ABB MEASUREMENT & ANALYTICS | DATA SHEET

Advance Optima AO2000 Series

Continuous gas analyzers

Measurement made easy

Modular continuous gas analyzers

A wide variety of measurement technology

- Analyzer modules for all process and emission monitoring applications
- Up to four analyzer modules handling a total of six sample components
- ‘Safety concept’ for measuring flammable gases in Zone 2 and for measuring corrosive and toxic gases
- Performance-tested for emission monitoring in accordance with EN 15267

Straightforward handling

- Common controls, common connection technology
- Automatic calibration with air or integral calibration cells eliminating the need for test gas cylinders
- Modular design for ease of service
- Self-monitoring function indicates when maintenance is required

Application-oriented design

- Housing design for 19-inch rack mounting or wall mounting
- Optional gas extraction
- Ethernet, Modbus® and PROFIBUS® interfaces
- Configurable analog and digital inputs and outputs

User-friendly operation

- Simultaneous numeric display and bar graph of measured values on a large graphics panel
- Menu-driven operator interface
- Clear-text status messages

Overview

The modular product line

Advance Optima AO2000 Series is a modular product line used for continuous process gas analysis.

The product line consists of the following modules:

- Analyzer modules,
- Pneumatic module,
- Electronics module with system controller and I/O modules,
- Housing with display and control unit and
- System bus.

The modules can be arranged in various ways to form single or multiple analyzer systems.

The electronics module, power supply and housing with display and control unit are also collectively referred to as the 'central unit'.

Measuring technology (analyzer modules)

The following analyzer modules are available for selection:

Analyzer module	Measuring task	Measurement-related data
Infrared photometer **Uras26**	Measurement of infrared-active gas components, such as CO, NO, SO_2	**Uras26 infrared photometer** from page 7 onwards
Ultraviolet photometer **Limas21 UV, Limas21 HW**	Measurement of NO, NO_2 and SO_2.	**Ultraviolet photometer Limas21 UV** from page 10 onwards
Oxygen analyzer **Magnos28**	Measurement of O_2 in operating gas or in N_2	**Oxygen analyzer Magnos28** from page 18 onwards
Oxygen analyzer **Magnos27**	Measurement of O_2 in flue gas or in N_2	**Oxygen analyzer Magnos27** from page 21 onwards
Trace oxygen analyzer **ZO23**	Measurement of O_2 in pure gases (N_2, CO_2, Ar)	**Trace oxygen analyzer ZO23** from page 23 onwards
Thermal conductivity analyzer **Caldos25, Caldos27**	Measurement of binary gas mixtures with different thermal conductivity, such as Ar in O_2, H_2 in Ar, CH_4 in N_2	**Thermal conductivity analyzer Caldos25** from page 26 onwards
Flame ionization detector **Fidas24, Fidas24 Ex, Fidas24 NMHC**	Measurement of hydrocarbons	**FID analyzer Fidas24** from page 33 onwards
Laser analyzer in **LS25**	Measurement in the near infrared spectrum e.g. O_2, NH_3, H_2O, CO, HCL	**Laser analyzer LS25** from page 46 onwards
Electrochemical oxygen sensor	Measurement of O_2	**Electrochemical oxygen sensor** from page 54 onwards

Each analyzer module consists of the sensor and associated electronics having its own processor.

The analyzer modules are connected to the system controller through the system bus. The external laser analyzer module LS25 is connected to the central unit via Ethernet.

The analyzer modules are supplied with DC 24 V from an integral power supply or an external unit.

The electrochemical oxygen sensor is assigned to an analyzer module as part of the pneumatic module.

… Overview

Pneumatic Module

When fully equipped, the pneumatic module includes one or three solenoid valves for test gas supply, one or two disposable filters for fine filtration, a pump with coarse filter and capillary tube for gas feed, one or two flow sensors for flow monitoring and an electrochemical oxygen sensor.

The pneumatics module is always associated with an analyzer module and installed in the same housing as the analyzer module.

Housing version

The system housing is available as a 19-inch rack-mount (model AO2020) or a wall-mount (model AO2040) unit with IP 20 or IP 54 housing protection (IP 40 in the version for emissions measurement).

IP 54 housing versions can be purged.

The display and control unit is located on the front panel of the housing when the electronics module is installed.

Electronics module, interfaces

The electronics module incorporates the system controller with the I/O-modules.

The **system controller** carries out the following functions:

- Processing and communicating the measured values supplied by the analyzer module sensor electronics,
- Compensating measured values, e.g. cross sensitivity correction,
- Controlling system functions, e.g. calibration.
- Display and control functions,
- Controlling associated systems, e.g. gas supply,
- Communicating with external systems.

The system controller communicates with the other functional units of the gas analyzer, such as the analyzer modules, via the system bus.

Interfaces for controlling associated systems and for communicating with external systems are located on the system controller (Ethernet 10/100/1000BASE-T interface) and on the I/O modules.

The **I/O modules** are attached and directly connected to the system controller board. There are six types of I/O modules:

- PROFIBUS® module with one RS485 and one MBP interface,
- Modbus® module with one RS485 and one RS232 interface,
- Digital I/O module with four digital inputs and four digital outputs,
- 2-way analog output modules have two analog outputs,
- 4-way analog output modules have four analog outputs,
- 4-way analog input modules have four analog inputs.

Examples of I/O module applications include:

- Output of measured values as current signals,
- Output of status and alarm signals,
- Calibration control,
- Control of external solenoid valves and pumps,
- Measuring range switching and feedback,
- Feed of current or status signals from external analyzers,
- Feed of status signals from peripherals.

System bus

The gas analyzer's functional units are interconnected via the system bus.

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

Only one electronics module with up to five I/O modules should be connected to a system bus structure.

Sample gas line conditioning

The SCC-F sample gas feed unit and the SCC-C sample gas cooler can be connected to the gas analyzer via the system bus by means of an I/O board installed in the sample gas feed unit.

Thus it is possible to display, monitor and control individual sample gas conditioning functions in the gas analyzer, such as cooler temperature or condensate and flow status.

For further information, please refer to the 'DS/SCC – System components and accessories for sample gas conditioning' data sheet.

Notes 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.
- The measurement-related data has been determined in accordance with IEC 61207-1:2010 'Expression of performance of gas analyzers – Part 1: General'. They are based on operation at atmospheric pressure (1013 hPa) and nitrogen as the associated gas. Compliance with these characteristics when measuring other gas mixtures can only be assured if their composition is known.
- The physical detection limit is the lower limit of the measurement-related data relative to the measuring range span.

… Overview

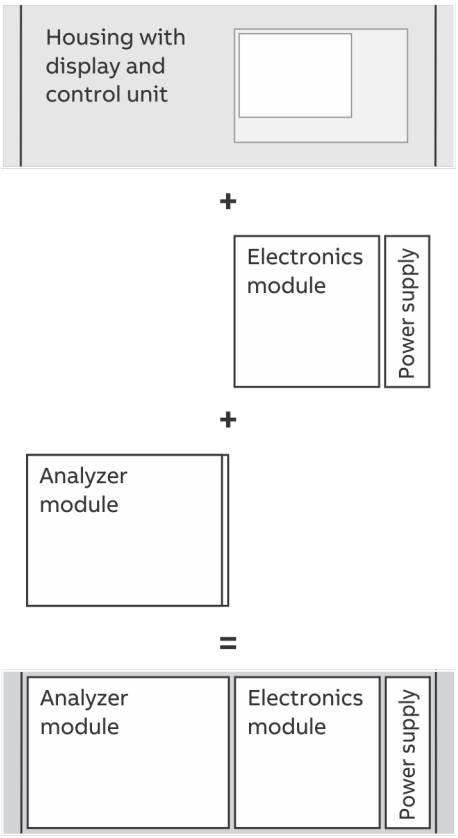
Configuration of analyzer units and multiple analyzer systems

This data sheet contains specifications for all modules in the Advance Optima AO2000 Series modular product line.
This data sheet was not intended to be used for configuring an analyzer unit or a multiple analyzer system. For a quotation please contact your ABB sales representative who can also provide advice and support during configuration.

Example 1 shows the modules and components that normally make up an analyzer unit as well as the selection possibilities for configuring an analyzer unit.

The modular product line allows modules and components to be formed into an analyzer unit (see **Example 1**) or into multiple analyzer systems (**Example 2**).

Example 1: Variant of an analyzer in a 19" housing (AO2020)



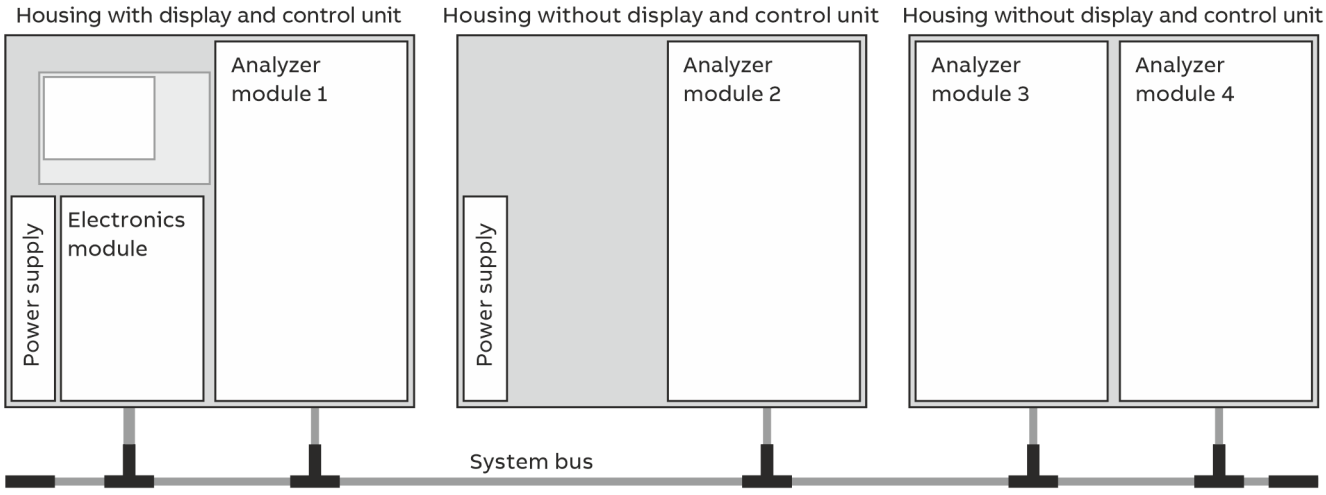
Housing with display and control unit (see page 62)
- Housing type
- with/without display and control unit
- Power supply (unless otherwise specified on electronics module)

Electronics module (see page 66)
- Power supply
- I/O module equipment
- Interfaces
- Power supply (see page 63)

Analyzer module (see page 7 to page 54)
- Gas path design
- Gas connections
- Type of installation
- Analyzer-specific data

System configuration
- Number of housings
- Number of analyzer modules
- System bus wiring
- DC 24 V analyzer power supply

Example 2: Variant of a multi-analyzer in a wall-mounted housing (AO2040)



Uras26 infrared photometer

Measuring principle

Non-dispersive infrared absorption

Photometer with 1 or 2 beam paths (gas paths) to measure up to 4 sample components

Sample components and measurement ranges

The Uras26 analyzer module has one physical measurement range per sample component. As an option, smaller measuring ranges can be electronically derived from the physical measurement range. The smallest range is measurement range 1.

The smallest measuring ranges specified in the following table refer to the 1st Measuring component of a optical path.

Sample component	Smallest class 1 range	Smallest class 2 range	Smallest meas. range Class 2 with calibration cell	Gas group*
CO	0 to 50 ppm	0 to 10 ppm	0 to 50 ppm**	A
CO_2	0 to 50 ppm	0 to 5 ppm	0 to 25 ppm**	A
NO	0 to 75 ppm	0 to 75 ppm	0 to 75 ppm**	A
SO_2	0 to 100 ppm	0 to 25 ppm	0 to 25 ppm**	A
N_2O	0 to 50 ppm	0 to 20 ppm	0 to 50 ppm**	A
CH_4	0 to 100 ppm	0 to 50 ppm	0 to 50 ppm**	A
NH_3	0 to 500 ppm	0 to 30 ppm	–	B
C_2H_2	0 to 200 ppm	0 to 100 ppm	0 to 100 ppm	B
C_2H_4	0 to 500 ppm	0 to 300 ppm	0 to 300 ppm	B
C_2H_6	0 to 100 ppm	0 to 50 ppm	0 to 50 ppm**	B
C_3H_6	0 to 250 ppm	0 to 100 ppm	0 to 100 ppm**	B
C_3H_8	0 to 100 ppm	0 to 50 ppm	0 to 50 ppm**	B
C_4H_{10}	0 to 100 ppm	0 to 50 ppm	0 to 50 ppm**	B
C_6H_{14}	0 to 500 ppm	0 to 100 ppm	0 to 100 ppm**	B
SF_6	0 to 5 ppm	0 to 4 ppm	–	B
H_2O	0 to 1000 ppm	0 to 500 ppm	0 to 500 ppm	C

* See price information

** The smallest measuring range 1 is shown. The largest measurement range should be at least four times larger.

Note
Other sample components on request.

Number of measuring ranges
1 to 4 measuring ranges per sample component

Largest measuring range
0 to 100 vol.-% or 0 vol.-% to saturation or 0 vol.-% to LEL
Measuring ranges within ignition limits cannot be provided.

Measuring range ratio
≤ 1:20

Suppressed measuring ranges
Electronic zero-point suppression or differential measurement based on a base level > 0 with flowing reference gas, max. suppression ratio of 1:10.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity error
≤ 1 % of span
Option: Linearization in accordance with EPA- specifications for automotive exhaust gas measurement

Repeatability
≤ 0.5 % of span

Zero drift
≤ 1 % of the measuring span per week;
for measuring ranges smaller than Class 1 up to Class 2:
≤ 3 % of span per week

Span drift
≤ 1 % of measured value per week

Output signal fluctuation (2 σ)
≤ 0.2 % of span at electronic T_{90}- time
= 5 s (class 1) or = 15 s (class 2)

Detection limit (4 σ)
≤ 0.4 % of the measuring span at electronic T_{90} time
= 5 sec (Class 1) or = 15 sec (Class 2)

… Uras26 infrared photometer

Influences

Flow effect

Flow rate in the 20 to 100 l/h range:
Within the detection limit

Associated gas effect/cross sensitivity

Analyzer calibration should be based on an analysis of the sample gas.

Selectivation measures to reduce the associated gas effect (options):
Incorporation of interference filters or filter cells, internal electronic cross-sensitivity or carrier gas correction for one sample component by other sample components measured with the Uras26.

Temperature effect

Ambient temperature in permissible range

- At the zero point:
  ≤ 1 % of the span per 10 °C; for measuring ranges smaller than class 1 to class 2:
  ≤ 2 % of the span per 10 °C
- On the sensitivity with temperature compensation:
  ≤ 3 % of the measured value per 10 °C
- On the sensitivity with thermostat effect at 55 °C (optional): ≤ 1 % of the measured value per 10 °C

Air pressure effect

- At the zero point:
  no influence effect
- On sensitivity with pressure correction using an integrated pressure sensor:
  ≤ 0.2 % of the measured value per 1 % of air pressure change

Power supply effect

DC 24 V ± 5 %: ≤ 0.2 % of span

Dynamic response

Warm-up time

approx. 30 minutes without thermostat; approx. 2 hours with thermostat.

T_{90} time

T_{90} = 2.5 sec 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 sec

Calibration

Calibration	Test gas
Zero-point calibration	With inert gas, e.g. nitrogen, or with ambient air that is free of the sample component.
End-point calibration	With test gas or with calibration cells filled with gas (option). It is recommended to verify the calibration cell set values once a year.

Note

When calibrating a multi-component analyzer, test gas mixtures can also be used if there are no cross-sensitivities between them. During calibration, possible electronic cross-sensitivity corrections are switched off, therefore, corrected measurement components should be calibrated only using a test gas consisting of the measurement component and an inert gas such as nitrogen.

Materials

Analyzer (sample cells)

- Tube: Aluminum or gold-plated aluminum;
- Window: CaF_2, option: BaF_2;
- Connection socket: Stainless steel 1.4571 (AISI 316Ti)

Gas lines and connectors

- Gas lines: FPM hoses or PTFE pipes with stainless steel connections;
  Option: Pipes made of stainless steel 1.4571
- Gas connections: stainless steel 1.4571

Gas connections

Refer to **Gas connections** on page 8

Sample gas conditions

Sample gas inlet conditions

Uras26 – sample gas input conditions	
Temperature	
If the sample gas taken from the process is hotter than the coldest point in the sample gas path, there may be condensation at this point, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement.	
Pressure	
Internal pressure drop:	< 5 hPa at standard flow rate of 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
Gauge pressure in the sample cell:	max. 500 hPa
Flow rate	20 to 100 l/h

Corrosive gases

Highly corrosive associated gas components, e.g. chlorine (Cl_2) and hydrogen chloride (e.g. HCl), as well as gases or aerosols containing chlorine must be cooled or undergo prior absorption. Provide for housing purge.

Flammable gases

- The analyzer module is suited 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 explosive in standard operation; If the sample gas is explosive in the event of a sample gas supply failure, then only seldom and briefly (in accordance with Zone 2).
- Pressure in the sample gas path in standard operation $p_e \leq 100$ hPa; in case of a sample gas supply failure the pressure must not up-scale the maximum value $p_e = 500$ hPa.
- The version with gas paths designed as stainless steel tubes should be selected and housing purge with nitrogen should be provided when measuring flammable gases and vapors.
- Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
- The pressure sensor must not be connected to the sample gas path.

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Ultraviolet photometer Limas21 UV

Measuring principle

Gas filter correlation or wavelength comparison in ultraviolet and visible spectrum range λ = 200 to 600 nm

Photometer to measure from 1 to 4 components.

Sample cells made from various materials are available for measurement in corrosive, toxic and flammable gases (see **Sample cells for Limas21 UV, Limas21 HW** on page 13).

Sample components and measurement ranges

The Limas21 UV analyzer module has one physical measurement range per sample component. As an option, smaller measuring ranges can be electronically derived from the physical measurement range. The smallest range is measurement range 1.

Sample component	Smallest class 1 range	Smallest class 2 range	Gas group*
NO**	0 to 50 ppm	0 to 10 ppm	A
SO_2	0 to 150 ppm	0 to 25 ppm	A
NO_2	0 to 250 ppm	0 to 50 ppm	B
NH_3	0 to 100 ppm	0 to 30 ppm	B
H_2S	0 to 50 ppm	0 to 25 ppm	B
Cl_2	0 to 250 ppm	0 to 100 ppm	D
CS_2	0 to 100 ppm	0 to 50 ppm	C
COS	0 to 500 ppm	0 to 250 ppm	C

* See price information

** The UV-RAS (ultra-violet resonant absorption spectroscopy) method is used to make the analyzer selective to the sample component NO.

Other sample components on request.

Number of measuring ranges
1 to 4 measuring ranges per sample component

Largest measuring range
0 to 100 vol.% or 0 vol.% to saturation or 0 vol.% to LEL
Measuring ranges within ignition limits cannot be provided.

Measuring range ratio
Measurement ranges freely adjustable within a range ratio of 1:20 relative to the factory-set reference measuring range

Measuring ranges with suppressed zero point
Electronic zero-point suppression, max. suppression ratio of 1:10

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They apply to measurement range 1 in a delivered analyzer module.

Linearity error
≤ 1 % of span; option: Linearization according to EPA specification for vehicle exhaust measurements

Repeatability
≤ 0.5 % of span

Zero drift
- ≤ 2 % of span per week.
- ≤ 1.5% of the measuring span per day (Recommendation: daily automatic zero point calibration)

Span drift
≤ 1 % of measured value per week

Output signal fluctuation (2 σ)
≤ 0.5 % of span with electronic T_{90}-time = 10 s;
for measuring ranges smaller than Class 1 to Class 2:
≤ 1 % of span

Detection limit (4 σ)
≤ 1 % of the measuring span; for ranges smaller than Class 1 to Class 2: ≤ 2 % of span

Influences

Flow effect

Flow rate in the range 20 to 100 l/h:
Selectivity measures to reduce associated gas effect (optional):

Associated gas effect/cross sensitivity

Analyzer calibration should be based on an analysis of the sample gas.

At zero-point:
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 Limas21.

Temperature effect

no influence effect; ¬On sensitivity without pressure correction:

- At zero point:
  ≤ 1 % of the span per 10 °C;
  for measuring ranges smaller than Class 1 to Class 2:
  ≤ 2 % of the span per 10 °C
- On sensitivity:
  ≤ 1 % of the measured value per 10 °C

Air pressure effect

- At zero point:
  No effect
- On sensitivity with pressure correction using an integrated pressure sensor:
  ≤ 0.2 % of the measured value per 1 % air pressure change

Power supply effect

DC 24 V ± 5 %: ≤ 0.2 % of span

Dynamic response

Warm-up time

Approx. 2.5 hour

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 sec

Calibration

Zero-point calibration

With inert gas, e.g. nitrogen, or with ambient air that is free of the sample component.

End-point calibration

with gas-filled calibration cells (optional) or with test gas. It is recommended to verify the calibration cell set values once a year.

During calibration of a multi-component analyzer, possible cross-sensitivity and/or carrier gas corrections by internal or external 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 such as nitrogen.

Materials

Refer to **Sample cells for Limas21 UV, Limas21 HW** on page 13.

… Ultraviolet photometer Limas21 UV

Housing purge

Purge gas

Refer to **Sample cells for Limas21 UV, Limas21 HW** on page 13.

Sample gas conditions

Sample gas inlet conditions

Limas21 UV – sample gas input conditions	
Temperature	
If the sample gas taken from the process is hotter than the coldest point in the sample gas path, it can condensate there, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement.	
Pressure	
Internal pressure drop:	< 5 hPa at standard flow rate of 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
Gauge pressure in the sample cell:	max. 500 hPa
Flow rate	20 to 100 l/h

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Corrosive, toxic and flammable gases

Refer to **Sample cells for Limas21 UV, Limas21 HW** on page 13.

Gas connections

Refer to **Sample cells for Limas21 UV, Limas21 HW** on page 13.

Sample cells for Limas21 UV, Limas21 HW

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**
Application	Standard applications	Corrosive gases	Corrosive, toxic and flammable gases
Wavelength range	200 to 600 nm	200 to 600 nm	200 to 600 nm
Resistance[1]			
Suitable for measurement of …	Non-corrosive gases	corrosive gases, e.g. wet Cl_2, wet HCl, H_2SO_4, SO_3, ozone	corrosive gases, e.g. dry HCl, dry $COCl_2$ (< 50 ppm H_2O)
Not suitable for measurement of …	Highly corrosive gases, e.g. gases containing chlorine, H_2SO_4, SO_3, fluorine compounds	Fluorine compounds	Wet gases containing chlorine, H_2SO_4, SO_3, fluorine compounds
Safety principle			
Toxic gases	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Sample cell purge[2] 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 (≤ 20 l/h) with sample component-free air or with N_2	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Sample cell purge[2] with N_2 or with sample component-free air under gauge pressure[3] with flow monitoring
Flammable gases[4]	Stainless steel gas lines, housing purge (≤ 20 l/h) with N_2	Housing purge (≤ 20 l/h) with N_2	Cell purge[2] with N_2
Seal integrity	< 1×10^{-3} hPa l/s	< 1×10^{-6} hPa l/s	< 1×10^{-6} hPa l/s
Pressure rating			
Continuous	p_e < 500 hPa	p_e < 500 hPa	p_e < 500 hPa
Spike	—	p_{abs} < 300 kPa	p_{abs} < 500 kPa
Sample cell material			
Cell tube	Aluminum	Silica glass (SiO_2)	Stainless steel 1.4571 (AISI 316Ti)
Window	CaF_2, adhesive fastening	Silica glass	CaF_2 or SiO_2, screwed connection
Seal	—	FFKM75	FFKM70
Connectors	Stainless steel 1.4571 (AISI 316Ti)	PFA	Stainless steel 1.4571 (AISI 316Ti)
Gas line materials	FPM or PTFE	PFA	Stainless steel 1.4571 (AISI 316Ti)
Gas connector materials	Stainless steel 1.4571 (AISI 316Ti)	PFA	Stainless steel 1.4571 (AISI 316Ti)
Sample gas connection design	Connectors with ⅛ NPT female threads For connection drawing, see **Limas21** on page 72.	Pipes 6/4 mm	Pipes with 4 mm outer diameter

1) See also **Sample gas inlet conditions** on page 12.
2) purge curtain
3) p_e = 7 to 20 hPa, flow 15 to 20 l/h
4) The analyzer module is suited for the measurement of flammable gases and vapors under atmospheric conditions (p_{abs} ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4. The sample gas must not be explosive at normal operation.
   Pressure in the sample gas path in standard operation p_e ≤ 100 hPa; in case of a sample gas supply failure the pressure must not up-scale the maximum value p_e = 500 hPa. Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.

Ultraviolet Photometer Limas21 HW

Measuring principle and application

Limas21 HW is a multi-component analyzer for simultaneous measurement of nitrogen compounds in wet sulfur-free flue gas without converter.

Measurement principle

Photometer to measure NO, NO_2 and NH_3.

Selectivation on the sample component NO using the UV-RAS (ultra-violet resonant absorption spectroscopy) method.

Wavelength comparison in ultraviolet spectrum range λ = 200 to 600 nm.

Application

Exhaust gas measurement for the development of combustion engines and methods for exhaust gas after-treatment, in particular for pure gas measurement after catalyst in:

- Four-stroke gasoline and diesel engines,
- Catalysts for nitrogen oxide reduction.

Process measurement e.g. for monitoring, controlling and optimizing DeNOx SCR processes.

Sample components and measuring ranges (recommendations), stability data

Exhaust gas measurement for four-stroke gasoline and diesel engines

Sample component	Smallest measurement range	Largest range
NO	0 to 100 ppm	0 to 5000 ppm
NO_2	0 to 100 ppm	0 to 2500 ppm

Linearity error

≤ 1 % of span.
≤ 2 % of measured value in accordance with EPA-specifications for automotive exhaust gas measurement

Repeatability

≤ 0.25 % of span

Zero drift

≤ 1 ppm or ≤ 1 % of span per 24 hours based on the smallest recommended measuring range (daily automatic zero point calibration recommended)

Span drift

≤ 1 % of measured value per week

Output signal fluctuation (2 σ)

≤ 400 ppb or ≤ 0.4 % of span at electronic T_{90} time = 5 s

Detection limit (4 σ)

≤ 800 ppb or ≤ 0.8 % of span at electronic T_{90} time = 5 s

Diluted exhaust gas measurement for four-stroke gasoline and diesel engines, bag measurement

Sample component	Smallest measurement range	Largest range
NO	0 to 10 ppm	0 to 500 ppm
NO_2	0 to 10 ppm	0 to 500 ppm

Linearity error
≤ 1 % of span.
≤ 2 % of measured value in accordance with EPA-specifications for automotive exhaust gas measurement

Repeatability
≤ 0.25 % of span

Zero drift
≤ 250 ppb or ≤ 2 % of the span per 8 hours based on the smallest recommended measuring range (daily automatic zero point calibration recommended)

Span drift
≤ 1 % of measured value per week

Output signal fluctuation (2 σ)
NO: ≤ 50 ppb or ≤ 0.5 % of span,
NO_2: ≤ 60 ppb or ≤ 0.5 % of span at electronic T_{90} time = 15 s

Detection limit (4 σ)
NO: ≤ 100 ppb or ≤ 1 % of span,
NO_2: ≤ 120 ppb or ≤ 1 % of span at electronic T_{90} time = 15 s

Process measurement

Sample component	Smallest measurement range	Largest range
NO	0 to 100 ppm	0 to 1000 ppm
NO_2	0 to 100 ppm	0 to 500 ppm
NH_3	0 to 100 ppm	0 to 500 ppm

Linearity error
≤ 1 % of span

Repeatability
≤ 0.25 % of span

Zero drift
≤ 1 ppm or ≤ 1 % of span per 24 hours based on the smallest recommended measuring range (daily automatic zero point calibration recommended)

Span drift
≤ 1 % of measured value per week

Output signal fluctuation (2 σ)
≤ 150 ppb or ≤ 0.15 % of span at electronic T_{90} time = 30 s

Detection limit (4 σ)
≤ 300 ppb or ≤ 0.3 % of span at electronic T_{90} time = 30 s

Measuring ranges

Quantity
1 to 4 measuring ranges per sample component

Measuring range ratio
Max. 1:20; Measuring ranges freely adjustable within a range ratio of 1:20 relative to the factory-set reference measuring range;

Max. 1:50 for fixed measuring ranges in accordance with EPA-specifications for automotive exhaust gas measurement.

… Ultraviolet Photometer Limas21 HW

Influences

Flow effect

Flow rate in the 20 to 90 l/h range: within the detection limit

Associated gas effect/cross sensitivity

Analyzer calibration should be based on an analysis of the sample gas.

Selectivation measures to reduce associated gas effect: Internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Limas21 HW.

Temperature effect

Ambient temperature in permissible range,
Sample cell thermostat control to +80 °C

- At zero point:
  ≤ 2 % of the span per 10 °C
- On sensitivity:
  ≤ 2 % of the measured value per 10 °C

Air pressure effect

- At zero point:
  No effect
- On sensitivity with pressure correction using an integrated pressure sensor:
  ≤ 0.2 % of the measured value per 1 % air pressure change

Power supply effect

DC 24 V ± 5 %: ≤ 0.2 % of span

Dynamic response

Warm-up time

Approx. 4 hour

T_{90}time

T_{90} ≤ 5 sec 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

Calibration

Zero-point calibration

With inert gas, e.g. nitrogen, or with ambient air that is free of the sample component.

End-point calibration

with gas-filled calibration cells (optional) or with test gas. It is recommended to verify the calibration cell set values once a year.

During calibration of a multi-component analyzer, possible cross-sensitivity and/or carrier gas corrections by internal or external 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 such as nitrogen.

Materials

Sample cell

Pipe and window: Quartz glass, screw connection: PVDF, connection piece: PTFE

Gas lines

PTFE, FPM

Gas connections

Stainless steel 1.4571 (AISI 303), 1.4305 (AISI 316Ti)

Housing purge

Purge gas

Sample component-free air or nitrogen Purge gas flow rate ≤ 10 l/h

Sample gas conditions

Sample gas inlet conditions

Limas21 HW – sample gas input conditions	
Sample gas composition	
Sulfur-free exhaust gas of combustors, SO_2 concentration < 25 ppm, H_2O < 20 vol.%, filtered with pore width ≤ 0.5 µm	
Temperature	
If the sample gas taken from the process is hotter than the coldest point in the sample gas path, it can condensate there, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement.	
Pressure	
Internal pressure drop:	< 5 hPa at standard flow rate of 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
Gauge pressure in the sample cell:	max. 500 hPa
Flow rate	20 to 90 l/h

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Gas connections

Refer to **Limas21** on page 72.

Notes

- The Limas21 HW analyzer module can only be mounted in the 19” housing.
- SO_2 influences the NH_3 measured value. If the sample gas mixture contains SO_2, the requirement of internal corrections must be scrutinized. When ordering the average water vapor concentration has to be specified. The influence is corrected internally.

Sample conditioning system requirements

Sample gas feed-in

The various applications require the sample gas feed-in to the gas analyzer at temperatures of 150 to 190 °C.

It is imperative to eliminate condensation and resublimation since NO_2 and NH_3 are easy soluble in water and can lead to salification. It is also imperative to prevent condensation of potentially present low-boiling hydrocarbons.

Sample gas inlet temperature

150 to 190 °C

Sample gas filter

During the measurement of NO and $NO2_2$: Sintered metal
Durind the measurement of NH_3: Ceramic; pore size ≤ 0,5 µm

Materials

PTFE, PVDF or Silicosteel®

Oxygen analyzer Magnos28

Measuring principle

Paramagnetic oxygen analyzer

Sample components and measurement ranges

Sample component	Smallest measurement range	Largest range
Oxygen (O_2)	0 to 0.5 vol.%	0 to 100 vol.%

Number of measuring ranges
There are four available measuring ranges. The measuring range limits can be freely configured on the device.

The measuring range limits are set to
0 to 10/15/25/100 vol.% O_2 or in accordance with the order.

Note
Measurement ranges should not be set within ignition limits.

Measuring ranges with suppressed zero point
Suppressed measuring ranges can be freely adjusted in the range from 0 to 100 vol.-%. Multiple measuring ranges must be overlapping.
The minimum measuring span is 0.5 vol.-%.

For suppressed measuring ranges, pressure correction using a pressure sensor is required. If the analyzer has been ordered with the suppressed measuring range, a pressure sensor will be installed at the factory.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity error
≤ 0.5 % of the measuring span or ≤ 0.005 vol.% O_2, the greater value applies

Repeatability
≤ 50 ppm O_2

Zero drift
≤ 0.05 vol.-% O_2 per week
The value may be elevated during first commissioning or after a longer service life.

Span drift
Drift per week: ≤ 0.2 % of the measured value or
≤ 0.01 vol. % O_2, the greater value applies

Output signal fluctuation (2 σ)
≤ 25 ppm O_2 at electronic T_{90} time (static/dynamic) = 3/0 sec

Detection limit (4 σ)
≤ 50 ppm O_2 at electronic T_{90} time (static/dynamic) = 3/0 sec

Influences

Flow effect

- Sample gas N_2:
  ≤ 0.1 vol. % O_2 in the permissible flow range;
- Sample gas air:
  ≤ 0.1 vol. % O_2 at a flow rate change of 10 l/h

Associated gas effect

Information on the influence of associated gases can be found in IEC 61207-3:2002 'Gas analyzers – Expression of performance – Part 3: Paramagnetic oxygen analyzers'.

Temperature effect

Average temperature effect in permissible ambient temperature range:

- At zero point:
  ≤ 0.02 vol. % O_2 per 10 °C
- On sensitivity:
  ≤ 0.3 % of the measured value per 10 °C
- For suppressed measuring ranges (if configured at the factory):
  ≤ 0.01 vol. % per 10 °C in the entire measuring range

Thermostat temperature: 60 °C

For suppressed and very small measuring ranges (≤ 0 to 1 vol. % O_2), greater temperature fluctuations (≥ 5 °C) at the installation site should be avoided.

Air pressure effect

- On sensitivity without pressure correction:
  ≤ 1 % of the measured value per 1 % air pressure change
- On sensitivity with pressure correction using an integrated pressure sensor (option):
  ≤ 0.1 % of the measured value per 1 % air pressure change
  For suppressed measuring ranges:
  ≤ 0.01 % of the measured value per 1 % air pressure change
  or ≤ 0.002 vol.-% O_2 per 1 % air pressure change, the greater value applies

Power supply effect

DC 24 V ± 5 %:
Selectivity measures to reduce associated gas effect (optional):

Position effect

Zero-point shift ≤ 0.05 vol. % O_2 per 1° deviation from horizontal location.
Position has no effect on the hard-mounted unit.

Dynamic response

Warm-up time

The analyzer typically reaches the specified zero point drift per week after 2 h.
For measuring spans of < 0 to 5 % as well as on initial commissioning or after a longer service life, the value may be higher.

T_{90}time

T_{90} ≤ 3 sec at a sample gas flow of 90 l/h and electronic T_{90} time (static/dynamic) = 3/0 sec, gas change from nitrogen to air (applies to a gas analyzer only with Magnos28)

Calibration

Calibration	Test gas
Zero-point calibration	Oxygen-free operating gas or with substitute gas
End-point calibration	Operating gas with a known oxygen concentration or a substitute gas such as dried air.
Single-point calibration (For measuring ranges higher 0 to 5 vol. % O_2)	Zero point gas or operating gas with known oxygen concentration
Measurement ranges with suppressed zero-point	Suppressed measuring ranges should be calibrated for the greatest possible accuracy with high-accuracy purity gases or test gases. For calibration recommendation see the following table.

Test gases for suppressed measuring ranges

Upper range value	Zero gas point	End point gas
Up to 100 vol. % O_2	N_2	100 % O_2
Up to about 21 vol. % O_2	N_2	Instrument air or high-purity test gas

… Oxygen analyzer Magnos28

Materials

Analyzer

- Sample chamber: • Stainless steel 1.4305, nickel alloy, glass, PtNi, silicon, gold, PTFE
- Gaskets: FPM, option: FFKM75

Sample gas conditions

Sample gas inlet conditions

Magnos28 – sample gas input conditions	
Temperature • If the sample gas taken from the process is hotter than the coldest point in the sample gas path, there may be condensation at this point, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement. • When there is a direct connection to the sample chamber, the maximum sample gas dew point is 55 °C. • Water vapor content variations cause volume errors.	
Designation of gas connections	
Internal pressure drop:	< 5 hPa at standard flow rate of 60 l/h.
Permissible absolute pressure range:	800 to 1600 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request.
Operation in non-hazardous areas (GP)	• Non-flammable sample gases: max. 1.6 bar • Flammable sample gases: max. 1,2 bar
Operation in potentially explosive areas (zone 2)	• Non-flammable sample gases: max. 1.6 bar • Flammable sample gases: max. 1,1 bar
Operation under higher pressure.	A pressure sensor is required to compensate for pressure influences.
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. See **Note - Pressure compensation with external pressure sensor** on page 20
The analyzer module is function-tested for 5000 hPa internal pressure without damage.	
Flow rate	30 to 90 l/h; measuring ranges ≤ 0 to 3 vol % O_2: 60l/h For highly suppressed measuring ranges and measuring ranges of ≤ 0 to 3 vol % O_2, changes of the sample gas flow should be avoided.

Corrosive gases

- Consultation with ABB Analytical is required if the sample gas contains Cl_2, HCl, HF or other corrosive components.
- If the sample gas contains NH_3, FFKM75 gaskets must be used; in this case, the pneumatic module cannot be connected to the analyzer module.
- The pressure sensor must not be connected to the sample gas path during measurement of corrosive gases.

Flammable gases

- The analyzer module is suited for the measurement of flammable gases and vapors under atmospheric conditions (p_{abs} ≤ 1.1 bar, oxygen content ≤ 21 vol.-%). Temperature class: T4.
- The sample gas may not be explosive in standard operation; If the sample gas is explosive in the event of a sample gas supply failure, then only seldom and briefly (in accordance with Zone 2).
- Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
- The pressure sensor must not be connected to the sample gas path.
- Housing purge with nitrogen should be provided during measurement of flammable gases and vapors.

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Pressure sensor

Note - Pressure compensation with external pressure sensor

If the integration of an external pressure signal into the signal processing is required, this must be specified when ordering.

External pressure compensation is calculated using a function block.

Gas connections

Refer to **Gas connections** on page 20.

Oxygen analyzer Magnos27

Measuring principle

Paramagnetic behavior of oxygen
Heavy-duty thermomagnetic analyzer

Sample components and measurement ranges

Sample component
Oxygen (O_2) in flue gas or in nitrogen (N_2)

Smallest measuring range
0 to 3 vol.% O_2

Measuring range quantity and measuring range limits
1 to 4 measuring ranges
Ranges are factory-set in accordance with order.

Largest measuring range
0 to 100 vol.% O_2
Measuring ranges within ignition limits cannot be provided.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity error
≤ 2 % of span

Repeatability
≤ 1 % of measuring span

Zero point drift
≤ 1 % of span per week

Span drift
≤ 2 % of measured value per week

Output signal fluctuation (2 σ)
≤ 0.5 % of smallest measuring range span at electronic T_{90} time = 0 s

Detection limit (4 σ)
≤ 1 % of the measuring span of the smallest measuring range at electronic T_{90} time = 0 s

Influences

Flow effect
≤ 1 % of span at a flow change of ±10 l/h. At an identical flow rate for test and sample gases, the flow rate effect is automatically compensated.

Associated gas effect
Magnos27 calibration applies only to the sample gas shown on the identification plate (= sample component + associated gas).

Temperature effect
Ambient temperature in permissible range
- At zero point:
  ≤ 2 % of span per 10 °C
- On the sensitivity:
  ≤ 0.5 % of the measured value per 10 °C

based on temperature at the time of calibration
Thermostat temperature = 63 °C.

Air pressure effect
- at zero point:
  < 0.05 vol. % O_2 per 1 % air pressure
- On sensitivity without pressure correction:
  ≤ 1.5 % of the measured value per 1 % of air pressure change
- On sensitivity with pressure correction using an integrated pressure sensor (option):
  ≤ 0.25 % of the measured value per 1 % of air pressure change

Option: calibration for operating altitude over 2000 m

Power supply effect
DC 24 V ± 5 %: ≤ 0.2 % of span

Position effect
Approx. 3 % of the span of the smallest measuring range per 1° deviation from horizontal orientation.
Position has no effect on the hard-mounted unit.

Dynamic response

Warm-up time
2 to 4 h

T_{90} time
T_{90}= 10 to 22 s, depending on sample gas flow and on the sample chamber connection (see **Gas connections** on page 22; applies to a gas analyzer only with Magnos27)

… Oxygen analyzer Magnos27

Calibration

Zero-point calibration
With oxygen-free process gas or substitute gas

End-point calibration
With process gas having a known oxygen concentration or with substitute gas

Materials

Analyzer
Stainless steel 1.4580 and 1.4305, glass

Gas lines and connectors
Stainless steel 1.4571 and 1.4305, PVC-C, FPM

Sample gas conditions

Sample gas inlet conditions

Magnos27 – sample gas input conditions	
Temperature • If the sample gas taken from the process is hotter than the coldest point in the sample gas path, there may be condensation at this point, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement. • When there is a direct connection to the sample chamber, the maximum sample gas dew point is 55 °C. • Water vapor content variations cause volume errors.	
Designation of gas connections	
Internal pressure drop:	< 5 hPa at standard flow rate of 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.
Gauge pressure in the measuring chamber:	max. 100 hPa.
Flow rate	20 to 90 l/h

Flammable gases
Measurement of flammable gases is not permitted.

Requirements for the sample gas outlet
The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Gas connections

Refer to **Gas connections** on page 22.

Trace oxygen analyzer ZO23

Measuring principle

Potentiometric measurement

Zirconium dioxide cell for determination of the oxygen concentration in accordance with Nernst's equation; reference gas: ambient air.

The analyzer module is used for the continuous measurement of oxygen in pure gases (N_2, CO_2, Ar). The measuring cell is catalytically inactivated to the extent that flammable carrier components in stoichiometric concentrations only negligibly reduce the oxygen value.

Sample components and measurement ranges

Sample component

Oxygen (O_2)

Measuring ranges and measuring range limits

4 measurement ranges
The limits of the measuring ranges are freely adjustable within the range of 0 to 1 ppm to 0 to 250,000 ppm O_2; they are factory-set to 0 to 1/10/100/1000 ppm O_2.
The following measurement data refer to a span of 100 ppm O_2 with a regulated flow rate of 8 ±0.2 l/h.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity

Owing to the measurement principle, zirconium dioxide cells are base linear.

Repeatability

< 1 % of the measuring span or 100 ppb O_2 (greater value applies)

Zero point drift

< 1 % of the measuring range per week or 250 ppb O_2 (greater value applies)

The zero point (reference point) is displayed if ambient air is present on the sample gas side.
The value for air of 20.6 vol. % O_2 (at 25 °C and 50 % relative air humidity) may deviate through aging of the cell.

Span drift

For pure gas measurements in N_2, CO_2 and Ar:
< 1 % of the measuring range per week or 250 ppb O_2 (greater value applies)

Depends on possible interfering components (catalyst poisons) in the sample gas and the aging of the cell.

Output signal fluctuation (2 σ)

< ±0.5 % of the measured value or 50 ppb O_2 (whichever is greater)

Detection limit (4 σ)

< ±1 % of the measured value or 100 ppb O_2 (whichever is greater)

… Trace oxygen analyzer ZO23

Influences

Flow effect

≤ 300 ppbv O_2 in the range from 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 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 must not exceed 100 ppm.

Temperature effect

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 value 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 effect

DC 24 V ± 5 %: no effect

Position effect

No position effect for permanently installed instruments

Dynamic response

Warm-up time

- The operating temperature of the cell is reached after approx. 15 minutes. Offset calibration with reference gas (ambient air) after 2 hours flow.
- The measurement is ready-to-run after valves and lines have been purged with sample gas. Typical purging time for valves and lines: approx. 2 to 5 hours.

T_{90}time

T_{90} < 60 sec for the alternation of 2 test gases in the measuring range 10 ppm with a sample gas flow rate = 8 l/h and electronic T_{90} time = 3 sec

Calibration

Offset calibration

The reference value for ambient air is calibrated at 20.6 vol.% O_2 by means of ambient air on the sample gas side.

End-point calibration

By means of test gas O_2 in N_2 (or in CO_2 or Ar);
O_2 concentration in the measuring range, e.g. 10 ppm O_2

Function test

Extended response time or reduced sensitivity are dimensions for the correct functioning of the measuring cell. The function test can be carried out without any additional test gases by feeding the sample gas with constant concentration.

Based on the progression of the test, it can be assessed whether the reaction time of the sensor lies within a specified tolerance. The function test is started manually and lasts approx. 15 minutes.

Additional function block configuration is required for the cyclic scan.

Materials

Analyzer

- Zirconium dioxide cell: ZrO_2, electrodes containing platinum
- Dust filter (optional): PP
- Flow sensor (optional): on semiconductor basis, nickel-plated brass

Gas lines and connectors

- Gas inlet (piped): Stainless steel 1.4571 (AISI 316Ti)
- Gas outlet: Silicone hose and FPM-hose
- Gas connections: Stainless steel 1.4401/1.4305

Sample gas conditions

Sample gas inlet conditions

Note
The analyzer module must not be used for measurement of ignitable gas/air or gas/oxygen mixtures.

ZO23 – sample gas input conditions	
Temperature	5 to 50 °C
Inlet pressure	$p_e \leq 70$ hPa
Flow rate	4 to 20 l/h

- The sample gas flow rate must be kept constant within the specified range at ±0.2 l/h.
- The sample gas must be taken unpressurized from a bypass.
- If the sample gas flow is too low, contamination effects from the gas lines (leaks, permeability, de-sorption) will lead to inaccuracies in the measurement result.
- If the sample gas flow is too high, asymmetrical cooling of the sensor may cause measurement errors. This can also cause quicker aging or damage to the measuring cell.

Note
The temperature, pressure and flow of the sample gas must be kept constant, to such an extent that the influence of variations on the measuring accuracy is acceptable, refer to **Influences** on page 24.

Corrosive gases

The presence of corrosive gases and catalyst poisons, such as halogens, gases containing sulfur and heavy-metal dust, leads to quicker aging and / or the destruction of the ZrO_2 cell.

Flammable gases

The analyzer module is suitable for measuring flammable gases in a non-explosive environment. The concentration of flammable gases in the sample gas must not exceed 100 ppm.

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Purge gas

If case purging is selected, purging may only be carried out with air (not with nitrogen), since the ambient air is used as a reference gas.

Note
The ZO23 cannot be connected to or combined with the pneumatic module.

Gas connections

Refer to **Gas connections** on page 25.

Thermal conductivity analyzer Caldos25

Measuring principle

Difference in thermal conductivity of various gases

Highly corrosion-resistant heat conductivity analyzer, measuring cell embedded in glass.

Sample components and measurement ranges

The Caldos25 is specifically designed for measurements of corrosive gas components.

Sample components and smallest measurement ranges (examples)

Sample component and associated gas	Smallest measurement range	Reference gas
H_2 in N_2 or air	0 to 0.5 Vol.-%	Air (sealed)
SO_2 in N_2 or air	0 to 1.5 Vol.-%	Air (sealed)
H_2 in Cl_2	0 to 0.5 Vol.-%	Flowing

Measuring range quantity and measuring range limits
1 to 4 measuring ranges per sample component
The measuring ranges are factory-set in accordance with the customer order.

Largest measuring range
0 to 100 vol. % or 0 vol. % to saturation
Measurement ranges within ignition limits cannot be provided.

Measuring range switching ratio
≤ 1:20

Measuring ranges with suppressed zero point
Span at least 2 vol.%, depending on application

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity error
≤ 2 % of span

Repeatability
≤ 1 % of span

Zero drift
≤ 1 % of span per week

Span drift
≤ 1 % of measured value per week

Output signal fluctuation (2 σ)
≤ 0.5 % of smallest measurement range span at electronic T_{90} time = 3 sec

Detection limit (4 σ)
≤ 1 % of smallest measurement range span at electronic T_{90} time = 3 sec

Influences

Flow effect

≤ 1 to 5 % of span at a flow change of ±10 l/h.
At an identical flow rate for test and sample gases, the flow rate effect is automatically compensated.

Associated gas effect

Analyzer calibration should be based on an analysis of the sample gas.

Measurement results can be greatly distorted by interfering components in complex (non-binary) gas mixtures.

Temperature effect

Ambient temperature in permissible range

- In any point of the measuring range:
  ≤ 1 % of span per 10 °C, based on the temperature at the time of calibration

Thermostat temperature = 60 °C (140 °F)

Air pressure effect

No effect in permissible operating condition range

Power supply effect

DC 24 V ± 5 %: ≤ 0.2 % of span

Position effect

< 1 % of span up to 10° deviation from horizontal orientation

Dynamic response

Warm-up time

1.5 hours

T_{90}time

T_{90} typical = 10 to 20 s; optional: T_{90} < 6 s
(applies to an analyzer unit with 1 analyzer module)

Calibration

Calibration	Test gas
Zero-point calibration	Sample-component-free process gas or substitute gas With suppressed measuring range: Substitute gas or operating gas with sample gas concentration close to the starting point of the measuring range
End-point calibration	Test gas, process gas with a known sample gas concentration or substitute gas

… Thermal conductivity analyzer Caldos25

Materials

Analyzer

Stainless steel 1.4305 (AISI 303), glass

Gas lines and connectors

- If the reference gas is sealed:
  Stainless steel 1.4305;
- If the reference gas is flowing:
  PVC-C, FPM gaskets;
- For corrosive measurement gas:
  PVC-C, FPM gaskets;

Contains the NH_3 sample gas, therefore FFKM gaskets are used.

Sample gas conditions

Sample gas inlet conditions

Caldos25 – sample gas input conditions	
Temperature • If the sample gas taken from the process is hotter than the coldest point in the sample gas path, there may be condensation at this point, if the gas contains components that can condense. The sample gas dew point should be at least 5 °C below the temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is required. • Water vapor content variations cause volume errors.	
Designation of gas connections	
Internal pressure drop:	< 5 hPa at standard flow rate of 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.
Gauge pressure in the measuring chamber:	max. 100 hPa.
Flow rate	Standard 10 to 90 l/h, Max. 90 to 200 l/h for option T_{90} < 6 s

Flowing reference gas

Gas inlet conditions same as sample gas

Flammable gases

- The analyzer module is suited for the measurement of flammable gases and vapors under atmospheric conditions (p_{abs} ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4.
- The sample gas may not be explosive in standard operation; If the sample gas is explosive in the event of a sample gas supply failure, then only seldom and briefly (in accordance with Zone 2).
- Pressure in the sample gas path in standard operation p_e ≤ 100 hPa; in case of a sample gas supply failure the pressure must not up-scale the maximum value p_e = 500 hPa.
- Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
- The pressure sensor must not be connected to the sample gas path.
- Housing purge with nitrogen should be provided during measurement of flammable gases and vapors. Flame barriers can be used as an option (except for the 'safety concept' version, see **Version in category II 3G for measurement of flammable and non-flammable gases ('Safety Concept')** on page 58).

Flame barriers	
Pressure drop	Approx. 40 hPa at a sample gas flow rate of 50 l/h
Material	Stainless steel 1.4571

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Gas connections

Refer to **Gas connections** on page 28.

Thermal conductivity analyzer Caldos27

Measuring principle

Difference in thermal conductivity of various gases

Micromechanical silicon sensor with especially short T_{90} time

Sample components and measurement ranges

Sample component and associated gas	Smallest measuring range	Smallest measurement range with suppressed zero-point
Ar in CO_2	—	50 to 100 Vol.-%
Ar in H_2	0 to 3 Vol.-%	99 to 100 Vol.-%
Ar in He	0 to 3 Vol.-%	99 to 100 Vol.-%
Ar in air	0 to 6 Vol.-%	94 to 100 Vol.-%
Ar in N_2	0 to 6 Vol.-%	97.5 to 100 Vol.-%
Ar in O_2	0 to 2 Vol.-%	90 to 100 Vol.-%
CH_4 in H_2	0 to 3 Vol.-%	99 to 100 Vol.-%
CH_4 in N_2	0 to 2 Vol.-%	99 to 100 Vol.-%
CO in H_2	0 to 3 Vol.-%	99 to 100 Vol.-%
CO_2in Ar	0 to 50 Vol.-%	—
CO_2 in H_2	0 to 3 Vol.-%	99 to 100 Vol.-%
CO_2 in air	0 to 3 Vol.-%	90 to 100 Vol.-%
CO_2 in N_2	0 to 3 Vol.-%	90 to 100 Vol.-%
H_2 in Ar	0 to 0.25 Vol.-%	97 to 100 Vol.-%
H_2 in CH_4	0 to 1 Vol.-%	97 to 100 Vol.-%
H_2 in CO	0 to 1 Vol.-%	97 to 100 Vol.-%
H_2 in CO_2	0 to 1 Vol.-%	97 to 100 Vol.-%
H_2 in stack gas	0 to 0.5 Vol.-%	—
H_2 in air	0 to 0.3 Vol.-%	—
H_2 in N_2	0 to 0.3 Vol.-%	97 to 100 Vol.-% 99 to 100 Vol.-%*
H_2 in NH_3	0 to 10 Vol.-%	90 to 100 Vol.-%
H_2 in O_2	0 to 1 Vol.-%	98 to 100 Vol.-%
He in Ar	0 to 1 Vol.-%	97 to 100 Vol.-%
He in air	0 to 2 Vol.-%	97 to 100 Vol.-%
He in N_2	0 to 2 Vol.-%	97 to 100 Vol.-%
Air in Ar	0 to 6 Vol.-%	94 to 100 Vol.-%
Air in CO_2	0 to 10 Vol.-%	90 to 100 Vol.-%
Air in H_2	0 to 3 Vol.-%	—
Ar in He	0 to 3 Vol.-%	98 to 100 Vol.-%
N_2 in Ar	0 to 6 Vol.-%	94 to 100 Vol.-%
N_2 in CH_4	0 to 6 Vol.-%	94 to 100 Vol.-%
N_2 in CO_2	0 to 10 Vol.-%	90 to 100 Vol.-%
N_2 in H_2	0 to 3 Vol.-%	99 to 100 Vol.-%
N_2 in He	0 to 3 Vol.-%	98 to 100 Vol.-%
NH_3 in H_2	0 to 10 Vol.-%	90 to 100 Vol.-%
O_2 in Ar	0 to 10 Vol.-%	90 to 100 Vol.-%

* Daily zero point check required

Sample components and measurement ranges for monitoring hydrogen-cooled turbo generators

Sample component and associated gas	Meas. range
CO_2 in air	0 to 100 Vol.-%
H_2 in CO_2	100 to 0 Vol.-%
H_2 in air	100 to 80/90 vol.%

Other sample components on request.

Measuring range quantity and measuring range limits

1 to 4 measuring ranges per sample component
Range limits are freely adjustable. They are factory-calibrated for the largest possible measurement range.

Largest measuring range

0 to 100 vol. % or 0 vol. % to saturation, depending on measurement task.
Measurement ranges within ignition limits cannot be provided.

Measuring range switching ratio

≤ 1:20

Measuring ranges with suppressed zero point

See the table above for spans

… Thermal conductivity analyzer Caldos27

Stability

These data apply only to measuring ranges ≥ class 2

Linearity error
≤ 2 % of span

Repeatability
≤ 1 % of span

Zero drift
≤ 2 % of smallest possible measuring range per week

Span drift
≤ 0.5 % of the smallest provided measuring range per week

Output signal fluctuation (2 σ)
≤ 0.5 % of smallest measurement range span at electronic T_{90} time = 3 sec

Detection limit (4 σ)
≤ 1 % of smallest measurement range span at electronic T_{90} time = 3 sec

Influences

Flow effect
≤ 0.5 % of span at a flow change of ±10 l/h. At an identical flow rate for test and sample gases, the flow rate effect is automatically compensated.

Associated gas effect
Analyzer calibration should be based on an analysis of the sample gas.

Temperature effect
Ambient temperature in permissible range.
At each point in the measuring range:
≤ 0.5 % of the measuring span per 10 °C, with respect to the temperature during calibration
Thermostat temperature = 60 °C (140 °F)

Air pressure effect
≤ 0.25 % of span per 10 hPa for the smallest ranges; for larger spans, the influence effect is correspondingly lower.
Power Supply Influence Calibration for operating altitude over 2000 m

Power supply effect
24 V DC ± 5 %: ≤ 0.2 % of span

Position effect
< 1 % of span up to 30° deviation from horizontal orientation

Dynamic response

Warm-up time

Approx. 30/60 minutes for class 1/2 measuring ranges

T_{90}time

T_{90} ≤ 2 s for direct sample chamber connection and sample gas flow = 60 l/h (applies to an analyzer unit with 1 analyzer module)

Calibration

Calibration	Test gas
Zero-point calibration	Sample-component-free process gas or substitute gas With suppressed measuring range: Substitute gas or operating gas with sample gas concentration close to the starting point of the measuring range
End-point calibration	Test gas, process gas with a known sample gas concentration or substitute gas
Single-point calibration with standard gas	Test gas with a known and constant rTC value or substitute gas (standard gas; possibly also dried room air)

Materials

Analyzer

- Sample chamber: Stainless steel 1.4305 (AISI 316Ti)
- Sensor: Gold, silicon oxi-nitride
- Gasket: FFKM75 (Perfluoro rubber)

Sample gas conditions

Sample gas inlet conditions

Note

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

Caldos27 – sample gas input conditions	
Temperature	
• If the sample gas taken from the process is hotter than the coldest point in the sample gas path, there may be condensation at this point, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement. • Water vapor content variations cause volume errors	
Designation of gas connections	
Internal pressure drop:	< 5 hPa at standard flow rate of 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
Gauge pressure in the measuring chamber:	max. 100 hPa
Flow rate	Typically 10 to 90 l/h, minimum 1 l/h

Corrosive gases

- Consultation with ABB Analytical is required if the sample gas contains Cl_2, HCl, HF, SO_2, NH_3, H_2S or other corrosive components.
- If the sample gas contains NH_3, flexible FPM tubes may not be used; flexible FFKM tubes must be used instead.
  In this case, the pneumatics module cannot be connected to the analyzer module.

… Thermal conductivity analyzer Caldos27

… Sample gas conditions

Flammable gases

- The analyzer module is suited for the measurement of flammable gases and vapors under atmospheric conditions (p_{abs} ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4.
- The sample gas may not be explosive in standard operation; If the sample gas is explosive in the event of a sample gas supply failure, then only seldom and briefly (in accordance with Zone 2).
- Pressure in the sample gas path in standard operation p_e ≤ 100 hPa; in case of a sample gas supply failure the pressure must not up-scale the maximum value p_e = 500 hPa.
- Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
- The pressure sensor must not be connected to the sample gas path.
- Housing purge with nitrogen should be provided during measurement of flammable gases and vapors. Flame barriers can be used as an option (except for the 'safety concept' version, see **Version in category II 3G for measurement of flammable and non-flammable gases ('Safety Concept')** on page 58).

Flame barriers	
Pressure drop	Approx. 40 hPa at a sample gas flow rate of 50 l/h
Material	Stainless steel 1.4571

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Gas connections

Refer to **Gas connections** on page 32.

FID analyzer Fidas24

Measuring principle

Flame-ionization detector

The analyzer module complies with the requirements for measuring instruments with flame ionization detection according to EN 12619.

Sample components and measurement ranges

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.

Number of sample components
4 sample components

Smallest measuring range
0 to 5 to 0 to 1500 mg org. C/m^3 or
0 to 10 to 0 to 3000 ppm C1

Largest measuring range
0 to 80 g org. C/m^3 or 0 to 15 vol. % C1
Other measuring ranges on request.

Measuring range quantity and measuring range limits
1 to 4 measuring ranges
The measuring ranges are factory-set per customer order.
Smallest to largest measuring range ratio 1:300 to 1:1500 , depending on the configuration.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

They apply to measuring ranges ≥ 50 mg org. C/m^3; for smaller measuring ranges these only apply if they are factory-set in accordance with the order.

Linearity error
≤ 2 % of span to 5000 mg org. C/m^3,
this value applies in one (calibrated) measuring range

Repeatability
≤ 0.5 % of measurement range

Zero drift
≤ 0.5 mg org. C/m^3 per week

Span drift
≤ 0.5 mg org. C/m^3 per week

Output fluctuation at zero point (2 σ)
≤ 0.5 % of span at electronic T_{90}-time = 20 s

Detection limit (4 σ)
≤ 1 % of span at electronic T_{90} time = 20 s

… FID analyzer Fidas24

Influences

Oxygen dependence

≤ 2 % of measured value for 0 to 21 vol. % O_2 or
≤ 0.3 mg org. C/m^3, the larger value applies in each case

Temperature effect

Ambient temperature in permissible range

- At zero point and on sensitivity:
  ≤ 2 % of the measured value per 10 °C or ≤ 300 ppb C1 per 10 °C

Power supply effect

- DC 24 V ± 5 %: ≤ 0.2 % of span or
- AC 230 V ± 10 %: ≤ 0.2 % of span or
- AC 115 V ± 10 %: ≤ 0.2 % of span

Dynamic response

Warm-up time

≤ 2 hours

T_{90}time

T_{90} < 1.5 s at sample gas flow = 80 l/h and electronic T_{90}time = 1 sec

Calibration

Calibration	Test gas
Zero-point calibration	With synthetic air or catalytically purified air or nitrogen, depending on the application.
End-point calibration	With propane or another hydrocarbon (substitute gas) in air or nitrogen, depending on the application.

Materials

Analyzer, gas lines and connectors

Stainless steel 1.4305 and 1.4571, FPM, PTFE, FFKM

Sample gas conditions

Sample gas inlet conditions

Fidas24 – sample gas input conditions	
Temperature	≤ Thermostat temperature (thermostat temperature for sample gas path, detector and air injector ≤ 200 °C, factory-set at180 °C)
Inlet pressure	p_{abs} = 800 to 1100 hPa
Flow rate	approx. 80 to 100 l/h at atmospheric pressure (1000 hPa)
Humidity	≤ 40 % H_2O

Further properties of the sample gas

The sample gas must not be explosive at any time.

The analyzer module must not be used for the measurement of gases containing organometallic compounds, e.g. lead-containing fuel additives or silicone oils.

Flammable gases

The gas analyzer may be used for the measurement of flammable gases provided that the flammable portion does not up-scale 15 Vol.-% CH_4 or does not up-scale C1 equivalents.

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Operational gases

Instrument air

Parameter	Value/Description
Quality	According to ISO 8573-1 Class 2 Particle size: max. 1 µm, Particle density: max. 1 mg/m^3, Oil content: max. 0.1 mg/m^3, Dew point: At least 10 °C below the lowest expected ambient temperature
Inlet pressure p_e	4000 hPa, ±500 hPa
Flow rate	Typically approx. 1800 l/h (1200 l/h for the air jet injector and approx. 600 l/h for the housing purge), max. approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air

Parameter	Value/Description
Quality	• Synthetic air or catalytically purified air • Organic hydrocarbon content: < 1 % of the measuring range
Inlet pressure p_e	1200 hPa, ±100 hPa
Flow rate	< 20 l/h

Combustion gas

Note

An H_2/He mixture may only be used if the gas analyzer has been ordered and delivered in the intended version.

Combustion gas parameter		
Quality	Hydrogen (H_2), Quality 5.0	H_2/He mix (40 %/60 %) Quality 5.0
Inlet pressure p_e	1200 hPa, ±100 hPa	1200 hPa, ±100 hPa
Maximum combustion gas flow	approx. 3 l/h	approx. 10 l/h

Note

A flow limiter must be provided on the hydrogen supply, see **Safe operation of the gas analyzer** on page 36.

Test gases

Test Gases for Zero Calibration	
Quality	Nitrogen, Quality 5.0, synthetic air or catalytically cleaned air with an organic C < 1 % MBU
Inlet pressure p_e	1000 ±100 hPa
Flow rate	130 to 250 l/h

Test gases for endpoint calibration	
Quality	Test gas in nitrogen or synthetic air with concentration adjusted to the measuring range
Inlet pressure p_e	1000 ±100 hPa
Flow rate	130 to 250 l/h

Zero point offset

If the zero point gas is not completely free of hydrocarbons (even purified nitrogen contains fractions of hydrocarbons), negative measured values may be displayed in small measuring ranges.

In this case, the sample gas contains a lower proportion of hydrocarbons than the zero point gas.

Gas and Electrical Connections

Refer to **Fidas24** on page 79.

… FID analyzer Fidas24

Safe operation of the gas analyzer

The device concept ensures that a concentration of combustible gas or an explosive mixture of combustible gas and ambient air cannot occur in the interior of the gas analyzer during normal operation.

The interior of the gas analyzer cannot be allocated to an (explosion protection) zone; an explosive gas mixture cannot escape to the outside.

The end user must make the following provisions to ensure safe operation of the gas analyzer:

- The combustion gas flow rate must be limited to a maximum of 10 l/h H_2 or 25 l/h H_2/He mixture. For this purpose, the end user has to provide suitable measures outside the gas analyzer.
- A shut-off valve must be installed in the combustion gas supply line to increase safety in the following operating conditions: 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 near the combustion gas supply.

FID analyzer Fidas24 NMHC

Measuring principle

Non-methane flame-ionization detector
(NMHC = Non-Methane Hydrocarbons)

The analyzer module complies with the requirements for measuring instruments with flame ionization detection according to EN 12619.

A non-methane converter is used in the Fidas24 NMHC to measure CH_4.

Sample components and measurement ranges

Sample components

Hydrocarbons.
The CH_4/NMHC ratio must be in the 1:9 to 9:1 range.

- Maximum concentration CH_4:
  26500 mg org. C/m^3 or 50000 ppm C1.
- Maximum concentration NMHC:
  5000 mg org. C/m^3 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.

Number of sample components

2 sample components: CH_4 and THC.
The calculated non-methane portion of the hydrocarbons is output as the 3rd NMHC component.

Smallest measuring range

0 to 5 to 0 to 1500 mg org. C/m^3 or
0 to 10 to 0 to 3000 ppm C1

Largest measuring range CH_4 and THC

0 to 50 to 0 to 25000 mg org. C/m^3 or
0 to 100 to 0 to 50000 ppm C1

Largest measuring range NMHC

0 to 5000 mg org. C/m^3 or
0 to 10000 ppm C1

Measuring range quantity and measuring range limits

1 to 4 measuring ranges
The measuring ranges are factory-set per customer order.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

They apply to measuring ranges ≥ 50 mg org. C/m^3; for smaller measuring ranges these only apply if they are factory-set in accordance with the order.

Linearity error

≤ 2 % of span to 5000 mg org. C/m^3,
this value applies in one (calibrated) measuring range

Repeatability

≤ 0.5 % of measurement range

Zero drift

≤ 0.5 mg org. C/m^3 per week

Span drift

≤ 0.5 mg org. C/m^3 per week

Output fluctuation at zero point (2 σ)

≤ 0.5 % of span at electronic T_{90}-time = 20 s

Detection limit (4 σ)

≤ 1 % of span at electronic T_{90} time = 20 s

… FID analyzer Fidas24 NMHC

Influences

Oxygen dependence

≤ 2 % of measured value for 0 to 21 vol. % O_2 or
≤ 0.3 mg org. C/m^3, the larger value applies in each case

Temperature effect

Ambient temperature in permissible range

- At zero point and on sensitivity:
  ≤ 2 % of the measured value per 10 °C or ≤ 300 ppb C1 per 10 °C

Power supply effect

- DC 24 V ± 5 %: ≤ 0.2 % of span or
- AC 230 V ± 10 %: ≤ 0.2 % of span or
- AC 115 V ± 10 %: ≤ 0.2 % of span

Dynamic response

Warm-up time

≤ 2 hours

T_{90}time

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

Switchover time

Between bypass and converter typically 20 s, depending on measuring range

Converter operating time

The catalyst is a consumable material.
Its service life depends on the concentration of the converted hydrocarbons.
Catalyst poisons (e.g. SO_2, HCl, H_2S, halogenated hydrocarbons, heavy metals) will shorten the converter service life. Their respective concentration should always be < 20 mg/m^3.
It is recommended to test the converter function once a year.

Calibration

Zero-point calibration

With synthetic air or catalytically purified air, depending on application

Sensitivity calibration

With methane or propane in air, depending on application

Materials

Analyzer, gas lines and connectors

Stainless steel 1.4305 and 1.4571, FPM, PTFE, FFKM

Sample gas conditions

Sample gas inlet conditions

Fidas24 – sample gas input conditions	
Temperature	≤ Thermostat temperature (thermostat temperature for sample gas path, detector and air injector ≤ 200 °C, factory-set at180 °C)
Inlet pressure	p_{abs} = 800 to 1100 hPa
Flow rate	approx. 80 to 100 l/h at atmospheric pressure (1000 hPa)
Humidity	≤ 40 % H_2O

Further properties of the sample gas

The sample gas must not be explosive at any time.

The analyzer module must not be used for the measurement of gases containing organometallic compounds, e.g. lead-containing fuel additives or silicone oils.

Flammable gases – Fidas24 NMHC

The gas analyzer may be used for the measurement of flammable gases provided that the total flammable portion does not up-scale 5 vol.-% CH_4 or does not up-scale C1 equivalents.

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Operational gases

Instrument air

Parameter	Value/Description
Quality	According to ISO 8573-1 Class 2 Particle size: max. 1 µm, Particle density: max. 1 mg/m^3, Oil content: max. 0.1 mg/m^3, Dew point: At least 10 °C below the lowest expected ambient temperature
Inlet pressure p_e	4000 hPa, ±500 hPa
Flow rate	Typically approx. 1800 l/h (1200 l/h for the air jet injector and approx. 600 l/h for the housing purge), max. approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air

Parameter	Value/Description
Quality	• Synthetic air or catalytically purified air • Organic hydrocarbon content: < 1 % of the measuring range
Inlet pressure p_e	1200 hPa, ±100 hPa
Flow rate	< 20 l/h

Combustion gas

Note

An H_2/He mixture may only be used if the gas analyzer has been ordered and delivered in the intended version.

Combustion gas parameter		
Quality	Hydrogen (H_2), Quality 5.0	H_2/He mix (40 %/60 %) Quality 5.0
Inlet pressure p_e	1200 hPa, ±100 hPa	1200 hPa, ±100 hPa
Maximum combustion gas flow	approx. 3 l/h	approx. 10 l/h

Note

A flow limiter must be provided on the hydrogen supply, see **Safe operation of the gas analyzer** on page 40.

Test gases

Test Gases for Zero Calibration	
Quality	Nitrogen, Quality 5.0, synthetic air or catalytically cleaned air with an organic C < 1 % MBU.
Inlet pressure p_e	1000 ±100 hPa
Flow rate	130 to 250 l/h

Test gases for endpoint calibration	
Sample components CH_4	CH_4 in air
THC sample components	C_3H_8 in air or CH_4 in air
Components for substitute gas calibration (if configured in accordance with the order):	CH_4 in air
Inlet pressure p_e	Depressurized
Flow rate	At least 20 l/h more than the sample gas flow

Test gases for converter effectiveness testing	
Test gas	CH_4 or C_2H_6 or C_3H_8 in air (separate test gas bottles), connection via a bypass
Inlet pressure p_e	Depressurized
Flow rate	At least 20 l/h more than the sample gas flow

Gas and Electrical Connections

Refer to **Fidas24** on page 79.

… FID analyzer Fidas24 NMHC

Safe operation of the gas analyzer

The device concept ensures that a concentration of combustible gas or an explosive mixture of combustible gas and ambient air cannot occur in the interior of the gas analyzer during normal operation.

The interior of the gas analyzer cannot be allocated to an (explosion protection) zone; an explosive gas mixture cannot escape to the outside.

The end user must make the following provisions to ensure safe operation of the gas analyzer:

- The combustion gas flow rate must be limited to a maximum of 10 l/h H_2 or 25 l/h H_2/He mixture. For this purpose, the end user has to provide suitable measures outside the gas analyzer.
- A shut-off valve must be installed in the combustion gas supply line to increase safety in the following operating conditions: 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 near the combustion gas supply.

AO2040-Fidas24 Ex for use in Zone 1, 21 und Zone 2, 22

The AO2040-Fidas24 Ex is an explosion proof variant of the Fidas24 analyzer module from the Advance Optima AO2000 series. The AO2040-Fidas24 Ex is a standalone variant of the AO2000.

The device consists of the following modules:

- Analyzer module Fidas24
- Electronics module with system controller and I/O modules
- Wall housing with display and control unit and attached purge and monitoring unit.

Explosion protection

The AO2040-Fidas24 Ex is available in the following variants:

- Equipment protection level EPL Gb for use in Zone 1
- Equipment protection level EPL Db for use in Zone 21
- Equipment protection level EPL Gc for use in Zone 2
- Equipment protection level EPL Dc for use in Zone 22

In all variants, the protection concept is based on a pressurized enclosure in accordance with EN 60079-2 and an intrinsically safe control unit in accordance with EN 60079-11. For the Zone 1 and Zone 21 variants, the customer interfaces must be protected with an all-pole isolating relay.

ATEX / IECEx versions

Design	Product code	Type examination certificate / Ex marking	Further requirements
Category “3G”, Equipment protection level “Gc”	24041- XXX2XXXXXXXX or XXX3XXXXXXXX	**ATEX** BVS 20 ATEX E 049 X ⟨Ex⟩ II 3G Ex pxb ib IIC T3 Gc **IECEx** IECEx BVS 20.0039X Ex pxb ib IIC T3 Gc	—
Category “2G”, Equipment protection level “Gb”	24041-XXX**1**XXXXXXXX	**ATEX** BVS 20 ATEX E 048 X ⟨Ex⟩ II 2G Ex pxb ib IIC T3 Gb **IECEx** IECEx BVS 20.0039X Ex pxb ib IIC T3 Gb	Installation of an additional interface relay for connections on the operator’s side, if these can still remain live after the power supply has been switched off or if the pressurized encapsulation fails.
Category “3D”, Equipment protection level “Dc”	24041-XXX**8**XXXXXXXX	**ATEX** BVS 20 ATEX E 049 X ⟨Ex⟩ II 3D Ex pxb ib [ib] IIIC T195°C Dc **IECEx** IECEx BVS 20.0039X Ex pxb ib [ib] IIIC T195°C Dc	Installation of a key switch to confirm that the interior of the housing has been cleaned of dust during commissioning.
Category “2D”, equipment protection level “Db”	24041-XXX**7**XXXXXXXX	**ATEX** BVS 20 ATEX E 048 X ⟨Ex⟩ II 2D Ex pxb ib [ib] IIIC T195°C Db **IECEx** IECEx BVS 20.0039X Ex pxb ib [ib] IIIC T195°C Db	Installation of an additional interface relay for connections on the operator’s side, if these can still remain live after the power supply has been switched off or if the pressurized encapsulation fails. Installation of a key switch to confirm that the interior of the housing has been cleaned of dust during commissioning.

… AO2040-Fidas24 Ex for use in Zone 1, 21 und Zone 2, 22

Measuring principle

Flame-ionization detector

The analyzer module complies with the requirements for measuring instruments with flame ionization detection according to EN 12619.

Sample components and measurement ranges

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.

Number of sample components
4 sample components

Smallest measuring range
0 to 5 to 0 to 1500 mg org. C/m^3 or
0 to 10 to 0 to 3000 ppm C1

Largest measuring range
0 to 80 g org. C/m^3 or 0 to 15 vol. % C1
Other measuring ranges on request.

Measuring range quantity and measuring range limits
1 to 4 measuring ranges
The measuring ranges are factory-set per customer order.
Smallest to largest measuring range ratio 1:300 to 1:1500 , depending on the configuration.

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

They apply to measuring ranges ≥ 50 mg org. C/m^3; for smaller measuring ranges these only apply if they are factory-set in accordance with the order.

Linearity error
≤ 2 % of span to 5000 mg org. C/m^3, this value applies in one (calibrated) measuring range

Repeatability
≤ 0.5 % of measurement range

Zero drift
≤ 0.5 mg org. C/m^3 per week

Span drift
≤ 0.5 mg org. C/m^3 per week

Output fluctuation at zero point (2 σ)
≤ 0.5 % of span at electronic T_{90}-time = 20 s

Detection limit (4 σ)
≤ 1 % of span at electronic T_{90}-time = 20 s

Influences

Oxygen dependence

≤ 2 % of measured value for 0 to 21 vol. % O_2 or
≤ 0.3 mg org. C/m^3, the larger value applies in each case

Temperature effect

- Ambient temperature in permitted range:
  - Standard: 5 to 45 °C
  - Measuring ranges < 100 ppm: 5 to 40 °C
- At zero point and on the sensitivity:
  < 2 % of the measured value per 10 K or < 300 ppb C1 per 10 K, the larger value shall respectively apply

Power supply effect

- DC 24 V ±5 %:
  ≤ 0.2 % of span or
- AC 230 / 115 V ±10 %:
  ≤ 0.2 % of span

Dynamic response

Warm-up time

≤ 2 h at nominal voltage and 25 °C ambient temperature

T_{90}time

T_{90} < 1.5 s at sample gas flow = 80 l/h and electronic T_{90}time = 1 s

Calibration

Calibration	Test gas
Zero-point calibration	With synthetic air or catalytically purified air or nitrogen, depending on the application.
End-point calibration	With propane or another hydrocarbon (substitute gas) in air or nitrogen, depending on the application.

Materials

Analyzer, gas lines and connectors

Stainless steel 1.4305 and 1.4571, FPM, PTFE, FFKM

Sample gas conditions

Sample gas inlet conditions

Parameter	Value/Description
Temperature	≤ 130 °C (also applies in the case of heated sample gas lines)
Inlet pressure p_{abs}	800 to 1100 hPa
Outlet pressure	The outlet pressure must be the same as the atmospheric pressure. Overpressure version: maximum 1250 hPa abs
Flow rate	Approx. 80 to 100 l/h at atmospheric pressure (1000 hPa)
Humidity	≤ 40 % H_2O

Note
The temperature, pressure and flow of the sample gas must be kept constant, to such an extent that the influence of variations on the measuring accuracy is acceptable, refer to **Stability** on page 42.

Further properties of the sample gas
The sample gas must not be explosive at any time.

The analyzer module must not be used for the measurement of gases containing organometallic compounds, e.g. lead-containing fuel additives or silicone oils.

Flammable sample gases

⚠ DANGER

Explosion hazard
Explosion hazards due to flammable sample gases with a C1-equivalent of ≥ 8 Vol-% CH_4.

- The flammable sample gas that is fed in must have the following specifications:

Sample gas specifications

- The sample gas that is fed in must at no time, exceed the C1-equivalent of 8 Vol-% CH_4.
- The sample gas that is fed in must not be potentially explosive.
- The specifications must also be adhered to during the start-up and shut-down processes, and the pressure, temperature and gas matrix must be taken into account.

Note

An explosive mixture of gases is defined as a mixture containing combustion components, that falls within the lower (UEG) and upper explosion limits (OEG), which is accompanied by the simultaneous presence of oxidizers (e.g. air, oxygen).

Requirements for the sample gas outlet
The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

… AO2040-Fidas24 Ex for use in Zone 1, 21 und Zone 2, 22

Operational gases

Properties of the instrument air

Parameter	Value/Description
Quality	According to ISO 8573-1 Class 2 Particle size: max. 1 µm, Particle density: max. 1 mg/m^3, Oil content: max. 0.1 mg/m^3, Dew point: At least 10 °C below the lowest expected ambient temperature
Inlet pressure p_e	4000 hPa, ±500 hPa; 5000 hPa, ±500 hPa for overpressure version
Temperature	Maximum 40 °C
Flow rate	Typically approx. 1200 l/h, refer also to Purge gas flow.

Note

For Fidas24-Ex in the overpressure version, the purge gas supply for the pressurized enclosure must be made separately from the instrument air supply. In the case of common supply, the pressure for the purge gas supply must be reduced using an additional pressure reducer.

Purging gas properties for pressurized enclosure (FS870S)

(in the case of separate supply)

Parameter	Value/Description
Quality	Class 533, in accordance with DIN ISO 8573-1
Inlet pressure p_e	4000 hPa, ±500 hPa
Temperature	Maximum 40 °C
Flow rate	Refer to Purge gas flow.
Note	
When using the instrument air of the Fidas24 as purging gas for the pressurized enclosure, the quality specified in the top table applies.	

Combustion air

Parameter	Value/Description
Quality	• Synthetic air or catalytically purified air • Organic hydrocarbon content: < 1 % of the measuring range
Inlet pressure p_e	1200 hPa, ±100 hPa
Flow rate	< 20 l/h

Combustion gas

Combustion gas parameter	
Quality	Hydrogen (H_2), Quality 5.0
Inlet pressure p_e	1200 hPa, ±100 hPa
Combustion gas flow rate*	Typical ≤ 3 l/h, maximum 10 l/h

* The combustion gas flow is limited to a maximum of 10 l/h H_2 by an integrated flow limiter.

Note

The safety valve installed in the analyzer closes safely up to a combustion gas pressure of 6 bar.
The operator must take suitable measures to prevent the occurrence of higher pressures at the combustion gas inlet.

Test gases

Test Gases for Zero Calibration	
Quality	• Nitrogen, quality 5.0; synthetic or catalytically purified air • Organic hydrocarbon content of < 1 % of the measuring range
Inlet pressure p_e	1000 ± 100 hPa
Flow rate	130 to 250 l/h

Test gases for endpoint 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 ±100 hPa
Flow rate	130 to 250 l/h

Purge gas flow

Initial purge

The purging gas flow rate and the duration of the purging process for the purging and monitoring unit FS870S are preset at the factory.

Parameter	Factory setting
Initial purge volumes	250 l
Purging gas flow rate during initial purging	3600 l/h (1 l/s)

During operation

The purging gas flow rate and the pressurized control range of the purging and monitoring unit FS870S are pre-programmed at the factory.

Parameter	Factory setting
Purge Gas Flow Rate during Operation	1080 l/h
Monitored pressurized control range	0.8 to 15 hPa

Gas and Electrical Connections

Refer to **Fidas24 Ex** on page 80.

Electrical data for the power supply

The power supply unit built into the system housing is used to supply the 24 V DC to the Fidas24 Ex module and the associated electronics with DC energy.

Power supply (entire device)	
Input voltage	110 to 230 V AC, ±10 %
Input Current	Maximum 2.0 A
Line Frequency Range	50 to 60 Hz, ±3 Hz
Power consumption (entire device)	Maximum 200 VA
Output Voltage	24 V DC, ±3 % (for optional cut-off relay control)
Connection	At the corresponding terminals of the purging and monitoring unit, refer to **Purging and monitoring unit FS870S** on page 84.

Battery

Application

Supply to the built-in clock in case of a voltage failure.

Type

Lithium button cell 3 V CR 2032

Note

Only the original battery type may be used as a replacement:

- Varta CR 2032 type no. 6032 or
- Renata type no. CR2032 MFR

Safe operation of the gas analyzer

The device concept ensures that a concentration of combustible gas or an explosive mixture of combustible gas and ambient air cannot occur in the interior of the gas analyzer during normal operation.

The interior of the gas analyzer cannot be allocated to an (explosion protection) zone; an explosive gas mixture cannot escape to the outside.

The end user must make the following provisions to ensure safe operation of the gas analyzer:

- The maximum permissible combustible gas inlet pressure must not be up-scaled, see **Combustion gas** on page 44.
- A shut-off valve must be installed in the combustion gas supply line to increase safety in the following operating conditions: 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 near the combustion gas supply.

Housing design

The housing is designed as a wall unit (model AO2040) with housing protection IP 65.

Housing materials

- Housing: Stainless steel 1.4016 (AISI 316Ti)
- Module back panel: Aluminum
- Keyboard foil: Polyester

Housing color

Light gray (RAL 7035), basalt gray (RAL 7012)

Weight

Wall-mounted housing with analyzer module:
18 to 23 kg

Dimensions

Refer to **Model AO2040-Fidas24 Ex** on page 84.

Laser analyzer LS25

Overview

Figure 1: AO2000-LS25

The LS25 is an external AO2000 laser analyzer module for an in situ or cross-stack application directly on site in the process, additional gas extraction and gas conditioning systems are therefore not necessary. This improves the availability of measurements and eliminates the risk of sample handling failure. The analyzer is mounted directly on flanges, purge gas connections and a tilting mechanism for easy alignment are included in the purge flange.

Rough process conditions are not a problem for the LS25, so measurements are possible, for example, under high process temperatures, high process pressures, high dust exposure and even with corrosive gases. Thanks to the tunable diode laser absorption spectroscopy (TDLAS), a non-contact optical measurement method, the analyzer remains unaffected by impurities and corrosive substances and therefore does not need regular maintenance.

Continuous purging of the optical windows prevents dust and other impurities from settling and the measuring gas from coming into contact with the optical windows. Measurement as an extractive system with an external measuring cell is of course also possible.

Highlights	Typical applications	Customer benefits
Line measurement over the complete measuring distance	Metal industry	In situ measurement
Fast reaction time	Power plants	fast process optimization
contactless measurement	Waste incineration plants	proven technology
No interference with associated gases	Chemical industry	Low maintenance costs
no zero point drift	Petrochemical industry	Reduction of emissions into the environment
Available for tough process conditions	Cement industry	Increased safety
ATEX, IECEX and CSA certified	Pulp & Paper Industry	Increased system availability

Measuring principle

The LS25 laser analyzer module is based on a measuring principle called single-line spectroscopy.
One single target gas absorption line with no interference is chosen in the near infrared spectral range.

A single mode diode laser operating around room temperature scans the respective absorption line.
The absorption caused by the sample gas is measured by means of a receiver located opposite, and the concentration is determined based on this.
An automatic correction of pressure and temperature changes is possible.

Sample components and measurement ranges

The LS25 laser analyzer module has one physical measurement range per sample component. The indicated measurement range can be freely calibrated within the physical measurement range.
The smallest detection limits and corresponding measuring ranges are shown in the table below.
Other sample components on request.

The optical path length is typically between 0.5 and 15.0 m.
Application-related deviations can occur.
In some cases, additional measures must be taken to achieve the smallest measuring ranges:
The measurement of low O_2 and H_2O concentrations require device and process purging with nitrogen.
Actual detection limit for a specific application will depend on the process conditions (pressure, temperature and gas composition) and optical path length. There are different device versions with different detection limits and process conditions for certain sample components.
Min. measurement range, max. pressure and max. temperature cannot necessarily be realized simultaneously.
The maximum pressure and temperature given are physical (spectroscopic) limits. Applications with increased temperature or pressure or with corrosive or flammable gas may require additional equipment.

Sample components and measurement ranges

Other sample components and higher pressures on request.

Sample components*	Smallest measurement range	Max. abs. Pressure	Max. temperature
O_2	0 to 1 vol.%	10 bar	1500 °C
NH_3	0 to 15 ppm	2 bar	500 °C
HCl	0 to 5 ppm	2 bar	600 °C
HF	0 to 2 ppm	2 bar	400 °C
H_2S	0 to 300 ppm	2 bar	300 °C
H_2O (ppm)	0 to 10 ppm	2 bar	1000 °C
H_2O (vol.%)	0 to 0.5 vol.%	2 bar	1500 °C
CO (ppm)	0 to 30 ppm	2 bar	1500 °C
CO (vol.%)	0 to 0.3 vol.%	2 bar	1500 °C
CO_2 (ppm)	0 to 100 ppm	2 bar	300 °C
CO_2 (vol.%)	0 to 1 vol.%	2 bar	1500 °C
NO	0 to 1000 ppm	2 bar	350 °C
N_2O	0 to 100 ppm	2 bar	200 °C
NO_2	0 to 500 ppm	2 bar	200 °C
HCN	0 to 30 ppm	2 bar	300 °C
CH_3I	0 to 100 ppm	1.5 bar	200 °C
CH_4 (vol.%)	0 to 1 vol.%	3 bar	1000 °C
CH_4 (ppm)	0 to 20 ppm	3 bar	300 °C
CH_2O	0 to 100 ppm	2 bar	200 °C
C_2H_4	0 to 100 ppm	1.5 bar	150 °C
C_2H_4O	0 to 100 ppm	1.5 bar	150 °C
$NH_3 + H_2O$	0 to 20 ppm 0 to 5 Vol.-%	1.5 bar	600 °C
$HCl + H_2O$	0 to 10 ppm 0 to 10 Vol.-%	1.5 bar	600 °C
$HF + H_2O$	0 to 3 ppm 0 to 2 Vol.-%	1.5 bar	400 °C
$HCN + NH_3$	0 to 30 ppm 0 to 300 ppm	2 bar	300 °C
CO (vol.%) + CO_2 (vol.%)	0 to 1 Vol.-% 0 to 1 Vol.-%	1.5 bar	600 °C
$HCl + CH_4$	0 to 300 ppm 0 to 0.2 Vol.-%	1.5 bar	200 °C
CO (ppm) + CH_4	0 to 20 ppm 0 to 200 ppm	1.5 bar	1500 °C
CO (ppm) + H_2O (vol.%)	0 to 300 ppm 0 to 10 Vol.-%	1.5 bar	1500 °C
O_2 + Temp.	0 to 1 vol.% 0 to 100 °C	2.0 bar	1500 °C

Note

The specified data are based on a 1 m optical path length, 25 °C sample gas temperature and a sample gas pressure of 1 bar abs., sample gas in nitrogen with a confidence level of 95 %, deviations from this are possible depending on the process.

Number of measuring ranges

1 range per sample component, 1 x transmission

Largest measuring range

Largest measuring range is generally 100 times the minimum measuring range for the same conditions. Larger measuring ranges are possible, for example by adjusting the optical path length or choosing a different absorption line, please contact ABB in this regard.

Sample gas properties

Maximum process gas temperature and pressure are given in the **Sample components and measurement ranges** on page 54 table.

Quantification of dust/particle concentration in the sample gas is necessary in order to determine max OPL. The maximum dust concentration must be checked by ABB Analytical.

Purge gasproperties

The purge gas (instrument air or nitrogen, depending on the process) must be free of oil and dust.
Recommendation: in accordance with ISO 8573.1 Class 2–3

The process purging gas flow is between 10 and 50 l/min, depending on the application.
The analyzer purging gas flow (Ex pxb – Zone 1 devices) must be at least 11 l/min or 48 l/min.

Stability

Linearity error

≤ 1 % of span

Repeatability

± Detection limit or ± 1 % of reading, whichever is greater (depending on the gas and application)

Zero drift

Due to the measuring principle, there is no zero point drift.

Output signal fluctuation (2 σ)

≤ 0.5 % of smallest measuring range

Detection limit (4 σ)

≤ 1 % of smallest measuring range

… Laser analyzer LS25

Influences

Flow effect

No effect on the measurement, but the flow will determine the amount of purge gas needed.

Associated gas effect/cross sensitivity

No cross sensitivity within normal operation conditions.

Temperature influence (depending on application)

- Ambient temperature in permitted range:
  No significant influence
- The temperature of the measured gas is taken into account by the analyzer so that the measured value can be corrected internally.
  - If the gas temperature is constant, a fixed value can be stored in the analyzer.
  - If the gas temperature varies, an external temperature signal (4 to 20 mA) can be used for internal compensation.

Influence of pressure (depending on application)

- At zero point:
  No influence effect.
- The pressure of the measured gas is taken into account by the analyzer so that the measured value can be corrected internally.
  - If the gas pressure is constant, a fixed value can be stored in the analyzer.
  - If the gas pressure varies, an external pressure signal (4 to 20 mA) can be used for internal compensation.

Power supply effect

DC 24 V ±5 %:
≤ 0.2 % of measuring span

Dynamic response

Warm-up time

< 15 min (depending on environment)

Response time

< 2 s

Calibration

Zero point check

With nitrogen or with ambient air free of sample components. The zero point cannot be calibrated. Due to the measuring principle, there is no zero point drift.

End point check

A review of the calibration data is recommended every 6 to 12 months, depending on the application

Validation

Depending on the application, online validation is possible using the optional internal or external validation cell

Calibration interval

Depending on the application;
typically once or twice a year

End pointcalibration

With test gas and a calibration cell.

Materials

Purge and alignment unit

Stainless steel 316SS.

Window

BK7 glass, optional: Synthetic quartz glass or sapphire glass

Mounting

Installation site requirements

The mounting location strongly influences the measurement result. The measurement gas must be well stirred at the selected location to produce a representative measurement result.

- Stratification in the measurement gas path results in erroneous measurement.
- If the measurement gas is charged with dust, it is recommended to mount the LS25 at right angles to the process gas flow.

Adjustment or installation flanges

Adjustment and installation flanges are available in the following variants and are compatible with:

- DN 50/PN 10 to 40, DN 80/PN 10 to 40, DN 100/PN 10 to 40,
- ANSI 2”/150 lbs, ANSI 2”/300 lbs, ANSI 3”/150 lbs,
- ANSI 3”/300 lbs, ANSI 4”/150 lbs, ANSI 4”/300 lbs

Note

The maximum permissible process pressure for the alignment flange is 1.5 bar absolute; an isolation flange must be used for higher pressures.

Alignment tolerance

Flanges parallel within 1.5°

Purging of windows

Compressed air or nitrogen, dry and oil-free (see **Purge gasproperties** on page 47)

Gas ports for purging

Choice of 6, 8, 10, 12 mm, ⅜” or ¼” Swagelok® fitting. For connection drawing, see **Flange and housing purge connection diagram** on page 53.

Weight

- Transmitter unit: 6.3 kg; Ex version: 7.9 kg
- Receiver unit: 3.9 kg
- Power supply units: Traco 1.6 kg or Pepperl+Fuchs 5 kg

Dimensions

Refer to **Dimensions, position of the purging connections and installation of cables** on page 52.

Electrical connections

Connection to AO2000 system housing

Ethernet 10/100BASE-T; RJ45 plug;
cable length: Min. 15 m, max. 100 m

Connection to receiver unit

15-pole female Sub-D connector
Cable length: Min. 5 m, max. 150 m

Power supply, external pressure and temperature signals

15-pole male Sub-D connector

- Cable length laser unit power supply: Min. 3 m, max. 100 m

Note

With Ex devices, the cables are not connected via connectors, but are already connected by means of a cable gland and internal terminals upon delivery.

Service computer

RS232, 9-pin female Sub-D connector; Ethernet

Connection diagrams

Refer to **Dimensions, position of the purging connections and installation of cables** on page 52.

Power supply

Input voltage

The transmitter unit is supplied with voltage via an external power supply unit. The power supply unit is optionally included in the scope of delivery

- Transmitter unit: 24 V DC, ±5 %
- Power supply unit: Input 85 to 264 V AC, output 24 VD C

Power

Max. 20 W

… Laser analyzer LS25

Use in Potentially Explosive Atmospheres

The LS25 has ATEX, IECEx and CSA certificates for use in potentially explosive atmospheres.

The external power supply is suited for use in ATEX Zone 2 and CSA Class I, Division 2.

ATEX/IECEx Zone 1, 21

ATEX Marking	
ATEX certificate:	Presafe 20 ATEX 69761X
Ambient temperature $T_{amb.}$	−20°C ≤ Ta ≤ +55°C
Ⓔx II 2 G Ex pxb [op is Ga] IIC T4 Gb	
Ⓔx II 2 D Ex pxb [op is Da] IIIC T100°C Db	

Table 1: Ex mark according to ATEX

IECEx marking	
IECEx certificate:	IECEx PRE 20.0072X
Ambient temperature $T_{amb.}$	−20°C ≤ Ta ≤ +55°C
Ex pxb [op is Ga] IIC T4 Gb	
Ex pxb [op is Da] IIIC T100°C Db	

Table 2: Ex marking according to IECEx

ATEX/IECEx Zone 2, 22

ATEX Marking	
ATEX certificate:	Presafe 16 ATEX 8621X
Ambient temperature $T_{amb.}$	−20°C ≤ Ta ≤ +55°C
Ⓔx II 3 G Ex ec nC [op is Ga] IIC T4 Gc	
Ⓔx II 3 D Ex tc [op is Da] IIIC T100°C Dc	

Table3: Ex marking in accordance with ATEX

IECEx marking	
IECEx certificate:	IECEx PRE 20.0071X
Ambient temperature $T_{amb.}$	−20°C ≤ Ta ≤ +55°C
Ex ec nC [op is Ga] IIC T4 Gc	
Ex tc [op is Da] IIIC T100°C Dc	

Table4: Ex marking in accordance with IECEx

TRACO POWER TEX 120-124 power supply unit

ATEX Marking	
ATEX certificate:	EPS 08 ATEX 1 137 X
Ambient temperature $T_{amb.}$	−40°C to 70°C
Ⓔx II 3G Ex ec IIC T4 Gc	

Table5: Ex marking in accordance with ATEX

The current certificates and approvals for the power supply unit are available for download at the following link:

QR code	**link**
	www.tracopower.com/series/tex-120

Table 6: Certificates TRACO POWER TEX 120-124

Power supply unit Pepperl+Fuchs PSC2.PS.GR.18.36.17.D-Y0168136

ATEX Marking	
ATEX certificate:	CESI 17 ATEX 013 X
Ambient temperature $T_{amb.}$	−25°C to 40°C
Ⓔx II 3 G D	

Table7: Ex marking in accordance with ATEX

IECEx marking	
IECEx certificate:	IECEx CES 18.0012X
Ambient temperature $T_{amb.}$	−25°C to 40°C
Ex ec nC IIC T4 Gc	
Ex tb IIIC T130°C Db	

Table8: Ex marking in accordance with IECEx

The certificates for the power supply unit are available for download at the following link:

QR code	**link**
	CE/AO2000-LS25/POWER-SUPPLY_4WAY

Table9: Certificates Pepperl+Fuchs PSC2.PS.GR.18.36.17.D-Y0168136

CSA certification, gas analyzer

CSA Class I Division 2, Groups A, B, C, D, Temperature class T4,
maximum ambient temperature +55°C, electrical devices

Applicable requirements:

Classes 2252 06 and 2252 86

- CAN/CSA C22.2 No. 61010-1-12,
  UPD1: 2015, UPD2: 2016, AMD1: 2018
  Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements
- UL 61010-1, 3rd edition (2012), AMD1: 2018
  Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements

Classes 2258 02 and 2258 82

- CSA Standard C22.2 No. 0-10
  General Requirements - Canadian Electrical Code Part II
- CSA Standard C22.2 No.0.4-M2004
  Bonding of Electrical Equipment
- CSA Standard C22.2 No. 213-M1987
  Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
- CAN/CSA C22.2 No. 61010-1-12,
  UPD1: 2015, UPD2: 2016, AMD1: 2018
  Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements
- UL 61010-1, 3rd edition (2012), AMD1: 2018
  Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements
- ANSI/ISA-12.12.01-2007
  Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous Classified) Locations

Certificate no.:

80168707

CSA certification, power supply unit

TRACO TEX 120-124

The power supply unit has its own CSA approval, which is registered under UL File e213613 (Class I, Division 2, group A, B, C & D, temp. Class T4).

The current certificates and approvals for the power supply unit are available for download at the following link:

QR code	link
	www.tracopower.com/series/tex-120

Table 10: Certificates TRACO POWER TEX 120-124

Pepperl+Fuchs PSC2.PS.GR.18.36.17.D-Y0168136

Part no.	PSC2.PS.GR.18.36.17.D-Y0168136
Drawing	CS-CXZ8
System bus, computer interfaces	240 V AC, 6 A, 27 W
SCCR	16 kA
Class I Division 2 GROUPS ABCD T4	
Type 4X –25°C <= Ta <= +40°C	

Table11: CSA certification

Certificate

The certificates for the power supply unit are available for download at the following link:

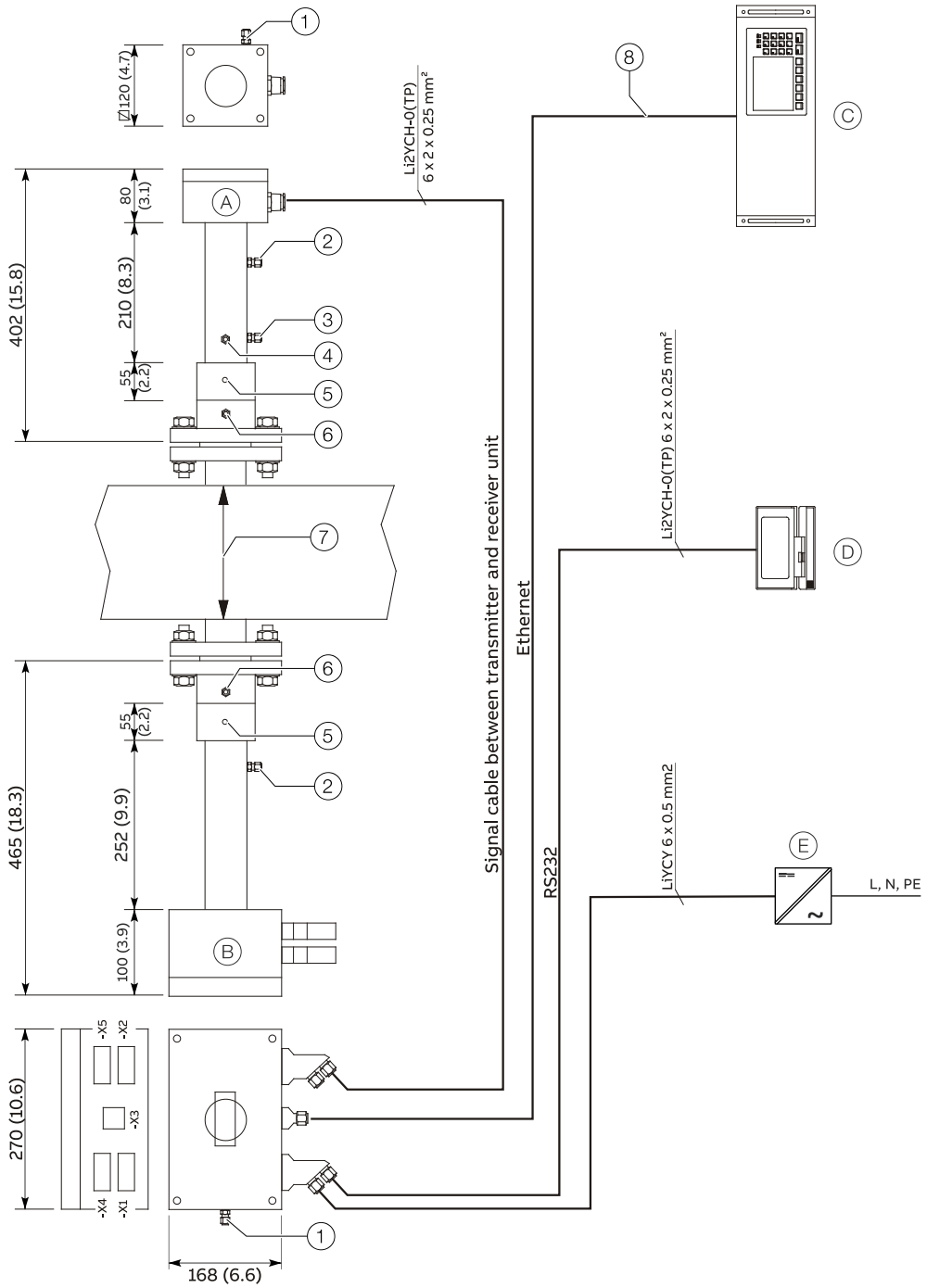
QR code	link
	CE/AO2000-LS25/POWER-SUPPLY_4WAY

Table12: Certificates Pepperl+Fuchs PSC2.PS.GR.18.36.17.D-Y0168136

… Laser analyzer LS25

Dimensions, position of the purging connections and installation of cables

(Deviations in explosion-proof designs and compact variants are possible)



(A) Receiver unit
(B) Transmitter unit
(C) AO2000 central unit
(D) Service PC
(E) Power supply unit

(1) Purge gas outlet (housing purging), Ø 6 mm
(2) Purge gas inlet (housing purging), Ø 6 mm
(3) Calibration gas outlet, Ø 6 mm
(4) Calibration gas outlet, Ø 6 mm
(5) Tap hole M8
(6) Purge gas inlet (flange purging), Ø 10 mm
(7) Optical distance 0.5 to 15 m (1.6 to 49.2 ft)
(8) CAT5 cable, for outdoor use or for direct earthing, with double PVC sheath

Figure 2: Block diagram of AO2000-LS25

Flange and housing purge connection diagram

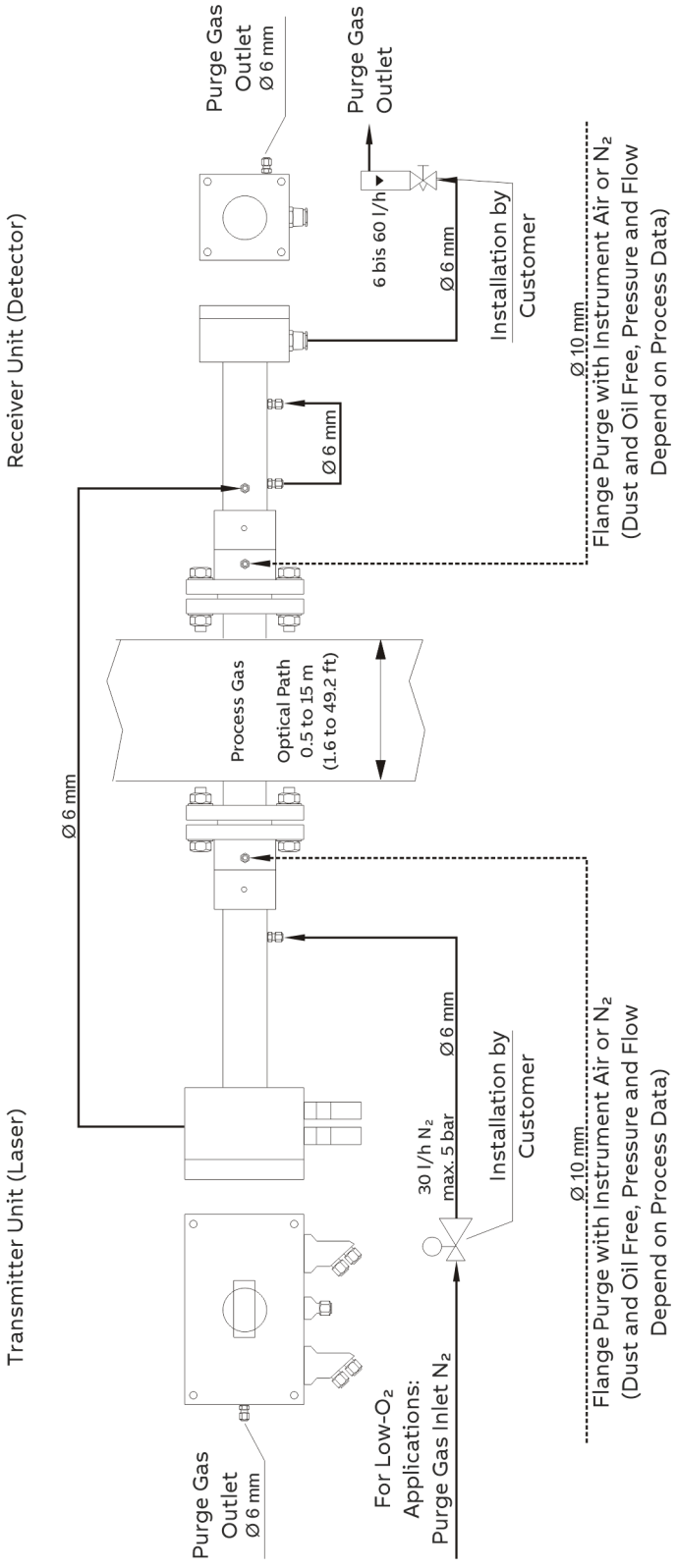


Figure 3: Flange and housing purge connection diagram

Electrochemical oxygen sensor

Note

- The oxygen sensor is always associated with an analyzer module and must be installed in the same housing with that analyzer module.
- The oxygen sensor can be used with the following analyzer modules:
  - Uras26, Limas21 UV with gas lines made of FPM.

Measuring principle

Electrochemical oxygen sensor

Sample components and measurement ranges

Sample component
Oxygen (O_2)

Smallest measuring range
0 to 5 vol.% O_2

Measuring range quantity and measuring range limits
1 to 2 measuring ranges
adjustable from 0 to 5 vol. % O_2 to 0 to 25 vol. % O_2

Stability

The following data only applies if all the influence variables (e.g. flow, temperature and air pressure) are constant. They relate to the smallest measurement range.

Linearity error
≤ 1 % of measuring span

Repeatability
≤ 0.5 % of span

Zero drift
Stable over long-term due to absolute zero point

Span drift
≤ 1 % of the measurement range per week

Output signal fluctuation (2 σ)
≤ 0.2 % of the total measuring range at electronic T_{90}-time (static/dynamic) = 5/0 s

Detection limit (4 σ)
≤ 0.4 % of the total measuring range with electronic T_{90}-time (static/dynamic) = 5/0 s

Influences

Flow effect
Flow rate in the 20 to 100 l/h range:
≤ 2 % of the total measuring range

Temperature effect
Ambient temperature in the permissible range:
≤ 0.2 vol.% O_2 per 10 °C

Air pressure effect

- At the zero point:
  no influence effect
- On sensitivity without pressure correction:
  ≤ 1 % of the measured value per 1 % of air pressure change
- on sensitivity without 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.

Power supply effect
Voltage and frequency in the permissible range:
≤ 0.2 % of the total measuring range

Dynamic response

T_{90}time
T_{90} ≤ 30 sec, depending on sample gas flow and system layout

Calibration

Calibration	Test gas
Zero-point calibration	The oxygen sensor zero is not calibrated since it is fundamentally stable.
End-point calibration	Ambient air with 20.96% Vol.-% O_2 or with synthetic air

Materials

- Sensor:
  polystyrene ABS, PTFE, FPM (fluoro rubber)
- Housing:
  PVC-U, FPM gasket (fluoro rubber)
- Gas connections:
  Stainless steel 1.4571 (AISI 316Ti)

Sample gas conditions

Sample gas inlet conditions

Electrochemical oxygen sensor - Sample gas input conditions	
Temperature	
If the sample gas taken from the process is hotter than the coldest point in the sample gas path, it can condensate there, if the gas contains components that can condense. Therefore, the sample gas dew point should be at least 5 °C below the lowest temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is an absolute requirement.	
Moisture content	
H_2O dew point ≥ 2 °C	
The oxygen sensor may not be used with dry sample gases.	
Pressure	
Internal pressure drop:	< 5 hPa at standard flow rate of 60 l/h
Flow rate	20 to 100 l/h

Associated gas

The oxygen sensor may not be used if the associated gas contains the following components:

H_2S, compounds containing chlorine or fluorine, heavy metals, aerosols, mercaptans, alkaline components

Requirements for the sample gas outlet

The analyzer is operated under atmospheric pressure; the sample gas outlet is open to atmosphere.

Pneumatic Module

Note

- The pneumatics module is always associated with an analyzer module and must be installed in the same housing with that analyzer module.
- The pneumatics module cannot be used when stainless steel tubes are used for the internal gas lines.
- The pneumatics module cannot be used with the following analyzer modules:
  - Limas21 UV, Limas21 HW with stainless steel, PFA or PTFE gas lines,
  - Fidas24, Fidas24 NMHC,
  - Analyzer modules in category 2G.

Test gas supply

Version
Choice of one or three 3/2-way solenoid valves

Power
Approx. 3 W per solenoid valve

Materials
PVDF, FPM, aluminum, stainless steel 1.4305

Fine filtration

Version
Disposable filter with borosilicate glass microfiber filter element

Retention rate
99.99 % for particles > 0.1 µm

Materials
Polyamide, borosilicate glass with PVDF binder

Gas supply

Version
Magnetic piston pump

Feed rate
Max. 60 l/h, depending on analyzer module and inlet/outlet pressure

Flow
Adjustable

Power
approx. 10 W

Materials
PVDF, EPDM, stainless steel 1.4571

Flow monitor

Version
Miniature flow sensor

Display and limit value monitoring
Configurable

Materials
Al_2O_3, silicon, gold, GFK

Pressure monitoring

Pressure sensor
(Optional) for additional monitoring tasks,
e.g. pressure measurement in the second gas path of the Uras26 analyzer module

Sample gas inlet conditions

The pneumatics module must not be used for measurement of flammable gases and ignitable gas/air or gas/oxygen mixtures.

Pneumatic module – sample gas inlet conditions	
Temperature	
5 to 45 °C (41 to 113 °F) The sample gas dew point should be at least 5 °C below the temperature throughout the sample gas path. Otherwise a sample gas cooler or condensate trap is required.	
Pressure	
Inlet pressure	p_e = −80 to +20 hPa
Flow rate	30 to 60 l/h

Corrosive gases
Corrosive associated gas components and aerosols must be cooled or undergo prior absorption.

Use in potentially explosive atmospheres

Explosion protection acc. to ATEX / IECEx

Uras26, Magnos28, Caldos25 and Caldos27

The AO2000 Series gas analyzers with Uras26, Magnos28, Caldos25 and Caldos27 in category 3G for measurement of flammable and non-flammable sample gas ('Safety concept') satisfy the European standards EN 60079-15:2010, EN 60079-2:2014, EN 60664-1:2007.

Ex marking

II 3G Ex nA pyb IIC T4 Gc

Uras26, Magnos28, Magnos27, Caldos25 and Caldos27

The AO2000 Series gas analyzers with Uras26, Magnos28, Magnos27, Caldos25 and Caldos27 in category 3G for measurement of non-flammable sample gas satisfy the European standards EN 60079-15:2010, EN 60664-1:2007.

Ex marking

II 3G Ex nA nC IIC T4 Gc

LS25 laser analyzer module

The LS25 analyzer module in category 3G for measurement of flammable and non-flammable sample gas satisfy the European standards
EN 60079-0:2012 + A11:2013, EN 60079-15:2010, EN 60079-28:2015, EN 60079-31:2014.

Ex marking

Refer to **Use in Potentially Explosive Atmospheres** on page 50.

AO2040-Fidas24 Ex

The AO2040-Fidas24 Ex is an explosion proof version of the Fidas24 analyzer module.
The AO2040-Fidas24 Ex is a standalone variant of the AO2000.

Ex marking

Refer to **ATEX / IECEx versions** on page 41.

Explosion protection according to U.S. and Canadian standards – CSA

The AO2000 Series gas analyzers with Uras26, Limas21 UV, Limas21 HW, Magnos28, Magnos27, Caldos25, Caldos27 and LS25 are certified for use in potentially explosive atmospheres Class 1, Division 2, Groups A, B, C, and D, Temperature code T4, ambient temperature see **Ambient temperature** on page 65.

Housing versions not equipped with conduit entries ('conduit entries') must be installed in a suited cabinet with provisions electrical connections in accordance with Division 2 wiring methods.

Certificate no.

1105720

Explosion protection for the customs union of Russia, Belarus and Kazakhstan – EAC TR CU

The AO2000 Series gas analyzers in the 'Safety Concept' version are certified for use in Zone 2 environments.

The AO2040-Fidas24 Ex is certified for use in Zone 1 or Zone 2 environments.

Certificate no.:

EAЭC RU C-DE.МЮ62.B.0137519

… Use in potentially explosive atmospheres

Explosion protection for China – NEPSI

The AO2000 Series gas analyzers with Uras26, Caldos25 and Caldos27 are certified for use in potentially explosive atmospheres. The gas analyzers may be used for measurement of non-flammable gases and vapors.

Marking
Ex nA nC IIC T4 Gc

Certificate no.
GYJ17.1139X

The AO2000 Series gas analyzers with Uras26, Caldos25 and Caldos27 are certified for use in potentially explosive atmospheres. They may be used for measurement of flammable gases and vapors.

Marking
Ex nA nC py IIC T4 Gc

Certificate no.
GYJ17.1140X

Explosion protection for South Korea – KCs

The AO2000 Series gas analyzers with Uras26, Caldos25 and Caldos27 are certified for use in potentially explosive atmospheres. They may be used for measurement of flammable gases and vapors.

Marking
No release of flammable sample gas

Certificate no.
16-GA4BO-0670X

Version in category II 3G for measurement of flammable and non-flammable gases (‘Safety Concept’)

Analyzer modules for the "Safety Concept":

- Uras26 in the version with safety cell and purged sample cell windows.
- Magnos28, Caldos25 and Caldos27 in the version with direct sample chamber connection and purged analyzer module housing.

The analyzer modules are built into the 19″ housing (model AO2020) or in the wall-mounted housing (model AO2040).

Monitoring of the purge gas flow rate is a feature of the ‘Safety Concept’. It is fully integrated into the gas analyzer, together with the controls and signal processing.

The version complies with the Directive 2014/34/EU (ATEX directive).

There are the following explosion protection measures in the gas analyzer:

- Non-sparking assemblies and components/non-incendive components/gasketed (sparking) devices in accordance with EN 60079-15 and
- Simplified positive pressurized enclosure per EN 60079-2.

Ex marking
II 3G Ex nA pyb II T4 Gc

IP rating
IP 54

Gas connections
Refer to **Gas connections ‘Safety concept’** on page 60.

Sample gas inlet conditions

'Safety Concept' – Sample gas inlet conditions	
Sample gas	
Flammable and non-flammable gases and vapors are not explosive in standard operation, if they are potentially explosive in the event of a malfunction, then only rarely and for a short time (according to Zone 2).	
Absolute pressure	≤ 1.1 bar
Oxygen content	≤ 21 vol. %
Temperature class	T4
Sample gas pressure	
On the sample gas inlet:	Gauge pressure p_e ≤ 3 hPa
On the sample gas outlet:	atmospheric
Sample gas flow	Max. 40 l/h
Sample gas shut off	
The operator has to guarantee the disconnection of the sample gas in case of the decommissioning of the gas analyzer and in case of an alarm (failure at the pressurized enclosure) in accordance with the additional special conditions for operation with flammable sample gases.	

If the sample gas is a mixture only of oxygen and flammable gases and vapors, it must not be explosive under any conditions. As a rule, this can be achieved by limiting the oxygen content to a maximum of 2 vol.-%.

Flammable gases and vapors that are explosive under the conditions encountered in analysis even when oxygen is excluded should be present in the mixture only in concentrations that are not critical to safety.

Purge gas for pressurized enclosure

'Safety Concept' – Purge gas inlet conditions	
Purge gas (protective inert gas)	Inert gas (N_2)
Connections	Purging gas inlet: "Analyzer Purge In", Purge gas outlet: 'Analyzer Purge Out'
Flow rate	• During operation: 15 to 20 l/h • During initial purge: 15 to 40 l/h
Pressure	Positive operating pressure p_e ≥ sample gas pressure + 0.5 hPa
Initial purge*	Compliance with the above purge gas flow rate is monitored in the gas analyzer. • Uras26: 1.6 minutes at a minimum of 15 l/h; • Magnos28, Caldos25, Caldos27: 18 minutes at a minimum of 15 l/h or 7 minutes at 40 l/h
Operation	The required overpressure of ≥ 0,5 hPa is reliably generated in the purge process compared to the sample gas via a capillary arranged in the purge gas path during the above purge gas flow.
Cable connectors not in use have to be closed with suitable vent plugs.	If the installation site of the gas analyzer is hazardous, An alarm is triggered if the flow rate falls below the minimum flow rate of 15 l/h (corresponding to approx. 7 hPa overpressure in the flush curtain) and if the maximum flow rate of 40 l/h (corresponding to approx. 50 hPa) is exceeded.

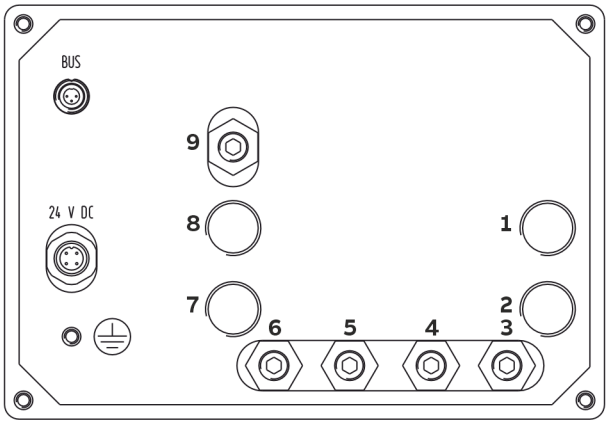
* Pre-purging is not necessary if it can be proven that there is no flammable sample gas in the sample gas path or in the purging gas path.

… Use in potentially explosive atmospheres

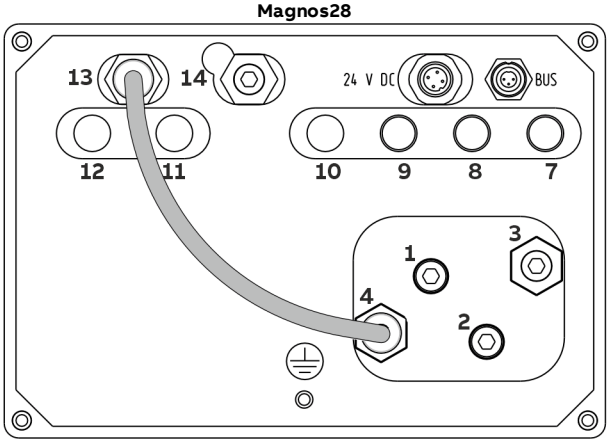
… Version in category II 3G for measurement of flammable and non-flammable gases (‘Safety Concept’)

Gas connections ‘Safety concept’

Uras26



Magnos28

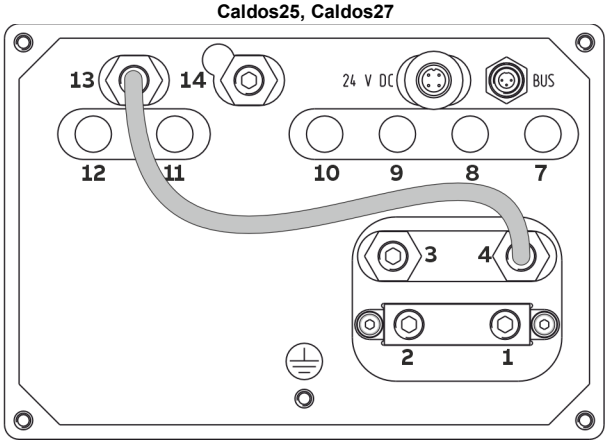


1 Sample gas inlet gas path 1
2 Sample gas outlet gas path 1
3 Purge gas inlet sample cell windows ‘**Analyzer Purge In**’
4 Purge gas inlet housing
5 Purge gas outlet housing
6 Purge gas outlet Flow rate monitoring ‘**Analyzer Purge Out**’
7 Sample gas outlet gas path 2
8 Sample gas inlet gas path 2
9 Pressure sensor (option)

1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet analyzer housing ‘**Analyzer Purge In**’
4 Purge gas outlet analyzer housing, piped with **13**
7 Purge gas inlet housing
8 Purge gas outlet housing
9 Pressure sensor 1
10 Pressure Sensor 2
11 not used, sealed
12 not used, sealed
13 Purge gas outlet flow rate monitor, piped with **4**
14 Purge gas outlet flow monitoring ‘**Analyzer Purge Out**’

Figure 4: ‘Safety Concept’ gas connections Uras 26, Magnos28

Caldos25, Caldos27



1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet analyzer housing ‘**Analyzer Purge In**’
4 Purge gas outlet analyzer housing, piped with **13**
7 Purge gas inlet housing
8 Purge gas outlet housing
9 Pressure sensor 1
10 Pressure Sensor 2
11 not used, sealed
12 not used, sealed
13 Purge gas outlet flow rate monitor, piped with **4**
14 Purge gas outlet flow monitoring ‘**Analyzer Purge Out**’

Figure 5: ‘Safety Concept’ gas connections Caldos25, Caldos27

Version in category II 3G for measurement of non-flammable gases

The explosion-proof design in category II 3G for the measurement of non-flammable gases and vapors is a special version of the gas analyzers of the AO2000 series.
The analyzer modules Uras26, Magnos28, Magnos27, Caldos25, Caldos27 and the electrochemical oxygen sensor are suited for measuring non-flammable gases.

The analyzer modules are mounted in the central unit housing or in a separate housing (either wall-mount or 19" rack unit).

The version complies with the Directive 2014/34/EU (ATEX directive).
The gas analyzer is protected by measures in accordance with EN 60079-15 (non-sparking electric equipment, gasketed sparking devices).

In undisturbed operation, there cannot be any sparking, arcing or impermissible temperatures inside the device.

NOTICE

Potential adverse effect on the IP rating
Yellow sealing plugs (transport protection) are applied to the gas connections on the analyzer and housing to secure them during transport. The yellow sealing plugs do not guarantee a sufficient IP rating.

- Remove the yellow sealing plugs before commissioning.
- Close unused gas connections with suited sealing plugs to guarantee the IP rating.

Ex marking

II 3G Ex nA nC IIC T4 Gc

Housing protection type

IP 54

General data

Operation

LCD display

Backlit graphics display, 320 x 240-pixel resolution

Measured value display

Digits with unit and bargraph; simultaneous display of up to 6 measured values, configurable

Units of measure

Selectable in physical units, e.g. ppm, vol.-%, mg/m^3 or g/m^3, as well as in % of span or mA

Digital value resolution

Better than 0.2 % of span

Status display

- Green LED: Power supply switched on
- Yellow LED: Maintenance required
- Red LED: Failure

Status messages

Plain text

Use

Panel with six soft keys, two cancel keys and 10-digit keypad; menu-driven interface, various languages available

Measuring range switchover and feedback

There are three ways of executing the measuring range switch-over:

- Manually on the gas analyzer
- Automatically (‘autorange’) by means of appropriate configured switch-over thresholds
- Externally controlled via appropriately configured digital inputs

The measuring range feedback can be implemented via appropriately configured digital outputs; it is independent of the se- lected type of measuring range switch-over.

Limit value monitoring

Limit values can be set during the gas analyzer configuration. The limit value signals (alarms) are output via digital outputs.

Housing

Versions

19″ housing (model AO2020) or
wall-mount housing (model AO2040)

IP rating

- IP 65 without power supply unit and without display and control unit, or in the version AO2040-Fidas24 Ex
- IP 54 with display and control unit and with connection box,
- IP 20 without connection box in accordance with EN 60529

Housing materials

- Housing: Stainless steel 1.4016 (AISI 316Ti)
- Module back panel: Aluminum
- Keyboard foil: Polyester

Housing color

Light gray (RAL 7035), basalt gray (RAL 7012)

Weight

Analyzer unit with one analyzer module:
18 to 23 kg

Dimensions

Refer to **Dimensions** on page 82.

Housing purge

Housing purge is possible with the IP 54 version with connection box.
The version can be fitted with screwed cable glands (in accordance with EN) or with conduit connections (in accordance with CSA).

Purge gas flow during operation max. 20 l/h (Fidas24, Fidas24 NMHC: approx. 300 l/h), purge gas pressure p_e = 2 to 4 hPa.
The purge gas should not contain any sample gas components.

Pressure sensor

Use

Analyzer module	Pressure sensor
Uras26, Limas21 UV, Limas21 HW, Caldos27	Factory-installed as standard
Magnos28, Magnos27	Factory-installed as an option
Caldos25, Fidas24, ZO23	Not required

Working range

p_{abs} = 600 to 1250 hPa

Materials

Silicone gel, plastics, FPM (Fluorocarbon rubber)

Sample gas composition

The pressure sensor must not be connected to the sample gas path when the sample gas is corrosive, flammable or explosive.

Gas connections

Layout

Gas ports on back (19” rack housing) or bottom (wall-mount housing) of the analyzer module.

Version

⅛ NPT female threads for commercially available adapters, e.g. Swagelok®, unless other versions are specified in the specification of the individual analyzer modules.

Refer to **Gas connections** on page 71.

Electrical connections

Central unit

- Power supply:
  3-pin grounded-instrument connector according to EN 60320/C14, connection cable supplied
- Ethernet: two 8-pin RJ45 female connectors
- System bus (3-pin female connector)

Analyzer modules

- Power supply: 4-pin male connector
- Heating of detector and sample gas inlet (Fidas analyzer modules): 4-pin male connector, connection cable included in delivery
- System bus (3-pin female connector)

AO2040-Fidas24 Ex

The power supply cable is connected to the corresponding terminals of the purging and monitoring unit, refer to **Purging and monitoring unit FS870S** on page 81.

Power supply

Power supply unit

The power supply is used to supply 24 V DC to the integrated analyzers and the associated electronics.

Input voltage	100 to 240 V AC, −15 %, +10 %
Input Current	2.2 A max
Line Frequency Range	50 to 60 Hz, ±3 Hz
Power consumption	Maximum 187 VA
Output Voltage	24 V DC, ±3 %
Connection	3-pin grounded-instrument connector to EN 60320/C14, connection cable in scope of supply

… General data

… Electrical connections

Power consumption of the analyzer modules

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
Limas21 UV	max. 100 W
Limas21 HW	max. 100 W
LS25	Max. 20 W
Magnos28	Max. 50 W
Magnos27	Max. 35 W
Pneumatic Module	Approx. 20 W
Uras26	Max. 95 W
ZO23	approx. 12/35 W in continuous/starting operation

Fidas24: Heating of detector and sample gas inlet

Input voltage	115/230 V AC, ± 15 % (max. 250 V AC)
Line Frequency Range	50/60 Hz, ±3 Hz
Power consumption	125 VA for Fidas24 detector, approx. 200 VA for Fidas24 NMHC detector, 125 VA for sample gas inlet (option)
Connection	4-pin male connector, connection cable included in scope of supply

Safety

In accordance with EN 61010-1

Protection class

- System housing: Protection class I
- Analyzer module: Protection class III

Overvoltage category

II

Pollution degree

2

Safe isolation

The power supply is electrically isolated from other circuits by means of reinforced or double insulation. Protective Extra Low Voltage (PELV) on low-voltage side.

Electromagnetic compatibility

In accordance with EN 61326-1

Noise immunity

Inspection level: industrial area, fulfills at least the evaluation criteria according to Table 2 of EN 61326-1.

Emitted interference

Limit values class B for electromagnetic radiation disturbance and conducted disturbance are met.

Emitted interference AO2040-Fidas24 Ex

Limit value class A for interference field strength and interference voltage is met.

Mechanical stress

Transport

Vibration test per EN 60068-2-6:1996.
Shock test per EN 60068-2-27:1995.
In its original packaging, the gas analyzer withstands normal shipping conditions.

Requirements for the installation site

Installation location

The gas analyzer is intended for indoor installation only.
The specification of the gas analyzer is applicable up to an altitude of 2000 m above sea level. Altitude above 2000 m on request.

The installation site must be stable enough to bear the weight of the gas analyzer!
For safe installation and disassembly, we recommend supporting the 19″ housing in the cabinet or rack with slide rails!

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	Vibration
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 area of the beam modulation frequency
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
Magnos28	max. ±0.04 mm at 5 to 20 Hz
Magnos27	max. ±0.04 mm at 5 to 60 Hz
ZO23	max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Caldos25	max. ±0.04 mm at 5 to 30 Hz
Caldos27	max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Fidas24	Max. 0.5 g, max. 150 Hz
Fidas24 NMHC	Max. 0.5 g, max. 150 Hz
LS25	Max. ±0.6 mm around the optical axis, max. 500 Hz

Note

For compliance with the metrological data, a vibration damped/decoupled installation of the gas analyzer may be necessary in accordance with the vibration effects at the installation site.

Ambient temperature

Analyzer module	During operation when installed in housing	
	without central unit	with central unit
Uras26	+5 to +45 °C	+5 to +40 °C
Limas21 UV	+5 to +45 °C	+5 to +40/45 °C with/without I/O cards
Limas21 HW	+15 to +35 °C	+15 to +35 °C
Magnos28	+5 to +50 °C	+5 to +45 °C
Magnos27	+5 to +45 °C, +5 to +50 °C*	+5 to +45 °C
ZO23	+5 to +45 °C	+5 to +45 °C
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
LS25	−20 to +55 °C, no direct solar radiation	
Oxygen sensor	+5 to+ 40 °C in 19-inch housing, +5 to +35 °C in wall-mount housing	
Central unit without analyzer module	+5 to +55 °C	

* With direct sample cell connection and when installed in housing without Uras26

Relative humidity

Maximum 75 %, no condensation

Climate class

- 3K3 for housing protection IP 20 (condensation not permitted)
- 3K4 for housing protection IP 54 (condensation permitted) in accordance with EN 60721-3-3: 1995

Air circulation

For sufficient air circulation, multiple housings in a 19” rack must be installed with a separation of at least 1 HU between housings.

Electrical connections

Electronics module

Measured value and signal processing

Processor system with buffered real-time clock and non-volatile memory for firmware and device data.
Software updates can be obtained via the Ethernet interface.

I/O modules

Number of Slots

5 slots (see **Terminal assignment** on page 66)

Specification

Refer to **Figure 6**.

Notes regarding conductor cross-section

- The maximum capacity of terminals for stranded or solid conductors is 1 mm^2 (17 AWG).
- The stranded conductor may be tinned on the tip or twisted for simplified connection.
- When using wire end ferrules the total section must not exceed 1 mm^2, i.e. the maximum stranded conductor section cannot be greater than 0.5 mm^2. The Weidmüller PZ 6/5 crimping tool must be used for crimping the ferrules.

Interfaces

Ethernet

To connect the gas analyzer to Ethernet networks. TCP/IP protocol and Modbus TCP/IP protocol via 10/100/1000BASE-T interface.
Electrical connection: Two 8-pin RJ45 plugs

System bus

Internal bus for communication between the gas analyzer's functional units.
Electrical connection: 3-pin female connector

Power supply

Input voltage

24 V SC, ±3 % from the power supply built in the system housing (see **Power supply unit** on page 63)

Power

approx. 15 W without I/O modules

Terminal assignment

Electronics module

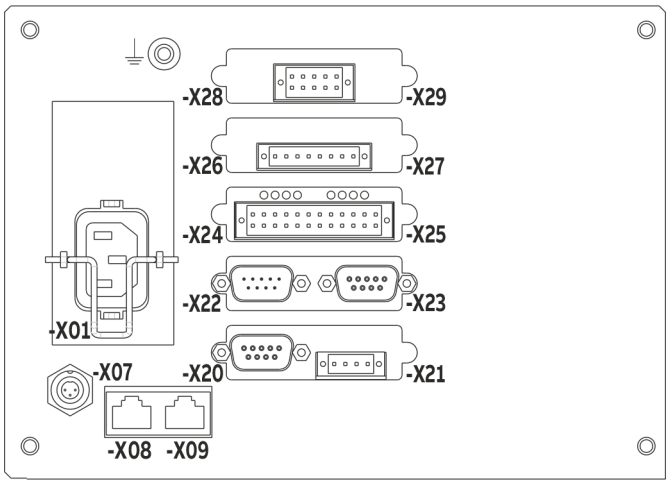


Figure 6: Terminal assignment of electronic module (example)

Connection	Description
-X01	Power supply (refer to page 63)
-X07	System bus (refer to page 5)
-X08, -X09	Ethernet 10/100/1000BASE-T interfaces
-X20 to -X29	I/O modules (5 slots), options: • Profibus-module (refer to page 67) • Modbus-module (refer to page 67) • Analog output module (2 or 4-channel) (refer to page 70) • Analog output module (refer to page 70) • Digital-I/O-module (refer to page 68)
⏚	Connection for potential equalization

PROFIBUS®-Module

Application

Integration of the gas analyzer into PROFIBUS PA and PROFIBUS DP networks for transfer of measured values and status signals as well as analog input, digital input and digital output signals.
Digital data transmission certified in accordance with the VDI 4201 guideline, Sheet 1 and Sheet 2.

Electrical connections

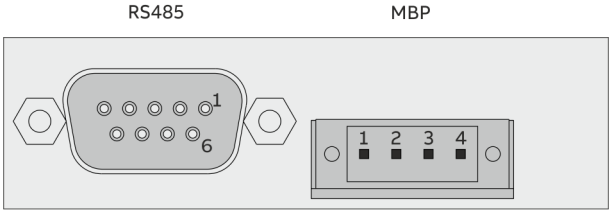


Image 7: PROFIBUS® module

RS485 interface

Version: 9-pin sub-D female connector

Pin	Signal	Description
1	—	not assigned
2	M24	24 V output voltage, ground
3	RxD/TxD-P	Receive/transmit 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/transmit data N, A-line
9	—	not assigned

MBP Interface (not intrinsically safe)

Model: 4-pole plug-in terminal strip with mating connector (included in the scope of delivery).

Pin	Signal
1	+
2	Shield
3	–
4	not used

Modbus®-Module

Application

Transmission of measured values and status signals as well as analog input, digital input and digital output signals to higher-level systems, e.g. to Windows standard applications via an M-DDE server.

Modbus slave protocol in RTU (Remote Terminal Unit) mode either via the RS232 or the RS485 interface (configurable).

Electrical connections

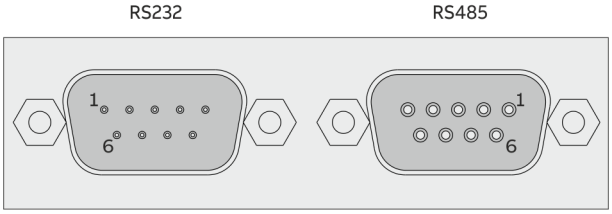


Figure 8: Modbus module

RS232 Interface

Version: 9-pin sub-D male connector

Pin	Signal
2	RxD
3	TxD
5	GND

RS485 interface

Version: 9-pin sub-D female connector

Pin	Signal
2	RTxD-
3	RTxD+
5	GND

… Electrical connections

… Terminal assignment

Digital I/O module

Electrical connections

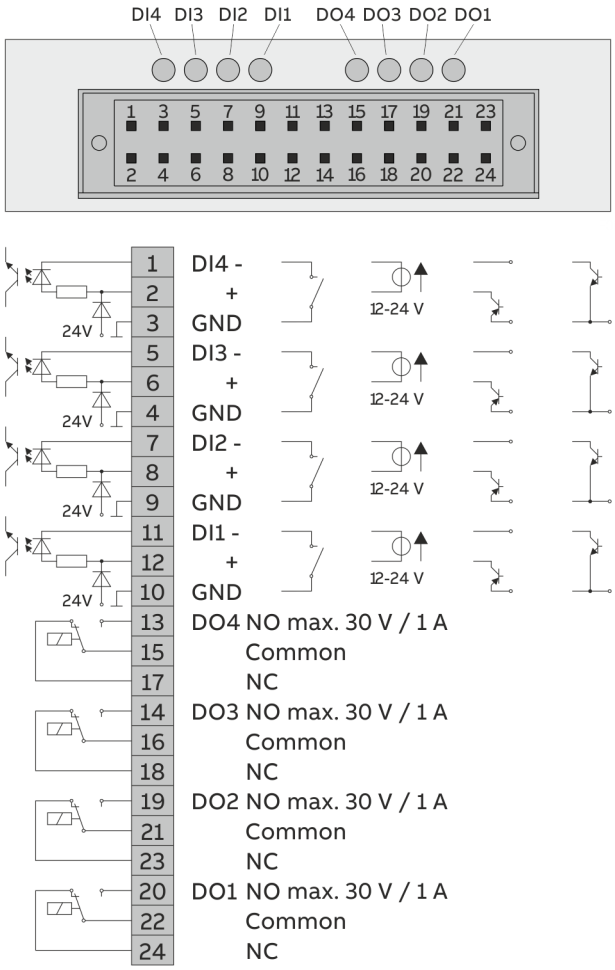


Figure 9: Electrical connections, digital I/O module

Digital inputs DI1 to DI4

Optocouplers with internal 24 V DC power supply. Control system alternatively available with potential-free contacts, with external voltage 12 to 24 V DC or with PNP or NPN open-collector driver.

Digital outputs DO1 to DO4

Potential-free changeover contacts, maximum contact load capacity 30 V/1 A.

Relays must at all times be operated within the specified data range.

Inductive or capacitive loads are to be connected with suitable protective measures (self-induction recuperation diodes for inductive loads and series resistors for capacitive loads).

Relays are shown in the unpowered state.

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

Version

2 × 12-pole plug-in terminal strip with mating connector (included in the scope of delivery).

Terminal assignment for the standard function block applications

Status signals, externally controlled calibration:		
	Individual status signal:	**Sum status signals:**
DO1	Failure	Overall status
DO2	Function Check	Limitation
DO3	Maintenance Required	Limitation
DO4	External solenoid valve	External solenoid valve
DI1	Start auto-calibration	Start auto-calibration
DI2	Disable auto-calibration	Disable auto-calibration
DI3	Calibrate zero-point	Calibrate zero-point
DI4	Calibrate end-point	Calibrate end-point
Measurement range control		
DO1	Measuring range feedback	
DO2		
DO3		
DO4		
DI1	Measuring range switch-over	
DI2		
DI3		
DI4		
Limit values		
DO1	Limitation	
DO2	Limitation	
DO3	Limitation	
DO4	Limitation	
DI1	Calibration cells on/off	
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 solenoid valve sample gas	

… Electrical connections

… Terminal assignment

Analog output modules

The analog output modules is available in two variants:

- As a 2-way analog output module with two independent analog outputs
- As a 4-way analog output module with four independent analog outputs

Analog outputs AO1 to AO4

0/4 to 20 mA (factory-set to 4 to 20 mA), common negative pole, electrically isolated from ground, freely connectible to ground, max. gain relative to protective ground potential 50 V, max. load 750 Ohm. Resolution 16 bit.
The output signal cannot be lower than 0 mA.

Electrical connections

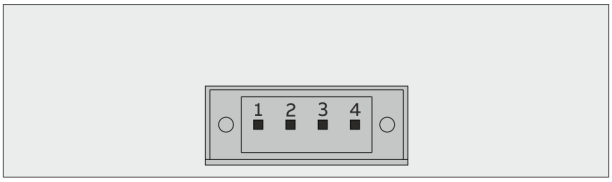


Figure 10: 2-way analog output module

Figure 11: 4-way analog output module

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

Version

4-pole or 8-pole plug-in terminal strip with counter plug (included in the scope of delivery).

Analog input modules

Electrical connections

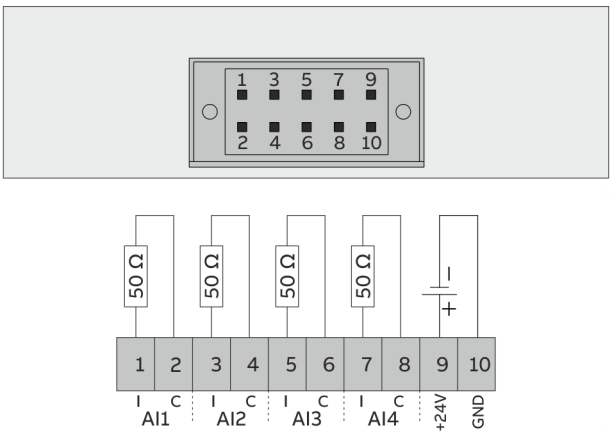


Figure 12: Analog input module

Pin	Signal	Description
1	AI1+	–20 to +20 mA, load 50 Ω,
2	AI1–	up to 10 V isolated from each other
3	AI2+	
4	AI2–	
5	AI3+	
6	AI3–	
7	AI4+	
8	AI4–	
9	+24 V	+24 V DC for supply of an external sensor, fused with
10	GND	100 mA (self-resetting fuse)

Design

2x5-pin terminal strip with mating connector (included in the scope of delivery).

Gas connections

Uras26

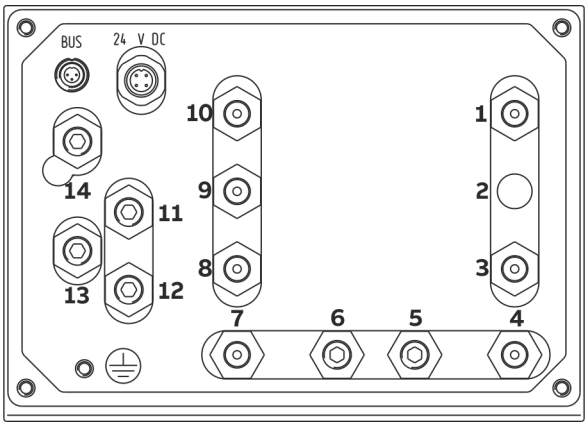


Figure 13: Gas connections Uras26

Figure 13 shows the assignment of the gas connections as an example for the three variants:

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

Gas connections Uras26

Pos.	Connection	Supplementary information	Design
1	Pressure Sensor for external pressure measurement (option)	The pressure sensor is connected to Terminal **1** via an FPM hose if the internal gas lines are designed as PTFE or stainless steel pipes, or if the 'Pressure sensor connected outside by hose' option is ordered.	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
2	not used	—	
3	Sample gas inlet (gas path 1)	Variant Ⓐ, Ⓑ or Ⓒ.	
4	Sample gas outlet (gas path 1)	For one measuring cell (variant Ⓐ) and for two measuring cells with separate gas paths (variant Ⓒ)	
5	Purge gas inlet (housing)	Option	
6	Purge gas outlet (housing)	Optional, also with flow sensor	
7	Sample gas inlet (gas path 2)	Variant Ⓒ	
8	Sample gas outlet (gas path 2)	Variant Ⓒ	
	Sample gas outlet (gas path 1)	For two sample cells in series (variant Ⓑ)	
9	Reference gas inlet	Optional, sample cell 1 flowing reference gas	
10	Reference gas outlet		

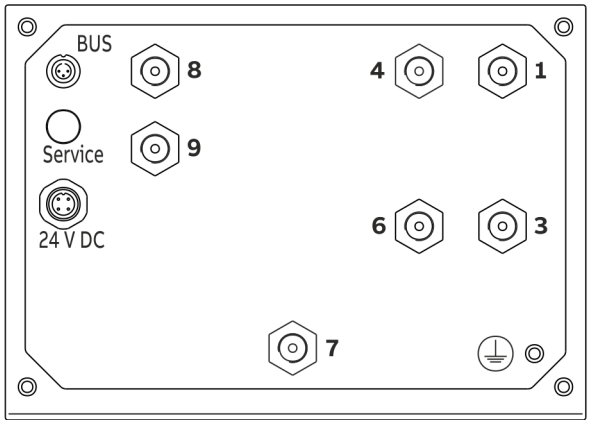
Gas connections pneumatic module (option)

Pos.	Connection	Supplementary information	Design
11	Sample gas inlet (gas path 1)	Variant Ⓐ, Ⓑ or Ⓒ.	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
12	Endpoint gas inlet (gas path 1) or sample gas inlet (gas path 2)	With 3 solenoid valves For variant Ⓒ: Gas path 2 (only with flow sensor)	
13	Test gas/zero point gas inlet (gas path 1) or sample gas outlet (gas path 2)	With 1 or 3 solenoid valves For variant Ⓒ: Gas path 2 (only with flow sensor) - in this case to be connected to sample gas input **7**	
14	Sample gas outlet (gas path 1)	Variant Ⓐ, Ⓑ or Ⓒ – to be connected to sample gas inlet **3**	

… Gas connections

Limas21

Limas21 UV:
Standard cell, quartz cell with FPM hoses, center connection cell made of aluminum or quartz



Limas21 UV:
Quartz cell with PFA Tubes

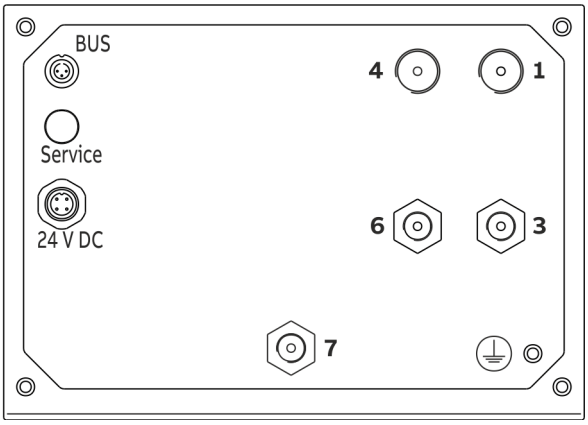


Figure 14: Limas21 UV gas connections

Limas21 UV gas connections

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305)
3	Purge gas inlet housing	Option	
4	Sample gas outlet	—	• Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
6	Purge gas outlet housing	Option	
7	Pressure sensor	The pressure sensor is routed to the outside via an FPM hose when the internal gas lines are made of PTFE, stainless steel or PFA.	
8	End-point gas inlet	Option with 3 solenoid valves, only for version with FPM hoses	
9	Zero-point gas inlet	Option, with 1 or 3 solenoid valves, only for version with FPM hoses	Connection to quartz cell with PFA tube • PFA 6/4 mm, screw-in fittings (not included in scope of delivery)

Limas21 UV: Safety cell **Limas21 HW**

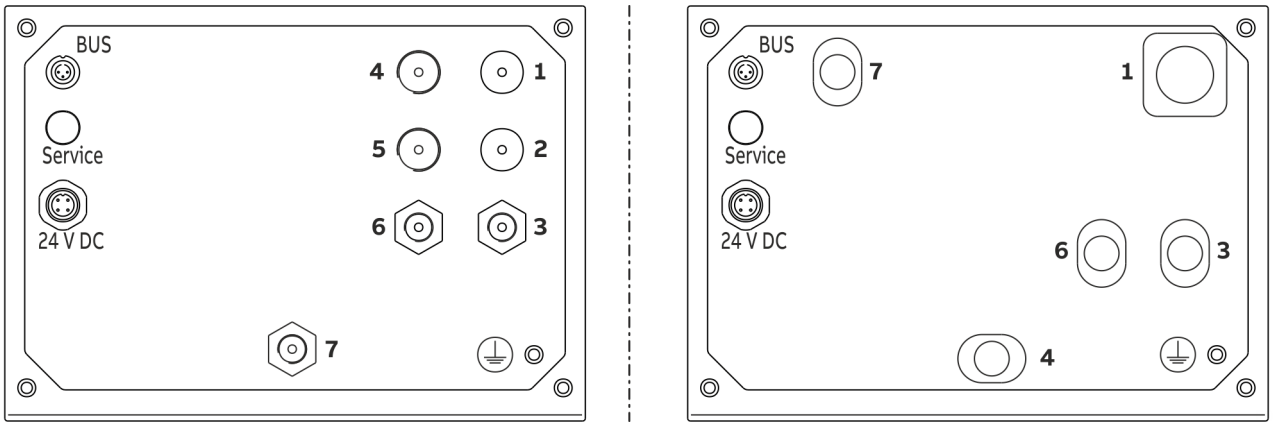


Figure 15: Limas21 UV and HW gas connections

Limas21 UV gas connections

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	Stainless steel tube with
2	Sample gas outlet	—	4 mm outer diameter
3	Purge gas inlet housing	Option with Limas21 UV	⅛-NPT internal thread (stainless steel 1.4305)
4	Purge gas inlet sample cell	—	FPM Pipe 4 × 1.5 mm
5	Purge gas outlet sample cell	—	
6	Purge gas outlet housing	Option with Limas21 UV	⅛-NPT internal thread (stainless steel 1.4305)
7	Pressure sensor	The pressure sensor is routed to the outside via an FPM hose.	

Limas21 HW gas connections

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305)
3	Purge gas inlet housing	—	
4	Sample gas outlet	Install the exhaust air line at a gradient, leading away from the gas analyzer.	
6	Purge gas outlet housing	—	
7	Pressure sensor	The pressure sensor is routed to the outside via an FPM hose.	

… Gas connections

Magnos28

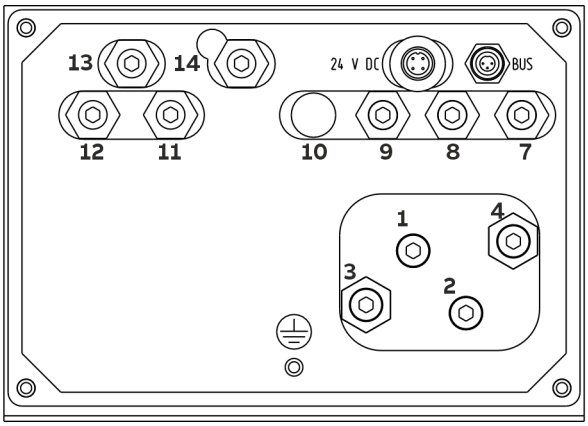


Figure 16: Magnos28 gas connections

Magnos28 gas connections

The sample cell is connected directly to the gas ports.

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	⅛ NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
2	Sample gas outlet	—	
3	Purge gas inlet analyzer	Option	
4	Purge gas outlet analyzer		
7	Purge gas inlet housing	Option	
8	Purge gas outlet housing	Optional, also with flow sensor	
9	Pressure sensor 1	Option. The pressure sensor is routed to the outside via an FPM hose. For measurements in suppressed measurement ranges, the sensor **9** and sample gas **2** outlet have to be connected to each other via a T-piece and with the use of short conductors.	
10	Pressure Sensor 2	Option. Second pressure sensor for additional external pressure measurement	

Gas connections pneumatic module (option)

Pos.	Connection	Supplementary information	Design
11	Sample gas inlet	—	⅛ NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
12	End-point 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**	

Magnos27

Sample cell connection by means of FPM hoses **Sample cell direct connection**

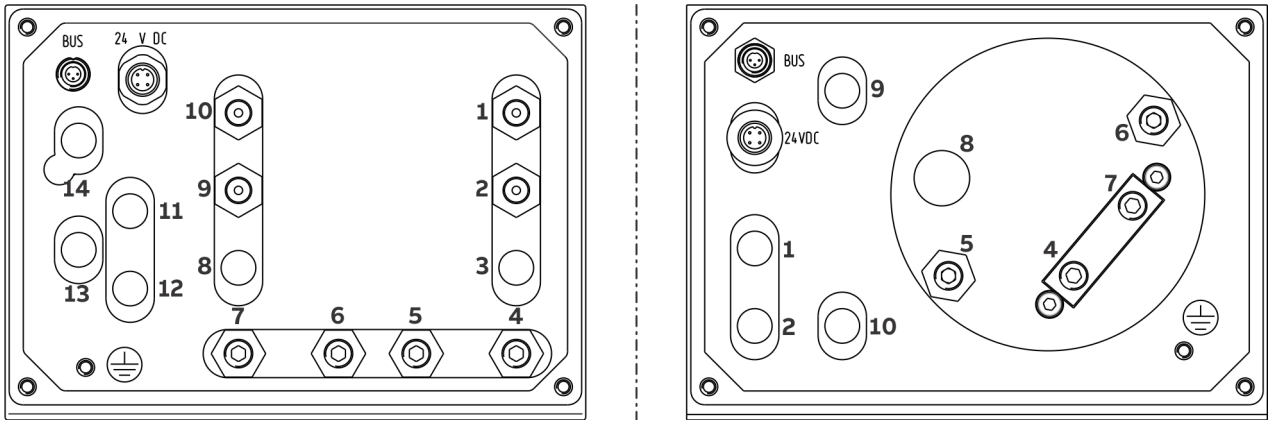


Figure 17: Magnos27 gas connections

Magnos27 gas connections

Note on the direct connection of the sample chamber

The sample cell is connected directly to the gas ports (for wall-mount housing only). Application e.g. when external gas supply is connected and for short T_{90} times.

Pos.	Connection	Supplementary information	Design
1	Purge gas inlet housing	Option	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
2	Purge gas outlet housing	Optional, also with flow sensor	
3	not used	—	
4	Sample gas inlet	—	
5	Purge gas inlet analyzer	—	
6	Purge gas outlet analyzer	—	
7	Sample gas outlet	—	
8	not used	—	
9	Pressure sensor 1	Option. The pressure sensor is routed to the outside via an FPM hose.	
10	Pressure Sensor 2	Option. Second pressure sensor for additional external pressure measurement	

Gas connections pneumatic module (option)

Pos.	Connection	Supplementary information	Design
11	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
12	End-point 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**	

… Gas connections

ZO23

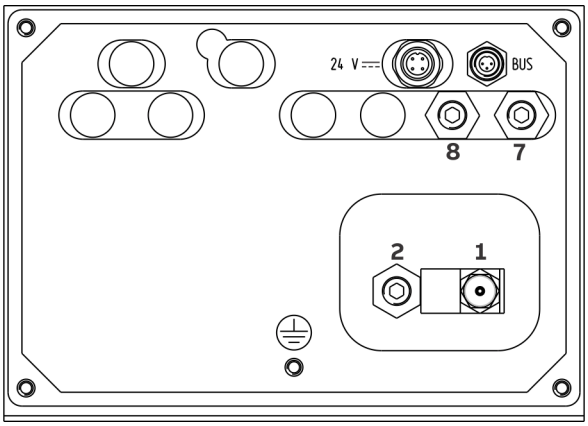


Figure 18: ZO23 gas connections

ZO23 gas connections

The measuring chamber is connected to sample gas inlet connection **1** via a stainless steel pipe and to sample gas outlet connection **2** via an FPM hose.

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	3 mm Swagelok® screwed connection
2	Sample gas outlet	—	⅛-NPT internal thread
7	Purge gas inlet housing	Only for IP 54 version	(stainless steel 1.4305)
8	Purge gas outlet housing	Only for IP 54 version	• Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)

Caldos25

Standard Version **Versions for corrosive sample gas or for flowing reference gas**

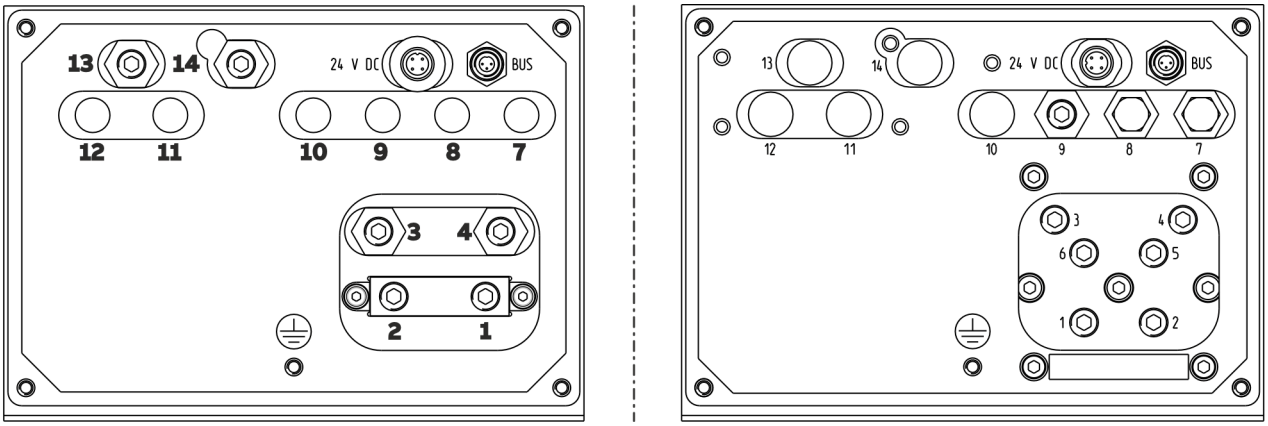


Figure 19: Caldos25 gas connections

Caldos25 gas connections

The sample cell is connected directly to the gas ports.

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery) **Note** Gas connections **1** to **6** in the versions for corrosive sample gas or for flowing reference gas are made of PVC-C. Do not use metal tubing connectors or adapters!
2	Sample gas outlet	—	
3	Purge gas inlet analyzer	—	
4	Purge gas outlet analyzer	—	
5	Reference gas inlet	Not in version for corrosive sample gas	
6	Reference gas outlet		
7	Purge gas inlet housing	Option	
8	Purge gas outlet housing	Optional, also with flow sensor	
9	Pressure sensor 1	Option. The pressure sensor is routed to the outside via an FPM hose.	
10	Pressure Sensor 2	Option. Second pressure sensor for additional external pressure measurement	

Pneumatic module gas connections (optional – not in version with sample cell direct connection)

Pos.	Connection	Supplementary information	Design
11	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
12	End-point 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**	

… Gas connections

Caldos27

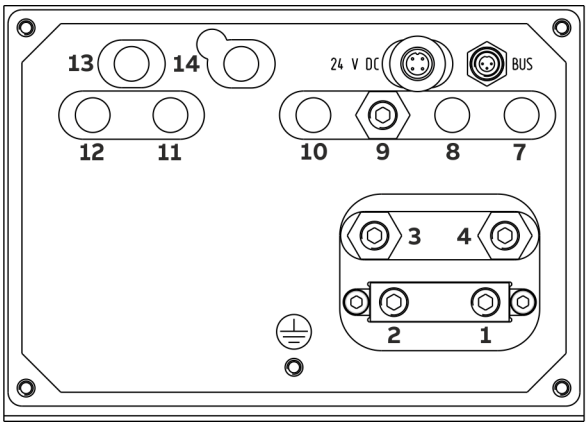


Figure 20: Caldos27 gas connections

Caldos27 gas connections

The sample cell is connected directly to the gas ports.

Pos.	Connection	Supplementary information	Design
1	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
2	Sample gas outlet	—	
3	Purge gas inlet analyzer	—	
4	Purge gas outlet analyzer	—	
7	Purge gas inlet housing	Option	
8	Purge gas outlet housing	Optional, also with flow sensor	
9	Pressure sensor 1	The pressure sensor is routed to the outside via an FPM hose.	
10	Pressure Sensor 2	Option. Second pressure sensor for additional external pressure measurement	

Gas connections pneumatic module (option)

Pos.	Connection	Supplementary information	Design
11	Sample gas inlet	—	⅛-NPT internal thread (stainless steel 1.4305) • Connection of hose lines: Straight screw-in socket (PP) with hose nozzles for hoses with inside diameter 4 mm (included in scope of delivery) • Connection of pipelines: Screw-in fittings (not included in the scope of delivery)
12	End-point 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**	

Fidas24

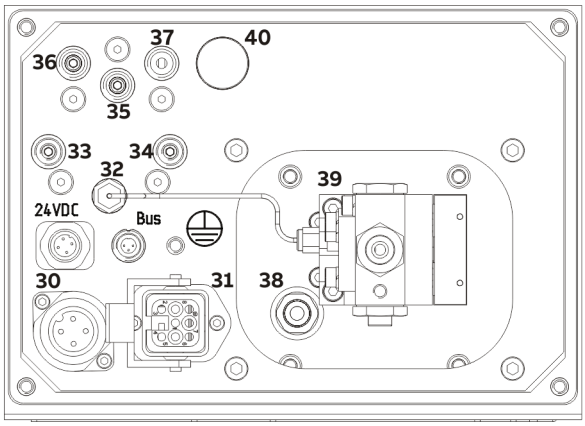


Figure 21: Gas and electric connections Fidas24 and Fidas24 NMHC

Gas connections of the analyzer

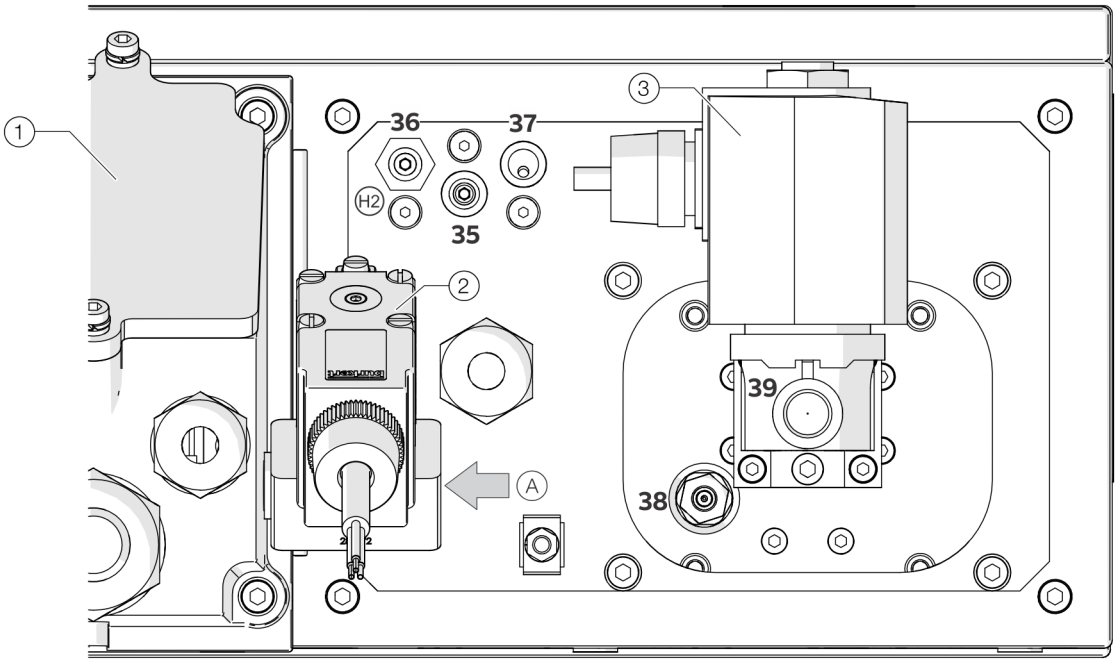
Pos.	Connection	Supplementary information	Design
32	Test gas outlet	—	⅛ NPT female thread for threaded connections (not included in scope of supply)
33	Zero-point gas inlet	—	
34	End-point gas inlet	—	
35	Combustion air inlet	—	
36	Combustion gas inlet	—	
37	Instrument air inlet	—	
38	Exhaust outlet	**Note** The inside diameter of the exhaust line must be increased to Ø ≥ 10 mm a maximum of 30 cm downstream of the exhaust outlet. Install the exhaust air line at a gradient, leading away from the gas analyzer.	Compression fitting for pipes with an outside diameter of 6 mm
39	Sample gas inlet	**Sample gas line connection** To heated sample gas inlet: • In wall-mount housing: bottom and right • In 19″ housing: back, top and bottom To unheated sample gas inlet: • In wall-mount and 19″ housing: back	Fitting for PTFE tubes or stainless steel tubes with an outer diameter of 6 mm
40	Pressure equalizing opening	With protective filter (the protective filter must be protected against humidity)	—

Electrical connections

Pos.	Connection	Supplementary information	Design
30	Power supply 115 / 230 V AC	For heating the detector with converter and sample gas inlet	4-pin male connector, connection cable included in scope of supply
31	Power supply (output)	Electrical connection to the heated sample gas connection	Permanently connected

… Gas connections

Fidas24 Ex

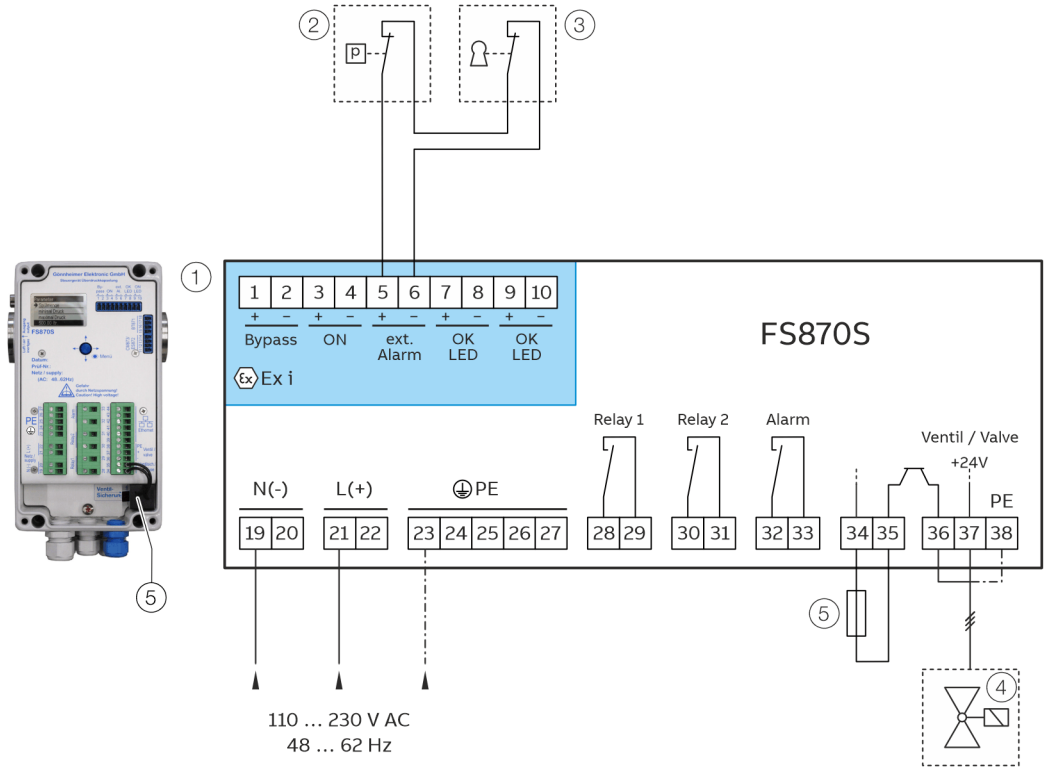


1 Connection box
2 Purging gas valve
3 Sample gas valve

Figure 22: Position of the gas connections AO2040-Fidas24 Ex

Pos.	Connection	Supplementary information	Design
35	Combustion air inlet	—	⅛" NPT female thread for threaded connections (not included in scope of supply)
36	Combustion gas inlet	with pre-assembled flow restrictor	
37	Instrument air inlet	—	
38	Exhaust outlet	—	Male thread for connection of the exhaust air pipe (stainless steel tube with an outside diameter of 10 mm, included in the scope of supply of the gas analyzer)
39	Sample gas inlet	Connection options for heated or unheated sample gas lines.	G ¼" NPT female thread for threaded connections (not included in scope of supply)
A	Purging gas inlet	Purging gas inlet for the pressurized enclosure Ex-p.	G ⅜" NPT female thread for threaded connections (not included in scope of supply)

Purging and monitoring unit FS870S



① Purging and monitoring unit FS870S
② Pressure switch for monitoring of the instrument air
③ Key switch for EPL Dc / Db design
④ Magnetic valve for the purging gas
⑤ Fuse for purging gas solenoid valve

Image 23: Purging and monitoring unit FS870S

Note

The components ②, ③, ④, ⑤ as well as the power supply to the gas analyzer are pre-wired at the factory.

Connections for power supply on the FS870S purging and monitoring unit

Terminal	Function/comments
19 / N	Neutral conductor
21 / L	Phase
23 / PE / ⏚	Protective earth (PE)

Relay output connections

Terminal	Function/comments
28 / 29	**Relay output 1 / 2**
30 / 31	De-energize the gas analyzer, pre-wired at the factory
32	**Alarm output**
33	Potential-free relay output for external signal transmitter, maximum 235 V AC, 5 A

Connections for intrinsically safe inputs/outputs

Terminal	Function/comments
1 / 2	**Not assigned**
3 / 4	**Not assigned**
5 / 6	**Input “Ext. Alarm“** Connected to the pressure switch internally, for monitoring of the instrument air supply. With devices for category 3D / 2D (Dc / Db), the additional key switch is also connected here.
7+ / 8−	**Not assigned**
9+ /10−	**Not assigned**

Dimensions

19” housing (model AO2020)

Dimensions in mm (in)

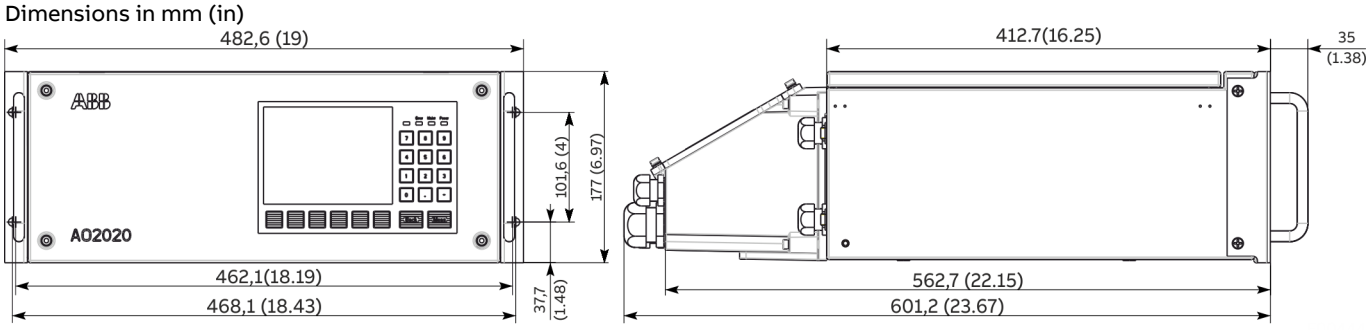
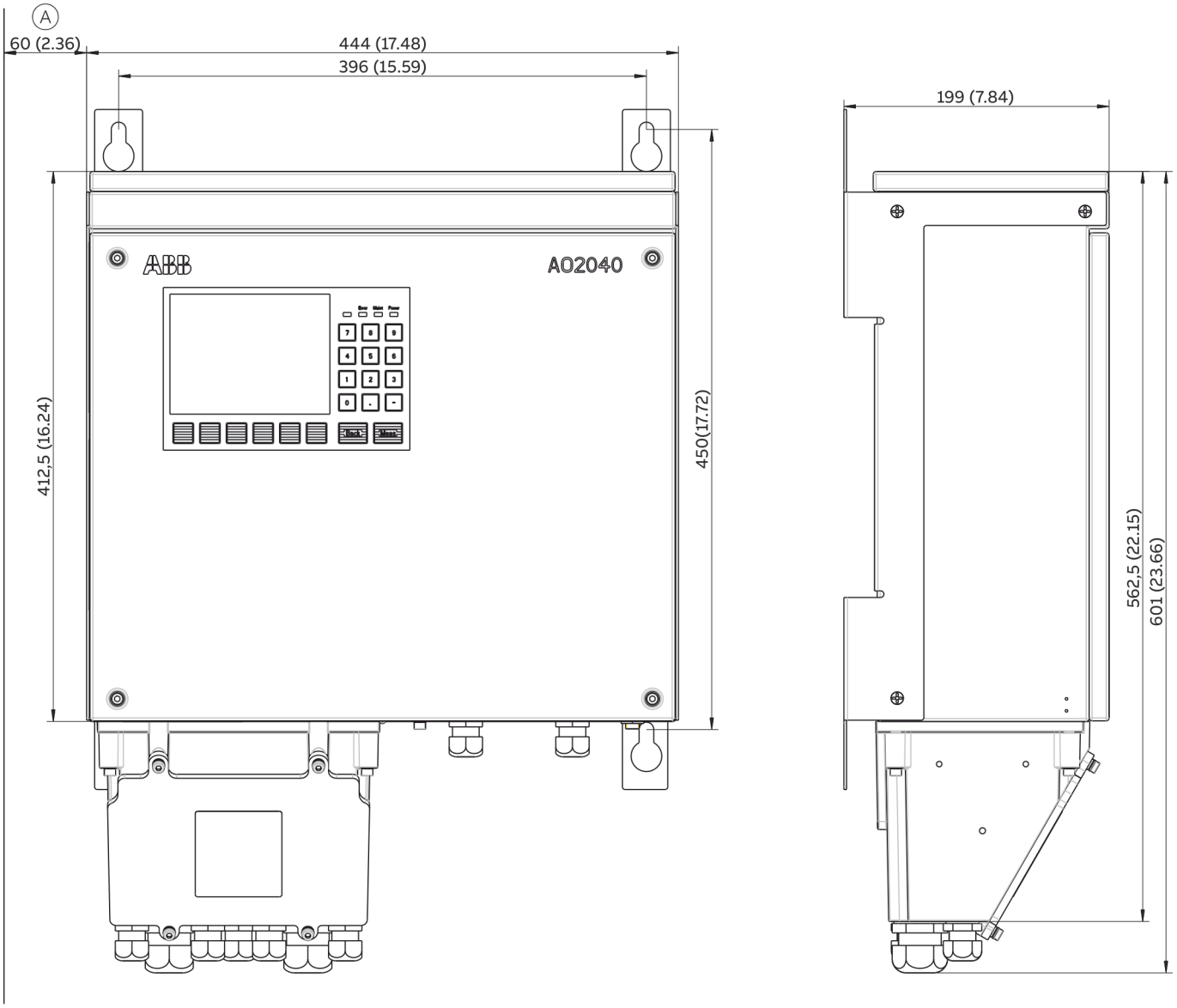


Figure 24: AO2020 dimensions

Wall-mount housing (model AO2040)

Dimensions in mm (in)



Ⓐ Consider free space to swivel the door

Figure 25: AO2040 dimensions

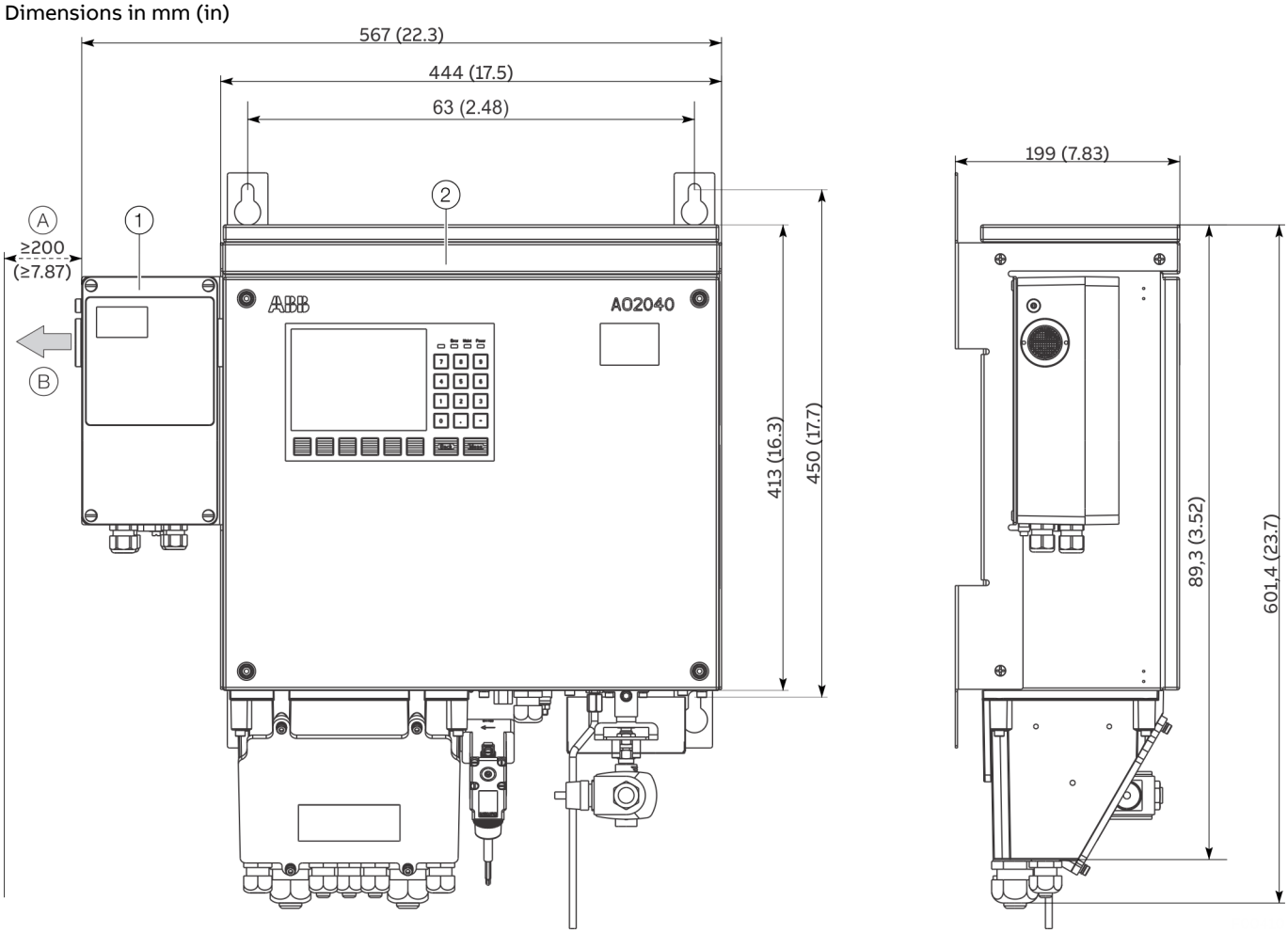
Additional information

- In the IP 54 version, the connection box shown in the dimensional drawings is flange-mounted to the housing.
- Adhere to the requirements at the installation site , refer to **Requirements for the installation site** on page 65.
- Take into consideration the additional space required for the connecting lines (approx. 100 mm).
- During installation of the Fidas24 gas analyzer with heated sample gas connector, take into consideration the additional space requirement for the heated sample gas impulse line (observe minimum bend radius in accordance with manufacturer data).
- When installing the wall unit, make sure to provide free space on the left side needed to swing out the door (approx. 60 mm).
- When installing the wall-mounted housing, ensure that there is additional free space above the housing, as some modules are only accessible from the top (approx. 300 mm).
- Install both the 19” housing and the wall unit such that the display is oriented vertically.
- For sufficient air circulation of several system housings in a 19” rack unit, mount with a distance of at least 1 HU between each other.

… Dimensions

Model AO2040-Fidas24 Ex

Dimensions in mm (in)



(A) Free space for unobstructed discharge of the purge gas
(B) Purge gas outlet
(1) Purging and monitoring unit FS870S
(2) System housing AO2040-Fidas24 Ex

Figure 26: Dimensions, Model AO2040-Fidas24 Ex

Additional information

- The connection box shown in the dimensional drawings is flange-mounted to the housing.
- Adhere to the requirements at the installation site , refer to **Requirements for the installation site** on page 65.
- The air outlet of the purging and monitoring unit must not be blocked.
- Take into consideration the additional space required for the connecting lines (approx. 100 mm).
- When mounting the gas analyzer, take the space required for the heated sample gas lines into account (observe the minimum bending radius, according to manufacturer's specifications).
- When installing the wall-mounted housing, ensure that there is additional free space above the housing, as some modules are only accessible from the top (approx. 300 mm).
- Mount the wall-mounted housing in such a way that the LCD display is clearly visible.

Approvals, tests and certificates

Performance tests

The gas analyzers of the AO2000 series Uras26 (measuring components CO, NO, SO_2, CO_2, N_2O) and electrochemical oxygen sensor (measuring component O_2) are suited for use in incineration plants that require approval in accordance with European Directives 2001/80/EC (13th BImSchV) and 2000/76/EG (17th BImSchV) as well as in annexes of the 27th/30th BImSchV and TA-Luft.
The requirements of QAL1 according to EN 15267 and EN 14181 are fulfilled.

- Report no. 821029 dated 6/30/2006;
  Announcement: BAnz of 10/14/2006, No. 194, page 6715.
- Report no. 1249694 dated 3/30/2009;
  Announcement: BAnz of 8/25/2009, No. 125, page 2932.
- Report no. 1710933 dated 9/30/2011;
  Announcement: BAnz of 3/2/2012, No. 36, page 923.
- Report no. 936/21217137/A dated 10/14/2011;
  Announcement: BAnz of 3/2/2012, No. 36, page 922.
- Report no. 1958844 dated 8/30/2013,
  Announcement: BAnz AT of 4/1/2014, No. B12, page 15.

Uras26, Magnos28, oxygen sensor
The AO2000 Series gas analyzers Uras26 (sample components CO, NO, NOx, SO_2, N_2O, CO_2), Magnos28 (sample component O_2) and electrochemical oxygen sensor (sample component O_2) meet the requirements of the 'MCERTS Performance Standards for Continuous Emission Monitoring Systems, Version 3.5 dated June 2016', EN 15267-3:2007 and QAL 1 in accordance with EN 14181:2014.
Certificate no. Sira MC080121/13 of 8/18/2017

Limas21 UV
The gas analyzers of the AO2000 series Limas21 UV (measuring components NO, NO_2, SO_2), and electrochemical oxygen sensor (measuring component O_2) are suited for use in incineration plants that require approval in accordance with European Directives 2001/80/EC (13th BImSchV) and 2000/76/EG (17th BImSchV) as well as in TA-Luft systems.
The requirements of QAL1 according to EN 15267 and EN 14181 are fulfilled.
Report no. 2231669.1 dated 9/1/2015;
Announcement: BAnz AT of March 14, 2016, No. B7, page 2.

Fidas24
The gas analyzer of the AO2000 series Fidas24 (measuring component Total-C) is suited for use in systems that require approval (13th BImSchV, 17th BImSchV, 30th BImSchV, TA-Luft) as well as in the annexes of the 27th BImSchV. The requirements of QAL1 according to EN 15267 and EN 14181 are fulfilled.
Report no. 936/21228173/A dated 10/21/2015;
Announcement: BAnz AT of March 14, 2016, No. B7, page 2.

Uras26 – Marine
The AO2000 Series gas analyzer Uras26 (sample components SO_2 and CO_2) is suited for use on vessels. The requirements of MEPC.184(59) and MEPC.259(68), Chapter 6 'Emission Testing' as well as the relevant requirements of Revised MARPOL Annex VI and NOx Technical Code 2008 are fulfilled.
Certificate No. 30652-15 HH of November 27, 2015

Limas21 UV – Marine
The AO2000 Series gas analyzer Limas21 UV (sample components NO, NO_2 and NOx) is suited for use on vessels.
The requirements of Revised MARPOL Annex VI and NOx Technical Code 2008 are fulfilled.
Certificate no. Doc no: 31786686/DNV; Issued in Hamburg on December 14, 2023

CE conformity

The AO2000 series gas analyzers satisfy the requirements of the European directives:

- 2014/35/EU Low Voltage Directive,
- 2014/30/EU EMC Directive,
- 2014/34/EU ATEX Directive (explosion-proof designs only) and
- 2011/65/EU RoHS Directive

Approval for USA and Canada – CSA

The AO2000 series gas analyzers are certified for use in 'general purpose' environments, evidenced by full compliance with standards CAN/CSA-C22.2 no. 61010-1-12 and UL Std. No. 61010-1 (Third Edition).

Certificate No. 70012655

Approval for the customs union of Russia, Belarus and Kazakhstan – EAC TR CU

The AO2000 Series gas analyzers are certified for use in general purpose environment.

- EAC TR CU Certificate:
  ЕАЭС N RU Д-DE.HB26.B.0014519
- Metrological certificate for Russia:
  No. 79593-20

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