



MITTON
INSTRUMENTS

Instruction Manual

ET1000

Earth Tester

Micro-ohmmeter

Rev 00

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1 Introduction

The ET1000 is a portable earth test instrument designed to measure earth electrode resistance, soil resistivity and conductor/joint resistance tests. It is a 4-terminal instrument which overcomes connection resistances of test leads and probes. The ET1000 is designed to cope with difficult test conditions such as high resistivity or dry soils. The ET1000 is a multiple use instrument and is ideal for earth testing in a high voltage substation environment and for resistivity testing for earth grid design. The ET1000 has a simple interface and mode selection.

This manual describes the operation of the ET1000 in its various modes. It also includes a description of the Wenner soil resistivity test method. It does not describe in detail all of the available soil resistivity testing methods since this information is readily available elsewhere.

2 Features

The ET1000 front panel and operation is straightforward and is detailed below:



3 Operation

Three different test modes are available: earth resistance, micro-ohms single shot, micro-ohms continuous. The different operating modes are selected by repeated pressing of the Power button (after first powering on).

3.1 Probe Integrity Test

At the commencement of each test, the ET1000 verifies the integrity of the test leads and P1, P2, C1, C2 probe contact resistance, to ensure that measurements can be made.

The ET1000 will auto range should there be significant noise (eg 50 Hz) appearing on the P1, P2 connections. In the event of total input voltage (eg noise) exceeding ± 24.5 V peak, P1, P2 over-range check probes will appear after the initial probe test.

Note that for resistance measurements, it is recommended that P1 and C1 be independently connected to the electrode under test. This will eliminate any connection contact resistance.

If there is no activity for 2 minutes the ET1000 will automatically shut down to conserve the battery.

3.2 Resistance/Resistivity Mode

In Earth R mode (resistance or resistivity measurements), the test current from C1, C2 is a 128 Hz square wave (ie reversing dc). This overcomes test lead mutual coupling and soil/electrode generated voltages. A 48 V square wave, limited to 65 mA max, is injected into the soil. The test current depends primarily on the contact resistance of the test probes. The resultant soil voltage is measured at the

P1, P2 terminals. The internal processing eliminates interference signals by appropriate waveform sampling and processing.

After the Earth R mode has been selected, pressing the Test button will commence the test. Once a reading had been obtained it will remain displayed until the next button push.

In the event that the soil resistivity or electrode resistance reading is $< 5 \text{ m}\Omega$ a message will appear on the screen " $< 5 \text{ m}\Omega$ ".

3.3 Resistivity High Voltage Mode

In areas where the C1, C2 probe contact resistance may be excessive (eg sandy or stony soils) and wetting area does not adequately reduce the contact resistance, then the option of using a much higher output voltage is available. In this situation "Use High Volts" will be displayed. Up to 400 V at 10 mA is used under these circumstances. Although the current is limited to 10 mA, care should be taken not to touch the C1, C2 connections or probes at the time of the test.

For added safety, in the high voltage mode, it is necessary to hold the Test button down for the complete test duration. Releasing the button at any time will stop the test.

3.4 Micro-ohmmeter Mode

In this mode, the ET1000 operates as a micro-ohmmeter. In micro-ohms mode the ET1000 operates at a frequency of approximately 1.5 Hz. It can measure down to several micro-ohms and so is suited to measuring the resistance of earth conductors joints, connection joints, conductor lengths (eg plant bonding) and also switch contacts. Two separate

operating modes are available. The first is one shot operation and the second is continuous operation should it not be practical to press the test button. Ensure good contact is being made with all connections otherwise measurement errors may result.

If the resistance measurement exceeds 1.5 Ω , "P1 + P2 probes high resistance" will be displayed. The Earth R mode should be used in this case.

3.5 Battery Charging

The ET10000 has an 11.1 V Li-ion battery with internal charge control. An external 15 Vdc 2 A supply (plug centre positive) is used to charge the battery. A charging icon and a low battery message will also show on the display. Full charge is approximately 12.5 V.

4 Field Testing

This section describes some of the practical aspects of field testing.

4.1 Test Probes

Recommended test probes are stainless steel rods, approximately 10 mm diameter, 300 mm long. Probes with a 4 mm hole to accept a 4 mm banana plug are suggested.

4.2 Test Plugs

The ET1000 will accept 4 mm banana plugs and banana plugs should be used on the test cables. Good quality (gold plated if available) plugs should be used. Plugs should be changed regularly should wear and tear, looseness or dirt become apparent.

4.3 Test Cables

Test cables and associated plugs should be thoroughly checked for integrity prior to any field testing.

Suggested cable lengths and sizes are:

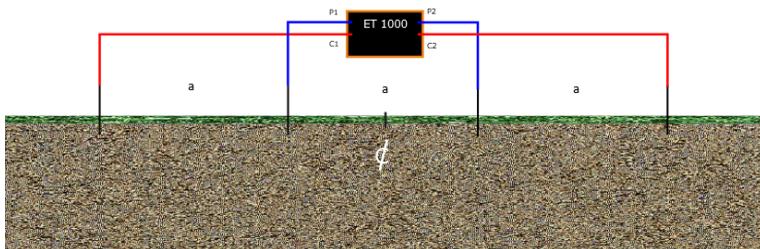
Current (C1, C2): 2 x 150 m, 1 mm² single core flexible, pvc insulated (“appliance or panel wire”)

Voltage (P1, P2): 2 x 50 m, 1 mm² single core flexible, pvc insulated (“appliance or panel wire”)

Cables should be carefully stored on reels. Note that during testing the current cables must have at least 50 m unwound to minimise the reactance in the current circuit.

5 Wenner Test

This diagram shows the basic Wenner Test layout. P1, P2 probe depths of 50 mm – 100 mm are recommended. Probe depths of 50 mm are recommended for probe spacings below 2 m. C1, C2 probe depths should be similar except that beyond 5 m probes depths can be greater since this enable more test current to flow. (The same applies for other test methods such as the Schlumberger Test). In dry ground conditions a small amount of water may be poured around the test probes, particularly the C1, C2 probes.



Suggested probe spacings are summarised in the table below. A practical method for probe spacing measurement is to use two 100 m fibreglass tape measures. Starting at the centre of the measurement area, run the tapes out in opposite directions.

It is important to take a number of measurements at small probe spacings in order to determine more accurately the upper layer soil characteristics, where buried earth conductors are more likely to exist.

a (m)	V (m)	I (m)	R (Ω)	ρ (Ω)
0.50	0.25	0.75		
1.00	0.50	1.50		
1.50	0.75	2.25		
2.00	1.00	3.00		
2.50	1.25	3.75		
3.00	1.50	4.50		
3.50	1.75	5.25		
4.00	2.00	6.00		
4.50	2.25	6.75		
5.00	2.50	7.50		
6.00	3.00	9.00		
8.00	4.00	12.00		
10.00	5.00	15.00		
15.00	7.50	22.50		
20.00	10.00	30.00		
25.00	12.50	37.50		
30.00	15.00	45.00		
35.00	17.50	52.50		
40.00	20.00	60.00		
50.00	25.00	75.00		
60.00	30.00	90.00		
66.00	33.00	99.00		
80.00	40.00	120.00		
90.00	45.00	135.00		
100.00	50.00	150.00		

Note that for the Wenner Test, $\rho = 2\pi aR$

It is highly recommended that the results (ρ vs a) are plotted on site (graph paper or spreadsheet). In this way, any outliers can be immediately identified and a retest carried out.

Measurements should be handwritten on a prepared form even if they are also entered into a spreadsheet.

Testing should be carried out clear of any metallic fencing, buried earthing or other conductive items such as pipes.

Several tests should be carried out at any one site. It is recommended that two long traverses, preferably at right angles to each other, be done as well as shorter traverses in nearby areas. The results can then be collectively assessed.

6 Specifications

Range (resistance):

5.000 m Ω - 9.999 m Ω , resolution 1 $\mu\Omega$
10.00 m Ω - 99.99 m Ω , resolution 10 $\mu\Omega$
100.0 m Ω - 999.9 m Ω , resolution 100 $\mu\Omega$
1.000 Ω - 9.999 Ω , resolution 1 m Ω
10.0 Ω - 99.9 Ω , resolution 10 m Ω
100.0 Ω - 999.9 Ω , resolution 100 m Ω
1,000 Ω - 9.999 k Ω , resolution 1 Ω

If a resistance > 350 Ω is being measured using the direct 4-wire method additional resistance should be added in the C1, C2 circuit to limit P1, P2 voltage to ± 24 V peak.

Range ($\mu\Omega$):

0 $\mu\Omega$ - 999 $\mu\Omega$, resolution 1 $\mu\Omega$
1.000 m Ω - 9.999 m Ω , resolution 1 $\mu\Omega$
10.00 m Ω - 99.99 m Ω , resolution 10 $\mu\Omega$
100.0 m Ω - 1.500 Ω , resolution 100 $\mu\Omega$

Accuracy: $\pm 0.5\%$ FSD

Operating temperature: 0 - 40 $^{\circ}\text{C}$

Input impedance: 2 M Ω /220 k Ω

Output current: 65 mA/10 mA

Output voltage: 48 V/400 V max

Operation: reversing dc (128 Hz resistance, 1.5 Hz micro-ohms)

Display: LCD

Power supply: 11.1 V 7.5 Ahr Li-ion

Battery life: 12 hrs

Charging time: approx 4 hours

Weight: 1 kg

Dimensions: 270 mm x 240 mm x 125 mm

7 Contact Details

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