Anton Paar

Measure
what is measurable
and make measurable
that which is not.

Galileo Galilei (1564-1642)

Instruction Manual and Safety Information

MKT 50

Millikelvin Thermometer

instrument software version: from 2.04

(Original Instructions)

Disclaimer

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Further information

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Contents

See the Reference Guide for a comprehensive description of the instrument.
Download Anton Paar documents for free from the Anton Paar website: https://www.anton-paar.com

1 Safety instructions

- Read the documentation before using the instrument.
- Follow all hints and instructions in the documentation to ensure the correct use and safe functioning of the instrument.
- The documentation is a part of the product. Keep it for the complete working life of the product and make it easily accessible for all persons involved with the product. If you receive any additions or revisions to the documentation from Anton Paar GmbH, these must be treated as part of the documentation.

1.1 Liability

- This document does not claim to address all safety issues associated with the use of the instrument and samples. It is your responsibility to establish health and safety practices and to determine the applicability of regulatory limitations.
- Anton Paar GmbH only warrants the proper functioning of the instrument if no modifications are made to mechanics, electronics, or software.
- Use the instrument only for the purpose described in the documentation. Anton Paar GmbH is not liable for damages caused by incorrect use of the instrument.
- The results delivered by the instrument depend not only on the correct functioning of the instrument, but also on various other factors. We therefore recommend that you have the results checked (e.g. plausibility tested) by skilled persons before consequential actions are taken based on the results.

1.2 Installation and use

- The installation procedure shall be carried out only by authorized persons who are familiar with the installation instructions.
- Use only accessories, consumables, or spare parts supplied or approved by Anton Paar GmbH.
- Ensure that all operators have been trained beforehand to use the instrument safely and correctly.
- The instrument is suited for indoor use only.
- In case of damage or malfunction, do not continue operating the instrument. Do not operate the instrument under conditions which could result in damage to goods or injuries or loss of life.

Operation in areas with risk of explosion

- The instrument is **not** explosion-proof and therefore must not be operated in areas with risk of explosion.

General precautions

- Before a measurement, check the wetted parts of the instrument for chemical resistance to the samples and cleaning agents used.

Battery Handling

- If the instrument is not to be used for a longer period, remove the batteries from the battery compartment.
- Leaking or damaged batteries can cause burns if they come into contact with your skin. Use gloves for their handling.
- Never short-circuit or open batteries.
- Do not expose batteries to heat or throw them into fire.
- Do not charge non-rechargeable batteries. There is a risk of explosion.
- Do not insert damaged batteries in the battery compartment. They can cause short circuits and fire.
- Use only 1.5 V AA batteries or 1.2 V AA rechargeable batteries of the same type and charge condition.
- Observe the correct polarity when placing the batteries.

1.3 Service and repairs

- Service and repair procedures may be carried out only by authorized persons or by Anton Paar GmbH.

1.4 Disposal

- Concerning the disposal of the instrument, observe the legal requirements in your country.

1.5 Conventions for safety messages

The following conventions for safety messages are used in this document:

WARNING

Description of risk
Warning indicates a hazardous situation which, if not avoided, **could** result in death or serious injury.

CAUTION

Description of risk
Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Description of risk
Notice indicates a situation which, if not avoided, could result in damage to property.

1.6 Safety signs on the instrument

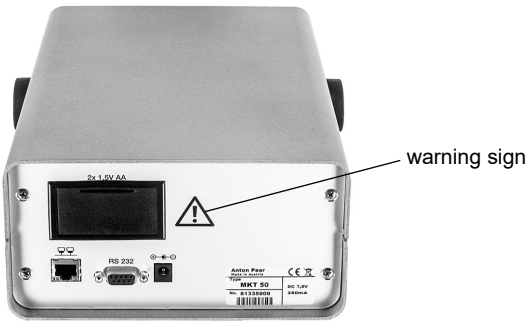

Fig. 1: Warning sign next to the battery compartment (rear of the instrument)

2 MKT 50 – an overview

The Millikelvin Thermometer MKT 50 measures temperatures in °C, K, or °F with exceptional accuracy. Combined with calibrated high-precision platinum resistance thermometers, MKT 50 achieves a reduction of system measurement uncertainties to an absolute minimum of as little as 1 mK (0.001 °C).

Connect the instrument to one or two Pt 100 industrial platinum resistance thermometers. Their temperature is calculated according to EN 60751 (formerly DIN IEC 751).

Pt 25.5 or Pt 100 standard platinum resistance thermometers are also suitable for the use as temperature sensors. The temperature of standard thermometers is calculated according to ITS-90 (International Temperature Scale 1990). Individual calibration parameters for up to 30 different sensors can be stored in the MKT 50. This provides easy recalibration and good traceability of the temperature measurement.

The instrument is operated via a menu-driven user interface. The current value, the mean value, and the standard deviation of 5 up to 50 values can be continuously displayed.

The self-heating effect of the sensor can be determined via the integrated self-heating test.

The instrument features an RS-232 serial interface and an Ethernet terminal. The integrated web server delivers all important data to any given web browser via internet or intranet.

2.1 Functional components

Front

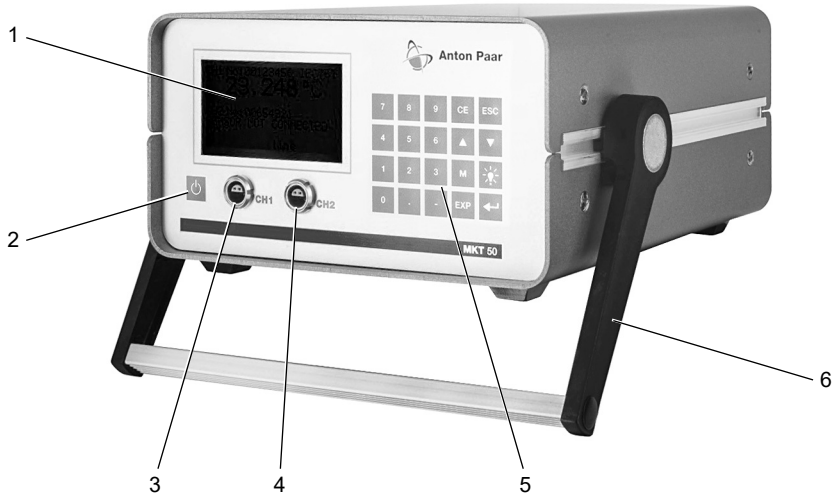

Fig. 2: Front view of the instrument

1 *Display*
2 *<Power on/off> key*
3 *“CH1” (channel 1) connector for sensor*
4 *“CH2” (channel 2) connector for sensor*
5 *Function keys*
6 *Carrying handle*

Rear

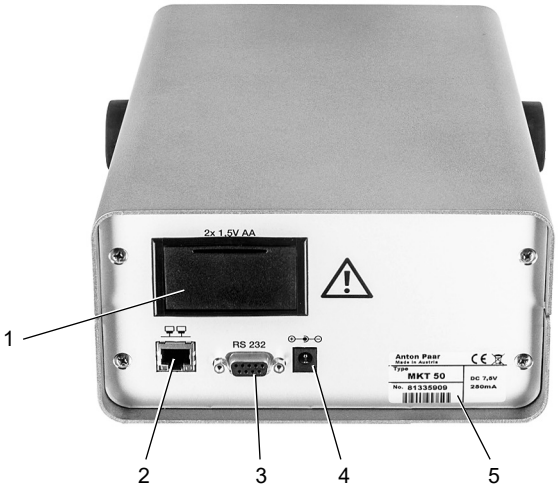

Fig. 3: Rear view of the instrument

1 *Battery compartment for two batteries of type AA*
2 *Ethernet (LAN) terminal (RJ45 connector)*
3 *RS-232 serial port (DE-9F connector)*
4 *Inlet for power adapter*
5 *Type plate with serial number*

3 Putting MKT 50 into operation

TIP: *Check the supplied parts for completeness as described in the Reference Guide.*

1. Check that the calibration numbers on these parts are identical:
   - the calibration certificate,
   - the sensor,
   - the parameter printout (“Configuration Parameters”) if existent.
2. Check that the serial number on the MKT 50 (see 5, fig. 3) matches the number on the optional parameter printout (“Configuration Parameters”).

Contact the manufacturer or supplier of the instrument in the case of any discrepancy.

3.1 AC-powered operation

NOTICE
Use only the supplied power adapter, mat. no. 223140.

1. Connect the supplied power adapter to the instrument’s power inlet (4, fig. 3).
2. Connect the power adapter to the mains supply with the power cable.

   The power adapter provides 7.5 V DC at a maximum of 5.34 A.

   While the instrument is AC-powered, the batteries will not be used.

   When the instrument is AC-powered, the main screen will show “line” in the bottom line.

3.2 Battery-powered operation

NOTICE
- Use only 1.5 V AA batteries or 1.2 V AA rechargeable batteries of the same type and charge condition.
- To charge rechargeable batteries, you have to remove them from the instrument.

The instrument comes with two 1.5 V AA batteries already inserted.

Exchanging the batteries

1. Gently pry the lid of the battery compartment (1, fig. 3) with a screwdriver.
2. Remove the worn-out batteries from the compartment.
3. Insert two new batteries.

NOTICE
Observe the correct polarity when you insert the batteries (see label in the battery compartment).

4. Close the lid of the battery compartment.

Battery charge status

When the instrument is battery-powered, the main screen will show the current battery voltage in the bottom line (e.g. “U: 2.5 V”).

If the voltage sinks below 2.2 V, the main screen shows “batt.”. In this case replace the batteries as soon as possible or operate the instrument AC-powered. Otherwise the instrument will switch itself off within a few minutes.

TIP: *Under typical operating conditions, the supplied alkaline batteries will last approx. 10 hours.*

TIP: *If you use batteries frequently, we recommend the use of rechargeable batteries due to environmental protection considerations.*

TIP: *The use of backlight, an RS-232 connection or an Ethernet connection cut the battery runtime short. When you employ these features, use batteries with a large capacity (> 2000 mAh).*

3.3 Assembling the measuring system

1. Connect the instrument to the mains supply (see section 3.1) or ensure that two batteries are loaded (see section 3.2).
2. If necessary, connect the sensor to the measuring cable (some sensors come with a non-detachable cable).
3. Plug the sensor cable into the “CH1” connector (3, fig. 2).

Fig. 4: MKT 50 with connected sensor

3.4 Switching the instrument on/off

- To switch the instrument **on**, press the <Power on/off> key (2, fig. 2).

  The instrument performs a self-test. If the self-test is completed successfully, you will briefly see a display as in fig. 5.

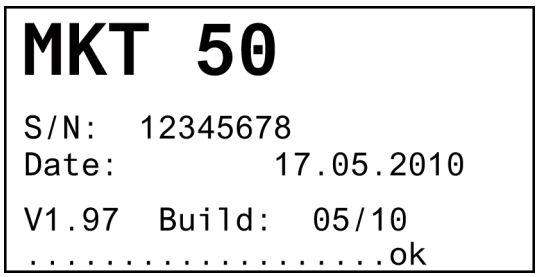

Fig. 5: Example of a display after self-test

  After start-up the instrument is in measuring mode, indicated by a blinking asterisk in the lower left corner of the main screen.

- To switch the instrument **off**, press the <Power on/off> key (2, fig. 2) for 1–2 seconds.

IMPORTANT: *The instrument can only be switched off in measuring mode (when the main screen is shown).*

The instrument displays the message “Power down” and turns itself off.

- If you switch off the instrument with the <Power on/off> key, the current operating status (e.g. averaging over 20 values) will be stored.
- If you interrupt the power supply in any other way (e.g. by pulling the plug), the instrument will turn itself off without storing the current operating status.

3.5 Getting started with pre-stored sensor parameters

If sensor parameters have already been entered and assigned to the sensor channels 1 and 2 ex factory, the instrument will display the current temperature of the sensors.

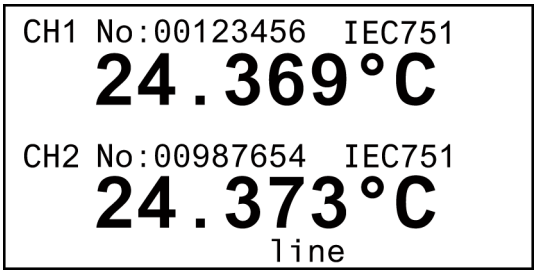

Fig. 6: Example of a measuring display

Before you start measuring with the instrument:

1. Check that the displayed sensor numbers “No” match the respective numbers on the sensor labels.
2. Check that the sensor parameters on the calibration certificate match the settings in the instrument, see section 5.4.1.

3.6 Getting started without stored sensor parameters

If no sensor parameters have been entered yet, the instrument will not display temperatures:

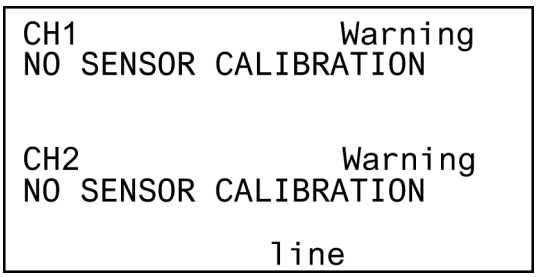

Fig. 7: Display before input and/or selection of sensor parameters

You may either switch to the resistance display mode (see section 5.5), or enter sensor parameters and assign these to sensor channels 1 or 2:

1. Enter the sensor parameters according to the calibration certificate (see section 5.4.1).
2. Assign the sensor parameters to the sensor channel 1 (“CH1”) or 2 (“CH2”) (see section 5.4.2).

   The instrument will then display the current temperature of the sensor as in fig. 6.

4 Operating the instrument

4.1 Keys on the front

0,1,2,3,4,5,6,7,8,9 (numerical keys)	• *In menu mode:* Selects a menu item directly by number. • *In an input field:* To enter a number.
. -	<Decimal point> / <Minus sign> To enter a number.
CE	<Clear> key • *In menu mode:* Deletes the last character entered. • *In measuring mode (if* **statistics display** *has been selected):* Toggles between two displays: - Display current temperature/resistance, mean, and standard deviation. - Display mean in big digits.
ESC	<Escape> key • *In menu mode:* Returns to the next higher menu level / to **measuring mode** (from the main menu). • *In an active input field:* Aborts the input and restores the previous content of the field.
▲ ▼	Arrow keys: <Up> / <Down> • *In menu mode:* Selects the previous/next menu item or input field within one menu. • *In measuring mode (if statistics display has been selected):* Increments/decrements the number N of measurements for the calculation of the average.
M	<Menu> key Switches from measuring mode to **menu mode**.
	<Lamp> key Backlight on/off
EXP	<Exponent> key To enter the exponent of a number.
	<Enter> key • *In menu mode:* Confirms the input. • *In measuring mode (if statistics display has been selected):* Temporarily shows the sensor name.
	<Power on/off> key Switches MKT 50 on or off (in measuring mode only).

4.2 Main screen (measuring mode)

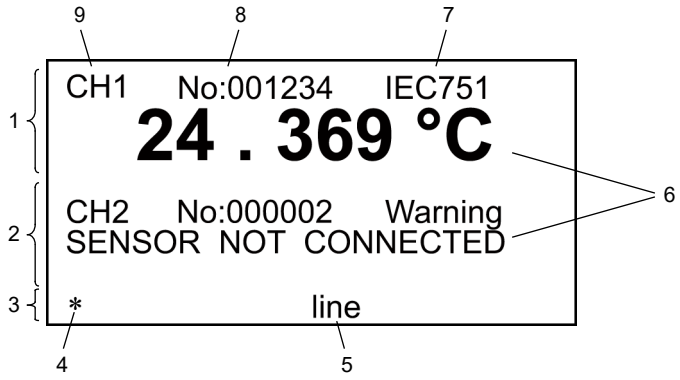

Fig. 8: Example main screen: one sensor connected, AC-powered operation

1 Sensor input 1 (channel 1)
2 Sensor input 2 (channel 2)
3 Instrument status
4 Blinking asterisk indicates "measuring mode"
5 Power supply / battery charge status
6 Temperature display (or error message)
7 Temperature calculation method (or "Warning")
8 Calibration number of sensor
9 Channel number

4.3 Menu navigation / making a selection

MKT 50 always starts in measuring mode (main screen).

Measuring mode <M> ►►► ◄◄◄ <ESC> **Menu mode**

- Press <M> to switch to menu mode.

  You will see the main menu.

```
  MAIN  MENU
➡ 1 Temperature Mode
  2 Resistance Mode
  3 Edit Configuration
  4 Security Options
  5 Self Heat Test:OFF
```

Fig. 9: Main menu

- To switch menus or make a selection:
  - Either enter the digit heading the menu item,
  - or use the arrow keys to navigate within menus and to select an item, then press <Enter>.

  With longer screen content, the symbols for the arrow keys ▲ or ▼ will show beside the menu title. Use the arrow keys to scroll through the content.
- Press <ESC> to return to the next higher menu level.
- Press <ESC> in the main menu to leave menu mode and return to measuring mode.

4.4 Entering numbers

After you have selected an input field and pressed <Enter>:

- Use the numerical keys, <Decimal point>, <Minus sign>, and <EXP> to enter numbers.
- Use <CE> to correct errors.
- Press <Enter> to finish character entry and to confirm the entered number.

5 Configuring the instrument

5.1 Date / time

Set date and time so that you may check the validity of a calibration.

1. Press <M> and select *3 Edit Configuration* > *1 Clock*.
2. Use the arrow keys to change between date and time setting.
   Select the date or time setting by pressing <Enter>.
3. Set the current date in the format “dd.mm.yyyy” (dd=day, mm=month, yyyy=year).
   Set the current time in the format “hh:mm:ss” (hh=hours, mm=minutes, ss=seconds).
   To change from day to month to year, or to change from hours to minutes to seconds, press <Enter>.
4. Press <ESC> and confirm with “1 YES” to store your settings.

5.2 Display backlight and contrast

Set the backlight to be automatically activated (“ON”) or deactivated (“OFF”) when the instrument is switched on.

During operation, you can use the <Lamp> key to activate or deactivate the backlight as needed.

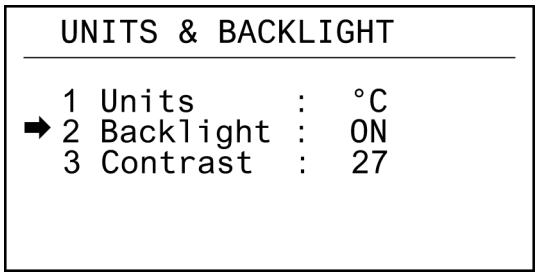

Fig. 10: Setting backlight and contrast of the display

1. Press <M> and select *3 Edit Configuration* > *6 Units & Backlight*.
2. Set “2 Backlight” to “ON” or “OFF” by pressing <Enter>.
3. To set the display contrast, select “3 Contrast”.
   Pressing <Enter> once, increments the contrast level by 1 step until you have reached maximum contrast (41), then it will switch the contrast level back to minimum contrast (20).
4. Press <ESC> and confirm with “1 YES” to store your settings.

5.3 Temperature units for display

1. Press <M> and select *3 Edit Configuration* > *6 Units & Backlight*.
2. Set “1 Units” to one of three temperature units by pressing <Enter>:
   - Celsius (°C)
   - Kelvin (K)
   - Fahrenheit (°F)

5.4 Sensor parameters and channels

The instrument measures the electrical resistance of the connected platinum sensors and calculates from it the temperature via internal formulas (in the most simple case, a quadratic equation).

The coefficients for these formulas are different for each sensor, they are called sensor parameters (or calibration parameters). Find these parameters in your calibration certificate.

The instrument can hold calibration parameters for up to 30 sensors.

IMPORTANT: *When you perform a precise temperature measurement, use calibrated sensors only.*

5.4.1 Entering or changing calibration parameters for a sensor

For each sensor that you connect to the instrument, you have to enter the calibration parameters according to the calibration certificate in order to be able to measure temperatures.

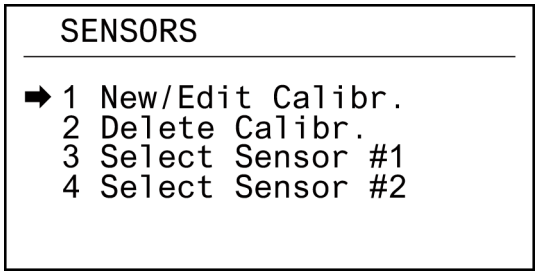

Fig. 11: Entering, deleting, and assigning calibration parameters

IMPORTANT: *Make sure that you are using the correct calibration parameters for your sensors since incorrect calibration parameters lead to erroneous results.*

1. Before you enter the calibration parameters, make sure that the date stored in the instrument is correct (see section 5.1).

   The date will be stored with the calibration parameters.

2. Press <M> and select *3 Edit Configuration* > *3 Sensors*.

   When prompted for your user password, enter it.

3. Select “1 New/Edit Calibr”.

   A list of stored sensor parameters for up to 30 sensors is shown. Initially all 30 sensor positions show “-------- Free”.

   In the example in fig. 12 sensor parameters for several sensors have already been stored. The sensor numbered “00000001” has been assigned to channel 1, and the sensor numbered “00125607” to channel 2. Sensor position 3 is free.

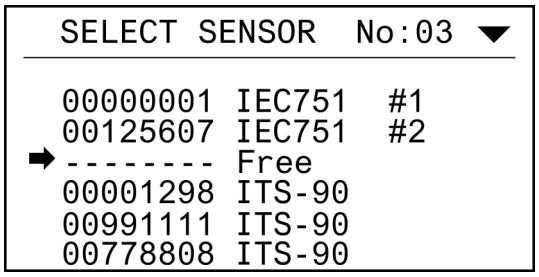

Fig. 12: Example list of stored sensor parameters

4. Select the first free sensor position (showing “-------- Free”), then press <Enter>.

   If all sensor positions are occupied, you will have to overwrite an existing sensor position.

5. Select the appropriate temperature calculation method and/or the temperature range (see the Reference Guide).

   If the norm is not specified on the calibration certificate, you can use the calibration parameters on the calibration certificate for differentiation. With EN 60751 the parameter R0 will always be used, whereas with ITS-90 the parameter R.01 [0.01 °C] will be specified.

   - For industry sensors, e.g. the MPMI sensors in Anton Paar’s MKT 50 sensor catalog, select “**DIN IEC 751**”.
   - For standard thermometers, select one of the 11 ranges of “**ITS-90**” or one of the two “auto-switch ranges” (see the Reference Guide).
   - For measurements between –40 °C and 600 °C (with medium to high requirements on uncertainty), standard polynomials are well suited (according to DAkkS guideline DAkkS-DKD-R 5-6[1], chapter 3). MKT 50 provides a polynomial of 4th order that can be used to approximate temperature sensors.

     Polynomial of 4th order:
     $R_t = R_0 \cdot (1 + A \cdot t + B \cdot t^2 + C \cdot t^3 + D \cdot t^4)$

6. Enter the calibration number “**Cal.No.**” written on the sensor and in the calibration certificate.

   If you have purchased the sensor with a calibration certificate, e.g. a DAkkS certificate (DAkkS: Deutsche Akkreditierungsstelle / German accreditation body) together with the MKT 50, you will find a calibration label on the LEMO socket of the sensor:

1234	current calibration number
D-K-15219-01-00	registration number of the accredited body / calibration office
2017-07	date of calibration (YYYY-MM)

   All specifications on the calibration label are also included in the corresponding calibration certificate.

   Each calibration service provides differently designed calibration labels, but all of them should at least include a calibration number and a date.

7. Enter a calibration time “**Cal.Time**” according to your experience and accuracy requirements.

   The calibration time “Cal.Time” counts the days until a re-calibration is due.

   A negative value for “Cal.Time” indicates for how many days a re-calibration has been overdue.

   When you use a sensor with expired calibration, the message “SENSOR CAL TIME” will be shown on the main screen next to the channel in question, and no temperature will be displayed anymore.

   - In this case check the sensor either at a fixed point or by comparison calibration with a reference thermometer.

IMPORTANT: *The calibration time depends mainly on the thermal stress on the platinum thermometer. It can only be estimated, and ultimately you will have to decide on it. Therefore, check your sensors and the instrument at the triple point or freezing point of water on a regular basis (independent of the calibra-*

1 *Bestimmung von Thermometerkennlinien [Determination of Thermometer Characteristics], Richtlinie DAkkS-DKD-R 5-6, 2010*

tion time) and also after major thermal stress. We recommend to perform a re-calibration at least once a year.

8. *If you have selected "DIN IEC 751":*
   Set the calibration temperature range (e.g. –50 °C to 200 °C, 0 °C to 420 °C, etc.) with the fields "**Cal.Low**" and "**Cal.High**".
9. Set the maximum sensor temperature in the field "**Max.Temp.**".

   If the sensor producer has not specified the maximum temperature, set it to a value approx. 5 °C above the upper limit of the calibration temperature range ("Cal.High").

   Do not choose a value below the upper limit of the calibration temperature range ("Cal.High"), or else the maximum temperature limit will not be monitored.

NOTICE
Exceeding the permissible operating temperature range can cause an irreversible change in sensor behavior and may require a new calibration.

10. Enter the **calibration parameters** (R0 / R.01 [0.01 °C], A, B, C, C1,... C5) according to the calibration certificate by overwriting the default values.

    Any ITS-90 parameter that does not have a corresponding coefficient on the calibration certificate must be set to 0.

    The number of parameters depends on the temperature range and the selected temperature calculation method.

    If you have selected "DIN IEC 751", the constant C is only used for temperatures below 0 °C. You can either set "C" to 0 or use the default value.
11. After you are done with your input, press <ESC> and save the new values.

Example of a Pt 100 sensor

Calibration number: 00000001
Temperature calculation method: EN 60751
Validity of the calibration: 180 days
Calibration temperature range: 0–200 °C
Maximum sensor temperature: 250 °C
R0 = 100.017
A = 0.0039126
B = –5.9153E–7

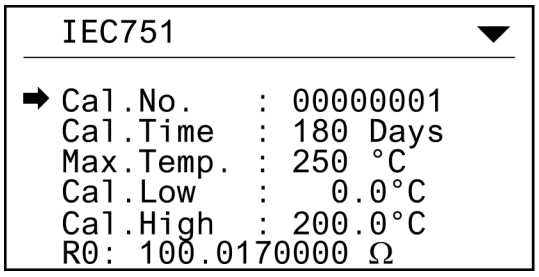

Fig. 13: Display after the example sensor parameters have been entered

After the maximum sensor temperature has been exceeded

1. Press <M> and select *3 Edit Configuration* > *3 Sensors* > *1 New/Edit Calibr*.

   The calibration of an "overheated" sensor is marked by "Max.Temp" in the field "Cal.Time".

   No temperature will be displayed when this calibration is assigned to a sensor channel, instead the message "Max Temp. exceeded" will be shown.

   - In order to use this calibration again, enter a positive number for calibration time.
2. Before continuing your work, check the sensor at least at the triple point or freezing point of water.

   You may only continue to use the calibration parameters if the deviation from the reference is within the permissible range.

   In most cases a new sensor calibration will be necessary, which means that you are provided new calibration parameters.

5.4.2 Assigning sensor parameters to a sensor channel

1. Press <M> and select *3 Edit Configuration* > *3 Sensors*.
2. Select
   - "3 Select Sensor #1" or
   - "4 Select Sensor #2".

TIP: *If you select the item "NO SENSOR Calibr." (first line of the list, sensor position 00) instead of a valid sensor calibration, only resistance values can be displayed for the sensor channel; you will not get temperatures displayed.*

5.5 Display type

Table 1: Display types of MKT 50

Display mode	*Display type*	*Description*
Temperature Mode	**Temperature**	Displays the temperature (with 3 digits after the decimal point).
	Temperature Stat. (statistics display)	Displays the current temperature (with 4 digits after the decimal point) as well as mean temperature and standard deviation of the moving average over N previous values (each with 5 digits after the decimal point). *Recommended for high-precision temperature measurements*
	T1–T2	Displays the temperature difference between sensor channels 1 and 2.
Resistance Mode	**Resistance**	Displays the ohmic resistance (with 4 digits after the decimal point).
	Resistance Stat. (statistics display)	Displays the current resistance as well as mean resistance and standard deviation of the moving average over N previous values (each with 5 digits after the decimal point). *Recommended for high-precision resistance measurements*
	R1/RR, R2/RR	Displays the ratios of the sensor resistances to the internal reference resistance (in large digits).
	R1/R2, R2/R1	Displays the ratios of the two sensor resistances (in large digits).

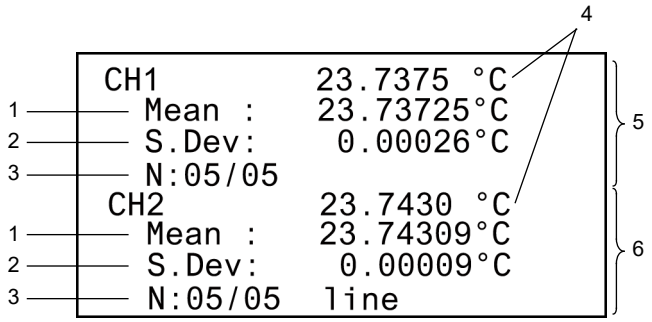

Fig. 14: Example display of temperature statistics (resistance statistics analogical)

1 Mean of the moving average over N previous values
2 Standard deviation of the moving average over N previous values
3 Number of measurements performed/set for the calculation of the average
4 Current measuring value
5 Sensor input 1 (channel 1)
6 Sensor input 2 (channel 2)

1. Press <M> and select the display mode (see table 1):
   - “1 Temperature Mode” or
   - “2 Resistance Mode”
2. Select the display type (see table 1).

   After the selection of a display type, the instrument automatically returns to measuring mode.
3. *If you have selected a statistics display type:*

   On the main screen press the <Up> and <Down> arrow keys at any time to set the number N of measurements used for the calculation of the average.

   N can be set between 5 and 50 in steps of 5.

   The currently set number N is shown below the statistical parameters, see example in fig. 14.

   After each change of N, it takes N×1.44 seconds until new statistical parameters are displayed.

Calculation of the statistical parameters

Mean:

$$\text{Mean} = Y_{mean} = \frac{1}{N} \times \sum_{i=1}^{N} Y_i$$

Empirical standard deviation:

$$\text{S.Dev} = \sqrt{\frac{1}{(N-1)} \times \sum_{i=1}^{N} (Y_i - Y_{mean})^2}$$

In both formulas, variable Y designates the measured quantity “temperature” or “resistance”.

TIP: *The standard deviation is a measure of the short-term stability of the measuring values and should be lower than the expected measurement uncertainty.*

5.6 Securing your settings

5.6.1 User password

The user password restricts the access to the menus *Edit Configuration* and *Lock/Unlock Device*. You will also have to specify the user password before you can change it.

TIP: *The instrument comes without a password set. We recommend setting a user password as soon as possible.*

TIP: *Use the lock password (see section 5.6.2) to restrict the access to the instrument via the RS-232 interface.*

IMPORTANT: *If you have forgotten your user password, contact your Anton Paar representative.*

- To prevent unauthorized access to the menus, change into measuring mode before you leave the instrument, or switch the instrument off.

Setting a user password

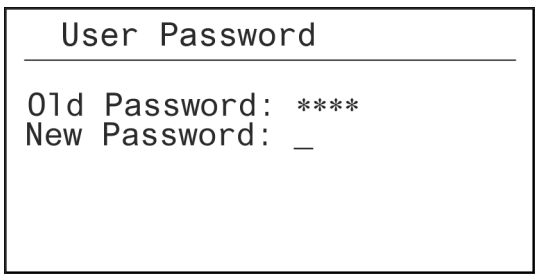

Fig. 15: Setting or changing the user password

1. Press <M> and select *4 Security Options* > *1 Edit User Password*.
2. Enter the old user password (“Old Password”), then press <Enter> to confirm.

   When you are setting a user password for the first time, enter the factory default “0000”.
3. Enter a new user password (“New Password”), then press <Enter> to confirm.
4. To save the new user password, answer the question “Save changes?” with “1 YES”.

5.6.2 Lock password

With the lock password, a second password besides the user password, you can lock parts of the menu so that the settings relevant for temperature measurement can no longer be manipulated. In this way, for example, standards bureau officers can lock the instrument for temperature measurements requiring official calibration.

After a lock password has been set, the menu items 1 to 3 in the submenu *3 Edit Configuration* are locked. Date and time, reference resistor parameters, and sensor parameters can no longer be altered, although they can still be viewed.

The lock password also prevents manipulation of these parameters via the RS-232 interface, notably you cannot assign new calibration parameters to a sensor channel.

IMPORTANT: *If you have forgotten the lock password, contact your Anton Paar representative. They are able to unlock the instrument. Afterwards you need to define a new lock password.*

Setting a lock password

1. Press <M> and select *4 Security Options* > *2 Lock Device*.
2. Enter a lock password.

   The instrument is locked now. Menu item 2 in submenu *4 Security Options* changes to *2 Unlock Device*.

To unlock the instrument

1. Press <M> and select *4 Security Options* > *2 Unock Device*.
2. Enter the lock password.

   The instrument is unlocked now. Menu item 2 in submenu *4 Security Options* changes back to *2 Lock Device*.

6 Upkeep and cleaning

Handling instrument and sensors

NOTICE
Connect only separated extra low voltage circuits (SELV according to EN 60950) to the instrument.

- Avoid exposing the instrument to direct sunlight and large temperature changes.
- After a large change of the ambient temperature the instrument requires some time to adjust to the ambient conditions.
- The instrument is designed for operation under typical laboratory conditions. Air humidity must not be condensing.
- Treat the sensor according to specifications of the manufacturer and the instructions coming with the sensor.
- Treat the sensor and its cable with utmost care.

NOTICE
Damage to temperature sensors and cables may affect the accuracy of the temperature measurement. Mechanical stress or humidity alter the properties of the sensor.
- Protect the sensor against thermal and mechanical shocks or stress as well as quick temperature changes. Otherwise the calibration may shift, or the sensor may be destroyed.
- Do not bend the sensor as this will break it.
- Do not bend, pinch, or stretch the cable. Do not pull at the cable.

- Use only shielded cables for connecting the sensors.
- Keep an appropriate term for repeating the calibration of the reference resistor and sensors used. Re-calibrate the MKT 50 and sensors at least once a year.
- In the following cases perform an instrument self-test (turn off the instrument for at least 3–4 seconds) and check the set parameters (RR, sensor calibration, user password):
  - before large measuring cycles,
  - after extraordinary operating conditions,
  - after service work on the instrument.

Calibration and adjustment on a regular basis

The instrument uses an internal reference resistor for measuring the electrical resistance of the sensor. For the calculation of an accurate temperature from the measured electrical resistance, it is necessary to regularly calibrate/adjust the instrument and the sensors used.

- Send the instrument to Anton Paar or to an official calibration service once a year for calibration/adjustment. For further information contact your local Anton Paar representative.
- In case you have the capacities to perform a calibration yourself, find details in the Reference Guide.

Cleaning housing and display

1. Clean the instrument housing and the display with a soft tissue and (warm) water.
2. Dry with a soft and dry tissue.

7 Maintenance and repair

7.1 Maintenance performed by an authorized Anton Paar service engineer

The instrument requires no periodical maintenance. However, optional services are available from your local Anton Paar representative upon request.

Following parts are generally excluded from the warranty (wear and tear parts)

- cables
- fuses
- batteries

All parts damaged in consequence of a fall of the instrument are generally excluded from the warranty as well.

7.2 Repair performed by an authorized Anton Paar representative

In case your instrument needs repair, contact your local Anton Paar representative, who will take care of the necessary steps. If your instrument needs to be returned, request an RMA (Return Material Authorization Number). It must not be sent without the RMA and the filled “Safety Declaration for Instrument Repairs”. Please make sure it is cleaned before return.

TIP: *Contact your local Anton Paar representative from the Anton Paar website under “Contact” (https://www.anton-paar.com).*

IMPORTANT: *You must not return instruments that are contaminated by radioactive materials, infectious agents, or other harmful substances that cause health hazards.*

Appendix A: Technical data

The following specifications apply to an ambient temperature of +23 °C.
Find all terms explained in “Grundlagen der Messtechnik” (“Fundamentals of metrology”), DIN 1319.

A.1: Specifications: MKT 50 as a high-precision resistance meter

Internal reference resistance	approx. 400 Ω
Measuring range	approx. 0 Ω to 440 Ω
Resolution	40 µΩ (0.1 ppm full scale)
Linearity error	< 0.4 mΩ (< 1 ppm full scale)
Measuring uncertainty[a] (confidence level: 95 %, number of measuring values: 50)	< 0.4 mΩ

a This value does not include the calibration uncertainty of the reference resistor used.

A.2: Specifications: MKT 50 as a high-precision thermometer (specifications without sensor)

Measuring range (depending on sensor)	–200 °C to 850 °C (as specified in EN 60751)
Resolution	0.1 mK (Pt 100)
Linearity error	< 1 mK (Pt 100) (< 1 ppm full scale)
Measuring uncertainty[a] (confidence level: 95 %, number of measuring values: 50)	< 1 mK (Pt 100)
Sensor	Platinum sensor up to a resistance of 440 Ω

a This value does not include the calibration uncertainty of the reference resistor used.

A.3: Instrument data and operating conditions

Internal reference resistor	
Producer, type	VISHAY, VHP 101 (400 Ω)
Temperature coefficient	< 0.3 ppm/°C (+15 °C to +25 °C)
Stability without strain (producer information)	±2 ppm max. dR after at least 10 years
Measuring current I_{DC}	0.5 mA
Measuring current I_{eff}	Normal operation: 0.41 mA During self-heating test: 0.29 mA (0.41/√2 = 0.29)
Self-heating test on	Measuring current/√2
Measuring time (complete, for both channels)	1.44 seconds
Warm-up time	60 minutes
Sensor connections	2 LEMO sockets, type 1S.304, 4-pin
Sensor input (channels)	2
Data output	• LAN/Ethernet (RJ45 connector) • RS-232 (DE-9F 9-pin D-sub socket) • optionally via USB (with a USB–RS-232 converter)
Display	Liquid crystal display, graphic, with LED backlight, 128×64 dots (approx. 65 mm × 35 mm)
Keyboard	20 keys
Dimensions (L × W ×H) (without handle)	240 mm × 190 mm × 110 mm (9.4 in × 7.5 in × 4.3 in)
Weight	approx. 2 kg (4.4 lbs)
Power supply	2 × AA batteries / rechargeable batteries 1.2–1.5 V *or* Power adapter: input 100–240 VAC 50/60 Hz 1.0–0.5 A voltage fluctuation ±10 % output 7.5 VDC 5.34 A 40 W max.
Environmental conditions (EN 61010)	indoor use only no direct exposure to sunlight
Ambient operating temperature	0 °C to 35 °C (32 °F to 95 °F)
Air humidity	< 90 % relative humidity, non-condensing
Altitude	max. 3000 m (9800 ft)
Pollution degree	2
Overvoltage category	II

Appendix B: Declarations of conformity

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EU Declaration of Conformity

(original)

Anton Paar

The Manufacturer **Anton Paar GmbH,** Anton-Paar-Str. 20, 8054 Graz, Austria – Europe hereby declares that the product listed below

Product designation:	**MKT 50 MILLIKELVIN-THERMOMETER**
Model:	**MKT 50**
Material number:	26878

is in conformity with the relevant European Union harmonisation legislation. This declaration of conformity is issued under the sole responsibility of the manufacturer.

Low Voltage Directive (2014/35/EU, OJ L 96/357 of 29.3.2014)

Applied harmonised standard:

- EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019

Electromagnetic Compatibility (2014/30/EU, OJ L 96/79 of 29.3.2014)

Applied harmonised standard:

- EN 61326-1:2013

RoHS Directive (2011/65/EU, OJ L 174/88 of 1.7.2011)

Place and date of issue: Graz, 11.06.2024

DocuSigned by:
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DI Steffen Riemer, MBA
Executive Director
Business Unit Measurement

DocuSigned by:
66833374CFAF464...

DI Dr. Wolfgang Baumgartner
Head of Lab Density & Concentration
Business Unit Measurement

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UK Declaration of Conformity

Anton Paar

The Manufacturer **Anton Paar GmbH,** Anton-Paar-Str. 20, A-8054 Graz, Austria – Europe hereby declares that the product listed below

Product designation:	**MKT 50 Millikelvin-Thermometer**
Model:	**MKT 50**
Material number:	26878

is in conformity with all the relevant UK legislation

Electrical Equipment (Safety) Regulations 2016, 2016 No. 1101

Electromagnetic Compatibility Regulations 2016, 2016 No. 1091

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012, 2012 No. 3032

complies with the designated standards:

- EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019
- EN 61326-1:2013

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Importer: Anton Paar Ltd, Unit F, The Courtyard, Hatfield Rd, St Albans AL4 0LA, United Kingdom;

Place and date of issue: Graz, 2024-06-11

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