MI-20KVe

High voltage insulation tester

User's guide

⚠ 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 acrylic cover of the galvanometer with the energized terminals. This could cause a static charge that will affect all the measurements.
- 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 and the output fuse could be blowed-up.
- 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.

⚠ Caution, refer to User Guide.

Equipment complies with current EU Directives.

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1. Description

The **MI-20KVe** high-voltage megohmmeter is a truly portable device that allows the measurement of insulation resistances using test voltages up to 20 kV. It employs a state-of-the-art technology for the safe measurements of insulation resistances up to 4.000.000 MΩ with 4 test voltages: 5 kV - 10 kV - 15 kV - 20 kV.

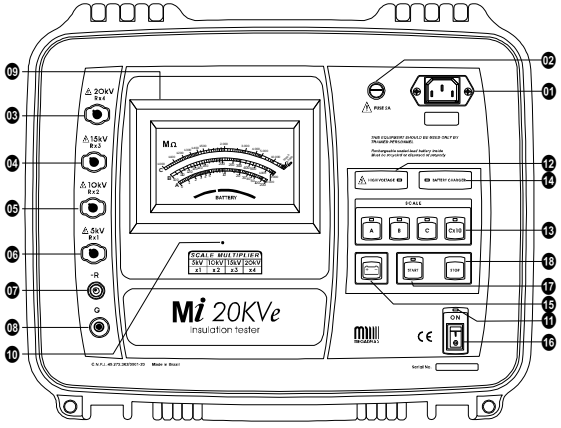
Readings are performed through an easy-to-read analogue indicator, having a broad scale. This equipment is specially well suited to test isolation resistances in transmission lines and medium voltage distribution systems, whether aerial or underground, as it allows to perform testing with voltages near to the operational value. Besides, it is an excellent auxiliary when detecting cable failures.

In order to maximize the operator's safety, this equipment was made within a plastic cabinet of high dielectric strength, with no metallic accessible parts. A light indicator warns about dangerous voltages presence, both in the equipment and in the element under testing, and switches off only when the discharge process has finished.

This megohmmeter has a GUARD terminal that allows to avoid the effects of parasitic resistances and surface currents on the insulation resistances under test. Due to its compact size and reduced weight, mechanical strength, self-contained battery supply, this apparatus is particularly suitable for field tests under severe environments. It is easily to be carried, very simple to be operated and stands severe handling conditions including frequent shocks, extreme temperatures, vibrations during transportation through hard roads, long direct exposure to solar radiation, dust, sand and other air-borne impurities, etc. Accuracy is not affected by all these adverse conditions and it is still comparable with that of the best laboratory instruments.

2. Measurements

2.1. Control panel



- **01**- **POWER INPUT**.
- **02**- **FUSE**.
- **03**- **20 kV TEST VOLTAGE**.
- **04**- **15 kV TEST VOLTAGE**.
- **05**- **10 kV TEST VOLTAGE**.
- **06**- **5 kV TEST VOLTAGE**.
- **07**- **CURRENT RETURN** terminal (-R).
- **08**- **GUARD** terminal (G).
- **09**- **ANALOGUE** indicator.
- **10**- **MECHANICAL ADJUST** (INFINITE).
- **11**- **ON** indicator.
- **12**- **HIGH VOLTAGE** indicator.
- **13**- Keyboard **RANGE** (A, B, C & CX10).
- **14**- **BATTERY CHARGER** indicator.
- **15**- **BATTERY CHECK** key.
- **16**- **ON/OFF** switch.
- **17**- **START** key.
- **18**- **STOP** key.

2.2. Power supply

Internal rechargeable 12 V - 7 Ah sealed lead acid battery.

2.3. Checking battery status

Battery measurement can be performed without interrupting high-voltage generation, which will provide a better evaluation of the battery status, by pressing the **BATTERY CHECK**⓯ during the measurement. So, the battery test is performed under actual consumption conditions and, for long lasting measurements, (i.e. *Polarization Index*), the evolution of battery status can be checked without affecting the measurement. The meter pointer should stop over the blue zone. If the pointer stop over the red zone this means that the battery is discharged and shall be charged.

2.4. 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**⓰ switch is switched off.
- Connect the equipment to mains of 220 - 240 V~ with power cord at the **Power Input**⓫ of the equipment. After a while, the luminous indicator LED⓮ 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.

***Note**: The battery looses part of its charge while being stored. Thus, before using the insulation tester for the first time, or after a time being out of use, the battery should be recharged.*

2.5. High voltage indicator

An indicator light (LED) ⓬ is warning the presence of high voltage at the output terminal during a measurement and remains lit until the discharge process is completed. When you press **STOP**⓲ key, the megohmmeter will start discharging the potentials accumulated in the apparatus, internal capacitances and in the element under test as well. When this discharging process is over, the **HIGH-VOLTAGE**⓬ led will turn off automatically. The test leads may be disconnected.

3. Operating instructions

1. Be sure that there are no voltage differences between the points at which the insulation tester will be connected, nor between them and ground. Caution: The insulation tester is inhibited to generate test voltage while it is connected to mains. Therefore, the power cable has to be unplugged from mains prior to press the start button.

2. Connect the *red banana pin* of the *red* cable to the 20 kV⓭, 15 kV⓮, 10 kV⓯ or 5 kV⓰, V terminal in accordance with the desired test voltage.

3. Connect the *black cable* to the -R⓱ insulation tester terminal (see fig. 2).

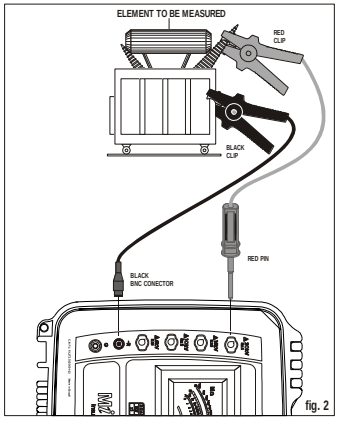


fig. 2

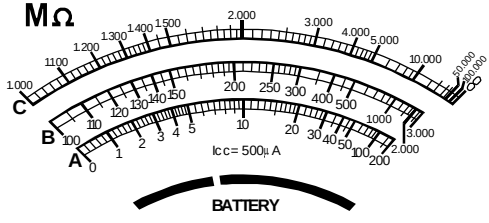
The alligator clamps in the drawings are only for illustration. The supplied clamps could be different than what's shown in the drawing.

4. The green **GUARD⓲** terminal is not always used. *Technical Note 32 explains the use of **GUARD⓲** terminal in order to minimizing the effect of stray resistances. When measurement is carried out between parts which none of them is grounded, (like between high-side and low-side windings of a transformer), **GUARD⓲** terminal must be connected to ground in order to fix the apparatus potential. **At any time a measurement is performed, either the -R⓱ or GUARD⓲ terminals must be connected to ground but never both simultaneously.** If none of these terminals are connected to ground, the insulation tester can reach a high potential that may result in an unstable non reliable reading. **If both terminals are simultaneously connected to ground**, there is a short-circuit between them and consequently the insulation tester **will measure with error**.*

5. Turn on the apparatus by pressing the **ON/OFF⓰** key. The **ON LED⓫** begins to bright.

6. Press the **START KEY⓱**. Then the high-voltage generator starts operating and the corresponding indication light turns on at the front panel. The meter pointer will indicate the value of the unknown resistance. If the element to be measured is strongly capacitive it will initially indicate a low resistance value, which will be gradually increased while the charging of that capacitance takes place. The instrument will always begin in the scale **A**.

7. When the measured resistance exceeds the maximum value in range **A**, press range **B** key, and if still the value is not achieved, press keys of ranges **C** or **Cx10**, as required.



8. Always remember to multiply the reading by the factor stated in the following table, depending on selected test voltage, see fig. 4.

SCALE MULTIPLIER			
5kV	10kV	15kV	20kV
x1	x2	x3	x4

9. When key **C x 10** is used, reading shall be carried out in range **C** and shall be multiplied by 10, in addition to the factor corresponding to the test voltage.

10. When you press **STOP KEY⓲**, the insulation tester will start discharging the potentials accumulated in the apparatus internal capacitances and in those of the element under test as well. When this discharging process is over (up to 60 seconds after turn off) the **HIGH-VOLTAGE LED⓬** will turn off automatically. The test leads may be disconnected. To finish measurement press **ON/OFF⓰** switch.

4. Polarization index (PI)

For this type of tests, the instrument must be connected and apply high voltage to the sample for 10 minutes. The polarization index is the ratio between the insulation resistance value measured after 10 minutes and the value measured after 1 minute.

$$IP = \frac{R_{10\ min}}{R_{1\ min}}$$

5. Infinite setting

The mechanical zero of galvanometer must be periodically checked. In order perform this checking, be sure that the insulation tester is off. The pointer should stay on the right end of the scale just over the infinite mark on scale **C**. In other case, the plastic screw at the bottom of the galvanometer acrylic cover shall be adjusted.

6. Replacement fuse ⚠

To check the instrument **FUSE⓬**, remove it with a screwdriver. If the fuse is ruptured replace it by another with the following specifications:

Fuse Schurter model SPT 5x20 (Time-lag) 2A/250V, High breaking capacity.

7. Cleaning

Cleaning of this instrument should be carried out using a soft cleaning anti-static liquid, after verifying that it doesn't affect the plastic parts used in the case and in the Control Panel of this equipment.

8. Technical specifications

Test voltages : 5 kV - 10 kV - 15 kV - 20 kV

Insulation test up to : 4,000,000 MΩ

Test Voltage	MEASURING INTERVALS (MΩ)				Scale Mult.	Output Resist.
	A	B	C	C x 10		
5 kV	0 - 200	100 - 3,000	1,000 - 100,000	10,000 - 1,000,000	x1	10 MΩ
10 kV	0 - 400	200 - 6,000	2,000 - 200,000	20,000 - 2,000,000	x2	20 MΩ
15 kV	0 - 600	300 - 9,000	3,000 - 300,000	30,000 - 3,000,000	x3	30 MΩ
20 kV	0 - 800	400 - 12,000	4,000 - 400,000	40,000 - 4,000,000	x4	40 MΩ

Short-circuit current : 500 μA

Test voltages accuracy : ±2% of nominal test voltages @ R ≥ 10 GΩ

Insulation tester accuracy : Class 2 (±2% of full scale deflection)

Analog indicator : Up to 98 mm scale length, taut band, with mirror (thus avoiding parallax errors)

Safety class : Meets the requirements of IEC 61010-1/1990, IEC 61010-1/1992 amendment 2

Environmental protection : IP-54 (with closed lid)

E.M.C. : In accordance with IEC 61326-1

Electrostatic immunity : In accordance with IEC 1000-4-2

Power supply : Internal rechargeable 12 V - 7 Ah sealed lead acid battery

Battery charger : 220 - 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)

Altitude : Up to 3000 m

Cabinet	: Manufactured using a strong plastic, easy-to-carry cabinet.
Carrying case	: A carrying bag provides easy transportation for the instrument and attachments.
Weight	: Approx. 9,8 kg
Dimensions	: 378 x 308 x 175 mm
Accessories	: • Measuring test leads, 1.80 m (2) • GUARD test lead, 1.80 m • Charger power cord. • Carrying case • User's guide.

9. Application note 32

Use of “Guard” terminal in megohmmeters

When insulation resistance measurements are performed with megohmmeters, 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.

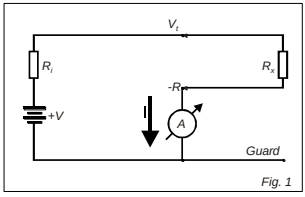


Fig. 1

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.

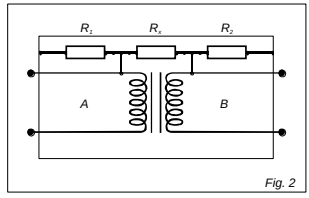


Fig. 2

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:

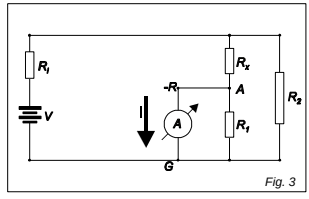


Fig. 3

In the circuit of fig. 3 it may be noted that R1 is in parallel with a low-value resistance (the one of the micro ammeter) therefore its influence is minimized 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 error lower than 10%. For example: Let us consider Rx = 3,000 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 3,000 MΩ, with an error lower than 10%.