INSTRUCTION MANUAL

DIGITAL MULTIMETER

MODEL 1505

KIKUSUI ELECTRONICS CORPORATION

TABLE OF CONTENTS

1. GENERAL

Kikusui Model 1505 Digital Multimeter is a compact multi-purpose digital voltmeter which measures DC and AC voltages and currents, and resistances.

This digital multimeter employs a liquid crystal device (LCD) which shows a digital readout from 0 to 1999.

A dry battery of 9V is provided as the power supply. An LSI is used to reduce power dissipation, thereby ensuring a longer battery life. An input terminal for an AC adapter is supplied to allow operation by AC power.

A double-integration system is employed for measurement. An automatic zero suppress circuit insures high performance for accurate measurement.

The measuring ranges of DC and AC voltages are 100μV - 1000V, DC current 0.1μA - 10A, AC current 1μA - 10A, and resistance 0.1Ω - 20MΩ. Thus the instrument covers a wide measuring range.

Furthermore, a short circuit test buzzer buzzes at approx. 5Ω or less and thereby makes short circuit checks easy.

2. SPECIFICATIONS

Instrument Name:	Digital Multimeter
Model Number:	Model 1505
Measuring Functions:	DC voltage, DC current, AC voltage, AC current, and resistance
Measuring System:	Double integration system
Indications:	LCD 3-1/2 disits
	Maximum effective display value: 1999
	Low battery indication ◄
	Polarity indication: Automatic (minus sign alone)
	Over-range indication: Lower three digits disappear.
Sampling Rate:	Approx. 2.5 times/sec
Ambient Temperature and Humidity:	0°C to 40°C (32°F to 104°F), less than 80% RH
Temperature Coefficient:	±(Accuracy + 0.05%/°C)
Storage Temperature:	-25°C to 60°C (-13°F to 140°F)
Power Supply:	9V dry battery (006P) Approx. 2.5 mA
Dimensions:	88 (W) x 38 (H) x 180 (D) mm (3.46 W x 1.50 H x 7.09 D in.)
Maximum Dimensions:	94 (W) x 38 (H) x 180 (D) mm (3.70 W x 1.50 H x 7.09 D in.)
Weight:	Approx. 320 g (11 oz.)

Accessories:	Instruction manual	1
	Test leads	1 set
	Battery (006P 9V)	1
	Fuse 2A	1
	Stand	1

DC voltage measurement:

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Input resistance	Maximum input voltage
200mV	±(0.35% of rdg + 1dig)	100µV	10MΩ	1100V peak
2V		1mV		
20V	±(0.5% of rdg + 1dig)	10mV		
200V		100mV		
1000V		1 V		

AC voltage measurement:

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Input resistance	Maximum input voltage
200mV	40Hz to 500Hz ±(1% of rdg + 5dig)	100µV	10MΩ (100pF or less)	DC 1000V AC 850Vrms
2V		1mV		
20V		10mV		
200V		100mV		
750V		1V		

DC current measurement:

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Voltage drop between terminals	Overcurrent protection
200µA	±(1% of rdg + 3dig)	0.1µA	250mV or less	Fuse 2A
2mA	±(1% of rdg + 1dig)	1µA		
20mA		10µA		
200mA		100µA		
2000mA	±(1.5% of rdg + 1dig)	1mA	0.7V or less	
10 A		10mA		NO PROTECT

AC current measurement:

Range	Accuracy 23°C±5°C (73.4°F±9°F) 40Hz - 500Hz	Resolution	Voltage drop between terminals	Overcurrent protection
2mA	±(3% of rdg + 5dig)	1μA	250mV or less	Fuse 2A
20mA	±(2% of rdg + 5dig)	10μA		
200mA		100μA		
2000mA		1mA	0.7V or less	
10 A		10mA		NO PROTECT

Resistance measurement:

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Maximum measurement current	Open-terminal voltage	Maximum allowable input voltage
200Ω	±(1% of rdg + 3dig)	0.1Ω	1.2mA	3.2V or less	250V AC/DC
2K	±(1% of rdg + 2dig)	1Ω	1.2mA		
20K		10Ω	320μA		
200K		100Ω	32μA		
2000K	±(1.5% of rdg + 2dig)	1kΩ	3.2μA		
20M	±(2% of rdg + 2dig)	10kΩ	320nA		

Short Circuit Test Buzzer: 200Ω range

Buzzes at approx. 5Ω or less.

3. OPERATING METHOD

3-1. Explanation of Front and Rear Panels

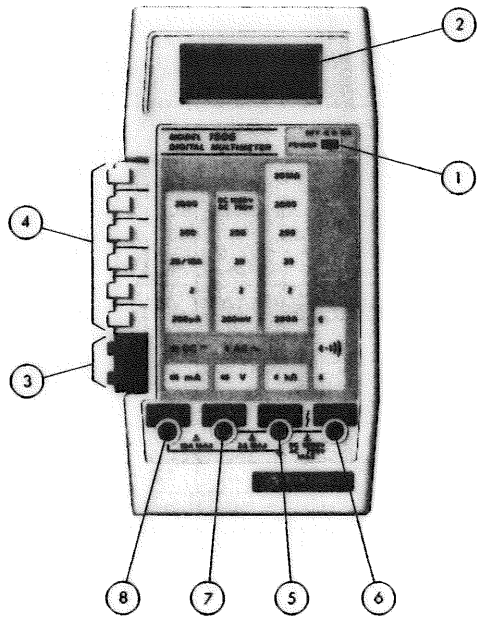

Figure 3-1-A

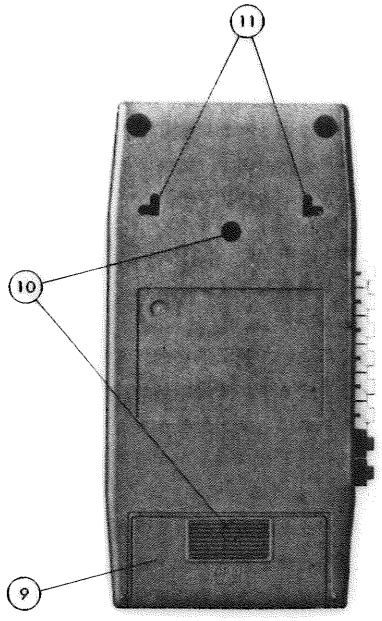

Figure 3-1-B

① POWER: AC main power ON-OFF switch.

② READOUT: The LCD works to display digits from 000 up to 1999 (3-1/2 digit decimal display). In the case of excessive input, "1", the most significant digit, alone is displayed and other digits disappear. In accordance with range setting, the decimal point moves and the corresponding unit of measure (mV, V, μA, mA, Ω, kΩ, or MΩ) is displayed. A minus sign "-" is displayed for a negative DC voltage or current input. A warning indicator lights up when the battery is low.

③ FUNCTION SWITCH: Pushbuttons for selecting measuring signals.

⌜ DC⎓ AC~ ⌟

Depress and lock this button for AC voltage or current measurement. Release this button for DC voltage or current measurement. The short circuit buzzer works when this switch and the switch for 200Ω range in Ω mode are depressed and locked.

⌜ mA V kΩ ⌟

Depress and lock this button for resistance measurement. Release this button for voltage and current measurements.

④ RANGE SWITCH: Pushbuttons for selecting measuring ranges. The figures noted on the right hand side refer to full-scale values of voltage, current and resistance ranges. These buttons are used, in conjunction with the FUNCTION selector buttons of ③, to select appropriate measuring ranges. The unit of measure varies with the range setting.

⑤ COM Terminal: This terminal is commonly used for all types of input. Although connected to the ground line of the instrument circuits, this terminal is isolated from the casing, thereby making floating voltage measurement possible. The withstanding voltage with respect to the casing ground is 500V DC or 500V rms AC.

⑥ V/kΩ Terminal: Input terminal for voltage and resistance measurements. Connect the test leads to this terminal and to the COM terminal for voltage and resistance measurements.

⑦ 2A Terminal: Connect the test leads to this terminal and to the COM terminal for current measurement.

⑧ 10A Terminal: Apply current to this terminal and to the COM terminal for current measurement from 2A up to 10A. The attached test leads cannot be used.

⑨ Battery Cover: Covers the battery and fuses. For battery or fuse replacement, move this cover in the direction indicated by the arrow (⇨) and lift off.

⑩ CASE Screws:

Remove these two screws to remove the CASE.

⑪ Stand holes: Install the stand whenever necessary.

3-2. Preparation for Measurement

1: Make certain that the power switch on the front panel is set to OFF when power is supplied. A dry battery of 9V(S-006P) or the optional AC adapter may be used to power the instrument.

2: Avoid using this instrument in such an environment where ambient temperature varies rapidly.

3: If the display is unstable with the use of AC power, change to battery operation.

4: Turn on the power switch for instrument operation. Make sure to turn off the switch after measurement completion.

5: The attached test leads are used to measure currents up to 2A. With the appropriate test leads, measurements of up to 10A are possible.

6: Service time of the dry battery is approx. 150 hours in voltage mode. Replace the dry battery with a new one when the low battery indicator is observed.

3-3. Replacement of The Dry Battery or of Fuses

1: An arrow mark (◀▬) on the LCD lights up when the dry battery is low. In such a case, immediately replace the battery.

2: Should excessive current flow between the mA terminal and the COM terminal, the fuses will blow out, thus protecting the multimeter. Should current measurement not be possible, inspect the fuses.

3: For battery and fuse replacement or fuse inspection, push OPEN on the battery cover and slide the cover downward in the direction indicated by the arrow as shown in Figure 3-2.

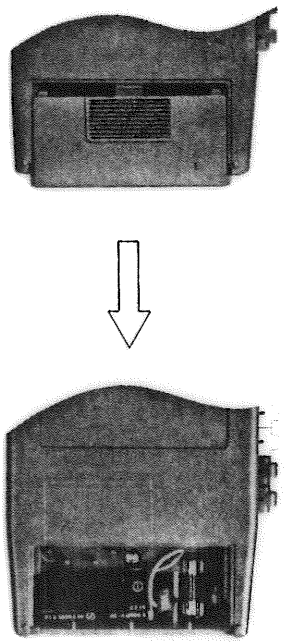

Figure 3-2

3-4. Measuring Procedures

3-4-1. DC Voltage Measurement

(1) Set the AC/DC selector switch to DC, depress the V.ma button of the V.mA/kΩ selector switch, and set the RANGE selector at a range suitable for the voltage to be measured.

(2) Connect the test leads (provided as accessories) to the COM terminal and to the V/kΩ terminal.

(3) If the level of the voltage to be measured is unpredictable, set the RANGE selector at the highest range, and then gradually lower the ranges until the readout displays a value lower than 1999.

3-4-2. DC Current Measurement

(1) Set the FUNCTION selector in the DC and V.mA states, and set the RANGE selector at a range suitable for the current to be measured.

(2) Connect the test leads to the COM and 2A terminals.

(3) If the level of the current to be measured is unpredictable, start measuring with the 2A range.

(4) When the current to be measured is from 2A to 10A, connect the test leads to the COM and 10A terminals and set the RANGE selector to 10A.

(5) When the current to be measured is more than 2A, the supplied test leads cannot be used. Perform the measurement using test leads that withstand the current to be measured.

3-4-3. AC Voltage Measurement

(1) Set the AC/DC selector in the AC state and depress the V.mA button of the V.mA/kΩ selector. Set the RANGE selector at a range suitable for the voltage to be measured.

(2) Connect the test leads to the COM and V/kΩ terminals.

(3) If the level of the voltage to be measured is unpredictable, set the RANGE selector at the highest range and then gradually lower the ranges until the readout displays a value lower than 1999.

3-4-4. AC Current Measurement

(1) Set the FUNCTION selector in the AC and V.mA states, and set the RANGE selector at a range suitable for the current to be measured.

(2) Connect the test leads to the COM and 2A terminals. If the level of the current to be measured is unpredictable, start measuring with the 2A range.

(3), (4) Follow the procedures stated in (4) and (5) in section 3-4-2 DC Current Measurement.

3-4-5. Resistance Measurement

(1) Set the V.mA/kΩ selector to kΩ and set the RANGE selector at a range suitable for the resistance to be measured. In this case, the AC/DC selector may be set to either AC or DC. However, in some cases, the buzzer sounds at the 200Ω range when AC is selected. (see section 3-4-6 for further information.)

3-4-6. Short Circuit Check with the Buzzer

(1) Set the FUNCTION selector to kΩ and the RANGE selector to 200Ω. In this case, the DC/AC ·))) selector is used as the ON/OFF switch for the buzzer. Set this switch to AC shown with the mark ·))).

(2) Connect the test leads to the COM and V/kΩ terminals for short circuit check. The buzzer sounds when the resistance to be measured is 5Ω or less. In addition, the value indicated shows resistance for short circuit.

NOTE: Since the open-terminal voltage for resistance measurement is approx. 2.8, exercise care when checking the circuits composed of a semiconductor such as a transistor, an IC, etc,.

4. OPERATING PRINCIPLE

4-1. Measuring Principle

(refer to the block diagram of Figure 4-1.)

The 1505 Digital Multimeter is basically a DC voltmeter. Therefore, for AC voltage measurement and resistance measurement, the input signal is first converted into a DC signal.

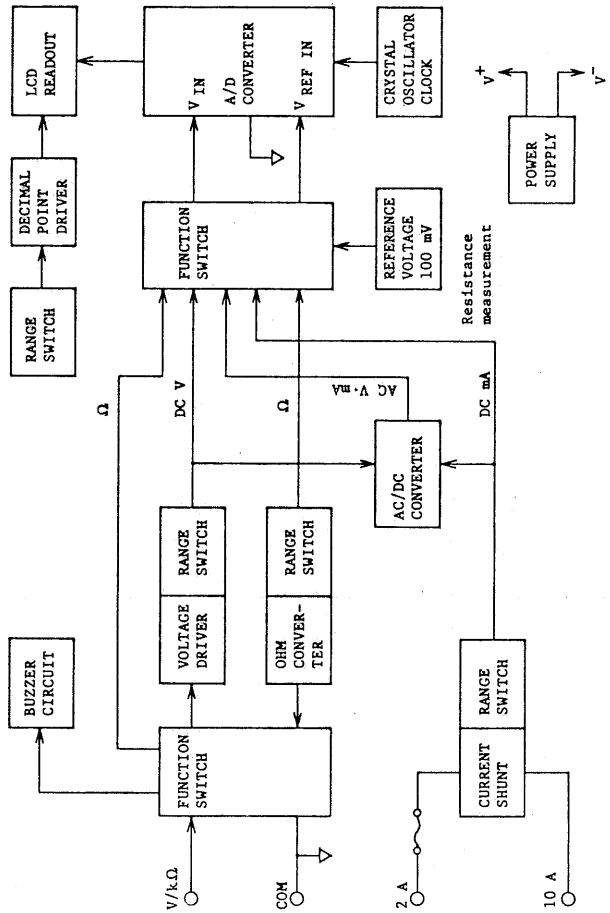

Figure 4-1

4-2. Voltage Measurement

DC and AC voltages are fed through the voltage divider and are permitted by the range switch to go as high as 200mV. The DC voltage is sent directly to the A/D converter. However, the AC voltage is converted into DC voltage by the AC/DC converter, and this DC voltage is sent to the A/D converter.

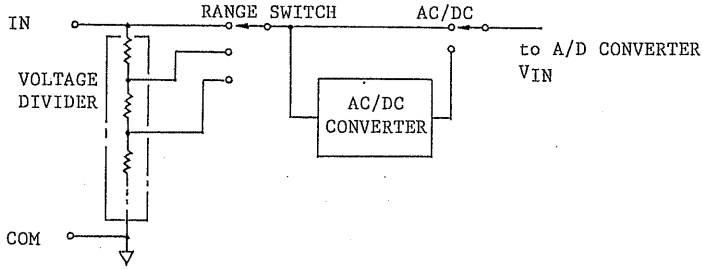

Figure 4-2

4-3. Current Measurement

DC and AC currents are fed through the current shunt and are permitted by the range switch to be as high as 200mV. The DC current is sent directly to the A/D converter. However, the AC current is converted into DC voltage by the AC/DC converter, and this DC voltage is sent to the A/D converter.

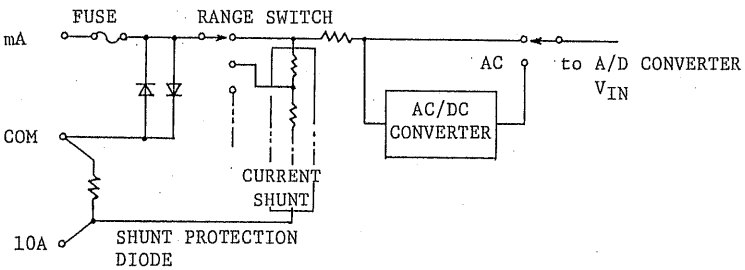

Figure 4-3

4-4. Resistance Measurement (OHM converter)

The ohm converter measures resistance by calculating the ratio between reference voltage V_{REF} and measured voltage V_{IN} input in the A/D converter. The ratio is given by,

$$\text{Indication} = \frac{V_{IN}}{V_{REF}} = \frac{V_X}{V_S} = \frac{R_X}{R_S} ,$$

where R_S is a reference resistor. In multimeter circuit, the reference resistors are used as voltage dividing resistors for voltage measurement.

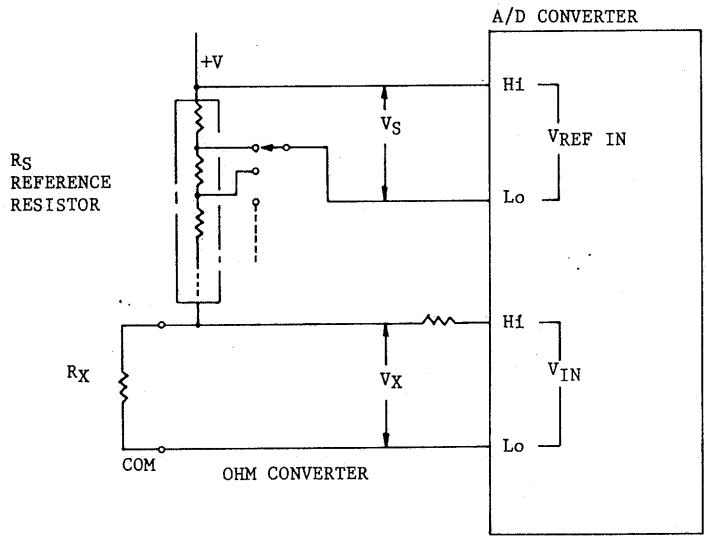

Figure 4-4

4-5. AC/DC Converter

This device consists of an operational amplifier and a rectifier. It converts the AC voltage input signal into a DC voltage output signal with a high conversion linearity.

4-6. A/D Converter

This A/D converter is a monolithic C-MOS LSI which contains a integrator, a LCD driver circuit, a reference voltage generator circuit, and a clock circuit, necessary for digital display of analog input signals. The output signal of 40kHz generated by the Crystal OSC clock is frequency-divided to provide three converter cycles for one measurement: that is, for auto-zero, signal integration, and inverse integration. In addition, it is designed to achieve 2.5 accurate readouts per second and thus permits a high noise reduction efficiency with a line frequency of 50Hz or 60Hz.

5. MAINTENANCE

5-1. Removing the Casing

Remove the two clamping-screws on the rear panel.

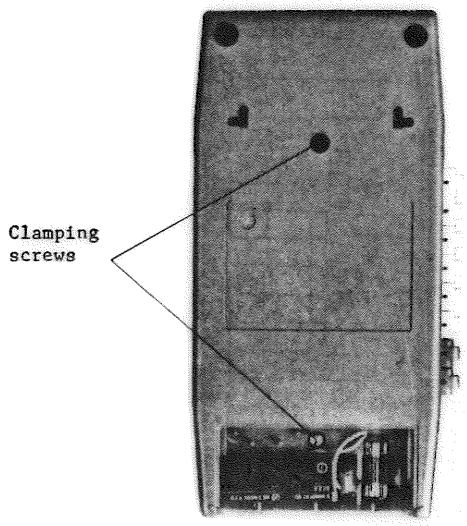

Figure 5-1

5-2. Layout of Adjusting Items

Layout of the adjusting items is shown in Figure 5-1.

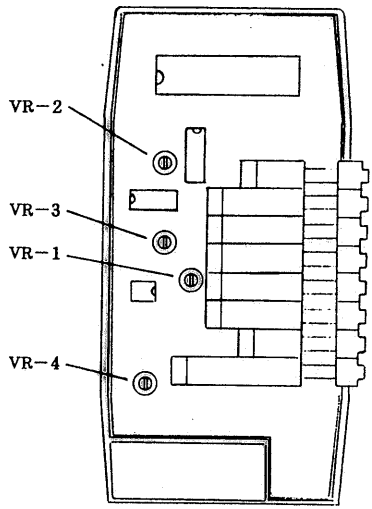

Figure 5-2

5-3. Calibration

The instrument should be periodically inspected and calibrated in order to maintain high performance of the instrument for a long period. Calibration should be done in a stable atmospheric temperature of approximately 23°C (73.4°F). Allow more than 30 minutes for stabilization after start-up.

5-3-1. DC Voltage Range Calibration

(1) Set the FUNCTION selector in the DC and V.mA states, set the RANGE selector to 200mA, short the input terminals, and make sure that the readout displays 00.0.

(2) Set the output voltage of a standard DC voltage generator (accuracy 0.05% or more) at +190.0mV and apply this voltage to the input terminal of this multimeter. Adjust the VR-4 so that the multimeter indicates 190.0.

(3) Change the RANGE selector of the multimeter over to 2V, set the standard voltage generator to 1.900V, and apply this voltage to the input terminal of the multimeter. Adjust the VR-1 so that the multimeter indicates 1.900.

5-3-2. AC Voltage Range Calibration

(1) Set the FUNCTION selector in the AC and V.mA states, set the RANGE selector to 200mV, set the output voltage of a standard AC voltage generator at 190.0mV with 100Hz, and apply this voltage to the input terminal. Adjust the VR-3 so that the multimeter displays 190.0.

5-3-3. Check of Measuring Ranges

(1) When the instrument calibration is through, inspect the measuring ranges of the instrument following Tables 5-1 to 5-5.

Table 5-1 DC voltage check

Range	Input	Readout
20V	+19.00V	18.90 - 19.10
200V	+190.0V	189.0 - 191.0
1000V	+1000V	995 - 1005
Standard instrument: Standard DC voltage generator (accuracy 0.05% or more)		

Table 5-2 AC voltage check

Range	Input	Frequency	Readout
2V	1.900V	100Hz	1.876 - 1.924
20V	19.00V	100Hz	18.76 - 19.24
200V	199.0V	100Hz	187.6 - 192.4
1000V	1000V	100Hz	985 - 1015
Standard instrument: Standard AC voltage generator (accuracy 0.1% or more)			

Table 5-3 DC current check

Range	Input	Readout
200μA	190.0 A	187.8 - 192.2
2mA	1.900mA	1.880 - 1.920
20mA	19.00mA	18.80 - 19.20
200mA	190.0mA	188.0 - 192.0
2000mA	1900 mA	1871 - 1929
10 A	10.00 A	9.84 - 10.16
Standard instrument: Standard DC current generator (accuracy 0.1% or more)		

Table 5-4 AC current check

Range	Input	Frequency	
2mA	1.900mA	100Hz	1.838 - 1.962
20mA	19.00mA	100Hz	18.57 - 19.43
200mA	190.0mA	100Hz	185.7 - 194.3
2000mA	1900mA	100Hz	1857 - 1943
10 A	10.00 A	100Hz	9.75 - 10.25
Standard instrument: Standard AC current generator (accuracy 0.1% or more)			

Table 5-5 Resistance check

Range	Input	Readout
200 Ω	shorted	00.0 - 00.2
200 Ω	190.0 Ω	187.8 - 192.2
2kΩ	1.900kΩ	1.880 - 1.920
20kΩ	19.00kΩ	18.80 - 19.20
200kΩ	190kΩ	188.0 - 192.0
2000kΩ	1900kΩ	1870 - 1930
20MΩ	19.00MΩ	18.60 - 19.40
Standard device: Standard resistors (accuracy 0.05% or more)		