

# TENMARS

## DIGITAL CLAMP METER



**TM-1017**





User's manual

HB2TM1017000



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## 1. SAFETY PRECAUTIONS AND PROCEDURES

This instrument has been designed in compliance with EN 61010 directive. For your own safety and to avoid damaging the instrument we suggest you follow the procedures hereby prescribed and to read carefully all the notes preceded by the symbol ⚠.



### WARNING

Should you fail to keep to the prescribed instructions you could damage the instrument and/or its components or endanger your safety.

Take extreme care of the following conditions while taking measurements:

- Do not measure voltage or current in humid or wet environments.
- Do not use the clamp in the presence of explosive gas (material), combustible gas (material), steam or dust.
- Do not touch the circuit under test if no measurement is being taken;
- Do not touch exposed metal parts, unused terminals, circuits and so on;
- Do not use the instrument if it seems to be malfunctioning (i.e. if you notice deformations, breaks, leakage of substances, absence of segments on the display and so on);
- Be careful when you measure voltages exceeding 20V as you may risk electrical shocks.
- Take care not to allow your hand to pass over the Safety Guard (see Fig. 1, pos.2) on current measurements and voltage measurements using the holster.

The following symbols are used:



Caution: refer to the instruction manual. An incorrect use may damage the tester or its components



High voltage danger: risk of electric shocks



Double insulated meter



AC voltage or current



DC voltage or current



Application around and removal from hazardous live conductors is permitted

### 1.1. PRELIMINARY INSTRUCTIONS

- This clamp has been designed for use in environments of pollution degree 2.
- It can be used for **CURRENT** measurements on installations of over voltage category III up to 600V (voltage between phase and earth) and for **VOLTAGE** and **FREQUENCY** measurements on installations of over voltage category III up to 600V (voltage between terminals and between phase and earth).
- Please use the standard safety precautions aimed at:
  - ♦ Protecting you against dangerous electric currents.
  - ♦ Protecting the instrument against incorrect operations.
- Only the leads supplied with the instrument guarantee compliance with the safety standards. They must be in good condition and, if necessary, be replaced with identical leads.
- Do not test circuits exceeding the current and voltage limits.
- Do not perform any test under environmental conditions exceeding the limits indicated in paragraphs 6.2.1.
- Assure the batteries are installed correctly.
- Before connecting the test leads to the circuit to be tested, make sure that the rotary selector switch is set to the correct function.
- Make sure that the LCD and rotary selector switch indicate the same function.

### 1.2. DURING USE



#### WARNING

Non compliance with warnings and/or instructions may cause damage to the tester or its components or injure the operator.

- Remove the clamp jaw from the conductor or circuit under test before changing the range.
- When the tester is connected to the measuring circuits, do not touch any unused terminal.
- Do not measure resistance in the presence of external voltages. Even if the circuit is protected, excessive voltage could cause the instrument to malfunction.
- When measuring current with the clamp jaws, first remove the test leads from the instrument's input jacks.
- When measuring current, any other source near the clamp jaw could affect its accuracy.
- When measuring current, always put the conductor to be tested in the middle of the clamp jaw to obtain the most accurate reading as referred into paragraph 4.1.2.
- While measuring, if the value remains unchanged check if the HOLD function is enabled.

### 1.3. AFTER USE

- After taking measurements turn off the clamp.
- If the instrument is not be used for a long period, remove the battery.

#### 1.4. DEFINITION OF MEASURING (OVERVOLTAGE) CATEGORY

The norm EN 61010: Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements, defines what a measuring category, usually called overvoltage category, is.

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 overcurrent 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

Thanks to a new development concept assuring double insulation as well as compliance with category III up to 600V you can rely on the utmost safety conditions (see chapter 1.4).

This instrument can perform the following measurements:

- AC voltage ( $V_{AC}$ ) with TRMS conversion mode.
- DC voltage ( $V_{DC}$ ).
- AC current ( $I_{AC}$ ) with TRMS conversion mode.
- Harmonic AC voltage (from DC to 25<sup>th</sup> components)
- Harmonic AC current (from 1<sup>st</sup> to 25<sup>th</sup> components).
- Frequency with input test leads.
- Frequency with clamp jaws.
- Resistance.
- Continuity test.
- Phase rotation with only one test lead.
- Active, reactive, apparent power and power factor measure on single-phase systems.
- Active, reactive, apparent power and power factor measure on balanced three phase systems.
- Active, reactive, apparent energy measurements on single-phase systems.
- Active, reactive, apparent energy measurements on balanced three phase systems.

Each parameter can be selected using the 7-position rotary switch, including an OFF position. There are also the following buttons: "⊙ FUNC", "MAX/MIN/PK", "ENERGY" and "D-H / ☼" or "⊙ FUNC / HARM", "MAX/MIN/PK / H↓", "ENERGY / H↑" and "D-H / ☼". For their use please see paragraph 4.2. The selected quantity appears on a high-contrast display with unit and function indication.

### 3. PREPARATION FOR USE

#### 3.1. PRELIMINARY CHECKS

This instrument has been checked mechanically and electrically before shipment. All precautions have been taken to assure that the instrument reaches you in perfect condition.

However, it is advisable to carry out a rapid check in order to detect any possible damage, which might have occurred in transit.

Check the accessories contained in the packaging to make sure they are the same as reported in paragraph 6.3.1.

#### 3.2. POWER SUPPLY

The instrument is supplied with 2 AAA batteries. The instruments battery life is about 90 hours.

The "⊕-" symbol appears when the batteries are nearly discharged. Replace them following the instructions in paragraph 5.2.

#### 3.3. CALIBRATION

The tester complies with the accuracy specifications listed in this manual and such compliance is guaranteed for one year, afterwards the tester may need recalibration.

#### 3.4. STORAGE

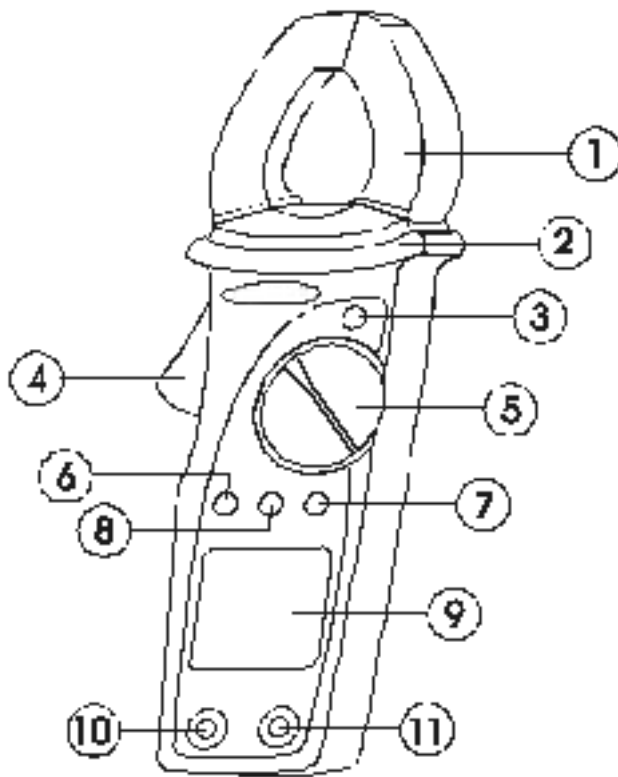
In order to guarantee the accuracy of the measurements, after a period of storage in extreme environmental conditions wait for the tester to stabilize to within the specified operating conditions (see environments specifications paragraph 6.2.1) before use.



## 4. OPERATING INSTRUCTIONS

### 4.1. INSTRUMENT DESCRIPTION

#### 4.1.1. Controls description



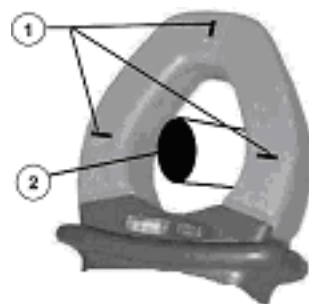
#### LEGEND:

1. Inductive clamp jaw.
2. Safety guard.
3. **D-H**, key.
4. Jaw trigger.
5. Rotary selector switch.
6. **ENERGY / H↑** key .
7. **FUNC / HARM** key .
8. **MAX/MIN/PK / H↓** key .
9. LCD display.
10. COM jack.
11. V/Ω jack.

Fig. 1: Instrument description

#### 4.1.2. Alignment marks

Put the conductor within the jaws on intersection of the indicated marks as close as possible (see Fig. 2) in order to meet the meter accuracy specifications.



#### LEGEND:

1. Alignment marks.
2. Conductor.

Fig. 2: Alignment marks.

#### 4.1.3. Rubber cap use to hold test leads

A rubber holster is provided with the instrument. This standard accessory, when fitted on the top of the clamp, can hold one of the two test leads, as shown in Fig. 3.




Fig. 3: Use of rubber test lead holster

This rubber holster has a very practical use. It allows the user to perform the measurements with both test leads while, more easily, observing the value on the display at the same time.

#### 4.1.4. AUTO POWER OFF function

In order to extend the battery life, the instrument switches off 5 minutes after the last rotary switch or button actuation.

When this function is enabled the symbol  is displayed.









To disable this function rotate the selector to the OFF position, then rotate the selector to any position while the  **FUNC** key is pressed.


Rotating the selector switch to the OFF position then back to any function again will re-enable the AUTO POWER OFF function.





## 4.2. DESCRIPTION OF FUNCTION KEYS

### 4.2.1. FUNC key


This key allows the user to cycle through each function's measurement modes with each key press.


- **V** : press  **FUNC** key to select between voltage and frequency measurement.
- **A** : press  **FUNC** key to select between current and frequency measurement.
- : press  **FUNC** key to start phase sequence detection.
- **W**: press  **FUNC** key to select between active energy, reactive energy, apparent energy, and power factor measurements on single-phase systems.
- **W3Φ**: press  **FUNC** key to select between active energy, reactive energy, apparent energy, and power factor measurements on three phase balanced systems.

Press & hold the  **FUNC** key for at least 1 second to activate the "Harmonic measurement mode". With the rotary selector switch in the following positions:

- **V** : press and hold the  **FUNC** key for at least 1 second to activate the voltage harmonic measurement. By pressing the **H**↑ and **H**↓ keys the individual harmonic values are displayed.
- **A** : press and hold the  **FUNC** key for at least 1 second to activate the current harmonic measurement. By pressing the **H**↑ and **H**↓ keys the individual harmonic values are displayed.

This function mode is disabled by:


- Pressing and holding the  **FUNC** key for at least 1 second.
- Rotating the selector to any other position.

More details about the  **FUNC** key use are specified in the measurements paragraphs.

### 4.2.2. **D-H** / key

This key enables the HOLD function. The symbol "**H**" is displayed when this function is enabled. To disable this function:

- Press the **D-H** key again
- Rotate the rotary selector switch to another position.

Press and hold the  key for 1 second to illuminate the backlight. The backlight automatically turns off about 5 seconds after the last rotary selector switch or button actuation.



### 4.2.3. **MAX/MIN/PK** key

By pressing and holding the **MAX/MIN/PK** key for at least 1 second, the instrument activates the maximum (**MAX**), minimum (**MIN**), average (**AVG**) and peak (**PK**) measurement modes. All of these values are continually updated even if only one of them is displayed. By repeatedly pressing the **MAX/MIN/PK** key each value is displayed with the corresponding frequency. To disable this function:

- Press and hold the **MAX/MIN/PK** key for at least 1 second.
- Rotate the selector to any position.

#### 4.2.4. ENERGY key

With the rotary selector on "**W**" or "**W3Φ**" position, press and hold this key at least 1 second to activate the energy measurement. With the rotary selector switch in the following positions:

- **W**: push the **ENERGY** key to start the active energy, reactive energy, apparent energy and power factor measurements on single-phase systems. Pushing  **FUNC** key every single parameter value is displayed.
- **W3Φ**: push the **ENERGY** key to start the active energy, reactive energy, apparent energy and power factor measurements on three phase-balanced systems. Pushing  **FUNC** key every parameter value is displayed.

### 4.3. DESCRIPTION OF ROTARY SWITCH FUNCTIONS

#### 4.3.1. AC / DC voltage measurement



#### WARNING

- The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.
- The instrument won't measure any AC value less than 1.5V.

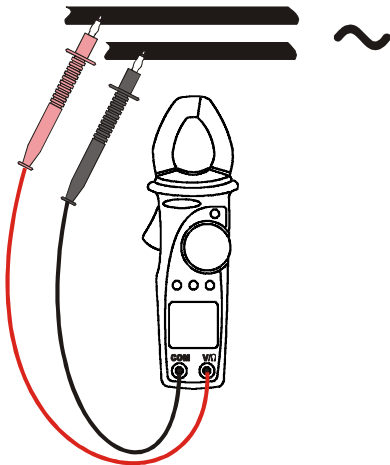


Fig. 4: AC voltage measurement

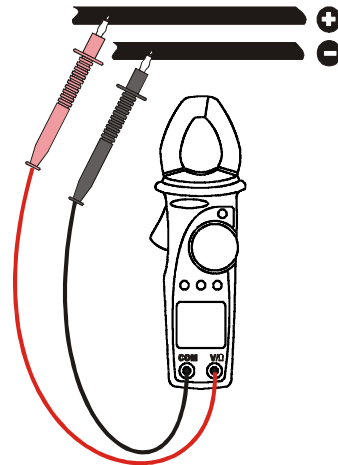



Fig. 5: DC voltage measurement

1. Select the "**V**  $\approx$ " position.
2. Insert the red lead into V/ $\Omega$  jack and the black lead into the COM jack. For ease of use, attach the rubber holster and insert a test lead (see Fig. 3).
3. Connect the test leads to the circuit under test (see Fig. 4 and Fig. 5). The instrument automatically selects AC or DC. For AC voltage measurements the frequency value is shown on the secondary display.
4. The "-" symbol indicates a negative DC voltage polarity.
5. The "**O.L**" symbol indicates a voltage higher than the full-scale capability of the instrument.
6. If the displayed value varies rapidly and reading it is difficult, press the **D-H** key to hold the displayed value. To disable this function press the **D-H** key again.
7. If the measurement is being performed in a dark environment, press and hold the  key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

By pressing and holding the **MAX/MIN/PK** key for at least 1 second, the instrument enables the maximum (MAX), minimum (MIN), average (AVG) and peak (PK) measurement recording mode. All of these values are continually updated even if only one is shown. Momentary **MAX/MIN/PK** keystrokes will cycle the display through these recorded values with their corresponding frequencies. To disable this function press and hold the **MAX/MIN/PK** key for at least 1 second or turn the selector to any other position.

#### 4.3.2. Frequency measurement (with test leads)



#### WARNING

- The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.
- The instrument won't measure any AC value less than 1.5V.

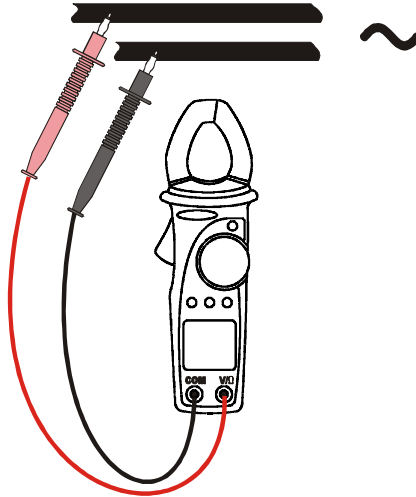



Fig. 6: frequency measurement with test leads

1. Select the "**V** ~" position.
2. Press the **FUNC** key to select the **Hz** function (in AC mode). Press the **FUNC** key again to return to the voltage measurement function.
3. Insert the red plug into V/Ω jack and the black plug into the COM jack. For ease of use, attach the rubber holster and insert a test lead (see Fig. 3).
4. Connect the test leads to the circuit under test (see Fig. 6). The measured frequency value is displayed.
5. The "**O.L**" symbol indicates a voltage higher than the full-scale capability of the instrument.
6. If the display is difficult to read, press **D-H** key to hold the measured value. To disable this function press the **D-H** key again.
7. If the measurement is being performed in a dark environment, press the  key for at least 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

By pressing and holding pressed **MAX/MIN/PK** key at least for 1 second, the instrument activates the maximum (MAX), minimum (MIN) and average (AVG) measurements. All these values are continually updated even if only one of them is shown. With a simple **MAX/MIN/PK** key pushing the values are cyclically displayed. To escape this function press and hold pressed **MAX/MIN/PK** key at least for 1 second or turn the selector to any position.

#### 4.3.3. Measurement of voltage harmonics



#### WARNING

- The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.
- Harmonic voltage measure is active for AC voltage on inputs only.

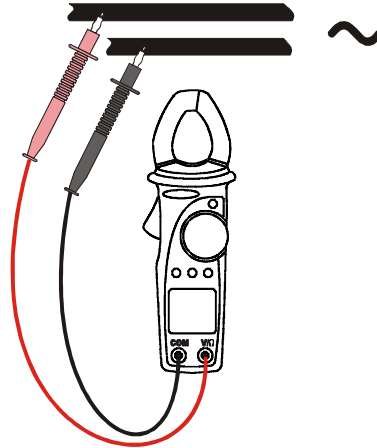



Fig. 7: voltage harmonic analysis

1. Select the "**V** ~" position.
2. Press **FUNC** key and keep it pressed at least 1 second until symbol "**THD%**" is displayed.
3. Insert the red plug into V/Ω jack and the black plug into COM jack. For ease of use, attach the rubber test lead holster and insert a test lead (see Fig. 3).
4. Connect the test leads to the circuit under test (see Fig. 6). The instrument displays the Total Harmonic Distortion value of the input signal. The symbol "**THD%**" is shown on the display. See chapter 6 for the parameter's definition.
5. With the **H↑** and **H↓** keys you can cycle through all available harmonic values from DC to the 25<sup>th</sup> order. On the secondary display is shown the order of the harmonic whose percentage value is displayed on the main one (ex. **H3%** means third harmonic).
6. Press the **FUNC** key to switch to the absolute harmonics' values displaying (from DC to 25<sup>th</sup> order). On the secondary display is shown the order of the harmonic whose absolute value is displayed on the main one (ex. **H3** means third harmonic).
7. If the display is difficult to read, press **D-H** key to hold the measured value. To disable this function press the **D-H** key again.
8. If the measurement is being performed in a dark environment, press and hold the  key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.
9. Press **FUNC** key to escape this mode going back to voltage measurement function (see paragraph 4.3.1).

#### 4.3.4. Resistance and continuity measurement



#### WARNING

Before attempting any resistance measurement remove the power from the circuit under test and discharge all the capacitors, if present.

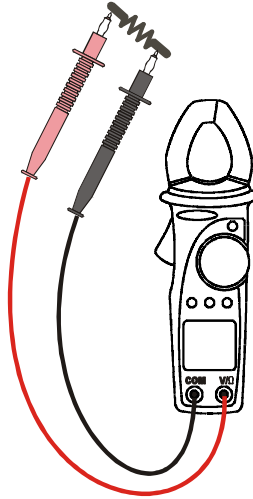



Fig. 8: resistance and continuity measurements

1. Select the " $\Omega$ •" position.
2. Insert the red plug into V/ $\Omega$  jack and the black plug into COM one. For an easy measurement use the rubber test lead holster inserting in it one test lead (see Fig. 3).
3. Connect the test leads to the circuit under test (see Fig. 8). The measured resistance value is displayed.
4. An audible beep sounds when the measured value is lower than 40 $\Omega$ .
5. The symbol "**O.L**" means that the measured voltage is higher than the full scale of the instrument.
6. If the display is difficult to read, press **D-H** key to hold the measured value. To disable this function press the **D-H** key again.
7. If the measurement is being performed in a dark environment, press and hold the  key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

By pressing and holding pressed **MAX/MIN/PK** key at least for 1 second, the instrument activates the maximum (MAX), minimum (MIN) and average (AVG) measurements. All these values are continually updated even if only one of them is shown. With a simple **MAX/MIN/PK** key pushing the values are cyclically displayed. To escape this function press and hold pressed **MAX/MIN/PK** key at least for 1 second or turn the selector to any position.

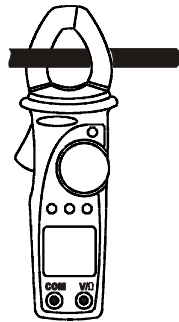


#### 4.3.5. AC current measurement

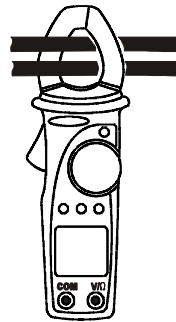


### WARNING

Before attempting any measurement disconnect all the test leads from the circuit under test and from the meter's input terminals.




**CORRECT**



**INCORRECT**

Fig. 9: AC current measurements

1. Select the "**A~**" position.
2. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 9). The values of current and frequency are shown on the main and secondary displays.
3. The symbol "**O.L**" means that the measured voltage is higher than the full scale of the instrument.
4. If the display is difficult to read, press the **D-H** key to hold the measured value. To disable this function press the **D-H** key again.
5. If the measurement is being performed in a dark environment, press and hold the  key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

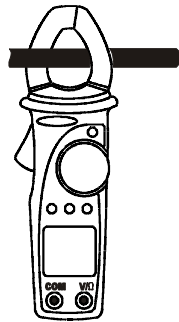
By pressing and holding the **MAX/MIN/PK** key at least for 1 second, the instrument activates the maximum (MAX), minimum (MIN), average (AVG) and peak (PK) measurements. All of these values are continually updated even if only one of them is displayed. With a simple **MAX/MIN/PK** key press the values are cyclically displayed including frequency (except for peak measurements which maximum value's frequency is associated to). To escape this function press and hold the **MAX/MIN/PK** key at least for 1 second or turn the selector to any other position.

#### 4.3.6. Frequency measurement (from the jaws)

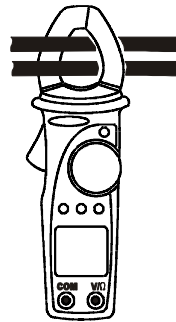


### WARNING

Before attempting any measurement disconnect all the test leads from the circuit under test and from the meter's input terminals.




**CORRECT**



**INCORRECT**

Fig. 10: frequency measurements from the jaws

1. Select the "**A~**" position.
2. Press **FUNC** key to select **Hz** function.
3. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 10). The value of frequency is shown on main display.
4. The symbol "**O.L**" means that the measured voltage is higher than the full scale of the instrument.
5. If the display is difficult to read, press **D-H** key to hold the measured value. To disable this function press the **D-H** key again.
6. If the measurement is being performed in a dark environment, press and hold the  key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.
7. Press **FUNC** key to escape this mode going back to current measurement function (see paragraph 4.3.5).

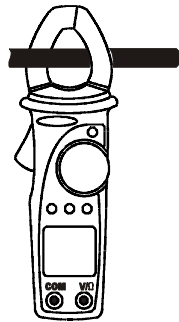
By pressing and holding pressed **MAX/MIN/PK** key at least for 1 second, the instrument activates the maximum (MAX), minimum (MIN) and average (AVG) measurements. All these values are continually updated even if only one of them is shown. With a simple **MAX/MIN/PK** key pushing the values are cyclically displayed. To escape this function press and hold pressed **MAX/MIN/PK** key at least for 1 second or turn the selector to any position.

#### 4.3.7. Measurement of current harmonics

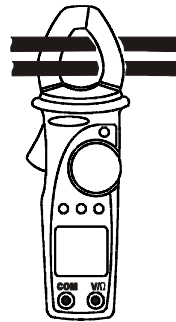


#### WARNING

Before attempting any measurement disconnect all the test leads from the circuit under test and from the meter's input terminals.



**CORRECT**



**INCORRECT**

Fig. 11: harmonic current measurement

1. Select the "**A~**" position.
2. Press the **FUNC** key and keep it pressed at least 1 second until symbol "**THD%**" is displayed.
3. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 11). The instrument displays the Total Harmonic Distortion value of the input signal. The symbol "**THD%**" is displayed. See chapter 6 for the parameter's definition.
4. With the **H↑** and **H↓** keys you can cycle through all available harmonic values from the 1<sup>st</sup> to the 25<sup>th</sup> order. On the secondary display is shown the order of the harmonic whose percentage value is displayed on the main one (ex. **H3%** means third harmonic).
5. Press the **FUNC** key to switch to the absolute harmonics' values displaying (from 1<sup>st</sup> to 25<sup>th</sup> order). The secondary display indicates the order of the harmonic whose absolute value is displayed on the main one (ex. **H3** means third harmonic).
6. If the display is difficult to read, press **D-H** key to hold the measured value. To disable this function, press the **D-H** key again.
7. If the measurement is being performed in a dark environment, press and hold the key for 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

#### 4.3.8. Power measurements on single phase systems



#### WARNING

The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.

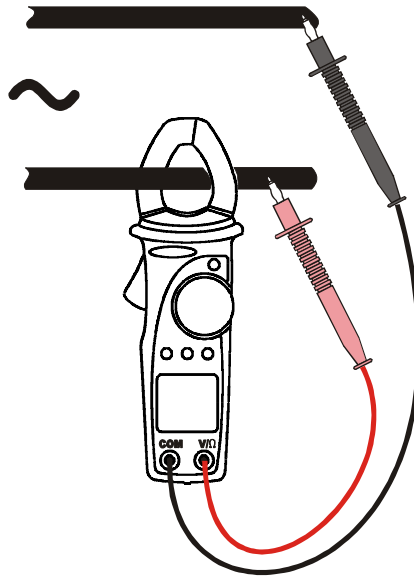





Fig. 12: power and energy measurement on single phase systems

1. Select the **"W"** position.
2. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 12).
3. Insert the red plug into V/ $\Omega$  jack and the black plug into COM one.
4. Connect the test leads to the circuit under test (see Fig. 12). The measured active power value and the symbol **"AC"** are displayed.
5. If the symbol **"⚠"** is displayed the input voltage and/or current value is higher than the instrument's full scale. Therefore the power and power factor values could be incorrect.
6. By pressing the **FUNC** key the following parameters are shown:
  - Active power (kW);
  - Reactive power (kVA<sup>R</sup>, capacitive **C**, inductive **I**);
  - Apparent power (kVA);
  - Power factor (Pfi or Pfc for inductive and capacitive respectively).
7. If reading the display is difficult, press the **D-H** key to hold the value. To disable this function press **D-H** key again.
8. If the measuring in a dark environment, press and hold the  key for at least 1 second to activate the backlight. It automatically turns OFF after 5 seconds.

By pressing and holding the **MAX/MIN/PK** key for at least 1 second, the instrument activates the maximum (MAX), minimum (MIN) and average (AVG) measurements. All these values are continually updated even if only one of them is displayed. With a simple **MAX/MIN/PK** key press the values are cyclically displayed. To escape this function press and hold the **MAX/MIN/PK** key at least for 1 second or turn the selector to any position.

#### 4.3.8.1. Energy measurements on single phase systems

1. Select the "**W**" position.
2. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 12).
3. Insert the red plug into V/ $\Omega$  jack and the black plug into COM one.
4. Connect the test leads to the circuit under test (see Fig. 12). The measured active power value and the symbol "**AC**" are displayed.
5. If the symbol " $\triangle$ " is displayed the input voltage and/or current value is higher than the instrument's full scale. Therefore the power and power factor values could be incorrect.
6. Press and hold the **ENERGY** key for at least 1 second to active the energy measurement mode.
7. By pressing the  **FUNC** key the following parameters are displayed:
  - Active energy (kWh);
  - Reactive energy (kVA<sup>Rh</sup>, capacitive **C**, inductive **I**);
  - Apparent energy (kVAh);
  - TIME with indication of energy measurement duration.
8. Press the **ENERGY** key to activate the energy measurement. The message "**MEASURING**" appears at the bottom of the display. Press the **ENERGY** key again to stop the energy measurement, the message "**MEASURING**" disappears from the display.
9. If the reading were difficult, press **D-H** key to hold the obtained value. To escape this function press the **D-H** key again.
10. If the measurement was performed in dark environments, press and hold the  key at least for 1 second to activate the backlight that is automatically turned OFF after 5 seconds.
11. Push **ENERGY** key and keep it pressed at least 1 second to escape from the energy measurement mode.

#### 4.3.9. Power measurements on three phase balanced systems



### WARNING

The maximum input for Voltage measurements is 600V. Do not attempt to take any voltage measurement exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock at the operator and damages to the clamp meter.

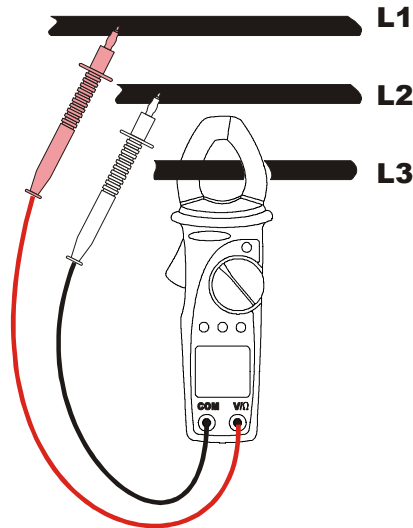





Fig. 13: power and energy measurement on three phase balanced systems

1. Select the "**W3Φ**" position.
2. Open the jaws and clamp the L3 phase cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 13).
3. Insert the red plug into V/Ω jack and the black plug into COM one.
4. Connect the red test lead to L1 phase conductor and the black test lead to L2 phase conductor (see Fig. 13). The measured active power value and the symbol "**AC**" are displayed.
5. If the symbol "⚠" is displayed the input voltage and/or current value is higher than the instrument's full scale. Therefore the power and power factor values could be incorrect.
6. By pressing the **FUNC** key the following parameters are displayed:
  - Active power (kW);
  - Reactive power (kVA<sup>R</sup>, capacitive **C**, inductive **I**);
  - Apparent power (kVA);
  - Power factor (Pfi or Pfc for inductive and capacitive respectively).
7. If the reading were difficult, press **D-H** key to hold the obtained value. To escape this function press the **D-H** key again.
8. If the measurement was performed in dark environments, press at least for 1 second the  key to activate the backlight that is automatically turned OFF after 5 seconds.

By pressing and holding the **MAX/MIN/PK** key for at least 1 second, the instrument activates the maximum (MAX), minimum (MIN) and average (AVG) measurements. All these values are continually updated even if only one of them is displayed. With a simple **MAX/MIN/PK** key press the values are cyclically displayed. To escape this function press and hold the **MAX/MIN/PK** key at least for 1 second or turn the selector to any position.

#### 4.3.9.1. Energy measurement on three phase balanced systems

1. Select the "**W3Φ**" position.
2. Open the jaws and clamp the L3 phase cable. Pay attention to the alignment marks (see paragraph 4.1.2. and Fig. 13).
3. Insert the red plug into V/Ω jack and the black plug into COM one.
4. Connect the red test lead to L1 phase conductor and the black test lead to L2 phase conductor (see Fig. 13). The measured active power value and the symbol "**AC**" are displayed.
5. If the symbol "⚠" is displayed the input voltage and/or current value is higher than the instrument's full scale. Therefore the power and power factor values could be incorrect.
6. Push **ENERGY** key and keep it pressed at least 1 second to active the energy measurement.
7. By pressing the  **FUNC** key the following parameters are displayed:
  - Active energy (kWh);
  - Reactive energy (kVA<sup>Rh</sup>, capacitive **C**, inductive **I**);
  - Apparent energy (kVAh);
  - TIME with indication of energy measurement duration.
8. Press the **ENERGY** key to activate the energy measurement. The counter is activated and the message "**MEASURING**" is showed on the bottom of the display. Press again **ENERGY** key to stop the energy measurement, the message "**MEASURING**" disappears from the display.
9. If the reading were difficult, press **D-H** key to hold the obtained value. To escape this function press the **D-H** key again.
10. If the measurement was performed in dark environments, press at least for 1 second the  key to activate the backlight that is automatically turned OFF after 5 seconds.
11. Push the **ENERGY** key and keep it pressed at least 1 second to escape from the energy measurement.

## 4.3.10. Detection of phase sequence

**WARNING**

The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.

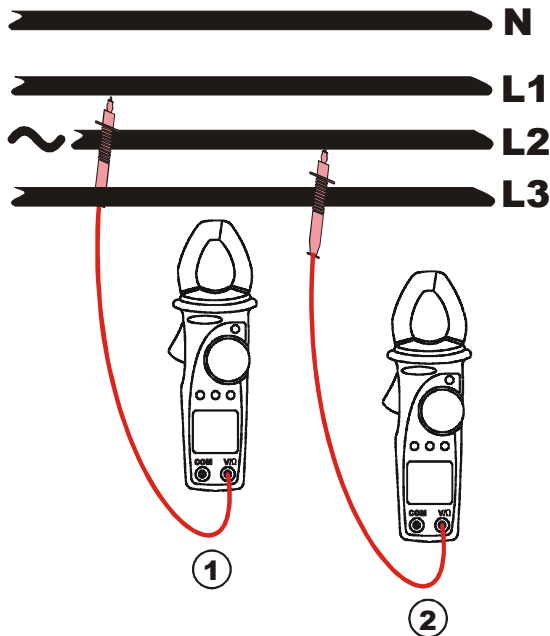


Fig. 14: phase rotation detection

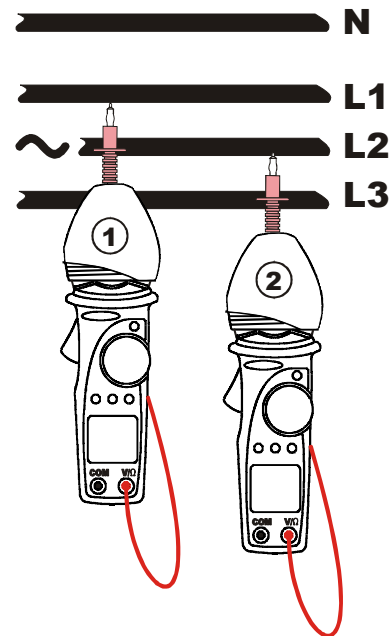



Fig. 15: phase rotation detection with rubber cup

1. Select the “” position.
2. Insert the red lead into V/ $\Omega$  jack.
3. The symbol “**1PH**” will appear on the secondary display. The instrument is ready to perform the first measurement.
4. Connect the red terminal to the L1 phase conductor (see Fig. 14, 1<sup>st</sup> measurement). If necessary use the rubber test lead holster and insert the red test lead (see Fig. 15, 1<sup>st</sup> measurement).

**WARNING**

During this measurement:


- The instrument must be held in the operator's hand.
- The test lead cable must not be in contact with or near to any voltage source that, due to instrument sensitivity, can abort the measurement.

5. When an input voltage greater than 80V is detected the buzzer sounds and the symbol “**PH**” is shown on the main display. Don't press any key and keep the test lead connected to L1 phase cable.

**WARNING**

If the input voltage value is less to 80V the instrument doesn't show “**PH**” symbol and it's not possible to execute the phase rotation detection.




6. After about one second **"MEASURING"** appears on the display indicating that the instrument is ready to execute the first measurement.
7. Press the  **FUNC** key, the **"MEASURING"** message will disappear.
8. Disconnect the test lead and the symbol **"2PH"** appears on the secondary display, the instrument is ready to perform the second measurement.
9. Connect the test lead to the L2 phase conductor (see Fig. 14 or Fig. 15, 2<sup>nd</sup> measurement).
10. When an input voltage greater than 80V is detected the buzzer sounds and the symbols **"PH"** is shown on the main display. Don't press any key and keep the test lead connected to L2 phase cable.




### WARNING

If the input voltage value is less to 80V instrument doesn't show **"PH"** symbol and it's not possible to execute the phase rotation detection.

11. After about one second **"MEASURING"** appears on the display indicating that the instrument is ready to execute the second measurement.
12. Press the  **FUNC** key, the **"MEASURING"** message will disappear.



### WARNING

If you Wait more than 10 seconds between the first  **FUNC** key press and the second, the instrument will display the **"SEC"** message and it's necessary to repeat all the measurements from the beginning. Rotate the selector to any position to escape the function and restart at step 1.

13. If the two tested phases follow the correct sequence, the instrument displays **"1.2.3."**, otherwise it displays **"2.1.3."** indicating an incorrect phase sequence.



### WARNING

- The detected voltage is NOT the phase to neutral voltage, but the voltage between the conductor and the operator who is holding the instrument. This value can be lower than the phase to neutral voltage. **DON'T TOUCH THE PHASE CABLE IF YOU AREN'T SURE THAT ANY VOLTAGE IS PRESENT.**
- If the operator is insulated from the ground (e.g. insulated floors, shoes with rubber soles, etc.) the instrument may not measure correctly. We recommend repeating test at least twice due to verify the rightness of the obtained result.

#### 4.3.10.1. Detection of phase coincidence

The purpose of this measurement is to verify the correct phase between 2 conductors before executing a parallel connection.



#### WARNING

The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.

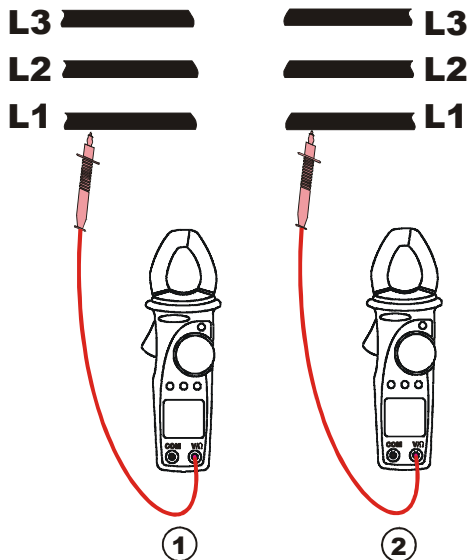


Fig. 16: phase detection

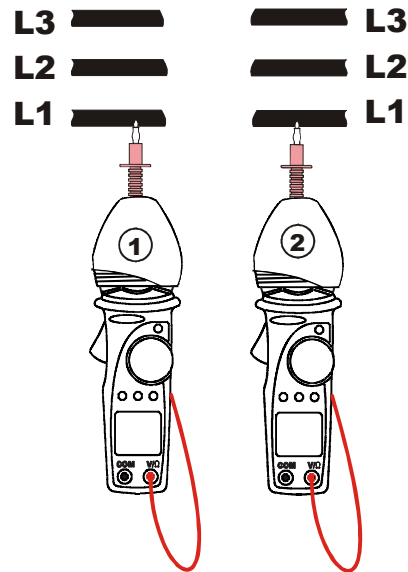



Fig. 17: phase detection with rubber cup

1. Select the “” position.
2. Insert the red plug into V/ $\Omega$  jack.
3. The symbol “1PH” is shown on the secondary display, the instrument is ready to perform the first measurement.
4. Connect the red terminal to the L1 phase conductor (see Fig. 16, 1<sup>st</sup> measurement). If necessary use the rubber cup to insert red test lead (see Fig. 17, 1<sup>st</sup> measurement).



#### WARNING

During this measurement:


- The instrument must always be held in the operator's hand.
- The test lead cable must not be in contact with or near to any voltage source that, due to instrument sensitivity, can abort the measurement.

5. When an input voltage greater than 80V is detected the buzzer sounds and the symbols “PH” is shown on the main display. Don't press any key and keep the test lead connected to L1 phase cable.



#### WARNING


If the input voltage value is less to 80V the instrument doesn't show the “PH” symbol and it's not possible to execute the phase rotation detection.

6. After about one second **"MEASURING"** appears on the display indicating that the instrument is ready to execute the first measurement.
7. Press the  **FUNC** key, the **"MEASURING"** symbol will disappear.
8. Disconnect the test lead. The symbol **"2PH"** appears on the secondary display. The instrument is now ready to perform the second measurement.
9. Connect the test lead to the second cable (see Fig. 14 or Fig. 15, 2<sup>nd</sup> measurement).
10. When an input voltage greater than 80V is detected the buzzer sounds and the symbols **"PH"** is shown on the main display. Don't press any key and keep the test lead connected to L1 phase cable.




### WARNING

If the input voltage value is less to 80V instrument doesn't show **"PH"** symbol and its not possible to execute the phase rotation detection.

11. After about one second **"MEASURING"** appears indicating the instrument is ready to execute the second measurement.
12. Press the  **FUNC** key, the **"MEASURING"** symbol disappears.



### WARNING

If you Wait more than 10 seconds between the first  **FUNC** key press and the second, the instrument will display the **"SEC"** message and it's necessary to repeat all the measurements from the beginning. Rotate the selector to any position to escape the function and restart at step 1.

13. If the two test cables belong to the same phase, the instrument displays **"1.1.-."**, otherwise it displays **"2.1.3."** or **"1.2.3."** This indicates that the two cables belong to two different phases.



### WARNING

- The detected voltage is NOT the phase to neutral voltage, but the voltage between the conductor and the operator who is holding the instrument. This value can be lower than the phase to neutral voltage. **DON'T TOUCH THE PHASE CABLE IF YOU AREN'T SURE THAT ANY VOLTAGE IS PRESENT.**
- If the operator is insulated from the ground (e.g. insulated floors, shoes with rubber soles, etc.) the instrument may not measure correctly. We recommend repeating test at least twice due to verify the rightness of the obtained result.

## 4.3.10.2. Phase detection

**WARNING**

The maximum Voltage input is 600V. Do not attempt to take any voltage measurements exceeding the limits indicated in this manual. Exceeding the limits could cause electrical shock or damage to the instrument.

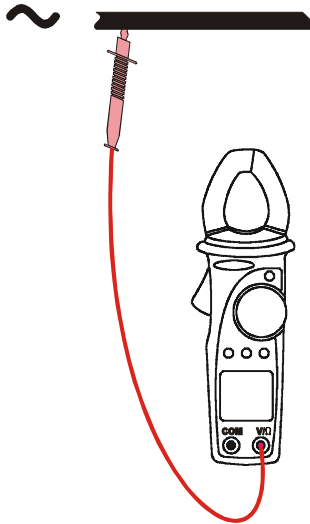


Fig. 18: Voltage detection

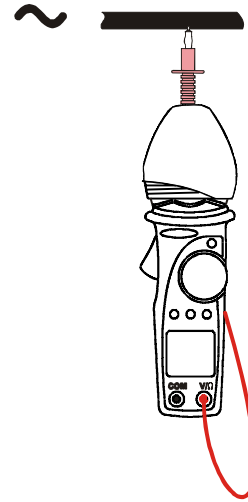



Fig. 19: Voltage detection with rubber cup

1. Select the “” position.
2. Insert the red plug into V/Ω jack.
3. Connect the red terminal to the L1 phase conductor (see Fig. 18, 1<sup>st</sup> measurement). If necessary use the rubber cup to insert red test lead (see Fig. 19, 1<sup>st</sup> measurement).
4. When an input voltage greater than 80V is detected the buzzer emits a sound and the symbols “**PH**” is shown on the main display.

**WARNING**

During this measurement:

- The instrument must be held in the operator's hand.
- The test lead cable must not be in contact with or near to any voltage source that, due to instrument sensitivity, can abort the measurement.

**WARNING**

- The detected voltage is NOT the phase to neutral voltage, but the voltage between the conductor and the operator who is holding the instrument. This value can be lower than the phase to neutral voltage. **DON'T TOUCH THE PHASE CABLE IF YOU AREN'T SURE THAT ANY VOLTAGE IS PRESENT.**
- If the operator is insulated from the ground (e.g. insulated floors, shoes with rubber soles, etc.) the instrument may not measure correctly. We recommend repeating test at least twice due to verify the rightness of the obtained result.

## 5. MAINTENANCE

### 5.1. GENERAL INFORMATION

1. This digital clamp meter is a precision instrument. Whether in use or in storage, please do not exceed the specifications to avoid any possible damage or danger during use.
2. Do not place this meter in high temperature and/or humidity or expose to direct sunlight.
3. Be sure to turn the meter off after use. For long term storage, remove the batteries to avoid leakage of battery fluid that can damage the internal components.

### 5.2. BATTERY REPLACEMENT

When the LCD displays the "**+-**" symbol, replace the batteries.



#### WARNING

Only experts and trained technicians should perform this operation. Remove the test leads or the circuit under test before replacing the batteries.

1. Turn the rotary switch to the OFF position.
2. Disconnect the test leads from the jacks and any cable from the jaws.
3. Unscrew the battery cover screw and remove the cover.
4. Replace the batteries with two new AAA batteries. Pay attention to the correct polarity.
5. Replace the battery cover and its screw.
6. Use the appropriate battery disposal methods for your area.

### 5.3. CLEANING

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

## 6. TECHNICAL SPECIFICATIONS

This product conforms to the prescriptions of the European directive on low voltage 73/23/EEC (LVD) and to EMC directive 89/336/EEC, amended by 93/68/EEC.

### 6.1. CHARACTERISTICS

Accuracy is indicated as [% of reading + digit number]. It is referred to the following reference conditions: 23°C ± 5°C with RH <75%.

#### DC Voltage

Range	Resolution	Accuracy	Input impedance
0 - 599.9V	0.1V	±(1.0% rdg + 3 dgt)	1MΩ

#### AC Voltage (TRMS)

Range	Resolution	Accuracy		Input impedance
		40 - 200Hz	200 - 400Hz	
1.6 - 599.9V	0.1V	±(1.0% rdg+3 dgt)	±(5.0% rdg + 3 dgt)	1MΩ

Max. Crest factor = 1.41

#### MAX / MIN / AVG / PEAK AC/DC Voltage

Function	Range	Resolution	Accuracy	Response time
MAX,MIN,AVG	10 ÷ 599.9V	0.1V	±(5.0% rdg + 10 dgt)	500ms
PEAK	10 ÷ 850V	1V	±(5.0% rdg + 10 dgt)	1ms

#### AC Current (TRMS)

Range	Resolution	Accuracy		Overload protection
		40 ÷ 200Hz	200 ÷ 400Hz	
0.0 - 399.9A	0.1A	±(1.0% rdg+3 dgt)	±(5.0% rdg + 5 dgt)	600A RMS

Max. Crest factor = 2

#### MAX / MIN / AVG / PEAK AC Current

Function	Range	Resolution	Accuracy	Response time
MAX,MIN,AVG	1.0 - 399.9A	0.1A	±(5.0% rdg + 10 dgt)	500ms
PEAK	10 - 800A	1A	±(5.0% rdg + 10 dgt)	15ms

#### Resistance and Continuity test

Range	Resolution	Accuracy	Overload protection
0.0 - 499.9Ω	0.1Ω	±(1.0% rdg + 5 dgt)	600V AC/DC RMS
500 - 999Ω	1Ω		
1000 - 1999Ω	3Ω		

Instrument emits a buzzer for R<40Ω

#### Frequency (with test leads/ with jaws)

Range	Resolution	Accuracy	Overload protection
40.0 - 399.9Hz	0.1Hz	±(0.5% rdg + 1 dgt)	600V RMS / 600A RMS

Voltage range for frequency measure, with test leads: 0.5 - 600V, with jaws: 0.5 - 400V

#### Voltage and current harmonics

Harmonic order	Resolution [V], [A]	Accuracy
1 - 15	0.1	±(10.0% rdg + 5 dgt)
16 - 25	0.1	±(15.0% rdg + 5 dgt)

Accuracy defined for: voltage ≥1.6V, current ≥2A

#### Power factor

Range	Resolution	Accuracy
0.20 - 1.00	0.01	± 3°

Accuracy defined for: sine wave, voltage 230 - 400V, current ≥2A, freq. 50-60Hz

#### Active power, Reactive power, Apparent power

Range [kW], [kVAR], [kVA]	Resolution [kW], [kVAR], [kVA]	Accuracy
0.00 - 99.99	0.01	±(3.5% rdg + 3 dgt)
100.0 - 999.9	0.1	

Accuracy defined for: sine wave, voltage 230- 400V, current ≥1A, freq. 50-60Hz, Pf: 0.8i - 0.8c

#### Phase sequence and phase coincidence

Range	Frequency range	Input impedance	Overload protection
50 - 600V	40 - 69Hz	1MΩ	600V RMS

**MAX / MIN / AVG Resistance and Continuity test**

Range	Resolution	Accuracy	Tempo di risposta
0.0 - 499.9Ω	0.1Ω	±(1.0% rdg + 5 dgt)	1s
500 - 999Ω	1Ω		
1000 - 1999Ω	3Ω		

Instrument emits a buzzer for R&lt;40Ω

**MAX / MIN / AVG Frequency (with test leads/ with jaws)**

Range	Resolution	Accuracy	Tempo di risposta
40.0 - 399.9Hz	0.1Hz	±(0.5% rdg + 1 dgt)	1s

Max Δf/Δt = 0.5Hz/s

**MAX / MIN / AVG Active power, Reactive power, Apparent power**

Range [kW], [kVAR], [kVA]	Resolution [kW], [kVAR], [kVA]	Accuracy	Tempo di risposta
0.1 - 99.99	0.01	±(3.5%rdg+3dgt)	1s
100.0 - 999.9	0.1		

Accuracy defined for: sine wave, voltage 230 ÷ 400V, current ≥1A, freq. 50-60Hz, Pf: 0.8i ÷ 0.8c

**MAX / MIN / AVG Power factor**

Range	Resolution	Accuracy	Response time
0.20 - 1.00	0.01	± 3°	1s

Accuracy defined for: sine wave, voltage 230 - 400V, current ≥2A, freq. 50-60Hz


**6.1.1. Safety standards**

Comply with:	EN 61010
Insulation:	Class 2, double reinforced insulation
Pollution:	Level 2
For inside use, max height:	2000m
Over voltage:	CAT III 600V between terminals and ground

**6.1.2. General data****Mechanical characteristics**

Size:	205 (L) x 64 (W) x 39 (D) mm
Weight (including battery):	about 280g batteries included
Jaws opening:	30mm
Max conductor size:	30mm

**Power supply**

Battery type:	2 batteries 1.5V LR03 AAA.
Low battery indication:	Symbol "  " is displayed when battery level is too low.
Battery life:	About 90 hours of continue measurement

**Display**

Characteristics:	4 dgt LCD with maximum reading 9999 units plus decimal point and sign
Sample rate:	64 samples in 20ms
Conversion mode:	TRMS

**6.2. ENVIRONMENTAL CONDITIONS****6.2.1. Climatic conditions**

Reference temperature:	23 ± 5°C
Operating temperature:	5 - 40 °C
Operating humidity:	<80% RH
Storage temperature:	-10 - 60 °C
Storage humidity:	<80% RH

**6.2.2. EMC**

This apparatus was designed in accordance with EMC standards in force and its compatibility has been tested in accordance EN61326 (1997) + A1 (1998) + A2 (2001).

**6.3. ACCESSORIES****6.3.1. Standard accessories**

The accessories contained inside the packaging are the following:

- Instrument
- Couple of test leads
- Couple of alligator clips
- Rubber cup for test lead holder
- Certificate of calibration
- User's manual
- Bag
- Batteries

## 7. SERVICE

### 7.1. WARRANTY CONDITIONS

This equipment is guaranteed against any material fault or manufacturer's defect, in accordance with the general conditions of sale. During the warranty period (one year), faulty parts may be replaced, with the manufacturer reserving the right to decide either to repair or replace the product.

In the event of returning the equipment to the after-sales service or to a regional branch, the outward transport is payable by the customer. The delivery must be agreed in advance with consignee.

For delivery indicate by means a note enclosed with the equipment, as clear as possible, the reasons for returning it use only the original packing.

Any damaging caused by shipment using NOT original packaging will be charged in any case to the consignor.

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

The warranty doesn't apply to the following cases:

- Accessories and battery aren't included in warranty.
- Repairs following unsuitable use of the equipment or by combining the latter with incompatible equipment.
- Repairs resulting from a not correct shipping.
- Repairs resulting from servicing carried out by a person not approved by the company.
- Modifications to the equipment without explicit authorization from our technical departments.
- Adaptation to a particular application not provided for by the definition of the equipment or by the instruction manual.

The contents of this manual may not be reproduced in any form whatsoever without our agreement.

**Our products are patented. The logotypes are registered. We reserve the right to modify characteristics and prices as part of technological developments which might require them.**

### 7.2. AFTER-SALE SERVICE

If the equipment weren't correctly working, before contacting the SERVICE test the battery condition, the test leads, etc., and change them if necessary.

If the equipment still weren't working, check if your operating procedure agrees with the one described in this manual.

In the event of returning the equipment it must be re-sent to the after-sales service (at address or to a regional branch), the outward transport is payable by the customer. The delivery must be agreed in advance with consignee.

For delivery indicate by means a note enclosed with the equipment, as clear as possible, the reasons for returning it use only the original packing.

Any damage caused by delivery with NO original packaging will be charged in any case to the consignor.



## 8. APPENDIX: VOLTAGE AND CURRENT HARMONICS

### 8.1. THEORY

Any periodical non-sine wave can be represented as a sum of sinusoidal waveforms each having a frequency that corresponds to an integer multiple of the fundamental frequency, according to the relation:

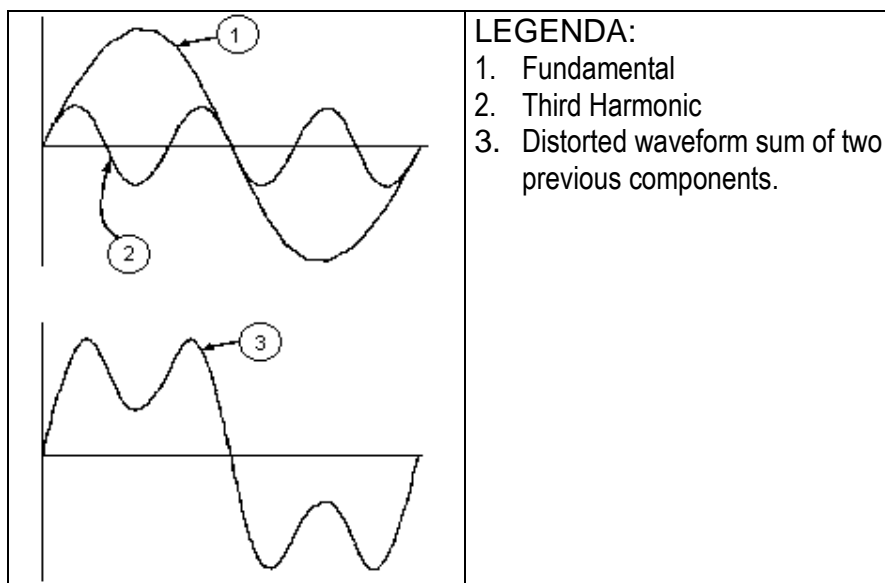
$$v(t) = V_0 + \sum_{k=1}^{\infty} V_k \sin(\omega_k t + \varphi_k) \quad (1)$$

where:

$V_0$  = Average value of  $v(t)$

$V_1$  = Amplitude of the fundamental of  $v(t)$

$V_k$  = Amplitude of the  $k^{\text{th}}$  harmonic of  $v(t)$



**Effect of the sum of 2 multiple frequencies.**

In the mains voltage, the fundamental has a frequency of 60 Hz, the second harmonic has a frequency of 120 Hz, the third harmonic has a frequency of 180 Hz and so on. Harmonic distortion is a constant problem and should not be confused with short durations events such as sags, surges or spikes.

It can be noted that in (1) the index of sigma is from 1 to the infinity. What happens in reality is that a signal does not have an unlimited number of harmonics: a number always exists after which the harmonics value is negligible. The EN 50160 standard recommends the index end in (2) in correspondence of the 40<sup>th</sup> harmonic.

A fundamental element to detect the presence of harmonics is THD defined as:

$$THD_v = \frac{\sqrt{\sum_{h=2}^{40} V_h^2}}{V_1}$$

This index takes all the harmonics into account. The larger it is, the more distorted the waveform gets.

## 8.2. LIMIT VALUES FOR HARMONICS

EN-50160 fixes the limits for the harmonic voltages, which can be introduced into the network by the energy provider. Under normal conditions, during whatever period of a week, 95% of the RMS value of each harmonic voltage, for a duration of 10 minutes, will have to be less than or equal to the values stated in the following table.

The total harmonic distortion (THD) of the supply voltage (including all the harmonics up to the 40<sup>th</sup> order) must be less than or equal to 8%.

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3		Order h	Relative voltage %Max
Order h	Relative voltage % Max	Order h	Relative voltage % Max		
5	6	3	5	2	2
7	5	9	1,5	4	1
11	3,5	15	0,5	6..24	0,5
13	3	21	0,5		
17	2				
19	1,5				
23	1,5				
25	1,5				

These limits, theoretically applicable only for the supplier of electric energy, provide however a series of reference values within which the harmonics introduced into the network by the user must be contained.

## 8.3. CAUSES FOR THE PRESENCE OF HARMONICS

Any apparatus that alters the sine wave or uses only a part of such a wave causes distortions to the sine wave and therefore harmonics.

All current signals result in some way virtually distorted. The most common situation is the harmonic distortion caused by non-linear loads such as electric household appliances, personal computers or motor speed control drives. Harmonic distortion causes significant currents at frequencies that are odd multiples of the fundamental frequency. Harmonic currents affect the neutral current.

In most countries, the mains power is three-phase 50/60Hz with a delta primary and star secondary transformers. The secondary generally provides 230V AC from phase to neutral and 400V AC from phase to phase. Balancing the loads on each phase has always represented a headache for electric systems designers.

Until some ten years ago, in a well balanced system, the vector sum of the currents in the neutral was zero or quite low (given the difficulty of obtaining a perfect balance). The devices were incandescent lights, small motors and other devices that presented linear loads. The result was an essentially sinusoidal current in each phase and a low current on the neutral at a frequency of 50/60Hz.

“Modern” devices such as TV sets, fluorescent lights, video machines and microwave ovens normally draw current for only a fraction of each cycle thus causing non-linear loads and subsequent non-linear currents. All this generates odd harmonics of the 50/60Hz line frequency. For this reason, the current in the transformers of the distribution boxes contains only a 50Hz (or 60Hz) component but also a 150Hz (or 180Hz) component, a 50Hz (or 300Hz) component and other significant components of harmonic up to 750Hz (or 900Hz) and higher.

The vector sum of the currents in a well balanced system that feeds non-linear loads may still be quite low. However, the sum does not eliminate all current harmonics. The odd multiples of the third harmonic (called “TRIPLENS”) are added together in the neutral conductor and can cause overheating even with balanced loads.

#### 8.4. CONSEQUENCES OF THE PRESENCE OF HARMONICS

In general, even harmonics, i.e. the 2<sup>nd</sup>, 4<sup>th</sup> etc., do not cause problems.

Designers should take into consideration the following points when designing a power distribution system that will contain harmonic current:

Installation parts	Effects attributed to Harmonics
Fuses	Heating of internal fuse elements. This over-heating can cause an explosion of the fuse casing.
Cables	<p>Increase in "body" effect. This means, for cables with many wires, the internal wires have higher impedance than external wires due to their inability to dissipate heat.</p> <p>The consequence of this is the current, which normally is distribute along the external surface of wire, produces:</p> <ul style="list-style-type: none"> <li>– an over-heating of the conductor;</li> <li>– a premature degrading of the cable's insulation;</li> <li>– an increase in line voltage drop.</li> </ul>
Neutral conductor	The triplens harmonics, odd multiples of three, sum on the neutral conductor (instead of erasing themselves) and generate a potential danger over-heating situation of the same conductor.
Transformer	<p>Increasing of copper loss due to a higher TRMS current value that circulate on internal circuits and due to "body" effect present on protected wires also.</p> <p>Increasing of iron loss due to hysteresis cycle distortion and due to generation of leakage currents on magnetic core.</p> <p>Heating of insulation material due to eventually DC component that can generate saturation of magnetic core column.</p>
Motors	<p>Increase of loss due to over-heating of internal circuits and possible damage of insulation material. Increase in motor vibration reducing efficiency and causing premature motor wear.</p> <p>The 5<sup>th</sup> and 11<sup>th</sup> harmonic components generate some abnormal electromagnetic coupling that can increase motor speed.</p>
Re-phased capacitance	Increase in "parallel resonance" present inside a circuit, due to inductive loads and re-phased capacitance, when at least one of the harmonics has the same frequency as the resonance phenomenon. Effects of this event can be very dangerous. with explosion of used re-phased capacitances.
RCD devices	Possible saturation of current sensing toroidal transducers resulting in incorrect measurements.
Energy disk counters	Increased rotation speed of a disk resulting in measurement error (especially in cases of low power factor loads).
Power controls switch	Reduce of electrical duration of contact surfaces.
UPS	Reduced power generation from UPS.
Electronics devices	Internal damage of electronic components.