

TENMARS

Autoranging Multimeter

TM-86




**User's
manual**

CE

HB2TM860000


TENMARS ELECTRONICS CO., LTD

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1. SAFETY PRECAUTIONS AND PROCEDURES

This meter is in compliance with safety Standards EN 61010-1 related to electronic measuring instruments. For your own safety and to avoid damaging the instrument follow the procedures described in this instruction manual and read carefully all notes preceded by this symbol . When taking measurements:

- Avoid doing that in humid or wet places - make sure that humidity is within the limits indicated in paragraph 6.2.1.
- Avoid doing that in rooms where explosive gas, combustible gas, steam or excessive dust is present.
- Keep you insulated from the object under test.
- Do not touch exposed metal parts such as test lead ends, sockets, fixing objects, circuits etc.
- Avoid doing that if you notice anomalous conditions such as breakages, deformations, fractures, leakages of battery liquid, blind display etc.
- Be particularly careful when measuring voltages exceeding 20V to avoid risk of electrical shocks.

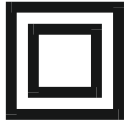
The following symbols are used:



CAUTION - refer to the instruction manual - an improper use may damage the instrument or its components



Danger high voltage: risk of electric shocks



Double insulated meter



AC voltage or current



DC voltage or current

1.1. PRELIMINARY

- This instrument has been designed for use in environments of pollution degree 2.
- It can be used for **VOLTAGE** and **CURRENT** measurements on installations of over voltage CAT III 1000V and CAT IV 600V.
- This instrument is not suitable for measurements of non sine wave voltage and current.
- When using the instrument always respect the usual safety regulations aimed at protecting you against the dangerous electric currents and protecting the instrument against incorrect operations.
- Only the leads supplied with the instrument guarantee compliance with the safety standards in force. They must be in good conditions and, if necessary, replaced with identical ones.

- Do not test or connect to any circuit exceeding the specified overload protection.
- Do not effect measurements under environmental conditions exceeding the limits indicated in paragraphs 6.1.1 and 6.2.1.
- Make sure that batteries are properly installed.
- Before connecting the test probes to the installation make sure that the rotary selector is positioned on the right function.
- Make sure that LCD and rotary selector indicate the same function.

1.2. DURING USE



CAUTION

An improper use may damage the instrument and/or its components or injure the operator.

- When changing the range, first disconnect the test leads from the circuit under test in order to avoid any accident.
- When the instrument is connected to measuring circuits never touch any unused terminal.
- When measuring resistors do not add any voltage. Although there is a protection circuit, excessive voltage could cause malfunctioning.
- If during measurement the displayed values remain constant check whether the HOLD function is

active.

1.3. AFTER USE

- After using the instrument turn it off.
- If you expect not to use the instrument for a long period remove the battery to avoid leakages of battery liquids which may damage its inner components.

1.4. MEASURING (OVERVOLTAGE) CATEGORIES DEFINITIONS

EN 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements, gives a definition of measuring category, usually called over voltage category. Paragraph 6.7.4: Measuring circuits:

(OMISSIS)

Circuits are divided into the following measurement categories:

- **Measurement category IV** is for measurements performed at the source of the low-voltage installation.

Examples are electricity meters and measurements on primary over current protection devices and ripple control units.

- **Measurement category III** is for measurements performed in the building installation.
Examples are measurements on distribution boards, circuit breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to fixed installation.
- **Measurement category II** is for measurements performed on circuits directly connected to the low voltage installation.
Examples are measurements on household appliances, portable tools and similar equipment.
- **Measurement category I** is for measurements performed on circuits not directly connected to MAINS.
Examples are measurements on circuits not derived from MAINS, and specially protected (internal) MAINS-derived circuits. In the latter case, transient stresses are variable; for that reason, the norm requires that the transient withstand capability of the equipment is made known to the user.

2. GENERAL DESCRIPTION

This meter performs the below listed measurements:

- DC Voltage
- AC sine wave Voltage
- DC Current
- AC sine wave Current
- Resistance
- Continuity
- Diode test
- Frequency
- Duty cycle
- Capacitance

All selectable by means of a 10 position rotary selector (including OFF position). In addition there are the **HOLD** key to hold the displayed value, the **R** key for manual selection of measuring ranges, the **REL** key for relative measurements and **SEL** key for selection between Frequency and Duty Cycle or for selection of DC and AC Current measurements.

The selected quantity is displayed with indication of measuring unit and active functions.

The instrument disposes of an Auto Power Off function consisting in an automatic switching off 15

minutes after last selector rotation or function selection.

3. PREPARATION FOR USE

3.1. INITIAL

This instrument was checked both mechanically and electrically prior to shipment. All possible cares and precautions were taken to let you receive the instrument in perfect conditions. Notwithstanding we suggest you to check it rapidly (eventual damages may have occurred during transport – if so please contact the local distributor from whom you bought the item).

Make sure that all standard accessories mentioned in paragraph are included. Should you have to return back the instrument for any reason please follow the instructions mentioned in paragraph 7.

3.2. SUPPLY VOLTAGE

The instrument is supplied by 2x1.5V batteries type IEC AAA LR03. When batteries are low, a low battery indication is displayed. To replace/insert batteries please refer to paragraph 5.2.

3.3. CALIBRATION

The instrument complies with the technical specifications contained in this manual and such compliance is guaranteed for 1 year. Annual recalibration is recommended.

3.4. STORAGE

After a period of storage under extreme environmental conditions exceeding the limits mentioned in paragraph 6.2.1 let the instrument resume normal measuring conditions before using it.

4. OPERATING INSTRUCTIONS

4.1. INSTRUMENT - DESCRIPTION

4.1.1. Front panel

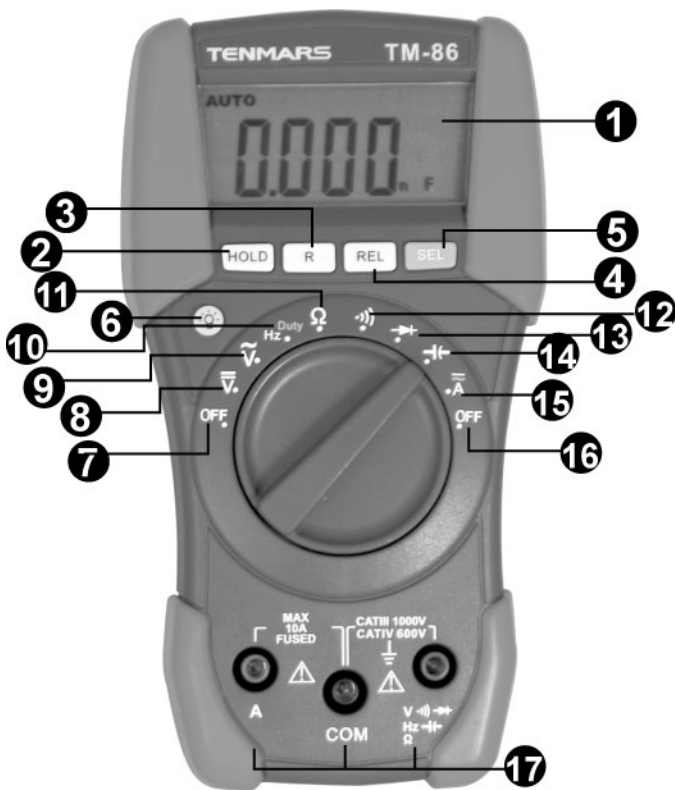


Fig. 1: Instrument description

LEGEND:

1. LCD
2. HOLD Key
3. R Key
4. REL Key
5. SEL Key
6. Backlight Key
7. OFF position
8. DCV position
9. ACV position
10. Hz and Duty position
11. Ω position
12. \cdot))) position
13. \blacktriangleright position
14. \curvearrowright position
15. DCA and ACA position
16. OFF position
17. Input terminals COM, A, and $V \Omega \blacktriangleright \cdot$))) Hz \curvearrowright

4.2.DESCRPTION OF FUNCTION KEYS

4.2.1. **HOLD** key

By pressing **HOLD** key the measured value is frozen on the display where the symbol "HOLD" appears. Press again **HOLD** to disable this function and resume normal operation.

4.2.2. **R (RANGE)** key

By pressing **R** key, the manual mode is activated and the "AUTO" symbol disappears from the display. Press **R** cyclically to change the measuring range and fix the decimal point on the display. To exit this function keep **R** key pressed for at least 1 second or rotate the selector to another position.

4.2.3. **REL** key


By pressing **REL** the relative measure is activated. The meter sets the display to zero and saves the actual value as reference. The "REL" symbol is shown at display. This function is not active on Hz, Duty Cycle, Continuity Test and Diode Test measurements. Pressing again the key to exit from this function.

4.2.4. **SEL** key

By pressing **SEL** key the selection of a double measured function on the display is possible. In particular this key is active only in Hz and Duty

position and to select between AC and DC current measure.

4.2.5. Backlight key ()

By pressing  key it's possible to activate the backlight function on the display. The function automatically disabled itself after some seconds and is available on each position of the rotary selector

4.2.6. Auto power off

The instrument automatically turns off 15 minutes after the last pressure of keys or the last selector rotation. To resume operation pressing **HOLD** key or turn the selector on OFF and turn on the instrument again.

4.3. MEASUREMENTS

4.3.1. DC Voltage measurement



CAUTION

The maximum input for DC voltage is 600V. Do not attempt to measure higher voltages to avoid electrical shocks or damages to the instrument.

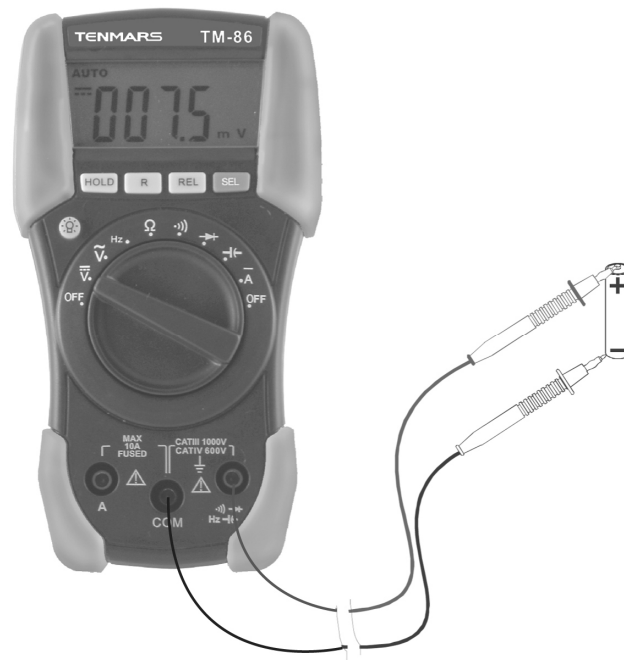


Fig. 2: Using the meter for DC Voltage measurement

1. Selecting the position **V $\overline{\text{—}}$** .
2. Pressing the **R** key to select the correct range or using the Auto range feature (see paragraph 4.2.2). If the voltage value under test is unknown, select the highest range.
3. Insert the test leads into the jacks, the red plug into **V $\overline{\text{—}}$** jack and black plug into **COM** jack (see Fig. 2).
4. Connect the red and black test leads to the positive and negative poles of the circuit under test respectively. The voltage value is displayed.
5. If the message "**O.L**" is displayed select a higher range.
6. The symbol "-" on the instrument display indicates that voltage has opposite direction with regard to the connection.

7. For HOLD function and Relative measure please refer to paragraph 4.2.

4.3.2. AC Voltage measurement



CAUTION

The maximum input for AC voltage is 600V. Do not attempt to measure higher voltages to avoid electrical shocks or damages to the instrument.

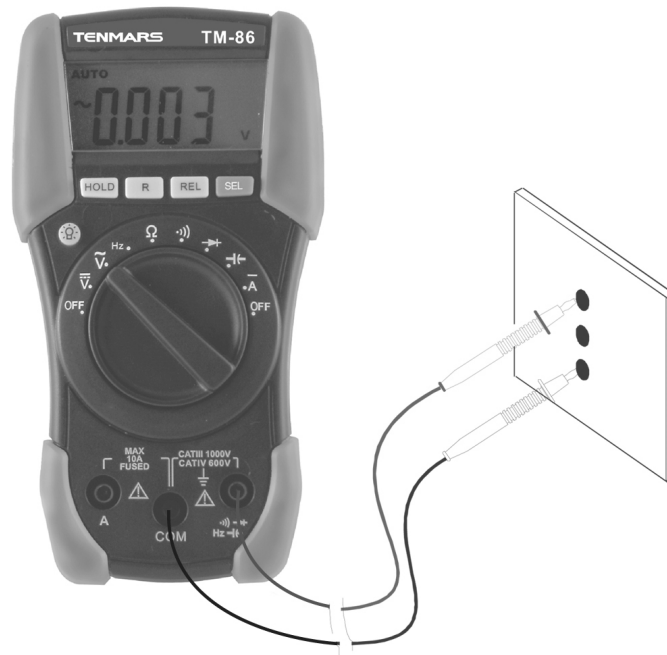


Fig. 3: Using the instrument for AC Voltage measurement

1. Selecting the position $V\sim$.
2. Pressing the **R** key to select the correct range or using the Auto range feature (see paragraph 4.2.2). If the voltage value under test is unknown, select the highest range.

3. Insert the test leads into the jacks, the red plug into $V\Omega\rightarrow$ \rightarrow Cx/Hz jack and black plug into **COM** jack (see Fig. 3).
4. Connect the test leads to the circuit under test. The voltage value is displayed.
5. If the message "O.L" is displayed select a higher range.
6. For HOLD function and Relative measure please refer to paragraph 4.2.

4.3.3. DC Current measurement



CAUTION

The maximum input for DC current is 10A. Do not attempt to measure higher currents to avoid electrical shocks or damages to the instrument.

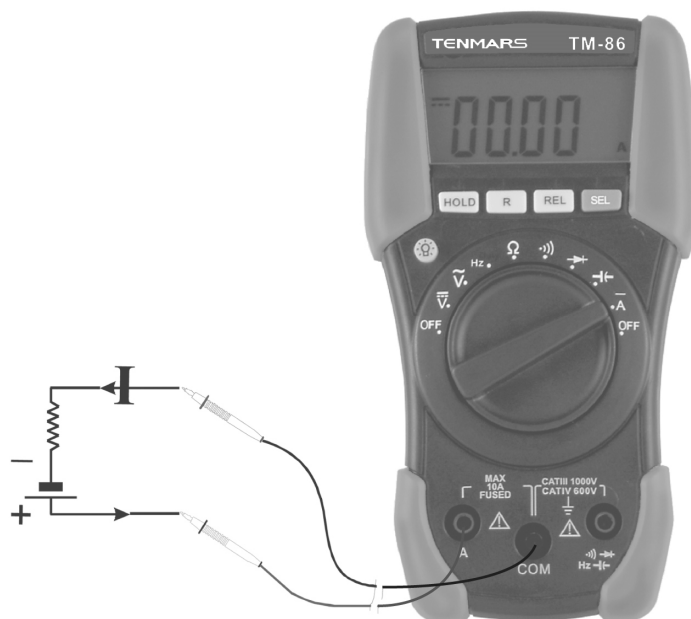




Fig. 4: Using the instrument for DC Current measurement

1. Power off the circuit under test.
2. Selecting the position . The message “” is shown at display.
3. Insert the test leads into the jacks, the red plug into **A** jack and black plug into **COM** jack (see Fig. 4).
4. Connect the red and the black plugs in series with the circuit whose current is to be measured respecting the polarities.
5. Energize the circuit under test. The current value will be displayed.
6. The message "**O.L.**" means that the detected current exceeds the limits.
7. The symbol "-" on the instrument display indicates that voltage has opposite direction with regard to the connection.
8. For HOLD function and Relative measure please refer to paragraph 4.2.

4.3.4. AC Current measurement



CAUTION

The maximum input for DC current is 10A. Do not attempt to measure higher currents to avoid electrical shocks or damages to the instrument.

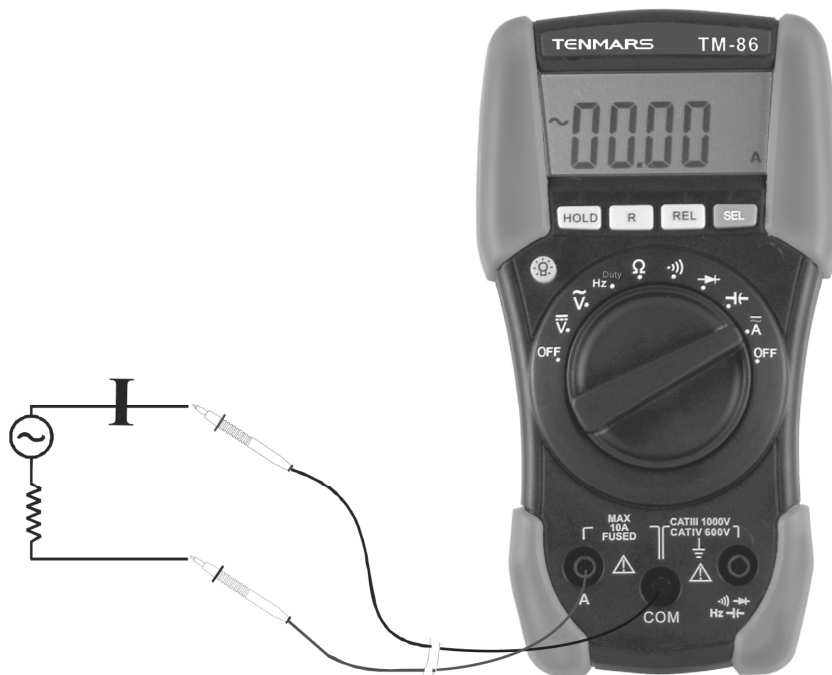


Fig. 5: Using the instrument for AC Current measurement

1. Power off the circuit under test.
2. Selecting the position **A $\tilde{\sim}$** .
3. Press the **SEL** key to select AC measurement. The “ $\tilde{\sim}$ ” symbol is shown at display.
4. Insert the test leads into the jacks, the red plug into **A** jack and black plug into **COM** jack (see Fig. 5).
5. Connect the red and the black plugs in series with the circuit whose current is to be measured respecting the polarities.
6. Energize the circuit under test. The current value will be displayed.
7. The message "**O.L.**" means that the detected current exceeds the limits.
8. For HOLD function and Relative measure please refer to paragraph 4.2.

4.3.5. Resistance measurement



CAUTION

Before taking resistance measurements on the circuit remove power from the circuit being tested and discharge all capacitors.



Fig. 6: Using the instrument for Resistance measurement

1. Selecting the position Ω .
2. Pressing the **R** key to select the correct range or using the Auto range feature (see paragraph 4.2.2). If the resistance value under test is unknown, select the highest range.
3. Insert the test leads into the jack, the red plug into **VΩHz** jack and black plug into **COM** jack (see Fig. 6).

4. Connect the test leads to the circuit under test; the resistance value is displayed.
5. If the message "O.L" is displayed a higher range must be selected.
6. For HOLD function and Relative measure please refer to paragraph 4.2.

4.3.6. Continuity test



CAUTION

Before taking resistance measurements on the circuit remove power from the circuit being tested and discharge all capacitors.

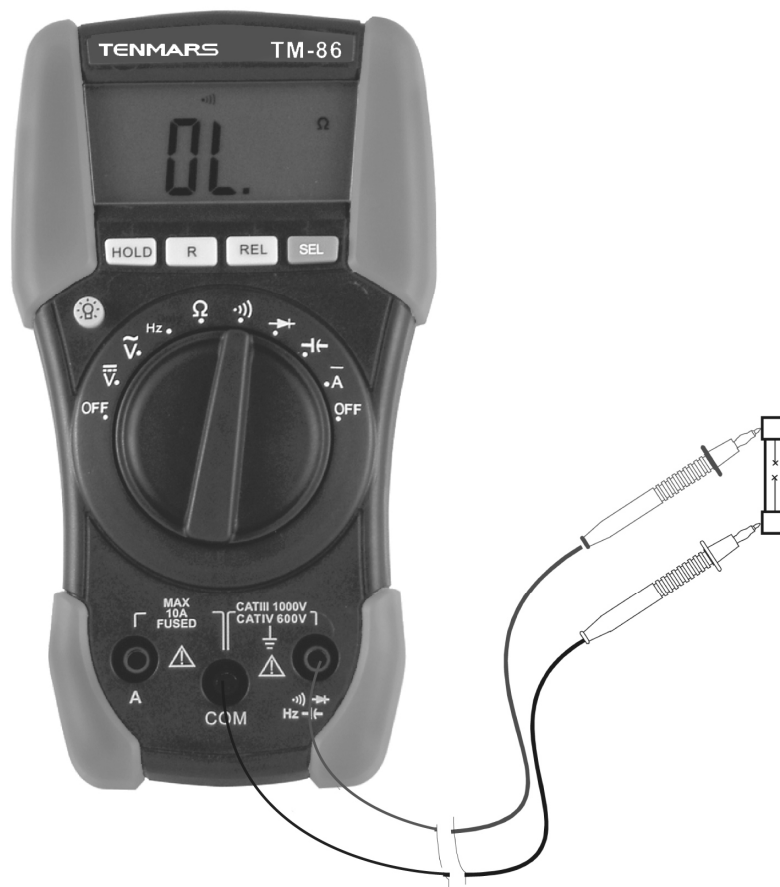




Fig. 7: Using the instrument for Continuity test

1. Selecting the position  .
2. Insert the test leads into the jacks, the red plug into  jack and black plug into **COM** jack.
3. Connect the test leads to the circuit under test.
4. The resistance value is displayed and the instrument emits a sound signal if the resistance value results to be lower than 140Ω .
5. The message "**O.L.**" on the display indicates that the resistance value is higher than 400Ω .

CAUTION



The displayed value is just indicative and does not correspond to the resistance value.

4.3.7. Diode test


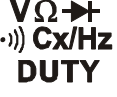
CAUTION



Before taking resistance measurements on the circuit remove power from the circuit being tested and discharge all capacitors.



Fig. 8: Using the instrument for Diode test

1. Selecting the position  .
2. Insert the test leads into the jacks, the red plug into  jack, and black plug into **COM** jack.
3. Connect the test leads to the diode under test observing the proper polarities (see Fig. 8).
4. The threshold voltage value of direct polarization is shown at display.
5. If the threshold voltage value is 0V the diode P-N junction is shorted circuit.
6. If the message “ **O.L.** ” is displayed the diode terminals are reversed, the diode P-N junction is damaged.

4.3.8. Frequency measurement



CAUTION

The maximum input for AC voltage is 600V. Do not attempt to measure higher voltages to avoid electrical shocks or damages to the instrument.

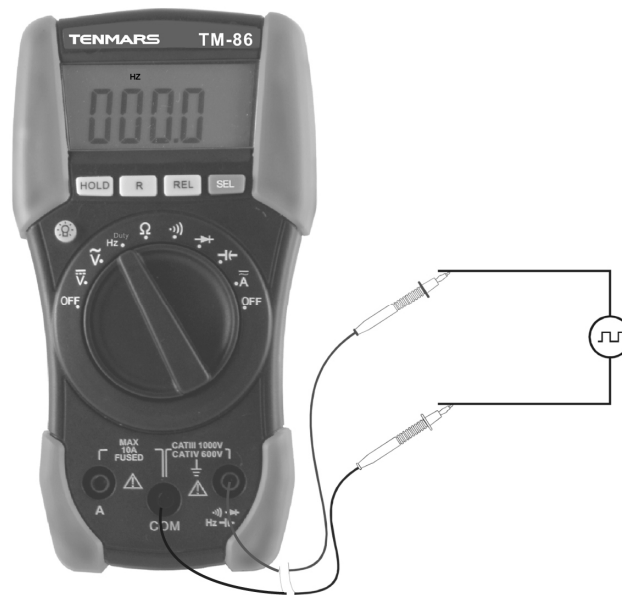


Fig. 9: Using the instrument for frequency measurement

1. Selecting the position **Hz/DUTY**. The symbol "Hz" is shown at display.
2. Insert the test leads into the jacks, the red plug into **VΩ→** jack and black plug into **COM** jack (see Fig. 9).
3. Connect the test leads to the circuit under test; the frequency value will be displayed.
4. If the message "O.L" is displayed the maximum readable value is reached.
5. For HOLD function please refer to paragraph 4.2.

4.3.9. Duty Cycle measurement

CAUTION



The maximum input for AC voltage is 600V. Do not attempt to measure higher voltages to avoid electrical shocks or damages to the instrument.

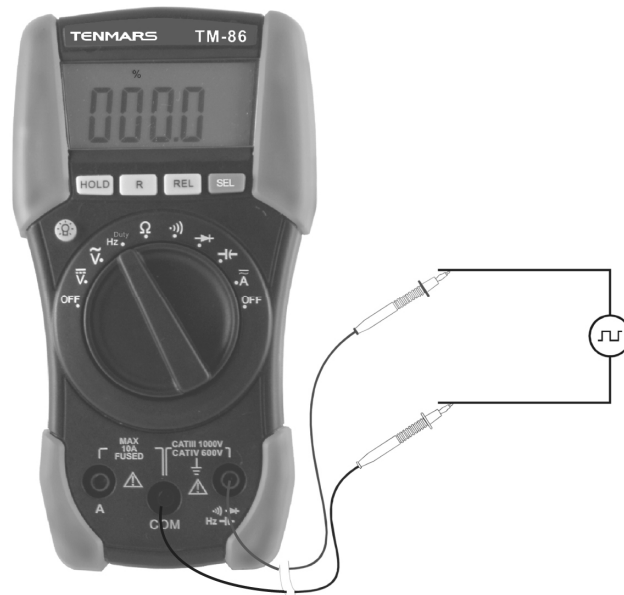


Fig. 10: Using the instrument for Duty Cycle measurement

1. Selecting the position **Hz/DUTY** and pressing **SEL** key. The symbol "%" is shown at display to meaning the measure, in percentage terms, of a Duty Cycle of a input signal as ratio between the during of "high" level and the period of the same signal.
2. Insert the test leads into the jacks, the red plug into **Cx/HZ/DUTY** jack and black plug into **COM** jack (see Fig. 10).

3. Connect the test leads to the circuit under test. The duty cycle value is shown at display.
4. If the message "O.L" is displayed the maximum readable value is reached.
5. For HOLD function please refer to paragraph 4.2.

4.3.10. Capacitance measurement

CAUTION

Before taking capacitance measurements in circuit remove power from the circuit being tested and discharge all capacitors. Use the short test lead pair for measurement to reduce the stray capacitance. Before connecting the test capacitor observe the display, which may have a reading other than zero every time the range is changed. Subtract this offset reading from the displayed reading of the test result of a capacitor to obtain the true value. Connect the test capacitor to the inputs respecting the polarity connections when required.





Fig. 11: Using the instrument for Capacitance measurement

1. Selecting the position $\rightarrow \text{C}$.
2. Insert the test leads into the jacks, the red plug into $\text{V} \Omega \rightarrow \text{C}$ jack and black plug into **COM** jack (see Fig. 11).
3. Connect the red and black test clamps to the capacitor terminals respecting if necessary the proper polarities. The capacitance value is shown on display.
4. If the message "**O.L**" is displayed the maximum readable value is reached.
5. For HOLD function and Relative measure please refer to paragraph 4.2.

5. MAINTENANCE

5.1. GENERAL INFORMATION

This is a precision instrument. To guarantee its performances be sure to use it according to these instructions and keep it stored on suitable environmental conditions Do not expose it to high temperatures or humidity or direct sunlight. Be sure to turn it off after use. If you expect not to use the instrument for a long period remove batteries to avoid leakages of battery liquid which could damage its inner components.

5.2. BATTERIES REPLACEMENT

When the low battery indication (see paragraph 6.1.2) is shown the batteries are to be replaced.




CAUTION

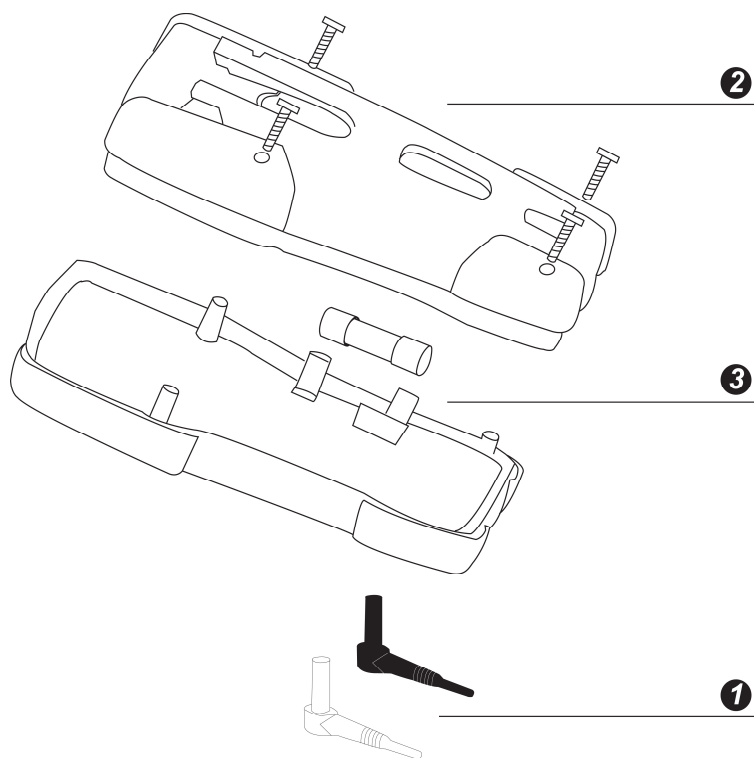
Only skilled technicians can open the instrument and replace batteries. Before removing batteries disconnect the test leads from the input terminals to avoid electrical shocks.

1. Turn off the instrument.
2. Disconnect the test leads from the input terminals.
3. Remove the fixing screws from the back case and detach it.

4. Remove all batteries replacing them with new ones of the same type (refer to paragraph 6.1.2) respecting the polarity signs.
5. Replace the back case and screws.
6. Use the appropriate battery disposal methods for your area.

5.3. FUSE REPLACEMENT

	<p style="text-align: center;">CAUTION</p> <p>Before replacing fuses, disconnect test leads from any energized circuit to avoid electrical shock.</p>
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LEGEND:

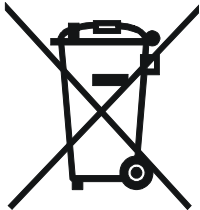
1. Turn OFF the meter and disconnect the test leads from the input terminals.
2. Unscrew the four fixing screws of the back holster and remove it.
3. Remove the defective fuse and install a new fuse of the same size and rating (fast 10A/600V Busman type). Make sure the new fuse is centered in the fuse holder. Re-screw the back holster

Fig. 12: Fuse replacement

5.4. CLEANING

To clean the instruments use a soft dry cloth. Never use a wet cloth, solvents or water.

5.5. END OF LIFE



Caution: this symbol indicates that equipment and its accessories shall be subject to a separate collection and correct disposal.

6. TECHNICAL SPECIFICATIONS

6.1. TECHNICAL FEATURES

The accuracy is indicated as [% of reading + number of digits]. It is referred to the following environmental conditions: temperature $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$, relative humidity $< 75\%$.

DC Voltage

Range	Resolution	Accuracy	Input impedance	Overload protection
400mV	0.1mV	$\pm(0.8\% \text{rdg} + 3 \text{dgt})$	10M Ω	600V DC/AC rms
4V	0.001V	$\pm(0.8\% \text{rdg} + 2 \text{dgt})$		
40V	0.01V			
400V	0.1V			
600V	1V	$\pm(1.0\% \text{rdg} + 2 \text{dgt})$		

AC Voltage

Range	Resolution	Accuracy (40÷400Hz)	Input impedance	Overload protection
400mV	0.1mV	not declared	10MΩ	600V DC/ACrms
4V	0.001V	±(1.0%rdg + 3dgt)		
40V	0.01V			
400V	0.1V			
600V	1V	±(1.2%rdg + 3dgt)		

DC Current

Range	Resolution	Accuracy (*)	Voltage drop	Overload protection
10A	0.01A	±(1.2%rdg + 3dgt)	200mV	Fusibile 10A/600V

(*)Accuracy is guaranteed for current up to: 6A continuous measurement, 7A 3 minutes uninterrupted measurement, up to 10A 2 minutes continuous measurement.

AC Current


Range	Resolution	Accuracy (*) (40÷400Hz)	Voltage drop	Overload protection
10A	0.01A	$\pm(2.0\%rdg + 5dgt)$	200mV	Fusibile 10A/600V

(*) Accuracy is guaranteed for current up to: 6A continuous measurement, 7A 3 minutes uninterrupted measurement, up to 10A 2 minutes continuous measurement.


Resistance

Range	Resolution	Accuracy	Max Open Circuit Voltage	Overload protection
400 Ω	0.1 Ω	$\pm(1.0\%rdg + 8dgt)$	circa 0.4V	600V DC/AC rms <30sec
4k Ω	0.001k Ω	$\pm(1.0\%rdg + 2dgt)$		
40k Ω	0.01k Ω			
400k Ω	0.1k Ω			
4M Ω	0.001M Ω			
40M Ω	0.01M Ω	$\pm(2.0\%rdg + 2dgt)$		

Diode Test

Feature	Direct voltage	Accuracy	Max Open Circuit Voltage	Overload protection
	0 – 1.000V	$\pm(0.5\%rdg + 3dgt)$	1.5V	600V DC/AC rms <30sec

Continuity test

Feature	Buzzer	Test Current	Max Open Circuit Voltage	Overload protection
	<140Ω	About 1mA	About 0.5V	600V DC/AC rms <30sec

Frequency (Autorange)

Range	Resolution	Accuracy	Overload protection
99.99H z	0.01Hz	$\pm(1.5\%rdg + 5dgt)$	600V DC/AC rms <30sec
999.9H z	0.1Hz		
9.999k Hz	1Hz		
99.99k Hz	10Hz		

Note: Never exceed voltage limits listed below.

Duty cycle (Autorange)

Range	Resolution	Accuracy	Overload protection
20 - 80%	0.1%	$\pm(1.0\%rdg + 5dgt)$	600VDC/ACrms <30sec

Note: Never exceed voltage limits listed below.

Voltage limits for Frequency and Duty Cycle

Working voltage	Frequency
$V_{MIN} \geq 1.5Vp-p$	0 – 400Hz
$V_{MAX} \leq 400Vrms$	
$V_{MIN} \geq 1.5Vp-p$	400 – 900Hz
$V_{MAX} \leq 10Vp-p$	
$V_{MIN} \geq 3.0Vp-p$	900Hz – 100kHz
$V_{MAX} \leq 10Vp-p$	

Capacitance (Autorange)

Range	Resolution	Accuracy	Overload protection
5nF	0.001nF	$\pm(5.0\%rdg + 25dgt)$	600VDC/ACrms <30sec
50nF	0.01nF	$\pm(3.0\%rdg + 5dgt)$	
500nF	0.1nF		
5 μ F	0.001 μ F		
50 μ F	0.01 μ F	$\pm(5.0\%rdg + 10dgt)$	
100 μ F	0.1 μ F(30s)		

6.1.1. Safety

The instrument complies with: EN 61010-1

Insulation: Class 2, Double insulation

Pollution degree: 2

Over voltage category: CAT III 1000V, CAT IV 600V

Max height: 2000m

6.1.2. General data

Mechanical characteristics


Dimensions: 163(L) x 88(W) x 48(H) mm

Weight (including batteries): approx. 280g

Power supply

Battery type: 2 batteries 1.5V AAA

MN2400 LR03 AM4

Indication of low batteries: the symbol "  " is displayed when batteries are low.

Battery life: approx. 170 hours

Display

Specifications: 3¾ LCD with max. Reading 3999 counts + symbol and decimal point

6.2.ENVIRONMENT

6.2.1. Environmental conditions

Reference temperature: 23° ± 5°C

Working temperature:	-5 ÷ 40 °C
Relative humidity:	<70%HR
Storage temperature:	-10 ÷ 60 °C
Storage humidity:	<70%HR

6.2.2. EMC

This instrument is designed and tested in compliance with the requirements of the European EMC Directive 89/336/EEC modified with 93/68/CEE and in accordance with Low Voltage Directive 73/23/EEC

6.3.ACCESSORIES

- Test leads
- User's manual
- Batteries
- Carrying Case.

7. SERVICE

7.1. WARRANTY CONDITIONS

This instrument is guaranteed against material or production defects, in accordance with our general sales conditions. During the warranty period the manufacturer reserves the right to decide either to repair or replace the product.

Should you need for any reason to return back the instrument for repair or replacement take prior agreements with the local distributor from whom you bought it. Do not forget to enclose a report describing

the reasons for returning (detected fault). Use only original packaging. Any damage occurred in transit due to no original packaging will be charged anyhow to the customer.

The manufacturer will not be responsible for any damage to persons or things.

The warranty doesn't apply to:

- Accessories and batteries (not covered by warranty).
- Repairs made necessary by improper use (including adaptation to particular applications not provided in the instructions manual) or improper combination with incompatible accessories or equipment.
- Repairs made necessary by improper shipping material causing damages in transit.
- Repairs made necessary by previous attempts for repair carried out by unskilled or unauthorized personnel.
- Instruments for whatever reason modified by the customer himself without explicit authorization of our Technical Dept.

The contents of this manual may not be reproduced in any form whatsoever without the manufacturer's authorization.

Our products are patented and our logotypes registered. We reserve the right to modify specifications and prices in view of technological improvements or developments which might be necessary.

7.2. AFTER-SALE SERVICE

Shouldn't the instrument work properly, before contacting your distributor make sure that batteries are correctly installed and working, check the test leads and replace them if necessary. Make sure that your operating procedure corresponds to the one described in this manual.

Should you need for any reason to return back the instrument for repair or replacement take prior agreements with the local distributor from whom you bought it. Do not forget to enclose a report describing the reasons for returning (detected fault). Use only original packaging. Any damage occurred in transit due to non original packaging will be charged anyhow to the customer.

The manufacturer will not be responsible for any damage to persons or things.

TENMARS



Professional Electrical and Environment Test & Measurement Instruments:

LED light meter, Temperature & Humidity meter
Infrared Thermometer, Sound level meter
Light meter, EMF meter, UV Light meter, RF meter
Hot wire Anemometer, Co meter
Anemometer, Lan cable tester, Co2 meter
Solar power meter, Radiation meter,
Clamp meter, Multimeter
Phase Rotation tester, Digital Insulation tester

**Our products of high quality are selling well
all over the world**

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