CIRCUTOR *MI-15KVe*

ELECTRONIC MEGOHMMETER

- TECHNICAL SPECIFICATIONS
- OPERATING INSTRUCTIONS

DESCRIPTION

The CIRCUTOR MI-15KV*e* electronic megohmmeter is a versatile, portable, user friendly, rugged instrument. It uses an efficient and well experienced technology providing reliable, safe and accurate insulation resistance measurements up to 3.000.000 MΩ, with four test voltages: 1.000, 5.000, 10.000 and 15.000 V.

Due to its compact size, reduced weight, mechanical strength and self-contained battery supply, this equipment is particularly suitable for field tests under severe environments. It is easy to be carried, very simple to be operated and stands violent handling conditions including frequent shocks, extreme temperatures, vibrations during transportation through rough roads, long direct exposure to solar radiation, dust, sand and other air-borne impurities, etc. In spite of all these adverse conditions, accuracy is not affected, and it is still comparable with that of the best laboratory instruments.

IMMUNITY AGAINST ELECTRIC AND MAGNETIC FIELDS

CIRCUTOR megohmmeters feature an effective filtering system that ensures full immunity against electromagnetic disturbances and prevents any variation induced by industrial frequency fields.

OPERATOR'S SAFETY

Due to the high voltages involved, operator's safety is a must. CIRCUTOR megohmmeters were designed considering this outstanding aspect:

- Case: Molded in high dielectric toughness plastic. With the exception of the output terminals, there are no conductive parts that are accessible to the operator. Terminals are placed in the farthest and most protected position in the case.

• HIGH-VOLTAGE INDICATOR LIGHT: An indicator light (LED) warns the presence of high voltage at the output terminal during a measurement and remains lit until the discharge process is completed.

MEASURING INTERVALS, TEST VOLTAGES

Test Voltage (volts)	MEASURING INTERVALS (MΩ)				Scale Multiplier	Output. Resistance
	A	B	C	C x 10		
1.000	0 - 20	20 - 400	200-20.000	2.000 - 200.000	x 2	3,12 MΩ.
5.000	0 - 100	100 - 2.000	1.000-100.000	10.000 -1.000.000	x 10	15,62 MΩ
10.000	0 - 200	200 - 4.000	2.000 - 200.000	20.000 - 2.000.000	X 20	31,25 MΩ
15.000	0 - 300	300 - 6.000	3.000 - 300.000	30.000 - 3.000.000	x 30	46,87 MΩ

TEST VOLTAGE STABILITY

1 % during full battery service life.

SHORT-CIRCUIT CURRENT

320 μ A.

CLASS

Class 2 (scale size) @ 30 º C.

BATTERY TEST

Allows checking battery status under real consuming conditions without interrupting the generation of test voltages.

GUARD TERMINAL

Allows the measurement of very high resistance values, eliminating the effect of stray resistances whose influence should be kept to a minimum.

CARRYING CASE

A robust synthetic leather carrying case provides easy and safe transportation of the instrument and its accesssories. The megohmmeter can be operated without leaving its case.

DIMENSIONS AND WEIGHT

290 x 155 x130 mm (outside dimensions without carrying case)

8 kg. (including equipment, carrying case, manual and test probes)

ENVIRONMENTAL OPERATING CONDITIONS

This equipment is designed to be used in outdoor field work under very unfavorable weather conditions. Room temperature may vary between 0°C and +50°C, with relative humidity close to saturation point without affecting the instrument operation.

SUPPLIED ACCESSORIES

Every megohmmeter is supplied with:

PT-3 , test probe, with cable and alligator clip (red), for the positive voltage output.

PR-3, test probe, with cable and alligator clip (black), for the **“-R”** terminal.

PG-3, test probe, with cable and alligator clip (green), for the "GUARD" terminal

PAT-3, test probe with acrylic rod, high-voltage cable (red), for the positive voltage output.

EMI1, synthetic leather carrying case lined with soft velvet.

MAN 1, operating manual in English.

CONTROL PANEL

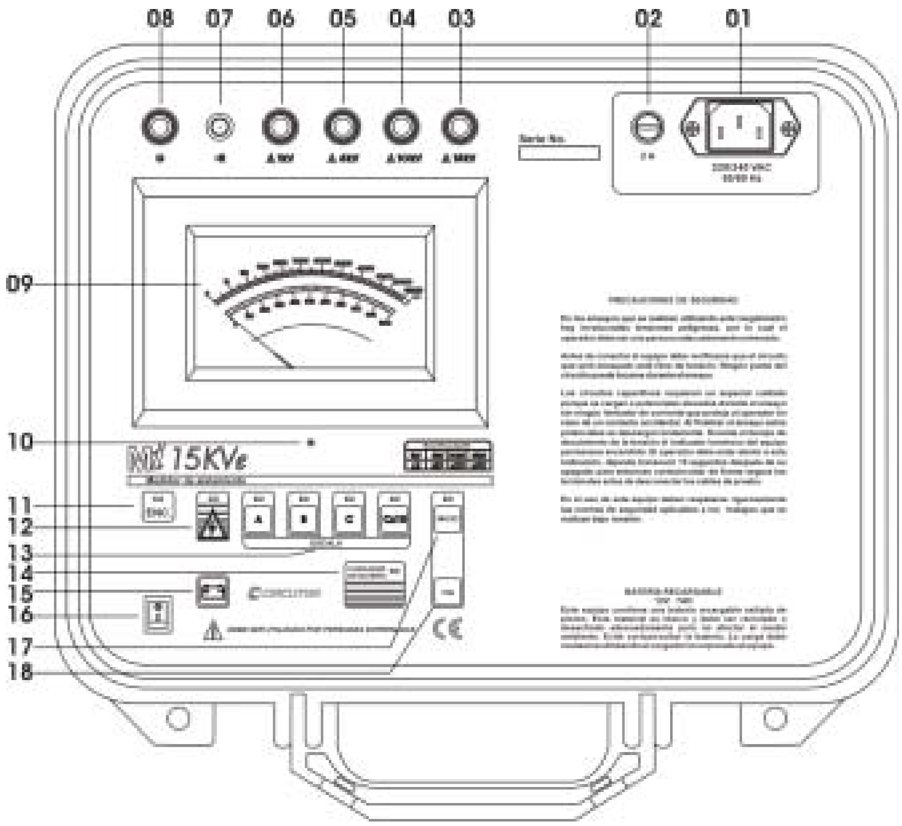

Fig. 1

1. POWER INPUT (220-240VAC).
2. 2A FUSE.
3. 15kV TEST VOLTAGE.
4. 10kV TEST VOLTAGE.

5. 5kV TEST VOLTAGE.
6. 1kV TEST VOLTAGE.
7. CURRENT RETURN TERMINAL. (-R)
8. GUARD TERMINAL (G)
9. ANALOGUE INDICATOR
10. MECHANICAL ADJUST (INFINITE)
11. ON INDICATOR
12. HIGH VOLTAGE INDICATOR
13. KEY BOARD RANGE (A, B, C & CX10)
14. BATTERY CHARGER INDICATOR.
15. BATTERY CHECK KEY
16. ON/OFF SWITCH
17. START KEY
18. STOP KEY

OPERATING INSTRUCTIONS

1) Be sure that there are no voltage differences between the points at which the megohmmeter will be connected, nor between them and ground.

Caution: The megohmmeter 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) Determine the value of test voltage to be used in the insulation resistance measurement.

3) Connect the ***red banana pin*** of the ***red*** cable to the 15kV **[3]**, 10.kV **[4]**, 5kV **[5]**, or 1kV **[6]**,V terminal in accordance with the desired test voltage.

4) Connect the ***black cable*** to the ***–R*** **[7]** megohmmeter terminal. (See fig 2).

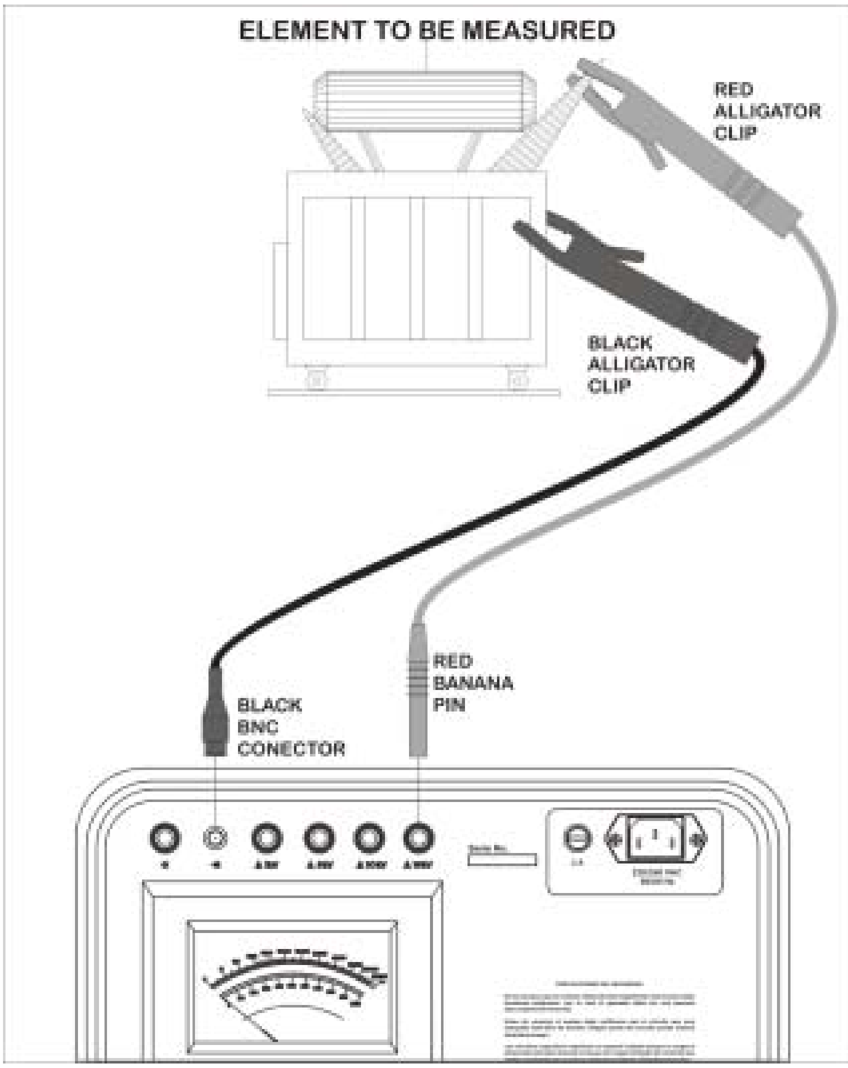
ELEMENT TO BE MEASURED
RED
ALLIGATOR
CLIP
BLACK
ALLIGATOR
CLIP
RED
BANANA
PIN
BLACK
BNC
CONECTOR

FIG. 2

5) The green ***GUARD*** **[8]** terminal is not always used. Application Note #32 explains the use of *GUARD* **[8]** 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), *GUARD* **[8]** terminal must be connected to ground in order to fix the apparatus potential. **At any time a measurement is performed, either the -R [7] or *GUARD* [8] terminals must be connected to ground but never both simultaneously.** If none of these terminals are connected to ground, the megohmmeter 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 megohmmeter **will measure with error**.

6) Connect the free ends of cables (*alligator clips*) to the element to be measured.

7) Turn on the apparatus by pressing the ***ON/OFF*** **[16]** key. The *ON LED* **[11]** begins to bright.

8)Press the ***START KEY*** **[17] .** 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***".

9) 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.

10) Always remember to multiply the reading by the factor stated in the following table, depending on selected test voltage:

11) 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.

12) When you press ***STOP*** KEY **[18]**, the megohmmeter 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 LED* **[12]** will turn off automatically. The test leads may be disconnected. To finish measurement press again and release ***ON/OFF*** switch **[16].**

13) In certain instances, when the apparatus is disconnected the pointer exceeds the infinite position to the right side. This is a normal behaviour.

13) **Checking battery status**. This operation may be performed before or during an insulation resistance measurement without interrupting high-voltage generation. Therefore the “BATTERY” key must be pressed while the megohmmeter is still operating (in any range). The meter pointer should stop over the blue zone. If the pointer moves to the red zone this means the battery is already run down and shall be charged.

Battery measurement can be performed without interrupting high-voltage generation (which will provide a better evaluation of the battery status) by turning on the “BATTERY” key 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.

14) **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 Icon Key* **[15]** 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

15) **Infinite setting. [10]** The mechanical zero of galvanometer must be periodically checked. In order perform this checking, be sure that the megohmmeter 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.

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 **[16]** is switched off.
- Connect the equipment to mains with power cord at the Power Input **[01]** of the equipment.
- After a while, the luminous indicator LED **[14]** 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.

- Later, the LED indicator **[14]** will keep on being lit in red up to completing the charge, when the indicator changes to green and will keep being like this up to the equipment is unplugged from mains.
- If during the battery charge the on-off switch **[16]** is switched on the charge will be momentarily interrupted and the LED **[14]** will start blinking.
- If during the charge the system detects that for any reason the battery is not receiving the normal charging current the LED indicator **[14]** will blink in red.
- If at the end of the maximum charging time the battery has not reached the complete charge, LED **[14]** will keep on blinking in green.
- The following chart summarizes the meaning of LED luminous indications **[14]**:

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 megohmmeter for the first time, or after a time being out of use, the battery should be recharged.

TECHNICAL NOTE # 32

USE OF *GUARD* TERMINAL IN MEGOHMMETERS

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

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

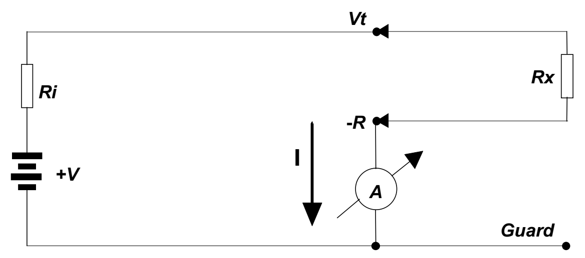

Fig. 1

Where:

V : DC high-voltage generator

Ri: Generator internal resistance

A : Indicator meter (microammeter)

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 microammeter. 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 whose influence on Rx should be minimum and if possible, zero.

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.

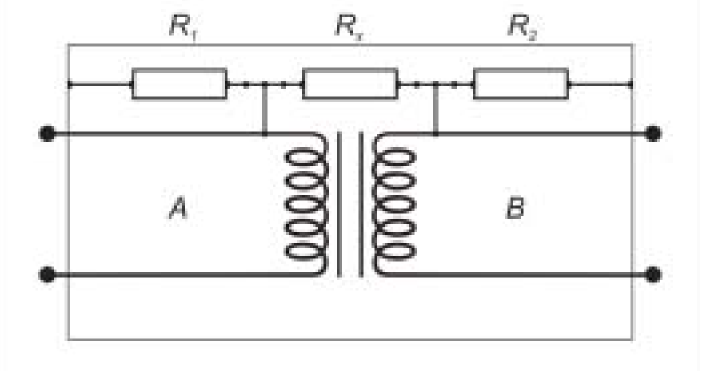

Fig. 2

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 turns on each side of the transformer may be disregarded as compared with the insulation resistance between primary and secondary windings measured by megohmmeter, **Rx** appears to be in parallel with (**R1 + R2**).

The situation is changed if we connect the transformer housing to **GUARD** terminal.

Then the resulting circuit will be:

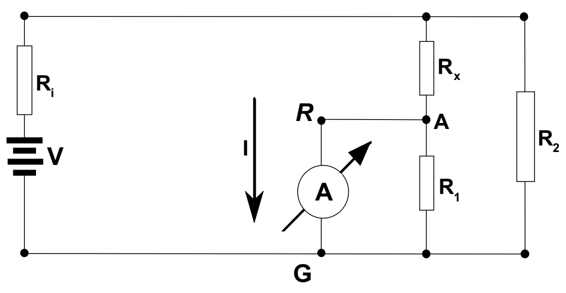

FIG. 3

In the circuit of Fig. 3 it may be noted that R1 is in parallel with a low-value resistance (the one from the microammeter) 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 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%.