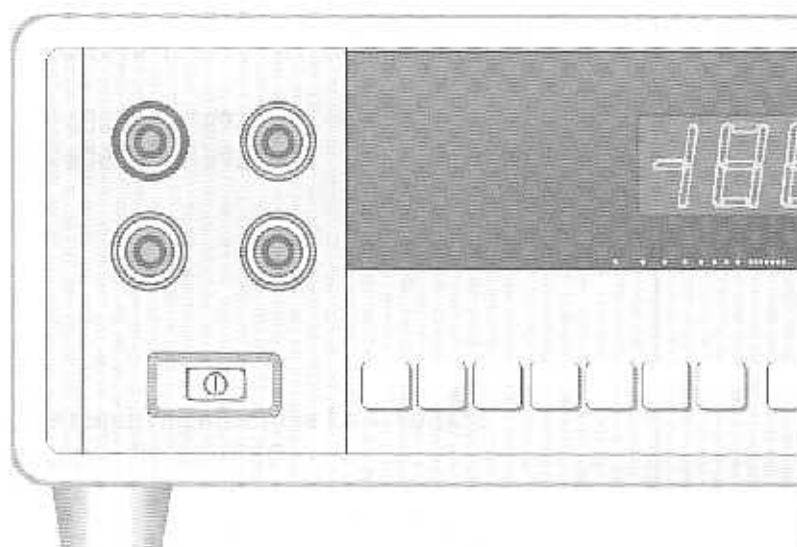




Digital Multimeter

DM-441B

True RMS Digital Multimeter
Operation Manual



Intelligent Systems Lab
California State University, Chico
www.gotbots.org

 **EZ Digital Co., Ltd.**

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturers Name : EZ Digital Co., Ltd.

Manufacturers Address : 222-28, Nae-dong, Ojeong-gu,
Bucheon-si, Gyeonggi-do
R.O.K, 421-160

Declares that the product :

Product Name : DIGITAL MULTIMETER

Model Numbers : DM-441B

Date : Oct. 25. 1995.

Conforms to the following product specifications :

Certified by TÜV Rheinland

Safety : EN 61010-1: 1993
(IEC 1010-1: 1990+A1:1992, modified)

EMC : EN 50081-1: 1992
EN 50082-1: 1992

Supplementary Information :

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

Bucheon, Gyeonggi

Location

C. Y. Kim

Cheol Young Kim
Quality Assurance Manager

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1. INTRODUCTION

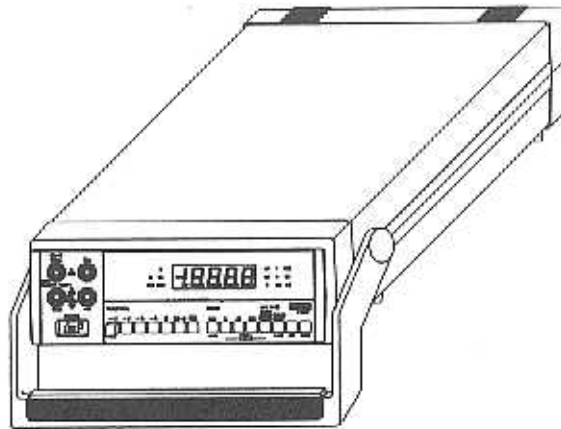


FIG 1-1 DM-441B

- ⊙ Your EZD model DM-441B is a portable, bench type digitalmultimeter with a 4 ½ digit light-emitting diode(LED).
 - ⊙ Your DM-441B can make hFE measurements, diode measurements,frequency measurements and continuity measurements in addition to the usual DMM measurement - AC/DC volts, AC/DC current and resistance.
 - ⊙ **TRUE RMS MEASUREMENT OF AC SIGNALS :**
TRUE RMS measurement is the only accurate way to directly measure ac sigals that are not noise-free pure sine waves. Your DM-441B measures ac voltage frequencies up to 50kHz.
 - ⊙ **SAFEY AND EMC :** Approval at TÜV
This meter has been designed and tested in accordance with safety and EMC.
 - SAFETY : EN61010-1 Approval at TÜV
 - EMC REGULATIONS : EN50081-1, EN55022, class B
EN50082-1, IEC801-2,3,4
- overvoltage cat. II
 - pollution deg. II

2. SAFETY INFORMATION

WARNING

READ "MULTIMETER SAFETY" BEFORE USING THE METER.

This meter has been designed and tested in accordance with IEC publication.

To ensure that the meter is used safely, follow all safety and operating instructions in this manual.

If the meter is not used as described in this manual the safety features of the meter might be impaired.

2-1. "WARNING" and "CAUTION"

"WARNING" is used for conditions and actions that pose hazards to the user, the word "CAUTION" is used for conditions and actions that may damage your meter

2-2. INTERNATIONAL ELECTRICAL SYMBOLS







	DANGEROUS VOLTAGE		GROUND
	AC-ALTERNATING CURRENT		IMPORTANT SAFETY INFORMATION IN MANUAL
	DC-DIRECT CURRENT		DOUBLE INSULATION

TABLE 2-1.

2-3. INPUT TERMINALS

To take a measurement, connect correctly the test lead with input terminals. The red color of input terminal allow you to have easy operation.

See FIG 2-1.

- ⑥ Do not use the meter if the meter or test lead look damaged, or if you suspect that the meter is not operating properly.
- ⑦ Turn off power to the circuit under test before cutting, unsoldering or breaking the circuit.
Small amounts of current can be dangerous.
- ⑧ When using the probes, keep your finger behind the the finger guards on the probes.

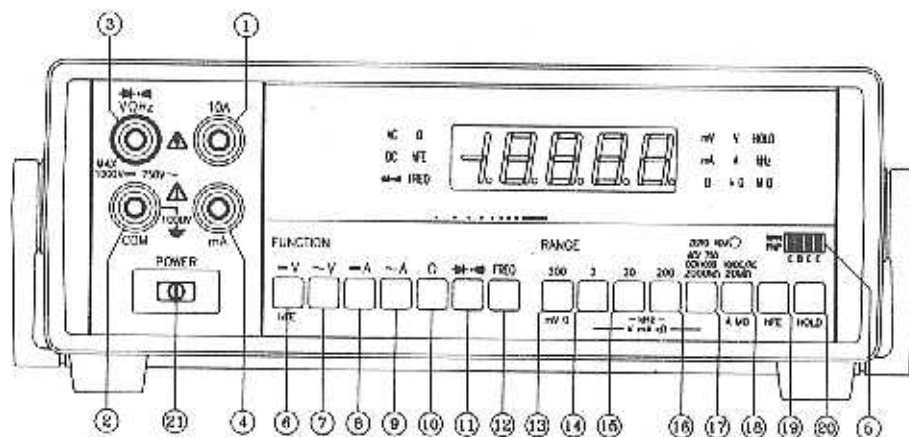


FIG 2-1. DM-441B FRONT VIEW

⑥	$\text{---} \text{V}$	VOLTS DC/hFE	⑩	Ω	RESISTANCE
⑦	$\sim \text{V}$	VOLTS AC	⑪	$\rightarrow \text{---} \text{---} \text{---}$	DIODE AND CONTINUITY
⑧	$\text{---} \text{A}$	AMPERES DC	⑫	FREQ	FREQUENCY
⑨	$\sim \text{A}$	AMPERES AC	⑬	⓪	POWER ON/OFF SWITCH

TABLE 2-3. FUNCTION SELECTED BY SWITCH

⑬	200mV Ω	200mV, 200 Ω RANGE	⑰	200V mA k Ω	DC100V/AC750V, 200mA, 200K Ω RANGE
⑭	2V mA K Ω	2V, 2mA, 2K Ω RANGE	⑱	10A M Ω	10A, 20M Ω RANGE
⑮	20V mA K Ω KHz	20V, 20mA, 20K Ω , 20KHz RANGE	⑲	hFE	hFE TEST
⑯	200V mA k Ω KHz	200V, 200mA, 20K Ω , 20KHz RANGE	⑳	HOLD	DATA HOLD FUNCTION

TABLE 2-4. RANGE SELECTED BY SWITCH

3. SPECIFICATIONS.

⊙NOTE:After turning on power, please allow a pre-heating period of as long as some 1 hour before use.

3-1.GENERAL SPECIFICATION.

- ⊙ 4 $\frac{1}{2}$ Digit : 20,000 count LED
- ⊙ Measurement rate : 2.5 times/sec
- ⊙ Protection for input overload
- ⊙ Dual slop integration A/D converter system
- ⊙ Over range indication : Most-significant digit flickered
- ⊙ Long-term calibration stability : one year
- ⊙ Temperatures : Operating : 0℃ ~ 50℃ (below 80%)
Storage : -20℃ ~ 60℃ (below 70%)
Guaranted accuracy : 23℃ ± 5℃
- ⊙ Line voltage : 103V ~ 126V, 50Hz/60Hz
206V ~ 252V, 50Hz/60Hz
- ⊙ Power consumption : 10 Wmax
- ⊙ Dimensions : 25.0cm 9.25cm 25.1cm (See FIG 3-1.)
- ⊙ Weight : 1.50kg

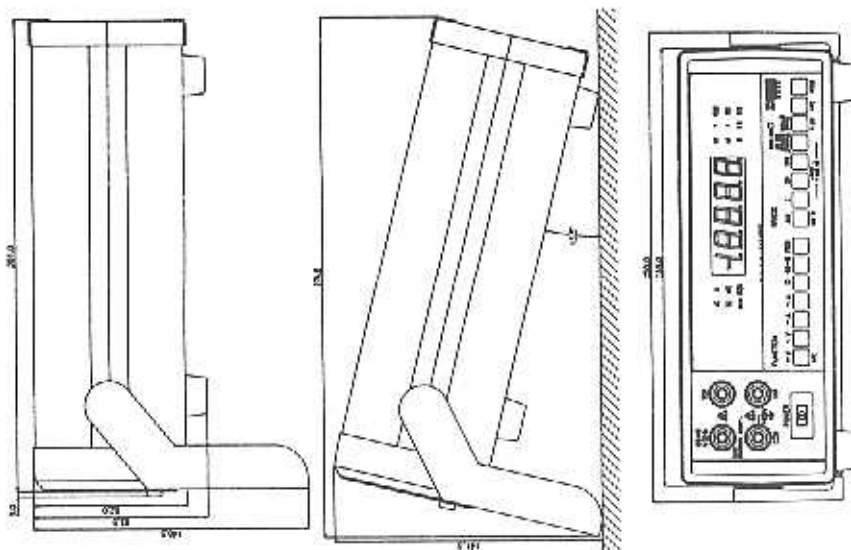


FIG 3-1. DIMENSIONS OF DM-441B

3-2. INPUT TERMINAL AND LIMITS

FUNCTION	INPUT TERMINAL		MINIMUM DISPLAY READING	MAXIMUM DISPLAY READING	MAXIMUM INPUT
V	V Ω Hz	COM	0.01mV	1000VDC, 750VAC	1000VDC, 750VAC
10A	10A	COM	0.001A	10A	10A/ 250V
mA	mA	COM	0.001mA	2000mA	2000mA/ 250V
Ω	V Ω Hz	COM	0.1 Ω	20M Ω	600VAC/ DC(1min)
Hz	V Ω Hz	COM	1Hz	200KHz	250VAC/ DC
CONTINUITY	V Ω Hz	COM			600VAC/ DC
DIODE	V Ω Hz	COM			600VAC/ DC(1min)
hFE	SOCKET				

TABLE 3-1. (* AC VALUE IS RMS VALUE)

3-3. TRUE RMS

In order to compare dissimilar waveforms, calculate ohm's law statements or power relationships, you must know the effective value of a signal.

If it is a dc signal, the effective value equals the dc level. If the signal is ac, however, we have to use the root mean square or rms value. The rms value of an ac current or ac voltage is defined as being numerically equal to the dc current or voltage that produces the same heating effect in a given resistance that the ac current or voltage produces.

In the past, average responding converters were the type of converter most widely used. theoretically, the rms value of a pure sine wave is $1/2^{1/2}$ of the peak value and the average value is $2/\pi$ of the peak value.

Since the meters converted to the average value, the value was $1/2^{1/2} \div 2/\pi = 1.11$ of the average value when measuring a sine wave. Most meters used an average responding converter and multiplied by 1.11 to present true rms measurements of sine waves. As the signal being measured deviated from a pure sine waves,

the errors in measurement rose sharply. Signal such as square waves, mixed frequencies, white noise, modulated signals, etc., could not be accurately measured. Rough correction factors could be calculated for ideal waveforms if the signal being measured was distortion free, noise-free, and a standard waveform. The true rms converter in this meter provides direct, accurate measurement of these and other signals.

4. OPERATING INSTRUCTIONS.

NOTES

The operating notes present the capabilities and limitations of your DM-441B and routine operator maintenance instructions.

4-1. ZERO ADJUSTMENT

Everybody can adjust to "0" at initial screen to get a exact reading value.

4-2. INPUT OVERLOAD PROTECTION.

CAUTION

EXCEEDING THE MAXIMUM INPUT OVERLOAD LIMITS CAN DAMAGE YOUR INSTRUMENT. THE TRANSIENT OVERLOAD PROTECTION CIRCUIT IS INTENDED TO PROTECT AGAINST SHORT DURATION HIGH ENERGY PULSES. TABLE 3-1 LISTS THE OVERLOAD LIMITS FOR EACH FUNCTION.

4-3. CHANGING INPUT POWER CONFIGURATION

The standard instrument has one of voltage setting :
115V or 230V, 50Hz/60Hz.

The transformer must be changed to accommodate a
different line voltage by voltage selector on the
rear of DM-441B.

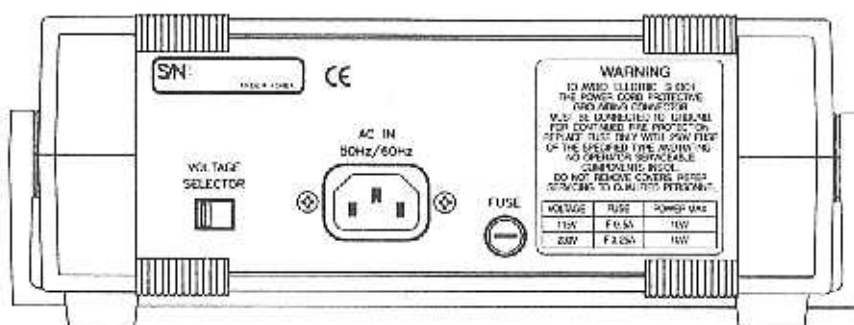


FIG 4-1. DM-441B REAR VIEW

4-4. POWER SWITCH

The power switch is located in the lower left corner
of the DM-441B front panel. See FIG 2-1.

This is a push-push switch so don't try to pull the
power switch to the O(OFF) position.

Push the power switch on your DM-441B to the I(ON)
position.

4-5. MEASURING VOLTAGE.

- ① Insert the black lead to common terminal and red one
to V Ω Hz terminal.
- ② To select a voltage function, push the \equiv V/hFE or \sim V switch.

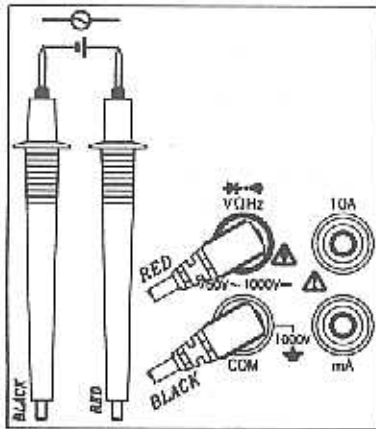


FIG4-2.MEASURING VOLTAGE

Each of ac/dc voltage ranges presents an input impedance of approximately $10M\Omega$. The frequency range for ac voltage measurement is $50Hz \sim 50KHz$.

⊙ COMBINED AC AND DC SIGNAL MEASUREMENTS

To measure combined waveforms, first measure the rms value of the ac component using the ac function of your meter. Measure the dc component using the dc function of your instrument. The relationship between the total rms value of the waveform and the ac component and the dc component is:

$$RMS \text{ Total} = \sqrt{(AC \text{ COMPONENT RMS})^2 + (DC \text{ COMPONENT})^2}$$

4-6. MEASURING CURRENT.

- ① If you do not know approximately what the current is, connect the black lead to common terminal and red one to 10A input terminal first to see if you have a safe level for the mA input terminal.
- ② To select a current function, push the $\text{---} A$ or $\sim A$ switch.

- ③ Select the proper range switch for your measurements.
- ④ Touch the probes to the points, and read the display.

Over range is being indicated by flickered figure "0.000".

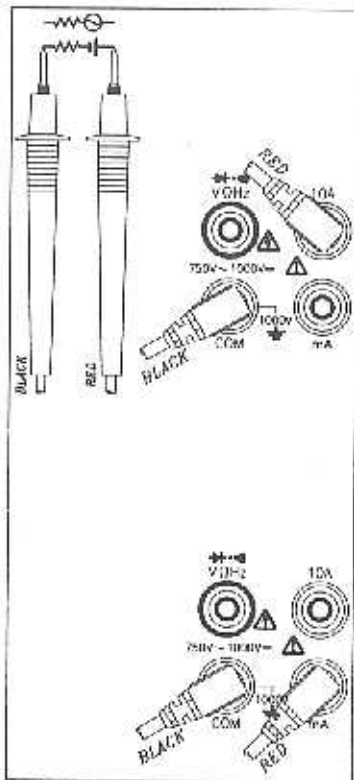


FIG 4-3 MEASURING CURRENT

- ③ Select the proper range switch for your measurements.
- ④ Touch the probes to the test points, and read the display.

Over range is being indicated by flickered figure "0.000".

The frequency range for ac current measurement is 50Hz ~ 20KHz.

When measurement current, the meter's internal shunt resistors develop a voltage across the meter's terminals called "burden voltage".

This voltage drop is very low in your meter, but it may affect precision circuit or measurements.

⊙ BURDEN VOLTAGE ERROR

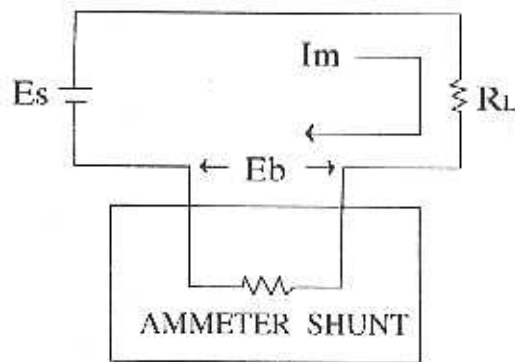
When a meter is placed in series with a circuit to measure current, you may have to consider an error caused by the voltage drop across the meter (in this case, across the protective fuses and current shunts).

This voltage drop is called burden voltage. The maximum fullscale burden voltages for your instrument are:0.3V for the three lowest ranges, and 0.9V for the 2000mA, 10A ranges.

These voltage drops can affect the accuracy of a

current measurement if the current source is unregulated and the resistance of the shunt the fuse represents a significant part(1/1000 or more) of the source resistance. If burden voltage dose present a problem, the percentage error can be calculated using the fomula in FIG 4-4.

This error can be minimized by selecting the highest



current range that provides the necessary resolution.

E_s = Source voltage

R_L = Load resistance + Source resistance

I_m = Measured current (display reading in amps)

E_b = Burden voltage (calculated), i.e.,

FIG 4-4. CALCULATING BURDEN VOLTAGE ERROR

Display reading expressed as a % of full scale(100

× reading/full scale) times full scale burden

voltage for selected range. See table

RANGE	FS BURDEN VOLTAGE
2mA TO 200mA	0.3VMAX
2000mA, 20A	0.9VMAX

Maximum current error due to burden voltage

$$IN \% = 100 \times Eb / (Es - Eb)$$

$$IN \text{ MILLIAMPS} = (Eb \times Im) / (Es - Eb)$$

Examples: $Es = 14V$, $RL = 9 \Omega$, $Im = 1497.0 \text{ mA}$

$$Eb = 100 \times 1497.0 / 2000.0 \times 0.9 (\text{from Table}) = 74.9\% \text{ of } 0.9 = 0.674V$$

$$\text{Maximum error in } \% = 100 \times 0.674 / (14 - 0.674) = 100 \times (0.674 / 13.326) = 5.06\%$$

Increase displayed current by 5.06% to obtain true current.

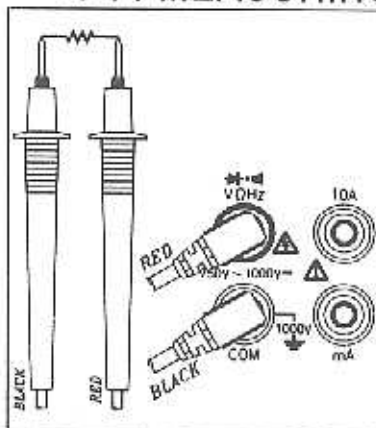
$$\text{Maximum error}/In \text{ milliamps} = (0.674 \times 1497.0) / (14 - 0.674) = 1009.0 / 13.326 = 75.7 \text{ mA}$$

Increase displayed current by 75.7mA to obtain true current.

WARNING

DO NOT APPLY THE VOLTAGE OF MORE THAN 60VDC OR 30VAC.

4-7. MEASURING RESISTANCE.



- ① Insert the black lead to common terminal and one to V Ω Hz terminal.
- ② To select a resistance function, push the Ω switch.
- ③ Select the proper range switch for your measurements.

FIG4-5.MEASURING RESISTANCE

④ Touch the probe to the test points, and read display.

* Disregard "-" displayed when the test leads are connected to the reverse terminals.

Over range is being indicated by flickered figure "0.000".

CAUTION

TURN OFF POWER ON THE TEST CIRCUIT AND DISCHARGE ALL CAPACITORS BEFORE ATTEMPTING IN-CIRCUIT RESISTANCE MEASUREMENTS. IF AN EXTERNAL VOLTAGE IS PRESENT ACROSS A COMPONENT, IT WILL BE IMPOSSIBLE TO TAKE AN ACCURATE MEASUREMENT OF THE RESISTANCE OF THAT COMPONENT.

4-8. MEASURING FREQUENCY

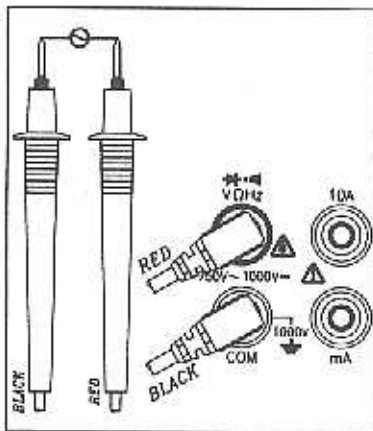


FIG 4-6 MEASURING FREQUENCY

- ① Insert the black lead to common terminal and red one to V Ω Hz terminal.
- ② To select a frequency function, push the FREQ switch.
- ③ Select the proper range switch for your measurements.
- ④ Touch the probe to the test points, and read the display.

The minimum input signal required to trigger is above 100mVrms. If the input signal is below the trigger level, frequency measurements will not be taken.

4-9. TRANSISTOR hFE TEST.

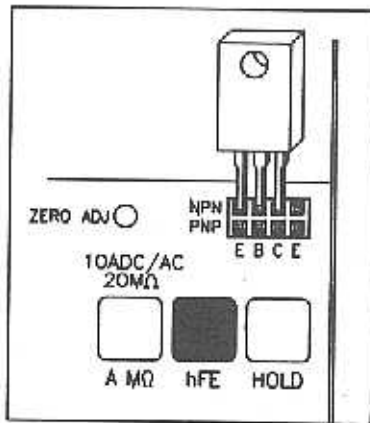


FIG 4-7. hFE TEST

- ① To select a voltage/hFE function, push the $\rightarrow V/hFE$ switch.
- ② Select the hFE range SWITCH for your measurements.
- ③ Insert the leads(emitter, base collector) into the proper holes of the sochet on the front panel, according to transistor type NPN or PNP. The display reads approximate hFE value at the test condition of Base current $2.4\mu A$ and VCE 3V. To select a hFE function, push the hFE switch on the range switch.

4-10. DIODE TEST

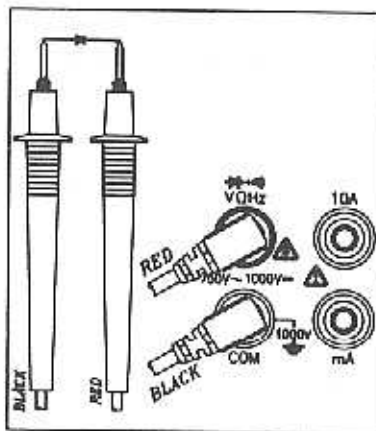
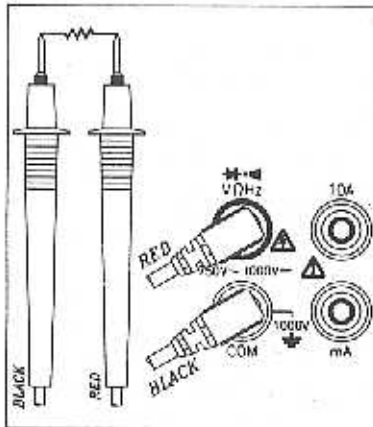


FIG 4-8. DIODE TEST

- ① Insert the black lead to common terminal and red one to V Ω Hz terminal.
- ② To select diode function, push the $\rightarrow V \Omega Hz$ switch. The forward voltage drop is displayed in mV unit. TEST CONDITION: Forward DC current(1mA) When Reversed, "000.0" is flickered.

4-11. CONTINUITY TEST

- ① Insert the black lead to common terminal and red one to V Ω Hz terminal.
- ② To select continuity function, to push the switch.



Test resistance below 200 Ω mode cause the meter to emit a continuous tone.

CAUTION

TURN OFF POWER ON THE TEST CIRCUIT AND DISCHARGE ALL CAPACITORS BEFORE ATTEMPTING CONTINUITY TESTING.

FIG 4-9. CONTINUITY TEST

4-12. HOLD FUNCTION

A measured value is holded on screen. Push "HOLD" to stop the recording of reading press "HOLD" again to start it.

- * If you push the "hold" when a measured value is "over range", the display goes out of sight

4-13. HANDLE

The handle can be rotated to four positions. One positions. One position allow it to be used as a carring handle.

Other positions allow the handle to be used as a bail to tilt the front panel for convenient bench top operation

5. RESOLUTION AND ACCURACY

FUNCTION	RANGE	RESOLUTION	ACCURACY	
DC VOLTAGE	200mV 2V 20V 200V	10 μ V 100 μ V 1 mV 10 mV	$\pm (0.1\% + 4\text{dgt})$	
	1000V	100mV	$\pm (0.15\% + 4\text{dgt})$	
AC VOLTAGE	200mV	10 μ V	$\pm (0.5\% + 20\text{dgt})$, (45Hz ~ 1KHz) $\pm (0.8\% + 10\text{dgt})$, (1KHz ~ 10KHz) $\pm (1.0\% + 10\text{dgt})$, (10KHz ~ 20KHz) $\pm (3.0\% + 30\text{dgt})$, (20KHz ~ 50KHz)	
	2V	100 μ V	$\pm (0.5\% + 20\text{dgt})$, (45Hz ~ 1KHz) $\pm (0.8\% + 10\text{dgt})$, (1KHz ~ 10KHz) $\pm (1.0\% + 20\text{dgt})$, (10KHz ~ 20KHz) $\pm (3.0\% + 30\text{dgt})$, (20KHz ~ 50KHz)	
	20V	1 mV	$\pm (0.5\% + 20\text{dgt})$, (45Hz ~ 1KHz) $\pm (1.5\% + 20\text{dgt})$, (1KHz ~ 10KHz) $\pm (2.5\% + 20\text{dgt})$, (10KHz ~ 20KHz) $\pm (5.0\% + 20\text{dgt})$, (20KHz ~ 50KHz)	
	200V	10 mV	$\pm (0.5\% + 20\text{dgt})$, (45Hz ~ 400Hz) $\pm (2.0\% + 20\text{dgt})$, (400Hz ~ 1KHz)	
	750V	100 mV	$\pm (1.0\% + 20\text{dgt})$, (45Hz ~ 400Hz) $\pm (3.5\% + 20\text{dgt})$, (400Hz ~ 1KHz)	
DC CURRENT	2 mA 20 mA 200 mA 2000 mA	0.1 μ A 1 μ A 10 μ A 100 μ A	$\pm (0.5\% + 1\text{dgt})$	
	10A	1 mA	$\pm (0.75\% + 3\text{dgt})$	
AC CURRENT	2 mA	0.1 μ A	$\pm (1.0\% + 10\text{dgt})$, (45Hz ~ 10KHz) $\pm (2.0\% + 20\text{dgt})$, (10KHz ~ 20KHz)	
	20 mA	1 μ A	$\pm (1.0\% + 10\text{dgt})$, (45Hz ~ 10KHz) $\pm (2.0\% + 20\text{dgt})$, (10KHz ~ 20KHz)	
	200 mA	10 μ A	$\pm (1.0\% + 10\text{dgt})$, (45KHz ~ 10KHz) $\pm (2.0\% + 20\text{dgt})$, (10KHz ~ 20KHz)	
	2000 mA 10A	100 μ A 1 mA	$\pm (1.0\% + 10\text{dgt})$, (45Hz ~ 2KHz)	
RESISTANCE	200 Ω	0.01 Ω	$\pm (2.0\% + 5\text{dgt})$	
	2 K Ω 20 K Ω 200 K Ω	0.1 Ω 1 Ω 10 Ω	$\pm (0.2\% + 2\text{dgt})$	
	2000 K Ω 20 M Ω	100 Ω 1 K Ω	$\pm (0.5\% + 2\text{dgt})$	
	FREQUENCY	20 KHz	1 Hz	$\pm (1.0\% + 3\text{dgt})$
		200 KHz	10 Hz	$\pm (2.0\% + 3\text{dgt})$
hFE	BASE CURRENT: 3.5 μ A VCE: 4.5V APPROX			
DIODE	TEST VOLTAGE: 4.5V APPROX. MAXIMUM TEST CURRENT: 1mA			
CONTINUITY	THRESHOLD: 200 Ω OR LESS			

* Temperature coefficient: $0.15 \times (\text{spec. acc}) / \text{yr} / \text{C}$, (18C or $> 28 \text{C}$)

* Accuracy is given as $\pm (\% \text{ of reading} + \text{number of least significant digits})$ at 18C to 28C with relative humidity up to 80% for a period of one year after calibration.

* Sources like small hand-held radio transceivers, fixed station radio and television transmitters, vehicle radio transmitters and cellular phones generate electromagnetic radiation that may induce voltages in the test leads of the multimeter. In such cases the accuracy of the multimeter cannot be guaranteed due to physical reasons.

6.MAINTENANCE

WARNING

TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, DO NOT GET WATER INSIDE THE CASE. REMOVE THE TEST LEADS AND POWER CORDS ANY INPUT SIGNALS BEFORE OPENING THE CASE.

6-2.INTRODUCTION

This section contains the maintenance information for your DM-441B digital multimeter. This information is divided into service information, calibration, fuse fuse replacement, etc.

6-2. SERVICE INFORMATION

If the meter fails, check the power and fuses and replace as needed. If the meter still does not work properly review this manual to make sure you are operating it correctly.

If the meter still malfunctions, pack it securely in its original shipping container and forward it, postage paid, to the EZD's distributor. Include a description of the malfunction EZD assumes no responsibility for damage in transit.

A meter under warranty will be promptly repaired a replaced(at EZD's option) and returned at no charge. If the warranty has lapsed, the meter will be repaired and returned for a fixed fee.

Contact the nearest EZD's distributor for information and prices.

6-3. CALIBRATION

Calibrate your meter once a year to ensure that it performs according to its specifications.

Contact the nearest distributor for calibration procedure.

6-4. FUSE REPLACEMENT

After disconnecting test leads and power cords turning off the multimeter, remove old fuse located with rear panel replace with new fuse. See FIG 4-1.

7. ACCESSORIES

Test leads : 1set
Power cord : 1pc
Operating manual : 1copy
Fuse : 1pc

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