ML428B

Interference/Field Strength Meter

Operation Manual

Fourth Edition

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

ANRITSU CORPORATION

Document No.: M-W0284AE-4.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Insure that you clearly understand the meanings of the symbols BEFORE using the equipment. Some or all of the following five symbols may not be used on all Anritsu equipment. In addition, there may be other labels attached to products which are not shown in the diagrams in this manual.

Symbols used in manual

DANGER ⚠ This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.

WARNING ⚠ This indicates a hazardous procedure that could result in serious injury or death if not performed properly.

CAUTION ⚠ This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Insure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.

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

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

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

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

These indicate that the marked part should be recycled.

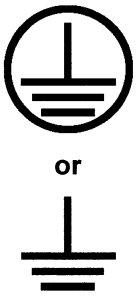
ML428B
Interference/Field Strength Meter
Operation Manual

1 October 1985 (First Edition)
21 July 2004 (Fourth Edition)

For Safety

WARNING ⚠

1. Measurement Categories
   This instrument is designed for Measurement category I (CAT I). Don't use this instrument at the locations of measurement categories from CAT II to CAT IV.
   In order to secure the safety of the user making measurements, IEC 61010 clarifies the range of use of instruments by classifying the location of measurement into measurement categories from I to IV.
   The category outline is as follows:
   Measurement category I (CAT I):
   Secondary circuits of a device connected to an outlet via a power transformer etc.
   Measurement category II (CAT II):
   Primary circuits of a device with a power cord (portable tools, home appliance etc.) connected to an outlet.
   Measurement category III (CAT III):
   Primary circuits of a device (fixed equipment) to which power is directly supplied from the power distribution panel, and circuits from the distribution panel to outlets.
   Measurement category IV (CAT IV):
   All building service-line entrance circuits through the integrating wattmeter and primary circuit breaker (power distribution panel).



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

For Safety

WARNING ⚠

Repair

WARNING⚠

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

Falling Over

4. This equipment should be used in the correct position. If the cabinet is turned on its side, etc., it will be unstable and may be damaged if it falls over as a result of receiving a slight mechanical shock.
   And also DO NOT use this equipment in the position where the power switch operation is difficult.

LCD

5. This instrument uses a Liquid Crystal Display (LCD); DO NOT subject the instrument to excessive force or drop it. If the LCD is subjected to strong mechanical shock, it may break and liquid may leak.
   This liquid is very caustic and poisonous.
   DO NOT touch it, ingest it, or get in your eyes. If it is ingested accidentally, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, irrigate them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash it off carefully and thoroughly.

For Safety

CAUTION ⚠

Replacing Fuse

CAUTION ⚠

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

   T___A indicates a time-lag fuse.
   ___A or F___ A indicate a normal fusing type fuse.

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

Cleaning

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

Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories including the National Institute of Advanced Industrial Science and Technology, and the National Institute of Information and Communications Technology, and was found to meet the published specifications.

Anritsu Warranty

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

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

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

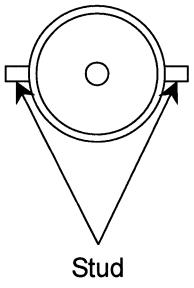
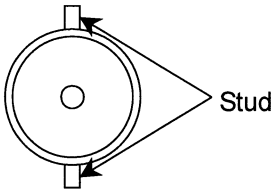
Anritsu Corporation will not accept liability for equipment faults due to unforeseen and unusual circumstances, nor for faults due to mishandling by the customer.

Anritsu Corporation Contact

If this equipment develops a fault, contact Anritsu Service and Sales offices at the address at the end of paper-edition manual or the separate file of CD-edition manual.

BNC-TYPE CONNECTOR INSTALLATION

The BNC-type connector installation has been modified as follows:

Before Modification	After Modification
	

N O T E

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

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

In the case of other voltage operation, change the connections of the power supply transformer, and the plate of voltage and current designations on the rear panel should be changed to suitable one. Order the plates from ANRITSU CORP. if necessary.

(See the service manual, Fig. 4-3 and circuit diagram 2)

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

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

**Vac	***A
100 to 127 V	1 A
200 to 250 V	0.5 A

Power Line Fuse Protection

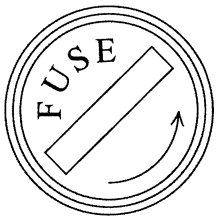
For safety, Anritsu products have either one or two fuses in the AC power lines as requested by the customer when ordering.

Single fuse: A fuse is inserted in one of the AC power lines.

Double fuse: A fuse is inserted in each of the AC power lines.

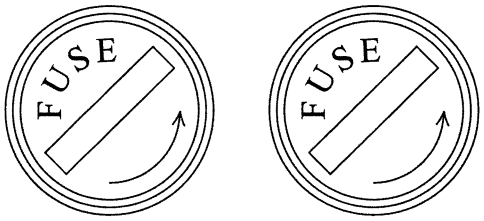
Example 1: An example of the single fuse is shown below:

Fuse Holder



Example 2: An example of the double fuse is shown below:

Fuse Holders



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SECTION 1

GENERAL

The ML428B Interference Field Strength Meter is a small, light-weight, general-purpose receiver which measures electrical field strength and voltage signal waves and interference waves from 9 kHz to 30 MHz.

To measure electrical field strength, a loop or rod antenna is used and the voltage induced to the antenna as a magnetic charge or an electric charge is measured.

Since the ML428B has a wide dynamic range and since it contains an average detector, a quasi-peak value detector, and a peak value detector, measurements which satisfy the CISPR and MIL standards can be performed.

This measuring instrument has the following features:

- A frequency can be set in the range of 9 kHz to 30 MHz, in units of 1 kHz/10 kHz/100 kHz/1 MHz, without band switching.
- Superior frequency stability is achieved by using a frequency synthesizer system in the local oscillator.
- Using the frequency preset function, up to 100 waves with different frequencies can be memorized and later recalled sequentially.
- Level calibration can be performed with a simple key operation.
- An appropriate indication system can be selected depending on the conditions of the signal to be measured. The signal level can be displayed on an analogic indicator or a digital display.
- The displayed value need not be converted using a table or cursor, because the electrical field strength is directly shown on a digital display.

- The auto range function allows simple signal level measurement since no attenuator adjustment is necessary.
- The tracking generator contained in this instrument allows the following functions: a level marker can be easily written onto the recorder, and operations, including antenna circuit, can be checked, and the characteristics of a circuit or measuring instrument can be measured.
- With an incorporated GP-IB interface, this instrument can be externally controlled by a personal computer in order to efficiently process the measured data.

SECTION 2

COMPOSITION AND SPECIFICATIONS

Table 2-1 Composition

Item	No.	Name	Qty.	Remarks
Equipment	1	Interference/Field Strength Meter ML428B	1	The GP-IB interface is installed.
Accessories	2	Ac power cord	1	RM12BPG-5S.2CC7 (1.5 m, with arrow-type tip)
	3	Dc power cord	1	
	4	Earphone	1	
	5	Coaxial cords	1	3CA-P2.RG-55/U.3CA-P2 (1 m)
	6	Connecting cord for recorder	1	BNC (1.5 m, with alligator clip)
	7	Fuses	3	**T***A 2 pieces, T2A: 1 piece**
	8	Operation manual, Interference/Field Strength Meter ML428B	1	

Table 2-2 Specifications

Item	Specifications
Input impedance	50 Ω nominal (BNC connector)
Frequency	
Range	9 kHz to 30 MHz
Display	Digital, 5-digits LCD, Lowest: 1 kHz, 10 kHz to 30 MHz
Setting	Step dial: 1 kHz, 10 kHz, 100 kHz, 1 MHz, selectable Fine dial: ±1 kHz continuously variable
Memory	100 frequencies

Table 2-2 Specifications (Cont.)

Item		Specifications
Frequency (cont.)		
Reference oscillator	Aging rate	±1 x 10^{-6}/Year
	Ambient temperature characteristics	±2.5 x 10^{-5}
Voltage measuring range (terminated value)		
Minimum value	9 to 49 kHz	-15 dBμV (C/N = 6dB, bandwidth 200 Hz, average value)
	50 to 149 kHz	-17 dBμV (C/N = 6 dB, bandwidth 200 Hz, average value)
	150 kHz to 30 MHz	-20 dBμV (C/N = 6 dB, bandwidth 200 Hz, average value)
Maximum value	LOG (Meter display)	115 dBμV
	LIN (Meter display)	95 dBμV
	Digital display	115 dBμV
Accuracy		±1.5 dB (at more than 20 dB higher than minimum value)
Field strength measuring range		
Minimum value	20 kHz	41 dBμV/m (C/N = 6 dB, bandwidth 200 Hz, average value)
	500 kHz	29 dBμV/m (C/N = 6 dB, bandwidth 200 Hz, average value)
	30 MHz	16 dBμV/m (C/N = 6 dB, bandwidth 200 Hz, average value)
Maximum value	9 kHz to 2.5 MHz	140 dBμV/m (LOG and digital display)
	2.5 to 30 MHz	130 dBμV/m (LOG and digital display)

Table 2-2 Specifications (Cont.)

Item		Specifications
Field strength measuring range (cont.)		
Accuracy		±2 dB (more than 20 dB higher than minimum value, using calibration table) Note: Accuracy of direct reading is ±3 dB.
Type of antenna		MP414B loop antenna (magnetic antenna)
Calibration oscillator		Sine wave, automatically tuned to receiving frequency.
Selectivity		
6 dB bandwidth	200 Hz band	200 +20/-30 Hz
	3 kHz band	3 ±0.3 kHz
	9 kHz band	9 ±1 kHz
Rejection	200 Hz band	$\geq$ 50 dB at 1 kHz off center
	3 kHz band	$\geq$ 50 dB at 2.5 kHz off center
	9 kHz band	$\geq$ 50 dB at 13.5 kHz off center
Signal to image ratio		$\geq$ 70 dB
Detection time constants		
Average value		Charge-time constant : $\leq$ 20 µs Discharge-time constant: $\leq$ 20 µs
Quasi-peak value		Charge-time constant : 45 ms ±20%, discharge-time constant: 500 ms ±20% (9 to 150 kHz) Charge-time constant : 1 ms ±20%, discharge-time constant: 160 ms ±20% (150 kHz to 30 MHz)
Peak value		Charge-time constant: $\leq$ 20 µs Holding time: 0.05 s, 0.3 s, or 3 s (switch-selectable)

Table 2-2 Specifications (Cont.)

Item		Specifications
Overload factor		Before detection: 24 dB (9 to 150 kHz) 30 dB (150 kHz to 30 MHz) After detection: 6 dB (9 to 150 kHz) 12 dB (150 kHz to 30 MHz)
Pulse response		In conformity with C.I.S.P.R. (at linear scale meter indication)
Level indication		
Analog meter range		LIN: 10 dB, fineness of scale: 1 dB LOG: 30 dB, fineness of scale: 1 dB
Digital	Display	4-digits LCD, resolution: 0.1 dB
	Unit	dBμV, dBμV/m, or dB (conversion factor of antenna)
Input range selection		Manual or autoranging Range: 110 dB (10 dB step, RF attenuator 10 dB x 6)
Output		
IF output	Frequency	455 kHz
	Level	$\geq$ 86 dBμV (terminated value, meter indication 0 dB)
	Impedance	50 Ω (BNC connector)
Output for recorder	Level	1 V ±10% (100 kΩ load, with indicator at full scale)
	Impedance	$\leq$ 150 Ω (BNC connector)
Output for monitoring		A1A, A2B, and A3E waves can be monitored with internal speaker or earphone. BFO is provided.

Table 2-2 Specifications (Cont.)

Item		Specifications
Tracking generator	Frequency setting	Automatically set to receiving frequency.
	Output	95 dBμV ±1dB (terminated value), Sine wave
	Impedance	50 Ω, (BNC connector)
Remote control		GP-IB (IEEE-488), SH1, AH1, T7, TE0, L4, LE0, SR1, RL2, PP0, DC1, DT0, C0
Ambient temperature, rated range of use		0° to 50°C
Power		**Ac **V ±10%, 47.5~63 Hz, ≤ 40 VA** Dc 11.5 V to 24 V, ≤ 2 A
Dimensions and **mass**		145H x 280W x 350D(mm), ≤ 11 kg

Table 2-3 Optional accessories (sold separately)

No.	Instrument	Remarks
1	Loop Antenna MP414B (10 kHz to 30 MHz)	One case for the MP414B One control cord: 5 m One coaxial cord (3CA-P2.RG-55/U.3CA-P2): 5 m
2	Rod Antenna MP415B (10 kHz to 30 MHz)	One case for the MP415B One control cord: 5 m One coaxial cord (3CA-P2.RG-55/U.3CA-P2): 5 m
3	Antenna Tripod MB27A	
4	Dc Power Supply MZ88A	12 V, 7.5 Ah, with one dc power cord: 0.5 m, and one ac power cord : 2.5 m
5	Artificial Mains Network MN423B (150 kHz to 30 MHz)	Meets C.I.S.P.R. specification Load current: $\leq$ 15 A One 75 Ω to 50 Ω Impedance transformer
6	Artificial Mains Network MN424B (450 kHz to 30 MHz)	Meets FCC specification Load current: $\leq$ 15 A
7	Artificial Mains Network MN425B (10 kHz to 30 MHz)	Meets FTZ specification Load current: $\leq$ 15 A

SECTION 3

OPERATION

3.1 Safety Measures

3.1.1 Power source

The ML428B normally operates on ** Vac ±10%, 50/60 Hz. See Notes at beginning of manual.

WARNING

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

3.1.2 Environmental conditions of the installation site

The ML428B operates normally at an ambient temperature from 0° to 50°C. It should not, however, be used in any of the following locations:

a. Locations subject to strong vibrations

b. Damp or dusty areas

c. Locations exposed to direct sunlight.

d. Locations which might be exposed to active gases.

CAUTION

If the ML428B is used at standard room temperature after having been used or stored at temperatures as low as 0°C for an extended period, condensation may cause it to short circuit. Be sure that the ML428B is free from condensation before turning the power on.

3.1.3 Maximum input signal level

CAUTION

If an external signal of +20 dBm or more is applied to the INPUT and OUTPUT terminals of the ML428B it may damage the internal circuitry.

3.2 Layout and Function of Controls

This section explains the layout and functions of the controls and connectors on the panels.

The numbers in the "No." column in the tables correspond to the numbers shown in the related figure. The characters in the "Indication" column in the tables are the symbols printed on the panel.

3.2.1 Front panel

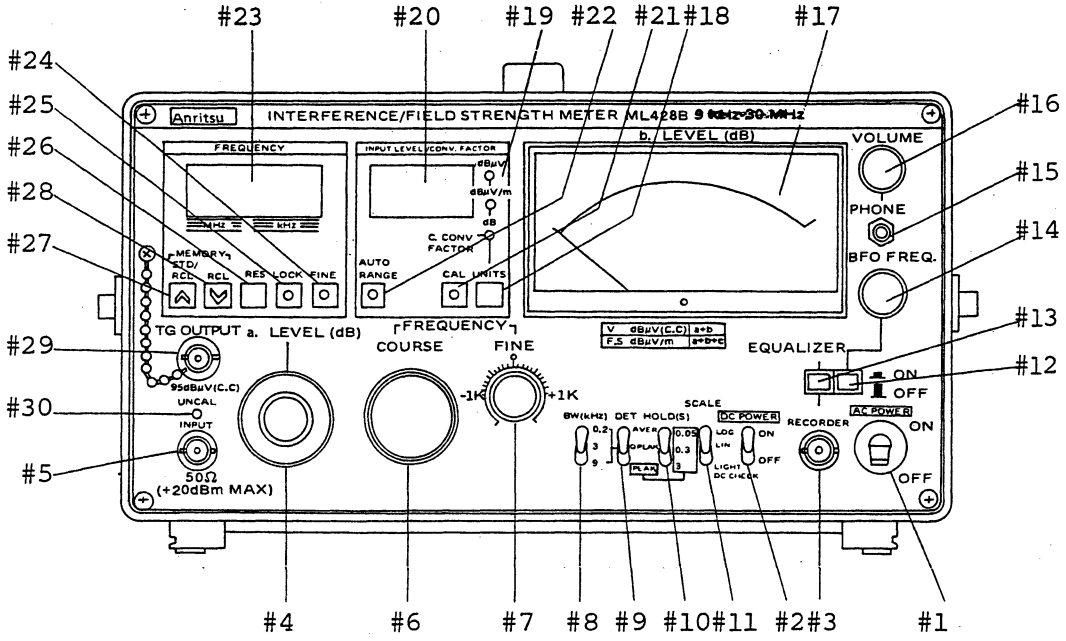


Fig. 3-1

Table 3-1 Explanation of Front Panel

No.	Indication	Explanation
#1	AC POWER ON OFF	Ac power switch: Used with an ac power source.
#2	DC POWER ON OFF	Dc power switch: Used with a dc power source. When both ac and dc power sources are connected and both switch #1 and switch #2 are turned on at the same time, only the dc power is supplied. When ac power is to be used, switch #2 must be set to the OFF position.
#3	RECORDER	Recorder connector: Used to connect the analog recorder. When the meter reads the full-scale position, this connector provides approx. 1 V output power.

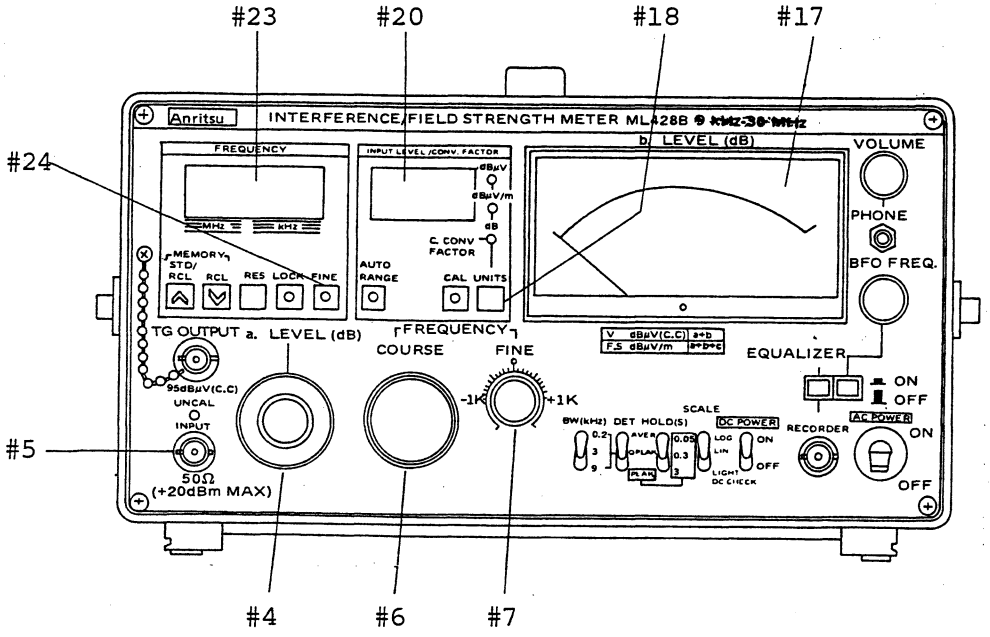


Fig. 3-2

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#4	a LEVEL (dB)	Level dial: Used to adjust the level so that the pointer of the analog meter indicator is located within the scale. This control consists of an RF attenuator and an IF attenuator. Combination of RF attenuation with IF attenuation is previously programmed. The input voltage of the signal to be measured is determined by the sum of this dial setting value and the value shown by indicator #17 (a+b dB). The total of this voltage (a+b) and the conversion factor* (it is displayed in digital display #20 by pressing unit switch #18) is the value of the electric field strength. (a+b+c dBμV/m)
#5	INPUT 50 Ω (+20 dBm MAX)	RF input connector: Used to input a signal which is to be measured. This connector is usually connected to an antenna. The maximum input level is +20 dBm (133 dBμV at 0.1 W, 50 Ω).

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#6	FREQUENCY COARSE	Frequency setting dial: Used to set the received frequency. The frequency set by this dial is displayed in the frequency display #23.
#7	FINE -1 K, 0, +1 K	FINE frequency adjustment dial: Used to make final adjustments to the received frequency. Turning this control will not alter the value displayed on frequency display #23. This control is activated only when the FINE switch #24 is pressed.

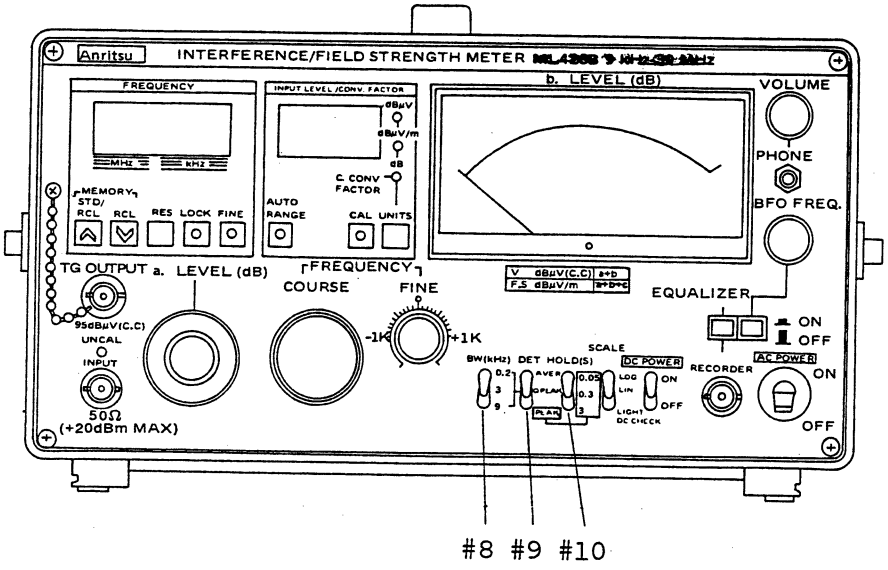


Fig. 3-3

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#8	BW (kHz) 0.2, 3, 9	Pass bandwidth switch: Used to select the pass bandwidth.
#9	DET AVER, Q.PEAK, PEAK	Detection mode switch: Used to select the detection mode of the detecting circuit. AVER : Average value mode Q.PEAK: Quasi-peak value mode PEAK : Peak value mode Detection time constant and pass bandwidth setting in the quasi-peak mode is related to the received frequency setting. That is, when the received frequency is between 9 kHz and 149 kHz, the charge-time constant is 45 ms, the discharge-time constant is 500 ms and pass bandwidth is 0.2 kHz. When the received frequency is between 150 kHz and 30 MHz, the charge-time constant is 1 ms, the discharge-time constant is 160 ms and pass bandwidth is 9 kHz.
#10	HOLD (S) 0.05, 0.3, 3	Holding time switch: Used to select a peak state holding time when switch #9 is set to PEAK (peak value mode). 0.05, 0.3, or 3 seconds can be selected.

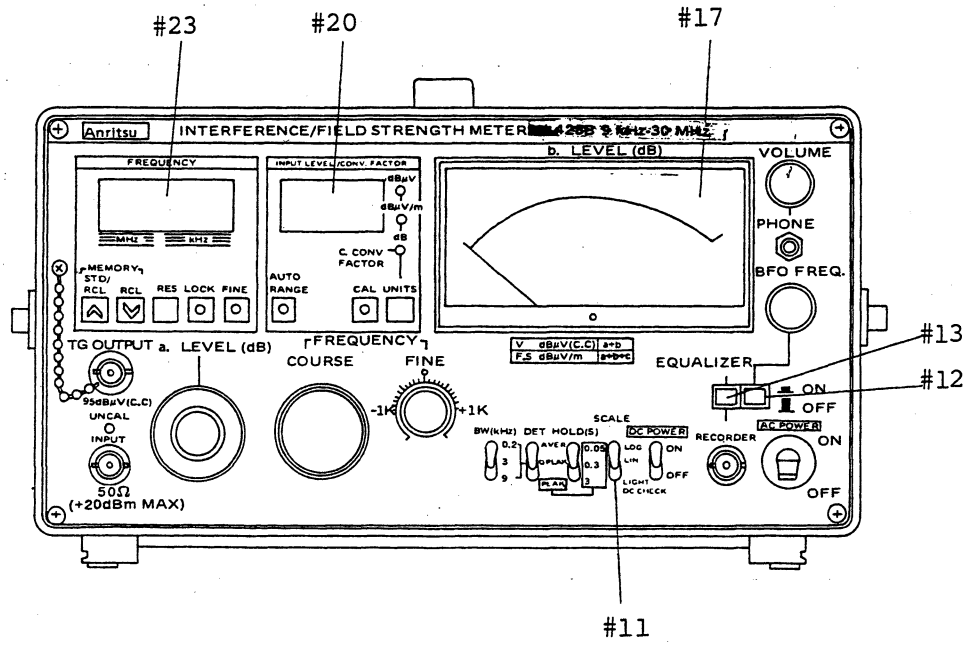


Fig. 3-4

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#11	SCALE LOG, LIN, CHECK, LIGHT	Indication scale change-over and dc power supply voltage check switch: LOG and LIN are used to switch the indication range of indicator #17. LIN selects the 10 dB range, and LOG selects the 30 dB range. CHECK is used for dc power supply voltage check. When the pointer of indicator #17 is within the blue-line range, the dc power supply can be used and the liquid crystal lamps of displays #20 and #23 will be on.
#12	(BFO) ON, OFF ▂ ▆	BFO switch: Used to operate the Beat Frequency Oscillator (BFO). ON starts the BFO, and OFF stops it. It is usually used to monitor the Al wave.
#13	EQUALIZER (ON, OFF)	Equalizer switch: The indicator of the interference wave meter, which conforms to the CISPR standard, has a fixed, mechanical time constant. Therefore, when a measured value is to be recorded, the signal must be supplied to the recorder through an equalizer circuit having characteristics equivalent to the mechanical time constant of the indicator. This switch is used to turn the equalizer on or off.

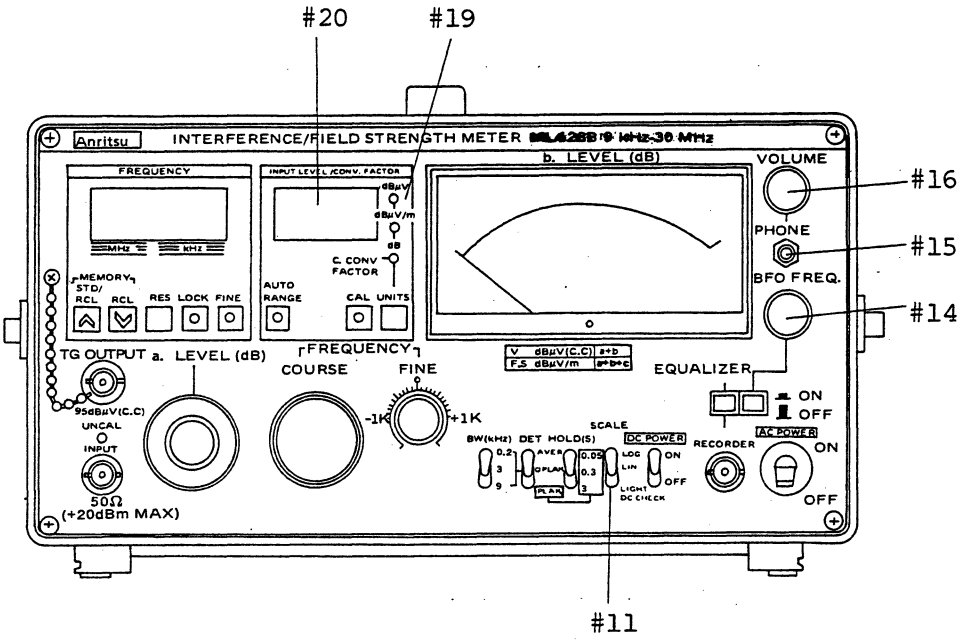


Fig. 3-5

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#14	BFO FREQ	BFO frequency adjustment knob: Using this control, the BFO frequency can be varied within approx. ±5 kHz from the zero beat point.
#15	PHONE	Earphone output jack: Output terminal used to monitor a demodulated signal through an external earphone. When the earphone is connected, the internal speaker is disconnected.
#16	VOLUME	Sound volume control: Used to adjust the sound volume of the monitor speaker or an earphone connected to #15.
#17	b. LEVEL (dB)	Level indicator: The sum of the value indicated by this meter and the value set at level dial #4 is the measured input-level value. This indicator has a linear scale (LIN) and a logarithmic scale (LOG). In the LOG scale, dB graduations are marked in equal interval. LIN or LOG can be selected using scale switch #11.

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#18	UNITS	Unit select switch: Used to select the level units of the digital level display #20. Selectable units are as follows: Voltage : dBμV Field strength : dBμV/m Conversion factor: dB The selected unit is indicated by unit indication lamp #19. Each time this switch is pressed, the indicated unit is changed as follows: dBμV → dBμV/m → dB → dBμV

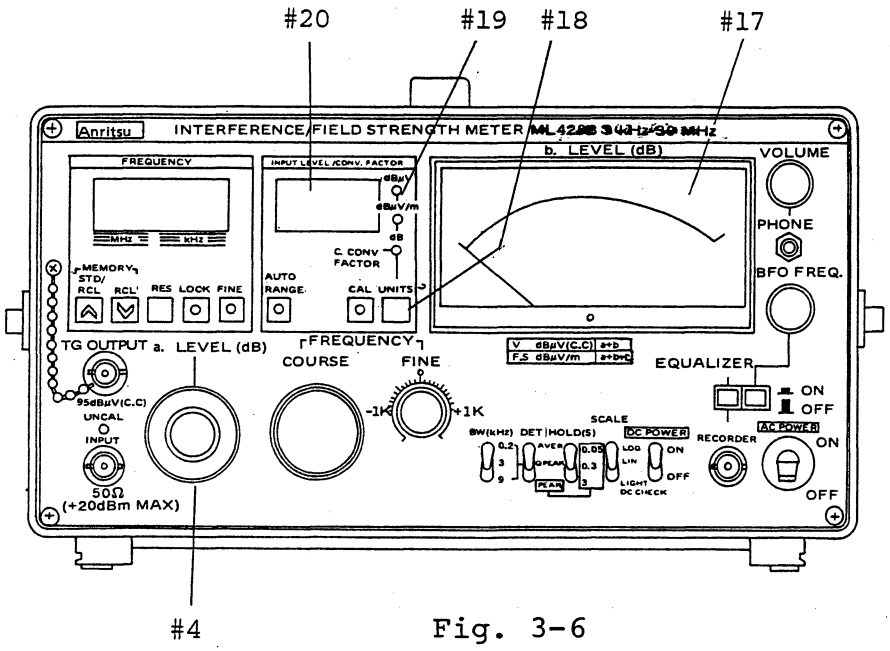


Fig. 3-6

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#19	dBμV, dBμV/m dB - C. CONV. FACTOR	Unit indication lamp: Indicates the unit selected by the unit select switch #18.
#20	INPUT LEVEL/ CONV FACTOR	Digital level display: Is a digital display for the voltage, the field strength, or the conversion factor. When the voltage level is displayed, terminated value is displayed. This value is equivalent to the sum of the level dial #4 value and the indicator #17 value. When field strength level is displayed, the result of subtracting the conversion factor from the voltage value is displayed. The conversion factor value is previously stored in Read-Only Memory (ROM) and corresponds to a specific antenna (MP414B loop antenna and MP415B rod antenna). When the loop antenna or the rod antenna is connected to the ML428B with a remote cord, the corresponding conversion factor is automatically selected. When MP414B or MP415B is not connected to the ML428B with a remote cord, the conversion factor which are stored by GP-IB are displayed. The conversion factor is used to obtain the field strength level using indicator #17.

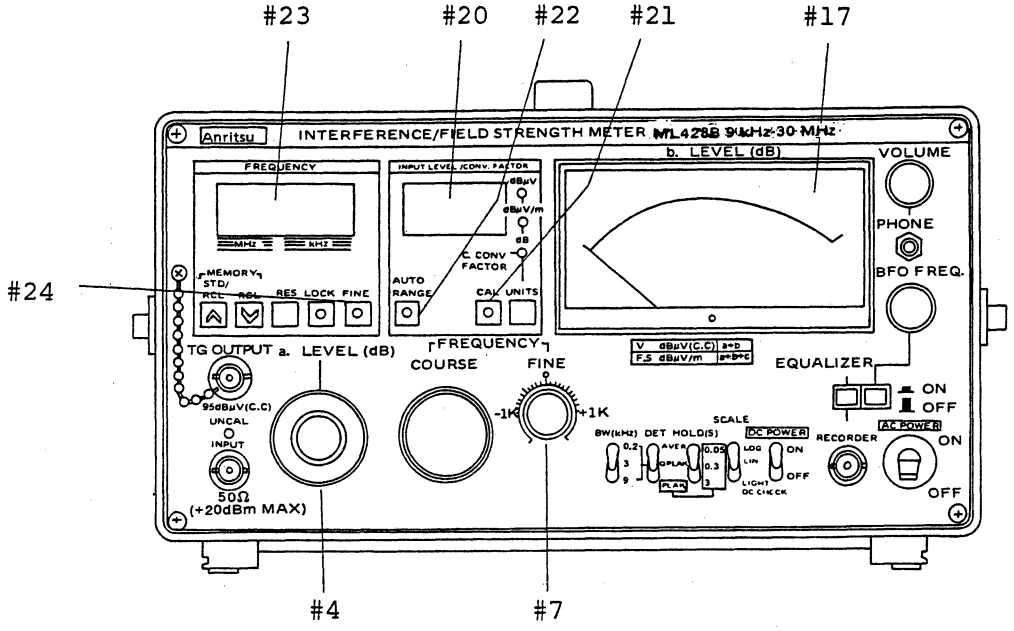


Fig. 3-7

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#21	CAL	Level calibration key with lamp: When this key is pressed, a series of level calibration operations are automatically performed. During calibration, the lamp is on. This key must be pressed immediately before measurement.
#22	AUTO RANGE	Auto range switch with lamp: Level dial #4 is usually set manually so the pointer of indicator #17 indicates an appropriate value. However, when the AUTO RANGE switch is pressed, the level is set automatically, and the measured value is displayed at level display #20. Therefore, since the value at level dial #4 is not changed, the level cannot be measured using indicator #17. If the level fluctuates rapidly, manual adjustment of level dial #4 may be better than the automatic adjustment. When the lamp is on, the auto range may be used.
#23	FREQUENCY MHz kHz	Frequency display: (5 digits) Displays the frequency which has been set.
#24	FINE	Fine adjustment key with lamp: When this key is pressed, the lamp goes on and frequency fine adjustment #7 can be performed.

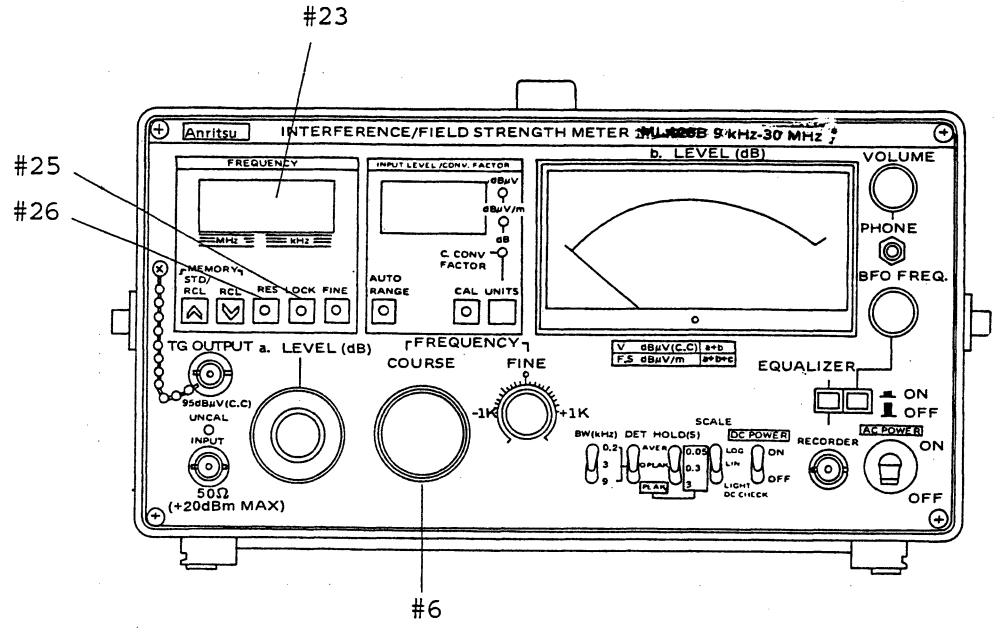


Fig. 3-8

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#25	LOCK	Frequency lock key with lamp: When this key is pressed, the frequency is fixed and no other frequency can be set. Lamp on : New frequency cannot be set. Lamp off: New frequency can be set.
#26	RES	Frequency step setting key with lamp: Selects the frequency variation step for the frequency setting dial #6. Each time this key is pressed, the frequency step is changed as follows: Digit of 1 MHz Digit of 0.1 MHz Digit of 0.01 MHz Digit of 0.001 MHz When the power is turned on, the digit set immediately before turning off the power is reset. The step which is being used is shown by a blinking display in frequency display #23. However, when the 1 kHz step is used, the display for the corresponding digit does not blink.

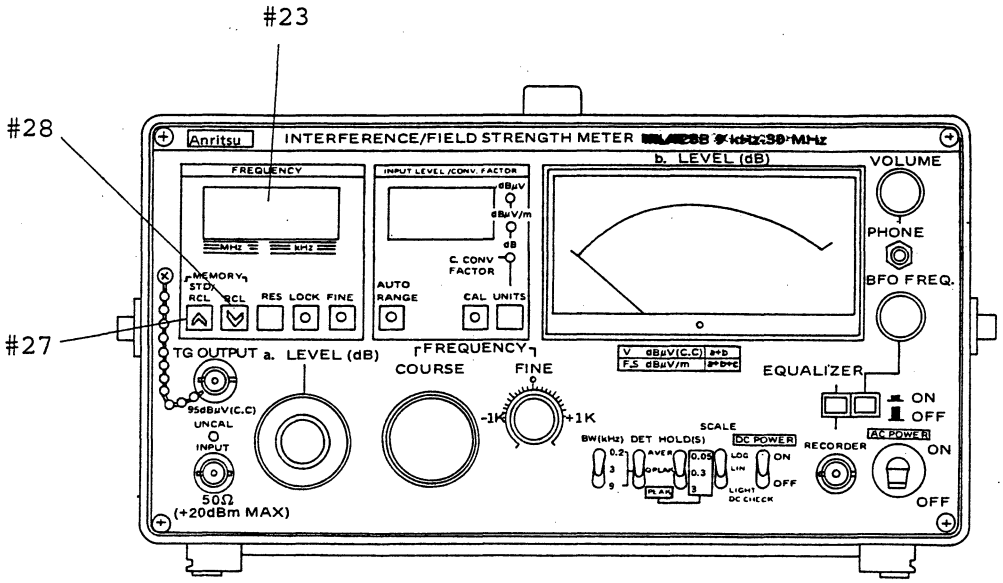


Fig. 3-9

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#27	MEMORY STO/RCL	Frequency store and frequency upward recall key: When this key is pressed, the frequency data displayed in frequency display #23 is stored into memory (address: N), and the next upward address (N+1) of the memory that will be recalled is displayed for a moment, and then the frequency data in the upward address (N+1) is recalled and displayed. When this key is pressed again, the frequency data in frequency display #23 is stored into the memory (address: N+1), and the next upward address (N+2) of the memory that will be recalled is displayed for a moment, and then the frequency data in the upward address (N+2) is recalled and displayed. If the key is pressed continuously, addresses only are displayed in sequence N+1, N+2, N+3, ... upward. Up to 100 frequencies can be stored. If an attempt is made to store more than 100 frequencies, an error sound (.--.) is emitted and the upward memory function stops.

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#28	MEMORY RCL	Frequency downward recall key: Used to recall the frequency data from the memory of the downward address. This recall is done toward the reverse direction of the frequency data stored memory sequence using frequency store and recall key #27. That is the last data that is stored is fetched first and displayed in frequency display #23. When this key is pressed, the next downward address (N-1) of the memory that will be recalled is displayed for a moment, and then the frequency data in the downward address (N-1) is recalled and displayed. When this key is pressed again, the next downward address (N-2) of the memory that will be recalled is displayed for a moment, and then the frequency data in the downward address (N-2) is recalled and displayed. If the key is pressed continuously, addresses only are displayed in sequence N-1, N-2, N-3, ... downward. If the key is pressed after the oldest data (first stored data) is displayed, an error sound (.---.) is emitted, and the frequency data displayed in frequency display #23 does not change. The MEMORY RCL and MEMORY STO keys also can be used to sequentially shift the already stored frequency data.

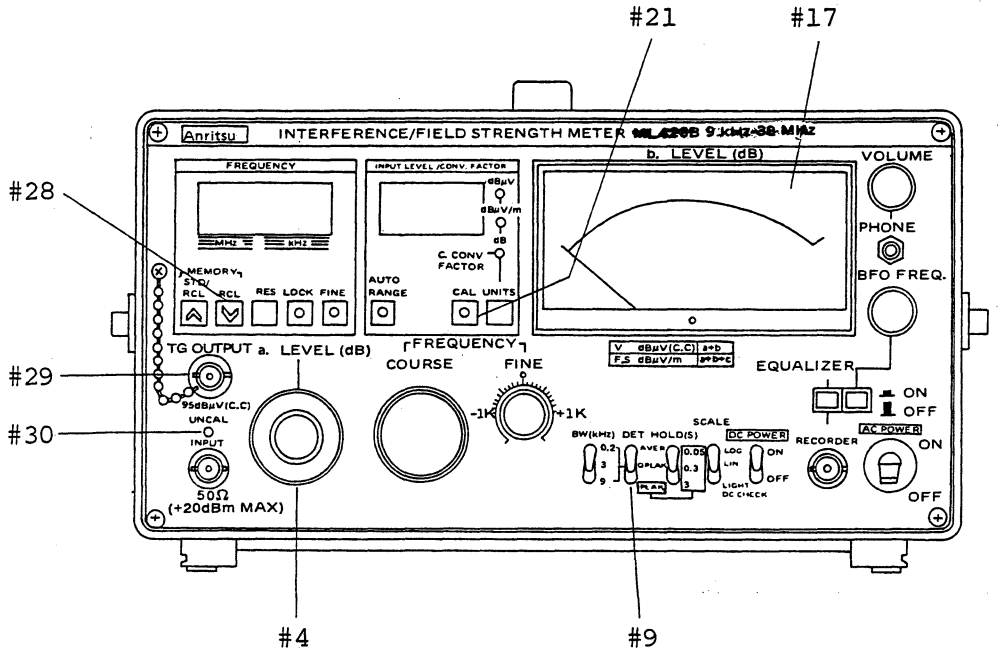


Fig. 3-10

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#29	TG OUTPUT	Tracking generator output connector: Used to output a signal whose frequency is equal to that of the received frequency. The output level is fixed to 95 dBμV (terminated value). This signal is not required for field strength measurement, but can be used for antenna tests, impedance bridge tests, and other transmission circuit tests.
#30	UNCAL	UNCAL lamp: While this lamp is on, the correct level can not be measured even if this unit is operating as if it were a normal receiver. When this lamp is on, press level calibration key #21 to perform calibration. When the calibration ends, the lamp will go off. Also when the internal receiving system is saturated because of excessive input, this lamp comes on. Also when input level is small and the level dial #4 is set to a high position, this lamp comes on. If excessive input is applied during broadcast wave measurement, the pointer of the indicator #17 overruns the scale.

Table 3-1 Explanation of Front Panel (Cont.)

No.	Indication	Explanation
#30	UNCAL (cont.)	However, when pulse noise is being measured in Q.PEAK mode, the indicator may not indicate the correct value even if the pointer does not overrun. This occurs when the receiving system is saturated. In this case, reset the level dial #4 and measure again after the lamp goes off. If level dial #4 is set to an improper value, UNCAL lamp #30 will come on. Improper setting combinations are as follows: . Detection mode switch #9 is set to the Q.PEAK position, and one of the following conditions is satisfied: 1) The level dial #4 value is 70, 80 or 90 dB in the range of 9 kHz to 149 kHz. 2) The level dial #4 value is 80 or 90 dB in the range of 150 kHz to 30 MHz. In the above cases also, adjust level dial #4 to turn off the lamp, and then measure again.

3.2.2 Rear panel

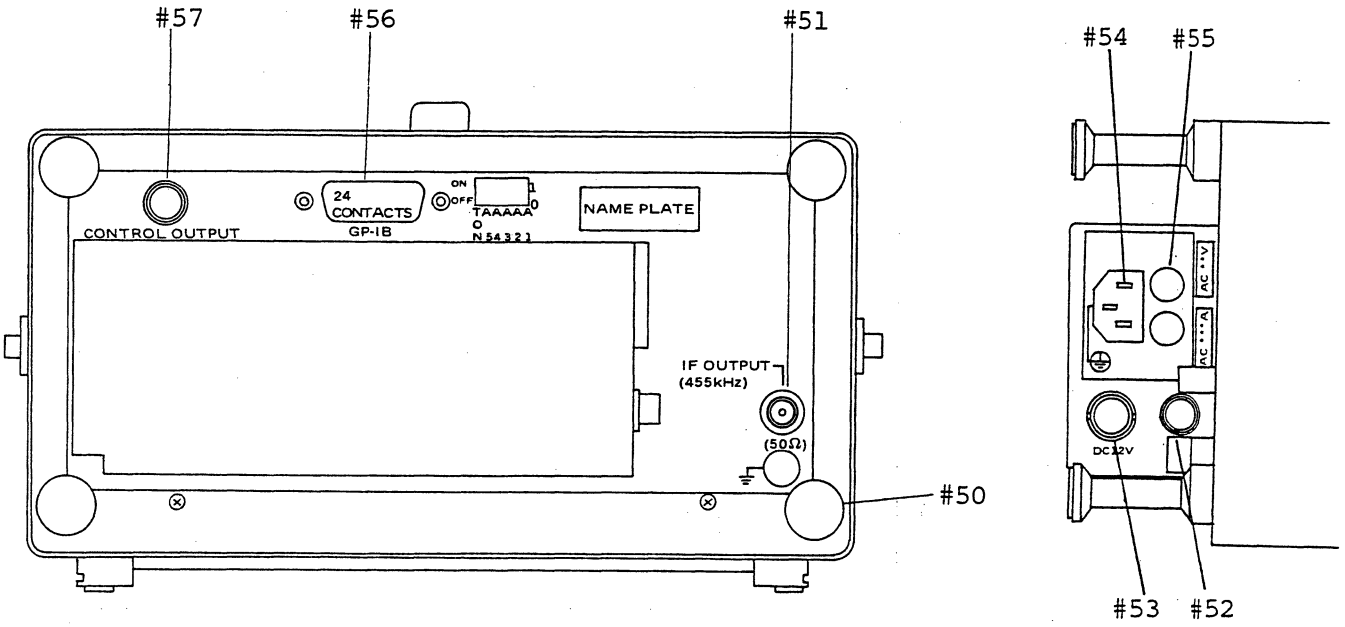


Fig. 3-11

Table 3-2 Explanation of Rear Panel

No.	Indication	Explanation
#50	⏚	Grounding terminal: Used to prevent electric shock.
#51	IF OUTPUT 455 kHz 50 Ω	IF output connector: Outputs a signal of approx. 86 dBμV (50 Ω terminated value) when indicator #17 indicates 0 dB.
#52	DC 2 A	2 A fuse: External dc power line fuse.

Table 3-2 Explanation of Rear Panel (Cont.)

No.	Indication	Explanation
#53	DC 12 V	Dc power connector: Used to connect to a dc power source with an attached dc power cord. (Voltage range: 11.5 to 24 V)
#54	AC ** V	Ac power connector: Used to connect to an ac power source with an attached ac power cord.
#55	AC *** A	Fuses: (2 pieces) Ac power line fuses. 1 A (100 to 120 V) or 0.5 A (200 to 240 V)
#56	GP-IB	GP-IB connector: Used to connect with the IEEE-488 digital standard bus.
#57	CONTROL OUTPUT	Control connector: Used to connect with an antenna control cord. The antenna contains several matching transformers, and one of which is automatically selected by a command from the ML428B.
#58	T A A A A A O N 5 4 3 2 1	GP-IB Address switch with talk only mode switch.

3.3 Preparing for Measurement

3.3.1 Connection to power source

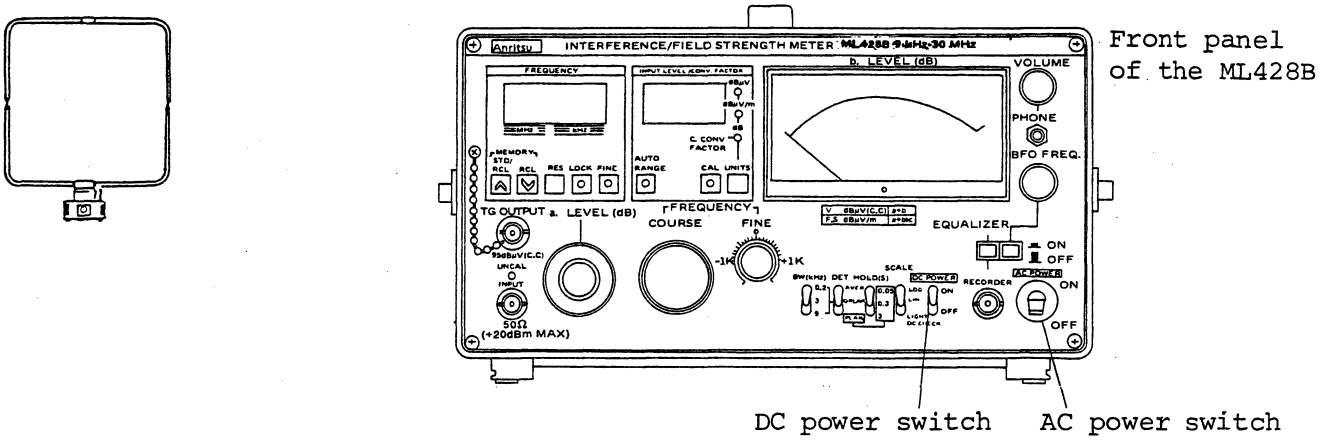


Fig. 3-12 Connection to Power Source

Connect the power source to the ML428B as shown in Fig. 3-12.

The ML428B has 2 power switches for ac and dc.

When the ac power is used, the dc power switch must be set to OFF.

If the dc power switch is in the ON position, ac power will not supplied.

When the dc power is to be used, the ac power switch may be in any position.

3.3.2 Connection to loop antenna

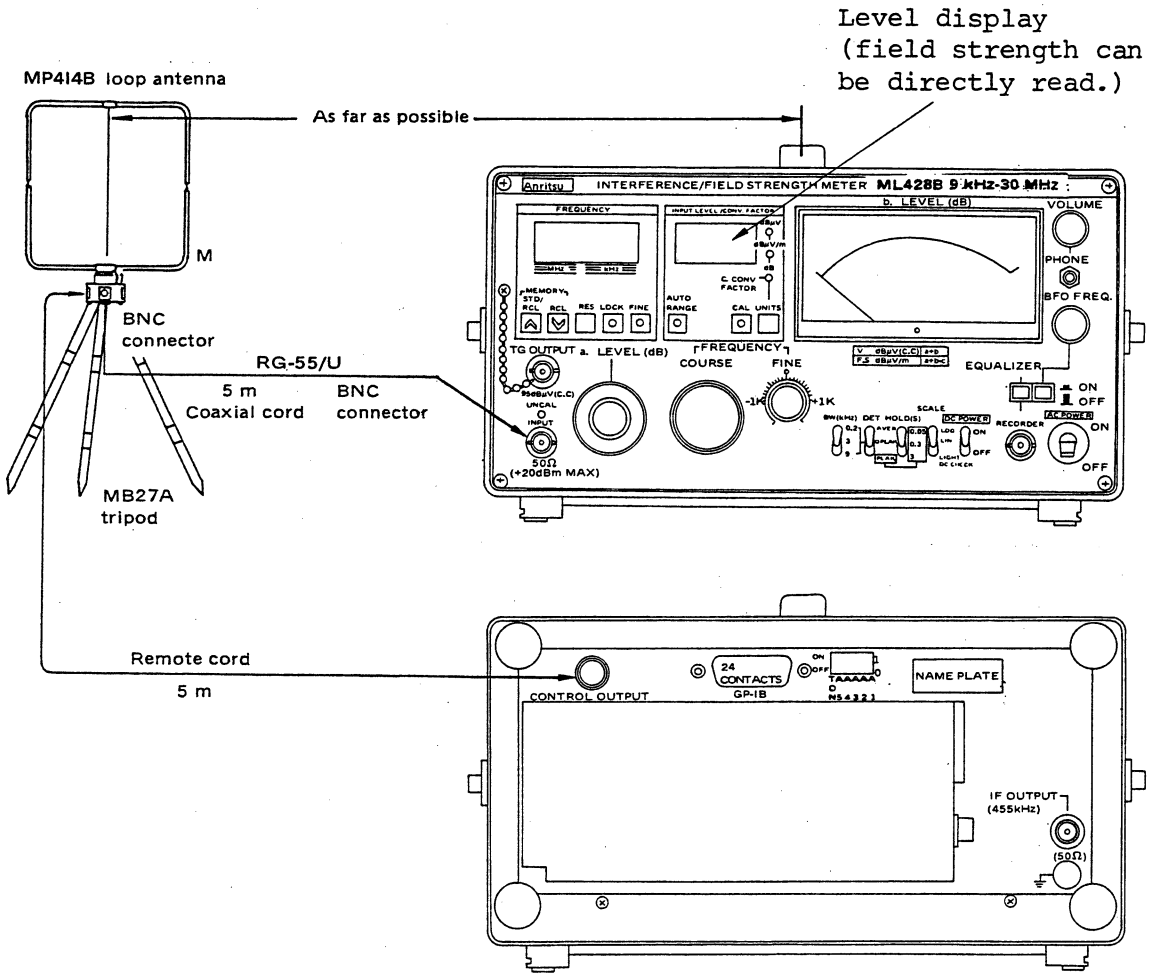


Fig. 3-13 Connection to a Loop Antenna

Connect the MP414B loop antenna to the ML428B as shown in Fig. 3-13. The antenna must be placed as far as possible away from the ML428B.

The field strength can be read directly from the level display.

3.3.3 Connection to rod antenna

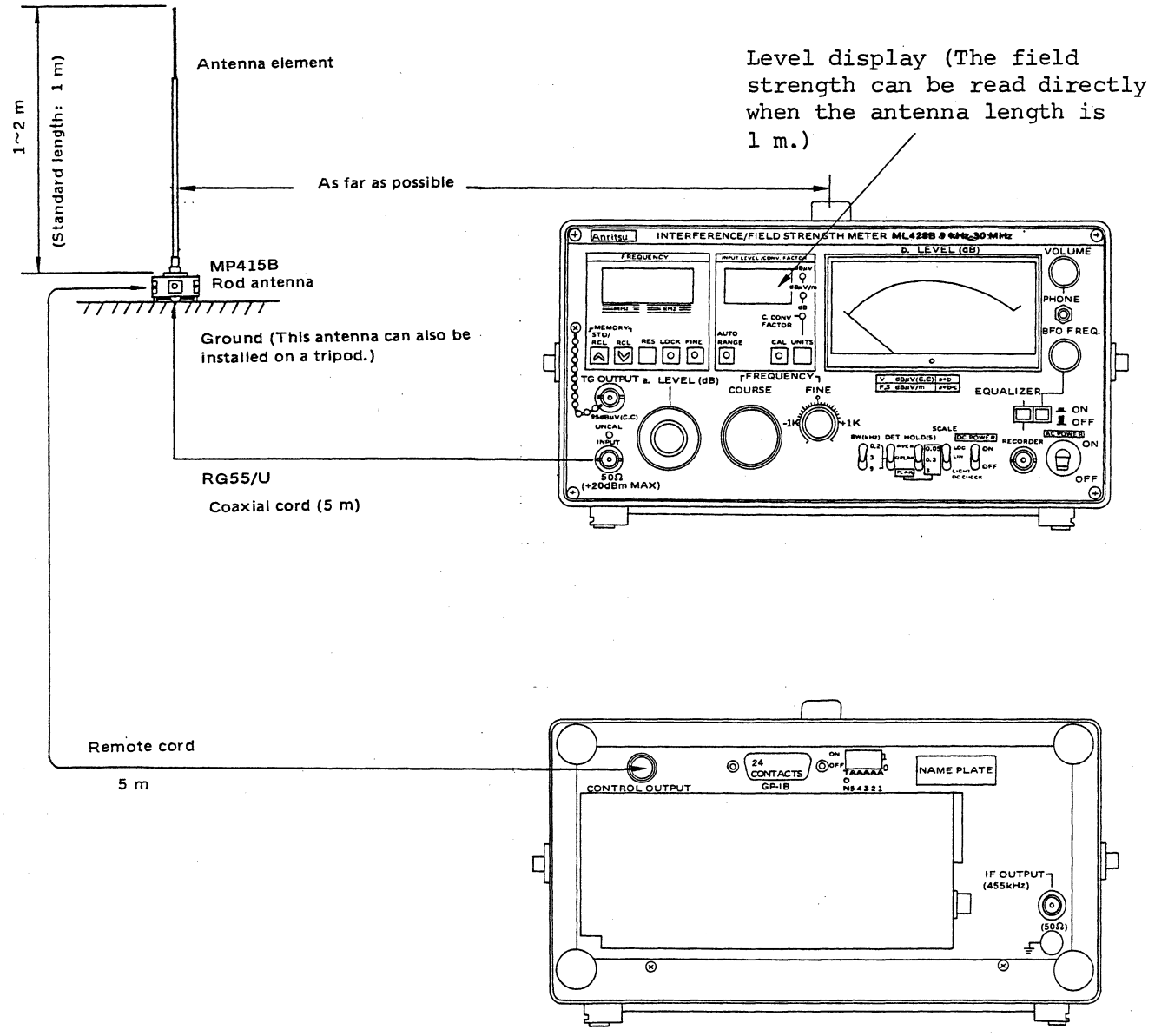


Fig. 3-14 Connection to Rod Antenna

Connect the MP415B rod antenna to the ML428B as shown in Fig. 3-14.

The antenna must be placed as far as possible from the ML428B in order to keep the directivity of the antenna and reduce the influence of the disturbing wave radiated by the ML428B.

Usually, the rod antenna is placed directly on the ground. However, when the antenna must be placed above the ground for disturb wave measurement or other purposes, the antenna can be installed on the MB27A tripod.

The antenna element length is 1 m (when shortened) or 2 m (when elongated). Needless to say, the sensitivity at 2 m is higher than that at 1 m. However, the standard length is 1 m. Since the conversion factor for a 1 m antenna element is stored in the ROM of the ML428B mainframe, the field strength can be read directly only when the element length is 1 m. When the element length is 2 m, one must calculate the value using the conversion table.

3.3.4 Confirmation of normal operation

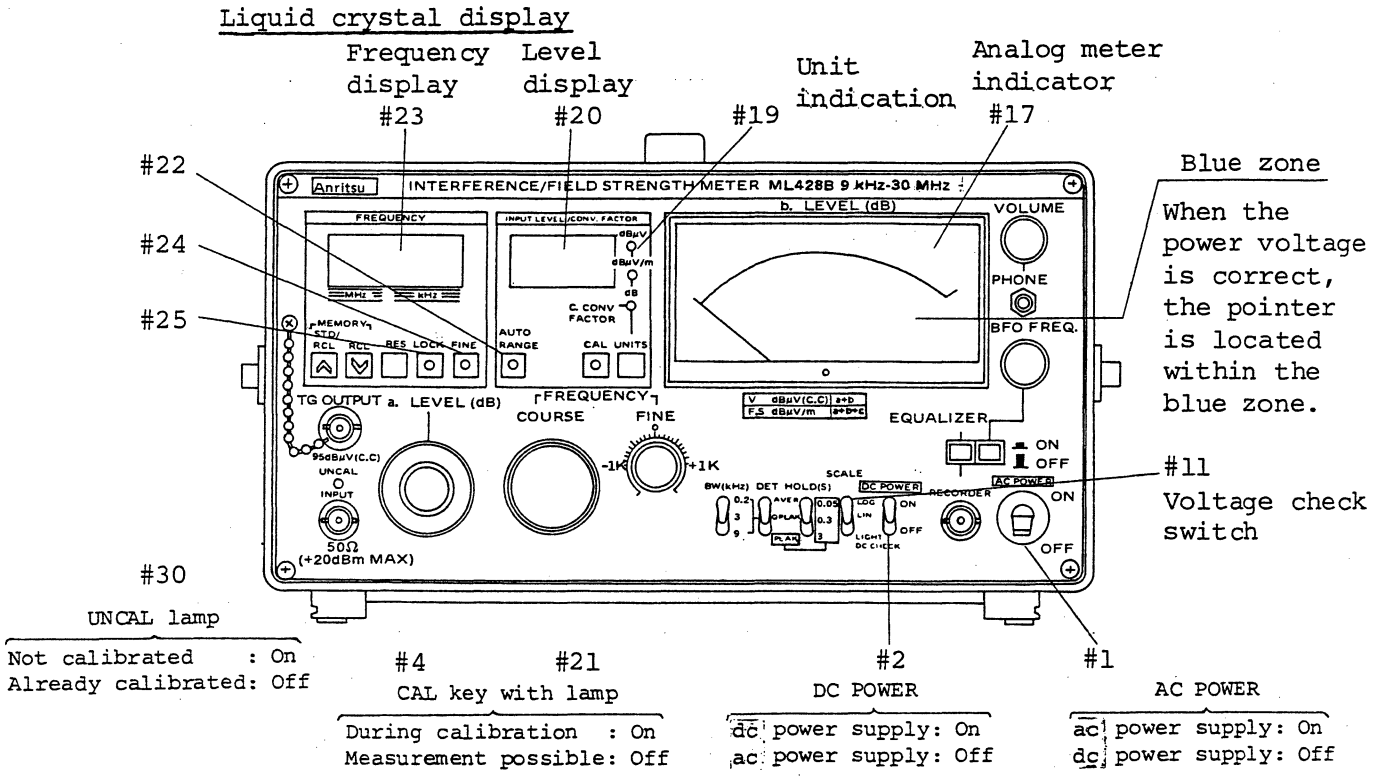


Fig. 3-15 Confirmation of Normal Operation

1) Power ON

(1) Connect the ac or dc power, and set power switch #1 or #2 to the ON position.

(2) UNCAL lamp #30 goes on first, and CAL lamp #21 comes on. After 4 to 8 seconds, UNCAL lamp #30 and CAL lamp #21 will go off at the same time.

This indicates that the level is automatically calibrated and the ML428B is ready to measure. That is, the internal receiving system is operating normally.

If CAL key #21 lamp blinks and UNCAL lamp #30 remains on, the operation of the receiving system is not normal. In this case, press CAL key #21. If this restores the normal condition, measurement can be performed.

(3) The internal memory of the ML428B is backed up with a battery. Therefore, the information which was set at the previous measurement is retained even after the power is turned off, and it can be reused when the power is turned on again.

Such reusable functions are provided with frequency display #23, auto range key #22, frequency fine adjustment key #24, frequency lock key #25, and unit key #19.

2) Power voltage check

When voltage check switch #11 is set to the CHECK/LIGHT position after the power is turned on, indicator #17 indicates the dc power voltage and the illumination lamps of liquid crystal panels #20 and #23 are turned on. When dc power is being used, verify that the pointer of the indicator #17 is located within the blue zone.

[Cautions]

1. When the detection mode is the Q.PEAK mode, UNCAL lamp #30 will not go off after the level calibration ends if level dial #4 is set to a position beyond the operation range of this measuring instrument. When the level dial is set to a proper value, UNCAL lamp #30 goes off and the ML428B is ready to measure.

2. When the detection mode is the Q.PEAK mode and frequency is set in the range 9 kHz to 149 kHz, calibration takes about 15 seconds.

Table 3-3 Level Dial Setting Range

Level dial scale / Detection mode	(dB)											
	-20	-10	0	10	20	30	40	50	60	70	80	90
Average value mode	o	o	o	o	o	o	o	o	o	o	o	o
Quasi-peak value mode (9 kHz to 149 kHz)	o	o	o	o	o	o	o	o	o	/	/	/
Quasi-peak value mode (0.15 MHz to 30 MHz)	o	o	o	o	o	o	o	o	o	o	/	/
Peak value mode	o	o	o	o	o	o	o	o	o	o	o	o

The slash (/) in this table indicates an improper combination (where UNCAL lamp #30 comes on).

3.4 Measurements

The ML428B has various functions, such as, detection, bandwidth selection, display (analog indicator and digital level displays), indicator scale selection (LOG or LINEAR), and level adjustment (auto or manual). Effective measurements can be performed by combining these functions.

To effectively utilize these functions, the user must know the features of each function.

Paragraph 3.4.1 explains these functions.

Paragraph 3.4.3 explains examples of measurements.

3.4.1 Function setting

(1) Combination of detection mode with pass bandwidth

Table 3-4 Combination of Detection Mode with Pass Bandwidth

Detection mode	Pass bandwidth
AVEQ	200 Hz, 3 kHz, 9 kHz
Q.PEAK	200 Hz (at 9 kHz to 0.149 MHz) or 9 kHz (at 0.15 to 30 MHz)
PEAK	200 Hz, 3 kHz, 9 kHz

In quasi-peak value detection, the usable pass bandwidth is limited as shown in Table 3-4.

In this case, measurements which satisfy the following specifications can be done:

9 kHz to 0.149 MHz CISPR Publ. 3
0.15 to 30 MHz CISPR Publ. 1

The time constant for detection is automatically set as follows when the frequency to be measured is set:

9 kHz to 0.149 MHz:
Charge-time constant ... 45 ms
Discharge-time constant ... 500 ms

0.15 to 30 MHz:
Charge-time constant ... 1 ms
Discharge-time constant ... 160 ms

(2) Combination of detection mode with level display

Table 3-5 Combination of Detection Mode with Level Display

	AVER	Q.PEAK	PEAK
Analog indicator	o	o	o
Digital display	Δ (Note 1)	Δ (Note 2)	o

Notes:

1. For sine wave measurement, this mode is useful.

   Don't use this mode for noise measurement because the error is large.

2. When a pulse with low repetition frequency is measured, the error becomes large.

The digital display circuit contains an equalizer which provides a response equivalent to the mechanical time constant of the analog indicator. In principle, the digital display and the indicator provide the same response. However, since use of the indicator is specified in the CISPR standard, the indicator should be used when more accurate measurement is required. The Δ mark may increase the measurement error.

(3) Selection of level adjustment function

Table 3-6 Combination of Level Adjustment Function with Display

Display	Manual range	Auto range
Analog indicator	Level dial value + Analog indicator value	Δ
Digital display	Direct reading	Direct reading

When a signal of an unknown level is to be measured, adjust the signal level by using the level dial (RF and IF attenuators) so that the pointer of the indicator is located within the scale. This adjustment can be done manually (manual range) or automatically (auto range). The auto range operation is performed within the ML428B, without regard to the level dial setting.

Therefore, when a level reading is to be made from the analog indicator (Δ), read the level dial setting value from the digital display and then set the level dial as shown below.

Example:

Digital display value	63.5 dB
Level dial estimated value**	60 dB
Analog indicator value	3.5 dB
Measured value	63.5 dB

** The attenuator value can be changed in 10 dB step.

(4) Selection of meter scale (LOG or LIN)

Table 3-7 Combination of Detection Mode with Indicator Scale

Detection mode	LOG	LIN
AVER	Δ (Note 1)	o
Q.PEAK	Δ (Note 2)	o
PEAK	o	o

Notes:

1. For sine wave measurement, this mode is useful.

   Don't use this mode for noise measurement because the error is large.

2. When a pulse with low repetition frequency is measured, the error becomes large.

For interference wave measurements using the CISPR standard, isolated pulses, as pseudo noises, must be measured completely. However, a large dynamic range is required to measure isolated pulses in the Q.PEAK mode. To solve this problem, the ML428B has the LIN (linear) scale with a range of 10 dB. Any noise within this range, including isolated pulses, can be measured.

If low-repetition-frequency pulses are measured using the LOG scale in Q.PEAK mode (W), the amplifier is saturated at the larger indicator values.

In this case, the UNCAL lamp will come on, and an incorrect measurement may be indicated. If this lamp is on, turn it off by adjusting the level dial and continue the measurement.

(5) Selection of measurement mode and display

Table 3-8 How to Read the Level

Display	Field strength	Voltage
Analog indicator	Level dial value + Analog indicator value + Digital display value*	Level dial value + Analog indicator value
Digital display	Direct reading	Direct reading

* Conversion factor

The field strength is acquired by adding the conversion factor (the value determined by the relationship between the field strength and received level) to the measured voltage obtained by connecting an antenna.

The conversion factor is already stored in the internal ROM of the ML428B. Therefore, when the digital display is used, the field strength can be directly read. When the analog indicator is used, the field strength can be obtained by adding the conversion factor to the voltage as shown in Table 3-8.

The measurement accuracy using the above method is ±3 dB. Higher accuracy can be obtained by measuring the voltage value (from the analog indicator or digital display) and by calculating the field strength by using both this voltage value and the conversion factor table included in the attached test results.

The accuracy obtained using the conversion factor table is ±2 dB.

3.4.2 Frequency setting

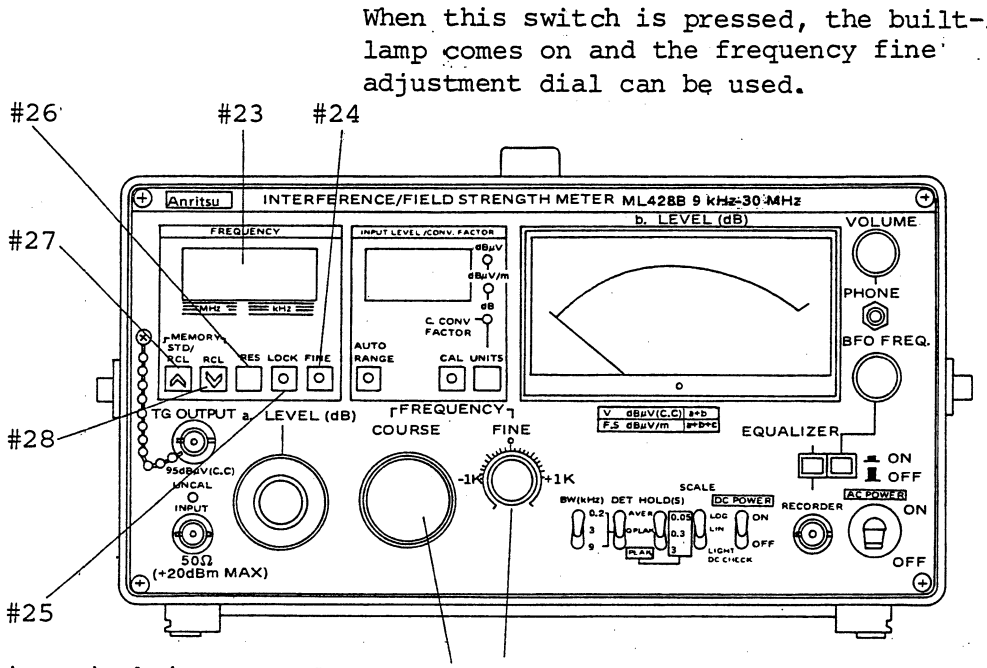


Fig. 3-16 Frequency Setting

The ML428B has the following 3 frequency setting methods:

1) Using the frequency setting dial #6
2) Using the internal memory (keys #27 and #28)
3) External control (See paragraph 3.5 GP-IB CONTROL.)

This section explains 1) and 2) above.

1) Setting using frequency setting dial #6

The frequency selected using the frequency setting dial is shown in frequency display #23. When this dial is used, its step must be selected using frequency step setting key #26. The possible step values are 1 kHz, 10 kHz, 100 kHz, and 1 MHz.

Each time key #26 is pressed, the frequency step is changed as follows:

1 MHz → 100 kHz → 10 kHz → 1 kHz → 1 MHz

The frequency step being used is shown in a blinking display. However, when the selected step is 1 kHz, the display will not blink.

Example: 12.576 (The digit of 1 MHz changes.)

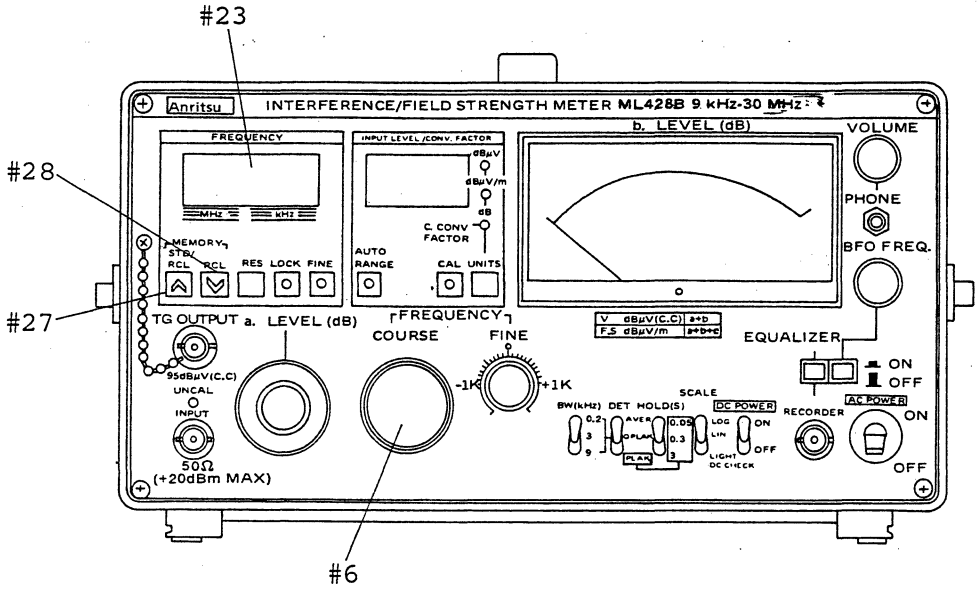


Fig. 3-17 Setting using Internal Memory

2) Setting using the internal memory

A frequency can be stored into the internal memory of the ML428B, and this stored frequency can be called and set.

When frequency store key #27 is pressed, the contents of display #23 are stored in the internal memory. Then, the frequency shown can be changed by turning the frequency setting dial #6 and pressing key #27 again.

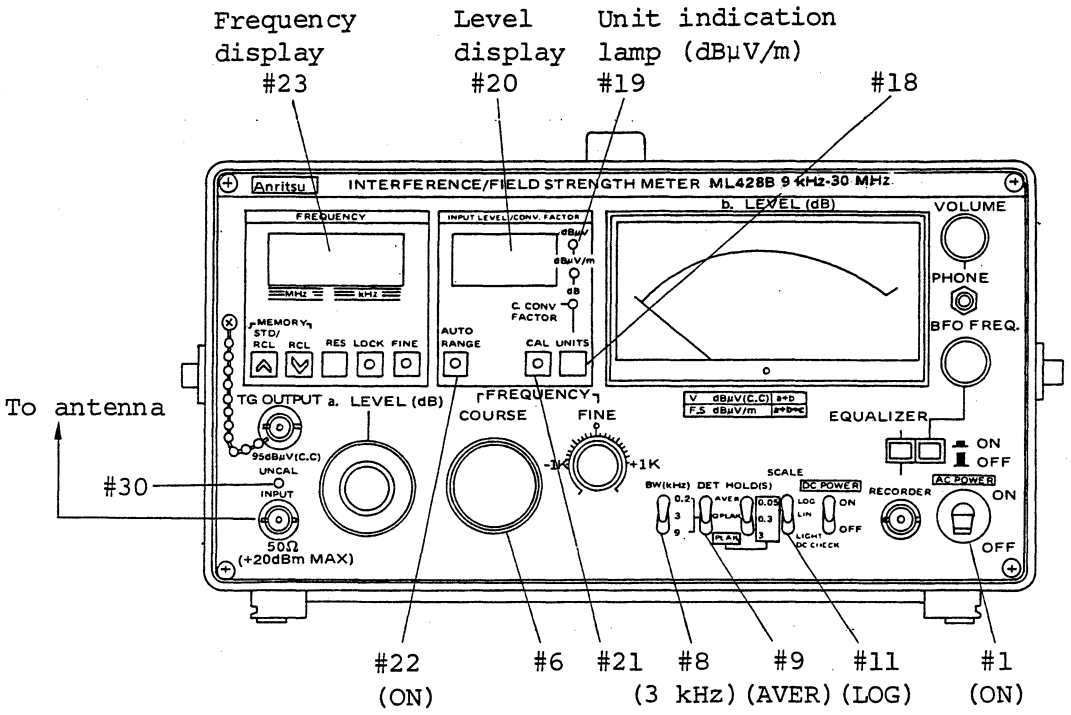
The newly displayed frequency is stored in the next address of the internal memory. Thus up to 100 frequencies can be stored. If an attempt is made to store more than 100 frequencies, an error sound (.--.) is emitted and frequency input becomes impossible.

The stored frequencies can be called by using frequency recall key #28. When this key is pressed, the last stored frequency is recalled and displayed at display #23. When key #28 is pressed again, the preceding frequency is displayed at #23. Thus, all the stored frequencies can be sequentially recalled and displayed. This calling and displaying does not alter the stored information. Therefore, a frequency which has been recalled previously can be recalled again by pressing key #27. When frequencies are stored, for example, in the sequence of 10 kHz, 20 kHz, 30 kHz, ..., key #28 and key #27 can be used as the frequency-down key and the frequency-up key respectively.

3.4.3 Measurements

This measuring instrument displays measurement at the analog indicator or at the digital display. For general measurement, digital display is more convenient. For measurement of fluctuating levels or interference waves, use of the analog indicator may be more convenient.

This section explains 2 standard measurement methods using the ML428B.



Voltage	: Displayed at #20 (Units: dBμV)
Field strength	: Displayed at #20 (Units: dBμV/m)

Fig. 3-18 Panel Operation for Field Strength Measurement

(1) Measurement of field strength

i) Connect the power cord and antenna.

ii) Set power switch #1 to ON.

iii) Set the function by setting switch #8 to 3 kHz, switch #9 to AVER, switch #11 to LOG, and switch #22 to ON. (The built-in lamp in switch #22 comes on.)

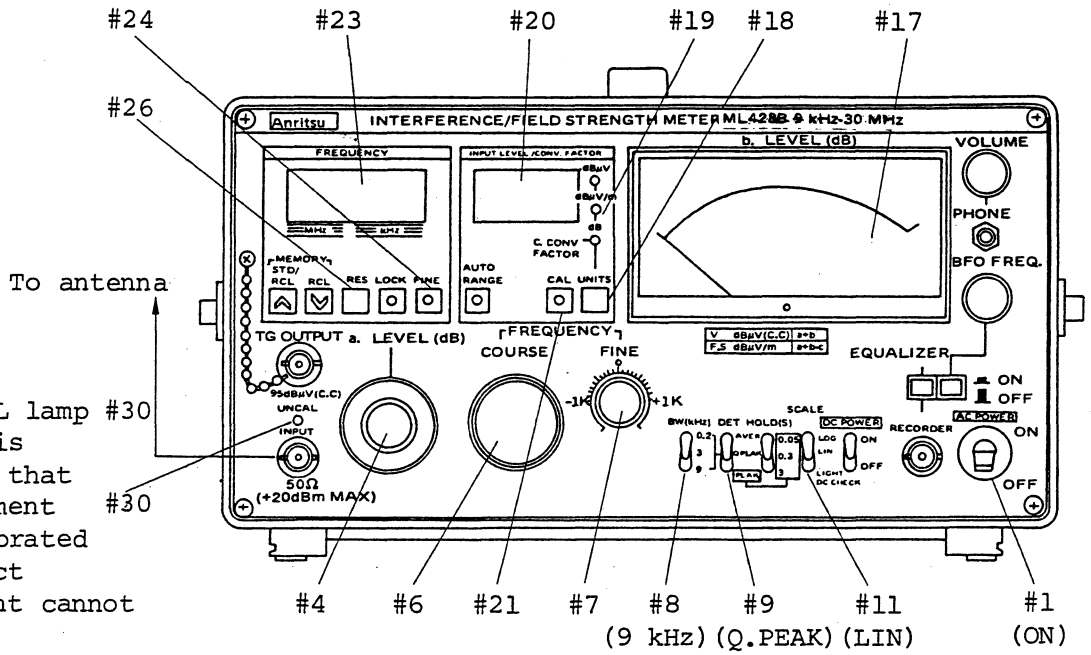
iv) Set the units to dBμV/m by using unit select switch #18. (The selected units are indicated by a lamp.)

Set the received frequency by using frequency setting dial #6 and frequency step setting key #26. (The received frequency is displayed at frequency display #23.)

v) Press CAL key #21. The lamp is on during calibration. When the lamp goes off, the instrument is ready to measure. At this time, the UNCAL lamp #30 goes off.

vi) Level display #20 shows field strength level. (When the units are dBμV, level display #20 shows voltage.) The information of the function which is once set is retained even if the power is turned off.

That is, when the power is turned on again, the function which was being used immediately before turning off the power is automatically set again, and the field strength is measured at once and shown in the level display #20.



Note:
When UNCAL lamp #30 is on, this indicates that the equipment is uncalibrated and correct measurement cannot be made.
In this case, calibrate by pressing CAL key #20.

Voltage	: Dial #4 value + indicator #17 value
Field strength:	Dial #4 value + indicator #17 value + display #20 value (Display #20 indicates conversion factor (dB).)

Note: When UNCAL lamp #30 is on, this indicates that the equipment is uncalibrated and correct measurement cannot be made.

In this case, calibrate by pressing CAL key #21.

Fig. 3-19 Panel Operation for Interference Field Strength Measurement

(2) Measurement of interference field strength (use of analog indicator)

i) Connect the power cord and antenna.

ii) Set power switch #1 to ON.

iii) Set the function by setting switch #9 to Q.PEAK, and switch #11 to LIN.

iv) Set the units to CONV FACTOR dB by using unit select switch #18. (The selected unit is indicated by a lamp.) Set the received frequency by using frequency setting dial #6 and frequency step setting key #26. (The received frequency is shown at frequency display #23.)

v) Press CAL key #21. The lamp is on during calibration. When the lamp goes off, measurement can be performed. At this time, UNCAL lamp #30 turns off. If the UNCAL lamp does not turn off, refer to paragraph 3.2.4.

vi) Adjust the input level by using level dial #4 so that the pointer of indicator #17 is located within the scale range. If UNCAL lamp #30 is on, adjust the input level using level dial #4 so that the UNCAL lamp goes off.

Field strength E is determined as follows:

$$E\ (dB\mu V/m) = V\ (dB\mu V) + K\ (dB)$$

Where, V is the sum of the level dial #4 value and the indicator #17 value. K is the conversion factor, which is shown in level display #20.

Example: When the level dial #4 value is 30 dB, the indicator #17 value is 8 dB, and the level display #20 value is -40, the field strength is as follows:

$$E = 30 + 8 + (+40) = 78\ (dB\mu V/m)$$

(3) Antennas

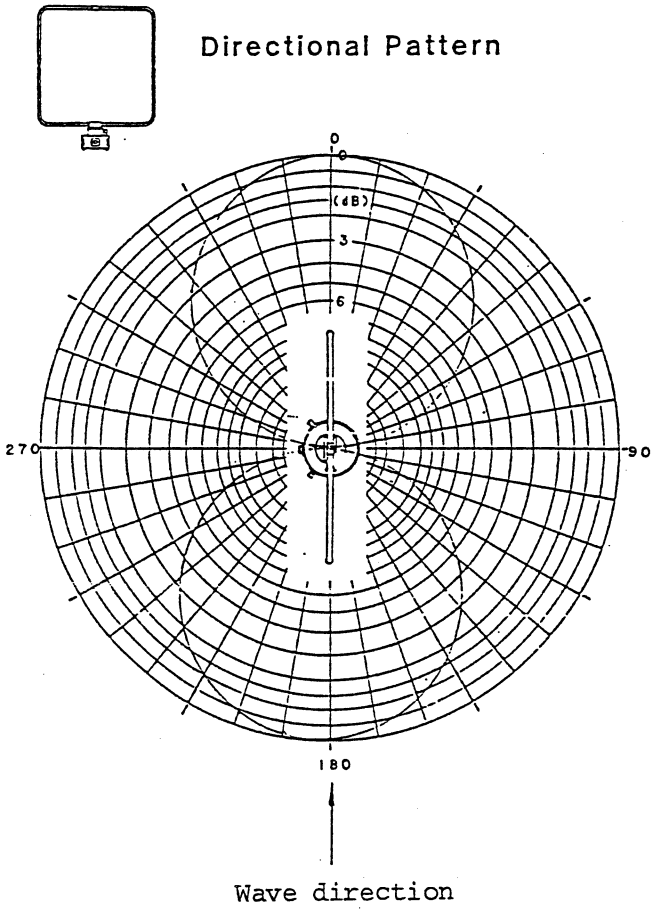


Fig. 3-20 Vertically-Polarized-Wave Horizontal-Plane Directivity of Loop Antenna

The MP414B loop antenna has directivity on the horizontal plane as shown in Fig. 3-20.

At measurement, direct the loop antenna so that the maximum measured value can be acquired.

Ambient conditions slightly influence this antenna, and variation of antenna height will not alter the measurement values significantly. This antenna is appropriate for measurement where high precision is required (e.g., measurement of the Effective Radiation Power (ERP) of a broadcast wave).

The MP415B rod antenna is nondirectional in principle.

As compared with the loop antenna, this rod antenna is largely influenced by ambiental conditions, and variation of antenna height causes significant change in the measured value. However, since it is more sensitive than the loop antenna, it is suitable for measuring of faint radio waves. Usually, the rod antenna is installed on the ground. However, when it must be raised, for example to alter wave measurement, it can be installed on a tripod. When the field intensity is to be directly read, the antenna element length must be 1 m.

The rod antenna element length is 1 m (when shortened) or 2 m (when elongated)

3.5 GP-IB Control

3.5.1 Outline of GP-IB control

The General Purpose Interface Bus (GP-IB) is used for measuring instrument controls. The proper name of this bus is the IEEE-488 interface bus.

The RS-232C and Centronics interface buses are generally used to connect a personal computer to peripheral equipment. However, these interface buses can be used only for connecting predetermined pairs, and more than one peripheral device cannot be controlled at the same time.

The GP-IB can control up to 15 peripheral devices. Respective peripheral devices to be controlled by the GP-IB are connected to the bus in parallel. Each of these peripheral devices is identified using a device number. Device numbers 0 to 30 can be assigned. The personal computer sends a device number, and the peripheral device having this device number is selected for communication with the personal computer.

Each peripheral device has specific codes to control the functions of the device. The ML428B has the device function codes listed in Table 3-9. When one of these codes is sent to the peripheral device, the function corresponding to the code is executed. For example, when "CL" is sent to the ML428B, the ML428B calibrates the level. This operation is the same as the operation caused by pressing the CAL switch on the ML428B panel. Almost all the ML428B functions which are operated from the panel can be controlled through GP-IB as listed in Table 3-9.

These codes are sent from a personal computer to a peripheral device by specifying these codes in a BASIC program.

However, different personal computers use slightly different BASIC languages, and methods of programming for GP-IB control may differ significant.

When viewed from the peripheral device, control codes received from a personal computer are not always available because different personal computers may use different control codes. In the worst case, BASIC programming may be insufficient for peripheral device control.

When the Packet III personal computer is used for GP-IB control, the ML428B can be completely controlled.

When the Packet III is used as the personal computer, programs for GP-IB control can be written quite easily.

When the computer is the talker (sender) and the peripheral device is the listener (receiver), an instruction can be given with a WRITE statement. When the computer is the listener (receiver) and the peripheral device is the talker (sender), an instruction can be given with a READ statement. In a simple program, special commands for GP-IB control are not required. (See an example of the program listed in Table 3-10.)

When a personal computer other than the Packet III is to be used, programming must be done according to the specifications given in the operation manual of the computer.

3.5.2 Connection to personal computer

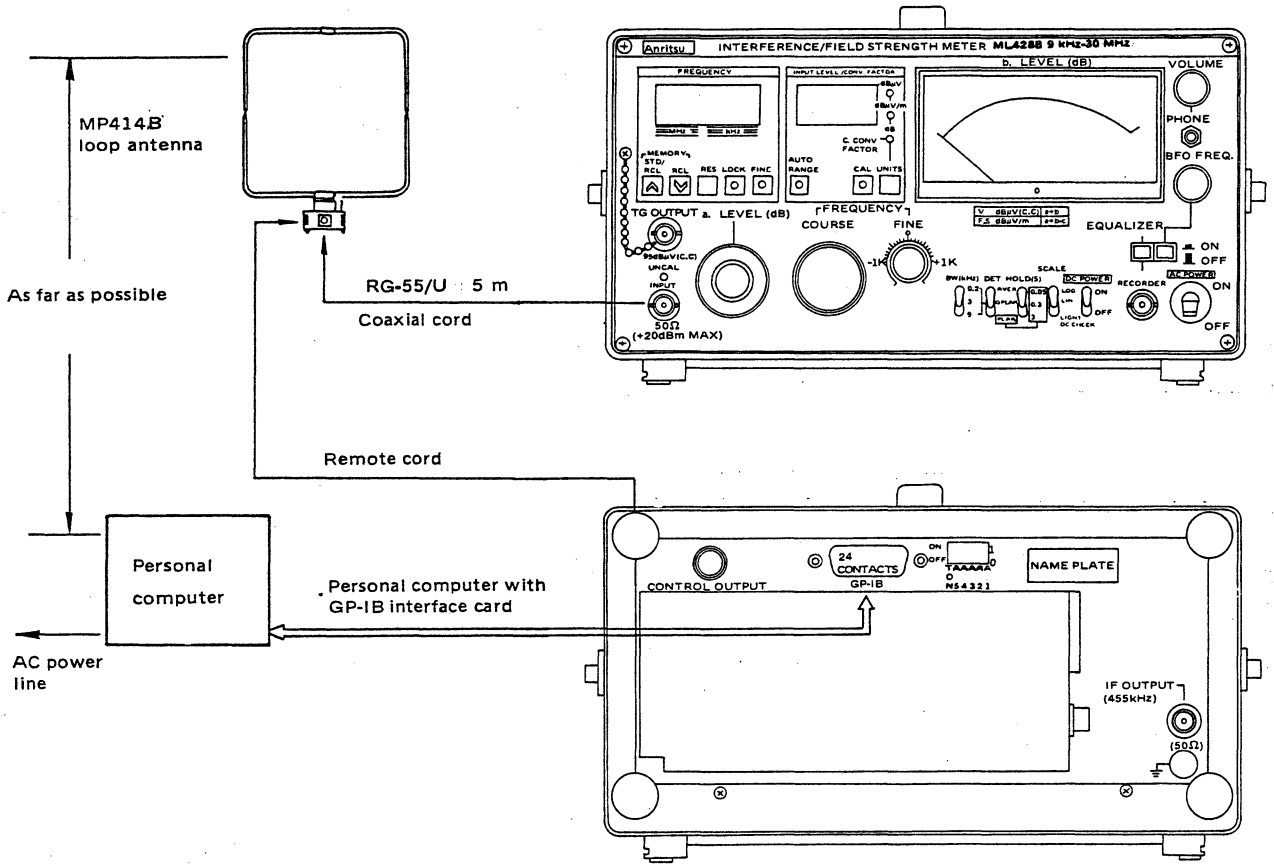


Fig. 3-21 Connection to a Personal Computer

As shown in Fig. 3-21, connect the ML428B to a personal computer having the GP-IB interface.

The most serious problem in personal computer use is the mixing of noise waves radiated from the personal computer.

Noise radiates from the power line, from the GP-IB cord, and from the cabinet. To minimize this noises, the loop antenna must be located as far away as possible from the personal computer, GP-IB cord, and ac power line.

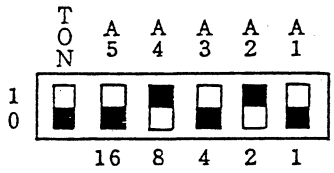
Moreover, direct the loop antenna and position the ML428B so that noise input is minimized.

3.5.3 Setting of device number

For GP-IB control, the device number of the ML428B must be previously set.

The device number is obtained by adding the weight of address code bits A1 to A5.

(Example)



In this example, the device number is 10.

(Since bit A2 and bit A4 are 1, the device number is calculated as follows:

2 + 8 = 10)

The device number must be in the range of 0 to 30.

Fig. 3-22 Address Switch

The device number of the ML428B is set to "8" before shipment.

Note on GP-IB address:

GP-IB address can specify 0 to 30.

31 (11111) is UNL (unlisten) or UNT (untalk) command of multi-line message, so can not be specified as a GP-IB address.

o Talker-only mode

Since the ML428B has the talker-only function, a printer (or other devices) with a GP-IB interface and the listen-only function can be directly driven through the GP-IB without using a personal computer.

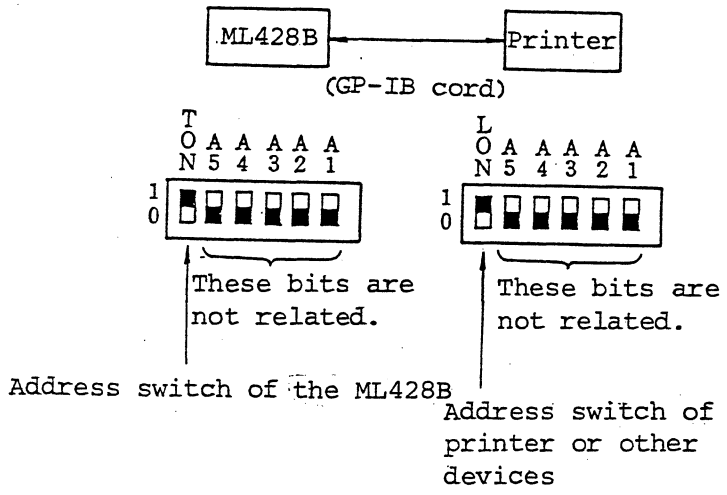


Fig. 3-23 Address Setting for Talker-Only Mode

In this mode, as soon as the switch is turned on, measured data is output to the printer.

Data is collected every 0.1 seconds, but the printing time interval is determined according to the specifications of the printer. If the printing speed is lower than 0.1 seconds/character, data received during printing after the buffer is full will be discarded.

Output example:

CF 28.125 MHz, L +39.4 dBUV

3.5.4 Device function codes and their use examples

Table 3-9 lists the device function codes for the ML428B control by GP-IB.

Table 3-9 Device Function Codes

Code	Function	Remarks
CF	Set a frequency	
CL	Execute CAL	
RL	Set the reference level	
DM	Change the units to dBμV/m	
DV	Change the units to dBμV	
CT	Change the units to the conversion factor	
AR	Set the auto range	
MD	Set detection mode	MD1: AVER, MD2: Q.PEAK MD3: PEAK
BW	Set BW	BW1: 200 Hz, BW2: 3 kHz BW3: 9 kHz (NOTE)*
OF	Output the set frequency	
OL	Output the level	
OR	Output the reference level	
EQ0	Turn off the equalizer	
EQ1	Turn on the equalizer	
AF	Set antenna conversion factor table	
ST	Start making antenna conversion factor table	
SP	Stop making antenna conversion factor table	

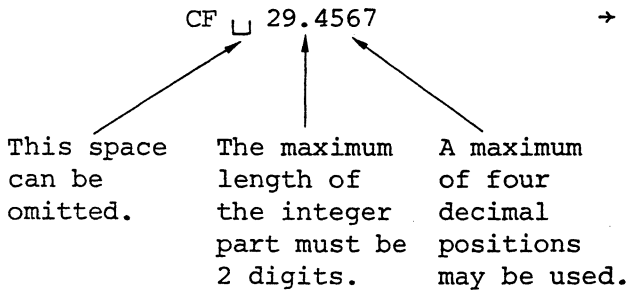
NOTE: When removed from Local mode to Remote mode, BW (bandwidth) data is not retained. So, set BW again.

The following explains each function in more detail. In the following explanation, the Packet IIe is used for programming.

o CF

Frequency setting request (CF numeric-data)

Example)



Valid input examples:

CF10	→	10.000 MHz
CF1	→	1.000 MHz
CF0.1	→	0.100 MHz
CF0.01	→	0.010 MHz

Invalid input examples:

These codes are ignored.

CF+1	A plus sign (+) is included.
C _ F1	An unnecessary space is included.
CF 100	The integer part consists of more than 2 digits.
CF 1.00000	More than four decimal positions are used.

Note:

Max. setting resolution is 0.1 kHz. In 0.1 kHz resolution, frequency stability is not the same as that of reference oscillator. The aging rate becomes approx. ±15 x 10^{-6}/year.

Program example 1:

```
30 WRITE @108: "CF 10.254"
```

Program example 2:

```
10 F = 10.254
20 WRITE @108 USING "C2, 1F6.3": "CF",F
```

Execution results:

The frequency is set to 10.254 MHz.

These execution results are the same as the results obtained by setting the receive frequency using frequency setting dial #6 on the front panel.

Examples 1 and 2 provide the same execution results. When a frequency is to be specified using a variable, a FORMAT statement must be specified.

---

o CL

CAL execution request

Program example:

```
WRITE @108 : "CL"
```

Execution results:

The level is calibrated. These execution results are the same as the results obtained by pressing level calibration key #21 on the front panel.

---

o RL

Reference level setting request

RL -20	-20 dB
RL -10	-10 dB
RL + 0	0 dB
RL +10	10 dB
RL +20	20 dB
RL +30	30 dB
RL +40	40 dB
RL +50	50 dB
RL +60	60 dB
RL +70	70 dB
RL +80	80 dB
RL +90	90 dB

Note: When a positive value is to be set as the reference level, the plus sign (+) which precedes the value may be omitted.

Program example:

```
WRITE @ 108: "RL +20"
```

Execution results:

The reference level is set to 20 dB.

These execution results are the same as the results obtained by setting level dial #4 to 20 dB.

---

o DM

Request to set level units to dBμV/m

Program example:

```
WRITE @108: "DM"
```

Execution results:

The level units are set to dBμV/m.

These execution results are the same as the results obtained by selecting dBμV/m by pressing the unit select key.

---

o DV

Request to set level units to dBμV

Program example:

```
WRITE @108: "DV"
```

Execution results:

The level units are set to dBμV.

These execution results are the same as the results obtained by selecting dBμV by pressing the unit select key.

---

o CT

Conversion factor setting request

Program example:

```
WRITE @108: "CT"
```

Execution results:

When this command is executed, the conversion factor of the antenna is displayed at the level display.

The data which is read by the READ statement is used not as level information but as the conversion factor value.

---

o AR

Auto range setting request

Program example:

```
WRITE @108: "AR"
```

Execution results:

These execution results are the same as the results obtained by pressing auto range key #22.

---

o OF

Set frequency output request

Output format: CF 3.000 MHz

Program example:

```
WRITE @108: "OF"
READ  @108: A$
```

Execution results:

Frequency information "CF 30.000 MHz" which is currently set is read and stored in character variable A$.

---

o OL

Level output request

Output format: L +25.0 dB
L +75.0 dBμV
L +100.0 dBμV/m

Program example:

```
WRITE @108: "OL"
READ  @108: A$
```

Execution results:

The measured level is stored in character variable A$.

---

o OR

Reference level output request

Output format: L +20.0 dB

Program example:

```
WRITE @108: "OR"
        .
        .
        .
READ  @108: A$
```

Execution results:

The reference level which is currently set (it is equal to the level dial value) is read and stored in character variable A$.

Note: When output request OF, OL, or OR is executed, the data must be read by a READ statement corresponding to the WRITE statement as shown in the above examples. A READ statement requires a WRITE statement.

o MD

Detection mode setting request

MD1	AVER
MD2	Q.PEAK
MD3	PEAK

Note: The numeric data which follows "MD" must consist of only one digit. If "0" is specified, "1" is assumed. If "4" or a greater value is specified, "3" is assumed.

Program example:

```
WRITE @108: "MD2"
```

Execution results:

Q.PEAK is set as the detection mode.

These execution results are the same as the results obtained by setting detection mode switch #9 to the Q.PEAK position.

Note: In Q.PEAK mode, pass bandwidth is set to 200 Hz or 9 kHz according to the receiving frequency. When the Q.PEAK mode is released, the pass bandwidth is retained and does not change.

o BW

Pass bandwidth setting request

BW1	200 Hz
BW2	3 kHz
BW3	9 kHz

Note: The numeric data which follows "BW" must consist of only one digit. If "0" is specified, "1" is assumed. If "4" or a greater value is specified, "3" is assumed.

Program example:

```
WRITE @108: "BW1"
```

Execution results:

The pass bandwidth is set to 200 Hz.

These execution results are the same as the results obtained by setting pass bandwidth switch #8 to 0.2 kHz.

o EQ

Equalizer on/off request

EQ0: Equalizer off
EQ1: Equalizer on

Note: The number which follows "EQ" must consist of only one digit. If "2" or a greater value is specified, "1" is assumed.

Program example:

```
WRITE @108: "BW1"
```

Execution results:

The equalizer circuit is turned on.

These execution results are the same as the results obtained by setting equalizer switch #13 to ON.

When a command is to be written, up to 30 device function codes can be written on one line.

Example: `WRITE @108: "CL,RL+20,DM,OL"`

- "ST" "AF" "SP"

  Writing Antenna Factor

  Program example:

```
WRITE @ 108: "ST"              : Starts making antenna
                                 conversion factor table
WRITE @ 108: "AF10.135 - 11.2"
WRITE @ 108: "AF10.515 - 10.3"
WRITE @ 108: "AF10.800 -  9.5"
                :
WRITE @ 108: "SP"              : Stops making antenna
                                 conversion factor table
```

  Result: Writes conversion factors -11.2 dB at 10.135 MHz, -10.3 dB at 10.515 MHz, -9.5 dB at 10.800 MHz, and .....

  Recalled conversion factors are as follows:

$f \leqq 10.135$ MHz : -11.2 dB
$f \leqq 10.515$ MHz : -10.3 dB
$f \leqq 10.800$ MHz : - 9.5 dB

  Conversion factor table requirements:

  - Data point number ... Max. 100
  - Data input order from lower frequency to upper frequency

3.5.5 Program example

Table 3-10 lists an example of a program which measures the level at a fixed frequency interval in a specific frequency range and displays the measured data in a bar chart.

Figure 3-16 shows an example of execution results of the above program. The horizontal axis of this chart indicates frequency, and the vertical axis indicates level.

Lines 50 to 440 of the program shown in Table 3-10 are used to plot a graph. The GP-IB function codes listed in Table 3-9 are used in line 500, 520, 530, and 550.

Line 500 sets a receive frequency.

Line 520 sets the pass bandwidth to 9 kHz.

Line 530 sets the reference level (level dial value) to 0 dB, and requests to read the measured level.

Line 550 assigns the read level to character variable A$.

Line 560 separates the numeric data from the A$-assigned data by deleting the units. Then, the data is assigned to variable "y".

Line 570 plots data "X" (frequency) and "y" (level) onto the graph.

When this program is executed, the program first requests the maximum and minimum values and scale interval of the scale on the X-axis. The operator must then input the frequency range and scale interval as shown in the following example:

[1] [,] [2] [,] [0] [.] [1] [RTN] (Units: MHz)

Next, the program requests the minimum and maximum values and scale interval of the scale on the Y-axis. The operator must input them.

[0] [,] [6] [0] [,] [5] [RTN] (Units dBμV)

The program then requests the operator to input the interval of the frequency to be measured.

[0] [.] [1] [RTN] (Units MHz)

Next, the title of the graph must be input/

[G] [P] [-] [I] [B] [T] [E] [S] [T] [RTN]

Finally, the program requests the operator to input the device number of the GP-IB.

[1] [0] [8] [RTN]

After all of the above input operations are completed, a graph is drawn and the measured data is plotted on the graph, as shown in Fig. 3-24.

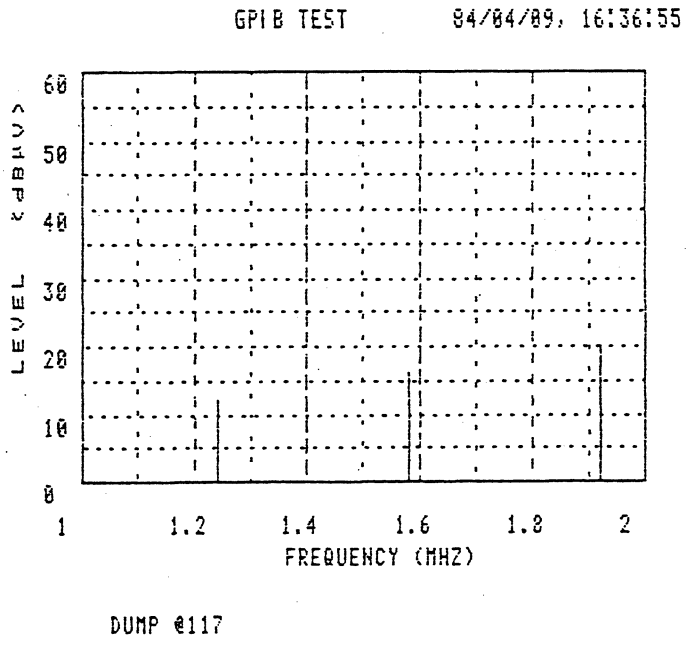


Fig. 3-24 Example of Test Program Execution

When this program is executed, the functions with values which were not defined in this program except pass bandwidth are executed assuming the values which were set before executing this program.

For example, if before executing the program the unit was dBμV, the detection mode was AVE, the equalizer function was OFF, and the pass bandwidth was 3 kHz, only the pass bandwidth is altered by executing the program.

	Before program execution (local state)		During or after program execution (remote state)
Units	dBμV	→	dBμV
Detection mode	AVER	→	AVER
Equalizer	OFF	→	OFF
Pass bandwidth	3 kHz	→	9 kHz

Table 3-10 Program Example

```
  10 !-----------------------------------------------------
  20 !              ML428 EXAMPLE PROGRAM
  30 !-----------------------------------------------------
  40 !    A GRAPH IS DRAWN BY PLOTTING FREQUENCY ON A HORIZONTAL AXIS AND LEVEL
 ON A VERTICAL AXIS.  [428FLIN5]
  50 DIM A$*20
  60 INPUT PROMPT "INPUT X-AXIS GAPH SCALE BY DELIMITING WITH A COMMA [XMIN,XMA
X,XSTEP (MHZ)]":XMIN,XMAX,XSTEP
  70 INPUT PROMPT "INPUT Y-AXIS GRAPH SCALE BY DELIMITING WITH A COMMA [YMIN,YM
AX,YSTEP (DBUV)]":YMIN,YMAX,YSTEP
  80 INPUT PROMPT "INPUT MEASUREMENT STEP (MHZ) ":MSTEP
  90 INPUT PROMPT "INPUT TITLE OF UP TO 10 CHARACTERS":NAME$
 100 INPUT PROMPT "INPUT GP-IB ADRESS (EX.:108)":GPIB
 110 CLEAR 0
 120 REM------------ GRAPH ----------------
 130 SET BOUNDS 0,145,0,100
 140 SET VIEWPORT 20,120,30,90
 150 SET WINDOW XMIN,XMAX,YMIN,YMAX
 160 PLOT XMIN,YMIN;XMAX,YMIN;XMAX,YMAX;XMIN,YMAX
 170 PLOT XMIN,YMIN;XMIN,YMAX
 180 CSIZE 9
 190 PLOT XMIN+(XMAX-XMIN)/2,YMAX
 200 CPLOT -10,1¥GRAPHIC PRINT NAME$
 210 CSIZE 1,1,0
 220 CPLOT XMAX,YMAX¥CPLOT -15,1¥GRAPHIC PRINT DATE$;",  ";TIME$
 230 ! X ------------------------------------
 240 SET LINE STYLE 2
 250 FOR N=XMIN TO XMAX STEP XSTEP
 260 PLOT N,YMIN;N,YMAX
 270 NEXT N
 280 SET LINE STYLE 3
 290 FOR N2=XMIN TO XMAX STEP XSTEP*2
 300 PLOT N2,YMIN;N2,YMAX
 310 PLOT N2,YMIN¥CPLOT -2,-2¥GRAPHIC PRINT N2
 320 NEXT N2
 330 PLOT XMIN+(XMAX-XMIN)/2,YMIN¥CPLOT -6,-3¥GRAPHIC PRINT "FREQUENCY (MHZ)"
 340 ! Y ------------------------------------
 350 OPTION ANGLE DEGREES
 360 SET LINE STYLE 2
 370 FOR M=YMIN TO YMAX STEP YSTEP
 380 PLOT XMIN,M;XMAX,M
 390 NEXT M
 400 FOR M2=YMIN TO YMAX STEP YSTEP*2
 410 PLOT XMIN,M2¥CPLOT -3,-1¥GRAPHIC PRINT M2
 420 NEXT M2
 430 PLOT XMIN,YMIN+(YMAX-YMIN)/2¥CPLOT -4,-3
 440 CSIZE 1,1,100¥GRAPHIC PRINT "LEVEL    (DBUV)"
 450 !   THE FOLLOWING IS FOR GP-IB CONTROL.
 460 !  GP-IB -------------------------------
 470 SET CLIP "ON"
 480 SET LINE STYLE 1
 490 FOR X=XMIN TO XMAX STEP MSTEP
 500 WRITE @GPIB USING "C2,1F6.3":"CF",X!  SET FREQUENCY
 510 !                                     @GPIB:ADDRESS NO.
 520 WRITE @GPIB:"BW3"!                    SET BW TO 9KHZ
 530 WRITE @GPIB:"RL90,OL"! SET REFERENCE LEVEL TO 90DB AND OUTPUT MEASURED LEV
EL.
 540 WAIT DELAY 2
 550 READ @GPIB:A$!                        ASSIGN DATA TO A$.
 560 LET Y=VAL(A$(3:8))
 570 PLOT X,Y;X,YMIN
 580 NEXT X
 590 SET CLIP "OFF"
 600 END
```

3.5.6 Notes on programming

When a frequency is to be set using a WRITE statement and level data is to be read with a READ statement or when CAL execution is to be specified by a WRITE statement and level data is to be read with a READ statement, the wait time must be specified as shown below:

. Frequency specification

```
10 WRITE @108 USING "C2, 1F6.3": "CF", 10.254
20 WAIT DELAY 1
30 READ @108: A$
```

. Level calibration (average value mode)

```
60 WRITE @108: "MD1, CL, OL"
70 WAIT DELAY 4
80 READ @108: A$
```

. Level calibration (quasi-peak value mode)

```
110 WRITE @108: "MD2, CL, OL"
112 WAIT DELAY 7
114 READ @108: A$
```

. Level calibration (peak value mode)

```
140 WRITE @108: "MD3, CL, OL"
150 WAIT RELAY 7
160 READ @108: A$
```

Note: The WAIT RELAY value must be specified in seconds.

When commands for DM, DV, and CT are to be consecutively executed, one must wait 0.2 seconds or longer before the next command is executed.

If sufficient delay is not acquired, the pre-alteration data may be set as the first READ statement data after alteration.

Example:

```
 10 WRITE @108: "DV, OL"
 20 WAIT DELAY .2
 30 READ @108: A$
 40 WRITE @108: "DM, OL"
 50 WAIT DELAY .2
 60 READ @108: B#
 70 WRITE @108: "CT, OL"
 80 WAIT DELAY .2
 90 READ @108: C$
100 PRINT A$, B$, C$
```

3.5.7 Notes on GP-IB operation

During GP-IB operation (remote mode), controls on the panel are inactivated.

If an error occurs during GP-IB operation and the following command is sent, the system may return to normal operation.

Press the RESET key (or the SHIFT RESET key of Packet IIe) to stop program execution.

Execute the following command in direct mode. (In direct mode, a command can be input directly from the keyboard.):

```
DCL #108
or
IFC @1
```

In some cases, one may resume normal operation by turning off the ML428B power switch and then turning it back on again.

The ML428B does not have a remote/local changeover switch. However, when the GP-IB cord is connected to the ML428B, execution of a WRITE statement immediately sets the ML428B to the remote mode.

It can be set to the local mode by turning off the ML428B power or by executing the following command in direct mode:

```
LCL @108
```

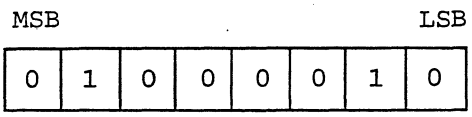
In local mode, the ML428B can be operated from its panel.

3.5.8 Notes on SRQ

Auto-ranging or CAL execution ending can be acknowledged by the status data shown below.

(1) When the range is changed by over- or under-ranging in auto-ranging, the SRQ (service request) command is activated and the status data becomes 66 (decimal).

Status Data



(Example 1)

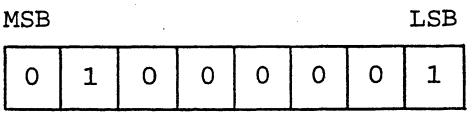
```
10  STATUS @ 108: A
20  IF A < > 66 THEN 40
30  WAIT DELAY 1 ¥ GO TO 10
40  WRITE @ 108: "OL"
50  READ @ 108: A$
```

(Example 2)

```
10  DO  WHILE A=66
20  STATUS @ 108: A
30  EXIT IF A=66
40  WAIT DELAY 1
50  LOOP
60  WRITE @ 108: "OL"
70  READ  @ 108: "A$"
```

(2) When CAL execution is ended, the SRQ command is activated and the status data becomes 65 (decimal).

Status Data



(Example 3)

```
10  WRITE @ 108: "CL"
20  STATUS @ 108: A
30  IF A=65 THEN 50
40  WAIT DELAY 0.5 ¥ GO TO 20
50  WRITE @ 108: "OL"
60  READ @ 108: A$
```

(Example 4)

```
10  WRITE @ 108: "CL"
20  DO UNTIL A=65
30  STATUS @ 108: A
40  EXIT IF A=65
50  LOOP
60  WRITE @ 108: "OL"
70  READ @ 108: A$
```

3.6 Average Value Detection Mode Measurement Precautions

Make measurements in the average value detection mode with the analog meter on LIN Scale.

Set the panel switches as listed in Table 3-11.

Table 3-11 Setting Conditions for Average Value Measurements

BW (kHz):	0.2 kHz	when receiving frequency	≤150 kHz
	9 kHz	when receiving frequency	≥150 kHz
DET:			AVER
SCALE:			LIN
Display:			Meter
EQUALIZER:			ON

When a sine wave is measured, the value measured in the average value detection mode is the same as that in the peak or quasi-peak value detection mode. However, for pulse noise, the measured value can be significantly different from that measured in the peak or quasi-peak detection modes depending on the pulse repetition frequency.

Pulse response characteristics in both the average and quasi-peak detection modes are shown by lines (1) and (2) of Fig. 3-25. The measured values vary with the setting conditions.

Note:

When LOG is selected as the SCALE setting, almost the same value as for LIN is obtained for a sine wave or random noise.

Note (cont.):

For pulse noise, the LOG scale value differs from the LIN scale value resulting in an error.

When selecting a digital display or using the GP-IB, the SCALE is automatically set to LOG. The errors caused by the LOG scale vary with the pulse repetition frequency.

The response characteristics in the LOG scale are shown by line (3) of Fig. 3-25.

[Reference]

The allowable average values specified by CISPR for the conducted EMI measurement of data processing equipment is 10 to 13 dB lower than the allowable quasi-peak values.

The interference wave levels in this case must satisfy the allowable values for both the quasi-peak and average values.

As shown in Fig. 3-26, for the pulse response characteristics, at frequencies lower than the point where the value 13 dB lower than the quasi-peak value and the average values intersect, a value measured in the quasi-peak detection mode is effective. At frequencies higher than the intersection, the average value detection mode is effective.

Thus, assuming a maximum error of -4 dB, the LOG scale is also recommended.

But pulse noise measurement in the LOG scale increases the danger of an error occurring because of internal circuit saturation depending the measurement range. Therefore, an accurate measurement value must be confirmed by the specified method (LIN scale) described in Table 3-11.

When using a personal computer for external control, it is recommended to use the measured output from the RECORDER output. Add it to the A/D converter of the personal computer, and fetch the data. Use the setting listed in Table 3-11.

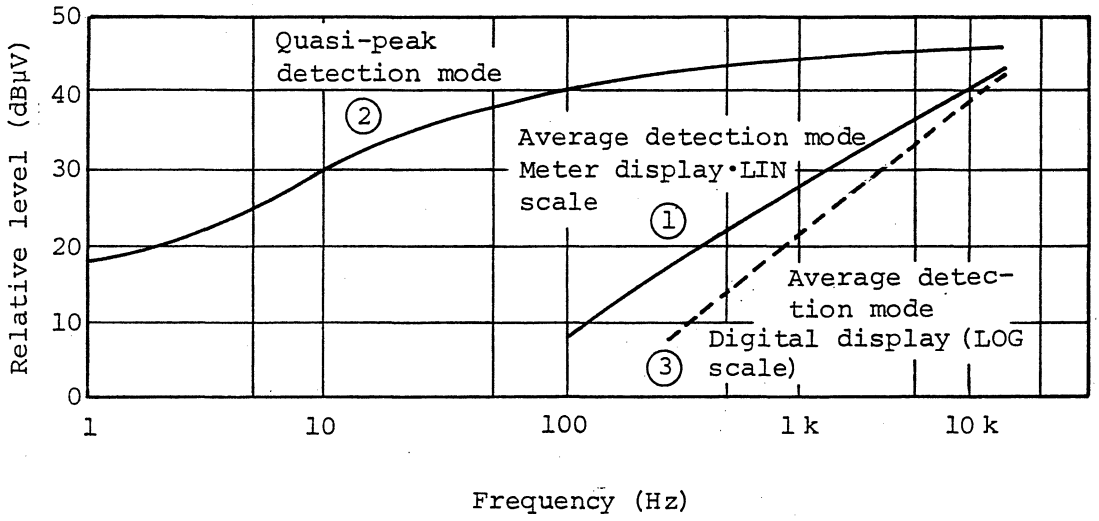


Fig. 3-25 Pulse Response Characteristics I at Quasi-peak and Average Detection Modes

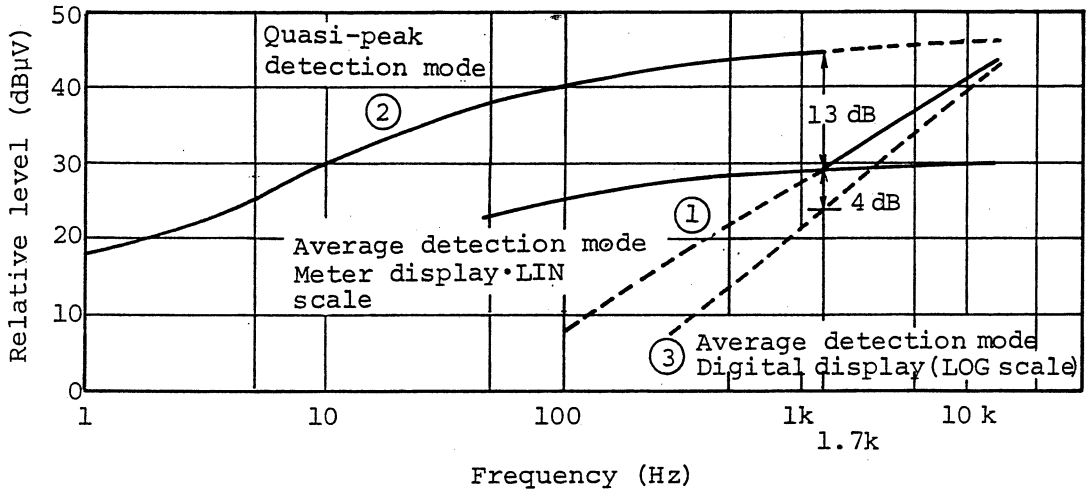


Fig. 3-26 Pulse Response Characteristics II at Quasi-peak and Average Detection Modes

SECTION 4

STORAGE

4.1 Storage Precautions

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

(1) Always clean the instrument throughly before storage.

(2) Do not store the instrument under high temperatures (55°C or more), high humidity (90% or more), or excessively low temperatures (-25°C or less).

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

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

4.2 Recommended Storage Conditions

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

Temperature: 0° to 30°C

Humidity : 40% to 80%

The storage area should not be subject to large fluctuations in temperature and humidity during a 24 hour period.

SECTION 5

PERFORMANCE CHECK

5.1 Introduction

The ML428B performance check is described for the following specifications:

1. Frequency
2. Level (voltage measuring range)
3. Selectivity
4. Pulse response
5. Output
6. Tracking generator
7. Remote control
8. Power

5.2 Equipment Required

Table 5-2 Equipment Required

No.	Equipment	Required Performance	Recommended Model (Anritsu)
1	Signal generator	Frequency range 25 to 1100 MHz Frequency accuracy $\pm 1 \times 10^{-7}$ Output level accuracy ±1 dB	MG655A
2	Level generator	Frequency range 9 kHz to 30 MHz Frequency accuracy $\pm 5 \times 10^{-8}$ Output level accuracy ±0.3 dB ($\geqq$ -80 dBm)	MG443B

Table 5-2 (Continued)

No.	Equipment	Required Performance	Recommended Model (Anritsu)
3	Spectrum analyzer	Frequency range 9 kHz to 250 MHz Measuring level range 10 to 120 dBμV	MS611A
4	Oscilloscope	Frequency range Dc to 200 MHz	
5	Pulse generator	Pulse width 10 μs to 1 ns Output level ±10 V	
6	Digital multimeter	Measuring voltage range 200 mVdc to 30 Vdc 200 mVac to 200 Vac Measuring voltage accuracy ±1% Measuring current range 200 mA ac.dc to 2 A ac.dc Measuring current accuracy ±1%	
7	Resistance attenuator	Frequency range Dc to 500 MHz Step dial 10 dB x 8, 1 dB x 10, 0.1 dB x 10 Attenuation accuracy ±0.4 dB Max.	MN510C
8	Frequency counter	Frequency range 10 Hz to 250 MHz Frequency stability (aging rate) $\leqq 2 \times 10^{-8}$/day	MF57A

Table 5-2 (Continued)

No.	Equipment	Required Performance	Recommended Model (Anritsu)
9	50 Ω feed-through terminator	Dc to 100 MHz	
10	100 kΩ feed-through terminator	Dc to 100 kHz	
11	150 Ω feed-through terminator	Dc to 100 kHz	
12	GP-IB controller	GP-IB control function	Packet III
13	Dc power supply	11.5 to 24 Vdc 2 A	

Note:

Required performance is the principal parameter required for the calibration, and is included to assist selection of alternative equipment. Satisfactory performance of alternative equipment must be verified prior to use and must bear evidence of current calibration.

5.3 Preliminary Operation

Warm up the ML428B for 30 minutes or more and check equipment.

5.4 Performance Checks

CAUTION

Unless otherwise specified, verify the results of each check and troubleshoot according to the separate Service Manual whenever the check specification is not met.

5.4.1 Frequency

(1) Specifications

Range : 9 kHz to 30.000 MHz

Display: Digital, 5-digits LCD, Lowest 1 kHz

(2) Setup

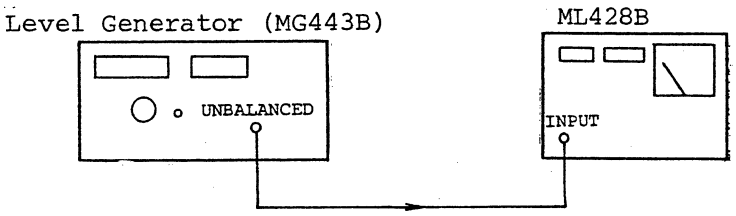


Fig. 5-1 Frequency Check Setup

(3) Procedures

Step	Procedure
1	Connect the MG443B output to the ML428B INPUT connector.
2	Set the MG443B output level to -7.0 dBm. (= 100 dBμV)
3	Set the ML428B as follows: LOCK : OFF FINE : OFF AUTO RANGE: OFF LEVEL (dB): 90 BW (kHz) : 0.2 DET : AVER
4	Set the ML428B frequency to 1 MHz, and press the CAL key.
5	Set the ML428B and MG443B frequencies to the values listed in Table 5-3. Then confirm that the measured value is approximately 100 dBμV for each frequency. Note: For 9 kHz, set the displayed frequency to 10 kHz and turn the FINE key on. Then, turn the FINE dial and set to -1 kHz. Turn the FINE key off for all other frequencies.

Table 5-3 Frequency Check

No.	Frequency (MHz)
1	0.010
2	0.100
3	0.149
4	0.150
5	0.250
6	0.399
7	0.400
8	0.700
9	0.999
10	1.000
11	1.700
12	2.499
13	2.500
14	3.500
15	4.199

No.	Frequency (MHz)
16	4.200
17	5.500
18	6.999
19	7.000
20	10.000
21	11.499
22	11.500
23	16.500
24	18.999
25	19.000
26	25.000
27	30.000

5.4.2 Level (Voltage measuring range, terminated value)

(1) Specifications

Minimum value

(C/N = 6 dB, BW 200 Hz, average value)

9 to 49 kHz	-15 dBμV
50 to 149 kHz	-17 dBμV
150 kHz to 30 MHz	-20 dBμV

Maximum value

LOG (Meter display)	115 dBμV
LIN (Meter display)	95 dBμV
Digital display	115 dBμV

Accuracy

±1.5 dB (at more than 20 dB higher than minimum value)

Digital level display

Display: 4-digits LCD
resolution 0.1 dB

Unit : dBμV, dBμV/m, or dB
(conversion factor of antenna.)

(2) Setup

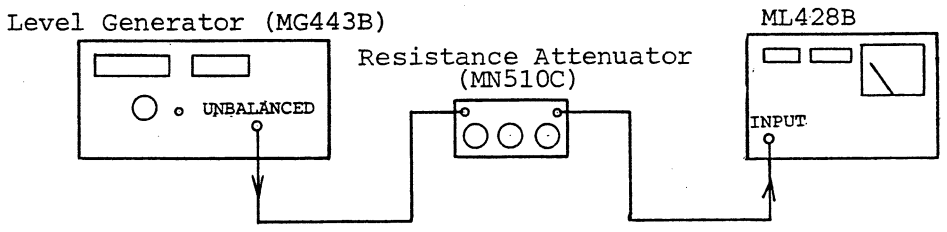


Fig. 5-2 Level Check Setup

(3) Procedures

(a) Minimum value

Step	Procedure
1	Connect the level calibrated MG443B output to the ML428B INPUT through the MN510C as shown in Fig. 5-2.
2	Set the ML428B as follows. LOCK : OFF FINE : OFF AUTO RANGE: OFF LEVEL (dB): -20 BW (kHz) : 0.2 DET : AVER SCALE : LIN
3	Set the frequencies of the MG443B and the ML428B to a frequency shown in Table 5-4.

Table 5-4 Setting Frequency for Level Check

No.	Frequency (MHz)
1	0.009
2	0.049
3	0.050
4	0.149
5	0.150
6	0.500
7	1.000
8	2.500
9	5.000
10	10.000
11	15.000
12	20.000
13	25.000
14	30.000

(Cont.)

Step	Procedure
4	Set the MN510C to 80 dB.
5	Set the MG443B output level to -80 dBm and shift the MG443B output frequency up or down by about 1 MHz.
6	Press the CAL key to calibrate level.
7	Measure the ML428B internal noise at the specified frequency by using the meter.
8	Gradually increase the ML428B input level by adjusting the MG443B output level or MN510C attenuation. Assume that the input level is the minimum voltage measurement value when the meter indication exceeds the internal noise level by 6 dB.
9	Repeat the steps 4 to 8 at the every frequency shown in Table 5-4.

(b) Maximum value

Step	Procedure
1	Connect the level calibrated MG443B output to the ML428B INPUT though the MN510C as shown in Fig. 5-2.
2	Set the MN510C to 0 dB.
3	Set the ML428B as follows: FINE : OFF AUTO RANGE: OFF LEVEL (dB): 90 BW (kHz) : 0.2 DET : AVER UNITS : dBμV

(Cont.)

Step	Procedure
4	Set the frequencies of the MG443B and the ML428B to a frequency shown in Table 5-4.
5	Press the CAL key to calibrate level.
6	Set the ML428B SCALE to LIN and set the MG443B output level to -12 dBm (95 dBμV). Check that the measured result shown by meter display is normal at the frequency.
7	Set the ML428B SCALE to LOG and set the MG443B output level to +8.0 dBm (115 dBμV). Check that the measured result shown by meter display and by digital display is normal at the frequency.
8	Repeat steps 4 to 7 at every frequency shown in Table 5-4.

(c) Accuracy

Step	Procedure
1	Connect the level calibrated MG443B output to the ML428B INPUT through the MN510C as shown in Fig. 5-2.
2	Set the ML428B as follows: FINE : OFF AUTO RANGE: ON BW (kHz) : 0.2 DET : AVER UNITS : dBμV
3	Set the frequencies of the MG443B and the ML428B to a frequency shown in Table 5-4.

(Cont.)

Step	Procedure
4	Press the CAL key to calibrate level.
5	Set the ML428B input level to a value 20 dB higher than the minimum value.
6	Check that the displayed value error on the digital display is within the ±1.5 dB at every frequency shown in Table 5-4.

(d) Display and units

Check that the measured level digital display is normal at the measurement above.

Press the UNITS key, and check that the unit display is switched to dBμV, dBμV/m, and dB.

5.4.3 Selectivity

(1) Specification

6 dB bandwidth

200 +20/-30 Hz
3 ±0.3 kHz
9 ±1 kHz

Rejection

200 Hz ≧50 dB at 1 kHz off center
3 kHz ≧50 dB at 2.5 kHz off center
9 kHz ≧50 dB at 13.5 kHz off center

Signal-to-image ratio

≧70 dB

(2) Setup

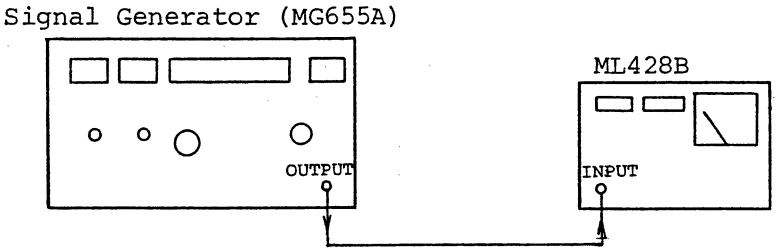


Fig. 5-3 Selectivity Check Setup

(3) Procedures

(a) 6 dB Bandwidth

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT.
2	Set the ML428B as follows: FINE : OFF UNITS : dBμV DET : AVER AUTO RANGE: ON BW (kHz) : 0.2, 3 or 9
3	Set the frequencies of the MG655A and the ML428B to 1 MHz.
4	Set the MG655A output level to 10 dBμV.
5	Record the ML428B measured level (digital display).
6	Increase the MG655A output level by 6 dB.
7	Increase the MG655A output frequency and record the frequency (fH) when the ML428B measured level (digital display) is the same as the value recorded in step 5.

(Cont.)

Step	Procedure
8	Decrease the MG655A output frequency and record the frequency (fL) when the ML428B measured level (digital display) is the same as the value recorded in step 5.
9	Subtract the recorded frequency in step 8 from the recorded frequency in step 7. This is the 6 dB bandwidth. 6 dB BW = (fH - fL)
10	Change the BW (kHz) of the ML428B and repeat steps 3 to 9.

(b) Rejection

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT.
2	Set the ML428B as follows: BW (kHz) : 0.2 (3 or 9) FINE : OFF UNITS : dBμV LEVEL (dB): 0 dB DET : AVER AUTO RANGE: OFF
3	Set the frequencies of the MG655A and the ML428B to 1 MHz.
4	Set the MG655A output level to 10 dBμV.
5	Record the ML428B measured level (digital display).
6	Set the MG655A output frequency to 1.001 MHz at BW (kHz) = 0.2 (1.0025 or 1.0135 MHz at BW (kHz) = 3 or 9 kHz).

(Cont.)

Step	Procedure
7	Adjust the MG655A output level so that the ML428B measured level (digital display) is the same as the value recorded at step 5, and record the output level at that time.
8	Subtract 10 dB from the MG655A output level in step 7. This value is the IF rejection at 1 kHz off center at BW (kHz) = 0.2 (2.5 kHz or 13.5 kHz off center at BW (kHz) = 3 or 9).
9	Set the MG655A output frequency to 0.999 MHz at BW (kHz) = 0.2 (0.9975 or 0.9865 at BW (kHz) = 3 or 9) and repeat steps 7 and 8.

(c) Signal-to-image ratio

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT.
2	Set the ML428B as follows: FINE : OFF UNITS : dBμV LEVEL (dB): 0 dB BW (kHz) : 0.2 DET : AVER
3	Set the frequencies of the MG655A and the ML428B to a receiving frequency shown in Table 5-5.
4	Press the CAL key to calibrate level.
5	Set the MG655A output level to 10 dBμV.

(Cont.)

Step	Procedure
6	Record the ML428B measured level (digital display).
7	Set the MG655A output frequency to the corresponding image frequency shown in Table 5-5.
8	Press the CAL key to calibrate level.
9	Increase the MG655A output level and record it when the ML428B measured level (digital display) is the same as the value recorded in step 6.
10	Subtract 10 dB from the MG655A output level in step 9. This value is the signal-to-image ratio.
11	Change the receiving frequency and repeat steps 4 to 10.

Table 5-5 Setting Frequency for Signal-to-Image Ratio Check

No.	Receiving Frequency (MHz)	Image Frequency (MHz)
1	0.1	180.1
2	0.3	180.3
3	0.7	180.7
4	1.5	181.5
5	3	183.0
6	5	185.0
7	10.5	190.5
8	16	196.0
9	25	205.0

5.4.4 Pulse response

The repetition response of the pulse response characteristics is expressed as the relative equivalent input level. This is the pulse signal input level with repetition frequency varied to indicate the same value as the indication value of the pulse signal with reference repetition frequency.

In addition, the pulse amplitude response is expressed as the level indication value when a pulse signal with the specified pulse width, amplitude, and repetition frequency is received.

(1) Specifications

(a) Pulse-repetition rate response (9 kHz to 150 kHz)

Table 5-6

Pulse repetition frequency (Hz)	25	100	60	10	5	2	1	Isolated pulse
Relative equivalent level of pulse (dB)	0 (reference)	-4.0 ±1.0	-3.0 ±1.0	4.0 ±1.0	7.5 ±1.5	13.0 ±2.0	17 ±2.0	19 ±2.0

(b) Pulse-repetition rate response (150 kHz to 30 MHz)

Table 5-7

Pulse repetition frequency (Hz)	100	1000	20	10	2	1	Isolated pulse
Relative equivalent level of pulse (dB)	0 (reference)	-4.5 ±1.0	6.5 ±1.0	10.0 ±1.5	20.5 ±2.0	22.5 ±2.0	23.5 ±2.0

(c) Pulse amplitude response

The response to a μVs pulses with a uniform spectrum up to at least b MHz, repeated at a frequency of c Hz is for all tuning frequencies, equal to the response to an unmodulated sine-wave signal at the tuned frequency with an e.m.f. of 2 mV r.m.s. (66 dB(μV)) from a signal generator with the same source impedance as the pulse generator.

Frequency Band	a (μVs)	b (MHz)	c (Hz)
9 to 150 kHz	13.5	0.15	25
150 kHz to 30 MHz	0.316	30	100

(2) Setup

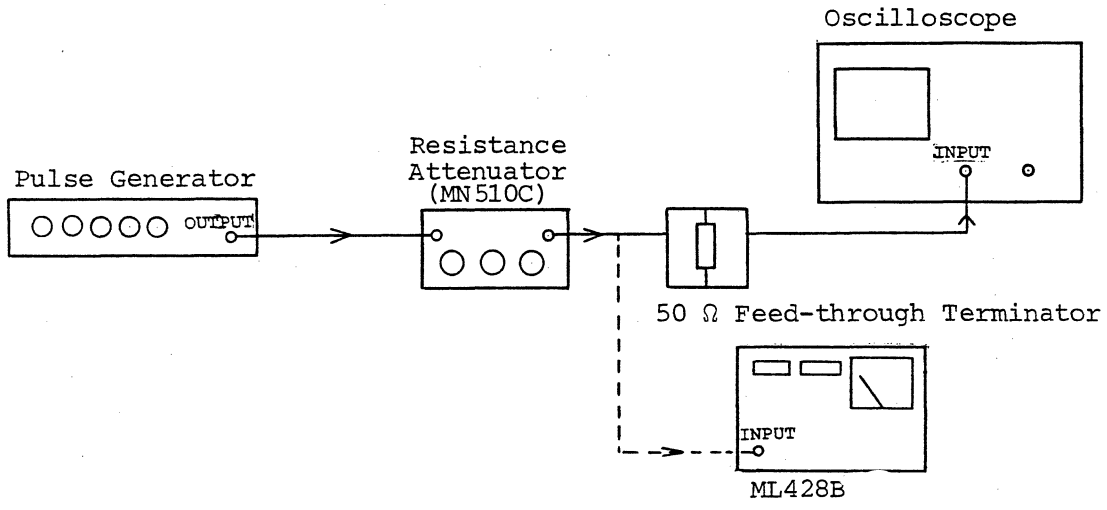


Fig. 5-4 Pulse Response Check Setup

(3) Procedures

Step	Procedure
(Pulse-repetition rate response check at 100 kHz).	
1	Set the ML428B receiving frequency to 100 kHz and the DET mode to Q.PEAK. Then press the CAL key to calibrate level.
2	Set the ML428B as follows: LEVEL (dB): 0 AUTO RANGE: OFF SCALE : LIN
3	Set the pulse width of the pulse generator output to approximately 1 μs and the repetition frequency to 25 Hz.
4	Set the level meter indicator deflection to -5 dB by varying the input level. The input level is assumed to be A.
5	Set the repetition frequency of the pulse generator output to a value listed in Table 5-6.
6	Adjust the ML428B input level so that the level meter indicator deflection can be set to -5 dB. The input level is assumed to be B. (B-A) is the relative equivalent input level at that frequency.
(Pulse amplitude response check at 100 kHz)	
7	Set the repetition frequency of the pulse generator output to 25 Hz. Connect the pulse generator output to an oscilloscope as shown in Fig. 5-4.

(Cont.)

Step	Procedure
8	Observing the waveform on the oscilloscope, set the pulse amplitude and width to 1 V and 1.67 μs, respectively.
9	Remove the 50 Ω feed through terminator, and measure the pulse output level using the ML428B, as shown in Fig. 5-4.
10	Confirm that |measured value-54| $\leqq$ +1.5 dB.
(Pulse-repetition rate response check at 30 MHz)	
11	Set the ML428B receiving frequency to 30 MHz and the DET mode to Q.PEAK. Then press CAL key to calibrate level.
12	Set ML428B as follows: LEVEL (dB): 10 AUTO RANGE: OFF SCALE : LIN
13	Set the pulse width of the pulse generator output to approximately 10 ns and the repetition frequency to 100 Hz.
14	Set the ML428B level meter indicator deflection to -5 dB by varying the input level. The input level is assumed to be A.
15	Set the repetition frequency of the pulse generator to a value listed in Table 5-7.
16	Adjust the ML428B input level so that the level meter indicator deflection can be set to -5 dB. The input level is assumed to be B. (B-A) is the relative equivalent input level at that frequency.

(Cont.)

Step	Procedure
(Pulse amplitude response check at 30 MHz)	
17	Set the repetition frequency of the pulse generator output to 100 Hz. Connect the pulse generator output to an oscilloscope as shown in Fig. 5-4.
18	Observing the waveform on the oscilloscope, set the pulse amplitude and width to 1 V and 8.3 ns, respectively.
19	Remove the 50 Ω feed through terminator, and measure the pulse output level using the ML428B, as shown in Fig. 5-4.
20	Confirm that |measured value-40.9| $\leqq$ +1.5 dB.

5.4.5 Output

(1) IF output

(a) Specifications

Frequency: 455 kHz

Level : ≧86 dBμV (terminated value, meter indication 0 dB)

(b) Setup

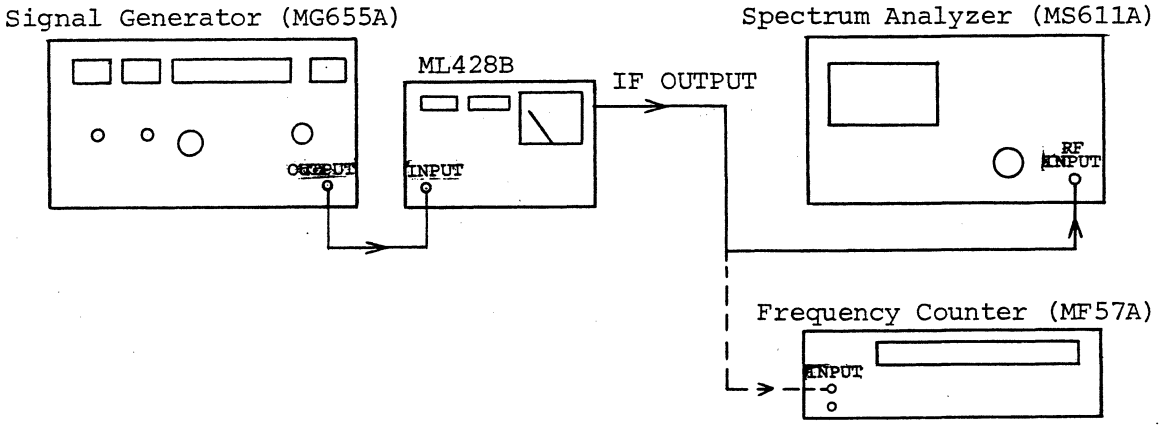


Fig. 5-5 IF Output Check Setup

(c) Procedures

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT and the ML428B IF OUTPUT to the MS611A RF INPUT.
2	Set the ML428B as follows: FINE : OFF FREQUENCY : 1 MHz AUTO RANGE: OFF LEVEL (dB): 10

(Cont.)

Step	Procedure
2 (cont.)	BW (kHz) : 0.2 DET : AVER UNITS : dBμV
3	Press the CAL key to calibrate level.
4	Set the MG655A as follows: Frequency : 1 MHz Output level: 5 dBμV
5	Measure the IF OUTPUT signal frequency with the MF57A.
6	Measure the IF OUTPUT signal level with the MS611A.
7	Convert the MS611A measured value to dBμV. 0 dBm/50 Ω = 107 dBμV (terminated value)

(2) Output for recorder

(a) Specifications

Level: 1 V ±10%
(100 kΩ load with indicator at full scale)

Impedance: $\leqq$ 150 Ω (BNC connector)

(b) Setup

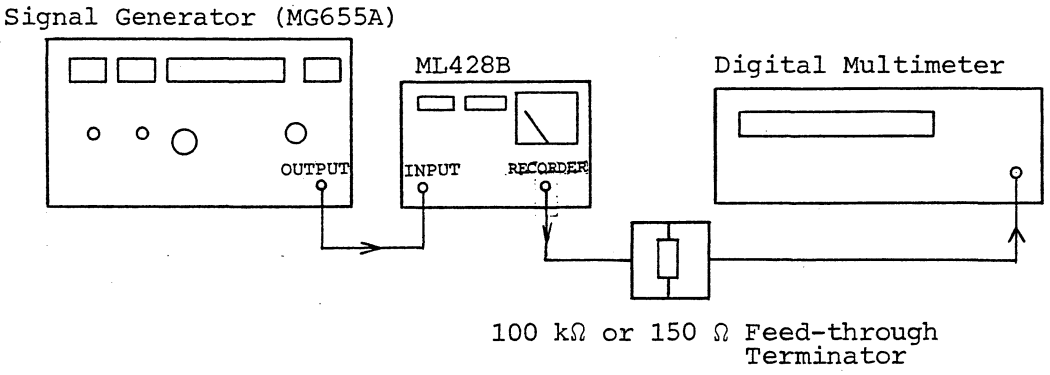


Fig. 5-6 Output for Recorder Check Setup

(c) Procedures

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT, then terminate the RECORDER output with a 100 kΩ feed-through terminator and connect it to the INPUT of a digital multimeter.
2	Set the ML428B as follows: FINE : OFF FREQUENCY : 1 MHz AUTO RANGE: OFF LEVEL (dB): 10 BW (kHz) : 0.2 DET : LOG SCALE : AVER
3	Set the MG655A as follows: Frequency : 1 MHz

(Cont.)

Step	Procedure
4	Measure the RECORDER output voltage with the multimeter. This value is A.
5	Change the RECORDER output terminator to 150 Ω and measure the RECORDER output voltage. This value is B. The impedance of RECORDER is calculated from the following formula: $Z = \left(\frac{A - B}{B \times 100000 - A \times 150}\right) \times 150 \times 100000 \quad (\Omega)$

(3) Output for monitoring

(a) Specification

A1A, A2B, and A3E waves can be monitored using the internal speaker or earphone. BFO is provided.

(b) Setup

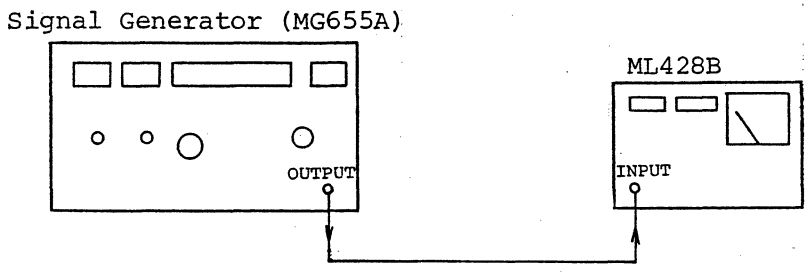


Fig. 5-7 Output For Monitoring Check Setup

(c) Procedures

Step	Procedure
1	Connect the MG655A output to the ML428B INPUT.
2	Set the ML428B as follows: FINE : OFF FREQUENCY : 1 MHz AUTO RANGE: ON BW (kHz) : 9
3	Set the MG655A as follows: Frequency : 1 MHz Output level: 20 dBμV
4	Turn the ML428B BFO switch on and set the VOLUME knob to the center position. Then, confirm that a beat sound is generated by turning the BFO FREQ knob.
5	Set the MG655A as follows: Modulation : AM Modulation frequency: 1 kHz Modulation factor : 50%
6	Turn the ML428B BFO switch off to confirm that a 1 kHz sound is being generated.

5.4.6 Tracking generator

(1) Specifications

Frequency setting: Automatically set to the receiving frequency

Output : 95 dBμV ±1 dB (terminated value), sine wave

Impedance : 50 Ω (BNC connector)

(2) Setup

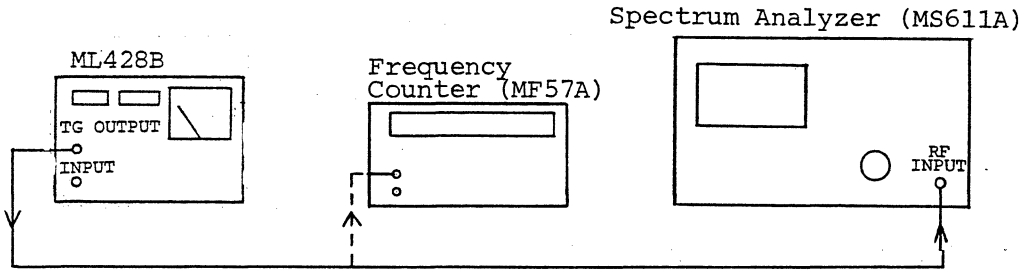


Fig. 5-8 Tracking Generator Check Setup

(3) Procedures

Step	Procedure
1	When connecting the ML428B TG OUTPUT connector to the MF57A input and changing the setting frequency according to Table 5-3, confirm that the MF57A indication value is within the specified range (setting frequency ±70 Hz). Note that the minimum frequency in Table 5-3 is 10 kHz.
2	Connect the ML428B TG OUTPUT to the MS611A RF INPUT.

(Cont.)

Step	Procedure
3	Set the ML428B and MS611A frequencies according to Table 5-3.
4	Calibrate the MS611A level and confirm that the TG OUTPUT level is 95 dBμV (-12 dBm) ±1 dB measuring the level.

5.4.7 Remote control

(1) Setup

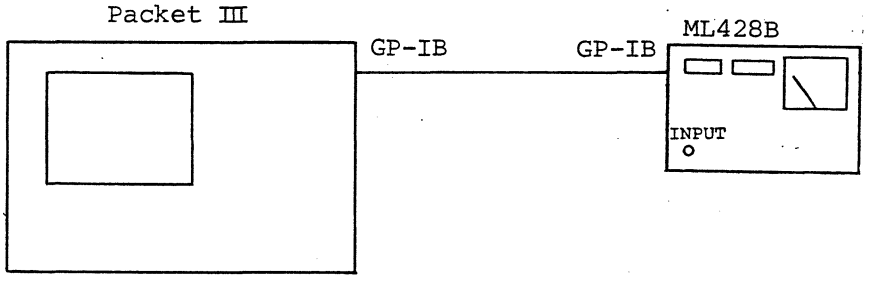


Fig. 5-9 Remote Control Check Setup

(2) Procedures

Step	Procedure
1	Check the ML428B device address. The ML428B device address is 8 at shipment from the factory.
2	Connect the GP-IB connector of the Packet III to that of the ML428B using a GP-IB cable.

(Cont.)

Step	Procedure
3	Send a frequency setting command and check that the frequency is set in accordance with the command at the FREQUENCY display of the ML428B. Sample program (Setting to 10.000 MHz) `WRITE @108: "CF10"` The 1 after the @ is the select code. It is set to the select code of the Packet III GP-IB interface.

4	Set a bandwidth setting request command. Check that the bandwidth is set properly and that the noise level changes according to the bandwidth switching.
	
	Sample program
	
	`10 WRITE @108: "RL-20,MD1"`
	`20 WRITE @108: "CF1.000"`
	`30 WRITE @108: "BW1"`
	`40 WAIT DELAY 3`
	`50 WRITE @108: "BW2"`
	`60 WAIT DELAY 3`
	`70 WRITE @108: "BW3"`
	`80 WAIT DELAY 3`
	`90 END`

5	Send a calibration execution request command and check that calibration is executed. Sample program `WRITE @108: "CL"`

(Cont.)

Step	Procedure
6	Send a reference level setting request command and check that the input level display changes according to the reference level switching. Sample Program 10 FOR I = -20 TO 90 20 WRITE @108 USING C2, F3.0: "RL", I 30 WAIT DELAY 2 40 NEXT I
7	Send a units setting request command and check that the INPUT LEVEL/CONV.FACTOR indicator UNITS display is switched to dBμV, dBμV/m and CONV.FACTOR. Sample program 10 WRITE @108: "DV" 20 WAIT DELAY 3 30 WRITE @108: "DM" 40 WAIT DELAY 3 50 WRITE @108: "CT" 60 WAIT DELAY 3 70 WRITE @108: "DV" 80 END Switched every three seconds.

(Cont.)

Step	Procedure

8 Send an auto range setting request command and check that the auto range switch lamp comes on and the input level display changes according to the command.

Sample program

```
10   WRITE @108: "RL90"
20   WAIT DELAY 3
30   WRITE @108: "AR"
40   END
```

9 Send a detection mode setting request command and check that the input level display changes according to the mode. The noise levels in PEAK and Q.PEAK modes are larger than that in AVER mode.

Sample program

```
10   WRITE @108: "CF1.000,BW3"
20   WRITE @108: "MD1"
30   WAIT DELAY 3
40   WRITE @108: "MD2"
50   WAIT DELAY 3
60   WRITE @108: "MD1"
70   WAIT DELAY 3
80   WRITE @108: "MD3"
90   END
```

(Cont.)

Step	Procedure

10	Send an equalizer on/off request command and check that the input level display fluctuation at ON is smaller than that at OFF.
	
	Sample program
	
	`10 WRITE @108: "BW3", "CF1.000", "RL-20", "MD1"`
	`20 WRITE @108: "EQ0"`
	`30 WAIT DELAY 3`
	`40 WRITE @108: "EQ1"`
	`50 END`

11	Send a set frequency output request command and check that the value on the FREQUENCY display is read by the Packet III.
	
	Sample program
	
	`10 DIM A$*20`
	`20 WRITE @108: "OF"`
	`30 READ @108: A$`
	`40 LET A = VAL (A$(4:11))`
	`50 PRINT A`
	`60 END`

(Cont.)

Step	Procedure
12	Send a level output request command and check that the value on the INPUT LEVEL display is read by the Packet III. Sample program 10 DIM A$*20 20 WRITE @108: "OL" 30 READ @108: A$ 40 LET A = VAL (A$(3:8)) 50 PRINT A 60 END
13	Send a reference level output request command and check that the reference level is read by the Packet III. Sample program 10 DIM A$*20 20 WRITE @108: "RL90" 30 WRITE @108: "OR" 40 READ @108: A$ 50 PRINT A$ 60 END

(Cont.)

Step	Procedure
14	Send a writing antenna factor request command and check that the factor is correctly written and displayed. After executing the following sample program, return to LOCAL mode. Press the UNITS key, set to C.CONV FACTOR and confirm that the displayed value equals the written value. Sample program 10 WRITE @108: "ST" 20 WRITE @108: "AF 1.00 + 20" 30 WRITE @108: "AF 5.00 + 30" 40 WRITE @108: "SP" 50 END
15	Send a Return To Local command and check that the ML428B is returned to the local state. Sample program 10 REN @108 20 INPUT PROMPT "PUSH RETURN";X 30 LCL @108 40 END When this program is run, the ML428B is placed into the remote state and front panel key input is invalid. When the Packet III [RETURN] key is then pressed, the ML428B returns to the local mode and key input is valid.

5.4.8 Power

(1) Specifications

Dc: ≦2 Adc (with 11.5 V to 24 V external power supply)

Ac: ≦40 VA (** Vac, 50/60 Hz)

(2) Setup for dc power supply

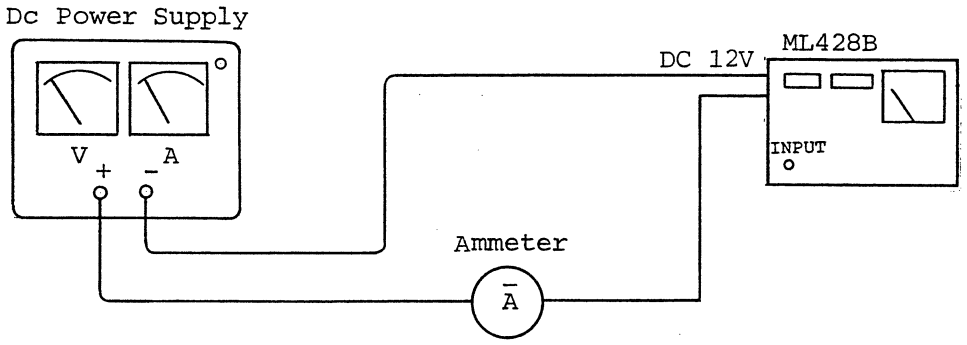


Fig. 5-10 Dc Power Check Setup

(3) Procedures for dc power

Step	Procedure
1	Connect the dc power supply output to the dc 12 V connector of the ML428B through a dc ammeter (digital multi-meter) as shown in Fig. 5-10.
2	Set the dc power supply output voltage to 24 V and supply dc power.
3	Set the ML428B DC POWER switch to ON. Read the value on the dc ammeter.

(4) Setup for ac power supply

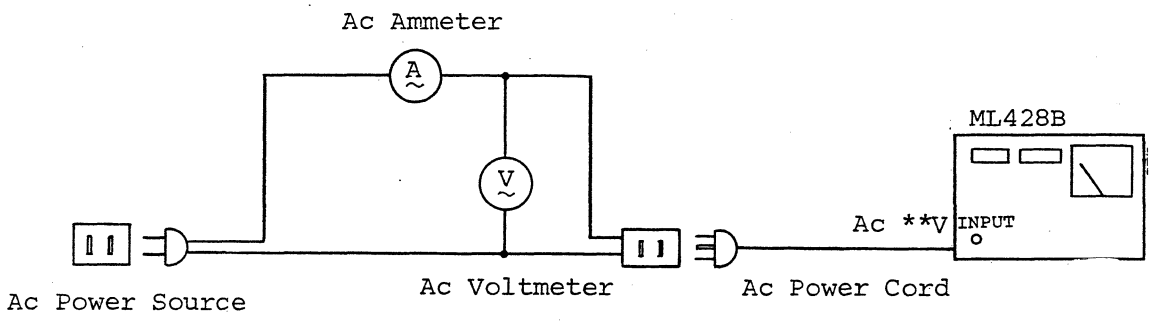


Fig. 5-11 Ac Power Check Setup

(5) Procedures for ac power

Step	Procedure
1	Connect the ac power cord to an ac power source through the ac ammeter (digital multi-meter) and ac voltmeter (digital multi-meter) as shown in Fig. 5-11.

(Cont.)

Step	Procedure
2	Set the ML428B AC POWER switch to ON. Read the values of the ac voltmeter and the ac ammeter. The power consumption value is calculated from the following formula: P = (reading on ac voltmeter) x (reading on ac ammeter)