MODEL 167

AC VOLTMETER

OPERATION MANUAL

KIKUSUI ELECTRONICS CORP.

C O N T E N T S

1. GENERAL

Kikusui Electronics' Model 167 is a transistorized high-sensitivity voltmeter which displays the mean value of the AC voltage measured. Using semiconductor elements in all circuits, Model 167 is compact, lightweight and consuming low power.

Model 167 consists of an impedance converter having a high input impedance, a voltage driver, a preamplifier, an indicator circuit, an output section, and voltage regulator circuit.

Model 167 measures an AC voltage within a range of 0.1 mV ~ 500 Vrms (-80 ~ +16 dBm) whose frequency is 10Hz ~ 100kHz .

It has eight measuring ranges in 10 dBm steps, and the meter scale is graduated in equal divisions by the effective value of sine wave.

Further, Model 167 can give an AC voltage output of approximately 1.5V in full scale from the output terminal. Therefore, measurement can be monitored or the equipment can be used as a preamplifier.

2. SPECIFICATIONS

Type	AC voltmeter
Model	167
Meter	Two-colored scale
Scale	Effective value of sine wave, and dBm value with respect to 1mW, 600Ω
Input :	
Input Terminals	Binding-posts, 19 mm (3/4") spacing
Input Resistance	10 MΩ for each range
Input Capacitance	100 pF for each range
Maximum Input Voltage	AC component : ±150 V DC component : ±400 V
Range selection	Operation by push-buttons on front panel or remote control is available. The switch for selecting is located on front panel.
Ranges	8 ranges: On rms scale 1.5/5/15/50/150/500 mV and 1.5/5 V On dBm scale -60/-50/-40/-30/-20/-10 and 0/10 dBm
Accuracy	±3% of full scale at 1 kHz

Frequency Response	10 Hz ~ 100 kHz ±3%
Stability	Less than 0.5% of full scale against ±10% fluctuation of line voltage
Noise	Less than 2% by short-circuiting the input terminals.

Output:

Output terminals	Binding-posts, 19 mm (3/4") spacing
Output voltage	Approximately 1.5 V at full scale
Distortion Factor	Less than 2% at full scale and 1 kHz
Frequency Response	10 Hz ~ 100 kHz $^{+1}_{-3}$ dB (with input resistance 10 MΩ, and input capacitance 30pF to terminals)

Power Requirement	____V, 50/60 Hz, approx. 5 VA
Dimensions	250(D) x 150(W) x 200(H) mm
(Maximum Dimensions)	305(D) x 155(W) x 220(H) mm
Weight	Approx. 4 kg

Accessories	Test data	1
	Operation manual	1

3. OPERATION

3.1 Explanation of Front and Rear Panel

① POWER — A snap switch turning on and off power supply. When the switch is pushed upward, Model 167 is energized. When Push-button switch is pushed, neon lamp above button pushed lights. For about 10 seconds after the switch is turned on, the meter pointer may possibly deflect irregularly.

② Range switch — By Push-button switch on front panel. a range of full scale of 1.5 mV ~ 5 V is selected.

③ INPUT terminals — Binding-posts to which the voltage to be measured will be connected.

④ Meter — The meter has the Following three scales:

1. " 50-scale " This scale is used with 5/50/500 mV and 5 V ranges. The "50" on the scale denotes 5 mV when the 5 mV is selected, and 50 mV when the 50 mV range is selected.
2. " 1.5-scale " This scale is used with 1.5/15/150 mV and 1.5 V ranges. The numeral on the scale denotes a value similarly to that of the 5-scale.
3. " dBm-scale " This scale is used to read the measured voltage in the dBm value with respect to 1 mW, 600Ω. This scale is used for all 8 ranges.

⑤ Output terminals — Output terminals for using Model 167 as an amplifier. Output voltage of approximately 1.5 V is available, when meter indicates full scale.

⑥ REMOTE, MANUAL — Push-button on front panel can be utilized in the MANUAL position. When it is required to operate the range selector from outside, turn the REMOTE, MANUAL switch in the REMOTE position.

Input terminals for control are located on the rear of the housing.

⑦ REMOTE TERMINALS — When the range selector is operated from outside, this terminals are used.

Relation between each range and connection of terminals is shown in Fig. 3-3 and table 3-1.

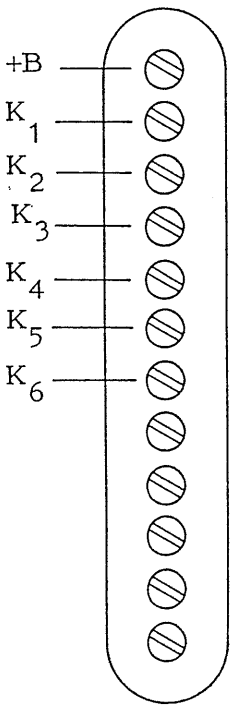


Fig. 3-3

	+B	K_1	K_2	K_3	K_4	K_5	K_6
1.5 mV range	○	○		○			
5 "	○	○			○		
15 "	○	○				○	
50 "	○	○					○
150 "	○		○	○			
500 "	○		○		○		
1.5 V "	○		○			○	
5 "	○		○				○

Table 3-1

Mark ○ in Table 3-1 represents relation between each range and connection of terminals. For example, when 50mV range is required, +B must be connected to K_1, and K_2.

In this case, neon lamp of 50mV on front panel lights.

* REMOTE terminals in Fig. 3-3 is located in order of +B, K_1, K_2, ... K_6 from upper terminal.

Front Panel

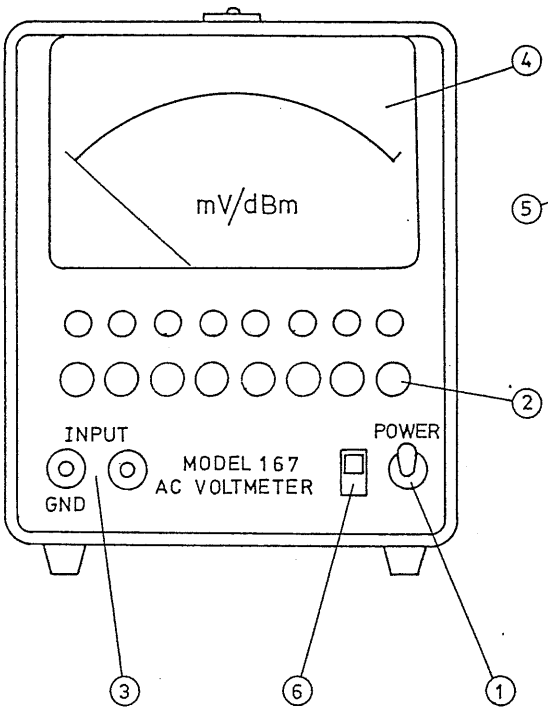


Fig. 3-1

Rear Panel

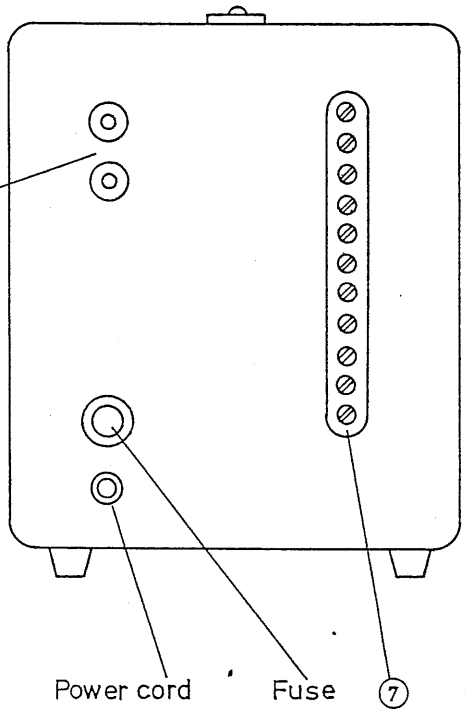
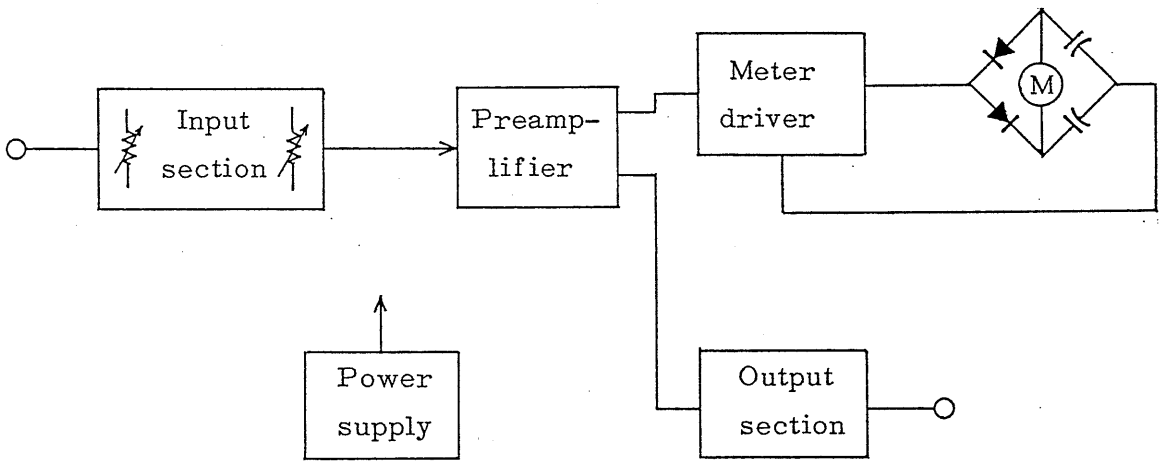


Fig. 3-2

4. OPERATION PRINCIPLE

Model 167 AC Voltmeter consists of an input section, a preamplifier, a meter driver, an output section, and a power supply.



4.1 Input section

The input section consists of a voltage pre-driver (0/40 dB), an impedance converter, and a main voltage driver composed of four ranges in 10 dB steps (0/10/20/30 dB) as shown in Fig. 4-2.

Reedrelays are used for switching range.

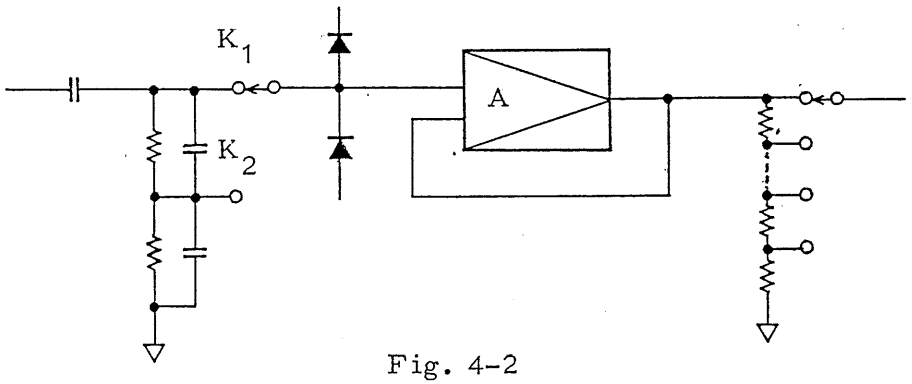


Fig. 4-2

For 1.5 ~ 50 mV ranges, the range switch is connected to contact K_1; for 150mV ~ 5V ranges, to contact K_2. The input having passed the voltage pre-driver enters the impedance converter.

The converter consists of transistors Q_1 and Q_2, with the FET in the first stage. The high-impedance signal is converted into low-impedance output and then supplied to the main voltage driver.

The main voltage driver divides the signal to approximately 1.5 mV according to the signal level. Diodes CR3 and CR4 are provided for protecting an excessive input.

4.2 Preamplifier

The preamplifier is a negative feedback amplifier, consisting of three transistors, for amplifying the faint signal delivered from the input section.

4.3 Meter driver

This is an amplifier using transistors Q_7 and Q_8. A current feedback is applied from the collector of transistor Q_8 to the emitter of transistor Q_7 through rectifier diodes.

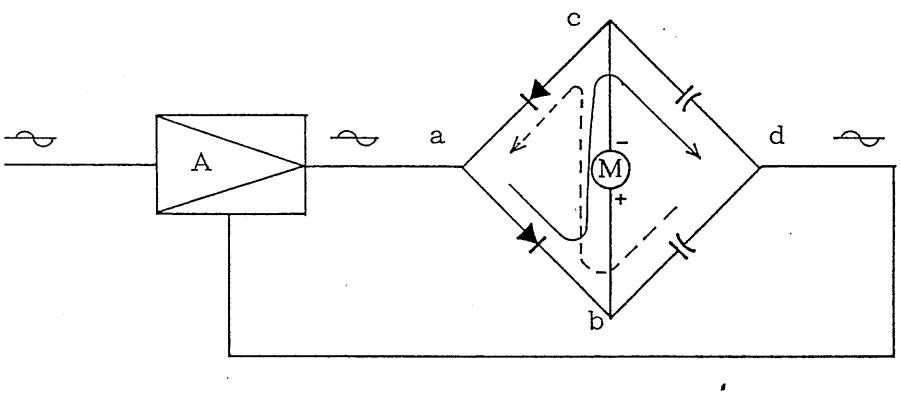


Fig. 4-3

For the above reason, the diodes are driven with nearly constant current, improving the non-linearity of diode and enabling linear meter indication. Fig. 4-3 illustrates the performance. During the positive output voltage cycle of the amplifier, current flows a→b→c→d as shown with a solid line, during the negative cycle, current flows d→b→c→a as shown with a dotted line. This makes the meter be driven according to the mean value of the current flow.

4.4 Output section

The collector voltage of transistor Q_4 in the preamplifier is amplified by transistor Q_6 and taken outside.

The output termianl gives an output of approximately 1.5 V at the full-scale meter indication.

4.5 Power supply

The power supply has regulated +7 and +25V output.

The +25 V voltage regulator circuit uses the reference voltage produced by utilizing the zener characteristic CR3, amplifies the error by transistor Q_3 and conducts series control by transistor Q_1 to obtain the regulated voltage. The regulated 7 V output is obtained by utilizing the reference voltage.

5. MAINTENANCE

5. Maintenance

5.1 Inspect parts inside the cabinet.

When it is necessary to inspect parts inside the cabinet, remove the two screws located on the rear of the cabinet, and pull out the panel and chassis from the case. Location of components, with panel and chassis removed, is illustrated in Fig. 5-1

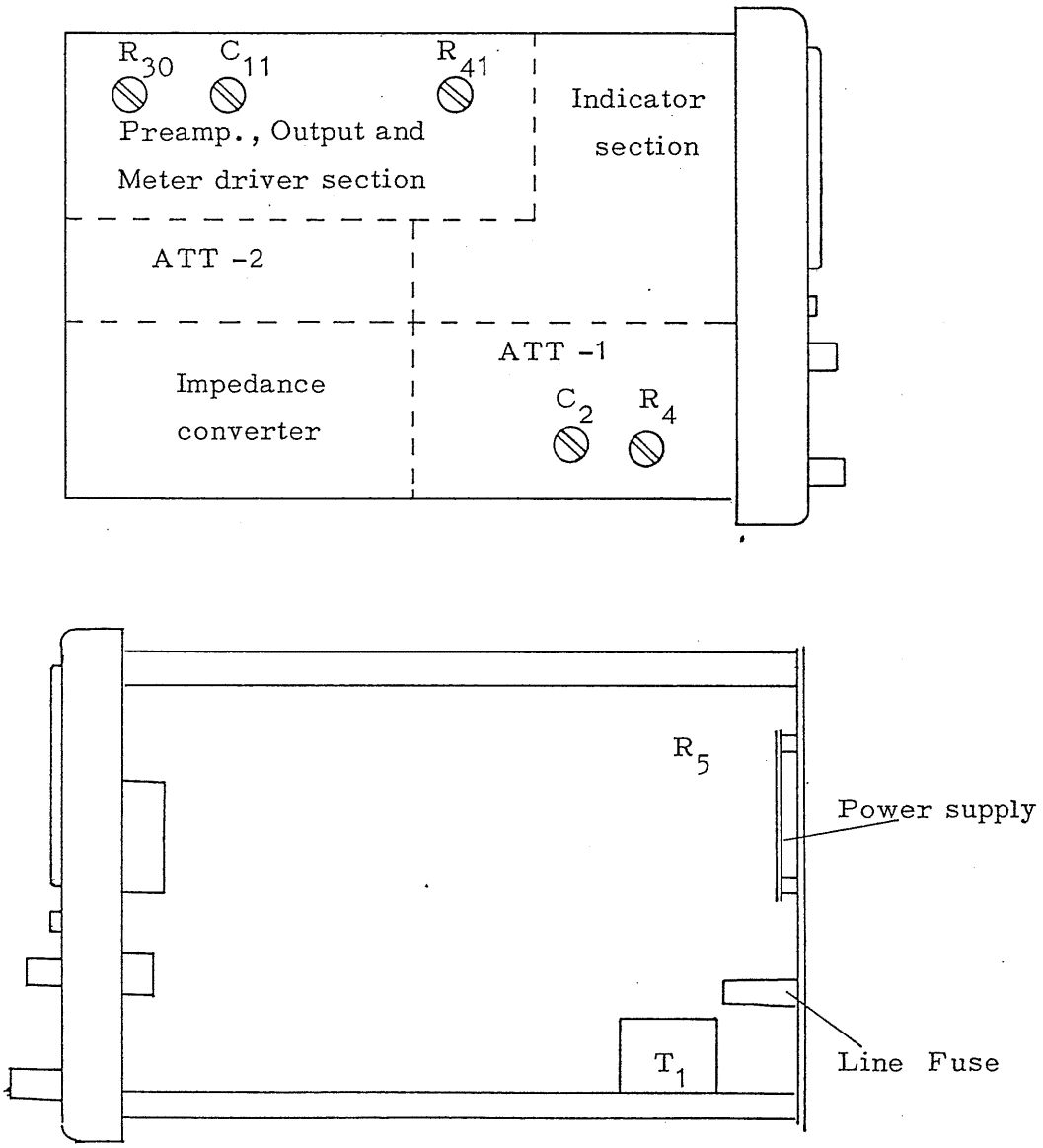


Fig. 5-1

5.2 Adjustment and calibration

When adjustment or calibration is needed during a long period of use or after repair, follow the instructions below:

(1) Adjustment of voltage regulator circuit

Connect a DC voltmeter between the emitter of transistor Q_1 in the power supply circuit, and the ground. Adjust variable resistor R_5 so that the DC voltmeter indicates +25 V.

(2) Calibration of preamplifier for high and low frequencies

Set the range switch to the 5 mV range, apply a calibration voltage (sine wave of low distortion factor) of 5 mV, 1 kHz, to the input terminal, and adjust variable resistor R_{30} of the preamplifier so that the meter has the full-scale indication precisely.

Change the frequency of the calibration voltage to 100 kHz and adjust trimmer capacitor C_{11} for the precisely full-scale meter indication.

(3) Adjustment of voltage pre-driver

Set the range switch to the 500 mV range, apply a calibration voltage of 500 mV, 400 Hz, to the input terminal, and adjust variable resistor R_4 of the voltage driver for the full-scale meter indication.

Change the frequency of the calibration voltage to 40 kHz and adjust trimmer capacitor C_2 for the full-scale meter indication.

Repeat the 400 Hz and 40 kHz, 500 mV adjustments two or three times for the complete calibration.

(4) Adjustment of output amplifier

Set the range switch to 500 mV range, apply a calibration voltage of 500 mV, 1 kHz , to the input terminal, and adjust variable resistor R_{41} so that the voltage at the output terminal is 1.5 V.

5.3 Trouble shooting

Model 167 is carefully assembled and adjusted, and then inspected under strict control before shipment. If the AC voltmeter should fail because of an accident or parts life, check the voltage distribution at various points the following tables.

Tables 5-1, 5-2 and 5-3 show the no-signal voltage distribution measured with respect to the ground by Kikusui Electronics' Model 107A VTVM (input resistance : 11 MΩ).

(1) Impedance converter

Table 5-1

Transistor	Emitter Source (V)	Base Gate (V)	Collector Drain (V)
Q_1 2SK30	3.7		22.3
Q_2 2SC372	3.1	3.7	25

(2) Preamplifier, meter driver and output section

Table 5-2

Transistor	Emitter (V)	Base (V)	Collector (V)
Q_3 2SC372			4.0
Q_4 2SC372	5.1	5.8	10.5
Q_5 2SA495	4.7	4.0	2.6
Q_6 2SC372	9.8	10.5	22.0
Q_7 "			5.5
Q_8 "	4.8	5.5	10.1

(3) Power supply

Table 5-3

Transistor	Emitter (V)	Base (V)	Collector (V)
Q_1 2SC515	25	25.6	37.4
Q_2 2SC372	25.6	26.2	37.4
Q_3 2SC372	7.0	7.6	26.0
CR_3 RD11A or 02Z11A	7.0	0	