

tinsley[↑]
PRECISION INSTRUMENTS

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INS-6005kV
5 kV Digital insulation tester
User guide

INS-6005kV

5 kV Insulation tester

User guide

GF-2093

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Safety warnings

- Before to use this instrument the User guide and Safety warnings must be read and understood.
- Safety procedures and rules for working near high voltage energized systems must be observed during the use of this equipment. **The generated voltages may be dangerous.**
- Do not connect or disconnect the test leads during the measurement.
- Be careful not to make short-circuit between the terminals while a measurement is running, because it could be dangerous for the operator.
- Be sure that there are not any voltage difference between the points to which the equipment will be connected to, neither between them and ground.
- The panel, terminals and connectors of the equipment must stay dry and clean.

This equipment should be used only by a trained and competent person, strictly applying suitable safety rules.

Used symbols

| | |
|---|---|
|  | Caution, risk of electric shock. |
|  | Caution, refer to User Guide. |
|  | Battery |
|  | Printer |
|  | Capacitance |
|  | Voltmeter |
|  | Equipment complies with current EU Directives. |
|  | The rubbish bin with a line through it means that in the European Union, the product must undergo selective disposal for the recycling of electric and electronic material, in compliance with Directive WEEE 2002/96/EC. |

Index

| | |
|--|----|
| 1. Description..... | 6 |
| 2. Panel control functions..... | 7 |
| 2.1. Keyboard..... | 8 |
| 2.2. Display..... | 10 |
| 3. Charging battery..... | 11 |
| 4. Connecting the INS-6005kV..... | 12 |
| 5. Use of "Guard" (G) terminal..... | 14 |
| 6. Setting tests..... | 15 |
| 6.1. Test voltage definition..... | 15 |
| 6.2. Selection of the operation mode..... | 16 |
| 6.2.1. Normal mode..... | 16 |
| 6.2.2. SVT Mode (step voltage tests)..... | 16 |
| 6.2.3. "TIMER" Mode..... | 18 |
| 6.2.4. "Pass / Fail" Test mode..... | 19 |
| 7. How to perform tests..... | 20 |
| 7.1. Measurement of the Dielectric Absorption Index (DAI)..... | 22 |
| 7.2. Measurement of the Polarization Index (PI)..... | 23 |
| 8. Other functions..... | 24 |
| 8.1. Backlight..... | 24 |
| 8.2. Filter..... | 24 |
| 8.3. True RMS AC/DC Voltmeter..... | 24 |
| 8.4. Leakage current measurement..... | 24 |
| 8.5. Capacitance measurement..... | 25 |
| 8.6. Hold..... | 25 |
| 8.7. Internal memory..... | 26 |
| 8.8. Battery status check..... | 26 |
| 8.9. Auto power-off..... | 26 |
| 9. Software..... | 27 |
| 9.1. USB Drivers..... | 27 |
| 9.2. Tinsley software..... | 27 |
| 10. Printer..... | 28 |
| 11. Cleaning..... | 28 |
| 12. Technical specifications..... | 29 |
| 13. Application note 32..... | 32 |

1. Description

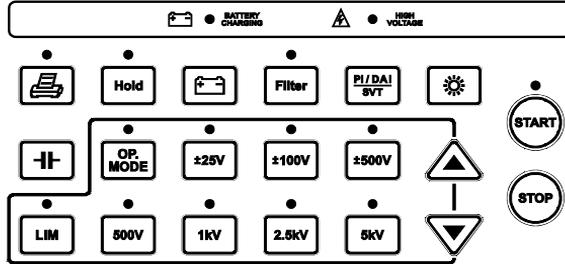
The digital insulation tester model **INS-6005kV** is at the cutting edge of Tinsley' insulation analyzer equipment and it is one of the more complete and sophisticated of the international market. It uses an efficient well experienced technology, which provides safe, reliable and accurate measurements of insulation resistances up to **5 T Ω** , with 4 pre-selected test voltages: **500 V - 1 kV - 2.5 kV - 5 kV**. Other test voltages (from 250 V up to 5 kV) may be selected in steps of **25 V, 100 V, or 500 V**.

A microprocessor controls the equipment, making the operation easier and enabling the incorporation of advanced features such as: Auto-range selection, Memory enabling storing up to 4000 readings, AC/DC voltmeter, Polarization and Dielectric absorption index automatic measurement, Measurement of Leakage Current and Capacitance, "TIMER" to program resistance test time, "Limit" allowing making test type "Pass / Fail" with programmable limit. Step Voltage Test, Built-in Printer, Real Time Clock and Calendar for measurement identification. Built-in chronometer, indicating elapsed time, in minutes and seconds, since the test started.

The USB interface enables communication of the equipment with a computer to transmit registered data. The Tinsley software analyzes the results and shows through charts and tables, automatically generating the test protocol. The built-in printer records values on paper every each 15 seconds, as a measurement taken document.

Due to its constructive features, this instrument is strong delivering an excellent performance both with laboratory and field works, under hard environment conditions.

2.1. Keyboard



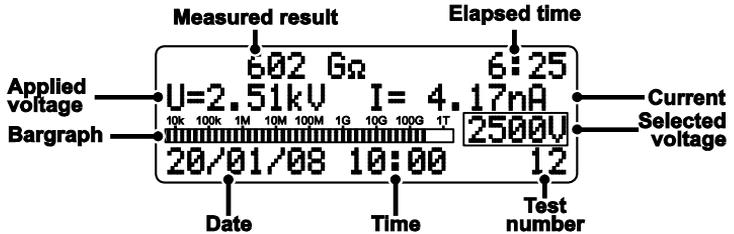
| Key | Function | LED |
|-----|---|---|
| | Turns the printer on/off | Indicates that the printer is turned on. |
| | Hold - Freeze the last reading on the display | The Hold function is on |
| | Battery - exhibits the battery charge status on the display | Indicates that the battery charger is on |
| | Filter - Activates the filter that minimizes the interferences of the external noise | Indicates that the filter is on |
| | Shows the calculated value on the display as a result of a Step Voltage Test (SVT), Polarization Index (PI) and Dielectric Absorption Index (DAI) | — |
| | Backlight - activates the display light | — |
| | Capacitance - exhibit the capacitance value | — |
| | Activated enables the programming of the Operation Mode (Normal, SVT or with TIMER of selectable time) | Indicates that the selection of the Operation Mode is enabled |

INS-6005kV

| | | |
|--|--|--|
|  | <p>Activated, enables programming of 25 V step tests voltages</p> | <p>25 V steps activated</p> |
|  | <p>Activated, enables programming of 100 V step tests voltages</p> | <p>100 V steps activated</p> |
|  | <p>Activated, enables programming of 500 V step tests voltages</p> | <p>500 V steps activated</p> |
|  | <p>Selection of 500 V test voltage</p> | <p>Indicates 500 V selected</p> |
|  | <p>Selection of 1 kV test voltage</p> | <p>Indicates 1 kV selected</p> |
|  | <p>Selection of 2.5 kV test voltage</p> | <p>Indicates 2.5 kV selected</p> |
|  | <p>Selection of 5 kV test voltage</p> | <p>Indicates 5 kV selected</p> |
|  | <p>These keys (decrease or increase) enable the selection of the value that is being programmed.</p> | <p>–</p> |
|  | <p>Activates / enables programming of the limit for the "Pass / Fail" test</p> | <p>Indicates when the measured resistance is lower than programmed limit</p> |
|  | <p>Start - Start test</p> | <p>Indicates that the test is being executed</p> |
|  | <p>Stop - End of test</p> | <p>–</p> |

2.2. Display

Measurement results in the corresponding measuring unit, elapsed time since the measurement started, selected test voltage, analogue indication by means of a bargraph and several messages to the operator are displayed on alphanumeric LCD.



3. Charging battery

The **INS-6005kV** uses a rechargeable LiFePO₄ 12 V - 6000 mAh.



At the end of battery useful life, the battery must be recycled or disposed of properly, in order to protect the environment.

Charging procedure:

- Check if the **INS-6005kV** is turned-off and connect it to the mains (AC adapter).
- The charging indicator (  **BATTERY CHARGING**) will turn on red and will remain that way until the battery is totally charged. Then the light will remain green and keep in that way until the **INS-6005kV** is disconnected of the mains.

| | |
|--------------------------------|--|
| Alternate green and red lights | Evaluation of the battery initial status when the source is connected, during one second. |
| Steady red light | Battery under charge. |
| Flashing red light | The battery was not successfully charged. It denotes some trouble in the battery charging process. |
| Steady green light | The charge has successfully finished. The battery is OK. |

The rechargeable battery does not have “memory effect” and there are no restrictions to start charging it as many times as is needed. However the battery could be damaged if remains in deep discharge for a while.

To avoid this effect, charge the battery before left the equipment in storage and don't let pass more than 30 days without recharge, even if the instrument wasn't used (under storage, the battery loses part of its charge).

IMPORTANT: while the equipment is connected to the mains supply the START key is inhibited, so you will not be able to make measurements.

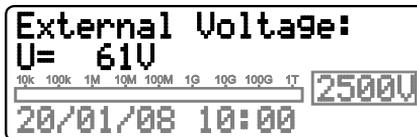
4. Connecting the INS-6005kV

ATTENTION: For a safe operation, the procedures detailed below should be carried out with the device Powered-Off.

Please, do check if there is no difference of potential voltages between the points where the **INS-6005kV** shall be connected to. Please, check the same between those points and the ground.

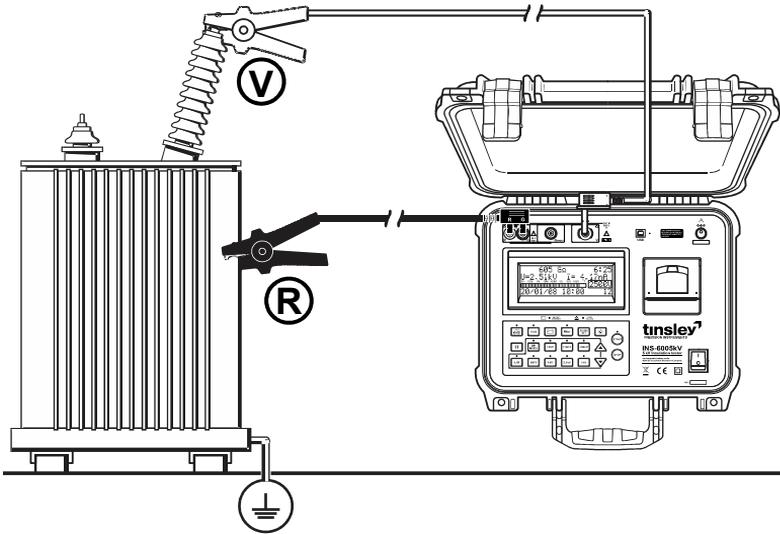
At the time of the connection and power-on, the equipment automatically enters in the voltmeter mode and begins to exhibit the circuit voltage in the display.

The circuit to be tested must be de-energized to avoid interferences in the measurement. The equipment will block the start of measurement if it detects a voltage greater than 60 V in the circuit.



INS-6005kV

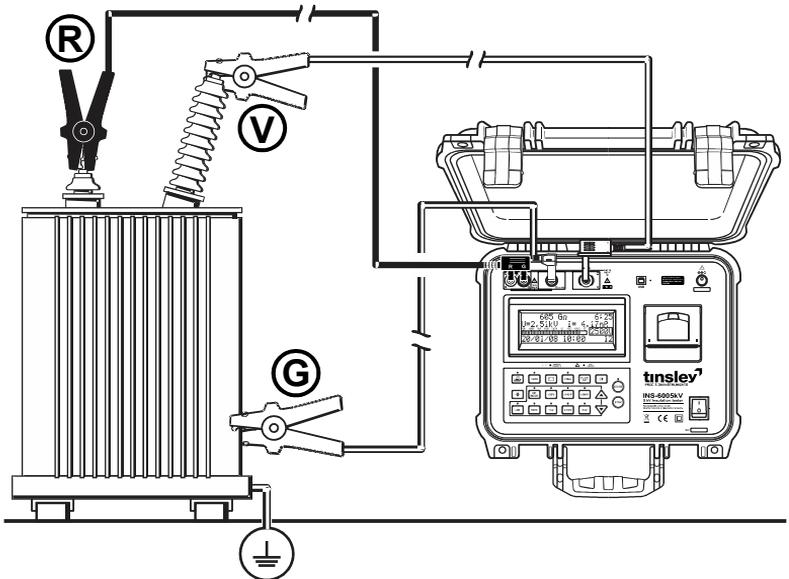
Connect the red cable security terminal to the equipment **(-V) output terminal**, the terminal of the black cable to the **zero reference (+R)** terminal and the “alligator” terminals to the element to be measured as indicated in the next figure.



The test leads in the picture are merely illustrative.

5. Use of “Guard” (G) terminal

Depending on the measurement to be made, the **Guard (G)** may be used or not. During the measurements, the equipment should be electrically grounded to avoid unsteady readings. When insulation is measured regarding grounding, the **R** terminal is connected to earth and the condition by means of which the equipment potential setting is fulfilled. If the measurement is performed between two parts, which are not grounded (for example, between two phase conductors in a three-phase cable), the equipment **GUARD** terminal must be grounded. This implies that **whenever a measurement is performed, one of the GUARD or R terminals must be grounded, but not both of them simultaneously.**



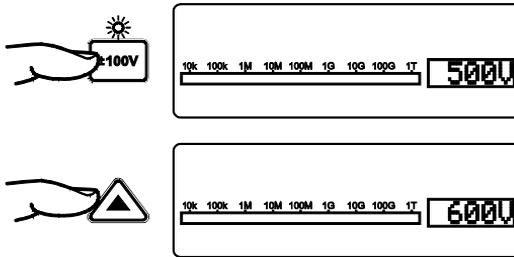
Technical Note 32, reproduced at the end of the manual, explains the usage of GUARD terminal in order to eliminate the parasite resistance effect over the result of measurements.

6. Setting tests

The insulation tester **INS-6005kV** is an extremely versatile instrument that enables automatic performance of several types of insulation tests, and records them in its internal memory and/or prints the results. Thus, it is necessary to appropriately define the tests to be performed, setting the following parameters before starting the measurement: Test voltage, Test duration for “TIMER” mode test, Maximum Voltage for step voltage test (SVT) and Minimum resistance limit for “Pass/ Fail” tests.

6.1. Test voltage definition

In order to define the test voltage value, first it is necessary to select one of voltage adjustment keys: **±25V** **±100V** **±500V**. These keys enable both the pre-programmed voltage selection (**500V** **1kV** **2.5kV** **5kV**) and the **▽** and **△** keys which increase or decrease the value of the step voltage test for 25 V, 100 V or 500 V, depending on the selected voltage adjustment key.



As long as the equipment is on, the voltage adjustment key **±500V** will be selected. Please, press again the adjustment key selected at the moment with the aim of leaving the test voltage selection mode.

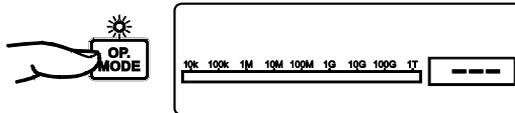
Note: Test voltage is the only one parameter that may be modified during tests.

6.2. Selection of the operation mode

The **INS-6005kV** insulation tester has four operation modes: Normal, with “TIMER”, SVT and “Pass / Fail”. The first three modes are selected using the **OP. MODE** key; the “Pass/ Fail” test mode is activated pressing **LIM** key.

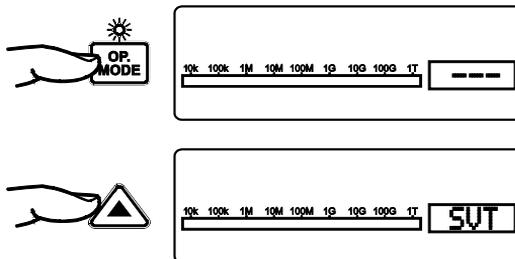
6.2.1. Normal mode

The normal mode is used in the resistance measurement with unique voltage, without time limit. When selected, there are no special indications in the display.



6.2.2. SVT Mode (step voltage tests)

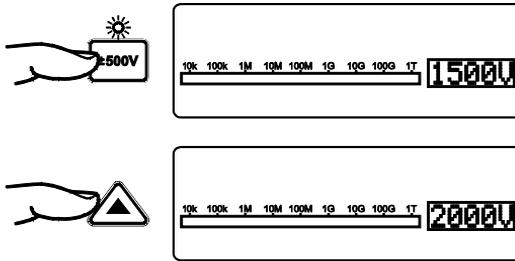
The use of **OP. MODE** key allows the **INS-6005kV** setting for the performance of a step voltage test; when this mode is selected, the display shows the **SVT** abbreviation.



INS-6005kV

Under this operation mode, the user does not define a specific voltage test, but a maximum voltage value. The device will start the test applying a 500 V voltage and increase this value in 500 V steps each minute until reaching the programmed voltage. At each stage, the **INS-6005kV** measures the resistance before advancing towards the following step.

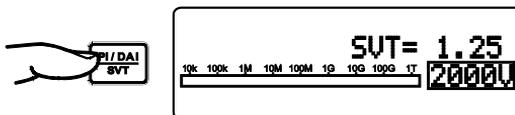
The use of voltage adjusting keys, determines the value of the highest voltage – which will be, in all cases, a multiple of 500 V, up to a 5000 V limit. It is advisable to use the **[±500V]** key in order to select this value; **[±25V]** and **[±100V]** keys may be used, but if the selected value is not a multiple of 500, it will be rounded down.



The test result is calculated according to the following formula:

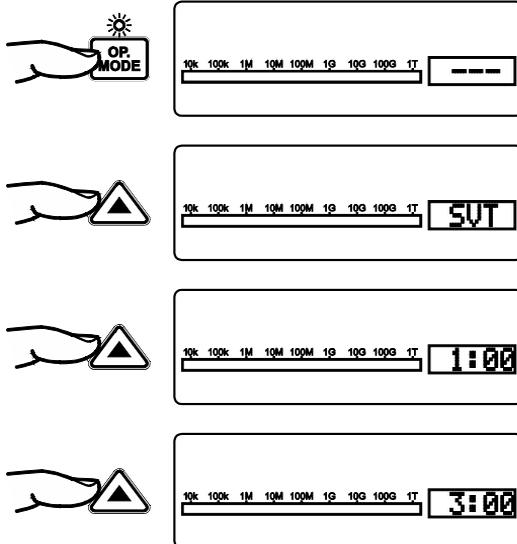
$$SVT = \frac{R_{VMAX}}{R_{500}}$$

After test ending, the value may be recovered by pressing **[PI/DAI SVT]** key.



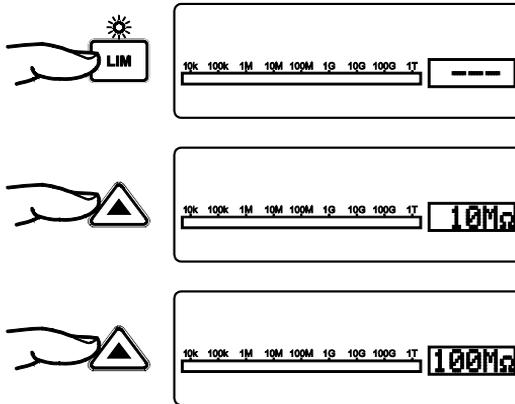
6.2.3. "TIMER" Mode

The use of  key allows the **INS-6005kV** setting for the performance of a pre-set - duration test; when this mode is selected, the display shows the programmed time. Use  and  keys to define the duration of the tests in 1 minute, 3 minutes, 10 minutes, 30 minutes or 90 minutes.



6.2.4. “Pass / Fail” Test mode

Press **LIM** key in order to determine the lower insulation limit for type “Pass / Fail” test. Select this value using **▲** and **▼** keys. Possible values are 10 MΩ, 100 MΩ, 1 GΩ or 10 GΩ.



During a “Pass/ Fail” test, the **INS-6005kV** will indicate when the insulation resistance is lower than the programmed limit, both with an intermittent beep and the **LIM** key led flashing. The **LIM** key led will remain flashing until the end of tests, or until the measurement of the resistance value is greater than the programmed limit.

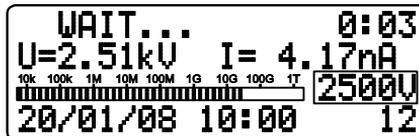
7. How to perform tests

After having set the desired measurement, press  key. The **HIGH VOLTAGE** indicator will turn on indicating that the insulation tester is applying high voltage to the element under test.



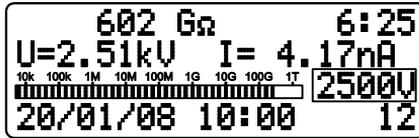
**HIGH
VOLTAGE**

During some seconds the intelligent auto-range system will search for the most convenient range for the value under measure. At this moment the display will show the message “WAIT...”.



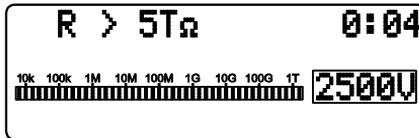
As soon as the **INS-6005kV** selects the appropriate range, the display will show the number of test, the selected voltage value, exhibiting the value of the applied voltage and the leakage current, date and time, will start counting the elapsed time and the resistance value indication will be exhibited with its corresponding unit, and the analogue indication will start by bargraph. In order to end the test, press the  key. At that moment, last measured values will remain frozen in the **MD-5075x** display. By pressing the  key again, the equipment will return to the voltmeter function.

Example:



The display exhibits the test number (12), the measured resistance value (602 GΩ), the voltage selected of 2500 V, the elapsed time (6:25 minutes), the applied voltage (2.51 kV), the leakage current (4.17 nA), date and time.

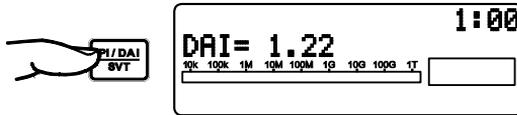
NOTE: If the resistance measured is greater than 5 TΩ @ 5 kV, the following message will be exhibited: **R > 5TΩ**



ATTENTION: Please, never connect or disconnect the test leads with the equipment under operation or while the High Voltage led is on. If there is a need to modify the connections, this should be done with the equipment disconnected and with discharged potentials (High Voltage led off)

7.1. Measurement of the Dielectric Absorption Index (DAI)

When pressing the  key during the test, the Dielectric Absorption Index (DAI) value will be exhibited on the display. It is only possible to apply this function after a minimum of 1 minute of measurement; in case the key is pressed before this minimum limit, the display will show the message of value exhibition of DAI value, but will not show any value.

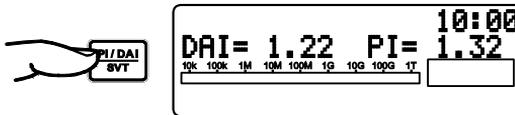


The polarization index is the quotient between the values of the insulation resistance measured at the 60 and 30 second, and it is useful for preventive and predictive maintenance of windings (present in transformers, motors, generators, etc.).

$$DAI = \frac{R_{60 \text{ seconds}}}{R_{30 \text{ seconds}}}$$

7.2. Measurement of the Polarization Index (PI)

When pressing the  key during the test, the Polarization Index (PI) value will be exhibited on the display. It is only possible to apply this function after a minimum of 10 minutes of measurement; in case the key is pressed before this minimum limit, the display will show the message of value exhibition of PI value, but will not show any value.



The polarization index is the quotient between the values of the insulation resistance measured both in 10 minutes and 1 minute. This index is useful to detect the damage of the insulation resistance by the excessive presence of dust, dirt and greases or through the action of chemical and physical agents.

$$PI = \frac{R_{10 \text{ minutes}}}{R_{1 \text{ minute}}}$$

8. Other functions

8.1. Backlight

The equipment display has a backlight. In order to activate it, press  key. After 10 seconds the backlight will auto-turn off. If you want to reactivate it, press  key again.

8.2. Filter

When insulation measurements are carried out in transformers or in large dimension machines, in presence of strong electromagnetic fields, it is possible for the equipment reading to be unstable, especially for resistance values higher than 100 MΩ. In these cases it is convenient to press the  key before starting the measurement activating the filter which allows for the reaching of the insulation resistance value in an upward curve without significant oscillation.

8.3. True RMS AC/DC Voltmeter

In order to use this function, connect the test points and turn on **MD-5075x**. The measured value will be exhibited automatically in the display.

| AC | DC |
|-------------------------|-------------------|
| 10 V up to 1000 Vr.m.s. | 10 V up to 1000 V |

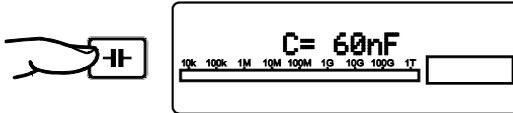
Precision: \pm (5% of the reading + 3 digits)

8.4. Leakage current measurement

During the tests, the equipment measures and exhibits in the display the leakage current value within a range of 1 nA up to 3 mA, with a Precision of \pm (10% of the reading + 3 digits).

8.5. Capacitance measurement

The capacitance value is obtained by measuring the insulation resistance. After finishing measuring (When the **STOP** key has been pressed), wait the high voltage LED turn off, and press the **HF** key and the capacitance value will be exhibited on the display.



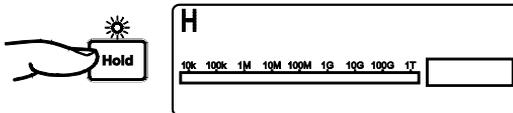
| Voltage | Capacitance |
|---------|------------------------|
| 500 V | 50 nF up to 10 μ F |
| 1,000 V | 50 nF up to 5 μ F |
| 2,500 V | 30 nF up to 2 μ F |
| 5,000 V | 30 nF up to 1 μ F |

Precision: $\pm 10\%$ of the measured value ± 3 digits

Note: "0" will be exhibited on the display when measuring values lower than 50 nF

8.6. Hold

This function allows holding the last performed reading on the display at the moment when pressing the **Hold** key, without interrupting the test. When this key is pressed again, the equipment updates the resistance and chronometer values. The led of **Hold** key and the letter **H** on the display indicate that the function has been activated

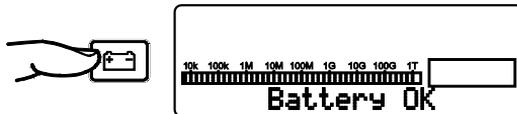


8.7. Internal memory

This equipment has an internal memory for up to 4000 measured values (approx. 280 DAI tests or 30 PI tests). This memory is administrated by the instrument and works in a cyclic way, this means, when the memory is full, the oldest values in the memory will be replaced by the newest ones. To avoid lost of data, always download the internal memory after finish the measurements.

8.8. Battery status check

Hold the  key pressed in order to check the battery status during measurements. The analogue bargraph will give an approximate visual representation of the remaining charge percentage; additionally, the display will show the message “**Battery OK**” if the charge is enough, or “**Battery Low**” if the charge is low. In this last case, it is highly advisable to charge the battery before using the apparatus. If battery charge is under 20% of the total, the message **Battery Low** will automatically appears on the display.



8.9. Auto power-off

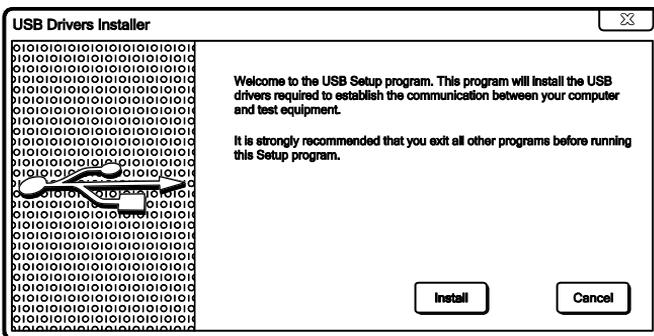
The **INS-6005kV** auto-turns off after 10 minutes of inactivity, or after 95 minutes of measuring without checking the battery status.

9. Software

9.1. USB Drivers

To install the USB drivers required for the communication between PC and equipment follow the instructions:

1. Connect the equipment in the PC using the USB cable.
2. If there is an available Internet connection, Windows will silently connect to the Windows Update website and install any suitable driver it finds for the device. If no suitable driver is automatically found then you need to insert the CD-ROM, supplied with the equipment, in the PC, run the executable “**usb-install.exe**” and click in “**Install**”.



9.2. Tinsley software

This software makes communication between the equipment and a computer with Windows operative system easier. It makes possible to synchronize the date and time of the equipment internal clock with the computer date and clock, to transfer the stored date, to clear the memory, to generate test graphics and protocols, etc. The installation and operation instructions are included in the software.

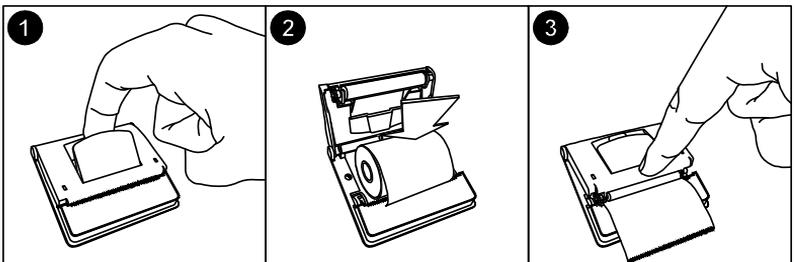
10. Printer

In order to enable the printing function press  key. Measured values will be printed each 15 seconds, and the Dielectric Absorption Index and Polarization Index will be printed after 1 minute and 10 minutes respectively. Printing may be started or stopped at any time during the test. However, it is convenient to turn the printer on before starting the test in order to print it complete, including the heading.

ATTENTION: Don't pull the paper. The printer can be easily damaged.

This printer uses 56 mm-wide thermal paper, which comes in a 30 mm-diameter reel.

- 1 Pull the lever located on the lid.
- 2 Insert the paper reel as shown in the figure.
- 3 Keep the tip of the paper out of the printer and close the lid.



11. Cleaning

The panel, terminals and connectors of the equipment must stay dry and clean. Cleaning should be made using a wet cloth in water and a soft detergent or isopropyl alcohol (be sure that the products to be used for cleaning does not affect plastic goods).

12. Technical specifications

| | |
|-----------------------------------|---|
| Test voltages | : 500 - 1,000 - 2,500 - 5,000 V with fast selection. From 250 V to 5 kV selectable in 25 V, 100 V or 500 V steps. DC, negative in relation to grounding. |
| Maximum resistance reading | : 5 T Ω @ 1 kV up to 5 kV 1 T Ω @ 500 V up to 1 kV 500 G Ω @ 250 V up to 500 V |
| DC Voltmeter | : 10 V up to 1000 Vdc Precision: \pm (5% of the reading + 3 digits) |
| AC voltmeter | : 10 V up to 1000 V r.m.s. Precision: \pm (5% of the reading + 3 digits) |
| Over voltage protection | : CAT III – 600 V |
| Current measurement | : 1 nA up to 3 mA \pm (10% of the reading + 3 digits) |
| Capacitance measurement | : 50 nF up to 10 μ F @ 500 V 50 nF up to 5 μ F @ 1,000 V 30 nF up to 2 μ F @ 2,500 V 30 nF up to 1 μ F @ 5,000 V Precision: \pm 10% of the reading \pm 3 digits |
| Short circuit current | : Max. 3 mA |
| Display | : Alphanumeric. It exhibits measurements both digitally and analogically by bargraph. |
| Test voltages accuracy | : \pm 3% of nominal value over a 10 G Ω resistance |

| | |
|---|--|
| Equipment accuracy | : ± 5% of reading between 1MΩ and 1TΩ @ 5kV ± 20% of reading between 1TΩ and 5TΩ @ 5kV (For lower test voltages, the superior limit is proportionally reduced) ± 20% of the reading between 10kΩ and 100kΩ ± 10% of the reading between 10kΩ and 1MΩ |
| Advanced features | : • Automated Polarization Index computing • Automated Dielectric Absorption Index computing • “Pass-fail” and fixed time tests • Step Voltage Test • Memory for up to 4000 measurements • Filter to minimize interferences |
| Printer | : Prints elapsed time, actual voltage applied to the element under test and measured resistance |
| PC Interface | : USB |
| Built-in chronometer | : Indicates elapsed time from the beginning of the measurement mm:ss format, up to 90:00 |
| Environmental protection index | : IP54 (with closed lid) |
| Safety | : In accordance with IEC 61010-1 |
| Electromagnetic compatibility (E.M.C.) | : In accordance with IEC 61326-1 |
| Electromagnetic irradiation immunity | : In accordance with IEC 61000-4-3 |
| Electrostatic immunity | : In accordance with IEC 61000-4-2 |
| Power supply | : Internal rechargeable battery 12 V - 6000 mAh |
| Battery charger | : AC Adapter: 12 V - 2 A |
| Operating temperature | : -5°C to +50°C |

INS-6005kV

| | |
|-----------------------------|---|
| Storage temperature | : -25°C to +65°C |
| Humidity | : 95% RH (non condensing) |
| Equipment weight | : Approx. 4.3 kg |
| Dimensions | : 340 x 295 x 152 mm |
| Supplied accessories | : • 3 measurement cables • AC Adapter • USB cable • Carrying bag • Operation manual • License for Tinsley software |

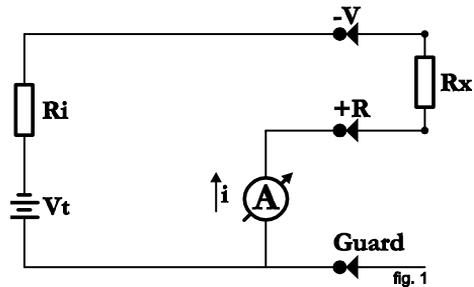
Subject to technical change without notice.

13. Application note 32

Use of “Guard” terminal in insulation testers

When insulation resistance measurements are performed with insulation testers, especially with high sensitivity instruments measuring high resistance values, the use of the *GUARD* terminal avoids the harmful influence of stray resistances.

In order to better explain the function of this terminal, let us start reviewing the insulation tester basic circuit diagram of fig. 1.



Where:

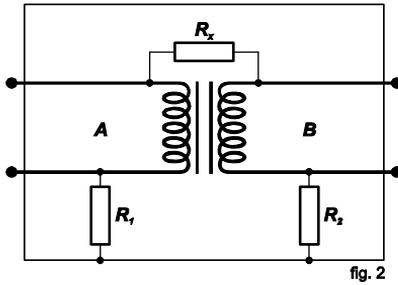
- V_t : DC high-voltage generator
- R_i : Generator internal resistance
- A : Indicator meter (micro-ammeter)

The unknown resistance (R_x) is connected between V and R terminals. Its value determines the current passing through the circuit, which in turn is indicated by the micro-ammeter. The value of R_x can be determined as follows:

$$R_x = \frac{V}{i} - R_i$$

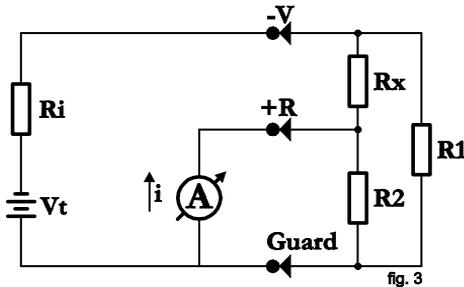
In many cases the resistance to be measured is in parallel with other stray resistances which influence on R_x should be minimized.

A typical example of this situation is when the insulation resistance between primary and secondary windings of a transformer mounted inside a metal housing is to be measured.



- Rx: Insulation resistance between primary and secondary winding.
- R1: Insulation resistance between primary winding and housing.
- R2: Insulation resistance between secondary winding and housing.

If the insulation tester (terminals V and R) is connected to transformer terminals A and B, and considering that the resistance of the coils on each side of the transformer may be disregarded, R_x appears to be in parallel with $(R_1 + R_2)$. The situation is changed if we connect the transformer housing to GUARD terminal. Then the circuit will be:



In the circuit of Fig. 3 it may be noted that R1 is in parallel with a low-value resistance (the one from the micro-ammeter) therefore its influence is reduced during reading.

Through resistance R2 circulates a current which is not passing through the meter and consequently does not affect the reading. In fact, current through R2 originates a certain error, since it creates an additional voltage drop in R1 which was not regarded during equipment calibration. As regards the practical use of instrument, it shall be considered that if R1 and R2 are higher than 100 M Ω , any value of Rx will be measured with an insignificant error. For example: Let us consider Rx = 3000 M Ω and R1 = R2 = 100 M Ω , the reading without using the GUARD terminal would be 187.5 M Ω , which is quite wrong. On the other hand, if the GUARD terminal is properly used, we would have 3000 M Ω .