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CHEMIST

Combustion Analyzer

USE AND MAINTENANCE MANUAL

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1.1 General Overview of the Flue Gas Analyser

CHEMIST is a portable flue gas analyser that was meticulously designed to meet statutory requirements and specific customer demands. It may be provided in a rugged ABS carry case or waterproof shoulder bag.
The instrument contains two cards with all the basic circuitry, pre-calibrated measuring cells, sample pump, membrane keypad, backlit graphic LCD display, high-capacity rechargeable Ni-MH battery pack and impact printer. The two halves of the case are firmly secured by eight screws on the rear of the instrument.
The pneumatic circuit and measuring cells inclusive of micromodule are located on the back side of the plastic case and are easily accessed for maintenance and replacement by removing the cover carrying the functions label.
The roll of paper is positioned at the upper end on the rear and may be easily replaced by removing the snap-on flap.
The pneumatic connectors for flue gas sampling and pressure/draught measurement are installed on the lower end of the instrument. Connectors are provided on the right hand side of the analyser for connecting the thermocouple sample probe and Pt 100 air temperature probe.
On the left hand side there is a socket outlet for connecting the external power supply and an 8-pin min-DIN for serial interface or Deprimometer (optional).
The HMI consists of a constantly active backlit graphic LCD display and membrane keypad. Menu screens and all user messages are in Italian or in the language specified in the purchase order. Use of the analyser is simplified by symbol keys that give direct access to main instrument functions. Shifting between the various menu screens is easy and user-friendly thanks to four cursor keys, an 'ok' key and 'esc' key.

1.2 Configurations and Sensors

The flue gas analyser features a large backlit alphanumeric display and built-in impact printer for ordinary paper, rechargeable battery pack, and user-replaceable pre-calibrated sensors.
CHEMIST is available in three versions:

AS0 620 AE: CHEMIST 200

Non-expandable dual sensor flue gas analyser (O_2 + CO), without solenoid valve.
CHEMIST 200 is used to conduct direct O_2 and CO analyses and to effect additional measurements and calculation of CO_2, air, flue gas and differential temperatures, pressure, draught, efficiency and excess air.

AS0 625 AE: CHEMIST 200 PLUS

Dual sensor flue gas analyser (O_2 + CO), expandable to three sensors, without solenoid valve. CHEMIST 200 PLUS is used to conduct direct O_2 and CO analyses and to effect additional measurements and calculation of CO_2, air, flue gas and differential temperatures, pressure, draught, efficiency and excess air.
The third sensor (NO) can be added to CHEMIST 200 PLUS at any instant without having to dispatch the instrument to a service centre.

AS0 630 AE: CHEMIST 300

Triple sensor flue gas analyser (O_2 + CO + NO), without solenoid valve. CHEMIST 300 is used to conduct direct O_2, CO and NO analyses and to effect additional measurements and calculation of CO_2 and NO_x, air, flue gas and differential temperatures, pressure, draught, efficiency and excess air.

All the above models are available with a solenoid valve on request. The solenoid valve, installed on the pneumatic circuit, accelerates the electrochemical cells' return to full operation in the event of exposure to excessively high concentrations of CO or NO.

2.0 TECHNICAL SPECIFICATIONS

2.1 Technical Specifications

Power supply:		Rechargeable battery, 5 x 6V 1800 mA/h elements with external charger.
Battery life:		9 hours of continuous operation (printing excluded).
Charging time:		2 hours to recharge from 0% to 90%.
Printer:		Internal 24-column impact printer for use with ordinary paper, (paper roll 18 m long x 57 mm wide).
Printer power supply:		From the analyser battery pack.
Printer autonomy:		Up to 40 analysis reports with batteries fully charged.
Internal data storage:		99 positions with storage of three analyses each, including date, time and client's name.
User details:		3 programmable user names.
Printout heading:		4 lines customisable by the user.
Display:		Backlit graphic LCD display measuring 42 x 60 mm.
Communications port:		Two-way RS232 serial port.
Stream filter:		With replaceable cartridge.
Smoke:		Using an external hand-operated manual pump; possibility of entering and printing the Bacharach smoke index.
Operating temperature range:		-5°C to +40°C
Storage temperature range:		-10°C to +50°C
Operating humidity range:		20% to 80% RH
Air pressure:		Atmospheric
Outer dimensions:	Analyser:	30,7 x 10,5 x 9,6 cm (W x H x D)
	Case:	48.2 x 37.5 x 16 cm (W x H x D)
Weight:	Analyser:	~ 1.1 kg
	Total:	~ 4.5 kg

2.2 Overview of Flue Gas Analyser Components

Fig. 2.2

Case
Rigid plastic case with outer dimensions 48.2 x 37.5 x 16 cm. Seven internal dividers allow the instrument and relative accessories to be safely lodged.

Keypad
Adhesive polyester keypad with preformed keys featuring main control functions (pos. A in Fig. 2.2).

Display
Backlit 128 x 64 pixel LCD display (pos. B in Fig. 2.2), with 8 lines x 20 characters available. Allows the user to view the measured parameters in the most comfortable format; a Zoom function displays the measured values in magnified form.

CAUTION: If the instrument is exposed to extremely high or extremely low temperatures, the quality of the display may be temporarily impaired. Display appearance may be improved by acting on the contrast key.

Printer
Internal 24-column impact printer for use with ordinary paper, (pos. C in Fig. 2.2). Thanks to the use of ordinary paper and an ink ribbon, running costs are lower and the printout is more legible and longer-lasting when compared to printouts obtained by other systems, besides being much more resistant to heat.
The print menu is accessed by pressing the relative key and, besides enabling read-out printing, the menu also allows you to modify print settings and to advance the paper manually so as to facilitate paper roll replacement.

Battery charger
The instrument is provided with a 12VDC, 2A power supply pack to charge the internal batteries.
The socket for connecting the battery charger to the instrument is shown as item L in Fig. 2.2. When the battery starts charging a red LED lights up alongside socket outlet L in Fig. 2.2.

Serial cable
Item M in Fig. 2.2 represents the serial communications interface for hooking up the instrument to a personal computer or for connecting Deprimometer optional probe.

Sample pump
The sample pump located inside the instrument is a DC-motor-driven diaphragm pump, powered by the instrument, and is such as to obtain optimal flow of the sampled gas being analysed.

Remote sampling unit
Stainless steel probe with plastic handgrip (pos. D in Fig. 2.2). Probe length: 18 cm (standard) or 30 cm (optional), with 8/22 mm sampling hole adapter cone.
Connected to the analyser via a 3 m rubber hose through a water separator and replaceable particulate filter (pos. E in Fig. 2.2).

Measuring cells
The instrument employs long-lasting sensors to measure the oxygen, carbon monoxide (hydrogen compensated) and nitrogen oxide (NO) content.
The measuring cells are electrochemical and do not require any maintenance.
Once spent, the cells can be easily replaced without having to dispatch the instrument and, since they are pre-calibrated, do not necessitate complicated calibration procedures involving the preparation of specimen mixtures.
Seitron certifies the accuracy of its analysers <u>only following the release of a calibration certificate by its laboratory</u>.

Temperature sensors
Flue gas temperature is measured by means of a thermocouple inserted in the tip of the probe.
The thermocouple is connected to the instrument via a compensated cable (pos. F in Fig. 2.2.) housed in a special seating in the rubber hose of the sample probe.
Connection to the instrument is achieved via a temperature-compensated male connector.
The cold junction is compensated by a Pt 100 resistance thermometer which measures the temperature at the thermocouple connector.
The type K thermocouple (nickel/nickel chromium) permits continuous measurements up to 800°C. If special-purpose probes are used, the instrument is able to measure temperatures as high as 999.9°C.
A Pt 100 resistance thermometer located inside the instrument measures the internal temperature; this sensor is also used to measure the ambient temperature.
Should the user want to measure the combustion air temperature directly in the intake duct, the optional remote Pt 100 sensor must be used - this measurement is recommended for more precise calculation of plant efficiency.

Remote temperature probe
The temperature probe consists of a Pt 100 probe, complete with 2 m cable and 7.5/17 mm pit adapter (pos. G in Fig. 2.2). This probe is used to measure the combustion air temperature, within a range of -10°C to +100°C, when boiler efficiency is to be calculated precisely.

Pressure sensor
The instrument features an internal piezoresistive sensor to measure the stack draught (negative pressure) and other parameters if required (gas network pressure, pressure drop across filters etc.). The user can switch from flue gas analysis to this reading by simply pressing a key.

Sample and + / - pressure inputs
Pos. I in Fig. 2.2 is the input of the sample probe complete with water separator and particulate filter. Pos. N and H in Fig. 2.2 are respectively the positive and negative internal differential pressure sensor inputs.
The positive input P+ N is used to measure pressure in general and for the tightness test. The negative input P- H is used to measure draught in accordance with standard UNI10845; the branch of the fume exhaust probe without the anti-condensation filter should be connected to it for simultaneous draught measurement and combustion analysis.
The positive input P+ and negative input P- are used simultaneously to measure differential pressure.

Fuel types
The instrument has been programmed with the technical characteristics that are typical of seven common fuels. By means of the optional PC configuration program, this list and the relative coefficients may be modified for up to a total of 10 fuels.
The following chart, derived from standard UNI 10389-1, lists the coefficients of the seven memorised fuels, used for calculating losses and efficiencies.

Coefficients for calculating combustion efficiency			
A1	A2	B	Fuel
0,66	0,38	0,010	Natural gas
0,63	0,42	0,008	LPG
0,68	0,50	0,007	Diesel oil
0,68	0,52	0,007	Fuel oil
0,671	0,375	0,0088	Methane G20
0,682	0,446	0,0070	Propane G31
0,684	0,458	0,0066	Butane G30

Smoke measurements
It is possible to enter the smoke values measured according to the Bacharach scale. The instrument will calculate the average and print the results in the analysis report.
An external pump, available as an optional, must be used to effect this measurement.

Pressure decay test
The instrument can perform the tightness test of a piping according to the italian standards UNI 7129 and UNI 11137-1. For this test the same pressure sensor used is the same as that for the draft test.

Calibration certificate
The instrument is calibrated by comparing to specimen samples provided by a Metrology Lab., certified periodically by internationally recognised laboratories.
A calibration certificate is provided with each and every instrument where every parameter is accompanied by the relevant nominal value, measured value, permissible error tolerances and measured error.

Electromagnetic compatibility
The instrument was designed to comply with Council Directive 2004/108/EC governing electromagnetic compatibility. Seitron's declaration of conformity may be found in Annex B.

2.3 Measurement and Accuracy Ranges

MEASUREMENT	SENSOR	RANGE	RESOLUTION	ACCURACY
O_2	Electrochemical	0 .. 25% vol	0.1% vol	±0.2% vol
CO (H_2 compensated)	Electrochemical	0 .. 8000 ppm	1 ppm	±20 ppm 0 .. 400 ppm ±5% measured value 400 .. 2000 ppm ±10% measured value 2000 .. 8000 ppm
NO (2)	Electrochemical	0 .. 4000 ppm	1 ppm	± 5 ppm 0 .. 100 ppm ± 5% measured value 100 .. 1000 ppm ± 10% measured value 1000 .. 4000 ppm
NOx (2)	Calculated	0 .. 12000 ppm	1 ppm	
CO_2	Calculated	0 .. 99.9% vol (1)	0.1% vol	
Air temperature	PT100 RTD	-20.0 .. 100.0 °C (3)	0.1 °C	±1 °C (4)
Flue gas temperature	type K thermocouple	-10.0 .. 999.9 °C (3)	0.1 °C	±2 °C -10 .. 200 °C ±1% measured value over 200 °C (5)
Differential temp.	Calculated	-100.0 .. +1000.0 °C	0.1 °C	
Draught / Pressure	Semiconductor	± 105 hPa (6)	0.01 hPa	±(-1,5% meas. val. +0,045 hPa) -105.00 .. -1.00 hPa ±5% measured value -1.00 .. -0.40 hPa ±0.02 hPa -0.40 .. 0.40 hPa ±5% measured value 0.40 .. 1.00 hPa
Excess air	Calculated	1.00 .. 23.00	0.01	
Stack loss	Calculated	0.0 .. 100.0 %	0.1 %	
Efficiency	Calculated	0.0 .. 100.0 %	0.1 %	
Smoke index	External instrument	0 .. 9	1	

Data relative to concentration accuracy are referred to an instrument operating at a constant temperature within the correct operating range (-5°C to +40°C), that has been on for at least 15 minutes, is powered by the internal battery and has completed auto-calibration.
Data relative to pressure and draught measurement accuracy are referred to an instrument operating at a constant temperature, that has been on for at least 30 minutes, and has completed “pressure zeroing”.

(1) The maximum CO_2 value displayed depends on the type of fuel.
(2) Measurements possible only with the model comprising the NO (nitrogen oxide) probe.
(3) The field of operation of probes may be more restricted.
(4) Stated precision includes error of the external sensor RTD Pt100 class A DIN 43760 (1980).
(5) Stated precision includes error of the external sensor thermocouple type K class 1 IEC584.
(6) Pressures greater than 750 hPa may permanently damage sensors or impair their characteristics.

3.0 USING THE FLUE GAS ANALYSER

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3.1 Preliminary operations

Remove the instrument from its packing and check it for damage. Make sure that the content corresponds to the items ordered. If signs of tampering or damage are noticed, notify the SEITRON service centre or agent immediately and keep the original packing. A label at the rear of the analyser bears the serial number. This serial number should always be stated when requesting technical assistance, spare parts or clarification on the product or its use.
Seitron maintains an updated database for each and every instrument.
Before using the instrument for the first time it is recommended to charge the battery for 12 hours with the instrument turned off.

3.2 Power supply

The instrument contains a high-capacity Ni-MH rechargeable battery.
The battery feeds the instrument, built-in printer and any other probes or remote devices that may be connected. The instrument runs for approximately 9 hours if the printer is not used. Should the battery be too low to effect the necessary measurements, the instrument can be hooked up to the mains via the power pack provided, allowing operations (and analysis) to proceed. The battery will be recharged whilst the instrument is being used.
The battery charge cycle is automatic and is divided into three phases:

- Quick charge: this begins as soon as the power pack is connected and the batteries are quickly recharged to 90% of their capacity. The process takes approximately 1 hour during which the red LED adjacent to the power pack connector stays on.
- Normal charge: charging is continuous and raises the battery to 100% capacity. This phase takes no longer than an hour and the red LED stays off.
- Trickle charge: A trickle current maintains the battery at its 100% capacity.

It generally takes 2 hours for the battery to charge completely. The red LED turns off when the battery is recharged at 90%, so the charging should continue for a further hour after the LED turning off. The instrument should not be left too long with the battery discharged since this will affect the functioning of the internal clock and will cancel the biasing of the NO sensor. Should this happen, it is recommended to carry out a 12 hour battery recharge and to allow the sensor the necessary adjustment time, as explained in point 9 of section 5.8. It is important not to leave the power supply connected for more than 12 hours in order not to damage the internal backup battery, responsible of correct working of the clock and the NO sensor biasing.

3.2.1 Battery check and replacement

The status of the internal battery can be checked during instrument auto-calibration or even after, if necessary, by pressing the information key **i** and accessing the “battery capacity” submenu. The menu displays the battery’s residual capacity and voltage. If battery charge appears to be low, let it discharge completely and then carry out a full 100% charge cycle by connecting the instrument to the power pack for 2 hours. If the problem persists, replace the battery pack with a SEITRON original or contact the SERVICE CENTRE to carry out the necessary repairs.

3.2.2 Use with external power pack

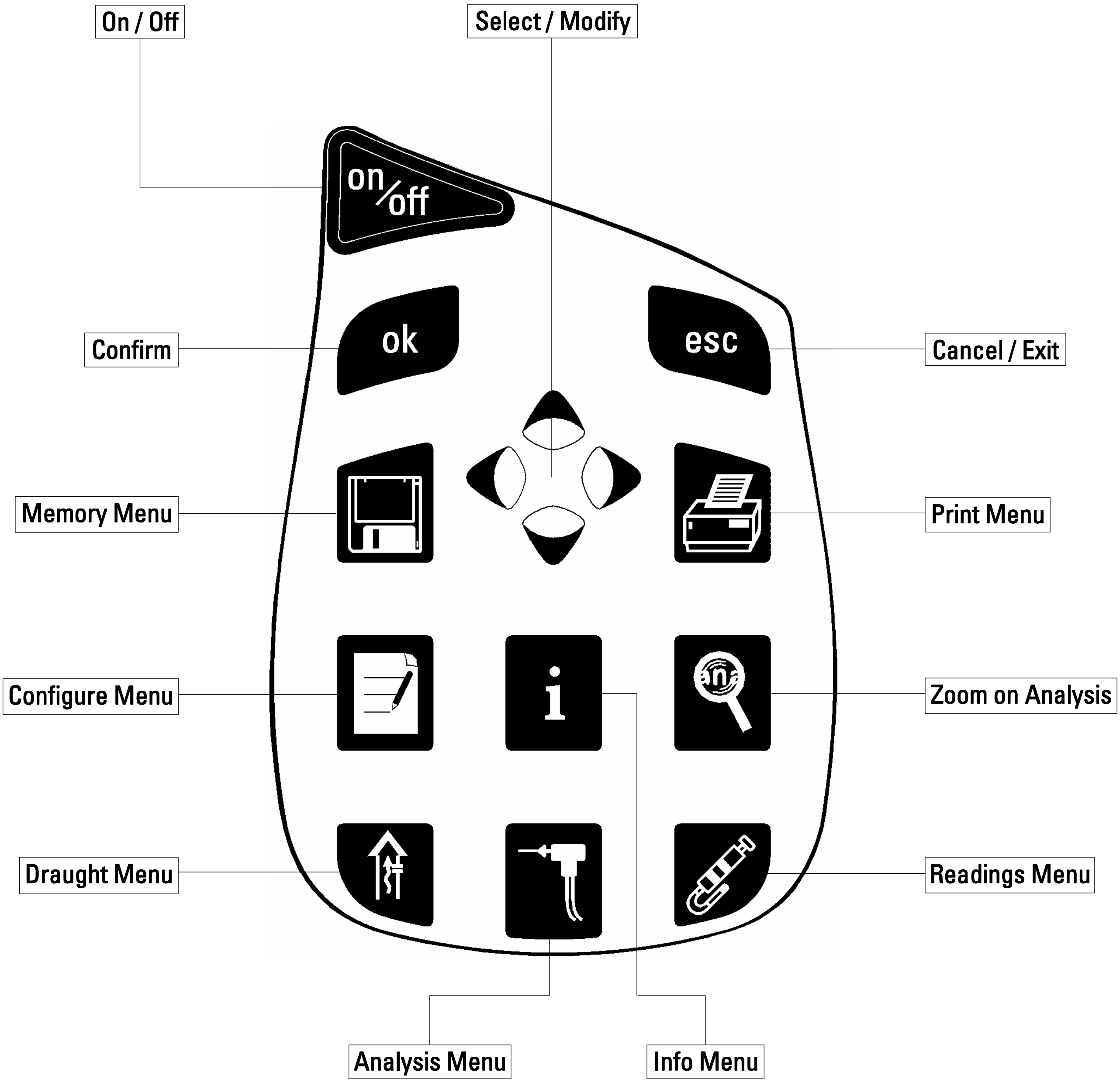
The instrument can work with the batteries fully discharged by connecting the external power pack provided.
Kindly note that while the battery is charging, some heat is generated which increases the instrument’s internal temperature. This may lower the accuracy of some readings. The air temperature must be measured using the air temperature probe since the internal sensor might lie at a different temperature with respect to ambient.
CAUTION: Before connecting the power pack to the mains check that the voltage data shown on the data plate corresponds with that provided. If the instrument is damaged as a result of it being connected to a voltage other than that specified, the warranty shall cease to be valid.

3.3 Connecting the sample probe

The sample probe consists of a stainless steel pipe with plastic handgrip and internal Type K thermocouple (Ni-NiCr) for measuring flue gas temperatures as high as 800°C.
The probe is connected to the analyser through two flexible hoses, a filter unit and a compensated cable for the thermocouple. Connect the polarised connector of the thermocouple to the relative socket on the right hand side of the instrument. The connector cannot be inserted wrongly thanks to different attachment widths. Slip the shorter hose into the filter unit (particulate/water trap) and connect the filter unit to the main connector on the instrument, marked “A”.
The longer of the two hoses (terminated with a male connector) must be connected to the negative pressure input of the instrument, which is marked with letter 'P-'. The connectors have different diameters to prevent erroneous connection, preventing the user from damaging the instrument.

4.0 OPERATION

4.1 Keypad overview



WARNING: to turn-on / off the instrument it is necessary to press and hold the On/Off button for at least 2 seconds.

4.2 Info Menu

This menu provides information regarding instrument status:

Battery capacity:
Shows the status of the internal battery.
The battery charge status is shown graphically and in text as a percentage between 0 and 100%, together with the battery voltage.

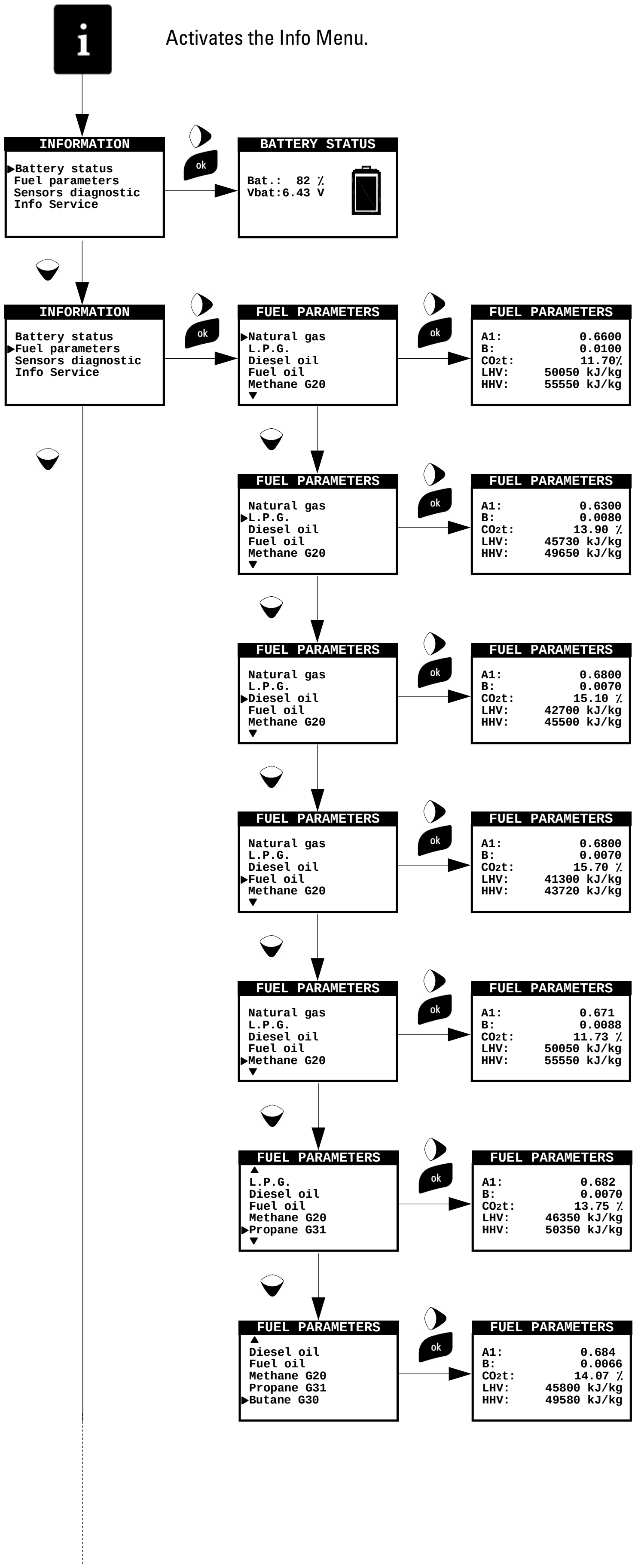
Fuel coefficients:
Shows the characteristic parameters for each of the fuels used in the calculation of the combustion efficiency.

Sensor diagnostics:
This displays useful information about the internal sensors and about instrument calibration.
The status of each of the internal gas sensors is shown, allowing rapid diagnosis to be carried out if these are generating some form of error.
Information regarding each gas sensor is contained in the relative submenu and includes: the type of sensor, the serial number and the actual current measured by the instrument.

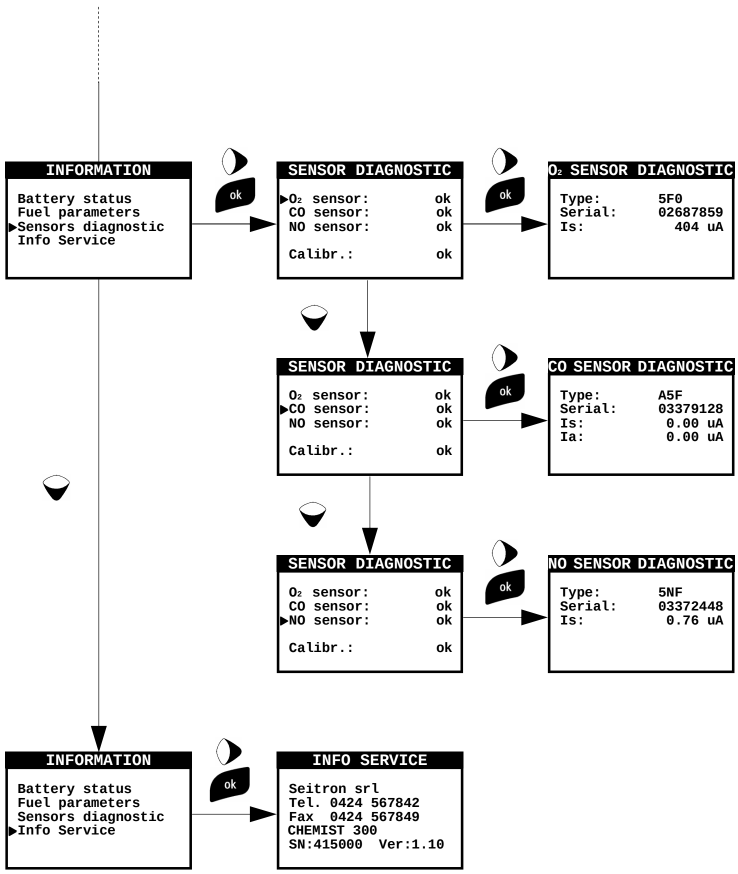
Info service:
This submenu contains details regarding the nearest service centre to be contacted in the event of breakdown or maintenance. The instrument model, serial number and firmware version are also displayed, permitting rapid product identification.

The Flow Chart in the following page shows how to browse through the Info Menu screens.

4.2.1 Flow Chart - Info Menu



To return to the previous screen, press esc.


INFORMATION
Battery status
Fuel parameters
▶Sensors diagnostic
Info Service
ok
SENSOR DIAGNOSTIC
▶O_2 sensor: ok
CO sensor: ok
NO sensor: ok
Calibr.: ok
ok
O_2 SENSOR DIAGNOSTIC
Type: 5F0
Serial: 02687859
Is: 404 uA
SENSOR DIAGNOSTIC
O_2 sensor: ok
▶CO sensor: ok
NO sensor: ok
Calibr.: ok
ok
CO SENSOR DIAGNOSTIC
Type: A5F
Serial: 03379128
Is: 0.00 uA
Ia: 0.00 uA
SENSOR DIAGNOSTIC
O_2 sensor: ok
CO sensor: ok
▶NO sensor: ok
Calibr.: ok
ok
NO SENSOR DIAGNOSTIC
Type: 5NF
Serial: 03372448
Is: 0.76 uA
INFORMATION
Battery status
Fuel parameters
Sensors diagnostic
▶Info Service
ok
INFO SERVICE
Seitron srl
Tel. 0424 567842
Fax 0424 567849
CHEMIST 300
SN:415000 Ver:1.10

4.3 Configure Menu

This menu is used to configure the instrument's reference parameters described below:

Fuel:
Lets the user select the type of fuel to be used during analysis. This datum can be varied either from this menu or during the analysis itself.

Units of measurement:
Through this submenu the user can modify the units of measurement for all the analysis parameters, depending on how they are used.

O_2 Reference:
In this mode the user can set the oxygen percentage level to which pollutant emission values detected during analysis will be referenced.

Display contrast:
The display contrast may be increased or decreased by acting on cursor keys ◐◓◑◒. This operation may be performed even when the introductory screen is active.

Automatic analysis:
The user can set analysis mode to either manual or automatic.
In manual mode the user performs the three necessary analysis operations manually. In automatic mode the cycle duration for each reading must also be set - in this case the instrument will conduct each analysis in the specified time.
Printing may also be manual or automatic. If "auto" printing is selected, the instrument will automatically print the analysis report in a predetermined format at the end of the automatic analysis.
If ' auto ' printing is selected also at the end of a tightness test a report will be printed automatically.

Condensation
The burner efficiency figure when condensation takes place is influenced by atmospheric pressure and humidity of the combustion air. As the atmospheric pressure is hardly precisely known, the operator is asked to enter a related parameter, i.e. the altitude of the place above the sea level, from which the pressure is then derived once the dependency from atmospheric conditions is neglected. In calculations the value of 101325 Pa is assumed as atmospheric pressure at sea level. Further the air relative humidity input is allowed, being this calculated at the combustion air temperature as measured from the instrument; in case this value is unknow the operator is recommended to enter 50% for this value.

Clock:
This allows the current time and date to be set. The user can select the date and hour format either in EU (European) or USA (American) mode.

Alarms:
This submenu allows the user to set and memorise 5 alarms, defining the monitored parameter for each, the alarm threshold and relative unit of measurement and whether it is a low or high-level alarm.
Low-level alarms are triggered when the reading drops below the defined threshold, whereas high-level alarms are triggered when the reading rises above the defined threshold. When an alarm threshold is crossed, the instrument emits an intermittent audible alarm besides activating a visible alarm wherein the background of the name of the relative reading will start flashing in the analysis screen. When the CO and NO concentration thresholds are crossed, besides activating the audible and visible alarms, the CO and NO solenoid valves may also be set to intervene and thereby interrupt sample flow. If the instrument is not fitted with a solenoid valve, the sample pump will in any case be stopped.

Auto-calibration/Pump:
This submenu is used to set the duration of the analyser auto-calibration cycle. It may also be used to switch off or switch on the sample pump temporarily. The sample pump cannot be switched off if the auto-calibration cycle is under way.

Test operator:
The name of the operator conducting the analysis may be set or modified through this submenu. A maximum of three names may be stored. The name of the selected operator will be printed on the analysis report.

Printout heading:
This allows the Company or Owner's name to be entered in four lines with 24 characters each, together with other details (e.g. address, tel. no.). This data will be printed on the heading of the analysis report.

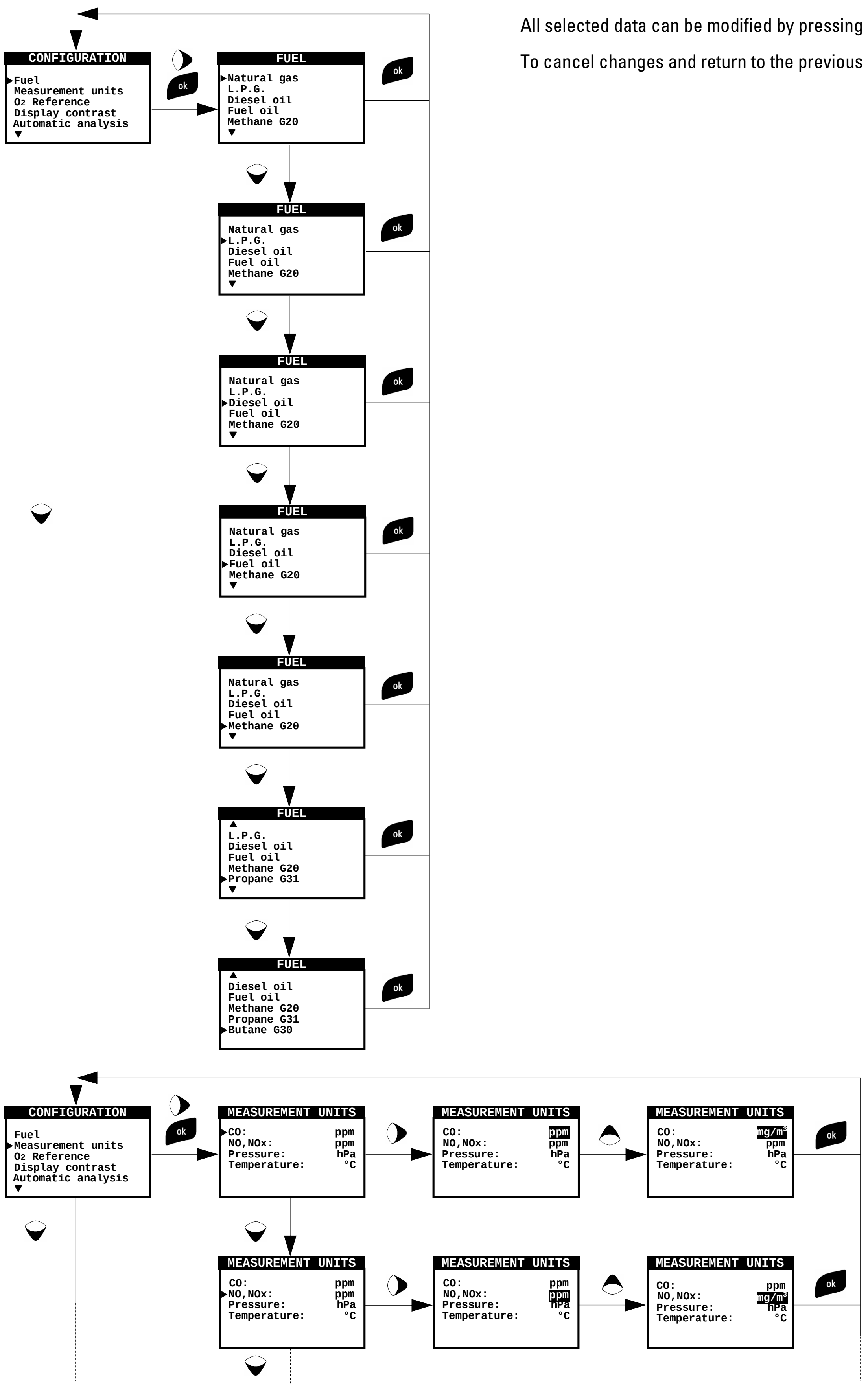
Micromanometer
Allows to configure the micromanometer input (optional) as P+ or P– port. In case P– is selected, the sign of pressure is inverted.

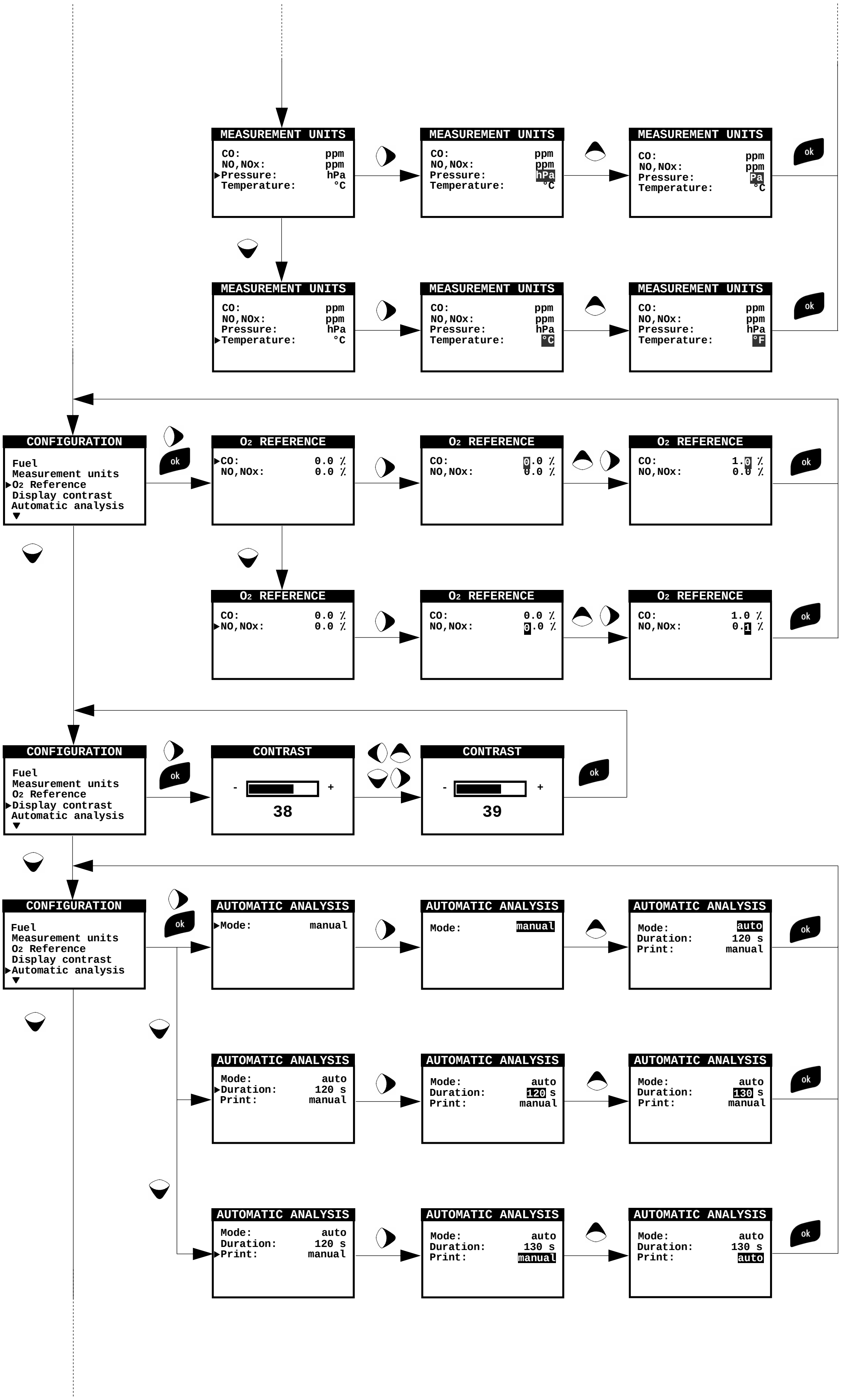
4.3.1 Flow Chart - Configure Menu

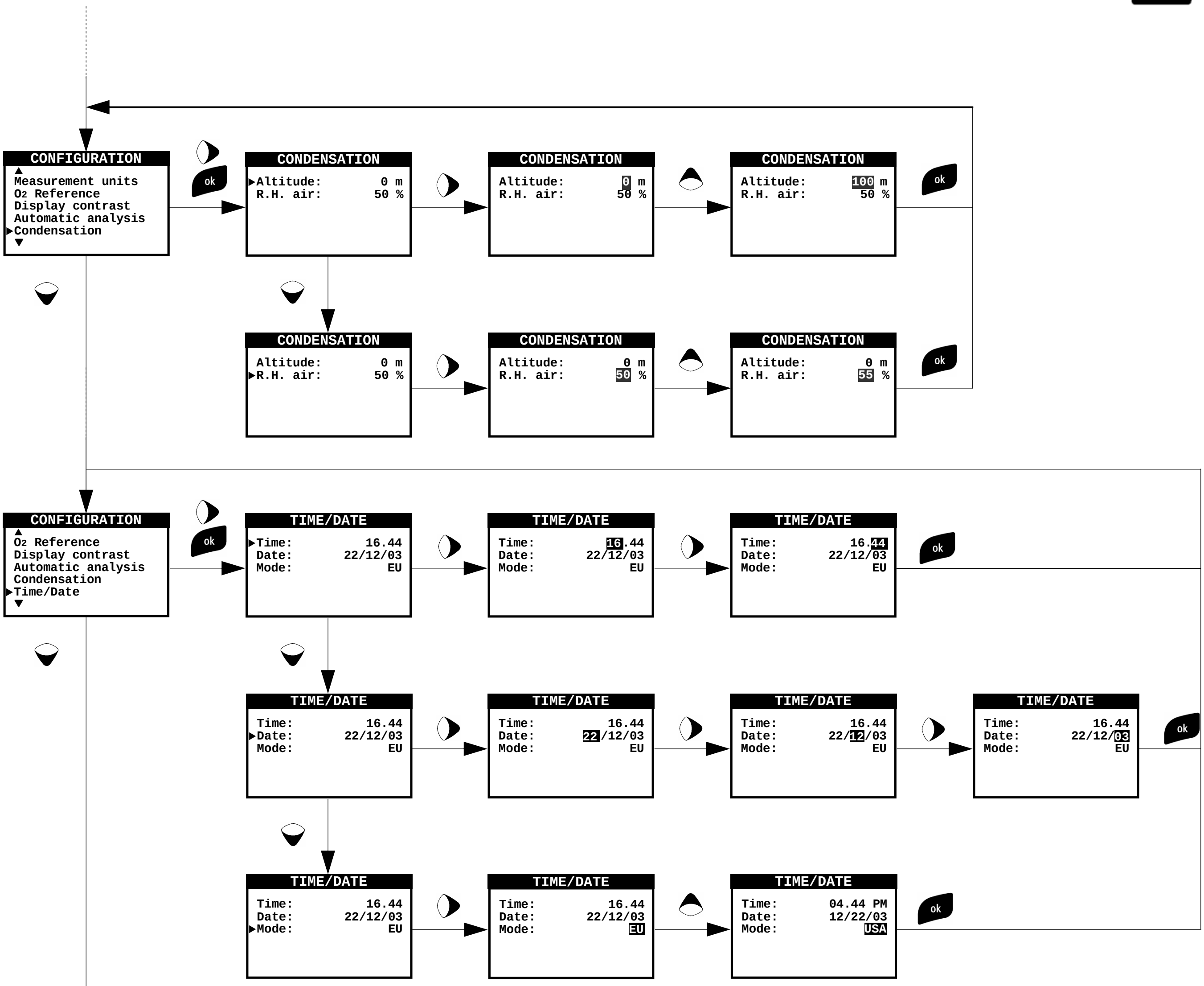
Activates the Configure Menu.

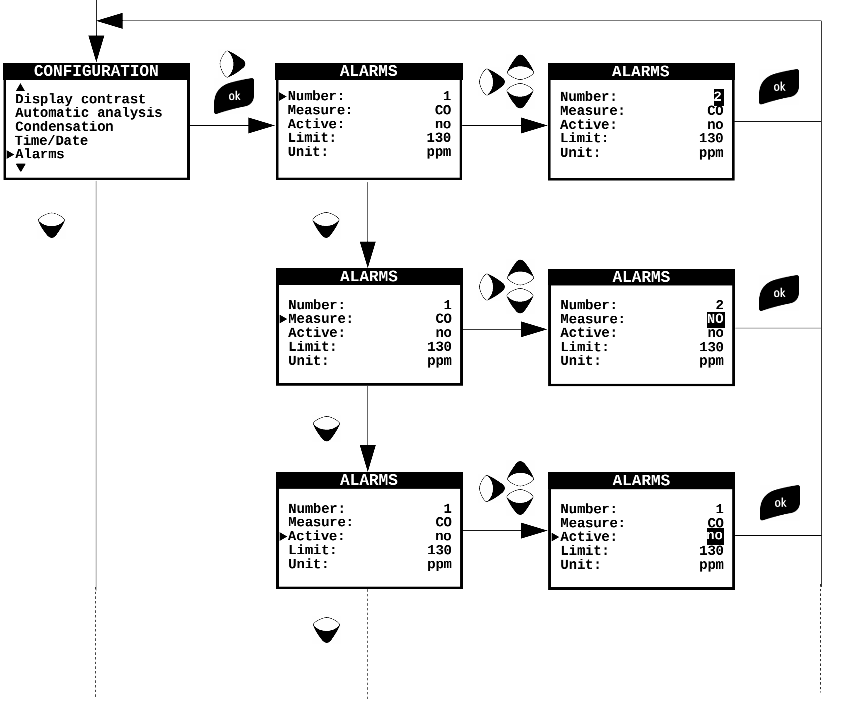
All selected data can be modified by pressing cursor keys.

To cancel changes and return to the previous menu press esc.




MEASUREMENT UNITS
CO: ppm
NO,NOx: ppm
Pressure: hPa
Temperature: °C
Pa
°F
ok
CONFIGURATION
Fuel
Measurement units
O2 Reference
Display contrast
Automatic analysis
O2 REFERENCE
CO: 0.0 %
NO,NOx: 0.0 %
CO: 1.0 %
NO,NOx: 0.1 %
CONTRAST
- +
38
39
AUTOMATIC ANALYSIS
Mode: manual
Mode: auto
Duration: 120 s
Print: manual
Duration: 130 s
Print: auto





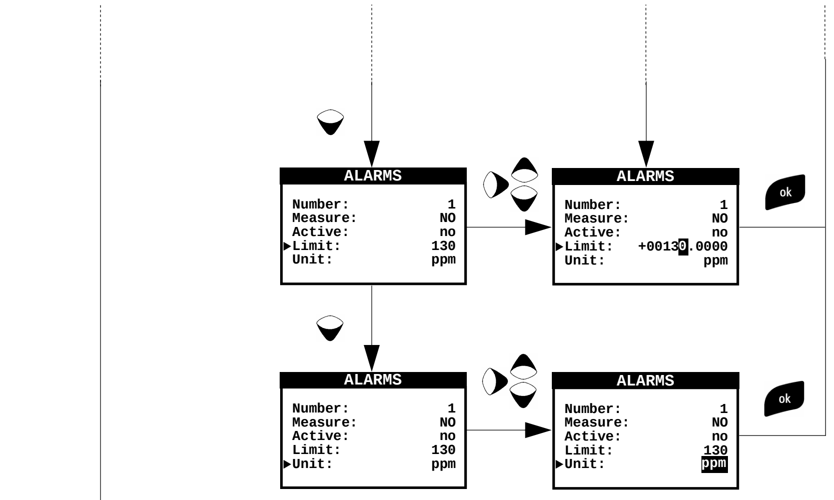
Select the figure to be modified with the keys ▼ ▲.
Modify the value of the highlighted figure with keys ◄ ►.

The values that can be selected with the ▼ ▲ keys for this parameter are:

CO, CO sv, NO, NO sv, O_2, P, Tf, Ta.

The values that can be selected with the ▼ ▲ keys for this parameter are:

maximum, minimum, no.



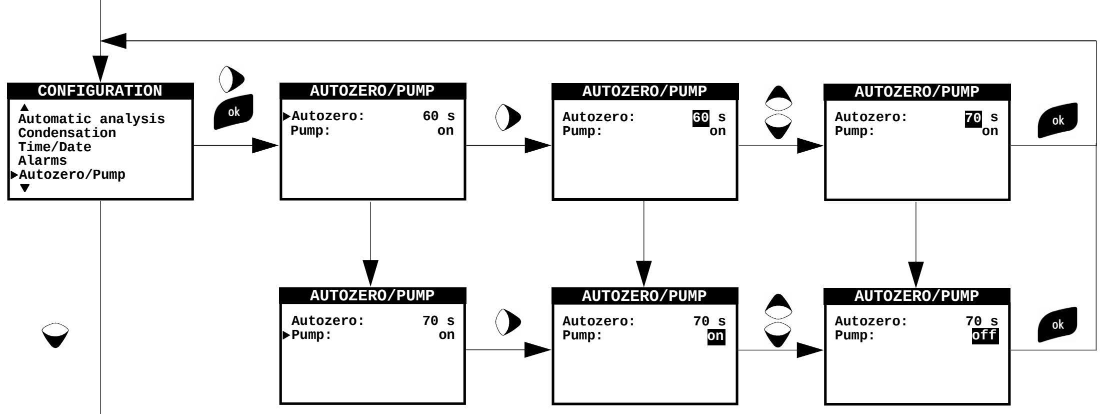
The alarm threshold values can be set via the keys within the following range:

- 99999.999 to + 99999.99

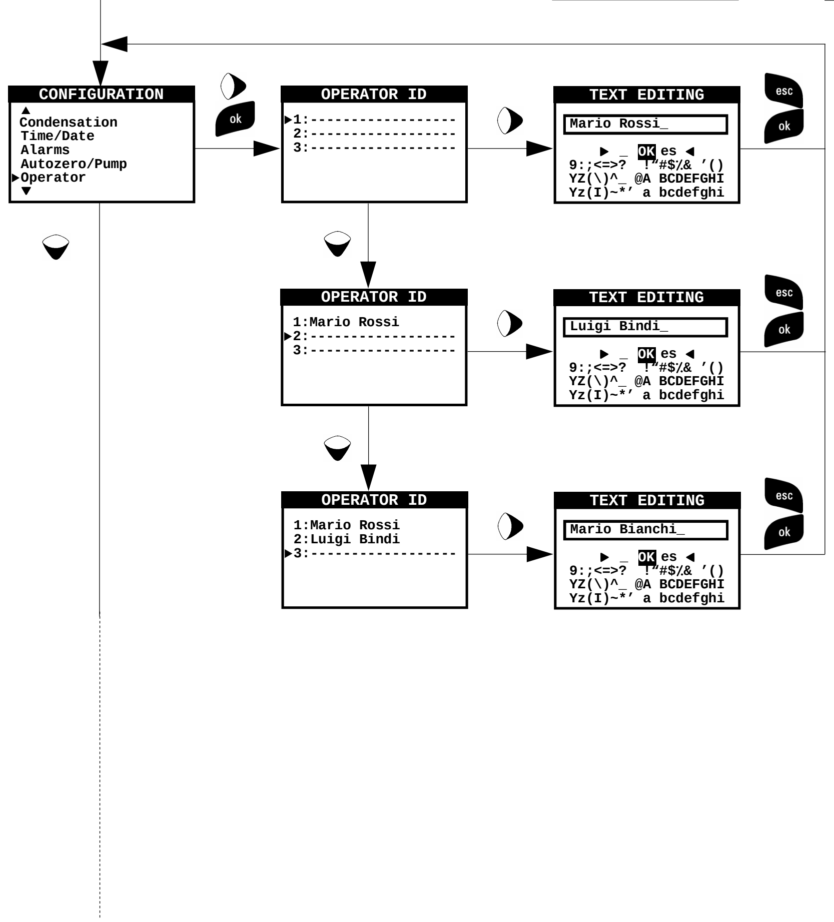
(the value is referred to the unit of measurement set) maximum, minimum, no.

The values that can be selected with the keys for this parameter are:

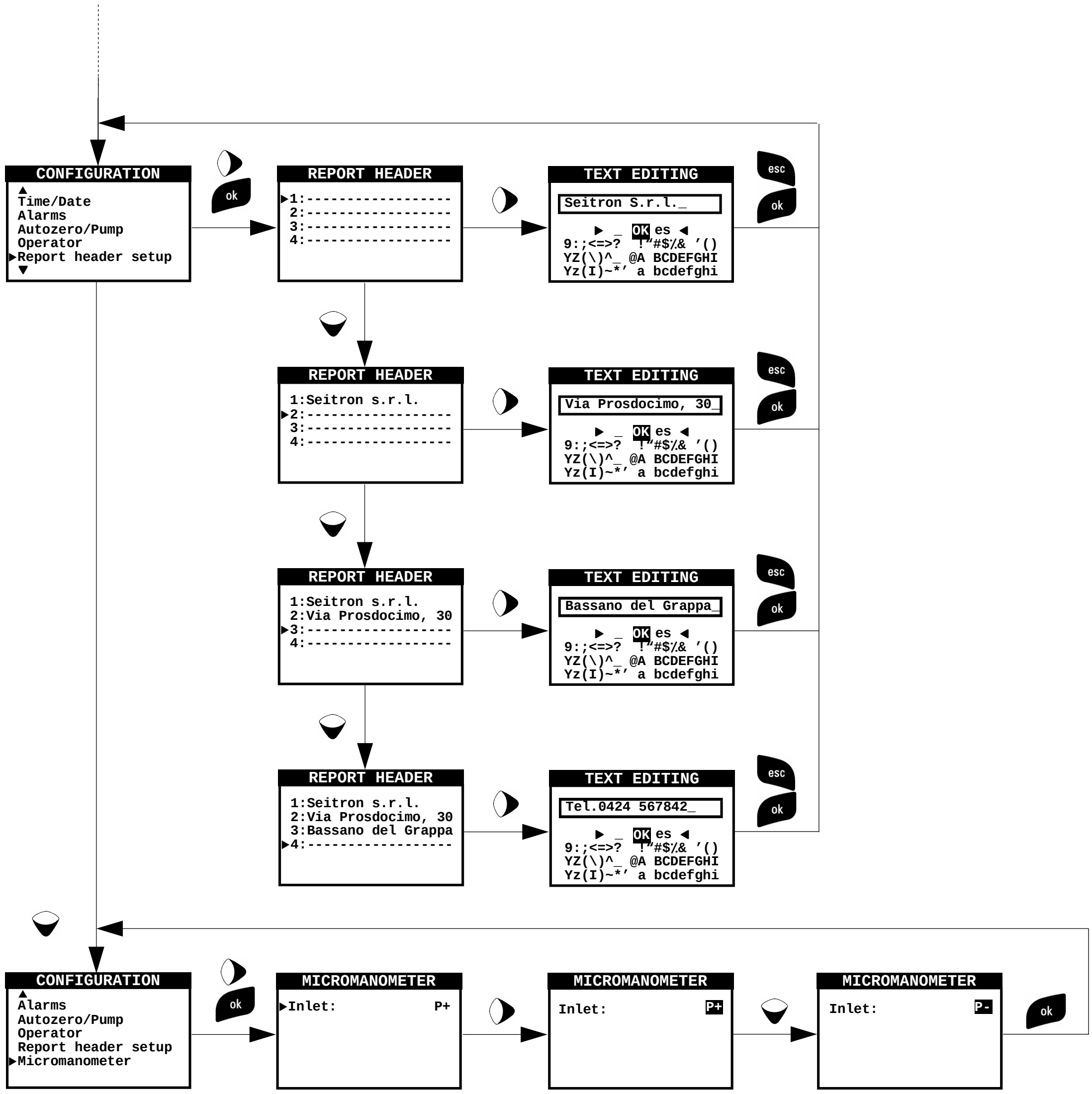
ppm, mg/m³, mg/kWh, g/GJ, g/m³, g/kWh,% .



Note:
The pump cannot be switched off during auto-calibration.
If auto-calibration has not been performed the pump cannot be switched on.



Use the “EDIT TEXT” function as follows:
Using the cursor keys, go to the box that corresponds to the letter or number required to form the desired word, and press 'ok' to confirm.
When you have finished striking in the desired text, still using the cursor keys, go to 'ok' to confirm the entered data or to 'esc' to exit without saving, and press the relative 'ok' or 'ok' button. The task is done.
If you wish to modify a letter or a whole line, all you need to do is position the cursor in front of the letter to be cancelled by means of the cursor keys in the first row of controls.
At this point go to the second row of controls and press the Esc key on the keypad. In this way the letter preceding the cursor can be cancelled, after which the desired text can be entered or the user can confirm and exit.



CONFIGURATION
Time/Date
Alarms
Autozero/Pump
Operator
▶Report header setup
ok
REPORT HEADER
▶1:------------------
2:------------------
3:------------------
4:------------------
TEXT EDITING
Seitron S.r.l._
▶ _ OK es ◀
9:;<=>? !"#$%& '()
YZ(\)^_ @A BCDEFGHI
Yz(I)~*' a bcdefghi
esc
ok
REPORT HEADER
1:Seitron s.r.l.
▶2:------------------
3:------------------
4:------------------
TEXT EDITING
Via Prosdocimo, 30_
REPORT HEADER
1:Seitron s.r.l.
2:Via Prosdocimo, 30
▶3:------------------
4:------------------
TEXT EDITING
Bassano del Grappa_
REPORT HEADER
1:Seitron s.r.l.
2:Via Prosdocimo, 30
3:Bassano del Grappa
▶4:------------------
TEXT EDITING
Tel.0424 567842_
CONFIGURATION
Alarms
Autozero/Pump
Operator
Report header setup
▶Micromanometer
MICROMANOMETER
▶Inlet: P+
MICROMANOMETER
Inlet: P+
MICROMANOMETER
Inlet: P-

4.4 Memory Menu

This menu is used to display and print individual and average values of the analysis data stored in memory.
Analysis data can be ordered either by memory position or by storage date; draught and smoke values can also be recalled. The Print Menu is enabled in both the analysis screen and draught and smoke level screen within the "Recall Memory" menu.

Save analysis:
This submenu displays the current active MEMORY and the data stored within, and allows the user to record new values or to overwrite them if these are already present and complete.

Display average:
Displays the average of the analysis data stored in the active memory.

Select memory:
Allows the user to select the memory within which to record any effected analyses or other data such as draught, smoke and ambient CO (NO) values. When the menu is accessed a preview of all saved data will appear.

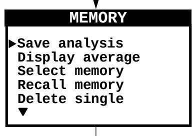
Recall memory:
This menu, just like the previous one, lets the memory be selected on the basis of the stored position or storage date, thereby letting all stored data be displayed (individual and average readings, draught, smoke and ambient CO (NO) values).

Delete single:
Allows the user to erase the data stored for a single memory. A confirmation is required in order to avoid an accidental loss of the formerly stored data.

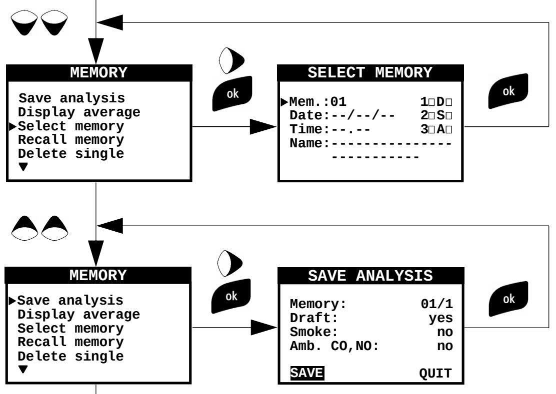
Delete all:
This is used to cancel the entire contents of the 99 memory positions; even for this option a confirmation is required in order to avoid an accidental loss of the formerly stored data.

4.4.1 Flow Chart - Memory Menu

Activates the Memory Menu. This menu is used to display and print the individual and average values of the analysis data stored in memory. Analysis data can be ordered either by memory position or by storage date; draught, smoke and ambient CO (NO) values can also be recalled. Inside the "Recall Memory" menu, the Print Menu is only enabled in the analysis screen or in the draught, smoke and ambient CO (NO) values screen.



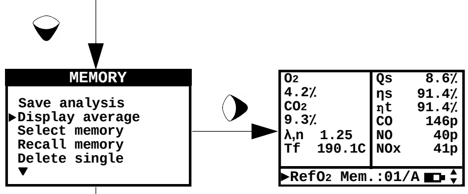
Standard UNI 10389-1 stipulates that the combustion efficiency has to be calculated on the basis of the average values of three readings. Three tests must therefore be memorised.



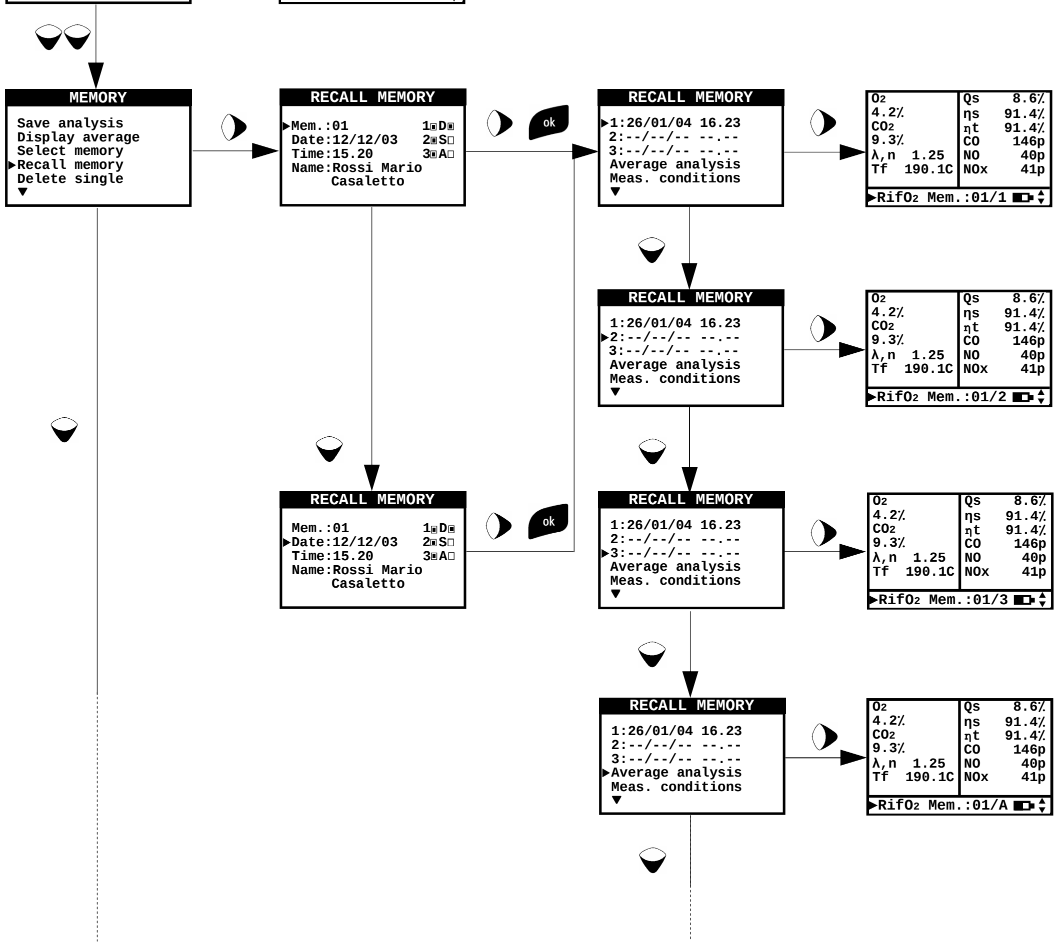
There are 99 storage areas, each of which is capable of storing three test records besides draught, smoke and ambient CO (NO) values. The memory can also be selected from the "Configure Analysis" menu.

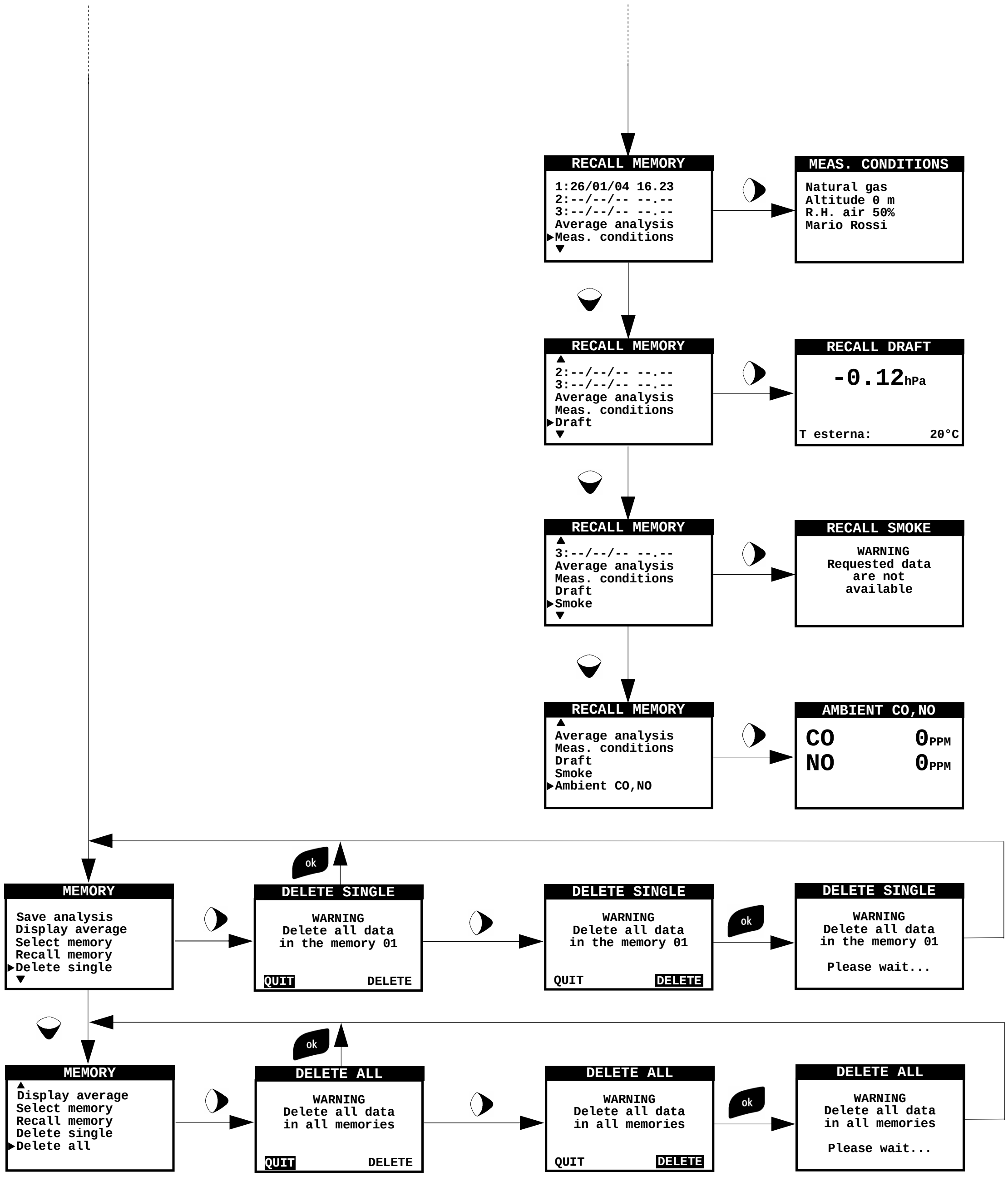
The name of the plant can be entered in the "Select Memory" menu by pressing the right cursor key in the "Name" field.

Analysis data is saved by pressing 'ok' with the MEMORISE option highlighted in the background. If draught, smoke and ambient CO (NO) values have been measured these are also memorised.



Once a series of test records has been memorised, the user can ask the instrument to display the average value. The relative analysis report can then be printed via the Print Menu.




RECALL MEMORY
1:26/01/04 16.23
2:--/--/-- --.--
3:--/--/-- --.--
Average analysis
Meas. conditions
MEAS. CONDITIONS
Natural gas
Altitude 0 m
R.H. air 50%
Mario Rossi
RECALL MEMORY
2:--/--/-- --.--
3:--/--/-- --.--
Average analysis
Meas. conditions
Draft
RECALL DRAFT
-0.12hPa
T esterna: 20°C
RECALL MEMORY
3:--/--/-- --.--
Average analysis
Meas. conditions
Draft
Smoke
RECALL SMOKE
WARNING
Requested data
are not
available
RECALL MEMORY
Average analysis
Meas. conditions
Draft
Smoke
Ambient CO,NO
AMBIENT CO,NO
CO 0PPM
NO 0PPM
MEMORY
Save analysis
Display average
Select memory
Recall memory
Delete single
ok
DELETE SINGLE
WARNING
Delete all data
in the memory 01
QUIT DELETE
DELETE SINGLE
WARNING
Delete all data
in the memory 01
QUIT DELETE
ok
DELETE SINGLE
WARNING
Delete all data
in the memory 01
Please wait...
MEMORY
Display average
Select memory
Recall memory
Delete single
Delete all
ok
DELETE ALL
WARNING
Delete all data
in all memories
QUIT DELETE
DELETE ALL
WARNING
Delete all data
in all memories
QUIT DELETE
ok
DELETE ALL
WARNING
Delete all data
in all memories
Please wait...

4.5 Print Menu

This menu is used to access the following print and check configurations:

Print analysis report:
Shows the details of the selected ticket type and allows to start printing.

Configure Print:
Allows to set the number of printed copies and layout of the ticket. The ticket layout selection is only valid for combustion analysis and can be chosen among Complete, Partial and Total. Tickets for draught, smoke, ambient gas concentration and tigthness test only allow a specific layout. Layouts for combustion analysis are specified as described in the following:

Full: includes a header with company data as well operator data previously programmed in the configuration menu, measurements sampled in the combustion analysis and, when sampled, the draught, smoke and CO - NO ambient gas values.

Partial: only reports the combustion analysis measurement values and informations, without any header, comments or blank lines for operator comments.

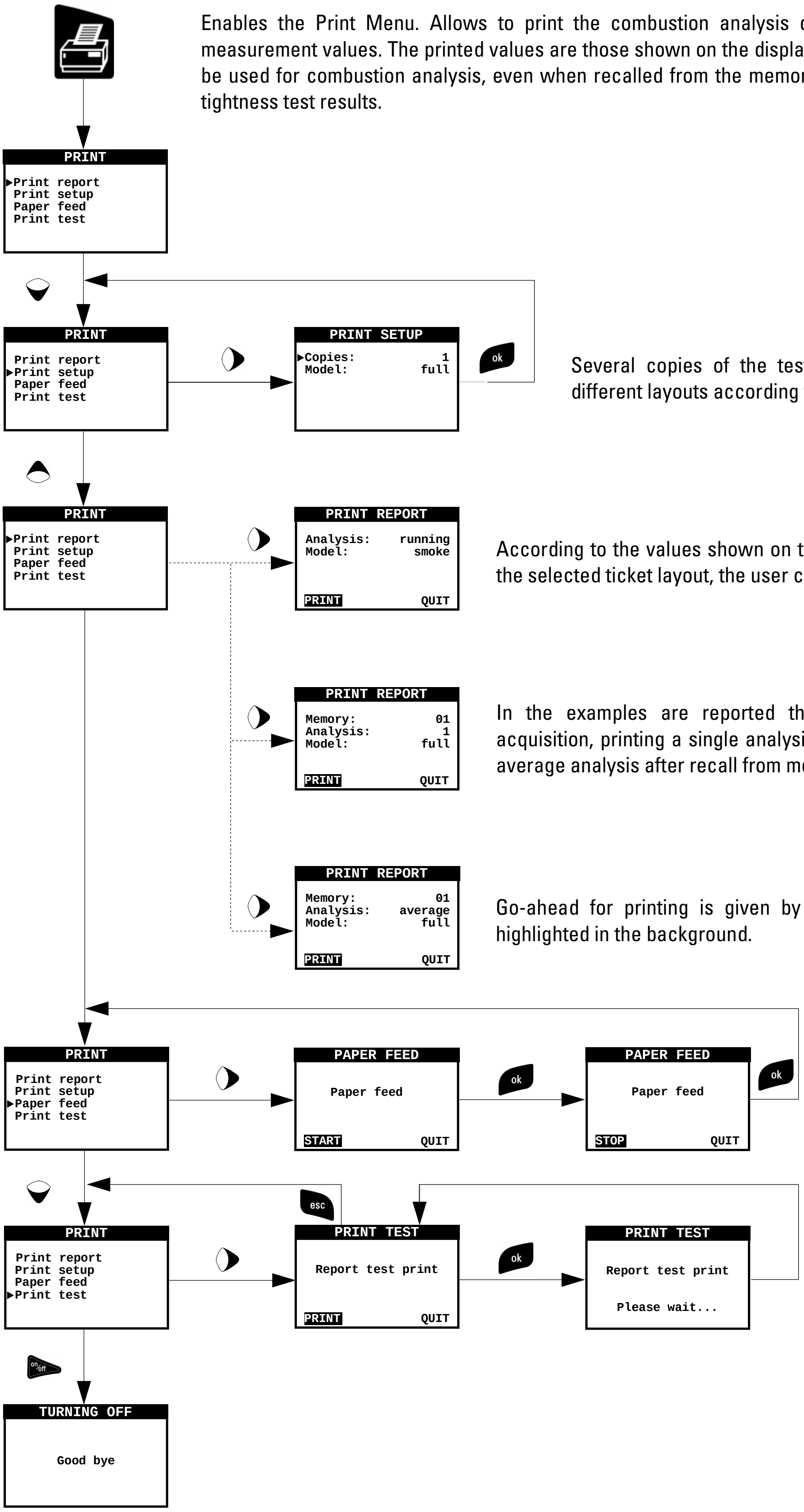
Total: is arranged with the complete layout of the average analysis followed by the single analysis measurements report.

Advance paper:
Feeds paper in the printer; this function is most useful when replacing the paper roll in the printer.

Trial print:
Prints a graphical/alphanumeric test ticket for a complete check of the printer operation.

4.5.1 Flow Chart - Print Menu

Enables the Print Menu. Allows to print the combustion analysis data on a paper ticket which reports the measurement values. The printed values are those shown on the display when the menu is enabled. This menu can be used for combustion analysis, even when recalled from the memory, for draught, smoke, ambient gas and for tightness test results.



Several copies of the test ticket can be printed, choosing among different layouts according to the informations included.

According to the values shown on the display when the menu is activated and the selected ticket layout, the user can choose among different models.

In the examples are reported the cases of printing the analysis under acquisition, printing a single analysis after recall from memory and printing an average analysis after recall from memory.

Go-ahead for printing is given by pressing ' ok ' with the PRINT option highlighted in the background.

4.6 Analysis Menu

Through this key the analysis results are displayed. Moreover the operator is allowed, once this key is further depressed, to display and possibly modify the analysis parameters before proceeding with the measurements.

Measured values are:

O_2 : Oxygen content (%) in flue gases.
CO: Carbon monoxide concentration in flue gases.
NO: Nitrogen monoxide concentration in flue gases.
Tf : Flue gases temperature.
Ta : Combustion supply air temperature.

Calculated values are:

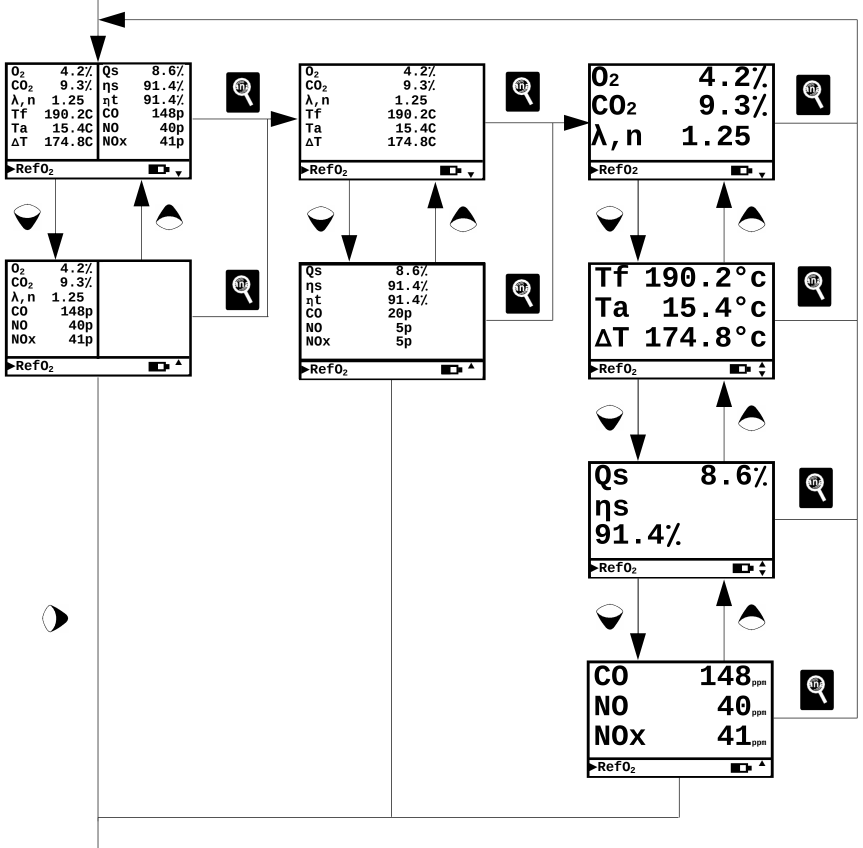
λ,n : Excess air, i.e. ratio between the effectively supplied combustion air volume and the ideal stoichiometric (theoretical) value.
CO_2 : Carbon dioxide content (%) in flue gases.
ΔT : Difference between flue gases temperature and combustion supply air temperature.
NOx: Nitrogen oxides concentration in flue gases.
Qs: Percentage of heat lost through the stack.
ηs: Sensible efficiency. This is the burner efficiency calculated according to the UNI 10389-1 standard, as ratio between the conventional heating power and the burner heating power. Among the combustion losses, only the sensible heat lost with the flue gases is taken into account, thus neglecting the radiation losses and incomplete combustion losses; this value is referred to LHV (Lower Heating Value) and cannot be higher than 100%.
The sensible efficiency value is to be compared against the minimum efficiency stated for the heating systems performances.
ηt: Total efficiency. It is the sum of sensible efficiency and the additional efficiently deriving from the recovery of water vapour condensation contained in the flue gasses, calculated according to the UNI 10389-1 standard. When it is greater than sensible efficiency, then condensation is taking place. It is referred to LHV (Lower Heating Value) and can exceed 100%.

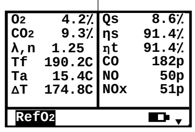
4.6.1 Zoom Menu

This menu can only be accessed when the analysis screen is displayed. This key is used to view the test data on a complete list or multi-page list or to zoom in on displayed text for better reading.

4.6.2 Flow Chart - Analysis Menu

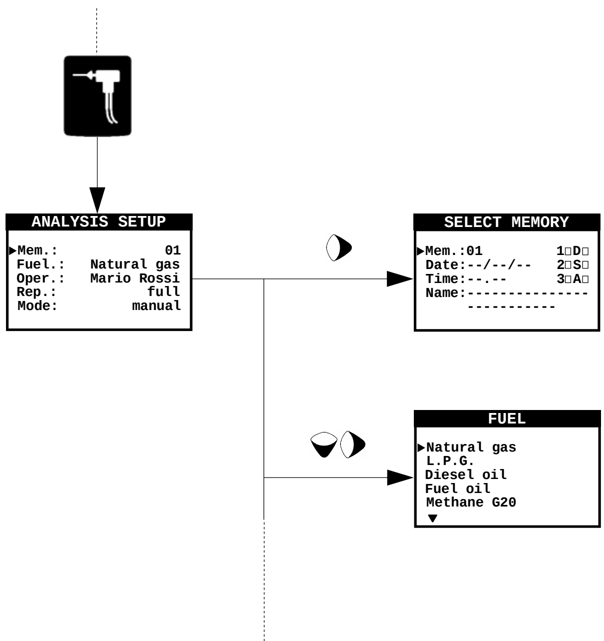
Activates the Analysis Menu.





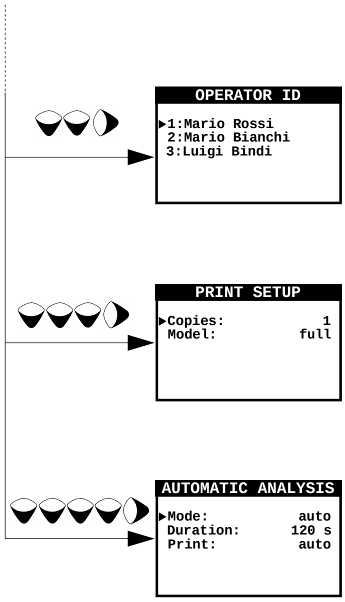
For each of the screens until now shown the display in 'O_2 reference mode' (RefO_2 is highlighted) can be activated by pressing the key.

By pressing the Analysis key once more, and starting from any of the above screens, the user may proceed as follows:



Select the memory wherein to store the acquired data.

Select the fuel of the plant being tested.



Select the test operator.

Setup the report printing, selecting the number of copies and the type of report to print.

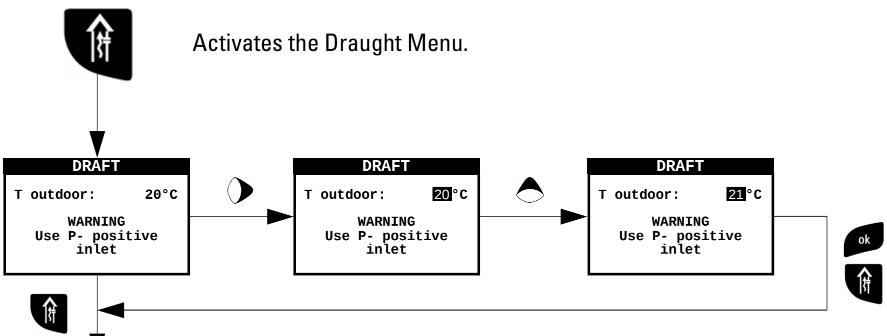
Select the analysis mode - automatic or manual. If automatic mode is selected, define the test time and print mode - automatic or manual.

4.7 Draught Menu

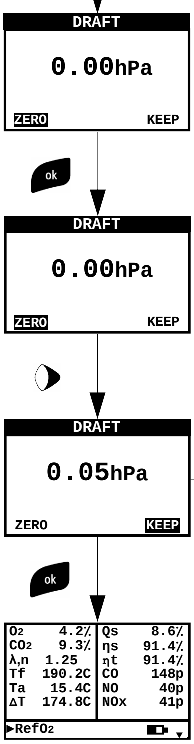
The DRAUGHT menu gives access to the chimney draught measurement. Being a negative pressure, in accordance with standard UNI10845, draught must be measured using the negative pressure input P-. The correct values for a natural draught boiler are therefore positive by definition. Before performing the measurement the instrument allows the user to input the external air temperature as required by the standard. Afterwards the measurement screen is reached: here the user can acquire the value displayed in order to add it to the running analysis measurements or, alternatively, print the relevant ticket through the 'PRINT' menu.

NOTE: The measurement may not be accurate due to condensation inside the fumes probe. Should you notice an inaccurate or unstable reading on the instrument, it is advisable to disconnect the fumes probe from the instrument itself, and purge pipes by blowing with a compressor. In order to be sure there is no humidity, it is suggested to perform the measurement by means of the transparent rubber pipe supplied on issue.

4.7.1 Flow Chart - Draught Menu

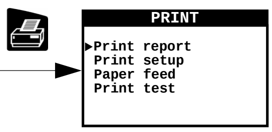


Connect the probe pressure input hose to the instrument P- input.
Enter the external air temperature.



Before starting the pressure zeroing sequence pay attention to remove the gas probe from the stack.

Pressure zeroing is accomplished by pressing ' ok ' with the ZERO option highlighted in the background.



Insert the probe in the chimney and measure the draught. In order to add the draught value to those of the ongoing analysis, please select KEEP through the right arrow key, then press ' ok '. For a printout of the ticket with the draught value, enable the PRINT menu through the relevant key, then proceed as in the combustion analysis printing. A draught value acquired into memory can be deleted by pressing again the 'draught' key: a series of dashes will appear in place of the measurement value; after this select the 'KEEP' option with ' ok '.

Once the data is stored, the instrument progresses automatically from the Draught Menu to the Analysis Menu.

NOTE: The draught values to be stored in the memory must be acquired before storing the analysis data.

4.8 Readings Menu

This menu is used to access the following readings:

Smoke:
One to three SMOKE values can be input through an optional external device (BACHARACH PUMP). The instrument then automatically calculates the average value of the input data. These measurements can be either stored in memory together with the combustion analysis data or printed on a ticket.

Ambient CO, NO:
This type of analysis lets the user measure the CO and NO values present in the environment, with the scope of checking the personal safety conditions of a specific working environment. The instrument leaves our factory with the following preset threshold values:

CO: 35 ppm Recommended exposure limit (REL) stipulated by the National Institute for Occupational Safety and Health (NIOSH), equivalent to 40 mg/m^3 and calculated as an 8-hour Time-Weighted Average (TWA).

NO: 25 ppm Recommended exposure limit (REL) stipulated by the National Institute for Occupational Safety and Health (NIOSH), equivalent to 30 mg/m^3 and calculated as an 8-hour Time-Weighted Average (TWA).

If, during these readings, the measured values exceed the established threshold values, the user will be warned by an audible alarm and the displayed values will start flashing. In this condition the keypad will block automatically until the alarm is acknowledged, the 'ok'/'esc' keys are pressed or until the measured values drop below the allowable limits.

Pressure:
It is possible, through the use of the external flexible pipe made in RAUCLAIR (supplied), to measure a pressure value within the range stated in the technical features (connect the pipe to P+ input). During the pressure measurement the 'HOLD' function is made available, which allows to 'freeze' the value shown on the display, by pressing 'HOLD' key.

Tightness test:
Chemist can perform the tightness test on heating plants which use combustible gases according to the standards UNI 7129 and UNI 11137-1, respectively applicable to new or renewed pipings and to existing pipings. The result of this tightness test, whose steps are described in the following, can be printed, once acquired, by starting the ' print menu ' in any of the screens of the ' Tightness Test ' menu.

New piping: UNI 7129 STANDARD
The standard UNI 7129 can be adopted for testing new piping systems or reconditioned ones. This test requires to charge the piping up to a pressure of at least 100 mbar, then wait for a stabilization time of at least 15 minutes required for nulling the thermal effects caused by the test gas compression and finally check for the tightness of the piping by analysing the way the pressure eventually decays against time. This check expects for no difference between two pressure readings performed in 15 minutes and with a manometer having a minimum resolution of 10 Pa.

Chemist allows the user to customize the stabilization phase through the following parameter:

WAIT TIME: it is the stabilization time and can be set by the user from 15 to 99 minutes. Please note that UNI 7129 standard requires a stabilization time of at least 15 minutes, anyway there is the possibility to skip stabilization by pressing 'ok' button.

Once the stabilization parameter has been set the user can proceed with the tightness test. Selecting the item 'Start Test', the test pressure required by the standard is shown, then a screen with actual pressure applied to the instrument inputs is displayed. After having zeroed the instrument and, subsequently, having charged the piping with at least 100 mbar, the tightness test can be started through the option 'TEST', which actually starts the stabilization phase. In the stabilization screen the following values are displayed:

P: Actual pressure measured by the instrument, in the selected measurement unit.
ΔP_1': Pressure variation in the last minute, updated every 10 seconds. This value gives a rough indication about the stabilization level reached in the piping system.
Wait time: Remaining time before the stabilization phase ends.

Once the stabilization phase is terminated the tightness test is started. This test is performed by observing how the pressure decays in time during a fixed 15 minutes interval, as stated in the applied standard.

During the tightness test phase the following values are displayed:

P1: Pressure measured at the beginning of the test.
P2: Pressure actually measured by the instrument.
ΔP: Pressure variation with respect to the initial value. In case the actual pressure is lower than the initial value (pressure is decreasing) this value has a negative sign.
Result: Reports the test result: **tight** when the pressure drop is greater than -10 Pa, **leak** when the pressure drop is smaller than -10 Pa. Positive pressure changes are symptom of a temperature change meanwhile the test is performed. Should this happen it is advisable to repeat the entire test.

Existing piping: UNI 11137-1 STANDARD
The standard UNI 11137-1 can be adopted for testing already existing internal piping systems. This test requires to charge the piping up to the test pressure, then wait for an unspecified stabilization time until the thermal effects caused by the test gas compression are nulled, and then calculate the amount of the possible leakage from the measure of the pressure decays in 1 minute time. The test pressure should be as close as possible as the reference conditions following explained.

REFERENCE CONDITIONS: According to the combustible gas to be used in the piping, the tightness test must be performed in one of the following reference conditions:

City gas:	Reference pressure for test with supply gas	1000 Pa
	Test pressure with air	5000 Pa
Natural gas:	Reference pressure for test with supply gas	2200 Pa
	Test pressure with air	5000 Pa
L.P.G.:	Reference pressure for test with supply gas	Standard to be defined Somebody proposes 5000 Pa
	Test pressure with air	Standard to be defined Somebody proposes 5000 Pa

Note: Chemist allows the user to perform the tightness test even with a combustible gas different from the supply gas. Anyway the reference standard does not provide a reference pressure in this situation, so the reference pressure is taken like test gas is the same. Test result should be considered only indicative.

Chemist allows the operator to customize the stabilization phase through the following parameter in the stabilization menu:

WAIT TIME: the stabilization phase duration can be set in the 1 .. 99 minutes range. As the UNI 11137-1 standard does not prescribe any stabilization duration, the factory setting for this value is borrowed from the UNI 7129 standard, which requires a minimum stabilization time of 15 minutes. The waiting can be interrupted any time by pressing the ' ok ' key, even in case the interval has not fully elapsed.

The tightness test performed according to the UNI 11137-1 standard requires the input of some data regarding the piping system and the test conditions, as described in the following.

PIPING VOLUME: An accurate tighness test performed according to the UNI 11137-1 standard requires to know the piping volume. Because this data if often unavailable, Chemist splits the test from the beginning into two different paths: the first is adequate for pipings having volume smaller than 25 dm^3 (liters); this is the most usual situation: in this case the volume value is not required because, through an 'overestimation' the piping is assumed as having a volume of 25 dm^3. The second path requires to input the piping value either directly through the keyboard when known, or by a calculation which takes into account the sum of the contributions due to each single pipe section or, finally, by measuring it through a simple procedure which requires the injection into the piping of a known gas quantity through a graduated syringe.
In case the volume calculation is used, for each single piping section the ‘Add tube’ option must be selected and then input the relevant material, nominal diameter and length. Chemist calculates the single section volume and adds it, when confirmed, to the total piping value. For error correction or for modifying the ongoing calculation the subtraction operation is also available.
When the 'Volume measurement' option is selected instead, the procedure, described also in the flow charts of the tightness test according to UNI 11137-1, is described in the following steps:

- Close both faucets in the kit assembly supplied for the test execution.
- Connect the graduated syringe to the hose which in the assembly is opposed to the pump.
- Open the faucet on the side where the syrynge is applied and withdraw exactly 100 ml (100 cc) of the gas present in the piping. Press the ' ok ' button.

- Inject the gas present in the syringe back into the piping and then close the faucet again.
- Wait for the pressure in the piping to stabilize. After a few seconds the instrument returns to the volume input screen in which the measured volume is shown. The proposed value can be accepted by pressing the ' ok ' button, modified through the arrow keys or rejected through the 'Esc' key.

COMBUSTIBLE GAS: consider that the amount of the leakage is strictly related to the nature of the gas under pressure. When the tightness of a piping has to be evaluated it is mandatory to specify the family to which the gas belongs: City Gas, Natural Gas or L.P.G..

TEST GAS: again the amount of the leakage is related to the nature of the gas under pressure, therefore it is mandatory to specify the type of the gas used: City Gas, Natural Gas, L.P.G. or air. Please note that the gas used for the test could also be different from the gas to be used in the plant and could even be a not flammable gas.

Once the stabilization parameter has been set the user can proceed with the tightness test. Selecting the item 'Start Test', the test pressure required by the standard is shown, then a screen with actual pressure applied to the instrument inputs is displayed. After having zeroed the instrument and, subsequently, having charged the piping to a pressure close to the reference values indicated, tightness test can be started through the option 'TEST', which actually starts the stabilization phase. In the stabilization screen the following values are displayed:

P: Actual pressure measured by the instrument, in the selected measurement unit.
ΔP_1': Pressure variation in the last minute, updated every 10 seconds. This value gives a rough indication about the stabilization level reached in the piping system.
Wait time: Remaining time before the stabilization phase ends.

Once the stabilization phase is terminated the tightness test is started. This test is performed by observing how the pressure decays in time during a fixed 1 minute interval, as stated in the applied standard. During the tightness test phase the following values are displayed:

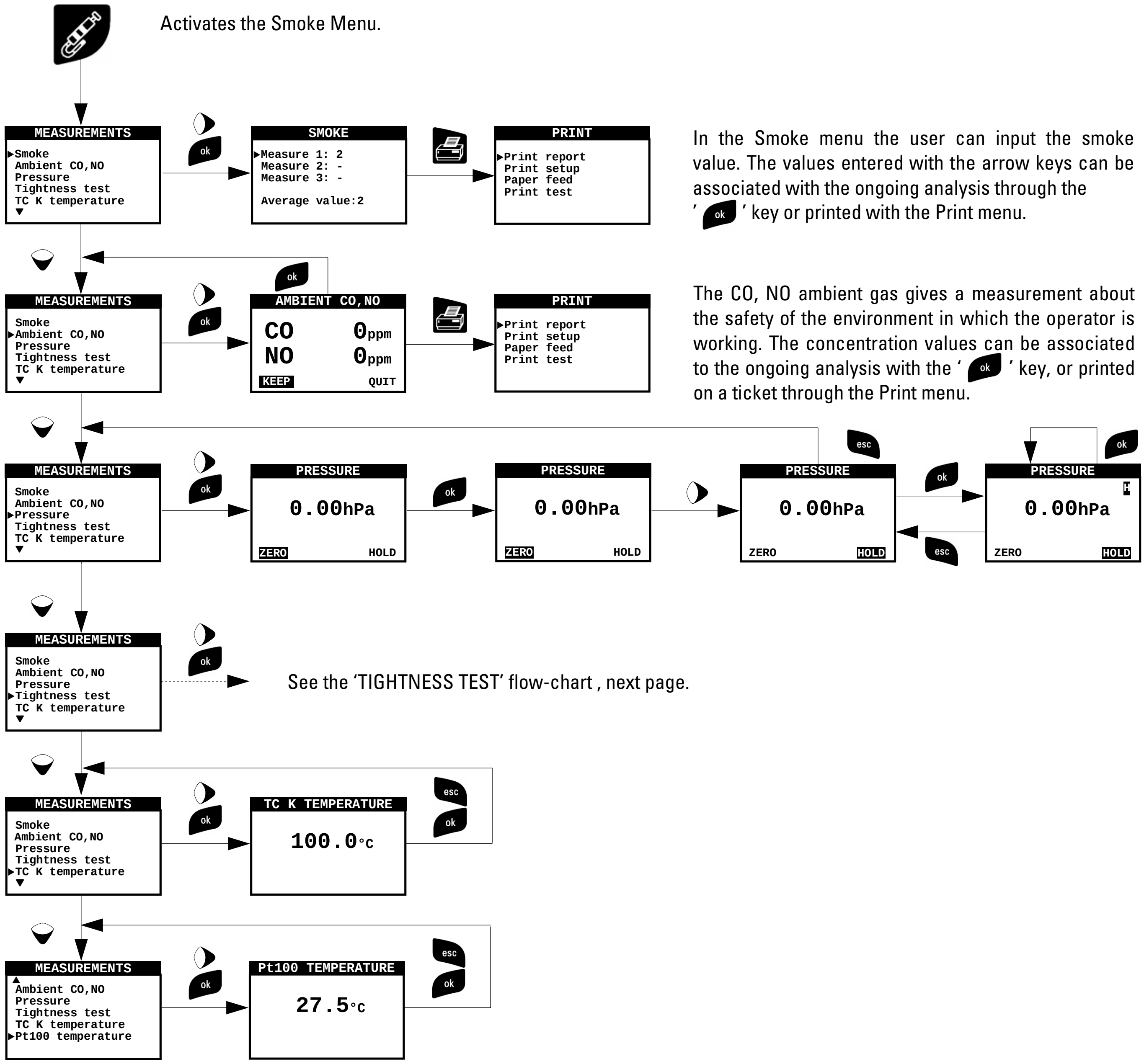
P_1: Pressure measured at the beginning of the test
P_2: Pressure actually measured by the instrument
ΔP: Pressure variation with respect to the initial value. In case the actual pressure is lower than the initial value (pressure is decreasing) this value has a negative sign.
Qtest: Is the calculated leakage measured in dm^3/h according to the conditions under which the test has been performed, i.e. the gas used for the test as well as the final pressure measured during the test.
Qref: is the calculated leakage measured in dm^3/h according to the reference conditions described in the standard, it is related to the gas to be used in the piping as well as to the reference pressure.
Result: is the result of the tightness test. **Compliant (piping suitable for operation):** when the leakage flow calculated in the reference conditions is lower than 1 dm^3/h. The system is authorized to operate wihtout restrictions or intervention. **Compl. 30 DD (piping temporarily suitable for operation):** when the leakage flow calculated in the reference conditions is included in the range 1 dm^3/h < Qrif < 5 dm^3/h. The system is authorized to operate only for the time needed for the maintenance of the pipe in order to fix the leakage problem, and in any case for no more than 30 days after the testing day. Once the fixing has been completed the piping must tested again for its tightness according to the UNI 7129 standard. **Non compliant (not suitable for operation):** when the leakage flow is greater than 5 dm^3/h. In this situation the measured leakage is such that the piping is not suitable for operation and must immediately placed out of order. Once the leakage problem has been fixed the piping must tested again for its tightness according to the UNI 7129 standard

TcK Temperature:
The user can measure the temperatures within the range specified in the technical specifications (e.g. plant delivery temperature) by using an OPTIONAL Type K thermocouple contact probe connected to the TcK input.

Pt100 Temperature:
The ambient temperature can be measured within the range specified in the technical specifications by connecting the remote air temperature probe provided with the instrument to the Pt100 input.

4.8.1 Flow Chart - Readings Menu

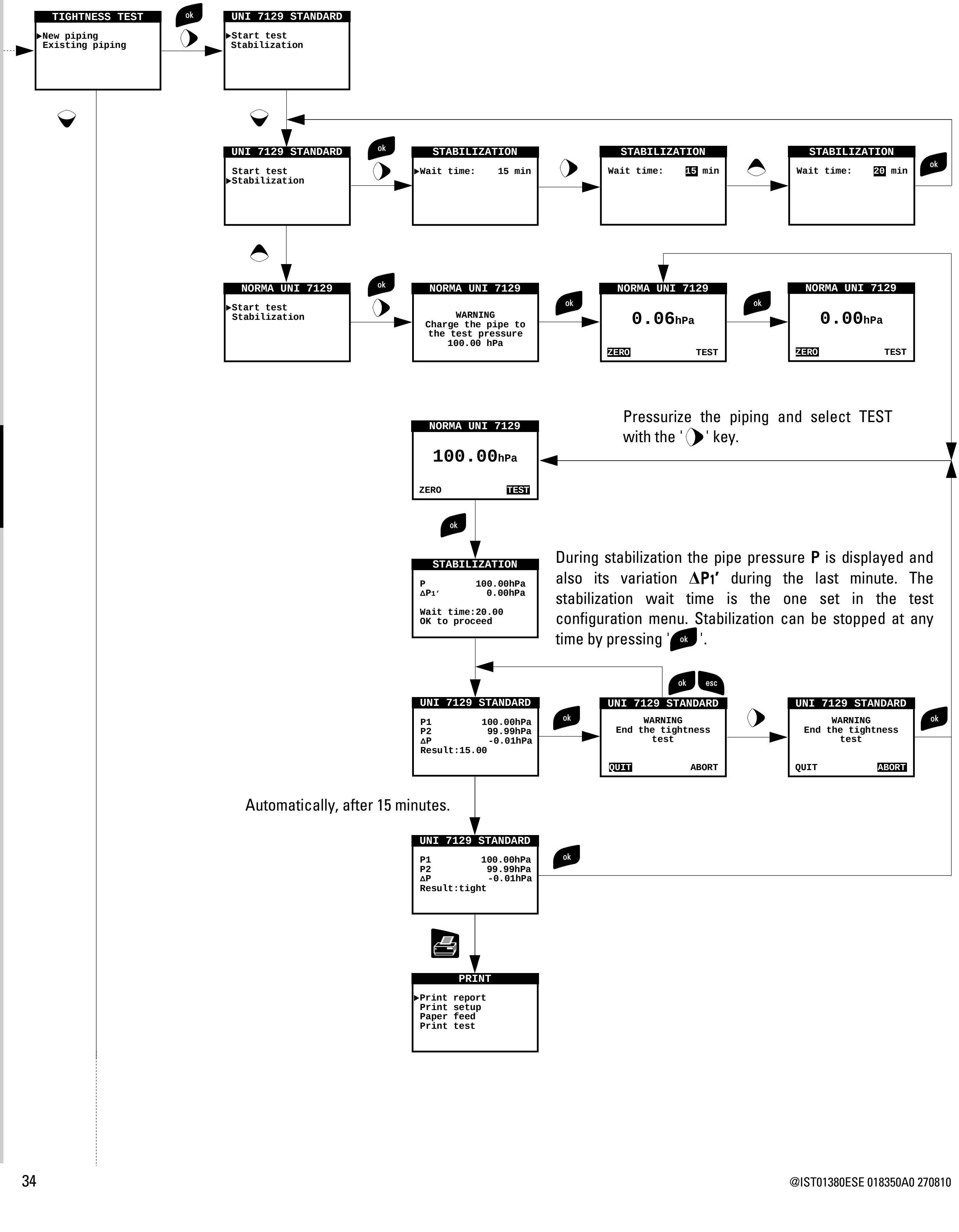
Activates the Smoke Menu.



In the Smoke menu the user can input the smoke value. The values entered with the arrow keys can be associated with the ongoing analysis through the ' ok ' key or printed with the Print menu.

The CO, NO ambient gas gives a measurement about the safety of the environment in which the operator is working. The concentration values can be associated to the ongoing analysis with the ' ok ' key, or printed on a ticket through the Print menu.

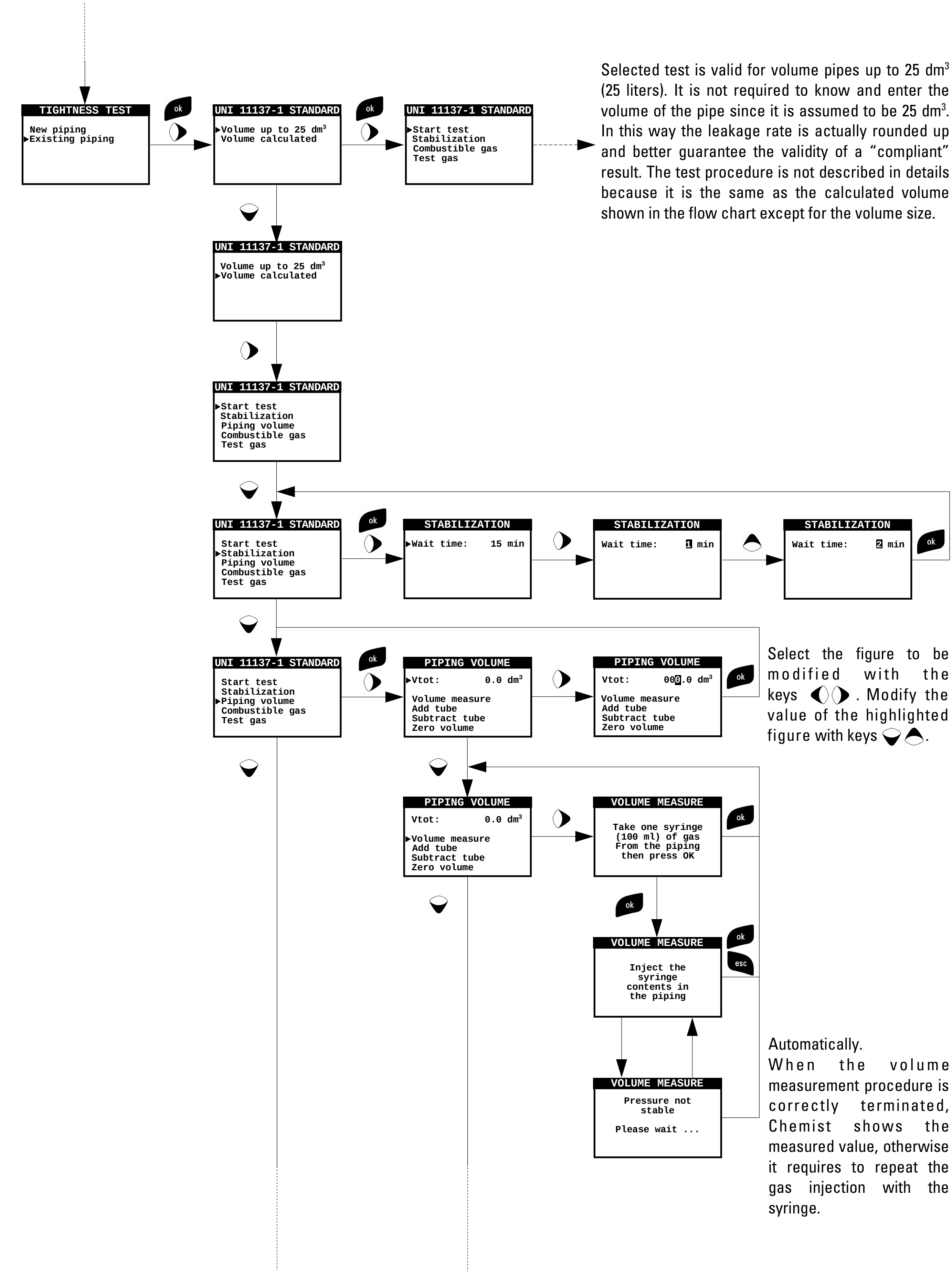
Tightness test flow-chart according to standards UNI 7129 and UNI 11137-1.



Pressurize the piping and select TEST with the '▸' key.

During stabilization the pipe pressure **P** is displayed and also its variation **ΔP1'** during the last minute. The stabilization wait time is the one set in the test configuration menu. Stabilization can be stopped at any time by pressing 'ok'.

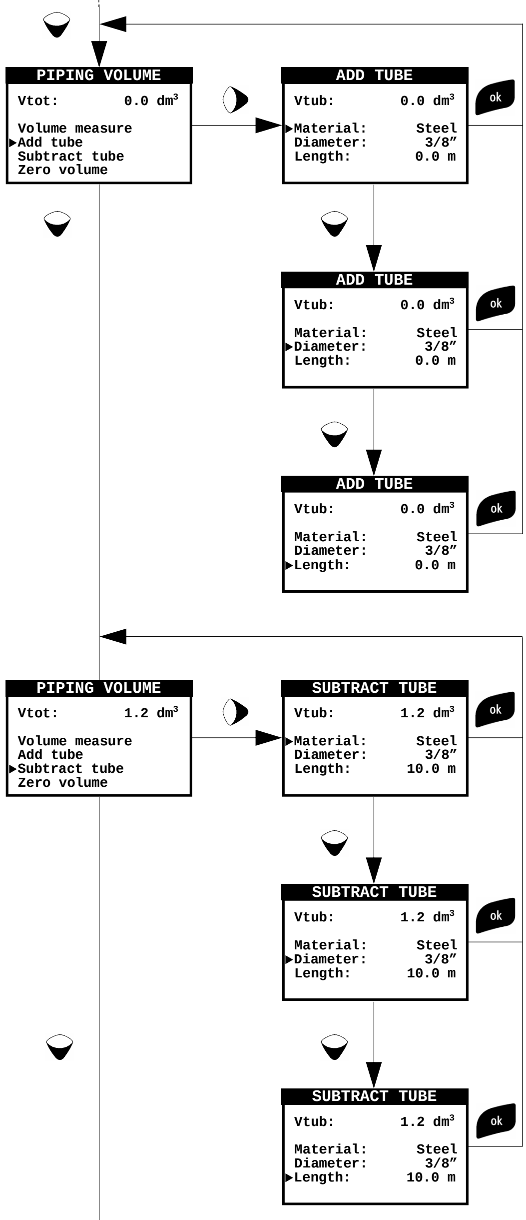
Automatically, after 15 minutes.



Selected test is valid for volume pipes up to 25 dm^3 (25 liters). It is not required to know and enter the volume of the pipe since it is assumed to be 25 dm^3. In this way the leakage rate is actually rounded up and better guarantee the validity of a "compliant" result. The test procedure is not described in details because it is the same as the calculated volume shown in the flow chart except for the volume size.

Select the figure to be modified with the keys . Modify the value of the highlighted figure with keys .

Automatically.
When the volume measurement procedure is correctly terminated, Chemist shows the measured value, otherwise it requires to repeat the gas injection with the syringe.



Select material with keys amongi tas:
Steel, Copper, PE.

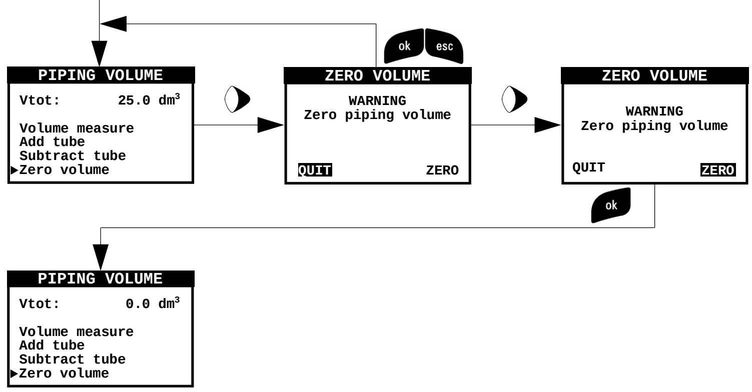
Select the nominal diameter with the keys.

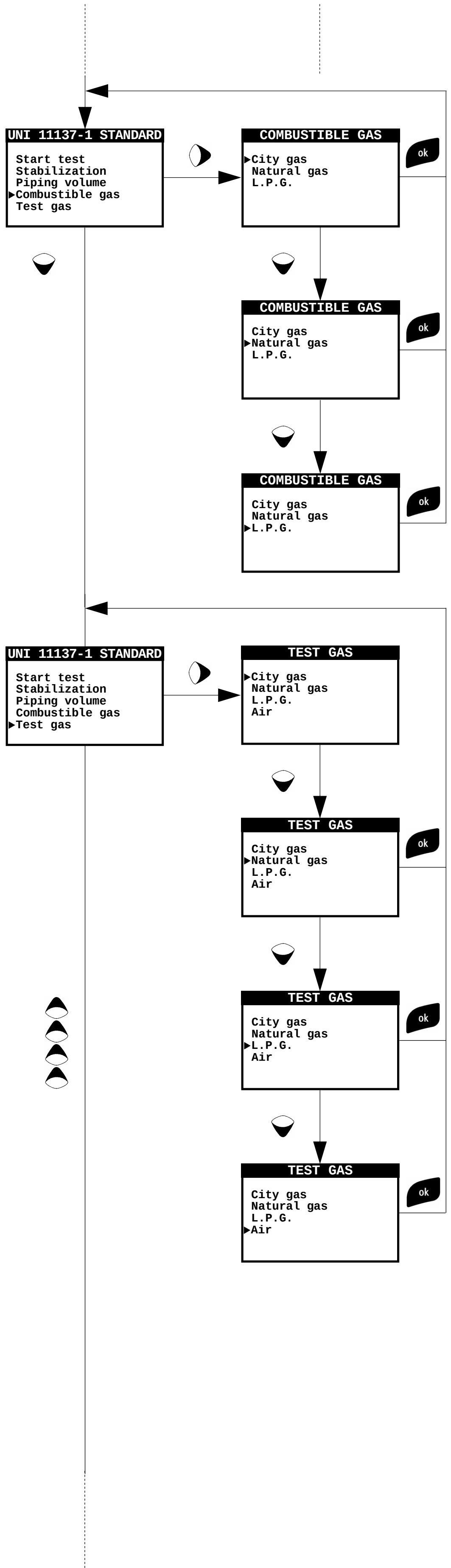
Select the figure to be modified with the keys. Modify the value of the highlighted figure with keys.

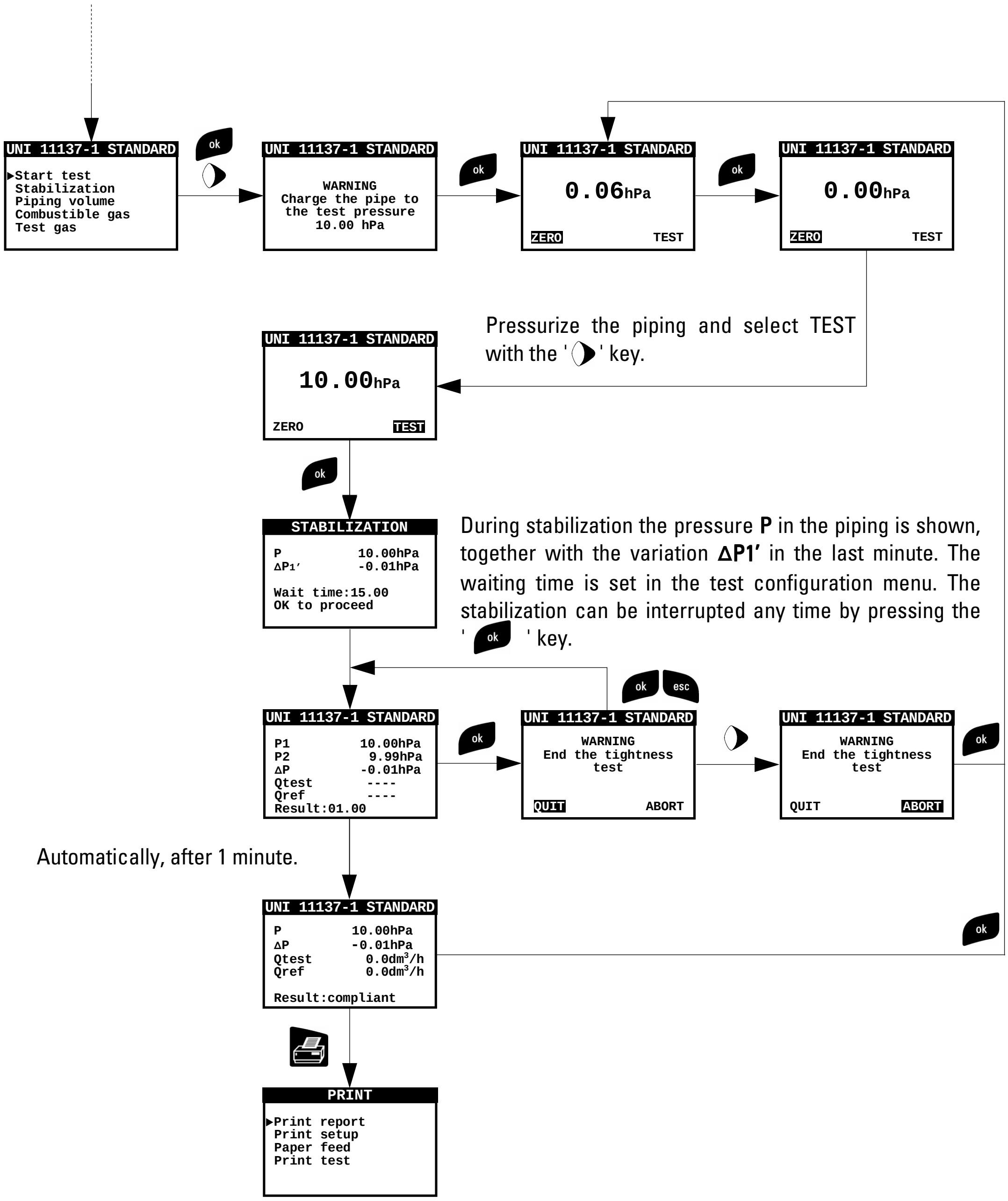
Select material with keys amongi tas:
Steel, Copper, PE.

Select the nominal diameter with the keys.

Select the figure to be modified with the keys. Modify the value of the highlighted figure with keys.



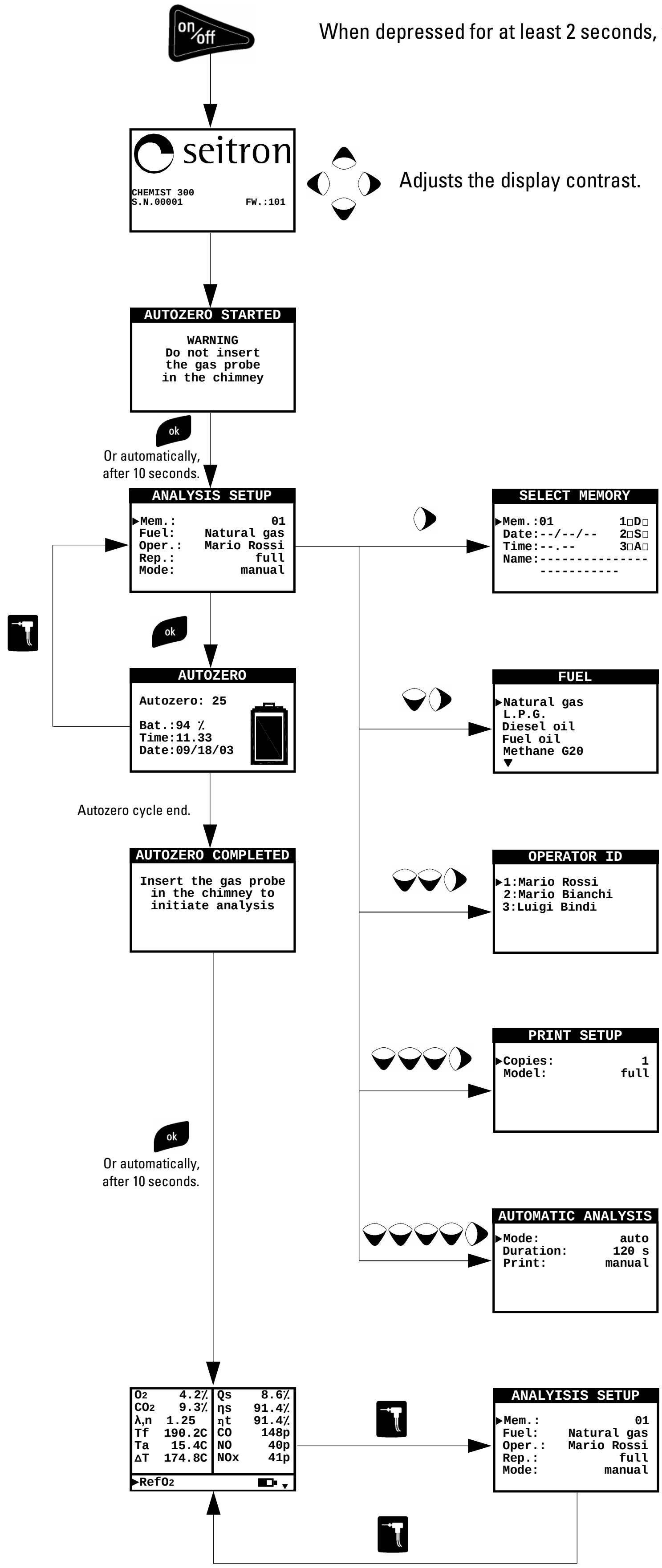

UNI 11137-1 STANDARD
Start test
Stabilization
Piping volume
▶Combustible gas
Test gas
COMBUSTIBLE GAS
▶City gas
Natural gas
L.P.G.
ok
COMBUSTIBLE GAS
City gas
▶Natural gas
L.P.G.
ok
COMBUSTIBLE GAS
City gas
Natural gas
▶L.P.G.
ok
UNI 11137-1 STANDARD
Start test
Stabilization
Piping volume
Combustible gas
▶Test gas
TEST GAS
▶City gas
Natural gas
L.P.G.
Air
TEST GAS
City gas
▶Natural gas
L.P.G.
Air
ok
TEST GAS
City gas
Natural gas
▶L.P.G.
Air
ok
TEST GAS
City gas
Natural gas
L.P.G.
▶Air
ok


UNI 11137-1 STANDARD
▶Start test
Stabilization
Piping volume
Combustible gas
Test gas
ok
UNI 11137-1 STANDARD
WARNING
Charge the pipe to the test pressure 10.00 hPa
ok
UNI 11137-1 STANDARD
0.06hPa
ZERO TEST
ok
UNI 11137-1 STANDARD
0.00hPa
ZERO TEST
Pressurize the piping and select TEST with the ' ' key.
UNI 11137-1 STANDARD
10.00hPa
ZERO TEST
ok
STABILIZATION
P 10.00hPa
ΔP1' -0.01hPa
Wait time:15.00
OK to proceed
During stabilization the pressure P in the piping is shown, together with the variation ΔP1' in the last minute. The waiting time is set in the test configuration menu. The stabilization can be interrupted any time by pressing the ' ok ' key.
ok esc
UNI 11137-1 STANDARD
P1 10.00hPa
P2 9.99hPa
ΔP -0.01hPa
Qtest ----
Qref ----
Result:01.00
ok
UNI 11137-1 STANDARD
WARNING
End the tightness test
QUIT ABORT
UNI 11137-1 STANDARD
WARNING
End the tightness test
QUIT ABORT
ok
Automatically, after 1 minute.
UNI 11137-1 STANDARD
P 10.00hPa
ΔP -0.01hPa
Qtest 0.0dm³/h
Qref 0.0dm³/h
Result:compliant
ok
PRINT
▶Print report
Print setup
Paper feed
Print test

4.9 Flow Chart - Configure Analysis Menu

When depressed for at least 2 seconds, turns the instrument on.

Adjusts the display contrast.



Key analyser parameters can be configured during auto-calibration. The ' ok ' and ' esc ' keys respectively confirm and cancel any effected modifications and take the user back to the previous level menu.

In the Select menus the cursor indicates the active value.

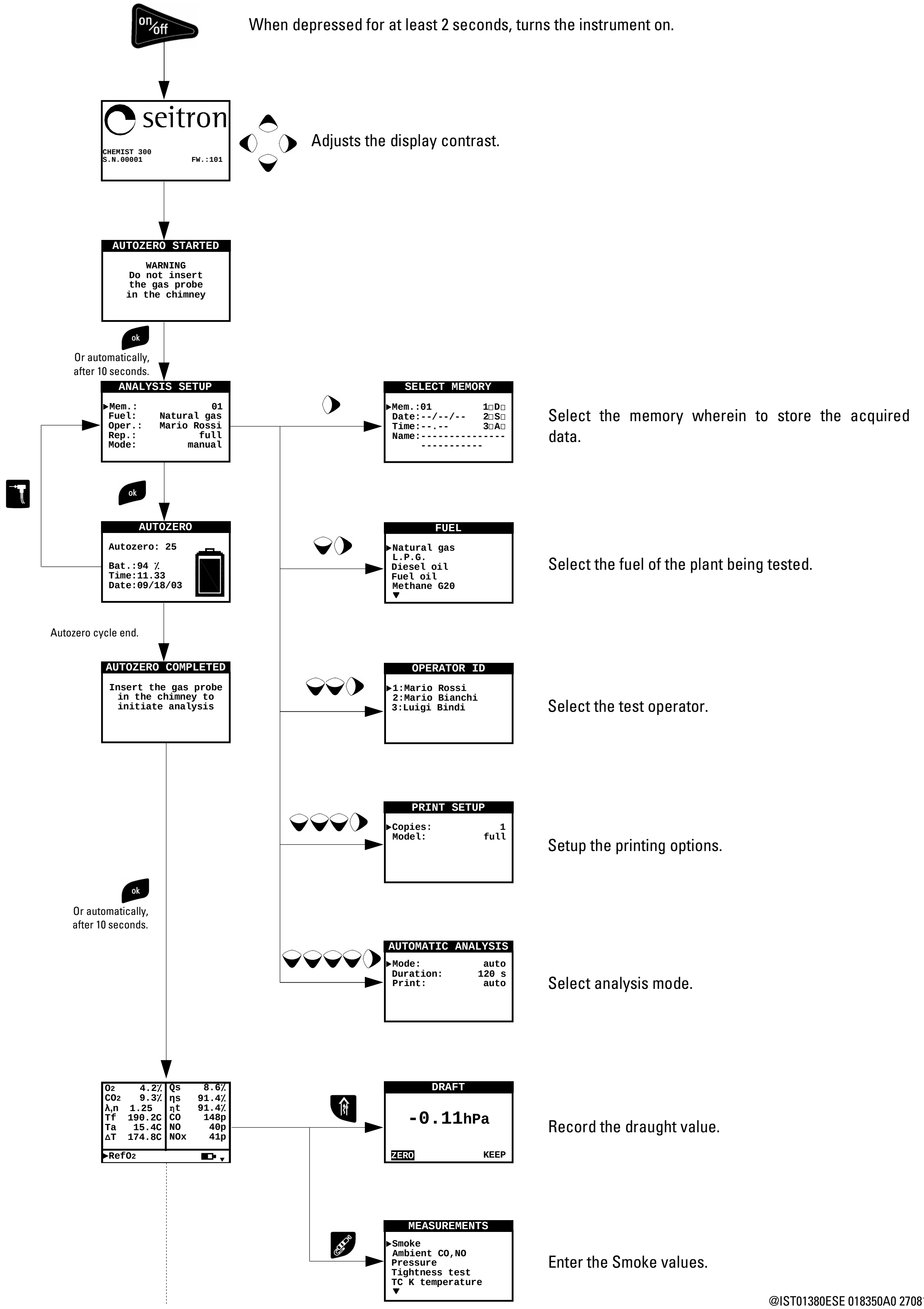
In this phase one can either select the test operator and/or change the name displayed (refer to Configure Menu).

Setup the report printing, selecting the number of copies and the type of report to print.

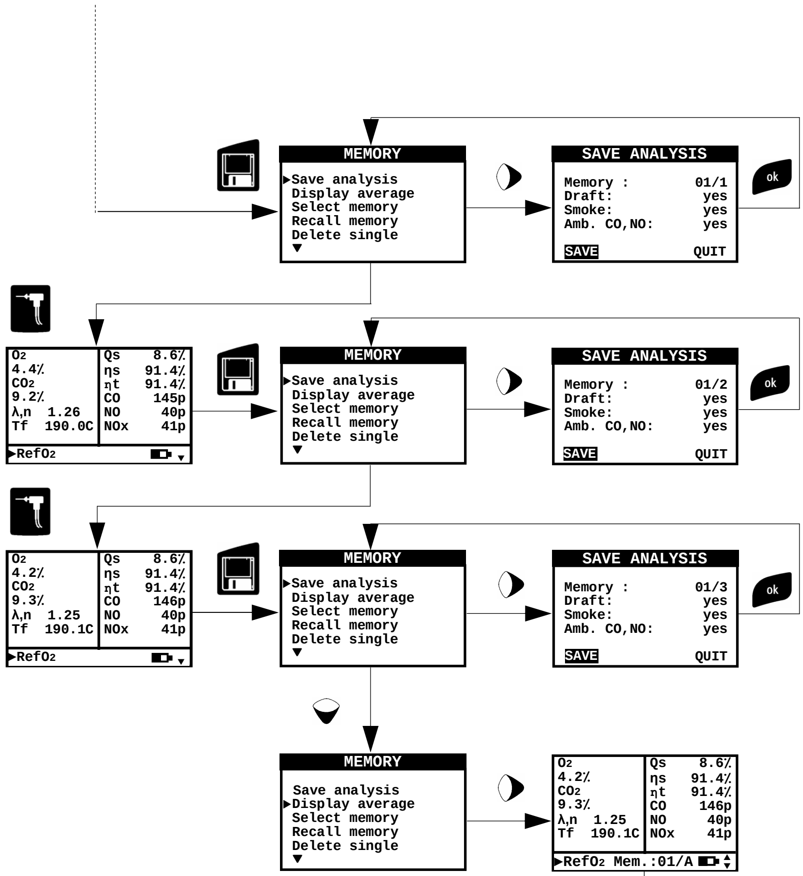
At this point the user can select the analysis mode - automatic or manual; if automatic mode is chosen the test time and printout format must also be set.

The Configure Analysis Menu can also be accessed after auto-calibration is complete.

4.10 Flow Chart – Flue Gas Analysis



How to proceed in manual mode (standard sequence).

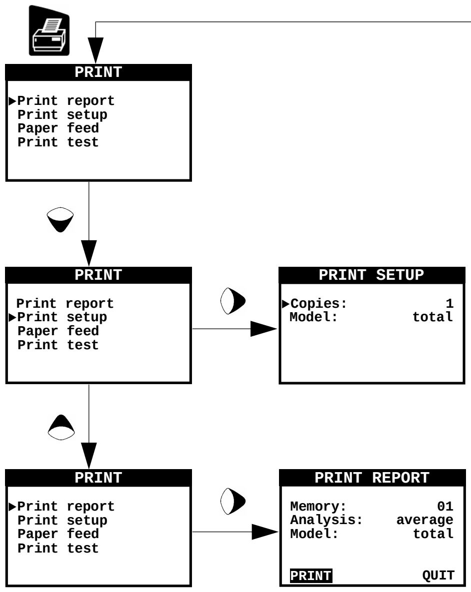


Memorise test 1.

Memorise test 2.

Memorise test 3.

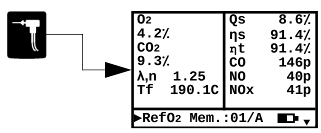
Recall the average test values.



If desired, set the preferred number of copies and analysis report format.

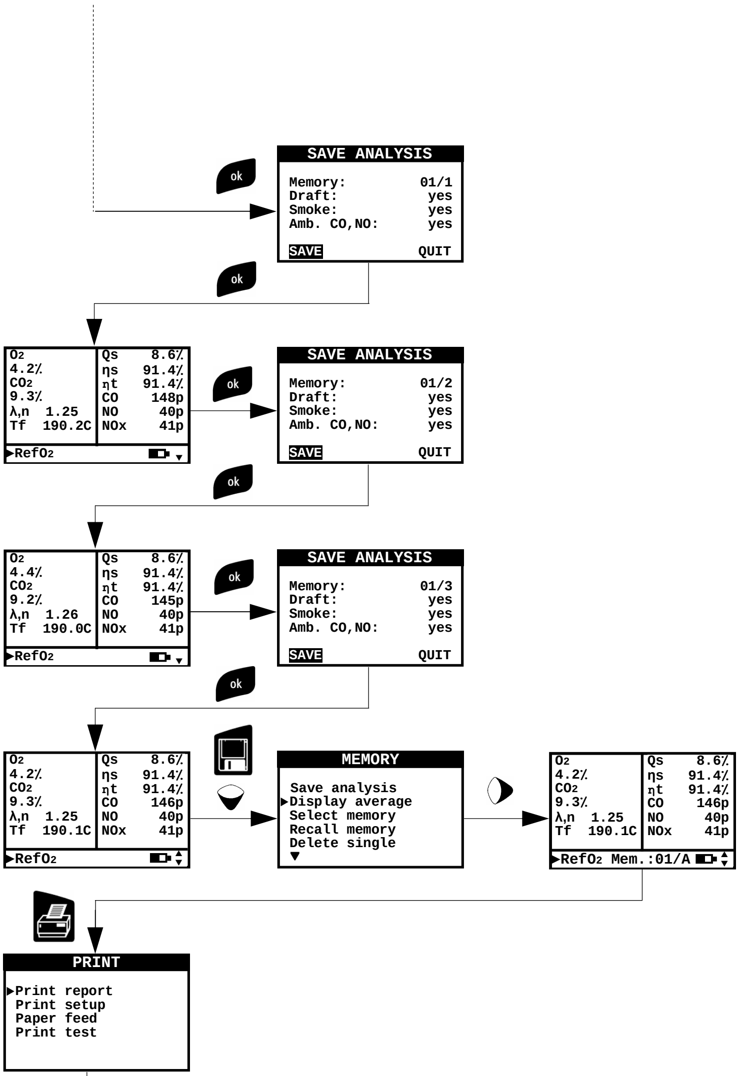
Print the analysis report.

When printing is complete return to the Analysis Menu by pressing:



The system is ready to carry out further tests.

How to proceed in manual mode (quick sequence).

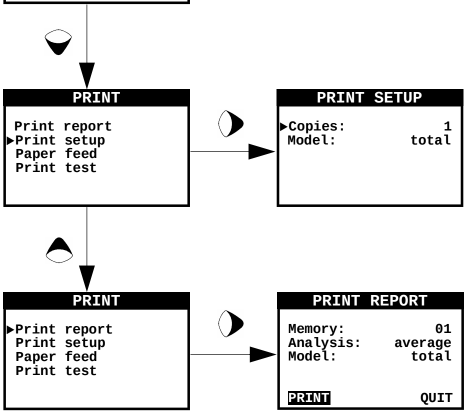


Memorise test 1.

Memorise test 2.

Memorise test 3.

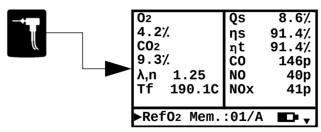
Recall the average test values.



If desired, set the preferred number of copies and analysis report format.

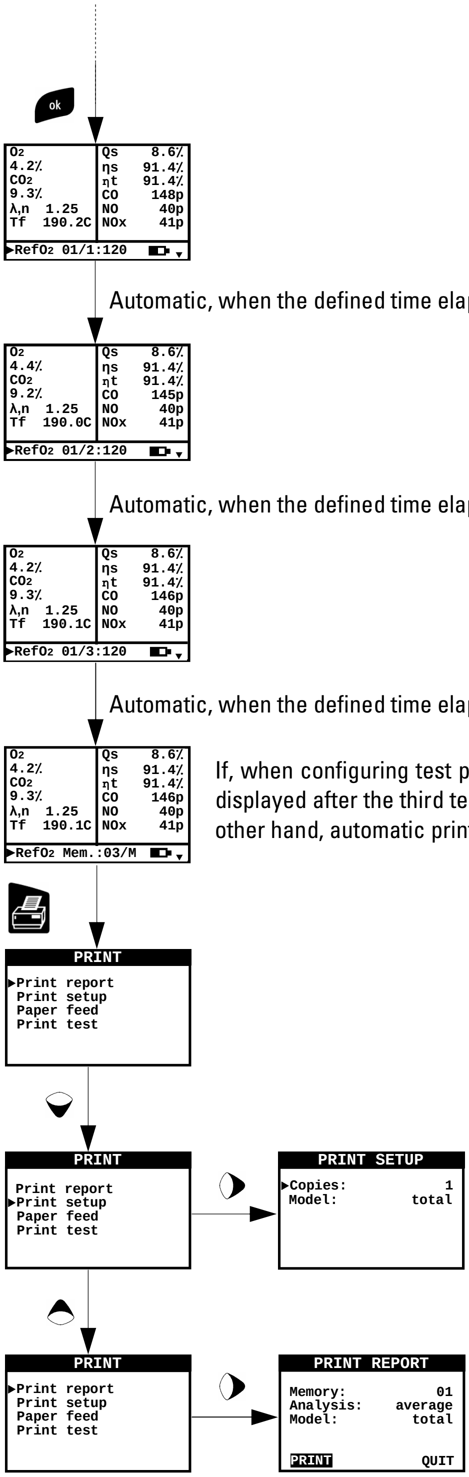
Print the analysis report.

When printing is complete return to the Analysis Menu by pressing:



The system is ready to carry out further tests.

How to proceed in automatic mode.

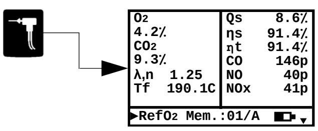


If, when configuring test parameters, manual printing has been selected (see example), the average values will be displayed after the third test values have been read. These may be printed by activating the relative menu. If, on the other hand, automatic printing has been selected, the average test values will be printed automatically.

If desired, set the preferred number of copies and analysis report format.

Print the analysis report.

When printing is complete return to the Analysis Menu by pressing:



The system is ready to carry out further tests.

4.11 FLUE GAS ANALYSIS

To perform complete flue gas analysis, follow the instructions below.

4.11.1 Switching on the instrument and auto-calibration

Press the On/Off key to switch on the instrument - an introductory screen will appear. After a couple of moments the instrument will zero itself and will state that the sample probe should not be inserted in the stack.
It is important that the sample probe is not inside the stack since, during auto-calibration, the instrument draws fresh air from the environment and detects the zero value of the O_2, CO and NO sensors, the details of which are then memorised and used for reference during the analysis. It is equally important that this phase is performed in a fresh-air environment.
The pressure sensor is also zeroed during auto-calibration.

4.11.2 Inserting the probe inside the stack

When auto-calibration is complete the instrument will instruct the user to insert the sample probe that has been previously connected to the relative input on the instrument, and the analysis screen will appear automatically.
In order for the probe to be inserted at the right point within the stack, its distance from the boiler has to be twice the diameter of the stack pipe itself or, if this is not possible, must comply with the boiler manufacturer's instructions.
In order to position the probe correctly, a reliable support must be provided by drilling a 13/16 mm hole in the manifold (unless already present) and screwing in the positioning cone provided with the probe - in this way no air is drawn from the outside during sampling.
The screw on the cone allows the probe to be stopped at the right measuring depth - this usually corresponds to the centre of the exhaust pipe. For greater positioning accuracy, the user may insert the probe gradually into the pipe until the highest temperature is read. The exhaust pipe must be inspected before carrying out the test, so as to ensure that no constrictions or losses are present in the piping or stack.

4.11.3 Flue Gas Analysis

After the sample probe has been inserted in the stack and the combustion air temperature probe (if used) has been inserted in the relative sample manifold, if the instrument has not been configured during auto-calibration, the following data must be configured:
Memory: use this submenu to define the memory in which the test data and client details are to be stored.
Fuel: the user will be asked to define the type of fuel used by the plant.
Operator: this is where the name of the test operator can be entered.
Mode: by entering this submenu, the user can determine the analysis mode - manual or automatic.
If automatic mode is chosen, the reading duration of each and every test must be set, besides the printing mode - manual or automatic. When flue gas analysis begins, the instrument will perform and memorise the three tests automatically, at the respective intervals set (at least 120 sec. according to UNI 10389-1).
At the end of each test the instrument will emit an audible alarm (one "beep" after the first test, two "beeps" after the second test and three "beeps" after the third test).
At this point, when all three tests are over, if "Manual Printing" has been chosen the instrument will display the average of the three tests with the possibility of recalling the individual values.
If desired, the user can then print the relative data (total, complete, etc....). On the contrary, if "Automatic Printing" was selected, the instrument will print the test data automatically, based on the current print settings, without displaying the average test values.

Caution: when in automatic mode Draught, Smoke and ambient CO (NO) measurements must be taken before initiating the flue gas analysis.

If, on the other hand, manual analysis mode is chosen, flue gas analysis will proceed manually (please see relative Flow Chart). In this case the print settings and automatic test duration will not be considered.
At this point manual analysis may commence, first waiting at least two minutes until the displayed values stabilise: The user can then proceed with data storage, if required, or print the analysis report directly.
The latter will be printed in the format set beforehand.
When all three tests are over, the user can recall the average analysis screen containing all the data necessary for compiling the maintenance log of the boiler or plant.
In both automatic and manual modes, all the pollutant values CO / NO / NO_x can be translated into normalised values (referenced to the previously defined O_2 level) by simply pressing the button ◗.

4.11.4 End of Analysis

At the end of the combustion analysis, carefully remove the sample probe and remote air temperature probe, if used, from their relative ducts, taking care not to get burnt.
Let the instrument draw in fresh air for a few minutes or at least until the values displayed return to their original values, that is **20.9-21.0** for **O_2** and **0** for **CO / NO / NO_x**.
Switch off the instrument by pressing the On/Off key.
At this point, if the instrument has detected a concentration of CO and/or NO greater than 100 ppm, a self-cleaning cycle will be initiated during which the pump will draw fresh outside air until the gas levels drop below the defined values.
At the end of the cycle (lasting no longer than 3 min.) the instrument will switch itself off automatically.

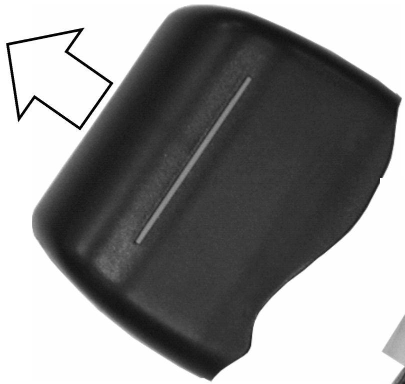
4.12 Measuring the Differential Pressure (OPTIONAL KIT)

The instrument is fitted with an internal temperature-compensated piezoresistive transducer to measure positive and negative pressures. This sensor, which is mounted on the instrument, is of the differential type.
If the special KIT is purchased, the sensor can be used to measure the differential pressure thanks to the positive and negative pressure connectors.
The measuring range varies between -1000.00 mm H_2O and +1000.00 mm H_2O.

4.13 Resetting the Microprocessor

In order to access the reset pushbutton, proceed as follows:

1) Apply a slight outward pressure on the cover of the printer, slide it out and remove it.



After removing the cover of the printer, the analyser will appear as shown below.

If the instrument is turned towards the operator, as shown in the adjacent figure, one can access the printer compartment and the **Reset** pushbutton.

5.0 MAINTENANCE

5.1 Routine maintenance
This instrument was designed and manufactured using top-quality components. Proper and systematic maintenance will prevent the onset of malfunctions and will increase instrument life altogether.
The following basic requisites are to be respected:
- Do not expose the instrument to substantial thermal shocks before use. If this happens, wait for the temperature to return to normal working values.
- Do not extract flue gas samples directly without using a particulate/water trap.
- Do not exceed sensor overload thresholds.
- When the analysis is over disconnect the sample probe and let CHEMIST draw fresh air for a few minutes, or at least until the displayed parameters return to their original values.
- Clean the filter unit when necessary, replacing the particulate filter and applying a jet of air to the sample probe hose to eliminate any condensate that may have formed.

Do not clean the instrument with abrasive cleaners, thinners or other similar detergents.

5.2 Preventive maintenance
At least once a year send the instrument to a SERVICE CENTRE for a complete overhaul and thorough internal cleaning.
SEITRON's highly qualified staff is always at your disposal and will provide you with all the sales, technical, application and maintenance details required.
The service centre will always return the instrument to you as new and in the shortest time possible. Calibration is performed using gases and instruments comparable with National and International Specimens. Annual servicing is accompanied by a specific calibration certificate that is a guarantee of perfect instrument performance as required by UNI 10389-1, besides being indispensable for users wishing to maintain ISO 9000 status.

5.3 Cleaning the sample probe
When you finish using the sample probe clean it thoroughly as described below before returning it to its case:
- Disconnect the sample probe from the instrument and from the water trap (Fig. a-b) then blow a jet of clean air into the hose of the probe (refer to Fig. c) to remove any residual condensate that may have formed within.

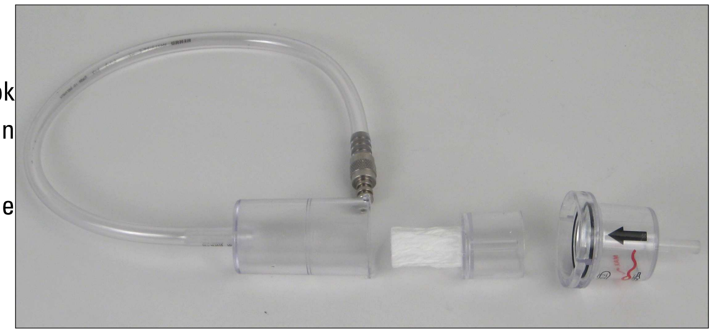

Fig. a


Fig. b

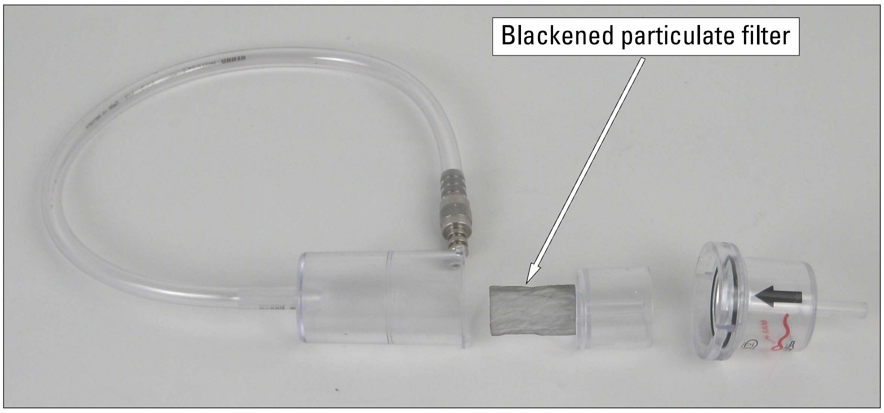
Fig. c

5.4 Maintaining the water trap / filter unit

To remove the water trap, just rotate the cover and unhook the filter holder body; remove the internal cup and then replace the filter (see figure on the side).
Clean all the filter parts using <u>water only</u>, dry the components and reassemble the filter.



5.5 Replacing the particulate filter



If the particulate filter appears black, especially on the inner surface (see adjacent example), it has to be replaced immediately. In this way gas flow is not obstructed.

5.6 Life of O_2, CO and NO sensors

The gas sensors used in this instrument are electrochemical: thus, when the relative gas is detected, a chemical reaction takes place inside them that generates an electrical current.
The electrical current acquired by the instrument is then converted into the corresponding gas concentration. Sensor life is strongly related to the consumption of the reagents within.
Sensor characteristics diminish as the reagents are consumed and when these have been used up completely the sensor must be replaced. The sensors must be recalibrated on a regular basis to assure measuring accuracy: recalibration can only be performed by a qualified SEITRON service centre. Chart 5.7 illustrates the characteristics inherent to each sensor.

5.7 Gas sensor life

SENSOR	AVERAGE LIFE	RECALIBRATION	TYPE
O_2 Oxygen	18 months	not necessary	5FO Smart CiTiceL
CO Carbon Monoxide	3 years	Yearly (1)	A5F Smart CiTiceL
NO Nitrogen oxide	3 years	yearly	5NF Smart CiTiceL

1. In case the instrument is used for personal safety a recalibration performed every 6 months is highly suggested.

5.8 Replacing the O_2, CO and NO sensors

The instrument's gas sensors need to be replaced periodically with new or recalibrated sensors (see chart below).
The sensors can be easily replaced by the user as instructed below:

1) Loosen the two screws and remove the rear flap to access the sensor compartment (Fig. 1).
2) Decide which sensor is to be replaced.
3) Remove the relative electrical connection (Fig. 4).
4) The sensor is a bayonet type - turn it counter clockwise to remove (Fig 5). When rotating the sensor make sure you do not exert pressure on the printed circuit board above: only exert force on the plastic capsule. After turning the sensor, pull it upwards (Fig. 6).
5) Insert the new sensor making sure that the electrical connection faces outwards and not towards the inside of the instrument.
6) Turn the sensor clockwise until it snaps in. When rotating the sensor make sure you do not exert any pressure on the printed circuit board above, but only on the plastic capsule.
7) Reinstate the electrical connection (Fig. 3).
8) If the S2 sensor is replaced (CO, Carbon Monoxide), remove the polarising metal plate (not used in octagonal board) from the printed circuit board above the sensor (Fig. 3) with the aid of pliers. When extracting the block, hold the printed circuit board steady so as not to subject the connections between the printed circuit board and the sensor capsule below to mechanical stress.

9) Replace the rear flap on the sensor compartment and retighten the two screws (Fig. 1).
Correct sensor operation may be verified by switching on the instrument and accessing the “Sensor Diagnostics” menu. It is normal for newly installed sensors to give a “current error”: you must wait until the sensor polarisation adjusts. The following chart lists the minimum adjustment time necessary for each sensor.

SENSOR	TYPE	COLOR	POSITION	SETTLING TIME
O2 Oxygen	AAC SE 01	Yellow	S1	24 hours
CO Carbon Monoxide	AAC SE 02	Red	S2	6 hours
NO Nitrogen oxide	AAC SE 03	Orange	S3	48 hours

If the instrument is used before the above adjustment period has occurred, the accuracy of the resulting measurements may be less than that declared.

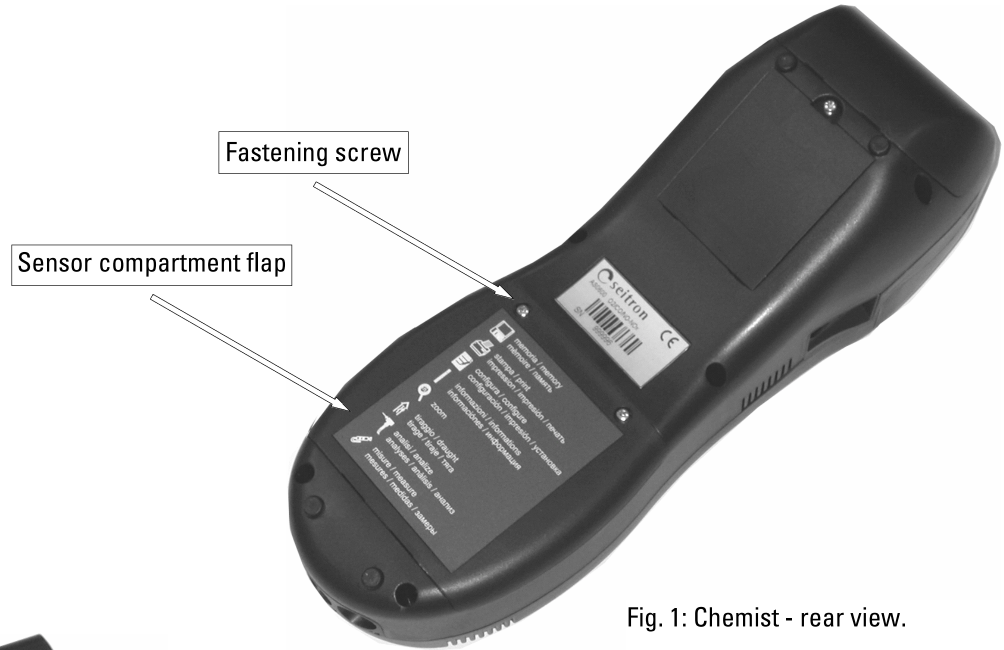


Fig. 1: Chemist - rear view.

Fig. 2: Sensor compartment.

Fig. 3: Example of sensor with electrical connection inserted.

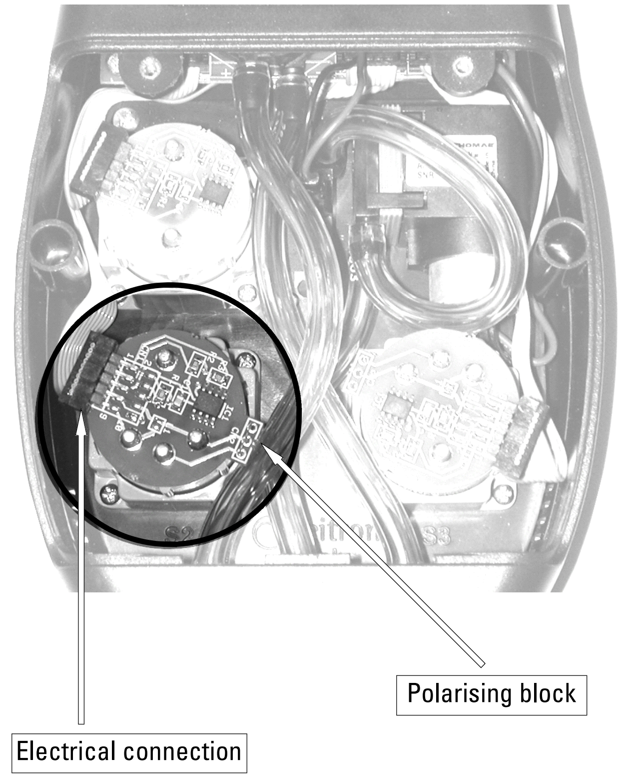


Fig. 4: Example of sensor with electrical connection removed.

Fig. 5: Example of rotated sensor.

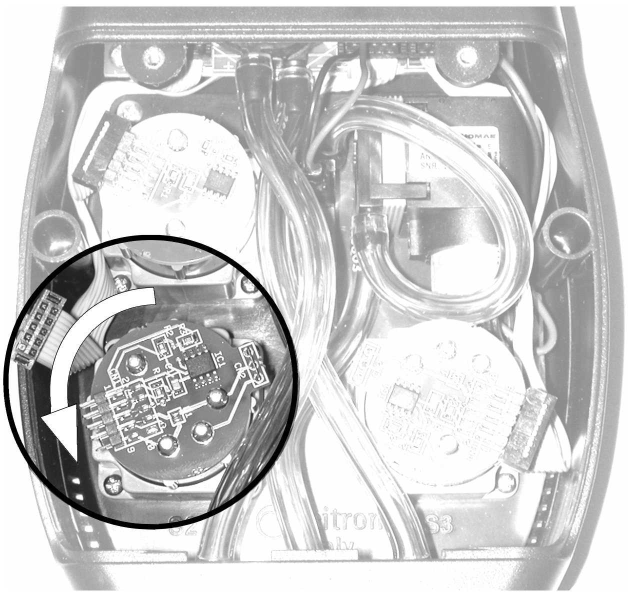
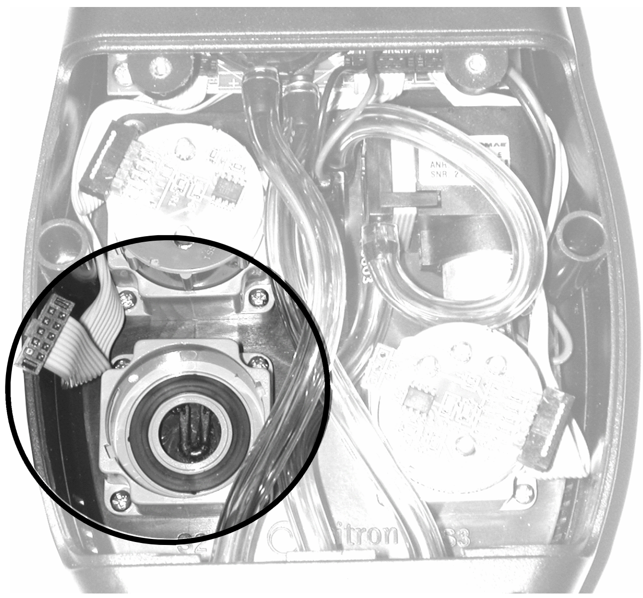


Fig. 6: Example of sensor compartment without sensors.



5.9 Replacing the battery pack

To replace the battery pack, proceed as follows:

1) Loosen the screw on the battery cover and remove the latter.

2) Slide out the battery pack.

3) Remove the battery pack connector and replace the battery pack with a new one, reversing the operations described above.

5.10 Replacing the printer paper roll

Remove the printer plastic door as explained in paragraph 4.13 (microcontroller reset).

Remove the paper roll plastic door by pressing to the inner the plastic tooth pointed by the arrow. The door is then remove applying a slight force towards the bottom.

Insert a new printer paper roll as shown in the picture.

Re-insert the paper plastic door and fit the edge of the paper stripe in the slot pointed by the arrow.

Advance some paper in the printer through the **'Print Menu' - 'Paper Feed'**, gently helping with the hand the paper stripe.

Close completely the printer plastic door paying attention to insert the paper stripe in the relevant slot located on the plastic door.

6.0 TROUBLESHOOTING

seitron

6.1 Troubleshooting guide

PROBLEM	PROBABLE CAUSES AND REMEDIES
The instrument does not work at all. When the On/Off pushbutton is pressed the instrument does not come on.	**a.** Keep the On/Off key depressed for at least 2 seconds. **b.** The battery is low; connect the battery charger to the instrument. **c.** The battery pack is not connected to the instrument; remove the cover from the battery compartment and connect the connector of the battery pack to the outlet on the printed circuit board. **d.** The instrument is faulty: send it to a service centre.
The battery symbol is empty on the inside.	The batteries are low. The instrument will remain on for a couple of minutes after which it will switch off; connect the battery charger.
After auto-calibration is complete the sensor diagnostics screen appears and gives an error for one or more cells.	**a.** Auto-calibration took place while the flue gas was being sampled. **b.** The O_2 sensor is faulty, is not connected correctly or is not connected at all. Check the above points, also referring to sections 5.6, 5.7, 5.8. **c.** The sensor was not allowed the necessary adjustment time or the instrument was left with a low battery for too long.
A pressure sensor error is shown in the pressure/draught screen.	There is a calibration problem. Send the instrument to a service centre.
The analysis screen gives a flue gas temperature (Tf) error.	**a.** The thermocouple is not connected; connect the thermocouple to the analyser. **b.** The sensor has been exposed to temperatures greater or lower than its operating temperature range. **c.** The thermocouple is faulty. Send the complete probe to a service centre.
The following symbol "----" appears on the analysis screen.	The instrument is not able to calculate a numerical value based on the flue gas analysis conducted. The "----" are replaced by numbers when the analyser detects valid combustion data.
"Max. Lim." or "Min. Lim" appears on the analysis screen.	The relative sensor is detecting a value that is beyond the analyser's measuring range. "Max. Lim" or "Min. Lim." are replaced by numbers when the instrument reveals values that are within the measuring range.
The sample pump sounds as though it is running slowly, tends to stop or does not even start.	**a.** Sample flow is obstructed. Check that the water filter is clean and that it is not completely soaked. Also check that the hose connected to the probe is not crushed. **b.** Sample intake flow is obstructed. Check that the particulate filter is clean. **c.** The pump is not connected as it should be. Remove the rear flap and check that the pump's electrical connector is connected to the printed circuit board. **d.** Pump is faulty. Replace the pump unit. **e.** Pump is disabled. The key combination i has been pressed. To re-enable the pump, switch off the instrument and then switch it on again.

Troubleshooting guide

PROBLEM	PROBABLE CAUSES AND REMEDIES
The rear lighting of the display is not on.	The backlighting LED's are faulty. Contact the nearest service centre to replace the display.
The batteries last less than 9 hours.	**a.** Battery capacity is limited by low temperatures. To achieve a longer battery life it is recommended to store the instrument at higher temperatures. **b.** The battery pack is old. Battery capacity tends to diminish with age. If battery life has become unacceptable, replace the battery pack:
The values shown in the analysis screen are not reliable.	**a.** Sensor/s is/are faulty. Check that the sensors are installed correctly by accessing the sensor diagnostics menu. **b.** The sample probe connection presents a leak. Check all joints and the conditions of the hose. **c.** Pump is faulty. Replace the pump unit. **d.** The instrument is faulty: Send it to a service centre for repair.
During the tightness test a "sensor error" is reported.	Check for the correct connection of the hose to the positive pressure input.

7.0 SPARE PARTS AND TECHNICAL

7.1 Spare parts

AAC BF01: Sensor junction block
AAC FA01: Particulate filter
AAC NI01: Ink ribbon for printer
AAC PB02: Battery pack - 5 x 6V 1800 mAh elements
AAC RC01: Paper roll for printer, h=57 mm, diam.= 40 mm
AAC SE04: Replaceable O_2 sensor
AAC SE05: Replaceable CO/H_2 sensor
AAC SE06: Replaceable NO/NO_x sensor

7.2 Accessories

AAC AL04: 100-240V~/12 VDC 2A power supply with 2 m. cable
AAC CR01: Rigid plastic case
AAC CT01: Shoulder bag
AAC DP01: Deprimometer for Draught test
AAC KP01: Differential pressure kit
AAC KT02: Tightness test kit
AAC PM01: Manual pump kit for smoke measurement + filters + Bacharach chart
AAC SA04: Air temperature probe (cable length 3 m)
AAC SF11: 180 mm sample probe with 3 m cable, extended temperature range up to 1100°C
AAC SF12: 300 mm sample probe with 3 m cable, extended temperature range up to 1100°C
AAC SF15: 750 mm sample probe with 3 m cable, extended temperature range up to 1100°C
AAC SF16: 1000 mm sample probe with 3 m cable, extended temperature range up to 1100°C
AACSL01: 220 mm flexible sample probe with 3 m cable, extended temperature range up to 1100°C
AAC SM01: Magnetic holder
AAC SW03: Configuration software kit (USB flash drive + PC cable)
AAC TA03: Particulate/water filter assembly
AAC TA03T: Particulate/water filter assembly with steel pipe and connector
AAC UA01: USB-RS232 cable

7.3 Service Centres

Seitron S.r.l.
Via Prosdocimo, 30
I-36061 Bassano del Grappa (VI) ITALY
Tel.: +39.0424.567842
Fax.: +39.0424.567849
E-mail: info@seitron.it
http://www.seitron.it

Example of Total analysis report.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: _______________

Test according to
UNI 10389-1

Chemist 300
Serial: 999989
Memory: 01
Analysis: average

Date: 20/04/05
Time: 10.15

Fuel: Natural gas
Altitude: 0 m
R.H. air: 50 %

     MEASURED VALUES
-------------------------
T flue       191.1 °C
T air         15.4 °C
O2             4.2 %
CO             146 ppm
NO              40 ppm

CO amb           0 ppm
NO amb           0 ppm

Draft:        0.05 hPa
T outdoor:      20 °C

    CALCULATED VALUES
-------------------------
λ,n           1.25
CO2            9.3 %
QS             8.6 %
ηs            98.5 %
ηc             4.9 %
ηt           103.4 %
ΔT           174.7 %
NOx             41 ppm

Ref. O2:       0.0 %
CO             182 ppm

Ref. O2:       0.0 %
NO              50 ppm
NOx             51 ppm

Notes:------------------
------------------------
------------------------
```

```
Analysis: 1
20/04/05 10.15

O2             4.2 %
CO2            9.3 %
λ,n           1.25
T flue       190.2 °C
T air         15.4 °C
ΔT           174.8 °C
QS             8.6 %
ηs            91.4 %
ηt            91.4 %
CO             148 ppm
NO              40 ppm
NOx             41 ppm

Analysis: 2
20/04/05 10.15

O2             4.4 %
CO2            9.2 %
λ,n           1.26
T flue       190.0 °C
T air         15.4 °C
ΔT           174.6 °C
Qs             8.6 %
ηs            91.4 %
ηt            91.4 %
CO             145 ppm
NO              40 ppm
NOx             41 ppm

Analysis: 3
20/04/05 10.15

O2             4.2 %
CO2            9.3 %
λ,n           1.25
T flue       190.1 °C
T air         15.4 °C
ΔT           174.7 °C
Qs             8.6 %
ηs            91.4 %
ηt            91.4 %
CO             146 ppm
NO              40 ppm
NOx             41 ppm
```

Example of Full analysis report.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: ______________

Test according to
UNI 10389-1

Chemist 300
Serial: 999989
Memory: 01
Analysis: average

Date: 20/04/05
Time: 10.15

Fuel: Natural gas
Altitude: 0 m
R.H. air: 50 %

     MEASURED VALUES
------------------------

T flue      190.1 °C
T air        15.4 °C
O2            4.2 %
CO            146 ppm
NO             40 ppm

CO amb          0 ppm
NO amb          0 ppm

Draft:      0.05 hPa
T outdoor:    20 °C

    CALCULATED VALUES
------------------------

λ,n          1.25
CO2           9.3 %
Qs            8.6 %
ηs           98.5 %
ηc            4.9 %
ηt          103.4 %
ΔT          174.7 °C
NOx            41 ppm

Ref. O2:      0.0 %
CO            182 ppm

Ref. O2:      0.0 %
NO             50 ppm
NOx            41 ppm

Notes:------------------
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------------------------
```

Example of Partial Ticket.

```
Date: 20/04/05
Time: 10.15

Flue: Natural gas
Altitude: 0 m
R.H. air: 50 %

O2              4.2 %
CO2             9.3 %
λ,n            1.25
T flue        190.1 °C
T air          15.4 °C
ΔT            174.7 °C
Qs              8.6 %
ηs             98.5 %
ηc              4.9 %
ηt            103.4 %
CO              146 ppm
NO               40 ppm
NOx              41 ppm

CO amb            0 ppm
NO amb            0 ppm

Draft:         0.05 hPa
T outdoor:       20 °C

Smoke:           3  1  2
Aver. n°:           2
```

Example of tightness test report ticket.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: _______________

Test according to
UNI 11137-1 standard
Indirect method

Chemist 300
Sign.: 999989

Date: 20/04/05
Time: 10.15

Stab. duration: 1 min
Test duration: 1 min

Comb. gas: City gas
Test gas: City gas

Vpip        25.0 dm³
P1         10.05 hPa
P2         10.03 hPa
ΔP         -0.02 hPa
Qtest        0.0 dm³/h
Qref         0.0 dm³/h

Result: compliant

Notes: ----------------
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-----------------------
```

Example of Draught Ticket.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: _______________

Chemist 300
Serial: 999989
Memory: 01

Date: 20/04/05
Time: 10.15

Draft:   0.05 hPa
T outdoor: 20 °C

Notes: ----------------
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```

Example of ambient CO, NO Ticket.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: _______________

Chemist 300
Serial: 999989
Memory: 01

Date: 20/04/05
Time: 10.15

CO amb           0 ppm
NO amb           0 ppm

Notes: ----------------
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-----------------------
```

Example of Smoke Ticket.

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith

Sign.: _______________

Chemist 300
Serial: 999989
Memory: 01

Date: 20/04/05
Time: 10.15

Fuel: Diesel

Smoke:  3  4  2
Aver. n°:     3

Notes: ----------------
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```

ANNEX B

Declaration of conformity

The manufacturer	Seitron S.r.l.	
with registered address in	Via Prosdocimo, 30 36061 Bassano del Grappa (VI) - Italy	
declares that the following products:	CHEMIST 200	(prod. code ASK 620 -E)
	CHEMIST 200 PLUS	(prod. code ASK 625 -E)
	CHEMIST 300	(prod. code ASK 630 -E)

Meet the fundamental requirements of Council Directives 2004/108/CE and 2006/95/CE. The full text declaring conformity to the EMC (Electromagnetic Compatibility) and LVD (Low Voltage) directives is available on request.

Ing. Vito Feleppa
Managing Director Seitron S.r.l.

Flue gas analysis according to Italian Law No. 10/1991 and subsequent modifications and supplements, Legislative Decree 192/2005 and the UNI 10389-1 standard

Preamble

It is Seitron's intention, by means of this compact guide, to provide boiler installers/service technicians with a quick and easy way to understand whether a boiler conforms to the requirements of Italian Law no. 10 dated January 1991, and subsequent modifications and supplements, and Legislative Decree 192/2005.

The contents of this guide have been extremely simplified whereby they are not to be deemed at all comprehensive of the complex phenomenon of combustion.

Flue Gas Analysis: theory

During the combustion process taking place in a boiler, part of the heat evolved by the burner is transferred to the water or air to be heated. The quantity of heat available at the burner is called the input rating (Pf) and is usually declared by the boiler manufacturer. Part of this energy, known as the useful output (Pu), is used by the boiler. The remainder is lost to the flue gas in the stack and is known as Stack loss (Qs).

Thus we can say that: Pf=Pu+Qs

THE THERMAL EFFICIENCY OF COMBUSTION is given by:

$$\eta=100-Qs$$

According to the Italian Legislative Decree 192/2005 the MINIMUM thermal efficiency η should respect the values below:

Period of installation	Minimum efficiency %	Minimum with Pn < 35 kW
Before 29/10/1993	84 + 2 * log Pn - 2	around 85 %
From 29/10/1993 to 31/12/1997	84 + 2 * log Pn	around 87 %
From 01/01/1998 to 07/10/2005	Standard boilers 84 + 2 * log Pn Low temperature boilers 87.5 + 1.5 * log Pn Condensing boilers 91 + 1 * log Pn	around 87 % around 90 % around 92.5 %
After 08/10/2005	Condensing boilers 90 + 2 * log Pn - 1 Other boilers 88 + 2 * log Pn - 1	around 92 % around 90 %

For hot air generators:

Period of installation	Minimum efficiency %	Minimum with Pn < 35 kW
Before 29/10/1993	83 + 2 * log Pn - 6	around 80 %
After 29/10/1993	84 + 2 * log Pn - 3	around 83 %

Stack loss is calculated by applying a simple formula which relates it to other easily measurable parameters:

$$Qs = \left(\frac{A2}{CO_2} + B\right)(Tf-Ta)$$

Where: A2, B = factor that depends on the fuel used
Tf = flue gas temperature
Ta = combustion air temperature
CO_2 = % carbon dioxide in the flue gas

Thus in order to calculate the stack loss and hence the thermal efficiency of a plant, one must measure the two temperatures (flue gas and air) and the level of carbon dioxide contained in the flue gas (% CO_2). These operations are performed automatically by the flue gas analyser during testing.

Let's take a look at the gases produced by combustion that need to be kept under control:

➢ *CO_2: CARBON DIOXIDE*

The maximum CO_2 values that can be obtained from perfect combustion (theoretical) for the different types of fuels are:

Fuel	**% max CO_2**
Methane	11,7
Propane	13,9
LPG	13,9
Butane	13,9
Diesel oil	15,1
Fuel oil	15,7

In truth, the percentage of CO_2 that can be detected during analysis will always be lower than these limit values.

➢ *CO: CARBON MONOXIDE*

Carbon monoxide (CO) is usually produced by bad combustion that is weak in oxygen: since CO is a highly dangerous gas (it is fatal for man even in very low concentrations: exposure to 400 ppm for 3 hours is already fatal), standard UNI 10389-1 has established a limit value beyond which the test results of the boiler plant are deemed unsatisfactory. The percentage of gas considered by the standards, however, is not the value measured directly in the flue gas, which is "diluted" with other combustion products, but is the value referred to the volume of flue gas generated by perfect combustion, that is, where the oxygen is zero. This limit is:

CO (referenced to 0% O_2) = 1000 ppm = 0.1%

Flue Gas Analysis: in practice

Below is an example of the flue gas analysis of a methane-fired boiler (natural gas) that is working correctly:

```
COMPANY ltd.
Park Road, 9
Tel.02/12345678

Oper.: John Smith
Sign.: ___________

Test according to
UNI 10389-1

Chemist 300
Serial: 421023
Memory: 01
Analysis: average

Date: 22/12/03
Time: 10:15

Fuel: Natural gas
Altitude: 0 m
R.H. air: 50 %

    MEASURED VALUES

T flue      190.1 °C
T air        15.4 °C
O2            4.2 %
CO            146 ppm
NO             40 ppm

Draft:       0.05 hPa
T outdoor:     20 °C

   CALCULATED VALUES

λ,n          1.25
CO2           9.3 %
QS            8.6 %
ηs           98.5 %
ηc            4.9 %
ηt          103.4 %
ΔT          174.7 °C
NOx            41 ppm

Rif. O2:      0.0 %
CO            182 ppm

Rif. O2:      0.0 %
NO             50 ppm
NOx            51 ppm

Notes: ______________
_____________________
_____________________
_____________________
```

Flue gas temperature Tf
This should be as low as possible: less heat leaving the stack will leave more heat available for heating purposes.

Combustion air temperature Ta
This is not always the same as the ambient temperature.
Combustion air may be heated by the flue gas in coaxial pipes, or may be drawn from outside: in these cases the remote air temperature probe is necessary.

Oxygen O_2
The percentage of oxygen in air is around 21%: an ideal combustion process will “burn” all the oxygen present; in truth, however, the residual percentage is never zero due to the presence of excess air.

Carbon Monoxide CO
This is expressed in parts per million and indicates the concentration of CO “diluted” in the flue gas.

Excess air λ, n
This is the ratio between the volume of air that actually enters the combustion chamber and that which is theoretically required.

Carbon Dioxide CO_2
This results from good combustion and should approach the theoretical threshold value as much as possible.

Stack loss Qs
This is the percentage of heat lost through the stack.

Sensible efficiency ηs
It is the burner efficiency calculated according to the UNI 10389-1 standard, as the ratio between conventional heating power and the burner heating power. Among the combustion losses, only the sensible heat lost with flue gasses is taken into account, thus neglecting the radiation losses and incomplete combustion losses. This value is referred to the Lower Heating Value (LHV) of the fuel and cannot exceed 100%.
The sensible efficiency value is to be compared against minimum efficiency stated for the heating system performances.

Condensation efficiency ηc
Efficiency deriving from the condensation of water vapour contained in flue gasses, calculated according to the UNI 10389-1 standard.

Total efficiency ηt
Total efficiency. It is the sum of sensible efficiency and condensation efficiency. It is referred to LHV (Lower Heating Value) and can exceed 100%.

Differential temperature ΔT
This is the difference between the temperature of the flue gas and that of the combustion air.

Carbon Monoxide CO (referenced to 0% O_2)
This is expressed in parts per million and indicates the concentration of CO that the law requires us to keep under control (it should be lower than 1000 ppm).

Instructions for accurate testing

In order to achieve a certain degree of accuracy when conducting flue gas analysis, the following should be respected:

- the boiler being checked should be running in steady state conditions
- the flue gas analyser should be switched on at least 3 minutes before testing (time to auto-calibrate) with the probe located in fresh air
- the point in which the probe is inserted for analysis has to be at a distance of approximately twice the stack diameter or, alternatively, as directed by the boiler manufacturer.
- the water trap should be completely empty and positioned vertically
- before switching off the instrument, extract the probe and wait at least 3 minutes (the CO value has to drop below 10 ppm)
- Before returning the instrument to its place, clean the water trap and relative hose; if water is present in the hose clean the latter by blowing inside.

WARRANTY CERTIFICATE

WARRANTY

The CHEMIST flue gas analyzer is guaranteed for **24 months** from purchasing date including the internal electrochemical sensors which are also guaranteed for **24 months** from purchasing date.
Seitron undertakes to repair or replace, free of charge, those parts that, in its opinion, are found to be faulty during the warranty period. The products which are found defective during the above mentioned periods of time have to be delivered to Seitron's Laboratories carriage paid. The following cases are not covered by this warranty: accidental breakage due to transport, inappropriate use or use that does not comply with the indications in the product's instruction leaflet.
Any mistreatment, repairs and modifications to the product not explicitly authorized by Seitron shall invalidate the present warranty.

IMPORTANT

For the product to be repaired under Warranty, please send a copy of this Certificate along with the instrument to be repaired, together with a brief explanation of the fault observed.

- -

Space reserved for user

Name: ____

Company: ____

User's notes:

____

____

____

____

____

Date: __________ S.N.: [ ]

seitron

Via Prosdocimo, 30 – 36061 – BASSANO DEL GRAPPA (VI) ITALY Tel. (+39).0424.567842 Fax. (+39).0424.567849

@IST01380ESE 018350A0 270810

seitron s.r.l.
Via Prosdocimo, 30 I-36061 BASSANO DEL GRAPPA (VI) ITALY Tel.: +39.0424.567842 Fax.: +39.0424.567849
http://www.seitron.it e-mail: info@seitron.it