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 according to 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 integrated pneumatics module
- Ethernet, Modbus and PROFIBUS interfaces
- Configurable analog and digital inputs and outputs

User-friendly operation
- Simultaneous digital and analog display of measured values on a large graphics panel
- Menu-driven operator interface
- Clear-text status messages
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**Modular analyzer product line**

**Overview**

Advance Optima AO2000 Series is a line of modules used for continuous process gas analysis.

The product line consists of the following modules:

- Analyzer modules
- Pneumatics module
- Electronics module with system controller and I/O modules
- Housing with display and control unit
- 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)**

- Infrared photometer analyzer module Uras26
- Process photometer analyzer modules Limas21 UV Limas21 HW
- Oxygen analyzer modules Magnos206 Magnos28 Magnos27
- Trace oxygen analyzer module ZO23
- Thermal conductivity analyzer modules Caldos25 Caldos27
- FID analyzer modules Fidas24 Fidas24 NMHC
- Laser analyzer module LS25
- Electrochemical oxygen sensor

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

The analyzer modules are linked to the system controller via the system bus. The laser analyzer module is linked 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 available as an option in combination with an analyzer module.

**Pneumatics module**

The pneumatics module contains the following elements when fully equipped:

- One or three solenoid valves to control test gas supply
- One or two disposable filter elements for fine filtration
- One gas supply pump with coarse filter and capillary
- One or two flow monitors

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

**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 (e.g. 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 modules have one RS485 and one MBP interface.
- Modbus modules have one RS485 and one RS232 interface.
- Digital I/O modules have 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
- Measurement range switching and feedback
- Feed of current or status signals from external analyzers
- Feed of status signals from peripherals
... Modular analyzer product line

Housing
The housing is available as a 19-inch rack-mount (model AO2020) or a wall-mount (model AO2040) unit with IP20 or IP54 protection. IP54 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.

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.

Connection of sample gas conditioning modules
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 “System components and accessories for sample gas conditioning” data sheet.
Configuration of analyzer units and multiple analyzer systems

This data sheet contains specifications for all modules and components 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.

Example 1 shows the modules and components that normally make up an analyzer unit as well as the 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 (see example 2).

Example 1: Analyzer unit configuration (19-inch housing)

Example 2: Multiple analyzer system variant (wall-mount housings)
Infrared analyzer module Uras26

**Measurement principle**

Non-dispersive infrared absorption in the $\lambda = 2.5$ to 8 $\mu$m wavelength range

Photometer to measure from 1 to 4 components with 1 or 2 beam paths and 1 or 2 receivers in each beam path

**Sample components and measurement ranges**

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

The smallest measurement ranges shown in the following table are based on the first sample component in beam path 1.

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Smallest class 1 range</th>
<th>Smallest class 2 range</th>
<th>Smallest class 2 range with calibration cell</th>
<th>Gas group</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>0– 50 ppm</td>
<td>0– 10 ppm</td>
<td>0– 50 ppm</td>
<td>A</td>
</tr>
<tr>
<td>CO₂</td>
<td>0– 50 ppm</td>
<td>0– 5 ppm</td>
<td>0– 25 ppm</td>
<td>A</td>
</tr>
<tr>
<td>NO</td>
<td>0– 75 ppm</td>
<td>0– 5 ppm</td>
<td>0– 75 ppm</td>
<td>A</td>
</tr>
<tr>
<td>SO₂</td>
<td>0– 100 ppm</td>
<td>0– 25 ppm</td>
<td>0– 25 ppm</td>
<td>A</td>
</tr>
<tr>
<td>N₂O</td>
<td>0– 50 ppm</td>
<td>0– 20 ppm</td>
<td>0– 50 ppm</td>
<td>A</td>
</tr>
<tr>
<td>CH₄</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>A</td>
</tr>
<tr>
<td>NH₃</td>
<td>0– 500 ppm</td>
<td>0– 30 ppm</td>
<td>–</td>
<td>B</td>
</tr>
<tr>
<td>C₂H₂</td>
<td>0– 200 ppm</td>
<td>0– 100 ppm</td>
<td>0– 100 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₂H₄</td>
<td>0– 500 ppm</td>
<td>0– 300 ppm</td>
<td>0– 300 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₂H₆</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₂H₈</td>
<td>0– 250 ppm</td>
<td>0– 100 ppm</td>
<td>0– 100 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₃H₆</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₃H₈</td>
<td>0– 500 ppm</td>
<td>0– 100 ppm</td>
<td>0– 100 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₄H₁₀</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>C₆H₁₄</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>R 134a</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>SF₆</td>
<td>0– 5 ppm</td>
<td>0– 4 ppm</td>
<td>–</td>
<td>B</td>
</tr>
<tr>
<td>H₂O</td>
<td>0–1000 ppm</td>
<td>0– 500 ppm</td>
<td>0– 500 ppm</td>
<td>C</td>
</tr>
</tbody>
</table>

1) See price information
2) The smallest measurement range 1 is shown. The largest measurement range should be at least four times larger.

Other sample components on request.

**Measurement range quantity**

1 to 4 ranges per sample component

**Largest measurement range**

0 to 100 vol.% or 0 vol.% to saturation or 0 vol.% to LEL

Measurement ranges within ignition limits cannot be provided.

**Measurement range ratio**

≤ 1:20

**Measurement ranges with suppressed zero-point**

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 apply only if all influence factors (e.g. flow rate, temperature, atmospheric pressure) are constant. They apply to measurement range 1 in a delivered analyzer module.

**Linearity deviation**

≤ 1 % of span

**Output fluctuation (2σ)**

≤ 0.2 % of span at electronic T90 time = 5 sec (class 1) or = 15 sec (class 2)

**Detection limit (4σ)**

≤ 0.4 % of span at electronic T90 time = 5 sec (class 1) or = 15 sec (class 2)

**Flow effect**

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

**Associated gas effect / cross sensitivity**

The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Incorporation of interference filters or filter vessels, internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Uras26.

**Temperature effect**

Ambient temperature in permissible range

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

**Air pressure effect**

- At zero-point: No effect
- On sensitivity with pressure correction by means of integral pressure sensor: ≤ 0.2 % of measured value per 1 % air pressure change

The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines. If tubing is used for internal gas lines, the pressure sensor is routed to the outside via a hose.

**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

90% response time
$T_{90} = 2.5\text{ sec for measurement cell length }= 200\text{ mm and sample gas flow } = 60\text{ l/h without signal damping (low pass filter). Low-pass time constant adjustable from 0 to 60 sec.}$

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 mixtures. 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 like nitrogen.

Materials in contact with the sample medium

Analyzer (sample cells)
Tubing: Aluminum or gold-plated aluminum. Window: CaF$_2$, option: BaF$_2$. Connectors: Stainless steel 1.4571 (SAE 316Ti).

Gas lines and connectors
FPM hoses and PTFE tubing with stainless steel connectors.
Option: Stainless steel tubes 1.4571 (SAE 316Ti).

Sample gas inlet conditions

Temperature
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

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

Flow rate
20 to 100 l/h

Corrosive gases
Highly corrosive associated gas components, e.g. chlorine (Cl$_2$) and hydrogen chloride (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 suitable for measuring flammable gases and vapors under atmospheric conditions ($p_{\text{abs}} \leq 1.1\text{ bar, oxygen content }\leq 21\text{ vol.\%}$). Temperature class: T4. The sample gas must not be explosive under normal conditions.

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 normal operation $p_{\text{abs}} \leq 100\text{ hPa}$; in case of a sample gas supply failure the pressure must not exceed the maximum value $p_{\text{abs}} = 500\text{ hPa}$. 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.

Version in category 3G see page 36

Gas connections

The drawing below shows the gas connection arrangement in an exemplary manner for the three variants: A 1 gas path with 1 sample cell, B 1 gas path with 2 sample cells in series and C 2 separate gas paths with 1 sample cell each.

The actual gas connection arrangement of an analyzer module is found in the analyzer data sheet for the delivered instrument.

![Gas connections diagram](image-url)
Process photometer analyzer module Limas21 UV

Measurement principle and application
Gas filter correlation or wavelength comparison in ultraviolet and visible spectrum range $\lambda = 200 \text{ to } 600 \text{ nm}$
Photometer to measure from 1 to 4 components
Sample cells made from various materials are available for measuring in corrosive, toxic and flammable gases (see page 12)

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

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Smallest class 1 range</th>
<th>Smallest class 2 range</th>
<th>Gas group</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO$_2$</td>
<td>0– 50 ppm</td>
<td>0– 10 ppm</td>
<td>A</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>0– 150 ppm</td>
<td>0– 25 ppm</td>
<td>A</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>0– 250 ppm</td>
<td>0– 100 ppm</td>
<td>B</td>
</tr>
<tr>
<td>NH$_3$</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>B</td>
</tr>
<tr>
<td>H$_2$S</td>
<td>0– 50 ppm</td>
<td>0– 25 ppm</td>
<td>B</td>
</tr>
<tr>
<td>Cl$_2$</td>
<td>0– 250 ppm</td>
<td>0– 100 ppm</td>
<td>D</td>
</tr>
<tr>
<td>CS$_2$</td>
<td>0– 100 ppm</td>
<td>0– 50 ppm</td>
<td>C</td>
</tr>
<tr>
<td>COS</td>
<td>0– 500 ppm</td>
<td>0– 250 ppm</td>
<td>C</td>
</tr>
</tbody>
</table>

1) See price information
2) 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.

Measurement range quantity
1 to 4 ranges per sample component

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

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

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

Stability
The following data apply only if all influence factors (e.g. flow rate, temperature, atmospheric pressure) are constant. They apply to measurement range 1 in a delivered analyzer module.

Linearity deviation
$\leq 1 \%$ of span
Option: Linearization acc. to EPA specifications for automotive exhaust gas measurement

Repeatability
$\leq 0.5 \%$ of span

Zero drift
$\leq 2 \%$ of span per week;
for ranges smaller than class 1 to class 2: $\leq 1.5 \%$ of span per day
(recommendation: daily automatic zero-point calibration)

Sensitivity drift
$\leq 1 \%$ of measured value per week

Output fluctuation (2 $\sigma$)
$\leq 0.5 \%$ of span at electronic T90 time $= 10$ sec;
for ranges smaller than class 1 to class 2: $\leq 1 \%$ of span

Detection limit (4 $\sigma$)
$\leq 1 \%$ of span;
for ranges smaller than class 1 to class 2: $\leq 2 \%$ of span

Influence effects

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

Associated gas effect/cross sensitivity
The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Incorporation of filters cells or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Limas21 UV.

Temperature effect
Ambient temperature in permissible range,
Sample cell thermostat control to $+60 \degree C$
– At zero-point: $\leq 1 \%$ of span per $10 \degree C$; for ranges smaller than class 1 to class 2: $\leq 2 \%$ of span per $10 \degree C$
– On sensitivity: $\leq 1 \%$ of measured value per $10 \degree C$

Air pressure effect
– At zero-point: No effect
– On sensitivity with pressure correction by means of integral pressure sensor: $\leq 0.2 \%$ of measured value per $1 \%$ air pressure change
The pressure sensor is located in the sample gas path if hoses are used as the internal gas lines. If tubing is used for internal gas lines, the pressure sensor is routed to the outside via a hose.

Power supply effect
DC 24 V $\pm 5 \%$: $\leq 0.2 \%$ of span
**Dynamic response**

**Warm-up time**
Approx. 2.5 hours

**90% response time**
$T_{90} = 4$ sec 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 like nitrogen.

**Materials in contact with the sample medium**
See page 12

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**Sample gas inlet conditions**

**Temperature**
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

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

**Flow rate**
20 to 100 l/h

**Corrosive, toxic and flammable gases**
See page 12

**Purge gas**
See page 12

**Gas connections**
See page 13
Process photometer analyzer module Limas21 HW

Measurement 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, NO₂ and NH₃.
The UV-RAS method (ultra-violet resonant absorption spectroscopy) is used to make the analyzer selective to the sample component NO.
Wavelength comparison in ultraviolet spectrum range \( \lambda = 200 \) to 600 nm.

Applications
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 measurement ranges (recommendations), stability data
Exhaust gas measurement for four-stroke gasoline and diesel engines

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Smallest range</th>
<th>Largest range</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>0–10 ppm</td>
<td>0–5000 ppm</td>
</tr>
<tr>
<td>NO₂</td>
<td>0–100 ppm</td>
<td>0–2500 ppm</td>
</tr>
</tbody>
</table>

Linearity deviation
\( \leq 1 \% \) of span, \( \leq 2 \% \) of measured value acc. to EPA specifications for automotive exhaust gas measurement.

Repeatability
\( \leq 0.25 \% \) of span.

Zero drift
\( \leq 1 \) ppm or \( \leq 1 \% \) of span per 24 hours based on the smallest recommended measurement range (daily automatic zero-point calibration recommended).

Sensitivity drift
\( \leq 1 \% \) of measured value per week.

Output fluctuation (2 σ)
\( \leq 400 \) ppb or \( \leq 0.4 \% \) of span at electronic T90 time \( = 5 \) sec.

Detection limit (4 σ)
\( \leq 800 \) ppb or \( \leq 0.8 \% \) of span at electronic T90 time \( = 5 \) sec.

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

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Smallest range</th>
<th>Largest range</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>0–10 ppm</td>
<td>0–5000 ppm</td>
</tr>
<tr>
<td>NO₂</td>
<td>0–100 ppm</td>
<td>0–2500 ppm</td>
</tr>
</tbody>
</table>

Linearity deviation
\( \leq 1 \% \) of span, \( \leq 2 \% \) of measured value acc. to EPA specifications for automotive exhaust gas measurement.

Repeatability
\( \leq 0.25 \% \) of span.

Zero drift
\( \leq 250 \) ppb or \( \leq 2 \% \) of span per 8 hours based on the smallest recommended measurement range (daily automatic zero-point calibration recommended).

Sensitivity drift
\( \leq 1 \% \) of measured value per week.

Output fluctuation (2 σ)
NO \( \leq 50 \) ppb or \( \leq 0.5 \% \) of span, NO₂ \( \leq 60 \) ppb or \( \leq 0.5 \% \) of span at electronic T90 time \( = 15 \) sec.

Detection limit (4 σ)
NO \( \leq 100 \) ppb or \( \leq 1 \% \) of span, NO₂ \( \leq 120 \) ppb or \( \leq 1 \% \) of span at electronic T90 time \( = 15 \) sec.

Process measurement

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Smallest range</th>
<th>Largest range</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>0–100 ppm</td>
<td>0–1000 ppm</td>
</tr>
<tr>
<td>NO₂</td>
<td>0–100 ppm</td>
<td>0–500 ppm</td>
</tr>
<tr>
<td>NH₃</td>
<td>0–100 ppm</td>
<td>0–500 ppm</td>
</tr>
</tbody>
</table>

Linearity deviation
\( \leq 1 \% \) of span.

Repeatability
\( \leq 0.25 \% \) of span.

Zero drift
\( \leq 1 \) ppm or \( \leq 1 \% \) of span per 24 hours based on the smallest recommended measurement range (daily automatic zero-point calibration recommended).

Sensitivity drift
\( \leq 1 \% \) of measured value per week.

Output fluctuation (2 σ)
NO \( \leq 50 \) ppb or \( \leq 0.5 \% \) of span at electronic T90 time \( = 15 \) sec.

Detection limit (4 σ)
NO \( \leq 100 \) ppb or \( \leq 1 \% \) of span at electronic T90 time \( = 15 \) sec.

Measurement ranges
Quantity
1 to 4 ranges per sample component.

Measurement range ratio
Max. 1:20. Measurement ranges are freely adjustable within a range ratio of 1:20 relative to the factory-set reference measurement range.
Max. 1:50 for fixed measurement ranges acc. to EPA specifications for automotive exhaust gas measurement.
Influence effects

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

Associated gas effect/cross sensitivity
The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect: 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 +82 °C
– At zero-point: ≤ 2 % of span per 10 °C
– On sensitivity: ≤ 2 % of measured value per 10 °C

Air pressure effect
– At zero-point: No effect
– On sensitivity with pressure correction by means of integral pressure sensor: ≤ 0.2 % of measured value per 1 % air pressure change
The pressure sensor is routed to the outside via a hose.

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

Dynamic response

90% response time
Approx. 4 hours
T ≤ 5 sec for measurement cell length = 260 mm and sample gas flow = 60 l/h with non-linear filter (static/dynamic) = 15/1 sec.
Low-pass time constant adjustable from 0 to 30 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 like nitrogen.

Materials in contact with the sample medium

Sample cell
Tubing and window: Silica glass, Screw connection: PVDF,
Connectors: PTFE

Gas lines and connectors
Stainless steel 1.4305 (SAE 303), 1.4571 (SAE 316Ti)

Housing purge

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

Sample gas inlet conditions

Sample gas composition
Sulfur-free exhaust gas of combustors, SO₂ concentration < 25 ppm, H₂O < 20 vol.%, filtered with pore width ≤ 0.5 µm

Temperature
Sample gas dew point ≤ 60 °C

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

Flow rate
20 to 90 l/h

Gas connections
See page 13

Notes

The analyzer module Limas21 HW can only be mounted in the 19-inch housing.

SO₂ influences the NH₃ reading. If the sample gas mixture contains SO₂, 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 sublimation since NH₃ and NO₂ are easy soluble in water and can result in salification. It is also imperative to prevent condensation of potentially present low-boiling hydrocarbons.

Sample gas inlet temperature (on the process side)
150 to 190 °C

Sample gas filter
For NO and NOₓ measurement: Sintered metal; for NH₃ measurement: Ceramics, pore width ≤ 0.5 µm

Materials in contact with the sample medium
PTFE, PVDF or Silicosteel

Exhaust gas conditions
Outlet pressure = atmospheric pressure, no resistance in the gas outlet.

Installation note
Route the exhaust gas line declining to allow for condensate drain-off.
**Process photometer analyzer modules Limas21 UV, Limas21 HW**

### Sample cells

<table>
<thead>
<tr>
<th></th>
<th>Standard cell</th>
<th>Quartz cell</th>
<th>Safety cell</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>Standard applications</td>
<td>Corrosive gases</td>
<td>Corrosive, toxic and flammable gases</td>
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<tr>
<td><strong>Wavelength range</strong></td>
<td>200 to 10000 nm</td>
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<td>CaF₂ window: 200 to 10000 nm SiO₂ window: 200 to 4000 nm</td>
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<tr>
<td><strong>Resistance</strong>&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>Suitable for measurement of ...</td>
<td>Highly corrosive gases, e.g. gases containing chlorine, H₂SO₄, SO₃, fluorine compounds</td>
<td>Fluorine compounds</td>
</tr>
<tr>
<td></td>
<td>Not suitable for measurement of ...</td>
<td>Corrosive gases, e.g. wet Cl₂, wet HCl, H₂SO₄, SO₃, ozone</td>
<td>Corrosive gases, e.g. dry HCl, dry COCl₂ (&lt; 50 ppm H₂O)</td>
</tr>
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</table>

### Safety principle

<table>
<thead>
<tr>
<th></th>
<th>Toxic gases</th>
<th>Corrosive gases</th>
<th>Flammable gases&lt;sup&gt;4)&lt;/sup&gt;</th>
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<td>Housing purge (≤ 20 l/h)</td>
<td>Housing purge (≤ 20 l/h)</td>
<td>Cell purge&lt;sup&gt;2)&lt;/sup&gt; with N₂ or with sample component-free air with negative pressure and flow monitoring; additional monitoring for sample gas traces possible</td>
</tr>
<tr>
<td>with sample component-free air or with N₂</td>
<td>with sample component-free air or with N₂</td>
<td>with excess pressure&lt;sup&gt;3)&lt;/sup&gt; and flow monitoring</td>
<td></td>
</tr>
</tbody>
</table>

### Seal integrity

<table>
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<th></th>
<th>Continuous</th>
<th>Spike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure rating</td>
<td>pₑ &lt; 500 hPa</td>
<td>pₑ &lt; 300 kPa</td>
</tr>
<tr>
<td></td>
<td>pₑ &lt; 500 hPa</td>
<td>pₑ &lt; 500 kPa</td>
</tr>
</tbody>
</table>

### Sample cell material

<table>
<thead>
<tr>
<th></th>
<th>Cell tube</th>
<th>Window</th>
<th>Seal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aluminum</td>
<td>CaF₂, adhesive fastening</td>
<td>FFKM75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silica glass (SiO₂)</td>
<td>FFKM70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silicon glass</td>
<td>calF₂ or SiO₂, threaded fastening</td>
</tr>
</tbody>
</table>

### Connectors

<table>
<thead>
<tr>
<th></th>
<th>Sample connectors&lt;sup&gt;1)&lt;/sup&gt;</th>
<th>Gas line materials&lt;sup&gt;1)&lt;/sup&gt;</th>
<th>Gas connector materials&lt;sup&gt;1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Connectors with ¼ NPT internal threads</td>
<td>FPM or PTFE</td>
<td>SS 1.4571 (SAE 316Ti)</td>
</tr>
<tr>
<td></td>
<td>Pipes 6/4 mm</td>
<td>PTFE</td>
<td>SS 1.4571 (SAE 316Ti)</td>
</tr>
<tr>
<td></td>
<td>Pipes with 4 mm outer diameter</td>
<td>PFA</td>
<td>SS 1.4571 (SAE 316Ti)</td>
</tr>
</tbody>
</table>

1) see pages 9, 11, Fehler! Textmarke nicht definiert. “Sample gas inlet conditions”

2) purge curtain

3) pₑ = 7 to 20 hPa, 15 to 20 l/h

4) The analyzer module is suitable for measuring flammable gases and vapors under atmospheric conditions (pₑ ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4. The sample gas must not be explosive under normal conditions. 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 normal operation pₑ ≤ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value pₑ = 500 hPa. Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
Gas connections

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

1. Sample gas inlet
2. Sample gas outlet
3. Purge gas inlet housing
4. Sample gas outlet
5. Purge gas outlet housing
6. Pressure sensor
7. End-point gas inlet (with 3 solenoids)
8. Zero-point gas inlet (with 1 or 3 solenoids)

1) Option
2) external connection, not for standard cell with FPM hoses
3) not for version with PTFE hoses

**Limas21 UV: Quartz cell with PFA tubes**

1. Sample gas inlet
2. Sample gas outlet
3. Purge gas inlet housing
4. Sample gas outlet
5. Purge gas outlet housing
6. Pressure sensor
7. Pressure sensor

1) Option

**Limas21 UV: Safety cell**

1. Sample gas inlet
2. Sample gas outlet
3. Purge gas inlet housing
4. Sample gas outlet
5. Purge gas outlet sample cell
6. Purge gas outlet sample cell
7. Pressure sensor
8. End-point gas inlet (with 3 solenoids)
9. Zero-point gas inlet (with 1 or 3 solenoids)

1) Option
2) external connection, not for standard cell with FPM hoses
3) not for version with PTFE hoses

**Limas21 HW**

1. Sample gas inlet
2. Sample gas outlet
3. Purge gas inlet housing
4. Sample gas outlet
5. Purge gas outlet housing
6. Pressure sensor
7. Pressure sensor
Oxygen analyzer module Magnos206

Measurement principle
Paramagnetic behavior of oxygen
Magnetomechanical oxygen analyzer

Sample component and measurement ranges
Sample component
Oxygen (O₂)

Smallest measurement range
0 to 0.5 vol.% O₂

Measurement range quantity and limits
4 measurement ranges
Measurement ranges are freely adjustable; they are factory-set to 0 to 10/15/25/100 vol.% O₂ or per order.

Largest measurement range
0 to 100 vol.% O₂
Measurement ranges within ignition limits cannot be provided.

Measurement ranges with suppressed zero-point
Max. measurement range suppression 1:100, e.g. 99 to 100 vol.% O₂. Highly suppressed measurement ranges (≥95 to 100 vol.% O₂) and initial measurement ranges in the same analyzer should be avoided. Pressure correction by means of pressure sensor required.

Stability
Linearity deviation
≤ 0.5 % of span, minimum 0.005 vol.% O₂

Repeatability
≤ 50 ppm O₂ (time base for gas exchange ≥ 5 minutes)

Zero drift
≤ 3 % of span of the smallest measurement range (per order) per week, minimum 300 ppm O₂ per week; following prolonged transport and storage time the drift can be higher during the first weeks of operation.

Sensitivity drift
≤ 0.1 vol.% O₂ per week or ≤ 1 % of measured value per week (not cumulative), whichever is smaller.
≤ 0.25 % of measured value per year, minimum 0.05 vol.% O₂ per year

Output fluctuation (2σ)
≤ 25 ppm O₂ at electronic T90 time (static/dynamic) = 3/0 sec

Detection limit (4σ)
≤ 50 ppm O₂ at electronic T90 time (static/dynamic) = 3/0 sec

Influence effects
Flow effect
≤ 0.1 vol.% O₂ in permissible range

Associated gas effect
Data regarding the effect of associated gases can be found in IEC 61207-3:2002 “Gas analyzers – Expression of performance – Part 3: Paramagnetic oxygen analyzers”.

Temperature effect
Ambient temperature in permissible range
– At zero-point: ≤ 0.02 vol.% O₂ per 10 °C
– On sensitivity: ≤ 0.3 % of measured value per 10 °C
Thermostat temperature = 64 °C

Air pressure effect
– On sensitivity without pressure correction:
  ≤ 1 % of measured value per 1 % air pressure change
– On sensitivity with pressure correction using integrated pressure sensor (optional):
  ≤ 0.1 % of measured value per 1 % air pressure change;
  for highly suppressed measurement ranges
  ≤ 0.01 % of measured value per 1 % air pressure change or
  ≤ 0.002 vol.% O₂ per 1 % air pressure change, whichever is greater.

Power supply effect
DC 24 V ± 5 %: ≤ 0.4 % of span

Position effect
Zero-point shift ≤ 0.05 vol.% O₂ per 1° deviation from horizontal location. Position has no effect on the hard-mounted unit.

Dynamic response
Warm-up time
< 1 hour

90% response time
T₉₀ ≤ 3.5 to 10 sec at a sample gas flow of 90 l/h and electronic T90 time (static/dynamic) = 3/0 sec, gas change from nitrogen to air (applies to an analyzer unit with 1 analyzer module)

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

End-point calibration
With process gas with a known oxygen concentration or a substitute gas such as dried air

Single-point calibration
For measurement ranges from 0–5 to 0–25 vol.% O₂:
Zero-point calibration with any oxygen concentration, e.g. with nitrogen or ambient air, processed through a cooler or H₂O absorber.
Pressure correction by means of pressure sensor is recommended for single-point calibration with air.
Depending on the measurement task involved, the zero- and end-points should be verified periodically (recommendation: once a year).

Calibration of measurement ranges with suppressed zero-point
Highly suppressed measurement ranges (≥95 to 100 vol.% O₂) should only be calibrated with test gases with concentrations in the selected measurement range. Single-point calibration can also be done within a suppressed measurement range. The O₂ concentration of the test gas must lie within the measurement range.
Materials in contact with the sample medium

Analyzer
Stainless steel 1.4305 (SAE 303), glass, platinum, rhodium, epoxy resin; FPM seals, optional: FFKM75

Sample gas inlet conditions
Temperature
+5 to +50 °C
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required. Water vapor content variations cause volume errors.

Pressure
Operation under atmospheric pressure: The sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request.
Operation under elevated pressure: A pressure sensor is required for pressure influence compensation.
Absolute pressure ≤ 1250 hPa: An optional internal pressure sensor can be connected to the sample gas path.
Absolute pressure ≥ 1250 hPa: An external pressure sensor must be connected to the sample gas path.
The analyzer module is function-tested for 5000 hPa internal pressure without damage.

Flow rate
30 to 90 l/h
Changes in gas flow rates should be avoided when using highly suppressed measurement ranges.

Corrosive gases
Consultation with ABB Analytical is required if the sample gas contains Cl₂, HCl, HF or other corrosive components. FFKM75 seals must be used if the sample gas contains NH₃. In this case, the pneumatics module cannot be connected to the analyzer module. The pressure sensor must not be connected to the sample gas path.

Flammable gases
The analyzer module is suitable for measuring flammable gases and vapors under atmospheric conditions (pₐ ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4. The sample gas must not be explosive under normal conditions.
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 normal operation pₛ ≤ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value pₛ = 500 hPa.
Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
Housing purge with nitrogen should be provided when measuring flammable gases and vapors. Flame barriers can be used as an option (except for the “safety concept” version, see page 36).
Pressure drop at the flame barriers approx. 40 hPa for a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571 (SAE 316Ti). The pressure sensor must not be connected to the sample gas path.

Version in category 3G see page 36

Gas connections
The sample cell is connected directly to the gas ports.

[Diagram of gas connections]

1 Sample gas inlet
2 Sample gas outlet
3 purge gas inlet analyzer ¹
4 purge gas outlet analyzer ²
7 purge gas inlet housing ³
8 purge gas outlet housing ³ (also with flow sensor)
9 Pressure sensor ¹
10 Pressure sensor ²

1) Option
2) not in version with performance test for emission monitoring
Oxygen analyzer module Magnos28

Measurement principle
Paramagnetic behavior of oxygen
Magnetomechanical oxygen analyzer

Sample component and measurement ranges
Sample component
Oxygen (O₂)

Smallest measurement range
0 to 0.5 vol.% O₂

Measurement range quantity and limits
4 measurement ranges
Measurement ranges are freely adjustable; they are factory-set to 0 to 10/15/25/100 vol.% O₂ or per order.

Largest measurement range
0 to 100 vol.% O₂
Measurement ranges within ignition limits cannot be provided.

Measurement ranges with suppressed zero-point
Max. measurement range suppression 1:100, e.g. 99 to 100 vol.% O₂. The combination of a suppressed and an initial measurement range is not possible. Pressure correction by means of pressure sensor required. The pressure sensor is equipped by the manufacturer when the analyzer has been ordered with a suppressed measurement range.

Stability
The following data apply only if all influence factors (e.g. flow rate, temperature, atmospheric pressure) are constant.

Linearity deviation
≤ 0.5 % of span, minimum 0.005 vol.% O₂

Repeatability
≤ 50 ppm O₂

Zero drift
≤ 3 % of span of the smallest measurement range (per order) per week, minimum 300 ppm O₂ per week

Sensitivity drift
≤ 0.1 vol.% O₂ per week or ≤ 1 % of measured value per week (not cumulative), whichever is smaller; ≤ 0.15 % of measured value per three months, minimum 0.03 vol.% O₂ per three months

Output fluctuation (2 ơ)
≤ 25 ppm O₂ at electronic T90 time (static/dynamic) = 3/0 sec

Detection limit (4 ơ)
≤ 50 ppm O₂ at electronic T90 time (static/dynamic) = 3/0 sec

Influence effects
Flow effect
≤ 0.1 vol.% O₂ in permissible range

Associated gas effect
Data regarding the effect of associated gases can be found in IEC 61207-3:2002 “Gas analyzers – Expression of performance – Part 3: Paramagnetic oxygen analyzers”.

Temperature effect
Ambient temperature in permissible range
– At zero-point: ≤ 0.02 vol.% O₂ per 10 °C
– On sensitivity: ≤ 0.3 vol.% O₂ per 10 °C
Thermostat temperature = 60 °C

Air pressure effect
– On sensitivity without pressure correction:
  ≤ 1 % of measured value per 1 % air pressure change
– On sensitivity with pressure correction using integrated pressure sensor (optional):
  ≤ 0.1 % of measured value per 1 % air pressure change; for highly suppressed measurement ranges ≤ 0.01 % of measured value per 1 % air pressure change or ≤ 0.002 vol.% O₂ per 1 % air pressure change, whichever is greater

Power supply effect
DC 24 V ± 5 %: within detection limit

Position effect
Zero-point shift ≤ 0.05 vol.% O₂ per 1° deviation from horizontal location. Position has no effect on the hard-mounted unit.

Dynamic response
Warm-up time
< 1 hour

90% response time
T₉₀ ≤ 3.0 sec at a sample gas flow of 90 l/h and electronic T90 time (static/dynamic) = 3/0 sec, gas change from nitrogen to air (applies to an analyzer unit with 1 analyzer module)

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

End-point calibration
With process gas with a known oxygen concentration or a substitute gas such as dried air

Single-point calibration
For measurement ranges from 0–5 to 0–25 vol.% O₂:
Zero-point calibration with any oxygen concentration, e.g. with nitrogen or ambient air, processed through a cooler or H₂O absorber.
Pressure correction by means of pressure sensor is recommended for single-point calibration with air.
Depending on the measurement task involved, the zero- and end-points should be verified periodically (recommendation: once a year).

Calibration of measurement ranges with suppressed zero-point
Highly suppressed measurement ranges (≥95 to 100 vol.% O₂) should only be calibrated with test gases with concentrations in the selected measurement range. Single-point calibration can also be done within a suppressed measurement range. The O₂ concentration of the test gas must lie within the measurement range.
Materials in contact with the sample medium

Analyzer
Stainless steel 1.4305 (SAE 303), nickel alloy, glass, PtNi, silicon, gold, PTFE; FPM seals, optional: FFKM75

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

Temperature
+5 to +50 °C
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required. Water vapor content variations cause volume errors.

Pressure
Operation under atmospheric pressure: The sample gas outlet is open to atmosphere. Internal pressure drop < 5 hPa with standard flow rate 60 l/h. Permissible absolute pressure range: 800 to 1250 hPa. Operation under lower absolute pressure (e.g. at altitudes above 2000 m) on request.
Operation under elevated pressure: A pressure sensor is required for pressure influence compensation.
Absolute pressure ≤ 1250 hPa: An optional internal pressure sensor can be connected to the sample gas path.
Absolute pressure ≥ 1250 hPa: An external pressure sensor must be connected to the sample gas path.

Flow rate
30 to 90 l/h
Changes in gas flow rates should be avoided when using highly suppressed measurement ranges.

Corrosive gases
Consultation with ABB Analytical is required if the sample gas contains Cl₂, HCl, HF or other corrosive components. FFKM75 seals must be used if the sample gas contains NH₃. In this case, the pneumatics module cannot be connected to the analyzer module. The pressure sensor must not be connected to the sample gas path.

Flammable gases
The analyzer module is suitable for measuring flammable gases and vapors under atmospheric conditions (p₀ ≤ 1.1 bar, oxygen content ≤ 21 vol.%). Temperature class: T4. The sample gas must not be explosive under normal conditions.
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 normal operation p₀ ≤ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value p₀ = 500 hPa.
Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
Housing purge with nitrogen should be provided when measuring flammable gases and vapors. Flame barriers can be used as an option. Pressure drop at the flame barriers approx. 40 hPa for a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571 (SAE 316Ti). The pressure sensor must not be connected to the sample gas path.

Gas connections

19-inch housing (model AO2020)
The sample cell is connected directly to the gas ports.

Wall-mount housing (model AO2040)
The sample cell is connected directly to the gas ports.

1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet analyzer 1)
4 Purge gas outlet analyzer 1)
7 Purge gas inlet housing 1)
8 Purge gas outlet housing 1) (also with flow sensor)
9 Pressure sensor 1 1)
10 Pressure sensor 2 1)
Pneumatics module 1):
11 Sample gas inlet
12 End point gas inlet (with 3 solenoids)
13 Test gas / zero-point gas inlet (with 1 or 3 solenoids)
14 Sample gas outlet – connect with sample gas inlet 1)
1) Option
2) not in version with performance test for emission monitoring
Oxygen analyzer module Magnos27

Measurement principle
Paramagnetic behavior of oxygen
Heavy-duty thermomagnetic analyzer

Sample component and measurement ranges

Sample component
Oxygen (O₂) in flue gas or in nitrogen

Smallest measurement range
0 to 3 vol.% O₂

Measurement range quantity
1 to 4 measurement ranges
Ranges are factory-set per customer order.

Largest measurement range
0 to 100 vol.% O₂
Measurement ranges within ignition limits cannot be provided.

Stability

Linearity deviation
≤ 2 % of span

Repeatability
≤ 1 % of span

Zero drift
≤ 1 % of span per week

Sensitivity drift
≤ 2 % of measured value per week

Output fluctuation (2σ)
≤ 0.5 % of smallest measurement range span at electronic
T₉₀ time = 0 sec

Detection limit (4σ)
≤ 1 % of smallest measurement range span at electronic
T₉₀ time = 0 sec

Influence effects

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

Temperature effect
Ambient temperature in permissible range
– At zero-point: ≤ 2 % of span per 10 °C
– On sensitivity: ≤ 0.5 % of measured value per 10 °C relative to temperature at the time of calibration
Thermostat temperature = 63 °C

Air pressure effect
– At zero-point: < 0.05 vol.% O₂ per 1 % air pressure change
– On sensitivity without pressure correction:
  ≤ 1.5 % of measured value per 1 % air pressure change
– On sensitivity with pressure correction:
  ≤ 0.25 % of measured value per 1 % 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 smallest measurement range span per 1° deviation from horizontal orientation. Position has no effect on the hard-mounted unit.

Dynamic response

Warm-up time
2 to 4 hours

90% response time
T₉₀ = 10 to 22 sec, depending on sample gas flow and on measurement cell connection (see “Gas connections”, applies to an analyzer unit with 1 analyzer module)

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 in contact with the sample medium

Analyzer
Stainless steel 1.4580 (SAE 316Cb) and 1.4305 (SAE 303), glass

Gas lines and connectors
Stainless steel 1.4571 (SAE 316Ti) and 1.4305 (SAE 303), PVC-C, FPM

Sample gas inlet conditions

Temperature
+5 to +50 °C
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required. Water vapor content variations cause volume errors.

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

Flow rate
20 to 90 l/h

Flammable gases
Measurement of flammable gases is not possible.

Gas connections

Sample cell connection by means of FPM hoses

Sample cell direct connection
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<sub>90</sub> times.

1 Purge gas inlet housing<sup>1)</sup>
2 Purge gas outlet housing<sup>1)</sup> (also with flow sensor)
3 –
4 Sample gas inlet
5 Purge gas inlet analyzer
6 Purge gas outlet analyzer
7 Sample gas outlet
8 –
9 Pressure sensor 1<sup>1)</sup>
10 Pressure sensor 2<sup>1)</sup>

Pneumatics module<sup>2)</sup>:
11 Sample gas inlet
12 End point gas inlet (with 3 solenoids)
13 Test gas / zero-point gas inlet (with 1 or 3 solenoids)
14 Sample gas outlet – connect with sample gas inlet 4
1) Option
2) Option – not in version with sample cell direct connection
Trace oxygen analyzer module ZO23

Measurement 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 (N₂, CO₂, and Ar). The measuring cell is catalytically inactivated to the extent that flammable carrier components in stoichiometric concentrations only negligibly reduce the oxygen value.

Sample component and measurement ranges

Sample component
Oxygen (O₂)

Measurement range quantity and limits
4 measurement ranges
Measurement ranges are freely adjustable within the
0 to 1 ppm to 0 to 250,000 ppm O₂ range; they are factory-set to
0 to 1/10/100/1000 ppm O₂
The following measurement data refer to a measurement span of
100 ppm O₂ with a regulated flow rate of 8 ± 0.2 l/h.

Stability

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

Repeatability
< 1 % of the measurement range or 100 ppb O₂ (whichever is greater)

Zero drift
The zero point (reference point) is displayed if ambient air is present on the sample gas side. The value for air of 20.6 vol.% O₂ (for 25 °C and 50 % relative humidity) may deviate through aging of the cell.
< 1 % of the measurement range per week or 250 ppb O₂ (whichever is greater)

Sensitivity drift
Depends on possible interfering components (catalyst poisons) in the sample gas and the aging of the cell.
For pure gas measurements in N₂, CO₂ and Ar: < 1 % of the measurement range per week or 250 ppb O₂ (whichever is greater)

Output fluctuation (2σ)
< ±0.5 % of the measured value or 50 ppb O₂ (whichever is greater)

Detection limit (4σ)
< ±1 % of the measured value or 100 ppb O₂ (whichever is greater)

Influence effects

Flow effect
≤ 300 ppbv O₂ in the permissible range

Associated gas effect
Inert gases (Ar, CO₂, and N₂) have no effect. Flammable gases (CO, H₂, CH₄) in stoichiometric concentrations to the oxygen content: Conversion of O₂ < 20 % of the stoichiometric conversion. If higher concentrations of flammable gases are present, higher O₂ 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 O₂ per 10 °C change in the ambient temperature (whichever is greater).

Air pressure effect
No effect through a change in air pressure; sample gas must flow out of the outlet without backpressure.

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 min. Offset calibration with reference gas (ambient air) after 2 h 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 h.

90% response time
T₉₀ < 60 s for the alternation of 2 test gases in the measurement range 10 ppm with a sample gas flow rate = 8 l/h and electronic T₉₀ time = 3 s

Calibration

Offset calibration
The reference value for ambient air is calibrated at 20.6 vol.% O₂ by means of ambient air on the sample gas side.

End-point calibration
By means of test gas O₂ in N₂ (or in CO₂ or Ar); O₂ concentration in the measurement range, e.g. 10 ppm O₂

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 min. An additional function block configuration is required for a cyclic scan.
**Materials in contact with the sample medium**

**Analyzer**
Zirconium dioxide cell: ZrO₂, electrodes containing platinum; Dust filter (option): PP; Flow sensor (option): on semiconductor basis, nickel-plated brass

**Gas lines and connectors**
Stainless steel 1.4571 (SAE 316Ti), FPM and silicon hoses in the gas outlet; Gas connections: stainless steel 1.4401/1.4305 (SAE 316/SAE 303)

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

**Temperature**
+5 to +50 °C

**Inlet pressure**
$p_e \leq 70$ hPa

**Outlet pressure**
Atmospheric pressure

**Flow rate**
4 to 20 l/h. Use a metering valve to set the flow rate.

**Corrosive gases**
The presence of corrosive gases and catalyst poisons, e.g. halogens, gases containing sulfur and heavy-metal dust, leads to faster aging and/or destruction of the ZrO₂ cell.

**Flammable gases**
The analyzer is suitable for measuring flammable gases in general purpose environment. The concentration of flammable gases in the sample gas must not exceed 100 ppm.

**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 trace oxygen analyzer module cannot be connected to the pneumatics module.

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**Gas connections**
The measuring chamber is connected to the sample gas inlet connection via a stainless steel tube (inlet side) and to the sample gas outlet connection via a FPM hose (outlet side).

1 Sample gas inlet 3 mm Swagelok®
2 Sample gas outlet ⅛ NPT internal thread
7 Purge gas inlet housing (only for IP54 version)
8 Purge gas outlet housing (only for IP54 version)
Thermal conductivity analyzer module Caldos25

Measurement principle
Difference in thermal conductivity of various gases
Highly corrosion-resistant thermal conductivity analyzer, sample cells embedded in glass

Sample components and measurement ranges
The Caldos25 is specifically designed for measurements of corrosive gas components.

<table>
<thead>
<tr>
<th>Sample component and associated gas</th>
<th>Smallest measurement range</th>
<th>Reference gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂ in N₂ or air</td>
<td>0–0.5 vol.%</td>
<td>Air (sealed)</td>
</tr>
<tr>
<td>SO₂ in N₂ or air</td>
<td>0–1.5 vol.%</td>
<td>Air (sealed)</td>
</tr>
<tr>
<td>H₂ in Cl₂</td>
<td>0–0.5 vol.%</td>
<td>Flowing</td>
</tr>
</tbody>
</table>

Measurement range quantity and limits
1 to 4 measurement ranges per sample component
Ranges are factory-set per customer order.

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

Measurement range switching ratio
≤ 1:20

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

Stability
Linearity deviation
≤ 2 % of span

Repeatability
≤ 1 % of span

Zero drift
≤ 1 % of span per week

Sensitivity drift
≤ 1 % of measured value per week

Output fluctuation (2 σ)
≤ 0.5 % of smallest measurement range span at electronic T90 time = 0 sec

Detection limit (4 σ)
≤ 1 % of smallest measurement range span at electronic T90 time = 0 sec

Influence effects
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 at each point in the measurement range: ≤ 1 % of span per 10 °C, based on temperature at the time of calibration
Thermostat temperature = 60 °C

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

90% response time
Typical T90 = 10 to 20 sec; optional: T90 < 6 sec
(appplies to an analyzer unit with 1 analyzer module)

Calibration
Zero-point calibration
With sample component-free process gas or substitute gas

End-point calibration
With process gas having a known sample gas concentration or with substitute gas
Materials in contact with the sample medium

Analyzer
Stainless steel 1.4305 (SAE 303), glass

Gas lines and connectors
For sealed reference gas: Stainless steel 1.4305 (SAE 303);
for flowing reference gas: PVC-C, FPM seals;
for corrosive sample gas: PVC-C, FPM seals; if the sample gas contains NH₃, FFKM seals are used.

Sample gas inlet conditions

Temperature
+5 to +50 °C
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required. Water vapor content variations cause volume errors.

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

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

Flowing reference gas
Gas inlet conditions same as sample gas

Flammable gases
The analyzer module is suitable for measuring 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 under normal conditions.
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 normal operation p_r ≤ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value p_r = 500 hPa.
Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
Housing purge with nitrogen should be provided when measuring flammable gases and vapors. Flame barriers can be used as an option (except for the "safety concept" version, see page 36). Pressure drop at the flame barriers approx. 40 hPa for a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571 (SAE 316Ti).

Version in category 3G see page 36

Gas connections

Standard version
The sample cell is connected directly to the gas ports.

Versions for corrosive sample gas or flowing reference gas
The sample cell is connected directly to the gas ports.

Caution!
In versions for corrosive sample gas or flowing reference gas, gas ports 1 to 6 are made of PVC-C.
Do not use metal adapters or hose nozzles!

1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet analyzer
4 Purge gas outlet analyzer
5 Reference gas inlet
6 Reference gas outlet
7 Purge gas inlet housing
8 Purge gas outlet housing (also with flow sensor)
9 Pressure sensor
10 Pressure sensor
11 Pneumatics module
12 Sample gas inlet
13 End point gas inlet (with 3 solenoids)
14 Test gas / zero-point gas inlet (with 1 or 3 solenoids)
15 Sample gas outlet – connect with sample gas inlet
1) Option
2) Not in version for corrosive sample gas
Thermal conductivity analyzer module Caldos27

**Measurement principle**
Difference in thermal conductivity of various gases
Micromechanical silicon sensor with especially short T90 time

**Sample components and measurement ranges**

<table>
<thead>
<tr>
<th>Sample component and associated gas</th>
<th>Measurement ranges</th>
<th>Standard gas for calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>class 1</td>
<td>class 2</td>
</tr>
<tr>
<td>Ar in O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0–20</td>
<td>vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in Ar</td>
<td>0–2.5</td>
<td>vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in N&lt;sub&gt;2&lt;/sub&gt; or air</td>
<td>0–3</td>
<td>vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in stack gas</td>
<td>0–5</td>
<td>vol.%</td>
</tr>
<tr>
<td>CH&lt;sub&gt;4&lt;/sub&gt; in N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0–20</td>
<td>vol.%</td>
</tr>
<tr>
<td>CH&lt;sub&gt;4&lt;/sub&gt; in air</td>
<td>0–4</td>
<td>vol.%</td>
</tr>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt; in N&lt;sub&gt;2&lt;/sub&gt; or air</td>
<td>0–30</td>
<td>vol.%</td>
</tr>
<tr>
<td>Ar in N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>75–100</td>
<td>vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>90–100</td>
<td>vol.%</td>
</tr>
<tr>
<td>CH&lt;sub&gt;4&lt;/sub&gt; in N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>90–100</td>
<td>vol.%</td>
</tr>
<tr>
<td>He in N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>90–100</td>
<td>vol.%</td>
</tr>
</tbody>
</table>

1) Only for measurement ranges ≥ class 1
2) Daily zero-point check required

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

<table>
<thead>
<tr>
<th>Sample component and associated gas</th>
<th>Measurement range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt; in air</td>
<td>0–100 vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>100–0 vol.%</td>
</tr>
<tr>
<td>H&lt;sub&gt;2&lt;/sub&gt; in air</td>
<td>100–80/90 vol.%</td>
</tr>
</tbody>
</table>

Other sample components on request.

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

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

**Measurement range switching ratio**
≤ 1:20

**Measurement ranges with suppressed zero-point**
See the table above for spans

**Stability**
These data apply only to measurement ranges ≥ class 2.

**Linearity deviation**
≤ 2 % of span

**Repeatability**
≤ 1 % of span

**Zero drift**
≤ 2 % of smallest possible measurement range per week

**Sensitivity drift**
≤ 0.5 % of smallest possible measurement range per week

**Output fluctuation (2 σ)**
≤ 0.5 % of smallest measurement range span at electronic T90 time = 0 sec

**Detection limit (4 σ)**
≤ 1 % of smallest measurement range span at electronic T90 time = 0 sec

**Influence effects**

**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**
The knowledge of the sample gas composition is necessary for the analyzer configuration.

**Temperature effect**
Ambient temperature in permissible range at each point in the measurement range: ≤ 0.5 % of span per 10 °C, based on temperature at the time of calibration
Thermostat temperature = 60 °C

**Air pressure effect**
≤ 0.25 % of span per 10 hPa for the smallest possible ranges given; for larger spans, the effect is correspondingly lower.
Option: Calibration for operating altitude over 2000 m

**Power supply effect**
DC 24 V ± 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 measurement ranges

**90% response time**
T<sub>90</sub> ≤ 2 sec for direct sample cell connection and sample gas flow of 60 l/h (applies to an analyzer unit with 1 analyzer module)

**Calibration**

**Zero-point calibration**
With test gas, measurement component-free process gas or substitute gas

**End-point calibration**
With test gas, process gas having a known sample gas concentration or substitute gas

**Simplified calibration with standard gas**
For measurement ranges ≥ class 1, a single-point calibration can be performed with standard gas, since the zero- and end-points will not drift independently due to the sensor principle employed.
This technique leaves out safety-related measurements. Depending on the measurement task involved, the zero- and end-points should be verified periodically (recommendation: once a year).
Materials in contact with the sample medium

Analyzer
Sample cell: Stainless steel 1.4305 (SAE 303); sensor: Gold, silicon oxi-nitride; seal: FFKM75

Sample gas inlet conditions

Temperature
+5 to +50 °C
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required. Water vapor content variations cause volume errors.

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

Flow rate
Normally 10 to 90 l/h, minimum 1 l/h

Corrosive gases
Consultation with ABB Analytical is required if the sample gas contains Cl₂, HCl, HF, SO₂, NH₃, H₂S or other corrosive components. FPM hoses should not be used if the sample gas contains NH₃. Instead, FFKM hoses should be used. In this case, the pneumatics module cannot be connected to the analyzer module.

Flammable gases
The analyzer module is suitable for measuring 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 under normal conditions.
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 normal operation p_s ≤ 100 hPa; in case of a sample gas supply failure the pressure must not exceed the maximum value p_s = 500 hPa.
Before using the analyzer module, the corrosion resistance against the specific sample gas must be checked.
Housing purge with nitrogen should be provided when measuring flammable gases and vapors. Flame barriers can be used as an option (except for the "safety concept" version, see page 36). Pressure drop at the flame barriers approx. 40 hPa for a sample gas flow rate of 50 l/h. Material of the flame barriers: Stainless steel 1.4571 (SAE 316Ti).

Version in category 3G see page 36

Gas connections

The sample cell is connected directly to the gas ports.

1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet analyzer
4 Purge gas outlet analyzer
7 Purge gas inlet housing 1)
8 Purge gas outlet housing 2) (also with flow sensor)
9 Pressure sensor 1
10 Pressure sensor 2
Pneumatics module 3):
11 Sample gas inlet
12 End point gas inlet (with 3 solenoids)
13 Test gas / zero-point gas inlet (with 1 or 3 solenoids)
14 Sample gas outlet – connect with sample gas inlet 1
1) Option

1) Option
FID analyzer module Fidas24

Measurement 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 measurement range
0–5 to 0–1500 mg org. C/m³ or 0–10 to 0–300 ppm C₁

Largest measurement range
0 to 80 g org. C/m³ or 0 to 15 vol.% C₁
Larger measurement ranges on request.

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

Stability
The following data apply only if all influence factors (e.g. flow rate, temperature, atmospheric pressure) are constant. They apply to measurement ranges \( \geq 50 \text{ mg org. C/m³} \), for smaller ranges these only apply if they are factory-set per customer order.

Linearity deviation
\( \leq 2 \% \text{ of span to 5000 mg org. C/m³} \)
this value applies in one (calibrated) measurement range

Repeatability
\( \leq 0.5 \% \text{ of measurement range} \)

Zero-point and sensitivity drift
\( \leq 0.5 \text{ mg org. C/m³ per week} \)

Output fluctuation at zero-point (2 σ)
\( \leq 0.5 \% \text{ of span at electronic T90 time = 20 sec} \)

Detection limit (4 σ)
\( \leq 1 \% \text{ of span at electronic T90 time = 20 sec} \)

Influence effects

Oxygen dependence
\( \leq 2 \% \text{ of measured value for 0–21 vol.% O}_2 \text{ or } \leq 0.3 \text{ mg org. C/m³}, \text{ the larger value applies} \)

Temperature effect
Ambient temperature in permissible range
at zero-point and on sensitivity: \( \leq 2 \% \text{ of measured value per } 10 \text{ °C or } \leq 300 \text{ ppb C₁ per 10 °C} \)

Power supply effect
DC 24 V ± 5 %: \( \leq 0.2 \% \text{ of span or AC 230 V ± 10 %: } \leq 0.2 \% \text{ of span} \)

Dynamic response

Warm-up time
\( \leq 2 \text{ hours} \)

90% response time
T₉₀ \( < 1.5 \text{ s at sample gas flow = 80 l/h and electronic T90 time = 1 sec} \)

Calibration

Zero-point calibration
With synthetic air or catalytically purified air or nitrogen, depending on application

Sensitivity calibration
With propane or another hydrocarbon (substitute gas) in air or nitrogen, depending on application

Materials in contact with the sample medium
Analyzer, gas lines and connectors
Stainless steel 1.4305 (SAE 303) and 1.4571 (SAE 316Ti), FPM, PTFE, FFKM

Operating gases and test gases

Instrument air
Quality per ISO 8573-1 class 2 (max. particle size 1 µm, max. particle concentration 1 mg/m³, max. oil content 0.1 mg/m³, pressure dew point at least 10 °C below the lowest foreseeable ambient temperature)
Inlet pressure pᵢ = 4000 ± 500 hPa
Flow rate typically approx. 1800 l/h (1200 l/h for air injector and approx. 600 l/h for housing purge), maximum approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air
Synthetic air or catalytically purified air with an organic C content < 1 % span
Inlet pressure pᵢ = 1200 ± 100 hPa
Flow rate < 20 l/h

Combustion gas
Hydrogen (H₂), grade 5.0, or H₂/He mixture (40/60 %)
Inlet pressure pᵢ = 1200 ± 100 hPa
Flow rate \( \leq 3 \text{ l/h (H₂) or approx. 10 l/h (H₂/He)} \)
A flow limiting device must be provided on the hydrogen supply (see section “Safe operation of the gas analyzer”).

Test gases
Zero-point calibration: Nitrogen, grade 5.0, or synthetic air or catalytically purified air
Sensitivity calibration: Sample component or substitute gas component in nitrogen or air
Inlet pressure pᵢ = 1000 ± 100 hPa
Flow rate 130 to 250 l/h
Sample gas inlet conditions

The sample gas may not be explosive at any time.

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

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

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

Outlet pressure
Atmospheric pressure

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

Humidity
≤ 40 % H₂O

Flammable gases
The analyzer module can be used for measurement of flammable gases as long as the total flammable portion does not exceed 15 vol.% CH₄ or C₁ equivalents.

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 of H₂ or 25 l/h of H₂/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 the safety in the following operating states: Shutting down the gas analyzer, failure of the instrument air supply, leakage in the combustion gas feed path inside the gas analyzer. This shut-off valve should be installed outside the analyzer house near the combustion gas supply.

Gas and electrical connections

30 Power supply AC 115 or 230 V for heating of detector and sample gas inlet (4-pin male plug, connecting cable supplied)
31 Electrical connection to heated sample gas inlet (fixed)
32 Test gas outlet
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 (male fitting for connecting the exhaust air outlet tube: Stainless steel tube with terminal nut and clamping ring, outside diameter = 6 mm, included in the scope of supply and delivery of the gas analyzer. Permissible maximum length of 30 cm; after that point the inner diameter of the exhaust line should be increased to ≥ 10 mm.)
39 Sample gas inlet, heated or unheated (Threaded connection for PTFE or stainless steel tubing with a 6-mm outer diameter)
40 Pressure compensation opening with protection filter
24 V External power supply DC 24 V (4-pin male plug)
Bus System bus (3-pin female plug)

Sample gas line connection

To heated sample gas inlet:
- In wall-mount housing: bottom and right
- In 19-inch housing: back, top and bottom
To unheated sample gas inlet:
- In wall-mount and 19-inch housing: back
FID analyzer module Fidas24 NMHC

Measurement 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 analyzer module for the measurement of CH₄.

Sample components and measurement ranges

Sample components
Hydrocarbons.
The CH₄/NMHC ratio must be in the 1:9 to 9:1 range.
Maximum concentration CH₄:
26500 mg org. C/m³ or 50000 ppm C₁.
Maximum concentration NMHC:
5000 mg org. C/m³ or 9330 ppm C₁.
The concentration of the gas components in the sample gas path must not exceed the temperature-dependent LEL. The analyzer temperature is 180 °C.

Number of sample components
2 sample components: CH₄ and THC. The calculated non-methane portion of the hydrocarbons is output as 3rd component NMHC.

Smallest measurement range
0–5 to 0–1500 mg org. C/m³ or 0–10 to 0–3000 ppm C₁

Largest measurement range CH₄ and THC
0–50 to 0–25000 mg org. C/m³ or 0–100 to 0–50000 ppm C₁

Largest measurement range NMHC
0–5000 mg org. C/m³ or 0–10000 ppm C₁

Measurement range quantity and limits
1 to 4 measurement ranges
Measurement ranges are factory-set per customer order.

Stability
The following data apply only if all influence factors (e.g. flow rate, temperature, atmospheric pressure) are constant. They apply to measurement ranges ≥ 50 mg org. C/m³, for smaller ranges these only apply if they are factory-set per customer order.

Linearity deviation
≤ 2 % of span to 5000 mg org. C/m³
this value applies in one (calibrated) measurement range

Repeatability
≤ 0.5 % of measurement range

Zero-point and sensitivity drift
≤ 0.5 mg org. C/m³ per week

Output fluctuation at zero-point (σ)
≤ 0.5 % of span at electronic T90 time = 20 sec

Detection limit (σ)
≤ 1 % of span at electronic T90 time = 20 sec

Influence effects

Oxygen dependence
≤ 2 % of measured value for 0–21 vol.% O₂ or ≤ 0.3 mg org. C/m³, the larger value applies

Temperature effect
Ambient temperature in permissible range at zero-point and on sensitivity: ≤ 2 % of 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

Dynamic response

Warm-up time
≤ 2 hours

90 % response time
T₉₀ < 2.5 s via bypass, T₉₀ < 3 s via converter at sample gas flow = 80 l/h and electronic T90 time = 1 sec

Switchover time
Between bypass and converter typically 20 s, depending on measurement range

Converter

Converter service life
The catalyst is a consumable material. Its service life depends on the concentration of the converted hydrocarbons. Catalyst poisons (e.g. SO₂, HCl, H₂S, halogenated hydrocarbons, heavy metals) will shorten the converter service life. Their respective concentration should always be < 20 mg/m³. 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 in contact with the sample medium

Analyzer, gas lines and connectors
Stainless steel 1.4305 (SAE 303) and 1.4571 (SAE 316Ti), FPM, PTFE, FFKM

Operating gases and test gases

Instrument air
Quality per ISO 8573-1 class 2 (max. particle size 1 µm, max. particle concentration 1 mg/m³, max. oil content 0.1 mg/m³, pressure dew point at least 10 °C below the lowest foreseeable ambient temperature), inlet pressure pᵢ = 4000 ± 500 hPa, flow rate typically approx. 1800 l/h (1200 l/h for air injector and approx. 600 l/h for housing purge), maximum approx. 2200 l/h (1500 l/h + 700 l/h)

Combustion air
Synthetic air or catalytically purified air with an organic C content < 1 % span, inlet pressure pᵢ = 1200 ± 100 hPa, flow rate < 20 l/h
Combustion gas
Hydrogen (H₂), grade 5.0, or H₂/He mixture (40/60 %), inlet pressure \( p_e = 1200 \pm 100 \, \text{hPa} \), flow rate \( \leq 3 \, \text{l/h} \) (H₂) or approx. 10 l/h (H₂/He). A flow-limiting device must be provided on the hydrogen supply (see section “Safe operation of the gas analyzer”).

Test gases
Zero-point calibration: Synthetic air or catalytically purified air. Sensitivity calibration: Sample component CH₄ in air, sample component THC: C₃H₈ in air or CH₄ in air. Inlet pressure \( p_e = 1000 \pm 100 \, \text{hPa} \), flow rate 130 to 250 l/h

Test gases for converter effectiveness testing
CH₄ or C₂H₆ in air (separate test gas bottles), connection via bypass, inlet pressure \( p_e = 1000 \pm 100 \, \text{hPa} \), flow rate 130 to 250 l/h

Sample gas inlet conditions
The sample gas may not be explosive at any time.

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

Temperature
\( \leq \) thermostat temperature
(Thermostat temperature for sample gas path, detector and air injector \( \leq 200 \, ^\circ \text{C} \), factory-set to 180 °C)

Inlet pressure
\( p_{\text{in}} = 850 \) to 1100 hPa

Outlet pressure
Atmospheric pressure

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

Humidity
\( \leq 40 \% \, \text{H}_2\text{O} \)

Flammable gases
The analyzer module can be used for measurement of flammable gases as long as the total flammable portion does not exceed 5 vol.% CH₄ or C1 equivalents.

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 of H₂ or 25 l/h of H₂/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 the safety in the following operating states: Shutting down the gas analyzer, failure of the instrument air supply, leakage in the combustion gas feed path inside the gas analyzer. This shut-off valve should be installed outside the analyzer house near the combustion gas supply.
Laser analyzer module LS25

Measurement 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 this single absorption line. A detector diametrically opposite detects the light and the absorption caused only by the target gas molecules. Once the absorption by the target gas molecules is detected, the gas concentration is calculated. Automatic corrections for temperature and pressure variations are included.

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 measurement ranges are shown in the table below:

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Min. measurement range</th>
<th>Max. abs. pressure</th>
<th>Max. temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂ 0– 1 vol.%</td>
<td>10 bar</td>
<td>1500 °C</td>
<td></td>
</tr>
<tr>
<td>NH₃ 0– 20 ppm</td>
<td>1.5 bar</td>
<td>500 °C</td>
<td></td>
</tr>
<tr>
<td>HCl 0– 5 ppm</td>
<td>1.5 bar</td>
<td>400 °C</td>
<td></td>
</tr>
<tr>
<td>HF 0– 3 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>H₂S 0– 300 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>H₂O (ppm) 0– 30 ppm</td>
<td>1.5 bar</td>
<td>1300 °C</td>
<td></td>
</tr>
<tr>
<td>H₂O (vol.%) 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>1500 °C</td>
<td></td>
</tr>
<tr>
<td>CO (ppm) 0– 20 ppm</td>
<td>1.5 bar</td>
<td>500 °C</td>
<td></td>
</tr>
<tr>
<td>CO (vol.%) 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>600 °C</td>
<td></td>
</tr>
<tr>
<td>CO₂ (ppm) 0– 100 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>CO₂ (vol.%) 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>1500 °C</td>
<td></td>
</tr>
<tr>
<td>NO 0– 1500 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>N₂O 0– 500 ppm</td>
<td>1.5 bar</td>
<td>200 °C</td>
<td></td>
</tr>
<tr>
<td>HCN 0– 30 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>CH₄ 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>500 °C</td>
<td></td>
</tr>
<tr>
<td>NH₃ + H₂O 0– 20 ppm</td>
<td>1.5 bar</td>
<td>500 °C</td>
<td></td>
</tr>
<tr>
<td>HCl + H₂O 0– 5 ppm</td>
<td>1.5 bar</td>
<td>400 °C</td>
<td></td>
</tr>
<tr>
<td>HF + H₂O 0– 3 ppm</td>
<td>1.5 bar</td>
<td>300 °C</td>
<td></td>
</tr>
<tr>
<td>CO (vol.%) + CO₂ (vol.%) 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>600 °C</td>
<td></td>
</tr>
<tr>
<td>HCl + CH₄ 0– 300 ppm</td>
<td>1.5 bar</td>
<td>400 °C</td>
<td></td>
</tr>
<tr>
<td>CO (ppm) + CH₄ 0– 20 ppm</td>
<td>1.5 bar</td>
<td>500 °C</td>
<td></td>
</tr>
<tr>
<td>CO (ppm) + H₂O (vol.%) 0– 5 vol.%</td>
<td>1.5 bar</td>
<td>1500 °C</td>
<td></td>
</tr>
<tr>
<td>O₂ + temp. 0– 1 vol.%</td>
<td>1.5 bar</td>
<td>1500 °C</td>
<td></td>
</tr>
</tbody>
</table>

Other sample components on request.
All specifications refer to an optical path length (OPL) of 1 meter, tested in ABB’s test/calibration jig. The standard optical path length ranges from 0.5 to 6 m (larger OPL on request). Application-dependent variations may occur. To obtain minimum measurement ranges in some cases additional measures have to be taken: Low level O₂ and H₂O require instrument and process purging with nitrogen. Actual detection limit for a specific application will depend on the gas conditions (pressure, temperature and gas composition) and optical path length. If more than one min. measurement range is shown, there are different instrument versions available.

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 toxic or flammable gas may require additional equipment.

Measurement range quantity
1 range per sample component, 1 x transmission

Largest measurement range
Largest measurement range is generally 100 times the minimum measurement range for the same conditions. Larger measurement ranges are normally possible by adaptation of measuring path and choice of a weaker absorption line.

Stability
Linearity deviation
≤ 1 % of span

Repeatability
± Detection limit or ± 1 % of reading, whichever is greater

Zero drift
< 2 % of smallest possible measurement range per 6 months

Span drift
< 4 % of measurement range per 6 months

Output fluctuation (2σ)
≤ 0.5 % of smallest measurement range

Detection limit (4σ)
≤ 1 % of smallest measurement range

Influence effects
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 effect
– Ambient temperature in permissible range: No significant effect
– Gas temperature effect: Typically ≤ 2 % of measured value per 10 °C (dependent on type of gas and gas conditions).
For large variations in gas temperature (> ±20 °C) separate temperature measurement for compensation is recommended.

Pressure effect
– At zero-point: No effect.
– Automatic compensation for large variations in sample gas pressure by measurement of absorption line width, alternatively by input from pressure sensor.

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

**Warm-up time**
Approx. 1 hour

**Response time**
Less than 2 seconds without signal averaging

**Calibration**

**Maintenance interval**
Depending on application and dust load. Typically between every 6 months and once a year (no consumables required).

**Zero-point check**
With inert gas, e.g. nitrogen, or with ambient air free of the sample component. The zero point cannot be calibrated. Due to the measurement principle, there is no zero-point drift.

**Calibration**
With test gas and a flow-through test cell. Calibration interval typically between every 6 months and once a year. Recommended calibration interval will be stated in calibration certificate that accompanies delivery.

**Materials in contact with the process gas**

**Purge and alignment unit**
316 SS

**Windows**
BK7 glass, optional: fused silica, for HF: sapphire

**Mounting**

**Available flanges**
DN50/PN10, DN80/PN10; ANSI 2°/150 lbs, ANSI 3°/300 lbs

**Alignment tolerances**
Flanges parallel within 1.5°

**Purging of windows**
Dry and oil-free pressurized air or gas, or by fan

**Gas ports for purging**
Standard: ¼-inch hose nozzle for hoses with 10 mm inner diameter. See page 32 for connection drawing.

**Weight**
Transmitter unit plus flange with purging unit: 9.5 (6.3 + 3.2) kg
Receiver unit plus flange with purging unit: 7.2 (4.0 + 3.2) kg
Flow-through test cell: 3.8 kg

**Dimensions**
See page 33

**Electrical connections on transmitter unit**

**Connection to central unit**
Ethernet 10/100BASE-T, RJ45 connector
Cable length: Standard 15 m, max. 100 m

**Connection to receiver unit**
15-pin female Sub-D connector
Cable length: Standard 5 m, max. 150 m

**Power supply, external pressure and temperature signals**
15-pin male Sub-D connector;
Cable length laser unit–power supply: Standard 3 m, max. 100 m;
Cable length power supply–plug: 3 m

**Service computer**
RS232, 9-pin female Sub-D connector; Ethernet

**Connection drawing**
See page 33

**Process gas properties**

**Maximum process gas temperature and pressure are given in the “Sample components and measurement ranges” table. Quantification of dust/particle concentration is necessary in order to determine max OPL. The maximum dust concentration must be checked by ABB Analytical.**

**Purge gas requirements**
The purge gas should not contain any sample gas components and must be oil- and dust-free.

**Power supply**

**Input voltage**
DC 24 V ± 5 % from an external power supply unit AC 115/230 V
(part of the delivery for general-purpose applications)

**Power consumption**
Approx. 20 W

**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, the LS25 must be mounted at right angles to the process gas flow.

**Explosion-proof versions**
The AO2000-LS25 Ex analyzer module is suited for use in areas in which explosive atmospheres caused by vapors, gases, mists, or air/dust mixtures are likely to occur. The external power supply is not approved for installation in hazardous areas.

**Version for use in zone 2**

**Marking**

II 3 G Ex nA nC [op is Ga] IIC T5 ¹ Gc, −20°C ≤ Tamb ≤ +55°C
II 3 D Ex tc [op is Da] IIIC T100°C Dc, −20°C ≤ Tamb ≤ +55°C
¹) T4 for special applications

**Housing protection type**
IP66

**Version for use in Class 1, Division 2 – CSA**
The AO2000-LS25 Ex analyzer module is certified for use in hazardous areas Class 1, Division 2, Groups A, B, C and D, Temperature Code T4, ambient temperature max. +55 °C.
Certificate No. 1105720
... Laser analyzer module LS25

Gas connections (general-purpose application)
Dimensions and electrical connections (general-purpose application)
—

Electrochemical oxygen sensor

**Measurement principle**
Electrochemical oxygen sensor

**Sample component and measurement ranges**

**Sample component**
Oxygen (O₂)

**Measurement range quantity and limits**
1 to 2 measurement ranges
Adjustable from 0–5 vol.% O₂ to 0–25 vol.% O₂

**Stability**

**Linearity deviation**
≤ 1 % of span

**Repeatability**
≤ 0.5 % of span

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

**Sensitivity drift**
≤ 1 % of the measurement range per week

**Output fluctuation (2σ)**
≤ 0.2 % of the measurement range at electronic T90 time (static/dynamic) = 5/0 sec

**Detection limit (4σ)**
≤ 0.4 % of the measurement range at electronic T90 time (static/dynamic) = 5/0 sec

**Influence effects**

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

**Temperature effect**
Ambient temperature in permissible range:
≤ 0.2 vol.% O₂ per 10 °C

**Air pressure effect**
- At zero-point: No effect
- On sensitivity with no pressure correction:
  ≤ 1 % of the measured value per 1 % air pressure change
- On sensitivity with pressure correction:
  ≤ 0.2 % of the measured value per 1 % air pressure change
  Pressure correction is only possible if the oxygen sensor is connected to an analyzer module with an integral pressure sensor.

**Power supply effect**
Voltage and frequency in the permissible range: ≤ 0.2 % of span

**Dynamic response**

**90% response time**
T₉₀ ≤ 30 sec, depending on sample gas flow and system layout

**Calibration**

**Zero-point calibration**
The oxygen sensor zero is not calibrated since it is fundamentally stable.

**End-point calibration**
With ambient air at 20.96 vol.% O₂

**Materials in contact with the sample medium**
Sensor: Polystyrol-ABS, PTFE, FPM;
Housing body: PVC-U, FPM seals;
Gas ports: Stainless steel 1.4571 (SAE 316Ti)

**Sample gas inlet conditions**
The oxygen sensor must not be used for measurement of flammable gases and ignitable gas/air or gas/oxygen mixtures.

**Temperature**
The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

**Moisture content**
H₂O dew point ≥ 2 °C
The oxygen sensor should not be used with dry sample gas.

**Inlet pressure**

pᵢ = 2 to 500 hPa

**Outlet pressure**
Atmospheric pressure

**Flow rate**
20 to 100 l/h

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

**Notes**
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 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 for measuring corrosive gases
- Analyzer modules in category 2G
Pneumatics module

Test gas supply

**Type**
One or three 3/2-way solenoid valves

**Power consumption**
Approx. 3 W per solenoid valve

**Materials in contact with the sample medium**
PVDF, FPM, aluminum, stainless steel 1.4305 (SAE 303)

Fine filtration

**Type**
Disposable filter with borosilicate glass microfiber filter element

**Retention rate**
99.99 % for particles > 0.1 μm

**Materials in contact with the sample medium**
Polyamide, borosilicate glass with PVDF binder

Gas supply

**Type**
Magnetic piston pump

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

**Flow rate**
Adjustable

**Power consumption**
Approx. 10 W

**Materials in contact with the sample medium**
PVDF, EPDM, stainless steel 1.4571 (SAE 316Ti)

Flow monitoring

**Type**
Miniature flow sensor

**Readout and limit value monitoring**
Configurable

**Materials in contact with the sample medium**
Al₂O₃, silicon, gold, GFK

Pressure monitoring

**Pressure sensor**
(Option) 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.

**Temperature**
+5 to +45 °C

The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

**Inlet pressure**
\( p_e = \sim -80 \) 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.

Notes

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

Sample gas inlet conditions

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

**Temperature**
+5 to +45 °C

The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

**Inlet pressure**
\( p_e = \sim -80 \) 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.

Notes

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

Sample gas inlet conditions

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

**Temperature**
+5 to +45 °C

The sample gas dew point should be at least 5 °C below the ambient temperature throughout the sample gas path. Otherwise, a sample gas cooler or condensate trap is required.

**Inlet pressure**
\( p_e = \sim -80 \) 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.

Notes

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
**Explosion protected versions in category 3G**

**Version in category 3G for measurement of flammable and non-flammable gases (“Safety concept”)**

The “safety concept” gas analyzers include:
- Uras26 in the version with safety cell and purged sample cell windows
- Magnos206, Caldos25 and Caldos27 in the version with direct sample cell connection and purged thermostat housing.

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 Directive 2014/34/EU (ATEX Directive). There are the following explosion protection measures in the gas analyzer:
- Non-arcing assemblies and components/non-hot components/sealed (arcing) devices per EN 60079-15 and
- Simplified positive pressure containment per EN 60079-2.

**Marking**

II 3G Ex nA pyb II T4 Gc

**Housing protection type**

IP54

**Sample gas inlet conditions**

**Sample gas**

Flammable and non-flammable gases and vapors
- Under atmospheric conditions ($p_{\text{max}} \leq 1.1$ bar, oxygen content $\leq 21$ vol.%),
- Temperature class T4,
- Not potentially explosive under normal conditions,
- If potentially explosive in the event of a fault, then only seldom and briefly (in accordance with zone 2).

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.

**Pressure**

At sample gas inlet: positive pressure $p_\text{a} \leq 3$ hPa,

at sample gas outlet: atmospheric

**Flow rate**

Max. 40 l/h

Inert gas curtain/purge gas/(Simplified) pressurized enclosure

**Purge gas**

Inert gas (nitrogen)

**Pressure**

Positive operating pressure $p_\text{a} \geq$ sample gas pressure + 0.5 hPa

**Flow rate**

During operation: 15 to 20 l/h, during initial purge: 15 to 50 l/h

**Initial purge**

Manually controlled, initial purge duration:
- Uras26: 1.6 minutes at min. 15 l/h
- Magnos206, Caldos25, and Caldos27: 18 minutes at min. 15 l/h or 6 minutes at min. 50 l/h

**Alarm**

When flow rate drops below a minimum value of 15 l/h (corresponds to approx. 7 hPa) and when flow rate exceeds a maximum value of 50 l/h (corresponds to approx. 60 hPa)

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

The analyzer modules Uras26, Magnos206, Magnos27, Caldos25 und Caldos27 are suitable 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-inch rack unit).

The version complies with the Directive 2014/34/EU (ATEX directive). The gas analyzer is protected by provisions according to EN 60079-15 (non-arcing electrical equipment, sealed arcing devices).

In undisturbed operation, there cannot be any sparking, arcing or impermissible temperatures inside the device. During operation, all unused gas ports should be plugged.

**Marking**

II 3G Ex nA nC IIC T4 Gc

**Housing protection type**

IP54
Gas connections “Safety concept”

Uras26

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 monitor “Analyzer purge out”
7 Sample gas outlet gas path 2
8 Sample gas inlet gas path 2
9 Pressure sensor (option)

Magnos206, Caldos25, Caldos27

1 Sample gas inlet
2 Sample gas outlet
3 Purge gas inlet thermostat chamber “Analyzer purge in”
4 Purge gas outlet thermostat chamber (rigid tubed 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 inlet flow rate monitor (rigid tubed with 4)
14 Purge gas outlet flow rate monitor “Analyzer purge out”
General data

Display and operation

Display
Backlit graphics display, 320 x 240-pixel resolution

Measured value display
Digits with unit and bar graph; simultaneous display of up to six measured values, configurable

Units of measure
Selectable in physical units, e.g. ppm, vol.% mg/m³ or g/m³, as well as in % of span or mA

Digital value resolution
Better than 0.2 % of span

Status indication
Green LED: Power supply on
Yellow LED: Maintenance request
Red LED: Failure

Status messages
Plain text

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

Measuring range switch-over 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 selected 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-inch housing (model AO2020) or Wall-mount housing (model AO2040)

Housing protection type
IP65 without power supply and without display/control unit, IP54 with display/control unit and connection box, IP20 without connection box per EN 60529

Housing materials
Housing: stainless steel 1.4016 (SAE 430), module rear panel: aluminum, keypad sheet: Polyester

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

Weight
Analyzer unit with one analyzer module: 18 to 23 kg

Dimensions
See page 45

Housing purge

Housing purge is possible with IP54 version with connection box. Purge version can be fitted with screwed cable glands (per EN) or with conduit connections (per CSA). Purge gas flow during operation max. 20 l/h (Fidas24, Fidas24 NMHC: approx. 300 l/h), purge gas pressure $p_{\text{abs}} = 2–4$ hPa. The purge gas should not contain any sample gas components.

Pressure sensor

Use
Standard: with Uras26, Limas21 UV, Limas21 HW, Caldos27; option: with Magnos206, Magnos28 and Magnos27; not necessary with Caldos25, Fidas24, ZO23

Working range
$p_{\text{abs}} = 600–1250$ hPa

Materials in contact with the sample medium
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-inch rack housing) or bottom (wall-mount housing) of the analyzer module

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

Electrical connections

Central unit
Power supply: 3-pin plug per EN 60320/C14, connecting cable supplied; Ethernet: Two 8-pin RJ45 plugs; System bus: 3-pin female plug

Analyzer modules
External power supply: 4-pin male plug; Heating of detector and sample gas inlet (FID analyzer modules): 4-pin male plug, connecting cable supplied; System bus: 3-pin female plug

Electrical safety

Tested per EN 61010-1:2010

Protection class
Central unit with electronics module (power supply): I; Analyzer modules without electronics module (power supply): III

Overvoltage category/pollution degree
Power supply: II/2

Safe isolation
The power supply is galvanically isolated from other circuits by means of reinforced or double insulation. Protective extra-low voltage (PELV) on low-voltage side
Electromagnetic compatibility

Noise immunity
Tested per EN 61326-1:2013. Inspection severity: Industrial area, fulfills at least the rating to table 2 of EN 61326.

Emitted interference
Tested per EN 61326-1:2013. Limit value class B for interference field strength and interference voltage is met.

Mechanical stress

Transport

Installation site requirements

Installation location
The gas analyzer is intended for indoor installation only. Altitude above 2000 m on request.

Vibration
Analyzer unit only:

<table>
<thead>
<tr>
<th></th>
<th>Operation:</th>
<th>Without electronics module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uras26:</td>
<td>Max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz, slight transient effect on sample value in the region of the beam modulation frequency</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Limas21 UV:</td>
<td>Max. 20.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Limas21 HW:</td>
<td>Max. 20.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz</td>
<td>+15 to +35 °C</td>
</tr>
<tr>
<td>Magnos206:</td>
<td>Max. 20.04 mm at 5 to 20 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Magnos28:</td>
<td>Max. 20.04 mm at 5 to 50 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Magnos27:</td>
<td>Max. 20.04 mm at 5 to 150 Hz</td>
<td>+5 to +50 °C</td>
</tr>
<tr>
<td>ZO23:</td>
<td>Max. 20.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Caldos25:</td>
<td>Max. 20.04 mm at 5 to 30 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Caldos27:</td>
<td>Max. 20.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Fidas24:</td>
<td>Max. 0.5 g, max. 150 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>Fidas24 NMHC:</td>
<td>Max. 0.5 g, max. 150 Hz</td>
<td>+5 to +45 °C</td>
</tr>
<tr>
<td>LS25:</td>
<td>Max. 20.06 mm around the optical axis, max. 500 Hz</td>
<td>+5 to +45 °C</td>
</tr>
</tbody>
</table>

Analyzer unit installed in cabinet (analyzer system): Max. acceleration 0.01 m s⁻² in a frequency range of 0.1 to 200 Hz. 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

<table>
<thead>
<tr>
<th></th>
<th>Operation:</th>
<th>With electronics module</th>
<th>Without electronics module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uras26:</td>
<td>+5 to +40 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Limas21 UV:</td>
<td>+5 to +40/45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Limas21 HW:</td>
<td>+15 to +35 °C</td>
<td>+15 to +35 °C</td>
<td></td>
</tr>
<tr>
<td>Magnos206:</td>
<td>+5 to +45 °C</td>
<td>+5 to +50 °C</td>
<td></td>
</tr>
<tr>
<td>Magnos28:</td>
<td>+5 to +45 °C</td>
<td>+5 to +50 °C</td>
<td></td>
</tr>
<tr>
<td>Magnos27:</td>
<td>+5 to +45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>ZO23:</td>
<td>+5 to +45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Caldos25:</td>
<td>+5 to +45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Caldos27:</td>
<td>+5 to +45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Fidas24:</td>
<td>+5 to +45 °C</td>
<td>+5 to +45 °C</td>
<td></td>
</tr>
<tr>
<td>Fidas24 NMHC:</td>
<td>+5 to +40 °C</td>
<td>+5 to +40 °C</td>
<td></td>
</tr>
<tr>
<td>LS25:</td>
<td>−20 to +55 °C, no direct solar irradiation</td>
<td>1) With direct sample cell connection and when installed in housing without Uras26</td>
<td></td>
</tr>
</tbody>
</table>

Relative humidity
< 75 %, no condensation

Climate class
3K3 for IP20 housing (non-condensing), 3K4 for IP54 housing (condensing) per EN 60721-3-3

Air circulation
For sufficient air circulation, multiple housings in a 19-inch rack must be installed with a separation of at least one height unit between housings.
… General data

Power supply

Power supply unit
Input voltage
AC 100 to 240 V, −15 %, +10 %, max. 2.2 A, 50 to 60 Hz ± 3 Hz

Power consumption
Max. 187 VA

Output voltage
DC 24 V ± 3 % to supply the electronics module (see page 41) and one analyzer module installed in the central unit or (optionally) one external analyzer module.

Fidas24, Fidas24 NMHC:
Heating of detector and sample gas inlet
Input voltage
AC 115 V or 230 V, ±15 % (max. AC 250 V), 47 to 63 Hz

Power consumption
Fidas24: 125 VA for detector
125 VA for sample gas inlet (option)
Fidas24 NMHC: Approx. 200 VA for detector
125 VA for sample gas inlet (option)

Analyzer modules
Input voltage
DC 24 V ± 5 %

Power consumption
Uras26: Max. 95 W
Limas21 UV: Max. 100 W
Limas21 HW: Max. 100 W
Magnos206: Max. 50 W
Magnos28: Max. 50 W
Magnos27: Max. 35 W
ZO23: Max. 35 W
Caldos25: Max. 25 W
Caldos27: Max. 17 W
Fidas24: Max. 40 W
Fidas24 NMHC: Max. 40 W
LS25: Approx. 20 W

Note regarding the analyzer module performance characteristics

The analyzer module performance characteristics indicated apply only when operated in conjunction with the central unit. They have been determined according to IEC 61207-1:2010 “Expression of performance of gas analyzers – Part 1: General”. They are based on 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 performance characteristics relative to the measuring range span.
**Electronics module**

**Processing of measured values and signals**
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 "Electrical connections")

**Technical data**
See pages 42 to 44

**Notes regarding conductor section**
- The maximum capacity of terminals for stranded or solid conductors is 1 mm² (17 AWG).
- The stranded conductor may be tinned on the tip or twisted for simplified connection.
- When using wire end ferrules the total section should not exceed 1 mm², i.e. the maximum stranded conductor section is 0.5 mm². 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 connections: Two 8-pin RJ45 plugs

**System bus**
Internal bus for communication between the gas analyzer’s functional units. Electrical connections: 3-pin female plug

**Power supply**

**Input voltage**
DC 24 V ± 3 % from the built-in power supply (see page 40)

**Power consumption**
approx. 15 W without I/O modules

**Electrical connections**

-X01 Power supply connection
-X07 System bus connection
-X08, Ethernet 10/100/1000BASE-T interfaces
-X09
-X20 I/O modules (5 slots), options:
to – Profibus module
-X29 – Modbus module
- Digital I/O module
- 2-way analog output module
- 4-way analog output module
- 4-way analog input module

Connection diagrams see pages 42 to 44

**Note**
The drawing shows an example for the I/O modules equipment.
I/O modules

Profibus module

Application
Integration of AO2000 into PROFIBUS PA and PROFIBUS DP networks for transfer of measured values and status signals as well as analog inputs, digital inputs and digital outputs. Digital data transmission certified according to guideline VDI 4201, Sheets 1 and 2.

Electrical connections
RS485 interface:
1 – not used
2 M24 24 V output ground, max. 0.2 A
3 Rx/D/TxD-P Receive/transmit data plus, B-line
4 – not used
5 DGND Data transmission potential (reference pot. for VP)
6 VP Supply voltage plus (5 V)
7 P24 24 V output voltage plus
8 Rx/D/TxD-N Receive/transmit data N, A-line
9 – not used
Design: 9-pin Sub-D female connector

MBP interface (non-intrinsically safe):
1 +
2 Shield
3 −
4 not used
Design: 4-pin terminal strip. Observe the information regarding conductor section (see page 41).

Modbus module

Application
Transfers measured values and status signals as well as analog inputs, digital inputs and digital outputs to host systems, e.g. to standard Windows applications via M-DDE Server; Modbus slave protocol in RTU (remote terminal unit) mode or via RS485 or RS232 interface (configurable).

Electrical connections
RS232 interface: RS485 interface:
2 Rx/D 2 RTxD−
3 TxD 3 RTxD+
5 GND 5 GND
Design: Design:
9-pin Sub-D male connector 9-pin Sub-D female connector
**Digital I/O module**

*4 digital inputs (DI1 to DI4)*
Optocouplers with internal DC 24 V power supply, jointly galvanically isolated from ground. Control with floating contacts, with external voltage DC 12 to 24 V or with open collector drivers PNP or NPN.

*4 digital outputs (DO1 to DO4)*
Floating double-throw contacts, max. contact load rating DC 30 V/1 A, galvanically isolated from ground. 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).

**Standard function block applications**
Status signals, externally controlled calibration:
- DO1 Failure/collective status
- DO2 Maintenance mode/limit value
- DO3 Maintenance request/limit value
- DO4 External solenoid valve
- DI1 Start automatic calibration
- DI2 Inhibit automatic calibration
- DI3 Calibrate zero-point
- DI4 Calibrate end-point

Measurement range control:
- DO1 Measurement range feedback
- DO2 Measurement range feedback
- DO3 Measurement range feedback
- DO4 Measurement range feedback
- DI1 Measurement range switchover
- DI2 Measurement range switchover
- DI3 Measurement range switchover
- DI4 Measurement range switchover

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

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

**Electrical connections**
See connection diagram
Design: 2x12-pin terminal strip. Observe the information regarding conductor section (see page 41). The pin layout in a delivered gas analyzer will be shown in the applicable "Analyzer data sheet". Relays are shown in the unpowered state. The unpowered state is the failure mode.
... I/O modules

2-way analog output module

2 analog outputs (AO1, AO2)
0/4 to 20 mA (configurable, factory-set to 4 to 20 mA), common negative pole, galvanically isolated from ground, freely connectable to ground, max. gain relative to protective ground potential 50 V, max. working resistance 750 Ω. Resolution 16 bit. The output signal cannot be lower than 0 mA.

Electrical connections
See connection diagram
Design: 4-pin terminal strip. Observe the information regarding conductor section (see page 41). The pin layout in a delivered gas analyzer will be shown in the applicable "Analyzer data sheet".

4-way analog output module

4 analog outputs (AO1 to AO4)
0/4 to 20 mA (configurable, factory-set to 4 to 20 mA), common negative pole, galvanically isolated from ground, freely connectable to ground, max. gain relative to protective ground potential 50 V, max. working resistance 750 Ω. Resolution 16 bit. The output signal cannot be lower than 0 mA.

Electrical connections
See connection diagram
Design: 8-pin terminal strip. Observe the information regarding conductor section (see page 41). The pin layout in a delivered gas analyzer will be shown in the applicable "Analyzer data sheet".

4-way analog input module

4 analog inputs (AI1 to AI4)
0 to 20 mA into 50 Ω, jointly galvanically isolated from ground.

Current output
DC 24 V for supply of an external sensor, fused with 100 mA (resettable fuse)

Electrical connections
See connection diagram
Design: 2x5-pin terminal strip. Observe the information regarding conductor section (see page 41). The pin layout in a delivered gas analyzer will be shown in the applicable "Analyzer data sheet".
**Dimensions**

**19-inch housing (model AO2020)**

![Dimensions in mm (in.)](image)

**Wall-mount housing (model AO2040)**

![Dimensions in mm (in.)](image)

**Notes**

The connection box is flanged to the housing in IP54 version. Take into consideration the space required for the connecting lines (approx. 100 mm/4 in.).

19-inch rack housing: For sufficient air circulation, multiple housings in a 19-inch rack must be installed with a separation of at least one height unit between housings.

With an installed FID analyzer module with heated sample gas connection take into consideration the space required for the heated sample gas line corresponding to its minimum bending radius.

Wall-mount housing: With an installed FID analyzer module, additional clearance (approx. 300 mm/12 in.) is required since some assemblies can only be accessed from above.
Certifications

Performance tests
The AO2000 Series gas analyzers Uras26 (sample components CO, NO, SO₂, CO₂, N₂O), Magnos206 (sample component O₂) and electrochemical oxygen sensor (sample component O₂) are certified for use in facilities requiring approval according to European directives 2001/80/EG and 2000/76/EG and meet the requirements of the 27th/30th BImSchV (German Federal Immissions Control Ordinance) and TA-Luft (German Technical Instructions on Air Quality) regulations. The requirements of QAL1 according to EN 15267 and EN 14181 are fulfilled.


The AO2000 Series gas analyzers Limas21 UV (sample components NO, NOₓ, SO₂, NO₂, CO₂), Magnos28 (sample component O₂), Magnos28 (sample component O₂) and electrochemical oxygen sensor (sample component O₂) 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 according to EN 14181:2014.

Certificate No. Sira MC080121/13 of August 18, 2017

The AO2000 Series gas analyzers Fidas24 (sample component C-total) is certified for use in facilities requiring approval according to European directives 2001/80/EG and 2000/76/EG and meet the requirements of the TA-Luft (German Technical Instructions on Air Quality) regulations. The requirements of QAL1 according to EN 15267 and EN 14181 are fulfilled.


Certificate No. Sira MC160293/01 of May 04, 2016

The AO2000 Series gas analyzer Uras26 (sample components SO₂ and CO₂) is certified 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

The AO2000 Series gas analyzer Limas21 UV (sample components NO, NOₓ, and NOx) is certified for use on vessels. The requirements of Revised MARPOL Annex VI and NOx Technical Code 2008 are fulfilled.

Certificate No. 31812-16 HH of October 13, 2016

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 and
2014/34/EU ATEX Directive (explosion-protected versions only).

Approval for USA and Canada – CSA

Certificate No. 70012655

Approval for the customs union of Russia, Belarus and Kazakhstan – GOST TR CU
The AO2000 Series gas analyzers are certified for use in general purpose environment.
GOST TR CU certificate No. TC N RU Д-DE.AB72.B.02310
Pattern approval certificate for Russia No. DE.C.31.004.A No. 37985.
Explosion protection to European standards


Marking:

II 3G Ex nA pyb II T4 Gc


Marking:

II 3G Ex nA nC IIC T4 Gc


Marking:

II 3 G Ex nA nC [op is Ga] IIC T5 1) Gc, −20°C ≤ T_{amb} ≤ +55°C
II 3 D Ex tc [op is Da] IIC T100°C Dc, −20°C ≤ T_{amb} ≤ +55°C
1) T4 for special applications

Type Examination Certificate No. Presafe 16 ATEX 8621X

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


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

Certificate No. 1105720

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

The AO2000 Series gas analyzers in the “safety concept” version are certified for use in Zone 2 environment.

Certificate No. TC RU C-DE.Г604.Б.00278

Explosion protection for China – NEPSI

The AO2000 series gas analyzers with Uras26, Magnos206, Caldos25 and Caldos27 are certified for use in hazardous locations. 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, Magnos206, Caldos25 and Caldos27 are certified for use in hazardous locations. The gas analyzers may be used for measurement of flammable gases and vapors.

Marking: Ex nA py IIC T4 Gc

Certificate No. GYJ17.1140X

Explosion protection for South Korea – KCs

The AO2000 Series gas analyzers with Uras26, Magnos206, Caldos25 and Caldos27 are certified for use in hazardous locations. They may be used for measurement of flammable gases and vapors.

Marking: Ex nA py II T4

Certificate No. 16-GA4BO-0670X
## Sample components and analyzer modules

The following table lists the sample components that can be measured with the AO2000 Series gas analyzers (other sample components available on request). In each case, the smallest measurement range and the appropriate analyzer module are given. Please see the data of the individual analyzer modules.

<table>
<thead>
<tr>
<th>Sample component</th>
<th>Requirements (examples)</th>
<th>Smallest meas. range</th>
<th>Analyzer module</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene C₂H₂</td>
<td>Small meas. ranges, selective measurement</td>
<td>0–100 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Ammonia NH₃</td>
<td>Process measurement</td>
<td>0–30 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Argon Ar in N₂</td>
<td>Especially short T₉₀ time</td>
<td>97.5–100 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>Butane C₄H₁₀</td>
<td>Small meas. ranges, selective measurement</td>
<td>0–50 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Chlorine Cl₂</td>
<td>Corrosive gases</td>
<td>0–100 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
</tr>
<tr>
<td>Nitrous oxide N₂O</td>
<td>Small measurement ranges</td>
<td>0–20 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Ethane C₂H₆</td>
<td>Small meas. ranges, selective measurement</td>
<td>0–50 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Helium He in N₂</td>
<td>Especially short T₉₀ time</td>
<td>97–100 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>Hexane C₆H₁₄</td>
<td>Selective measurement</td>
<td>0–100 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Carbon dioxide CO₂</td>
<td>Small measurement ranges</td>
<td>0–5 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Carbon disulfide CS₂</td>
<td>Toxic/flammable gases</td>
<td>0–50 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
</tr>
<tr>
<td>Carbon monoxide CO</td>
<td>Small meas. ranges, emission measurement</td>
<td>0–10 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Carbon dioxide sulfide COS</td>
<td>Toxic/flammable gases</td>
<td>0–250 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
</tr>
<tr>
<td>Hydrocarbons Total</td>
<td>Fast hot measurement</td>
<td>0–5 mg C/m³</td>
<td>Fidas24</td>
<td>Page 26</td>
</tr>
<tr>
<td>Methane CH₄</td>
<td>Small meas. ranges, selective measurement</td>
<td>0–50 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>CH₄ in N₂</td>
<td>Especially short T₉₀ time</td>
<td>99–100 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>CH₄ in N₂ or air</td>
<td>Especially short T₉₀ time</td>
<td>0–2 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>Propane C₃H₈</td>
<td>Small meas. ranges, selective measurement</td>
<td>0–50 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Oxygen O₂</td>
<td>Magnetomechanical measurement principle</td>
<td>0–0.5 vol.%</td>
<td>Magnos206</td>
<td>Page 14</td>
</tr>
<tr>
<td>Sulfur dioxide SO₂</td>
<td>Emission measurement</td>
<td>0–25 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Hydrogen sulfide H₂S</td>
<td>Exhaust gas, process measurement</td>
<td>0–25 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
</tr>
<tr>
<td>Nitrogen dioxide NO₂</td>
<td>Corrosive gases</td>
<td>0–50 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
</tr>
<tr>
<td>Nitrogen monoxide NO</td>
<td>Emission measurement</td>
<td>0–75 ppm</td>
<td>Uras26</td>
<td>Page 6</td>
</tr>
<tr>
<td>Hydrogen H₂ in Ar</td>
<td>Especially short T₉₀ time</td>
<td>0–0.25 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>H₂ in Cl₂</td>
<td>Corrosive gases</td>
<td>0–0.5 vol.%</td>
<td>Caldos25</td>
<td>Page 22</td>
</tr>
<tr>
<td>H₂ in stack gas</td>
<td>Especially short T₉₀ time</td>
<td>0–0.5 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>H₂ in N₂</td>
<td>Especially short T₉₀ time</td>
<td>99–100 vol.%</td>
<td>Caldos27</td>
<td>Page 24</td>
</tr>
<tr>
<td>H₂ in N₂ or air</td>
<td>Corrosive gases</td>
<td>0–0.5 vol.%</td>
<td>Caldos25</td>
<td>Page 22</td>
</tr>
<tr>
<td>Small measurement ranges</td>
<td>0–10 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
<td></td>
</tr>
<tr>
<td>Combustion exhaust gas</td>
<td>0–10 ppm</td>
<td>Limas21 HW</td>
<td>Page 10</td>
<td></td>
</tr>
<tr>
<td>Combustion exhaust gas</td>
<td>0–10 ppm</td>
<td>Limas21 HW</td>
<td>Page 10</td>
<td></td>
</tr>
<tr>
<td>Small measurement ranges</td>
<td>0–10 ppm</td>
<td>Limas21 UV</td>
<td>Page 8</td>
<td></td>
</tr>
<tr>
<td>Combustion exhaust gas</td>
<td>0–10 ppm</td>
<td>Limas21 HW</td>
<td>Page 10</td>
<td></td>
</tr>
</tbody>
</table>

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... Notes