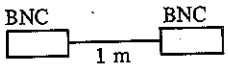
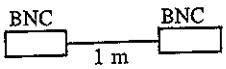
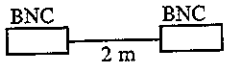
Component	Type of measurement	Options, peripheral devices	Details
Switch Semiconductor switch	· Magnitude, Phase, Delay time · Impedance characteristics · Crosstalk	Impedance measuring kit	3.1
Compander AGC amplifier	· Level characteristics		4.6
Magnetic head	· Impedance characteristics	Impedance measuring kit	
Antenna	· Impedance characteristics	Impedance measuring kit	
Optical element	· Magnitude, Phase, Delay time · Distortion · Impedance characteristics	(Low distortion signal source) Impedance measuring kit	4.7
Oscillator	· Frequency · Spurious · C/N · Output level		3.6.3 3.2.2 3.2.3
Filter · Crystal · Ceramic · LC · SAW · Active · Mechanical · SCF · Digital	· Magnitude, Phase, Delay time · Level characteristic · Characterization Center frequency, bandwidth Guaranteed attenuation, ripple · Impedance characteristics	PTA option Impedance measuring kit	4.2
Feedback loop · AGC circuit · PLL · AFC · Servo system	· Loop gain · Compressing characteristics		3.1
Equalizer	· Magnitude, Phase, Delay time		3.1
Dolby IC	· Magnitude · Level characteristic		3.1

Component	Type of measurement	Options, peripheral devices	Details
AM modulator	· Modulation factor · Modulation distortion · Modulation frequency response · Envelope measurement		4.8

1.2 COMPOSITION AND SPECIFICATIONS

Table 1-2 shows the standard composition of the MS420[ ]. See the appendix at the end of this manual for its specifications.

Table 1-2 Standard Composition

Item	Name	Q'ty	Remarks
Instrument	MS420[ ]	1	B type: 75Ω K type: 50Ω
Accessories	Measuring cable	2	 for B type
		1	 for B type
		2	 for K type
		1	 for K type
	Key for power switch	2	
	Power supply cord	1	
	Fuse	1	100 to 130Vac: 5A 200 to 260Vac: 3.15A
	Operation Manual Network/Spectrum Analyzer MS420[ ]	1	
	Service Manual Network/Spectrum Analyzer MS420[ ]	1	

1.3 OPTIONS, ACCESSORIES, PERIPHERAL DEVICES AND RECOMMENDED DEVICES

Table 1-3 indicates their selection guide.

Table 1-3 Selection Guide for Options and Application Parts

[Options]

Name	Uses	Remarks
PBMI option	An interface for PBM (plug-in Bubble Memory) which can be incorporated in the MS420[ ]. (Use) • Can store 6 kinds of panel setting content in one PBM. • Can use the PBM as a file of the PTA.	Attaches one PBM. See appendix 2 for details.
PBM option	An 8K byte bubble memory which can be plugged-in from the front panel.	See appendix 2 for details.
PTA option	A built-in interpreter of the PTL (Personal Test Language) which performs control and calculation of the MS420[ ]. PTA option can be incorporated in the MS420[ ].	Concurrent use of the PBMI, PBM and printer is recommended. See appendix 2 for details.
Angles	Panel cover, front handle kit, and rack mount adapter kit can be provided.	See appendix 3 for details.

[Accessories]

Name	Uses	Remarks
Transformer	Used for measurements of balanced circuit or other impedance than 75Ω and 50Ω.	See appendix 8 for details.
AC probe	Used for in-circuit measurement.	See appendix 5 for details.
Cable	Measurement and interface cables can be provided.	See appendix 6 for details.
Impedance measuring kit	Reflection bridge and impedance probe can be provided for impedance measurement.	See appendix 7 for details.
Portable test rack	Can be used as the movable bench car of the MS420[ ] or can tilt it.	See appendix 8 for details.

[Peripheral Devices]

Name	Uses	Remarks
Synthesizer	Used as the signal source for offset tracking	See appendix 9 for details.
S-parameter test set	Used for S-parameter measurement	See appendix 10 for details.
GP-IB extender	Used to interlock one MS420[ ] with another at end to end.	See appendix 11 for details.
Personal computer	Used as a controller when an automatic measuring system is configured through GP-IB.	See appendix 12 for details.
BCD converter	Can be controlled by the PTA or personal computer through GP-IB (Use) Control of jig	See appendix 13 for details.
Multifunction selector	Can be controlled by the PTA or personal computer through GP-IB. (Use) Used as scanner.	See appendix 14 for details.

[Recommended Devices]

Name	Uses	Remarks
Polaroid camera	Used for hard copying of the picture on the CRT.	See appendix 15 for details.
Video plotter	Used for hard copying of the picture on the CRT.	See appendix 16 for details.
Video display	Used to enlarge the picture on the CRT.	See appendix 17 for details.
Printer	Used as peripheral device for hardcopy printout of measured values or the PTA option is used.	See appendix 18 for details.
High impedance probe	Used for in-circuit measurement.	See appendix 19 for details.

SECTION 2 OPERATION

CONTENTS

CONTENTS (Cont'd)

SECTION 2 OPERATION

2.1 POWER SOURCE

The MS420[ ] normally operates on ** Vac ±10 %, 50/60 Hz. See Notes at beginning of manual.

WARNING

1. *Be sure to ground the ⏚ terminal on the rear panel of the unit or the ground terminal of the power supply cord to avoid electrical shocks.*
2. *Make sure the power switch is off and the power supply cord unplugged whenever replacing fuses.*

2.2 ENVIRONMENTAL CONDITIONS OF THE INSTALLATION SITE

The MS420[ ] operates normally at an ambient temperature from 0 to 45°C. It should not, however, be used in any of the following locations:

a. Locations subject to strong vibrations

b. Damp or dusty areas

c. Locations exposed to direct sunlight.

d. Locations which might be exposed to active gases.

CAUTION

If the MS420[ ] is used at standard room temperature after having been used or stored at temperatures as low as 0°C for an extended period, condensation may cause it to short circuit. Be sure that the MS420[ ] is free from condensation before turning the power on.

2.3 MAXIMUM INPUT SIGNAL LEVEL

CAUTION

If an external signal of +20 dBm or more is applied to the INPUT and OUTPUT terminals of the MS420[ ] it may damage the internal circuitry.

2.4 MAXIMUM SUPPLY CURRENT

CAUTION

The PROBE SOURCE can supply maximum 50 mA at +15 V. Larger loads will blow the internal fuses.

2.5 FRONT PANEL DESCRIPTION

Figure 2.1 shows the front panel of the MS420[ ]. The operation keys are used in the following three modes:

(a) Basic mode

When the power is first turned on the keys are set to basic mode. The functions indicated directly on the front panel are executed in this mode. General descriptions of these functions are given in Table 2.1.

(b) ADV FUNCTION mode

This mode is activated by pressing the BEGIN key (blue key) and it remains effectively until the RETURN key is pressed. Keys 0 to 9 and some of the operations indicated on the key top are executed when in this mode. Refer to paragraph 2.8 - (35) for further details.

(c) PTA mode

This is the active mode if the MS420[ ] is equipped with the PTA option. When the PTA lamp is lit, the operations indicated on the key tops and keys 0 to 9 can be executed.

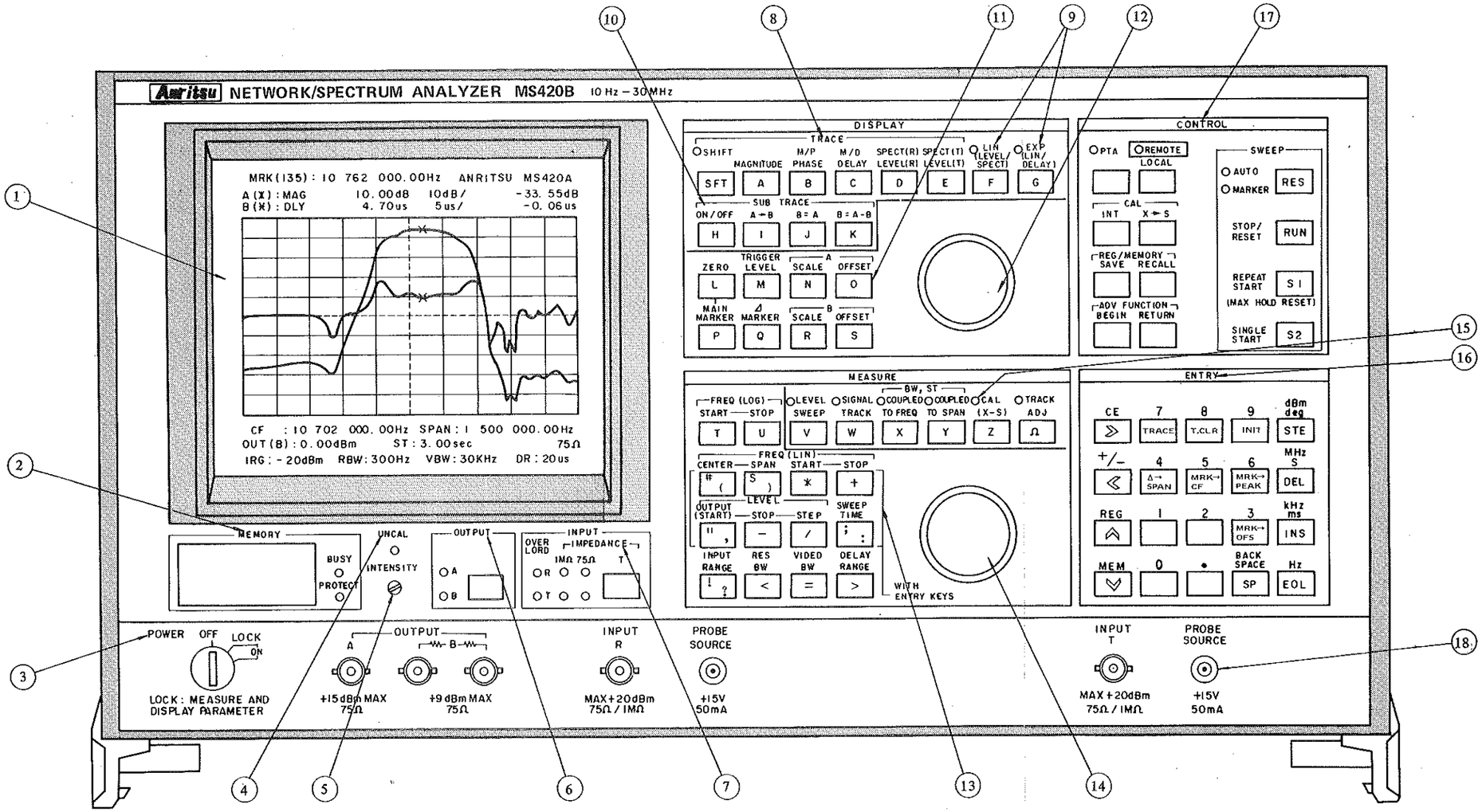


Fig. 2-1 Front Panel

Table 2-1 Front Panel

	No.	General description	Details
	①	CRT	2.7
	②	MEMORY: PBM receptacle and operation indicator lamp	2.8 – (40)
	③	POWER: Power switch	2.8 – (1)
	④	UNCAL: Misoperation indication lamp	2.8 – (2)
	⑤	INTENSITY: CRT brightness adjustment knob	
	⑥	OUTPUT: Synthesizer output switching key	2.8 – (3)
	⑦	INPUT: Input terminal impedance indicator, overload indicator, and T input impedance switching key	2.8 – (4) 2.8 – (5)
DISPLAY	⑧	TRACE: Can set the following measurement functions: MAGNITUDE PHASE DELAY MAGNITUDE/PHASE MAGNITUDE/DELAY LEVEL (R) LEVEL (T) SPECT (R) SPECT (T)	2.8 – (6)
	⑨	LIN, EXP: Auxiliary keys for level, spectrum and delay measurements	2.8 – (7) 3.2.5
	⑩	SUB TRACE: Can set the following memory functions: A→B: Copies measured values into B memory. B = A: Displays the same measured values graphically on the CRT using a different scale. B = A – B: Subtracts the value in B memory from the measured value and displays the result on the CRT.	2.8 – (8) 3.4
	⑪	These keys specify the following items relating to the measured values displayed on the CRT. The display conditions are set using knob A ⑫.	
		A-SCALE, OFFSET	2.8 – (13)
		B-SCALE, OFFSET	2.8 – (14)
		MAIN MARKER	2.8 – (10)
		ΔMARKER	2.8 – (11)
		ZERO MARKER	2.8 – (9)
		TRIGGER LEVEL	2.8 – (12)

Table 2-1 Front Panel (Cont'd)

	No.	General description	Details
MEASURE	⑫	Knob A	
	⑬	These keys specify items to set the following measurement conditions. The actual measuring conditions are set by knob B ⑭ or ENTRY keys ⑯.	
		Frequency sweeping mode and frequency range.	2.8 – (15) ~ (17)
		Synthesizer output level	2.8 – (18)
		SWEEP TIME	2.8 – (19)
		INPUT RANGE	2.8 – (20)
		RES BW	2.8 – (21)
		VIDEO BW	2.8 – (22)
		DELAY RANGE	2.8 – (23)
	⑭	Knob B	
	⑮	'These keys set the following measurement functions:	
		LEVEL SWEEP	2.8 – (24)
		SIGNAL TRACK	2.8 – (25)
		COUPLED TO FREQ	2.8 – (26)
		COUPLED TO SPAN	2.8 – (27)
		CAL (X - S)	2.8 – (28)
		TRACK ADJ	2.8 – (29)
ENT-RY	⑯	ENTRY: is used to set the numerical measuring condition values and the addresses of SAVE and RECALL.	2.8 – (16) Note
CONTROL	⑰	These keys set the following control functions:	
		PTA	2.8 – (30)
		LOCAL	2.8 – (31)
		CAL-INT	2.8 – (32)
		CAL-X→S	2.8 – (33)
		REG/MEMORY	2.8 – (34)
		ADV FUNCTION	2.8 – (35)
		SWEEP	2.8 – (36) ~ (39)
	⑱	Input and output connectors	2.9

Table 2-2 Abbreviation

CRT Display	Front Panel Indication	Meaning
MRK	MAIN MARKER	MAIN MARKER
ΔMRK	ΔMARKER	ΔMARKER
FRQ	–	FREQUENCY COUNT (MARKER FREQUENCY)
MAG	MAGNITUDE	MAGNITUDE
PHA	PHASE	PHASE
DLY	DELAY	DELAY
M/P	M/P	MAGNITUDE/PHASE
M/D	M/D	MAGNITUDE/DELAY
L (R)	LEVEL (R)	LEVEL (R)
L (T)	LEVEL (T)	LEVEL (T)
S (R)	SPECT (T)	SPECTRUM (T)
S (T)	SPECT (T)	SPECTRUM (T)
LIN	LIN	LINEAR
EXP	EXP	EXPAND
VID	–	VIDEO
LIN/EXP	–	LINEAR/EXPAND
VID/EXP	–	VIDEO/EXPAND
dB/	SCALE	dB/DIVISION . . . . . SCALE
deg/	SCALE	deg/DIVISION . . . . . SCALE
nS/	SCALE	nS/DIVISION . . . . . SCALE
⋮	⋮	⋮
ms/	SCALE	ms/DIVISION . . . . . SCALE
CF	CENTER	CENTER FREQUENCY
SPAN	SPAN	SPAN FREQUENCY
START	START	START FREQUENCY
STOP	STOP	STOP FREQUENCY
OUT (A)	OUTPUT (START)	OUTPUT LEVEL or START LEVEL (level sweep)
OUT (B)	OUTPUT-A, B	( ): OUTPUT terminal
STOP	STOP	STOP LEVEL
STEP	STEP	STEP LEVEL
ST	SWEEP TIME	SWEEP TIME
IRG	INPUT RANGE	INPUT RANGE
RBW	RES BW	RESOLUTION BANDWIDTH
VBW	VIDEO BW	VIDEO BANDWIDTH
DR	DELAY RANGE	DELAY RANGE

2.6 REAR PANEL DESCRIPTION

The following Fig. 2-2 and Table 2-3 show the arrangement and functions of the switches and connectors on the rear panel of the MS420[ ].

Note

Be sure to set the STD switch to INT.

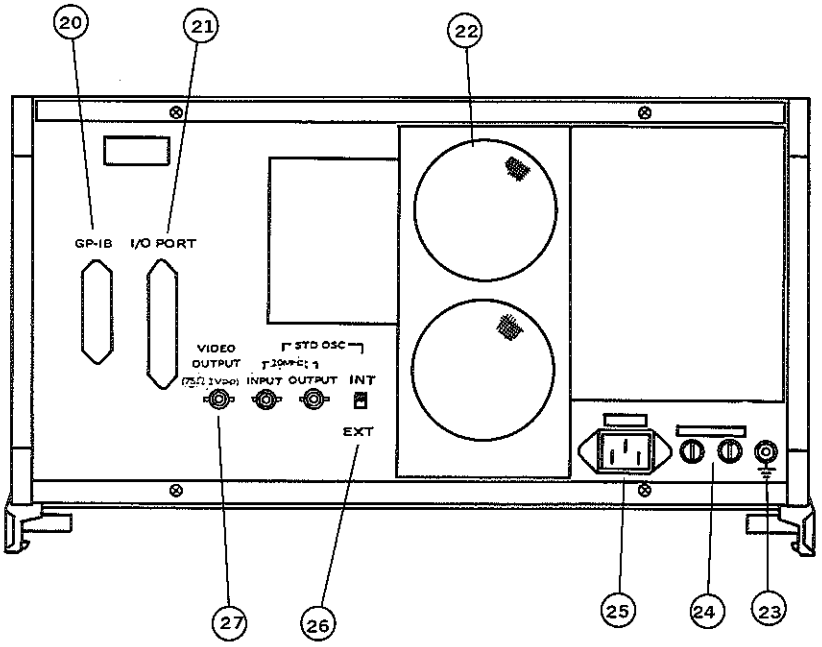


Fig. 2-2 Rear Panel

Table 2-3 Rear Panel

No.	General description		Details
⑳	GP-IB:	Connector for GP-IB	GP-IB OPERATION MANUAL
㉑	I/O PORT:	This I/O connector is used for periphreal controls using the PTA.	PTA OPERATION MANUAL
㉒	Fan		——
㉓	⏚ :	This ground terminal protects the user from electric shock.	——
㉔	FUSE:	Fuse holder	——
㉕	Power cable connector		——
㉖	STD OSC:	Reference oscillator (10 MHz) selection switch.	——
	OUTPUT:	Output connector of the reference oscillator.	——
	INPUT:	Input connector of the reference oscillator.	——
㉗	VIDEO OUTPUT: (75 Ω, 1 Vp-p)	Output connector for the video signal. The output voltage is about 1 Vp-p at 75 Ω load.	

2.7 CRT DISPLAY

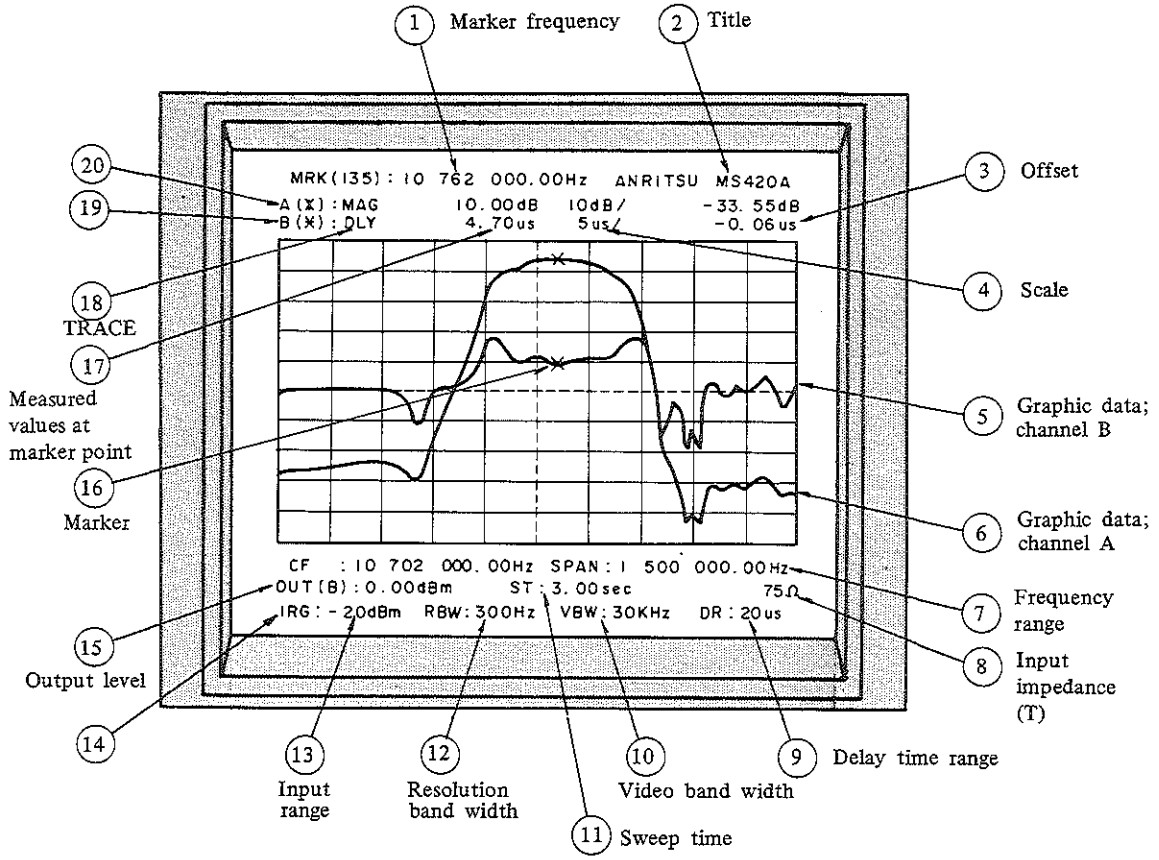


Fig. 2-3 CRT Display

(1) TRACE (Measuring items) (18)

These are displayed at (18)

Note

Line (19) and graphic data (5) are displayed only when M/P, M/D, or SUBTRACE is on.

For linear display and video sweep, line (20) is displayed as follows:

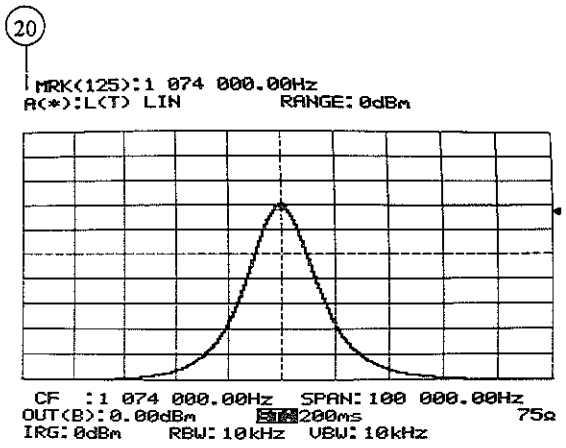


Fig. 2-4 Linear display (LIN)

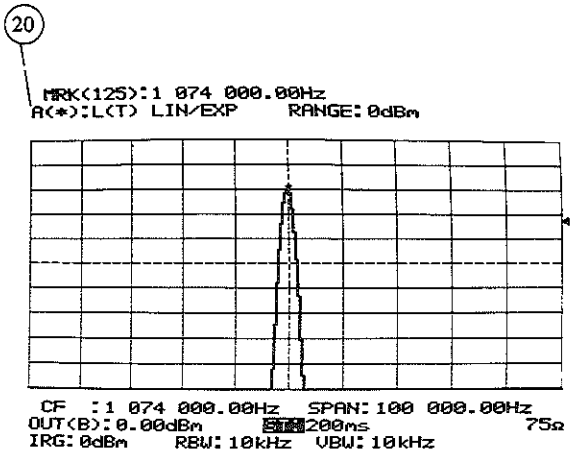


Fig. 2-5 Linear expand display (LIN/EXP)

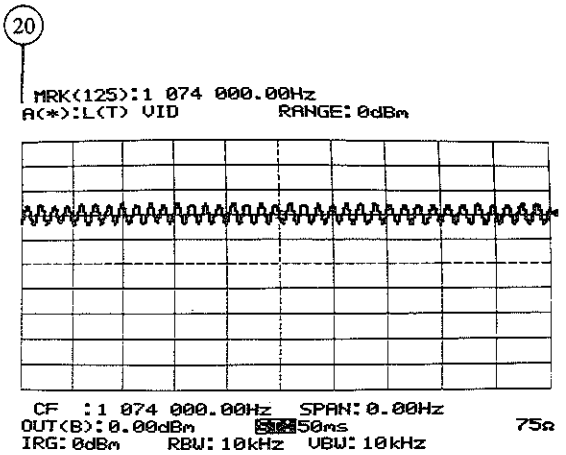


Fig. 2.6 Video sweep (VID)

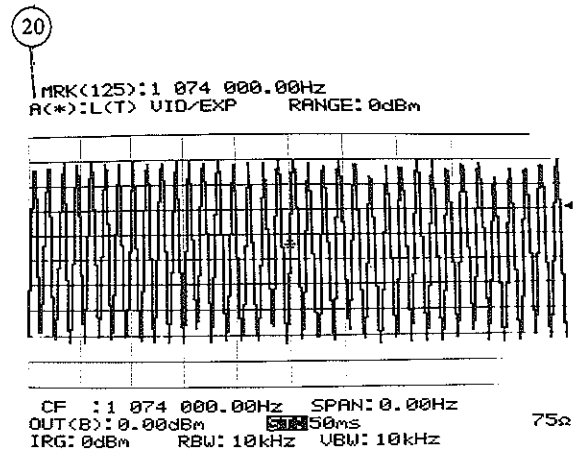


Fig. 2-7 Video expand sweep (VID/EXP)

For frequency count mode, MRK①is displayed as FRQ.

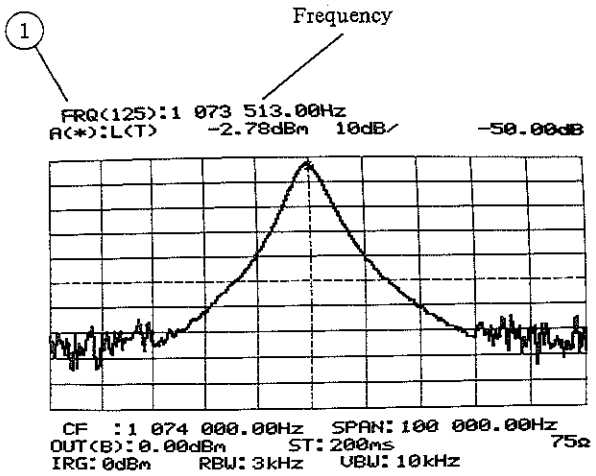


Fig. 2-8 Frequency Count

(2) Display of measured values at marker point①⑯ ⑰

The frequency at marker point ⑯ is displayed at ① and the measured values at ⑰. Further, when the Δ and zero markers are used, they are displayed as follows:

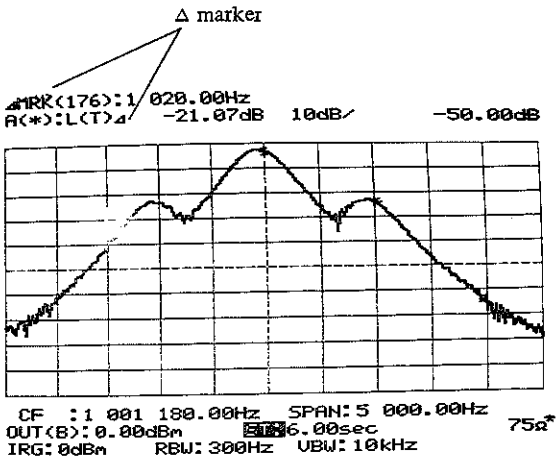


Fig. 2-9 ΔMarker

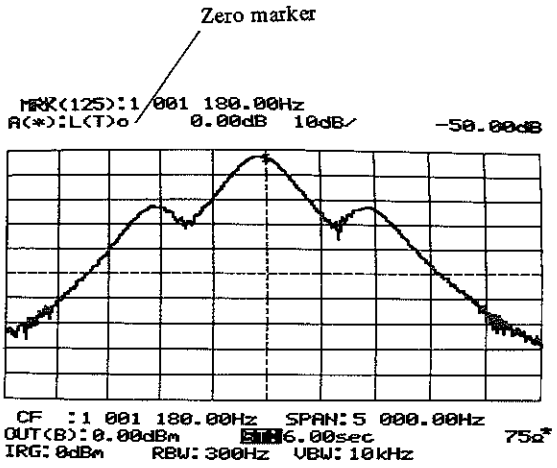


Fig. 2-10 Zero Marker

(3) Scale, Offset③④

A graduation of the graphic display scale is displayed at ④. The offset is the center value of the graphic display ordinate and is displayed at③.

(4) Title ②

The user can set a title of up to 15 characters. Refer to paragraph 2.8-(35) for further detail.

(5) Graphic data ⑤⑥

One or two channels of data can be displayed graphically.

(6) Frequency range ⑦

The sweeping frequency range is indicated as follows by means of the sweep function.

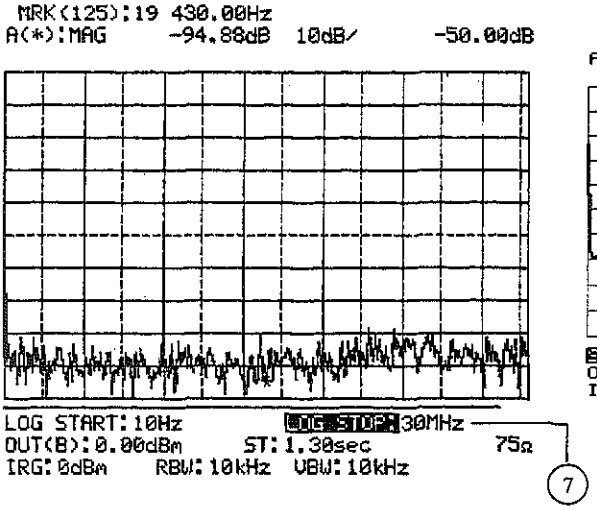


Fig. 2-11 Logarithmic sweep

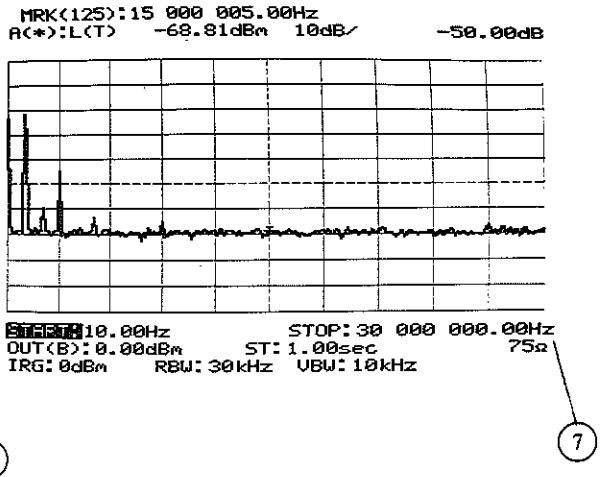


Fig. 2-12 Linear sweep (Start/Stop)

See Fig. 2-3 for linear sweep (CENTER/SPAN)

Note

If arbitrary frequencies are set at each points as the MS420[ ] controlled by the PTA option or Personal-computer through GP-IB, this line can be erased.

(7) Output level (15)

This indicates the output level of the synthesizer. The letter in brackets indicates the output port. When [STOP] and [STEP] keys are pushed, STOP and STEP levels are displayed as follows:

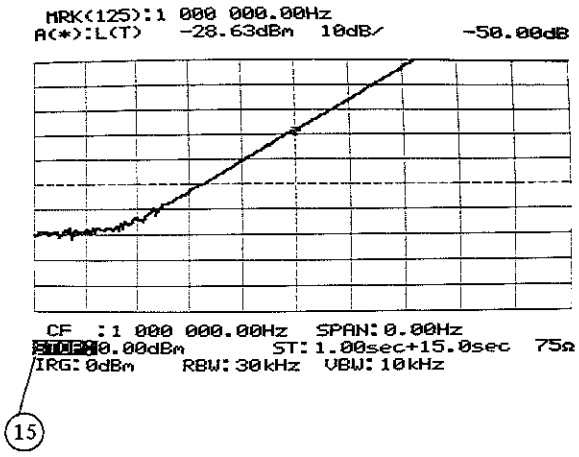


Fig. 2-13 STOP level

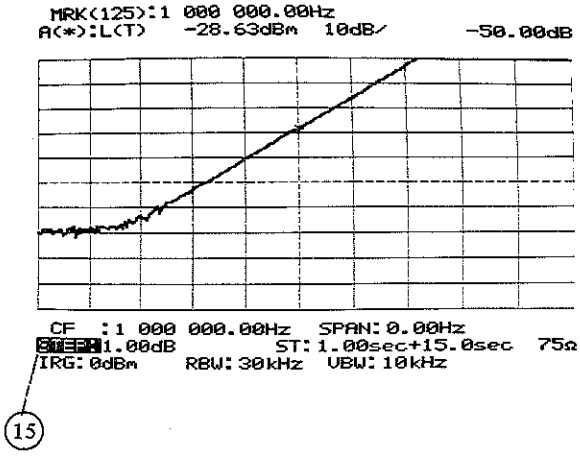


Fig. 2-14 STEP level

(8) Sweep time (11)

This displays the sweep time. The sweep time for level sweep and integration are displayed as follows (adding + 15.0 sec. display):

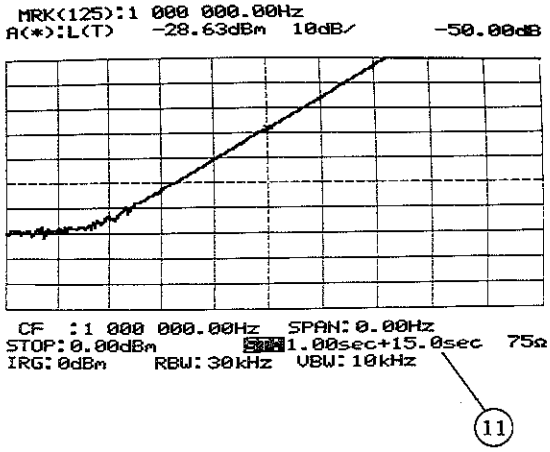


Fig. 2-15 Sweep Time (ST)

(9) T-channel input impedance ⑧

The T-channel input impedance is displayed at ⑧.

(10) Input range ⑬

The input range is displayed at ⑬.

(11) Resolution band width ⑫

The resolution band width is displayed at ⑫.

(12) Video band width ⑩

The video band width is displayed at ⑩

(13) Delay time range ⑨

The delay time range is displayed at ⑨ only if DELAY is selected.

(14) ADV FUNCTION ⑭

The lowest line ⑭ is used to display the ADV functions. The functions are displayed as follows:

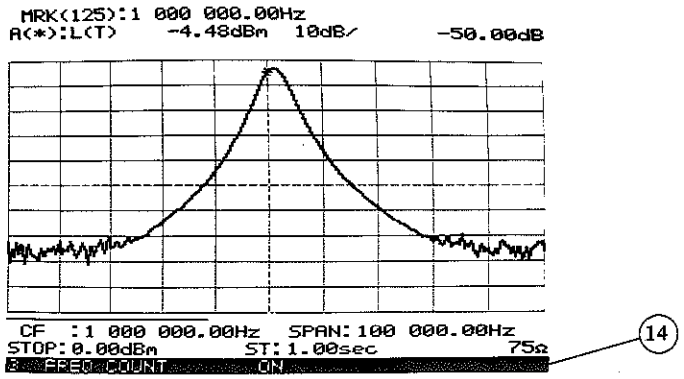


Fig. 2-16 ADV FUNCTION

2.8 OPERATION

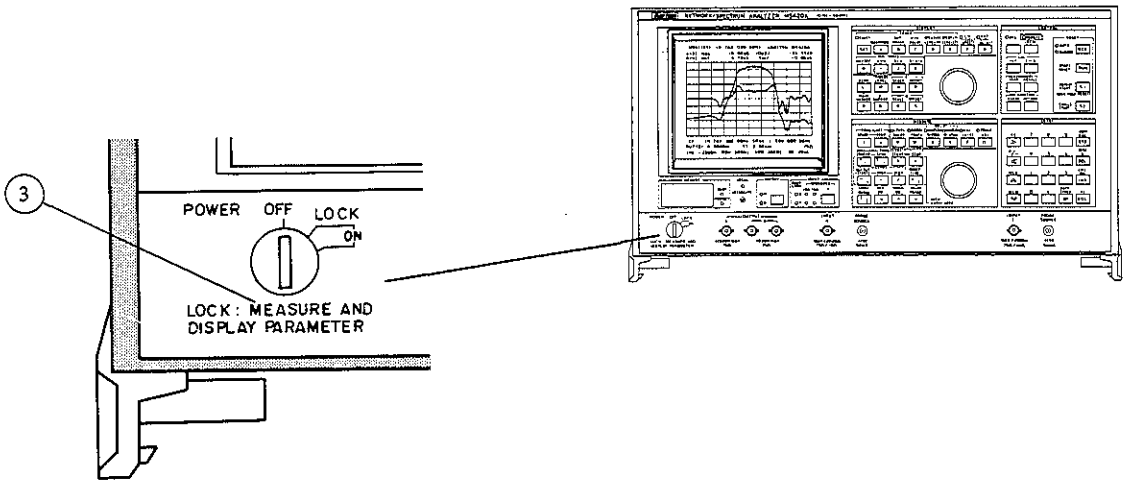


Fig. 2-17 Operation (1)

(1) POWER③

Note

The MS420[ ] is provided with two kinds of power switch keys, X and W. When the W key is used, most of the functions shown on the front panel are disabled.

The power switch has three modes any one of which can be selected by key.

(a) OFF mode: Power off.

(b) LOCK mode: Power is on, but the keys indicated in Fig. 2-18 can not operate. When the power is on, the initial status of the front panel is as shown in Fig. 2-19.

(c) ON mode: Power is on and all front panel functions are operable.

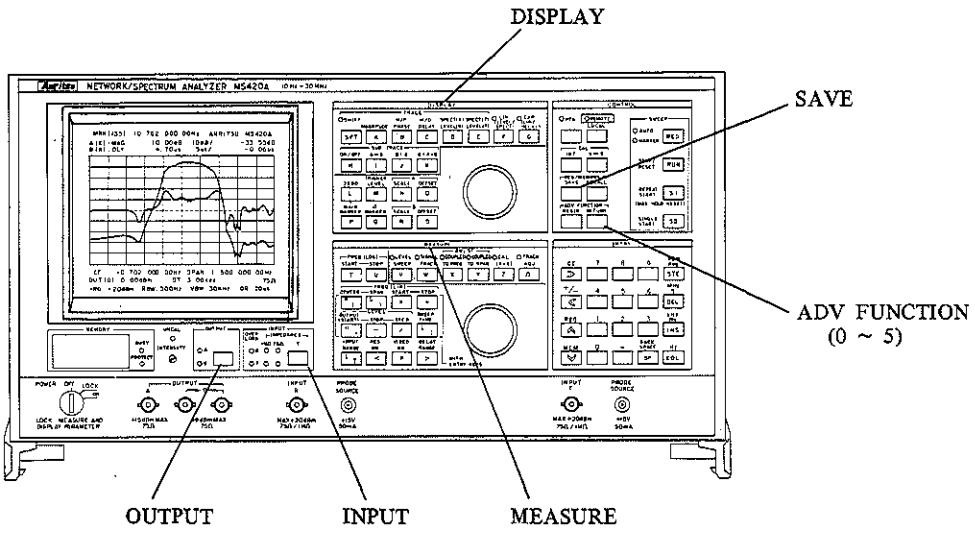
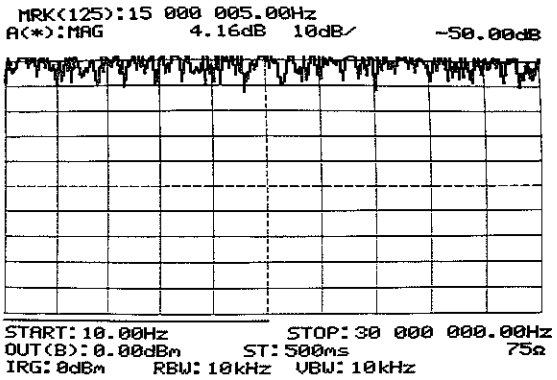


Fig. 2-18 Panel LOCK

(1) CRT display



(2) Function

LIN . . . . . OFF
EXP . . . . . OFF

TRACE	SCALE	OFFSET
PHASE	50 deg/	0 deg
DELAY	100 mS/	0 mS
L (R), S (R)	10 dB/	–50 dBm
L (T), S (T)	10 dB/	–50 dBm

FREQ (LOG)
- START . . . . . 10 Hz
- STOP . . . . . 30 MHz

FREQ (LIN)
- CENTER . . . . . 15000000.00 Hz
- SPAN . . . . . 30000000.00 Hz

LEVEL
- OUT (START) . . . . . 0 dBm
- STOP . . . . . 9 dBm
- STEP . . . . . 1 dB

DELAY RANGE . . . . . 400 mS
LEVEL SWEEP . . . . . OFF
SIGNAL TRACK . . . . . OFF
COUPLED TO FREQ . . . . . OFF
COUPLED TO SPAN . . . . . OFF
CAL (X-S) . . . . . OFF
TRACK ADJ . . . . . OFF
SWEEP
- AUTO/MARKER . . . . . AUTO
- REPEAT . . . . . ON

ADV FUNCTION
- INTEGRATING . . . . . OFF
- MAX HOLD . . . . . OFF
- IMPEDANCE (R) . . . . . 75 Ω
- FREQ COUNT . . . . . OFF
- TRACKING ΔF . . . . . OHz
- TRACKING MODE 0
- AUTOCAL TIME 0
- SWEEP MARKER . . . . . ON
- BUZZER . . . . . ON

Fig. 2-19 Initial Status

Note

After the power is turned on, the screen shown in Fig. 2.20 (A) appears on the CRT. And then about 15 minutes later, the screen shown in Fig. 2-20 (B) appears on the CRT and the internal (INT) calibration is performed. Be sure to wait for this display before using the MS420[ ]. Refer to item (32) for details of INT calibration.

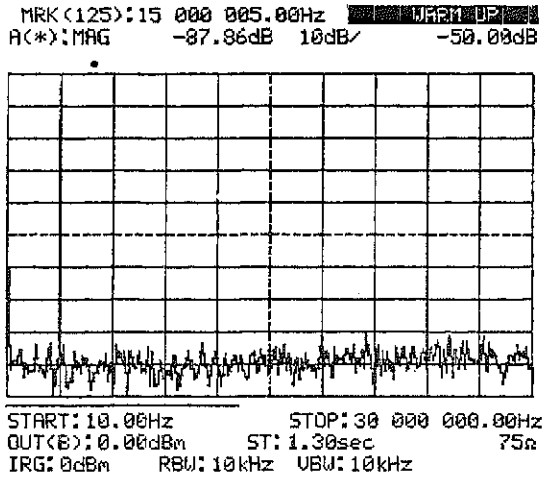


Fig. 2-20 (A) WARM-UP

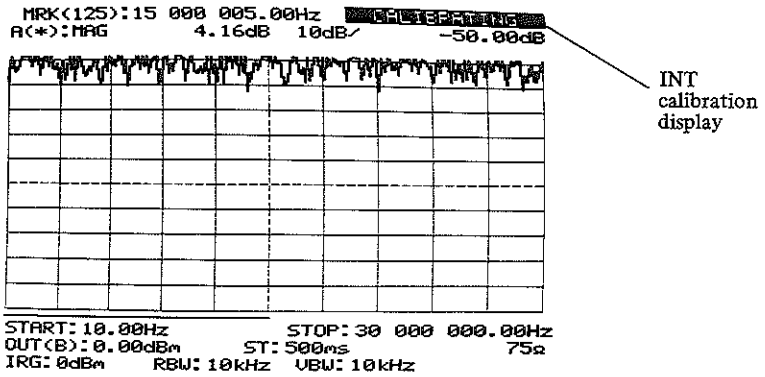


Fig. 2-20 (B) INT calibration

MEMO

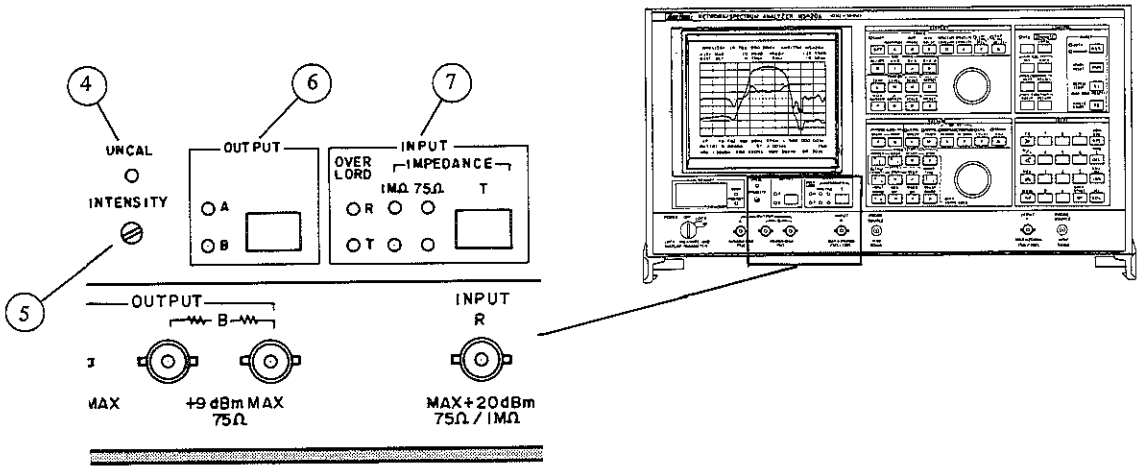


Fig. 2-21 Operation (2)

(2) UNCAL lamp (4)

If this lamp lights, it means that a measured value shown on the CRT is wrong. This lamp can be turned off by increasing any one of ST, RBW and VBW. Try to set these items so that this lamp stays off. Refer to SECTION 3 for detail operation.

(3) OUTPUT (6)

Every time this key is pressed, lamps A and B light alternately as the synthesizer output terminal switches between OUTPUT - A and OUTPUT - B (18).

A: Signals are output to OUTPUT - A (18).

B: Signals are output to OUTPUT - B (18).

Note

When output-B is used, both OUTPUT-B terminals are terminated with 75 Ω (B type) or 50 Ω (K type), the output level of both are equal to the level displayed on the CRT.

(4) INPUT-OVER LOAD ⑦

This lamp lights when the input signal is higher level than IRG. Set IRG so that this lamp remains off.

when the lamp is on: Increase IRG until the lamp goes out.

when the lamp is off: Decrease IRG as far as possible without tuning the lamp on

CAUTION

If the OVERLOAD lamp does not turn off when in the +20 dBm range, disconnect the device under test immediately. Continued use at this level, even for a short time, may cause the input circuit of the MS420[ ] to burn out.

(5) INPUT-IMPEDANCE-T ⑦

Each time this key is pressed, the T-side input impedance is switched to 1M and 75 Ω (B type) or 50 Ω (K type).

Note

Refer to item (35) for details on switching the R-side input impedance.

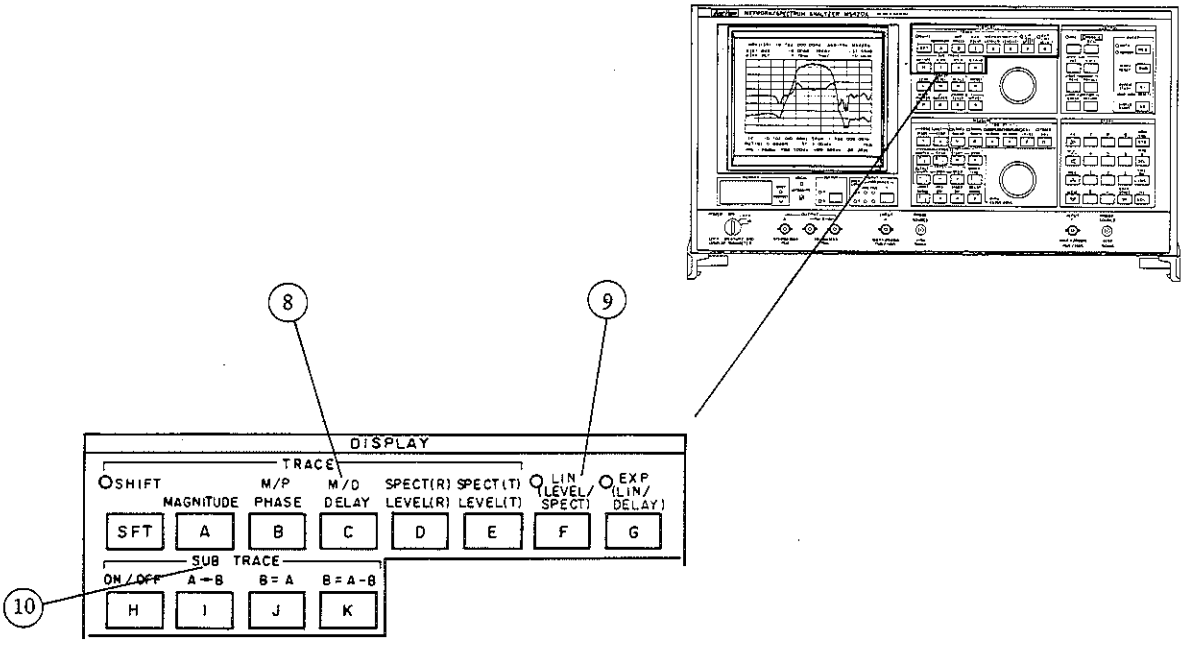


Fig. 2-22 Operation (3)

(6) TRACE⑧

Any of the following measuring items can be activated when the appropriate is pressed. Each time [SHIFT] key is pressed, the SHIFT lamp will turn on and off alternately.

Table 2-4 TRACE

Measuring items	Key operations		CRT display
	SHIFT lamp	[TRACE] key	
Magnitude	ON, OFF	[MAGNITUDE]	A(*): MAG
Magnitude/phase	ON	[M/P PHASE]	A (*): MAG B (*): PHA
Phase	OFF		A (*): PHA
Magnitude/delay time	ON	[M/D DELAY]	A (*): MAG B (*): DLY
Delay time	OFF		A (*): DLY
Spectrum (R)	ON	[SPECT (R) LEVEL (R)]	A (*): S (R)
Level (R)	OFF		A (*): L (R)
Spectrum (T)	ON	[SPECT (T) LEVEL (T)]	A (*): S (T)
Level (T)	OFF		A (*): L (T)

(7) LIN, EXP ⑨

Each time this key is pressed, the lamp turns on and off alternately and one of the measuring functions of the following table is set. This lamp cannot be turned on under any conditions other than those listed in the table. Further, if the conditions shown in the table cease to be satisfied, this lamp automatically turns off.

Table 2-5 LIN/EXP

LIN	EXP	Conditions	Measuring function
ON	OFF	When the TRACE is S (R), S (T), L (R), or L (T) and the frequency sweep width is not 0 Hz.	Indicated linearly on the vertical axis.
ON	ON		Indicated linearly and expanded 10 times around the trigger level center on the vertical axis.
ON	OFF	When the TRACE is S (R), S (T), L (R), or L (T) and the frequency sweep width is 0 Hz.	Indicates the envelope of an input signal (video sweep)
ON	ON		Indicates the envelope expanded 10 times around the trigger level center.
OFF	ON	When the TRACE setting is DELAY.	Expansion mode of delay time.

(8) SUB TRACE ⑩

This function is very effective in making single item measurements (except magnitude/phase and magnitude/delay time). Pushing each key once selects the next function.

[ON/OFF]: When this key is pressed, the SUB TRACE function can be turned on an off alternately. When SUB TRACE is turned on, the contents of the B-channel memory are displayed on the CRT.

[A→B]: The latest measured-value is copied into the B-channel memory and held there and the copied memory contents are displayed on the CRT. SCALE and OFFSET have the same values as the A channel.

[B=A]: A value matching that of the item selected by TRACE is displayed on the CRT. SCALE and OFFSET have the same values as the A channel.

[B=A−B]: The difference between the newly measured value and B-channel memory contents copied at A → B is displayed. SCALE and OFFSET have the same value as the A channel.

Note

The display of SUB TRACE on the CRT can be adjusted by SCALE and OFFSET of the B channel.

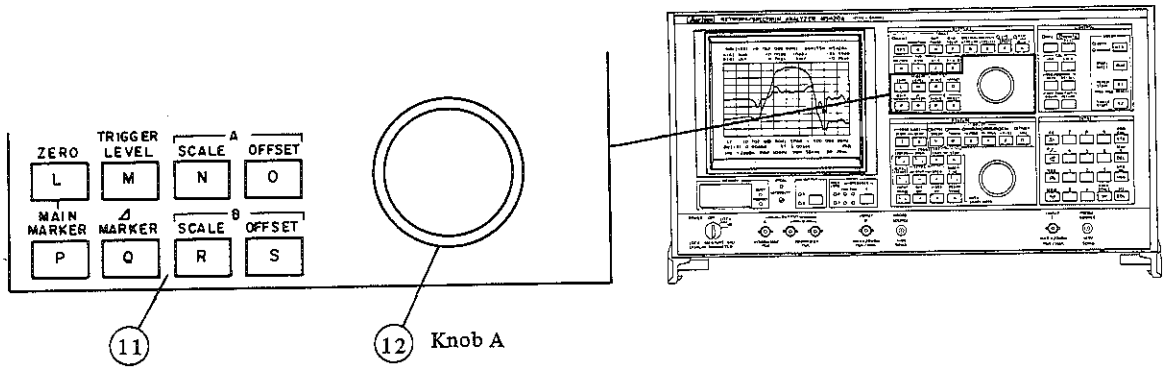


Fig. 2-23 Operation (4)

(9) ZERO (11)

When this key is pressed, the latest value measured at the marker point is memorized and the difference between it and the current value measured at the marker point is displayed on the CRT. This function is released by pressing the MAIN MARKER key.

(10) MAIN MARKER (11)

After this key is pressed once, the knob A (12) can be used to move the main marker, and the frequency and value measured at the marker point are displayed on the CRT.

(11) ΔMARKER (11)

When this key is pressed, the current main marker is copied on the CRT. If the main marker is then moved, two markers are displayed on the CRT, and the difference between them is displayed together with the frequency and measured values. To release this function, press the MAIN MARKER key.

(12) TRIGGER LEVEL (11)

If this key is pressed while running a linear display or video sweep, the trigger level can be adjusted by knob A (12). Refer to paragraph 3.2.5 for details of video sweep operation.

(13) A-SCALE, OFFSET (11)

When the SCALE key is pressed, the scale of the vertical axis on the CRT can be adjusted by knob A (12). Pushing of OFFSET key enables knob A (12) to move the waveform on the CRT by 1/10 of the current CRT scale.

Note

1. *Turn knob A (12) clockwise or counterclockwise to move the waveform upward or downward.*
2. *When the waveform is off screen, increase SCALE.*
3. *When the top or bottom of the scale is displayed brightly, the waveform is off scale on the CRT.*
4. *During linear display or video sweep operations, SCALE is disabled and OFFSET is used to adjust the range.*

(14) B-SCALE, OFFSET (11)

This key is functionally the same as (13) above and is used in the following cases:

Magnitude/phase:	Adjustment of the phase waveform
Magnitude/delay time:	Adjustment of the delay time waveform
SUB TRACE:	Adjustment of the B-channel waveform

Note

This key is disabled during linear display and video sweep operations.

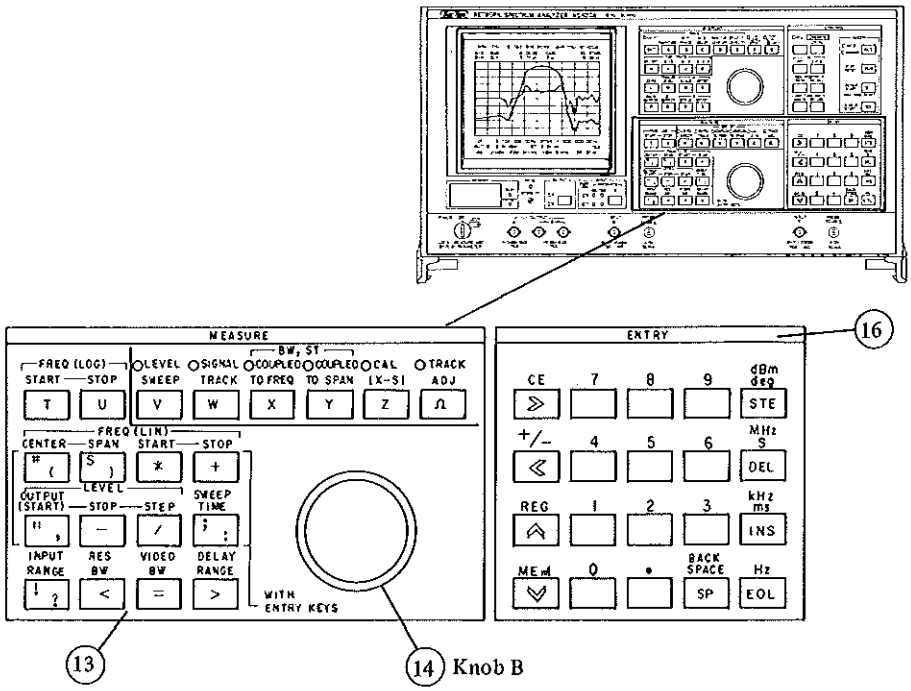


Fig. 2-24 Operation (5)

(15) FREQ (LOG) (13)

If the START or STOP key is pressed, the logarithmic frequency sweep mode is selected and the start or stop frequency of the logarithmic sweep can be selected from among the following values by knob B (14).

Start frequency (START): 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz

Stop frequency (STOP): 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, 10 MHz and 30 MHz

Note

Logarithmic sweep operation start and stop frequencies other than the above can be set using the PTA option or a personal computer through GP-IB.

(16) FREQ (LIN) CENTER/SPAN ⑬

When the [CENTER] or [SPAN] key is pressed, the frequency linear sweep mode is selected and the sweep center frequency or sweep band width can be set with knob B ⑭ or the ENTRY keys ⑯.

Center frequency (CF): 10.00 to 30000000.00 Hz

Band width (SPAN): 0 to 30000000.00 Hz

The resolution here is 2.5 Hz.

Setting frequency

Method	Step	Operation
a	1	Press the [CENTER] or [SPAN] key.
	2	Turn knob B ⑭ to set the desired frequency.
b*		Press these keys in order: [CENTER] [1] [2] [.] [4] [MHz].
c*		Press these keys in order: [SPAN] [5] [0] [kHz].
d*		Press these keys in order: [1] [0] [0] [kHz]. (See Note)

* Example: (b) Center frequency = 12.4 MHz
(c) Span = 50 kHz
(d) Reset span to 100 kHz

Note

(1) When changing condition of items that is shown on an inverse video line as in Fig. 2-25, only set data may be set by using method d.

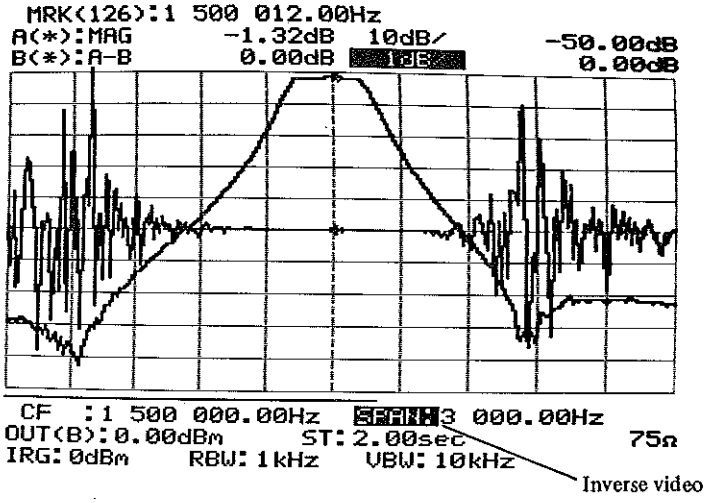


Fig. 2-25 Inverse Video Display

(2) ENTRY key (16)

The ENTRY key is used in combination with some of the MEASURE keys and the [SAVE] and [RECALL] keys.

- *[CE]: Used to clear all keyed-in values before the unit key (dBm/deg, MHz/S, kHz/mS, and Hz) is pressed.*
- *[+/–]: Used to invert the sign of the input data.*
- *[REG]/[MEM]: Used in combination with the [SAVE] and [RECALL] keys.*
- *[0] - [9], [.] : Data input keys.*
- *[BACK SPACE]: Used to clear the least significant digit of input data.*
- *[dBm/deg], [MHz/S], [kHz/mS], and [Hz]: Unit keys, when pressed, activate keyed input.*

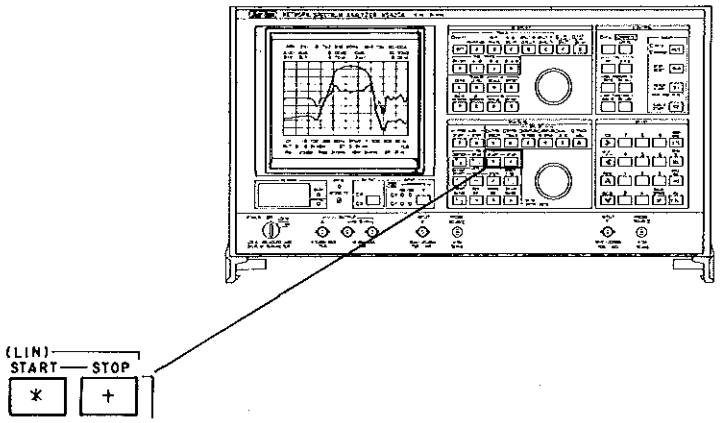


Fig. 2-26 Operation (6)

(17) FREQ (LIN) START/STOP (13)

When the START or STOP key is pressed, the frequency linear sweep mode is selected and the start or stop frequency of sweep can be set by knob B (14) or the ENTRY keys (16).

Start or stop frequency: 0 to 30 000 000.00 Hz

The resolution is 2.5 Hz and the stop frequency most be greater than the start frequency.

Setting frequencies:

Method	Step	Operation
a	1	Press the START or STOP key
	2	Turn knob B (14) to set the desired frequency.
b*		Press these keys in order: START 1 0 . 7 MHz .
c*		Press these keys in order: STOP 2 1 . 5 MHz .
d*		Press these keys in order: 2 5 MHz . (See Note)

* Example: (b) Start = 10.7 MHz
(c) Stop = 21.5 MHz
(d) Reset stop to 25 MHz

Note

1. *Items which are already shown on an inverse video line may be set only by using the ENTRY keys (method d).*
2. *Frequency of LOG (START/STOP), LIN (START/STOP) and LIN (CENTER/SPAN) which is already set can be recalled only by pressing the rated MEASURE key.*
3. *See item (16) for ENTRY key operation.*

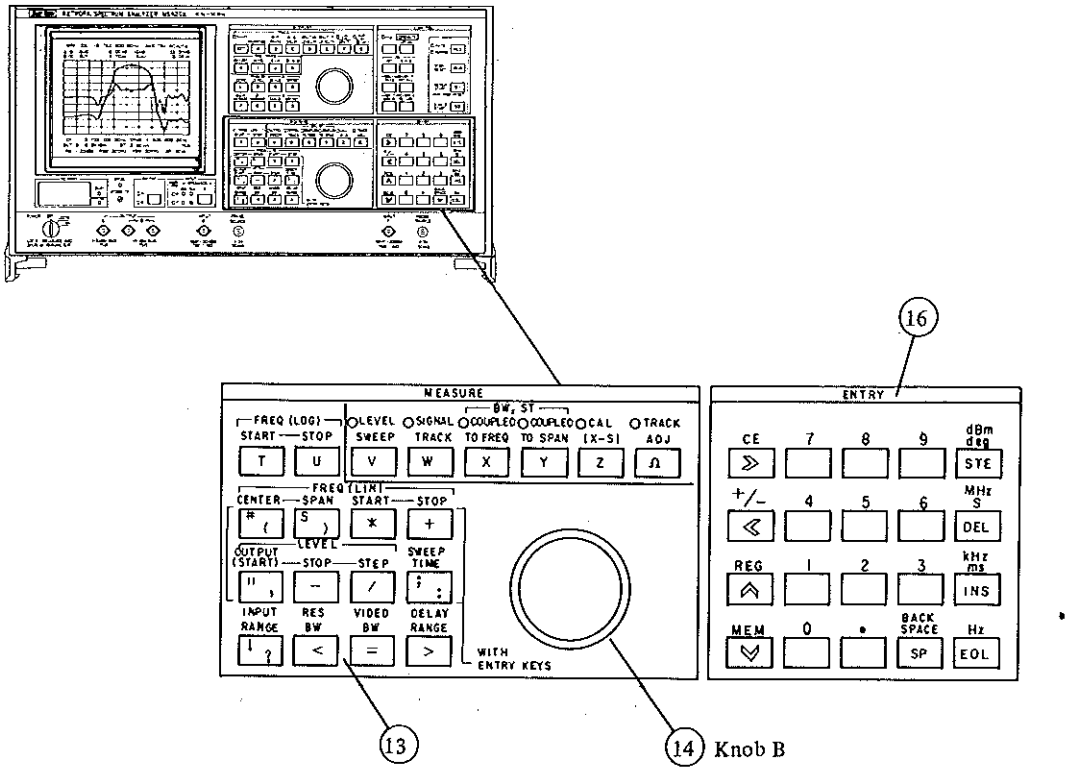


Fig. 2-27 Operation (7)

(18) LEVEL (13)

These keys are used to set the sysnthesizer output level.

OUTPUT A: –110 to +15 dBm, resolution 0.01 dB.

OUTPUT B: –110 to +9 dBm, resolution 0.01 dB.

(a) [OUTPUT (START)]: When this key is pressed, the synthesizer output level can be set with knob B (14) or the ENTRY keys (16). When setting with knob B, the level can be increased or decreased by STEP value set in item (C) below. For level sweep operations, this key is used to set the start level.

(b) [STOP]: When this key is pressed, the stop level for level sweep operations can be set by knob B (14), or the ENTRY keys (16). When setting with knob B (14), the level can be increased or decreased by STEP value set in item (C) below.

(c) [STEP]: When this key is pressed, the STEP level for level sweep operations can be set by knob B (14) or the ENTRY keys (16). When setting with knob B (14), the level is changed by half (decrement) or twice (increment) just before starting operation.

Setting the level

Method	Step	Operation
a	1	Press the [OUTPUT], [STOP] or [STEP] key.
	2	Turn knob B (14) to set the desired level.
b		Press these keys in order: [STOP] [+/−] [5] [0] [.] [0] [5] [dBm].
c		Press these keys in order: [1] [0] [.] [1] [7] [dBm]. (See Note)

Note

1. *Items which are already shown in an inverse video line on the CRT may only be set by the ENTRY keys (method c).*
2. *See item (16) for ENTRY key operation.*

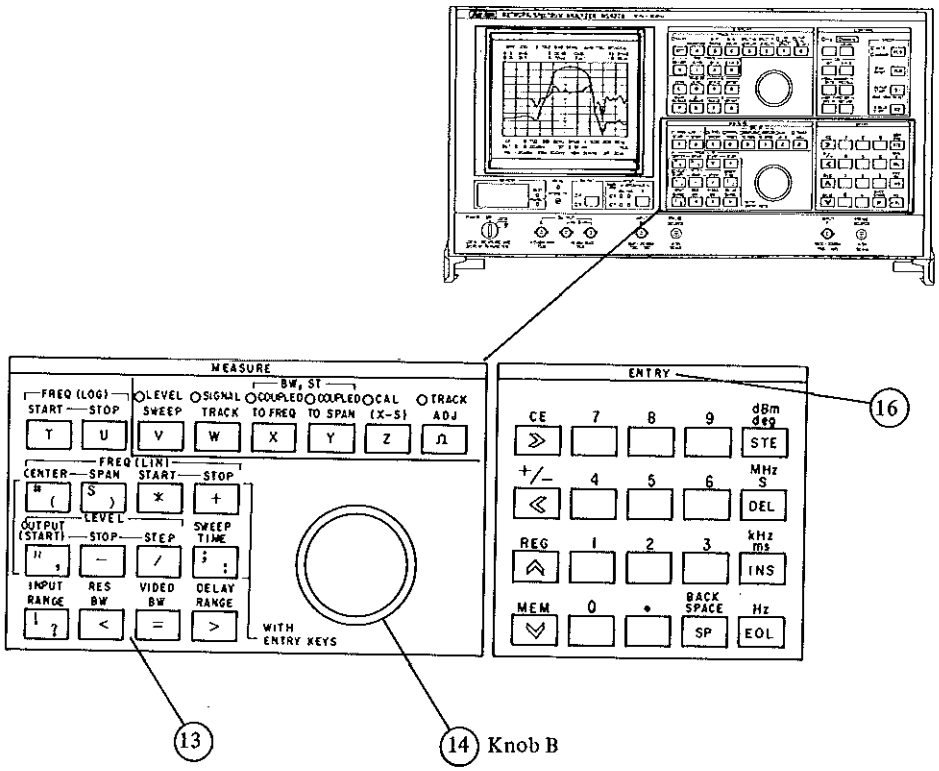


Fig. 2-28 Operation (8)

(19) SWEEP TIME (ST) (13)

After pressing this key, the sweep time can be set by knob B (14) or the ENTRY keys (16).

Setting range

- Knob B (14): 50 ms to 25 hours

  The minimum value varies according to the item being measured.

- ENTRY key (16): 50 ms to 9000 s.

  When the EOL key is pressed, the unit can be translated automatically to ms, s, min, and hour with two significant figures.

Setting Sweep time

Method	Step	Operation
a	1	Press the [SWEEP TIME] key.
	2	Turn knob B ⑭ to set the desired value.
b		Press these keys in order: [SWEEP TIME] [5] [0] [0] [mS].
c		Press these keys in order: [1] [0] [0] [0] [mS]. (See Note 1)

Note

1. *Items already shown in an inverse video line on the CRT can only be set by the ENTRY keys.*
2. *See item (16) for ENTRY key operation.*

(20) INPUT range ⑬

After pressing this key, knob B ⑭ can be used to set the input range. The R and T channels are always set to the same range.

(21) RES BW (RBW) ⑬

After pressing this key, knob B ⑭ can be used to set the resolution bandwidth.

(22) VIDEO BW (VBW)

After pressing this key, knob B ⑭ can be used to set the video bandwidth.

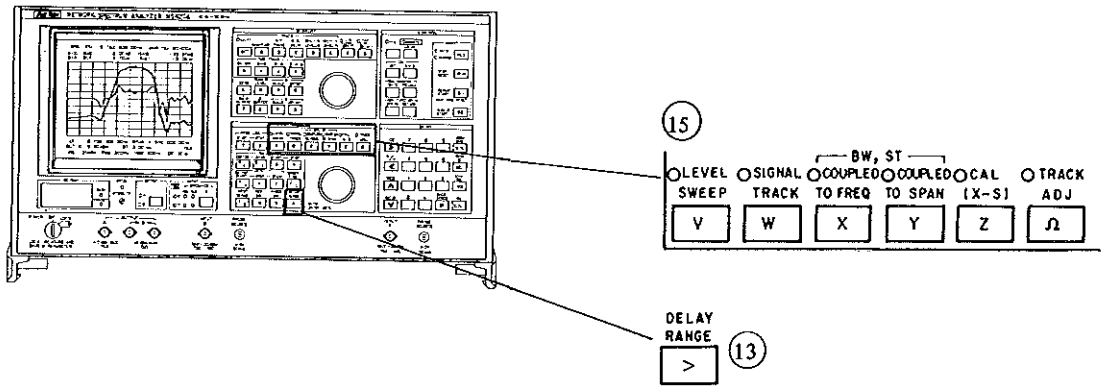


Fig. 2-29 Operation (9)

(23) DELAY RANGE (DR) (13)

After pressing this key, knob B (14) can be used to set the delay time range. This can be set only if the delay time has been set as a TRACE (measurement item).

CAUTION

MISSETTING DR SOMETIMES LEADS TO GROSS ERRORS. BE SURE TO USE THE CORRECT OPERATION METHOD TO MEASURE THE DELAY TIME ACCORDING TO PARAGRAPH 3.1.4.

(24) LEVEL SWEEP (15)

Each time this key is pressed, the lamp turns on or off alternately. When this lamp is on, the synthesizer output level is swept. See paragraph 3.3 for further details.

(25) SIGNAL TRACK (15)

For LEVEL and SPECTRUM measurements, the lamp is turned on or off alternately each time this key is pressed.

If this lamp is on and the frequency sweep is linear mode, the frequency is reset for each sweep so that the peak value of the input signal is made the center of the sweep.

(26) COUPLED TO FREQ (15)

Each time this key is pressed in MAGNITUDE, PHASE, DELAY or LEVEL measurement, this lamp turns on or off alternately. When this lamp is on, the RBW, VBW and ST are automatically set in relation to the measuring frequency. See paragraph 3.5-(2) for further details.

(27) COUPLED TO SPAN (15)

For SPECTRUM measurements, the lamp turns on or off alternately each time this key is pressed. When this lamp is on, the RBW, VBW and ST are automatically set in relation to the sweep width. See paragraph 3.5-(3) for further details.

(28) CAL (X – S) (15)

Each time this key is pressed, the lamp turns on or off alternately. When this lamp is on, the measured values are automatically corrected by the contents of S memory stored during the X→S calibration.

Note

Be sure to press the $\boxed{X \rightarrow S}$ *key before turning on the X – S lamp, otherwise the measured values are corrected by the incorrect data. See paragraph 2.10-(3) for further details.*

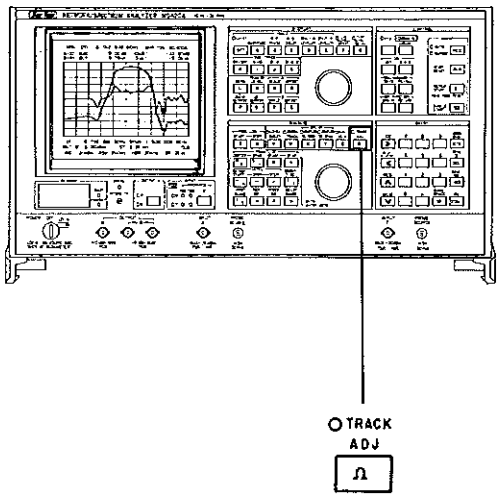


Fig. 2-30 TRACK ADJ

(29) TRACK ADJ (15)

When RBW is less than 300 Hz, the lamp turns on or off each time this key is pressed. When this lamp is on, the center frequency of the intermediate frequency filter can be adjusted as described below. This adjustment is required to obtain the best dynamic range for transmission characteristics and the best accuracy for level measurements.

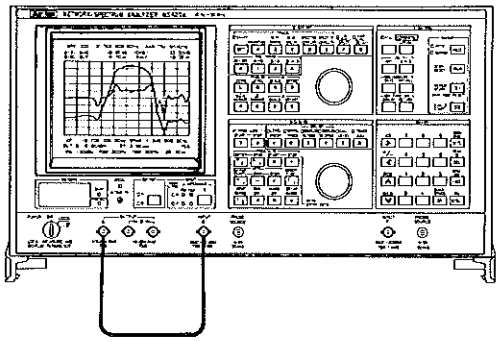


Fig. 2-31 Connection for TRACK ADJ

Adjustment:

Step	Procedure
1	Connect as shown in Fig. 2-31
2	Set as follows: ● TRACE . . . . . L (R) ● CF . . . . . 1 MHz ● SPAN . . . . . 0 Hz ● OUT (A) . . . . . 0 dBm ● ST . . . . . 1 Sec ● IRG . . . . . +10 dBm ● RBW . . . . . 10 Hz ● VBW . . . . . 100 Hz ● AUTO/MARKER . . . . . MARKER ● IMPEDANCE . . . . . 75 Ω/50 Ω
3	Press the TRACK ADJ key.
4	Adjust knob B (14) so that the greatest measured value is shown at the marker point.
5	Press the TRACK ADJ key to turn the lamp off.

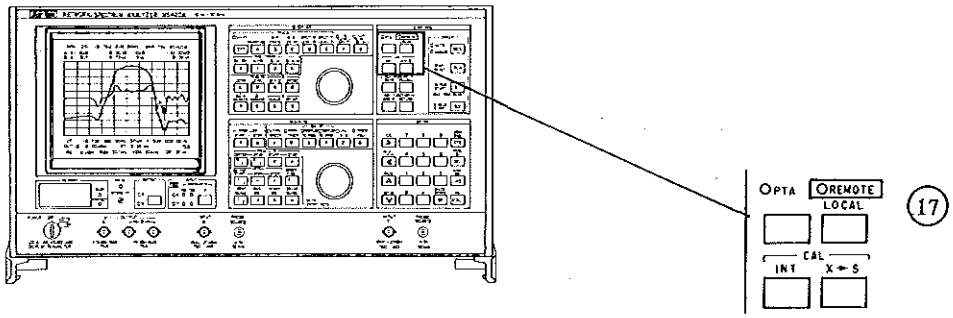


Fig. 2-32 Operation (10)

(30) PTA (17)

When the PTA option is incorporated in the MS420[ ], the lamp turns on or off each time this key is pressed. Refer to the PTA OPERATION MANUAL for further details.

(31) LOCAL (17)

When the MS420[ ] is controlled through GP-IB and if this key is pressed when the REMOTE lamp is on, the REMOTE lamp will turn off. Local control of the MS420[ ] is activated.

(32) CAL-INT (17)

After this key is pressed, INT calibration mode is established once the sweep operation ends.

Note

1. *Nonlinear errors are collected during INT calibration and calibrated automatically during the measurement cycle.*
2. *Calibration connections are made automatically inside the MS420[ ] during INT calibration.*
3. *Calibration starts in one of the following three situations:*
   - *15 minutes after the power is turned on.*
   - *When the [CAL-INT] key is pressed.*
   - *Once the period set on the timer has elapsed. Refer to item (35) for details on setting the timer.*
4. *About 15 minutes after the power is turned on, the INT calibration is performed automatically. If this function is not necessary, perform the following operation.*
   - *Press [BEGIN] key*
   - *Press [/] [7] [EOL] keys in this order*
   - *Press [0] [EOL] keys in this order*
   - *Press [RETURN] key*
   - *Press [CAL-INT] key*

MEMO

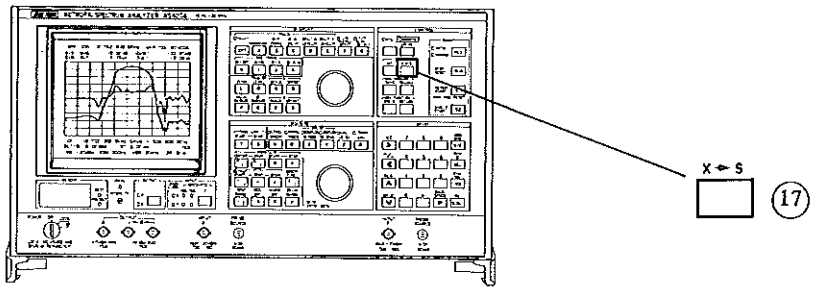


Fig. 2-33 Operation (11)

(33) CAL – X→S (17)

After this key is pressed, one sweep establishes the X→S calibration mode and all measured values are stored into S memory.

Note

1. *X→S calibration is used to correct offset errors, including frequency response of the measuring system.*
2. *X→S calibration only stores the measured values in S memory. The CAL – X–S lamp (15) must be on to correct offset errors.*
3. *X→S calibration of transmission characteristics usually uses a direct connection circuit as reference.*
4. *For level measurements, the synthesizer output level is used as a reference level. The following levels are used for calibration.*
   - *+20 dBm IRG . . . . . 0 dBm*
   - *+10 dBm IRG . . . . . 0 dBm*
   - *0 dBm IRG . . . . . 0 dBm*
   - *–10 dBm IRG . . . . . –10 dBm*
   - *–20 dBm IRG . . . . . –20 dBm*
   - *–30 dBm IRG . . . . . –30 dBm*
   - *–40 dBm IRG . . . . . –40 dBm*
5. *Connection for X→S calibration is shown in Figs. 2-34 and 2-35.*

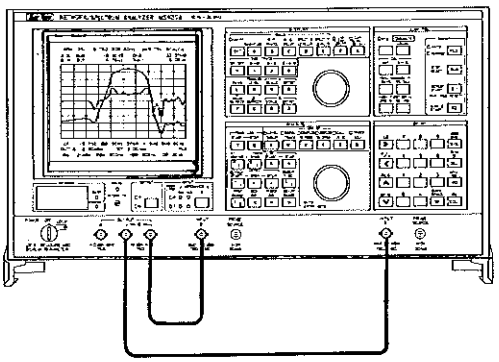


Fig. 2-34 Transmission Characteristic

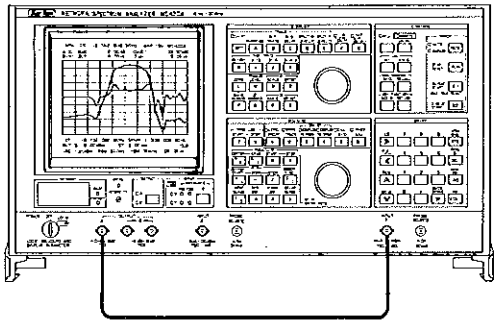


Fig. 2-35 Level/Spectrum

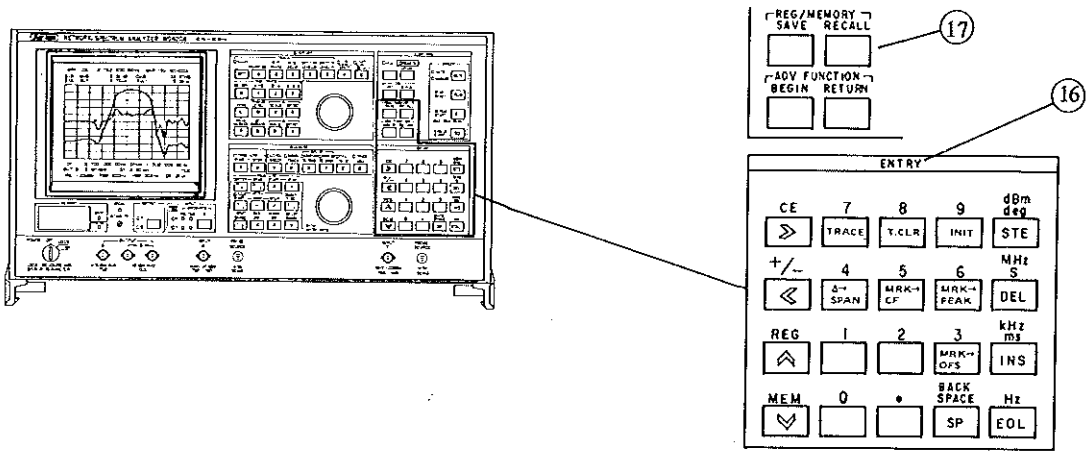


Fig. 2-36(A) Operation (12)

(34) REG/MEMORY (17)

The SAVE and RECALL keys are used to store and recall the front panel setting status.

- REG mode: Can store three panel setting states. Stored data will be void as the power is off.
- MEMORY mode: Refer to item (40).

Operating method (REG mode)

Method	Opeation
a.	Press these keys in order: SAVE [**] REG [*] 1
b.	Press these keys in order: SAVE [*] 0
c.	Press these keys in order: RECALL [**] REG [*] 2
d.	Press these keys in order: RECALL [*] 1

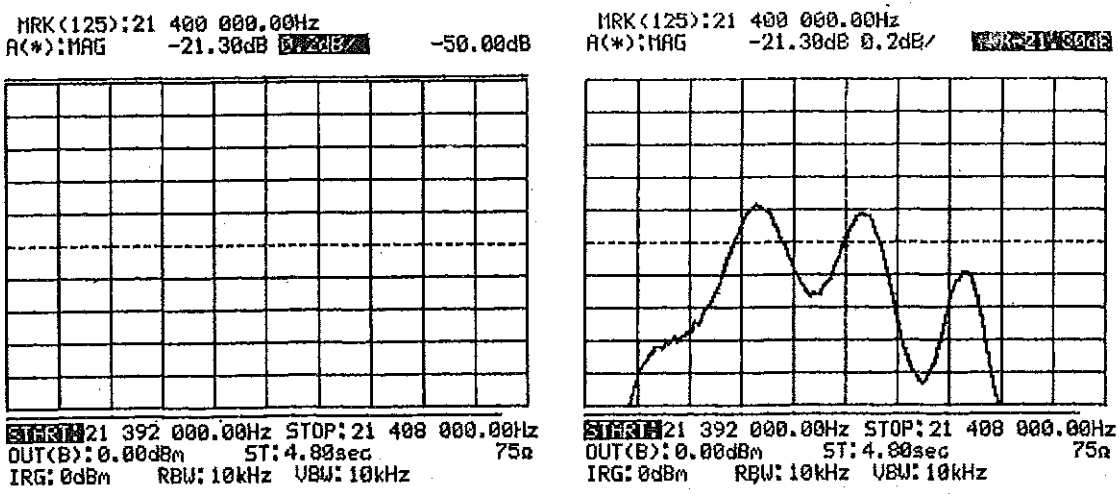
Note

1. ** must be 0, 1 or 2.*
2. *** may be omitted (method c, d).*
3. *After the power is on, the MS420[ ] is initialized (power on status) by pressing the RECALL and 9 keys in this order.*

Moreover, the [SAVE] and [RECALL] keys are used to perform the following functions.

- Press the [RECALL] and [3] keys (Automatic offset setting)

  This automatically sets the offset to the marker readout value on the CRT, as shown in the following figure.

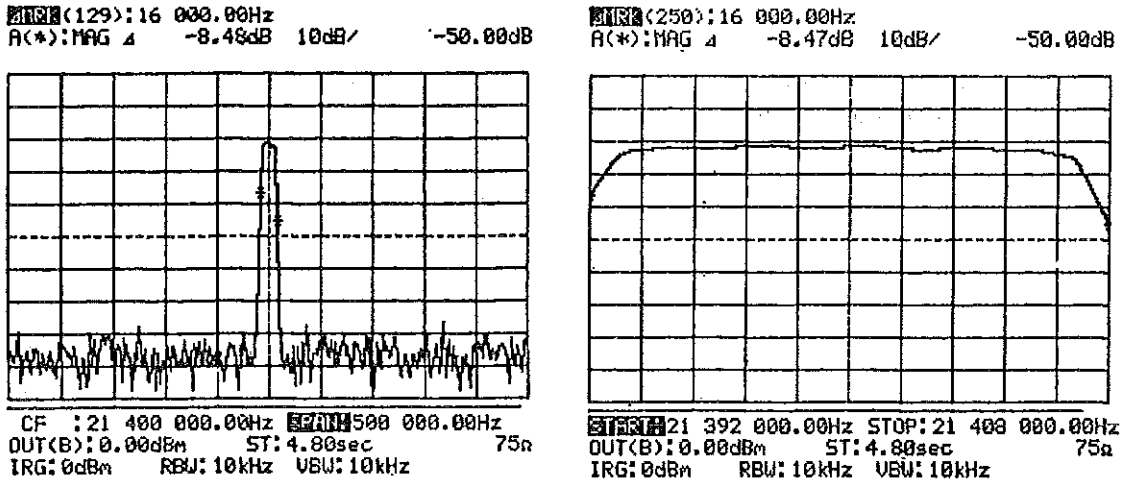


(A) Before Pressing [RECALL] and [3] Keys (B) After Pressing [RECALL] and [3] Keys

Fig. 2-36 (B) Automatic Offset Setting

- Press the [RECALL] and [4] keys (ΔF → START/STOP)

  As shown in the following figure, this automatically sets the frequency sweep mode to START/STOP. The sweep width is automatically set to the frequencies pointed by the two markers before this is done.



(A) Before Pressing [RECALL] and [4] Keys (B) After Pressing [RECALL] and [4] Keys

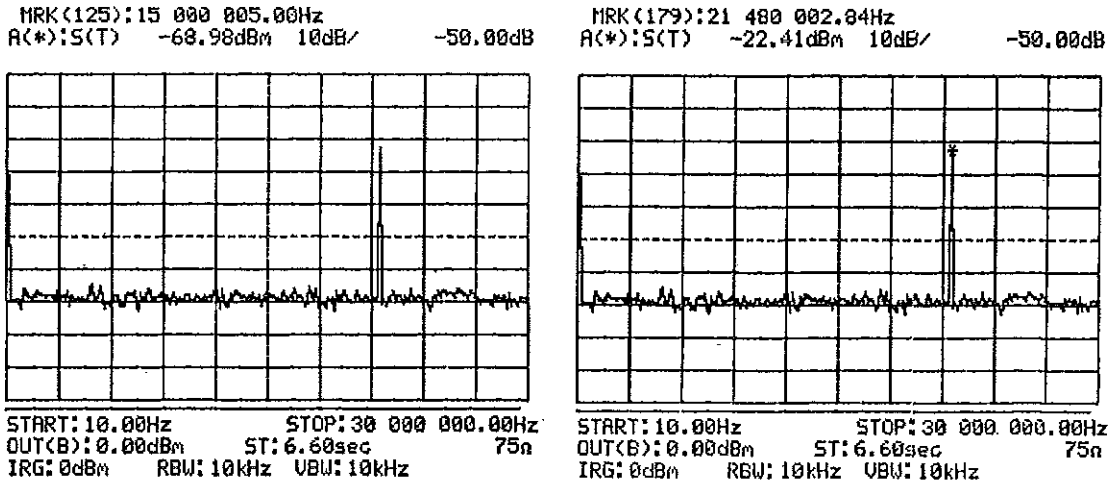
Fig. 2-36 (C) ΔF → SPAN

- Press the [RECALL] and [5] keys (Marker frequency → CF)

  This automatically sets the frequency sweep mode to CF/SPAN. The center frequency (CF) is automatically set to the main marker frequency before this is done. The main marker is automatically set to the center position on the CRT.

- Press the [RECALL] and [6] keys (Marker → Peak)

  This automatically sets the main marker on the CRT to the maximum point of trace-A.



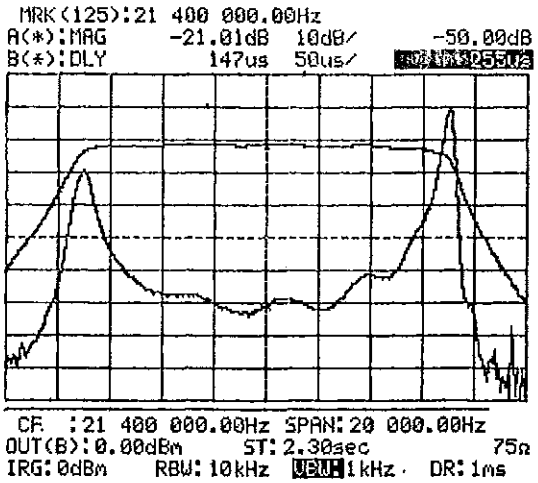
(A) Before Pressing [RECALL] and [6] Keys (B) After Pressing [RECALL] and [6] Keys

Fig. 2-36 (D) Marker → Peak

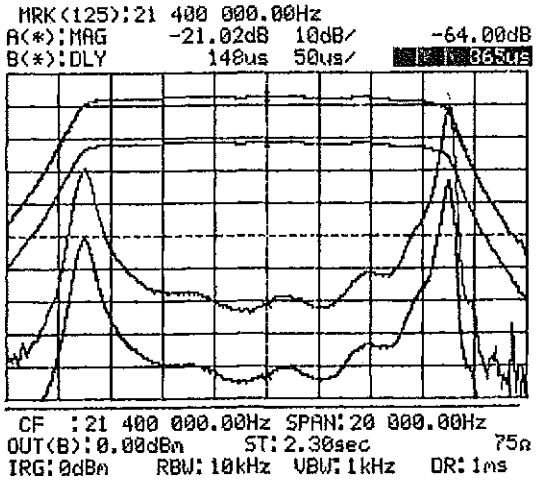
- Press the [SAVE], [MEM] and [7] keys (Save Trace)

  This stores the trace datas on the CRT and the front panel settings into the plug-in-bubble-memory (PBM).

  The PBM uses to store trace datas and up to five front panel settings, or six front panel settings. Consequently, trace datas cannot be stored into the PBM that have previously stored six front panel settings.



(A) SAVE TRACE



(B) RECALL TRACE

Fig. 2-36 (E) SAVE TRACE

- Press the [RECALL], [MEM] and [7] keys (RECALL TRACE)

  This displays trace datas saved in the PBM on the CRT low-intensity screen. It also resets front panel settings saved in the PBM.

- Press the [RECALL], [MEM] and [8] keys (TRACE CLEAR)

  This erases trace datas displayed on the CRT low-intensity screen.

- Press the [RECALL] and [9] keys (Initialization)

  This initializes the MS420[ ] to the conditions originally held when the power was turned on.

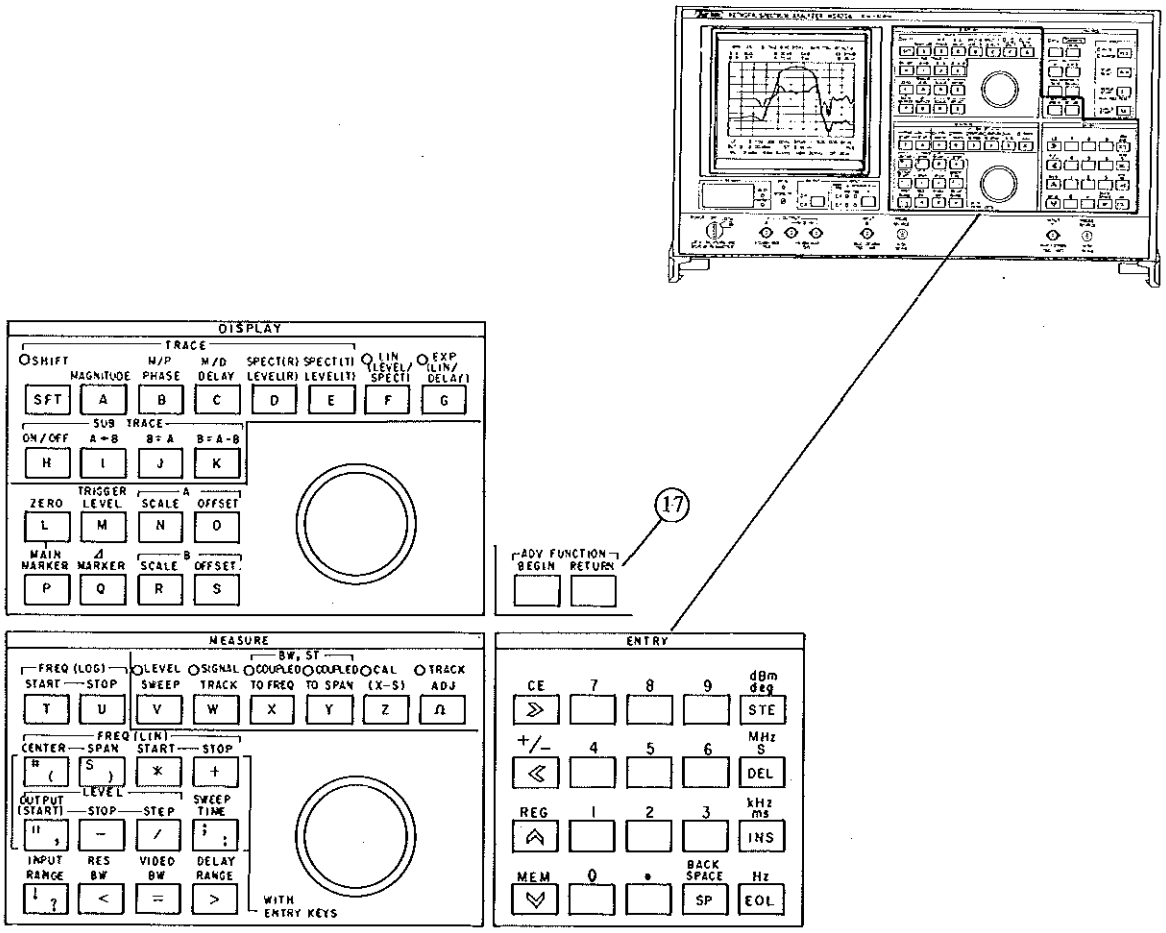


Fig. 2-37 Operation (13)

(35) ADV FUNCTION (17)

These keys are used to set several advensed functions which cannot be selected directly from the front panel. These functions are operated with the ENTRY keys and the following blue key.

Note

The following characters and keys are used with the ADV FUNCTION.

[A] ~ [Z], [a] ~ [z], [Ω], [(], [)], [*], [+], [,], [-], [/], [:], [?], [<], [=], [>], [#], [$], ["], [;], [!], [0] ~ [9], [.], [SP], [EOL]

The 16 items in the following table are available with the ADV function.

Table 2-6 ADV FUNCTION

Item		Data	Description
Number	Characters		
0	INTEGRATING	ON/OFF	Integrates the measured values
1	MAX HOLD	ON/OFF	Holds the maximum value
2	IMPEDANCE (R)	75/1M (50/1M)	Switches the R-side impedance.
3	FREQ COUNT	ON/OFF	Frequency measurement
4	TRACKING ΔF	Frequency	Offset tracking
5	TRACKING MODE	0/1/2	
6	TITLE	Alphanumeric characters	Comment display
7	AUTO CAL TIME	0 ~ 99	Auto-calibration period
8	SWEEP MARKER	ON/OFF	Sweep marker on or off
9	BUZZER	ON/OFF	Buzzer on or off
10	CP-IB COMMAND	Alphanumeric characters	Control of GP-IB
11	WRITE	Alhpanumeric characters	
12	DATA OUT	Alphanumeric characters	
13	READ	Alhpanumeric characters	
14	FORMAT WRITE	GO	PBM control
15	BACK UP	ON/OFF	

Note

Items 14 and 15 are displayed only when the PBMI option is incorporated in MS420 [ ].

(a) Explanation of functions

- INTEGRATING
  This function is used to measure a signal of poor stability. See paragraph 3.6.1 for further details.

- MAX HOLD:
  This is valid only for L (R), L (T), S (R) and S (T) and holds the maximum value of each sweep. Pressing the REPEAT START key clears the held data.
  See paragraph 3.6.2 for further details.

- IMPEDANCE (R)
  This is used to switch the R-side input impedance.

- FREQ COUNT
  This is valid only for L (R), L (T), S (R) and S (T) and measures the input signal frequency specified by the marker. Refer to paragraph 3.6.3 for further details.

- TRACKING Δ F and TRACKING MODE
  This is used to set the offset tracking parameters. Refer to paragraph 3.6.4 for further details.

- TITLE
  This enables the user to insert a comment of up to 15 characters on the upper right corner of the CRT.

- AUTO CAL TIME
  This is used to set the INT calibration period in one-minute steps at from 1 to 99 minutes. For 0, INT calibration is not started from the timer.

- SWEEP MARKER

- BUZZER

- GP-IB COMMAND, WRITE, DATA OUT and READ
  These functions are fully explained elsewhere in this manual according to how they are used with various other functions.
  See paragraph 3.6.4, 3.6.5 and GP-IB Operation Manual.

- FORMAT WRITE and BACK UP
  Refer to item (40) for details.

(b) Operating method

Operation of the ADV Function starts when the [BEGIN] key is pressed and ends when the [RETURN] key is pressed. When the [BEGIN] key is pressed, the bottom line on the CRT is displayed with inverse video as shown in Fig. 2-38. This indicates that the ADV FUNCTION has been called and is ready.

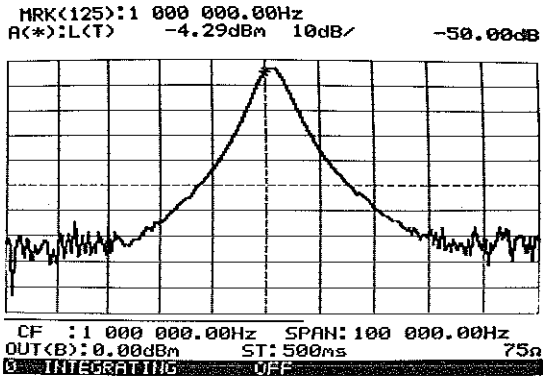


Fig. 2-38 ADV FUNCTION

Step	Procedure
1.	Press [BEGIN] key
2.	Press [/] [6] [EOL] keys in this order
3.	Press [M] [S] [4] [2] [0] [A] keys in this order

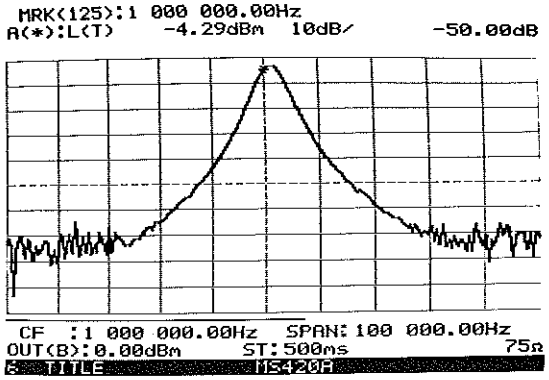


Fig. 2-39 TITLE (1)

4. Press [EOL] key

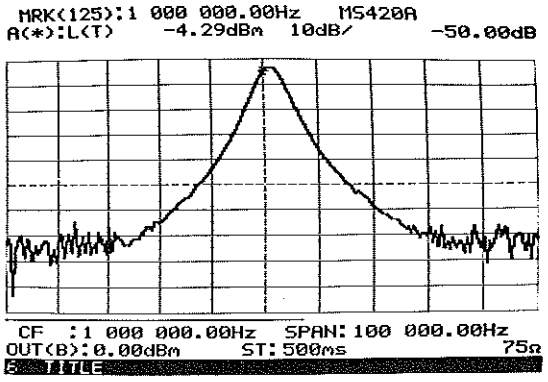


Fig. 2-40 TITLE (2)

5. Press [RETURN] key

Note

1. *Every function can be called in order by pressing the [▽] or [△] key.*
2. *The above procedure is for the TITLE function. The procedure for the other functions is similar to the above.*

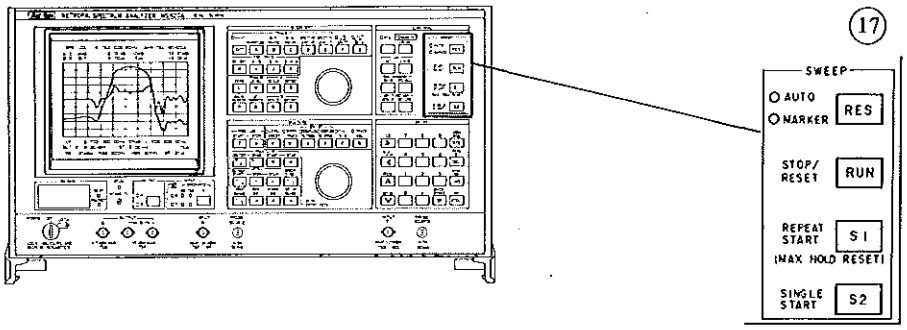


Fig. 2-41 Operation (14)

(36) AUTO/MARKER (17)

Each time this key is pressed, the AUTO and MARKER lamps turn on alternately.

AUTO: Sweeps the entire rnage.

MARKER:

ΔMARKER Off: Measures only at the main marker point.

ΔMARKER on: Sweeps between two markers.

(37) STOP RESET (17)

When this key is pressed, the following operations are carried out.

During a sweep operation: Stops the sweep.

During suspension of a sweep operation: Returns to the sweep starting point and stops the sweep.

(38) REPEAT START (17)

When this key is pressed, the following operations are carried out.

During sweep operation or when operation is suspended at the sweep start point: Initiates the sweep repeatedly from the start point.

During suspension of a sweep operation: Continues the sweep and repeats it.

Note

When MAX HOLD is ON, the data is initialized by pressing this key.

(39) SINGLE START ⑰

When this key is pressed, the following operations are carried out.

During a sweep operation: Sweeps from the start point only once.

During suspension of a sweep operation: Continues the sweep and sweeps only once.

(40) MEMORY②

When the PBM is plugged into the built-in PBMI (Plug-in Bubble Memory Interface) socket, the memory mode SAVE/RECALL and BACK UP functions can operate. The PBM can also be used as a program file for the PTA option. For using the PTA option, please refer to the PTA OPERATION MANUAL for details.

(a) Write Protect

As the Fig. 2-42 shows, the PBM is provided with a slide key for write protection. If this key is set to Write Inhibit, data cannot be written. When the PBM is inserted into the socket, the PROTECT lamp (green) lights.

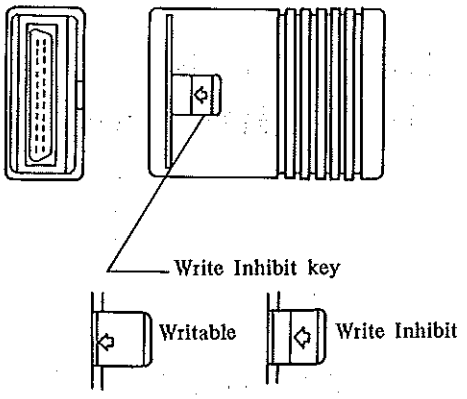


Fig. 2-42 Write Protect

(b) BUSY lamp

The BUSY lamp lights while the PBMI and PBM are in access. Be sure not to unplug the PBM while this lamp is lit.

(c) Format Write

Before using a new PBM or clearing the contents of an old one, an initial format is written to the PBM. This operation should be performed as explained below.

STEP	Procedure

1. Press the [BEGIN] key to activate the ADV function.
2. Press these keys in order: [/] [1] [4] [EOL].

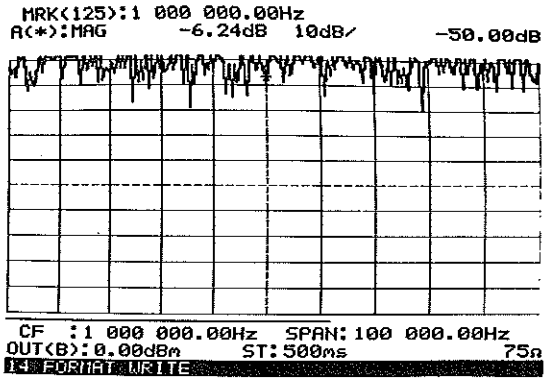


Fig. 2-43 Format Write (1)

3. Press these keys in order: [G] [0] [EOL].

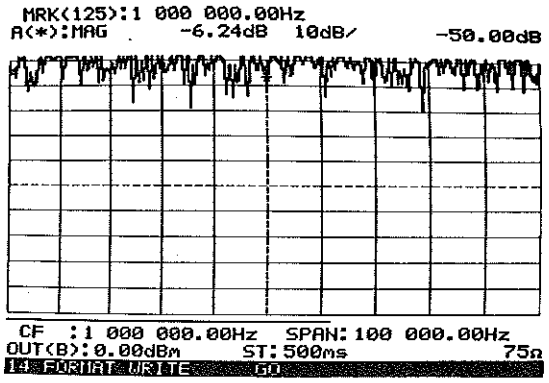


Fig. 2-44 Format Write (2)

4. Wait until the BUSY lamp goes out.

Note

The BUSY lamp will stay lit for 1.5 to 3 seconds.

5. Press the [RETURN] key.

(d) SAVE/RECALL (17)

The SAVE/RECALL key of MEMORY mode is used as follows.

Method	Operation
a	Press these keys in order: [SAVE] [MEM] [3] *.
b	Press these keys in order: [RECALL] [MEM] [5] *.

Note

1. *The part marked * is an address for which integers 0 to 5 must be used.*
2. *The BUSY lamp (2) will light for 1.5 to 3 seconds.*
3. *The panel setting status and the following memory contents can be stored.*
   SUB TRACE OFF: The contents of SA and SB memory
   SUB TRACE ON: The contents of SA memory and B memory

(e) BACK UP

After the PBM is plugged in, the Write Protect key is set to "Writable", and the following operation is carried out, the current panel setting status is stored in the PBM. This means that, even if the power is cut off by mistake, the previous status can be recalled merely by switching the power back on.

Setting the BACK UP function

Step	Procedure
1	Press the [BEGIN] key (17).
2	Press these keys in order: [/] [1] [5] [EOL].
3	Press these keys in order: [0] [N] [EOL].
4	Press the [RETURN] key (17).

Recalling back up data:

Press these keys in order: [RECALL] [MEM] [6].

Note

The contents of S and B memories are not backed up by the BACK UP function.

2.9 CONNECTING TEST DEVICES

The following explains the fundamental connections for each measurement item.

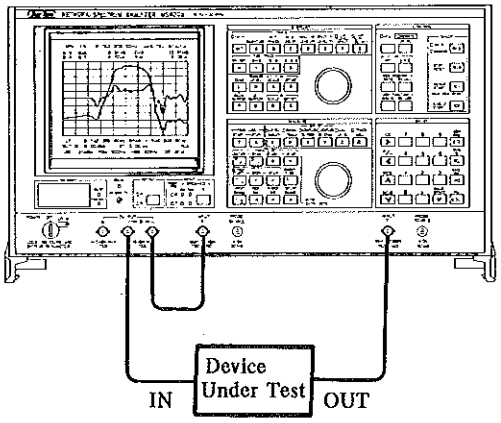


Fig. 4-45 MAG, PHA, DLY

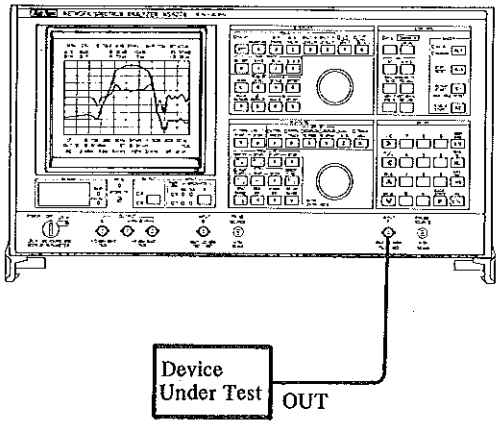


Fig. 4-46 LEVEL, SPECTRUM

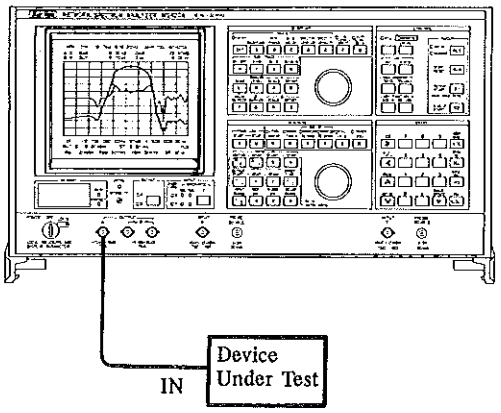


Fig. 4-47 Synthesizer

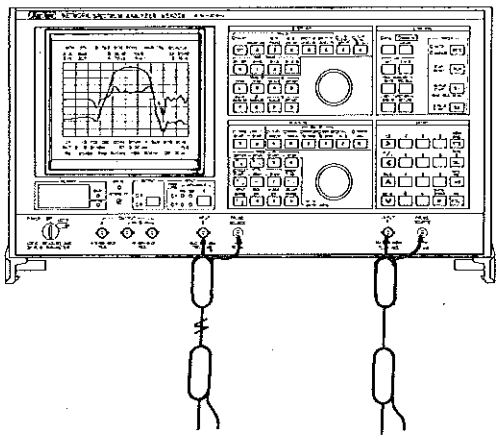


Fig. 4-48 AC probe

2.10 FUNCTION TEST

The following explains how to test very simply the fundamental functions of the MS420[ ]. Refer to SECTION 6 for further details on confirming functions and performance.

(1) POWER ON

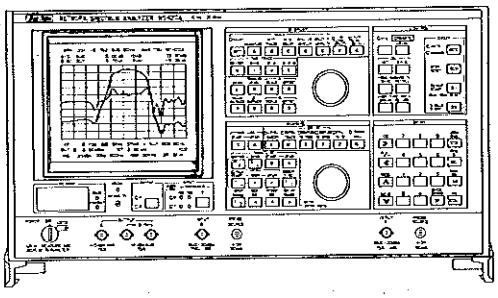


Fig. 2-49 Connection

With the power on, the waveform of Fig. 2-50 is displayed on the CRT. See Fig. 2-19 for further details.

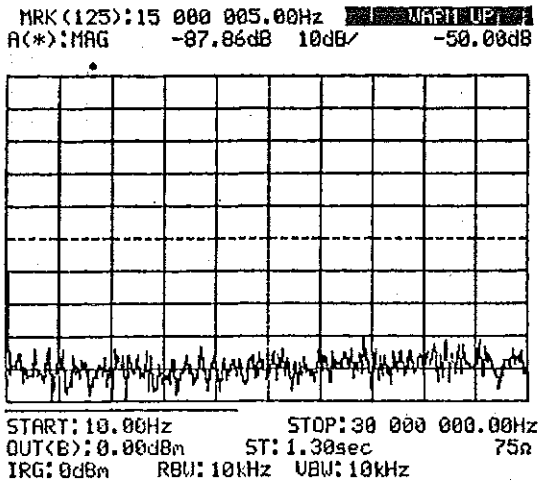


Fig. 2-50 Initial Display

Fifteen minutes after the power is turned on, "CALIBRATING" will be displayed on the upper right corner of the CRT as shown in Fig. 2-51. When this message disappears, the MS420[ ] is ready to take actual measurements.

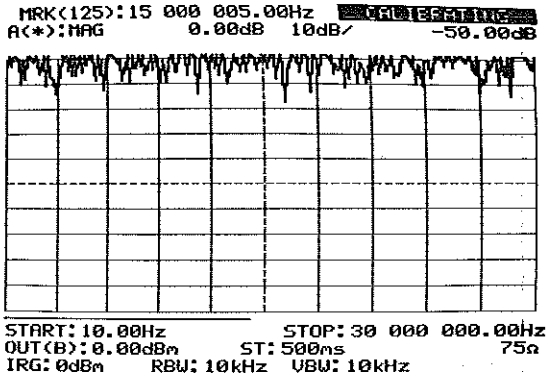


Fig. 2-51 CALIBRATING

(2) TRACE

The following are examples of CRT displays when TRACE is changed by two different connections.

Table 2-7 TRACE

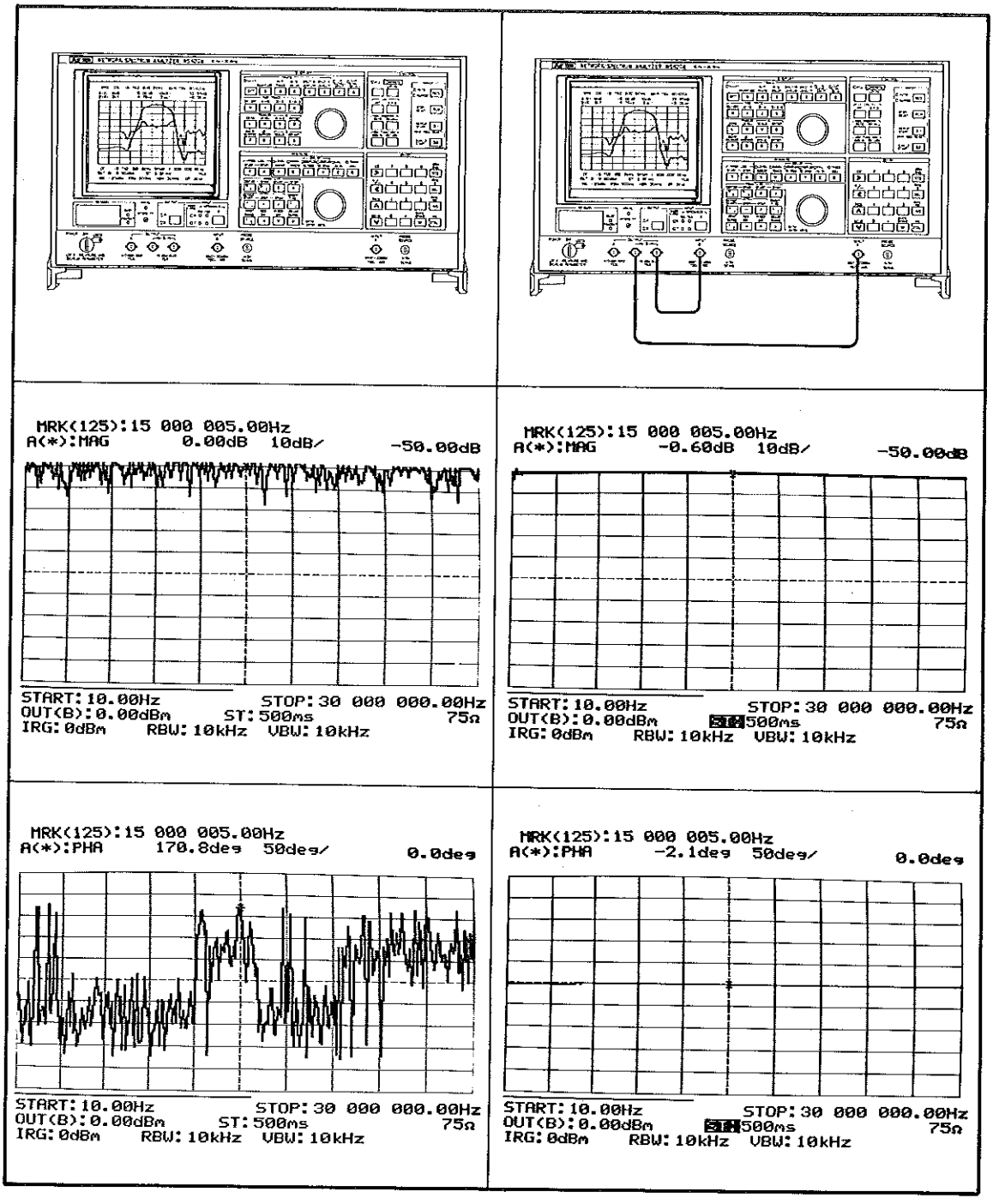
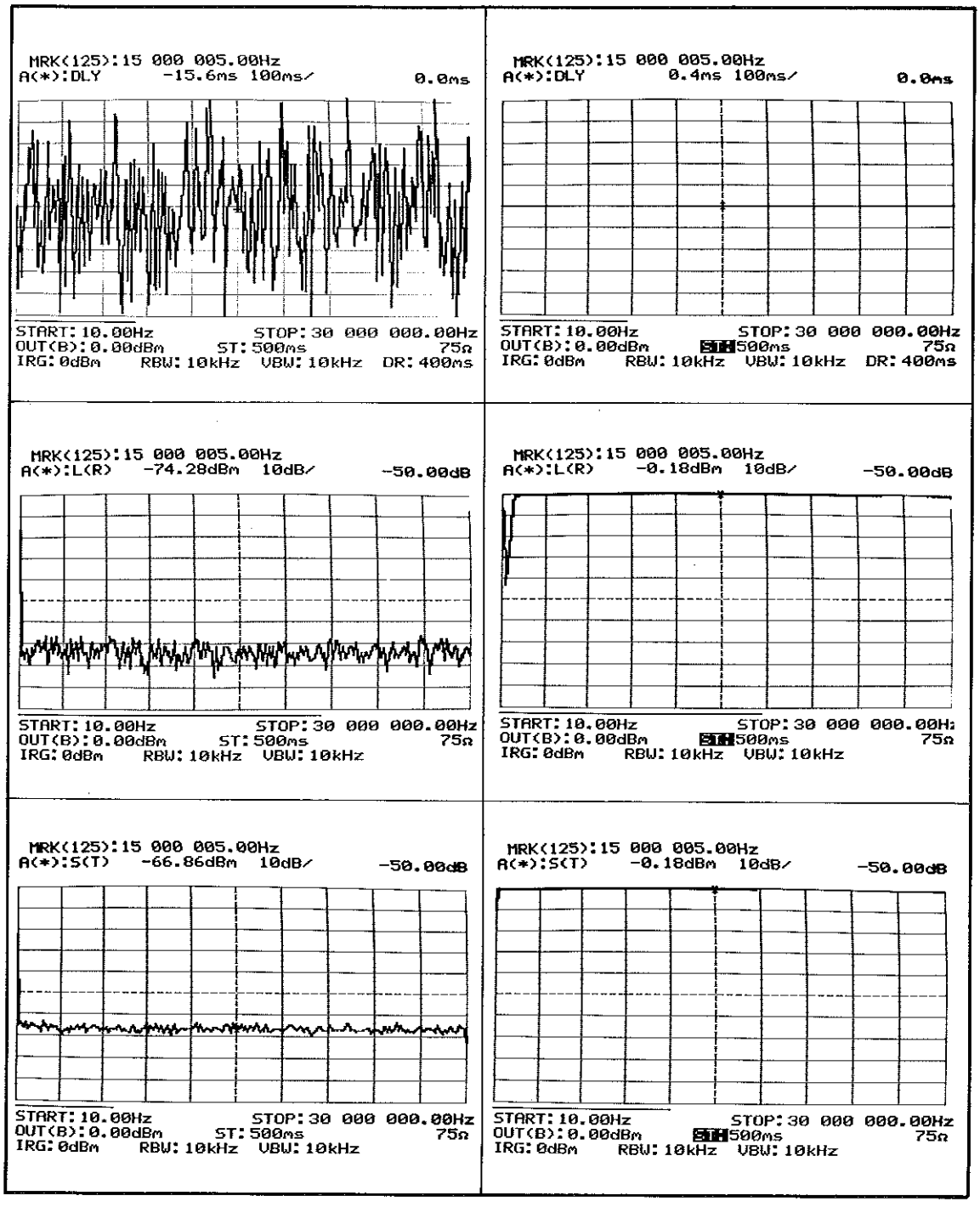


Table 2-7 TRACE (Cont'd)



(3) Calibration

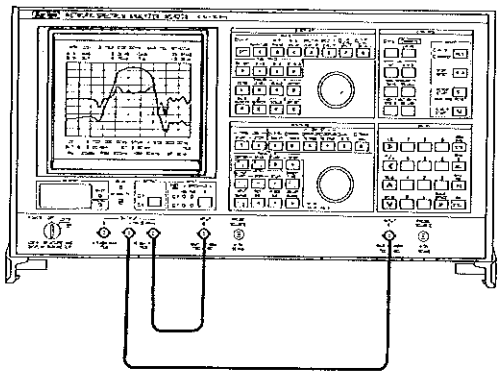


Fig. 2-52 Connection for Calibration

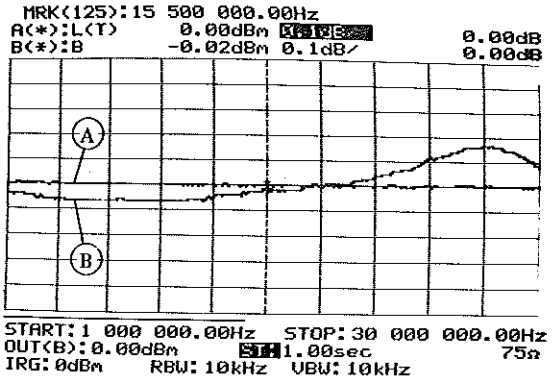


Fig. 2-53 Calibration Display

When magnitude is measured with the connection diagram shown in Fig. 2-52 waveform (B) of Fig. 2-53 is displayed on the CRT. This measured value shows the frequency response of the MS420[ ] itself. To eliminate this frequency response, do the following.

Step	Procedure
1.	Press the [X→S] key.
2.	Wait one sweep cycle.
3.	Turn the CAL X-S Lamp on.
4.	Wait for the waveform (A) shown in Fig. 2-53 to appear on the CRT.
5.	If a measurement sample is connected after this, the measurement made will be correct.

Note

1. *If this calibration is made for measurements of magnitude, phase, and delay time when directly coupled circuits are connected, the measured value will be "0".*
2. *For measurements of level and spectrum, an absolute level is calibrated.*
3. *An level measurement error will show as "0" even when using this calibration. Refer to paragraph 3.2.3 and 3.2.4 for further details.*

(4) Dynamic range

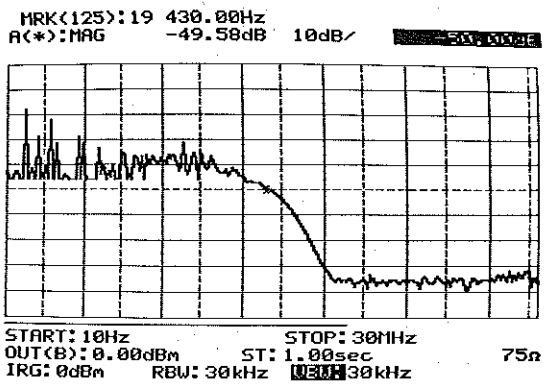


Fig. 2-54 RBW 30 kHz

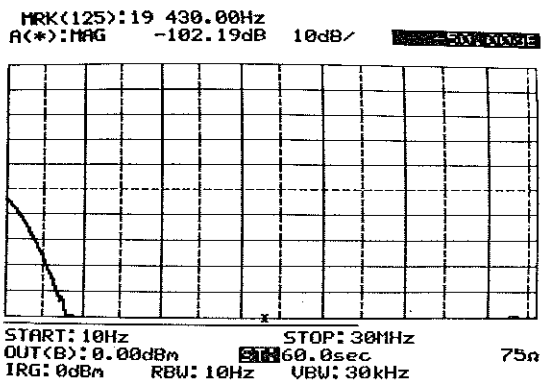


Fig. 2-55 RBW 10 Hz

RBW is the factor which determines the dynamic range. When the RBW is changed, the dynamic range varies as shown in Fig. 2-54 and 2-55. Fig. 2-56 shows the specification of a dynamic range. Measure the magnitude or level to confirm the above. As a rule, the smaller the RBW, the larger the dynamic range.

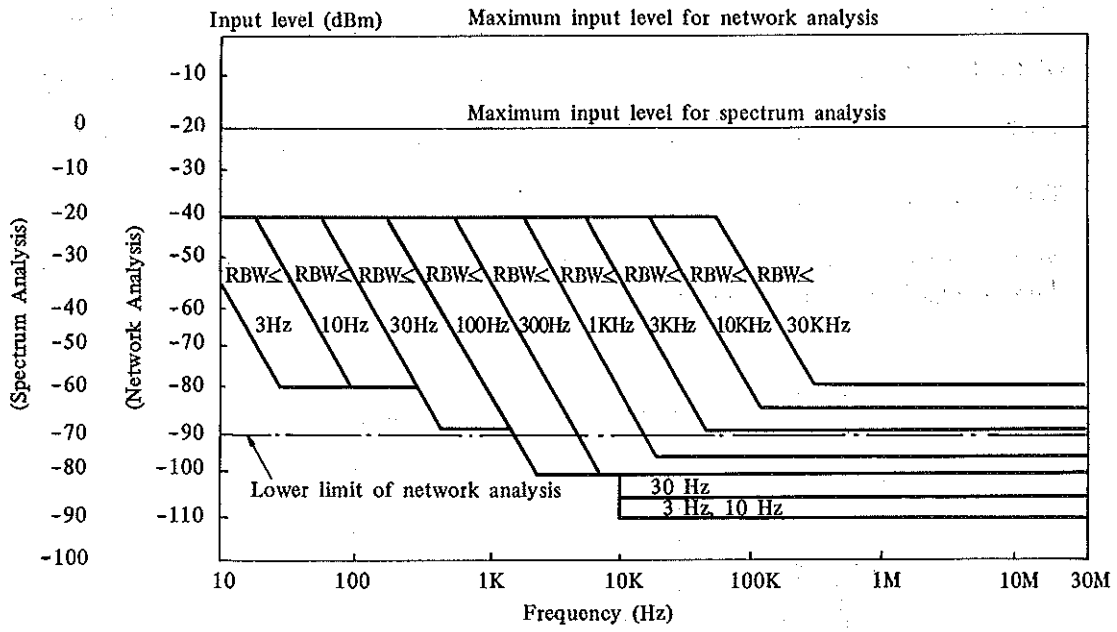


Fig. 2-56 Dynamic Range

(5) Level sweep

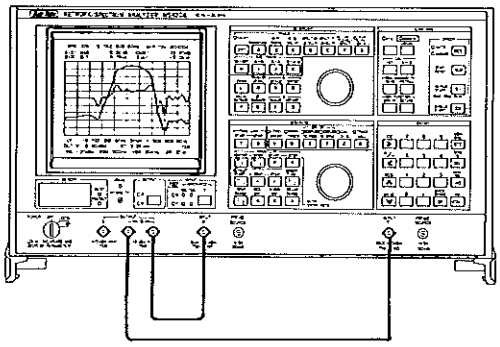


Fig. 2-57 Connection for Level Sweep

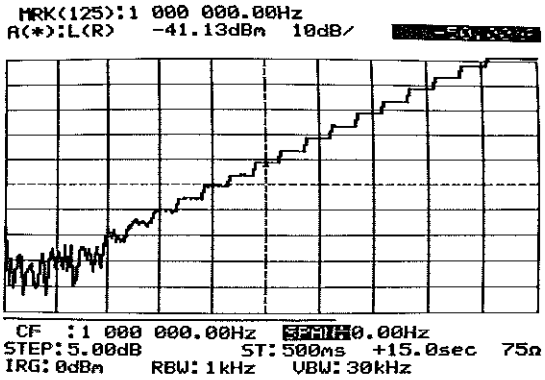


Fig. 2-58 Level Sweep (1)

If the following conditions are set with the connection shown in Fig. 2-57 and a level sweep is performed, the waveform shown in Fig. 2-58 is displayed on the CRT.

TRACE ..... L (R)

OUT (START) ..... −100 dBm

STOP ..... 0 dBm

STEP ..... 5 dB

When changing the measuring item from TRACE L (R) to TRACE MAGNITUDE, the waveform shown in Fig. 2-59 is displayed on the CRT.

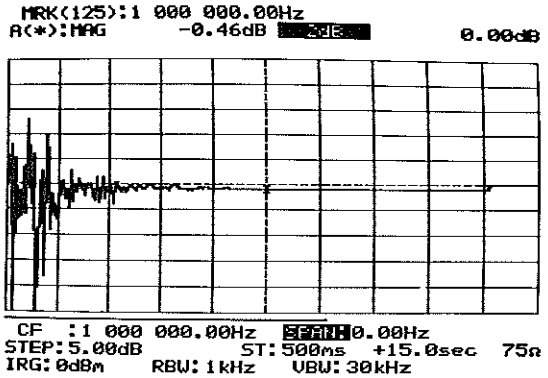
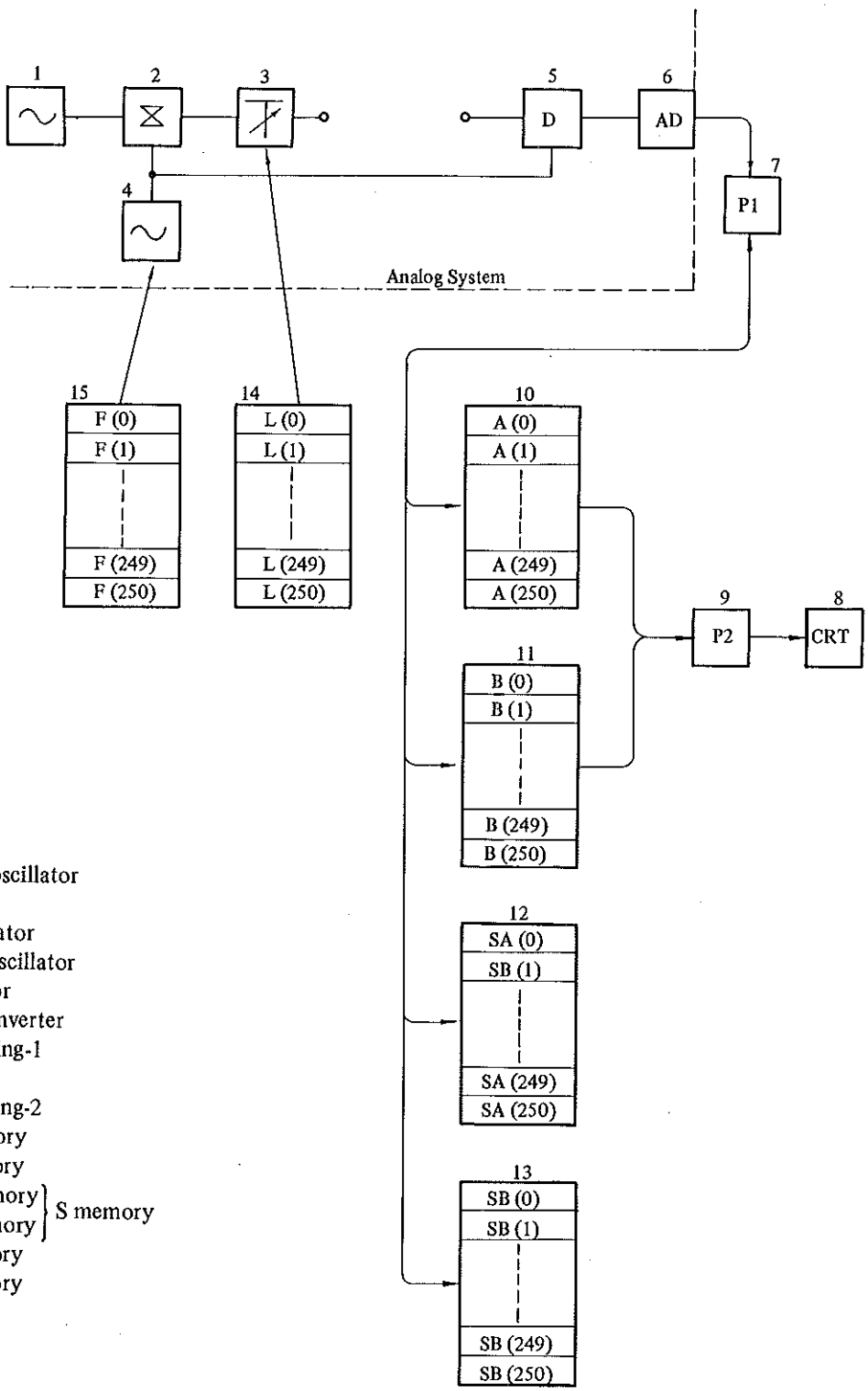


Fig. 2-59 Level Sweep (2)

2.11 MEMORY SYSTEM

The MS420[ ] performs measurements on the basis of arrayed configuration memory. Descriptions are loaded in this memory system as described below. Figure 2-60 shows how this system is connected to an analog system. The flow of measurements based on this figure is shown in Fig. 2-61. The X values (measured values at each point) in the figure are stored in memories A, B, SA, and SB through the flow shown in Table 2-8. P2 processing as shown in the table is the adjustment of SCALE and OFFSET.

Figure 2-62 shows the operating functions for these memories. This figure shows how to control an element of each memory by peripheral units. For example, if the GP-IB and PTA option are used, it means that all memories can be operated freely. Control of the F and L memories from the front panel is limited. Refer to paragraph 2.8 for further details.



Notes:

1. Fixed oscillator
2. Mixer
3. Attenuator
4. Local oscillator
5. Detector
6. A/D converter
7. Processing-1
8. CRT
9. Processing-2
10. A memory
11. B memory
12. SA memory } S memory
13. SB memory }
14. L memory
15. F memory

Fig. 2-60 Memory Configuration

Table 2-8 Data Flow

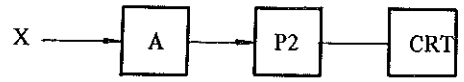
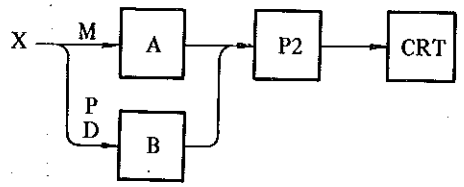
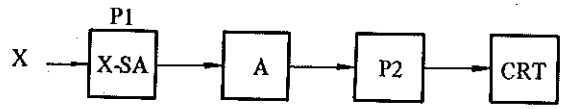
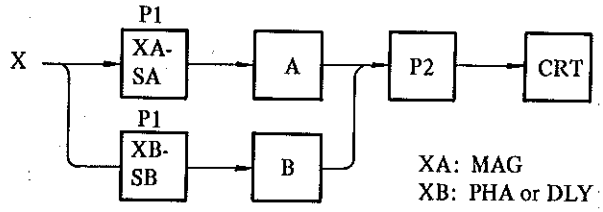
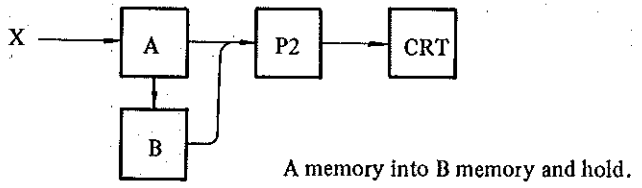
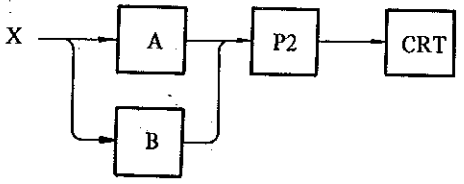
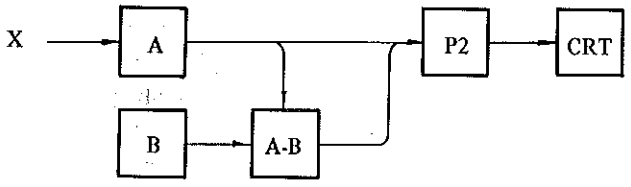
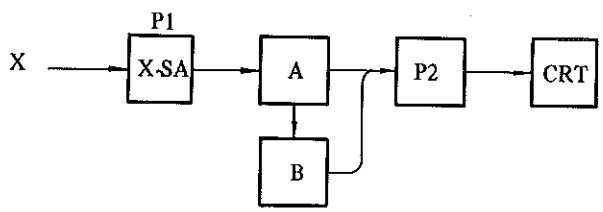
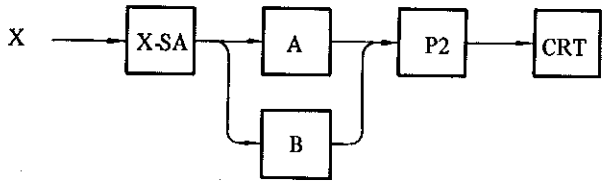
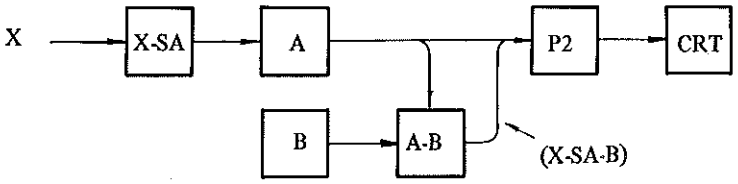
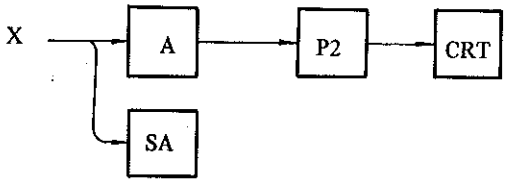
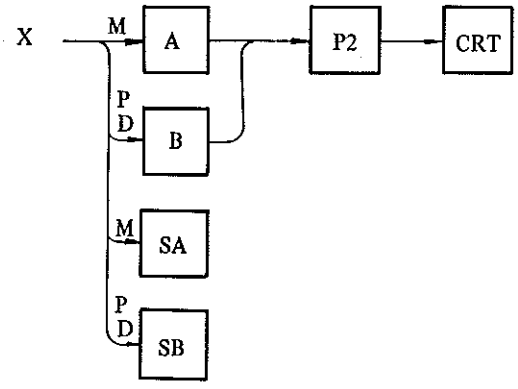
Functions			Data flow
MAG, PHS, DLY, LEVEL, SPECT X-S; OFF SUB TRACE: OFF			
M/P, M/D X-S; OFF SUB TRACE: OFF			
MAG, PHS, DLY, LEVEL, SPECT X-S; ON SUB TRACE: OFF			
M/P, M/D X-S; ON SUB TRACE: OFF			
MAG PHS DLY LEVEL SPECT SUB TRACE : ON	X-S: OFF	A→B	
		B = A	
		B = A – B	

Table 2-8 Data Flow (Cont'd)

Functions			Data flow
MAG PHS DLY LEVEL SPECT SUB TRACE: ON	X-S: ON	A → B	
		B = A	
		B = A – B	
MAG, PHS, DLY, LEVEL, SPECT One sweep after pressing the [X → S] key.			
M/P, M/D One sweep after pressing the [X → S] key.			

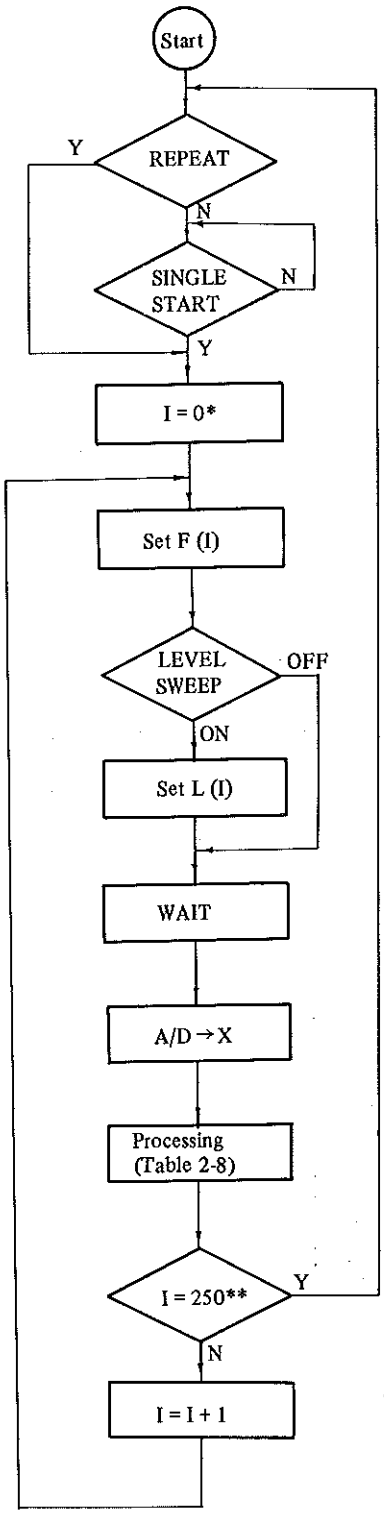
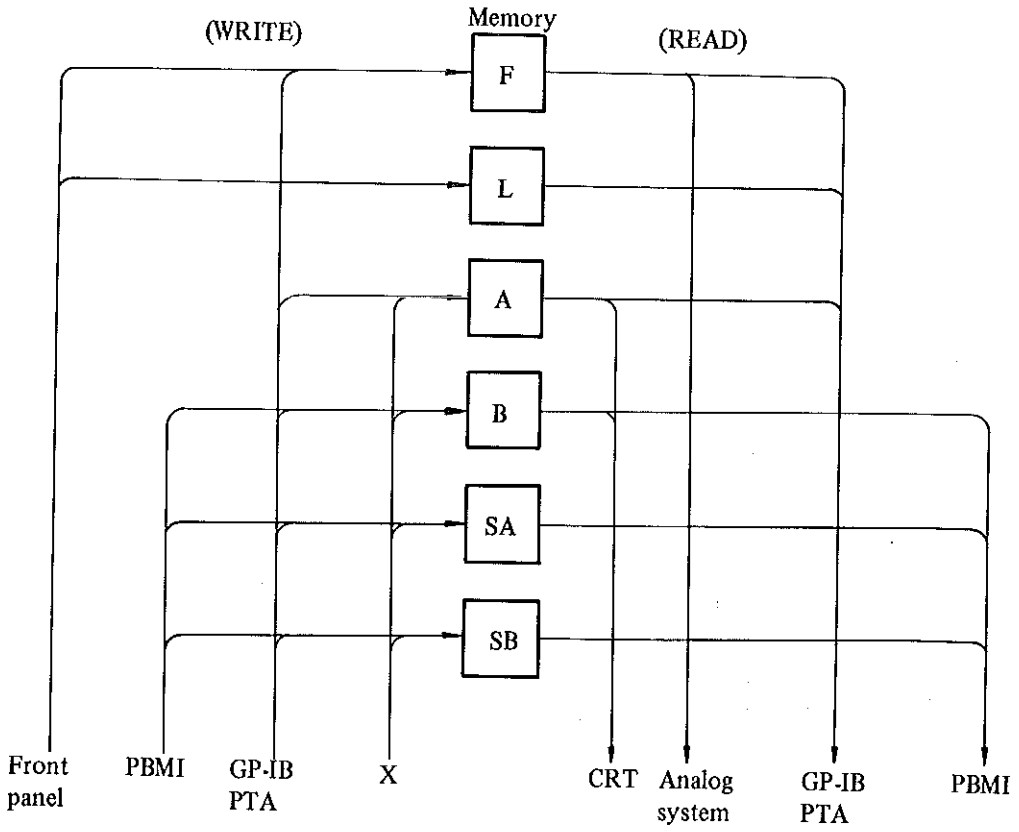


Fig. 2-61 Measurement Flowchart

Note

1. For marker sweep operation, * and ** become the value at the marker point.
2. For Δmarker sweep operation, * and ** are the start and stop points, respectively.



Variable name

	GP-IB	PTA
F	FQ, FQR, MMR	F
L	LV, LVR, MMR	L
A	XA, XAR	XA
B	XB, XBR	XB
SA	SA, SAR	XSA
SB	SB, SBR	XSB

Fig. 2-62 Memory Access

SECTION 3 MEASUREMENT

CONTENTS

SECTION 3 MEASUREMENT

3.1 NETWORK ANALYSIS

3.1.1 Principles of Analysis

A network's transmission and reflection characteristics are often used to delineate the network's properties. The MS420[ ] measures a frequency response of the magnitude, phase, and delay time and displays these values on the CRT. A network's reflection characteristics can be measured by combining a reflection bridge with the MS420[ ];

(1) Transmission characteristics

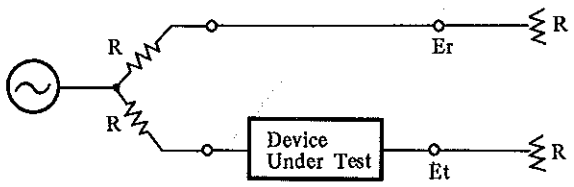


Fig. 3-1 Transmission Characteristics

In Fig. 3-1, the relation between Er and Et is as follows:

$$\frac{Et}{Er} = |K| \cdot e^{j\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1),$$

where |K| is the amplitude ratio (called MAGNITUDE) and ϕ is the phase shift called PHASE (rad). From formula 3.1, magnitude A, phase θ, and delay time τ are as below:

$$A = 20 \log |K| \quad \text{(dB)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

$$\theta = \frac{360}{2\pi}\phi \quad \text{(deg)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

$$\tau = \frac{d\phi}{d\omega} \quad \text{(S)}$$

$$\simeq \frac{\Delta\phi}{\Delta\omega} = -\frac{1}{360} \cdot \frac{\Delta\theta}{\Delta F} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4),$$

where ϕ = phase (rad), ω = angular frequency, $\Delta\theta$ = phase difference (deg), and ΔF = frequency difference (Hz). The magnitude and phase are measured directly and displayed on the CRT.

The delay time can be obtained by measuring the phase difference $\Delta\theta$ between two the frequencies, $f_0 + \frac{\Delta F}{2}$ and $f_0 - \frac{\Delta F}{2}$, and calculating with formula 3.4.

ΔF is called the aperture frequency and its relationship to DR, the resolution, and the measuring range are shown in Table 3-1.

In the EXPAND mode, the resolution is 1/10 times of normal mode, and measuring time is increased by inserting the integrator, automatically.

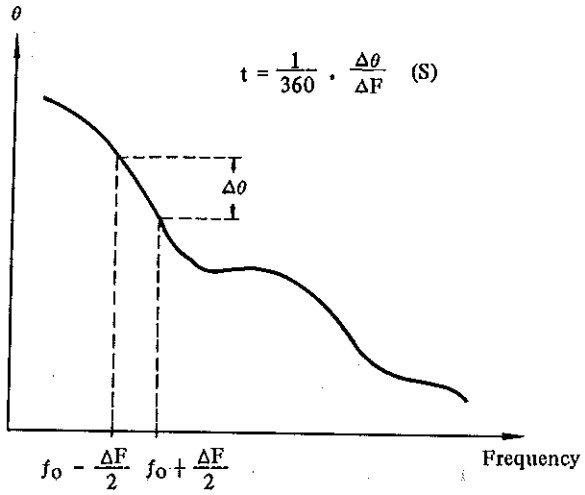


Fig. 3-2 Measurement of Delay Time

Table 3.1 Measurement of Delay Time

Range	Aperture ΔF	NORMAL		EXPAND		Frequency range
		Range	Resolution	Range	Resolution	
1μS	400kHz	± 1μS	1μS	±100nS	0.1nS	1MHz ~ 30MHz
2	200	± 2	2	±200	0.2	500kHz ~ 30MHz
4	100	± 4	4	±400	0.4	250kHz ~ 30MHz
10	40	± 10	10	± 1μS	1	100kHz ~ 30MHz
20	20	± 20	20	± 2	2	50kHz ~ 30MHz
40	10	± 40	40	± 4	4	25kHz ~ 30MHz
100	4	±100	100	± 10	10	10kHz ~ 30MHz
200	2	±200	200	± 20	20	5kHz ~ 30MHz
400	1	±400	400	± 40	40	2.5kHz ~ 30MHz
1mS	400Hz	± 1mS	1μS	±100	100	1kHz ~ 30MHz
2	200	± 2	2	±200	200	500Hz ~ 30MHz
4	100	± 4	4	±400	400	250Hz ~ 30MHz
10	40	± 10	10	± 1mS	1μS	100Hz ~ 30MHz
20	20	± 20	20	± 2	2	50Hz ~ 30MHz
40	10	± 40	40	± 4	4	25Hz ~ 30MHz
100	4	±100	100	± 10	10	12Hz ~ 30MHz
200	2	±200	200	± 20	20	11Hz ~ 30MHz
400	1	±400	400	± 40	40	10Hz ~ 30MHz

(2) Reflection characteristics

If the impedance of device under test and reference impedance are Zx and Ro, respectively, the reflection coefficient S is determined as follows:

$$S = |S| \cdot e^{j\phi} = \frac{Zx - Ro}{Zx + Ro} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.5)$$

$$\theta = \frac{360}{2\pi}\phi \quad \text{(deg)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.6)$$

$$\delta = 20 \log_{10} \frac{1}{|S|} \quad \text{(dB)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.7)$$

S is detected with a reflection bridge, and δ, θ are measured with the MS420[ ]. All values are displayed on the CRT.

(3) Impedance

Two terminal impedance can be measured with the Impedance Probe MA413A.

3.1.2 Magnitude

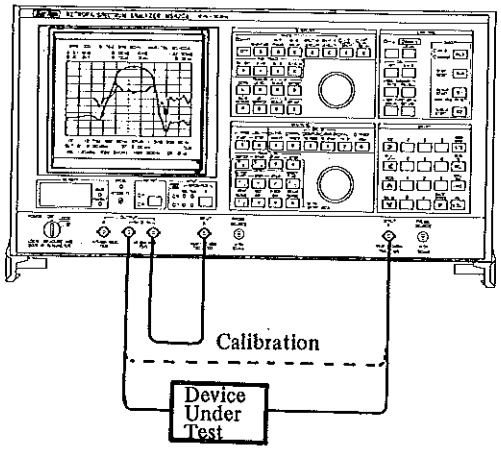


Fig. 3.3 Magnitude Measurement Connections

Magnitude is one of the fundamental measurements when determining transmission characteristics. This paragraph explains how to set the RBW for the optimal dynamic range, and the sweep time (ST) magnitude measurements. This example assumes the device under test is a band pass filter with a 1.5 MHz center frequency.

(1) Procedures

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on.

- OUTPUT . . . . . B
- IMPEDANCE . . . . . 75Ω (B type) or 50Ω (K type)
- LEVEL-OUTPUT . . . . . 0 dBm
- LEVEL SWEEP . . . . . OFF
- COUPLED TO FREQ . . . . . OFF
- TRACE . . . . . MAGNITUDE

Note

After the power is on, press the [RECALL] *and* [9] *keys in that order to initialize the MS420[ ].*

Step	Procedure
3	Set the frequency as indicated below: Center frequency (CF): 1.5 MHz SPAN: 5 kHz
4	Check the OVERLOAD lamp and set the IRG as follows: When on: Increase IRG until the lamp goes out. When off: Decrease IRG as much as possible without turning the lamp on.
5	Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

6 Make the VBW setting wider than the RBW setting.

Note

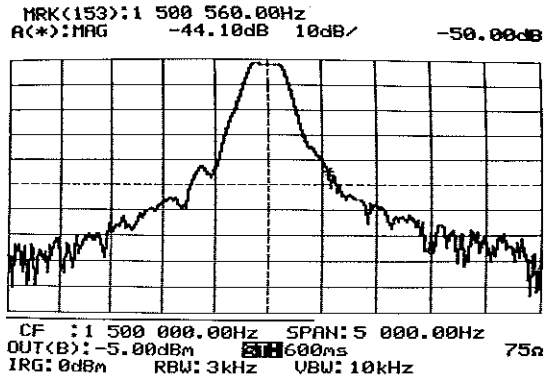
See paragraph 3.4.1.(b) for details of the VBW.

7. Check the UNCAL lamp. If it is on, increase ST until it goes out (Fig. 3.4).

Note

If the setting time of the device under test is greater than ST, it is necessary to further increase ST to a point where the trace on the CRT does not change (Fig. 3.5).

Step	Procedure



UNCAL: OFF

Fig. 3-4 ST Adjustment (A)

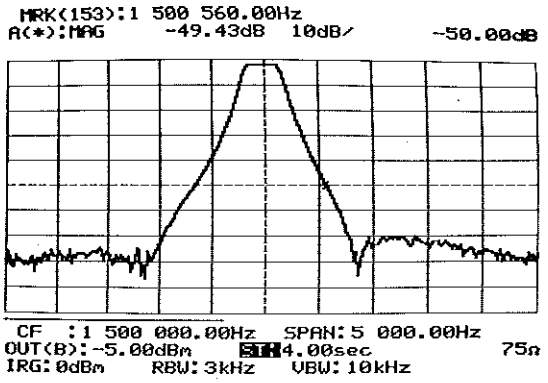


Fig. 3-5 ST Adjustment (B)

8 Connect OUTPUT B to INPUT T directly (dotted line in Fig. 3-3) and press the [X → S] key.

9 After one sweep measurement, connect a device under test.

10 Turn the X – S lamp on.

Note

If the frequency, IRG, and RBW are changed, restart the operation from step 8.

11 Read the measured values on the CRT.

(2) Level setting

The MS420[ ] can measure over a very wide range of levels. Since the characteristics of the circuit being measured (irrespective of its being an active or passive circuit) may change according to the measuring level used, a proper measuring level should be determined by one of the following condition.

- A device under test should be tested in actual operating status.
- A device under test should be tested at a level without distortion.

Fig. 3.6 is the level diagram of the MS420[ ] measuring system.

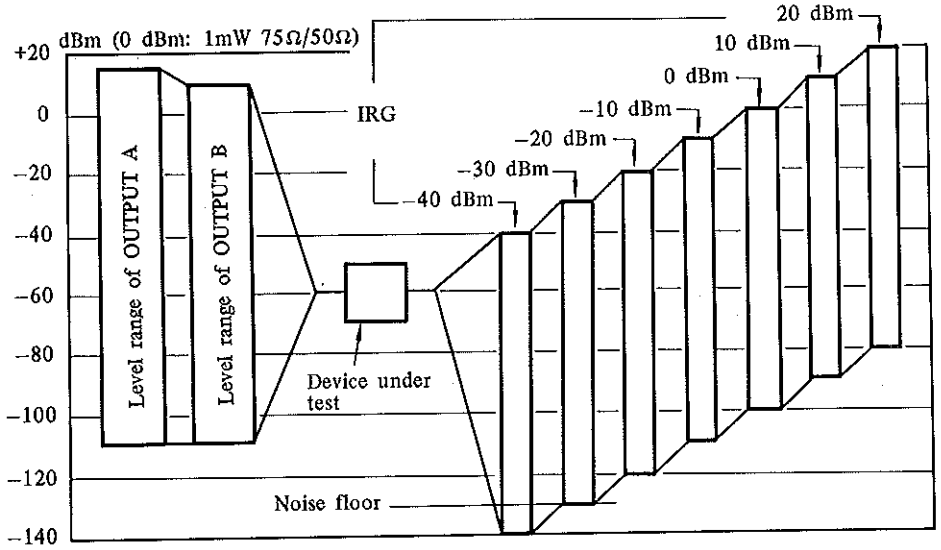
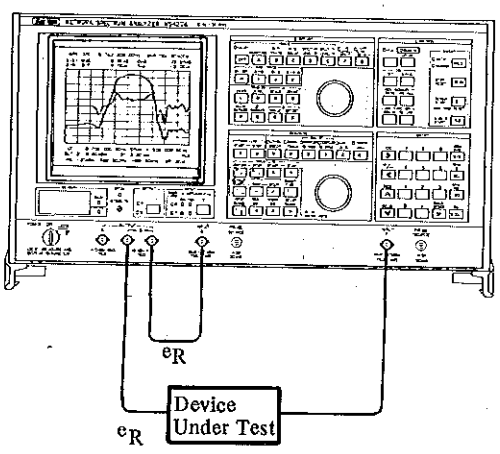


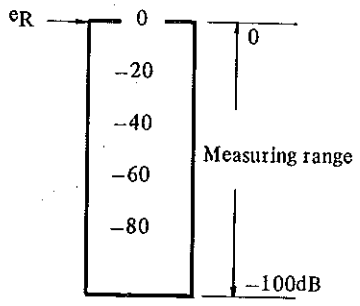
Fig. 3.6 Level Diagram of the MS420[ ] Measuring System

(3) Selecting an effective dynamic range

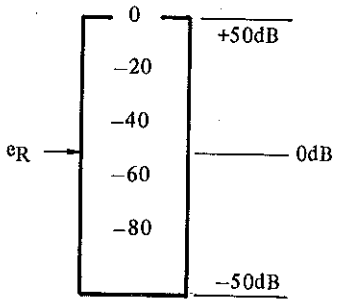
The MS420 [ ] has up to 100 dB dynamic range. Use the following level settings to make the best use of the dynamic range.

- Loss circuit: Used to equalize the output level (e_R) of a synthesizer with the input range (IRG).
- Gain circuit: Used to make the output level (e_R) of a synthesizer using the maximum gain of the measuring band smaller than the input range (IRG).





Loss circuit (Filter)



Gain circuit (Amplifier)

Fig. 3.7 Selecting an Effective Dynamic Range

If the loss of the impedance converter used for a device under test having an impedance other than 75Ω is too large, the measured dynamic range will be narrow.

In such cases, insert a resistance attenuator in the channel R route as shown in Fig. 3.8, and then this attenuation should be equal to the insertion loss of device under test including the impedance converter. This will allow for use of a lower IRG (Fig. 3.6.)

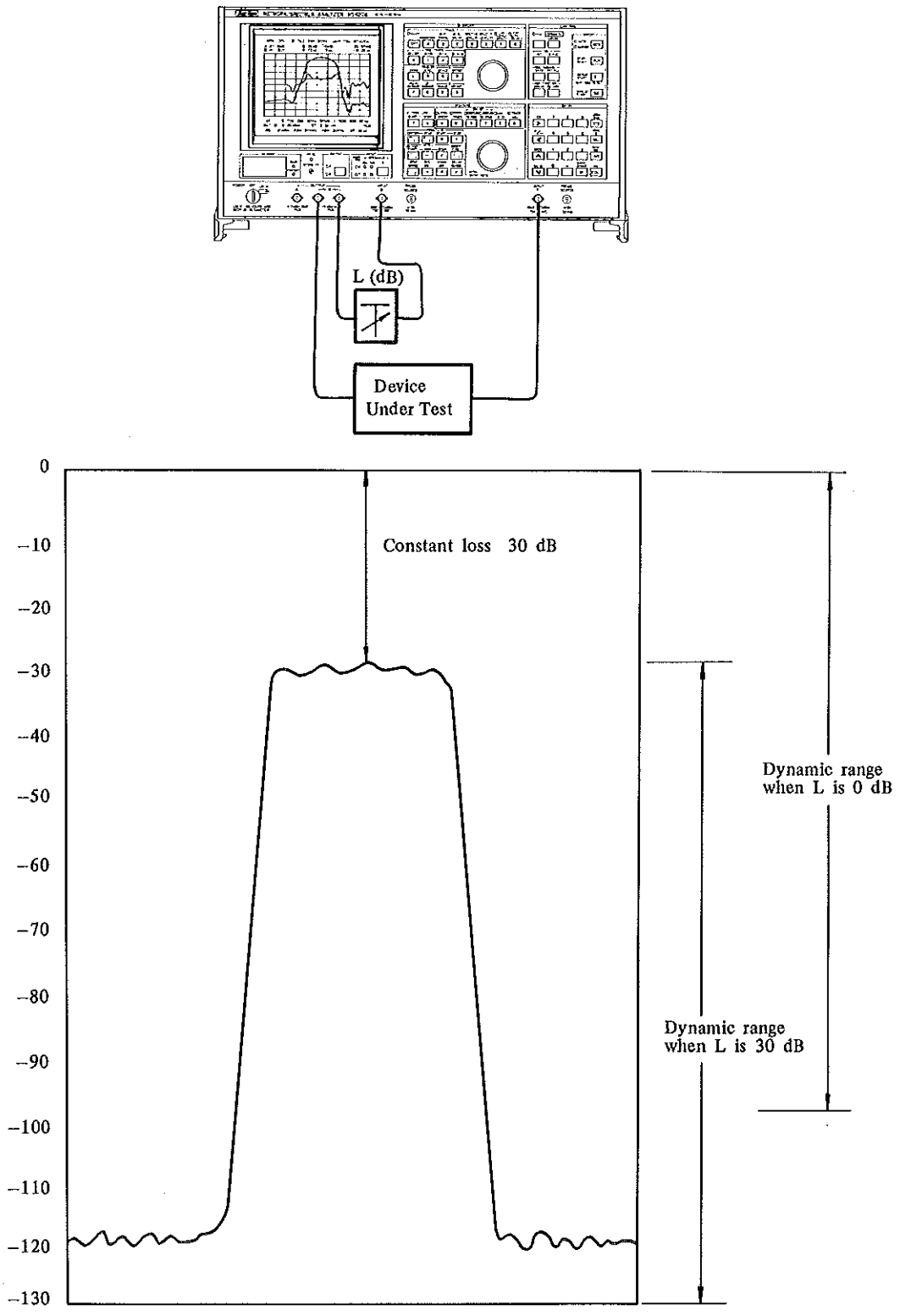


Fig. 3.8 Improving the Dynamic Range

(4) Impedance

See paragraph 5.2 for measurement under impedance conditions other than 75Ω/50Ω.

(5) TRACK ADJ

When RBW is 3 Hz or 10 Hz, it is advisable to occasionally check TRACK ADJ to ensure accuracy. In such case, see paragraph 2.8 – (29) for more information.

3.1.3 Phase, Magnitude/Phase

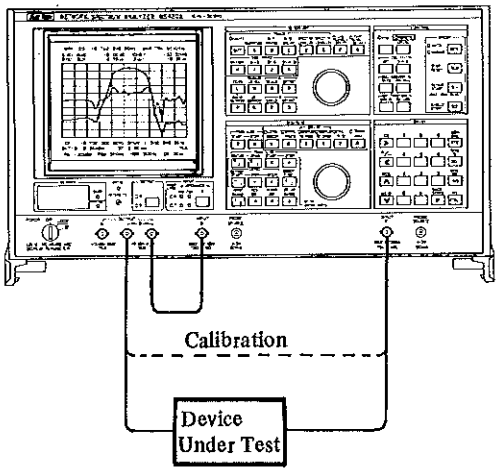


Fig. 3.9 Phase Measurement Connections

When magnitude is measured under the correct conditions, phase will be measured accurately. This paragraph explains the general operating procedures used for making a phase measurement of a band-pass filter with a 1.5 MHz center frequency.

For magnitude/phase measurements, the procedures for magnitude measurement are nearly the same as those given in paragraph 3.1.2. The only difference between the phase and magnitude/phase measurement procedures is that phase measurement makes use of OFFSET and SCALE of the B-channel for waveform adjustments.

(1) Procedures

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL – OUTPUT . . . . . 0 dBm • LEVEL – SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is on, press the* [RECALL] *and* [9] *keys in that order to initialize the MS420[ ]*

Step	Procedure

3 Press the [PHASE] key of the TRACE. The SHIFT lamp should go out.

Note

For magnitude/phase, turn the SHIFT lamp on.

4 Set the frequency.

CF: 1.5 MHz
SPAN: 2 kHz

5 Watch the OVER LOAD lamp while setting the IRG level as indicated below:

When the lamp is on: Increase IRG until the lamp goes out.
When the lamp is off: Decrease IRG as far as possible without turning the lamp on.

6 Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

7 Make the VBW setting wider than the RBW setting.

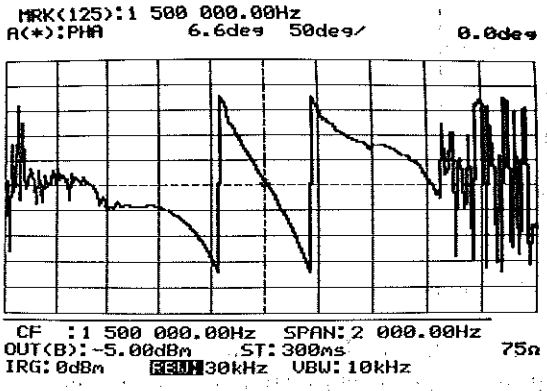
Note

See paragraph 3.4.1 – (b) for VBW.

Step	Procedure
8	If the UNCAL lamp is found to be on after checking, increase ST until it goes out (Fig. 3.10).

Note

If the setting time of the device under test is greater than ST, it is necessary to further increase ST to a point where the trace on the CRT does not change (Fig. 3.11)



UNCAL: OFF

Fig. 3.10 ST Adjustment (A)

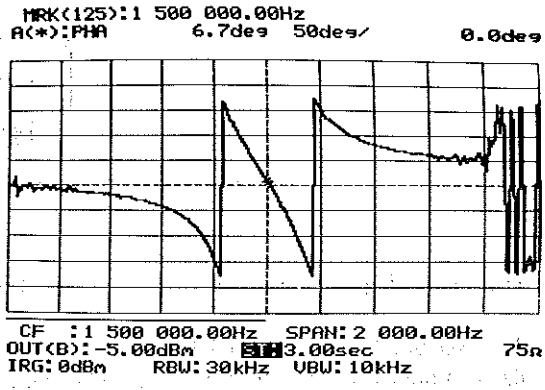


Fig. 3.11 ST Adjustment (B)

9	Connect OUTPUT B to INPUT T directry and press the [X → S] key.
10	Once a single sweep measurement finishes, connect a device under test.
11	Turn the X – S lamp on.

Note

If the frequency, IRG, and RBW are changed, repeat the operations from step 9.

12	Read the measured value on the CRT.

Note

See the following paragraph if necessary.

- *Setting measurement level:* *Paragraph 3.1.2 – (2)*
- *Setting effective dynamic range:* *Paragraph 3.1.2 – (3)*
- *Impedance convertor* *Paragraph 5.2*
- *TRACK ADJ:* *Paragraph 2.8 – (29)*

3.1.4 Delay Time, Magnitude/delay Time

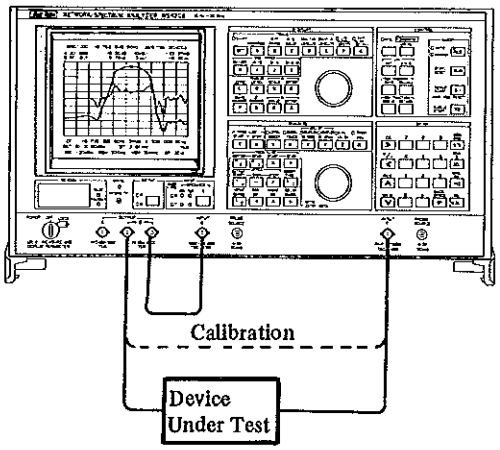


Fig. 3.12 Connections for Delay Time Measurement

The MS420[ ]provides two kinds of delay time measurement modes.

The NORMAL mode is used for general delay time measurements. The EXPAND mode is used when the device under test has a long absolute delay time and frequency response which are too small to be measured with adequate resolution, or when a resolution below 1 ns is required.

For magnitude/delay time measurements, the magnitude measurement procedures are the same as those given in Section 3.1.2. The differences between delay time measurement procedures are explained in Note.

(1) Procedures (NORMAL mode)

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *If the save function has not been used after the power is on, press the* [RECALL] *and* [0] *keys in that order to initialize the MS420[ ].*
3	Set the frequency. CF: 1.5 MHz SPAN: 1 kHz
4	Press the [DELAY] key of the TRACE. *Note* *Turn the SHIFT lamp on for magnitude/delay time measurement.*
5	Turn the EXP lamp off.
6	Check the OVERLOAD lamp and set IRG as follows: When on: Increase IRG until the lamp goes out. When off: Decrease IRG as far as possible without turning the lamp on.

Step	Procedure

7 Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 Hz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

8 Make the VBW setting wider than the RBW setting

Note

See Paragraph 3.4.1 – (b) for VBW.

9 Set ST so that the UNCAL lamp is off.

10 Decrease the DR gradually from 400 ms. The waveform on the CRT should change from that shown in Fig. 3.13 to that in Fig. 3.14.

Fix the DR once the waveform shown in Fig. 3.14 appears on the CRT.

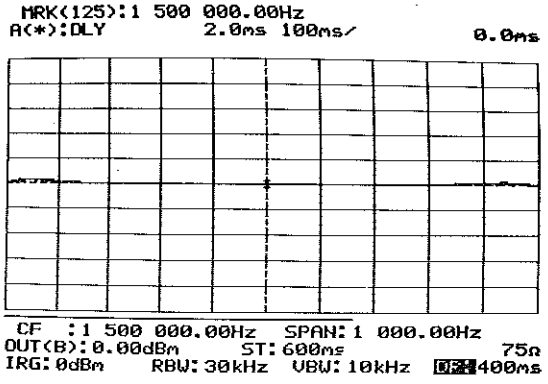


Fig. 3.13 DR Adjustment (A)

Step	Procedure

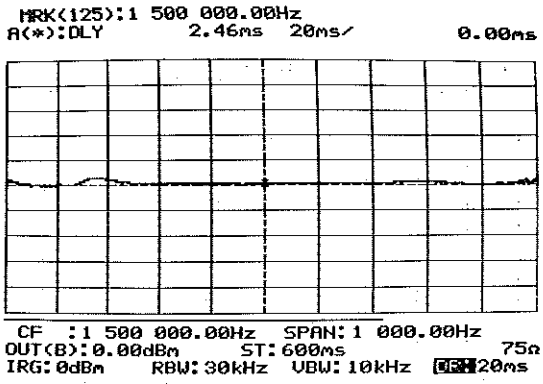


Fig. 3.14 DR Adjustment (B)

11 Press the A-SCALE key.

Note

Press the B-SCALE key for magnitude/delay time measurement.

12 Set the SCALE so that the waveform on the CRT increases to the size shown Fig. 3.15.

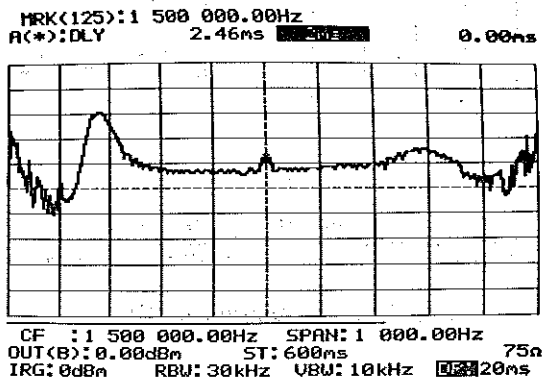


Fig. 3.15 Scale Adjustment

Step	Procedure
13	Adjust the ST so that the UNCAL lamp does not light.

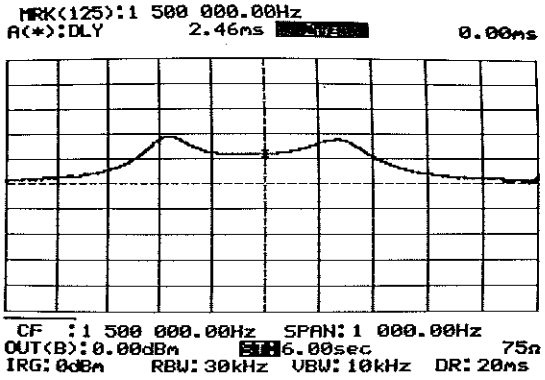


Fig. 3.16 ST Adjustment

14 If DR changes at this time, the waveform on the CRT may vary from that shown in Fig. 3.17 to that in Fig. 3.18. To reduce measuring errors as much as possible, set the minimum DR where the peak values as shown in Figs. 3.18 (asterisked part) are largest and also stop to changing.

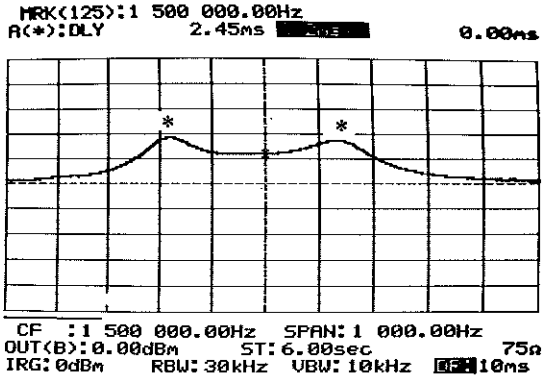


Fig. 3.17 DR Adjustment (C)

Step	Procedure

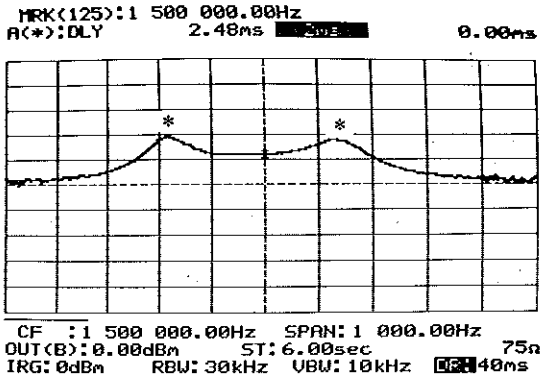


Fig. 3.18 DR Adjustment (D)

15 Read the measured values on the CRT.

Use Δ marker for frequency response.

(2) Procedure (EXPAND mode)

Step	Procedure
1 to 14	The same as for NORMAL mode.
15	Press the [A-OFFSET] key.

Note

Press the [B-OFFSET] key for magnitude/delay time measurement.

16 Set the offset so that the center value of the expanded part is displayed on the center of the CRT. (Fig. 3.19)

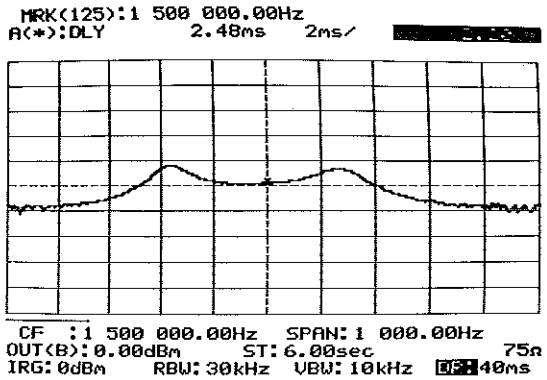


Fig. 3.19 Offset Adjustment

17 Press the [EXP] key. At this point, ST is increased.

18 Press the [A-SCALE] key.

Note

Press the [B-SCALE] key for magnitude/delay time measurement.

Step	Procedure

19 Set the scale so that the waveform on the CRT is large enouth to be seen easily. (Fig. 3.20)

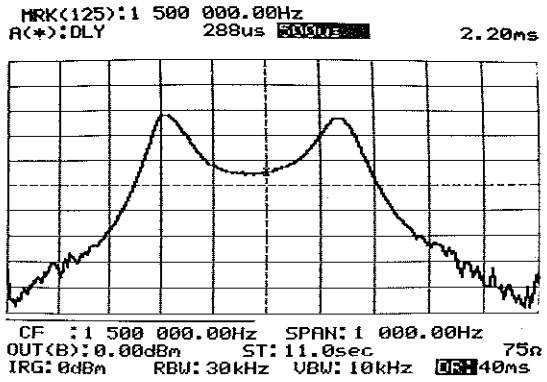


Fig. 3.20 SCALE Adjustment

20 Read the measured values on the CRT. Note that, in this mode, the values at each display point on the CRT are not valid. Only the inter-point relative values (frequency response) are effective (Fig. 3.21). For that reason, absolute delay time must be measured in NORMAL mode.

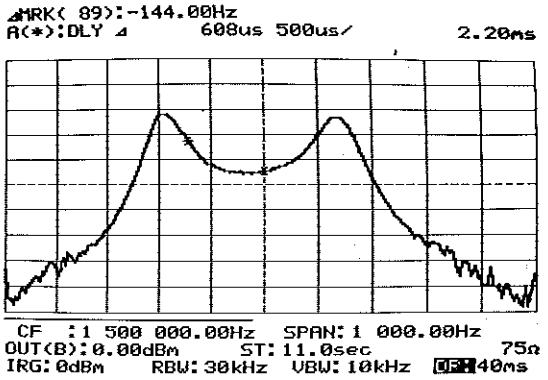


Fig. 3.21 ΔMarker

(3) Calibration

Usually, frequency response of the measuring system need not be calibrated when in NORMAL mode.

In EXPAND mode the frequency response of the measuring system sometimes lead to problems and the calibration procedures are different from the magnitude and phase measurement. With this in mind, the calibration method explained here in premised on all measuring conditions of the EXPAND mode being set.

Step	Procedure
1	Connect OUTPUT B to INPUT directly.
2	Note for later the present offset values and then set the offset to 0.
3	Press the [X → S] key.
4	Turn the X – S lamp on.
5	Connect the device under test.
6	Restore the original offset value.
7	Calibrated values of the measuring systems frequency response are displayed on the CRT.
	Measure only the frequency response, reading the values with the Δ marker.

(4) Misoperation

This item covers the causes of and recovery procedures for operation mistakes which are possible during delay time measurement.

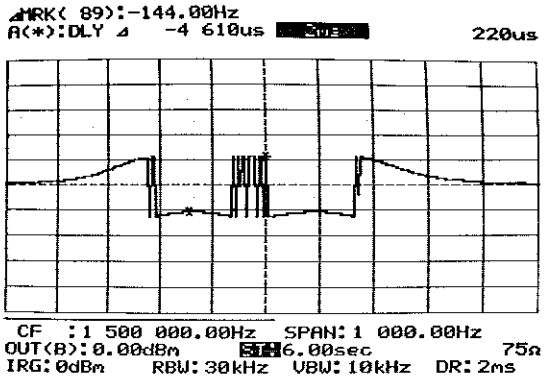


Fig. 3.22 Too small a DR

(a) Increase the DR. (Fig. 3.22)

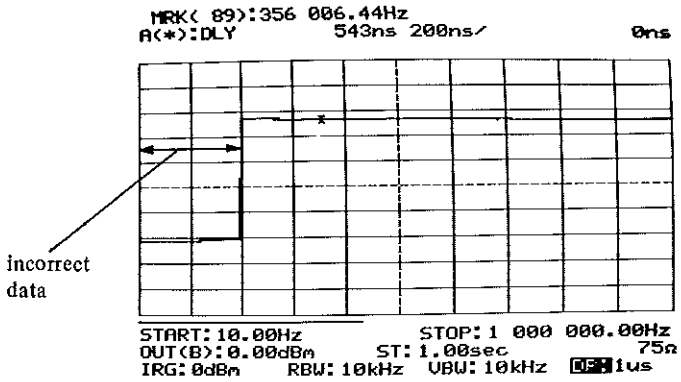


Fig. 3.23 Too low a frequency

(b) The lowest frequency is too low for the DR. (Fig. 3.23)

(c) The sweep time is long while ST is small. This occurs when SPAN or RBW is very narrow. Once the conditions are set correctly, the sweep time will be normal.

(d) The sweep stops mid-way. This is normal.

Note

See the following paragraph if necessary

- *Setting measurement level:* *Paragraph 3.1.2–(2)*
- *Setting effective dynamic range:* *Paragraph 3.1.2–(3)*
- *Inpedance converter:* *Paragraph 5.2*
- *TRACK ADJ:* *Paragraph 2.8–(29)*

3.2 LEVEL AND SPECTRUM MEASUREMENT

3.2.1 Principles of Measurement

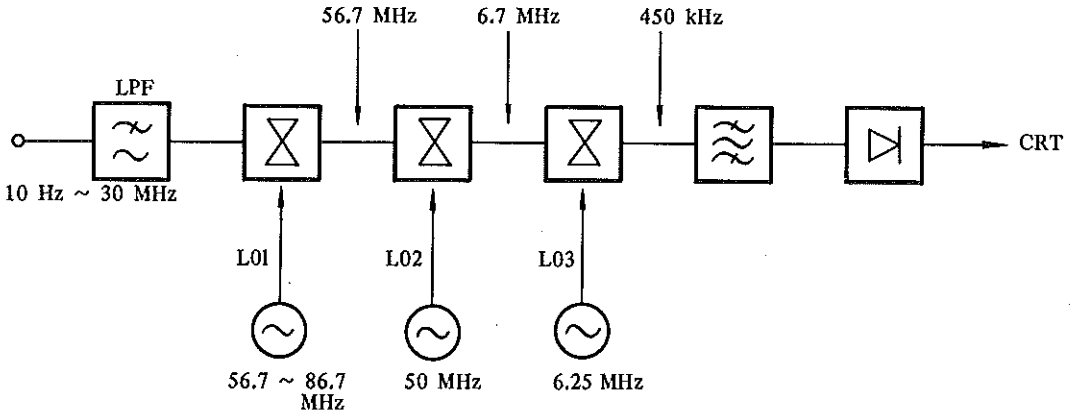
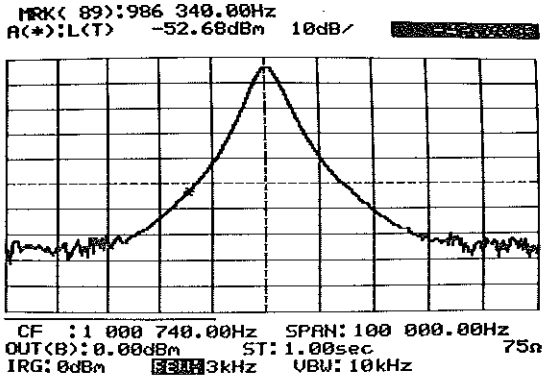


Fig. 3.26 Receiving Section

The receiving section of the MS420[ ] consists of a triple superheterodyne system receiver, as shown in Fig. 3.26. The frequency spectrum of an input signal can be displayed on the CRT, when sweeping the 1st local (LO1) and indicating frequencies on the horizontal axis and the detection output of the IF signal on the IF signal on the vertical axis.

The 1st local is a synthesizer and is swept digitally. This sweep operation is performed in either LEVEL or SPECTRUM mode. The LEVEL mode is used for general measurements and the SPECTRUM mode is used when the RBW is narrower than sweeping bandwidth.

(1) LEVEL mode



This displays only the measured value at each point.

Fig. 3-27 LEVEL mode

In this mode TRACE is L(R) and L(T) and 251 points of data sampled within the sweep frequency range are displayed on the CRT. This is all shown in Fig. 3.27 which shows one frequency component in the sweep band and the selectivity characteristics of the intermediate frequency filter (BPF of Fig. 3.26).

Note

1. *If, in this mode, the difference between two adjoining frequencies becomes larger than the RBW setting, the frequency spectrum cannot be defected correctly. In such cases, use the SPECTRUM mode.*

2. *Only the specified frequency signal can be detected. This enables the MS420[ ] to detect and display a only specified frequency spectrum in plural frequency spectrums.*

(2) SPECTRUM mode

In this mode TRACE is S(R) and S(T). It enables any spectrum between sampling points to be detected because the 1st local frequencies are swept by RBW/5 frequency step. At worst, a detection error of 0.2 dB may be produced in this mode.

Note

This mode is very useful in detecting an unknown signal. It does, however, take a long time to sweep.

3.2.2 Frequency Spectrum Measurements

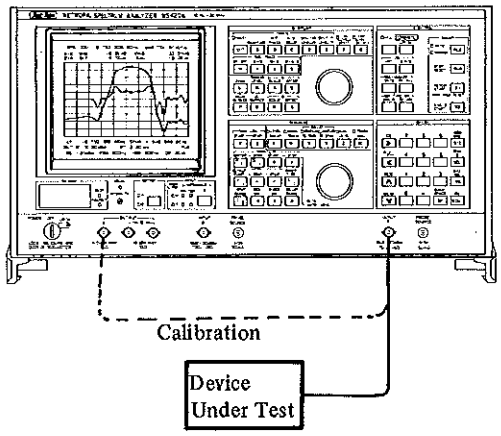


Fig. 3.28 Spectrum Analysis Connection

Measurement of frequency spectrum output from device under test can be done for a wide variety of signal waveforms and for a wide range of objects.

This paragraph explains the fundamental procedures for measuring frequency spectrums. Level, noise, frequency measurements, and video sweep operations are explained in other paragraphs.

Note

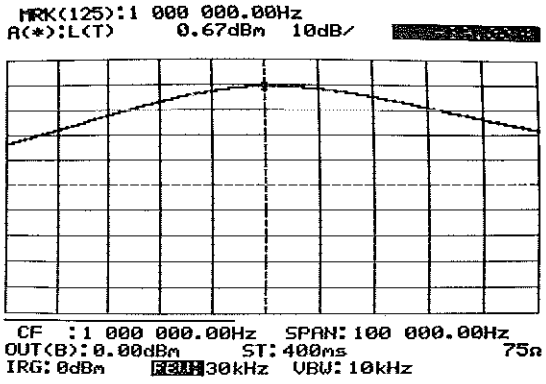
Refer to paragraphs 3.2.3, 3.2.4, 3.2.5, and 3.4 for details on level measurement, noise measurement, video sweep operation, and frequency measurement, respectively.

(1) Procedure

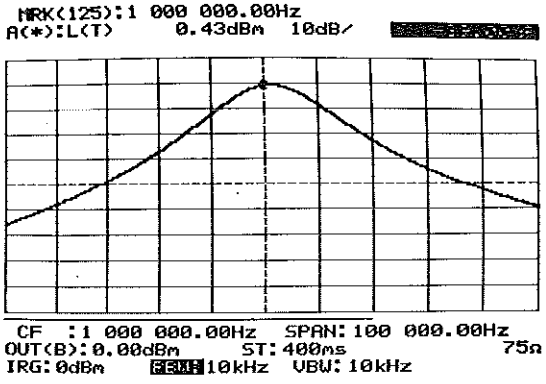
Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the [RECALL] and [9] keys in that order to initialize the MS420[ ].*
3	Set TRACE to S(T).
4	Set the frequency.
5	Check the OVERLOAD lamp and set IRG as follows: When on: Increase IRG until the lamp goes out. When off: Decrease IRG as far as possible without turning the lamp ON.
6	Set RBW as indicated below. The adjusting procedure is explained in the next step.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 kHz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

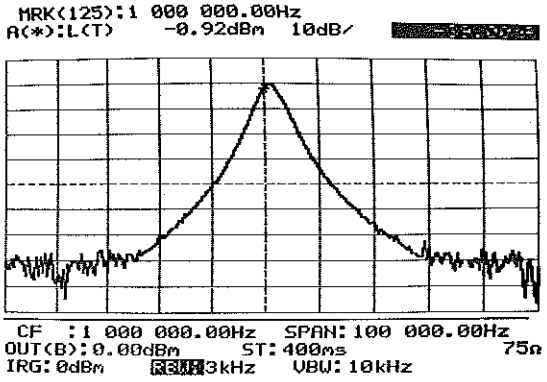
Step	Procedure
7	If RBW is varied from 30 KHz to 300 Hz when receiving a signal with CF: 1 MHz and SPAN: 100 KHz, the waveform shown in Fig. 3.29 is displayed on the CRT. In this example, it is best to measure the frequency spectrum with RBW: 1 KHz.



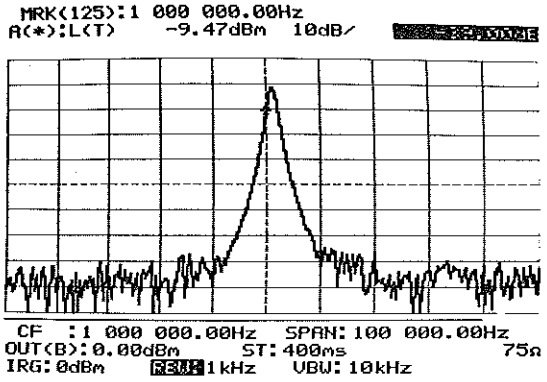
RBW 30 kHz



RBW 10 kHz



RBW 3 kHz



RBW 1 kHz

Fig. 3-29 RBW Adjustment

(2) Examples

(a) Distortion-measurement

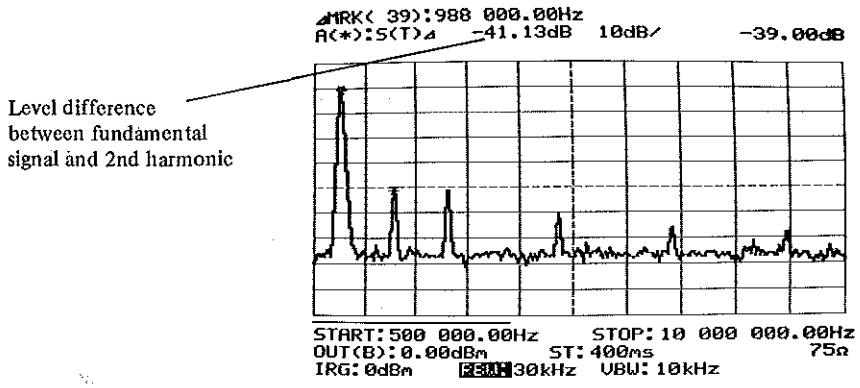


Fig. 3.30 Distortion Measurement

Figure 3.30 shows a waveform indicating a 1 MHz fundamental signal and its harmonics spectrum. When the sweep steps are greater (10 MHz/250) than the RBW (30 kHz) in this example, TRACE should be set in SPECTRUM mode.

A ratio of the fundamental signal and each harmonic can be obtained easily with the Δ marker. Since the frequency difference is also displayed at the same time, harmonic components and other components can be discriminated easily. Further, the total harmonic distortion (THD) can be obtained with the following formula:

$$THD = \frac{1}{A_1} \cdot \sqrt{A_2^2 + A_3^2 + A_4^2 + ... + A_n^2} \cdot 100 \ (\%)$$

A_1 : Amplitude of fundamental signal

A_2, A_3 ... A_n : Amplitude of $_n$ order harmonics.

(b) Near spurious measurement

Figure 3.31 shows a spectrum waveform when a 1 MHz signal is measured with an RBW of 3 Hz. As can be seen in the figure, a signal 50 Hz away can be measured with more than 80 dB of the dynamic range. This is very helpful for spurious measurement of the power supply frequency component. In such measurements, the sweep time must be sufficiently long to read the results clearly.

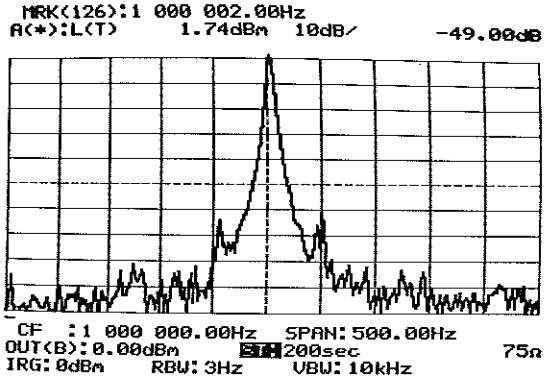


Fig. 3.31 Near Spurious Measurement

(c) Measurement of AM wave

Figure 3.32 shows a spectrum when a 1 MHz signal is AM-modulated with 1 kHz.

In this example, RBW is set to 100 Hz because a component 1 kHz away from the carrier wave need only be measured.

Because the spectrum at a point 2 kHz apart from the carrier wave is a harmonic component, the modulation distortion can be obtained from this level.

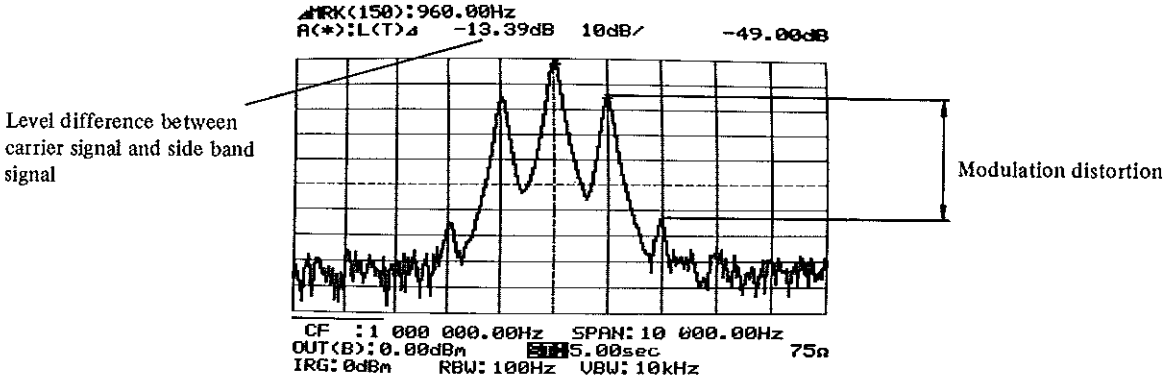


Fig. 3.32 AM Wave Measurement

3.2.3 Level Measurement

When the marker is set to the peak of the spectrum being measured, the level at the marker point is displayed digitally (Fig. 3.33).

When only an approximate input signal level is needed, this method is sufficient. To obtain a more exact level, however, the following procedures must be taken.

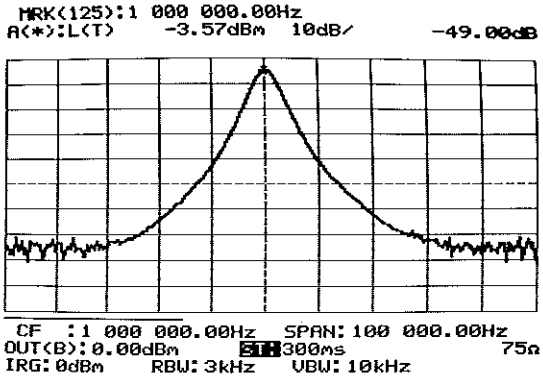


Fig. 3-33 Level Display

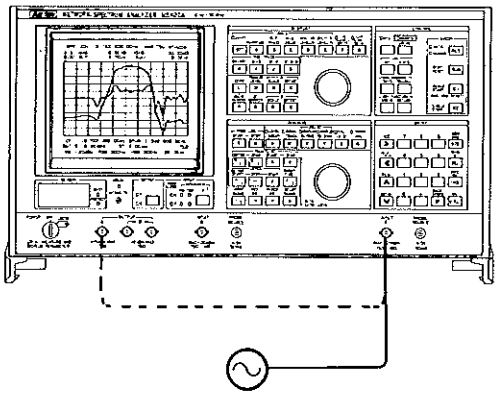


Fig. 3-34 Connections for Level Measurement

Step	Procedure
1	Turn the power on
2	Confirm that the following items are set when the power is ON. • OUTPUT ..... B • IMPEDANCE ..... 75Ω or 50Ω • LEVEL-OUTPUT ..... 0 dB • LEVEL-SWEEP ..... OFF • COUPLED TO FREQ ..... OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS420[ ].*
3	Connect a signal to the input terminal (INPUT – T)
4	Set TRACE to L(T)
5	Turn the LIN lamp off.
6	Set the input signal frequency to CF.

Step	Procedure

7 Set SPAN, RBW, and ST as follows.

Frequency	SPAN	RBW	ST
≦ 100 Hz	50 Hz	3 Hz	150 sec
≧ 100 Hz	200 Hz	10 Hz	50 sec
≧ 300 Hz	500 Hz	30 Hz	10 sec
≧ 1 kHz	2 kHz	100 Hz	5 sec
≧ 3 kHz	5 kHz	300 Hz	1 sec
≧ 10 kHz	20 kHz	1 kHz	500 ms
≧ 30 kHz	50 kHz	3 kHz	500 ms
≧ 100 kHz	200 kHz	10 kHz	500 ms
≧ 300 kHz	500 kHz	30 kHz	500 ms

8 Check the OVERLOAD lamp.

When the lamp is on: Increase IRG until the lamp goes out.

When the lamp is off: Decrease IRG as far as possible without turning the lamp on.

9 Confirm the following setting.

OUTPUT: A
T-side INPUT IMPEDANCE; 75Ω (B type) or 50Ω (K type)

10 Turn on the FREQ COUNT mode with the ADV FUNCTION.

11 Set the measured frequency value to CF.

12 Connect OUTPUT–A to INPUT–T directly and press the [X → S] key.

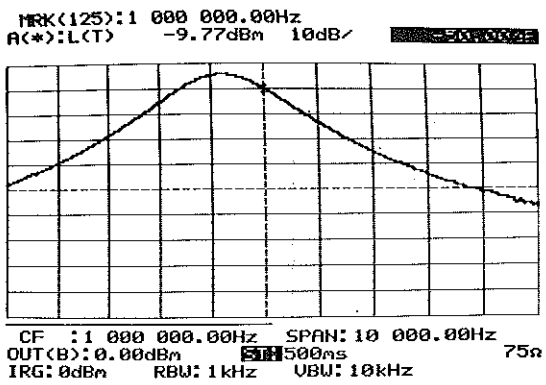
13 After one sweep measurement, connect a signal to the INPUT–T for measment.

14 Turn the X – S lamp ON.

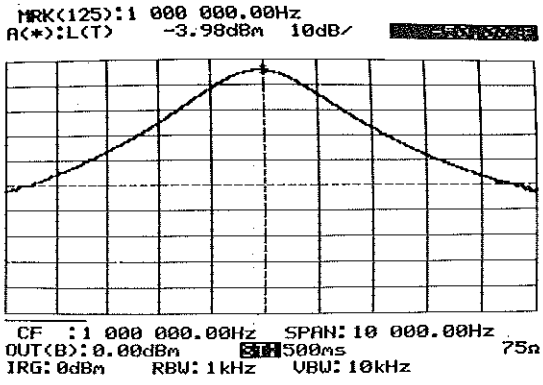
15 The value measured at this marker point indicates the exact signal level.

Note

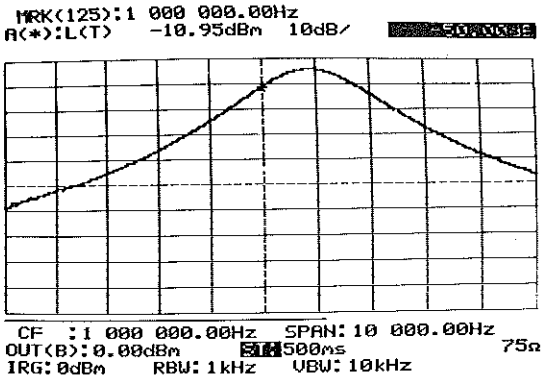
1. *One of the three CRT displays shown in Figs. 3.35(a), (b) and (c) will appear.*
   (b) The level can be read by setting the marker at the top of the sepctrum without separation in steps 8 and 9.
   (a) and (c): A tracking error is indicated. Perform TRACK ADJ as explained in paragraph 2.8-(29). Repeat measurement steps 1 through 15.
2. *This method is used to get the frequency of an input signal to coincide with the calibration frequency.*
3. *This measurement is effective only when the frequency of the signal to be measured is stable.*
4. *When the measured signal frequency is unstable, measure the detoning error as explained in paragraph 3.2.4(a) and correct the top level of the spectrum by using this value.*



(a)



(b)



(c)

Fig. 3-35 Level Measurement

3.2.4 Noise Measurement

The MS420[ ] can neasure random noise levels, but because it uses a mean value detection, correction is required for rms value detection. To obtain the noise level per Hz, correct by setting RBW. The noise level per Hz is represented by the following formula.

$$N = L + B + 1 + \delta \quad (dBm / \sqrt{Hz}) \qquad (3.9)$$

- δ — Detuning error correction
- 1 — Sensitivity correction of detected mean value
- B — RBW correction
- L — MS420[ ] indication value

Table 3-2 RBW Correction
(to 1 Hz Bandwidth)

RBW	B
3 Hz	−5 dB
10	− 10
30	− 15
100	− 20
300	− 25
1 k	− 30
3 k	− 35
10 k	− 40
30 k	− 45

The actual noise level is obtained by measuring the δ and L and then calculating from the formula. The B value can taken from Table 3.2.

(1) How to measure the detuning error.

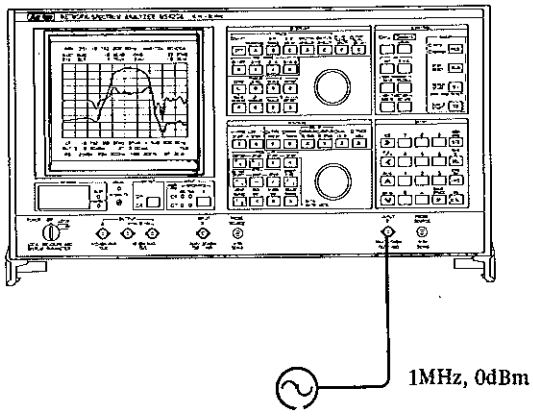


Fig. 3-36 Detuning error measurement connection

Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS420[ ].*
3	Set TRACE to L(T)
4	Set CF to 1 MHz.

Step | Procedure

5 Set SPAN, RBW and ST as follows.

Frequency	SPAN	RBW	ST
≦ 100 Hz	10 Hz	3 Hz	100 sec
≧ 100 Hz	50 Hz	10 Hz	50 sec
≧ 300 Hz	100 Hz	30 Hz	10 sec
≧ 1 kHz	500 Hz	100 Hz	5 sec
≧ 3 kHz	1 kHz	300 Hz	1 sec
≧ 10 kHz	5 kHz	1 kHz	500 ms
≧ 30 kHz	10 kHz	3 kHz	500 ms
≧ 100 kHz	50 kHz	10 kHz	500 ms
≧ 300 kHz	100 kHz	30 kHz	500 ms

6 Set IRG to 0 dBm

7 Set the A–SCALE OFFSET as follows:
SCALE – 0.5 dB
OFFSET – 0.00 dB

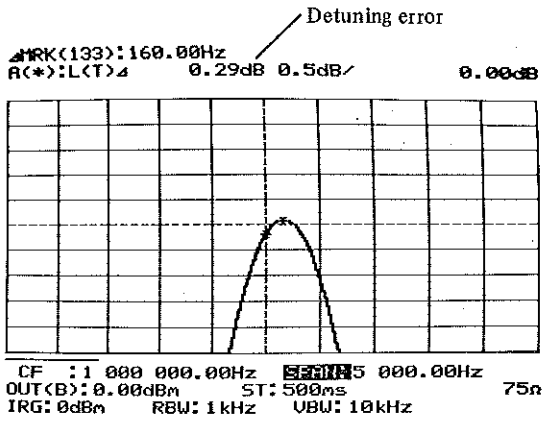


Fig. 3-37 Detuning Error

8 When the Δ marker is set as shown in Fig. 3-37, the digital display indicates a detuning error.

Note

Use a 1 MHz signal source with excellent frequency stability and accuracy.

(2) Noise measurement

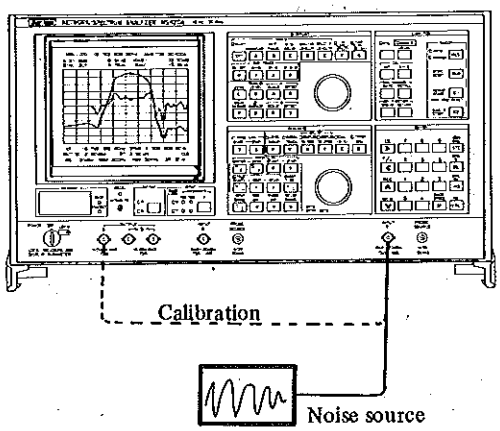


Fig. 3-38 Noise Measurement Connection

Step	Procedure
1	Turn the power ON.
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS420[ ].*
3	Set TRACE to L(T).
4	Set the frequency range.
5	Set the following items. • OUTPUT . . . . . A

Step	Procedure

6 Set RBW as indicated below.

Frequency	RBW
≦ 100 Hz	3 Hz
≧ 100 Hz	3 Hz, 10 Hz
≧ 300 Hz	3 Hz to 30 Hz
≧ 1 kHz	3 Hz to 100 Hz
≧ 3 kHz	3 Hz to 300 Hz
≧ 10 kHz	3 Hz to 1 kHz
≧ 30 kHz	3 Hz to 3 kHz
≧ 100 kHz	3 Hz to 10 kHz
≧ 300 kHz	3 Hz to 30 kHz

7 Connect a signal to be measured to INPUT–T for measurement.

8 Set ST so that the UNCAL lamp is off.

9 Check the OVERLOAD lamp and set IRG as follows:
When the lamp is ON: Increase IRG until the lamp goes out.
When OFF: Decrease IRG as far as possible without turning the lamp ON.

10 Connect OUTPUT–A and INPUT–T directly and press the [X → S] key.

11 After one sweep measurement turn the X – S lamp on and connect the signal to be measured.

12 Calculate the noise level per Hz, using the displayed L(T) value for L in the formula 3.9.

Note

For the noise measurements make sure that the noise of the MS420[ ] is smaller than that of the signal to be measured. This is confirmed checking to see whether the measured value decreases when the input signal removed.

3.2.5 Linear Display and Video Sweep

(1) Linear display

When TRACE is L(R), L(T), S(R) and S(T), the vertical axis can be displayed linearly (logarithmic in normal cases). Examples of logarithmic and linear displays are given below.

Note

The video sweep mode is established when the frequency width is 0 Hz and the LIN lamp is on. See item (2) in this paragraph for the procedures to follow at this point.

(a) Logarithmic display / Linear display

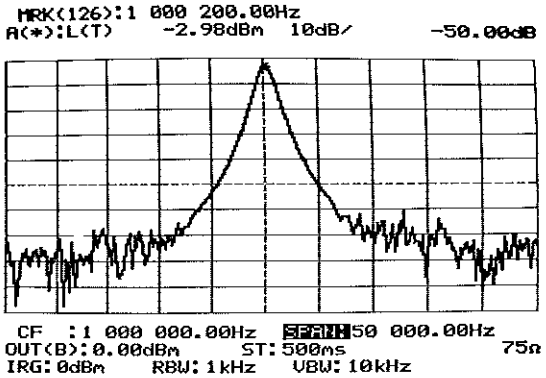


Fig. 3-39 Logarithmic Display

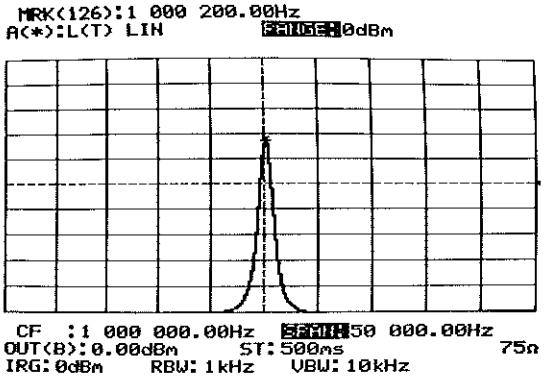


Fig. 3-40 Linear Display

Figure 3-39 shows a logarithmic display when measuring a signal in L(R), L(T), S(R) or S(T).

Figure 3-40 shows the waveform displayed on the CRT when the LIN lamp is turned on under the same conditions as given above.

(b) Linear expansion display

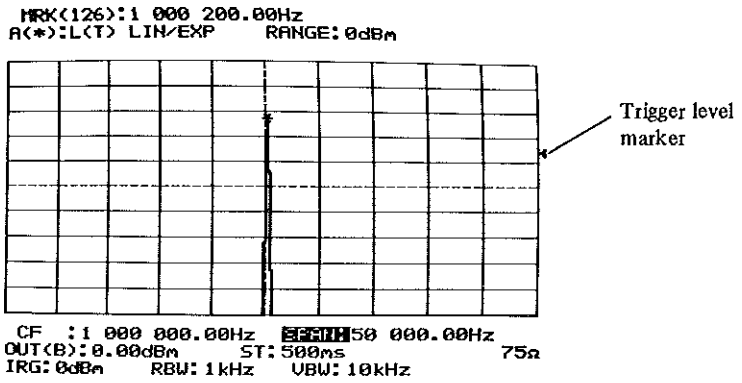


Fig. 3-41 Linear Expanded Display

Figure 3-41 show the waveform displayed on the CRT when the EXP lamp is turned ON under the same measuring conditions as given in Fig. 3-39. In this figure, the waveform is expanded 10 times around the trigger level marker shown in Fig. 3-40.

(c) Adjusting and reading the linear display

The size of a waveform displayed linearly can be switched by 10 dB steps using A-OFFSET or IRG. A-OFFSET adjusts the IF range. The range display on the CRT is the sum of the above two and indicates the top line of the CRT scale.

Fig. 3-42 shows how to read the RANGE.

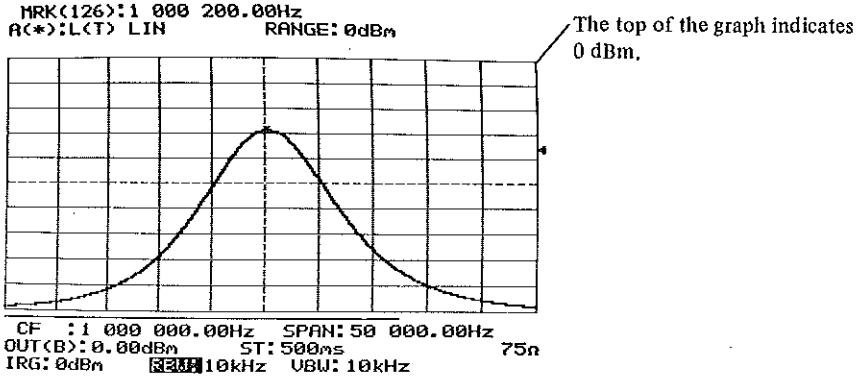
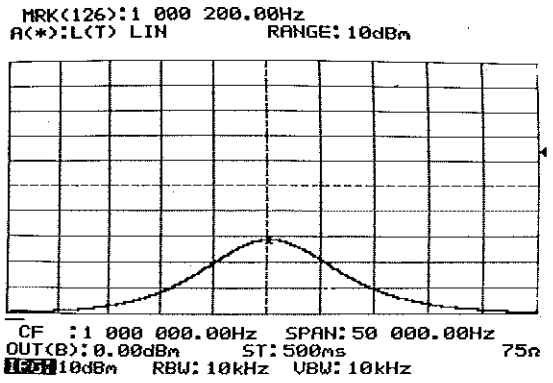


Fig. 3-42 How to Read the Linear Display

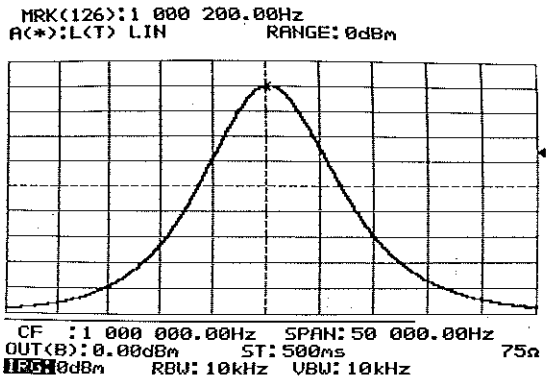
Figure 3-43 (a) ~ (c) shows the display waveform on the CRT when the range is switched.

RANGE: 10 dBm



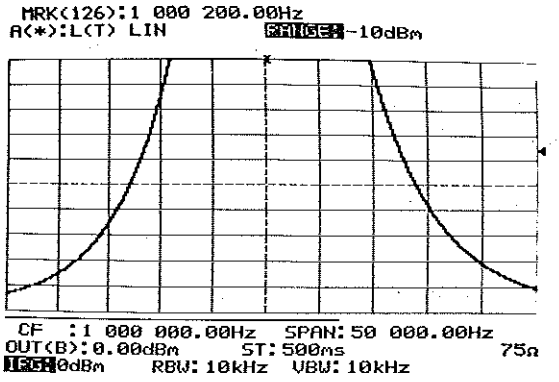
(a)

RANGE: 0 dBm



(b)

RANGE: –10 dBm



(c)

Fig. 3-43 Linear Display

(2) Video Sweep Operation

Video sweep is used to display the envelope of an input signal on the CRT. The principal specifications are as follows:

- Carrier frequency: 10 Hz to 30 MHz
- Modulation frequency: 1 Hz to 400 Hz
- Sweep mode: REPEAT
SINGLE
- Trigger system: Internal trigger
- Trigger level: Can be displayed on the CRT and adjusted with the tuning knob.

Note

The highest modulation frequency is limited by RBW and VBW.

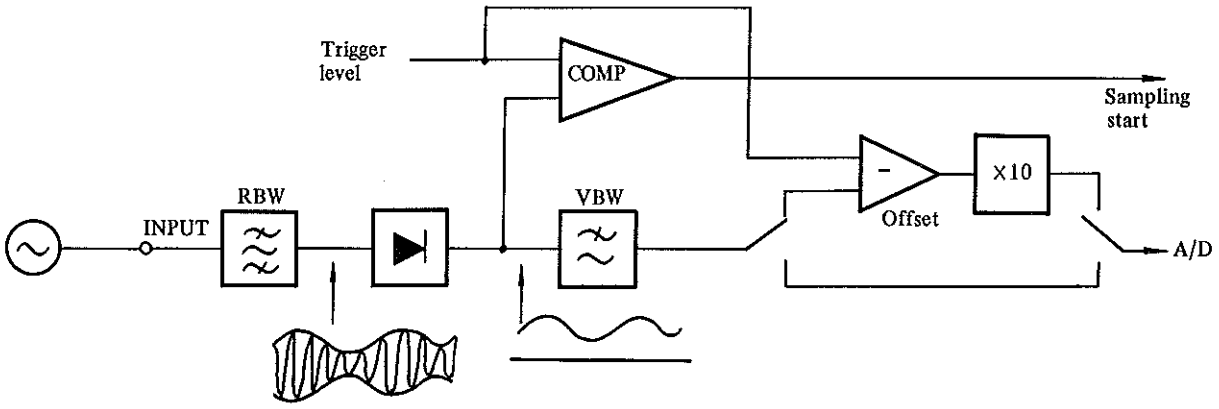


Fig. 3-44 Principle of video sweep operation

The principle of video sweep operation is shown in Fig.3-44. An input signal detected at the linear detector is digitalized in a definite cycle by the A/D converter.

This digitalized data can be regenerated as an envelope of the input signal on the CRT. The trigger level can be set to any level of the detector output and a sampling start signal is generated at the crossing point of the detector output. This trigger level becomes an offset in EXPAND mode. This means that the signal display is expanded 10 times around the trigger level when in EXPAND mode.

Note

The video sweep operation has a definite cycle of sampling, but the sampling cycle when displaying linearly is not definite because it interlocks with the frequency sweep operation.

(1) Procedures

Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL OUTPUT . . . . . 0 dB • LEVEL SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS420[ ].*
3	Set TRACE to L(T).
4	Set CF to the carrier frequency of the input signal.
5	Set SPAN to 5 Hz.
6	Set RBW as indicated below.
7	Set VBW to 10 kHz.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 kHz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

Step	Procedure
8	Check the OVERLOAD lamp. • When the lamp is ON: Increase IRG until the lamp goes out. • When the lamp is OFF: Decrease IRG as far as possible without turning the lamp ON.
9	Turn the LIN lamp ON.
10	Adjust A-OFFSET so that the input signal is displayed within the scale. (Fig. 3-45)
11	Adjust the trigger level marker as shown in Fig. 3-46.
12	The MS420[ ] is ready for video sweep operation when SPAN is set to 0 Hz. (Fig. 3-47)
13	Adjust ST so the waveform is easy to read. (Fig. 3-48)

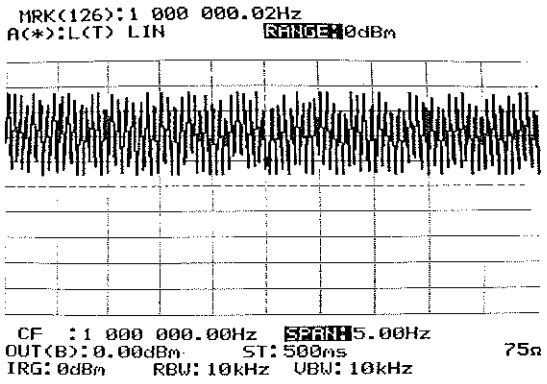


Fig. 3.45 Video Sweep (A)

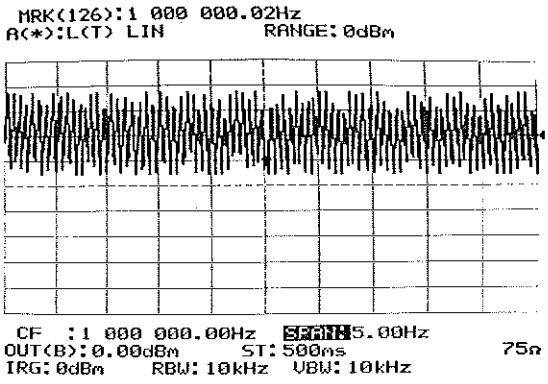


Fig. 3-46 Video Sweep (B)

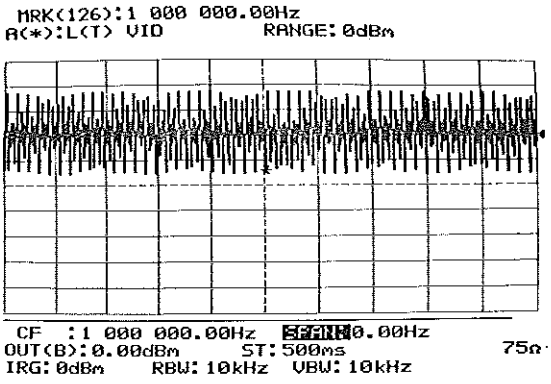


Fig. 3-47 Video Sweep (C)

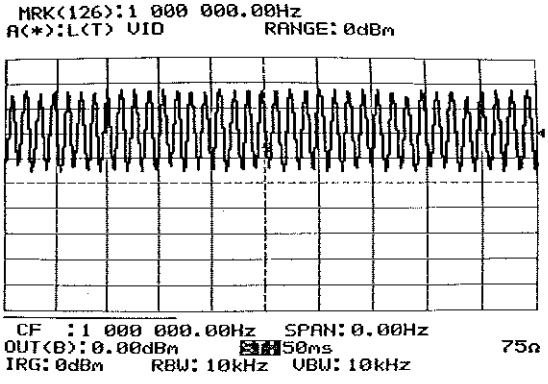


Fig. 3-48 Video Sweep (D)

3.3 SYNTHESIZER

The MS420[ ] has a built-in synthesizer as its signal source. This synthesizer can be used as a tracking generator for measuring transmission characteristics, a calibration signal source for level measurements, and as an independent synthesizer. This paragraph explains how to use the MS420[ ] as an independent synthesizer and how to carry out a level sweep operation.

(1) Synthesizer

When using the MS420[ ] as an independent synthesizer, set the frequency and level as explained below.

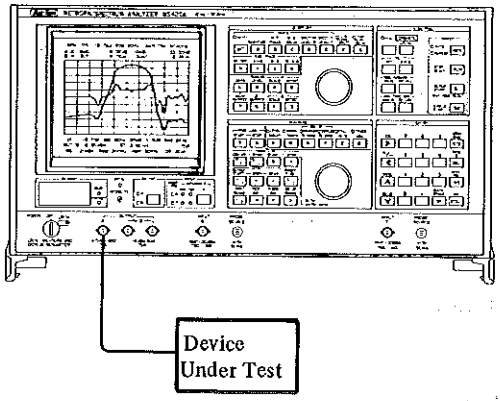


Fig. 3-49 Synthesizer

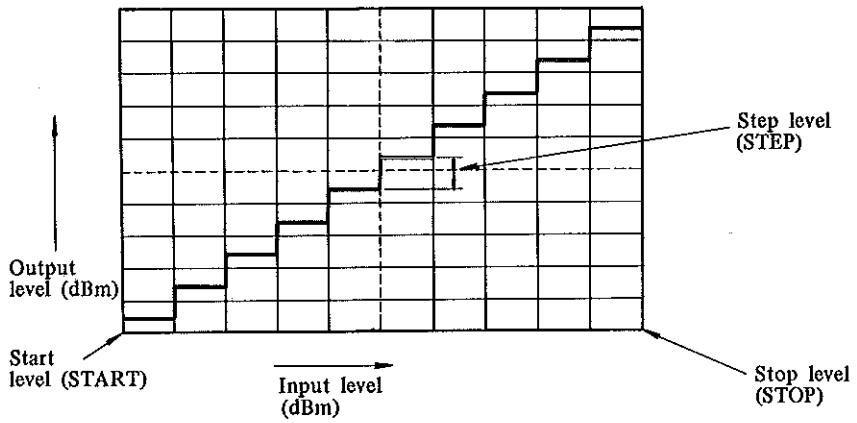
Step	Procedure
1	Set the OUTPUT to A
2	Set the MAIN marker to center (125)
3	Set the AUTO/MARKER to MARKER.
4	Press the [REPEAT START] key.
5	Set the output frequency to CF.
6	Press the [OUTPUT (START)] key and set the output level.

Note

1. *The MS420[ ] should not be used as the sweep signal source without interlocking it with its receiving section.*
2. *The frequency and level can be output by repeating steps 5 and 6 above.*

(2) Level sweep

The MS420[ ] can sweep a signal level while the frequency is kept constant or sweep both the level and frequency at the same time. The first procedure is used to test level characteristics and the second is used when the equalizer amplifier is to be measured at a constant output level. In both cases, the level is swept as explained below.



• $m = \frac{STOP - START}{STEP.}$

START, STOP; − 110.00 ~ + 15.00 dBm

STEP: 0 ~ 125 dB

m: Indicates the number of level switching steps over the full sweep range which is carried from the decimal point position.

The level is switched at each $\frac{250}{m-1}$ (truncated below the decimal point).

Level L (n) of step n is,

$L(n) = START + n \cdot STEP$

n: 0, 1, 2, ... , m − 1

$L(m) = STOP$

Fig. 3-50 Level Sweep

3.4 SUB TRACE

SUB TRACE can be used for one item measurement(TRACE other than M/P and M/D). SUB TRACE has the following three functions:

(1) A → B

(a) When this key is pressed, the latest contents of memory A are copied and stored into memory B.

(b) SCALE and OFFSET have the same values as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET.

(d) The contents of memory B can be backed-up at the PBM. See paragraph 2.8–(40).

(e) This function is used as a preparatory operation when using the A – B function of item (3) and also used as described below.

Fig. 3-51 shows simultaneous display of two measured waveforms of filter. This is convenient when matching a filter characteristic to the reference filter characteristic, or when finding the correlation between two filters having a different center frequency.

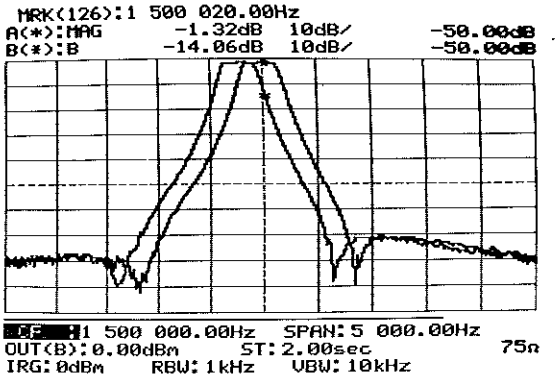


Fig. 3-51 Display Example (A → B)

(2) B = A

(a) After this key is pressed, the measured value is stored in both memory A and memory B.

(b) SCALE and OFFSET are the same value as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET'

(d) This function is convenient when desirting to observe the entire characteristic and the pass-band ripple of a bandpass filter simultaneously.

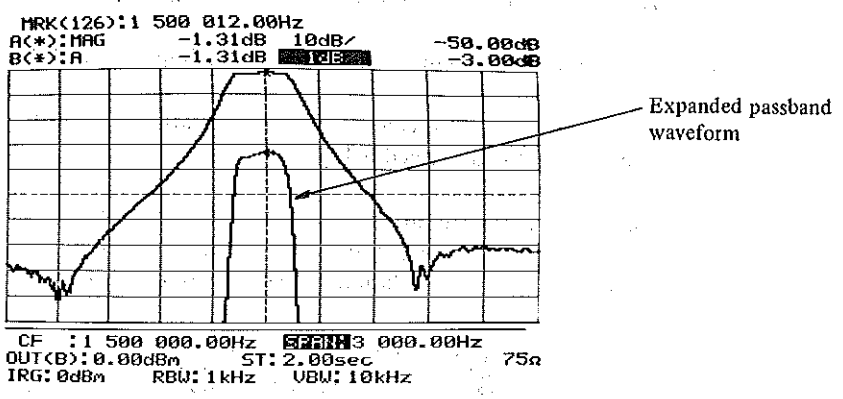


Fig. 3-52 Display Example (B = A)

(3) B = A – B

(a) After this key is pressed, the difference between the channel A measured value and the contents of memory B is displayed at channel B.

(b) SCALE and OFFSET are the same as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET.

(d) This function is convenient when comparing the measured values of two devices under test.

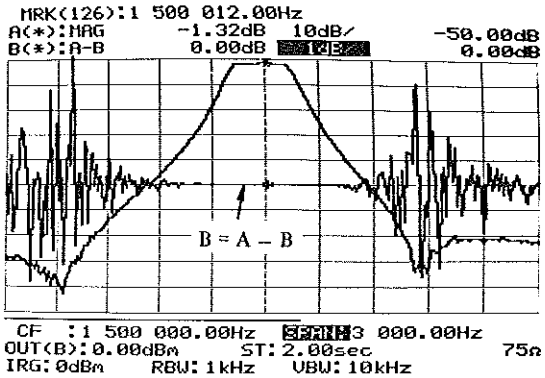
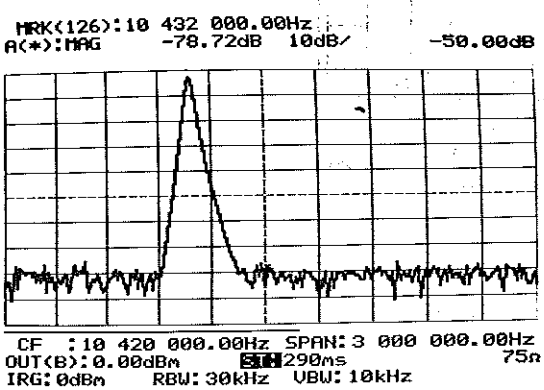


Fig. 3-53 Display Example (B = A–B)

3.5 AUTOSETTING

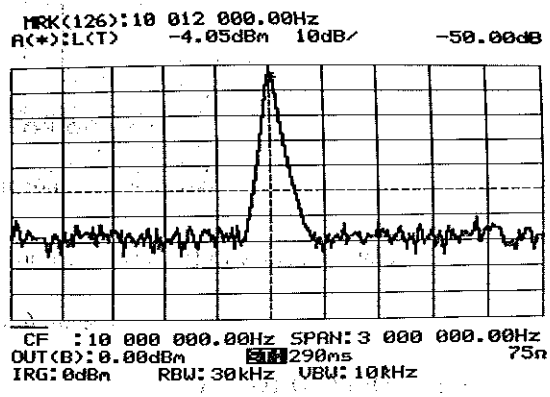
(1) SIGNAL TRACK

When this lamp is on and the frequency sweep is linear, the frequency for each sweep is automatically set so the peak value of the received signal is at the center. Fig. 3-54 and 3-55 show an example.



SIGNAL TRACK: OFF

Fig. 3-54 SIGNAL TRACK (A)



SIGNAL TRACK: ON

Fig. 3-55 SIGNAL TRACK (B)

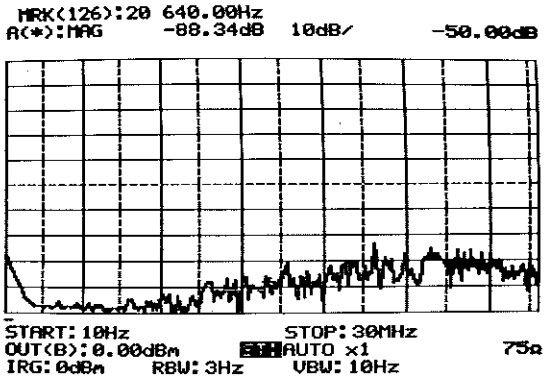
(2) COUPLED TO FREQ.

When this lamp is on, RBW and ST are automatically set according to the measurement frequency.

Note

1. *This function is must effective during logarithmic sweep. Do not use it during linear sweep because the RBW will not be change continuously and is unstable.*
2. *ST can be variable. Use it to match the response time of the device under test during circuit analysis.*

Fig. 3-56 shows an example. The connection is the same as Fig. 3-3.



RBW changes with the scale line frequency.

Fig. 3-56 COUPLED TO FREQ

(3) COUPLED TO SPAN

When this lamp is on, RBW, VBW, and ST are automatically set according to the scan width.

3.6 ADV FUNCTION

3.6.1 Integrating

The following methods are used to stabilize the values measured with the MS420[ ], that is to lower the noise level

(a) Narrow RBW

Noise level decreases in comparison with band width. See Fig. 3-57.

(b) Narrow VBW

The mean value of noise is constant, but scattering can be reduced. See Fig. 3-58.

(c) Lengthen ST.

Automatic averaging in relation to sweep time. See Fig. 3-59.

ST $<$ 1 sec : no averaging

ST $>$ 1 sec : averaging 10 times

ST $>$ 10 sec: averaging 100 times.

(d) Integration

By turning on INTEGRATING of ADV FUNCTION, the measured value at one point is integrated, for time shown in the table below. See Fig. 3-60.

RBW	Integrating time
100 Hz to 30 kHz	20 ms / 16.7 ms *
30 Hz	33 ms
10 Hz	100 ms
3 Hz	333 ms

* Can be switched according to ac power supply frequency.

Measuring examples are shown below.

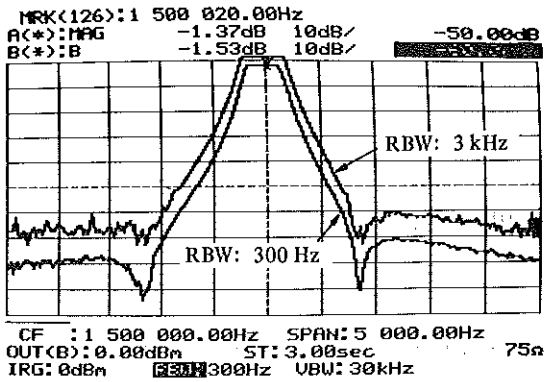


Fig. 3-57 Effect of RBW

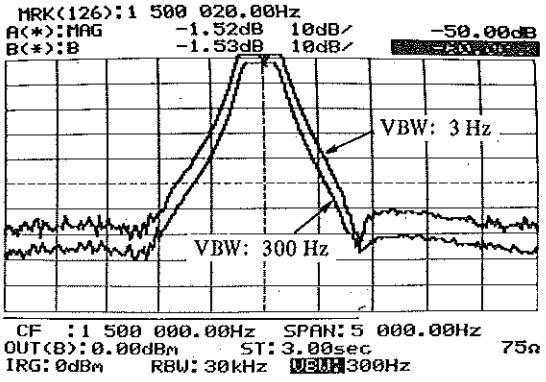


Fig. 3-58 Effect of VBW

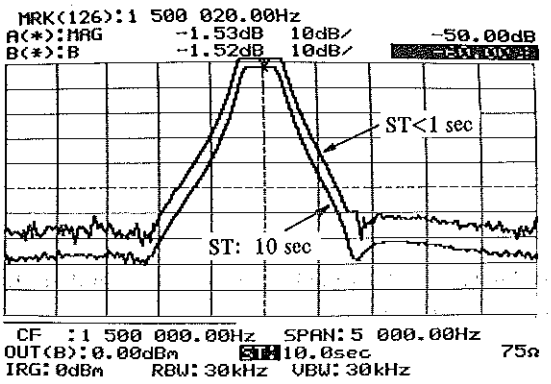


Fig. 3-59 Effect of ST

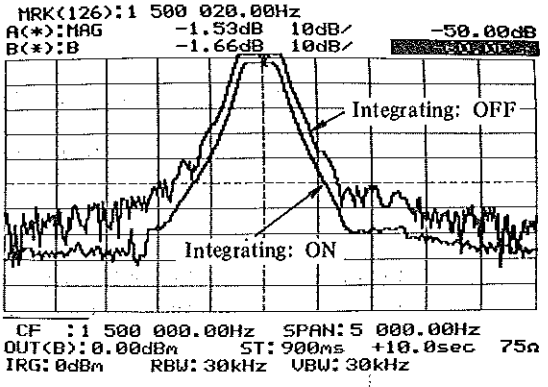
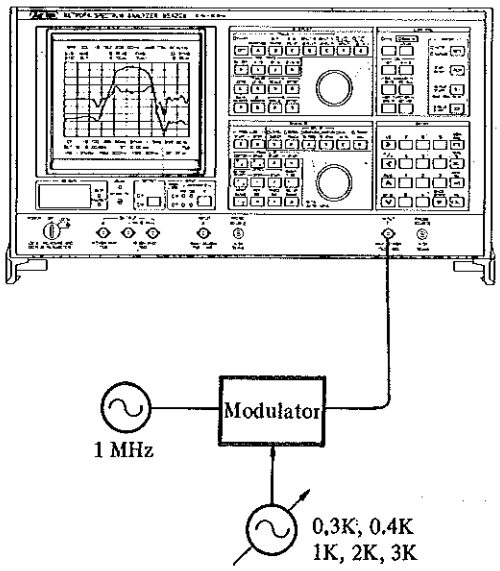
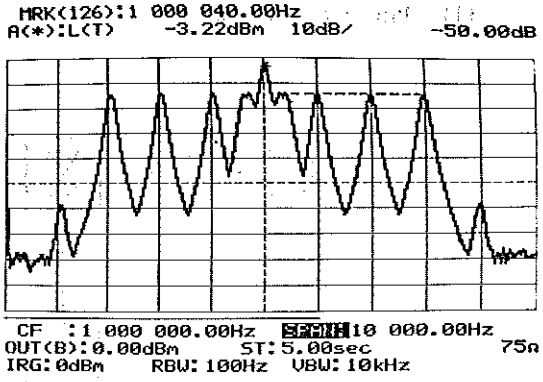


Fig. 3-60 Effect of integrating

3.6.2 MAX HOLD

If MAX HOLD is turned on when TRACE is L(R), L(T), S(R), or S(T), the maximum value at each point for each sweep is held as the measured value. This measured value is cleared by pressing the [REPEAT START] key. The following is an example of measuring using this function.





Dotted data shows a response of modulation frequency.

Fig. 3-61 Measurement of modulation frequency response

3.6.3 Frequency count

When the frequency count mode is turned on by ADV FUNCTION, the MS420[ ] can be used as s frequency counter with 1 Hz resolution. Since the MS420[ ] is a tuning-type receiver, it can measure the frequencies of low-level signals. Further, it can measure the specified frequency spectrums of signals having more than one spectrum.

(1) Principle of operation

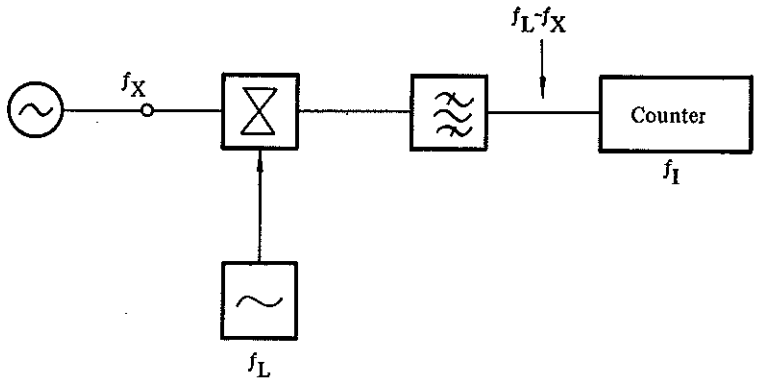


Fig. 3-62 Frequency count

Figure 3-62 shows the operation principle of a frequencv counter. Using the count value fi (gate time is 1 sec.) of the digital counter in the digital counter in the figure, fx is obtained from the following formula.

$$fx = f_L - f_I$$

fx can be calculated in the above formula, because f_L is a set value of a local synthesizer.

(2) Procedure

Step	Procedure
1	Turn the power ON.
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 75Ω or 50Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL– SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, pressing the [RECALL] and [9] keys in that order to initialize the MS420[ ].*
3	Set TRACE to L (R), L (T), S (R) or S (T).
4	Set the sweep frequency range.
5	Set RBW as indicated below.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 Hz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

Step	Procedure
6	Adjust IRG so that the OVERLOAD lamp if OFF.
7	Adjust ST so that the UNCAL lamp is OFF.
8.	Press the [BEGIN] key of ADV FUNCTION.
9	Press the [/] [4] and [EOL] keys in that order.
10.	Press the [O] [N] and [EOL] keys in that order.
11	Press the [RETURN] key.
12	When the MAIN marker is set to the spectrum measured, the frequency of the spectrum is measured and displayed at every sweep.

Note

If AUTO/MARKER is set to MARKER, measurement repetition rate will be greater.

3.6.4 Frequency Offset Tracking

By connecting the MS420[ ] with the MG443B, MG440A or MG545[ ]. Frequency Synthesizer through the GP–IB, they can be tracked by shifting their frequency. This function and the excellent flatness of the MG443B, MG440A and MG545[ ] output levels make it possible to accurately measure the magnitude characteristics of a misxer or a circuit including a mixer.

(1) Connection

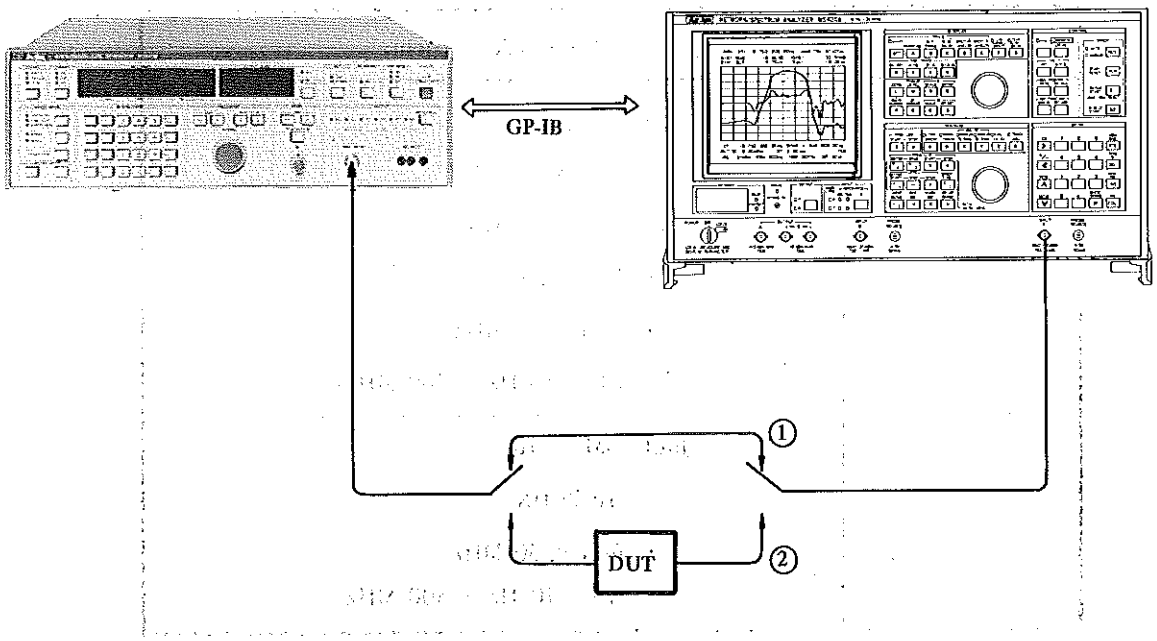


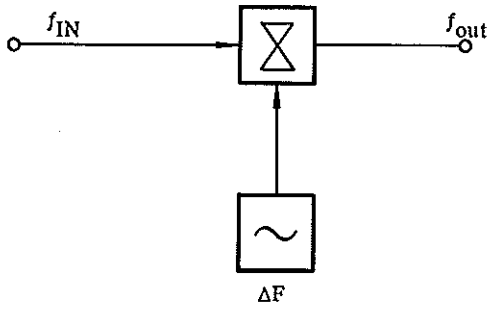
Fig. 3-63 Connections

(2) Frequency Conversion System

With the frequency conversion system, any one of the three modes shown in Fig. 3-64 can be selected.

(3) Measuring accuracy

The accuracy of this measurement is determined by the flatness of the Frequency Synthesizer output level and linearity of level measurement with the MS420[ ]. The output level accuracy of each Frequency Synthesizer is given in Table 3-5.



MODE	Conversion system
0	fout : f_{IN} + ΔF • fout ≦ 30 MHz
1	fout : f_{IN} − ΔF • fIN > ΔF • fout ≦ 30 MHz • fIN : 10 Hz ~ 500 MHz
2	fout : ΔF − fIN • ΔF > fIN • fout ≦ 30 MHz • fIN : 10 Hz ~ 500 MHz

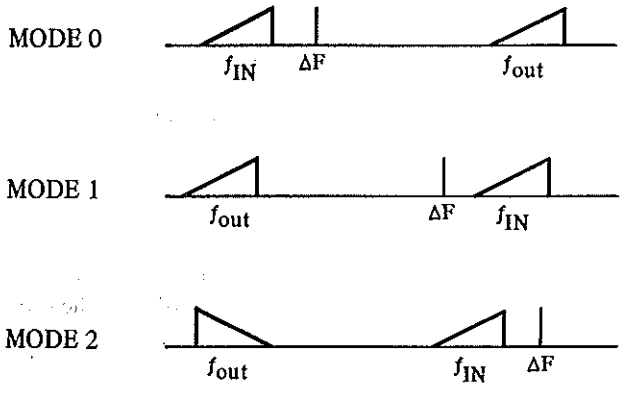


Fig. 3-64 Frequency Conversion System

Table 3-5 Synthesizer Output Level Accuracy

Level	MG443B	MG440A	MG545A
+ 15 dBm			
	10Hz ±0.2 7MHz ±0.3 13MHz ±0.4 30MHz	10 Hz ~ 100 Hz ± 0.3	
+ 10			
+ 5	10 Hz 7 MHz 30 MHz	100 Hz ~ 1 MHz ± 0.2	100 kHz ~ 100 MHz ±0.25
– 0	± 0.15 ± 0.2	1 ~ 10 MHz ± 0.3	10 kHz ~ 500 MHz ±0.6
– 5		10 ~ 30 MHz ± 0.4	
– 10			
– 15			
– 20		10 Hz ~ 100 Hz ± 0.4	
– 25		100 Hz ~ 1 MHz ± 0.3	
– 30			
– 35		1 MHz ~ 10 MHz ± 0.4	
– 40		10 MHz ~ 30 MHz ± 0.5	
– 50			
– 55	10 Hz 7 MHz 30 MHz		
– 60	± 0.2 ±0.3	± 0.6	
⟨			
– 80			

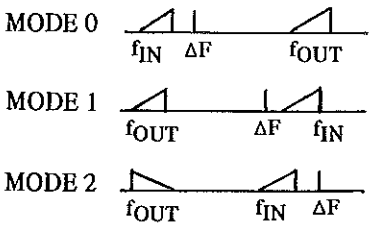
(4) Procedure

Step	Procedure
1	Turn on the power. (MS420[ ] is initialized by pressing the [RECALL] and [9] keys)
2	Set the following items. • TRACE : L (T) • INPUT IMPEDANCE : * • FREQUENCY : Set the DUT output frequency • RES BW : * • VIDEO BW : * (*: Set these values according to the specified measurement conditions of the DUT)
3	Set the SYNTHESIZER according to the specified measurement conditions of the DUT exclusive of the frequency. Set the MG443B STEP FREQ to (MS420[ ] SPAN)/250, when the SYNTHESIZER FORMAT F is used.
4	Set the sweep time so that the UNCAL lamp does not light.
5	Press the [BEGIN] key.
6	Press the [/] [1] [0] and [EOL] keys.
7	Press the [A] [D] [R] [C] and [EOL] keys.
8	Press the [/] [1] [1] and [EOL] keys.
9	Press the [#] [0] [,] [A] and [EOL] keys. SYNTHESIZER FORMAT SYNTHESIZER GP-IB ADDRESS

SYNTHESIZER FORMAT

A : MG440A/K
MG545A/K
MG443B only mode
B : MG440C/M
MG545C/M
C : Wavetek 178
D : MG443B
E : HP3336
F : MG443B High speed

Step	Procedure
10.	Press the [/] [4] and [EOL] keys, and then the [0] and [EOL] keys.
11.	Press the [RETURN] key.
12.	Connect the synthesizer output connector to the MS420[ ] INPUT-T connector directly through a circuit or with a cable instead of the DUT.
13.	Set the IRG so that the OVERLOAD lamp does not light.
14.	Set the sweep time to obtain the appropriate measured data display on the CRT.
15.	Press the [CAL X→S] key, and wait for completion of one sweep measurement.
16.	Connect the DUT.
17.	Press the [BEGIN] key.
18.	Press the [/] [5] and [EOL] keys.
19.	Set the TRACKING MODE referring to the following figure.
20.	Press the [/] [4] and [EOL] keys, and then set the ΔF.
21.	Press the [RETURN] key.
22.	Confirm that the OVERLOAD lamp does not light.
23.	Read the measured value on the CRT using the marker.



* To release the tracking, proceed as follows:

Step	Procedure
1	Press the [BEGIN] key.
2	Press the [/], [1], [1] and [EOL] keys in that order.
3	Press the [EOL] key.

* When changing the output level of the MG443A, do the following:

Step	Procedure
1	Set the AUTO/MARKER key of the MS420[ ] to MARKER.
2	Press the [LOCAL] key of the MG443B.
3	Set the output level.
4.	Set the AUTO/MARKER of the MS420[ ] to AUTO.

3.6.5 Tracking

One MS420[ ] can be used as the signal source and another MS420[ ] can be connected to it as the receiver. This is convenient when measuring the transmission characteristic between two FDM repeater stations, etc.

(1) Connection

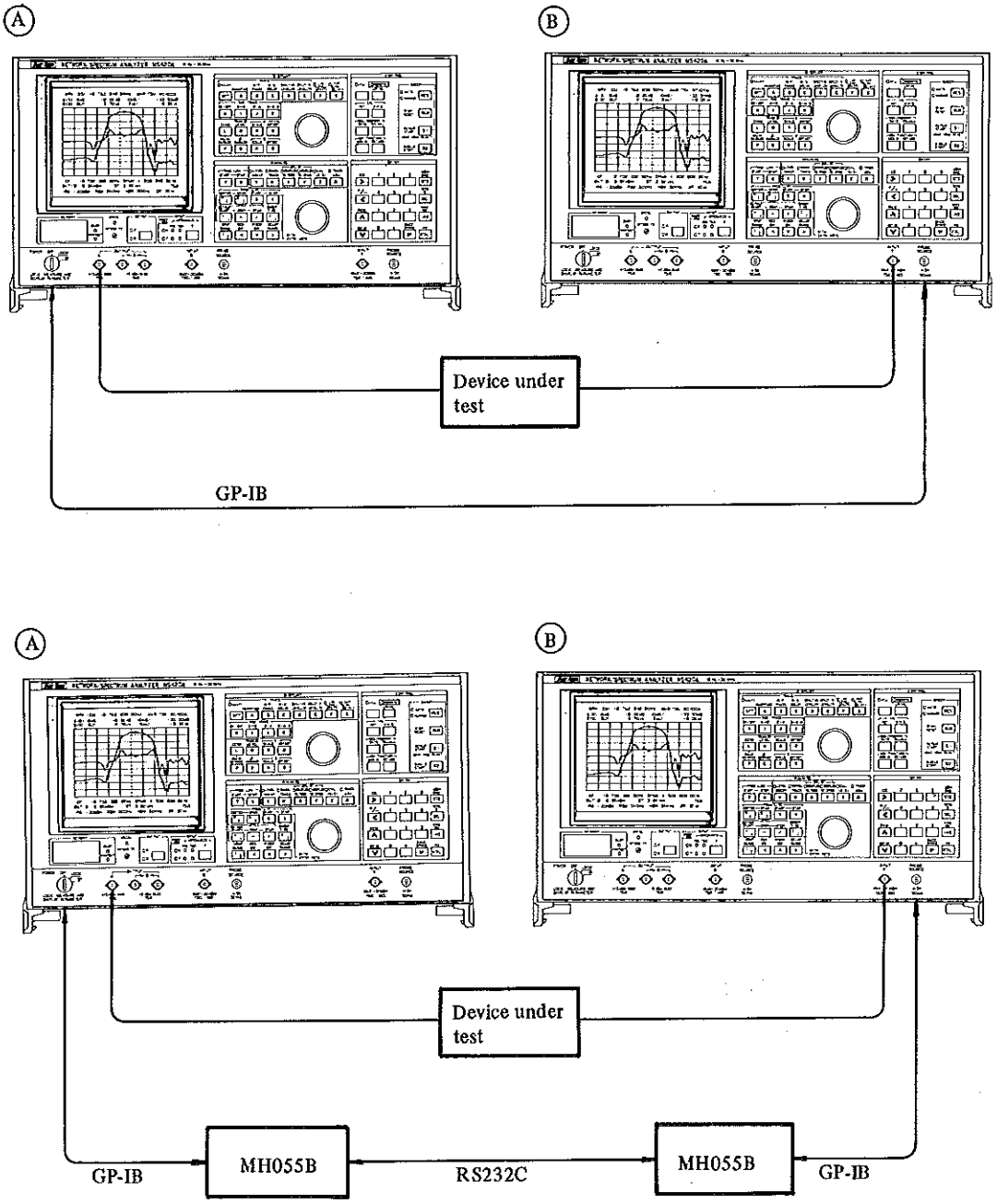
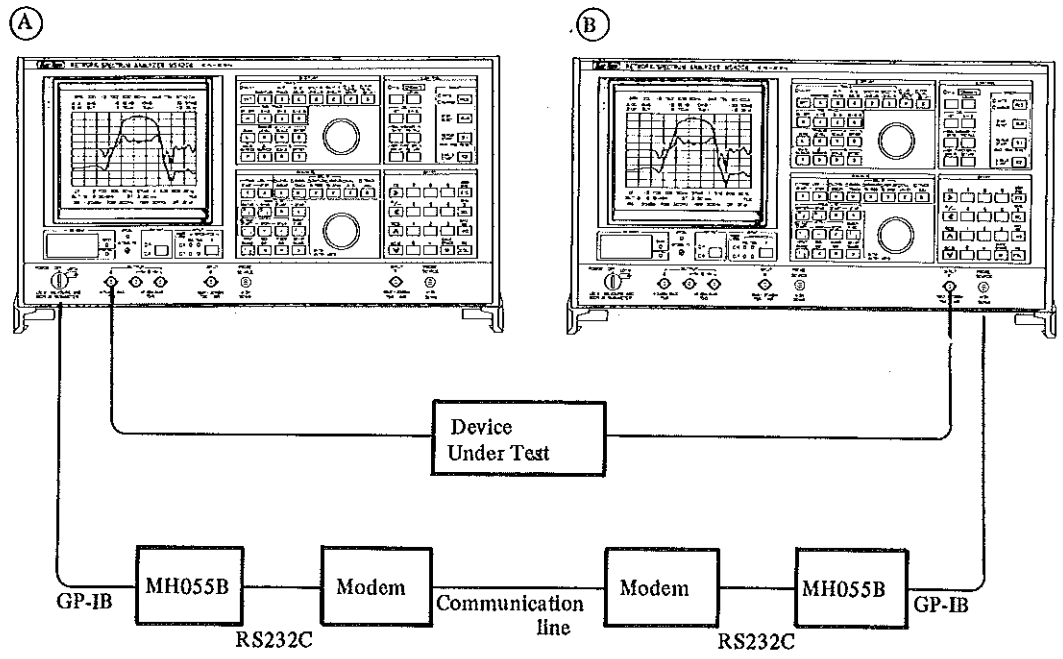


Fig. 3-65 Connection



A: Signal source
B: Receiver
MH055B: GP-IB extender

Fig. 3-65 Connection (Cont'd)

(2) Procedure

Step	Procedure
1	Interconnect two MS420[ ] as shown in Fig. 3-65, and set MS420[ ] – Ⓐ GP–IB address 1.
2	Set the power switch of MS420[ ]–Ⓐ (signal source) to ON.
3	Set the power switch of MS420[ ]–Ⓑ (receiver) to ON.
4	Set the MS420[ ]– Ⓐ as follows • OUTPUT . . . . . A • LEVEL . . . . . * • Sweep frequency . . . . . * • LEVEL SWEEP . . . . . OFF Set * according to the measurement specifications.

Step	Procedure
5	Set MS420[ ] – Ⓑ as follows: • TRACE . . . . . L(T) • INPUT IMPEDANCE . . . . . 75Ω (A type) 50Ω (J type) • OUTPUT . . . . . A • VBW . . . . . 30 kHz Operation of MS420[ ] – Ⓑ is described below. *Note* *See paragraph 3.4.1–(b) for the VBW.*
6	Press the [BEGIN] key.
7	Press the [/] [1] [0] [EOL] keys in this order.
8	Press the [A] [D] [R] [C] [EOL] keys in this order.
9	Press the [/] [1] [1] [EOL] keys in this order.
10	Press the [#] [1] [,] ["] [F] [M] [1] ["] [EOL] keys in this order
11	Press the [/] [1] [0] [EOL] keys in this order.
12	Press the [F] [A] [R] [1] [EOL] keys in this order *Note* *After this operation, the two MS420[ ] are tracked by frequency. To release this tracking, press the [F] [A] [R] [0] [EOL] keys in this order.*
13	Press the [RETURN] key.
14	Check the OVER LOAD lamp, and set IRG as follows: Lamp ON: Increase IRG until the lamps turns OFF. Lamp OFF: Decrease IRG as far as possible without turning the lamp ON.

Step	Procedure

15 Set the RBW according to the following conditions:

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 200 kHz	3 Hz to 10 kHz
> 200 kHz	3 Hz to 30 kHz

16 Increase ST until the UNCAL lamp goes out and the measured value no longer changes. Refer to 3.1.2 (1) STEP 1.

17 Directly connect OUTPUT–A and INPUT–T, then press the [X → S] key.

18 After one sweep measurement, turn on X–S lamp and connect INPUT–T to the output of the device under test.

19 Read the measured value.

Note

1. *MS420[ ] – (A) can be controlled from MS420A[ ] – (B) as follows:*

   (a) Press the [BEGIN] key.

   (b) Press the [/] [1] [0] [EOL] keys in this order.

   (c) Press the [#] [1] , ["] ["] , [EOL] keys in this order.
   The part enclosed by ["] and ["] is the GP-IB control command. Refer to the GP-IB operation manual for details.

2. *The above operation can be program controlled by using the PTA option.*

SECTION 4 APPLICATION

CONTENTS

SECTION 4 APPLICATION

4.1 GENERAL DESCRIPTION

The MS420[ ] can measure and analyze many types of analog elements, circuits, devices and signals. The measuring method varies with different objects, but description is made here about the measuring method and rules on fundamental objects. Apply these procedures to similar devices not included in this manual.

Impedance measurement is the principal item of measurement on L, C, R and resonators. Refer to the "Impedance measuring kit operation manual" for measurement of these elements.

4.2 CRYSTAL AND CERAMIC FILTER

Taking advantage of the excellent stability and High-Q, these filters are often used as a narrow band-pass filter. They are indispensible in communication equipments.

The filters are evaluated by the following items:

(a) Insertion loss

(b) Pass-band ripple

(c) Pass-band group delay-time characteristics

(d) Pass band-width

(e) Center frequency

(f) Guaranteed attenuation (out of band)

(g) Attenuation slope

These items can be calculated from the transmission characteristics described in paragraph 3.1. High-speed *vary. (Avoid overload of device input)*

Note

1. *Narrow and sweep the RBW slowly when measuring an object with wide dynamic range.*
2. *The characteristics may change according to the testing level. Be sure to find the level range in which the characteristics do not vary. (Avoid overload of device input)*
3. *Generally, impedance conversion is required. Refer to paragraph 5.2.*
4. *Check if vibration changes the characteristics.*
5. *Measurement of typical crystal filter is explained in paragraph 3.1.2 through 3.1.4.*

4.3 ACTIVE FILTER

The active filter is used below several hundred kHz and consists of an operational amplifier, capacitors and resistors. Measurement of this filter is fundamentally the same as that of other filter. Pay attention to the fact that this filter has an operational amplifier as component.

Note

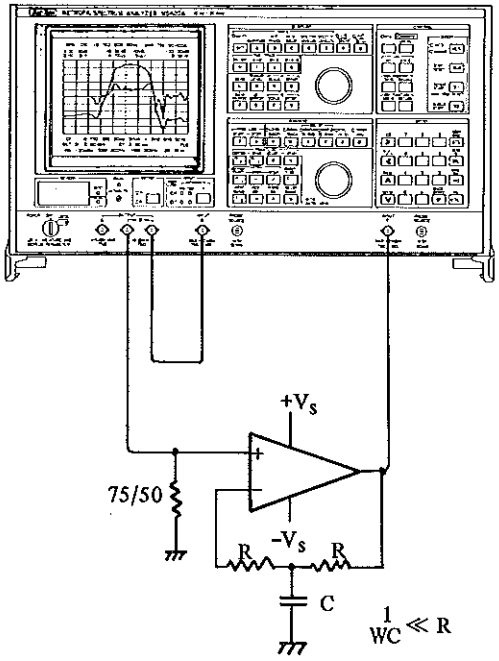
1. *Noise from the operational amplifier may narrow the dynamic range. For that reason, avoid measuring with inadequate device input levels.*
2. *Contrary to the above, excessive high levels may produce distortion and change the transmission characteristics of the operational amplifier, thus resulting in a change of filter characteristic. Choose the measuring level with utmost care.*

4.4 OPERATIONAL AMPLIFIER

An operational amplifier is one of the most fundamental elements which configure an analog circuit. Therefore, it is evaluated by many items. The measuring methods and results of some representative items are shown in Fig. 4-1 through Fig. 4-6.

Note

Since an operational amplifier has generally a large gain, care must be taken to present oscillations due to the test circuit.



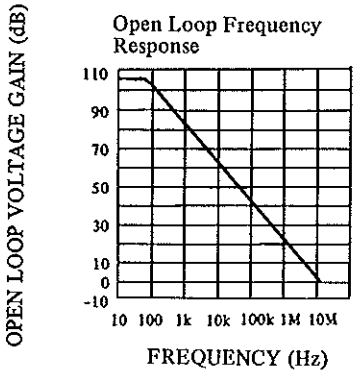
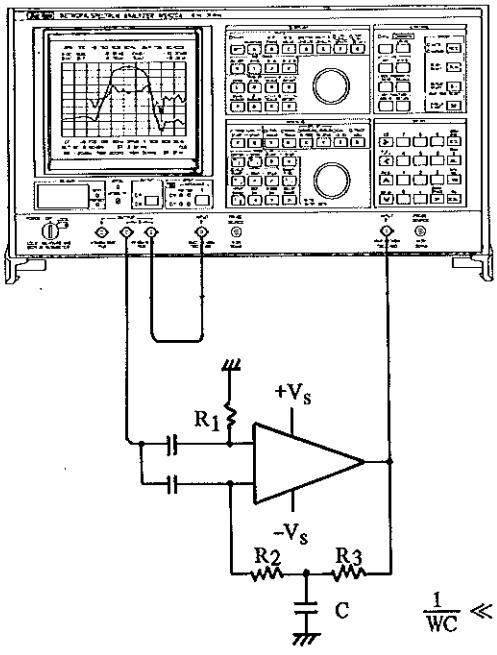
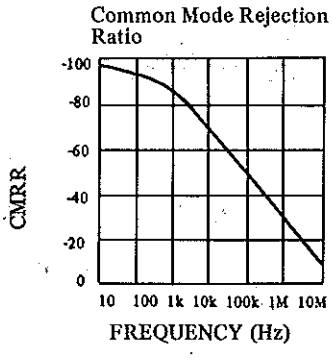


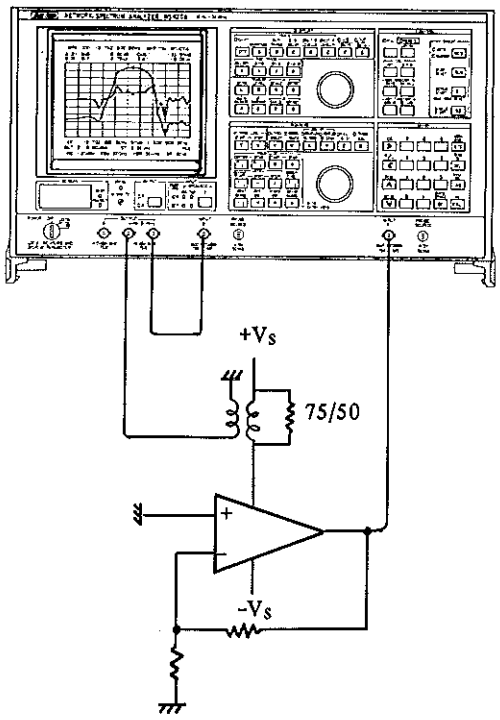
Fig. 4.1 Open Gain





$R_1 = R_2$; 75/50

Fig. 4.2 CMRR



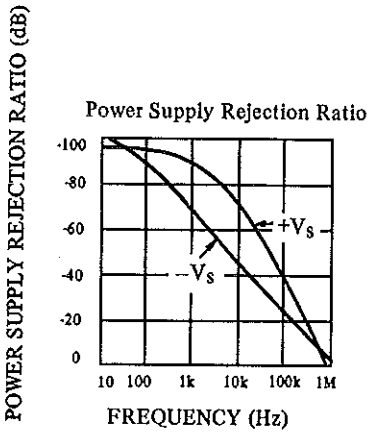


Fig. 4.3 Power Supply Rejection

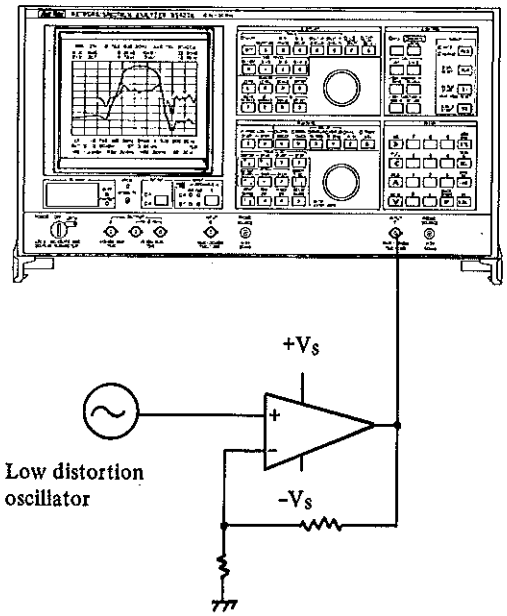


Fig. 4.4 Distortion

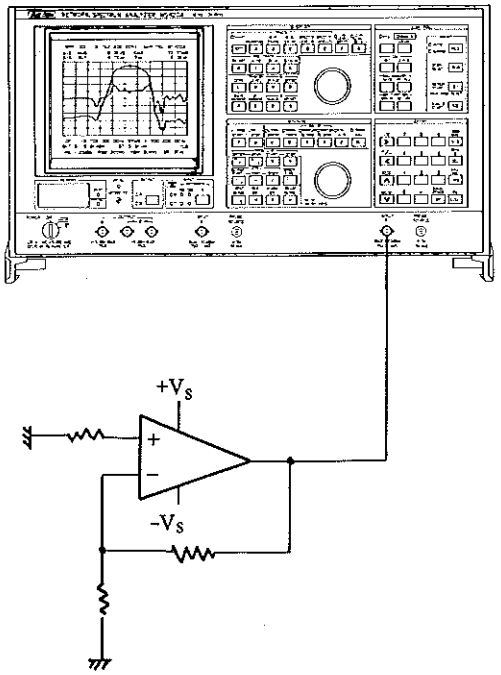


Fig. 4.5 Noise

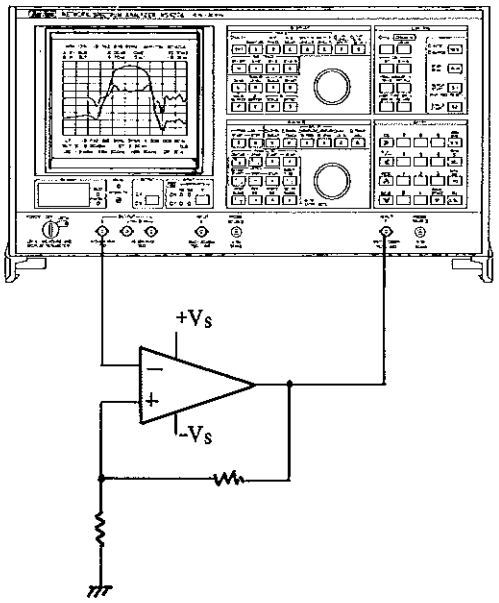


Fig. 4.6 Maximum Output Level

4.5 EQUALIZER

A high performance electronic device often uses an equalizer. The following are some examples of equalizer.

(a) Delay equalizer for band-pass filter

This is used to improve the frequency response of the group delay time of a band pass filter.

(b) Line amplifier for coaxial cable transmission

Since the transmission loss of a coaxial cable is proportional to $\sqrt{F}$, a line amplifier is designed to have the reverse characteristic to the above.

Note

F: frequency

(c) Dolby-IC

This is used to improve the high frequency noise characteristic of an audio tape recorder. Further, this equalization characteristic changes with input level changes.

Wide dynamic range and high accuracy in measurement are the common requirements of these equalizers. In such measurements, SUB TRACE (see paragraph 3.4) is conveniently used.

Note

1. *When the design values of an equalizer are set in the B-memory, the deviation from them is displayed on the CRT by using the function B=A–B of the SUB TRACE.*
2. *PTA option or personal computer is used to set the design values in the B-memory.*
3. *The content of the B-memory can be backed up to PBM. For that reason, if the design values have been backed up to the PBM in advance, they can be used without the PTA and personal computer.*

4.6 AGC CIRCUIT

The AGC (Automatic Gain Control) circuit can be evaluated with the compressing and response characteristics, and loop stability.

(a) AGC circuit

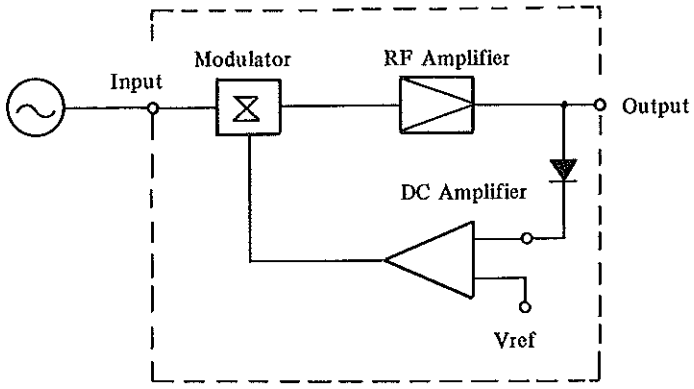


Fig. 4-7 AGC Circuit

(b) Compressing characteristic

This can be evaluated by the degree of output level change when the input signal level is varied. Measure the output level of the AGC circuit with sweeping the synthesizer output level. An example is shown in Fig. 4.8.

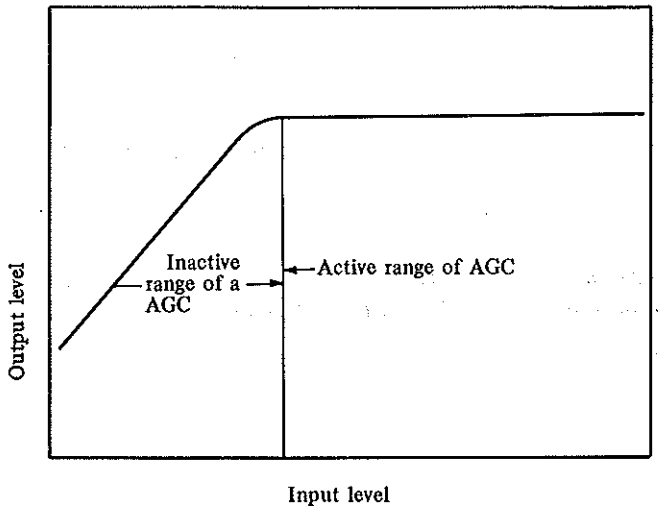


Fig. 4.8 Compression Characteristic

(c) Response time and loop stability

These can be evaluated measuring the loop gain. The response time can be judged by the frequency response of loop gain, and the loop stability by the gain and phase margins. The loop gain can be measured by the following connections. One example of frequency response of loop gain is shown in Fig. 4-9.

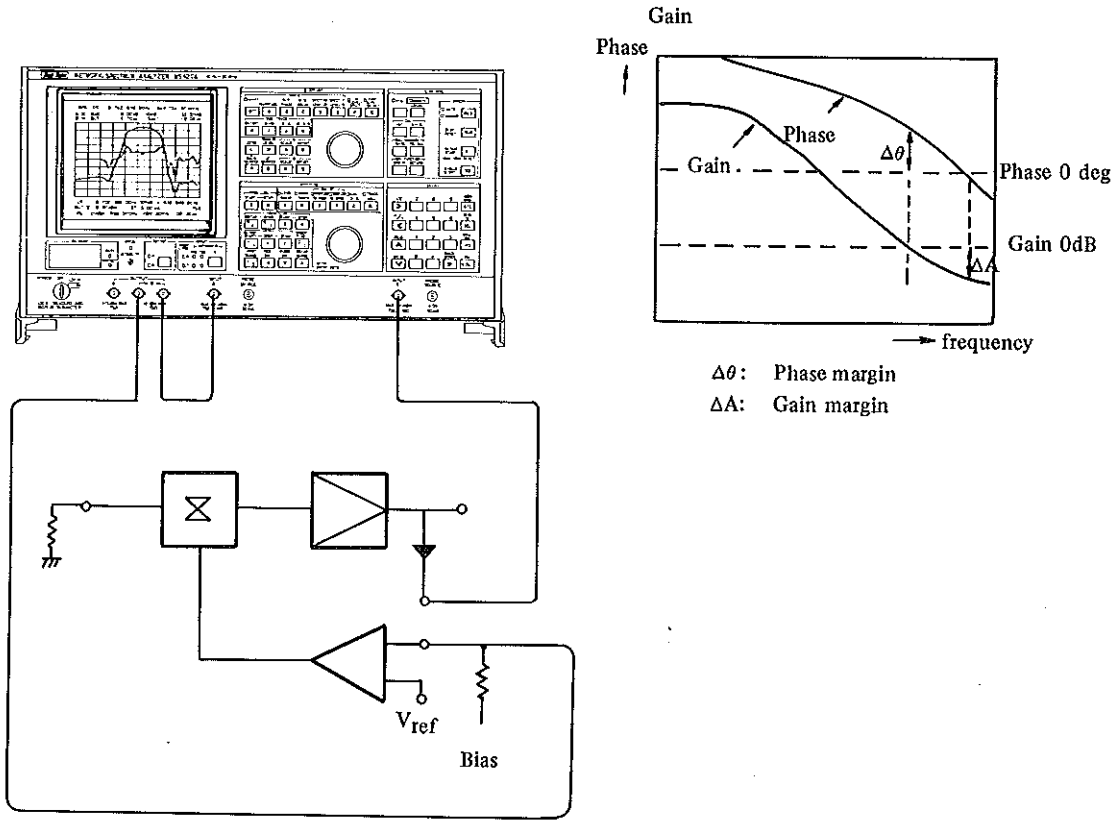


Fig. 4-9 Loop Gain

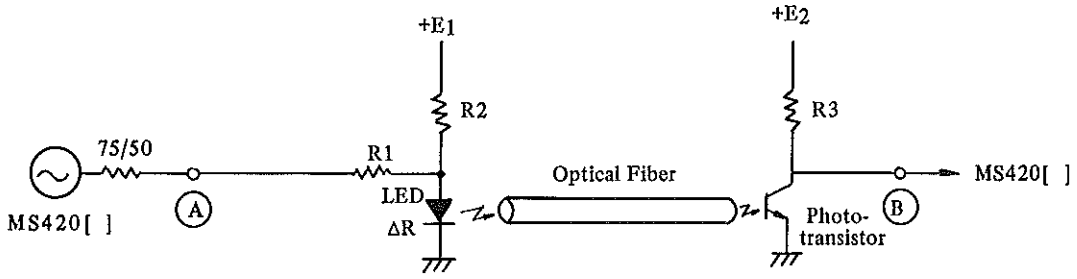
Note

1. *Since gain generally depends on bias (V ref), evaluate it at the worst value.*
2. *This measurement can be applied to PLL and AFC circuits.*

4.7 OPTICAL ELEMENT

Measurement of optical transmission line using LED, optical fiber and photo transistor is explained in the paragraph.

(a) Connection



ΔR : LED internal resistance
R2≫ R1
R1 = 75Ω (or 50Ω) -ΔR
R3 : 75Ω (A type), 50Ω (J type)

Fig. 4-10 Optical Element

Note

1. *Set the matching resistance, R1 to the value of 75Ω (B type) 50Ω (K-type) minus LED internal resistance.*
2. *Give an appropriate dc. bias to LED.*
3. *If any two characteristics of the LED, fiber, and photo transistor are known, the other one can be determined.*

(b) Transmission characteristics

Measure the transmission characteristics between Ⓐ and Ⓑ according to pragraph 3.1.

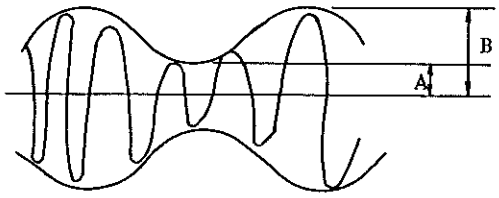
(c) Distortion

Connect a low distortion signal source to Ⓐ of Fig. 4.10 and evaluate distortion from the spectrum at Ⓑ point.

4.8 AM MODULATOR

The AM modulator is explained as follows.

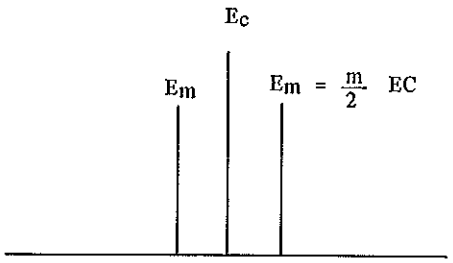
(1) Modulation factor



$$m = \frac{B - A}{A + B} \cdot 100\ (\%)$$

A and B is obtained on the video sweep.

(a) Time domain



$$m = \frac{2\,Em}{Ec} \cdot 100\ (\%)$$

(b) Frequency domain

Fig. 4-11 Modulation Factor

(2) Modulation distortion

Modulation distortion can be measured easily from the level difference between the fundamental wave and the spectrum of harmonic waves.

(3) Modulation frequency response

(a) Connection

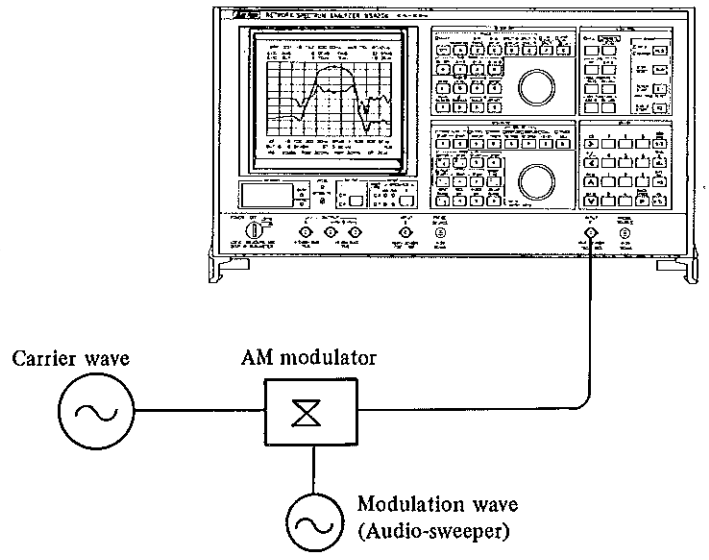


Fig. 4-12 Connection for Modulation Frequency Response Measurement

(b) Measuring example

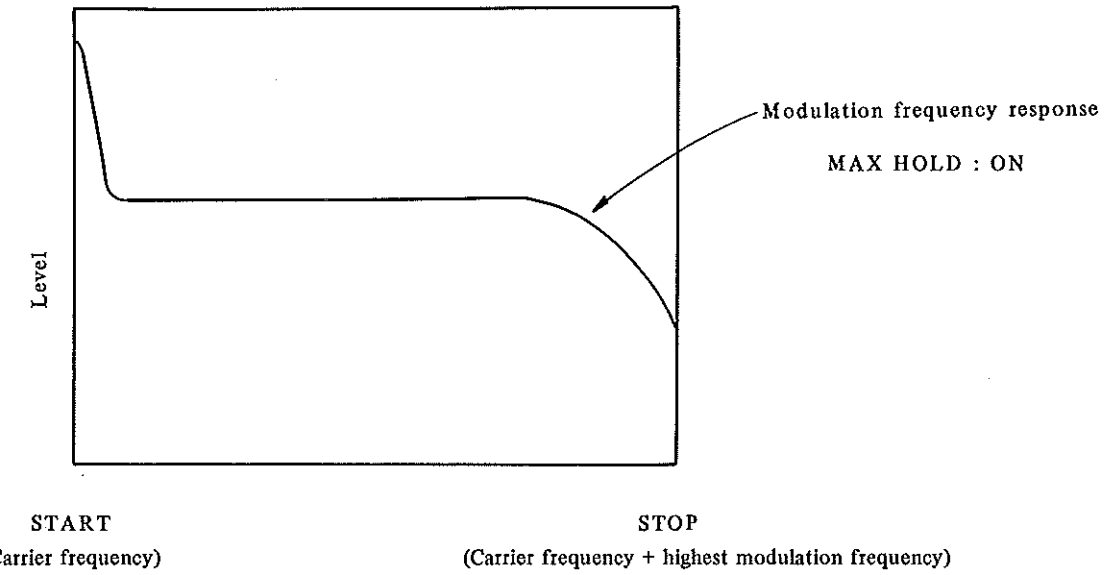


Fig. 4-13 Modulation Frequency Response

(4) Envelope measurement

Refer to paragraph 3.2.5

SECTION 5 ACCESSORIES/PERIPHERAL DEVICES

CONTENTS

SECTION 5 ACCESSORIES/PERIPHERAL DEVICES

5.1 IN-CIRCUIT MEASUREMENT (PROBE)

The in-circuit measurement requires a probe with high input impedance. Table 5.1 shows the probe and main performance for MS420[ ] use.

CAUTION

1. *No guarantee is given for any damage to the MS420[ ] or probe which occurs by using probes other than the MA45A. Use the probe after having fully understood how to handle it.*
2. *Connect the power supply terminal of the MA45A to PROBE SOURCE and turn the power ON.*

Connection of each probe is indicated in Fig. 5-1 through 5-3. Judge from the main performance of Table 5-1 which probe is adequate for a particular measuring object. Refer to SECTION 3 for how to operate.

Table 5-1 High Input Impedance Probe

Name	Frequency	Input level	Input capacity	Input resistance	Loss	Remarks
MA45A (Anritsu)	100Hz to 30MHz	2.74 Vrms Max.	≦20pF	≧3MΩ	10dB	Power source: supplied from the PROBE SOURCE of the MS420[ ]
1121A AC Probe (Hp)	1kHz to 500MHz	350m Vrms Max.	≦3pF	100kΩ	0dB	Power source: supplied from the 1122A (hp)
P6008 (Tektronix)	DC to 100MHz	27.4 Vrms Max. (when the MS420[ ] is connected)	7.5pF	≧10MΩ	20dB	Power source: Not required.
P6009 (Tektronix)	DC to 150 MHz	274 Vrms Max. (when the MS420[ ] is connected)	2.5pF	≧10MΩ	40dB	Power source: Not required.
P6013A (Tektronix)	DC to 100 kHz	2.74K Vrms Max. (when the MS420[ ] is connected)	3pF	≧100MΩ	60dB	Power source: Not required.

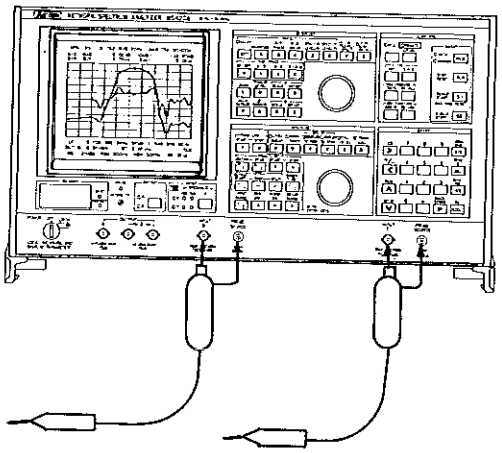


Fig. 5-1 MA45A

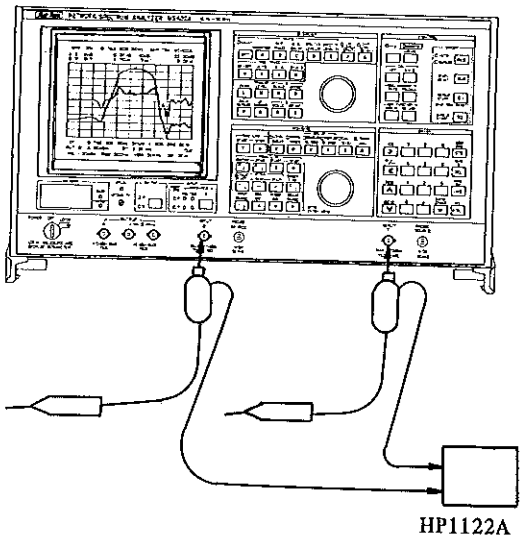


Fig. 5-2 HP1121A

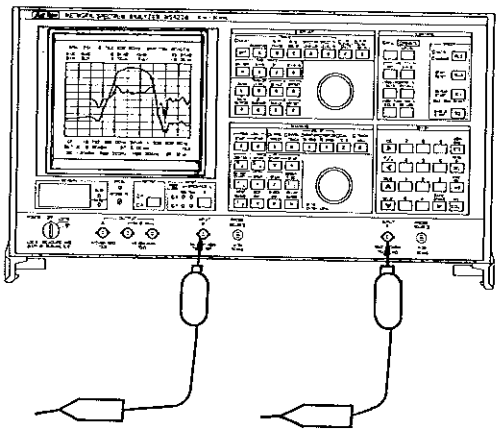


Fig. 5-3 P6008
P6009
P6013A

5.2 IMPEDANCE CONVERSION (TRANSFORMER)

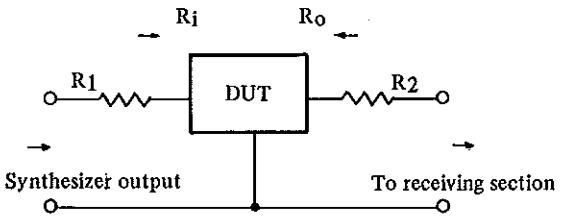
When the input/output impedance of a circuit to be measured (filter, for example) is not 75Ω or 50Ω, impedance conversion is required.

The following are the methods

(1) Method by resistance pad

o I/O impedance > Rs

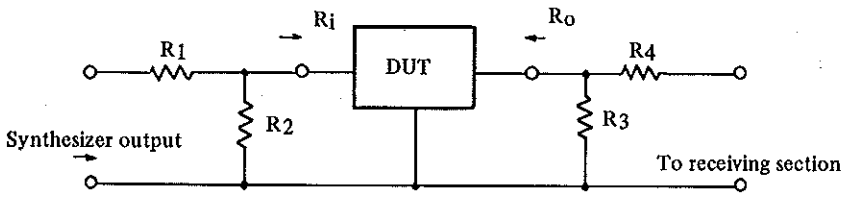
Rs: 75 Ω (A type)
50 Ω (J type)



$R1 = Ri - Rs\ (\Omega)$
$R2 = Ro - Rs\ (\Omega)$

(Ri : Input impedance
Ro: Output impedance)

o I/O impedance < Rs



$$R1 = \sqrt{\frac{1 - K1}{K1}} \cdot Ri \qquad R3 = \frac{1}{\sqrt{K\,(1 - K2)}} \cdot Ro$$

$$R2 = \frac{1}{\sqrt{K1\,(1 - K1)}} \cdot Ri \qquad R4 = \sqrt{\frac{1 - K2}{K2}} \cdot Ro$$

$$K1 = \frac{Ri}{Rs} \qquad K2 = \frac{Ro}{Rs}$$

Fig. 5-4 Impedance conversion by resistance pad

(2) Method by transformer

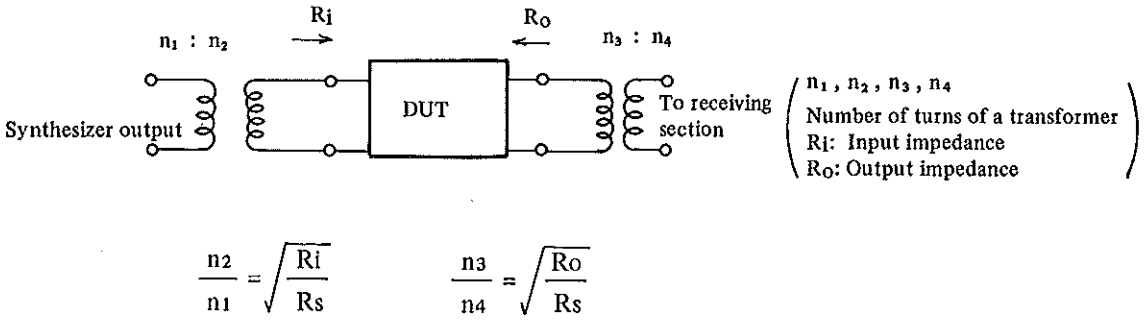


Fig. 5-5 Impedance conversion by transformer

Appendix 4 shows the kinds of transformers supplied by the ANRITSU.

5.3 HARD COPY

For hard copy of the measured data, video plotter, digital printer and polaroid camera can be used.

(1) Video plotter

Hard copies of the picture on the CRT can be obtained easily and speedily by connecting the VIDEO OUT terminal of the MS420[ ] and the VIDEO IN terminal of the video plotter (UA855 being recommended). Figs. 5-6 and 5-7 show the connection and hard-copy examples respectively.

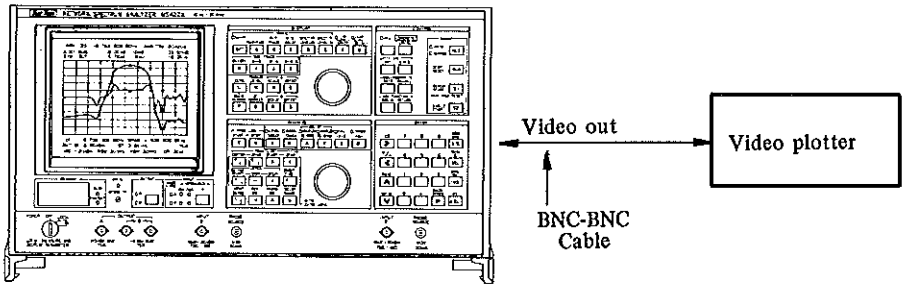


Fig. 5-6 Connection for video plotter

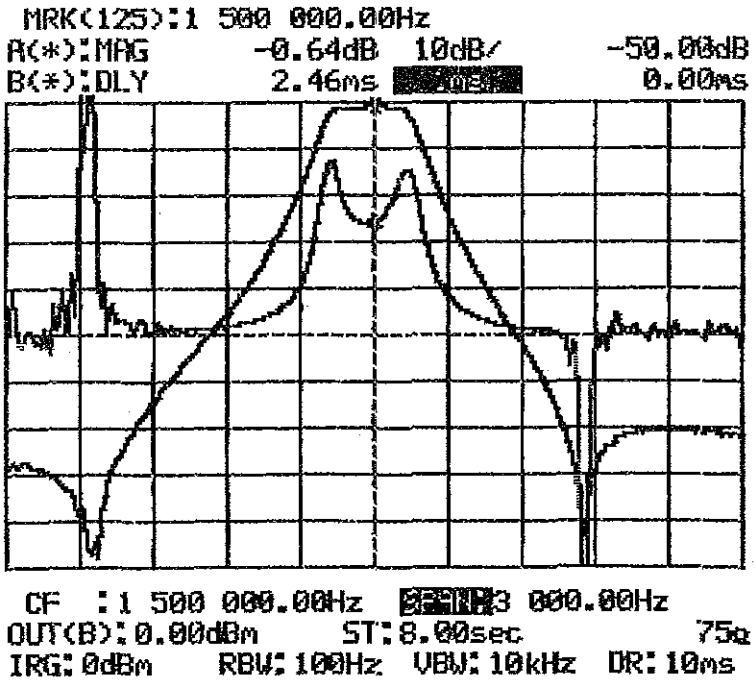


Fig. 5-7 Video protter output example (Actual size)

(2) Digital printer

By connecting the digital printer with GP-IB (IEE 488, IEC-625-1) interface to the GP-IB connector of the MS420[ ], measured values can be issued as numerical data.

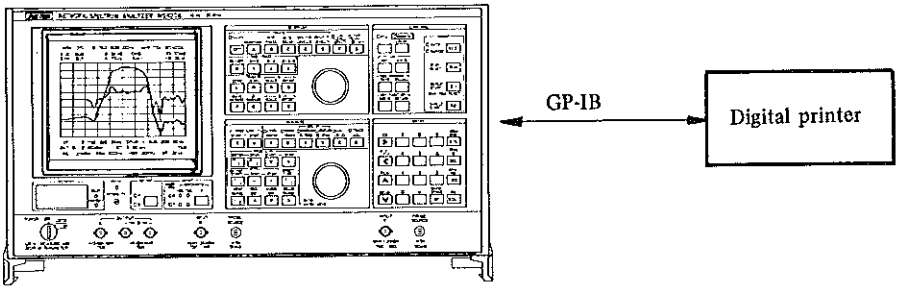


Fig. 5-8 Connections for Digital Printer

Step	Procedure
1.	Press the [BEGIN] key.
2.	Press the [/] [1] [2] and [EOL] keys in this order.
3.	Press the [#] [3] [,] [2] [0] [0] [,] [5] [;] and [EOL] keys in this order. (Ⓐ: [3]; Ⓑ: [2] [0] [0]; Ⓒ: [5]; Ⓓ: [;])

Note

Ⓐ : *Printer GP-IB address*
Ⓑ : *Measuring point of output starting*
Ⓒ : *Number of output points*
Ⓓ : *If the immediate excution command ([;] or [:]) is omitted, measurement results and output whenever a sweep operation is terminated.*

Example

Measuring point	Frequency	Amplitude	DLY
200	24000002.00Hz	–91.56dB	–333.2ms
201	24120001.96Hz	–92.88dB	–230.0ms
202	24240001.92Hz	–94.79dB	61.6ms
203	24360001.88Hz	–90.15dB	–515.2ms
204	24480001.84Hz	–95.62dB	12.8ms

4. Press the [RETURN] key.

5.4 REFLECTION BRIDGE

5.4.1 General

Reflection Bridges (MA412A/J, MA27A and MA312A/B/C) measure a return loss and a S-parameter (S11 and S22) when used with the MS420[ ].

[Principal Performances]

- Frequency : 10 Hz to 30 MHz
- Impedance : MA412A : 75 Ω unbalanced
  MA412J : 50 Ω unbalanced
  MA27A : 600 Ω balanced
  MA312A : 75 Ω balanced
  MA312B : 135 Ω balanced
  MA312C : 150 Ω balanced
- Directivity : > 50 dB

[Measurement applications]

- An input and output impedance of communication equipments.
- Transistor S-parameter
- An input and output impedance of video equipments.
- A VSWR of antennas.

5.4.2 Composition and Specifications

Table 5-2 to 5-7 show the standard compositions of MA412A, MA412J, MA27A, MA312A, MA312B and MA312C, respectively.

Table 5-8 and 5-9 show each specification of their reflection bridges, independently.

Each reflection bridge is separately contracted.

Table 5-2 Standard Composition of the MA412A

Item	Q'ty
MA412A Reflection Bridge	1
Measurement cable BNC-BNC, 10 cm	1
Standard terminations 75 Ω : MP541A 0 Ω : MP49A	 1 1

Table 5-3 Standard Composition of the MA412J

Item	Q'ty
MA412J Reflection Bridge	1
Measurement cable BNC-BNC, 10 cm	1
Standard terminations 50 Ω : MP541J 0 Ω : MP49A	 1 1

Table 5-4 Standard Composition of the MA27A

Item	Q'ty
MA27A Reflection Bridge	1
Measurement cable M·214-M·214, 10 cm	1
Standard terminations 600 Ω : MP24A 0 Ω : MP34A	 1 1

Table 5-5 Standard Composition of the MA312A

Item	Q'ty
MA312A Reflection Bridge	1
Measurement cable M·214-M·214, 10 cm	1
Standard terminations 75 Ω : MP33B 0 Ω : MP34A	 1 1

Table 5-6 Standard Composition of the MA312B

Item	Q'ty
MA312B Reflection Bridge	1
Measurement cable M·214-M·214, 10 cm	1
Standard terminations 135 Ω : MP33B 0 Ω : MP34A	 1 1

Table 5-7 Standard Composition of the MA312C

Item	Q'ty
MA312C Reflection Bridge	1
Measurement cable M·214-M·214, 10 cm	1
Standard terminations 150 Ω : MP33C 0 Ω : MP34A	 1 1

Table 5-8 Specifications

Item \ Model	MA412A	MA412J	MA27A
Impedance	75 Ω unbalanced	50 Ω unbalanced	600 Ω balanced
Connector	BNC	BNC	Terminal (usable for M-214)
Frequency	10 Hz - 100 kHz 30 kHz - 30 MHz } two ranges	10 Hz - 100 kHz 30 kHz - 30 MHz } two ranges	10 Hz - 250 kHz
Directivity	> 50 dB	> 50 dB	> 60 dB : 10 Hz - 150 kHz > 40 dB : 150 - 250 kHz
Open/short	< 0.5 dB < 5 deg	< 0.5 dB < 5 deg	< 0.5 dB <5 deg
Dimensions and weight	54 H, 53 W, 141 Dmm ≦ 0.9 kg	54 H, 53 W, 141 Dmm ≦ 0.9 kg	66 H, 53 W, 149 Dmm ≦0.8 kg

Table 5-9 Specifications

Item \ Model	MA312A	MA312B	MA312C
Impedance	75 Ω balanced	135 Ω balanced	150 Ω balanced
Connector	Terminal (usable for M-214)	Terminal (usable for M-214)	Terminal (usable for M-214)
Frequency	2 kHz - 2 MHz	2 kHz - 2 MHz	2 kHz - 2 MHz
Directivity	> 50 dB	> 50 dB	> 50 dB
Open/short	< 0.5 dB < 5 deg	< 0.5 dB < 5 deg	< 0.5 dB < 5 deg
Dimensions and weight	66 H, 53 W, 149 Dmm ≦ 0.8 kg	66 H, 53 W, 149 Dmm ≦ 0.8 kg	66 H, 53 W, 149 Dmm ≦ 0.8 kg

5.4.3 Using the Reflection Bridge

(1) Display

Example of 25 kHz resonator characteristics measurement

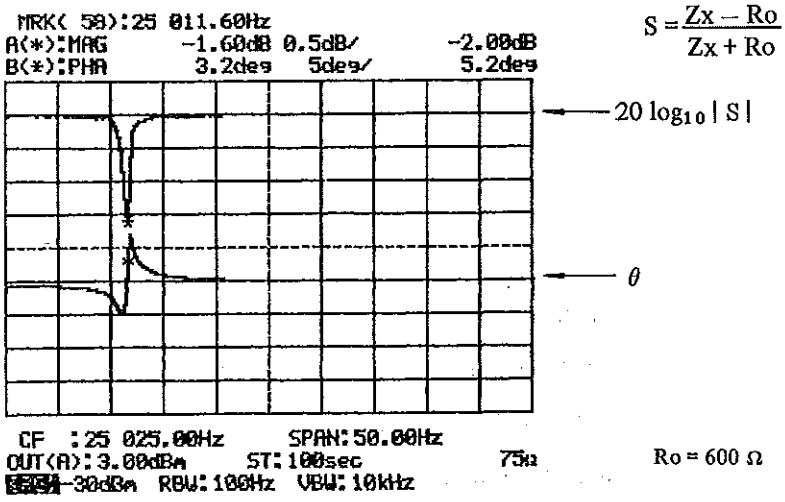


Fig. 5-9 DISPLAY

(2) Connection

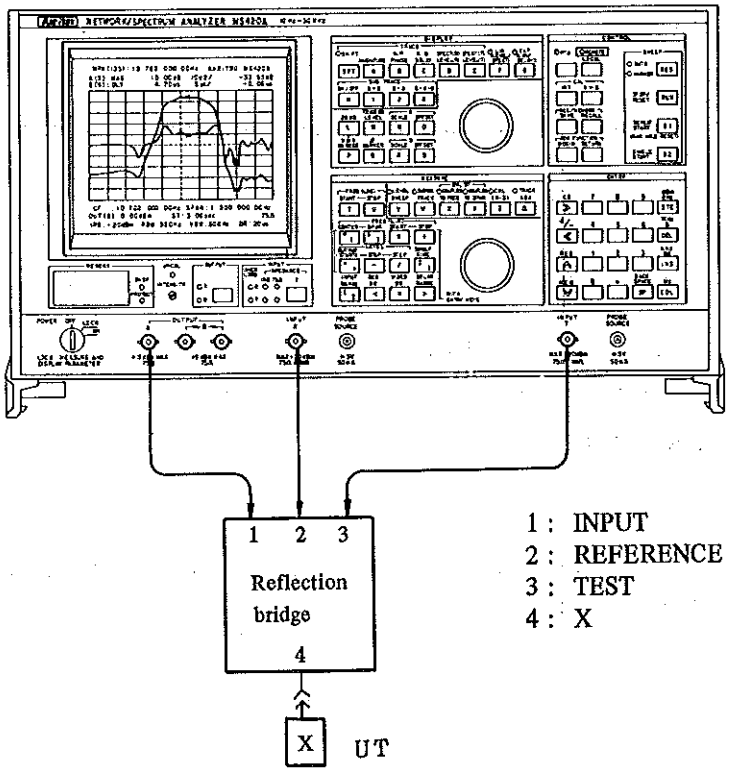


Fig. 5-10 CONNECTION

(3) Measurement Procedure

Step	Procedure
1	Connect the reflection bridge as shown in the figure.
2	Set the TRACE switch to M/P (or MAGNITUDE for return loss measurement).
3	Set the following parameters: OUTPUT . . . . . A INPUT IMPEDANCE . . . . . 75 Ω/50 Ω FREQUENCY . . . . . * OUTPUT LEVEL . . . . . * SWEEP TIME . . . . . * INPUT RANGE . . . . . * RES BW . . . . . * VIDEO BW . . . . . * * Sets to the required value.
4	When using MA412A/J, set the range switch for the correct frequency.
5	Open terminal X and press the [X→S] key. (When return loss is measured, jumper terminal X to provide 0 Ω, which reduces the measurement error.)
6	Turn on the X-S lamp and connect the test circuit to terminal X.
7	Use the OFFSET/SCALE switch to adjust the size of a waveform displayed on the CRT.
8	Read a measured value by using a marker.

5.5 IMPEDANCE PROBE

5.5.1 General

MA413A Impedance Probe is an accessory that measures an impedance between two terminals in Z (absolute) and θ (phase) when used with the MS420 [ ].

[Principal performance]

- Frequency : 30 kHz to 30 MHz
- Impedance : 1 Ω to 1 MΩ, ±180 deg
- Standard resistance : 100 Ω

[Applications of impedance measurement]

- Frequency response of L, C, R
- Resonator
- Amplifier
- Oscillator

5.5.2 Composition and Specifications

Table 5-10 shows the standard composition of MA413A, Table 5-11 shows the standard composition of MA414A and Table 5-12 shows the specifications of MA413A.

The MA414A is separately contracted.

Table 5-10 Standard Composition of the MA413A

Item	Q'ty
MA413A Impedance Probe	1
MA415A Standard termination 100 Ω	1
Plastic Case	1

Table 5-11 Standard Composition of the MA414A

Item	Q'ty
Accessories	
Flexible type : MA416A	1
Clip type : MA417A	1
BNC-P type : MA418A	1
BNC-R type : MA419A	1
Standard terminations (100 Ω)	
BNC-R : MA420A	1
BNC-P : MA421A	1

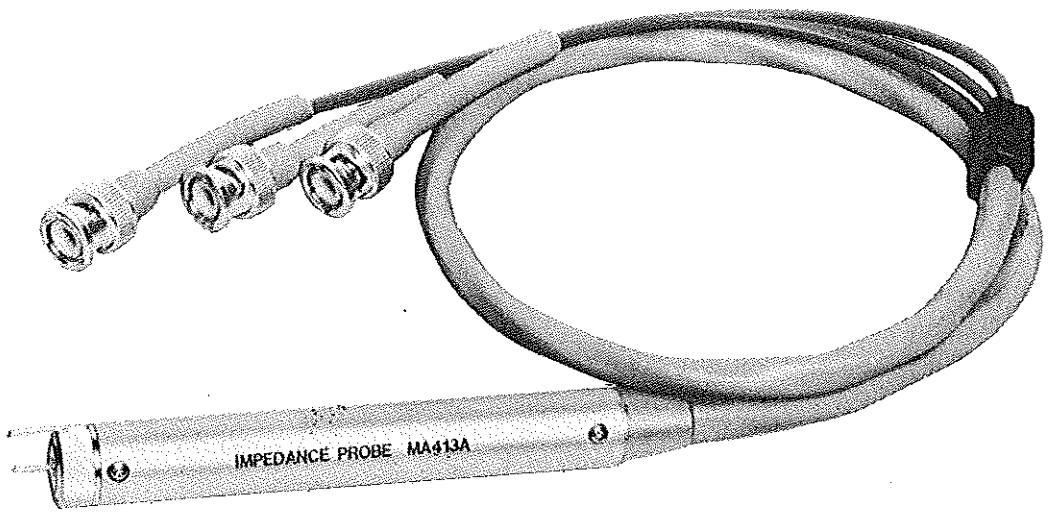


Table 5-12 Specifications of the MA413A

Item	Specifications
Frequency range	30 kHz to 30 MHz
Impedance	1 Ω to 1 MΩ, ±180 deg.
Residual impedance	Resistance : < 1.5 Ω (Typical value : 1 Ω) Inductance : < 50 nH (Typical value : 35 nH) Capacitance : < 0.3 pF (Typical value : 0.15 pF)
DC cut	None
Standard resistance	100 Ω
Dimensions and Weight	Approx. 15 ϕ x 1200 mm, Approx. 180 g

5.5.3 Principle of Operation

An equivalent circuit of the MA413A is as shown in Fig. 5-11

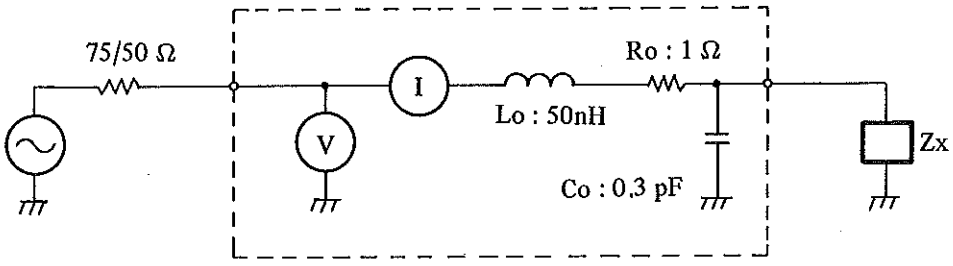


Fig. 5-11 Equivalent Circuit of MA413

(I) : Connected to the INPUT-R of MS420[ ].

(V) : Connected to the INPUT-T of MS420[ ].

Measurement method: The Zx is measured by comparing to the standard resistance of 100 Ω.

Notes

1) *The measured value includes the error caused by the residual impedances Lo, Co and Ro within the probe.*
2) *The residual impedances when the MA413A is used with the Impedance Measurement kit MA414A are shown in Table 5-13.*

Table 5-13

Accessory	Residual impedance (Typical)		
	Ro	Co	Lo
MA416A	1 Ω	1.7 pF	50 nH
MA417A	1.6 Ω	6 pF	300 nH
MA418A	1 Ω	2.2 pF	50 nH
MA419A	1 Ω	1.8 pF	50 nH

5.5.4 Using the Impedance Probe

(1) Display

Example of 25 kHz resonator characteristics measurement.

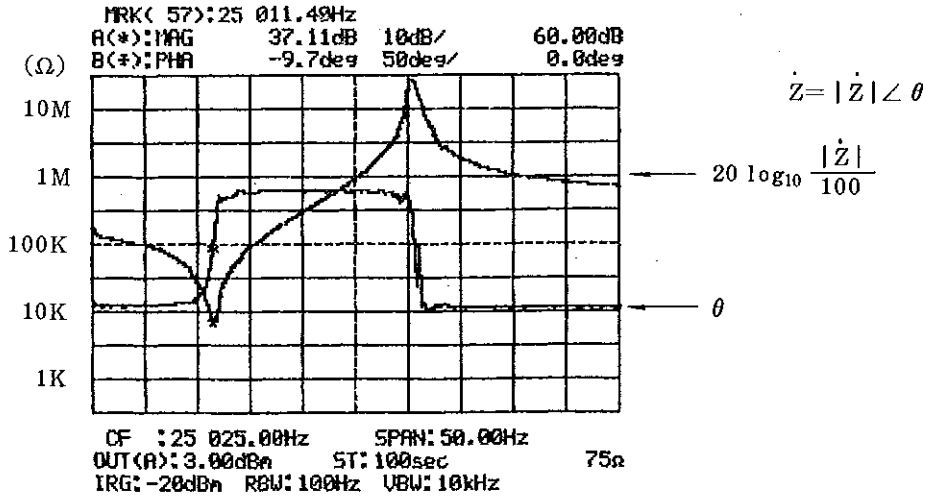


Fig. 5-12 DISPLAY

(2) Connection

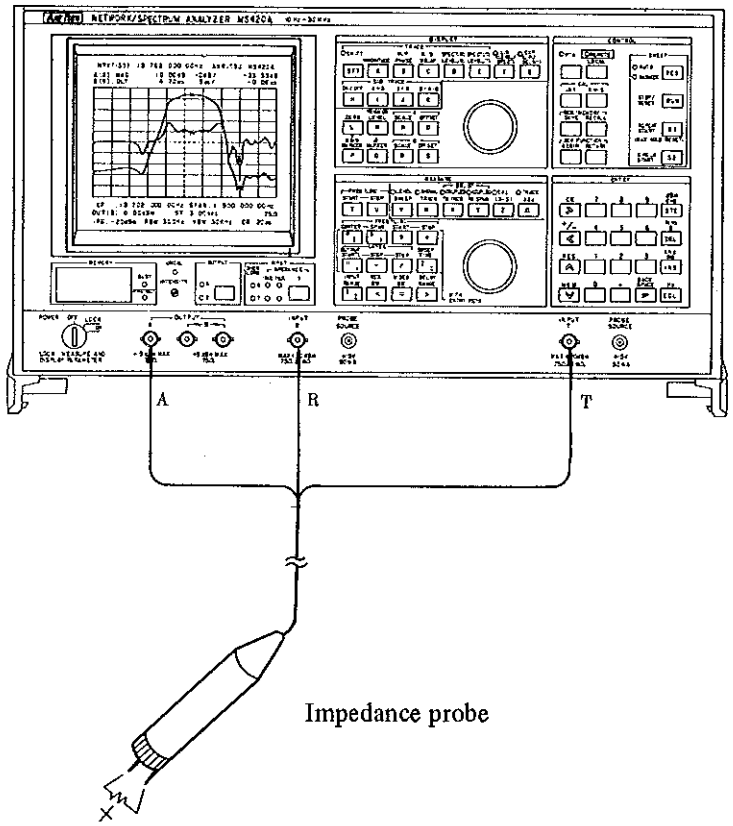


Fig. 5-13 CONNECTION

(3) Measurement Procedure

Step	Procedure
1	Connect the impedance probe as shown in the figure.
2	Set the TRACE switch to M/P.
3	Set the following parameters: OUTPUT . . . . . A INPUT IMPEDANCE . . . . . 75 Ω/50 Ω FREQUENCY . . . . . * OUTPUT LEVEL . . . . . * SWEEP TIME . . . . . * INPUT RANGE . . . . . * RES BW . . . . . * VIDEO BW . . . . . * * Sets to the required value.
4	Connect a 100 Ω standard resistor to terminal X, and press the [X→S] key.
5	Turn on the X-S lamp and connect a test circuit to terminal X.
6	Use the OFFSET/SCALE switch to adjust the size of the waveform displayed on the CRT.
7	Read the measured value by using the marker.

SECTION 7 STORAGE

CONTENTS

SECTION 7 STORAGE

7.1 STORAGE, CAUTIONS

Attention should be paid to the items listed below when storing the instrument for an extended period of time.

(1) Always clean the instrument throughly before storage.

(2) Do not store the instrument in a place of high temperatre (55°C or more), high humidity (90 % or more), or excessive low temperature (–25°C or less).

(3) Do not store the instrument in direct sunlight or in a dusty place.

(4) Do not store the instrument in a place where it may be affected by condensation or corrosive gases.

7.2 RECOMMENDED STORAGE CONDITIONS

In addition to the conditions listed above, the following environmental conditions are recommended when storing the instrument for an extended period of time.

Temperature: 0 to 30°C
Humidity: 40 to 80 %

The place should not be subject to large changes in temperature and humidity during the day.

APPENDIX

CONTENTS

APPENDIX 1-(a) MS420[ ] SPECIFICATIONS

<table>
<tr><th colspan="2">Items</th><th>Specifications</th><th>Network Analysis</th><th>Spectrum Analysis</th></tr>
<tr><td colspan="2" rowspan="2">Measuring items</td><td>Magnitude, Phase, Delay,
Magnitude and Phase, Magnitude and Delay</td><td>o</td><td></td></tr>
<tr><td>Level (R), Level (T), Spectrum (R), Spectrum (T)
R: Reference input, T: Test input
Level: Measures the level at only frequency points displayed on the CRT
Spectrum: Display the maximum value of the signal by making a measurement with frequency steps fine enough to acquire all frequencies in full sweep bandwidth</td><td></td><td>o</td></tr>
<tr><td rowspan="2">Frequency</td><td>Range</td><td>10Hz to 30 MHz, Resolution: 10 mHz</td><td>o</td><td>o</td></tr>
<tr><td>Reference crystal Oscillator</td><td>Frequency: 10 MHz
Stability: $\leqq 5 \times 10^{-8}$ after 10 minutes warm-up, based on the frequency after one hour warm-up $\pm 1 \times 10^{-7}$ (0 to 45°C)</td><td>o</td><td>o</td></tr>
<tr><td rowspan="4">Input</td><td>Channel</td><td>2 channels (R and T)</td><td>o</td><td>o</td></tr>
<tr><td>Impedance</td><td>1 MΩ: 1 MΩ ±10% shunted by ≦70 pF (50 pF typical)
75Ω/50Ω: Return loss: ≧30 dB</td><td>o</td><td>o</td></tr>
<tr><td>Range (IRG)</td><td>−40 to +20 dBm, 10 dB steps</td><td>o</td><td>o</td></tr>
<tr><td>Connector</td><td>BNC</td><td>o</td><td>o</td></tr>
<tr><td rowspan="4">Dynamic range</td><td>Image rejection</td><td>≧70 dB</td><td>o</td><td>o</td></tr>
<tr><td>IF rejection</td><td>≧70 dB</td><td>o</td><td>o</td></tr>
<tr><td>Internal distortion</td><td>≦−60 dB at 100 Hz to 200 kHz
(Resolution Bandwidth: ≦300 Hz)
≦−70 dB at 200 kHz to 15 MHz</td><td></td><td>o</td></tr>
<tr><td>Average noise level</td><td>At level measurement when the input channel and impedance are T and 75 Ω/50 Ω.
<table>
<tr><th>Resolution bandwidth</th><th>Frequency</th><th>Values relative to input range</th></tr>
<tr><td>10 Hz</td><td>100 Hz to 30 MHz</td><td>−60 dB</td></tr>
<tr><td>10 Hz</td><td>10 kHz to 30 MHz</td><td>−90 dB</td></tr>
<tr><td>30 Hz</td><td>300 Hz to 30 MHz</td><td>−70 dB</td></tr>
<tr><td>30 Hz</td><td>10 kHz to 30 MHz</td><td>−85 dB</td></tr>
</table></td><td></td><td>o</td></tr>
</table>

APPENDIX 1-(a) MS420[ ] SPECIFICATIONS

<table>
<tr><th colspan="2">Item</th><th>Specifications</th><th>Network Analysis</th><th>Spectrum Analysis</th></tr>
<tr><td rowspan="2">Dynamic range</td><td rowspan="2">Average noise level</td><td>
<table>
<tr><th>Resolution bandwidth</th><th>Frequency</th><th>Values relative to input range</th></tr>
<tr><td>100 Hz</td><td>1 kHz to 30 MHz</td><td>−80 dB</td></tr>
<tr><td>300 Hz</td><td>3 kHz to 30 MHz</td><td>−80 dB</td></tr>
<tr><td>1 kHz</td><td>10 kHz to 30 MHz</td><td>−75 dB</td></tr>
<tr><td>3 kHz</td><td>30 kHz to 30 MHz</td><td>−70 dB</td></tr>
<tr><td>10 kHz</td><td>100 kHz to 30 MHz</td><td>−65 dB</td></tr>
<tr><td>30 kHz</td><td>300 kHz to 30 MHz</td><td>−60 dB</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>The best data for the network analysis is 10 dB or more improvement over above values.</td><td>o</td><td></td></tr>
<tr><td rowspan="2">Crosstalk</td><td>Between input R and T</td><td>≧100 dB</td><td>o</td><td></td></tr>
<tr><td>Between synthesizer output and input T</td><td>≧120 dB</td><td>o</td><td>o</td></tr>
<tr><td rowspan="2">Resolution bandwidth</td><td>3 dB bandwidth</td><td>3 Hz to 30 kHz in 1,3 sequence
Accuracy: ±20% at ≧30 Hz</td><td>o</td><td>o</td></tr>
<tr><td>Selectivity</td><td><20:1, shape factor 60 dB/3dB</td><td>o</td><td>o</td></tr>
<tr><td colspan="2">Video bandwidth</td><td>1 Hz to 30 kHz in 1, 3 sequence</td><td>o</td><td>o</td></tr>
<tr><td rowspan="3">Magnitude measurement</td><td>Range</td><td>100 dB, Resolution: 0.01 dB</td><td rowspan="3">o</td><td rowspan="3"></td></tr>
<tr><td>Offset error</td><td>Frequency response and input range/resolution bandwidth switching errors can automatically be corrected by memorizing the calibration data (usually based on the through connection).</td></tr>
<tr><td>Linearity</td><td>0 to −50 dB : ±0.15 dB
−50 to −60 dB: ±0.5 dB
−60 to −70 dB: ±1 dB
−70 to −80 dB: ±2 dB
±1 dB (0 to −10 dB) for resolution bandwidth 3 Hz</td></tr>
<tr><td rowspan="2">Level/ spectrum measurement</td><td>Range</td><td>−130 to +20 dBm, Resolution: 0.01 dB</td><td rowspan="2"></td><td rowspan="2">o</td></tr>
<tr><td>Offset error</td><td>Frequency response and input range errors can automatically be corrected by memorizing the standard data calibrated with the reference signal (synthesizer output)</td></tr>
</table>

Item		Specifications	Network Analysis	Spectrum Analysis
Level/ spectrum measure-ment	Linearity	0 to −50 dB : ±0.15 dB −50 to −60 dB: ±1 dB −60 to −70 dB: ±3 dB ±1 dB (0 to −10dB) for resolution bandwidth 3Hz		○
Phase measure-ment	Range	±180 degrees, Resolution: 0.1 deg.	○	
	Offset error	Frequency response and input range/resolution band-width switching errors can automatically be corrected by memorizing the calibration data (usually based on the through connection).		
	Level charac-teristic	0 to −50dB : ±1.5 deg. −50 to −70 dB: ±3 deg. at resolution bandwidth 3 kHz.		
Delay measure-ment	Range	1 μs to 400 ms in 1,2,4 sequence	○	
	Resolution	Normal: 1/1000 of measurement range Expand: 1/10000 of measurement range		
	Offset error	Frequency response can automatically be corrected by memorizing the calibration data (usually based on the through connection).		
	Level charac-teristic	(0.5% of full scale +0.5% of reading) at 0 to −50dB and resolution bandwidth ≧10 Hz for 1 μs range (1 − 30 MHz)		
Synthesizer output	A output	−110 to +15 dBm, Resolution: 0.01 dB	○	○
	B output	−110 to +9 dBm, Resolution: 0.01 dB (power splitter output) Both output terminated		
	Level accuracy Impedance	±0.3 dB at +5 dBm 75 Ω/50 Ω, Return loss: >30 dB		
	Connector	BNC		
Frequency measurement		Resolution: 1 Hz, Accuracy : Reference frequency ±1 Hz		○
Sweep mode	Frequency	LIN : START/STOP, CENTER/SPAN LOG: START/STOP	○	○
	Level	START/STOP/STEP		

APPENDIX 1-(a) MS420[ ] SPECIFICATIONS

Item		Specifications	Network Analysis	Spectrum Analysis
Sweep point		251	o	o
Sweep time (ST)		500 ms* to 24 hours/SPAN *: Depends on measurement item and measurement conditions	o	o
Sweep range	AUTO	Automatic sweep over the full range	o	o
	MARKER	Measures only marker point or sweeps only the range between two markers.		
Sweep control		RESET, STOP, REPEAT START, SINGLE START	o	o
Automatic setting		SIGNAL TRACK: Ganged to maximum received signal automatically		o
		BW, ST: COUPLED TO FREQ Resolution bandwidth, Video bandwidth and Sweep time are automatically set to the optimum value by ganging with span width	o	o
		BW, ST: COUPLED TO SPAN Resolution bandwidth, Video bandwidth and Sweep time are automatically set to the optimum value by ganging with span width		o
Calibration	INT	Non-linearity error correction	o	o
	X → S	Offset error correction		
Calculation	X – S	Automatic correction of offset error	o	o
	A – B	Arithmetic processing between A and B memories		
	Δ	Deviation between MAIN marker and Δ marker		
	ZERO	Deviation from reference value		
Display	CRT	6.5 – inch electromagnetic deflection	o	o
	Trace	Same as the measuring items (rectangular coordinates)		
	Sub-trace	Same as the measuring items (rectangular coordinates) B, A, A – B. It is not performed for Magnitude/Phase and Magnitude/Delay		
	Marker	2 (MAIN marker and Δ marker)		
	Character	Marker point data, Trace condition, Measurement condition		

Item		Specifications	Network Analysis	Spectrum Analysis
Function memory		3 (Trace condition, Measurement condition)	o	o
Rear panel INPUT/ OUTPUT	Video output	75Ω load, Approx. 1 Vp-p (BNC)	o	o
	10 MHz reference output	TTL level (BNC)		
	10 MHZ reference input	TTL level (BNC)		
	X → S switching signal	Open collector (36 pins)		
	GP-IB	Compatible with IEEE488 (24 pins)		
Remote control		GP-IB (IEEE488, IEC 625-1, 24 pins) SH1, AH1, T6, L4, SR1, RL1, PP0, DC0, DT0, C28 All functions (without power and intensity) of front panel are remotely controllable	o	o
Power		** Vac ±10%, 50/60 Hz, <330 VA	o	o
Ambient temperature rated range of use		0°C to +45°C	o	o
Dimensions and weight		221.5H, 426W, 451D mm, ≦35 kg	o	o

APPENDIX 1-(b) GP-IB Connection

Pin No.	Connection	
1	DIO 1	Data bus
2	DIO 2	
3	DIO 3	
4	DIO 4	
5	EOI	Interface control bus
6	DAV	Data byte transfer control bus
7	NRFD	
8	NDAC	
9	IFC	Interface control bus
10	SRQ	
11	ATN	
12	SHIELD	
13	DIO 5	Data bus
14	DIO 6	
15	DIO 7	
16	DIO 8	
17	REN	Interface control bus
18 -- 24	GND	

APPENDIX 1-(c) I/O PORT CONNECTION

Pin No.	Connection	
1	GND	Control signal
2	NSTART	
3	NMEAS	
4	NRUNS	
5	NDOA0	Output port A
6	1	
7	2	
8	3	
9	4	
10	5	
11	6	
12	7	
13	NDOB0	Output port B
14	1	
15	2	
16	3	
17	4	
18	5	
19	6	
20	7	
21	NDIOC0	Output port C
22	1	
23	2	
24	3	
25	NDIOD0	Output port D
26	1	
27	2	
28	3	
29	NRDC	Status signal of port
30	NRDD	
31	NWTS	
32	NC	Nonconnected
33	NC	
34	+5V	+5 V, 100 mA output
35	CAL	Switching signal, Open collector
36	+20V	+20 V, 100 mA output

APPENDIX 2-(a) PTA OPTION SPECIFICATIONS

Display	Number of display characters		42 characters x 21 lines = 882 characters
	Displayable characters		Upper and lower case characters, numerals, special symbols, and cursor (total: 96 characters)
	Character font		5 x 7 dot matrix
	Graphic		2 screens (High and Low intensity displays), each 255 x 217 dots
Keyboard	Character key		Upper and lower case letters, numerals, special symbols (total: 50 keys)
	Edit key		[DEL] [INS] [∧] [∨] [<] [>]
	Command key		[RUN] [STE] [EOL] [RES]
	Switch key		[S1] [S2]
Memory	Program area		12k bytes
PTL	Command		Basic commands (8 types) and PBM control commands (3 types)
	Statement		Basic statements (15 types) and GP-IB statement (2 types)
	Function		Arithmetic functions (12 types), boolean functions (4 types), and system functions (8 types)
	System subroutine		Display subroutines (4 types), GP-IB subroutines (2 types), and buzzer subroutine.
	Variable		Numeric, string, and system variables
	Data type	Single-precision integer	1 byte: 0 to 255
		Double-precision integer	2 bytes: –32768 to +32767
		Single-precision real number	4 bytes: Number of effective digits is 7, and exponential range is 10^{-20} to 10^{18}
		Double-precision real number	8 bytes: Number of effective digits is 14, and exponential range is 10^{-14} to 10^{13}
		Character	Maximum: 128 bytes
		Bit	Maximum: 8 bits
	Interface		GP-IB and I/O port
PBM	Circuit system		Serial loop
	Storage capacity		8K bytes (User area is 7.5K bytes)
	Program file		Maximum: 30 programs

APPENDIX 2-(b) A LIST OF PTL FUNCTIONS

Item number	Item			Format
1.1	Command	Delete		DELETE [line number 1] [, [line number 2]]
1.2	Command	List		LIST [line number 1] [, [line number 2]]
				LISTG address, [line number 1] [, [line number 2]]
1.3	Command	Renumber		RENUM [new line number [, increment [, old line number]]]
1.4	Command	Execution start		RUN [start line number] [, suspension line number]
1.5	Command	Execution continue		CONT [suspension line number]
1.6	Command	Save		SAVE program name
1.7	Command	Load		LOAD program name
1.8	Command	Program name list		PLIST
2.1	Statements	Comment		REM ["comment"]
2.2	Statements	Array declaration		DIM variable name (array size) [, variable name (array size) . . .]
2.3	Statements	Substitution		[LET] variable = expression
2.4	Statements	Branch		GOTO line number
2.5	Statements	Branch to subroutines		GOSUB line number
2.6	Statements	Return from subroutines		RETURN
2.7	Statements	Decision		IF variable = variable (or constant) statement
2.8	Statements	Repetition start		FOR numeric variable = initial value TO ending value [STEP increment]
2.9	Statements	Repetition termination		NEXT numeric variable
2.10	Statements	Key input		INPUT variable [format] [, variable [format] . . .]
2.11	Statements	Display		PRINT variable [format] [, variable [format] . . .] [;]
2.12	Statements	Home position		HOME
2.13	Statements	Erase		ERASE
2.14	Statements	Wait		WAIT constant
2.15	Statements	GP-IB input		READ address, variable [format] [, variable [format] . . .]
2.16	Statements	GP-IB output		WRITE address, variable [format] [, variable [format] . . .] [;]
2.17	Statements	System subroutine execution		CALL system subroutine name [(parameter (, parameter . . .))]
3.1	System subroutines	Screen clear		CRTC (N)
3.2	System subroutines	Screen return		CRTR (N)
3.4	System subroutines	Character string display		CRTC (X, Y, string, N)
3.5	System subroutines	Graphics display		CRTG (X0, Y0, X1, Y1, N)
3.6	System subroutines	IFC		IFC
3.7	System subroutines	SRQ output		RSV
3.8	System subroutines	Address modification		ADR (N)
3.9	System subroutines	Buzzer		BZR
4.1	Functions	Arithmetic functions		SIN, COS, TAN, ASN, ACS, ATN, LN, LOG, EXP, SQR, ABS, SGN
4.2	Functions	Boolean functions		NOT, AND, OR, NOR
4.3	Functions	System functions	Maximum value	MAX (maximum value point, starting point, terminating point, memory area)
			Minimum value	MIN (minimum value point, starting point, terminating point, memory area)
			Cut frequency 1	BNDL (designated measured-value point, search start point, designated measured-value, memory area)
			Cut frequency 2	BNDH (designated measured-value point, search start point, designated measured-value, memory area)
			Ripple 1	RPL1 (starting point, terminating point, memory area)
			Ripple 2	RPL2 (inflection point number, starting point, terminating point, memory area)
			Pole 1	POLL (low range pole point, starting point, designated attenuation, memory area)
			Pole 2	POLH (high range pole point, starting point, designated attenuation, memory area)

APPENDIX 3 ACCESSORIES (Option)

Order No.	Name	Remarks
34Y73726D	Panel cover	Front and Rear panel covers
34Y73731D	Front handle kit	Handle 2
34Y73732D	Rack mount kit	Handle ..... 2 Angle 2

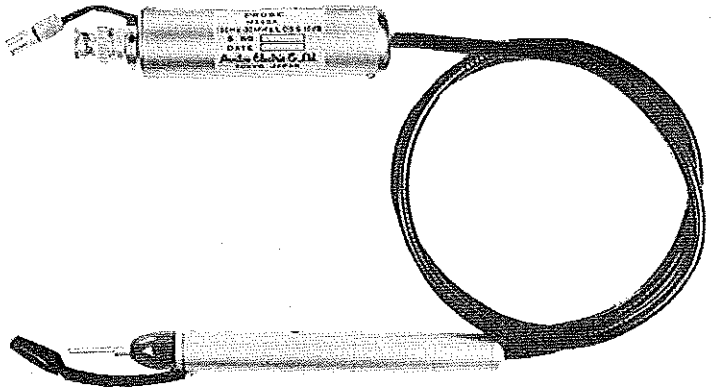
APPENDIX 4 TRANSFORMER

The transformers can be used to measure the magnitude, phase, delay, level, and spectrum of devices having balanced input and output impedances.

Model	Impedance		Frequency range
	Input	Output	
MA29A	75	600	30 Hz to 150 kHz
MA29J	50	600	30 Hz to 150 kHz
MA313A	75	75	4 kHz to 2 MHz
MA313J	50	75	4 kHz to 2 MHz
MA314A	75	135	4 kHz to 2 MHz
MA314J	50	135	4 kHz to 2 MHz
MA315A	75	150	4 kHz to 2 MHz
MA315J	50	150	4 kHz to 2 MHz

- Input connector is a BNC type in an unbalanced circuit.
- Output connectors are terminals compatible with M-214.
- Frequency response : <0.3 dB
- Return loss : >25 dB

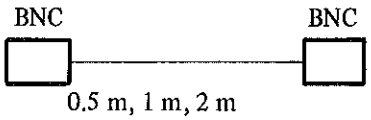
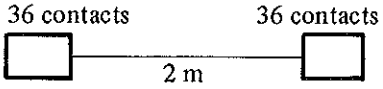
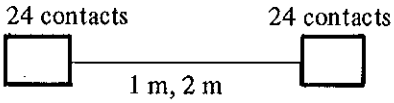
APPENDIX 5 AC PROBE (MA45A)



Specifications

Item	Specifications
Frequency	100 Hz to 30 MHz
Input level	2.74 Vrms MAX
Input capacitance	≦ 20 pF
Input impedance	≧ 3 MΩ
Loss	10 dB

APPENDIX 6 CABLE

Name	Detail
Coaxial cable	
I/O Port cable	
GP-IB cable	

APPENDIX 7 IMPEDANCE MEASURING KIT

Specifications of Reflection Bridges

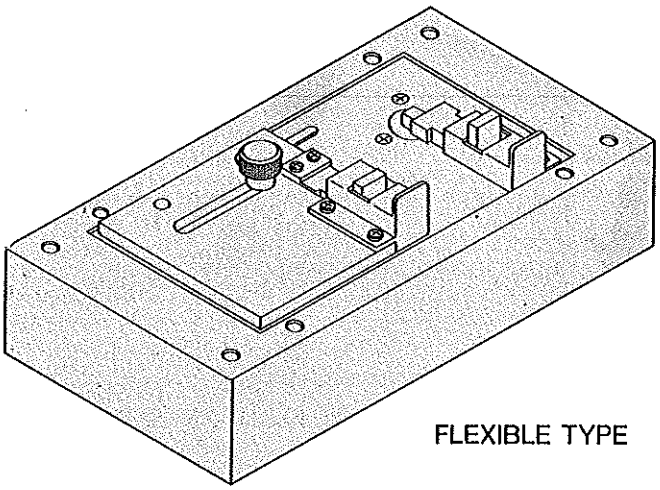
Item \ Model	MA412A	MA412J	MA27A
Impedance	75 Ω unbalanced	50 Ω unbalanced	600 Ω balanced
Connector	BNC	BNC	Terminal (compatible with M-214)
Frequency	10 Hz - 100 kHz 2 ranges 30 kHz - 30 MHz	10 Hz - 100 kHz 2 ranges 30 kHz - 30 MHz	10 Hz - 250 kHz
Directivity	>50 dB	>50 dB	>60 dB: 10 Hz - 150 kHz >40 dB: 150 - 250 kHz
Open/short	<0.5 dB, <5 deg	<0.5 dB, <5 deg	<0.5 dB, <5 deg
Standard termination	75 Ω, 0 Ω	50 Ω, 0 Ω	600 Ω, 0 Ω
Measurement cable	BNC-BNC, 10 cm	BNC-BNC, 10 cm	M-214-M-214, 10 cm
Dimensions and weight	54H, 53W, 141Dmm ≦0.9 kg	54H, 53W, 141Dmm ≦0.9 kg	66H, 53W, 149Dmm ≦0.8 kg

Item \ Model	MA312A	MA312B	MA312C
Impedance	75 Ω balanced	135 Ω balanced	150 Ω balanced
Connector	Terminal (compatible with M-214)	Terminal (compatible with M-214)	Terminal (compatible with M-214)
Frequency	2 kHz - 2 MHz	2 kHz - 2 MHz	2 kHz - 2 MHz
Directivity	>50 dB	>50 dB	>50 dB
Open/short	<0.5 dB, <5 deg	<0.5 dB, <5 deg	<0.5 dB, <5 deg
Standard termination	75 Ω, 0 Ω	135 Ω, 0 Ω	150 Ω, 0 Ω
Measurement cable	M-214-M-214, 10 cm	M-214-M-214, 10 cm	M-214-M-214, 10 cm
Dimensions and weight	66H, 53W, 149Dmm ≦0.8 kg	66H, 53W, 149Dmm ≦0.8 kg	66H, 53W, 149Dmm ≦0.8 kg

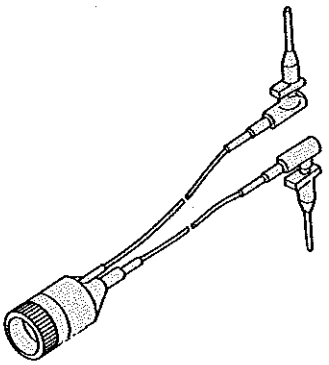
Specification of MA413A Impedance Probe

Item	Specification
Frequency range	30 kHz to 30 MHz
Impedance	1 Ω to 1 MΩ, ±180 deg.
Residual impedance	Resistance : <1.5 Ω (Typical value: 1 Ω) Inductance : <50 nH (Typical value: 35 nH) Capacitance : <0.3pF (Typical value: 0.15 pF)
DC cutoff	None
Standard resistance	100 Ω

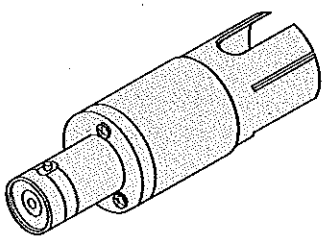
M414A Impedance Measurement Kit



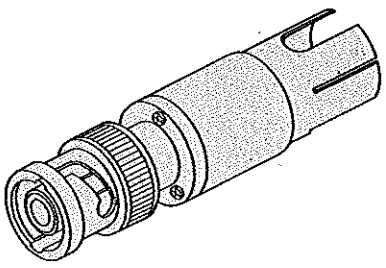
FLEXIBLE TYPE



CLIP TYPE



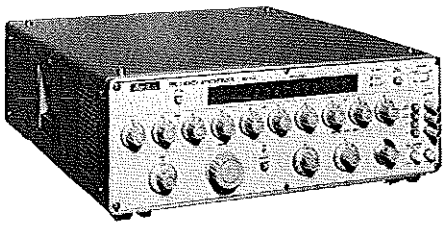
BNC RELEPTACLE TYPE



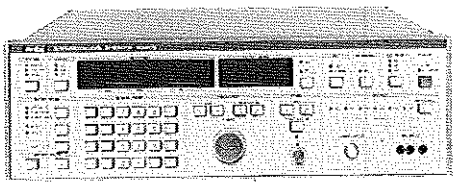
BNC JACK TYPE

APPENDIX 8 PORTABLE TEST RACK (MB23A)

APPENDIX 9 SYNTHESIZER



MG440A



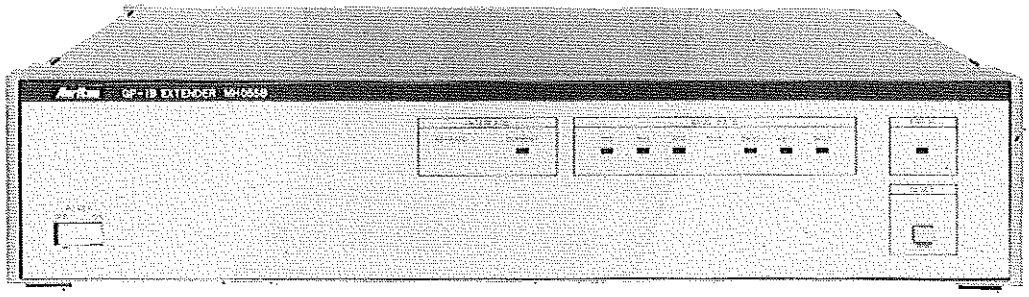
MG443B

Item	MG440A	MG443B	MG545[ ]
Frequency	10 Hz to 30 MHz 0.01 Hz resolution	10 Hz to 30 MHz 1 Hz resolution	10 KHz to 500 MHz 0.01 Hz resolution
Output level	–80 to +15 dBm Accuracy: ± 0.2 dB	–80 to +15 dBm Accuracy: ± 0.15 dB	–60 to +10 dBm Accuracy: ± 0.4 dB
Impedance Connector	75 Ω/50 Ω unbalanced BNC 150 Ω/600 Ω balanced I-214	75 Ω/50 Ω unbalanced BNC 75Ω/135 Ω/150 Ω/ 600 Ω balanced I-214	A type: 50Ω N K type: 75 Ω NC
GP-IB interface	Option	Standard	Option

APPENDIX 10 S PARAMETER TEST SET (UNDER DEVELOPMENT)

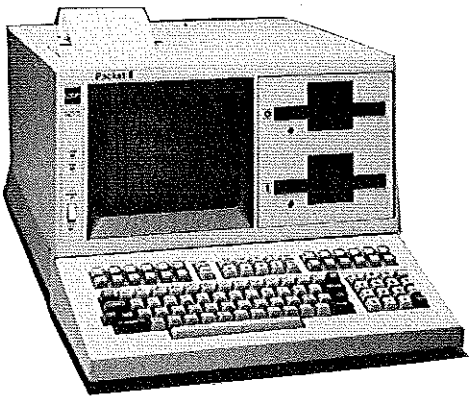
Item	Specifications
Impedance	type A: 75 Ω/600 Ω type J: 50 Ω/600 Ω
Frequency	75 Ω, 50 Ω unbalanced 10 Hz to 100 kHz 30 kHz to 30 MHz } 2 ranges 600 Ω balance 10 Hz to 150 kHz
Directivity	≧ 50 dB

APPENDIX 11 MH055B GP-IB EXTENDER



Item	Specifications
GP-IB interface transfer	GP-IB interface status can be sent to the opposite extender.
Serial interface	◦ Modem interface (JIS C 6361, 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

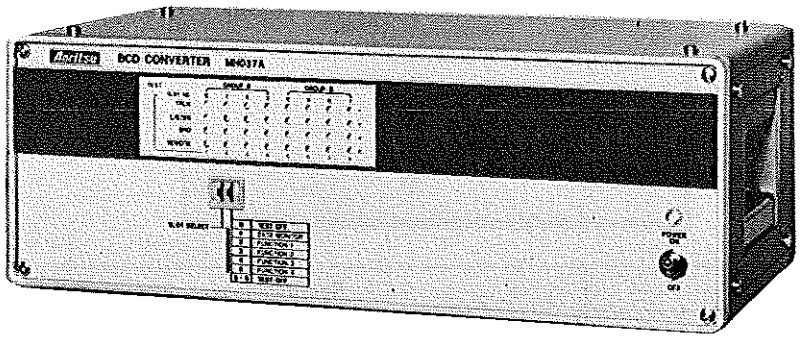
APPENDIX 12 PACKET II HY PERSONAL COMPUTER



	Basic Unit
Memory Size	RAM256K byte (user's memory, 150K bytes or more)
Display	9.5 inch CRT, 64 characters x 21 lines, 5 x 7 dot matrix, alphanumeric characters and symbols, Greek letters
Memory Unit	Mini-floppy disk, approx. 300K bytes per unit
Clock/Timer	1 clock (year, month, hour, minute, second), 4 timers
Tone Generator	Variable frequency and length
Keyboard	Full keyboard: ASCII, ten numeric keys, function keys, editing keys, system command keys Simple keyboard: ten numeric keys and functions keys
I/O slot	7 (2 for memory and 5 for interfaces)

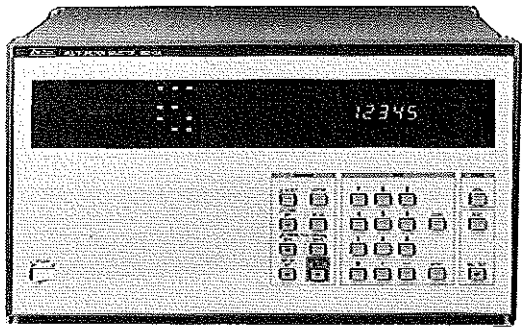
	Extended Basic (Standard Equipped)
Effective Digits	Decimal, 12 digits
Dynamic Range	$0, \pm 10^{\pm 99}$
Types of Numerical Variables	Double precision, single precision, integer precision
Operators	+ – * / ↑ = < > & AND OR NOT NOR
Array Dimensions	Up to three dimensions
Character String Data Length	255 Characters
Characters Handled	Alphanumeric letters (capitals and small letters), symbols, numbers, Greek letters
Names of Variables	Numerical Variables: Alphanumeric letters beginning with A to Z Character String Variables: Alphanumeric letters beginning with A to Z with a "&" added to the end. (Any desired number of characters)
Statements:	90 Input/Output statement GP-IB control statement Exceptional processing statement and others
Numeric Supplied Functions	37
Binary Operation Functions	10
Character String Functions	20

APPENDIX 13 MH037A BCD CONVERTER



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 MH045A Parallel Output Unit: 16 bit relay contact

APPENDIX 14 MS010A MULTI FUNCTION SELECTOR



Item	Specifications
Slots for units	23 slots, multiple slots used according to the kind of unit
Interface	GP-IB SH1, AH1, T6, L4, SR1, RL1, PP0, CD1, DT0, C0
Channel combination setting	60
Collection data setting	60
Self-check function	SELF TEST key, executed when power turned on

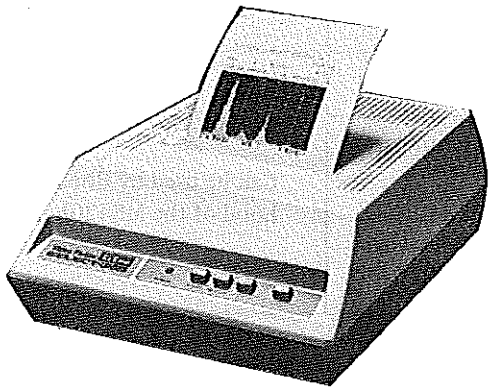
Units

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 650kHz to 2MHz	75Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH357A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	110Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH358A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	135Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH359A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	150Ω balanced	≦0.2dB	≧35dB	≧100dB ≧100dB	≦−120dBm
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 13 to 30MHz 30 to 100MHz	75Ω unbalanced	≦0.2dB ≦0.3dB ≦0.5dB	≧35dB ≧33dB ≧22dB	≧115dB ≧105dB ≧95dB	≦−120dBm
MH655A	4 (BNC)	4 (BNC)	DC to 100kHz 100 to 500MHz	50Ω unbalanced	≦0.2dB ≦0.5dB	≧25dB ≧22dB	≧90dB ≧80dB	≦−100dBm

APPENDIX 15 POLAROID CAMERA

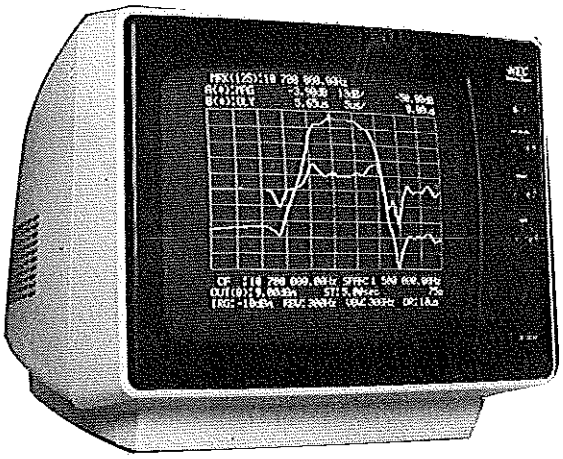
Camera	Adaptor	Manufacturer	Remarks
197B	10378A	HP	Can be used by directly mounting it on the CRT hood of the MS420[ ].
C-5C	016-0357-01	TEKTRONIX	
C-59 AP	016-0249-04	TEKTRONIX	
C-28	016-0249-04	TEKTRONIX	

APPENDIX 16 UA855 VIDEO PLOTTER



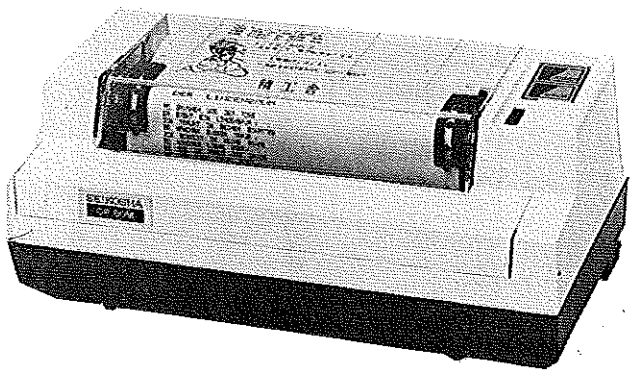
1.	Recording specifications	
	Recording method	Electrosensitive recording
	Resolution	Standard resolution mode..... 640 dots (60 column/line) High resolution mode ..... 1280 dots (120 columns/line)
	Number of rasters to be printed	Interlaced scanning: Max. 1000, Noninterlaced scanning: Max. 500
	Picture size	96 x 128 mm (standard resolution) 96 x 256 mm (high resolution)
	Recording speed	Typical 12 secs/screen (standard resolution) Typical 24 secs/screen (high resolution)
	Reverse printout	Positive and negative printing
2.	Paper specifications	
	Name	UA-855 recording paper
	Length	40 m
	Width	127 mm (5 inches)
	Outside diameter of roll	Max. 75 mm
3.	Input signal specifications	
	Type	Composite video signal: Video white positive, 0.5 – 10Vp-p Separate video signals: Video signal: 0.5 – 10Vp-p (positive negative) Sync signal: TTL level (positive or negative)
	Scanning method	Interlaced and noninterlaced
	Composite video signal synchronization range	Noninterlaced scanning: Vertical 1.67 ± 5ms, horizontal 63.5 ± 35μs Interlaced scanning: Vertical 16.7 ± 5ms, horizontal 63.5 ± 5μs
	Connector	Composite video signal: BNC receptable Separate video signals: DIN-8P socket

APPENDIX 17 JB-1203M DISPLAY



Item	Specification
CRT	12 inch 90° deflection C1270P31
Display color	Green (P31)
Input signal system	Composite video signal
Input signal	Polarity: Synchronous negative Amplitude: 1.0 Vp-p
Input impedance	High impedance or 75Ω switching Bridge connectable
Signal bandwidth	20 MHz
Geometrical distortion	≦2%
Display area	Width 210 x height 150 mm
Display characters	Max 2000 chars (80 chars x 25 lines)
Scan frequency	Horizontal: 15.75 KHz Vertical: 60 Hz

APPENDIX 18 GP-80M PRINTER (WITH OPTION)



SPECIFICATIONS

A.	Print method	Impact dot matrix print (SEIKOSHA's uni-hammer method)
B.	Character matrix	5 x 7 dot matrix
C.	Characters	96 upper/lower case characters, numerals and symbols
D.	Graphics	Dot addressable. 7 vertical dots per column, max 480 columns.
E.	Character codes	8-bit ASCII
F.	Character size	Height: 7 dots (2.82 mm) Width : 5 dots (1.76 mm)
G.	Print speed	30 characters/sec (left to right, unidirectional)
H.	Max. number of columns	80 columns
I.	Character spacing	12 characters/inch
J.	Linefeed spacing	6 lines/inch . . . . . Character mode 9 lines/inch . . . . . Graphic mode
K.	Linefeed speed	5 linefeeds/sec . . . . . Character mode 7.5 linefeeds/sec . . . . . Graphic mode
L.	Paper feed	Pin feed
M.	Paper width	4.5 to 8 inches acceptable
N.	Multiple copies	Original plus 2 copies
O.	Inked ribbon	Single color, inked roller built-in cassette type