INSTRUCTION MANUAL FOR

VOLT/OHM METER

MODEL 123

KIKUSUI ELECTRONICS CORPORATION, JAPAN

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.

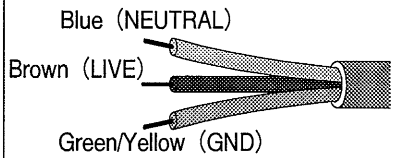
☐ AC power cable

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.

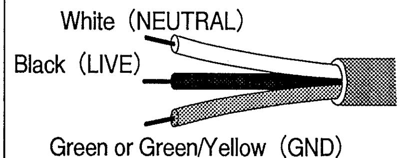
WARNING

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

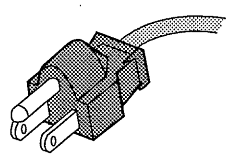
☐ Without a power plug



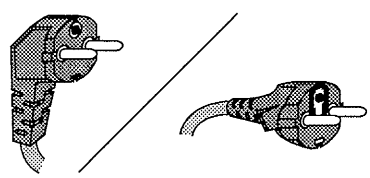
☐ Without a power plug



☐ 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

TABLE OF CONTENTS

	PAGE
1. GENERAL	1
2. SPECIFICATIONS	2
3. OPERATION METHOD	5
3.1 DESCRIPTION OF FRONT PANEL	5
3.2 PREPARATIONS FOR MEASUREMENT	7
3.3 DC VOLTMETER	8
3.4 AC VOLTMETER	10
3.4.1 AC VOLTAGE MEASUREMENT	10
3.4.2 AC CURRENT MEASUREMENT	10
3.4.3 OUTPUT POWER MEASUREMENT	11
3.4.4 WAVEFORM ERROR	11
3.4.5 DECIBEL CONVERSION CHARTS	12
3.5 OHMMETER	16
4. OPERATING PRINCIPLE	17
4.1 DC VOLTMETER	17
4.1.1 INPUT CIRCUIT	17
4.1.2 DC AMPLIFIER	17
4.2 AC VOLTMETER	19
4.2.1 INPUT CIRCUIT	19
4.2.2 AC AMPLIFIER AND METER DRIVING CIRCUIT	20
4.3 OHMMETER	21
4.3.1 INPUT CIRCUIT AND VOLTAGE SOURCE	21
4.3.2 DC AMPLIFIER	22
4.4 POWER SUPPLY	22
5. MAINTENANCE	23
5.1 ACCESS TO INTERNAL COMPONENTS	23
5.2 ADJUSTMENT AND CALIBRATION	23
5.3 SERVICING	25

* Decibel Conversion Charts

* Schematic Diagrams

1. GENERAL

The Kikusui Model 123 Volt/Ohm Meter is a versatile instruments which measures DC volts, AC volts, and ohms. The instrument employs solid-state electronics, consumes less power, and is compact and light.

The same scales are used for both DC and AC. The scales are of uniform divisions and easily readable. LED's (light emitting diodes) are provided for clear distinction between scale "1" and scale "3". These LED's are interlocked with the RANGE switch. This provision almost perfectly eliminates possible mistakes of reading a wrong scale with respect to setting of the RANGE switch.

When the OHMS button is depressed for resistance measurement, the LED of the ohmmeter scale lights.

The DC voltage measuring circuit incorporates an automatic polarity switching feature (AUTO POLARITY feature). The polarity of the measured DC voltage is indicated by LED's on the meter panel.

The DC voltmeter covers a total range of 3 mV - 300 V which is divided into 9 ranges in 1-3-1-3 sequence.

The AC voltmeter covers a total range of 3 mV - 300 V rms (-50 ~ 52 dBm) which is divided into 9 ranges in an equal progression of 10-dBm step.

The ohmmeter covers a total range of 0.1 Ω - 1000 MΩ which is divided into 9 ranges.

The measuring terminal of the instrument is isolated from the casing.

2. SPECIFICATIONS

Instrument name:	Volt/Ohm Meter
Model No.:	Model 123
Indicating meter:	Scale length 105 mm, three colors, FS 1 mA 1.0/3.1 graduation. dBm scale with 1 mW 600 Ω as reference. Ohm scale

(1) DC voltmeter

Polarity:	Automatic polarity switching. Polarity indicated by LED on meter panel.
Measuring ranges:	30/100/300 mV and 1/3/10/30/100/300 V (total 9 ranges)
Input resistance:	10 MΩ (for all ranges)
Input capacitance:	Not higher than 65 pF (Not higher than 130 pF when Model 973 Test Prod is used)
Accuracy:	±3% F.S.
Maximum input voltage:	300 V when no AC component is included. 300 V (at peak value) when AC component is included.

(2) AC voltmeter

Measuring ranges:	RMS scale ... 30/100/300 mV and 1/3/10/30/100/300 V (total 9 ranges)

	dBm scale ... -30/-20/-10 and 0/10/20/30/40/50 dBm
Input resistance:	10 MΩ (for all ranges)
Input capacitance:	30 mV - 1 V ranges ... 80 pF or less 3 V - 300 V ranges ... 60 pF or less (when Model 973 Test Prod is used 30 mV - 1 V ranges ... 140 pF or less 3 V - 300 V ranges ... 120 pF or less)

Maximum input voltage:

30 mV - 1 V ranges

AC component:	150 V rms or 200 V peak
DC component:	±400 V

3 V - 300 V ranges

AC component:	300 V rms or 200 V peak
DC component:	±400 V

Accuracy:	±3% F.S., at 1 kHz

Frequency response:

10 Hz - 2 MHz:	±10% (with 1 kHz as reference)
30 Hz - 1 MHz:	±5% (with 1 kHz as reference)
50 Hz - 500 kHz:	±3% (with 1 kHz as reference)

Noise:	Not higher than 2% (with input terminal shorted)

(3) Ohmmeter

Measuring ranges:	0.1 Ω - 1000 MΩ (7 ranges)
Scale center values:	10/100/1k/10k/100k/1M/10MΩ
Applied voltage:	1.5 V maximum

Accuracy

Scale-center ranges x0.3 - x3: ±5% of scale center

Scale-center ranges x0.1 - x10: ±10% of scale center

Stability:	Better than 0.5% F.S. for ±10% line voltage variation
Ambient temperature:	5 to 35°C
Humidity:	85% R.H.
Power requirements:	____________ V, 50/60 Hz, approx. 5 VA
Dimensions:	138 (W) x 159 (H) x 280 (D) mm
(maximum)	(140 W x 190 H x 325 D mm)
Weight:	Approx. 2.4 kg
Accessories:	Model 973 Test Prod (1)
	Instruction manual (1)

3. OPERATION METHOD

3.1 DESCRIPTION OF FRONT PANEL

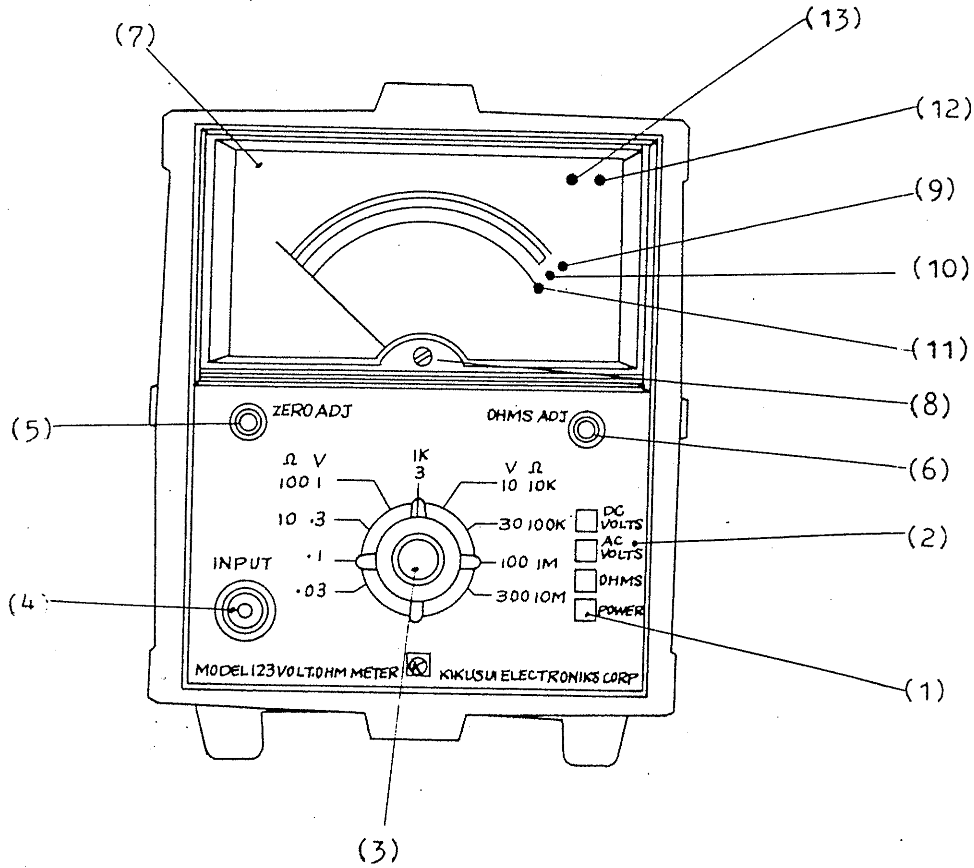


Fig. 3-1

(1) POWER: Push-button switch for power ON-OFF. Depressed and locked state is for ON; re-depressed and released state is for OFF.

(2) MODE selector: Push-button switches for selection of measuring mode for DC VOLTS, AC VOLTS, or OHMS.

(3) RANGE switch: Rotary switch located in the center of the front panel. Selects measuring ranges (9 ranges covering

0.03 V - 300 V). Red letters indicate dBm values and blue letters OHM values.

(4) INPUT terminal: The measured voltage or resistance is connected to this terminal with Model 973 Test Prod (supplied). (The GND circuit of this instrument is isolated from its chassis and panels.)

(5) ZERO ADJ: Zero adjustment for DC VOLTS and OHMS. (No adjustment is required for AC VOLTS.) Zero adjustment initially must be made by depressing the DC VOLTS button of the MODE selector, connecting the Test Prod and GND clip, and setting the RANGE switch in the 0.03 V position. The zero point is where the meter pointer deflection is made minimum. The meter pointer may not be successfully moved to the zero point of the scale due to noise of the instrument itself. This, will cause no measurement errors. It must be noted, however, that this will cause indication errors related to polarity.

(6) OHMS ADJ: For resistance measurement, this knob must be so adjusted that, with the input terminal open, the meter pointer indicates the "∞" (infinitive) position of the ohmmeter scale.

(7) Indicating meter: The indicating meter has three scales as below.

(i) "1.0 scale": For 1.0 V and 1/10/100 V ranges. The "1.0" position of the scale signifies 0.1 V at the 0.1 V range or 100 V at the 100 V range.

(ii) "3 scale": For 0.03/0.3 V and 3/30/300 V ranges. Meanings of scale positions are similar to that of the "1.0 scale."

(iii) "dBm scale": For AC VOLTS measurement, the input signal is indicated in dBm value with reference to 1 mW 600 Ω. The same scale is used for all of -30 to +50 dBm.

(8) Meter zero adj: For mechanical zero adjustment of the indicating meter.

(9) (10) LED's for scale indication: These LED's are interlocked to the RANGE switch. LED (9) lights for 0.1/1/10/100 V ranges and LED (10) for 0.03/0.3/3/30/300 V ranges.

(11) LED for OHMS scale: Interlocked with MODE buttons and lights when the OHMS button is depressed.

(12) (13) LED for polarity indication: For DC measurement only. LED (12) lights when the measured signal is positive with respect to the GND terminal and LED (13) lights when it is negative.

3.2 PREPARATIONS FOR MEASUREMENT

(1) Ensure that the POWER switch on the front panel is OFF.

(2) Check that the meter pointer is indicating the zero position of the scale. If the pointer is shifted, return it to the zero position with the meter zero adjustment. (If the instrument power has been turned on, turn off the power and allow approximately 5 minutes of cool-off time and, then, make the mechanical zero adjustment of the meter.)

(3) Connect the power plug of the instrument to a receptacle of a ____ V 50/60 Hz power line.

(4) For measurement of other than OHMS, set the RANGE switch in the 300 V position.

(5) Turn on the POWER switch. When this is done, corresponding LED's will light. The meter pointer may deflect at random for several seconds after the instrument power is turned on. The same may happen when the power is turned off.

(6) When the meter pointer is stabilized, the instrument is ready for measurement. (Make zero adjustment as required.)

3.3 DC VOLTMETER

(1) Connect the Test Prod to the INPUT terminal.

(2) Depress the DC VOLTS button of the MODE selector.

(3) Use meter scale "1" or "3". The LED's located at the right-hand ends of the scales are interlocked with the RANGE switch. Reading must be made with the scale of which LED is lighted. The scale factors and measuring units are shwon in Table 3-1.

(4) The instrument has an automatic polarity switching feature (AUTO POLARITY feature). Polarities are indicated with the two LED's located at upper right of the meter panel.

(5) For measurement, connect the GND clip to one end of the measured voltage, touch the other end with the Test Prod, and select an appropriate range. The instrument is incorporated with such overload protection circuit that it is not damaged even when a voltage of 300 V is applied when the instrument is set at the 0.03 V (30 mV) range.

Table 3-1

RANGE	SCALE	MULTIPLE	UNIT
±0.03 V	3	x0.01 (x10)	V (mV)
±0.1 V	1	x0.1 (x100)	V (mV)
±0.3 V	3	x0.1 (x100)	V (mV)
±1 V	1	x1	V
±3 V	3	x1	V
±10 V	1	x10	V
±30 V	3	x10	V
±100 V	1	x100	V
±300 V	3	x100	V

* As this instrument employs the AUTO POLARITY feature for DC voltage measurement, diodes are used in the feedback loop of the DC amplifier. (Refer to Section "OPERATING PRINCIPLE.") Therefore, if an AC component is superimposed on the DC signal, the AC component which has not been eliminated by the low pass filter (frequencies below 50 Hz) is rectified into a DC component and causes errors. Both polarity indication LED's will light, in this case.

* Model 972C High Voltage Probe (option) is available. This probe expands the DC voltage measuring range from 300 V to 30 kV. The input resistance of the probe is 1000 MΩ.

3.4 AC VOLTMETER

3.4.1 AC VOLTAGE MEASUREMENT

(1) Depress the AC VOLTS button of the MODE selector. Lest overloading should be caused to the instrument, set initially the RANGE switch at the highest range and, then, observing the meter indication, turn it gradually to lower ranges.

(2) Use the same scales with that for DC. Refer to Sub-Section 3.3 for range factors and units of measure.

(3) For dBm measurement (with 1 mW, 600 Ω as reference), use the common dBm scale and determine the dBm value as follows: The "0" position of the dBm scale is corresponding to the reference level of the range being used. The measured value can be known by adding the range dBm value to the read dBm value.

Example 1: If dBm scale reading is 2 at the "30 dBm (30 V) range," the measured dBm can be known as below.

$$2 + 30 = 32 \text{ dBm}$$

Example 2: If dBm scale reading is 1 dBm at the "-20 dBm (100 mV) range," the measured dBm can be known as below.

$$1 + (-20) = -19 \text{ dBm}$$

3.4.2 AC CURRENT MEASUREMENT

AC current (I) can be known by feeding the current in a known non-inductive resistor (R) and measuring with this instrument the voltage drop (E) developed across the resistor and calculating the current as $I = E/R$.

3.4.3 OUTPUT POWER MEASUREMENT

An apparent power (VA) being consumed in an impedance (X) can be known by measuring the voltage (E) developed across the impedance and calculating the power as $VA = E^2/R$. If the impedance is a non-inductive resistance (R), the power consumed is calculated as $P = E^2/R$.

This instrument has a dBm scale and the power can be directly read in terms of dBm, provided R = 600 Ω. When the load resistance is 1 Ω - 10 kΩ, the power in terms of dBm can be known by adding the value obtained by referring to the decibel conversion charts of Figs. 3-2 and 3-3.

3.4.4 WAVEFORM ERROR

This instrument in measuring principle is an "average-value indication" type while its scale is calibrated in terms of effective value (r.m.s. value) for sine wave. If the measured signal waveform is distorted, waveform errors will be introduced. Degrees of errors are shown in Table 3-2.

Table 3-2

Waveform of measured voltage	r.m.s. value	Meter reading
Amplitude 100% fundamental wave	100 %	100 %
100% fundamental + 10% 2nd harmonic	100.5	100
100% fundamental + 20% 2nd harmonic	102	100 - 102
100% fundamental + 50% 2nd harmonic	112	100 - 110
100% fundamental + 10% 3rd harmonic	100.5	95 - 104
100% fundamental + 20% 3rd harmonic	102	94 - 108
100% fundamental + 50% 3rd harmonic	112	90 - 116

3.4.5 DECIBEL CONVERSION CHARTS

(1) Decibel

Bel (B) denotes the ratio between two powers in terms of common logarithms with base 10. Decibel (dB) is one-tenth of Bel and affix d is used to indicate deci. It is defined as below.

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

In other words, the ratio of power P_2 with respect to power P_1 is given in terms of 10 times of common logarithms.

If the impedances of the circuits of P_1 and P_2 are equal, the power ratio can be given in voltage ratio or current ratio as below.

$$dB = 20 \log_{10} \frac{E_2}{E_1} \quad \text{or} \quad 20 \log_{10} \frac{I_2}{I_1}$$

Decibel originally had been defined in terms of ratio between two powers as above. Actually, however, since long ago, decibel has been used to denote ratio between two figures in general.

For example, assume that the input voltage of an amplifier is 10 mV and its output voltage is 10 V. The gain of this amplifier is 10 V/10 mV = 1000 times which in terms of dB is expressed as below.

$$\text{Gain} = 20 \log \frac{10\ \text{V}}{10\ \text{mV}} = 60\ (\text{decibel})$$

For decibel expression, the reference or 0 dB must be clearly indicated. In the case of the above example, the output voltage should be indicated as 10 V = 60 dB (10 mV = 0 dB) with the reference level corresponding to 0 dB enclosed in parentheses.

(2) dBm

Term dBm is an abbreviation of dB (mW). It signifies power ratio with 1 mW as reference or 0 dB. Normally the circuit impedance is 600 Ω. To be more accurate, therefore, it should be written as dB (mW, 600 Ω).

With power and impedance defined as above, decibel can be used to indicate voltage and current as well as power. The below-mentioned values are used as reference for dBm.

0 dBm = 1 mW or 0.775 V or 1.291 mA

The decibel scale of this instrument is calibrated in such dBm values as above and, therefore, a conversion process is required when measurement is made on decibel of which reference is other than 1 mW, 600 Ω. Conversion can be easily made by adding a certain value to the meter reading, referring to the conversion charts of Figs. 3-2 and 3-3.

(3) Method of Use of the Decibel Conversion Chart

Fig. 3-2 shows a chart for conversion of ratio of quantities (numbers) into decibel. Quantities (scales) may be of power (or equivalent), voltage, or current.

Example 1: With 1 mW as reference, what is 5 mW in dB value?

Since the quantities are of power, use the left-hand scale. From 5 mW/1 mW = 5, the dB value is found to be 7 dB (mW) as indicated by the dotted lines in Fig. 3-2.

Example 2: With 1 mV as reference, what are 50 mW and 500 mW in dB values?

When the ratio is higher than 0.1 or than 10, refer to Fig. 3-3 and calculate the dB value by addition.

50 mW = 5 mW x 10 = 7 + 10 = 17 dB

500 mW = 5 mW x 100 = 7 + 20 = 27 dB

Table 3-3

Ratio		dB	
		Power ratio	Voltage or current ratio
10,000	$= 1 \times 10^4$	40 dB	80 dB
1,000	$= 1 \times 10^3$	30 dB	60 dB
100	$= 1 \times 10^2$	20 dB	40 dB
10	$= 1 \times 10^1$	10 dB	20 dB
1	$= 1 \times 10^0$	0 dB	0 dB
0.1	$= 1 \times 10^{-1}$	-10 dB	-20 dB
0.01	$= 1 \times 10^{-2}$	-20 dB	-40 dB
0.001	$= 1 \times 10^{-3}$	-30 dB	-60 dB
0.0001	$= 1 \times 10^{-4}$	-40 dB	-80 dB

Example 3: What is 15 mV in dB (V) value?

Since the reference is 1 V, calculate at first as 15 mV/1 V = 0.015. Using the voltage or current scale, 0.015 = 15 x 0.01 = 3.5 + (-40) = -36.5 dB (V) or, as a reciprocal, 1 V/15 mV = 66.7

66.7 = 6.67 x 10 ⟶ 16.5 +20 = 36.5 dB (V)

(4) Method of Use of Decibel Conversion Chart

Fig. 3-3 shows a chart for conversion from a dBm value measured by this instrument into a power value.

Example 1: The voltage across the voice coil of a speaker was measured with this instrument. The voice coil impedance was 8 ohms and the meter reading was -4.8 dBm. What was the power (the apparent power, to be more accurate) in wattage?

As shown by the dotted line in Fig. 3-3, the value to be added for 8 Ω is found as +18.8. The sum of addition of this value with the meter-indicated value is the power in terms of dB (mW 8 Ω).

$$\text{dB (mW 8 Ω)} = -4.8 + 18.8 = +14$$

Conversion of 14 dB (mW 8 Ω) into wattage can be made employing Fig. 3-2 as 14 dB (mW 8 Ω) → 25 mW.

Example 2: To supply a power of 1 W to a load of 10 kΩ, what voltage is required to be applied?

1 W is 1000 mW which is 30 dB (mW). Therefore, calculate the voltage for 30 dB (mW 10 kΩ). Using Fig. 3-3, the value to be added for 600 Ω → 10 kΩ is found to be -12.2. So, the reading of this instrument on the dB (mW 600 Ω) scale must be 30 - (-12.2) = 42.2. The answer is the voltage which will cause the instrument to indicate 42.2 - 40 = 2.2 dBm on the 40 dBm range (0 - 100 V) scale. It is calculated as 42.2 dBm = 100 V.

3.5 OHMMETER

(1) Depress the OHMS button of the MODE selector. The LED of the OHMS scale will light.

(2) Use the blue OHMS scale of which LED is lighted as above Item (1).

(3) No further zero adjustment is required if the instrument has already been zero-adjusted for DC VOLTS measurement.

(4) Disconnect the Test Prod and GND clip (to make the input circuit open), and so adjust the OHM ADJ knob that the meter pointer deflects to the "∞" (infinitive) position of the OHMS scale.

(5) Clamp with the GNC clip one end of the resistor to be measured and touch with the Test Prod the other end of the resistor, and read the meter indication. The resistance can be known by multiplying the reading by the range factor.

Example 1: A fixed resistor of unknown resistance was measured at the "x10MΩ" range. The pointer barely deflected and remained close to the "0" position. Thus the resistance was known to be much less than 10 MΩ. The range was gradually lowered as "x1MΩ" → "x100kΩ" → "x10kΩ". The pointer indicated 0.2. Since the meter indication is more accurate at its mid-scale positions, the range was further reduced to "x1kΩ". The meter indicated 2 or the resistance was measured to be 2 kΩ.

* Regarding measurement of a low resistance at the "x10Ω" range, the meter may not indicate the zero position even when the Test Prod and GND clip are shorted because there still remains conductor resistances of lead wires and contact resistances of switches. The true value can be known by subtracting the residual resistance from the meter reading. In practice, however, no substantially large error is introduced when measurement at this range is made in the same manner as at other ranges.

4. OPERATING PRINCIPLE

The measuring circuits of the Model 123 VOLT/OHM METER are shown in Figs. 4-1, 4-3, and 4-6. The GND circuit is isolated from the chassis.

4.1 DC VOLTMETER

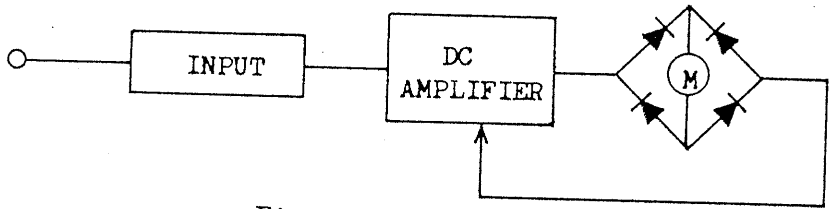


Fig. 4-1

4.1.1 INPUT CIRCUIT

The input circuit consists of an attenuator covering a total range of 0 to -70 dB in 10-dB steps and a low pass filter having an overvoltage protection circuit.

After the RANGE switch is turned in accordance with the level of the input signal, the AC component superimposed on the DC component to be measured is attenuated with a low pass filter having an appropriate cut-off frequency. When a abnormally large voltage is applied to this filter circuit, the diodes in the circuit act to protect the DC amplifier of the subsequent stage.

The function of the attenuator is such that the input at the 0.03 V range and 0.1 V range is directly fed through but the input at the other ranges is attenuated to approximately 0.1 V.

4.1.2 DC AMPLIFIER

The DC amplifier consists of a pair of FET's and an IC. The output is fed back to the input through an automatic polarity selection circuit (AUTO POLARITY circuit) and a current feedback circuit. Thus, the indicating meter is driven in a constant-current mode and the instrument operation is very stable.

Fig. 4-2 illustrates the AUTO POLARITY circuit. When the input voltage is positive with respect to the ground, the amplifier output is positive and the current flows in the direction of a ⟶ b ⟶ c ⟶ d as indicated by the solid line. When the input is negative, the current flows in the direction of d ⟶ b ⟶ c ⟶ a as indicated by the dotted line. Thus, the indicating meter deflects in the positive direction irrespective of polarity of the input voltage. Three transistors are used following the amplifier output for polarity indication in DC voltage measurement.

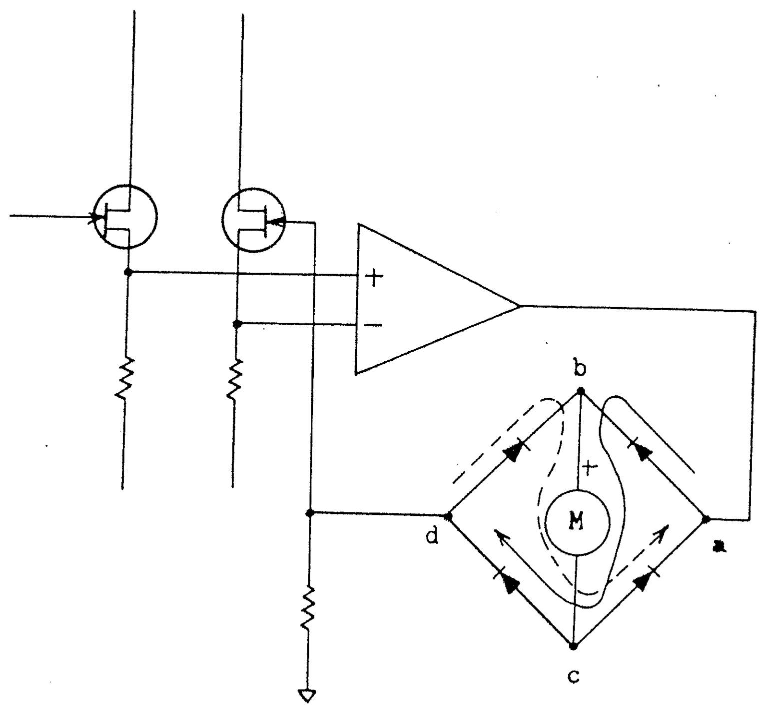


Fig. 4-2

4.2 AC VOLTMETER

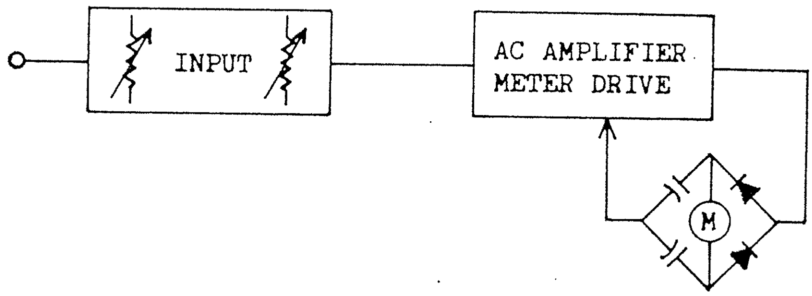


Fig. 4-3

4.2.1 INPUT CIRCUIT

The input circuit consists of a pre-attenuator (0/40 dB), an impedance converter, and a post-attenuator (10dB-step, 5 ranges of 0/10/20/30/40 dB) as shown in Fig. 4-4.

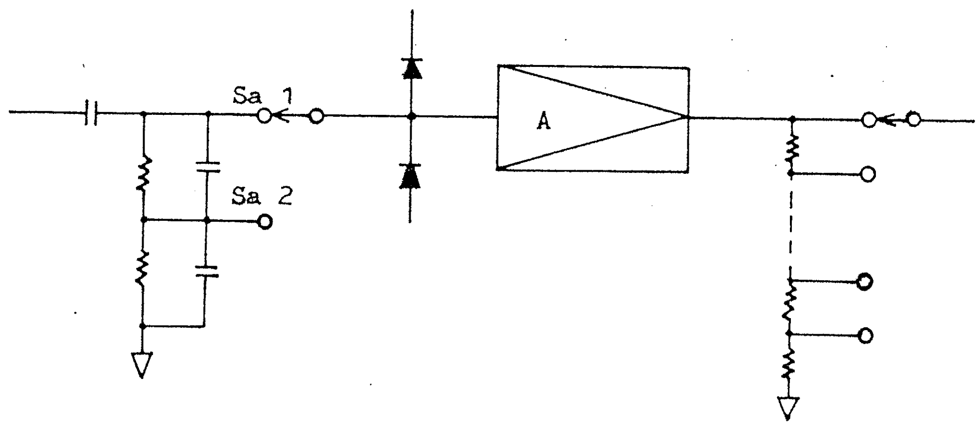


Fig. 4-4

The input signal is fed to Sa 1 when the RANGE switch is in a 0.03 V - 1 V position or to Sa 2 when the switch is in a 3 V - 300 V position, it is attenuated correspondingly, and, then, it is applied to the impedance converter. The impedance converter employs three transistors, with FET's at its initial stage. Its function is to convert the high input impedance into a low output impedance for the post-attenuator. The post-attenuator attenuates the input signal to approximately 0.03 V in accordance with the signal level. The diodes connected at the input circuit of the impedance converter are for protection against abnormally large input.

4.2.2 AC AMPLIFIER AND METER DRIVING CIRCUIT

This block amplifies the signal received from the input circuit and drives the indicating meter. It uses four transistors and employs a negative feedback circuit. A current feedback circuit connects the collector of Q704 to the base of Q701 through rectifier diodes.

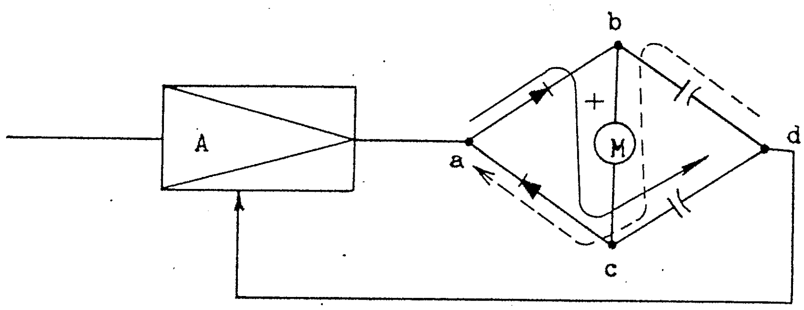


Fig. 4-5

Thus, the diodes are driven with almost constant current and non-linearity of diodes is greatly improved. The operation is shown in Fig. 4-5. For the positive half cycle of the amplifier output, the current flows in the direction of a → b → c → d as indicated by the solid line in Fig. 4-5. For the negative half cycle, the current flows in the direction of d → b → c → a as indicated by the dotted line. The meter indicates the average value of the current.

4.3 OHMMETER

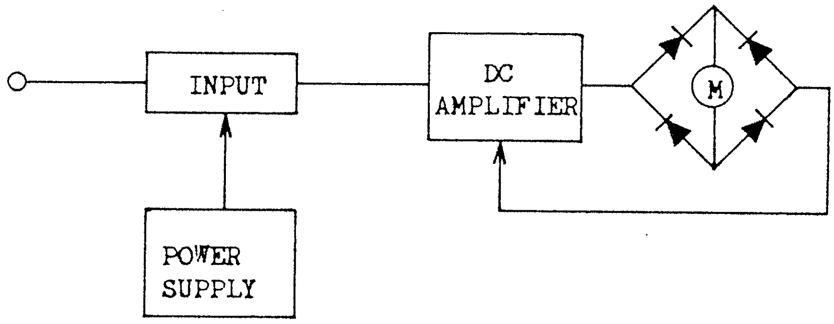
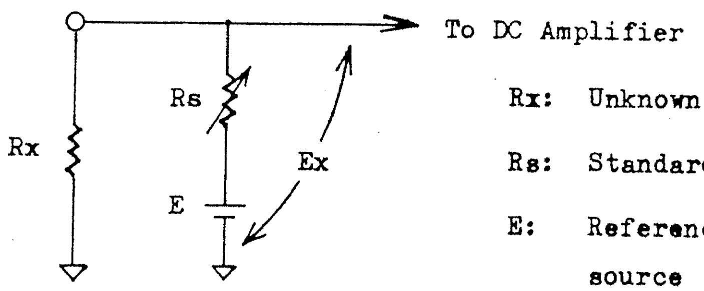


Fig. 4-6

4.3.1 INPUT CIRCUIT AND VOLTAGE SOURCE

The input circuit consists of standard resistors for 7 ranges in 20-dB step. The measuring circuit including a voltage source is shown in Fig. 4-7.



Rx: Unknown resistor

Rs: Standard resistor

E: Reference voltage source

Fig. 4-7

Referring to Fig. 4-7, voltage Ex applied to the DC amplifier is given as below.

$$Ex = \frac{1}{Rx + Rs} E$$

Gain of the DC amplifier must be so adjusted that the meter indicates the full scale when the reference voltage E (V) is applied to the DC amplifier. When a resistance of 1 kΩ is measured at the 1 kΩ range for example, voltage Ex which is applied to the DC amplifier is given as below.

$$Ex = \frac{1\ k\Omega}{1\ k\Omega + 1\ k\Omega} E = \frac{1}{2} E$$

In this case, the standard resistor Rs for the 1 kΩ range must be kept at 1 kΩ.

As can be seen in the above, the measuring circuit is so designed that, when the measuring range is the same with the measured resistance, the meter pointer deflects to the 50% F.S. position.

4.3.2 DC AMPLIFIER

The DC amplifier for the DC voltmeter is used in common for the ohmmeter also.

4.4 POWER SUPPLY

The power supply consists of three regulated voltage supply circuits: two for ±15 V and one for +1.4 V. The latter is used as the standard voltage source for the ohmmeter.

5. MAINTENANCE

5.1 ACCESS TO INTERNAL COMPONENTS

To gain access to the internal components, turn 180 degrees the four screws at the upper and lower sections of the housing and remove it which is symmetrical to the right and left. Layout of components is shown in Fig. 5-1.

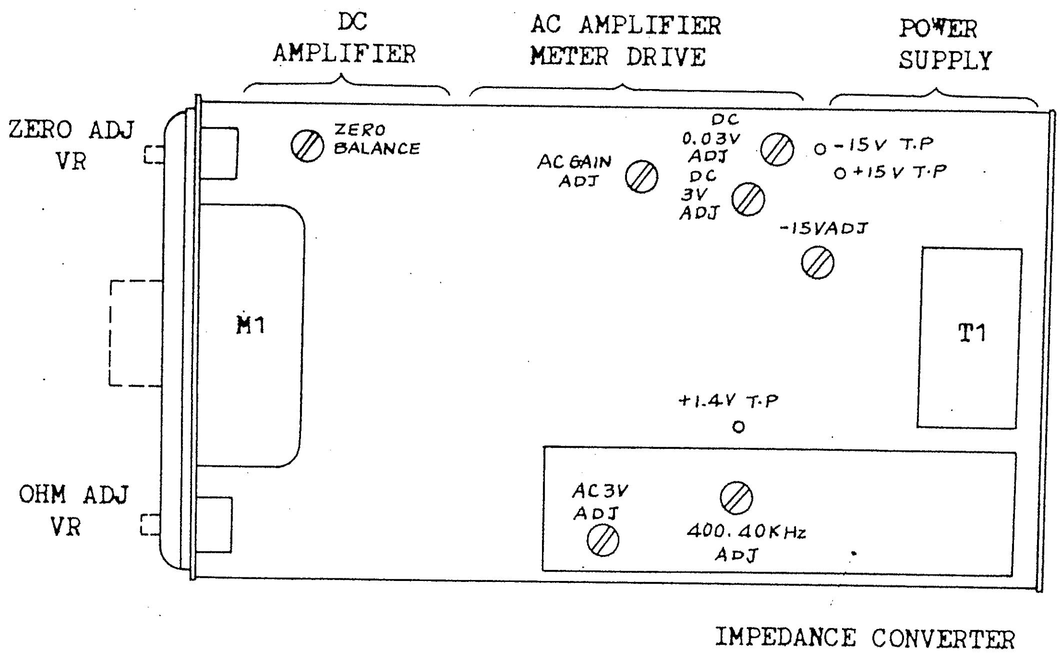


Fig. 5-1 Top view

5.2 ADJUSTMENT AND CALIBRATION

If the instrument does not satisfy its performance specification after it has been used for a long period or after it is repaired, it must be adjusted and calibrated as below. Before the below-mentioned procedure, make mechanical zero adjustment of the indicating meter as described in Sub-section 3.1 (8).

(1) Adjustment of Regulated DC Voltage Circuit

Connect a DC voltmeter between -15T·P and GND. So adjust the -15V ADJ variable resistor that the DC voltmeter reads -15 V. Next, connect the DC voltmeter between +15T·P and GND, and check that the voltmeter indication is within a range of +14.5 V to +15.5 V. Also, connect the DC voltmeter between +1.4VT·P and GND, and check that the voltmeter indication is within a range of +1.3 V to +1.5 V.

(2) Adjustment of DC Voltmeter

(a) Depress the DC VOLTS button of the MODE selector, set the RANGE switch in the 0.03 V position, and short the input terminal. Set the ZERO ADJ variable resistor in a mid-position of its total rotation angle, and so adjust the ZERO BALANCE variable resistor that the meter deflection is made minimum.

(b) Apply a calibration voltage of 0.03 V to the input. So adjust the DC 0.03 V ADJ that the meter pointer deflects precisely to the full scale position. Next, set the RANGE switch in the 3 V position and apply a calibration voltage of 3 V. So adjust the DC 3 V ADJ that the meter pointer deflects precisely to the full scale position.

(3) Adjustment of AC Voltmeter

(a) Depress the AC VOLTS button of the MODE selector, set the RANGE switch in the 0.1 V position, apply a calibration voltage of 0.1 V, 1 kHz or 400 Hz (sine wave of low distortion factor) to the input, and so adjust the AC GAIN ADJ that the meter pointer deflects accurately to the full scale position.

(b) Turn the RANGE switch to the 3 V position, apply a calibration signal of 3 V, 400 Hz to the input, and so adjust the AC 3V ADJ variable resistor that the meter pointer deflects accurately to the full scale position. Next, make the calibration signal frequency 40kHz and so adjust the 400Hz/40kHz ADJ that the same deflection as above is obtained. Repeat alternately the adjustments for 400 Hz and 40 kHz for several times so that both requirements are simultaneously satisfied.

5.3 SERVICING

The instrument has been manufactured under stringent quality control and shipped after severe inspection. Yet, if the instrument should fail due to aging or other cause, service the instrument referring to Tables 5-1, 5-2, 5-3, and 5-4 which list circuit voltages with respect to the -15 V line.

(1) DC Amplifier

Table 5-1

FET	Source (V)	Gate	Drain (V)
Q301 E-400 (1/2)	+15.8	-	+30
Q301 E-400 (1/2)	+15.8	-	+30

(2) Impedance Converter

Table 5-2

Transistor FET	Emitter Source (V)	Base Gate (V)	Collector Drain (V)
Q601 2SK-30Y	+15.2	-	+26.1
Q602 2SA495	+26.7	+26.1	+15.2
Q603 2SC458	+11.1	+11.8	+15.2

(3) AC Amplifier and Indicating Meter Driving Circuit

Table 5-3

Transistor	Emitter (V)	Base (V)	Collector (V)
Q702 2SA495	+16.3	+15.6	+9.8
Q701 2SC458	+16.4	+17.1	+30
Q703 2SC458	+9.2	+9.8	+30
Q704 2SC458	+8.5	+9.2	+19.6

(4) Power Supply

Table 5-4

(a) ±15 V

Transistor	Emitter (V)	Base (V)	Collector (V)
Q201 2SC1124	+30.1	+30.7	+39.3
Q202 2SC458	+15.0	+15.7	+30.7
Q203 2SA495	+6.9	+6.2	+0.5
Q204 2SA509	±0	+0.6	+9.0

(b) +1.4 V

Transistor	Emitter (V)	Base (V)	Collector (V)
Q101 2SC1124	+16.5	+17.1	+23.0
Q102 2SC458	+15.0	+15.7	+17.1

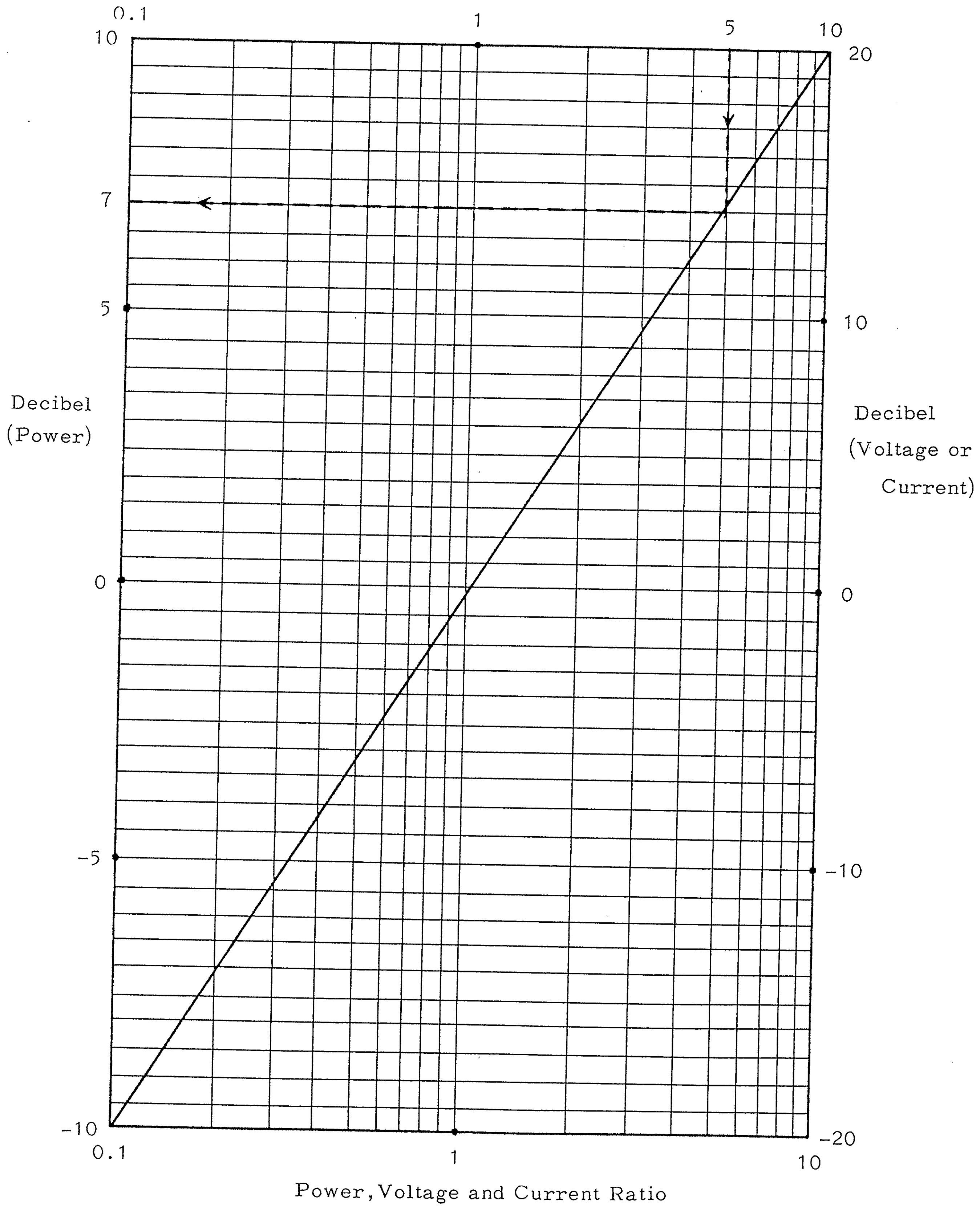


Fig. 3-2 Decibel Conversion Chart

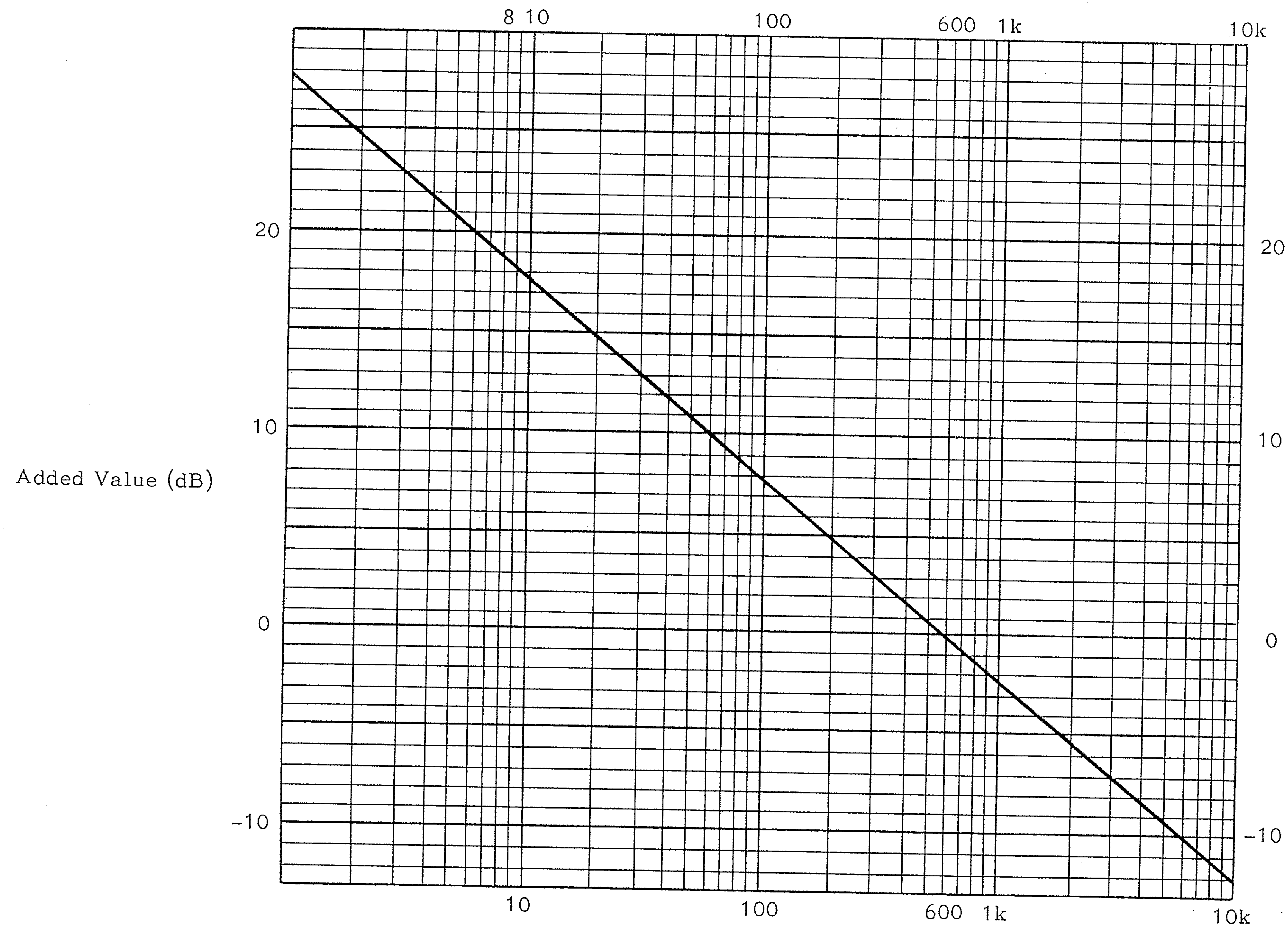


Fig. 3-3 Decibel Conversion Chart