ETREL

ELECTRIC VEHICLE CHARGING STATION

ETREL INCH DUO

ELECTRICAL MEASUREMENTS GUIDE

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1 PERFORMING ELECTRICAL MEASUREMENTS

Electrical measurements must be performed by licensed electrician and must be in accordance with requirements set in national legislation. In this document only information on specifics of some of the electrical measurements is given.

2 EARTHING CONDUCTOR CONTINUITY TEST

Continuity measurement should be performed for protective conductors, including conductors in the main and additional equipotential. Measurement will have to be made between PE terminal of charging station's socket and inlet PE conductor. If the charging station is equipped with cable, the measurement should be made between PE conductor of the cable plug and inlet PE conductor.

WARNING!
Before carrying out the measurements, switch off the charging station or main power supply.

Continuity measurement should be made with a current greater than or equal to 200 mA. The open circuit test voltage should be between 4 and 24V (AC or DC). The measuring range shall include values 0,2 Ω to 2 Ω and the maximum percentage operating uncertainty within this measuring range shall not exceed +- 30 %. The resolution of digital equipment shall be at least 0.1 Ω.

The use of instrument, with option of measuring at higher current than 200 mA increases the accuracy of the measurement. The method of measurement is shown in the figure:

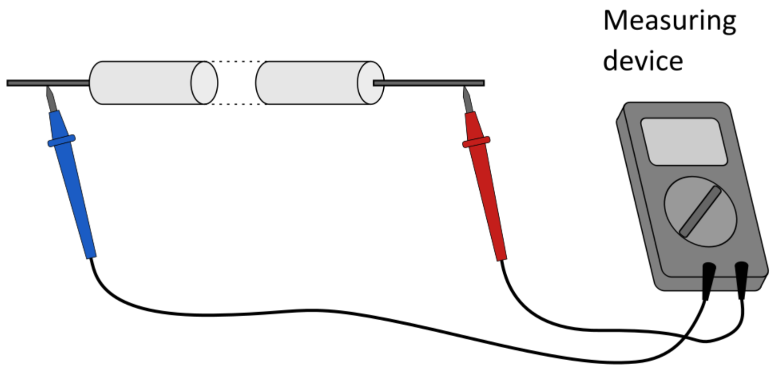


Figure 1: Continuity measurement

Continuity of the wire is considered to be met if the connection resistance does not exceed the value of 2 Ω.

3 INSULATION RESISTANCE MEASUREMENT

Measurements of the insulation resistance of electric cables are performed between active conductors and between active conductors and the protective conductor connected to the earthing system.

Insulation resistance, measured at a test voltage of 250 V d. c. is satisfactory if its value is not less than 1 MΩ.

Table 1: Insulation resistance measurement conditions

Nominal voltage	Test voltage	Insulation resistance
230/400 V, up to 500 V (Applicable to all charging station from Etrel)	**250 V d. c.**	**≥ 1 MΩ**

⚠

BECAUSE THE CHARGING STATION HAS VARISTORS INSTALLED, THEY MAY AFFECT THE MEASUREMENT RESULT OR MAY BE DAMAGED.

THE TEST VOLTAGE FOR THIS CIRCUIT SHOULD BE SET TO 250 V DC.

THE MEASURED INSULATION RESISTANCE SHOULD BE AT LEAST 1 MΩ.

TO PERFORM THE INSULATION RESISTANCE TEST, THE POWER SUPPLY MUST BE DISCONNECTED.

Explanation:

Please follow the procedure as stated in the standard IEC 60364-6, which is stating that all current-using equipment must be disconnected before the test of insulation resistance, Chapter 6.4.3.3. To perform the insulation resistance test, the power supply must be disconnected.

As specified in IEC 60364-6, 6.4.3.3 Insulation resistance of the electrical installation:

Because the charging station has varistors installed, they may affect the measurement result or may be damaged. It is not possible to disconnect the varistors and the test voltage for this circuit should be set to 250 V d. c. and the measured insulation resistance should be at least 1 MΩ.

*The standard values of insulation resistance measurement, shown in the table below **are not applicable**.*

Table 2: Standard values of insulation resistance measurement are not applicable

Nominal voltage [V]	Test voltage d. c. [V]	Insulation resistance [MΩ]
SELV and PELV	250	0,5
Up to 500 V including FELV	500	1
Above 500 V	1000	1

4 RCD TEST

The effectiveness of the automatic disconnection of the power supply by RCD devices should be checked with the use of appropriate test equipment, confirming that the relevant requirements are met and considering the operating characteristics of the device. The effectiveness of the protection measure can be considered satisfied if the trip occurs at a certain value of the leakage current and within a certain time.

Each socket of the charging station should always be protected with an individual RCD, which can be part of device or part of the installation.

The standard IEC 61851-1 specifies that this RCD should have sensitivity of 30 mA and be of Type B or equivalent. The possible equivalent is the use of RCD of Type A with additional DC leakage sensor.

The effectiveness of the automatic disconnection of the power supply by RCD devices should be checked with the use of appropriate test equipment, confirming that the relevant requirements are met and taking into account the operating characteristics of the device.

The effectiveness of the protection measure can be considered satisfied if the trip occurs at a certain value of the leakage current and within a certain time.

Table 3: Type AC and A residual current circuit breakers without built-in overcurrent protection - normalized switching time values

Normalized tripping time values for residual current $I_{\Delta n}$				
RCD Type A General purpose	Testing current	$I_{\Delta n}$	2 $I_{\Delta n}$	≥ 5 $I_{\Delta n}$
	Maximum tripping times	0.3 s	0.15 s	0.04 s

Table 4: Type B RCDs - normalized tripping time values for residual currents in rectifier circuits and for smoothed residual current

Normalized tripping time values for residual current $I_{\Delta n}$				
RCD Type B General purpose	Testing current	2 $I_{\Delta n}$	4 $I_{\Delta n}$	≥ 10 $I_{\Delta n}$
	Maximum tripping times	0.3 s	0.15 s	0.04 s

5 EFFECTIVENESS OF THE PROTECTION AGAINST ELECTRIC SHOCK

In the case of TN systems, the effectiveness of protective measures in the event of damage by tripping the power supply is checked by:

a) measurement of fault loop impedance,

b) verification of the characteristics and/or effectiveness of the associated protection.

For the TN system, the following condition should be met:

$$Z_S \times I_a \leq U_o$$

Where:

- Z_S is the fault loop impedance,
- I_a is a current that causes an automatic power cut-off within the time specified in the table below,
- U_o is the rated AC or DC voltage with respect to earth.

Table 5: Maximum switch-off times

System	**120 V < Uo ≤ 230V** AC	**230 V < Uo ≤ 400V** AC
TN	0,4 s	0,2 s
TT	0,2 s	0,07 s

In TN systems, for distribution circuits and circuits with a rated current above 32 A, the permissible maximum time of switching off is 5 s.

6 EARTH ELECTRODE RESISTANCE MEASUREMENT

Measuring of the resistance of an earth electrode shall be made by an appropriate method. Various methods exist and none of them is ideal, as they all have advantages and disadvantages. The methods, described below, are proposed in standard IEC 60364-6.

Other methods may be used if allowed by national legislation. The value of the measured resistance shall be less than 100 mΩ.

An example is a method of measurement using two auxiliary earth electrodes, Method C1. Where the location of the installation is such that it is not possible in practice to provide the two auxiliary earth electrodes, measurement of the earth fault loop impedance according to Methods C2 or C3 will give an acceptable approximate value.

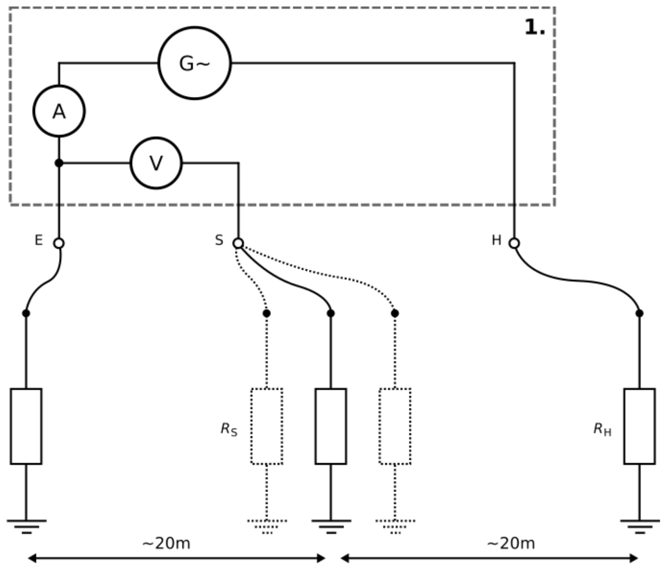
MEASUREMENT OF EARTH ELECTRODE RESISTANCE USING AN EARTH ELECTRODE TEST INSTRUMENT (METHOD C1)

An alternating current of a steady value is passed between the disconnected earth electrode, E, and a temporary auxiliary earth electrode, H, placed at a distance from E such that the resistance areas of the two electrodes do not overlap.

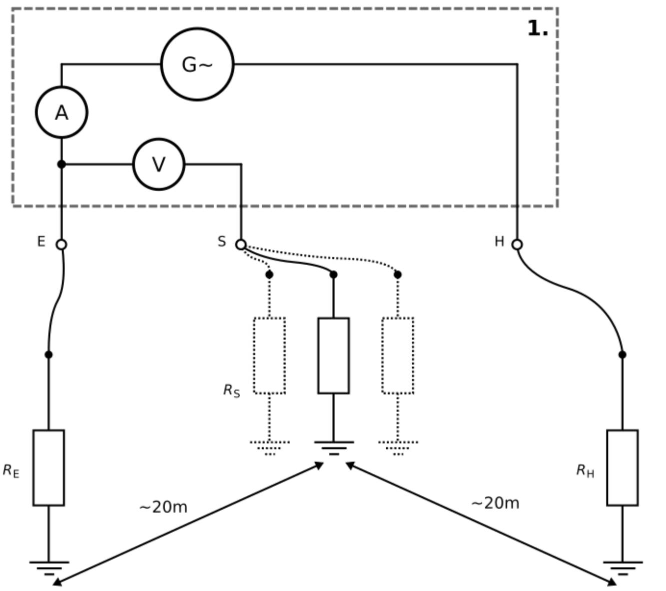
A second temporary probe electrode, S, which may be a metal spike driven into the ground, is then inserted half-way between E and H, and the voltage drop between E and S is measured. In most cases S should be placed at approximately 20 m from E and H. The electrodes may be arranged in a linear formation (see following figure, a. case) or triangular formation (see following figure, b. case) to suit available space.

The resistance of the earth electrode is then the voltage between E and S, divided by the current flowing between E and H, provided there is no overlap of the resistance areas.

To check that the resistance of the earth electrode is a true value, two further readings are taken with the second electrode, S, moved approximately 10 % of the linear distance between E and H from the original position. If the three results are substantially in agreement, the mean of the three readings is taken as the resistance of the earth electrode E. If there is no such agreement, the tests are repeated with the distance between E and H increased.



a) Electrodes arranged in linear formation



b) Electrodes arranged in triangular formation

Key

1.	Earth electrode test instrument according to IEC 61557-5
R_E	Earth electrode resistance
R_S	Temporary probe electrode resistance (voltage)
R_H	Temporary auxiliary probe earth electrode resistance (current)

Figure 2. Measurements of the earth electrode resistance

MEASUREMENT OF EARTH ELECTRODE RESISTANCE USING A FAULT LOOP IMPEDANCE TEST INSTRUMENT (METHOD C2)

Measurement of the earth fault loop impedance at the origin of the electrical installation may be carried out with a test instrument according to IEC 61557-3.

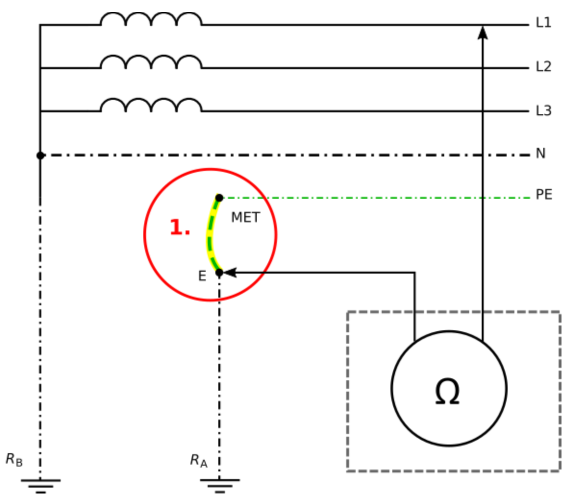
The test should be performed on the live side of the main switch with the supply to the installation switched OFF and with the earthing conductor temporarily disconnected from the main earthing terminal (MET).

The test instrument should be set to a range appropriate for the value of earth fault loop impedance likely to be expected for a given system earthing arrangement (typically in the region of 0 Ω to 20 Ω).

The test instrument should be connected as shown in the following figure. Where any doubt exists, the instrument should be connected as described in the manufacturer's instructions.

Only a small proportion of the measured earth fault loop impedance is derived from those parts of the loop other than the electrode and so the result obtained from this test can be taken as a reason able approximation of the earth electrode resistance.

It is important that the earthing conductor is reconnected to the MET of the installation before the supply is reinstated.



1. Earthing conductor temporarily disconnected from the main earthing terminal (MET).

Figure 3. Measurement of the earth electrode resistance using an earth fault loop impedance test instrument

MEASUREMENT OF EARTH ELECTRODE RESISTANCE USING CURRENT CLAMPS (METHOD C3)

With reference to the following figure the first clamp induces a measuring voltage U into the loop, the second clamp measures the current I within the loop. The loop resistance is calculated by dividing the voltage U by the current I.

As the resulting value of parallel resistances R1 … Rn is normally negligible, the unknown resistance is equal to, or slightly lower than, the measured loop resistance.

The voltage and current coils may be in individual clamps separately connected to an instrument or in a single combined clamp.

This method is directly applicable to TN systems and within meshed earthing of TT systems.

In TT systems, where only the unknown earth connection is available, the loop can be closed by a temporary connection between earth electrode and neutral conductor (quasi-TN system) during measurement.

To avoid possible risks due to currents caused by potential differences between neutral and earth, the system should be switched off during connection and disconnection. It should be noted that the values of resistance obtained using Method C3 will typically be higher than those obtained using Method C1 because of the earth loop measurement.

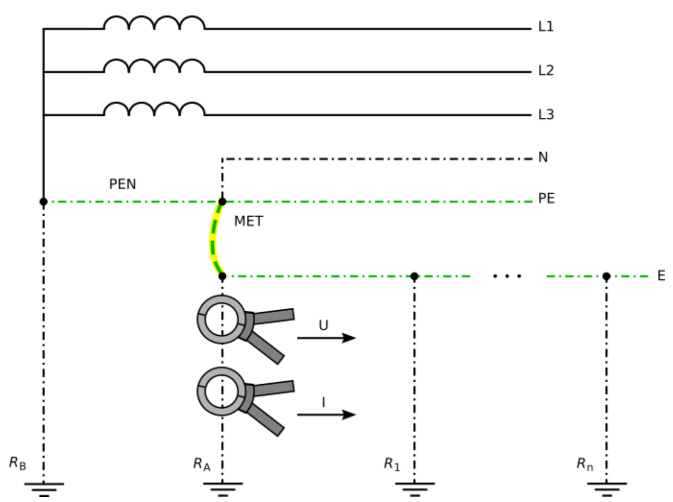


Figure 4. Measurement of earth electrode resistance using current clamps

2-POINT (DEAD EARTH) METHOD

In areas where driving ground rods may be impractical, the two-point method can be used. With this method, the resistance of two electrodes in a series is measured by connecting the P1 and C1 terminals to the ground electrode under test; P2 and C2 connect to a separate all-metallic grounding point (like a water pipe or building steel).

The dead earth method is the simplest way to obtain a ground resistance reading but is not as accurate as the three-point method and should only be used as a last resort, it is most effective for quickly testing the connections and conductors between connection points.

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