ENGLISH

User manual

1.800.561.8187 www.itm.com information@itm.com

Table of Contents:

1. SAFETY PRECAUTIONS AND PROCEDURES

This instrument has been designed in compliance with IE/EN61010-1 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 ⚠.

CAUTION

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

1.1. PRELIMINARY INSTRUCTIONS

- This instrument has been designed for use in environments of pollution degree 2
- It can be used for **CURRENT** measurements on installations of measurement CAT III 600V (voltage between phase and to ground) and for **VOLTAGE** and **FREQUENCY** measurements on installations of CAT III 600V (voltage between terminals and between phase and to ground)
- Please use the standard safety precautions aimed at protecting you against dangerous electric currents and 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
- Do not test circuits exceeding the current and voltage limits.
- Do not perform any test under conditions exceeding the limits indicated in § 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.

1.2. DURING USE

CAUTION

Non compliance with CAUTIONs 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 § 4.1.2.
- While measuring, if the value remains unchanged check if the HOLD function is enabled (**H** symbol at display)

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 IEC/EN61010-1: 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

Those instruments HT4020 and HT4022 can perform the herewith measurements:

- AC TRMS voltage
- DC voltage
- AC TRMS current
- Harmonic AC voltage (from DC to 25th components) and THD% (HT4022)
- Harmonic AC current (from 1st to 25th components) and THD% (HT4022)
- Voltage frequency with input test leads
- Current frequency with clamp jaws
- Resistance and continuity test
- Phase rotation and coincidence test with 1 test lead
- Active, reactive, apparent power on single-phase and balanced three phase systems
- Power factor measure on single-phase and balanced three phase systems
- Active, reactive, apparent energy on single-phase and 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 /** " (HT4020) or "**FUNC / HARM**", "**MAX/MIN/PK / H↓**", "**ENERGY / H↑**" and "**D-H /** " (HT4022). For their use please see § 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 § 6.3.1.

3.2. POWER SUPPLY

The instrument is supplied with 2x1.5V 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 § 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.

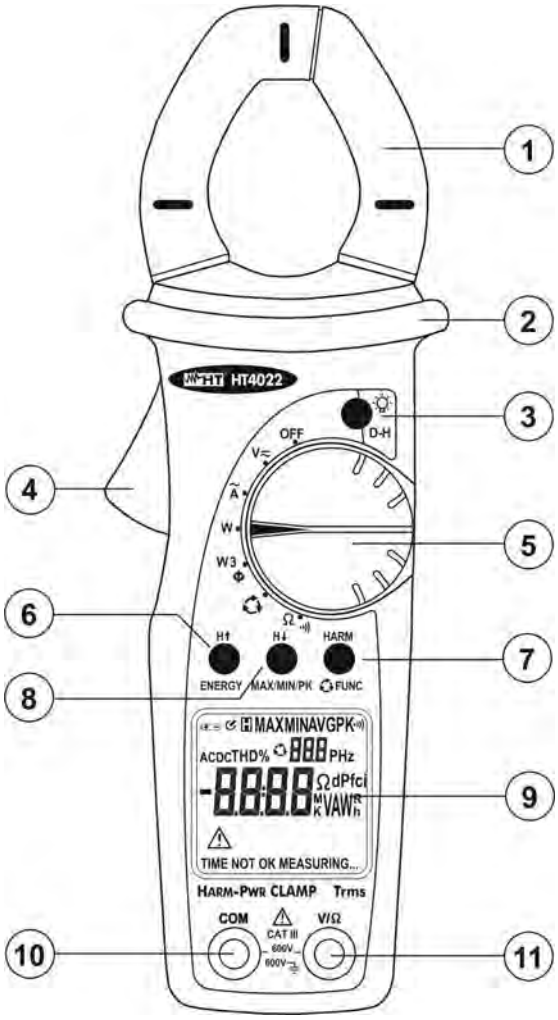
3.4. STORAGE

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 § 6.2.1) before use.

4. OPERATING INSTRUCTIONS

4.1. INSTRUMENT DESCRIPTION

4.1.1. Controls description



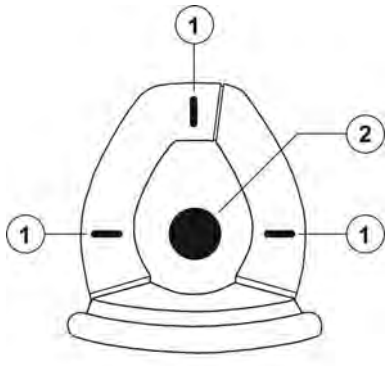
CAPTION:

1. Inductive clamp jaw
2. Safety guard
3. **D-H**, ☼ key
4. Jaw trigger
5. Rotary selector switch.
6. **ENERGY** key (HT4020)
   ENERGY/H↑ key (HT4022)
7. ↻ **FUNC** key (HT4020)
   ↻ **FUNC / HARM** key (HT4022)
8. **MAX/MIN/PK** key (HT4020)
   MAX/MIN/PK/H↓ key (HT4022)
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.



CAPTION:

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. Disable 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 perform the herewith procedure:

1. Switch OFF the instrument
2. While **FUNC** key is pressed switch on the instrument rotate the selector to any position

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. 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 or rotate the selector switch to another position.

Press and hold the **D-H/☼** key for 1 second to enable the backlight. The backlight automatically turns off about 5 seconds after the last rotary selector switch or button actuation.

4.2.2. ↻ FUNC and ↻FUNC/HARM 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. Press and hold the ↻**FUNC/HARM** key (HT4022) for at least 1 second to activate the voltage 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/HARM** key for at least 1 second or rotating the selector to any other position
- **A~**: press ↻ **FUNC** key to select between current and frequency measurement. Press and hold the ↻**FUNC/HARM** key (HT4022) 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/HARM** key for at least 1 second or rotating the selector to any other position
- ↻: 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.

4.2.3. MAX/MIN/PK and MAX/MIN/PK/H↓ 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 or rotate the selector to any position. In **HARM** measurement (HT4022) the pressure of **MAX/MIN/PK/H↓** key allows to decrease the order of AC voltage or current harmonic (see § 4.3.3 and § 4.3.7)

4.2.4. ENERGY and ENERGY/H↑ key

With the rotary selector on "**W**" or "**W3Φ**" position, press and hold this key at least 1 second to activate the energy measurement (see § 4.3.8 and § 4.3.9). The pressure of **ENERGY/H↑** key allows to increase the order of AC voltage or current harmonic (see § 4.3.3 and § 4.3.7). Push **ENERGY** key and keep it pressed at least 1 second to escape from the energy measurement mode

4.3. OPERATING INSTRUCTIONS
4.3.1. AC/DC Voltage measurement

CAUTION

- 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.

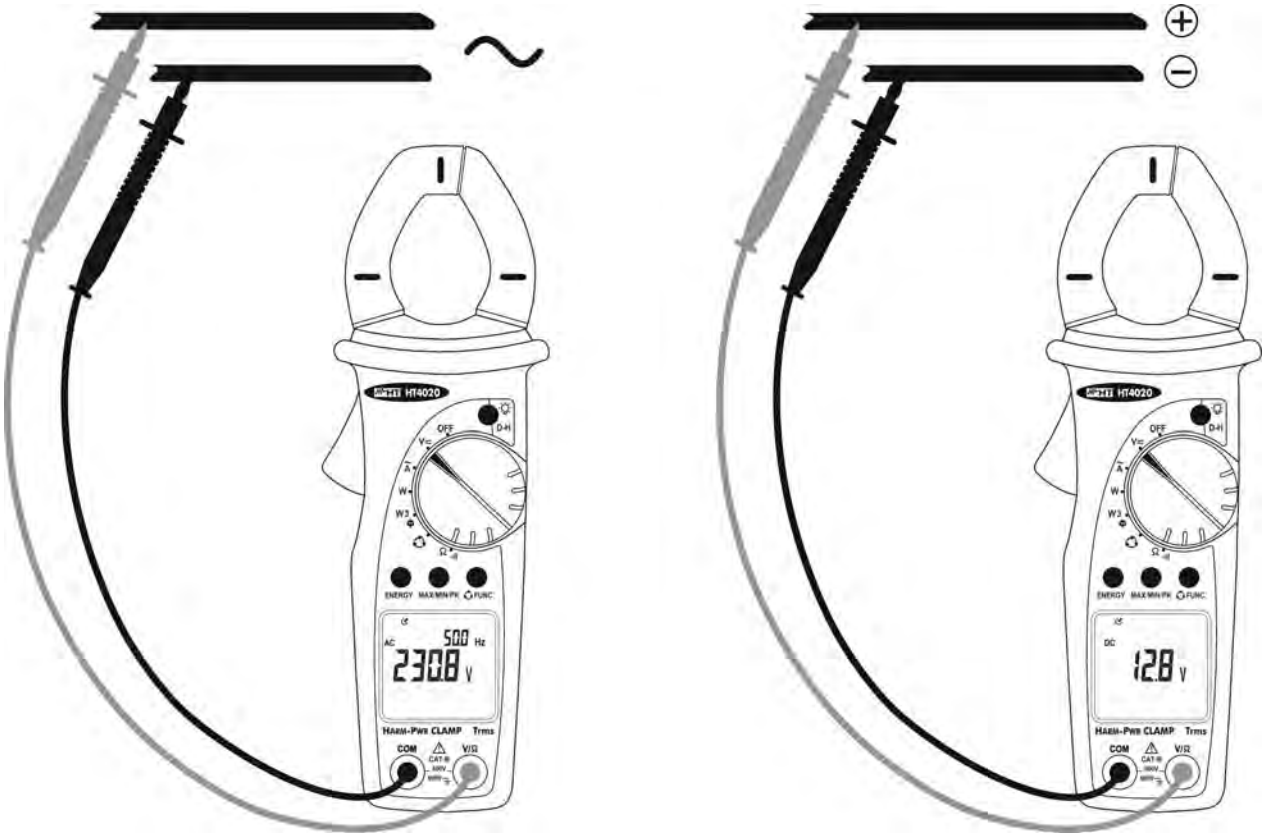


Fig. 4: Use of instrument for DC/AC voltage measurement

1. Select the "**V** ≂" position.
2. Insert the red lead into **V/Ω** 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). 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. For HOLD and MAX/MIN/AVG/PK features refer to § 4.2.1 and § 4.2.3)

4.3.2. AC Voltage frequency measurement

CAUTION

- 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. 5: Use of instrument for AC voltage frequency measurement

1. Select the "**V** ≂" position
2. Press the **FUNC** key to select the **Hz** 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. 5). The measured frequency of AC voltage value is displayed
5. The "**O.L**" symbol indicates a frequency higher than the full-scale capability of the instrument
6. For HOLD and MAX/MIN/AVG features refer to § 4.2.1 and § 4.2.3
7. Press the **FUNC** key again to return to the voltage measurement function

4.3.3. Measurement of Voltage Harmonics (HT4022)

CAUTION

- 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.

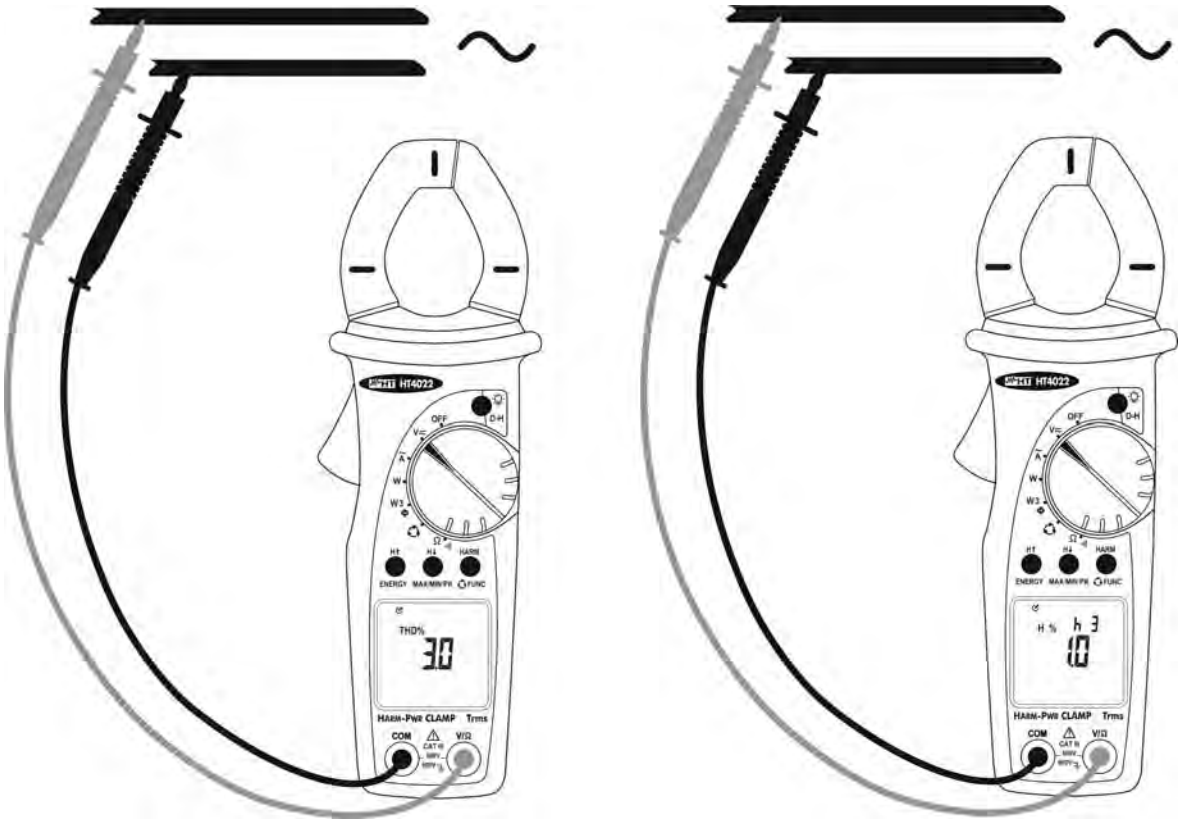


Fig. 6: Use of instrument for AC voltage harmonic measurement

1. Select the "**V** ≂" position
2. Press **FUNC/HARM** 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 **COM** into 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 § 8 for the parameter's definition
5. With the **H↑** and **H↓** keys you can cycle through all available harmonic values from DC to the 25th 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 25th 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. Press **FUNC** key to escape this mode going back to voltage measurement function (see § 4.3.1)

4.3.4. Resistance and continuity test

CAUTION

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

Fig. 7: Use of instrument for resistance and continuity test

1. Select the "Ω•))" position.
2. Insert the red plug into **V/Ω** 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. 7). The measured resistance value is displayed.
4. The continuity test is always enabled. An audible beep sounds when the measured value is <40Ω
5. The symbol "**O.L**" means that the measured voltage is higher than the full scale of the instrument
6. For HOLD and MAX/MIN/AVG features refer to § 4.2.1 and § 4.2.3

4.3.5. AC Current measurement

CAUTION

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

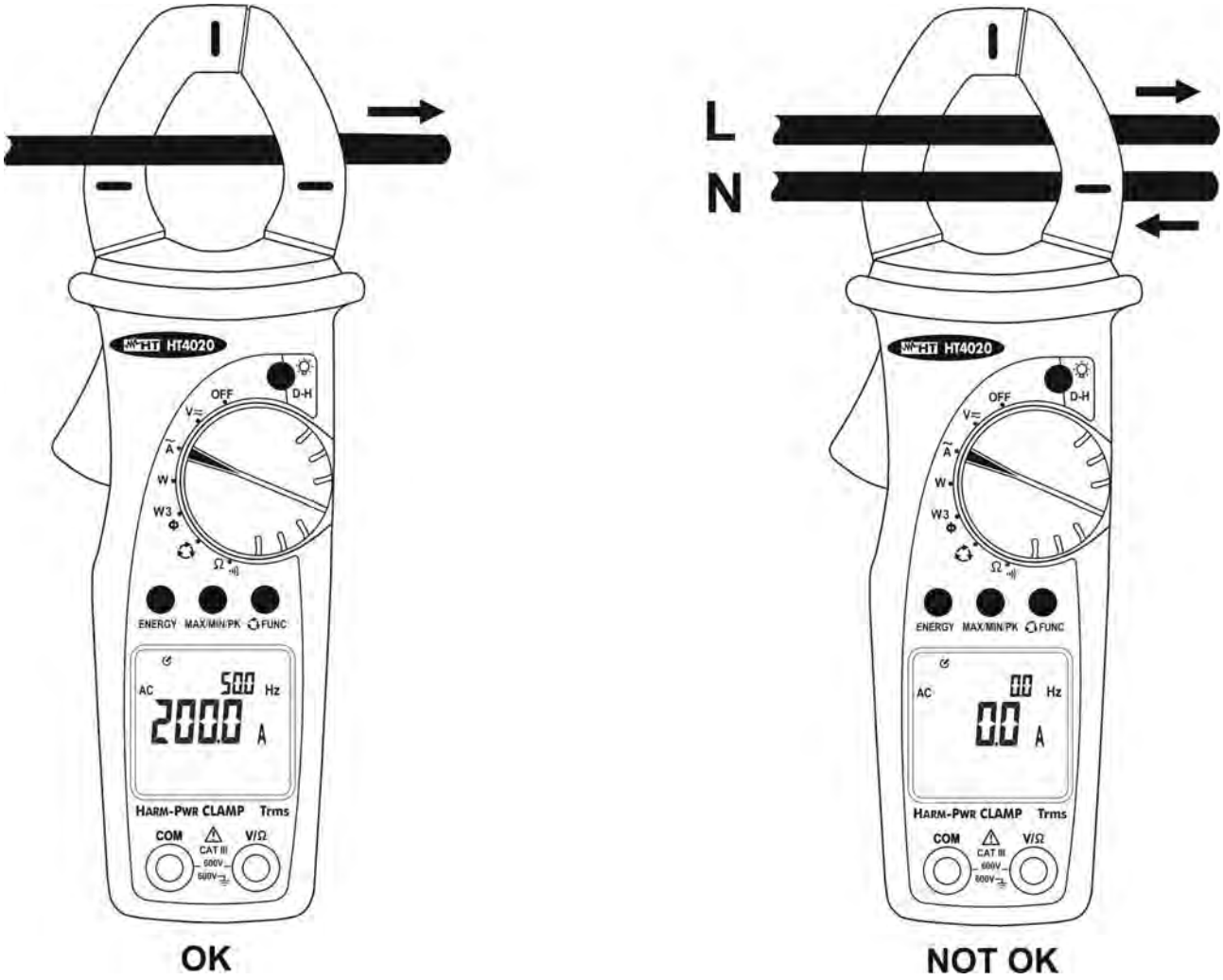


Fig. 8: Use of instrument for AC current measurements

1. Select the "$\widetilde{A}$" position
2. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see § 4.1.2. and Fig. 8). 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. For HOLD and MAX/MIN/AVG/PK features refer to § 4.2.1 and § 4.2.3

4.3.6. AC Frequency current measurement

CAUTION

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

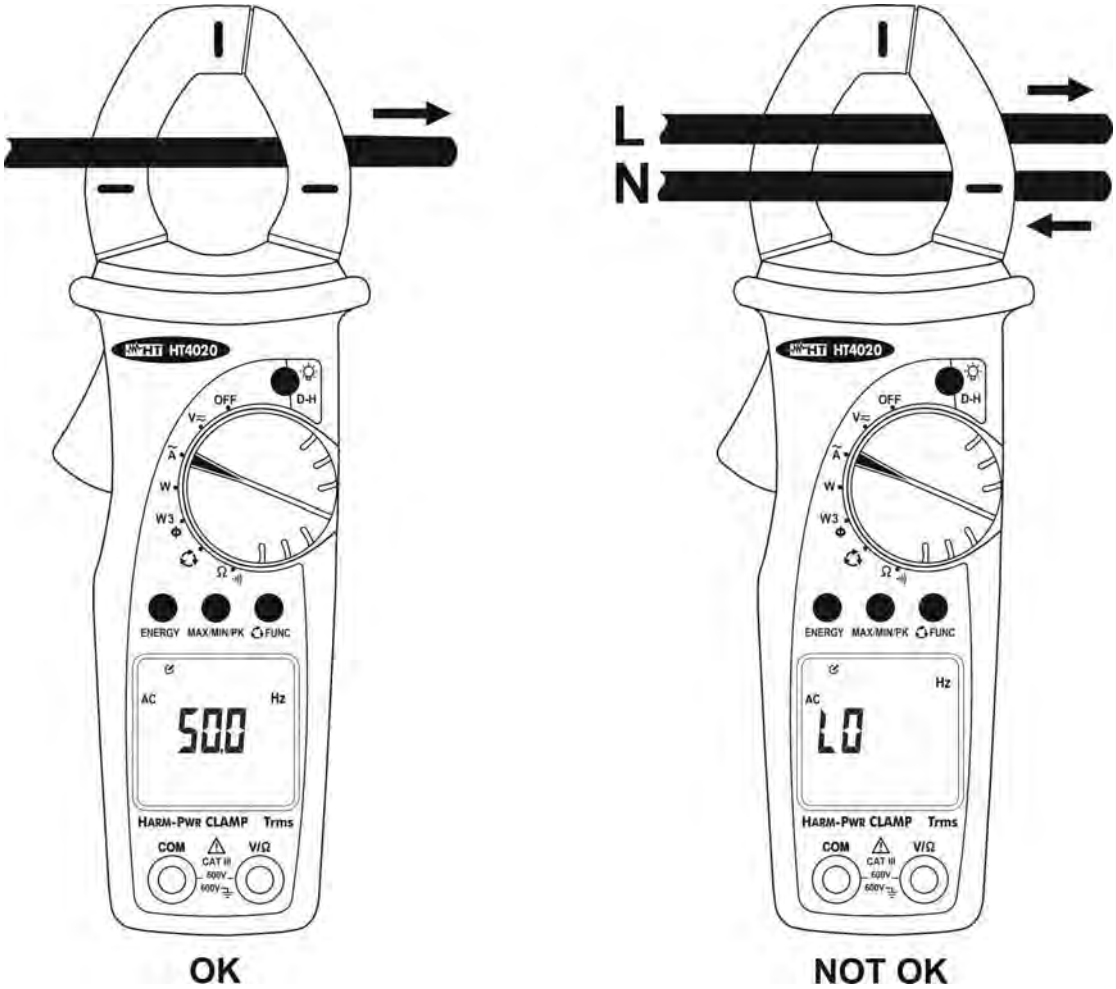


Fig. 9: Use of instrument for AC current frequency measurement

1. Select the "$\tilde{A}$" 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 § 4.1.2. and Fig. 9). The value of frequency is shown on display
4. The symbol "**O.L**" means that the measured voltage is higher than the full scale of the instrument. The symbol "**LO**" is shown in case of wrong connection of the instrument (see Fig. 9) or for measured values lower that the minimum range
5. For HOLD and MAX/MIN/AVG features refer to § 4.2.1 and § 4.2.3
6. Press **FUNC** key to escape this mode going back to current measurement function (see § 4.3.5).

4.3.7. Measurement of Current Harmonics (HT4022)

CAUTION

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

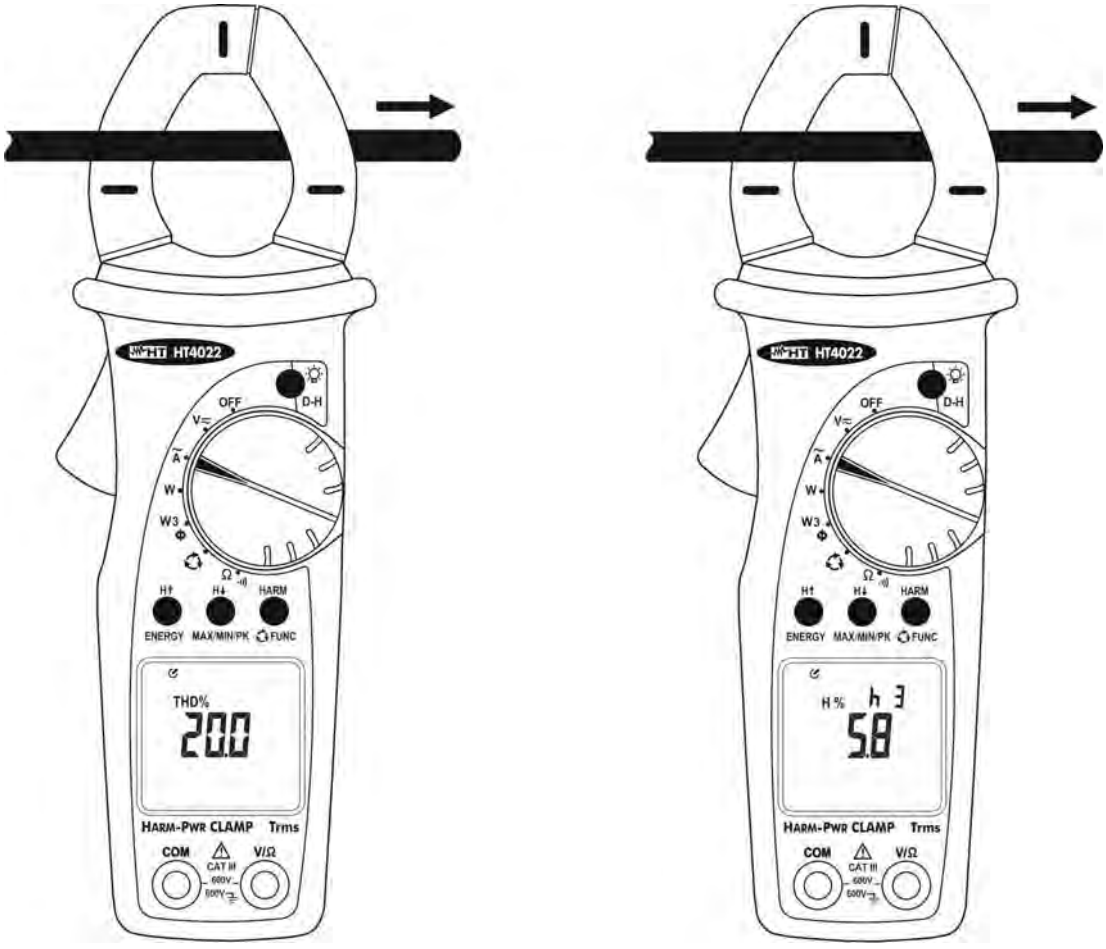


Fig. 10: Use of instrument for AC harmonic current measurement

1. Select the "$\tilde{A}$" position
2. Press the **FUNC/HARM** 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 § 4.1.2. and Fig. 10). The instrument displays the Total Harmonic Distortion value of the input signal. The symbol "**THD%**" is displayed. See § 8 for the parameter's definition.
4. With the **H↑** and **H↓** keys you can cycle through all available harmonic values from the 1st to the 25th 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/HARM** key to switch to the absolute harmonics' values displaying (from 1st to 25th 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. Press **FUNC/HARM** key to escape this mode going back to current measurement function (see § 4.3.5)

4.3.8. Power/Energy measurement on single phase system

CAUTION

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.

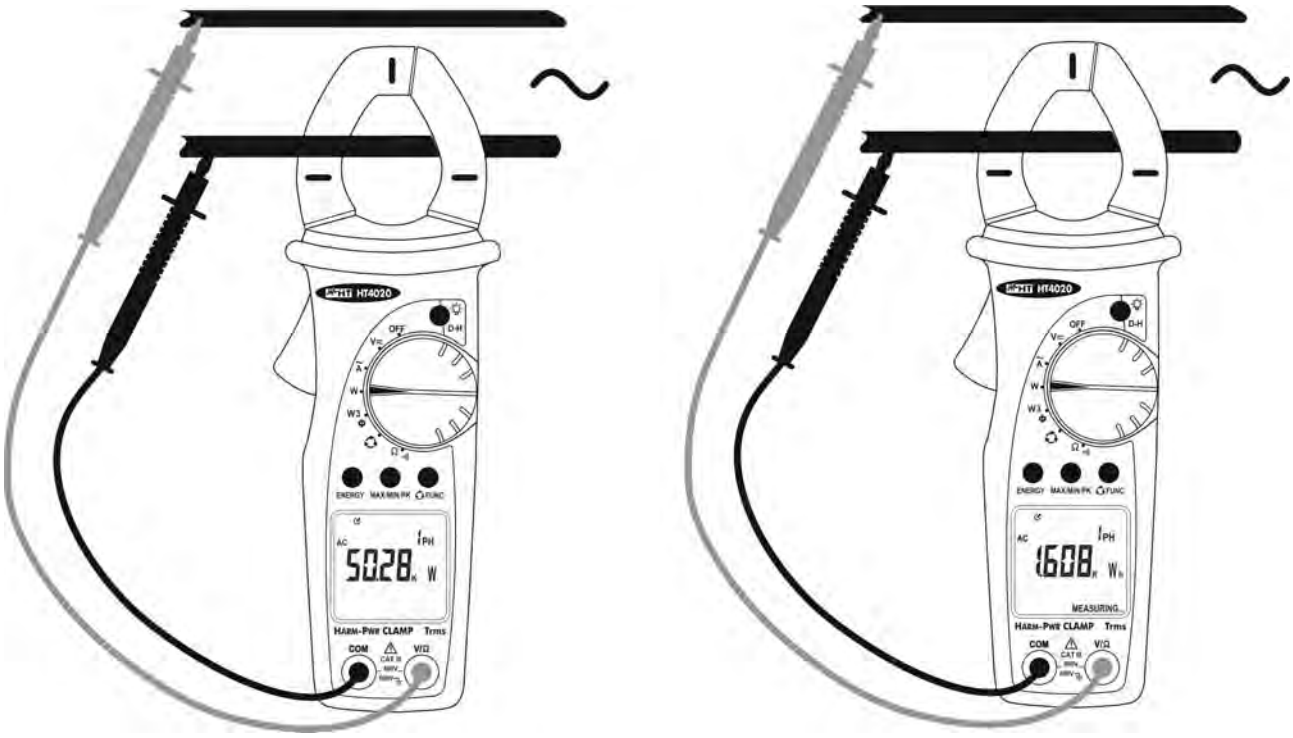


Fig. 11: Use of instrument for power/energy measurement on single phase system

1. Select the "**W**" position
2. Open the jaws and clamp only one cable. Pay attention to the alignment marks (see § 4.1.2. and Fig. 11)
3. Insert the red plug into **V/Ω** jack and the black plug into **COM** one
4. Connect the test leads to the circuit under test (see Fig. 11). The measured active power value is 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 parameters active power (kW), reactive power (kVA^R, capacitive **C**, inductive **I**), apparent power (kVA), power factor (Pfi or Pfc for inductive and capacitive respectively) are displayed
7. Press and hold the **ENERGY** key for at least 1 second to active the energy measurement mode. By pressing the **FUNC** key the parameters active energy (kWh), reactive energy (kVA^Rh, capacitive **C**, inductive **I**), apparent energy (kVAh), TIME with indication of energy measurement duration are displayed
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. For HOLD and MAX/MIN/AVG features refer to § 4.2.1 and § 4.2.3
10. Press **ENERGY** key for at least 1 second to escape this mode going back to power measurement function

4.3.9. Power/Energy measurement on three phase balanced system

CAUTION

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.

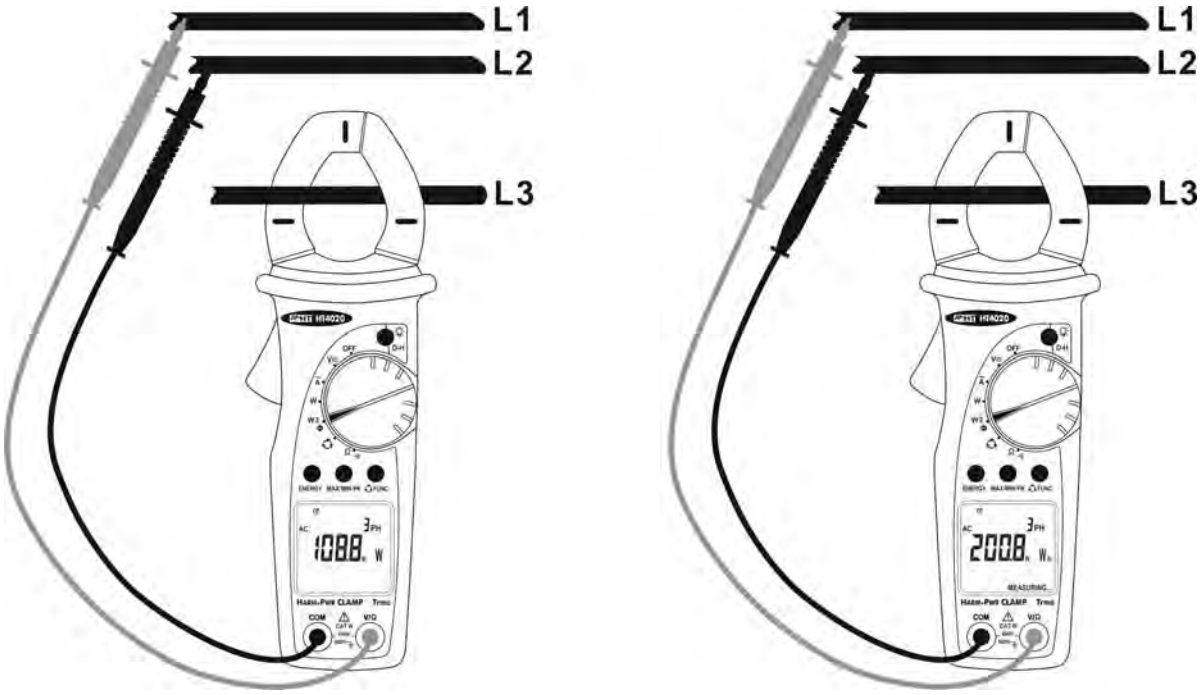


Fig. 12: Use of instrument for power/energy measure on three phase balanced system

1. Select the "**W3Φ**" position
2. Open the jaws and clamp the L3 phase cable. Pay attention to the alignment marks (see § 4.1.2. and Fig. 12)
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. 12). The measured active power value is 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 parameters active power (kW), reactive power (kVA^R, capacitive **C**, inductive **I**), apparent power (kVA), power factor (Pfi or Pfc for inductive and capacitive respectively) are displayed
7. Press and hold the **ENERGY** key for at least 1 second to active the energy measurement mode. By pressing the **FUNC** key the parameters active energy (kWh), reactive energy (kVA^Rh, capacitive **C**, inductive **I**), apparent energy (kVAh), TIME with indication of energy measurement duration are displayed
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. For HOLD and MAX/MIN/AVG features refer to § 4.2.1 and § 4.2.3
10. Press **ENERGY** key for at least 1 second to escape this mode going back to power

4.3.10. Detection of phase sequence indication with 1 wire method

CAUTION

- 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
- During this measurement the instrument must be always held in the operator's hand and 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

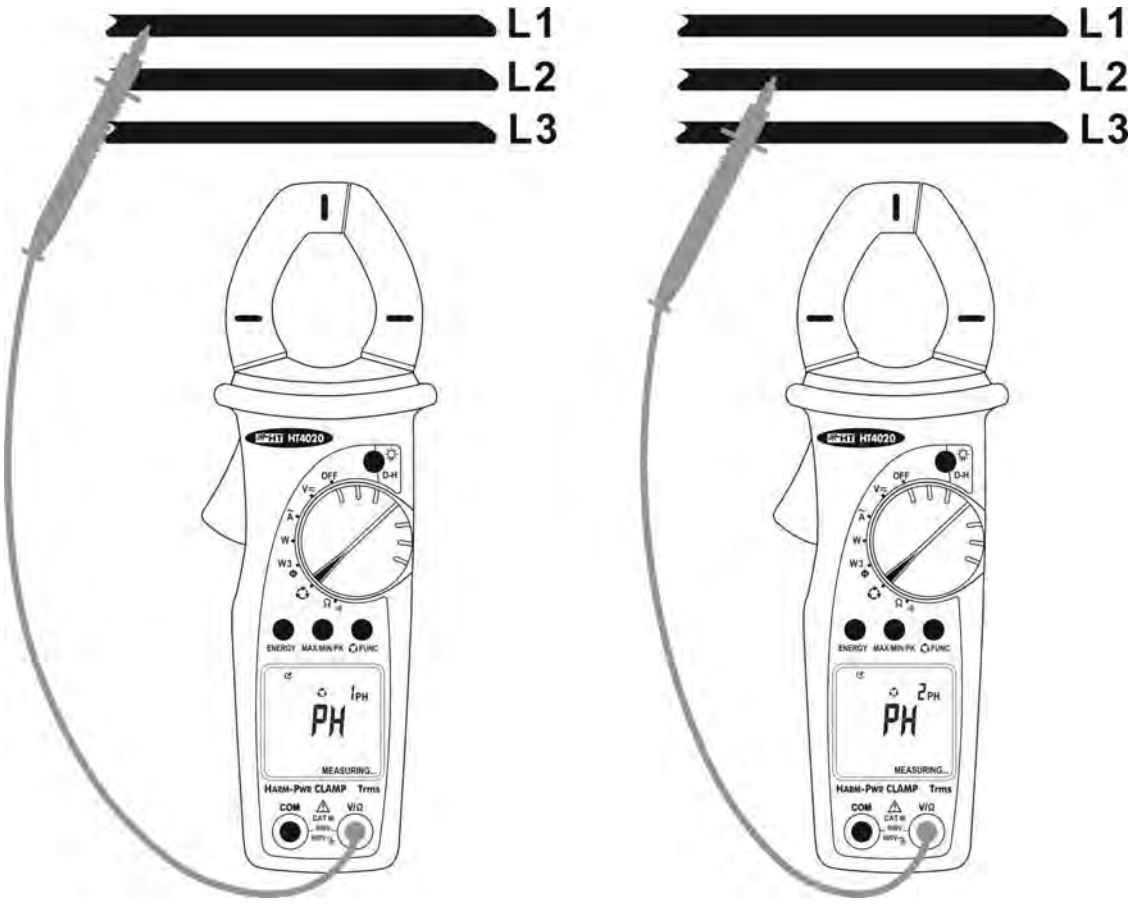


Fig. 13: Use of instrument for phase sequence indication with 1 wire

1. Select the "↻" position. The symbol "**1PH**" will appear on the secondary display
2. Insert the red lead into **V/Ω** jack
3. Connect the red terminal to the L1 phase conductor (see Fig. 13 – left part). If necessary use the rubber test lead holster and insert the red test lead
4. When an input voltage >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.

CAUTION

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

5. After about one second "**MEASURING**" appears on the display indicating that the

6. Press the **FUNC** key, the "**MEASURING**" message will disappear.
7. Disconnect the test lead and the symbol "**2PH**" appears on the secondary display
8. Connect the test lead to the L2 phase conductor (see Fig. 13 – right part)
9. When an input voltage >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 L2 phase cable.

CAUTION

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

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

CAUTION

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.

12. 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.

CAUTION

- 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 thick rubber, 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 with 1 wire method

CAUTION

- The purpose of this measurement is to verify the correct phase between 2 conductors before executing a parallel connection
- 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
- During this measurement the instrument must be always held in the operator's hand and 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

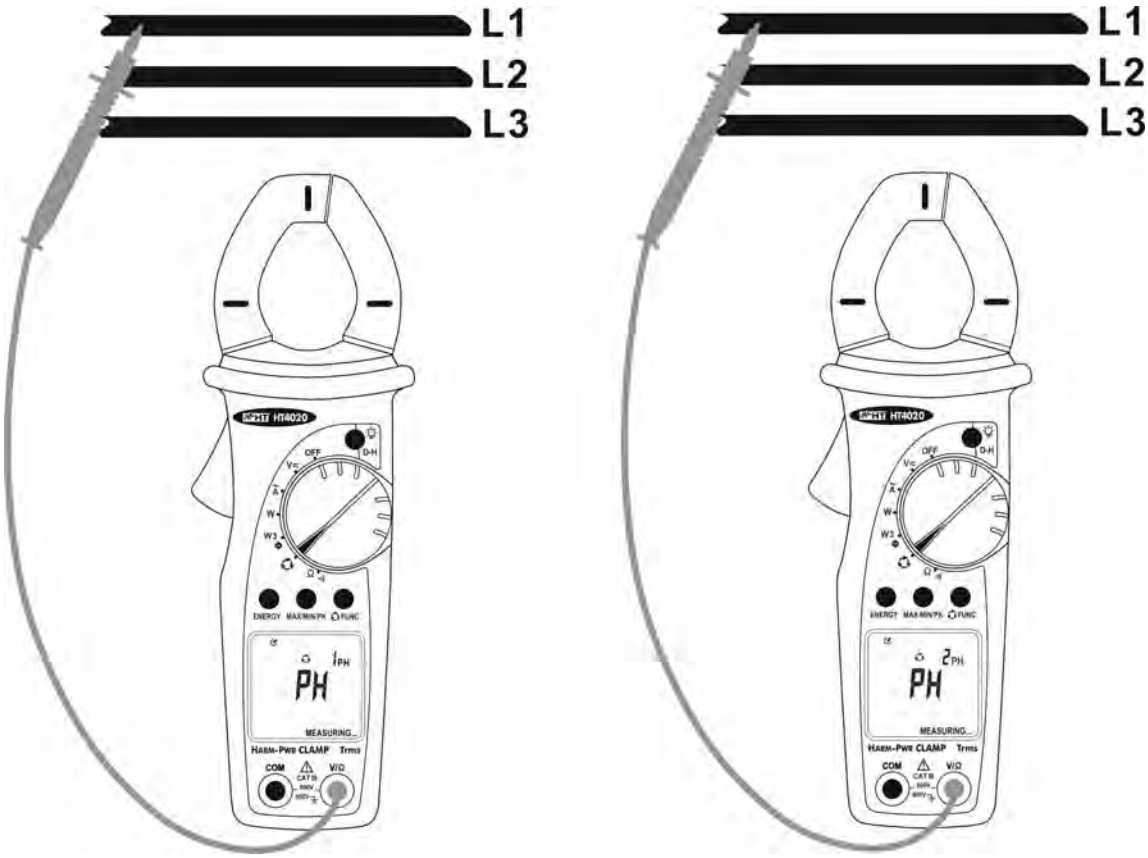


Fig. 14: Use of instrument for phase coincidence indication with 1 wire

1. Select the "↻" position. The symbol "**1PH**" is shown on the secondary display
2. Insert the red plug into **V/Ω** jack
3. Connect the red terminal to the L1 phase conductor of the first 3-phase system (see Fig. 14 – left part). If necessary use the rubber cup to insert red test lead
4. When an input voltage >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

CAUTION

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

5. After about one second "**MEASURING**" appears on the display indicating that the instrument is ready to execute the first measurement (see Fig. 14 – left part)

6. Press the **FUNC** key, the "**MEASURING**" symbol will disappear.
7. Disconnect the test lead from the first 3-phase system . The symbol "**2PH**" appears on the secondary display
8. Connect the test lead to the L1 phase of the second 3-phase system (see Fig. 14 – right part)
9. When an input voltage >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.

CAUTION

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

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

CAUTION

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.

12. 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

CAUTION

- 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 thick rubber, 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 with 1 wire method

CAUTION

- 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
- During this measurement the instrument must be always held in the operator's hand and 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

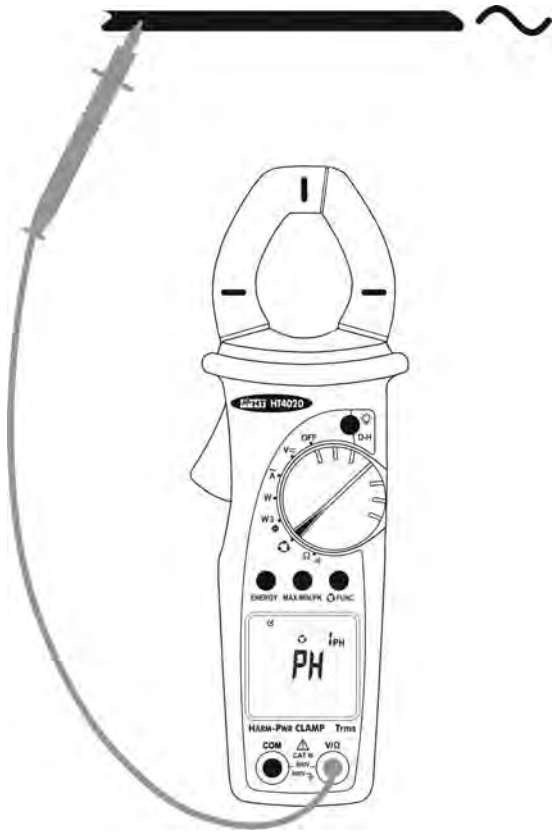


Fig. 15: Use of instrument for phase detection indication with 1 wire

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. 15). If necessary use the rubber cup to insert red test lead
4. When an input voltage >80V is detected the buzzer emits a sound and the symbols "**PH**" is shown on the main display

CAUTION

- 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 thick rubber, etc.) the instrument may not measure correctly. We recommend repeating test at least twice due to verify the rightness of the

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

CAUTION

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 one of the same type (see § 6.2). Pay attention to the correct polarity.
5. Replace the battery cover and it's 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.

5.4. 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 CHARACTERISTICS

Accuracy indicated as [%rdg + (num. digit * resolution)] referred to: 23°C±5°C, <75%RH

DC Voltage

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

AC TRMS Voltage

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

Max. Crest factor = 1.41

MAX / MIN / AVG / PEAK AC/DC Voltage

Function	Range	Resolution	Accuracy	Response time
MAX,MIN,AVG	10.0 ÷ 599.9V	0.1V	±(5.0%rdg + 10dgt)	500ms
PEAK	10 ÷ 850V	1V		1ms

AC TRMS Current

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

Max. Crest factor = 2

MAX / MIN / AVG / PEAK AC Current

Function	Range	Resolution	Accuracy	Response time
MAX,MIN,AVG	10.0 ÷ 399.9A	0.1A	±(5.0%rdg + 10dgt)	500ms
PEAK	10 ÷ 800A	1A		15ms

Resistance and Continuity test

Range	Resolution	Accuracy	Overload protection
0.0 ÷ 499.9Ω	0.1Ω	±(1.0%rdg + 5dgt)	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 + 1dgt)	600V RMS / 600A RMS

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

Voltage and current harmonics (HT4022 only)

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

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/energy, Reactive power/energy, Apparent power/energy

Range [kW,kWh], [kVAR,kVARh], [kVA, kVAh]	Resolution [kW,kWh], [kVAR,kVARh], [kVA, kVAh]	Accuracy
0.00 ÷ 99.99	0.01	±(3.5%rdg + 3dgt)
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
80 ÷ 600V	40 ÷ 69Hz	1MΩ	600V RMS

MAX / MIN / AVG Resistance and Continuity test

Range	Resolution	Accuracy	Response time
0.0 ÷ 499.9Ω	0.1Ω	±(1.0%rdg + 5dgt)	1s
500 ÷ 999Ω	1Ω		
1000 ÷ 1999Ω	3Ω		

Instrument emits a buzzer for R<40Ω

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

Range	Resolution	Accuracy	Response time
40.0 ÷ 399.9Hz	0.1Hz	±(0.5%rdg + 1dgt)	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	Response time
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. Reference standards

Safety: IEC/EN61010-1
Insulation: double insulation
Pollution degree: 2
Max height of use: 2000m (6562ft)
Measurement category: CAT III 600V between terminals and to ground

6.2. GENERAL SPECIFICATIONS

Mechanical characteristics

Dimensions (L x W XH): 205 x 64 x 39mm (8 x 3 x 2in)
Weight (including batteries): 280g (10ounces)
Jaws opening: 30mm (1in)
Max conductor size: 30mm (1in)

Power supply

Battery type: 2x1.5V alkaline batteries type AAA LR03
Low battery indication: Symbol "  " displayed
Battery life: About 90 hours of continue measurement
Auto Power OFF: after 5 minutes of idleness (disabled)

Display

Characteristics: 4 dgt LCD, max 9999 points, decimal point and sign
Sample rate: 64 samples in 20ms
Conversion mode: TRMS

6.3. ENVIRONMENTAL CONDITIONS

6.3.1. Climatic conditions

Reference temperature: 23 ± 5°C (73 ± 41°F)
Operating temperature: 0 ÷ 40°C (32 ÷ 104°F)
Operating humidity: <80%HR
Storage temperature: -10 ÷ 60°C (14 ÷ 140°F)
Storage humidity: <80%HR

This product conforms to the prescriptions of the European directive on low voltage 2006/95/EEC (LVD) and to EMC directive 2004/108/EEC

6.4. ACCESSORIES

6.4.1. Standard accessories

- Couple of test leads
- Couple of alligator clips
- Rubber cup for test lead holder
- ISO9000 calibration certificate
- Carrying bag
- Batteries
- User manual

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

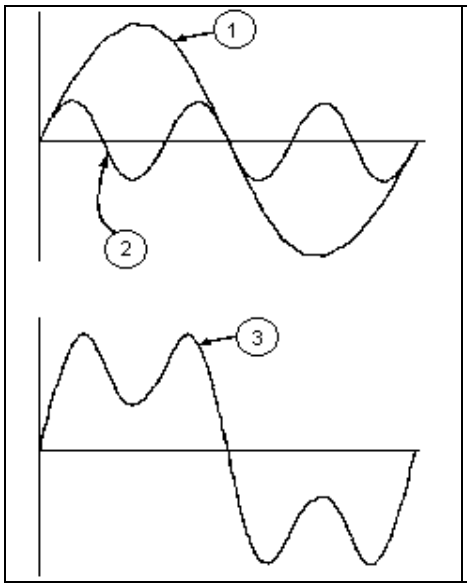
8.1. THEORY

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^{th} harmonic of v(t)



LEGENDA:
1. Fundamental
2. Third Harmonic
3. Distorted waveform sum of two previous components.

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^{th} harmonic.

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

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

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% if 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 40th 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 complete 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 complete 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 2nd, 4th 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	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. The consequence of this is the current, which normally is distribute along the external surface of wire, produces: – an over-heating of the conductor; – a premature degrading of the cable's insulation; – an increase in line voltage drop.
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	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. Increasing of iron loss due to hysteresis cycle distortion and due to generation of leakage currents on magnetic core. Heating of insulation material due to eventually DC component that can generate saturation of magnetic core column.
Motors	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. The 5th and 11th harmonic components generate some abnormal electromagnetic coupling that can increase motor speed.
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.