Field guide

Control and adjustment of portable flue gas analysers

With practical advice, tips and tricks

Introduction

This guide is intended for users of Testo flue gas analysers who are responsible for their control and adjustment by means of test gases on the basis of particular requirements in respect of quality or accuracy.

It contains all the answers to questions which have cropped up on this subject at Testo over the course of time.

For those users who do not wish to explore this subject in greater depth, Testo offers a regular control and adjustment service (including calibration protocol) almost anywhere in the world.

This guide will help users decide which type of control they should choose.

It also offers information that would go far beyond the scope of the operating instructions for analysers.

What is missing? What has not been dealt with intensively enough? We welcome your ideas, amendments and suggestions for how this guide can be improved. They will be considered in the next issue.

The Board of Directors

Burkart Knospe　　Wolfgang Hessler　　Martin Schulz

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1. Definition of terms

Calibration

The determination, under prescribed conditions, of the mutual association between the indication of the analyser on the one hand and the relevant values of a variable (in this case test gas) represented as a measurement standard on the other. Result of a calibration: ⇨ Error of measurement.

Adjustment or alignment

Elimination of the falsifying systematic error of measurement for the intended application, e.g. readjustment with test gas in the event of deteriorating sensor sensitivity.

Standardisation

The standardisation of a measuring device comprises the quality inspections and identification markings to be carried out in accordance with standardisation regulations (e.g. standardisation laws, regulations on weights and measures). It is in actual fact impossible to standardise a flue gas analyser.

Error of measurement (accuracy)

Indicated measurement minus the true value of the measured variable. This can be represented in a variety of ways:

- relative deviation from the measured value
- deviation relative to the limit value of the measuring range
- absolute indication, for instance as vol. % or ppm.

Reproducibility (repeat accuracy)

Standard deviation of a series of measured values from measurements performed at short intervals of time and carried out according to a defined measurement procedure by the same operator on the same parts, using the same equipment and at the same place.

Linearity

Deviation from the correct values of the measured values displayed across a measuring range.

Zero point

What the sensor signal unit displays in the absence of the gas to be verified (= “target gas”).

Slope/sensitivity

Sensor signal per admitted (unit of) concentration. This is determined in adjustment, calibration and is stored for later measurements.

Measuring range

This is the concentration range in which the target gas can be measured by the sensor/unit with the specified accuracy.

Cross-sensitivity

The characteristic of sensors to react not only to the target gas to be verified, but also to other gases.

Response time

Period of time the sensor/unit needs in order to react to the introduced concentration with a stable signal/indication. In practice, t_{xy} times are given, e.g. T_{90} time. This is the length of time until 90 % of the introduced concentration is displayed.

Oxidation

The combination of elements with oxygen. In gases, for instance, the oxidation of NO produces NO_2.

Absorption

This is understood to mean the penetration of gases or gas mixtures into liquids or solid substances. NO_2, for instance, is absorbed/fixed by rubber or silicone hoses.

Adsorption

Adsorption takes place if gases are held solely by the surface forces when they come into contact with a solid substance, e.g. the inside wall of a hose. These “captured” gases are then given off again uncontrolledly (e.g. the presence of NO_2 is indicated even though no more NO_2 gas is applied).

2. The principles of test gases

Test gases are used for the calibration and adjustment of flue gas analysers. Different gas mixtures are required according to the device, the configuration and the sensors.

Gas mixtures:
Gas mixtures are homogeneous mixtures of different types of atoms and molecules. A large number of gases and possible combinations are available. However, the production of gas mixtures is constrained by the physical and chemical properties of the components and by aspects to do with safety.

The effects (cross-sensitivity) on other sensors in a fully-configured analyser with 5 or 6 sensors result from the use of several bottles with single concentrations (e.g. 100 ppm NO, residual N_2).

Components:
The gas constituents CO, O_2, N_2 etc. of a mixture are known as the components. Information on them can be found on the analysis certificate.

Carrier gas/basic gas:
This gas is the main constituent of the mixture. The main carrier gas used is nitrogen (N_2) or synthetic air.

Indication of content/concentration:
The amount of substance that does not depend on pressure and temperature. The common units are ppm (parts per million) or % (parts per 100). Conversion: 1 % = 10,000 ppm.

Other common indications are the volume vpm (volume per million) or mass kg/m^3. However, these are dependent on pressure and temperature and require the indication of the standard operating conditions, for instance the standard conditions of temperature 0 °C = 273.15 K and pressure = 1.013 hPa.

In practice, many mixtures can be regarded more or less as a mixture of ideal gases in which the same amount of substance of the respective components takes up the same volume. This means that the amount of substance in ppm and the volume in vpm are equivalent in this approximation.

Accuracy of test gas/certificate:
Test gases can be obtained in a variety of accuracy classes. The achievable precision depends on the type and the content of the desired components.

For analysers, the test gas used usually has an analysis tolerance (does not correspond to the manufacturer's tolerance) of 2 % of the measured value.

For the purposes of traceability, it is important that test gases with a manufacturer's certificate are used.

Information on the analysis certificate:

- Production tolerance
  This is the maximum permitted deviation of a component (actual value) from the prescribed target value in the manufacture of the gas mixture.
- Analysis tolerance
  After the mixture has been produced, the exact composition is determined with restorative methods of analysis. The analysis tolerance gives the maximum deviation of the measured value indicated on the certificate from the true value of a component.
- Stability and period of use
  Depending on their type, gas mixtures cannot be stored and used indefinitely. This "use by" date must be indicated on the analysis certificate. Two years is typical for standard gas mixtures.
- Filling pressure and minimum pressure of use
  The filling pressure corresponds to the bottle pressure of a new bottle at the reference temperature. The minimum pressure of use must not be underused because stable concentrations are no longer guaranteed.

- Storage temperature
  The storage temperature should be observed in order to prevent the gas mixture from changing over time and to avoid adsorption effects if temperatures are too low.

Test gas containers:
Test gases are available in pressurised gas cylinder bottles from specialist gas manufacturers. In Europe the standard bottle sizes have volumes of 50, 40, 10 and 2 litres.

These bottles are bought on a rental/money-back basis. Smaller aluminium bottles are also available. See Testo's calibration bottles.

The typical standard filling pressure of the larger steel bottles is about 150 or 200 bar. In a 10-litre bottle, this means a useful volume of 1500 litres of gas.

For portable flue gas analysers with a flow rate of 1.0 to 1.2 l/min, it is assumed that 5 to 6 litres of gas will be required per calibration/adjustment (for each sensor) in the case of single gases.

For the above 10-litre bottle, this is enough for about 300 controls/adjustments. When determining the optimal bottle size, it must also be remembered that the maximum period of use of the test gas is around 2 years. The test gases should definitely not be used any more after 2 years, regardless of how much is left in the bottle.

Test gas combination - multiple or single gases?
A single gas is taken to mean a gas mixture of the mixed substance and a carrier gas (residual gas). Example: 300 ppm CO, residual nitrogen (N_2).

Multiple gases contain more than one of the desired components (maximum 4). However, it must be remembered that not all combinations are possible.

Multiple gases are also normally more expensive, and some of them have a shorter period of use. The advantage of multiple gases is the reduction in the number of bottles and thus simpler handling. Recommendation: Manufacturers hold standard combinations (mixes) in stock. These standard concentrations should be preferred in the event of purchase.

If using multiple gases, it is also important to note any cross-sensitivities of gas sensors (see Point 4.5). Example: An SO_2 sensor with NO_2 cross-sensitivity cannot be adjusted using mixed gas containing NO_2.

Safety advice for handling test gases:

Operations with test gases demand particular attention with regard to safety. Please refer to TRGS 280 (Operation of pressurised gas vessels).

Important safety aspects - an overview (not complete):

- Gas bottles must always be protected against falling over, e.g. by means of chains or belts.
- Test gas bottles must only be stored and used in well-ventilated rooms or under venting. Danger of poisoning.

The maximum working concentration and its short-time value must not be exceeded.

Gas	Threshold limit value	Short-time value	Short-time value duration
CO	30 ppm	60 ppm	30 min
CO_2	5 000 ppm	1 %	60 min
NO	5 ppm	10 ppm	5 min
NO_2	5 ppm	10 ppm	5 min
SO_2	2 ppm	4 ppm	5 min
NH_3	50 ppm	100 ppm	5 min
H_2S	10 ppm	20 ppm	10 min

- With explosive gases, note the explosion limit:
  methane 5 %, propane 2.1 % and hexane 1 %.
- Additional regulations must be observed when transporting (e.g. by car, aircraft etc.).

3. Hardware for adjustment and control (material composition)

The materials in the hardware that is used must satisfy the following criteria:

The pressure reducer fittings and pipes to and from the gas bottles should be made of stainless steel (reason: aggressive, corrosive gases). In the case of bottles with a brass outer thread (e.g. for CO, CO_2), the pressure regulator can be made of brass for reasons of cost.

In the case of reactive gases such as NO_2, SO_2, the hose material used must have a negligible level of absorption. Recommended materials: Teflon® (PTFE), Viton®, Tygon® or C-Flex®.

Admitting gas into an analyser

Gas should be admitted into the flue gas analyser unpressurised if at all possible. Ideally, a bypass with indication of the test gas overflow will be used for admission (measuring range 0...2 litres/minute). This gas flow meter (flowmeter) will help to ensure both that no ambient air is taken in and that test gas is not unnecessarily “wasted” through the bypass outlet.

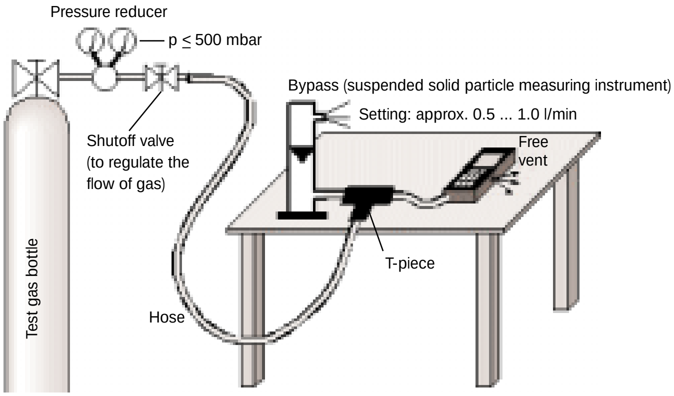


Fig.: Typical setup and hosing

Alternatively, the test gas can be applied directly without a bypass by using a precision pressure regulator.

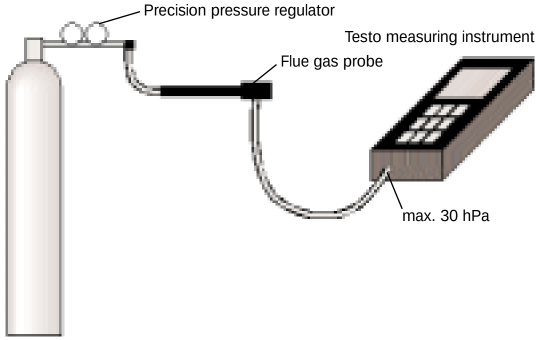


Fig.: Gas adjustment using a precision pressure regulator

With this method, the pressure of the test gas must be 12”wc (0.433 PSI). Excessive pressure will lead to incorrect results. The ideal recommended maximum pressure at the gas inlet is 8” wx (0.288 PSI). If necessary, the differential pressure of the analyser can be measured in order to check the gas pressure.

General information

Before any gas adjustment/calibration, the devices and the gas routes from the test gas bottles must be checked for leaktightness. To this end the gas inlet is sealed up, for instance, and an indication of < 0.03 l/min in devices with integrated flow measurement is achieved.

In the case of gases with absorption effects such as NO_2 and SO_2, the test gas should be admitted via the tip of the probe. This ensures that absorption effects in the gas route are compensated via this gas adjustment so that the real gas measurements are as precise as possible.

Special advice for the adjustment process:

☑ Make sure that the ambient temperature remains the same throughout gas adjustment.

☑ Wait until the devices have warmed up (e.g. about 30 minutes for the testo 350 M/XL).

☑ To ensure the greatest possible accuracy, in the ideal case the same ambient conditions should prevail during gas adjustment as during real gas measurement.

☑ Do not choose a test gas concentration that is too low for the slope adjustment. See Point 4.4 for a recommendation.

☑ The zero point and slope value must be stable before adjustment is started.

☑ With mixed gases, allow for the influences due to cross-sensitivities. It may be that the corresponding cross-sensitivity also has to be adjusted.

4 Adjustment/alignment

4.1 Factory adjustment at Testo Flue gas analysers

Every flue gas analyser runs through a computerised adjustment and test cycle during production or after repair/servicing at Testo, during which a wide variety of test gases are applied, during this operation the sensors and the unit are gone over “with a fine-toothed comb”.

Photograph: Adjustment cabinet for Testo analysers

In total up to 17 different gas mixes are used at Testo, depending on the type and configuration of the device. The different gas mixes are required both for adjustment and for the subsequent control. This is carried out at different concentrations to those used in the adjustment. The other adjustment points (slope points) are chosen in such a way that the unit can be used across the entire indicated measuring range and so that universal applicability in practice is guaranteed without any additional adjustment being required. The result of the test gas control with other concentrations than in the adjustment is documented on the adjustment protocol. This adjustment protocol (= calibration protocol) is enclosed with every unit.

Kalibrier-Protokoll

Photograph: Calibration protocol for the testo 350 XL after leaving the factory

Test gas concentrations used for factory calibration
(As at August 2003)

	Calibration gas*	Testo measuring instrument						
		testo 325 I	testo 325 M	testo 325 XL	testo 300	testo 300 XXL	testo 350 M/XL	testo 360
C O 0...10,000 ppm	400 ... 1,000 ppm CO 1 ... 5 % O_2			X	X	X	X	X
CO_{low} 0...500 ppm	300 ... 400 ppm CO 1 ... 5 % O_2						X	
CO_{high} 0...40,000 ppm	5,000 ppm CO 1 ... 5 % O_2	X						
C O 0...2000 ppm	700 ppm CO 1 ... 5 % O_2	X	X					
NO (standard)	60 ... 800 NO	X			X	X	X	X
NO_{low}	40 ... 300 NO						X	
NO_2	100 ... 200 ppm NO_2 Residual synthetic air					X	X	X
SO_2	1,000 ... 2,000 ppm SO_2	X			X		X	X
H_2S	100 ... 200 ppm H_2S						X	
HC (C_xH_y)	4,000 ... 5,000 ppm CH_4 Residual synthetic air						X	X
CO_2	15 ... 40 Vol.%						X	X

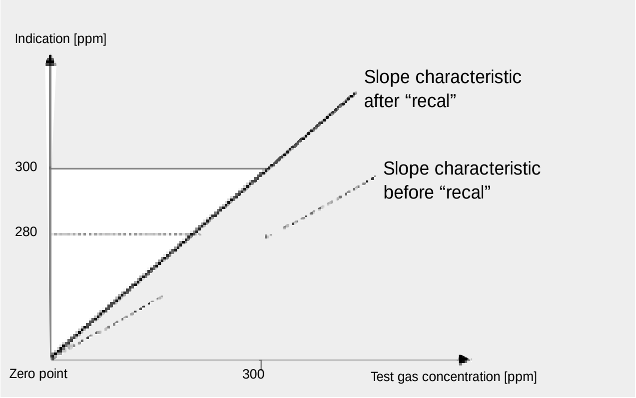
* Residual N_2 unless otherwise indicated

For the subsequent control, other concentrations of test gases are used and documented in the calibration protocols. In general, the specifications (accuracies) specified in the documents such as the brochure or operating instructions must be met in the control with test gas.

4.2 Adjustment/readjustment with Testo devices - options for the user

Most Testo flue gas analysers offer the user the option of controlling or adjusting the device by means of calibration gases. To keep this as simple and reliable as possible, a 1-point recalibration (“recal”) is carried out. This recalibration can be used for:

- Narrowing the measuring range down to specific requirements (increasing the accuracy for a certain measuring range)
- “Tightening” the sensor signal after a loss of sensitivity (eliminating sensor ageing).



The zero point is automatically checked by the measuring instrument in fresh air during the ON phase. Separate zero point correction is not required in electrochemical measuring cells, unlike optical sensors, because the zero point is extremely stable.

Since test gases are absolutely essential for every readjustment and calibration, in most countries Testo offers a control, readjustment and calibration service in its own, well-equipped laboratory.

The advantages of using this service are:

- there is no need to stock test gases
- necessary repairs and/or service work can be carried out at the same time
- a “neutral” certificate (calibration protocol) is obtained
- it is inexpensive, since the user does not need to invest in gases etc.

4.3 Adjustment intervals

When and how often a control should be performed with test gas depends on the accuracy requirements and on the traceability of the measurement results.

In official measurements (state testing or EPA), for instance, it is a requirement that a control be performed and documented before every measurement.

For those areas not regulated by legislation and other rules, the following recommendations for test gas control and adjustment apply:

1 x per year
Normal use, concentration in the lower third of the measuring ranges, no particular requirements regarding accuracy.

2 - 4 x per year (every 3 to 6 months)
More frequent use, longer-lasting measurements (over several hours), concentration up to 2/3 of the measuring ranges, or where-accuracy is quite important.

more than 12 x per year (monthly)
Daily use, depends very much on the measured values, high concentrations, continuous measurements lasting several days, accuracy/comparability is extremely important.

4.4 Recommended gas concentrations

In the ideal scenario, test gas concentrations in the range of the measured flue gas concentrations would be used for adjustment ("recal"). However, limits must be set in the lower and upper measuring range.

1.) The smallest feasible test gas concentrations for adjustment are:

	Minimum gas concentration
CO	150 ppm
CO_{low}	50 ppm
NO	80 ppm
NO_{low}	40 ppm
H_2S	40 ppm
SO_2	100 ppm
NO_2	40 ppm
HC	4,000 ppm
CO_2	2 vol.%

2.) The smallest test concentrations for the calibration check are:

	Smallest gas concentration	In comparison: detection limits of testo 350 M/XL
O_2	0.5 ... 20.0 vol.%	0.1 vol.%
CO	10 ppm	2 ppm
CO_{low}	5 ppm	0.8 ppm
NO	10 ppm	2 ppm
NO_{low}	5 ppm	0.5 ppm
H_2S	10 ppm	1 ppm
SO_2	10 ppm	2 ppm
NO_2	10 ppm	1 ppm
C_XH_Y	4,000 ppm	100 ppm
CO_2	0.5 vol.%	0.2 vol.%

Side constraints for the use of low concentrations are:

- Use absorption-free hose material
- Apply the test gas at the tip of the probe
- Use single gases, e.g. NO with nitrogen as the carrier gas
- Use the device “warmed up” (warm-up time at least 20 minutes)
- Zero with clean air after 20 minutes
- Maximum overpressure of the test gas: 12” WC;
  better: unpressurised via bypass
- Pump flow in the unit $\geq$ 0.5 l/min
- Apply the test gas for at least 7 minutes

For adjustment in higher concentration ranges, a test gas whose concentration corresponds to about 25 - 30 % of the desired measuring range limit value is sufficient. Because of the greater strain on the sensors, adjustment at the limit value of the measuring range should only be carried out in exceptional cases.

Recommended gas components for mixed gases (e.g. for a fully-configured testo 350 XL):

1st bottle:	$CO + N_2$
2nd bottle:	$SO_2 + O_2 + N_2$
3rd bottle:	NO_2 + synthetic air
4th bottle:	H_2S + synthetic air/N_2
5th bottle:	CH_4/propane/butane + synthetic air (Attention! For C_xH_y measurement on the pellistor principle there must be an O_2 content of > 2 % in the test gas).
6th bottle:	17% CO_2 in N_2 (Att: CO_2 calibration is two point process. Use bottle 1, CO in N_2 as your CO_2 “zero” point.)

The use of test gases containing O_2 has the following advantages (O_2 < 5 %).

- The accuracy of the O_2 indication can be verified
- The leaktightness and plausibility of the indication can be checked
- Simulation of real flue gases.

Test gases with no O_2 content do not result in any damage to the electrochemical measuring cell because the oxygen required for electrochemical transformation is taken from the electrolyte of the cell. Nevertheless, the measuring cell requires fresh air phases at regular intervals for regeneration. That is why the test gas should not be applied for more than 5 minutes during gas control or gas adjustment. Rinsing with fresh ambient air should then be carried out.

4.5 Cross-sensitivity

a) Gas cross-sensitivity

When a single gas concentration is applied, it may happen that an additional sensor displays a value that is not in the test gas at all. In this case we speak of the cross-sensitivity or selectivity of a sensor. Multiple gas analysers such as the testo 350 take this situation into account by applying cross-sensitivity coefficients to the sensor signals and indicating them on the display. In addition, sensors with diffusion filters which prevent the interfering gas from penetrating into the sensor are used.

With all other devices this is done by the Testo Service department (if necessary).

b) Water vapour

Cross-sensitivities exist in some measuring processes, e.g. CO infrared measurement. This is not the case with electrochemical measuring cells. Even with IR sensor technology, the effect on the gas components by the water vapour must be taken into account.

In practice, the test gas is not led through a hydraulic seal, since the influence remains within the tolerance of the unit.

5. Step by step - here, using the testo 350

Example: Control and adjustment of a CO module with test gas 1000 ppm/1.4 % O_2.

1. Switch the unit on and wait until the ON phase is over.
2. Connect the test gas to the analyser via the flue gas probe.

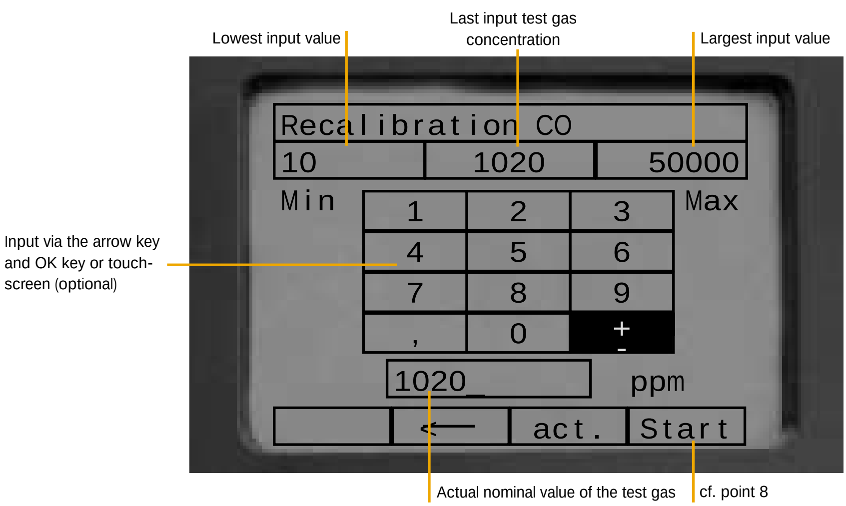
3. Open the test gas bottle and set the flow rate on the flowmeter to about 1.5 l/min.

4. Press the Start key to start the pump in the analyser. You may need to regulate the test gas volume again (watch the flowmeter).

5. Check the displayed value against the nominal value of the test gas.

6. To recalibrate, press the Book key in the “Sensors” menu and select —> o.k. —> “Recalibration” —> CO.

7. Enter the nominal value of the test gas.



8. Start the recalibration

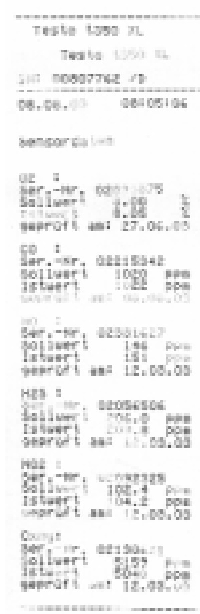
Caution:

- Check the flow of test gas via the flowmeter regularly.
- Wait until the value is stable (approx. 3 minutes) before pressing OK.

Save the nominal/actual value (from software issued January 2003 on).

The analyser takes the nominal value as the actual value and saves it. Do a control check with another test gas if necessary.

The testo 350 M/XL saves the deviation from the nominal and actual value. This automatically created calibration protocol is printed out on the device's internal printer.



9. Shut off the supply of test gas and withdraw the gas tube (hose) from the analyser.

10. Rinse the analyser by pumping in fresh air for about 1-2 minutes.

6. Troubleshooting

1. Gas adjustment in general not easily reproducible (indicated value is not correct, even after adjustment).

Possible causes:

- Adjustment was initiated before the value was stable.
- Adjustment conditions not identical with control conditions, sensors drifts too much or sensor is consumed.

Influences on the reproducibility of the gas adjustment

- Test gas bottles used in adjustment different from those used in control
- Ambient temperature, device temperature
- Flow rate of measuring gas
- Pressure of the test gas at the gas inlet
- Pressure reducer/regulator causes pressure jolts
- Time when adjustment is initiated and value is read off in control
- Leakage in the entire gas route system
- Adjustment point outside the sensor measuring range or outside the sensor specification

Remedy:

- Rinse pressure reducer and hoses through if necessary
- Keep general influencing conditions stable
- Carry out a leak test before gas adjustment
- Do not change the test gas bottle between adjustment and control
- Note the sensor specification and Testo recommendation for test gas
- Replace sensors with significant drift
- If adjusting several sensors one after the other, you may need to rinse through between the individual test gas admissions (to avoid or minimise possible cross-sensitivity effects)

2. Long response times of NO_2, SO_2, H_2S

Causes:
Contaminated flue gas probe, probe tube, particle filter, gas cooler, ... damp particle filter. Flow rate or pump capacity too low (NO_2 is sensitive to flow rate). Components for admitting test gas made from material that distorts the test gas due to absorption effects (e.g. silicone tubing with NO_2 and SO_2). Hoses and test gas pipes too long and internal diameter unnecessarily large in the admission system.

Remedy:
Clean/dry the listed measuring system components or renew if necessary. To admit test gas use materials such as teflon and stainless steel (pressure reducer).

Keep hose and pipe lengths and internal diameter to a minimum. In general, the smaller all the volumes in the system, the more precise the gas calibration.

3. Excessive deviation from additional analyser

Causes:
Different adjustment gases used in the Testo device and the other unit.

Different cross-sensitivities when mixed gases are used.

Remedy:
Use the same test gases (measuring ranges should be similar). If possible, use test gases with only one component.

testo 325 i

The testo 325 M, the successor to the tried-and-tested testo 325-1, meets all the requirements governing the adjustment of furnaces for heating engineers, while the option of differential pressure measurement also helps the gas engineer in servicing operations.
TÜV for O_2, CO_2 and °C/°F

The TÜV-inspected testo 325 XL helps the heating engineer carry out control measurements. It meets all the requirements for the adjustment, servicing and maintenance of furnaces.
TÜV for O_2, CO_2, °C, °F and CO

- CO measuring ranges up to 4,000 ppm
- Two differential pressure measuring ranges
- Measured values output with date and time
- Memory for 20 measuring blocks (testo 325 XL)

CO measurement up to 4000 ppm

Storable O_2 air inlet measurement for ambient air-dependent systems (only testo 325 XL)

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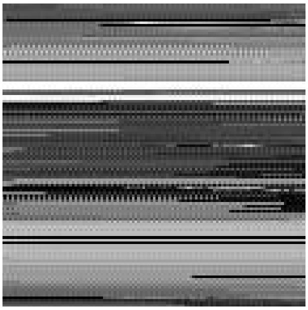
testo 325-I: Single gas industrial analyser

The testo 325-I is the way into cost-effective flue gas measurement for CO, NO and SO_2. It combines precision with ease of use and low costs, making it the ideal partner for emissions checks and monitoring thermal processes.
The measuring result is continuously displayed on the screen throughout the measuring process. The measured value along with the data and time are documented by the wireless Testo printer at the press of a button.

- Easy to operate and use, large display
- Easy replacement of measuring cells by the user on site
- Magnetic SoftCase protects the instrument from dirt and impacts
- Measured values output with date and time
- Power supply via battery or power pack

Adjustment of flue gas recovery for NO_X reduction



Adjustment of gas-driven engines with the CO_{high} analyser

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testo 325-I: 4 versions covering every application

testo 325-I SO_2

- Check emissions of coal and heavy fuel stoves
- Monitor flue gas desulphurisation systems
- Process control in the glass and ceramics industry

testo 325-I NO

- Check emissions of engines and furnace chambers
- Check nitrogen removal systems/catalytic converters
- Adjust flue gas recovery for NOx reduction

testo 325-I CO_{low}

- Check emissions and adjust gas burners
- Localise secondary air influxes in long flue gas channels

testo 325-I CO_{high}

- Check the atmosphere of thermal processes in the manufacturing sector (tunnel furnaces, curing ovens, melt and annealing processes)
- Adjust process burners
- CO engine exhaust measurement for industrial trucks

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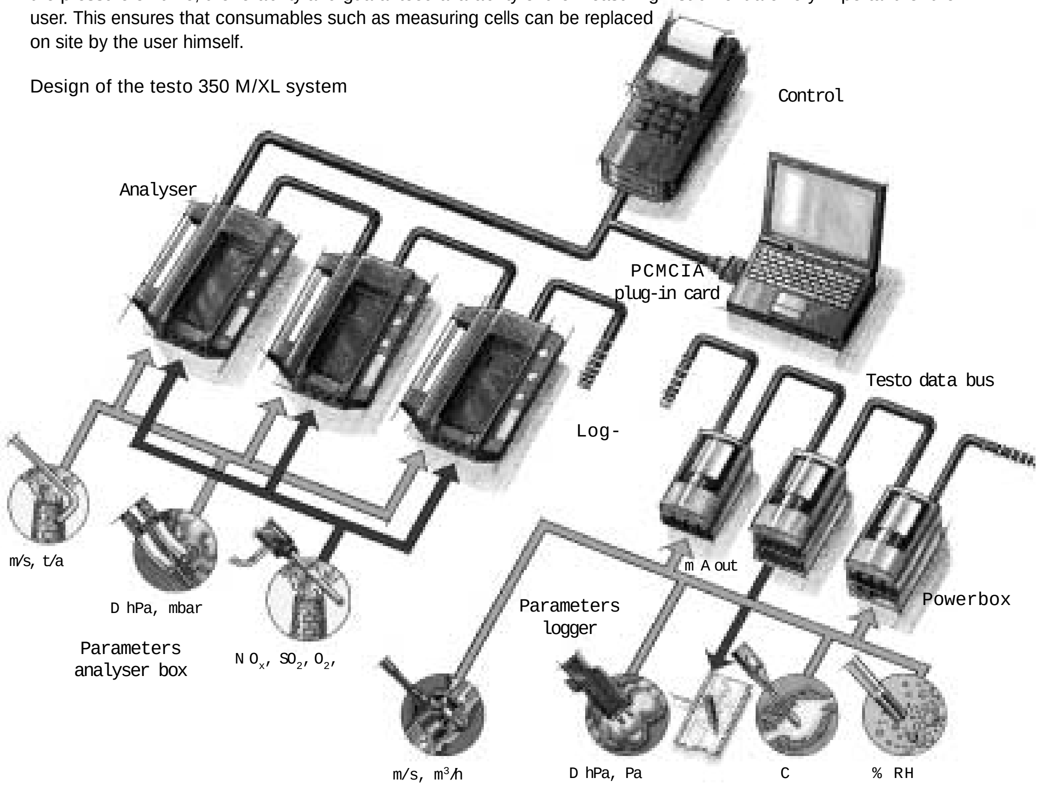
testo 350: The world's most advanced emission analyser

For portable use in industrial systems, the measuring instrument must be robust and as easy as possible to transport. Ideally, the unit will remain in its case during operation. A further problem comes with the distance between the gas sampling point and the burner (= place of measurement). That's why the control unit in the testo 350 M/XL can be detached, enabling it to be used at distances of up to several hundred metres from the analyser box. While on the subject of gas preparation: from short spot measurement through to measurements lasting several hours, the use of a gas preparation in the industrial sector is a must. Only then can precise measurements, for example of NO_X or SO_2, be achieved, while the measuring instrument is also protected against aggressive condensation from the flue gas. Given the pressure on time, the reliability and guaranteed availability of the measuring instrument are very important for the user. This ensures that consumables such as measuring cells can be replaced on site by the user himself.

Design of the testo 350 M/XL system



The corresponding flue gas and flow probes as well as temperature probes are available for the different applications. Flue gas probes are available in lengths of up to 4 m, 1,700 °C and/or heated (to avoid condensation). There are temperature probes for surface, gas and fluid measurements. With flow probes, vane and hot-wire/hot-bulb probes can be connected to the control unit as well as the pitot tubes.

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testo 350

The testo 350 is a flexible, portable measuring system that adapts to meet a wide range of requirements. The instrument can thus be used for

- adjustments on all kinds of industrial burners
- recording concentrations of crude and pure gas over a long period of time
- monitoring atmospheres in process ovens of all kinds
- maintaining stationary engines such as cogeneration power stations
- verifying gas pressures and gas speeds both in flue gas and in air inlet ducts.

The entry-level testo 350 M consists of a control unit, analyser box and flue probe. It measures O_2, CO, NO (optional), NO_2; CO_2 direct (optional), SO_2 (optional), (max. 4 measuring modules), temperature and differential pressure as well as the usual calculated variables of CO_2, qA, etc.

The detachable control unit can also be employed as a stand-alone measuring instrument for temperature, flow rate, differential pressure, relative humidity etc. The measured values are documented with the integrated printer. The analyser box contains a complete Peltier gas preparation for the controlled disposal of condensation.

The additional features of the higher-spec testo 350 XL include the measuring parameters of NO and NO_2, a trigger input, a fresh air valve as well as the option of upgrading with 2 further measuring modules, e.g. CO_2 direct, HC, SO_2 or H_2S).

Features

- Mains-independent operation even with gas preparation (up to 2-3 h)
- Analyser box with data memory function even without the control unit
- Fast and simple operation via touchscreen (optional)
- Measuring range extension (optional) for CO
- The matching flue gas probe can be selected for each application
- Special gas sensors ensure extremely high accuracies in the lower range for CO and NO
- Low weight (approx. 4.5 kg) and small size mean easier handling
- Stable transport case allows use in tough environments

Analyser box

The analyser box is the “heart” of the analyser. In one housing are integrated:

- The relevant gas sensors and differential pressure measurement
- Measuring gas pump with flow rate monitoring
- Peltier gas preparation (with hose pump for condensation disposal)
- CO shut-off to protect the CO sensor
- Rechargeable NiMH battery (without memory effect)
- Integrated power pack (110/230 V, 50...60 Hz)
- Measurement data memory (1 MB)
- Options such as fresh-air valve (for lengthy measurements using the testo 350 M, standard in the XL)

Control unit

The control unit can control the entire system and read out the data. It is also a handheld measuring instrument for differential pressure (integrated) and has a further probe input for temperature, moisture, flow rate etc.

Other advantages:

- PC interface (RS232) for reading out data
- Illuminated graphic display
- Simple, menu-controlled operation with freely assignable function keys
- Integrated data memory (1 MB)
- Print out current or saved data
- Touchscreen operation (optional) for rapid operation and inputting
- Magnets on the rear to enable fixing at the place of measurement
- Robust housing with impact protection
- Power supply via analyser box with exchangeable battery unit or power pack


Control unit


Analyser box

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Copy model

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Suggestion for improvement / Request for product information

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☐ I would like more information about the following products:

☐ testo 325-I ☐ testo 350 M/XL ☐ testo 325 M/XL ☐ testo 300 XXL

☐ testo 330-2 ☐ testo 335

We are grateful for any suggestion for improvement that will help us keep this test gas guide up to date and adapt it to the requirements of the industry.

☐ I have the following suggestion for improvement:

Chapter	Page	Subject	Suggestion