

Anritsu

SERVICE MANUAL

MICROWAVE SYSTEM ANALYZER

ME453K/L/M

ME538K/L/M

ANRITSU ELECTRIC CO., LTD.

TOKYO, JAPAN

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NOTES

- (1) This equipment is operable on a voltage from AC 100 V to AC 127 V or from AC 200 V to AC 254 V by changing the connections of the power supply circuit.

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

In the case of other voltage operation, change the connection of the power supply circuit, and the plates of voltage designation on the rear panel should be changed to suitable one. Order the plates to Anritsu Electric Co., Ltd. if necessary.

- (2) In the manual, a power supply voltage is represented by AC ** V.

CONTENTS

	Page
SECTION 1	GENERAL INFORMATION
1.1	INTRODUCTION 1-1
1.2	MAINTENANCE PERIOD 1-1
1.3	ORDERING REPAIR PARTS 1-1
1.4	DISTINCTION BETWEEN PERFORMANCE CHECK AND CALIBRATION 1-1
1.5	SPECIFICATION 1-1
SECTION 2	PERFORMANCE CHECKS
2.1	INTRODUCTION 2-1
2.2	EQUIPMENT REQUIREMENTS 2-5
2.3	PRELIMINARY OPERATION 2-7
2.4	CALIBRATION PROCEDURE 2-8
2.4.1	Transmitter 2-8
2.4.2	Receiver 2-20
2.4.3	Measurements 2-32
2.5	TEST PERFORMANCE SHEET 2-44
SECTION 3	PREPARATION OF REPAIR
3.1	INTRODUCTION 3-1
3.2	DECOMPOSITION 3-1
3.2.1	Decomposition of Transmitter and Receiver 3-1
3.2.2	Removing the Outer Cover 3-2
3.2.3	Removing CRT 3-3
3.2.4	Disassembly and Mechanical Parts List .. 3-5

CONTENTS (Cont'd)

		Page
3.3	Instruments and Accessories Required for Calibration, Adjustment, Troubleshooting and Repair	3-15
3.3.1	Instruments	3-15
3.3.2	Accessories	3-16
SECTION 4 CALIBRATION AND ADJUSTMENT		
4.1	INTRODUCTION	4-1
4.1.1	General Maintenance	4-2
4.2	TRANSMITTER	4-2
4.2.1	IF OUTPUT Power	4-4
4.2.2	SWEEP WIDTH \pm MHz	4-4
4.2.3	SWEEP OUTPUT $V_p/75\Omega$	4-4
4.2.4	BB OUTPUT Level	4-5
4.2.5	FM DEVIATION	4-6
4.2.6	IF CENTER FREQ	4-6
4.2.7	BB FREQUENCY	4-6
4.2.8	SWEEP REDUCTION	4-7
4.2.9	SWEEP FREQUENCY	4-7
4.2.10	BB SWEEPER FREQUENCY	4-7
4.3	RECEIVER	4-8
4.3.1	IF LEVEL dBm	4-10
4.3.2	SLIDE MARKER	4-10
4.3.3	BB LEVEL dBm	4-10
4.3.4	DEVIATION kHz rms	4-10
4.3.5	Adjustment of Scale Sensitivity	4-12
4.3.6	Centering of SPECTRUM	4-13

CONTENTS (Cont'd)

	Page
4.3.7	SPECTRUM SWEEP WIDTH 4-14
4.3.8	P-P 4-14
4.3.9	X-Y RECORDER OUTPUT 4-15
4.3.10	INTENSITY 4-15
 SECTION 5 TROUBLESHOOTING AND REPAIR	
5.1	INTRODUCTION 5-1
5.2	TRANSMITTER 5-2
5.2.1	General 5-2
5.2.2	Troubleshooting the Transmitter 5-6
5.2.3	Z1 IF OSCILLATOR AND AMPLIFIER 5-13
5.2.4	Z2 COUNTER 5-19
5.2.5	Z3 SWEEP OSCILLATOR AND BB AMPLIFIER ... 5-27
5.2.6	Z4 BB OSCILLATOR 5-33
5.2.7	Z5 CRYSTAL OSCILLATOR AND BB SWEEPER ... 5-39
5.2.8	Z8 MOTHER BOARD 5-43
5.2.9	Z9 LED BOARD 5-47
5.2.10	Z10 FRONT BOARD 5-51
5.2.11	Z11 POWER SUPPLY 5-55
5.2.12	Z2 SWITCH BOARD 5-59
5.3	RECEIVER 5-60
5.3.1	General 5-60
5.3.2	Troubleshooting the Receiver 5-65
5.3.3	Z1 RANGING AND AVG 5-75
5.3.4	Z2 PHASE DETECTOR 5-83

CONTENTS (Cont'd)

	Page
5.3.5 Z3 BB DETECTOR	5-89
5.3.6 Z4 DISCRIMINATOR	5-97
5.3.7 Z5 IF MIX AND RETURN LOSS	5-103
5.3.8 Z6 MARKER AND SPECTRUM	5-109
5.3.9 Z7 CPU	5-115
5.3.10 Z9 MOTHER BOARD	5-125
5.3.11 Z10 OPERATING/LED BOARD	5-129
5.3.12 Z11 LED DRIVER	5-133
5.3.13 Z12 X SELECT/X-Y RECORDER	5-139
5.3.14 Z13 CRT DRIVER	5-145
5.3.15 Z14 POWER SUPPLY	5-149
5.3.16 Z15 AVG	5-153
5.3.17 Z8 GP-IB/Z18 CONNECTOR BOARD (OPTION) ..	5-157
5.3.18 CHARACTER DISPLAY	5-165

SECTION 6 REPLACEABLE PARTS

6.1 INTRODUCTION	6-1
6.2 METHOD OF READING CAPACITORS/RESISTORS	6-3
6.2.1 Capacitor Identification	6-3
6.2.2 Resistor Identification	6-4
6.3 ORDERING INFORMATION	6-5
6.4 COMPONENT LIST	6-6

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains the service information required to maintain the MICROWAVE SYSTEM ANALYZER ME453K/L/M and ME538K/L/M. It includes performance checks, troubleshooting techniques, adjustment, calibration procedures and repairs.

1.2 MAINTENANCE PERIOD

This test equipment is designed to permit stable performance over a long life. However performance may vary due to stress and changes in the operating conditions. To use the Test Equipment in its initial condition, periodic maintenance and checks are required. If any problems occur, repair them in accordance to this service manual or contact the nearest ANRITSU service department.

1.3 ORDERING REPAIR PARTS

Parts required for repair should be ordered as explained in paragraph 6.4.

1.4 DISTINCTION BETWEEN PERFORMANCE CHECK AND CALIBRATION

How to check that the test equipment operates normally:

- ① Check that all functions are performed normally as explained in Section 2.
- ② Calibrate the levels and frequencies by referring to Section 4.

1.5 SPECIFICATION

Tables 1-1 and 1-2 list the specifications of this test equipment.

Table 1-1 SPECIFICATIONS

Measurements

Items		Models	ME538K/L/M	
			70 MHz Band	70 MHz Band
Amplitude (IF INPUT terminal)	Inherent Slope	± 0.05 dB/ ± 25 MHz	± 0.05 dB/ ± 25 MHz	± 0.05 dB/ ± 25 MHz, ± 0.1 dB/ ± 40 MHz, ± 0.2 dB/ ± 50 MHz
	Measuring Range	0 to 16 dB		
	Max Sensitivity	0.01 dB/DIV (at Y2 Display)		
	IF INPUT Level	+10 to -20 dBm		
Amplitude (R.F.T. LOSS INPUT terminal)	Inherent Slope	± 1 dB		
	Measuring Range	0 to 8 dB		
	Sensitivity	1 dB/DIV, 5 dB/DIV		
	INPUT Level	-60 to -20 dBm		
Group Delay	Inherent Slope	0.3 ns/ ± 15 MHz, 0.5 ns/ ± 25 MHz	0.3 ns/ ± 15 MHz, 0.5 ns/ ± 25 MHz	0.3 ns/ ± 20 MHz, 0.5 ns/ ± 30 MHz, 1 ns/ ± 50 MHz
	Measuring Range	0 to 400 ns		
	Max Sensitivity	0.1 ns/DIV (at Y2 Display)		
	Noise	0.05 ns/Condition; $f_M = 200$ kHz \sim 278 kHz, Deviation 200 kHz rms, Using Average function.		
Linearity	Inherent Slope	0.2%/ ± 25 MHz	0.2%/ ± 25 MHz	0.2%/ ± 50 MHz
	Measuring Range	0 to 80 %		
	Max Sensitivity	0.05 %/DIV		
	Noise	0.01 %/Condition, $f_M < 1$ MHz, Deviation 200 kHz rms, Using Average function.		
Differential Phase	Inherent Slope*1	0.3°/ ± 15 MHz, 0.5°/ ± 25 MHz	0.3°/ ± 15 MHz, 0.5°/ ± 25 MHz	0.3°/ ± 20 MHz, 0.5°/ ± 30 MHz, 0.8°/ ± 50 MHz
	Measuring Range	0 to 40°		
	Max Sensitivity	0.2°/DIV		
	Noise	0.02°/Condition, $f_M = 5.6$ MHz, Deviation 500 kHz rms, Using Average function.		
		*1: Specified frequency range = Carrier sweep width + 2 f_M		
Differential Gain	Inherent Slope*2	0.2%/ ± 15 MHz, 0.4 %/ ± 25 MHz	0.2%/ ± 15 MHz, 0.4 %/ ± 25 MHz	0.3%/ ± 20 MHz, 0.4 %/ ± 30 MHz, 0.6 %/ ± 50 MHz
	Measuring Range	0 to 80 %		
	Max Sensitivity	0.05 %/DIV		
	Noise	0.01 %/Condition, $f_M = 5.6$ MHz, Deviation 500 kHz rms, Using Average function		
		*2: Specified frequency range = Carrier sweep width + 2 f_M		
IF Return Loss	Frequency Range	70 ± 25 MHz	70 ± 25 MHz	140 ± 50 MHz
	Measuring Range	10 to 50 dB accuracy depends on using bridge.		
	Sensitivity	1 dB/DIV, 5 dB/DIV		
AM to PM Conversion	Residual PM	0.3°/dB/ ± 25 MHz	0.3°/dB/ ± 25 MHz	0.3°/dB/ ± 35 MHz
	Measuring Range	0.3°/dB to 16°/dB		
Spectrum	Center Frequency	70 ± 20 MHz Auto tuning	70 ± 20 MHz Auto tuning	140 ± 30 MHz Auto tuning
	Sweep Width	Approx. ± 700 kHz		
	Max Sensitivity	Detects 0.1 dB change of modulating signal at carrier zero point.		
	Deviation	K type - 340 kHz rms at 200 kHz, L type - 472 kHz rms at 277.778 kHz, M type - 425 kHz rms at 250 kHz.		

Table 1-1 SPECIFICATIONS (Cont'd)

Deviation	Measuring Range	20 kHz to 999 kHz rms at built-in BB frequencies \leq 8.2 MHz.			
	Accuracy	10 % at built-in BB frequency \leq 8.2 MHz.			
	Calibration	Deviation meter is calibrated by easy key operation. Accuracy reaches 1 % theoretically at specified modulation frequency. Deviation is as shown in the following table by Bessel zero method.			
		Model	Modulation freq.	Key in factor	
K type		200 kHz	340 kHz rms		
L type	277.778 kHz	472 kHz rms			
M type	250 kHz	425 kHz rms			
Modulator Sensitivity	Mod Signal Level	-50 to +10 dBm			
	Deviation	Use the DEVIATION meter function or use the carrier zero deviation with the SPECTRUM function.			
De-modulator Sensitivity	IF Signal	Calibrate the deviation with DEVIATION meter function or SPECTRUM function.			
	Demo BB Level	-50 to +10 dBm			
Inherent Noise (IF to IF) (For all models)	Group Delay	Linearity	Differential Phase	Differential Gain	Detection Band: 3 kHz
	66 kHz to 93 kHz: 0.3 ns rms 200 kHz to 278 kHz: 0.1 ns rms 400 kHz to 556 kHz: 0.05 ns rms	0.02% rms	0.05 ° rms	0.1% rms	
	Deviation: 200 kHz rms, $f_M < 1$ MHz		Deviation: 500 kHz rms, $f_M = 5.6$ MHz		

BB (Baseband) measurement

BB to BB Measurements (For all models)	Item	Inherent slope	Measuring range	Max. sensitivity	Noise
	Group Delay	0.1 ns	0 to 400 ns	0.1 ns/DIV (at Y2)	0.2 ns
	Linearity	0.1 %	0 to 80 %	0.05 %/DIV	0.05 %
	Differential Phase	0.1 °	0 to 40 °	0.2 °/DIV	0.05 °
	Differential Gain	0.1 %	0 to 80 %	0.05 %/DIV	0.05 %
Measuring Condition	BB level: -30 dBm				
BB Return Loss	Frequency	Built-in BB frequency or BB amplitude option			
	Range	10 to 40 dB, 1 dB/DIV (BB amplitude option)			
BB Amplitude (Option)	1 frequency range: 60 kHz to 15 MHz, Level: +10 dBm to -50 dBm, Inherent slope: Inherent slope: ± 0.5 dB/100 kHz to 13 MHz Measuring range: 0 to 8 dB, Max. sensitivity: 0.1 dB/DIV				
DC Input	Measuring range: 0 to ± 400 mV, Max. sensitivity: 1 mV/DIV				

Table 1-2 SPECIFICATIONS

Receiver

<p>IF Input</p>	<p>Frequency Range (AFC capture and hold range)</p> <p>Level Range</p> <p>Level Display</p> <p>Level Accuracy</p> <p>Impedance</p> <p>Input Frequency Sweep Width</p> <p> Maximum Sweep Width</p> <p> Minimum Sweep Width</p> <p>Demodulation</p>	<p>70 MHz band: 45 to 95 MHz 140 MHz band: 90 to 190 MHz When BB frequency is 55.6 kHz (or 27.8 kHz). *1 70 MHz band: 60 to 80 MHz 140 MHz band: 130 to 150 MHz</p> <p>+10 to -20 dBm</p> <p>3-digit LED display Resolution: 0.1 dB</p> <p>±0.3 dB at +4 dBm</p> <p>75 Ω Return Loss: >30 dB at +4 dBm</p> <p>±25 MHz/center frequency 70 MHz ±50 MHz/center frequency 140 MHz When BB frequency is 55.6 kHz (or 27.8 kHz). ±10 MHz/center frequency 70/140 MHz.</p> <p>The minimum sweep width required for reproducing the HOR signal on the CRT ±0.2 MHz</p> <p>66.6 kHz, 80 kHz to 8.2 MHz *1 BB frequency 55.6 kHz (or 27.8 kHz) is demodulated when sweep frequency is only 18 Hz.</p>
<p>IF Return Loss Input</p>	<p>The return loss input is used with the same frequency applied to IF INPUT to lock the AFC loop.</p> <p>Input Level Range</p> <p>Flatness</p> <p>Impedance</p>	<p>-20 to -60 dBm</p> <p>±1 dB/45 to 95 MHz ±1 dB/90 to 140 MHz</p> <p>75 Ω Return Loss: >28 dB</p>
<p>BB Input (BB + Sweep)</p>	<p>BB Frequency Range</p> <p>BB Level Range</p> <p>BB Level Display</p> <p>BB Level Accuracy</p> <p>Impedance</p> <p>Sweep Frequency Range</p> <p>Sweep Voltage Range</p> <p>X Phase Setting Range</p>	<p>66 kHz to 15 MHz</p> <p>+10 to -50 dBm</p> <p>3-digit LED display Resolution: 0.1 dB</p> <p>±0.3 dB at 0 dBm</p> <p>75 Ω Return Loss: >28 dB at 0 dBm/frequency 66 kHz to 15 MHz</p> <p>18 to 100 Hz</p> <p>±50 mV to ±5 V</p> <p>0 to 360°</p>

*1 Optional

Table 1-2 SPECIFICATIONS (Cont'd)

Phase Detector	Input Frequency	The BB frequency is selected automatically.		
		K type	L type	M type
	f1	66.667 kHz	92.593 kHz	83.333 kHz
	f2	200 kHz	277.778 kHz	250 kHz
	f3	400 kHz	555.556 kHz	500 kHz
	f4	2 MHz	2.4 MHz	
	f5	3.58 MHz		
	f6	4.43 MHz		
	f7	5.6 MHz		
	f8	8.2 MHz		
	f9	12.39 MHz (ME538K/L/M)		
	f10	55.556 kHz ¹ (option)		
	Capture Range	$\pm 5 \text{ Hz} \leq 555.556 \text{ kHz}$ $5 \times 10^{-6} \leq 12.39 \text{ MHz}$ $*1 \pm 1 \text{ Hz} \leq 55.5556 \text{ kHz}$		
Frequency Markers	Slide Marker	Variable side markers: 70 \pm 25 MHz, 140 \pm 50 MHz		
	Frequency Display	4-digit LED display Resolution: 10 kHz		
	Accuracy	$\pm 1 \times 10^{-4} \pm 1$ digit		
	2 MHz Comb + Slide	2 MHz Comb Markers + Variable side markers		
Center Frequency Counter	Counts the center frequency of the swept IF signal and displays it on the 5-digit LED display. The display to the LED display is made by selecting either the slide marker frequency or center frequency with a key.			
	Frequency Range	70 MHz band: 45 to 90 MHz 140 MHz band: 90 to 190 MHz		
	Frequency Display	4-digit LED display (ME453K/L/M) 5-digit LED display (ME538K/L/M) Resolution: 10 kHz		
	Accuracy	$\pm 1 \times 10^{-3} \pm 1$ digit		
IF Sweep Width Measurement	Measuring Range	70 MHz band: ± 0.2 to ± 25 MHz 140 MHz band: ± 0.2 to ± 50 MHz		
	Resolution	0.2 to 9.99 MHz: 10 kHz 10 to 50 MHz: 100 kHz		
	Accuracy	$\pm 5 \times 10^{-2} \pm 1$ digit		
BB Output (Rear Panel)	Level	-7 dBm, typical		
	Impedance	75 Ω , nominal		
Ext. Sweep Input (Rear Panel)	Frequency	18 Hz to 100 Hz		
	Level	1 Vp-p		
	Impedance	>5 k Ω , nominal		
X-Y Recorder Output (Option)	Output	X: 0 to 4 V Y: 0 to 4 V Pen lift: Open Pen down: Ground		
	Sweep Speed	20 sec., 40 sec., nominal		

¹ 27.8 kHz can be supplied if specified.

*1 Optional

Table 1-2 SPECIFICATIONS (Cont'd)

Transmitter

IF Output	Frequency Range	70 MHz band: 45 to 95 MHz 140 MHz band: 90 to 190 MHz																																												
	Center Frequency Display	4-digit LED display (MF453K/L/M) 5-digit LED display (ME538K/L/M) Resolution: 10 kHz																																												
	Accuracy	$\pm 1 \times 10^{-4} = \pm 1$ digit/CW																																												
	Stability	± 100 kHz at 70 MHz ± 200 kHz at 140 MHz 5 hrs after 1/2 hr warm-up																																												
	Level Range	+10 to -70 dBm (1 dB step attenuator) Continuously variable range: $> \pm 1$ dB																																												
	Level Accuracy	± 0.3 dB at +4 dBm																																												
	Harmonics	< -30 dB																																												
	Impedance	75 Ω Return Loss: > 30 dB at +4 dBm																																												
IF Sweep Width	Sweep Width Range	70 MHz band: 0 to ± 25 MHz 140 MHz band: 0 to ± 50 MHz																																												
	Sweep Width Display	3-digit LED display Resolution: 0.1 MHz																																												
	Auto Sweep Reduction	The sweep width is reduced by 2 x BB frequency $\pm 10\%$ when BB frequency > 1 MHz. This function can be reset with a switch.																																												
FM Deviation	Mod frequency	Same as BB frequency (item 6)																																												
	Deviation Range	5 to 1000 kHz rms																																												
	Deviation Display	4-digit LED display Resolution: 1 kHz rms																																												
AUX IF Output	Frequency Range	Same as IF OUTPUT specifications (item 1).																																												
	Output Level	-10 dBm																																												
	Level Accuracy	$< \pm 1$ dB																																												
	Impedance	75 Ω , nominal																																												
Crystal Output	Frequency	70 MHz band: 70 MHz 140 MHz band: 140 MHz																																												
	Output Level	+5 dBm																																												
	Level Accuracy	$< \pm 1$ dB																																												
	Impedance	75 Ω , nominal																																												
BB + Sweep Output	BB Frequency	<table border="1"> <thead> <tr> <th></th> <th>K type</th> <th>L type</th> <th>M type</th> </tr> </thead> <tbody> <tr> <td>f1</td> <td>66.667 kHz</td> <td>92.538 kHz</td> <td>83.333 kHz</td> </tr> <tr> <td>f2</td> <td>200 kHz</td> <td>277.778 kHz</td> <td>250 kHz</td> </tr> <tr> <td>f3</td> <td>400 kHz</td> <td>555.556 kHz</td> <td>500 kHz</td> </tr> <tr> <td>f4</td> <td>2 MHz</td> <td colspan="2">2.4 MHz</td> </tr> <tr> <td>f5</td> <td colspan="3">3.58 MHz</td> </tr> <tr> <td>f6</td> <td colspan="3">4.43 MHz</td> </tr> <tr> <td>f7</td> <td colspan="3">5.6 MHz</td> </tr> <tr> <td>f8</td> <td colspan="3">8.2 MHz</td> </tr> <tr> <td>f9</td> <td colspan="3">12.39 MHz (ME538K/L/M)</td> </tr> <tr> <td>f10</td> <td colspan="3">55.556 kHz¹ (option)</td> </tr> </tbody> </table>		K type	L type	M type	f1	66.667 kHz	92.538 kHz	83.333 kHz	f2	200 kHz	277.778 kHz	250 kHz	f3	400 kHz	555.556 kHz	500 kHz	f4	2 MHz	2.4 MHz		f5	3.58 MHz			f6	4.43 MHz			f7	5.6 MHz			f8	8.2 MHz			f9	12.39 MHz (ME538K/L/M)			f10	55.556 kHz ¹ (option)		
		K type	L type	M type																																										
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f10	55.556 kHz ¹ (option)																																													
	<p>¹ Can be changed to 27.778 kHz if so specified. Sweep frequency is automatically set to 18 Hz when f10 is selected.</p> <p>BB Frequency ± 5 Hz ≤ 555.556 kHz Accuracy $\pm 5 \times 10^{-6} \leq 12.39$ MHz ± 1 Hz ≤ 55.5556 kHz *1</p>																																													

*1 Optional

Table 1-2 SPECIFICATIONS (Cont'd)

(Cont'd) BB + Sweep Output	BB Level	+10 to -50 dBm A 10 dB step attenuator and 0 to -10 dB continuously variable dial are provided for setting the level.
	BB Level Display	3-digit LED display Resolution: 0.1 dB
	BB Level Accuracy	±0.3 dB at 0 dBm
	BB Harmonics	<-38 dB
	BB Impedance	75 Ω Return Loss: >28 dB at -10 dBm
	Sweep Frequency	Line (50/60 Hz), 70 Hz Option (select one frequency from 18 Hz to 100 Hz) Ext. (18 Hz to 100 Hz)
	Sweep Level	0 to 6.5 Vp-p/75 Ω
	Sweep Level Display	3-digit LED display Resolution: 0.01 V
	Sweep Level Accuracy	±10 % at 6 Vp-p
	Sweep Harmonics	<-35 dB
Sweep Impedance	75 Ω, nominal	
Sweep Output	Sweep Level	0 to 25 Vp-p/10 kΩ
	Sweep Level Display	3-digit LED display Resolution: 0.01 x 4 V
	Sweep Level A Accuracy	±10 % at 24 Vp-p
Ext. Sweep Input (Rear panel)	Frequency	18 to 100 Hz
	Level	2 Vp-p
	Impedance	75 Ω, nominal
BB Sweeper (Option)	Frequency Range	60 kHz to 15 MHz
	BB Output Level	+10 dBm to -50 dBm (10 dB step attenuator) Continuously variable range: 0 to -10 dB
	BB Level Display	3-digit LED display Resolution: 0.1 dB
	Inherent slope	±0.5 dB/100 kHz to 13 MHz The value of the sum of the receiver and transmitter.
Impedance	75 Ω Return Loss: >28 dB at -10 dBm	

Table 1-2 SPECIFICATIONS (Cont'd)

Low BB frequency (55.6 kHz or 27.8 kHz)
specification (Option)

Group Delay	Inherent Slope	70 ±10 MHz: 5 ns 140 ±10 MHz: 5 ns
	Measuring Range	0 to 400 ns
	Max. Sensitivity	2 ns/div.
	Noise	1 ns, *1
Linearity	Inherent Slope	70 ±10 MHz: 0.5 % 140 ±10 MHz: 0.5 %
	Measuring Range	0 to 80 %
	Max. Sensitivity	0.1 % div.
	Noise	0.1 %*

* With deviation 100 kHz rms using average function.

General Specifications

Input and Output Connector	BNC or SP connector Other type of connector can be installed if requested by the user: e.g., WECO560A or equivalent
Power Supply	260 VA Transmitter: 85 VA Receiver: 175 VA Voltages are available from 100 V AC to 254 V AC, at the request of the user. Tolerance ±10 %
Ambient temperature (Rated range of use)	0° to 50°C
Dimensions and Weight	Receiver: 177H x 426W x 450D(mm), ≤18.5 kg Transmitter: 133H x 426W x 450D(mm), ≤13.5 kg

SECTION 2

PERFORMANCE CHECKS

2.1 INTRODUCTION

The TEST INSTRUMENT is calibrated according to Table 2-1 to 2-3.

The TEST PERFORMANCE SHEET is prepared in paragraph 2.5.

Environmental range at which specifications apply:
 Temperature 0°C to +50°C Relative humidity 95% (50°C)

Table 2-1 Calibration Description of Transmitter

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
(1) IF OUTPUT LEVEL	Accuracy: ± 0.3 dB (+4 dBm)/ 70 MHz, 140 MHz	The IF output level is measured by using a Standard Level Meter
(2) IF CENTER FREQUENCY	Accuracy: ± 20 kHz/70 MHz, 140 MHz	The IF center frequency is measured by using a Frequency Counter
(3) IF SWEEP WIDTH	Accuracy: \pm (displayed value x 3%) ± 0.5 MHz	The IF sweep width is measured by using a MSA Receiver
(4) FM DEVIATION	Accuracy: 10% at built-in BB frequency ≤ 8.2 MHz	The FM deviation is measured by using a MSA Receiver
(5) BB OUTPUT LEVEL	Accuracy: ± 0.3 dB (0 dBm), F1 ^{*1} to 12.39 MHz	The BB output level is measured by using Standard Level Meter
(6) BB FREQUENCY	Accuracy: F1, F2, F3 ^{*1} - ± 5 Hz, F4 to 12.39 MHz - $\pm 5 \times 10^{-6}$	The BB frequency is measured by using Frequency Counter
(7) SWEEP OUTPUT (BB + SWEEP OUTPUT TERMINAL)	Level range: 0 to ≥ 6.5 Vp-p (75 Ω) Accuracy: $\pm 10\%$ (6 Vp-p)	The sweep output level is measured by using Oscilloscope and 75 Ω Terminator

Table 2-1 Calibration Description of Transmitter (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
(8) SWEEP OUTPUT (SWEEP OUTPUT TERMINAL)	Level range: 0 to ≥ 25 Vp-p (10 k Ω) Accuracy: $\pm 10\%$ (24 Vp-p)	The sweep output level is measured by using Oscilloscope and 10 k Ω Terminator
(9) AUX IF OUTPUT	Accuracy: -10 dBm ± 1 dB/ 70 MHz, 140 MHz	The output level is measured by using Level Meter
(10) CRYSTAL OUTPUT	Accuracy: +5 dBm ± 1 dB/ 70 MHz, 140 MHz	

*1	Microwave System Analyzer		
	K type	L type	M type
F1	66.667 kHz	92.593 kHz	83.333 kHz
F2	200 kHz	277.778 kHz	250 kHz
F3	400 kHz	555.556 kHz	500 kHz
F4	2 MHz	2.4 MHz	

Table 2-2 Calibration Description of Receiver

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
(1) IF INPUT LEVEL	Accuracy: ± 0.3 dB (+4 dBm), 70 MHz, 140 MHz	The input levels are measured by using MSA Transmitter and Standard Level Meter
(2) BB INPUT LEVEL	Accuracy: ± 0.3 dB (0 dBm)	
(3) FM DEVIATION	Accuracy: $\pm 10\%$ at built-in BB frequency ≤ 8.2 MHz	The FM deviation is measured by using MSA Transmitter
(4) FREQUENCY MARKER	Center Marker accuracy: ± 100 kHz/70 MHz ± 200 kHz/140 MHz	The frequency marker accuracy is measured by using Synthesized Oscillator and MSA Transmitter
(5) X-Y RECORDER OUTPUT (Optional)	X : DC 0 to $\geq +4$ V Y : DC 0 to $\geq +4$ V	The X-Y recorder output is measured by using an Oscilloscope
(6) PHASE DETECTION CAPTURE RANGE	± 5 Hz ≤ 555.556 kHz $5 \times 10^{-6} \leq 12.39$ MHz	The phase detection capture range is measured by using a Synthesized Oscillator
(7) DC INPUT	Range: 0 to ± 400 mV Accuracy: $\pm 5\%$	The dc input is measured by using a Standard DC Voltage Generator

Table 2-3 Calibration Description of Measurements

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
<p>(1) IF TO IF BAND</p> <p>(i) AMPLITUDE</p> <p>(ii) GROUP DELAY</p> <p>(iii) LINEARITY</p> <p>(iv) DIFFERENTIAL PHASE</p> <p>(v) DIFFERENTIAL GAIN</p>	<p>70 MHz Band ± 0.05 dB/± 25 MHz</p> <p>140 MHz Band ± 0.05 dB/± 25 MHz ± 0.1 dB/± 40 MHz ± 0.2 dB/± 50 MHz</p> <p>70 MHz Band 0.3 ns/± 15 MHz 0.5 ns/± 25 MHz</p> <p>140 MHz Band 0.3 ns/± 20 MHz 0.5 ns/± 30 MHz 1.0 ns/± 50 MHz</p> <p>70 MHz Band 0.2%/± 25 MHz</p> <p>140 MHz Band 0.2%/± 50 MHz</p> <p>70 MHz Band 0.3°/± 15 MHz 0.5°/± 25 MHz</p> <p>140 MHz Band 0.3°/± 20 MHz 0.5°/± 30 MHz 0.8°/± 50 MHz</p> <p>70 MHz Band 0.2%/± 15 MHz 0.4%/± 25 MHz</p> <p>140 MHz Band 0.3%/± 20 MHz 0.4%/± 30 MHz 0.6%/± 50 MHz</p>	<p>These characteristic items are measured back to back of the MSA.</p> <p>Sweep width = Carrier sweep width + 2fM</p>
<p>(2) BB TO BB</p> <p>(i) GROUP DELAY</p> <p>(ii) LINEARITY</p> <p>(iii) DIFFERENTIAL PHASE</p> <p>(iv) DIFFERENTIAL GAIN</p>	<p>Accuracy: $\pm 5\%$ at 10 ns</p> <p>Accuracy: $\pm 10\%$ at 10%</p> <p>Accuracy: $\pm 5\%$ at 1°</p> <p>Accuracy: $\pm 10\%$ at 10%</p>	<p>These characteristics are measured back to back of the MSA.</p>
<p>(3) IF RETURN LOSS</p>	<p>Inherent slope: ± 1 dB/70 ± 25 MHz, -30 dBm</p> <p>± 1 dB/140 ± 50 MHz, -30 dBm</p>	
<p>(4) AM TO PM CONVERSION</p>	<p>Residual PM: 0.3°/dB 70 ± 25 MHz, 140 ± 35 MHz</p>	
<p>(5) BB AMPLITUDE (Optional)</p>	<p>Inherent slope: ± 0.5 dB/100 kHz to 13 MHz, 0 dBm</p>	

2.2 EQUIPMENT REQUIREMENTS

Note:

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to use. All applicable equipment must bear evidence of current calibration.

Table 2-4 Equipment Requirements

Item	Generic Term	Minimum Use Specifications	Calibration Equipment
T2.1	STANDARD LEVEL METER	(1) Frequency range : 10 kHz to 200 MHz or more (2) Level measurement : -10 dBm to +6 dBm range (3) Level measurement : Within ± 0.1 dB accuracy (4) Input impedance : 75 Ω	ML59B
T2.2	LEVEL METER	(1) Frequency range : 10 kHz to 20 MHz (2) Level measurement : -60 dBm to +20 dBm range (3) Level measurement : ± 0.3 dB accuracy (4) Input impedance : 75 Ω	ML424A
T2.3	FREQUENCY COUNTER	(1) Measuring frequency: 10 kHz to 1 GHz range (2) Input level range : -15 dBm (3) Measuring frequency: 1 kHz resolution	MF76A
T2.4	SPECTRUM ANALYZER	(1) Frequency range : 10 kHz to 1.7 GHz	MS62B
T2.5	DIGITAL VOLT-METER	(1) Voltage measurement: 1 mV to 100 V range	-

Table 2-4 Equipment Requirements (Cont'd)

Item	Generic Term	Minimum Use Specification	Calibration Equipment
T2.6	OSCILLOSCOPE	(1) Frequency range : dc to 30 MHz (2) Input level range : 5 mV/div to 10 V/div	-
T2.7	OSCILLATOR	(1) Frequency range : 10 Hz to 20 MHz (2) Output level : -30 dBm to +10 dBm (3) Output impedance : 75 Ω	MG424A
T2.8	TRACKING GENERATOR	Measures frequency response in combination with the spectrum analyzer MS62B	MH628A
T2.9	ELECTRONIC VOLT-METER	(1) Frequency range : 10 kHz to 1 GHz (2) Measuring voltage : 300 V to 3 V rms range (3) Input impedance : Below 1 pF	ML69A
T2.10	SYNTHESIZER	(1) Frequency range : 10 kHz to 200 MHz (2) Output Level : 0 dBm (3) Output Impedance : 75 Ω	MG545A
T2.11	STANDARD DC VOLTAGE GENERATOR	(1) Output Range : 0 to ± 1.00 V	-

2.3 PRELIMINARY OPERATION

- (1) Turn on the power of the TEST INSTRUMENT.
- (2) This calibration should be performed after a warm up period of 30 minutes or more.

2.4 CALIBRATION PROCEDURE

Note:

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met.

2.4.1 Transmitter

(1) IF Output Level

(a) Specifications

Level accuracy: ± 0.3 dB at +4 dBm

(b) Setup

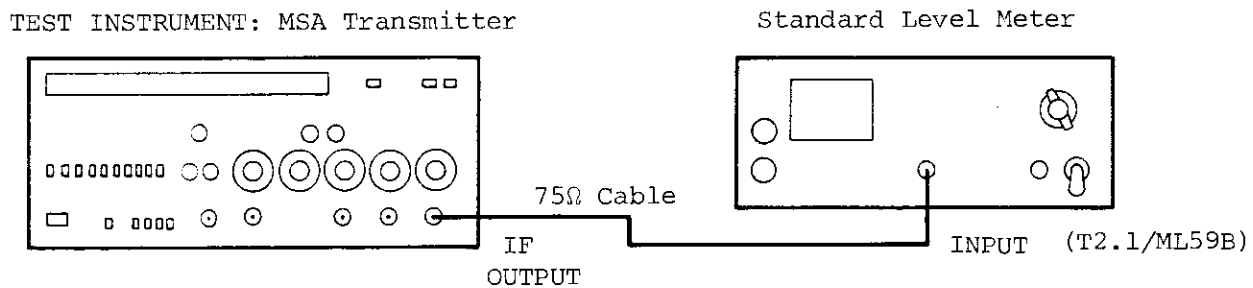


Fig. 2-1 IF Output Level Test

(c) Procedures

- (i) Connect the MSA IF OUTPUT to the Standard Level Meter.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND 70 MHz or 140 MHz
BB, IF IF
- ② IF OUTPUT LEVEL dBm +4 dBm
- ③ IF CENTER FREQ MHz 70 MHz or 140 MHz
- ④ SWEEP FREQUENCY LINE
- ⑤ SWEEP WIDTH \pm MHz 0 MHz
- ⑥ SWEEP REDUCTION OFF
- ⑦ BB FREQUENCY Hz 200 kHz, 278 kHz or 250 kHz
- ⑧ DEVIATION kHz rms 200 kHz rms

(iii) Read the Standard Level Meter indication

(iv) Verify that the level is within +4 dBm \pm 0.3 dB

(2) IF Center Frequency

(a) Specifications

IF Center Frequency accuracy

70 MHz: \pm 10 kHz \pm 1 digit

140 MHz: \pm 20 kHz \pm 1 digit

(b) Setup

TEST INSTRUMENT: MSA Transmitter

Frequency Counter

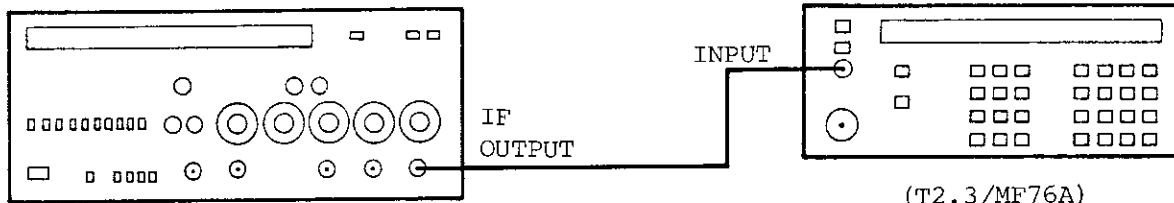


Fig. 2-2 IF Center Frequency

(c) Procedures

- (i) Connect the MSA IF OUTPUT to the Frequency counter.
- (ii) Set the controls as shown below.

TRANSMITTER:

①	TRANSMITTER MODE	
	IF BAND	Required IF band.
	BB, IF	IF.
②	IF CENTER FREQ	70.00 MHz or 140.00 MHz
③	SWEEP FREQUENCY	LINE.
④	SWEEP WIDTH ±MHz	0 MHz.
⑤	SWEEP REDUCTION	OFF.
⑥	BB FREQUENCY Hz	F2.
⑦	DEVIATION kHz rms	0 kHz rms.
⑧	IF OUTPUT LEVEL dBm	Level specified by application.

(iii) Set Resolution Band of the frequency counter to 100 Hz.

(iv) Verify that the display error is within the following values:

- 70 MHz: Within ±10 kHz ±1 digit (±20 kHz)
- 140 MHz: Within ±20 kHz ±1 digit (±30 kHz)

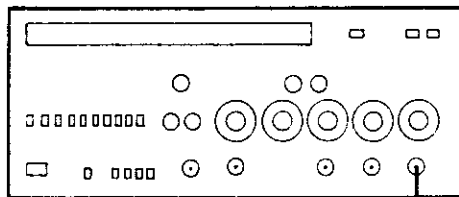
(3) IF Sweep Width

(a) Specifications

Sweep width accuracy: ±(displayed value x 3%)
±0.5 MHz

(b) Setup

TEST INSTRUMENT: MSA Transmitter



MSA Receiver

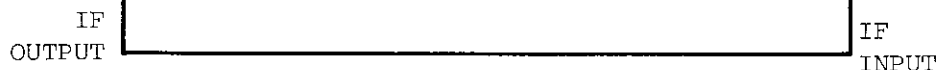
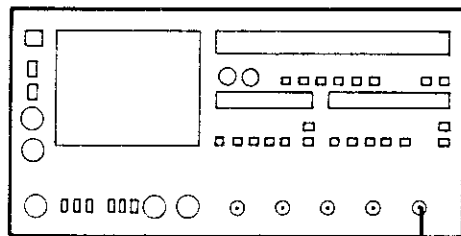


Fig. 2-3 IF Sweep Width

(c) Procedures

- (i) Connect the IF OUTPUT to the IF Input.
- (ii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|-----------------------|---|
| ① | TRANSMITTER MODE | |
| | IF BAND | Required IF band. |
| | BB, IF | IF. |
| ② | IF CENTER FREQ | 70 MHz or 140 MHz |
| ③ | SWEEP FREQUENCY | LINE. |
| ④ | SWEEP WIDTH \pm MHz | 70 MHz band \pm 10 MHz, \pm 25 MHz
140 MHz band \pm 10 MHz, \pm 50 MHz |
| ⑤ | SWEEP REDUCTION | Push ON if the automatic sweep reduction function is required. |
| ⑥ | BB FREQUENCY Hz | F2. |
| ⑦ | DEVIATION kHz rms | 200 kHz rms. |
| ⑧ | IF OUTPUT LEVEL dBm | Level specified by application. |

RECEIVER:

- | | | |
|---|-------------------|--|
| ⑨ | RECEIVER MODE | |
| | IF BAND | 70 MHz or 140 MHz. |
| | BB, IF | IF. |
| ⑩ | RANGE | AUTO. |
| ⑪ | FREQ SELECT | MARKER. Set the frequency to observing band width. |
| ⑫ | X SELECT | IF. |
| ⑬ | X PHASE, BLANKING | Adjust the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON. |

- (iii) Adjust the marker frequency knob of the MSA receiver to obtain the CRT image shown in Fig. 4-4.

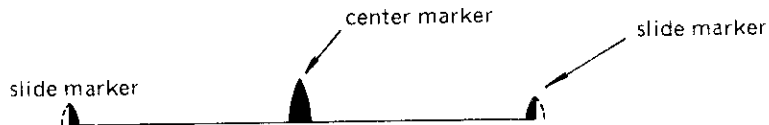


Fig. 2-4 Marker Image on CRT

(4) Read slide marker display on the Receiver at this time.

(5) Verify that the display is the value shown below.

$\pm 0.8 \text{ MHz}/70 \text{ M} \pm 10 \text{ MHz}$

$\pm 1.25 \text{ MHz}/70 \text{ M} \pm 20 \text{ MHz}$

$\pm 0.8 \text{ MHz}/140 \text{ M} \pm 10 \text{ MHz}$

$\pm 2.0 \text{ MHz}/140 \text{ M} \pm 50 \text{ MHz}$

(4) FM Deviation

(a) Specifications

Accuracy: 10% at built-in BB frequency $\leq 8.2 \text{ MHz}$

(b) Setup

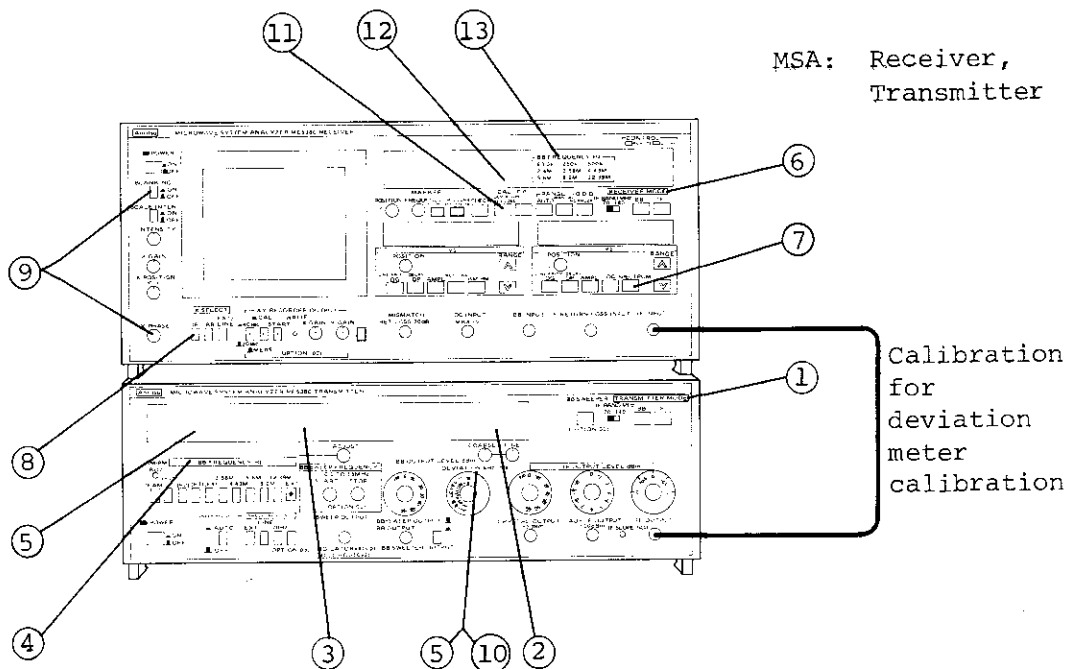


Fig. 2-5 FM Deviation

(C) Procedures

- (i) Connect the IF OUTPUT to the IF Input.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND 70 MHz or 140 MHz
BB, IF IF.
- ② IF CENTER FREQ 70 MHz or 140 MHz.
- ③ SWEEP WIDTH \pm MHz Zero.
- ④ BB FREQUENCY K type-200 kHz, L type-278 kHz, M type-250 kHz.
- ⑤ DEVIATION kHz rms Set the deviation to K type-340 kHz rms, L type-472 kHz rms and M type-425 kHz rms.

RECEIVER:

- ⑥ RECEIVER MODE
IF BAND Same as Transmitter.
BB, IF IF.
- ⑦ Y2 keys SPECTRUM.
- ⑧ X SELECT IF.
- ⑨ X PHASE, BLANKING Adjust the knob to make the tracing spectrum image coincide with the re-tracing spectrum image when the BLANKING switch is OFF.
- ⑩ DEVIATION dial of TRANSMITTER Readjust the DEVIATION kHz rms dial of the TRANSMITTER to get the first carrier zero spectrum on the CRT screen.

- (iii) Read the transmitter deviation display at first carrier zero.
- (iv) Verify that the transmitter deviation display is the value shown below.

Model	Specifications
K type	340 kHz rms \pm 10%
L type	472 kHz rms \pm 10%
M type	425 kHz rms \pm 10%

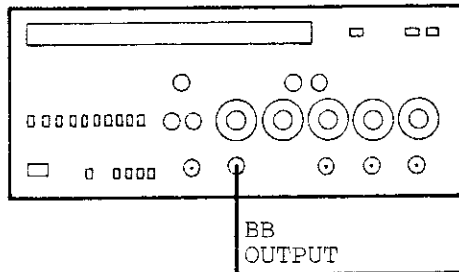
(5) BB Output Level

(a) Specifications

Level Accuracy: ± 0.3 dB (0 dBm)

(b) Setup

TEST INSTRUMENT: MSA Transmitter



Standard Level Meter

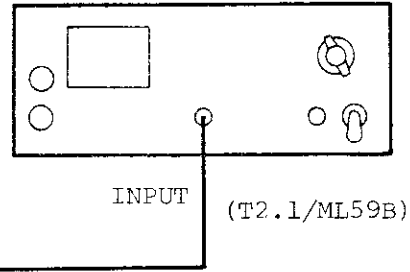


Fig. 2-6 BB Output Level

(c) Procedures

- (i) Connect the MSA BB OUTPUT to the INPUT of the Standard Level Meter.
- (ii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|---------------------|---|
| ① | TRANSMITTER MODE | BB. |
| ② | (OUTPUT SELECT) | BB OUTPUT <input checked="" type="checkbox"/> |
| ③ | BB OUTPUT LEVEL dBm | 0 dBm. |
| ④ | SWEEP OUTPUT | Zero. |
| ⑤ | BB FREQUENCY | F1 to 12.38 MHz |

- (iii) Read the Standard Level Meter indication.
- (iv) Verify that the indication is within 0 dBm ± 0.3 dB.

(6) BB Frequency

(a) Specifications

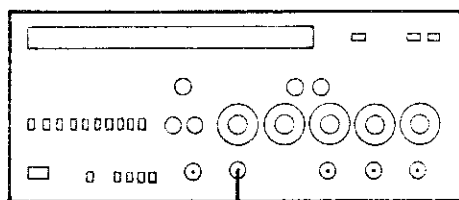
BB FREQUENCY: Low freq.: K type-66.666, 200 and 400 kHz, L type-92.593, 277.778, 555,556 kHz, M type-83.333, 250, 500 kHz.

High freq.: 2 (type K), 2.4 (L, M type), 3.58, 4.43, 5.6, 8.2 MHz
12.39 MHz (ME538K/L/M).

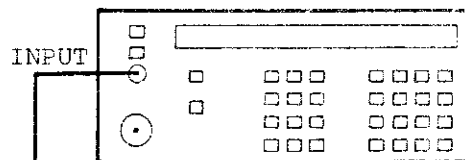
Accuracy: Low freq. - ± 5 Hz,
High freq. - $\pm 5 \times 10^{-6}$.

(b) Setup

TEST INSTRUMENT: MSA Transmitter



Frequency Counter



(T2.3/MF76A)

Fig. 2-7 BB Frequency

(c) Procedures

- (i) Connect the MSA BB OUTPUT to the Input of the Frequency Counter.
- (ii) Set the resolution SW to 1 Hz of the Frequency Counter.

(iii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|---------------------|------------------|
| ① | TRANSMITTER MODE | BB. |
| ② | (OUTPUT SELECT) | BB OUTPUT ■ |
| ③ | BB OUTPUT LEVEL dBm | 0 dBm. |
| ④ | SWEEP OUTPUT | Zero. |
| ⑤ | BB FREQUENCY | F1 to 12.38 MHz. |

(iv) Read the frequency counter display.

(v) Verify that the display satisfies the specifications of section 2.4.1 (6), (a).

(7) Sweep Output (BB + Sweep Output terminal)

(a) Specification

Level Range: 0 to ≥ 6.5 Vp-p (75 Ω)

Level Accuracy: $\pm 10\%$ (6 Vp-p)

(b) Setup

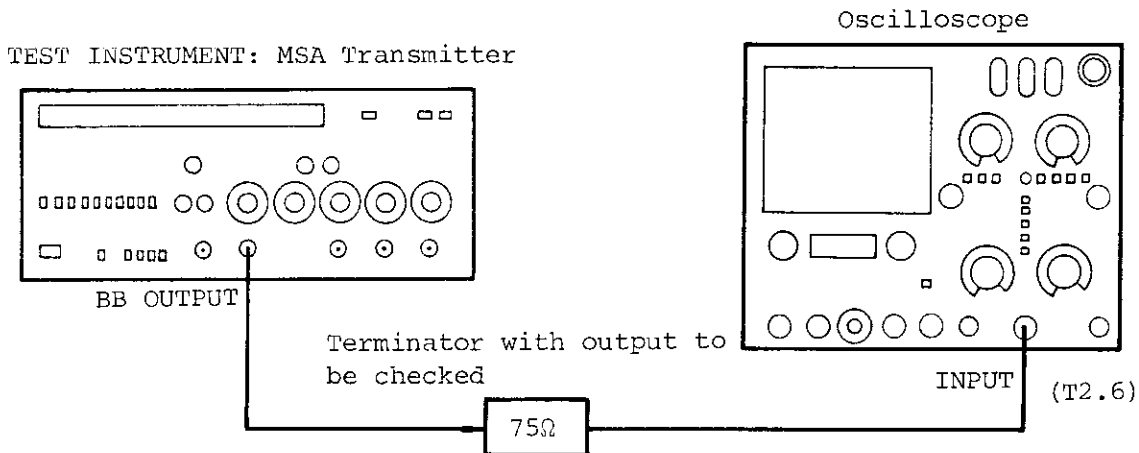


Fig. 2-8 Sweep Output (BB + Sweep Output terminal)

(c) Procedures

- (i) Connect the MSA BB OUTPUT to the INPUT of the Oscilloscope via 75 Ω Terminator.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE BB.
- ② (OUTPUT SELECT) BB + SWEEP OUTPUT ■
- ③ BB OUTPUT LEVEL dBm -50 dBm.
- ④ SWEEP FREQUENCY LINE or 70 Hz.
- ⑤ BB SWEEP OUTPUT 3.00 Vp-p/75 Ω (Set the ADJUST knob).

- (iii) Read the voltage of the waveform displayed on the oscilloscope.
- (iv) Verify that this voltage is within 6 Vp-p $\pm 10\%$.
- (v) Vary the level from minimum to maximum with the SWEEP OUTPUT ADJUST knob. Read its value on the oscilloscope used.
- (vi) Verify that the voltage is 0 to ≥ 6.5 Vp-p.

(8) Sweep Output (Sweep Output terminal)

(a) Specification

Level range: 0 to 25 Vp-p or greater/10 k Ω
Level Accuracy: $\pm 10\%$ (24 Vp-p)

(b) Setup

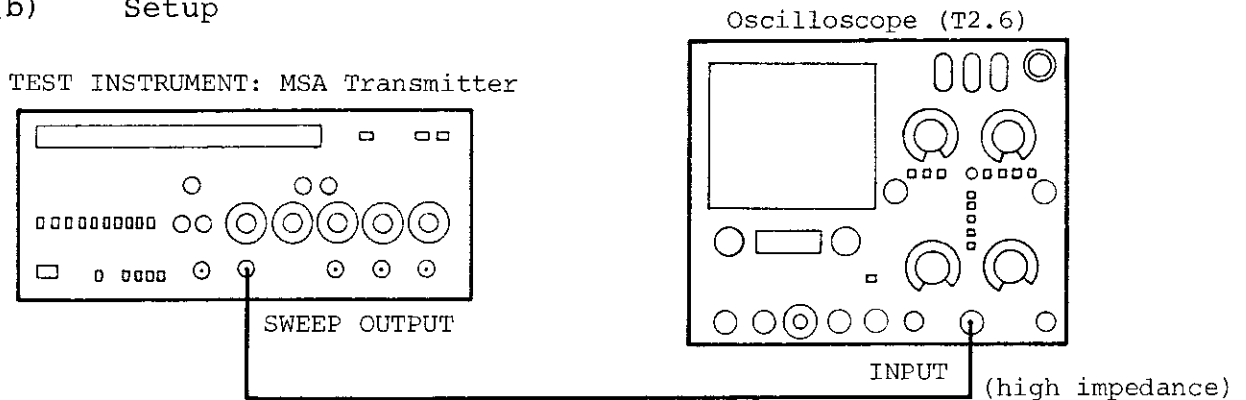


Fig. 2-9 Sweep Output (Sweep Output terminal)

(c) Procedures

- (i) Connect the MSA SWEEP OUTPUT to the Input of the Oscilloscope.
- (ii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|---------------------|--------------------------|
| ① | TRANSMITTER MODE | BB. |
| ② | (OUTPUT SELECT) | BB + SWEEP OUTPUT ■ |
| ③ | BB OUTPUT LEVEL dBm | 0 dBm. |
| ④ | SWEEP FREQUENCY | LINE or 70 Hz. |
| ⑤ | BB SWEEP OUTPUT | 3.12 Vp-p (75 Ω) |

- (iii) Read the voltage of the waveform displayed on the oscilloscope.
- (iv) Verify that this voltage is within 24 Vp-p $\pm 10\%$.
- (v) Vary the level from minimum to maximum with the SWEEP OUTPUT ADJUST knob. Read its value on the oscilloscope used.
- (vi) Verify that the voltage is 0 to ≥ 25 Vp-p.

(9) AUX IF Output

(a) Specification

Level Accuracy: -10 dBm ± 1 dB

(b) Setup

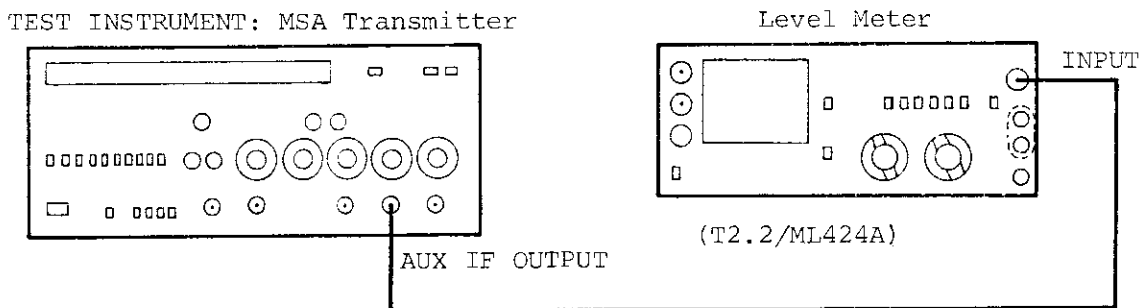


Fig. 2-10 AUX IF Output

(c) Procedures

- (i) Connect the MSA AUX IF OUTPUT to the Input of the Level Meter.
- (ii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|---------------------|--|
| ① | TRANSMITTER MODE | |
| | IF BAND | 70 MHz or 140 MHz |
| | BB, IF | IF. |
| ② | IF CENTER FREQ | 70 MHz or 140 MHz. |
| ③ | SWEEP FREQUENCY | LINE. |
| ④ | SWEEP WIDTH ±MHz | 0 MHz. |
| ⑤ | DEVIATION kHz rms | Set to 200 kHz rms. |
| ⑥ | IF OUTPUT LEVEL dBm | Required level (-20 dBm to +10 dBm). (Set Variable Attenuator to 0). |

- (iii) Read the Level Meter indication.
- (iv) Verify that level is within -10 dBm ±1 dB

(10) CRYSTAL Output

(a) Specification

Level Accuracy: +5 dBm ±1 dB

(b) Setup

TEST INSTRUMENT: MSA Transmitter

Level Meter

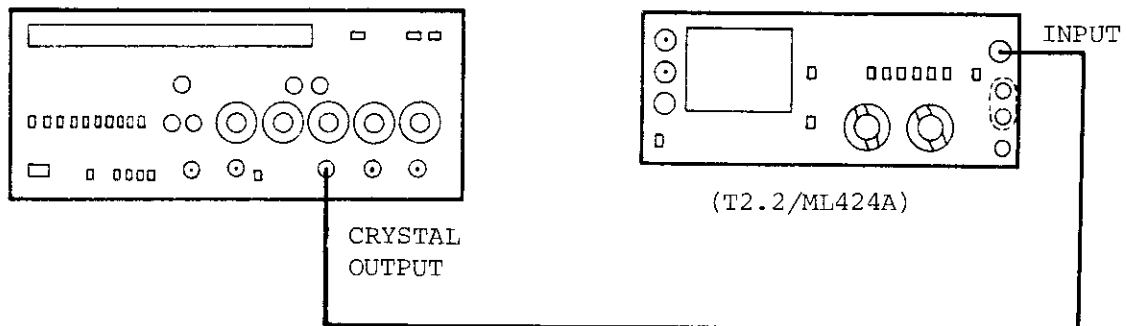


Fig. 2-11 Crystal Output

(c) Procedures

- (i) Connect the MSA CRYSTAL OUTPUT to the Input of the Level Meter.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND Required IF band.
BB, IF IF.
- ② IF CENTER FREQ 70 MHz or 140 MHz.

- (iii) Read the Level Meter indication.
- (iv) Verify that level is within +5 dBm \pm 1 dB.

2.4.2 Receiver

(1) IF Input Level

(a) Specifications

Level accuracy: \pm 0.3 dB/+4 dBm, 70 MHz or 140 MHz.

(b) Setup

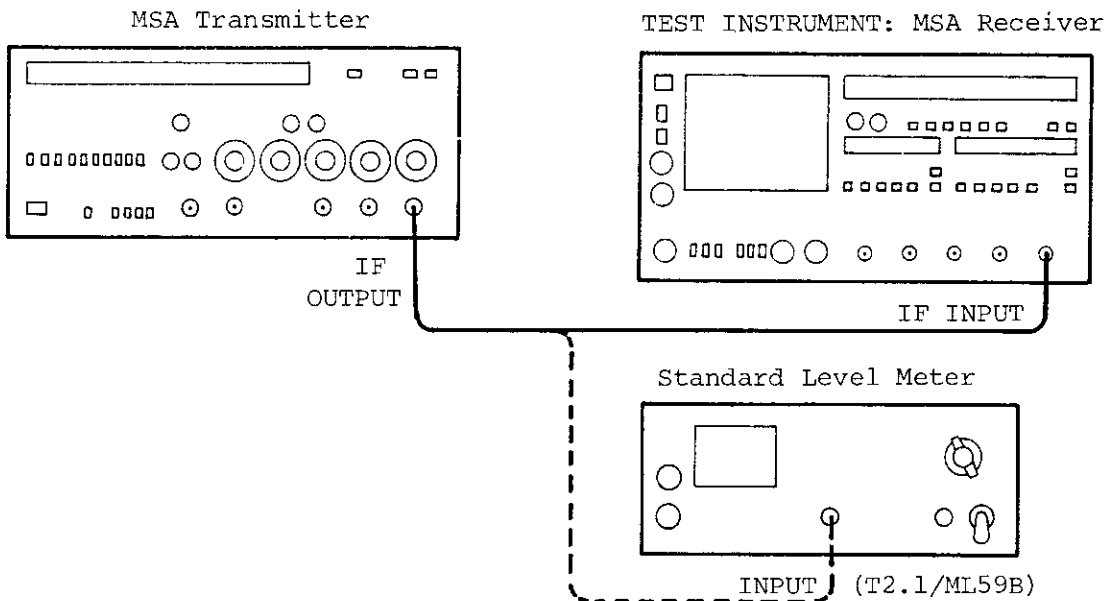


Fig. 2-12 IF Input Level Test

(c) Procedures

(i) Set the controls of the MSA Transmitter as shown below.

①	TRANSMITTER MODE	
	IF BAND	70 MHz or 140 MHz
	BB, IF	IF.
②	IF CENTER FREQ	70 MHz or 140 MHz
③	SWEEP FREQUENCY	LINE.
④	SWEEP WIDTH \pm MHz	Zero.
⑤	SWEEP REDUCTION	ON.
⑥	BB FREQUENCY Hz	F2.
⑦	DEVIATION kHz rms	Zero.
⑧	IF OUTPUT LEVEL dBm	+4 dBm.

(ii) Connect the IF OUTPUT of the Transmitter to the Input of the Standard Level Meter.

(iii) Set IF OUTPUT LEVEL of the transmitter to obtain a standard level meter indication of +4 dBm.

(iv) Connect the IF OUTPUT of the MSA Transmitter to the IF INPUT of the MSA Receiver.

(v) Set the controls of the MSA Receiver as shown below.

①	RECEIVER MODE	Same as Transmitter Mode.
	IF BAND	
	BB, IF	IF.

(vi) Read the IF INPUT LEVEL of the MSA Receiver.

(vii) Verify that IF INPUT LEVEL is within +4 dBm \pm 0.3 dB/70 MHz or 140 MHz.

(2) BB Input Level

(a) Specifications

Level accuracy: \pm 0.3 dB/0 dBm

(b) Setup

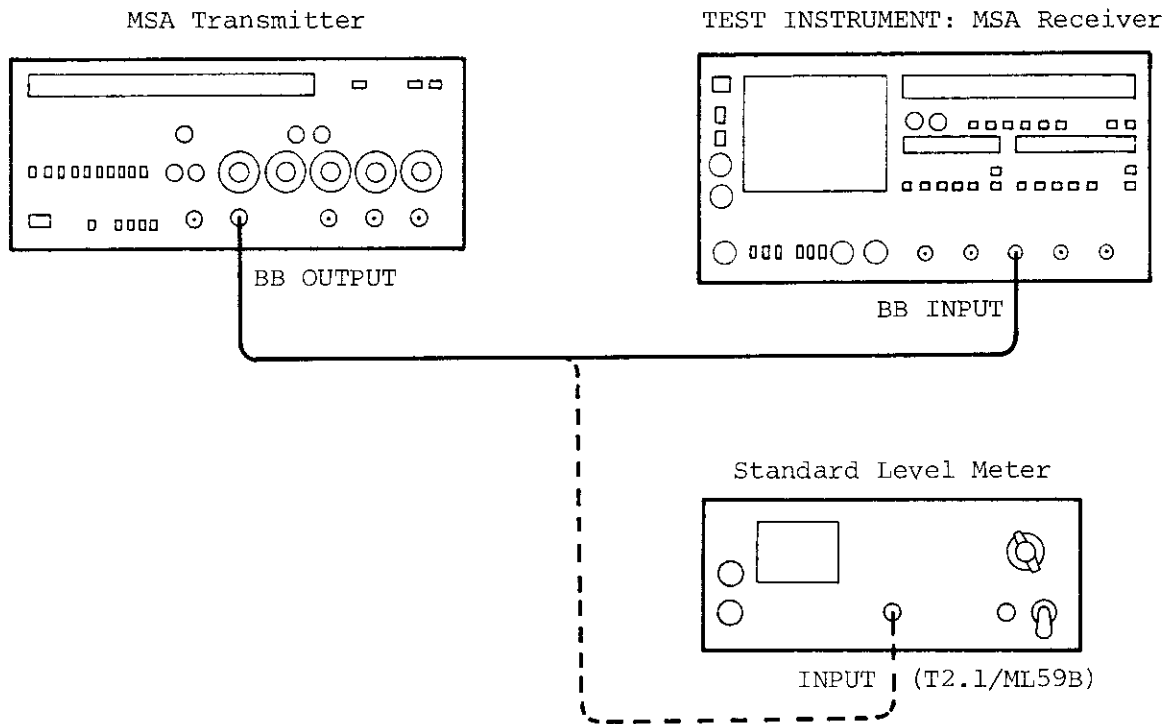


Fig. 2-13 BB Input Level Test

(c) Procedures

(i) Set the controls of the MSA Transmitter as shown below.

- | | | |
|---|---------------------|---|
| ① | TRANSMITTER MODE | BB. |
| | (OUTPUT SELECT) | BB OUTPUT <input checked="" type="checkbox"/> |
| ② | BB OUTPUT LEVEL dBm | 0 dBm. |
| ③ | SWEEP OUTPUT | Zero. |
| ④ | BB FREQUENCY | F1. |

(ii) Connect the BB OUTPUT of the Transmitter to the Input of the Standard Level Meter.

(iii) Set BB OUTPUT LEVEL of the transmitter to obtain a standard level meter indication of 0 dBm.

(iv) Connect the BB OUTPUT of the MSA Transmitter to the BB INPUT of the MSA Receiver.

(v) Set the controls of the MSA Receiver as shown below.

- ① RECEIVER MODE BB.
- ② BB LEVEL dBm Read the level.

(vi) Read the BB INPUT LEVEL of the MSA Receiver.

(vii) Verify that BB INPUT LEVEL is within $0 \text{ dBm} \pm 0.3 \text{ dB}$.

(viii) Change the transmitter BB frequency from F1 to 12.39 MHz and repeat the measurements of steps (2) to (7).

(3) FM Deviation

(a) Specifications

Accuracy: 10% at the built-in BB frequencies
 $\leq 8.2 \text{ MHz}$

(b) Setup

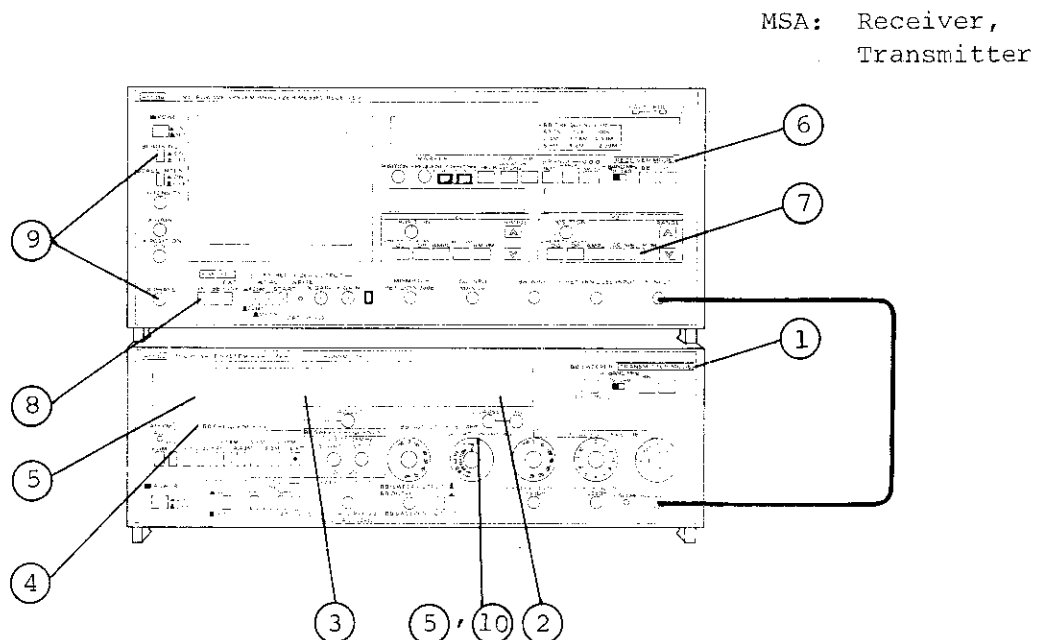


Fig. 2-14 FM Deviation Test

(c) Procedures

- (i) Connect the IF OUTPUT of the MSA Transmitter to the IF INPUT of the MSA Receiver.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND 70 MHz or 140 MHz.
BB, IF IF.
- ② IF CENTER FREQ 70 MHz or 140 MHz.
- ③ SWEEP WIDTH +MHz Zero.
- ④ BB FREQUENCY A type-200 kHz, B type-278 kHz, C type-250 kHz.
- ⑤ DEVIATION kHz rms Set the deviation to A type-340 kHz rms, B type-472 kHz rms and C type-425 kHz rms.

RECEIVER:

- ⑥ RECEIVER MODE
IF BAND Same as Transmitter.
BB, IF IF.
- ⑦ Y2 keys SPECTRUM.
- ⑧ X SELECT IF.
- ⑨ X PHASE, BLANKING Adjust the knob to make the tracing spectrum image coincide with the re-tracing spectrum image when the BLANKING switch is OFF.
- ⑩ DEVIATION dial of TRANSMITTER Readjust the DEVIATION kHz rms dial of the TRANSMITTER to get the first carrier zero spectrum on the CRT screen.

- (iii) Read the FM Deviation of the Transmitter.
- (iv) Verify that FM Deviation accuracy is within $\pm 10\%$.

(4) Frequency Marker

(a) Specifications

Center Marker Accuracy: ± 100 kHz/70 MHz,
 ± 200 kHz/140 MHz

(b) Setup

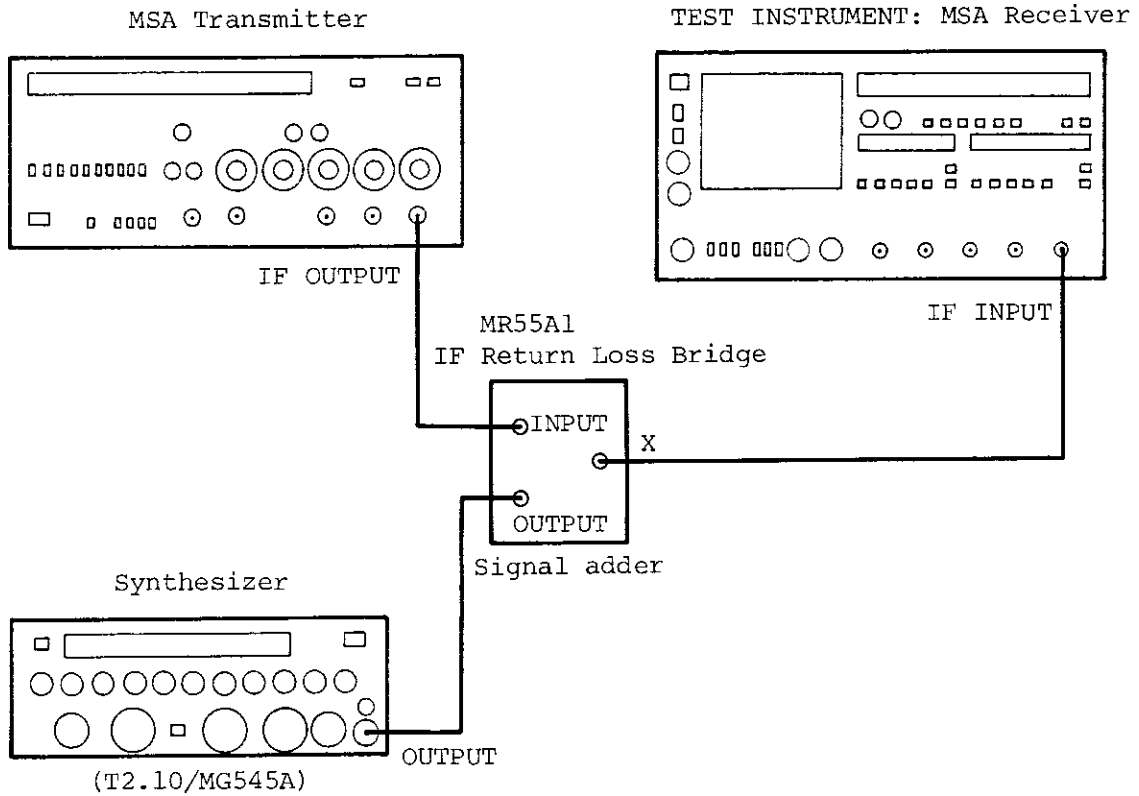


Fig. 2-15 Frequency Marker Test

(c) Procedures

- (i) Connect the Transmitter IF OUTPUT to Input port of the IF Return Loss Bridge.
- (ii) Connect the Synthesizer Output to Output port of the IF Return Loss Bridge.
- (iii) Connect the IF Return Loss Bridge X port to the IF INPUT of MSA Receiver.

(iv) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
 - IF BAND 70 MHz, 140 MHz
 - BB, IF IF.
- ② IF CENTER FREQ 70 MHz or 140 MHz
- ③ SWEEP FREQUENCY LINE.
- ④ SWEEP WIDTH \pm MHz ± 1 MHz.
- ⑤ SWEEP REDUCTION OFF.
- ⑥ BB FREQUENCY Hz F2.
- ⑦ DEVIATION kHz rms 200 kHz rms.
- ⑧ IF OUTPUT LEVEL dBm 0 dBm.

RECEIVER:

- ⑨ RECEIVER MODE
 - IF BAND 70 MHz or 140 MHz
 - BB, IF IF.
- ⑩ RANGE MANUAL.
- ⑪ FREQ SELECT MARKER. Set the frequency to observing band width.
- ⑫ X SELECT IF.
- ⑬ X PHASE, BLANDING Adjust the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
- ⑭ Measurements Y1: LINEARITY, Range 1.0%/DIV. Y2: OFF.

(v) Set the synthesizer output level to -40 dBm.

(vi) Set the synthesizer frequency so that the center of the marker and the beat waveform of the Linearity trace match as shown below.

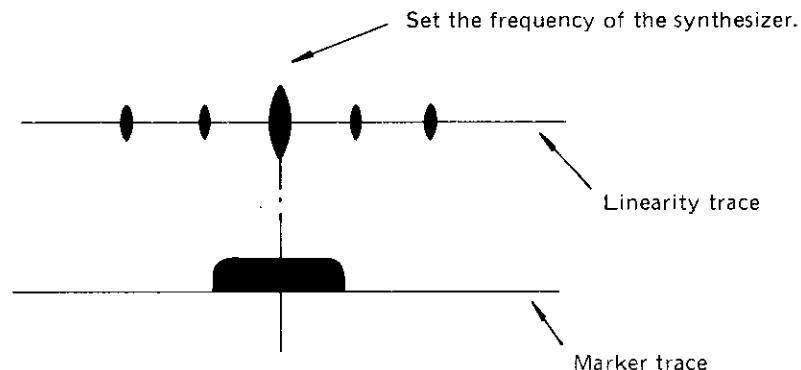


Fig. 2-26 The CRT trace

- (vii) Read the frequency on the synthesizer used.
- (viii) Verify that its value is ± 100 kHz/70 MHz, ± 200 kHz/140 kHz.

(5) X-Y Recorder

(a) Specifications

Output Level: X-axis DC 0 to +4 V,
 Y-axis DC 0 to +4 V

Pen lift : up ... high down ... ground

(b) Setup

TEST INSTRUMENT:
 MSA Receiver (rear panel)

Oscilloscope

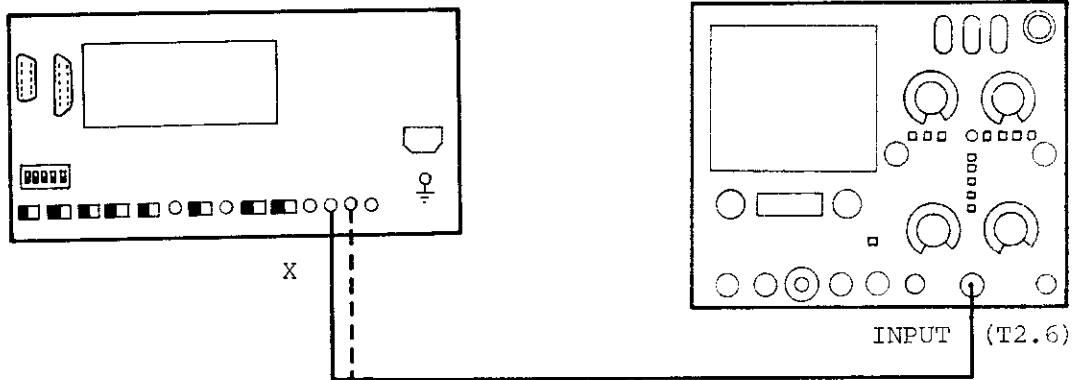
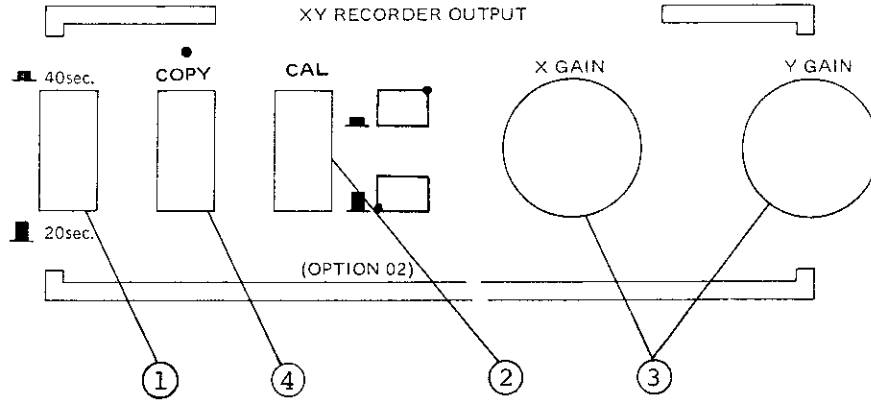


Fig. 2-17 X-Y Recorder Test

(c) Procedures

(i) Set the controls as shown below:



- ① 40 sec, 20 sec: Pen speed selector. Set to required speed.
- ② CAL : Calibration
- ③ X, Y gain: Adjust to the minimum level and maximum level.
- ④ COPY

(ii) Connect the X Output or Y Output of the Receiver to the Oscilloscope Input.

(iii) Read the minimum value and maximum value of the image on the oscilloscope.

(iv) Verify that its voltage is 0 to $\geq +4$ V.

(6) Phase Detection Capture Range

(a) Specification

Capture Range: ± 5 Hz \leq 555.556 kHz
 $\pm 5 \times 10^{-6}$ \leq 12.39 MHz

(b) Setup

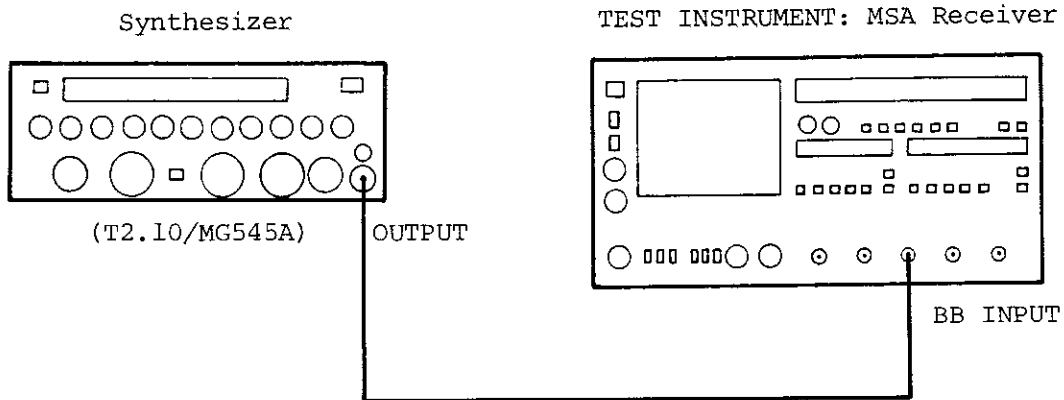


Fig. 2-18 Phase Detection Capture Range Test

(c) Procedures

(i) Set the Receiver of the MSA as shown below.

①	RECEIVER MODE	BB.
②	RANGE	AUTO.
③	MARKER	OFF.
④	X SELECT	LINE.
⑤	Y1	DELAY/DP
⑥	Y2	OFF.
⑦	CAL	ON.

(ii) Set the Synthesizer as shown below.

①	OUTPUT LEVEL	0 dBm.
②	FREQUENCY	Set in accordance with Table 2-5.

(iii) Connect the Output of the Synthesizer to the BB INPUT of the MSA.

(iv) Verify that the BB FREQUENCY LED display of the MSA receiver lights and that two calibration traces ($10 \text{ ns} < 555.556 \text{ kHz}$, $1^\circ < 12.39 \text{ MHz}$) are displayed on the CRT. The phase capture operation can be verified with this check.

Table 2-5 Phase Detection Capture Range

Specification	K type	L type	M type	Note
±5 Hz	66.667 kHz	92.593 kHz	83.333 kHz	F1
	200.000 kHz	277.778 kHz	250.000 kHz	F2
	400.000 kHz	555.556 kHz	500.000 kHz	F3
±5 x 10 ⁻⁶	2 MHz	2.4 MHz		F4
	3.58 MHz			
	4.43 MHz			
	5.6 MHz			
	8.2 MHz			
	12.39 MHz			

(7) DC Input

(a) Specifications

Range: 0 to ±400 mV

Accuracy: ±5%

(b) Setup

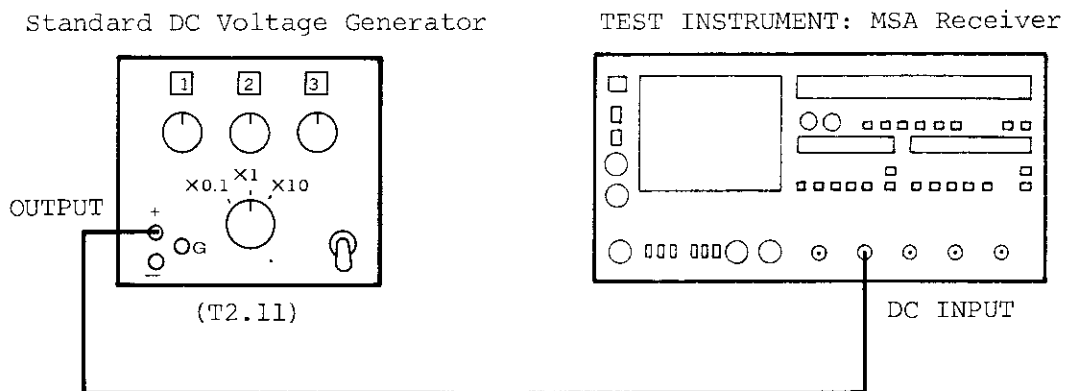


Fig. 2-19 DC Input Test

(c) Procedures

- (i) Connect the Standard DC Voltage Generator Output to the DC INPUT of the MSA.
- (ii) Push Y2 key to DC
- (iii) Set at range 1 mV/DIV using the range key.
- (iv) Set the CRT image of the receiver to the center at input 0 V.
- (v) Adjust the voltage of the standard DC voltage generator so that the 2 lines on the CRT are on the -4 cm and +4 cm lines.
- (vi) Read the voltage of the standard DC voltage generator.
- (vii) Verify that the voltage is within $\pm 5\%$.
- (viii) Change the range from 1 mV/DIV to 100 mV/DIV and repeat the measurements of steps (iv) to (vii).

2.4.3 Measurements

(1) Preliminary Operation

Before performing measurements calibration set the MSA rear panel switches as shown below.

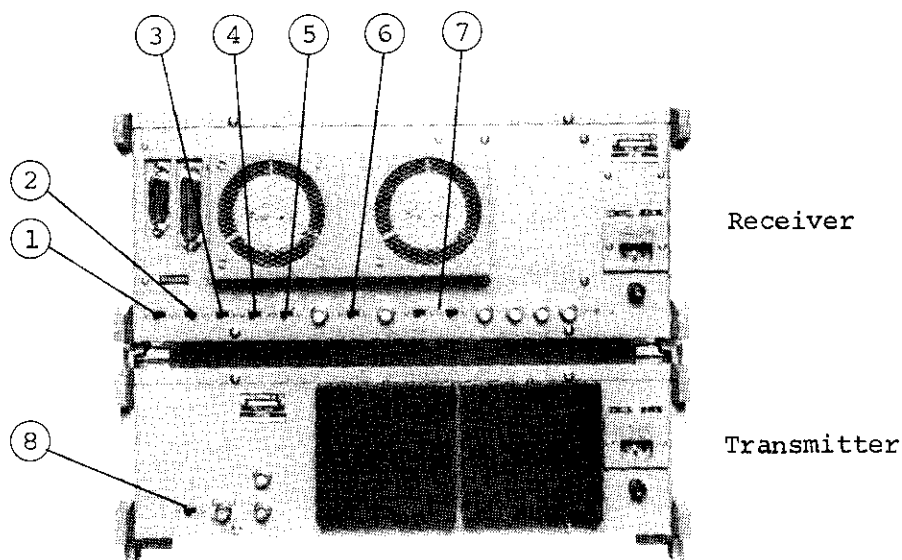


Fig. 2-20 Switch Setting (Rear panel)

Set the controls as shown below.

- | | | |
|---|------------------------|--------------|
| ① | BB SELECT | : NORMAL |
| ② | CHARACTER | : ON |
| ③ | PLL CUT | : HIGH |
| ④ | CRT TRACE | : CHOP |
| ⑤ | THRESHOLD
EXTENTION | : OFF |
| ⑥ | EXT/LINE SELECT | : LINE |
| ⑦ | MARKER SELECT | : SLIDE, INT |
| ⑧ | BB SELECT | : INT |

(2) IF to IF (IF Amplitude, Group Delay, Linearity, Differential Phase, Differential Gain).

(a) Specifications

Table 2-6 IF - IF AMPL, GD, LIN, DP, DG Specifications

Measurements	Models	ME538K/L/M	
	ME453K/L/M	70MHz Band	140MHz Band
Amplitude	$\pm 0.05\text{dB}/\pm 25\text{MHz}$	$\pm 0.05\text{dB}/\pm 25\text{MHz}$	$\pm 0.05\text{dB}/\pm 25\text{MHz}$, $\pm 0.1\text{dB}/\pm 40\text{MHz}$, $\pm 0.2\text{dB}/\pm 50\text{MHz}$
Group Delay	$0.3\text{ns}/\pm 15\text{MHz}$, $0.5\text{ns}/\pm 25\text{MHz}$	$0.3\text{ns}/\pm 15\text{MHz}$, $0.5\text{ns}/\pm 25\text{MHz}$	$0.3\text{ns}/\pm 20\text{MHz}$, $0.5\text{ns}/\pm 30\text{MHz}$, $1\text{ns}/\pm 50\text{MHz}$
Linearity	$0.2\%/\pm 25\text{MHz}$	$0.2\%/\pm 25\text{MHz}$	$0.2\%/\pm 50\text{MHz}$
Differential Phase*	$0.3^\circ/\pm 15\text{MHz}$, $0.5^\circ/\pm 25\text{MHz}$	$0.3^\circ/\pm 15\text{MHz}$, $0.5^\circ/\pm 25\text{MHz}$	$0.3^\circ/\pm 20\text{MHz}$, $0.5^\circ/\pm 30\text{MHz}$, $0.8^\circ/\pm 50\text{MHz}$
Differential Gain*	$0.2\%/\pm 15\text{MHz}$, $0.4\%/\pm 25\text{MHz}$	$0.2\%/\pm 15\text{MHz}$, $0.4\%/\pm 25\text{MHz}$	$0.3\%/\pm 20\text{MHz}$, $0.4\%/\pm 30\text{MHz}$, $0.6\%/\pm 50\text{MHz}$

* : Sweep width = Carrier sweep width + 2fM

(b) Setup

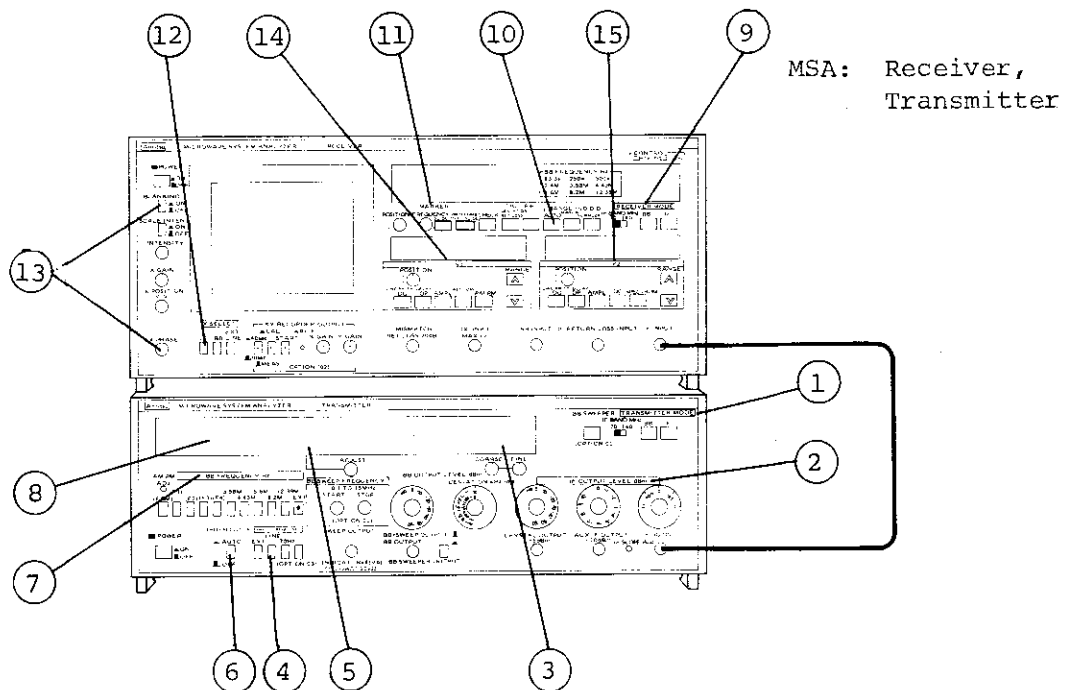


Fig. 2-21 IF to IF Test

(c) Procedures

- (i) Connect the IF OUTPUT of the Transmitter to the IF INPUT of the Receiver.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND 70 MHz or 140 MHz.
BB, IF IF.
- ② IF OUTPUT LEVEL dBm 0 dBm.
- ③ IF CENTER FREQ MHz 70 MHz or 140 MHz.
- ④ SWEEP FREQUENCY LINE.
- ⑤ SWEEP WIDTH ±MHz 25 MHz.
- ⑥ SWEEP REDUCTION ON.
- ⑦ BB FREQUENCY Hz 200 kHz, 278 kHz or 250 kHz for Delay, Linearity Measurement.
5.6 MHz for DG, DP Measurement.
- ⑧ DEVIATION kHz rms 200 kHz rms for Delay Linearity Measurement.
500 kHz rms for DG, DP Measurement.

RECEIVER:

- ⑨ RECEIVER MODE
IF BAND Same as Transmitter.
BB, IF IF.
- ⑩ RANGE AUTO.
- ⑪ FREQ SELECT MARKER, FREQUENCY - Set to ±25 MHz.
- ⑫ X SELECT IF.
- ⑬ X PHASE Adjust the knob to make the tracing marker pulses coincide with the retracing marker pulse while the BLANKING is OFF.
After adjusting, set the BLANKING switch to ON.

(iii) IF Amplitude

- ⑭ Y1 selectors AMPL
- ⑮ Y2 selectors OFF

If the item key LEDs light, push these keys again.
The LEDs turn off and these functions enter the OFF state.

- ⑩ Confirmation: Read the inherent slope on the CRT, and verify if it satisfies the amplitude specifications of section 2.4.3, (2), a.

Note: SLOPE ADJ is used for compensation of the cable characteristics.

(iv) GROUP DELAY & LINEARITY

- ⑦ (TRANSMITTER) Set as follows.
BB FREQ: Type K 200 kHz.
Type L 278 kHz.
Type M 250 kHz.
- ⑧ (TRANSMITTER)
DEVIATION: 200 kHz rms.
- ⑭ Y1 selectors: DELAY/DP.
- ⑮ Y2 selectors: LINEARITY/DG.
- ⑯ Confirmation: Read the slope of the trace on the CRT, and verify that it satisfies the group and linearity specifications of section 2.4.3, (2), (a).

(v) Differential Phase & Differential Gain

- ⑦ (TRANSMITTER)
BB FREQ: Set to 5.6 MHz.
- ⑧ (TRANSMITTER)
DEVIATION: 500 kHz rms.
- ⑭ Y1 selectors: DELAY/DP.
- ⑮ Y2 selectors: LINEARITY/DG.
- ⑯ Confirmation: Read the slope of the trace on the CRT, and verify that it satisfies the DP and DG specifications of section 2.4.3, (2), (a).

(3) BB to BB (Group Delay, Linearity, Differential Phase, Differential Gain).

(a) Specifications

Table 2-7 BB - BB Group Delay, Linearity, DP, DG Specifications

	Accuracy
Group Delay	±5% at 10 ns
Linearity	±10% at 10%
Differential Phase	±5% at 1°
Differential Gain	±10% at 10%

(b) Setup

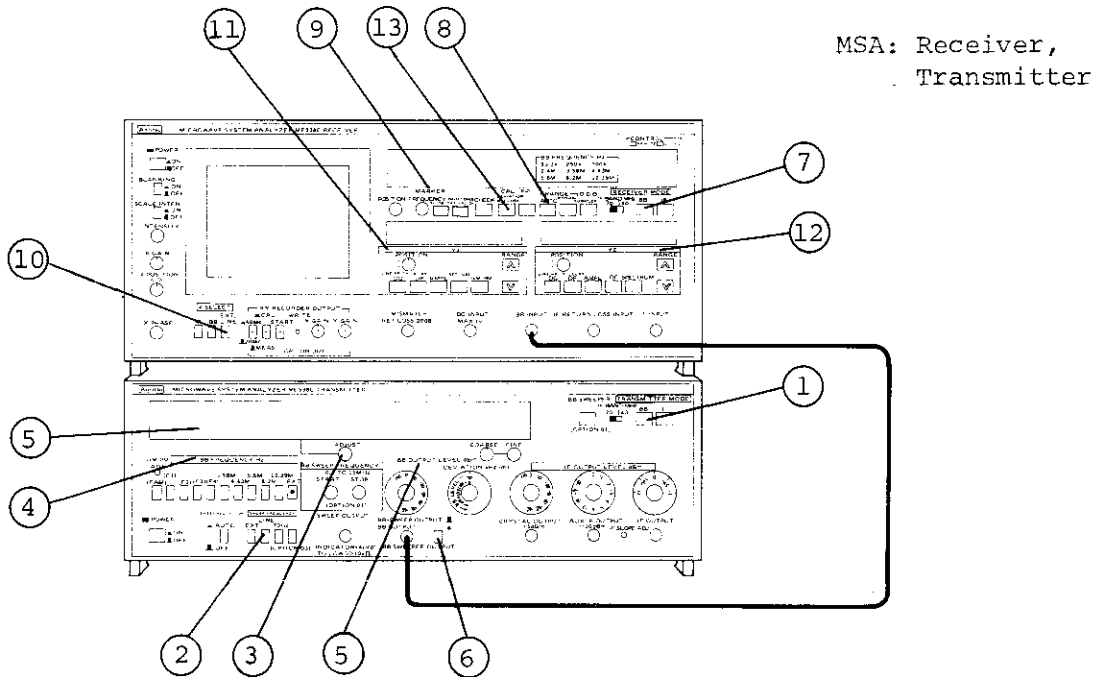


Fig. 2-22 BB to BB Test

(c) Procedures

- (i) Connect the BB OUTPUT of the Transmitter to the BB INPUT of the Receiver.
- (ii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE BB, IF BB.
- ② SWEEP FREQUENCY LINE.
- ③ SWEEP OUTPUT $V_p/75 \Omega$ 1 V_p
- ④ BB FREQUENCY Set according to the calibration items. (Table 2-7)
- ⑤ BB OUTPUT LEVEL dBm 0 dBm.
- ⑥ (OUTPUT SELECT) BB OUTPUT

RECEIVER:

- ⑦ RECEIVER MODE BB.
- ⑧ RANGE AUTO.
- ⑨ FREQ SELECT COUNTER.
- ⑩ X SELECT LINE.
- ⑪ Y1 Set according to the calibration items. (Table 2-7)
- ⑫ Y2 OFF.
- ⑬ CAL ON.

- (iii) Read the separation between the two traces on the CRT, and compare it with the calibration value shown below and verify that it satisfies the specifications.

Calibration item	BB frequency	Calibration value	Specification
① Group Delay	K type: 200kHz	10ns	±5% at 10ns
② Linearity	L type: 278kHz M type: 250kHz	10%	±10% at 10%
③ Differential Phase	5.6MHz	1°	±5% at 1°
④ Differential Gain		10%	±10% at 10%

(4) IF Return Loss

(a) Specifications

Inherent Slope: ± 1 dB/70 \pm 25 MHz, -30 dBm
 ± 1 dB/140 \pm 50 MHz, -30 dBm

(b) Setup

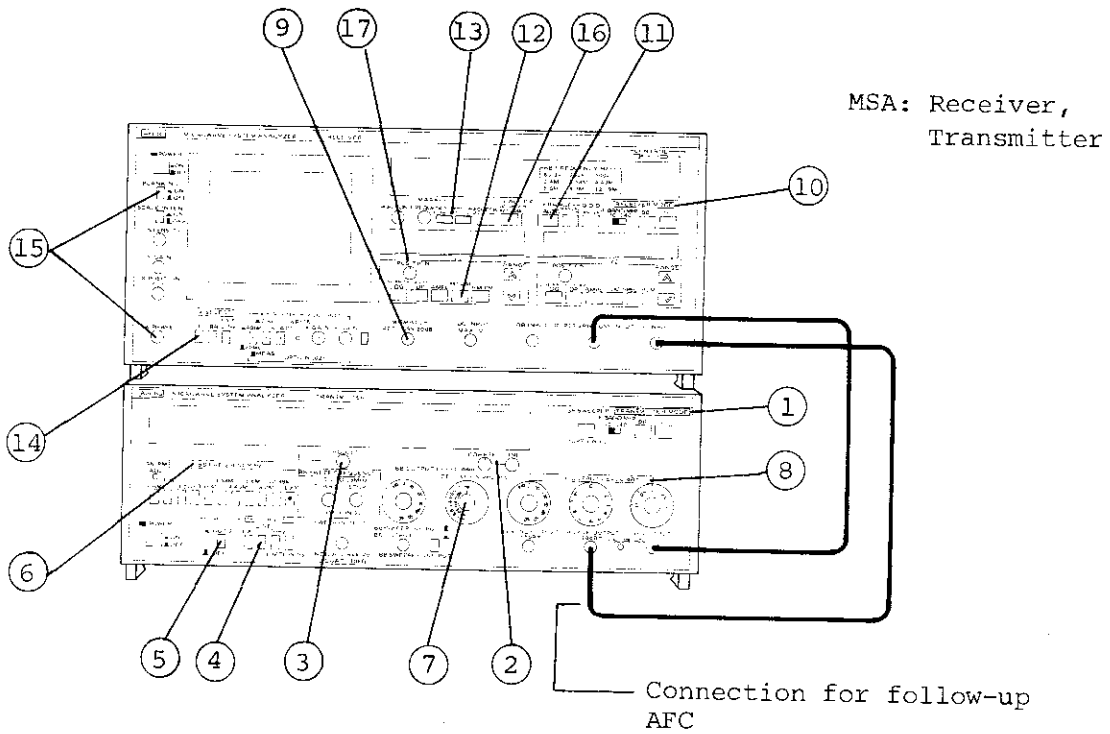


Fig. 2-23 IF Return Loss Test

(c) Procedures

- (i) Connect the AUX IF OUTPUT of the Transmitter to the IF INPUT of the Receiver.
- (ii) Connect the IF OUTPUT of the Transmitter to the IF Return Loss Input of the Receiver.
- (iii) Set the controls as shown below.

TRANSMITTER:

- ① TRANSMITTER MODE
IF BAND 70 MHz or 140 MHz.
BB, IF IF.
- ② IF CENTER FREQ 70 MHz or 140 MHz.
- ③ SWEEP WIDTH 70 MHz BAND: ± 25 MHz,
140 MHz BAND: ± 50 MHz
- ④ SWEEP FREQUENCY LINE.
- ⑤ SWEEP REDUCTION OFF.
- ⑥ BB FREQUENCY Hz F2.
- ⑦ DEVIATION kHz rms 200 kHz rms.
- ⑧ IF OUTPUT LEVEL dBm -30 dBm

RECEIVER:

- ⑨ MISMATCH Not defined
RET LOSS 20 dB
- ⑩ RECEIVER MODE
IF BAND Same as TRANSMITTER.
BB, IF IF.
- ⑪ RANGE AUTO.
- ⑫ Y2 keys RET LOSS.
- ⑬ FREQ SELECT MARKER.
- ⑭ X SELECT IF.
- ⑮ X PHASE, BLANKING Adjust the knob to make the tracing marker image coincide with the re-tracing marker image while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
- ⑯ CAL Push this key twice. The calibration factor 20 dB is displayed on Y2 panel indicator.
- ⑰ POSITION Adjust the 20 dB return loss image on CRT to the center of the Y axis scale.

- (iv) Read the inherent slope of the CRT trace.
- (v) Verify that the inherent slope is less than ± 1 dB/70 \pm 25 MHz, ± 1 dB/140 \pm 50 MHz.

(5) AM to PM Conversion

(a) Specifications

Residual PM: $0.3^\circ/\text{dB}$ at 70 ± 25 MHz
 $0.3^\circ/\text{dB}$ at 140 ± 35 MHz

(b) Setup

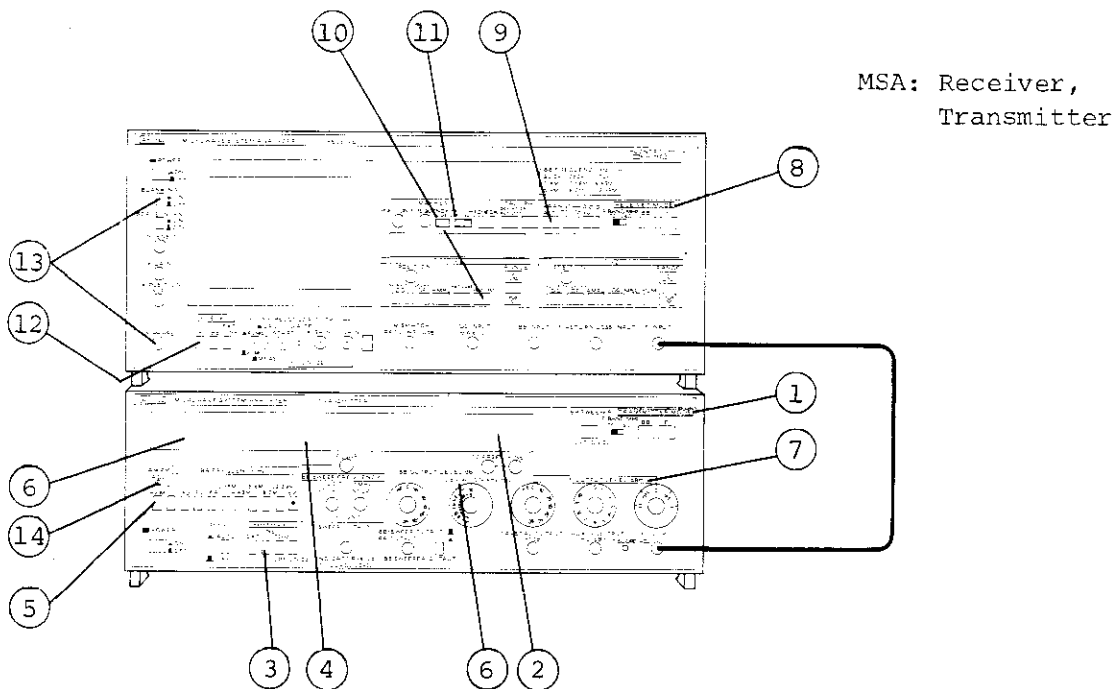


Fig. 2-24 AM to PM Conversion Test

(c) Procedures

- (i) Connect the IF OUTPUT of the Transmitter to the IF INPUT of the Receiver.
- (ii) Set the controls as shown below.

TRANSMITTER:

- | | | |
|---|-----------------------|--|
| ① | TRANSMITTER MODE | |
| | IF BAND | 70 MHz or 140 MHz. |
| | BB, IF | IF. |
| ② | IF CENTER FREQ | 70 MHz or 140 MHz. |
| ③ | SWEEP FREQUENCY | LINE. |
| ④ | SWEEP WIDTH \pm MHz | Required sweep width. |
| ⑤ | AM-PM | Push. |
| | | (a) IF OUTPUT signal is AM and FM modulated. |
| | | (b) The modulation frequencies are K type-200 kHz, L type-278 kHz, M type-250 kHz. |
| | | (c) The AM modulation frequencies are a little larger (500 Hz) than FM modulation frequencies. |
| ⑥ | DEVIATION kHz rms | Set to 200 kHz rms. |
| ⑦ | IF OUTPUT LEVEL dBm | Required level (-20 dBm to +10 dBm). |

RECEIVER:

- | | | |
|---|-------------------|---|
| ⑧ | RECEIVER MODE | |
| | IF BAND | Same as TRANSMITTER. |
| | BB, IF | IF. |
| ⑨ | RANGE | AUTO. |
| ⑩ | Y1 keys | AM-PM. |
| ⑪ | FREQ SELECT | MARKER. |
| ⑫ | X SELECT | IF. |
| ⑬ | X PHASE, BLANKING | Adjust the knob to make the tracing marker signal coincide with the re-tracing marker signal while the BLANKING switch is OFF. |
| ⑭ | AM-PM ADJ | Minimize the amplitude of the beat wave by adjusting knob of the TRANSMITTER, when the amplitude (peak to peak) is more than 0.3°/dB, as shown in Fig. a. |

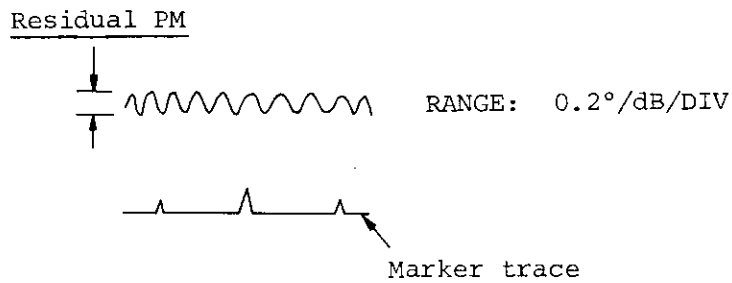


Fig. a Residual PM Beat Wave of CRT Trace

- (iii) Read the peak to peak value (residual PM) of the CRT trace.
- (iv) Verify that the residual PM is less 0.3°/dB.

(6) BB Amplitude (Optional)

(a) Specifications

Inherent Slope: ± 0.5 dB/100 kHz to 13 MHz

(b) Setup

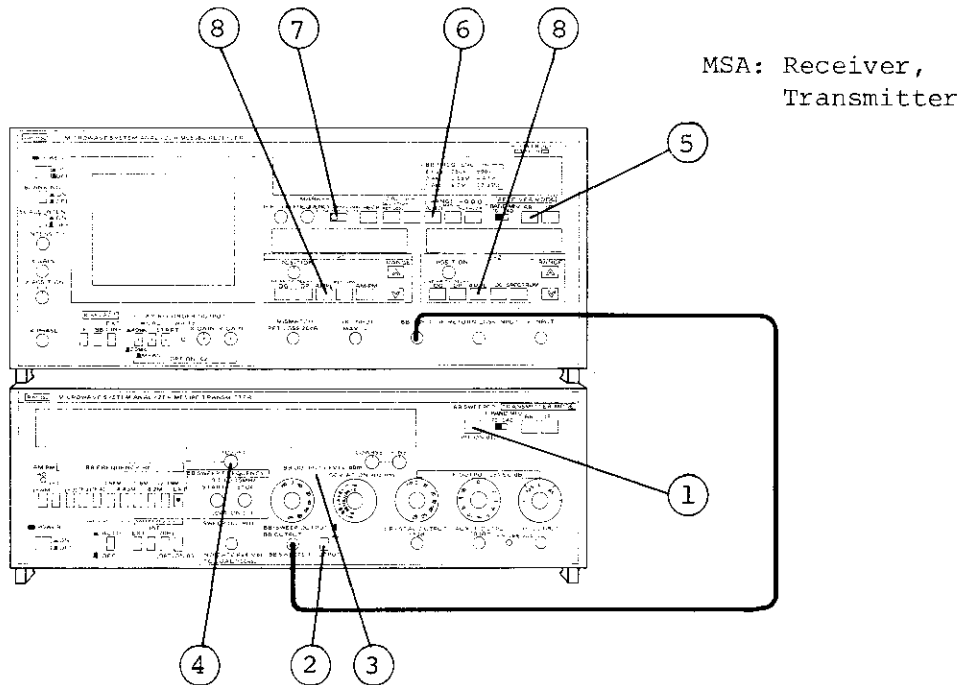


Fig. 2-25 BB Amplitude Test

(c) Procedures

- (i) Connect the BB OUTPUT of the Transmitter to the BB INPUT of the Receiver.
- (ii) Set the controls as shown below.

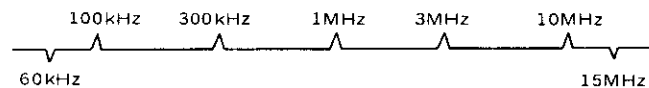
TRANSMITTER:

- | | | |
|---|----------------------|---|
| ① | BB SWEEPER | Push. |
| ② | (OUTPUT SELECT) | BB OUTPUT <input checked="" type="checkbox"/> |
| ③ | BB OUTPUT LEVEL dBm | 0 dBm. |
| ④ | BB SWEEPER FREQUENCY | START: 100 kHz
STOP : 13 MHz |

RECEIVER:

- | | | |
|---|---------------|----------|
| ⑤ | RECEIVER MODE | BB. |
| ⑥ | RANGE | AUTO. |
| ⑦ | FREQ SELECT* | COUNTER. |
| ⑧ | Y1 or Y2 keys | AMPL. |

*Note; Marker frequency on CRT



- (iii) Read the inherent slope of the CRT trace.
- (iv) Verify that the inherent slope is less than ± 0.5 dB/100 kHz to 13 MHz.

2.5 TEST PERFORMANCE SHEET

The test performance sheets are made after careful inspection of your instrument.

Specification items other than the following are also checked and found to be correct.

DATE _____

TEST NO. _____

OPERATOR _____

TEMP _____

RELATIVE HUMIDITY _____

TESTED BY _____

TYPE ME453/538 K/L/M

MICROWAVE SYSTEM ANALYZER SERIAL NO. _____

NO.	INSPECTION ITEM	SPECIFICATION	RESULTS	REMARKS
2.4.1	Transmitter			
(1)	IF Output Level			
(a)	Level accuracy	$\pm 0.3\text{dB}/+4\text{dBm}$	___ dB	
(2)	IF Center Frequency			
(a)	Center frequency accuracy	70MHz: $\pm 10\text{kHz} \pm 1\text{digit}$ ($\pm 20\text{kHz}$)	___ kHz	
		140MHz: $\pm 20\text{kHz} \pm 1\text{digit}$ ($\pm 30\text{kHz}$)	___ kHz	
(3)	IF Sweep Width			
(a)	Sweep width accuracy	$\pm(\text{displayed value} \times 3\%) \pm 0.5\text{Hz}$ 70 $\pm 10\text{MHz}$ 70 $\pm 25\text{MHz}$ 140 $\pm 10\text{MHz}$ 140 $\pm 50\text{MHz}$	___ MHz ___ MHz ___ MHz ___ MHz	
(4)	FM Deviation			
(a)	Accuracy	$\pm 10\%$ at built-in BB frequency $\leq 8.2\text{MHz}$ K type 340kHz rms L type 472kHz rms M type 425kHz rms	___ kHz rms	Measure the item of F2 (BB Frequency) of the Transmitter
(5)	BB Output Level			
(a)	Level accuracy	$\pm 0.3\text{dB}/0\text{dBm}$ F1 F2 F3 F4 3.58MHz 4.43MHz 5.6MHz 8.2MHz 12.39MHz	___ dB ___ dB ___ dB ___ dB ___ dB ___ dB ___ dB ___ dB ___ dB	

TYPE ME453/538 K/L/M

MICROWAVE SYSTEM ANALYZER SERIAL NO. _____

NO.	INSPECTION ITEM	SPECIFICATION	RESULTS	REMARKS
(6)	BB Frequency			
(a)	Frequency accuracy	$\pm 5\text{Hz}$: F1 to F3 $\pm 5 \times 10^{-6}$: F4 to 12.39MHz		
		F1	_____ Hz	
		F2	_____ Hz	
		F3	_____ Hz	
		F4	_____ kHz	
		3.58MHz	_____ kHz	
		4.43MHz	_____ kHz	
		5.6MHz	_____ kHz	
		8.2MHz	_____ kHz	
		12.39MHz	_____ kHz	
(7)	Sweep Output (BB+Sweep Output terminal)			
(a)	Level range	0 to $\geq 6.5\text{Vp-p}$	_____ to _____ Vp-p	
	Level accuracy	$\pm 10\%/6\text{Vp-p}$	_____ %	
(8)	Sweep Output (Sweep Output terminal)			
(a)	Level range	0 to $\geq 25\text{Vp-p}$	_____ to _____ Vp-p	
	Level accuracy	$\pm 10\%/24\text{Vp-p}$	_____ %	
(9)	AUX IF Output			
(a)	Level accuracy	$\pm 1\text{dB}/-10\text{dBm}$		
		70MHz	_____ dB	
		140MHz	_____ dB	

TYPE ME453/538 K/L/M

MICROWAVE SYSTEM ANALYZER SERIAL NO. _____

NO.	INSPECTION ITEM	SPECIFICATION	RESULTS	REMARKS
(10)	Crystal Output			
(a)	Level accuracy	$\pm 1\text{dB}/+5\text{dBm}$		
		70MHz	___ dB	
		140MHz	___ dB	
2.4.2	Receiver			
(1)	IF Input Level			
(a)	Level accuracy	$\pm 0.3\text{dB}/+4\text{dBm}$		
		70MHz	___ dB	
		140MHz	___ dB	
(2)	BB Input Level			
(a)	Level accuracy	$\pm 0.3\text{dB}/0\text{dBm}$		
		F1	___ dB	
		F2	___ dB	
		F3	___ dB	
		F4	___ dB	
		3.58MHz	___ dB	
		4.43MHz	___ dB	
		5.6MHz	___ dB	
		8.2MHz	___ dB	
		12.39MHz	___ dB	
(3)	FM Deviation			
(a)	Accuracy	$\pm 10\%$ at built-in BB frequency $< 8.2\text{MHz}$	___ kHz rms	Measure the item at F2 (BB frequency) of the Transmitter.
		K type 340kHz rms		
		L type 472kHz rms		
		M type 425kHz rms		
(4)	Frequency Marker			
(a)	Center Marker accuracy	$\pm 100\text{kHz}/70\text{MHz}$	___ kHz	
		$\pm 200\text{kHz}/140\text{MHz}$	___ kHz	
(5)	X-Y recorder Output (Optional)			

TYPE ME453/538 K/L/M

MICROWAVE SYSTEM ANALYZER SERIAL NO. _____

NO.	INSPECTION ITEM	SPECIFICATION	RESULTS	REMARKS
(a)	Level	X: DC 0 to $\geq 4V$ Y: DC 0 to $\geq 4V$	<u>to V</u> <u>to V</u>	
(6)	Phase Detection			
(a)	Capture range	F1: $\pm 5Hz$ F2: $\pm 5Hz$ F3: $\pm 5Hz$ F4: $\pm 5 \times 10^{-6}$ (2MHz: $\pm 10Hz$) (2.4MHz: $\pm 12Hz$) 3.58MHz: $\pm 5 \times 10^{-6}$ ($\pm 18Hz$) 4.43MHz: $\pm 5 \times 10^{-6}$ ($\pm 22Hz$) 5.6MHz: $\pm 5 \times 10^{-6}$ ($\pm 28Hz$) 8.2MHz: $\pm 5 \times 10^{-6}$ ($\pm 41Hz$) 12.39MHz: $\pm 5 \times 10^{-6}$ ($\pm 62Hz$)	<u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u> <u>- to + Hz</u>	
(7)	DC Input			
(a)	Range accuracy	$\pm 5\%$ Range 1mV/DIV Range 2mV/DIV Range 5mV/DIV Range 10mV/DIV Range 20mV/DIV Range 50mV/DIV Range 100mV/DIV	<u> </u> % <u> </u> % <u> </u> % <u> </u> % <u> </u> % <u> </u> % <u> </u> %	

TYPE ME453/538 K/L/M

MICROWAVE SYSTEM ANALYZER SERIAL NO. _____

NO.	INSPECTION ITEM	SPECIFICATION	RESULTS	REMARKS
2.4.3	Measurements			
(2)	IF to IF			
(a)				
(i)	IF Amplitude	$\pm 0.05\text{dB}/70\pm 25\text{MHz}$	\pm dB	Measure the item at F2 (BB frequency) of the Transmitter
		$\pm 0.05\text{dB}/140\pm 25\text{MHz}$	\pm dB	
		$\pm 0.1\text{dB}/140\pm 40\text{MHz}$	\pm dB	
		$\pm 0.2\text{dB}/140\pm 50\text{MHz}$	\pm dB	
(ii)	Group Delay	$0.3\text{ns}/70\pm 15\text{MHz}$	ns	
		$0.5\text{ns}/70\pm 25\text{MHz}$	ns	
		$0.3\text{ns}/140\pm 20\text{MHz}$	ns	
		$0.5\text{ns}/140\pm 30\text{MHz}$	ns	
		$1.0\text{ns}/140\pm 50\text{MHz}$	ns	
(iii)	Linearity	$0.2\%/70\pm 25\text{MHz}$	%	
		$0.2\%/140\pm 50\text{MHz}$	%	
(iv)	Differential Phase	$0.3^\circ/70\pm 20\text{MHz}$	°	
		$0.5^\circ/70\pm 25\text{MHz}$	°	
		$0.3^\circ/140\pm 20\text{MHz}$	°	
		$0.5^\circ/140\pm 30\text{MHz}$	°	
		$0.8^\circ/140\pm 50\text{MHz}$	°	
(v)	Differential Gain	$0.2\%/70\pm 15\text{MHz}$	%	Measure the item at 5.6MHz (BB frequency) of the Transmitter
		$0.4\%/70\pm 25\text{MHz}$	%	
		$0.3\%/140\pm 20\text{MHz}$	%	
		$0.4\%/140\pm 30\text{MHz}$	%	
		$0.6\%/140\pm 50\text{MHz}$	%	
(4)	IF Return Loss			
(a)	Inherent slope	$\pm 1\text{dB}/70\pm 25\text{MHz}$	dB	Measure the item at -30 dBm
		$\pm 1\text{dB}/140\pm 50\text{MHz}$	dB	
(5)	AM to PM conversion			
(a)	Residual PM	$0.3^\circ/\text{dB}, 70\pm 25\text{MHz}$	°	
		$0.3^\circ/\text{dB}, 140\pm 35\text{MHz}$	°	
(6)	BB Amplitude (Optional)			
(a)	Inherent slope	$\pm 0.5\text{dB}/100\text{kHz to } 13\text{MHz}$	dB	

