Advance Optima Continuous Gas Analyzers

AO2000-MultiFID14 NMHC

FID Analyzer

Start-Up and Maintenance Manual

41/24-106 EN Rev. 3

IMPORTANT!

The gas analyzer uses hydrogen as a combustion gas!

Consideration must be given to the following information and instructions contained in this start-up and maintenance guide at all times to ensure safe operation of the gas analyzer!

Power and productivity
for a better world™

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Start-Up and Maintenance Manual

Publication No. 41/24-106 EN
Revision 3
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Some Preliminary Comments …

… on the contents of the start-up and maintenance manual

This start-up and maintenance manual for the AO2000-MultiFID14 NMHC (Non-Methane Hydrocarbon) analyzer is a supplement to the operator's manual for the AO2000 Series continuous gas analyzers.

It contains all information you need to install, start up, calibrate and maintain the analyzer. However, it does not contain any information on the operator interface, configuration and initialization of the analyzer; this can be found only in the AO2000 Series operator's manual.

… on additional documentation

In addition to the existing start-up and maintenance manual, the following publications are available for the AO2000 Series continuous gas analyzers:

Operator's manual	Publication No. 42/24-10 EN
Specification sheet	Publication No. 10/24-1.20 EN

… on 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".

… on symbols and font style in the operator's manual

⚠	indicates safety notices which must be followed while handling the analyzer, in order to prevent danger to the operator.
ⓘ	indicates special features for handling the analyzer and for using this start-up and maintenance manual.
1, ***2***, ***3***, …	identifies reference numbers in the figures.
`Display`	identifies an indication in the display.
`Input`	identifies an input by the operator • either by pressing a softkey • or by selecting a menu item • or by input from the numeric keypad

General Safety Notes

Intended Application

The AO2000-MultiFID14 NMHC analyzer is designed for continuous measurement of hydrocarbon concentration in gases or vapors.

Prerequisite for Safe Operation

To ensure error-free and safe operation of the analyzer, it must be appropriately transported and stored, professionally installed and started up, and also properly operated and carefully serviced.

Personnel Qualification

Only persons familiar with installation, start-up, operation and servicing of comparable instruments and having the qualification necessary for their activity may work on the analyzer.

Notices and Regulations to be Followed

The following requirements are mandatory:
- the content of this operator's manual,
- the safety notices attached to the analyzer,
- the pertinent safety regulations for erection and operation of electrical installations and
- the pertinent safety regulations for handling gases, acids, condensate, etc.

National Codes

The ordinances, standards and guidelines cited in this operator's manual are applicable in the Federal Republic of Germany. When the analyzer is used in other countries, the pertinent national codes must be followed.

Analyzer Safety and Safe Operation

The analyzer is built and tested per EN 61010 Part 1, "Safety regulations for electrical measuring, control, regulation and laboratory instruments", and was in safe condition when it left the factory.

To preserve this condition and ensure safe operation, the safety notices identified with the symbol ⚠ in this operator's manual must be followed. Otherwise persons may be endangered and the analyzer itself as well as other instruments and equipment may be damaged.

Notice on Explosion Protection

The AO2000-MultiFID14 NMHC analyzer must not be used for measurement of gas/air or gas/oxygen mixtures capable of exploding during operation. When measuring combustible gas that can form an explosive mixture with air or oxygen, special precautions must be taken to prevent the risk of explosion.

Further 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 Notes for Handling Electronic Measuring Instruments

Protective Lead Terminal	The connection between the protective lead terminal and a protective lead must be made before all other connections.
Danger of Broken Protective Lead	The analyzer may constitute a danger if the protective lead is broken inside or outside the analyzer or if the protective lead terminal becomes loose.
Correct Operating Voltage	Before turning on the power supply make sure the operating voltage selected on the analyzer matches the line voltage.
Danger when Opening Covers	Live parts may be exposed when opening covers or removing parts, even if tools are not needed to do so. Terminal points may also be live.
Danger when Working on the Opened Analyzer	Before work is done on the opened analyzer, the analyzer must be isolated from all voltage sources. Only professionals familiar with the dangers involved are permitted to work on the opened analyzer under voltage.
Danger due to Charged Capacitors	A period of 10 minutes after the analyzer has been isolated from all voltage sources is needed before the capacitors in its power supply are discharged.
Use of Correct Fuses	Only fuses of the specified type and rated current are permitted as replacements. Rewired fuses must not be used. The fuse holder must not be short-circuited.
If Safe Operation is no Longer Possible	If it must be assumed that safe operation is no longer possible, the analyzer must be shut down and secured against inadvertent operation. It must be assumed that safe operation is no longer possible • when the analyzer is visibly damaged, • when the analyzer is no longer working, • after prolonged storage under unfavorable conditions, • after severe stresses and strains during shipping.

Installation Location Requirements

The gas analyzer is only intended for installation indoors.

Short Gas Paths

Install the analyzer as close as possible to the sampling location

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

Adequate Air Circulation

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

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

Protection from Adverse Conditions

Protect the analyzer from:
- Cold
- Direct sunlight and heat
- Large temperature variations
- Strong air currents
- Accumulations of dust and dust infiltration
- Corrosive atmospheres
- Vibration

Environmental Conditions

Atmospheric pressure	600 to 1250 hPa
Relative humidity	max. 75 %
Ambient temperature at storage and transport	–25 to +65 °C
Ambient temperature in operation	+5 to +38 °C

Gas Inlet Conditions

The gas inlet conditions listed in the following tables apply to the inlet of the analyzer module.

CAUTION!
If the sample gas contains halogens or acid gases such as HCl, H_2S, SO_2 or NO_x, the catalyst will be irreversibly damaged by contact with these contaminants.

Definition

$p_e = p_{abs} - p_{amb}$

where p_e = gauge pressure, p_{abs} = absolute pressure, p_{amb} = atmospheric pressure

Sample Gas

Temperature	Inlet Pressure p_{abs}	Flow Rate
≤ Thermostat temperature (Thermostat temperature for measurement gas path, detector and air injector ≤ 200 °C, factory-set to 180 °C)	850 to 1100 hPa (0.85 to 1.1 bar)	80 to 100 l/h

The concentration of the sample component may be not higher than 10,000 ppm C1.

Supply Gases

Type, Quality	Inlet Pressure p_e	Flow Rate
Instrument air:		
Quality per ISO 8573-1 class 2 (max. particle size 1 µm, max. particle concentration 1 mg/m³, max. oil content 0.1 mg/m³, pressure dew point at least 10 °C below the lowest foreseeable ambient temp.)	4000 ± 500 hPa [2] (4.0 ± 0.5 bar)	approx. 1800 l/h [1]
Combustion air:		
synthetic or catalytically purified air with an organic C content < 1 % of span	1200 ± 100 hPa [2] (1.2 ± 0.1 bar)	< 40 l/h
Combustion gas [3]:		
H_2, 5.0 grade or	1200 ± 100 hPa [2] (1.2 ± 0.1 bar)	≤ 4 l/h or
H_2/He mixture (40 %/60 %) [4]		approx. 10 l/h

1) typical value (1200 l/h for integrated air injection + approx. 600 l/h for housing purge), maximum 2200 l/h (1500 l/h + 700 l/h)
2) typical value; for start-up (see page 31), the pressure must be set to that value specified in the analyzer data sheet.
3) Provide a flow limiter on the combustion gas supply (see page 12).
4) H_2/He mixtures should only be used if the analyzer has been ordered and delivered in the proper configuration.
   If the analyzer has been delivered in the H_2/He mixture configuration, H_2 should never be used as the combustion gas. This will lead to overheating and destruction of the detector.

Inlet pressures must be constant during operation. This can be ensured by using two-stage pressure-reducing valves.

Continued on next page

Gas Inlet Conditions, *conrtinued*

Test Gases

Type, Quality	Inlet Pressure p_e	Flow Rate
Zero gas:		
N_2, 5.0 grade or synthetic or catalytically purified air with an organic C content < 1 % of span	1000 ± 100 hPa (1.0 ± 0.1 bar)	130 to 250 l/h
Span gas:		
Propane in N_2 or air with a concentration adapted to the measurement range	1000 ± 100 hPa (1.0 ± 0.1 bar)	130 to 250 l/h
Test gases for effectiveness testing:		
Propane and methane in N_2 or air (separate test gas containers) with a concentration adapted to the measurement range	Zero pressure (via bypass)	130 to 250 l/h

Materials Supplied

Standard Materials Supplied

Quantity	Description
1	AO2000-MultiFID14 NMHC Analyzer
1	Analyzer Data Sheet (in the system housing)
1	AO2000 Series Operator's Manual
1	AO2000-MultiFID14 NMHC Start-Up and Maintenance Manual
1	CD-ROM containing technical documentation and communication software
1	Power cord, 5 m long, with screwed-on connector for non-heating appliances and separate grounded connector for the power supply to the electronics module
1	Power cord, 5 m long, with 4-prong plug and separate grounded connector for the power supply to the detector heater and the heated sample gas port
1	Accessories bag with threaded couplings and O-rings for the sample gas port
1	System bus terminating resistor

Materials Supplied Additionally (Depending on Analyzer Model)

Quantity	Description
1	Receptacle for heated sample gas port connector
	Interconnecting cables, tees and terminating resistors for the system bus (per purchase order)
	Socket connectors for the terminals of the I/O boards (per purchase order)
2	Inserts for the M23 threaded cable connectors for the IP54 enclosure

Installation

(see page 18 for instructions)

- 4 M8 or M10 bolts

Gas Connection Installation

(see page 16 for instructions)

For supply gases and test gases:

- 6 metal threaded connections with 1/8-NPT threads and PTFE sealing tape or
- 6 metal threaded connections with G-1/8 thread (DIN/ISO 228/1) and O-rings / sealing washers

Gas Line Connection

(see pages 19 to 25 for instructions)

For supply gases, test gases and exhaust air:

- PTFE or stainless-steel tubes with 4 mm ID and
  PTFE or stainless-steel tubes with ≥ 10 mm ID for exhaust air
- Threaded tube couplings
- Pressure regulators

For sample gas:

- Heated sample gas line (recommended: TBL 01) or unheated sample gas line (PTFE or stainless-steel tube with 4 mm ID)

ℹ The threaded couplings and O-rings necessary for the connection are included in the materials supplied with the analyzer module.

Provide measures for restriction of the combustion gas flow

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

ABB recommends the use of a bulkhead fitting with an integrated flow restrictor which is installed in the combustion gas supply line. This bulkhead fitting can be obtained from ABB:
- Combustion gas H_2: part number 8329303,
- Combustion gas H_2/He mixture: part number 0769359.

Provide a shut-off valve in the combustion gas supply line

A shut-off valve must be installed in the combustion gas supply line to increase safety in the following operating states:
- Putting the gas analyzer out of service,
- Failure of the instrument air supply,
- Leakage in the combustion gas feed path inside the gas analyzer.

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

ABB recommends the use of a pneumatic shut-off valve activated by instrument air (only possible in “continuous purging” mode.) Recommended type: Swagelok® SS-42GS6MM-A15C3.

ℹ If such a pneumatic shut-off valve cannot be installed, measures must be taken to monitor the collective status or the “Failure” status of the gas analyzer (see section “Failure of the instrument air supply” page 57).

Unpack Analyzer

CAUTION!

The analyzer weighs approx. 25 kg. Two persons are needed for unpacking and carrying.

Unpacking

Step	Action
1	Remove the analyzer and foam packing or wrapping from the shipping box.
2	Remove the foam packing or wrapping and set the analyzer aside on a clean surface.
3	Clean the adhering packing residue from the 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 (see “Materials Supplied” section, page 11)
- Keep the shipping box and padding material for future shipping needs.

Identification Plates and Analyzer Data Sheet

Identification Plates

The analyzer identification plate is located externally on one side panel of the system housing.

The MultiFID14 NMHC analyzer module has two identification plates: one also located externally on a side panel of the system housing and the other inside the analyzer on a side panel of the analyzer module.

The identification plate of the electronics module is located externally on the terminal plate above the terminals of the I/O boards.

Analyzer Data Sheet

The analyzer data sheet contains essentially the following information for the central unit and for each analyzer module:

- Order number (A-No.),
- Part number (P-No.),
- Fabrication date,
- Fabrication number (F-No.),
- Serial number,
- Software version,
- Power supply voltage,
- Measurement range data,
- Configured correction functions,
- Connection diagrams for signal inputs and outputs,
- Connection diagrams for gas inlets and outlets.

In addition, the user (and also ABB Service) can document service tasks and modifications performed on your analyzer in the analyzer data sheet.

Where is the analyzer data sheet located?

The analyzer data sheet is kept in an envelope which is attached to the inside of the housing door.

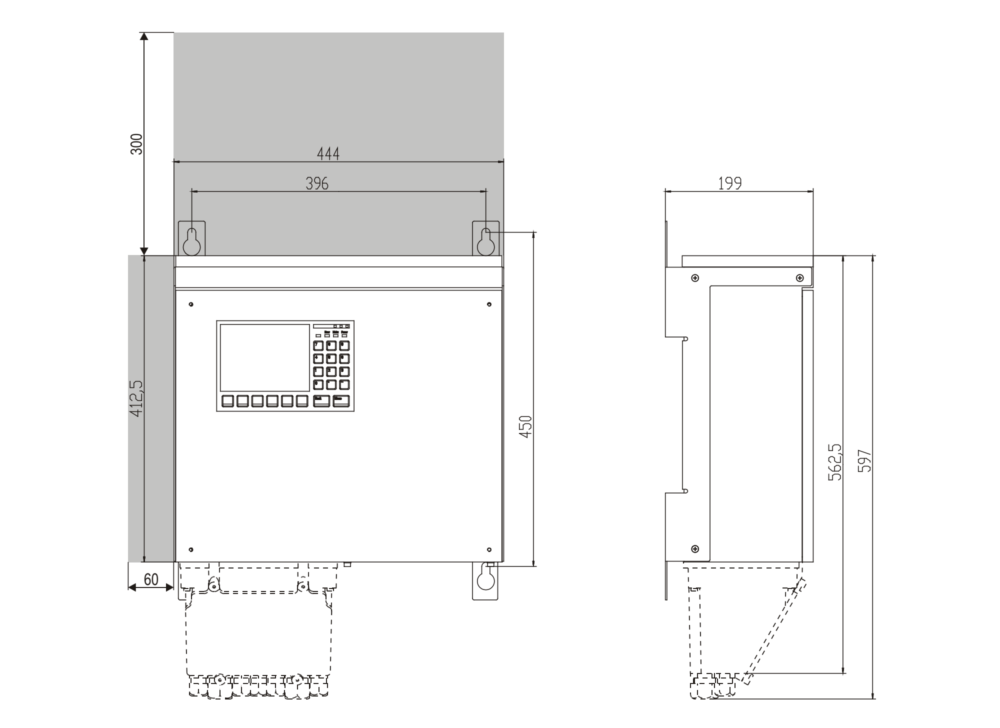
- The analyzer data sheet should be kept with the gas analyzer so that it is always available for reference.
- During operation be sure to note the device- and system-specific data in the analyzer data sheet. These data can differ from the information contained in this operator’s manual.

Dimensional Diagrams

Figure 1

Wall-Mount Housing

(Dimensions in mm)



- The connection box shown with dashed lines in the dimensional diagram is flange-mounted to the IP54 housing.
- Observe the installation location requirements (see Page 9).
- Consider the additional space required for connecting lines (approx. 100 mm).
- When installing the analyzer with a heated sample gas port, consider the space requirement for the heated sample gas line (observe the manufacturer's recommended minimum bend radius).
- When installing the housing, consider the free space required on the left side to open the door (approx. 60 mm, shown in gray in Figure 1).
- When installing the housing, allow for additional space above the housing since some units can only be accessed from the top (approx. 300 mm, shown in gray in Figure 1).
- Install the housing so that the screen is oriented vertically.

Gas Connection Installation

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

Port Design

The ports for the supply gases and test gases are designed as connection nipples with 1/8 NPT internal threads.

The ports for sample gas and exhaust air are designed as threaded couplings for PTFE or stainless-steel tubes with 6 mm OD.

Materials Needed

Quantity	**Material** (not supplied)
6	Metal threaded connections with 1/8-NPT threads and PTFE sealing tape or
6	Metal threaded connections with G-1/8 thread (DIN/ISO 228/1) and O-rings / sealing washers

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.

Use only metal threaded connectors.

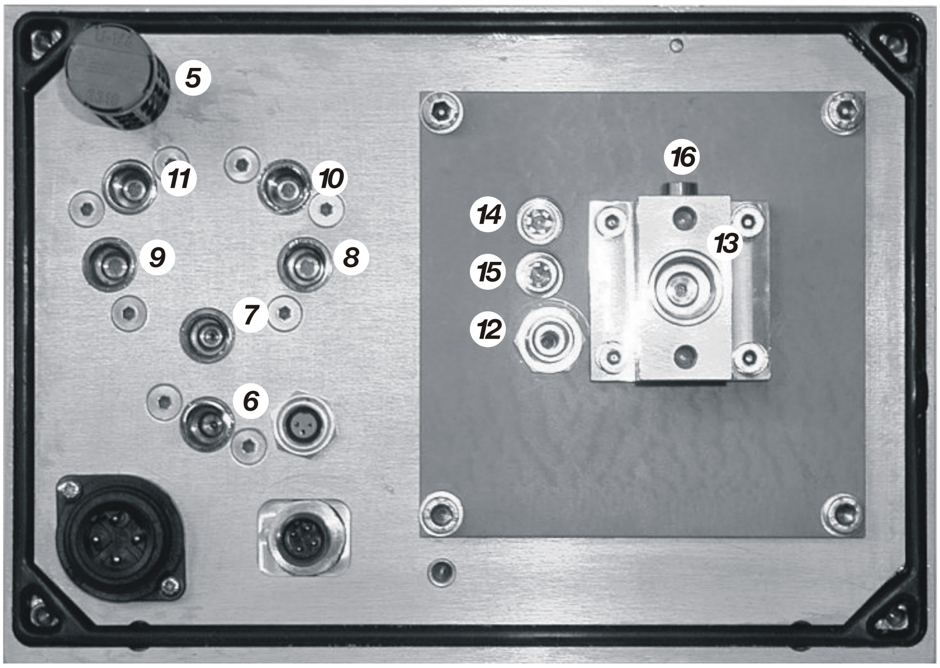
Gas Connection Installation

Step	**Action**
1	Remove plastic sealing stoppers from the connection ports.
2	Using appropriate sealing material (PTFE sealing tape, O-rings, sealing washers), insert the tubing or threaded connectors in the connection ports. Screw the fittings on carefully and not too tightly. Follow the manufacturer's installation instructions.

Continued on next page

Figure 2

Connection Diagram (Gas Ports)



5 Pressure compensator opening with particle filter
6 Instrument air inlet
7 Test gas outlet (connected to ***16***)
8 Span gas inlet
9 Zero gas inlet
10 Combustion gas inlet
11 Combustion air inlet
12 Exhaust air outlet
13 Sample gas inlet (the photo shows an unheated sample gas port)
14 Bypass nozzle 1
15 Bypass nozzle 2
16 Sample gas inlet on sample gas port (connected to ***7***)

- Protect the particle filter at pressure compensator opening ***5*** from moisture.
- Follow instructions for connecting the gas lines (see pages 19 to 25).

CAUTION!

Do not open any threaded connections in the analyzer gas paths. Doing so will damage gas path seal integrity.

If device-internal gas path threaded connections are opened (by trained personnel only), a seal integrity check must be performed with a leak detector (thermal conductivity) when the device is reassembled.

The seal integrity of the combustion gas feed path within the gas analyzer must be checked regularly (see page 54).

Combustion gas flowing out of the leak points thus formed in the internal gas paths can cause fire and explosions (even outside the analyzer itself).

CAUTION!

The analyzer weighs approx. 25 kg. The following points should be observed:

- **Two persons are needed for installation.**
- **The location (e.g., cabinet or wall) must be capable of supporting the analyzer's weight.**
- **The housing cover can drop when opened.**

Materials Needed

Quantity	**Fastener** (not supplied)
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 15.

Gas Line Connection

CAUTION!

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

Follow the fitting manufacturer's instructions. Be sure to use a backup wrench when tightening gas line threaded connections (gas ports).

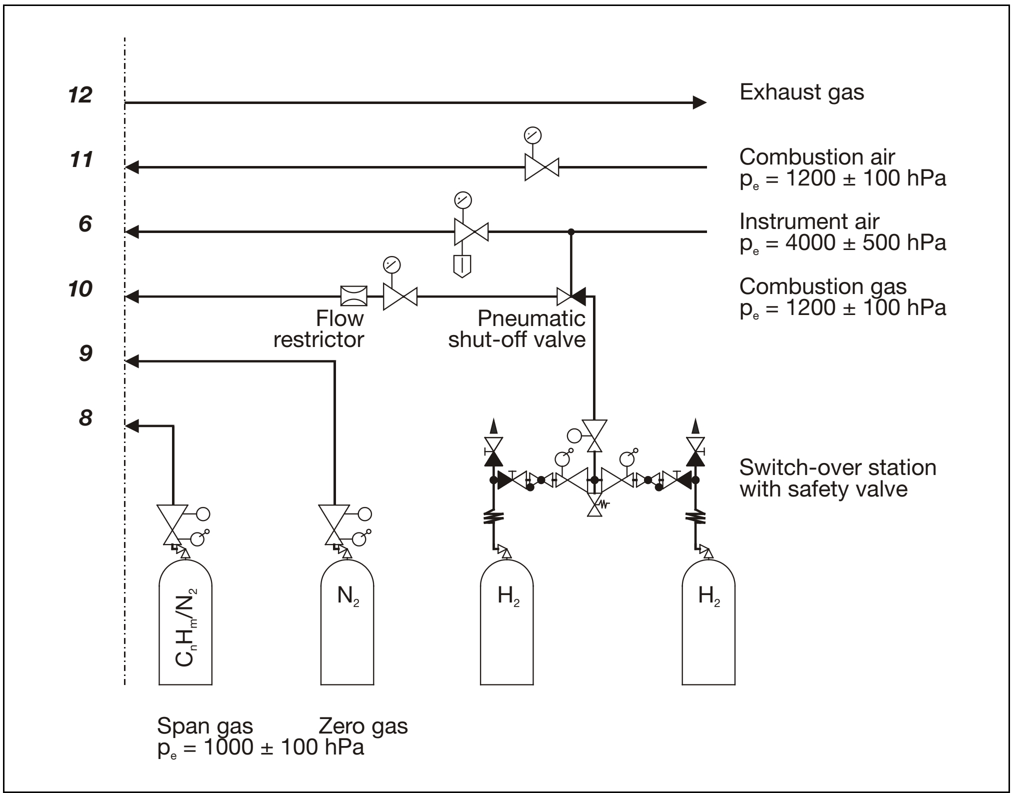
Which gas lines must be connected?

Gas line	See
Test gases	Page 20
Exhaust air	Page 20
Combustion gas	Page 21
Instrument air, combustion air	Page 22
Sample gas (heated sample gas port) or	Page 23
Sample gas (unheated sample gas port)	Page 25

Figure 3

Connection of the gas lines to the MultiFID14 NMHC

The numbering of the gas connections corresponds to the numbering in the connection diagram (see Figure 2, page 17) as well as to the tags on the reverse side of the analyzer module.



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Test Gas Connection

The test gas outlet is connected to the sample gas connection at the factory (see Figure 17“Gas diagrams”, page 63).

If the test gas is supplied directly at the sampling site, remove the link between the sample gas outlet and sample gas inlet on the sample gas port and seal the sample gas connection opening with an M6 screw.

Exhaust Air Connection

Exhaust air should be routed without pressurization to the atmosphere or to an exhaust pipe directly or via the shortest possible large-diameter line.

Use PTFE or stainless steel exhaust air line. The medium temperature reaches 200 °C.

The ID of the exhaust line should be increased to ≥ 10 mm within no more than 30 cm from the exhaust outlet.

Do not route exhaust gases via flow reducers or shutoff valves.

Purging the Sample Gas Line

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

Combustion Gas Line Connection

CAUTION!

The pertinent safety regulations for handling combustible gases must be followed.

Combustion Gas Line Connection

Step	Action
Combustion Gas Line Cleaning	
1	Pump cleaning agent (alkaline cleaner, solvent, stainless steel pickling fluid) through the tube.
2	Purge tube thoroughly with distilled water.
3	Purge tube for several hours at a temperature above 100 °C with synthetic air or nitrogen (10 to 20 l/h).
4	Close off tube ends.
Combustion Gas Line Connection	
5	Connect two-stage pressure-reducing valve (for ultra-pure gases) to the combustion gas cylinder.
6	Connect combustion gas line to the pressure-reducing valve.
7	Install a flow restrictor in the combustion gas supply line to restrict combustion gas flow to 10 l/h H_2 or 25 l/h H_2/He mixture. This is to ensure the safe operation of the gas analyzer even with a defect in the combustion gas feed path (e.g. loose fitting inside instrument).
8	Install shut-off valve in the combustion gas supply line. The installation of a pneumatic valve is recommended; this valve must be regulated by the instrument air supply in such a way that in the event of its failure (and consequently in the event of the failure of continuous case purging, see page 22) the combustion gas supply is shut off automatically.
9	Connect combustion gas line through a pressure regulator (0 to 1.6 bar) directly to combustion gas inlet ***10*** of the analyzer module (see Figure 2, page 17, and Figure 3, page 19).
Combustion Gas Line Seal Integrity Check	
10	Check seal integrity of the combustion gas line (see page 52 for instruction).

Instrument Air and Combustion Air Line Connection

Instrument Air Line Connection

Instrument air is used as motive air for the air injector (if installed) and as housing purge air.

Connect instrument air line via a pressure regulator (0 to 6 bar) to instrument air inlet ***6*** of the analyzer module (see Figure 2, page 17, and Figure 3, page 19).

Combustion Air Line Connection

Connect combustion air line via a pressure regulator (0 to 1,6 bar) to combustion air inlet ***11*** of the analyzer module (see Figure 2, page 17, and Figure 3, page 19).

Housing Purge

Why should the housing be purged?

The housing of a gas analyzer equipped with the MultiFID14 NMHC analyzer module must always be purged since combustible gases (H_2 or H_2/He mixture) are routed into the module.

Purge Air Supply

Part of the instrument air (approx. 600 to 700 l/h) to the air injector is continuously routed as purge air through the housing, even when the gas analyzer is out of operation.

Separate Purging of Central Unit and Analyzer Module

There is no gas-tight separation of the central unit and analyzer module. 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 IP54 system housing.

Due to differing purge gas supply requirements, the MultiFID14 NMHC analyzer module should not be purged in series with other analyzer modules.

Sample Gas Line Connection (Heated Sample Gas Port)

CAUTION!

Before start-up of the analyzer module it is imperative to remove any plastic sealing stopper inserted in a sample gas inlet at the factory.

Sample Gas Line Material

Use PTFE or stainless steel sample gas line. (Recommendation: use heated sample gas line TBL 01.) The medium temperature reaches 200 °C.

Sample Gas Line Connection

With a heated sample gas port the sample gas line can be connected to one of the sample gas inlets I or II (see Figure 5). A sample gas line cannot be connected to sample gas inlet III (structural constraints); it must always be kept closed.

Connect the heated sample gas line directly to the sample gas inlet. Make sure the O-rings are properly seated and that the sample gas line is fully inserted in the sample gas port.

Unused Sample Gas Inlets

If …	then …
the analyzer draws in sample gas through the sample gas line	the unused sample gas inlets should be blocked with the threaded cap inserted at the factory.
the sample gas is under positive pressure	one sample gas inlet must be open and connected with an exhaust gas line to avoid any accumulation of positive pressure in the analyzer module.

Fittings and O-Rings

The required fittings and O-rings are supplied in the accessory kit.

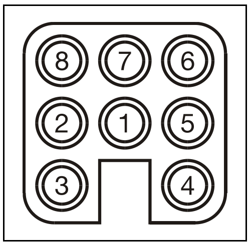
Electrical Connections

(see Figure 4)

Step	Action
1	Connect the Pt-100 resistance thermometer leads to a suitable controller.
2	Connect the PTC heating element power supply leads to a suitable solid-state relay. 230 VAC: series connection, 115 VAC parallel connection.

Figure 4

Heated Sample Gas Port Plug Layout



6–7	PTC Heating Element 1
1–5	PTC Heating Element 2
3–4	Pt-100 Resistance Thermometer
8	⏚
2	Not used

The illustration shows the pin side of the connection cable plug and thus the solder side of the matching female jack.

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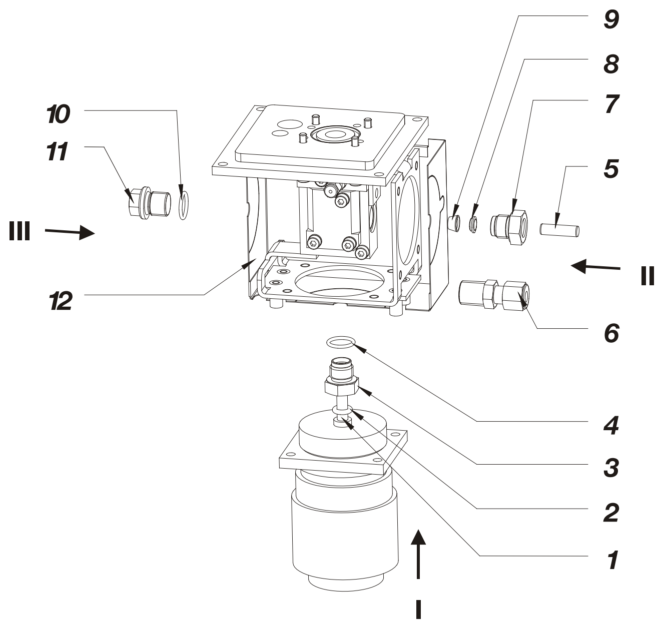
Figure 5

Sample Gas Line Connection on Heated Sample Gas Port

(Wall-mount housing, view from above right)



1 Heated Sample Gas Line (tube with 4/6-mm ID/OD)
2 O-Ring 6.02 x 2.62
3 Fitting
4 O-Ring 12.42 x 1.78

Connection of Additional Sample Gas Line or Plug:
5 Sample Gas Line (tube with 4/6-mm ID/OD) or 6 x 20 Stopper Pin either with
6 1/4 NPT Threaded Fitting (with PTFE sealing tape; not supplied) or with
7 Fitting
8 Cone Ring
9 Sealing Ring

Plug:
10 O-Ring 12.42 x 1.78
11 Plug Screw

12 Cover

Sample Gas Inlets:	Sample Gas Line Connection:
I	Below
II	Right
III	Not Possible

Maximum Sample Gas Line Length

The maximum length of the heated sample gas line (4 mm ID) is 30 m.

Sample Gas Line Connection (Unheated Sample Gas Port)

CAUTION!

Before start-up of the analyzer module it is imperative to remove any plastic sealing stopper inserted in the sample gas inlet at the factory.

Sample Gas Line Connection

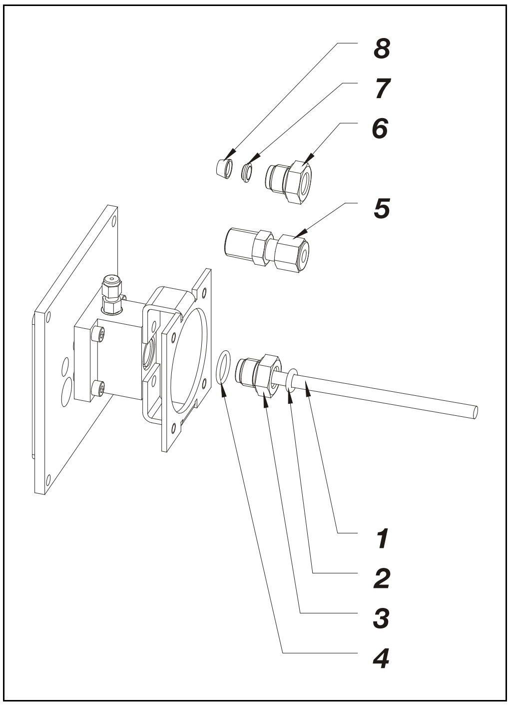
There is only one sample gas inlet for an unheated sample gas line (see Figure 6).

If the sample gas is under positive pressure, a tee should be installed between the sample gas line and sample gas inlet. The free end of the tee should be connected to an exhaust line to avoid any accumulation of positive pressure in the analyzer module.

Figure 6

Sample Gas Line Connection on Unheated Sample Gas Port

(Wall-mount housing and 19-inch housing)



1 Sample Gas Line (PTFE or stainless-steel tube with 4/6-mm ID/OD)

Connection either with

2 O-Ring 6.02 x 2.62

3 Fitting

4 O-Ring 12.42 x 1.78

or with

5 1/4 NPT Threaded Fitting (with PTFE sealing tape; not supplied)

or with

6 Fitting

7 Cone Ring

8 Sealing Ring

Maximum Sample Gas Line Length

The maximum length of the heated sample gas line (4 mm ID) is 50 m.

Chapter 4 Electrical Line Connection

Power Supply Line Connection – Safety Notes

CAUTION!

Comply with the pertinent national safety regulations for installation and operation of electrical equipment as well as the following safety notices.

Before connecting the power supply, make sure that the operating voltage setting of the analyzer matches the line voltage.

Connect the protective lead terminal to a protective lead before making any other connections. When the supplied power cord is used, this is ensured by the leading pin of the protective lead.

The analyzer may become hazardous if the protective lead breaks inside or outside the analyzer or the protective lead terminal is separated.

Use only fuses of the specified type and rated current as replacements. Do not use rewired fuses. The fuse holder must not be short-circuited.

Parts of the power-supply circuit may continue to be under voltage even if the line fuse blows.

Never connect line voltage (115 VAC or 230 VAC) to the 24 V ⎓ input of the analyzer module. This would destroy the electronics of the analyzer module.

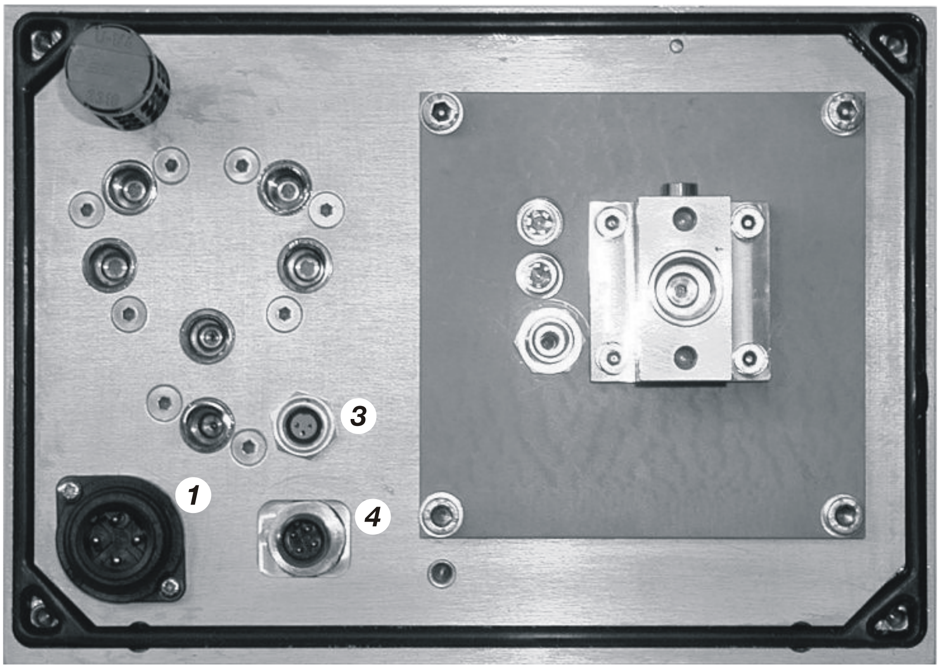
Install an easily accessible circuit breaker close to the analyzer so that all poles can be disconnected from the power supply. Label the breaker to ensure that the circuit it controls is clearly identifiable.

Never pull the plug connectors of the 115/230 VAC power supply for the detector heater and the converter heater while the power is on.

Connection Diagram (Electrical Connections)

Figure 7

Connection Diagram (Electrical Connections)



1 115/230 VAC power supply of detector heater and if necessary of heated sample gas port (see also Figure 11)
3 System bus
4 24 V ⎓ power supply (see also Figure 9)

Power Consumption

Power Consumption

Component	Power supply	Power consumption
Central unit	115/230 VAC	200 VA
Detector heater	115/230 VAC	120 VA
Converter heater	115/230 VAC	100 VA
Heated sample gas port	115/230 VAC	100 VA
Analyzer module	24 VDC	65 W

24 VDC Power Supply Line Connection

24 VDC Connection Cable

If the gas analyzer is set up so that an analyzer module is to be powered by an external 24 VDC power source, a 5-meter long cable (2 x 0.5 mm^2) with a 4-prong plug will be supplied for connection to the analyzer module. The wires on the free end of the cable are to be connected to an external power source (see Figure 8).

Figure 8

24 VDC Connection Cable

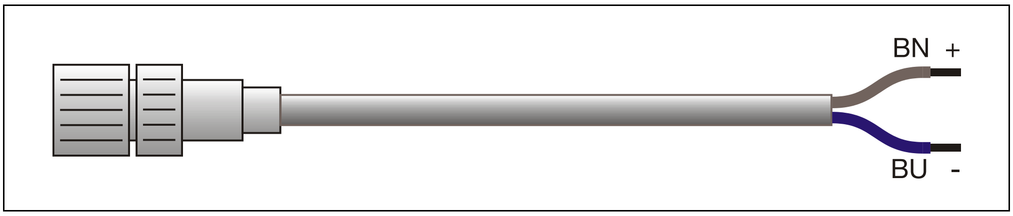
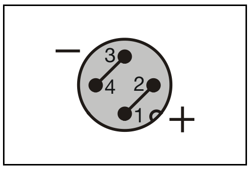


Figure 9

Analyzer Module 24 V ⎓ Connection



The illustration shows the pin side of the analyzer module 24 V ⎓ plug and thus the solder side of the matching female jack.

24 VDC Connection to the Analyzer Module

Proceed as follows to connect the 24 V DC power supply to an analyzer module not installed in the central unit:

Step	Action
1	Connect the supplied 24 VDC connection cable and plug to analyzer module 24 V ⎓ connector ***4*** (see Figure 9) and screw tight.
2	Connect the free end of the connection cable to an external power supply.

Extending the 24 VDC Connection Cable

The 24 VDC connection cable can be extended if necessary. The following conditions should be satisfied:

- The extension cable should have a conduction section of at least 2.5 mm^2.
- The extension cable should be no more than 30 m long.
- The extension cable should be connected as close as possible to the 24 VDC connection cable supplied, i.e., the 24 VDC connection cable should be as short as possible.

115/230 VAC Power Supply Line Connection

115/230 VAC Connection Cable

A 5-m connection cable (3 x 1.5 mm^2, see Figure 10) with 4-prong plug for connection to the analyzer module (see Figure 11) is supplied for the 115/230 VAC power supply of detector heater and if necessary of heated sample gas port.

Figure 10

115/230 VAC Connection Cable

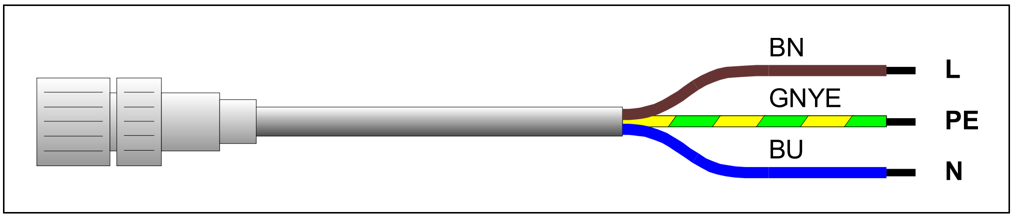
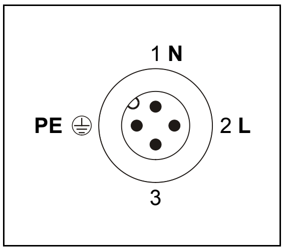


Figure 11

Analyzer Module 115/230 VAC Connection



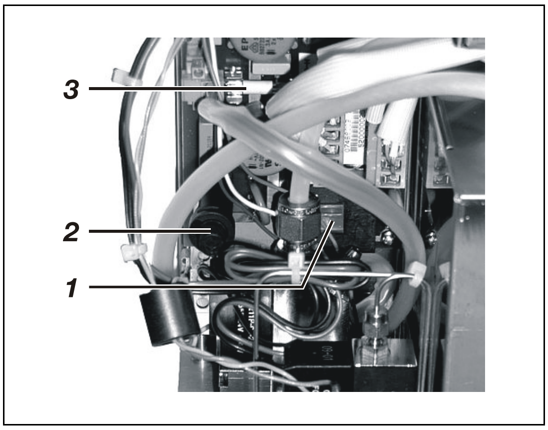
The illustration shows the pin side of plug ***1*** on the analyzer module.

Operating Voltage Change

The operating voltage of the detector heater and the converter heater can be switched between 115 VAC and 230 VAC by switch ***1*** on the power distribution board (see Figure 12). Fuse ***2*** must be replaced when the operating voltage is changed.

Figure 12

Position of Switches and Fuses on the Power Distribution Board



1 115/230 VAC switch
2 230 VAC M 2A or 115 VAC M 4A fuse
3 24 VDC M 3.15A fuse

Continued on next page

115/230 VAC Connection

Step	Action
1	⚠ Make sure the gas analyzer power supply is set to the proper line voltage. Adjust the operating voltage setting as necessary. Make sure the operating voltage indicated on the MultiFID14 NMHC analyzer module identification plate is the same as the line voltage. If applicable, set the proper operating voltage on the power supply board.
2	Make sure the power supply cable has an adequately dimensioned protective device (breaker).
3	Install an easily accessible breaker in the power supply or a switched receptacle near the analyzer to make sure the gas analyzer can be completely separated from the power source. Label the breaker to ensure that the circuit it controls is clearly identifiable.
4	Using the connector for non-heating equipment, connect the power cord supplied to the ***-X01*** power supply connector in the electronics module and secure with the clip.
5	Connect the supplied 115/230 VAC connection cable and 4-prong plug to the analyzer module power supply connector ***1*** of the analyzer module and screw tight.
6	Heated sample gas port (See Figure 4, page 23): 1. Connect the Pt-100 resistance thermometer leads to a suitable controller. 2. Connect the PTC heating element power supply leads to a suitable solid-state relay. 230 VAC: series connection, 115 VAC parallel connection.
7	Connect the wires on the free end of each power cord to the power source – by means of the attached grounded plug as the case may be. ℹ The 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.

Analyzer Start-Up

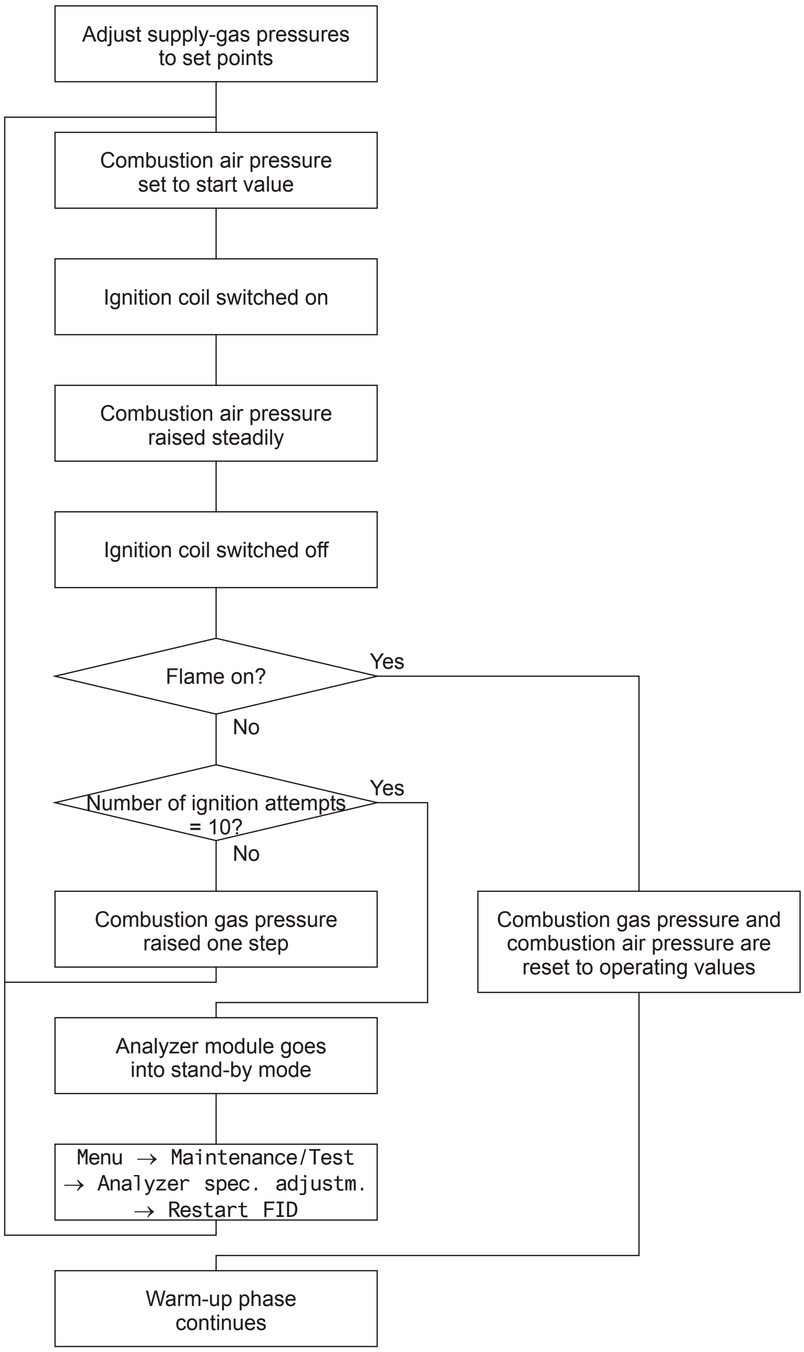
Analyzer Start-Up

Step	Action
Turn on power supply, initial heating phase, turn on supply gases	
1	⚠ Before connecting the power supply, check once again that both the operating voltage set on the analyzer power supply and the operating voltage indicated on the MultiFID14 NMHC analyzer module identification plate match the line voltage.
2	Turn on the power supplies for the • Analyzer • Detector heater • Heated sample gas port, if applicable. When the analyzer module is not built into the central unit: • Turn on the separately installed 24-VDC power supply of the analyzer module.
3	The following events will occur after the power supply is turned on: 1. The three “Power,” “Maint” and “Error” LEDs light up. 2. The gas analyzer power-on message appears on the screen. The power-on message shows the software version. The booting consists of the “Booting Database” and “Booting Display” phases. 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.
4	Select the `Controller values` menu item: **`MENU → Diagnostic/Information → Module specific → Controller values`** The variables for the temperature regulators are indicated under this menu item: `T-Re.D` Detector temperature `T-Re.Ko` Converter temperature The temperature values will rise slowly after the power supply is activated. The converter temperature controller variables are limited to 50 %.
5	Turn on instrument air, combustion air and combustion gas (H_2 or H_2/He mixture). Using the appropriate external pressure regulator, adjust the initial pressure to the value specified in the analyzer data sheet. ℹ The pressure values shown on the gas port labels, in the data sheet and in the “Gas Inlet Conditions” section (see page 10) are only typical values. Only the factory-determined values shown on the analyzer data sheet of the analyzer module are applicable for safe operation.

Continued on next page

Step	Action
6	In the `Controller values` menu item also the variables for the internal pressure regulators are indicated; set the supply gas pressures by means of the variables: `Input` Instrument air at combustion-chamber inlet `Output` Instrument air at combustion-chamber outlet `Air` Combustion air `H2` Combustion gas (H_2 or H_2/He mixture) Random values may be displayed at first for the variables. The values are updated for the first time approx. 30 seconds. after selection of the menu item and thereafter approx. every 30 seconds. Pressure control continues to run in the background. Depending on the pilot pressure setting, pressure setting times can be long. If the operator does not press any key for more than five minutes while in menu operation, the analyzer switches automatically to measuring operation to display of sample values (“time out”).
7	As soon as the temperature of the detector has reached the threshold value (150 °C) the appropriate solenoid valve in the analyzer module automatically connects the instrument air. The vacuum and combustion air controllers work to keep pressures at the applicable set points. Sample gas begins to flow through the analyzer as soon as the instrument air is connected.
8	After the pressures are at the applicable set points, the associated solenoid valve in the analyzer module automatically starts the combustion gas supply. The combustion gas controller attempts to establish the set point pressure value.
Adjust the variables for the internal pressure regulators	
	Steps 9 to 11 should only be performed if the analyzer module does not automatically start operation at the pressure values indicated on the analyzer data sheet. If the internal pressure controller values do not match these values, the pilot pressures must be changed.
9	Instrument air: Use the external pressure regulator to set the `Output` variable to approx. 60 % (max. 70 %). Variable too large ⇒ reduce pressure. Variable too small ⇒ raise pressure. (The `Input` variable depends on the sample gas flow rate.)
10	Combustion air: Use the external pressure regulator to set the `Air` variable to approx. 60 % (max. 70 %). Variable too large ⇒ raise pressure. Variable too small ⇒ reduce pressure.
11	Combustion gas: Use the external pressure regulator to set the `H2` variable to approx. 40 % (max. 50 %). Variable too large ⇒ raise pressure. Variable too small ⇒ reduce pressure.

Continued on next page

Step	Action
Flame ignition (automatic)	
12	

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Step	Action
ⓘ	Flame ignition may take up to 10 minutes, depending on the number of ignition attempts. During initial commissioning of the gas analyzer, it can happen that – depending on the length of the combustion gas supply line – there is still not enough combustion gas available to ignite the flame initially. In this case, the ignition of the flame must be restarted using the function `Restart FID`. The flame temperature is displayed in the `Flame` parameter under the `Auxiliary raw values` menu item; it must be at least 30 °C higher than the detector temperature. Actual start-up of the analyzer is complete when the flame ignites.

Returning the gas analyzer to service

Step	Action
1	Feed in instrument air and combustion air and purge the gas analyzer for at least **20 minutes.**
2	Switch on the power supply of the gas analyzer.
3	Open the combustion gas supply and set the combustion gas pressure.
4	Feed in sample gas.
5	Carry out a seal integrity test.

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 AO2000 Series Operator's Manual).

Adjusting the Filter (T90 time)

The MultiFID14 NMHC analyzer module has a non-linear filter.

Menu path: **`MENU → Configure → Component specific → Filter → Select component → …`**

Parameters	Explanation	Value [1)]
`T90-1`	Low-pass time constant for constant measured value.	20 sec.
`T90-2`	Low-pass time constant for measured value changes.	1 sec.
`Switching Threshold`	Switching threshold relative to measurement range. T90-2 applies on over/undershoot.	1 %

1) Recommendation

Warm-Up Phase

Definitions

The *warm-up* phase covers the period after the power supply has been turned on until measurement drift is acceptable. This depends on the measurement span. The warm-up phase includes the initial heating phase.

The *initial heating phase* covers the period after the power supply has been turned on until the detector temperature reaches the threshold value (150 °C).

Warm-Up Phase Duration

The warm-up phase lasts approx. 2 hours.

The warm-up phase can take longer if the 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.

Status Messages

The following status messages are present during the initial heating phase:

Short Text	Description
Working temperature	The detector temperature has not yet reached the threshold value.
Flame fault	The flame is not yet lit.
Temperature limit value 1, 2	The temperature of the detector (`T-Re.D`) and of the converter (`T-Re.Ko`) is above or below the upper or lower limit value 1 (2).
Pressure limit value 1, 2	The pressure at one of the internal pressure regulators for instrument air (`Input, Output`), combustion air (`Air`) or combustion gas (`H2`) is above or below the upper or lower limit value 1 (2).

Reading

The reading and `--E--` flash alternately, signaling that the displayed measurement value is not valid.

Readiness

At the end of the warm-up phase the analyzer is ready to carry out measurements and can be calibrated.

CAUTION!

Never pull the 115/230 VAC power supply plug connectors for the detector heater and the converter heater while the power is on.

CAUTION!

The heated sample gas port cover is hot during operation. Its temperature is higher than 70 °C.

Electrical Zero Calibration

Electrical Zero Calibration on Initial Start-Up

At measurement ranges < 150 mg C/m^3 the zero point may need to be recalibrated on initial start-up.

This is because the combustion gas and combustion air as well as their lines can become contaminated with hydrocarbons. These cause a zero point offset, which is electronically corrected by the electrical zero calibration.

Corrections required during electrical zero calibration are not treated as drift; consequently the setting reserve capacity is not exhausted, as occurs in zero point calibration.

Set Point Value

The set point value for electrical zero calibration is 0 ppm or 0 mg/m^3.

Menu Path

`MENU → Maintenance/Test → Analyzer spec. adjustm. → Electr. zero cal. FID`

- Please also read the Chapter “Gas Analyzer Calibration” of the AO2000 Series Operator’s Manual.
- During calibration the cyclical change between bypass and converter is disabled. The zero and span gases are routed via the bypass.

Sample Component and Measurement Ranges

Sample Component and Measurement Range

The MultiFID14 NMHC analyzer module has 1 sample component with 1 measurement range.

The ratio of methane to other hydrocarbons in the sample gas should be in the range of CH_4 : NMHC = 1 : 9 to 9 : 1.

The measurement range is factory-set per customer order.

The smallest measurement range is 0 to 5 mg C/m^3.

- The associated amplification levels cannot be changed via the display and control unit.
- After changing the measurement range limits the linear converter parameters should be adjusted.

Test Gases

Test Gases for Calibration

Type, Quality	Inlet Pressure p_e	Flow Rate
Zero gas:		
N_2, 5.0 grade or synthetic or catalytically purified air with an organic C content < 1 % of span	1000 ± 100 hPa (1.0 ± 0.1 bar)	130 to 250 l/h
Span gas:		
Propane in N_2 or air with a concentration adapted to the measurement range	1000 ± 100 hPa (1.0 ± 0.1 bar)	130 to 250 l/h

Zero Offset

If the zero gas is not absolutely free of hydrocarbons (even high-purity nitrogen contains some hydrocarbons), negative readings may be displayed in low-level measurement ranges (the process gas is “cleaner” than the zero gas). This can be prevented by setting the zero at a positive value instead of zero during calibration.

To produce hydrocarbon-free zero gas, air is passed through a combustion furnace at 800 °C in order to burn all hydrocarbons. This gas can be used to determine the necessary offset relative to cylinder gases or catalytically purified zero gases.

Test Gas Concentration

Set the zero and span test gas concentrations, which are used as set point values for calibration.

Menu Path

`MENU` → `Configure` → `Calibration data` → `Manual calibration` or `Automatic calibration` or `Ext. controlled cal.` → `Test gas concentration`

Test Gas Flow Monitor (Pressure Switch)

Test Gas Pressure and Test Gas Flow Rate

By setting the test gas pressure such that the test gas flow at the sample gas inlet corresponds to the gas inlet conditions (130 to 250 l/h) the test gas surplus will flow toward the sampling site and prevent sample gas traces from influencing the calibration results.

If the test gas is connected directly to the sample gas port (see "Gas Line Connection" section, page 19), it must be available as unpressurized excess (130 to 250 l/h) here also.

Flow Monitoring during Automatic Calibration (Pressure Switch)

If test gases are supplied to the separate test gas inlets, during automatic calibration the integral pressure switch can be activated for flow monitoring. Calibration is discontinued in case of inadequate flow.

The pressure switch can be activated for
- Zero gas
- Span gas and
- Zero and span gas

Menu Path

`MENU → Configure → Calibration Data → Automatic Calibration → Other Parameters → Pressure Switch`

Test Gas Supply at Sample Gas Inlet during Manual Calibration

If the test gas is supplied directly to the sample gas inlet during manual calibration the following message will appear in the display when the pressure switch is active:

`No calibration gas. Pressure switch has not detected any calibration gas.`

This message can be overridden by pressing the Back key.

Analyzer Module Manual Calibration

- The MultiFID14 NMHC analyzer module should only be calibrated after the warm-up phase, i.e., approx. 2 hours after connecting the power supply.
- The zero should be calibrated manually prior to a manual span calibration.

Test Gas Supply

If the test gases enter at the zero or span gas input, the test gas supply is controlled by the integral valves.

If the test gas enters directly via the sample gas inlet, the zero and span gases must be blocked off.

Analyzer Module Manual Calibration

Step	Action
1	Select the `Manual Calibration` menu: **`MENU → Calibrate → Manual calibration`**
2	For single calibration: Select **`Measurement range`** with the arrow keys.
Zero calibration:	
3	Select **`Zero gas`** with the arrow keys, **`ENTER`**.
4	Turn on the zero gas supply.
5	If necessary use the numeric keypad to enter the test gas concentration [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 **`Span gas`** with the arrow keys, **`ENTER`**.
9	Turn on the span gas supply.
10	If necessary use the numeric keypad to enter the test gas concentration [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 to 12 for other measurement ranges.	

1) The initialized test gas concentration (see page 38) is shown as the set point.

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.

Concentration Data Conversion

Different Concentration Data Units

The concentration is expressed in various units in the measurement of organic carbon compounds (total C):

- mg org. C/m^3 (e.g., in measurements per 17. BImSchV [17th Regulation of Federal Emission Protection Act])
- mg C_nH_m/m^3
- ppm C_nH_m (e.g., in measurements per TA-Luft [Technical Directive for Air], data on test-gas cylinders)

Thus it is often necessary to convert concentration data from one unit to another.

Conversion ppm → mg C_nH_m/m^3

$$\text{mg } C_nH_m/m^3 = \text{ppm} \times \frac{\text{Molecular Weight}}{V_m}$$

Conversion ppm → mg C/m^3

$$\text{mg } C/m^3 = \text{ppm} \times \frac{\text{Number of C atoms} \times 12.011}{V_m}$$

Mole volume V_m = 22.414 for 0 °C and 1013 hPa, V_m = 24.05 for 20 °C and 1013 hPa

Example 1

A MultiFID14 NMHC analyzer has a measurement range of 0-50 mg C/m^3. Propane (C_3H_8) in N_2 or in air is used as the test gas.

How large can the maximum test gas concentration be in ppm or mg/m^3 without exceeding the measurement range?

$$\frac{50 \times 22.414}{3 \times 12.011} = 31.102 \text{ ppm } C_3H_8$$

$$\frac{31.102 \times (3 \times 12.011 + 8 \times 1.008)}{22.414} = 61.19 \text{ mg } C_3H_8/m^3$$

Continued on next page

Example 2

If a gas other than propane is used, its response factor must be considered (see "Response Factor" section on page 43).

If methane (CH_4) is used, how large can the maximum test gas concentration be in ppm or mg/m^3 without exceeding the measurement range?

$$\frac{50 \times 22.414}{1 \times 12.011} = 93.306 \text{ ppm } CH_4$$

$$\frac{93.306 \times (1 \times 12.011 + 4 \times 1.008)}{22.414} = 66.785 \text{ mg } CH_4/m^3$$

The methane response factor is 1.07; i.e. the sample value indication is too large by this factor. To determine the maximum test gas concentration that avoids exceeding the measurement range, the measured value reading should be divided by the response factor.

$$\frac{93.306}{1.07} = 87.202 \text{ ppm } CH_4$$

$$\frac{66.785}{1.07} = 62.416 \text{ mg } CH_4/m^3$$

A test gas container with approx. 80 ppm of CH_4 is specified. According to the certificate, the test gas concentration in the test gas container is 81.2 ppm CH_4.

This is equivalent to a concentration of

$$\frac{81.2 \times 1 \times 12.011}{22.414} = 43.513 \text{ mg C}/m^3$$

Considering the response factor, the indication should be adjusted to

$43.513 \times 1.07 = 46.559 \text{ mg C}/m^3$

Response Factor

Definition

$$\text{Response factor} = \frac{\text{Meas. value indication}}{\text{Concentration}} \quad \text{or}$$

$$\text{Concentration} = \frac{\text{Meas. value indication}}{\text{Response factor}}$$

By definition, the response factor for propane (C_3H_8) is equal to 1.00.

Response Factors

Response factors for the MultiFID14 NMHC analyzer module are listed in the table below.

Response factors for an individual analyzer module may differ slightly from the values below.

Sample Component		Response Factor
Acetone	C_3H_6O	0.71
Benzene	C_6H_6	1.07
Butane	C_4H_{10}	0.98
Butyl acetate	$C_6H_{12}O_2$	0.84
Chlorobenzene	C_6H_5Cl	1.02
Cyclohexane	C_6H_{12}	1.02
Ethane	C_2H_6	1.01
Ethyl acetate	$C_4H_8O_2$	0.72
Ethylbenzene	C_8H_{10}	0.89
Ethyne (Acetylene)	C_2H_2	0.95
Isopropanol	C_3H_8O	0.74
Methane	CH_4	1.07
n-Heptane	C_7H_{16}	0.94
Perchloroethylene (Tetrachloroethene)	C_2Cl_4	0.97
Propane	C_3H_8	1.00
p-Xylene	C_8H_{10}	0.89
Toluene	C_7H_8	0.96

Sample Gas Filter Replacement at Heated Sample Gas Port

When is replacement needed?

Replace the sample gas filter in the heated sample gas port if it is contaminated and the sample gas flow is reduced.

Material Required

- Sample gas filter with O-rings (part number 0768649)
- 4 mm hex wrench

Sample Gas Filter Replacement

(see Figure 13)

Step	Action
1	⚠ Turn off the sample gas supply to the analyzer module. Turn off 115/230 VAC power supply of analyzer and heater and, if applicable, the separate 24 VDC supply of the analyzer module. ⚠ The heated sample gas port is hot (approx. 180 °C).
2	Loosen the three mounting screws ***1*** (4 mm hex key) and remove the sample gas filter ***2*** from the sample gas port unit.
3	Remove O-rings ***3*** and ***4***, as well as the contaminated sample gas filter ***5*** from sample gas filter holder ***2***.
4	Place the new sample gas filter ***5*** and new O-rings ***3*** and ***4*** in the sample gas filter holder ***2***. ⚠ Always use new O-rings with a new sample gas filter. Contaminated or damaged O-rings will reduce sample gas path seal integrity and lead to erroneous measurement values.
5	Place sample gas filter holder ***2*** on the sample gas port block and secure it with three mounting screws ***1***. Tighten mounting screws only sufficiently to achieve metal-to-metal contact of the sample gas filter holder. Make sure that O-rings ***3*** and ***4*** do not fall out of the sample gas filter holder.
ℹ	If the sample gas filter is severely contaminated, clean the bypass nozzles (see page 46 for instructions).
6	Restore sample gas supply to the analyzer module.
7	Activate power supply.
8	Check supply gas variables and adjust if necessary (see page 32).
9	Calibrate analyzer at end of warm-up phase.

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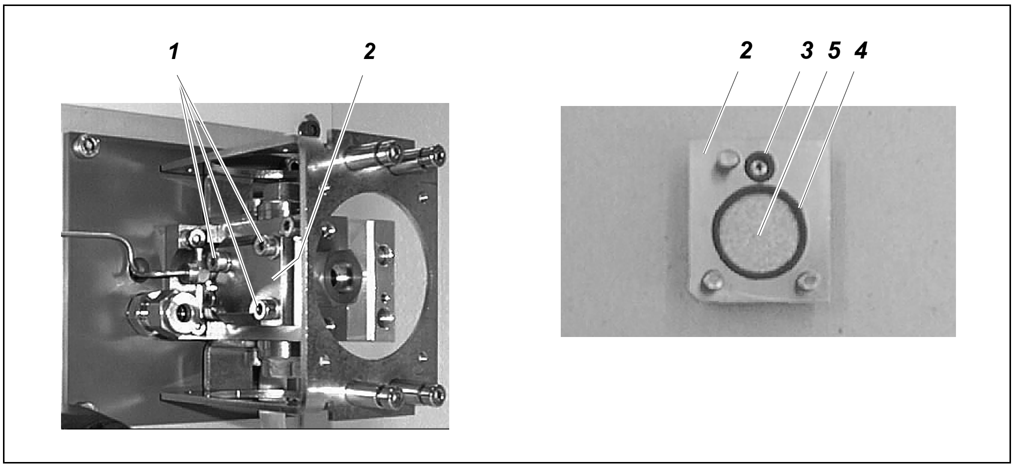
Figure 13

Sample Gas Filter in Heated Sample Gas Inlet



1 Mounting screws
2 Sample Gas Filter Holder
3 O-Ring
4 O-Ring
5 Sample Gas Filter

Bypass Nozzle Cleaning

When is cleaning needed?

The bypass nozzles should be cleaned if the sample gas inlet pressure is too high due to plugged bypass nozzles. This condition is identified by a "Pressure Regulator Inlet" status message.

Material Required

- 5 mm hex wrench
- 3 mm hex wrench
- Ultrasound bath with aqueous cleaner (e.g. Extran)

Bypass Nozzle Cleaning

(see Figure 14)

Step	Action
1	Turn off the sample gas supply to the analyzer module. Turn off the analyzer and heater 115/230 VAC power supply. The heated sample gas inlet is hot (approx. 180°C). The two bypass nozzles have different diameters: Upper nozzle 1: 0.7 mm, lower nozzle 2: 0.9 mm. They must not be interchanged. We recommend cleaning the bypass nozzles separately.
2	Loosen threaded connection ***2*** (5 mm wrench) and remove it from the cavity with sealing ring ***3***. Unscrew bypass nozzle ***4*** (3 mm wrench).
3	Clean the bypass nozzle in an ultrasound unit. Use an aqueous cleaner (e.g. Extran).
4	Screw the bypass nozzle ***4*** completely in the cavity. Place sealing ring ***3*** in the cavity and tightly secure fastener ***2***.
5	Restart the sample gas supply to the analyzer module.
6	Turn on the power supply.
7	Calibrate the analyzer after the warm-up phase ends.

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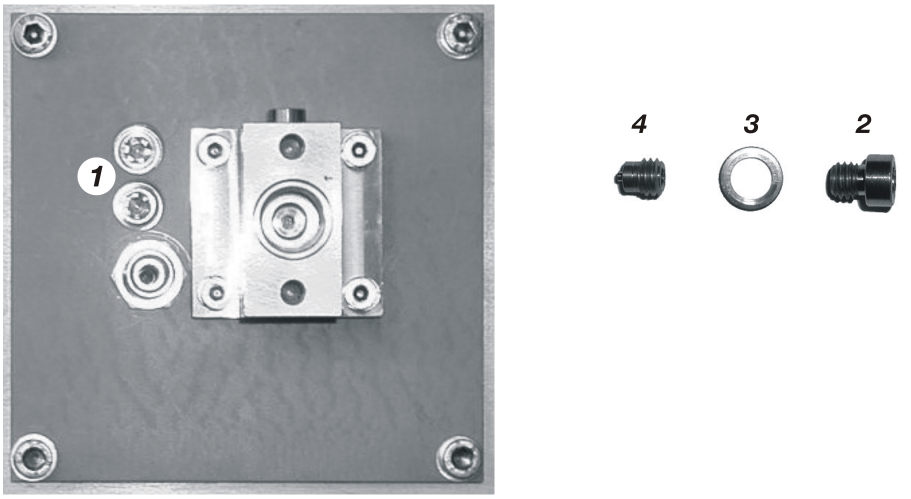
Figure 14

Bypass Nozzles



1 Bypass nozzle location
2 Fastener
3 Sealing ring
4 Bypass nozzle

Cleaning the Air Injector

When is cleaning needed?

The air injector should be cleaned when the sample gas outlet pressure is too high, i.e. if the negative pressure can no longer be set to p_{abs} < 600 hPa.

Material Required

- 14-mm open-end wrench
- Long hook to remove the O-ring from the exhaust outlet.
- Detector O-ring set (part number 0768646)
- Ultrasound bath with aqueous cleaner (e.g. Extran)

Cleaning the Air Injector

(see Figure 15)

Step	Action
1	⚠ Turn off the sample gas supply to the analyzer module. Turn off 115/230 VAC power supply of analyzer and heater and, if applicable, the separate 24 VDC supply of the analyzer module. The heated sample gas port is hot (approx. 180 °C).
2	Remove the exhaust line from exhaust outlet ***1***.
3	Loosen fastener ***2*** (14-mm wrench). Remove adapter ***3*** and air injector ***4*** from the exhaust outlet. ℹ If O-ring ***8*** remains in the exhaust outlet, remove it with a long hook.
4	Clean the air injector in an ultrasound unit. Use aqueous cleanser (e.g., Extran).
5	Replace O-rings ***5***, ***6***, ***7*** and ***8*** with new O-rings. ⚠ Always replace O-rings when cleaning the air injector. Contaminated or damaged O-rings will reduce sample gas path seal integrity and lead to erroneous measurement values.
6	Place adapter ***3*** and air injector ***4*** in the exhaust outlet (orient as shown in Figure 13) and tighten fastener ***2***.
7	Connect the exhaust line to the exhaust air outlet ***1***.
8	Restore sample gas supply to the analyzer module.
9	Activate power supply.
10	Check supply gas variables and adjust if necessary (see page 32).
11	Calibrate analyzer at end of warm-up phase.

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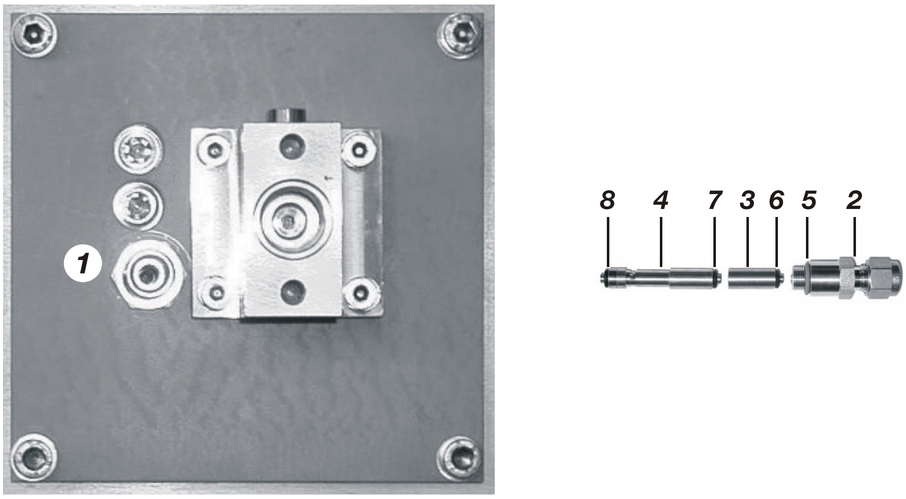
Figure 15

Air Injector



1 Exhaust outlet	***3*** Adapter	***5*** O-Ring	***7*** O-Ring
2 Fastener	***4*** Air injector	***6*** O-Ring	***8*** O-Ring

Catalyst Temperature

Depending on the catalyst material, there is a temperature range in which methane passage is maximal and passage of other hydrocarbons is minimal (see Figure 16).

The temperature range limits result from the following requirements:
- Methane loss should not exceed 15% (passage range I).
- Propane slip should not exceed 2% (passage range II).

The temperature range upper limit should not be exceeded.

Effectiveness Test

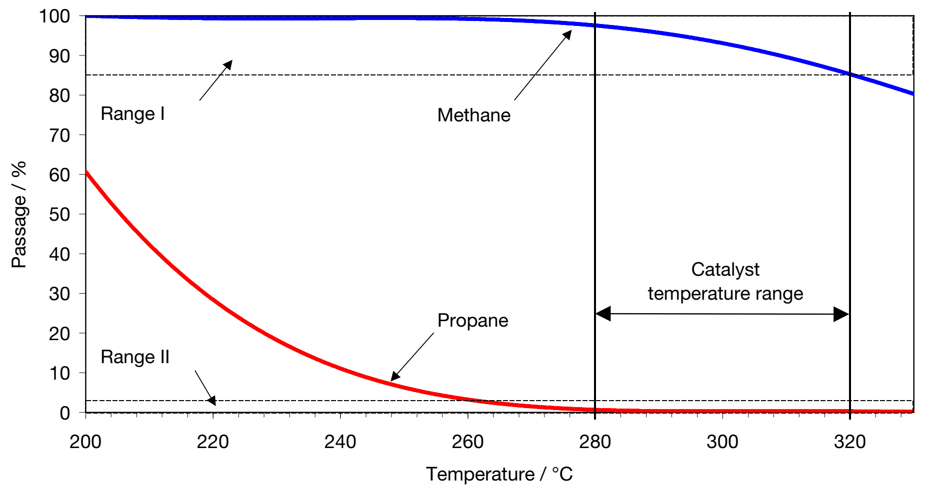
The effectiveness test verifies the degree of catalyst activity by measuring the passage of methane and propane.

The effectiveness test does not need to be performed in normal operation. We recommend performing an effectiveness test once a year.

The effectiveness test is not run in calibration mode but in measurement mode (with cyclical switching between bypass and converter).

Figure 16

Catalyst Passage of Methane and Propane as a Function of Catalyst Temperature



Test Gas for Effectiveness Testing

Type, Quality	Inlet pressure p_e	Flow rate
Propane and methane in N_2 or air (separate test gas containers) with a concentration adapted to the measurement range	Zero pressure (via bypass)	130 to 250 l/h

Before the Effectiveness Test

Before the effectiveness test the sample component zero and span points must be calibrated with propane.

Continued on next page

Determination of Methane Loss

Methane loss is determined using the following formula:

$$\text{Methane Loss /\%} = \frac{(\text{Bypass Reading} - \text{Converter Reading}) \times 100}{\text{Bypass Reading}}$$

Methane loss at the catalyst is normally approx. 10-15%.

Calculation of the Methane Correction Factor

The methane correction factor is determined using the following formula:

$$\text{Correction Factor} = \frac{\text{Bypass Reading}}{\text{Converter Reading}}$$

The correction factor (accurate to 3 decimal places) is entered in the Linear Converter 'K2' function block.

Determination of Propane Slip

Propane slip is determined using the following formula:

$$\text{Propane Slip /\%} = 100 - \frac{(\text{Bypass Reading} - \text{Converter Reading}) \times 100}{\text{Bypass Reading}}$$

If the propane slip exceeds 2%, the converter should be replaced.

Check Seal Integrity of the Combustion Gas Supply Line

IMPORTANT!

The leak-tightness test described in this section may only be performed by qualified and specially trained people.

If these conditions are not met or the prescribed work equipment is not available, then the leak-tightness test must be performed by ABB Service.

Regular check of the seal integrity of the combustion gas supply line

The seal integrity of the combustion gas supply line must be regularly checked with one of the following, depending on whether the combustion gas is provided from a cylinder or a central supply.

Combustion gas from a cylinder

Step	Action
1	Disconnect the power supply of the gas analyzer. Ensure shut-off valve in combustion gas supply line is open.
2	Adjust combustion gas pressure to 1.1 times that of normal combustion gas pressure, i.e. approx. 1.4 bar.
3	Note the cylinder pressure indication on the high-pressure gauge.
4	Close the valve of the combustion gas cylinder.
5	Watch the indication on the high-pressure gauge – it may not change significantly over a period of 10 minutes. If no change is discernible, continue with Step 6. A significant change in the indication is a sign of a leak in the combustion gas feed path between the cylinder pressure reducer and the inlet valve of the gas analyzer. In this case, the following measures must be carried out: 1. Check the combustion gas line between the cylinder and the gas analyzer with a leak detection spray. A leak in this area must be remedied and the seal integrity test repeated before the gas analyzer is returned to service. 2. If a leak cannot be found in the combustion gas line, the combustion gas inlet valve of the gas analyzer is leaky. **In this case, the gas analyzer may not be returned to service under any circumstances!** The combustion gas inlet valve must be exchanged by the ABB Service.
6	Upon completion of leak-tightness test, readjust combustion gas pressure to normal pressure; i.e. 1.2 bar

Continued on next page

Combustion gas from a central supply

Step	Action
1	Disconnect the power supply of the gas analyzer. Ensure shut-off valve in combustion gas supply line is open.
2	Adjust combustion gas pressure to 1.1 times that of normal combustion gas pressure, i.e. approx. 1.4 bar.
3	Note the pressure indication on the pressure gauge of the pressure reduction valve.
4	Shut off the combustion gas feed.
5	Watch the indication on the pressure gauge – it may not change significantly over a period of 10 minutes. If no change is discernible, continue with Step 6. A significant change in the indication is a sign of a leak in the combustion gas feed path between the pressure reduction valve and the inlet valve of the gas analyzer. In this case, the following measures must be carried out: 1. Check the combustion gas line between the pressure reduction valve and the gas analyzer with a leak detection spray. A leak in this area must be remedied and the leak-tightness test repeated before the gas analyzer is returned to service. 2. If a leak cannot be found in the combustion gas line, the combustion gas inlet valve of the gas analyzer is leaky**. In this case, the gas analyzer may not be returned to service under any circumstances!** The combustion gas inlet valve must be exchanged by the ABB Service.
6	Upon completion of leak-tightness test, readjust combustion gas pressure to normal pressure i.e. 1.2 bar.

Check Seal Integrity of the Combustion Gas Feed Path in the Gas Analyzer

IMPORTANT!

The leak-tightness test described in this section presupposes specialist knowledge and necessitates work on the open, live gas analyzer. Therefore, it may only be performed by qualified and specially trained people.

If these conditions are not met or the prescribed work equipment is not available, then the leak-tightness test must be performed by ABB Service.

Regular inspection of the seal integrity of the combustion gas feed path in the gas analyzer

The leak-tightness of the combustion gas feed path in the gas analyzer must be checked at regular intervals.

To locate the sections of the combustion gas feed path to be inspected, the pneumatic diagram must be consulted (see page 63).

Procedure

Step	Action
	The gas analyzer must be in operation (flame on).
1	Combustion gas feed path with positive (combustion gas inlet to combustion gas nozzle): Sniff out all the junctions using a leak search detector (measurement principle thermal conductivity).
2	Combustion gas feed path with negative pressure (in the detector, downstream from the combustion gas nozzle): Connect zero reference gas at sample gas inlet. Coat all the junctions in succession with a small gas cloud containing hydrocarbons (e. g. with spray coolant or test gas containing hydrocarbons or a cloth soaked in acetone). Observe the measured value readout; in the event of a positive change in the measured value, the junction concerned is leaky.

If there is a leak, put gas analyzer out of service

If a leak has been detected in the combustion gas feed path inside the gas analyzer, then **the gas analyzer must be put out of service; it may under no circumstances be put back into operation.** The cause of leak must be ascertained and remedied by ABB Service.

Flow Problem

Sample gas nozzle or sample gas filter plugged	Check for obstructions in sample gas nozzle and sample gas filter in sample gas port. Change the sample gas filter (see page 44 for instructions).

Temperature Problem

Faulty temperature sensor or heater connections	Check the connecting lines and plug connectors. Check the line seating in the insulated jackets.

Unstable Readings

Vibration	Reduce vibrations where the analyzer is installed.
Sample gas path leakage	Check the integrity of the analyzer module sample gas paths.
Loss of sensitivity	Check the sensitivity variation. Contact service personnel for sample gas nozzle replacement.
Excessive sample gas outlet pressure	Check air injector for obstructions and clean as needed (see page 48 for instructions). Increase instrument air pressure. Check exhaust air line: It must have a large ID.
Combustion air contaminated	Check combustion air supply.
Fluctuating supply gas pressures	Check instrument air, combustion air and combustion gas supply.

Continued on next page

Pressure Regulator Problems

Unstable pressure values	Adjust supply gas pressures such that the variables have the following values (see page 32): for instrument air (`Outlet`) approx. 60 % for combustion air (`Air`) approx. 60 % for combustion gas (`H2`) approx. 40 % Have the pressure regulator modules checked.

Pressure regulator variables do not match set values

`Air`	Variable ≤ 40 %	Lower combustion air pressure.
	Variable ≥ 90 %	Raise combustion air pressure.
`H2`	Variable ≤ 30 %	Lower combustion gas pressure.
	Variable ≥ 90 %	Raise combustion gas pressure.
`Inlet`	Variable ≤ 50 %	Lower sample gas inlet pressure. Clean bypass nozzle (see page 46 for instructions).
`Outlet`	Variable ≤ 50 %	Raise instrument air pressure. Clean air injector (see page 48 for instructions). Reduce sample gas line length.
	Variable ≥ 90 %	Clean bypass nozzle. Lower instrument air pressure.

Zero Drift

Sample gas line contaminated	Clean sample gas line.
Inadequate combustion air catalytic converter performance	Reduce hydrocarbon content.
Contaminated combustion gas line	Clean combustion gas line.
Saturated active charcoal filter	Replace active charcoal filter (see Service Manual for instructions).

Continued on next page

Flame Does Not Ignite

Air in the Combustion Gas Line

Make sure no air enters the combustion gas feed lines when the combustion gas tank is connected or changed. Air drawn into the combustion feed line can cause the flame to go out in the analyzer.

The analyzer module will attempt to restart the flame up to 10 times in a period of approx. 10 minutes using progressively higher combustion gas pressures. If this is not successful, the unit goes into the stand-by mode. In this case the flame ignition process is restarted:

`Menu → Maintenance/Test → Analyzer spec. Adjustm. → Restart FID`

Note
Standby operation means: Heater on, instrument air valve closed, housing purge on.

Excessive combustion air pressure

Reduce combustion air pressure (per analyzer data sheet).

Failure of the Instrument Air Supply

Shut-off of the combustion gas supply in the event of failure of the instrument air supply

It must be ensured that in the event of failure of the instrument air supply, the combustion gas supply to the analyzer module is shut off.

As a rule, this is guaranteed by the installation of a pneumatic shut-off valve in the combustion gas supply (recommendation, see page 21); this valve must be controlled by the instrument air supply such that in the event of its failure (and consequently in the event of failure of continuous case purging, see page 22) the combustion gas supply is automatically shut off.

If such a pneumatic shut-off valve is not installed, then the following precautions and measures must be taken:

- The collective status or the "Failure" status of the gas analyzer must be monitored.
- If the status occurs, then the cause must be inspected in situ on the gas analyzer.
  - If the gas analyzer is not in operation (e.g. as a result of a power failure), then the supply gases must be shut off (for instructions see page 59).
  - If the gas analyzer is in operation, then it must be checked whether there is an adequate instrument air supply. If this is the case, then the status messages must be checked (see page 58). If this is not the case, then the following procedure must be adopted
    1. Shut off the combustion gas feed.
    2. Restore instrument air supply.
    3. Purge the gas analyzer for at least 20 minutes.
    4. Switch on the combustion gas supply.
    5. The gas analyzer starts automatically.

Status Messages

The MultiFID14 NMHC analyzer module status messages are listed below.

Please also consult Chapter “Status Messages” of the AO2000 Series Operator’s Manual, which also contains the complete list of all status messages.

List Structure

The list of status messages contains the following information:

No. Number of the status message; appears in the menu bar of the detailed display

Text Full text of the status message as it appears 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 Explanations and measures to react to the status message

No.	Text	O	E	M	F	Reaction
321	The detector temperature is below the condensation limit.	x	x			Error message during the warm-up phase. If the error message appears after warm-up, check the thermal link and replace as needed.
322	The flame is out.	x	x			Error message during the warm-up phase. If the error message appears after warm-up, check the supply gases. Check ignition coil.
323	The analyzer is in the fail-safe state.	x	x			Cause: Flame temperature > 400 °C, detector temperature > set point + 30 °C, Pt-100 lead break or short. Turn power supply off and back on after ≥ 3 seconds. Notify service if the error message recurs. *Note* *Fail safe status means: Heater off, combustion gas valve closed, instrument air valve closed, housing purge on.*
324, 325	The temperature is above or below the upper or lower limit value 1 (2).			x		The temperature of the detector (`T-Re.D`) and of the converter (`T-Re.Ko`) is outside the limit values. Error message during the warm-up phase. It disappears as soon as the temperature has reached the respective set point. If the error message appears after the warm-up phase, check whether the ambient temperatures are within the permissible range (+5 to +38 °C). Check thermal link.
329, 330	The pressure is above or below the upper or lower limit value 1 (2).			x		Check supply gas pressures: `Output` Instrument air `Air` Combustion air `H2` Combustion gas

Chapter 8 Analyzer Shutdown and Packing

Analyzer Shutdown

Analyzer Shutdown

Step	Action
Temporary Shutdown:	
1	Turn off the sample gas and the combustion air and combustion 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 analyzer power supply.
4	Turn off the instrument air supply.
Additional Steps for Long-Term Shutdown:	
5	Remove the gas lines from the analyzer module ports. Tightly seal the gas ports.
6	Disconnect the electrical wiring from the electronic module and, if applicable, the analyzer module connections.

Recommissioning

When recommissioning the gas analyzer, the instructions on page 34 must be followed.

Ambient Temperature

Ambient temperature during storage and transport: –25 to +65 °C

Preparing the Analyzer for Shipping and Packing

CAUTION!

The analyzer weighs approx. 25 kg. Two persons are needed for removal and carrying.

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 IP54 version of the system housing close off the connection box cable openings by inserting the appropriate plates.

When returning an 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 analyzer in bubble foil or corrugated cardboard. When shipping overseas additionally place the 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 analyzer in an adequately sized box lined with cushioning material (foam or similar substance). The cushioning material's thickness should be adequate for the 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

Description

Measurement Principle of the Flame Ionization Detector

The flame ionization detector (FID) uses as measuring effect the ionization of organic carbon atoms in a hydrogen flame. Hydrocarbon-free combustion air must be supplied to maintain the flame.

The hydrogen flame burns in an electric field generated by a DC voltage between two electrodes. Ionized particles are produced when hydrocarbons present in the sample gas are burned in the hydrogen flame. As a result, an ionization current directly proportional to the number of organic carbon atoms in the sample gas flows between the electrodes. The ionization current is electrically amplified and converted to a voltage signal.

Methane-Free Hydrocarbon Measurement

Methane is a common component found in ambient air and also contained in fuels. Since methane is not an environmentally relevant component, there is a need to remove the methane content from consideration when measuring carbon emissions.

In the MultiFID14 NMHC analyzer module the sample gas is divided into two equal flows. Part of the flow is routed via a heated catalyst and the other part is sent unchanged to the flame.

In the catalyst, oxygen and all hydrocarbons, except methane, in the sample gas react to CO_2 and H_2O. The slippage of hydrocarbon compounds not taking part in the reaction should not exceed 2%. The methane loss in the catalyst is approx. 10-15%.

A shuttle valve arrangement alternately supplies the flame with treated and untreated sample gas. This will measure the concentration values for total hydrocarbons and methane. The difference between the two values is used to determine total hydrocarbons without methane. All three measurement values are displayed and output.

Continued on next page

Design

The analyzer consists of the central unit and MultiFID14 NMHC analyzer module. The analyzer module is connected with the electronics module of the central unit via the system bus.

The analyzer module contains the following components (see page 63, Figure 17):

- detector ***A*** with
  - combustion chamber ***B***,
  - integrated air injection pump ***C***,
  - Converter ***K*** and
  - Shuttle valve ***L***,
- negative pressure regulator ***D***,
- combustion air regulator ***E***,
- combustion gas regulator ***F*** and
- sample gas inlet ***13*** (heated or unheated).

The negative pressure regulator ***D*** generates a constant negative pressure of p_{abs} = 780 hPa or 580 hPa downstream from the nozzle at the sample gas inlet and in combustion chamber ***B***. The major part of the sample gas drawn in (approx. 80 to 100 l/h) is routed via bypass nozzles ***4*** and ***15*** into the combustion chamber and is carried together with the instrument air for air injector pump ***C*** to exhaust air outlet ***12***. A small constant fraction of the sample gas is mixed with the combustion gas and passed through a burner nozzle into combustion chamber ***B***. This mixture is burned in contact with the combustion air. Shuttle valve ***L*** (controlled by the central unit) alternately reroutes the combustion chamber sample gas flow to converter ***K***.

The flow rates of combustion air and combustion gas are maintained constant with pressure regulators ***E*** and ***F***.

The sample gas line is connected to the (heated or unheated) sample gas inlet ***13***, where pressure fluctuations of p_{abs} = 850 to 1100 hPa are permissible without changing the sample gas flow rate in the combustion chamber.

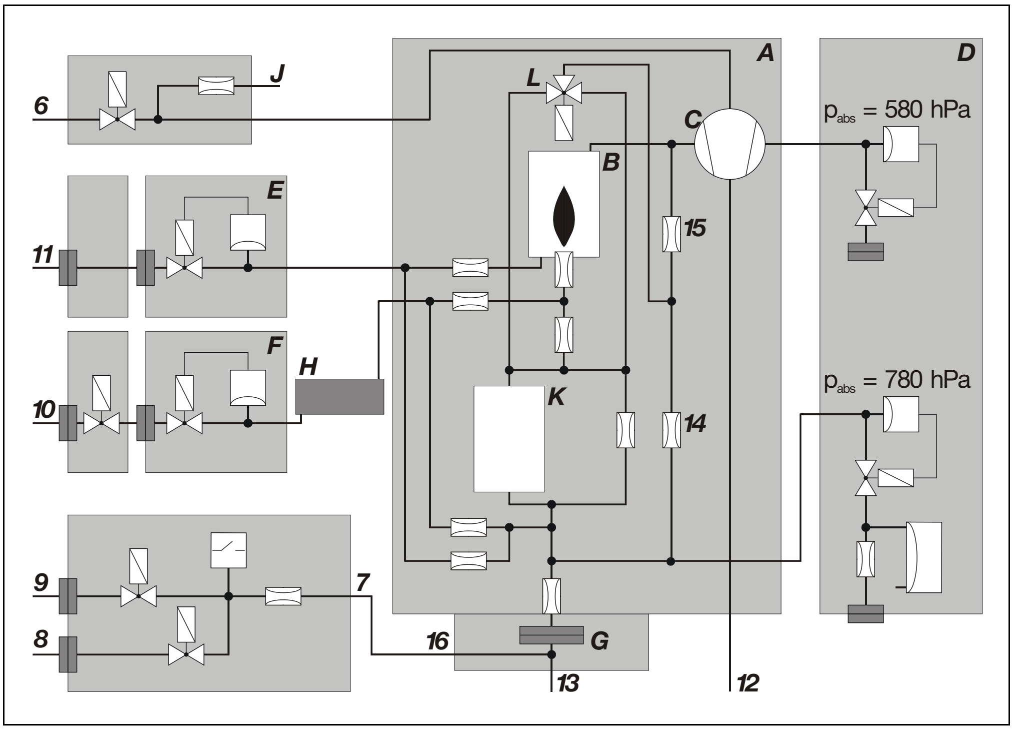
Working Principle

Once the detector temperature has reached the threshold value of 150 °C, the instrument air for the air injector is turned on and the negative pressure regulator and the combustion air controller set the working pressures. Next, the combustion gas supply is activated and the combustion gas pressure is set to a constant value. A built-in ignition coil ignites the hydrogen flame, and a temperature sensor monitors the flame temperature.

During operation the analyzer module monitors all relevant temperatures and pressures and transmits an error message in the event of faulty values.

Figure 17

Gas Diagram



- ***6*** Instrument air inlet
- ***7*** Test gas outlet
- ***8*** Span gas inlet
- ***9*** Zero gas inlet
- ***10*** Combustion gas inlet
- ***11*** Combustion air inlet
- ***12*** Exhaust outlet
- ***13*** Sample gas inlet
- ***14*** Bypass nozzle 1
- ***15*** Bypass nozzle 2
- ***16*** Test gas inlet on sample gas port
- ***A*** Detector
- ***B*** Combustion chamber
- ***C*** Air injector
- ***D*** Negative pressure regulator
- ***E*** Combustion air regulator
- ***F*** Combustion gas regulator
- ***G*** Sample gas filter
- ***H*** Active charcoal filter
- ***J*** Housing purge
- ***K*** Converter
- ***L*** Shuttle valve

Port numbers correspond to the connection diagram (see page 17, Figure 2) and the inscriptions on the back of the analyzer module.

Operating Specifications

The following data apply to measurement ranges ≥ 50 mg org. C/m³, for smaller ranges these only apply if they are factory-set per customer order.

Linearity deviation	≤ 2 % of measuring ranges to 5,000 mg org. C/m³, this value applies to one (calibrated) range
Repeatability	≤ 0.5 % of measurement range
Zero-point and sensitivity drift	≤ 0.5 mg org. C/m³ per week
Output signal variation (2 σ)	≤ 0.5 % of span at electronic T90 time = 20 sec
Detection limit (4 σ)	≤ 1 % of span at electronic T90 time = 20 sec
O_2 dependence	≤ 2 % of measured value for 0 to 21 Vol.-% O_2 or ≥ 0.3 mg org. C/m³, whichever is greater
Temperature influence	Ambient temperature in permissible range; on zero-point and on sensitivity: ≤ 2 % per 10 °C in 0 to 15 mg org. C/m³ measurement range
Power supply influence	24 VDC ± 5 %: ≤ 0.2 % of measuring range
T_{90} time	T_{90} < 3 seconds at sample gas flow = 80 l/h and electronic T90 time = 1 sec (with unheated sample gas inlet; applies to a gas analyzer with one analyzer module)

Electrical Safety

Test	per EN 61010-1:2001
Protection Class	I
Overvoltage Category / Pollution Level	Power supply 115/230 VAC: II/2 Power supply 24 VDC: II/2 Signal inputs and outputs: II/2
Safe Isolation	The 115/230 VAC power supply is galvanically isolated from other circuits by means of reinforced or double insulation. Protective extra low voltage (PELV) on low-voltage side.

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