PEM 9002

Portable Emissions Monitor

(US - Version, V1.0)

TELEDYNE
ANALYTICAL INSTRUMENTS

TELEDYNE
ANALYTICAL INSTRUMENTS

16830 Chestnut Street City of Industry,
California 91748, USA
TEL: 626-934-1500
TOLL FREE: 888-789-8168
FAX: 626-934-1651
www.teledyne-ai.com

WARRANTY SUMMARY

Teledyne warrants that the products it manufactures will be free from defects in materials and workmanship for a period of one year from the date of delivery from factory.

If a product proves defective within the respective period, Teledyne will provide repair or replacement as described in the complete warranty statement.

To arrange for service or obtain a copy of the complete warranty statement, please contact your nearst Teledyne distributor.

EXCEPT AS PROVIDED IN THIS SUMMARY OR THE APPLICABLE WARRANTY STATEMENT, TELEDYNE MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED,INCLUDING WITHOUT LIMITATION THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL TELEDYNE BE LIABLE FOR INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES.

Table of Contents

1. Product Description

The Gas Analysis Computer is a multiple -function analyzer with integrated calculating functions. Measurements are in accordance with the general regulations set forth by the BIMSchV (German Regulations concerning the protection against harmful effects on the environment) at all kinds of combustion plants within the framework of the monitoring of exhaust systems.

a) Measurement and calculation parameters for monitoring exhaust systems and for determining the efficiency of combustion plants:

Measured Values:	T.Gas	Waste or flue gas temperature	°F or °C
	T.Room	Air or ambient temperature	°F or °C
	O2	Oxygen content	% Volume
	CO	Carbon monoxide	ppm - mg/m³ - mg/kWh
	NO	Nitrogen monoxide (Option)	ppm - mg/m³ - mg/kWh
	SO2	Sulphur dioxide (Option)	ppm - mg/m³ - mg/kWh
	Draft	Draft or Pressure	inches of H_2O (iWC)
Calculated Values:	CO2	Carbon dioxide	% Volume
	CO 0%	Carbon monoxide, undiluted	ppm
	Effi.	Combustion efficiency	%
	Ex.air	Excess air value	
	Losses	Waste gas losses	%
	NOx	Nitrogen oxides (optional)	ppm - mg/m³ - mg/kWh
	T.Diff	Differential temperature (TG-TA)	°F or °C

b) Measuring Procedure

Temperature Measurem.:	K-type thermocouple (NiCr-Ni) for waste or flue gas temperature K-type thermocouple (NiCr-Ni) for air or ambient temperature.
O2-Measurement :	Electrochemical measuring cell.
CO-Measurement :	Electrochemical measuring cell.
Draft Measurement :	Piezo-resistive principle with internal temperature compensation.
Measuring Duration:	Short-term memory measurements of max. 60 minutes are possible, followed by a new calibration phase with ambient air.
Waste Gas Measurement :	Via an external water separator and filter, the waste gas is fed to the sensors by means of a gas feed pump. The pump capacity during the feeding phase is approx. 0.8 l/min.
Sensor Calibration:	60 seconds after switching on the instrument.
CO Concentration:	CO sensor with H_2 compensation, measuring range 0 - 4.000 ppm. Cutoff threshold at 4.000 ppm for sensor protection via separate flush pump. The remaining measuring values are not affected. The instrument is switched on again at a value of 1.600 ppm.
Waste Gas Sampling:	By means of a waste gas sampling probe with retainer cone.

c) Instrument Description

Electrical Supply:	NiCad battery 6V/4.0 Ah, external charger.
Display:	With backlight; alphanumeric and graphic display. 4 lines of 16 characters each, plus menu line.
Computer Interface:	RS 232.
Printer Interface:	Pin Printer (Normal Paper).
Printer:	External infrared thermo-paper printer.
Memory:	100 memory blocks
Adm. Operating Temp.:	+ 40 °F to + 104 °F (+ 5°C to + 40°C).
Adm. Storage Temp.:	-22 °F to + 140 °F (- 30°C to + 50 °C).
Mech. Dimensions:	10.6” x 9.6” x 6.9” (270 x 245 x 175 mm).
Weight:	8.0 lbs (3,8 kg).
Standard Version:	Instrument, battery charger, combined flue gas temperature probe / watertrap and hose assembly with measuring cone, ambient air temperature sensor, carrying case and manual.

2. Physical Data

Measuring ranges: (General Specifications)	CO	0 ... 4.000 ppm
	CO-0%	0 ... 9.999 ppm
	O2	0 ... 20,9 % Volume
	T.Gas	+ 32 °F to + 1.850 °F (0 °C ... + 1.000 °C)
	T.Room	-5 °F to + 212 °F (- 20 °C ... +100 °C)
	Draft/Pressure	± 60 inches of H_2O (± 150.0 hPa)
	CO2	0,0 ... CO2 max % Volume
	Losses	0 ... 100%
	Efficiency	100 ... 0%
	Excess air	1 ... 99.999.
Optional:	NOx, NO	0 ... 2.000 ppm
	SO 2, NO	0 ... 2.000 ppm
	CO High	0 ... 1.0 % Volume (10.000 ppm)

2.1 Calculation Formulae

Calculation of the CO2 value:

$$CO2 = CO2max * \left(1 - \frac{O2}{20.9}\right) \text{ in \% Volume}$$

CO2max: Max. CO2-value (fuel-specific) in % Volume.
O2: Measured oxygen content in % Volume.
21: Oxygen content of the air in % Volume.

Calculation of the waste gas loss:

$$qA = (T.Gas - T.Air) * \left(\frac{A2}{21 - O2} + B\right) \text{ in \%}$$

T.Gas: Waste / flue gas temperature in °F or °C.
T.Room: Combustion / ambient temperature in °F or °C.
A2, B: Fuel-specific factors.

Calculation of the excess air value (Lambda):

$$Lambda = \frac{CO2max}{CO2} = \frac{20.9}{20.9 - O2}$$

Calculation of the combustion efficiency value (Eta):

$$Eta = 100 - qA \text{ in \%}$$

Calculation of CO 0% (undiluted):

$$CO0\% = CO * Lambda \text{ in ppm}$$

3. Technical Data

Waste or Flue Gas Temperature Measurement

Sensor:	K-type thermocouple
Range:	+32 °F to 1.850 °F (0 to + 1.000 °C)
Resolution:	0.1 °F or °C
Accuracy:	±2°F / ±1°C (0 to + 400 °C)
	±0.5 % of reading (up to 1.000 °C)

Combustion Air or Ambient Temperature Measurement

Sensor:	K-type thermocouple
Range:	-5 °F to + 212 °F (- 20 to + 100 °C)
Resolution:	0.1 °F or °C
Accuracy:	±2°F / ±1°C (0 to + 100 °C)
	±6°F / ±3°C (-20.0 to 0.0 °C)

Draft or Pressure Measurement

Sensor:	Piezoresistive pressure sensor
Range:	± 60 in. H_2O or ±150 hPa
Resolution:	0.01 in. H_2O or hPa
Accuracy:	±0.08 in. H_2O or ±0.02 hPa (up to ±8.0 in. H_2O or ± 2.00 hPa)
	±1 % of reading (up to ±80.0 in. H_2O or ± 20.0 hPa)
	±3 % of reading (above ±80.0 in. H_2O or ± 20.0 hPa)

Oxygen (O2) Measurement

Range:	0 to 20.9 % Volume
Accuracy:	±0.2 % Volume
Resolution:	0.1 % Volume
Sensor:	Electro-chemical cell
Response time (T97):	< 70 sec

Carbon dioxide (CO2) Calculation

Calculated from O2 measurement

Range:	0 to CO2 max.
Accuracy:	±0.2 % Volume
Resolution:	0.1 % Volume
Response time (T97):	< 70 sec

Carbon monoxide (CO) Measurement (with H2 compensation)

Range:	0 to 4.000 ppm
Accuracy:	±5 ppm (up to 150 ppm) ±5 % of reading (up to 4.000 ppm)
Resolution:	1 ppm
Sensor:	Electro-chemical cell
Response time (T90):	< 60 sec

Options

Nitrogen monoxide (NO) Measurement

Range:	0 to 2.000 ppm
Accuracy:	±5 ppm (up to 150 ppm)
	±5 % of reading (up to 2.000 ppm)
Resolution:	1 ppm
Sensor:	Electro-chemical cell
Response time (T90):	< 60 sec

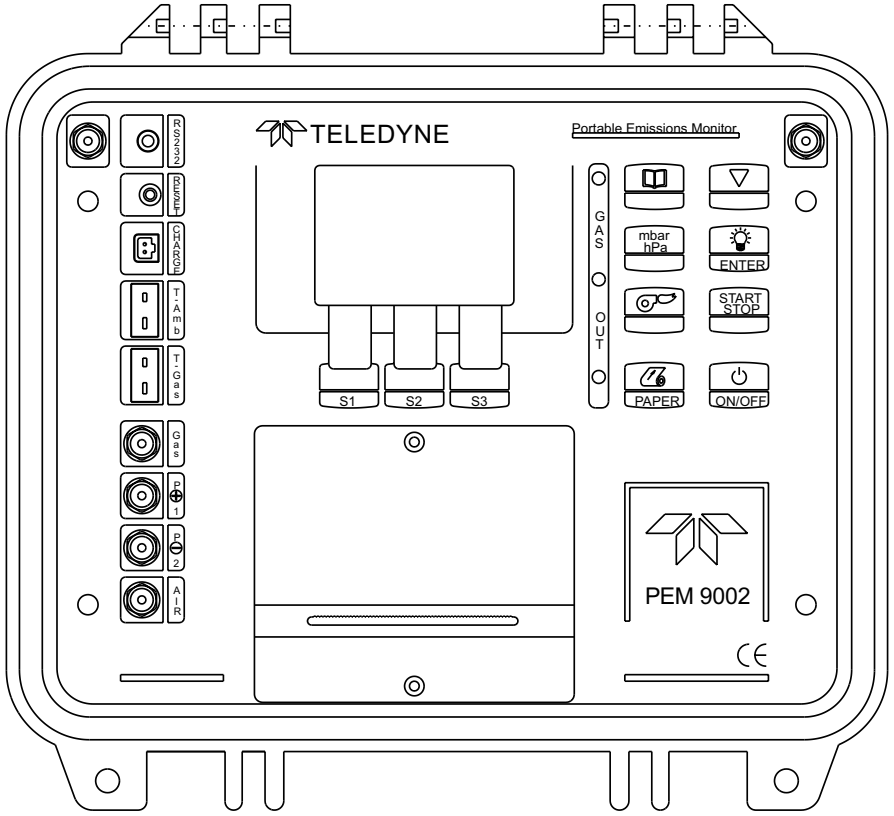
CO Measurement (without H2 compensation)

Range:	0 ... 1.0 % Volume (10.000 ppm)
Resolution:	0.01 % Volume
Sensor:	Electro-chemical cell
Response time (T90):	< 60 sec

Sulphur dioxide (SO2) Measurement

Range:	0 to 2.000 ppm
Accuracy:	±5 ppm (up to 150 ppm)
	±5 % of reading (up to 2.000 ppm)
Resolution:	1 ppm
Sensor:	Electro-chemical cell
Response time (T90):	< 60 sec

4 Front Panel Overview



5 Keypad Functions

On / Off

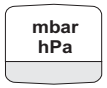
to

Soft Keys

Start Measurements
Gas Feed Pump On / Off

Scroll Measurements

Fuel Selection



Start Draft Measurement

Scroll Key

Backlight On / Off
Confirm in Memory Mode

6 User Guide

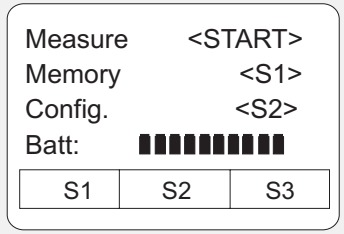
6.1 Program Start Menu

Switch on the instrument — 0 / I

Start Measurements — START STOP

Calls up the memory program — S1

Call up the Configuration Menu — S2



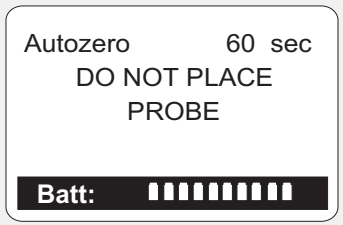
Note: The battery status is determined by how many battery symbols that are dark.

7 dark symbols = 70 % of battery power capacity

6.2 Calibration Menu

Note: Do not place probe - Leave in ambient air until the unit is finished with the calibration phase.

Note: Any errors that occur during calibration are displayed on the information line.



Battery symbols: empty full

Possible Error Messages:

Low Batt
Batt empty
T-Room Sensor ?
T-Gas Sensor ?
O2 Sensor defect
O2 Sens. Service
CO - Sensor ?
CO - Sensor defect
CO - val. overflow
NO - Sensor ?
NO - Sensor defect
NO - val. Overflow

6.3 Fuel Selection

Select fuel menu

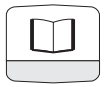
Scroll through list to select fuel be usedl

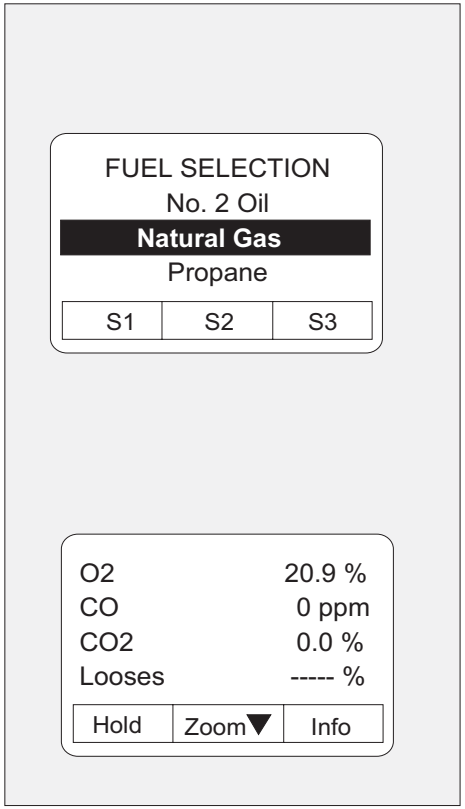
List of possible fuels:

No. 2 Fuel Oil	Northsea gas
Natural Gas	No. 6 Fuel Oil
Propane	No. 4 Fuel Oil
Butane	

Confirm selected fuel

Within the measuring program, all measured values can be displayed by scrolling down (the values are viewed 4 at a time)





6.4 Additional Functions of the Measuring Program

Fuel Selection		Change Fuel Selection
Gas Feed Pump		Gas Pump On / Off
Display Illumination		Backlight On / Off

6.5 Draft Measurement

Start draft measurement

from the measuring program: mbar hPa

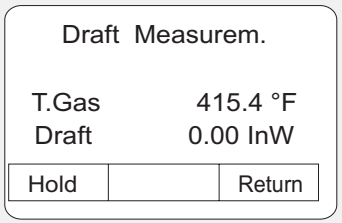
Attention:
No pressure values Exceeding ± 60 inches of H_2O
(± 150 hPa mbar)!

Note:
For draft Measurement, connect air tube to the positive (+) connector only.

Hold — Hold measured values — S1

Return — Terminate draft measurement — S3

Before pressing the mbar/hPa key, pull the air tube off the instrument!
The draft sensor is calibrated (0.00 InW or hPa).



Carefully replace the air tube.
Wait until the measured value has stabilized.

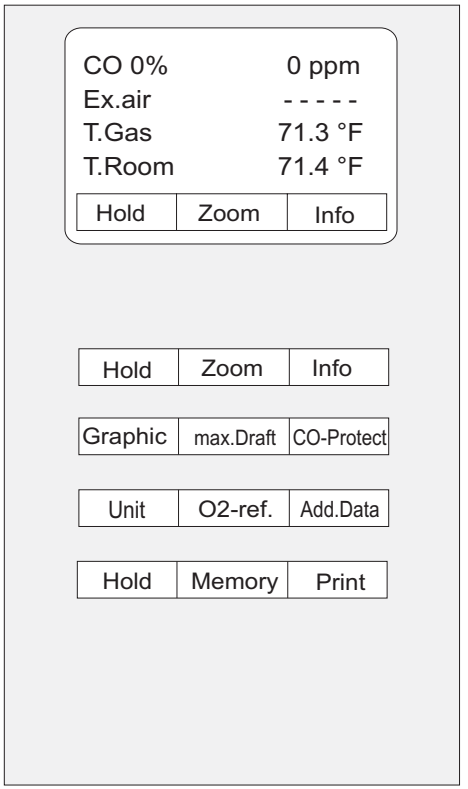
Record the measured draft value.

This value is stored with the current measuring values.
The measuring mode is continued.

6.6 Menu Lines

Display next menu line

The menu line makes it possible to operate the instrument in a fast and easy way. Pressing the appropriate soft key (S1 to S3) accesses submenu directly and/or allows direct execution of a function.



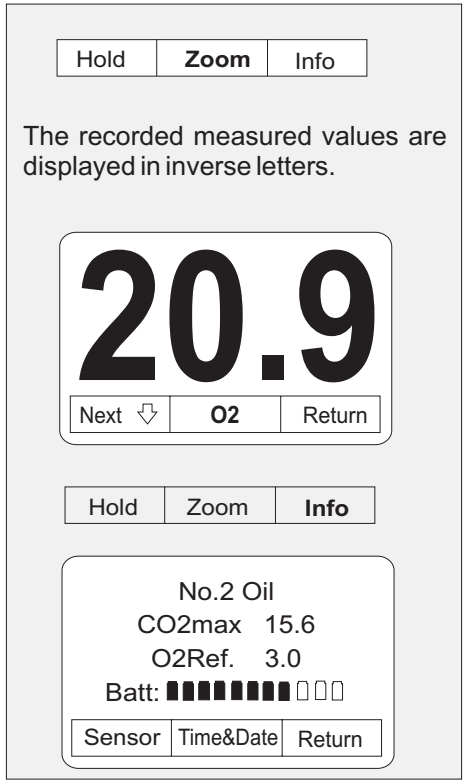
6.6.1 Menu Line 1

Hold — Intermediate storage of measured values — S1

Zoom — Enlarged display of measured values — S2

Print
Or
Info — Opens the Information Box — S3

Note: The information Box displays the current status of battery, the selected fuel type (including CO2 max value) and the O2 reference value for converting units.



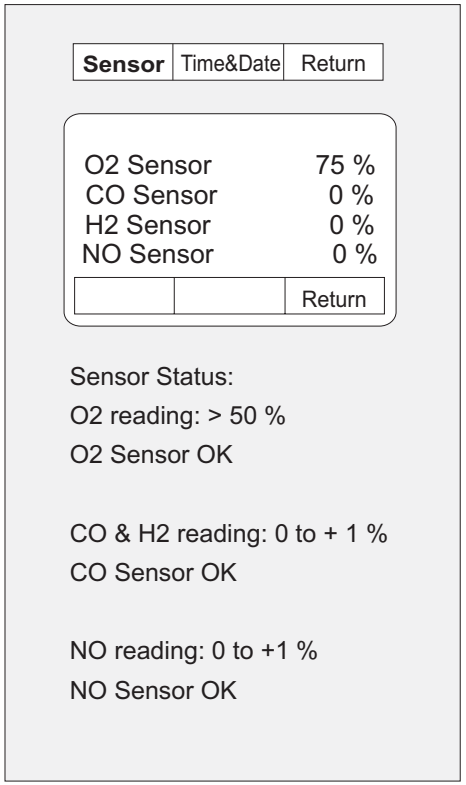
6.6.1.1 Menu: Information Box

Sensor	Sensor values (Info just for service)	S1

Momentary Sensor failure or degrading can be solved by longer flush periods in ambient air or / and by exchanging the filter elements.

Note:
If the failure or degrading keeps occuring and cannot be fixed, please contact the supplier!

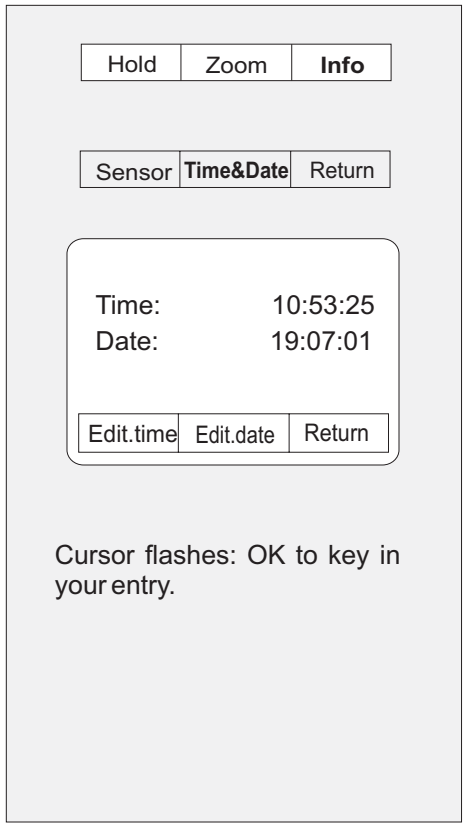
Return	Back to the Information Box	S3



6.6.1.2 Menu: Time and Date

From Informations Menu

Time&Date	Call up time and date	S2
Edit.time	Set current time	S1
Edit.date	Set current date	S2
	Change numerical value	▼
	Advance to the next digit position	ENTER
Return	Terminate editing function	S3

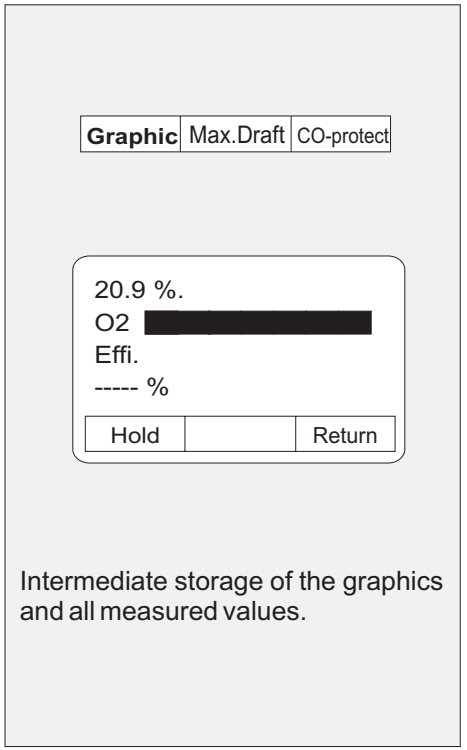


6.6.2 Menu Line 2

From the measuring program:

6.6.2.1 Menu: Graphic

Graphic	Call up the Graphics Menu	S1
Hold	Intermediate storage of the graphics	S1
Return	Terminate graphics menu	S3



Intermediate storage of the graphics and all measured values.

6.6.2.2 Menu: Core of waste gas flow (Max. Draft)

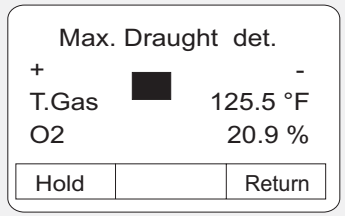
From the measuring program:

max.Draft — Enter Max. Draft Menu — S2

The menu: 'Max. Draft' provides a graphic display of such tendencies as rising or falling temperatures, which are indicated by oscillations of the bar graph. As soon as the temperature has stabilized the bar graph appears in the center of the display.
Note: If necessary, intermediate storage of measured values is possible as follows:

Hold — Intermediate storage of measured values — S1

Return — Terminate Max. Draft menu — S3



All measured value will be stored in the intermediate storage.

When the over-range value of 4.000 ppm has been reached the CO flush pump is switched on **automatically.**

6.6.2.3 Menu: CO Purge System (manual)

CO-Protect — CO Flush pumps On / Off — S3

6.6.3 Menu Line 3

From the measuring program:

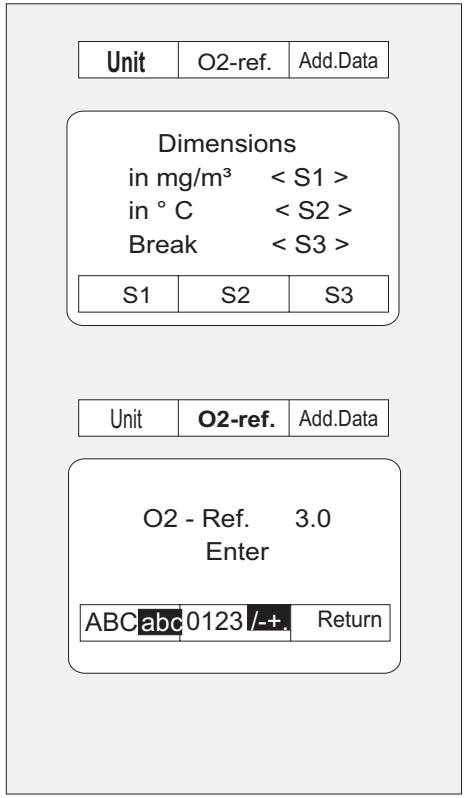
6.6.3.1 Menu: Units

Unit	Call up the 'Units' Menu	S1
S1	Change units to mg/m³	S1
S2	Change units to ° C	S2

6.6.3.2 Menu: O2 - Reference

From the measuring program:

S2	Confirm O2 reference and terminate	S2



6.6.3.3 Menu: Additional Data (add. Data)

From the measuring program:

Add.Data Calls up menu for entering additional data — S2

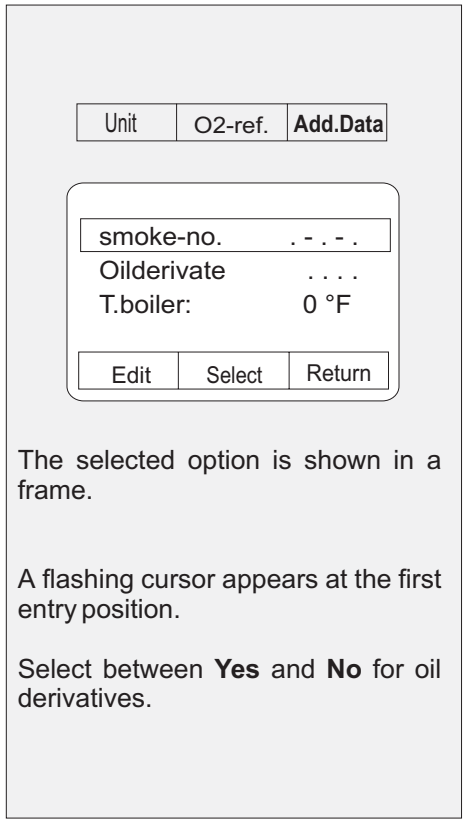
Select Select Line — S2

Edit Change Value — S1

Change numerical value — ▼

Advance to the next digit position — ENTER

Return Terminate editing function — S3



The selected option is shown in a frame.

A flashing cursor appears at the first entry position.

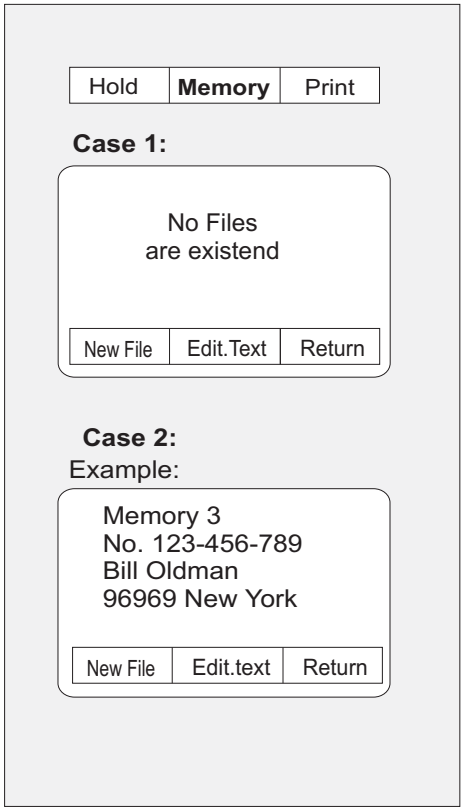
Select between **Yes** and **No** for oil derivatives.

6.6.4 Menu Line 4

From the Measuring Program:

6.6.4.1 Memory Functions

Hold	Interm. storage of measured values	S1
Memory	Calls up the memory program	S2



Case 1: No memory blocks created.

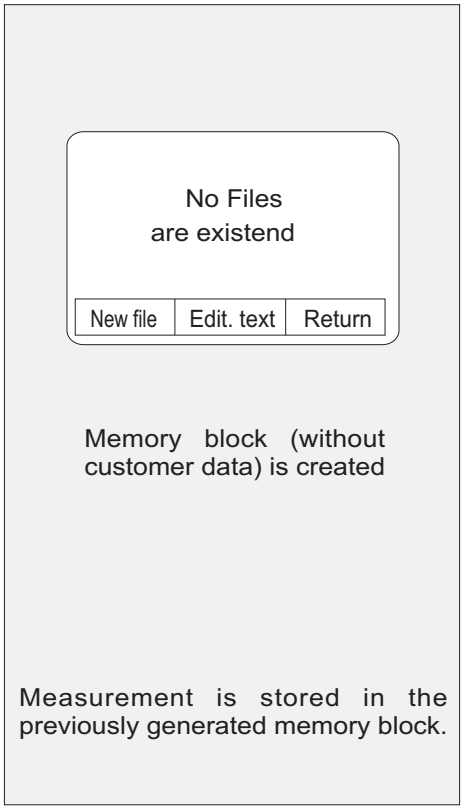
NewFile — Create new memory block — S1

Creates a memory block with additional data (e.g. type of combustion plant, customer address etc.) see Section 6.6.4.2, page 29.

Return — Confirm memory block generation. — S3

Calls up the next memory menu

Save — Stores measured values — S3



Memory block (without customer data) is created

Measurement is stored in the previously generated memory block.

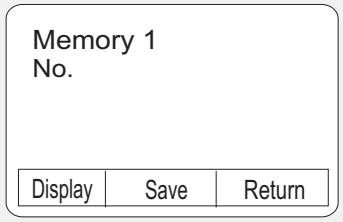
Case 2: Memory blocks already exist.

(Please refer to Section 6.6.4.2 "Create Memory Blocks")

Scrolls existing memory blocks

Save

Stores measured values in the selected block



Intermediately stored measured values are now stored in the selected memory block!

Other Memory Functions

Note: If memory blocks exist, stored data can be accessed as follows:

Scrolls existing memory blocks

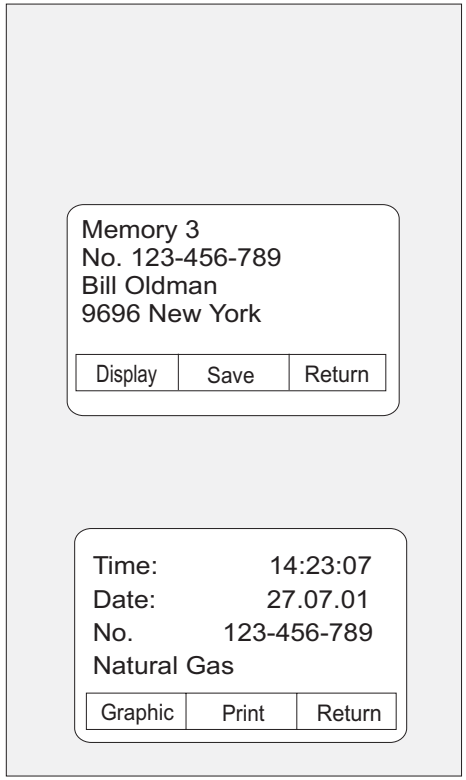
Display — Views selected memory blocks — S1

Scrolls measuring data in the memory

Grafic — Graphics display of measured values — S1

Print — Prints the stored measurement — S2

Return — Terminates the View function — S3



6.6.4.2 Menu: Create Memory Blocks

Generation of memory blocks and entry of customer data

Calls up other lines of the memory menu.

New File — Creates new memory block. — S1

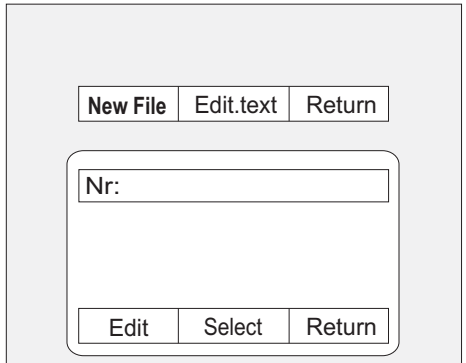
Edit — Enter customer number — S1

0123 /-+. — Selects the character set — S2

Selects characters

Advances to next digit position — ENTER

Return — Terminates entry — S3



Toggles between figures and special characters

Available characters for (customer) code:

Figures: 0 to 9
Special characters: - + . , : * > < /

You can enter up to 13 consecutive characters into the (customer) code line.

Select — Selects the next entry line — S2

Edit — Switches on the entry mode — S1

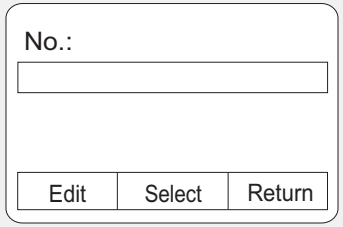
ABC abc — Character set: Capitalization/Small Initial Letters — S1

0123 /-+. — Character set: Figures/Special Characters — S2

Selects Characters — ▼

Advances to the next digit position — ENTER

Return — Terminates entry. — S3



Toggles between capitalization and small letters.

Toggles between figures and special characters.

Available selection of characters:

Letters:	a to z, ä, ö, ü, ß
Letters:	A to Z, Ä, Ö. Ü
Figures:	0 to 9
Special characters:	- + . , : * > < /

Up to 16 characters can be entered consecutively.

Select — Selects the next entry line. (S2)

Up to four lines of customer data can be entered.

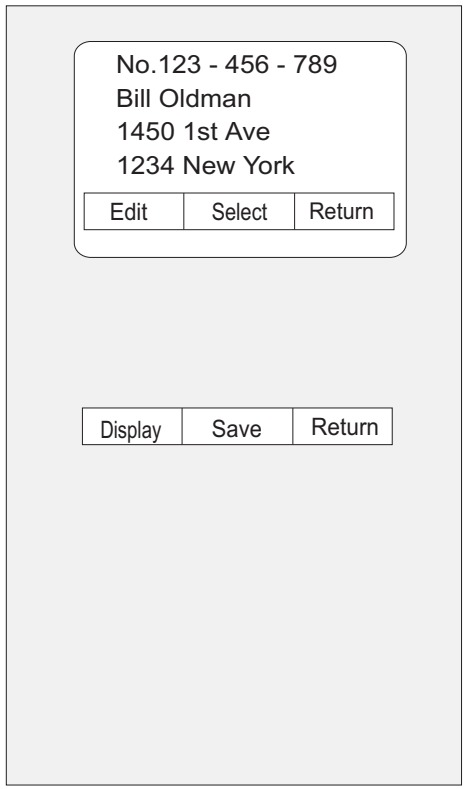
Return — Returns to the measuring menu. (S3)

Display next menu line

The memory block is saved for later measurements or until it is deleted again.

Stored values can be viewed by means of menu point 'Display

New measured values can be stored in the memory block by mean means of menu point 'Save'.



6.6.4.3 Menu: Delete Memory Data

Calls up other memory menus

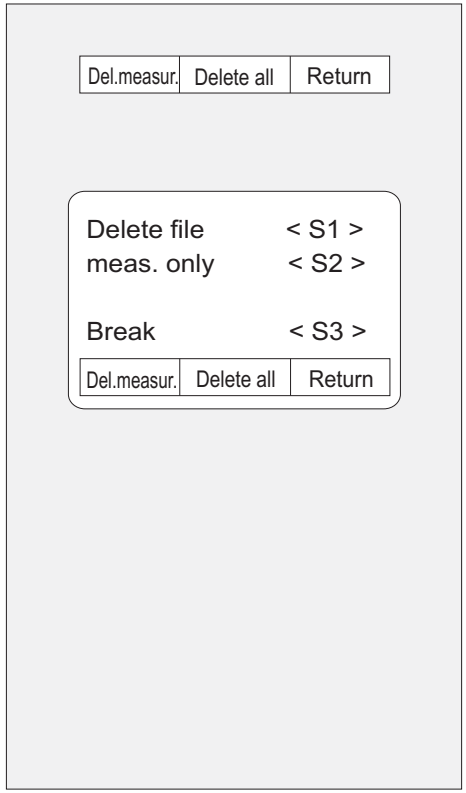
Selects the block to be deleted

Del.measur. Deletes the measurement S1

Deletes block incl. additional data S1

Deletes measurement only S2

Abort S3



Delete all — Clears all memories — S2

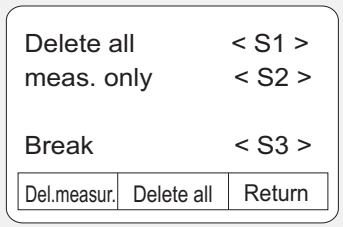
Deletes all — S1

Attention: All memories inlcuding additional data will be deleted!

Deletes measurements only — S2

Abort — S3

Return — Terminates memory function — S3



Returns to measuring menu.

6.6.4.4 Printing the Measured Values

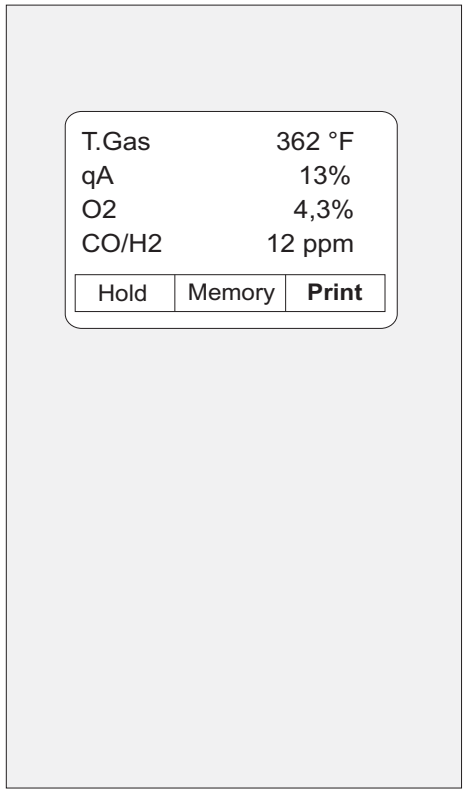
Direct printout from the measurement:

Print — Printout of current measuring values — S3

Printout of intermediately stored values:

Hold — Intermediate storage of measured values — S1

Print — Printout of measured values — S3



6.7 Configuration Menu

From the Program Start Menu:

Call up the Configuration Menu — S2

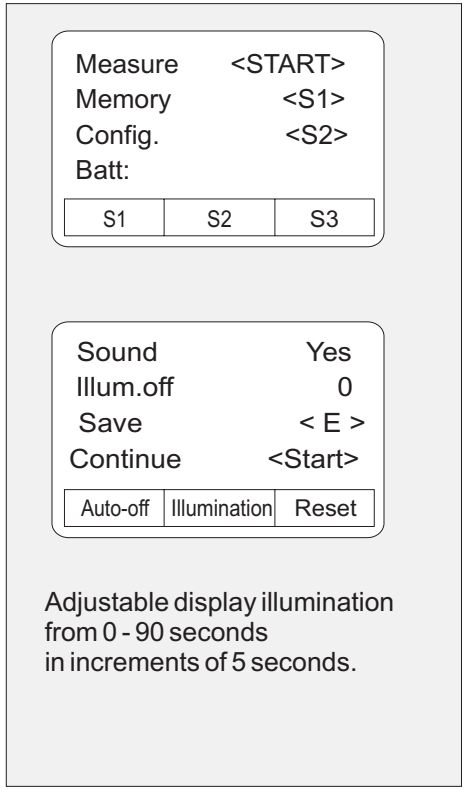
Changing the Configuration Data:

Sound — Switches the acoustic signal On / Off — S1

Illumination — Sets the time interval for the display back light — S2

Stores the configuration data — ENTER

Aborts the Configuration Menu — START STOP



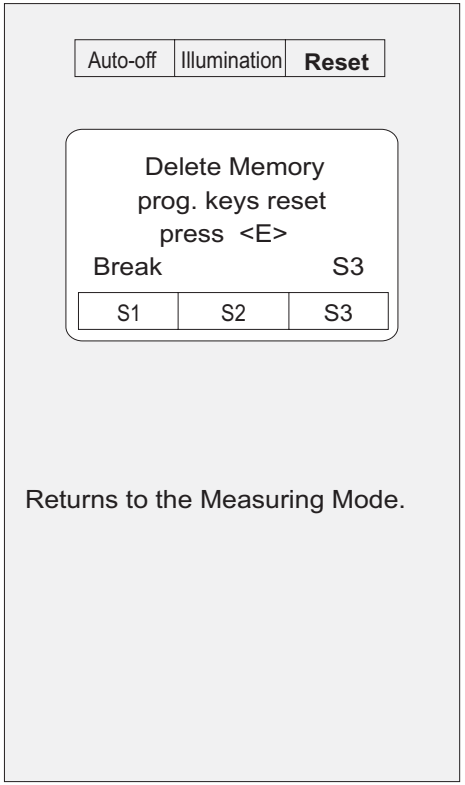
Adjustable display illumination
from 0 - 90 seconds
in increments of 5 seconds.

From the Configuration Menu

Reset	Resets all instrument parameters	S3

Attention: Confirming Reset with ENTER cancels all instrument settings. All memory blocks are deleted.

Confirm Reset	ENTER
Aborts the Reset routine	S3



6.8 Entering the Company Address

From the Program Start Menu:

Call up the Configuration Menu

From the Configuration Menu:

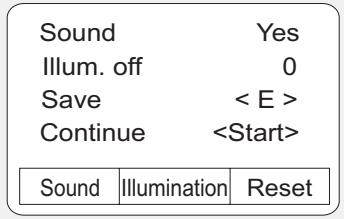
Call up Address Entry

Edit — Switch on the Entry Mode

Entry of letters, figures and special characters as in the memory mode (Section 6.6.4.2).

Select — Advance to the next line.

Return — Terminate Address Entry



The entered or corrected company address is now saved and will always appear on the printout of measuring data.

7. System Maintenance

Waste Gas Cleaning System: See drawing on page 42.

Attention:

Empty the condensate reservoir completely after each measuring operation. Water residues within the measuring instrument will destroy the pumps and sensors!
Damage of the filter and / or improperly fitted filter will greatly decrease o eliminate the filter function and will eventually destroy pumps and sensors.

Check the microfilter for contaminations and replace as necessary.

If the pump capacity is reduced, exchange the diaphragm filter.

Make sure that threaded parts are straight when placed on and tighten them moderately. Ensure sufficient sealing by means of O-rings.

Plug-type elements and flanges:

Remove any gas residues. Grease with Vaseline.

Storage:

Store in a cool and dry environment at a temperature of approx. 60 °F (20 °C).

Damages: **Guarantee and warranty obligations do not apply to damages caused by improper handling, negligence and grave external influences.**

8. RS - 232 Interface

Provides connections for special Service and Data Communications.

9. Battery / Line Voltage Operation

Battery operation: Maximum 36 hours of continuous measuring.

Battery charger: External charger 110 V~/ 60 Hz.
Intelligent monitoring by means of instrument-integrated microcontroller

To maintain the service life and performance of the NiCad battery, please observe the instructions under 'Information on charging the battery'.

Status display of the storage battery: Shown on the bottom line of the display during the calibration phase. During the measurement, the status of the battery can be read from The 'Info' Menu.

Information on Charging the Battery

PEM9002 is equipped with an NiCad storage battery. The service life and capacity of the battery are considerably affected by the way the instrument is charged and used. In order to make the handling safer, the instrument has a load management unit.

If an NiCad battery is, for example, always charged from 80% to 100% and never run down to the final discharge voltage, it will lose some of its capacity. This is called the 'memory effect' , i.e. the battery remembers to what extent it is run down.

A part of this memory effect is suppressed in the PEM9002 in that the battery cannot be recharged until it has dropped below 60%.

Constant overcharging, too, has adverse effects on the NiCad battery. In order to prevent this, the charged capacity, the voltage and the temperature of the battery are monitored in the PEM9002.
When predefined limits are exceeded, the charging process is interrupted. After the appropriate parameters have been neutralized the charging process is automatically restarted again.

The service life of the NiCad battery can be significantly reduced when the instrument is operated at temperatures below 40 °F (5°C).

The graphic charge-level indicator of the PEM9002 (10 battery symbols), which appears in the one-line status display during the calibration phase, helps the user estimate correctly the capacity of the battery. The instrument continuously measures the incoming and outgoing current during operation and charging. Under normal operating conditions, the instrument should be operated until the battery is completely run down. When this advice is followed, the actual capacity of the NiCad battery will definitely be shown on the display.

Storing the instrument is only recommended if the NiCad battery is fully charged. If the instrument has to be stored for a prolonged time (approx. 2 weeks or longer) it is recommended to leave the instrument connected to the charger. The same applies to low-level discharge of the battery: leave the instrument connected to the charger for a longer period (up to 12 hours).

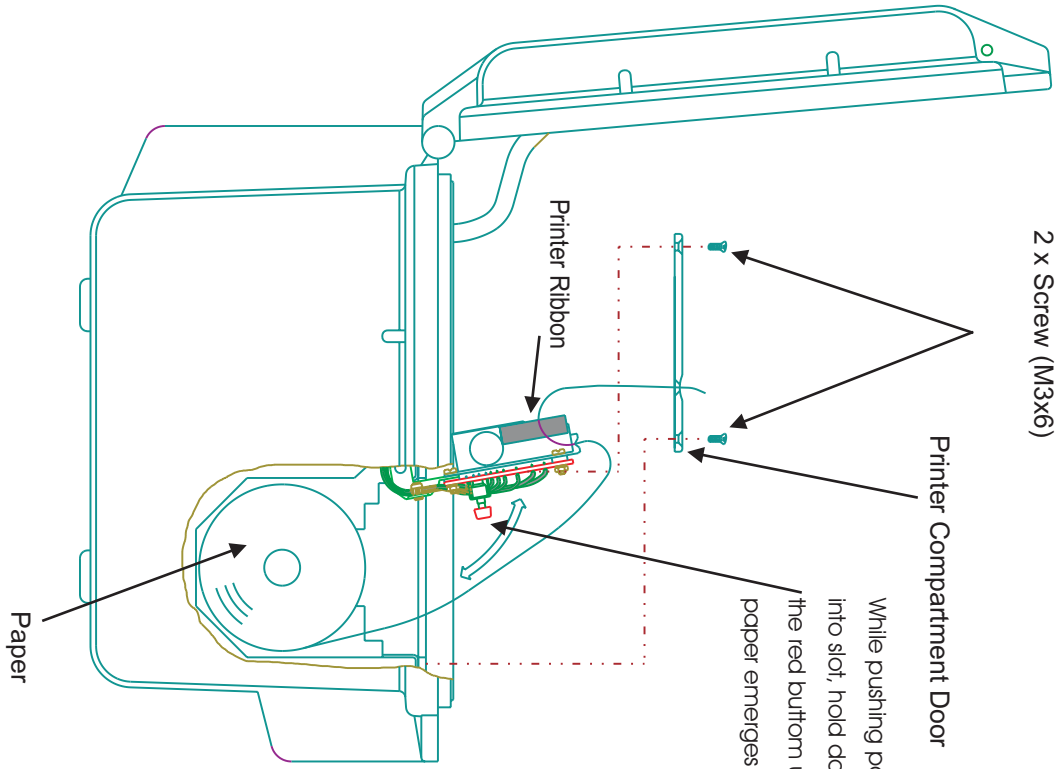
If the instrument is operated at temperatures exceeding the admissible temperature range, if the NiCad battery is older, or if incomplete charging cycles (charging/discharging) are performed, it is possible that the display no longer corresponds to the current status of the battery.

In this case the display is corrected as follows: discharge the battery by switching on until the instrument switches off automatically. After that, connect the instrument to the associated charger and wait until the end of the charging period (max. 4 hours). When the charging process is completed, the PEM9002 switches off automatically.

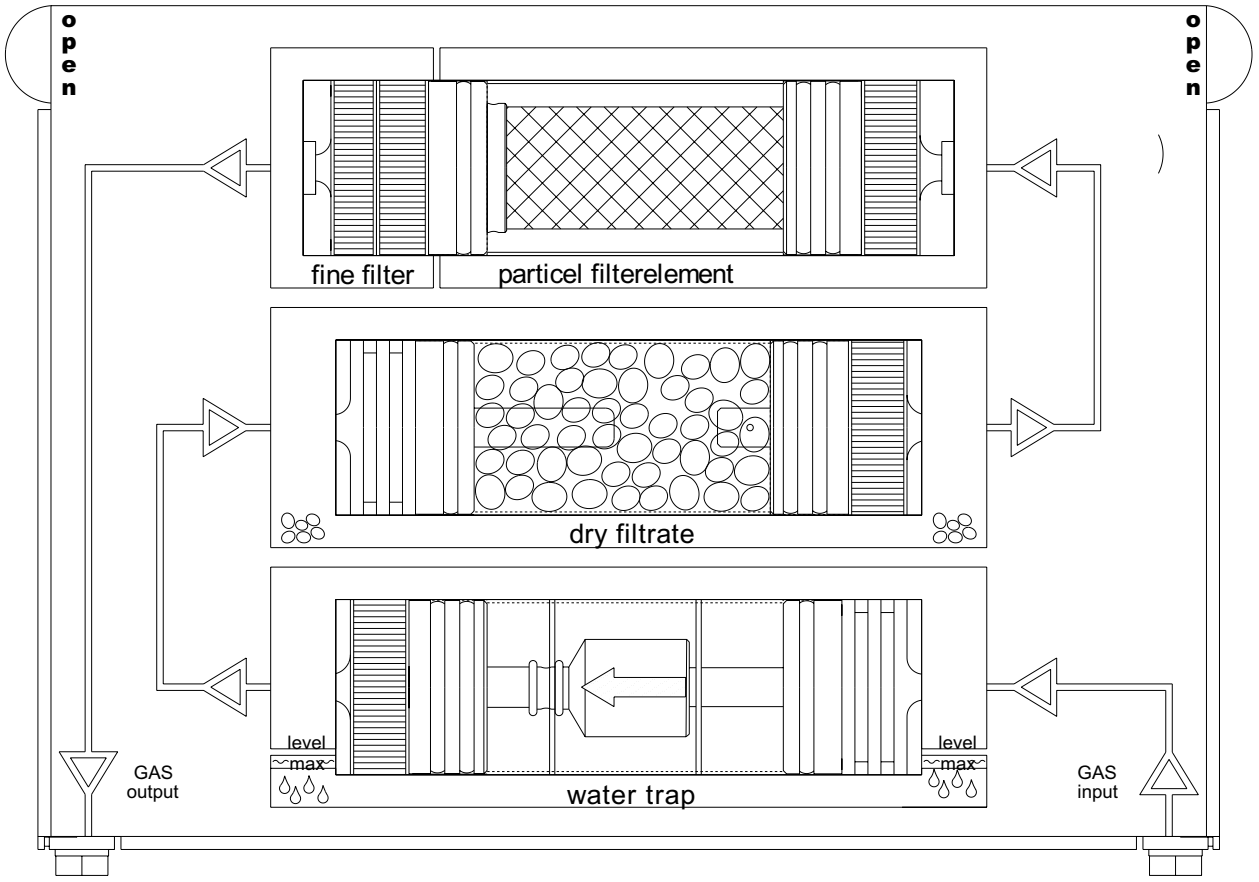
Used or Dead Battery

For replacement of a Used or Dead battery, the analyzer has to sent back to the supplier / manufacturer.

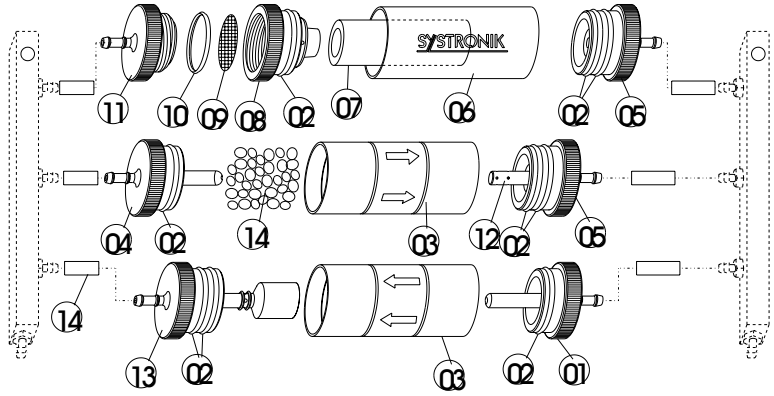
10. Loading Paper



11. Waste Gas Cleaning System



11.1 PEM 9002 - Filters and other cleaner parts



Replacement Parts(Part No.): 20594 (01) / 20370 (02) / 20596 (03) / 22049 (04) / 21954 (05) / 21779 (06) / 20919 (07) / 20592 (08) / 20921 (09) / 20365 (10) / 20591 (11) / 21955 (12) / 22017 (13) / 21427 (14)

Maintenance: *- Empty the condensate reservoir after each measuring operation.*
- Check the microfilter for contaminations and change as necessary.
- If the pump capacity decreases, change the hydrophob filter.

Attention! Damaging the filter or inserting it incorrectly will lead to invalid results!
Grease all tight or stiff parts with vaseline.