MODEL 107B, 107C

VOLT-OHM METER

INSTRUCTION MANUAL

KIKUSUI ELECTRONICS CORP.

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

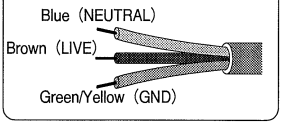
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

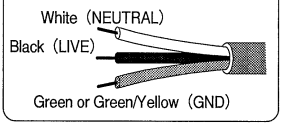
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

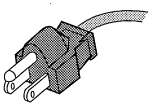
☐ Without a power plug



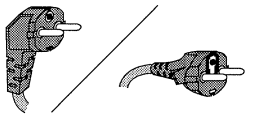
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

CONTENTS

1. GENERAL

The MODEL 107B and 107C VOLT-OHM METER are designed compact, lightweight and comsuming little power. These instruments consist of a highly stable DC amplifier which is composed of a differential amplifier with FETs, a cell and precision resistors for ohmmeter, a voltage divider circuit for DC voltmeter and, a halfwave voltage doubler rectifier circuit and a voltage divider circuit for AC voltmeter.

Every measurement can be made using only a single test prod.

The MODEL 107B can be operated with an external power supply which is cell or optional MODEL PU-4 AC ADAPTOR. This model is suitable for portable use.

The MODEL 107C can be operated within a wide range of supply line voltage, and is suitable for production lines.

2. SPECIFICATIONS

Type	VOLT-OHM METER	
Model	107B, 107C	
Power requirement	MODEL 107B	9V dry battery 6F22 (S-006P for JIS) or external power source by optional adaptor MODEL PU-4 AC ADAPTOR (Current consumption : Approximately 1.5 mA) 1.5V dry cell R22 (Europe, D for USA and SUM-1 for JIS) for ohmmeter.
	MODEL 107C	This model can be operated with supply line voltage of 90V ~ 132V or 180V ~ 264V by changing the wiring of the transformer. 1.5V dry cell R22 (Europe, D for USA and SUM-1 for JIS) for ohmmeter. Power consumption : 1 VA or less at AC 100V 50Hz/60Hz.
Dimensions (Maximum)	140 W x 200 H x 100 D mm (150 W x 240 H x 130 D mm)	
Weight (Main body)	MODEL 107B	Approximately 1.9 kg
	MODEL 107C	Approximately 2.0 kg
Meter	Scale length	Approximately 102 mm
	Three colored scale, moving coil type, F.S 100μA	
Accessories	MODEL G-1 TEST PROD	1
	Instruction manual	1
Ambient temperature	5°C ~ 35°C	
Ambient humidity	85 % or less	

2.1 Ohmmeter

Measurable range	0.1Ω ~ 1000MΩ in 7 ranges
Center of scale	10, 100, 1 k, 10 k, 1M and 10MΩ
Application voltage	Maximum 1.7V (Average 1.5V with R20 cell)
Accuracy	Within ± 3 % of scale length

2.2 DC voltmeter

Polarity	Positive or negative polarity can be selected
Measurable range	0 ~ ± 0.5, 1.5, 5, 15, 50, 150, 500 and 1500V
Input resistance	11MΩ ± 3% in all ranges with MODEL G-1
Input capacitance	2.0pF or less in all ranges with MODEL G-1
Accuracy	Within ± 3% of full scale
Maximum allowable input voltage	0.5V range ± 150V or 150Vp-p 1.5V range ± 450V or 450Vp-p 5V ~ 1500V range ± 1500V or 1500Vp-p

2.3 AC voltmeter

Type	Peak to peak voltmeter
Measurable range	For sine wave signal 0 ~ 1.5, 5, 15, 50, 150, 500 and 1500Vrms For general waveform signal 0 ~ 4.2, 14, 42, 140, 420, 1400 and 4200Vp-p (Note : Measurable range at 4200Vp-p is maximum 2200Vp-p.) -20 ~ +6, 16, 26, 36, 46, 56 and 66 dBm (0 dBm = 600Ω, 1 mW of sine wave signal)
Input resistance	Refer to Fig. 3-18 shown in page 25.
Input capacitance	With no MODEL G-1 105pF or less At 1.5, 5, 15, 50 and 150V ranges (1.5Vrms input) 25pF or less At 500V and 1500V ranges With MODEL G-1 135pF or less At 1.5, 5, 15, 50 and 150V ranges (1.5Vrms input) 60pF or less At 500V and 1500V ranges
Accuracy	Within ± 3% of full scale
Frequency response	With MODEL G-1, reference 1 kHz Within ± 3% at a range of 30Hz ~ 2MHz Within ± 10% at a range of 15Hz ~ 4MHz
Maximum allowable input voltage	600Vp-p or less at 1.5V ~ 150V ranges 2200Vp-p or less at 500V ~ 1500V ranges

3. OPERATION

3.1 Explanation of panel, scale and test prod

3.1.1 Front panel and rear panel (Refer to Fig. 3-1 ~ Fig. 3-4.)

① Meter
② Screw for mechanical zero adjustment of meter
③ Knob for ZERO ADJ
④ Knob for OHMS ADJ
⑤ Function selector switch
⑥ Range switch
⑦ Connector for test prod
⑧ Snap (With pulling forward this knob approx. 5mm horizontally, rear cover is removed.)
⑨ Power switch (MODEL 107B only)
⑩ Pilot lamp (MODEL 107C only)
⑪ Jack for AC adaptor (MODEL 107B only)

3.1.2 Scale (Refer to Fig. 3-5 and Fig. 3-6.)

① R scale for ohmmeter (red)
② AC/DC, DC or RMS 50V scale for voltmeter (black)
③ AC/DC, DC or RMS 15V scale for voltmeter (black)
④ 5V AC, RMS 5V AC scale for voltmeter (blue)
⑤ 1.5V AC, RMS 1.5V AC scale for voltmeter (blue)
⑥ p-p 140V scale below ② (black)
⑦ p-p 42V scale below ③ (black)
⑧ dBm (16 dBm) scale below ④ (blue)
⑨ dBm (6 dBm) scale below ⑤ (blue)
⑩ Polarity indication for zero center meter
⑪ LOW level range indication of TTL
⑫ HIGH level range indication of TTL
⑬ BATTERY OK and BATTERY OK range indication in the BATTERY TEST position for MODEL 107B

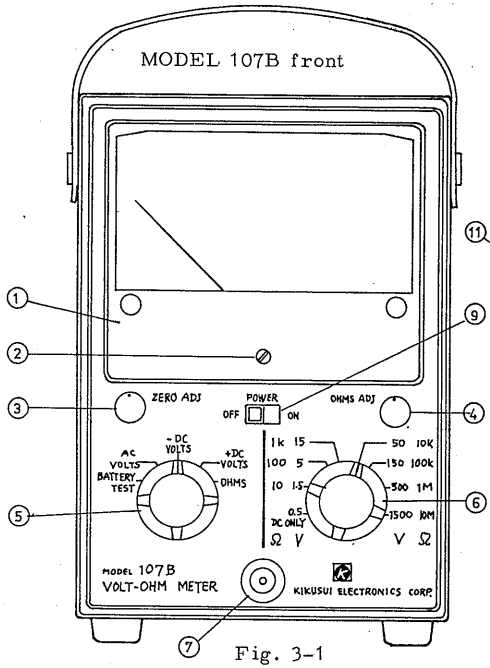


Fig. 3-1

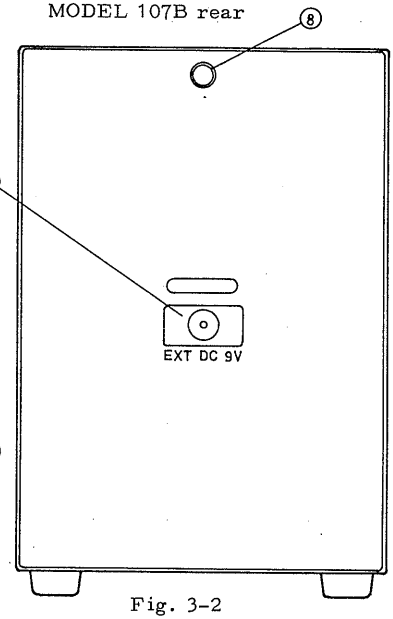


Fig. 3-2

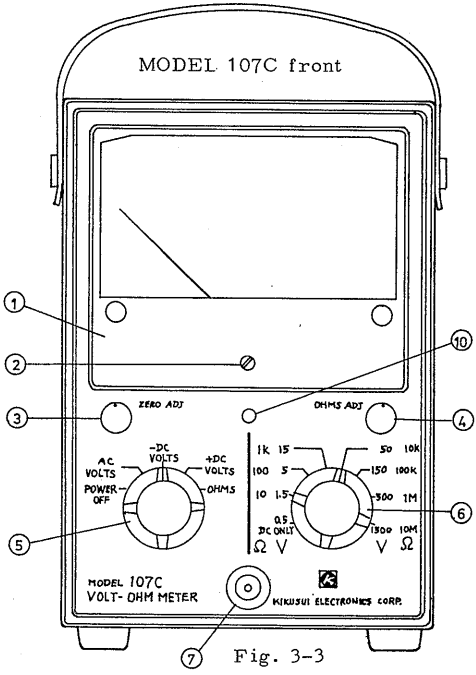


Fig. 3-3

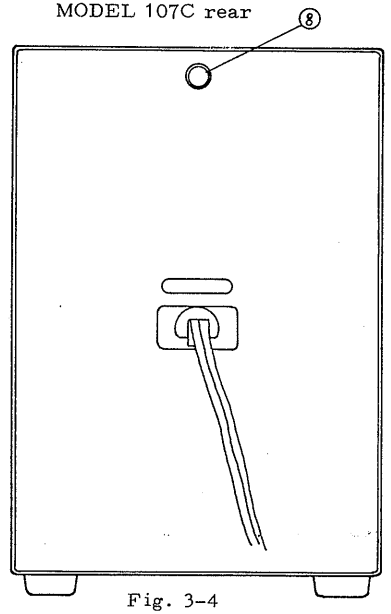


Fig. 3-4

MODEL 107B meter scale

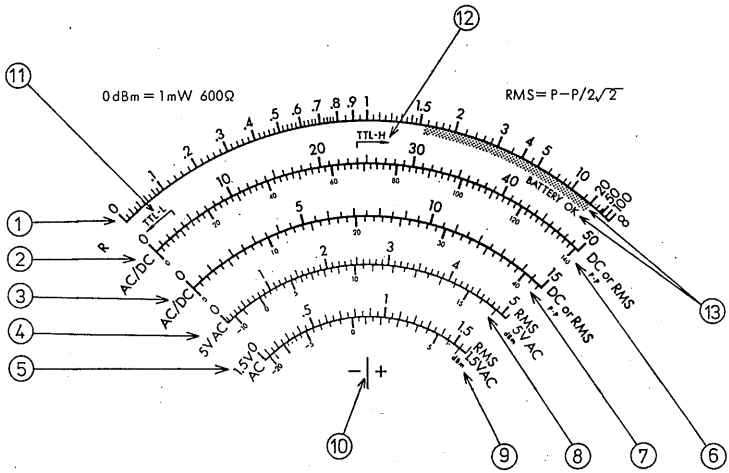


Fig. 3-5

MODEL 107C meter scale

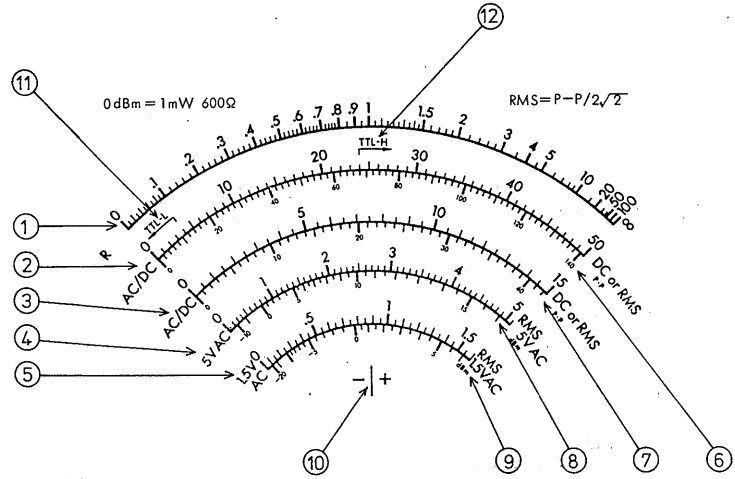
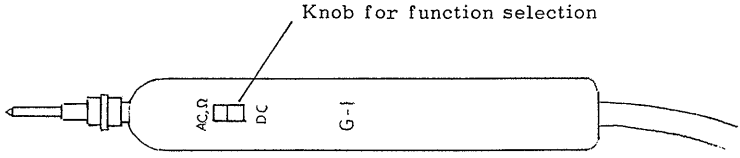


Fig. 3-6

3.1.3 Test prod

The MODEL G-1 TEST PROD is very strong. However, be careful of setting of knob, because large error is caused by setting the knob to the incorrect position.



AC V , Ω ← → ± DC V

(Slide direction of knob for function selection)

Fig. 3-7

3.2 Before operation

3.2.1 General description

The MODEL 107B and 107C VOLT-OHM METER are designed, manufactured, and tested, through long experience and under rigid control to withstand electrically and mechanically hard usage, to use within a wide range of ambient temperature and to endure under high humid atmosphere. Similarly to handling of common electronic equipments, however, it is not recommended that this equipment is handled under the above condition.

(1) Position

This equipment is vertically installed, when it is calibrated. However, the meter indicator has been dynamically balanced. Therefore, this equipment can be installed either vertically or horizontally, or with an inclination.

(2) Power source

A 6F22 dry battery (9V, S-006P for JIS) is used for the MODEL 107B, and this equipment can be for approximately a month, when it is operated for 8 hours in a day. The dry battery can be checked by turning the function selector switch to the BATTERY TEST position. The MODEL 107B can also be operated with an optional MODEL PU-4 AC ADAPTOR. The MODEL 107C can be operated with supply line voltage within a range of 90V ~ 132V or 180V ~ 264V of nominal 50Hz or 60Hz. The available supply line voltage range can be alterated by changing the internal wiring (Refer to CIRCUIT DIAGRAM.). This equipment stably operates for fluctuation of supply line voltage, and shift of zero level is negligible for most cases. A dry cell R20 (for IEC and Europe, D for USA, and SUM-1 for JIS) is used for ohmmeter inside the MODEL 107B and 107C. It should be exchanged every 6 months, even if the equipment has not been used.

(3) Withstand voltage

Insulation between the cabinet and the power cord can withstand at AC 1000V for a minute.

(4) Exchange of battery or cell

Rear cover of the MODEL 107B and 107C can be opened and closed by a snap, and exchange of dry battery or cell can be easily made.

Since internal resistors and trimmer capacitors are elaborately adjusted, be careful so as not to touch them, if unnecessary.

3.2.2 Preparation (The same for every usage)

No pilot lamp of the MODEL 107B is provided for saving of current consumption of battery. When the POWER switch is slided to the ON position, a red mark is indicated. A pilot lamp of the MODEL 107C, when turn the power on. The MODEL 107B and 107C immediately operate stably.

Initial procedure for measurement is given as follows.

	MODEL 107B	MODEL 107C
(1)	Adjustment of mechanical zero point. Prior to applying the power, set the switch for power to the OFF, and place meter pointer exactly over zero point on the scale.	
(2)	Set function selector switch to the BATTERY TEST.	Connect power cord to power source.
(3)	Slide the POWER switch to the ON, and check meter pointer indicates a range of the BATTERY OK on the meter scale. Set the function selector switch in either + or - DC VOLTS.	Turn the function selector switch clockwise from the OFF position. Check the pilot lamp lights, and set the function selector switch in either + or - DC VOLTS.
(4)	Place the meter pointer exactly over zero point on the scale by turning the ZERO ADJ knob. In this adjustment, it is preferred that the test prod is connected to the GND clip. Meter pointer moves to the same direction as turning direction of the knob in the +DC VOLTS and OHMS modes, and inverse direction to turning direction of the knob in the -DC VOLTS and AC VOLTS modes.	

Caution

When this equipment is kept in high humid place for along period, or is suddenly subjected to a high temperature from low temperature, circuits with high impedance in the equipment may be dewed. Therefore, in the ohmmeter mode, infinite position deviates, when range switch is turned toward higher resistance range. In the voltmeter mode, zero position deviates, when range switch is turned toward low voltage range. In such a case, no meter pointer deviation is obtained by keeping on operation for several minutes.

Since the meter is high sensitive and delicately adjusted, and antistatic agent is applied inside of the meter cover, the meter cover should not be removed.

3.3 Measurement of resistance

3.3.1 Features

The MODEL 107B and 107C have following features in ohmmeter mode.

(1) Measurable range is wide.
Resistance value between 0.1Ω and 1000MΩ such as megger, i.e., a coverage of 10 billion times (10^{10}) can be measured. Using a seperate DC source, it is also possible to measure more than 1000MΩ. For instance, with a 1500V DC source, resistance up to 2,000,000MΩ can be measured.

(2) Measurement range is divided in rational steps.
The most accurate measurement can be made with using the scale near the center. As range is divided in 10 times step, resistance of 3Ω ~ 30MΩ can be measured with the scale near the center.

(3) Test voltage is low.
The voltage applied to measured resistance is 1.7V or less. Therefore, insulation of audio equipment and so on in which Rochelle salt is used can be measured without damage on it.

3.3.2 Measurement

(1) Slide the knob provided on the MODEL G-1 TEST PROD to AC,Ω position with pushing it downward.

(2) Turn the function selector switch to the OHMS position.

(3) Use the outermost red scale R for reading.

(4) Clip the tip of the MODEL G-1 with the GND clip, and turn the ZERO ADJ knob so that meter pointer indicates exactly zero point.

(5) Disconnect the GND clip from the tip, and turn the OHS ADJ knob so that meter pointer indicates exactly position.

(6) Clip one end of resistor measured with the GND clip, and contact the tip of the MODEL G-1 with another end. Then, resistance value is obtained from reading of meter indication multiplied by a figure indicated by range switch.

1. Example of measurement of resistance

A resistor with faded marking is measured in x10MΩ range. Then, an indication of nearly zero is obtained. Therefore, resistance value is extremely low in comparison with 10MΩ. Range switch is turned to x1MΩ, to x100KΩ and finally to x10KΩ. Then, an indication of 0.18 is obtained as dotted line shown in Fig. 3-8. Since accuracy is highest around center position in ohmmeter mode, range switch is further turned to x1KΩ position. Then, an indication of 1.8 is obtained as continuous line shown in Fig. 3-8. When an indication as alternate long and short dash line shown in Fig. 3-8 in x10MΩ range, resistance is obtained as 40 x 10MΩ = 400MΩ.

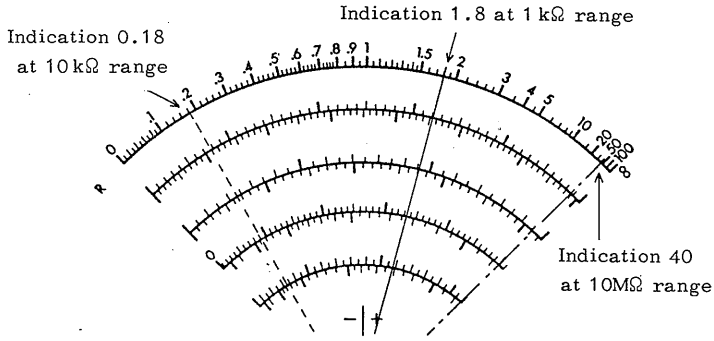


Fig. 3-8

Caution

(1) Measurement can be started from appropriate range.

(2) When restance in a circuit is measured, no voltage must be applied to component measured. In such a case, power is turned off, and check that no voltage is applied to component measured.

(3) In measurement of insulation resistance of capacitors, ends of capacitor should be discharged with a lead prior to measurement. The larger the capacitance and the higher the resistance, the longer time is required to charge up the capacitor. Therefore, meter pointer once deflects to 0Ω position, and indicates insulation resistance according to charging of the capacitor.

(4) Since the series restance included in the lead of the MODEL G-1 and GND clip is approximately 0.1Ω, meter indicates approximately 0.1Ω, when the range switch is turned from the x100Ω position to the x10Ω position. In x10Ω range, zero point is adjusted in other range than x10Ω position, and 0.1Ω is subtracted from the measured value. However, large error is not included in the meter indication, even if measurement is made with the same method as other ranges.

(2) Measurement of extremely high resistance (Value more than 100MΩ)

The MODEL 107B and 107C can also be used to measure extremely high resistance and component to which specified voltage is applied which could not be measured in ohmmeter mode. In this case, since the MODEL 107B or 107C is used as a DC voltmeter, chapter 3.4 should also be referred to. Circuit for measurement is shown in Fig. 3-9.

(1) Contact the MODEL G-1 at point A, and measure indicated voltage Ea.

(2) Then, contact it at point B, and measure indicated voltage Eb.

(3) Unknown resistance Rx can be obtained as follows.

$$Rx = \frac{11(Ea - Eb)}{Eb} M\Omega = 11 \times (\frac{Ea}{Eb} - 1)\ M\Omega$$

If $\frac{Ea}{Eb} \gg 1$, voltage applied to unknown resistance is approximately Ea, and unknown resistance Rx is obtained as $Rx = 11 \times \frac{Ea}{Eb} M\Omega$.

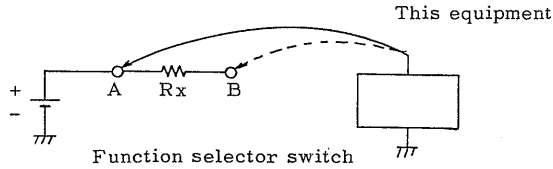


Fig. 3-9

3.4 Measurement of DC voltage

3.4.1 Features

The MODEL 107B and 107C have following features in DC voltmeter mode.

(1) Measurable range is wide.
The positive and negative voltages from 0.01V to 1500V can be measured. Range is divided in 8 steps. Using the optional the MODEL HV-2 HIGH VOLTAGE PROBE for measuring voltage more than 1500V, it is also possible to measure up to 35kV. Range is also divided in 8 steps.

(2) Measurement range is divided in rational steps.
Ranges are divided in multiples of approximately 3, such as 0.5V, 1.5V, 5V ... , Therefore, any voltage can be presented with a deflection of more than 1/3 of total scale length, and accurate indication is always obtained.

(3) Input resistance is high.
Input resistance is 11MΩ in all ranges. Therefore, the voltage of common high resistance circuit is accurately indicated. Input resistance of conventional circuit tester which meter is directly deflected is generally 1kΩ/V for low grade equipment and 20kΩ/V for high grade equipment. According to this expression, sensitivity in 0.5V range of this equipment is represented as 22000kΩ/V. When the MODEL HV-2 is used with the MODEL 107B and 107C, input resistance of this equipment becomes 1100MΩ in all ranges.

(4) This equipment withstands over voltage input.
Meter and other components is not damaged even when 1500V is applied with range switch in 0.5V position.

(5) This equipment can be used as a zero center meter.
Refer to Item 3.4.2.

3.4.2 Mesurement

(1) Slide the knob provided on the MODEL G-1 in the DC position with pushing it downward.

(2) Turn the function selector switch to the +DC VOLTS or -DC VOLTS position.
+DC VOLTS position is used for positive voltage input with respect to ground.

- DC VOLTS position is used for negative voltage input with respect to ground.

(3) 50V scale or 15V scale is used as shown in Table 3-1.

	Available range DC or RMS scale	Multiplication
± DC 0.5V DC ONLY	50V	x 0.01
" 1.5V	15V	x 0.1
" 5 V	50V	x 0.1
" 15VV	15V	x 1
" 50 V	50V	x 1
" 150 V	15V	x 10
" 500 V	50V	x 10
" 1500 V	15V	x100

Table 3-1

(4) Turn the ZERO ADJ knob so that meter pointer exactly indicates zero point.

(5) The function switch should be first set to 1500V position, and gradually turned counterclockwise until an appropriate indication is obtained on the meter.

(6) Connect the GND clip to one end of circuit measured, and contact the tip of the MODEL G-1 at another end of the circuit. Read the meter indication in appropriate range.

1. Example of DC voltage measurement
A voltage in AVC circuit of a radio receiver is measured. The GND clip is connected to chassis. Since AVC voltage is negative with respect to chassis, the function selector switch is set to - DC VOLTS.

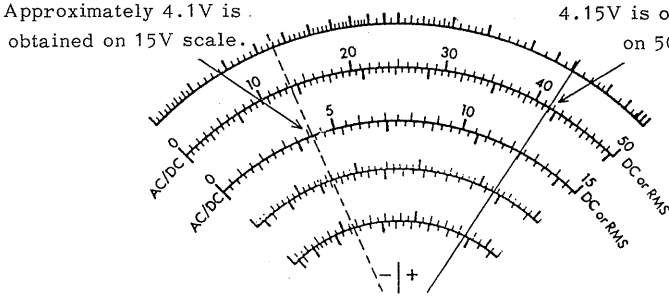


Fig. 3-10

With switch placed in the 1500V position, no indication is recognized. Therefore, range switch is gradually turned counterclockwise, and indication such as dotted line shown in Fig. 3-10 is obtained in the 15V range. Then, approximately 4.1V is obtained in the 15V DC or RMS scale. In DC voltmeter mode, the larger meter pointer deflects, the more accurate meter indication becomes. In order to read the indication with much accuracy, range switch is further turned to the 5V position. Meter indicates as continuous line. Then indication is read 41.5V in 50V scale, and 4.15V is obtained by mental arithmetic. Since the function switch is set in the -DC VOLTS position, AVC voltage is -4.15V with respect to chassis.

2. Zero center meter

The MODEL 107B and 107C can also be used zero center DC voltmeter for use in adjustment of FM discriminator circuit of FM radio receiver and other use. The procedure is shown as follows.

(1) Set the function selector switch in the +DC VOLTS position.

(2) Turn the ZERO ADJ knob so that the meter pointer indicates the center of the scale (25V in the 50V scale, 7.5V in the 15V scale).

(3) If the meter pointer indicates 43V in the 50V range, 43V - 25V = 18V is obtained with mental arithmetic. If 14V is indicated, 14V - 25V = -11V is obtained. The mark - | + below the scale represents polarity of input voltage.

3. Assurance value of TTL level

Absolute definition of output voltage of TTL ICs is decided to maintain noise margins characteristic of TTL level. The function selector switch is placed in the +DC VOLTS position, and set the range switch in the 5V position. TTL-L and TTL-H marks are printed between 50V scale and R scale. It is represented with the 50V scale and this mark that meter pointer deflection less than the mark TTL-L is low level of TTL and deflection more than the mark TTL-H is high level of TTL. If 46 is obtained in the 50V scale, the value 46V x 0.1 = 4.6V is high level of TTL, because of higher level than TTL-H.

3.5 Measurement of AC voltage

3.5.1 Features

The MODEL 107B and 107C can also be used as three kinds of AC voltmeters, and have following features.

- o RMS value voltmeter (Sine wave only)
- o P-P value voltmeter (Any waveform)
- o dBm meter (Output level meter)

(1) Measurable range is wide.
0.1Vrms minimum ~ 1500Vrms maximum
0.1Vp-p minimum ~ 2200Vp-p maximum
-20dBm minimum ~ +66dBm maximum

Each mode is divided in 7 ranges.

(2) Range is divided in rational step.
Since the ranges of RMS voltmeter and P-P voltmeter are divided in multiples of approximately 3 per step, and the range of dBm meter is divided in 10dBm per step, any voltage can be measured with high accuracy.

(3) Input impedance is high.
The MODEL G-1 employs coaxial cable composed of polyethylene insulation. Since the outer conductor is connected to the chassis, measurement is not affected by inductance from outside. Input capacitance is also low and constant. Moreover, resistors and capacitors connected in parallel with input terminal are disconnected from the input circuit in the ranges less than 150V (150Vrms, 420Vp-p and 46dBm).

(4) Measurable frequency range is wide.
Indication accuracy is within ± 3% from 30Hz to 2MHz.

3.5.2 Measurement (Common to RMS, P-P and dBm modes.)

(1) Slide the knob of the MODEL G-1 to the AC, Ω position with pushing downwards.

(2) Set the function selector switch in the AC VOLTS position.

(3) Set the range switch in the 1.5V position.

(4) Clip the tip of the MODEL G-1 with the GND clip, and turn the ZERO ADJ knob so that meter pointer indicates exactly zero point.

(5) Begin to make measurement from the 1500V range.

Caution

When the tip is taken off from measured point, meter pointer slowly return to zero volts because of large time constant of rectifier circuit for AC voltage measurement. When the range switch is turned to the 500V position from the 1500V position in AC voltmeter mode, the meter pointer may momentarily overscale. The life of this equipment is not affected by such overscale.

3.5.3 RMS voltmeter

One of 50V scale, 15V scale, AC 5V scale and AC 1.5V scale is used as below Table 3-2.

Maximum measurable voltage (rms)	Range	Available range DC or RMS scale	Multiplication
1.5V	1.5V	AC 1.5V	x 1
5 "	5 "	AC 5 "	x 1
15 "	15 "	15 "	x 1
50 "	50 "	50 "	x 1
150 "	150 "	15 "	x 10
500 "	500 "	50 "	x 10
1500 "	1500 "	15 "	x 100

Table 3-2

1. Example

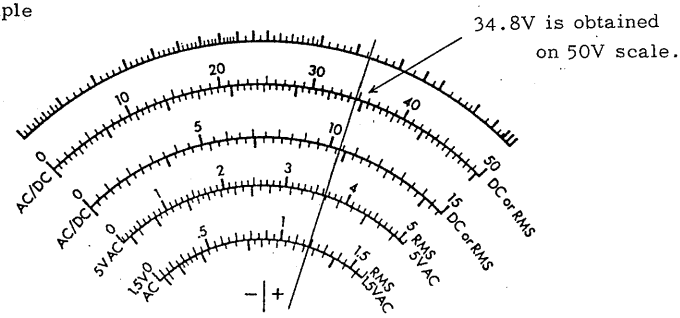


Fig. 3-11

Measuring a sine wave signal with range switch placed in the 500V position, meter indicates as continuous line shown in Fig. 3-11. In this example, 34.8V x 10 = 348V is obtained with the 50V scale. When the 1.5V or 5V range is used, a special scale is used. If meter indication as Fig. 3-11 in the 5V range is obtained, voltage is not 34.8V, but 36.5V. If in the 1.5V range, voltage is 1.19V.

3.5.4 P-P voltmeter

One of 50V scale, 15V scale, AC 5V scale and AC 1.5V scale is used as below Table 3-3.

Maximum measurable voltage (rms)	Range	Available range DC or RMS scale	Multiplication
1.5V	1.5V	15V*	x 0.1
5 "	5 "	50V*	x 0.1
15 "	15 "	15V	x 1
50 "	50 "	50V	x 1
150 "	150 "	15V	x 10
500 "	500 "	50V	x 10
1500 "	1500 "	15V	x 100

Table 3-3 * Refer to below example.

1. Example

(1) Output signal voltage at plate of video amplifier tube in a TV receiver is measured. In this example, the range switch is first placed in the 1500V position, and gradually turned counterclockwise. In the 50V range, meter indication as alternate long and short dash line shown in Fig. 3-12 is obtained. 100Vp-p is obtained at arrow B on the p-p scale. In 5 ranges more than the 15V, red p-p scale provided below the RMS scale is directly read.

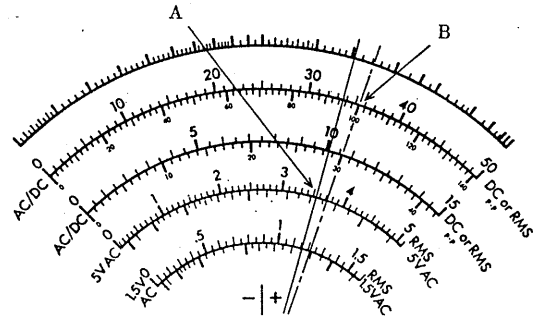


Fig. 3-12

(2) When vertical synchronizing signal voltage is measured, meter indication as arrow A on continuous line shown in Fig. 3-12 is obtained. Since no p-p scale is provided in the AC 5V scale, the p-p scale in the 50V scale is utilized as following procedure.

Indication corresponding with 3.52Vrms on the AC 5V scale is obtained on 50V scale as alternate long and short dash line. Then, 100Vp-p is obtained from p-p scale below the 50V scale. 100Vp-p x 0.1 = 10Vp-p is obtained with mental arithmetic. When p-p value is measured in the 1.5V or 5V range, 15V or 50V scale is utilized as above procedure.

3.5.5 Output level meter (dBm meter)

One of 50V scale, 15V scale, AC 5V scale and AC 1.5V scale is used as below Table 3-4.

Maximum measurable (dBm)	Range	Available range DC or RMS scale	Addition
+ 6 dBm	1.5V	AC 1.5V	0 dBm
" 16	5 "	" 5 "	0 "
" 26	15 "	" 1.5 "	20 "
" 36	50 "	" 5 "	20 "
" 46	150 "	" 1.5 "	40 "
" 56	500 "	" 5 "	40 "
" 66	1500 "	" 1.5 "	60 "

Table 3-4 * Refer to below example.

1. Example

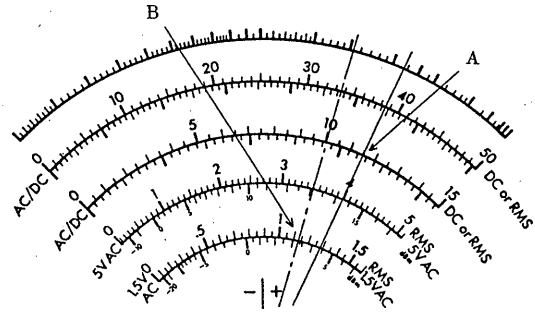


Fig. 3-13

(1) A signal voltage across 600Ω load is measured in the 1.5V range, and meter indication is obtained as arrow B on alternate long and short dash line shown in Fig. 3-13. In this example, +3.45 dBm is directly obtained from the dBm scale below the 1.5V scale. When dBm value lower than +16 dBm is measured, indicated value with red

red dBm scale below the RMS scale directly represents dBm value.

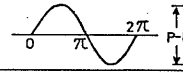
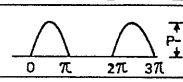
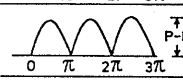
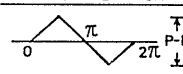
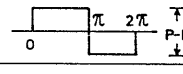
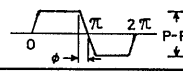
(2) Output of an amplifier terminated with 600Ω load is measured. In this example, meter indication is obtained as arrow A on continuous line shown in Fig. 3-13 in the 15V range. Since no dBm scale is provided below the 15V scale, the dBm scale below the AC 1.5V scale is utilized as following procedure. In dication corresponding with 11.5V on the AC 15V scale is obtained on the 1.5V scale. Value indicated by arrow B on the dBm scale below the 1.5V scale is added to additive value in Table 3-4, and +3.45 dBm +20 dBm = +23.45 dBm is obtained with mental arithmetic. When the dBm value in the upper ranges than 15V range is measured, the dBm value is calculated from the dBm value of the 1.5V or 5V scale corresponding with the RMS value indicated. 20 dBm, 40 dBm or 60 dBm obtained from Table 3-4 is added to the above dBm value.

3.5.6 Expression of AC voltage

AC voltage is generally expressed by root mean square value. Expression of the voltage is represented with root mean square value, when it is merely expressed without any additive expression as lamp voltage is 100V, Heater voltage of vacuum tube is 6.3V and so on. Root mean square value of AC voltage is the voltage which works as DC voltage does in the same period. Root mean square value E is defined by following formula, where "e" gives instantaneous value at any time and T gives period.

$$E = \sqrt{\frac{1}{T}\int_0^T e^2 \cdot dt}$$

Since the root mean square value is represented by the square root of the arithmetic mean of the squares of instantaneous value.
AC voltage is also expressed by mean value, peak value, peak to peak value and so on. Mean value is signified by arithmetic mean of absolute value of instantaneous value. Peak value and peak to peak value should be referred to Table 3-5.

Type	Waveform	rms value	form factor	Crest factor
Sine wave		$\frac{P-P}{2\sqrt{2}}=0.354\,P-P$ (RMS scale x 1)	$\frac{\pi}{2\sqrt{2}}=1.11$	$\sqrt{2}=1.414$
Half wave rectification		$\frac{P-P}{2}=0.5\,P-P$ (RMS scale x 1.414)	$\frac{\pi}{2}=1.571$	2
Full wave rectification		$\frac{P-P}{\sqrt{2}}=0.707\,P-P$ (RMS scale x 2)	$\frac{\pi}{2\sqrt{2}}=1.11$	$\sqrt{2}=1.414$
Triangular waveform		$\frac{P-P}{2\sqrt{3}}=0.289\,P-P$ (RMS scale x 0.817)	$\frac{2}{\sqrt{3}}=1.154$	$\sqrt{3}=1.732$
Square wave		$\frac{P-P}{2}=0.5\,P-P$ (RMS scale x 1.414)	1	1
Trapezoidal waveform		$\frac{P-P}{2}\sqrt{1-\frac{4\phi}{2\pi}}$	$\sqrt{1-\frac{4\phi}{3\pi}}\Big/1-\frac{\phi}{\pi}$	$1\Big/\sqrt{1-\frac{4\phi}{3\pi}}$

$$\text{form factor} = \frac{\text{rms value}}{\text{mean value}}\ ,\ \text{crest factor} = \frac{\text{peak value}}{\text{rms value}}$$

1. Rectifier circuit of measured voltage

Since half wave double voltage rectifier circuit in rectifier circuit for AC for AC voltage measurement, indication corresponding with peak to peak value of measured value is obtained. Relation between peak to peak value and root mean square value of AC voltage is different from voltage waveform. Root mean square value of sinewave is $1/2\sqrt{2}$ of peak to peak value. RMS and dBm scale of this equipment are graduated so that meter accurately indicates voltage for sine wave. Therefore, other waveform may may indicates inaccurate value.

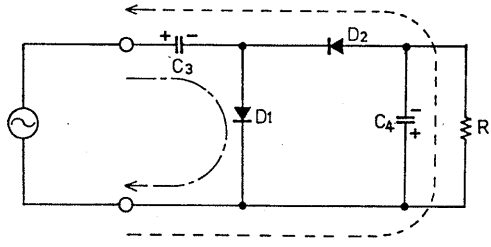


Fig. 3-14

2. dBm (Decibel)

dB is expressed as a logarithm of power (P) ratio with respect to certain reference. Generally, it is expressed with the power ratio with respect to 1 mW as follows.

$$dB = 10 \log_{10} \frac{P_1}{P_2}$$

For example, 1 mW = 0 dB, 10 mW = 10 dB, ... 1 W = 30 dB.
dBm is especially defined for 600Ω load. Relation between voltage E, current I and power P is represented as follows.

$$P = EI = \frac{E^2}{R} = I^2R$$

Therefore, power, voltage and current corresponding with 0 dBm signifies following value.

0 dBm = 1 mW ..... at 600Ω load

$$0 \text{ dBm} = \sqrt{1 \text{ mW} \times 600\Omega} = 0.7754 \text{V}$$

$$0 \text{ dBm} = \frac{1 \text{ mW}}{600\Omega} = 1.291 \text{ mA}$$

These relations are shown in Fig. 3-15. Since the dBm scale of this equipment is graduated for sine wave signal, indication may be inaccurate for distorted waveform. If load has other resistance than 600Ω, dBm is obtained by adding a value shown in Fig. 3-16. Although dB signifies power ratio, it may mean voltage, current or gain of them.

$$dB = 20 \log_{10} \frac{E_2}{E_1} = 20 \log_{10} \frac{I_2}{I_1} = 10 \log_{10} \frac{P_2}{P_1}$$

Appropriate values are selected for E_1, I_1 and P_1. For example, input voltage as E_1 and output voltage as E_2 are used for expressing voltage gain of amplifier. Especially, 1 μV is used for input voltage of radio receiver as reference. Then, 1 μV is defined as 0 dB.

3. Decibel conversion chart

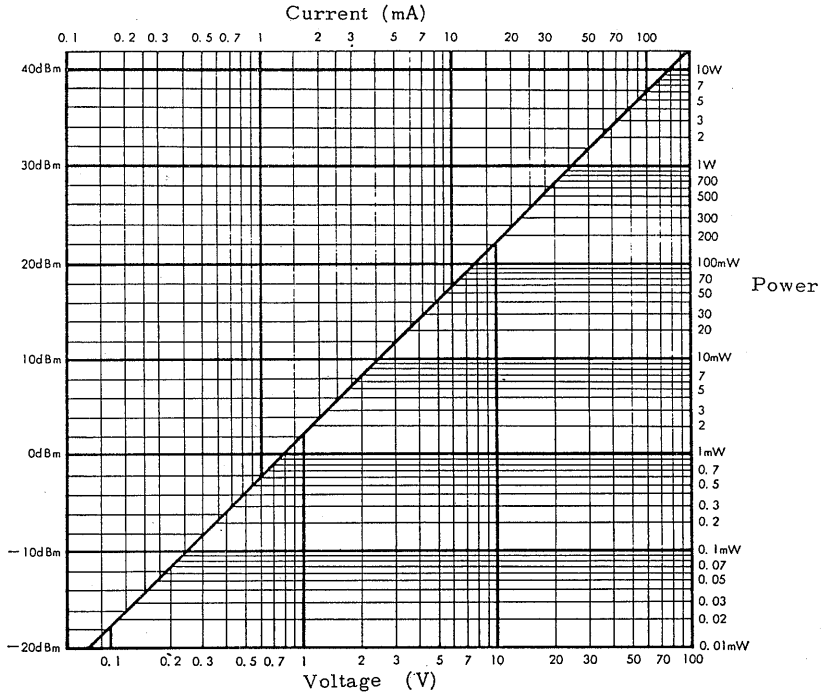


Fig. 3-15

Fig. 3-15 is used for obtaining power, voltage and current from dBm value. Fig. 3-16 is used in conjunction with Fig. 3-15 for load having resistance than 600Ω. For example, when the voltage across load having resistance of 16Ω indicates 1.1V (3dBm), 3dB+15.7dB=18.7dB (0dB=1mW) is calculated from 15.7dB shown with dotted line in Fig. Fig. 3-16. 76mW converted to power is obtained by using Fig. 3-15, and 69mA converted to current from Fig. 3-15 by calculating 3dB+15.7dB x 2=34.4dB. If calculated value exceeds 40dB, the value from which 20 is subtracted
20dB is subtracted from it. 10 times of the current obtained from its value with Fig. 3-15 is required value.

Additive dB chart

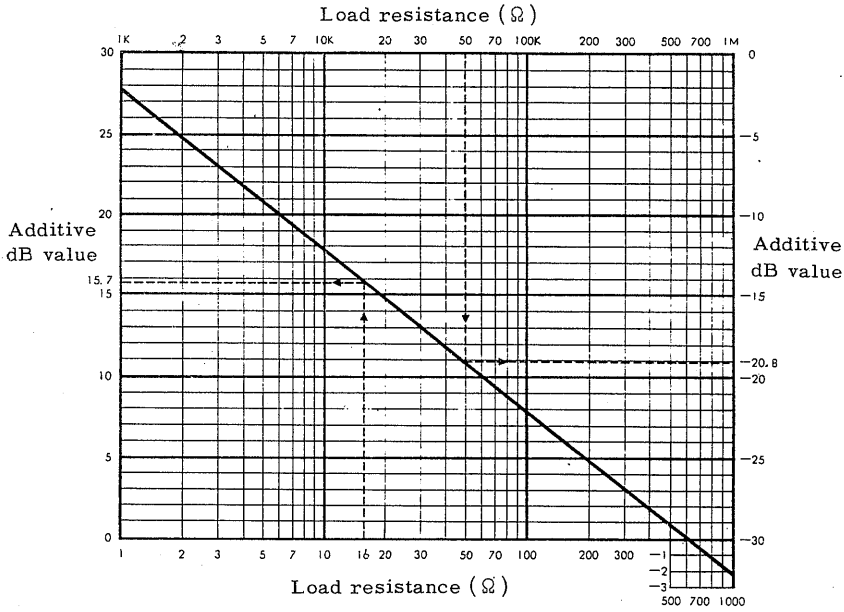


Fig. 3-16

3.5.7 Typical frequency response characteristic (at 5V range)

Typical frequency response characteristic is shown in Fig. 3-17. Each individual characteristic is a little different.

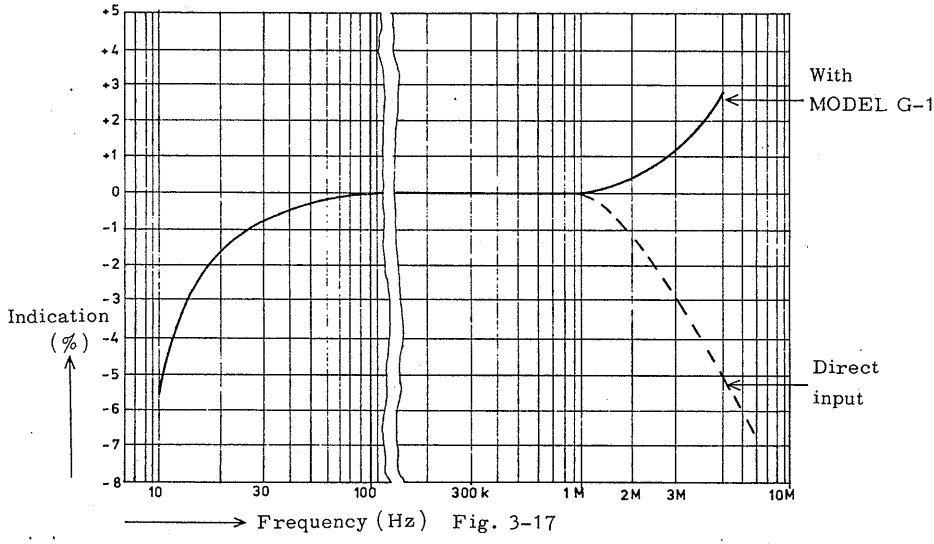


Fig. 3-17

The frequency response characteristic at specified condition fully meets teh specification. In the other condition than the specified condition, characteristic is different from characteristic shown in Fig. 3-17 for the resonance of the MODEL G-1.

3.5.8 Typical characteristic of input resistance in AC voltmeter mode

Typical input resistance characteristic in AC voltmeter mode is shown in Fig. 3-18. Each individual characteristic is a little different.

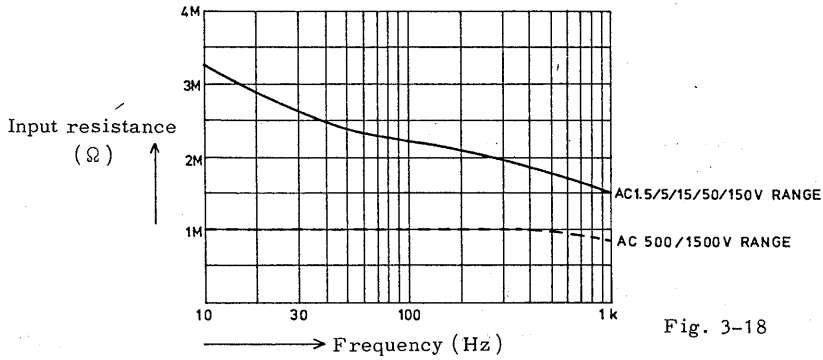


Fig. 3-18

4. MAINTENANCE

4.1 Calibration

When special accurate measurement is necessary, the equipment is used for a long period or some parts are replaced, recalibration should be made. Since standard instrument used for calibration directly decides calibration accuracy, fully accurate instrument should be used.

4.1.1 Preparation

At first, mechanical zero of this equipment and standard instrument must be adjusted, and warmed up for 30 minutes at least. Supply line voltage must be maintained at 100V by an automatic voltage regulator or other method having little distortion.

4.1.2 DC voltmeter

This mode is calibrated at the 50V range. Output of stable DC power source is applied to appropriate voltage variation system, and a standard DC voltmeter and this equipment are connected in parallel with its output. Adjust the voltage variation system so that the standard instrument indicates 50V, and adjust the DC GAIN ADJ variable resistor VR3 so that the meter indicates 50V. Indication in other ranges is checked by same method as above adjustment. If other circuit parameters are not changed, accuracy in the other ranges should remain within a specified tolerance.

4.1.3 AC voltmeter

AC voltmeter mode is also calibrated at the 50V range. Adjust the AC GAIN ADJ variable resistor VR4 same as the calibration of DC voltmeter mode. A signal applied to this equipment and standard instrument must be supplied from a sine wave generator with low distortion (100Hz ~ 1000Hz). Check indication in other ranges with same method as above adjustment. If other circuit parameters are not changed, accuracy in the other ranges should remain within a specified tolerance.

4.2 Exchange of dry battery and cell

A 6F22 (S-006P for JIS) dry battery is used for circuit operation of the MODEL 107B. A 6F22 dry battery must be exchanged, when meter pointer indicates lower scale than a range of the BATTERY OK with turning the function selector switch to the BATTERY TEST position. A R20 (for Europe, D for USA, and SUM-1 for JIS) cell is installed in both MODEL 107B and 107C. A cell sealed with metal case so that electrolyte does not leak is wraped with a polyethylene bag, and installed in this equipment. A cell should be checked as follows.

(1) Set the function selector switch in the OHMS position, and set the range switch in the x10Ω position.

(2) Adjust the zero point and ∞ point. Then, connect the tip of the MODEL G-1 to the GND clip again.

(3) 10 seconds later, disconnect the tip of the MODEL G-1 from the GND clip, and check meter indication. In case of cell expended, meter pointer indicates below ∞ point.

4.3 Internal parts location

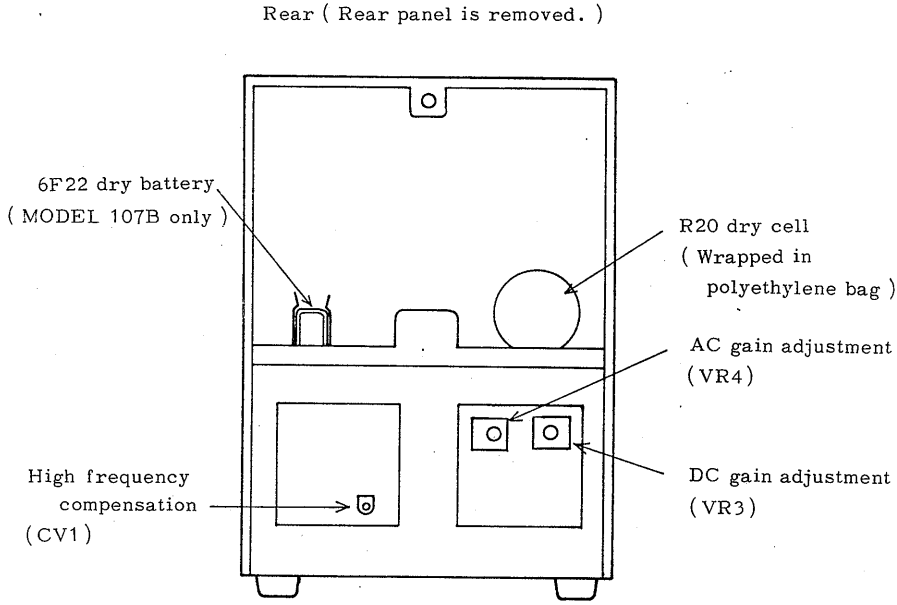


Fig. 4-1