testo 480 · Climate measuring instrument

Instruction manual

1 Contents

2 Safety and the environment

2.1. About this document

Symbols and writing standards

Representation	Explanation
⚠	Warning advice, risk level according to the signal word: **Warning!** Serious physical injury may occur. **Caution!** Slight physical injury or damage to the equipment may occur. > Implement the specified precautionary measures.
🛈	Note: Basic or further information.
1. ... 2. ...	Action: more steps, the sequence must be followed.
> ...	Action: a step or an optional step.
- ...	Result of an action.
Menu	Elements of the instrument, the instrument display or the program interface.
[OK]	Control keys of the instrument or buttons of the program interface.
... | ...	Functions/paths within a menu.
"..."	Example entries

Warnings

Always pay attention to information that is marked by the following warnings with warning pictograms. Implement the specified precautionary measures.

Representation	Explanation
NOTICE	indicates circumstances that may lead to damage to the products
⚠ **CAUTION**	indicates potential minor injuries

2.2.　　Ensure safety

> Only operate the product properly, for its intended purpose and within the parameters specified in the technical data. Do not use any force.

> The objects to be measured or the measurement environment may also pose risks: Note the safety regulations valid in your area when performing the measurements.

> Do not perform contact measurements on non-insulated, live parts.

> Do not store the product together with solvents. Do not use any desiccants.

> Carry out only the maintenance and repair work on this instrument that is described in the documentation. Follow the prescribed steps exactly. Use only original spare parts from Testo.

> Temperatures given on probes relate only to the measuring range of the sensors. Do not expose handles and feed lines to temperatures in excess of 40 °C (104 °F), unless they are expressly permitted for higher temperatures.

> After the final measurement, allow probes and probe shafts to cool down sufficiently in order to avoid burns from the hot sensor tip or the probe shaft.

> Improper use of rechargeable batteries can lead to destruction or injuries by means of current surges, fire or escaping chemicals. The following instructions must be observed to avoid such hazards:
>   • Only use in accordance with the directions in the instruction manual.
>   • Do not short, take apart or modify.
>   • Do not expose to heavy impacts, water, fire or temperatures above 60 °C.
>   • Do not store in the proximity of metal objects.
>   • Do not use leaky or damaged rechargeable batteries. In the event of contact with battery acid: Thoroughly wash affected area with water and consult a doctor, if necessary.

- Only charge in the instrument or the recommended charging station.
- Immediately stop the charging process if this is not completed in the given time.
- In the event of improper function or signs of overheating, immediately remove the rechargeable battery from the measuring instrument/charging station. Caution: Rechargeable battery may be hot!

Use

> Please read this documentation through carefully and familiarize yourself with the product before putting it to use. Pay particular attention to the safety instructions and warning advice in order to prevent injuries and damage to the products.

> Keep this document to hand so that you can refer to it when necessary.

> Hand this documentation on to any subsequent users of the product.

2.3. Protecting the environment

> Dispose of faulty rechargeable batteries/spent batteries in accordance with the valid legal specifications.

> At the end of its useful life, send the product to the separate collection for electric and electronic devices (observe local regulations) or return the product to Testo for disposal.

3 Specifications

3.1. Use

The testo 480 is a measuring instrument for measuring climate-related parameters. The testo 480 is ideal for comfort level measurements for the workplace evaluation and flow measurements in and at ventilation and air-conditioning systems.

The instrument is only to be used by qualified expert personnel. Then product must not be used in explosive environments!

3.2. Technical data

Hand-held instrument

Feature	Values
Measurement parameters	• Temperature (°C, °F, difference-°C, difference-°F) • Humidity (%RH, td°C, td°F, wet bulb °C, wet bulb °F, g/m^3, g/ft^3, g/kg, g/lb, kJ/kg, BTU/lb, ppm, Vol%) • Flow velocity (m/s, ft/m) • Pressure (Pa, hPa, mbar, kPa, bar, psi, inH_2O, inHg, mmH_2O, Torr) • CO_2 (ppm, Vol%) • Lux (Lux, footcandle)
Sensor connections	• 2x temperature (TC type K) • 1x differential pressure • 3x digital probes (flow, humidity, temperature, CO_2, Lux, absolute pressure)
Interfaces	• Mini USB • Infrared for testo report printer • SD card • Mains connection
Internal memory capacity	1.8 GB (approx. 60,000,000 measuring values)
Rechargeable battery life	Approx. 17 h (hand instrument without probe with 50% display brightness)

Feature	Values
Measuring cycle	0.5 s
Operating temperature	0 to +40 °C
Storage temperature	-20 to +60 °C
Dimensions	81 mm x 235 mm x 39 mm
Housing material	ABS, TPE, PMMA
Weight	Approx. 435 g
IP protection class	30 (with connected probes)

Integrated measurement (at 22 °C, ±1 digit)

Feature	Values
Temperature (TC type K; internal reference point measurement: measuring range 0 to +40 °C, accuracy ±0.5 °C)	Measuring range: -200.0 to +1370.0 °C Accuracy: ±(0.3 °C + 0.1 % of meas. val.) Resolution: 0.1 °C
	i The accuracy information applies in a similar, stable temperature state. Plugging in the main unit, charging the battery or adding digital probes can distort this temporarily, and additional errors may occur.
Differential pressure	Measuring range: -25 to +25 hPa Accuracy[1]: ±(0,3 Pa + 1% of meas. val.) Resolution: 0.001 hPa
	i The accuracy specification applies immediately after zeroing of the sensor. For long-term measurements, mains operation with fully-charged battery is recommended. Temperature coefficient: <0.01% FS/K typical

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[1] Source: DIN EN ISO 7726

Feature	Values
Absolute pressure	Measuring range: +700 to +1100 hPa Accuracy: ±3 hPa Resolution: 0.1 hPa

Standards, tests, warranty

Feature	Values
EU Directive	2004/108/EC
Vibration	IEC 60068-2-6
Warranty	2 years, warranty conditions: see www.testo.com/warranty

Mains unit (0554 8808) for continuous measurements and battery charging

Feature	Values
Output voltage	5 V / 4 A
EU Directive	2004/108/EC
Warranty period	2 years, warranty conditions: see www.testo.com/warranty

**Lithium battery**

Feature	Values
Charging option	In instrument
Charging current	Max. 2.5 A per battery
Discharge current	Max. 1.5 A per battery
Charge time	Approx. 8 h
Battery life	Approx. 17 h (hand instrument without probe with 50% display brightness)
Ambient temperature	0 – 40 °C / 32 – 104 °F
Long-term storage temperature	<23 °C / <73 °F
EU Directive	2004/108/EC
Warranty period	2 years, warranty conditions: see www.testo.com/warranty

4 Product description

4.1. Overview

4.1.1. Hand instrument
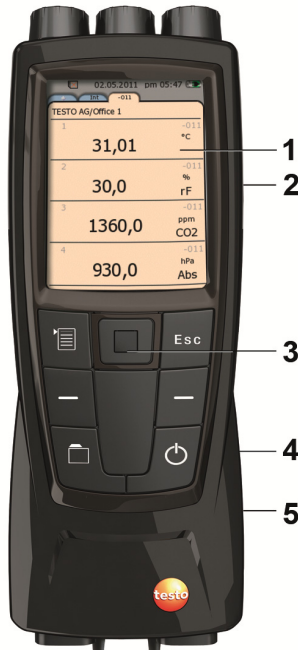
1 Display
2 Mini USB interface (right-hand side of instrument)
3 Control buttons and trackpad (navigation field)
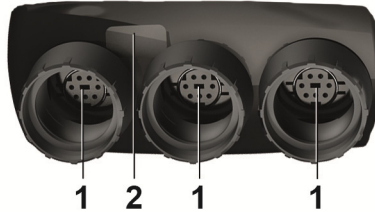4 SD card slot (right-hand side of instrument)
5 Magnetic holder (on back)

> ⚠ **CAUTION**
>
> **Damage to other equipment caused by strong magnets!**
>
> **>** Keep well away from products that could be damaged by the effects of magnetism (e.g. pacemakers, monitors, computers or credit cards).

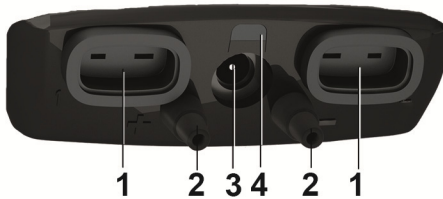## 4.1.2. Instrument connections and interfaces

Top

1   Probe sockets for digital probes
2   IR interface for printouts with testo report printer (art. no. 0554 0549)

> **⚠ CAUTION**
>
> **Risk of injury from infrared beam!**
> >   Do not direct infrared beam at human eyes!

Bottom

1   TC connection for temperature probe type K
2   Connections for differential pressure (+/- sign on the instrument)
3   Mains socket
4   Status LED, mains socket

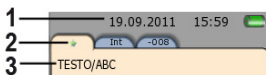| Status	Explanation
LED off	Rechargeable battery is not charging
LED on, lights up	Rechargeable battery is charging

Status	Explanation
LED on, flashes slowly	Rechargeable battery is not charging, instrument/battery temperature too high
LED on, flashes quickly	Rechargeable battery is not charging, battery faulty

4.1.3.   Controls

Button	Functions
[⏻]	Switch measuring instrument on / off
[▢]	The following symbols are used to operate the trackpad. see Navigating in the menu, page **19**. Move your finger on the trackpad to scroll up or down on the screen. **[▯▮▯]** Move your finger smoothly over the trackpad from top to bottom: scrolls down. Move your finger smoothly over the trackpad from bottom to top: scrolls up. **[▬]** Move your finger smoothly over the trackpad from left to right: scrolls right. Move your finger smoothly over the trackpad from right to left: scrolls left. **[▪]** Briefly touch the trackpad with your finger to confirm the selection. When confirming, you should notice a click similarly to pressing a button.
[Esc]	Back, cancel function
[▤]	Open main menu, save settings
[–]	Configurable button for quick access to a frequently used function. The button is not preassigned at the factory. Configure button, see Performing settings, page **22**.
[▰]	Explorer is opened, see Explorer menu, page **27**.

4.1.4. Display

Status line and tabs

1 Status bar (dark grey background):

| Icon	Explanation
〡×〡	There is no SD card in the instrument
〡	Printing
05.05.2011 am 09:08	Date and time
〡	Battery operation
	Indication of remaining capacity of the rech. batt. by the colour and fill level of the battery symbol (green = 5-100%, red = < 5%)
〡	Mains operation
	Indication of remaining capacity of rech. batt: see above

2 Tabs:

Tab name	Explanation
♥ (Favourites tab)	The Favourites tab is the actual work area for the instrument see Favourites tab, page **25**.
	Here, measurement values of various probes can be combined into one measurement, and measuring programs can be run, saved and printed.
Int	Measurement values of the internal sensors and connected TC probes are displayed.

Tab name	Explanation
-881 (Example; the last three digits of the serial number of the probe are displayed. The full serial number of the probe is shown on a label on the probe.)	An additional tab is displayed for each connected probe with the measurement values of the probe and the calculated parameters. The tabs are displayed in the order in which the probes were connected to the instrument.

3   Info field of register tabs: display of the selected measuring location/measuring point. The displayed measuring point can be selected in Explorer, see Explorer menu, page **27**.

Measuring view
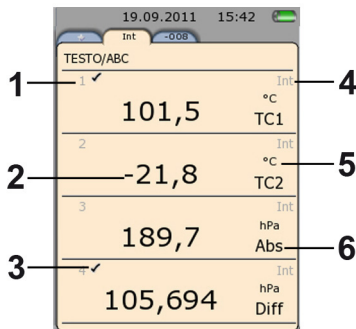
1   Line number
2   Measurement value
3   Indication that the measurement value is also displayed in the Favourites tab.
4   Probe designation
5   Unit
6   Measurement parameter

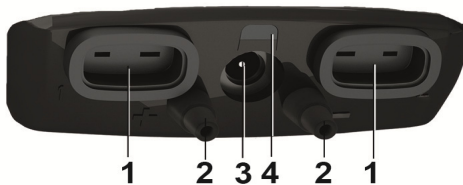The measuring view can be changed individually for each tab, see Setting the measurement display, page **23**.

5   First steps

5.1.   Commissioning

Initial charging of rechargeable battery

The testo 480 is delivered with a partially charged battery. Charge the battery fully before using it for the first time.

1. Connect the mains unit to the mains socket (**3**).

2. Connect the mains plug to a power socket.
-   Battery charging is started: status LED (**4**) lights up.
-   The battery is fully charged: status LED (**4**) is off.
3. Disconnect instrument from the mains unit.
-   After initial charging of the rech. battery, the instrument is ready for use.

Switching on

1. Switch the instrument on with [⏻].
-   The start screen appears.

For initial commissioning or after a factory reset, the **Initial operation** menu is opened automatically. Set the required menu language:

>   Call up the required selection list with [■].

2. Select the language with [▊] and confirm with [■].
-   Instrument language is changed.
3. Set the date and time with [▊] and [▬] and confirm with [■].

4. Select ISO/US units with **[ ]** and confirm with **[ ]**.

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i The setting only relates to the measured values and can be individually adjusted for each measurement value if required.

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5. **[ ]** → **Save and close**.
-   The current measurement values are displayed. The instrument is now operational.

Switching off

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i Unsaved measurement values are lost when the instrument is switched off.

> Switch the instrument off with **[ ]**.

Connecting probes / sensors

Probes are detected automatically by the instrument.

Make sure the connections are secure, but do not use force!

> Insert the probe connector into the probe socket:
    • Bottom of the instrument: TC probe (type K)
    • Top of the instrument: digital probe:

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i Push/pull plug-in connections protect digital probes from being unintentionally disconnected from the instrument.

> Connect pressure tubes to **+** and **-**.

⚠ **Caution!** Danger of injury caused by the pressure tube jumping away from the connection socket!
    > Ensure correct connection.

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Removing probes

Thermocouple (TC) probe:

> Unplug connector from the socket.

Digital probe:

1. Pull back outer sleeve to release the push/pull plug-in connection.
2. Unplug connector from the socket.

Connecting the mains unit

If the mains unit is connected, the instrument is powered automatically via the mains unit.

i When power is supplied via the mains unit, the instrument may heat up. This may increase the measurement uncertainty during TC measurement.

1. Plug the mains unit instrument connector (art. no. 0554 8808) into the mains socket on the bottom of the instrument.
2. Plug the mains unit plug into a mains socket.
- The instrument is supplied with power via the mains unit and battery charging begins automatically.

5.2. Getting to know the product

5.2.1. Navigating in the menu

1. Press [▤].
- The **Options** menu is opened. Selected function is highlighted white.
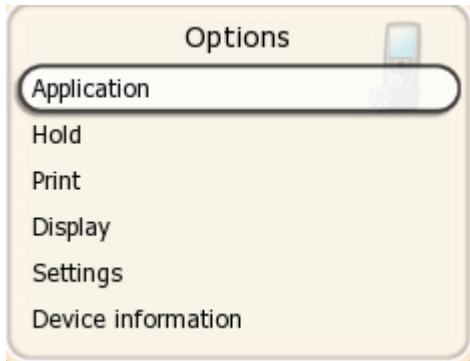
2. Select navigation/function:

   • [▮] Move the trackpad down to select the menu item.

   • [▮] Briefly touch the trackpad with your finger to confirm the selection.

   • Press **[Esc]** to cancel the action and switch to measuring mode.

Short form

This document uses a short form for describing operating steps (e.g. calling up a function).

Example: calling up **Min/Max** function

Short form	[▤] →	**Display**	→ **Min/Max**.
Steps required	1. Open Main menu: [▤].	2. Select **Display** menu: [▮]. 3. Confirm selection: [▮].	4. Select **Min/Max** menu: [▮]. 5. Confirm selection: [▮].

5.2.2. Calling up a function

1. Select function: [⬛⬛].
- A box appears around the selected function.
2. Confirm selection: [⬛].
- The selected function is opened.

5.2.3. Exit the menu

> Press **[Esc]**.

ℹ Before the entered data or measurement data may be lost, a confirmation prompt always appears, which must be confirmed with [⬛].

Or

> **[⬛]** → **Save and close**.

5.2.4. Switching to another tab

> Select the required tab: [⬛].
- Required tab is activated and all other tabs are greyed out.

5.2.5. Entering values

Some functions require values (numbers, units, characters) to be entered. Depending on the function that is chosen, the values are entered via either a list field or an input editor.

List field

```
Date format:

  dd.mm.yyyy

  mm-dd-yyyy

  yyyy-mm-dd
```
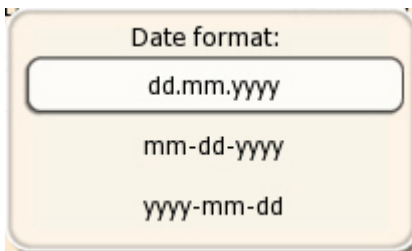
1. Select the value to be changed (numerical value, unit): [⬛], [⬛⬛] (depending on the selected function).
2. Press [⬛].
3. Set value: [⬛], [⬛⬛] (depending on the selected function).

4. Confirm the entry: [■].
5. Repeat steps 1 and 4 as required.
6. Save the entry: [▤] → **Save and close**.

Input editor

1. Select the value to be changed (character): [━], [▐▌].
2. Accept value: [■].
   Options:
   > Toggle between upper / lower case characters:
     ⇧ aA Select
   > Toggle between characters and numbers: select ⌈ *123 or
     ⌈ ABC .
   > Insert space: select
     ⎵ .
   > Delete character in front of cursor:
     select ⌫ .
3. Repeat steps 1 and 2 as required.
4. Save the entry: select ✓.

5.2.6.   Saving values

> [▤] → **Save and close**.

6 Using the product

6.1. Performing settings

1. Press **[📋]**.
- The configuration menu is opened.
2. Select **Settings** and set parameters:

Symbol	Explanation
Energy brightness	The brightness of the display can be adapted to suit ambient conditions.
Trackpad	It is possible to set the response time of the trackpad.
Speed-dial keys	Functions that are frequently required can be assigned to one of the two function keys **[–]**.
Energy management	It is possible to set the time frame for automatically switching off the instrument or the display illumination to preserve the battery.
Date/time	Various displays can be selected.
Password	When password protection is enabled, all these functions can only be carried out by entering the password: • Instrument factory reset • Probe reset • Firmware update • Change/deactivate password • Probe name ℹ️ If you forget the password, it can only be reset by Testo Service Password protection is not set as default.
Units	It is possible to toggle between ISO and US units. The setting only relates to the unit of the measured parameters, not to the calculated parameters.

Symbol	Explanation
Norm data	The temperature and absolute pressure values for the internal calculation of the standard flow rate can be changed. Factory-set: 25 °C, 1013.25 hPa
Pressure settings	Selection of the additional information that should be included on a measurement value printout.
Language	The instrument language is set. Select a language that you can understand well.
Factory reset	The instrument is reset to the factory settings: • Settings • Adjustment data • Password deactivated • Favourites tab is blank > After a factory reset, switch off the instrument with **[⏻]** and then switch it on again.

3. **[📖]→ Save and close**.
- Instrument switches to the measuring view.

6.2.   Setting the measurement display

The measurement display can be set individually for each probe tab. These settings are saved in the probe and also apply when the probe is next connected.

✓ Tab for which the measurement display should be changed is selected.

1. Press **[📖]**.
- The configuration menu is opened.
2. Select **Display** function and set parameters:

Adjustable parameters

Representation	Explanation
Min/max	When the ✓ function is activated, each line shows: average value, min value and max value. To deactivate: select function again.

Representation	Explanation
Parameter display	The individual lines can be changed in the parameter display: • Changing measurement parameters and units: Select line [■]. • Move/delete/insert lines [▤]. • Copy lines to Favourites tab [▤]. Lines displayed on the Favourites tab are indicated with a tick.
Number of lines	Selects how many lines should be displayed at the same time. If not all lines can be displayed at the same time, a scrollbar appears on the right. The remaining lines can be displayed with [▮].

- Instrument switches to the selected measuring view.

see Calculated measurement parameters, page 24

6.2.1. Calculated measurement parameters

The following calculated measurement parameters can – depending on the connected probes – also be included in the measurement value display for the measured parameters.

Operating flow rate

Value calculated from measured air velocity multiplied by the cross-section under the prevailing conditions in the application (e.g. 56 °C, 920 hPa).

Standard flow rate

Value calculated from the operating flow rate relating to the values entered under norm data (e.g. 25 °C, 1013 hPa).

Dampness degree (pressure-dependent)

Unit g/kg: Describes how many grams of water are contained in a kg of dry air. It is used to calculate the absolute pressure entered under norm data.

Water content

Indicates the volume percentage of water vapour in the measured gas. Unit is not absolute (ppm or %).

Dewpoint

Temperature at which condensation of the water vapour in the gas occurs.

Psychrometer temperature (pressure-dependent)

Wet-bulb temperature of a psychrometer. It is used to calculate the absolute pressure entered under norm data

Enthalpy

Heat content of the measured gas. Unit kJ/kg or BTU/lb.

Absolute humidity

Describes how many grams of water are contained in a cubic metre of the currently measured gas. Unit g/m³.

6.3.   Favourites tab

The Favourites tab ⬕ is the actual work area for the instrument. Here, measurement values of various probes can be combined into one measurement, and measuring programs can be run, saved and printed.

Only the measurement values displayed on the Favourites tab are saved in the measurement protocol.

> ~~[▤] → Display → Parameter display → [▤] → Add line to Favorites~~.

When the probe is first connected, all measurable parameters are transferred over to the Favourites tab. Calculated measurement parameters must be added manually on the Favourites tab.

Adjusting the displayed measurement parameters

> **[▤] → Display → Parameter display → [▤]**

6.4. Probe menu

Call up function:

> **[📋]** → **Probe menu**.

Adjustable parameters

Symbol	Explanation
Damping (moving average)	Damping type and duration can be individually adjusted. Damping can be activated/deactivated.
Probe info	Probe name, serial number and probe type are displayed.
Probe name	Probe name can be edited.
Adjustment info	The probe-specific adjustment data saved on the probe can be displayed.
	i The digital probes allow direct measurement and signal conversion in the probe. This technology means that measurement uncertainty caused by the instrument is no longer an issue.
	The probe can be calibrated without a hand instrument.
	Entering the adjustment data via the EasyClimate software generates a zero-error display.
Humidity adjustment	Humidity adjustment is possible with the following probes: • Humidity probe • IAQ probe • Thermal air flow measuring head and humidity probe
	i When a thermal air flow measuring head and humidity probe is used, the probe must be deactivated before the adjustment.

Symbol	Explanation
Probe reset	Probe is reset to the factory settings: • Measurement value display • Probe name • Adjustment table • Humidity adjustment • Damping

6.5. Explorer menu

In Explorer, all saved measurement values are displayed with the assigned data like the measuring program and customer data in a set structure.

> **i** Measurement values that were not saved are lost when the measuring instrument is switched off!

Calling up the Explorer view

> Press **[▇]**.
- Explorer structure is displayed.
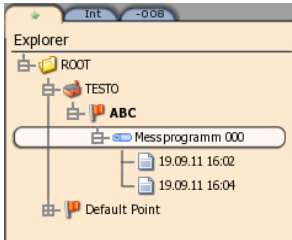
Icon	Feature
📁	**i** The root folder is a default folder, which cannot be deleted, moved or renamed. The folder is used to structure data and is where all elements (such as folders, measuring locations, measuring points, etc.) are saved.
⊟	Selection collapses sub-tree.
⊞	Selection expands sub-tree.

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Default Point	Factory-set measuring point under which the measuring programs are saved if no specific measuring location is created.
	Measuring location documenting the name and address of the customer. A measuring location can have several measuring points.
	Measuring point (e.g. ventilation shaft 1) documenting the location description with measurement-related parameters, e.g. cross-sections. A measuring point can have several measuring programs.
	Measuring program documenting the measuring process and the start and stop criteria for the measurement (e.g. continuous or punctual measurement).
	Grid measurement (standards-compliant air flow and volumetric flow rate measurement in ventilation and air-conditioning systems) see Grid measurement, page **34**.
	Turbulence measurement (standards-compliant measurement of comfort) see Turbulence measurement, page **38**.
	Report of the saved measurement data
	i All settings configured in the Explorer structure before measurement are stored in the protocol and cannot be subsequently changed.

i The Explorer structure can also be edited via the EasyClimate software and re-imported into the instrument.

Creating a new folder

A folder is always created in another folder.

1. Select the (root) folder in which the new folder is to be created.
2. **[ ]** → **New folder**.
3. Enter name.
4. Finalise the entry: **[ ]** → **Save and close**.

Other folder options

- **[📋] → New measuring location**: create new measuring location in the selected folder.
- **[📋] → Edit folder**: change the name of an existing folder.
- **[📋] → Delete folder**: delete an existing folder, including the locations created therein.

Creating a new location

A location is always created in a folder.

1. Select the folder in which the location is to be created.
2. **[📋] → New measuring location**.
3. Enter values.
4. Finalise the entry: **[📋] → Save and close**.

Other measuring location options

> **[📋] → New measuring point**: create new measuring point in the selected measuring location.
> **[📋] → Edit measuring location**: make changes to an existing location.
> **[📋] → Delete measuring location**: delete an existing measuring location, including the measuring points created therein.

Creating a new measuring point

A measuring point is always created under a measuring location.

1. Select the measuring location in which the measuring point is to be created.
2. **[📋] → New measuring point**.
3. Enter values.
4. Finalise the entry: **[📋] → Save and close**.

Other measuring point options

> **[🗐] → Select measuring point**: measuring point is selected and displayed in the status line in the measuring view. Reports are saved under the selected measuring point.

> **[🗐] → Edit measuring point**: make changes to an existing measuring point.

> **[🗐] → Delete measuring point**: delete an existing measuring point, including the measurement protocols saved for it.

> **[🗐] → New measuring program**: determine parameters for a new individual measurement.

> **[🗐] → New grid measurement**: carry out grid measurement, see Grid measurement, page **34**.

> **[🗐] → New turbulence measurement**: carry out turbulence measurement, see Turbulence measurement, page **38**.

> **[🗐] → New PMV/PPD measurement**: Carrying out a PMV/PPD measurement, see PMV/PPD measurement, page **43**.

> **[🗐] → New WBGT measurement**: Carrying out a WBGT measurement, see WBGT measurement, page **41**.

For creating a new measuring program, see PMV/PPD measurement, page **43**.

*see WBGT measurement, page **41***

*see Measuring program, page **31***

6.6.   Measurements & Measuring programs

General measurement information

• Depending on the measurement parameter to be measured, certain probes must be plugged into the instrument.

• Some (thermal) probes require a warming-up phase until they are ready to measure.

Adjustment phase

• For some measurement parameters, additional calculation parameters must be set to ensure correct measurement results, see Performing settings, page **22**

6.6.1. Retaining ("holding") measurement values

Displayed measurement values can be held on the Favourites or Probe tabs and printed out. The measurement values cannot be saved in one measurement protocol.

> **[📋] →Hold**.

- The measurement value is retained. **⏸** is displayed.

> Cancel Hold: **[📋] →Hold**.

Held measurement values can be printed see Measuring program, page **31**

The measuring values can be saved in one measurement protocol.

6.6.2. Quick back-up

With quick back-up, the current measuring values are saved to the folder selected for the measurement.

If no measuring point has been selected, the measurement protocols are saved under "Default Point".

> **[📋] → Quick back-up**.

- Measuring values are saved.

*see Printing measurement values, page **49***

6.6.3. Measuring program

You can customise measuring programs to match the relevant measuring task (e.g. continuous or punctual measurement). These measuring programs are linked to a specific measuring point. After the measurement, the relevant measurement protocols are saved under the measuring program.

For creating a new measuring program,
A measuring program is always created under a measuring point.

1. Press **[📁]**.
- Explorer structure is displayed.
2. Select a measuring point for which the measuring program should be created.
3. **[📋] → New measuring program**.

4. Determine parameters.

Parameter	Explanation
Name	Name under which the measuring program is saved in Explorer.
Measuring point	Measuring point to which the measuring program is assigned.
Measuring type	• Continuous: Mean calculation across a specific period • Punctual: Mean calculation across individual current values buffered via **[■]** or button on probe handle. • Continuous/Punctual: At each point a mean value is calculated according to the end criterion set (Duration or Number of values). At the end of the measurement, an overall mean value is calculated.
Measuring rate	Interval at which the measurement values are recorded.
Start criterion	• Manual: Measurement is triggered via **[■]**. • Date/Time: Measurement starts at a set time.
End criterion	• Manual: Measurement is ended via **[▤]** → **End**. • Date/Time: Measurement ends at a set time. • Duration: measurement ends after a set duration has lapsed. • Number of values: measurement ends after a sequence of measured values.

> **i** The measuring program only applies to the Favourites tab. Only the values displayed on the Favourites tab are saved in the measurement protocol.

5. Save setting and navigate to the measuring program: select **[▤] → Save and start measurement**.

> If you do not want the measurement to start immediately: select **[▤] → Save and close**.

---

i Another way to create a measuring program in the Favourites tab under the selected measuring point:

> **[▤] → Application → Measuring program**.

Starting a measuring program

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i If a start date has been set, the program starts automatically. In the case of a manual start, the measurement must be triggered as described.

---

1. Select required measuring program.

2. **[▤] → Start measuring program**.

> Depending on the selected start criterion, the measurement must be started via **[■]**.
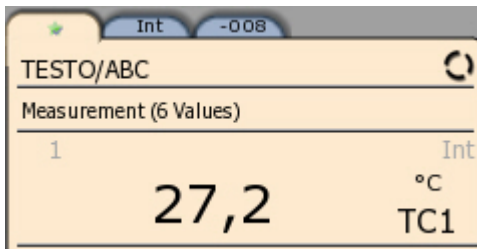
Other measuring program options

> **[▤] → Edit measuring program**: make changes to an existing measuring program.

> **[▤] → Delete measuring program**: delete an existing measuring program.

6.6.4. Grid measurement

There are various options for measuring the air and volumetric flow rate in ventilation and air-conditioning systems. These are distinguishable by the measuring range in particular. For the testo 480, there are three different flow probes:

- Thermal probes (incl. temperature measurement and possibly humidity measurement) for low flow speeds
- 16 mm wheel measuring head (incl. temperature measurement) for average flow velocities
- Pitot tube for measurements at high velocities and in heavily contaminated flows with a high percentage of particles

---

i Detailed background information on grid measurement and carrying it out can be found in the Testo **Ambient Air Measurement for Practical Users** field guide. You can request a free copy or download it from www.testo.com.

Selecting a suitable measuring point

The main prerequisite for accurate measurement is the suitability of the measuring point. Minimum distances from points of discontinuity must be observed:

- From points of discontinuity upstream of the flow, observe a clearance of at least six times the hydraulic diameter Dh = 4A/U (A: channel cross-section, U: channel circumference).
- From points of discontinuity downstream of the flow, observe a clearance of at least twice the hydraulic diameter Dh = 4A/U (A: channel cross-section, U: channel circumference).

Preparing for measurement

✓ 16 mm wheel measuring head, thermal air flow measuring head and humidity probe or Pitot tube is connected.

1. Switch the instrument on.
2. Create a new measuring point in Explorer under the required measuring location.
3. Set the following parameters:

Parameter	Values
Temperature, **Relative humidity** and **Absolute pressure**	The parameters must be correctly entered or measured. This affects the measurement with Pitot tube. Thermal probe has an internal absolute pressure sensor. No entry is required here.
Flow rate correction factor	Must be 1.00 (has a proportional effect on the flow rate).
Pitot factor	Only has to be entered for measurement with Pitot tube, see Pitot tube measurement, page **39**.
Channel geometry	Profile and dimensions of the channel. Select channel geometry with **[■]**:
Electric power	Manual input value, only used for logging.

4. In Explorer, under the created measuring point, create a new grid measurement, see Explorer menu, page **27**.
5. Make the following settings to suit the measuring point:

Parameter	Values
Measuring type	Punctual or Continuous/Punctual The end criterion can be defined individually depending on the selection.
Nominal volumetric flow	Information value for the nominal volumetric flow. The unit can be freely selected, this value appears in the protocol and on the printout as supplementary information.
Probe	Select probe via serial number with **[■]**. **i** If a Pitot tube is connected, the differential pressure is measured when **INT** is selected.
Layout Measuring points	The number of measuring points depends on the distance from the point of discontinuity and irregularities in the profile. More information can be found in the Testo "Ambient Air Measurement for Practical Users" field guide.

Parameter	Values
Measuring type	Punctual or Continuous/Punctual
	The end criterion can be defined individually depending on the selection.
Nominal volumetric flow	Information value for the nominal volumetric flow. The unit can be freely selected, this value appears in the protocol and on the printout as supplementary information.
Hole position	Select any hole position with [■] depending on channel accessibility.
Edge spacing	For example, damping of the channel wall can be taken into consideration. Entered values influence the coordination of the measuring points.
Uncertainties Channel	Estimated uncertainty of the channel dimensions. Entered value is taken into account in the flow rate calculation.
Uncertainties Density (air density, only for Pitot tube measurement)	When all relevant measurement parameters (temperature, relative humidity, absolute pressure) are measured, the value can be set to 0.

6. Save setting and navigate to the measuring program: select **[▤] → Save and start measurement**.

> If you do not want the measurement to start immediately: select **[▤] → Save and close**.

Performing the measurement

✓ All points under "Preparing for measurement" have been carried

out.

1. Position the probe at the grid measurement point shown in the form of a chart on the display.

2. With **[■]** or the integrated measurement button on the probe, transfer the measured value, or start the continuous/punctual measurement.

- The measured point is indicated with a tick.
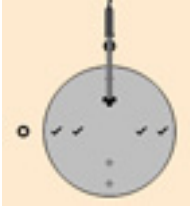
- The position of the measuring point is automatically moved to the next point on the display and the new immersion depth required is displayed. The immersion depth of the probe can be found on the scale of the probe shaft.

3. Repeat steps 1 and 2 until all points have been measured.

- The individual velocity measurement values are used to calculate the mean flow velocity, from which the volumetric air flow is then calculated.

> **ℹ** If high differences in flow velocities are ascertained over the cross-section, the number of measuring points is to be increased.
>
> The number of measuring points is then adequate if the measurement value for each area is representative for its immediate surroundings, i.e. if it can be regarded as a genuine mean value for its portion of the area.

4. Before the measurement is completed, any measured point can be approached. If this point needs to be remeasured → **[📋]**→ **Repeat measurement**.

ℹ️ As soon as all measuring points have been input, "Measurement completed" is displayed. The whole measurement can be repeated → **[📋]**→ **Repeat HVAC measurement**.

> Select **[📋]** → **Save and close**.
- Measurement protocol is saved in Explorer under the selected measuring point.

The HVAC protocol contains multiple views, which can be changed via**[📋]**.
- Values Result: End result (mean value) and deviation of the flow velocity and volumetric flow parameters.
- Graphic Result: Channel view with the results per measuring point.
- HVAC program parameters: preset parameters for the measurement (e.g. channel geometry).
- Density parameters: preset values for calculating the density (temperature, humidity, absolute pressure).

6.6.5. Turbulence measurement

A connected turbulence probe 0628 0143 enables the turbulence to be calculated for the flow value in accordance with DIN EN 13779.

The turbulence probe 0628 0143 has an internal absolute pressure sensor used to carry out automatic compensation. There is no need to enter an absolute pressure value here.

✓ Turbulence probe 0628 0143 is connected.

1. Press **[🟧]**.
- Explorer structure is displayed.
2. Select the desired measuring point.
3. **[📋]** → **New turbulence measurement**.
- Turbulence calculation window is opened.
4. Start measurement: **[⬛]**.
- Turbulence determination is started. It takes 180 sec., but can also be ended early.
- When measurement is completed: turbulence is displayed in %, calculated according the formula:

$$Turb = \frac{\sqrt{\frac{1}{n-1} \sum_{i=1}^{n} \quad}}{\overline{\upsilon}} \times 100$$

and draught rating as per EN ISO 7730 is displayed.
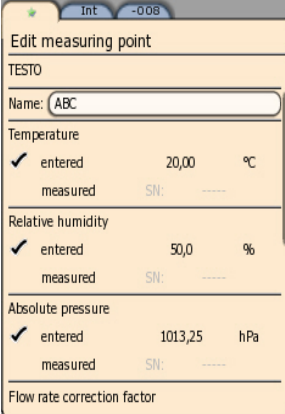
5. **[📋] → Save and close.**

- Measurement protocol is saved under the selected measuring point.

6.6.6.   Pitot tube measurement

To measure flow with a Pitot tube, the following parameters must be entered in the measuring point (manual entry or measured values).

- Temperature
- Relative humidity
- Absolute pressure

These three paramet

These three parameters are taken into account in the calculation of the flow.

The Pitot factor for Pitot tubes is generally the same and must be entered:

- Pitot tubes from Testo 1.00
- Straight Pitot tubes, Pitot factor: 0.67

For Pitot tubes from other manufacturers, the Pitot factor can be found in the instruction manual or you should ask your supplier.

For carrying out the measurement, see Measuring program, page **31** or see Grid measurement, page **34**.

6.6.7.   Measurement with the funnel

A flow rate funnel is required to determine the flow rate at ventilation systems. The funnel set (art. no. 0563 4170) comprises a funnel for measuring at poppet valves (200 x 200 mm) and a funnel for measuring at fans (330 x 330 mm). The opening of the funnel should cover the grille completely and tightly.

1. Secure the 100 mm wheel measuring head in the funnel handle.
2. Connect 100 mm wheel measuring head to the instrument.
3. Switch the instrument on.

The following parameters must be entered for the funnel measurement in the measuring point, as they influence the measurement result:

• Flow rate correction factor: value 1.00
• Channel geometry (dimensions of the funnel used)

> **i** The input variables for the testovent 410/415 can be found in the funnel instruction manual or on the funnel label.
>
> For the testovent 417 funnel set, use the following information (deviates from the information on the funnel): Ø 8,5cm.

For carrying out the measurement, see Measuring program, page **31**.

6.6.8.   Pressure measurement

The testo 480 has an internal absolute and differential pressure sensor. The pressure measurement values are therefore displayed on the **Int** tab.

1. Connect pressure tubes for differential pressure measurement (**2**) to **+** and **-**.
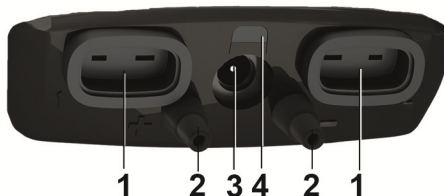
> **⚠ Caution!** Danger of injury caused by the pressure tube jumping away from the connection socket!
> > Ensure correct connection.

2. Switch the instrument on with [**⏻**].

3. Position the instrument ready for measurement and stabilise.

ℹ The parameter display depends on the position of the pressure sensor.

4. Zero parameter display: **[🗐]**→ **Zero**.

- Current pressure measurement value appears on the **Int** tab in the set unit.

> Change pressure unit in the parameter display: **[🗐]**→ **Display**→ **Parameter display**→ **[■]**→ Select measurement parameter from list → **[■]**→**[🗐]**→ **Save and close**.

If the measurement values fluctuate widely, it is advisable to damp the measurement values. Damping is activated in the probe menu see Probe menu, page **26**.

6.6.9. CO_2 measurement

- The CO_2 probe measures the absolute pressure. The displayed CO_2 value is compensated automatically in line with the absolute pressure.
- Due to the sensor, the probe has a relatively high power consumption. For continuous measurements, use a mains unit for the power supply.
- To avoid the effects of the CO_2 content of respired air, hold the probe as far away from your body as possible.
- If sudden changes occur in the concentration, the probe will require approx. 30 - 60 sec. to adapt to the environment. Gently waving the probe reduces the adjustment period.

6.6.10. WBGT measurement

ℹ Measurement program available as of firmware version 1.05.

ℹ Make sure that the specific instrument and cable temperatures are not exceeded. Extension cables should be used for high radiation temperatures in particular.

With the WBGT set, the WBGT (Wet Bulb Globe Temperature) climate index is determined as per DIN 33403 or ISO 7243. The WBGT index is used to determine the maximum permissible exposure time at workplaces exposed to heat (e.g. steel industry, foundries, glass industry or blast furnaces).

To calculate the WBGT, 3 different temperatures must be measured:

- Radiation temperature T_g (globe thermometer)
- Ambient temperature T_a
- Wet bulb temperature T_{nw} (temperature of a naturally ventilated psychrometer)

The calculation is carried out with the following formulas:

WBGT = 0.7 x T_{nw} + 0.3 x T_g

WBGTS = 0.7 x T_{nw} + 0.2 x T_g + 0.1 x T_a

Preparing for measurement

✓ Globe thermometer, wet bulb temperature and air temperature probes are connected and mounted on a tripod.

1. Switch the instrument on.

Selecting a suitable measuring point

i The settings in the measuring point have no effects on the measurement result.

Performing a measurement

✓ All points under "Preparing for measurement" have been carried out.

1. Press **[▮]**.
- Explorer structure is displayed.
2. Select the desired measuring point.
3. **[🗐] → New WBGT measurement**.
- WBGT measurement is opened.
4. Select ID numbers of the individual probes.
5. Select measuring type and measuring rate.
6. Set criteria for start and end of the measurement.
7. **[🗐] → Save and start measurement**

i During the measurement, the values are calculated from the current measuring values.

After the measurement, a calculation is carried out based on mean values.

8. **[🗐] → Save and close**
- Measurement protocol is saved under the selected measuring point.

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6.6.11. PMV/PPD measurement

$\mathbf{i}$ Measurement program available as of firmware version 1.05.

The PMV/PPD measurement determines the comfort level (PMV = Predicted Mean Vote) and the relative discomfort (PPD = Predicted Percentage Dissatisfied) e.g. at workstations and is described in the ISO 7730.

The mean radiation temperature required for determining PMV/PPD is calculated in the testo 480 from the measurement parameters of globe temperature, ambient temperature and air speed. The formula is based on forced convection and applies to standard bulbs with 150 mm diameter.[2]

Necessary measuring values
- Mean radiation temperature in °C = t_r
- Globe temperature in °C = t_g
- Ambient temperature in °C = t_a
- Air speed in $^m/_s$ = v_a

tr = [(tg+273)4+2.5*108*va0.6*(tg-ta)]1/4-273

Factors to be entered
- Clothing
  Clothing reduces body heat losses and is therefore classified based on its insulating value.
  The insulating effect of clothing is given in the unit clo or m² °K/W (1 clo = 0.155 m² °K/W).
  The clo value can be calculated by adding together the values of the individual items of clothing.
  Insulating values for individual items of clothing can be found in ISO 7730.
  Alternatively, a ~~clo~~ range can be selected.

---

[2] Only with positive pressures

- Activity
  The metabolic rate gives the energy released by oxidation processes in the human body, and depends on muscle activity. The metabolic rate is given in met or W/m^2 (1 met = 58.2 W/m² body surface area). The average adult has a body surface area of 1.7 m². In a state of thermal comfort, a person with a metabolic rate of 1 met has heat loss of approx. 100 W. When calculating the metabolic rate, a mean value of the activity of the relevant person affected within the past hour must be used. Met values for various activities can also be found in ISO 7730.

Input parameters for clothing

Parameter in clo	Parameter in m2K/W	Explanation
0 – 0.02		No clothing
0.03 – 0.29	0.005 – 0.045	Underwear
0.30 – 0.49	0.046 – 0.077	Shorts and T-shirt
0.50 – 0.79	0.078 – 0.122	Trousers and T-shirt
0.80 – 1.29	0.123 – 0.200	Light business wear
1.30 – 1.79	0.201 – 0.277	Warm business wear
1.80 – 2.29	0.278 – 0.355	Jacket or coat
2.30 – 2.79	0.356 – 0.432	Warm winter clothing
2.80 – 3.00	0.433 – 0.465	Extremely warm winter clothing

Input parameters for activity

Parameter in met	Parameter in W/m2	Explanation
0.1 – 0.7	6 – 45	Lying down, relaxed
0.8 – 0.9	46 – 57	Sitting down, relaxed
1.0 – 1.1	58 – 59	Seated activity
1.2 – 1.5	70 – 92	Standing up
1.6 – 1.7	93 – 104	Standing up, light activity
1.8 – 1.9	105 – 115	Standing up, moderate activity

Parameter in met	Parameter in W/m2	Explanation
2.0 – 2.3	116 – 139	Slow walking
2.4 – 2.9	140 – 174	Quick walking
3.0 – 3.4	175 – 203	Strenuous activity
3.5 – 4.0	204 - 233	Extremely strenuous activity

> **i** The factors to be entered refer to the ISO 7730 Appendix B and C.

> **i** We recommend using the following probes:
> - Globe thermometer (0602 0743)
> - Humidity probe (0636 9743)
> - Comfort probe (0628 0143)
> - Tripod (0554 0743)

Preparing for measurement

✓ Globe thermometer, wet bulb temperature and air temperature probes are connected and mounted on a tripod.
1. Switch the instrument on.

Performing a measurement

✓ All points under "Preparing for measurement" have been carried out.

1. Press **[▮]**.
- Explorer structure is displayed.
2. Select the desired measuring point.
3. **[▤] → New PPMV/PPD measurement**.
- PMV/PPD measurement is opened.
4. Select ID numbers of the individual probes.
5. Specify parameters and unit for clothing and activity.
6. Select measuring type and measuring rate.

7. Set criteria for start and end of the measurement.

8. **[📋] → Save and start measurement**

> ℹ️ During the measurement, the values are calculated from the current measuring values.
>
> After the measurement, a calculation is carried out based on mean values.

9. **[📋] → Save and close**

- Measurement protocol is saved under the selected measuring point.

10. The measurement protocol is displayed.

11. **[📋] → Graphic**

Graphical representation
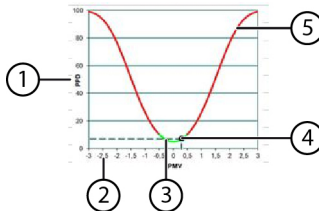
1 PPD axis, scale from 0% to 100%
2 PMV axis, scale from -3 to +3
3 Green area of curve from -0.5 to 0.5 PMV
4 Calculated point from PPD and PMV.
5 Critical area of curve

Formula for display

$PPD = 100-95*exp(-0.03353*PMV^4 - 0.2179*PMV^2)$

6.6.12.   Saving measurement values

All measurement protocols displayed in Explorer are saved in the internal instrument memory.

Saving measurement values on an SD card

1. Insert SD card.

---

i   Only SD cards with max. 2 GB space can be used.

---

2. Select root folder in the Explorer view.

3. [▤] → **Export**.

-   An export message is displayed.

Importing measurement values from an SD card

> **i** When importing data from an SD card, **all** data in the internal instrument memory is overwritten.

1. Insert SD card.

> **i** Only SD cards with max. 2 GB space can be used.

2. Select root folder in the Explorer view.
3. [🗐] → **Import**.
- A list of importable data is displayed.
4. Select the required entry.
- An import message is displayed.

6.6.13. Printing measurement values

> **i** Selection of the additional information that should be included on a measurement value printout, see Performing settings, page **22**.

From measuring mode

✓ testo printer (0554 0549) has been switched on.

✓ Required tab has been selected.

1. Align IR interfaces testo 480 and testo printer.

2. Select **[📋]** → **Print**.

- The set measuring view and 🖨 are displayed.

- Printout of the currently displayed measurement values is produced.

From the instrument memory

✓ testo printer (0554 0549) has been switched on.

1. Press **[📂]**.

2. Navigate to the saved measuring protocol.

3. Select **[📋]** → **Open measurement protocol**.

- Measurement data view is opened.

4. Align IR interfaces testo 480 and testo printer.

5. Select **[📋]** → **Print**.

- The printout is generated.

> **i** The saved measurement protocols can also be displayed via the testo EasyClimate software.

6.6.14. Display measuring values graphically

Measuring values of max. four measurement parameters can be displayed as a colour graphic over a period of 110 seconds. In the case of longer time frames, the oldest values are deleted and replaced by the new ones. The graphic mode is purely a display mode, i.e. the measuring values cannot be stored.

Selection of the displayed measurement parameters is based on the display sequence in measuring mode.

- First measurement parameter displayed: red
- Second measurement parameter displayed: green

- Third measurement parameter displayed: blue
- Fourth measurement parameter displayed: violet

1. Select the required tab.

> If necessary change the order of the measurement parameters, as only the first four measurement parameters are displayed.

2. **[📋] → Graphic mode**.

- Graphic mode is activated ✓.

> Exit graphic mode: **[📋] → Graphic mode** or **[ESC]**.

> ℹ️ The values are deleted when switching tabs, however graphic mode is not terminated. On returning to the tab, the measurement starts again in graphic mode.
>
> If the values are to be retained after switching tabs, **[📋] →** select **Hold** .
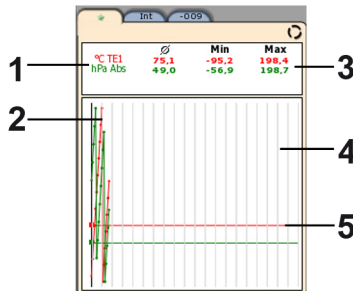
1   Displayed measuring values
2   Graphically displayed measuring value
3   Average, minimum and maximum values since graphic mode selection
4   Vertical scaling marking (5 seconds)
5   Specific x-axis of the respective measurement parameter in the same colour as the graphically displayed measuring value

6.6.15.   Transferring measurement values

> **i**   To view and evaluate the measurement results on the PC, you need the testo EasyClimate software.

1. Switch on the testo 480.
2. Connect the instrument to the PC with a mini USB cable.
- Instrument is identified by the PC as a USB mass storage device. The operating system automatically assigns the instrument memory a drive letter. This is displayed in Windows Explorer.

> **i**   When the instrument is connected to the PC, the instrument control keys are locked. As soon as the instrument is disconnected from the PC, it can be operated again via the control keys.

3. For carrying out an instrument readout via testo EasyClimate software and processing data, see separate testo EasyClimate software instrument manual.

7 Maintaining the product

Cleaning the instrument

> If the housing of the instrument is dirty, clean it with a damp cloth.

Do not use any aggressive cleaning agents or solvents! Weak household cleaning agents and soap suds may be used.

7.1.1. Battery care

> Charge new rechargeable battery fully before commissioning.

> If possible, always discharge the rechargeable battery and recharge it fully.

> At low ambient temperatures, the rechargeable battery running time decreases. This reduces the available useful life.

> Do not store the rechargeable battery for long periods when discharged. (The best storage conditions are at 50-80 % charge level and 10-20 °C ambient temperature; charge fully before using again).

> The rechargeable battery life depends on the storage, operating and ambient conditions. The available useful life of the rechargeable battery reduces more and more with frequent use. If the useful life is significantly shortened, the rechargeable battery should be replaced.

7.1.2. Carrying out humidity adjustment

In humidity calibration, the measurement parameter of the connected probe is adjusted to the reference value at the two standard adjustment points 11.3 % RH and 75.3 % RH and the deviations between the measuring value and the nominal value are minimised across the entire measuring range.

The Testo adjustment set provides a reference value to calculate the offset for a humidity adjustment.

Humidity adjustment is possible with the following probes:

• Humidity probe

• IAQ probe

• Thermal air flow measuring head and humidity probe

---

i When a thermal air flow measuring head and humidity probe is used, the probe must be deactivated before the adjustment (**[▤] → Switch off flow probe**). The probe can only then be exposed to the reference conditions.

✓ Instrument is switched on and probe is connected.

✓ Probe is already exposed to reference conditions (e.g. salt pot) for an adequate adjustment time.
  • Adjustment time for humidity probe at least 30 min
  • Adjustment time for IAQ probe at least 1 h
  • Adjustment time for thermal air flow measuring head and humidity probe at least 3 h

✓ Tab for the relevant probe is activated.

1. **[▤] → Probe menu**.
2. Select reference value used (11.3%RH/75.3%RH).
3. **[▤] → Adjustment**.
- A pop-up window with the remaining adjustment time is displayed.
4. **[▤] → End**.
- Adjustment menu is closed.
5. Carry out adjustment for the second adjustment point.

7.1.3. Carrying out a firmware update

Updated firmware can be installed on the instrument.

> **i** A firmware update can also be carried out with testo EasyClimate.

✓ Instrument is switched on.

1. Download the current firmware file from www.testo.com/download-center (registration required).
2. Unzip downloaded zip file.
3. Connect the instrument to the PC with a mini USB cable.
- Instrument is identified by the PC as a USB mass storage device. The operating system automatically assigns the instrument memory a drive letter. This is displayed in Windows Explorer.

> **i** When the instrument is connected to the PC, the instrument control buttons are locked. As soon as the instrument is disconnected from the PC, it can be operated again via the control buttons.

4. Copy unzipped firmware file and **res** folder to **Update** folder.
5. Log out instrument from Windows (safely remove hardware).
6. Unplug USB cable.
7. Switch the instrument off.
8. Switch the instrument on.
- Firmware has been updated.

8 Tips and assistance

8.1. Questions and answers

Question	Possible causes / solution
▭ flashes	Rechargeable battery is low. > Switch to mains operation.
-+++- lights up instead of the measurement parameter display	The value is above the permissible measuring range. > Keep to the permissible measuring range.
+---+ lights up instead of the measurement parameter display	The value is below the permissible measuring range. > Keep to the permissible measuring range.
- - - - lights up instead of the measurement parameter display	Instrument sensor is faulty. > Contact your dealer or the Testo Customer Service.
Data cannot be copied to the SD card or imported from the SD card.	SD card is write-protected. > Cancel write protection (small slider control on the SD card).
Instrument no longer responds when a button is pressed.	Internal error has occurred. 1. Hold down [⏻] for >10 sec. - The instrument is switched off. 2. Switch instrument on with [⏻].

If we could not answer your question, please contact your dealer or Testo Customer Service. For contact data, see back of this document or website www.testo.com/service-contact.

8.2. Accessories and spare parts

Description	Article no.
System case for comfort level measurement	0516 4801
System case for grid measurements	0516 4800
Tripod for workplace evaluation with holders for hand instrument and probe; can also be used as probe extension, e.g. for 100 mm probe	0554 0743
Connection hose, silicone-free, 5 m, load to max. 700 hPa	0554 0453
Connection hose, silicone, 5 m, load to max. 700 hPa	0554 0440
Funnel set comprising funnel for disc valves (Ø 200 mm) and funnel for fans (330 x 330 mm) for supply and exhaust air	0563 4170
Testovent 410, flow rate funnel, Ø 340 mm/330 x 330 mm, incl. case	0554 0410
Testovent 415, flow rate funnel, Ø 210 mm/190 x 190 mm, incl. case	0554 0415
Testo high speed printer with wireless infrared interface, 1 roll of thermal paper and 4 AA batteries	0554 0549

For a complete list of all accessories and spare parts, please refer to the product catalogues and brochures or look up our website www.testo.com