testo 350 · Flue gas analyzer

Short manual

1 Contents

> **i** These brief instructions provide an overview over the most
> important functions of the product. Before using the product
> you should absolutely read and follow the operating
> instructions!

This document describes the product testo 350 with the device
setting **Country version** | **Great Britain**.

1.1. Technical data

1.1.1. Measurement ranges and resolution

Analysis box

Measurement parameter	Measurement range without dilution of all sensors	Measurement range with dilution of all sensors (option)
O_2	0…25Vol.%	The reading does not appear in the display.
CO, H_2-comp.	0…10000ppm	2500…50000ppm
COlow, H_2-comp.	0…500ppm	500…2500ppm
NO	0…4000ppm	1500…20000ppm
NOlow	0…300ppm	300…1500ppm
NO_2	0…500ppm	500…2500ppm
SO_2	0…5000ppm	500…25000ppm
H_2S	0…300ppm	200…1500ppm
CO_2-(IR)	0…50Vol.%	The reading does not appear in the display.
HC [1, 2]	Natural gas: 100…40000ppm Propane: 100…21000ppm Butane: 100…18000ppm	Natural gas: 500…8000000ppm Propane: 500…42000000ppm Butane: 500…36000000ppm

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[1] Detection limit: 50ppm

[2] Strict compliance with the lower explosion limit is mandatory.

The dilution of all sensors results in an additional measuring error (measuring inaccuracy).

1.1.2.   Other instrument data

Control Unit

Feature	Values
Rech. batt. service life	approx. 5h (display switched on, Bluetooth® deactivated)

Meas. box

Rech. batt. service life	2.5h (with gas cooler and IR module) / 4.5h (without gas cooler and IR module)

2 Product description

2.1. Control Unit

2.1.1. Overview

1 IrDA interface

2 Switch On / Off

3   Magnetic holder (on rear)

CAUTION
Strong magnets
Damage to other devices!
> Keep a safe distance from products which could be damaged by magnets (e.g. monitors, computers, pacemakers, credit cards).

4   Display

5   Keyboard

6   Contact bar for meas. box (on rear)

7   Interfaces: USB 2.0, charger, Testo Data bus

2.1.2.   Keyboard

Key	Functions
[⏻]	Switch measuring instrument on / off
[OK] Example	Function key (orange, 3x), relevant function is shown on the display
[▲]	Scroll up, increase value
[▼]	Scroll down, reduce value
[esc]	Back, cancel function
[📑]	Open main menu
[i]	Open menu **Instrument diagnosis**

2.1.3.   Connections / interfaces
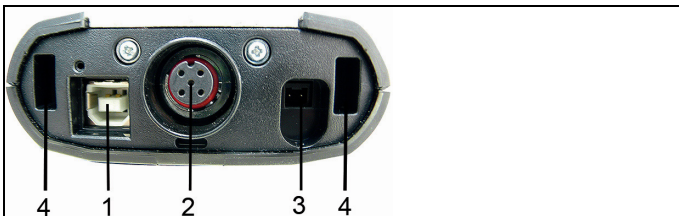
1   USB 2.0

2   Testo Data bus

3   Connecting socket for mains unit 0554 1096

4   Guide groove for locking with meas. box

2.2.   Meas. box

2.2.1.   Overview


1   Condensate trap and condensate container

2   Locking/unlocking button for Control Unit

3   Particle filter

4   Filter fresh air inlet (option: fresh air valve / measurement range extension overall (5x))

5   Contact bar for connection to Control Unit

6   Guide pins for locking with Control Unit

7   Diluting gas filter

8   Status display

2.2.2. Status display

The status display shows the operating status of the meas. box:

Display	Status
green / permanent (meas. box switched on)	Mains operation or rech. batt operation / rech. batt. fully charged
red / flashing (meas. box switched on)	• Rech. batt. operation / residual rech. batt. capacity < 20% • other device error
green / flashing (meas. box switched off)	Charge rech. batt.
green / permanent (meas. box switched off)	Rech. batt. fully charged, trickle charge
green, red / alternately flashing	Update mode active

2.2.3. Connections / interfaces
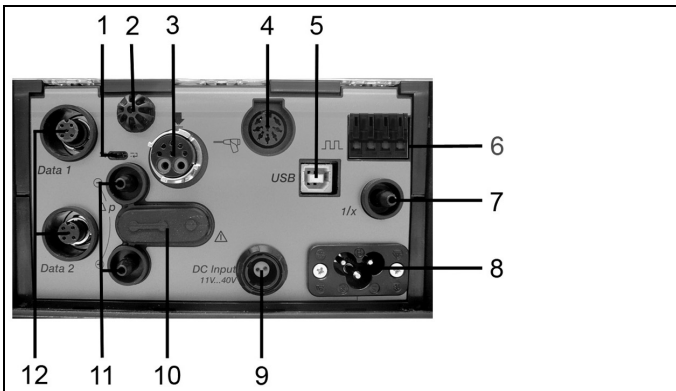
1 Data bus termination slide switch

2 Sensor for combustion air temperature

3 Flue gas probe

4 Sensor input

5 USB 2.0

6 Trigger input

7 Dilution gas inlet for measurement range extension

8 Mains connection 100...240V AC, 47...63Hz

9 DC-voltage input 11…40V DC (option)

9

10 Covering cap gas channel access (only for servicing purposes)

|	Plugged in covering cap: Position (●—● ●) must not be changed!

11 Pressure ports p+ and p-

12 Testo data bus

2.2.4. Menu guidance meas. box

Main menu	Menu	Description
Applications	-	Select an application in accordance with the measuring task to be performed
Folder	-	Create and manage folders and locations
Fuels	-	Select and configure fuels
Measurement Records	-	Display and manage measurement records
Device settings	**Dilution**	Set the dilution factor
	Measurement view	Configure the display, set measurement parameters and units for selected application and measurement type
	Units	Set units for display variables
	Date / time	Set date, time, time format:
	Power Options	Set automatic instrument shut-down and switch off display backlight in rech. batt. operation
	Display brightness	Set display brightness
	Printer	Select printer, enter print text
	Bluetooth®	Bluetooth® on / off
	Language	Set instrument language
	Country version	Set country version (fuels, display variables, calculation formulas)
	Password protection	Change password
	Analog input	Configure analog input
	Databus	Display of bus address, enter bus length

Main menu	Menu	Description
Sensor settings	-	Make sensor settings, perform calibration / adjustment
Programs	-	Configure and activate measuring programs
Instrument diagnosis	**Error diagnosis**	Display of present errors
	Gas path check	Perform tightness test
	Sensor diagnosis	Perform sensor diagnosis
	Device information	Display of device information

2.2.5. Modular flue gas probe
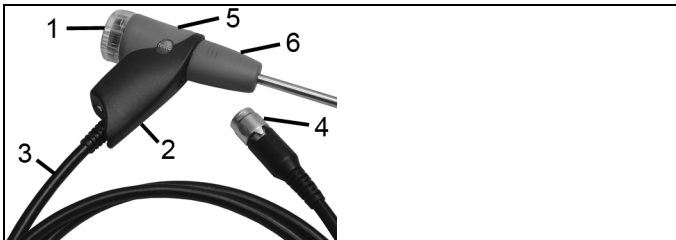
1 Removable filter chamber with window and particle filter
2 Probe handle
3 Connecting cable
4 Connector plug for measuring instrument
5 Probe module lock release
6 Probe module

3 First steps

3.1. Commissioning

3.1.1. Control Unit

The Control Unit has a permanently installed rechargeable battery.

> Remove the protective film from the display.

> Charge the rech. batt. fully before using the Control Unit.

Recharging the rech. batt. of the Control Unit

The rech. batt. can only be charged at an ambient temperature of ±0...+35°C. If the rech. batt. had been completely discharged, the charging time at room temperature will take about 7h (charging with mains adapter) or approx. 14h (charging via Testo Data bus).

Charging via meas. box

✓ Control Unit is locked to meas. box or is connected via the Testo Data bus cable.

✓ The meas. box is supplied via the mains unit.

During operation with low charge power or in switched off state.

3.1.2. Meas. box

The meas. box is supplied with a rech. batt. already fitted.

> Charge the rech. batt. fully before using the meas. box.

Charging the rech. batt. of the meas. box

The rech. batt. pack can only be charged at an ambient temperature of ±0...+35°C. If the rech. batt. has been discharged completely, the charging time at room temperature is approx. 6h.

✓ The meas. box is switched off.

> Connect mains cable to meas. box and mains socket.

- Charging will start, the fan may come on automatically. The status LEDs lights green while the rech. batt. is being charged.

- Once the rech. batt. has been charged the instrument will automatically change to trickle charge. The status LEDs permanently light green.

Meas. box via DC-voltage input DC

Cable with battery terminals and adapter for connection to meas. box required (0554 1337, accessory)

- If the meas. box is switched off the rech. batt. charging process will start automatically. Battery charging stops when the flue gas analyser is switched on by the Control Unit.

3.2.   Getting to know the product

3.2.1.   Connecting probes / sensors

> **i**   Sensor detection takes place during the activation
>   process: Sensors that are required must always be
>   connected before the flue gas analyser is switched on,
>   or the flue gas analyser must be switched off and then
>   on again after a sensor change, so that the correct
>   sensor data can be read.

> Connect the required probes / sensors to the corresponding
  ports.

3.2.2.   Connecting system components

3.2.2.1.   Connection using contact strip

The Control Unit can be plugged on and locked to the meas. box.

1. Place the guide groove in the bottom side of the Control Unit
   over the guide pins of the meas. box.

2. Press the Control Unit against the meas. box until the locking/
   unlocking buttons noticeably clicks into place **two times**.

> **i**   To protect the display (e.g. during transport) the Control
>   Unit can also be inserted with the back facing up, however,
>   in this case there is no connection to the meas. box.

3.2.2.2.   Connecting via Data bus cable (accessory)

The individual components (e.g. Control Unit with meas. box or
meas. box with meas. box) can be connected using the Testo
databus cable.

> Connect the Data bus cable to the Data bus interfaces.

Please observe the following points when setting up a connection via databus cable:

- Use only Testo databus cables
- Do not route databus cables in the vicinity of electric power cables.
- Ensure sufficient power supply by supplying each meas. box with mains voltage.
- The cables should ideally be plugged in before the system is switched on. Connecting during operation (hot plugging) is possible, however, depending on the combination the system may need to be switched off and on again.
- The connection cannot be separated under load.
- Data bus subscribers: max. 16 meas. boxes in one Data bus system.
- Cable length: max. 50m between Control Unit and meas. box, max. 800m between all meas. boxes in the databus system.
- Each component in the Data bus system must have an unambiguous bus address.
- The bus system must have a defined electrical termination, see below.

Electrical termination of the bus system

The databus system is linear in structure. The Control Unit or the Testo databus controller with USB connection represents the beginning of the line.
The end is represented by the last components connected in the system (meas. box or analog output box). This component must have a defined electrical termination.

An analog output box is the furthest subscriber.

> Insert the Data bus termination plug into the Data bus socket on the analog output box.

A meas. box is the furthest subscriber.

> Set the Data bus termination slide switch in the meas. box to switch position right ( ).

3.2.2.3. Connection via Bluetooth® (option)

or

or

The Control Unit can be connected to a meas. box or a PC/
Notebook via Bluetooth®, as long as both components are
equipped with this function.

3.2.3. Switching on

Before switching on

> Connect all system components.

> Connect all required probes / sensors.

> Connect all system components to the electric power supply.

When switching on the Control Unit

- should be plugged on the contact strip of the meas. box

or

- connected with a Data bus cable

or

- plugged to the mains cable of the meas. box, so that starting via Bluetooth® is enabled.

Switching on

> press **[⏻]**.

- The Welcome Screen is displayed (approx. 5s)
- The Control Unit display screen appears.
- The Control Unit searches for connected meas. boxes and shows these as independent tabs in the display.

i Control Unit and meas. box are not connected:
If the Control Unit has already been switched on, you must press **[⏻]** once again for a short moment to set up a connection to the meas. box.

3.2.4. Printing / saving data

Printing and saving is accomplished via the menu **Options**, which is accessed via the left function key and is available in many different menus (e.g. in the menu **Measurement Type**).

Assign the function **Save** or **Print** to the right function key.

i Only readings, which have a display field in the measurement view assigned, will be saved / printed out.

i The measurement data can be printed out parallel to the saving process, while a measurement program is running.

3.2.5. Switching off

i Unsaved readings will be lost when the flue gas analyser is switched off.

Rinse phase

When switched off, the meas. box checks whether flue gases are still in the sensors. The sensors are rinsed with fresh air, if this should be necessary. The duration of the rinse phase depends on the gas concentration in the sensors.

> press **[⏻]**.

- The rinse phase starts.
- The flue gas analyser switches off. It is normal for the fan of the meas. box to run on for a while.

3.3.   Folders / Locations

(only available via **Meas. Box** tab)

All readings can be saved under the currently active location. Readings not yet saved are lost when the measuring instrument is switched off.

Folders and locations can be created, edited, copied and activated. Folders and locations (incl. protocols) can be deleted.

Calling up the function:

> **[📱] → Folders → [OK]**.

Adapting the display:

> Toggle between overview (display of number of locations per folder) and detailed view (display of all locations per folder): **[Overview]** or **[Details]**.

Activating a location:

> Select the location → **[OK]**.

- The location is activated and the menu **Measurement Type** is opened.

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. **[Options] → New location→ [OK]**.

3. Enter values or make settings.

The following inputs/settings are possible:

Parameter	Description
Location	Enter name
Application	Select application
Fuel	Select fuel
Profile	Enter diameter, length, width, height and area.
	For correct measurement of the volume flow you must set the profile and area. A volumetric flow rate is calculated from the geometries entered here together with the measured velocity.

Parameter	Description
Pitot Tube Factor	The parameter "Pitot tube factor" influences the measurement of flow speed, volume flow rate and mass flow. The Pitot factor depends on the type of Pitot tube used: Straight Pitot tubes: Factor = 0.67 Prandt'l Pitor tubes (bent): Factor = 1
Humidity	The parameter "Humidity" (combustion air humidity) influences the calculation of qA (flue gas loss) and flue gas dew point. The factory setting is 80.0% humidity. To achieve a higher accuracy, the values can be adjusted to the actual ambient conditions.
Pressure absolute	The absolute pressure influences the calculation of flow speed, volume flow, mass flow and flue gas dew point. The factory setting is 980mbar. To achieve a higher accuracy, the values can be adjusted to the actual ambient conditions. **i** If a CO_2-(IR) module is installed, the absolute pressure value measured there will automatically be used.
Barometric pressure	**i** The input of the barometric pressure and the height above sea level is only required when no absolute pressure is available (no CO_2 IR module present). The barometric pressure influences the calculation of flow speed, volume flow, mass flow and flue gas dew point. To achieve a higher accuracy, the values can be adjusted to the actual ambient conditions. This is 1013mbar as an annual average, regardless of the altitude. Depending on the current weather, this pressure can fluctuate by ±20mbar around the annual average.
Altitude	The height above sea level influences the calculation of flow speed, volume flow, mass flow and flue gas dew point. To achieve a higher accuracy, the value can be adjusted to the actual ambient conditions.

Parameter	Description
Dewpoint	The parameter "Dewpoint" (combustion air dewpoint) influences the calculation of qA (flue gas loss) and flue gas dew point. The factory setting for the dewpoint is 1.5°C. To achieve a higher accuracy, the values can be adjusted to the actual ambient conditions.

4. Finalise the entry: **[Finished]**.

Other location options:

> **[Options]** → **Edit location**: Make changes to an existing location.

> **[Options]** → **Copy location**: Make a copy of an existing location in the same folder.

> **[Options]** → **Delete location**: Delete an existing location.

Create a new folder:

1. **[Options]** → **New Folder** → **[OK]**.
2. Enter values or make settings.
3. Finalise the entry: **[Finished]**.

Other folder options:

•   **Edit Folder**: Make changes to an existing folder.
•   **Copy Folder**: Make a copy of an existing folder.
•   **Delete Folder**: Delete an existing folder, including the locations created therein.
•   **Delete All Folders**: Delete all existing folders, including the locations created therein.

4 Using the product

4.1. Performing settings

4.1.1. Assigning the right hand function key

The right function key can have a function from the **Options** menu assigned to it. The menu **Options** is accessed via the left function key and is available in many different menus. This assignment is only valid for the currently opened menu / the opened function.

✓ A menu / function is opened in which the **Options** menu is displayed on the left function key.

1. Press **[Options]**.

2. Select option: **[▲]**, **[▼]**.

Depending on the menu / function from which the **Options** menu was opened, various functions are available.

3. Assign the selected function to the right function key: Press the **[Config. Key]**.

4.1.2. Instrument settings

4.1.2.1. Measurement view

(only available via **Meas. Box** tab)

The parameters / units and the display representation (number of readings displayed per display page) can be set.

The settings are only valid for the currently chosen combination of application and measurement type, which is indicated by the symbol (application) and the text (measurement type) in the info field.

Total overview of selectable parameters and units (available selection depends on the chosen application / measurement type):

Display	Measurement parameter
FT	Flue gas temperature
AT	Combustion air temperature
HCT	Heat carrier temperature
Δp	Differential pressure
Δp1	Differential pressure 1 (flue gas + m/s)
Δp2	Differential pressure 2 (flue gas + ΔP)
Draught	Flue draught
Pabs	Absolute pressure
Pump	Pumping capacity
O2	Oxygen
O2ref	Oxygen reference
CO2	Carbon dioxide
CO2max	maximal carbon dioxide content
Effn	Efficiency

Display	Measurement parameter
Effg	Efficiency under due consideration of the heat value range
CO	Carbon monoxide
uCO	Carbon monoxide undiluted
AmbCO	Ambient carbon monoxide
NO	Nitrogen monoxide
NO2	Nitrogen dioxide
NOx	Nitrogen oxide
SO2	Sulphur dioxide
H2S	Hydrogen sulphide
HC	Hydrocarbon
H2	Hydrogen
λ	Air ratio
Smoke numberØ	Mean smoke number
Oil deposits	Oil deposits yes/no
Ratio	Poison index
Vel	Flow velocity
Volume flow	Volume flow
Dew Pt	Flue gas dew point temperature
MCO	Mass flow CO
MNOx	Mass flow NOx
MSO2	Mass flow SO_2
MH2S	Mass flow H_2S
CO2IR	Carbon dioxide IR active
MCO2IR	Mass flow CO_2-IR
AmCO2	Ambient carbon dioxide
%rH ambient	Humidity measuring value external sensor
UI ext	external voltage
Itemp	Instrument temperature

Calling up the function:

> [📋] → **Device settings** → **[OK]** → **Measurement view** → **[OK]**

21

Change parameter / unit in a line:

1. Select the line: **[▲]**, **[▼]** → **[Change]**
2. Select the parameter: **[▲]**, **[▼]** → **[OK]**
3. Select the unit: **[▲]**, **[▼]** → **[OK]**
4. Save changes: **[OK]**

Options:

> **[Options]** → **Number of lines**: Change the number of measuring values per display page.
> **[Options]** → **Blank line**: Insert the empty line before the selected line.
> **[Options]** → **Delete line**: Delete the selected line.
> **[Options]** → **Factory setting**: Reset the readings display to factory setting.

4.1.2.2. Date / time

This function is available in both the meas. box and the Control Unit. Changes are accepted for the Control unit and for the meas. box.

Date, time mode and time can be set.

Calling up the function:

> **[📖]** → **Instrument Settings** → **[OK]** → **Date/Time** → **[OK]**

Set date/time

1. Select parameter: **[◄]**, **[▲]**, **[▼]** → **[Edit]**.
2. Set parameter: **[▲]**, **[▼]** and partly **[◄]**, **[►]**→ **[OK]**.
3. Save changes: **[Save]**.

4.1.3. Programs

Five flue gas measuring programs can be set, saved and executed.

The **Trigger** function (trigger signal as start/stop criterion) is only available for devices with the trigger input option.

i Instrument settings cannot be changed if a program is active or running.

ℹ️ The program **Flue Gas (before + after cat)** checks whether the meas. box is equipped with a fresh air valve. If not, a measuring program with normal flue gas measurement will be added, instead of the program **Flue Gas (before + after cat)**. A program **Flue Gas (before + after cat)** without fresh air valve does not show any sensible measuring results.

Calling up the function:

> **[📋] → Programs → [OK]**.

Activating / deactivating a program:

> Select the program: **[▲]**, **[▼] → [Enable]** or **[Disable]**.

- When activating a program: The program is activated and the measurement type matching the program is opened.

Editing the measuring program:

Adjustable parameters:

Parameter	Function
Measurement program	Edit program name
Measurement type	Select flue gas menu: • Flue gas • Flue gas + m/s • Flue gas ΔP • Flue gas (before and after catalyst) • Solid fuel
Reading per mean value	With mean value **Yes** only mean values will be saved.

23

Parameter	Function
Start	Determine the start criterion • The measuring program is started at any time (the function key automatically changes to the stop function). • Time Start of measurement at a pre-programmed time. • External signal Trigger signal to control the start of measuring programs.
Stop	Determining the stop criterion • The measuring program is stopped at any time (the function key automatically changes to the start function) • Time The recoding of readings stops at a desired time. • External signal Trigger signal to control the stop of measuring programs. • Duration Setting cycles to save readings. • Memory full Saving readings ends when the memory is full.
Gas time	Selection of gas time cycle
Rinse time	Enter the rinse time. ⓘ The measurement program always begins with a rinse phase (duration: 6min). Measuring phases (gas time) and rinsing phases (rinsing time) alternate according to the programmed values.
Meas. rate	The meas. rate is the saving cycle for mean values It is programmed in units of seconds, minutes, whereby the smallest possible meas. rate depends on the number and type of connected probes.

1. Select the program: **[▲]**, **[▼]** → **[OK]**.
2. Press **[Change]**.
3. Press **[Change]**.
4. Edit program name: **[▲]**, **[▼]**, **[◄]**, **[►]**.
5. Confirm the entry: **[OK]**.
6. Repeat steps 4 and 5 as required.
7. Press **[Next]**.
8. Perform steps 4 and 7 for further criteria accordingly.
9. Press **[Finished]**.

4.2.   Measuring

4.2.1.   Preparing for measurement

> **i** The combustion air temperature (VT) is continuously measured by the temperature sensor installed in the meas. box. The fresh air required for the zeroing phase is drawn in through the exhaust if no fresh air valve (option) is installed and through the valve inlet if a fresh air valve is installed. The flue gas probe can thus already be inside the flue gas channel before or during the zeroing phase.

Before switching on

> Check whether:
   • All system components are properly connected.
   • All required probes / sensors are connected.
   • The power supply of all system components is guaranteed.

During then zeroing phase

During the zeroing phase the sensors of the flue gas analyser are zeroed. The zero point and the drift of the sensors is checked. The O2 value is set to 21% O2.

> Make sure that the ambient air is free of interfering gases (e.g. CO, NO) during zeroing!

Before the measurement

> Set the fuel for the furnace system to be measured.
> Assign the required measurement parameters and units to a display field in the measurement view.

25

> Activate the location to which the readings are to be assigned.

> Make sure that the gas outlets are free, so that the gas can escape without obstruction. Otherwise the measurement results may be corrupted.

4.2.2. Applications

You can choose from fixed saved and a user defined application (application defined on the basis of the measuring object).

The memory contains suitable device settings for the meas. box and typical fuels and calculations for these applications. These quickly provides you with optimized device configurations for the respective measuring task and the device will automatically inform you about important application specific peculiarities (information in the display).

Calling up the function:

> **[📋]** → **Applications** → **[OK]**.

ℹ Press the function key **Options** to open configuration menus.

1. Selecting an application: **[⌃]**, **[⌄]** → **[OK]**.

2. Selecting fuel: **[⌃]**, **[⌄]** → **[OK]**.

3. Choose measurement type: **[⌃]**, **[⌄]** → **[OK]**.