ACF-NT

Multicomponent Analyzer System for Emission and Process Monitoring

Operator's Manual

42/23-572 EN Rev. 2

Contents

Foreword

The Content of this Manual

This manual contains all the information you will need to safely and efficiently operate and maintain the ACF-NT Analyzer System.

This manual contains information on all the functional units in the analyzer system. Your analyzer system as delivered may differ from the version described in this manual.

System Documentation

The system documentation consists of a set of drawings individually prepared for each analyzer system as delivered. It includes the following plans:

- Layout Plan
- Piping Plan
- Wiring Plan
- Terminal Plan
- Connection Plan

The system documentation is supplied as part of the analyzer system.

Supplementary Documentation

Title	Publication No.
Specification Sheet	10/23-8.11 EN
Installation Instructions	42/23-571 EN

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

ABB Automation GmbH,
Analytical, Marketing Communication,
Telefax: +49-(0)69-7930-4566, E-mail: analytical-mkt.deapr@de.abb.com

Additional Information on the Internet

Additional information on ABB Analytical products and services is available on the Internet at “http://www.abb.com/analytical”.

Symbols and Type Format in this Manual

indicates safety information to be heeded during analyzer system operation in order to avoid risks to the user.

identifies specific information on operation of the analyzer system as well as on the use of this manual.

1, ***2***, ***3***, … identifies reference numbers in figures.

`Display` identifies a display on the screen.

`Input` identifies input from the user.

Important Safety Information

Proper Operation

The ACF-NT analyzer system is designed for continuous measurement of concentrations of specific components in gases or vapor.

Explosion Protection

The analyzer system must not be used to measure combustible gas/air or gas/oxygen mixtures. The analyzer system must not be installed in hazardous locations.

Requirements for Safe Operation

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

Personnel Qualifications

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

Special Information and Precautions

These include

- The content of this manual.
- The safety labels affixed to the analyzer system.
- The applicable safety precautions for installing and operating electrical devices
- Safety precautions for working with gases, acids, condensates, etc.

Safety Labels Affixed to the Analyzer System

Observe the safety labels affixed to the analyzer system:

Consult Documentation!

Hot Surface! (Temperature > 60 °C)

Risk of Electric Shock!

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 analyzer system is used in other countries.

Analyzer System Safety and Safe Operation

The analyzer system is designed and tested in accordance with EN 61010 Part 1/ IEC 1010-1, "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 damage the analyzer system as well as other systems and instruments.

Additional Information

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

Please contact your local 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 should be attached to the protective lead connector before any other connection is made.

Risks of a Disconnected Protective Lead

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

Correct Operating Voltage

Be sure the analyzer system voltage setting matches the line voltage before connecting the power supply.

Risks Involved in Opening the Covers

Current-bearing components can be exposed when 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 Analyzer System

The analyzer system must be disconnected from all power sources before being opened for any work. All work on an analyzer system 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 analyzer system can retain their charge even when it 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 fuse holder contacts.

When safe operation can no longer be assured …

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

The possibility of safe operation is excluded:

- If the analyzer system is visibly damaged
- If the analyzer system no longer operates
- after prolonged storage under adverse conditions
- after severe transport stresses

Safety Tips for Handling the FTIR Spectrometer

Electrical Safety

The FTIR Spectrometer consists of an exposed metal chassis that is connected directly to earth via a power supply cord and is therefore classified as “Safety Class I” equipment.

WARNING!

When used to analyze flammable gases, the equipment is subject to acceptance by the local inspection authorities having jurisdiction.

For continued fire protection use specified line fuse only. Disconnect power cord before replacing fuse.

To avoid electrical shock, the power cord protective conductor must be connected to earth.

To avoid electrical shock, do not operate this equipment if it bears any sign of damage to any portion of its exterior surface.

Do not expose this equipment to any source of excessive moisture.

Do not use this equipment in an explosive atmosphere.

Laser and High Voltage

Under normal operating conditions, the FTIR spectrometer can be operated in complete safety (Class 1 Laser Product – see rating plate).

Do not open the spectrometer enclosure during normal operation – no user-serviceable parts inside.

However, since the instrument contains a laser and uses high voltages (accessible only when the spectrometer enclosure is open), observe the following warnings.

WARNING!

The enclosure of the spectrometer is to be opened only by authorized ABB Service Personnel.

Opening the enclosure may result in exposure to laser radiation and high voltages.

Laser type:	**He-Ne Laser**	**Class 3B as per IEC-60825-1** **Class 111a as per 21 CFR 1040.10**
Output power:	**max. 3.2 mW**	
Wavelength:	**632.8 nm**	

Avoid eye exposure to direct to direct or mirrored laser radiation. It is recommended to wear laser safety goggles when working on the open spectrometer.

High voltage is present at the red wire connected to the laser tube inside the enclosure.

The voltage is approximately 7 kV at startup, and between 1200 V and 1400 V under normal operating conditions.

Because of the capacitors in the laser power supply, the high voltage may be present even when the power is off.

Safety Tips for Handling the VOC Analyzer

DANGER!

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

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

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

CAUTION!

The combustion gas path inside the VOC analyzer is checked for leaks at the factory. No seal integrity testing is required during normal operation.

Safety Tips for Handling Harmful Gases

WARNING!

Some of the gases measured with the analyzer system are harmful to health.

Therefore, the sample gas must not escape from the gas path during normal operation and maintenance works.

A seal integrity check of the analyzer system has to be performed at regular intervals.

The diluted exhaust gas must be drained out of the installation room of the analyzer cabinet.

Restart

Initial startup of the analyzer system should be performed by trained personnel of the manufacturer or the supplier.

Restart

Perform the following steps when restarting the analyzer system e.g. after maintenance or a facility shutdown.

Activating the Instrument Air Supply

- Set the initial pressure (p_e = 5–7 bar).
- Check the moisture indicator in the air purifier: green = OK, yellow = not OK.
- Activate the instrument air supply to the FTIR spectrometer at the earliest 1 hour after activating the power supply. This will ensure the air is sufficiently dry.

Activating the Power Supply

- Make sure all circuit breakers (fuses) are deactivated.
- Turn on the main switch.
- Activate the circuit breakers (fuses) – starting with those for the FTIR spectrometer.

Connecting the Filtered Air

- Check the filtered spectrometer purge air flow rate and set it to approx. 200 l/hr if necessary.

Checking the Temperature

- Check the temperature of the heated components (gas sampling probe, filter unit and sample gas line; desired value 180 °C).

Starting the VOC Analyzer

- Start the VOC analyzer following the instructions and information in the AO2000-MultiFID14 Start-up and Maintenance Manual (Publication No. 41/24-105 EN).

Warm-Up Phase

The warm-up phase takes approx. 3 hours.

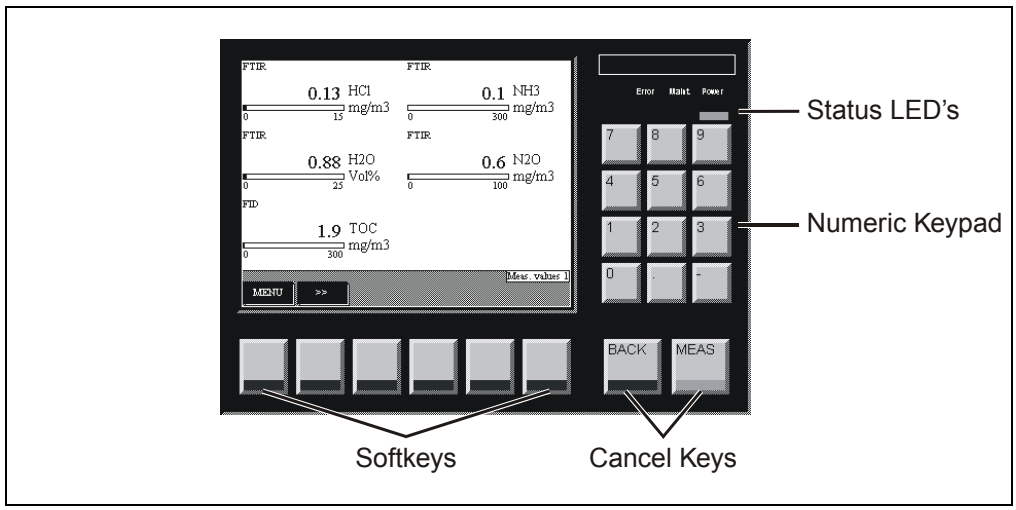
Calibration

- Start the manual zero correction (see section “FTIR Spectrometer Zero Calibration”, page 30).

Display/Control Unit

Figure 1

Display/Control Unit



Status LED's

Power Green LED: The power supply is on.

Maint Yellow LED: The "Maintenance Request" status signal is on. The measured value is valid.

Error Red LED: The "Error" status signal is on. The measured value is no longer valid.

Cancel Keys

Back — Allows the operator to cancel a function or menu item and to return to the previous menu level.

Meas — 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 ENTER are stored; unconfirmed items are not accepted.

Softkeys

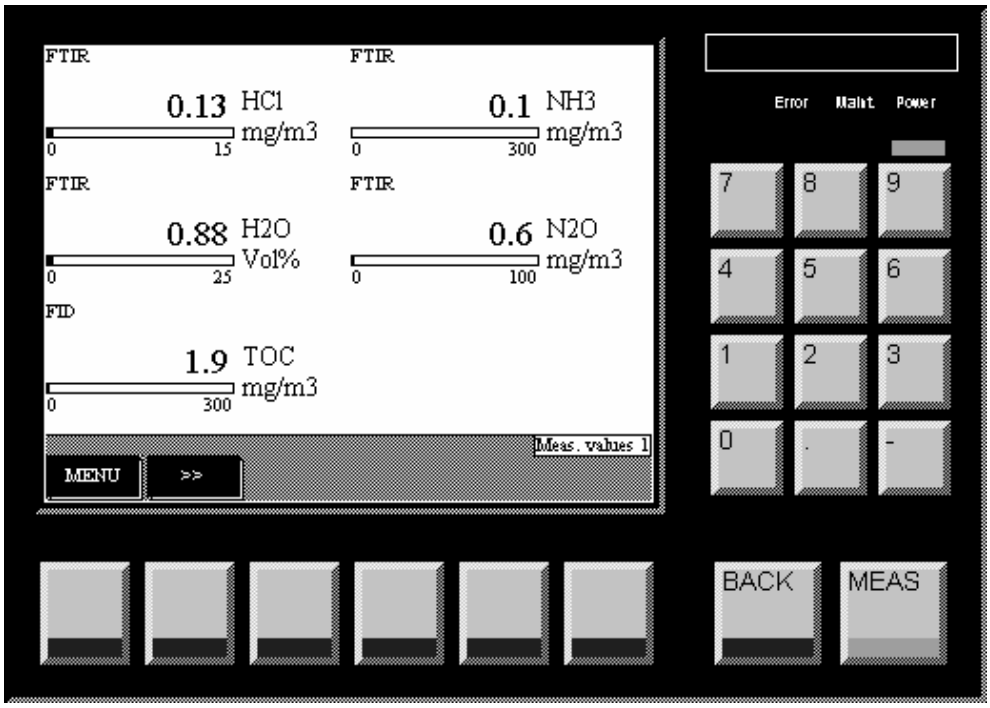
Allows the operator to scroll to the next display "page". This key only allows forward scrolling.

STATUS MESSAGE — Appears in measurement mode if an "Error" or "Maintenance request" condition arises. This key allows the operator to call up the status message log and view the status messages. The operator can also call up a detailed display for any message in the log.

“Measured Values” Screen

Figure 2

“Measured Values” Screen



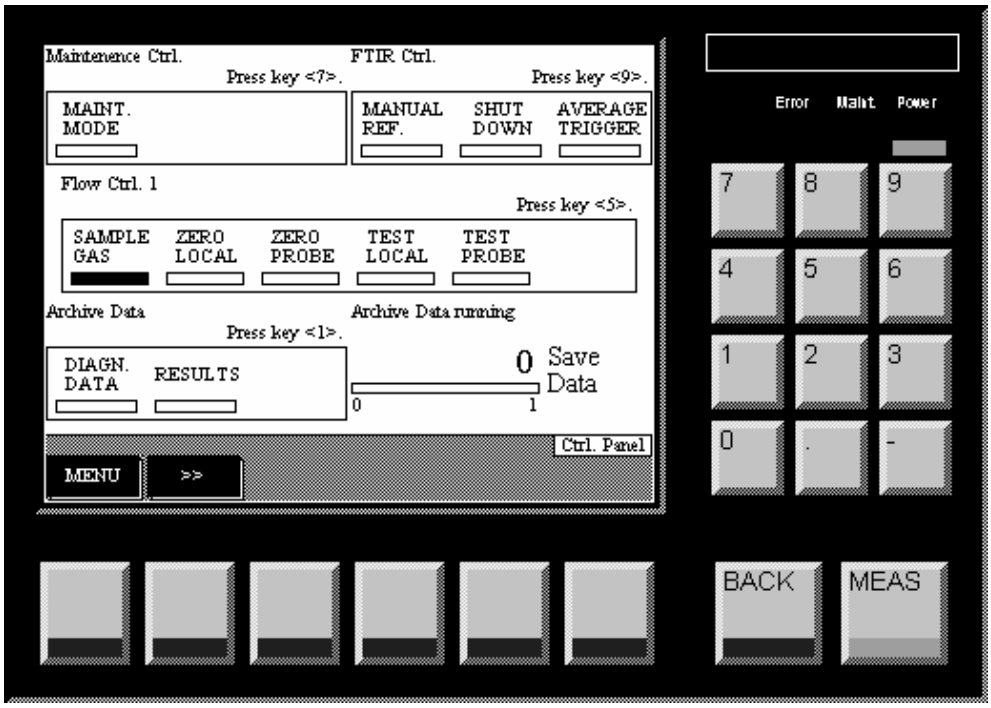
“Measured Values” Screen

Values measured by the analyzer system, i.e. the FTIR spectrometer, the O_2 analyzer and the VOC analyzer (FID) are displayed on pages 1 to 3 of the “Measured Values” screen. Up to six measured values are displayed on one page. The actual number of pages depends on the number of measurement components configured in the analyzer system.

“Control Panel” Screen

Figure 3

“Control Panel” Screen



Indication

The “Control Panel” screen offers controls for various functions of the analyzer system. Functions activated manually are indicated by means of a filled rectangle below the function’s name.

Operation

The controls are operated in the following manner:

Press the number key that corresponds to the position of the control and is indicated above the control. In the following screen, press the corresponding function key. Thereby, the system switches back to the control panel screen, and the function just activated is indicated by means of a filled rectangle.

Password Protection

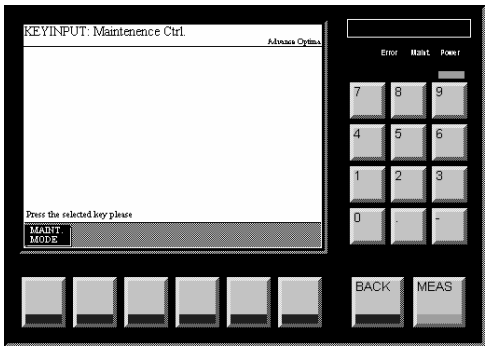
All control panel functions except the “Maintenance control” are password protected.

Changing the password is described on page 18.

Continued on next page

Maintenance Control

MAINT. MODE — Operate before starting and after finishing maintenance work (“Maintenance Key Switch”)

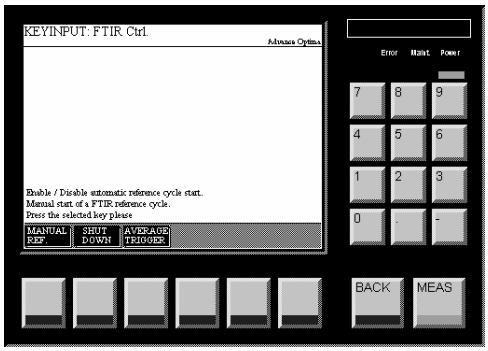


FTIR Control

MANUAL REF. — Manual activation of reference spectrum recording, e.g. for restarts

SHUT DOWN — Manual activation of purge air for the gas sampling probe

AVERAGE TRIGGER — Acquisition of average values, e.g. for LOD or standard deviation

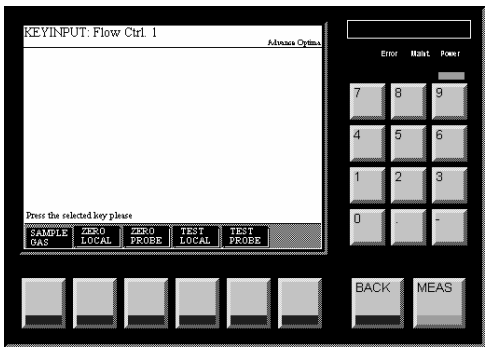


Flow Control

SAMPLE GAS — Sample gas supply (normal operation)

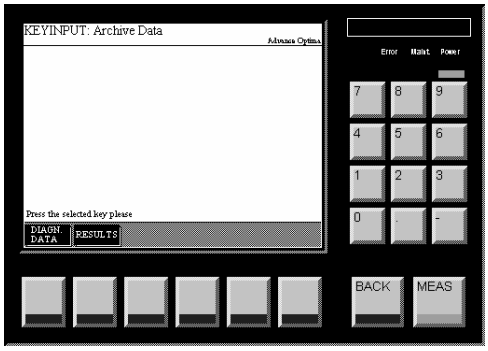
ZERO LOCAL / **ZERO PROBE** — Zero gas activation. Supply directly to the sample cell or via the probe

TEST LOCAL / **TEST PROBE** — Test gas activation. Supply directly to the sample cell or via the probe



Archive Data

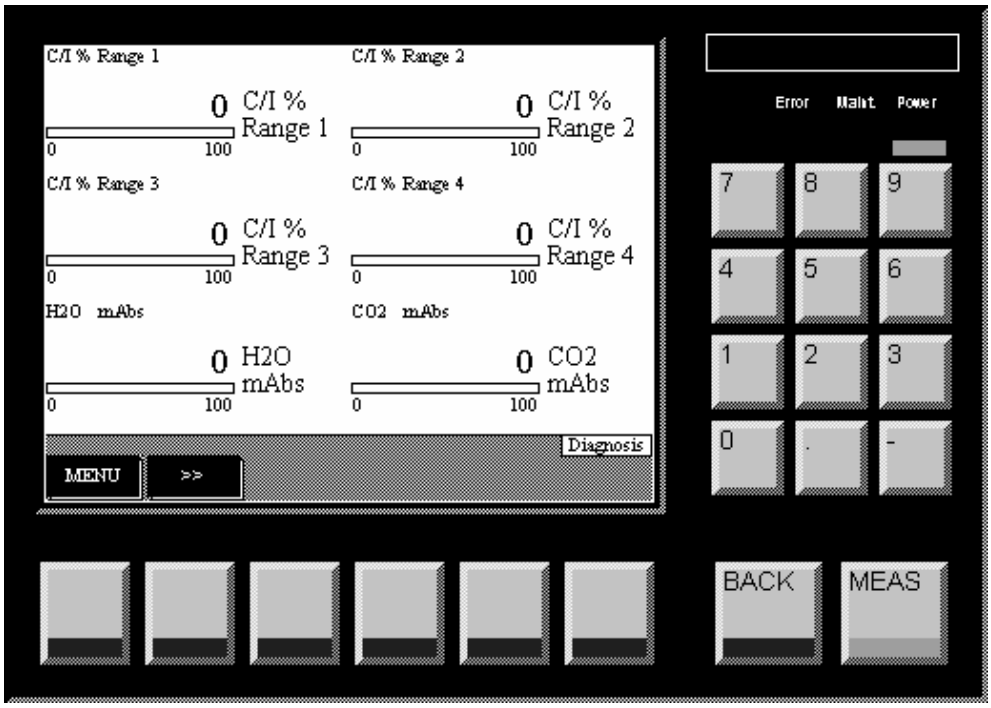
Function not yet available



“Diagnosis” Screen

Figure 4

“Diagnosis” Screen



Indication

The indications in the “Diagnosis” screen are used for service purposes.

The upper four indications C/I % show the relation of the current spectral intensity to the initial one for 4 spectral regions of a reference spectrum. Increasing values correspond to a loss in spectral intensity.

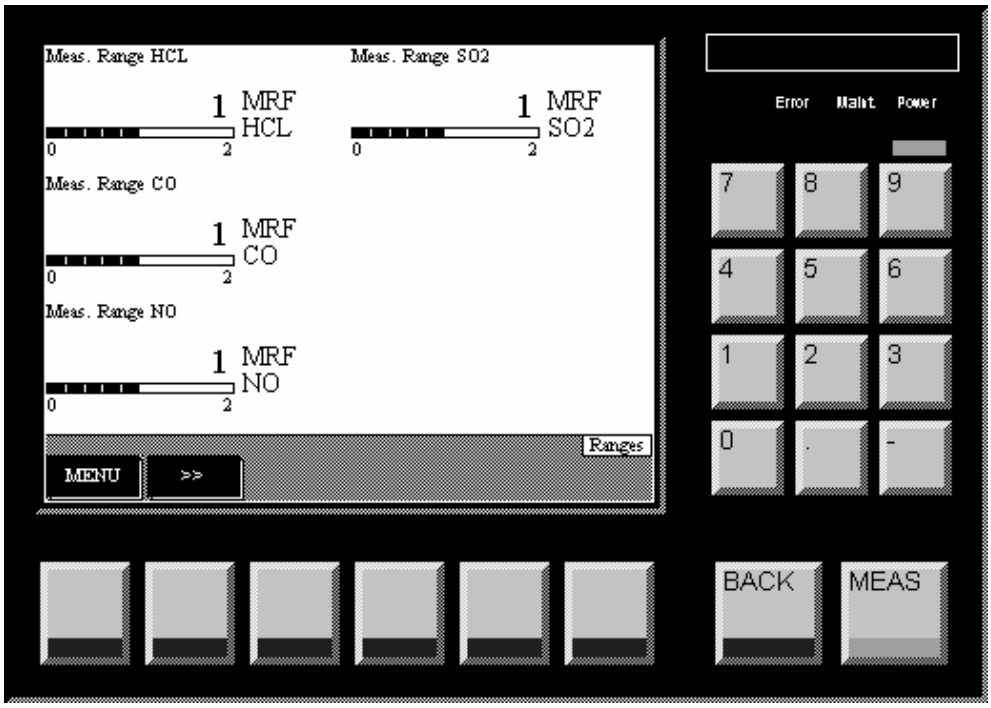
The lower two indications show the H_2O and CO_2 background values.

The indicated values are updated with each recording of the reference spectrum (every 12 hours). For further explanations see section “FTIR Spectrometer Zero Calibration”, page 30)

“Ranges” Screen

Figure 5

“Ranges” Screen



Indication

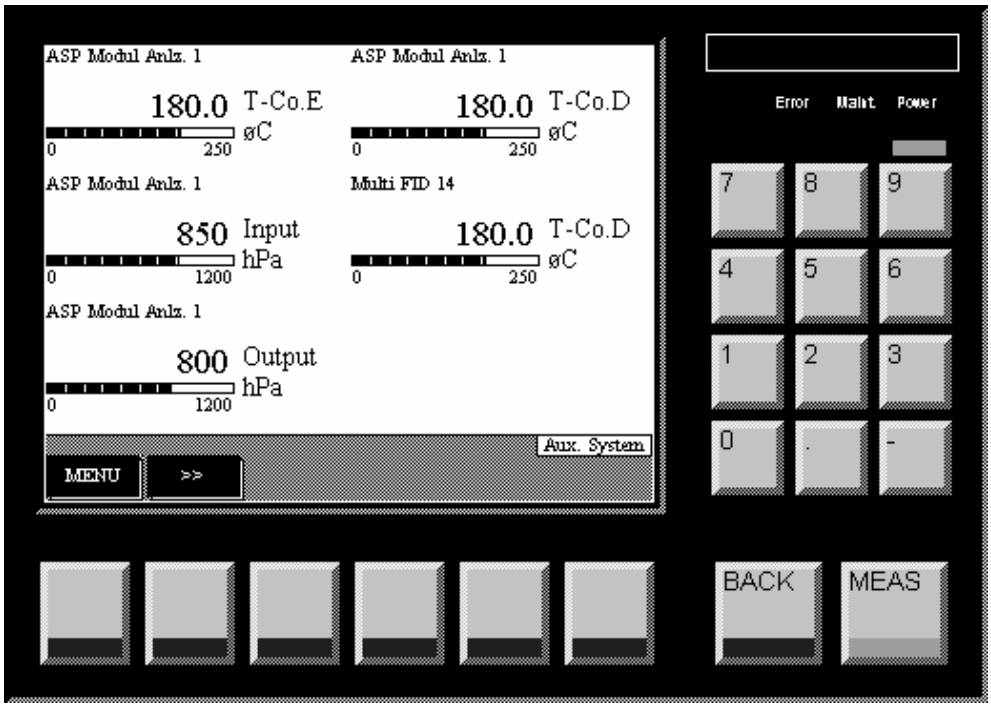
The “Ranges” screen displays the number of the activated measurement range (1 or 2) for measurement components with two measurement ranges.

Note: MRF = Measuring Range Feedback
Measuring Range 1 = High range, Measuring Range 2 = Low range

“ASP Module” Screen

Figure 6

“ASP Module” Screen



Indication

The “ASP Module” screen displays the values of the ASP module temperature and pressure regulators.

Parameter		Default
`T-Co.D`	Temperature controller sample conditioning block	180 °C
`T-Co.E`	Temperature controller sample cell	180 °C
`Input`	Sample cell pressure	850 hPa
`Output`	Injector pump pressure	800 hPa

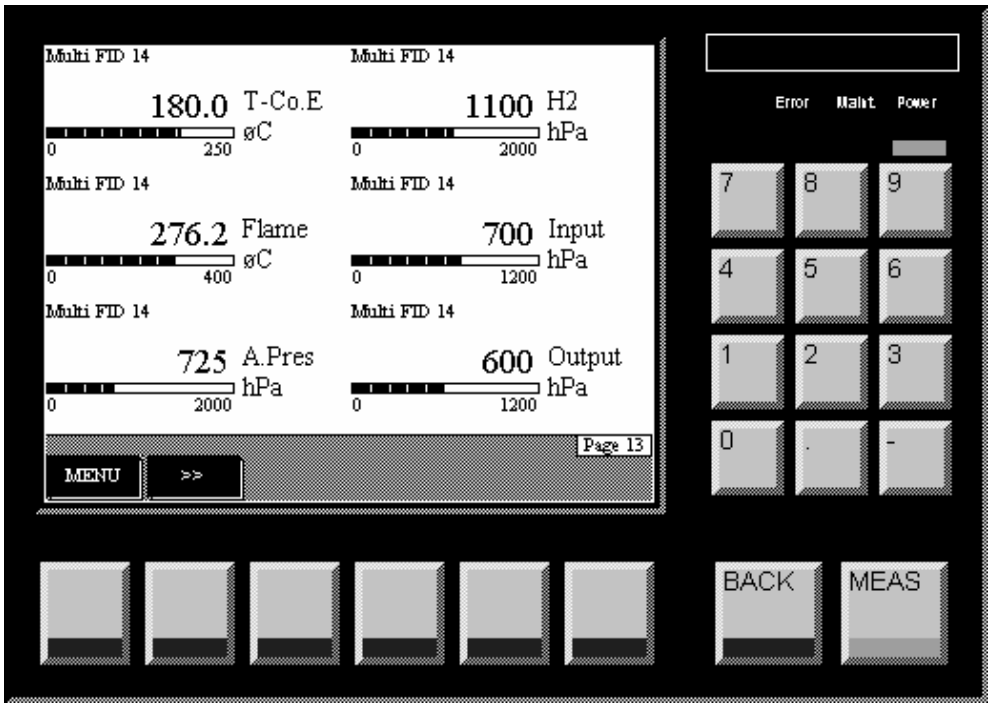
Note

The Multi-FID 14 `T-Co.D` *value actually belongs to the “Multi-FID” screen (see page 16).*

“Multi-FID” Screen

Figure 7

“Multi-FID” Screen



Indication

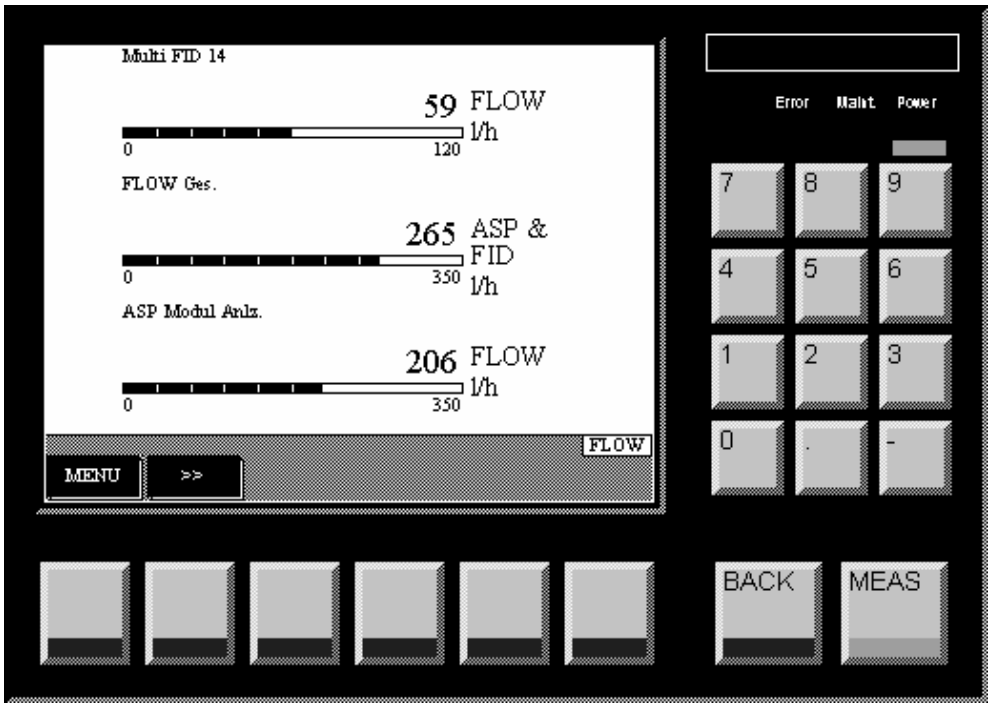
The “Multi-FID” screen displays the values of the VOC analyzer temperature and pressure regulators.

Parameter		Default
T-Co.D	Detector temperature (on “ASP Module” screen)	180 °C
T-Co.E	Sample gas port temperature	180 °C
Flame	Flame temperature	260–300 °C
A.Pres	Combustion air pressure	725 hPa
H2	Combustion gas pressure	1100 hPa
Inlet	Instrument air pressure at combustion chamber inlet	700 hPa
Output	Instrument air pressure at combustion chamber outlet	600 hPa

“Flow” Screen

Figure 8

“Flow” Screen



Indication

The “Flow” screen displays the various sample gas flow values:

Parameter		Default
`Multi-FID 14`	Sample gas flow through the VOC analyzer	60 l/h
`FLOW Ges.`	Total sample gas flow	260 l/h
`ASP Module`	Sample gas flow through the ASP module	200 l/h

Changing the Password

Changing the Password

Step	Action	Input
1	Select the `Change Password` menu item.	**MENU** ↓ **Configure** ↓ **System** ↓ **Change password**
2	Use the arrow keys to select the user group for which the password is to be changed (for example).	**Maintenance** **ENTER**
3	Use the numeric keypad to enter the old 6-digit password (for example).	**471100** **ENTER**
4	Use the numeric keypad to enter the new 6-digit password (for example).	**471200** **ENTER**
5	Re-enter the new password (for example).	**471200** **ENTER**

Chapter 3 Maintenance

Safety Notes

CAUTION!

Only persons familiar with the maintenance of comparable analyzer systems and certified as being capable of such work should work on the system.

Safety Labels Affixed to the Analyzer System

CAUTION!

Observe the safety labels affixed to the analyzer system:

Consult Documentation!

Hot Surface! (Temperature > 60 °C)

Risk of Electric Shock!

Harmful Gases

WARNING!

Some of the gases measured with the analyzer system are harmful to health.

Therefore, the sample gas must not escape from the gas path during normal operation and maintenance works.

A seal integrity check of the analyzer system has to be performed at regular intervals.

The diluted exhaust gas must be drained out of the installation room of the analyzer cabinet.

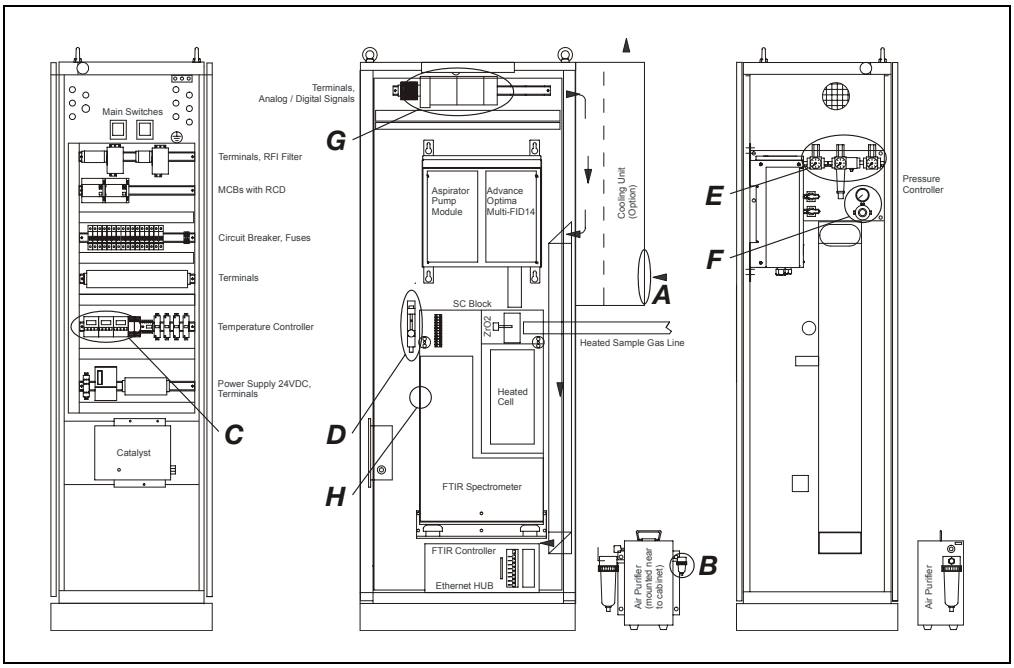
Cleaning Hints

Cleaning Hints

- Never use water or any solvents to clean parts inside the analyzer cabinet.
- The analyzer system shall always operate with cabinet door closed. If dust invades the cabinet it shall be removed using a broom and a vacuum cleaner.
- The outside of the analyzer cabinet can be cleaned with a wet towel and mild cleaning agents. Pay attention that no droplets invade the cabinet.

Figure 9

Interior View



Visual Inspection

(see Fig. 9)

	External instrument air regulator		5–7 bar
	External gas cylinder pressure reducers: Zero gas oxygen analyzer (1 to 4 Vol% O_2 in N_2) Combustion gas VOC analyzer (H_2) Zero gas VOC analyzer (N_2 or zero gas for O_2 analyzer) Span gas VOC analyzer (Propane in N_2)		 1.2 ± 0.1 bar 1.2 ± 0.1 bar 1.2 ± 0.2 bar 1.2 ± 0.2 bar
A	Air conditioning unit: Filter mesh		White
B	Air purifier: Moisture indicator		Green
	Display: Measured values, temperatures, pressures, flows		Page 10 to 17
C	Temperature controllers of heated probe tube, heated filter and heated sample gas line (see Wiring Plan for assignment)		180 °C each
D	Purge gas flow meter		> 200 l/h
E	Instrument air pressure regulators (from left to right): VOC analyzer combustion air (-J12) Main regulator (-J11) ASP module (-J13)		 1.2 ± 0.1 bar 4.0 ± 0.5 bar 2.5 ± 0.2 bar
F	Air purifier pressure regulator (-J08)		1.2 ± 0.1 bar
G	Status LEDs of analog and digital output modules		Green
H	Status LEDs on FTIR control panel:	“Power” “Data”	Green Yellow blinking

Seal Integrity Check

When is the seal integrity check needed?

The seal integrity check must be performed regularly.

The seal integrity check methods differ depending on whether a VOC analyzer (MultiFID14) is installed in the analyzer system.

ACF-NT with VOC Analyzer (MultiFID14)

The seal integrity check can be performed easily using a lighter when a VOC analyzer (MultiFID14) is installed in the analyzer system.

Let the butane of the lighter stream (do not ignite!) against all fittings, connections and screws for a short time (max. 1–2 seconds).

- Start at the probe and proceed to the analyzer cabinet.
- Open the SC block insulation.

CAUTION!
The SC block is hot (approx. 180 °C)!

- Test the sample gas line connection to the SC block as well as the connections to and from the cell and also towards the SC block.

If there is even a small leak the measured values of the FID will increase immediately and will decrease relative fast to normal measurement values.

Do not let stream the gas from the lighter too long to the connections especially when testing the SC block. This would result in a “cloud” of hydrocarbons and because of the short distances it would be difficult to decide which connection has the leak.

ACF-NT without VOC Analyzer (MultiFID14)

The seal integrity check of the SC block should be performed using a U-tube manometer when no VOC analyzer (MultiFID14) is installed in the analyzer system.

Interrupt the sample gas supply.

- Close **all** inputs and outputs at the SC block, also the instrument air connections.

CAUTION!
The SC block is hot (approx. 180 °C)!

- Disconnect the sample gas line from the SC block and connect a tee fitted with a shut-off valve.
- Connect a U-tube manometer half filled with water to the free end of the tee.
- Blow air or nitrogen through the shutoff valve to a gauge pressure of $p_e \approx 50$ hPa (= 500 mm water column).
- Close the shut-off valve. The pressure should not change measurably in 3 minutes (pressure drop ≤ 3 hPa). A sharp pressure drop is a sign of a leak.

Wear Part Replacement

Prior to performing any maintenance works on the analyzer system be sure to activate the Maintenance Control on the "Control Panel" screen (see page 12) thus setting the "Maintenance Mode" status signal.

Also set the Flow Control on the "Control Panel" screen either to "Zero gas local" or "Zero gas probe" to avoid any contact to the measuring gas.

Be sure to reset these settings after finishing the maintenance work.

Replacing Wear Parts

Component	Part No.	Replacement	Instructions
Gas sampling probe filter or filter stone	0730683 0730682	every 3 months	see Page 23
SC block filter	0768914	every 6 months	see Page 26
Air purifier inlet filter	0999755	every 6 months	see Page 28
Air conditioning unit filter mesh	0999765	every 3 months	see Page 28

Battery on the System Controller

Type "Sonnenschein SL-360/S" or "Saft LS14500"

Spare Parts Information

Spare parts information can be found on the Internet in the "Spare Parts Information and Ordering System Parts OnLine" using the address

http://www.abb.com/partsonline.

Replacing the Filter Element in the Probe

Cleaning the Filter Element

If the filter element is not permeable enough anymore, remove it so that you can remove the contamination mechanically.

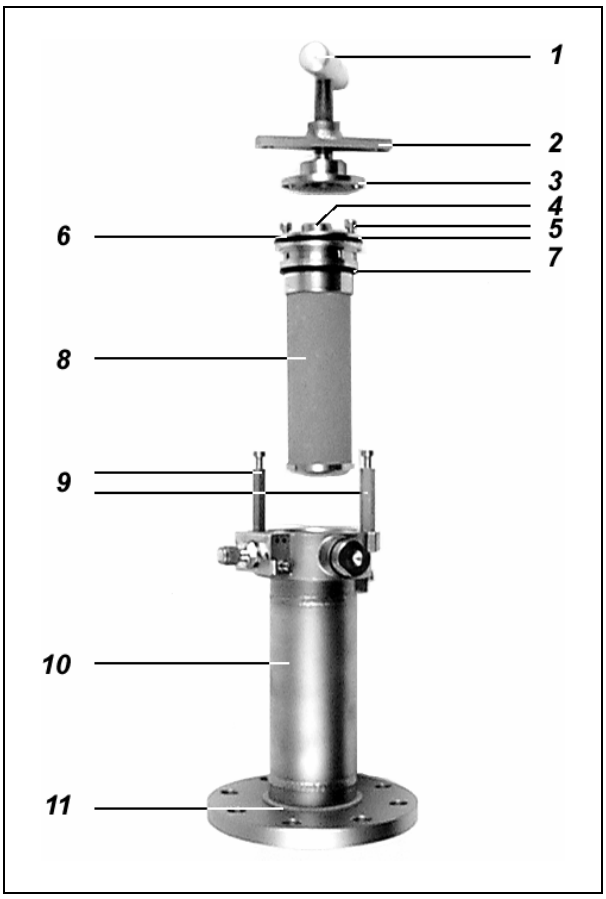
Replacing the Filter Stone

If the filter stone is obviously damaged, replace it with a new one.

To avoid a prolonged down time of the analyzer system the complete filter insert (Part No. 0730683) should be changed. The disassembling, cleaning and assembling of the used filter stone and O-rings should be done separately.

Figure 10

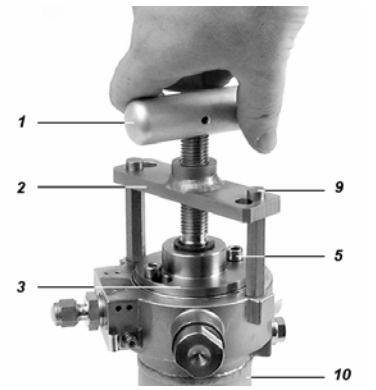
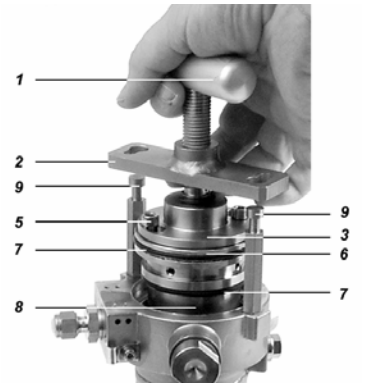
Filter Element



1 T-handle
2 Bridge
3 Detaching disk
4 Locking screw
5 Removal screws
6 Flange
7 O-ring seals
8 Filter element
9 Bridge holding device
10 Casing
11 Casing inner seal (green)

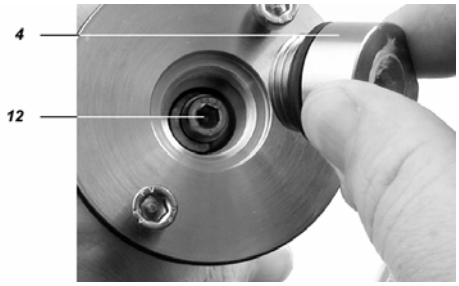
Continued on next page

Replacing the Filter Element

Step	Action	
1	Turn the T-handle ***1*** of the filter removal device ***1-3*** in counter-clockwise direction. This pulls the filter element ***8*** via the detaching disk ***3*** out of the casing ***10***.	
2	Turn bridge ***2*** until it can be pulled off from the bridge holding device ***9*** through the elongated holes.	
3	Pull out filter element ***8*** with bridge ***2*** and detaching disk ***3***.	
4	Turn detaching disk ***3*** until it can be pulled off from the hexagon screws ***5*** via the elongated holes.	
	⚠ Never loosen or tighten the hexagon screws ***5***. They have been adjusted at the factory so that the detaching disk ***3*** can be easily moved.	

Continued on next page

Step	Action
either	
5	Clean the filter element ***8***.
6	Replace seals ***7*** (O-rings from the accessory set). Re-lubrication is not necessary even after replacing O-rings ***7***. It is not necessary to replace the green casing inner seal ***11*** between flange ***6*** and casing ***10***.
7	Re-install the filter element ***8***: Steps 1 to 4 in reverse order.
or	
5	Screw off locking screw ***4*** with open-end spanner NW 22.
6	Screw out the hexagon socket screw ***12*** underneath locking screw ***4***.
7	Take out the filter stone.
8	Insert a new filter stone (Part No. 0730682; with new O-rings from the accessory set).
9	Replace seals ***7*** (O-rings from the accessory set). Re-lubrication is not necessary even after replacing O-rings ***7***. It is not necessary to replace the green casing inner seal ***11*** between flange ***6*** and casing ***10***.
10	Re-install the filter element ***8***: Steps 1 to 4 in reverse order.



Cleaning/Replacing the Sample Gas Filter in the SC Block

When is cleaning/ replacement needed?

Clean or replace the 1 µ stainless steel filter in the sample conditioning block (SC block) if it is contaminated and the sample gas flow is reduced.

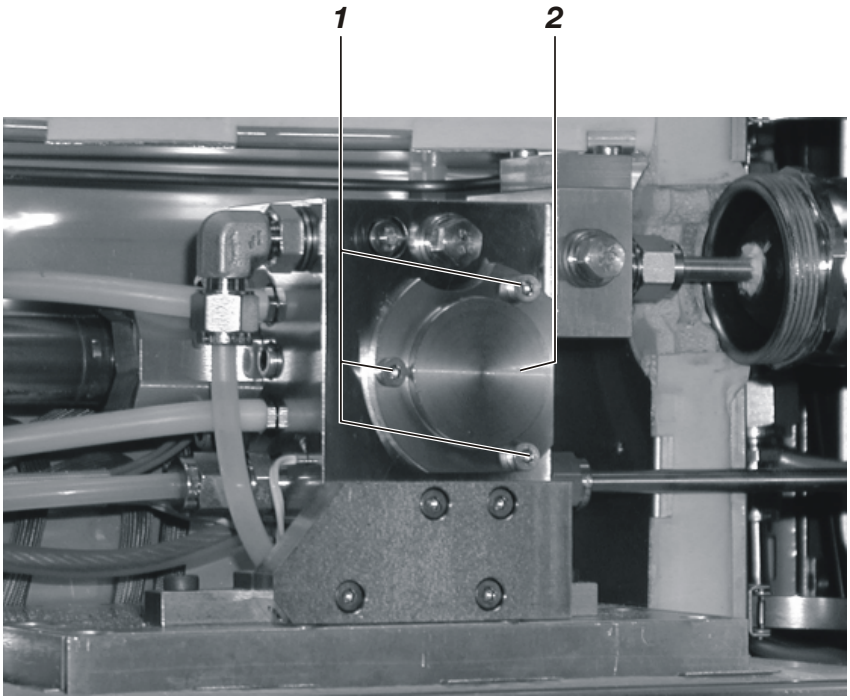
To avoid a prolonged down time of the analyzer system the complete gas filter ACF-NT (Part No. 0768914) should be changed. The disassembling, cleaning and assembling of the used filter should be done separately.

CAUTION!

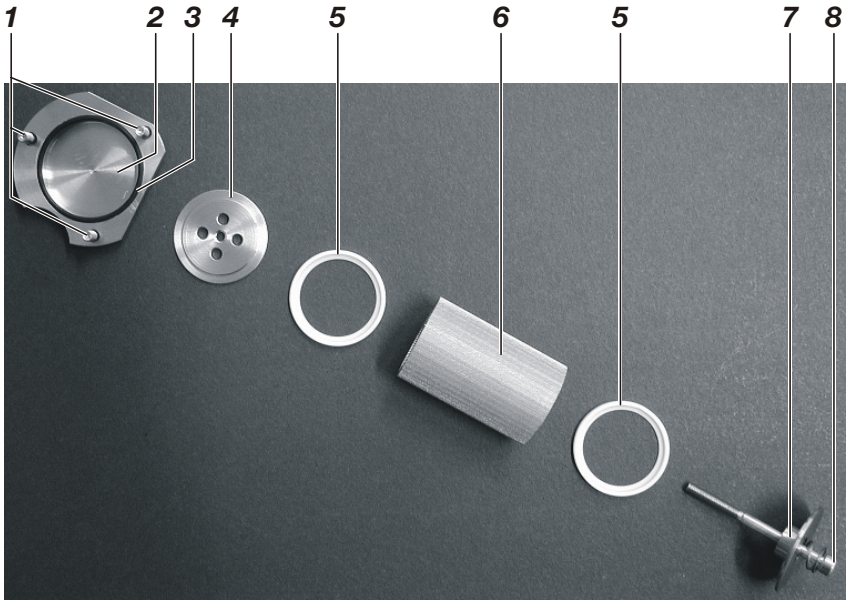
The sample conditioning block is hot (approx. 180 °C).

Cleaning/Replacing the Sample Gas Filter

Step	Action
1	Turn off the sample gas supply.
2	Loosen the three mounting screws ***1*** (4 mm hex key) and remove the sample gas filter cover ***2*** from the sample conditioning block.



Continued on next page

Step	Action
3	Remove the sample gas filter assembly from the sample conditioning block and disassemble it. 
4	Clean the sample gas filter ***6*** in an ultrasonic bath. Use an aqueous cleaner (e.g. Extran). Wash the filter element several times with distilled water and acetone and dry it thoroughly. If a VOC analyzer is integrated in the analyzer system all hydrocarbons must be removed to avoid drift of the VOC analyzer.
5	Replace the O-ring ***3*** in the sample gas filter cover ***2***. Replace the O-ring on the back of the bottom plate ***4*** (not visible in the photo) and the two PTFE profile gaskets ***5***. ⚠ Always use new O-rings and gaskets with a cleaned sample gas filter. Contaminated or damaged O-rings and gaskets will reduce sample gas path seal integrity and lead to erroneous measurement values.
6	Re-assemble the sample gas filter assembly and place it in the sample conditioning block.
7	Place sample gas filter cover ***2*** on the sample conditioning 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.

Replacing the Air Purifier Inlet Filter

When is inlet filter replacement needed?

Decreasing flow at the FTIR purge gas flow meter is an indication of inlet filter clogging. A preventive change every 6 months during regular system maintenance is recommended.

CAUTION!

The air purifier is pressurized (5 to 7 bar)!

Replacing the Air Purifier Inlet Filter

Step	Action
1	Disconnect power supply and close the shut-off cocks down- and up-stream (-J07) of the air purifier.
2	Depressurize the filter by slowly unscrewing the filter housing collar.
3	Unscrew the filter housing collar and lower the filter bowl. Remove the filter element retainer disc at the base of the cartridge.
4	Replace the exhausted cartridge (Part No 0999755; set of 3) and re-assemble the filter.

Replacing the Air Conditioner Filter Mesh

When is filter mesh replacement needed?

The cooling capacity of the air conditioner depends upon the cleanness of the filter mesh. It should be replaced if it begins to turn dark.

Replacing the Air Conditioner Filter Mesh

Step	Action
1	Remove the grid which holds the filter mesh in place.
2	Change the filter mesh (Part No 0999765).
3	Re-assemble the grid.

FTIR Spectrometer Zero Spectrum

The zero spectrum is recorded automatically twice a day. It is used for zero and sensitivity corrections. The zero spectrum is also named reference spectrum

Zero calibration is described in detail in the “FTIR Spectrometer Zero Calibration” section (see page 30).

FTIR Spectrometer Span Check

The span check maintenance interval is 6 months. If a deviation greater than 4 % results during span check, the span must be adjusted using test gases.

Span check is described in detail in the “FTIR Spectrometer Span Check” section (see page 32).

Test Gases for FTIR Spectrometer Span Check

Zero spectrum:		Purified Air (“Zero Gas”)	
Span check:	1	SO_2 + CO + NO + rest N_2	Supplied at test gas port
	2	HCl in N_2	
	3	NH_3 in N_2	
Alternative for	2	HCl + H_2O + air from evaporator	Supplied directly to sample conditioning block or sample gas line
Alternative for	3	NH_3 + H_2O + air from evaporator	
	4	H_2O in air from evaporator	
	5	HF + H_2O + air from evaporator	

Before each test gas change, purge the test gas paths with the zero gas for at least 10 minutes. In case of NH_3 span check use this test gas as the last to avoid reactions with other gases.

O_2 Analyzer Calibration

The O_2 analyzer is automatically adjusted at the officially established maintenance interval (once per month).

O_2 analyzer zero and span calibration is described in detail in the “Oxygen Analyzer Calibration” section (see page 33).

Test Gases for O_2 Analyzer Calibration

Zero Gas	1 to 4 Vol% O_2 in N_2	Supplied at test gas port
Span Gas	Clean air from the air purifier	Permanently connected to system

VOC Analyzer Calibration

The VOC analyzer is automatically adjusted at the officially established maintenance interval (every 14 days).

The VOC analyzer zero and span calibration is described in detail in the “VOC Analyzer Calibration” section (see page 34).

Test Gases for VOC Analyzer Calibration

Zero Gas	N_2 or oxygen zero gas	Supplied at “Zero Gas FID” port
Span Gas	n-Propane C_3H_8 in N_2 (70 to 80 % of measuring range)	Supplied at “Span Gas FID” port

FTIR Spectrometer Zero Calibration

Measuring Principle

The analyzer measures the intensity of infrared absorption of gases in the sample cell. Absorption is determined over a spectrum or band.

Raw Spectrum

When analyzing a gas the analyzer first calculates a raw spectrum. This spectrum is a measure of the energy reaching the infrared detector after the infrared beam has traversed the gas. The raw spectrum contains the desired absorption information, but this information is divided again by the zero spectrum to eliminate any optical system changes (contamination, aging, etc.).

Zero Spectrum

The zero spectrum is determined by analyzing a sample cell filled with a “zero gas” (a gas that does not absorb infrared radiation, such as nitrogen or air with all infrared-active components filtered out). On a point-by-point basis, the software divides the sample’s raw spectrum by the zero spectrum to determine the absorption spectrum. Therefore the zero spectrum is also called reference spectrum

Instrument Reaction

The absorption spectrum depends on various factors: infrared source spectrum, optical material absorption capability, infrared detector response time. Taken together, these factors form the inherent system reaction, also known as “instrument response”.

When should a zero spectrum be measured?

Since over time the instrument response can change, a new zero spectrum must be recorded at regular intervals. This procedure is called zero calibration or “zeroing” the analyzer. Naturally, the analyzer must be zeroed (or referenced) before it can be used. Since over extended periods of time the infrared source can change and this includes the mirror in contact with the sample gas in the sample cell, we recommend setting the analyzer zero point at least once a day.

Automatic Reference Spectrum Recording

The analyzer system performs the zero calibration automatically twice a day every 12 hours (according to the German TÜV approval).

The FTIR controller triggers the start of this event and also controls the valves and the flushing times. When the starting time is reached, the following sequence runs:

Phase	Description
1	The “Maintenance Mode” status signal is set and the analyzer system is switched to “Zero gas local”.
2	The measuring cell is flushed with dry air to ensure that the sample gas is exchanged for dry air (duration 5 minutes).
3	A new reference spectrum (zero spectrum) is recorded (duration 2 minutes).
4	The analyzer system is switched back to “Sample gas”.
5	The measuring cell is flushed with sample gas (duration 3 minutes)
6	The first measurement spectrum is recorded (duration 2 minutes).
7	After the recording of first measurement spectrum is finished the “Maintenance Mode” status signal is re-set and the measurement results are valid.

Continued on next page

Manual Reference Spectrum Recording

Sometimes it is necessary to record a new zero spectrum before or after certain maintenance works (e.g. before a span check).

The above-described sequence can be started manually by activating the "Manual Ref." function in the "Control Panel" screen (see page 12).

Signal Drift

Unlike conventional analyzers there are no deviations attributable to signal drift in analog circuits since the analyzer is completely digital. Zero calibration thus has nothing to do with the signal drift seen in analog circuits; it is just a matter of correcting the instrument response.

Self-Test

During each zero calibration the analyzer automatically performs a self-test. This test compares current instrument response with the initial instrument response data. The test also establishes the quality of the zero gas since it measures its concentration of H_2O and CO_2.

A zero calibration is invalid if it is established that the criteria required for the test are not in effect. This causes the message "Maintenance Request" or "System Failure" to appear as a status signal, as indication of the status LED's and in the display after pressing the "Status Message" softkey.

FTIR Spectrometer Span Check

Correction Factor

Span calibration establishes a correction factor for each component in order to assure the accuracy of the values displayed. This calibration is required since there can be slight deviations between the optical components of various analyzers. The correction factor is also known as measuring range amplification.

Span Calibration

In a span calibration the sample cell is filled with a known gas concentration and analyzed. For this a gas having a concentration of the applicable component at the upper end of the measuring range is recommended.

When should a span calibration be performed?

A span calibration must be performed on starting the analyzer system.

Since the factors involved in this calibration do not change over time, this calibration only needs to be repeated if the optical components are changed during maintenance (readjustment, change or cleaning of the optical components).

Calibration with Steam Generator

Test containers cannot be filled with the H_2O sample component. Thus a device capable of producing a specific steam concentration in a continuous flow must be used.

Since the calibration mix dew point is above room temperature, the calibration gas must be supplied directly to the air injector in order to avoid noticeable cooling of the H_2O-air mix.

Procedure

Step	Action
1	Set the Maintenance Mode via the “Control Panel” screen and switch the Flow control to either “Test gas local” or “Test gas probe” (see page 12).
2	Make sure the proper calibration gas is connected to the test gas port of the analyzer system.
3	Open test gas cylinder pressure reducer and check inlet pressure and flow.
4	Wait until the sample cell is completely purged and the values have stabilized between individual analyses. With a calibration gas flow rate of 5 l/min. it will take approximately 5 minutes for the sample cell to be completely purged.
5	Some components like NO_2, HCl, HF and NH_3 need quite a long time to reach equilibrium (30 to 90 minutes). Wait this time or use aqueous solutions of HCl, HF or NH_3 with a water-evaporator to obtain shorter times.
6	Note down the reading and compare it to the concentration on the cylinder. The difference should be smaller than 4 %.
7	If the reading factor is outside this range, the problem is either in the calibration gas or in the sampling system.

Oxygen Analyzer Calibration

Zero Calibration

For the zero calibration a test gas cylinder with 1 to 4 Vol% oxygen in nitrogen is used.

Span Calibration

For the span calibration air from the air purifier with a stable content of 20.96 Vol% oxygen is used.

Maintenance Interval

According to the officially established maintenance interval zero and span calibration have to be performed once per month.

Calibration Control

The oxygen analyzer calibration is performed as externally controlled calibration.

The FTIR controller generates the control signals for zero and span alignment and for the switching of the solenoids. The FTIR controller also controls the purging times which are needed to ensure that the proper gas is at the analyzer sensor.

Zero Calibration Data

Calibration Method	Common
Calculation Method	Offset
Test Gas Concentration	1 to 4 Vol% O_2 in N_2

Span Calibration Data

Calibration Method	Common
Calculation Method	Amplification
Test Gas Concentration	20.96 Vol% O_2 (dry air)

Manual Calibration

For service purposes a manual calibration is also possible. For this the zero and span concentrations have to be entered in

Menu → Configure → Calibration Data → Manual calibration → Test gas concentration

Never start an automatic calibration for the oxygen analyzer. As there is no need no purging times are set for automatic calibration.

VOC Analyzer Calibration

Zero Calibration

For the zero calibration either nitrogen from a cylinder or the zero gas for the oxygen analyzer is used. In the latter case a T-piece must be used to connect the test gas cylinder with the test gas port and the FID zero gas port of the analyzer system.

Span Calibration

For the span calibration n-Propane in nitrogen from a test gas cylinder is used.

Maintenance Interval

According to the officially established maintenance interval zero and span calibration have to be performed every 14 days.

Calibration Control

The VOC analyzer calibration is performed as externally controlled automatic calibration.

The FTIR controller triggers the start of the automatic calibration.

Calibration Data

Enable	Off	
Test gas concentration	Zero	0
	Span	Bottle concentration
Single zero calibration	Never	
Single span calibration	Never	
Common zero and span calibration	Always	

No.	Message Text	F	MR	MM	Comments
	Syst. Failure	X			Measured value is invalid.
	Syst. Maint. Req.		X		Measured value is valid.
	Syst. Maintenance			X	Discard the measured value as a process measured value.
	Module Failure				Error on Module RGM11, MultiFID14, FTIR.
	FID Error				FID measured value is invalid.
	FID Maint. req.		X		The analyzer is in a state that will soon require user intervention.
	FID Maint. mode			X	The analyzer is being calibrated or serviced.
	O2 Error				O2 measured value is invalid.
	O2 Maint. req.		X		The analyzer is in a state that will soon require user intervention..
	O2 Maint. mode			X	The analyzer is being calibrated or serviced.
110	Sys. Boot				
1001	Pump ctrl.				
10000	Emerg. Purge	X			Emergency purge, check temp error (FTIR, probe, pipe, sample gas line).
10001	Message back purge			X	
10002	FTIR Failure	X			Contact service.
10003	FTIR Maint. Req.		X		Contact service.
10004	FTIR Maintenance			X	
10005	Temp MGL	X			Temp. error sample gas line.
10005	Temp Pipe	X			Temp. error pipe.
10005	Temp Probe	X			Temp. error sample probe.
10007	Flow spectrom.		X		Flow to FTIR is too low.
10008	Service			X	Key “Service” is activated.
10009	Enablir failure	X			Contact service.
10010	Enablir Maint. Req.		X		
10011	Enablir Maintenance			X	
10013	Com watchdog	X			Contact service.
10014	Sequence trigger			X	Key “Shut down” is activated.
10015	Zero Y04			X	Zero gas valve is activated.
10016	Span Y05			X	Span gas valve is activated.
10017	Error save data				
10018	Shut down				Shut down process is running.
10019	High conc.	X			Concentration too high.
10020	Purge locked				
10021	Start Purge			X	Key “Start purging” is activated.
10022	ZRO2	X			Detector measuring value exceeds the –10000 to +5000 range. Oxygen-free test gas is being used.

F = Failure
MR = Maintenance Request
MM = Maintenance Mode

Taking the Analyzer System Out of Service

Temporarily Taking the Analyzer System Out of Service

Step	Action
1	Stop the sample gas flow by switching the Flow Control to “Zero gas probe” (see page 12). VOC analyzer (option): Shut off the combustion gas supply.
2	⚠ Purge the analyzer system with air from the air purifier for at least 15 minutes.
3	Leave the FTIR spectrometer, FTIR controller and air purifier power supplies on. Turn off the power supply to all other components.

Operating Specifications

Sample Components and Measuring Ranges

FTIR Spectrometer [1]	Smallest Measuring Range	Detection Limit	Smallest Measuring Range	Detection Limit
SO_2	0–75 mg/m³	0.27 mg/m³	0–25 ppm	0.09 ppm
NO	0–200 mg/m³	1.65 mg/m³	0–150 ppm	1.24 ppm
NO_2	0–40 mg/m³	0.41 mg/m³	0–20 ppm	0.20 ppm
CH_4	0–100 mg/m³	0.72 mg/m³	0–150 ppm	1.1 ppm
N_2O	0–50 mg/m³	0.25 mg/m³	0–25 ppm	0.13 ppm
NH_3	0–15 mg/m³	0.20 mg/m³	0–20 ppm	0.27 ppm
HCl	0–15 mg/m³	0.26 mg/m³	0–10 ppm	0.16 ppm
HF	0–5 mg/m³	0.12 mg/m³	0–10 ppm	0.13 ppm
CO	0–75 mg/m³	0.23 mg/m³	0–60 ppm	0.18 ppm

	Measuring Range	Detection Limit
H_2O	0–40 Vol.-%	0.01 Vol.-%
CO_2	0–30 Vol.-%	0.01 Vol.-%

VOC Analyzer [2]	Smallest Measuring Range	Detection Limit
VOC	0–15 mg/m³	0.3 mg/m³

O_2 Analyzer	Measuring Range	Detection Limit
O_2	0–25 Vol.-%	0.2 Vol.-%

Measuring ranges within ignition limits cannot be provided.

1) The values are based on a data acquisition time of 120 seconds, a standard deviation of 3 σ and a cell path length of 6.4 m.
2) The measuring range can be reduced or enlarged by a factor of max. 4 (to the smallest indicated measuring range).

Cross-Sensitivity ≤ ±4 % of the smallest measuring range

Linearity < ±2 % of the smallest measuring range

Sensitivity Drift < 4 % in 6 months

Zero Drift Automatically corrected

Response Time T_{90} < 150 seconds, display refreshment time < 40 seconds

Temperature Drift < ±2 % of the smallest measuring range per 10 K change

Air Pressure Influence None (automatically controlled through the aspirator pump module)

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Printed in the Fed. Rep. of Germany (03.07)

42/23-572 EN Rev. 2

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