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The HF Earth Resistance Measuring Instrument was built in compliance to VDE 0411. Provided that the instrument is used as prescribed, the safety of the instrument and of the user is guaranteed.

In order to preserve the perfect state of safety and to guarantee safe utilisation, it is absolutely necessary that you carefully and completely study the operating instructions and that you follow them exactly in every respect. Only the specialist staff is authorized to make measurements with the HW2S. The instrument may never be connected to live parts. The HW2S is a measuring instrument which must be handled carefully. Vibrations, moisture and exposure to external voltages must be avoided in particular. Electrostatic charges (also of the operating crew) must absolutely be avoided, as they may lead to the destruction of the instrument.

The instrument may not be exposed to frost or to temperatures above 60° C.

If there is any visible damage, it must be assumed that safe operation is no longer possible. In this case the instrument must be switched off immediately and protection against unintentional operation must be ensured.

After extended storage periods and under unfavourable conditions or after heavy stress due to transportation the instrument must be checked in order to ensure its safe operation.

When opening the instrument, live parts may be exposed. Before any overhaul, exchange of parts or adjustment, the instrument must be disconnected from all voltage sources. Overhauls may only be carried out by a qualified person who is familiar with all the hazards involved.

The instrument complies with protection class II.

Only fuses of the rated current and type are allowed. It is forbidden to use repaired fuses or to short-circuit the fuse holder.

HF-Earth Resistance Measuring Instrument HW2S

1 Button for checking of instrument
2 Information display
3 Button for checking the batterie
4 Illumination of display (2)
5 Measured-value display
6 Button for automatic measurement
7 Fuse of measuring circuit
8 230 V socket
9 Fuse for charging circuit
10 Pilot lamp “charge”
11 Operation switch
12 Pilot lamp for operation
13 Socket for auxiliary earth rod (H)
14 Socket for probe (S)
15 Socket for tower leg (E)
The HF Earth Resistance Measuring Instrument HW2S serves for the determination of earthing resistances of overhead transmission line towers with tower-top earth wire. The instrument has been designed especially for the routine control of the effectiveness of tower earthings at a minimum of effort and time.

For measuring, a sinusoidal current flows from the tower foot (E) to the auxiliary earth rod (H). The voltage drop is measured by probe S. The earth electrode resistance can be determined from the current/voltage ratio.

The high frequency measuring method offers the advantage of eliminating the influence of adjacent tower earthing connected by earth wires.

The measured result is comparable with the results achieved by measurements using conventional bridges, however, without the time-consuming and complicated process of lifting and insulating the earthwire against the tower.

Range of application: 2-100 ohms.

Subject to physical limits the measuring results of the HW2S are comparable with low frequency measuring bridges in the range 2-25 Ohm only.

Extreme and particularly unfavourable conditions may influence the measured results.

The shown result can be influenced by interference voltages. Such influence can mostly be detected by repeated measurements.

The instrument is approved for operation of an ambient temperature of 50°C.
Function of buttons and indications

The instrument is operated by means of 4 push-buttons. A selected function will be performed within 15 seconds. If another operation is started meanwhile, the original one will be interrupted, and the latest operation will be executed.

The current mode of operation or measured results are shown on two displays:

- current operating status (text)
- measured values according to the selected function
- error messages (flashing)
- number of tower

The information display (2) consists of two lines and can be illuminated push button (4). The following information is shown:

- current operating status (text)
- measured values according to the selected function
- error messages (flashing)
- number of tower

The display (5) shows the measured value tower’s dissipation resistance after a valid measurement. When the instrument is ready for operation, the indication is ---,--
With the push-button TEST (1) two different test functions may be selected. If the button is pressed once, an internal test is performed. If the button TEST is pressed twice within 0.5 seconds, an external test takes place.

The instrument contains a built-in test resistor of 10 ohms for the internal test. During execution the measuring current is first adjusted to 20 mA. Then, the resistance is determined by measurement of the voltage.

**Internal Test**
- Turn the operating switch (11) to the right for operation. The pilot lamp (12) comes on.
- Press button TEST (1). Thereby the integrated test resistor is activated.
- After approx. 5 seconds the display (5) shows the result, which should range between 9.5 and 10.5 ohms.
- Switch off the instrument or continue with any measurement.

**External Test**
With this test the object connected to the sockets is measured. If no object is connected, the measurement is interrupted, and an error message appears.

For starting the external test, push-button TEST (1) must be depressed twice within 0.5 seconds.

During both measurements any inductive resistance fraction is not compensated. This means that any inductive fractions of the object are included in the indicated result.
Checking of battery

The battery supply can be checked by depressing button U/I (3). In additional the actual measurement current is shown.

If an object to be tested is connected to the sockets, the current is set to 20 mA. If there is no object connected, the display shows the instantaneous current flowing.

Executing

– Turn the operating switch (11) to the right and set it to “Operation”. The pilot lamp (12) will light up.

– Press button U/I (3). After a short time, the battery voltage and the measuring current are indicated on the display (2). The battery voltage should be in-between 10.0 and 13.7 V.

– The rated voltage of the charged battery is 12.0V. During the charging process the battery voltage may rise to 14.5 V.

– If the voltage drops below 10.0 V, an error message will be shown (see item “error messages”).

Illumination of indicating display

With the yellow button (4) the illumination of the indicating display can be switched on and off. The illumination can be switched on in any operating phase.

In order to save battery power, the illumination is switched off automatically after 5 seconds.
The measurement of an externally connected object is started by depressing the red button for automatic measurement (AUTO). A real object always contains an inductive resistance fraction. To compensate this inductive fraction, capacitors are connected in series. The HW2S automatically determines the required capacitance during the adjustment procedure. The adjustment procedure and the currently effective capacitance with the associated value of resistance, can be read on the information display (2) during the measuring process.

Measuring procedure
- Drive auxiliary rod «H» (about 1100 mm long) and probe «S» (about 630 mm long) into the grounds so that the supplied measuring cables are laid out to their full extent. Preferably at a right angle to the transmission line and in a straight line with respect to the object to be tested.
- Insert one end of the measuring cable of the auxiliary earth rod (about 75 m HF cable) into socket “H” and connect the other end to the auxiliary earth rod «H».
- Insert one end of the probe measuring cable (about 40 m NYAF) into socket “S” and connect the other end to the probe «S».
- Connect the tower stub with the measuring cable (about 1.5 m NYAF) to socket “E” making sure that a good contact is established between the tower sub and the earth clamp.
- Turn operating switch (11) to the right and set it to “Operation”. Pilot lamp (12) lights up.
- Press the button for automatic measurement (6). After a certain period (about 15 seconds) the measured result can be read on the indicating display (5). If it isn’t possible to obtain a result, the reason is shown on the information display (see section “Error messages”).
- If further measurements are planned, the instrument may be left switched on. The result of the last measurement is still shown, the measuring current is interrupted however. The instrument has been switched over to standby in order to reduce the battery load.

For longer interruptions the operating switch (11) should be set to the intermediate position “Off”. The pilot lamp “Operation” (12) goes out.
Storage of Measured Data

The integral measured data memory permits a storage up to a maximum of 100 towers- or measured values. The measured values are stored in a so-called “remanent memory” (battery-buffered RAM). This ensures a backup of the measured values in case the battery of the HW2S may fail. A subsequent data storage can be executed.

The measured values are downloaded as a text file via a serial data cable (RS232) and can be inserted into an EXCEL table, for example, for further evaluation or processing. The earth resistance meter is ready to take measurements once the measuring probe (“S” probe, “auxiliary earth” probe) and the “E” tower connection have been properly connected. Once the earth resistance meter has been switched on, the date, time and the “Ready” message appear on the display. Every measurement is being saved with the precise date and time and the current measured value. The ABB-Protokoll program, which can be found on the CD resistance meter, has to be installed to provide a download of the measured results from the earth resistance meter. The measured values can then be saved. The folder “ABBPrt1- Installer” is located in folder “ABBPrt1” on the CD. Open the contents of this folder and double-click on the application to start the Setup process.

The "Mess-Protokoll" (Measurement Report) program can be set up in the following 4 languages:
- German
- English
- Spanish
- French

Up to 100 (0-99) reports can be stored in the HW2S. The tower number (0-99) increases by 1 after each measurement and after 99 changes to 00. Data that has not been transmitted will then be overwritten! The tower number can be inputted into the HW2S before a measurement is taken. After the report data has been downloaded, it is not automatically deleted but remains in the memory of the earth resistance meter. Therefore the data must be manually deleted after completion of the download, using the "Delete" button, so that the earth resistance meter is ready to take measurements from tower number 00 when it is next used.

Detailed instructions about operating the measured data storage can be found on the CD supplied with every earth resistance meter. The program "ABB-Protokoll", which is needed for storage of the data, can also be found on this CD.
Measurements will be interrupted if a malfunction occurs during execution. This will be announced on display (2). Mainly three error messages may come up:

**A - Current low valued**
This error message comes up if the required measuring current could not be set, making a correct result impossible.

Reasons for this announcement may be:

– Interruption in the measuring cable to the auxiliary earth rod (H)

– Poor connection of the measuring cable to the probe or to the instrument

– The earth resistance of the auxiliary earth rod is too high. To reduce the earth resistance, drive the auxiliary earth rod deeper into the ground or drive a second one into the ground at a few meters distance and connect it to the first one.

– Maximum resistance of auxiliary earth: 1 kohm

– Maximum resistance for probe S max. 5 kohm

**B - Measuring cable interrupted**
This error message comes up if there is an interruption in the measuring cables or poor connection to the probe or to the instrument or the contact resistance is too high.

**C - Charge Battery**
Irrespective of any manual checking of the battery with button U/I (3) the battery is permanently monitored during operation. This takes place cyclically with 1 sec intervals (without indication on display). If the voltage drops below 10.0 V, an error message appears.

This error announcement can only be disabled by turning off the instrument with operating switch (11). The battery should be recharged immediately to prevent a pole reversal of individual cells.
Charging the battery

- The battery is charged with the built-in charging unit by connecting it to a mains voltage of 230 V (frequency: 50/60 Hz).

- Due to their low internal resistance, the Ni-Cad cells are subject to automatic discharge, depending on the ambient temperature. The graphs show the extent of the usual self-discharge of these cells at various temperatures.

- After extended storage periods, i.e. 2-4 months, the battery should be charged for about 18-24 hours before using the HW2S. Excessive storage periods involve the danger of a polarity reversal of one or several cells. The danger of polarity reversal appears when the voltage drops below 10.0 V. In this case the battery must be recharged immediately.

- Recharging a normally discharged battery (10.0 V) takes approx. 24 hours.

- The operating switch may be left in position “Charge” for a certain time without harming the Ni-Cad cells. To avoid a polarity reversal it is sufficient to charge the battery every 2-3 months for 18-24 hours.

- For charging, discharging and storage of the battery the following temperature limits should be adhered to:
  - Charging +10° to +35°C (50°C max)
  - Discharging -20° to +45°C (50°C max)
  - Storage 0° to +45°C (a maximum of 60°C is allowable for not more than 24 hours)

The temperature has a considerable influence on capacity, voltage and service life of the battery.

The extent of the usual self-discharge of these cells at various temperatures

[Graph showing the extent of self-discharge at different temperatures]
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