

DIGITAL LOW RESISTANCE OHM METER



INSTRUCTION MANUAL

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1. Safety Rules

CAUTION



RISK OF ELECTRIC SHOCK

This tester has been designed with your safety in mind. However, no design can completely protect against incorrect use. Electrical circuits can be dangerous and/or lethal when lack of caution or poor safety practices are used.

Do not carry out field measurements on either the power system grounding or anything connected to it, without ensuring the contact or circuit under test is fully isolated.

Take all the necessary precautions. Do not exceed the limits of this instrument. The circuit to be tested must be de-energised and isolated before connections are made to it.

Do not use test leads, probes or crocodiles/aligators clips that are dirty, damaged or have broken or cracked insulation. Such accessories should be removed and repaired Immediately.

Always disconnect the test leads before replacing any fuse. Always replace the fuse with the type specified and ensure that they are correctly fitted.

Double check your settings and leads connections before measuring. Make a sketch to ensure proper operation and the principle of measurement is correct and well understood.

Do not touch any exposed wiring, connections or other "live" parts of an electrical circuit. If in doubt, check the circuit for no voltage first before testing it.

Disconnect the tester from any external circuit when charging the battery.

CAUTION



READ THE MANUAL

Follow the instructions in the Manual for every measurement. Read and understand the general instructions before attempting to use this tester.

2. Safety Check

Before using the tester check the condition of the battery. This is done by switching the tester ON.

If the BAT LOW symbol appears the battery needs charging.

When charging the battery, changing a fuse, or removing the cover to access the internal circuitry, always disconnect the test leads.

When replacing the fuse use only the type specified, and insert correctly in the fuse holder.

Double check the settings, and lead connections before making measurements.

DON'T TOUCH

Don't touch exposed wiring, connections or other "Live" parts of an electrical circuit. If in doubt, check the circuit first for voltage before touching or connecting to it.

Do not use cracked or broken test leads.

**THIS INSTRUMENT SHOULD ONLY BE USED BY A COMPETENT,
SUITABLY TRAINED PERSON.**

**REMEMBER
SAFETY IS NO ACCIDENT**



CAUTION RISK OF ELECTRIC SHOCK



CAUTION READ THE MANUAL

3. General Description

The Digital Low Resistance Ohm and Contact Meter is a battery (rechargeable) operated instrument which supply a constant current to the circuit under test, with which, stable, accurate measurements of very low resistance (down the micro ohm) can be made, still, over a wide range of values.

Resolution on the lowest range is $1\mu\text{ohm}$ and on the highest range, 100 milli-ohm.

The meter has 6 measuring ranges, from 2000 micro-ohm to 200.0 ohms.

Measurements are displayed on a large $3\frac{1}{2}$ digit custom liquid crystal display.

This instrument is powered from its internal rechargeable battery.

It has a regulated DC constant current source with current of 10mA, 100mA and 1A.

During recharge of the battery, the instrument is disconnected from the battery. Measurements can only be made while not charging.

The instrument supply the current to the resistance being measured through the C_1 and C_2 terminals (C_1 being +, C_2 being -).

The voltage drop across the resistance under test is measured by the potential terminals P_1 and P_2 (P_1 being +, P_2 being -).

Should the current regulation drops out, the RC Led will lit, indicating that the resistance in the current circuit is too high. (Lowering the current by selecting a higher resistance range can solve the regulation.)

Should the R_p Led lights up, it mean that the voltage measured on the resistance is too high, and therefore over-range. (Lowering the current by selecting a higher resistance range can solve the over voltage on R_p .)

The resistance can only be measured precisely when the R_p and R_c Leds do not lit. If anyone of these leds lights up, then the measurement will be inaccurate.

The I_{CCS} LED is the LED indicating the Constant Current Source being OFF. When this led lights up, it mean that the current injection has been switched OFF (could be over-temperature).

The METER has a built-in custom $3\frac{1}{2}$ digit liquid crystal display which can be viewed in most lightning conditions.

This display indicates the conditions (Hold, m, buzzer, polarity condition of load, + or -, automatic decimal point change with range selection).

The ranges are selected by the 'SCROLL / RANGE' push button.

A test is initiated by pressing the TEST/STOP push-button.

The instrument takes measurements for 10 seconds if the TEST/ STOP push-button is depressed for less than 3 seconds (EnerSave mode).

If the TEST/STOP push button is depressed for more than 3 seconds, the test will carry on for 60 seconds.

The tester switch "OFF" completely when the OFF push button is pressed, but The METER has also an auto-off feature

The tester "Hold" the last reading before stopping the test.

The tester is fuse protected and has a crowbar between C_1 and C_2 . This crowbar is activated by voltage. If the voltage is too high, that crowbar will blow the C_F fuse automatically to interrupt the circuit.

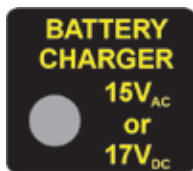
The voltage between P_1 and P_2 is also protected for over voltage .If that voltage is too high, the crowbar will blow the P_F fuse automatically to interrupt the circuit.

The tester has a temperature shut down.

The temperature sensing is done on the current regulation transistor. Should this over-temperature alarm be activated, the I_{CCS} OFF LED will lit, indicating the current has been shut down.

Allow the instrument to cool down for a while before proceeding further.

4. Operating Instructions



The connector for the Battery charger can accept AC or DC signals up to a maximum of 22Vdc. There is a full bridge rectifier inside the tester, as well as a regulated battery charger. The battery is charged to 13.8V. We recommend the use of the power supply (step down transformer) which is supplied with this tester. The light on the power supply transformer will light up when the battery charger is working.



Depressing the ON key will switch the tester "ON". At switch "ON", the tester retrieves the last settings utilized. These are the current/range settings which were last utilized by the Instrument. At Switch ON, the buzzer sounds to confirm the "ON" status.



Depressing the OFF key will switch the instrument "OFF". This "OFF" switch is software operated. At switch OFF, the buzzer will sound to confirm the "OFF" condition is processed by the micro. Next, the tester will be switched OFF completely.



Depressing the SCROLL/RANGE key will stop the test, if in progress, then will change the scale, to the higher ohmic scale (going down on the tester). Depressing the key again will move to the next range etc... Each range illuminates its corresponding led.



Provided, the TESTER is ON, when the TEST Start/Stop is depressed, the selected TEST will start (if stopped) or stop (if in progress). The TEST Start/Stop also has the EnerSave features. What that mean, is that if you depress the TEST Start/Stop key for more than 3 second, while starting the test, then, the test will be carried up to a duration of 1 minute (long Test). But, if you depress the TEST Start/Stop Key for less than 3 second, or just depress it, than the instrument will enter the EnerSave mode, and the test duration is limited to about 10 seconds. In both cases, the Test is stopped automatically by the instrument, but the user can always override the auto-stop, by depressing the TEST Start/Stop key at any time, in any mode.

Range Indication by LED:

Test Current 1A

Resistance 0-2.000m Ω (2000u Ω)



When this LED lights up, the instrument will measure up to 1999u Ω and will display it as milli ohms. The resistance which can be measured using this scale/range is from 0.000m to 1.999m Ω .

Range Indication by LED:

Test Current 1A

Resistance 0-20.00m Ω



When this LED lights up, the instrument will measure up to 19.99m Ω and will display it as milli ohms.

The resistance which can be measured using this scale/range is from 00.00m to 19.99m Ω .

Range Indication by LED:

Test Current 1A

Resistance 0-200.0mΩ



When this LED lights up, the instrument will measure up to 199.9mΩ and will display it as milli ohms. The resistance which can be measured using this scale/range is from 000.0m to 199.9mΩ.

Range Indication by LED:

Test Current 100mA

Resistance 0-2000mΩ



When this LED lights up, the instrument will measure up to 1999mΩ and will display it as milli ohms.

The resistance which can be measured using this scale/range is from 0000m to 1999mΩ.

Range Indication by LED:

Test Current 100mA

Resistance 0-20.00Ω

When this LED lights up, the instrument will measure up to 19.99Ω and will display it as ohms.



The resistance which can be measured using this scale/range is from 00.00 to 19.99Ω.

Range Indication by LED:

Test Current 10mA

Resistance 0-200.0Ω

When this LED lights up, the instrument will measure up to 199.9Ω and will display it as ohms. The resistance which can be measured using this scale/range is from 000.0 to 199.9Ω.





Main Status Indicators by LED:

Constant Current Source Indicator.

When this LED lights up, the Constant Current Source is shut down.

The Constant Current Source is shut down when the test is not in progress.

While in progress, the Constant current Source LED does not lights up.

After Switching the Instrument ON, the I_{CCS} OFF led will lights up.

When a test has stopped, the I_{CCS} OFF led will lights up.

In case of Over-Temperature, the I_{CCS} OFF led will lights up.

The R_C indicator LED lights up, when the resistance between the current terminals is too high for the constant current source to regulate.

This indicator is only significant while the test is in progress. You can try to lower the test current if it comes on while testing.

The R_P indicator LED lights up, when the potential between the potential terminals is too high. This also can be due to the resistance under test being too high for that current range. Try to lower the current or increase the resistance range.(only significant while the test is progress).



5. Display



The HOLD Sign indicator comes on when the readings are held.

This happen:

HOLD

At switch "ON", as no reading has been done yet, so the display is on Hold with whatever value when TEST stops. When Scroll/Range is depressed while a test is in progress.

·)))

The Sound Sign indicator is shown while the buzzer is working. That mean that when the buzzer sound, the sign is ON

⎓+

The Low Battery Sign indicator is showing when the battery need charging.

■

The negative sign is shown when the test leads are reversed. This instrument is calibrated while the Test leads are in the Correct polarity.

6. Specifications

ELECTRICAL

Resistance Ranges

Range: 0 to 2.000mΩ in steps of 0.000001Ω
0 to 20.00mΩ in steps of 0.00001Ω
0 to 200.0mΩ in steps of 0.0001Ω
0 to 2000mΩ in steps of 0.001Ω
0 to 20.00Ω in steps of 0.01Ω
0 to 200.0Ω in steps of 0.1Ω

Accuracy: 0 to 2.000mΩ => ± (5%rdg + 5 dgt)
0 to 20.00mΩ => ± (4%rdg + 4 dgt)
0 to 200.0mΩ => ± (4%rdg + 4 dgt)
0 to 2000mΩ => ± (3%rdg + 4 dgt)
0 to 20.00Ω => ± (2%rdg + 4 dgt)
0 to 200.0Ω => ± (2%rdg + 4 dgt)

Test Current: 1A ±3%
100mA ±2%
10mA ±1.5%.

Maximum Output Voltage: 10V rms
Response Time: 1secs nominal
Voltage Withstand: 6V AC between any two terminals
Battery Low Indication point: 10V nominal

MECHANICAL

Size: 330 x 260 x 160 mm
Material: Polycarbonate/ABS
Weight (less carrying case): Approx. 3800 g (with battery)
Display: Custom Liquid Crystal

ENVIRONMENTAL

Operating temperature Range: -15°C to + 55°C
Storage Temperature: -20°C to + 70°C

GENERAL

Safety: IEC/EN 61010-1
EN 61326+A1+A2, EN 55011, EN 61000-3-2,
EN 61000-3-3+A1, EN 6100-4-2+A2,
EN 61000-4-3+A2, EN 61000-4-4+A2,
EN 61000-4-5+A1, EN 61000-4-6+A1,
And EN 61000-4-11+A1

Battery: 12 V rechargeable 12V 2.3AH

Fuses: 1 X 500mA (Potential Fuse)
1 X 2A (Current Fuse)
Slow Blow, 250V type

SPARES AND ACCESSORIES

Test Leads: TEL-4136 B
TEL-4136 BU
TEL-4136 G
TEL-4136 R

Fuses: 500mA
2A

Battery: 12V Rechargeable

Instruction Manual

7. Cleaning

Clean the instrument case with an anti-static cleaner and wipe with dry cloth.

8. Inside LID Instruction Label

THE INSTRUMENT IS DISABLED WHILE CHARGING. DISCONNECT BATTERY CHARGER TO OPERATE IT.

BATTERY CHARGER
15V_{ac}
or
17V_{ac}

The battery charger needs low voltage AC or DC to be connected to it's input (front panel connector). The internal battery charger has it's own regulation and the incoming voltage does not need to be regulated.

WHEN THE INTERNAL BATTERY HAS REACHED IT'S END OF LIFE, ONLY REPLACE IT WITH THE SAME TYPE

Depress the **SCROLL / RANGE** button to change the range.

If you use the selected range, the instrument will keep this information in memory.

The next time you will switch the instrument ON, this range will be automatically selected.

If testing is in progress while depressing **SCROLL/RANGE**, the Test will be stopped,

1A
2000mA

1A
2000mA

1A
2000mA

100mA
2000mA

100mA
2000mA

100mA
2000mA

RANGE

SCROLL RANGE

TEST Start/Stop

Switch the **TEST ON** or **OFF**. The **TEST** also auto-stop after 1 minute if **EnerSave** is disabled. Every time the **TEST** is stopped, the display is automatically **HELD**. If **TEST** depressed for less than 3 Sec. While standing a **TEST**, **EnerSave** is Enabled. When **EnerSave** is Enabled, **TEST** duration is reduced to around 10Sec.

- **I_{test}** OFF Source OFF,
- **R_c**
- **R_p**

This LED indicates that the current has been stopped (Constant Current Source OFF).

This LED indicates that the resistance in the Current Circuit is too high, or the current can't be regulated.

This LED indicates that the Potential Circuit Voltage is TOO high.

4T

RECOMMENDED METHOD

Using the 4T method, R_{ext} , R_{int} does not affect the readings. R_{ext} and R_{int} are negligible as no current goes into P1 and P2.

C1 & P1 SHORTED

3T

Using the 3T method, R_{ext} does not affect the readings. R_{int} is negligible as no current goes into and P2 but R_{ext} is added to R_{p1} .

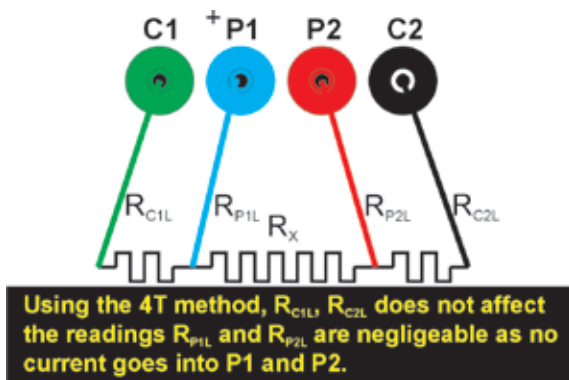
C1 & P1 SHORTED

2T

Using the 2T method, the resistance of the test leads are added to the readings. This is not recommended for low resistance and long leads.

FUSES: Both fuses (P_1 = Potential Circuit Fuse; C_1 = Current Circuit Fuse) are automatically blown if the corresponding crowbar has fired. The fuses must only be replaced by the same type of the same specification P_1 = 50mA; C_1 = 2A slow bow.

9. 4 Terminals Measurement



For measuring low to very low resistance (contact resistance), this is the preferred measuring method because the resistance of the test leads does not have an effect (negligible) on the measuring results.

R_{C1L} is the Resistance of the Current Lead going to C1

R_{C2L} is the Resistance of the Current Lead going to C2

R_{P1L} is the Resistance of the Current Lead going to P1

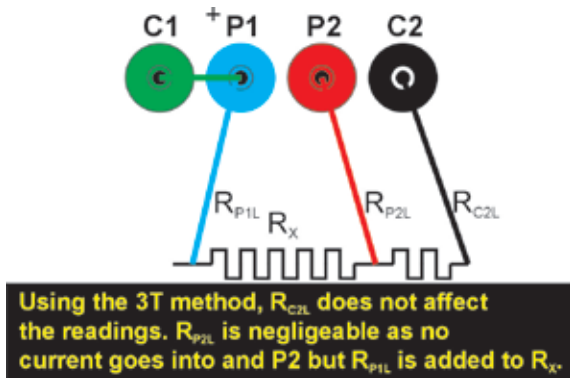
R_{P2L} is the Resistance of the Current Lead going to P2

The input impedance between P1 & P2 is 10M ohms, so because the current being drawn by these pins is so small, the voltage loss on $R_{P1L} + R_{P2L}$ is very small too.

So the loss in these potential wires is not even influencing the voltage measured on P1 P2.

Due to the fact that the tester has a constant current source, the current flowing between C1 to C2 is constant. Provided the resistance of the current leads are reasonably low (low enough for the current regulation to still be able to regulate properly), the measurement using this method will give the bet results of all the methods.

10. 3 Terminals Measurement



For measuring low resistance, this measuring method can be utilized C1 and P1 terminals are shorted at the tester.

R_{C2L} is the Resistance of the Current Lead going to C2

R_{P1L} is the Resistance of the Current Lead going to P1

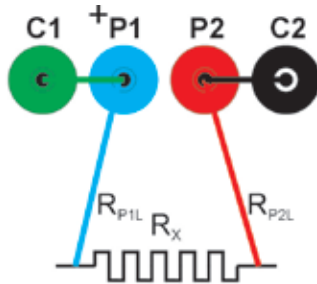
R_{P2L} is the Resistance of the Current Lead going to P2

In this case, R_{P1L} is not negligible anymore, because the current going into this lead is the constant current, which is high. So the error of R_{P1L} exist and in reality, this error is added to R_X . So, if the resistance under test is much higher than the test lead, than, this method could be accepted.

This method is a simplified method of measurement.

Always, keep in mind, that R_{P1L} is your error resistance.

11. 2 Terminals Measurement



Using the 2T method, the resistance of the test leads are added to the readings. This is not recommended for low resistance and long leads.

For measuring resistance, this measuring method can be utilized. C1 and P1 terminals are shorted, P2 and C2 are shorted at the tester. R_{P1L} is the Resistance of the Current Lead going to P1. R_{P2L} is the Resistance of the Current Lead going to P2. In this case, R_{P1L} and R_{P2L} are not negligible anymore, because the current going into these leads is the constant current, which is high. So the error of $R_{P1L} + R_{P2L}$ exist and in reality, this error is added to R_X . So, if the resistance under test is much higher than the test leads, than, this method could be accepted.

This method is a simplified method of measurement. Always, keep in mind, that R_{P1L} and R_{P2L} are your error resistance. This is not an accurate method and is not recommended, unless the resistance is above 10 ohms.

12. Typical Applications

Measuring the contact resistance of circuit breakers.

Measuring Circuit breaker resistance is very important. If the resistance of a circuit breaker become too large, than, the current going through will warm up the circuit breaker ($R \times I^2$) and it could start a fire. If the resistance is too high, the power transferred to the load could be too low and the load could malfunction.

Measuring the bonding of welding points.

Welding point or good connections are the basic of good earthing and continuity in electrical wiring. This is specially true for protection conductors. For example lightning protection conductors requires extremely low resistance to conduct the lightning into the earth.

On aircrafts, the lightning must be conducted from one side to the other side of the wings by low resistance conductors, instead of going through the frame of the plane.

These resistance can be checked with this instrument.

Measuring the contact resistance of bolted conductors.

Similarly to bonding of welding points, some times, connections are done using bolted conductors or using bolted lugs. These contact resistance can be tested and measured with this instrument.

Measuring the copper resistance fo transformers.

The low resistance of transformer winding can be measured with this instrument, to ascertain the ohmic component of the winding.

Measuring the earthing conductor resistance.

Earthing conductor Resistance is one of the most important component of an electrical protection system. The measurement of its value can be done using this instrument.

Measuring the earth mat connections resistance.

The Earth mat connections resistance is done using the 4 wires method, to ensure accuracy of these low resistance.

The earth mat is connected using very low resistance connections to ensure fault current are passed without or very little resistance.

It is very important to measure these connections, using the 4 wires methods, to ensure added accuracy and remove errors from the test leads. Earth mat rely completely on good connections and low resistance for their effectiveness. Their regular testing and correct measurement will ensure proper working of the protection systems.

13. Working Principle of The Instrument

This Test Instrument has a regulated current source which injects its regulated DC current into the low resistance to measure.

The current is injected into the resistance under test through the terminals C1 and C2.

This Test Instrument has a DC voltmeter which measure the DC voltage across the resistance to be measured.

The Voltmeter connections are on P1 and P2.

The display shows a number proportional to the ratio of the current injected and the voltage measured. $R=U/I$

When the user change the range of the instrument, the current regulation change, from 10mA to 1A, according to the user selection. The current selected is shown on its corresponding LED, on the left of the facia.

When selecting a current, the range is automatically selected by the processor.

So, selecting a current and a range has the same function and is using one push button.

The Instrument is processor driven and the software takes care of the different switching elements inside the circuit.

The product has protection against over-voltage and over-temperature.

14. Charging The Battery

This instrument has an internal rechargeable battery.

Only use the supplied battery charger to charge it.

To avoid safety issues, do not connect to a device to test or use while re-charging the battery.

However, the internal circuitry will disconnect the measuring and testing circuitry while charging, it is recommended to make sure that no test leads are connected while charging the internal battery.

Do not try to by pass that circuit, or warranty will be void.

The battery has a maximum life of about one or 2 years, depending of its maintenance.

Only replace with the same type of battery.

15. Fuse Replacement

REPLACING THE POTENTIAL FUSE

The P_F fuse mean it's the Potential Fuse.

The Potential Measurement Circuit of this instrument is fuse protected.

Only replace with the same type as the original fuse.

The Potential Fuse is 500mA Slow Blow type.

EPLACING THE CURRENT FUSE

The C_F fuse mean it's the Current Fuse.

The Current Injection Circuit of this instrument is fuse protected.

Only replace with the same type as the original fuse.

The Current Fuse is 2A Slow Blow type.

16. The Storage and Maintenance of Batteries

- The storage temperature range : $-30^{\circ}\text{C}\sim 50^{\circ}\text{C}$, the humidity range : 25%~85%.
- Fully charge the batteries before storage ; if not, battery life will be shorter.
- Batteries under storage at ambient temperature of 25°C should be recharged every six months to maintain their quality, performance and reliability. The interval of this charge should be reduced to 50% by each 10°C rise in temperature above 25°C .
- Charge the batteries based on storage temperatures, as follows :
 - < 20°C (68°F) storage : charge every 9 months
 - $20^{\circ}\text{C}\sim 30^{\circ}\text{C}$ ($68^{\circ}\text{F}\sim 86^{\circ}\text{F}$) storage : charge every 6 months
 - > 30°C (86°F) storage : charge every 3 months

RECOMMENDED RECHARGING INTERVAL & METHOD

STORAGE TEMPERATURE	RECHARGE INTERVAL & METHOD
Below 20°C (68°F)	9 months, charge for 16 hrs at 2.4V/cell
$20^{\circ}\text{C}\sim 30^{\circ}\text{C}$ ($68^{\circ}\text{F}\sim 86^{\circ}\text{F}$)	6 months, charge for 16 hrs at 2.4V/cell
above 30°C (86°F) (avoid this storage condition)	3 months, charge for 16 hrs at 2.4V/cell

17. Notes