

ABB MEASUREMENT & ANALYTICS | OPERATING INSTRUCTION

AO2000

Continuous gas analyzers



Integrated analyzer system

Measurement made easy

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Preface

Content of this operating instruction

This operating instruction contains all the information necessary for the safe and compliant installation, start-up, operation, calibration, configuration and maintenance of the gas analyzer.

NOTE

Descriptions and instructions for the Fidas24 analyzer module in this operating instruction generally also apply for the Fidas24 NMHC analyzer module. Divergent and supplementary descriptions and instructions for the Fidas24 NMHC analyzer module are added if applicable.

Additional documentation

Title	Publication No.
AO2000 Series Continuous gas analyzers – Data sheet	DS/AO2000-EN
Function blocks: Descriptions and configuration – Technical information	30/24-200 EN
AO-HMI Remote control interface – Technical information	30/24-311 EN
AO2000 Series PROFIBUS DP/PA interface – Technical information	30/24-315 EN
AO2000 Modbus and AO-MDDE – Technical information	30/24-316 EN
AO2000-LS25 Laser analyzer module – Commissioning instruction	CI/AO2000-LS25-EN

Further information

Analyzer data sheet

The version of the delivered gas analyzer is described in the "Analyzer data sheet" supplied with the gas analyzer.

DVD-ROM "Software tools and technical documentation"

The DVD-ROM "Software tools and technical documentation" with the following contents is included in the scope of supply of the gas analyzer:

- Software tools
- Operating instructions
- Data sheets
- Technical information
- Certificates

Internet

You will find information on ABB Analytical products and services on the Internet at "<http://www.abb.com/analytical>".

Service contact

If the information in this operating instruction does not cover a particular situation, ABB Service will be pleased to supply additional information as required.

Please contact your local service representative. For emergencies, please contact

ABB Service,
Telephone: +49-(0)180-5-222 580, Telefax: +49-(0)621-381 931 29031,
E-mail: automation.service@de.abb.com

Symbols and typefaces in this instruction

ATTENTION identifies safety information to be heeded during gas analyzer operation, in order to avoid risks to the user.

NOTE identifies specific information on the operation of the gas analyzer as well as on the use of this instruction.

1, 2, 3, ...	Identifies reference numbers in figures.
Display	Identifies a display on the screen.
Input	Identifies a user entry <ul style="list-style-type: none"> • either by pressing a soft key • or by selecting a menu item • or via the numeric keypad
Function block	Identifies a function block designation.
'Name'	Identifies a function block name assigned by the gas analyzer or entered by the user.
p_e	Gauge pressure
p_{abs}	Absolute pressure
p_{amb}	Atmospheric pressure

Guideline for installation and commissioning

Basic steps

The following basic steps should be followed for the installation and commissioning of the gas analyzer:

- 1** Note the information on the intended application (see page 12).
- 2** Follow safety precautions (see page 13).
- 3** Prepare for the installation, provide the requisite material (see page 34).
- 4** Unpack the gas analyzer (see page 73).
- 5** Check gas path seal integrity (see page 268).
- 6** Install the gas analyzer (see page 79).
- 7** Connect the gas lines (see page 80).
- 8** Connect the electrical leads (see page 107).
- 9** Check the Installation (see page 126).
- 10** Purge the gas paths and housing (see page 127).
- 11** Start-up the gas analyzer (see page 128).

Safety information

Intended application

Intended application

The AO2000 Series gas analyzers are designed for continuous measurement of the concentration of individual components in gases or vapors.

Any other use is not as specified.

The specified use also includes taking note of this operating instruction.

The AO2000-Fidas24 and Fidas24 NMHC gas analyzers may not be used for the measurement of ignitable mixtures during normal service. Special measures must be taken to prevent an explosion hazard during the measurement of flammable gas which can form an explosive mixture in association with air or oxygen.

The AO2000 Series gas analyzers as well as the models with type of protection II 3G for measurement of non-flammable gases and vapors must not be used for measurement of explosive mixtures. Explosion-protected models of the gas analyzers are available for this application.

Please note the information on intended application for versions

- with type of protection II 3G for measurement of non-flammable gases and vapors (see page 18),
- with type of protection II 3G for measurement of flammable and non-flammable gases (see page 20) and
- for use in Class I Div. 2 explosion hazard areas (see page 33).

Special requirements for the operator

Special requirements for the operator

- The operator must ensure that the gas analyzer is operated only with a sample gas mixture in which the concentration of flammable sample gas is below the LEL.
- No explosive gas mixture may be introduced into the gas analyzer – taking into account pressure, temperature and gas matrix.
- Before commissioning the gas analyzer, the sample gas path must be purged to remove any potentially explosive gas mixtures from the sample gas path.
- The operator is obliged to subject the gas analyzer to a leak test at regular intervals, but at least once a year and after any work on the sample gas path.
- The operator must ensure that when the gas analyzer is switched off, the sample gas supply is interrupted and the sample gas path is purged with compressed air or an inert gas.

Safety information

Requirements for safe operation

In order to operate in a safe and efficient manner the device should be properly handled and stored, correctly installed and set-up, properly operated and correctly maintained.

Personnel qualifications

Only persons familiar with the installation, set-up, operation and maintenance of comparable devices and certified as being capable of such work should work on the device.

Special information and precautions

These include

- The content of this operating instruction,
- The safety information affixed to the device,
- The applicable safety precautions for installing and operating electrical devices,
- Safety precautions for working with gases, acids, condensates, etc.

National regulations

The regulations, standards and guidelines cited in this operating instruction are applicable in the Federal Republic of Germany. The applicable national regulations should be followed when the device is used in other countries.

Device safety and safe operation

The device is designed and tested in accordance with the relevant safety standards and has been shipped ready for safe operation. To maintain this condition and to assure safe operation, read and follow the safety information in this operating instruction. Failure to do so can put persons at risk and can lead to device damage as well as damage to other systems and devices.

Protective lead connection

The protective lead (ground) should be attached to the protective lead connector before any other connection is made.

Risks of a disconnected protective lead

The device can be hazardous if the protective lead is interrupted inside or outside the device or if the protective lead is disconnected.

Risks involved in opening the covers

Current-bearing components can be exposed when the covers or parts are removed, even if this can be done without tools. Current can be present at some connection points.

Risks involved in working with an open device

All work on a device that is open and connected to power should only be performed by trained personnel who are familiar with the risks involved.

When safe operation can no longer be assured

If it is apparent that safe operation is no longer possible, the device should be taken out of operation and secured against unauthorized use.

The possibility of safe operation is excluded:

- If the device is visibly damaged,
- If the device no longer operates,
- After prolonged storage under adverse conditions,
- After severe transport stresses.

Fidas24: Information on the safe operation of the gas analyzer

CAUTION

The gas analyzer uses hydrogen as a combustion gas!
All the information and instructions contained in this operating instruction must be complied with without fail to ensure safe operation of the gas analyzer!

Measures of the manufacturer

The following measures ensure that the enrichment of combustion gas or an explosive mixture of combustion gas and ambient air cannot occur inside the gas analyzer during normal operation:

- The seal integrity of the combustion gas feed path is checked for a leakage rate of $< 1 \times 10^{-4}$ hPa l/s before delivery.
- The combustion gas/air mixture (before and after the ignition point) is diluted in the detector with compressed air.
- The combustion gas feed is not connected to the supply during start-up until the internal nominal pressures have been set.
- The combustion gas feed is switched off if the internal nominal pressures cannot be set during the ignition phase (e.g. because of insufficient compressed air or combustion air feed).
- The combustion gas feed is switched off after several unsuccessful ignition attempts.
- If the flame goes out during operation the combustion gas feed is switched off if the following ignition attempts are unsuccessful.

The interior of the gas analyzer is not assigned to an (explosion protection) zone; no explosive gas mixture can escape from it to the outside.

Conditions to be complied with by the end user

The end user must comply with the following prerequisites and conditions to ensure safe operation of the gas analyzer:

- The gas analyzer may be used for the measurement of flammable gases provided that the flammable portion does not exceed the following limit values:
Fidas24: 15 vol.% CH₄ or C1 equivalents,
Fidas24 NMHC: 5 vol.% CH₄ or C1 equivalents.
- The relevant safety regulations for working with flammable gases must be complied with.
- The gas connection diagram (see page 83) must be complied with when connecting the combustion gas and combustion air.
- The combustion gas feed path in the gas analyzer may not be opened! The combustion gas feed path can become leaky as a result! Escaping combustion gas can cause fires and explosions, also outside the gas analyzer!
- If the combustion gas feed path in the gas analyzer has been opened, however, it must always be checked for seal integrity (see page 285) with a leak detector after it has been sealed again (leakage rate $< 1 \times 10^{-4}$ hPa l/s).
- The seal integrity of the combustion gas line (see page 283) outside the gas analyzer and the combustion gas feed path (see page 285) in the gas analyzer must be checked on a regular basis.
- The maximum pressures of combustion gas and combustion air (see page 48) may not be exceeded.

- The maximum combustion gas flow (see page 48) may not be exceeded.
- The combustion gas flow rate must be limited to a maximum of 10 l/h of H₂ or 25 l/h of H₂/He mixture. For this purpose, the end user has to provide suitable measures (see page 48) outside the gas analyzer.
- A shut-off valve (see page 48) must be installed in the combustion gas supply line to increase the safety in the following operating states:
 - Shutting down the gas analyzer,
 - Failure of the instrument air supply,
 - Leakage in the combustion gas feed path inside the gas analyzer.This shut-off valve should be installed outside the analyzer house in the vicinity of the combustion gas supply (cylinder, line).
- If there is no automatic shut-off of the combustion gas supply to the gas analyzer in case of an instrument supply failure, a visible or audible alarm must be triggered (see page 335).
- When measuring flammable gases, it must be made sure that in case of a failure of the instrument air supply or of the analyzer module itself the sample gas supply to the analyzer module is shut off and the sample gas path is purged with nitrogen.
- The unobstructed exchange of air with the environment must be possible around the gas analyzer. The gas analyzer may not be directly covered. The openings in the housing towards the top and at the side may not be closed. The distance to laterally adjacent built-in components must be at least 4 mm.
- If the gas analyzer is installed in a closed cabinet, adequate ventilation of the cabinet must be provided (at least 1 change of air per hour). The distance to adjacent built-in components towards the top and at the side must be at least 4 mm.

Notes for network and data security

Customer's responsibility

The gas analyzer is designed to be connected to and to communicate information and data via a network interface.

It is the customer's sole responsibility to provide and continuously ensure a secure connection between the gas analyzer and the customer's network or any other network (as the case may be). The customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB Ltd and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Active services and open ports on the Ethernet interface

22/tcp	Used for software update only. No direct access to the device.
502/tcp	Used for Modbus/TCP. The device allows any Modbus client to connect, there is no access restriction to authorized clients only.
8001/tcp	Used for Test and Calibration Software. Binary, proprietary protocol.

Modbus and PROFIBUS interfaces

The customer shall be aware that Modbus and PROFIBUS protocols are insecure protocols.

Access credentials

Access to the calibration and to the menus used to change the configuration of the instrument is restricted by password protection (see page 149).

It is recommended to change the factory-set passwords.

Version with type of protection II 3G for measurement of non-flammable gases and vapors

Intended application

The AO2000 Series gas analyzers with analyzer modules Uras26, Magnos206, Magnos27, Caldos25 and Caldos27 with type of protection II 3G have been tested for explosion protection and are suitable for use in hazardous areas in compliance with the technical data (see page 37) and the special conditions for operation (see below). They are suitable for continuous measurement of the concentration of individual components in non-flammable gases or vapors.

Any other use is not as specified.

The specified use also includes taking note of this operating instruction.

Important safety note

According to EU Directive 2014/34/EU and the general requirements for equipment installed in explosive atmospheres stated in IEC 60079-0, the scope of the certification of our equipment is limited to atmospheric conditions, unless specified otherwise in our certificates.

Atmospheric conditions are defined as follows:


- Temperature range -20 to $+60$ °C
- Pressure range $p_{abs} = 80$ to 110 kPa (0.8 to 1.1 bar)
- Ambient air with normal oxygen content, typically 21 % v/v

If the **atmospheric conditions are not met**, the operator is obliged to ensure the safe operation of our equipment outside the atmospheric conditions by means of further measures (for example, assessment of the gas mixture) and / or supplementary protection devices.

Description

The explosion-protected version with type of protection II 3G for the measurement of non-flammable gases and vapors is a special version of the AO2000 Series gas analyzers.

This version is different from other versions by the following designation on the identification plate:

 II 3G Ex nA nC IIC T4 Gc

Operating the gas analyzer under regular conditions cannot cause any ignitable sparks, arcs or impermissible temperatures inside the device.

NOTE

For further information please refer to the Declaration of Conformity. The Declaration of Conformity can be found on the DVD-ROM "Software tools and technical documentation" which is delivered together with the gas analyzer.

Special requirements for operation

- The gas analyzer must be switched off if it is obviously faulty (is not operating smoothly).
- The connectors may not be plugged in or unplugged while the power is on.
- The gas analyzer housing may not be opened while the power is on.
- In order to comply with degree of case protection IP54,
 - Cables have to be properly inserted in the screwed cable glands and sealed by screwing the nut firmly,
 - Cable connectors not in use have to be closed with suitable vent plugs,
 - System bus and 24 VDC power supply terminals not in use have to be closed with the provided seals.
- Only the original battery types Varta CR2032 type no. 6032 or Renata type no. CR2032 MFR may be used as replacement for the battery on the system controller.

Version with type of protection II 3G for measurement of flammable gases ('Safety Concept') and non-flammable gases

Intended application

Intended application

The gas analyzers are designed for continuous measurement of the concentration of individual components in

- non-flammable gases and vapors,
- flammable gases and vapors of Group IIC and Temperature Class T4, which can seldom and then only briefly form a potentially explosive atmosphere (zone 2).

Any other use is not as specified.

The specified use also includes taking note of this operating instruction.

Important safety note

According to EU Directive 2014/34/EU and the general requirements for equipment installed in explosive atmospheres stated in IEC 60079-0, the scope of the certification of our equipment is limited to atmospheric conditions, unless specified otherwise in our certificates.

Atmospheric conditions are defined as follows:

- Temperature range -20 to +60 °C
- Pressure range $p_{abs} = 80$ to 110 kPa (0.8 to 1.1 bar)
- Ambient air with normal oxygen content, typically 21 % v/v

If the **atmospheric conditions are not met**, the operator is obliged to ensure the safe operation of our equipment outside the atmospheric conditions by means of further measures (for example, assessment of the gas mixture) and / or supplementary protection devices.

Important information for the operator

Limiting the purge gas pressure

The purging system of the gas analyzer has no relief opening. Therefore, the maximum internal pressure must be limited by the operator. The standard EN 60079-2 requires the safe limitation of the purge gas pressure even in the single-fault mode. The control of the purge gas pressure is therefore to be performed in single-fault proof mode by the operator.

Purge gas outlet and sample gas outlet

In order to ensure an overpressure of 7 hPa in the purge gas path as compared with the sample gas path at a minimum purge gas flow of 15 l/h, the outlet of the sample gas and the outlet of the purge gas have to be discharged against the same pressure level (atmospheric). The common discharging of sample gas and purge gas (for example, into a common exhaust gas line / flare) is not permissible, since this leads to the risk of the backflow of flammable gases into the purge gas path.

Emergency supply of purge gas

If, in the event of failure of the primary supply, an emergency supply with an ignition protective gas is provided (for example, in order to continue operating the gas analyzer), each supply point must be able to maintain the required pressure level or the required amount of ignition protection gas independently of each other. The two supply points may have common pipes or lines.

Installation of the gas analyzer and the supply lines

When installing the gas analyzer as well as the supply and exhaust air lines, the requirements according to EN 60079-2 Annex D as well as according to EN 60079-14 must be fulfilled. The requirements listed below are an excerpt from these standards. They are explicitly listed here because of their importance for safe operation of the gas analyzer. However, this list of requirements in the above standards does not exempt the operator from his obligation to perform the installation of the gas analyzer and the associated supply lines in accordance with relevant national and international standards and regulations, including any additional requirements.

In particular the requirements of IEC/TR 60070-16 "Electrical apparatus for explosive gas atmospheres. Part 16: Artificial ventilation for the protection of analyzer(s) houses" and IEC 61285 "Industrial-process control – Safety of analyzer houses" shall be taken into account as appropriate.

Requirements of EN 60079-2 Annex D

- Temperature of protective gas at the inlet: If necessary, measures should be taken to avoid condensation and freezing.
- If the compressor intake line passes through a hazardous area, it should be constructed of non-combustible material and protected against mechanical damage and corrosion.
- Power for protective gas supply: The electrical power for the protective gas supply (blower, compressor, etc.) should be either taken from a separate power source or taken from the supply side of the electrical isolator (e.g. disconnect) for the pressurized enclosure.
- The maximum pressure and flow of the flammable substance into the containment system should not exceed the ratings specified by the manufacturer (see section "Technical data" (see page 25)).
- The supply pressure of the sample gas and the protective gas must be limited by the operator according to the maximum pressure values (see section "Technical data" (see page 25)).

Requirements of EN 60079-14

- All ducts and their connecting parts shall be able to withstand a pressure equal to 1.5 times the maximum overpressure, specified by the manufacturer of the pressurized equipment, for normal operation: Sample gas supply $3 \text{ hPa} \times 1.5 = 4.5 \text{ hPa}$, purge gas supply $50 \text{ hPa} \times 1.5 = 75 \text{ hPa}$.
- The materials used for the ducts and connecting parts shall not be adversely affected by the specified protective gas nor by the flammable gas or vapors in which they are to be used.
- Ducting should be located in a non-hazardous area as far as is reasonably practicable.
- Ducts for exhausting the protective gas should preferably have their outlets in a non-hazardous area.
- If the internal pressure or flow of protective gas falls below the minimum prescribed value, the loss of pressure is signaled by an error status at the digital output (see analyzer data sheet). It must be ensured that this signal is indicated in a manner that it is immediately apparent to the operator. The pressurization system shall be restored as soon as possible, or else the electrical supply shall be switched off manually.
- The predefined minimum pre-purge time for the pressurized volume of the analyzer comprises the pipelines within the gas analyzer. The purging time shall be extended by the time required to purge the free volume of the connected pipes (supply pipes) which are not part of the device with at least five times their volume at the lowest flow rate of 15 l/h.
- Care should be taken to keep the temperature of the protective gas below 40 °C at the inlet of the enclosure.

Description

Gas analyzers for the 'Safety Concept'

Gas analyzers for the 'Safety Concept' consist of analyzer modules

- Limas11 IR, Uras26 (see page 28) in the version with safety cell and purged sample cell windows,
- Caldos25, Caldos27, Magnos206 (see page 30) in the version with direct sample chamber connection and purged thermostat room,

each mounted in the 19-inch housing (Model AO2020) or wall-mounted housing (Model AO2040).

The purge gas flow monitoring (see page 32) is a constituent part of the 'Safety Concept', including a control and evaluation, it is fully integrated into the gas analyzer.

Design

The gas analyzer consists of the central unit (system housing with display and operator control unit, power supply unit and electronics module) and the analyzer module.

The analyzer module is installed in the central unit or in a separate housing.

The version satisfies the provisions of the European Directive 2014/34/EU (ATEX Directive). It is designed to EN 60079-15 and EN 60079-2.

NOTE

The Declaration of Conformity can be found on the DVD-ROM "Software tools and technical documentation" which is delivered together with the gas analyzer.

The temperature class of the analyzer is T4.

The measurement function of the gas analyzers was not checked for suitability for influencing of other devices in hazardous areas.

Remark: Non-flammable gas is a gas mixture with a proportion of flammable components which is always – therefore even in the event of an error – smaller than the lower explosive limit (LEL).

Designation



II 3G Ex nA pyb II T4 Gc

Internal and external explosion protection

No release of flammable sample gas

A release of flammable sample gas from the sample gas path ("containment system") into the system housing is reliably prevented by the following measures:

- The sample gas paths of the analyzer module are technically sealed, connected by metal tubes and tested for seal integrity.
- The sample cell of the Uras26 Analyzer Module is designed to be fail-safe (with the exception of windows and seals). Connection pipes and sample cell are metallic, welded to each other and routed from the system housing without additional cable glands.
- A gas purge curtain encloses all the parts of the sample gas path which are not fail-safe, e.g. windows or seals. It is designed in pressurized enclosure type "py". When operated in accordance with the technical data (see page 25), the purging gas pressure is usually at least 0.5 hPa above sample gas pressure. In this way, the sample gas path meets the basic requirements for "no release" as specified in EN 60079-2:2005, Section 11.1.
- At appropriate intervals the sample gas pressure and function of the pressurized enclosure are checked.
- At appropriate intervals the sample gas path and purge gas path are checked for leak tightness.

Remark: The term "purging gas" is used in the sense of "inert gas" in accordance with EN 60079-2.

No electrical ignition sources in the system housing

The electrical components in the system housing are non-arcing assemblies and components or "sealed devices" as per EN 60079-15. Thus there are no electrical ignition sources in the system housing during normal operation.

If sample gas is released in spite of the measures described above and a dangerous explosive atmosphere forms briefly inside the system housing, explosion protection is nevertheless assured.

No ignition sources in the sample gas path

There are no ignition sources in the sample gas path during normal operation.

External explosion protection

Only non-hot assemblies and components are located inside the system housing.

Technical data

Electrical specifications

Power supply	System housing with central unit and analyzer module: 100 to 240 V AC (- 15 %, + 10 %), 2,2 to 0,7 A, 47 to 63 Hz; System housing with 2 analyzer modules: 24 V DC, max. 95 W per module, Functional extra-low voltage "PELV"
Signal inputs and outputs	Functional extra-low voltage "PELV"
System bus, computer interfaces	Functional extra-low voltage "PELV"

For further electrical data, see "Advance Optima AO2000 Series" data sheet.

System housing

Housing protection type	IP54 as per EN 60529
-------------------------	----------------------

Ambient temperature

	during operation with analyzer module installed in a system housing	
	without electronics module	with electronics module
Limas11 IR	+5 to +45 °C	+5 to +45 °C, +5 to +40 °C with I/O modules
Uras26	+5 to +45 °C	+5 to +40 °C
Caldos25	+5 to +45 °C	+5 to +45 °C
Caldos27	+5 to +50 °C	+5 to +45 °C
Magnos206	+5 to +50 °C	+5 to +45 °C

Sample gas path ("containment system")

Sample gas	Flammable and non-flammable gases and vapors under atmospheric conditions ($p_{abs} \leq 1.1$ bar, oxygen content ≤ 21 vol.%); Temperature Class T4, for Limas11 IR: T6; not potentially explosive under normal conditions, if potentially explosive in the event of a fault, then only seldom and briefly (in accordance with Zone 2); (only for Limas11 IR:) occasionally potentially explosive under normal conditions (in accordance with Zone 1), Temperature Class T4. Mixtures of flammable gases and vapors and oxygen that are not explosive under normal conditions or in the event of a fault. As a rule, these can be achieved if the oxygen content is reliably limited to max. 2 vol.% or the flammable component is reliably limited to max. 50 % LEL. Flammable gases and vapors that are explosive under the conditions encountered during analysis, even when oxygen is excluded, may be present in the mixture to be analyzed only in concentrations that are considered non-critical according to safety regulations.
Flow	max. 40 l/h
Pressure	At sample gas inlet: max. positive pressure $p_e \leq 3$ hPa, at sample gas outlet: atmospheric
Turning off the sample gas	by user when shutting down the analyzer and in case of an alarm (pressurized enclosure failure) additional special conditions for operation with flammable sample gas (see page 27)

Purge curtain / purge gas / pressurized enclosure

Designation of gas connections	Purge gas inlet: "Analyzer Purge In", Purge gas outlet: "Analyzer Purge Out"
Purge gas	Inert gas (N ₂)
Flow	During operation: 15 to 20 l/h, during initial purge: 15 to 40 l/h
Initial purging	Manually controlled; initial purge duration: Limas11 IR, Uras26: 1.6 minutes at min. 15 l/h; Caldos25, Caldos27, Magnos206: 18 minutes at min. 15 l/h or 7 minutes at min. 40 l/h. An initial purge is not necessary, if it has been proved that no flammable sample gas is present in the sample gas path or purge gas path.
Operation	A capillary located in the purge gas path monitors that the required positive pressure of the purge curtain is ≥ 0.5 hPa above that of the sample gas at the above purge gas flow rates.
Monitoring	Compliance with the above purge gas flow rate is monitored in the gas analyzer. Alarm signal at digital output in accordance with data in the analyzer data sheet if the minimum flow rate of 15 l/h (corresponds to approx. 7 hPa) is undershot and the maximum flow rate of 40 l/h (corresponds to approx. 50 hPa) is overshoot.

Special requirements for operation

Special requirements

- All cables must enter via the specified cable fittings and be sealed by tightening the nuts in accordance with IP54. Cable connectors not in use have to be closed with suitable vent plugs.
- If the installation site of the gas analyzer is hazardous,
 - The external connectors on the analyzer module "Power supply 24 V DC" and "System bus" which are accessible without having to open the system housing may not be plugged in or unplugged while the power is on.
 - The system housing may not be opened while the power is on.

Additional special requirements for operation with flammable sample gas

- The sample gas pressure in the gas analyzer must correspond to the atmospheric conditions in all operational conditions and in the event of faults (positive pressure ≤ 3 hPa).
- If pressurized enclosure fails (supply of purge gas to the purge curtain) and an alarm is triggered, the fault must be corrected quickly. The gas analyzer can remain in operation. If the fault cannot be eliminated quickly, supply of the sample gas must be cut off.
- If the gas analyzer is not in operation, then the supply gases must be cut off.
- Tests:
 - At start-up, after failure of the pressurized enclosure and at regular intervals, a test for proper functioning of the pressurized enclosure must be conducted by a technically competent person. At this time, the conditions stipulated in the section "Technical data" (see page 25) should be checked and established.
 - The alarm output must be checked.
 - The seal integrity of the sample gas path and purge gas path must be checked at suitable intervals
- If the gas analyzer contains several analyzer modules, the pressurized enclosure must be installed as well as monitored and checked separately for each individual analyzer module. In the event of a fault, an alarm must be triggered in each individual analyzer module.

NOTES

The pressurized enclosure (supply of purge gas to the purge curtain) and if required, a housing purge must be provided separately.

The pressurized enclosure is not required if the gas analyzer is used to measure non-flammable gases.

Limas11 IR, Uras26: Version for the 'Safety Concept'

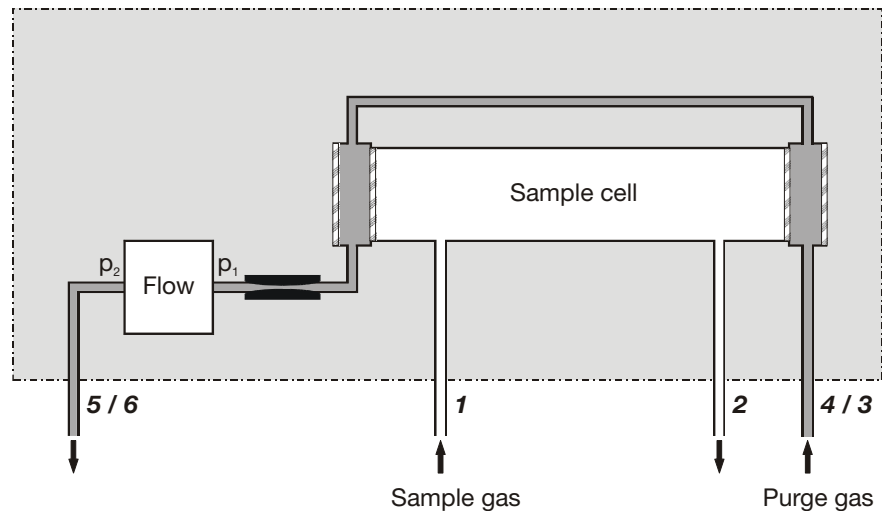
Purging the cell windows

Purge at a slight positive pressure flows through the sample cell windows of the safety cell. In the event of a leak in the sample gas path, e.g. cracking of the sample cell window, the purge gas flows into the sample cell and, in this way, prevents flammable gases from emerging from the analyzer module.

The purge gas is introduced to the purge curtain at a flow rate of 15 to 20 l/h and at a positive pressure of $p_e \leq 50$ hPa. As a result of the capillary, a positive pressure of $p_e = 7$ to 20 hPa is established. The purge gas flow is measured by a flow meter located downstream from a capillary in the sample gas path. The outlet pressure should be open to atmospheric pressure.

The signal from the flow sensor is monitored and evaluated by a function block application (see section "Monitoring of purge gas flow" (see page 32)).

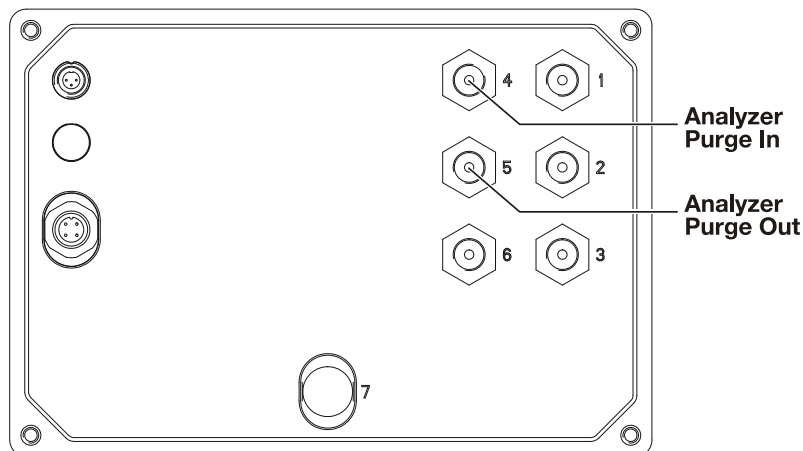
Purge curtain



Limas11 IR	Uras26	
1	1	Sample gas inlet
2	2	Sample gas outlet
4	3	Purge gas inlet sample cell windows "Analyzer Purge In"
5	6	Purge gas outlet flow monitoring "Analyzer Purge Out"

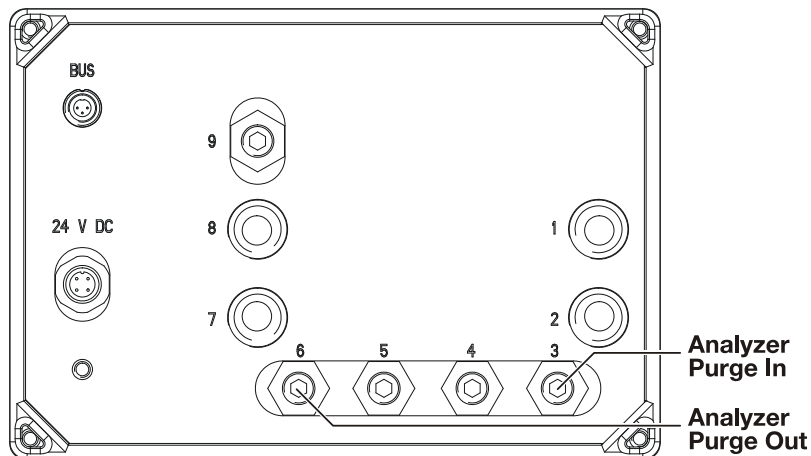
Gas connections

Limas11 IR



- 1 Sample gas inlet
- 2 Sample gas outlet
- 3 Purge gas inlet for housing
- 4 Purge gas inlet sample cell windows **"Analyzer Purge In"**. Connect needle valve upstream to adjust the purge gas flow rate to 15 to 20 l/h
- 5 Purge gas outlet flow monitoring **"Analyzer Purge Out"**
- 6 Purge gas inlet for housing
- 7 Pressure sensor (option)

Uras26



- 1 Sample gas inlet optical beam path 1
- 2 Sample gas outlet optical beam path 1
- 3 Purge gas inlet sample cell windows **"Analyzer Purge In"**. Connect needle valve upstream to adjust the purge gas flow rate to 15 to 20 l/h
- 4 Purge gas inlet for housing
- 5 Purge gas inlet for housing
- 6 Purge gas outlet flow monitoring **"Analyzer Purge Out"**
- 7 Sample gas outlet optical beam path 2
- 8 Sample gas inlet optical beam path 2
- 9 Pressure sensor (option)

Caldos25, Caldos27, Magnos206: Version for the 'Safety Concept'

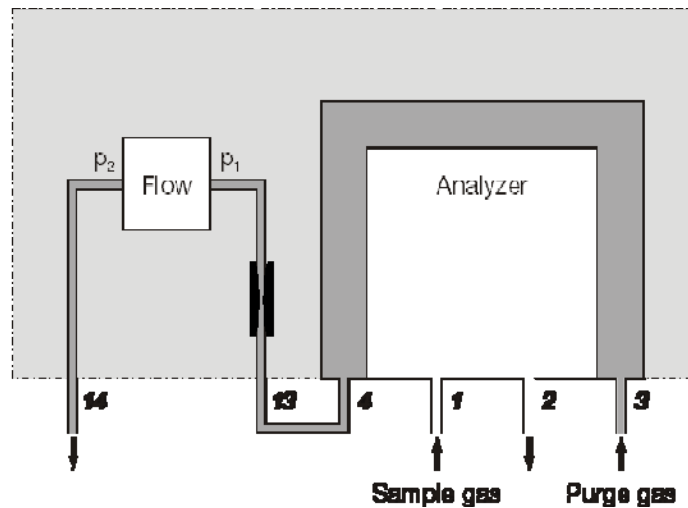
Purging of the thermostat chamber

The thermostat chamber that encloses the analyzer is flushed with purge gas at a slight positive pressure. The purge curtain formed in this manner comprises all of the parts of the sample gas path. In the event of a leak in the sample gas path, the purge gas flows into the analyzer and, in this way, prevents flammable gases from emerging from the analyzer module.

The purge gas is introduced at a flow rate of 15 to 20 l/h and a positive pressure of $p_e \leq 50$ hPa to the thermostat chamber. As a result of the capillary, a positive pressure of $p_e = 7$ to 20 hPa is established. The purge gas flow is measured by a flow meter located downstream from a capillary in the sample gas path. The outlet pressure should be open to atmospheric pressure.

The signal from the flow sensor is monitored and evaluated by a function block application (see section "Monitoring of purge gas flow" (see page 32)).

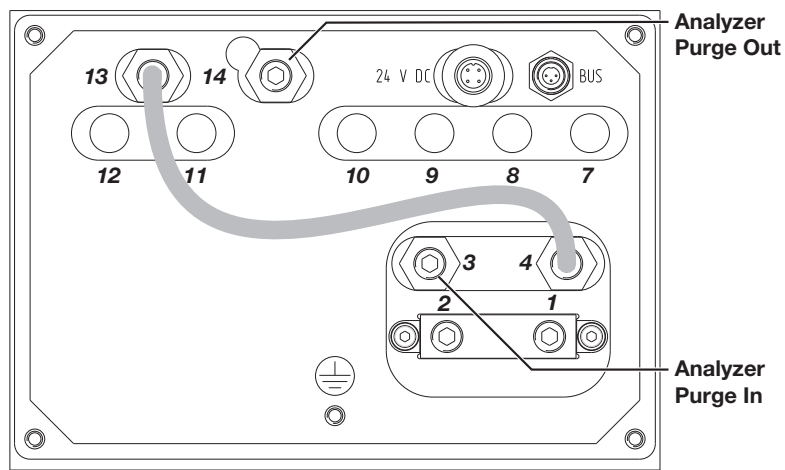
Purge curtain



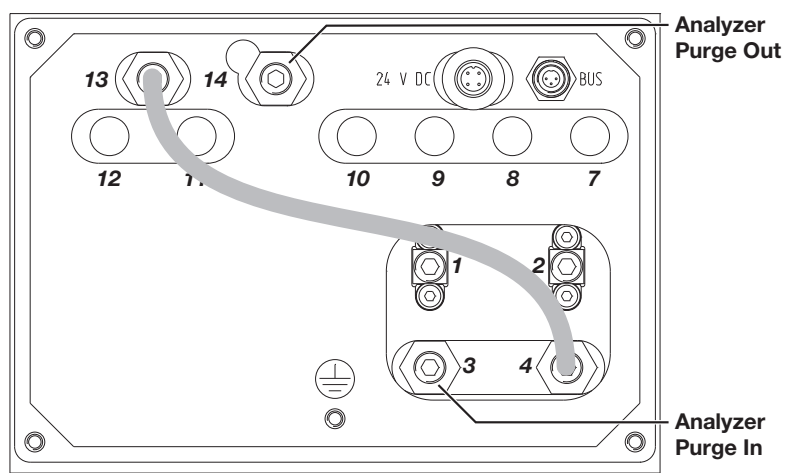
- 1 Sample gas inlet
- 2 Sample gas outlet
- 3 Purge gas inlet thermostat chamber "Analyzer Purge In"
- 4 Purge gas outlet thermostat chamber, ex works tubed with 13
- 13 Purge gas inlet flow monitoring
- 14 Purge gas outlet flow monitoring "Analyzer Purge Out"

Gas connections

Caldos25, Caldos27



Magnos206



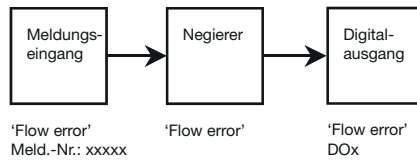
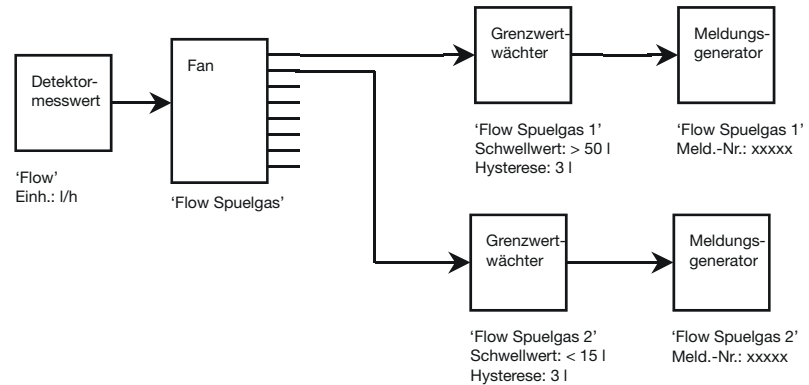
- 1 Sample gas inlet
- 2 Sample gas outlet
- 3 Purge gas inlet thermostat chamber "**Analyzer Purge In**". Connect needle valve upstream to adjust the purge gas flow rate to 15 to 20 l/h.
- 4 Purge gas outlet thermostat chamber, ex works tubed with **13**
- 7 Purge gas inlet for housing
- 8 Purge gas inlet for housing
- 9 Pressure sensor
- 10 Pressure sensor
- 11 unused, closed off
- 12 unused, closed off
- 13 Purge gas inlet flow monitoring
- 14 Purge gas outlet flow monitoring "**Analyzer Purge Out**"

Purge gas flow monitoring

Purge gas flow monitoring

The purge gas flow is continuously measured by a flow sensor. The signal of the flow sensor is monitored and evaluated by a function block application. This function block application is configured ex works. The monitoring and evaluation is designed individually for each analyzer module.

Function block application for purge gas flow monitoring



Output of a status signal

In the event of a flow error in the purge gas feed path, a status signal is output via a digital output (see "Analyzer data sheet"). The user must connect the status signal so that a visible or audible alarm is triggered.

Version for use in Class I Div. 2 explosion hazard areas

Intended application

The AO2000 Series gas analyzers with analyzer modules Caldos25, Caldos27, Limas21 UV, Limas21 HW, Magnos206, Magnos28, Magnos27 and Uras26 are certified for use in Class 1, Div. 2 explosion hazard areas, Groups A, B, C, and D, Temperature code T4.

Housing versions not equipped with conduit entries must be installed in a suitable enclosure, cabinet or rack with provision for connection of Div. 2 wiring methods, acceptable to the local inspection authority having jurisdiction.

Certificate

Certificate No. 1105720

Warnings

WARNING – EXPLOSION HAZARD
 Substitution of components may impair suitability for Class I Division 2.
 Secure all connectors with fasteners provided.
 Relay contacts rated 30 V/1 A.
 I/O connectors must only be connected to Class 2 circuits.

Ratings and ambient temperature

Analyzer module	Rating	Ambient temperature
Caldos25	max. 25 W	+5 to +45 °C
Caldos27	max. 17 W	+5 to +50 °C
Limas21 UV	max. 100 W	+5 to +45 °C
Limas21 HW	max. 100 W	+15 to +35 °C
Magnos206	max. 50 W	+5 to +50 °C
Magnos28	max. 50 W	+5 to +50 °C
Magnos27	max. 35 W	+5 to +45 °C
Uras26	max. 95 W	+5 to +45 °C

Preparation for installation

Scope of supply and delivery

Standard scope of supply and delivery

- Gas analyzer Model AO2020 (19-inch housing) or Model AO2040 (wall-mount housing)
- Screwed fittings with tubing connectors for the connection of flexible tubes
- Mains lead, length 5 m, grounded-instrument connector and separate grounding connector
- Mating plugs (socket housing) for the electrical connection of the I/O modules (plugged on the I/O modules)
- Screwdriver (required for attaching the electric lines in the mating plugs)
- System bus terminating resistor
- DVD-ROM "Software tools and technical documentation" with software tools and technical documentation
- Commissioning instruction
- Analyzer Data Sheet

Also in the scope of supply and delivery depending on version

- Connecting cable for the 24 V DC supply to analyzer modules which are not installed in the central unit
- Connecting cable, T-pieces and terminating resistors for the system bus (according to order)
- Inserts for the M32 screwed cable glands (only IP54 version)

Fidas24:

- Mains lead, length 5 m, with 4-pin socket connector and separate grounding connector for the power supply to the heating of the detector and the heated sample gas connection
- Accessories pack with fittings and O-rings for connection of the sample gas line
- Exhaust pipe with fitting nut and compression fitting

Material required for the installation (not supplied)

Gas connections

- Threaded connections with ½ NPT threads and PTFE sealing tape
Fidas24: Only use threaded connections of metal!

Fidas24: Gas lines

Process gases, test gases and waste air

- PTFE or stainless steel tubes with 4 mm inside diameter and PTFE or stainless steel tube with ≥ 10 mm inside diameter for waste air
- Tube fittings
- Pressure regulator
- Flow restrictor in the combustion gas supply line (see page 48)
- Shut-off valve in the combustion gas supply line (see page 48)

Sample gas

- Heated sample gas line (recommended: TBL 01) or unheated sample gas line (PTFE or stainless steel tube with inside/outside diameter 4/6 mm).
The fittings and O-rings-required for the connection are included in the scope of supply and delivery of the gas analyzer.

Flowmeter

- In the Caldos25 and Uras26 analyzer modules with flowing reference gas, a flowmeter with a needle valve must be installed in the sample gas line and in the reference gas line, in order to adjust the flow rate in the two lines to the optimum value.

Assembly

19-inch housing

- 4 oval head screws (Recommendation: M6; this depends on the cabinet/rack system).
- 1 pair of mounting rails (execution depends on the cabinet/rack system).

Wall-mount housing

- 4 screws M8 or M10.

Signal lines

- Select required conductive material which is appropriate for the length of the lines and the predictable current load.
- Notes concerning the cable cross-section for connection of the I/O modules:
 - The max. capacity of terminals for stranded wire and solid wire is 1 mm² (17 AWG).
 - The stranded wire can be tinned on the tip or twisted to simplify the assembly.
 - When using wire end ferrules, the total cross-section may not be more than 1 mm², i.e. the cross-section of the stranded wire may not be more than 0.5 mm². The PZ 6/5 crimping tool of Weidmüller & Co. must be used for crimping the ferrules.
- Max. length of the RS485 leads 1200 m (max. transmission rate 19200 bit/s).
- Max. length of the RS232 leads 15 m.

24V supply to the analyzer modules

Extension cable

- Min. cable cross-section 2.5 mm².
- Max. length 30 m.

Power supply unit

- If 2 analyzer modules are installed in a system housing, a separate power supply be provided for their power supply. This power supply unit must comply with the specifications of the AO2000 power supply unit.

Power supply lines

- If the supplied mains lead is not used, select conductive material which is appropriate for the length of the lines and the predictable current load.
- Provide a mains isolator or a switched socket-outlet, in order to be able to disconnect all the power from the gas analyzer if required.

Installation location

Installation location requirements

The gas analyzer is only intended for installation indoors.

The technical data of the gas analyzer (see data sheet and section "Analyzer module operating specifications" (see page 346)) are valid for an installation location altitude up to 2000 meters above sea level.

The installation site must be stable enough to bear the weight of the gas analyzer!

Short gas paths

Install the gas analyzer as close as possible to the sampling location.

Install the gas conditioning and calibration modules as close as possible to the gas analyzer.

Adequate air circulation

Provide for adequate natural air circulation around the gas analyzer. Avoid heat build-up.

When installing several system housings in a 19-inch housing, maintain a minimum spacing of 1 height unit between housings.

The complete surface of the system housing is used to dissipate the heat losses.

Protection from adverse conditions

Protect the gas analyzer from

- Cold,
- Exposure to heat from e.g. the sun, furnaces, boilers
- Temperature variations
- Strong air currents
- Accumulation of dust and ingress of dust
- Corrosive atmosphere
- Vibration.

Climatic conditions

Relative humidity max. 75 %, no condensation		
Ambient temperature for storage and transport with integrated oxygen sensor		-25 to +65 °C -25 to +60 °C
Ambient temperature range during operation with		
Analyzer module	installed in a system housing without electronics module	installed in a system housing with electronics module or with power supply only
Caldos25	+5 to +45 °C	+5 to +45 °C
Caldos27	+5 to +50 °C	+5 to +45 °C
Fidas24	+5 to +45 °C	+5 to +45 °C
Fidas24 NMHC	+5 to +40 °C	+5 to +40 °C
Limas11 IR	+5 to +45 °C	+5 to +45 °C ¹⁾
Limas21 UV	+5 to +45 °C	+5 to +45 °C ¹⁾
Limas21 HW	+15 to +35 °C	+15 to +35 °C
Magnos206	+5 to +50 °C	+5 to +45 °C
Magnos28	+5 to +50 °C	+5 to +45 °C
Magnos27	+5 to +45 °C ²⁾	+5 to +45 °C
Uras26	+5 to +45 °C	+5 to +40 °C
ZO23	+5 to +45 °C	+5 to +45 °C
Oxygen sensor in 19-inch housing	+5 to +40 °C	+5 to +40 °C
in wall-mount h.	+5 to 35 °C	+5 to +35 °C

1) +5 to +40 °C when I/O modules are installed

2) +5 to +50 °C for sample chamber direct connection and installation in housing without electronics module or Uras26

Vibrations/shocks

If the gas analyzer is installed in a cabinet, the maximum acceleration amplitude may not exceed 0.01 ms^{-2} in a frequency range of 0.1 to 200 Hz.

If the gas analyzer is not installed in a cabinet, the following data for the individual analyzer modules apply.

Analyzer module	Vibrations/shocks
Caldos25	max. ± 0.04 mm for 5 to 30 Hz
Caldos27	max. ± 0.04 mm for 5 to 55 Hz; 0.5 g for 55 to 150 Hz
Fidas24	max. 0.5 g, max. 150 Hz
Fidas24 NMHC	max. 0.5 g, max. 150 Hz
Limas11 IR	max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Limas21 UV	max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Limas21 HW	max. ± 0.04 mm / 0.5 g at 5 to 150 Hz
Magnos206	max. ± 0.04 mm at 5 to 20 Hz
Magnos28	max. ± 0.04 mm at 5 to 20 Hz
Magnos27	max. ± 0.04 mm at 5 to 60 Hz
Uras26	max. ± 0.04 mm at 5 to 55 Hz; 0.5 g at 55 to 150 Hz; slight transient effect on measured value in the region of the beam modulation frequency
ZO23	max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz

Remark: Compliance with the metrological data can only be assured if data on vibration amplitude and frequency range at the installation site are available and suitable means are employed to decouple the analyzer.

Pressure sensor

In which analyzer modules is a pressure sensor installed?

Analyzer module	Pressure sensor
Limas11 IR, Limas21 UV, Limas21 HW, Caldos27, Uras26	installed ex works
Magnos206, Magnos28, Magnos27	installed ex works as an option
Caldos25, Fidas24, ZO23	not required

The information as to whether a pressure sensor has been installed in an analyzer module can be found in the

MENU → Diagnosis/Information → System Overview menu item after selecting the respective analyzer module.

Information on the connection of the pressure sensor can be found in the "Gas connections" (see page 80) sections of the individual analyzer modules.

Information for the proper operation of the pressure sensor

The following information should be noted for the correct operation of the pressure sensor:

- Prior to the commissioning of the analyzer module, the screw cap has to be screwed out of the connectors of the pressure sensor.
- For a precise pressure correction the connection of the pressure sensor and sample gas outlet have to be connected to each other via a T-piece and short lines. The lines must be as short as possible or – in the case of a greater length – have a sufficiently large internal diameter (≥ 10 mm) so that the flow effect is minimized. If the pressure sensor connection is not connected to the sample gas outlet, the pressure sensor and the sample gas outlet must be on the same pressure level.
- If the pressure sensor is connected to the sample gas feed path, the sample gas must not contain any corrosive, flammable or ignitable components.
- Pressure sensor working range: $p_{\text{abs}} = 600$ to 1250 hPa

NOTE

Further information on the subject of pressure correction can be found in the sections "Air pressure correction" (see page 271) and "Air pressure value correction" (see page 272).

Housing purge

When does a housing purge become necessary?

A housing purge becomes necessary when the sample gas contains flammable, corrosive or toxic components.

Prerequisite for housing purge

A housing purge is possible if the system housing is protected to IP54 (with connection box) or IP65 (without power supply). The purging gas connectors (1/8 NPT female thread) are factory-installed based on orders.

Caldos25, Caldos27, Magnos206, Magnos28, Magnos27 analyzer modules

In gas analyzers with the Caldos25, Caldos27, Magnos206, Magnos28 and Magnos27 analyzer modules there is a gas-tight separation of the central unit and the analyzer. As a result, the central unit and the analyzer can be purged both separately (in parallel) and jointly (in series).

Limas11 IR, Limas21 UV, Limas21 HW, Uras26 and ZO23 analyzer modules

In gas analyzers with the Limas11 IR, Limas21 UV, Limas21 HW, Uras26 and ZO23 analyzer modules there is no gas-tight separation of the central unit and the analyzer. They can therefore only be purged together. If separate purging of the central unit and the analyzer is required, the analyzer module must be installed in a separate system housing protected to IP54.

Fidas24 and Fidas24 NMHC analyzer modules

In gas analyzers with the Fidas24 and Fidas24 NMHC analyzer modules the housing purge is provided in such a way that a part (approx. 600 to 700 l/h) of the instrument air is conducted continuously through the housing as purge air. Thus it is made sure that no ignitable gas mixture can form within the housing in case of a leak in the combustion gas path.

NOTE

The analyzer modules Caldos25, Caldos27, Limas11 IR, Limas21 UV, Limas21 HW, Magnos206, Magnos28, Magnos27, Uras26 and ZO23 may not be purged in series with the analyzer module Fidas24 and Fidas24 NMHC on account of the different requirements for the purge gas supply.

Central unit with housing purge

A central unit with no analyzer module installed can also be ordered in the version "with housing purge". In this case, the purging gas connectors are installed ex works in the end plate. This closes the system housing to the rear and at the bottom instead of the analyzer module.

ATTENTION

In the case of joint purging of the central unit and analyzer, the purge gas must first of all be conducted through the central unit and then through the analyzer. If the flow is in the opposite direction and there are leaks in the sample gas feed path, corrosive sample gas components can destroy the electronic components!

An analyzer module which is used to measure corrosive sample gas components must always be positioned last in the line!

Purge gas

The following is to be used as purge gas:

- Nitrogen when measuring flammable gases and
- Instrument air when measuring corrosive gases (quality per ISO 8573-1 Class 3, i.e. max. particle size of 40 μm , max. oil content 1 mg/m^3 , max. dew point +3 $^{\circ}\text{C}$).

NOTE

The purge gas may not contain any sample gas components! Any sample components in the purge gas can cause false readings.

Purge gas flow rate during initial purge

The purge gas flow and the duration of the purge process depend on the volume to be purged (see the following table). If the purge gas flow is lower than specified, the duration of the purging must be extended accordingly.

Volume to be purged	Purge gas flow rate	Duration
Gas path	100 l/h (max.)	approx. 20 s
Central unit with or without analyzer module	200 l/h (max.)	approx. 1 h
Analyzer separately: Caldos25, Caldos27, Magnos206, Magnos28, Magnos27	200 l/h (max.)	approx. 3 min

Purge gas flow rate during operation

Purge gas flow rate at device inlet max. 20 l/h (constant), purge gas positive pressure: $p_e = 2$ to 4 hPa.

For a purge gas flow rate at the device inlet of 20 l/h, the purge gas flow rate at the device outlet is approx. 5 to 10 l/h.

Information for the selection and use of flowmeters:

- Measuring range 7 to 70 l/h
- Pressure drop < 4 hPa
- Needle valve open
- Recommendation: Flowmeter 7 to 70 l/h, Part Number 23151-5-8018474

ATTENTION

Purge gas can escape from the housing if there are any leak points. When using nitrogen as the purge gas, take all required precautions against suffocation.

The purge gas flow must always be restricted upstream of the purge gas inlet! If the purge gas flow is not restricted until after the purge gas outlet, the full pressure of the purge gas will affect the housing seals which can destroy the operator panel keypad!

Power supply

Gas analyzer power supply

A power supply is installed in the central unit of the gas analyzer. It provides the supply voltage to power the electronics module.

Analyzer module power supply

The analyzer module requires a 24 V DC voltage supply $\pm 5\%$.

If the analyzer module is installed in the central unit, power can be supplied by the central unit power supply.

If the analyzer module is installed in a separate system housing rather than in the central unit, a distinction has to be made between three housings:

- The analyzer module can be powered by the central unit power supply if the optional power line filter -Z01 is installed in the central unit and no analyzer module is installed in the central unit.
- If only one analyzer module is installed in the system housing, an AO2000 power supply can be installed in the same system housing.
- If two analyzer modules are installed in the (separate) system housing, a power supply outside the system housing must be provided. This power supply unit must comply with the specifications of the AO2000 power supply unit.

NOTE

Only 1 analyzer module may be supplied with 24 VDC from the central unit power supply! A separate 24 VDC supply is required for additional analyzer modules.

Power supply

The central unit power supply provides 24 VDC for the electronics module and one analyzer module installed in the central unit or one external analyzer module.

Input voltage	100 to 240 VAC, -15 %, +10 %
Input current	max. 2.2 A
Line frequency range	50 to 60 Hz ± 3 Hz
Power consumption	max. 187 VA
Output voltage	24 V DC $\pm 3\%$
Connection	3-pin grounded-instrument connector to EN 60320-1/C14, connecting cable supplied

Module power consumption

Module	Power consumption
System controller	approx. 15 W
I/O modules	each approx. 10 W
Caldos25	max. 25 W
Caldos27	max. 17 W
Fidas24	max. 40 W
Fidas24 NMHC	max. 40 W
Limas11 IR	max. 100 W
Limas21 UV	max. 100 W
Limas21 HW	max. 100 W
Magnos206	max. 50 W
Magnos28	max. 50 W
Magnos27	max. 35 W
Uras26	max. 95 W
ZO23	approx. 12/35 W in continuous/starting operation
Pneumatic module	approx. 20 W

Fidas24, Fidas24 NMHC: Detector and sample gas inlet heaters

Input voltage	115 VAC or 230 VAC, $\pm 15\%$ (max. 250 VAC)
Line frequency range	47 to 63 Hz
Power consumption	125 VA for detector Fidas24, approx. 200 VA for detector Fidas24 NMHC, 125 VA for sample gas inlet (option)
Connection	4-pin connector, connecting cable supplied

Safety

Test	to EN 61010-1:2010
Class of protection	Central unit with electronics module (power supply): I; Analyzer module without electronics module (power supply): III
Overvoltage category / degree of pollution	Power supply: II/2
Safe isolation	The electronics module power supply is galvanically isolated from other circuits by means of reinforced or double insulation. Functional extra-low voltage (PELV) on the low-voltage side.

Electromagnetic compatibility

Interference immunity	Tested to EN 61326-1:2013. Inspection severity: Industrial area, fulfills at least the rating to Table 2 of EN 61326.
Emitted interference	Tested to EN 61326-1:2013. Limit value class B for interference field strength and interference voltage is met.

Caldos25: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 30 Hz

Sample gas

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.
When there is a direct sample chamber connection the maximum sample gas dew point is 55 °C.
Fluctuations in water vapor content cause volume errors.

Pressure The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample chamber max. 100 hPa.

Flow 10 to 90 l/h, max. 90 to 200 l/h for option T90 < 6 s

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{\text{abs}} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

A housing purge with nitrogen must be provided for the measurement of flammable gases and vapors. Flame barriers can be used as an option (with the exception of the 'Safety Concept' version (see page 20)). Pressure drop at the flame barriers approx. 40 hPa with a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571.

Prior to using the analyzer module, the corrosion resistance of the sample gas must be tested.

Flowing reference gas

Gas inlet conditions as for sample gas

Test gases

Zero-point calibration

Sample-component-free process gas or substitute gas

End-point calibration

Process gas with a known sample gas concentration or substitute gas

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 233) must be considered.

Gas connections

see section "Caldos25: Gas connections" (see page 80)

Caldos27: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +50 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz

Sample gas

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.
When there is a direct sample chamber connection the maximum sample gas dew point is 55 °C.
Fluctuations in water vapor content cause volume errors.

Pressure The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample chamber max. 100 hPa.

Flow 10 to 90 l/h, min. 1 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Corrosive gases

If the sample gas contains Cl₂, HCl, HF, SO₂, NH₃, H₂S or other corrosive components, ABB Analytical must be consulted.

If the sample gas contains NH₃, flexible tubes of FPM may not be used; flexible tubes of FFKM must be used instead. In this case, the pneumatic module cannot be connected to the analyzer module.

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{abs} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

A housing purge with nitrogen must be provided for the measurement of flammable gases and vapors. Flame barriers can be used as an option (with the exception of the 'Safety Concept' version (see page 20)). Pressure drop at the flame barriers approx. 40 hPa with a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571.

Prior to using the analyzer module, the corrosion resistance of the sample gas must be tested.

Test gases

Zero-point calibration

Test gas, sample-component-free process gas or substitute gas

End-point calibration

Test gas, process gas with a known sample gas concentration or substitute gas

Caldos27 with standard gas calibration

Standard gas with a defined relative thermal conductivity (rTC)

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 234) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer ex works. It is connected to a connection port via an FPM tube.

Gas connections

see section "Caldos27: Gas connections" (see page 82)

Fidas24: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. 0.5 g, max. 150 Hz

Sample gas

Sample components

Hydrocarbons. The concentration of the gas components in the sample gas path must not exceed the temperature-dependent LEL. The analyzer temperature is 180 °C.

Sample gas inlet conditions

Temperature ≤ Thermostat temperature (thermostat temperature for sample gas path, detector and air jet injector ≤ 200 °C, pre-set ex works to 180 °C)

Inlet pressure $p_{\text{abs}} = 800$ to 1100 hPa

Flow Approx. 80 to 100 l/h at atmospheric pressure (1000 hPa)

Humidity ≤ 40 % H₂O

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Sample gas outlet conditions

The outlet pressure must be the same as the atmospheric pressure.

Flammable gases

The gas analyzer may be used for the measurement of flammable gases provided that the flammable portion does not exceed 15 vol.% CH₄ or C1 equivalents.

Further sample gas inlet conditions

The sample gas may not be explosive at any time.

The analyzer module must not be used for measurement of gases containing organometallic compounds, e.g. leaded gasoline additives or silicone oils.

Process gases

Instrument air

Quality	as per ISO 8573-1 Class 2 (max. particle size 1 μm , max. particle density 1 mg/m^3 , max. oil content 0.1 mg/m^3 , dew point at least 10 $^{\circ}\text{C}$ below the lowest expected ambient temperature)
Inlet pressure	$p_e = 4000 \pm 500 \text{ hPa}$
Flow	typically approx. 1800 l/h (1200 l/h for air jet injector and approx. 600 l/h for housing purge), maximum approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air

Quality	Synthetic air or catalytically cleaned air with an organic C content < 1 % of span
Inlet pressure	$p_e = 1200 \pm 100 \text{ hPa}$
Flow	< 20 l/h

Combustion gas

Quality	Hydrogen (H_2), quality 5.0	H_2/He mixture (40 %/60 %)
Inlet pressure	$p_e = 1200 \pm 100 \text{ hPa}$	$p_e = 1200 \pm 100 \text{ hPa}$
Flow	$\leq 3 \text{ l/h}$	approx. 10 l/h

NOTE

H_2/He mixture may only be used if the gas analyzer has been ordered and supplied in the execution specified for this. If the gas analyzer has been supplied in the execution for H_2/He mixture, H_2 may not be used as a combustion gas under any circumstances. This would cause overheating and therefore the destruction of the detector!

ATTENTION

A flow restriction and a shut-off valve must be installed in the combustion gas supply line by the end user, so that safe operation of the gas analyzer is ensured.

Flow restrictor in the combustion gas supply line

The combustion gas flow must be restricted to a maximum of 10 l/h of H_2 or 25 l/h of H_2/He mixture. Suitable measures outside the gas analyzer must be provided by the end user for this purpose.

ABB recommends the use of a bulkhead fitting with an integrated flow restrictor which must be installed in the combustion gas supply line. This bulkhead fitting can be purchased from ABB:

- Combustion gas H_2 : Part Number 8329303,
- Combustion gas H_2/He mixture: Part number 0769359.

Shut-off valve in the combustion gas supply line

A shut-off valve must be installed in the combustion gas supply line to increase the safety in the following operating states:

- Shutting down the gas analyzer,
- Failure of the instrument air supply,
- Leakage in the combustion gas feed path inside the gas analyzer.

This shut-off valve should be installed outside the analyzer house in the vicinity of the combustion gas supply (cylinder, line).

ABB recommends the use of a pneumatic shut-off valve which is actuated by the instrument air. This shut-off valve can be purchased from ABB: Part number 0769440.

If a pneumatic shut-off valve of this kind cannot be installed, precautionary measures must be taken, so that the overall status or the "failure" status of the gas analyzer is monitored (see section "Fidas24: Troubleshooting" (see page 335)).

Test gases

Zero-point calibration

Quality	Nitrogen, Quality 5.0, synthetic air or catalytically cleaned air with an organic C content < 1 % of span
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow	130 to 250 l/h

End-point calibration

Quality	Sample component or substitute gas component in nitrogen or synthetic air with concentration adjusted to the measuring range
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow	130 to 250 l/h

NOTE

The notes for calibrating (see page 238) must be considered.

Gas connections

see section "Fidas24: Gas connections" (see page 83)

Fidas24 NMHC: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +40 °C without electronics module

+5 to +40 °C with electronics module or with power supply only

Vibrations/shocks

max. 0.5 g, max. 150 Hz

Sample gas

Sample components

Hydrocarbons. The CH₄:NMHC ratio must be in the 1:9 to 9:1 range.

Maximum concentration CH₄: 26500 mg org. C/m³ or 50000 ppm C1.

Maximum concentration NMHC: 5000 mg org. C/m³ or 9330 ppm C1.

The concentration of the gas components in the sample gas path must not exceed the temperature-dependent LEL. The analyzer temperature is 180 °C.

Sample gas inlet conditions

Temperature ≤ Thermostat temperature (thermostat temperature for sample gas path, detector and air jet injector ≤ 200 °C, pre-set ex works to 180 °C)

Inlet pressure $p_{\text{abs}} = 850$ to 1100 hPa

Flow Approx. 80 to 100 l/h at atmospheric pressure (1000 hPa)

Humidity ≤ 40 % H₂O

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Sample gas outlet conditions

The outlet pressure must be the same as the atmospheric pressure.

Flammable gases

The analyzer module may be used for the measurement of flammable gases provided that the flammable portion does not exceed 5 vol.% CH₄ or C1 equivalents.

Further sample gas inlet conditions

The sample gas may not be explosive at any time.

The analyzer module must not be used for measurement of gases containing organometallic compounds, e.g. leaded gasoline additives or silicone oils.

Catalyst poisons in the sample gas (e.g. SO₂, HCl, H₂S, halogenated hydrocarbons, heavy metals) will shorten the converter service life. Their respective concentration should always be < 20 mg/m³.

Process gases

Instrument air

Quality	as per ISO 8573-1 Class 2 (max. particle size 1 μm , max. particle density 1 mg/m^3 , max. oil content 0.1 mg/m^3 , dew point at least 10 $^{\circ}\text{C}$ below the lowest expected ambient temperature)
Inlet pressure	$p_e = 4000 \pm 500 \text{ hPa}$
Flow	typically approx. 1800 l/h (1200 l/h for air jet injector and approx. 600 l/h for housing purge), maximum approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air

Quality	Synthetic air or catalytically cleaned air with an organic C content < 1 % of span
Inlet pressure	$p_e = 1200 \pm 100 \text{ hPa}$
Flow	< 20 l/h

Combustion gas

Quality	Hydrogen (H_2), Quality 5.0	H_2/He mixture (40 %/60 %)
Inlet pressure	$p_e = 1200 \pm 100 \text{ hPa}$	$p_e = 1200 \pm 100 \text{ hPa}$
Flow	$\leq 3 \text{ l/h}$	approx. 10 l/h

NOTE

H_2/He mixture may only be used if the gas analyzer has been ordered and supplied in the execution specified for this. If the gas analyzer has been supplied in the execution for H_2/He mixture, H_2 may not be used as a combustion gas under any circumstances. This would cause overheating and therefore the destruction of the detector!

CAUTION

A flow restriction and a shut-off valve must be installed in the combustion gas supply line by the end user, so that safe operation of the gas analyzer is ensured.

Flow restrictor in the combustion gas supply line

The combustion gas flow must be restricted to a maximum of 10 l/h of H_2 or 25 l/h of H_2/He mixture. Suitable measures outside the gas analyzer must be provided by the end user for this purpose.

ABB recommends the use of a bulkhead fitting with an integrated flow restrictor which must be installed in the combustion gas supply line. This bulkhead fitting can be purchased from ABB:

- Combustion gas H_2 : Part number 8329303,
- Combustion gas H_2/He mixture: Part number 0769359.

Shut-off valve in the combustion gas supply line

A shut-off valve must be installed in the combustion gas supply line to increase the safety in the following operating states:

- Shutting down the gas analyzer,
- Failure of the instrument air supply,
- Leakage in the combustion gas feed path inside the gas analyzer.

This shut-off valve should be installed outside the analyzer house in the vicinity of the combustion gas supply (cylinder, line).

ABB recommends the use of a pneumatic shut-off valve which is actuated by the instrument air. This shut-off valve can be purchased from ABB: Part number 0769440.

If a pneumatic shut-off valve of this kind cannot be installed, precautionary measures must be taken, so that the overall status or the "failure" status of the gas analyzer is monitored (see section "Fidas24: Troubleshooting" (see page 335)).

Test gases

Zero calibration

Quality	Synthetic air or catalytically purified air with an org. C content of < 1 % span
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

Span calibration

Components	Sample component CH ₄ : CH ₄ in air Sample component THC: C ₃ H ₈ in air or CH ₄ in air Substitute gas component (when configured per order): CH ₄ in air
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

Converter effectiveness testing

Components	CH ₄ in air or C ₂ H ₆ in air (separate test gas containers), connection via bypass
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

NOTE

The notes for calibrating (see page 241) must be considered.

Gas connections

see section "Fidas24: Gas connections" (see page 83)

Limas11 IR, Limas21 UV: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +45 °C with electronics module or only with power supply

+5 to +40 °C with electronics module, if I/O modules are installed, or only with power supply

Vibrations/shocks

max. ± 0.04 mm at 5 to 55 Hz; 0.5 g at 55 to 150 Hz

Sample gas

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

Pressure The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample cell max. 500 hPa.

Flow 20 to 100 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Flammable, corrosive or toxic gases

Depending on which sample cell has been installed in the analyzer module, the following application restrictions and notes must be observed:

	Standard cell	Quartz cell	Safety cell
Suitable for measurement of ...	Non-corrosive gases	Corrosive gases, e.g. wet Cl ₂ wet HCl, H ₂ SO ₄ , SO ₃ , ozone	Corrosive gases, e.g. dry HCl, dry COCl ₂ (< 50 ppm H ₂ O)
Not suitable for measurement of ...	Highly corrosive gases, e.g. gases containing chlorine, H ₂ SO ₄ , SO ₃ , fluorine compounds	Fluorine compounds	Wet gases containing chlorine, H ₂ SO ₄ , SO ₃ , fluorine compounds
Toxic gases	Housing purge ³⁾ with sample component-free air or with N ₂	Housing purge ³⁾ with sample component-free air or with N ₂	Sample cell purge ¹⁾ with N ₂ or with sample component-free air under negative pressure and flow monitoring; additional monitoring for sample gas traces possible
Corrosive gases	PTFE gas lines, housing purge ³⁾ with sample component-free air or with N ₂	Housing purge ³⁾ with sample component-free air or with N ₂	Sample cell purge ¹⁾ with N ₂ or with sample component-free air under positive pressure ²⁾ with flow monitoring
Flammable gases ⁴⁾	Gas lines of stainless steel, housing purge ³⁾ with N ₂	Housing purge ³⁾ with N ₂	Sample cell purge ¹⁾ with N ₂

1) "Purge curtain"

2) $p_e = 7$ to 20 hPa, 15 to 20 l/h

3) ≤ 20 l/h

4) See the following section for further information

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{abs} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas feed path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

For the measurement of flammable gases and vapors, the version with internal gas lines made of stainless steel should be selected and a housing purge with nitrogen provided.

Prior to using the analyzer module, the corrosion resistance against the sample gas must be tested.

Test gases

Zero-point calibration

Nitrogen or air or UV sample component-free gas

End-point calibration

Calibration cells or test gas for each sample component

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 249) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer ex works.

The pressure sensor is located in the sample gas feed path if the internal gas lines are executed as FPM flexible tubes. The connection of the pressure sensor is led to the outside via an FPM hose if the internal gas lines are executed as tubes. The connection of the pressure sensor is documented in the pneumatic diagram contained in the analyzer data sheet.

Gas connections

see section "Limas11 IR, Limas21 UV, Limas21 HW: Gas connections" (see page 84)

Limas21 HW: Preparation for installation

Installation site

Ambient temperature

+15 to +35 °C with installation in a system housing with or without an electronics module

Vibrations/shocks

max. ± 0.04 mm / 0.5 g at 5 to 150 Hz

Sample gas

Sample gas composition

Stack gas from incinerators without sulfur content, SO₂ concentration < 25 ppm, H₂O concentration < 20 vol.%, filtered with pore size ≤ 0.5 μ m

Sample gas inlet conditions

Temperature	Sample gas dew point ≤ 65 °C
Pressure	The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample cell max. 500 hPa.
Flow	20 to 90 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Test gases

Zero-point calibration

Nitrogen or air or UV sample component-free gas

End-point calibration

Calibration cells or test gas for each sample component

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The Notes for calibrating (see page 249) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer ex works.

The pressure sensor is located in the sample gas feed path if the internal gas lines are executed as FPM flexible tubes. The connection of the pressure sensor is led to the outside via an FPM hose if the internal gas lines are executed as tubes. The connection of the pressure sensor is documented in the pneumatic diagram contained in the analyzer data sheet.

Gas connections

see section "Limas11 IR, Limas21 UV, Limas21 HW: Gas connections" (see page 84)

Sample conditioning system requirements

Sample gas feed-in

The various applications require sample gas feed-in to the gas analyzer at temperatures of 150 to 190 °C. The formation of condensation and sublimation must be excluded without fail, since NO₂ and NH₃ are highly soluble in water or can cause salt formation. In addition, any low-boiling hydrocarbons present must be prevented from precipitating.

Sample gas inlet temperature (from the process)

150 to 190 °C

Sample gas filter

for the measurement of NO and NO₂: sintered metal; for the measurement of NH₃: ceramic; pore size ≤ 0.5 μm

Materials of the gas-bearing components

PTFE, PVDF or silicosteel

Installation note

Route the exhaust gas line declining to allow for condensate drain-off.

NOTE

Please refer to the special information for the gas line connection (see page 84), start-up (see page 133), calibration (see page 249) and shutting down (see page 343)!

Magnos206: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +50 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 20 Hz

Sample gas

Sample gas inlet conditions

Temperature	<p>The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.</p> <p>When there is a direct sample chamber connection the maximum sample gas dew point is 55 °C.</p> <p>Fluctuations in water vapor content cause volume errors.</p>
Pressure	<p>Operation under atmospheric pressure: The sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request.</p> <p>Operation under elevated pressure: A pressure sensor is required for pressure influence compensation. Absolute pressure ≤ 1250 hPa: An optional internal pressure sensor can be connected to the sample gas path. Absolute pressure ≥ 1250 hPa: An external pressure sensor must be connected to the sample gas path.</p> <p>The analyzer module is function-tested for 5000 hPa internal pressure without damage.</p>
Flow	<p>30 to 90 l/h</p> <p>Abrupt changes in the sample gas flow rate should be avoided when using highly suppressed measurement ranges.</p>

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Corrosive gases

If the sample gas contains Cl_2 , HCl, HF or other corrosive components, the analyzer may only be used if the sample gas composition has been taken into account by the manufacturer for the configuration of the analyzer.

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{\text{abs}} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

A housing purge with nitrogen must be provided for the measurement of flammable gases and vapors. Flame barriers can be used as an option (with the exception of the 'Safety Concept' version (see page 20)). Pressure drop at the flame barriers approx. 40 hPa with a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571.

Prior to using the analyzer module, the corrosion resistance of the sample gas must be tested.

Test gases

Zero-point calibration

Oxygen-free process gas or nitrogen

End-point calibration

Process gas with a known oxygen concentration or a substitute gas, e.g. dried air

Magnos206 with a suppressed measuring range

Test gas with an oxygen concentration in the selected measuring range

Magnos206 with single-point calibration

Test gas with an oxygen concentration in an existing measuring range or nitrogen or ambient air. Same moisture content as process gas.

ATTENTION

In order to avoid accumulations of explosive gas mixtures, do not use air as a test gas for single-point calibration when measuring flammable gases!

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 251) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer as an option. It is connected to a connection port via an FPM tube.

With measurements in suppressed measuring ranges the connection of the pressure sensor and the sample gas outlet are to be connected to each other via a T-joint and short lines.

Particular care should be taken that the gas discharge line is as short as possible or – in the case of a greater length – has a sufficiently wide inside diameter (at least 10 mm).

Gas connections

see section "Magnos206: Gas connections" (see page 88)

Magnos28: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +50 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 20 Hz

Sample gas

Sample gas inlet conditions

Temperature	<p>The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.</p> <p>When there is a direct sample chamber connection the maximum sample gas dew point is 55 °C.</p> <p>Fluctuations in water vapor content cause volume errors.</p>
Pressure	<p>Operation under atmospheric pressure: The sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request.</p> <p>Operation under elevated pressure: A pressure sensor is required for pressure influence compensation. Absolute pressure ≤ 1250 hPa: An optional internal pressure sensor can be connected to the sample gas path. Absolute pressure ≥ 1250 hPa: An external pressure sensor must be connected to the sample gas path.</p>
Flow	<p>30 to 90 l/h</p> <p>Abrupt changes in the sample gas flow rate should be avoided when using highly suppressed measurement ranges.</p>

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Corrosive gases

If the sample gas contains Cl_2 , HCl, HF or other corrosive components, the analyzer may only be used if the sample gas composition has been taken into account by the manufacturer for the configuration of the analyzer.

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{\text{abs}} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

A housing purge with nitrogen must be provided for the measurement of flammable gases and vapors. Flame barriers can be used as an option (with the exception of the 'Safety Concept' version (see page 20)). Pressure drop at the flame barriers approx. 40 hPa with a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571.

Prior to using the analyzer module, the corrosion resistance of the sample gas must be tested.

Test gases

Zero-point calibration

Oxygen-free process gas or nitrogen

End-point calibration

Process gas with a known oxygen concentration or a substitute gas, e.g. dried air

Magnos28 with a suppressed measuring range

Test gas with an oxygen concentration in the selected measuring range

Magnos28 with single-point calibration

Test gas with an oxygen concentration in an existing measuring range or nitrogen or ambient air. Same moisture content as process gas.

ATTENTION

In order to avoid accumulations of explosive gas mixtures, do not use air as a test gas for single-point calibration when measuring flammable gases!

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 255) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer as an option. It is connected to a connection port via an FPM tube.

With measurements in suppressed measuring ranges the connection of the pressure sensor and the sample gas outlet are to be connected to each other via a T-joint and short lines.

Particular care should be taken that the gas discharge line is as short as possible or – in the case of a greater length – has a sufficiently wide inside diameter (at least 10 mm).

Gas connections

see section "Magnos28: Gas connections" (see page 89)

Magnos27: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

+5 to +50 °C without electronics module or Uras26 and version with sample chamber direct connection

Vibrations/shocks

max. ± 0.04 mm at 5 to 60 Hz

Sample gas

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required. When there is a direct sample chamber connection the maximum sample gas dew point is 55 °C. Fluctuations in water vapor content cause volume errors.

Pressure The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample chamber max. 100 hPa.

Flow 20 to 90 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Flammable gases

The gas analyzer may not be used for the measurement of flammable gases.

Test gases

Zero-point calibration

Oxygen-free process gas or Nitrogen

End-point calibration

Process gas with a known oxygen concentration or a substitute gas, e.g. dried air

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 259) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer as an option. It is connected to a connection port via an FPM tube.

Gas connections

see section "Magnos27: Gas connections" (see page 91)

Uras26: Preparation for installation

Installation site

Ambient temperature

During operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +40 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz; slight transient effect on measured value in the region of the beam modulation frequency

Sample gas

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

Pressure The analyzer module is operated under atmospheric pressure; the sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request. Overpressure in the sample cell max. 500 hPa.

Flow 20 to 100 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Corrosive gases

Highly corrosive associated gas components such as chlorine (Cl_2 or hydrogen chlorides (e.g. wet HCl) as well as gases or aerosols containing chlorine must be cooled or pre-absorbed. A housing purge must be provided.

Flammable gases

The analyzer module is suitable for the measurement of flammable gases and vapors under atmospheric conditions ($p_{\text{abs}} \leq 1.1$ bar, oxygen content ≤ 21 vol.%). Temperature class: T4.

The sample gas may not be potentially explosive in normal operation; if it is potentially explosive in the event of faults in the sample gas supply, then only rarely and for a short time (corresponding to Zone 2).

Pressure in the sample gas feed path in normal operation $p_e \leq 100$ hPa; in the event of faults in the sample gas supply, the pressure may not exceed the maximum value of $p_e = 500$ hPa.

For the measurement of flammable gases and vapors, the version with internal gas lines made of stainless steel should be selected and a housing purge with nitrogen provided.

Prior to using the analyzer module, the corrosion resistance of the sample gas must be tested.

Flowing reference gas

Gas inlet conditions as for sample gas

Test gases

Zero-point calibration

Nitrogen or air or IR sample component-free gas

End-point calibration

Calibration cells or test gas for each sample component or test gas mixture for multiple sample components if no cross-sensitivity is present. Concentration of the span gas 70 to 80 % of the final value of the larger measurement range. For suppressed measurement ranges: concentration of the span gas within the suppressed measurement range, if possible equal to the final value.

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 261) must be considered.

Pressure sensor

The pressure sensor is installed in the gas analyzer ex works.

The pressure sensor is located in the sample gas feed path if the internal gas lines are executed as FPM flexible tubes. The connection of the pressure sensor is led to the outside via an FPM hose if the internal gas lines are executed as tubes. The connection of the pressure sensor is documented in the pneumatic diagram contained in the analyzer data sheet.

Gas connections

see section "Uras26: Gas connections" (see page 93)

ZO23: Preparation for installation

Installation site

Ambient temperature

during operation with analyzer module installed in a system housing

+5 to +45 °C without electronics module

+5 to +45 °C with electronics module or with power supply only

Vibrations/shocks

max. ± 0.04 mm at 5 to 55 Hz; 0.5 g at 55 to 150 Hz

No heat sources or magnetic fields

No heat sources or devices which generate strong magnetic fields (e.g. electric motors or transformers) may be located in the vicinity of the installation site.

Sample gas

ATTENTION

The gas analyzer may not be used for the measurement of ignitable gas/air or gas/oxygen mixtures.

Sample gas inlet conditions

Temperature +5 to +50 °C

Inlet pressure $p_e \leq 70$ hPa

Flow 4 to 20 l/h

The sample gas flow rate must be kept constant at ± 0.2 l/h in the specified range. The sample gas must be taken from a bypass at zero pressure. If the sample gas flow rate is too low, the effects of contaminants from the gas lines (leaks, permeabilities, desorptions) have an adverse effect on the measurement result. If the sample gas flow rate is too high, asymmetrical cooling of the sensor can cause measuring errors. This can also cause faster aging of or damage to the sample cell.

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Corrosive gases

The presence of corrosive gases and catalyst poisons, e.g. halogens, gases containing sulphur and heavy metal dusts, causes faster aging and/or or destruction of the ZrO_2 cell.

Flammable gases

The analyzer module is suitable for the measurement of flammable gases in a non-hazardous environment. The concentration of flammable gases in the sample gas may not exceed 100 ppm.

Associated gas effect

Inert gases (Ar, N₂) have no effect. Flammable gases (CO, H₂, CH₄) in stoichiometric concentrations for the oxygen content: Conversion of O₂ < 20 % of the stoichiometric conversion. If there are higher concentrations of flammable gas, higher O₂ conversion rates must be expected.

Sample gas outlet conditions

The outlet pressure must be the same as the atmospheric pressure.

Test gases

Reference point (= electrical zero)

Clean ambient air; its oxygen concentration can be calculated from the value for dry air and the factor for the consideration of the water vapor content.

Example:

Water vapor content at 25 °C and 50 % relative humidity = 1.56 vol.% of H₂O
⇒ factor 0.98

Oxygen concentration = 20.93 vol.% of O₂ × 0.98 = 20.6 vol.% of O₂

End point

Test gas with oxygen concentration in the smallest measurement range (e.g. 2 ppm O₂ in N₂)

NOTES

The pressure conditions at reference point and end point must be identical. Notes for checking the reference point and end point (see page 263) must be considered.

Purge gas

If a housing purge is selected (only in IP54 version), purging may only be carried out with air (not with nitrogen) as the ambient air serves as a reference gas.

Gas connections

see section "ZO23: Gas connections" (see page 95)

Installation and sample conditioning

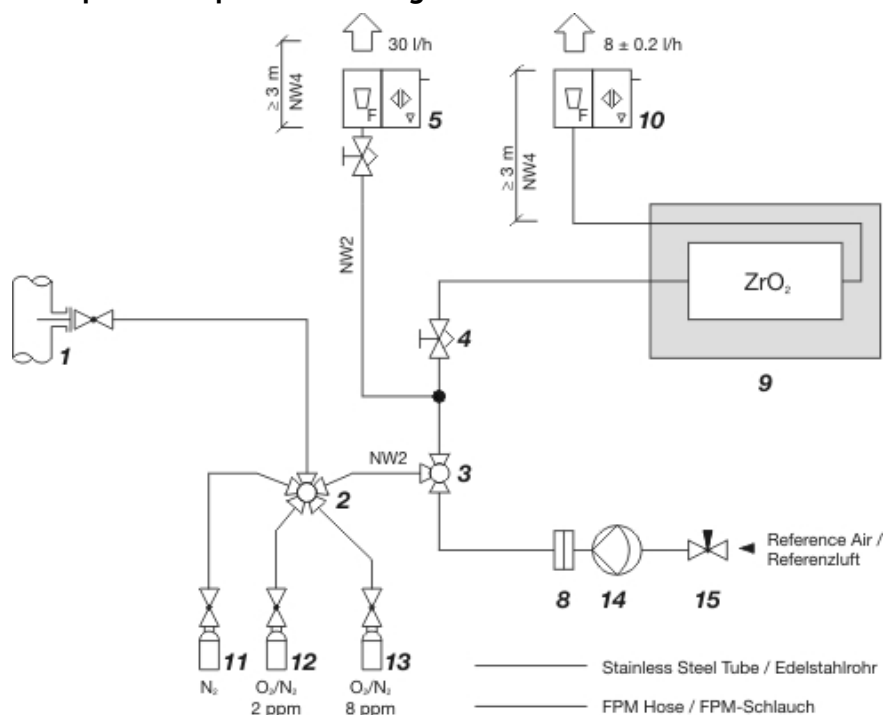
ATTENTION

The ingress of liquids into the analyzer module can cause serious damage including destruction of the sample cell.

NOTE

The following information on installation and the sample conditioning must be considered for the measurement and the execution of controlled calibrations (manual, automatic and externally controlled calibration). Manually operated cocks and valves must be replaced by controlled valves suitable for the oxygen trace measurement, as required.

Example of sample conditioning



- 1** Sampling point with primary shut-off valve
- 2** Multi-way ball valve
- 3** 3/2-way ball valve¹⁾
- 4** Fine-control valve
- 5** Flowmeter with needle valve and alarm contact
- 6** 2-way ball valve¹⁾
- 7** 2-way ball valve¹⁾
- 8** Air filter¹⁾
- 9** Gas analyzer
- 10** Flowmeter without needle valve, with alarm contact
- 11** Purge gas cylinder with N₂¹⁾
- 12** Test gas cylinder with e.g. 2 ppm of O₂ in N₂²⁾
- 13** Test gas cylinder with 8 ppm O₂ in N₂¹⁾
- 14** Pump¹⁾
- 15** Needle valve¹⁾

1) Option

2) A hard-mounted test gas cylinder is normally adequate.
The annual check of the reference point can also be carried out with a non-stationary air supply.

Gas sampling

The nominal diameter of the line from the sampling point to the first switch-over valve should be 4 mm.

A bypass can be positioned upstream of the first switch-over valve, in order to obtain a faster analysis. With a nominal diameter of 4 mm, the bypass should be longer than 3 m, in order to prevent back diffusion from the ambient air.

The sample gas pressure must be reduced at the sampling point. An evaporating pressure regulator must be provided for sampling from liquid gas lines.

Sample gas supply line

The sample gas supply line must consist of stainless steel tubing, be as short as possible and have as few transitions as possible.

The diameter of tube from the beginning of the first switch-over valve should be 3 mm on the outside and 2 mm on the inside. The sample gas connection to the gas analyzer is specified for a tube with an outside diameter of 3 mm. The connections should be executed as Swagelok® fittings.

The ZO23 oxygen trace analyzer module may not be connected in series with other ZO23 analyzer modules or other gas analyzers.

Gas outlet line

The gas outlet line can be executed as a flexible tube. With a nominal diameter of 4 mm, its length should be more than 3 m, in order to prevent back diffusion from the ambient air.

Bypass

The gas analyzer is connected to a gas flow in the bypass at a constant flow rate (approx. 30 l/h). The needle valve is installed upstream of the branch to the gas analyzer and the bypass flowmeter downstream of the branch to the gas analyzer.

The gas analyzer takes 8 l/h from the gas flow. A surplus of approx. 20 l/h remains. If several ZO23 analyzer modules are supplied with gas in parallel (redundant measurement), the flow rate must be set, so that the bypass has a surplus of 20 l/h.

With a nominal diameter of 4 mm, the bypass from the outlet of the gas analyzer should be longer than 3 m, in order to prevent back diffusion from the ambient air.

On account of possible leaks, the flowmeters are always placed in the bypass feed path downstream of the branch to the gas analyzer, respectively, downstream of the gas analyzer; they may on no account be installed in the sample gas supply line upstream of the sample cell.

Waste gas

The sample gas and the bypass must be conducted into the atmosphere or into an unpressurized waste gas collecting system at an adequate distance from the gas analyzer. Long line runs and pressure variations must be avoided.

For metrological and technical safety reasons, sample gas and bypass may not be discharged into the atmosphere in the vicinity of the gas analyzer, since the ambient air serves as reference air and also to exclude suffocation through a lack of oxygen. It must be ensured that the waste gas only reaches respiratory air when adequately diluted.

Oxygen sensor: Preparation for installation

Installation site

Ambient temperature

During operation with the oxygen sensor installed

+5 to +35 °C in a wall-mount housing

+5 to +40 °C in a 19-inch housing

NOTE

The oxygen sensor is always assigned to an analyzer module and must be installed in the same housing as this analyzer module.

Sample gas

ATTENTION

The gas analyzer may not be used for the measurement of ignitable gas/air or gas/oxygen mixtures.

Sample gas inlet conditions

Temperature The dew point of the sample gas must be at least 5 °C lower than the lowest ambient temperature in the overall sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

Inlet pressure $p_e = 2$ to 500 hPa

Flow 20 to 100 l/h

Remark: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also chapter "Analyzer module operating data" (see page 346)).

Moisture content

H₂O dew point ≥ 2 °C. The oxygen sensor may not be used with dry sample gases.

Associated gases

The oxygen sensor may not be used if the associated gas contains the following components: H₂S, compounds containing chlorine or fluorine, heavy metals, aerosols, mercaptans, alkaline components.

Flammable gases

The oxygen sensor may not be used for the measurement of flammable gases.

Sample gas outlet conditions

The outlet pressure must be the same as the atmospheric pressure.

Test gases

Zero-point calibration

Zero is not calibrated since it is fundamentally stable.

End-point calibration

Ambient (non-process) air with constant oxygen content (20.96 vol.%) or synthetic air

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

NOTE

The notes for calibrating (see page 264) must be considered.

Unpacking the gas analyzer and installation

Unpacking the gas analyzer

ATTENTION

Depending on its design, the gas analyzer weighs from 18 to 25 kg!
Unpacking and transporting requires two persons!

Unpacking

- 1 Remove the gas analyzer and foam packing or other packaging materials from the shipping box.
- 2 Take off the foam packing and other packaging and place the gas analyzer in a clean area.
- 3 Clean the adhesive packaging residue from the gas analyzer.

NOTES

If there is shipping damage which points to improper handling, file a damage claim with the shipper (railway, mail or freight carrier) within seven days. Make sure that none of the enclosed accessories are lost during unpacking (see section "Scope of delivery" (see page 34)).

Keep the shipping box and packaging material for future shipping needs.

Identification plate

Identification plates

The gas analyzer has several identification plates:

- The gas analyzer identification plate is located outside on a side wall of the system housing.
- The system housing identification plate is located on the right side wall inside the 19-inch housing and on the left side wall inside the wall-mount housing..
- The analyzer module identification plate is located externally on the connection board (except for analyzer modules with direct connection to the sample chamber).
- The electronics module identification plate is located externally on the connection board.
- The pneumatic module identification plate is located at the rear behind the back plate (behind the flow sensors).

Contents of the identification plate

The gas analyzer identification plate contains the following information:

- Part number (P-No.)
- Production number (F-No.)
- Order number (A-No.)
- Power supply (voltage, frequency, max. power consumption)
- Installed analyzers with sample components and measuring ranges

Analyzer data sheet

Contents of the analyzer data sheet

For the central unit and each analyzer module the analyzer data sheet contains the following information:

- Order number (A-No.)
- Part number (P-No.)
- Production number (F-No.)
- Date of manufacture
- Power supply (voltage, frequency, power consumption)
- Sample components and measuring ranges
- Production numbers of the installed modules.

Additionally, the maintenance work or any modifications performed on the gas analyzer can be documented on the analyzer data sheet.

Storage of the analyzer data sheet

The analyzer data sheet is located in a sleeve which is affixed

- on the left-hand side panel inside the 19-inch housing (model AO2020) and
- on the inside of the door of the wall-mounting case (model AO2040).

NOTES

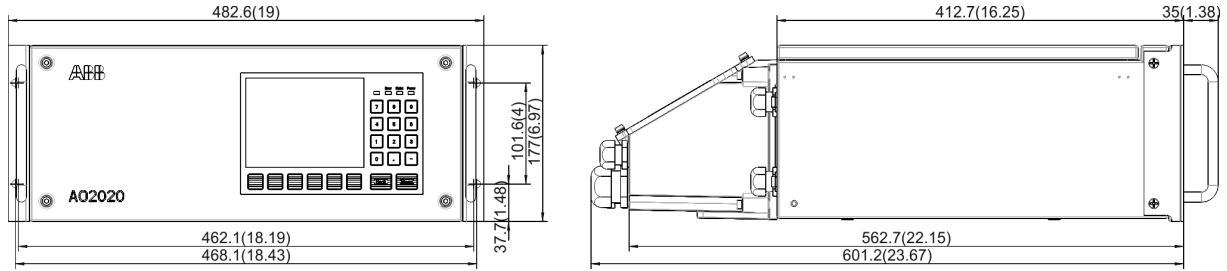
The analyzer data sheet should be kept with the gas analyzer so that it is always available for reference.

During start-up be sure to note the data in the analyzer data sheet. These data can differ from the general information contained in this operator's manual.

Dimensional diagrams

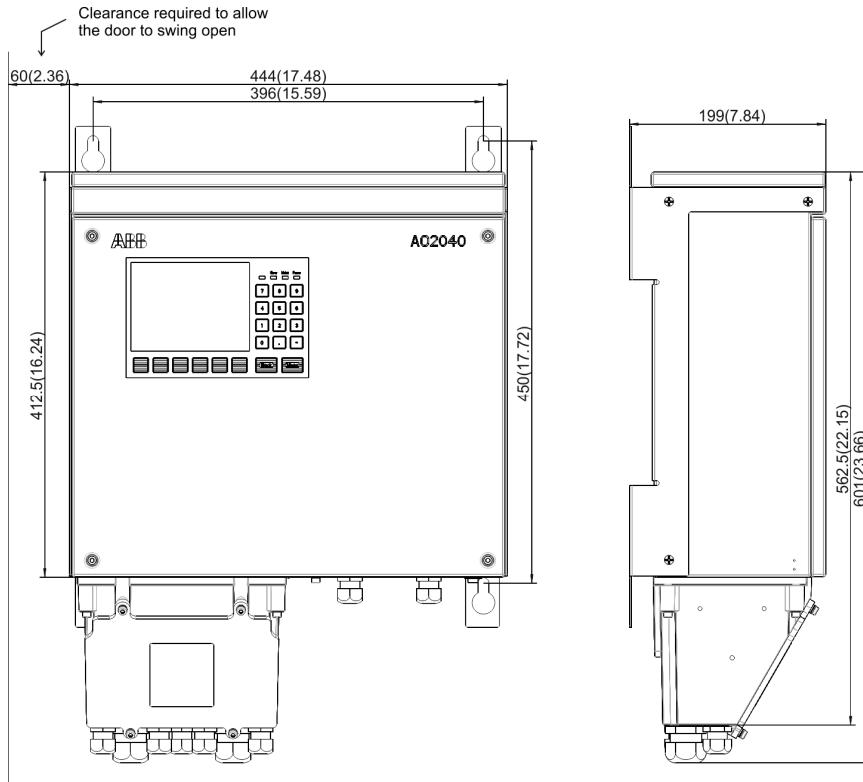
19-inch housing (model AO2020)

Dimensions in mm (in)



Wall-mount housing (model AO2040)

Dimensions in mm (in)



Additional notes

- The connection box shown in the dimensional diagrams is flange-mounted to the IP54 housing.
- Observe the installation location requirements (see page 37).
- The connecting lines require additional installation clearance (approx. 100 mm (3.94 in)).
- When installing the Fidas24 gas analyzer with heated sample gas connection, note that the depth of the housing (without connection box) is increased by approx. 76 mm (3 in) and that clearance is required for the heated sample gas line (comply with minimum bending radius in accordance with manufacturer's instructions).
- When installing the wall-mount housing, note that clearance is required on the left side to allow the door to swing open (approx. 60 mm (2.36 in)).
- When installing the wall-mount housing, note that additional clearance is required above the housing, since some modules are only accessible from above (approx. 300 mm (11.81 in)).
- The 19-inch housing and the wall-mount housing should be installed with vertical orientation of the display.
- Multiple system housings in a 19-inch housing should be installed with a separation of at least one height unit to ensure adequate air circulation.

Gas connection installation

Design of the gas connections

The analyzer module gas ports have 1/8 NPT internal threads (connection diagrams, see chapter "Gas line connection" (see page 80)).

Fidas24: The sample gas connection is executed as fitting for PTFE or stainless steel tube with an outside diameter of 6 mm. The exhaust air connection has an external thread for connection of the exhaust air tube (stainless steel tube with terminal nut and clamp ring, outside diameter = 6 mm, supplied with the gas analyzer).

Requisite material

Material	supplied
Tubing connectors with 1/8 NPT thread and PTFE sealing tape	yes no
or	
Threaded connections with 1/8 NPT thread and PTFE sealing tape	no no

ATTENTION

The fittings must be clean and free of residue! Contaminants can enter the analyzer and damage it or lead to false measurement results!

Do not use sealing compound to seal the gas connections! Constituents of the sealing compound can lead to false measurement results!

Pneumatic module: The gas connection ports are made of plastic (PVDF). Do not use metal tubing connectors or threaded connectors.

Caldos25: The analyzer module gas connection ports in the version for flowing reference gas or for corrosive sample gas are made of plastic (PVC-C). Do not use metal tubing connectors or threaded connectors.

Fidas24: Only use threaded connections of metal!

Gas connection installation

- 1 Screw out the yellow plastic screwing caps (5 mm hexagon socket) from the connection ports.
- 2 Screw in the tubing or threaded connectors with sealing material in the connection ports.

NOTES

We strongly recommend that the gas lines are connected to the analyzer module before the gas analyzer is installed, since the gas ports are now easily accessible.

Screw in the fittings carefully and not too tightly! Follow the manufacturer's installation instructions for the fittings!

Gas path seal integrity verification

The leak tightness of sample gas path and (if applicable) reference gas path is checked at the factory. Since the gas path seal integrity can be affected during shipping, the leak tightness should be checked (see page 268) at the installation site.

NOTE

We strongly recommend that the tightness of the gas feed paths are checked for leak tightness before the gas analyzer is assembled, since the system housing must be opened in the event of a leak.

Gas analyzer installation

ATTENTION

Depending on its design, the gas analyzer weighs from 18 to 25 kg!

Two persons are needed for installation!

The installation location (e.g. bay, 19-inch rack, wall) must be capable of supporting the gas analyzer's weight.

The 19-inch housing must be supported with rails in the bay or rack.

Neither the 19-inch nor the wall-mount housings use hinges to secure the housing cover! The cover can drop when opened.

Requisite material

19-inch housing

- 4 oval head screws (Recommendation: M6; this depends on the cabinet/rack system).
- 1 pair of mounting rails (execution depends on the cabinet/rack system).

Wall-mount housing

- 4 screws M8 or M10.

Installation

Install the system housing in the cabinet/rack or using the selected mounting accessories. Refer to the dimensional diagrams (see page 76).

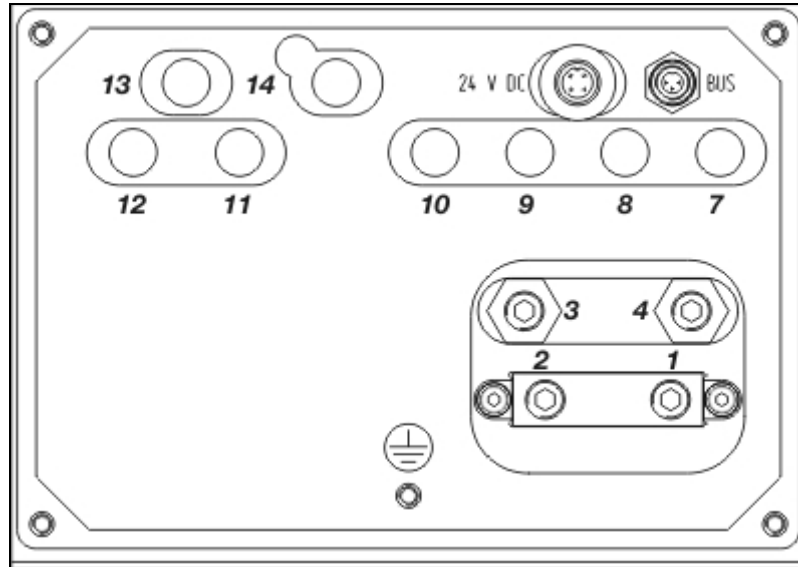
Gas line connection

Caldos25: Gas connections

Gas connections

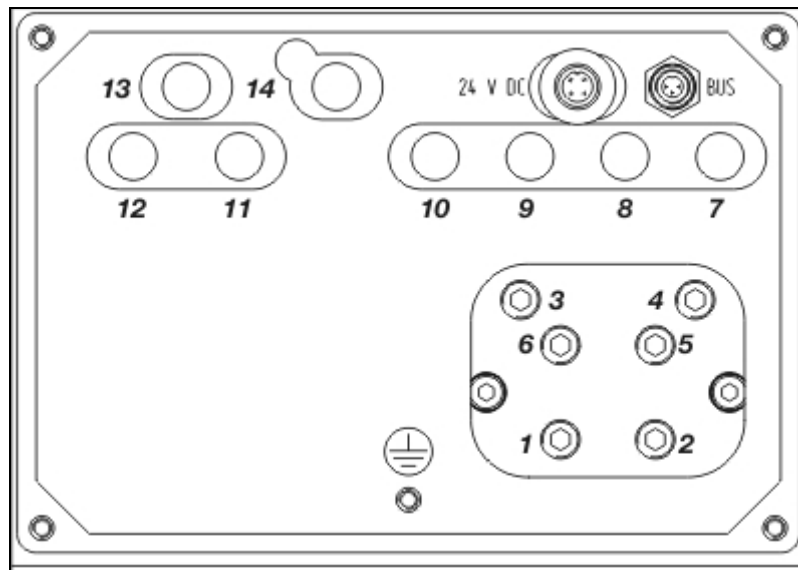
Standard version

The sample chamber is connected directly to the gas connections.



Versions for corrosive sample gas or for flowing reference gas

The sample chamber is connected directly to the gas connections.



- 1** Sample gas inlet
 - 2** Sample gas outlet
 - 3** Purge gas inlet analyzer
 - 3** Purge gas outlet analyzer
 - 5** Reference gas inlet ²⁾
 - 6** Reference gas outlet ²⁾
 - 7** Housing purge gas inlet ¹⁾
 - 8** Purge gas outlet housing ¹⁾ (also with flow sensor)
 - 9** Pressure sensor 1 ¹⁾
 - 10** Pressure sensor 2 ¹⁾
Pneumatic module ^{1) 2)};
 - 11** Sample gas inlet
 - 12** Span gas inlet (with 3 solenoid valves)
 - 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
 - 14** Sample gas outlet – to be connected to sample gas inlet 1
- 1) Option
2) Not in the version for corrosive sample gas

Design of the gas connections unless stated otherwise:
 $\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

NOTE

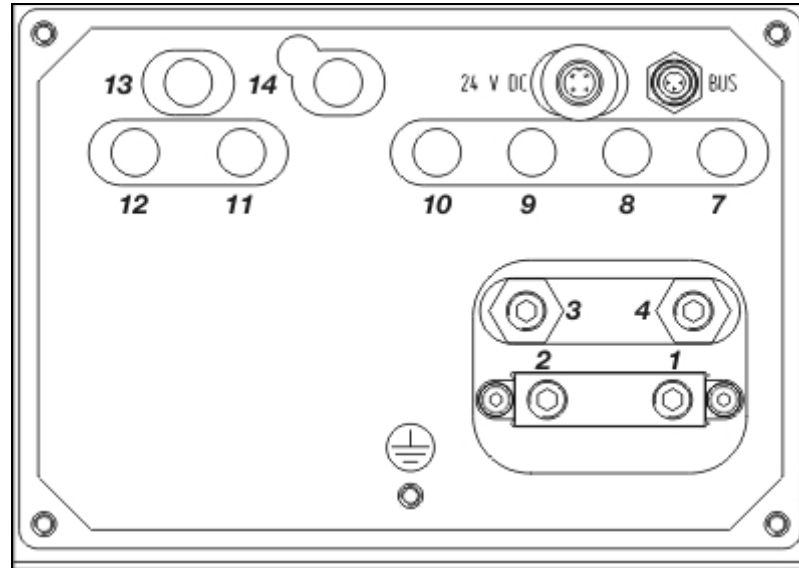
The gas connections **1** to **6** in the versions for corrosive sample gas or for flowing reference gas are of PVC-C. Do not use metal tubing connectors or adapters!

Additional gas connections, see section "Caldos25, Caldos27, Magnos206: Version for the 'Safety Concept'" (see page 30).

Caldos27: Gas connections

Gas connections

The sample chamber is connected directly to the gas connections.



- 1** Sample gas inlet
- 2** Sample gas outlet
- 3** Purge gas inlet analyzer
- 4** Purge gas outlet analyzer
- 7** Purge gas inlet for housing¹⁾
- 8** Purge gas outlet for housing¹⁾ (also with flow sensor)
- 9** Pressure sensor 1
- 10** Pressure sensor 2
- Pneumatic module¹⁾:
- 11** Sample gas inlet
- 12** Span gas inlet (with 3 solenoid valves)
- 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
- 14** Sample gas outlet – to be connected to sample gas inlet 1
- 1) Option

Design of the gas connections unless stated otherwise:

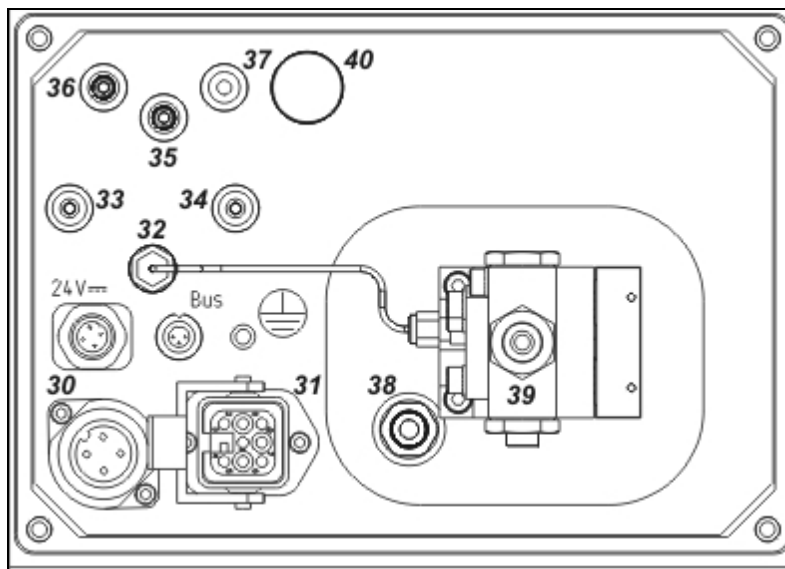
$\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

Additional gas connections, see section "Caldos25, Caldos27, Magnos206:

Version for the 'Safety Concept'" (see page 30).

Fidas24, Fidas24 NMHC: Gas and electrical connections

Gas and electrical connections



- 30** Power supply 115 V AC or 230 V AC for heating the detector and sample gas inlet (4-pin plug connector, connecting cable supplied)
 - 31** Electrical connection to the heated sample gas inlet (hard mounted)
 - 32** Test gas outlet
 - 33** Zero gas inlet
 - 34** Span gas inlet
 - 35** Combustion air inlet
 - 36** Combustion gas inlet
 - 37** Instrument air inlet
 - 38** Exhaust air outlet (screw joint for PTFE or stainless steel tube with outside diameter = 6 mm. The inside diameter of the exhaust air line must be widened to max. 30 cm downstream of the exhaust air outlet to ≥ 10 mm.)
 - 39** Sample gas inlet, heated or unheated (screw joint for PTFE or stainless steel tube with outside diameter = 6 mm)
 - 40** Pressure equalizing opening with protective filter (the protective filter must be protected against moisture)
- 24 V External power supply 24 V DC (4-pin plug connector)
- Bus System bus (3-pin socket connector)

Design of the gas connections unless stated otherwise:
 $\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

Limas11 IR, Limas21 UV, Limas21 HW: Gas connections

Gas connections

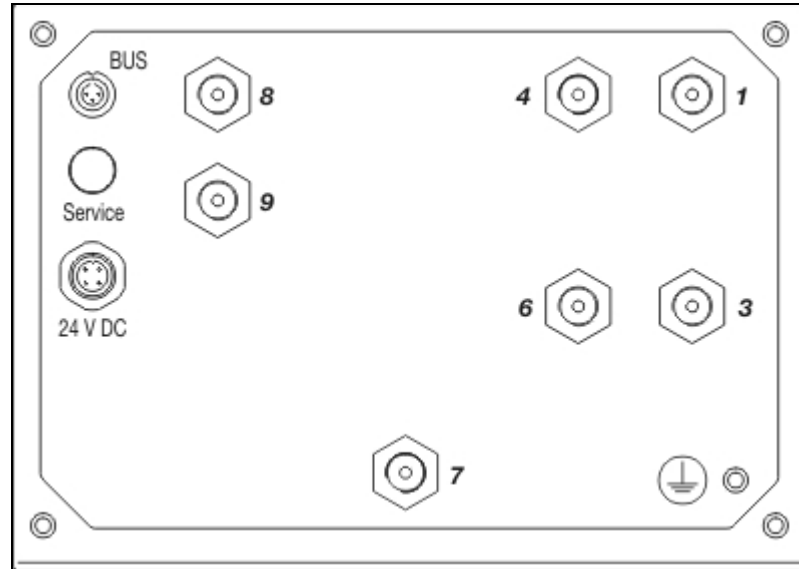
Limas11 IR, Limas21 UV:

Standard cell with FPM or PTFE hoses

Quartz cell with FPM hoses

**Center connection cell made of aluminum with FPM or Cr hoses
(60 °C)**

**Center connection cell made of quartz with PTFE/FPM or PTFE/Cr
hoses (60 °C)**



- 1** Sample gas inlet
- 3** Housing purge gas inlet ¹⁾
- 4** Sample gas outlet
- 6** Purge gas outlet for housing ¹⁾
- 7** Pressure sensor ²⁾
- 8** Span gas inlet (with 3 solenoid valves) ^{1) 3)}
- 9** Zero gas inlet (with 1 or 3 solenoid valves) ^{1) 3)}

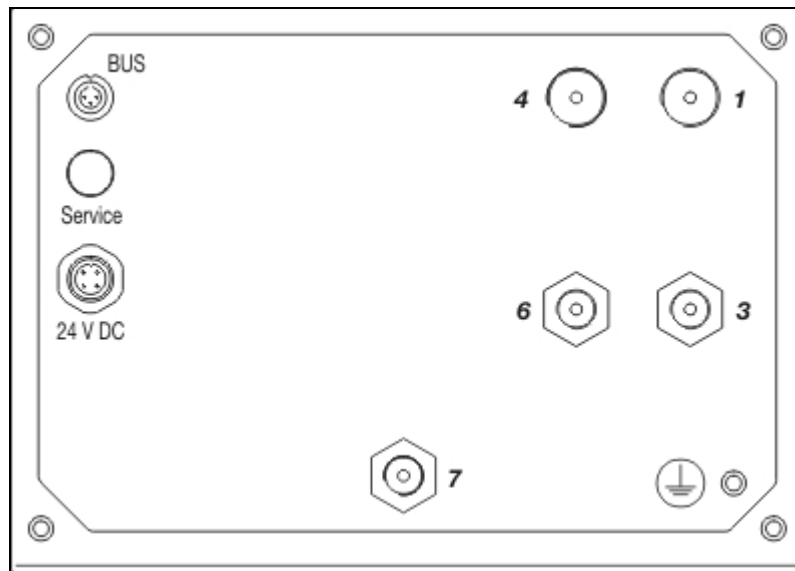
1) Option

2) External connection, not for the standard cell with FPM hoses

3) not for version with PTFE hoses

Design of the gas connections unless stated otherwise:

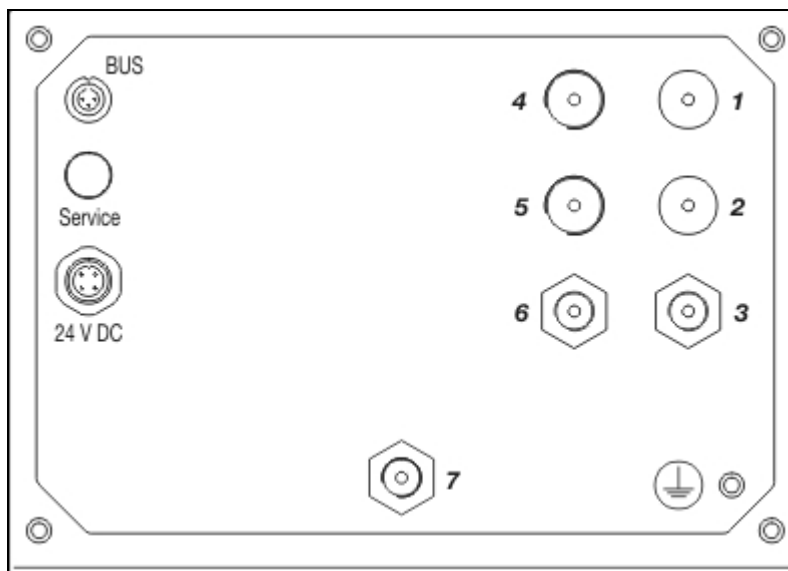
$\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

**Limas11 IR, Limas21 UV:
Quartz cell with PFA tubes**

- 1** Sample gas inlet (PFA tube 6/4 mm)
- 3** Housing purge gas inlet ¹⁾
- 4** Sample gas outlet (PFA tube 6/4 mm)
- 6** Purge gas inlet for housing ¹⁾
- 7** Pressure sensor
- 1) Option

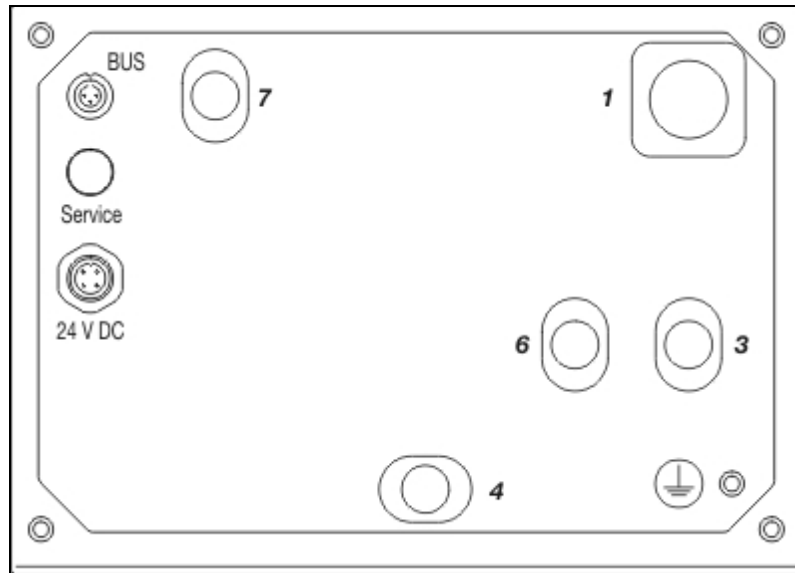
Design of the gas connections unless stated otherwise:
 $\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

**Limas11 IR, Limas21 UV:
Safety cell**



- 1** Sample gas inlet (stainless steel tube with 4 mm outside diameter)
- 2** Sample gas outlet (stainless steel tube with 4 mm outside diameter)
- 3** Housing purge gas inlet ¹⁾
- 4** Purge gas inlet sample cell (FPM tube 4x1.5)
- 5** Purge gas outlet sample cell (FPM tube 4x1.5)
- 6** Housing purge gas outlet ¹⁾
- 7** Pressure sensor
- 1) Option

Design of the gas connections unless stated otherwise:
 $\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

**Limas21 HW:
Quartz cell**

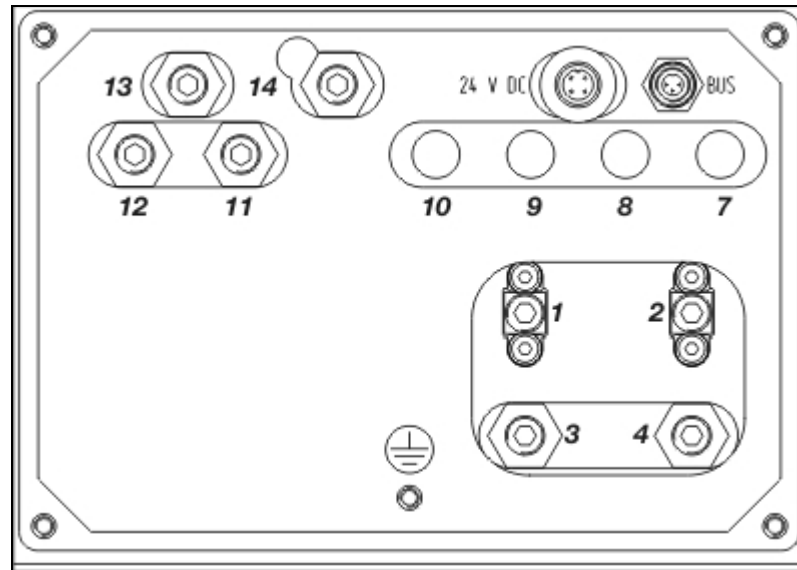
- 1** Sample gas inlet
- 3** Purge gas inlet for housing
- 4** Sample gas outlet
- 6** Purge gas outlet for housing
- 7** Pressure sensor

Design of the gas connections unless stated otherwise:
 $\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

Magnos206: Gas connections

Gas connections

The sample chamber is connected directly to the gas connections.



- 1** Sample gas inlet
 - 2** Sample gas outlet
 - 3** Purge gas inlet for analyzer²⁾
 - 4** Purge gas outlet for analyzer²⁾
 - 7** Purge gas inlet for housing¹⁾
 - 8** Purge gas inlet for housing¹⁾ (also with flow sensor)
 - 9** Pressure sensor 1¹⁾
 - 10** Pressure sensor 2¹⁾
Pneumatics module¹⁾:
 - 11** Sample gas inlet
 - 12** Span gas inlet (with 3 solenoid valves)
 - 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
 - 14** Sample gas outlet – to be connected to inlet **1**
- 1) Option. With measurements in suppressed measuring ranges the connection of the pressure sensor and the sample gas outlet are to be connected to each other via a T-joint and short lines.
- 2) not in version with performance test for emission monitoring

Design of the gas connections unless stated otherwise:

1/8 NPT female thread for threaded connections (not supplied)

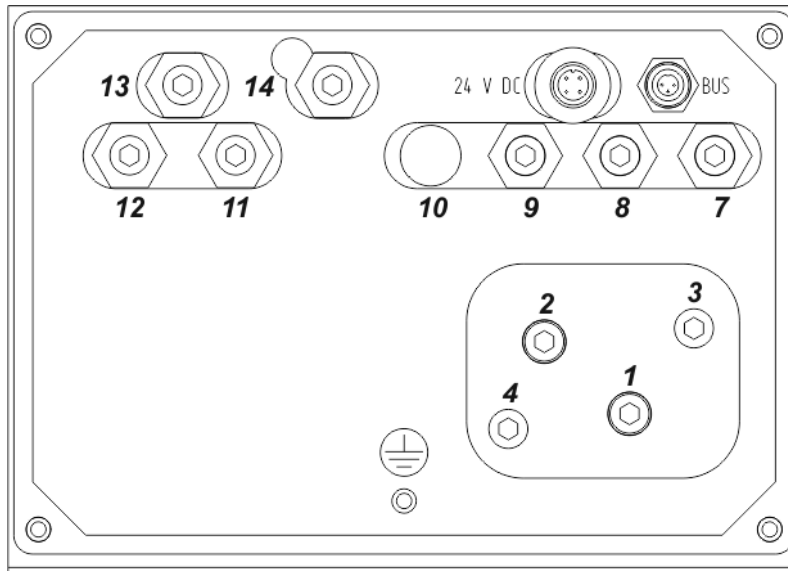
Additional gas connections, see section "Caldos25, Caldos27, Magnos206: Version for the 'Safety Concept'" (see page 30).

Magnos28: Gas connections

Gas connections

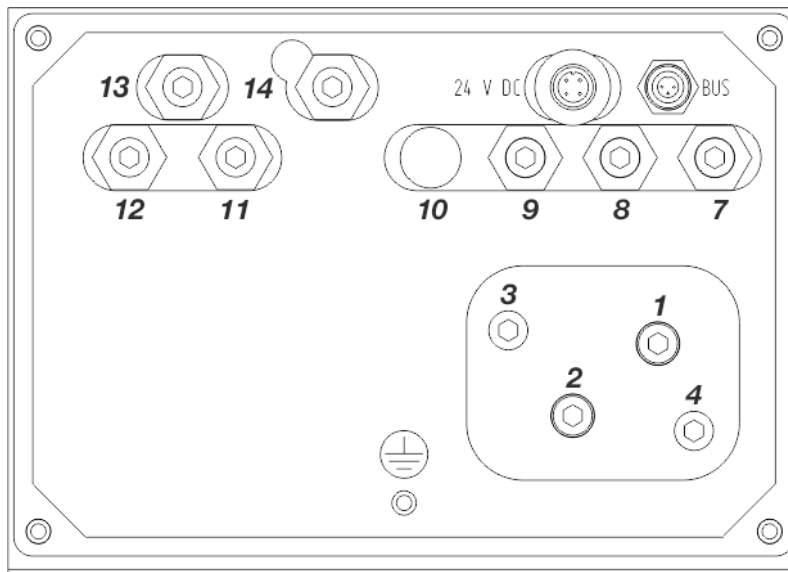
19-inch housing (Model AO2020)

The sample chamber is connected directly to the gas connections.



Wall-mount housing (Model AO2040)

The sample chamber is connected directly to the gas connections.



- 1** Sample gas inlet
- 2** Sample gas outlet
- 3** Purge gas inlet for analyzer²⁾
- 4** Purge gas outlet for analyzer²⁾
- 7** Purge gas inlet for housing¹⁾
- 8** Purge gas inlet for housing¹⁾ (also with flow sensor)
- 9** Pressure sensor 1¹⁾
- 10** Pressure sensor 2¹⁾

Pneumatics module¹⁾:

- 11** Sample gas inlet
- 12** Span gas inlet (with 3 solenoid valves)
- 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
- 14** Sample gas outlet – to be connected to inlet **1**

1) Option. With measurements in suppressed measuring ranges the connection of the pressure sensor and the sample gas outlet are to be connected to each other via a T-joint and short lines.

2) not in version with performance test for emission monitoring

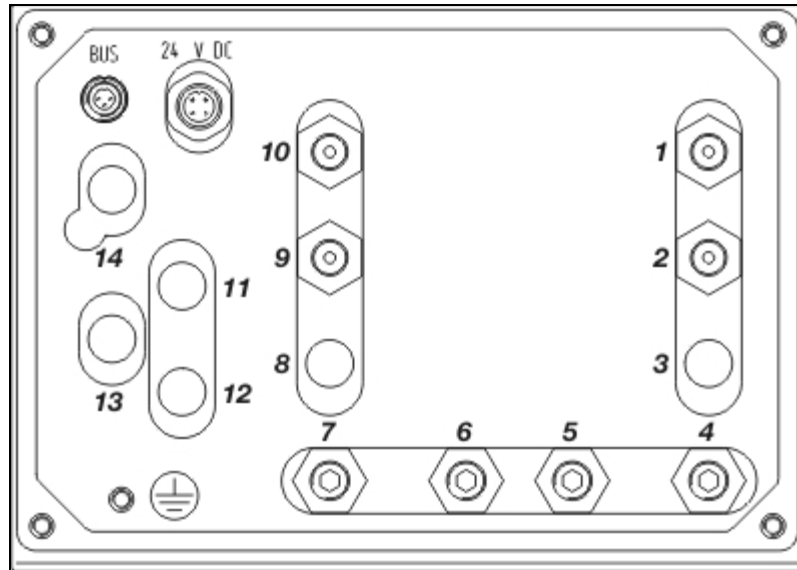
Design of the gas connections unless stated otherwise:

$\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

Magnos27: Gas connections

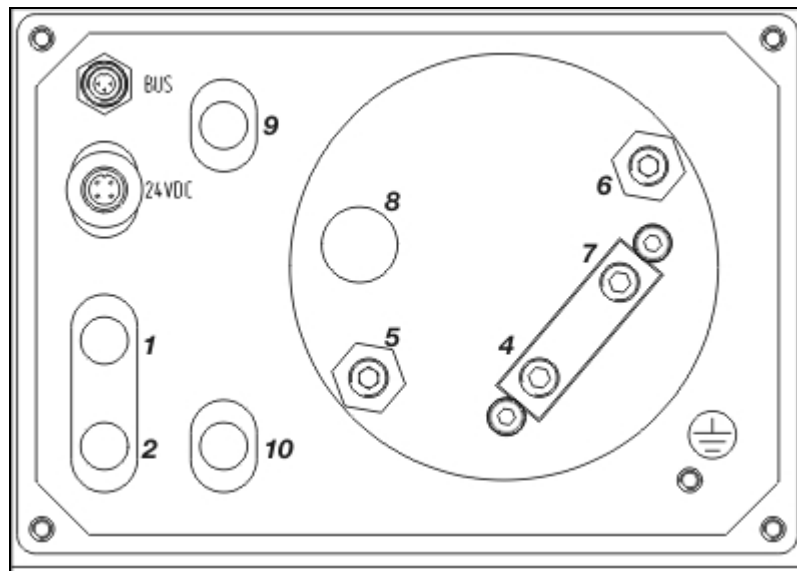
Gas connections

Sample chamber connection to FPM hoses



Sample chamber direct connection

The sample chamber is directly connected to the gas connections (only in the wall-mount housing). Application e.g. for connection of an external gas feed and for a short T90 time.



- 1** Purge gas inlet for housing ¹⁾
 - 2** Purge gas outlet for housing ¹⁾ (also with flow sensor)
 - 3** –
 - 4** Sample gas inlet
 - 5** Purge gas inlet for analyzer
 - 6** Purge gas outlet for analyzer
 - 7** Sample gas outlet
 - 8** –
 - 9** Pressure sensor 1 ¹⁾
 - 10** Pressure sensor 2 ¹⁾
 - Pneumatic module ²⁾:
 - 11** Sample gas inlet
 - 12** Span gas Inlet (with 3 solenoid valves)
 - 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
 - 14** Sample gas outlet – to be connected to sample gas inlet **4**
- 1) Option
- 2) Option – not in the version with sample chamber direct connection

Design of the gas connections unless stated otherwise:

$\frac{1}{8}$ NPT female thread for threaded connections (not supplied)

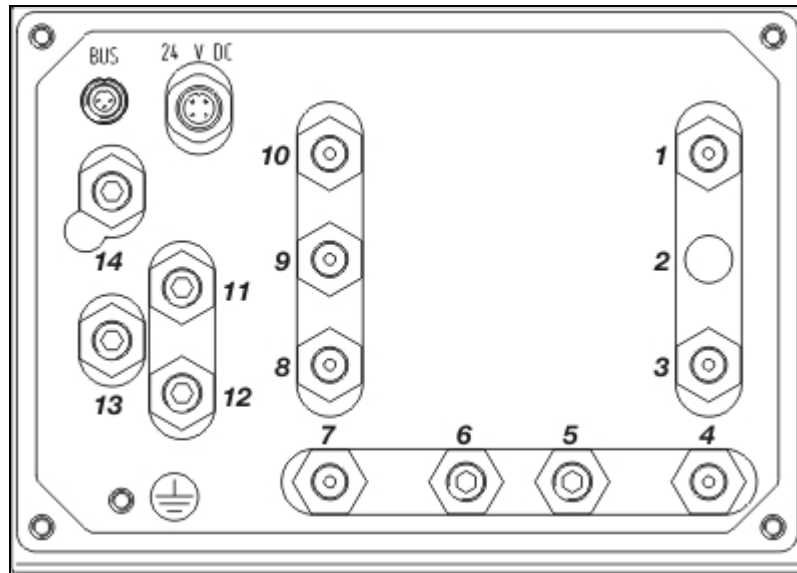
Uras26: Gas connections

Gas connections

The following illustration shows the assignment of the gas connections as an example for the three variants

- A** 1 gas path with 1 sample cell,
- B** 1 gas path with 2 sample cells in series and
- C** 2 separate gas paths with 1 sample cell each.

The assignment of the gas connections of a supplied analyzer module is documented in the analyzer data sheet enclosed with the gas analyzer.



- 1** Pressure sensor for external pressure measurement¹⁾
 - 2** –
 - 3** Sample gas inlet **A** or **B** or **C** gas path 1
 - 4** Sample gas outlet **A** or **C** gas path 1
 - 5** Purge gas inlet for housing¹⁾
 - 6** Purge gas inlet for housing¹⁾ (also with flow sensor)
 - 7** Sample gas inlet **C** gas path 2¹⁾
 - 8** Sample gas outlet **B** or **C** gas path 2¹⁾
 - 9** Reference gas inlet for sample cell 1¹⁾
 - 10** Reference gas outlet for sample cell 1¹⁾
- Pneumatics module¹⁾:
- 11** Sample gas inlet **A** or **B** or **C** gas path 1
 - 12** Span gas inlet (with 3 solenoid valves)
or sample gas inlet **C** gas path 2 (only with flow sensor)
 - 13** Test gas/zero-point gas inlet (with 1 or 3 solenoid valves)
or sample gas outlet **C** gas path 2 (only with flow sensor) – in this case
to be connected to sample gas inlet **7**
 - 14** Sample gas outlet **A** or **B** or **C** gas path 1 – to be connected to sample
gas inlet **3**

1) Option

Design of the gas connections unless stated otherwise:

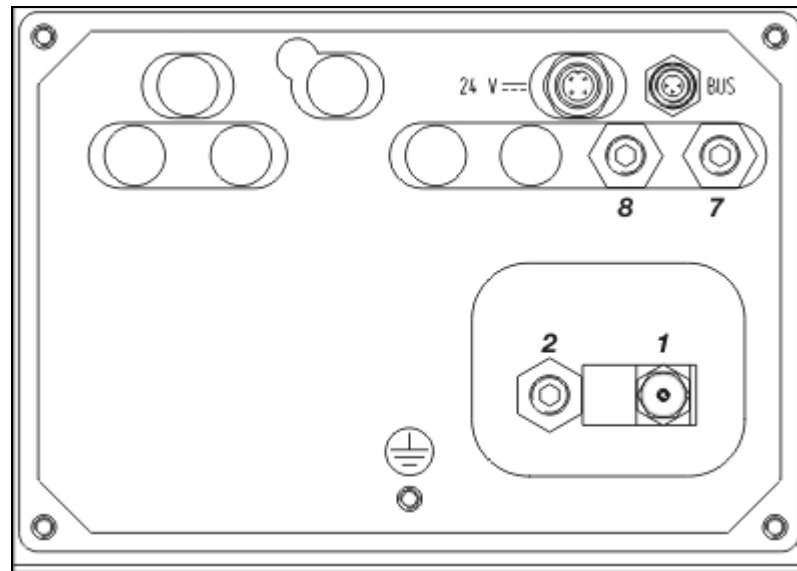
1/8 NPT female thread for threaded connections (not supplied)

Additional gas connections, see section "Uras26: Version for the 'Safety Concept'" (see page 28).

ZO23: Gas connections

Gas connections

The sample chamber is connected to the sample gas inlet connection via a stainless steel tube on the inlet side and to the sample gas outlet connection via an FPM hose on the outlet side.



- 1** Sample gas inlet (3 mm Swagelok®)
- 2** Sample gas outlet (1/8 NPT female thread)
- 7** Purge gas inlet for housing (only in IP54 version)
- 8** Purge gas outlet for housing (only in IP54 version)

Design of the gas connections unless stated otherwise:

1/8 NPT female thread for threaded connections (not supplied)

Gas line connection

ATTENTION

The lines and fittings must be clean and free of any residues (e.g. particles left over from manufacturing). Contaminants can enter the analyzer and damage it or lead to false measurement results!

NOTES

The installation of gas connections is described in section "Installing the gas connections" (see page 78).

Follow the manufacturer's installation instructions for the fittings! In particular, hold the male fittings (gas connections) in place when connecting the gas lines.

Follow the manufacturer's instructions when laying and connecting the gas lines.

If gas lines made of stainless steel are connected to the analyzer modules, the lines must be connected to the building-side equipotential bonding.

Never connect more than three analyzer modules in series!

Gas line connection

Connect the gas lines – made of a material appropriate for the measurement task – to the installed gas ports.

Evacuate exhaust gases

Conduct exhaust gases directly into the atmosphere or through a line with a large internal diameter which is as short as possible, or into a gas discharge line. Do not conduct exhaust gases via restrictions or shut-off valves.

NOTE

Dispose of corrosive, toxic or combustible exhaust gases according to the regulations!

Provide for sample gas line purging

Install a shut-off valve in the sample gas line (definitely recommended with pressurized sample gas), in order to provide a means for purging the gas line system by feeding in an inert gas, e.g. nitrogen, from the gas sampling point.

Flowmeter installation in the reference gas line

In the Caldos25 and Uras26 analyzer modules with flowing reference gas, a flowmeter with a needle valve must be installed in the sample gas line and in the reference gas line, in order to adjust the flow rate in the two lines to the optimum value.

Limas21 HW: Special information for gas line connection

- Lay heated sample gas line without any mechanical stresses and connect to the sample gas inlet.
- Insulate the connection between the sample gas line and the gas analyzer to prevent the formation of cold bridges.
- Ensure that no sample gas can flow through the sample gas line, before the temperature has stabilized at the set point of 180 °C!
- Lay the sample gas outlet line with a downward gradient, so that any condensate can run off.

Fidas24: Connecting the gas lines

CAUTION

The relevant safety regulations for working with flammable gases must be complied with.

The fittings of the gas paths in the gas analyzer may not be opened. The gas paths can become leaky as a result.

However, if the fittings of the gas paths in the gas analyzer have been opened (only by trained personnel), a seal integrity test with a leak detector (thermal conductivity) must always be carried out after they have been sealed again.

The seal integrity of the combustion gas supply line outside the gas analyzer must be checked regularly.

Combustion gas which escapes through leak points in the gas paths in the instrument can cause fires and explosions, also outside the gas analyzer.

The lines and fittings must be clean and free of any residues (e.g. particles left over from manufacturing). Contaminants can enter the analyzer and damage it or lead to false measurement results!

NOTES

The installation of gas connections is described in section "Installing the gas connections" (see page 78).

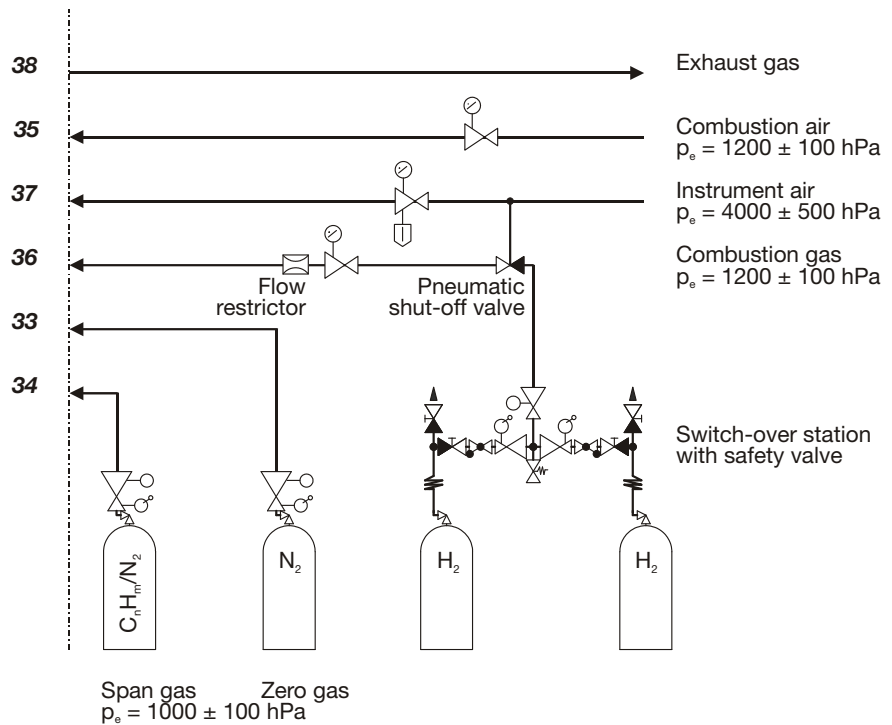
Follow the manufacturer's installation instructions for the fittings! In particular, hold the male fittings (gas connections) in place when connecting the gas lines.

Follow the manufacturer's instructions when laying and connecting the gas lines.

If gas lines made of stainless steel are connected to the analyzer modules, the lines must be connected to the building-side equipotential bonding.

Never connect more than three analyzer modules in series!

Connection of process gases and test gases



The numbering of the gas connections corresponds to the numbering in the connection diagram (see page 83) as well as the labeling on the rear of the analyzer module.

Instrument air connection

Instrument air is used as propellant for the air jet injector and as purging air for the housing purge (see page 40).

Connect (see page 83) the instrument air line to the instrument air inlet of the analyzer module via a pressure regulator (0 to 6 bar).

Combustion air connection

Connect (see page 83) the combustion air line to the combustion air inlet of the analyzer module via a pressure regulator (0 to 1.6 bar).

Combustion gas connection

See section "Fidas24: Connecting the combustion gas line" (see page 100)

Test gas connection

The test gas outlet is connected to the sample gas connection ex works.

If the test gases are to be introduced directly into the gas sampling point, the connection between the test gas outlet and the test gas inlet on the sample gas connection must be removed, and the respective opening in the sample gas connection must be sealed with an M6 screw, so that it is gas-tight.

Exhaust air connection

Conduct exhaust air directly into the atmosphere at zero pressure through a line with a large internal diameter which is as short as possible, or into a gas discharge line.

Use an exhaust air line of PTFE or stainless steel! The temperature of the medium can be up to 200 °C! Lay the exhaust air line with a downward gradient.

The inside diameter of the exhaust line should be increased to ≥ 10 mm within no more than 30 cm from the exhaust outlet. If a very long exhaust air line is used, its inside diameter must be much larger than 10 mm; otherwise the pressure regulation in the gas analyzer may not work properly.

Do not conduct waste air via restrictions or shut-off valves!

NOTE

Dispose of corrosive, toxic or combustible exhaust gases according to the regulations!

Fidas24: Connecting the combustion gas line

Connecting the combustion gas line

Cleaning the combustion gas line

- 1 Pump cleaning agent (alkaline cleaner, stainless steel pickling agent) through the stainless steel tube.
- 2 Thoroughly rinse the tube with distilled water.
- 3 Purge the tube for several hours at a temperature of > 100 °C with synthetic air or with nitrogen (10 to 20 l/h).
- 4 Seal the ends of the tube.

Connecting the combustion gas line

- 5 Connect a two-stage cylinder pressure reducer (version for high purity gases) to the combustion gas cylinder.
- 6 Connect the combustion gas line to the cylinder pressure reducer.
- 7 Install a flow restrictor in the combustion gas supply line which restricts the combustion gas flow to 10 l/h of H₂ or 25 l/h of H₂/He mixture. This means that operation of the gas analyzer is safe even with a defect in the combustion gas feed path (e.g. leaks).
- 8 Install a shut-off valve in the combustion gas supply line. It is recommended that a pneumatic valve is installed; this valve must be controlled by the instrument air supply in such a way that the combustion gas feed is automatically shut off if the instrument air supply fails (see page 335) (and the continuous housing purge therefore fails).
- 9 Connect (see page 83) the combustion gas line to the combustion gas inlet of the analyzer module via a pressure regulator (0 to 1.6 bar).

Check the seal integrity of the combustion gas line

- 10 Check (see page 283) the seal integrity of the combustion gas line after connection.

Fidas24: Connecting the sample gas line (heated sample gas connection)

CAUTION

If a plastic vent plug has been inserted in the sample gas inlet in the factory, it must be removed without fail before commissioning the analyzer module!

Material of the sample gas line

Use a sample gas line of PTFE or stainless steel! (Recommendation: use a heated sample gas line TBL 01.) The temperature of the medium can be up to 200 °C!

Connecting the sample gas line

The heated sample gas line is connected directly to the sample gas inlet. In this respect, the correct seat of the O-rings must be ensured and also that the sample gas tube is inserted all the way in into the sample gas connection.

Unused sample gas inlets

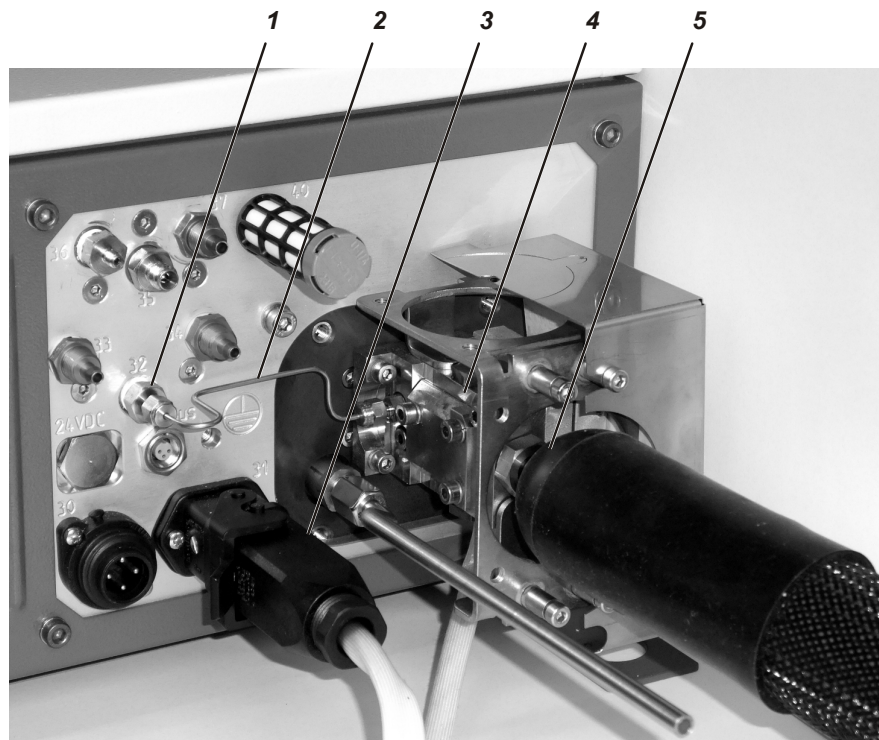
If the analyzer module draws in the sample gas through the sample gas line, the unused sample gas inlets must be sealed with the screw plugs (screwed in in the factory).

If the sample gas is under positive pressure, a sample gas inlet must be open and connected to an exhaust gas discharge line, so that no positive pressure builds up in the analyzer module.

Fittings and O-rings

The requisite fittings and O-rings are included in the supplied accessories pack.

Heated sample gas connection

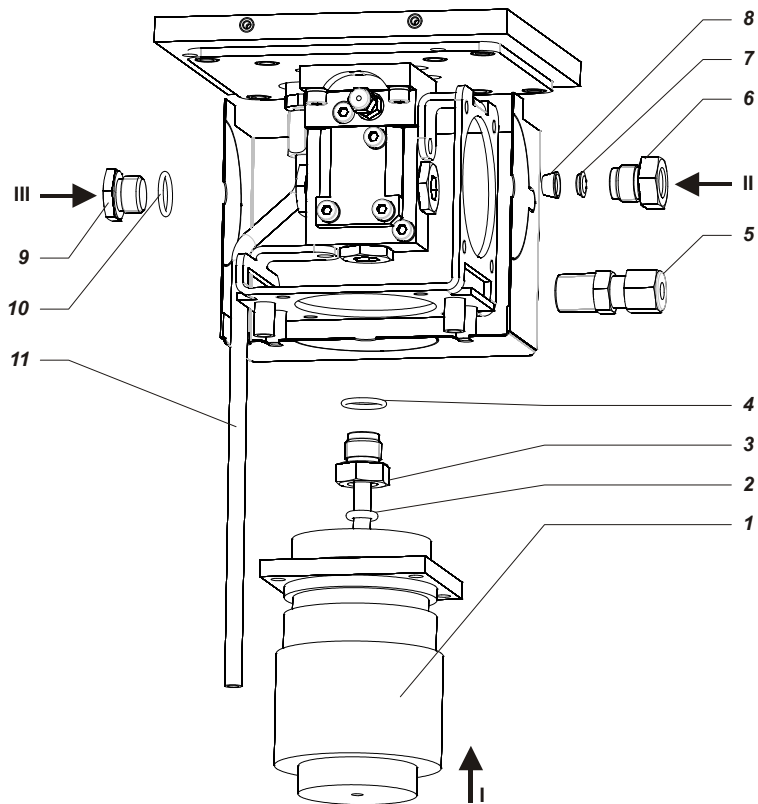


- 1** Test gas outlet
- 2** Connection of test gas outlet – sample gas connection
- 3** Electrical connection to the heated sample gas connection
- 4** Heated sample gas connection
- 5** Heated sample gas line (example)

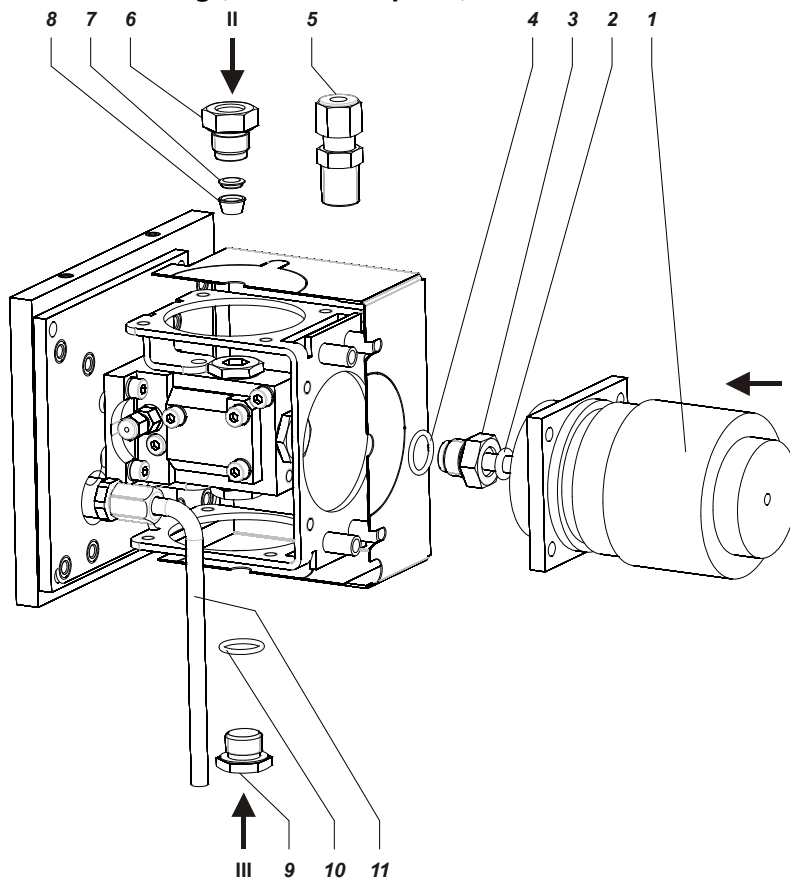
Remark: One half of the cover of the heated sample gas connection has been removed in the picture.

Connection of the sample gas line to the heated sample gas connection

Wall-mount housing (view from bottom right)



19-inch housing (view from top left)



Connection of the sample gas line

- 1 Heated sample gas line (tube with inside/outside diameter 4/6 mm)
 - 2 O-ring 6.02 x 2.62
 - 3 Socket
 - 4 O-ring 12.42 x 1.78
- Connection of a further sample gas line (tube with outside diameter 6 mm):
- either with
- 5 Male fitting G $\frac{1}{4}$ "
- or with
- 6 Socket
 - 7 Tapered ring
 - 8 Compression fitting
- Closure:
- 9 Screw cap
 - 10 O-ring 12.42 x 1.78
-
- 11 Exhaust gas tube

Sample gas inlets:	Connection of the sample gas line	
	on 19-inch housing:	on wall-mount housing:
I	from the rear	from below
II	from above	from the right
III	from below	not possible – the sample gas inlet must always be closed

Maximum length of the sample gas line

The maximum length of the heated sample gas line (inside diameter 4 mm) is 60 m.

Provide for sample gas line purging

Install a shut-off valve in the sample gas line (definitely recommended with pressurized sample gas), in order to provide a means for purging the gas line system by feeding in an inert gas, e.g. nitrogen, from the gas sampling point.

Fidas24: Connecting the sample gas line (unheated sample gas connection)

CAUTION

If a plastic vent plug has been inserted in the sample gas inlet in the factory, it must be removed without fail before commissioning the analyzer module!

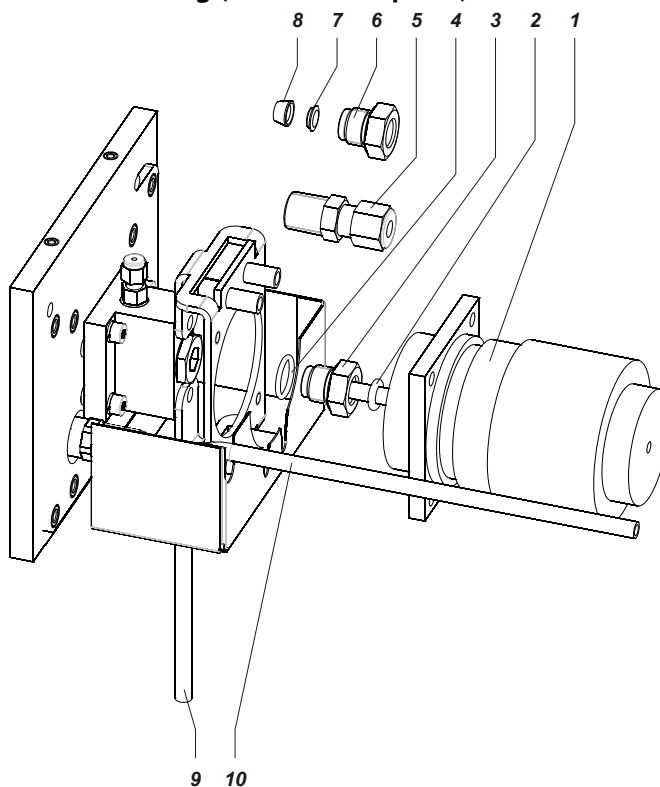
Connection of the sample gas line

The unheated sample gas connection has only one sample gas inlet.

If the sample gas is under positive pressure, a T-piece must be connected between the sample gas line and the sample gas inlet. The free connection of the T-piece must be connected to an exhaust gas discharge line, so that no positive pressure builds up in the analyzer module.

Connection of the sample gas line to the unheated sample gas connection

19-inch housing (view from top left)



Connection of the sample gas line

- 1** Sample gas line (heated or unheated, PTFE or stainless steel tube with inside/outside diameter 4/6 mm)
Connection either with
- 2** O-ring 6.02 x 2.62
- 3** Socket
- 4** O-ring 12.42 x 1.78
or with
- 5** Male fitting G $\frac{1}{4}$ "
or with
- 6** Socket
- 7** Tapered ring
- 8** Compression fitting

- 9** Exhaust gas tube for 19-inch housing
- 10** Exhaust gas tube for wall-mount housing

Maximum length of the sample gas line

The maximum length of the unheated sample gas line (inside diameter 4 mm) is 50 m.

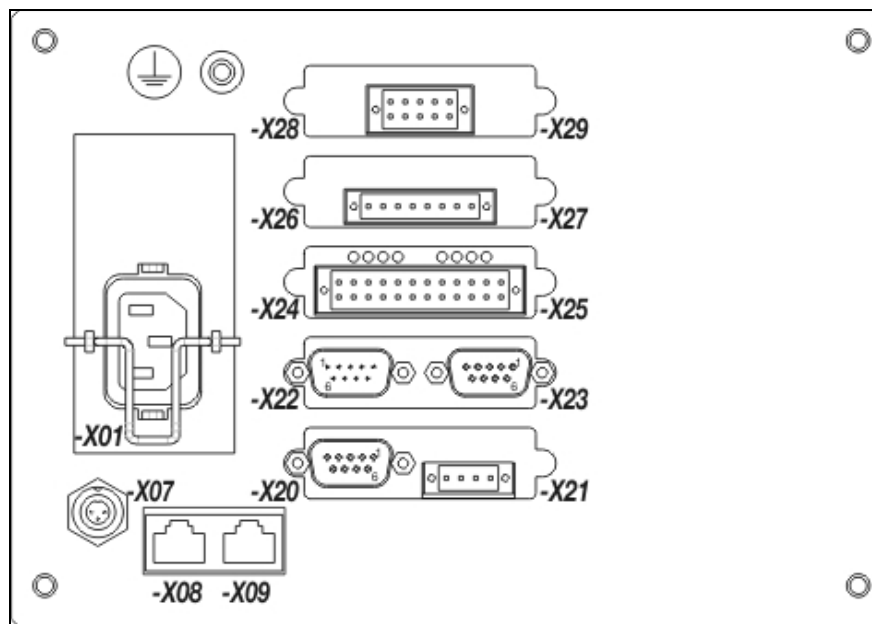
Provide for sample gas line purging


Install a shut-off valve in the sample gas line (definitely recommended with pressurized sample gas), in order to provide a means for purging the gas line system by feeding in an inert gas, e.g. nitrogen, from the gas sampling point.

Connecting the electrical leads

Electronics module connection diagram

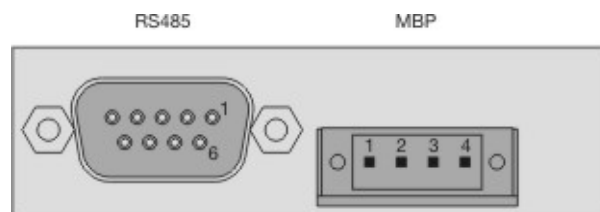
Electronics module connection diagram



- X01** Power supply connection (see page 124)
- X07** System bus connection (see page 118)
- X08, -X09** Ethernet 10/100/1000BASE-T connection
- X20 to -X29** I/O Modules (5 slots), options:
 - Profibus module (see page 108)
 - Modbus module (see page 109)
 - 2-way analog output module (see page 110)
 - 4-way analog output module (see page 110)
 - 4-way analog input module (see page 111)
 - Digital I/O module (see page 112)
-  Potential compensation connection (see page 124)

The connection diagram shows an example for the equipment of the electronics module with I/O modules.

Profibus module: Electrical connections



RS485 interface

Pin	Signal	Explanation
1	–	not assigned
2	M24	24 V output voltage, ground
3	RxD/TxD-P	Receive/send data plus, B line
4	–	not assigned
5	DGND	Data transmission potential (reference potential for VP)
6	VP	Supply voltage plus (5 V)
7	P24	24 V output voltage plus, max. 0.2 A
8	RxD/TxD-N	Receive/send data N, A line
9	–	not assigned

Design: 9-pole female Sub-D plug

MBP interface (not intrinsically safe)

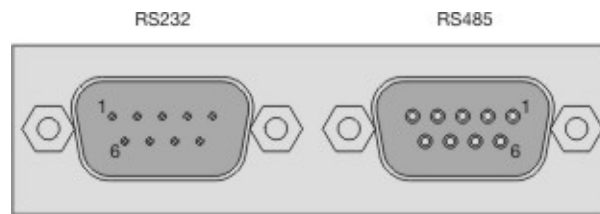
Pin	Signal
1	+
2	Shield
3	–
4	not assigned

Design: 4-pole plug-in terminal strip. Please refer to the information about the requisite material (see page 116)!

NOTE

For additional information on "Profibus", refer to the Technical Information "AO2000 Profibus DP/PA Interface".

Modbus module: Electrical connections



RS232 interface

Pin	Signal
2	RxD
3	TxD
5	GND

Design: 9-pole male Sub-D plug

RS485 interface

Pin	Signal
2	RTxD-
3	RTxD+
5	GND

Design: 9-pole female Sub-D plug

NOTE

For additional information on "Modbus", refer to the Technical Information "AO2000 Modbus and AO-MDDE".

Analog output module: Electrical connections

2-Way Analog Output Module



4-Way Analog Output Module



Pin	Signal
1	AO1+
2	AO1-
3	AO2+
4	AO2-
5	AO3+
6	AO3-
7	AO4+
8	AO4-

Analog outputs AO1 to AO4

0/4 to 20 mA (pre-set ex works to 4 to 20 mA), common negative pole, electrically isolated to ground, can be connected to ground as required, in this regard, max. gain compared to local protective ground potential 50 V, working resistance max. 750 Ω . Resolution 16 bit. The output signal may not be less than 0 mA.

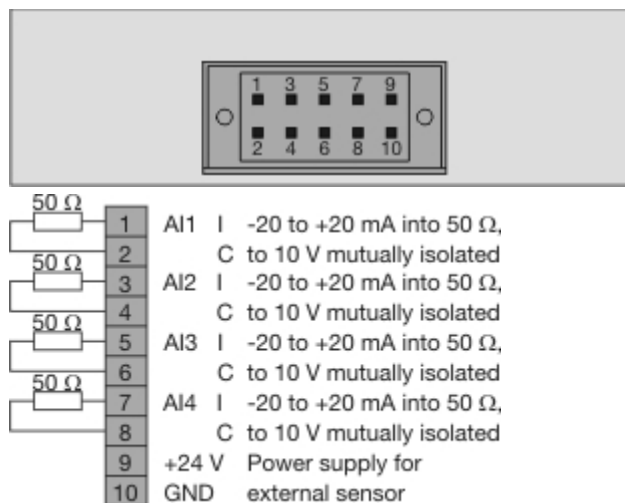
Design

4-pole or 8-pole plug-in terminal strip. Please refer to the information about the requisite material (see page 116)!

Terminal layout

An analog output is allocated in the sequence of the sample components for each sample component. The sequence of the sample components is documented in the analyzer data sheet (see page 75) and on the identification plate (see page 74).

Analog input module: Electrical connections



Analog inputs AI1 to AI4

0 to 20 mA, load 50 Ω

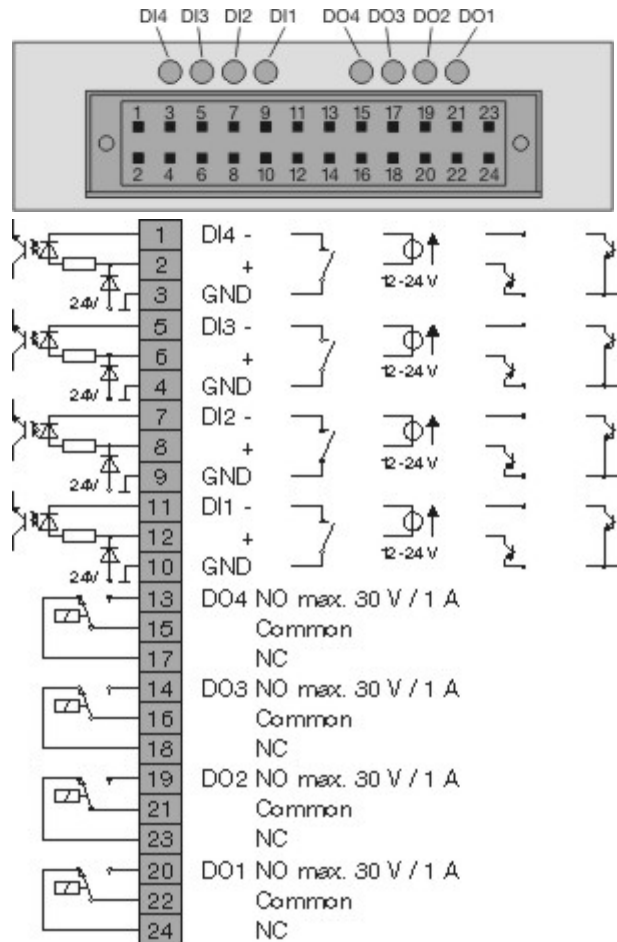
Current output +24 V

+24 V DC for supply of an external sensor, fused with 100 mA (self-resetting fuse)

Design

2x5-pin terminal strip. Please refer to the information about the requisite material (see page 116)!

Digital I/O module: Electrical connections



Digital inputs DI1 to DI4

Opto-electronic coupler with 24 V DC. As an alternative, activation by floating contacts with an external voltage of 12 to 24 V DC or by Open-Collector drivers PNP or NPN.

Digital outputs DO1 to DO4

Floating double-throw contacts, max. contact load rating 30 V/1 A.

The relays must always be operated within the specified data. Inductive or capacitive loads are to be connected with appropriate protective measures (freewheeling diodes for inductive and series resistors with capacitive loads).

Relays are shown in the unpowered state. The unpowered state corresponds to the state in the event of a fault ("fail safe").

Design

2x12-pole plug-in terminal strip. Please refer to the information about the requisite material (see page 116)!

Connections of the standard function block applications

Status signals/Externally controlled calibration:

	Single status signals:	Overall status signal:
DO1	Failure	Overall status
DO2	Maintenance mode	Limit value
DO3	Maintenance request	Limit value
DO4	External solenoid valve	External solenoid valve
DI1	Start automatic calibration	Start automatic calibration
DI2	Inhibit automatic calibration	Inhibit automatic calibration
DI3	Adjust zero point	Adjust zero point
DI4	Adjust end point	Adjust end point

Measuring range control:

DO1	Measuring range feedback
DO2	Measuring range feedback
DO3	Measuring range feedback
DO4	Measuring range feedback
DI1	Measuring range switch-over
DI2	Measuring range switch-over
DI3	Measuring range switch-over
DI4	Measuring range switch-over

Limit values:

DO1	Limit value
DO2	Limit value
DO3	Limit value
DO4	Limit value
DI1	Calibration cells in/out
DI2	Hold current output
DI3	Pump on/off
DI4	External failure

Calibration control:

DO1	External solenoid valve sample gas
DO2	External solenoid valve zero gas
DO3	External solenoid valve span gas
DO4	External pump on/off
DI1	Pump on/off
DI2	External failure
DI3	External failure
DI4	External failure

Standard terminal connections

Basic principles

The terminal connections are allocated

- in the order of the registered analyzer modules and
- within an analyzer module, in the order of the sample components.

The order of the analyzer modules and sample components is documented in the analyzer data sheet and on the type plate. Beginning with analyzer module 1 and sample component 1, the input and output functions are first of all allocated in turn to available free connections of the I/O modules (slots **-X20** to **-X29**).

Profibus, Modbus

The slot of the optional Profibus module (see page 108) is always **-X20**.

The slot of the optional Modbus module (see page 109) is **-X20**, or **-X22** if a Profibus module is present.

Analog outputs

Analog outputs are available at the 2-way analog output module or the 4-way analog output module (see page 110). Analog output is allocated for each sample component in the order of the sample components.

Alarm values

Alarm values are available at the Digital I/O module (see page 112) with the standard function block application "Status signals/ext. calibration" (if the gas analyzer has been set to collective status during the installation of an analyzer module) or on the Digital I/O module with the standard function block application "Alarm values". An alarm value is allocated for each sample component in the order of the sample components.

Standard application "Measuring range control"

Measuring range control can be implemented for all sample components with more than one measuring range. Each Digital I/O module includes

- 4 digital inputs (DI) for the measuring range switch-over and
- 4 digital outputs (DO) for the measuring range feedback signal.

Sample component with	Assignment	DI and DO configuration
2 measuring ranges	1 DI and 1 DO	NO open: Measuring range 1, NO closed: Measuring range 2
3 measuring ranges	3 DI and 3 DO	NO closed: Active meas. range
4 measuring ranges	4 DI and 4 DO	NO closed: Active meas. range

The measuring range control is not installed across I/O modules.

Example: A gas analyzer contains 4 sample components with the following number of measuring ranges:

Sample components	Number of measuring ranges
Sample component 1 (SC1)	3 measuring ranges (MR1, MR2, MR3)
Sample component 2 (SC2)	3 measuring ranges (MR1, MR2, MR3)
Sample component 3 (SC3)	2 measuring ranges (MR1, MR2)
Sample component 4 (SC4)	2 measuring ranges (MR1, MR2)

The following connection assignments result from this:

Assignment for 1st Digital I/O Module	Assignment for 2nd Digital I/O Module
DI/DO 1: SC1: MR1	DI/DO 1: SC2: MR1
DI/DO 2: SC1: MR2	DI/DO 2: SC2: MR2
DI/DO 3: SC1: MR3	DI/DO 3: SC2: MR3
DI/DO 4: SC3: MR1, MR2	DI/DO 4: SC4: MR1, MR2

Connecting the signal lines

NOTES

Follow local regulations on installing and connecting electrical wiring.
Lay the signal lines separately from the power supply lines.
Lay analog and digital signal lines separately from each other.
Mark the cables or mating plugs in such a way that they can be clearly assigned to the corresponding I/O modules.

Requisite material

- Select conductive material which is appropriate for the length of the lines and the predictable current load.
- Notes concerning the cable cross-section for connection of the I/O modules:
 - The max. capacity of terminals for stranded wire and solid wire is 1 mm² (17 AWG).
 - The stranded wire can be tinned on the tip or twisted to simplify the assembly.
 - When using wire end ferrules, the total cross-section may not be more than 1 mm², i.e. the cross-section of the stranded wire may not be more than 0.5 mm². The PZ 6/5 crimping tool of Weidmüller & Co. must be used for crimping the ferrules.
- Max. length of the RS485 leads 1200 m (max. transmission rate 19200 bit/s). Cable type: 3-core twisted-pair cable, cable cross-section 0.25 mm² (e.g. Thomas & Betts, Type LiYCY).
- Max. length of the RS232 leads 15 m.
- The mating plugs (socket housing) for the plug-in terminal strips on the I/O modules are supplied.

Connection box

In the IP54 version of the system housing, the back of the electronics module is protected with a connection box.

The connection box has:

- EN version: Five M20 and two M32 threaded cable connections
- CSA version: One 1¼-inch and two ¾-inch conduits.

Two M32 threaded cable connections are provided to route system bus, Modbus, Profibus and Ethernet cables.

Protective cap

A protective cap is factory-installed on the rear of the electronics module when the Limas21 UV analyzer module is installed in the central unit.

NOTE

It is imperative to re-install the protective cap after connection of the electrical lines. Otherwise light penetration during operation may lead to erroneous measurement values and measurement range overflows.

Connecting the signal lines

- 1** Only for the wall-mount housing (model EL3040): Pass the cables through the screwed cable glands and strip to a length of approx. 20 cm (8 in).
M20: Remove the plugs from the insert; and leave the ring in the screwed cable glands for sealing and strain relief.
M32: Remove the plugs from the screwed cable glands. If required, slit open the insert with drill holes from the accessories pack and press over the cable; seal any open drill holes with dowel pins from the accessories pack.
- 2** Connect the lines to the mating plugs as shown in the connection diagrams of the I/O modules.
- 3** Attach the mating plug to the plug-in terminal strips on the I/O modules.

System bus connection

System bus

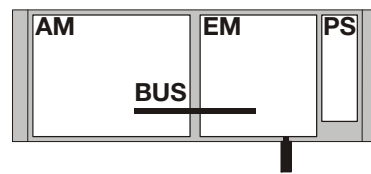
The functional components of the gas analyzer, i.e. the electronics module, the external I/O devices and the analyzer modules communicate with each other via the system bus.

The system bus structure is linear with a maximum length of 350 m.

One system housing

The system bus connection is established at the factory if the electronics module and an analyzer module are installed in one system housing.

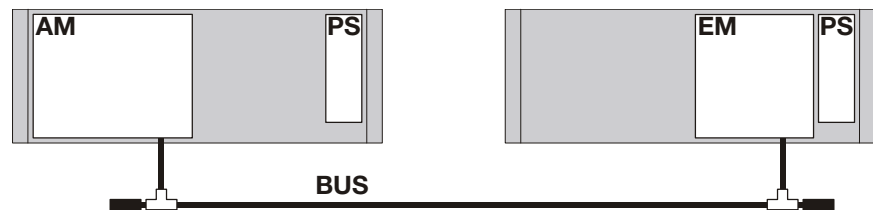
In this case a terminating resistor should be installed in the system bus connector of the electronics module (supplied with the unit).



- AM** Analyzer module
- EM** Electronics module
- PS** Power supply
- BUS** System bus (internal)
- Terminating resistor

Multiple system housings

If the electronics module and the analyzer module are accommodated in several system housings, they must be interconnected externally via the system bus.



- AM** Analyzer module
- EM** Electronics module
- PS** Power supply
- BUS** System bus (external)
- Terminating resistors

ATTENTION

Only one electronics module should be connected to a system bus structure. Multiple electronics modules should never be interconnected via the system bus!

Requisite material

The required system bus cables, T-joints and terminating resistors are supplied per the order.

ATTENTION

For system bus connections use only the yellow system bus cables, T-joints and terminating resistors. Do not use the violet connectors as they are only for Modbus connections.

The modules should never be interconnected without using T-joints and terminating resistors.

System bus connection

- 1 Place a T-joint on the system bus connection (designated "BUS") of each module (electronics and analyzer).
- 2 Connect the T-joints with the system bus cables.
- 3 Place a terminating resistor on the open ends of each T-piece.

Extension of the system bus cable

Note the following information if using other than the standard system bus cables and plugs to extend the system bus:

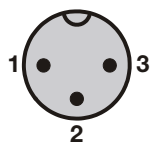
- A shielded cable with twisted pairs and the following specifications is to be used as an extension cable.

Number and section of conductors	2 x 2 x 0.25 mm ²
Inductance	approx. 0.67 mH/km
Impedance	approx. 80 Ω
Coupling (1 kHz)	approx. 300 pF/100 m
Operating capacitance	Conductor–conductor approx. 120 nF/km, Conductor–shield approx. 160 nF/km

- For EMC purposes route the system bus cable via metal connection boxes with metallic cable threaded connections. Connect the shield to the threaded connections. Connect the unused wires in the 4-conductor extension cable in the connection box to a PE clamp.

System bus plug layout

(Seen from pin side of cable plug)

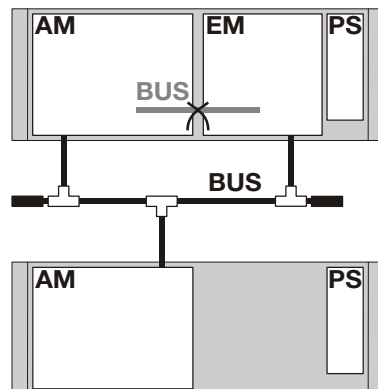


Pin	Wire color	Signal
1	green	System bus LOW
2	brown	System bus HIGH
3	white	System bus GROUND

Adding an analyzer module to the system bus

- 1 Open the internal system bus connection between the existing analyzer module and the electronics module in the gas analyzer.
- 2 Place a T-joint on the system bus connection (designated "BUS") of each module (electronics and analyzer modules).
- 3 Connect the T-joints with the system bus cables.
- 4 Place a terminating resistor on the open ends of each T-piece.
- 5 Set up the added analyzer module.

Several analyzer modules: Connection via the system bus



- AM** Analyzer modules
- EM** Electronics module
- PS** Power supply
- BUS** System bus (external)
- Terminating resistors

Power supply line connection – Safety notes

ATTENTION

Follow all applicable national safety regulations for the installation and operation of electrical devices as well as the following safety precautions. The protective lead (ground) should be attached to the protective lead connector before any other connection is made. The protective lead connection is assured when the power cable supplied is used.

The gas analyzer can be hazardous if the protective lead is interrupted inside or outside the gas analyzer or if the protective lead is disconnected.

Only fuses of the specified type and rated current should be used as replacements. Never use patched fuses. Do not short-circuit the fuse holder contacts.

If the power supply fuse fails, some power supply switch components can still carry current.

Never connect line voltage to a 24-VDC analyzer module input. This will destroy the analyzer module electronics.

An easily accessible mains isolator must be installed near the gas analyzer in order to be able to completely disconnect the latter from the power supply. Mark the mains isolator in such a way that assignment to the devices to be separated can be clearly identified.

ATTENTION

Fidas24: The gas analyzer and the analyzer module must be de-energized before the connector of the 115/230 V AC power supply for heating the detector and the heated sample gas connection is connected or disconnected. Otherwise the heating may be damaged.

Power supply line connection to an analyzer module

NOTES

The following information and instructions should be followed when connecting the 24-VDC power supply to an analyzer module that is not installed in the central unit but in a separate system housing.

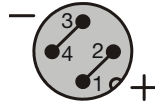
The notes on the power supply (see page 42) must also be considered.

24-VDC connecting cable

If an analyzer module is not installed in the central unit but in a separate system housing a 24-VDC connecting cable (length 5 m (16.4 feet), cross section 2 x 0,5 mm²) will be supplied.



The receptacle on one cable end is designed to connect to the 24-VDC male plug on the analyzer module.

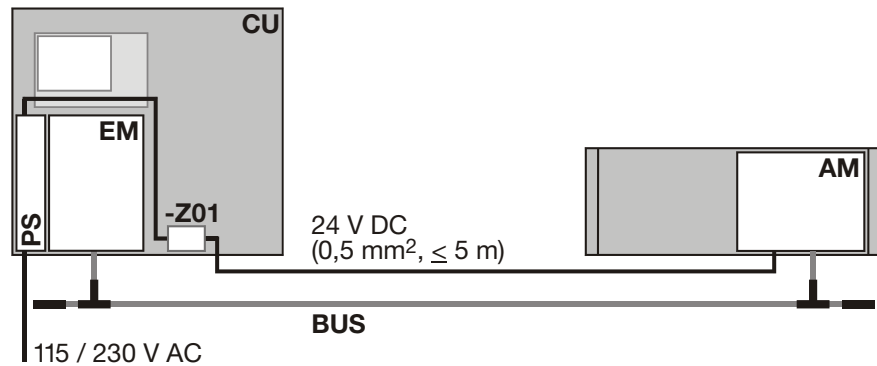


The illustration shows the pin side of the analyzer module plug and thus the solder side of the matching female jack.

The wires on the free end of the connecting cable are intended for connection to

- the power supply filter -Z01 in the central unit or
- an external power supply.

Connecting 24-VDC power from the central unit power supply to a separate analyzer module



AM	Analyzer module
CU	Central unit
EM	Electronics module
PS	Power supply
-Z01	Power line filter
BUS	System bus

24-VDC connection

- 1 Connect the supplied connection cable with receptacle to the 24-V DC connection on the analyzer module.
- 2 Connect the wires on the free end of the cable to the power supply filter -Z01 in the central unit or to the external power supply.

Extending the 24-VDC connection cable

The 24-VDC connection cable has a wire section of 0.5 mm²; it is limited to a length of 5 meters (16.4 feet).

Note the following conditions if the connection cable has to be extended:

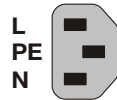
- The extension cable must have a wire section of at least 2.5 mm².
- The extension cable should be no more than 30 meters (100 ft) long.
- The extension cable should be connected as close as possible to the receptacle of the supplied 24-VDC connection cable, i.e. the supplied 24-VDC connection cable should be made as short as possible.

Power supply line connection

Requisite material

The gas analyzer is supplied with a power cord and a separate two-prong grounded plug. The power cord is 5 meters (16.4 feet) long and has a three-prong grounded-instrument plug for connection to the power supply. If the supplied mains lead is not used, select conductive material which is appropriate for the length of the lines and the predictable current load.

Power supply connection



The illustration shows the pin side of the plug in the power supply.

Power supply line connection

- 1 Ensure that the power supply feeder has an adequately dimensioned protective device (circuit-breaker).
- 2 Install an easily accessible mains isolator in the power supply feeder near the gas analyzer, or a switched socket-outlet, in order to be able to completely disconnect the gas analyzer from the power supply if required. Mark the mains isolator in such a way that the assignment of the devices to be disconnected can be clearly recognized.
- 3 Connect the power cord supplied to the **-X01** with grounded-instrument connector on the power supply connector of the electronics module and secure it with the clip.
- 4 Connect the other end of the power cord to the power source.

NOTE

The gas analyzer may start when the power supply is connected.

Connecting equipotential bonding

The electronics module and the analyzer modules have a potential compensation connector designated by the symbol \oplus . The connection has an M5 female thread for screwing in suitable screws or terminals.

Use this connection to link each module to the building's potential compensator in accordance with local regulations.

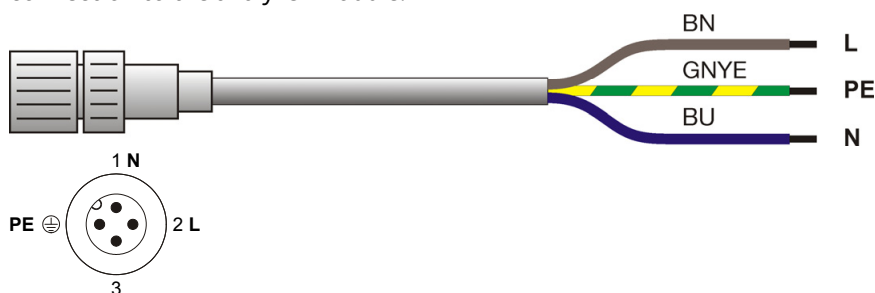
Fidas24: Power supply line connection

CAUTION

The gas analyzer and the analyzer module must be de-energized before the connector of the 115/230 V AC power supply for heating the detector and the heated sample gas connection is connected or disconnected. Otherwise the heating may be damaged.

115/230-V-AC connecting cable

A connecting cable is supplied for the 115/230 V AC power supply for heating the detector and, if applicable, the heated sample gas connection (length 5 m, cable cross-section 3 x 1.5 mm²) with a 4-pole socket connector for the connection to the analyzer module.



The illustration shows the pin side of the plug **30** in the analyzer module (see page 83).

The operating voltage of the detector heating is automatically detected and switched. The set voltage can be identified through two LEDs on the mains distribution card.

115/230 V AC connection to the analyzer module

- 1 Ensure that the power supply feeder has an adequately dimensioned protective device (circuit-breaker).
- 2 Install an easily accessible mains isolator in the power supply feeder near the gas analyzer, or a switched socket-outlet, in order to be able to completely disconnect the heating of the detector and the heated sample gas connection from the power supply if required. Mark the mains isolator in such a way that the assignment of the devices to be disconnected can be clearly recognized.
- 3 Make sure that the gas analyzer and the analyzer module are de-energized.
- 4 Attach the supplied 115/230-V-AC connecting cable with the 4-pole socket connector to the power supply connection **30** of the analyzer module and screw tight.
- 5 Connect the wires on the free end of the power cable to the power supply.

Gas analyzer start-up

Installation check

Installation check

Check that the gas analyzer has been correctly installed before the starting it up.

Test	
Is the gas analyzer securely fastened (see page 79)?	<input type="checkbox"/>
Are all gas lines including that of the pressure sensor correctly connected (see page 80)?	<input type="checkbox"/>
Have all the signal, control and interface lines, the power supply lines and, if applicable, the system bus been correctly laid and connected (see page 107)?	<input type="checkbox"/>
Are all devices needed for gas conditioning, calibration and waste gas disposal correctly connected and ready for use?	<input type="checkbox"/>

Gas path and housing initial purge

Purge before commissioning

The gas paths and if necessary, the system housing should be purged prior to starting the gas analyzer.

Firstly this ensures that the gas paths and system housing are free from contaminants e.g. corrosive gases, and accumulations of dust on start-up.

Secondly this prevents any explosive gas/air mixture present in the gas paths or system housing being ignited when the power supply is connected.

Purge gas

Nitrogen or instrument air should be used as a purge gas.

Purge gas flow rate during initial purge

The purge gas flow and the duration of the purge process depend on the volume to be purged (see the following table). If the purge gas flow is lower than specified, the duration of the purging must be extended accordingly.

Volume to be purged	Purge gas flow rate	Duration
Gas path	100 l/h (max.)	approx. 20 s
Central unit with or without analyzer module	200 l/h (max.)	approx. 1 h
Analyzer separately: Caldos25, Caldos27, Magnos206, Magnos28, Magnos27	200 l/h (max.)	approx. 3 min

NOTE

The purge gas flow rates given in the table only apply to the initial purge. Other values apply during operation (see page 136).

ATTENTION

Purge gas can escape from the housing if there are any leak points. When using nitrogen as the purge gas, take all required precautions against suffocation.


The purge gas flow must always be restricted upstream of the purge gas inlet! If the purge gas flow is not restricted until after the purge gas outlet, the full pressure of the purge gas will affect the housing seals which can destroy the operator panel keypad!

Power supply activation

NOTE

The gas analyzer may not be calibrated until the warm-up phase has been concluded.


Power supply activation

- 1 Turn on the power supply of the gas analyzer with the external breaker switch.
- 2 If necessary, turn on the separate 24-VDC power supply of the analyzer module.
- 3 The following events will occur after the power supply is turned on:
 - 1 The three "Power", "Maint" and "Error" LEDs light up.
 - 2 The different booting phases are displayed on the screen. Also the software version is displayed.
 - 3 After a brief time the screen switches to measurement mode.
 - 4 The softkey  appears on the screen. This indicates the possibility of a temperature or flow problem during the warm-up phase. By pressing the softkey the user can recall the status message summary and view status message details.

Fidas24: Gas analyzer start-up

Gas analyzer start-up

Switch on the power supply, heating-up phase, feed in supply gases

- 1 Switch on the power supply of the gas analyzer and the heaters of the Fidas24.
If the analyzer module is not installed in the central unit, switch on the separately installed 24 V DC supply of the analyzer module.
- 2 The following events will occur after the power supply is turned on:
 - 1 The three "Power", "Maint" and "Error" LEDs light up.
 - 2 The different booting phases are displayed on the screen. Also the software version is displayed.
 - 3 After a brief time the screen switches to measurement mode.
 - 4 The softkey  appears on the screen. This indicates the possibility of a temperature or flow problem during the warm-up phase. By pressing the softkey the user can recall the status message summary and view status message details.
- 3 Select the Controller measured values menu item:
MENU → Diagnostics/Information → Module-specific → Controller Measured Values
Amongst other things, the controlling variables of the temperature regulator are displayed in this menu option:
T-Re.D Detector temperature
T-Re.E Temperature of the heated gas connection
T-Re.K Temperature of the internal combustion air preparation
TR.VV1 Temperature of the preamplifier
The temperature values slowly increase after the power supply is switched on.
- 4 Feed in instrument air, combustion air and combustion gas (H₂ or H₂/He mixture). Adjust the pressure to the value specified in the Analyzer Data Sheet with the corresponding external pressure regulator.
- 5 The controlled variables of the internal pressure regulator are also displayed in the Controller measured values menu item; the pressures of the supply gases are set by means of the controlled variables:
MGE Pressure at the sample gas nozzle
MGA Pressure in the combustion chamber (outlet)
C-Air Combustion air
C-Gas Combustion gas (H₂ or H₂/He mixture)
To begin with, any values can be displayed for the controlled variables. The values are updated for the first time approx. 10 s after selecting the menu option and then approx. every 10 s. The pressure control is in progress in the background. It may take some time to set the pressures depending on the setting of the inlet pressure.
The gas analyzer automatically reverts to the measurement mode to display values if the operator has not pressed a key in menu mode in the last five minutes.

- 6** The following status messages are active during the heating-up phase:
- "Operating temperature": the temperature of the detector has not yet reached the threshold.
 - "Flame error": the flame has not yet ignited.
 - "Temperature limit value 1, 2": the temperature of the detector (T-Re .D) and possibly of the heated sample gas connection (T-Re .E) is over or below the upper or lower limit value 1 (2).
 - "Pressure limit value 1, 2": the pressure at one of the internal pressure regulators for instrument air (i n l e t, o u t l e t), combustion air (a i r) or combustion gas (H₂) is over or below the upper or lower limit value 1 (2).
- 7** As soon as the temperature of the detector reaches the threshold value (150 °C) the corresponding solenoid valve in the analyzer module automatically switches off the instrument air. The negative pressure regulation and the combustion air regulation attempt to adjust the pressures to the respective set point.
The sample gas begins to flow through the analyzer after the instrument air is connected.
- 8** After the pressures have been adjusted to the respective set point, the respective solenoid valve in the analyzer module automatically connects the combustion gas. The combustion gas regulation attempts to adjust the pressure to the set point.

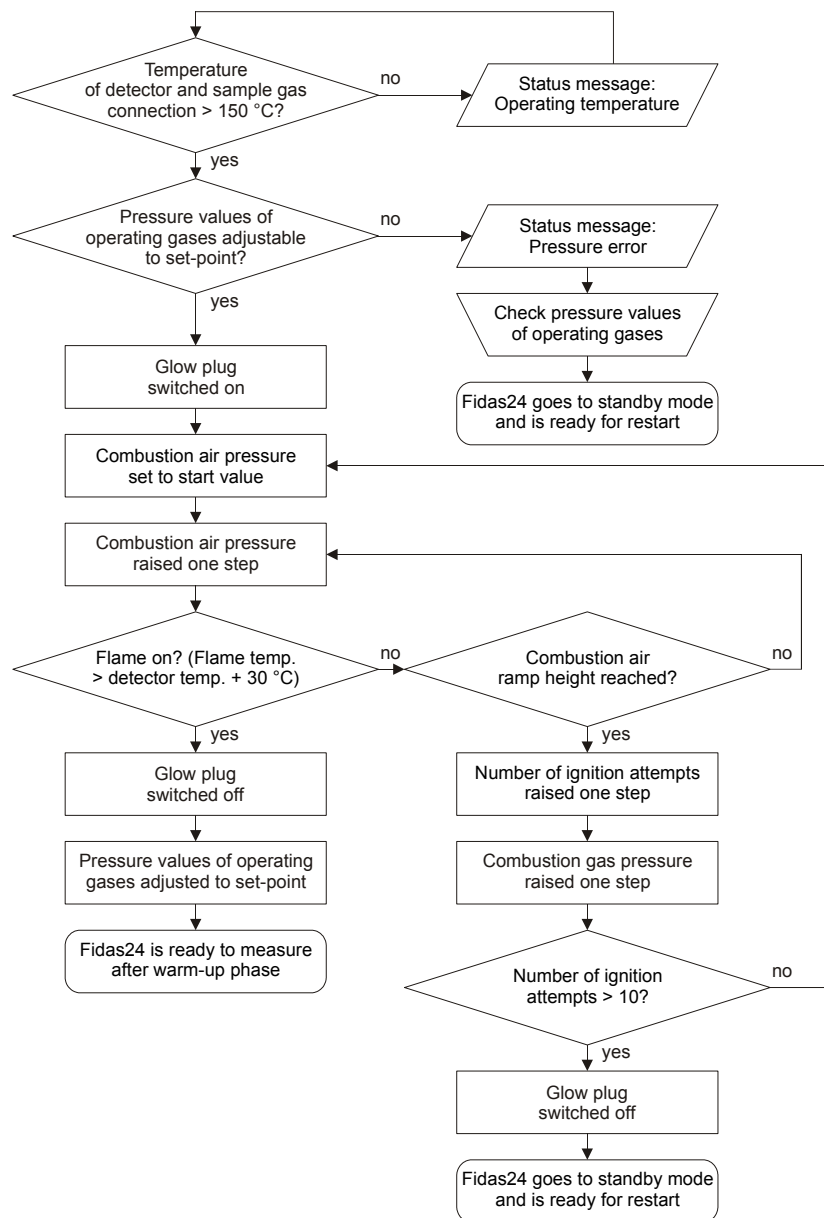
Adjustment of the controlled variables of the internal pressure regulators

If the analyzer module is not automatically put into service with the pressure values specified in the analyzer data sheet, the controlled variables of the internal pressure regulators must be adjusted. If the controlled variables of the internal pressure regulators deviate, the inlet pressures of instrument air, combustion air and combustion gas must be changed (steps 9 to 11).

- 9** Instrument air: use the external pressure regulator to set the controlled variable for `Outlet` to approx. 60 % (max. 70 %).
Controlled variable too high ⇒ reduce pressure.
Controlled variable too low ⇒ increase pressure.
(The controlled variable for `Inlet` depends on the sample gas flow rate.)
- 10** Combustion air: use the external pressure regulator to set the controlled variable for `Air` to approx. 55 % (max. 60 %).
Controlled variable too high ⇒ reduce pressure.
Controlled variable too low ⇒ increase pressure.
- 11** Combustion gas: use the external pressure regulator to set the controlled variable for `H2` to approx. 42 % (max. 52 %).
Controlled variable too high ⇒ increase pressure.
Controlled variable too low ⇒ reduce pressure.

Ignition of the flame

12 The flame ignites automatically:



Depending on the number of ignition attempts, the flame can take up to 10 minutes to ignite.

Depending on the length of the combustion gas supply line, it is possible that not enough combustion gas is available to ignite the flame at first during the initial start-up of the gas analyzer. In this case, the ignition of the flame must be restarted (see page 277) in the menu Standby/Restart FID.

The temperature of the flame is displayed in the Raw measured values auxiliary variables menu option in the Flame parameter; the flame is regarded as "on" when the flame temperature is at least 30 °C higher than the detector temperature.

The actual start-up of the gas analyzer is concluded with the ignition of the flame.

Restarting the gas analyzer

- 1 Feed in instrument air and combustion air and purge the gas analyzer **for at least 20 minutes**.
- 2 Turn on the gas analyzer power supply.
- 3 Turn on the combustion gas supply and check the combustion gas pressure.
- 4 Carry out a seal integrity test on the combustion gas line (see page 283).
- 5 Turn on the sample gas supply.

ATTENTION

The gas analyzer and the analyzer module must be de-energized before the connector of the 115/230 V AC power supply for heating the detector and the heated sample gas connection is connected or disconnected. Otherwise the heating may be damaged.

The cover of the heated sample gas terminal is hot during operation. It reaches a temperature of more than 70 °C!

Limas21 HW: Gas analyzer start-up

Gas analyzer start-up

- 1 Turn on the gas analyzer power supply.
- 2 Wait for the warm-up phase to end. Wait at least 2 hours until the temperature of the heated sample gas line has stabilized at 180 °C.
- 3 Purge the complete sample gas feed path (sample gas line and gas analyzer) for at least 1 h with clean and dust-free ambient air.
- 4 Turn on the sample gas supply.

ZO23: Gas analyzer start-up

Gas analyzer start-up procedure, initial calibration at the installation site

- 1** Turn on the gas analyzer power supply.
After approx. 15 minutes, the sample cell has reached its operating temperature. If required, the gas analyzer can be calibrated at the reference point (see step 3) and the end point (see step 5).
- 2** For setting the reference point (= electrical zero), feed ambient air wait and until the measured value has stabilized (duration approx. 2 hrs.).
Meanwhile, purge the test gas valves and the gas supply line with oxygen-free gas (e.g. with nitrogen from a loop feeder) or with sample gas (flow rate 5 to 10 l/h).
- 3** Set reference point to 20.6 vol.% of O₂.
- 4** Feed span gas and wait until the measured value has stabilized (duration max. 2 hrs.).
- 5** Set end-point value in accordance with the certificate of analysis of
- 6** The gas analyzer is ready for performing measurements; feed sample gas.

NOTE

Information for test gases can be found in the section "ZO23: Preparation for installation" (see page 67).

Warm-up phase

Warm-up phase

The duration of the warm-up phase depends on which analyzer module is installed in the gas analyzer.

Analyzer module	Duration of the warm-up phase
Caldos25	1.5 hours
Caldos27	30/60 minutes for class 1/2 measurement ranges ¹⁾
Fidas24	≤ 2 hours
Fidas24 NMHC	≤ 2 hours
Limas11 IR	Approx. 2.5 hours
Limas21 UV	Approx. 2.5 hours
Limas21 HW	Approx. 4 hours
Magnos206	≤ 1 hour
Magnos28	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx. 0.5/2 hours without/with thermostat
ZO23	Approx. 15 minutes

1) See "AO2000 Series" data sheet for class details.

NOTES

The warm-up phase can take longer if the gas analyzer was not brought to room.

During the warm-up phase measurement values can be outside the ranges specified in the data sheet.

Warm-up phase duration

The warm-up phase is deemed to be over when the measured value drift indication is acceptable. This depends on the size of the measurement range.

NOTE for Fidas24

Unused sample gas lines and sampling probes can release hydrocarbons after the first start-up over a longer period. Therefore, it can take a longer time until the measured value drift has reached an acceptable value.

Operation

Ready to perform measurements

At the end of the warm-up phase the gas analyzer is ready to carry out measurements.

Verify the calibration

The gas analyzer is calibrated ex works. However, transport stresses and the pressure and temperature conditions at the installation site may influence the calibration. Thus it is recommended to verify the gas analyzer calibration at the installation location.

Turn on the sample gas supply

The sample gas supply should be turned on only after calibration.

Adjusting sample gas flow rate

Analyzer module	Sample gas flow rate	
Caldos25	10 to 90 l/h	(for option T90 < 6 s: max. 90 to 200 l/h)
Caldos27	10 to 90 l/h	min. 1 l/h
Fidas24	80 to 100 l/h	with atmospheric pressure (1000 hPa)
Fidas24 NMHC	80 to 100 l/h	with atmospheric pressure (1000 hPa)
Limas11 IR	20 to 100 l/h	
Limas21 UV	20 to 100 l/h	
Limas21 HW	20 to 90 l/h	
Magnos206	30 to 90 l/h	
Magnos28	30 to 90 l/h	
Magnos27	20 to 90 l/h	
Uras26	20 to 100 l/h	
ZO23	5 to 10 l/h	The flow rate must be kept constant to ± 0.2 l/h in this range. The sample gas must be taken from a bypass at zero pressure.

Adjusting reference gas flow rate

In the Caldos25 and Uras26 analyzer module versions with flowing reference gas, the sample gas flow rate and the reference gas flow rate must be set to the optimal value.

For special applications of the Caldos25 the reference gas flow rate must be set to lower values down to 1 l/h.

Adjusting purge gas flow rate

The purge gas flow rate should be set as follows in gas analyzers with the housing purge capability:

Purge gas flow rate at device inlet max. 20 l/h (constant), purge gas positive pressure: $p_e = 2$ to 4 hPa.

For a purge gas flow rate at the device inlet of 20 l/h, the purge gas flow rate at the device outlet is approx. 5 to 10 l/h.

Fidas24: Housing purge during operation

A part (approx. 600 to 700 l/h) of the instrument air for the air jet injector is conducted continuously through the housing as purge air.

Date and time check

A correct date and time setting (see page 183) is required for proper operation of functions such as automatic calibration and logging of error messages.

- 1 Select the Date/Time menu item:
MENU → Configure → System → Date/Time
- 2 Check and, if necessary, correct the date and time.

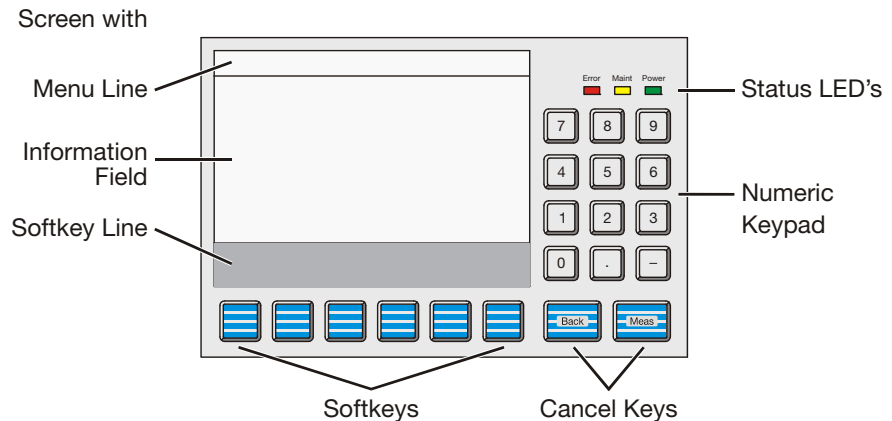
NOTE

The gas analyzer is factory-set to the GMT+1 time zone.

Gas analyzer operation

Display and control unit

Overview



The display and control unit contains:

- The screen (see page 139) with
 - Menu line,
 - Information field,
 - Softkey line,
- Status LEDs (see page 141),
- Numeric keypad (see page 142),
- Cancel keys (see page 143) and
- Softkeys (see page 144).

In both system housing versions the display and control unit is located on the front face.

Display and control unit operating modes

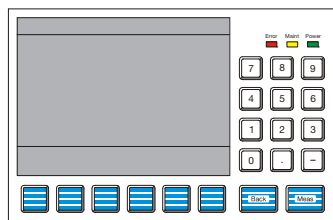
The display and control unit operating modes are

- Measurement and
- Menu.

The display and control unit operating modes have no effect on measurement operations, i.e. gas analyzer measurement functions continue while in menu mode.

Screen

Screen



The backlit graphics has a 320 x 240-pixel resolution.

The screen is divided into three panels

- Menu line
- Information field
- Softkey line

The menu line

The menu line appears at the upper edge of the screen. A line separates it from the information field.

It shows the current menu path and thus allows the operator to see where the system is in the menu tree. Additionally it shows the name of the analyzer being processed.

The information field in measurement mode

In the measurement mode the information field shows the following information for each sample component in the analyzer modules installed in the gas analyzer:

- Values in numeric form and as a bar graph
- The physical unit for the measured value
- The measurement component designation
- The measurement range lower and upper limit values on the horizontal bar graph
- The analyzer type
- The analyzer name

Values from up to six sample components can be displayed simultaneously.

It is user-configurable

- which measurement values are shown on the screen and
- at which positions on the screen the measurement values are displayed.

In addition, the user can configure display elements that allow to

- enter values (see page 207) directly in the measurement mode or
- actuate keys (see page 209).

NOTE

For further information about the screen in the measurement mode refer to the "Display" (see page 198) section.

The information field in menu mode

In menu mode the information field contains the menu or individual menu items or parameters with the applicable values, as well as operator prompts.

The softkey line

The softkey line appears at the lower edge of the screen. Its gray background distinguishes it from the information field.

The softkeys are further explained in the "Softkeys" (see page 144) section.

Message display

Message display functions

The blinking message display in the softkey line has the following functions:

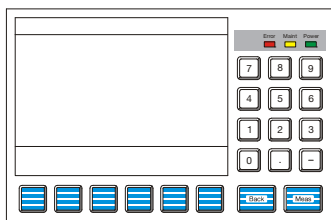
- It prompts for the STATUS MESSAGE key to be pressed whenever a status
- It shows that a password is active.
- It shows that the gas analyzer is being controlled from a remote HMI.
- It shows that an automatic calibration process is running in the gas analyzer.

Display of status messages

When a status message is generated by the **Message Generator** function block its short text is displayed on the message display as configured in the function block. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Status LEDs

Status LEDs



The three LEDs next to the screen show the user the gas analyzer's status.

Power



The green "Power" LED lights when the power supply is on.

Maint



The yellow "Maint" LED lights when the "Maintenance request" status signal is active.

The STATUS MESSAGE softkey appears on the screen at the same time.

Error



The red "Error" LED lights when the "Failure" status signal or the overall status signal is active.

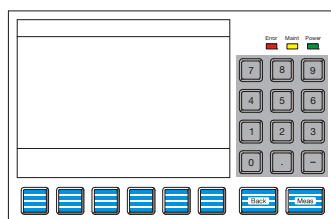
The STATUS MESSAGE softkey appears on the screen at the same time.

NOTE

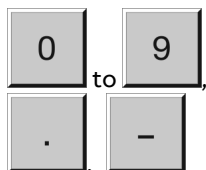
Chapter "Status messages, troubleshooting" (see page 315) contains detailed information on status messages and status signals.

Numeric keypad

Numeric keypad



The numeric keypad is located to the right of the screen, under the status LED's.



The operator can enter values directly with the:

- numeric keys "0" through "9"
- decimal point "." and
- minus sign "-".

Examples:

- Test gas concentration,
- Date and time
- Air pressure
- Password

NOTE

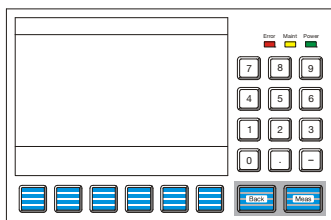
Any digits displayed cannot be overwritten directly. They must be deleted with the BACKSPACE or CLEAR key before new digits can be entered.

Entering text with the numeric keypad

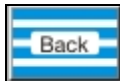
The "Text entry" (see page 146) section explains how to enter information such as sample component or user names with the numeric keypad.

Cancel keys

Cancel keys



The "Back" and "Meas" keys located under the numeric keypad are designated as cancel keys.



The "Back" key allows the operator to cancel a function or menu item and return to the previous menu level.

Only entries confirmed with the ENTER key are stored; unconfirmed items are not accepted.

The "Back" key also allows the operator to clear gas analyzer help text and messages.



The "Meas" key allows the operator to cancel a function or menu item and to return to the measured value display in measurement mode.

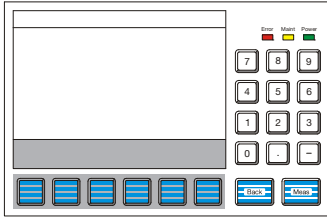
Only entries confirmed with the ENTER key are stored; unconfirmed items are not accepted.

NOTE

The gas analyzer automatically reverts to the measurement mode to display values if the operator has not pressed a key in menu mode in the last five minutes ("time out").

Softkeys

Softkeys



The six keys under the screen and the softkey line at the lower edge of the screen are known as softkeys.

A softkey is the combination of the key and its designation in the softkey line.

A softkey does not have any set function, but is assigned a function for a given situation as shown in the softkey line of the screen.

Pressing a softkey is the equivalent of pressing the key assigned to the function; this process is illustrated by the quasi-three-dimensional softkey representation on the screen.

Softkeys are also called keys in this manual.

The softkeys in measurement mode



In the measurement mode, the softkey line contains the softkeys `MENU` and `>>`. The softkey `Status message` also appears if an error occurs.

The `MENU` key is used to call up the main menu and switch to menu mode when in measurement mode.

The `>>` key allows the operator to scroll to the next display "page". This key only allows forward scrolling.

The "Back" key is used for backward scrolling.

The `Status message` key appears in measurement mode if a "Failure" or "Maintenance request" condition arises.

This key allows the operator to call up the status message summary and view the status messages.

The user can also call up a detailed display for any message in the log.

NOTE

Chapter "Status messages, troubleshooting" (see page 315) contains detailed information on status messages and status signals.

The softkeys in menu mode

In menu mode, a series of softkeys appears on the softkey line. Their descriptions and functions depend on the specific situation.

In menu mode the standard softkeys have the following functions:



The operator uses these two arrow keys to move the selection cursor up or down, e.g. in menus or lists to choose vertically arranged (menu) items.

The menu item selected is reversed, i.e. appearing as bright characters on a dark background.



The operator uses these two arrow keys to move the selection cursor left or right, e.g. into or out of a submenu or to select (menu) items arranged adjacent to each other.

The menu item selected is reversed, i.e. appearing as bright characters on a dark background.



The operator can use the BACKSPACE key to delete characters to the left of the cursor (as in a PC keyboard).



The operator can use the CLEAR key to delete all characters in a selected field.



The operator can use the ENTER key to:

- Call up menu items for processing
- Start functions
- Confirm entries, e.g. parameter settings

The ENTER key is always at the right margin of the softkey line.



The operator can use the HELP key to access context-sensitive help. The screen will then show a help message explaining the menu item selected.

The operator can use the "Back" key to clear the help message.

Representation of entries in this operator's manual

In this operator's manual entries to be made by the operator will not be identified by key symbols but by the following type styles (these are examples only):

Press cancel keys:	Back, Meas
Press softkeys:	MENU, HELP, ENTER, BACKSPACE
Select menu items:	Calibrate, Configure
Enter numbers:	0 to 9

Text entry

Entering text

When text, such as measurement components or user names, is to be entered an image of the numeric keypad appears on the screen.

The following characters are shown using a total of four pages:

- Letters A to Z and a to z
- Special characters * () % & : < > / and blank
- Digits 0 to 9 . -

Each character is accessed using the key in the corresponding position on the numeric keypad. Examples:

Letters: A L t Blank or space character

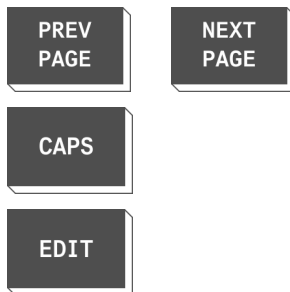
Key: 7 - 2 9

An input line appears at the lower edge of the screen for new text to be entered or existing text to be modified.

Text is entered and modified in two ways:

- The operator enters text in the input mode.
- The operator modifies already entered text in the edit mode.

Softkeys in the input mode



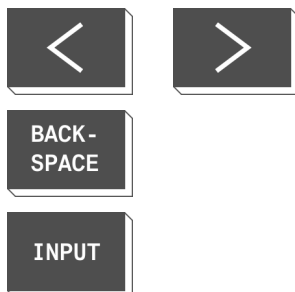
The softkeys in the input mode have the following functions:

The **PREV PAGE** and **NEXT PAGE** keys allow the operator to move to the previous or next keypad page.

The **CAPS** key allows the operator to switch between upper- and lowercase letters.

The **EDIT** key allows the operator to switch into the edit mode.

Softkeys in the edit mode



The softkeys in the edit mode have the following functions:

The two arrow keys allow the operator to move the cursor left and right in the entry line.

The operator can use the **BACKSPACE** key to delete characters to the left of the cursor (as in a PC keyboard).

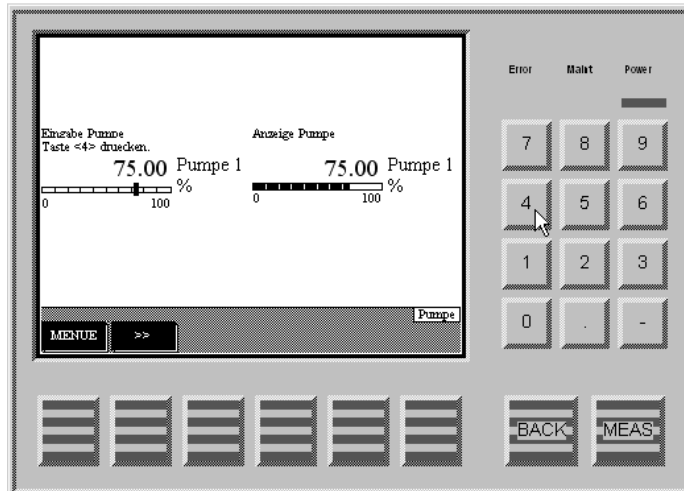
The **INPUT** key allows the operator to change to the input mode.

Operating by value entry

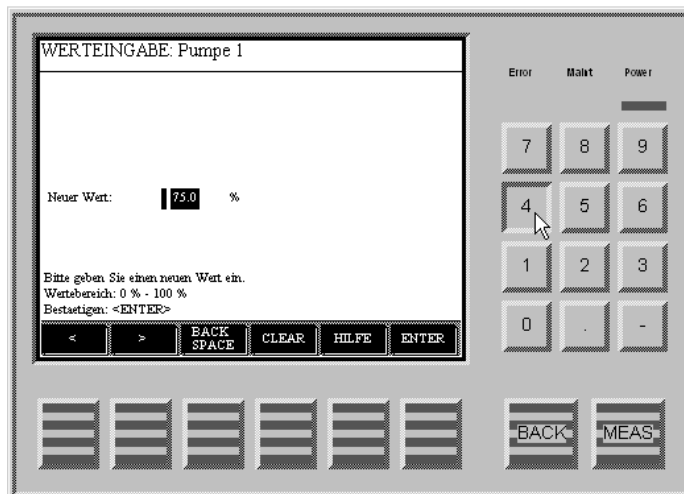
Value entry

Values are entered during measurement by pressing the number key that corresponds to the position of the display element in the display and that is indicated above the display element.

In the example, this is key 4:



A field then appears for entering the value:



Description and configuration

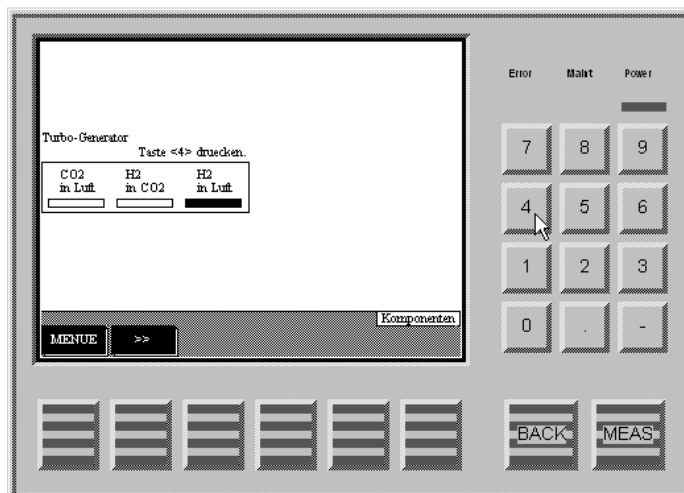
Further information can be found in sections "Value entry" (see page 207) and "Configuring value entry" (see page 208).

Operating by key entry

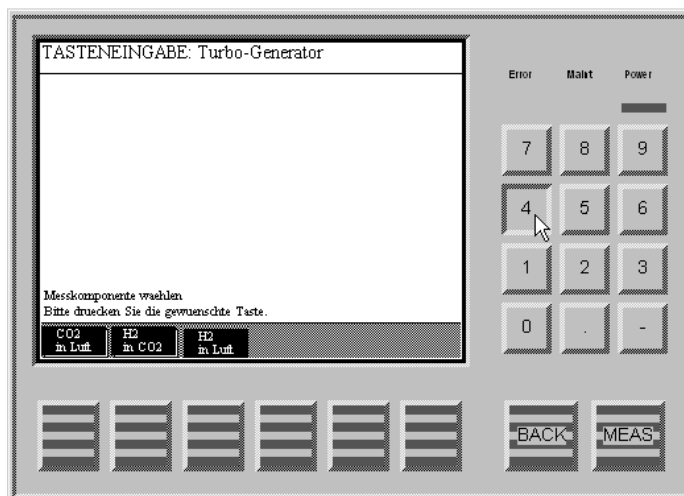
Key entry

Key entries are made during measurement mode by pressing the number key that corresponds to the position of the display element on the display and that is indicated over the display element.

In the example, this is key 4:



A softkey line then appears with the configured keys:



Description and configuration

Further information can be found in sections "Key entry" (see page 209) and "Configuring key entry" (see page 210).

Password protection

Elements of password protection

Password protection consists of three elements

- Password level,
- User group,
- Password.

Password level

Each menu item is assigned a password level. Password levels are numbered with 0, 1, 2 and 3.

Menu items are assigned to different password levels in order to assure that specific menu items can only be changed by authorized users.

User group

The definition of a user group is that every user that belongs to it has access entitlement at certain password levels, i.e. can make changes to the menu items at these levels.

Some user groups are set-up at the factory.

A user group can be made up of one or more users.

Password

Every user group set-up in the system has a password.

The password consists of six digits which can be entered via the numeric keypad.

Passwords are pre-assigned for the factory-set user groups.

Factory setting

User group	Access to password levels	Default password
Every user	0	None
Maintenance team	0, 1	471100
Specialist team	0, 1, 2	081500
Function block specialist	0, 1, 2, 3	325465
Field service	0, 1, 2, 3, 4, S	737842

It is recommended to change the default passwords.

CAUTION

After entering the password for password level 3, you can access all of the function block applications. When configuring function blocks, existing applications with their configurations and links can be damaged or destroyed!

NOTE

Technical Bulletin "Function Blocks – Descriptions and configuration" contains complete information on the "Function block" concept as well as detailed descriptions of the individual function blocks.

Viewing menu items

All users can view all menu items, regardless of password level, without entering a password.

Changing menu items

All users can make changes to password level 0 menu items without entering a password.

Password level 1, 2 and 3 menu items can only be changed if the user belongs to the group authorized for that level and after the user's password has been entered.

Note: Entering the main menu and thus switching to the menu mode can be password protected (see the "Inhibit operation" (see page 186) section).

Change privilege

After entering the password the user is authorized to change any menu items on all password levels accessible at the user's level.

Duration of the change privilege

The change privilege remains in effect until:

- The analyzer automatically switches to measurement mode if the user has not pressed a key for more than about 5 minutes (time out).
- Or the user presses the "Meas" key twice in succession.

The change privilege remains in effect if the user presses the "Meas" key only once to return to measurement mode. This is indicated by the "Password active" status message.

In this manner the user does not have to re-enter a password to change a menu item if he or she returns to the menu mode within approximately 5 minutes.

Note: The change privilege thus refers to a temporary authorization to change menu items. In contrast, the access privilege refers to a fundamental and configurable authorization to change menu items at certain password levels.

Changing the password

Changing the password is described in the "Gas analyzer configuration" (see page 185) section.

User interface priority

Note: The user interface is designated using the acronym "HMI", which stands for "human machine interface".

User interfaces

The AO2000 series gas analyzers have several user interfaces:

- The local operation user interface is the display and control unit on the gas analyzer ("local HMI").
- The remote operation user interface is a PC running the "AO-HMI" software ("remote HMI"). For detailed information on remote operation, see the "AO-HMI" technical bulletin.

HMI priority

A gas analyzer (or more accurately an analyzer module) can only be operated via one HMI.

The password hierarchy controls which HMI has or retains priority for operation (refer to the following table). As a rule, the HMI with the level n+1 password has priority over an HMI with the level n password. An exception is the local HMI with level n password which has priority over a remote HMI with a level n password.

1st user:	2nd user:	
	Remote HMI receives ...	Local HMI receives ...
Remote HMI level n	Priority with level n+1	Priority with level n
Local HMI level n	Priority with level n+1	–

NOTE

If a second user with an HMI receives priority over another HMI, all first user input not confirmed with the ENTER key is lost and processes in progress (e.g. calibration) will be stopped.

Specifics for manual calibration

Manual calibration runs at level 0, thus no password is needed. It is protected in the following manner from being stopped by another HMI:

On entering the Calibrate menu the level 1 password is automatically assigned. Therefore, any other HMI must at least enter a level 2 password in order to assume priority for operation. In this event the calibration run would be stopped.

Access lock

Access lock via function block configuration

Independent of the user interface priority adjustment it is possible to completely lock the access to the operation of the gas analyzer from a certain user interface (HMI),

This lock is effected by configuration of the function block **Access Lock**. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Access denied

When a user tries to operate the gas analyzer via a locked HMI, the following text is displayed after pressing the Menu key:

Access denied!
The gas analyzer operation
is currently locked.
Cancel: <BACK>

Access lock via password protection

As an alternative to the above-described complete access lock it is possible to inhibit entering the main menu and thus switching to the menu mode via password protection (see page 186).

Menu tree

Menu tree

Menu		
_ Calibrate		
_ Manual calibration	0	
_ Automatic calibration	0	
_ Configure		
_ Component specific		
_ Measurement range	0	
_ Filter	1	
_ Pressure controller	2	
_ Autorange	1	
_ Alarm values	1	
_ Active component	0	
_ Module text	2	
_ Calibration data		
_ Manual calibration	1	
_ Automatic calibration	1	
_ Ext. controlled cal.	1	
_ Output current response	1	
_ Function blocks		
_ Miscellaneous	3	
_ Inputs	3	
_ Outputs	3	
_ Mathematics	3	
_ Multiplexer/Demultiplexer	3	
_ Measurement	3	
_ Sample system	3	
_ Calibration/Correction	3	
_ System		
_ Date/Time	2	
_ Language	2	
_ Change password		
_ Setup system modules	2	
_ Save configuration	1	
_ Status signals	2	
_ Network	2	
_ Display	2	
		_ Maintenance/Test
		_ System
		_ Atm. pressure
		_ Display test
		_ Keyboard test
		_ Analyzer spec. adjustm.
		_ Pump
		_ Atm. press. anz
		_ Calibration reset
		_ Basic calibration
		_ Measure cal. cell
		_ Optical adjustm.
		_ Phase adjustm.
		_ Relinearization
		_ Amplification optimization
		_ Cross sensitivity adjustm.
		_ Carrier gas adjustm.
		_ Electr. zero cal. FID
		_ Restart FID
		_ Diagnostics/Information
		_ System overview
		_ Module specific
		_ Raw values
		_ Auxiliary raw values
		_ Status
		_ Controller values
		_ Lamp intensity
		_ Uras26 Status
		_ Logbook

For reasons of brevity only the top level parameters and functions are shown; the menu branches more extensively at most menu items, e.g. into the various measurement components or into the selection and adjustment of values.

Some menu items are analyzer-specific, i.e. they only appear when particular analyzer modules are integrated into the gas analyzer.

'Function blocks' sub-menu (see page 182)

'Calibration data' sub-menu (see page 225)

Password levels

For each menu item its password level (0, 1, 2, 3) is shown in the table.

For some menu items, individual sub-menu items are on a higher password level. These apply especially to those sub-menu items which allow access to function block applications.

Remark: The "Change password" menu item is not assigned to a specific password level. In order to change a password the old password of this password level must be entered.

Gas analyzer configuration: Measurement component-specific functions

Measurement range configuration

Measurement range switch-over

Menu path

MENU → Configure → Component-Specific → Measurement Range → Select Component → ...

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure

Select the measurement range with the arrow keys and press ENTER to confirm.

NOTE

The measurement range selected is shown on the screen after switching to measurement mode.

Modifying measurement range limits

Menu path

MENU → Configure → Component-Specific → Measurement Range → Select Component → ...

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure

Select the measurement range with the arrow keys, press CHANGE LIMITS, select START VALUE or END VALUE, change the measurement range limit and confirm with ENTER.

NOTES

For the automatic measurement range changeover (see page 161) to function properly, the measurement ranges MR1, MR2 ... must be configured in ascending order, i.e. $MR1 < MR2 < \dots$

The measurement range selected or changed is shown on the screen after switching to measurement mode.

Steps after changing measurement range limits

The calibration of the relevant measurement range should be checked after the range limits have been changed. If the ratio of the old to the new measurement range is $\geq 1:10$, we recommend manually calibrating (see page 265) the end point.

Parameters of the auto-range switching (see page 161) should be verified after the range limits have been changed.

Notes for individual analyzer modules

Caldos25, Magnos27

Measurement ranges are factory-set and cannot be modified.

Caldos27

Measurement ranges are freely selectable for binary gas mixtures. They are factory-calibrated for the largest possible measurement range. However adjustability is limited if, for example, the measurement ranges crosses the explosive limit or areas of the measurement ranges cannot be implemented due to ambiguities.

Measurement ranges are not freely adjustable in the case of multiple-component mixtures with "interference components" that have been calibrated at the factory or if a cross-sensitivity correction has been configured. In these cases the measurement ranges are factory-set per customer order.

Magnos206, Magnos28

Measurement ranges are freely selectable. At the factory they are either set to 0 to 10/15/25/100 vol.% O₂ or per order.

Limas11 IR, Limas21 UV, Limas21 HW, Uras26

Measurement ranges are freely selectable.

The Limas11 IR, Limas21 UV, Limas21 HW and Uras26 analyzer modules have one physical measurement range per sample component. The limits of this measurement range are determined by the minimum and the maximum value of the product of the gas concentration and sample cell length $(c \times l)_{\min}$ or $(c \times l)_{\max}$.

Up to four measurement ranges – within the limits of the physical measurement range – can be ordered for each sample component. The maximum ratio of the spans is 1:20. The measurement ranges can be starting measurement ranges or suppressed measurement ranges.

If a calibration cell is provided for the measurement component, its set point will always be at the upper end of the largest measurement range. When the new measurement range is smaller than the old one the associated calibration cell may continue to be used.

In addition to the above measures, we recommend checking (see page 292) the linearity of the new measurement range and measuring (see page 291) the associated calibration cell after the range limits have been changed.

Oxygen sensor

Measurement range 1 is freely adjustable from 0 to 5 vol.% O₂ to 0 to 25 vol.% O₂. Measurement range 2 is factory-set permanently to 0 to 25 vol.% O₂.

Changing the number of decimal places

Menu path

MENU → Configure → Component-Specific → Measurement Range → Select Component → ...

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure

Select the measurement range with the arrow keys, press SET DECIMAL, set the number of decimal places with the arrow keys and press ENTER to confirm.

NOTES

The setting only affects the values indicated on the screen.

The number of decimal places cannot be increased.

The altered number of decimal places is shown on the screen after switching to measurement mode.

Number of decimal places

When the screen displays the measured value in physical units (e.g. ppm) the number of places after the decimal point depends on the size of the set measurement range:

Span	Places after the decimal point
≤ 0.05	5
≤ 0.5	4
≤ 5	3
≤ 50	2
≤ 500	1
> 500	0

For the display of the measured value as a percentage of the whole measuring range (%Span) two places are always shown after the decimal point.

When setting the parameters, the number of decimal places is the same as in the display in measuring mode.

Adding a measurement range

NOTE

The addition of measurement ranges is only possible with the Fidas24 analyzer module.

Menu path

MENU → **Configure** → **Component-Specific** → **Measurement Range** → **Select Component** → ...

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

If the entry "Free" appears in the list, a measurement range can be added to the configuration of the sample component. The softkey **NEW MEASURING RANGE** is displayed for this purpose.

NOTE

The addition of measurement ranges can be locked when configuring the gas analyzer by means of the test and calibration software TCT. In this case the entry "Free" is not shown, even if fewer than the 4 maximum possible measurement ranges are displayed.

Procedure

- 1 Press **NEW MEASURING RANGE**.
- 2 Confirm safety interrogation by pressing **NEW MEASURING RANGE**, if necessary, enter password (level 1).
In the list a new measurement range is displayed instead of the entry "Free".
- 3 If necessary, select the menu for changing range limits (see page 156) and change the limits of the added measurement range by pressing **CHANGE LIMITS**.
- 4 If necessary, select the menu for changing places after the decimal point (see page 158) and change the number of decimal places in the added measurement range by pressing **DECIMAL POINTS**.

Deleting a measurement range

NOTE

The deletion of measurement ranges is only possible with the Fidas24 analyzer module.

Menu path

MENU → **Configure** → **Component-Specific** → **Measurement Range** → **Select Component** → ...

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

If a measurement range can be deleted from the configuration of the sample component, then the softkey **DELETE MEASURING RANGE** is displayed.

NOTES

The deletion of measurement ranges can be locked when configuring the gas analyzer by means of the test and calibration software TCT.

The active measurement range (in which measurements are currently taken) and measurement ranges of the currently active calibration method cannot be deleted.

Procedure

- 1 Press **DELETE MEASURING RANGE**.
- 2 Confirm safety interrogation by pressing **DELETE MEASURING RANGE**, if necessary, enter password (level 1).
The entry "Free" is displayed in the list instead of the deleted measurement range.

Auto-ranging parameterization

Menu path

MENU → Configure → Component-Specific → Autorange →
Select Component → ...

NOTE

The automatic measurement range changeover (auto-ranging) only functions properly when the measurement ranges MR1, MR2, ... have been configured (see page 156) in ascending order, i.e. $MR1 < MR2 < \dots$

Lower threshold, upper threshold

On reaching the lower threshold value set here (as a percentage of the current measurement range scale), the analyzer module automatically switches to the next lower range.

On reaching the upper threshold value set here (as a percentage of the current measurement range scale), the analyzer module automatically switches to the next higher range.

NOTE

The lower and upper threshold values should be selected so that the gas analyzer is not constantly switching between two measurement ranges (see the example below).

Assigned ranges

Parameters can be set for measurement ranges to be included for auto-ranging can be initialized. The number of measurement ranges available depends on the analyzer module.

NOTE

The parameter cannot be selected if the analyzer module has only two measurement ranges since these are automatically included in the auto-ranging function.

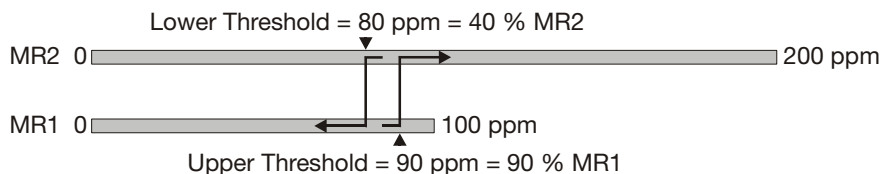
Status

Auto-ranging can be off or on.

Example for auto-ranging

Measurement range 1: 0 to 100 ppm, measurement range 2: 0 to 200 ppm

Lower threshold = 80 ppm = 40 % MR2, upper threshold = 90 ppm = 90 % MR1



Procedure

Parameter	Range	Action
Lower threshold	0 to 100%	Set
Upper threshold	0 to 100%	Set
Assigned ranges	MR1, MR2, MR3, MR4	Select
Status	on or off	Select

Limit value monitor parameterization

Menu path

MENU → Configure → Component-specific → Limit Values → Select Limit Monitor → ...

Range selection

All available limit value monitors are shown.

Procedure

Parameter	Explanation	Action
Direction	< = Alarm on underflow of threshold value > = Alarm on exceeding threshold value	Select
Threshold	in physical units	Set
Hysteresis	in physical units	Set

Standard configuration

As a rule, limit value monitoring for those components to be measured by the gas analyzer is factory-set. This requires that there be enough digital outputs on the I/O modules to handle the number of sample components.

Note: Limit value monitors are factory-set or user-configured **Limit Monitor** function blocks. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Filter parameterization

Menu path

MENU → Configure → Component-Specific → Filter →
Select Component → ...

Range

0 to 60 seconds

Procedure

Parameter	Explanation	Action
Linear filter (Caldos25, Caldos27, Magnos27, Limas11 IR, Limas21 UV, Limas21 HW):		
T90	Low-pass time constant	Set
Non-linear filter (Fidas24, Magnos206, Magnos28, Uras26):		
T90-1	Low-pass time constant for constant measured value	Set
T90-2	Low-pass time constant for measured value changes	Set
Threshold	Threshold. T90-2 applies for overshoot	Set

Non-linear filter

T90-2 should be adjusted $T90-2 \leq T90-1$ for the non-linear filter.

The switching threshold (in %) is generally based on the largest measurement range selected (reference measurement range).

Recommendation for

Fidas24: T90-1 = 20 s, T90-2 = 1 s, threshold = 0.001 %

Magnos206: T90-1 = 3 s, T90-2 = 0 s, threshold = 0.1 %

Magnos28: T90-1 = 3 s, T90-2 = 0 s, threshold = 0.1 %

Uras26: T90-1 = 5 s, T90-2 = 0 s, threshold = 0.6 %

Active component selection

Menu path

MENU → Configure → Component-specific → Active Component

Active component

The "Active component" parameter appears with the Caldos25, Caldos27, Fidas24, Magnos206, Magnos28 and Magnos27 analyzer modules.

Several sample components can be calibrated on these analyzer modules. However, there is always only one component measured and indicated.

Procedure

Select the active component with the arrow keys and press ENTER to confirm.

Subsequently, use the "Measurement range" menu item to select the range for the desired active component.

NOTE

The selected active component and measurement range are shown on the screen after switching to measurement mode.

Configuring a component

Menu path

MENU → Configure → Component-specific → Active Component

After selecting the component the menu "Configure component" is called up with the softkey **COMP. CONFIG.**

Display

Typ	Name	Einheit
S K	C3H8 Propan	ppm
S A	CH4 Methan	ppmC1
S	Frei	---
S	Frei	---

Eintrag auswaehlen und Funktionstaste druecken.

All the components of a detector are listed in the menu ("component list"). The following information is shown for each component:

Type	S	System component = a component configured at the factory
	S A	Active, i.e. system component currently being measured
	S K	System component used for calibration
	B	User component = a component configured by the user
	B A	Active, i.e. user component currently being measured
	B K	User component used for calibration
	Name	above
below		Full name of the component
Unit		The physical unit used for the measured value display

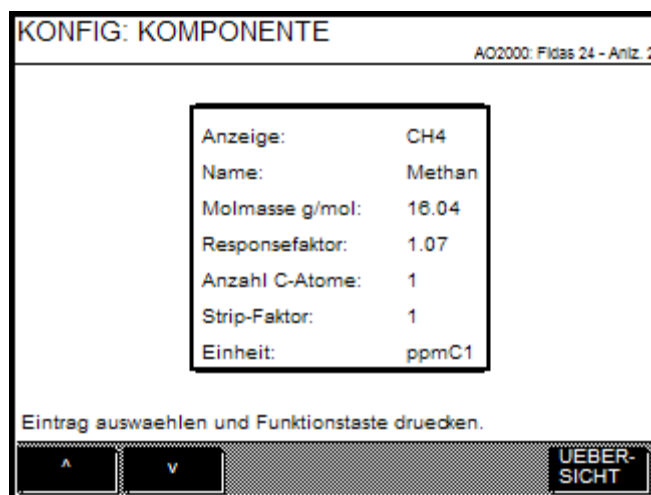
If not all four possible components of the detector are configured, the entry "Free" appears at a point in the list.

Softkeys

The following softkeys are displayed in the menu depending on which options exist for display or configuration of a particular component:

DELETE COMP.	The component can be deleted (see page 175).
CHANGE COMP.	The configuration of the component can be changed (see page 172).
NEW COMP.	A new component can be added (see page 168).
UNIT SELECTION	The physical unit used for the measured value display can be changed.
DETAIL	The detailed display, i.e. a separate window with a detailed list of the component data, is opened (see below).
OVERVIEW	The detailed display is closed.

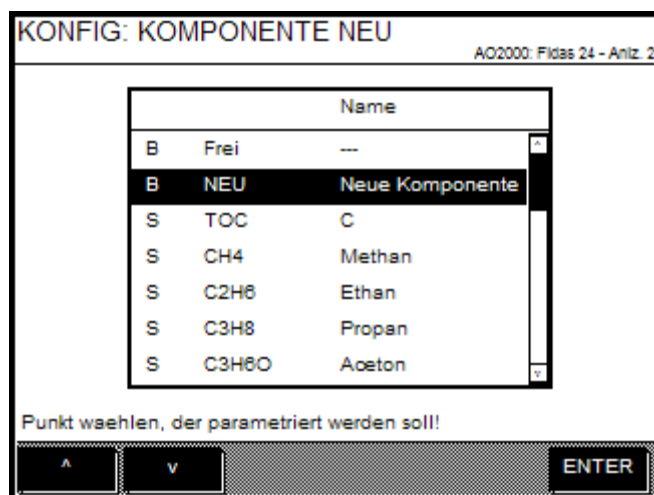
Detailed display



The following component data are listed in the detailed display:

Display	Name of the component in the measured value display, e.g. structure formula
Name	Full name of the component
Molar mass g/mol	Molar mass in g/mol
Response Factor	Detector reply related to propane for the respective component
Quantity of C-atoms	Number of C-atoms in the molecule of the component
Strip Factor	Ratio of the concentration of a component in the water to the concentration of the same component in the gas flow after the strip event
Unit	The physical units used for readout values

Component selection list



The component selection list contains

- all (24 factory-configured) system components,
- if applicable, the user components already configured and
- an entry with the name "Free".

The following information is displayed for each component:

Type	S = System component or B = User component
Display	Name of the component in the measured value display, e.g. total formula
Name	Full name of the component

Adding a component

If not all four positions are occupied in the component list (see page 165), a new system or user component can be added.

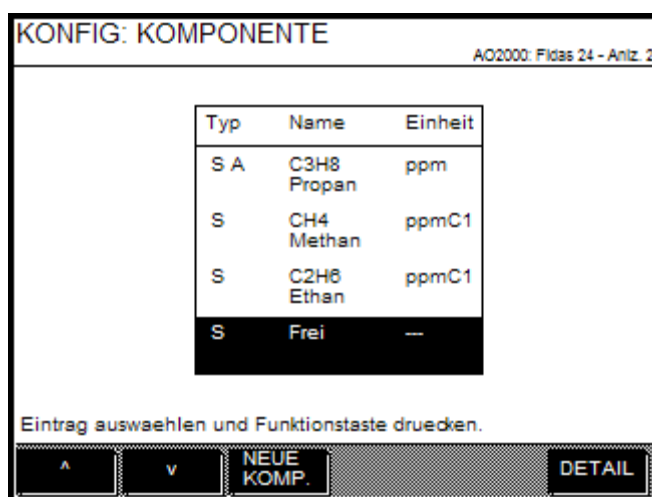
Menu path

MENU → **Configure** → **Component-specific** → **Active Component**

Select component and confirm with **ENTER**.

Adding a component

- 1 Press softkey **CONFIG**. The "Configure Component" menu is displayed with the component list.
- 2 Select the entry "Free" in the component list.



- 3 Press softkey **NEW COMP**.
- 4 Press softkey **NEW COMP** in succession. If applicable, enter password (level 3).
A window appears with the component data. If a component was not yet configured at the point of the free entry, no component data is displayed.
If a component was already configured at the point of the free entry, its component data is displayed. If this component is included in the component list, press the **Back** key and by pressing the **Meas** key, return to the measured value display. Otherwise continue with Step 5.
- 5 Press softkey **COMP LIST**.
The component selection list (see page 167) is displayed.
Depending on whether a user component or a system component is to be added, proceed according to one of the following two directions.

Adding a user component

- 1 Select the entry "Free" in the component selection list and confirm with ENTER.

KONFIG: KOMPONENTE C4H10 AO2000: Fidas 24 - Aniz. 2

	Name	Beschreibung
B	Frei	—
S	TOC	C
S	CH4	Methan
S	C2H6	Ethan
S	C3H8	Propan
S	C3H8O	Aceton
S	C4H10	Butan

Punkt waehlen, der parametriert werden soll!

A V ENTER

- 2 Enter the display name of the new component. This input is required as a minimum for the new component to be saved in the component list.

KONFIG: KOMPONENTE NEU AO2000: Fidas 24 - Aniz. 2

Anzeige:	NEU
Name:	Neue Komponente
Typ:	Benutzerdefiniert
Molmasse g/mol:	165.83
Responsefaktor:	0.98
Anzahl C-Atome:	2
Strip-Faktor:	1
Einheit:	ppm

Punkt waehlen, der parametriert werden soll!

A V KOMP. LISTE BESTAETIGEN ENTER

Enter the additional parameters for the new component and save the configuration with **CONFIRM**,

- 3 The component list is displayed.

KONFIG: KOMPONENTE AO2000: Fidas 24 - Anz. 2

Typ	Name	Einheit
S A	C3H8 Propan	ppm
S	CH4 Methan	ppmC1
S	C2H6 Ethan	ppmC1
B	NEU Neue Komponente	ppm

Eintrag auswaehlen und Funktionstaste druecken.

A
V
KOMP.
LOESCH
KOMP.
AENDERN
EINHEIT
AUSWAHL
DETAIL

- 4 Quit the menu with **Back** or **Meas**.

Adding a system component

- 1 Select a (factory-configured) system component in the component selection list and confirm with **ENTER**.

KONFIG: KOMPONENTE C4H10 AO2000: Fidas 24 - Anz. 2

Anzeige:	C4H10
Name:	Butan
Typ:	Systemkomponente
Molmasse g/mol:	58.12
Responsefaktor:	0.98
Anzahl C-Atome:	4
Strip-Faktor:	1
Einheit:	ppm

Punkt waehlen, der parametriert werden soll!

A
V
KOMP.
LISTE
BESTAE-
TIGEN

- 2 If necessary, change the unit and save the configuration with **CONFIRM**.
Note: The other parameters of a system component cannot be changed.

- 3 The component list is displayed.

KONFIG: KOMPONENTE AO2000: Filas 24 - Anlz. 2

Typ	Name	Einheit
S A	C3H8 Propan	ppm
S	CH4 Methan	ppmC1
S	C2H6 Ethan	ppmC1
S	C4H10 Butan	ppmC1

Eintrag auswählen und Funktionstaste druecken.

⏪	⏩	KOMP. LOESCH	KOMP. AENDERN	EINHEIT AUSWAHL	DETAIL
---	---	-----------------	------------------	--------------------	--------

- 4 Quit the menu with **Back** or **Meas**.

Changing a component

The (maximum four) components, which are displayed in the component list (see page 165), can be changed. Either the parameters of a component can be changed or one component can be replaced by another.

Menu path

MENU → **Configure** → **Component-specific** → **Active Component**
Select component and confirm with **ENTER**.

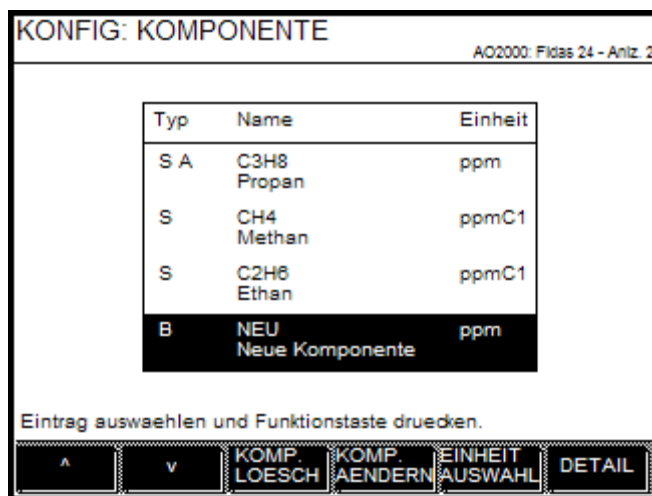
Change parameter of a component

NOTES

In the case of a system component (Type S) only the parameter "Unit" can be changed; in the case of a user component (Type B) all the parameters can be changed with the exception of the parameter "Type".

The parameters of the active component (Type SA or BA) and the component used for calibration (Type SK or BK) cannot be changed.

- 1 Press softkey **COMP. CONFIG**. The "Configure Component" menu is displayed with the component list.
- 2 In the component list select the component with parameters which are to be changed.



- 3 Press softkey **CHANGE COMP**. Enter password (level 3), as applicable. The parameters of the component are displayed.

- 4 Select the parameters to be changed, initiate the change with **ENTER**, enter the change and save with **ENTER**.

KONFIG: KOMPONENTE NEU AO2000: Fidas 24 - Anz. 2

Anzeige:	NEU
Name:	Neue Komponente
Typ:	Benutzerdefiniert
Molmasse g/mol:	165.83
Responsefaktor:	0.98
Anzahl C-Atome:	2
Strip-Faktor:	1
Einheit:	ppm

Punkt waehlen, der parametriert werden soll!

A
V
KOMP. LISTE
ENTER

- 5 Quit the menu with **Back** or **Meas**.

Replace one component with another component

- 1 Press softkey **COMP**. **CONFIG**. The "Configure Component" menu is displayed with the component list.
- 2 Select the modules in the component list which is to be replaced by another component.

KONFIG: KOMPONENTE AO2000: Fidas 24 - Anz. 2

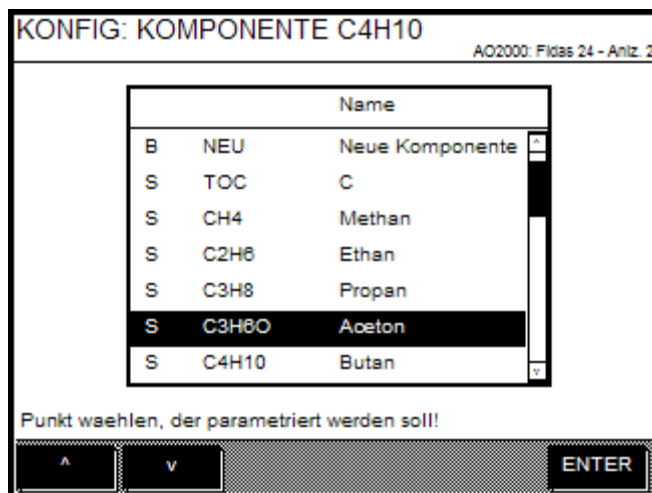
Typ	Name	Einheit
S A	C3H8 Propan	ppm
S	CH4 Methan	ppmC1
B	NEU Neue Komponente	ppm
S	C4H10 Butan	ppmC1

Eintrag auswaehlen und Funktionstaste druecken.

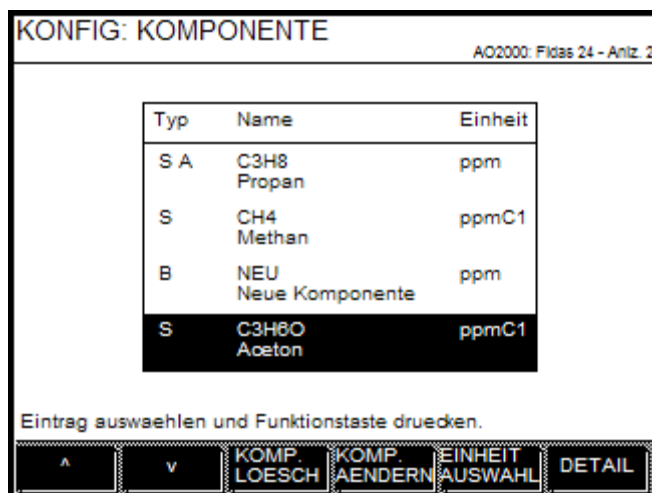
A
V
KOMP. LOESCH
KOMP. AENDERN
EINHEIT AUSWAHL
DETAIL

- 3 Press softkey **COMP**. **CHANGE**. Enter password (level 3), as applicable. The parameters of the component to be replaced are displayed.

- 4 Press softkey **COMP . LIST**. Select the new component in the component selection list and press the softkey **ENTER**.



- 5 Confirm the overwriting of the component with **ENTER** and save the configuration with **CONFIRM**.



- 6 Quit the menu with **Back** or **Meas**.

Deleting a component

A (system or user) component can be deleted from the component list (see page 165). After deletion the component is no longer available for display or calibration; however, it is still included in the component selection list and can be added (see page 168) to the component list again later on.

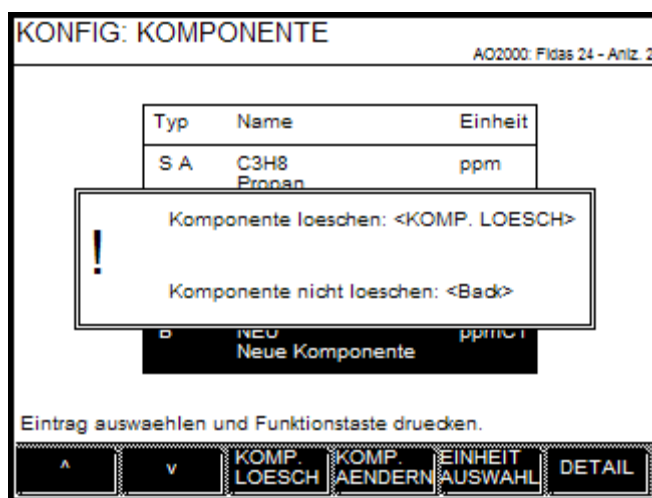
A user component which is no longer required can be finally deleted from the component selection list (see page 167). The system components cannot be deleted.

Menu path

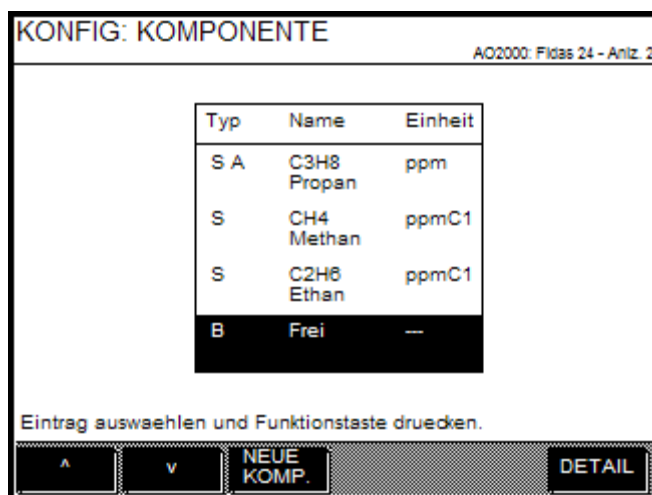
MENU → **Configure** → **Component-specific** → **Active Component**
Select component and confirm with **ENTER**.

Delete component from the component list

- 1 Press **COMP. CONFIG.** softkey. The "Configure Component" menu is displayed with the component list.
- 2 Select the component to be deleted in the component list.
- 3 Press softkey **COMP. DELETE**.



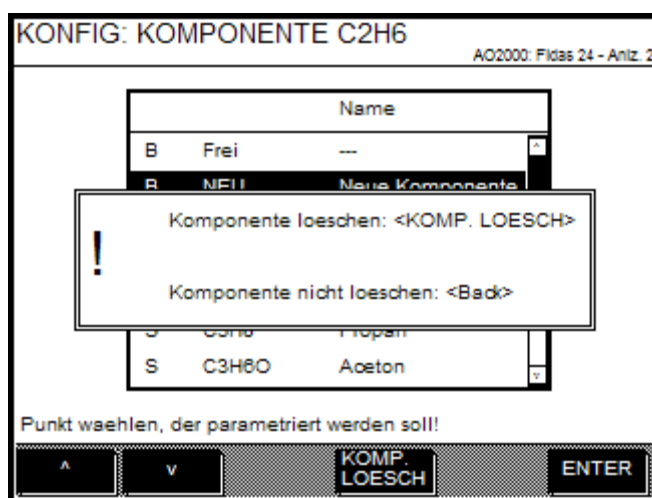
- Press **COMP. DELETE** softkey in succession. Enter password (level 3), as applicable.
The component is deleted permanently from the component list and the entry "Free" is displayed.



Note: The active component (Type A) and the component used for calibration (Type K) cannot be deleted.

Delete user component from the component selection list

- Press **COMP. CONFIG.** softkey. The "Configure Component" menu is displayed with the component list.
- Select any component in the component list.
- Press **CHANGE COMP.** softkey, enter password (level 3), as applicable and then press **COMP. LIST** softkey. The component selection list is displayed.
- Select the user component to be deleted in the component selection list.
- Press **DELETE COMP.** softkey.



- Press **DELETE COMP.** in succession.
The user component is permanently deleted from the component selection list.

Changing the unit of a component

The physical unit used for the measured value display of a component, e.g. ppm or mg/m³, can be changed directly in the "Configure Component" menu.

One of the units defined at the factory can be selected for system components. For user components, the choice of units depends on which of the parameters required for the calculation have been entered during configuration (see page 168) of the component.

Changing a unit of component is possible for the following analyzer modules:

Analyzer module	Unit
Caldos27	ppm, vol.%
Fidas24	ppmC1, ppm, vol.%, mgC/m ³ , gC/m ³ , mg/m ³ , g/m ³ , %LEL, mgC/l, gC/l, mg/l, g/l
Magnos206	ppm, vol.%
Magnos28	ppm, vol.%
Magnos27	ppm, vol.%
Uras26	ppm, vol.%, mg/m ³ , g/m ³
ZO23	ppm, vol.%

Prerequisites for this are:

- AMC Software version ≥ 3.3.2,
- Measured value display set to ppm at the factory,
- Unit switching activated at the factory.

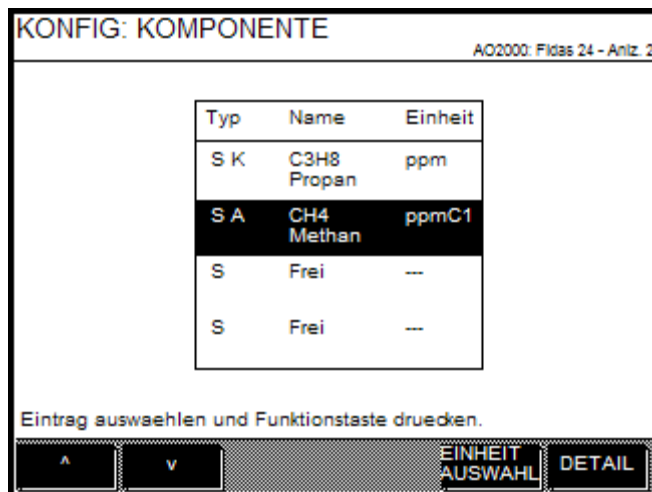
Menu path

MENU → **Configure** → **Component-specific** → **Active Component**

Select component and confirm with **ENTER**.

Changing the unit

- 1 Press **COMP. CONFIG.** softkey. The "Configure Component" menu is displayed with the component list.
- 2 In the component list select the component with unit which is to be changed.



- 3 Press **UNIT SELECTION** softkey. Enter password (level 3), as applicable. A list of the units available is displayed.
- 4 Select the desired unit and confirm with **ENTER**.
- 5 A security prompt appears with the information that when switching the unit, the range limits of the component are automatically adjusted.
- 6 Confirm the switching of the unit with **ENTER** or cancel with **Back**.
- 7 Quit the menu with **Back** or **Meas**.
- 8 Check the range limits (see page 156) and the number of decimal places (see page 158) and adjust if necessary.

Changing module name

Menu path

MENU → **Configure** → **Component-specific** → **Module name**

Module name

The module name is shown in the display next to the module type. Here you can enter a name relating to the measuring point, for example.

Monolingual or bilingual

The module name can be entered independent of the language of the user interface (see page 184) or separately for both languages.

Text length

The length of the text for the module name is limited to 24 characters for a monolingual entry, and limited to two times 10 characters for a bilingual entry.

Entering the module name

When entering the module name, use the same procedure as entering text (see page 146).

NOTES

The changed module name is shown in the display after switching to measuring mode.

If the module name appears next to or under the module type depends on the configured size for displaying the measured quantity (see page 198).

Gas analyzer configuration: Function blocks

The 'Function blocks' concept

What are function blocks?

Function blocks are small units of the processing software with a specific function. Information is taken in at the inputs, processed in specific ways and the results appear at the block outputs.

What are function blocks used for?

Function blocks are used for overall and specific configuration and setting parameters of gas analyzer functions.

Examples of function blocks

The following examples illustrate the operation of function blocks:

A **Limit value monitor** tracks a value to determine if it violates limit values and passes the result to a digital output.

A **Digital input** places a signal at a (hardware) digital input for subsequent processing in other function blocks.

An **Add** function block combines the signals at its two inputs and places the total at its output.

A **Component measurement value** outputs the measurement signal from an analyzer module for subsequent processing in other function blocks.

Application = Function block linking

A function block is linked to other function blocks via its inputs and outputs. Various function blocks are factory-linked to other function blocks to make applications (see the "Standard configuration" (see page 181) section).

Parameter assignment of function blocks

Various specific parameters, in addition to input and output linking, determine the functionality of a block.

The as-delivered gas analyzer has standard values assigned to these parameters. These standard values can be accepted or reprogrammed.

Password

The level 3 password (see page 149) must be entered in order to configure an application. Make sure that existing application configurations and links are not damaged or deleted.

Complete information

Technical Bulletin "Function Blocks – Descriptions and configuration" contains complete information on the "Function block" concept as well as detailed descriptions of the individual function blocks.

Standard configuration

Standard configuration

Various applications are factory-configured. These standard configurations are based on

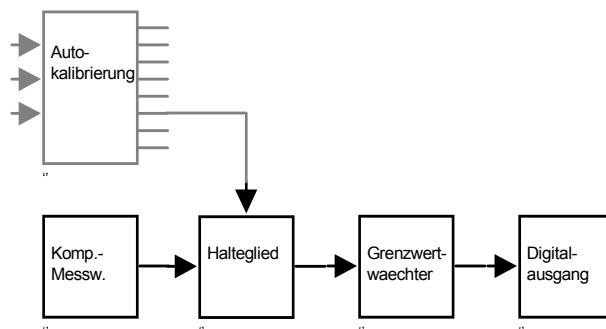
- standard input/output pin configuration and
- the available sample components

Some factory-configured applications require field linking of additional function blocks.

Example: Limit value monitoring

The limit value monitoring application consists of a factory configured link between

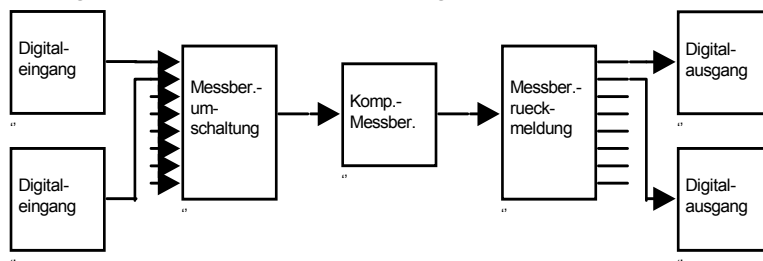
- **Component measurement value, Hold, Limit monitor** and **Digital output** function blocks.



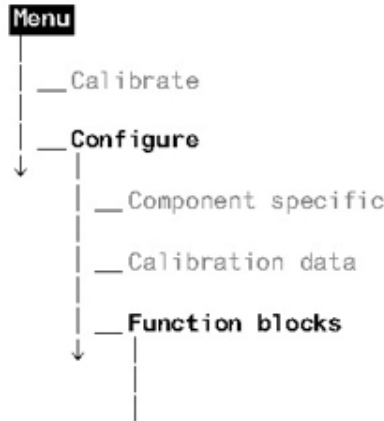
Example: Measuring range switch-over/feedback signal

The measurement range switch-over/feedback application consists of a factory-configured linkage between

- a **Measuring range switch-over** function block with several **Digital input** function blocks and **Component range** function block, as well as
- a **Range feedback** function block with the same **Component measuring range** function block and several **Digital output** function blocks.



The 'Function blocks' sub-menu



Miscellaneous	Limit monitor
Inputs	Hold
Outputs	Feedback
Mathematics	Timer
Multiplexer/Demultiplexer	Sequencer
Measurement	Access lock
Sample system	
Calibration/Correction	

Miscellaneous	
Inputs	Digital input
Outputs	Analog input
Mathematics	Message input
Multiplexer/Demultiplexer	Constant
Measurement	
Sample system	
Calibration/Correction	

Miscellaneous	
Inputs	
Outputs	Digital output
Mathematics	Analog output
Multiplexer/Demultiplexer	Message insert
Measurement	
Sample system	
Calibration/Correction	

Miscellaneous	
Inputs	Negate
Outputs	Add
Mathematics	Subtract
Multiplexer/Demultiplexer	Multiply
Measurement	Divide
Sample system	Or
Calibration/Correction	And
	Linear converter

Miscellaneous	
Inputs	Fan
Outputs	Multiplexer
Mathematics	Demultiplexer
Multiplexer/Demultiplexer	Priority encoder
Measurement	Priority decoder
Sample system	Binary -> Decimal
Calibration/Correction	Decimal -> Binary

Miscellaneous	Comp. meas. value
Inputs	Det. meas. value
Outputs	Comp. range
Mathematics	Range control
Multiplexer/Demultiplexer	Range feedback
Measurement	Active component MUX
Sample system	
Calibration/Correction	

Miscellaneous	
Inputs	
Outputs	
Mathematics	
Multiplexer/Demultiplexer	
Measurement	
Sample system	Calibration cell
Calibration/Correction	Solenoid
	System pump
	Pump

Miscellaneous	
Inputs	
Outputs	
Mathematics	
Multiplexer/Demultiplexer	Autocal
Measurement	Ext. controlled cal.
Sample system	Cross sens. corr.
Calibration/Correction	Carrier gas corr.

Gas analyzer configuration: System functions

Setting the time zone, date and time

Menu path

MENU → Configure → System → Date/Time

Procedure

Parameter	Explanation
Time Zone	The time zone can be selected either from the GMT (Greenwich Mean Time) values or from the continent/country/city list.
Date	Date must be entered in month/day/year format. Enter year with 4 digits.
Time	Time must be entered in hour: minute:second format. Enter seconds, too.

Definitions

GMT = Greenwich Mean Time

CET = Central European Time = GMT + 1 hour

CEST = Central European Daylight-saving Time = GMT + 2 hours

Daylight-saving time

The gas analyzer is automatically set to daylight-saving time.

Note: This applies only when the time zone has been selected from the continent/country/city list and not from the GMT values list.

Condition as delivered

The gas analyzer is factory-set to the GMT+1 time zone.

Accept the time settings

Press the softkey SET TIME to accept the modified time settings.

Selecting user interface language

Menu path

MENU → Configure → System → Language

Language selection

Two user interface languages are factory-configured (per order) in the gas analyzer. In the menu item Language the user can switch between these two languages.

Other languages

Other user interface languages can be loaded into the gas analyzer using the SMT Software Migration Tool. SMT can be found on the DVD-ROM "Software tools and technical documentation" which is delivered with the gas analyzer.

These language pairs are available:

- English – German
- English – French
- English – Italian
- English – Dutch
- English – Spanish
- English – Brazilian
- English – Polish
- German – Dutch

Changing the password

Menu path

MENU → Configure → System → Change password

Password protection

See "Password protection" (see page 149) section for basic information on password protection.

Factory setting

User group	Access to password levels	Default password
Every user	0	None
Maintenance team	0, 1	471100
Specialist team	0, 1, 2	081500
Function block specialist	0, 1, 2, 3	325465
Field service	0, 1, 2, 3, 4, S	737842

It is recommended to change the default passwords.

Procedure

- 1 Select the menu item Change password.
- 2 Select the user group.
- 3 Enter the old password.
- 4 Enter the new password (6 digits).
- 5 Re-enter the new password,
- 6 Leave the menu item with **Back**.

NOTE

Password level 0 is not displayed in the Change password menu item.

CAUTION

After entering the password for password level 3, you can access all of the function block applications. When configuring function blocks, existing applications with their configurations and links can be damaged or destroyed!

Inhibit operation

Menu path

MENU → Configure → System → Change password

Inhibit operation

Operation of the gas analyzer, i.e. entering the main menu and thus switching to the menu mode, can be password protected.

After inhibition the gas analyzer can only be operated when the level 1 password has been entered.

The level 3 password must be entered to configure the password protection. The level 3 password must be entered.

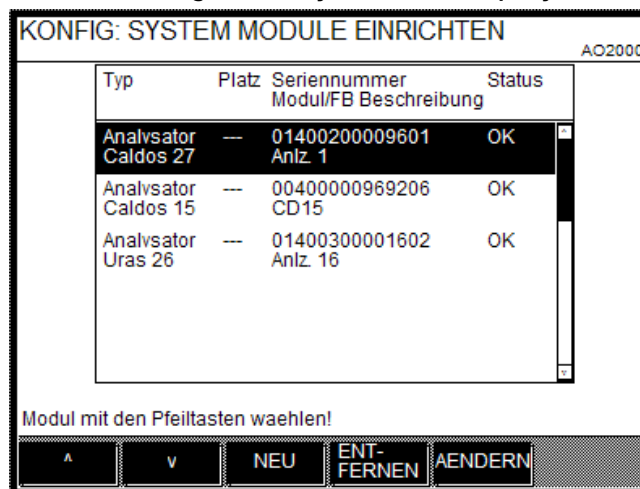
Procedure

Press the MENU ACCESS softkey in the Change password menu item and set the password protection.

Setting up system modules

Menu path

MENU → Configure → System → Setup system modules



Function

If system modules are added to a gas analyzer, replaced (changed) or removed, this modification must be configured in the software.

Definition

System modules are

- Analyzer modules: Uras26, Limas11 IR, Limas21 UV, Limas21 HW, Magnos206, Magnos28, Magnos27, Caldos25, Caldos27, Fidas24, Fidas24 NMHC, ZO23
- I/O modules: Profibus, Modbus, 2-way analog output, 4-way analog output, 4-way analog input, digital input/output
- External I/O devices: e.g. cooler I/O board.

Analyzer modules and external I/O devices

Analyzer modules and external I/O devices are connected to the system controller via the system bus. They must be identified by their serial number (see below) in order to be recognized by the gas analyzer.

I/O modules

The I/O modules are attached and directly connected to the system controller board. They have no serial numbers.

An I/O module is automatically recognized by the gas analyzer when it is added for the first time or as replacement for an already existing I/O module.

Serial number

The 14-digit serial number of the analyzer modules is found in the analyzer data sheet and on a label affixed to the module, generally on the CPU board. The serial number contains the following information (for example):

01400000012301

The first 3 digits indicate the module type:

014 Analyzer module

004 Analyzer module

006 Cooler I/O board (installed in the SCC-F Sample gas feed unit as an option)

008 LS25 Laser analyzer module

The remaining 11 digits are the actual serial number of the module.

Function block application

When setting up the digital I/O module, a function block application must be configured. It is also possible to assign another function block application to this system module during operation. The standard function block applications with the respective connection layouts of the module are listed in the "Electrical connections: Digital I/O module" (see page 112) section.

Unknown system module

There are several reasons for a system module to have an `Unknown` status in the `Setup system modules` menu item:

Cause: The system module was not found after the power supply was turned on (status message no. 201).

Corrective action Reestablish the system bus connection to the system module and press the `RESTART` softkey.

Cause: The system bus connection to the system module is broken (status message no. 209).

Corrective action: Reestablish the system bus connection to the system module and press the `RESTART` softkey.

Cause: The system module serial number was entered incorrectly.

Corrective action: Press the `CHANGE` softkey and correct the serial number.

NOTE

Automatic calibration of an analyzer module is not possible during setting up system modules.

Adding a system module

NOTES

If no system module is configured or an added system module is not yet configured in a gas analyzer, the **NEW** softkey will appear on the screen. Press this softkey to go directly to the **Setup System Modules** menu.

The procedure for adding an analyzer module and an external I/O device differs from the procedure for adding an I/O module (see the following instructions).

Adding a new analyzer module or a new I/O device

- 1 Select the **Set Up System Modules** menu item.
The list of the system modules existing in the system is displayed.
- 2 Press the **NEW** softkey.
- 3 Enter the 14-digit serial number for the new system module.
- 4 In the list the added system module will be shown with **New** status.
- 5 Save the configuration change by pressing **ENTER** or discard it by pressing **Back**.

Adding a new I/O module

- 1 Select the **Set Up System Modules** menu item.
The list of the system modules existing in the system is displayed.
- 2 Select the I/O module which has been added and automatically recognized by the gas analyzer and press the **NEW** softkey.
- 3 When adding a digital I/O module:
Press the **FB APPL.** softkey and select a function block application.
- 4 In the list the new system module will be shown with **New** status.
- 5 Save the configuration change by pressing **ENTER** or discard it by pressing **Back**.

NOTE

When retrofitting a Profibus module, it must always be installed as the lowest I/O module, i.e. on slot X20/X21.

Replacing a system module

Removing and reinstalling an existing system module

As a rule, when an existing system module is removed and reinstalled (e.g. after a repair) it does not require any setup.

When the system module is reconnected to the system bus it is automatically recognized and its configuration is automatically stored. For automatic recognition to take place the gas analyzer must be in measurement mode.

CAUTION!

When an existing system module is replaced with another system module the function "Delete" should not be used to delete the old system module. This function would irretrievably delete the parameter settings and function block configuration of the old system module.

In order to retain the parameter settings and function block configuration of the old system module when replacing a system module, the function "Change" must be used.

NOTES

The type and configuration of the new system module must match the configuration of the old system module.

When an existing I/O module has been replaced with an I/O module of the same type, the new I/O module is automatically recognized by the gas analyzer and its configuration is not necessary.

Replacing an existing system module (analyzer module or I/O device) with another system module

- 1 Select the **Set Up System Modules** menu item.
The list of the system modules existing in the system is displayed.
- 2 Select the system module (analyzer module or I/O device) to be replaced and reconfigured.
In the list this system module will be shown with an **Unknown** or **Error** status.
- 3 Press the **CHANGE** softkey.
Do not press the **DELETE** softkey! This would irretrievably remove the system module's parameter settings and function block configuration!
- 4 Enter the 14-digit serial number for the new system module.
- 5 In the list the new system module will now be shown with the **Replaced** status.
- 6 Save the configuration change by pressing **ENTER** or discard it by pressing **Back**.

Removing a system module

Sequence when removing system modules

When removing system modules from the gas analyzer always proceed according to the following sequence:

- 1 Remove the system module in the software (see below for instructions).
- 2 Dismount the system module from the gas analyzer.

Removing an installed system module without a replacement

- 1 Select the **Set Up System Modules** menu item.
The list of the system modules existing in the system is displayed.
- 2 Select the system module to be removed (and not replaced).
- 3 Press the **DELETE** softkey.
This will irretrievably remove the system module's parameter settings and function block configuration!
- 4 In the list the deleted system module's status will change to **Deleted**.
- 5 Save the configuration change by pressing **ENTER** or discard it by pressing **Back**.

Saving the configuration

Menu path

MENU → Configure → System → Save configuration

Automatic saving of the configuration

The database containing the configuration data and logbook recordings is automatically saved in two configuration files.

The database is saved at the time when parameters have been changed in the menu mode. Saving takes place either when the user deactivates an entered password by pressing the "MEAS" key twice or when the gas analyzer automatically reverts to measurement mode by "time out".

When the gas analyzer is booting the last saved valid configuration file is loaded.

Manual saving of the configuration

The database can also be saved manually. This is useful e.g. for buffering a large function block configuration.

Backup

In addition to automatic or manual saving of the configuration a backup of the current configuration can be created. This backup can be saved in a separate memory area and can be loaded when required e.g. to reset the gas analyzer to a well-defined state.

NOTE

Using the software tool "SMT light" it is possible to save a backup of the current configuration on a separate storage medium. "SMT light" can be found on the DVD-ROM "Software tools and technical documentation" which is delivered together with the gas analyzer.

Configuring status signals

Menu path

MENU → Configure → System → Status signals

Function

The status signal configuration is set at the factory per customer's order. Generally this configuration does not have to be changed in the field.

Selection

The following signals are available:

- Individual status signals, i.e. Error, Maintenance request and Maintenance mode
- Overall status signal.

NOTES

If the status signal configuration is changed from "overall status signal" to "individual status signal", the digital outputs DO2 and DO3 of the standard function block application "Status signals/externally controlled calibration" (see page 112) which possibly are assigned to limit value signals will be overwritten with single status signals.

For further information on status signals, see the "System status: Status signals" (see page 319) section.

Configuring an Ethernet connection

Menu path

MENU → Configure → System → Network → TCP/IP Network

DHCP X9:		aus
IP Adresse X9:		192.168.1.39
IP Adress-Maske X9:		255.255.255.0
IP Gateway-Adresse X9:		192.168.1.250
DHCP X8:		aus
IP Adresse X8:		192.168.2.1

Punkt waehlen, der parametriert werden soll!
Bestaetigen: <ENTER>

Function

Both Ethernet 10/100/1000BASE-T interfaces can be used to link the gas analyzer to an Ethernet network (with TCP/IP protocol).

The first Ethernet interface is referred to as X9 and the second one as X8.

Parameters

The parameters which have to be input depend on the DHCP setting:

DHCP on: Network name (max. 20 characters, no blanks and special characters),

DHCP off: IP address, IP address mask and IP gateway address.

Addresses

The IP address, IP address mask and IP gateway address must be obtained from the system administrator.

NOTES

Addresses of TCP/IP classes D and E are not supported.

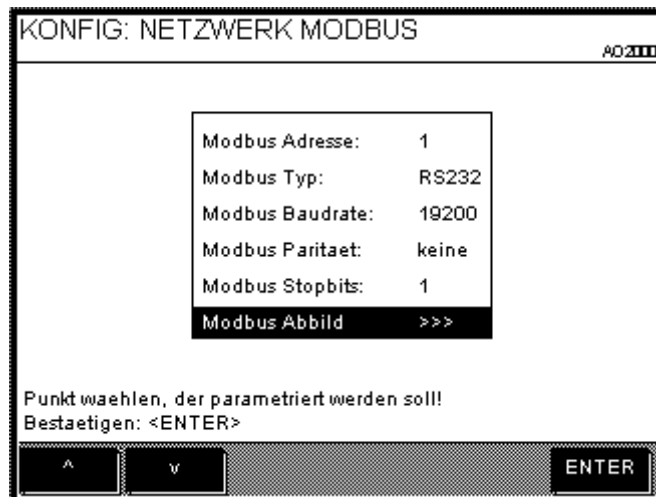
The address bits that can be varied in the address mask may not all be set to 0 or 1 (broadcast addresses).

The IP address must not be mistaken for the Ethernet hardware address (or MAC address). The world-wide unique 12-digit MAC address is stored on each network board by the manufacturer. It is termed Ethernet address in the AO2000 series gas analyzers and can be viewed in the **Diagnostics/Information** → **System overview** → **SYSCON** menu.

Configuring a Modbus connection

Menu path

MENU → Configure → System → Network → Modbus



Function

On the one hand, the gas analyzer can be connected to a network with Modbus protocol via the RS232 or the RS485 interface and on the other hand via the Ethernet interface (Modbus via TCP/IP).

NOTE

The menu item `Modbus` is only displayed if the Modbus module (see page 109) is installed in the gas analyzer.

Parameters

The gas analyzer supports the Modbus slave protocol with RTU (remote terminal unit) mode. The Modbus access interval should be > 500 ms.

The `Modbus address` can be set in the 1 to 255 range.

For `Modbus type`, select the interface which connects the gas analyzer to the Modbus network (RS232 or RS485).

The data transfer default settings are shown in the Figure above.

The `Modbus map` permits an overview of the Modbus Register address.

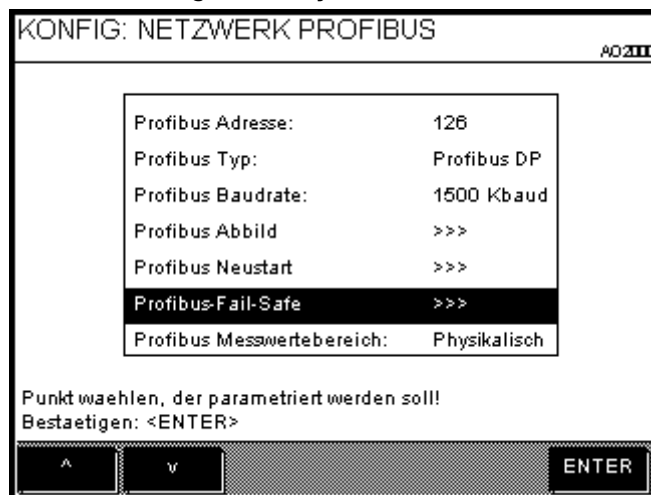
NOTE

For additional information on "Modbus", refer to the Technical Information "AO2000 Modbus and AO-MDDE".

Configuring Profibus

Menu path

MENU → Configure → System → Network → Profibus



Parameters

Parameter	Range selection	
Profibus address	1 to 126	
Profibus type	Profibus DP	Connection to the RS485 interface
	Profibus PA	Connection to the MBP interface (non-intrinsically safe)
Profibus baudrate	RS485 interface	automatically, 9600 Baud, 19200 Baud, 93750 Baud, 187.5 Kbaud, 500 Kbaud, 1500 Kbaud, 3000 Kbaud, 6000 Kbaud
	MBP interface	set to 31250 Baud
Profibus map	Profibus inputs	Measured values, Bus analog outputs, Analog inputs, Analog outputs, Digital inputs, Bus digital outputs, Digital outputs
	Profibus outputs	Bus analog inputs, Bus digital inputs
Profibus restart	Warm start	With Warm start the Profibus stack is reset, comparable with a power off/on.
	Cold start	With Cold start, all the parameters which are stored in the Profibus stack as store parameters are reset to the default value.
Profibus fail safe	Measured value	The value of the Profibus function block comes after the output value of the AO2000 function block.
	Hold value	The Profibus function block holds the last output value. The display of the AO2000 function block may differ from this.
Profibus meas. value range	Physical	The Profibus-AI value is the physical measured value for AO2000.
	VDI 4201	The physical measured values of AO2000 are scaled to the range -10000 to 0 to +10000. 0 equals physically zero and 10000 corresponds to the end value of the indication range (according to VDI 4201).

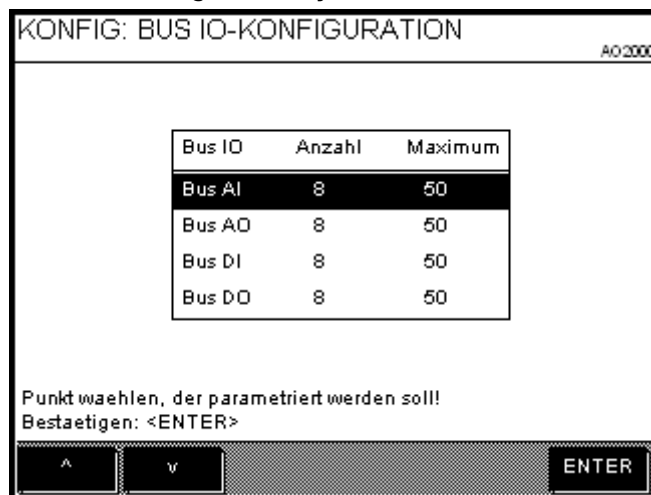
NOTE

For additional information on "Profibus", refer to the Technical Information "AO2000 Profibus DP/PA Interface".

Configuring Bus I/Os

Menu path

MENU → Configure → System → Network → BUS IO



Number of Bus I/Os

Changing the number of Bus I/Os will affect the Modbus address range, Profibus map and Ethernet linking.

Reducing the number of Bus I/Os may cause transmission errors if the settings in the communication partners are not matched. This may also cause damage in the function block applications.

Parameters

Parameter	Function	Read	Write	Example
BUS AI	Bus analog inputs	x	x	for analog value input into the function block application
BUS AO	Bus analog outputs	x	–	for analog value output from the function block application
BUS DI	Bus digital inputs	x	x	for control of functions such as auto calibration, measurement range control after function block configuration
BUS DO	Bus digital outputs	x	–	for display of functions linked by function block configuration, e.g. alarm signaling

Gas analyzer configuration: Display

Display features

The display can be configured

In measurement mode the gas analyzer screen is freely configurable. A standard layout is configured on each delivered unit (see below).


Display elements

Display elements are:

- the default measured quantities in the gas analyzer (sample components, auxiliary quantities, current outputs and current inputs), and
- freely configured displays of measured quantities as well as value entries or key entries.

"Pages"

The screen is divided into "pages", i.e. the display elements are summarized on pages. Up to six measurement values can be displayed per page.

The pages brought up when scrolling with the softkey  can be configured.

A value can only be displayed on a single page.

System pages (standard layout)

The gas analyzer normally displays its measured values in a fixed sequence on the various screen pages. This holds true for the measured quantities of system modules (see page 187), that were added by the user.

Since up to six values can be displayed on a page, the number of system pages depends on the number of values.

The user cannot delete system pages.

The following table shows the standard system page layout in a gas analyzer with no more than six sample components and variables each.

Page	Standard assignment	On/Off
1	Sample component measurement values in physical units	On
2	Sample component measurement values in %MRS	On
3	Current signals at the analog outputs	On
4	Variable measurement values (e.g. flow, temperature, pressure) in physical units	Off
5	Sample component measurement values in %MRS	Off
6	Current signals at the analog inputs (if available)	On

User pages

In addition to the system pages the user can set up so-called user pages (see page 203).

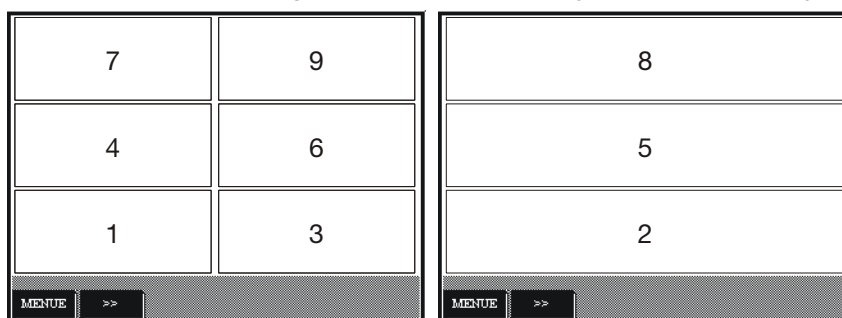
Function blocks as sources

The values of all the function blocks in the system can be configured as a source for the display. The source of the display of value entries or key entries is also a function block that was created when configuring the display elements. The display of the function block value is independent of the other links of the function block.

Note: All sample components, auxiliary quantities, current outputs and current inputs exist as function blocks in the system, i.e., all of these measured quantities are displays of function blocks in the system. Technical Bulletin "Function Blocks – Descriptions and configuration" contains complete information on the "Function block" concept as well as detailed descriptions of the individual function blocks.

Display element positioning on the screen

The display elements can be represented in two sizes. A maximum of three large and six small display elements can be represented on a page. Large and small display elements can be mixed with each other. The positions are numbered as shown in the following figure. The numbering of the positions corresponds to the arrangement of the number keys next to the display.



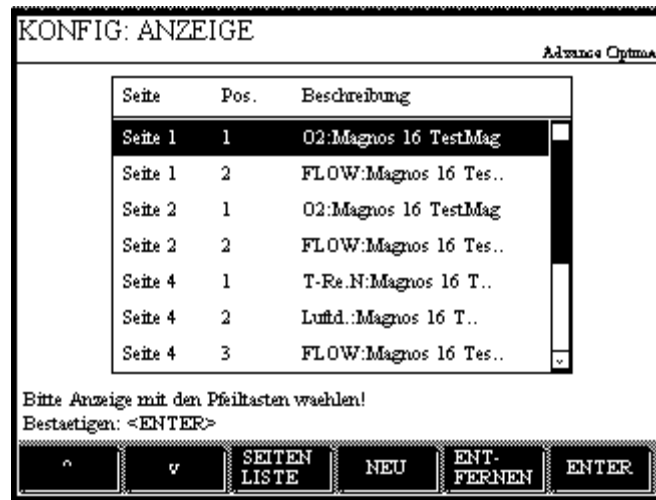
Views

The following views are available for screen configuration:

- Display overview (see page 200)
- Page overview (see page 201) and
- Parameter overview (see page 202).

Display overview

Display overview



Explanations

The screen overview contains the following information for each display element:

Page	Name of page on which the value is displayed
Pos.	Position of the display on the page
Description	Name of the value

Softkeys in the screen overview

The screen overview softkeys have the following functions:

The **PAGE LIST** softkey calls up the page overview (see page 201).

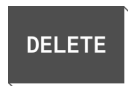


The **NEW** softkey starts the configuration of a new value, e.g.

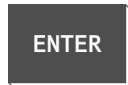


- Configuring the bar display or point display (see page 206),
- Value entry (see page 208),
- Key entry (see page 210).

The **DELETE** softkey deletes the value selected by the user.



The **ENTER** softkey calls up the parameter overview (see page 202) for the display element selected.








Page overview

Page overview

KONFIG: ANZEIGE SEITENUEBERSICHT			
Advanced Optima			
Nr.	Name	Belegung	Type
1 An	Seite 1	33%	System
2 An	Seite 2	33%	System
3 Aus	Seite 3	17%	System
4 Aus	Seite 4	50%	System
5 Aus	Seite 5	50%	System
6 Aus	Seite 6	33%	System

Bitte Seite mit den Pfeiltasten waehlen!
Bestaetigen: <ENTER>

Explanations

No .	The page overview contains the following information:
Name	Page number and status ("On" or "Off")
Assignment	Name of the page
Type	Page assignment
	System: Pages configured by system with standard layout
	User: Page configured by the user

Page overview softkeys

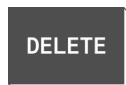


The page overview softkeys have the following functions:

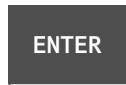
The operator toggles the selected screen page on or off with the PAGE ON/OFF softkey.



The NEW softkey starts the configuration of a new (user) page (see page 203).



The DELETE softkey deletes the page selected by the user. Only empty "user" pages can be deleted.



The ENTER softkey allows the user to input text to change the name of the selected page.



The "Back" key returns the user to the display overview (see page 200).

Parameter overview

Parameter overview



Explanations

The display parameters have the following functions:

Name

The name of the display element set by the system cannot be changed.

Measuring point

The description entered for the Measuring point appears over the element display during measurement operation. The description is set by the system; it can be changed for the user-configured display elements. The maximum length is 20 characters.

Source

The Source of the display elements is always a function block. The source cannot be changed for the display elements of the default assignment, i.e. the measured quantities, and for the key entries.

Page

The parameter Page indicates the page on which the display element is shown. Each display element can be moved to any system or user page.

Position

The Position of a display element on a system page is determined by the system. It can be changed by being exchanged with another display element. The user can freely configure the position on a user page.

Style

The Style of display depends on the source type. The following display styles exist: bar display, point display, value entry (see page 207) and key entry (see page 209). Examples of the different display styles are shown as soon as this parameter is selected.

Range Low,
Range High

The Range Low and Range High parameters determine the measurement range span of the bar display and the point display. They cannot be changed for the display elements of the default assignment, i.e., the measured quantities.

Places

The Places parameter determines the number of decimal places (see page 158) for the digital display of the measured values. It cannot be changed for the display elements of the default assignment, i.e., the measured quantities.

User page configuration

User page configuration

- 1 Select menu item **Display**.
- 2 Call up the page overview.
- 3 Start configuring a new page with **NEW**.
- 4 Either: Enter the page name. The page overview is displayed.
Or: Go directly to the page overview. In this case the system assigns the name "Page #" where # = page number.
- 5 The new page will appear in the page overview:
No.: Assigned by the system, status "on"
Name: As entered in step 4
Usage: 0% (no measured quantity)
Type: User

Moving a display element from one page to another

Moving a display element from one page to another

- 1 Select menu item **Display**.
- 2 Select the display element in the display overview.
- 3 Select the parameter **Page**.
- 4 In the displayed page overview, select the target page. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position.
- 5 In the displayed parameter overview of the display element, the new page and new position are displayed.
If the new page is a system page, the display element is located in the first free position.
If the new page is a user page, the display element is located in the same position as the old page, or if this is already taken, in position 8. If this is also taken, the display element cannot be moved (display ----).
- 6 If the new page is a user page and other positions are free, the position of the display element can be changed.
Select the parameter **Position**.
The nine possible positions are graphically represented; free positions are identified by the position number.
Select the desired position with the corresponding number key.
- 7 Switch over to measuring mode.
The display element is now shown on the new page.

Moving a display element within a page

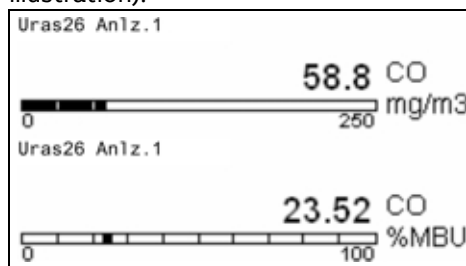
Moving a display element within a page

- 1 Select menu item **Display**.
- 2 Select the display element in the display overview.
- 3 Select the parameter **Position**.
The nine possible positions are graphically represented.
- 4 If the display element is on system page, its position can only be exchanged with that of another display element (the softkey **Swap Display** is pressed.)
If the display element is on user page, its position can either be exchanged with that of another display element (the softkey **Swap Display** is pressed), or it can be moved to a free position (the softkey **Swap Display** is not pressed).
Select the desired position with the corresponding number key.
- 5 Switch to measuring mode.
The display element is now displayed at the new position.

Configuring the bar display or point display

Configuring the bar display or point display

- 1 Select menu item **Display**.
- 2 Start configuration of the new display element with **NEW**.
- 3 Select the parameter **Source**.
The function block menu is displayed.
- 4 Select the function block whose value is displayed.
When configuring the display, it does not matter if a link has been entered for the function block.
- 5 For the parameters **Name**, **Measuring point** and **Source**, system default values are displayed. The parameter **Name** cannot be changed.
- 6 Select the parameter **Page**.
The page overview is displayed.
- 7 Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position.
If the selected page is a system page, the position of the display element is set by the system; it can only be changed using **Swap Display** (see page 205).
If the selected page is a user page, the position must be configured.
- 8 Select the parameter **Position**.
The nine possible positions are graphically represented; free positions are identified by the position number.
- 9 Select the position with the corresponding number key.
- 10 Select the parameter **Type**.
- 11 Select the display type:
Bar graph (top of the illustration) or **Point graph** (bottom of the illustration).



- 12 Set the parameters **Range Low**, **Range High** and **Places**. If necessary, change the description of the display element in the parameter **Measuring Point**.
- 13 Switch to measuring mode.
The newly configured display element is now shown in the display. The description of the display element is shown above the display. Shown to the right of the display are the name and unit of the function block selected in step 4. These two parameters can be changed by configuring the function block.

Value entry

Configuring value entry



Description

The source of the display element **Value Entry** is the function block **Constant** that is automatically generated during configuration. The output of this function block accepts the entered value.

For the entered value to be effective, the generated function block must be linked (see Technical Information "Function Blocks – Descriptions and Configuration" for detailed description).

Configuration

The following are to be configured for the display element **Value Entry**

- the start and end of the entry range,
- the number of decimal places in the display,
- two lines of text that are displayed when the display element is used, and
- the password level on which the entry value can be changed.

Use

Values are entered during measurement by pressing the number key that corresponds to the position of the display element in the display and is indicated above the display element. A field then appears for entering the value (see section "Operating by value entry" (see page 147)). The display element **Value Entry** accordingly represents a response to the actual value entry.

Configuring value entry

Configuring value entry

- 1 Select menu item **Display**.
- 2 Start configuration of the new display element with **NEW**.
- 3 Select the parameter **Page**.
The page overview is displayed.
- 4 Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position.
If the selected page is a system page, the position of the display element is set by the system; it can only be changed using **Swap display** (see page 205).
If the new page is a user page, the position must be configured.
- 5 Select the parameter **Position**.
The nine possible positions are graphically represented; free positions are identified by the position number.
- 6 Select the position with the corresponding number key.
- 7 Select the parameter **Type**.
- 8 Select display type **Value entry**.
This creates a **Constant** function block; whose system-issued name, 'Value page-position', is displayed in the parameter **Source**. This name cannot be changed here; it can only be changed by configuring the function block (see step 11).
- 9 Select the parameter **Config entry** and configure the other parameters: entry range, decimal places, text and password level. The configuration of reverse entry ranges (e.g. 100 to 0 ppm) is possible.
- 10 The description of the display element is entered in the parameter **Measuring point**.
- 11 Select the function block created in step 8, enter the name and unit, and link the function block to an application via its output (see Technical Information "Function Blocks – Descriptions and Configuration" for detailed description).
- 12 Switch to measuring mode.
The newly configured display element is now shown in the display. The description of the display element is shown above the display. To the right of the display, the name and unit of the function block are displayed that were entered in step 11.

Key entry

Configuring key entry



Description

The source of the display element **Key Entry** is one or more **Constant** function blocks that is automatically generated during configuration. Upon "actuation", the output of this function block assumes the value that was established during configuration.

For the entered value to be effective, the generated function blocks must be linked (see Technical Information "Function Blocks – Descriptions and Configuration" for detailed description).

Configuration

The following are to be configured for the display element **Key Entry**:

- the number of keys (1 to 6) – the keys are assigned to the softkeys,
- the key type
 - key or
 - switch or
 - option key,
- the parameters for each key
 - label,
 - value key released, and
 - value key pressed,
- two lines of text that are displayed when the display element is used, and
- the password level on which the keys can be used.

Use

Key entries are made during measurement mode by pressing the number key that corresponds to the position of the display element on the display and that is indicated over the display element. A softkey line then appears with the configured keys (see section "Operating by key entry" (see page 148)). The display element **Key Entry** accordingly represents a response to the actual Key Entry.

Configuring key entry

Configuring key entry

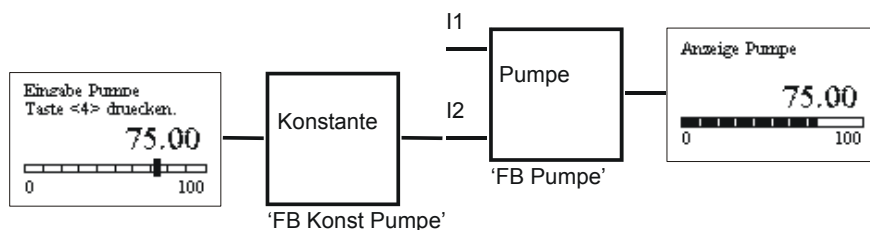
- 1 Select menu item **Display**.
- 2 Start configuration of the new display element with **NEW**.
- 3 Select the parameter **Page**.
The page overview is displayed.
- 4 Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position.
If the selected page is a system page, the position of the display element is set by the system; it can only be changed using **Swap display** (see page 205).
If the new page is a user page, the position must be configured.
- 5 Select the parameter **Position**.
The nine possible positions are graphically represented; free positions are identified by the position number.
- 6 Select the position with the corresponding number key.
- 7 Select the parameter **Type**.
- 8 Select the display type **Key entry**.
This creates a single function block **Constant**, whose system default name 'Value page-position' is displayed in the parameter Source. This name does not appear in the display. If necessary, it can be changed by configuring the function block (see step 11).
- 9 Select the parameter **Config keys** and configure the other parameters: key number, key type, label, value released/pressed, text and password level. If all the keys are configured individually, a separate **Constant** function block is created for each key.
- 10 The description of the display element is entered in the parameter **Measuring point**.
- 11 Select each of the function blocks created in steps 8 and 9 and link to an application with its output 1 (see Technical Information "Function Blocks – Descriptions and Configuration" for detailed description).
- 12 Switch to measuring mode.
The newly configured display element is now shown in the display. The description of the display element is shown above the display.

Example: Entering and displaying the pump output

Configuring and using a value entry

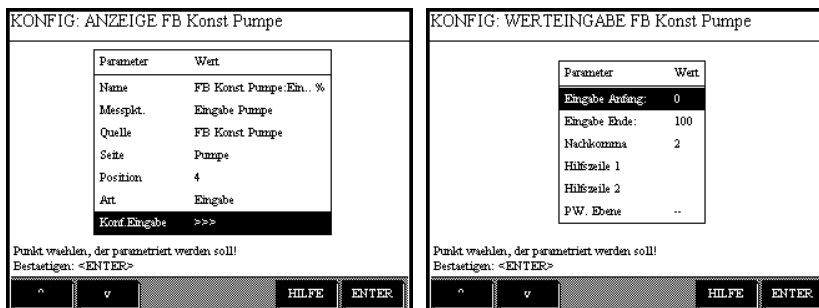
The configuration and use of a value entry will be explained using the following example of entering and displaying the pump output.

The following Figure shows the function block configuration that results from the configuration of the example. It consists of the function block 'FB Const Pump' that is created when configuring the display element 'Input Pump', and the function block 'Pumpe' that is the system default.

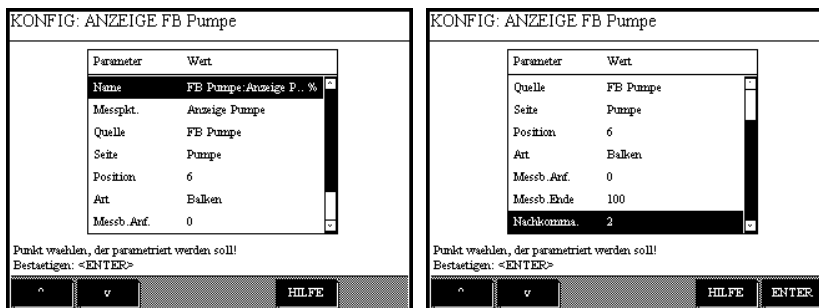


Configuring value entry

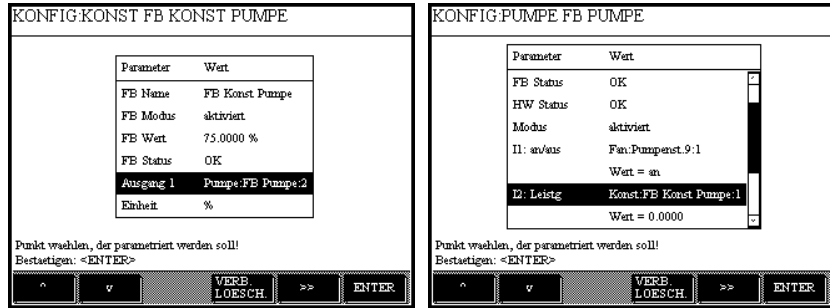
- 1 Configure the display element for the pump output value entry. The source is the function block 'FB Const Pump'.



- 2 Configure the display element for the bar display of the pump output. The source is the function block 'FB Pump'.

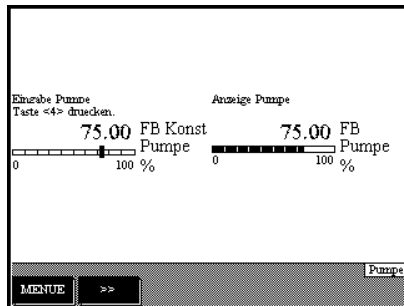


- 3 Link Output 1 of the function block 'FB Const Pump' to input I2: Speed of the function block 'FB Pump'.

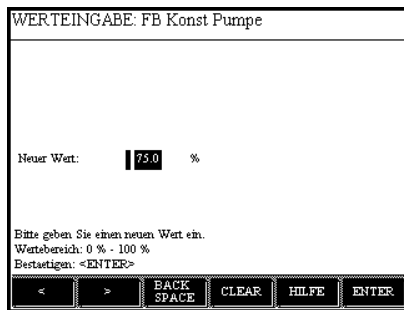


Results of the configuration example

The following diagram shows the display with the display elements "Value entry" and "Bar display".



The following diagram shows the field for entry of the value; this is selected by pressing key 4 during measurement mode (see section "Operating by value entry" (see page 147)).



Calibration: Principles

Calibration control

Calibration control

Depending on the gas analyzer version and equipment, there are three methods for controlling calibration:

- Manual calibration
- Automatic calibration
- Externally controlled calibration

All analyzer modules can be calibrated using any of the three methods.

Calibration start

- Manual calibration is started manually via the gas analyzer's display and control unit.
- Automatic calibration is started at time intervals determined by the internal clock or by an external control signal or manually via the gas analyzer's display and control unit.
- Externally controlled calibration is triggered by an external control signal.

Wait until the warm-up phase has ended

Calibration should only be started after the warm-up phase.

Analyzer module	Duration of the warm-up phase
Caldos25	1.5 hours
Caldos27	30/60 minutes for class 1/2 measurement ranges ¹⁾
Fidas24	≤ 2 hours
Fidas24 NMHC	≤ 2 hours
Limas11 IR	Approx. 2.5 hours
Limas21 UV	Approx. 2.5 hours
Limas21 HW	Approx. 4 hours
Magnos206	≤ 1 hour
Magnos28	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx. 0.5/2 hours without/with thermostat
ZO23	Approx. 15 minutes

1) See "AO2000 Series" data sheet for class details.

Plausibility check during the calibration

If during calibration the gas analyzer finds implausible values (e.g. if the span and zero values are equal), calibration is stopped and an error message is generated. The values stored for the last calibration remain in effect.

Status signal

The "Maintenance mode" status signal is set during calibration.

Manual calibration

Definition

Manual calibration means: Zero and span are calibrated separately by pressing the gas analyzer display and control unit softkeys.

Test gas infeed

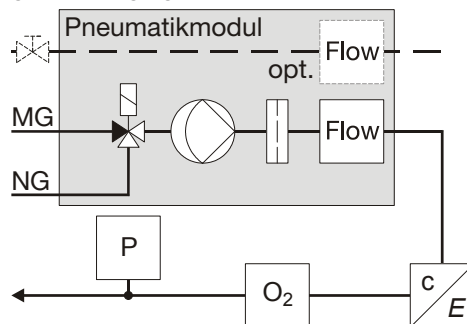
The test gas supply can be started by activating a multiple-way ball valve or solenoid valve.

If the analyzer module is assigned to a pneumatic module and the latter is fitted with a single solenoid valve to control the test gas supply (see following Figure), the zero gas and span gas must be fed to the zero gas inlet (NG). This also applies if an external solenoid valve is used and controlled via a digital output.

The pump status (on/off during manual calibration) matches the setting for automatic calibration (see page 227).

Example

Test gas connection for Caldos27 with single-point calibration, Magnos206 with single-point calibration, Magnos28 with single-point calibration, Limas11 IR, Limas21 UV and Limas21 HW with calibration cells, Uras26 with calibration cells with flow monitoring as option, e.g. for flowing reference gas or purge gas (external needle valve required):



MG	Sample gas inlet
NG	Zero gas inlet
Flow	Flow monitoring
O ₂	Oxygen sensor
P	Pressure sensor in analyzer module
c/E	Analyzer

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

Analyzer modules with multiple detectors

In the case of analyzer modules with several detectors (e.g. Uras26) each detector should be calibrated sequentially.

Air pressure effect

If the gas analyzer does not have an integrated pressure sensor for air pressure correction, the air pressure value should be checked and reset (see page 272) as required prior to calibrating the analyzer module:

- if the gas analyzer's operating site altitude has changed since the last calibration or
- if the air pressure effect (see page 346) on the measured value is too high.

Waiting period following manual calibration

If the Output Current Response parameter is set to Hold, current output is halted for a specific time to allow the measurement value to stabilize after automatic calibration is ended.

This interval is:

Test gas → Sample gas purge time + 4 x T90 or

Test gas → Sample gas purge time + 1 x T90-1 + 3 x T90-2.

The waiting period is the same as that following automatic calibration (see page 216).

Calibration data

Setting the calibration data is described in section "Calibration data for manual calibration" (see page 226).

Analyzer module manual calibration

Manual calibration of an analyzer module is described in section "Analyzer module manual calibration" (see page 265).

Automatic calibration

Definition

Automatic calibration means: Zero and span calibration run automatically after starting.

Test gas supply

The test gas supply can be started automatically by means of the pneumatic module's solenoid valves or via external solenoid valves.

Depending on the gas supply circuit and the number of analyzer modules installed there are several layout possibilities for the test gas supply (see page 219).

Dew point

The dew point of the test gases must be approximately the same as the dew point of the sample gas.

Analyzer modules with several detectors

In analyzer modules with several detectors (e.g. Uras26) all detectors are calibrated simultaneously.

Starting the automatic calibration

Automatic calibration is started

- at time intervals determined by the internal clock
- by an external control signal or
- manually via the gas analyzer's display and control unit.

Internal start

Automatic calibration is normally started cyclically on a time-controlled basis by the internal clock of the gas analyzer.

The cycle time is provided with a parameter with the calibration data (see page 227).

External start

The "Start automatic calibration" control signal is needed for external starting of automatic calibration:

Level	Low 0 to 3 V → High 12 to 24 V edge. The Low → High transition may also be generated by an external contact. After the transition the High level must be present for at least 1 s.
Input	Digital input DI1 on Digital I/O module – "Status signals/ Externally controlled calibration" (see page 112) (standard function block application)

Manual start

The automatic calibration can be manually started on the display and control unit. It is effected

- Only as zero-point calibration or
- Only as end-point calibration (for restrictions see "Calibration data for automatic calibration" (see page 227)) or
- As a common zero-point and end-point calibration.

Manual start of an analyzer module is described in section "Manual start of the automatic calibration" (see page 266).

Disable automatic calibration

The "Block automatic calibration" control signal is needed for blocking automatic calibration:

Level	High Level 12 to 24 V. Automatic calibration is disabled as long as the high level is active. The next automatic calibration after switching to a Low level will be started according to the parameterized cycle time.
Input	Digital input DI2 on Digital I/O module – "Status signals/ Externally controlled calibration" (see page 112) (standard function block application)

Automatic calibration start, block and cancel

Start	Block	Cancel
Controlled by interval:		
If "Activation" parameter is set to "on"	if "Activation" parameter is set to "off" or with the "Block Automatic Calibration" control signal	by appropriate configuration of the Cancel management (see page 227) parameter or of the function block Automatic Calibration
Externally controlled:		
with the "Start Automatic Calibration" control signal	with the "Block Automatic Calibration" control signal	As per interval controlled Start
Manually activated:		
with START		with STOP
NOTE		
Automatic calibration of an analyzer module is impossible when it is operated with the test and calibration software TCT and during setting up system modules.		

Message display

During automatic calibration an Autocal running message blinks in the softkey line.

Waiting period following automatic calibration

If the Output Current Response parameter is set to Hold, current output is halted for a specific time to allow the measurement value to stabilize after automatic calibration is ended.

This interval is:

Test gas → Sample gas purge time + 4 x T90 or

Test gas → Sample gas purge time + 1 x T90-1 + 3 x T90-2.

Calibration data

Setting the calibration data is described in section "Calibration data for automatic calibration" (see page 227).

Setting the T90 time constants is described in section "Filter parameterization" (see page 163).

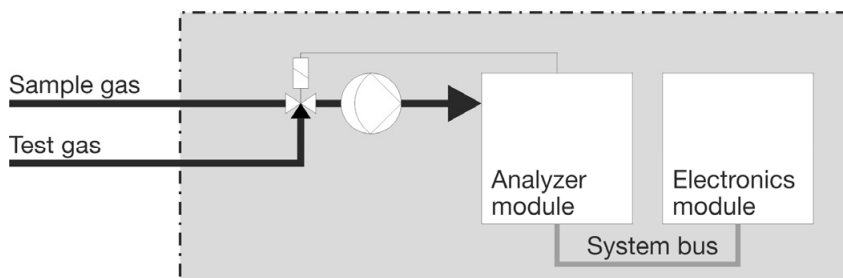
Test gas supply control for automatic calibration

Test gas supply

The test gas supply for automatic calibration can be started by means of the gas module's integral solenoid valves or via external solenoid valves.

Depending on the gas supply circuit and the number of analyzer modules installed there are several layout possibilities for the test gas supply:

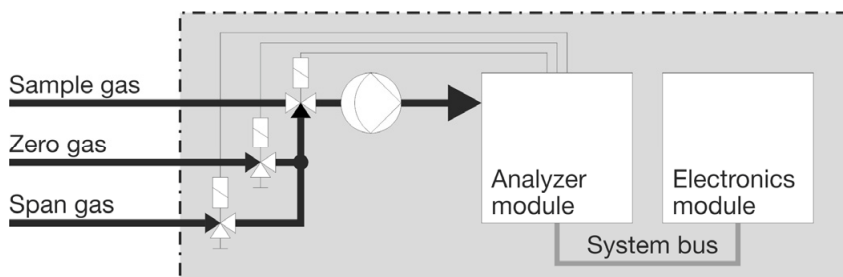
1 analyzer module, integral pneumatic module with 1 solenoid valve



To calibrate analyzer modules with simplified calibration procedures:

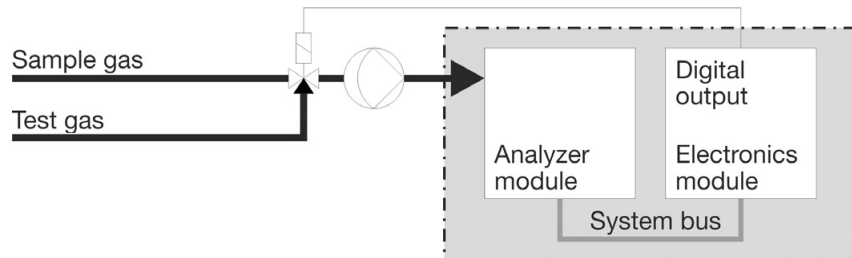
- Caldos27 with single-point calibration
- Magnos206 and Magnos28 with single-point calibration
- Limas11 IR, Limas21 UV, Limas21 HW with calibration cells
- Uras26 with calibration cells
- Oxygen sensor.

1 analyzer module, integral pneumatic module with 3 solenoid valves



To calibrate all analyzer modules that can be used with the pneumatic module.

1 analyzer module, external gas supply with 1 solenoid valve

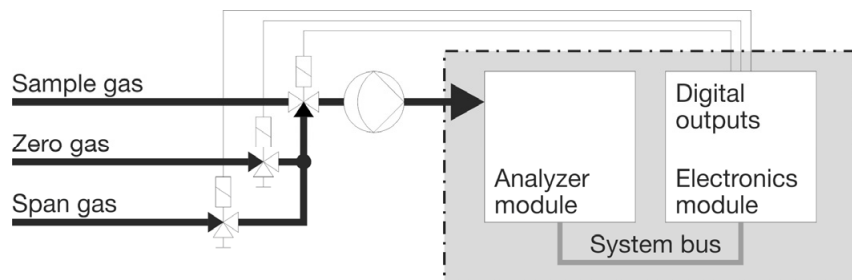


To calibrate analyzer modules with simplified calibration procedures:

- Caldos27 with single-point calibration
- Magnos206 and Magnos28 with single-point calibration
- Limas11 IR, Limas21 UV, Limas21 HW with calibration cells
- Uras26 with calibration cells
- Oxygen sensor.

The external solenoid is controlled via a digital output on the electronics module (Digital output DO4 on Digital I/O module – "Status signals/ Externally controlled calibration" (see page 112) standard function block application).

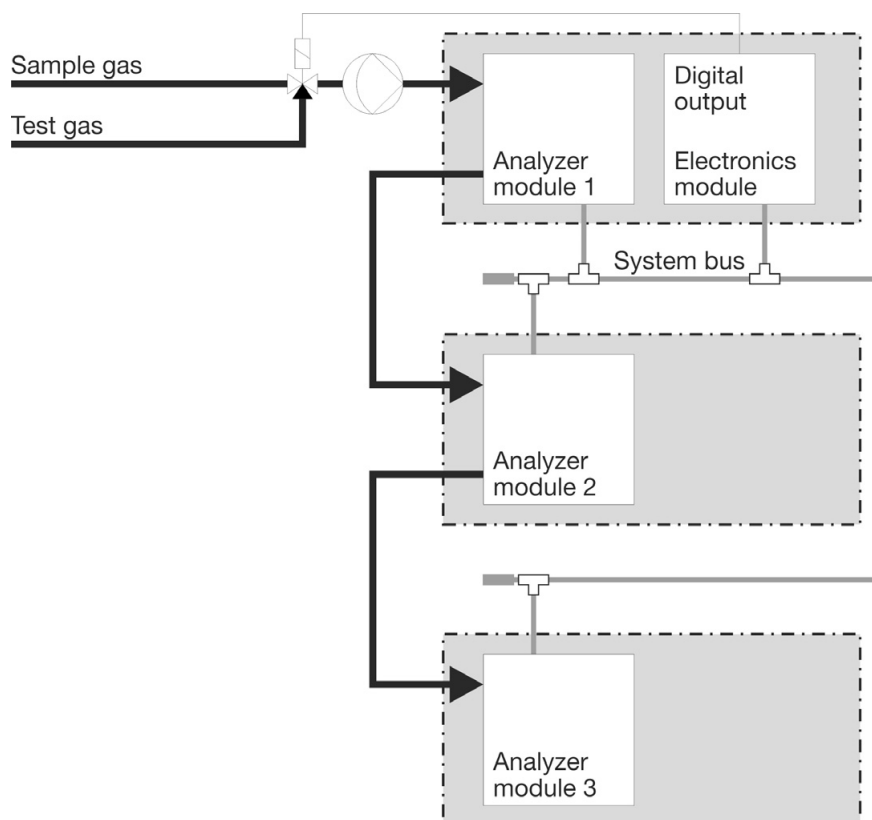
1 analyzer module, external gas supply with 3 solenoid valves



To calibrate all analyzer modules with zero and span gas, even without an integral pneumatic module.

The external solenoid valves are controlled via digital outputs on the electronics module (Digital outputs DO1, DO2 and DO3 on Digital I/O module – "Calibration control" (see page 112) standard function block application).

3 analyzer modules, external gas supply with 1 solenoid valve



To calibrate three analyzer modules connected in series with simplified calibration procedures:

- Caldos27 with single-point calibration
- Magnos206 and Magnos28 with single-point calibration
- Limas11 IR, Limas21 UV, Limas21 HW with calibration cells
- Uras26 with calibration cells
- Oxygen sensor.

During the calibration of the analyzer module the external solenoid valve is as standard controlled via a digital output on the electronics module via a digital output (Digital output DO4 on Digital I/O module – "Status signals/ Externally controlled calibration" (see page 112) standard function block application).

If the sample components of the individual analyzer modules show cross sensitivities among each other, it must be made sure by appropriate arrangement of additional solenoid valves that the test gas can be supplied separately to each analyzer module. When activating the solenoid valves, it must be taken into consideration that all analyzer modules are calibrated simultaneously during automatic calibration.

Externally controlled calibration

Definition

Externally controlled calibration means: Zero-point and end-point value alignment is triggered by control signals from an external control unit.

Test gas supply

The test gases should be supplied automatically by external solenoid valves also controlled by the external control unit. The dew point of the test gases must be approximately the same as the dew point of the sample gas.

Analyzer modules with several detectors

In analyzer modules with several detectors (e.g. Uras26) all detectors are calibrated simultaneously.

Control signals for the externally controlled calibration

Control signal	Level ¹⁾	Digital input ³⁾	
Zero alignment	Edge Low → High ²⁾	DI3	"Status Signals/ Externally controlled calibration"
Span alignment	Edge Low → High ²⁾	DI4	
Calibration cell in/out ⁴⁾	In: High, out: Low	DI1	"Alarm values"
Hold current signal	High	DI2	

- 1) Low level 0 to 3 V, High level 12 to 24 V
- 2) The Low → High transition may also be generated by an external contact. After the transition the High level must be present for at least 1 s.
- 3) Standard function block applications (see page 112)
- 4) Uras26 analyzer module only

Requirements for the external control set-up

For the Caldos25, Caldos27, Magnos206, Magnos28 and Magnos27 analyzer modules the external calibration control must be set up such that the zero-point calibration always precedes end-point calibration.

The external control unit must produce the control signals for zero and span alignment and for the external pneumatic components, e.g. solenoid valves and pumps.

External control of calibration must be set up so that calibration starts only if there is no "Error" or "Maintenance mode" status signal.

Also the external calibration control must allow for a purge time from the point of gas switch-over until stabilization of the measurement value, i.e. until the zero or span calibration is initiated. Depending on the length of the gas paths in the gas analyzer and on the sample components involved, this purge time can take several minutes.

To allow measurement values to stabilize, the "Hold current signal" control signal should remain set for a specified time after calibration is finished.

Calibration data

Setting calibration data is described in section "Calibration data for externally controlled calibration" (see page 231).

Calibration methods

Calibration method

An analyzer module (detector) can have one or more (gas) components with one or more measurement ranges each.

To calibrate the analyzer module, establish whether the components and ranges should be calibrated jointly or individually. This decision is based on the calibration method configuration.

Single calibration

The analyzer module zero and end points in each measurement range are calibrated individually for each sample component.

Single calibration has no effect on other measurement ranges for the same sample components and on other sample components.

Single calibration is only possible and practical in the manual calibration mode. Single calibration is required if there are skips in the readings during measurement range switches because these indicate differences in the calibrations of the individual measurement ranges.

Common calibration

Only the analyzer module start and end points in one measurement range are calibrated for each sample component. The start and end points of the other measurement ranges are then corrected electronically on the basis of the values established by this calibration.

A common calibration has no effect on the other sample components in the analyzer module.

In general the start point (zero) is calibrated in the smallest measurement range and the end point (span) is calibrated in the measurement range for which a suitable test gas is available.

Substitute gas calibration

If test gases are not available for calibration, e.g. because they cannot be filled in test gas cylinders or because their components are not compatible with each other, the analyzer module can be set ex works as per order for calibration with a substitute gas. In this case, in addition to the sample component measurement ranges, one or several ranges are set up at the factory for substitute gas components.

One start point and one end point are calibrated in the analyzer module's substitute gas measurement ranges. The start and end points of all substitute gas and sample gas component ranges are then corrected electronically on the basis of the values established by the substitute gas calibration.

NOTE

Substitute gas calibration must always be used to calibrate **all** (sample gas and substitute gas) components for analyzer modules **set up** for substitute gas calibration. Single or common calibration either in the sample component or substitute gas measurement ranges leads to erroneous analyzer module calibration.

Overview

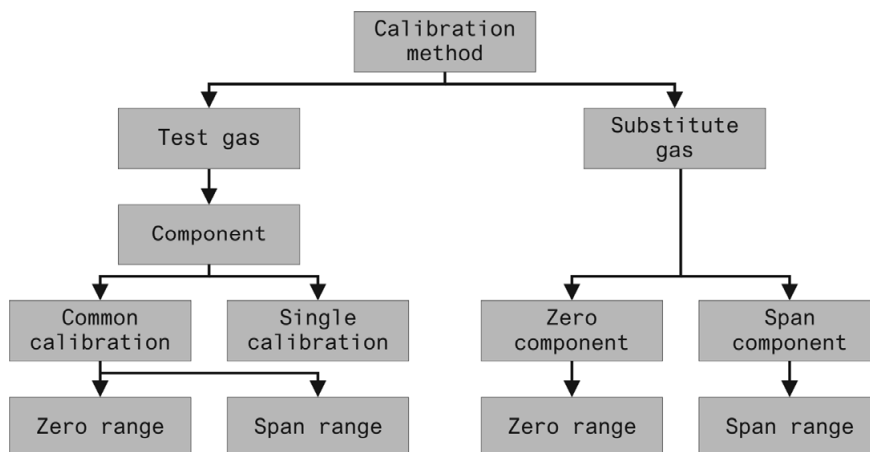
The following table summarizes the various calibration methods.

Qty.	Calibration				
SC	MR	method	To configure ...	Calibrate ...	Calibration affects ...
1	1	Test gas/ Single		zero and span individually for each measuring range and each sample compo- nent	only each measuring range
≥ 1	> 1	Test gas/ Common	the measurement ranges for zero and span calibra- tion	zero in one measurement range and span in another range for each sample component	all measuring ranges of each sample component
> 1	≥ 1	Substitute gas	components and measur- ing ranges for zero and span calibration	zero in one component measurement range and span in one range for an- other component	all detector components and measurement ranges

SC = Sample and substitute gas components

MR = Measurement ranges per component

Setting the calibration method



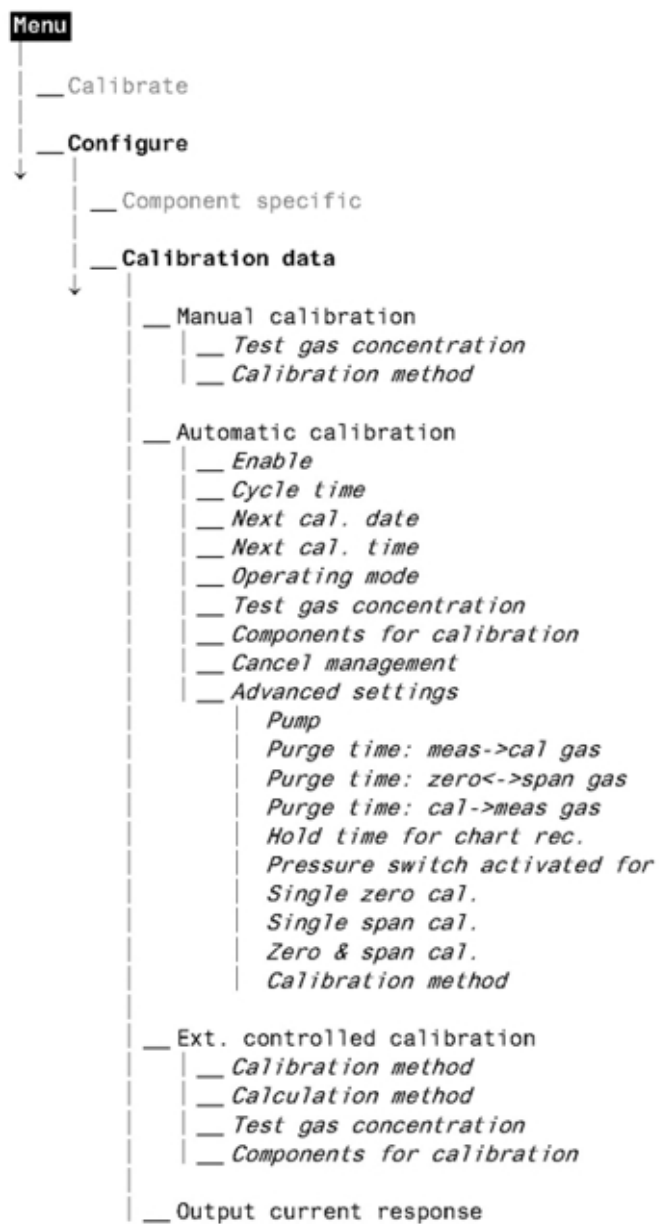
The calibration method can be set separately for the three types of calibration control (manual, automatic and external).

For common and substitute gas calibration the sample ranges for zero and span calibration of all three types of calibration control are adjusted jointly.

For substitute gas calibration the zero and span calibration components should also be set.

Gas analyzer configuration: Calibration data

The 'Calibration data' sub-menu



Calibration data for manual calibration

Menu path

MENU → Configure → Calibration Data → Manual Calibration
→ ...

Test gas concentration

The zero and span test gas concentrations to be used as set points for manual calibration need to be set for the selected sample component and measurement range.

Calibration method

The method for manual calibration (see page 223) needs to be set.

For ...	Select ...:
Common calibration	The sample component and the measurement ranges for zero and span calibration for the selected component.
Substitute gas calibration	The (substitute gas) components for zero and span calibration and the measurement range for the selected component.

NOTE

The components and measurement ranges settings apply to manual, automatic and externally controlled calibration.

Drift calculation

In MENU → Configure → Calibration data → Drift calculation, it can be set if the relative drift between two calibrations is calculated only for automatic calibration or for both automatic and manual calibration.

Only one relative drift value is saved, i.e. if an automatic calibration is configured and active and a manual calibration is performed the relative drift is calculated relative to the last automatic calibration and vice versa.

Calibration data for automatic calibration

Menu path

MENU → Configure → Calibration Data → Automatic Calibration
→ ...

Activation

Automatic calibration is only performed when activated.

The "off" setting applies only to the interval-controlled start of automatic calibration.

Cycle time

The cycle time shows the time intervals over which automatic calibration is to be carried out.

Date and time of next calibration

The gas analyzer will perform the next automatic calibration at the time established here. The cycle time starts from this point of time.

Operating mode

Automatic calibration is based on the function block **Autocalibration**. This function block operates either as calibration or as validation (see page 230). The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Test gas concentration for the calibration

The zero and span test gas concentrations to be used as set points for automatic calibration need to be set for the selected sample component and measurement range.

If the Limas11 IR, Limas21 UV, Limas21 HW or Uras26 analyzer module is equipped with calibration cells the test gas concentration does not have to be set.

Components for calibration

The sample components to be calibrated during zero and span calibration need to be selected.

Cancel management

Automatic calibration is always terminated when there is a system bus fault and when the input "block" is set (for example, when the control signal "Block automatic calibration" is applied).

You can configure if the automatic calibration is to be terminated when one of the three states occurs: "System failure", "Analyzer failure" or "Analyzer maintenance request".

You can also configure if gas analyzer should repeat automatic calibration after the cause of termination has been eliminated. Set the number of repetitions and the time between repetitions.

NOTE

The configured repetition is not effective when the automatic calibration has been terminated by enabling the input "Cancel" of the **Autocalibration** function block.

Pump

Setting should be made whether the pump is on or off during automatic calibration-on or off. This setting also applies to manual calibration.

Purge time

Setting should be made for the length of the interval

- between turning on the zero gas flow and starting zero calibration;
- between turning on the test gas flow and starting span calibration
- between restarting the sample gas flow and initiating measurement so that gas residues do not distort the calibration or the measurement result.

NOTE

The purge time should be set to at least three times the T_{90} time of the entire analyzer system.

Single zero-point calibration

Settings should be made whether zero calibration will always or never be carried out alone, i.e. without subsequent span calibration.

Single span calibration

Settings should be made whether span calibration will always or never be carried out alone, i.e. without prior zero calibration.

Joint zero and span calibration

Settings should be made whether zero and span calibration will be carried out jointly always or never or at every nth automatic calibration.

Example:

- Single zero calibration: Always
- Single span calibration: Never
- Joint zero and span calibration: Every 7th

This setting effects with a cycle time of 1 day a zero calibration being carried out every day and a span calibration being carried out once a week.

For the analyzer modules Caldos25, Caldos27, Magnos206, Magnos28 and Magnos27 these parameters must be set up such that the zero calibration always precedes span calibration.

Calibration method

The calibration method (see page 223) for automatic calibration needs to be set for the selected sample component.

The zero and span calibration measurement ranges for common and substitute gas calibration are chosen in the Manual Cal. → Calibration method parameter.

The "calibration method" parameter is not available in the analyzer modules Limas11 IR, Limas21 UV, Limas21 HW and Uras26 since automatic calibration is always run as common calibration.

Drift calculation

In MENU → Configure → Calibration data → Drift calculation, it can be set if the relative drift between two calibrations is calculated only for automatic calibration or for both automatic and manual calibration.

Only one relative drift value is saved, i.e. if an automatic calibration is configured and active and a manual calibration is performed the relative drift is calculated relative to the last automatic calibration and vice versa.

Validation

Validation procedure

Validation runs in principle just like an automatic calibration. The difference is that during validation a measurement value deviation from the set point values is not corrected automatically. Instead the procedure is as follows:

- When the (test gas) measurement values for start and end point are within the respective limits provided with the parameters the success of the validation is recorded in the logbook.
- When the (test gas) measurement values for start and end point are outside the parameterized limit values the failure of the validation is recorded in the logbook. Either the "Maintenance request" status is set or a calibration of the sample component is performed.

Validation parameters

The parameter settings for automatic calibration (see page 227) also apply to validation.

After selecting validation in the `Operating Mode` parameter, it must be set

- If the validation result shall be logged and
- If in case of a validation failure
 - the "Maintenance request" status shall be set or
 - the sample component shall be calibrated.

In the `Test gas concentration` parameter the start- and end-point limit values have to be set for each sample component. If these limit values are over- or undershot the validation is rated as failure.

Calibration data for externally controlled calibration

Menu path

MENU → Configure → Calibration Data → Ext. controlled cal.
→ ...

NOTE

The menu path refers to the **Externally Controlled Calibration** function block. The zero and span calibration parameters are selected separately. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Calibration method

The method for externally controlled calibration (see page 223) needs to be set for the selected sample component.

The zero and span calibration measuring ranges for common- and substitute gas calibration are chosen in the Manual Cal. → Calibration method parameter.

The "calibration method" parameter is not available in the analyzer modules Limas11 IR, Limas21 UV, Limas21 HW and Uras26 since externally controlled calibration is always run as common calibration.

Calculation method

Select whether the calibration is to be calculated as

- Offset calibration
- Amplification calibration
- Offset and amplification calibration.

Test gas concentration

The zero and span test gas concentrations to be used as set points for externally controlled calibration need to be set for the selected sample component and measurement range.

Components for calibration

The sample components to be calibrated during zero and span calibration need to be selected.

Output current response

Menu path

MENU → Configure → Calibration data → Output current response
→ . . .

Output current response

Signals at the current outputs (analog outputs)

- Are held at the last measured value prior to starting calibration or
- Can follow measurement value changes during calibration.

Notes for calibrating analyzer modules

Caldos25: Notes for calibrating

Sample components

The analyzer module has at least one sample component with 1 range.

Associated gas effect

The analyzer module measurement technique is based on the differing thermal conductivity of various gases.

Since this technique is non-selective, the concentration of a sample component can be accurately measured only in a binary or quasi-binary gas mixture.

If other associated gas components are present in the sample gas their effect on initial factory calibration must be considered.

Test gases

Zero calibration: Test gas or sample-component-free process gas or substitute gas

Span calibration: Test gas or process gas having a known sample gas concentration or substitute gas

Test gas for corrected sample components

During calibration possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like Nitrogen.

Calibration with substitute gas

If test gases are not available for calibration, the analyzer module can be factory-set for calibration with a substitute gas (see also section "Calibration methods" (see page 223)). This setting is documented in the analyzer data sheet.

Substitute gas calibration of the analyzer module is described using the example of "CO₂ measurement in flue gas" (see page 237).

Sequence of calibration

Zero-point calibration must always precede end-point calibration.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Caldos27: Notes for calibrating

Sample components

The analyzer module has at least one sample component with 1 range.

Associated gas effect

The analyzer module measurement technique is based on the differing thermal conductivity of various gases.

Since this technique is non-selective, the concentration of a sample component can be accurately measured only in a binary or quasi-binary gas mixture.

If other associated gas components are present in the sample gas their effect on initial factory calibration must be considered.

Test gases

Zero calibration: Test gas or sample-component-free process gas or substitute gas

Span calibration: Test gas or process gas having a known sample gas concentration or substitute gas

Test gas for corrected sample components

During calibration possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like Nitrogen.

Calibration with substitute gas

If test gases are not available for calibration, the analyzer module can be factory-set for calibration with a substitute gas (see also section "Calibration methods" (see page 223)). This setting is documented in the analyzer data sheet.

Substitute gas calibration of the analyzer module is described using the example of "CO₂ measurement in flue gas" (see page 237).

Single point calibration with standard gas

Single-point calibration of the analyzer module with standard gas is described in section "Caldos27: Single-point calibration with standard gas" (see page 235).

Sequence of calibration

Zero-point calibration must always precede end-point calibration. Single-point calibration with standard gas is the exception to this.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Caldos27: Single-point calibration with standard gas

Single-point calibration with standard gas

For measuring ranges \geq class 1 in the Caldos27 analyzer module, a single-point calibration can be carried out with standard gas (standard gas calibration). This standard gas calibration is carried out exclusively as span calibration and causes an amplification correction. Safety-related measurements are excluded from this technique. Depending on the measurement task involved, the zero and end points should be verified periodically (recommendation: once a year).

Note: Classification of measuring ranges into class 1 and class 2 is specified in "Advance Optima AO2000 Series Continuous gas analyzers" data sheet.

Measurement range for standard gas

When the Caldos27 analyzer module is ordered with standard gas calibration, the factory-set measurement range for the standard gas is 0 to 60,000 rTC (rTC = relative thermal conductivity). During basic calibration in the factory one standard gas is calibrated in this measurement range. Due to sensor tolerances the values of other standard gases can differ by up to 5 % from this scaling.

Set points for standard gases

N ₂	10,000 rTC
Air	10,070 rTC
Ar	7,200 rTC
CO ₂	7,500 rTC
CH ₄	14,000 rTC
He	50,000 rTC
H ₂	60,000 rTC

Calibration method

Standard gas calibration is fundamentally a substitute gas calibration (see page 223) without zero calibration. The correction values are transferred to all the analyzer module's sample components and measurement ranges.

Calibration data

Calibration data for manual calibration	
Calibration method	Substitute gas calibration
Zero component	Standard gas ¹⁾
Span component	Standard gas
Test gas concentration	Value depending on standard gas ³⁾

Calibration data for automatic calibration	
Calibration method	Substitute gas calibration ²⁾
Single zero-point calibration	Never
Single span calibration	Always
Zero-point and span calibration together	Never
Test gas concentration	Value depending on standard gas ³⁾

- 1) Though standard gas calibration is carried out exclusively as span calibration, standard gas must also be chosen as zero component.
- 2) Settings of sample components and measurement ranges for zero and span calibration are taken over from the calibration data for manual calibration.
- 3) See table above "Set points for standard gases"

Manual calibration

Manual standard gas calibration must be carried out (see page 265) exclusively as span calibration.

Caldos25, Caldos27: Substitute gas calibration

Example

Substitute gas calibration in the Caldos25 and Caldos27 is described using the example of "CO₂ measurement in flue gas".

CO₂ measurement in flue gas

The composition of the various combustion products in the sample gas is known₂ measurements of flue gas from single-component firings. The flue gas out of the cooler primarily contains CO₂, O₂, N₂ and Ar. CO₂ cannot be measured in mixed-firing flue gases.

Test gases

The following table shows test gases for the calibration of the 0 to 20 vol.% of CO₂ measurement range:

Fuel	Test gas composition in vol.% for								
	Zero	Middle concentration				Span			
		CO ₂	O ₂	N ₂	Ar	CO ₂	O ₂	N ₂	Ar
Gas	Air	10	3	86	1	20	–	79	1
Oil	Air	10	8	81	1	20	–	79	1
Coal	Air	10	10	79	1	20	–	79	1

Calibration with substitute gas

Since the test gases in this table are not available everywhere, the analyzer module can be factory-set for calibration with a substitute gas. In this case an additional measurement range is calibrated for 0 to 20 vol.% of CO₂ in N₂ (N₂ and CO₂/N₂ mixtures are available practically everywhere).

Measurement ranges

Component 1	CO ₂ in flue gas	Meas. range 1	0 to 10 vol.%
		Meas. range 2	0 to 20 vol.%
Component 2	CO ₂ in N ₂ (substitute gas)	Meas. range 1	0 to 20 vol.%

Calibration data

Calibration method	Substitute gas calibration	
Zero component	Component 1	Meas. range 1 or
	Component 2	Meas. range 1
Span component	Component 2	Meas. range 1

Calibration

- Calibrate zero with air (component 1) or N₂ (component 2).
- Calibrate span with test gas 18 vol.% CO₂ in N₂.

Other measurement tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Fidas24: Notes for calibrating

Sample components and measurement ranges

The Fidas24 analyzer module has always at least 1 sample component with 1 measurement range.

Up to 4 sample components with up to 4 measurement ranges are possible for each measuring component.

NOTE

A substitute gas component can be set up at the factory even if it has not been ordered.

Setting of measurement ranges

The measurement ranges are factory-set per customer order.

The measurement range can be varied as follows depending on the adjusted amplification:

Low amplification: 150,000 ppm C1 to 100 ppm C1

High amplification: 3,000 ppm C1 to 10 ppm C1

The smallest measurement range is 0 to 5 mg org. C/m³ equivalent to 0 to 10 ppm CH₄.

NOTE

The associated amplification levels are set at the factory during calibration. They can only be changed using the TCT test and calibration software.

Setting the calibration method

For detailed information on the calibration methods, see the "Calibration methods" (see page 223) section.

Analyzer module with 1 sample component

- 1 Select calibration method: **Test gas** → **Single / Common**
- 2 Select measuring range for zero calibration: **Zero Meas. Range**
- 3 Select measuring range for zero calibration: **Span**.

Analyzer module with several sample components

- 1 Select calibration method: **Test gas / Substitute gas**
- 2 Select component for zero calibration: **Zero Comp.**
- 3 Select measuring range for zero calibration: **Zero Meas. Range**
- 4 Select component for span calibration: **Span comp.**
- 5 Select measuring range for span calibration: **Span Meas. Range**

Test gases

Zero-point calibration

Quality	Nitrogen, Quality 5.0, synthetic air or catalytically cleaned air with an organic C content < 1 % of span
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow	130 to 250 l/h

End-point calibration

Quality	Sample component or substitute gas component in nitrogen or synthetic air with concentration adjusted to the measuring range
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow	130 to 250 l/h

Zero offset

If the zero reference gas is not completely free of hydrocarbons (even purified nitrogen contains fractions of hydrocarbons), negative measured values may be displayed in small measuring ranges (the process gas is "cleaner" than the zero reference gas).

Test gas infeed

The test gases for the zero and span calibration must be fed in via solenoid valves; the test gases are connected automatically by means of the integral valves.

If the test gas is connected at the sample gas inlet the zero gas and span inlet gas must be sealed.

Test gas flow monitoring (pressure switch)

Test gas pressure and test gas flow

If the test gas pressure is set in such a way that the test gas flow at the sample gas inlet complies with the gas inlet conditions (130 to 250 l/h.), then the test gas surplus flows in the direction of the gas sampling point and thus prevents sample gas fractions from falsifying the calibration result.

If the test gas is connected directly at the sample gas inlet (see also "Fidas24: Gas line connection" (see page 97) section), here too an unpressurized surplus (130 to 250 l/h) must be provided.

Test gas flow monitoring during automatic calibration (pressure switch)

If the test gases are connected at the separate test gas inlets, the built-in pressure switch can be activated during automatic calibration to monitor the flow of the test gases. If the flow is insufficient, calibration is stopped.

The pressure switch can be activated for

- zero gas,
- span gas and
- zero and span gas.

Menu path

MENU → Configure → Calibration Parameters → Automatic Calibration → Advanced settings → Pressure switch activated for

Test gas connection at the sample gas inlet during manual calibration

If the test gas is connected directly at the sample gas inlet during manual calibration, when the pressure switch is activated the following message appears in the display:

No calibration gas, pressure switch has not detected any calibration gas.

This message can be bypassed by pressing the **Back** key.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Fidas24 NMHC: Notes for calibrating

Sample components and measuring ranges

The Fidas24 NMHC analyzer module measures both the total content of organic carbons (THC) and the sole methane content (CH₄) in the sample gas. The non-methane content of the hydrocarbons (NMHC) is then calculated from the difference between these alternately measured values.

Two detectors with sample components THC and CH₄ are configured in the analyzer module. The calculated concentration of non-methane hydrocarbons is output as third sample component NMHC.

1 to 4 measuring ranges per sample component are available. The measuring ranges are factory-set per customer order.

Calibration

The analyzer module is calibrated in ppm C1 in the factory. Therefore, for example 100 ppm propane are indicated as 300 ppm C1.

Test gases tolerances affect the precision of the NMHC calculation. Hence it is recommended to calibrate all sample components with methane as test gas.

For the calibration of the sample component THC, a second (substitute gas) component CH₄ can be configured in the factory per customer order. Substitute gas calibration and test gas calibration are then configured as calibration methods. Substitute gas calibration must always be selected as calibration method in normal measuring operation.

Setting the calibration method

For detailed information on the calibration methods, see the "Calibration methods" (see page 223) section.

Analyzer module with 1 sample component

- 1 Select calibration method: **Test gas** → **Single / Common**
- 2 Select measuring range for zero calibration: **Zero Meas. Range**
- 3 Select measuring range for span calibration: **Span Meas. Range**.

Analyzer module with several sample components

- 1 Select calibration method: **Test gas / Substitute gas**
- 2 Select component for zero calibration: **Zero Comp.**
- 3 Select measuring range for zero calibration: **Zero Meas. Range**
- 4 Select component for span calibration: **Span comp.**
- 5 Select measuring range for span calibration: **Span Meas. Range**

Test gases

Zero calibration

Quality	Synthetic air or catalytically purified air with an org. C content of < 1 % span
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

Span calibration

Components	Sample component CH ₄ : CH ₄ in air Sample component THC: C ₃ H ₈ in air or CH ₄ in air Substitute gas component (when configured per order): CH ₄ in air
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

Converter effectiveness testing

Components	CH ₄ in air or C ₂ H ₆ in air (separate test gas containers), connection via bypass
Inlet pressure	$p_e = 1000 \pm 100$ hPa
Flow rate	130 to 250 l/h

Test gas concentration set points for span calibration

Sample component CH₄

Set point CH₄ = Test gas concentration CH₄

Sample component THC, calibration method "Test gas calibration"

Set point THC = Test gas concentration C₃H₈

Set point THC = Test gas concentration CH₄ / Response factor CH₄

Sample component THC, calibration method "Substitute gas calibration"

Set point CH₄ = Test gas concentration CH₄

Zero offset

If the zero reference gas is not completely free of hydrocarbons (even purified nitrogen contains fractions of hydrocarbons), negative measured values may be displayed in small measuring ranges (the process gas is "cleaner" than the zero reference gas).

Test gas infeed

If the test gases are connected at the zero gas and span gas inlet, the test gases are connected automatically by means of the integral valves.

If the test gas is connected at the sample gas inlet, the zero gas and span gas inlets must be sealed.

Test gas flow monitoring (pressure switch)

Test gas pressure and test gas flow

If the test gas pressure is set in such a way that the test gas flow at the sample gas inlet complies with the gas inlet conditions (130 to 250 l/h.), then the test gas surplus flows in the direction of the gas sampling point and thus prevents sample gas fractions from falsifying the calibration result.

If the test gas is connected directly at the sample gas inlet (see also "Fidas24: Gas line connection" (see page 97) section), here too an unpressurized surplus (130 to 250 l/h) must be provided.

Test gas flow monitoring during automatic calibration (pressure switch)

If the test gases are connected at the separate test gas inlets, the built-in pressure switch can be activated during automatic calibration to monitor the flow of the test gases. If the flow is insufficient, calibration is stopped.

The pressure switch can be activated for

- zero gas,
- span gas and
- zero and span gas.

Menu path

MENU → Configure → Calibration Parameters → Automatic Calibration → Advanced settings → Pressure switch activated for

Test gas connection at the sample gas inlet during manual calibration

If the test gas is connected directly at the sample gas inlet during manual calibration, when the pressure switch is activated the following message appears in the display:

No calibration gas, pressure switch has not detected any calibration gas.

This message can be bypassed by pressing the **Back** key.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Fidas24: Substitute gas calibration

Example

Substitute gas calibration in the Fidas24 is described using the example "Acetone measurement in room air".

Acetone measurement in room air

Acetone (C_3H_6O) in higher concentrations cannot be filled test gas containers. For this reason the analyzer module is factory-set for calibration with the substitute gas propane (C_3H_8) in N_2 .

Measuring ranges

Component 1	C_3H_6O in room air	Meas. range 1	0 to 10,000 ppm
Component 2	C_3H_8 in N_2 (substitute gas)	Meas. range 1	0 to 10,000 ppm

Calibration parameters

Calibration method	Substitute gas calibration	
Zero component	Component 1 C_3H_6O	Measuring range 1 or
	Component 2 C_3H_8	Measuring range 1
Span component	Component 1 C_3H_6O	Measuring range 1 or
	Component 2 C_3H_8	Measuring range 1

Calibration

- Calibrate zero with air (component 1 or component 2).
- Calibrate span with test gas 18 vol.% propane in N_2 .

Other measurement tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Fidas24: Response factor and other relevant variables

Response factor

Definition

$$\text{Response factor} = \frac{\text{Measured value display}}{\text{concentration}}$$

$$\text{Concentration} = \frac{\text{Measured value display}}{\text{Response factor}}$$

or

The response factor of propane (C₃H₈) is equal to 1.00 as defined.

Response factors for Fidas24 analyzer module

Sample component		Response factor ¹⁾
Toluol	C ₇ H ₈	0.95
Chlorbenzene	C ₆ H ₅ Cl	0.95
p-Xylol	C ₈ H ₁₀	0.92
Benzol	C ₆ H ₆	0.99
Ethylbenzene	C ₈ H ₁₀	0.92
Propane	C ₃ H ₈	1.00
n-Hexane	C ₆ H ₁₄	0.97
n-Octane	C ₈ H ₁₈	0.93
iso-Octane	C ₈ H ₁₈	1.04
Trichlorethylene	C ₂ HCl ₃	0.96
Tetrachlorethylene	C ₂ Cl ₄	1.00
Ethane	C ₂ H ₆	1.01
Butane	C ₄ H ₁₀	0.97
Methanol	CH ₃ OH	0.74
Butanol	C ₄ H ₉ OH	0.83
Acetic acid	C ₂ H ₄ O ₂	0.52
Dichlormethane	CH ₂ Cl ₂	1.00
Methane	CH ₄	1.14

1) Measurement of the components in synthetic air

NOTE

The response factors for an individual analyzer module may differ slightly from the values indicated in the table.

Response factors for additional sample components

If a measuring component is added with a response factor which was not factory-set, we recommend determining this as follows:

Response factor_{Component}

$$= \frac{\text{Measured value display}_{\text{Component}} \times \text{Test gas concentration}_{\text{Propane}}}{\text{Measured value display}_{\text{Propane}} \times \text{Test gas concentration}_{\text{Component}}}$$

The following information should therefore be noted in particular:

- The zero point should not differ essentially from the calibrated zero point, in particular when measuring with small concentrations. Otherwise the display must be offset against the deviation from the calibration of the zero point with the measured value display.
- The response factors of a gas in nitrogen and in synthetic air may differ considerably from each other.
- The measurements should always be performed with a sample component and a measuring range, e.g. TOC in ppm C1. When calculating the test gas concentration, the number of C-atoms must be considered.
- Test gas cylinders with high accuracy should be (1 % and better) used.

Other relevant variables

The following variables must be stored in the software of the gas analyzer for each measuring component: molar mass, number of C-atoms, response factor and strip factor. These variables are stored for the standard sample components; they must be entered when adding a user component.

Molar mass

$$M_C = 12.011 \text{ g/mol}$$

$$M_H = 1.008 \text{ g/mol}$$

Molar volumes

$$V_m = 22.414 \text{ for } 0 \text{ }^\circ\text{C and } 1013 \text{ hPa}$$

$$V_m = 24.05 \text{ for } 20 \text{ }^\circ\text{C and } 1013 \text{ hPa}$$

Fidas24: Conversion of concentration data

Various units for concentration data

When measuring organic carbon compounds (total C) the concentration is indicated in various units. The most important units are:

- mg C/m³ (e.g. for measurements in accordance with German 17. Federal Regulation on Emissions)
- mg C_nH_m/m³
- ppm C_nH_m (e.g. for measurements in accordance with German Federal Regulations on Air Purity, details on test gas cylinders)
- ppm C1 (for TOC [total organic carbons] or methane CH₄)

Examples for the conversion of units and concentration data

Conversion ppm to mg C_nH_m/m³

$$\text{mg C}_n\text{H}_m/\text{m}^3 = \text{ppm} \times \frac{\text{Molecular weight}}{V_m}$$

Conversion ppm to mg C/m³

$$\text{mg C}/\text{m}^3 = \text{ppm} \times \frac{\text{Number of C atoms} \times 12.011}{V_m}$$

Conversion ppm to ppm C1

$$\text{ppm C1} = \text{ppm} \times \text{Number of C atoms}$$

Example 1

The analyzer module has a measuring range of 0 to 50 mg C/m³. As a test gas, propane (C₃H₈) in N₂ or in air is used.

What is the maximum test gas concentration in ppm or mg/m³ for the measuring range not to be exceeded?

$$c_{\text{C}_3\text{H}_8} [\text{ppm}] = \frac{\text{MR} \times V_m}{\text{Number of C atoms} \times M_{\text{C}}} = \frac{50 \times 22.414}{3 \times 12.011} = 31.102 \text{ ppm C}_3\text{H}_8$$

$$c_{\text{C}_3\text{H}_8} [\text{mg}/\text{m}^3] = \frac{c_{\text{C}_3\text{H}_8} [\text{ppm}] \times (\text{Number of C atoms} \times M_{\text{C}} + \text{Number of H atoms} \times M_{\text{H}})}{V_m}$$

$$c_{\text{C}_3\text{H}_8} [\text{mg}/\text{m}^3] = \frac{31.102 \times (3 \times 12.011 + 8 \times 1.008)}{22.414} = 61.19 \text{ mg C}_3\text{H}_8/\text{m}^3$$

Example 2

If a test gas other than propane is used, its response factor (see page 245) must be taken into consideration.

What is the maximum test gas concentration in ppm or mg/m³ if methane (CH₄) is used?

$$c_{\text{CH}_4} [\text{ppm}] = \frac{\text{MR} \times V_m}{\text{Number of C atoms} \times M_C} = \frac{50 \times 22.414}{1 \times 12.011} = 93.306 \text{ ppm CH}_4$$

$$c_{\text{CH}_4} [\text{mg/m}^3] = \frac{c_{\text{CH}_4} [\text{ppm}] \times (\text{Number of C atoms} \times M_C + \text{Number of H atoms} \times M_H)}{V_m}$$

$$c_{\text{CH}_4} [\text{mg/m}^3] = \frac{93.306 \times (1 \times 12.011 + 4 \times 1.008)}{22.414} = 66.785 \text{ mg CH}_4/\text{m}^3$$

The response factor for methane is $R_{f_{\text{CH}_4}} = 1.13$; i.e. the measured value display is too great by this factor. In order to determine the maximum test gas concentration to avoid exceeding the measuring range, the measured value display must be divided by the response factor.

$$c_{\text{maxCH}_4} [\text{ppm}] = \frac{c_{\text{CH}_4} [\text{ppm}]}{R_{f_{\text{CH}_4}}} = \frac{93.306}{1.13} = 82.572 \text{ ppm CH}_4$$

$$c_{\text{maxCH}_4} [\text{mg/m}^3] = \frac{c_{\text{CH}_4} [\text{mg/m}^3]}{R_{f_{\text{CH}_4}}} = \frac{66.785}{1.13} = 59.102 \text{ mg CH}_4/\text{m}^3$$

A test gas cylinder with approx. 80 ppm CH₄ is ordered. The test gas concentration in the test gas cylinder is 81.2 ppm CH₄ according to the certificate.

This is equivalent to a concentration of

$$c_{\text{CH}_4} [\text{mg C/m}^3] = \frac{c_{\text{Cylinder}} \times \text{Number of C atoms} \times M_C}{V_m}$$

$$c_{\text{CH}_4} [\text{mg C/m}^3] = \frac{81.2 \times 1 \times 12.011}{22.414} = 43.513 \text{ mg C/m}^3$$

Considering the response factor, the indication should be adjusted to

$$c_{\text{maxCH}_4} [\text{mg C/m}^3] = c_{\text{CH}_4} \times R_{f_{\text{CH}_4}} = 43.513 \times 1.13 = 49.1697 \text{ mg C/m}^3$$

Limas11 IR, Limas21 UV, Limas21 HW: Notes for calibrating

Calibration

Calibration can be performed in range 1 and range 2 for each sample component. It is always a common calibration and thus affects both measuring ranges.

Calibration cells

The use of calibration cells allows the analyzer module to be calibrated without using test gas containers.

A maximum of 5 calibration cells can be installed. Each calibration cell is filled with a test gas matched to the sample components and measurement ranges.

Test gases for zero calibration

A zero gas is required for zero calibration in any case.

In addition to nitrogen, ambient air can be used for zero calibration. If the ambient air contains sample gas components, these must be removed with a suitable absorber.

Test gases for end-point calibration without calibration cells

A test gas is required for each sample component for span calibration without calibration cells. Observe the notes in the "Analyzer Data Sheet" when preparing the test gas mixtures. The concentration of the span gas should be 70 to 80 % of the end value of the measurement range.

Test gases for span calibration of suppressed ranges

For suppressed ranges, the span gas concentration must be within the suppressed range. If possible it should be equal to the end value of the suppressed measuring range (and thus the end value of the larger measurement range).

Test gases for automatic calibration

In principle a test gas for each sample component is required for the internally or externally controlled automatic calibration.

A test gas mixture containing each sample component in the appropriate concentration may be used only when all sample components have no mutual cross-sensitivity and/or carrier gas influences.

Analyzer with internal cross-sensitivity correction

During calculation possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are disabled for the calculation. The following information should therefore be noted in particular:

All the sample components must always be calibrated in the following sequence for the zero-point calibration:

- First that sample component which is not corrected,
- Afterwards that sample component which is affected by the smallest number of corrections,
- Up to that sample component which is affected by the largest number of corrections.

Example

Sample components	NO, SO ₂ , NO ₂
Cross-sensitivity correction	NO by SO ₂ and NO ₂ , SO ₂ by NO ₂ , NO ₂ not corrected.
Sequence for zero-point calibration	1. NO ₂ , 2. SO ₂ , 3. NO.

All the sample components must also always be calibrated in the end-point calibration. Here, a corrected sample component may only be calibrated using a test gas contain no components which cause cross-sensitivity, i.e. which only consists of the sample component and an inert gas, e.g. N₂.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Limas21 HW: Special notes for calibrating NO₂ and NH₃

Calibration with calibration cells

We recommend using the calibrating cells installed as an option in the gas analyzer for calibrating NO₂ and NH₃.

During the calibration with calibration cells zero gas must be connected. Clean and dust-free ambient air can also be used as a test gas.

The zero gas should be applied at the sample gas path inlet in order to approximate the conditions in measurement operation as closely as possible during calibration.

The zero gas should be humidified to prevent the sample gas feed from drying out during calibration and intake times consequently being too long after switching back to measurement mode.

Calibration with test gases

We recommend calibrating the gas analyzer every 6 to 12 months with test gas.

Zero gas and test gas should be connected directly at the gas analyzer to avoid intake times being too long.

Magnos206: Notes for calibrating

Sample components

The Magnos206 analyzer module has at least one sample component normally with 4 measuring ranges.

Test gases

Zero calibration: Oxygen-free process gas or substitute gas

Span calibration: Process gas with a known oxygen concentration or substitute gas, e.g. dried air

Highly suppressed measuring ranges (≥ 95 to 100 vol.% of O₂) should only be calibrated with test gases with O₂ concentration in the selected measurement range.

Test gas for corrected sample components

During calibration possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like Nitrogen.

Calibration with substitute gas

If test gases are not available for calibration, the analyzer module can be factory-set for calibration with a substitute gas (see also section "Calibration methods" (see page 223)). This setting is documented in the analyzer data sheet.

Substitute gas calibration of the Magnos206 analyzer module is described using the example of "Purity measurement of CO₂" (see page 254).

Single-point calibration

Single-point calibration of the Magnos206 analyzer module is described in the "Magnos206: Single-point calibration" (see page 252) section.

Suppressed measuring ranges

If suppressed measurement ranges with a suppression ratio of $\geq 1:5$ are set in the Magnos206 analyzer module, the pressure sensor has been specially adjusted at the factory. Therefore, only a common calibration should be carried out (not a single or substitute gas calibration) in this case.

Sequence of calibration

Zero-point calibration must always precede end-point calibration.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Magnos206: Single-point calibration

Single-point calibration

The long-term sensitivity drift of the Magnos206 analyzer module is less than 0.05 vol.% O₂ per year for measurement ranges up to 25 vol.% of O₂. Thus a regular offset correction is sufficient. This so-called single-point calibration can be conducted at each point on the characteristic curve since a parallel shift of this curve results. Depending on the measurement task, however, we also recommend that an end-point calibration is carried out once a year.

Note: The short-term sensitivity drift can amount to 1 % of the measured value per week.

Test gas

A test gas with any concentration of O₂ can be used for single point calibration as long as it lies within one of the measurement ranges in the analyzer module.

Environmental air can also be used as the test gas.

The test gas must have the same moisture content as the process gas.

CAUTION!

In order to avoid accumulations of explosive gas mixtures, do not use air as a test gas for single-point calibration when measuring flammable gases!

Suppressed measuring range

The single-point calibration can also be carried out in a measuring range with a suppressed zero point, provided that the suppression ratio is $\leq 1:5$. In this case as well, the O₂ concentration of the test gas must be within the measurement range.

The drift at 100 vol.% of O₂ is smaller than 0.24 vol.% of O₂ per year.

Air pressure

The current air pressure must be considered for the single-point calibration. This is done automatically if a pressure sensor is incorporated in the analyzer module.

Note: The sensitivity drift is much greater than 0.05 vol.% O₂ without pressure correction.

Calibration method

If the analyzer module has one sample component the single-point calibration is carried out as common calibration only at the zero point.

If the analyzer module has more than one sample component the single-point calibration is carried out as a substitute gas calibration only at the zero point (see page 223).

Calibration data for an analyzer module with one sample component

Example: Test gas = air

Calibration data for manual calibration	
Calibration method	Common single-point calibration
Calibration measurement range	0 to 25 vol.% of O ₂
Test gas concentration	20.96 vol.% of O ₂

Calibration data for automatic calibration	
Calibration method	Common calibration (test gas)
Single zero-point calibration	Always
Single span calibration	Never
Common zero and span calibration	Never
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

Calibration data for an analyzer module with > 1 sample component

Example: Test gas = air

Calibration data for manual calibration	
Calibration method	Substitute gas calibration
Zero component	O ₂ in N ₂
Zero range	0 to 25 vol.% of O ₂
Span component	n.a.
Span range	n.a.
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

Calibration data for automatic calibration	
Calibration method	Substitute gas calibration ¹⁾
Single zero-point calibration	Always
Single span calibration	Never
Common zero and span calibration	Never
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

- 1) Settings of sample components and measurement ranges for zero and span calibration are taken over from the calibration data for manual calibration.

Magnos206: Substitute gas calibration

Example

Substitute gas calibration of the Magnos206 analyzer module is described using the example of "Purity measurement of CO₂".

Purity measurement of CO₂

For CO₂ purity measurements, the smallest concentrations of O₂ are measured in CO₂, e.g. 0 to 1 vol.% of O₂ in CO₂.

Calibration with substitute gas

Since O₂ in CO₂ is not available as a test gas and due to the O₂ zero shift caused by CO₂, the analyzer module is factory-set for calibration with substitute gas.

In this case a measurement range for 0 to 25 vol.% of O₂ in N₂ is calibrated in addition (N₂ and O₂/N₂ mixtures are available practically everywhere).

Measuring ranges

Component 1	O ₂ in CO ₂	Meas. range 1	0 to 1 vol.%
		Meas. range 2	0 to 15 vol.%
		Meas. range 3	0 to 25 vol.%
		Meas. range 4	0 to 100 vol.%
Component 2	O ₂ in N ₂ (substitute gas)	Meas. range 1	0 to 25 vol.%

Calibration parameters

Calibration method	Substitute gas calibration	
Zero component	Component 1	Meas. range 1 or
	Component 2	Meas. range 1
Span component	Component 2	Meas. range 1

Calibration

- Calibrate zero with CO₂ (component 1) or N₂ (component 2).
- Calibrate span with dried air (contains 20.96 vol.% of O₂).

Other measurement tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Magnos28: Notes for calibrating

Sample components

The Magnos28 analyzer module has at least one sample component normally with 4 measuring ranges.

Test gases

Zero calibration: Oxygen-free process gas or substitute gas

Span calibration: Process gas with a known oxygen concentration or substitute gas, e.g. dried air

Highly suppressed measuring ranges (≥ 95 to 100 vol.% of O_2) should only be calibrated with test gases with O_2 concentration in the selected measurement range.

Test gas for corrected sample components

During calibration possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like Nitrogen.

Calibration with substitute gas

If test gases are not available for calibration, the analyzer module can be factory-set for calibration with a substitute gas (see also section "Calibration methods" (see page 223)). This setting is documented in the analyzer data sheet.

Substitute gas calibration of the Magnos28 analyzer module is described using the example of "Purity measurement of CO_2 " (see page 258).

Single-point calibration

Single-point calibration of the Magnos28 analyzer module is described in the "Magnos28: Single-point calibration" section (see page 256).

Suppressed measuring ranges

If suppressed measurement ranges with a suppression ratio of $\geq 1:5$ are set in the Magnos28 analyzer module, the pressure sensor has been specially adjusted at the factory. Therefore, only a common calibration should be carried out (not a single or substitute gas calibration) in this case.

Sequence of calibration

Zero-point calibration must always precede end-point calibration.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Magnos28: Single-point calibration

Single-point calibration

The long-term sensitivity drift of the Magnos28 analyzer module is less than 0.15 % of measured value per three months (at least 0.03 vol.% O₂ per three months) for measurement ranges up to 25 vol.% O₂. Thus a regular offset correction is sufficient. This so-called single-point calibration can be conducted at each point on the characteristic curve since a parallel shift of this curve results. Depending on the measurement task, however, we also recommend that an end-point calibration is carried out once a year.

Note: The short-term sensitivity drift can amount to 1 % of the measured value per week.

Test gas

A test gas with any concentration of O₂ can be used for single point calibration as long as it lies within one of the measurement ranges in the analyzer module.

Environmental air can also be used as the test gas.

The test gas must have the same moisture content as the process gas.

CAUTION!

In order to avoid accumulations of explosive gas mixtures, do not use air as a test gas for single-point calibration when measuring flammable gases!

Suppressed measuring range

The single-point calibration can also be carried out in a measuring range with a suppressed zero point, provided that the suppression ratio is $\leq 1:5$. In this case as well, the O₂ concentration of the test gas must be within the measurement range.

The drift at 100 vol.% of O₂ is smaller than 0.24 vol.% of O₂ per year.

Air pressure

The current air pressure must be considered for the single-point calibration. This is done automatically if a pressure sensor is incorporated in the analyzer module.

Calibration method

If the analyzer module has one sample component the single-point calibration is carried out as common calibration only at the zero point.

If the analyzer module has more than one sample component the single-point calibration is carried out as a substitute gas calibration only at the zero point (see page 223).

Calibration data for an analyzer module with 1 sample component

Example: Test gas = air

Calibration data for manual calibration	
Calibration method	Common single-point calibration
Calibration measurement range	0 to 25 vol.% of O ₂
Test gas concentration	20.96 vol.% of O ₂

Calibration data for automatic calibration	
Calibration method	Common calibration (test gas)
Single zero-point calibration	Always
Single span calibration	Never
Common zero and span calibration	Never
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

Calibration data for an analyzer module with > 1 sample component

Example: Test gas = air

Calibration data for manual calibration	
Calibration method	Substitute gas calibration
Zero component	O ₂ in N ₂
Zero range	0 to 25 vol.% of O ₂
Span component	n.a.
Span range	n.a.
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

Calibration data for automatic calibration	
Calibration method	Substitute gas calibration ¹⁾
Single zero-point calibration	Always
Single span calibration	Never
Common zero and span calibration	Never
Test gas concentration zero gas	20.96 vol.% of O ₂
Test gas concentration span gas	n.a.

- 1) Settings of sample components and measurement ranges for zero and span calibration are taken over from the calibration data for manual calibration.

Magnos28: Substitute gas calibration

Example

Substitute gas calibration of the Magnos28 analyzer module is described using the example of "Purity measurement of CO₂".

Purity measurement of CO₂

For CO₂ purity measurements, the smallest concentrations of O₂ are measured in CO₂, e.g. 0 to 1 vol.% of O₂ in CO₂.

Calibration with substitute gas

Since O₂ in CO₂ is not available as a test gas and due to the O₂ zero shift caused by CO₂, the analyzer module is factory-set for calibration with substitute gas.

In this case a measurement range for 0 to 25 vol.% of O₂ in N₂ is calibrated in addition (N₂ and O₂/N₂ mixtures are available practically everywhere).

Measuring ranges

Component 1	O ₂ in CO ₂	Meas. range 1	0 to 1 vol.%
		Meas. range 2	0 to 15 vol.%
		Meas. range 3	0 to 25 vol.%
		Meas. range 4	0 to 100 vol.%
Component 2	O ₂ in N ₂ (substitute gas)	Meas. range 1	0 to 25 vol.%

Calibration parameters

Calibration method	Substitute gas calibration	
Zero component	Component 1	Meas. range 1 or
	Component 2	Meas. range 1
Span component	Component 2	Meas. range 1

Calibration

- Calibrate zero with CO₂ (component 1) or N₂ (component 2).
- Calibrate span with dried air (contains 20.96 vol.% of O₂).

Other measurement tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Magnos27: Notes for calibrating

Sample components

The Magnos27 analyzer module has at least one sample component with one measurement range and one measurement range for flue gas measurements of O₂ in N₂ substitute gas component with 1 range.

Associated gas effect

Because of the thermomagnetic measurement technique employed by the Magnos27 analyzer module, associated gases have an effect on results.

For this reason the sample gas composition must be considered during initial calibration at the factory.

Test gases

Zero calibration: Oxygen-free process gas or substitute gas

Span calibration: Process gas with a known oxygen concentration or substitute gas, e.g. dried air

Test gas for corrected sample components

During calibration possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas like Nitrogen.

Calibration with substitute gas

If test gases are not available for calibration, the analyzer module can be factory-set for calibration with a substitute gas (see also section "Calibration methods" (see page 223)). This setting is documented in the analyzer data sheet.

Substitute gas calibration of the Magnos27 analyzer module is described using the example of "Oxygen measurement in flue gas" (see page 260).

Sequence of calibration

Zero-point calibration must always precede end-point calibration.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

Magnos27: Substitute gas calibration

Example

Substitute gas calibration of the Magnos27 analyzer module is described using the example of "Oxygen measurement in flue gas".

Oxygen measurement in flue gas

The sample gas composition is known in the case of oxygen measurements.

Test gases

Zero gas: 16 vol.% CO₂ in N₂

Span gas: 10 vol.% of O₂ and 8.3 vol.% of CO₂ in N₂

Calibration with substitute gas

Since these test gases are not available everywhere, the analyzer module is factory-set for calibration with a substitute gas.

In this case an additional measurement range is calibrated for 0 to 25 vol.% of O₂ in N₂ (N₂ and O₂/N₂ mixtures are available practically everywhere).

Measuring ranges

Component 1	O ₂ in flue gas	Meas. range 1	0 to 5 vol.%
		Meas. range 2	0 to 10 vol.%
Component 2	O ₂ in N ₂ (substitute gas)	Meas. range 1	0 to 25 vol.%

Calibration parameters

Calibration method	Substitute gas calibration	
Zero component	Component 2	Meas. range 1
Span component	Component 2	Meas. range 1

Calibration

- Calibrate zero with N₂ (component 2).
- Calibrate span with dried air (contains 20.96 vol.% of O₂) or with an O₂/N₂ mixture.

Other measurement tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Uras26: Notes for calibrating

Calibration

Calibration can be performed in range 1 and range 2 for each sample component. It is always a common calibration and thus affects both measuring ranges.

Calibration cells

The use of calibration cells allows the analyzer module to be calibrated without using test gas containers.

A calibration cell can be installed in each of the analyzer module's beam paths. Each calibration cell is filled with a test gas matched to the sample components and measurement ranges set up in the corresponding beam path.

Test gases for zero calibration

A zero gas is required for zero calibration in any case.

In addition to nitrogen, ambient air can be used for zero calibration. Water vapor must be absorbed using a cooler. If the ambient air contains sample gas components, these must be removed with a suitable absorber (for CO: HOPCALIT®, for CO₂: Sodium hydroxide on substrate).

Test gases for end-point calibration without calibration cells

A test gas is required for each detector for span calibration without calibration cells. In the case of automatic and externally controlled calibration, a test gas mixture is required for all detectors since all are calibrated simultaneously. The span gas concentration should be 70 to 80 % of the end value of the largest measurement range.

Test gases for span calibration of suppressed ranges

For suppressed ranges, the span gas concentration must be within the suppressed range. If possible it should be equal to the end value of the suppressed measuring range (and thus the end value of the larger measurement range).

Test gases for automatic calibration

In principle a test gas for each sample component is required for the internally or externally controlled automatic calibration.

A test gas mixture containing each sample component in the appropriate concentration may be used only when all sample components have no mutual cross-sensitivity and/or carrier gas influences.

Analyzer with internal cross-sensitivity correction

During calculation possible electronic cross-sensitivity and/or carrier gas corrections by other measurement components are disabled for the calculation. The following information should therefore be noted in particular:

All the sample components must always be calibrated in the following sequence for the zero-point calibration:

- First that sample component which is not corrected,
- Afterwards that sample component which is affected by the smallest number of corrections,
- Up to that sample component which is affected by the largest number of corrections.

Example

Sample components	CO ₂ , CH ₄ , C ₃ H ₆
Cross-sensitivity correction	CO ₂ by CH ₄ , CO ₂ by C ₃ H ₆ , C ₃ H ₆ is not corrected.
Sequence for zero-point calibration	1. C ₃ H ₆ , 2. CH ₄ , 3. CO ₂ .

All the sample components must also always be calibrated in the end-point calibration. Here, a corrected sample component may only be calibrated using a test gas contain no components which cause cross-sensitivity, i.e. which only consists of the sample component and an inert gas, e.g. N₂.

Wait until the warm-up phase has ended

The analyzer module should only be calibrated after the warm-up phase (see page 135).

ZO23: Check of the end point and reference point

NOTE

Information for test gases can be found in the section "ZO23: Preparation for installation" (see page 67).

Check of the end point

It is recommended that the end point is checked approx. 4 weeks after start-up.

Further checks of the end point should be carried out as required.

Check of the reference point

It is recommended that the reference point is checked once a year or as required.

Oxygen sensor: Notes for calibrating

Test gases

The zero point of the oxygen sensor is not calibrated, as it is stable owing to the principle.

Ambient (non-process) air with a constant oxygen content (e.g. 20.96 vol.%) is required for span calibration. Synthetic air can also be used.

Test gases for simultaneous calibration of the oxygen sensor and analyzer module

The oxygen sensor and associated analyzer module are calibrated simultaneously.

Therefore when the oxygen sensor is to be calibrated with the following analyzer

- Magnos206 and Magnos28 with single-point calibration
- Limas11 IR, Limas21 UV, Limas21 HW with calibration cells
- Uras26 with calibration cells

the zero gas should contain the required concentration of oxygen.

In all other cases the span gas should contain the required concentration of oxygen.

External control arrangement

The design of the external control of calibration should take into consideration that the oxygen sensor's span value is stable only after a waiting period of ≥ 40 seconds.

Wait until the warm-up phase has ended

The oxygen sensor is always calibrated at the same time as the associated analyzer module. Therefore, calibration should begin only after this module's warm-up phase.

Calibrating the gas analyzer

Gas analyzer manual calibration

NOTES

Calibration should only be started after the warm-up phase.

A manual zero calibration must always be carried out before a manual span calibration.

Gas analyzer manual calibration

- 1 Select the Manual Calibration menu:
MENU → **Calibrate** → **Manual Calibration**
- 2 For single calibration: Select **Component** and **Measurement Range**.
Zero calibration:
- 3 Select **Zero Gas**.
- 4 Turn on the zero gas supply.
- 5 If necessary, change the test gas concentration¹ shown, **ENTER**.
- 6 When the sample value indication stabilizes, initiate zero calibration with **ENTER**.
- 7 Accept the calibration result with **ENTER**
or **REPEAT**² calibration (back to step 5)
or reject calibration with **Back** (back to step 6)
or reject calibration with **Meas** (back to measurement value readout).
Span calibration:
- 8 Select **Span Gas**.
- 9 Turn on the span gas supply.
- 10 If necessary, change the test gas concentration³ shown, **ENTER**.
- 11 When the sample value indication stabilizes, initiate span calibration with **ENTER**.
- 12 Accept the calibration result with **ENTER**
or **REPEAT**⁴ calibration (back to step 10)
or reject calibration with **Back** (back to step 11)
or reject calibration with **Meas** (back to measurement value readout).
- 13 For single calibration, repeat steps 2 to 12 for other components and measurement ranges.

¹ The parameterized test gas concentration is displayed. If the set point is altered here, the parameterized test gas concentration is overwritten.

² A calibration may have to be repeated if the measured value is not stable after initiation of the calibration. The repeated calibration is based on the measured value obtained in the preceding calibration.

³ The parameterized test gas concentration is displayed. If the set point is altered here, the parameterized test gas concentration is overwritten.

⁴ A calibration may have to be repeated if the measured value is not stable after initiation of the calibration. The repeated calibration is based on the measured value obtained in the preceding calibration.

Manual start of the automatic calibration

NOTES

Calibration should only be started after the warm-up phase.

For the Caldos25, Caldos27, Magnos206, Magnos28 and Magnos27 analyzer modules, it is not admissible to perform only a span calibration. A zero calibration must always precede a span calibration.

Automatic calibration

Automatic calibration can be performed

- as zero calibration alone or
- as span calibration alone or
- jointly as zero and span calibration.

Manual start of the automatic calibration

- 1 Select the Automatic calibration menu:
MENU → Calibrate → Automatic calibration
- 2 Only zero-point calibration: **ZERO AUTOCAL**
Only span calibration: **SPAN AUTOCAL**
Common Zero and Span Calibration: **ZERO & SPAN AUTOCAL**

Manual stop of the automatic calibration

The user can end the automatic calibration process by pressing the STOP softkey.

When automatic calibration is stopped, the analyzer module is in an indefinite state. For example, the zero-point calibration may have been completed and calculated, but the end-point calibration has not yet been carried out.

For this reason, automatic calibration will have to be restarted and allowed to run to completion after any cancelation of automatic calibration.

Validation

The procedure described above applies in the same way if the analyzer module is in validation (see page 230) operating mode.

Inspection and maintenance

CAUTION

The tasks described in this chapter require special training and under some circumstances involve working with the gas analyzer open and powered up. Therefore, they should only be performed by qualified and specially trained personnel.

Inspection

Normal operation of the gas analyzer

In normal operation the measured values from the installed analyzer modules are shown on the display screen and the green "Power" LED is lit.

Periodic checks

Module, assembly	Function	Interval	✓	
Sample gas flowmeter	Caldos25	10 to 90 l/h, max. 200 l/h	Regularly	<input type="checkbox"/>
	Caldos27	10 to 90 l/h		
	Fidas24	80 to 100 l/h		
	Fidas24 NMHC	80 to 100 l/h		
	Limas11 IR	20 to 100 l/h		
	Limas21 UV	20 to 100 l/h		
	Limas21 HW	20 to 90 l/h		
	Magnos206	30 to 90 l/h		
	Magnos28	30 to 90 l/h		
	Magnos27	20 to 90 l/h		
	Uras26	20 to 100 l/h		
ZO23	5 to 10 l/h ± 0.2 l/h			
Pneumatic module disposable filter	Staining	Regularly	<input type="checkbox"/>	
Gas analyzer gas lines	Seal integrity	Regularly	<input type="checkbox"/>	
Seals between doors and housing	Contamination, foreign material	Before each closing	<input type="checkbox"/>	

Checking gas path seal integrity

When should gas paths checked for seal integrity?

Gas path seal integrity should be checked periodically. It must be verified after the gas paths inside or outside the gas analyzer have been opened (e.g. after removing or installing an analyzer module).

Requisite material

1 pressure gauge, 1 plastic tubing, (3 feet in length), 1 T-piece with shut-off valve, air or nitrogen

CAUTION

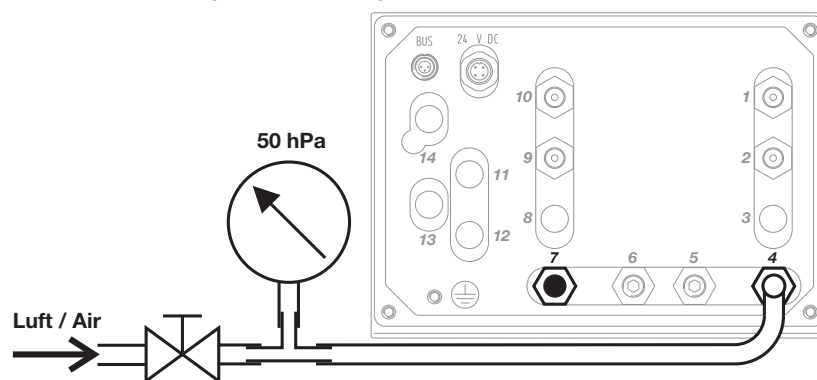
If the seal integrity test is to be carried out with air and there is the possibility of a combustion gas being present in the gas paths or if a combustion gas is to be introduced later, the gas paths should first be purged with nitrogen. Otherwise seal integrity test can be performed with nitrogen.

NOTE

The following instructions apply to all gas paths in the gas analyzer, therefore to all sample gas paths and – in the Caldos25 and Uras26 analyzer modules – to the reference gas path.

Checking gas path seal integrity

Example: Sample gas path in Magnos27



- 1 Seal the outlet of the gas path to be tested (**7** in the example) so it is gas-tight.
- 2 Connect plastic tubing with the T-piece fitted with a shut-off valve to the inlet of the gas path to be tested (**4** in the example).
- 3 Connect the free end of the T-piece to the pressure gauge.
- 4 Blow air or nitrogen through the shut-off valve until the sample gas feed path is under a positive pressure of $p_e \approx 50 \text{ hPa}$ (= 50 mbar). Close the shut-off valve. Maximum positive pressure $p_e = 150 \text{ hPa}$ (= 150 mbar).
Limas11 IR, Limas21 UV, Limas21 HW with quartz sample cell: Gauge pressure $p_e \approx 400 \text{ hPa}$ (= 400 mbar), Maximum positive pressure $p_e = 500 \text{ hPa}$ (= 500 mbar).
- 5 The pressure should not change measurably in 3 minutes ($\leq 3 \text{ hPa}$). A sharp pressure drop is a sign of a leak in the gas path being tested.
Limas11 IR, Limas21 UV, Limas21 HW with quartz sample cell: Test duration 15 minutes.
- 6 Repeat steps 1 to 5 for all gas paths in the gas analyzer.

Pump activation, pump output adjustment

Switching the pump on and off

The pump installed in the internal pneumatic module and external pumps connected to appropriately configured digital outputs can be activated and deactivated manually, for instance in emergency situations.

The emergency shutdown cannot be overridden by the automatic calibration.

Setting the pump output

The output of the pump installed in the internal gas module can be adjusted manually only when the pump is in operation.

If there is a flow sensor in the pneumatic module, its reading is shown when adjusting the pump output.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Pump

The first screenshot shows the 'SERVICE/TEST: Pumpe' menu with a table of pump details:

FB Name	Gerät	Stat./Leistg.
Pumpe	CalDen Anlz. 1:1	an/100%
Ext. Pumpe	DIO:5 EA-Karte 5 D0:4	SERVICE

Below the table, it states: 'SERVICE bedeutet Pumpe aus. Bei AUTO laeuft die Pumpe entsprechend der konfigurierten Einstellung. Leistungseinstellung nur bei laufender Pumpe.'

The second screenshot shows the same menu with the pump output set to 50%. It also displays the flow rate: 'Durchfluss von Durchflussmesser #1: 7.20 l/h' and the instruction: 'Pumpenleistung eingeben! Bereich: 1..100%. Mit <Back> zurueck zur Uebersicht.'

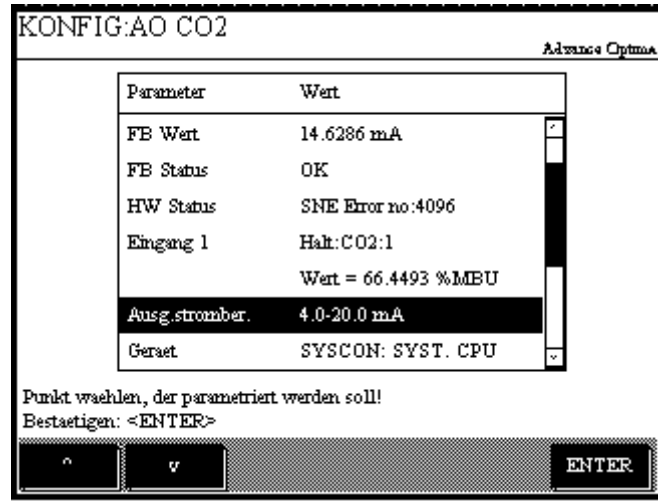
Changing analog output current range

Method

The current range of the individual analog outputs can be modified by setting the parameter for the applicable **Analog output** function block. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks..

Menu path

MENU → Configure → Function blocks → Outputs → Analog output



Changing current range

The current range is changed using the Output current range parameter.

Selection

The current range choices are 0 to 20 mA, 2 to 20 mA and 4 to 20 mA.

NOTE

The output signal may not be less than 0 mA and larger than 22 mA.

Current range limitation

The output signal is limited to the range which is specified in the parameters Lower limit and Upper limit. These parameters are set to 0 mA and 22 mA respectively in the factory.

Air pressure correction

Air pressure effect

A specific amount of change in air pressure will result in a specific change in a measurement value, depending on the measurement principle employed by the analyzer module.

Measures to minimize air pressure effect

The air pressure effect be minimized by

- installing a pressure sensor in the analyzer module (this can only be done at the factory) or
- Entering the current atmospheric pressure as a correction value.

In which analyzer modules is a pressure sensor installed?

Analyzer module	Pressure sensor
Limas11 IR, Limas21 UV, Limas21 HW, Caldos27, Uras26	installed ex works
Magnos206, Magnos28, Magnos27	installed ex works as an option
Caldos25, Fidas24, ZO23	not required

The information as to whether a pressure sensor has been installed in an analyzer module can be found in the MENU → Diagnosis/Information → System Overview menu item after selecting the respective analyzer module.

Air pressure values

Operating altitude meters above mean sea level	Mean air pressure			
	hPa (mbar)	psi	mm Hg (Torr)	in Hg
-200	1037	15.04	778	30.63
-100	1025	14.87	769	30.28
±0	1013	14.69	760	29.92
+100	1001	14.52	751	29.57
200	989	14.34	742	29.21
300	977	14.17	733	28.86
400	965	14.00	724	28.50
500	955	13.85	716	28.19
600	943	13.68	707	27.84
700	932	13.52	699	27.52
800	921	13.36	691	27.21
900	909	13.18	682	26.85
1000	899	13.04	674	26.54
1100	888	12.88	666	26.22
1200	877	12.72	658	25.91
1300	867	12.57	650	25.59
1400	856	12.42	642	25.28
1500	845	12.26	634	24.96
1600	835	12.11	626	24.65
1700	825	11.97	619	24.37
1800	815	11.82	611	24.06
1900	804	11.66	603	23.74
2000	793	11.50	595	23.43

Air pressure value correction

When should the air pressure value be corrected?

The air pressure value must be checked and readjusted as required in the following cases:

- If the gas analyzer's operating site altitude has changed since the last calibration or
- if the air pressure effect on the measured value is too high.

NOTE

An incorrect air pressure value will produce erroneous measurement values.

Limas11 IR, Limas21 UV, Limas21 HW and Uras26 with integral pressure sensor and calibration cells

A pressure sensor is factory-installed in the Limas11 IR, Limas21 UV, Limas21 HW and Uras26 analyzer modules. The pressure sensor is calibrated to 1013 hPa. This is the reference pressure for the test gas concentration when measuring the calibration cells.

If the air pressure value needs to be changed, the following steps are also required

- Calibrate the sample components with test gases and then
- Measure the calibration cells.

Air pressure value correction

The current atmospheric pressure can be entered as a correction value for each analyzer module or for all analyzer modules as a group.

Menu path

For one analyzer module:

**MENU → Maintenance/Test → Analyzer spec. adjustm. →
Atm. press. anlz → ...**

For all analyzer modules as a group:

MENU → Maintenance/Test → System → Atm. pressure

NOTE

If the pressure sensor is connected to the sample gas output line, the sample gas flow must be interrupted while calibrating the pressure sensor so that the sample gas pressure does not distort the measured pressure.

Calibration reset

What does the calibration reset do?

A calibration reset returns the analyzer module's calibration to basic calibration values. Furthermore, the offset drift and amplification drift are electronically returned to basic calibration values (see page 274).

Note: The absolute offset and amplification drift values are calculated cumulatively starting from the last basic calibration. The relative offset and amplification drift values are calculated between the last and next to last automatic calibration. The absolute and relative offset and amplification drift values can be viewed in the **MENU** → **Diagnostic/Information** → **Module specific** → **Status** menu item.

When should a calibration reset be performed?

A calibration reset should be performed if an analyzer module can no longer be calibrated by normal means. A possible cause of this is calibration of the analyzer module with the wrong test gases.

Menu path

MENU → **Maintenance/Test** → **Analyzer spec. adjustm.** → **Calibration Reset**

NOTE

The analyzer module should be calibrated after a calibration reset.

Basic calibration

What does the basic calibration do?

A basic calibration of an analyzer module sets the module back in an initial state. The offset drift and amplification drift are set to zero. The drift history is lost.

When should a basic calibration be performed?

Basic calibration of an analyzer module should be performed only in exceptional cases when changes that affect calibration have been made. This may be the case e.g. after exchanging subassemblies.

For the Uras26 analyzer module, a basic calibration can be performed at the zero point for calibration to the cooler dew point during commissioning at the sampling point.

Check prior to a basic calibration

Prior to a basic calibration, check and ensure

- That the gas analyzer is in proper operating condition
- That the sample conditioning units are in proper operating condition
- That the correct test gases are being used.

Test gases

The zero and/or span calibration test gases are required for a basic calibration.

Performing the basic calibration

The basic calibration is performed for each sample component or – for the Caldos25 and Magnos27 analyzer modules – for each measurement range.

The basic calibration can be performed

- Individually at the zero point
- Individually at the end point, as well as
- Together (successively) at the zero and end points.

A calibration reset (see page 273) is also performed in the case of common basic calibration at the zero and end points.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Basic Calibration

Cross sensitivity alignment

Electronic cross sensitivity correction

AO2000 offers the ability to electronically correct cross sensitivity, in contrast to using purely physical methods (for example, for infrared absorption, optical filter or flowing reference gas).

Electronic cross sensitivity correction is possible with the Caldos25, Caldos27, Limas11 IR, Limas21 UV, Limas21 HW, Magnos206, Magnos28 and Uras26 analyzer modules. In addition, this function must be factory-set per customer order.

The electronic **cross-sensitivity correction** is configured as a function block application. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Cross sensitivity correction is an offset correction.

Interference component concentration is continuously measured and corrected by means of the measurement value. Alternatively, the interference component concentration can be entered directly as a correction value during the cross-sensitivity alignment.

Internal and external cross sensitivity correction

Interference component concentration can be measured in two ways:

- Using the analyzer module with which the sample component is measured (internal cross sensitivity correction, possible only with the Limas11 IR, Limas21 UV, Limas21 HW and Uras26 analyzer modules) or
- With another AO2000 analyzer module or another analyzer (external cross sensitivity correction). The correction signal, i.e. the measured value of the interference component is transferred to the analyzer module with the sample component to be corrected via the system bus or analog input.

When should a cross sensitivity alignment be performed?

A cross sensitivity alignment, i.e. alignment of the cross sensitivity correction function, should not be performed in normal operation.

We recommend checking the cross sensitivity correction once a year.

Test gas for cross sensitivity alignment

One of the following test gases is needed for the cross sensitivity alignment:

- Either a sample component-free test gas containing the maximum concentration
- Or the interference component span gas of the interference component.

Prior to the cross sensitivity alignment

Prior to the cross sensitivity alignment, the zero and end points of the applicable sample and interference components must be calibrated with test gases in the respective analyzer module.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Cross sensitivity adjustm.

Carrier gas alignment

Electronic carrier gas correction

In principle, the electronic carrier gas correction operates in the same manner as the electronic cross sensitivity correction (see page 275).

Carrier gas correction is possible only if the cross sensitivity correction function has been factory-configured per customer order.

Carrier gas correction is similarly configured as a function block application. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Carrier gas correction is an amplification correction.

When should a carrier gas alignment be performed?

A carrier gas alignment, i.e. alignment of the carrier gas correction function, should not be performed in normal operation.

We recommend checking the carrier gas correction once a year.

Test gas for carrier gas alignment

A gas mixture with the appropriate concentrations of sample and interference components is required as the test gas.

Prior to the carrier gas alignment

Prior to the carrier gas alignment, the zero and end points of the applicable sample and interference components must be calibrated with test gases.

If the interference component influences the zero indication of the sample component, a cross sensitivity alignment is required prior to the carrier gas alignment.

Set point entry

Enter the sample component concentration as the set point.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Carrier gas adjustm.

Fidas24: Standby / Restart

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Standby/Restart FID

Display of the operating status of the Fidas24

The screenshot shows the 'SERVICE/TEST: STANDBY/NEUSTART FID' menu. At the top right, it says 'AO2000: Fidas24 - Art. 1'. Below this is a table with two columns: 'Parameter' and 'Wert'. The table contains the following data:

Parameter	Wert
Flamme 1	242.0 C
Zuendversuch	erfolgreich
Status	Messbetrieb
Luftd.	720.0 hPa
H2	1200.0 hPa

Below the table, there are two lines of text: '<STANDBY> um Standby-Modus zu aktivieren.' and '<STANDBY & PURGE> Standby & Nullgas-Spuelung.'. At the bottom of the screen, there are four buttons: 'A', 'V', 'STANDBY', and 'STANDBY & SPUELEN'.

The most important operating data of the Fidas24 are displayed:

Flame 1	Flame temperature
Ignition attempt	The number of ignition attempts until ignition of the flame is displayed. The display "successful" means that the first ignition attempt was successful.
Status	Measuring mode
	Standby
	Flame error
	Fail safe
Air Pr.	Combustion air pressure
H2	Combustion gas pressure

Definitions

Standby mode: heater on, combustion gas valve closed, combustion air valve closed, instrument air valve closed, housing purging on, zero gas valve open for standby with detector purging.

Fail-safe status: heater off, combustion gas valve closed, instrument air valve closed, housing purging on, zero gas valve open.

Put Fidas24 into standby mode

If the softkeys **STANDBY** or **STANDBY PURGE** are displayed in the menu **Standby/Restart FID**, the Fidas24 can be put into standby mode:

STANDBY	Standby mode is activated.
STANDBY PURGE	Standby mode with opening of the zero gas valve to purge the detector is activated (only in version with test gas connection).

Put Fidas24 into measurement mode again

If the Fidas24 can be restarted from standby mode or after a flame error, the softkey **RESTART** is displayed in the menu **Standby/Restart FID**:

RESTART The restart is initiated.

After initiation of the restart, the menu can be quit with **Meas** or **Back**; the restart sequence is continued.

However, the restart sequence can also continue to be observed in the menu. The current values for the flame temperature, combustion air pressure and combustion gas pressure as well as the number of ignition attempts are displayed.

If ignition of the flame has failed after 10 attempts, for the parameter **Ignition attempts 10 - failed** is displayed. By pressing the softkey **RESTART** another restart can be initiated.

Fidas24 in fail-safe status

If a serious fault has occurred in the analyzer module, the analyzer module is put in fail safe status; in the menu **Standby/Restart FID** the indication **Fail safe** appears for the parameter **Status**.

Fail-safe status: heater off, combustion gas valve closed, instrument air valve closed, housing purging on, zero gas valve open.

The cause of the failure must be determined from the status messages (see page 322).

A cold restart in the menu is not possible; after fault correction the gas analyzer must be cold restarted by switching off and on again.

Fidas24: Replacement of the sample gas filter in the heated sample gas connection

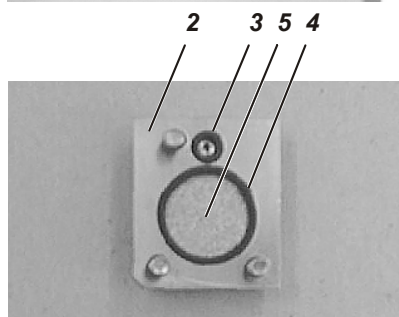
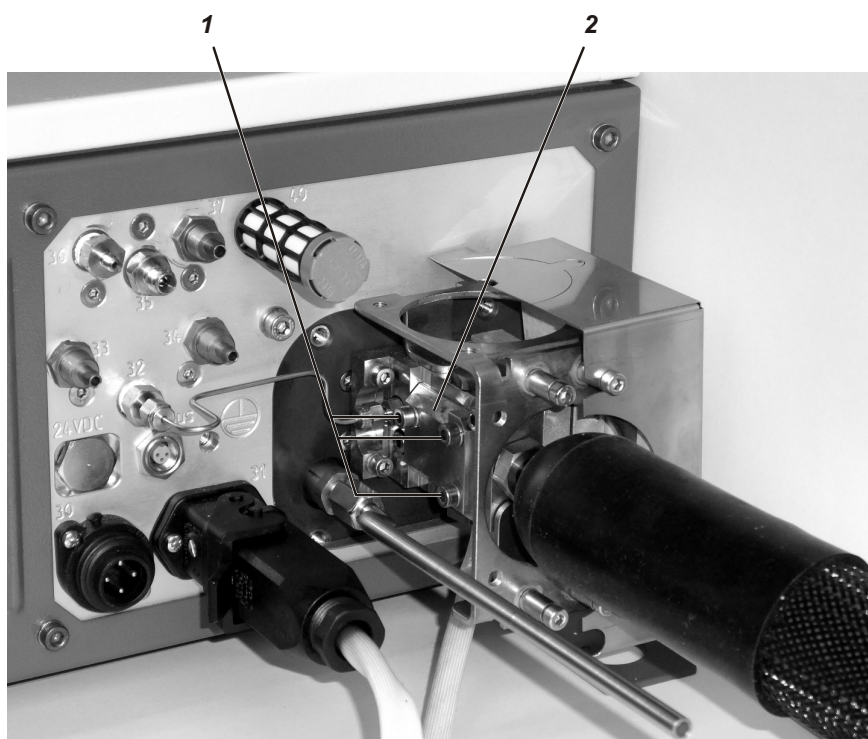
When should the filter be replaced?

The replacement of the sample gas filter in the heated sample gas connection is necessary if it is contaminated and the sample gas flow is too low as a result.

Requisite material

- Sample gas filter with O-rings (Part Number 0768649)
- Allen key, key size 4 mm

Replace sample gas filter



- 1 Mounting screws
- 2 Sample gas filter holder
- 3 O-ring
- 4 O-ring
- 5 Sample gas filter

CAUTION!

The heated sample gas connection is hot (approx. 180 °C)! Allow the sample gas connection to cool down after switching off the power supply (approx. 30 minutes).

- 1** Turn off the sample gas supply to the analyzer module.
Switch off 115/230-V-AC power supply of the gas analyzer and heater as well as if necessary, the separate 24-V-DC supply of the analyzer module.
- 2** Loosen three mounting screws **1** and remove sample gas filter holder **2** from the sample gas terminal section.
- 3** Remove O-rings **3** and **4** as well as contaminated sample gas filter **5** from the sample gas filter holder **2**.
- 4** Insert new sample gas filter **5** and new O-rings **3** and **4** into the sample gas filter holder **2**.
NOTE: Always replace O-rings in conjunction with sample gas filter. Contaminated or damaged O-rings impair the seal integrity of sample gas path; this leads to erroneous measurement values.
- 5** Put sample gas filter holder **2** on the sample gas terminal section and secure with the three mounting screws **1**. Only tighten mounting studs until the sample gas filter holder touches the metal. When doing so, take care that the O-rings **3** and **4** do not fall out from the sample gas filter.
- 6** Reconnect the sample gas supply to the analyzer module.
- 7** Activate the power supply.
- 8** Check output variables of the internal pressure regulator for the supply gases and adjust if necessary (see section "Fidas24: Gas analyzer start-up" (see page 129)).
- 9** Calibrate the gas analyzer at the end of the warm-up phase.

Fidas24: Cleaning the air jet injector

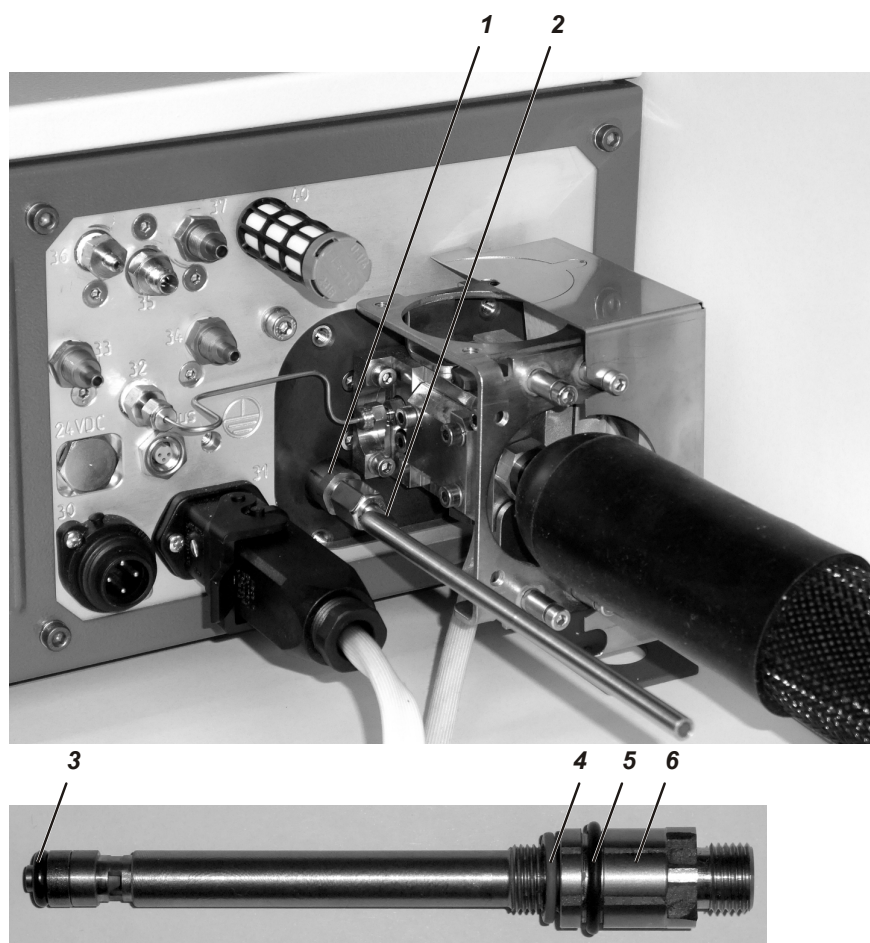
When should the air jet injector be cleaned?

Cleaning of the air jet injector is necessary if the sample gas outlet pressure is too high, i.e. if the negative pressure can no longer be adjusted to $p_{\text{abs}} < 600 \text{ hPa}$.

Requisite material

- Open-end wrench, key size 12 mm and 14 mm
- O-Ring set for the detector (Part Number 0769343)
- Ultrasonic bath with aqueous cleaning agent (e.g. Extran)

Cleaning the air jet injector



- 1 Exhaust air outlet with screwed-in air jet injector
- 2 Exhaust pipe
- 3 O-ring
- 4 O-ring
- 5 O-ring
- 6 Air jet injector removed

CAUTION!

The heated sample gas connection is hot (approx. 180 °C)! Allow the sample gas connection to cool down after switching off the power supply (approx. 30 minutes).

- 1** Turn off the sample gas supply to the analyzer module.
Switch off 115/230-V-AC power supply of the gas analyzer and heater as well as if necessary, the separate 24-V-DC supply of the analyzer module.
- 2** Unscrew exhaust pipe **2** from the exhaust air outlet **1** (key size 12 mm).
- 3** Unscrew air jet injector from the exhaust air outlet **1** (key size 14 mm).
- 4** Clean air jet injector in ultrasonic bath. Use aqueous cleaning agent (e.g. Extran).
- 5** Replace O-rings **3**, **4** and **5** with new O-rings.
NOTE: When cleaning the air jet injector always replace all three O-rings. Contaminated or damaged O-rings impair the suction performance of the air jet injector; this may result in the failure of the Fidas24. Slightly lubricate all three O-rings with high temperature grease (part no. 772341) before mounting them.
- 6** Screw air jet injector **6** into the exhaust outlet. Make sure that the O-rings are seated correctly.
- 7** Screw the exhaust pipe **2** onto the **1** exhaust air outlet.
- 8** Reconnect the sample gas supply to the analyzer module.
- 9** Switch on the power supply.
- 10** Check output variables of the internal pressure regulator for the supply gases and adjust if necessary (see section "Fidas24: Gas analyzer start-up" (see page 129)).
- 11** Calibrate the gas analyzer at the end of the warm-up phase.

Fidas24: Checking the combustion gas supply line for seal integrity

CAUTION

The seal integrity test described in this section should only be performed by qualified and specially trained personnel. If these conditions are not provided or the prescribed materials are not available, a seal integrity test must be carried out by ABB after sales service.

Regular seal integrity check of the combustion gas supply line

The seal integrity of the combustion gas supply line must be checked regularly according to one of the two following instructions, depending on whether the combustion gas is supplied from a cylinder or from a central unit.

Combustion gas from a cylinder

- 1 Switch off the gas analyzer power supply. Ensure that the shut-off valve in the combustion gas supply line is open.
- 2 Set the combustion gas pressure to 1.1 x the normal pressure of the combustion gas, i.e. approx. 1.4 bar.
- 3 Mark cylinder pressure indication on the high pressure gauge.
- 4 Close the valve of the combustion gas cylinder.
- 5 The display on the high pressure gauge – it should not change measurably in 10 minutes.

A measurable change in the display is an indication of a leak in the combustion gas feed path, between the cylinder pressure reducer and the combustion gas inlet valve of the gas analyzer. In this case, the following measures must be taken:

- 1 Check the combustion gas line between the cylinder and gas analyzer with a leak-detecting spray. A leak in this area must be remedied and another leak test must be performed before the gas analyzer is put into operation again.
- 2 If a leak cannot be found in the combustion gas line, the combustion gas inlet valve of the gas analyzer is leaking. **In this case, the gas analyzer may not be returned to service on any account!** The combustion gas inlet valve must be replaced by ABB Service.
- 6 After conclusion of the seal integrity test, set the combustion gas pressure to normal pressure again, i.e. 1.2 bar.

Combustion gas supply from a central unit

- 1 Switch off the gas analyzer power supply. Ensure that the shut-off valve in the combustion gas supply line is open.
- 2 Set the combustion gas pressure at 1.1 x the normal pressure of the combustion gas, i.e. at approx. 1.4 bar.
- 3 Mark pressure indication on the gauge of the pressure reducer.
- 4 Shut off the combustion gas supply.
- 5 Observe the display on the pressure gauge – it should not change measurably in 10 minutes.

A measurable change in the display is an indication of a leak in the combustion gas path between the pressure reducer and the combustion gas inlet valve of the gas analyzer. In this case the following measures are to be taken:

- 1 Check the combustion gas line between the pressure reducer and gas analyzer with a leak detection spray. A leak in this area must be remedied and another leak test must be performed before the gas analyzer is put into operation again.
- 2 If no leak is found that means the gas analyzer combustion gas inlet valve is leaky. **In this case, the gas analyzer may not be returned to service on any account!** The combustion gas inlet valve must be replaced by ABB Service.
- 6 After conclusion of the seal integrity test, set the combustion gas pressure to normal pressure again, i.e. 1.2 bar.

Fidas24: Checking the combustion gas feed path in the gas analyzer for seal integrity

CAUTION

The seal integrity test described in this section requires special training and under some circumstances involves working with the gas analyzer open and powered up. Therefore, it must only be performed by qualified and specially trained personnel.

If these conditions are not provided or the prescribed materials are not available, a seal integrity test must be carried out by ABB Service.

Regular seal integrity check of the combustion gas path in the gas analyzer

The gas analyzer must be in operation (flame on).

- 1** Inspection of combustion gas feed path with positive pressure (combustion gas inlet to combustion gas nozzle):
With a leak detector (measurement principle thermal conductivity) sniff all the connection points.
- 2** Inspection of the combustion gas feed path with negative pressure (in the detector, after the combustion gas nozzle):
Connect zero gas at the sample gas inlet.
Envelope all the connection points one after the other with a small gas cloud containing hydrocarbons (e.g. with coolant or test gas containing hydrocarbons or an acetone-soaked rag).
Observe the measured value display while doing so; if there is a positive change in the measured value, the connection concerned is leaking.

If there is a leak, shut down the gas analyzer

If a leak has been established in the combustion gas feed path inside the gas analyzer, **the gas analyzer must be put out of operation; it may under no circumstances be put into operation again.** The cause of the leak must be determined and remedied by ABB Service.

Fidas24 NMHC: Converter effectiveness testing

Converter service life

The catalyst is a consumable material. Its service life depends on the concentration of the converted hydrocarbons. Catalyst poisons (e.g. SO₂, HCl, H₂S, halogenated hydrocarbons, heavy metals) will shorten the converter service life. Their respective concentration should always be < 20 mg/m³.

Effectiveness test

The effectiveness test verifies the degree of converter activity by measuring the passage of methane (methane loss) and ethane (ethane slip).

The effectiveness test does not need to be performed in normal operation. We recommend performing an effectiveness test once a year.

Test gases for effectiveness testing

Components	Methane in air and ethane in air (separate test gas containers), connection via bypass
Inlet pressure	p _e = 1000 ± 100 hPa
Flow rate	130 to 250 l/h

Calibration prior to effectiveness testing

Before the effectiveness test the zero and span points of the sample components CH₄ and THC must be calibrated.

Perform effectiveness testing

Determine methane loss

- 1 Connect test gas methane.
- 2 Press key **Conv . Test**. Test gas flows through the converter.
- 3 Write down THC (converter) reading.
- 4 Press key **THC**. Test gas flows through the bypass.
- 5 Write down THC (bypass) reading.
- 6 Determine the methane loss according to the following formula:

$$\text{Methane loss / \%} = \frac{(\text{Bypass reading} - \text{Converter reading}) \times 100}{\text{Bypass reading}}$$
 Methane loss is typically approx. 5 to 15 %.
- 7 Connect sample gas and press key **AUTO** to return to measuring mode.

Determine ethane slip

- 1 Connect test gas ethane.
- 2 Press key **Conv . Test**. Test gas flows through the converter.
- 3 Write down THC (converter) reading.
- 4 Press key **THC**. Test gas flows through the bypass.
- 5 Write down THC (bypass) reading.
- 6 Determine the ethane slip according to the following formula:

$$\text{Ethane slip / \%} = \frac{\text{Converter reading} \times 100}{\text{Bypass reading}}$$
 Replace converter if ethane slip exceeds 2 %.
- 7 Connect sample gas and press key **AUTO** to return to measuring mode.

Uras26: Optical alignment

Definition

Optical alignment of the Uras26 analyzer module will minimize the asymmetry on the detector of the incident radiation through the sample and reference sides of the sample cell.

When should optical alignment be performed?

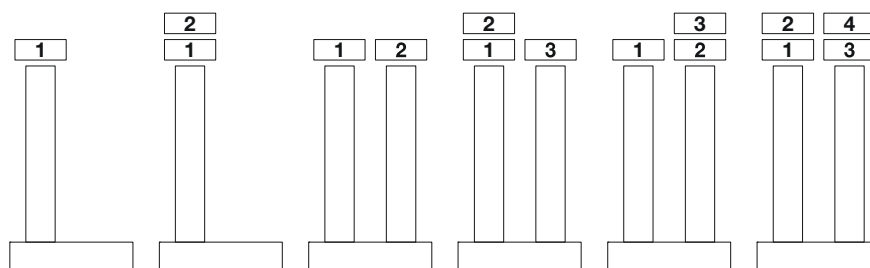
An optical alignment must always be performed

- If the offset drift has fallen below the permissible range (50 % of the physical measuring range).
- After a component (emitter, sample cell, calibration unit/cell, detector) is installed in or removed from a beam path.

How should optical alignment be performed?

Each beam path in the analyzer module must be optically aligned separately. If there are two detectors in a beam path, the optical alignment should be performed in the rearmost detector (as seen from the emitter). During an optical alignment, beam path intensity is varied by means of mechanical apertures and, if necessary, by turning the emitter case. For this, the system housing must be opened.

Detector arrangement



Detector numbers correspond to the numbers assigned to the series of measurement components as shown on the module identification plate.

Test gas

During optical alignment the zero gas supply must be turned on.

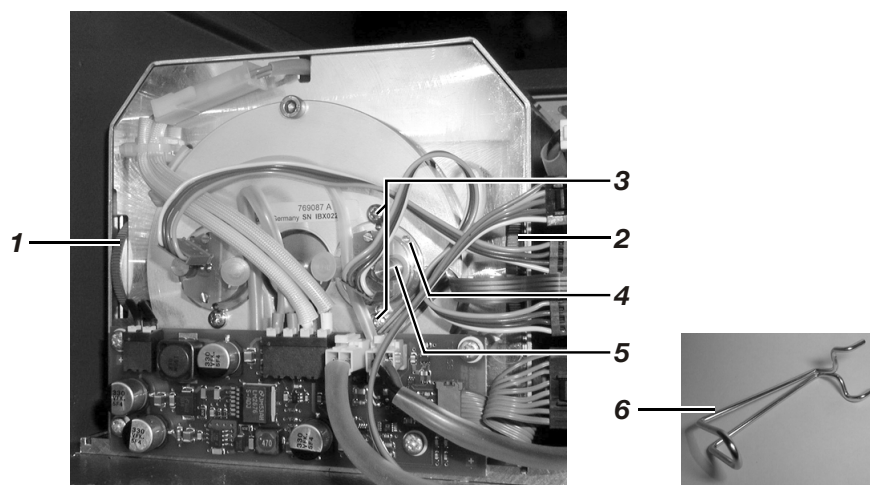
Emitter wrench

An "emitter wrench" is required to rotate the emitter case. It is affixed to the analyzer module.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Optical adjustm.

Uras26 analyzer module emitter



- 1 Beam path 1 aperture adjustment wheel
- 2 Beam path 2 aperture adjustment wheel
- 3 Two emitter case mounting screws (beam path 2 here)
- 4 Openings for emitter wrench insertion
- 5 Emitter case
- 6 Emitter wrench

Optical alignment procedure

CAUTION!

Current-bearing components can be exposed when the covers or parts are removed, even if this can be done without tools. Current can be present at some connection points. All work on a gas analyzer that is open and connected to power should only be performed by trained personnel who are familiar with the risks involved.

- 1** Turn on the zero gas supply.
- 2** Open the 19-inch housing front plate or the wall housing cover.
- 3** Select the menu item `Optical adjustm.`
- 4** Select the `Sample` component to be measured in the rear detector (as seen from the emitter).
- 5** Minimize the (zero gas) value displayed by turning the applicable beam path aperture adjustment wheel **1** and **2**.
If the measurement value is much smaller than 1,000,000, then go to Step 10.
If the measurement value is still greater than 1,000,000, then go to Step 6.
- 6** Loosen the two emitter case mounting screws **3** and insert the emitter wrench **6** in openings **4**.
- 7** Turn the emitter case **5** until the displayed value is minimized. (The minimum can be greater than 1,000,000.)
- 8** Tighten the emitter unit mounting screws **3**.
- 9** Repeat steps 5 to 8 until a minimum value is displayed.
- 10** Close the 19-inch housing front plate or the wall housing cover.
- 11** If the emitter is replaced, perform a phase alignment (see page 290) for all sample components.
If the emitter is not replaced, calibrate the zero and span points for all sample components in the beam path.

Uras26: Phase alignment

Definition

Sample / reference signal phasing is optimized in the Uras26 by performing a phase alignment.

When should phase alignment be performed?

A phase alignment must always be performed after optical alignment (see page 287) when the emitter is replaced.

How should phase alignment be performed?

A separate phase alignment must be performed for each detector (= sample component) in an analyzer module.

The phase alignment is performed electronically and there is no need to open the system housing.

Test gases

During the phase alignment zero and span gas supply should be turned on successively for each sample component.

If the analyzer module is equipped with calibration units the calibration cells are automatically inserted in the beam path for span alignment. Meanwhile zero gas must remain turned on.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Phase adjustm

Phase alignment procedure

- 1 Select the Phase adjustm. menu item.
- 2 Select the Sample component.
- 3 Turn on the zero gas supply.
- 4 Wait until the measurement value reading stabilizes and activate the alignment procedure.
- 5 If the analyzer module is equipped with calibration cells, then let the zero gas be turned on.
If the analyzer module has no calibration cells, turn on the span gas supply.
- 6 Wait until the measurement value reading stabilizes and activate the alignment procedure.
- 7 Repeat steps 2 to 6 for all sample components.
- 8 Calibrate the zero and end points for all sample components in the analyzer module (basic calibration).

Limas11 IR, Limas21 UV, Limas21 HW, Uras26: Measurement of calibration cells

Definition

The measurement of a calibration cell in the Limas11 IR, Limas21 UV, Limas21 HW and Uras26 analyzer modules means:

Determining what calibration cell "deflection" is equivalent to the calibration reading with test gas. The "deflection" is stored as the "set point" of the calibration cell.

When should calibration cells be measured?

We recommend measuring the calibration cells once a year.

We recommend measuring the calibration cells

- after end-point calibration of a sample component with test gas or
- after any change in measurement range limits or
- after a relinearization (see page 292).

Before measuring the calibration cells

Prior to measuring the calibration cells, the zero and end points of the applicable sample components must be calibrated with test gases.

Test gas

During calibration cell measurement the zero gas supply must be turned on.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Measure cal.cell

Limas11 IR, Limas21 UV, Limas21 HW, Uras26: Relinearization

When should relinearization be performed?

Sample component relinearization should be performed

- If the linearity deviation exceeds the permissible value von 1 % of the span.
- If the start of a suppressed measurement range is to be calibrated.
- After a component (lamp/emitter, sample cell, calibration unit/cell, detector) is installed in or removed from a beam path.

We recommend performing the relinearization of a sample component after the measurement range limits have been changed.

NOTE

Relinearization is performed separately for each sample component.

Test gases

Depending on the number and type of measurement ranges, test gases with varying concentrations are required for relinearization:

Number and type of meas. ranges	Test gas concentration
1 measurement range	Approx. 40 to 60 % measurement range end value ("center point gas")
2 measurement ranges	End value of the smaller measurement range
2 measurement ranges, 1 of which is suppressed.	Start value of the suppressed measurement range

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Relinearization

Relinearization procedure

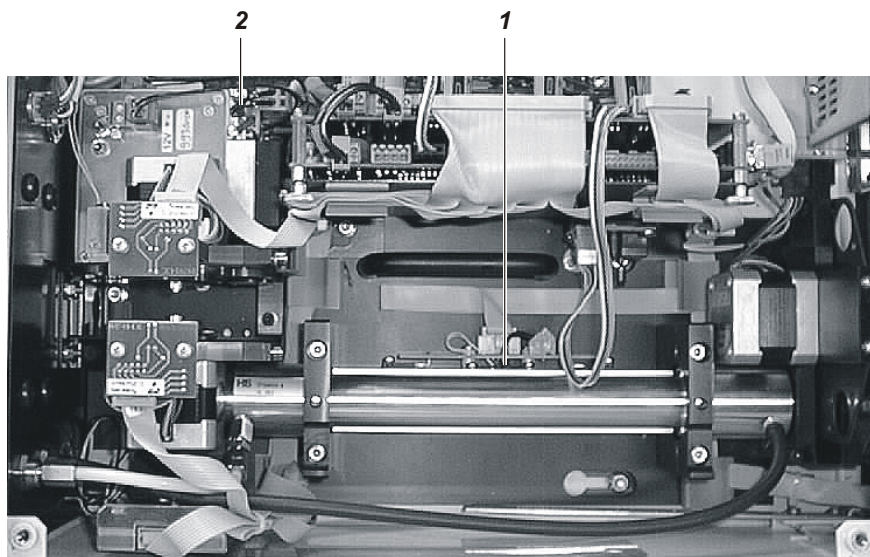
- 1 Perform (see page 274) the basic calibration for the zero and span of the sample component to be relinearized.
- 2 Select the **Relinearization** menu item.
- 3 Select the **Sample component**.
- 4 Turn on the test gas supply.
- 5 Enter the test gas concentration set point value.
- 6 Wait until the measurement value reading stabilizes and activate the alignment procedure.
- 7 Repeat steps 3 to 6 for all sample components.

Limas11 IR, Limas21 UV, Limas21 HW: Thermal link replacement

When should the thermal link be replaced?

A defective thermal link will usually be indicated by an insufficient sample cell temperature (T-Re. K) or lamp temperature (T-Re. L) error message. In this case check the thermal link and replace as necessary.

Thermal link replacement



CAUTION!

The sample cell and the lamp are hot (approx. 55 °C or approx. 60 °C)! Allow the modules to cool down after switching off the power supply (approx. 30 minutes).

- 1 Switch off the gas analyzer power supply!
- 2 Open the wall housing door or the 19-inch housing cover.
- 3 Disconnect the thermal link from the sample cell **1** and/or the lamp **2**.
- 4 Release the spring clips and/or retainer and pull the thermal link from the opening.
- 5 Check the continuity of the thermal link; if necessary, insert a new thermal link (part number 0745836) in the opening and secure it with the spring clips and/or retainer.
- 6 Connect the thermal link.
- 7 Close the system housing so that it is tight.
Light penetration during operation leads to erroneous measurement values and overranging ("Intensity" status message).
- 8 Turn on the gas analyzer power supply.

Limas11 IR, Limas21 UV: Aluminum sample cell cleaning

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see section "Limas11 IR, Limas21 UV, Limas21 HW: Troubleshooting" (see page 339)).

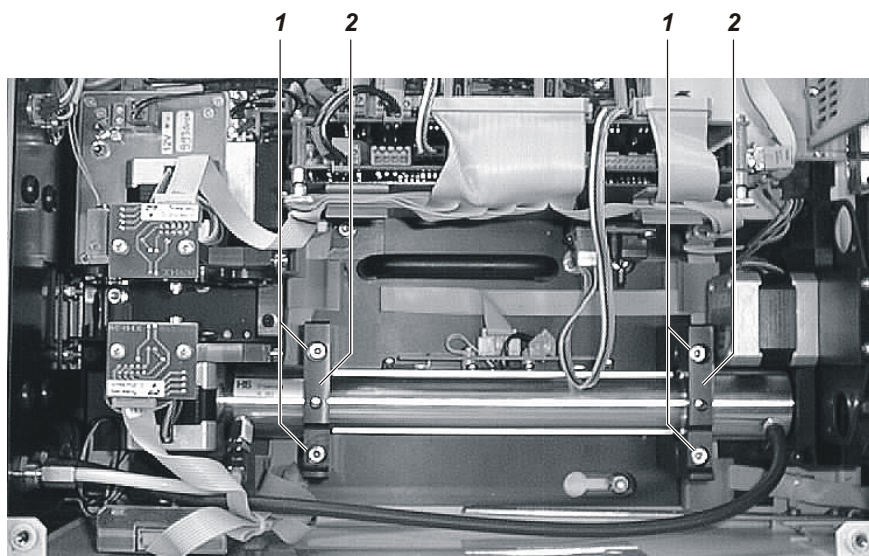
Status messages

When beam intensity becomes too low the appropriate status messages (see page 322) will be displayed.

Requisite material

- For cleaning: Neutral detergent, deionized water, ethanol
- For drying: Oil- and dust-free (instrument) air or nitrogen
- Spray bottle
- 2 plugs for sealing the sample cell
- 2 Pieces of FPM/FKM tubing or PTFE pipe

Aluminum sample cell cleaning



CAUTION

The sample cell is hot (approx. 55 °C)! Allow the sample cell to cool after the power supply has been turned off (approx. 30 minutes).

Preparation for sample cell removal:

- 1 Disconnect the supply of sample gas to the analyzer module! Switch off the gas analyzer power supply!
- 2 Open the wall housing door or the 19-inch housing cover.

Sample cell removal:

- 3 Loosen the sample gas tubing/pipe from the sample cell ports and housing wall and pull them from the housing.
When removing the sample gas pipes make sure no contaminants contained in the pipes fall into the housing.
The sample gas tubing/pipes removed should not be reused since they are contaminated; follow the appropriate rules for disposal.
- 4 Loosen 4 screws **1** (socket-head, wrench opening 3 mm) and remove 2 mounting brackets **2**.
- 5 Remove the sample cell from its housing.

Sample cell cleaning:

- 6 Clean the sample cell with a warm detergent/water mixture.
Do not use other cleaners as they can damage the sample cell.
- 7 Thoroughly rinse the sample cell with deionized water and then with ethanol.
- 8 Dry the sample cell with oil- and dust-free air (30 to 100 l/h.).
- 9 Check that the contamination has been removed.
Clean the entire sample gas line system in the same way!

Sample cell installation:

- 10 Place the sample cell in its housing. The index pin should be on the side of the sample cell that is toward the beam splitter. Turn the sample cell in its housing until the index pin engages in the hole in the housing.
- 11 Install the 2 mounting brackets **2** and secure them with the 4 screws **1**.
- 12 Install the new sample gas tubing or pipes on the sample cell ports and on the module's rear wall.
- 13 Check the integrity of the analyzer module gas paths (see page 268).

Return the gas analyzer to service:

- 14** Close the system housing so that it is tight.
Light penetration during operation leads to erroneous measurement values and overranging ("Intensity" status message).
- 15** Turn on the gas analyzer power supply.
- 16** Wait for the warm-up phase to end. Turn on the sample gas supply.
- 17** Check linearity.

Aluminum sample cell with center connection

An aluminum sample cell with center connection is built-in in the Limas21 UV analyzer module with Class 2 NO measurement ranges. In this version, the sample gas inlet is in the center and the sample gas outlets are at the ends of the sample cell. This has to be observed when re-installing the sample cell after cleaning.

Limas11 IR, Limas21 UV, Limas21 HW: Quartz sample cell cleaning

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see section "Limas11 IR, Limas21 UV, Limas21 HW: Troubleshooting" (see page 339)).

Status messages

When beam intensity becomes too low the appropriate status messages (see page 322) will be displayed.

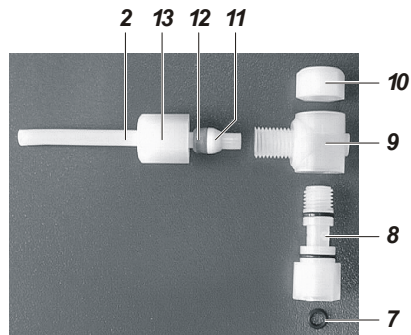
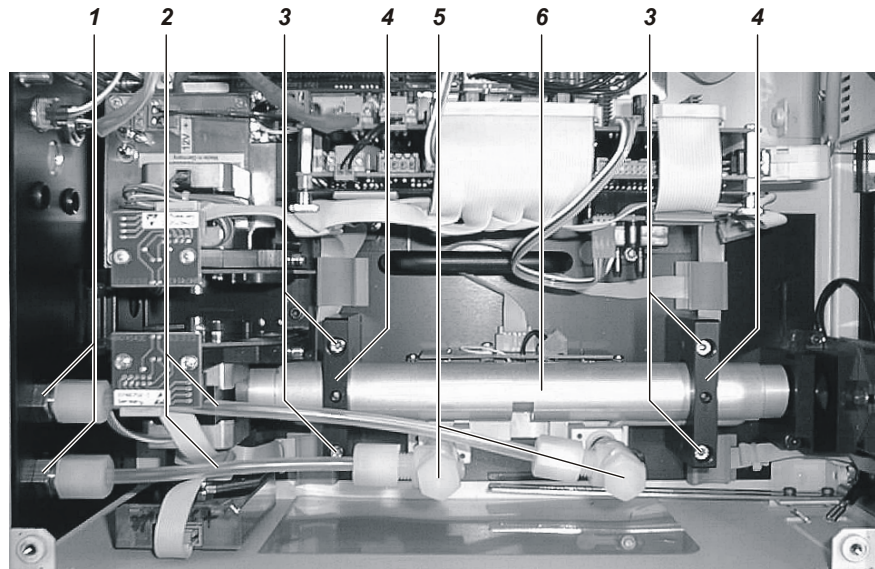
Requisite material

- For cleaning: Neutral detergent, deionized water, ethanol
- For drying: Oil- and dust-free (instrument) air or nitrogen
- Spray bottle
- 2 plugs for sealing the sample cell
- Spare parts kit (Part Number 0768823)

ATTENTION

The quartz sample cell should be handled with extreme care! Especially the connection ports can easily break when the sample cell is handled improperly.

Quartz sample cell cleaning



CAUTION

The sample cell is hot (approx. 55 °C)! Allow the sample cell to cool after the power supply has been turned off (approx. 30 minutes).

Preparation for sample cell removal:

- 1 Turn off the sample gas supply to the analyzer module. Switch off the gas analyzer power supply!
- 2 Open the wall housing door or the 19-inch housing cover.

Sample cell removal:

- 3 Loosen the sample gas pipes **2** from the connections on the sample cell **5** and from the housing rear wall **1** and pull them from the housing. When removing the sample gas pipes make sure no contaminants contained in the pipes fall into the housing. The sample gas pipes removed should not be reused since they are contaminated; follow the appropriate rules for disposal.
- 4 Loosen screws **3** (socket-head, wrench opening 3 mm) and remove 2 mounting brackets **4**
- 5 Remove the sample cell **6** from its housing.
- 6 Unscrew the elbow/pivot fittings **5** from the sample cell.

Sample cell cleaning:

- 7** Clean the sample cell with a warm detergent/water mixture. Acids, alkalis or solvents can be used as cleansers in case of severe contamination. Be sure to follow the appropriate instructions for use and disposal when using acids, alkalis or solvents. Do not use hydrofluoric acid (HF) as it can destroy the sample cell.
- 8** Rinse the cell very thoroughly with deionized water until the detergent is completely removed. Finally, rinse the cell with ethanol until all water is removed.
- 9** Dry the sample cell with oil- and dust-free air (30 to 100 l/h.).
- 10** Check that the contamination has been removed.
Also clean the elbow fittings and the entire sample gas line system.

Sample cell installation:

- 11** Place new FFKM75 O-rings **7** on the sample cell connection ports.
- 12** Place the internal parts **8** of the elbow/pivot fittings on the ports and tighten them by hand. Place the elbows **9** on the internal parts with their ports facing toward the housing back wall and secure them by hand-tightening the nuts **10**.
The threaded connections must never be tightened any more than hand-tight. Otherwise the connections may not be securely sealed.
- 13** Place the sample cell **6** in its holder with the gas ports pointing to the left housing wall (as seen from the front/above).
- 14** Install 2 mounting brackets **4** – making sure that the notches for the sample cell gas lines also face the left wall – and secure with 4 screws **3**.

Connect the sample gas lines to the sample cell:

- 15** Push the sample gas tubes **2** through fittings **1** on the housing back wall. Make sure the sample gas lines are smooth and straight on both ends and that there are no kinks.
- 16** Slide nuts **13**, cutting rings **12** and sealing rings **11** on the sample gas pipes **2**.
- 17** Slide the sample gas tubes **2** up to the stop in the elbow/pivot fittings **5** on the sample cell and hand-tighten nuts **13**. Hand-tighten the nuts on fittings **1** on the housing back wall.
The threaded connections must never be tightened any more than hand-tight. Otherwise the connections may not be securely sealed.
- 18** Check the integrity of the analyzer module gas paths (see page 268). Pay attention to higher seal integrity requirements!

Restarting the gas analyzer:

- 19** Close the system housing so that it is tight.
Light penetration during operation leads to erroneous measurement values and overranging ("Intensity" status message).
- 20** Turn on the gas analyzer power supply.
- 21** Wait for the warm-up phase to end. Turn on the sample gas supply.
- 22** Check linearity.

Limas11 IR, Limas21 UV: Safety cell cleaning

Description of the safety cell

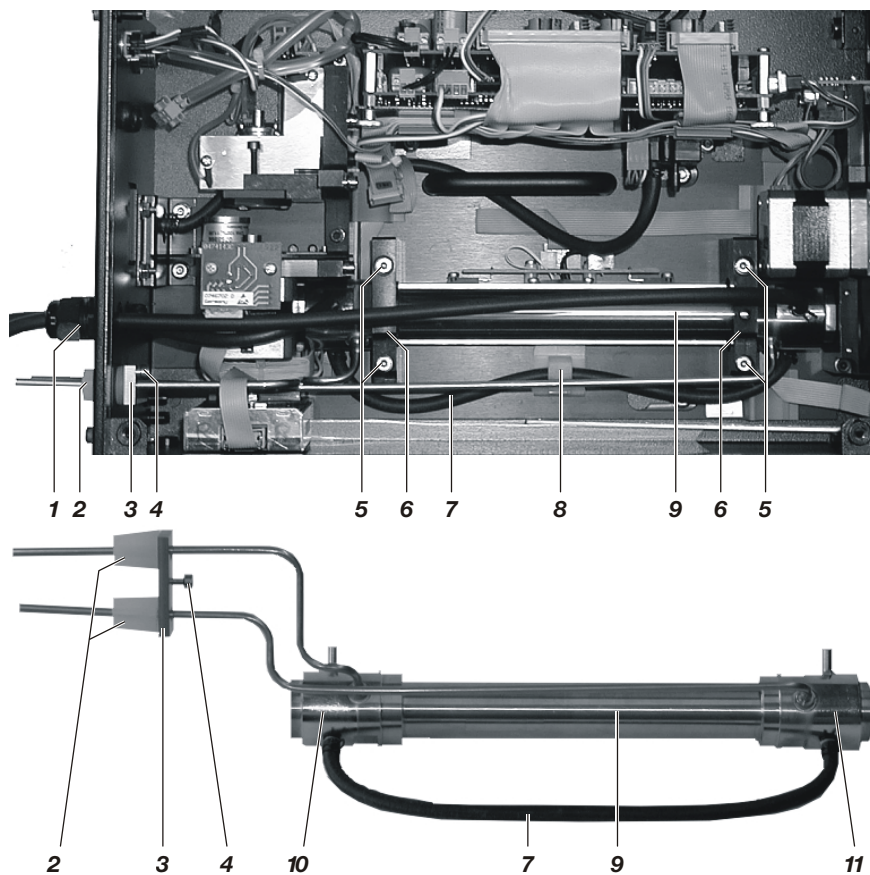
The safety cell comprises three components:

- Sample cell of stainless steel 1.4571,
- Beam guide tube 1 of brass (on the side pointing to the beam splitter),
- Beam guide tube 2 of brass (on the side pointing to the measuring detector).

The beam guide tubes are screwed into the sample cell and press the cell window against the clamped 22.1x1.6-FFKM70 O-ring seals. In this manner, the sample gas side of the cell is sealed so that it is gas-tight. One 28x2-FKM80 O-ring seal is located on the periphery of each of the beam guide tubes. The purge gas chamber is sealed so that it is gas-tight to the outside by means of this seal.

The tightness of the sample cell has been tested in the factory for a leakage rate of $< 1 \times 10^{-6}$ mbar l/s.

Safety cell in the analyzer module



- 1** Couplings of the purge gas lines
- 2** Plug
- 3** Retaining board
- 4** Screw
- 5** Screws
- 6** Mounting bracket
- 7** Purge gas hose
- 8** Fixing device
- 9** Sample cell
- 10** Beam guide
- 11** Beam guide

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see section "Limas11 IR, Limas21 UV, Limas21 HW: Troubleshooting" (see page 339)).

Status messages

When beam intensity becomes too low the appropriate status messages (see page 322) will be displayed.

Requisite material

Qty.	Description
For sample cell removal:	
1	Hexagonal wrench 4 mm
1	Hexagonal wrench 3 mm
1	Crosshead screw driver 4,5 mm
1	Small flat nose pliers
2	Plugs for sealing the sample gas tubing
For disassembly and assembly of the sample cell:	
1	Plug for sealing the sample cell
1	Open-end wrench 25 mm for sample cell with nominal length 216 mm
1	Open-end wrench 30 mm for sample cell with nominal length 216 mm
2	Open-end wrenches 30 mm for sample cells with other nominal lengths
1	Vise
1	"Vacuum pen"
1	Small pair of tweezers
	Soft paper towels
For cleaning the sample cell and the sample gas tubing:	
1	Circular brush with plastic bristles, diameter approx. 20 mm
2	Spray bottles
	Neutral detergent, deionized water, ethanol
	Oil- and dust-free (instrument) air or nitrogen
For the seal integrity test (positive pressure method):	
1	Pressure gauge, measuring range $p_e = 0$ to 400 hPa
1	T-piece with shut-off valve
1	Hose, inside diameter 4 mm, length approx. 0.5 m
2	Hose clamps
	Oil- and dust-free (instrument) air or nitrogen

Replacement parts required

Qty.	Description	Part No.
2	O-ring seals 22.1x1.6 FFKM70	650 505
2	O-ring seals 28x2 FKM80	650 519
2	Windows of calcium fluoride 25.2x4	598 216
2	Vent plugs for sample gas tubing A 5.2 LDPE	456 894
2	Plugs for sample gas tubing	402 541

ATTENTION

It is imperative that the following procedure is carried out step by step and with the greatest of care. Otherwise there is a danger that the safety cell is no longer absolutely tight after cleaning and therefore no longer performs its function!

The following is to be noted in particular:

The cell windows must not be damaged!

The old O-ring seals must not be used again! After cleaning, new O-ring seals must be used!

After cleaning, the tightness of the sample cell must be tested for a leakage rate of $< 1 \times 10^{-4}$ mbar l/s.

Note: If necessary, the tightness of the sample cell can be tested for a lower leakage rate by means of a Helium leakage test.

ATTENTION

Toxic, caustic or corrosive fluid may be contained in the sample cell! This fluid can escape when the sample cell is opened.

In consequence of this, suitable measures for the collection and disposal of the fluid are to be taken before removal of the sample cell!

Cleaning the safety cell

ATTENTION

The sample cell and the lamp or the radiation source are hot (approx. 60 °C)! Allow the modules to cool down after switching off the power supply (approx. 30 minutes).

Preparation for sample cell removal:

- 1 Turn off the sample gas and purge gas supply to the analyzer.
- 2 Purge the sample gas feed path with dry nitrogen (flow approx. 60 l/h, duration approx. 30 minutes).
- 3 Seal the sample gas inlet and outlet of the sample cell (tubing) with one plug each, so that no fluid can escape during the removal of the sample cell.
- 4 Switch off the gas analyzer power supply!
- 5 Open the wall housing door or the 19-inch housing cover.

Sample cell removal:

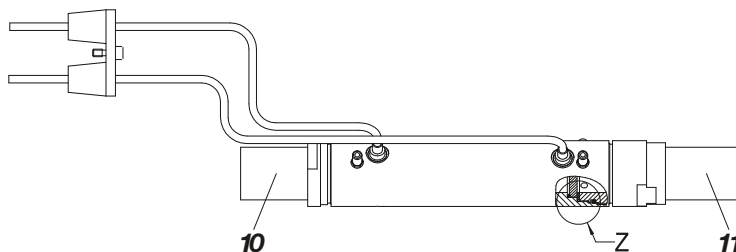
- 6 Undo the 2 couplings **1** of the purge gas lines on the rear of the analyzer module and pull the purge gas hoses into the interior of the device. Remove the purge gas hose **7** from the fixing device **8**.
- 7 If applicable, remove the purge gas hose from the inlet of the flow sensor (option).
- 8 To open the leadthroughs of the sample gas tubing, undo the screw **4** (socket-head, wrench opening 3 mm) for securing the retaining board **3**, remove the 2 plugs **2** from the leadthroughs and push towards the interior of the device on the sample gas tubing.
- 9 Loosen the 4 screws **5** (socket-head, wrench opening 3 mm) and remove mounting brackets **6**.
- 10 Lift the sample cell **9** on the side pointing to the measuring detector and pull out obliquely upwards from the housing towards the measuring detector.
- 11 Remove the purge gas hoses from the connections of the sample cell.

Disassembly of the sample cell:

- 12** Hold the sample cell with 2 open-end wrenches (clamp 1 open-end wrench in the vise, in order to fix the sample cell in position) and unscrew the two beam guide tubes **10** and **11**.
Take care that the cell windows do not fall out and that they are not damaged!
- 13** If the cell windows are stuck to the O-ring seals, they must be removed by flushing the sample cell with compressed air. Wear safety glasses when working with compressed air! Point the opening of the sample cell away from the body!
 - 1** Insert a soft paper towel into the aperture of the sample cell to collect the cell window.
 - 2** Seal the opening of a sample gas tube with a plug and pressurize the other sample gas tube with compressed air ($p_e \approx 100 \text{ kPa} = 1 \text{ bar}$). The cell window is thereby removed from the seal. Collect the cell window in the paper towel.
Fluid can escape from the sample cell! Follow the relevant safety regulations!
 - 3** Seal the opening of the sample cell with a plug and pressurize the sample cell with compressed air once again. The other cell window is thereby removed from the seal. Collect the cell window in the paper towel.
- 14** Remove the 2 O-ring seals 22.1x1.6 FFKM70 dispose with a pair of tweezers Also remove and dispose of the 2 O-ring seals 28x2 FKM80.
The O-ring seals may not be used again! Always replace them with new seals!

Cleaning the sample cell and sample gas tubing:

- 15** Clean the sample cell with a warm detergent/water mixture. If necessary, use a circular brush with plastic bristles.
- 16** Clean the sample gas tubing in the same way. To do this, use a spray bottle to rinse the sample gas tubing with the detergent/water mixture. In the case of heavier contamination, the following can also be used as a cleaning agent:
 - organic solvents or
 - in turn, diluted soda lye, water, diluted nitric acid for neutralization, water.Be sure to follow the appropriate instructions for use and disposal when using acids, alkalis or solvents.
- 17** Check that the contamination has been removed.
- 18** Rinse the sample cell and tubing very thoroughly with deionized water until the detergent is completely removed. Finally, rinse the cell with ethanol until all water is removed.
- 19** Dry the sample cell and sample gas tubing with oil- and dust-free air (30 to 100 l/h).
Clean the entire sample gas line system in the same way!

Sample cell installation:

Carry out steps 20 to 22 on both sides of the sample cell in turn.

- 20** Insert a new O-ring seal 22.1x1.6-FFKM70 **12** in the sample cell.



Z

The seat of the O-ring seal may not be damaged and must be absolutely free of oil and dust.

- 21** Check that the sample cell is not damaged!
Insert the cell window into the sample cell by means of the "vacuum pen" pipette.
When doing so, take care that the cell window does not fall out and that it is not damaged!

- 22** Insert a new O-ring seal 28x2-FFKM80 **13** into the groove of beam guide tube.



Z

Screw the beam guide tube fingertight into the sample cell.
Screw in the shorter beam guide tube **10** into the side of the sample cell, on which the apertures of the sample gas tubing are located.

- 23** Hold the sample cell with 2 open-end wrenches (clamp one open-end wrench in the vise, in order to fix the sample cell in position) and screw in the beam guide tubes **10** and **11** as far as they will go.

Checking the sample cell for tightness:

For the assembly of the sample cell as prescribed, a leakage rate of $< 1 \times 10^{-4}$ mbar l/s must be safely reached. This is tested as follows:

- 24** Seal the aperture of one sample gas tube so that it is gas-tight.
25 Connect the T-piece with shut-off valve to the aperture of the other sample gas tube with the hose.
26 Connect the free end of the T-piece to the pressure gauge.
27 Blow air through the shut-off valve until the sample cell is under a positive pressure of $p_e \approx 400$ hPa (= 400 mbar). Close the shut-off valve.
28 The pressure may not change significantly in 15 minutes at a constant temperature. A sharp drop in pressure is an indication of a leak inside the sample cell.

Sample cell installation:

- 29 Push the purge gas hoses onto the connections of the sample cell and secure by means of the clamping springs.
- 30 Check that the plugs 2 are seated on the sample gas tubing.
- 31 Insert the sample cell into the housing obliquely from above in such a way that the sample gas tubes project through the leadthroughs to the outside.
- 32 Slowly lower the sample cell initially onto the side pointing to the beam splitter and then onto the side pointing to the measuring detector and insert in the fixing device.
- 33 Clamp the purge gas hose 7 in the fixing device 8.
- 34 Attach the 2 mounting brackets 6 and fasten by means of the 4 screws 5 (socket-head, wrench opening 3 mm).
- 35 Press the 2 plugs 2 into the leadthroughs. Fix the retaining board 3 in position with the screw 4.
- 36 If applicable, push the purge gas line onto the input of the flow sensor (option) and fasten by means of the spring.
- 37 Lay the purge gas lines in the housing in such a way that no movable parts, e.g. the chopper wheel, are obstructed, feed through the 2 couplings 1 and fix in position.

Restarting the gas analyzer:

- 38 Close the system housing so that it is tight.
Light penetration during operation leads to erroneous measurement values and overranging ("Intensity" status message).
- 39 Turn on the gas analyzer power supply.
- 40 Purge the sample gas feed path. With corrosive sample gases, purge the entire sample gas line system with dry nitrogen.
- 41 Wait for the warm-up phase to end.
- 42 Check the zero point and end point and calibrate if necessary.
- 43 Start the sample gas and purge gas supply.

Limas21 UV, Limas21 HW: Lamp (EDL) replacement

NOTE

Any maintenance and repair of optical parts requires wearing clean cotton gloves!

CAUTION

When working on the gas analyzer while energized and with the case open, personal protective equipment to protect the eyes and skin from UV radiation must be worn (goggles and gloves). Operating the EDL outside the analyzer system is not allowed. The reason is the potentially dangerous emission of UV radiation in the wavelength range 190 to 400 nm. The safety glasses to be used must be suitable for UV protection according to EN 166 (yellow lenses are recommended).

When should the lamp be replaced?

The Electrodeless Discharge Lamp (EDL) has a limited lifetime. Lamp replacement operations shall be accounted for maintaining analyzer functionality over the time.

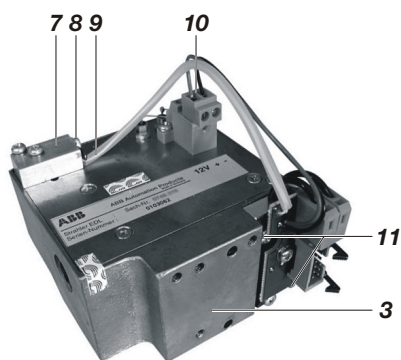
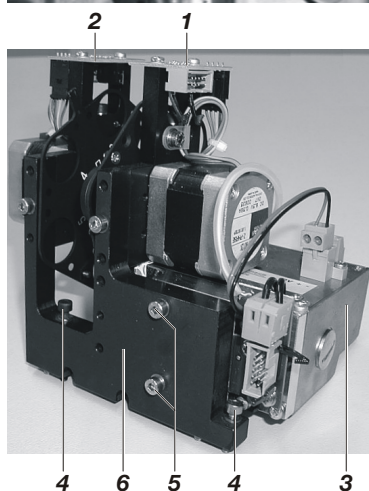
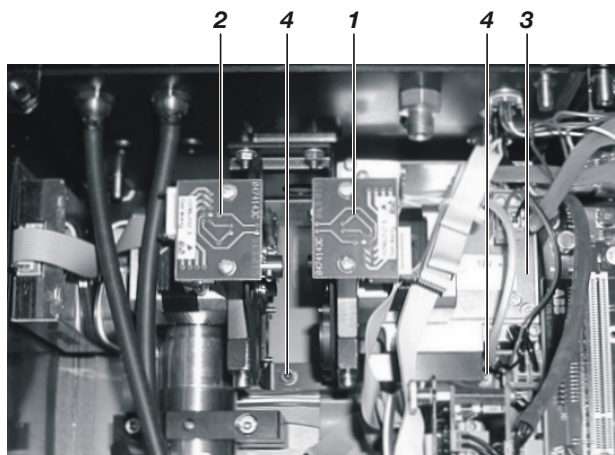
The analyzer notifies the user about reduced source intensity through a dedicated analyzer status message (see page 322) (No. 358). Upon notification of such message, an investigation of root cause has to be planned and in case of lamp intensity being significantly reduced, a preventive lamp change shall be planned within the shortest turnaround possible.

When the source intensity reaches a value at which the short-term stability of the smallest measurement range becomes too low, the analyzer notifies a lamp failure message (No. 359). In this case the lamp must be replaced immediately.

Determining lamp service life

Lamp service hours are displayed in the Maintenance/Test → Analyzer spec. adjustm. → Amplification optimization menu.

Lamp (EDL) replacement



- 1** Light barrier circuit board 1
- 2** Light barrier circuit board 2
- 3** Lamp (EDL)
- 4** Fastening screws of the support
- 5** Fastening screws of the lamp
- 6** Support
- 7** Temperature sensor block
- 8** Fastening screw of the temperature sensor
- 9** Temperature sensor
- 10** 12-V-supply connector
- 11** Fastening screws of the heater block

CAUTION

The lamp is hot (approx. 60 °C)! Allow the lamp to cool down after the power supply has been disconnected (approx. 30 minutes).

Remove the old lamp:

- 1** Switch off the gas analyzer power supply!
- 2** Open the wall housing door or the 19-inch housing cover.
- 3** Remove the connector cables to the light barrier boards **1** and **2** above the filter.
- 4** Remove the cables from the lamp **3**.
- 5** Loosen 2 fastening screws **4** of the support using a 3-mm Allen wrench.
- 6** Remove the support with both filter wheels, step motors and lamp from the housing.
- 7** Loosen 2 mounting screws **5** of the lamp **3** using a number 3 Allen wrench.
- 8** Remove complete lamp **3** from the support **6**.
- 9** Loosen the 12-V-supply connector **10**.
- 10** Remove the mounting screw **8** with washer and mounting bracket for the temperature sensor **9**.
These parts are needed to mount the temperature sensor to the new lamp.
- 11** Remove the temperature sensor **9** from the cavity of the temperature sensor block **7**.
- 12** Loosen the 2 mounting screws **11** of the heater block and remove the complete heater block from the lamp **3**.

Install the new lamp:

- 13** Before installing the new lamp, record the serial number shown on the identification plate. It will be needed during amplification optimization.
- 14** Perform steps 3 to 12 in reverse order.

Restarting the gas analyzer:

- 15** Close the system housing so that it is tight.
Light penetration during operation leads to erroneous measurement values and overranging ("Intensity" status message).
- 16** Turn on the gas analyzer power supply and wait for the warm-up phase to end.-up.
- 17** Perform amplification optimization (see page 310).
- 18** Recommendation: Check sensitivity and linearity.

Limas11 IR, Limas21 UV, Limas21 HW: Amplification optimization

Definition

The amplification optimization procedure automatically seeks and identifies the optimum measurement range for the sample and reference receiver analog/digital converter.

When should amplification optimization be performed?

Amplification optimization should be performed,

- after the lamp (EDL) has been replaced,
- after a module (sample cell, calibration cell, interference filter, receiver) has been removed or inserted in the beam path,
- if the status message No. 301 "Measurement value exceeds the analog/digital converter value range" is present (with system housing closed light-proof).

NOTE

Amplification optimization alone cannot correct the causes for the status messages No. 358 and 359 "Lamp intensity above or below (middle of) permissible range".

How should amplification optimization be performed?

- When the lamp has been replaced:
 - Write down the serial number of the new lamp prior to installation.
 - Perform amplification optimization for all sample components, thereby entering the serial number of the new lamp.
- When a module has been removed or inserted in the beam path:
 - Write down the serial number of the installed lamp.
 - Perform amplification optimization for all sample components, thereby entering an arbitrary lamp number.
 - Perform amplification optimization for all sample components, thereby entering the serial number of the installed lamp.
- When the status message No. 301 is present:
 - Perform amplification optimization for each sample component for which the status message is present.

Test gas

The zero gas supply should be turned on during amplification optimization.

Menu path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Amplification optimization

Functions of the softkeys

New Lamp	Optimizes all receiver signals for all sample components; this overwrites any stored initial intensities with a new initial value.
Optimization	Optimizes receiver signals for a specific sample component; this does not overwrite the stored initial intensities.
Optimize All	Optimizes receiver signals for all sample components; this does not overwrite the stored initial intensities.

Perform amplification optimization

- 1 Turn on the zero gas supply.
If a solenoid valve is used to switch to zero gas, the supply will be activated automatically.
- 2 Select the **Amplification optimization** menu item.
- 3 Select the first sample component for which status message No. 301 is present.
- 4 Press the **New Lamp** or **Optimize** or **Optimize All** softkey.
After pressing **New Lamp** a window will appear for entering the serial number of the new lamp. After this the amplification optimization procedure will run automatically for all sample components and cannot be interrupted.
- 5 Wait until the measurement value reading stabilizes and activate the alignment procedure with **ENTER**.
- 6 Confirm the amplification optimization by pressing **ENTER** (the zero point will be automatically aligned) or reject the result by pressing **Back** or **Meas**.
- 7 Repeat steps 3 to 6 for all sample components for which status message No. 301 is present.

ZO23: Function test

Description

The function test is used to carry out a rapid and regular check of the response time of the sample cell. The function test can be carried out without any test gases by feeding the sample gas with constant concentration. It has a very high correlation with the check using gas. In case of doubt, the latter is decisive, however. The function test facilitates the preventive maintenance of the gas analyzer, since a requisite exchange of the sample cell becomes plannable through the change in the response time. The values determined in the function test are stored in the log. As a result, the progression of the response time of the measuring cell can always be traced back.

Procedure

In the function test, the build-up of an oxygen potential in the sample cell is simulated through the connection of an electrical test current. The change in the oxygen potential correlates with the response time of the sample cell. A small change in the oxygen potential points to a relatively fast response time of the measuring cell. In this case, the result of the function test is "Test Passed". If the value deviates from the value before the completion of the test by more than 10 % of the value before the beginning of the test, the result is rejected, since it is assumed that the change in the sample gas was too high during the test.

Test factor

The test result can be tailored to the required response time. In this connection, the test factor can be set by the user within the range 1 to 200 %. A test factor of 100 % is set ex works.

Test factor 1 to 99 %	Test requirements lower	$T_{90} > 60 \text{ s}$
Test factor 100 to 200 %	Test requirements higher	$T_{90} \leq 60 \text{ to } 20 \text{ s}$

If the test criteria are not met, the test factor must either be changed or the sample cell checked by means of test gases.

Check of the measuring cell using test gases

Two test gases (see page 67) with different concentrations within the measuring range are required to check the T_{95} time, e.g. a test gas with 2 ppm O_2 and one with 8 ppm O_2 . The T_{95} time is determined through alternate application of the test gases. Beforehand, purge the test gas valves and the gas supply line with oxygen-free gas (e.g. with nitrogen from a loop feeder) or with sample gas (flow rate 5 to 10 l/h, duration approx. 2 h).

Carrying out the function test

The function test takes approx. 15 minutes. It is therefore recommended that it is carried out at a time when the process control is not adversely affected thereby.

The function test is executed in 2 phases:

- 1 Test current on: After start-up, the test current is applied to the measuring cell for approx. 400 s.
- 2 Test current off: The test current is then switched off, and the function test is ended after a further 400 s.

Menu path

**MENU → Maintenance/Test → Analyzer spec. adjustm. →
Z023 function test**

Pneumatic module: Disposable filter replacement

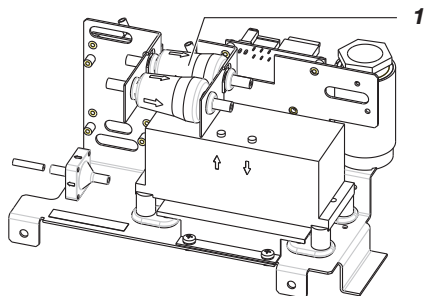
When should the disposable filter be replaced?

The gas module disposable filter should be changed if it is stained by contaminants.

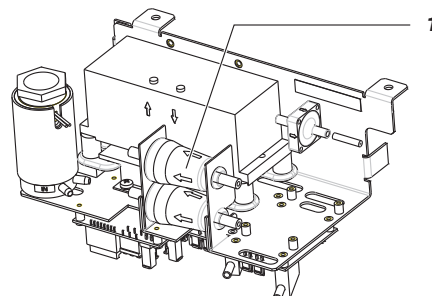
We recommend changing the disposable filter (catalog number 23044-5-8018418) every six months.

Location of disposable filter in pneumatic module

19-inch housing



Wall-mount housing



1 Disposable filter

⇒ Flow direction

Disposable filter replacement

- 1** Disconnect the supply of sample gas to the analyzer module! Switch off the gas analyzer power supply!
- 2** Open the wall housing door or the 19-inch housing front plate.
- 3** Remove the disposable filter **1** from the bracket in the pneumatics module.
- 4** Remove the hose clamps from both sides of the disposable filter and disconnect the hoses.
Properly dispose of the contaminated filter.
- 5** Attach the hoses to the new disposable filter and fasten them with the hose clamps.
Pay attention to the flow direction. The flow direction ⇒ is marked on the disposable filter housing.
- 6** Place the disposable filter in the support in the pneumatic module.
- 7** Check the integrity of the analyzer module gas paths (see page 268).
- 8** Close the system housing.
- 9** Turn on the gas analyzer power supply.
- 10** Wait for the warm-up phase to end. Turn on the sample gas supply.

Status messages, troubleshooting

ATTENTION

The tasks described in this chapter require special training and under some circumstances involve working with the gas analyzer open and powered up. Therefore, they should only be performed by qualified and specially trained personnel.

Dynamic QR code

Application

Dynamic QR Code is a unique feature to display dynamically generated QR codes on the gas analyzer screen.

The QR code contains static information for device identification as well as dynamically generated information on system configuration and gas analyzer health status .

Static data for device identification are among other data:

- Production number
- Production date
- Software version
- Serial numbers of built-in analyzer modules and components

Dynamic data for error diagnosis are among other data:

- Status messages
- Measured values
- Temperature, pressure and flow values
- Drift values
- Analyzer-specific values

In combination with mobile devices (smartphone, tablet, etc.) Dynamic QR Code represents an innovative way of customer's communication which allows, for instance, improved case-specific support by ABB resulting in an increased availability of analyzer assets.

Dynamic QR Code is compatible with the ABB application "my Installed Base" as well as with standard QR code scanner applications.

Handling

The QR code is selected in the gas analyzer's diagnosis menu and displayed on the gas analyzer's screen.

There is a direct link from the status messages overview to the diagnosis menu. In addition, the QR code can be selected in Remote HMI and scanned from the computer screen.

The displayed QR code is scanned using the QR code scanner application installed in the mobile device. The resulting text information displayed on the mobile device's screen is then sent by e-mail or a suitable messenger service to the local service representative defined in the "Measurement Care" agreement.

As an alternative, a photo of the displayed QR code can be sent to the service representative.

Select QR code

Menu path

Menu → Diagnosis/Info. → QR Code Display

Procedure

- 1 Select system overview or specific analyzer module.
- 2 Select QR code with **ENTER**.
- 3 Scan QR code.
- 4 Return to selection with **Back**.

The diagnosis menu can be selected directly from the status messages overview.

The QR code can also be selected in Remote HMI and scanned from the computer screen.

Recommended QR code scanner applications

ABB recommends the use of the following QR code scanner applications (available free of charge for iOS and Android):

"my Installed Base" by ABB

Download in App Store:



Download in Google Play:



"QR Scanner" by Kaspersky

Download in App Store:



Download in Google Play:



Process status

Definitions

The **process status** (see below) provides information on measurement values and the process being monitored by the analyzer.

System status (see page 318) provides information on the gas analyzer itself.

Process status

The term "process status" includes

- Transgression of measuring range limits
- Transgression of limit values

by the measured values.

Transgression of measurement range limits

If a sample component value is $> +130\%$ or $< -100\%$ of the span, the measured value in the display flashes. A status message is also generated in each case; these messages will not be entered into the logbook.

The thresholds established cannot be changed.

Transgression of limit values

If a measured value is above or below a limit value, this status is output as a binary signal at one of the digital outputs.

Two prerequisites must be met to this effect:

- The limit value must be assigned (see page 181) to a digital output by means of function block configuration.
- The limit value monitoring parameters (direction of effect, threshold value, hysteresis) must be set (see page 162).

The assignment of limit values to certain digital outputs is factory-set; this is documented in the analyzer data sheet.

System status: Status messages

Where are status messages generated?

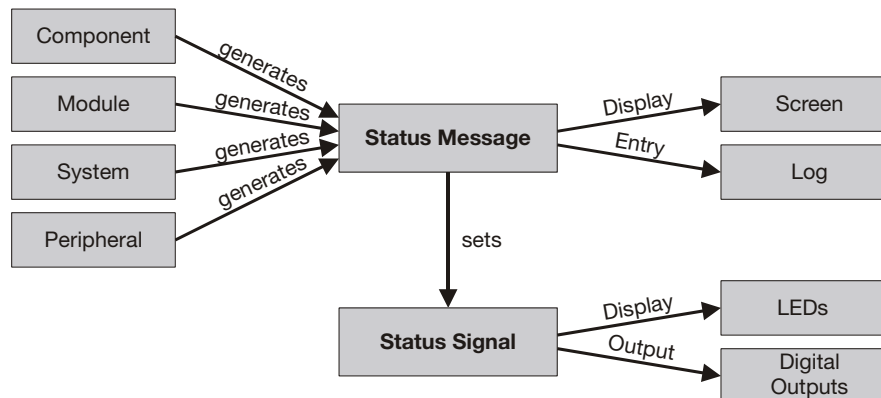
Status messages are generated

- By the gas analyzer, i.e.
 - The system controller (signal processing, calibration, system bus)
 - The analyzer modules
 - The pneumatic module
 - The temperature and pressure regulators
 - The I/O modules and external I/O devices
- By peripherals, for example
 - The system cooler
 - Other sample gas conditioning modules.

User-configured status messages

Status messages are generated by the gas analyzer and by peripherals. Additionally, by configuring the **Message generator** function block, status messages from the analyzer and peripherals can be linked into the status message processing system. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

Status message processing



- Status messages are shown on the screen and recorded in the log.
- Status messages set a corresponding status signal (overall status or individual status).
- Status signals are indicated using status LEDs and output via the system controller digital outputs.

Status message display

The Status message softkey appears as soon as a status message is generated. By pressing the softkey the user can recall the status message summary and view status message details.

Logging status messages

Status messages are logged. Messages concerning a transient gas analyzer state with no direct effect on measurements are not logged. Such messages include

- "A password is active!"
- "This system is currently under remote control!"
- "Automatic calibration in progress."

System status: Status signals

Overall or individual status

The status signal is factory-configured (see page 193) to output as an overall or individual status.

Overall status

If the gas analyzer is configured to output overall status, status messages are issued as overall status indications.

Individual status

If the gas analyzer is configured to output individual status, status messages are issued as the "Failure" or "Maintenance request" or "Maintenance mode" individual status indications.

The following table shows possible causes of individual status signals and how to evaluate the values measured.

Individual status signal	Cause	Evaluation of measured value
Failure	The analyzer is in a state that requires immediate user intervention.	The measured value is invalid.
Maintenance request	The analyzer is in a state that will soon require user intervention.	The measured value is valid.
Maintenance mode	The gas analyzer is being calibrated or serviced.	The measured value is not a process measured value and is to be discarded.

Individual status by analyzer module or sample component



In principle, the individual status signals apply to the entire gas analyzer (system status).

However, by configuring the **Message input** function block, individual status messages for each analyzer module or for each sample component can be output separately via digital outputs. The Technical Information "Function Blocks – Descriptions and configuration" contains complete information on the individual function blocks.

I/O device status messages are only reported as system status signals.

Status indication

Gas analyzer status is indicated by means of status LEDs.

LED	Status
Error 	Overall status or individual "Error" status
Maint 	Individual "Maintenance request" status

Status message categories

Status message categories

In terms of operator reaction, there are three categories of status messages:

- Status messages not requiring acknowledgment
- Status messages requiring acknowledgment
- Status messages requiring acknowledgment and troubleshooting

Status messages not requiring acknowledgment

The instrument operates normally after the status has been cleared. When the status is cleared, the status signal is reset and the status message disappears.

Example: Temperature error during the warm-up phase.

Status messages requiring acknowledgment

The instrument operates normally after the status has been cleared; however, the operator must be informed of the status. When the status is cleared, the status signal is reset. The status message disappears as soon as the operator has acknowledged it. The operator is thus informed about the malfunction of the instrument.

Example: No new measurement values from the analog/digital converter.

Status messages requiring acknowledgment and intervention

The instrument may not operate normally after the status has been cleared; the operator must therefore acknowledge the status and eliminate the cause of the status message. The status signal is reset and the status message disappears as soon as the operator has acknowledged it, and the cause of the status message has been eliminated.

Example: The offset drift between two calibrations exceeds the permissible range.

Summary

The following table shows

- the time sequence of the three status message categories
- The identifier used to identify the status messages in the summary (q, Q and I).

Status messages not requiring acknowledgment

Status begins	Status ends
LED lights up	LED goes out
Status signal set	Status signal reset
Message appears	Message canceled

Status messages requiring acknowledgment

Status begins	Status ends	Acknowledge
LED lights up	LED goes out	
Status signal set	Status signal reset	
Message appears q	Message remains I	Message canceled

Status begins	Acknowledge	Status ends
LED lights up		LED goes out
Status signal set		Status signal reset
Message appears q	Message remains Q	Message canceled

Status messages requiring acknowledgment and intervention

Status begins	Status ends	Acknowledge, correct
LED lights up		LED goes out
Status signal set		Status signal reset
Message appears q	Message remains I	Message canceled

Status begins	Acknowledge, correct	Status ends
LED lights up		LED goes out
Status signal set		Status signal reset
Message appears q	Message remains Q	Message canceled

Status messages

List layout

The status message list contains the following information:

No.	The status message number appears in the menu line display
Text	Full text of the status message is shown in the detailed display
S	x = Status message sets the overall status
A	x = Status message sets the "Error" individual status
W	x = Status message sets the "Maintenance request" individual status
F	x = Status message sets the "Maintenance mode" individual status
Reaction/Remark	Explanations and corrective measures in case of status messages

Status messages

No.	Text	S	A	W	F	Reaction/Remark
Run time error						
1– 21	Runtime error 1 to Runtime error 21					Notify Service if these messages occur repeatedly.
System controller						
101	System controller shut down at					For information; shows date and time
102	System controller starts up at					For information; shows date and time as well as warm or cold start
103	Install Module:					For information
104	Remove Module:					For information
105	Reactivate Module:					For information
106	A user installed module:					For information
107	A user removed module:					For information
108	A user replaced module:					For information
109	A password is active! To delete, press the <MEAS> key on the measurement value display.					For information on Password Protection see "Password protection" (see page 149) section; not logged
110	System booting.					Not logged
111	This system is currently under remote control					Not logged
112	Display/control unit synchronizing with analyzer. Please wait.					Not logged
113	The system time was changed from -> to:					Not logged
114	The system is saving the changed parameters. Please wait.					

No.	Text	S	A	W	F	Reaction/Remark
116	The Profibus Module is mounted on the wrong slot! The Profibus interface is therefore not working. Please remount the Profibus Module on slot X20/X21.	x	x			See message text
117	The configuration backup was saved.					
118	The configuration backup was loaded. The system has been restarted.					
119	The system configuration could not be loaded!, This system therefore contains no configuration now. Please enter menu: Configure/System/Save Save configuration to load your backup configuration. Or use SMT to re-install your configuration.	x	x			See message text

System bus

201	The selected system bus module could not be found.	x	x			Check plug connections and terminating resistors on the system bus. Make sure the system bus module serial number is correctly entered: MENU → Diagnostics/Information → System overview
203	The selected system bus module does not exist.	x	x			Check plug connections and terminating resistors on the system bus.
208	The system bus was not able to transfer data into the database.	x	x			The system bus module software version is not compatible with that of the system controller; update the system controller software.
209	The system bus connection to this module is interrupted.	x	x			Check the system bus connection to the indicated system bus module. Check the power supply system of the indicated system bus module.
210	The system bus module configuration has changed.	x	x			For information; the configuration data are automatically updated
211	The system bus module has no more on-board memory.	x	x			Check the system bus module configuration: MENU → Diagnostics/Information → System overview
214	The system is currently maintained with Optima SMT.					
215	The analyzer module has an internal communication error!	x	x			Notify Service.
216	The analyzer module has an internal program error!	x	x			Notify Service.
250	The selected analyzer module could not be found!	x	x			Check the connectors and cabling.
251	The connection to the analyzer has been lost!	x	x			Check the connectors and cabling.
252	The EEPROM data of the analyzer is faulty!	x	x			Check the configuration with TCT.
253	Communication with the analyzer is faulty!	x	x			Check the connectors and cabling.

No.	Text	S	A	W	F	Reaction/Remark
254	The boot program of the analyzer is defective! Notify Service!	x	x			Notify Service.
255	The program of the analyzer is defective! Notify Service!	x	x			Notify Service.
Analyzer modules						
300	No new measured values from the analog/digital converter.	x	x			Notify Service.
301	The measured value exceeds the range of the analog/digital converter.	x	x			Check the sample gas concentration. Notify Service.
302	Offset drift exceeds half the permissible range.			x		Check analyzer module and sample preparation. Permissible range: 150 % of smallest installed measurement range; 50% of physical measurement range for Uras26. Notify service when drift exceeds these values
303	Offset drift exceeds permissible range.	x	x			
304	Amplification drift exceeds half the permissible range.			x		Manually calibrate the indicated detector at zero and end point. Check analyzer module and sample preparation.
305	Amplification drift exceeds the permissible range.	x	x			Permissible range: 50 % the the detector sensitivity. Notify Service when drift exceeds this value.
306	The offset drift between two calibrations exceeds the permissible range.			x		These messages are generated by automatic calibration. Check calibration for plausibility. Fix possible cause of implausibility. Manually calibrate the indicated detector at zero (No. 306) and end point (No. 307).
307	The amplification drift between two calibrations exceeds the permissible range.			x		Permissible range: 15 % of the smallest installed measuring range; 6 % of the smallest installed measuring range for measurements on plants subject to approval and pursuant to the 27th and 30th BImSchV (Federal Regulation on Immissions)
308	A computational error occurred during the calculation of the measured value.	x	x			Notify Service.
309	The temperature regulator is defective.			x		See the status message from the applicable temperature detector
310	Temperature correction was turned off for this component because the temperature measured value is invalid.			x		See the status message from the applicable temperature detector
311	The pressure regulator is defective.	x	x			See the status message from the applicable pressure detector
312	The pressure correction turned off for this component because of invalid measured pressure value.			x		See the status message from the applicable pressure detector
313	Cross-sensitivity correction is impossible for this component because the correction value is invalid.			x		See the status message from the applicable correction detector
314	Carrier gas correction is impossible for this component because the correction value is invalid.			x		See the status message from the applicable correction detector

Auxiliary detector

No.	Text	S	A	W	F	Reaction/Remark
315	No new measured values from the analog/digital converter.			x		Notify Service.
316	The measured value exceeds the range of the analog/digital converter.			x		Notify Service.
317	A computational error occurred during calculation of the measurement value.			x		Notify Service.
Uras						
318	No new measured values from the analog/digital converter.	x	x			Notify Service.
Caldos, Magnos						
319	The measurement bridge is improperly balanced.	x	x			Notify Service.
320	The measurement amplifier offset is too high.	x	x			Notify Service.
MultiFID, Fidas						
321	The detector temperature is below the lowest temperature permissible.	x	x			Status message during warm-up phase. If the status message appears after warm-up phase: Check the thermal link and replace if necessary.
322	The flame is out.	x	x			Status message during warm-up phase. If the status message appears after warm-up phase: Check gas supply, heater plug
323	The analyzer is in the fail-safe state.	x	x			Causes: Flame temperature > detector set point + 200 °C, hardware fault, Pt-100 line break or short circuit. Switch power supply off and back on after ≥ 3 seconds. If this status message appears again, notify Service. Remark: Fail-safe-state means: Heater off, combustion gas valve closed, instrument air valve closed, case purging on, zero-gas valve open.
Temperature regulator						
324	Temperature is above or below upper and/or lower limit value 1.			x		Status messages during the warm-up phase. If the Status messages appear following the warm-up phase: Check whether the permissible ambient temperature range (see page 332) is being maintained. Check the analyzer module thermal link and replace if necessary.
325	Temperature is above or below upper and/or lower limit value 2.			x		Fidas24: The temperatures of the detector (T-Re . D) and if applicable, the heated sample gas connection (T-Re . E) are outside the limit values.
Pressure regulator						
326	No new measured values from the analog/digital converter.	x	x			Notify Service.
327	The measured value exceeds the range of the analog/digital converter.	x	x			Notify Service.
328	A calculation error occurred during calculation of the measurement value.	x	x			Notify Service.
329	Pressure above or below upper and/or lower limit value 1.			x		Fidas24: Check the supply gas pressure: Output = instrument air,

No.	Text	S	A	W	F	Reaction/Remark
330	Pressure above or below upper and/or lower limit value 2.			x		Air = combustion air, H2 = combustion gas.
331	The output variable of the pressure regulator is out of range.	x	x			Fidas24: Check the supply gas pressure.
I/O devices						
332	Auxiliary voltage failure on I/O board.	x	x			Defective I/O board. Replace the board.
333	Unavailable I/O type configured.	x	x			Correct the configuration with the test and calibration software.
334	No new measured values from the analog/digital converter.	x	x			Defective I/O board. Replace the board.
335	The measured value exceeds the range of the analog/digital converter.	x	x			Check signals at analog inputs. If OK, check the configuration and calibration of the analog inputs.
336	A calculation error occurred during calculation of the measurement value.	x	x			Check the configuration and calibration of the analog inputs and outputs.
337	Broken analog output line	x	x			Check the analog output lines.
338	Line break in the digital input (moisture sensor).	x	x			Check moisture sensor in the system cooler.
339	Line break or short circuit in the analog input.	x	x			Check system cooler temperature.
340	Analog input value exceeds upper or lower limit value 1.			x		Check system cooler temperature.
341	Analog input value exceeds upper or lower limit value 2.			x		Check system cooler temperature.
Flow monitor (pneumatic module)						
342	The flow rate undershoots limit value 1			x		Check sample preparation. Alarm value 1 = 25 % of MRS.
343	Flow rate undershoots limit value 2.	x	x			Check sample preparation. Alarm value 2 = 10 % of MRS. Automatic calibration is interrupted and disabled
Measured value						
344	Measured value overshoots measuring range value.					Measured value > +130 % of MRS, not logged
345	Measured value undershoots the measurement value range.					Measured value < -100 % of MRS, not logged
Limas						
356	The analyzer in warm-up phase.	x	x			Status message during warm-up phase. If the status message appears after warm-up, a temperature error has occurred in the lamp or in the sample cell or in the measurement or reference detector amplifier. Notify Service.
357	Limas motor optimization in progress.	x	x			Status message after warm-up phase Motor optimization should be concluded after approx. 2 minutes. If the status message is still present afterwards, a filter wheel or the calibration wheel is blocked, e.g. by a loose cable. Check cable and clip on.

No.	Text	S	A	W	F	Reaction/Remark
358	Lamp intensity above or below middle of permissible range.			x		Lamp intensity has fallen to 10% of Init value. Check the intensity values in the Diagnostics /Test → Module specific → Lamp Intensity menu. If all four values have fallen by about the same amount compared to the Init values, the cause is reduced lamp intensity. The lamp should be soon replaced (see page 307). If only the two measurement detector values have dropped, the cause is probably a contaminated sample cell. Clean the sample cell (see page 294) or exchange it.
359	Lamp intensity above or below permissible range.	x	x			Lamp intensity has fallen to 5% of Init value. Check the intensity values in the Diagnostics /Test → Module specific → Lamp Intensity menu. If all four values have fallen by about the same amount compared to the Init values, the cause is reduced lamp intensity. Replace the lamp (see page 307) and perform an amplification optimization (see page 310).
360	Filter wheel 1 cannot be initialized.	x	x			Notify Service.
361	Filter wheel 2 cannot be initialized.	x	x			Notify Service.
362	The calibration filter wheel cannot be initialized.	x	x			Notify Service.
363	The Limas analyzer board cannot be initialized.	x	x			Notify Service.
364	A new lamp has been installed. The amplifiers settings are optimized.					For information
365	The Limas amplifiers settings are optimized.					For information
LS25						
366	The LS25 analyzer has an overall error.	x	x			
367	The LS25 analyzer has a maintenance request.	x		x		
368	The LS25 analyzer starts measurement.	x	x			
369	LS25 analyzer detector error #	x	x			
370	Beam transmission too low			x		The beam transmission has fallen below the limit value for reliable measurements. This indicates improper alignment of the optical units or contamination of the optical windows. Clean optical windows and check alignment.
371	The temperature input signal exceeds the permissible range.			x		The gas temperature is outside the permissible range for temperature equalization. The accuracy of the measured gas concentration could have been reduced. If the supplied values are correct, the device is operating outside the specifications.
372	The pressure input signal exceeds the permissible range.			x		The gas pressure is outside the permissible pressure equalization range. The accuracy of the measured gas concentration could have been reduced. If the supplied values are correct, the device is operating outside the specifications.

No.	Text	S	A	W	F	Reaction/Remark
373	The flow sensor signal outside permissible range.			x		
374	No measurement. The detector signal is too low.	x	x			The laser beam does not reach the detector. Clean optical window. Check optical beam path for obstacles and realign optics.
375	The input current loop (4-20mA) has an error.	x	x			Error when entering pressure and/or temperature via 4-20-mA input. The measured gas concentration is most likely incorrect. Check connections to the temperature/pressure sensor or use fixed settings for temperature or pressure respectively.
376	This LS25 module is undergoing maintenance.	x			x	Communication with service software via RS232. No measured values are transferred.
Uras						
378	The chopper wheel is blocked.	x	x			Notify Service.
379	Chopper wheel speed not OK.	x	x			Notify Service.
380	IR source element or electronics defective.	x	x			Notify Service.
381	High voltage in the preamplifier defective.	x	x			Notify Service.
382	Meas. value is influenced by shock.	x	x			
Flow controller						
398	No new measured values from the analog/digital converter.	x	x			Notify Service.
399	The measured value overshoots the range of the analog/digital converter.	x	x			Check the sample gas concentration. Check connectors in the gas analyzer. Notify Service.
400	A calculation error occurred during calculation of the measurement value.	x	x			Notify Service.
401	The flow rate exceeds upper or lower limit value 1.			x		Check sample gas path. Notify Service.
402	The flow rate exceeds upper or lower limit 2.	x	x			Check sample gas path. Notify Service.
403	The flow regulator controlled variable is out of the valid range.	x	x			Notify Service.
ZO23						
404	Temperature is above or below upper and/or lower limit value 2.	x	x			Notify Service.
405	A ZO23 function test has been performed.					For information
406	This ZO23 analyzer has failed the function test!			x		Change test factor or check sample cell with test gas.
407	A ZO23 function test is in progress.				x	For information
408	The ZO23 function test is canceled!				x	Keep sample gas concentration stable or use test gas.
Fidas24						

No.	Text	S	A	W	F	Reaction/Remark
411	The analyzer is in standby. Re-activation in menu: Service/Test..Standby/Restart FID.	x			x	Restart Fidas24.
412	Ignition failed. Analyzer must be manually reactivated. Re-activation in menu: Maintenance/Test..Standby/Restart FID.	x	x			Check operating gases. Restart Fidas24.
413	Auxiliary voltage failure in the analyzer hardware.	x	x			Notify Service.
414	The controller output value is out of the permissible range. (< 20%)	x			x	Check operating gases and connection lines. Restart Fidas24 if necessary. Notify Service.
415	The controller output variable is out of the permissible range. (> 90%)	x			x	Check operating gases and connection lines. Restart Fidas24 if necessary. Notify Service.
Calibration						
500	System bus communication faulty.					
501	Requested function is not available on the system module.					Check the analyzer module software version and perform an update if needed.
502	A system error occurred in the system module concerned.					The calibration is interrupted. Notify Service.
503	Amplification error during calibration. Calibration impossible.			x		The calibration is interrupted. Span gas concentration too low – check.
507	A combination of the following errors occurred: Half Drift Limit, Drift Limit, Amplification or Delta Drift.					
508	Unknown error number. Check software versions.					Message during the automatic calibration. Check analyzer module and system controller software versions.
509	Automatic calibration started.					For information
510	Automatic calibration ended.					For information
511	Automatic calibration interrupted externally.					For information
512	Automatic calibration in progress.				x	For information; not logged
513	System bus communication faulty during automatic calibration.					
514	External calibration started.					For information
515	External calibration ended.					For information
516	External calibration in progress				x	For information; not logged
517	Device being serviced.				x	For information, e.g. during manual calibration, not logged
518	The calibration could not be performed, because the measured value is not stable.					

No.	Text	S	A	W	F	Reaction/Remark
519	Preamplifier overflow error: Calibration could not be performed because of preamplifier override.					
520	Initial zero calibration started.					For information
521	Initial zero calibration ended.					For information
522	Initial zero calibration interrupted.					For information
523	Initial zero calibration incomplete. System bus communication fault during calibration.					For information
524	Initial zero calibration started.				x	For information; not logged
525	Linearization impossible: Linearization did not produce a valid result. Measurement					See message text
526	Linearization impossible: Linearization could not be performed, i.e. the characteristic is linear.					See message text
527	Initial calibration for component:					For information
528	Autocalibration not started, i.e. manual calibration was running.					For information
529	Calibration was stopped because no raw measured values were recorded.	x		x		
530	Calibration stopped because the pressure switch did not detect any calibration gas.	x		x		
531	Automatic validation started.					For information
532	Automatic validation ended.					For information
533	Automatic validation externally interrupted.					For information
534	Automatic validation in progress.				x	For information; not logged
535	Automatic validation successful for:					
536	Automatic validation out of limits for:					
537	Automatic validation out of limits for:			x		
User-Configured Messages						
800	An external error occurred during:	x	x			Default texts for the Message Generator function block are supplemented with the full text defined during function block configuration.
801	A user-defined error occurred during:	x	x			
802	A user-defined maintenance request occurred during			x		
803	A user-defined maintenance mode event occurred during:				x	

No.	Text	S	A	W	F	Reaction/Remark
Miscellaneous Messages						
1000	This function block has an error:	x	x			Is supplemented with a reference to the function block type.
1001	Condensate penetration.					Overall message for guiding reaction to condensate penetration; not logged
1002	Flow rate too high at this point!	x	x			Currently not used
1003	Flow rate too low at this point!	x	x			Currently not used
System Cooler						
1100	Cooler temperature too high.	x	x			Sample gas feed module pump is automatically turned off. Check the system cooler and sample gas preparation system.
1101	Cooler temperature too low.	x	x			
1102	Condensate penetration in cooler.	x	x			
1103	Flow rate too low in cooler.			x		Check the system cooler and sample gas preparation system.
1104	Cooler condensate level too high.			x		
1105	Cooler condensate level too high.			x		Empty the condensate bottle.
1106	Cooler reagent level too low.			x		Fill the reagent container.

Gas analyzer: Troubleshooting

Blinking measurement value readout

Measured signal overshoots measurement range limits

Note: Measured value > +130 % of MRS or measured value < -100 % of MRS. Additionally, status messages 344 or 345 are generated.

Blinking --E-- alternately in measurement value readout

Problem in measured signal processing

- View status messages.
- Identify cause and repair.

Blinking --E-- in mA value readout

Problem in output current circuit

- Identify cause (e.g. line break) and repair.

Flow error

External gas lines or filter contaminated, clogged up or leaky

- Disconnect gas analyzer from the gas conditioning system.
- Blow compressed air through gas lines or mechanically clear them.
- Exchange filter elements and filter beds.
- Check gas lines for seal integrity.

Gas feed paths in the gas analyzer kinked or leaky

- Disconnect gas analyzer from the gas conditioning system.
- Check whether the gas lines in the analyzer module or to the pneumatic module are kinked or have become detached from the connections.
- Check the seal integrity (see page 268) of the analyzer module gas paths and (if applicable) of the lines to the pneumatics module.

Sample gas flow rate conditions

Analyzer module	Sample gas flow rate
Caldos25	10 to 90 l/h (for option T90 < 6 s: max. 90 to 200 l/h)
Caldos27	10 to 90 l/h min. 1 l/h
Fidas24	80 to 100 l/h with atmospheric pressure (1000 hPa)
Fidas24 NMHC	80 to 100 l/h with atmospheric pressure (1000 hPa)
Limas11 IR	20 to 100 l/h
Limas21 UV	20 to 100 l/h
Limas21 HW	20 to 90 l/h
Magnos206	30 to 90 l/h
Magnos28	30 to 90 l/h
Magnos27	20 to 90 l/h
Uras26	20 to 100 l/h
ZO23	5 to 10 l/h The flow rate must be kept constant to ± 0.2 l/h in this range. The sample gas must be taken from a bypass at zero pressure.

Temperature problem

Gas analyzer still in warm-up phase

- The duration of the warm-up phase depends on which analyzer module is installed in the gas analyzer.

Analyzer module	Duration of the warm-up phase
Caldos25	1.5 hours
Caldos27	30/60 minutes for class 1/2 measurement ranges ¹⁾
Fidas24	≤ 2 hours
Fidas24 NMHC	≤ 2 hours
Limas11 IR	Approx. 2.5 hours
Limas21 UV	Approx. 2.5 hours
Limas21 HW	Approx. 4 hours
Magnos206	≤ 1 hour
Magnos28	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx. 0.5/2 hours without/with thermostat
ZO23	Approx. 15 minutes

1) See "AO2000 Series" data sheet for class details.

Excessive air movement

- Reduce the flow of air around the gas analyzer.
- Install shielding against drafts.

Ambient temperature outside of permissible range

- Protect the gas analyzer from cold and heat sources such as the sun, ovens and
- Observe climatic conditions

Relative humidity max. 75 %, no condensation		
Ambient temperature for storage and transport with integrated oxygen sensor		-25 to +65 °C
		-25 to +60 °C
Ambient temperature range during operation with		
Analyzer module	installed in a housing without electronics module	installed in a housing with electronics module or with power supply only
Caldos25	+5 to +45 °C	+5 to +45 °C
Caldos27	+5 to +50 °C	+5 to +45 °C
Fidas24	+5 to +45 °C	+5 to +45 °C
Fidas24 NMHC	+5 to +40 °C	+5 to +40 °C
Limas11 IR	+5 to +45 °C	+5 to +45 °C ¹⁾
Limas21 UV	+5 to +45 °C	+5 to +45 °C ¹⁾
Limas21 HW	+15 to +35 °C	+15 to +35 °C
Magnos206	+5 to +50 °C	+5 to +45 °C
Magnos28	+5 to +50 °C	+5 to +45 °C
Magnos27	+5 to +45 °C ²⁾	+5 to +45 °C
Uras26	+5 to +45 °C	+5 to +40 °C
ZO23	+5 to +45 °C	+5 to +45 °C
Oxygen sensor in 19-inch housing	+5 to +40 °C	+5 to +40 °C
in wall-mount housing	+5 to 35 °C	+5 to +35 °C

1) +5 to +40 °C when I/O modules are installed

2) +5 to +50 °C for sample chamber direct connection and installation in housing without electronics module or Uras26

Caldos25, Caldos27, Magnos206, Magnos28, Magnos27: Troubleshooting

Temperature problem

Connecting leads of the temperature sensor or the heater disconnected

- Check the connecting leads and connectors.
- Check the line seating in the insulated jackets.

Defective thermal link

- Check thermal link for continuity and replace if necessary.

Leaking thermostat or open purge gas connections

- Check the seal integrity between the thermostat chamber and the mounting flange; tighten mounting bolts or replace O-rings as needed.
- Seal the analyzer purge gas inlet and outlet with sealing connectors.
- Check the purge gas and reduce as needed: in operation max. 20 l/h, positive pressure $p_e = 2$ to 4 hPa.

Unstable readings

Gas path leakage

- Check the seal integrity (see page 268) of the analyzer module gas paths and (if applicable) of the lines to the pneumatics module.

Fidas24: Troubleshooting

Flow error

Sample gas inlet nozzle or sample gas filter clogged

- Check whether sample gas inlet nozzle and sample gas filter in the sample gas terminal are clogged.
- Replace sample gas filter (see page 279).

Temperature problem

Connecting leads of the temperature sensor or the heater disconnected.

- Check the connecting leads and connectors.
- Check the fit of the leads in the wire end ferrules.
- Inspect power supply of the heater.

Unstable readings

Vibrations

- Reduce vibration at the installation site.

Sample gas path leaky

- Check gas path in the analyzer module and in the sampling modules for seal integrity.

Loss of sensitivity

- Have sample gas nozzle replaced by Service.

Sample gas outlet pressure too high

- Check air jet injector for congestion, if necessary clean (see page 281). Increase instrument air pressure. Check air discharge line; it must have a large internal diameter.

Combustion air contaminated

- Check combustion gas supply

Fluctuating process gas pressures

- Check the supply of instrument air, combustion air and combustion gas

Pressure regulator fault

Unstable pressure values

- Adjust external pressure of the supply gases such that the output variable for instrument air (output) is approx. 60 %, for combustion air (Air) is approx. 55 %, for combustion gas (H2) is approx. 42 %.
- Have the pressure regulator modules checked.

Pressure regulator output variables not equal to set points

Air	Output variable $\leq 50\%$	• Reduce combustion air primary pressure.
	Output variable $\geq 90\%$	• Increase combustion air primary pressure
H2	Output variable $\leq 40\%$	• Reduce combustion gas primary pressure.
	Output variable $\geq 90\%$	• Increase combustion gas primary pressure.
Input	Output variable $\leq 50\%$	• Reduce sample gas inlet pressure
Output	Output variable $\leq 50\%$	• Increase the instrument air pressure
		• Clean air jet injector (see page 281).
		• Reduce length of the gas discharge line or increase cross-section.
	Output variable $\geq 90\%$	• Reduce instrument air pressure.

Zero drift

Sample gas line contaminated

- Clean sample gas line.

Combustion air catalyst is not operating adequately

- Reduce hydrocarbon content.
- Exchange catalyst.

Combustion gas line contaminated

- Clean combustion gas line.

Flame does not ignite

Air in the combustion gas line

When connecting or replacing the combustion gas bottle make sure that no air penetrates into the combustion gas supply line. Air which has penetrated the gas supply line results in the flame in the analyzer going out.

The analyzer module automatically tries to reignite the flame up to 10 times in a period of approx. 10 minutes with increased combustion gas pressure each time. If this is unsuccessful, the analyzer module switches to operating status "**Wait for restart**". In this case ignition of the flame must be restarted:

Menu → Maintenance/Test → Analyzer spec. adjustm. → Standby/Restart FID

Remark: The operating status "Wait for restart" means: Heater on, Combustion gas valve closed, Instrument air valve open, Housing purge on.

Combustion air pressure too high

Reduce combustion air pressure (note details in Analyzer Data Sheet).

Fidas24 in fail-safe status

If a serious fault has occurred in the analyzer module, the analyzer module is put in fail safe status; in the menu Standby/Restart FID the indication Fail safe appears for the parameter Status.

Fail-safe status: heater off, combustion gas valve closed, instrument air valve closed, housing purging on, zero gas valve open.

The cause of the failure must be determined from the status messages (see page 322).

A cold restart in the menu is not possible; after fault correction the gas analyzer must be cold restarted by switching off and on again.

Failure of instrument air supply

Shutting-off gas supply if instrument air supply fails

It must be ensured that the gas supply to the analyzer module is shut off if the instrument air supply fails.

As a rule, this is ensured by installing a pneumatic shut-off valve in the gas supply line (recommendation) (see page 48); this valve must be controlled by the instrument air supply in such a way that if it fails (and as a result continuous case purging fails) (see page 40), the gas supply is automatically shut off.

If such a pneumatic shut-off valve is not installed, the following precautions and measures must be taken:

- The Overall Status or the "Failure" status of the gas analyzer must be monitored.
- If the status appears, the cause must be verified in the gas analyzer on site:
 - If the gas analyzer is not in operation (e.g. as a result of a supply voltage failure), the supply gases must be shut off (see section "Gas analyzer shutdown" (see page 343)).
 - If the gas analyzer is in operation, an adequate instrument air supply must be verified. If this is the case, the status messages must be verified. If this is not the case, proceed as follows:
 1. Shut off the combustion gas supply.
 2. Reestablish instrument air supply.
 3. Purge gas analyzer for 20 minutes.
 4. Turn on combustion gas supply.
 5. Gas analyzer starts automatically.

Note for measuring flammable gases

When measuring flammable gases, it must be made sure that in case of a failure of the instrument air supply or of the analyzer module itself the sample gas supply to the analyzer module is shut off and the sample gas path is purged with nitrogen or synthetic air.

Limas11 IR, Limas21 UV, Limas21 HW: Troubleshooting

Temperature problem

Connecting leads of the temperature sensor or the heater disconnected

- Check the connecting leads and connectors.
- Check the fit of the leads in the wire end ferrules.

Defective thermal link

- Check thermal link for continuity and replace if necessary.

Measured value display is not stable

Leaks in the gas feed paths

- Check the seal integrity (see page 268) of the analyzer module gas paths and (if applicable) of the lines to the pneumatics module.

Beam intensity too low

- Read the current intensity values using `Diagnostics/Test → Module-specific → Lamp intensity` menu item (start the zero gas supply for this) and compare this value with Init value displayed (the Init values were stored following amplification optimization after installation of a new lamp). A significant decrease (by a factor of 10 or more) is the probable cause of unstable measurement value readings.

Three different cases can be identified:

- 1 If only the two measurement detector values have dropped, there is probably a contaminated sample cell. Clean the sample cell.
- 2 If all four values are have dropped by similar amounts then lamp intensity has probably decreased. Perform an amplification optimization (see page 310) or replace the lamp (see page 307).
- 3 For NO measurement only: If the reference receiver "Reference" value has increased or not as markedly decreased as a percentage relative to the reference receiver "Measurement" value and if at the same time the sensitivity span has decreased (loss of sensitivity), aging of the selectivity cell is the probable cause (see the service manual for more information).

"Sample Value Overflow or Underflow" status signal

Drift or aging of optical components (lamp, sample cell, detector, etc.)

- Determine the cause.
- If required clean or replace the affected components.
- Subsequently, perform an amplification optimization (see page 310), to bring the receiver signal back to its optimal range.

Uras26: Troubleshooting

Temperature problem

Connecting leads of the temperature sensor or the heater disconnected

- Check the connecting leads and connectors.
- Check the fit of the leads in the wire end ferrules.

Defective thermal link

- Check thermal link for continuity and replace if necessary.

Unstable readings

Leaks in the gas feed paths

- Check the seal integrity (see page 268) of the analyzer module gas paths and (if applicable) of the lines to the pneumatics module.

Vibrations

- Provide measures to reduce the vibrations. Permissible vibration levels: for analyzer max. ± 0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz; when installed in cabinet max. 0.01 ms^{-2} at 0.1 to 200 Hz.
- Increase T90; increase switching threshold for non-linear filter (see page 163).

Loss of sensitivity

- Check the sensitivity variation:
Indication < 75 %: "Maintenance request" status signal appears. The detector concerned will need to be changed soon.
Indication < 50 %: The "Failure" status signal appears.

Uneven emitter modulation

- Remove the emitter.
CAUTION: The emitter temperature is approx. 60 °C in the thermostat version of the Uras26!
- Check if the chopper wheel turns smoothly.
- Check the clamp ring seating.
- The chopper wheel should not extend beyond the notch.
- Have the emitter and modulator checked by Service.

Pneumatic module: Troubleshooting

Flow error

Condensation in the flowmeter

- Disconnect gas analyzer from the gas conditioning system.
- Dry the flow meter by heating it and blowing it with compressed air.
- Check the operation of the upstream sample gas cooler.

Inadequate gas supply

- Connect the flow meter, ball chamber or pressure gauge directly to the gas supply pump and measure the pressure or vacuum.
- Check the pump and change the membrane if necessary.
- Check the disposable filter and replace (see page 314) if necessary.
- Check the solenoid valve(s) and replace if necessary.

Notify service

Who should you contact for further help?

Please contact your local service representative. For emergencies, please contact

ABB Service,

Telephone: +49-(0)180-5-222 580, Telefax: +49-(0)621-381 931 29031,

E-mail: automation.service@de.abb.com

Before you notify service ...

Before you notify service because of a malfunction or a status message, please check whether there actually is an error and whether the gas analyzer is actually operating out of specifications.

When you notify service ...

When you notify service because of a malfunction or a status message, have the following information available:

- The production number (F-No.) of the system housing in which the defective or improperly operating unit is located. It is located on the system housing identification plate, inside the right wall of the 19-inch housing and inside the left wall of the wall-mount housing, as well as in the Analyzer Data Sheet,
- The system controller and system module software versions are found in the menu item
MENU → Diagnostics/Information. → System overview.
- An exact description of the problem or status as well as the status message text or number.

This information will enable the service personnel to help you quickly.

Have the analyzer data sheet (see page 75) ready – it contains important information that will help the service personnel to find the cause of the malfunction.

When you return the gas analyzer to the service department ...

CAUTION

When you return the gas analyzer to the service department, e.g. for repair, please state which gases have been supplied to the gas analyzer. This information is needed so that service personnel can take any requisite safety precautions for harmful gases.

Gas analyzer shutdown and packing

Gas analyzer shutdown

Gas analyzer shutdown

In the case of a temporary shutdown:

- 1 Turn off the sample gas supply and reference gas supply, if applicable.
- 2 Purge the gas lines and gas feed paths in the analyzer module with dry fresh air or nitrogen for at least 5 minutes. Limas21 HW: Purge sample gas feed path gas lines and gas feed paths in the analyzer module with at least with clean and dust-free air for at least 1 hour.
- 3 Switch off the gas analyzer power supply.

In the case of a long-term shutdown, carry out the following in addition:

- 4 Remove the gas lines from the gas analyzer ports. Tightly seal the gas ports.
- 5 Disconnect the electrical leads from the gas analyzer.

Fidas24: Gas analyzer shutdown

In the case of a temporary shutdown:

- 1 Turn off the sample gas supply.
- 2 Purge sample gas line with nitrogen for at least 5 minutes from the sampling point.
- 3 Set the gas analyzer to standby operation (see page 277). In case of corrosive and flammable gases set the gas analyzer to standby operation with detector purging.
- 4 Shut off combustion air supply and combustion gas supply.

In the case of a long-term shutdown, carry out the following in addition:

- 5 Shut off instrument air supply.
- 6 Switch off the gas analyzer power supply.
- 7 Remove the gas lines from the gas analyzer ports. Tightly seal the gas ports.
- 8 Disconnect the electrical leads from the gas analyzer.

Fidas24: Gas analyzer restart

- 1 Feed in instrument air and combustion air and purge the gas analyzer **for at least 20 minutes**.
- 2 Turn on the gas analyzer power supply.
- 3 Turn on the combustion gas supply and check the combustion gas pressure.
- 4 Carry out a seal integrity test on the combustion gas line (see page 283).
- 5 Turn on the sample gas supply.

See also the instructions in the section "Fidas24: Gas analyzer start-up" (see page 129).

Ambient temperature

Ambient temperature during storage and transport: -25 to +65 °C

Packing the gas analyzer

ATTENTION

Depending on its design, the gas analyzer weighs from 18 to 25 kg! Two persons are needed for removal.

Packing the gas analyzer

- 1 Remove the system bus terminating resistor from the electronics module and secure it to the housing, e.g. with adhesive tape. If the terminating resistor remains in the electronics module it can be broken during shipment causing damage to the resistor as well as to the system bus ports on the electronic module.
- 2 In the IP54 version of the system housing close off the connection box cable openings by inserting the appropriate plates.
- 3 Remove adapters from the gas ports and tightly seal the gas ports.
- 4 If the original packaging is not available, wrap the gas analyzer in bubble wrap or corrugated cardboard. When shipping overseas, additionally shrink-wrap the gas analyzer air-tight in 0.2 mm thick polyethylene film adding a drying agent (such as silica gel). The amount of drying agent should be appropriate for the package volume and the expected shipping duration (at least 3 months).
- 5 Pack the gas analyzer in an adequately sized box lined with shock-absorbing material (foam or similar). The thickness of the shock-absorbing material should be adequate for the weight of the gas analyzer and the mode of dispatch. When shipping overseas, additionally line the box with a double layer of bitumen paper.
- 6 Mark the box as "Fragile Goods".

Ambient temperature

Ambient temperature during storage and transport: -25 to +65 °C

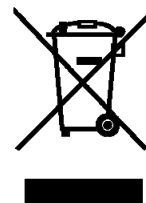
CAUTION

When you return the gas analyzer to the service department, e.g. for repair, please state which gases have been supplied to the gas analyzer. This information is needed so that service personnel can take any requisite safety precautions for harmful gases.

Disposal

Notes for disposal

Products that are marked with the adjacent symbol may not be disposed of as unsorted municipal waste (domestic waste). They should be disposed of through separate collection of electric and electronic devices.



This product and its packaging are manufactured from materials that can be recycled by specialist recycling companies.

Bear the following in mind when disposing of this product and its packaging:

- As of 8/15/2018, this product will be under the open scope of the WEEE Directive 2012/19/EU and relevant national laws.
- The product must be supplied to a specialist recycling company. Do not use municipal waste collection points. These may be used for privately used products only in accordance with WEEE Directive 2012/19/EU.
- If there is no possibility to dispose of the old equipment properly, ABB service can take care of its pick-up and disposal for a fee. To find your local ABB service contact visit abb.com/contacts or call +49 180 5 222 580.

Analyzer modules operating specifications

Note on the metrological data of the analyzer modules

The metrological data for the analyzer modules apply only when operated in conjunction with the central unit. They have been determined according to IEC 61207-1: 2010 "Expression of performance of gas analyzers – Part 1: General". They are based on nitrogen as the associated gas. Compliance with these data when measuring other gas mixtures can only be assured if their composition is known. The physical detection limit is the lower limit of the performance characteristics relative to the measuring range span.

Caldos25: Operating specifications

Linearity deviation	≤ 2 % of span
Repeatability	≤ 1 % of span
Zero drift	≤ 1 % of span per week
Sensitivity drift	≤ 1 % of the measured value per week
Output fluctuation (2 σ)	≤ 0.5 % of smallest measurement range span at electronic T ₉₀ time = 0 s
Detection limit (4 σ)	≤ 1 % of smallest measurement range span at electronic T ₉₀ time = 0 s
Flow influence	≤ 1 to 5 % of span at a flow change of ±10 l/h. At the same sample and test gas flow rate, the flow influence is automatically compensated.
Associated gas effect	Knowledge of the sample gas composition is required for the analyzer configuration. Measurement results can be greatly distorted by interfering components in complex (non-binary) gas mixtures.
Temperature influence	At each point in the measurement range: ≤ 1 % of span per 10 °C, with respect to the temperature during calibration. Thermostat temperature = 60 °C; Ambient temperature in permissible range
Air pressure effect	No effect in permissible operating condition range
Power supply influence	24 V DC ± 5 %: ≤ 0.2% of span
Position influence	< 1 % of span up to 10° deviation from horizontal orientation
T ₉₀ time	T ₉₀ typical = 10 to 20 s; Option: T ₉₀ < 6 s (applies to a gas analyzer with one analyzer module)

Caldos27: Operating specifications

	The stability data apply only to measurement ranges \geq Class 2.
Linearity deviation	$\leq 2\%$ of span
Repeatability	$\leq 1\%$ of span
Zero drift	$\leq 2\%$ of the smallest possible measurement range per week
Sensitivity drift	$\leq 0.5\%$ of the smallest possible measurement range per week
Output fluctuation (2σ)	$\leq 0.5\%$ of smallest measurement range span at electronic T90 time = 0 s
Detection limit (4σ)	$\leq 1\%$ of smallest measurement range span at electronic T90 time = 0 s
Flow influence	$\leq 0.5\%$ of span at a flow change of ± 10 l/h. At the same sample and test gas flow rate, the flow influence is automatically compensated.
Associated gas effect	The knowledge of the sample gas composition is necessary for the analyzer configuration.
Temperature influence	At each point in the measurement range: $\leq 0.5\%$ of span per $10\text{ }^{\circ}\text{C}$, with respect to the temperature during calibration. Thermostat temperature = $60\text{ }^{\circ}\text{C}$; Ambient temperature in permissible range
Air pressure effect	$\leq 0.25\%$ of span per 10 hPa for the smallest possible ranges given; in larger measurement ranges the influence effect is correspondingly smaller. Working range of installed pressure sensor: $p_{\text{abs}} = 600$ to 1250 hPa Option: Operating altitude over 2000 m
Power supply influence	$24\text{ V DC} \pm 5\%$: $\leq 0.2\%$ of span
Position influence	$< 1\%$ of span up to 30° deviation from horizontal orientation
T ₉₀ time	$T_{90} \leq 2\text{ s}$ with direct sample chamber connection and sample gas flow = 60 l/h (applies to a gas analyzer with one analyzer module)

Fidas24, Fidas24 NMHC: Operating specifications

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. These apply for the measuring ranges ≥ 50 mg org. C/m³; for smaller measuring ranges these only apply if they set are at the factory per customer order.

Linearity deviation	≤ 2 % of the measurement span up to 5000 mg org. C/m ³ , this value applies in a (calibrated) measuring range
Repeatability	≤ 0.5 % of the measuring range
Zero-point and sensitivity drift	≤ 0.5 mg org. C/m ³ per week
Output fluctuation (2σ)	≤ 0.5 % of span at electronic T ₉₀ time = 20 s, not smaller than 10 μ g org. C/m ³
Detection limit (4σ)	≤ 1 % of span at electronic T ₉₀ time = 20 s, not smaller than 20 μ g org. C/m ³
Oxygen dependence	≤ 2 % of measured value for 0 to 21 vol.% O ₂ or ≤ 0.3 mg org. C/m ³ , whichever is greater
Temperature influence	Ambient temperature in permissible range: on zero point and on sensitivity: ≤ 2 % per 10 °C in the measurement range 0 to 15 mg org. C/m ³
Power supply influence	24 V DC ± 5 %: ≤ 0.2 % of span or 230 V AC ± 10 %: \leq of span
T ₉₀ time Fidas24	T ₉₀ < 1.5 s at a sample gas flow rate = 80 l/h and electronic T ₉₀ time = 1 s
T ₉₀ time Fidas24 NMHC	T ₉₀ < 2.5 s via bypass, T ₉₀ < 3 s via converter at sample gas flow = 80 l/h and electronic T ₉₀ time = 1 s
Switch-over time (Fidas24 NMHC)	between bypass and converter typically 20 s, depending on measurement range

Limas11 IR, Limas21 UV: Operating specifications

Linearity deviation	≤ 1 % of span
Repeatability	≤ 0.5 % of span
Zero drift	≤ 2 % span per week; for ranges smaller than Class 1 to Class 2: ≤ 1.5 % span per day (Recommendation: daily automatic zero-point calibration)
Sensitivity drift	≤ 1 % of the measured value per week
Output fluctuation (2 σ)	Limas21 UV: ≤ 0.5 % of span at electronic T90 time = 10 s Limas11 IR: ≤ 0.5 % of span at electronic T90 time (static/ dynamic) = 60/5 s for ranges smaller than Class 1 to Class 2: ≤ 1 % of span
Detection limit (4 σ)	≤ 1 % of the span; for ranges smaller than Class 1 to Class 2: ≤ 2 % of span
Flow influence	Flow rate in the 20 to 100 l/h range: within the detection limit
Associated gas effect / cross sensitivity	The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Installation of filter cells or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Limas11 IR or Limas21 UV
Temperature influence	At zero point: ≤ 1 % of span per 10 °C, for measurement ranges smaller than Class 1 to Class 2: ≤ 2 % of span per 10 °C On sensitivity: ≤ 1 % of the measured value per 10 °C Sample cell temperature regulation to 60 °C; Ambient temperature in permissible range
Air pressure effect	At zero point: no influence effect On sensitivity with pressure correction with an integral pressure sensor: ≤ 0.2 % of the measured value per 1 % air pressure change The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines. The connection of the pressure sensor is led to the outside if the internal gas lines are executed as tubes. Pressure sensor working range: $p_{abs} = 600$ to 1250 hPa
Power supply influence	24 V DC ± 5 %: ≤ 0.2 % of span
T ₉₀ time	T ₉₀ = 4 s for measurement cell length = 262 mm and sample gas flow = 60 l/h without signal damping (low pass filter). Low-pass time constant adjustable from 0 to 60 s

Limas21 HW: Operating specifications

Linearity deviation	Exhaust gas and diluted exhaust gas measurement: $\leq 1\%$ of span, $\leq 2\%$ of measured value acc. to EPA specifications for automotive exhaust gas measurement Process measurement: $\leq 1\%$ of span
Repeatability	$\leq 0.25\%$ of span
Zero drift	Exhaust gas and process measurement: ≤ 1 ppm or $\leq 1\%$ of span per 24 hours Diluted exhaust gas measurement: ≤ 250 ppb or $\leq 2\%$ of span per 8 hours in each case based on the smallest recommended measurement range Daily automatic zero-point calibration recommended
Sensitivity drift	$\leq 1\%$ of the measured value per week
Output fluctuation (2σ)	Exhaust gas measurement: ≤ 400 ppb or $\leq 0.4\%$ of span at electronic T90 time = 5 s Diluted exhaust gas measurement: NO ≤ 50 ppb or $\leq 0.5\%$ of span, NO ₂ ≤ 60 ppb or $\leq 0.5\%$ of span at electronic T90 time = 15 s Process measurement: ≤ 150 ppb or $\leq 0.15\%$ of span at electronic T90 time = 30 s
Detection limit (4σ)	Exhaust gas measurement: ≤ 800 ppb or $\leq 0.8\%$ of span at electronic T90 time = 5 s Diluted exhaust gas measurement: NO ≤ 100 ppb or $\leq 1\%$ of span, NO ₂ ≤ 120 ppb or $\leq 1\%$ of span at electronic T90 time = 15 s Process measurement: ≤ 300 ppb or $\leq 0.3\%$ of span at electronic T90 time = 30 sec
Flow influence	Flow rate in the 20 to 90 l/h range: within the detection limit
Associated gas effect / cross sensitivity	The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Limas21 HW
Temperature influence	Ambient temperature in permissible range, sample cell thermostat control to +82 °C; at zero point: $\leq 2\%$ of span per 10 °C, on sensitivity: $\leq 2\%$ of measured value per 10 °C
Air pressure effect	At zero point: no influence effect On sensitivity with pressure correction with an integral pressure sensor: $\leq 0.2\%$ of the measured value per 1% air pressure change The connection of the pressure sensor is led to the outside. Pressure sensor working range: p _{abs} = 600 to 1250 hPa
Power supply influence	24 V DC $\pm 5\%$: $\leq 0.2\%$ of span
T ₉₀ time	T90 ≤ 5 s for measurement cell length = 260 mm and sample gas flow = 60 l/h with non-linear filter (static/dynamic) = 15/1 s. Low-pass time constant adjustable from 0 to 30 s.

Magnos206: Operating specifications

Linearity deviation	≤ 0.5 % of span
Repeatability	≤ 50 ppm O ₂ (time base for gas exchange ≥ 5 minutes)
Zero drift	≤ 3 % of span of the smallest measurement range (per order) per week, minimum 300 ppm O ₂ per week following prolonged transport and storage time the drift can be higher during the first weeks of operation.
Sensitivity drift	≤ 0.1 vol.% O ₂ per week or ≤ 1 % of measured value per week (not cumulative), the smaller value applies; ≤ 0.25 % of the measured value per year
Output fluctuation (2 σ)	≤ 25 ppm O ₂ at electronic T90 time (static/dynamic) = 3/0 s
Detection limit (4 σ)	≤ 50 ppm O ₂ at electronic T90 time (static/dynamic)= 3/0 s
Flow influence	≤ 0.1 vol.% O ₂ in permissible range
Associated gas effect	Influence effect of the associated gases is described in the IEC 61207-3:2002 "Gas analyzers – Expression of performance – Part 3: Paramagnetic oxygen analyzers"
Temperature influence	At zero point: ≤ 0.02 vol.% O ₂ per 10 °C; On sensitivity: ≤ 0.1 % of the measured value per 10 °C. Thermostat temperature = 64 °C; ambient temperature in permissible range
Air pressure effect	At zero point: no influence effect; On sensitivity without pressure correction: ≤ 1 % of the measured value per 1 % air pressure change; On sensitivity with pressure correction by means of internal pressure sensor: ≤ 0.1 % of the measured value per 1 % of air pressure change; for highly suppressed measurement ranges ≤ 0.01 % of the measured value per 1 % of air pressure change or ≤ 0.002 vol.% of O ₂ per 1 % pressure change, whichever is greater. Pressure sensor working range: p _{abs} = 600 to 1250 hPa
Power supply influence	24 V DC ± 5 %: ≤ 0.4 % of span
Position influence	Zero-point shift ≤ 0.05 vol.% O ₂ per 1° deviation from horizontal orientation. Position has no effect on the hard-mounted unit.
T ₉₀ time	T ₉₀ ≤ 3.5 to 10 s at sample gas flow = 10 l/h and electronic T90 time (static/dynamic) = 3/0 s, gas switching from N ₂ to air (applies to a gas analyzer with one analyzer module)

Magnos28: Operating specifications

Linearity deviation	≤ 0.5 % of span, at least 0.005 vol.% O ₂
Repeatability	≤ 50 ppm O ₂ (time base for gas exchange ≥ 5 minutes)
Zero drift	≤ 3 % of span of the smallest measurement range (per order) per week, minimum 300 ppm O ₂ per week following prolonged transport and storage time the drift can be higher during the first weeks of operation.
Sensitivity drift	≤ 0.1 vol.% O ₂ per week or ≤ 1 % of measured value per week (not cumulative), the smaller value applies; ≤ 0.15 % of measured value per three months, at least 0.03 vol.% O ₂ per three months
Output fluctuation (2 σ)	≤ 25 ppm O ₂ at electronic T90 time (static/dynamic) = 3/0 s
Detection limit (4 σ)	≤ 50 ppm O ₂ at electronic T90 time (static/dynamic)= 3/0 s
Flow influence	≤ 0.1 vol.% O ₂ in permissible range
Associated gas effect	Influence effect of the associated gases is described in the IEC 61207-3:2002 "Gas analyzers – Expression of performance – Part 3: Paramagnetic oxygen analyzers"
Temperature influence	At zero point: ≤ 0.02 vol.% O ₂ per 10 °C; On sensitivity: ≤ 0.3 vol.% O ₂ per 10 °C. Thermostat temperature = 60 °C; ambient temperature in permissible range
Air pressure effect	At zero point: no influence effect; On sensitivity without pressure correction: ≤ 1 % of the measured value per 1 % air pressure change; On sensitivity with pressure correction by means of internal pressure sensor: ≤ 0.1 % of the measured value per 1 % of air pressure change; for highly suppressed measurement ranges ≤ 0.01 % of the measured value per 1 % of air pressure change or ≤ 0.002 vol.% of O ₂ per 1 % pressure change, whichever is greater. Pressure sensor working range: p _{abs} = 600 to 1250 hPa
Power supply influence	24 V DC ± 5 %: within the detection limit
Position influence	Zero-point shift ≤ 0.05 vol.% O ₂ per 1° deviation from horizontal orientation. Position has no effect on the hard-mounted unit.
T ₉₀ time	T ₉₀ ≤ 3 s at sample gas flow = 90 l/h and electronic T90 time (static/dynamic) = 3/0 s, gas switching from N ₂ to air (applies to a gas analyzer with one analyzer module)

Magnos27: Operating specifications

Linearity deviation	≤ 2 % of span
Repeatability	≤ 1 % of span
Zero drift	≤ 1 % of span per week
Sensitivity drift	≤ 2 % of the measured value per week
Output fluctuation (2 σ)	≤ 0.5 % of smallest measurement at electronic T90 time = 0 s
Detection limit (4 σ)	≤ 1 % of smallest measurement at electronic T90 time = 0 s
Flow influence	≤ 1 % of span at a flow change of ± 10 l/h. At the same sample and test gas flow rate, the flow influence is automatically compensated.
Associated gas effect	Magnos27 calibration applies only to the sample gas (= sample component + associated gas) shown on the identification plate.
Temperature influence	At zero point: ≤ 2 % of span per 10 °C; On sensitivity: ≤ 0.5 % of measured value per 10 °C; each with respect to the temperature during calibration. Thermostat temperature = 63 °C; Ambient temperature in permissible range
Air pressure effect	At zero point: < 0.05 vol.% of O ₂ per 1 % air pressure change; On sensitivity without pressure correction: ≤ 1.5 % of the measured value per 1 % air pressure change; On sensitivity with pressure correction (option): ≤ 0.25 % of the measured value per 1 % air pressure change. Option: Operating altitude over 2000 m
Power supply influence	24 V DC \pm 5 %: ≤ 0,2 % of span
Position influence	Approx. 3 % of smallest measurement range span per 1° deviation from horizontal orientation. Position has no effect on the hard-mounted unit.
T ₉₀ time	T ₉₀ = 10 to 22 s, depending on sample gas flow and sample chamber connection (applies to a gas analyzer with one analyzer module)

Uras26: Operating specifications

Linearity deviation	≤ 1 % of span
Repeatability	≤ 0.5 % of span
Zero drift	≤ 1 % span per week; for ranges smaller than Class 1 to Class 2: ≤ 3 % of span per week
Sensitivity drift	≤ 1 % of the measured value per week
Output fluctuation (2 σ)	≤ 0.2 % of span at electronic T90 time = 5 s (Class 1) or 15 s (Class 2)
Detection limit (4 σ)	≤ 0.4 % of span at electronic T90 time = 5 s (Class 1) or 15 s (Class 2)
Flow influence	Flow rate in 20 to 100 l/h: within the detection limit
Associated gas effect / cross sensitivity	The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Installation of interference filters or filter cells or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Uras26.
Temperature influence	At zero point: ≤ 1 % of span per 10 °C, for measurement ranges smaller than Class 1 to Class 2: ≤ 2 % of span per 10 °C On sensitivity with temperature compensation: ≤ 3 % of the measured value per 10 °C On sensitivity with thermostat effect at 55 °C (Option): ≤ 1 % of the measured value per 10 °C Ambient temperature in permissible range:
Air pressure effect	At zero point: no influence effect On Sensitivity by means of an integral pressure sensor: ≤ 0.2 % of the measured value per 1 % air pressure change The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines. An external port is used for the pressure sensor if tubing is used for the internal gas lines. Pressure sensor working range: $p_{abs} = 600$ to 1250 hPa
Power supply influence	24 V DC ± 5 %: ≤ 0.2 % of span
T ₉₀ time	T ₉₀ = 2.5 s for measurement cell length = 200 mm and sample gas flow = 60 l/h without signal damping (low pass filter). Low-pass time constant adjustable from 0 to 60 s.

ZO23: Operating specifications

Linearity deviation	Owing to the measurement principle, zirconium dioxide cells are base linear.
Repeatability	< 1 % of the span or 100 ppb O ₂ (whichever is greater)
Zero drift	The zero point (reference point) is displayed if ambient air is present on the sample gas side. The value for air 20.6 vol.% O ₂ (for 25 °C and 50 % relative humidity) may deviate due to aging of the cell. < 1 % of the measuring range per week or 250 ppb O ₂ (whichever is greater)
Sensitivity drift	Depends on possible interfering components (catalyst poisons) in the sample gas and the aging of the cell. For pure gas measurements in N ₂ , CO ₂ and Ar: < 1 % of the measuring range per week or 250 ppb O ₂ (whichever is greater)
Output fluctuation (2 σ)	< ±0,5 % of the measured value or 50 ppb O ₂ (whichever is greater)
Flow influence	≤ 1 % of the measured value or 100 ppb O ₂ (whichever is greater) The flow rate is kept constant to ±0,2 l/h in the permissible range. The permissible range is 5 to 10 l/h.
Associated gas effect	Inert gases (Ar, CO ₂ , N ₂) have no effect. Flammable gases (CO, H ₂ , CH ₄) in stoichiometric concentrations to the oxygen content: Conversion of O ₂ < 20 % of the stoichiometric conversion. If higher concentrations of flammable gases are present, higher O ₂ conversions must be expected. The concentration of flammable gases in the sample gas may not exceed 100 ppm.
Temperature influence	The effect of the ambient temperature in the permissible range of +5 to +45 °C is < 2 % of the measured value or 50 ppb O ₂ per 10 °C change in the ambient temperature (whichever is greater).
Air pressure effect	No effect through a change in air pressure; sample gas must flow out of the outlet without back pressure.
Power supply influence	24 V DC ± 5 %: no effect
Position influence	Position has no effect on the hard-mounted unit
T ₉₀ time	T ₉₀ < 60 s for the alternation of 2 test gases in the measurement range 10 ppm with a sample gas flow rate = 8 l/h and electronic T90 time = 3 s (applies to an analyzer unit with 1 analyzer module)

Oxygen sensor: Operating specifications

Linearity deviation	Linear in the range of > 1 vol.% of O ₂
Repeatability	≤ 0.5 % of span
Zero drift	Stable in the long-term due to absolute zero point
Sensitivity drift	≤ 1 % of the measured value per week
Output fluctuation (2 σ)	≤ 0.2 % of span at electronic T90 time (static/dynamic)= 5/0 s
Detection limit (4 σ)	≤ 0.4 % of span at electronic T90 time (static/dynamic)= 5/0 s
Flow influence	Flow rate in 20 to 100 l/h: ≤ 2 % of the span
Temperature influence	Ambient temperature in permissible range: ≤ 0.2 vol.% of O ₂ per 10 °C
Air pressure effect	At zero point: no influence effect; On sensitivity without pressure correction: ≤ 1 % of the measured value per 1 % air pressure change; On sensitivity with pressure correction: ≤ 0.2 % of the measured value per 1 % air pressure change. Pressure correction is only possible if the oxygen sensor is connected to an analyzer module with an integral pressure sensor. Pressure sensor working range: p _{abs} = 600 to 1250 hPa
T ₉₀ time	T ₉₀ ≤ 30 s, depending on sample gas flow and system layout

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