MD-5060x

5 kV digital insulation tester

User's Guide

GU-1290

Printed in Germany.

∀

Safety warnings

- Before to use this instrument the User's 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.
- Do not touch the test leads before the high voltage indicator turn-off.
- Be careful not to make short-circuit between the high voltage terminals and the "R" or "Guard" 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 megohmmeter 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.

Equipment complies with current EU Directives.

Index

1. Description

The SOURCETRONIC model **MD-5060x** digital smart insulation tester is versatile, robust and easy-to-use equipment. It uses an efficient well experienced technology, which provides reliable, safe and accurate measurements of insulation resistances up to 5,000,000 MΩ @ 5 kV, with 4 pre-selected test voltages: 500 V - 1 kV - 2.5 kV - 5 kV, with the possibility of increasing or decreasing these values in steps of 100 V or 500 V.

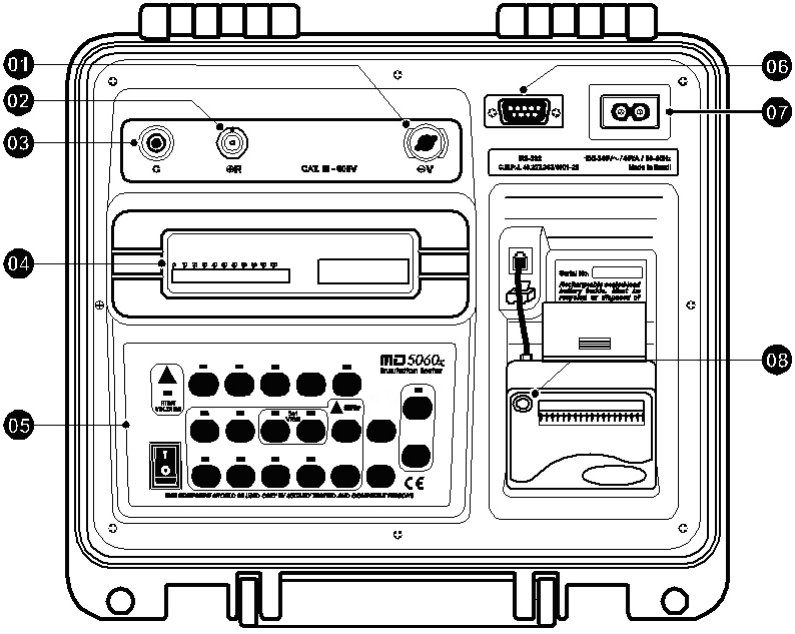
A state-of-the-art microprocessor controls the equipment operation and enables the incorporation of advanced features which make measurements easier:

- Auto-range selection
- Built-in printer enabling tests recording.
- NVRAM memory, enabling storing up to 4000 readings to be later downloaded to an IT equipment.
- Built-in chronometer, indicating elapsed time, in minutes and seconds, since the test started.
- Real-time clock, indicating hour, minutes and calendar.
- Voltage measurement, really applied during the test.
- Polarization index calculation and automatic indication (*PI*).
- Dielectric absorption index calculation and automatic indication (*DAI*).
- RS232 output with optical insulation for the acquisition of readings carried out with software and hardware.
- Timer enabling programming of test duration up to 30 sec., 1 min (absorption index), 3 min, 10 min (polarization index) and 30 min
- SVT - Step Voltage Test.
- Programmable limit. It makes it possible to carry out “Pass-fail test”.
- Switchable filter to minimize external noise interference.

Other features important in this equipment are the negative voltages that refer to the zero potential terminal (R), for detecting moisture within the installations, due to the electroendosmosis effect.

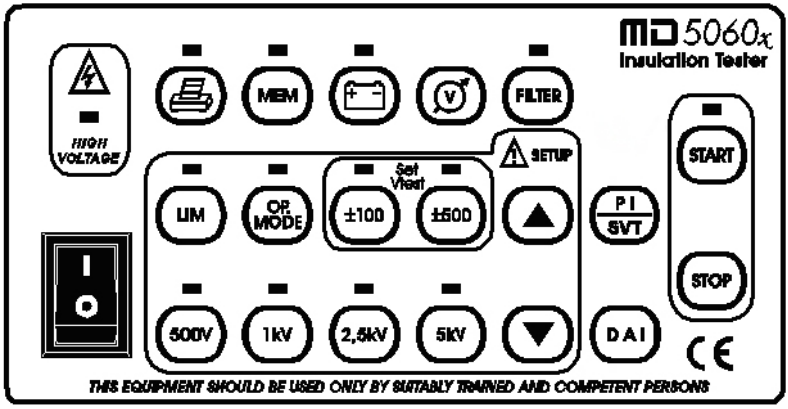
Due to its reduced dimensions and weight, power supply autonomy and mechanical resistance, this equipment is suitable for fieldwork under extreme weather conditions. It is easy to carry, very simple to be operated and resistant to violent treatment, which unavoidably includes frequent bumps, extremely high or low temperatures, intense vibrations during transportation over rough roads, long exposure to direct sunlight, splashes of water, sand and other wind-carried particles, etc. Everything without affecting its accuracy, comparable to the best laboratory insulation testers.

2. Control panel



!	**Voltage output** terminal (-V)	%	**Keyboard**
∀	**Zero reference** terminal (+R)	&	**RS232** communication port
#	**Guard** terminal (G)	ə	**Power supply input**
∃	**Display**	(	**Paper feed** control

2.1. Keyboard



Button	Function	Led
	On/Off switch.	-
Γ	When activated, it allows to program test voltage in steps of 100 V. It enables the fast voltage selection keys IϑKΛ.	100 V steps test voltage.
H	When activated, it allows to program test voltage in steps of 500 V. It enables the fast voltage selection keys IϑKΛ.	500 V steps test voltage.
I	Fast selection of 500 V test voltage.	500 V test voltage.
ϑ	Fast selection of 1 kV test voltage.	1 kV test voltage.
K	Fast selection of 2.5 kV test voltage.	2.5 kV test voltage.
Λ	Fast selection of 5 kV test voltage.	5 kV test voltage.
Φ	When activated, it allows to program the Operation Mode (Normal, SVT or TIMER).	Indicates Operation Mode is enabled.

E	When activated, it allows to program the limit of the “Pass-Fail test”.	Indicates LIM function is on.
N	Increase the value that is being programmed.	-
O	Decrease the value that is being programmed.	-
M	It activates the filter that minimizes external noise interference.	Indicates filter function is on.
Δ	Displays the actual voltage applied.	-
X	It shows the battery charge status on the display.	Indicates that the battery charger is in operation.
B	Hold - freeze the last reading on the display.	MEM function is on.
Θ	It displays the calculated value as the result of a Dielectric Absorption Index.	-
Π	It displays the calculated value as the result of a Step Voltage Test (SVT) or Polarization Index (PI).	-
A	Turns On/Off the printing of the measured values on the printer.	The printer is on.
P	Starts the test.	Indicates that the test is being carried out.
Σ	End of test.	-

2.2. Indicators

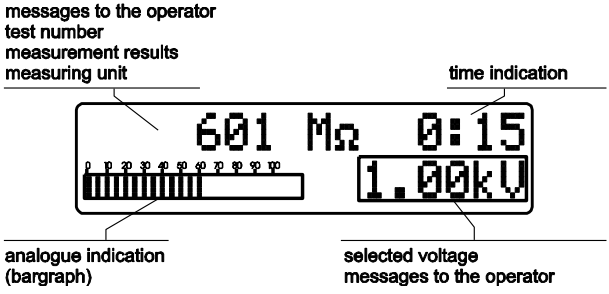
2.2.1. High voltage indicator

A light indicator displays the occurrence of high voltage on the output terminal during the measurement and keeps lit until the discharging process has been completed.

Do not touch the test leads before the high voltage indicator turn-off.

2.2.2. Display

Alphanumeric LCD where the measurement result, the corresponding measuring unit, the elapsed time since the measurement started, the analogue indication by means of a bargraph and messages to the operator are displayed (in English).



Analogue bargraph

The equipment analogically indicates the resistance value being measured. The bargraph provides a visualization of the gradual variation of the insulation resistance value during the test.

Built-in chronometer

It features the elapsed time (in minutes and seconds) since test voltage is applied.

Real time clock

It has a real time clock with date, hours and minutes indication, to make identification of tests recorded in paper or in memory easier.

Test number
Tests are automatically numbered by the equipment to make their identification easier. The test number is printed at the beginning of each test and it is stored in memory.

Model and serial number
At the beginning of each test, the equipment model, as well its serial number, are registered, making it possible to relate the obtained results with their respective equipment Calibration Certificate.

3. Tests definition

The **MD-5060x** is an extremely versatile equipment, which allows to carry out several kinds of insulation tests automatically, recording all the results in its internal memory or printing them. It is necessary to define the tests properly, selecting its parameters before starting the test:

- **Test voltage**
- **Equipment operation mode**
- **Minimum resistance limit, for the "Pass-fail test"**

These three parameters shall be defined before starting the test. The test voltage is the only parameter that can be modified during the test. The ΓΗΕΦ keys makes it possible to enter the different equipment programming modes. The O (decrease) and N (increase) keys select the value. The functions of the ΓΗΕΦ keys are mutually exclusive. Selecting one of these keys implies releasing any other selected key.

3.1. Test voltage

The Γ or H key enable the test voltage programming mode. Whenever the equipment is turned-on, the H key will be selected by default.
Γ :: Enables test voltage adjustments in 100 V steps.
H :: Enables test voltage adjustments in 500 V steps.

Pre-set voltages

Fast selection keys for pre-set test voltages.
I :: Selects 500 V voltage.
ϑ :: Selects 1 kV voltage.
K :: Selects 2.5 kV voltage.
Λ :: Selects 5 kV voltage.
To operate them it is necessary that one of the keys Γ or H is selected.

Increase / Decrease test voltage

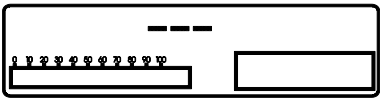
N :: Increases the present test voltage in 500 V or 100 V steps.
O :: Decreases the test voltage in 500 V or 100 V steps.
To operate them it is necessary that one of the keys Γ or H is selected.

3.2. OP. MODE

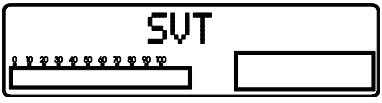
The Φ key makes it possible to select the equipment operation mode, the test type or its duration. The possible operation modes are:

Normal Mode

Resistance measurement test with unique voltage, without time limit.



SVT Mode
Carries out the step voltage test automatically, always starting with 500 V and reaching the programmed voltage, in 500 V steps.



Timer Mode
Defines the test duration. The possible values are 30 sec, 1 min, 3 min, 10 min and 30 min. The defined time is shown on the display. This programming must be carried out before starting the test. Press the Φ key during the test makes it possible to hardly visualize the selected value, without any possibility of adjusting it.

When the selected mode is different from the Normal mode, the Φ key led flashes in order to warn the operator that the equipment is programmed for a special test (SVT or with Timer).

3.3. LIM. “Pass-fail test”

The E key allows to program the lower insulation limit in 10 MΩ, 100 MΩ, 1 GΩ or 10 GΩ. By using this key, the insulation tester will indicate with a BEEP (intermittent sound) and with the E key led when the insulation resistance is lower than the programmed limit acting, in this case, as a “Pass-fail test” device. The E key led will remain flashing until the test is

finished or until the measured resistance limit is higher than the programmed limit.

3.4. Voltmeter

By pressing the Δ key, the equipment will measure the voltage effectively applied to the element being tested.

3.5. Memory (HOLD)

The B key allows to hold the last performed reading on the display, at the moment this key was pressed, without interrupting the test. When this key is pressed again, the equipment updates the resistance and time values. The B key led and the letter **H** on the display indicates that the function was activated.

3.6. Filter

When insulation measures are carried out in transformers or in large dimension machines, in presence of strong electromagnetic fields, it is possible that the equipment reading is unstable, especially for resistance values higher than 300 MΩ. In these cases it is convenient to press the M key before starting the measurement. This function allows to reach the insulation resistance value in an upward curve without significant oscillations.

3.7. Dielectric Absorption Index (DAI)

The Θ key makes it possible to visualize the Dielectric Absorption Index value on the display. For this kind of test, the equipment should be connected, applying voltage to the sample for 60 seconds. After this period, the operator must press the Θ key to read the absorption index value on the display. If this key is pressed before the 1-minute period has elapsed, the display will show DAI = - - -. The Dielectric Absorption Index is the ratio between the insulation resistance value measured after 60 seconds and the value measured after 30 seconds. This value is useful to determine whether it is necessary to perform preventive and predictive

maintenance on the coils (transformers, engines and motors, generators, etc.).

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

3.8. Polarization index (PI)

The Π key makes it possible to visualize the Polarization Index value on the display. For this type of test, the equipment must be connected and applying voltage to the sample for 10 minutes. After this period, the operator must press the Π key to show the PI value on the instrument display. If the key is pressed before the 10-min period has elapsed, the display will show PI= - - -. The polarization index is the ratio between the insulation resistance value measured after 10 min and the value measured after 1 min. This index is useful to determine whether it is necessary to perform preventive and predictive Maintenance in order to detect any insulation resistance wear and tear due to the excess of dust, dirt, grease, or else the action of chemical or physical agents, etc.

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

3.9. Step Voltage Test (SVT)

After selecting the SVT function with the Φ key, the operator must select the test maximum voltage with the H key. In this function, the equipment allows the selection of maximum voltages only from 500 V up to 5000 V in 500 V steps. If the operator selects a halfway voltage between two 500 V steps by using the Γ key, the equipment will carry out the test from the 500 V up to reaching an equal voltage value or a value that is straight below the 500 multiple value. During the first minute the generated test voltage is of 500 V. This voltage is incremented in 500 V steps until it reaches the maximum programmed voltage. Each voltage step is applied during one minute, and the resistance is measured before going up to the following voltage. The test result is calculated with this formula:

$$SVT = \frac{R_{V\,MAX}}{R_{500}}$$

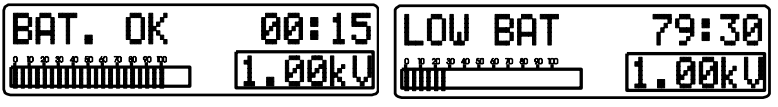
After the test is finished, the value can be recovered by pressing the Π key.

3.10. Built-in printer

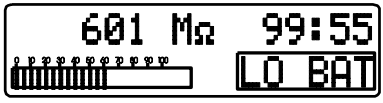
In order to enable the printing function press A key. Measured values will be printed each 15 seconds, and the Dielectric Absorption Index and Polarization Index will be printed after 1 minute and 10 minutes respectively. Printing may be started or stopped at any time during the test. However, it is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

3.11. Battery status check

During the measurement, it is possible to check the battery status. The X key must be pressed. If the battery charge is enough, it will read “BAT OK”. If the charge is not enough, the message will be “LOW BAT”, and the battery should be recharged. The analogue bargraph will give an approximate idea of the remaining charge percentage (at least 20% is required for a normal operation).



When the battery charge reaches the normal operation minimum value, the message LO BAT appears automatically in the area where the test tension value is indicates, alternating it every 1 second.



3.12. Auto power-off

The Auto-Power-off function turns off the equipment consumption (independently of the timer function) in two situations:

- **During the measurement** - After 35 minutes of operation, without allowing that the battery status checking function is carried out during that period.
- **Idle equipment** - After 10 minutes of inactivity.

4. Battery charger

This equipment has an intelligent built-in circuit that controls the battery charge and doesn't allow the equipment to operate during the charging process. In order to charge the battery, follow this procedure:

- Verify that the **On/Off** switch is switched off.
- Connect the power supply cable plug into **input** ɜ. After a while, the battery charge indicator (X key led) will blink alternatively in green and red during one second, while the charger verifies the initial condition of the battery to select the optimised parameters of the charge.

The following chart summarizes the meaning of LED luminous indications:

Green and red flashing alternatively	Test of the initial condition of the battery when plugging the mains, during one second.
Permanent red	Battery under charge.
Flashing red	Charging current is less than normal.

Permanent green	The charging process has been successfully finished. Battery OK.
Flashing green	The charging process has finished, nevertheless the battery hasn't received the complete charge.

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

The rechargeable battery does not show the "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.

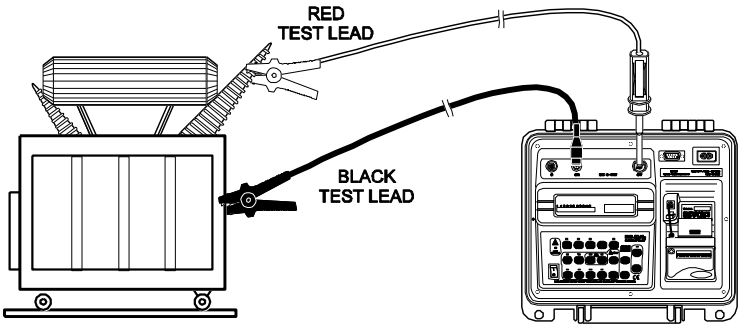
To avoid this effect, charge the battery before left the equipment in storage and don't let pass more than 30 days without recharge, even if the instrument wasn't used (under storage, the battery loses part of its charge).

5. Step by step instructions

Check if there is no differences of potential voltage between the points where the equipment shall will be connected to, nor between them and the ground.

1. Connect the red security terminal (red cable) to the insulation tester (-V) output terminal (see figure).

2. Connect BNC terminal to the **ZERO REFERENCE (+R)** terminal and the terminals to the element to be measured as indicated in the figure below.



The test leads in the picture are merely illustrative.

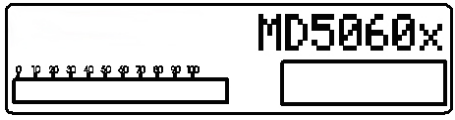
3. The G (GUARD) terminal can be used or not, according to the measurement that is going to be carried out.

IMPORTANT:
During measurements, the equipment must be electrically referred to earth in order prevent the equipment from being on a high potential, which may produce unstable 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 tree-phase cable), the megohmmeter 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.** SOURCETRONIC

Application Note 32 explains the usage of Guard terminal for minimizing the parasite resistance effect, whose influence one intends to minimize.

4. Turn the equipment by using the On/Off switch. 

5. The following message will appear on the display:



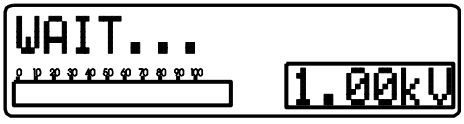
6. The **PRESS START** message will appear immediately.

7. In order to make repetitive tests performance easier, when the equipment is turned on, the test voltage will be the same voltage selected for the last performed test, meanwhile the equipment will be in the 500 V steps voltage test programming mode (H key led flashing). To modify this voltage, use the N and O keys or the fast selection IϑKΛ keys. For a voltage test fine adjustment (in 100 V steps) press the Γ key. In this condition, the N and O keys make it possible to decrease or increase the 100 V steps test voltage to select 500, 600, 700, ... 5000 Vdc.

8. To leave the voltage test programming mode just press the activated key again in order to deactivate it (the associated led will stop flashing). Now, the voltage selected value will be recorded in the equipment RAM memory for future tests.

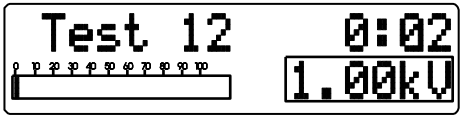
9. Press P key. The **high voltage led** turns on immediately, indicating that the equipment internal generator is applying voltage to the element that is being tested. If, during the test, it is necessary to change the test voltage, item 7 sequence shall be repeated.

10. For a few seconds, the self-scale smart system will search for the most convenient range for the value being measured. Meanwhile, the display will show the message:

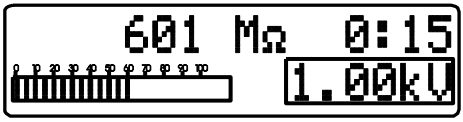


11. Then, the display will show the test number, the selected voltage value and it will start the elapsed time count. If the measured value is within the device scope, the test number indication will provide place for the resistance value indication and its corresponding unit, and it will start the analogue bargraph indication.

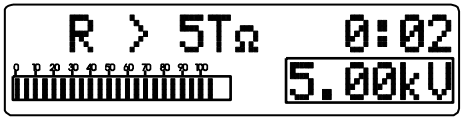
12. If, for example, the measured value is 601 MΩ with a selected voltage of 1000 V the display will initially remain on during a few seconds, as it is shown below, informing that test 12 was started.



13. After a few seconds, in the same example, the display will indicate that the measured resistance value is 601 MΩ, as it is shown:



14. If the measured value exceeds 5 TΩ @ 5 kV, the following message will be read:

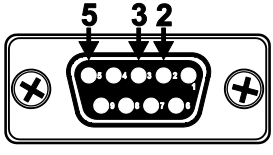


6. MegaLogg2 Software

This software makes communication between the equipment and a computer with Windows operative system easier. It makes it 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 tests graphics and protocols, etc. The installation and operation instructions are included in the software.

7. Data collection in the computer

RS232 output port

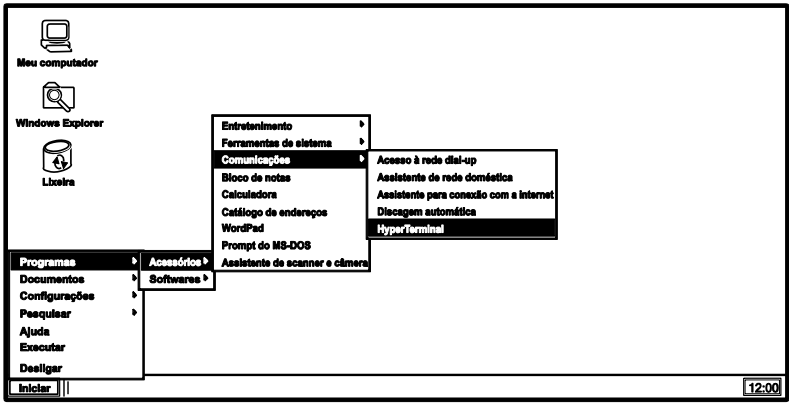


The equipment has an RS232 output in the control panel that can be used to register measurements in a serial printer or data collector. The outputs are the following ones: Pin 2: Rx ; Pin 3: Tx ; Pin 5: Gnd;

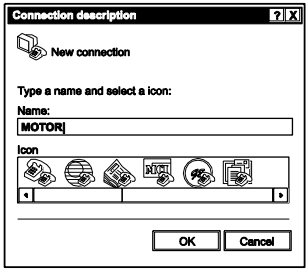
Transfer data to a computer

To transfer data from the **MD-5060x** to a PC-type computer, use the cable provided with the accessories. Connect it to RS232 PORT, and the opposite end of your PC RS232 connector.

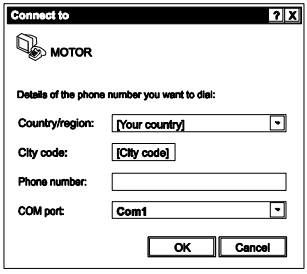
Open Windows: Start > Programs > Accessories > Communications > Hyper Terminal, as shown in the figure below:



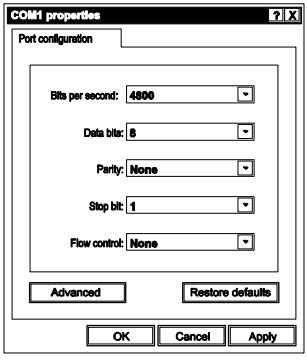
To set up a new connection, enter a name and then select an icon. In this example, the name chosen was “MOTOR”. Click OK.



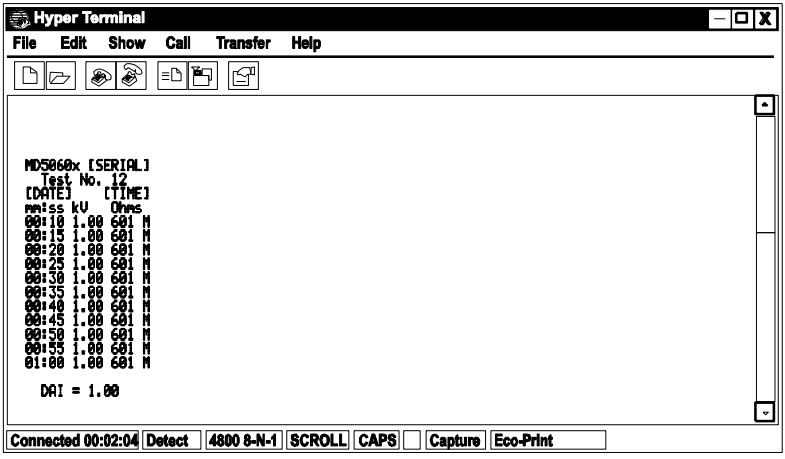
Then check if there is an accessible communications port, for instance Com 1 or Com 2. Choose the correct port in the next window. In this example, the port would be Com 1.



After clicking on OK, go to the next window to fill out the relevant data 4800, 8, none, 1, none.



Now the PC is ready to collect the information obtained from measurements. If P is pressed, the **MD-5060x** will start sending data to the computer. A typical line can feature the following format:



8. Printer

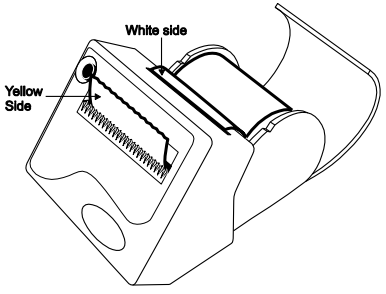
Printing sample

```
MD5060X  aaXXXXa
Test  No.     12
xx/xx/xxxx  xx:xx
mm:ss   kV   Ohms
00:15  0,50  601M
00:30  0,50  601M
00:45  0,50  601M
01:00  0,50  601M
 DAI=  1.00
```

Paper feed

The (, switch, which is a blue key located in the left upper part of the printer body, is the Paper feed control. Press this key 3 times after the test is finished and before cutting the paper, in order to visualize the last lines.

This printer uses 37mm-wide thermal paper, which comes in a 33mm-diammeter reel. The figure shown below indicates how to put the paper. Press the key (, (until the paper appears). To remove the old paper reel, cut the paper next to it and press the key (. The removal used-reel operation must be carried out in this way due to the fact that the paper movement is in one-way only, that is, the paper can be moved in one direction only.



ATTENTION: Don't pull the paper, always use the Paper feed key. Never try to put the paper back into the printer. In any of these cases, the printer can be easily damaged.

9. Technical specifications

Test voltages	:	500, 1000, 2500, 5000 V with fast selection. 500 V to 5 kV in 100 V or 500 V steps. DC, negative in relation to grounding.
Maximum resistance reading	:	5 TΩ @ 5 kV.
Short circuit current	:	1.5 ± 0.5 mA
Test voltages accuracy	:	± 3% of nominal value over 10 GΩ resistance.
Equipment basic accuracy	:	5% of reading ± 3 digits (1 MΩ to 500 GΩ at any test voltage).
Advanced features	:	Automated Polarization Index computing Automated Dielectric Absorption Ratio computing Step Voltage Test Programmable timer. “Pass-fail test” with programmable limits.
Built-in printer	:	Prints elapsed time, actual voltage applied to the charge and measured resistance.
Serial data output	:	RS232 @ 4800 bps. It allows the connection to a serial printer, to a portable computer or a laptop, or to a data-logger.
Memory up to 4000 readings	:	It allows for the storage of 4000 tests readings in its internal NVRAM memory.
Built-in chronometer	:	Shows elapsed time since measurement stats in mm:ss format.
Real time clock	:	Indicates date, hour and minutes.
Environmental protection	:	IP54 (with closed lid)
Safety class	:	Meets the requirements of IEC 61010-1:1990, IEC 61010-1:1992 amendment 2.
EMC	:	In accordance with IEC 61326-1
Electromagnetic irradiation Immunity	:	In accordance with IEC 61000-4-3
Electrostatic immunity	:	In accordance with IEC 1000-4-2

Power supply	:	Internal rechargeable battery (12 V - 2.3 Ah).
Battery charger	:	100 - 240 V~ mains supply.
Operating temperature range	:	-5°C to 50°C.
Storage temperature range	:	-25°C to 65°C.
Humidity range	:	95% RH (non condensing).
Dimensions	:	274 x 250 x 124 mm
Equipment weight	:	Approx. 3.6 kg.
Supplied accessories	:	2 Measuring test leads (1.8 m). 1 Guard test lead (1.8 m). 1 Power supply cable. 1 RS232 communication cable. 1 Thermal printer. 1 MegaLogg2 user license. 1 User guide. 1 Carrying bag.

Subject to technical change without notice.

10. 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 megohmmeter basic circuit diagram of fig. 1.

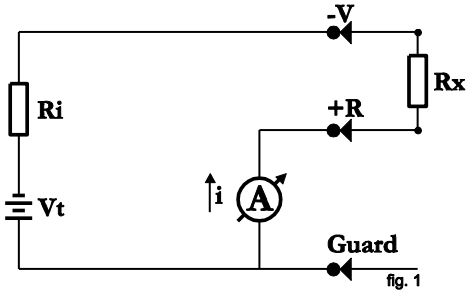


fig. 1

Where:

+V : DC high-voltage generator
Ri : Generator internal resistance
A : Indicator meter (micro-ammeter)

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

$$Rx = \frac{V}{i} - Ri$$

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

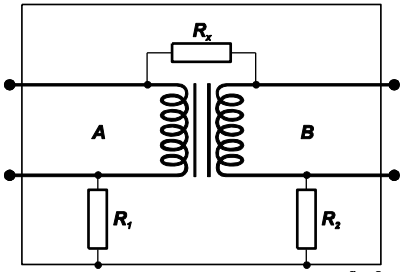


fig. 2

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 megohmmeter (terminals Vt 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, Rx appears to be in parallel with (R1 + R2). The situation is changed if we connect the transformer housing to GUARD terminal. Then the circuit will be:

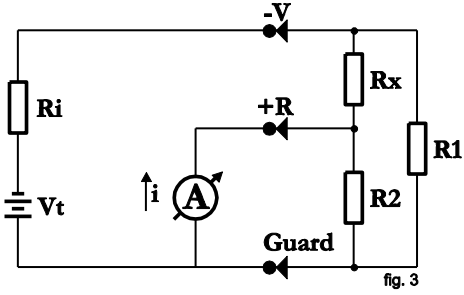


fig. 3

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 megohmmeter calibration. As regards the practical use of megohmmeter, it shall be considered that if R1 and R2 are higher than 100 MΩ, any value of Rx will be measured with an insignificant error. For example: Let us consider Rx = 3000 MΩ and R1 = R2 = 100 MΩ, the reading without using the GUARD terminal would be 187.5 MΩ, which is quite wrong. On the other hand, if the GUARD terminal is properly used, we would have 3000 MΩ.

11. Warranty

SOURCETRONIC warrants to the original purchaser that each equipment it manufactures will be free from defects in material and workmanship under normal use and service. The warranty period is valid for 12 months, except the built-in rechargeable battery that has 6 months, and begins on the date of shipment. The manufacturer's warranty does not apply to any product or accessories which, in the manufacturer's opinion, has been misused, altered, neglected, or damaged by accident or abnormal conditions of operation and handling.

To obtain warranty service, send the equipment, with a description of the difficult, shipping and insurance prepaid, to SOURCETRONIC. The manufacturer assumes no risk for damage in transit. SOURCETRONIC will, at its option, repair or replace the defective equipment free of charge or refund your purchase price. However, if SOURCETRONIC determines that the failure was caused by misuse, alteration, accident or abnormal condition or handling, you will be charged for the repair and the repaired equipment will be returned to you transportation prepaid.

This warranty is exclusive and is instead of all other warranties, express or implied, including but not limited to any implied warranty or merchantability or fitness for a particular purpose or use. SOURCETRONIC will not be responsible for any special, indirect, incidental, or consequential damages or loss of data, whether in contract, or otherwise.

Liability limitation

The liability for malfunctioning of the equipment is limited to the application of the warranty pursuant to the aforementioned provisions. The manufacturer does not take any responsibility for any eventual damage due to the use or impossibility to the use of the equipment such as the loss of memory data, accidents in the field, loss of profit, etc.

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