Megger

MJ159, MJ359, 210170

Major Megger Insulation Resistance Testers

User Guide

Megger Limited reserves the right to alter the specification of its products from time to time without notice. Although every effort is made to ensure the accuracy of the information contained within this document it is not warranted or represented by Megger Limited. to be a complete and up-to-date description.

For Patent information about this instrument refer to the following web site:

megger.com/patents

This manual supersedes all previous issues of this manual. Please ensure that you are using the most recent issue of this document. Destroy any copies that are of an older issue.

Declaration of Conformity

Hereby, Megger Instruments Limited declares that radio equipment manufactured by Megger Instruments Limited described in this user guide is in compliance with Directive 2014/53/EU. Other equipment manufactured by Megger Instruments Limited described in this user guide is in compliance with Directives 2014/30/EU and 2014/35/EU where they apply.

The full text of Megger Instruments EU declarations of conformity are available at the following internet address:

megger.com/eu-dofc

Contents

1. Safety Warnings

1.1. Safety and Hazard Symbols

The Safety and Hazard symbols detail in this section are part of the Instrument's case.

Icon	Description
	HIGH VOLTAGE: risk of electrical shock
	Caution: Refer to User Guide
	Equipment complies with current EU directives
	Equipment complies with current UKCA legislation
	Equipment protected throughout by double insulation or reinforced insulation
	Do not dispose of to landfill, sewage systems or by fire

- Safety warnings and user instructions must be read and understood before the instrument is used. They must be observed during use.
- The instrument must be used only by suitably trained and competent persons. Protection provided by the instrument may be impaired if it is not used in a manner specified by the manufacturer.
- The instrument should not be used if any part of it is damaged.
- Test leads, probes and clips must be in good order, clean and with no broken or cracked insulation.
- The circuit under test must be switched off, de-energized and isolated before insulation or continuity tests are made.
- The 210170 protected for measurement connection to circuits up to CAT III 300 V Line – Ground, and 500 V Line – Line.
- The MJ159 and MJ359 are protected for measurement connection to circuits up to CAT II 300 V Line – Ground, and 500 V Line – Line.
- The TEST button must not be pressed when making a voltage test.
- The TEST button must not be pressed while connecting the test leads or while changing ranges.
- Circuit connections must not be touched during a test.
- The default voltmeter and automatic discharge are additional safety features and should not be regarded as a substitute for normal safe working practice.
- It is recommended that fused test leads are used when measuring voltage on high energy systems.
- After insulation tests, capacitive circuits must be allowed to discharge before disconnecting the test leads.
- Do not rely on automatic discharge provided by the instrument.
- Replacement fuses must be of the correct size, type and rating.
- The moving coil meter shows the resistance of the test subject when the test button is pressed and the test voltage remaining when the button is released. It does not show voltage while the test is active.
- Be aware that the moving coil may be affected by strong external magnetic fields.
- The red LED set into the moving coil meter is to provide indication that the (MJ359 only) supply inlet is connected to the mains. It does not indicate voltage on the measurement terminals.

Mains categories for measurement connections are rated as follows:

CAT IV: Measurement category IV: Equipment connected between the origin of the low-voltage mains supply and the distribution panel.

CAT III: Measurement category III: Equipment connected between the distribution panel and the electrical outlets.

CAT II: Measurement category II: Equipment connected between the electrical outlets and the user's equipment.

Measurement equipment may be safely connected only to circuits at the marked rating or lower.
The connection rating is that of the lowest rated component in the measurement circuit.

2. Description

Major Megger ***MJ159, MJ359*** and ***210170*** testers are compact instruments designed to give rapid, accurate and direct measurement of continuity and insulation resistance of domestic and industrial wiring, cables, transformers, motors, generators electrical machinery and appliances.

Being self-powered, the instruments are suitable for use during installation and commissioning work as well as for service and maintenance applications.

Insulation measuring range is 0,1 Ω to 2000 MΩ (MJ159, MJ359), 0,1 Ω to 20,000 MΩ (210170). Automatic discharge for capacitive circuits under test is provided.

A guard terminal can be used to minimise the effects of surface leakage when carrying out insulation resistance tests.

In addition each instrument has a 5000 Ω Resistance range making them ideal for testing electrical installations.

Nominal test voltages are 100 V, 250 V, 500 V and 1000 V selectable.

All instruments have a Mains (line) voltage measuring range of 0 to 600 V. Although calibrated for AC voltage, this feature will give decaying voltage indication following the testing of equipment possessing capacitance.

The instruments use a moving coil meter with taut band suspension; white scales on a black scale plate and an orange 'dayglow' needle indicates the resistance value being measured.

MJ159 and ***210170*** are powered by a low voltage, hand cranked, brushless AC generator which is connected, after rectification, to a DC to DC converter. The generator is designed to be easy to turn even under full load.

The ***MJ359*** is a dual powered unit by either Mains (line) or hand cranked generator powered.

The case is robust, yet light-weight, made from a high impact ABS. Mounted on top of the case is a five position, rotary range selection switch and a '**Test** push button.

Three shrouded 4 mm terminal sockets marked '-', '**G**' and '**+**' are provided on the side of the case for test lead connection.

Test lead resistance is included in the instrument calibration. For this reason, only the test leads supplied or replacement ones should be used.

After the test leads have been connected to the instrument terminals, the carrying handle folds down neatly over them. Should the carrying handle accidentally become detached from the case it may easily be 'sprung' back into position.

3. Operation

3.1. Testing precautions

Should the plug on the power cord (**MJ359**) not be the type for your receptacles (socket outlets) do not use an adaptor. Use a suitable alternative power cord, or if necessary change the plug by cutting the cord and fitting a suitable plug.

The colour code of the cord is :

	U.S.A.
Ground	Green
Neutral	WhiteBlue
Line	Black

3.2. Performance checks

The instrument will operate in any position, but the specified accuracies assume that the instrument is face up, on a firm level surface. This is particularly true for hand cranked units to obtain a smooth constant crank speed.

1. Without the test leads being connected to the instrument, but with the rotary selector switch set to the 1 kV range press and hold down the '**Test**' button, whilst turning the generator handle at >180 rev/min.
   The meter pointer should remain over the '∞' (infinity) position on the scale. This establishes that there is no leakage through the instrument itself.
2. Check that the test leads, probes and crocodile clips are in good order, clean and with no broken or cracked insulation. Connect two of the test leads to the '+' and '-' terminals on the side of the instrument case and ensure that their clips are not touching anything.
3. Press the '**Test**' button again and keep it pressed whilst turning the generator handle (Hand cranked models) at >180 rev/min and observe the meter needle. The needle should rest over the '∞' (infinity) position on the scale. If it does not, the test leads may be faulty and should be inspected more closely for damage. Replace them if necessary with calibrated leads available as optional accessories
4. Connect the test lead clips together, press the '**Test**' button and turn the generator handle (hand cranked models) again. The meter should read zero. If it indicates infinity or a high resistance value the leads may be open circuit and should be inspected further. Replace them if necessary. (Shorting the leads together and obtaining a zero reading also shows that the instrument is working).

Note: To avoid creating leakage paths when insulation testing, it is advisable not to allow the leads to twist together nor trail across metalwork.

3.3. Voltage measurement

When not testing (i.e. in standby mode) the instruments act as a voltmeter (0 to 600 Volts AC). Therefore, as soon as the test leads are connected to the item under test, any AC voltage present will be immediately shown. Thus indication is given that the item has not been completely de-energized.
The instrument also monitors circuit discharge when the '**Test**' button is released following an insulation test on a capacitive item, e.g. a long cable. In this case it is important to realize that the actual voltage (DC in nature) is not given, but the meter does indicate when the voltage has decayed to zero and therefore when it is safe to remove the test leads. Note, however, that the instrument does not indicate the presence of negative DC voltage.

3.4. Resistance measurement

With the leads connected to the instrument, and having completed any preliminary checks:

1. Set the selector switch to the 'Ω' position.
2. Connect the leads across the isolated circuit.
3. Press and hold the '**Test**' button and turn the generator handle (hand cranked models) at >180 rev min.
4. The resistance will be indicated on the 'Ω' scale.

Note:- If necessary repeat the continuity test with the leads reversed. The effects of any stray e.m.fs. in the sample under test may then be negated by taking the average of the two readings.

Operation

3.5. Insulation testing

After connecting the test leads to the instrument and carrying out any preliminary checks:

1. Set the selector switch to the required test voltage. Connect the test leads to the isolated circuit to be tested, as follows:-
   1.1. For insulation tests to earth (ground):- Connect the '+'test lead to earth (ground) or the frame of the equipment,and the '-' lead to that part of the circuit to be tested.
   1.2. For insulation tests between wires:- Connect a lead to the core of each of the wires.
2. Press the '**Test**' button and whilst keeping it pressed turn the generator handle (hand cranked models) at >180 rev/min.
3. The meter needle will indicate the value of insulation resistance on the 'MΩ' scale.

If a capacitive circuit is tested the needle will initially deflect towards zero and then gradually rise to its final steady value as the capacitance is charged to the output voltage of the tester.

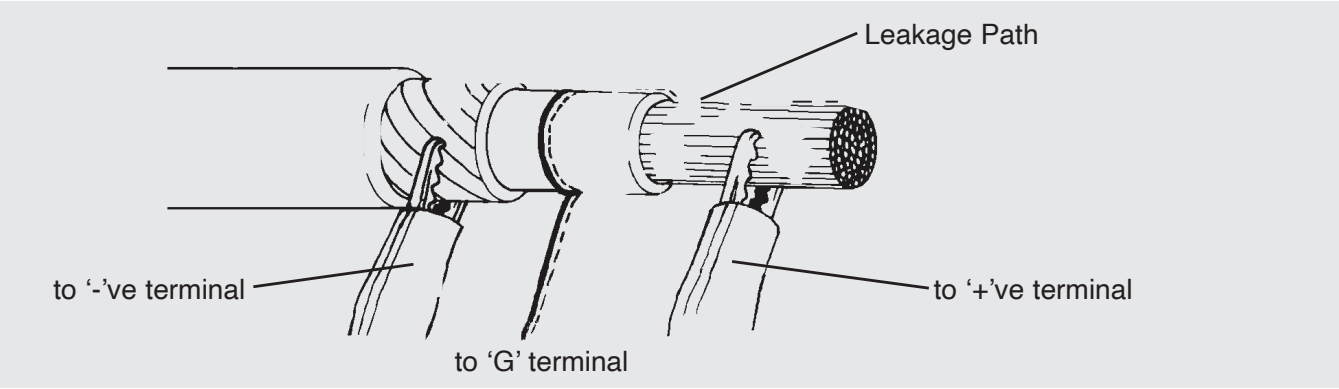
If several successive readings of '∞' are obtained, connect the two farthest ends of the test leads together and carry out a check on the leads. A zero reading should result which double checks that the leads are not disconnected or broken and therefore, the insulation resistance readings are correct.

Note: With non-hand cranked models, the readings are taken after pressing the 'Test' button, there is no other control to operate.

Capacitive circuits automatically discharge through the tester when the '**Test**' button is released. The approximate discharge voltage will be indicated on the voltage scale. Wait a few moments for the voltage to decay to zero before disconnecting the test leads.

3.6. Using the guard terminal (G)

For basic insulation tests and where there is little possibility of surface leakage affecting the measurement, it is unnecessary to use the guard terminal. i.e. if the insulator is clean and there are unlikely to be any adverse current paths. However, in cable testing there may be surface leakage paths across the insulation between the bare cable and the external sheathing due to the presence of moisture or dirt. Where it is required to remove the effect of this leakage, particularly at high testing voltages, a bare wire may be bound tightly around the insulation and connected via the third test lead to the guard terminal '**G**'.



The guard terminal is at the same potential as the negative terminal. Since the leakage resistance is effectively in parallel with the resistance to be measured, the use of the guard causes the current flowing through surface leakage to be diverted from the measuring circuit. The instrument therefore reads the leakage of the insulator, ignoring leakage across its surface.

3.7. Fuse checking and replacement

3.7.1. MJ159 and MJ359

3.7.2. Resistance circuit fuse check

1. Disconnect the test leads and set the rotary selector switch to the 'Ω' position.
2. Press the 'Test' button and keep it pressed whilst turning the generator handle.
3. The measurement should be beyond full scale (>5 kΩ) on the Resistance scale.

If the reading is approximately zero on the Resistance scale, the 500 mA fuse has ruptured and should be replaced.

3.7.3. MJ159 and MJ359

3.7.4. Insulation circuit fuse check

1. Connect the test leads together and set the rotary selector switch to any 'MΩ' position.
2. Press the 'Test' button and keep it pressed whilst turning the generator handle.
3. The measurement should be zero on the Insulation scale.

If the reading is infinity (∞) on the Insulation scale, the 7 A fuse has ruptured and should be replaced.

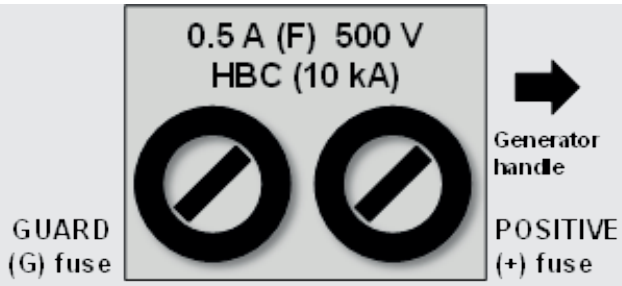
3.7.5. 210170

3.7.6. Guard and Positive fuses check

1. Connect all three test leads together and set the rotary selector switch to any 'MΩ' position.
2. Press the 'Test' button and keep it pressed while turning the generator handle.
3. The measurement should be approximately 2 MΩ on the insulation scale.

If the reading is zero on the Insulation scale, the 500 mA 'G' (Guard) fuse further from the generator handle has ruptured and should be replaced.

If the reading is infinity (∞) on the Insulation scale, the 500 mA '+' (Positive) fuse nearer to the generator handle has ruptured and should be replaced.



Fuse positions on 210170

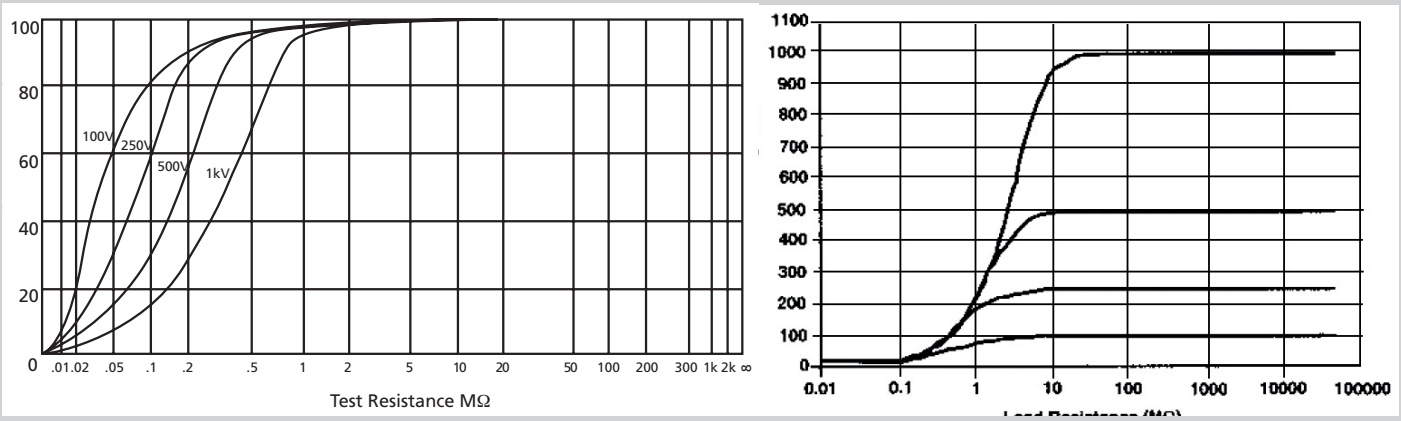
3.7.7. Fuse replacement

The fuses are held in bayonet holders in the base of the instrument. To change a fuse, disconnect the mains supply (**MJ359**) and the test leads, then use a screwdriver to release the centre part of the holder containing the fuse. Remove the ruptured fuse and replace with a fuse of the correct size and rating ("4. Specifications" on page 10). Refit the fuseholder and secure it with a screwdriver.

4. Specifications

Note: The presence of fast transients in excess of 1.0 kV or r.f. in excess of 0.5 volts on measured circuit may affect the results

	MJ159	MJ359	210170
Insulation Resistance:	0.1 Ω to 2000 MΩ		0 Ω to 20,000 MΩ
Accuracy:	±1.25% of fsd on a 2.8" (71.1 mm) arc length		±3% of scale length on a 3.08" (78.2 mm) arc length
Nominal Test Voltages:	DC: 100 V, 250 V, 500 V, 1000 V.		
Applied test voltage accuracy: 100 V range	+40%, -0% max.		+5%, -5% max.
Applied test voltage accuracy: 250 V, 500 V, 1000 V ranges	+30%, -0% max.		+5%, -5% max.
Test Voltage characteristics:			



Midscale resistance:	4 MΩ	40 MΩ
Short Circuit Current:	1.9 mA	220 µA nominal on all ranges
Maximum Load Capacitance:	1 µF with less than ±0.1" pointer movement	
Discharge rate:	Up to 1 µF capacitance is discharged from 1000 V to less than 60 V in less than 4 s	
Automatic discharge:	Capacitive circuits are automatically discharged when the "TEST" button is released following an insulation test.	
LOW RESISTANCE RANGE		
Measuring range:	0.1 Ω to 5000 Ω	
Accuracy:	±1.25% of fsd on a 2.8" (71.1 mm) arc length	±3% of scale length on a 3.08" (78.2 mm) arc length
Test Voltage (open circuit):	3 V ±0.2 V	3 V ±5%
Scale length:	2.8" (71.1 mm)	3.08" (78 mm)
Short circuit current:	2 mA ±10%	30 mA ±10%
SAFETY VOLTAGE MEASUREMENT		
Voltage measurement	0.1 V to 600 V AC; the meter is RMS calibrated and average responding	
Safety voltage indicator:	Indicates the presence of DC voltages. Scaling is not the same as the AC meter. True DC voltage can be approximated by dividing the scale reading by 2.22	
Accuracy:	2.5% of full scale	
PHYSICAL CHARACTERISTICS		
Dimensions	H 8.25 x W 5 x D 5". (H 213 x W 124 x D 128 mm)	
Mass	Approximately 1 kg (2 lb 3 oz)	
Cleaning	Wipe disconnected instrument with a clean cloth dampened with soapy water or Isopropyl Alcohol (IPA).	

POWER SUPPLY AND SAFETY			
Power Supply:	Hand cranked brushless AC generator, Cranking speed >180 rev/min	Hand cranked brushless AC generator, Cranking speed >180 rev/min or 120 V 50/60 Hz mains (line) supply	Hand cranked brushless AC generator, Cranking speed >180 rev/min
Safety:	BS EN/IEC 61010-1 BS EN/IEC 61010-2-034 measurement CAT II 300 V to earth (ground), 500 V phase to phase		BS EN/IEC 61010-1 BS EN/IEC 61010-2-034 measurement CAT III 300 V to earth (ground), 500 V phase to phase
Flash Test:	4.5 kV AC r.m.s		
Fuses:	500 mA (F) HBC 50 kA 600 V (32 mm x 6 mm)		
	7 A (F) 440 V Ceramic 10 kA HBC 11/4 x 1/4 in. (32 mm x 6 mm)		500 mA (F) HBC 50 kA 600 V (32 mm x 6 mm)
	N/A	Power connection plug 100 mA 240 V HBC (20 mm x 5 mm)	N/A
ENVIRONMENT			
E.M.C.:	BS EN/IEC 61326-1		
Operating Temperature:	14 °F to 122 °F (-10 °C to 50 °C)		
Storage Temperature:	-4 °F to 158 °F (-20 °C to +70 °C)		
Humidity operating:	70 % RH max. at 68 °F (20 °C), 60 % RH max. at 95 °F (35 °C), 50 % RH max. at 105 °F (40 °C)		
Humidity storage:	95 % RH max. at 95 °F (35 °C)		

5. Accessories

ORDERING INFORMATION

Description	Part number
MJ159 Hand-cranked insulation tester	6410-863
MJ359 120 V AC/hand-cranked insulation tester	6410-865
210170 extended range insulation tester	6410-957
Included accessories	
User guide (all three models)	6172-113
Test lead set (3 leads, 3 prods, 3 clips)	1007-155
Power cord/Mains lead (MJ359 only)	1008-016
Test record card (pack of 20)	6111-216
Carrying case/pouch	1008-021

Description	Part number
Optional accessories	
Fuses 500 mA, 600 V (F) H.B.C. [pk of 5]	6121-561
"A Stitch in Time" manual	AVTM21-P8B
Fused prod and clip lead (x2) set	1002-015

6. Application Notes

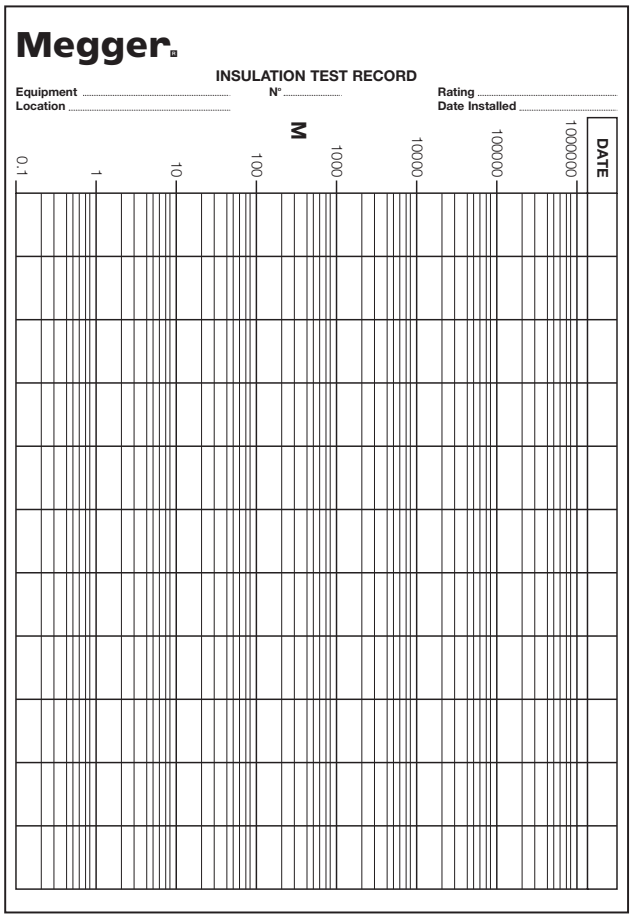
6.1. Preventive maintenance

The proverb ‘A stitch in time saves nine’ inspired the title of a Megger Limited booklet on insulation testing, as it neatly sums up the benefits of preventive maintenance. The savings come in financial terms from costly repairs, lost production, lost profits and in human terms, from lives saved in the event of dangerous electrical faults.

Regular insulation testing of electrical equipment can help to detect deteriorating insulation. The effects which cause insulation to deteriorate include mechanical damage, vibration, excessive heat or cold, dirt, oil, moisture and localized voltage stresses – all of which can arise on most industrial or utility equipment.

Insulation tests are sometimes used in isolation as absolute measures of the quality of the insulation. This is most appropriate when equipment is being installed and checked for compliance with a specified ‘Pass’ level. For operational equipment the key factors are trends in the insulation readings.

It is therefore important that records of insulation readings are kept, relating to each piece of equipment or ‘Asset’ in your testing regime. **Megger Limited** supplies test record cards to assist with such record keeping. There are also a number of influences on the insulation readings: temperature, humidity and surface leakage, for example. A range of test techniques has been developed to help with the interpretation of your insulation tests.



Test Record Example

6.2. Insulation testing concepts

Insulation resistance can be considered by applying Ohm's Law.
The measured resistance is determined from the applied voltage divided by the resultant current,

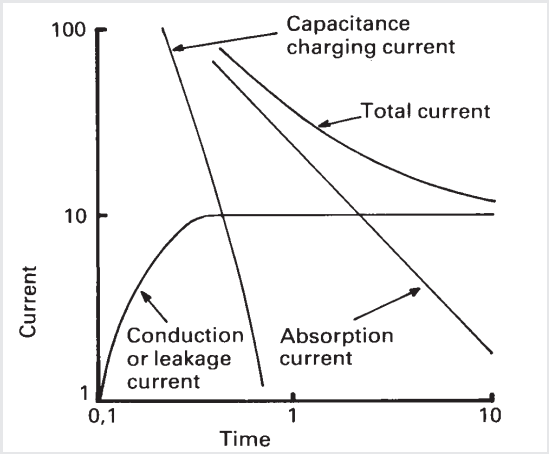
$$R = \frac{V}{I}$$

There are two further important factors to be considered.
These are:

(i) the nature of the current through and/or over the insulation
(ii) the length of time for which the test voltage is applied.

These two factors are linked.

The total current that flows is made up of three separate currents:-



1. Capacitance charging current. This current is initially high and drops as the insulation becomes charged to the applied voltage.
2. Absorption current. This current is also initially high but drops at a much slower rate than the charging current.
3. Conduction or Leakage current. This is a small steady current that can be sub-divided into two:-
   - 3.1. A current flowing along conduction paths through the insulation material.
   - 3.2. A current flowing along conduction paths over the surface of the insulation material

As the total current depends upon the time for which the voltage is applied, Ohm's Law theoretically applies at infinite time.

The charging current falls relatively rapidly as the equipment under test becomes charged. The time depends upon the leakage current and capacitance of the item under test.

Items with more capacitance (e.g. long supply cables) will take more time to charge. The absorption current decreases relatively slowly compared with the charging current. In essence it depends upon the nature of the insulation material.

The conduction or Leakage current builds up quickly to a steady value and then remains constant for a particular applied voltage under stable conditions. It is this current that is affected by moisture, dirt etc. and the degree to which it flows bears a direct relation to the quality of the insulation, and consequently to the value of the insulation resistance measured.
An increase in the leakage current is a pointer to possible future problems.

7. Instrument Repair and Spare Parts

The instrument circuit contains static sensitive devices, and care must be taken in handling the printed circuit board. If the protection of an instrument has been impaired it should not be used, and be sent for repair by suitably trained and qualified personnel. The protection is likely to be impaired if, for example, the instrument shows visible damage, fails to perform the intended measurements, has been subjected to prolonged storage under unfavourable conditions, or has been exposed to severe transport stresses.

New Instruments are Guaranteed for 1 Year from the Date of Purchase by the User.

Note: Any unauthorized prior repair or adjustment will invalidate the Warranty.

For service requirements contact:–

Megger Limited Archcliffe Road Dover Kent CT17 9EN **U.K.** Tel: +44 (0) 1304 502 243 Fax: +44 (0) 1304 207 342	OR	**Megger Valley Forge** 400 Opportunity Way Phoenixville PA 19460 **U.S.A.** Tel: +1 610 676 8579 Fax: +1 610 676 8625

or an approved repair company.

7.2.1. Approved Repair Companies

A number of independent instrument repair companies have been approved for repair work on most Megger instruments, using genuine Megger spare parts. Consult the Appointed Distributor / Agent regarding spare parts, repair facilities and advice on the best course of action to take.

7.2.2. Returning an Instrument for Repair

An instrument returned to the manufacturer for repair should be sent freight pre-paid to the appropriate address. A copy of the invoice and the packing note should be sent simultaneously by airmail to expedite clearance through Customs. A repair estimate showing freight return and other charges will be submitted to the sender, if required, before work on the instrument commences.

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