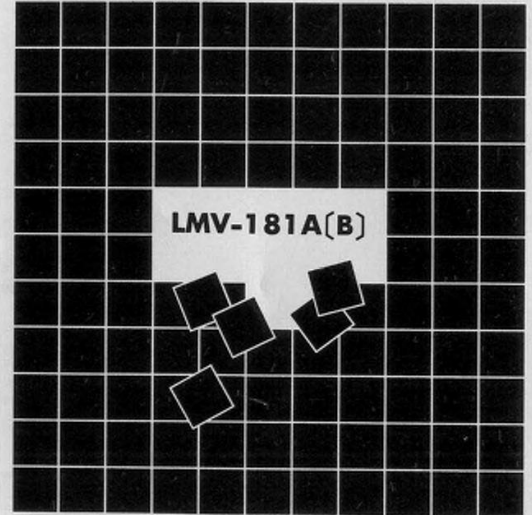


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**AC MILLIVOLTMETER**

INSTRUCTION MANUAL




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Note: This instruction manual applies to both 181A and 181B, and the information in brackets [ ] refers to the 181B.

### 1. General

These instruments are millivoltmeters and voltmeters with mean value indicating devices that offer effective value calibration, and are used for measuring sine wave alternating current voltages of  $100\mu\text{V}$  to  $300\text{V}$  [ $150\text{V}$  to  $500\text{V}$ ] in the  $5\text{Hz}$  to  $1\text{MHz}$  frequency range. These instruments are highly sensitive and precise. New circuitry insures wide range readings with excellent linearity characteristics. The use of output terminals enables application of these units as wide-band high gain amplifiers or pre-amplifiers on other electronic apparatus.

### 2. Features

1. Wide band-width of  $5\text{Hz}$  to  $1\text{MHz}$ .
2. High accuracy;  $\pm 2\%$ .
3. Highly precise, reliable and stable voltmeters of new circuit design.
4. Wide-use voltmeters with two decibel scales ( $0\text{dB} = 1\text{V}$ ,  $0\text{dB} = 0.775\text{V}$ ) in addition to the effective voltage scales.
5. The output is calibrated at  $1\text{Vrms}$  full scale, so that these instruments can be used as low-noise high-gain pre-amplifiers on wave form monitors.

### 3. Specifications

#### Voltmeter

Measuring voltage range	$100\mu\text{V}$ to $300\text{V}$ [ $150\mu\text{V}$ to $500\text{V}$ ]
Measuring range	Measuring range    12 ranges 1, 3, 10, 30, 100, 300 mV 1, 3, 10, 30, 100, 300V

1

[1.5, 5, 15, 50, 150, 500mV]  
[1.5, 5, 15, 50, 150, 500V]

Decibel range            12 ranges  
-60, -50, -40, -30, -20, -10dB  
0, +10, +20, +30, +40, +50dB  
(0 dB = 1V, 0 dB = 0.775 V)

Measuring accuracy	$\pm 2\%$ of full scale (at 1 kHz or 400 Hz)
Frequency characteristics	5 Hz to 1 MHz $\pm 10\%$ 10 Hz to 500 kHz $\pm 5\%$ 20 Hz to 100 kHz $\pm 2\%$ (1 kHz as base)
Input resistance	10 M $\Omega$
Input capacitance	Under 50 pF (1mV to 300mV [ $1.5\text{mV}$ to $500\text{mV}$ ]) Under 35 pF (1V to 300V [ $1.5\text{V}$ to $500\text{mV}$ ])
Maximum input voltage	AC peak + DC = 600V
Noise	Within 2% of full scale by shorting input

#### Amplifier

Output voltage	1V no load when 1.0V [5.0V] is indicated at full scale of each range
Frequency characteristics	10Hz to 500kHz -3 dB (1 kHz as base)
Output impedance	600 $\Omega$ $\pm 20\%$
Distortion factor	Within 1% at full scale (1 kHz)
Operating temperature range	0 to 40°C

2

Operating humidity range	Less than 85%
Power Supply	100V $\pm$ 10% 50/60 Hz (can be changed to 120V, 220V, 240V by switching over the interior trans-tap)
	2.5 VA
Size and weight	132(W) $\times$ 150(H) $\times$ 250(D)mm, 2 kg. (exclusive of buttons, rubber legs and handle)
Accessories .....	Terminal adaptor for plug type . . . . . 1 Connection cable (pair-plug to clip) . . . . . 1 Spare fuse . . . . . 1 Instruction manual . . . . . 1

4. System diagram

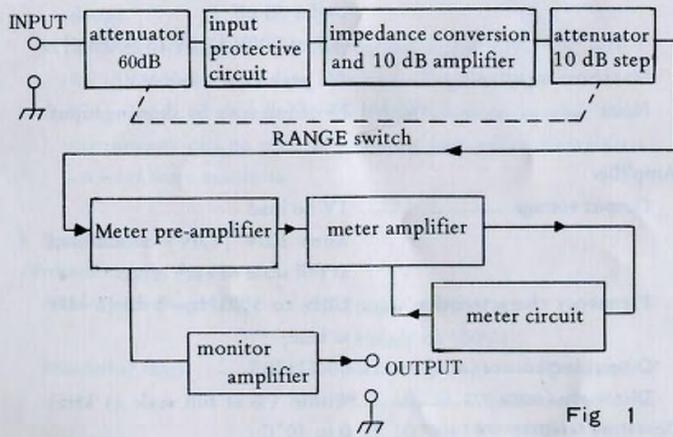


Fig 1

5. Panel functions

Explanations of the front and rear panel controls are shown below.

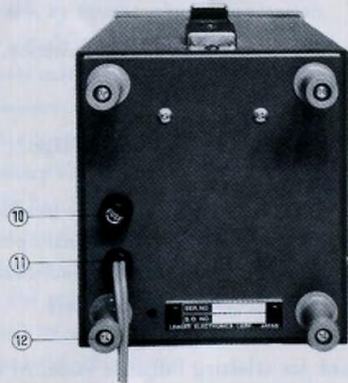
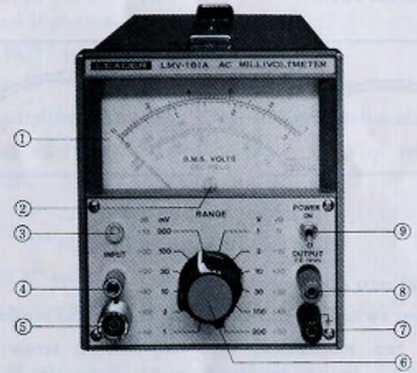


Fig 2

① Meter Faces

Voltage and dB scales are calibrated as shown in Figure 3.

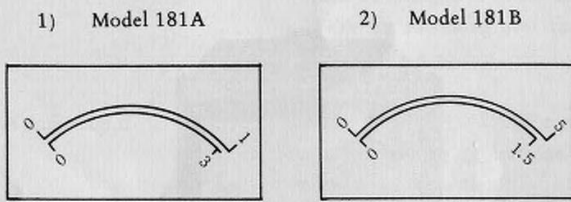


Fig 3

2) Mechanical zero adjustment screw

Turn power switch ⑨ to off. Set the voltage calibration to 0 by adjusting the mechanical zero adjustment screw with an insulated screwdriver.

③ Pilot lamp

When power switch ⑨ is pushed up to turn power on, the lamp should light.

④ "INPUT" (metallic terminal)

This is the ground terminal when measuring voltage.

⑤ INPUT (plug, U.H.F. type)

This is the connector for applying voltage to be measured. Type M and type UHF connectors and twin-type banana plugs can be used because ④ and ⑤ are 19mm apart. Individual banana plugs may also be used with ④ and ⑤ separately.

⑥ RANGE button

This button is used for selecting full scale value. At each stop position, the voltage values of the full scale are indicated in

black, and the absolute levels of 0 dB calibration are shown in dB.

⑦ "OUTPUT" (black terminal)

When this instrument is used as an amplifier, this output terminal is ground.

⑧ "OUTPUT" (red terminal)

This is the "Hot" output terminal when this instrument is used as an amplifier. When the meter indicates full scale at each stop position of the range switch ⑥, 1 Vrms of voltage can be obtained.

"1" calibration in the case of 181A

"5" calibration in the case of 181B

⑨ "POWER" switch

Power goes on if the switch is pushed up to "ON".

⑩ FUSE

Protects instrument against overload and short circuits. Fuse is removable by counter-clockwise rotation.

⑪ Power supply cord

Connects unit to power source.

⑫ Cord winder

Provides convenient power cord storage.

6. Preliminary notes

6-1 The line voltage used for this instrument should be  $\pm 10\%$  of the rated value.

6-2 Mechanical zero adjustment of the indicator

If the pointer of the scale is not at 0 when power is off, set to 0 by adjusting the mechanical zero adjust screw with an insulated screwdriver.

### 6-3 Excessive input voltage

The maximum input voltage of this instrument is AC peak + DC = 600V. Do not apply a voltage greater than this value. If a larger input is applied to the input terminals, circuit parts may be damaged or destroyed.

### 6-4 Input waveform

This instrument gives indications according to the mean value of the input waveform, and the calibration is done in effective values of sine waves. Therefore, distortion of the input voltage waveform may result in incorrect readings.

### 6-5 Induction noise

When the measured voltage is very small, or when the impedance of the source of the measured voltage is relatively high, an incorrect indication may result due to the induction of external noises. If this occurs, use shielded cables to reduce or eliminate noise pick-up.

## 7. Operation

### 7-1 Preparation

1. Before connecting this instrument to the power source, check to see that the pointer of the scale is at 0. If it is off 0, set it to 0 by adjusting the zero adjustment screw.
2. Connect the power plug to the power source of the correct voltage.
3. Set the range switch to 300V [500V] in advance.
4. When the power switch is turned to ON, the pilot lamp should light.

The pointer will vibrate irregularly for about five seconds after power goes on, but it does not indicate a malfunction.

5. The instrument will stabilize in about five seconds after power is applied.

### 7-2 Measurement of AC Voltage

1. The meter will indicate presence of voltages when a connection is made to the "INPUT" terminal and the voltage to be measured is applied.
2. If the reading is less than 30% of full scale, turn the "RANGE" button counterclockwise, and reduce the voltage range gradually. Read the indicated value when the pointer is more than 30% of the full scale and less than full scale.
3. There are two maximum voltage calibrations, "1" and "3" ["1.5" and "5"], on the scale. Tables 1 and 2 show the positions of "RANGE" buttons vs. the calibration of the voltages used.

LMV - 181A

RANGE	Scale	Multiplier	V per DIV
300V	0 - 3	100	10 V
100V	0 - 1	100	2 V
30V	0 - 3	10	1 V
10V	0 - 1	10	0.2 V
3V	0 - 3	1	0.1 V
1V	0 - 1	1	0.02V
300 mV	0 - 3	100	10 mV
100 mV	0 - 1	100	2 mV
30 mV	0 - 3	10	1 mV
10 mV	0 - 1	10	0.2 mV
3 mV	0 - 3	1	0.1 mV
1 mV	0 - 1	1	0.02 mV

Table 1

LMV-181B

RANGE	Scale	Multiplier	V per DIV
500 V	0-5	100	10 V
150 V	0-1.5	100	5 V
50 V	0-5	10	1 V
15 V	0-1.5	10	0.5 V
5 V	0-5	1	0.1 V
1.5V	0-1.5	1	0.05V
500 mV	0-5	100	10 mV
150 mV	0-1.5	100	5 mV
50 mV	0-5	10	1 mV
15 mV	0-1.5	10	0.5 mV
5 mV	0-5	1	0.1 mV
1.5mV	0-1.5	1	0.05mV

Table 2

7-3 How to use Decibel Range

The indicator has the following two red dB calibrations:

0 dB = 0.775 V (1 mW 600Ω ..... dBm)

0 dB = 1 V ..... dBV

Table 3 shows each dB range vs dBm and dBV.

Range setting	LMV-181A		LMV-181B	
	dBm	dBV	dBm	dBV
+50	+30to+52	+30to+50	+30to+56	+30to+54
+40	+20to+42	+20to+40	+20to+46	+20to+44
+30	+10to+32	+10to+30	+10to+36	+10to+34
+20	0to+22	0to+20	0to+26	0to+24
+10	-10to+12	-10to+10	-10to+16	-10to+14
0	-20to+ 2	-20to+ 0	-20to+ 6	-20to+ 4
-10	-30to- 8	-30to-10	-30to- 4	-30to- 6
-20	-40to-18	-40to-20	-40to-14	-40to-16
-30	-50to-28	-50to-30	-50to-24	-50to-26
-40	-60to-38	-60to-40	-60to-34	-60to-36
-50	-70to-48	-70to-50	-70to-44	-70to-46
-60	-80to-58	-80to-60	-80to-54	-80to-56

Table 3

Decibel values can be read by adding range dB values to indicated values of the pointer.

Example 1

Scale + 1 dB

Range + 20 dB

Level + 21 dBm

Example 2

Scale - 4 dBV

Range - 30 dB

Level - 34 dBV

7-4 Use of "OUTPUT" terminal

When the indicator show "1" ["5"] at full scale, the "OUTPUT" terminal can obtain an output of 1Vrms no matter where the RANGE switch is positioned. An oscilloscope can be used as a monitor of measured signal waveforms, or as a pre-amplifier by connection to the "OUTPUT" terminal. Table 4 shows the degrees of amplification when the instrument is used as a pre-amplifier.

Notes: The following troubles will occur if a low load impedance is connected to the terminal.

Resistance ..... Output voltage is lowered. Low frequency characteristics deteriorate.

Capacitance ..... As load capacitance increases, high frequency characteristics deteriorate.

Range setting (dB)	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50
Degree of amplification (dB)	60	50	40	30	20	10	0	-10	-20	-30	-40	-50

Table 4

7-5 Measurement of alternating current

When AC voltage is V, alternating current is I and resistance is R, there is a relationship as follows:

$$I = V/R$$



Current can be determined out by measuring the voltages at both ends of the resistance based on the above relationship.

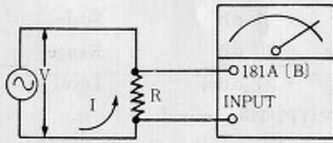


Fig 4

Note: The "INPUT" terminal of this instrument is grounded at one end.

#### 8. Functional description

LMV-181A and LMV-181B are similar as far as functions are concerned. They consist of a 60 dB attenuator, input protective circuit, impedance conversion circuit, 10 dB step attenuator, meter pre-amplifier, meter amplifier, meter circuit, monitor amplifier and stabilization power circuit.

##### 1. 60 dB attenuator

Controls input voltage so that the impedance conversion circuit will work normally. The attenuation quantity is 0 dB in the 1 mV – 300 mV [1.5 mV – 500 mV] range, and 60 dB in higher ranges.

##### 2. Input protective circuit

It consists of  $Q_1$  and  $Q_2$ , and protects FET  $Q_3$  from excessively large input voltages.

##### 3. Impedance conversion circuit + 10 dB amplifier

It consists of  $Q_3$  (FET) and  $Q_4$  converts high input impedance

into low impedance, and has an amplification factor of +10 dB.

##### 4. 10 dB step attenuator

In conjunction with the 60 dB attenuator, it selects proper values to be measured.

##### 5. Meter pre-amplifier

It consists of  $Q_5$  and  $Q_7$ , and amplifies small signals into large signals.

##### 6. Meter amplifier and meter circuit

Consists of  $Q_9$ ,  $Q_{10}$ ,  $Q_{11}$ ,  $D_2$ ,  $D_3$  and meter. The rectifier circuits of  $D_2$  and  $D_3$  and the meter are in the feedback circuit of the amplifier, so, the indications of the meter are in proportion to the input voltage.

##### 7. Monitor amplifier

1 Vrms output is obtained at the "OUTPUT" terminal when the meter indicates full scale after a signal is taken out of a part of the meter preamplifier and amplified.

##### 8. Stabilization power circuit

This circuit consists of  $D_4$ ,  $D_5$ ,  $D_6$  and  $D_7$  rectifier circuits and  $D_8$ ,  $Q_{12}$  and  $Q_{13}$  stabilization circuits. With  $D_8$  Zener diode as the reference voltage, it supplies +18V stabilized voltage to the impedance conversion circuit, meter pre-amplifier, meter amplifier and monitor amplifier.

##### 9. Maintenance

###### 9-1 Changing fuses

A fuse can be removed by turning the fuse holder on the rear side in the direction of the arrow. Use 0.1A fuses. After fuses are changed, be sure to investigate the cause. Take appropriate steps before power is turned back on.

### 9-2 How to remove the cover

Remove the cover as shown below.

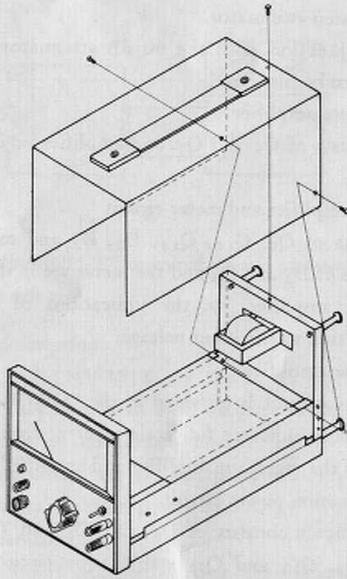


Fig 5

Remove the three screws on the top and side of the cover, slide it backward by 1 to 2cm, and then remove it.

### 9-3 Changing the voltage to the correct power source voltage

The power transformer is on the rear side when the case is opened. The terminals numbered 1, 2, 3\* and 1, 2, 3\* are primary ones. When changing the voltage of the applied power source, change wiring as shown in Figure 6.

\*1, 2, 3 for each primary winding; there are two primary windings.

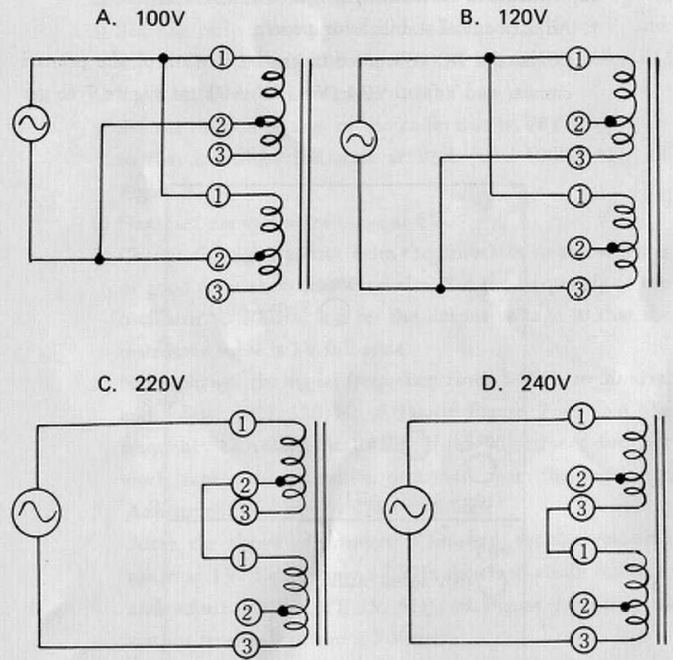


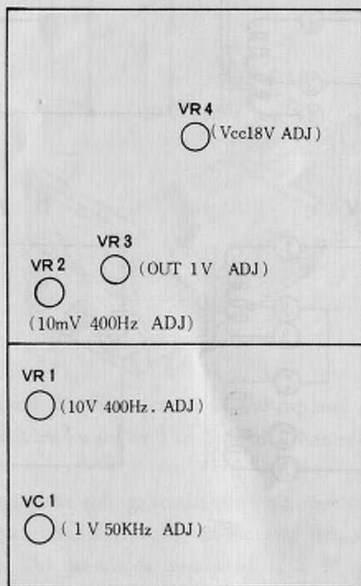
Fig 6

#### 9-4 Adjustment and correction

If specifications are not met after repairs are made, make adjustments or corrections as follows:

##### 1. Adjustment of stabilization power

Connect a DC voltmeter to the +18V line of the printed circuit, and adjust VR4 (Vcc18V ADJ) of Figure 7 to get +18V.



when viewed from above

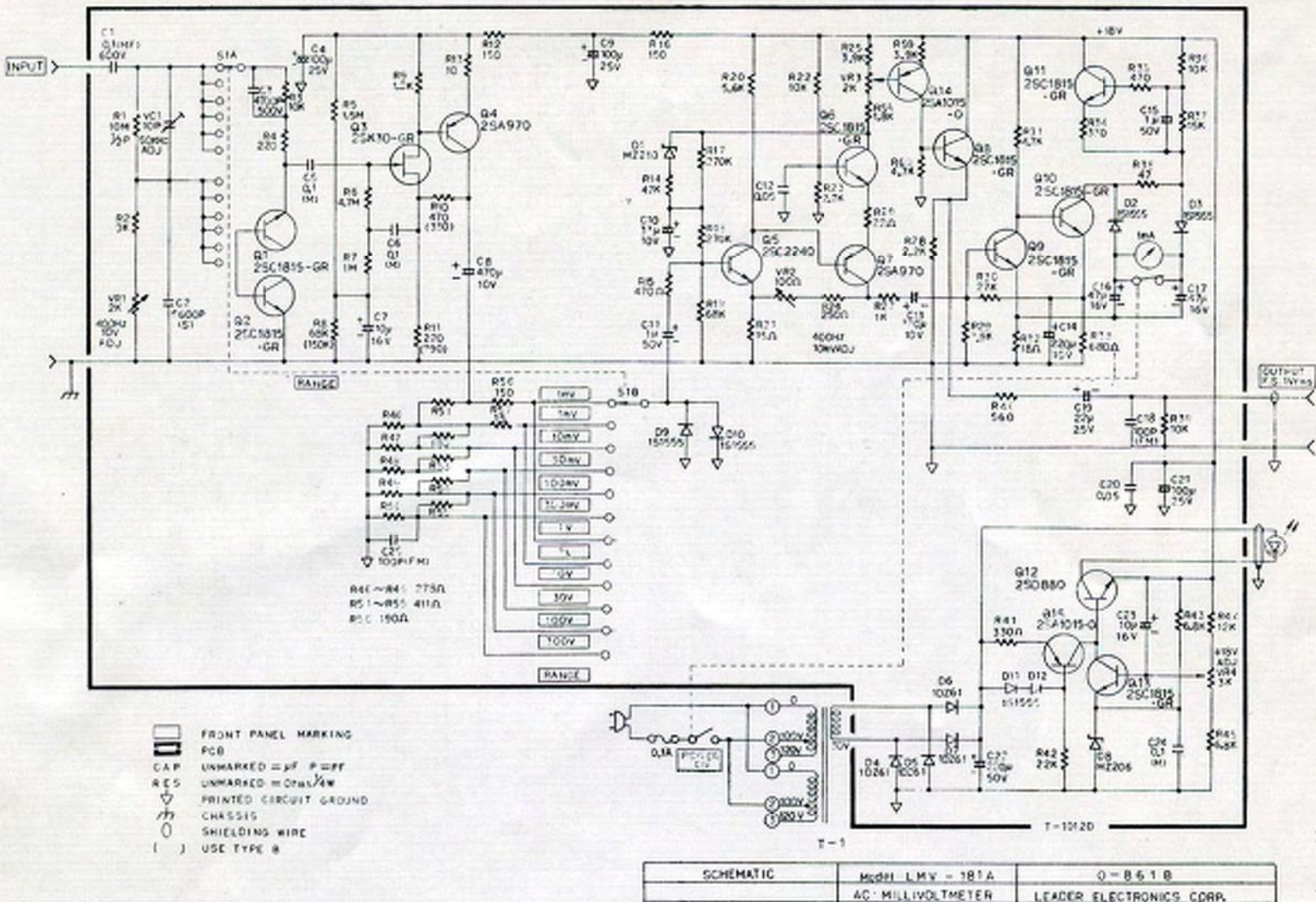
Fig 7

##### 2. Procedure for correcting indicated values

- 1) Connect a voltmeter calibrator to the INPUT.
  - 2) Set the voltmeter range at 10 mV.
  - 3) Set the output voltage of the calibrator to 10 mV, and adjust VR2 (10 mV 400 Hz AJD) of Figure 7 to full scale.
  - 4) Next, set the voltmeter range at 10 V.
  - 5) Set the output voltage of the calibrator to 10V, and adjust so that it will be full scale at VR1 (10V 400Hz ADJ) of Figure 7.
  - 6) Next, set the voltmeter range at 1V.
  - 7) Change the signal source from the calibrator to an oscillator of good frequency characteristics. Set the frequency of the oscillator to 500Hz, and set the output voltage so that the instructed value is 1V full scale.
  - 8) Next, change the signal frequency from 500 Hz to 50 kHz, and adjust VC1 (50kHz ADJ) of Figure 7 so that the frequency characteristics is flat. If this adjustment does not work, repeat the correction procedure from the beginning.
- ##### 3. Adjustment of output voltage terminals

After the above adjustment is finished, set the voltmeter range at 1V. Next, apply a 1 kHz signals to attain full scale, and adjust VR3 (OUT 1V ADJ) of Figure 7 so that the output terminal voltage is 1 Vrms.

Note: In the case of the 181B, adjust each set voltage by a multiplier of 1.5. For instance, 10 mV should be changed to 15 mV.



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