Advance Optima Continuous Gas Analyzers

AO2000 Series

Software Version 5.0

Operator's Manual

42/24-10 EN Rev. 9

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Content of the Operator's Manual

This operator's manual contains all the information you will need to safely and efficiently install, start-up, operate and maintain the AO2000 series gas analyzers.

This operator's manual contains information on all the functional units in the gas analyzers. The delivered gas analyzer may differ from the version described.

Analyzer Data Sheet

The version of the delivered gas analyzer will be described in the "Analyzer Data Sheet" supplied with each gas analyzer (see Section "Gas Analyzer Identification", Page 2-3).

Analyzer Modules and Gas Analyzers Not Described in this Operator's Manual

This operator's manual does not contain any information on installation, start-up and maintenance of the following AO2000 Series analyzer modules and gas analyzers:

- MultiFID14 and MultiFID14 NMHC analyzer modules,
- LS25 laser analyzer module,
- Explosion protected versions of the AO2000 Series gas analyzers in Category 2G,
- Explosion protected versions of the AO2000 Series gas analyzers in Category 3G for measurement of flammable gases.

For these analyzer modules and gas analyzers, separate operator's manuals are available which are listed in the "Additional Publications" table below.

Additional Publications

Title	Publication No.
Advance Optima AO2000 Series Continuous Gas Analyzers – Data Sheet	10/24-1.20 EN
Function Blocks – Descriptions and Configuration	30/24-200 EN
AO2000 Modbus and AO-MDDE	30/24-316 EN
Remote Control Interface AO-HMI – Emulation of the AO2000 Display and Control Unit	30/24-311 EN
MultiFID14 Analyzer Module – Start-Up and Maintenance Manual	41/24-105 EN
MultiFID14 NMHC Analyzer Module – Start-Up and Maintenance Manual	41/24-106 EN
LS25 Laser Analyzer Module – Operator's Manual	41/24-109 EN
Analyzer Modules in Category 2G – Operator's Manual	42/24-12 EN
Central Unit in Category 2G – Operator's Manual	42/24-13 EN
Gas Analyzer in Category 3G for Measurement of Flammable Gases – Operator's Manual	42/24-14 EN

These publications can be ordered from your authorized ABB representative or from

ABB Automation GmbH, Analytical, Marketing Communication,
Telefax: +49-(0)69-79 30-45 66, E-Mail: analytical-mkt.deapr@de.abb.com

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Additional Information on CD-ROM

A CD-ROM with the following content is added to the gas analyzer:

- Operator's Manuals,
- Data Sheets,
- Technical Information Sheets,
- Spare Parts Lists,
- Certificates,
- Software Tools.

Further Information on the Internet

Further information on the products and services of ABB Analytical will be found on the Internet at "http://www.abb.com/analytical".

Symbols and Typefaces

⚠	Indicates safety information to be heeded during gas analyzer operation in order to avoid risks to the operator.
ⓘ	Identifies specific information on operation of the gas analyzer as well as on the use of this manual.
Module Name	Indicates specific information for individual analyzer modules.
1, ***2***, ***3***, ...	Identifies reference numbers in the figures.
`Display`	Identifies a message in the display.
`Input`	Identifies a user entry • either by pressing a soft key • or by selecting a menu item • or via the numeric keypad
Function Block	Identifies a function block designation.
'Name'	Identifies a function block name assigned by the gas analyzer or entered by the user.

Relationship between Operator’s Manual and Software Version

Software Version

The software of the AO2000 Series Gas Analyzers is modular in design.

The system controller and the analyzer modules are all equipped with their own processor and software.

Each software package is updated separately and bears its own version number.

This manual will refer only to the system controller software version.

Operator’s Manual Validity

This operator’s manual applies to the software version listed on the title page.

It remains valid until the digit following the first decimal point is changed.

Software Update

If a software update involves a modification or expansion of functionality, this is indicated by changing the version number following the first decimal point.

The operator’s manual is accordingly revised and a new edition is published. This is reflected by increasing the publication number by one.

Software Versions and Operator’s Manual Edition

Software Version	Operator’s Manual Edition (Publication Number)
1.0	42/24-10-0
1.1	42/24-10-1
1.2	42/24-10-2
1.3	42/24-10-3
	42/24-10-4 Edition 11.99
1.4	42/24-10-4 Edition 03.00
2.0	42/24-10-5
3.0	42/24-10 Rev. 6
	42/24-10 Rev. 7
4.0	42/24-10 Rev. 8
5.0	42/24-10 Rev. 9

Where can I find the software version number?

The software version number is shown

- On the gas analyzer’s startup screen
- On the analyzer data sheet (see page 2-3)
- In the following menu item
  `MENU → Diagnostic/Information → System overview`

Important Safety Information

Intended Application

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

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

Requirements for Safe Operation

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

Personnel Qualifications

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

Special Information and Precautions

These include
- The content of this operator’s manual.
- The safety information affixed to the gas analyzer.
- The applicable safety precautions for installing and operating electrical devices
- Safety precautions for working with gases, acids, condensates, etc.

National Regulations

The regulations, standards and guidelines cited in this operator’s manual are applicable in the Federal Republic of Germany. The applicable national regulations should be followed when the gas analyzer is used in other countries.

Gas Analyzer Safety and Safe Operation

The gas analyzer is designed and tested in accordance with EN 61010 Part 1, “Safety Provisions for Electrical Measuring, Control, Regulation and Laboratory Instruments” and has been shipped ready for safe operation.

To maintain this condition and to assure safe operation, read and follow the safety information identified with the ⚠ symbol in this manual. Failure to do so can put persons at risk and can lead to gas analyzer damage as well as damage to other systems and instruments.

Additional Information

If the information in this operator’s manual does not cover a particular situation, ABB Service is prepared to supply additional information as needed.

Contact your local ABB Service representative. For emergencies, please contact:

ABB Service, Telephone: +49-(0)180-5-222580, Telefax: +49-(0)621-38193129031, E-Mail: automation.service@de.abb.com

Safety Tips for Handling Electronic Measurement Devices

Protective Lead Connection	The protective lead (ground) should be attached to the protective lead connector before any other connection is made.
Risks of a Disconnected Protective Lead	The gas analyzer can be hazardous if the protective lead is interrupted inside or outside the gas analyzer or if the protective lead is disconnected.
Proper Operating Voltage	Be sure the gas analyzer voltage setting matches the line voltage before connecting the power supply.
Risks Involved in Opening the Covers	Current-bearing components can be exposed when the covers or parts are removed, even if this can be done without tools. Current can be present at some connection points.
Risks Involved in Working with an Open Gas Analyzer	The gas analyzer must be disconnected from all power sources before being opened for any work. All work on a gas analyzer that is open and connected to power should only be performed by trained personnel who are familiar with the risks involved.
Charged Capacitors	The capacitors in the gas analyzer power supply discharge after 10 minutes when the gas analyzer is disconnected from all power sources.
Use of Proper Fuses	Only fuses of the specified type and rated current should be used as replacements. Never use patched fuses. Do not short-circuit the fuseholder contacts.
When Safe Operation can no Longer be Assured	If it is apparent that safe operation is no longer possible, the gas analyzer should be taken out of operation and secured against unauthorized use. The possibility of safe operation is excluded: • If the gas analyzer is visibly damaged • If the gas analyzer no longer operates • After prolonged storage under adverse conditions • After severe transport stresses

Explosion-protected Version with Type of Protection II 3G for Measurement of Non-flammable Gases and Vapors: Description and Special Conditions for Operation

Intended Application

The AO2000 Series gas analyzers with type of protection II 3G are tested for explosion protection. They are suitable for use in hazardous areas in compliance with the technical data (see “Installation Location Requirements” section, page 1-1) and the special conditions (see below). They may be used for the measurement of non-flammable gases and vapors.

Special Version

The explosion-protected version with type of protection II 3G for the measurement of non-flammable gases and vapors is a special version of the AO2000 Series gas analyzers. This version is different from other versions by the following designation on the identification plate.

Designation

Ex II 3G EEx nAC II T4 X

Description

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

For further information please refer to the Declaration of Conformity which can be found on the CD-ROM delivered with the gas analyzer.

Special Conditions for Operation in Hazardous Areas

- The device must be switched off when it is observably disturbed (i.e. when it is not in undisturbed operation).
- The connectors may not be plugged in or unplugged while the power is on.
- The analyzer housing may not be opened while the power is on.
- All cables must enter via the specified cable fittings and be sealed by tightening the nuts in accordance with IP54.
- Unused cable fittings must be closed off with plugs in accordance with IP54.
- Measures must be taken outside the device against intermittent noise on the data lines (transients) exceeding 84 VAC / 105 VDC.
- Only the original battery types Varta CR2032 (type no. 6032) or Renata CR2032 may be used as replacement for the battery on the system controller.

Installation Location Requirements

Short Gas Paths

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

Locate the gas preparation and calibration assemblies as close as possible to the gas analyzer.

Adequate Air Circulation

Provide for adequate natural air circulation around the gas analyzer. Avoid heat buildup.

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

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

Protection from Adverse Conditions

Protect the gas analyzer from:
- Cold
- Direct sunlight and heat
- Large temperature variations
- Strong air currents
- Accumulations of dust and dust infiltration
- Corrosive atmospheres
- Vibration (see “Vibrations”, page 1-2)

Environmental Conditions

Air pressure range		600 to 1250 hPa
Relative humidity		max. 75 %
Ambient temperature range at storage and transport		–25 to +65 °C
Ambient temperature range during operation with analyzer module	installed in a system housing without electronics module	installed in a system housing with electronics module or with power supply only
Caldos25	+5 to +45°C	+5 to +45°C
Caldos27	+5 to +50°C	+5 to +45°C
Limas11	+5 to +45°C	+5 to +45°C 1)
Magnos206	+5 to +50°C	+5 to +45°C
Magnos27	+5 to +45°C 2)	+5 to +45°C
Uras26	+5 to +45°C	+5 to +40°C
Oxygen Sensor	+5 to +40°C	+5 to +40°C

1) +5 to +40°C when I/O modules are installed
2) +5 to +50°C for measurement chamber direct connection and installation in system housing without electronics module or Uras26

Continued on next page

Installation Location Altitude

The maximum installation location altitude is 2000 m.

Vibrations

If the gas analyzer is installed in a cabinet the maximum acceleration amplitude is 0.01 ms^{-2} in a frequency range of 0.1 to 200 Hz.

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

Analyzer Module	Vibrations
Caldos25	max. ±0.04 mm at 5 to 30 Hz
Caldos27	max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Limas11	max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz
Magnos206	max. ±0.04 mm at 5 to 20 Hz
Magnos27	max. ±0.04 mm at 5 to 60 Hz
Uras26	max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz, slight transient effect on sample value in the region of the beam modulation frequency

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

Sample Gas Inlet and Outlet Conditions

Gas Inlet Conditions

The following sample gas and, if applicable, flowing reference gas inlet conditions apply to the analyzer modules and the gas module.

Module	Temperature	Pressure p_e 3)	Flow Rate
Caldos25	+5 to +50°C 1)2)	2 to 100 hPa 6)	10 to 90 l/h max. 90 to 200 l/h 4)
Caldos27	+5 to +50°C 1)2)	2 to 100 hPa 6)	10 to 90 l/h min. 1 l/h
Limas11	+5 to +45°C 1)	2 to 500 hPa	20 to 100 l/h
Magnos206	+5 to +50°C 1)2)	2 to 100 hPa 6)	30 to 90 l/h 5)
Magnos27	+5 to +50°C 1)2)	2 to 100 hPa 7)	20 to 90 l/h
Uras26	+5 to +45°C 1)	2 to 500 hPa	20 to 100 l/h
Oxygen Sensor	+5 to +40°C 1)	2 to 500 hPa	20 to 100 l/h
Gas Module	+5 to +45°C 1)	–80 to +20 hPa	30 to 60 l/h

1) 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 can result in cross sensitivity.

2) When there is a direct sample chamber connection the maximum sample gas dew point is 55°C. Water vapor can result in cross sensitivity.

3) $p_e = p_{abs} - p_{amb}$ where
p_e = positive pressure, p_{abs} = absolute pressure, p_{amb} = atmospheric pressure

4) For option $T_{90} < 6$ sec

5) Abrupt changes in gas flow rates should be avoided when using highly suppressed measurement ranges.

6) Pressure resistance of the analyzer $p_e \leq 1000$ hPa (1 bar)

7) Pressure resistance of the analyzer $p_e \leq 400$ hPa (0.4 bar)

Note: Sample gas temperature, pressure and flow rate should be maintained constant to such a degree that the fluctuation influence on the accuracy of measurement is acceptable (see also Appendix 2 “Analyzer Module Operating Specifications”).

Gas Outlet Conditions

The outlet pressure should be equal to atmospheric pressure.

Continued on next page

Flammable, Corrosive or Toxic Gases

A housing purge is required if the sample gas contains flammable, corrosive or toxic components (see "Housing Purge" section, page 3-5).

Please observe additionally the following application restrictions and notes:

Module	**Application Restrictions and Notes**		
Caldos27	If the sample gas contains Cl_2, HCl, HF, SO_2, NH_3, H_2S or other corrosive components, operation of the analyzer is allowed only when the sample gas composition has been taken into account during configuration at the factory.		
Magnos206	If the sample gas contains Cl_2, HCl, HF or other corrosive components, operation of the analyzer is allowed only when the sample gas composition has been taken into account during configuration at the factory.		
Uras26	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.		
Limas11	Standard Cell	Quartz Cell	Safety Cell
Suitable for measurement of ...	Non-corrosive gases	Corrosive gases, e.g. wet Cl_2, wet HCl, H_2SO_4, SO_3, ozone	Corrosive gases, e.g. dry HCl, dry $COCl_2$ (< 50 ppm H_2O)
Not suitable for measurement of ...	Highly corrosive gases, e.g. gases containing chlorine, H_2SO_4, SO_3, fluorine compounds	Fluorine compounds	Wet gases containing chlorine, H_2SO_4, SO_3, fluorine compounds
Toxic Gases	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Cell purge [1] with N_2 or with sample component-free air with negative pressure and flow monitoring; additional monitoring for sample gas traces possible
Corrosive Gases	Housing purge (≤ 20 l/h) with sample component-free air or with N_2, PTFE gas lines	Housing purge (≤ 20 l/h) with sample component-free air or with N_2	Cell purge [1] with N_2 or with sample component-free air with excess pressure [2] and flow monitoring
Flammable Gases	Housing purge (≤ 20 l/h) with N_2	Housing purge (≤ 20 l/h) with N_2	Cell purge [1] with N_2
Zone 2 Flammable Gases	–	–	Cell purge with N_2 with excess pressure [2] and flow monitoring
Oxygen Sensor	H_2O dew point ≥ 2 °C. The oxygen sensor should not be used with dry and with flammable sample gas. It should not be used if the associated gas contains the following components: H_2S, chlorine or fluorine compounds, heavy metals, aerosols, mercaptane, base components.		
Gas Module	Corrosive associated gas components and aerosols must be cooled or undergo prior absorption. The gas module should not be used with flammable sample gas.		

1) purge curtain

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

Test Gases for Calibration

Analyzer Module	Zero Calibration	Span Calibration
Caldos25, Caldos27	Test gas or sample-component-free process gas or substitute gas	Test gas or process gas having a known sample gas concentration or substitute gas
Magnos206	Oxygen-free process gas or substitute gas	Process gas with a known oxygen concentration or a substitute gas
with suppressed measurement range		Measurement ranges ≥95 to 100 Vol.-% O_2: Test gas with O_2 concentration in the selected measurement range.
with single point calibration		Test gas with any concentration of O_2 within one of the measurement ranges or ambient air. Same moisture content as in the process gas. **In order to avoid accumulations of explosive gas mixtures, do not use air as a test gas for single-point calibration when measuring flammable gases!**
Magnos27	Oxygen-free process gas or substitute gas	Process gas with a known oxygen concentration or a substitute gas
Uras26, Limas11	Nitrogen or air If the ambient air contains sample gas components, these must be removed with a suitable absorber.	Calibration cells (optional) Span calibration without calibration cells: Test gas for each detector or measurement component. Span gas concentration 70 to 80 % of the end value of the largest measurement range. For suppressed ranges: Span gas concentration within the suppressed range, if possible equal to the end value.
only for Uras26	Water vapor must be absorbed using a cooler.	Automatic and externally controlled calibration: Test gas mixture for all detectors since all are calibrated simultaneously.
only for Limas11		Observe the notes in the “Analyzer Data Sheet” when preparing the test gas mixtures.
All analyzer modules		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 N_2.
Oxygen Sensor	Zero is not calibrated since it is fundamentally stable.	Ambient (non-process) air with a constant oxygen content (20.96 Vol.-%) or synthetic air. For simultaneous calibration with analyzer modules observe the notes on page 8-C-15.

Test Gas Dew Point The test gas dew point must be nearly identical to the sample gas dew point.

Generally observe the “Notes for Calibrating the Analyzer Modules” in Chapter 8, Section C.

Purge Gas for Housing Purge

Purge Gas

The following purge gases can be used:

- Nitrogen when measuring flammable gases or
- Instrument air when measuring corrosive gases (quality per ISO 8573-1 Class 3, i.e. max. particle size of 40 μm, max. oil content 1 mg/m^3, max. pressure dew point +3 °C).

For the Limas11 and Uras26 analyzer modules the purge gas should not contain any sample gas components. Any sample components in the purge gas can cause false readings.

Purge Gas Flow Rate during Initial Purge

The purge gas flow and the duration of the purge process depend on the volume to be purged (see the following table). If the purge gas flow rate is lower than indicated the duration of the process must be increased correspondingly.

Volume to be Purged	Purge Gas Flow Rate	Duration
Gas Path	100 l/h (max.)	approx. 20 sec.
Central Unit with or without Analyzer Module	200 l/h (max.)	approx. 1 hr.
Analyzer separately: Caldos25, Caldos27, Magnos206, Magnos27	200 l/h (max.)	approx. 3 min.

Purge Gas Flow Rate during Operation

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

- Because of leakage losses the purge gas flow rate at the device output is approx. 5 to 10 l/h for a purge gas flow rate at the device inlet of 20 l/h.
- Notes for selection and use of flow meters:
  - Measuring range 7 to 70 l/h
  - Pressure drop < 4 hPa
  - Needle valve open
- Recommendation: Flow meter 7 to 70 l/h, Catalog No. 23151-5-8018474

CAUTION!

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

CAUTION!

Purge gas flow must always be restricted upstream of the purge gas inlet! If the purge gas flow is restricted after the purge gas outlet, the housing seals are subjected to full purge gas pressure which can result in damage to the keypad!

Power Supply Information

Gas Analyzer Power Supply

There is a power supply in the gas analyzer's central unit (see “Power Supply” section, Page 1-8). It provides the supply voltage to power the electronics module and one analyzer module.

Analyzer Module Power Supply

The analyzer module requires a 24 VDC ± 5 % voltage supply.

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

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

- The analyzer module can be powered by the central unit power supply if the optional power line filter -Z01 is installed in the central unit and no analyzer module is installed in the central unit.
- If only one analyzer module is installed in the system housing, the AO2000 power supply installed in the system housing can be used.
- If two analyzer modules are installed in the system housing, a power supply outside the system housing must be provided. This power supply must equal the rating of the AO2000 power supply (see “Power Supply” section, Page 1-8).

CAUTION!

Only one analyzer module should be supplied with 24 VDC from the central unit power supply. A separate 24-VDC supply is required for additional analyzer modules.

Power Supply

Application

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

Power Supply Specifications

Input Voltage	100–240 VAC, –15 %, +10 %
Input Current	max. 2.2 A
Line Frequency Range	50–60 Hz ± 3 Hz
Power Consumption	max. 187 W
Output Voltage	24 VDC ± 5 %
Line Power Connection	3-pin grounded-instrument connector per EN 60320/C14

Module Power Consumption

Module	Power Consumption	
System Controller	approx. 15 W	
I/O Modules	approx. 10 W	per module
Caldos25	max. 25 W	
Caldos27	max. 12 W	
Limas11	max. 85 W	
Magnos206	max. 50 W	
Magnos27	max. 35 W	
MultiFID14	max. 65 W	
Uras26	max. 95 W	
Gas Module	approx. 20 W	

Scope of Delivery

Standard Equipment

Quantity	Description
1	AO2000 Gas Analyzer
1	"Analyzer Data Sheet" (in the system housing)
1	Operator's Manual
1	CD-ROM containing technical documentation and communication software
1	Power cord, 5 meters long, with grounded-instrument connector and separate grounded two-pin plug
1	System bus termination resistor
	Plastic tubing connectors (quantity equal to the number of gas ports)

Options

(depending on the version)

Quantity	Description
	Connection cables for analyzer module 24 VDC power supply
	Connection cables, tees and terminating resistors for the system bus (per order)
	Terminal strips to connect I/O modules (per order)
2	Inserts for M32 cable threaded connections in the IP-54 version

Material Needed for Installation (not delivered)

Gas Connections

- Threaded connections with 1/8 NPT threads and PTFE sealing tape

Flow Meter

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

Installation

19-inch housing:

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

Wall-mount housing:

- 4 M8 or M10 bolts.

Signal Lines

- Selection of the required conductors depends on line length and planned current load.
- Notes regarding conductor section for I/O module connection:
  - The maximum capacity of terminals for stranded or solid conductors is 1 mm^2 (17 AWG).
  - The stranded conductor may be tinned on the tip or twisted for simplified connection.
  - When using wire end ferrules the total section should not exceed 1 mm^2, i.e. the maximum stranded conductor section is 0.5 mm^2. The Weidmüller PZ 6/5 crimping tool must be used for crimping the ferrules.
- Maximum line length 1200 meters (3940 feet, transmission rate max. 19200 bit/s) for RS485.
- Maximum line length 15 meters (50 feet) for RS232.

Analyzer Module 24 VDC Supply

Extension cable:

- Minimum conductor section 2.5 mm^2.
- Maximum line length 30 m (100 feet).

Power supply:

- If two analyzer modules are installed in the system housing, a power supply outside the system housing must be provided. This power supply must equal the rating of the AO2000 power supply (see page 1-8).

Power Supply Line

- If the power cord supplied is not used, make your selection of a suitable cable based on line length and planned current load.
- Provide a breaker in the power supply line or a switched receptacle to make sure the gas analyzer can be completely separated from the power source.

List of Figures Related to Installation

List of Figures Related to Installation

Basic Steps for Installation and Start-Up

Step	Action	see Page
	Follow safety precautions	xi, xii, xiii
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10	Calibrate the gas analyzer	Chapter 8

Gas Analyzer Unpacking

CAUTION!

The gas analyzer can weigh from 18 to 23 kg (40 to 50 pounds). Two persons are needed for unpacking and carrying.

Unpacking

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

- If there is shipping damage which points to improper handling file a damage claim with the shipper (railway, mail or freight carrier) within seven days.
- Make sure that none of the enclosed accessories are lost during unpacking.
- Keep the shipping box and packaging material for future shipping needs.

Gas Analyzer Identification

What do we mean by "Gas Analyzer Identification"?

When we say "Gas analyzer Identification" we mean answering the following questions:

- For what tasks is the gas analyzer intended?
- What are the components that make up the gas analyzer?
- What are the characteristics (e.g. power supply voltage, measurement range, etc.) of the individual modules?

How can you identify your gas analyzer?

Your gas analyzer can be identified by
- The identification plates affixed to the gas analyzer
- The "analyzer data sheet" included with the gas analyzer

Identification Plates

The gas analyzer has several identification plates:

- The gas analyzer identification plate (see Figure 2-1) is on the outside of the system housing (as seen from the front).
- On the 19-inch version the system housing identification plates are inside the right sidewall and on the left sidewall inside the wall-mount housing.
- The analyzer module identification plate is located externally on the connection board (except for analyzer modules with direct connection to the sample chamber). Also each analyzer has its own identification plate.
- The electronics module identification plate is located externally on the connection board.
- The gas module identification plate is located at the rear behind the flow sensors).

Figure 2-1

Typical Gas Analyzer Identification Plate

(Example)

Identification plate	
AO2000	
P-No. 24031-0-111000000000	← Gas Analyzer Part Number
A-No. 00000604 / 2000 **F-No.** 3.505229.9	← Order Number and Production Number
Baugruppen / Modules	
1. P.-No. 24511-0-113110201002, F-No. 3.505250.9 Uras26	← Housing and Installed Module Part and Production Numbers
2. P.-No. 24311-0-131100000001, F-No. 3.505215.9 Housing	
3. P.-No. 24411-0-110000010011, F-No. 3.505248.9 Electronic	
	← Notes Regarding Special Qualifications (CSA, Ex, GOST, …)

Continued on next page

Analyzer Data Sheet

For the central unit and each analyzer module the analyzer data sheet contains the following information:
- Order Number (A-No.),
- Part Number (P-No.)
- Production Date
- Production Number (F-No.)
- Serial Number
- Software Version
- Power Supply Voltage
- Measurement Range Information
- Configured Correction Functions
- Signal Input and Output Connection Drawings
- Gas Inlet and Outlet Connection Drawings

Additionally, you (and ABB Automation Service) can document on the analyzer data sheet any maintenance work or modifications performed on your gas analyzer.

Where is the analyzer data sheet located?

The analyzer data sheet is located in a sleeve which is affixed
- to the inner side of the left side wall (19-inch rack-mount housing) or
- to the inner side of the door (wall-mount housing)

- The analyzer data sheet should be kept with the gas analyzer so that it is always available for reference.
- During operation be sure to note the device- and system-specific data in the analyzer data sheet. These data can differ from the information contained in this operator's manual.

Dimensional Diagrams

Figure 2-2

19-Inch Housing

(dimensions in mm)

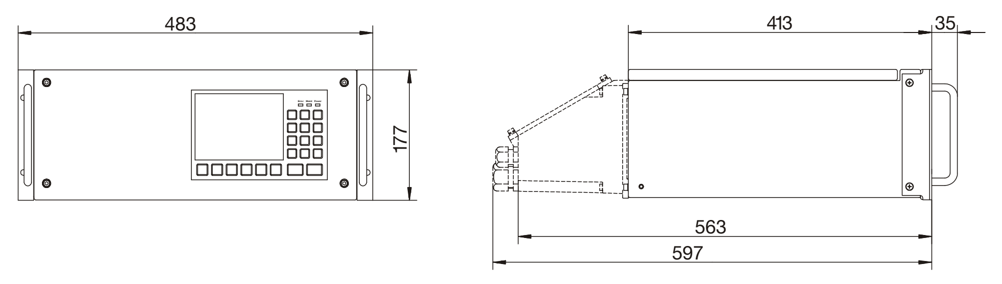
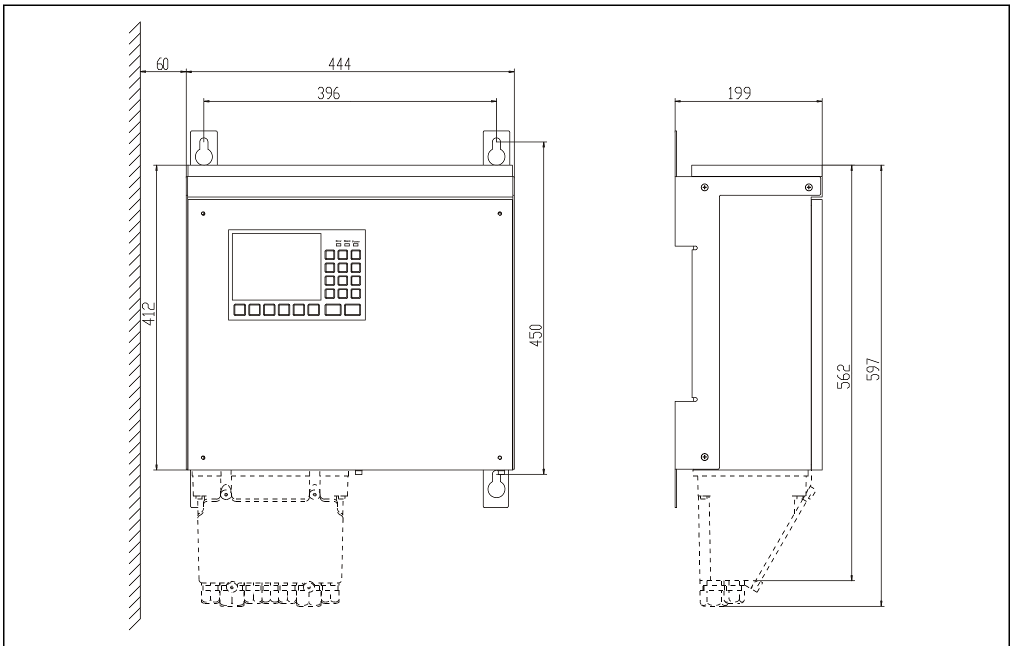


Figure 2-3

Wall-Mount Housing

(dimensions in mm)



Additional Notes

- The connection box shown with dashed lines in the dimensional diagrams is flange-mounted to the IP-54 housing.
- Observe the installation location requirements (see Page 1-1).
- The connecting lines require additional installation clearance (approx. 100 mm).
- When installing the wall-mount housing note that clearance (approx. 60 mm) is required on the left side to allow the door to swing open.
- The 19-inch housing and the wall-mount housing should be installed with vertical orientation of the display.
- Multiple system housings in a 19-inch rack should be installed with a separation of at least one height unit.

Gas Connections Installation

Since the gas ports are now easily accessible, connect the gas lines to the analyzer module before the gas analyzer is installed.

Gas Port Design

The analyzer module gas ports have 1/8-NPT internal threads (connection diagrams see Chapter 3 “Gas Line Connection”).

What materials are needed?

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

CAUTION!

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

Do not use sealing compounds to seal the gas connections.
Sealing compound components can lead to false measurement results.

The gas connections on the gas module are made of plastic (PVDF). Do not use metal tubing connectors or threaded connectors.

The gas connection ports on the Caldos25 versions for flowing reference gas and for corrosive sample gas are made of plastic (PVC-C). Do not use metal tubing connectors or threaded connectors.

Gas Connection Installation

Step	Action
1	Remove the yellow stopper screws (5 mm Allen screws) from the connection ports.
2	Screw the tubing or threaded connectors with sealing material in the connection ports. Screw the fittings on carefully and not too tightly. Follow the manufacturer’s installation instructions.

Gas Path Seal Integrity Verification

The sample gas and reference gas (if applicable) path seal integrity is checked in the factory. Since the gas path seal integrity can be affected during shipping, this check should be performed at the installation site (see page 9-2 for instructions).

Since the system housing has to be opened if a leak is found, the gas path seal integrity should be checked before the gas analyzer is installed.

CAUTION!

A system housing with an electronics module and an analyzer module weighs from 18 to 23 kg (40 to 50 pounds). The following points should be observed:

- **Two persons are needed for installation.**
- **The location (e.g. bay, 19-inch rack, wall) must be capable of supporting the gas analyzer's weight.**
- **The 19-inch housing must be supported with rails in the bay or rack.**
- **Neither the 19-inch nor the wall-mount housings use hinges to secure the housing cover. The cover can drop when opened.**

What materials are needed?

Quantity	**Fastener** (not supplied)
19-inch housing:	
4	Oval-head screws (Recommendation: M6; this depends on the cabinet/shelf system)
1 pair	Rails (Design depends on cabinet/shelf system)
Wall-mount housing:	
4	M8 or M10 bolts

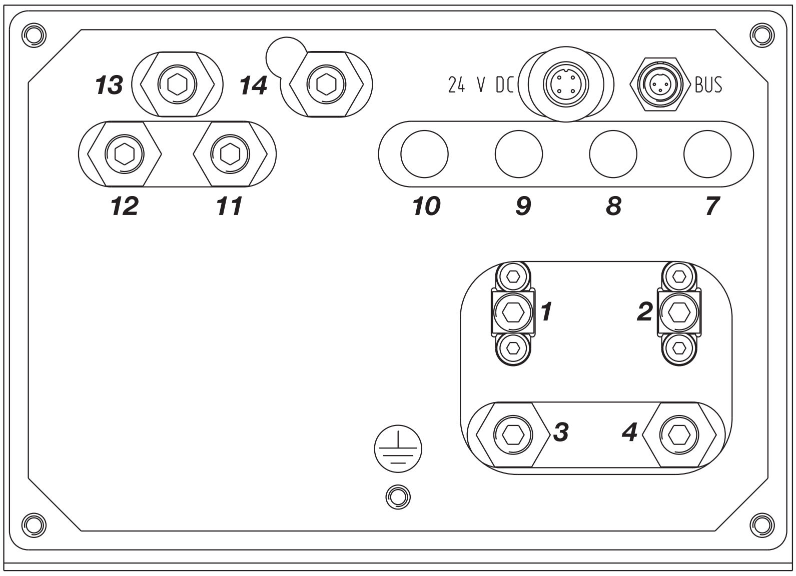
Installation

Install the system housing in the cabinet/shelf or on the wall with the required fasteners. Observe the dimensional diagrams and the additional notes on page 2-4.

Chapter 3 Gas Line Connection

Magnos206: Gas Connections

Figure 3-1

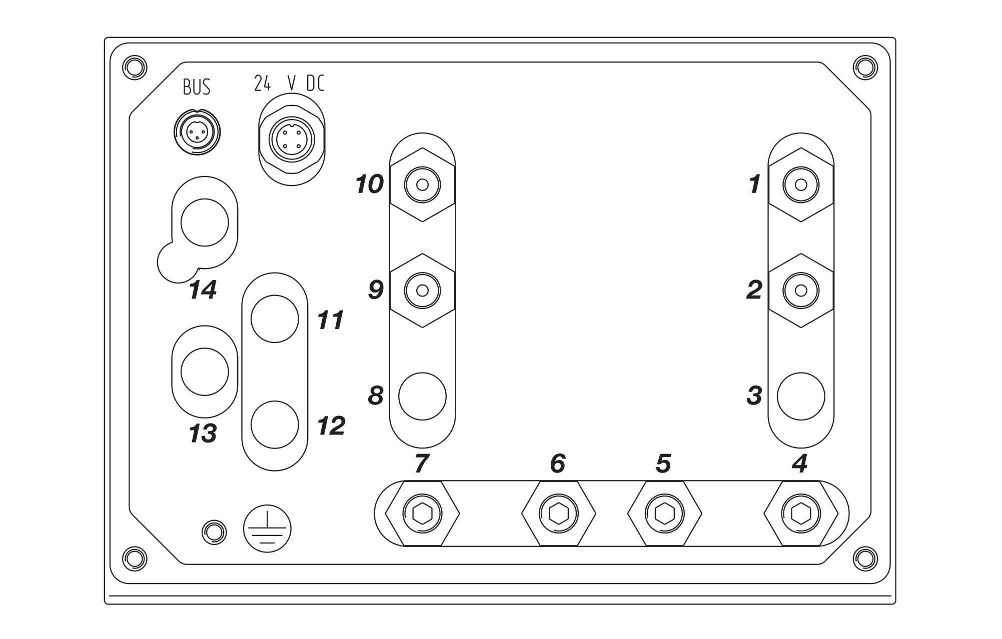


Gas Connections

1	Sample Gas Inlet
2	Sample Gas Outlet
3	Purge Gas Inlet Analyzer 2)
4	Purge Gas Outlet Analyzer 2)
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 Inlet ***1***

1) Option
2) not in version with performance test for emission monitoring

Figure 3-2



Gas Connections

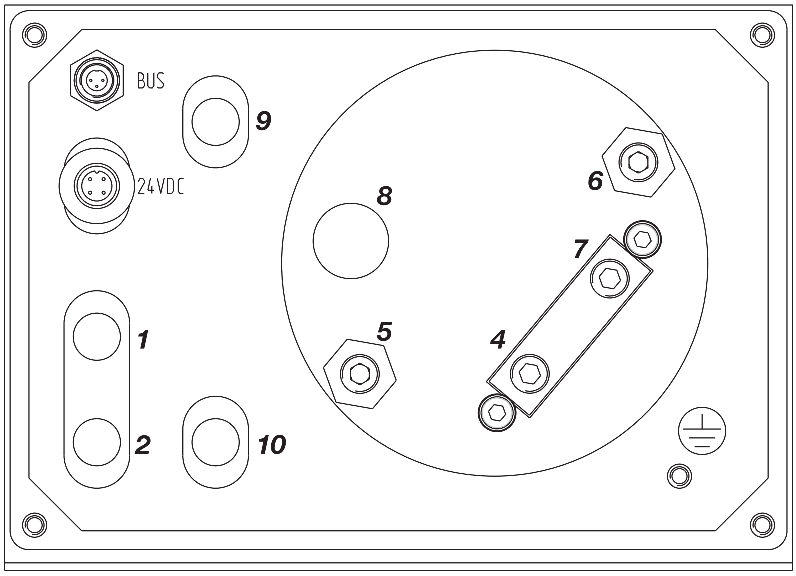
1 Purge Gas Inlet Housing [1)]
2 Purge Gas Outlet Housing [1)] (also with Flow Sensor)
3 –
4 Sample Gas Inlet
5 Purge Gas Inlet Analyzer
6 Purge Gas Outlet Analyzer
7 Sample Gas Outlet
8 –
9 Pressure Sensor 1 [1)]
10 Pressure Sensor 2 [1)]

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 Inlet ***4***

1) Option

Sample Cell Direct Connection, only in Wall-Mount Housing

Figure 3-3

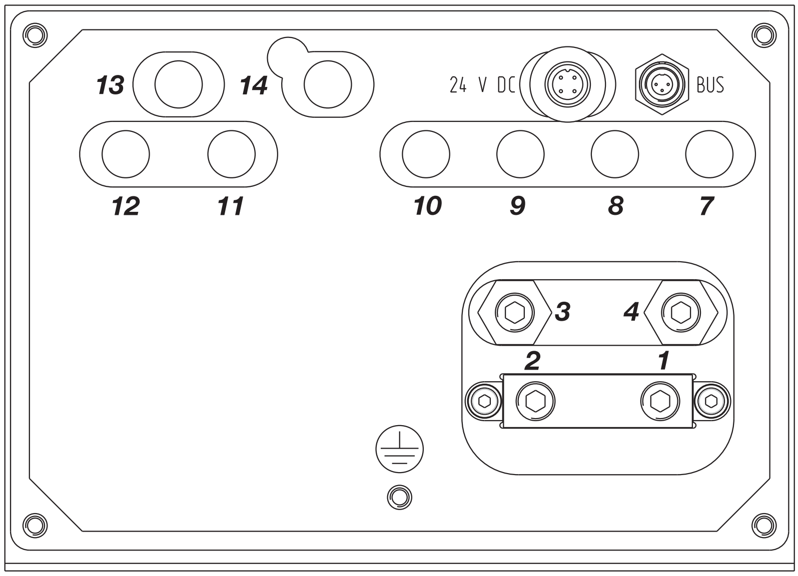


Gas Connections

1	Purge Gas Inlet Housing 1)
2	Purge Gas Outlet Housing 1) (also with Flow Sensor)
4	Sample Gas Inlet
5	Purge Gas Inlet Analyzer
6	Purge Gas Outlet Analyzer
7	Sample Gas Outlet
8	–
9	Pressure Sensor 1 1)
10	Pressure Sensor 2 1)

1) Option

Figure 3-4



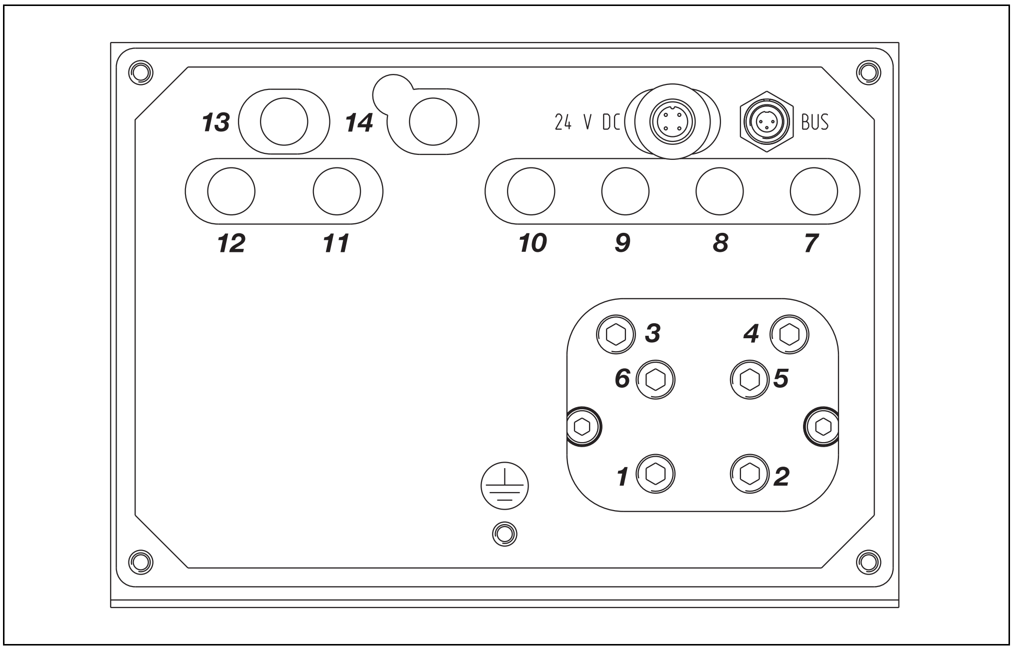
Gas Connections

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 [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 Inlet ***1***

1) Option

Corrosive Sample Gas or Flowing Reference Gas

Figure 3-5



Gas Connections

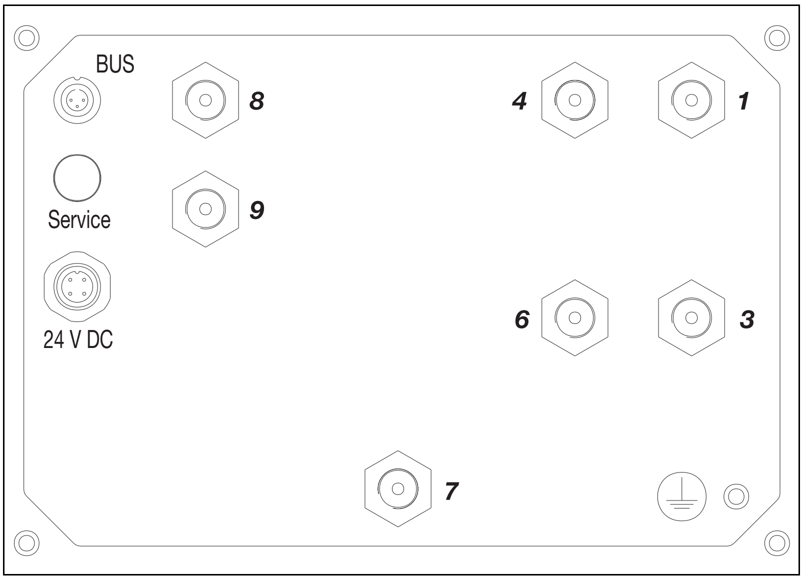
1	Sample Gas Inlet
2	Sample Gas Outlet
3	Purge Gas Inlet Analyzer
4	Purge Gas Outlet Analyzer
5	Reference Gas Inlet [2)]
6	Reference Gas Outlet [2)]
7	Purge Gas Inlet Housing [1)]
8	Purge Gas Outlet Housing [1)] (also with Flow Sensor)
9	Pressure Sensor 1 [1)]
10	Pressure Sensor 2 [1)]
	Pneumatics Module [1) 2)]:
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 Inlet ***1***

1) Option
2) Not in version for corrosive sample gas

Gas ports ***1*** to ***6*** are made of PVC-C. Do not use metal adapters!

Standard Cell, Quartz Cell, Quartz Cell with Center Connection

Figure 3-6



Gas Connections

1	Sample Gas Inlet
3	Purge Gas Inlet Housing [1)]
4	Sample Gas Outlet
6	Purge Gas Outlet Housing [1)]
7	Pressure Sensor [2)]
8	End-Point Gas Inlet (with 3 solenoids) [1) 3)]
9	Zero-Point Gas Inlet (with 1 or 3 solenoids) [1) 3)]

1) Option
2) only for standard cell with PTFE hoses
3) not for version with PTFE hoses

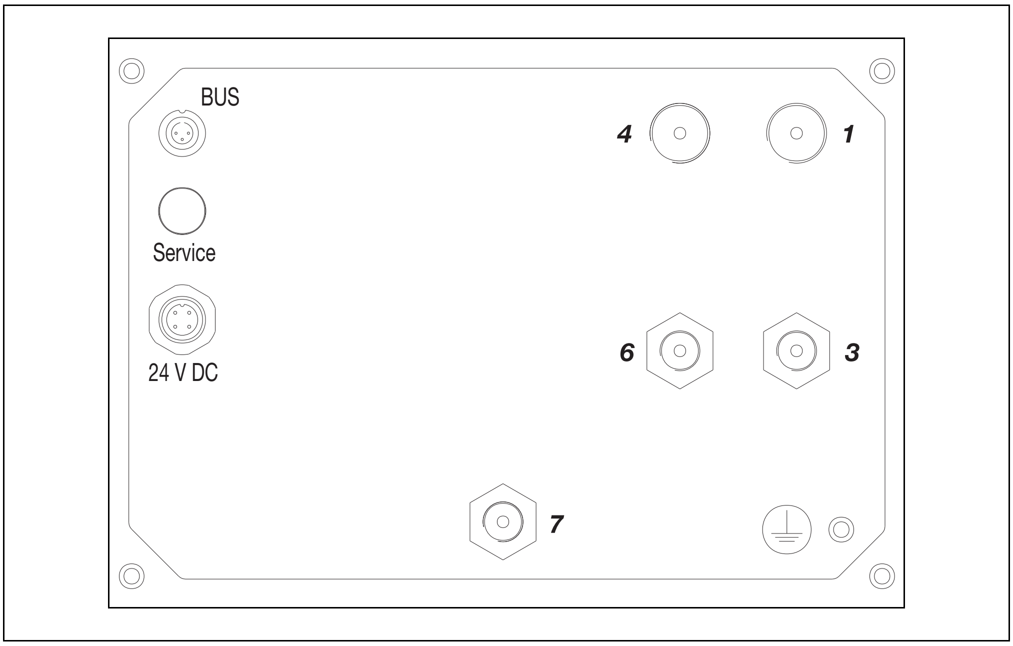
This connection diagram applies for the following versions of the Limas11 analyzer module:

- Standard cell with FPM or PTFE hoses
- Quartz cell with FPM hoses
- Center connection cell made of aluminum with FPM or Cr hoses (60 °C)
- Center connection cell made of quartz with PTFE/FPM or PTFE/Cr hoses (60 °C)

The Limas11 HW analyzer module for hot/wet measurement of NO, NO_2, NH_3 is described in Supplement 2 to Operator’s Manual 42/24-10 EN.

Quartz Cell with PFA Tubes

Figure 3-7



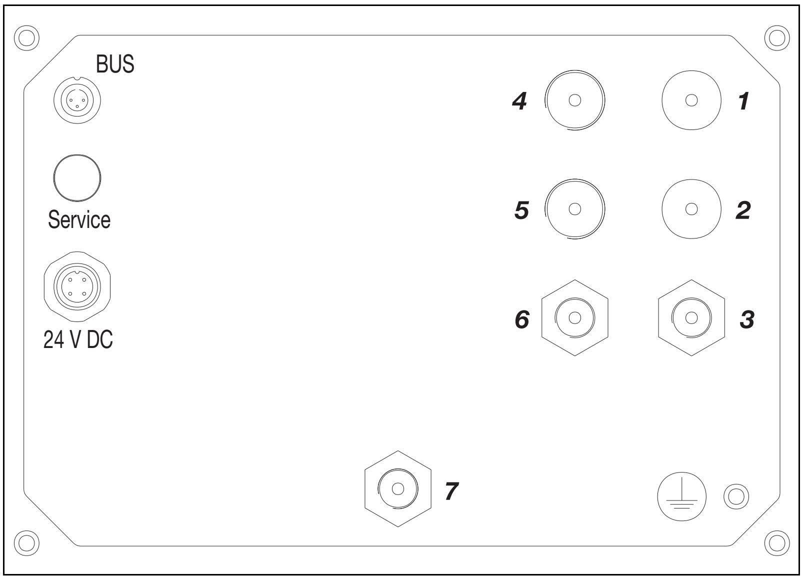
Gas Connections

1	Sample Gas Inlet
3	Purge Gas Inlet Housing [1)]
4	Sample Gas Outlet
6	Purge Gas Outlet Housing [1)]
7	Pressure Sensor

1) Option

Safety Cell

Figure 3-8

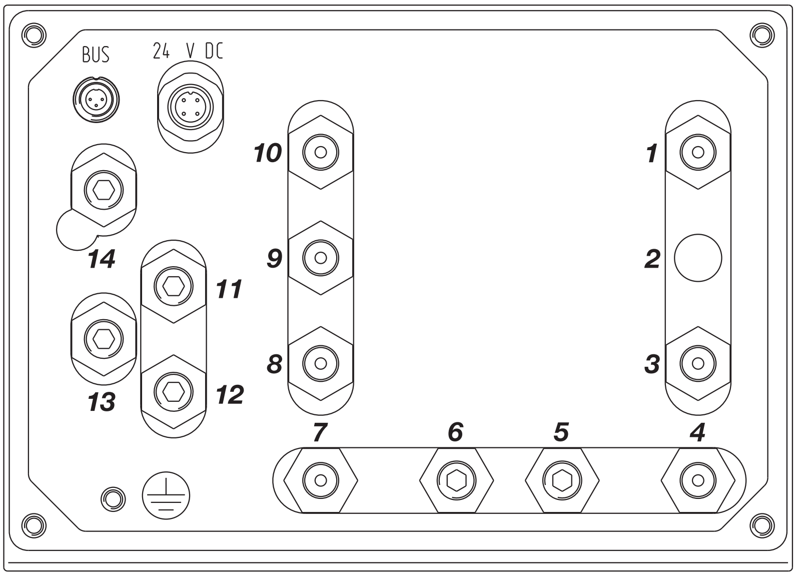


Gas Connections

1	Sample Gas Inlet
2	Sample Gas Outlet
3	Purge Gas Inlet Housing [1)]
4	Purge Gas Inlet Sample Cell
5	Purge Gas Outlet Sample Cell
6	Purge Gas Outlet Housing [1)]
7	Pressure Sensor

1) Option

Figure 3-9



Gas Connections

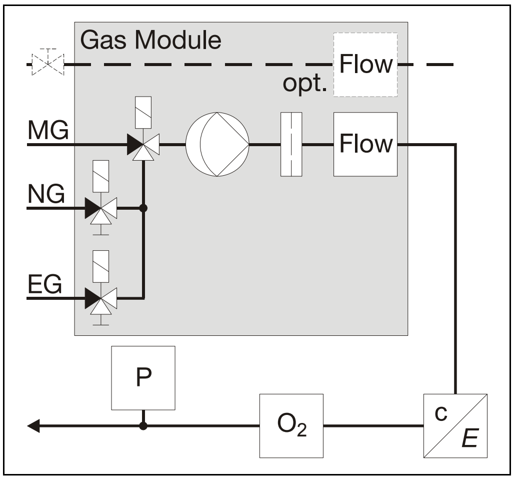
1	Pressure Sensor for External Pressure Measurement [1)]
2	–
3	Sample Gas Inlet Gas Path 1
4	Sample Gas Outlet Gas Path 1
5	Purge Gas Inlet Housing [1)]
6	Purge Gas Outlet Housing [1)] (also with Flow Sensor)
7	Sample Gas Inlet Gas Path 2 [1)] (separate gas paths)
8	Sample Gas Outlet Gas Path 2 [1)] (separate gas paths and gas paths in series)
9	Reference Gas Inlet Gas Path 1 [1)]
10	Reference Gas Outlet Gas Path 1 [1)]
	Pneumatics Module [1)]:
11	Sample Gas Inlet Gas Path 1
12	End Point Gas Inlet (with 3 solenoids) or Sample Gas Inlet Gas Path 2 (only with Flow Sensor)
13	Test Gas/Zero-Point Gas Inlet (with 1 or 3 solenoids) or Sample Gas Outlet Gas Path 2 (only with Flow Sensor) >> ***7***
14	Sample Gas Outlet Gas Path 1 – Connect with Inlet ***3***

1) Option

One of the several possible Uras26 connection arrangements is shown. The actual connection arrangement of an analyzer module is found in the analyzer data sheet for the delivered instrument.

Figure 3-10

Analyzer Module and Gas Module with 3 Solenoid Valves

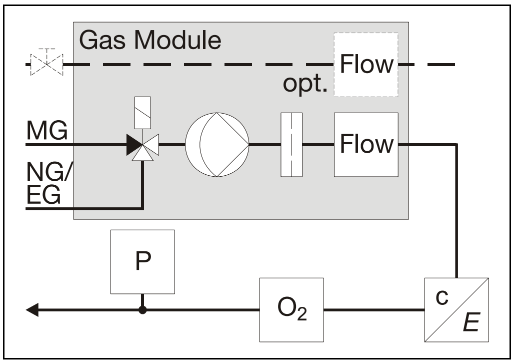


Test gas connection for
Caldos27,
Magnos206,
Magnos27,
Limas11 without calibration cells,
Uras26 without calibration cells

Option: Flow monitoring, e.g. for flowing reference gas or purge gas (external needle valve required)

Figure 3-11

Analyzer Module and Gas Module with 1 Solenoid Valve

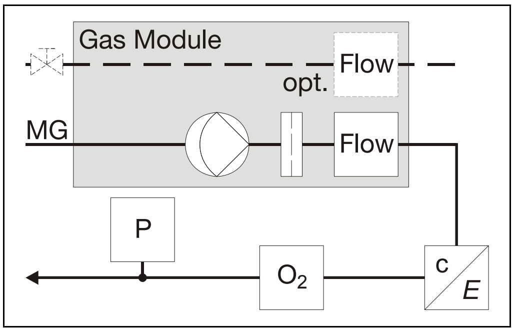


Test gas connection for
Caldos27 with single-point calibration,
Magnos206 with single-pt. calibration,
Limas11 with calibration cells,
Uras26 with calibration cells

Option: Flow monitoring, e.g. for flowing reference gas or purge gas (external needle valve required)

Figure 3-12

Analyzer Module and Gas Module without Solenoid Valves

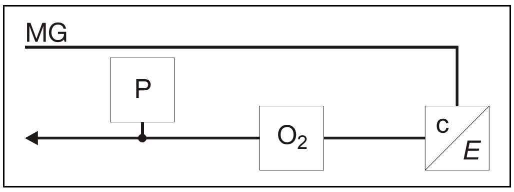


External test gas connection for Caldos27, Magnos206, Magnos27, Limas11, Uras26

Option: Flow monitoring, e.g. for flowing reference gas or purge gas (external needle valve required)

Figure 3-13

Analyzer Module without Gas Supply



Caldos25, Caldos27, Magnos206, Magnos27, Limas11, Uras26 without gas supply

MG	Sample Gas
NG	Zero gas
EG	Span Gas
Flow	Flow Monitor
O_2	Oxygen Sensor (Option)
P	Pressure Sensor in Analyzer Module
c/*E*	Analyzer

Pressure Sensor

Which analyzer modules have a pressure sensor?

Analyzer Module	Pressure Sensor
Uras26, Limas11, Caldos27	built-in at the factory
Caldos25	not necessary
Magnos206, Magnos27	built-in at the factory as an option
MultiFID14	cannot be built in

Use the `MENU → Diagnostic/Information → System overview menu` item and select the appropriate analyzer module to determine if a pressure sensor is installed.

Pressure Sensor Connection

Analyzer Module	Pressure Sensor Connection
Uras26, Limas11	In the sample gas path if pipes are used as the internal gas lines. Connected to an external port via a FPM/FKM pipe if tubing is used for the internal gas lines (see Figures 3-6 to 3-9, pages 3-6 to 3-9 and pneumatic diagram in the analyzer data sheet).
Caldos27	Connected to port ***9/10*** via a FPM/FKM pipe (see Figure 3-4, page 3-4).
Magnos27	Connected to port ***9/10*** via a FPM/FKM pipe (see Figures 3-2 and 3-3, pages 3-2 and 3-3).
Magnos206	Connected to port ***9/10*** via a FPM/FKM pipe (see Figure 3-1, page 3-1). For measurements in suppressed measurement ranges, the pressure sensor port and the sample gas outlet must be connected via a tee and short lines. Please observe that the exhaust line is kept as short as possible or, if longer lines are necessary, that the inner diameter is sufficiently large (≥ 10 mm).

Notes for Proper Pressure Sensor Operation

Please observe the following notes for the proper operation of the pressure sensor:

- Remove the yellow plug from the pressure sensor port before start-up of the analyzer module.
- For a precise pressure correction, the pressure sensor port must be connected to the sample gas outlet via a tee and short lines. To reduce the flow effect, the lines must be kept as short as possible or, if longer lines are necessary, the inner diameter must be sufficiently large (≥ 10 mm).
- If the pressure sensor is connected to the sample gas path, the sample gas must not contain corrosive components nor may it be flammable or at risk of explosion.
- If the pressure sensor port is not connected to the sample gas outlet, precise pressure correction can only take place if the pressure sensor and the sample gas outlet are on the same pressure level.

Further information about pressure correction can be found in sections “Air Pressure Correction”, page 9-28, and “Air Pressure Value Correction”, page 9-29.

Housing Purge

When should the housing be purged?

A housing purge is required if the sample gas contains combustible, corrosive or toxic components.

Housing Design

A housing purge is possible if the system housing is designed for IP54 (with connection box) or IP65 (without power supply) protection. The purge gas connection ports (1/8-NPT internal threads) are factory installed per order.

Housing Purge

In gas analyzers with the Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules there is a gas-tight separation between the central unit and analyzer. Therefore, the central unit and analyzer can be purged separately (parallel) or jointly (series).

In gas analyzers with the Limas11 and Uras26 analyzer modules there is no gas-tight separation of the central unit and analyzer. Therefore, they can only be purged together. If the central unit and analyzer must be purged separately, the analyzer module must be installed in a separate IP-54 system housing.

Due to differing purge gas supply requirements, the Limas11, Uras26, Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules should not be purged in series with the MultiFID14 analyzer module.

CAUTION!

For joint purging of the analyzer and central unit, the purge gas must first be routed through the central unit and then through the analyzer. Flow direction inversion and leaks in the sample gas path can result in damage to electronics by corrosive sample gas components.

An analyzer module used to measure corrosive sample gas components should be the last unit connected in a series.

Central Unit Housing Purge

A central unit with no analyzer module installed can be ordered as a "housing purge" version. In this case the purge gas connection ports are factory installed in the terminator plate which installed at the back or bottom of the system housing instead of an analyzer module.

Purge Gas Supply Requirements

Nitrogen or instrument air should be used as purge gas (refer to the "Purge Gas for Housing Purge" section, page 1-6, for detailed information).

CAUTION!

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

Purge gas flow must always be restricted ahead of the purge gas inlet!
If the purge gas flow is restricted after the purge gas outlet, the housing seals are subjected to full purge gas pressure which can result in damage to the keypad!

CAUTION!

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

- Gas port installation is described in Chapter 2, "Gas Connections Installation" section.
- Follow the fittings manufacturer's installation instructions. Be sure to use a backup wrench when tightening gas line threaded connections.
- Follow the manufacturer's instructions when laying and connecting the sample gas line.
- If gas lines made of high-grade steel are connected to the analyzer modules with a direct measuring chamber connection, the lines also need to be connected to the building-side equipotential bonding.
- Never connect more than three analyzer modules in series.

Gas Line Connection

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

Evacuate Exhaust Gases

Exhaust gases should be routed to the atmosphere or to an exhaust pipe directly or via the shortest possible large-diameter line. Do not route exhaust gases via flow reducers or shutoff valves.

Process corrosive, toxic or combustible exhaust gases in an appropriate manner.

Provide for Gas Line System Flushing

Install a shutoff valve in each gas inlet line (this is definitely recommended for pressurized gases) and provide a means of flushing the gas line system via the sampling port with an inert gas, e.g. nitrogen.

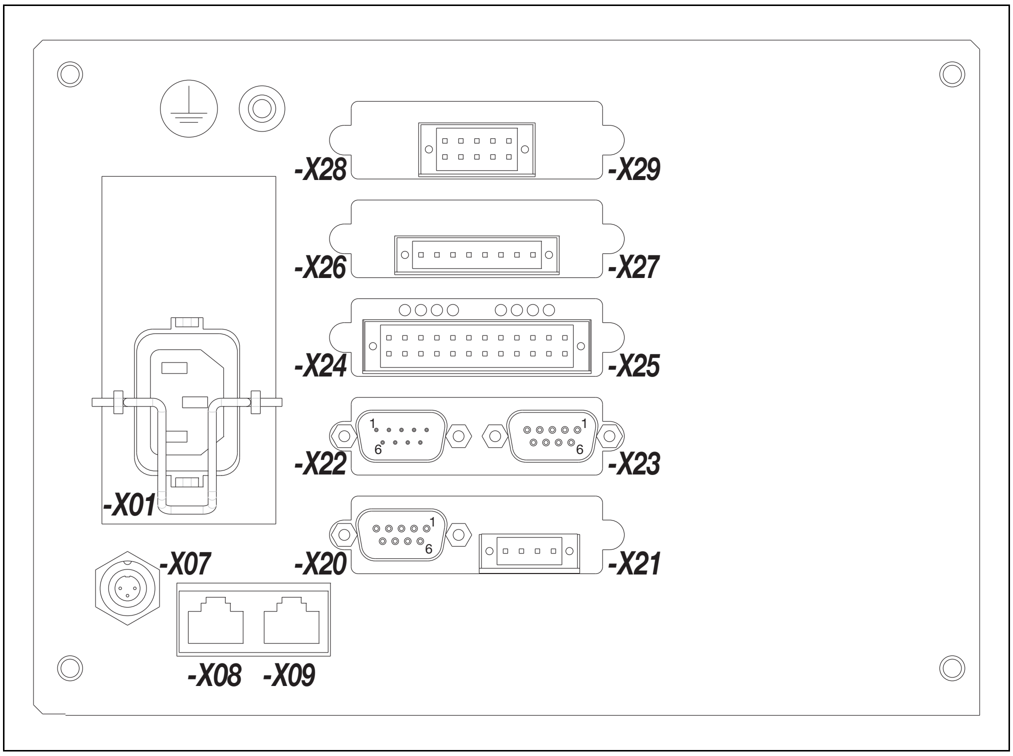
Flow Meter Installation in the Reference Gas Line

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

Electronics Module Connections

Figure 4-1

Electronics Module Connections

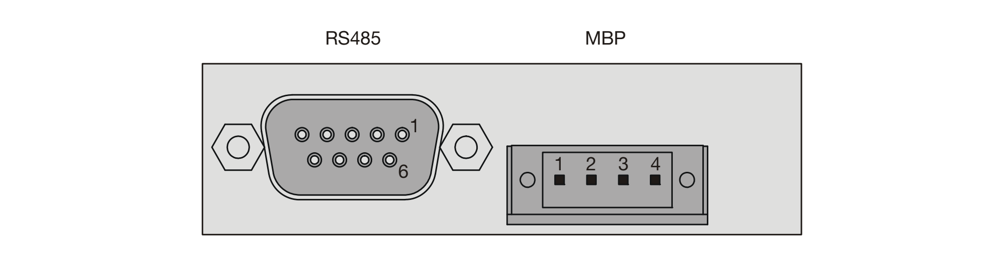


		For connection see
-X01	Power Supply Connection	Page 4-18
-X07	System Bus Port	Page 4-10
-X08, ***-X09***	Ethernet 10/100/1000BASE-T Interface	
-X20 to ***-X29***	I/O Modules (5 slots), Options:	
	– Profibus Module	Page 4-2
	– Modbus Module	Page 4-3
	– 2-Way Analog Output Module	Page 4-4
	– 4-Way Analog Output Module	Page 4-5
	– 4-Way Analog Input Module	Page 4-6
	– Digital I/O Module	Page 4-7
⏚	Potential Compensation Connection	Page 4-18

ℹ The connection drawing shows an example for the I/O modules equipment.

Figure 4-2

Profibus Module Connection Diagram



RS485 Interface:

1	–	not used
2	M24	24 V Output Ground
3	RxD/TxD-P	Receive/Transmit Data Plus, B-Line
4	–	not used
5	DGND	Data Transmission Potential (Reference Potential for VP)
6	VP	Supply Voltage Plus (5 V)
7	P24	24 V Output Voltage Plus, max. 0.2 A
8	RxD/TxD-N	Receive/Transmit Data N, A-Line
9	–	not used

Design: 9-pin Sub-D female connector

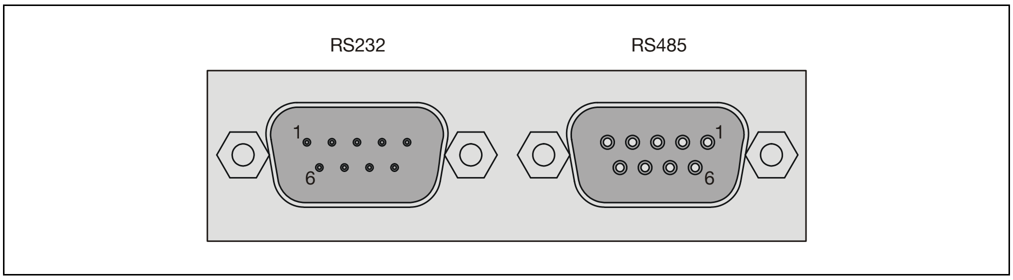
MBP Interface (non-intrinsically safe):

1 +
2 Shield
3 –
4 not used

Design: 4-pin terminal strip for stranded or solid conductors with a maximum section of 1 mm^2 (17 AWG). Note: Observe the information on needed materials (see page 4-13).

Figure 4-3

Modbus Module Connection Diagram



RS232 Interface:

2 RxD
3 TxD
5 GND

Design: 9-pin Sub-D male connector

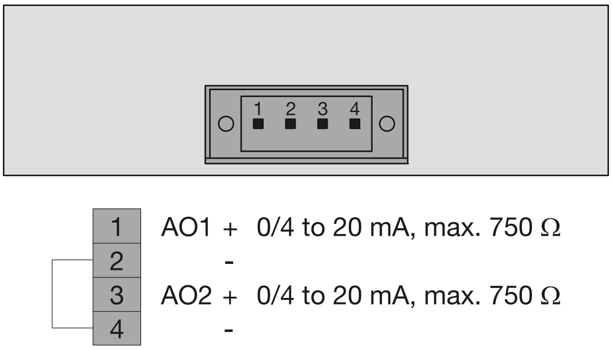
RS485 Interface:

2 RTxD–
3 RTxD+
5 GND

Design: 9-pin Sub-D female connector

Figure 4-4

2-Way Analog Output Module Connection Diagram



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

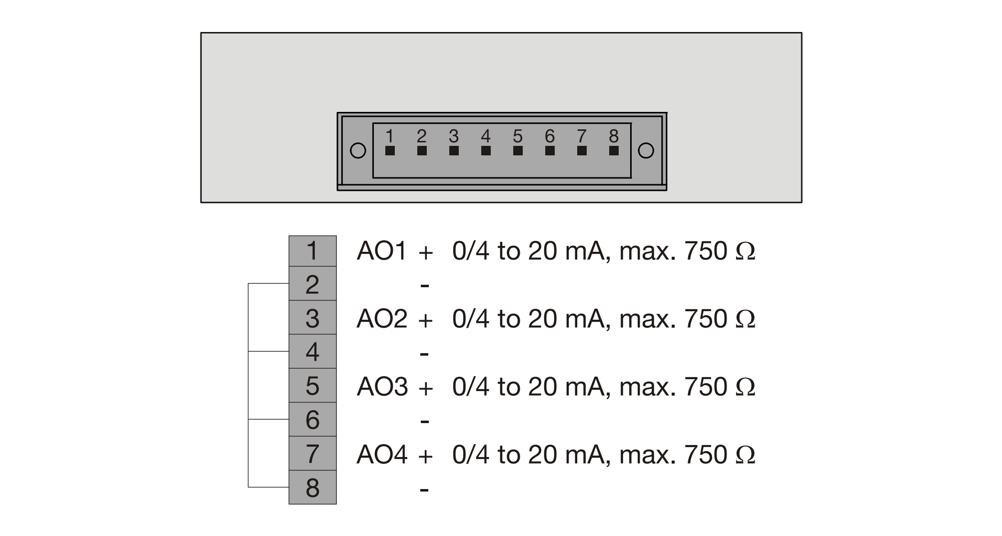
Design: 4-pin terminal strip for stranded or solid cable with a maximum section of 1 mm^2 (17 AWG). Observe the information on needed materials (see page 4-13).

ℹ “Standard Terminal Connections” section (see page 4-9) contains information on standard terminal assignment. Please observe also the specifications in the analyzer data sheet.

4-Way Analog Output Module: Electrical Connections

Figure 4-5

4-Way Analog Output Module Connection Diagram



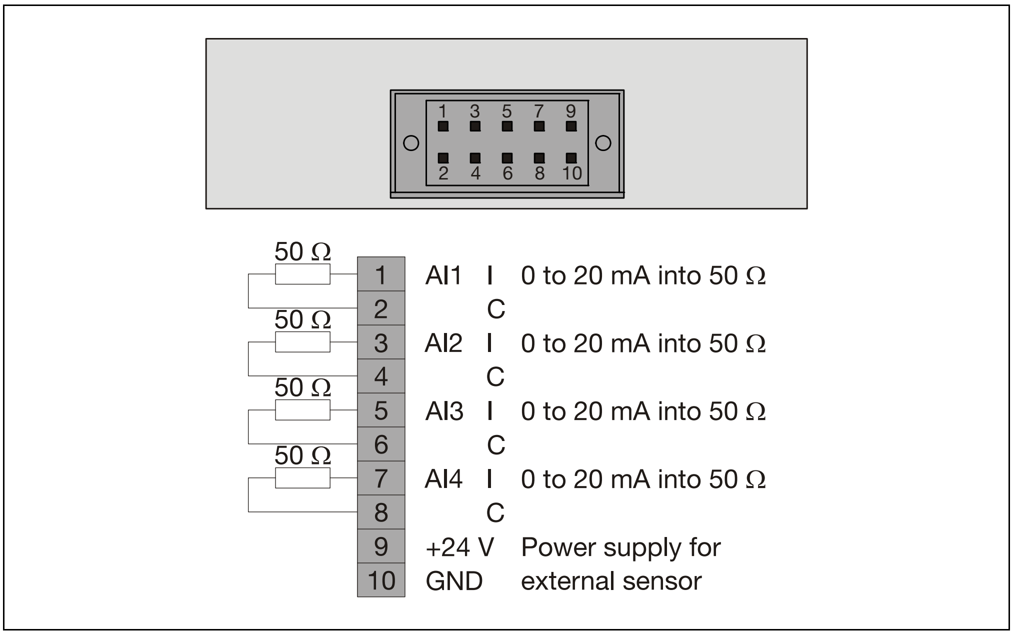
AO1-AO4 Analog Outputs:
0/4-20 mA (configurable, factory-set to 4-20 mA), common negative pole, galvanically separated from ground, freely connectable to ground, max. gain vs. local protective ground potential 50 V, max. working resistance 750 Ω. Resolution 16 bit. The output signal cannot be lower than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

Design: 8-pin terminal strip for stranded or solid cable with a maximum section of 1 mm^2 (17 AWG). Observe the information on needed materials (see page 4-13).

"Standard Terminal Connections" section (see page 4-9) contains information on standard terminal assignment. Please observe also the specifications in the analyzer data sheet.

Figure 4-6

4-Way Analog Input Module Connection Diagram

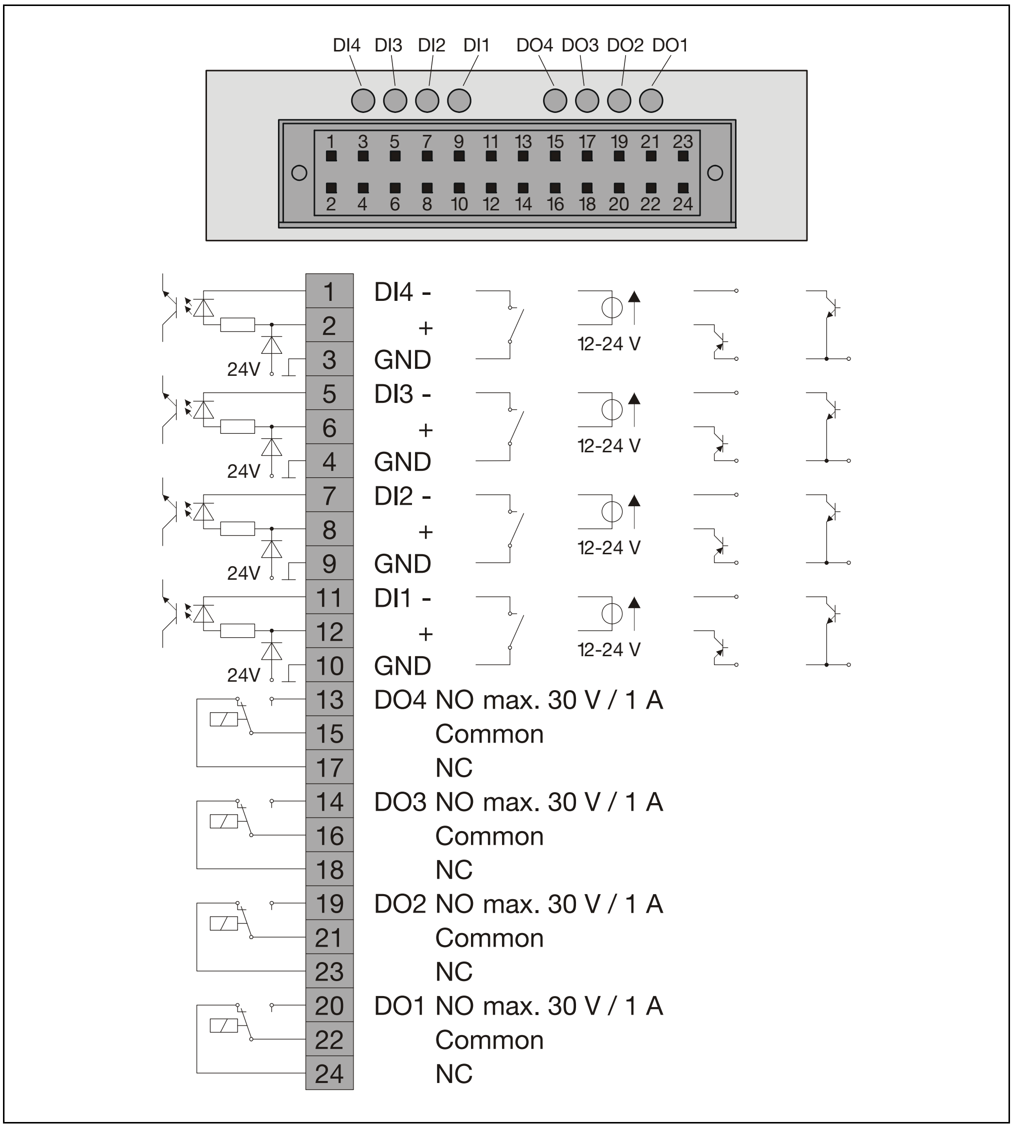


AI1-AI4	Analog Inputs: 0 to 20 mA into 50 Ω
+24 V	Current Output: +24 VDC for supply of an external sensor, fused with 100 mA (resettable fuse)

Design: 2x5-pin terminal strip for stranded or solid cable with a maximum section of 1 mm^2 (17 AWG). Observe the information on needed materials (see page 4-13)!

Figure 4-7

Digital I/O Module Connection Diagram



DI1-DI4 Digital Inputs:
Optocoupler with internal 24 VDC power supply. Control with floating contacts, with external voltage 12–24 VDC or with open collector drivers PNP or NPN..

DO1-DO4 Digital Outputs:
Floating double-throw contacts, max. contact load rating 30 V/1 A
Relays must at all times be operated within the specified data range. Inductive or capacitive loads are to be connected with suitable protective measures (self-induction recuperation diodes for inductive loads and series resistors for capacitive loads).

Design: 2x12-pin terminal strip for stranded or solid cable with a maximum section of 1 mm^2 (17 AWG). Observe the information on needed materials (see page 4-13).

“Standard Terminal Connections” section (see page 4-9) contains information on standard terminal assignment. Please observe also the specifications in the analyzer data sheet. Relays are shown in the unpowered state. The unpowered state is the failure mode (“fail safe”).

Continued on next page

Connections of the Standard Function Block Applications

Status Signals / Externally Controlled Calibration:

	Single Status Signals:	Collective Status Signal:
DO1	Failure	Collective Status
DO2	Maintenance Mode	Limit Value
DO3	Maintenance Request	Limit Value
DO4	External Solenoid Valve	External Solenoid Valve
DI1	Start Automatic Calibration	Start Automatic Calibration
DI2	Inhibit Automatic Calibration	Inhibit Automatic Calibration
DI3	Adjust Zero-Point	Adjust Zero-Point
DI4	Adjust End-Point	Adjust End-Point

Measuring Range Control:

DO1 Measuring Range Feedback
DO2 Measuring Range Feedback
DO3 Measuring Range Feedback
DO4 Measuring Range Feedback
DI1 Measuring Range Switchover
DI2 Measuring Range Switchover
DI3 Measuring Range Switchover
DI4 Measuring 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

Standard Terminal Connections

Basic Principles

The terminal connections are allocated
- in the order of the registered analyzer modules and
- within an analyzer module, in the order of the sample components.

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

Profibus, Modbus

The slot of the optional Profibus module is always ***–X20***. The slot of the optional Modbus module is ***–X20***, or ***–X22*** if a Profibus module is present.

Analog Outputs

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

Alarm Values

Alarm values are available at the digital I/O module “Status signals / external calibration” (if the gas analyzer has been set to collective status during the installation of an analyzer module) or the digital I/O module “Alarm values”. An alarm value is allocated for each sample component in the order of the sample components.

Standard Application Measuring Range Control

Measuring range control can be implemented for all sample components with more than one measuring range. Each digital I/O module includes
- 4 digital inputs (DI) for the measuring range switch-over and
- 4 digital outputs (DO) for the measuring range feedback signal.

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

The measuring range control is not installed across I/O modules.
Example: A gas analyzer contains 4 sample components with the following number of measuring ranges:

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

The following connection assignments result from this:

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

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

System Bus Connection

System Bus

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

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

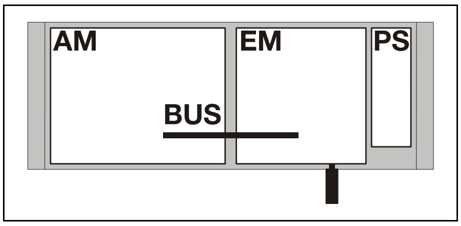
One System Housing

The system bus connection is established at the factory when the gas analyzer functional components (e.g. an electronics module and an analyzer module) are installed in one system housing.

In this case a terminating resistor should be installed in the system bus connector (supplied with the unit, see Figure 4-8).

Figure 4-8

One System Housing: Terminating Resistor on the Electronics Module



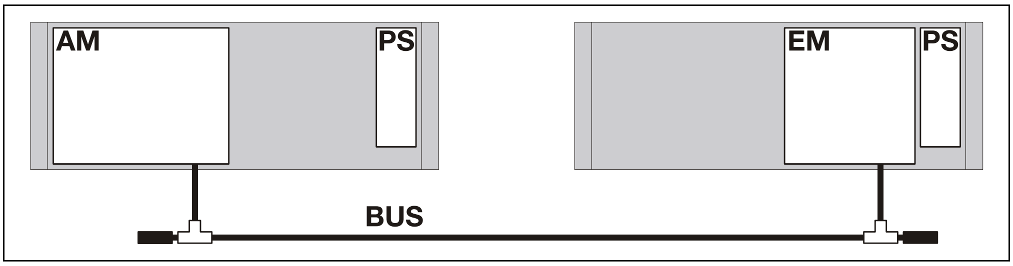
AM Analyzer Module
EM Electronics Module
PS Power Supply
BUS System Bus (Internal)
▬ Terminating Resistor

Multiple System Housings

If the gas analyzer functional components are installed in several system housings, they must be interconnected externally via the system bus (see Figure 4-9 and instructions on the following page).

Figure 4-9

Multiple System Housings: Connection via the System Bus



AM Analyzer Module
EM Electronics Module
PS Power Supply
BUS System Bus (External)
▬ Terminating Resistors

CAUTION!

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

Continued on next page

What materials are needed?

The required system bus cables, tees and terminating resistors are supplied per the order.

CAUTION!

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

The modules should never be interconnected without using tees and terminating resistors.

System Bus Connection

Step	Action
1	Place a tee on the system bus connection (designated “BUS”) of each module (electronics and analyzer).
2	Connect the tees with the system bus cables.
3	Place a terminating resistor on the open ends of each tee.

System Bus Cable Extension

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

- For extension purposes a shielded 4-conductor cable with twisted pairs and a wire section ≥ 0.5 mm^2 should be used.

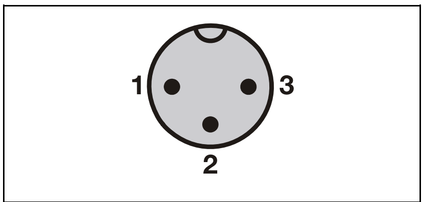
Number and section of conductors	2 x 2 x 0.25 mm^2	
Inductance	approx. 0.67 mH/km	
Impedance	approx. 80 Ω	
Coupling (1 kHz)	approx. 300 pF/100 m	
Operating capacitance	Conductor–Conductor Conductor–Shield	approx. 120 nF/km approx. 160 nF/km

- For EMC purposes route the system bus cable via metal connection boxes with metallic cable threaded connections. Connect the shield to the threaded connections. Connect the unused wires in the 4-conductor extension cable in the connection box to a PE clamp.
- Figure 4-10 shows the pin layout of the 3-pin system bus plug.

Figure 4-10

System Bus Plug Layout

(Seen from pin side of cable plug)



Pin	Wire Color	Signal
1	green	System Bus LOW
2	brown	System Bus HIGH
3	white	System Bus GROUND

Continued on next page

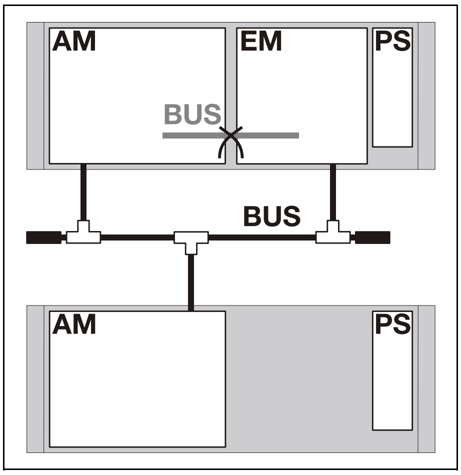
Adding an Analyzer Module to the System Bus

(see Figure 4-11)

Step	Action
1	Open the internal system bus connection between the existing analyzer module and the electronics module.
2	Place a tee on the system bus connection (designated “BUS”) of each module (electronics and all analyzer modules).
3	Connect the tees with the system bus cables.
4	Place a terminating resistor on the open ends of each tee.
5	Set up the added analyzer module (see “Setting Up System Modules” section, page 7-C-5).

Figure 4-11

Multiple Analyzer Modules: Connection via the System Bus



AM Analyzer Modules
EM Electronics Module
PS Power Supply
BUS System Bus (External)
▬ Terminating Resistors

CAUTION!

Follow local regulations on installing and connecting electrical wiring.

- Locate the signal, control and interface lines separately from the power supply lines.
- Locate the analog and digital signal leads separately from each other.
- Carefully plan the arrangement of signal lines in the cables as well as the use of connector box openings in the IP-54 system housing.

What materials are needed?

- Selection of the required conductors depends on line length and planned current load.
- Notes regarding conductor section for I/O module connection:
  - The maximum capacity of terminals for stranded or solid conductors is 1 mm^2 (17 AWG).
  - The stranded conductor may be tinned on the tip or twisted for simplified connection.
  - When using wire end ferrules the total section should not exceed 1 mm^2, i.e. the maximum stranded conductor section is 0.5 mm^2. The Weidmüller PZ 6/5 crimping tool must be used for crimping the ferrules.
- Maximum line length 1200 meters (3940 feet, transmission rate max. 19200 bit/s) for RS485.
- Maximum line length 15 meters (50 feet) for RS232.
- The matching female connector housings for the connection strips on the I/O modules are supplied with the device.

Connection Box

The IP-54 version of the system housing has a connection box on the back of the electronics module.

The connection box has:
- EN version: Five M20 and two M32 threaded cable connections
- CSA version: One 1-1/4-inch and two 3/4-inch conduits.

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

Protective Cap

A protective cap is factory-installed on the rear of the electronics module when the Limas11 UV analyzer module is installed in the central unit.

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

Continued on next page

Wiring Connection

IP20 Version of System Housing:	
Step	**Action**
1	Connect the wiring to the connector housing according to the connection diagrams.
2	Connect the connector housings to the terminal strips.

Version of System Housing with connection box:	
Step	**Action**
1	Run the cables through the connection box openings. M20: Remove the plug from the insert; the ring remains in place as a gasket and strain relief. M32: Remove the plugs from the threaded connections. Press the insert from the accessory kit over the cable; seal off the free opening with the pin from the accessory kit.
2	Connect the wiring to the connector housings according to the connection diagrams.
3	Connect the connector housings to the terminal strips.

Mark the cables or the connector housings of the I/O modules so that their respective relationship to the I/O modules is clear.

Power Supply Line Connection – Safety Notes

CAUTION!

Follow all applicable national safety regulations for the preparation and operation of electrical devices as well as the following safety precautions.

The gas analyzer voltage must be set to match the line voltage before the power supply is connected.

The protective lead should be attached to the protective lead connector before any other connection is made. The protective lead connection is assured when the power cable supplied is used.

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

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

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

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

Install a breaker near the gas analyzer in order to completely disconnect it from the power supply. Mark the breaker so that its relationship to the protected device is clear.

Power Supply Line Connection to the Analyzer Module

- The following information and instructions should be followed when connecting the 24-VDC power supply to an analyzer module that is not installed in the central unit but in a separate system housing.
- Information in the sections “Power Supply Information”, page 1-7, and “Power Supply”, page 1-8, should also be followed.

24-VDC Connecting Cable

If an analyzer module is not installed in the central unit but in a separate system housing a 5-meter (16.4-feet) long cable (2 x 0.5 mm^2, see Figure 4-12) will be supplied.

The receptacle on one cable end is designed to connect to the 24-VDC male plug on the analyzer module or the I/O base module (see Figure 4-13).

The wires on the free end of the connecting cable are intended for connection to
- The power supply filter -Z01 in the central unit (for an example see Figure 4-14) or
- An external power supply

Figure 4-12

24-VDC Connecting Cable

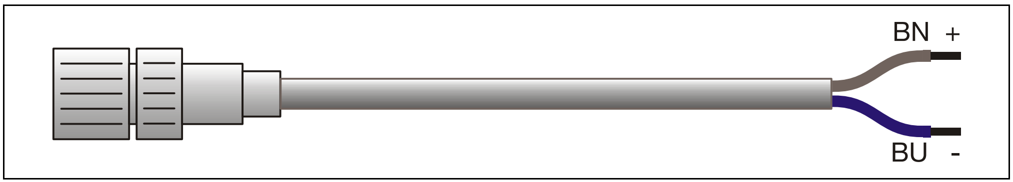
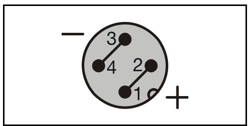


Figure 4-13

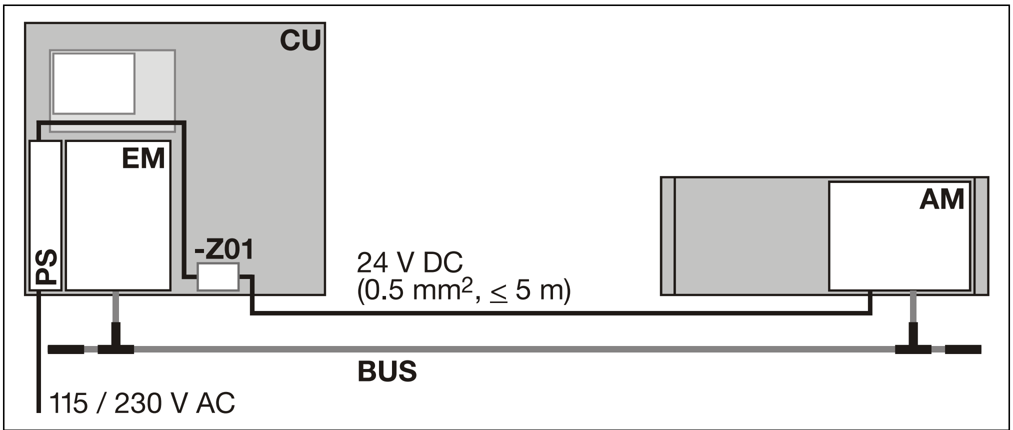
24-VDC Connection



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

Figure 4-14

Connecting 24-VDC Power from the Central Unit Power Supply to a Separate Analyzer Module



AM	Analyzer Module	**EM**	Electronics Module	**-Z01**	Power Supply Filter
CU	Central Unit	**PS**	Power Supply	**BUS**	System Bus

Continued on next page

24-VDC Connection

Step	Action
1	Connect the supplied connection cable with receptacle to the 24-VDC connection on the analyzer module or the I/O base module.
2	Connect the wires on the free end of the cable to the power supply filter -Z01 in the central unit or to the external power supply.

Extending the 24-VDC Connection Cable

The 24-VDC connection cable has a wire section of 0.5 mm^2, it is limited to a length of 5 meters (16.4 feet).

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

- The extension cable must have a wire section of at least 2.5 mm^2.
- The extension cable should be no more than 30 meters (98 ft) long.
- The extension cable should be connected as close as possible to the receptacle of the supplied 24-VDC connection cable, i.e. the supplied 24-VDC connection cable should be made as short as possible.

Power Supply Line Connection

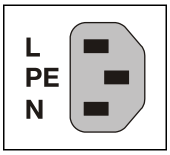
What materials are needed?

The gas analyzer is supplied with a power cord and a separate two-prong grounded plug. The power cord is 5 meters (16.4 feet) long and has a three-prong grounded-instrument plug for connection to the power supply.

If the power cord supplied is not used, make your selection of a suitable cable based on line length and planned current load.

Figure 4-15

Power Supply Connection



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

Power Supply Line Connection

Step	Action
1	Make sure the power supply leads have an adequately dimensioned protective device (breaker).
2	Install a breaker in the power supply line or a switched receptacle near the gas analyzer to make sure the gas analyzer can be completely separated from the power source. Mark the breaker so that its relationship to the protected device is clear.
3	Connect the power cord supplied to the ***–X01*** power supply connector in the electronics module and secure it with the clip.
4	Connect the other end of the power cord to the power source. [i] The gas analyzer may start when the power supply is connected.

Potential Compensation Connection

The electronics module and the analyzer modules have a potential compensation connector designated by the symbol ⏚. The connector has M5 internal threads for the installation of a matching screw or clamp.

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

Chapter 5 Gas Analyzer Start-Up

Installation Check

Installation Check

Make sure the gas analyzer is correctly installed before carrying out any start-up procedures.

Use the following check list:

Check	✓
• Is the gas analyzer securely fastened? (See “Gas Analyzer Installation” section, page 2-6)	❒
• Are all gas lines correctly connected? (See Chapter 3 “Gas Line Connection”)	❒
• Are all signal, control, interface, power supply and (if applicable) system bus lines correctly placed and connected? (See Chapter 4 “Electrical Connection”)	❒
• Are all devices needed for gas preparation, calibration and exhaust processing correctly connected and ready for use?	❒

Gas Path and Housing Initial Purge

Take note of the instructions in the “Housing Purge” section, page 3-12.

Purge Prior to Start-Up

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

First this ensures that the gas paths and system housing are free from contaminants (e.g. corrosive gases) and dirt on start-up.

Second this prevents the possibility of an explosive gas/air mixture being present in the gas paths or system housing when the power supply is connected.

Purge Gas Supply Requirements

Nitrogen or instrument air should be used as purge gas (refer to the “Purge Gas for Housing Purge” section, page 1-6, for detailed information).

Purge Gas Flow and Duration of Purge Process

The purge gas flow and the duration of the purge process depend on the volume to be purged (see the following table). If the purge gas flow rate is lower than indicated the duration of the process must be increased correspondingly.

Volume to be Purged	Purge Gas Flow Rate	Duration
Gas Path	100 l/h (max.)	approx. 20 sec.
Central Unit with or without Analyzer Module	200 l/h (max.)	approx. 1 hr.
Caldos25, Caldos27, Magnos206, Magnos27 (analyzer separately)	200 l/h (max.)	approx. 3 min.

The purge gas flow rates given in the table only apply to the initial purge. During operation other values apply (see “Operation” section, page 5-5).

CAUTION!

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

CAUTION!

Purge gas flow must always be restricted upstream of the purge gas inlet! If the purge gas flow is restricted after the purge gas outlet, the housing seals are subjected to full purge gas pressure which can result in damage to the keypad!

Power Supply Activation

CAUTION!

For gas analyzers with Limas11 or MultiFID14 analyzer modules:
Before activating the power supply check once again that the gas analyzer operating voltage setting matches the line voltage.

The sample gas supply should be turned on only at the end of the warm-up phase and after calibration.

Power Supply Activation

Step	Action
1	Turn on the power supply of the gas analyzer with the external breaker switch.
2	Turn on the separate 24-VDC power supply of the analyzer module if necessary.

Function Check

The following events will occur after the power supply is turned on:

Phase	Description
1	The three “Power”, “Maint” and “Error” LEDs light up.
2	The different booting phases are displayed on the screen. Also the software version is displayed.
3	After a brief time the screen switches to measurement mode.
4	The STATUS MESSAGE softkey appears on the screen. This indicates the possibility of a temperature or flow problem during the warm-up phase. By pressing the softkey the user can recall the status message summary and view status message details.

Date and Time Check

A correct date and time setting is required for proper operation of functions such as automatic calibration and time/date logging of error messages.

Step	Action
1	Select the `Date/time` menu item: **`MENU → Configure → System → Date/Time`**
2	Check and, if necessary, correct the date and time (For more information see “Setting Time Zone, Date and Time”, page 7-C-1).

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

Warm-Up Phase

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

Analyzer Module	Warm-Up Phase Duration
Caldos25	1.5 hours
Caldos27	Approx. 30/60 minutes for class 1/2 measurement ranges [1)]
Limas11	Approx. 2.5 hours
Magnos206	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx 0.5/2 hours without/with thermostat

1) See “AO2000 Series” Data Sheet (publication number 10/24-1.20 EN) for class details.

- The warm-up phase can take longer if the gas analyzer was not brought to room temperature before the power supply was activated.
- During the warm-up phase measurement values can be outside the ranges specified in the data sheet.

Warm-Up Phase Duration

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

Readiness

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

Calibration Verification

The gas analyzer is calibrated in the factory. Transport stresses as well as pressure and temperature conditions at the installation location may however influence the calibration. Thus it is recommended to verify the gas analyzer calibration at the installation location.

Chapter 8 describes the gas analyzer calibration procedures.

Sample Gas Supply

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

Adjusting Sample Gas Flow Rate

Module	Sample Gas Flow Rate	
Caldos25	10– 90 l/h	(for option T_{90} < 6 sec.: max. 90–200 l/h)
Caldos27	10– 90 l/h	min. 1 l/h
Limas11	20–100 l/h	
Magnos206	30– 90 l/h	
Magnos27	20– 90 l/h	
Uras26	20–100 l/h	
Oxygen Sensor	20–100 l/h	
Gas Module	30– 60 l/h	

Adjusting Reference Gas Flow Rate

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

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

Adjusting Purge Gas Flow Rate

The purge gas flow rate should be set as follows in gas analyzers with the housing purge capability:
Purge gas flow rate at device inlet max. 20 l/h (constant),
Purge gas positive pressure p_e = 2 to 4 hPa

- Because of leakage losses the purge gas flow rate at the device output is approx. 5 to 10 l/h for a purge gas flow rate at the device inlet of 20 l/h.
- Notes for selection and use of flow meters:
  - Measuring range 7 to 70 l/h
  - Pressure drop < 4 hPa
  - Needle valve open
- Recommendation: Flow meter 7 to 70 l/h, Catalog No. 23151-5-8018474

Display and Control Unit

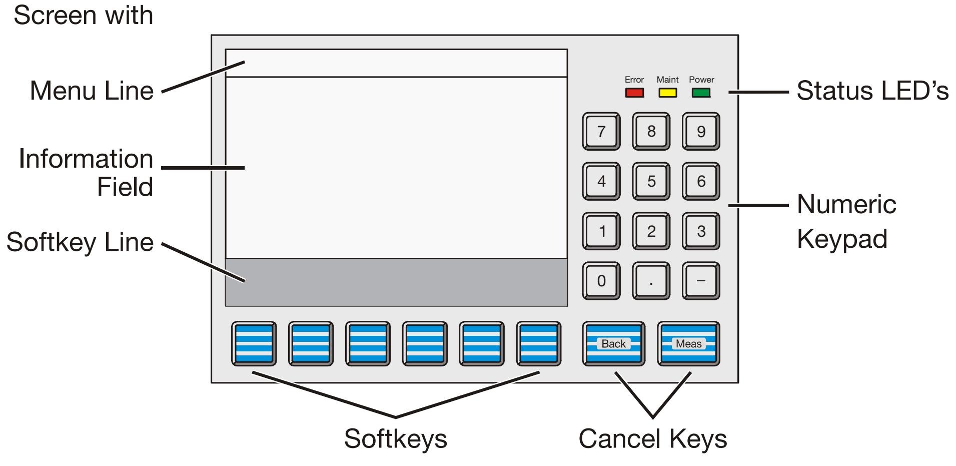
Overview

The display and control unit contains:
- The screen with
  - Menu line
  - Information field
  - Softkey line
- Status LED's
- Numeric keypad
- Cancel keys
- Softkeys

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

Figure 6-1

Display and Control Unit

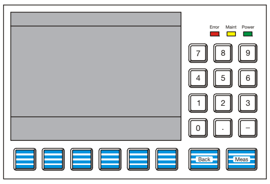


Display and Control Unit Operating Modes

The display and control unit operating modes are
- Measurement
- Menu

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

Screen



The backlit graphics screen has a 320x240-pixel resolution.

The screen is divided into three panels (see Figure 6-1):
- Menu line
- Information field
- Softkey line

Menu Line

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

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

The Information Field in Measurement Mode

In the measurement mode the information field shows the following information for each sample component in the analyzer modules installed in the gas analyzer:
- Values in numeric form and as a bar graph
- The physical unit for the measured value
- The measurement component designation
- The measurement range lower and upper limit values on the bar graph
- The analyzer type
- The analyzer name

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

It is user-configurable
- which measurement values are shown on the screen and
- at which positions on the screen the measurement values are displayed.

In addition, the user can configure display elements that allow to
- enter a value (pump output for example, see page 6-10) or
- actuate keys (for example to switch measuring components, see page 6-11).

For further information about the screen in the measurement mode refer to the “Display” section (see page 7-D-1).

The Information Field in Menu Mode

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

The Softkey Line

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

The softkeys are further explained in the “Softkeys” section (see page 6-7).

Message Display Functions

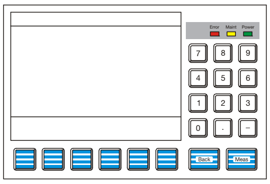
The blinking message display in the softkey line has the following functions:

- It prompts for the `STATUS MESSAGE` key to be pressed whenever a status message appears (refer to the "System Status: Status Messages" section, page 10-2).
- It shows that a password is active (refer to the "Password Protection" section, page 6-12).
- It shows that the gas analyzer is being controlled from a remote HMI (refer to the "User Interface Priority" section, page 6-15).
- It shows that an automatic calibration process is running in the gas analyzer (refer to the "Automatic Calibration" section, page 8-A-4).

Display of Status Messages

When a status message is generated by the **Message Generator** function block its text is displayed as configured in the function block. For a complete description of the function block, see the "AO2000 Function Blocks – Descriptions and Configuration" technical bulletin (Publication No. 30/24-200 EN).

Status LED's



The three LED's next to the screen indicate the gas analyzer's status.

Power

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

Maint

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

The STATUS MESSAGE softkey appears on the screen at the same time (see page 6-7).

Error

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

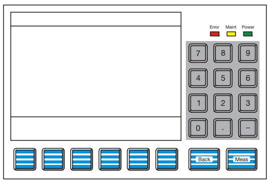
The STATUS MESSAGE softkey appears on the screen at the same time (see page 6-7).

Chapter 10 contains information on status messages and status signals.

Numeric Keypad

Numeric Keypad

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



0 ... 9, . , –

The operator can enter values directly with the:
- numeric keys “0” through “9”
- decimal point “.”
- minus sign “-”

Examples:
- Test gas concentration
- Date and time
- Air pressure
- Password

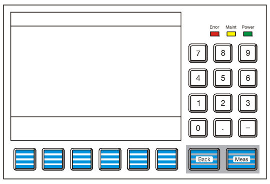
Any digits displayed cannot be overwritten. They must be deleted with the `BACKSPACE` or `CLEAR` key before new digits can be entered.

Entering Text with the Numeric Keypad

The “Text Entry” section (see page 6-9) explains how to enter information such as sample component or user names with the numeric keypad.

Cancel Keys

Cancel Keys

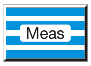


The “Back” and “Meas” keys located under the numeric keypad are designated as cancel keys.

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

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

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

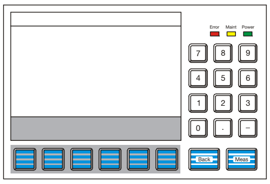


The “Meas” key allows the operator to cancel a function or menu item and to return to the measured value display in measurement mode.

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

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

Softkeys



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

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

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

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

Softkeys are also called keys in this manual.

The Softkeys in Measurement Mode

The softkeys MENU and >> appear in measurement mode.

The STATUS MESSAGE softkey also appears if an error occurs.

MENU

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

>>

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

The “Back” key is used for backward scrolling.

STATUS MESSAGE

The `STATUS MESSAGE` key appears in measurement mode if an “Failure” or “Maintenance request” condition arises.

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

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

All status messages are listed in Chapter 10.

Continued on next page

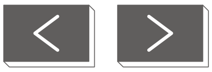
The Softkeys in Menu Mode

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

In menu mode the standard softkeys have the following functions:

The operator uses these two arrow keys to move the selection cursor up or down in a menu or list to choose menu items.

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

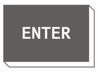


The operator uses these two keys to move the selection cursor left or right, e.g. into or out of a submenu or to select an item in a subordinate list.

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

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

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



The operator can use the `ENTER` key to:
- Call up menu items for processing
- Start functions
- Confirm entries, e.g. parameter settings

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

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

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

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

Press cancel keys: **Back**, **Meas**

Press softkeys: **`MENU`**, **`HELP`**, **`ENTER`**, **`BACKSPACE`**

Select menu items: **`Calibrate`**, **`Configure`**

Enter numbers: **`0`** ... **`9`**

Entering Text

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

The following characters are shown using a total of four pages:
- Letters   A-Z and a-z
- Symbols   Blank * ( ) % & : < > /
- Digits   0 to 9 . -

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

Letters:	A	L	t	Blank
Key:	7	-	2	9

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

Text is entered and modified in two ways:
- The operator enters text in the input mode.
- The operator modifies already entered text in the edit mode.

Softkeys in the Input Mode

The softkeys in the input mode have the following functions:

PREV PAGE NEXT PAGE

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

CAPS

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

EDIT

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

Softkeys in the Edit Mode

The softkeys in the edit mode have the following functions:

< >

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

BACK-SPACE

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

INPUT

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

Value Entry

Values are entered during measurement mode by pressing the number key that corresponds to the position of the display element in the display and is indicated above the display element. In the example below, this is key 4 (see Fig. 6-2).
A field then appears for entering the value (see Fig. 6-3).

Fig. 6-2

Value Entry: Display During Measurement Mode

(Example: Setting the Pump Output)

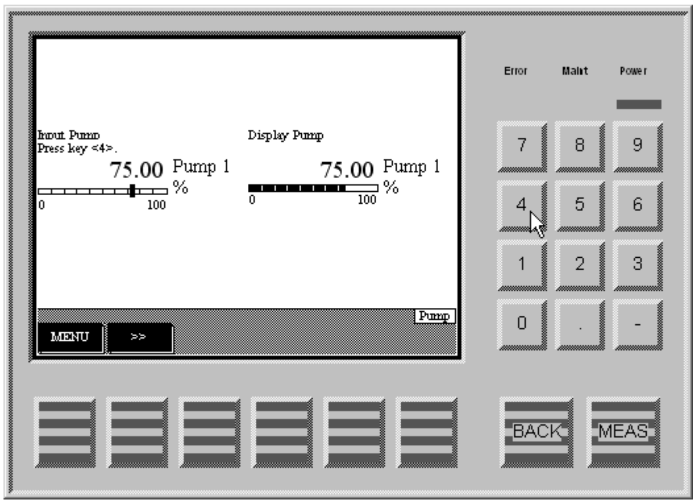
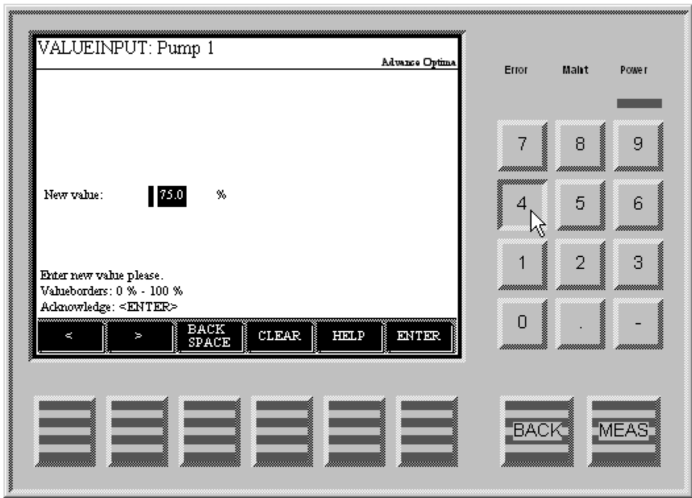


Fig. 6-3

Value Entry: Entering a Value

(Example)



Description and Configuration

The display element `Value Entry` is described on page 7-D-10.
The configuration is described on page 7-D-11.

Key Entry

Key entries are made during measurement mode by pressing the number key that corresponds to the position of the display element on the display and that is indicated over the display element. In the example, this is key 4 (see Fig. 6-4). A softkey line then appears with the configured keys (see Fig. 6-5).

Fig. 6-4

Key Entry: Display During Measurement Mode

(Example: Switching Measuring Components)

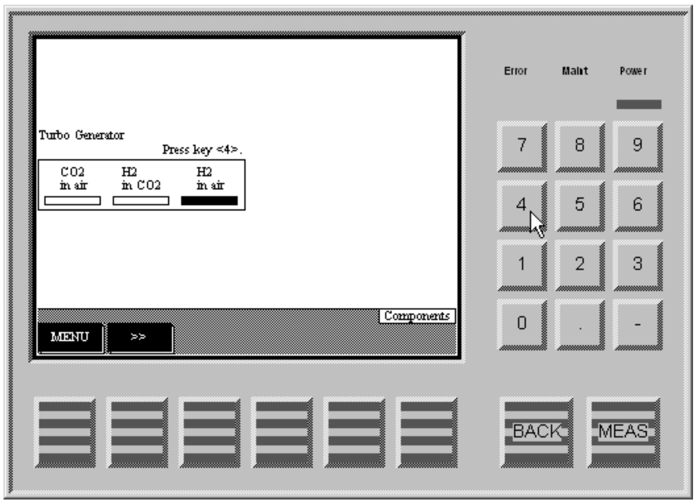
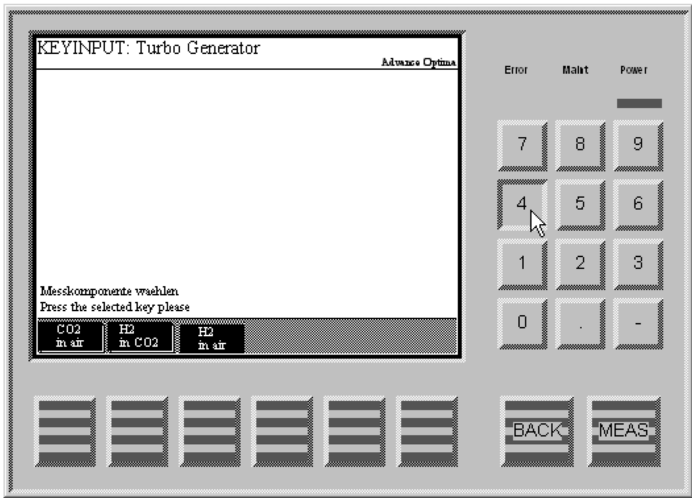


Fig. 6-5

Key Entry: Using the Keys

(Example)



Description and configuration

The display element `Key Entry` is described on page 7-D-12. The configuration is described on page 7-D-13.

Elements of Password Protection

Password protection consists of three elements:
- Password level
- User group
- Password

Password Level

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

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

User Group

The members of a user group are authorized to access a specific password level, i.e. to change the menu items at that level.

Some user groups are set-up at the factory.

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

Password

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

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

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

Factory Setting

User group	Access to password levels	Password
Every user	0	None
Maintenance team	0, 1	471100
Specialist team	0, 1, 2	081500
Function block specialist	0, 1, 2, 3	325465

CAUTION!

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

Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (publication number 30/24-200 EN) contains complete information on the “Function Block” concept as well as detailed descriptions of the individual function blocks.

Continued on next page

Viewing Menu Items

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

Changing Menu Items

All users can execute all password level 0 menu items without entering a password.

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

Note

Entering the main menu and thus switching to the menu mode can be password protected (see the "Inhibit Operation" section, page 7-C-4).

Change Privilege

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

Duration of the Change Privilege

The change privilege remains in effect until:

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

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

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

Note

The change *privilege thus refers to a temporary authorization to change menu items.*

In contrast, the access *privilege refers to a fundamental and configurable authorization to change menu items at certain password levels.*

Changing the Password

Changing the password is described in Chapter 7 "Gas Analyzer Configuration".

User Interface Priority

Note — *The user interface is designated using the acronym “HMI”, which stands for “human machine interface”.*

User Interfaces

The AO2000 series gas analyzers have several user interfaces.

- The local operation user interface is the display and control unit on the gas analyzer (“local HMI”).
- The remote operation user interface is a PC running the “AO-HMI” software (“remote HMI”).

  For detailed information on remote operation, see the “AO-HMI” technical bulletin (Publication No. 30/24-311 EN).

HMI Priority

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

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

1st User:	2nd User:	
	Remote HMI has priority	Local HMI has priority
Remote HMI Level n	Priority with Level n+1	Priority with Level n
Local HMI Level n	Priority with Level n+1	

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

Specifics for Manual Calibration

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

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

Access Lock

Independent of the user interface priority adjustment (see page 6-14) it is possible to completely lock the access to the operation of the gas analyzer from a certain user interface (HMI).

This lock is effected by configuration of the function block **Access Lock**. For a detailed function block description, see the “AO2000 Function Blocks – Descriptions and Configuration” technical bulletin (Publication No. 30/24-200 EN).

Access Denied

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

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

Access Lock via Password Protection

As an alternative to the above-described complete access lock it is possible to inhibit entering the main menu and thus switching to the menu mode via password protection (see the “Inhibit Operation” section, page 7-C-4).

Menu Tree

The following table summarizes the gas analyzer menu tree.

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

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

Password Levels

For each menu item its password level (0 , 1 , 2 , 3 is shown in the table.

For some menu items, individual sub-menu items are on a higher password level. These applies especially to those sub-menu items which allow access to function block applications.

Note: The "Change password" menu item is not assigned to a specific password level. To change a password the old password of the respective level must be entered (see "Changing the Password" section, page 7-C-3).

The "Function blocks" sub-menu is detailed in Chapter 7, Section B.

The "Calibration data" sub-menu is detailed in Chapter 8, Section B.

Continued on next page

Menu

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

Chapter 7 Gas Analyzer Configuration

Section A Measurement Component-Specific Functions

Measurement Range Switching

Menu Path `MENU → Configure → Component specific → Measurement range (→ Select component) → …`

Selection All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure Select the measurement range with the arrow keys and press `ENTER` to confirm.

ℹ The measurement range selected shown on the screen after switching to measurement mode.

Modifying Measurement Range Limits

Menu Path

`MENU → Configure → Component specific → Measurement range (→ Select component) → …`

Selection

All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure

Select the measurement range with the arrow keys, press `CHANGE LIMITS`, select `START VALUE` or `END VALUE`, change the measurement range limit and confirm with `ENTER`.

ⓘ For the automatic measurement range changeover (see page 7-A-6) to function properly, the measurement ranges MB1, MB2, … must be configured in ascending order, i.e. MB1 < MB2 < … .

ⓘ The measurement range selected or changed and the altered number of decimal places is shown on the screen after switching to measurement mode.

Steps After Changing Measurement Range Limits

Calibration of the associated measurement range should be verified after changing measurement range limits. If the ratio of the old to the new measurement range is ≥ 1:10, we recommend manually calibrating the end point.

Parameters of the auto-range function should be verified after changing measurement range limits (see page 7-A-6).

Notes for Individual Analyzer Modules

Caldos25, Magnos27	Measurement ranges are factory-set and cannot be modified.
Caldos27	Measurement ranges are freely selectable for binary gas mixtures. They are factory-calibrated for the largest possible measurement range. There is a limit to the setting capability. If, for example the measurement ranges cross the explosive limit or areas of the measurement ranges cannot be implemented due to ambiguities. Measurement ranges are not freely adjustable in the case of multiple-component mixtures with “interference components” that have been calibrated at the factory or if a cross-sensitivity correction has been configured. In these cases the measurement ranges are factory-set per customer order.
Magnos206	Measurement ranges are freely selectable. At the factory they are either set to 0–10/15/25/100 Vol.-% O_2 or per order.
Limas11, Uras26	Measurement ranges are freely selectable. See the “Limas11, Uras26: Instructions for Changing Measurement Range Limits” section, page 7-A-3.
Oxygen Sensor	Measurement range 1 is freely adjustable from 0–5 Vol.-% O_2 to 0–25 Vol.-% O_2. Measurement range 2 is factory-set to 0–25 Vol.-% O_2.

Limas11, Uras26: Notes for Changing Measurement Range Limits

Physical Measurement Range

The Limas11 and Uras26 analyzer modules have one physical measurement range per sample component. The limits of this measurement range are determined by the minimum and the maximum value of the product of the gas concentration and measurement cell length $(c \cdot l)_{min}$ or $(c \cdot l)_{max}$.

Measurement Ranges in a Delivered Analyzer Module

Up to four measurement ranges – within the limits of the physical measurement range – can be ordered for each sample component. The maximum ratio of the spans is 1:20. The measurement ranges can be starting measurement ranges or suppressed measurement ranges.

Analyzer Module with Calibration Cells

If a calibration cell is provided for the measurement component, its set point will always be the upper end of the largest measurement range.

If the new measurement range is smaller than the old measurement range, the associated calibration cell can still be used.

After Changing Measurement Range Limits

It is recommended after changing the measurement range limits

- To verify the end point of the new measurement range,
- To verify the linearity of the new measurement range (see “Limas11, Uras26: Relinearization” section, page 9-8).
- To measure the associated calibration cell (see “Limas11, Uras26: Measurement of Calibration Cells” section, page 9-7).

Changing the Number of Decimal Places

Menu Path `MENU → Configure → Component specific → Measurement range (→ Select component) → …`

Selection All measurement ranges configured (at the factory) for a sample component are displayed.

Procedure Select the measurement range with the arrow keys, press `SET DECIMAL`, set the number of decimal places with the softkeys and confirm the selection by pressing `ENTER`.

ⓘ The setting only affects the values indicated on the screen.

The number of decimal places cannot be increased.

ⓘ The altered number of decimal places is shown on the screen after switching to measurement mode.

Number of Decimal Places When the screen displays the measured value in physical units (e.g. ppm) the number of places after the decimal point depends on the size of the set measuring span:

Span (in physical units)	≤ 5	> 5 to ≤ 50	> 50 to ≤ 500	> 500
Places after the decimal point	3	2	1	0

For the display of the measured value as a percentage of the whole measuring range (%Span) two places are always shown after the decimal point.

The number of decimal places when setting the parameters is the same as in the display in measuring mode.

Filter Initialization

Menu Path `MENU → Configure → Component specific → Filter → Select component → …`

Range 0–60 seconds

Procedure

Parameter	Explanation	Action
Linear Filter (Caldos25, Caldos27, Limas11, Magnos27, Uras26):		
`T90`	Time constant	Set
Non-linear Filter (Magnos206):		
`T90-1`	Time constant for constant measured value	Set
`T90-2`	Time constant for measured value changes	Set
`Threshold`	T90-2 applies to overshoot	Set

T90-2 should be adjusted ≤ T90-1 for the non-linear filter.

The switching threshold (in %) is generally based on the largest measurement range selected (reference measurement range).

Recommendation for
Magnos206 : T90-1 = 3 sec., T90-2 = 0 sec., Threshold = 0.1 %
Uras26 T90-1 = 5 sec., T90-2 = 0 sec., Threshold = 0.6 %

Auto-Range Initialization

Menu Path `MENU → Configure → Component specific → Autorange → Select component → …`

The automatic measurement range changeover only functions properly when the measurement ranges MB1, MB2, … have been configured in ascending order, i.e. MB1 < MB2 < … (see page 7-A-2).

Lower Threshold, Upper Threshold

On reaching the lower threshold value set here (as a percentage of the current measurement range scale), the analyzer module automatically switches to the next lower range.

On reaching the upper threshold value set here (as a percentage of the current measurement range scale), the analyzer module automatically switches to the next higher range.

The lower and upper threshold values should be selected so that the gas analyzer is not constantly switching between two measurement ranges (see the example below).

Assigned Measurement Ranges

The measurement ranges to be included for autoranging can be initialized. The number of measurement ranges available depends on the analyzer module.

The parameter cannot be selected if the analyzer module has only two measurement ranges since these are automatically included in the autoranging function.

Status

Autoranging can be off or on.

Example

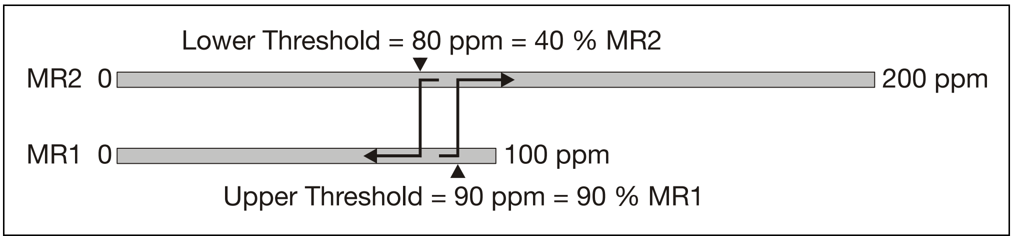
(see Figure 7-A-1)

Measurement Range 1: 0–100 ppm, Measurement Range 2: 0–200 ppm

Lower Threshold = 80 ppm = 40 % MR2, Upper Threshold = 90 ppm = 90 % MR1

Figure 7-A-1

Auto-Ranging



Procedure

Parameter	Range	Action
`Lower threshold`	`0…100%`	Set
`Upper threshold`	`0…100%`	Set
`Assigned ranges`	`MR1, MR2, MR3, MR4`	Select
`Status`	`on or off`	Select

Limit Value Monitor Initialization

Menu Path

`MENU → Configure → Component specific → Limit Values → Select Limit Monitor → …`

Selection

All available limit value monitors are shown.

Procedure

Parameter	Explanation	Action
`Direction`	< = Alarm on underflow threshold value > = Alarm on exceeding threshold value	Select
`Threshold`	in physical units	Set
`Hysteresis`	in physical units	Set

Standard Configuration

As a rule, limit value monitoring for those components to be measured by the gas analyzer is factory-set. This requires that there be enough digital outputs on the I/O modules to handle the number of sample components.

Note

Limit value monitors are factory-set or user-configured ***Limit Monitor*** *function blocks. Technical Bulletin "AO2000 Function Blocks – Descriptions and Configuration" (publication number 30/24-200 EN) contains complete information on the function block.*

Active Component Selection

Menu Path

`MENU → Configure → Component-Specific → Active Component`

Active Component

The “Active Component” parameter appears with the Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules.

Several sample components can be calibrated on these analyzer modules. However, there is always only one component measured and indicated.

Procedure

Select the active component with the arrow keys and press `ENTER` to confirm.

Subsequently, use the `Measurement range` menu item to select the range for the desired component.

The selected sample component and measurement range are shown on the screen after switching to measurement mode.

Changing Module Name

Menu Path `MENU → Configure → Component-specific → Module text`

Module Name The module name is shown in the display next to the module type. Here you can enter a name relating to the measuring point, for example.

Monolingual or Bilingual The module name can be entered independent of the language of the user instructions (see page 7-C-2) or separately for both languages.

Text Length The length of the text for the module name is:
- limited to 24 characters for a monolingual entry, and
- limited to two times 10 characters for a bilingual entry.

Entering the Module Name When entering the module name, use the same procedure as entering text (see page 6-9).

The changed module name is shown in the display after switching to measuring.

If the module name appears next to or under the module type depends on the configured size for displaying the measured quantity (see the "Display" section, page 7-D-1).

Section B Function Blocks

The Function Block Concept

What are function blocks?

Function blocks are small units of the processing software with a specific function. Information is taken in at the inputs, processed in specific ways and the results appear at the block outputs.

What are function blocks used for?

Function blocks are used for overall and specific configuration and initialization of gas analyzer functions.

Examples of Function Blocks

The following examples illustrate the operation of function blocks:

A **Limit value monitor** tracks a value to determine if it violates limit values and passes the result to a digital output.

A **Digital input** places a signal at a (hardware) digital input for subsequent processing in other function blocks.

An **Add** function block combines the signals at its two inputs and places the total at its output.

A **Fan** splits an input signal into several output signals.

A **Component measurement value** outputs the measurement signal from an analyzer module for subsequent processing in other function blocks.

Application = Function Block Linking

A function block is linked to other function blocks via its inputs and outputs.
A sequence of interlinked function blocks forms an application in the gas analyzer.

Various function blocks are factory-linked to other function blocks to make applications (see the “Standard Configuration” section, page 7-B-2).

Function Block Initialization

Various specific parameters, in addition to input and output linking, determine the functionality of a block.

The as-delivered gas analyzer has standard values assigned to these parameters. These standard values can be accepted or reprogrammed.

Password

The level 3 password must be entered in order to configure an application. Make sure that existing application configurations and links are not damaged or deleted when configuring.

Complete Information

Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (publication number 30/24-200 EN) contains complete information on the “Function Block” concept as well as detailed descriptions of the individual function blocks.

Standard Configuration

Standard Configuration

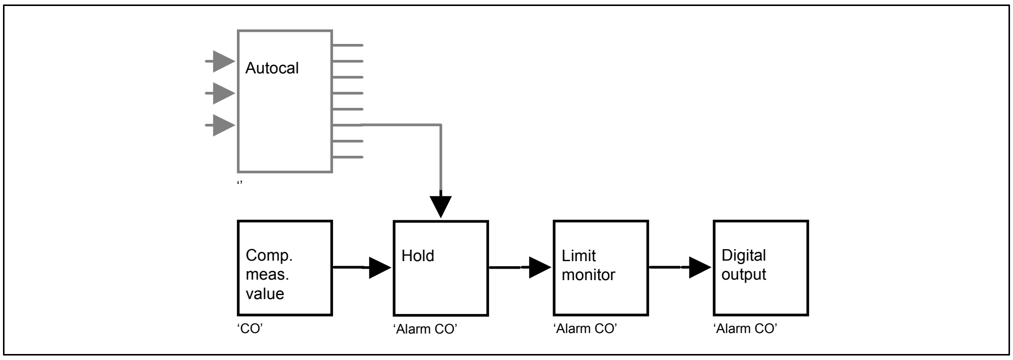
Various applications are factory-configured. These standard configurations are based on
- Standard input/output pin configuration
- The available sample components

Some factory-configured applications require field linking of additional function blocks.

Example: Limit Value Monitoring

The limit value monitoring application (see Figure 7-B-1) consists of a factory-configured link between the **Component measurement value, Hold, Limit monitor** and **Digital output** function blocks.

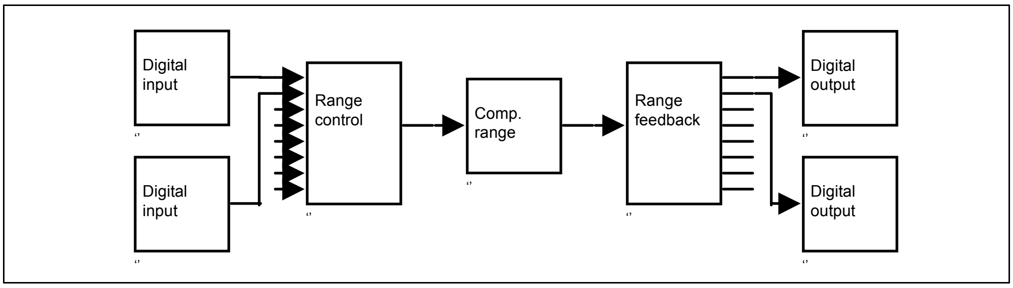
Figure 7-B-1



Example: Measurement Range Switching/Feedback

The measurement range switching/feedback application (see Figure 7-B-2) consists of a factory-configured linkage between
- A **Range control** function block with several **Digital input** function blocks and a **Component range** function block, as well as
- a **Range feedback** function block with the **Component range** function block and several **Digital output** function blocks.

Figure 7-B-2



Menu
- Calibrate
- **Configure**
  - Component specific
  - Calibration data
  - **Function blocks**
    - **Miscellaneous**
      - Limit monitor
      - Hold
      - Feedback
      - Timer
      - Seqencer
      - Access lock
    - **Inputs**
      - Digital input
      - Analog input
      - Message input
      - Constant
    - **Outputs**
      - Digital output
      - Analog output
      - Message insert
    - **Mathematics**
      - Negate
      - Add
      - Subtract
      - Multiply
      - Divide
      - Or
      - And
      - Linear converter
    - **Mulitplexer/Demultiplexer**
      - Fan
      - Multiplexer
      - Demultiplexer
      - Priority encoder
      - Priority decoder
      - Binary –> Decimal
      - Decimal –> Binary
    - **Measurement**
      - Comp. meas. value
      - Det. meas. value
      - Comp. range
      - Range control
      - Range feedback
      - Active component MUX
    - **Sample system**
      - Calibration cell
      - Solenoid
      - System pump
      - Pump
    - **Calibration/Correction**
      - Autocal
      - Ext. controlled cal.
      - Cross sens. corr.
      - Carrier gas corr.

Setting the Time Zone, Date and Time

Menu Path

`MENU → Configure → System → Date/Time`

Procedure

Parameter	Explanation
`Time zone`	The time zone can be selected either from the GMT (Greenwich Mean Time) values or from the continent/country/city list.
`Date`	Date must be entered in month/day/year format. Enter year with 4 digits.
`Time`	Time must be entered in hour:minute:second format. Enter seconds, too.

Daylight Savings Time

The gas analyzer is automatically set to daylight savings time.

Note: This applies only when the time zone has been selected from the continent/country/city list and not from the GMT values list.

Factory Setting

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

Accept the Time Settings

Press the softkey `SET TIME` to accept the modified time settings.

Selecting User Interface Language

Menu Path `MENU → Configure → System → Language`

Language Selection

Two user interface languages are factory-configured (per order) in the gas analyzer. In the menu item `Language` the user can switch between these two languages.

Other Languages

Other user interface languages can be loaded into the gas analyzer using the AO-SMT Software Migration Tool. AO-SMT can be found on the CD-ROM which is delivered with the gas analyzer.

These language pairs are available:

- English – German
- English – French
- English – Italian
- English – Dutch
- English – Spanish
- English – Brazilian
- German – Dutch

Changing the Password

Menu Path `MENU → Configure → System → Change password`

Password Protection See Chapter 6 “Gas Analyzer Operation” for basic information on “Password Protection”.

Factory Setting

User group	Access to Password levels	Password
Every user	0	None
Maintenance team	0, 1	471100
Specialist team	0, 1, 2	081500
Function block specialist	0, 1, 2, 3	325465

Procedure Select the `Change password` menu item, select the user group, enter the old password, enter the new password (6 digits), re-enter the new password, leave the menu item with **Back**.

Password level 0 is not displayed in the `Change password` menu item.

CAUTION!

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

Inhibit Operation

Menu Path

MENU → Configure → System → Change password

Inhibit Operation

Operation of the gas analyzer, i.e. entering the main menu and thus switching to the menu mode, can be password protected.

After inhibition the gas analyzer can only be operated when the level 1 password has been entered.

The level 3 password must be entered to configure the password protection.

Procedure

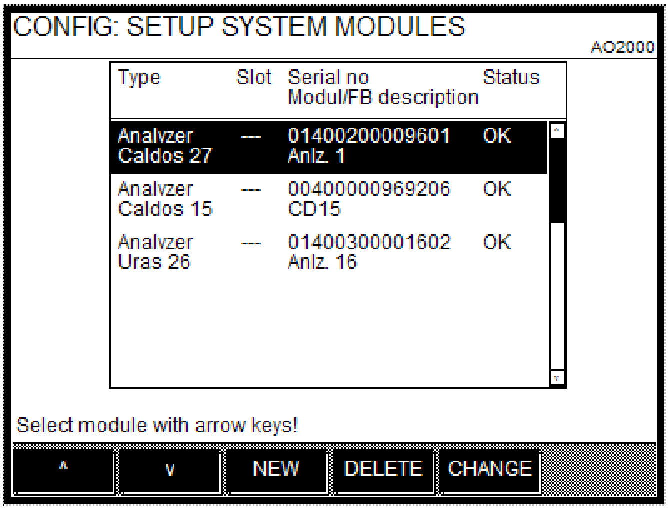
Press the MENU ACCESS softkey in the “Change password” menu item and set the password protection.

Setting Up System Modules

Menu Path `MENU → Configure → System → Setup system modules`

Figure 7-C-1

Setting Up System Modules



Function

If system modules are added to a gas analyzer, replaced (changed) or removed, this modification must be configured in the software.

Definition

System modules are

- Analyzer modules:
  Uras26, Limas11, Magnos206, Magnos27, Caldos25, Caldos27, MultiFID14, ZO23
- I/O modules:
  Profibus, Modbus, 2-way analog output, 4-way analog output, 4-way analog input, digital I/O
- External I/O devices:
  e.g. cooler I/O board.

Analyzer Modules and External I/O Devices

Analyzer modules and external I/O devices are connected to the system controller via the system bus. They must be identified by their serial number (see below) in order to be recognized by the gas analyzer.

I/O Modules

I/O modules are plugged onto and directly connected with the system controller. They have no serial numbers.

An I/O module is automatically recognized by the gas analyzer when it is added for the first time or as replacement for an already existing I/O module.

Continued on next page

Serial Number

The 14-digit serial number is found in the analyzer data sheet and on a label affixed to the module, generally on the CPU board. The serial number contains the following information (for example):

`0 1 4 0 0 0 0 0 0 1 2 3 0 1`

- Module serial number
- Module type:
  - 014 Analyzer Module
  - 004 Analyzer Module
  - 006 Cooler I/O Board [1)]
  - 008 LS25 Laser Analyzer Module

1) installed in the SCC-F Sample Gas Feed Unit as an option

Function Block Applications

When setting up the digital I/O module, a function block application must be configured. It is also possible to assign another function block application to this system module during operation. The standard function block applications with the respective connection layouts of the module are listed on page 4-8.

Unknown System Module

There are several reasons for a system module to have an `Unknown` status in the `Setup system modules` menu item:

Cause	Corrective Action
The system module was not found after the power supply was turned on (status message no. 201).	Reestablish the system bus connection to the system module and press the **RESTART** softkey.
The system bus connection to the system module is broken (status message no. 209).	Reestablish the system bus connection to the system module and press the **RESTART** softkey.
The system module serial number was entered incorrectly.	Press the **CHANGE** softkey and correct the serial number.

Automatic calibration of an analyzer module is not possible during setting up system modules.

Adding a System Module

- If no system module is configured or an added system module is not yet configured in a gas analyzer, the `NEW` softkey will appear on the screen. Press this softkey to go directly to the `Setup System Modules` menu.
- The procedure for adding an analyzer module and an external I/O device differs from the procedure for adding an I/O module (see the following instructions).

Adding a New Analyzer Module or a New I/O Device

Step	Action
1	Select the **`Set Up System Modules`** menu item. The list of the system modules existing in the system is displayed.
2	Press the **`NEW`** softkey.
3	Enter the 14-digit serial number for the new system module.
4	In the list the new system module will be shown with a `New` status.
5	Save the configuration change by pressing **`ENTER`** or discard it by pressing **Back.**

Adding a New I/O Module

Step	Action
1	Select the **`Set Up System Modules`** menu item. The list of the system modules existing in the system is displayed.
2	Select the I/O module which has been added and automatically recognized by the gas analyzer and press the **`NEW`** softkey.
3	When adding a digital I/O module: Press the **`FB APPL.`** softkey and select a function block application.
4	In the list the new system module will be shown with a `New` status.
5	Save the configuration change by pressing **`ENTER`** or discard it by pressing **Back.**

When retrofitting a Profibus module, it must always be installed in the lowest slot X20/X21.

Replacing a System Module

Removing and Reinstalling an Existing System Module

As a rule, when an existing system module is removed and reinstalled (e.g. after a repair) it does not require any setup.

When the system module is reconnected to the system bus it is automatically recognized and its configuration is automatically stored. For automatic recognition to take place the gas analyzer must be in measurement mode.

CAUTION!

When an existing system module is replaced with another system module the function “DELETE” should not be used to delete the old system module. This function would irretrievably delete the parameter settings and function block configuration of the old system module!

In order to preserve the parameter settings and function block configuration of the old system module when replacing a system module, the function “CHANGE” must be used.

- The type and configuration of the new system module must match the characteristics of the old system module.
- When an existing I/O module has been replaced with an I/O module of the same type, the new I/O module is automatically recognized by the gas analyzer and its configuration is not necessary.

Replacing an Existing System Module (Analyzer Module or I/O Device) with Another System Module

Step	Action
1	Select the **`Set Up System Modules`** menu item. The list of the system modules existing in the system is displayed.
2	Select the system module (analyzer module or I/O device) to be replaced and reconfigured. In the list this system module will be shown with an `Unknown` or `Error` status.
3	Press the **`CHANGE`** softkey. ⚠ Do not press the `DELETE` softkey! This will irretrievably remove the system module’s parameter settings and function block configuration!
4	Enter the 14-digit serial number for the new system module.
5	In the list the new system module will now be shown with a `Replaced` status.
6	Save the configuration change by pressing **`ENTER`** or discard it by pressing **Back.**

Removing a System Module

Sequence when Removing System Modules

When removing system modules from the gas analyzer proceed according to the following sequence:

1. Remove the system module in the software (see below for instructions)
2. Dismount the system module from the gas analyzer.

Removing an Installed System Module without a Replacement

Step	Action
1	Select the **`Set Up System Modules`** menu item. The list of the system modules existing in the system is displayed.
2	Select the system module to be removed (and not replaced).
3	Press the **`DELETE`** softkey. ⚠ This will irretrievably remove the system module's parameter settings and function block configuration!
4	In the list the deleted system module's status will change to `Deleted`.
5	Save the configuration change by pressing **`ENTER`** or discard it by pressing **Back.**

Saving the Configuration

Menu Path `MENU → Configure → System → Save configuration`

Automatic Saving

The database containing the configuration data and logbook recordings is automatically saved in two configuration files.

The database is saved at the time when parameters have been changed in the menu mode. Saving takes place either when the user deactivates an entered password by pressing the “Meas” key twice or when the gas analyzer automatically reverts to measurement mode by “time-out”.

When the gas analyzer is booting the last saved valid configuration file is loaded.

Manual Saving

The database can also be saved manually, e.g. to buffer a large function block configuration.

Backup

In addition to automatic and manual saving of the configuration a backup of the current configuration can be saved in a separate memory area. It can be loaded e.g. to reset the gas analyzer to a well-defined state.

Using the software tool “SMT light” it is possible to save a backup of the current configuration on a separate storage medium. “SMT light” can be found on the CD-ROM “Software Tools and Technical Documentation” which is delivered together with the gas analyzer.

Configuring Status Signals

Menu Path `MENU → Configure → System → Status signals`

Function

The status signal configuration is set at the factory per the customer's order.

Generally this configuration does not have to be changed in the field.

Selection

The following signals are available:
- Individual status signals, i.e. Error, Maintenance Request and Maintenance Mode
- Overall status signal

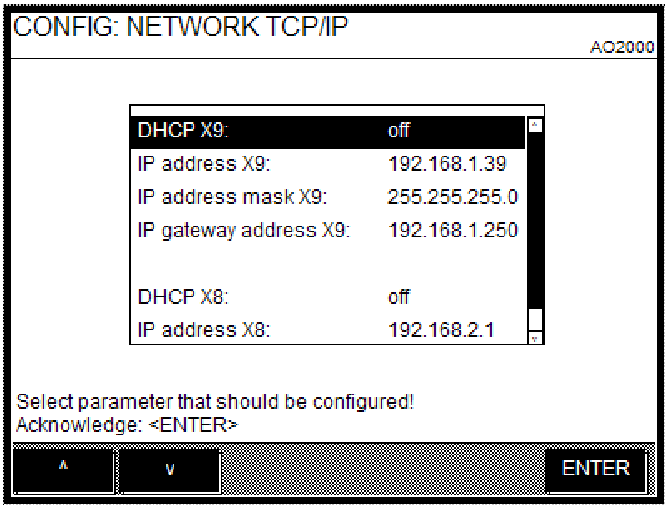
- If the status signal configuration is changed from "overall status signal" to "individual status signal", the digital outputs DO2 and DO3 of the standard function block application "status signals/externally controlled calibration" which possibly are assigned to limit value signals will be overwritten with single status signals.
- For further information on status signals, see the "System Status: Status Signals" section, page 10-4.

Menu Path

`MENU → Configure → System → Network → TCP/IP Network`

Figure 7-C-2

TCP/IP Configuration



Function

Both Ethernet 10/100/1000BASE-T interfaces can be used to link the gas analyzer to an Ethernet network (with TCP/IP protocol).

The first Ethernet interface is referred to as X9 and the second one as X8.

Parameters

The parameters to be set depend on the DHCP (Dynamic Host Configuration Protocol) setting:

DHCP on: Device name (max. 20 characters, no blanks and special characters),
DHCP off: IP address, IP address mask und IP gateway address.

Addresses

IP address, IP address mask and IP gateway address should be obtained from the network administrator.

- Addresses of TCP/IP classes D and E are not supported.
- The address bits that can be varied in the address mask cannot all be set to 0 or 1 (broadcast addresses).

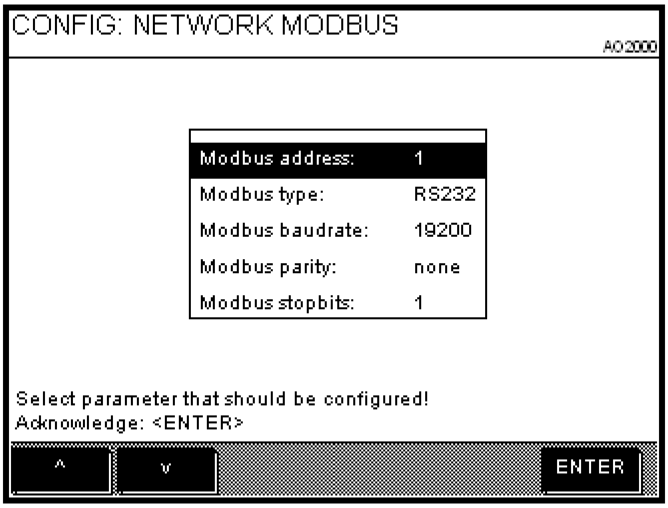
Note

The IP address must not be mistaken for the Ethernet hardware address (or MAC address). The world-wide unique 12-digit MAC address is stored on each network board by the manufacturer. It is termed Ethernet address in the AO2000 series gas analyzers and can be viewed in the `Diagnostics/Information → System overview → SYSCON` *menu item.*

Menu Path `MENU → Configure → System → Network → Modbus`

Figure 7-C-3

Modbus Configuration



Function

The gas analyzer can be connected to a network with Modbus protocol via the RS232 or the RS485 interface.

The RS232/RS485 module must be installed in the gas analyzer. Only then the `Modbus` menu item is displayed.

Parameters

The gas analyzer supports the Modbus slave protocol with RTU (remote terminal unit) mode. The Modbus access interval should be >500 ms.

The `Modbus address` can be set in the 1-255 range.

For `Modbus type`, select the interface which connects the gas analyzer to the Modbus network (RS232 or RS485).

The data transfer default settings are shown in Figure 7-C-3.

For additional Modbus information see the “AO2000 Modbus and AO-MDDE” technical bulletin (Publication No. 30/24-316 EN).

Configuring Profibus

Menu Path `MENU → Configure → System → Network → Profibus`

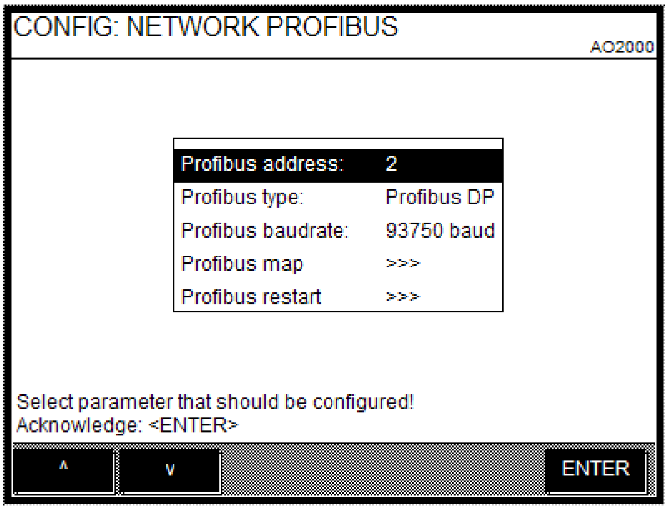


Figure 7-C-4

Profibus Configuration

Parameter	Selection	
`Profibus address`	1 to 126	
`Profibus type`	Profibus DP	Connection to the RS485 interface
	Profibus PA	Connection to the MBP interface (non-intrinsically safe)
`Profibus baudrate`	RS485 interface	automatically, 9600 Baud, 19200 Baud, 93750 Baud, 187.5 KBaud, 500 KBaud, 1500 KBaud, 3000 KBaud, 6000 KBaud
	MBP interface	set to 31250 Baud
`Profibus map`	Profibus inputs	Measured values, Bus analog outputs, Analog inputs, Analog outputs, Digital inputs, Bus digital outputs, Digital outputs
	Profibus outputs	Bus analog inputs, Bus digital inputs
`Profibus restart`	Warm start	With Warm start the Profibus stack is reset, comparable with a power off/on.
	Cold start	With Cold start, all the parameters which are stored in the Profibus stack as store parameters are reset to the default value.

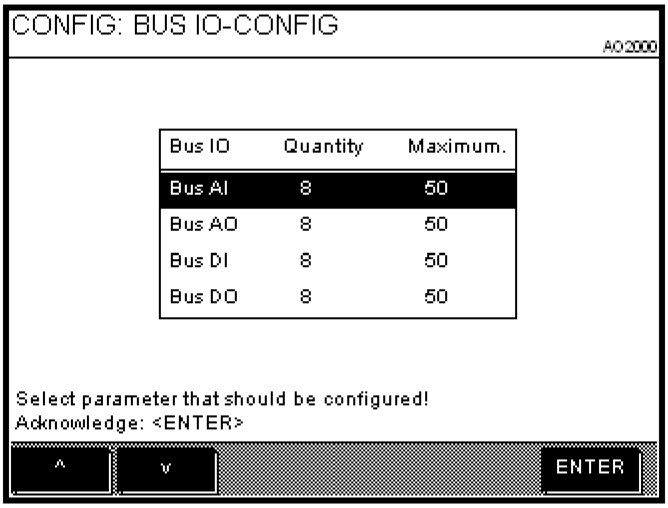
ℹ For additional Profibus information see the "AO2000 Profibus DP/PA Interface" technical bulletin (Publication No. 30/24-315 EN).

Configuring Bus I/Os

Menu Path `MENU → Configure → System → Network → BUS IO`

Figure 7-C-5

Bus I/O Configuration



Number of Bus I/Os

Changing the number of Bus I/Os will affect the Modbus address range, Profibus image and Ethernet linking.

Reducing the number of Bus I/Os may cause transmission errors if the settings in the communication partners are not matched. This may also cause damage in the function block applications.

Parameter	Function	Read	Write	Example
`BUS AI`	Bus analog inputs	x	x	for analog value input into the function block application
`BUS AO`	Bus analog outputs	x	–	for analog value output from the function block application
`BUS DI`	Bus digital inputs	x	x	for control of functions such as auto calibration, measurement range control after function block configuration
`BUS DO`	Bus digital outputs	x	–	for display of functions linked by function block configuration, e.g. alarm signaling

Section D Display

Display Features

The display can be configured

In measurement mode the gas analyzer screen is freely configurable. A standard layout is configured on each delivered unit (see below).

Display Elements

Display elements are:

- the default measured values in the analysis system (measured quantities, auxiliary quantities, current outputs and current inputs), and
- freely configured displays of measured quantities as well as value entries or key entries.

“Pages”

The screen is divided into “pages”, i.e. the values present in the system are summarized on pages. Up to six measurement values can be displayed per page.

The pages brought up when scrolling with the >> softkey can be configured.

A value can only be displayed on a single page.

System Pages (Standard Layout)

The gas analyzer normally displays its measured values in a fixed sequence on the various screen pages. This also holds true for the measured quantities of system modules that were added by the user (see “Setting Up System Modules“ section, page 7-C-5).

Since up to six values can be displayed on a page, the number of system pages depends on the number of values.

The user cannot delete system pages.

The following table shows the standard system page layout in a gas analyzer with no more than six sample components and variables each.

Page	Standard Layout	On/Off
1	Sample component measurement values in physical units	On
2	Sample component measurement values in %Span	On
3	Current signals at the analog outputs	On
4	Variable measurement values (e.g. flow, temperature, pressure) in physical units	Off
5	Sample component measurement values in %MRS	Off
6	Current signals at the analog inputs (if available)	On

User Pages

In addition to the system pages the user can set up so-called user pages (see page 7-D-6).

Continued on next page

Function Blocks as Sources

The values of all the function blocks in the system can be configured as a source for the display. The source of the display of value entries or key entries is also a function block that was created when configuring the display elements. The display of the function block value is independent of the other links of the function block.

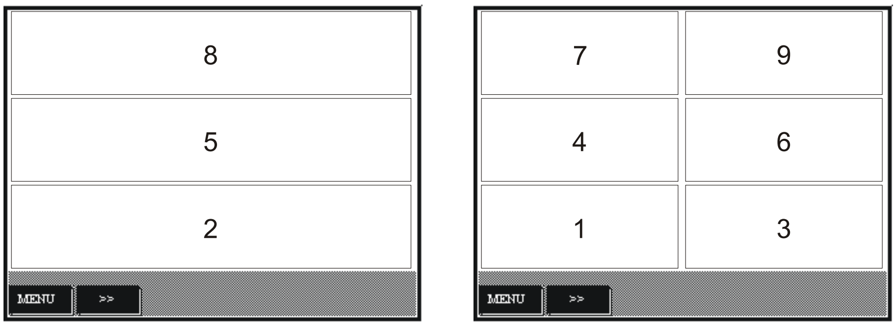
Note: All measuring components, auxiliary quantities, current outputs and current inputs exist as function blocks in the system, i.e., all of these measured quantities are displays of function blocks in the system.

Display Element Positioning on the Screen

The display elements can be represented in two sizes. A maximum of three large and six small display elements can be represented on a page. Large and small display elements can be mixed with each other. The positions are numbered as shown in Figure 7-D-1. The numbering of the positions corresponds to the arrangement of the number keys next to the display.

Figure 7-D-1

Position Numbering

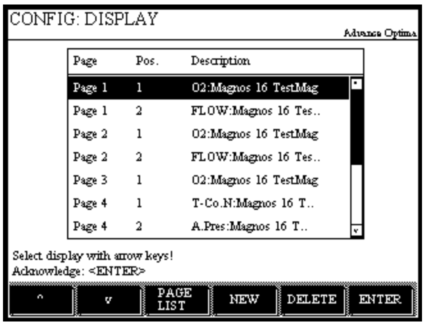


Views

The following views are available for screen configuration:
- Display overview (see page 7-D-3)
- Page overview (see page 7-D-4)
- Parameter overview (see page 7-D-5)

Figure 7-D-2

Display Overview



Explanations The screen overview contains the following information:

Page Name of page on which the value is displayed

Pos. Position of the value on the page (see Figure 7-D-1)

Description Name of the value

Softkeys in the Screen Overview The screen overview softkeys have the following functions:

PAGE LIST — The PAGE LIST softkey calls up the page overview (see page 7-D-4).

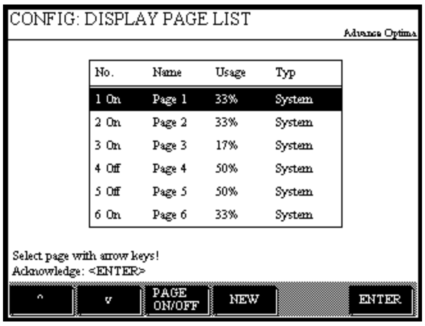
NEW — The NEW softkey starts the configuration of a new value, e.g.
- Bar display or point display (see page 7-D-9)
- Value entry (see page 7-D-11)
- Key entry (see page 7-D-13)

DELETE — The DELETE softkey deletes the value selected by the user.

ENTER — The ENTER softkey calls up the parameter overview for the values selected (see page 7-D-5).

Figure 7-D-3

Page Overview



Explanations The page overview contains the following information:

No. Page number and status ("On" or "Off")

Name Name of the page

Assignment Page Assignment

Type System: Pages configured by system with standard layout
User: Pages configured by user

Softkeys in the Page Overview The page overview softkeys have the following functions:

PAGE ON/OFF — The PAGE ON/OFF softkey toggles the selected screen page on or off.

NEW — The NEW softkey starts the configuration of a new (user) page (see page 7-D-6).

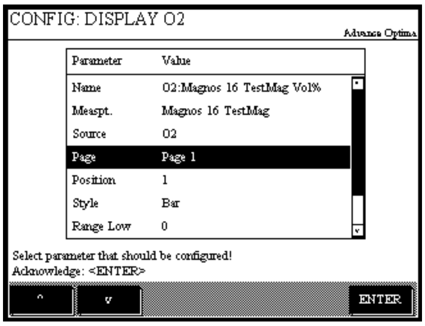
DELETE — The DELETE softkey deletes the page selected by the user. Only empty "user" pages can be deleted.

ENTER — The ENTER softkey allows the user to input text to change the name of the selected page.

Back — The "Back" key returns the user to the display overview (see page 7-D-3).

Figure 7-D-4

Parameter Overview



Explanations The display parameters have the following functions:

`Name` The `Name` of the display element is set by the system and cannot be changed.

`Measuring point` The description entered for the `Measuring point` appears over the display element during measurement operation. The description is set by the system; it can be changed for the user-configured display elements. The maximum length is 20 characters.

`Source` The `Source` of the display elements is always a function block. The source cannot be changed for the display elements of the default assignment, i.e. the measured quantities, and for the key entries.

`Page` The parameter `Page` indicates the page on which the display element is shown. Each display element can be moved to any system or user page.

`Position` The `Position` of a display element on a system page is determined by the system. It can be changed by being exchanged with another display element.

The user can freely configure the position on a user page.

`Style` The `Style` of display depends on the source type. The following display styles exist: bar display, point display, value entry and key entry.

Examples of the different display styles are shown as soon as this parameter is selected.

The value entry and key entry display styles are explained in greater detail on pages 7-D-10 and 7-D-12.

`Range Low`, `Range High` The `Range Low` and `Range High` parameters determine the measurement range of the bar display and the point display. They cannot be changed for the display elements of the default assignment, i.e., the measured quantities.

`Places` The `Places` parameter determines the number of decimal places for the digital display of the measured values for the bar display and point display. It cannot be changed for the display elements of the default assignment, i.e., the measured quantities.

User Page Configuration

Step	Action
1	Select the `Display` menu item.
2	Call up the page overview.
3	Start configuring a new page with `NEW`.
4	Either: Enter the page name. The page overview is displayed. Or: Go directly to the page overview. In this case the system assigns the name “Page #” where # = page number.
5	The new page will appear in the page overview: No. Assigned by the system, status “on” Name: Enter as in step 4 Usage: 0% (no values) Type: User

Moving a Display Element from One Page to Another

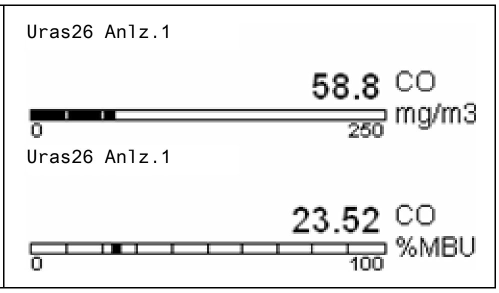
Step	Action
1	Select the menu item `Display`.
2	Select the display element in the display overview.
3	Select the parameter `Page`.
4	In the displayed page overview, select the target page. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position.
5	In the displayed parameter overview of the display element, the new page and new position are displayed. If the new page is a: system page, the display element is located in the first free position. user page, the display element is located in the same position as the old page, or if this is already taken, in position 8. If this is taken, the display element cannot be moved (display ––––).
6	If the new page is a user page and other positions are free, the position of the display element can be changed. Select the parameter `Position`. The nine possible positions are graphically represented; free positions are identified with the position number. Select the desired position with the corresponding number key.
7	Switch to measuring. The display element is now shown on the new page.

Moving a Display Element Within a Page

Step	Action
1	Select menu item **Display**.
2	Select the display element in the display overview.
3	Select the parameter **Position**. The nine possible positions are graphically represented.
4	If the display element is on a: system page, its position can only be exchanged with that of another display element (the softkey Swap Display is pressed.) user page, Its position can either be exchanged with that of another display element (the softkey Swap Display is pressed), or it can be moved to a free position (the softkey Swap Display is not pressed). Select the desired position with the corresponding number key.
5	Switch to measuring. The display element is now displayed at the new position.

Configuring the Bar Display or Point Display

Step	Action
1	Select menu item `Display`.
2	Start configuring the new display element with `NEW`.
3	Select the parameter `Source`. The function block menu is displayed.
4	Select the function block whose value is displayed. When configuring the display, it does not matter if a link has been entered for the function block.
5	For the parameters `Name`, `Measuring point` and `Source`, the system default values are displayed. The parameter `Name` cannot be changed.
6	Select the parameter `Page`. The page overview is displayed.
7	Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e. in which there is at least one free position. If the selected page is a: system page, the position of the display element is set by the system; it can only be changed using `Swap Display` (see page 7-D-8). user page, the position must be configured.
8	Select the parameter `Position`. The nine possible positions are graphically represented; free positions are identified with the position number.
9	Select the position with the corresponding number key.
10	Select the parameter `Type`.

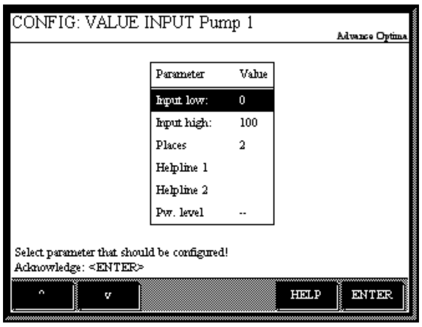
11	Select the display type:
	`Bar graph`
	`Point graph`
	

12	Set the parameters `Range Low`, `Range High` and `Places`. If necessary, change the description of the display element in the parameter `Measuring Point`.
13	Switch to measuring. The newly configured display element is now shown in the display. The description of the display element is shown above the display. Shown to the right of the display are the name and unit of the function block selected in Step 4. These two parameters can be changed by configuring the function block.

Value Entry

Figure 7-D-5

Configuring the Value Entry



Description

The source of the display element `Value Entry` is the function block **Constant** that is automatically generated during configuration. The output of this function block accepts the entered value.

For the entered value to be effective, the generated function block must be linked to a function block application after configuring the display (for details, see the technical information “AO2000 Function Blocks – Descriptions and Configuration” (document No. 30/24-200 EN)).

Configuration

The following are to be configured for the display element `Value Entry` (see page 7-D-11):

- the start and end of the entry range,
- the number of decimal places in the display,
- two lines of text that are displayed when the display element is used, and
- the password level on which the entry value can be changed.

Use

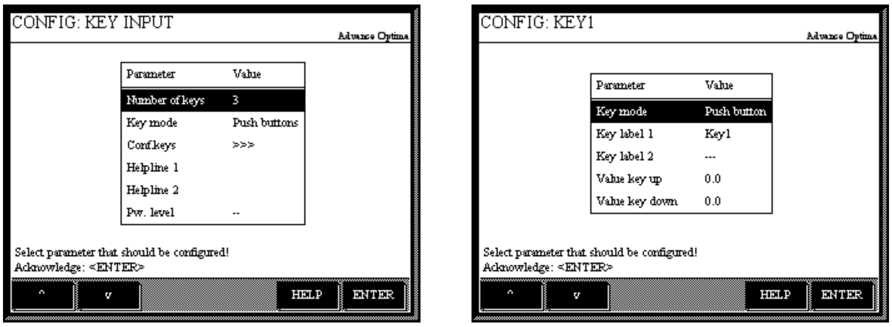
Values are entered during measurement by pressing the number key that corresponds to the position of the display element in the display and is indicated above the display element. A field then appears for entering the value (see “Operating by Value Entry” section, page 6-10). The display element `Value Entry` accordingly represents a response to the actual value entry.

Configuring Value Entries

Step	Action
1	Select the menu item **Display**.
2	Start configuring the new display element with **NEW**.
3	Select the parameter **Page**. The page overview is displayed.
4	Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e., in which there is at least one free position. If the selected page is a: system page, the position of the display element is set by the system; it can only be changed using Swap Display (see page 7-D-8). user page, the position must be configured.
5	Select the parameter **Position**. The nine possible positions are graphically represented; free positions are identified by the position number.
6	Select the position with the corresponding number key.
7	Select the parameter **Type**.
8	Select display type **Value entry**. This creates a **constant** function block whose system-issued name, 'Value page-position', is displayed in the parameter Source. This name cannot be changed here; it can only be changed by configuring the function block (see Step 11).
9	Select the parameter **Config entry** and configure the other parameters: entry range, decimal places, text and access level.
10	Enter the description of the display element in the parameter **Measuring point**.
11	Select the function block created in Step 8, enter the name and unit, and link the function block to an application via its output 1 (for details, see technical information "AO2000 Function Blocks – Descriptions and Configuring" (document No. 30/24-200 DE)).
12	Switch to measuring. The newly configured display element is now shown in the display. The description of the display element is shown above the display. To the right of the display, the name and unit of the function block are displayed that were entered in Step 11.

Figure 7-D-6

Configuring the Key Entry



Description

The source of the display element `Key Entry` is one or more **Constant** function blocks that is automatically generated during configuration. Upon “actuation”, the output of this function block assumes the value that was established during configuration.

For the entered value to be effective, the generated function blocks must be linked to a function block application after configuring the display (for details, see the technical information “AO2000 Function Blocks – Descriptions and Configuration” (document No. 30/24-200 EN)).

Configuration

The following are to be configured for the display element `Key Entry` (see page 7-D-13)

- the number of keys (1 to 6) – the keys are assigned to the softkeys,
- the key type
  - key or
  - switch or
  - option key,
- the parameters for each key
  - label,
  - value key released, and
  - value key pressed,
- two lines of text that are displayed when the display element is used, and
- the password level on which the keys can be used.

Use

Key entries are made during measurement by pressing the number key that corresponds to the position of the display element on the display and is indicated above the display element. A softkey line then appears with the configured keys (see “Operating by Key Entry” section, page 6-11). The display element `Key Entry` accordingly represents a response to the actual key entry.

Configuring Key Entries

Step	Action
1	Select the menu item `Display`.
2	Start configuration of the new display element with `NEW`.
3	Select the parameter `Page`. The page overview is displayed.
4	Select the page on which the display element is to be displayed. Only those pages can be selected with an assignment < 100 %, i.e., in which there is at least one free position. If the selected page is a: system page, the position of the display element is set by the system; it can only be changed using `Swap Display` (see page 7-D-8). user page, the position must be configured.
5	Select the parameter `Position`. The nine possible positions are graphically represented; free positions are identified with the position number.
6	Select the position with the corresponding number key.
7	Select the parameter `Type`.
8	Select the display type `Key entry`. A single function block, **constant,** is created whose system-default name, 'Value page-position', is displayed in the parameter `Source`. This name does not appear in the display. If necessary, it can be changed by configuring the function block (see Step 11).
9	Select the parameter `Config keys` and configure the other parameters: key number, key type, label, value released/pressed, text and access level. If all the keys are configured individually, a separate **constant** function block is created for each key.
10	The description of the display element is entered in the parameter `Measuring point`.
11	Select each of the function blocks created in Steps 8 and 9 and link to an application with its output 1 (for details, see technical information "AO2000 Function Blocks – Descriptions and Configuration" (document No. 30/24-200 EN)).
12	Switch to measuring. The newly configured display element is now shown in the display. The description of the display element is shown above the display.

Example: Entering and Displaying the Pump Output

Configuring and Using a Value Entry

The configuration and use of a value entry will be explained using the following example of entering and displaying the pump output.

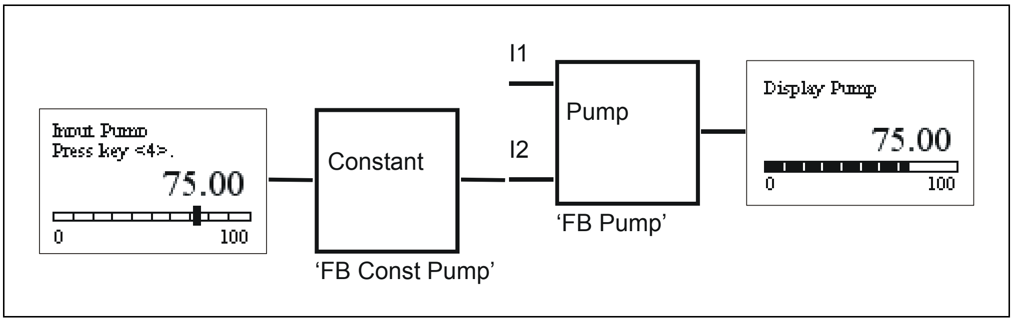
Figure 7-D-7 shows the function block configuration that results from the configuration of the example. It consists of the function block 'FB Const Pump' that is created when configuring the display element "Input Pump", and the function block 'FB Pump' that is the system default.

Figures 7-D-8 to 7-D-10 show the parameters of the display elements and function blocks.

Figure 7-D-11 shows the results of the configuration example in the display on the left, and the field for entering the value on the right; This is retrieved by pressing key 4 during measurement (see "Operating by Value Entry" section, page 6-10).

Figure 7-D-7

Function Block Configuration



Configuring Value Entry

Step	Action
1	Configure the display element for the pump output entry (see Figure 7-D-8). The source is the function block 'FB Const Pump'.
2	Configure the display element for the bar display of the pump output (see Figure 7-D-9). The source is the function block 'FB Pump'.
3	Link output 1 of the function block 'FB Const Pump' to input I2: Speed of the function block 'FB Pump' (see Figure 7-D-10).

Continued on next page

Figure 7-D-8

Configuring Value Entries

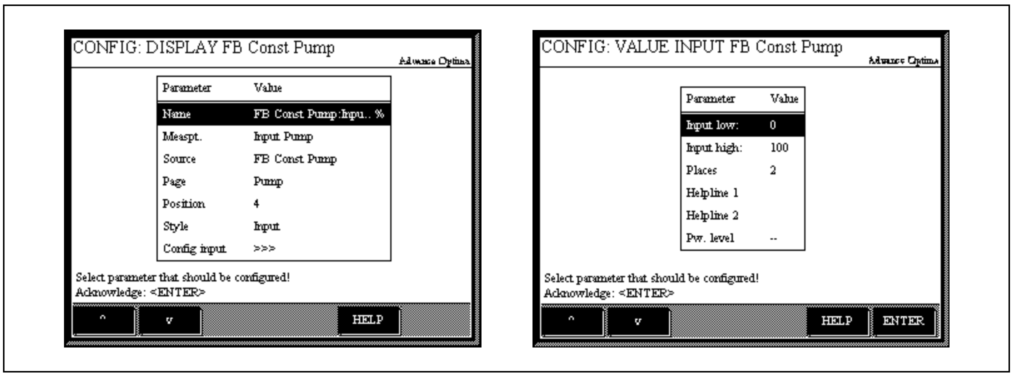


Figure 7-D-9

Configuring Bar Display

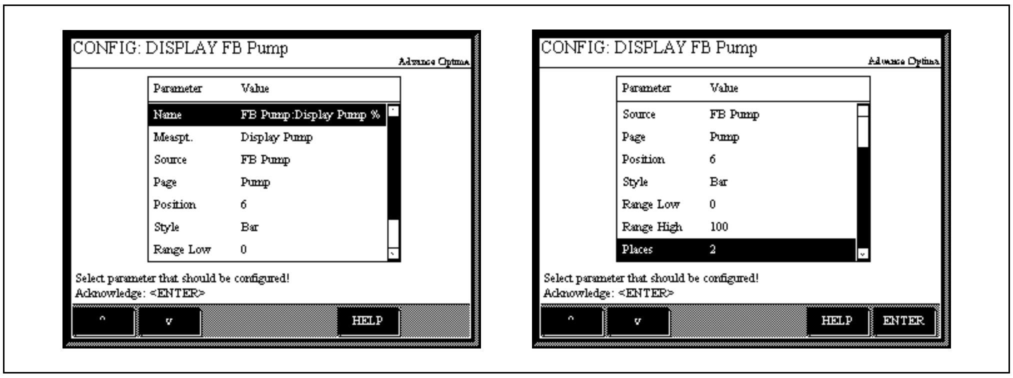


Figure 7-D-10

Linking Function Blocks

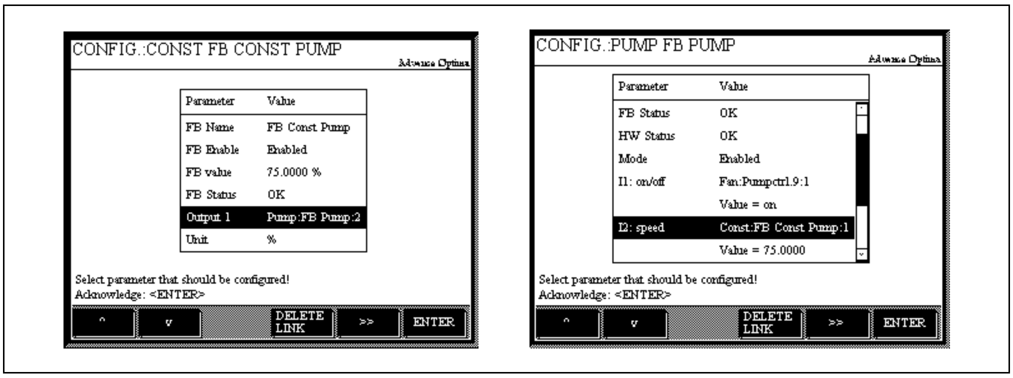
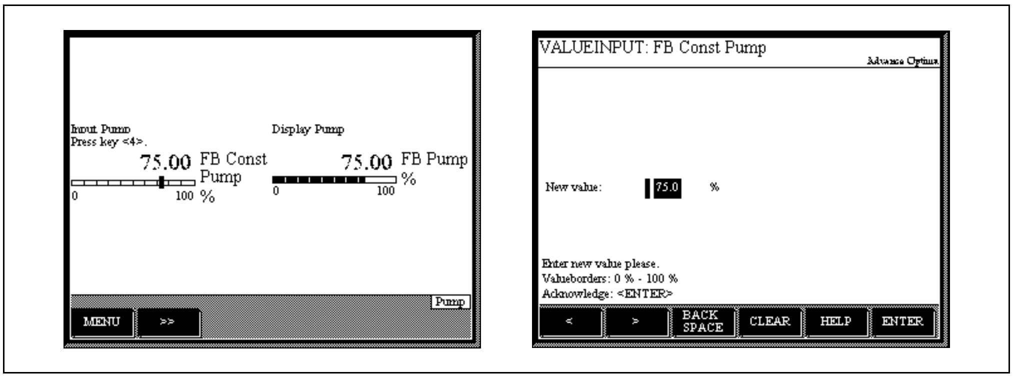


Figure 7-D-11

Left: **Display with Elements: "Value Entry" and "Bar Display"**

Right: **Value Entry**



Chapter 8 Gas Analyzer Calibration

Section A Principles

Calibration Control

Calibration Control

Depending on the gas analyzer version and equipment, there are three methods for controlling calibration:

- Manual calibration
- Automatic calibration
- Externally controlled calibration

All analyzer modules can be calibrated using any of the three methods.
See Section C, “Notes for Calibrating Analyzer Modules” for details.

Calibration Start

- Manual calibration is started manually via the gas analyzer’s display and control unit.
- Automatic calibration is started at time intervals determined by the internal clock or by an external control signal or manually via the gas analyzer’s display and control unit.
- Externally controlled calibration is triggered by an external control signal.

Warm-up Phase

Calibration should only be started after the warm-up phase.

Analyzer Module	Warm-Up Phase Duration
Caldos25	1.5 hours
Caldos27	Approx. 30/60 minutes for class 1/2 measurement ranges [1)]
Limas11	Approx. 2.5 hours
Magnos206	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx 0.5/2 hours without/with thermostat

Plausibility Test in Calibration

If during calibration the gas analyzer finds implausible values (e.g. if the span and zero values are equal), calibration is stopped and an error message is generated. The values stored after the last calibration remain in effect.

Status Signal

The “Maintenance Mode” status signal is set during calibration.

Definition

Manual calibration means:

Zero and span are calibrated separately by pressing the gas analyzer display and control unit softkeys.

Test Gas Supply

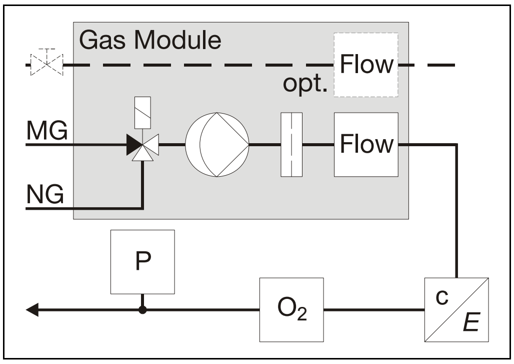
The test gas supply can be started by activating a multiple path valve.

If the analyzer module is assigned to a gas module and the gas module is fitted with a single solenoid valve to control the test gas supply (see Fig. 8-A-1), the zero gas and span gas must be fed to the zero gas inlet (NG). This also applies if an external solenoid valve is used and controlled via a digital output.

The pump status (on/off during manual calibration) matches the setting for automatic calibration (see page 8-B-3).

Figure 8-A-1

Analyzer Module with Gas Module



Test gas connection for
Caldos27 with single-point calibration,
Magnos206 with single-point calibration,
Limas11 with calibration cells,
Uras26 with calibration cells

Option: Flow monitoring, e.g. for flowing reference gas or purge gas (external needle valve required)

MG Sample Gas
NG Zero Gas
Flow Flow Monitor
O_2 Oxygen Sensor
P Pressure Sensor in Analyzer Module
c/*E* Analyzer

Test Gas Dew Point

The test gas dew point must be nearly identical to the sample gas dew point.

Analyzer Modules with Multiple Detectors

In analyzer modules with several detectors (e.g. the Uras26) each detector should be calibrated sequentially.

Air Pressure Effect

If the gas analyzer does not have a pressure sensor for air pressure correction, the air pressure value should be checked and reset as required prior to calibrating the analyzer module:
- If the gas analyzer's operating site height has been changed since the last calibration
- If the air pressure effect on the measured value is too high (see also Appendix 2, "Analyzer Module Operating Specifications").

(For instructions, see "Air Pressure Value Correction" section, page 9-28.)

Continued on next page

Waiting Period Following Manual Calibration

If the `Output Current Response` parameter is set to Hold, current output is halted for a specific time to allow the measurement value to stabilize after manual calibration.

This interval is:
Test gas → Sample gas purge time + 4 x T90 or
Test gas → Sample gas purge time + 1 x T90-1 + 3 x T90-2.

The waiting period is the same as that following automatic calibration (see “Automatic Calibration” section, page 8-A-5).

Calibration Data

Setting the calibration data is described on page 8-B-2.

Manual Calibration of an Analyzer Module

Manual calibration of an analyzer module is described on page 8-D-1.

Automatic Calibration

Definition

Automatic calibration means:

Zero and span calibration run automatically after starting.

Test Gas Supply

The test gas supply can be started automatically by means of the gas module's solenoid valves or via external solenoid valves.

Depending on the gas supply circuit and the number of analyzer modules installed there are several test gas layout possibilities (see "Test Gas Supply Control for Automatic Calibration" section, page 8-A-6).

Test Gas Dew Point

The test gas dew point must be nearly identical to the sample gas dew point.

Analyzer Modules with Multiple Detectors

In analyzer modules with several detectors (e.g. the Uras26) all detectors are calibrated simultaneously.

Starting Automatic Calibration

Automatic calibration is started

- At time intervals determined by the internal clock
- By an external control signal
- Manually via the gas analyzer's display and control unit

Internal Start

Normally automatic calibration is started on a time interval basis by the internal clock.

The cycle time is initialized with the calibration data (see "Calibration Data for Automatic Calibration" section, page 8-B-3).

External Start

The "Start automatic calibration" control signal is needed for external starting of automatic calibration:

Level	Low (0–3 V) → High (12–24 V) edge. The Low → High transition may also be generated by an external contact. After the transition the High level must be present for at least 1 second.
Input	Digital input DI1 on Digital I/O Module – "Status signals/Externally controlled calibration" standard function block application

Manual Start

Automatic calibration can be started manually on the display and control unit. It is effected

- Only as zero calibration or
- Only as span calibration (see also "Calibration Data for Automatic Calibration" section, page 8-B-4) or
- As a common zero and span calibration.

Manual start of the automatic calibration of an analyzer module is described on page 8-D-2.

Continued on next page

Blocking Automatic Calibration

The “Block automatic calibration” control signal is needed for blocking automatic calibration:

Level High Level (12–24 V). Automatic calibration is blocked as long as the High level is present. The next automatic calibration after switching to a Low level will be started according to the initialized cycle time.

Input Digital input DI2 on Digital I/O Module – “Status signals/Externally controlled calibration” standard function block application

Automatic Calibration Start, Block and Cancel

Start	Block	Cancel
Controlled by interval if “Activation” parameter is set to “on”	if “Activation” parameter is set to “off” or with the “Block Automatic Calibration” control signal	by appropriate configuration of the `Cancel Management` parameter (see page 8-B-3) or of the **Automatic Calibration** function block (see Technical Bulletin 30/24-200 EN)
Externally controlled with the “Start Automatic Calibration” control signal	with the “Block Automatic Calibration” control signal	As per Interval-Controlled Start
Manually activated with **START**		with **STOP**

Automatic calibration of an analyzer module is impossible
- when it is operated with the test and calibration software TCT and
- during setting up system modules.

Message Display

During automatic calibration an `Autocal running` message blinks in the softkey line.

Waiting Period Following Automatic Calibration

If the `Output Current Response` parameter is set to Hold, current output is halted for a specific time to allow the measurement value to stabilize after automatic calibration.

This interval is:
Test gas → Sample gas purge time + 4 x T90 or
Test gas → Sample gas purge time + 1 x T90-1 + 3 x T90-2.

Calibration Data

Setting the calibration data is described on pages 8-B-3 and 8-B-4.
Setting the time constant T90 is described on page 7-A-5.

Test Gas Supply Control for Automatic Calibration

Test Gas Supply

The test gas supply for automatic calibration can be started by means of the gas module's integral solenoid valves or via external solenoid valves.

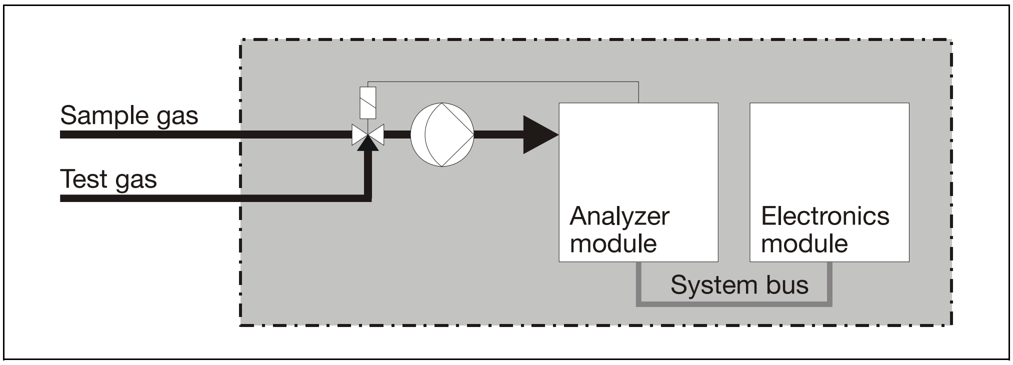
Depending on the gas supply circuit and the number of analyzer modules installed there are several test gas layout possibilities (see Figures 8-A-2 to 8-A-6):

1 Analyzer Module, Gas Module Installed with 1 Solenoid

To calibrate analyzer modules with simplified calibration procedures:

- Caldos27 with single-point calibration
- Magnos206 with single-point calibration
- Limas11 with calibration cells
- Uras26 with calibration cells
- Oxygen Sensor

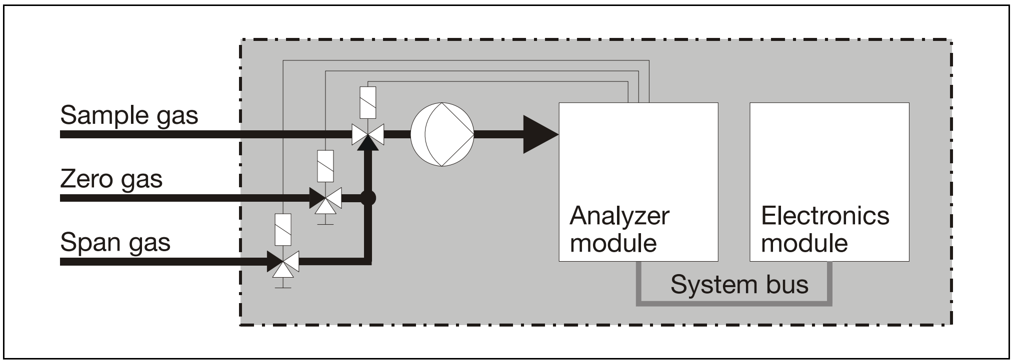
Figure 8-A-2



1 Analyzer Module, Gas Module Installed with 3 Solenoids

To calibrate all analyzer modules that can be used with the gas module.

Figure 8-A-3



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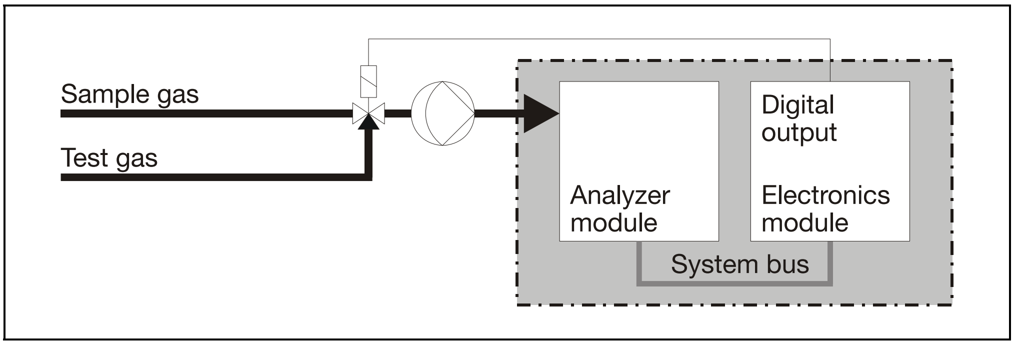
1 Analyzer Module, External Gas Supply with 1 Solenoid

To calibrate analyzer modules with simplified calibration procedures:

- Caldos27 with single-point calibration
- Magnos206 with single-point calibration
- Limas11 with calibration cells
- Uras26 with calibration cells
- Oxygen Sensor

The external solenoid is controlled via a digital output on the electronics module (Digital output DO4 on Digital I/O Module – “Status signals / Externally controlled calibration” standard function block application).

Figure 8-A-4

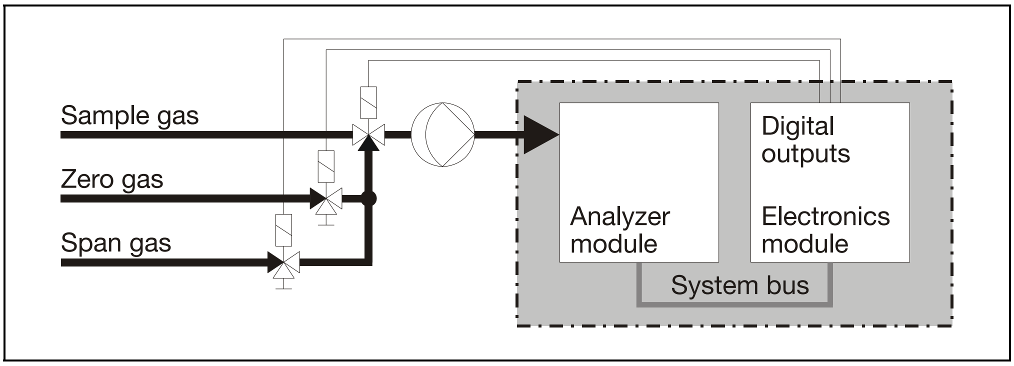


1 Analyzer Module, External Gas Supply with 3 Solenoids

To calibrate all analyzer modules with zero and span gas even without an integral gas module.

The external solenoids are controlled via digital outputs on the electronics module (Digital outputs DO1, DO2 and DO3 on Digital I/O Module – “Calibration control” standard function block application).

Figure 8-A-5



Continued on next page

3 Analyzer Modules, External Gas Supply with 1 Solenoid

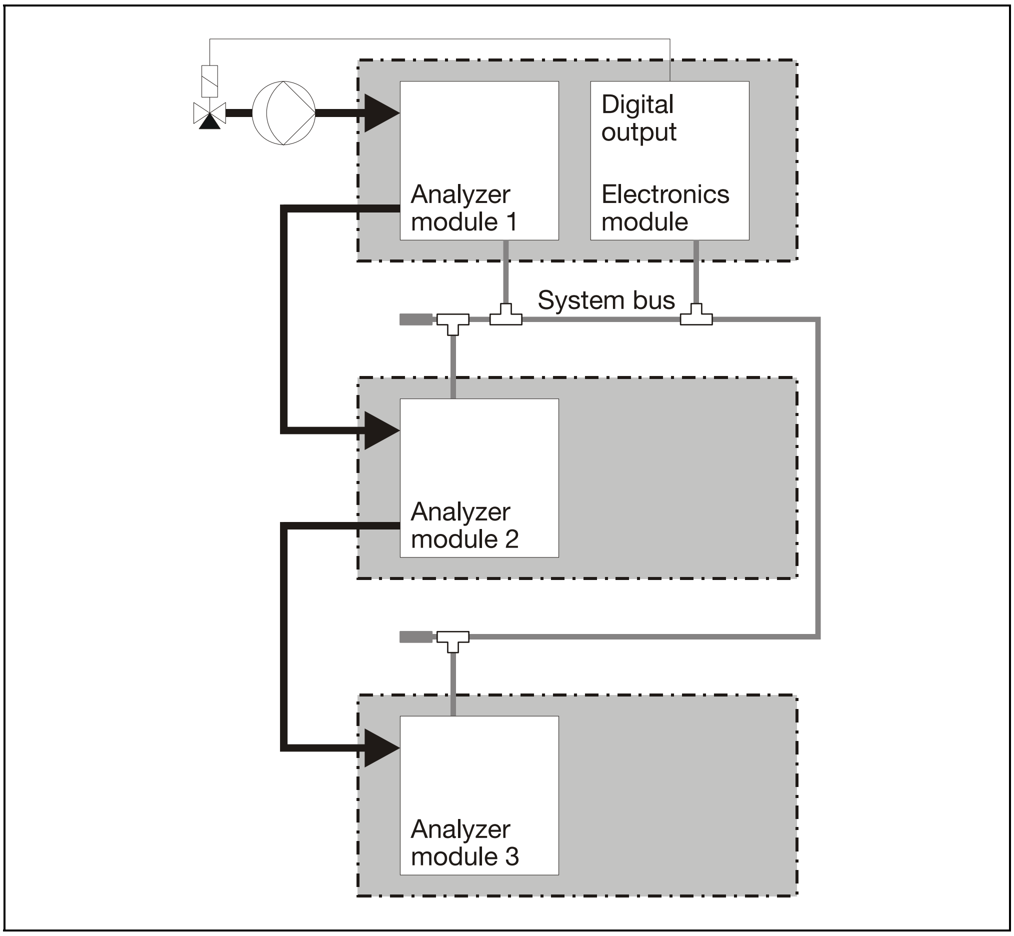
To calibrate three analyzer modules connected in series with simplified calibration procedures:

- Caldos27 with single-point calibration
- Magnos206 with single-point calibration
- Limas11 with calibration cells
- Uras26 with calibration cells
- Oxygen Sensor

The external solenoid is controlled via a digital output on the electronics module (Digital output DO4 on Digital I/O Module – “Status signals / Externally controlled calibration” standard function block application).

If the sample components of the individual analyzer modules show cross sensitivities among each other, it must be made sure by appropriate arrangement of additional solenoid valves that the test gas can be supplied separately to each analyzer module. With respect to the control of these solenoid valves, it must be taken into consideration that all analyzer modules are calibrated simultaneously during automatic calibration.

Figure 8-A-6



Externally Controlled Calibration

Definition

Externally controlled calibration means:

Zero and span value alignment is triggered by control signals from an external control unit.

Test Gas Supply

The test gases should be started automatically by external solenoid valves also controlled by the external control unit.

Test Gas Dew Point

The test gas dew point must be nearly identical to the sample gas dew point.

Analyzer Modules with Multiple Detectors

In analyzer modules with several detectors (e.g. the Uras26) all detectors are calibrated simultaneously.

Externally Controlled Calibration Control Signals

Control Signal	Level [1]	Input	
Zero alignment	Low → High Edge [2]	DI3	“Status signals/Externally controlled calibration” [3]
Span alignment	Low → High Edge [2]	DI4	
Calibration cell in/out [4]	In: High, Out: Low	DI1	“Limit values” [3]
Hold current signal	High	DI2	

1) Low Level 0–3 V, High Level 12–24 V
2) The Low → High transition may also be generated by an external contact. After the transition the High level must be present for at least 1 second.
3) Standard function block applications
4) Uras26 analyzer module only

External Control Arrangement

For the Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules, the external calibration control must be set up such that the zero point calibration always precedes end point calibration.

The external control unit must produce the control signals for zero and span alignment and for the external gas components, e.g. solenoids and pumps.

External control of calibration must be set up so that calibration starts only if there is no “Error” or “Maintenance Mode” status signal.

Also the external calibration control must allow for a purge time from the point of gas switchover until stabilization of the measurement value, i.e. until the zero or span calibration is initiated. Depending on the length of the gas paths in the gas analyzer and on the sample components involved, this purge time can take several minutes.

To allow measurement values to stabilize, the “Hold Current Signal” control signal should remain set for a specified time after calibration is finished.

Calibration data

Setting the calibration data is described on page 8-B-6.

Calibration Method

An analyzer module (detector) can have one or more (gas) components with one or more measurement ranges each.

To calibrate the analyzer module, establish whether the components and ranges should be calibrated jointly or individually. This decision is based on the calibration method configuration.

Single Calibration

The analyzer module start and span values for each measurement range are calibrated individually for each sample component.

Single calibration has no effect on other measurement ranges for the same sample components and on other sample components.

Single calibration is only possible and practical in the manual calibration mode. Single calibration is required if there are skips in the readings during measurement range switches because these indicate differences in the calibrations of the individual measurement ranges.

Note: Skips in readings during measurement range switches do not occur in the Uras26, Limas11 and Magnos206 since these analyzer modules have only one physical measurement range.

Common Calibration

Only the analyzer module start- and end-points in one measurement range are calibrated for each sample component. The start- and end-points of the other measurement ranges are then corrected electronically on the basis of the values established by this calibration.

A common calibration has no effect on the other sample components in the analyzer module.

In general the start-point (zero) is calibrated in the smallest measurement range and the end-point (span) is calibrated in the measurement range for which a suitable test gas is available.

Substitute Gas Calibration

If test gases are not available for calibration, e.g. because test gas containers cannot be filled with them or because of incompatibilities between their components, an analyzer module can be set to substitute gas calibration. In this case, in addition to the sample component measurement ranges, one or more ranges are set up at the factory for substitute gas components.

One start-point and one end-point are calibrated in the analyzer module's substitute gas measurement ranges. The start- and end-points of all substitute gas and sample gas measurement ranges are then corrected electronically on the basis of the values established by the substitute gas calibration.

Substitute gas calibration **must always** be used to calibrate **all** (sample gas and substitute gas) components for analyzer modules set up for substitute gas calibration. Single or common calibration either in the sample component or substitute gas measurement ranges leads to erroneous analyzer module calibration.

Continued on next page

Overview

The following table summarizes the various calibration methods.

Quantity SC	MR	Calibration Method	To configure ...	Calibrate ...	Calibration affects ...
1	**1**	**Test Gas/ Single**		• Zero • Span individually for each sample component and range	Measurement range
≥ 1	**> 1**	**Test Gas/ Common**	Measurement ranges for zero and span calibration	• Zero in one measurement range • Span in another range for each sample component	All sample component measurement ranges
> 1	**≥ 1**	**Substitute Gas**	Components and measurement ranges for zero and span calibration	• Zero in one component measurement range • Span in one range for another component for each detector	All detector components and measurement ranges

SC = Sample and Substitute Gas Components
MR = Measurement Ranges per Component

Setting the Calibration Method

(see Figure 8-A-7)

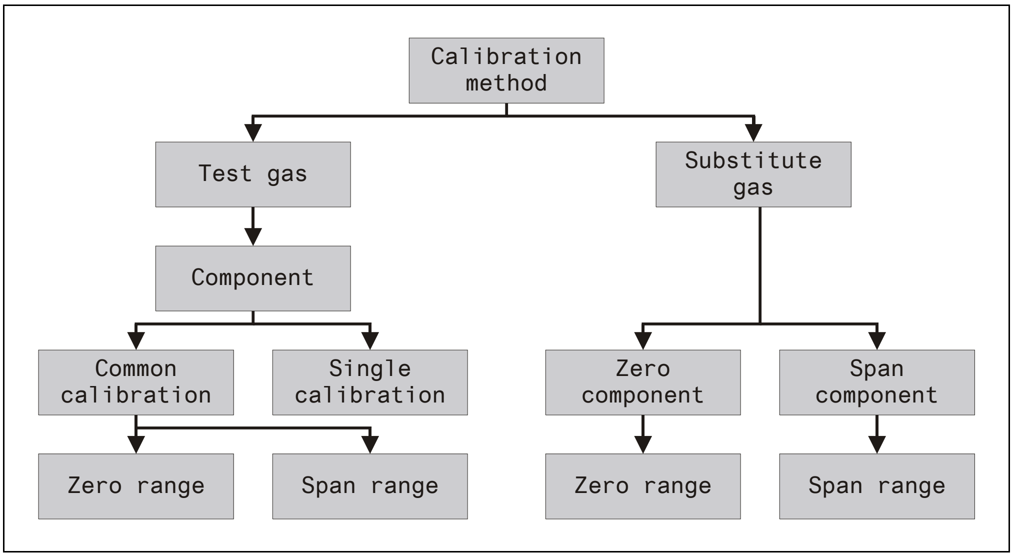
The calibration method can be set separately for manual, automatic and externally controlled calibration.

For common and substitute gas calibration the sample ranges for start- and end-point calibration of all three types of calibration control are adjusted jointly.

For substitute gas calibration the zero and span calibration components should also be set.

Figure 8-A-7

Setting the Calibration Method



The "Calibration Data" Sub-Menu

```
Menu
 |
 | __Calibrate
 |
 | __Configure
 ↓    |
      | __Component specific
      |
      | __Calibration data
      ↓    |
           | __Manual calibration
           |     | __Test gas concentration
           |     | __Calibration method
           |
           | __Automatic calibration
           |     | __Enable
           |     | __Cycle time
           |     | __Next cal. date
           |     | __Next cal. time
           |     | __Operating mode
           |     | __Test gas concentration
           |     | __Components for calibration
           |     | __Cancel management
           |     | __Advanced settings
           |           | Pump
           |           | Purge time: meas->cal gas
           |           | Purge time: zero<->span gas
           |           | Purge time: cal->meas gas
           |           | Hold time for chart rec.
           |           | Pressure switch activated for
           |           | Single zero cal.
           |           | Single span cal.
           |           | Zero & span cal.
           |           | Calibration method
           |
           | __Ext. controlled calibration
           |     | __Calibration method
           |     | __Calculation method
           |     | __Test gas concentration
           |     | __Components for calibration
           |
           | __Output current response
```

Calibration Data for Manual Calibration

Menu Path

`MENU → Configure → Calibration data → Manual calibration → ...`

Test Gas Concentration

The zero and span test gas concentrations to be used as set points for manual calibration need to be set for the selected sample component and measurement range.

Calibration Method

The method for manual calibration needs to be set (see also “Calibration Methods” section, page 8-A-10).

For ...	... select:
Common calibration	• The sample component and • The measurement ranges for start- and end-point calibration for the selected component.
Substitute gas calibration	• The (substitute gas) components for start- and end-point calibration and • The measurement range for the selected component.

The components and measurement ranges settings apply to manual, automatic and externally controlled calibration.

Calibration Data for Automatic Calibration

Menu Path

`MENU → Configure → Calibration data → Automatic calibration → ...`

Activation

Automatic calibration is only performed when activated.

The “off” setting applies only to the interval-controlled start of automatic calibration.

Cycle Time

The cycle time shows the time intervals over which automatic calibration is to be carried out.

Date and Time of Next Calibration

The gas analyzer will perform the next automatic calibration at the time established here. The cycle time will begin to run at that point.

Operating Mode

Automatic calibration is based on the function block **autocalibration**. This function block operates either as calibration or as validation.

Section “Validation” contains a detailed description of the validation (see page 8-B-5).

Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (publication number 30/24-200 EN) contains a detailed description of the function block **autocalibration**.

Test Gas Concentration

The zero and span test gas concentrations to be used as set points for automatic calibration need to be set for the selected sample component and measurement range.

If the Limas11 or Uras26 analyzer module is equipped with calibration cells the test gas concentration does not have to be set.

Components for Calibration

The sample components to be calibrated during zero and span calibration need to be selected.

Cancel Management

Automatic calibration is always terminated when there is a system bus fault and when the input “block” is set (for example, when the control signal “Block automatic calibration” is applied).

You can configure if the automatic calibration is to be terminated when one of the three states occurs: “system failure”, “analyzer failure” or “analyzer maintenance request”.

You can also configure if the analysis system should repeat automatic calibration after the cause of termination has been eliminated. Set the number of repetitions and the time between repetitions.

ℹ The configured repetition is not effective when the automatic calibration has been terminated by enabling the input “Cancel” of the **autocalibration** function block.

Continued on next page

Pump

This determines whether the pump is on or off during automatic calibration. This setting also applies to manual calibration.

Purge Time

This determines the length of the interval during which the gas paths will be purged to eliminate any residual gases that might interfere with calibration or measurement:

- Between turning on the zero gas flow and starting zero calibration
- Between turning on the test gas flow and starting span calibration
- Between restarting the sample gas flow and initiating measurement

The purge time should be set to at least three times the T_{90} time of the entire analyzer system.

Single Zero Calibration

Determines whether zero calibration will always or never be carried out alone, i.e. without subsequent span calibration.

Single Span Calibration

Determines whether span calibration will always or never be carried out alone, i.e. without prior zero calibration.

Zero and Span Calibration

Determines whether zero and span calibration will be carried out jointly always or never or at every n^{th} automatic calibration.

Example:

- Single Zero Calibration — Always
- Single Span Calibration — Never
- Common Zero and Span Calibration — Every 7^{th}

This setting effects with a cycle time of 1 day a zero calibration being carried out every day and a span calibration being carried out once a week.

For the Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules, these parameters must be set up such that the zero point calibration always precedes end point calibration.

Calibration Method

The method for automatic calibration needs to be set for the selected sample component (see also “Calibration Methods” section, page 8-A-10).

The zero and span calibration measurement ranges for common and substitute gas calibration are chosen in the `Manual calibration → Calibration method` parameter.

The “Calibration method” parameter is not available in the Limas11 and Uras26 analyzer modules since automatic calibration is always run as common calibration.

Validation Procedure

Validation runs in principle just like an automatic calibration. The difference is that during validation a measurement value deviation from the set point values is not corrected automatically. Instead the procedure is as follows:

- When the (test gas) measurement values for start and end point are within the initialized limit values the success of the validation is recorded in the logbook.
- When the (test gas) measurement values for start and end point are outside the initialized limit values the failure of the validation is recorded in the logbook. Either the “maintenance request” status is set or a calibration of the sample component is performed.

Validation Parameters

The parameter settings for automatic calibration also apply to validation.

After selecting validation in the `Operating mode` parameter, it must be set

- If the validation result shall be logged and
- If in case of a validation failure
  - the “maintenance request” status shall be set or
  - the sample component shall be calibrated.

In the `Test gas concentration` parameter the start- and end-point limit values have to be set for each sample component. If these limit values are over- or undershot the validation is rated as failure.

Calibration Data for Externally Controlled Calibration

Menu Path

`MENU → Configure → Calibration data → Ext. controlled cal. → ...`

The menu path refers to the **Externally Controlled Calibration** function block. The zero and span calibration parameters are selected separately. Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (publication number 30/24-200 EN) contains a detailed description of the function block.

Calibration Method

The method for externally controlled calibration needs to be set for the selected sample component (see also “Calibration Methods” section, page 8-A-10).

The zero and span calibration measurement ranges for common and substitute gas calibration are chosen in the `Manual calibration → Calibration method` parameter.

The “Calibration method” parameter is not available in the Limas11 and Uras26 analyzer modules since the externally controlled calibration is always run as common calibration.

Calculation Method

Select whether the calibration is to be calculated as
- Offset calibration
- Amplification calibration
- Offset and amplification calibration

Test Gas Concentration

The zero and span test gas concentrations to be used as set points for manual calibration need to be set for the selected sample component and measurement range.

Components for Calibration

The sample components to be calibrated during zero and span calibration need to be selected.

Output Current Response

Menu Path

`MENU → Configure → Calibration data → Output current response → ...`

Output Current Response

Signals at the current outputs (analog outputs)
- Are held at the last measured value prior to starting calibration or
- Can follow measurement value changes during calibration.

Caldos25: Notes for Calibrating

Sample Components

The Caldos25 analyzer module has at least one sample component with one measurement range.

Associated Gas Influence

The Caldos25 analyzer module measurement technique is based on the differing thermal conductivity of various gases.

Since this technique is non-selective, the concentration of a sample component can be accurately measured only in a binary or quasi-binary gas mixture.

If other associated gas components are present in the sample gas their effect on factory calibration must be considered.

Test Gases

Zero Calibration:	Test gas or sample-component-free process gas or substitute gas
Span Calibration:	Test gas or process gas having a known sample gas concentration or substitute gas

Test Gas for Corrected Sample Components

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, a corrected measurement component should be calibrated only using a test gas consisting of the measurement component and an inert gas like N_2.

Calibration with Substitute Gases

If test gases are not available for calibration, the Caldos25 analyzer module can be factory-set for calibration with substitute gases (see the "Calibration Methods" section, page 8-A-10).

Substitute gas calibration of the Caldos25 analyzer module is described using the example of "CO_2 Measurement in Flue Gas", on page 8-C-4.

Sequence of Calibration

Zero point calibration must always precede end point calibration.

Wait Until End of Warm-Up Phase

The Caldos25 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 2–4 hours after connecting the power supply.

The time required for the warm-up phase depends on the measurement range.

Caldos27: Notes for Calibrating

Sample Components

The Caldos27 analyzer module has at least one sample component with one measurement range and, for measurement ranges ≥ Class 1, the standard gas substitute gas component.

Associated Gas Influence

The Caldos27 analyzer module measurement technique is based on the differing thermal conductivity of various gases.

Since this technique is non-selective, the concentration of a sample component can be accurately measured only in a binary or quasi-binary gas mixture.

If other associated gas components are present in the sample gas their effect on factory calibration must be considered.

Test Gases

Zero Calibration:	Test gas or sample-component-free process gas or substitute gas
Span Calibration:	Test gas or process gas having a known sample gas concentration or substitute gas

Test Gas for Corrected Sample Components

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, a corrected measurement component should be calibrated only using a test gas consisting of the measurement component and an inert gas like N_2.

Calibration with Substitute Gases

If test gases are not available for calibration, the Caldos27 analyzer module can be factory-set for calibration with substitute gases (see the “Calibration Methods” section, page 8-A-10).

Substitute gas calibration of the Caldos27 analyzer module is described using the example of “CO_2 Measurement in Flue Gas”, on page 8-C-4.

Single-Point Calibration with Standard Gas

Single-point calibration of the Caldos27 analyzer module with standard gas is described on page 8-C-3.

Sequence of Calibration

Zero point calibration must always precede end point calibration.

Wait Until End of Warm-Up Phase

The Caldos27 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 30 minutes after connecting the power supply.

The time required for the warm-up phase depends on the measurement range.

Caldos27: Single-Point Calibration with Standard Gas

Single-Point Calibration with Standard Gas

For measurement ranges ≥ measurement range class 1 in the Caldos27 analyzer module, standard gas can be used for single-point calibration. This standard gas calibration is carried out exclusively as span calibration and causes an amplification correction. Safety-related measurements are excluded from this technique. Depending on the measurement task involved, the zero- and end-points should be verified periodically (Recommendation: once a year).

Note: Classification of measurement ranges into class 1 and class 2 is specified in Data Sheet 10/24-1.20 EN.

Measurement Range for Standard Gas

When the Caldos27 analyzer module is ordered with standard gas calibration, the factory-set measurement range for the standard gas is 0–60,000 rTC (rTC = relative thermal conductivity). During basic calibration in the factory one standard gas is calibrated in this measurement range. Due to sensor tolerances the values of other standard gases can differ by up to 5 % from this scaling (see following table for set-points).

Set-points for Standard Gas

N_2	10,000 rTC	Ar	7,200 rTC	CH_4	14,000 rTC	H_2	60,000 rTC
Air	10,070 rTC	CO_2	7,500 rTC	He	50,000 rTC		

Calibration Method

Standard gas calibration is fundamentally a substitute gas calibration without zero calibration (see also “Calibration Methods” section, page 8-A-10). The correction values are transferred to all the analyzer module’s sample components and measurement ranges.

Calibration Data

Calibration data for manual calibration	
Calibration method	Substitute gas calibration
Zero component	Standard gas [1)]
Span component	Standard gas
Test gas concentration	Value depending on standard gas [3)]

Calibration data for automatic calibration	
Calibration method	Substitute gas calibration [2)]
Single zero calibration	never
Single span calibration	always
Common zero and span calibration	never
Test gas concentration	Value depending on standard gas [3)]

1) Though standard gas calibration is carried out exclusively as span calibration, standard gas must also be chosen as zero component.
2) Settings of sample components and measurement ranges for zero and span calibration are taken over from the calibration data for manual calibration.
3) See table “Set-points for Standard Gas”

Manual Calibration

Manual standard gas calibration must be carried out exclusively as span calibration (see also “Analyzer Module Manual Calibration” section, page 8-D-1).

Caldos25 and Caldos27: Substitute Gas Calibration

Example

Substitute gas calibration in the Caldos25 and Caldos27 is described using the example of CO_2 Measurement in Flue Gas.

CO_2 Measurement in Flue Gas

The composition of the various combustion products in the sample gas is known in the case of CO_2 measurements of flue gas from single-component firings. The flue gas out of the cooler primarily contains CO_2, O_2, N_2 and Ar. CO_2 cannot be measured in mixed-firing flue gases.

Test Gases

The following table shows test gases for the calibration of the 0-20 Vol.-% CO_2 measurement range:

Fuel	Test Gas Composition in Vol.-% for								
	Zero	Middle Concentration				Span			
		CO_2	O_2	N_2	Ar	CO_2	O_2	N_2	Ar
Gas	Air	10	3	86	1	20	–	79	1
Oil	Air	10	8	81	1	20	–	79	1
Coal	Air	10	10	79	1	20	–	79	1

Calibration with Substitute Gases

Since the test gases in this table are not available everywhere, the analyzer module can be factory-set for calibration with a substitute gas.

In this case an additional measurement range is calibrated for 0–20 Vol.-% CO_2 in N_2 (N_2 and CO_2/N_2 mixtures are available practically everywhere).

Measurement Ranges

Component 1	CO_2 in Flue Gas	Meas. Range 1	0-10 Vol.-%
		Meas. Range 2	0-20 Vol.-%
Component 2	CO_2 in N_2 (Substitute Gas)	Meas. Range 1	0-20 Vol.-%

Calibration Parameters

Calibration Method	Substitute Gas Calibration	
Zero Component	Component 1 Component 2	Meas. Range 1 or Meas. Range 1
Span Component	Component 2	Meas. Range 1

Calibration

- Calibrate zero with air (component 1) or N_2 (component 2).
- Calibrate span with test gas 18 Vol.-% CO_2 in N_2.

Other Measurement Tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Limas11: Notes for Calibrating

Calibration

Calibration can be performed in range 1 and range 2 for each sample component. It is always a common calibration and thus affects both ranges.

For additional information on measurement ranges, please refer to "Limas11, Uras26: Notes for Changing Measurement Range Limits" section, page 7-A-3.

Calibration Cells

The use of calibration cells allows the Limas11 analyzer module to be calibrated without using test gas containers.

A maximum of 5 calibration cells can be installed. Each calibration cell is filled with a test gas matched to the sample components and measurement ranges set up in the corresponding beam path.

Test Gases for Zero Calibration

A zero gas is required for each zero calibration.

In addition to nitrogen, ambient air can be used for zero calibration. Water vapor must be absorbed using a cooler. If the ambient air contains sample gas components, these must be removed with a suitable absorber.

Test Gases for Span Calibration without Calibration Cells

A test gas is required for each measurement component for span calibration without calibration cells. The span gas concentration should be 70-80% of the end value of the largest measurement range.

Test Gases for Span Calibration of Suppressed Ranges

For suppressed ranges, the span gas concentration must be within the suppressed range. If possible, it should be equal to the end value of the suppressed range (and thus the end value of the larger measurement range).

Test Gas for Automatic Calibration

In principle a test gas for each sample component is required for the internally or externally controlled automatic calibration.

A test gas mixture containing each sample component in the appropriate concentration may be used only when all sample components have no mutual cross-sensitivity and/or carrier gas influences.

Continued on next page

Limas11 with Internal Cross-Sensitivity Correction

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, the following notes should be observed:

For zero-point calibration **all** sample components must be calibrated in the following sequence:

- First that sample component which is not corrected,
- Afterwards that sample component which is affected by the smallest number of corrections,
- Up to that sample component which is affected by the largest number of corrections.

Example:	Sample components	NO, SO_2, NO_2
	Cross-sensitivity correction	NO by SO_2 and NO_2, SO_2 by NO_2, NO_2 not corrected.
	Sequence for zero-point calibration	1st NO_2 – 2nd SO_2 – 3rd NO.

For end-point calibration likewise **all** sample components must be calibrated. In doing so, a corrected sample component should be calibrated only using a test gas containing no components which cause cross-sensitivity, i.e. consisting only of the measurement component and an inert gas like N_2.

Wait Until End of Warm-Up Phase

The Limas11 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 1.5 hours after connecting the power supply.

Magnos206: Notes for Calibrating

Sample Components

The Magnos206 analyzer module has at least one sample component normally with four measurement ranges.

Test Gases

Zero Calibration: Oxygen-free process gas or substitute gas

Span Calibration: Process gas with a known oxygen concentration or a substitute gas such as dried air

Highly suppressed measurement ranges (≥95-100 Vol.-% O_2) should only be calibrated with test gases with O_2 concentrations in the selected measurement range.

Test Gas for Corrected Sample Components

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, a corrected measurement component should be calibrated only using a test gas consisting of the measurement component and an inert gas like N_2.

Calibration with Substitute Gases

If test gases are not available for calibration, the Magnos206 analyzer module can be factory-set for calibration with substitute gases (see the “Calibration Methods” section, page 8-A-10).

Substitute gas calibration of the Magnos206 analyzer module is described using the example of “Purity Measurement in CO_2” on page 8-C-8.

Single-Point Calibration

Single-point calibration of the Magnos206 analyzer module is described on page 8-C-7.

Suppressed Measurement Ranges

If suppressed measurement ranges with a suppression ratio of ≥ 1:5 are set in the Magnos206 analyzer module, the pressure sensor has been specially adjusted at the factory. In this case, only a common calibration should be done (not a single or substitute gas calibration).

Sequence of Calibration

Zero point calibration must always precede end point calibration.

Wait Until End of Warm-Up Phase

The Magnos206 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 1 hour after connecting the power supply.

Magnos206: Single-Point Calibration

Single-Point Calibration

The long-term sensitivity drift of the Magnos206 analyzer module is less than 0.05 Vol.-% O_2 per year for measurement ranges up to 25 Vol.-% O_2. Thus a regular offset correction is sufficient. This so-called single-point calibration can be conducted at each point on the characteristic curve since a parallel shift of this curve results. Depending on the measurement task involved, we recommend performing an additional span calibration once a year.

Note: The short-term sensitivity drift can amount to 1% of the measured value per week.

Test Gas

A test gas with any concentration of O_2 can be used for single point calibration as long as it lies within one of the measurement ranges in the analyzer module.

Environmental air can also be used as the test gas.

The test gas must have the same moisture content as the process gas.

CAUTION!

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

Suppressed Measurement Ranges

Single point calibration can also be done within a suppressed measurement range if the suppression ratio is $\leq 1:5$. In this case as well, the O_2 concentration of the test gas must lie within the measurement range.

Air Pressure

In single point calibration, the current air pressure must be taken into account. This is done automatically if a pressure sensor is incorporated in the analyzer module.

Note: The sensitivity drift is $\gg 0.05$ Vol.-% O_2 without pressure correction.

Calibration Method

When the analyzer module has one sample component the single-point calibration is carried out as common calibration only at the zero point.

When the analyzer module has more than one sample component the single-point calibration is carried out as an substitute gas calibration only at the zero point.

For detailed information on the calibration methods, see the “Calibration Methods” section, page 8-A-10.

Continued on next page

Calibration Data for an Analyzer Module with 1 Sample Component

(Example:
Test Gas = Air)

Calibration data for manual calibration	
Calibration method	Common single-point calibration
Calibration measurement range	0-25 Vol.-% O_2
Test gas concentration	20.96 Vol.-% O_2

Calibration data for automatic calibration	
Calibration method	Common calibration (test gas)
Single zero calibration	always
Single span calibration	never
Common zero and span calibration	never
Test gas concentration zero gas	20.96 Vol.-% O_2
Test gas concentration span gas	n.a.

Calibration Data for an Analyzer Module with > 1 Sample Component

(Example:
Test Gas = Air)

Calibration data for manual calibration	
Calibration method	Substitute gas calibration
Zero component	O_2 in N_2
Zero range	0-25 Vol.-% O_2
Span component	n.a.
Span range	n.a.
Test gas concentration zero gas	20.96 Vol.-% O_2
Test gas concentration span gas	n.a.

Calibration data for automatic calibration	
Calibration method	Substitute gas calibration [1)]
Single zero calibration	always
Single span calibration	never
Common zero and span calibration	never
Test gas concentration zero gas	20.96 Vol.-% O_2
Test gas concentration span gas	n.a.

1) Settings of sample components and measurement ranges for zero and span calibration are taken over from the calibration data for manual calibration.

Magnos206: Substitute Gas Calibration

Example

Substitute gas calibration of the Magnos206 analyzer module is described using the example of purity measurement of CO_2.

Purity Measurement of CO_2

For CO_2 purity measurements, the smallest concentrations of O_2 are measured in CO_2, e.g. 0-1 Vol.-% O_2 in CO_2.

Calibration with Substitute Gases

Since O_2 in CO_2 is not available as a test gas and, due to the O_2 zero shift caused by CO_2 (see “Magnos206 Operating Specifications” section, page A-2-4), the analyzer module is factory-set for calibration with substitute gas.

In this case an additional measurement range is calibrated for 0-25 Vol.-% O_2 in N_2 (N_2 and O_2/N_2 mixtures are available practically everywhere).

Measurement Ranges

Component 1	O_2 in CO_2	Meas. Range 1	0-1 Vol.-%
		Meas. Range 2	0-15 Vol.-%
		Meas. Range 3	0-25 Vol.-%
		Meas. Range 4	0-100 Vol.-%
Component 2	O_2 in N_2 (Substitute Gas)	Meas. Range 1	0-25 Vol.-%

Calibration Parameters

Calibration Method	Substitute Gas Calibration	
Zero Component	Component 1 Component 2	Meas. Range 1 or Meas. Range 1
Span Component	Component 2	Meas. Range 1

Calibration

- Calibrate zero with CO_2 (component 1) or N_2 (component 2).
- Calibrate span with dried air (containing 20.96 Vol.-% O_2).

Other Measurement Tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Magnos27: Notes for Calibrating

Sample Components

The Magnos27 analyzer module has at least one sample component with one measurement range and one measurement range for flue gas measurements of the O_2 in N_2 substitute gas component.

Associated Gas Influence

Because of the thermomagnetic measurement technique employed by the Magnos27 analyzer module, associated gases have an effect on results.

For this reason the sample gas composition must be considered during initial calibration at the factory.

Test Gases

Zero Calibration: Oxygen-free process gas or substitute gas

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

Test Gas for Corrected Sample Components

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, a corrected measurement component should be calibrated only using a test gas consisting of the measurement component and an inert gas like N_2.

Calibration with Substitute Gases

If test gases are not available for calibration, the Magnos27 analyzer module can be factory-set for calibration with substitute gases (see the “Calibration Methods” section, page 8-A-10).

Substitute gas calibration of the Magnos27 analyzer module is described using the example of “Oxygen Measurement in Flue Gas”, on page 8-C-12.

Sequence of Calibration

Zero point calibration must always precede end point calibration.

Wait Until End of Warm-Up Phase

The Magnos27 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 2-4 hours after connecting the power supply.

Magnos27: Substitute Gas Calibration

Example

Substitute gas calibration of the Magnos27 analyzer module is described using the example of Oxygen Measurement in Flue Gas.

Oxygen Measurement in Flue Gas

The sample gas composition is known in the case of oxygen measurements in flue gas.

Test Gases

Zero Gas: 16 Vol.-% CO_2 in N_2
Span Gas: 10 Vol.-% O_2 and 8.3 Vol.-% CO_2 in N_2

Calibration with Substitute Gases

Since these test gases are not available everywhere, the analyzer module is factory-set for calibration with a substitute gas.

In this case an additional measurement range is calibrated for 0-25 Vol.-% O_2 in N_2 (N_2 and O_2/N_2 mixtures are available practically everywhere).

Measurement Ranges

Component 1	O_2 in flue gas	Meas. Range 1	0-5 Vol.-%
		Meas. Range 2	0-10 Vol.-%
Component 2	O_2 in N_2 (Substitute Gas)	Meas. Range 1	0-25 Vol.-%

Calibration Parameters

Calibration Method	Substitute Gas Calibration	
Zero Component	Component 2	Meas. Range 1
Span Component	Component 2	Meas. Range 1

Calibration

- Calibrate zero with N_2 (component 2).
- Calibrate span with dried air (containing 20.96 Vol.-% O_2) or with an O_2/N_2 mixture.

Other Measurement Tasks

For other measurement tasks select the test gases and measurement ranges in a similar manner according to the sample gas composition.

Calibration

Calibration can be performed in range 1 and range 2 for each sample component. It is always a common calibration and thus affects both ranges.

For additional information on measurement ranges, please refer to “Limas11, Uras26: Notes for Changing Measurement Range Limits” section, page 7-A-3.

Calibration Cells

The use of calibration cells allows the Uras26 analyzer module to be calibrated without using test gas containers.

A calibration cell can be installed in each of the analyzer module’s beam paths. Each calibration cell is filled with a test gas matched to the sample components and measurement ranges set up in the corresponding beam path.

Test Gases for Zero Calibration

A zero gas is required for each zero calibration.

In addition to nitrogen, ambient air can be used for zero calibration. Water vapor must be absorbed using a cooler. If the ambient air contains sample gas components, these must be removed with a suitable absorber (for CO: HOPCALIT®, for CO_2: Sodium hydroxide on substrate).

Test Gases for Span Calibration without Calibration Cells

A test gas is required for each detector for span calibration without calibration cells. In the case of automatic and externally controlled calibration, a test gas mixture is required for all detectors since all are calibrated simultaneously. The span gas concentration should be 70-80% of the end value of the largest measurement range.

Test Gases for Span Calibration of Suppressed Ranges

For suppressed ranges, the span gas concentration must be within the suppressed range. If possible, it should be equal to the end value of the suppressed range (and thus the end value of the larger measurement range).

Test Gas for Automatic Calibration

In principle a test gas for each sample component is required for the internally or externally controlled automatic calibration.

A test gas mixture containing each sample component in the appropriate concentration may be used only when all sample components have no mutual cross-sensitivity and/or carrier gas influences.

Continued on next page

Uras26 with Internal Cross-Sensitivity Correction

During calibration cross-sensitivity and/or carrier gas corrections by other measurement components are switched off. Therefore, the following notes should be observed:

For zero-point calibration **all** sample components must be calibrated in the following sequence:
- First that sample component which is not corrected,
- Afterwards that sample component which is affected by the smallest number of corrections,
- Up to that sample component which is affected by the largest number of corrections.

Example:	Sample components	CO_2, CH_4, C_3H_6
	Cross-sensitivity correction	CO_2 by CH_4, CO_2 by C_3H_6, C_3H_6 not corrected.
	Sequence for zero-point calibration	1^{st} C_3H_6 – 2^{nd} CH_4 – 3^{rd} CO_2.

For end-point calibration likewise **all** sample components must be calibrated. In doing so, a corrected sample component should be calibrated only using a test gas containing no components which cause cross-sensitivity, i.e. consisting only of the measurement component and an inert gas like N_2.

Wait Until End of Warm-Up Phase

The Uras26 analyzer module should only be calibrated after the warm-up phase, i.e. approx. 2 hours after connecting the power supply.

Oxygen Sensor: Notes for Calibrating

Test Gases

The oxygen sensor zero is not calibrated since it is fundamentally stable.

Ambient (non-process) air with a constant oxygen content (e.g. 20.96 Vol.-%) is required for span calibration. Synthetic air can also be used.

Test Gases for Simultaneous Calibration of the Oxygen Sensor and Analyzer Module

The oxygen sensor and associated analyzer module are calibrated simultaneously during automatic and externally controlled calibration.

Therefore when the oxygen sensor is to be calibrated with the following analyzer modules

- Magnos206 with single-point calibration
- Limas11 with calibration unit
- Uras26 with calibration units

the zero gas should contain the required concentration of oxygen.

In all other cases the span gas should contain the required concentration of oxygen.

External Control Arrangement

The design of the external control of calibration should take into consideration that the oxygen sensor's span value is stable only after a waiting period of ≥ 40 seconds.

Wait Until End of Warm-Up Phase

The oxygen sensor is always calibrated at the same time as the associated analyzer module. Therefore, calibration should begin only after this module's warm-up phase.

Analyzer Module Manual Calibration

For information on the calibration data for manual calibration, please refer to page 8-B-2.

To optimize accuracy, perform a manual zero calibration prior to calibrating the span value.

Analyzer Module Manual Calibration

Step	Action
1	Select the `Manual Calibration` menu. **`MENU`** → **`Calibrate`** → **`Manual Calibration`**
2	For Single Calibration: Select **`Components`** and **`Measurement Range`**.
Zero calibration:	
3	Select the **`Zero Gas`**.
4	Turn on the zero gas supply.
5	If necessary, change the test gas concentration shown [1)], **ENTER**.
6	When the sample value indication stabilizes, initiate zero calibration with **ENTER**.
7	Accept the calibration result with **ENTER** or **REPEAT** calibration [2)] (back to step 5) or reject calibration with **Back** (back to step 6) or reject calibration with **Meas** (back to measurement value readout).
Span Calibration:	
8	Select the **`Span Gas`**.
9	Turn on the span gas supply.
10	If necessary, change the test gas concentration shown [1)], **ENTER**.
11	When the sample value indication stabilizes, initiate span calibration with **ENTER**.
12	Accept the calibration result with **ENTER** or **REPEAT** calibration [2)] (back to step 10) or reject calibration with **Back** (back to step 11) or reject calibration with **Meas** (back to measurement value readout).
For Single Calibration: Repeat steps 2–12 for the other components and measurement ranges.	

1) The initialized test gas concentration is shown as the set point. By changing the set point in this step the initialized test gas concentration will be overwritten (see also the “Calibration Data for Manual Calibration” section, page 8-B-2).

2) It may be necessary to repeat calibration if the measurement value is still not stable after calibration has been started. The subsequent process is based on the measurement value obtained in the previous calibration.

Manual Start of the Automatic Calibration

For information on the calibration data for automatic calibration, please refer to pages 8-B-3 and 8-B-4.

Manual Start of the Automatic Calibration

Automatic calibration is started
- Only as zero calibration or
- Only as span calibration or
- As a common zero and span calibration.

For the Caldos25, Caldos27, Magnos206 and Magnos27 analyzer modules, it is not admissible to perform only a span calibration. A zero calibration must always precede a span calibration.

Proceed as follows to manually start automatic calibration – even outside of the cycle intervals initialized:

Step	Action	
1	Select the `Automatic Calibration` menu: **`MENU → Calibrate → Automatic calibration`**	
2	Only zero calibration:	**`ZERO AUTOCAL`**
	Only span calibration:	**`SPAN AUTOCAL`**
	Common zero and span calibration:	**`ZERO & SPAN AUTOCAL`**

Manual Stop of the Automatic Calibration

The user can end the automatic calibration process by pressing the `STOP` softkey.

When automatic calibration is stopped, the analyzer module is in an indefinite state. For instance, it is possible for zero calibration to be finalized while span calibration has not yet been started.

For this reason, automatic calibration will have to be restarted and allowed to run to completion after any cancellation of automatic calibration.

Validation

The procedure described above applies in the same way if the analyzer module is set to “validation” operating mode.

Chapter 9 Inspection and Maintenance

CAUTION!

The tasks described in this chapter require special training and under some circumstances involve working with the gas analyzer open and powered up. Therefore, they should only be performed by qualified and specially trained personnel.

WARNING!

EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

Inspection

Normal Operation of the Gas Analyzer

In normal operation the measured values from the installed analyzer modules are shown on the display screen and the green “Power” LED is lit.

Periodic Checks

Module, Assembly	Function	Interval	✓
Flow meter	Sample Gas Flow Indication Caldos25 10–90 l/h, max. 200 l/h Caldos27 10–90 l/h Limas11 20–100 l/h Magnos206 30–90 l/h Magnos27 20–90 l/h Uras26 20–100 l/h O_2 Sensor 20–100 l/h Gas Module 30–60 l/h	Regularly	☐
Gas Module Disposable Filter	Staining (see page 9-25)	Regularly	☐
Gas analyzer Gas Lines	Seal Integrity (see page 9-2)	Regularly	☐
Seals Between Doors and Housing	Contamination, Foreign Material	Before Each Closing	☐

Checking Gas Path Seal Integrity

When should gas path seal integrity be checked?

Gas path seal integrity should be checked periodically. It must be verified after the gas paths inside or outside the gas analyzer have been opened (e.g. after removing or installing an analyzer module).

What materials are needed?

1 pressure gauge, 1 plastic tubing, approx. 1 m (3 feet) in length, 1 tee with shut-off valve, air or nitrogen

CAUTION!

If the seal integrity test is to be carried out with air and there is the possibility of a combustible gas being present in the gas paths or if a combustible gas is to be introduced later, the gas paths should first be purged with nitrogen. Otherwise the seal integrity test can be performed with nitrogen.

The following instructions apply to all gas paths in the gas analyzer, therefore to all sample gas paths and – in the Caldos25 and Uras26 analyzer modules – to the reference gas path.

Checking Gas Path Seal Integrity

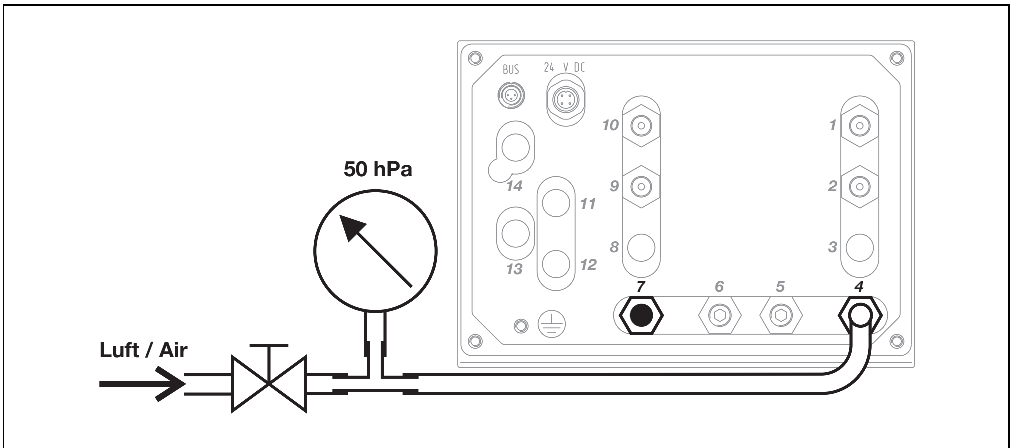
(see example in Figure 9-1)

Step	Action
1	Plug the outlet of the gas path to be tested (***7*** in the example).
2	Connect plastic tubing with a tee fitted with a shutoff valve to the inlet of the gas path to be tested (***4*** in the example).
3	Connect the free end of the tee to the pressure gauge.
4	Blow air or nitrogen through the shutoff valve until the gas path is pressurized to $p_e \approx 50$ hPa (= 50 mbar). Close the shutoff valve. Maximum pressure $p_e = 150$ hPa (= 150 mbar). Limas11 with quartz sample cell: Gauge pressure $p_e \approx 400$ hPa (= 400 mbar), maximum gauge pressure $p_e = 500$ hPa (= 500 mbar).
5	The pressure should not change measurably in 3 minutes. A sharp pressure drop is a sign of a leak in the gas path being tested. Limas11 with quartz sample cell: Test duration 15 minutes.
6	Repeat steps 1-5 for all gas paths in the gas analyzer.

Figure 9-1

Seal Integrity Test

(Example: Sample Gas Path in Magnos27)



Magnos27: Thermal Link Replacement

The service handbooks describe the procedure for replacing the Caldos25, Caldos27, Magnos206 and Uras26 thermal link.

When is replacement needed?

The thermal link should be replaced if a thermal link failure is the probable cause of a temperature error (see also “Caldos25, Caldos27, Magnos206, Magnos27 Problems” section, page 10-18).

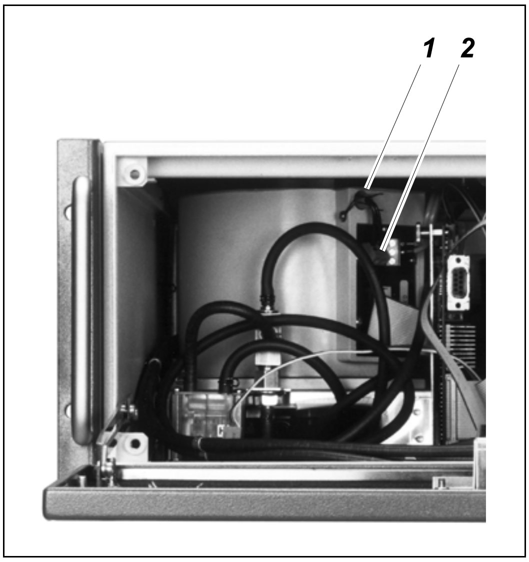
Thermal Link Replacement

(see Figure 9-2)

Step	Action
1	⚠ Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing front plate.
3	Disconnect the thermal link from the thermostat connection terminals ***2***.
4	Bend back the thermal link spring clips on the cable guide and pull the thermal link ***1*** from the cavity in the thermostat annular heater.
5	Insert a new thermal link (part number 0740712) in the cavity and close the spring clips.
6	Connect the new thermal link to the thermostat connection terminals.
7	Close the system housing.
8	Turn on the gas analyzer power supply.

Figure 9-2

Location of Magnos27 Analyzer Module Thermal Link



1 Thermal Link
2 Thermostat Connection Terminals

Uras26: Optical Alignment

Definition

Optical alignment of the Uras26 analyzer module will minimize asymmetry of the radiation which falls in through the sample and reference sides of the sample cell.

When should optical alignment be performed?

An optical alignment must always be performed
- If the offset drift has fallen below the permissible range (50% of the physical measurement range)
- After a component (emitter, sample cell, calibration unit/cell, detector) is installed in or removed from a beam path.

How should optical alignment be performed?

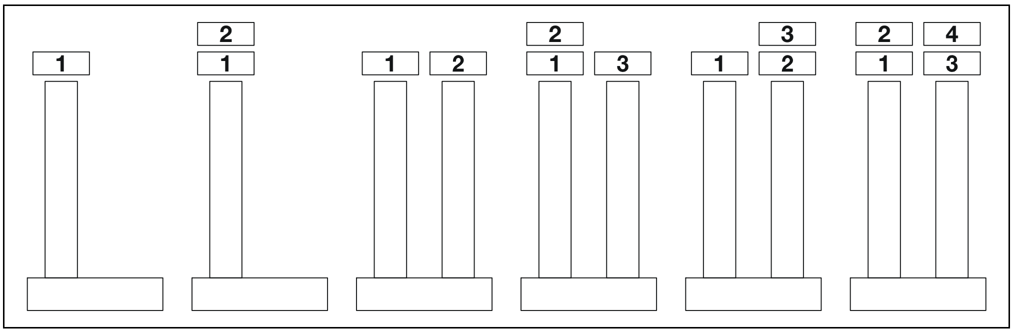
Each beam path in the analyzer module must be optically aligned separately. If there are two detectors in a beam path, the optical alignment should be performed in the rearmost detector (as seen from the emitter). During an optical alignment, beam path intensity is varied by means of mechanical apertures and, if necessary, by turning the emitter case. For this, the system housing must be opened (see Figure 9-4, page 9-5).

Detector Arrangement

Figure 9-3 shows the detector layout. Detector numbers correspond to the numbers assigned to the series of measurement components as shown on the analyzer module identification plate.

Figure 9-3

Uras26 Analyzer Module Detector Numbering



Test Gas

During optical alignment the zero gas supply must be turned on.

Emitter Wrench

An "emitter wrench" is required to rotate the emitter case (see Figure 9-4, page 9-5). It is affixed to the analyzer module.

CAUTION!

Current-bearing components can be exposed when the covers or parts are removed, even if this can be done without tools. Current can be present at some connection points. All work on a gas analyzer that is open and connected to power should only be performed by trained personnel who are familiar with the risks involved.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Optical adjustm.`

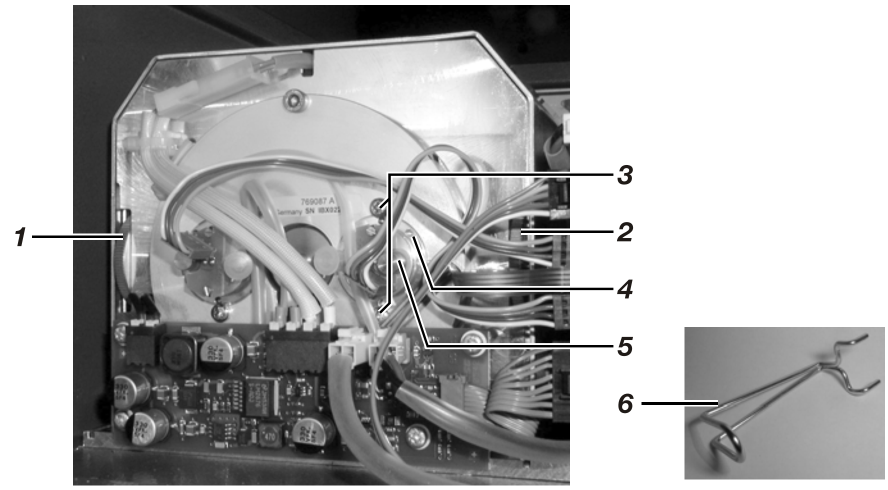
Continued on next page

Procedure

Step	Action	
1	Turn on the zero gas supply.	
2	Open the 19-inch housing front plate or the wall housing cover.	
3	Select the `Optical adjustm.` menu item.	
4	Select the `Sample component` to be measured in the rear detector (as seen from the emitter).	
5	Minimize the (zero gas) value displayed by turning the applicable beam path aperture adjustment wheel ***1*** or ***2*** (see Figure 9-4).	
	If	Then
	The measurement value is much smaller than 1,000,000	Go to Step 10.
	The measurement value is greater than 1,000,000	Go to Step 6.
6	Loosen the two emitter case mounting screws ***3*** and insert the emitter wrench ***6*** in openings ***4***.	
7	Turn the emitter case ***5*** until the displayed value is minimized. (The minimum can be greater than 1,000,000.)	
8	Tighten the emitter unit mounting screws ***3***.	
9	Repeat steps 5-8 until a minimum value is displayed.	
10	Close the 19-inch housing front plate or the wall housing cover.	
11	If	Then
	The emitter is replaced	Perform a phase alignment for all sample components (see page 9-6).
	The emitter is not replaced	Calibrate the zero and span points for all sample components in the beam path.

Figure 9-4

Uras26 Analyzer Module Emitter



1 Beam path 1 aperture adjustment wheel
2 Beam path 2 aperture adjustment wheel
3 Two emitter case mounting screws (beam path 2 here)
4 Openings for emitter wrench insertion
5 Emitter Case
6 Emitter Wrench

Uras26: Phase Alignment

Definition

Sample/reference signal phasing is optimized in the Uras26 by performing a phase alignment.

When should phase alignment be performed?

A phase alignment must always be performed after optical alignment when the emitter is replaced (see page 9-4).

How should phase alignment be performed?

A separate phase alignment must be performed for each detector (= sample component) in an analyzer module.

The phase alignment is performed electronically and there is no need to open the system housing.

Test Gases

During the phase alignment a zero and span gas supply should be turned on successively for each sample component.

If the analyzer module is equipped with calibration units the calibration cells are automatically inserted in the beam path for span alignment. Meanwhile zero gas must remain turned on.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Phase adjustm.`

Procedure

Step	Action	
1	Select the `Phase adjustm.` menu item.	
2	Select the `Sample component.`	
3	Turn on the zero gas supply.	
4	Wait until the measurement value reading stabilizes and activate the alignment procedure.	
5	If	Then
	The analyzer module has no calibration cells	Turn on the span gas supply.
	The analyzer module is equipped with calibration cells	Let the zero gas be turned on.
6	Wait until the measurement value reading stabilizes and activate the alignment procedure.	
7	Repeat steps 2-6 for all sample components.	
8	Calibrate the zero and span points for all sample components in the analyzer module.	

Limas11, Uras26: Measurement of Calibration Cells

Definition

The measurement of a calibration cell in the Limas11 and Uras26 analyzer modules means:

Determining what calibration cell “deflection” is equivalent to the test gas calibration reading. This “deflection” is stored as the calibration cell “set value”.

When should calibration cells be measured?

We recommend measuring the calibration cells once a year.

We recommend measuring the calibration cells
- after end-point calibration of a sample component with test gas or
- after any change in measurement range limits (see “Limas11, Uras26: Notes for Changing Measurement Range Limits” section, page 7-A-3) or
- after a relinearization (see “Limas11, Uras26: Relinearization” section, page 9-8).

Before measuring the calibration cells

Prior to measuring the calibration cells, the zero and end points of the applicable sample components must be calibrated with test gases.

Test Gas

During calibration cell measurement the zero gas supply must be turned on.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Measure cal. cell`

Limas11, Uras26: Relinearization

When should relinearization be performed?

Sample component relinearization should be performed

- If the linearity deviation exceeds the permissible 1% of span
- If the start of a suppressed measurement range is to be calibrated
- After a component (lamp/emitter, sample cell, calibration unit/cell, detector) is installed in or removed from a beam path.

We recommend to perform the relinearization of a sample component after measurement range limits have been changed (see “Limas11, Uras26: Notes for Changing Measurement Range Limits” section, page 7-A-3).

Test Gases

Depending on the number and type of measurement ranges, test gases with varying concentrations are required for relinearization.

Number and Type of Meas. Ranges	Test Gas Concentration
1 Measurement Range	Approx. 40–60% of the measurement range end value (“center point gas”)
2 Measurement Ranges	End value of smaller measurement range
2 Measurement Ranges, 1 of which is suppressed	Start value of suppressed measurement range

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Relinearization`

Procedure

Step	Action
	ⓘ Relinearization is performed separately for each sample component.
1	Perform the basic calibration for the zero and span of the sample component to be relinearized (see page 9-30).
2	Select the `Relinearization` menu item.
3	Select the `Sample component`.
4	Turn on the test gas supply.
5	Enter the test gas concentration set point value.
6	Wait until the measurement value reading stabilizes and activate the alignment procedure.
7	Repeat steps 3-6 for all sample components.

Limas11: Thermal Link Replacement

When should a thermal link be replaced?

A defective thermal link will usually be indicated by an Insufficient Sample Cell Temperature (T-Re.K) or Lamp Temperature (T-Re.L) error message (see “Status Messages” section, page 10-11). In this case check the thermal link and replace as necessary.

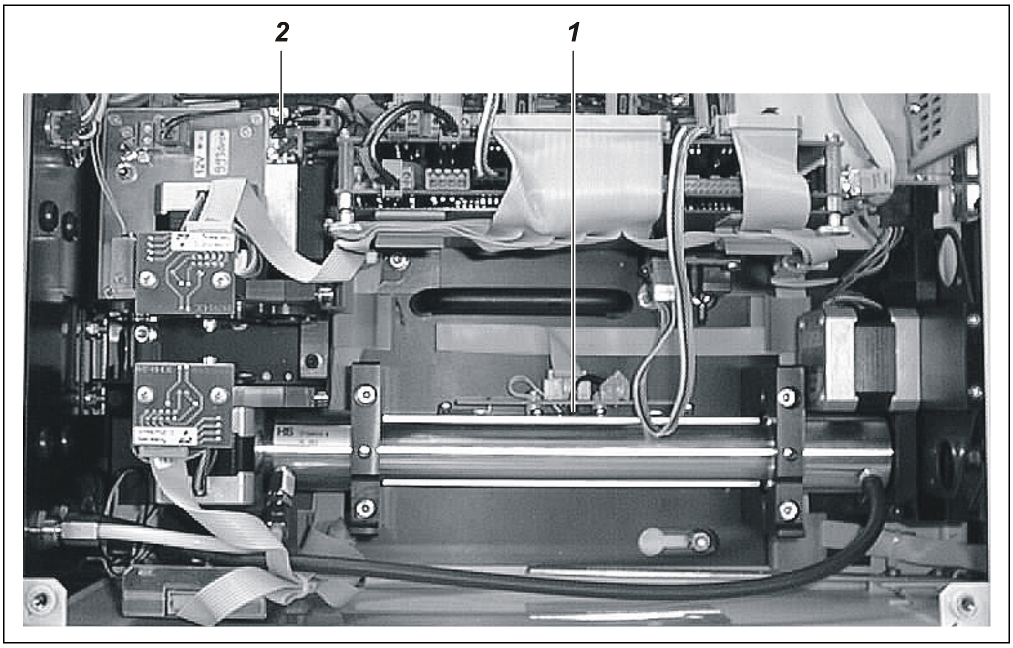
Thermal Link Replacement

(see Figure 9-5)

Step	Action
1	⚠ Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing cover. ⚠ The sample cell and the lamp are hot (approx. 55/60 °C)!
3	Disconnect the thermal link from the sample cell ***1*** and/or the lamp ***2***.
4	Release the spring clips and/or retainer and pull the thermal link from the opening.
5	Check the continuity of the thermal link; if necessary, insert a new thermal link (part number 0745836) in the opening and secure it with the spring clips and/or retainer.
6	Connect the thermal link.
7	Close the system housing. ℹ Light penetration during operation leads to erroneous measurement values and measurement range overflows (“Intensity” status message).
8	Turn on the gas analyzer power supply.

Figure 9-5

Thermal Links in the Limas11 Analyzer Module



1 Sample cell thermal link
2 Lamp thermal link

Limas11: Aluminum Sample Cell Cleaning

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see “Limas11 Problems”, page 10-20).

Status Messages

When beam intensity becomes too low the appropriate status messages will be displayed. For additional information see the “Status Messages” section, page 10-13.

Material Required

Quantity	Description
	For cleaning: Neutral detergent, deionized water, ethanol
	For drying: Oil- and dust-free (instrument) air or nitrogen
1	Spray bottle
2	Plug to close off sample cell
2	Pieces of FPM/FKM tubing or PTFE pipe

Aluminum Sample Cell Cleaning

(see Figure 9-6)

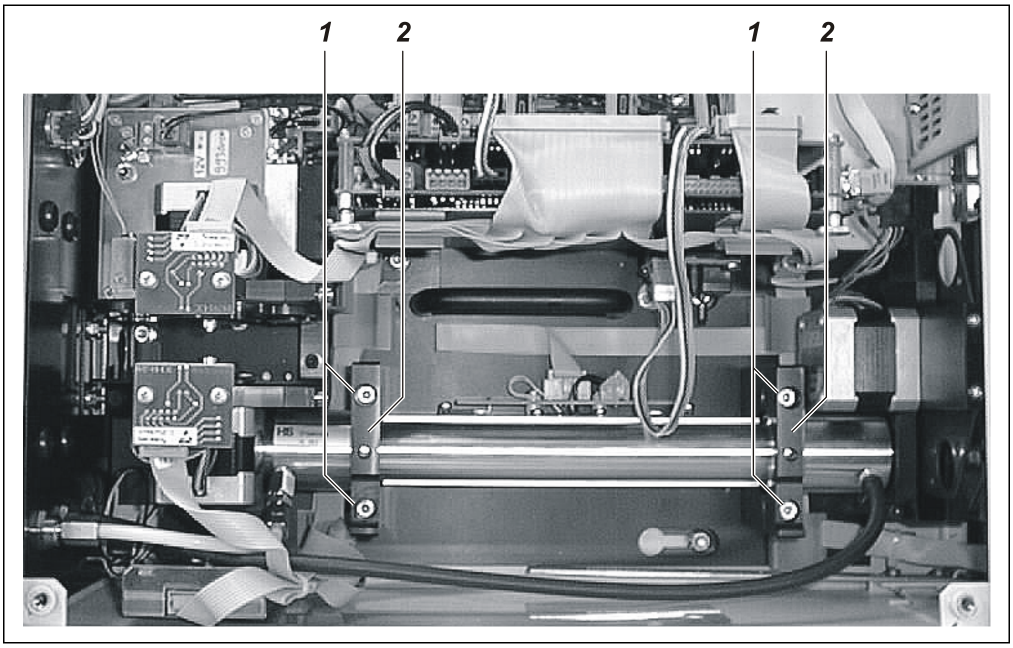
Step	Action
Preparation for sample cell removal:	
1	⚠ Turn off the sample gas supply to the analyzer module. Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing cover. ⚠ The sample cell is hot (approx. 55 °C)!
Sample cell removal:	
3	Loosen the sample gas tubing/pipe from the sample cell ports and housing wall and pull them from the housing. ⚠ When removing the sample gas tubing/pipe make sure no fluids drip into the housing. The sample gas tubing/pipe removed should not be reused since it is contaminated; follow the appropriate rules for disposal.
4	Loosen 4 screws ***1*** (3-mm Allen screws) and remove 2 mounting brackets ***2***.
5	Remove the sample cell from its housing.
Sample Cell Cleaning:	
6	Wash the sample cell with a warm detergent/water mixture. ⚠ Do not use other cleaners as they can damage the sample cell.
7	Thoroughly rinse the sample cell with deionized water and then with ethanol.
8	Dry the sample cell with oil- and dust-free air (30-100 liters/hour).
9	Check that the contamination has been removed.
ℹ	Also clean the sample gas line system.

Continued on next page

Step	Action
Sample Cell Installation:	
10	Place the sample cell in its housing. The index pin should be on the side of the sample cell that is toward the beam splitter. Turn the sample cell in its housing until the index pin engages in the hole in the housing.
11	Install the 2 mounting brackets ***2*** and secure them with the 4 screws ***1***.
12	Install the sample gas tubing or pipes on the sample cell ports and on the module's rear wall.
13	Check the integrity of the analyzer module gas paths (see page 9-2).
Restarting the analyzer module:	
14	Close the system housing. ℹ Light penetration during operation leads to erroneous measurement values and measurement range overflows ("Intensity" status message).
15	Turn on the gas analyzer power supply.
16	Wait for the warm-up phase to end. Start the sample gas supply.
17	Check linearity.

Figure 9-6

Aluminum Sample Cell in the Limas11 Analyzer Module



1 Allen Screws (3 mm)
2 Mounting Bracket

Aluminum Sample Cell with Center Connection

An aluminum sample cell with center connection is built-in in the Limas11UV analyzer module with Class 2 NO measurement ranges. In this version, the sample gas inlet is in the center and the sample gas outlets are at the ends of the sample cell. This has to be observed when re-installing the sample cell after cleaning.

Limas11: Quartz Sample Cell Cleaning

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see “Limas 11 Problems”, page 10-20).

Status Messages

When beam intensity becomes too low the appropriate status messages will be displayed. For additional information see the “Status Messages” section, page 10-13.

Material Required

Quantity	Description
	For cleaning: Neutral detergent, deionized water, ethanol
	For drying: Oil- and dust-free (instrument) air or nitrogen
1	Spray bottle
2	Plug to close off sample cell
1	Spare parts kit (part number 0768823)

CAUTION!

The quartz sample cell should be handled with extreme care! Especially the connection ports can easily break when the sample cell is handled improperly.

Quartz Sample Cell Cleaning

(See Fig. 9-7 and 9-8)

Step	Action
Preparation for sample cell removal:	
1	Turn off the sample gas supply to the analyzer module. Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing cover. The sample cell is hot (approx. 55 °C)!
Sample cell removal:	
3	Loosen the sample gas pipes ***2*** from the connections on the sample cell ***5*** and from the housing back wall ***1*** and pull them from the housing. Save the nut, cutting rings and sealing rings for reinstallation. When removing the sample gas pipes make sure no contaminants contained in the pipes fall into the housing. The sample gas pipes removed should not be reused since they are contaminated; follow the appropriate rules for disposal.
4	Loosen 4 screws ***3*** (3-mm Allen screws) and remove 2 mounting brackets ***4***.
5	Remove the sample cell ***6*** from its housing.
6	Unscrew the elbow/pivot fittings ***5*** from the sample cell.

Continued on next page

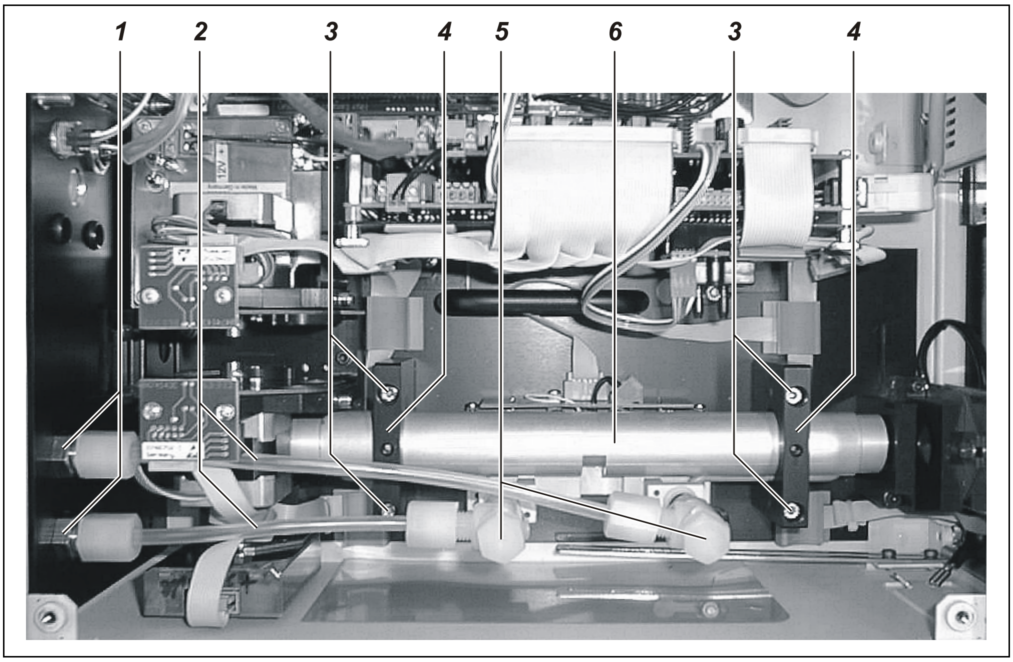
Step	Action
Sample Cell Cleaning:	
7	Wash the sample cell with a warm detergent/water mixture. Acids, alkalis or solvents can be used as cleansers in case of severe contamination. Be sure to follow the appropriate instructions for use and disposal when using acids, alkalis or solvents. Do not use hydrofluoric acid (HF) as it can destroy the sample cell.
8	Rinse the cell very thoroughly with deionized water until the detergent is completely removed. Finally, rinse the cell with ethanol until all water is removed.
9	Dry the sample cell with oil- and dust-free air (30-100 liters/hour).
10	Check that the contamination has been removed.
	Also clean the elbow fittings and the sample gas line system.
Sample Cell Installation:	
11	Place new FFKM75 O rings ***7*** on the sample cell connection ports.
12	Place the internal parts ***8*** of the elbow/pivot fittings on the connection ports and tighten them by hand. Place the elbows ***9*** on the internal parts with their ports facing toward the housing back wall and secure them by hand-tightening the nuts ***10***. The threaded connections must never be tightened any more than hand-tight. Otherwise the connections may not be securely sealed.
13	Place the sample cell ***6*** in its holder with the gas ports pointing to the left wall (as seen from the front/above).
14	Install 2 mounting brackets ***4*** – making sure that the notches for the sample cell gas lines also face the left wall – and secure with 4 screws ***3***.
Connect the sample gas lines to the sample cell.	
15	Push the sample gas tubes ***2*** through the threaded fittings ***1*** on the housing back wall. Make sure the sample gas lines are smooth and straight on both ends and that there are no kinks.
16	Slide nuts ***13***, cutting rings ***12*** and sealing rings ***11*** on the sample gas pipes ***2***.
17	Slide the sample gas tubes ***2*** up to the stop in the elbow/pivot fittings ***5*** on the sample cell and high-tighten nuts ***13***. Hand-tighten the nuts on fittings ***1*** on the housing back wall. The threaded connections must never be tightened any more than hand-tight. Otherwise the connections may not be securely sealed.
18	Check the integrity of the analyzer module gas paths (see page 9-2). Remember the higher seal integrity requirements.

Continued on next page

Step	Action
Restarting the analyzer module:	
19	Close the system housing.
	ⓘ Light penetration during operation leads to erroneous measurement values and measurement range overflows ("Intensity" status message).
20	Turn on the gas analyzer power supply.
21	Wait for the warm-up phase to end. Start the sample gas supply.
22	Check linearity.

Figure 9-7

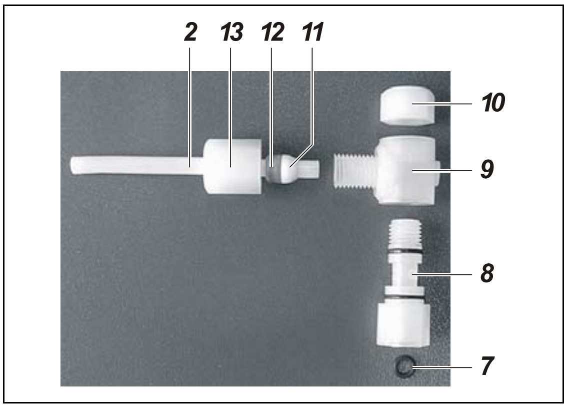
Quartz Sample Cells in the Limas 11 Analyzer Module



- ***1*** Threaded Fittings on Housing Back Wall
- ***2*** Sample Gas Tubes
- ***3*** Allen Screws (3 mm)
- ***4*** Mounting Bracket
- ***5*** Elbow/Pivot Fittings (see Figure 9-8 for Components)
- ***6*** Quartz Sample Cell

Figure 9-8

Elbow/Pivot Fitting Components



- ***2*** Sample Gas Tube
- ***7*** FFKM75 O ring
- ***8*** Internal Part
- ***9*** Elbow
- ***10*** Nut
- ***11*** Sealing Ring
- ***12*** Cutting Ring
- ***13*** Nut

Description of the Safety Cell

The safety cell comprises three components:
- Sample cell of stainless steel 1.4571,
- Beam guide tube 1 of brass (on the side pointing to the beam splitter),
- Beam guide tube 2 of brass (on the side pointing to the measuring detector).

The beam guide tubes are screwed into the sample cell and press the cell windows against the chambered 22.1x1.6 FFKM70 O-ring seals. In this manner, the sample gas side of the cell is sealed so that it is gas-tight. One 28x2-FKM80 O-ring seal is located on the periphery of each of the beam guide tubes. The purge gas chamber is sealed so that it is gas-tight to the outside by means of this seal.

The tightness of the sample cell has been tested in the factory for a leakage rate of $< 1 \times 10^{-6}$ mbar l/s.

Fig. 9-9

Safety Cell in the Limas11 Analyzer Module

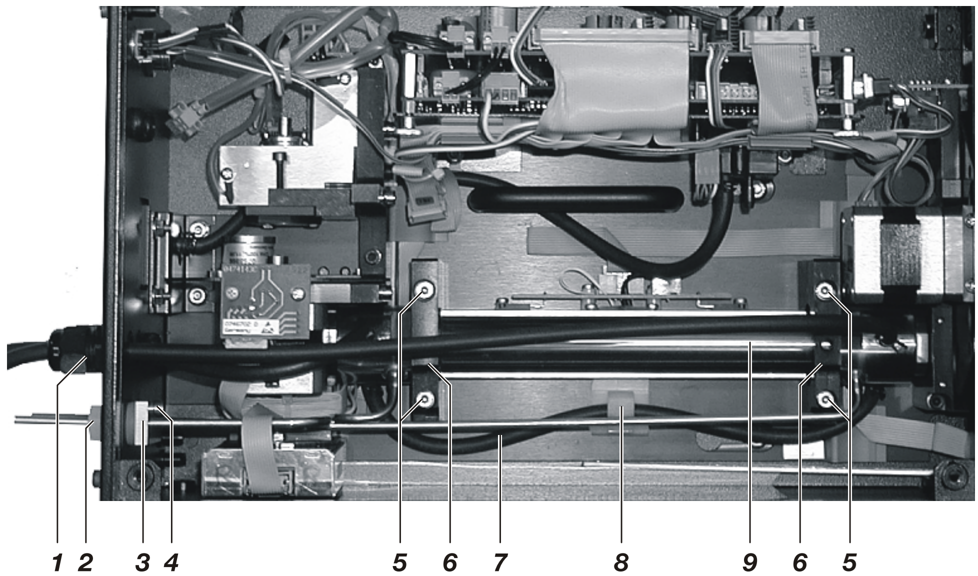
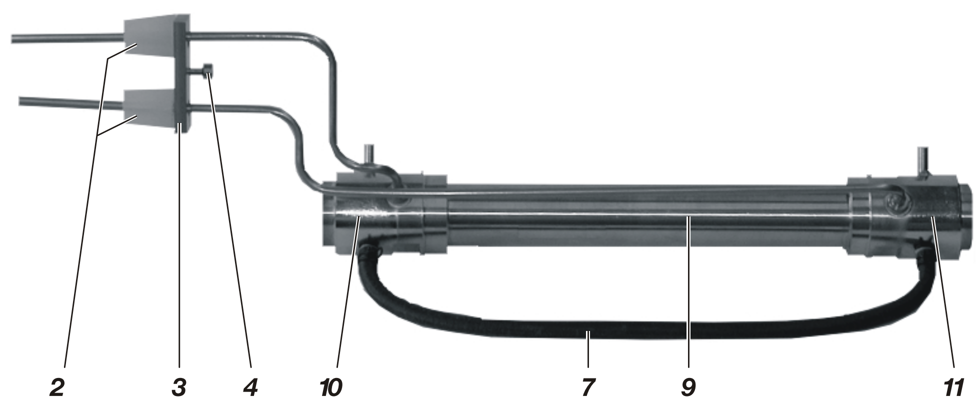


Fig. 9-10

Safety Cell



1 Couplings of the Purge Gas Lines
2 Plugs
3 Retaining Board
4 Screw
5 Screws
6 Mounting Bracket
7 Purge Gas Hose
8 Fixing Device
9 Sample Cell
10 Beam Guide Tube
11 Beam Guide Tube

Continued on next page

When should the sample cell be cleaned?

Sample cell contamination can result in unstable measurement values due to low lamp intensity (see "Limas 11 Problems", page 10-20).

Status Messages

When beam intensity becomes too low the appropriate status messages will be displayed. For additional information see the "Status Messages" section, page 10-13.

Material Required

Qty.	Description
For sample cell removal:	
1	Hexagonal wrench 4 mm
1	Hexagonal wrench 3 mm
1	Crosshead screw driver 4,5 mm
1	Small flat nose pliers
2	Plugs for sealing the sample gas tubing
For disassembly and assembly of the sample cell:	
1	Plug for sealing the sample cell
1	Open-end wrench 25 mm for sample cell with nominal length 216 mm
1	Open-end wrench 30 mm for sample cell with nominal length 216 mm
2	Open-end wrenches 30 mm for sample cells with other nominal lengths
1	Vise
1	"Vacuum pen"
1	Small pair of tweezers
	Soft paper towels
For cleaning the sample cell and the sample gas tubing:	
1	Circular brush with plastic bristles, diameter approx. 20 mm
2	Spray bottles
	Neutral detergent, deionized water, ethanol
	For drying: Oil- and dust-free (instrument) air or nitrogen
For the seal integrity test (positive pressure method):	
1	Pressure gauge, measuring range p_e = 0...400 hPa
1	Tee with shut-off valve
1	Hose, inside diameter 4 mm, length approx. 0.5 m
2	Hose clamps
	Oil- and dust-free (instrument) air or nitrogen

Replacement Parts Required

Qty.	Description	Part No.
2	O-ring seals 22.1x1.6 FFKM70	650 505
2	O-ring seals 28x2 FKM80	650 519
2	Windows of calcium fluoride 25.2x4	598 216
2	Vent plugs for sample gas tubing A 5.2 LDPE	456 894
2	Plugs for sample gas tubing	402 541

Continued on next page

CAUTION!

It is imperative that the following procedure is carried out step by step and with the greatest of care. Otherwise there is a danger that the safety cell is no longer absolutely tight after cleaning and therefore no longer performs its function!

The following is to be noted in particular:

- **The cell windows must not be damaged!**
- **The old O-ring seals must not be used again! After cleaning, new O-ring seals must be used!**
- **After cleaning, the tightness of the sample cell must be tested for a leakage rate of < 1 x 10^{-4} mbar l/s!**

Note: If necessary, the tightness of the sample cell can be tested for a lower leakage rate by means of a He leakage test.

CAUTION!

Toxic, caustic or corrosive fluid may be contained in the sample cell! This fluid can escape when the sample cell is opened. In consequence of this, suitable measures for the collection and disposal of the fluid are to be taken before removal of the sample cell!

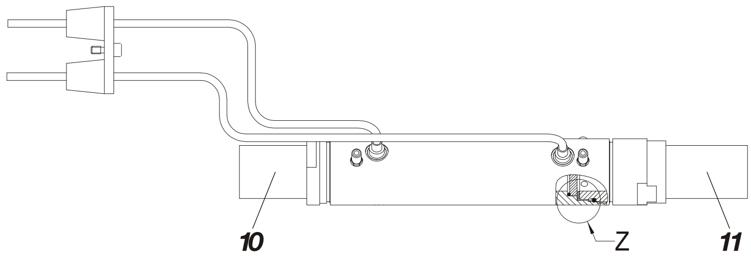
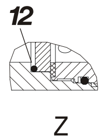
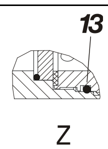
Cleaning the Safety Cell

Step	Action
Preparation for Sample Cell Removal:	
1	⚠ Turn off the sample gas and purge gas supply to the analyzer module!
2	Purge the sample gas feed path with dry nitrogen (flow approx. 60 l/h, duration approx. 30 minutes).
3	Seal the sample gas inlet and outlet of the sample cell (sample gas tubing) with one plug each, so that no fluid can escape during the removal of the sample cell.
4	⚠ Switch off the gas analyzer power supply!
5	Open the wall housing door or the 19-inch housing cover.
6	⚠ The sample cell and the lamp or the radiation source are hot (approx. 60 °C)! Allow the modules to cool (approx. 30 minutes).

Continued on next page

Step	Action
Sample Cell Removal:	
7	Undo the 2 couplings ***1*** of the purge gas lines on the rear of the analyzer module and pull the purge gas hoses into the interior of the device. Remove the purge gas hose ***7*** from the fixing device ***8***.
8	If applicable, remove the purge gas hose from the input of the flow sensor (option).
9	To open the leadthroughs of the sample gas tubing, undo the screw ***4*** (socket-head, wrench opening 3 mm) for securing the retaining board ***3***, remove the 2 plugs ***2*** from the leadthroughs and push towards the interior of the device on the sample gas tubing.
10	Undo the 4 screws ***5*** (socket-head, wrench opening 3 mm) and remove 2 mounting brackets ***6***.
11	Lift the sample cell ***9*** on the side pointing to the measuring detector and pull out obliquely upwards from the housing towards the measuring detector.
12	Remove the purge gas hoses from the connections of the sample cell.
Disassembly of the Sample Cell:	
13	Hold the sample cell with 2 open-end wrenches (clamp 1 open-end wrench in the vise, in order to fix the sample cell in position) and unscrew the two beam guide tubes ***10*** and ***11***. ⚠ Take care that the cell windows do not fall out and that they are not damaged!
14	If the cell windows are stuck to the O-ring seals, they must be removed by flushing the sample cell with compressed air. ⚠ Wear safety glasses when working with compressed air! Point the opening of the sample cell away from the body! 1 Insert a soft paper towel into the aperture of the sample cell to collect the cell window. 2 Seal the opening of a sample gas tube with a plug and pressurize the other sample gas tube with compressed air ($p_e \approx 100$ kPa = 1 bar). The cell window is thereby removed from the seal. Collect the cell window in the paper towel. ⚠ Fluid can escape from the sample cell! Follow the relevant safety regulations! 3 Seal the opening of the sample cell with a plug and pressurize the sample cell with compressed air once again. The other cell window is thereby removed from the seal. Collect the cell window in the paper towel.
15	Remove the 2 O-ring seals 22.1x1.6 FFKM70 with a pair of tweezers and dispose of. Also remove and dispose of the 2 O-ring seals 28x2 FKM80. ⚠ The O-ring seals may not be used again! Always replace them with new seals!

Continued on next page

Step	Action
Cleaning the Sample Cell and Sample Gas Tubing:	
16	Clean the sample cell with a warm detergent/water mixture. If necessary, use a circular brush with plastic bristles.
17	Clean the sample gas tubing in the same way. To do this, use a spray bottle to rinse the sample gas tubing with the detergent/water mixture. ℹ In the case of heavier contamination, the following can also be used as a cleaning agent: – organic solvents or – in turn, diluted soda lye, water, diluted nitric acid for neutralization, water. ⚠ When using acids, lyes or solvents, please follow the relevant safety and disposal regulations!
18	Check that the contamination has been removed.
19	Rinse the sample cell and sample gas tubing thoroughly with deionized water, until the detergent has been completely washed out. Afterwards, rinse with ethanol, until the water has been washed out.
20	Dry the sample cell and sample gas tubing with oil- and dust-free air (30–100 l/h).
ℹ	Clean the entire sample gas line system in the same way!
Sample Cell Installation:	
	
ℹ	Carry out steps 21 to 23 on both sides of the sample cell in turn.
21	Insert a new O-ring seal 22.1x1.6-FFKM70 ***12*** in the sample cell. ⚠ The seat of the O-ring seal may not be damaged and must be absolutely free of oil and dust. 
22	⚠ Check that the sample cell is not damaged! Insert the cell window into the sample cell by means of the “vacuum pen” pipette. ⚠ When doing so, take care that the cell window does not fall out and that it is not damaged!
23	Insert a new O-ring seal 28x2-FKM80 ***13*** into the groove of the beam guide tube and screw the beam guide tube fingertight into the sample cell. ℹ Screw in the shorter beam guide tube ***10*** into the side of the sample cell, on which the apertures of the sample gas tubing are located. 

Continued on next page

Step	Action
24	Hold the sample cell with 2 open-end wrenches (clamp 1 open-end wrench in the vise, in order to fix the sample cell in position) and screw in the beam guide tubes ***10*** and ***11*** as far as they will go.
Checking the Sample Cell for Tightness:	
ℹ	For the assembly of the sample cell as prescribed, a leakage rate of $< 1 \times 10^{-4}$ mbar l/s must be safely reached. This is tested as follows:
25	Seal the aperture of one sample gas tube so that it is gas-tight.
26	Connect the T-piece with shut-off valve to the aperture of the other sample gas tube with the hose.
27	Connect the free end of the T-piece to the pressure gauge.
28	Blow air through the shut-off valve until the sample cell is under an positive pressure of $p_e \approx 400$ hPa (= 400 mbar). Close the shut-off valve.
29	The pressure may not change significantly in 15 minutes at a constant temperature. A sharp drop in pressure is an indication of a leak inside the sample cell.
Installing the sample cell:	
30	Push the purge gas hoses onto the connections of the sample cell and secure by means of the clamping springs.
31	Check that the plugs ***2*** are seated on the sample gas tubing.
32	Insert the sample cell into the housing obliquely from above in such a way that the sample gas tubes project through the leadthroughs to the outside.
33	Slowly lower the sample cell initially onto the side pointing to the beam splitter and then onto the side pointing to the measuring detector and insert in the fixing device.
34	Clamp the purge gas hose ***7*** in the fixing device ***8***.
35	Attach 2 mounting brackets ***6*** and fasten by means of the 4 screws ***5*** (socket-head, wrench opening 3 mm).
36	Press the 2 plugs ***2*** into the leadthroughs. Fix the retaining board ***3*** in position with the screw ***4***.
37	If applicable, push the purge gas line onto the input of the flow sensor (option) and fasten by means of the spring.
38	Lay the purge gas lines in the housing in such a way that no movable parts, e.g. the chopper wheel, are obstructed, feed through the 2 couplings ***1*** and fix in position.
Restarting the gas analyzer:	
39	Close the system housing so that it is tight. ℹ Light penetration during operation leads to erroneous measurement values and overranging (“Intensity” status message).
40	Turn on the gas analyzer power supply.
41	Purge the sample gas feed path. With corrosive sample gases, purge the entire sample gas line system with dry nitrogen.
42	Wait for the warm-up phase to end.
43	Check the zero point and end point and calibrate if necessary.
44	Start the sample gas and purge gas supply.

When should the lamp be replaced?

Over a period of 2-3 years the plasma-discharge fill gas will dissipate, causing a loss of lamp intensity. The lamp must be replaced when its intensity reaches a value at which the short-term stability of the smallest measurement range is too low.

Status messages

When beam intensity becomes too low the appropriate status messages will be displayed. For additional information see the “Status Messages” section, page 10-13.

Determining Lamp Service Life

Lamp service hours are displayed in the `Maintenance/Test → Analyzer spec. adjustm. → Amplification Optimization` menu.

Lamp Replacement

(see Figure 9-11)

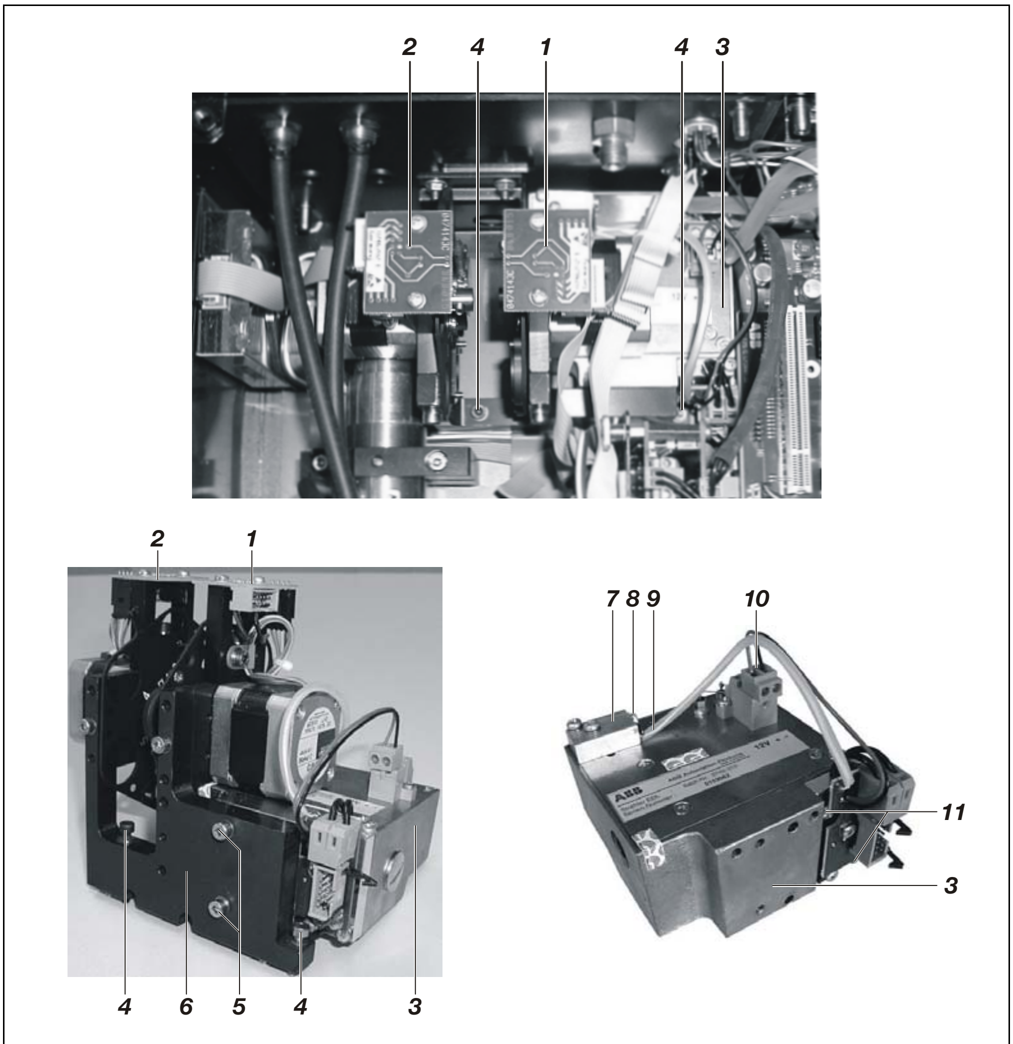
Step	Action
Remove the old lamp:	
1	⚠ Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing cover. ⚠ The lamp is hot (approx. 60 °C)!
3	Remove the cables to the light barrier boards ***1*** und ***2*** above the filter wheels.
4	Remove the cables from the lamp ***3***.
5	Loosen 2 fastening screws ***4*** of the support using a 3-mm Allen wrench.
6	Remove the support with both filter wheels, step motors and lamp.
7	Loosen 2 fastening screws ***5*** of the lamp ***3*** using a 3-mm Allen wrench.
8	Remove complete lamp ***3*** from the support ***6***.
9	Loosen the 12-V-supply connector ***10***.
10	Remove the fastening screw ***8*** with washer and holder of the temperature sensor ***9***. ⓘ These parts are needed to mount the temperature sensor to the new lamp!
11	Remove the temperature sensor ***9*** from the hole in the temperature sensor block ***7***.
12	Loosen 2 fastening screws ***11*** of the heater block and remove the complete heater block from the lamp ***3***.
Install the new lamp:	
13	Before installing the new lamp, record the serial number shown on the identification plate. It will be needed during amplification optimization.
14	Perform steps 3–12 in reverse order.

Continued on next page

Step	Action
Restart the analyzer module:	
15	Close the system housing. ⓘ Light penetration during operation leads to erroneous measurement values and measurement range overflows (“Intensity” status message).
16	Turn on the gas analyzer power supply and wait for the warm-up phase to end.
17	Perform an amplification optimization (see “Amplification Optimization” section, page 9-23).
18	Recommendation: Check sensitivity and linearity.

Figure 9-11

Lamp (EDL) in the Limas11UV Analyzer Module



1 Light Barrier Board 1
2 Light Barrier Board 2
3 Lamp (EDL)
4 Fastening Screws of the Support
5 Fastening Screws of the Lamp
6 Support
7 Temperature Sensor Block
8 Fastening Screw of the Temperature Sensor
9 Temperature Sensor
10 12-V-Supply Connector
11 Fastening Screws of the Heater Block

Limas11: Amplification Optimization

Definition

The amplification optimization procedure automatically seeks and identifies the optimum measurement range for the sample and reference receiver analog/digital converter.

When should amplification optimization be performed?

Amplification optimization should be performed,
- after the lamp has been replaced,
- after a module (sample cell, calibration cell, interference filter, receiver) has been removed or inserted in the beam path,
- if the status message No. 301 “Measurement value exceeds the analog/digital converter value range” is present (with system housing closed).

Amplification optimization alone cannot correct the causes for the status messages No. 358 and 359 “Lamp intensity above or below (middle of) permissible range”.

How should amplification optimization be performed?

- When the lamp has been replaced:
  - Write down the serial number of the new lamp prior to installation.
  - Perform amplification optimization for all sample components, thereby entering the serial number of the new lamp.
- When a module has been removed or inserted in the beam path:
  - Write down the serial number of the installed lamp.
  - Perform amplification optimization for all sample components, thereby entering an arbitrary lamp number.
  - Perform amplification optimization for all sample components, thereby entering the serial number of the installed lamp.
- When the status message No. 301 is present:
  - Perform amplification optimization for each sample component for which the status message is present.

Softkeys

`New Lamp`	Optimizes all receiver signals for all sample components; this overwrites any stored initial intensities with a new initial value.
`Optimize`	Optimizes receiver signals for a specific sample component; this does not overwrite the stored initial intensities.
`Optimize All`	Optimizes receiver signals for all sample components; this does not overwrite the stored initial intensities.

Test Gas

The zero gas supply should be turned on during amplification optimization.

Fortsetzung auf der folgenden Seite

Menu Path

MENU → Maintenance/Test → Analyzer spec. adjustm. → Amplification optimization

Procedure

Step	Action
1	Turn on the zero gas supply. If a solenoid valve is used to switch to zero gas, the supply will be activated automatically.
2	Select the Amplification optimization menu item.
3	Select the first sample component for which status message No. 301 is present.
4	Press the **New Lamp** or **Optimize** or **Optimize All** softkey. After pressing New Lamp a window will be appear for entering the serial number of the new lamp. After this the amplification optimization procedure will run automatically for all sample components and cannot be interrupted.
5	Wait for measurement value readings to stabilize and end the amplification optimization procedure by pressing **ENTER**.
6	Confirm the amplification optimization by pressing **ENTER** (the zero point will be automatically aligned) or reject the result by pressing **Back** or **Meas**.
7	Repeat steps 3-6 for all sample components for which status message No. 301 is present..

Gas Module: Disposable Filter Replacement

When should the disposable filter be replaced?

The gas module disposable filter should be changed if it is stained by contaminants.

We recommend changing the disposable filter (catalog number 23044-5-8018418) every six months.

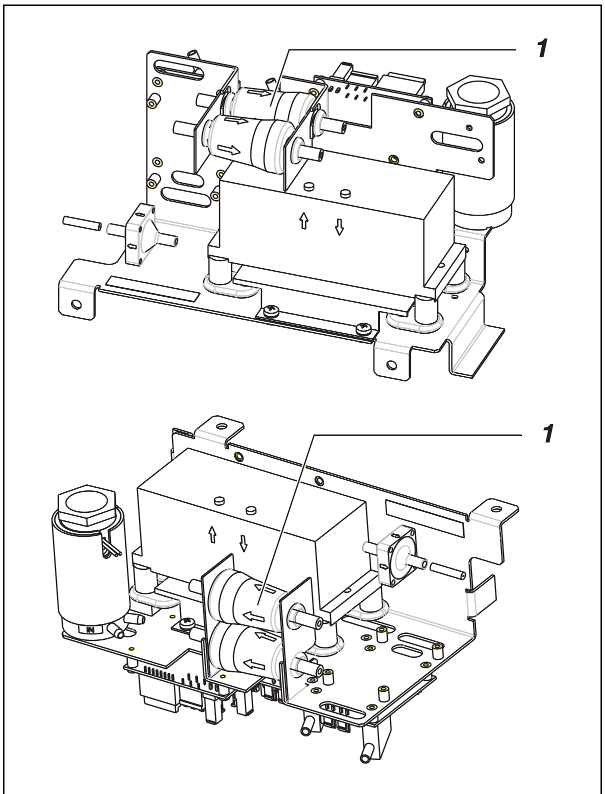
Disposable Filter Replacement

Step	Action
1	⚠ Turn off the sample gas supply to the analyzer module. Turn off the gas analyzer power supply.
2	Open the wall housing door or the 19-inch housing front plate.
3	Remove the disposable filter ***1*** from the bracket.
4	Remove the hose clamps from both sides of the disposable filter and disconnect the hoses. ℹ Properly dispose of the contaminated filter.
5	Attach the hoses to the new disposable filter and fasten them with the hose clamps. ℹ Pay attention to the flow direction. The flow direction ⇨ is marked on the disposable filter housing.
6	Place the disposable filter in the support.
7	Check the integrity of the analyzer module gas paths (see page 9-2).
8	Close the system housing.
9	Turn on the gas analyzer power supply.
10	Wait for the warm-up phase to end. Turn on the sample gas supply.

Figure 9-12

Location of Disposable Filter in Gas Module

above:
in 19-inch housing
below:
in wall-mount housing



1 Disposable Filter

⇨ Flow Direction

Pump Activation, Pump Output Adjustment

Pump Activation

The pump installed in the internal gas module and external pumps connected to appropriately configured digital outputs can be activated and deactivated manually, for instance in emergency situations.

An emergency shutdown cannot be bypassed by automatic calibration.

Pump Output Adjustment

The output of the pump installed in the internal gas module can be adjusted manually only when the pump is in operation.

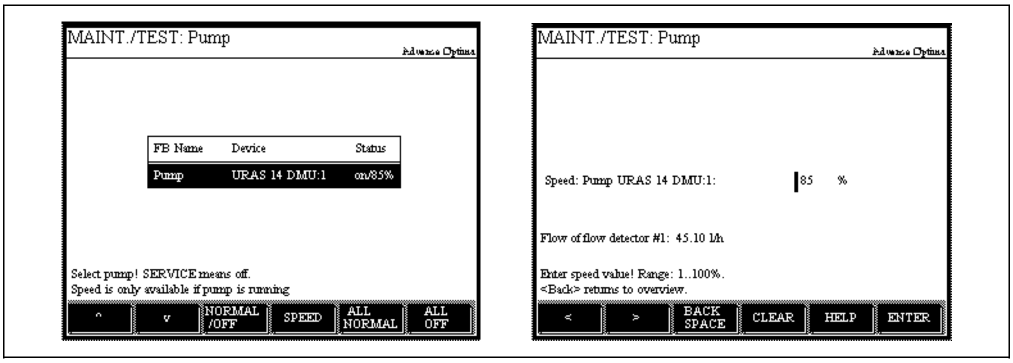
If there is a flow sensor in the gas module, its reading is shown when adjusting the pump output.

Menu Path

`MENU` → `Maintenance/Test` → `Analyzer spec. adjustm.` → `Pump`

Figure 9-13

Pump Output Adjustment



Changing Analog Output Current Range

Method

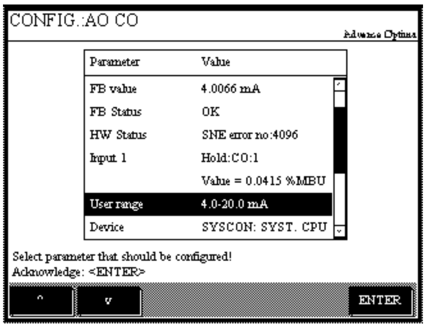
The current range of the individual analog outputs can be modified by initializing the applicable **Analog output** function blocks. Technical Bulletin "AO2000 Function Blocks – Descriptions and Configuration" (Publication No. 30/24-200 EN) contains a detailed description of the function block.

Menu Path

`MENU → Configure → Function blocks → Outputs → Analog output`

Figure 9-14

Analog Output Function Block Parameters



Changing Current Range

The current range is changed using the `User range` parameter.

Selection

The current range choices are 0-20 mA, 2-20 mA and 4-20 mA.

The output signal cannot be lower than 0 mA.

Air Pressure Effect

A specific amount of change in air pressure will result in a specific change in a measurement value, depending on the measurement principle employed by the analyzer module.

Measures to Minimize Air Pressure Effect

Air pressure effect can be minimized by:
- Installing a pressure sensor in the analyzer module (this can only be done at the factory) or
- Entering the current atmospheric pressure as a correction value.

Which analyzer modules have a pressure sensor?

Analyzer Module	Pressure Sensor
Uras26, Limas11, Caldos27	built-in at the factory
Caldos25	not necessary
Magnos206, Magnos27	built-in at the factory as an option
MultiFID14	cannot be built in

Use the `MENU` → `Diagnostic/Information` → `System overview` menu item and select the appropriate analyzer module to determine if a pressure sensor is installed.

Air Pressure Values

Operating Altitude meters above mean sea level	Mean Air Pressure hPa (mbar)	psi	mm Hg (Torr)	in Hg
–200	1037	15.04	778	30.63
–100	1025	14.87	769	30.28
±0	1013	14.69	760	29.92
+100	1001	14.52	751	29.57
200	989	14.34	742	29.21
300	977	14.17	733	28.86
400	965	14.00	724	28.50
500	955	13.85	716	28.19
600	943	13.68	707	27.84
700	932	13.52	699	27.52
800	921	13.36	691	27.21
900	909	13.18	682	26.85
1000	899	13.04	674	26.54
1100	888	12.88	666	26.22
1200	877	12.72	658	25.91
1300	867	12.57	650	25.59
1400	856	12.42	642	25.28
1500	845	12.26	634	24.96
1600	835	12.11	626	24.65
1700	825	11.97	619	24.37
1800	815	11.82	611	24.06
1900	804	11.66	603	23.74
2000	793	11.50	595	23.43

Air Pressure Value Correction

An incorrect air pressure value will produce erroneous measurement values.

When should the air pressure value be set?

The air pressure value must be checked and readjusted as required in the following cases:

- If the gas analyzer's operating site altitude has changed since the last calibration
- If the air pressure effect on the measured value is too high (see also Appendix 2, "Analyzer Module Operating Specifications").

Limas11 and Uras26 with Integral Pressure Sensor and Calibration Cells

A pressure sensor is factory-installed in the Limas11 and Uras26 analyzer modules. The pressure sensor is calibrated to 1013 hPa. This is the reference pressure for the test gas concentration when measuring the calibration cells.

If the air pressure value needs to be changed, the following items are also required

- Calibrate the sample components with test gases and then
- Measure the calibration cells

Air Pressure Value Correction

The current atmospheric pressure can be entered as a correction value for each analyzer module or for all analyzer modules as a group.

Menu Path

For one analyzer module:
`MENU → Maintenance/Test → Analyzer spec. adjustm. → Atm. press. anlz → ...`

For all analyzer modules as a group:
`MENU → Maintenance/Test → System → Atm. pressure`

If the pressure sensor is connected to the sample gas output line, the sample gas flow must be interrupted while calibrating the pressure sensor so that the sample gas pressure does not distort the measured pressure.

What does the calibration reset do?

A calibration reset returns the analyzer module's calibration to basic calibration values. Additionally, the offset drift and amplification drift are electronically returned to basic calibration values (see "Basic Calibration" section, page 9-31).

Note

The absolute offset and amplification drift values are calculated in cumulative fashion starting from the last basic calibration.

The relative offset and amplification drift values are calculated between the last and next to last automatic calibration.

The absolute and relative offset and amplification drift values can be viewed in the `MENU → Diagnostic/Information → Module specific → Status` *menu item.*

When should a calibration reset be performed?

A calibration reset should be performed if an analyzer module can no longer be calibrated by normal means. A possible cause of this is calibration of the analyzer module with the wrong test gases.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Calibration reset`

ℹ The analyzer module should be calibrated after a calibration reset.

Basic Calibration

What does the basic calibration do?

A basic calibration of an analyzer module places the module's calibration status back in an initial state. The offset drift and amplification drift are set to zero. The drift history is lost.

When should a basic calibration be performed?

Basic calibration of an analyzer module should be performed only in exceptional cases when changes that affect calibration have been made. This may be the case e.g. after exchanging subassemblies.

For the Uras26 analyzer module, a basic calibration can be performed at the zero point for calibration to the cooler dew point during commissioning at the sampling point.

Check prior to a Basic Calibration

Prior to a basic calibration, check and ensure
- That the gas analyzer is in proper operating condition
- That the sample conditioning units are in proper operating condition
- That the correct test gases are being used.

Test Gases

The zero and/or span calibration test gases are required for a basic calibration.

Performing the Basic Calibration

The basic calibration is performed for each sample component or – for the Caldos25 and Magnos27 analyzer modules – for each measurement range.

The basic calibration can be performed
- Individually at the zero point
- Individually at the end point, as well as
- Together (successively) at the zero and end points

A calibration reset is also performed in the case of common basic calibration at the zero and end points (see “Calibration Reset” section, page 9-30).

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Basic calibration`

Cross-Sensitivity Alignment

Electronic Cross-Sensitivity Correction

AO2000 offers the ability to electronically correct cross sensitivity, in contrast to using purely physical methods (for example, for infrared absorption, optical filter or flowing reference gas).

Electronic cross sensitivity correction is possible with the Caldos25, Caldos27, Limas11, Magnos206 and Uras26 analyzer modules. In addition, this function must be factory-set per customer order. It is configured as a function block application.

A detailed description of the function block **Cross sensitivity correction** is contained in the Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (Publication No. 30/24-200 EN).

Cross sensitivity correction is an offset correction.

Interference component concentration is continuously measured and corrected by means of the measurement value. Alternatively, the interference component concentration can be entered directly as a correction value during the cross sensitivity alignment.

Internal and External Cross Sensitivity Correction

Interference component concentration can be measured in two ways:
- Using the analyzer module with which the sample component is measured (internal cross sensitivity correction, possible only with the Limas11 and Uras26 analyzer modules) or
- With another AO2000 analyzer module or another analyzer (external cross sensitivity correction) The correction signal, i.e. the measured value of the interference component is transferred to the analyzer module with the sample component to be corrected via the system bus or analog input.

When should a cross sensitivity alignment be performed?

A cross sensitivity alignment, i.e. alignment of the cross sensitivity correction function, should not be performed in normal operation.

We recommend checking the cross sensitivity correction once a year.

Test Gas for Cross Sensitivity Alignment

One of the following test gases is needed for the cross sensitivity alignment:
- Either a sample component-free test gas containing the maximum concentration of the interference component
- Or the interference component span gas.

Prior to the Cross Sensitivity Alignment

Prior to the cross sensitivity alignment, the zero and end points of the applicable sample and interference components must be calibrated with test gases in the respective analyzer module.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Cross sensitivity adjustm.`

Electronic Carrier Gas Correction

In principle, the electronic carrier gas correction operates in the same manner as the cross sensitivity correction (see “Cross Sensitivity Alignment” section, page 9-32).

Carrier gas correction is possible only if the cross sensitivity correction function has been factory-configured per customer order.

Carrier gas correction is similarly configured as a function block application. A detailed description of the function block **Carrier gas correction** is contained in the Technical Bulletin “AO2000 Function Blocks – Descriptions and Configuration” (Publication No. 30/24-200 EN).

Carrier gas correction is an amplification correction.

When should a carrier gas alignment be performed?

A carrier gas alignment, i.e. alignment of the carrier gas correction function, should not be performed in normal operation.

We recommend checking the carrier gas correction once a year.

Test Gas for Carrier Gas Alignment

A gas mixture with the appropriate concentrations of sample and interference components is required as the test gas.

Prior to the Carrier Gas Alignment

Prior to the carrier gas alignment, the zero and end points of the applicable sample and interference components must be calibrated with test gases.

If the interference component influences the zero indication of the sample component, a cross sensitivity alignment is required prior to the carrier gas alignment.

Set Point Entry

Enter the sample component concentration as the set point.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Carrier gas adjustm.`

CAUTION!

The tasks described in this chapter require special training and under some circumstances involve working with the gas analyzer open and powered up. Therefore, they should only be performed by qualified and specially trained personnel.

Process Status

Definitions

Process status provides information on measurement values and the process being monitored by the analyzer.

System status (see page 10-2) provides information on the gas analyzer itself.

Process Status

The term “process status” includes
- Transgression of measurement range limits
- Transgression of measurement value limit values

Transgression of Measurement Range Limits

If a sample component value is > +130% or < –100% of the measurement range span, the sample component value in the display flashes. A status message is also generated which is not entered into the logbook.

The thresholds established cannot be changed.

Transgression of Limit Values

If a sample component value is above or below a limit value, this status can be communicated as a binary signal at one of the system controller or I/O board digital outputs.

Two prerequisites must be met for this to happen:
- The limit value must be assigned to a digital output by means of function block configuration (see “Standard Configuration” section, page 7-B-2).
- The limit value monitoring parameters (direction of effect, threshold value, hysteresis) must be set (see “Limit Monitor Initialization” section, page 7-A-7).

The assignment of limit values to certain digital outputs is factory-set; this is documented in the analyzer data sheet.

Where are status messages generated?

Status messages are generated
- By the gas analyzer, i.e.
  - The system controller (signal processing, calibration, system bus)
  - The analyzer modules
  - The gas module
  - The temperature and pressure regulators
  - The I/O modules and external I/O devices
- By peripherals, for example
  - The system cooler
  - Other sample gas conditioning modules

User-Configured Status Messages

Status messages are automatically generated by the gas analyzer and by peripherals.

Additionally, by configuring the **Message generator** function block, status messages from the analyzer and peripherals can be linked into the status message processing system (see Technical Bulletin 30/24-200 EN "AO2000 Function Blocks – Descriptions and Configuration" for details).

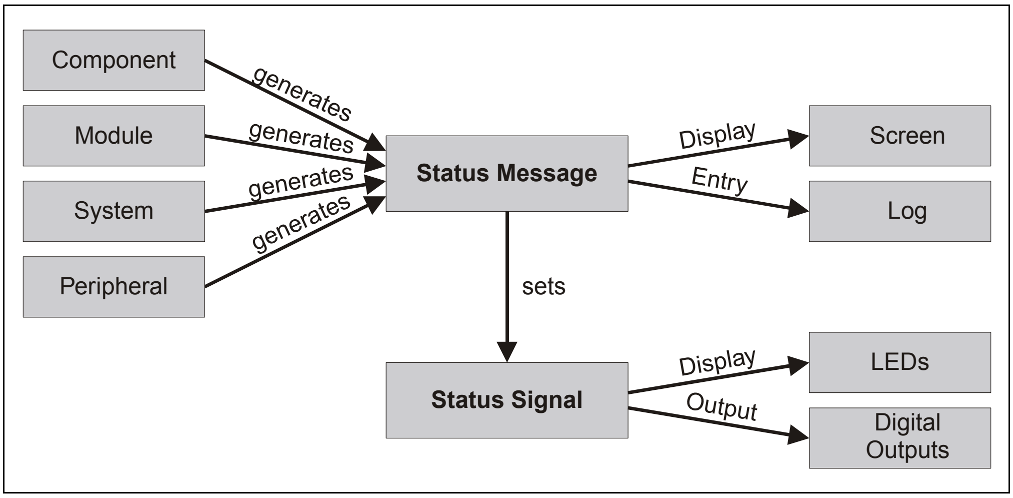
How are status messages processed?

(see Figure 10-1)

- Status messages are shown on the screen and recorded in the log.
- Status messages set a corresponding status signal (overall status or individual status).
- Status signals are indicated using status LEDs and output via the system controller digital outputs.

Figure 10-1

Status Message Processing



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Status Message Display

The `STATUS MESSAGE` softkey appears as soon as a status message is generated. By pressing the softkey the user can recall the status message summary and view status message details.

Logging Status Messages

Status messages are logged.

Messages concerning a transient gas analyzer state with no direct effect on measurements are not logged. Such messages include

- "A password is active!"
- "This system is temporarily under remote control!"
- "Automatic calibration in progress."

Overall Status or Individual Status

The status signal is factory-configured to output as an overall or individual status indicator (refer to “Configuring Status Signals” section, page 7-C-9).

Overall Status

If the gas analyzer is configured to output overall status, status messages are issued as overall status indications.

Individual Status

The following table shows possible causes of individual status signals and how to evaluate the values measured.

Status Signal	Cause	Evaluation of Measured Value
Error	The analyzer is in a state that requires immediate user intervention.	The value is invalid.
Maintenance Required	The analyzer is in a state that will soon require user intervention.	The value is valid.
Maintenance Mode	The gas analyzer is being calibrated or serviced.	Discard the value as a process measurement value.

Individual Status by Analyzer Module or Sample Component

In principle, the individual status signals apply to the entire gas analyzer (system status).

However, by configuring the **Message input** function block, individual status messages for each analyzer module or for each sample component can be output separately via digital outputs (see Technical Bulletin 30/24-200 EN “AO2000 Function Blocks – Descriptions and Configuration” for details).

I/O board status messages are only reported as system status signals.

Status Indication

Gas analyzer status is indicated by means of status LEDs.

LED	Status
Error	Overall or Individual “Error” Status
Maint	Individual “Maintenance Required” status

Status Message Categories

Status Message Categories

In terms of operator reaction, there are three categories of status messages (see the summary on the following page):

- Status messages not requiring acknowledgment
- Status messages requiring acknowledgment
- Status messages requiring acknowledgment and intervention

Status Messages Not Requiring Acknowledgment

The system operates normally after the status is cleared.

When the status is cleared, the LED goes out, the status signal is reset and the status message is canceled.

Example: Temperature error during the warm-up phase.

Status Messages Requiring Acknowledgment

The system operates normally after the status is cleared; however, the operator is aware of the status.

When the status is cleared, the LED goes out and the status signal is reset. The status message is only canceled after operator acknowledgment. In this manner, the operator is aware of the system malfunction.

Example: No new measurement values from the analog/digital converter.

Status Messages Requiring Acknowledgment and Intervention

The system may not operate normally after the status condition is cleared; therefore, the operator should acknowledge the condition and actively eliminate the cause of the message.

The LED goes out, the status signal is reset and the status message is only canceled after the operator acknowledges the status message and eliminates the cause.

Example: The offset drift between two calibrations exceeds the permissible range.

Continued on next page

Summary

The following table shows
- The time sequence of the three status message categories (phases 1-3)
- The identifier used to identify the status messages in the summary (a, A and I).

Phase 1	Phase 2	Phase 3
Status Messages Not Requiring Acknowledgment		
Status begins LED lights up Status signal set Status message appears	**Status ends** LED goes out Status signal reset Status message canceled	
Status Messages Requiring Acknowledgment		
Status begins LED lights up Status signal set a Status message appears	**Status ends** LED goes out Status signal reset I Status message remains	**Acknowledge** Status message canceled
Status begins LED lights up Status signal set a Status message appears	**Acknowledge** A Status message remains	**Status ends** LED goes out Status signal reset Status message canceled
Status Messages Requiring Acknowledgment and Intervention		
Status begins LED lights up Status signal set a Status message appears	**Status ends** I Status message remains	**Acknowledge, correct** LED goes out Status signal reset Status message canceled
Status begins LED lights up Status signal set a Status message appears	**Acknowledge, correct** A Status message remains	**Status ends** LED goes out Status signal reset Status message canceled

List Layout

The status message list contains the following information:

No.	Number of the status message as shown in the detailed display
Text	Full text of the status message as shown in the detailed display
O	x = Status message sets the overall status
E	x = Status message sets the “Error” individual status
M	x = Status message sets the “Maintenance Request” individual status
F	x = Status message sets the “Maintenance Mode” individual status
Reaction/ Remark	Explanations and corrective measures in case of status messages

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
Runtime Error						
1–21	Runtime Error 1 to 21					Notify service if these status messages occur repeatedly.
System Controller						
101	System controller shut down at					For information; shows date and time
102	System controller starts up at					For information; shows date and time as well as warm start or cold start
103	Installing Module:					For information
104	Removing Module:					For information
105	Reactivating Module:					For information
106	A user installed module:					For information
107	A user removed module:					For information
108	A user replaced module:					For information
109	A password is active! To delete, press the <MEAS> key on the measurement value display.					Not logged
110	System booting.					Not logged
111	This system is temporarily under remote control!					Not logged
112	Display/control unit synchronizing with analyzer. Please wait.					Not logged
113	The system time was changed from -> to:					Not logged
114	The system is saving the changed parameters. Please wait!					
116	The Profibus Module is mounted on the wrong slot! The Profibus interface is not working. Please remount the Profibus Module on slot X20/X21.	x	x			
117	The configuration backup was saved.					
118	The configuration backup was loaded. The system has been restarted.					
119	The system configuration could not be loaded! This system contains no configu-ration now. Please enter menu Configure/System/Save confi-guration to load your backup configuration. Or use SMT to re-install your configuration.					

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
System Bus						
201	The selected system bus module could not be found.	x	x			Check plug connections and terminating resistors on the system bus. Make sure the system bus module serial number is correctly entered: `MENU → Diagnostics/Information → System overview`
203	The selected system bus module does not exist.	x	x			Check plug connections and terminating resistors on the system bus.
208	The system bus was not able to transfer data into the database.	x	x			The system bus module software version is not compatible with that of the system controller; update the system controller software.
209	The system bus connection to this module is interrupted.	x	x			Check the system bus connection to the indicated module. Check the power supply system of the indicated system bus module.
210	The system bus module configuration has changed.	x	x			For information; the configuration data are automatically updated
211	The system bus module has no more on-board memory.	x	x			Check the system bus module configuration: `MENU → Diagnostics/Information → System overview`
214	The system is currently maintained with Optima SMT.					
215	The analyzer module has an internal communication error!	x	x			Notify service.
216	The analyzer module has an internal program error!	x	x			Notify service.
Analyzer Modules						
300	No new measurement values from analog/digital converter.	x	x			Notify service.
301	Measurement value exceeds the analog/digital converter value range.	x	x			Check sample gas concentration. Notify service.
302	Offset drift exceeds half the permissible range.			x		Check analyzer module and sample preparation. Permissible range: 150% of smallest installed measurement range; 50% of physical measurement range for Uras26. Notify service when drift exceeds these values.
303	Offset drift exceeds permissible range.	x	x			
304	Amplification drift exceeds half the permissible range.			x		Check analyzer module and sample preparation. Permissible range: 50% of detector sensitivity. Notify service when drift exceeds these values.
305	Amplification drift exceeds permissible range.	x	x			
306	The offset drift between two calibrations exceeds the permissible range.			x		These messages are generated by automatic calibration. Check calibration for plausibility. Fix possible cause of implausibility. Perform manual zero (no. 306) or end point (no. 307) calibration on indicated detector. Permissible range: 15% of smallest installed measurement range; for measurements in facilities requiring authorization and per 27th and 30th BImSchV, 6% of smallest installed measurement range.
307	The amplification drift between two calibrations exceeds the permissible range.			x		

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
308	A computer error occurred during calculation of the measurement value.	x	x			Notify service.
309	The temperature regulator is defective.			x		See the status message from the applicable temperature detector
310	Temperature correction turned off for this component because of invalid temperature measurement value.			x		See the status message from the applicable temperature detector
311	The pressure regulator is defective.	x	x			See the status message from the applicable pressure detector
312	Pressure correction turned off for this component because of invalid pressure measurement value.			x		See the status message from the applicable pressure detector
313	Cross-sensitivity correction is impossible for this component because the correction value is invalid.			x		See the status message from the applicable correction detector
314	Carrier gas correction is impossible for this component because the correction value is invalid.			x		See the status message from the applicable correction detector
Auxiliary Detector						
315	No new measurement values from analog/digital converter.			x		Notify service.
316	Measurement value exceeds the analog/digital converter value range.			x		Notify service.
317	A computer error occurred during calculation of the measurement value.			x		Notify service.
Uras						
318	No new measurement values from analog/digital converter.	x	x			Notify service.
Caldos, Magnos						
319	The measurement bridge is improperly balanced.	x	x			Notify service.
320	The measurement amplifier offset is too high.	x	x			Notify service.

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
MultiFID						
321	The detector temperature is below the lowest permissible temperature.	x	x			Status message during the warm-up phase. If the status message appears after warm-up: Check the thermal link and replace as needed (see the MultiFID14 analyzer module start-up and maintenance manual, publication number 41/24-105 EN).
322	The flame is out.	x	x			Status message during the warm-up phase. If the status message appears after warm-up: Check the gas supply.
323	The analyzer is in the fail-safe state.	x	x			Inadequate combustion gas supply; turn power supply off and back on after ≥ 3 seconds. Notify service.
Temperature Regulator						
324	Temperature above or below upper and/or lower limit value 1.			x		Status message during the warm-up phase. If the status message appears after warm-up: Check if the permissible ambient temperature range is being maintained (see page 10-19). Check the analyzer module thermal link and replace if necessary.
325	Temperature above or below upper and/or lower limit value 2.			x		
Pressure Regulator						
326	No new measurement values from analog/digital converter.	x	x			Notify service.
327	Measurement value exceeds the analog/digital converter value range.	x	x			Notify service.
328	A computer error occurred during calculation of the measurement value.	x	x			Notify service.
329	Pressure above or below upper and/or lower limit value 1.			x		MultiFID14: Check the supply gas pressure.
330	Pressure above or below upper and/or lower limit value 2.			x		MultiFID14: Check the supply gas pressure.
331	The pressure regulator control variable is beyond the valid range.	x	x			MultiFID14: Check the supply gas pressure.
I/O Devices						
332	Accessory voltage defect on I/O board.	x	x			Defective I/O board. Replace the board.
333	Unavailable I/O type configured.	x	x			Correct the configuration with the test and calibration software.
334	No new measurement values from analog/digital converter.	x	x			Defective I/O board. Replace the board.
335	Measurement value exceeds the analog/digital converter value range.	x	x			Check signals at analog inputs. If OK, check the configuration and calibration of the analog inputs.

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
336	A computer error occurred during calculation of the measurement value.	x	x			Check the configuration and calibration of the analog inputs and outputs.
337	Broken analog output line.	x	x			Check the analog output lines.
338	Broken digital input line (moisture sensor).	x	x			Check the moisture sensor in the system cooler.
339	Broken or shorted analog input line.	x	x			Check system cooler temperature.
340	Analog input value above or below upper or lower limit value 1.			x		Check system cooler temperature.
341	Analog input value above or below upper or lower limit value 2.			x		Check system cooler temperature.
Flow Monitor (Gas Module)						
342	Flow rate under limit value 1.			x		Check sample preparation. Limit value 1 = 25% MRS.
343	Flow rate under limit value 2.	x	x			Check sample preparation. Limit value 2 = 10 % MRS. Automatic calibration is interrupted and locked out.
Measurement Value						
344	Value above measurement value range.					Value > +130 % MRS, not logged
345	Value below measurement value range.					Value < –100 % MRS, not logged
Limas						
356	Analyzer in warm-up phase.	x	x			Status message during warm-up phase. If the status message appears after warm-up, a temperature error has occurred in the lamp or in the sample cell or in the measurement or reference detector amplifier. Notify service.
357	Limas motor optimization in progress.	x	x			Status message after warm-up phase
358	Lamp intensity above or below middle of permissible range.			x		Lamp intensity has fallen to 10% of Init value. Check the intensity values in the `Diagnostics/Test → Module specific → Lamp Intensity` menu. If all four values have fallen by about the same amount compared to the Init values, the cause is reduced lamp intensity. The lamp should soon be replaced. If only the two measurement detector values have dropped, the cause is probably a contaminated sample cell. Clean the sample cell or exchange it.
359	Lamp intensity above or below permissible range.	x	x			Lamp intensity has fallen to 5% of Init value. Check the intensity values in the `Diagnostics/Test → Module specific → Lamp Intensity` menu. If all four values have fallen by about the same amount compared to the Init values, the cause is reduced lamp intensity. Replace the lamp and perform an amplification optimization.

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
360	Filter wheel 1 cannot be initialized.	x	x			Notify service.
361	Filter wheel 2 cannot be initialized.	x	x			Notify service.
362	The calibration filter wheel cannot be initialized.	x	x			Notify service.
363	The Limas analyzer board cannot be initialized.	x	x			Notify service.
364	A new lamp is installed and the amplifiers settings are optimized.					For information
365	The LIMAS amplifiers settings are optimized.					For information
LS25						
366	The LS25 analyzer has an error.	x	x			
367	The LS25 analyzer has a maintenance request.	x		x		
368	The LS25 analyzer starts measurement.	x	x			
369	LS25 analyzer detector error #	x	x			
370	The beam transmission exceeds the permissible range.			x		Low transmission
371	The temperature input signal exceeds the permissible range.			x		T out of range
372	The pressure input signal exceeds the permissible range.			x		P out of range
373	The flow sensor signal exceeds the permissible range.			x		
374	The detector signal is too low for measurement.	x	x			Laser line-up error
375	The input current loop (4-20mA) has an error.	x	x			T-read error, P-read error
376	This LS25 module is under maintenance.	x			x	Communication with service software via RS232. No measured values are transferred.
Uras						
378	Chopper wheel jammed.	x	x			Notify service.
379	Chopper wheel speed not OK.	x	x			Notify service.
380	IR radiator or electronics faulty.	x	x			Notify service.
381	High voltage at preamplifier faulty.	x	x			Notify service.

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
382	Meas. value is influenced by shock.	x	x			
Flow Controller						
398	No new measuring values from analog/digital converter.	x	x			Notify service.
399	The measuring value exceeds the range of the analog/digital-converter.	x	x			Check sample gas concentration. Notify service.
400	A calculation error occurred during calculation of the measurement value.	x	x			Notify service.
401	The flow exceeds upper or lower limit 1.			x		Check sample gas path. Notify service.
402	The flow exceeds upper or lower limit 2.	x	x			Check sample gas path. Notify service.
403	The controller output value is out of range.	x	x			Notify service.
ZO23						
404	Temperature above or below upper and/or lower limit value 2.	x	x			Notify service.
405	A ZO23 function test has been performed:					For information
406	This ZO23 analyzer has failed the function test!			x		Change test factor or check cell with test gas.
407	A ZO23 function test is running.				x	
408	The ZO23 function test is canceled!				x	Keep sample gas concentration constant or use test gas.
Calibration						
500	System bus communication defect.					
501	Requested function is not available on the system module.					Check the analyzer module software version and perform an update if needed.
502	A system error occurred in the system module addressed.					Calibration is interrupted. Notify service.
503	Amplification error during calibration. Calibration impossible.			x		Calibration is interrupted. Insufficient span gas concentration – Check.
507	A combination of the following errors occurred: Half Drift Limit, Drift Limit, Amplification or Delta Drift.					
508	Unknown error number. Check software versions.					Message during automatic calibration. Check analyzer module and system controller software versions.

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
509	Automatic calibration started.					For information
510	Automatic calibration ended.					For information
511	Automatic calibration externally interrupted.					For information
512	Automatic calibration in progress.				x	For information, not logged
513	System bus communication defect during automatic calibration.					
514	External calibration started.					For information
515	External calibration ended.					For information
516	External calibration in progress.				x	For information, not logged
517	Device being serviced.				x	For information, e.g. during manual calibration, not logged
518	The calibration could not be done, because the value is not stable.					
519	Preamplifier overflow error: Calibration could not be performed because of preamplifier override.					
520	Initial zero calibration started.					For information
521	Initial zero calibration ended.					For information
522	Initial zero calibration interrupted.					For information
523	Initial zero calibration incomplete. System bus communication defect during calibration.					For information
524	Initial zero calibration in progress.				x	For information, not logged
525	Linearization impossible: Linearization did not produce a valid result. Measurement value possibly inaccurate. Check center point gas.					See message text
526	Linearization impossible: Linearization could not be performed Ie the characteristic is linear.					See message text
527	Initial calibration for component:					For information
528	Autocalibration not started Ie manual calibration was running.					For information

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
529	Calibration stopped because no raw measurement values were found.	x		x		
530	Calibration stopped because the pressure switch did not detect any calibration gas.	x		x		
531	Automatic validation started.					For information
532	Automatic validation ended.					For information
533	Automatic validation externally interrupted.					For information
534	Automatic validation in progress.				x	For information, not logged
535	Automatic validation successful for:					
536	Automatic validation out of limits for:					
537	Automatic validation out of limits for:			x		
User-Configured Messages						
800	An external error occurred during:	x	x			These **Message Generator** function block default texts are supplemented with the text prepared during function block configuration.
801	A user-defined error occurred during:	x	x			
802	A user-defined maintenance requirement occurred during:			x		
803	A user-defined maintenance mode event occurred during:				x	
Miscellaneous Messages						
1000	This function block has an error:	x	x			Supplemented with a reference to the function block type.
1001	Condensate penetration.					Overall message for guiding reaction to condensate penetration; not logged
1002	Flow rate excessive at this point.	x	x			Currently not used
1003	Flow rate inadequate at this point.	x	x			Currently not used

Continued on next page

No.	Text	O	E	M	F	Reaction/Remark
System Cooler						
1100	Cooler temperature too high.	x	x			Sample gas feed module pump is automatically turned off. Check the system cooler and sample gas preparation.
1101	Cooler temperature too low.	x	x			
1102	Condensate penetration in cooler.	x	x			
1103	Flow rate inadequate in cooler.			x		Check the system cooler and sample gas preparation.
1104	Cooler condensate level too high.			x		
1105	Cooler condensate level too high.			x		Empty the condensate bottle.
1106	Cooler reagent level too low.			x		Fill the reagent container.

Blinking Measurement Value Readout

Measured signal violates measurement range limits

Note:
Measurement value > +130 % MRS or measurement value < −100 % MRS
Additionally, status messages 344 or 345 are generated.

Blinking - - E - - in Measurement Value Readout

Problem in measured signal processing

- View status messages.
- Identify cause and repair.

Blinking - - E - - in mA Value Readout

Problem in output current circuit

- Identify cause (e. g. line break) and repair.

Flow Problem

External gas lines or filters dirty, plugged or leaking

- Disconnect the gas analyzer from the gas preparation system.
- Blow out the gas lines with compressed air or clear them mechanically.
- Change the filter elements and packings.
- Check gas line seal integrity.

Gas analyzer gas paths crimped or leaking

- Disconnect the gas analyzer from the gas preparation system.
- Check the analyzer module gas lines and the gas module lines for crimping or loose connections.
- Check the integrity of the analyzer module gas paths and (if applicable) of the lines to the gas module (see page 9-2 for instructions).

Continued on next page

Temperature Problem

Gas analyzer still in warm-up phase

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

Analyzer Module	Warm-Up Phase Duration
Caldos25	1.5 hours
Caldos27	Approx. 30/60 minutes for class 1/2 measurement ranges
Limas11	Approx. 2.5 hours
Magnos206	≤ 1 hour
Magnos27	2 to 4 hours
Uras26	Approx 0.5/2 hours without/with thermostat

Excessive air movement

- Reduce the flow of air around the gas analyzer.
- Install shielding against drafts.

Ambient temperature outside of permissible range

- Protect the gas analyzer from cold and heat sources such as the sun, ovens and vats.
- Maintain the permissible ambient temperature range:

Ambient temperature range during operation with analyzer module	installed in a system housing without electronics module	installed in a system housing with electronics module or with power supply only
Caldos25	+5 to +45°C	+5 to +45°C
Caldos27	+5 to +50°C	+5 to +45°C
Limas11	+5 to +45°C	+5 to +45°C 1)
Magnos206	+5 to +50°C	+5 to +45°C
Magnos27	+5 to +45°C 2)	+5 to +45°C
Uras26	+5 to +45°C	+5 to +40°C
Oxygen Sensor	+5 to +40°C	+5 to +40°C

1) +5 to +40°C when I/O modules or I/O boards are installed
2) +5 to +50°C for measurement chamber direct connection and installation in system housing without electronics module or Uras26

Temperature Problem

Faulty temperature sensor or heater connections

- Check the connecting lines and plugs.
- Check the line seating in the insulated jackets.

Defective thermal link

- Check thermal link continuity and replace if necessary (see page 9-3 for instructions).

Leaking thermostat or open purge gas connections

- Check the seal integrity between the thermostat chamber and the mounting flange; tighten mounting bolts or replace O rings as needed.
- Seal the analyzer purge gas inlet and outlet with sealing connectors.
- Check the purge gas flow (maximum operating level of 20 l/h; positive pressure p_e = 2 to 4 hPa) and reduce as needed.

Unstable Readings

Gas path leakage

- Check the integrity of the analyzer module gas paths and (if applicable) of the lines to the gas module (see page 9-2 for instructions).

Temperature Problem

Faulty temperature sensor or heater connections

- Check the connecting lines and plugs.
- Check the line seating in the insulated jackets.

Defective thermal link

- Check thermal link continuity and replace if necessary (see page 9-9 for instructions).

Unstable Readings

Gas path leakage

- Check the integrity of the analyzer module gas paths and (if applicable) of the lines to the gas module (see page 9-2 for instructions).

Emitter intensity too low

- Read the current intensity value using the `Diagnostics/Test → Module specific → Lamp Intensity` menu item (start the zero gas supply for this) and compare this value to the Init value displayed (the Init values were stored following amplification optimization after installation of a new lamp). A significant decrease (by a factor of 10 or more) is the probable cause of unstable measurement value readings. Three different cases can be identified:
  1 If only the measurement receiver values have dropped the sample cell is probably contaminated. Clean the sample cell (see pages 9-10, 9-12 or 9-15 for instructions).
  2 If all four values are have dropped by similar amounts then lamp intensity has probably decreased. Perform an amplification optimization (see page 9-23 for instructions) or replace the lamp (see page 9-21 for instructions).
  3 For NO measurement only: If the reference receiver “Reference” value has increased or not as markedly decreased as a percentage relative to the reference receiver “Measurement” value and if at the same time the sensitivity span has decreased (loss of sensitivity), aging of the selectivity cell is the probable cause (see the service manual for more information).

“Sample Value Overflow or Underflow” Status Signal

Drift or aging of optical elements (lamp, sample cell, detector, etc.)

- Determine the cause
- Clean or replace the affected elements.
- Perform an amplification optimization (see page 9-23 for instructions) to bring the receiver signal back to its optimal range.

Temperature Problem

Faulty temperature sensor or heater connections

- Check the connecting lines and plugs.
- Check the line seating in the insulated jackets.

Defective thermal link

- Check thermal link continuity and replace if necessary.

Unstable Readings

Vibration

- Take measures to reduce vibration.
  Permissible vibration levels: for analyzer max. ±0.04 mm at 5 to 55 Hz, 0.5 g at 55 to 150 Hz; when installed in cabinet max. 0.01 ms^{-2} at 0.1 to 200 Hz.
- Increase the low pass time constant T90 (see page 7-A-5 for instructions).

Gas path leakage

- Check the integrity of the analyzer module gas paths and (if applicable) of the lines to the gas module (see page 9-2 for instructions).

Loss of sensitivity

- Check the sensitivity variation:
  Indication < 75%: The “Maintenance request” status signal appears. The detector involved will need to be changed soon.
  Indication < 50 %: The “Failure” status signal appears. Replace the detector involved.

Uneven emitter modulation

- Remove the emitter.
  ⚠ The emitter temperature is approx. 60 °C in the thermostat version of the Uras26!
- Check if the chopper wheel turns smoothly.
- Check the clamp ring seating.
- The chopper wheel should not extend beyond the notch.
- Have the emitter and modulator assembly checked by the service department.

Flow Problem

Condensation in the flow meter

- Disconnect the gas analyzer from the gas preparation system.
- Dry the flow meter by heating it and blowing it with compressed air.
- Check the operation of the upstream sample gas cooler.

Inadequate gas supply

- Connect the flow meter, ball chamber or pressure gauge directly to the gas supply pump and measure the pressure or vacuum.
- Check the pump and change the membrane as necessary.
- Check and, if necessary, replace the disposable filter (see page 9-24 for instructions).
- Check and, if necessary, replace the solenoid(s).

Notify Service

Who to contact for further help?

Contact your local ABB Service representative. For emergencies, please contact:

ABB Service, Telephone: +49-(0)180-5-222580, Telefax: +49-(0)621-38193129031, E-Mail: automation.service@de.abb.com

Before you notify service …

Before calling for service because of a problem or status message, determine whether there actually is an error and whether the gas analyzer is actually operating out of specifications (see Appendix 2).

When you notify service …

When calling for service because of a problem or status message have the following information available:

- The **production number** (F-No.) of the system housing in which the defective or improperly operating unit is located.
  It is located on the system housing identification plate, inside the right wall of the 19-inch rack unit and inside the left wall of the wall-mount housing, as well as in the analyzer data sheet.
- The system controller and system module **software versions** are found in the `MENU → Diagnostics/Information → System overview` menu item
- An **exact description** of the problem or status as well as the status message text or number

This information will enable service personnel to help you quickly.

When calling for service because of a problem or status message have the analyzer data sheet available. It contains important information that will help the service personnel find the cause of the fault.

When you return a unit to the service department …

When returning a gas analyzer or an analyzer module to the service department, e.g. for repair, please indicate which gases have been supplied to the analyzer module. This information is needed so that service personnel can take any safety precautions required for harmful gases.

Chapter 11 Gas Analyzer Shutdown and Packing

Gas Analyzer Shutdown

Gas Analyzer Shutdown

Step	Action
Temporary Shutdown:	
1	Turn off the sample gas and, if applicable, reference gas supplies.
2	Purge the gas lines and analyzer module with dry fresh air or nitrogen for at least 5 minutes.
3	Turn off the gas analyzer power supply.
Long-Term Shutdown:	
4	Remove the gas lines from the analyzer module ports. Tightly seal the gas ports.
5	Disconnect the electrical wiring from the electronic module and, if applicable, the analyzer module connections.

Ambient Temperature Ambient temperature during storage and transport: –25 to +65 °C

Preparing the Gas Analyzer for Shipping and Packing

CAUTION!

A system housing with an electronics module and an analyzer module weighs from 18 to 23 kg. Two persons are needed for removal.

Preparation for Shipping

Step	Action
1	⚠ Remove the system bus terminating resistor from the electronics module and secure it to the housing, e.g. with adhesive tape. If the terminating resistor remains in the electronics module it can be broken during shipment causing damage to the resistor as well as to the electronic module system bus receptacle.
2	Unscrew the adapters from the gas ports.
3	Tightly seal the gas ports with plugs.
4	In the IP-54 version of the system housing close off the connection box cable openings by inserting the appropriate plates.

When returning a gas analyzer or an analyzer module to the service department, e.g. for repair, please indicate which gases have been supplied to the analyzer module.

This information is needed so that service personnel can take any safety precautions required for harmful gases.

Packing

Step	Action
1	If the original packaging is not available, wrap the gas analyzer in bubble foil or corrugated cardboard. When shipping overseas additionally place the gas analyzer in a 0.2-mm thick polyethylene bag, add a drying agent (such as silica gel) and seal the bag air-tight. Use an amount of drying agent appropriate for the package volume and the planned shipping schedule (at least 3 months).
2	Place the gas analyzer in an adequately sized box lined with cushioning material (foam or similar substance). The cushioning material's thickness should be adequate for the gas analyzer's weight. When shipping overseas additionally wrap the box in a layer of protective waterproof wrapping.
3	Mark the box as “Fragile Material”.

Ambient Temperature Ambient temperature during storage and transport: –25 to +65 °C

Appendix 1 Gas Analyzer Overview

Gas Analyzer

Components

The AO2000 Series Continuous Gas Analyzers consist of:

- analyzer modules and
- a central unit.

The central unit consists of:

- the electronics module, consisting of the system controller, the I/O modules (optional) and the power supply, and
- the system housing with the display and control unit.

A gas module can be connected to supply gases to an analyzer module.

Equipment Levels

The smallest gas analyzer equipment level is made up of the central unit and one analyzer module. Up to four analyzer modules for measuring up to six sample components can be connected to a central unit.

System Housing

Electronics module, power supply and an analyzer module can be installed together in one system housing. Additional analyzer modules are installed in separate system housings.

Power Supply

A supply voltage of 100–240 VAC is required for the central unit. The analyzer modules are powered with 24 VDC from the central unit power supply or from separate power supplies.

System Bus

The system controller, the analyzer modules and the I/O devices are interconnected via the system bus. The system bus is linear in design and has a maximum length of 350 meters.

Interfaces

Various types of interfaces can be used by the gas analyzer to communicate with external systems. These include an available Ethernet interface (TCP/IP protocol), the RS232 and RS485 interfaces (Modbus protocol) as well as the RS485 and the (non-intrinsically safe) MBP interfaces (Profibus DP or Profibus PA protocol).

Explosion Protection

Special gas analyzer versions are available for use in explosion risk areas:

- The AO2060-Caldos15, -Caldos17, -Magnos106 and -Uras14 analyzer modules in category 2G are designed to “Flame-proof Enclosure” (Ex d) ignition protection and are suitable for measurement of flammable gases and non-flammable gases.
- The AO2040-CU Ex central unit in category 2G is designed to “Pressurized Apparatus with Leak Compensation” (Ex p) ignition protection.
- The category 3G versions are suitable for measurement of flammable gases (“safety concept”) and non-flammable gases.

Analyzer Modules

Analyzer Modules	• Caldos25	Thermal conductivity analyzer module
	• Caldos27	Thermal conductivity analyzer module
	• Limas11	Process photometer analyzer module
	• LS25	Laser analyzer module
	• Magnos206	Oxygen analyzer module
	• Magnos27	Oxygen analyzer module
	• MultiFID14	FID analyzer module
	• MultiFID14 NMHC	FID analyzer module
	• Uras26	Infrared analyzer module
	• ZO23	Trace oxygen analyzer module

Components

Each analyzer module consists of:

- A sensor
- The associated electronics with an integral processor.

Oxygen Sensor

The electrochemical oxygen sensor is available as an option in combination with an analyzer module.

Gas Module

Gas Module

The gas module is used to supply gases to the gas analyzer. A fully equipped gas module contains the following elements:

- One gas supply pump
- One or three solenoids to control test gas supply
- One or two disposable fine-filtration elements
- One or two flow monitors

The gas module is always associated with an analyzer module. It is installed in the same housing as the analyzer module.

System Controller

The system controller carries out the following functions:

- Processing and communicating the measurement values supplied by the analyzer module sensor electronics
- Compensating the measurement values, e.g. cross-sensitivity correction
- Controlling system functions, e.g. calibration
- Display and control functions
- Controlling associated devices, e.g. system components for sample gas conditioning
- Communication between the gas analyzer and external systems

The system controller communicates with the other AO2000 units (e.g. the analyzer modules) via the system bus.

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

I/O Modules

The I/O modules are attached and directly connected to the system controller board.

There are various types of I/O modules:

- The 2-way analog output module has two analog outputs.
- The 4-way analog output module has four analog outputs.
- The 4-way analog input module has four analog inputs.
- The digital I/O module has four digital inputs and four digital outputs.
- The Modbus module has one RS485 and one RS232 interface.
- The Profibus module has one RS485 and one MBP interface (non-intrinsically safe).

I/O Devices

The I/O board in the SCC-F Sample Gas Feed Unit is used for connection of sample gas conditioning devices.

System Housing

Versions

The system housing is available as a 19-inch housing or a wall-mount housing with IP 20 or IP 54 housing protection.

IP 65 protection is in effect if no power supply and no display and control unit is installed in the system housing (e.g. if two analyzer modules are installed together in one system housing).

Housing Purge

Housing Purge is possible in system housings with IP 54 protection (with connection box) or IP 65 protection (without power supply).

The purge gas connection ports (1/8-NPT internal threads) are factory installed per order. The electrical cable connection openings are either threaded connections or conduits.

The housing is generally purged via the analyzer module purge gas ports. Separate purge gas ports are installed to purge a central unit that has no analyzer module installed.

Display and Control Unit

Display and Control Unit Components

The display and control unit contains:

- A back-lit graphics screen (320x240-pixel resolution)
- Three status indication LED's
- A keypad with six softkeys, two cancel keys and a numeric keypad

Readout Values

Readout values from the analyzer modules, as well as from other sensors (e.g. flow, pressure and temperature), are displayed as:

- Numeric values with the applicable physical units
- A horizontal bar graph

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

User Interface

A menu-driven user interface allows the operator to use, initialize and configure the gas analyzer.

Menus, values and operator prompts appear on the display.

Appendix 2 Analyzer Module Operating Specifications

The analyzer module characteristics indicated apply only when operated in conjunction with the central unit.

The performance characteristics have been determined according to the international standard IEC 1207-1: 1994 “Expression of performance of gas analyzers”. They are based on N_2 as the associated gas. Compliance with these characteristics when measuring other gas mixtures can only be assured if their composition is known.

Caldos25 Operating Specifications

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.
Flow influence	≤ 1 to 5 % of span at a flow change of ±10 l/h. At the same sample and test gas flow rate the flow influence is automatically compensated.
Associated gas influence	The knowledge of the sample gas composition is necessary for the analyzer configuration. Measurement results can be greatly distorted by interfering components in complex (non-binary) gas mixtures.
Temperature influence	At each point in the measurement range: ≤ 1 % of span per 10 °C, based on temperature during calibration; Ambient temperature in permissible range, thermostat temperature = 60 °C
Air pressure influence	No effect in permissible operating condition range
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of span
Position influence	< 1 % of span up to 10° deviation from horizontal orientation
T_{90} time	Typical T_{90} = 10 to 20 sec.; Option: T_{90} < 6 sec. (applies to a gas analyzer with one analyzer module)

Caldos27 Operating Specifications

Linearity deviation	≤ 2 % of span
Repeatability	≤ 1 % of span
Zero drift	≤ 2 % of the smallest possible measurement range per week
Sensitivity drift	≤ 0.5 % of the 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
	The stability data apply only to measurement ranges ≥ Class 2.
Flow influence	≤ 0.5 % of span at a flow change of ±10 l/h. At the same sample and test gas flow rate the flow influence is automatically compensated.
Associated gas influence	The knowledge of the sample gas composition is necessary for the analyzer configuration.
Temperature influence	At each point in the measurement range: ≤ 0.5 % of span per 10 °C, based on temperature during calibration; Ambient temperature in permissible range, thermostat temperature = 60 °C
Air pressure influence	≤ 0.25 % of span per 10 hPa for the smallest possible ranges given; in larger measurement ranges the influence effect is correspondingly smaller. Working range of installed pressure sensor: p_{abs} = 600 to 1250 hPa Option: Operating altitude over 2000 m
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of span
Position influence	< 1 % of span up to 30° deviation from horizontal orientation
T_{90} time	T_{90} ≤ 2 sec. with direct sample chamber connection and sample gas flow = 60 l/h (applies to a gas analyzer with one analyzer module)

Limas11 Operating Specifications

Linearity deviation	≤ 1 % of span
Repeatability	≤ 0.5 % of span
Zero drift	≤ 2 % of span per week; for ranges smaller than Class 1 to Class 2: ≤ 1.5 % of span per day (Recommendation: daily automatic zero-point calibration)
Sensitivity drift	≤ 1 % of measured value per week
Output fluctuation (2 σ)	• Limas11 UV: ≤ 0.5 % of span at electronic T90 time = 10 sec. • Limas11 IR: ≤ 0.5 % of span at electronic T90 time (static/dynamic) = 60/5 sec. for ranges smaller than Class 1 to Class 2: ≤ 1 % of span
Detection limit (4 σ)	≤ 1 % of span; for ranges smaller than Class 1 to Class 2: ≤ 2 % of span
Flow influence	Flow in 20 to 100 l/h range: within detection limit
Associated gas influence/ Cross-sensitivity	The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Installation of filter cells or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Limas11.
Temperature influence	• 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: ≤ 1 % of measured value per 10 °C Ambient temperature in permissible range, sample cell thermostat temperature = 60 °C
Air pressure influence	• At zero-point: no influence effect • On sensitivity with pressure correction via 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. An external port is used for the pressure sensor if tubing is used for the internal gas lines. Pressure sensor working range: p_{abs} = 600 to 1250 hPa
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of span
T_{90} 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.

Linearity deviation ≤ 0.5 % of span

Repeatability ≤ 50 ppm O_2 (time base for gas exchange ≥ 5 minutes)

Zero drift ≤ 3 % of span of the smallest measurement range (per order) per week, minimum 300 ppm O_2 per week; following prolonged transport and storage time the drift can be higher during the first weeks of operation.

Sensitivity drift ≤ 0.1 % Vol.-% O_2 per week or ≤ 1 % of measured value per week (not cumulative), the smaller value applies; ≤ 0.25 % of measured value per year

Output fluctuation (2 σ) ≤ 25 ppm O_2 at electronic T90 time (static/dynamic) = 3/0 sec.

Detection limit (4 σ) ≤ 50 ppm O_2 at electronic T90 time (static/dynamic) = 3/0 sec.

Flow influence ≤ 0.1 Vol.-% O_2 in permissible range

Associated gas influence The effect of associated gases with a concentration of 100 Vol.-% as a shift of the zero-point (ΔZero) in Vol.-% O_2 can be estimated using the guidelines in the following table:

Associated Gas Concentr. 100 Vol.-%		ΔZero
Hydrogen	H_2	+0.28
Hydrogen sulfide	H_2S	–0.45
Argon	Ar	–0.26
Helium	He	+0.30
Neon	Ne	+0.13
Nitrogen	N_2	0
Nitrogen oxide	NO	+43
Nitrogen dioxide	NO_2	+28
Nitrous oxide	N_2O	–0.20
Carbon monoxide	CO	–0.01

Associated Gas Concentr. 100 Vol.-%		ΔZero
Carbon dioxide	CO_2	–0.32
Carbon oxysulfide	COS	–0.90
Ethane	C_2H_6	–0.46
Ethylene	C_2H_4	–0.29
Methane	CH_4	–0.24
Propane	C_3H_8	–0.98
Propylene	C_3H_6	–0.55
Trichloroethylene	C_2HCl_3	–2.17
Vinylchloride	CH_2CHCl	–0.75
For further associated gases refer to EN 61207-3		

Temperature influence
- At zero-point: ≤ 0.02 Vol.-% O_2 per 10 °C
- On sensitivity: ≤ 0.1 % of measured value per 10 °C

Ambient temperature in permissible range, thermostat temperature = 64 °C

Air pressure influence
- At zero-point: no influence effect
- On sensitivity without pressure correction: ≤ 1 % of measured value per 1 % air pressure change
- On sensitivity with pressure correction by means of internal pressure sensor (option): ≤ 0.1 % of measured value per 1 % pressure change; for highly suppressed measurement ranges ≤ 0.01 % of measured value per 1 % pressure change or ≤ 0.002 Vol.-% O_2 per 1 % pressure change, whichever is greater.

Pressure sensor working range: p_{abs} = 600 to 1250 hPa

Power supply influence 24 VDC ± 5 %: ≤ 0.4 % of span

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

T_{90} time T_{90} ≤ 3.5 to 10 sec. at sample gas flow = 90 l/h and electronic T90 time (static/dynamic) = 3/0 sec., gas switching from N_2 to air (applies to a gas analyzer with one analyzer module)

Magnos27 Operating Specifications

Linearity deviation	≤ 2 % of span
Repeatability	≤ 1 % of span
Zero drift	≤ 1 % of span per week
Sensitivity drift	≤ 2 % of 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.
Flow influence	≤ 1 % of span at a flow change of ±10 l/h. At the same sample and test gas flow rate the flow influence is automatically compensated.
Associated gas influence	Magnos27 calibration applies only to the sample gas (= sample component + associated gas) shown on the identification plate.
Temperature influence	• At zero-point: ≤ 2 % of span per 10 °C • On sensitivity: ≤ 0.5 % of measured value per 10 °C both based on temperature during calibration Ambient temperature in permissible range, thermostat temperature = 63 °C
Air pressure influence	• At zero-point: < 0.05 Vol.-% O_2 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: Operating altitude over 2000 m
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of span
Position influence	Approx. 3 % of smallest measurement range span per 1° deviation from horizontal orientation. Position has no effect on the hard-mounted unit.
T_{90} time	T_{90} = 10 to 22 sec., depending on sample gas flow and sample chamber connection (applies to a gas analyzer with one analyzer module)

Uras26 Operating Specifications

Linearity deviation	≤ 1 % of span
Repeatability	≤ 0.5 % of span
Zero drift	≤ 1 % of span per week; for ranges smaller than Class 1 to Class 2: ≤ 3 % of span per week
Sensitivity drift	≤ 1 % of measured value per week
Output fluctuation (2 σ)	≤ 0.2 % of span at electronic T90 time = 5 sec. (class 1) or = 15 sec. (Class 2)
Detection limit (4 σ)	≤ 0.4 % of span at electronic T90 time = 5 sec. (class 1) or = 15 sec. (Class 2)
Flow influence	Flow in 20 to 100 l/h range: within detection limit
Associated gas influence/ Cross-sensitivity	The knowledge of the sample gas composition is necessary for the analyzer configuration. Selectivity measures to reduce associated gas effect (optional): Installation of interference filters or filter cells or internal electronic cross-sensitivity correction or carrier gas correction for a sample component by other sample components measured with the Uras14.
Temperature influence	• 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 (option): ≤ 1 % of measured value per 10 °C Ambient temperature in permissible range
Air pressure influence	• At zero-point: no influence effect • On sensitivity with pressure correction via 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. An external port is used for the pressure sensor if tubing is used for the internal gas lines. Pressure sensor working range: p_{abs} = 600 to 1250 hPa
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of span
T_{90} time	T_{90} = 2.5 sec. for measurement cell length = 200 mm and sample gas flow = 60 l/h without signal damping (low pass filter). Low-pass time constant adjustable from 0 to 60 sec.

Oxygen Sensor Operating Specifications

Linearity deviation	Linear in the range > 1 Vol.-% O_2
Repeatability	≤ 0.5 % of span
Zero drift	Stable over long-term due to absolute zero point
Sensitivity drift	≤ 1 % of measurement range scale per week
Output fluctuation (2 σ)	≤ 0.2 % of the measurement range at electronic T90 time (static/dynamic) = 5/0 sec.
Detection limit (4 σ)	≤ 0.4 % of the measurement range at electronic T90 time (static/dynamic) = 5/0 sec.
Flow influence	Flow rate in 20 to 100 l/h range: ≤ 2 % of measurement range scale
Temperature influence	Ambient temperature in permissible range: ≤ 0.2 Vol.-% O_2 per 10 °C
Air pressure influence	• At zero-point: No effect • On sensitivity without pressure correction: ≤ 1 % of measured value per 1 % air pressure change • On sensitivity with pressure correction: ≤ 0.2 % of measured value per 1 % air pressure change Pressure correction is only possible if the oxygen sensor is connected to an analyzer module with an integral pressure sensor. Pressure sensor working range: p_{abs} = 600 to 1250 hPa
T_{90} time	T_{90} ≤ 30 seconds, depending on sample gas flow and system layout

Electrical Safety

Test	per EN 61010-1:2001
Protection Class	Central unit with electronics module (power supply): I Analyzer module without electronics module (power supply): III
Overload Category/ Pollution Level	Electronics module power supply: III/2 Analyzer module power supply: II/2 Signal inputs and outputs: II/2
Safe Isolation	The electronics module power supply is galvanically isolated from other circuits by means of reinforced or double insulation. Operational low voltage (PELV) on low-voltage side

Electromagnetic Compatibility

Noise Immunity	Tested to EN 61326-1:2006. Inspection severity: Industrial area, fulfills at least the rating “continuously monitored operation” to Table 2 of EN 61326.
Emitted Interference	Tested to EN 61326-1:2006, EN 61000-3-2:2006 and EN 61000-3-3:1995 + A1:2001 + A2:2005. Limit value class B for interference field strength and interference voltage is met.

Appendix 3 ZO23 Trace Oxygen Analyzer Module

Safety Information

WARNING!

The analyzer module must not be used for measurement of ignitable gas/air or gas/oxygen mixtures. The concentration of flammable gases in the sample gas must not exceed 100 ppm.

The presence of corrosive gases and catalyst poisons, e.g. halogens, sulfurous gases and heavy-metal dusts, results in faster aging and/or the destruction of the measuring cell.

The ingress of liquids into the analyzer module can lead to serious damage including the destruction of the measuring cell.

After disconnection of the power supply, the case of the measuring cell has an excess temperature of approx. 95 °C, which decreases only slowly.

Intended Application

The trace oxygen analyzer module ZO23 is intended for the continuous measurement of the oxygen concentration in pure gases (N_2, CO_2, Ar).

Please refer to the "Information for the Installation and Sample Conditioning" (see page A-3-4).

Requirements at the Installation Site

Ambient Temperature +5 to +45 °C with installation in a system housing with an electronics module

Heat Sources and Magnetic Fields No heat sources or instruments which generate strong magnetic fields (e.g. electric motors or transformers) may be located in the proximity of the installation site.

Sample Gas Inlet Conditions

Conditions at the Sample Gas Inlet of the Gas Analyzer

Temperature:	+5 to +50 °C
Pressure:	2 to 20 hPa positive pressure

Sample Gas Flow Rate 5 to 10 l/h. The flow rate must be kept constant to ±0.2 l/h in this range. The flow rate is kept constant to 8 ± 0.2 l/h with integrated pump and flow control. The sample gas must be taken from a bypass at zero pressure.

If the sample gas flow rate is too low, contaminants from the gas lines (leaks, permeability, desorption) will adversely affect the measuring result.

If the sample gas flow rate is too high, asymmetrical cooling of the sensor may cause measuring errors. This can also cause faster aging or damage to the measuring cell.

Flammable and Corrosive Gases The analyzer must not be used for measurement of ignitable gas/air or gas/oxygen mixtures. The concentration of flammable gases in the sample gas must not exceed 100 ppm.

The presence of corrosive gases and catalyst poisons, e.g. halogens, sulfurous gases and heavy-metal dusts, results in faster aging and/or the destruction of the measuring cell.

Associated Gas Effect Inert gases (Ar, CO_2, N_2) have no effect. Flammable gases (CO, H_2, CH_4) in stoichiometric concentrations to the oxygen content: Conversion of O_2 < 20 % of the stoichiometric conversion. If higher concentrations of flammable gases are present, higher O_2 conversions must be expected.

Test Gases

Test Gases

Reference point (= electrical zero): Clean ambient air; its oxygen concentration is established from the value for dry air and the factor for consideration of the water vapor content

Example:
Water vapor content at 25 °C and 50 % relative humidity
= 1.56 % Vol. O_2 ⇒ Factor = (100 % – 1.56 %) / 100 % = 0.984
O_2 concentration = 20.93 % Vol. O_2 × 0.984 = 20.6 % Vol. O_2

End-point: Test gas with oxygen concentration in the smallest measuring range (e.g. 2 ppm O_2 in N_2)

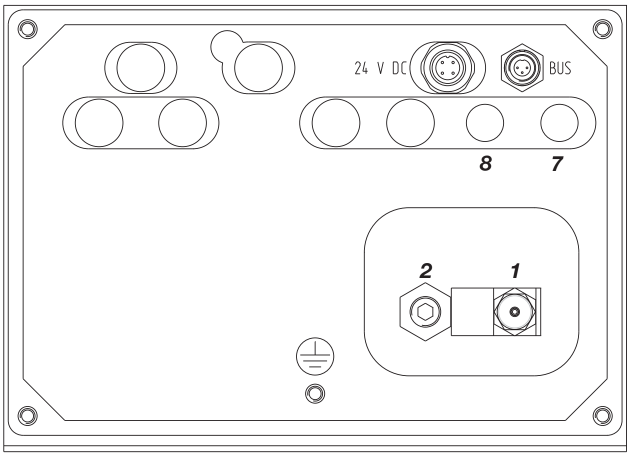
Note

The pressure conditions at reference point and end point must be identical!

Connection Diagram

Figure A-3-1

Connection Diagram



1 Sample gas inlet (3 mm Swagelok®)
2 Sample gas outlet (1/8 NPT female thread for commercially available adapter, e.g. Swagelok®)
7 Housing purge gas inlet [1)]
8 Housing purge gas outlet [1)]

1) only in IP54 version

Figure A-3-2

ZO23 with Internal Pump and Flow Sensor:

Example of Sample Conditioning

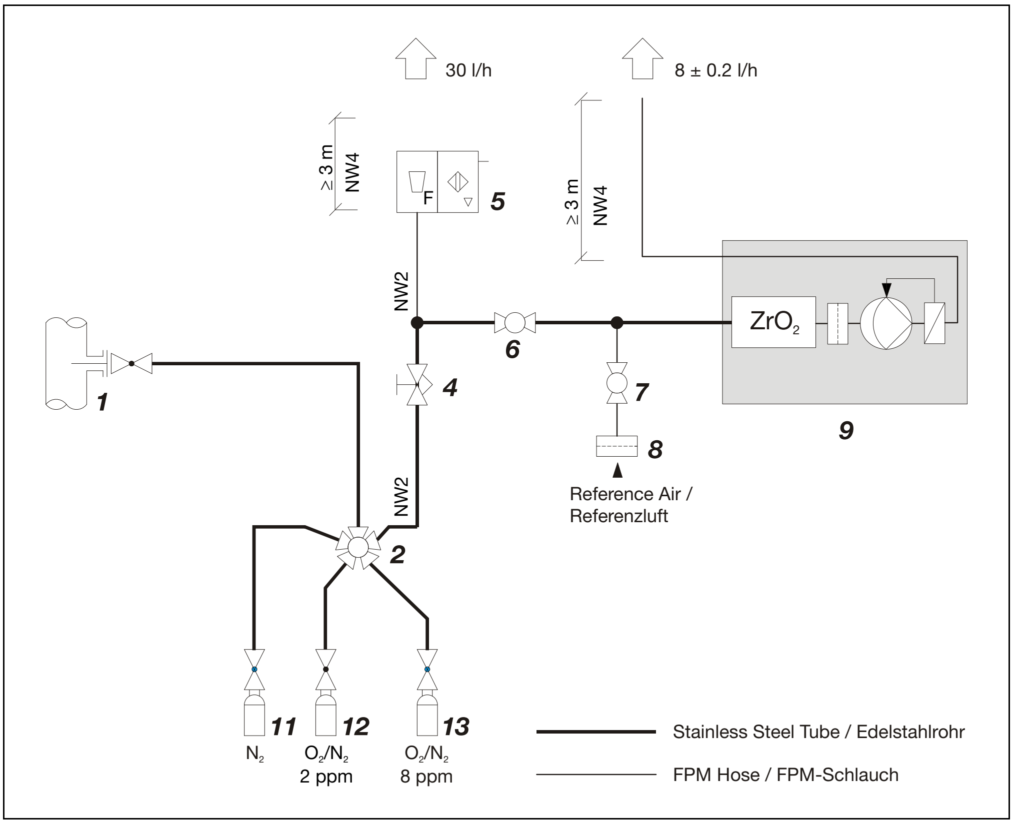
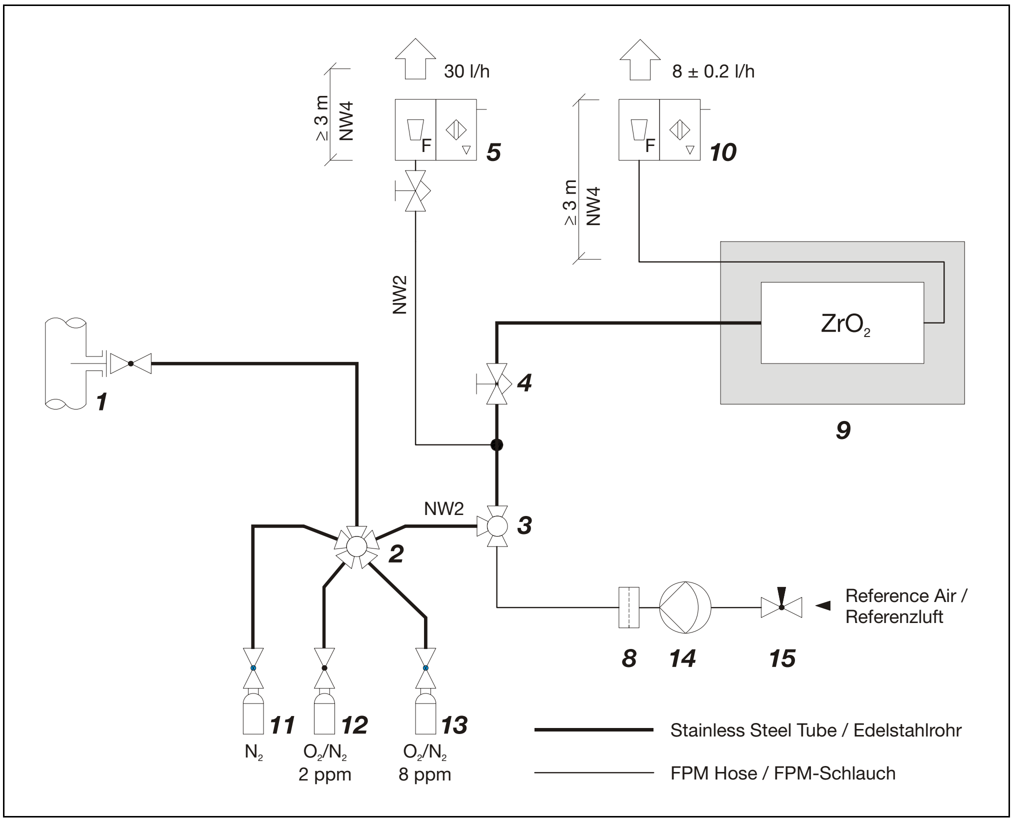


Figure A-3-3

ZO23 without Internal Pump and Flow Sensor:

Example of Sample Conditioning



Continued on next page

Legend for Figures A-3-2 and A-3-3

1 Sampling point with primary shut-off valve
2 Multi-way ball valve
3 3-way ball valve [1)]
4 Fine-control valve
5 Flow meter with needle valve and alarm contact
6 2-way ball valve [1)]
7 2-way ball valve [1)]
8 Air filter [1)]
9 Gas analyzer
10 Flow meter without needle valve, with alarm contact
11 Test gas cylinder with N_2 [1)]
12 Test gas cylinder with e.g. 2 ppm O_2 in N_2 [2)]
13 Test gas cylinder with 8 ppm O_2 in N_2 [1)]
14 Pump [1)]
15 Needle valve [1)]

1) Option
2) A hard-mounted test gas cylinder is normally adequate. The annual check of the reference point (see page A-3-7) can also be carried out by means of a non-stationary air supply.

The following information for installation and sample conditioning has to be observed when executing measurement and controlled calibration (manual, automatic and externally controlled calibration). Manually operated valves have to be replaced by controlled valves which are suitable for trace oxygen measurement if required.

Gas Sampling

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

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

The sample gas pressure must be reduced at the sampling point. A heated adjustable pressure regulator is also to be provided if samples are taken from liquid gas lines.

Sample Gas Supply Line

The sample gas supply line must consist of stainless steel tubing, be as short as possible and have the fewest joints possible.

The diameter of tube from the beginning of the first switch-over valve should be 3 mm externally and 2 mm internally. The sample gas connection to the gas analyzer is specified for a tube with an external diameter of 3 mm. Swagelok® fittings should be used for the connections.

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

For the gas analyzer version without internal pump and flow sensor, a fine-control valve must be provided to set the flow (see section “Sample Gas Flow Rate”, page A-3-2). The primary pressure must be kept constant in order to obtain a stable flow rate.

Gas Outlet Line

Flexible tubing can be used for the gas outlet line. With a nominal diameter of 4 mm, its length should be more than 3 m to prevent back diffusion from the ambient air.

Continued on next page

Bypass

The gas analyzer is connected to a constant gas flow (approx. 40 l/h) in the bypass. The needle valve is installed upstream of the branch to the gas analyzer, and the bypass flow meter downstream of the branch to the gas analyzer.

The gas analyzer takes 8 l/h from the gas flow. There is a surplus of approx. 30 l/h. If several ZO23 analyzer modules are supplied with gas in parallel (redundant measurement), the flow must be set in such a way that the bypass has a surplus of 30 l/h.

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

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

Exhaust Gas

The sample gas and the bypass must be conducted to the atmosphere or to an unpressurized exhaust gas collecting system at an adequate distance from the gas analyzer. Long conduction paths and pressure variations must be avoided.

For measurement and safety-related reasons, sample gas and bypass may not be discharged into the atmosphere in the proximity of the gas analyzer, since the ambient air serves as reference air, and also in order to exclude asphyxiation as a result of oxygen deficiency. It must be ensured that any exhaust gas which gets into respiratory air is sufficiently diluted.

Start-Up

Refer to page A-3-3 for information on the test gases

See also Chapter 8 “Gas Analyzer Calibration”, Section A “Principles” for information on calibration.

Gas Analyzer Start-Up Procedure, Initial Calibration at the Installation Site

Step	Action
1	Switch on the power supply to the gas analyzer. After approx. 15 minutes, the measuring cell has reached its operating temperature. If required, the gas analyzer can be calibrated at the reference point (see step 3) and the end-point (see step 5) before measurement is started.
2	For setting the reference point (= electrical zero), feed ambient air (flow rate see page **Fehler! Textmarke nicht definiert.**) and wait until the measured value has stabilized (duration approx. 2 hrs). Meanwhile, purge the test gas valves and the gas supply line with oxygen-free gas (e.g. with nitrogen from a loop feeder) or with sample gas (flow rate 5 to 10 l/h).
3	Set reference point to 20.6 % Vol. O_2. Please refer to page A-3-3 for calculation of the oxygen concentration.
4	Feed end-point gas (e.g. 2 ppm O_2 in N_2) and wait until the measured value has stabilized (duration max. 2 hrs).
5	Set end-point value in accordance with the certificate of analysis of the test gas cylinder used.
6	The gas analyzer is ready for performing measurements; feed sample gas.

Check of the End-Point and Reference Point

Refer to page A-3-3 for information on the test gases

Check of the End-Point

It is recommended that the end-point is checked approx. 4 weeks after start-up.

Further checks of the end-point should be carried out as required.

Check of the Reference Point

It is recommended that the reference point is checked once a year or as required.

Function Test

Description

The function test is used to carry out a rapid and regular check of the response time of the measuring cell. The function test can be carried out without any additional test gases by feeding the sample gas with constant concentration. It has a very high correlation with the check using gas. In case of doubt, the latter is decisive, however. The function test facilitates the preventive maintenance of the gas analyzer, since a requisite exchange of the measuring cell becomes plannable through the change in the response time. The values determined in the function test are stored in the log. As a result, the progression of the response time of the measuring cell can always be traced back.

Procedure

In the function test, the build-up of an oxygen potential in the measuring cell is simulated through the connection of an electrical test current. The change in the oxygen potential correlates with the response time of the measuring cell. A small change in the oxygen potential points to a relatively fast response time of the measuring cell. In this case, the result of the function test is “Test Passed”. If the value deviates from the value before the beginning of the test by more than 10 % after completion of the function test, the result is rejected, since it is assumed that the change in the sample gas was too high during the test.

Test Factor

The test result can be tailored to the required response time. In this connection, the test factor can be set by the user within the range 1 to 200 %. A test factor of 100 % is set ex works.

Test factor 1 to 99 %	Test requirements lower	T90 time > 60 s
Test factor 100 to 200 %	Test requirements higher	T90 time ≤ 60 to 20 s

If the test criteria are not met, the test factor must either be changed or the measuring cell checked by means of test gases.

Check of the Measuring Cell Using Test Gases

Two test gases with different concentrations within the measuring range are required to check the T95 time, e.g. a test gas with 2 ppm O_2 and one with 8 ppm O_2 (refer to “Information for the Installation and Sample Conditioning”, page A-3-4). The T95 time is determined through alternate application of the test gases. Beforehand, purge the test gas valves and the gas supply line with oxygen-free gas (e.g. with nitrogen from a loop feeder) or with sample gas (flow rate 5 to 10 l/h, duration approx. 2 hrs).

Carrying out the Function Test

The function test takes approx. 15 minutes. It is therefore recommended that it is carried out at a time when the process control is not adversely affected thereby.

The function test is executed in 2 phases:

Test current on	After start-up, the test current is applied to the measuring cell for approx. 400 s.
Test current off	The test current is then switched off, and the function test is ended after a further 400 s.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → ZO23 function test`

Operating Specifications

Measurement Principle	The ZrO_2 cell measures the difference in the oxygen concentration between the reference side (with air) and the measuring side (with oxygen traces).
Linearity Deviation	Owing to the measurement principle, zirconium dioxide cells are base linear.
Repeatability	< 1 % of the measurement range or 100 ppb O_2 (whichever is greater)
Zero Drift	The zero point (reference point) is displayed if ambient air is present on the sample gas side. The value for air of 20.6 Vol. % O_2 (for 25 °C and 50 % relative humidity) may deviate through aging of the cell. < 1 % of the measurement range per week or 250 ppb O_2 (whichever is greater)
Sensitivity Drift	Depends on possible interfering components (catalyst poisons) in the sample gas and the aging of the cell. For pure gas measurements in N_2, CO_2 and Ar: < 1 % of the measurement range per week or 250 ppb O_2 (whichever is greater)
Output Fluctuation (2 σ)	< ±0.5 % of the measured value or 50 ppb O_2 (whichever is greater)
Flow Influence	≤ 1% of the measured value or 100 ppb O_2 (whichever is greater) for a flow rate of 8 ± 0.2 l/h. The flow rate must be kept constant to ±0.2 l/h in the permissible range. The permissible range is 5 to 10 l/h. The flow rate is kept constant to 8 ± 0.2 l/h with integrated pump and flow control.
Associated Gas Influence	Inert gases (Ar, CO_2, N_2) have no effect. Flammable gases (CO, H_2, CH_4) in stoichiometric concentrations to the oxygen content: Conversion of O_2 < 20 % of the stoichiometric conversion. If higher concentrations of flammable gases are present, higher O_2 conversions must be expected. The concentration of flammable gases in the sample gas must not exceed 100 ppm.
Temperature Influence	The effect of the ambient temperature in the permissible range of +5 to +45 °C is < 2 % of the measured value or 50 ppb O_2 per 10 °C change in the ambient temperature (whichever is greater).
Air Pressure Influence	No effect through a change in air pressure; sample gas must flow out of the outlet without back pressure.
Power Supply Influence	24 V DC ± 5 %: no effect
Position Influence	No position effect for permanently installed instruments
T_{90} Time	T_{90} < 60 s for the alternation of 2 test gases in the measurement range 10 ppm with a sample gas flow rate = 8 l/h and electronic T90 time = 3 s (applies to an analyzer unit with 1 analyzer module)

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