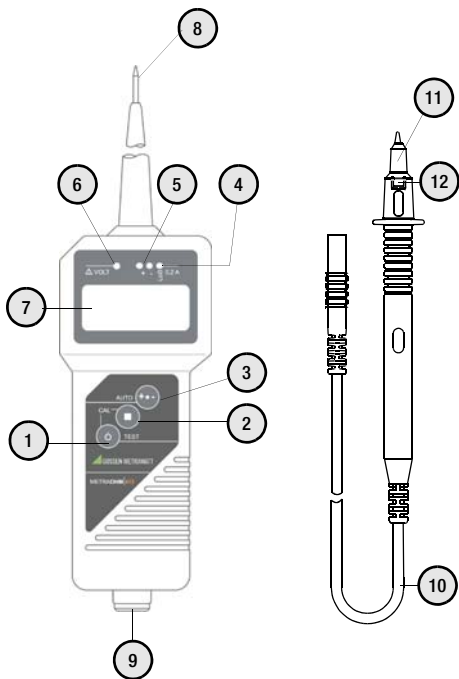


# **METRAOHM | 413**

Low impedance resistance measurement instrument





- 1 – On/Off switch, see chap. 3  
– Auto test, see chap. 3  
– Zero balancing (with key ), see chap. 4.2
- 2 – Zero balancing (with key ), see chap. 4.2  
– Measurement (press and hold key)
- 3 – Polarity reversal, see chap. 4.3.2  
– Query measured values, see chap. 4.3.2  
– Automatic measurement mode, see chap. 4.3.3
- 4 LED for LO- $\Omega$  mode, measuring current 200 mA
- 5 LEDs + / – for polarity indication
- 6 LED VOLT for warning of interference voltage
- 7 Display for measured value and test probe polarity as well as battery test
- 8 Test probe
- 9 Measurement cable connector
- 10 Measurement cable
- 11 Safety cap, see chap. 1 (application)
- 12 Snap lock, see chap. 1 (application)

### Meaning of symbols on the instrument



Warning concerning a point of danger.  
(Attention: observe documentation!)



Indicates EC conformity

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## 1 Application

**METRAOHM | 413** is a low impedance measuring instrument with digital display for the safe testing of cable resistances up to 2000 k $\Omega$  in electric systems with nominal voltages up to 500 V.

It is designed for testing extensive protective conductor systems, earthing systems and potentializing systems as well as shielding and lightning protection systems.

Reliable measuring results are obtained by the 200 mA measuring current and by the automatic acquisition of minimum values.

Resistances between the reference earth (e.g. equipotential bonding strip) and the measuring points are measured by using any desired measurement cable (up to 3.5  $\Omega$ ).

The measurement cable resistance is saved during automatic zero balancing and taken into account for future measurements.

In conformity with standard DIN EN 61010-031, measurements in an environment according to measuring category III may only be performed with the safety cap applied to the test probe of the measurement cable.

For establishing contact in 4 mm jacks you have to remove the safety cap by levering out the snap lock of the safety cap with another sharp object (e.g. the second test probe).

## 2 Safety

You have selected a measuring instrument which provides a high level of safety. It meets the requirements in accordance with EN/IEC 61557-1+4 (VDE 0413 part 1+4) and EN/IEC 61010.

**In order to assure safe and proper use, it is imperative that you read these operating instructions thoroughly and completely before placing your instrument into service.**

All instructions included therein must be followed carefully when using this instrument.




**Please observe the following safety precautions:**

- The measuring instrument may only be used for **power systems** with an operating voltage of **maximum 500 V**.
- Measurements may **only** be taken **at voltage-free system components**.
- Only use plugs which are provided with an insulation against accidental contact (IP 2x with collar) for the socket of **METRAOHM | 413** when you perform measurements on locations where voltage may be present.
- If the switched-on instrument comes into contact with a voltage of at least approx. 15 V, an acoustic as well as an optical warning signal (see chap. 4.3), are generated. In this case, the DUT must be made voltage-free before resistance measurements are performed.


## 3 Initial Start-Up

The measuring instrument is delivered ready for operation with a 9 V battery, IEC 6 LR 61. Before initial start-up, or after a period of storage, observe the instructions in chap. 6.


### Switching On


Press key  briefly (display:  and green +LED). The symbol  signifies that the instrument is ready for measurement.

### Switching Off

Press key  again. The instrument switches off automatically if no key is activated for approx. 20 seconds.

### Auto Test

Keep key  pressed when switching the instrument on.

The instrument is in perfect condition when all segments of the LCD and the 3 LEDs light up, an acoustic signal sounds, symbol  appears after releasing the key and the green LED lights up. If any of the displays fails, if only partly, or if readiness for operation is not indicated during the auto test, the measuring instrument may no longer be used and must be sent in for repair.

If the error message **FUSE Err** is displayed, the

instrument is no longer ready for use and the over-voltage fuse must be replaced by the manufacturer.

## Battery Test

If an empty battery symbol is displayed, the battery must be replaced (siehe chap. 6.1).

## 4 Measuring and Testing

### 4.1 Measurement Set-Up

Any desired measurement cable (up to approx.  $3.5 \Omega$ ), which can be balanced as described in chap. 4.2, can be used between the reference earth (e.g. equipotential bonding strip or system earth) and the **METRAOHM | 413**. By connecting several cables one after the other, measurement points at distances of up to 100 m from the reference earth can be reached! In environments with strong field influences each measurement cable should be completely unwound so as to prevent inductive influences.

- **Drum with 50 m measurement cable** (accessory)  
Directly connect the plug of the drum with the socket of the **METRAOHM | 413**. The drum can thus be placed onto the floor during measurement. Insert the contact-protected plug of the measurement cable with test probe into the socket of the drum. Fix the test probe at the corresponding measuring point.
- **25 m reel** (accessory)  
Directly connect the plug of the reel with the socket of the **METRAOHM | 413**.  
Fix the second plug at the corresponding measuring point.



From time to time the plugs of the reel and the drum must be cleaned.

### 4.2 Zero Balancing

The **METRAOHM | 413** must be balanced together with the entire measurement cable prior to each measuring series (see chap. 4.1). In this process the resistance of the measurement cable as well as contact resistances are stored and compensated for future measurements. Compensation is done automatically for all measuring ranges with  $1 \mu\text{A} \dots 200 \text{ mA}$ .

Manual zero balancing is also required if the same measurement cable is re-used after some time in order to take temperature influences into account.

- Affix the measurement cable to the reference earth and ensure good contact (remove corrosion first if necessary!).
- Plug the measurement cable plug into the socket of the **METRAOHM | 413** (with adapter cable if reel-off drum is used).

- Switch the measuring instrument on. Press and hold key  and press key  in addition. On the display, symbol **CAL** appears and the + and Lo-Ω LEDs light up at the same time. A progress bar appears in the top line.
- Apply the test probe to the reference earth, **ensuring good contact, immediately after activation of zero balancing**. Otherwise **Err** appears on the display and the transaction is stopped.

### Sequence of Electronic Zero Balancing:

- The 7 segments of the progress bar fade out one after the other in line with the progress of the operation, while each faded-out segment is acknowledged by an acoustic signal.
  - Polarity is reversed after half the sequence is completed: the green – LED now lights up instead of the green + LED, **-CAL** appears.
  - The last segment of the progress bar fades out, subsequently **CAL** disappears.
  - **+|** appears and the green + LED lights up: zero balancing is completed.
- You may now release contact.

The measurement cable resistance is saved to memory until a new zero balancing is conducted. This value is preserved even if the measuring instrument is switched off or the battery is replaced.



#### Attention!

If the message „Err“ (Err = Error) appears and the measuring instrument switches off shortly thereafter, zero balancing must be repeated. This error occurs if the test probe slips during balancing, or if the cable is of high impedance (above 3.5 Ω).


- 
- For test purposes we recommend that the first measurement (see chap. 4.3) always be made directly at the reference earth (equipotential bonding strip or system earth) with the test probe at the measurement cable terminal. The result should be less than 0.04 Ω for both polarities.

Wound up cables may cause erroneous measurements due to inductivities.

### 4.3 Measuring

After measurement set-up and zero balancing, the measuring instrument is ready for operation together with the zero-balanced cable (see chap. 4.2). Standard measurements with or without polarity reversal as well as quick measurements can be conducted.

Direction of current flow is indicated in the display as + or –. The displayed sign applies to the test probe on the measuring instrument.


- ⇒ Remove corrosion or paint from the measuring point, if necessary.
- ⇒ Switch on the measuring instrument: Key  **+|** appears and the green + LED lights up.
- ⇒ Apply the measuring probe in as vertical a position as possible, ensuring good contact.



### Attention!

If the red LED blinks and an acoustic warning sounds, an interference voltage is present! The test at the selected measurement point must be interrupted (see chap. 4.3.4). A short warning signal can, on the other hand, be caused by an inductive voltage (e.g. coil not unwound) or by static charges, which have no effect on the measurement.

### 4.3.1 Standard Measurement


- ⇒ Press key  until a constant measured value is displayed.

For measured values below 10  $\Omega$  **METRAOHM | 413** changes automatically into the LO- $\Omega$  mode and measures with a current of 200 mA.


In the display „Lo- $\Omega$ “ appears and the LED at the far right signals a measuring current of 200 mA. If the measured value is out of the measuring range ( $>1999 \text{ k}\Omega$ ) **OL** (Overflow) blinks on the display.

### 4.3.2 Measurement with Polarity Reversal

It is required if galvanic voltages might affect the measuring result.

- ⇒ after completed measurement with positive polarity (see above): Press key  *Indication of readiness for measurement with different polarity: **-|** and green LED -*
- ⇒ Perform the measurement with negative polarity in the same manner.

### Querying the Two Measured Values






- ⇒ Request the stored positive and negative measured value with key  and compare them.

If the values differ substantially from each other, galvanic voltages as from approx. 15 V are probably present.

- ⇒ Repeat both measurements.
- ⇒ If the result is the same, the mean value between + and - is to be assumed.

### 4.3.3 Automatic Measurement

Automatic measurement is only suitable for measurements of resistances  $< 10 \Omega$  and is always performed with a measuring current of 200 mA (test per VDE 0413).

- Activate automatic measurement mode:  
Press and hold key  until **AuTo** (automatic) and **RdY** (Ready) are shown in the display, the two polarity LEDs light up briefly.
- Start automatic measurement:  
Press key  briefly.  
The measurement takes approx. 3 seconds, polarity reversal is done automatically.
- To change between the two resistance values measured with different polarities:  
Press key .  
The measuring results are preserved until a new measurement is performed.
- Press key  briefly in order to perform further measurements.
- Re-activate standard measurement:  
Press and hold key  until **AuTo** disappears from the display. As soon as **RdY** fades out, standard measurements can be performed again.

### Possible errors

No measurement result is indicated.

Causes:                   – slipping of the test probe  
                              – heavily fluctuating impedances

Remedy:                 Repeat the measurement

Even after repeated measurement no clear measurement result is obtained:

Remedy:                 Perform standard measurement with longer measurement durations and both polarities.

### 4.3.4 Recognition of Interference Voltage

Applying voltage to the test probes of the measuring instrument in switched-on condition is signalled as follows:

- The voltage value is displayed on the LCD.
- Red LED **VOLT** blinks, alternately, symbol **-U-** appears on the LCD.
- In the case of alternating voltage, symbol  $\sim$  for AC is also displayed.
- Additionally, an **intermittent acoustic signal** sounds **as a warning signal** between 15 V and 400 V.



#### Note

For voltages below 15 V a value is shown which may considerably differ from the actual voltage applied as this resistance measuring instrument is not designed for voltage measurement.

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If either direct or alternating voltage is present, resistance measurement may not be performed, until the conductor is made voltage-free.



### Attention!

The measuring instrument is protected by semiconductors in the range up to 400 V, and above that by a 500 V fuse. If the fuse should blow, the instrument must be sent to our repair and replacement service for replacement (see chap. 7). The fuse is automatically checked during the instrument's auto testing.

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## 5 Technical Data

Resistance measuring instrument per EN/IEC 61557-1 EN/IEC 61557-4 and EN/IEC 61010

Measuring ranges	0.01 $\Omega$ ... 1999 k $\Omega$
Accuracy	$\pm(1.5\%$ of rdg. + 4 digits) for 20 °C
Measuring current	< 10 $\Omega$ 200 mA constant > 10 $\Omega$ 20 mA ... 1 $\mu$ A
Open-circuit voltage	> 4 V
Digital display	two-line LCD, height: 10 mm, 3½ places, overflow indication by „OL“
Voltage indication	red LED, acoustic warning signal, numerical display
Measuring category	CAT II 600 V, CAT III 300 V
Overvoltage protection	reversible up to 400 V nomi- nal voltage by semiconduc- tors, from 400 to 500 V by special fuse (can only be replaced at the factory)
Operating temperature	-10 ... +50 °C
Power supply	9 V block battery IEC 6 LR 61 AIMn automatic shut-off after 20 s without measurement, multi-stage BAT display
EMC requirement	DIN EN 61326
Housing	Protection IP 65 impact-resistant ABS with unbreakable display window
Dimensions	60 mm x 230 mm x 40 mm
Weight	180 g (including battery)

## 6 Maintenance

### 6.1 Battery

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#### **Attention!**

A depleted battery must be removed from the instrument. If the battery leaks the electrolyte must be completely removed. Dispose of batteries in accordance with environmental regulations!

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The current state of the battery is indicated by the three-stage battery symbol in the display. When the battery is fully charged, all three segments are shown. If the battery symbol is half full, a large number of measurements is still possible. If an empty symbol is shown, the battery voltage is too low for measuring. The battery must be replaced by a new one. Depending on the battery type, you can perform at least 5 more measurements in this condition.

Attention: If the empty battery symbol blinks, the measured values are no longer reliable. The battery must be replaced immediately in this case. The battery is located behind the cover at the rear, which is secured with a screw.

Only 9 V block AlMn batteries, IEC 6 LR 61 should be inserted.

Alternatively, nickel metal hydride storage batteries (NiMH batteries) may be used. Ni-Cd batteries are not recommended as only about 60 measurements can be performed due to the steep discharge curve and no „discharge message“ is given.

### 6.2 Plugs, Sockets and Contacts

Keep them clean and free of corrosion and clean them if necessary.

### 6.3 Housing

No special maintenance is required for the housing. Keep outside surfaces clean. Use a slightly dampened cloth for cleaning. Avoid the use of cleansers, abrasives or solvents.

### 6.4 Storage

For lengthy periods of storage the measuring instrument is to be stored in a dry environment with temperatures between  $-10\text{ °C}$  and  $+70\text{ °C}$ . It is to be kept in a closed covering without battery.

### 6.5 Recalibration

The respective measuring task and the stress to which your measuring instrument is subjected affect the ageing of the components and may result in deviations from the guaranteed accuracy. If high measuring accuracy is required and the instrument is frequently used in field applications, combined with transport stress and great temper-

ature fluctuations, we recommend a relatively short calibration interval of 1 year. If your measuring instrument is mainly used in the laboratory and indoors without being exposed to any major climatic or mechanical stress, a calibration interval of 2-3 years is usually sufficient.

During recalibration\* in an accredited calibration laboratory (DIN EN ISO/IEC 17025) the deviations of your instrument in relation to traceable standards are measured and documented. The deviations determined in the process are used for correction of the readings during subsequent application.

We are pleased to perform DKD or factory calibrations for you in our calibration laboratory. Please visit our website at

[www.gossenmetrawatt.com](http://www.gossenmetrawatt.com) (→ Services → DKD Calibration Center *or* → FAQs → Calibration questions and answers).

By having your measuring instrument calibrated regularly, you fulfill the requirements of a quality management system per DIN EN ISO 9001.

## 6.6 Device Return and Environmentally Compatible Disposal

The **instrument** is a category 9 product (monitoring and control instrument) in accordance with ElektroG (German Electrical and Electronic Device Law). This device is not subject to the RoHS directive.

We identify our electrical and electronic devices (as of August 2005) in accordance with WEEE 2002/96/EG and ElektroG with the symbol shown to the right per DIN EN 50419.



These devices may not be disposed of with the trash. Please contact our service department regarding the return of old devices.

If you use **batteries** or **rechargeable batteries** in your instrument or accessories which no longer function properly, they must be duly disposed of in compliance with the applicable national regulations.

Batteries or rechargeable batteries may contain harmful substances or heavy metal such as lead (Pb), cadmium (Cd) or mercury (Hg).

The symbol shown to the right indicates that batteries or rechargeable batteries may not be disposed of with the trash,



but must be delivered to collection points specially provided for this purpose.

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\* Verification of specifications or adjustment services are not part of the calibration. For products from our factory, however, any necessary adjustment is frequently performed and the observance of the relevant specification is confirmed.

## 7 Repair and Replacement Parts Service Calibration Center\* and Rental Instrument Service

When you need service, please contact:

GMC-I Service GmbH

### Service Center

Thomas-Mann-Straße 20

90471 Nürnberg • Germany

Phone +49 911 817718-0

Telefax +49 911 817718-253

E-Mail [service@gossenmetrawatt.com](mailto:service@gossenmetrawatt.com)

[www.gmci-service.com](http://www.gmci-service.com)

This address is only valid for Germany.  
Please contact our representatives or subsidiaries  
for service in other countries.

\* **DKD** Calibration Laboratory  
for Electrical Quantities DKD-K-19701  
accredited per DIN EN ISO/IEC 17025:2005

Accredited measured quantities: direct voltage,  
direct current values, DC resistance, alternating  
voltage, alternating current values, AC active  
power, AC apparent power, DC power,  
capacitance, frequency and temperature

### Competent Partner

GMC-I Messtechnik GmbH is certified in accordance with DIN EN ISO 9001:2008.

Our DKD calibration laboratory is accredited by the Deutscher Kalibrierdienst (*German Calibration Service*) under registration number DKD-K-19701.

We offer a complete range of expertise in the field of metrology: from **test reports** and **proprietary calibration certificates** right on up to **DKD calibration certificates**.

Our spectrum of offerings is rounded out with free **test equipment management**.

As a full service calibration laboratory, we can calibrate instruments from other manufacturers as well.

## 8 Product Support

When you need service, please contact:

GMC-I Messtechnik GmbH

### Product Support Hotline

Phone +49 911 8602-0

Fax +49 911 8602-709

E-Mail [support@gossenmetrawatt.com](mailto:support@gossenmetrawatt.com)

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• A pdf version is available on the internet