

Section 2
OPERATION

2.1 UNPACKING

The Series 2000 digital multimeter was shipped in a protective packing case which contained the following items:

- One Series 2000 digital multimeter,
- One line cord (3-wire),
- One instruction manual,
- One certificate of traceability to NBS Standards,
- One warranty card, and
- One copy of the test and inspection data for this instrument.

Before discarding the carton, ascertain that all these have been removed.

If the carton showed signs of rough handling or damage, inspect the multimeter carefully and report the damage to the shipping company immediately. Fill out the warranty card as directed and return it to the factory.

2.2 OPERATING CONTROLS AND INDICATORS

The front panel controls and indicators are identified in Figure 2-1 and the functions described in Table 2-1. The rear panel controls are identified in Figure 2-2 and described in Table 2-2.

2.3 POWER CONNECTIONS

The DMM is shipped with the power switch preset for the AC voltage source anticipated in the user area and the setting is recorded on the Test Data

forwarded with the instrument. (In the United States this is 115V.) The AC source selection switch, S201, is located on the rear panel of the DMM, and its setting may be changed, if necessary. Use a small-blade screw driver to set S201 to the proper value as stamped on switch.

2.4 GUARD CONNECTIONS

Instrument construction provides a GUARD circuit connected to the internal shield surrounding the analog and A/D sections of the instrument and isolated from any analog input or external ground. Prior to any measurement, a proper GUARD connection must be made in order to bring the internal shield as close as possible to the voltage potential of the low side of the input circuit. The low side of the input is separated from internal grounds, and is brought out as a front panel connection where it may be connected as required.

The GUARD connection should be made to minimize the common mode currents through the voltage measuring circuit, and it should be connected to the low side as close to the voltage source as possible. If it is not feasible to connect at the source, make the connection between GUARD and the low side of the input at the DMM front panel.

Table 2-1

FRONT PANEL CONTROLS AND INDICATORS

NOTE

Complete operating instructions follow the description of controls and indicators.

Fig. Ref.	Control/Indicator	Description	Function
1.	ON	Push-push switch & light indicator	Applies AC power to the unit from the connected source.
2.	DC	Push switch & light indicator	Selects DC voltage measurement mode of DMM operation. Is interlocked with other modes so that it is pushed out upon selection of another mode.

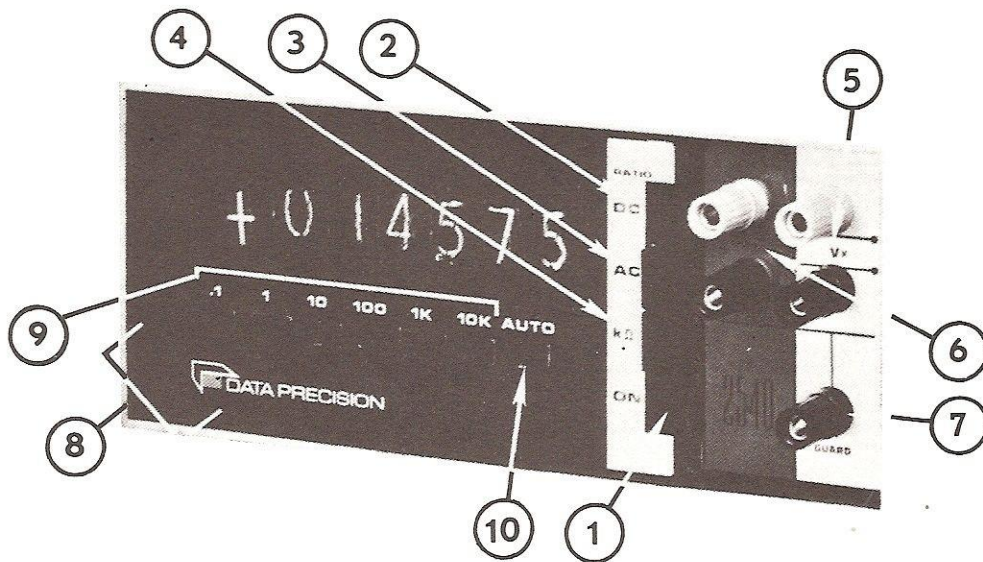


Figure 2-1. MODEL 2500 DMM Front Panel Controls and Indicators

Table 2-1 (Continued)

FRONT PANEL CONTROLS AND INDICATORS

Fig. Ref.	Control/ Indicator	Description	Function
3.	AC	Push switch & light indicator	*Selects AC voltage measurement mode of DMM operation. Is interlocked with other modes so that it is pushed out upon selection of another mode.
4.	k Ω	Push switch & light indicator	*Selects resistance measurement mode of DMM operation. Is interlocked with other modes so that it is pushed out upon selection of another mode.
5.	V _x	Two 5-way binding posts	Connection for input voltage, AC or DC, or resistance.
6.	R _x	Two 5-way binding posts	Current source and sink terminals for resistance connection. Connection for voltage ratio reference input.
7.	GUARD	One 5-way binding post	External connection to guard shield.
8.	DISPLAY	NIXIE Tube indicators	Displays digital readout for a maximum of 120000. Decimal point is selected automatically and appears in the appropriate NIXIE tube to indicate value of a direct reading. Sign is displayed automatically when in DC measurement mode.
9.	<u>RANGE DC</u> 0.1 1 10 100 1000 10000	Push switch for manual range selection	Selects value of full scale range to be used by DMM in measuring input. Is interlocked so that only one may be in at a time. 0.1 for use with option A1/A2. 10000 for use with k Ω function only.
10.	AUTO	Push switch for automatic range selection	Initiates DMM operation to locate range for which the input signal will be measured between 10% and 120% of full scale.
*If function is not included in instrument, switch can not be depressed.			

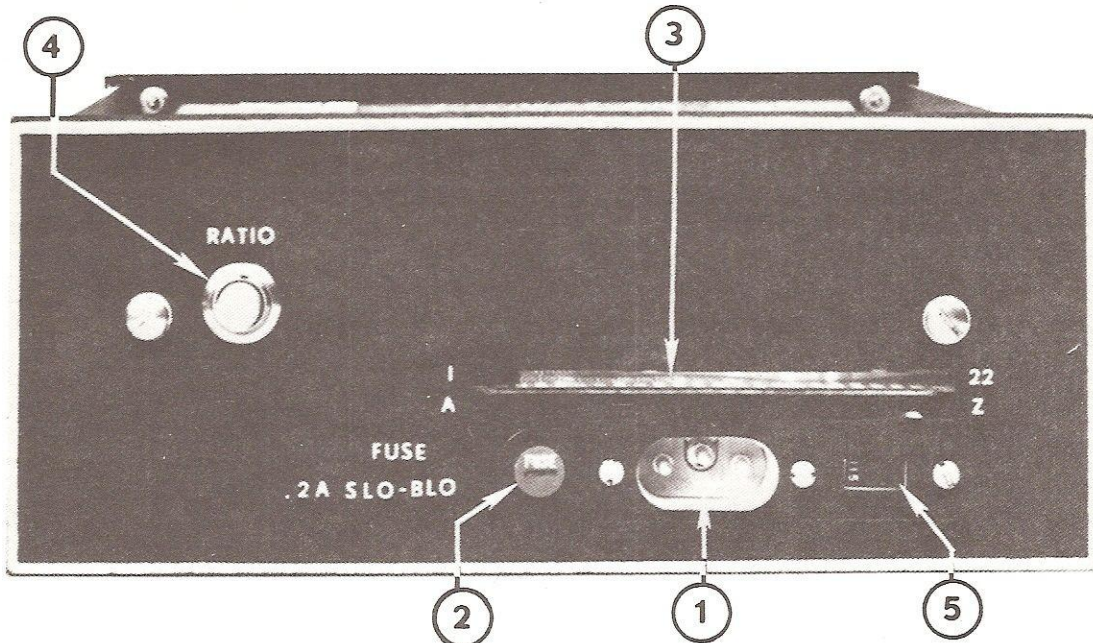


Figure 2-2. MODEL 2500 DMM Rear Panel Controls and Indicators

Table 2-2 REAR PANEL CONTROLS AND INDICATORS			
Fig. Ref.	Control/Indicator	Description	Function
1.	POWER	3-conductor connector	Connector for line cord.
2.	FUSE	Receptacle and holder	For a 2/10 amp slow-blow line fuse.
3.	REMOTE	PC Connector	Provides digital output of measured value, indicates selected range of operation, and provides input for remote control of range and remote triggering of DMM operations.
4.	RATIO	Push-push switch	Selects ratio mode of multi-meter operation in which external source is used instead of the internal reference.
5.	LINE VOLTAGE SWITCH	115/230V switch	Connects proper transformer voltage taps so that Series 2000 will work in user area.

2.5 RANGING

a. Manual Ranging

The DMM is a direct reading instrument in any voltage or resistance range setting, and displays ten times the actual when making Ratio measurement. When anyone of the fixed ranges is chosen, the display will automatically indicate correct polarity of high input terminal referred to low (in DC), and will read the input voltage to 5-1/2 significant figures (up to 119999). An out-of-range input signal will result in two effects simultaneously --

1. A 120000 reading on the display (and decimal point).
2. A blinking "1" in the most significant digit.

When the DMM is switched to the correct range, the reading will be steady at less than 120000.

Zero's in the most significant digits indicate that the full scale range may be decreased. Full resolution capability of the instrument is being used when the reading is between 010000 and 119999, 10% to 120% of full scale, with proper decimal point location.

b. Auto Ranging

When Auto Range is chosen, the meter will automatically settle at that range wherein the reading is between 10% and 120% of full scale.

At the end of each conversion, the range sensing circuit interrogates its result to determine whether the answer is above 119999 or below 010000. If above 119999, the ranging circuit starts the next conversion at the highest range scale. At the end of the succeeding conversion, if the reading is below 010000, the auto-range circuit drops the range one level and performs the next cycle conversion. The DMM reduces the range scale one level at a time, until the reading is obtained on scale between 010000 and 1200000.

Decimal point indication on the display follows the range change to keep the result direct reading. As soon as an on-scale reading is reached, the result may be read. Note that each reading is discrete and independent and is complete measurement in itself.

2.6 ZEROING

In all modes of operation, the Model 2500 DMM instruments self-adjust for zero, and no zero-adjustment is required.

NOTE

If no input is connected to the instrument and a sensitive range is selected, spurious readings may appear because of the high impedance input. These are of no consequence and do not indicate any incorrect performance when the instrument is properly connected for use.

2.7 VOLTAGE MEASUREMENTS
(Operating Instructions for Making Voltage Measurements)

a. General

The same procedure is used in AC voltage and DC voltage measurements. Precautions to avoid pickup and stray signals should be strictly observed because high frequency spurious inputs may be mistaken for acceptable signals in the AC measuring mode. Refer to paragraph 2.4 for information on GUARD connection. If possible, enclose both input leads in a shield and connect the shield to GUARD at the instrument end, and to the low side of signal at the source end.

b. Procedure

(See paragraph 2.8 for Ratio.)

1. Select appropriate voltage measurement mode, AC or DC.
2. Connect input circuit to V_x (Figure 2-3).
3. Make appropriate GUARD connections.

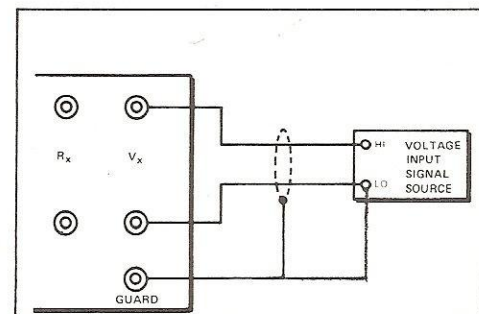


Figure 2-3. Voltage Measurement Connections

4. a) If using Manual Ranging (paragraph 2.5 a.), select most sensitive range that does not cause DMM to indicate an overrange condition. This will utilize full 5 digits of DMM resolution capability.

b) If using Auto Ranging (paragraph 2.5 b.), wait until display stabilizes at on-scale range before reading.

c. Waveform and Error Comments-AC Mode

In measuring input AC voltages, the DMM circuitry blocks any incoming DC, and the instrument operates within specification accuracy for any superimposed DC voltage up to 500 volts. The DMM measures the average value of one-half cycle of the resulting AC waveform, and calibrates the output display in RMS of an equivalent sine wave.

2.8 VOLTAGE MEASUREMENTS (RATIO)

a. General

Series 2000 DMM will measure the ratio of any AC or DC voltage within normal operating limits referenced to an external DC reference voltage between +1 volt and +11 volts. The displayed ratio value will be 10 times the true ratio.

b. Procedure

1. Press RATIO push button at Rear Panel (Figure 2-2). Observe corresponding lamp lighted on front panel.
2. Select appropriate AC or DC mode. Observe corresponding lamp lighted on front panel.
3. Select appropriate manual range or auto range.
4. Install links as shown in Figure 2-4.

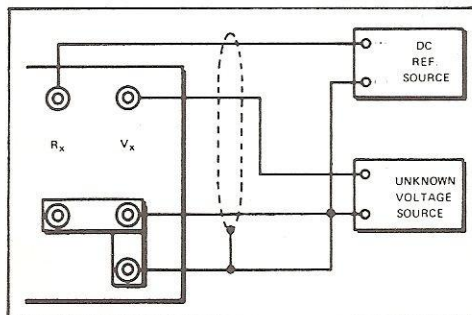


Figure 2-4. DMM Connections for RATIO Measurement

5. Connect voltage input signal to the front panel Vx connectors as in Figure 2-4.

6. Connect the reference voltage input signal to the front panel Rx connectors as shown in Figure 2-4.

7. Read output after display is stable. Divide by 10 to obtain true ratio of unknown to known reference. Sign of display reading will indicate relative polarity of applied voltages for DC inputs.

2.9 RESISTANCE MEASUREMENT

a. General

The Series 2500 DMM measures any resistor between 1.19999 k Ω full scale and 11.9999 megohms full scale and offers full four-wire measurement capability to achieve the specified accuracy. (Series 2400, 1.1999 k Ω - 11.999 megohms full scale.) For rapid measurements, where extreme accuracy is not necessary, the convenience of two-wire resistance measurements is also afforded.

b. Four-Wire Measurements

1. Select k Ω measurement mode. Observe that appropriate lamp is lighted at front panel.
2. Connect the Vx terminals to inner connection points, A, of the unknown resistor as shown in Figure 2-5.
3. Connect the current source and sink to the outer connection points, B, of the unknown resistor as shown in Figure 2-5.
4. Connect GUARD to the low side (current sink) of the circuit as shown in Figure 2-5.
5. Select appropriate manual or auto range switch for expected resistance. Note that highest range of 10000 is available in resistance measurement mode.

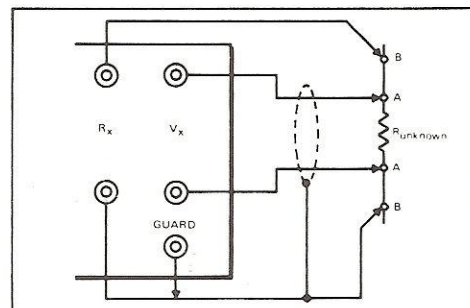


Figure 2-5. Four-Wire Resistance Measurement

6. Observe display. As soon as decimal point location is stable, a correct reading may be made. An over range condition will result in a blinking indication as in voltage measurements (see paragraph 2.5 a.).

7. When measuring high resistance values, it is desirable to shield the resistor through to the connections A and B to reduce the effects of any spurious voltage.

c. Two-Wire Measurements

When making two-wire resistance measurements, connect the unknown resistance and the current source and sink to the connection points as shown in Figure 2-6. Perform the measurement as in steps 4. through 7. in paragraph 2.9 a., above.

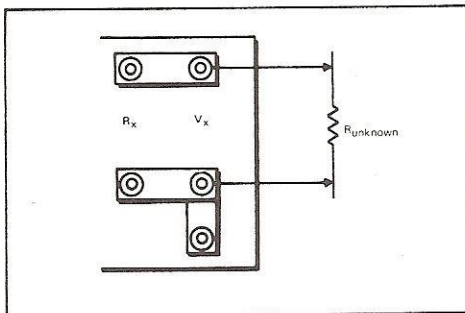


Figure 2-6. Two-Wire Resistance Measurement

2.10 REMOTE OPERATION

a. Set-Up

To obtain remote control and to transmit data from Series 2000 DMM --

1. Prepare a cable with 44-pin connector VIKING 2VK22D/1-3 or equivalent, and cabled as shown in Table 2-3.

2. Remove protective covering from the PC Board connector at Rear Panel and connect cabled connector.

b. Output Signals Specifications and Applications

1. Data Output - Parallel format of five binary-coded decimal digits and sign are transmitted with DTL/T²L compatibility. Logic is positive true:

Logic "1" +2.4V
Logic "0" +0.4V sink for
4 mA

Polarity positive is logic "1".

Signals remain as latched on output lines between conversions.

2. Range scale in use is indicated by logic "0". Inactive ranges are logic "1"'s.

(Decimal point is indicated by range in use.)

3. End of Conversion (EOC) is indicated by positive going transition of voltage on EOC line, at which time (during transition), the data output is being updated. The negative going voltage transition of the EOC output signal occurs at the start of conversion in each measurement cycle and serves as a forewarning of the positive going transition (and upcoming data update) to occur after 100 milliseconds and within 220 milliseconds thereafter.

4. Overload - A zero logic level on this line indicates the input of a signal more than 120% of the selected full scale range, necessitating a range change. This output thus serves to indicate existence of incorrect data on the output lines and may be used to inhibit input of incorrect data to receiving printers, computers, etc. It also has a short negative pulse at EOC.

c. Remote Control

1. General - In order to exercise external trigger control of Series 2000 DMM, ALL front panel range switches must be placed in the open (non-selected) position.

2. External Trigger - Application of a 2.4V positive voltage pulse between 1 usec and 100 millisecc wide causes the instrument to initiate the measurement cycle and to update the data output until the next trigger command. The BCD data remains on the output lines between updates, permitting computer processing or printing (logging), and the repetition rate of the external trigger may be adjusted to allow the necessary time between data updates for data receptors to complete their processing (printing, computer input, editing, etc.).

It is also possible to operate range control remotely and internally trigger:

- Set range switches to Open.
- Choose range by grounding proper line.
- Correct trigger enable (pin J) to external trigger (pin 21) to rear panel.

It is also necessary to select the range to be used by grounding the appropriate line (either logic level or direct ground).

3. Trigger ENABLE - Logic zero state inhibits conversions when unit is triggered from internal source.

When the level is changed to logic "1" on the ENABLE line, the instrument will make a conversion at the next appearance of a positive pulse or at the next succeeding trigger pulse.

Table 2-3

REMOTE CONTROL/OUTPUT CABLE			
A	Ground	1	Ground
B	10^1 <i>10⁰</i>	2	8
C	8,000	3	4
D	4,000	4	2
E	2,000	5	1
F	1,000	6	10^4
H	10^0 <i>10⁻¹</i>	7	80
J	Enable	8	40
K	NC	9	20
L	NC	10	10
M	NC	11	10^3 <i>10²</i>
N	800	12	NC
P	400	13	NC
R	200	14	Read Output
S	100	15	80,000
T	10^2 <i>10¹</i>	16	40,000
U	NC	17	20,000
V	NC	18	10,000
W	NC	19	100,000
X	NC	20	+
Y	Overload	21	Ext. Trig.
Z	Ground	22	Ground