INSTRUCTION MANUAL

DIGITAL VOLT OHM METER

MODEL 1503

KIKUSUI ELECTRONICS CORPORATION

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.

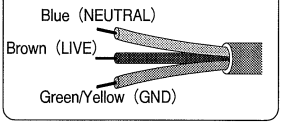
☐ AC power cable

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.

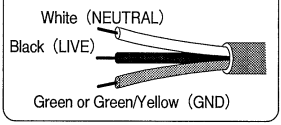
WARNING

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

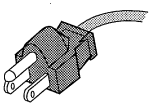
☐ Without a power plug



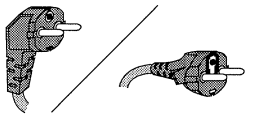
☐ Without a power plug



☐ 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

1. GENERAL

Kikusui Model 1503 Digital Volt Ohm Meter is an accurate instrument which measures a DC voltage for a range of $\pm$0.000 V ~ 1000.0 V and a resistance for a range of 0.000 kΩ ~ 19.999 MΩ. The instrument has an automatic zero erase circuit and employs a double integration system.

For DC voltage measurement, the instrument automatically identifies the polarity of the input voltage and displays a minus sign when the input voltage is negative.

As the automatic zero erase circuit is incorporated, the instrument requires no zero adjustment and ensures reliable measurement.

Employing IC's to the full and LED's, the instrument is compact, light, and consumes less power, while ensuring a high operation reliability.

The input circuit can be floated from the casing (by removing the shorting bar from between LOW and GND terminal), enabling measurement of a voltage between two points which are floated from the ground.

2. SPECIFICATIONS

Instrument name: Model 1503 Digital Volt Ohm Meter

Measuring functions: DC voltage measurement and resistance measurement

System: Double integration system

Indications

Display: LED readout (red)
Maximum effective display value: 19999
Polarity indication: Automatic (minus sign alone)
Over-input indication: By flashing of displayed characters

Sampling rate: Approx. 3 times/sec

Ambient temperature and humidity: $0^{\circ}C \sim 40^{\circ}C$, less than 85% RH

Withstand voltages

Both HIGH and LOW terminals can be floated from the casing (by disconnecting the shorting bar from between LOW and GND terminal)

Between HIGH/LOW terminal and casing: 500 V DC max.
Between HIGH/LOW terminal and AC power line: 500 V DC max.

Power requirements: 100 V $\pm$10%, 50/60 Hz AC, approx. 11 VA (can be modified to 110V, 117V, 220V, 230V, or 240V by internal tap connection change)

External dimensions: 200 W x 80 H x 250 D mm

(Maximum dimensions): 220 W x 90 H x 295 D mm (345 D mm when carying)

Weight (net): Approx. 2.6 kg

Accessory: Instruction manual ..... 1 copy

DC voltmeter section

Range	2 V	20 V	200 V	1000 V
Accuracy ($18^{\circ} \sim 28^{\circ}C$)	±(0.035% of rdg + 0.01% of FS)			±(0.04% of rdg + 0.02% of FS)
Temperature coefficient	100 μV	1 mV	10 mV	100 mV
Input resistance	10 MΩ			
Maximum continuous input overvoltage	±1200 V			

Ohmmeter section

Range	2 kΩ	20 kΩ	200 kΩ	2000 kΩ	20 MΩ
Accuracy ($18^{\circ}C \sim 28^{\circ}C$)	±(0.04% of rdg + 0.01% of FS)			±(0.08% of rdg + 0.01% of FS	±(0.3% of rdg + 0.1% of FS)
Temperature coefficient (max.)	0.005%/°C			0.01%/°C	0.02%/°C
Resolution	0.1 Ω	1 Ω	10 Ω	100 Ω	1 kΩ
Measuring current	1 mA	100 μA	10 μA	1 μA	100 nA
Maximum continuous input overvoltage	+1000 V, -50 V	+1000 V, -100 V			

Open input voltage of ohmmeter: Approx. 21 V

3. OPERATION METHOD

3.1 Explanation of Front Panel

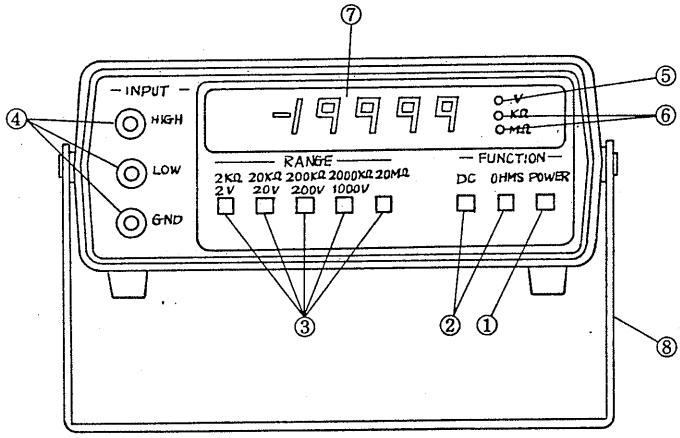


Fig. 3-1

① POWER: AC main power ON-OFF switch. The depressed and locked state is for ON; the pushed again and popped-up state is for OFF.

② FUNCTION: Pushbuttons for selection of measuring function between "DC" (DC voltage) and "OHMS" (resistance measurement).

③ RANGE: Pushbuttons for selection of measuring range. The figures noted upward the buttons are full-scale values of voltage or resistance. Should be set in an appropriate state in conjunction with the "FUNCTION" button of ②.

④ HIGH, LOW, GND: Input terminals -- "HIGH" for high impedance and "LOW" for low impedance. Both "HIGH" and "LOW" terminals are isolated from the casing, for floating voltage measurement. The withstand voltage with respect to the ground is 500 V DC maximum. The GND terminal is connected to the casing.

⑤ V: LED light which turns ON when the instrument is set for DC voltage measurement (2 V ~ 1000 V ranges).

⑥ kΩ, MΩ: LED lights which indicate the measuring units -- "KΩ" light for 2 kΩ ~ 2000 kΩ ranges and "MΩ" light for 20 MΩ range.

⑦ Readout: 5-digit readout with LED's, for 0 ~ 19999. When in over-input, this figure flashes. The decimal point moves in accordance with range setting. The minus sign "-" is displayed for a negative input voltage.

⑧ Handle: The carrying handle can be used also as a tilting support. For tilting, turn and lock the handle in the "LOCK" position.

3.2 Measuring Procedures

(1) Turn-ON the "POWER" switch ①. The value displayed by the readout may vary for several seconds after turning-ON the POWER switch. This is transiential and not an abnormal indication.

(The instrument is stabilized in some tens seconds after turning-ON the POWER switch. When a very high accuracy is required, however, allow 30 minutes or more of stabilization period.)

(2) DC voltage measurement:

Press the DC switch ② and set the "RANGE" switch in an appropriate position.

Connect the high impedance line of the measured voltage to the "HIGH" terminal (red binding post) ④ and the low impedance line to the "LOW" terminal (white binding post) ④. When the distance from the measured voltage source is long, use a shielded cable of good insulation.

Note: If the measured voltage level is unpredictable, set at first the instrument at the highest range and, then, gradually lower the range so that the readout indicates a value lower than 19999.

(3) Resistance Measurement

Press the "OHMS" switch and set the "RANGE" switch in an appropriate position.

Connect the high impedance line of the measured resistance to the "HIGH" terminal (red binding post) ④ and the low impedance line to the "LOW" terminal (white binding post) ④.

Note: If the measured resistance level is unpredictable, set at first the instrument at the highest range and, then, gradually lower the range so that the readout indicates a value less than 19999.

Precautions:

(1) For measurement of a high resistance, use a shielded cable of good insulation. (For measurement in dump atmosphere, use a moisture-proof cable.)

(2) When a low resistance is measured using long leadwires, to eliminate the error caused by the leadwires, measure the resistance of the leadwires by shorting them at the measuring end and subtract the leadwire resistance from the measured overall value.

4. OPERATING PRINCIPLE

4.1 Outline of Measuring Principle

The 1503 Digital Volt Ohm Meter basically is a DC voltmeter. The resistance is measured by converting it into a voltage signal by feeding a certain current to the measure resistor. The fed current differs by range.

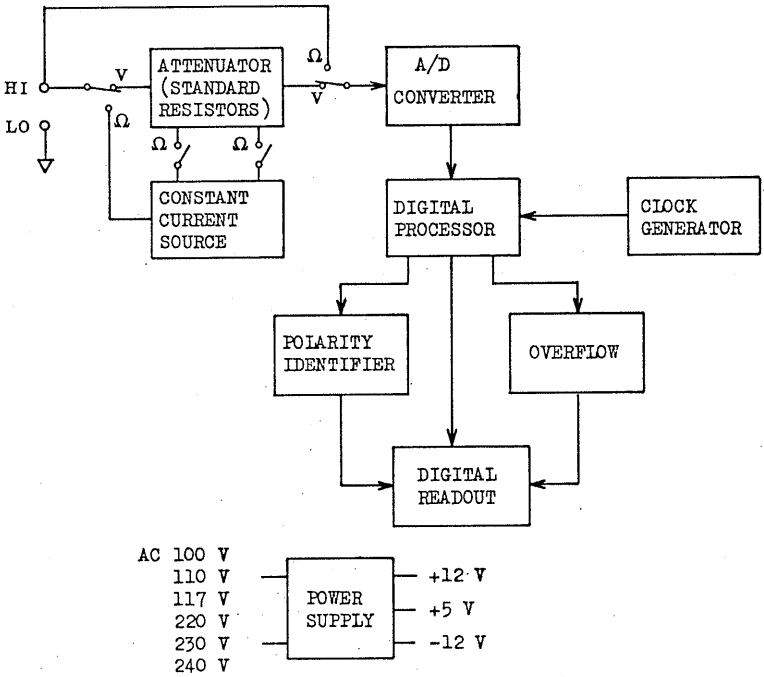


Fig. 4-1. Block diagram

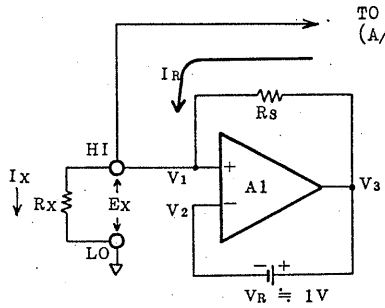
4.2 Attenuator (Standard Resistors)

For voltage measurement, the attenuator provides a constant input resistance of 10 MΩ and attenuates the input voltage in 20-dB steps (0/20/40/60 db).

For resistance measurement, the attenuator (precision resistors) are used to produce a constant current for each range for measurement of resistance in terms of voltage.

4.3 Constant Current Source

For resistance measurement of 2 kΩ ~ 20 MΩ, constant currents of 0.1 μA ~ 1 mA for respective ranges are fed to the measured resistor from the constant current source and the voltage drop developed across the resistor is measured. The operating principle of the constant current circuit is shown in Fig. 4-2.



I_R: Current which flows in R_X

R_X: Measured resistor

R_S: Standard resistor

A_1: Differential amplifier

V_R: Reference voltage

I_X: Current flows in R_X

E_X: Terminal voltage

Fig. 4-2

$$V_1 \fallingdotseq V_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$V_R = V_3 - V_2 \fallingdotseq V_3 - V_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$I_X \fallingdotseq I_R \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$I_R = \frac{V_3 - V_1}{R_S} \fallingdotseq \frac{V_R}{R_S} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$I_X \fallingdotseq \frac{V_R}{R_S} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

V_R and R_S of equation (5) are constant. Therefore, I_X also is constant ..... (6)

$$E_X = I_X R_X \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

As can be seen in equations (6) and (7), terminal voltage E_X is directly proportional to measured resistance R_X.

4.4 A/D Converter

The A/D converter converts an analog signal into a digital signal, performs compensations for the drift voltage and offset voltage provided by the automatic zero erase circuit, and sends the resultant digital signal -- which is corresponding to the input voltage -- to the digital processor.

The automatic zero erase circuit has a measuring period and an automatic zero compensation period. The ratio of the two period for each cycle is 2:1.

During the automatic zero compensation period, the internal offset voltage and drift voltage are stored in a capacitor (the stored voltage is used as the reference voltage for automatic zero compensation.

During the measuring period, the effect of the offset voltage and drift voltage is nullified by using the voltage stored as above.

4.5 Digital Processor

The digital processor consists of a control circuit, time base counter, BCD counter, latch memory, and multiplexer circuit.

The control circuit performs timing control operation and up/down logic control operation in conformity with the state of the comparator output. The time base counter generates a clock signal (time base signal) for switching between measuring period and automatic zero compensation period.

The digital data is loaded in the latch memory and is sent in a time-sharing mode to the decoder and, then, the data is displayed on the readout.

4.6 Reference Voltage Generator

The reference voltage generator produces a highly stable DC voltage of approximately 8.2 V which is used by the A/D converter.

4.7 Clock Generator

The clock generator produces a clock signal which is used for processing the digital signals. This generator employs a Colpitts circuit and its standard oscillating frequency is 163.8 kHz.

4.8 Power Supply

The power supply provides regulated DC powers of +5 V, +12 V and -12 V. The +5 and +12 V powers employ IC voltage regulators. The -12 V power is regulated employing a differential amplifier and using the +12 V power as the reference voltage.

5. MAINTENANCE

5.1 Removing the Covers

Before removing the casing covers, be sure to disconnect the power plug from the AC receptacle. To remove the top cover, undo the four clamping-screws at the four corners of the top cover; to remove the bottom cover, undo the four clamping-screws at the four corners of the bottom cover.

5.2 Layout of Adjustments

Adjustments are located as shown in Fig. 5-1.

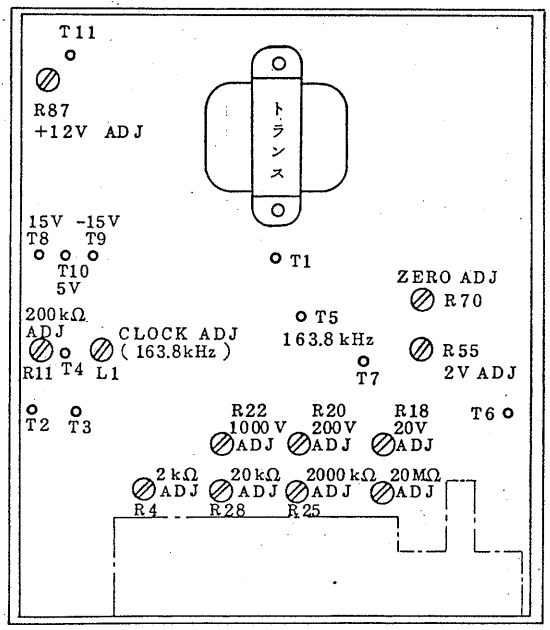


Fig. 5-1

5.3 Calibration

To maintain the high accuracy of the instrument for a long period, the instrument should be periodically inspected and calibrated. Calibration should be done in a stable atmospheric temperature of approximately 23°C. Allow more than 30 minutes of stabilization period after turning-ON the instrument power.

5.3.1 Checking the Supply Voltages

Check the supply voltages as shown in Table 5-1.

Check point	Voltage (with respect to ground)
+5 V power: T-10	4.5 ~ 5.5 V
+12 V power: T-8	+11.5 ~+12.5 V
-12 V power: T-9	-11 ~ -13 V

Table 5-1

5.3.2 Checking the Clock Generator

Connect a counter to T 5 and so adjust L1 that the oscillating frequency of the clock generator becomes 163.8 kHz ±10 kHz.

5.3.3 Calibration of DC Voltage Ranges

(1) Press the "DC" button of "FUNCTION" selector and the "2 V" button of "RANGE" selector. Short the input terminals "HIGH" and "LOW", and so adjust R70 that the readout indicates "0.000".

(2) Set the DC reference voltage generator (accuracy 0.01% or better) at +1.9990 V. Apply this voltage to the 1503 and so adjust R55 that the readout indicates "+1.9990" V.

(3) In the same manner as above, set the 1503 at 20 V, 200 V and 1000 V ranges and apply 19.990 V, 199.90 V and 1000.0 V, respectively, with the DC reference voltage generator, and so adjust R18, R20 and R22, respectively, that the readout indicates the corresponding values.

5.3.4 Calibration of Resistance Ranges

(1) Press the "OHMS" button of "FUNCTION" selector and the "200 kΩ" button of "RANGE" selector. Apply a standard resistor of 199.90 kΩ (accuracy 0.01% or better) to the 1503, and so adjust R11 that the readout indicates 199.90 kΩ.

(2) In the same manner as above, press the 20 MΩ, 2000 kΩ and 20 kΩ ranges and apply a standard resistor of 19.990 MΩ (accuracy 0.06% or better), 1999.0 kΩ (accuracy 0.02% or better) and 19.990 kΩ (accuracy 0.01% or better), respectively, and so adjust R24, R25 and R28, respectively, that the readout indicates the corresponding values.

(3) If long leadwires are used when measuring resistances at lower ranges (especially at "2 kΩ" range) and the resistance of the leadwires is not neglibible, the resistance of the leadwires should be subtracted from the total value.

For one method, short the leadwires at the measuring point and know the leadwire resistance (R_w). Subtract this value (R_w) from the total value to know the resistance of the measured resistor alone.

For more convenient method -- eliminating the subtraction calculation --, set the instrument at the "2 kΩ" range and connect a standard (accuracy 0.01% or better) resistor of 1.9990 kΩ at the measuring end of the short leadwires. So adjust R4 that the readout indicates 1.9990 kΩ.

5.4 Troubleshooting

The 1503 is manufactured under stringent quality control program and would not fail under normal use. Should it fail, however, check the circuit voltages referring to Table 5-2. The voltages shown in Table 5-2 are as measured with respect to the ground (unless specified otherwise) using a voltmeter of input resistance 11 MΩ (Kikusui Series 107 instruments, Model 116A or 115A).

The fuse is located at the inner rear of the instrument. To gain access to the fuse, remove the casing of the instrument.

Check point	Voltage
T1	21 ~ 23 V
T2 ~ T3	0.98 ~ 1.02 V
T4	-3.5 ~ -4.1 V
Source of Q8	-3.5 ~ -4.1 V
T7	7.9 ~ 8.5 V
T11	6.8 ~ 7.5 V

Table 5-2

5.5 AC Line Voltage Conversion

The 1503 can be converted for operation on a 110 V, 117 V, 220 V, 230 V, or 240 V. For this conversion, change the grey wire from the 100 V AC point on the main printed circuit board (A1) to the required point (110 V, 117 V, 220 V, 230 V, or 240 V) on the same printed circuit board.