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<td>4-13. Handle</td>
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</table>
1. INTRODUCTION

FIG 1-1

- Your EZD model 72-410A is a portable, bench type digital multimeter with a 4½ digit light-emitting diode (LED).
- The 72-410A 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 signals that are not noise-free pure sine waves. The 72-410A measures ac voltage frequencies up to 50 kHz.
- 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 THIS METER.

This meter has been designed and tested in accordance with IEC publication. To ensure that the meter is used safety, 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

<table>
<thead>
<tr>
<th></th>
<th>DANGEROUS VOLTAGE</th>
<th>GROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚠</td>
<td>AC-ALTERNATING</td>
<td>IMPORTANT SAFETY INFORMATION IN MANUAL</td>
</tr>
<tr>
<td></td>
<td>CURRENT</td>
<td></td>
</tr>
<tr>
<td>⚫</td>
<td>DC-DIRECT CURRENT</td>
<td>DOUBLE INSULATION</td>
</tr>
</tbody>
</table>

TABLE 2-1.

2-3. INPUT TERMINALS
To take a measurement, correctly connect the test lead with the prober input terminals. As indicated (positive / negative) the red color of input terminal allow you to have easy operation. See FIG 2-1.
① 10A  Amperes Input Terminal  
For current measurements (AC or DC) up to 10A continuous when the function selector switch is in the 10A position.

② COM  Common Terminal (Ground)  
Return terminal for all measurements.  
Do not apply more than 1000V between the (com) terminal and earth ground. (Black color)

③ V Ω Hz  Volts, Ohms, Continuity, Frequency, Diode test input terminal (Red color)

④ mA  mA input Terminal.

⑤ Socket  Transistor hFE input Terminal

WARNING
TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, DO NOT APPLY MORE THAN 1000V BETWEEN COM TERMINAL AND EARTH GROUND.
TO AVOID ELECTRICAL SHOCK, USE CAUTION WHEN WORKING ABOVE 60VDC OR 30VAC RMS, SUCH VOLTAGES POSE A SHOCK HAZARD.

2-4. LINE VOLTAGE SELECTION AND FUSE RATINGS.

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>FUSE</th>
<th>POWER MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>103V−126V (50Hz/60Hz)</td>
<td>F 0.5A 250V</td>
<td>10W</td>
</tr>
<tr>
<td>206V−252V (50Hz/60Hz)</td>
<td>F 0.25A 250V</td>
<td>10W</td>
</tr>
</tbody>
</table>

TABLE 2-2.

- Select the proper function and range for your measurements.
- Disconnect the live test lead before disconnecting the common test lead.
Do not use the meter if the meter or test lead look damaged, or if you suspect that the meter is not operating properly.

Turn off power to the circuit under test before cutting, unsoldering or breaking the circuit. Small amounts of current can be dangerous.

When using the probes, keep your finger behind the finger guards on the probes.

FIG 2-1. 72-410A FRONT VIEW

TABLE 2-3. FUNCTION SELECTED BY SWITCH

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>V</td>
<td>VOLTS DC/hFE</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>V</td>
<td>VOLTS AC</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>AMPERES DC</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>AMPERES AC</td>
<td>21</td>
</tr>
</tbody>
</table>

TABLE 2-4. RANGE SELECTED BY SWITCH

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>200 mV</td>
<td>200 mV</td>
<td>200 Ω RANGE</td>
</tr>
<tr>
<td>14</td>
<td>2 V mA kΩ</td>
<td>2V2mA2K Ω RANGE</td>
<td>18</td>
</tr>
<tr>
<td>15</td>
<td>20 V mA kΩ</td>
<td>20V20mA20K Ω,20KHz RANGE</td>
<td>19</td>
</tr>
<tr>
<td>16</td>
<td>200 V mA kΩ</td>
<td>200V20mA,200K Ω,200KHz RANGE</td>
<td>20</td>
</tr>
</tbody>
</table>
3. SPECIFICATIONS.

NOTE: After turning on power, please allow a pre-heating period of as long as some 15 minutes before use.

3-1. GENERAL SPECIFICATION.

- 4 ½ 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°C ~ 50°C (below 80%)
  Storage: -20°C ~ 60°C (below 70%)
- Guaranteed accuracy: 23°C ± 5°C
- Line voltage: 103V ~ 126V, 50Hz/60Hz
  206V ~ 252V, 50Hz/60Hz
- Power consumption: 10 W max
- Dimensions: 25.0cm 9.25cm 25.1cm (See FIG 3-1.)
- Weight: 1.50kg

FIG 3-1. DIMENSIONS
3-2. INPUT TERMINAL AND LIMITS

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>INPUT TERMINAL</th>
<th>MINIMUM DISPLAY READING</th>
<th>MAXIMUM DISPLAY READING</th>
<th>MAXIMUM INPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>VΩHz COM</td>
<td>0.01mV</td>
<td>1000VCD,750VAC</td>
<td>1000VDC,750VAC</td>
</tr>
<tr>
<td>10A</td>
<td>10A COM</td>
<td>0.001A</td>
<td>10A</td>
<td>10A/250V</td>
</tr>
<tr>
<td>mA</td>
<td>mA COM</td>
<td>0.001mA</td>
<td>2000mA</td>
<td>2000mA/250V</td>
</tr>
<tr>
<td>Ω</td>
<td>VΩHz COM</td>
<td>0.1Ω</td>
<td>20MΩ</td>
<td>600VAC/DC(1min)</td>
</tr>
<tr>
<td>Hz</td>
<td>VΩHz COM</td>
<td>1Hz</td>
<td>200KHz</td>
<td>250VAC/DC</td>
</tr>
<tr>
<td>CONTINUITY</td>
<td>VΩHz COM</td>
<td></td>
<td></td>
<td>600VAC/DC</td>
</tr>
<tr>
<td>DIODE</td>
<td>VΩHz COM</td>
<td></td>
<td></td>
<td>600VAC/DC(1min)</td>
</tr>
<tr>
<td>hFE</td>
<td>SOCKET</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 $1/\sqrt{2}$ 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 $1/2^{\frac{1}{2}} \div 2/\pi = 1.11$ 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 72-410A and routine operator maintenance instructions.

4-1. ZERO ADJUSTMENT
Everybody can adjust to "0" at initial screen to get an 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.

4-4. POWER SWITCH
The power switch is located in the lower left corner of the 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 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 V/hFE or ~V 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".

FIG4-2. MEASURING VOLTAGE

Each ac/dc voltage range presents an input impedance of approximately 10MΩ. The frequency range for ac voltage measurement is 50Hz ~ 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 the 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:

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

4-6. MEASURING CURRENT.

① If you do not know approximately 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 --- A or ~ A switch.
Select the proper range switch for your measurements.

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 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.

\[
Es = Source\ voltage
\]
\[
RL = Load\ resistance + Source\ resistance
\]
\[
Im = Measured\ current\ (display\ reading\ in\ amps)
\]
\[
Eb = Burden\ voltage\ (calculated), i.e.,
\]

**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
Maximum current error due to burden voltage
IN % = $100 \times \frac{E_b}{E_s - E_b}$
IN MILLIAMPS = $\frac{E_b \times I_m}{E_s - E_b}$
Examples: $E_s = 14V$, $R_L = 9 \Omega$, $I_m = 1497.0 \text{mA}$
$E_b = 100 \times 1497.0/2000.0 \times 0.9 \text{(from Table)} = 74.9\% \text{ of } 0.9 = 0.674V$
Maximum error in % = $100 \times \frac{0.674}{(14-0.674)} = 100 \times \frac{0.674}{13.326} = 5.06\%$
Increase displayed current by 5.06\% to obtain true current.
Maximum error/In milliamps = $\frac{0.674 \times 1497.0}{(14-0.674)} = 1009.0/13.326 = 75.7\text{mA}$
Increase displayed current by 75.7\text{mA} 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

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.

To select a voltage/hFE function, push the \( \Rightarrow V/hFE \) switch.

Select the hFE range Switch for your measurements.

Insert the leads (emitter, base collector) into the proper holes of the socket 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

Insert the black lead to common terminal and red one to V \( \Omega \) Hz terminal.

To select diode function, push the \( \Rightarrow \) 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 termin
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 held 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 con:venient bench top operation.
5. RESOLUTION AND ACCURACY

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>RANGE</th>
<th>RESOLUTION</th>
<th>ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DC VOLTAGE</strong></td>
<td>200mV</td>
<td>10μV</td>
<td>±(0.05% + 4dgt)</td>
</tr>
<tr>
<td></td>
<td>2V</td>
<td>100μV</td>
<td>±(0.05% + 4dgt)</td>
</tr>
<tr>
<td></td>
<td>20V</td>
<td>1mV</td>
<td>±(0.15% + 4dgt)</td>
</tr>
<tr>
<td></td>
<td>200V</td>
<td>10mV</td>
<td>±(0.15% + 4dgt)</td>
</tr>
<tr>
<td></td>
<td>1000V</td>
<td>100mV</td>
<td>±(0.15% + 4dgt)</td>
</tr>
<tr>
<td><strong>AC VOLTAGE</strong></td>
<td>200mV</td>
<td>10μV</td>
<td>±(0.5% + 20dgt), (45Hz ~ 1kHz)</td>
</tr>
<tr>
<td></td>
<td>2V</td>
<td>100μV</td>
<td>±(0.8% + 10dgt), (1kHz ~ 10kHz)</td>
</tr>
<tr>
<td></td>
<td>20V</td>
<td>1mV</td>
<td>±(1.0% + 10dgt), (1kHz ~ 10kHz)</td>
</tr>
<tr>
<td><strong>DC CURRENT</strong></td>
<td>2mA</td>
<td>0.1mA</td>
<td>±(0.5% + 1dgt)</td>
</tr>
<tr>
<td></td>
<td>20mA</td>
<td>1μA</td>
<td>±(0.75% + 3dgt)</td>
</tr>
<tr>
<td></td>
<td>200mA</td>
<td>10μA</td>
<td>±(1.0% + 10dgt), (45Hz ~ 10kHz)</td>
</tr>
<tr>
<td></td>
<td>2000mA</td>
<td>100μA</td>
<td>±(2.0% + 20dgt), (10kHz ~ 20kHz)</td>
</tr>
<tr>
<td><strong>AC CURRENT</strong></td>
<td>2mA</td>
<td>0.1μA</td>
<td>±(1.0% + 10dgt), (45Hz ~ 10kHz)</td>
</tr>
<tr>
<td></td>
<td>20mA</td>
<td>1μA</td>
<td>±(2.0% + 20dgt), (10kHz ~ 20kHz)</td>
</tr>
<tr>
<td><strong>RESISTANCE</strong></td>
<td>2kΩ</td>
<td>0.1Ω</td>
<td>±(0.5% + 3dgt)</td>
</tr>
<tr>
<td></td>
<td>20kΩ</td>
<td>1Ω</td>
<td>±(0.2% + 2dgt)</td>
</tr>
<tr>
<td></td>
<td>200kΩ</td>
<td>10Ω</td>
<td>±(0.2% + 2dgt)</td>
</tr>
<tr>
<td></td>
<td>2MΩ</td>
<td>1kΩ</td>
<td>±(0.5% + 3dgt)</td>
</tr>
<tr>
<td><strong>FREQUENCY</strong></td>
<td>20kHz</td>
<td>1Hz</td>
<td>±(1.0% + 3dgt)</td>
</tr>
<tr>
<td></td>
<td>200kHz</td>
<td>10Hz</td>
<td>±(2.0% + 3dgt)</td>
</tr>
<tr>
<td><strong>hFE</strong></td>
<td></td>
<td></td>
<td>BASE CURRENT: 3.5μA, VCE: 4.5V APPROX</td>
</tr>
<tr>
<td><strong>DIODE</strong></td>
<td>TEST VOLTAGE: 4.5V APPROX, MAXIMUM TEST CURRENT: 1mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CONTINUITY</strong></td>
<td></td>
<td></td>
<td>CONTINUITY: THRESHOLD: 200 Ω OR LESS</td>
</tr>
</tbody>
</table>

* Temperature coefficient: 0.15 × (spec. acc'y)/°C, (18°C or ~ 28°C)
* Accuracy is given as ±(%, of reading + number of least significant digits) at 18°C to 28°C 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.

6-1. INTRODUCTION
This section contains the maintenance information for your digital multimeter. This information is divided into service information, calibration, fuse replacement, etc.

6-2. 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
8. MEMO