INSTRUCTION MANUAL

DIGITAL MULTIMETER

MODEL 1502

KIKUSUI ELECTRONICS CORPORATION

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1. GENERAL

Kikusui Model 1502 Digital Multimeter is a multiple-purpose digital voltmeter which measures DC and AC voltages and currents, and resistance also. It is incorporated with full safety features including overvoltage input protection for all ranges.

The maximum display value of the digital readout is 1999.

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

The measuring sensitivity is high and the instrument covers wide measuring ranges. Namely, the measuring ranges of DC and AC voltages are 100 μV - 1000 V, DC and AC currents 0.1 μA - 1000 mA, and resistance 0.1 Ω - 19.99 MΩ. When the Ω-Lo range is selected for resistance measurement, the maximum open-terminal voltage is 0.5 V. This range may be used when resistance measurement with a lower open-terminal voltage than that of the Ω-Hi is required.

The instrument employs a double-intergration system for measurement. As the automatic zero erase circuit is incorporated, the instrument requires no zero adjustment and ensures reliable measurement.

Employing ICs and LEDs, the instrument is compact, light, and consumes less power, while ensuring a high operation reliability.

The input circuit is floated from the casing, enabling safer measurement of a voltage between two points which are floated from the ground.

2. SPECIFICATIONS

Instrument name: Model 1502 Digital Multimeter

Measuring functions: DC voltage, DC current, AC voltage, AC current, and resistance

Measuring system: Double integration system

Indications

Display: LED readout
Maximum effective display value: 1999
Polarity indication: Automatic (minus sign alone)
Over-range indication: Lefties "1" digit alone lights and right-hand three digits go off.

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

Storage temperature: -20°C to 70°C (-4°F to 158°F)

Withstanding voltage to ground: 500 V DC, 500 Vrms AC

Power requirements: 100 V, 50/60 Hz AC, approx. 2.7 VA

External dimensions: 180 W × 64 H × 200 D mm
(7.09 W × 2.52 H × 7.88 D in.)

(Maximum dimensions): 180 W × 75 H × 215 D mm
(7.09 W × 2.95 H × 8.47 D in.)

Weight (net): Approx. 1.6 kg (3.5 lb.)

Accessory: Test leads ..... 1 set
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DC voltage measurement

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Input resistance	Maximum input voltage	Temperature coefficient
200mV	±(0.1% of rdg +1 digit)	100 µV	10 MΩ	1100 V peak (5 kV for transient signal)	(Accuracy) ±0.01%/°C
2 V		1 mV			
20 V		10 mV			
200 V		100 mV			
1000 V		1 V			

DC current measurement

Range	Accuracy 23°C±5°C (73.4°F±9°F)	Resolution	Voltage drop between terminals	Overcurrent protection	Temperature coefficient
200 µV	±(0.5% of rdg +1 digit)	0.1 µA	0.25 V or less	Fuse (1 A)	(Accuracy) ±0.01%/°C
2 mA		1 µA			
20 mA		10 µA			
200 mA	±(0.8% of rdg +1 digit)	100 µA	0.35 V or less		
1 A		1 mA	0.7 V or less		

AC voltage measurement

Range	Accuracy 23°C±5°C (73.4°F±9°F)				Resolution	Maximum input voltage
	40-500Hz	500-1kHz	1kHz-2kHz	2kHz-5kHz		
200mV	±(0.5% of rdg +4 digits)	±(0.75% of rdg +4 digits)			100 µV	1100 V rms
2 V					1 mV	
20 V			±(5% of rdg +6 digits)		10 mV	
200 V					100 mV	
1000 V	±(0.75% of rdg +4 digits)				1 V	

Average-value measurement

Input impedance: 10 MΩ, with 200 pF or less

Temperature coefficient: (Accuracy)±0.01%/°C

AC current measurement

Range	Accuracy 23°C±5°C (73.4°F±9°F) 40Hz-1kHz	Resolution	Voltage drop between terminals	Overvoltage protection	Termperature coefficient
200 µA	±(1% of rdg +4 digits)	0.1 µA	0.25 Vrms or less	Fuse (1A)	(Accuracy) ±0.01%/°C
2 mA		1 µA			
20 mA		10 µA			
200 mA	±(1.2% of rdg +4 digits)	100 µA	0.35 Vrms or less		
1 A		1 mA	0.7 Vrms or less		

Resistance measurement

Range	Accuracy 23°C±5°C (73.4°F±9°F)		Resolution	Maximum measuring current	
	Hi	Lo		Hi	Lo
200 Ω	±(0.4% of rdg +1 digit) +0.2		0.1 Ω	1.2 mA	
2 kΩ	±(0.3% of rdg +2 digits)	±(0.6% of rdg +2 digits)	1 Ω	1.2 mA	120 µA
20 kΩ			10 Ω	320 µA	50 µA
200 kΩ			100 Ω	32 µA	5 µA
2000 kΩ			1 kΩ	3.2 µA	500 nA
20 MΩ	±(0.75% of rdg +2 digits)	±(1% of rdg +2 digits)	10 kΩ	320 nA	50 nA

Maximum allowable input voltage: 250 V DC/rms

Open-terminal voltage: Hi 3.2 V, Lo 0.5 V

Temperature coefficient: (Accuracy)±0.01%/°C

3. OPERATION METHOD

3-1. Explanation of Front Panel

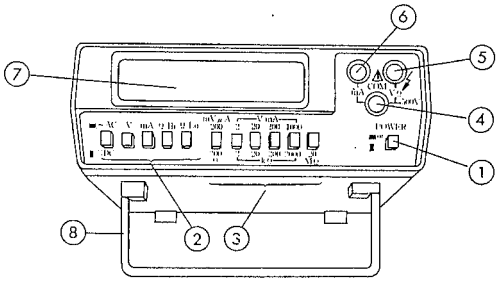

Figure 3-1

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 SELECTOR BUTTONS: Pushbuttons for selecting measuring ranges.

"⎓ ~ AC, ⎓ DC" button:

Depress and lock this button for AC voltage or current measurement. Unlock this button for DC measurement.

"V" button: Depress and lock this button for voltage measurement.

"mA" button: Depress and lock this button for current measurement.

"Ω-Hi" button: Depress and lock this button for resistance measurement.

"Ω-Lo" button: Depress and lock this button for resistance measurement with open-terminal voltage not higher than 0.5 V.

③ Range selector buttons: Pushbuttons for selecting measuring ranges. The figures noted at the buttons are full-scale values of voltage, current and resistance ranges. These buttons are used, in conjunction with the FUNCTION selector buttons of ②, to select appropriate measuring ranges.

④ COM terminal: This terminal is used in common for all types of input. Although connected to the ground line of the instrument circuits, this terminal is isolated from the casing for floating voltage measurement. The withstanding voltage with respect to the casing ground is 500 V DC or 500 Vrms AC.

⑤ V·Ω terminal: Input terminal for voltage measurement and resistance measurement. For current measurement, use ⑥ "mA" terminal.

⑥ mA terminal: Input terminal for current measurement. For current measurement, use this terminal and the COM terminal.

⑦ Readout: Readout with LEDs for 000 - 1999 (3-1/2 digit decimal display). When in over-input, "1" of the most-significant digit alone is displayed and other digits go off. 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.

⑧ Stand: Support for tilting the instrument for ease of observation. For storing the instrument or stacking two or more instruments, fold down the stand.

3-2. Explanation of Rear Panel

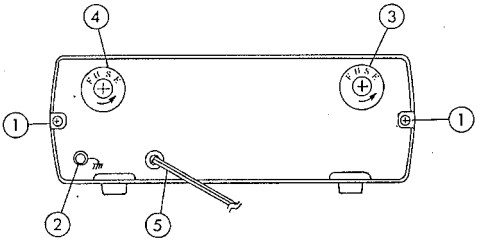

Figure 3-2

① Casing clamping-screws: Clamping-screws of the casing. To remove the casing, remove these screws and pull out the casing backward.

② Ground terminal: For grounding the casing to earth.

③ Fuse holder 1: Overcurrent protection fuse for current measurement. 1 A, 30 mm tubular fuse.

④ Fuse holder 2: Fuse of the input power circuit.

⑤ AC power cord: AC input power cord to be connected to an AC line receptacle (100 V, 50/60 Hz AC).

3-3. Preparations for Measurement

(1) Turn off the power switch on the front panel.

(2) Connect the AC input power cord to an AC line receptacle (100 V, 50/60 Hz AC).

(3) Do not use the instrument in a place where ambient temperature varies rapidly.

(4) The instrument is ready for operation when a few minutes has elapsed after turning on the power switch. If a higher accuracy is required, however, allow a stablization period of approximately 30 minutes or over.

(5) If indication of the display unit is unstable, inverse the insertion of the power plug in the line receptacle.

3-4. Measuring Procedures

3-4-1. DC Voltage Measurement

(1) Set the AC/DC selector switch in the DC state, press the V button of the FUNCTION selector, and set the RANGE selector at a range suitable for the voltage to be measured.

(2) Connect the test leads (supplied as accessories) to the COM and V·Ω 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.

3-4-2. DC Current Measurement

(1) Set the FUNCTION selector in the DC and 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 mA terminals.

(3) If the level of the current to be measured is unpredictable, start measuring with the 1 A range.

3-4-3. AC Voltage Measurement

(1) Set the AC/DC selector in the AC state and press the V button of the FUNCTION 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·Ω 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 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 mA terminals. If the level of the current to be measured is unpredictable, start measuring with the 1 A range.

3-4-5. Resistance Measurement

(1) Press the *Ω-Hi or Ω-Lo button of the FUNCTION selector and set the RANGE selector at a range suitable for the resistance to be measured. The AC/DC button may be in either state.

(2) Connect the test leads to the COM and V·Ω input terminals and measure resistance. If the level of the resistance to be measured is unpredictable, set the RANGE selector at first at 20 MΩ and then gradually reduce the ranges.

(3) If lead wires longer than the accessory test leads are used, pay attention to the resistance of the leadwires when measuring at low ranges or to their insulation resistance when measuring at high ranges.

* Ω-Hi and Ω-Lo in resistance measurement:

Use the Ω-Hi state for regular resistance measurement and silicon semiconductor continuity measurement. This measuring state provides a sufficient voltage for turning on a silicon PN junction.

Use the Ω-Lo state for measurement of "in-circuit" resistance. This measuring state provides a low voltage which does not turn on the silicon PN junction and, therefore, the circuit resistance can be measured with less effect of the semiconductor.

4. OPERATING PRINCIPLE

4-1. Outline of Measuring Principle

The 1502 Digital Multimeter basically is a DC voltmeter. (See the block diagram of Figure 4-1.) For AC voltage measurement and resistance measurement, the input signal is converted into a DC signal. For DC current measurement, the current to be measured is fed through a resistor and the voltage drop across the resistor is measured. For AC voltage measurement the voltage is divided with a voltage divider and for AC current measurement the current is fed through a resistor, and the resultant AC voltage is converted into a DC voltage by an AC/DC converter. For resistance measurement, the signal is converted into a DC voltage signal by an OHM converter (used in common for the voltage divider).

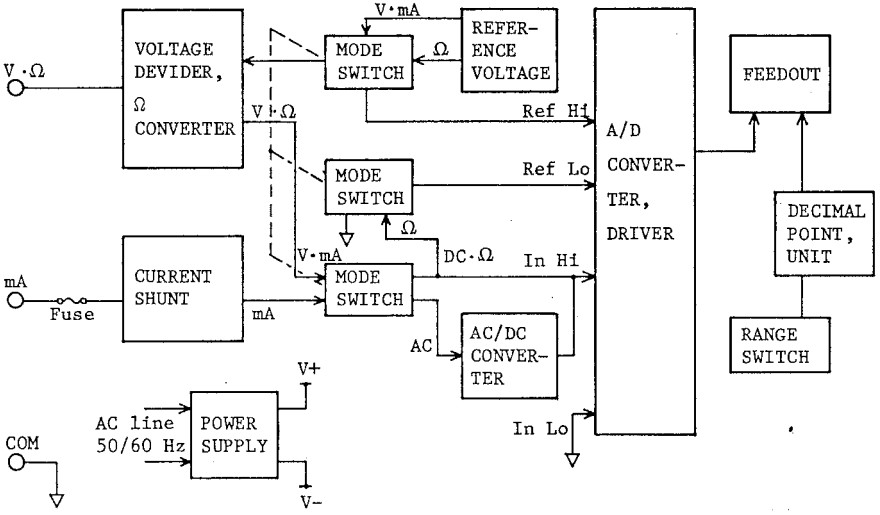

Figure 4-1. Block diagram

4-2. Voltage Divider and Current Shunt

The voltage divider and current shunt are used in common for DC and AC voltage measurements and DC and AC current measurements. For resistance measurement, the voltage-dividing resistors are used as standard resistors for developing voltage drops.

4-3. AC/DC Converter

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

4-4. OHM Converter

The A/D converter, as explained in the next item, measures the input voltage by comparing it with a reference voltage. The ohm converter, as shown in Figure 4-2, measures a resistance (R_X) in terms of change in the ratio between V_{IN} and V_{REF} (Hi), by measuring the resultant signal with the A/D converter. The measurement theoretically is not affected by variation of reference voltage V_{REF}, attaining a high reference voltage rejection ratio.

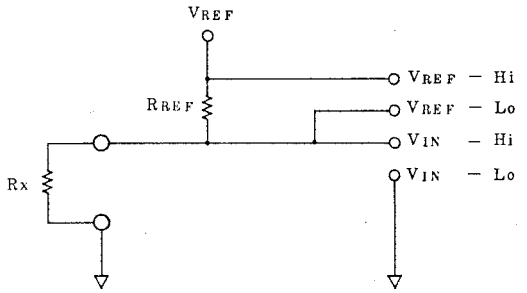

Figure 4-2. Block diagram of the ohm converter

4-5. A/D Converter

The A/D converter employs an LSI which includes a clock circuit, a reference voltage generator circuit, a display driver circuit, and a 7-segment decoder circuit on a single piece of CMOS IC chip. Reduction in the number of components ensures a high reliability.

o System timing:

The output signal of the clock signal oscillator circuit is frequency-divided by 4. The signal is further frequency-divided to provide three converter cycles: for signal integration (1000 counts), inverse integration of reference voltage (0 - 2000 counts), and auto-zero (1000 - 3000 counts). For the auto-zero period, a period in which no reverse interation of the reference voltage is done is used, and 4000 measuring cycles (16000 clock pulses) can be accomplished irrespective of the input voltage.

4-6. Reference Voltage Generator

The reference voltage is used for the AD comverter and ohm converter. The reference voltage is a very stable DC voltage of approximately 2.8 V (with respect to analog common) produced by a zener diode on an LSI chip.

For the reference voltage when in other mode than resistance measurement and the Ω·Lo reference voltage, a stable DC voltage is produced by a circuit consisting of a constant-voltage IC and precision resistors.

4-7. Clock Generator

The clock generator produces a clock pulse signal used for processing of digital signals. The generator is a quartz oscillator circuit of 40 kHz.

4-8. Power Supply

This circuit produces regulated DC powers of +5 V and -5 V for respective circuits of the instrument.

5. MAINTENANCE

5-1. Removing the Casing

Before removing the casing, be sure to disconnect the power cord from the AC line receptacle. Undo the two clamping-screws on the rear panel and pull out slowly the front panel.

5-2. Layout of Adjustments

Layout of the adjustments is shown in Figure 5-1.

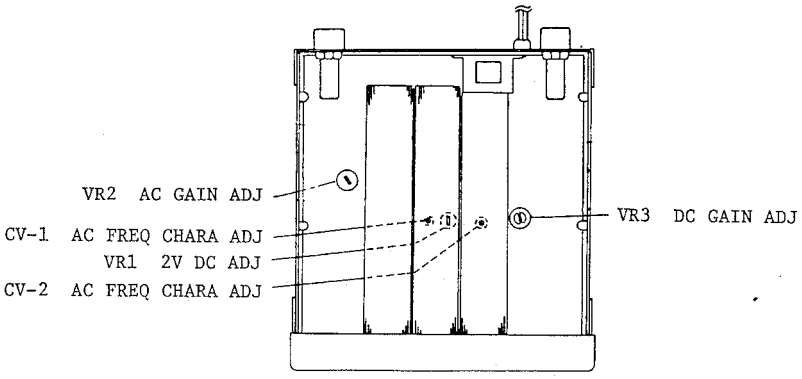

Figure 5-1

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 (73.4°F). 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 follows:

Between Ic 8 output and COM:	Approx. 5 V
Between DZ-2 cathode and anode:	Approx. -5 V

5-3-2. DC Voltage Range Calibration

(1) Set the FUNCTION selector in the DC and V states, set the RANGE selector in the 200 mV state, short the input terminals, and check that the readout displays zero.

(2) Set the output voltage of a standard DC voltage generator (accuracy 0.007% or better) at +199.0 mV and apply this voltage to the input terminal of this multimeter. So adjust VR3 that the multimeter indicates 199.0 mV.

(3) Change the RANGE selector of the multimeter to 2 V, set the standard voltage generator at 1.990 V, and apply this voltage to the input terminal of the multimeter. So adjust the VR1 that the multimeter indicate 1.990 V.

5-3-3. AC Voltage Range Calibration

(1) Set the FUNCTION switch in the AC and V states, set the RANGE selector in the 200 mV states.

(2) Set the output voltage of a standard AC voltage generator (accuracy 0.05% or better) at 199.0 mV 100 Hz and apply this voltage to the input terminal of this multimeter. So adjust VR2 that that the multimeter indicates 199.0 mV.

(3) Change the RANGE selector of the multimetor to 2 V, set the standard voltage generator at 1.990 V 2 kHz.
So adjust the CV-1 that the multimeter indicates 1.990 V.

(4) Change the RANGE selector of the multimeter to 20 V, set the standard voltage generator at 19.90 V 2 kHz.
So adjust the CV-2 that the multimeter indicates 19.90 V.

5-3-4. Check of Measuring Ranges

(1) After the instrument calibration is over, check the measuring ranges of the instrument as shown in Tables 5-2 to 5-6.

Table 5-2. DC voltage check

Range	Input	Readout
20 V	+19.90 V	19.88 - 19.92
200 V	+199.0 V	198.8 - 199.2
1000 V	+1000 V	999 - 1001

Standard instrument: Standard DC voltage generator (accuracy 0.007% or better)

Table 5-3 DC current check

Range	Input	Readout
200 μA	+199.0 μA	198.2 - 199.8
2 mA	+1.990 mA	1.982 - 1.998
20 mA	+19.90 mA	19.82 - 19.98
200 mA	+190.0 mA	188.5 - 191.5
1000 mA	+1000 mA	992 - 1008

Standard instrument: Standard DC current generator (accuracy 0.05% or better)

Table 5-4 AC voltage check

Range	Input	Frequency	Readout
2 V	1.990 V	100 Hz	1.981 - 1.999
20 V	19.90 V	100 Hz	19.81 - 19.99
200 V	199.0 V	100 Hz	198.1 - 199.9
1000 V	1000 V	100 Hz	992 - 1008

Standard instrument: Standard AC voltage generator (accuracy 0.05% or better)

Table 5-5. AC current Check

Range	Input	Frequency	Readout
200 μA	190.0 μA	100 Hz	188.5 - 191.5
2 mA	1,900 mA	100 Hz	1.885 - 1.915
20 mA	19.00 mA	100 Hz	18.85 - 19.15
200 mA	190.0 mA	100 Hz	188.3 - 191.7
1000 mA	1000 mA	100 Hz	990 - 1010

Standard instrument: Standard AC current generator (accuracy 0.07% or better)

Table 5-6. Resistance check

Mode	Range	Input	Readout
Ω-Hi	200 Ω	shorted	00.0 - 00.3
Ω-Hi	200 Ω	199.0 Ω	198.6 - 199.6
Ω-Hi	2 kΩ	1.990 kΩ	1.988 - 1.992
Ω-Lo	2 kΩ	1.990 kΩ	1.988 - 1.992
Ω-Hi	20 kΩ	19.90 kΩ	19.88 - 19.92
Ω-Lo	20 kΩ	19.90 kΩ	198.8 - 199.2
Ω-Hi	200 kΩ	199.0 kΩ	198.8 - 199.2
Ω-Lo	200 kΩ	199.0 kΩ	198.8 - 199.2
Ω-Hi	2000 kΩ	1990 kΩ	1988 - 1992
Ω-Lo	2000 kΩ	1990 kΩ	1988 - 1992
Ω-Hi	20 MΩ	19.00 kΩ	18.89 - 19.11
Ω-Lo	20 MΩ	19.00 kΩ	18.84 - 19.16

Standard device: Standard resistors (accuracy 0.01% or better)