MA4701A, MA4703A, MA4705A
MA4601A, MA4603A
MA4702A, MA4704A

Power Sensors

Instruction Manual

Fourth Edition

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

Measuring Instruments Division
Measurement Group

ANRITSU CORPORATION

ERRATA (MA4701A, MA4703A, MA4705A,
MA4601A, MA4603A, MA4702A, MA4704A Inst.)

ITEM	DESCRIPTION		
	ERROR	CORRECT	Rev. No.
P.2-6	Table 2-4 (a) MA4701A Max. input 30 mW average	300 mW average	4.1

WARNING

NO OPERATOR SERVICEABLE PARTS INSIDE.

REFER SERVICING TO QUALIFIED PERSONNEL.

CAUTION

FOR CONTINUED FIRE PROTECTION REPLACE

ONLY WITH SPECIFIED TYPE AND RATED FUSE.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

SECTION 1

GENERAL

The MA4701A, MA4703A, MA4705A, MA4601A, MA4603A, MA4702A, and MA4704A Sensors (called MA4[ ]A Series Power sensors) sense the rms power of RF signals and convert it to an electrical signal. They are used with the ML4803A Power Meter, which amplifies, detects, and displays the converted signals.

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 Composition

2.1.1 Standard composition

The standard composition is given in Table 2-1.

Table 2-1 Standard Composition

No.	Name	Qty.
1	Power Sensor MA[ ]A	1
2	Instruction manual	1

2.1.2 Power meter, sensor and optional accessories combinations

The MA4[ ]A Series power sensors are used with the ML4803A Power Meter.

The power sensor sensitivity is calibrated by using the built-in calibration oscillator (50 MHz, 0 dB output) in the ML4803A Power Meter. Since the CAL OUTPUT terminal is N-type (50 Ω), the optional accessories of Table 2-2 (sold separately) are necessary for the MA4703A, MA4705A, MA4603A, MA4702A, and MA4704A sensors.

The ML4803A Power Meter and MA4[ ]A Series power sensors and optional accessories combinations are shown in Fig. 2-1.

Table 2-2 Sensors and Optional Accessories

Sensor	Optional accessories (part code)
MA4703A, MA4705A	APC3.5 ↔ N Conversion Connector (J0364)
MA4702A	MP47A Attenuator for sensitivity calibration
MA4704A	APC3.5 ↔ N Conversion Connector (J0364) MP47A Attenuator for sensitivity calibration
MA4603A	Sensitivity Calibration 50 Ω ↔ 75 Ω Conversion Connector (J0365)

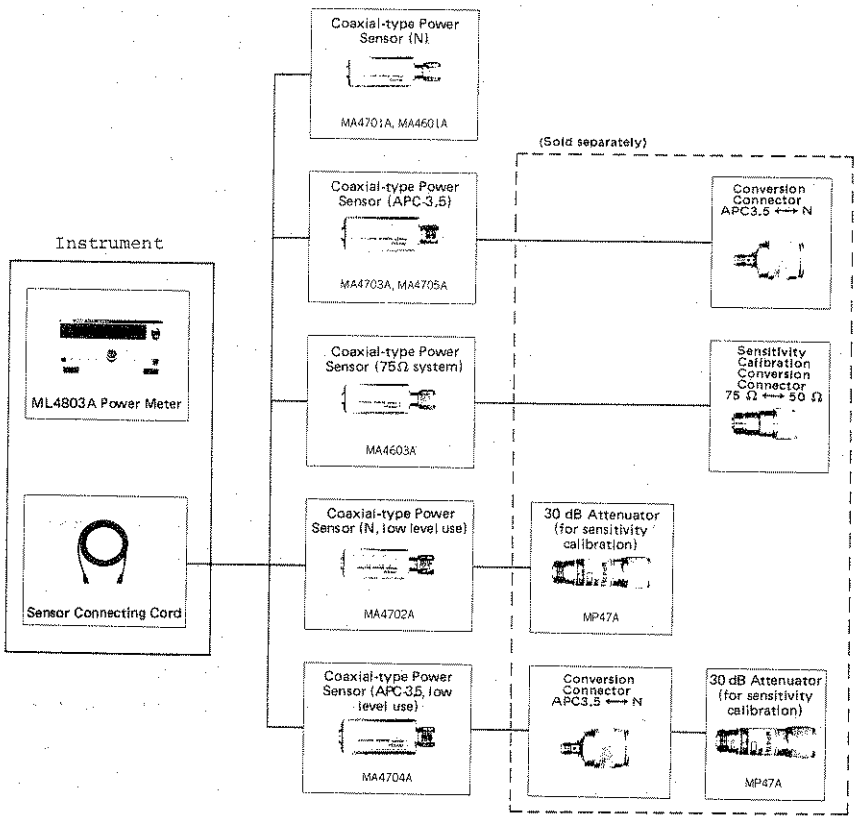


Fig. 2-1 Power Meter and Power Sensor Combinations

2.2 Optional Accessories

Various fixed attenuators, which connect to the power sensor input terminals, are available for measuring power that exceeds the power measurement range of the power sensor.

Various coaxial-waveguide converters are also available for measuring the power of waveguide terminals.

These optional accessories are listed in Table 2-3.

2.3 Specifications

The specifications of the MA4[ ]A Series power sensors are given in Table 2-4.

2.4 Calibration Factor (CAL FACTOR) Error

The MA4[ ]A Series power sensors calibration factor (CAL FACTOR) errors are shown in Table 2-5. These values include the power standard error and trace error.

2.5 Detecting Element Field Replacement

The detecting element of the MA4701A, MA4703A, MA4705A, MA4601A, and MA4603A power sensors can be replaced in the field.

The replacement detecting element is identified by the letter "M" after the model number.

Example:

The MA4701A Power Sensor replacement detecting element is coded as MA4701AM.

For a detailed description of field replacement, see SECTION 7.

Table 2-3 Optional Accessories

Name	Part code	Remarks
N-APC3.5 Conversion connector	J0364	Required for MA4703A, MP4705A, and MA4704A sensors
Sensitivity Calibration 50 Ω ↔ 75 Ω Conversion Connector	J0365	Required for MA4603A
MP47A Attenuator (30 dB) for sensitivity calibration	———	Required for MA4702A and MA4704A sensors
MP721D Attenuator (20 dB)	———	Type N, Max. power 2 W (+33 dBm), dc to 12.4 GHz
Attenuator (20 dB)	J0077	Type N, Max. power 2 W (+33 dBm), dc to 18 GHz
MP758D Attenuator (20 dB)	———	APC3.5, Max. power 1 W (+30 dBm), dc to 26.5 GHz
High Power Attenuator (30 dB)	J0063	Type N, Max. power 10 W (+40 dBm), dc to 12.4 GHz
High Power Attenuator (20 dB)	J0078	Type N, Max. power 10 W (+40 dBm), dc to 18 GHz
High Power Attenuator (30 dB)	J0079	Type N, Max. power 25 W (+44 dBm), dc to 8 GHz
7 GHz Band Coaxial - Waveguide Adapter	J0064A	5.8 to 8.2 GHz Type N (J) - waveguide WRJ-7, flange BRJ-7
10 GHz Band Coaxial - Waveguide Adapter	J0064B	8.2 to 12.4 GHz Type N (J) - waveguide WRJ-120, flange BRJ-120
10 GHz Band Coaxial - Waveguide Adapter	J0064C	8.2 to 12.4 GHz Type N (J) - waveguide WRJ-10, flange BRJ-10
18 GHz Band Coaxial - Waveguide Adapter	J0367	17.7 to 21.2 GHz SMA (J) - waveguide WRJ-180, flange FUBR180
22 GHz Band Coaxial - Waveguide Adapter	J0367	18 to 26.5 GHz APC3.5 (J) - waveguide WRJ-220, flange FUBR220
30 GHz Band Coaxial - Waveguide Adapter	J0368	26.5 to 34 GHz APC3.5 (J) - waveguide WRJ-320, flange FUBR320
Taper Waveguide (WRJ320 ↔ WRJ260)	J0369	WRJ320 (FUBR320) ↔ WRJ260 (FUBR260) conversion taper

Table 2-4 Power Sensor Specifications

(a) Amorphous Power Sensors

Sensor Model	Frequency range	Nominal Impedance (Ω)	Power range	Max. VSWR	Max. input	Linearity error	Input connector	Size (mm) Weight (g)
MA4701A	10MHz to 18GHz	50	+20dB, (100mW) to -30dB, (1μW)	10 to 30MHz : 1.4 30 to 50MHz : 1.18 50MHz to 2GHz: 1.1 2 to 12.4GHz : 1.18 12.4 to 18GHz: 1.28	30mW average	+10 to +20 dBm range only ±3%	N	25 x 34 x 98 200
MA4703A	50MHz to 26.5GHz	50		50 to 100MHz : 1.15 0.1 to 2GHz : 1.10 2 to 12.4GHz : 1.15 12.4 to 18GHz: 1.20 18 to 26.5GHz: 1.25			APC-3.5	25 x 34 x 87 200
MA4705A	50MHz to 32GHz			26.5 to 32GHz: 1.50				
MA4601A	100kHz to 5.5GHz	50		100 to 300kHz: 1.3 300kHz to 1MHz:1.2 1MHz to 4GHz : 1.1 4 to 5.5GHz : 1.2			N	25 x 34 x 98 200
MA4603A	100kHz to 2GHz	75		100 to 300kHz: 1.4 300 kHz to 2GHz: 1.15			NC	

Table 2-4 Power Sensor Specifications (Cont'd)

(b) Diode Power Sensors

Sensor Model	Frequency range	Nominal Impedance (Ω)	Power range	Max. VSWR	Max. Input	Linearity error	Input connector	Size (mm) Weight (g)
MA4702A	10MHz to 18GHz	50	-70dBm (0.1nW) to -20dBm (10μW)	10 to 30MHz : 1.4 30MHz to 4GHz: 1.15 4 to 8GHz : 1.2 8 to 18GHz : 1.3	200mW average 200mW peak	-30 to -20dBm range only ±2%	N	25 x 34 x 98 200
MA4704A	50MHz to 26.5GHz	50		50MHz to 4GHz: 1.15 4 to 8GHz : 1.2 8 to 18GHz : 1.3 18 to 26.5GHz: 1.54			APC-3.5	25 x 34 x 87 200

Notes:

1. For calibration factor (CAL FACTOR) errors, see Table 2-5.
2. The linearity error for other than the maximum range can be ignored.

Table 2-5 Calibration Factor Errors (Units %)

FREQ	MA4701A		MA4703A		MA4705A		M4601A		M4603A		M4702A		M4704A	
	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS
0.1MHz	----	----	----	----	----	----	4.8	2.6	4.7	2.6	----	----	----	----
10MHz	4.7	2.6	----	----	----	----	4.1	2.5	4.2	2.5	5.2	2.7	----	----
100MHz	4.1	2.5	5.6	3.1	5.6	3.1	4.1	2.5	4.2	2.5	5.0	2.7	6.3	3.3
1GHz	4.1	2.5	5.6	3.1	5.6	3.1	4.1	2.5	4.2	2.5	5.0	2.7	6.3	3.3
2GHz	4.1	2.5	5.6	3.1	5.6	3.1	4.1	2.5	4.2	2.5	5.0	2.7	6.3	3.3
4GHz	4.7	2.6	5.8	3.2	5.8	3.2	4.2	2.5	----	----	5.3	2.7	6.3	3.3
6(5.5G)Hz	4.7	2.6	5.8	3.2	5.8	3.2	(4.2)	(2.5)	----	----	5.3	2.7	6.3	3.3
8GHz	5.7	2.8	6.8	3.4	6.8	3.4	----	----	----	----	5.8	3.0	7.1	3.5
10GHz	6.1	2.9	6.8	3.4	6.8	3.4	----	----	----	----	7.0	3.3	7.6	3.6
12GHz	6.1	2.9	6.8	3.4	6.8	3.4	----	----	----	----	7.0	3.3	8.1	3.8
14GHz	6.8	3.1	6.9	3.4	6.9	3.4	----	----	----	----	9.2	4.0	9.1	4.2
16GHz	6.8	3.1	6.9	3.4	6.9	3.4	----	----	----	----	9.2	4.0	9.1	4.2
18GHz	6.8	3.1	6.9	3.4	6.9	3.4	----	----	----	----	9.2	4.0	9.1	4.2
20GHz	----	----	10.1	5.1	10.1	5.1	----	----	----	----	----	----	15.0	6.3
22GHz	----	----	10.1	5.1	10.1	5.1	----	----	----	----	----	----	15.0	6.3
24GHz	----	----	10.1	5.1	10.1	5.1	----	----	----	----	----	----	15.0	6.3
26.5GHz	----	----	10.1	5.1	10.1	5.1	----	----	----	----	----	----	15.0	6.3
28GHz	----	----	----	----	12.9	6.1	----	----	----	----	----	----	----	----
30GHz	----	----	----	----	12.9	6.1	----	----	----	----	----	----	----	----
32GHz	----	----	----	----	12.9	6.1	----	----	----	----	----	----	----	----

Note:

MAX: Maximum error
RSS: Probable error

SECTION 3

OPERATION

3.1 Safety Measures

If power that exceeds the rated value is input to a sensor, the sensor and meter may be damaged.

Do not apply power over the maximum input power directly to a sensor.

The maximum input power of the sensors are shown below.

Sensor	Maximum average input power
MA4701A, MA4703A, MA4705A MA4601A, MA4603A	+25 dBm (300 mW)
MA4702A, MA4704A	+23 dBm (200 mW)

3.2 Usage and Storage Conditions

These sensors are designed to operate normally in an ambient temperature range of 0° to 50°C. For best operation however, they should be used at normal room temperature whenever possible. Do not use or store them in locations where

1. vibrations are severe
2. it is damp or dusty
3. there is exposure to direct sunlight
4. there is exposure to active gases
5. there is exposure to magnetism
6. oxidation or rusting may occur.

They should be stored in a temperature range of -25°C to 50°C, and a humidity range of 0% to 90%. They should be cleaned before storage. The storage area should not be subject to large fluctuations in temperature over a 24-hour period.

If they are operated at room temperature after being used or stored for a long period at low temperatures, condensation may occur and cause short-circuiting. To prevent this do not turn the power on until they are completely dry.

SECTION 4

PRINCIPLES OF OPERATION

4.1 Block Diagram

The power sensors block diagram is shown in Fig. 4-1. The MA4[ ]A Series power sensor consists of a detecting element which senses RF power, a chopper circuit which converts the sensed DC signal to an AC signal, and a pre-amplifier which amplifies the chopper output signal.

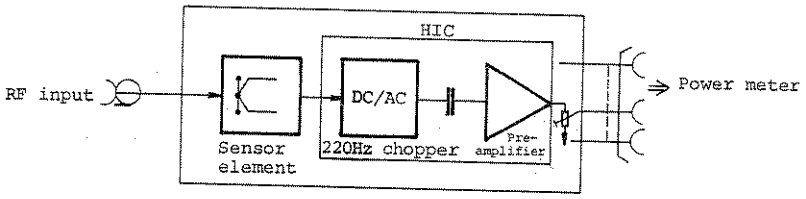


Fig. 4-1 MA4[ ] Series Power Sensor Block Diagram

4.2 Sensor Element

There are two kinds of power detection elements in the MA4[ ]A Series power sensors: One is a thermocouple-type element with an amorphous semiconductor which is mainly composed silicon and germanium (MA4701A, MA4703A, MA4705A, MA4601A, MA4603A), the other is a diode element (MA4702A, MA4704A).

4.2.1 Amorphous power sensor

The thermocouple-type power sensor is a power sensor which uses Seebeck's effect. This generates a potential difference between two different conductors when there is a temperature difference between the contact surfaces of the two conductors.

The Anritsu amorphous power sensor consists of a thermocouple with an amorphous silicon semiconductor. A diagram is shown in Fig. 4-2.

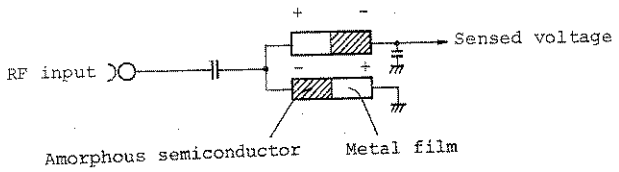


Fig. 4-2 Amorphous Thermocouple

Since the thermocouple power sensor can, in theory, detect the rms value of the true power, it is suitable for measuring the true power of CW, and modulated waves, etc.

4.2.2 Diode power sensor

The ANRITSU diode power sensor uses a zero-bias Schottky diode as the detecting element. Since the diode always operates in the square-law region, true power can also be measured, the same as the amorphous power sensor.

4.3 Chopper Circuit

The dc-voltage detected by the thermocouple or diode is at an extremely low level. When this signal is dc-amplified (DC AMP), the amplifier drift has a significant effect and accurate power measurement is difficult.

To eliminate the effect of amplifier drift, the ML4803A converts the detected voltage to an ac signal and amplifies this ac signal. The circuit that converts the dc signal to an ac signal is called a chopper circuit. The chopper circuit converts the dc signal to a 220 Hz ac signal. Its principle of operation is shown in Fig. 4-3.

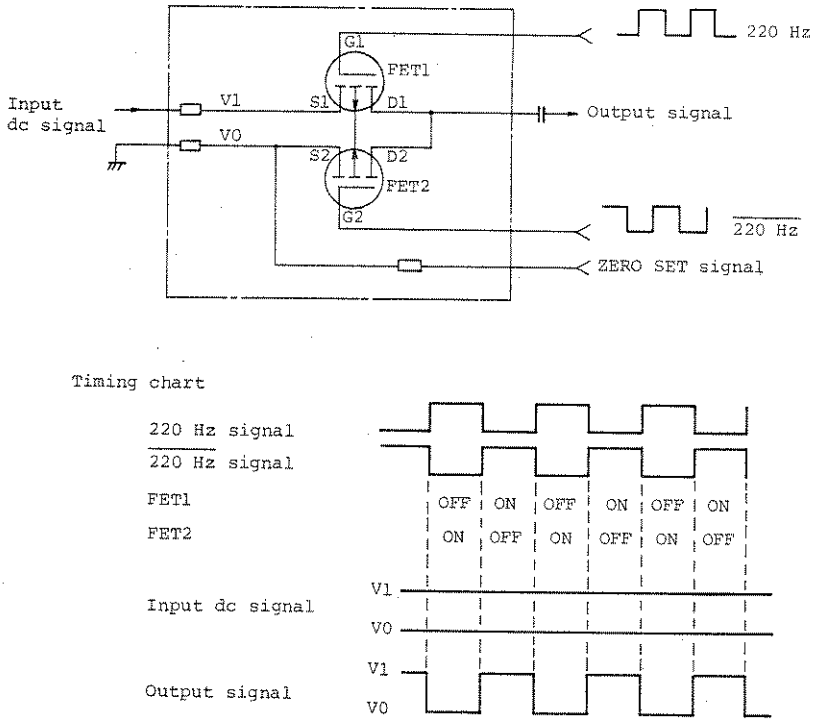


Fig. 4-3 Chopper Circuit

4.4 Preamplifier

The overall noise of a measuring instrument largely depends on the noise generated by the preamplifier. Therefore, the preamplifier must have low noise and low drift characteristics. The MA4[ ]A series sensor has low noise and drift characteristics as a result of a hybrid IC (HIC) which contains the chopper circuit and preamplifier.

The amorphous power sensor and diode power sensor have different detection sensitivities and are matched to the indicator by changing the preamplifier gain.

SECTION 5

PERFORMANCE TEST

5.1 Introduction

When an acceptance inspection for this equipment is required, perform the performance check according to paragraph 5.2.

5.2 VSWR (Voltage Standing Wave Ratio) Performance Test

The maximum VSWR and reflection coefficient of the power sensors are given in Table 5-1.

Measure the power sensor VSWR with a measuring system that satisfies the VSWR measurement accuracy given in Table 5-1 (Newtork analyzer, etc).

Table 5-1 VSWR and Reflection Coefficient

MA4[ ]A Series Power Sensor

(1) Amorphous power sensor

Model	Frequency range	VSWR measurement accuracy	Measured value	Maximum VSWR (reflection coefficient)
MA4701A	10 to 30 MHz	±0.03	———	<1.4 (0.166)
	30 to 50 MHz	±0.02	———	<1.18 (0.083)
	50 MHz to 2 GHz	±0.02	———	<1.10 (0.048)
	2 to 12.4 GHz	±0.02	———	<1.18 (0.083)
	12.4 to 18 GHz	±0.025	———	<1.28 (0.123)
MA4703A	50 to 100 MHz	±0.02	———	<1.15 (0.069)
	0.1 to 2 GHz	±0.02	———	<1.10 (0.048)
	2 to 12.4 GHz	±0.02	———	<1.15 (0.069)
	12.4 to 18 GHz	±0.02	———	<1.20 (0.090)
	18 to 26.5 GHz	±0.025	———	<1.25 (0.111)
MA4705A	26.5 to 32 GHz	±0.04	———	<1.5 (0.200)
MA4601A	100 to 300 kHz	±0.03	———	<1.3 (0.130)
	300 kHz to 1 MHz	±0.02	———	<1.2 (0.090)
	1 MHz to 4 GHz	±0.02	———	<1.1 (0.048)
	4 to 5.5 GHz	±0.02	———	<1.2 (0.090)
MA4603A	100 to 300 kHz	±0.03	———	<1.4 (0.166)
	300 kHz to 2 GHz	±0.02	———	<1.15 (0.069)

(2) Diode power sensor

Model	Frequency range	VSWR measurement accuracy	Measured value	Maximum VSWR (reflection coefficient)
MA4702A	10 to 30 MHz	±0.03	———	<1.4 (0.166)
	30 MHz to 4 GHz	±0.02	———	<1.15 (0.069)
	4 to 8 GHz	±0.02	———	<1.2 (0.090)
	8 to 18 GHz	±0.03	———	<1.3 (0.130)
MA4704A	50 to 4 GHz	±0.02	———	<1.15 (0.069)
	4 to 8 GHz	±0.02	———	<1.2 (0.090)
	8 to 18 GHz	±0.03	———	<1.3 (0.130)
	18 to 26.5 GHz	±0.05	———	<1.54 (0.212)

SECTION 6

MAINTENANCE

6.1 Required Instruments

Table 6-1 Required Instruments

Instrument	Required performance
Ohmmeter	Measurement range : 1 Ω to 100 kΩ Accuracy: ±5%
Multimeter	Resistance measurement range: 10 Ω to 100 k Ω (Measurement current: 0.6 mA)

6.2 Mechanical Construction and Parts Layout

The mechanical construction assembly of each part is shown in Fig. 6-1.

For a description of the power sensor disassembly and reassembly procedures, see SECTION 7.

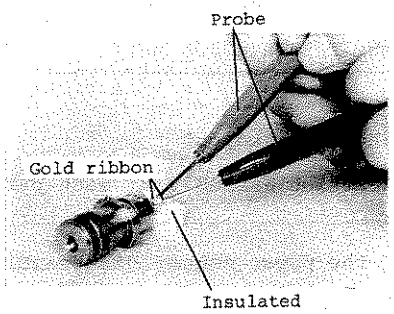
6.3 Troubleshooting

The power sensor basically consists of a detecting element (Z1 module) and an amplifier (Z2 amp).

Troubleshoot the power sensor using the following flowchart.

Disassemble power sensor as described in SECTION 7 and remove detecting element (Z1 module).

Measure detecting element resistance. The figure below shows an example of probe operation when troubleshooting the sensor. The bulkhead assembly should be placed on an insulated stand so that a load is not applied to the lead wires (gold ribbons).



Element resistance within range in Table 6-2?

No → Detecting element (Z1 module) faulty

Yes

Z2 amp faulty

CAUTION

Measure the element resistance by measuring the resistance across the two leads (gold ribbon) coming from the Z1 module.

The Z1 module is extremely sensitive to electrical and mechanical shock. When measuring the element resistance, prevent static electric charges and do not apply unnecessary force to the two leads. For a description of static electricity prevention, see paragraph 7.2.

Table 6-2 Element Resistance

Sensor	Element resistance
MA4701A MA4703A MA4705A MA4601A	200 Ω ±1.4 Ω *1
MA4603A	300 Ω ±20 Ω *1
MA4702A MA4704A	Forward direction ≦600 Ω *2 Reverse direction ≧3 kΩ *2

*1 Measured with ohmmeter

*2 Measured with multimeter of 0.6 mA

NO.	PARTS NO.	DESCRIPTION	Q'TY	NOTE
(1)	———	BULKHEAD ASSEMBLY	1	REFER TO Fig. 6-1 2/2
(2)	———	CONNECTOR: ASSEMBLY	(1)	
(3)	———	MODULE ASSEMBLY	(1)	
(4)	MA[ ]AZ	AMP SECTION ASSEMBLY (FOR MA4701A, MA4703A, MA4705A, MA4601A, MA4603A)	1	
		AMP SECTION ASSEMBLY (FOR MA4702A, MA4704A)	1	
(5)	———	AMP BOARD ASSEMBLY	(1)	
(6)	———	LEAD CLAMP ASSEMBLY	(1)	
(7)	———	OUTPUT CONNECTOR	(1)	
(8)	———	FLANGE	(1)	
(9)	———	FLEXIBLE PKG	(1)	
(10)	———	INSIDE CASE (DOWN)	(1)	
(11)	42H13229	INSIDE CASE (UP)	1	
(12)	44H85808	SHIELD PLATE	2	
(13)	44Y88402 A~G	OUTSIDE CASE (UP)	1	WITH NAME PLATE
(14)	44Y88403 A~G	OUTSIDE CASE (DOWN)	1	WITH CALFACTOR PLATE
(20)	2FPS4S7	SCREW	8	

NOTE:

1. BULKHEAD ASSEMBLY (1) consists of CONNECTOR ASSEMBLY (2) and MODULE ASSEMBLY (3)

2. AMP SECTION ASSEMBLY (4) consists of AMP BOARD ASSEMBLY (5), LEAD CLAMP ASSEMBLY (6), OUTPUT CONNECTOR (7), FLANGE (8), FLEXIBLE PKG (9) and INSIDE CASE 10

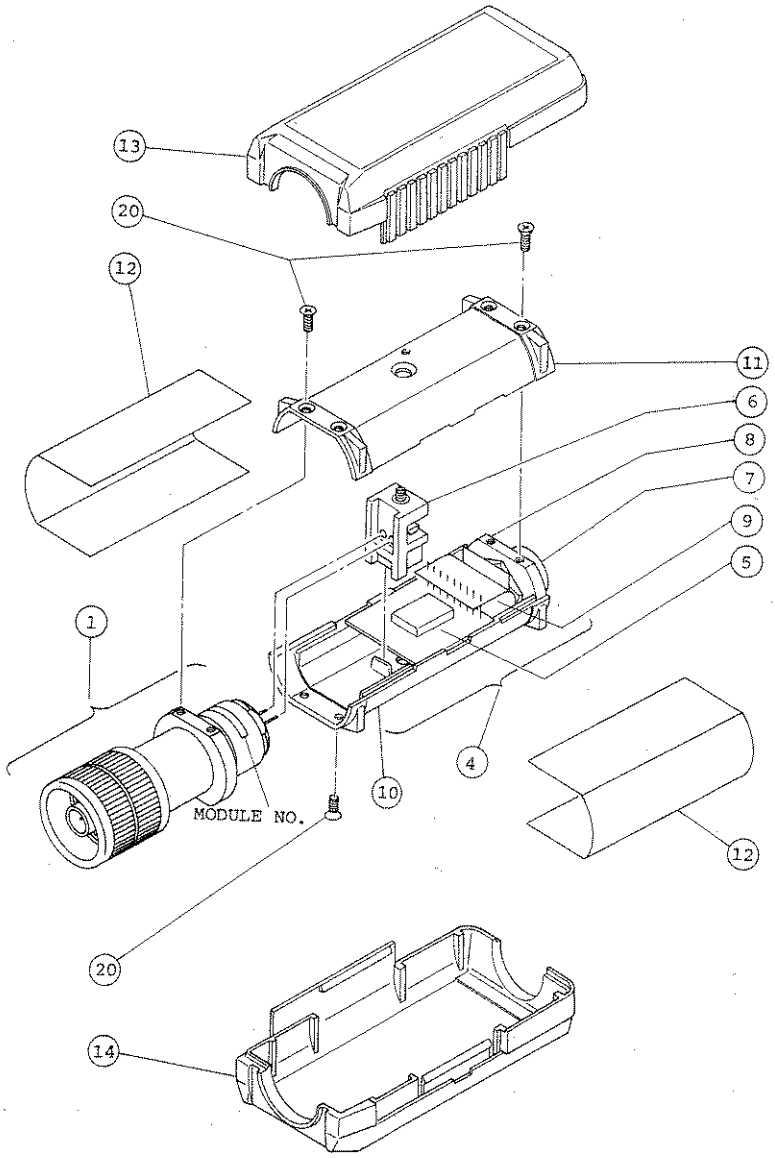


Fig. 6-1 Mechanical Construction (Assembly) 1/2

NO.	PARTS NO.	DESCRIPTION	Q'TY	NOTE
①	———	BULKHEAD ASSEMBLY	(1)	
②	MA4[ ]AJ	CONNECTOR ASSEMBLY (N) (FOR MA4701A, MA4601A)	1	
		CONNECTOR ASSEMBLY (N) (FOR MA4702A)	1	
		CONNECTOR ASSEMBLY (NC) (FOR MA4603A)	1	
		CONNECTOR ASSEMBLY (APC3.5) (FOR MA4703A, MA4705A, MA4704A)	1	
⑮	———	CONNECTOR SHELL	(1)	
⑯	———	CENTER CONDUCTOR ASSEMBLY	(1)	
⑰	———	RING	(1)	
⑱	———	CONTACT SPRING	(1)	
⑲	———	CAP	(1)	
③	MA4701AM	MODULE ASSEMBLY (FOR MA4701A ONLY)	1	
	MA4703AM	MODULE ASSEMBLY (FOR MA4703A ONLY)	1	
	MA4705AM	MODULE ASSEMBLY (FOR MA4705A ONLY)	1	
	MA4601AM	MODULE ASSEMBLY (FOR MA4601A ONLY)	1	
	MA4603AM	MODULE ASSEMBLY (FOR MA4603A ONLY)	1	
	MA4702AM	MODULE ASSEMBLY (FOR MA4702A ONLY)	1	
	MA4704AM	MODULE ASSEMBLY (FOR MA4704A ONLY)	1	

NOTE:

1. CONNECTOR ASSEMBLY ② consists of CONNECTOR SHELL ⑮, CENTER CONDUCTOR ASSEMBLY ⑯, RING ⑰, CONTACT SPRING ⑱ and CAP ⑲.

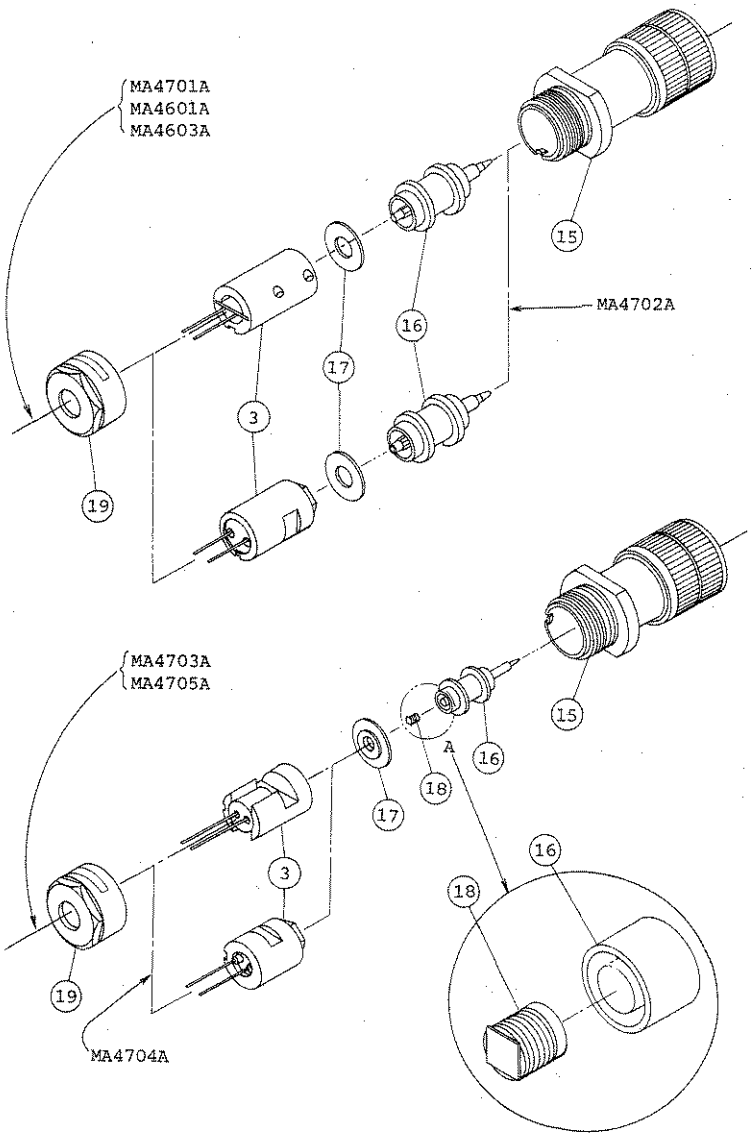


Fig. 6-1 Mechanical Construction (continued) 2/2
(BULKHEAD ASSEMBLY details)

SECTION 7

DETECTING ELEMENT FIELD REPLACEMENT

The internal detecting element (Z1 module) of the MA4701A, MA4703A, MA4705A, MA4601A, and MA4603A amorphous sensors can be replaced in the field. The detecting element of the MA4702A and MA4704A diode sensors cannot be replaced in the field.

Most power sensor troubles are caused by a damaged detecting element (burnt out by overinput). In this case, the down time can be greatly shortened by replacing the detecting element in the field if absolutely necessary.

Replace the detecting element of the amorphous sensors carefully, based on a complete understanding of the work procedures and precautions described below.

Tools for field replacement are listed in Table 7-1, and these tools can be easily used in the field.

Table 7-1 Required Tools for Field Replacement

No.	Tool	Anritsu part No.
1	Flat-bladed torque screwdriver	Z0068
2	Wrench	Z0069
3	Torque wrench	Z0070
4	Phillips screwdriver	Z0071
5	Tweezer	Z0072
6	Flat-bladed screwdriver	Z0073

7.1 Description

The detecting element is the most important part of the power sensor and governs its power measurement accuracy. For this reason, the power sensor should be returned to the factory for repairs (detecting element replacement, preamp replacement, etc.), adjustment, and calibration. However, if the user can check performance (VSWR measurement) after the detecting element has been replaced, or if emergency repairs are absolutely necessary, the detecting element can be replaced in the field as described below.

The detecting element is modular and is replaced in the field by changing this module. The detecting element module connects directly to the power sensor input coaxial connector. The contact at this part has an affect on the VSWR characteristic of the power sensor. The detecting element module is also very sensitive to electric shock and must be handled with care. Therefore, it is recommended that detecting element field replacement be performed by an electronics technician.

Besided the replacement element (module), calibration factor (CAL FACTOR) data is also supplied (label on case) as a field replacement part. When the detecting element has been replaced in the field, the CAL FACTOR accuracy may be somewhat higher than the catalog value.

The field replacement CAL FACTOR error is given in Table 7-2.

Table 7-2 Field Replacement CAL FACTOR Error
(Units %)

MAX: Maximum error
RSS: Probable error

	Sensor									
	MA4701A		MA4703A		MA4705A		MA4601A		MA4603A	
	Error									
Frequency	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS	MAX	RSS
0.1MHz	-	-	-	-	-	-	6.6	2.7	6.8	2.9
10MHz	7.0	2.9	-	-	-	-	5.1	2.6	5.4	2.6
100MHz	5.1	2.6	7.0	3.2	7.0	3.2	5.1	2.6	5.4	2.6
1GHz	5.1	2.6	7.0	3.2	7.0	3.2	5.1	2.6	5.4	2.6
2GHz	5.1	2.6	7.0	3.2	7.0	3.2	5.1	2.6	5.4	2.6
4GHz	6.4	2.7	7.6	3.4	7.6	3.4	5.4	2.6	-	-
6GHz (5.5GHz)	6.4	2.7	7.6	3.4	7.6	3.4	(6.0)	(2.7)	-	-
8GHz	7.4	3.0	8.6	3.6	8.6	3.6	-	-	-	-
10GHz	8.3	3.2	8.6	3.6	8.6	3.6	-	-	-	-
12GHz	8.3	3.2	8.6	3.6	8.6	3.6	-	-	-	-
14GHz	9.7	3.6	9.2	3.7	9.2	3.7	-	-	-	-
16GHz	9.7	3.6	9.2	3.7	9.2	3.7	-	-	-	-
18GHz	9.7	3.6	9.2	3.7	9.2	3.7	-	-	-	-
20GHz	-	-	13.8	5.6	13.8	5.6	-	-	-	-
22GHz	-	-	13.8	5.6	13.8	5.6	-	-	-	-
24GHz	-	-	13.8	5.6	13.8	5.6	-	-	-	-
26.5GHz	-	-	13.8	5.6	13.8	5.6	-	-	-	-
28GHz	-	-	-	-	19.0	7.3	-	-	-	-
30GHz	-	-	-	-	19.0	7.3	-	-	-	-
32GHz	-	-	-	-	19.9	7.3	-	-	-	-

7.2 Static Electricity Prevention at Power Sensor Disassembly, Repair and Reassembly

The MA4[ ]A Series power sensors use an amorphous semiconductor/Schottky barrier diode as the detecting element.

The preamp uses a CMOS field effect translation (FET) and a low-noise operational amplifier (OP AMP). These parts are extremely sensitive to external static electricity induction and static electricity leakage from the human body. When disassembling, repairing, and reassembling the power sensor, prevent static electricity.

Use the following static electricity prevention measures:

1. Ground the instruments, electrical facilities, and work bench to a common ground. It is recommended that a conductive mat be placed on the work bench and work be done on this mat. To prevent electric shock by electric leakage, always ground the conductive mat through a resistance of about 1 MΩ.

2. Ground the worker's body. To prevent electric shock by electric leakage, always ground the worker's body through a resistance of abut 1 MΩ.

3. Check that there is no electricity leaking from surrounding electrical facilities.

7.3 Field Replacement Procedure

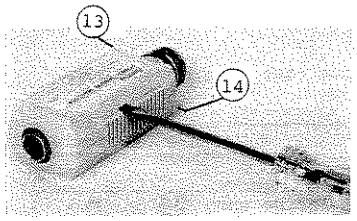
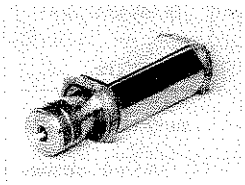
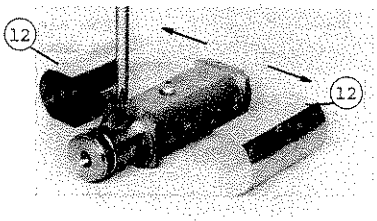
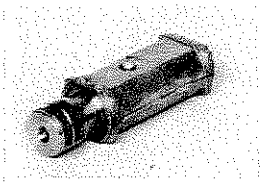
7.3.1 Field replacement detecting element handling precautions

The field replacement detecting element (Z1 module) is housed in a metal case. Do not remove it from the case except when necessary.

Do not place the removed detecting element on a plastic or vinyl container that is easily charged with static electricity.

7.3.2 Power sensor disassembly (See Fig. 6-1)

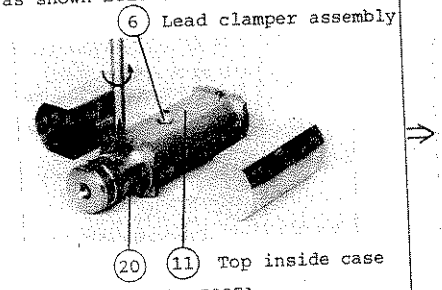
Disassemble the power sensor in the following order:

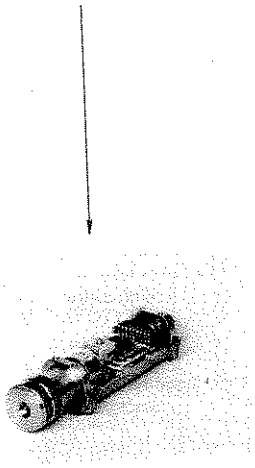
Step	Procedure
1	Remove the outside cases (13) and (14). The cases can be removed easily by inserting the end of a flat bladed screwdriver into the groove in the case and twisting the screwdriver as shown below.  required tool: Z0073 Outside case (13) : Case with Name Plate Outside case (14) : Case with CAL FACTOR label 
2	Remove the two shield plates (12); Slide the two shield plates in the direction of the arrow.  

(continued)

Step	Procedure
3	Remove the top inside case (11) ;

remove the case by removing the four mounting screws (20) at the top inside case (11) (the case at which the head of the lead clamper assembly (6) screw is visible is the top inside case) and lifting the case gently as shown below.

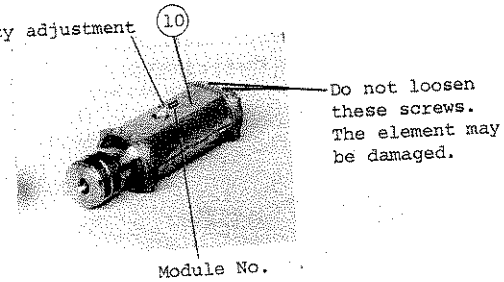




required tool: Z0071

Note:

Do not remove the bottom inside case (10) (case where the sensor sensitivity adjuster ⊘ is visible). The top and bottom side cases are the same shape. Do not confuse them.



Step	Procedure

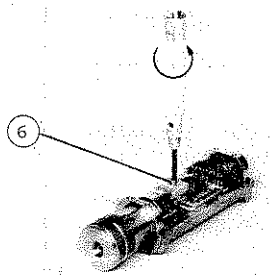
4 Remove the bulkhead assembly (1). The bulkhead assembly is the part consisting of the input connector J1 and detecting element (Z1 module).

CAUTION

Follow the operation order; if the wrong order is followed, the sensor may be damaged.

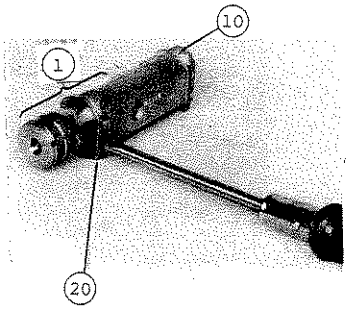
(1) First, insert the screwdriver into the solot in the head of the lead clamper assembly (6) screw and loosen the screw by turning it in the arrow direction as shown below.

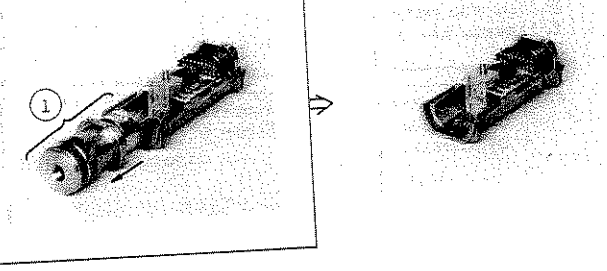
required tool:
Z0068



(2) Next, in the state shown below, while firmly holding the bulkhead assembly (1) and bottom inside case (10) with your hand, unscrew the mounting screws (20) at the bulkhead assembly (1) in the arrow direction with a screwdriver, and remove them.

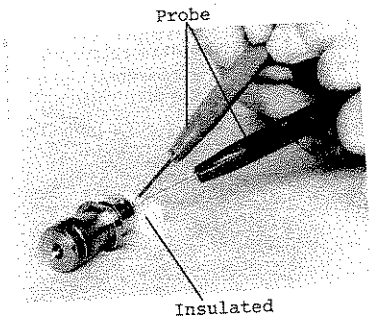
required tool:
Z0071



Step	Procedure
(3)	Finally, slowly side the bulkhead assembly (1) in the arrow direction and remove it as shown below. 

This completes basic disassembly. SECTION 6 troubleshooting and Z2 amp repair and replacement are performed in this state.

The figure below shows an example of probe operation when troubleshooting the sensor. The bulkhead assembly (1) should be placed on an insulated stand so that a load is not applied to the lead wires (gold ribbons).



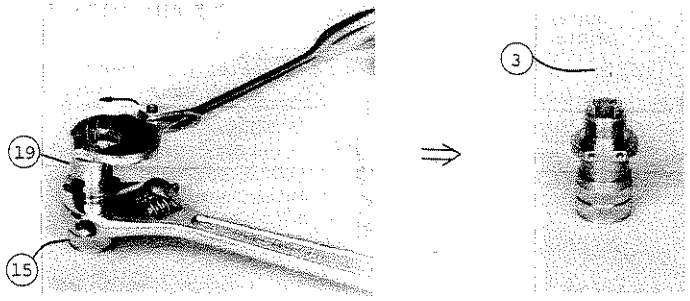
7.3.3 Detecting element replacement

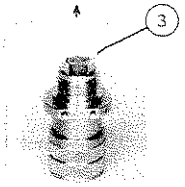
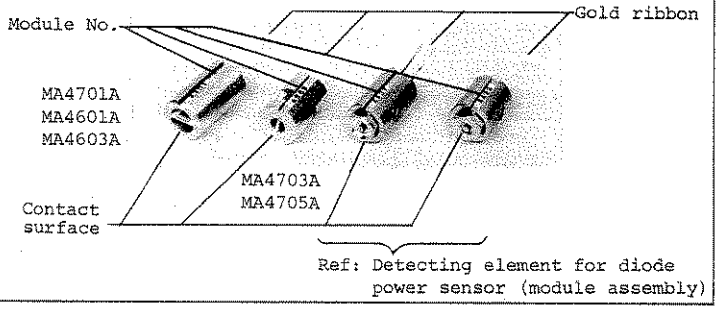
Replace the detecting element after further disassembly in the order described below.

NOTE:

The interior parts (detecting element [module assembly] (3), center conductor assembly (16), ring (17), contact spring (18)) are held by cap (19). They are freed by loosening cap (19).

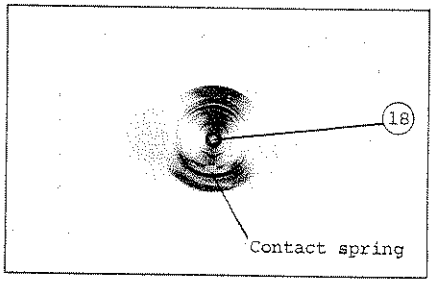
Perform the procedures described below with the connector at the bottom and the sensor vertical as shown in each figure. Never work with the sensor tilted or facing downward; the interior parts will fall out and may be damaged or lost.

Step	Procedure
1	Remove cap (19). Hold the flange of the connector shell (15) with a wrench, or clamp it in a vice, and turn the cap in the arrow direction with a torque wrench. Remove the cap upward as shown in the figure below so that the gold ribbons of the detecting element (module assembly) (3) are not damaged.  required tool: Z0069, Z0070

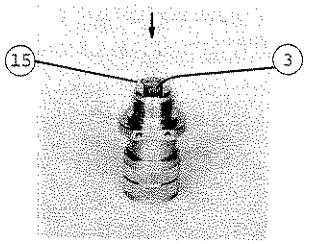
Step	Procedure
2	Pull out the detecting element (3) in the arrow direction (upward) as shown in the figure below.  Note: There is a groove in the detecting element (module assembly) (3) which guides the element along the connector shell (15) tab. Do not turn this groove.
3	Insert the replacement detecting element (module assembly). Notes: 1. There are two types replacement detecting element (module assembly) below. Handle it carefully and do not touch the contact surface indicated by arrow in the figure and gold ribbons. 

Step	Procedure

2. Before inserting the detecting element (module assembly), always check that the contact spring (18) is at the center. Also check that there is not dirt etc. inside the detecting element.



Align the connector shell (15) tab and detecting element (module assembly) (3) groove and insert the detecting element gently.



4 Install the cap (19).

Pass the gold ribbons of the detecting element (module assembly) (3) through the hole in the cap (19) and tighten the cap slowly so that the gold ribbons are not damaged.
This is the opposite of step 1.
(Tighten the cap to a torque of about 20 kg.)

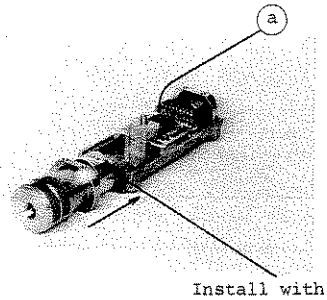
The above completes detecting element (module assembly) replacement.

7.3.4 Power sensor reassembly

Basically, the power sensor is reassembled in the opposite order of disassembly. However, when the detecting element is replaced in the field, the detection sensitivity must be readjusted.

Reassemble the power sensor in the following order:

Step	Procedure
1	Install the bulkhead assembly (1).
	(1) First, while pressing the (a) part of the amp board assembly (5) against the bottom inside case (10) with your hand, pass the gold ribbons of the bulkhead assembly (1) through the hole in the lead clamper assembly (6) and assemble the sensor so that it is on the amp board assembly. Always install the bulkhead assembly (1) so that the module No. on the cap (19) is at the top. If installed in the opposite direction, the polarity will be changed and the sensor will not operate.



Install with the module No. at the top

(continued)

Step	Procedure

(2) Next, refer to step 4-(3) in paragraph 7.3.2 and tighten the two mounting screws (20) and fix the bulkhead assembly (1) to the bottom inside case (10).

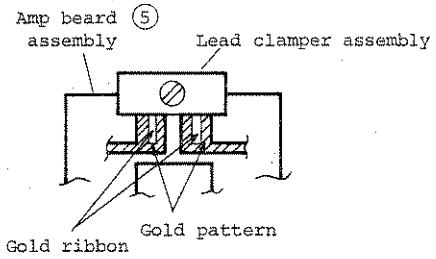
Note:

Recheck that the module No. on the cap (19) is visible.

(3) Finally, refer to step 4-(1) in paragraph 7.3.2 and turn the screw in the direction opposite the arrow and connect the gold ribbons and amp board assembly (5) with the lead clamper assembly (6).

Note:

At this time, check that the gold ribbons are touching the gold pattern of the amp board.



If the gold ribbons are not touching the gold pattern, adjust the position of the ribbons with tweezers (Z0072), etc.

2 Refer to step 3 of paragraph 7.3.2 and install the top inside case (11).

7.3.5 Power sensor sensitivity readjustment (Z2 amp gain adjustment)

After work is completed up to step 2 of paragraph 7.3.4, readjust the power sensor sensitivity.

The sensitivity of each detecting element is different. After field replacement, the power sensor sensitivity is readjusted to match the ML4803A, or other power meter, by adjusting the gain of the Z2 amp. Note that the function of this sensitivity adjustment is different from that of "Sensor Sensitivity Adjustment" described in paragraph 4.1.5 of the ML4803A Power Meter operation manual.

Connect the power sensor with the new detecting element module to an MA4803A Power Meter, and adjust its sensitivity as described in the following procedure. When turning on the ML4803A Power Meter power, initialize the internal settings. (See paragraph 4.1.3 of the ML4803A operation manual.)

Step	Procedure
1	Read the REFERENCE CAL FACTOR from the label on the outside of the case of the replacement detecting element. (See Fig. 7-1.)

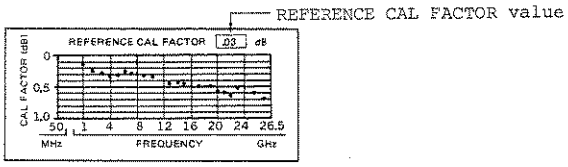


Fig. 7-1 REFERENCE CAL FACTOR

Note:

The REFERENCE CAL FACTOR value is different for each sensor and each detecting element.

(continued)

Step	Procedure

The REFERENCE CAL FACTOR of the MA4701A, MA4703A, MA4705A, MA4601A, MA4702A, and MA4704A 50 Ω sensors matches the REFERENCE CAL FACTOR at 50 MHz.

To compensate for the 50 Ω ↔ 75 Ω conversion connector loss, the REFERENCE CAL FACTOR value (at 50 MHz) + 0.18 dB (50 Ω ↔ 75 Ω connector loss compensation component) is set as the REFERENCE CAL FACTOR value of the MA4603A 75 Ω sensor.

2 Set the read value at CAL F of the ML4803A.

Setting method:

(1) Select CAL F with the SELECT key.

(2) Set the value read at step 1 with the rotary encoder (Fig. 7-2).

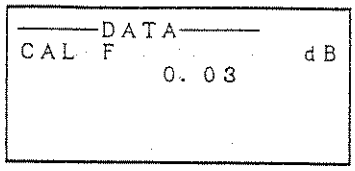


Fig. 7-2 REFERENCE CAL FACTOR Setting

(continued)

Step	Procedure

3 Connect the sensor to the ML4803A CAL OUTPUT connector.

The connection method differs with the sensor.

(1) Connect the MA4701A or MA4601A Sensor directly to the CAL OUTPUT connector.

(2) Connect the MA4703A or MA4705A Sensor to the CAL OUTPUT connector through an N-APC3.5 Conversion Connector (Optional accessory) as shown in Fig. 7-3.

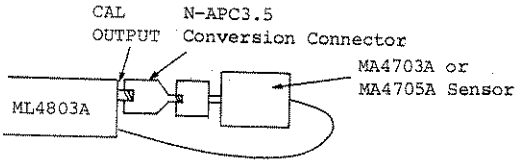


Fig. 7-3 MA4703A and MA4705A Sensitivity Calibration

(3) Connect the MA4603A Sensor to the CAL OUTPUT connector through a 50 ↔ 75 Ω Conversion Connector (Optional accessory)

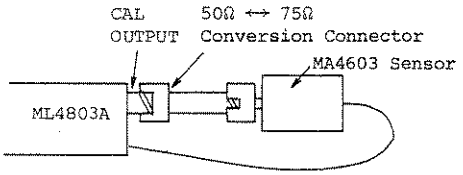


Fig. 7-4 MA4603A Sensitivity Calibration

Step	Procedure

Notes:

1. Connect the MA4702A sensor to the CAL OUTPUT connector through an MP47A 30 dB Attenuator (Optional accessory) as shown in Fig.7-5.

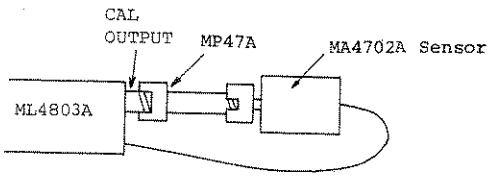


Fig. 7-5 MA4702A Sensitivity Calibration

2. Connect the MA4704A sensor to the CAL OUTPUT connector through an MP47A 30 dB Attenuator and N-APC3.5 Conversion Connector as shown in Fig. 7-6.

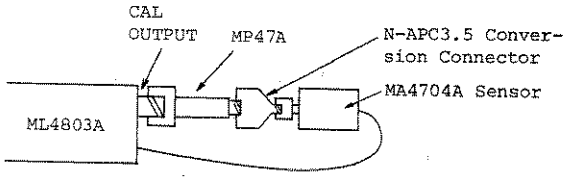
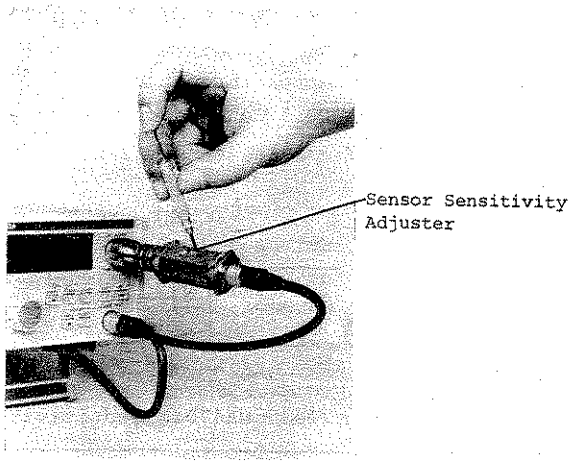


Fig. 7-6 MA4704A Sensitivity Calibration

(continued)

Step	Procedure
4	Press the ML4803A CAL OUTPUT ON key; the key lamp lights and a 50 MHz, 0 dBm calibration signal is output.
5	Adjust the power sensor sensitivity adjuster ⊘ to obtain an ML4803A Power Meter indication of 0.00 dBm (1.000 mW). At this time, do not press the ML4803A (CAL) ADJ key. Note: Adjust the sensor sensitivity adjuster of the MA4702A and MA4704A power sensors to obtain a power meter indication of -30.00 dBm (1.000 µW).



(continued)

Step	Procedure
6	The above step completes sensitivity adjustment after field replacement. Disconnect the power sensor from the ML4803A Power Meter and proceed to the next assembly step.
7	Install the two shield plates (12). This is the opposite of paragraph 7.3.2 step 2.
8	Install the outside cases (13) and (14). Set the sensor body in one outside case (13) and install other outside case (14) from the top and fit the two cases together. Note: When the detecting element is replaced, always exchange the outside case (14) (case with the calibration factor factor label) with the outside case of the replacement detecting element. An outside case with CAL FACTOR data label is supplied with the replacement detecting element.
9	The above step completes sensor reassembly.

SECTION 8

REPLACEABLE PARTS

8.1 Introduction

This section contains information about ordering replacement parts of components. The following table shows circuit references (hereafter: CKT REF) and abbreviations used for items in the Parts Lists. The quantity of each item in the Parts List is "one".

(1) Circuit reference

AT:	Attenuator	K:	Relay	Q:	Transistor, diode, IC, rectifier	V:	Neon lamp, vacuum tube
C:	Capacitor	L:	Coil, microinductor	R:	Resistor	X:	Crystal OSC
F:	Fuse	M:	Meter, timer	S:	Switch	Z:	Unit
J:	Jack, plug, connector	P:	Lamp	T:	Transformer		

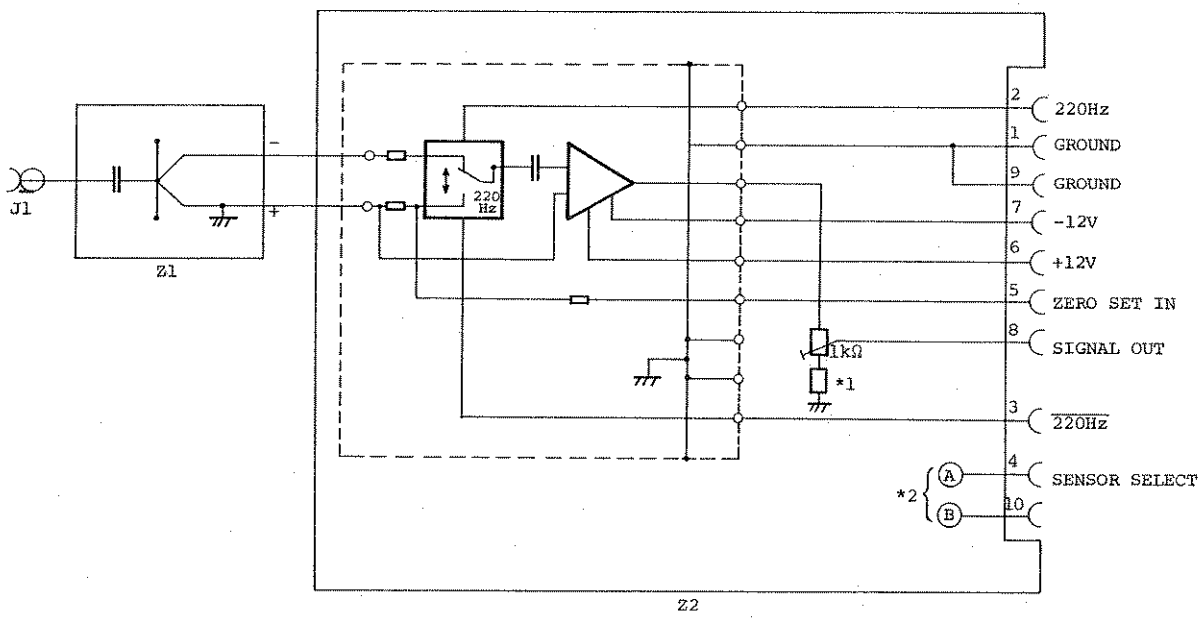
(2) Abbreviations

A:	amperes	Multi:	multiplying
Att, R var:	variable attenuator using film elements	N-ch:	N-channel
		non-lin:	non-linear taper
BL:	boundary layer	Non-pol:	non polarity
Cer:	ceramic	NPN:	negative-positive-negative
CF:	carbon film	Ω:	ohms
Comp:	composition	p:	pico (x 10^{-12})
CRT:	cathode-ray tube	Plast:	plastic film
Di:	diode	PMTR:	potentiometer
DIP:	dual in-line package	PNP:	positive-negative-positive
Elect:	electrolytic aluminum	p-p:	peak-to-peak value
F:	farad	RFC:	RF choke
FET:	field-effect transistor	R-lamp:	resistor lamp
G:	ground	rms:	effective value (root-mean-square)
Ge:	germanium	SBD:	Schottky barrier diode
H:	henry	SCR:	silicon-controlled rectifier
Hz:	hertz	Si:	silicon
IC:	integrated circuit	SRD:	step-recovery diode
IEC:	Conforms to IEC Safety Standards.	Tant:	tantalum
J-FET:	junction FET	TM:	time-lag
k:	kilo (x 10^{3})	Tr:	transistor
LED:	light-emitting diode	Trans:	transformer
M:	mega (x 10^{6})	μ:	micro (x 10^{-6})
m:	milli (x 10^{-3})	V:	volt
MF:	metallized film	Var:	variable
MOS-FET:	metal-oxide semiconductor FET	WW:	wire-wound
M paper:	metallized paper	XTAL:	crystal
M plast:	metallized plastic film		

8.2 Ordering Information

When ordering parts, please give the following descriptions by referring to the Parts List of Table 8-1.

Item		Example
(1)	Name of Instrument	POWER SENSOR MA4701A
(2)	CKT REF	J1
(3)	Name of Part	MA4701AJ
(4)	Quantity	1
(5)	Serial No. of Instrument	M31257



*1 Temperature compensation posister (MA4702A, MA4704A only)

*2 Sensor test signal

Sensor	A	B
MA4701A, MA4703A MA4705A MA4601A, MA4603A	GROUND (0V)	OPEN
MA4702A, MA4704A	OPEN	-12V

Fig. 8-1 MA4[ ]A Series Power Sensor Circuit Diagram

Table 8-1 MA4[ ]A Series Power Sensor Parts List

	CKT REF		
Sensor	J1	Z1	Z2
MA4701A	MA4701AJ Connector	MA4701AM Module	MA4701AZ Amplifier
MA4703A	MA4703AJ Connector	MA4703AM Module	MA4703AZ Amplifier
MA4705A	MA4705AJ Connector	MA4705AM Module	MA4705AZ Amplifier
MA4601A	MA4601AJ Connector	MA4601AM Module	MA4601AZ Amplifier
MA4603A	MA4603AJ Connector	MA4603AM Module	MA4603AZ Amplifier
MA4702A	MA4702AJ Connector	MA4702AM Module	MA4702AZ Amplifier
MA4704A	MA4704AJ Connector	MA4704AM Module	MA4704AZ Amplifier