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APPENDIX

TECHNICAL MANUAL

AC32M

CHEMILUMINESCENT NITROGEN OXIDE ANALYZER

- JUNE 2010 -

Environnement S.A
L'instrumentation de l'environnement

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EPA Reference designation

Environnement S. A. Model AC32M NO2 Analyzer *Automated Reference Method:* **RFNA-0202-146**

“Environnement S. A. Model AC32M Chemiluminescent Nitrogen Oxides Analyzer," operated with a full scale range of 0 - 500 ppb, at any temperature in the range of 10°C to 35°C, with a 5-micron PTFE sample particulate filter, with response time setting 11 (automatic response time), and with or without the following option: internal permeation oven.

[*Federal Register:* Vol. 67, page 15567, 04/02/02]

CHAPTER 1
GENERAL INFORMATION

1. GENERAL INFORMATION

Rack version

Tight box version

Figure 1–1 – AC32M Presentation

1.1 GENERAL INFORMATION

1.1.1 PRESENTATION

The AC32M analyzer is a nitrogen monoxide and nitrogen dioxide analyzer designed to monitor low concentrations in ambient air.

The monitor operates on the principle that nitrogen oxide (NO) will emit light (chemiluminescence) in the presence of highly oxidizing ozone molecules.

The instrument provides many advantages by use of recent advanced electronical and optical technologies and requires very limited maintenance.

The sample analyzed is obtained through a teflon tube (external diameter: 6 mm) connected to the rear of the unit. The sample is acquired by means of an external pump.

The measurement is indicated by a liquid crystal display on the front panel.

1.1.2 DESCRIPTION

1.1.2.1 Front panel

The front panel includes :

A general switch

A backlit liquid crystal display

- 16 lines 40 columns (240 x 128 pixels),
- the display provides the measurement values according to the selected unit, the information required for programming and testing the unit.

A keyboard with 6 touch-sensitive keys

The control and check functions of the unit are performed using the keyboard.

- the function of each key varies with the different screens or menus.

Figure 1–2 – Keyboard and display

1.1.2.2 Rear panel

The rear panel of the AC32M contains all the electrical connectors and gas inlets/outlets.

Gas inlets/outlets (right hand-side)

- Sample inlet to be analyzed is composed of a fitting for 4/6 mm tube associated with a dust filter holder (3) containing a teflon filtering membrane. The filter is located inside the analyzer for the tight box version. This inlet is sealed when the NO2 or NH3 permeation bench options are vailable (Figure 1–3 et Figure 1–5).
- "Span gas" inlet is composed of a 4/6 fitting (4) used to connect an external span gas, supplied at atmospheric pressure.
- "Zero air" inlet (5) for connection of a gas free from all traces of NO or NO_2 supplied at atmospheric pressure.
- "Pump outlet" composed of a 4/6 fitting (6) used to connect the external pump.

ATTENTION : The pump outlet must be linked to the activated charcoal cartridge. The unused fitting on the pump is the vent.

Optional:

- Zero air inlet for permeation bench – calibration checking (7) (Figure 1–3 and Figure 1–5).
- The inlet / outlet (12) and (13) to connect rack NH3S2 option (Figure 1–5). The rear panels of AC32M and rack CNH3 must be connected together according to the scheme :
  - CNH3 ▶ AC32 with CNH3 ▶ AC32
  - AC32 ▶ CNH3 with AC32 ▶ CNH3

An excess flowmeter (14) enables to control the necessary permanent excess.

Electrical connections and equipment (left hand-side)

- The mains power supply unit is composed of a 3-pin plug used to connect a normal cord and the general fuse: 3.15 A/220 V or 6.3 A/115 V (1).
- 1 or 2 SUB D 37-points plugs to connect recorders and external devices (9) (ESTEL board option).
- 1 SUB D 9-points plug enables to connect the rack $CNH3_{S2}$ option to à AC32M (15) (Figure 1–5).
  - Besides, these plugs are also used to connect:
    - Current or voltage analog output of measurements,
    - Remote control of checking cycles of the analyzer,
    - Information output (dry contact) in case of alarm,
- 1 standard plug with 25 pins for COM1 (RS 232 or RS 422) and COM2 (RS232) serial links (10).
- 1 supply plug of external pump (8).

Ventilation device (2) and (11)

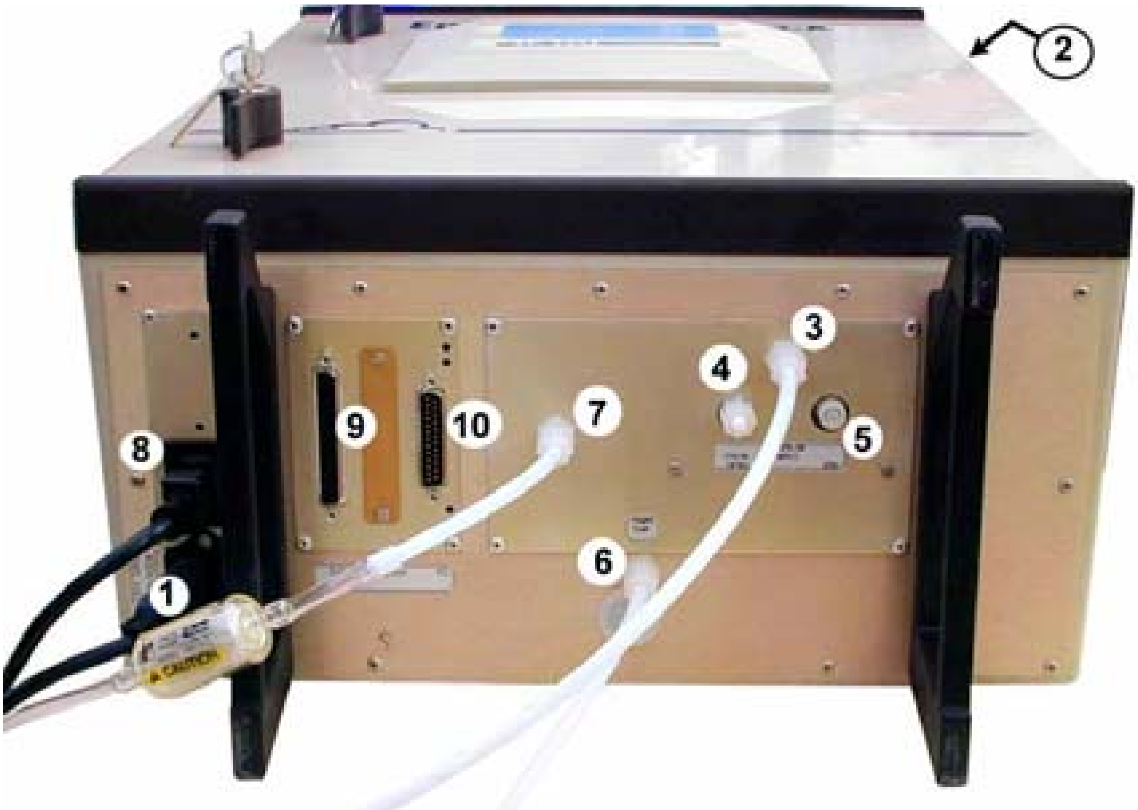
- Ventilation consists of two removable grids, two acrylic filters, two fans (inside the instrument) in the rack version, and one fan in the tight box version.

Figure 1–3 – Rear panel with NO2 bench option

Figure 1–4 – Normal rear panel

Figure 1–5 – Rear panel with permeation bench option and connection to $CNH3_{S2}$ rack

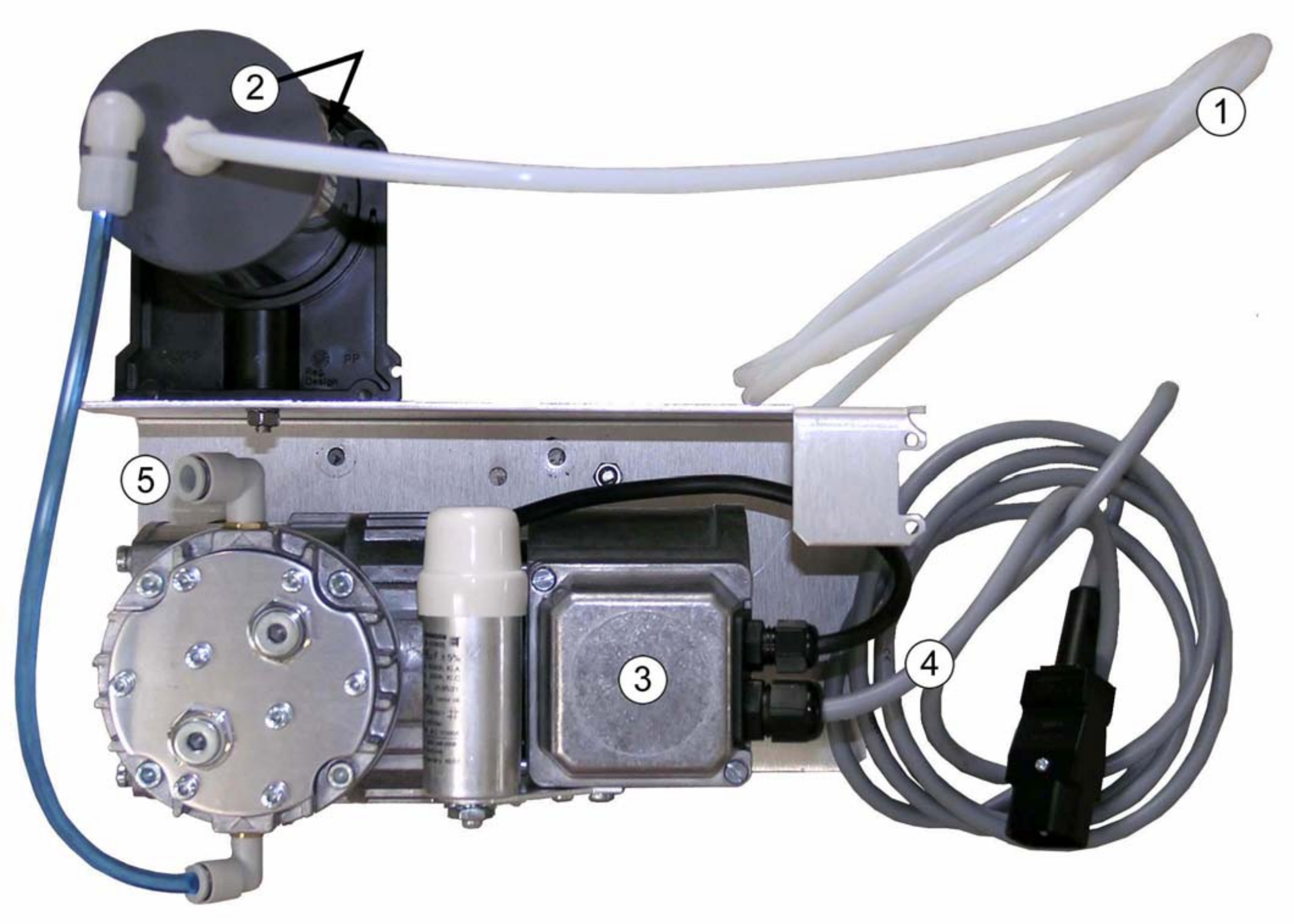
Rack version



Tight box version

Figure 1–6 – Rear panel (rack version) and inferior panel (tight box version)

(1) mains power supply, (2) ventilation device, (3) inlet of sample to be analyzed, (4) span gas inlet, (5) zero air inlet, (6) pump output, (7) zero air inlet for permeation bench – calibration checking, (8) supply plug of external pump, (9) SUB D 37 points plug to connect recorders and external devices through ESTEL board, (10) normal 25-pin plug for serial link, (11) ventilation device, (12) and (13) connection of $CNH3_{S2}$ rack, (14) excess flow meter, (15) SUB D 9 points plug to connect $CNH3_{S2}$ rack, (16) 18 points output if SOREL board option available.



(1) pump connection of AC32M, (2) refillable filter cartridge, (3) diaphragm pump, (4) pump power supply, (5) pump outlet.

Figure 1–7 – Standard pump

1.1.2.3 Internal components overview

The internal components are accessed by simply unscrewing the screws at rear and lateral sides of the analyzer and removing the upper cover.

Physical part

This includes the following equipment:

- the solenoid valve filter set (1 and 2),
- the measurement chambers block (9), which holds in the cycles solenoid valves.
- the ozone generator (13),
- the $NO_2 \rightarrow NO$ converter (12).

After passing through the dust filter (1), the sample to be analyzed passes through the solenoid valves set (2). An external pump creates a vacuum pressure in the measurement chamber (9).

A "dring sample" option enables to prevent any water interference. It consists in inserting a permapure dryer between the dust filter and the zero/etal SV block.

The sample is sucked into this chamber through a 0.31 mm diameter restrictor which limits the flow rate to 42 l/h in direct circuit for the NO cycle, through the $NO_2 \rightarrow NO$ converter (12) for the NOx cycle, and through the pre-reaction chamber for the reference cycle (sample mixed with ozone).

The ozone circuit is composed of dust filtering cartridge (15), an air dryer (10) and a discharge ozone generator (13).

The air containing ozone is sucked into the measurement chamber through a 0.1 mm diameter restrictor which limits flow rate to 4 l/h.

In case of NO2 permeation bench, a teflon block (16) is added to the existing permapure block to ensure the permanent ventilation of the permeation tube located inside the block (17).

Electronic part

The cut-out power supply (11) supplies the module board with 24V through the mains power supply connecting board (7).

The Module board (6) holds in:

- The microprocessor, which carries out the acquisition data processing, the calculations, the automatisms and the interfaces control.
- The analog to digital converter which receives, through a multiplexer, signals given by the optical sensor (photo multiplier) as well as signals given by the pressure sensors (8) and the temperature sensors.
- The main power supplies + 15 V, - 15 V, + 5 V and the temperature regulation circuits.

The (optional) ESTEL board (4), contains analog and logical inputs/outputs.

The RS4i serial interface board (3) enables direct dialog with a micro-computer or through a modem link or with a printer.

The interface board (14) necessary for interconnections between Module board, keyboard and display is located on the front panel of the analyzer. For the tight box version, this interface board is located inside the door.

The measurement chamber, protected by a cover, is heated to 60°C ; control is performed at mother board level.

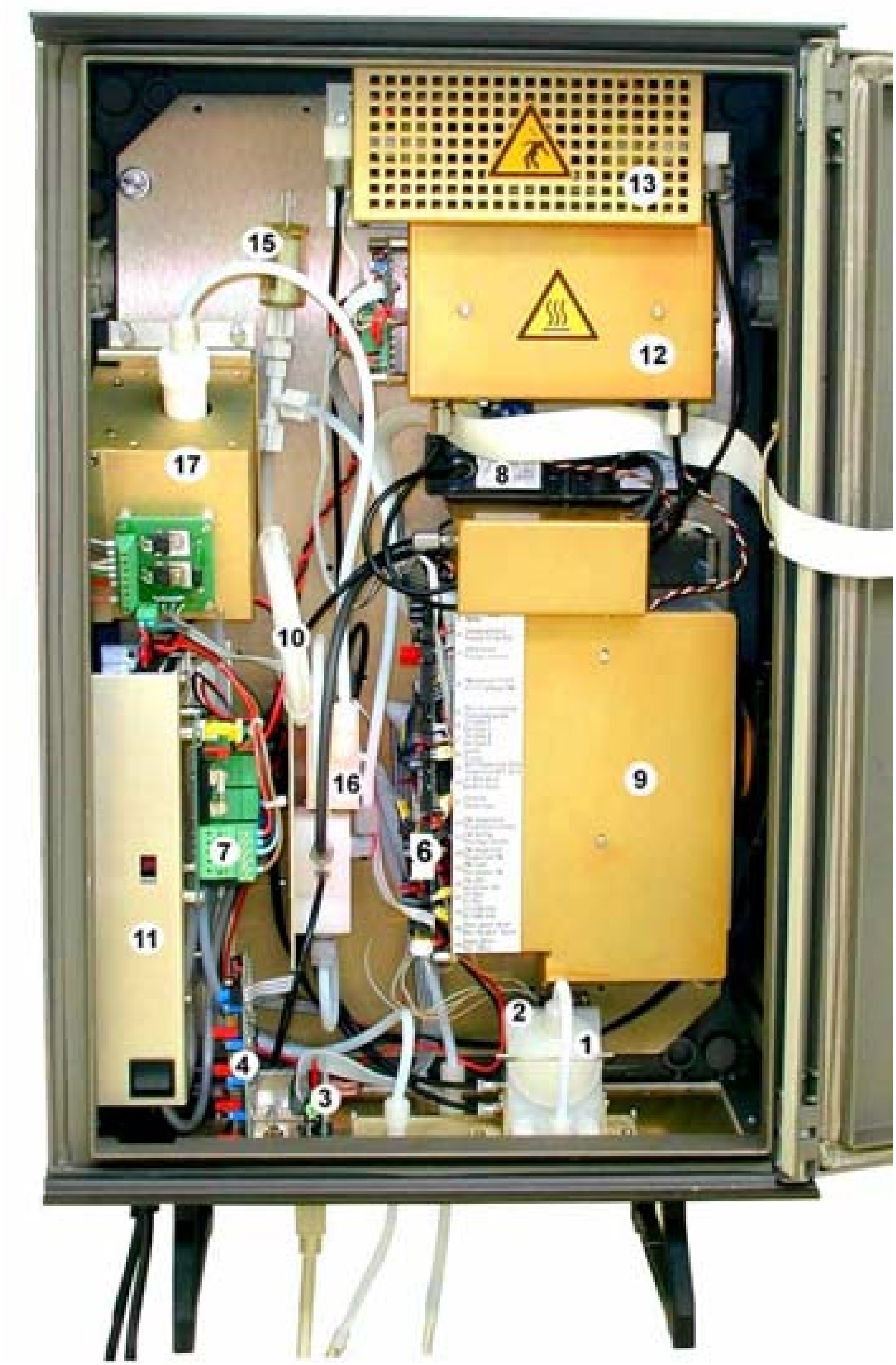


Figure 1–9 – Internal components of tight box version

(1) dust filter, (2) zero/span SV block, (3) RS4i board, (4) ESTEL board or SOREL board (options), (6) Module board of AC32M, (7) SBT board, (8) pressure sensors, (9) measurement chamber, (10) dryer of ozone generator, (11) 24 volts power supply, (12) NOx converter oven, (13) ozone generator, (15) dust filter of ozone generator, (16) extra Teflon block - option of NO2 permeation bench, (17) permeation bench.

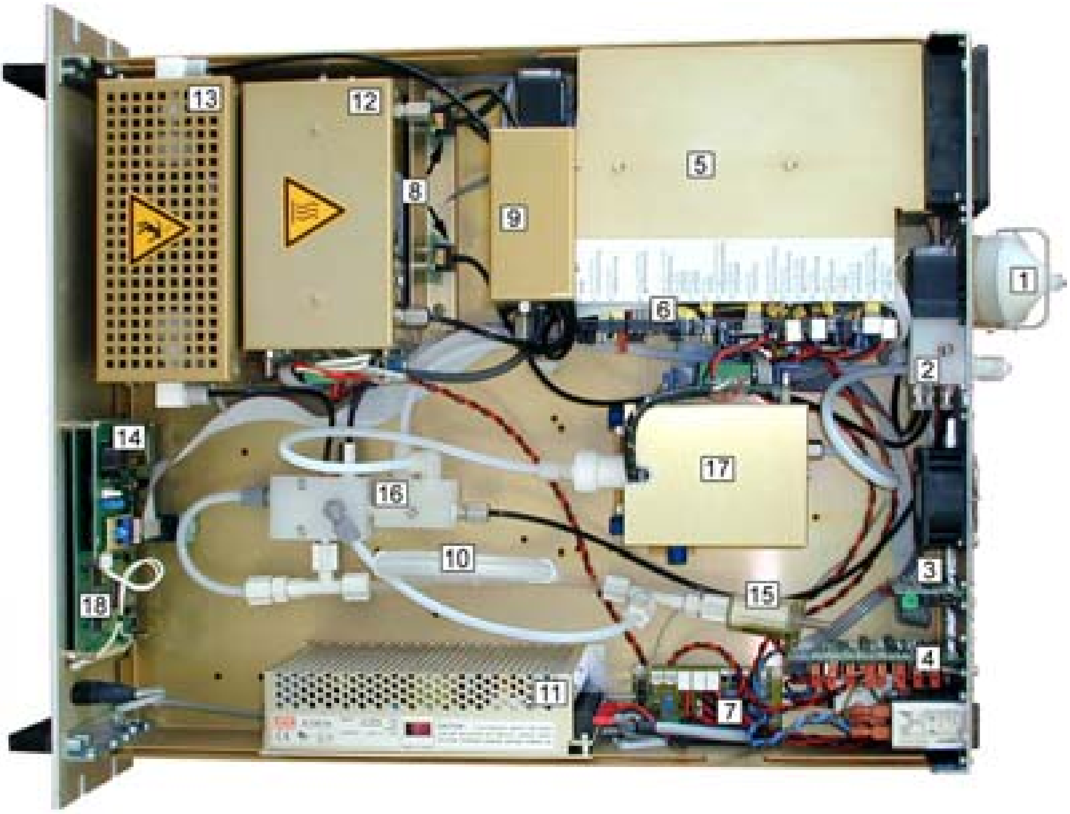


Figure 1–10 – Internal components of AC32M with NO2 permeation bench

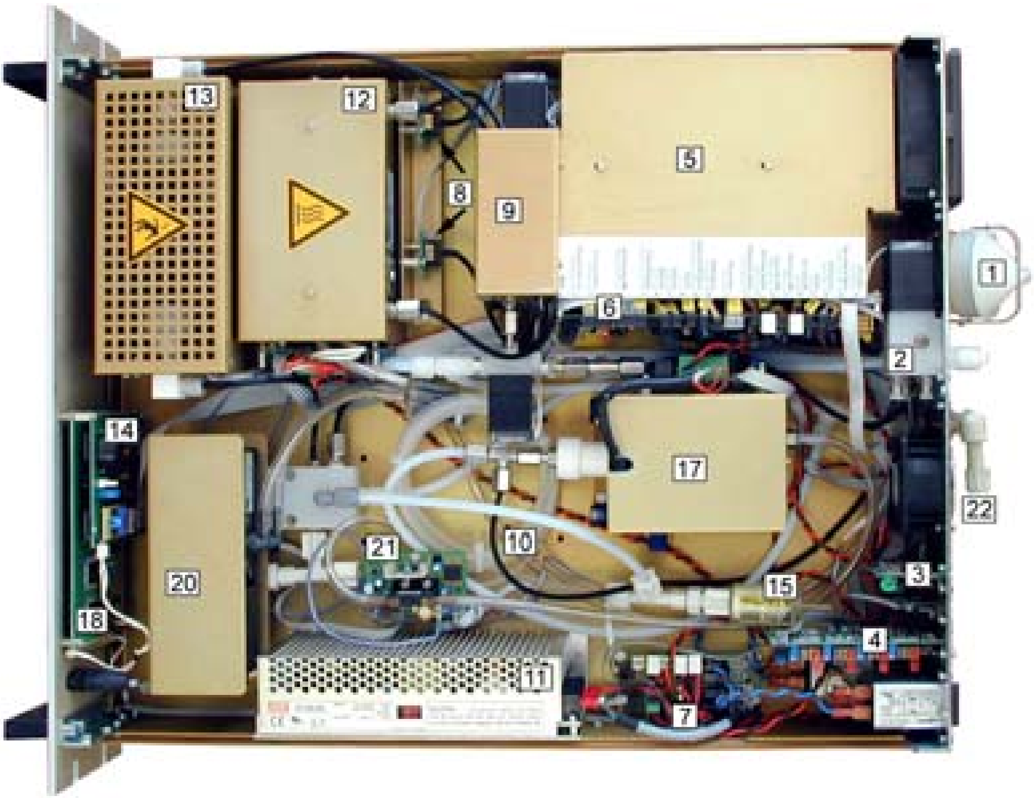


Figure 1–11 – Internal components of AC32M with permeation bench and CNH3 rack option

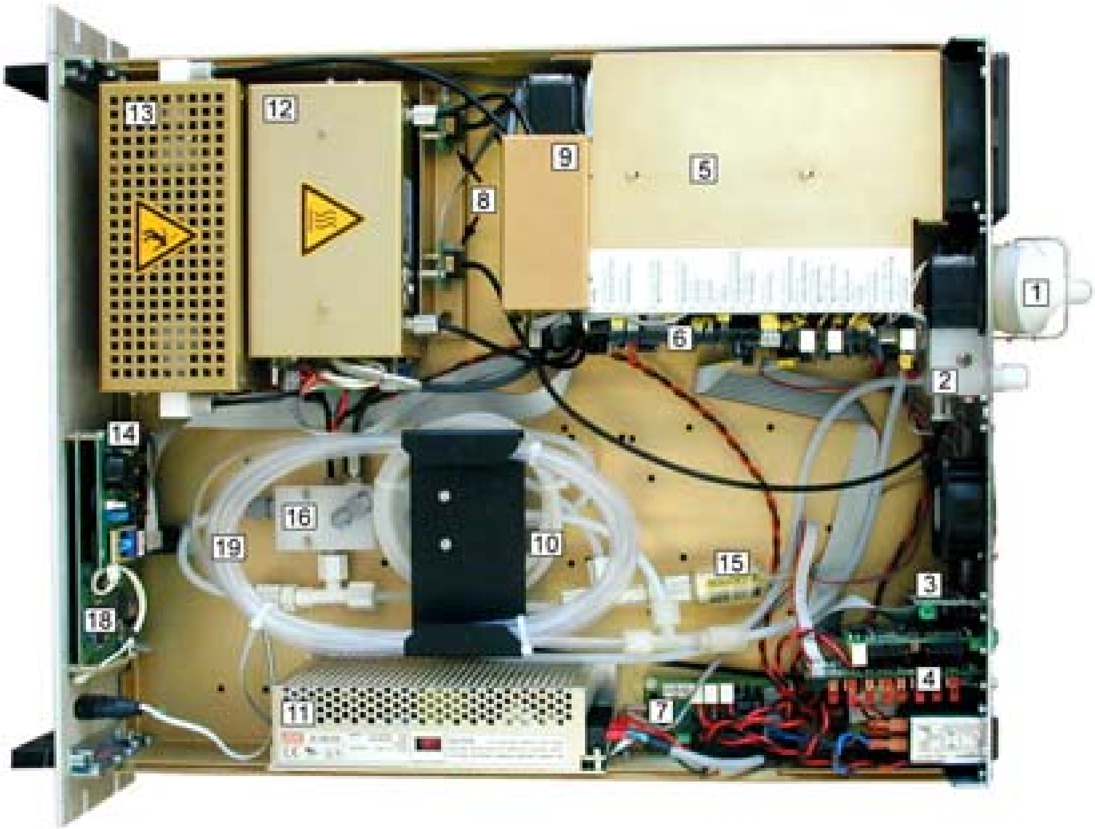


Figure 1–12 – Internal components of AC32M with sample dryer option

(1) dust filter, (2) zero/etal SV block, (3) RS4i board, (4) ESTEL board (option) or SOREL board, (5) Photomultipler block, (6) Module board AC32M, (7) SBT board, (8) pressure sensors, (9) measure chamber, (10) dryer of ozone generator, (11) 24 volts power supply, (12) NOx converter oven, (13) ozone generator, (14) interface LCD board, (15) dust filter of ozone generator, (16) extra Teflon block, (17) permeation bench, (18) LCD screen, (19) sample dryer (option), (20) pump of NH3 permeation bench (option), (21) board of fluid control (NH3 bench option), (22) flowmeter of excess.

1.1.3 VARIOUS OPERATING MODES

1.1.3.1 Standard

- Programmable measurement range from 0.05 to 50 ppm with a lower detectable limit of 0.4 ppb.
- Remote-controlled (optional) or programmable automatic calibration and zero sequences.
- Automatic response time enabling very good monitoring of the pollutant evolution and improvement of the minimum detectable.
- Automatic checking of the parameters influencing metrology, and correct operation testings.
- Measurement values stated in ppb / µg m^{-3} or ppm / mg.m^{-3} units, according to the programmed measurement range.
- Memorization of average measurements with a programmable period (capacity: 5700 averages).

1.1.3.2 Optional

The monitor can be equipped with the following options:

- Analog outputs of NO - NOx and NO_2 concentration (ESTEL board option).
- Remote signaling of the « measurement », « zero », « calibration » and « alarm » functions (ESTEL or SOREL board options).
- A NO2 permeation bench.
- A CNH3 rack (with or without NH3 permeation bench),
- A drying sample (excepted when NH3 rack available),
- Ozone killer,
- RAM extension,

The analyzer is also available in tight box version.

1.1.4 ASSOCIATED EQUIPMENT

- Pumping assembly,
- Recorders.

1.2 CHARACTERISTICS

1.2.1 TECHNICAL CHARACTERISTICS

Measurement range	:	User programmable (maximum 50 ppm)
Unit	:	Ppb, ppm or µg.m $^{-3}$, mg.m $^{-3}$ (programmable)
Noise (σ)	:	0.2 ppb (automatic response time)
Minimum detectable limit (2σ)	:	0.4 ppb (automatic response time)
Minimum response time (0-90 %)	:	40" (programmable)
Zero drift	:	< 1 ppb./ 24 hours
Span drift	:	< 1% / 7days
Linearity	:	± 1%
Repeatability	:	1 %
Sample flow rate	:	0.66 l/min.
Ozone flow rate	:	0,06 l/min.
Chamber negative pressure (with KNF PM 7837-026 pump)	:	200 mb (absolute value)
$NO_2 \rightarrow NO$ converter	:	Molybdenum at 340°C
P.M. temperature	:	Controlled at 10°C by default
Reaction chamber temperature	:	60°C
Display	:	LCD 240 x 128 text and graphic mode
Control keyboard	:	6 function keys
Input/Output signals (ESTEL board option)	:	4(optional) analog outputs of 0-1 V, 4-20 mA 4 analog inputs of 0-2.5V 4 remote controls inputs 6 output of potential free NO contact
Digital output (RS4i board option)	:	2 communication ports - RS232 or RS422 format
Power supply	:	220 V - 50 Hz (115 V - 60 Hz on request) + ground
Consumption	:	400 VA maximum
Operating temperature	:	+ 5°C to + 40°C
Alarms checks	:	– permanent – Detection and indication of malfunctions : temperature, flow rates, electrical parameters, – Exceeding of NO, NOx, NO_2 measurement thresholds (programmable).
Tests and diagnostics for maintenance	:	Selection on keyboard and display of all the parameters.
Backup saving time of stored data in RAM and of the real time clock	:	> 6 months with built-in battery
Pump assembly and activated charcoal filter	:	External

1.2.2 OPERATING CHARACTERISTICS

Not applicable.

1.2.3 STORAGE CHARACTERISTICS

– Temperature : – 10 °C to 60 °C.

1.2.4 INSTALLATION CHARACTERISTICS

1.2.4.1 Links between units

The AC32M uses the external links and power supplies illustrated here below:

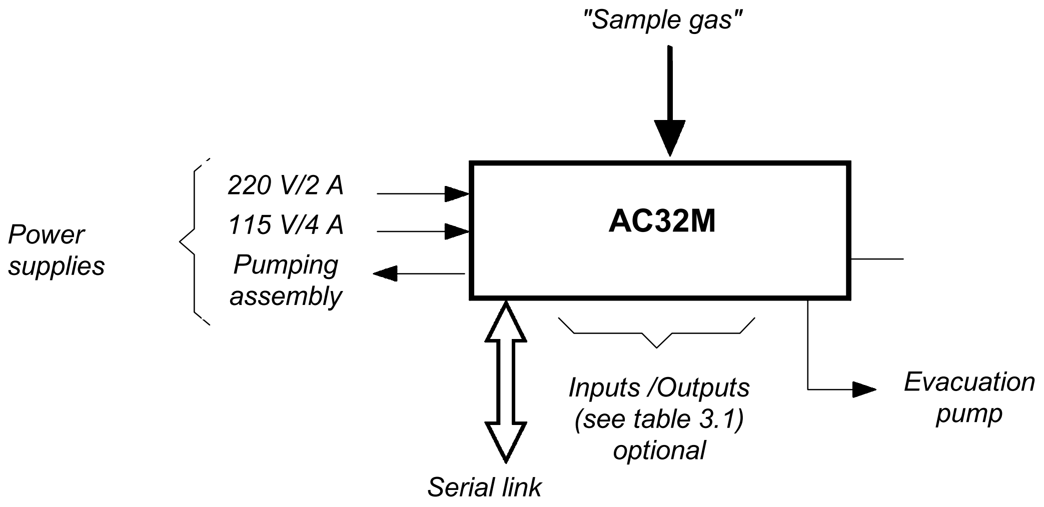


Figure 1–13 – Links between units

1.2.4.2 Dimensions and weight

The analyzer is a standard 19 inch, 3 unit rack high.

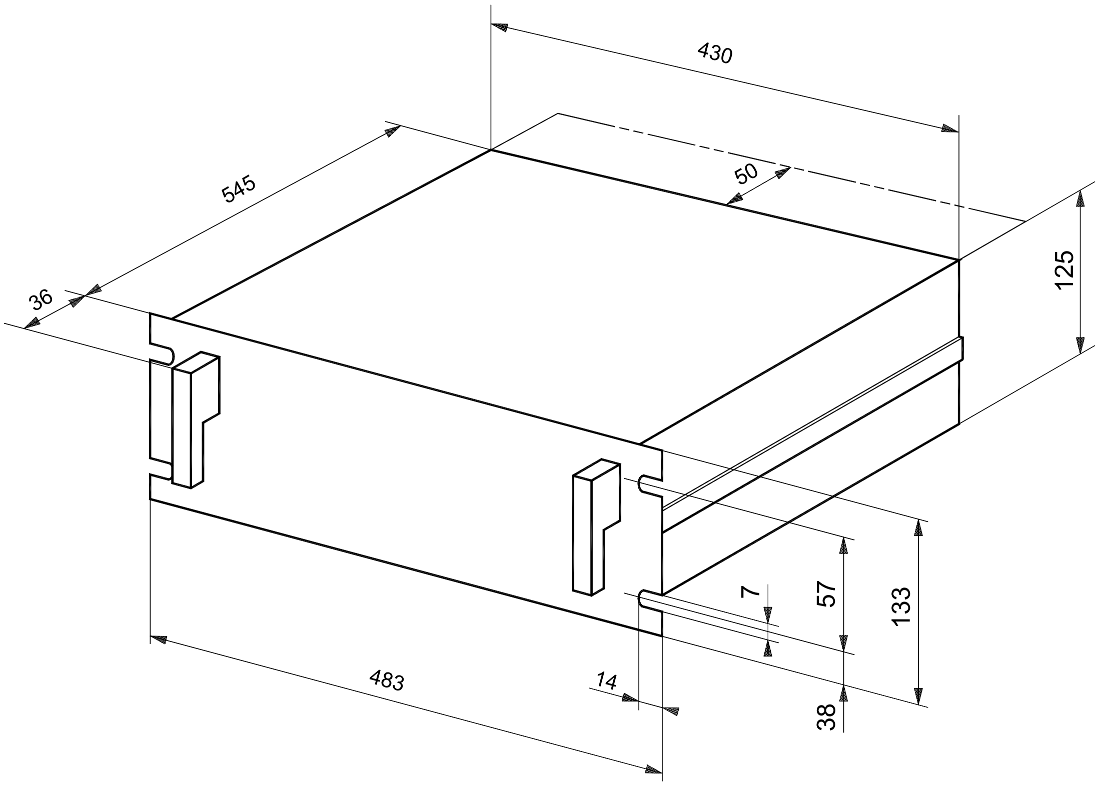
- Length: 591 mm (rack version) 430 mm (tight box version)
- Width: 483 mm (rack version) 225 mm (tight box version)
- Height: 133 mm (rack version) 740 mm (tight box version)
- Weight: 25 kg (rack version) 21 kg (tight box version)

1.2.4.3 Handling and storage

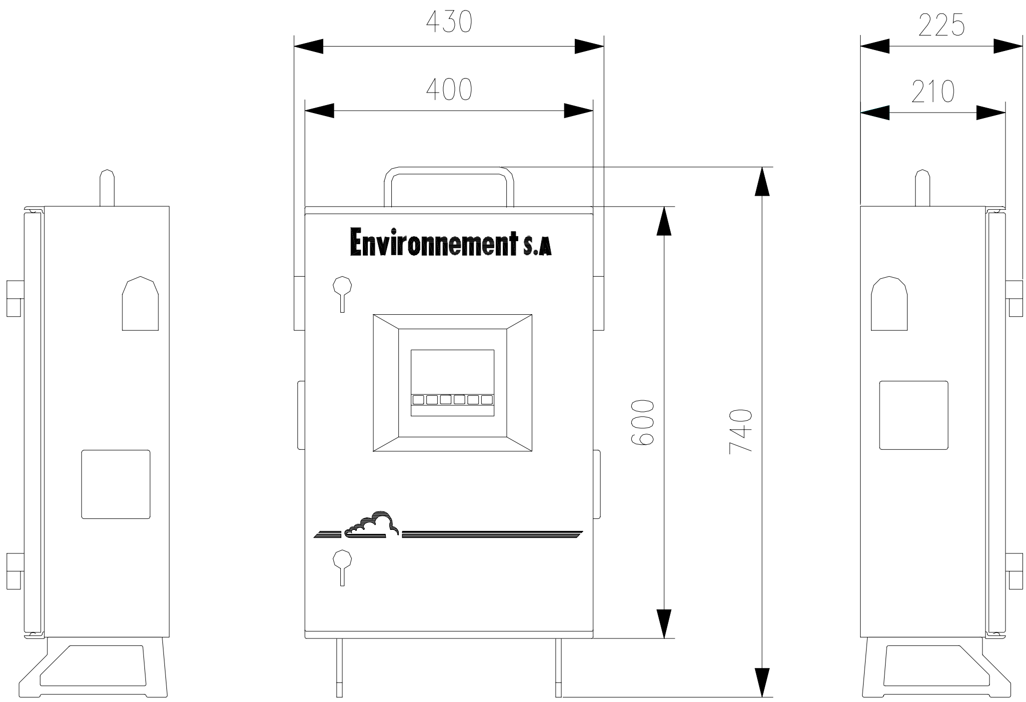
The AC32M analyzer must be handled with care to avoid damage the various connectors and fittings on the real panel.

Make sure that fluid inlets and outlets of the analyzer are protected with covers whenever storing the monitor.

The analyzer is stored in a foam-packed case provided for this purpose.



Rack version



Tight box version

Figure 1–14 – Outline dimensions

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CHAPTER 2

PRINCIPLE OF OPERATION

2. PRINCIPLE OF OPERATION

2.1 PRINCIPLE OF MEASUREMENT

Chemilunescence corresponds to an oxidation of NO molecules by ozone molecules:

$$NO + O_3 \rightarrow NO_2^* + O_2$$

The return to a fundamental electronic state of the excited NO_2^* molecules is made by luminous radiation in a 600-1200 nanometers spectrum:

$$NO_2^* \rightarrow NO_2 + hv$$

This energy can be lost by chock with some molecules found in the sample (Quenching). By lowering the pressure in the reaction chamber, the probability of chock is reduced in order to obtain a better chemical luminous yield.

The reaction chamber is separated from the detector by an optical filter, which selects only the radiation of wavelengths greater than 610 nanometers, thus eliminating interferences due to hydrocarbons.

The radiation measurement is made by a photo-multiplier. The electrical signal it delivers is amplified and digitized for treatment by the microprocessor.

In order to be measured by chemiluminescence, the NO_2 must be first transformed into NO. A molybdenum oven is used to carry out this reduction according to the following reaction:

$$2NO_2 \xrightarrow{Mo} 2NO + O_2$$

Sampling is made by a pump placed at the end of the circuit.

The measurement is done in 3 cycle steps:

- Reference cycle: the sample is led into a pre-reaction chamber to be blended with ozone. The NO molecules contained in the gas are oxidized into NO_2 before entering the reaction chamber. The signal thus measured without chimiluminescence by the PM, may be considered as “zero air” measurement and used as reference signal.
- NO cycle: the sample is directly led into the measurement chamber where NO oxidation by ozone is carried out. The signal measured by the PM is proportional to the number of NO molecules contained in the sample.
- NO_x cycle: The sample flows through the converter oven; then it is blended with ozone inside the reaction chamber The signal measured by the PM is proportional to the number of NO and NO_2 (from NO reduction) molecules contained in the sample.

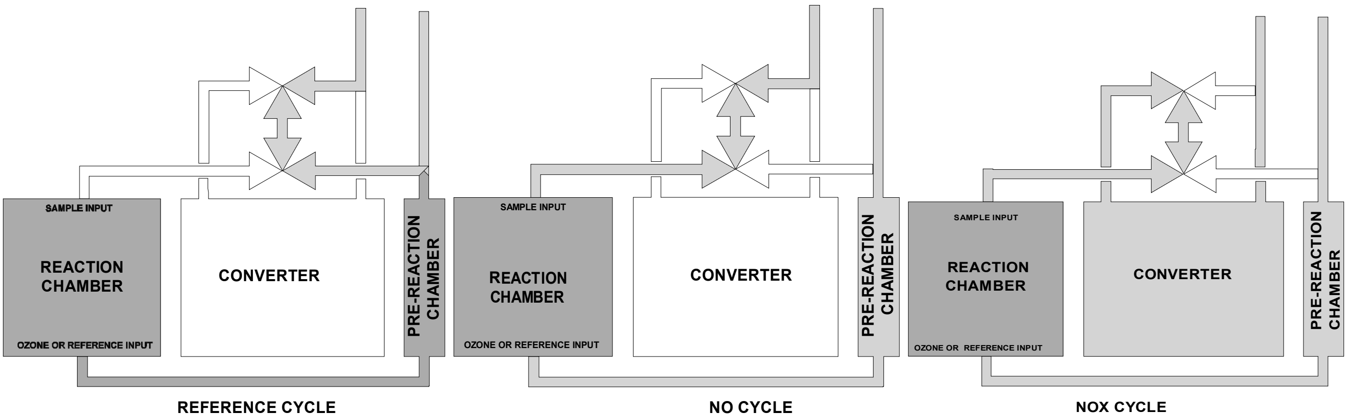

Figure 2–1 - Cycles

The ozone necessary for the chemiluminescence reaction is generated by a discharge ozone generator.

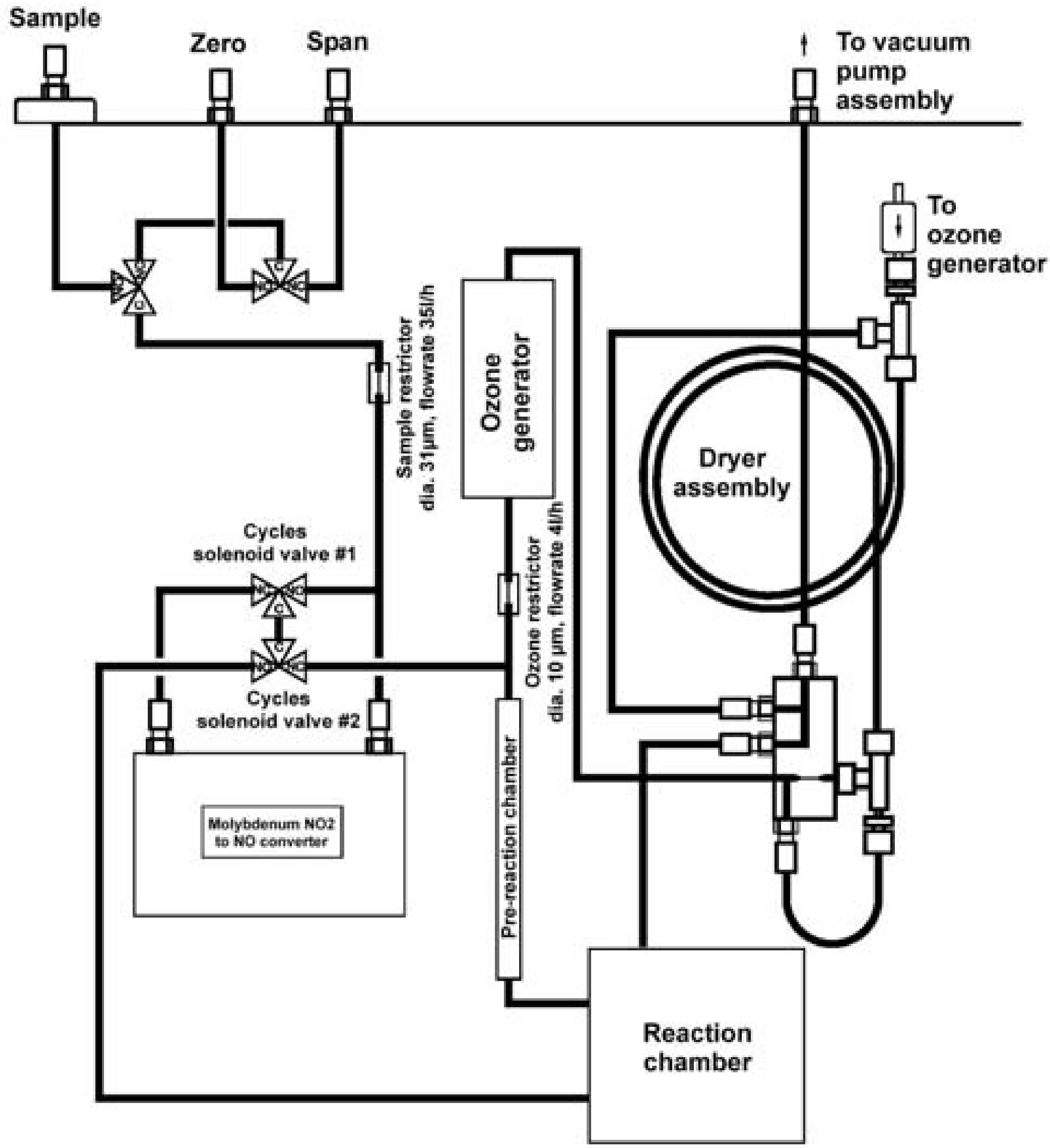

Figure 2–2 – General principle diagram

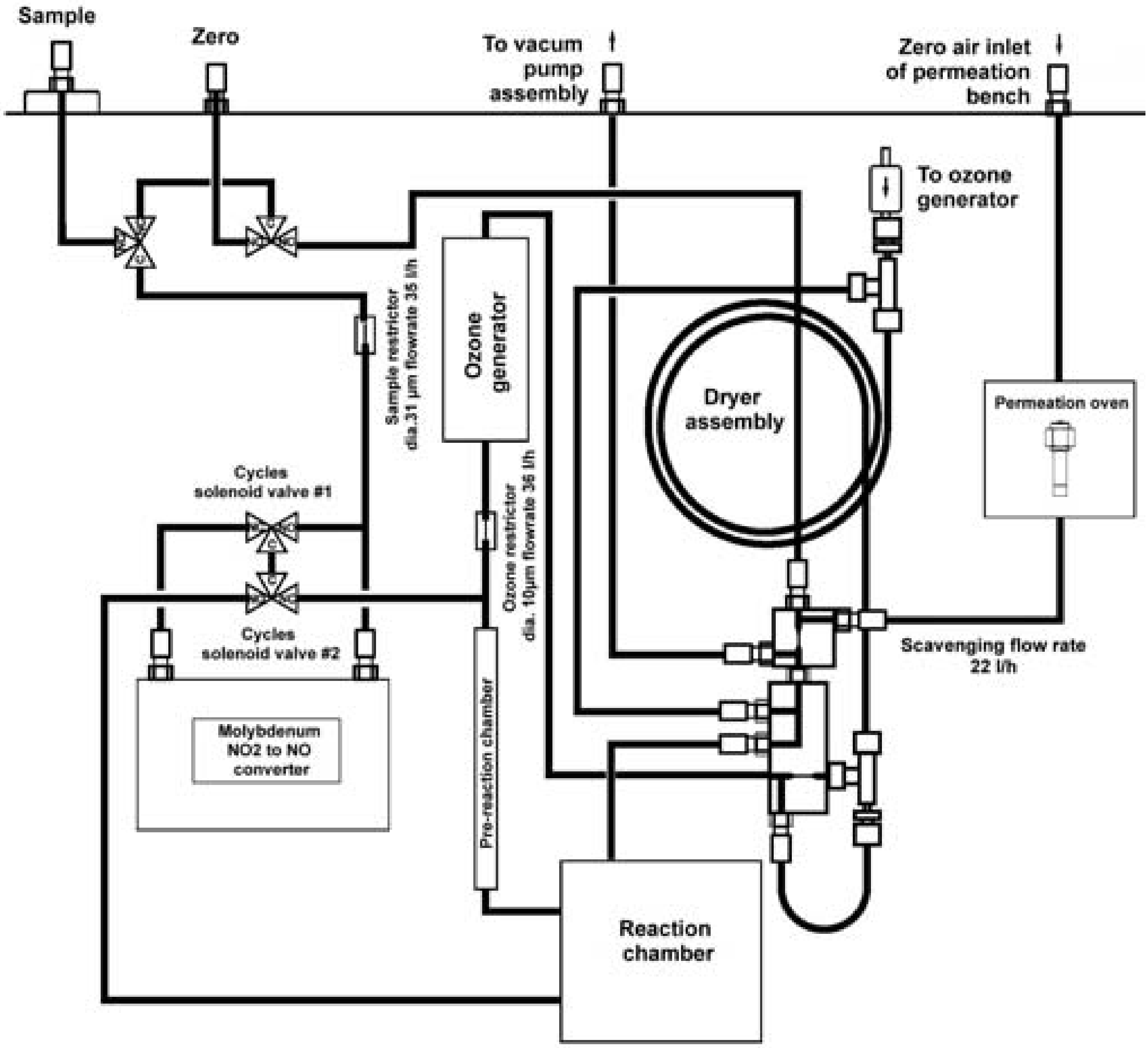

Figure 2–3 – General principle diagram with optional permeation bench

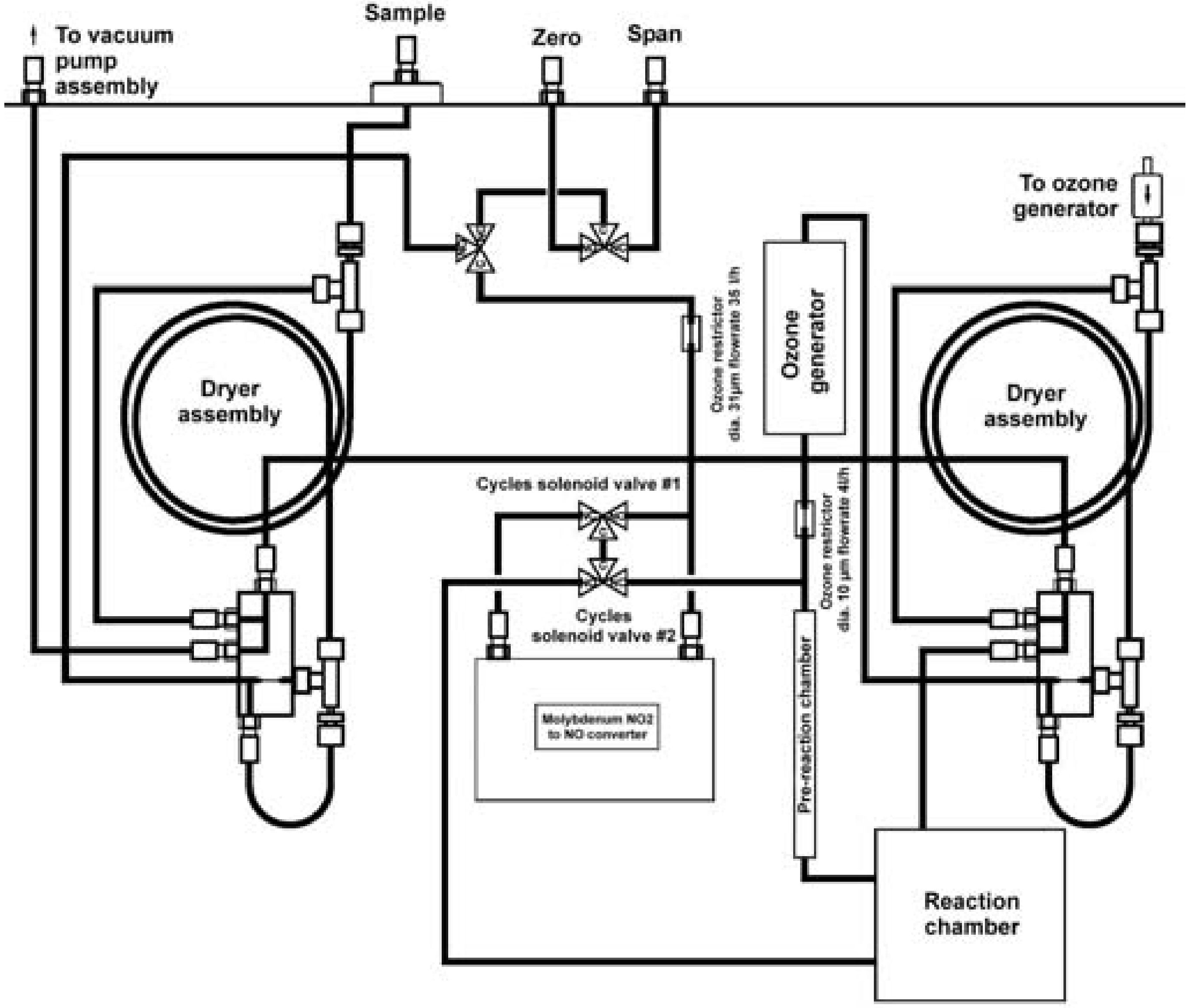

Figure 2–4 - General principle diagram with optional sample dryer

2.2 DESCRIPTION OF MAIN MODULES

Converter

The converter is made of a sealed container filled with grid-shaped molybdenum. The assembly is thermal insulated by ceramic wool. The oven temperature is controlled to 340 °C by an electronic board, a heating ring and a built-in PT100 probe.

Control is made at 340°C because it takes into account thermal loss associated to thermal gradient due to lower temperature air scavenging, as well as body thermal insulation. The molybdenum grids are at a temperature of 320°C.

P.M. block

This component includes three sub-assemblies:

– The reaction chamber:

  This chamber is composed of a gold-plated aluminum block, on which a glass window is flanged at the PM side. PM block air tightness, on the chamber side, is ensured by a flanged filter disk.

  This chamber block includes:

  - Cycles solenoid valves,
  - Fluid inlets / outlets,
  - Ttwo restrictors located at the sample and ozone inlets to control the flow of each fluid circuit (42 and 4 l/h),
  - Two pressure sensors, upstream and downstream, to check flow rate,
  - One heating element and one temperature sensor are used to regulate the temperature of the chambers at 60°C.

– A P.M. enclosure:

  The photomultiplier tube is placed inside the enclosure and separated from the reaction chamber by an optical filter. The enclosure is cooled down and kept at constant temperature (10°C by default) with two Peltier-effect thermoelectric elements.

– A footing:

  In the lower part of the block, there is a footing used to connect the High Voltage power supply and the P.M. tube output signal, as well as an electronic board to format P.M. signal.

Gas inlets S.V. assembly (optional)

A two 3-way solenoid valves assembly is used to select one of the three analyzer inlets: « sample », « zero air » or « span gas ». Protection against dust is ensured by a PTFE filter connected to the "sample" inlet.

Dryer

The PERMA-PURE dryer operates according to a drying process, which could be called "permeation-distillation". The dryer is made of two concentric tubes, the internal tube is made of a special water-permeable polymer. The molecules are transferred, through this tube, from the side where the water content is the highest to the side where it is the lowest. To ensure a lower partial water pressure on the outside of the polymer tube, the tube periphery is placed under vacuum condition and rinsed by a portion of the flow rate leaving the tube.

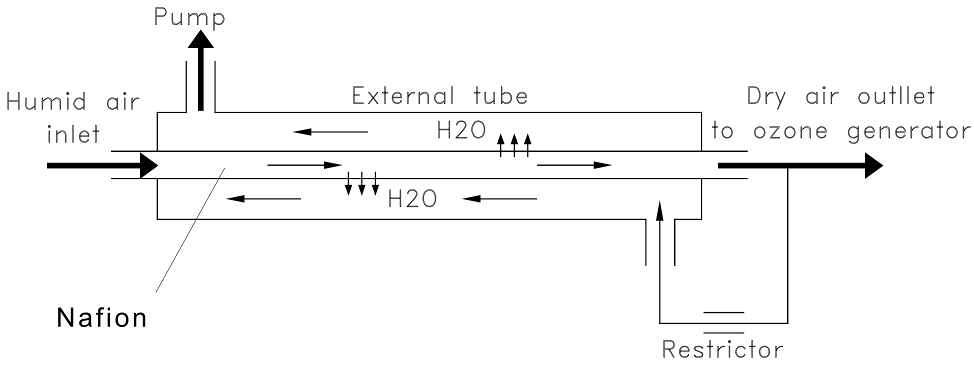

Figure 2–5 – PERMA-PURE dryer

Ozone generator

The ozone generator is formed by two cylindrical, coaxial electrodes. The internal electrode, made of a stainless steel cylinder, is connected to the HV (4.5 KV) circuit. The external electrode is a glass cylinder covered with a thin metal sheet connected to the ground. The assembly is secured by two PTFE pieces with vacuum tightness ensured by O-rings. The dry air circulating between the electrodes is oxidized and transformed in part into ozone. The electrical power supply is provided by an electronic board and a HV transformer.

2.3 SIMPLIFIED FLOW CHART OF MAIN PROGRAM

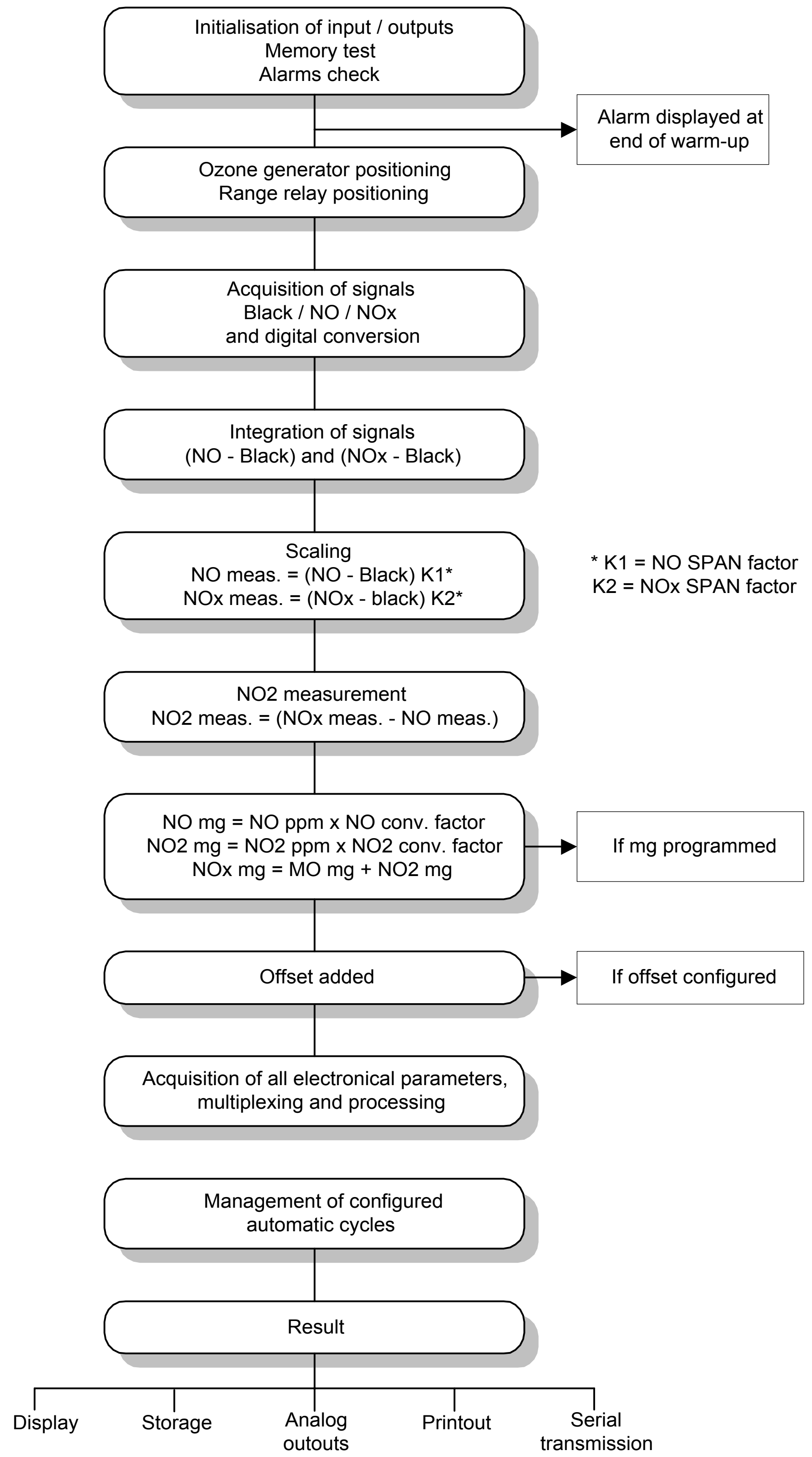

Figure 2–6 – Simplified flowchart of the main program

2.4 RESPONSE TIME

In order to optimize its metrology, AC32M is equipped with a software function called "automatic response time" that enables measurements filtering, depending on evolution of concentrations.

This response time is set to 11 by default, because it corresponds to analyzer optimum response giving both quick answer and detectable minimum.

2.4.1 PRINCIPLE

The response time may be programmed from 01 to 20.

Two RT groups may be considered:

- from 01 to 10 = "manual" RT
- from 11 to 20 = "automatic" RT

From 01 to 10 : on each acquisition, every 5 seconds, a number of elements equal to RT replace the same RT number of oldest values in a group of 60 elements. Therefore, response times vary from 300 to 30 seconds.

To calculate theoretical value of this response time, it is necessary to divide: $\frac{300}{\mathrm{TR}}$.

The RT parameter enables to change the analyzer integration time. The greater the RT, the quicker the response. With the "manual" RT, the user is advised that, the greatest the RT, the noisier the measurement.

From 11 to 20: response time is weighted. See here below:

First, it is calculated an instantaneous reading average corresponding to the minimum response time.

$$[MES]_{AVERAGE} = \frac{1}{n}\sum_{1}^{n}[MEAS]_{INSTANTANEOUS}$$

n = number of instantaneous measurements; it depends on the programmed response time $[\mathrm{TR}]_{MIN}$.

Then, a weighted average between the filtered values ($[MEAS]_{FILTERED}$) and average measurements ($[MES]_{AVERAGE}$) is recursively calculated according to the formula:

$$[MEAS]_{DISPLAYED} = [MEAS]_{FILTERED(new)} = X[MEAS]_{FILTERED(old)} + Y[MEAS]_{AVERAGE}$$

When the difference ($[MEAS]_{FILTERED(old)} - [MEAS]_{AVERAYGE}$) exceeds a determined threshold, the value of Y is increased up to a 99 % maximum value which corresponds to a fixed response time of TR_{MIN}.

$$X + Y = 100\ \%$$

When ($[MEAS]_{FILTERED\ (old)} - [MEAS]_{AVERAGE}$) is below the threshold, the value of Y is progressively decreased.

The more stable is the measurement, the more X tends to 99 %.

2.4.2 PROGRAMMING THE RESPONSE TIME

The "automatic response time" function may be activated or inhibited in the *CONFIGURATION ⇨ Measurement mode* menu.

The minimum response time may also be modified in that menu.

See chapter 3 (§.3.3.4.2 "*CONFIGURATION ⇨ Measurement mode*") for more details about the way to program such functions.

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CHAPTER 3

OPERATING INSTRUCTION

3 OPERATING INSTRUCTION

(a) AC32M with built-in Dryer

(b) AC32M with permeation bench and CNH3 rack options

(1) Mains power supply, (2) external pump supply, (3) ESTEL connection (option), (4) SOREL board output (option), (5) serial link standard socket, (6) connection to rack $CHN3_{S2}$ (option)

Figure 3-1 - Electrical connections

Table 3-1 - DB37 and DB25 connectors link

RS232 / 422 SERIAL LINKS

COM1	COM2
2- TX	14- TX
3- RX	16- RX
4- RTS	7- GND
7- GND	
20- DTR	
21- TX	
11- RX	

ESTEL BOARD(S)

PIN N°	CONNECTION	PIN N°	CONNECTION
1	+ ANA OUTPUT 1	17	REMOTE CONTROL 3
2	+ ANA OUTPUT 2	18	REMOTE CONTROL 4
3	+ ANA OUTPUT 3	19	+5VCC
4	+ ANA OUTPUT 4	20	ANA OUTPUT GROUND
5	+ANA INPUT 1	21	ANA OUTPUT GROUND
6	+ANA INPUT 2	22	ANA OUTPUT GROUND
7	+ANA INPUT 3	23	ANA OUTPUT GROUND
8	+ANA INPUT 4	24	ANA INPUT GROUND
9-28	RELAY 6 CONTACT	25	ANA INPUT GROUND
10-29	RELAY 5 CONTACT	26	ANA INPUT GROUND
11-30	RELAY 4 CONTACT	27	ANA INPUT GROUND
12-31	RELAY 3 CONTACT	34	REMOTE CONTROL GROUND
13-32	RELAY 2 CONTACT	35	REMOTE CONTROL GROUND
14-33	RELAY 1 CONTACT	36	REMOTE CONTROL GROUND
15	REMOTE CONTROL 1	37	REMOTE CONTROL GROUND
16	REMOTE CONTROL 2		

NOTE : The relay contact outputs are normally open and potential free. The remote controls are made by closing a potential free dry contact. The analog inputs accept maximum 2.5 VCC.

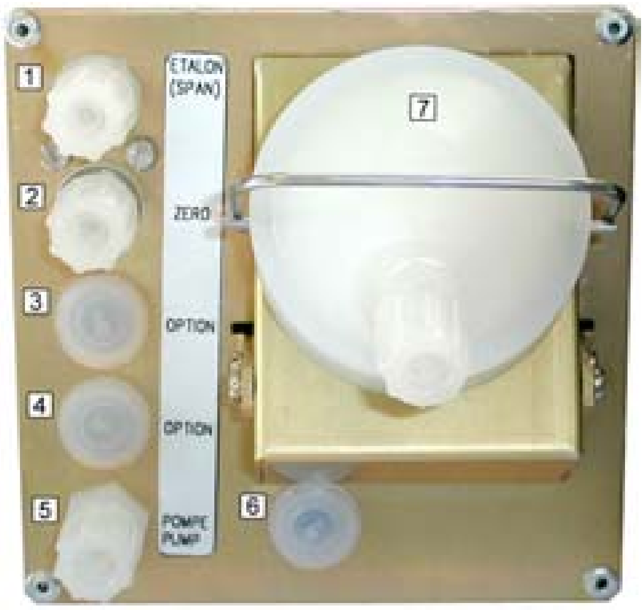
3.1 INITIAL START-UP

The monitor is checked and calibrated in the factory before delivery.

3.1.1 PRELIMINARY OPERATIONS

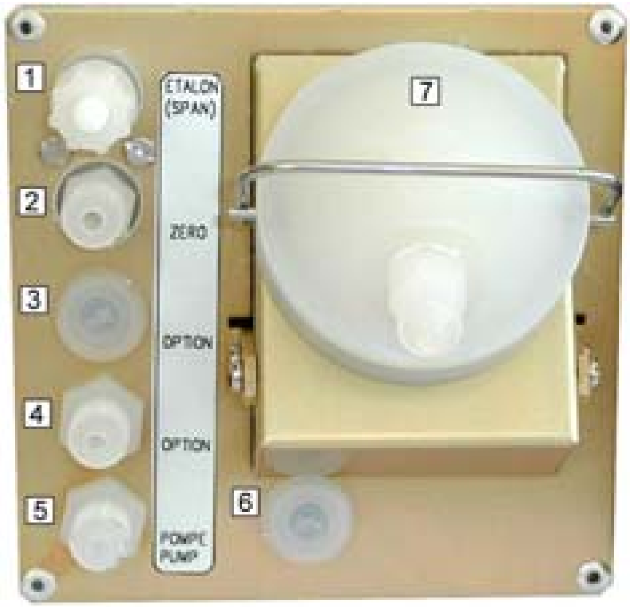
Start-up first consists in carrying out the following preliminary operations:

- Visually examine the interior of the instrument in order to ensure that no element has been damaged during transport.
- Remove the caps from the “gas” inlets and outlets on the analyzer (keep these aside for future storage, see Chapter 1.2.3).
- Using a Teflon tube 4/6 diam, connect the pump outlet to active charcoal cartridge present on the pump unit (see Fig 1.4)
- Connect the 4/6 Teflon air sampling tube to the "sample inlet" after having checked for the presence of a Teflon filtering diaphragm in the inlet dust filter.
- Check the presence of dust filter on OZONE GENERATOR inlet.
- Connect the digital outputs to the DB25 connector (see Table 3-1).
- Connect the analog inputs / outputs to DB37 connector(s) (see Table 3-1).
- Connect the logical inputs / outputs to the DB37 connector(s) (see Table 3-1).
- Connect the mains power supply cord to a socket: 230 V, 50 Hz + ground or 115 V, 60 Hz + ground according to the supply voltage specified in the order.
- Connect the power supply cord to the pump unit.
- Connect the analyzer linking Teflon tube to pump assembly.
- If the permeation bench option is available, insert the permeation tube.



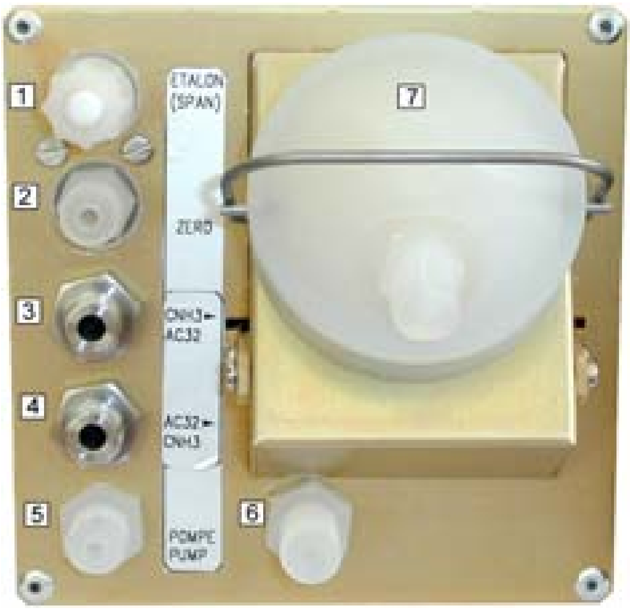
(1) span gas inlet, (2) zero air inlet, (3) possible option – sealed on this picture, (4) possible option – sealed on this picture, (5) pump output, (6) possible option – sealed on this picture, (7) sample inlet.

Figure 3–2 – Standard connection of fluids



(1) span gas inlet, (2) zero air inlet, (3) possible option – sealed on this picture, (4) zero air inlet of permeation bench, (5) pump output, (6) possible option – sealed on this picture, (7) sample inlet.

Figure 3–3 – Connection of fluids when NO2 permeation bench available



(1) span gas inlet – sealed in case of built-in permeation bench, (2) zero air inlet, (3) from $NH3_{S2}$ rack output, (4) to $NH3_{S2}$ rack input, (5) pump output, (6) zero air inlet of built-in permeation bench, (7) inlet of sample to be analyzed.

Figure 3–4 – Fluid connection when the options "bluit-in permeation bench" and "$NH3_{S2}$ rack" are available

3.1.2 PERMEATION TUBE INSTALLATION (WHEN OPTION AVAILABLE)

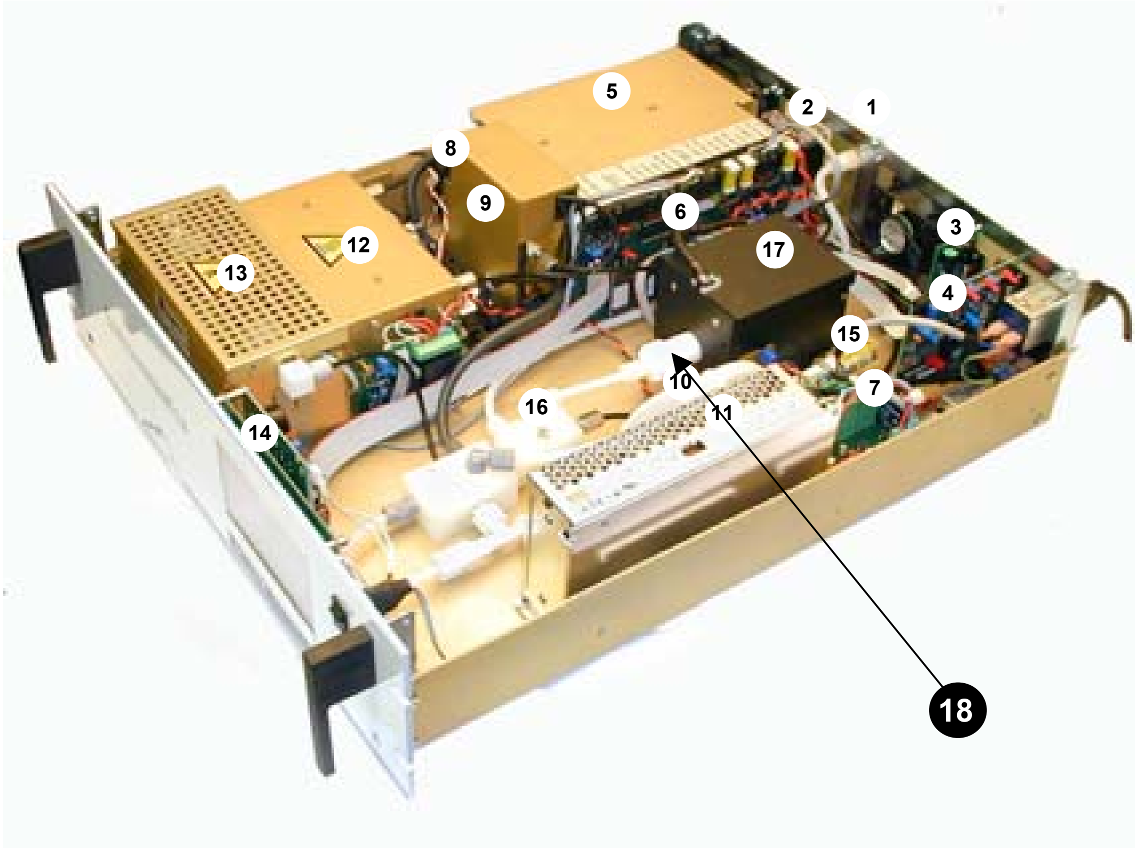
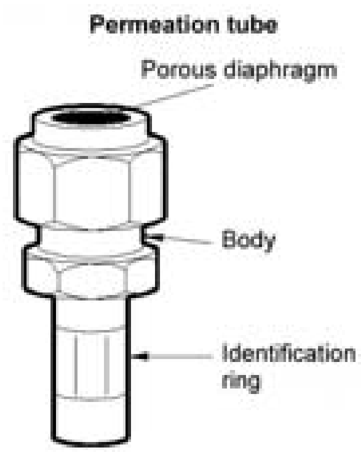


Figure 3-5 – Permeation tube installation



Pull the Teflon tap of permeation bench inlet (18). After putting it out of its housing, insert permeation tube in temperature-controlled enclosure of permeation bench, with porous diaphragm faced to the bottom.

NOTE : ***It is essential NOT TO OPEN permeation tube and NOT TO BREAK porous diaphragm.***

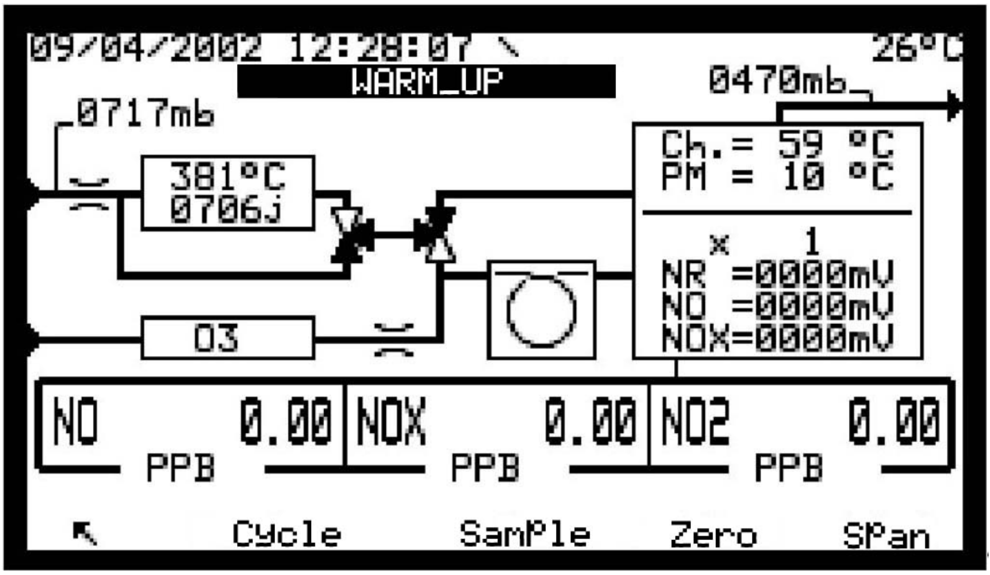
If analyzer has to be kept out of voltage, it is necessary to remove tube from permeation bench, place it in its delivery box with drying bags, and store it in a cool place.

3.1.3 STARTING UP THE UNIT

Push the ON/OFF switch located on the front panel. The analyzer passes into «warm-up» cycle (duration of this cycle is a function of time passed since the last switch off.)

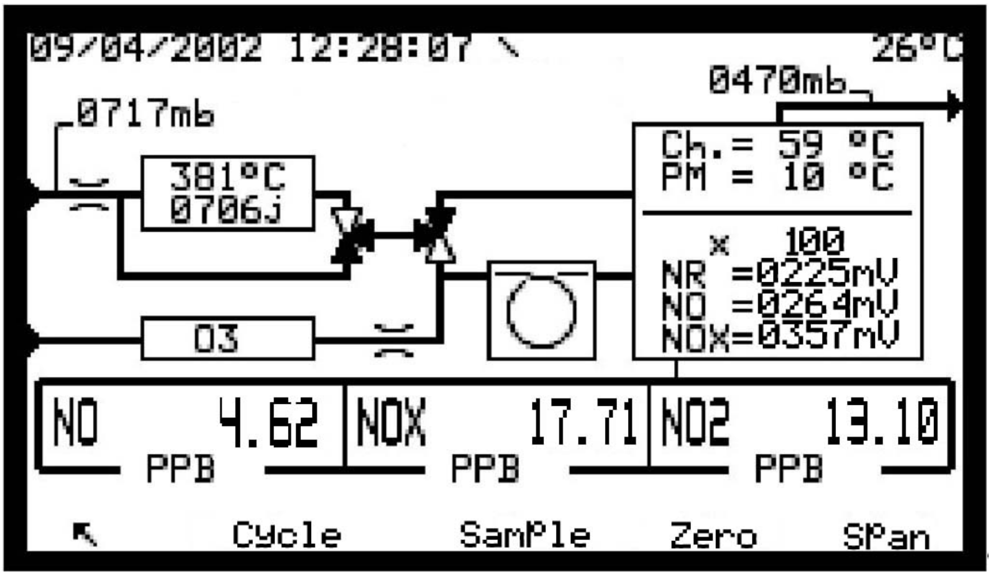
The two essential conditions for «warm-up» cycle termination are the following:

- the regulation temperatures of both photo-multiplier and NO→NO2 converter are correct,
- all the metrological parameters are within operational limits, the "WARM-UP" message blinks in upper part of the screen.



Display after warm-up:

Screen *MEASUREMENT ⇨ Synoptic*



STOP **After 8 hours without action on any key, the screen passes into stand-by mode. Pressing down any key makes it going back to display mode.**

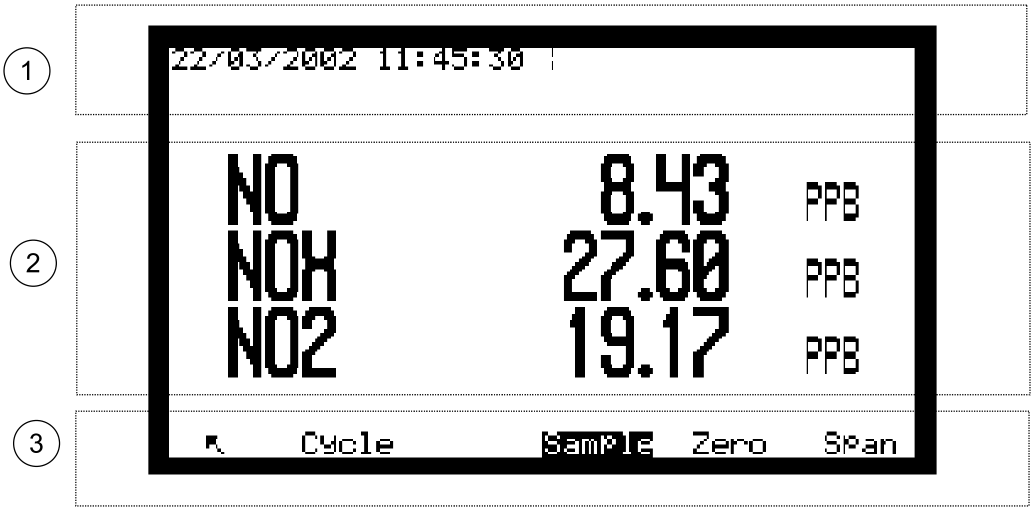
3.2 PROGRAMMING THE AC32M

3.2.1 SELECTION AND MODIFICATION OF THE PROGRAMMABLE PARAMETERS

The keyboard is located below the LCD screen. The bottom line gives the function of each key for the current screen.

The title of the menus and the selected fields are displayed in reverse video. By default, the first line of the menus is selected. In the next paragraphs, the selected parameters are symbolized in white on black background.

3.2.1.1 Screen areas definition



① Information area: displays the date and time in the top left corner. In the top right corner, the "WARM-UP" or "SPAN" messages blink. The "ALARM" message appears if an operating fault is detected among the instrument operating parameters.

② Measurement or configuration area: displays the measurement parameters (gas, value, units...) or the programmable parameters according to the selected menu.

③ Status area and keys functions: displays the keys function, the analyzer operating mode and the gas inlet ("Sample" in the above example).

NOTE : In the next paragraphs, the keys are symbolized by the icon or function displayed inside a rectangle.

3.2.1.2 Definition of the main functions of the 6 keys keyboards.

(The availability of these functions is context dependent)

↖	Used to display the previous menu or to abort the current operation (parameter programming), etc…)
↑	Used to select the required sub-menu or the parameter to be modified. Also used to increase the digit whose modification is in progress.
↓	Used to select the required sub-menu or the parameter to be modified. Also used to decrease the digit whose modification is in progress.
←	Moves the cursor to the left (only available during numerical parameters modification).
→	Moves the cursor to the right (only available during numerical parameter).
✳	Authorizes the selected parameter modification.
↵	Used to valid the selection or the value of the parameter whose modification is in progress.
🖨	Used to print out the current screen.

3.2.2 PROGRAMMING THE OPERATING PARAMETERS

3.2.2.1 Programming the digital parameters

Select the parameter with the ↓ or ↑ key in the appropriate menu, press down the ✳ key to access to the modification of the parameter, the 1st digit blinks. Select the digit to be modified with the ← or → key, then increase it with the ↑ key or decrease it with the ↓ key. The ↵ key validates the modifications of the selected field, the ↖ key cancels the modifications of the selected field.

3.2.2.2 Programming of configurable parameters with toggle list

Select the parameter with the ↓ or ↑ key in the appropriate menu, press down the ✳ key to access to the modification of the parameter, the field blinks. Select with the ↑ or ↓ key the wanted value in the toggle list. The ↵ key validates the modification of the selected field, the ↖ key cancels the modification of the selected field.

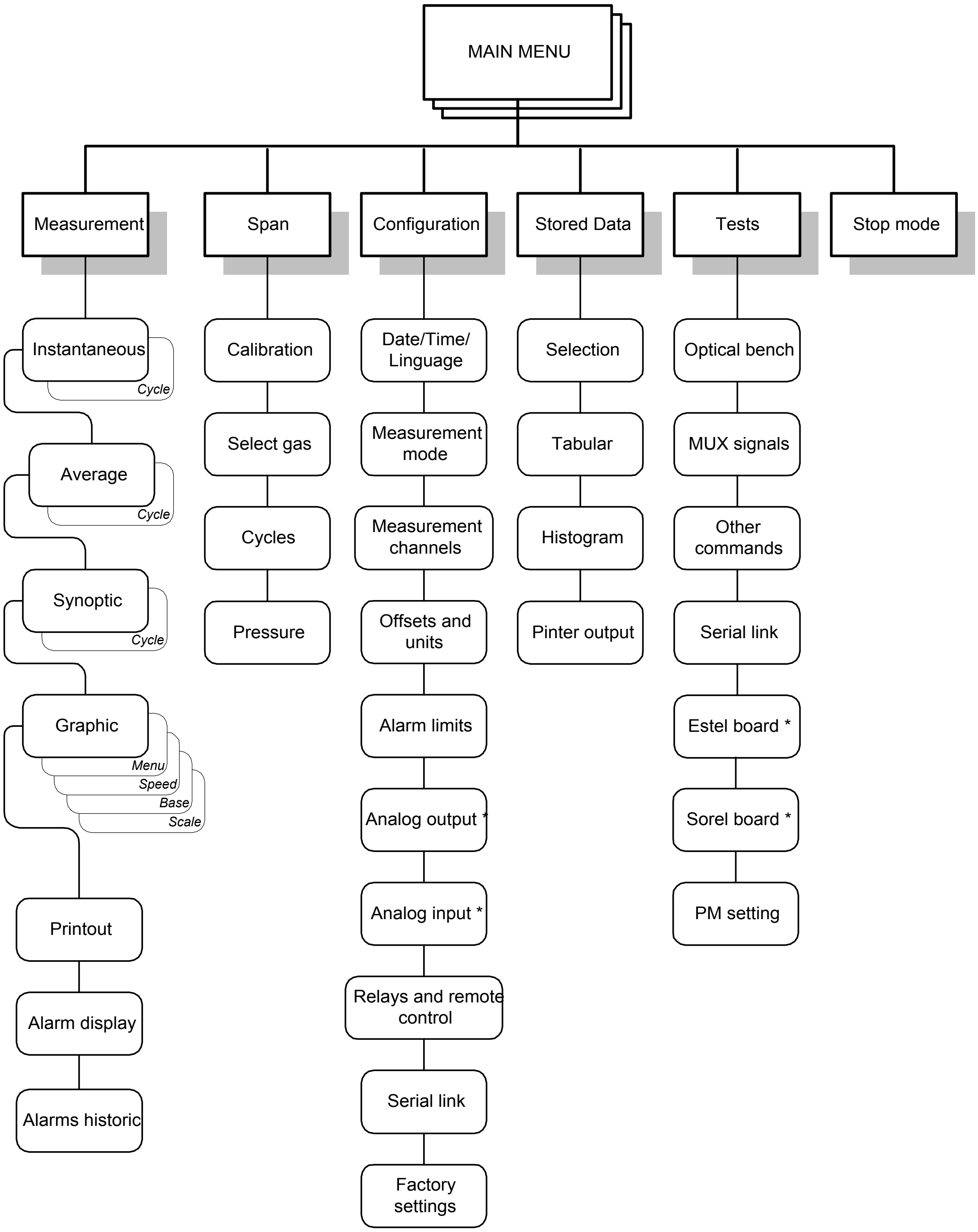


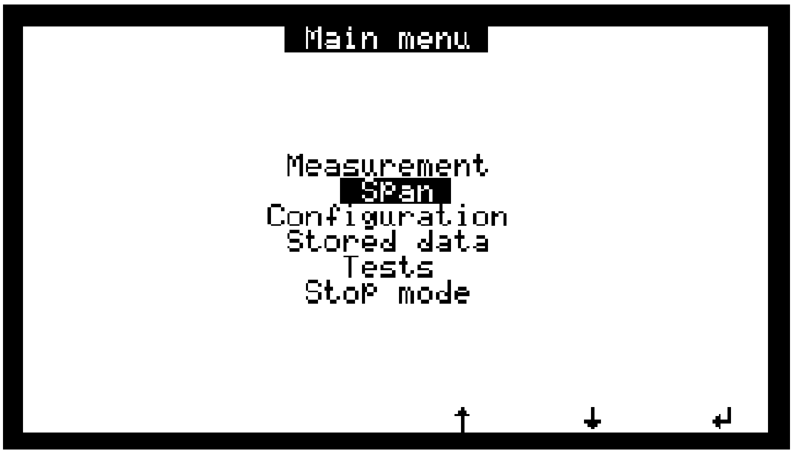
Figure 3-6 - Software overview

* Note: appears in the menu only when option present

3.3 DESCRIPTION OF THE DIFFERENT SCREENS

3.3.1 MAIN MENU

This screen is used to choose the menus giving access to the analyzer operating parameters.



Select the menu with the ↑ or ↓ key, validate the selection with the ↵ key.

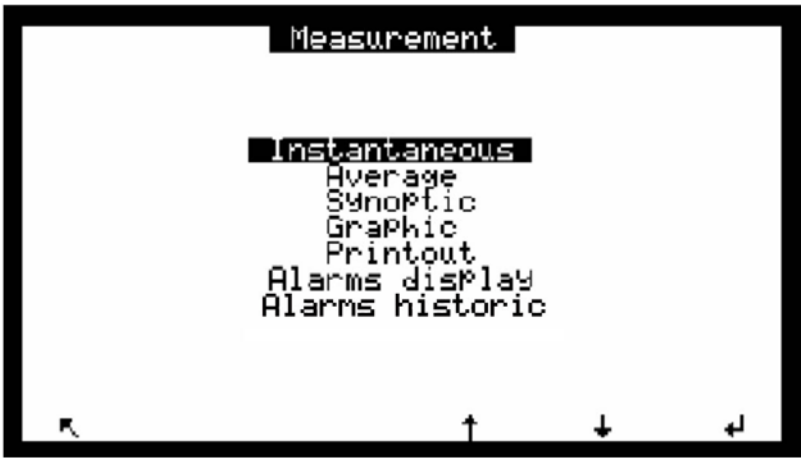
Example:

ACTION	DISPLAY	REMARKS
	Measurement Span Configuration Stored data Tests Stop mode	– Display of the main menu, the 1ST item is selected by default.
↓	Measurement **Span** Configuration Stored data Tests Stop mode	– Selection of the next item.
↓	Measurement Span **Configuration** Stored data Tests Stop mode	– Selection of the next item.
↵	**Date/Time/Language** Measurement mode Measure channels Offsets and units Alarms limits Analog outputs Analog inputs Relays and remote control Serial link Factory settings	– Validates the selection (Configuration menu) and displays the sub-menu.
↖	Measurement Span **Configuration** Stored data Tests Stop mode	– Goes back to the previous menu.

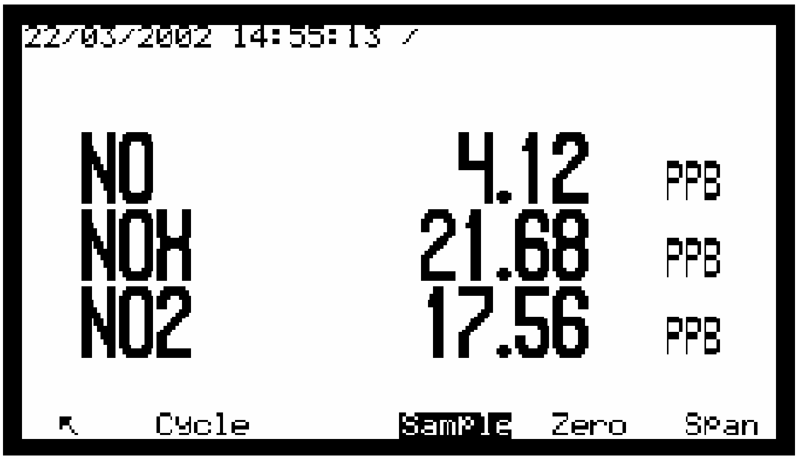
NOTE : In order to make the reading easier, when a sub menu is quoted in the text, the corresponding menu is reminded before (ex. CONFIGURATION ⇨ Date / Time /Language).

3.3.2 MEASUREMENT

This screen is used to choose the measurement display mode: instantaneous, average, synoptic (diagram) or graphic, to activate the real-time printout and to display possible alarms.



3.3.2.1 MEASUREMENT ⇨ Instantaneous



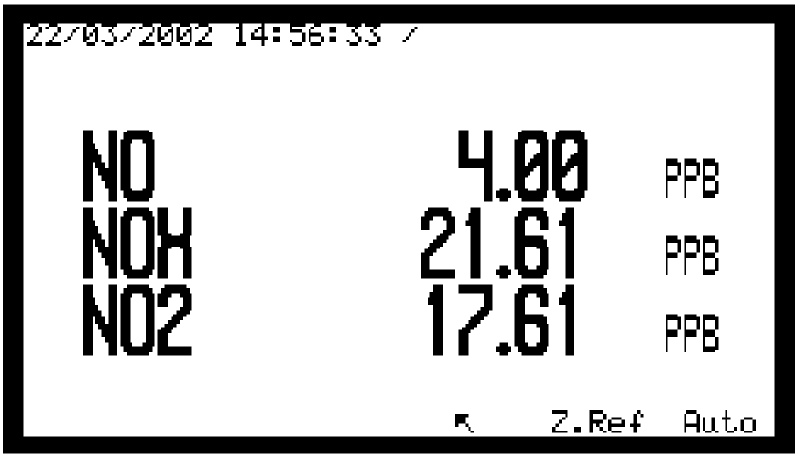
Definition of this screen specific keys

Sample — Selects the sample gas inlet. The sample is continuously sampled through the inlet dust filter. The measurement mode, the unit and the range are those chosen in the *Configuration* menu and the corresponding sub-menus. This mode can be interrupted at any time by starting an automatic cycle or by changing to another mode (ZERO, SPAN, et c.).

Zero — Selects the zero gas inlet. Allows manual trigger of measurement checking cycle on external zero air. The analyzer gives its reading on this filter, possibly increased by a programmed offset. This operation is used to check the response and the drift of the zero.

Span — Selects span gas inlet. Enables manual checking of span gas. Screen displays measured value on gas span increased by a possible programmed offset. This operation allows to check the stability and the drift of the analyzer and to determine if it is necessary to launch an auto-span cycle or to program its repetition period.

Cycle — Gives access to the screen allowing manual launching of measurement cycles.



Z.ref Enables to manually launch an automatic corrective cycle of zero in case of difference between electrical zero and zero gas

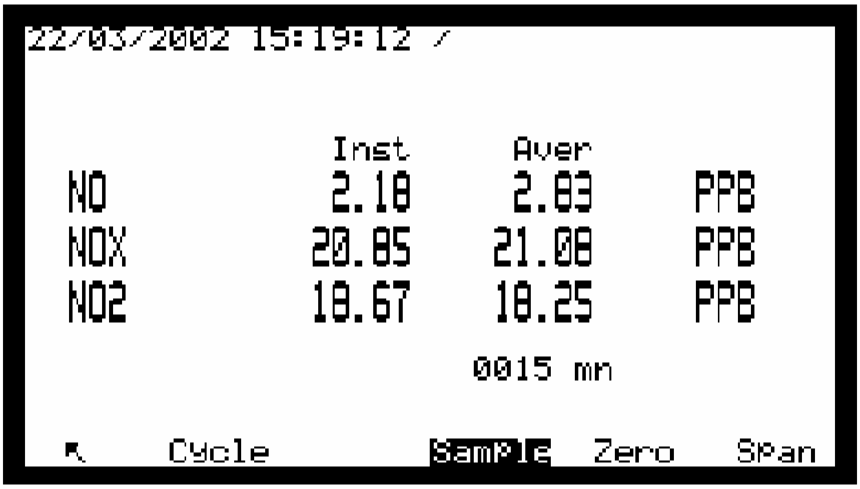
Auto Enables to manually launch an automatic span cycle. The analyzer adjusts automatically its span K-factor in order to equal its read values (minus the respective programmed offset) and span gas concentrations programmed for the selected gas inlet.
The span gas concentrations are programmable in the *Span ⇨ Select Gas* menu, the concentrations programmed for the used gas inlet are reminded in the top right corner of the screen (NO=XXXX, NOX=ZZZZ). Duration is programmed in the *Span ⇨ Cycles* menu. The cycle duration countdown is displayed in the right top corner of the screen. Cycle is achieved when countdown reached 0000 sec. Cycle can be shorten pressing down the Auto key. The new span factors are then memorized if the read values equal span concentrations ± 5 %.

This function launches the auto-span using the gas inlet selected before pressing down the Auto key. Thus, it is necessary to select the wished gas inlet before carrying out an auto span

To go back to normal measurement after manual calibration, press down the Sample key to select the sample inlet.

This function launches zero-adjust calculation at current gas inlet automatically. Adjustment values are reduced to +/- 5 ppb. To know adjustment values, refer to *CONFIGURATION ⇨ Measurement mode* menu.

3.3.2.2 MEASUREMENT ⇨ Averages

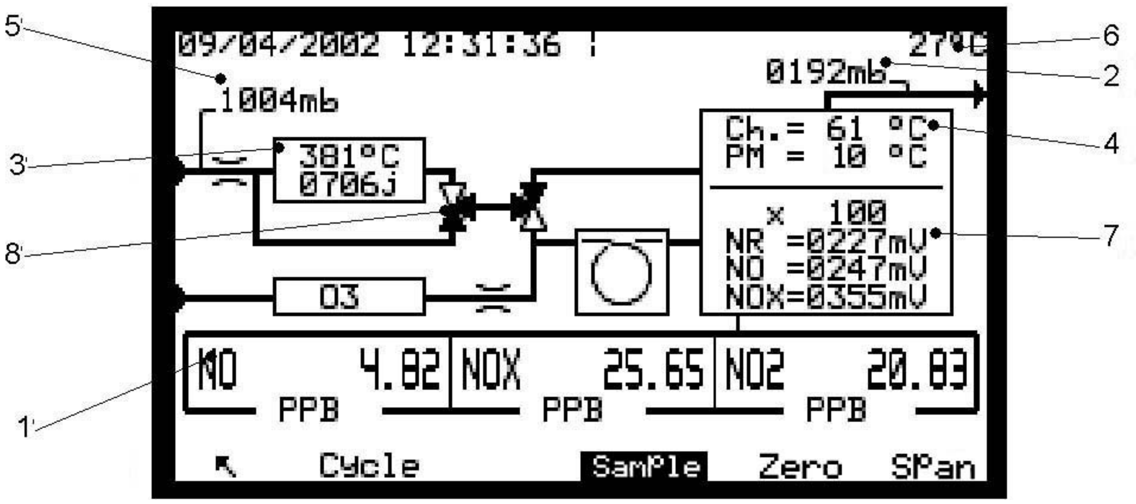


Definition of the specific keys of this screen

The keys of this screen have the same functions as *MEASUREMENT ⇨ Instantaneous* screen.

3.3.2.3 MEASUREMENT ⇨ Synoptic

This screen represents the whole flow circuit and displays significant values for its checking: gas, concentrations and units (1), measurement chamber pressure, (2), temperature and autonomy of NO ➔ NO_2 converter (3), chamber and photo-multiplier temperatures (4), sample inlet pressure (5), internal temperature (6), operating parameters of the photo-multiplier unit including temperature, range, black signal (NR), NO signal raw and raw NOx signal (7). The SV-cycle symbol (8) gives the cycle status.

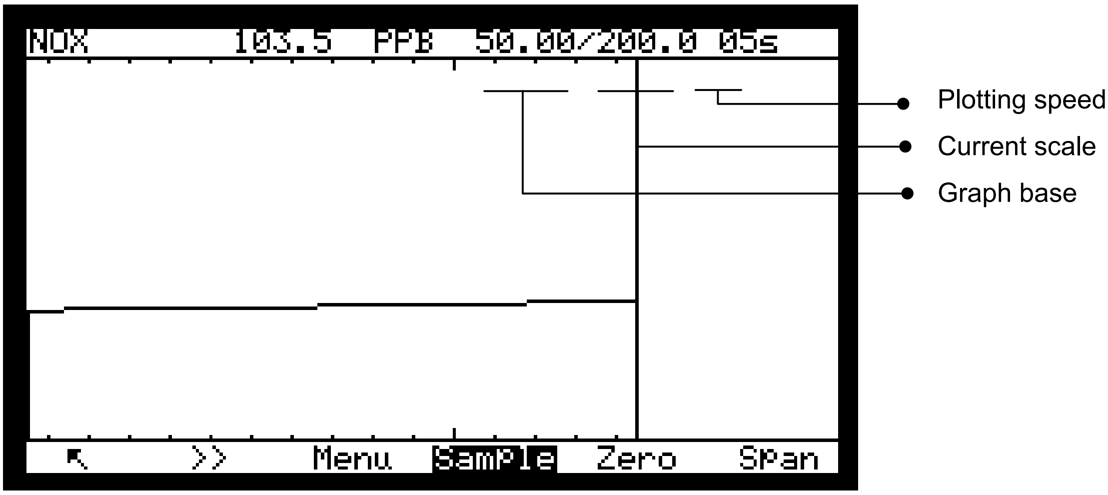


Definition of the specific keys to this screen.

The keys of this screen have the same functions as *MEASUREMENT ⇨ Instantaneous* screen.

3.3.2.4 MEASUREMENT ⇨ Graphic

This screen enables a graphic plotting of the measurement values on sample, zero or span gas inlet. The vertical line shows the current position: the refreshed measurements are given on the left side of this line. The vertical full scales of the graphics are those programmed for the analog outputs.



Definition of the specific keys to this screen

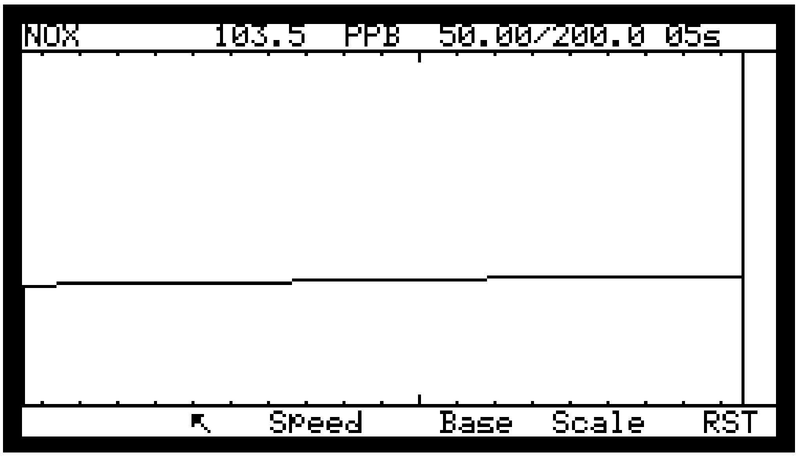
The keys of this screen have the same function than the screen *MEASUREMENT ⇨ instantaneous*. When sample inlet is already active, pressing down the [Sample] key refreshes the graph. Press down the [>>] key to select the parameter to display.

3.3.2.4.1 Graphic ⇨ screen "Menu"

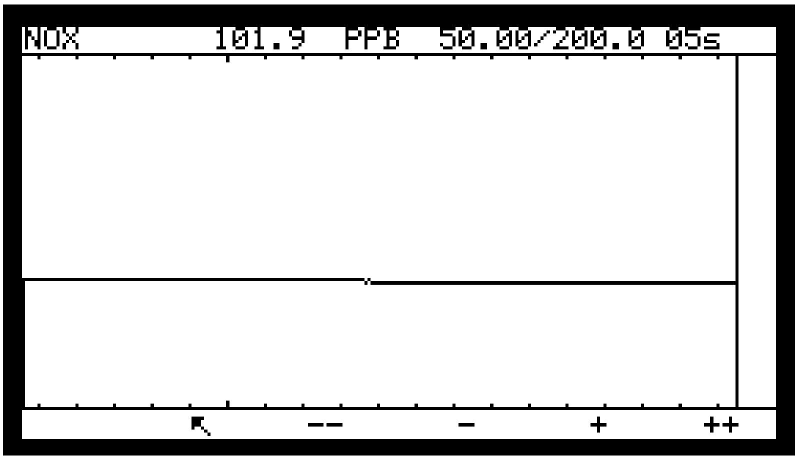
Pressing down the [Menu] key gives access to the following graph adjustments:

- Plotting speed
- Base line
- Full scale

The [RST] key is used to Reset the graph to Zero



3.3.2.4.2 Graphic ⇨ screen "Base"



Pressing down the [Menu] allows to adjust the value of the graph base line (The minimum value is zero, the maximum value is just inferior to the full scale)

[– –] Divides 10 times the current base line (when the base line is 5, it resets to zero)

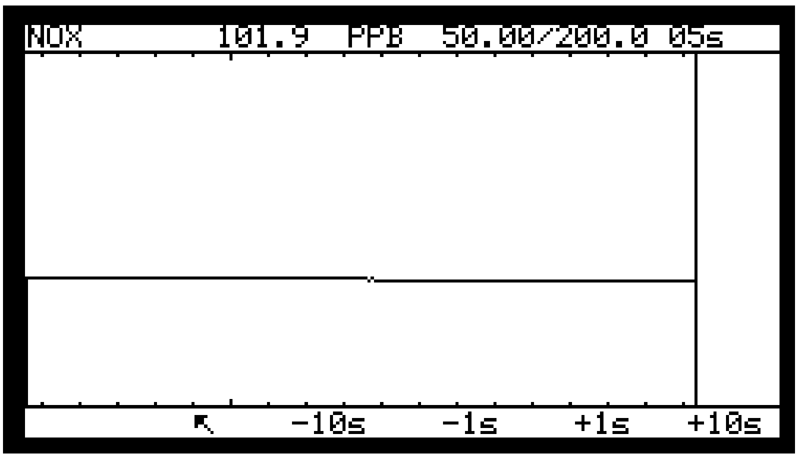
[–] Selects the inferior base line among 5000, 2000, 1000, 500, 200, 100, 50, 20, 10, 5, 2, 1, and 0.

[+] Selects the superior base line among 0, 1, 2, 5, 10, 20, 50,100, 200, 500, 1000, 2000, and 5000.

[++] Multiplies 10 times the current base line.

3.3.2.4.3 Graphic ⇨ screen "Plotting speed"

Pressing down the [Speed] key allows to adjust the plotting speed on the screen (the minimum value is 1 second, the maximum value is 60 seconds).



[- 10s] Decreases 10 seconds to the current plotting speed

[- 1s] Decreases 1 second to the current plotting speed

[+1s] Increases 1 second to the current plotting speed

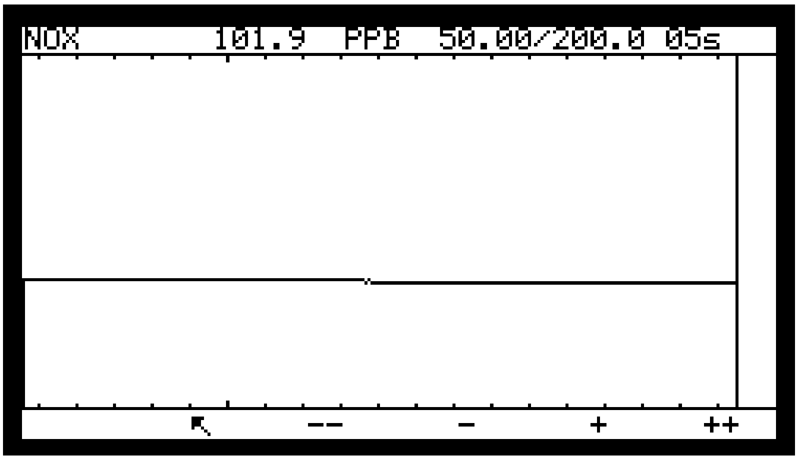
[+10s] Increases 10 seconds to the current plotting speed

The programmed time corresponds to the interval duration between 2 points of the graph.

E.g.: when the plotting speed is 10 seconds, the graphic screen lasts for 240 x 10 = 2400 seconds.

3.3.2.4.4 Graphic ⇨ screen "Scale"

Pressing down the [Scale] key allows to adjust the full scale of the graph (the minimum value is just superior to the base line, the maximum value is 10000)



This screen enables to adjust the full scale of the graph (maximum 10000).

[--] Divides 10 times the current scale (when the scale is 5, it resets to zero)

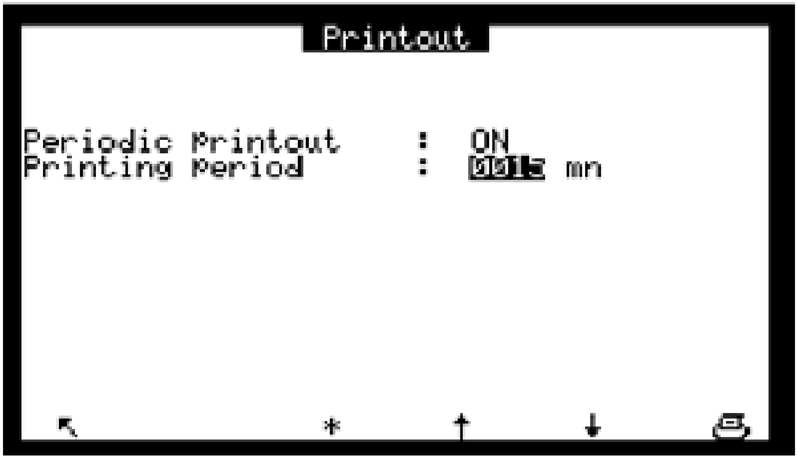
[-] Selects the current scale among 5000, 2000, 1000, 500, 200, 100, 50, 20, 10, 5, 2, 1, and 0.

[+] Selects the current scale among 0, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000.

[++] Multiplies 10 times the current scale.

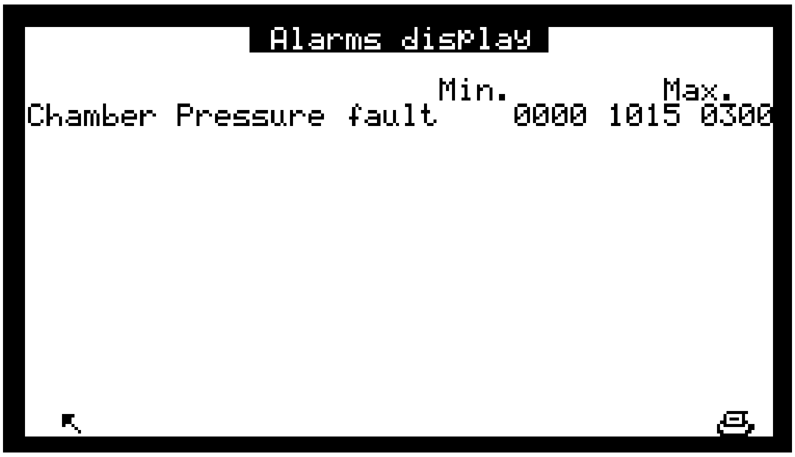
3.3.2.5 MEASUREMENT ⇨ Printout.

This menu is used to start real time printout on a serial printer connected to the COM2 serial port. It is also used to define the calculation period and printing rate of the average measurements (from 0001 to 9999mn).



3.3.2.6 MEASUREMENT ⇨ Alarms display

This screen displays the operating faults in case of alarm. Possible corrective actions for these faults are given in chapter 5.



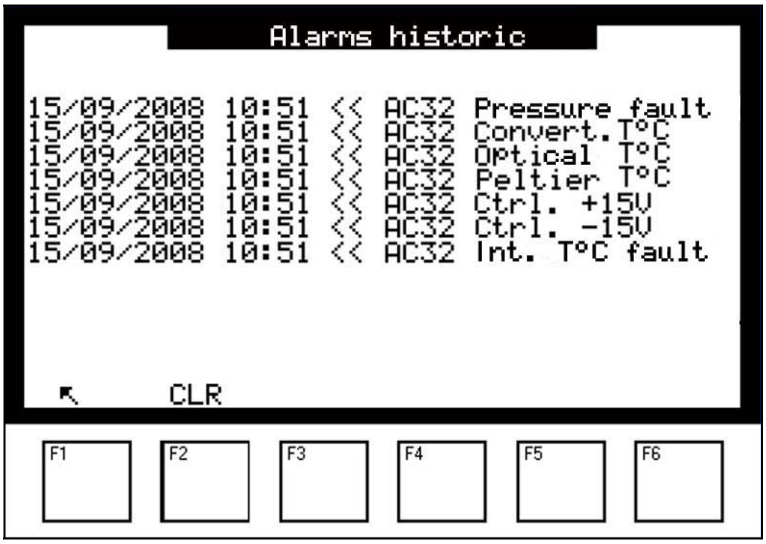
3.3.2.7 MEASUREMENT ⇨ Alarms historic

This screen displays the history of the last « alarms »:

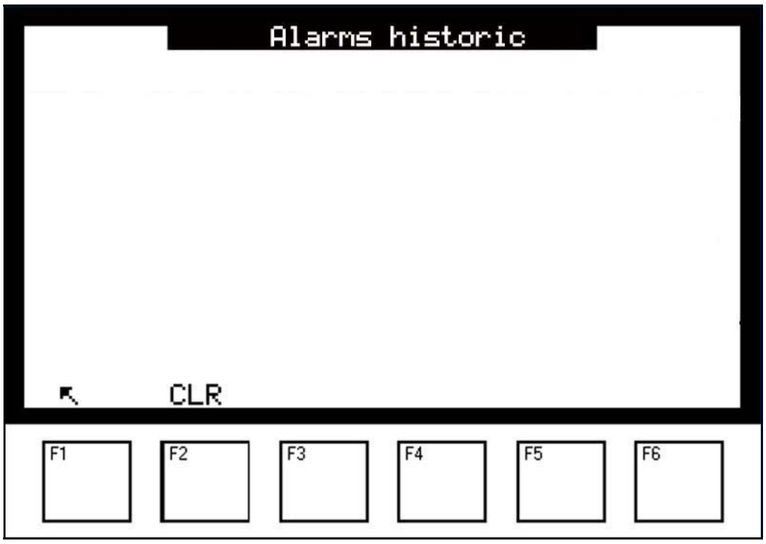
« >> » indicates the date and hour of alarm trigger,

« << » indicates the date and hour when the alarm was cancelled.

This screen has a limited capacity: after 11 fields displayed, when a new alarm is triggered or cancelled, this event display overwrites the oldest event.



Press down the F2 « CLR » key, enables to clear the screen display, for example, after maintenance.



3.3.3 SPAN

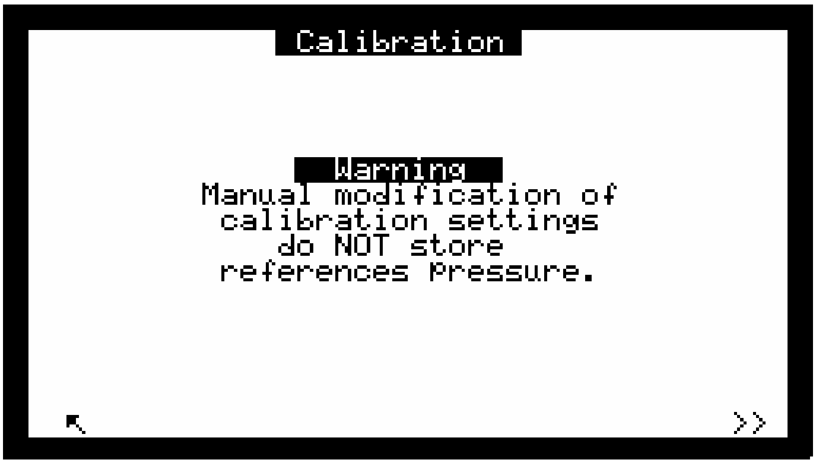
This menu is used to access the following functions:

- Programming the span factors K
- Programming the span gas values
- Gas inlet selection for span cycles
- Programming the automatic cycle periods and duration.

3.3.3.1 Span ⇨ CALIBRATION

NO and NOx span coefficients are calculated during the auto-cal cycles. This screen is used to modify these factors manually.

WARNING : Manual modifications of calibration settings do NOT store references pressures.

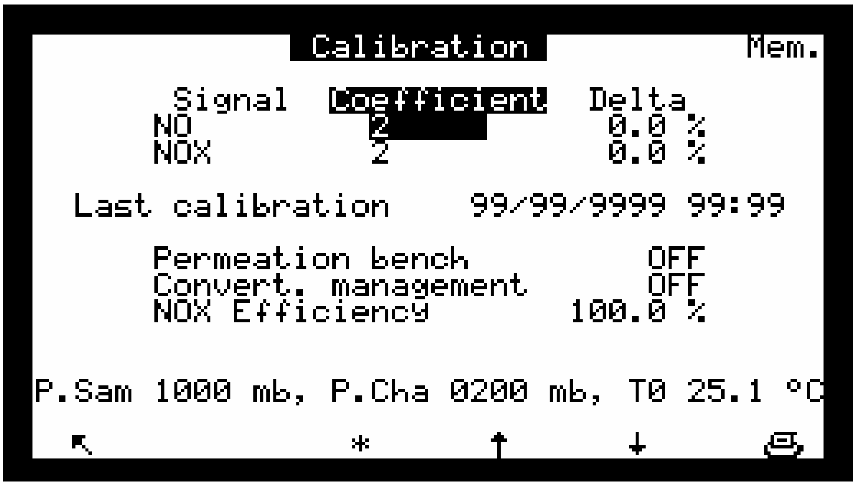


Measurement is compensated in pressure.

During an automatic calibration, the values of sample pressures and chamber pressure are memorized. Both these reference values will operate in pressure compensation of the measurement.

The coefficient variations after a new auto-cal cycle are displayed in the "Delta" fields. To reset the "Delta" in case of calibration alarm due to a wrong use of the auto-calibration function, select the Coefficient field of the gas whose the Delta % is greater than 5.0, press down the ✳ key, then the ↵ key. Exit the screen by pressing down the ↖ key and press down the ↵ key to display again the *SPAN ⇨ Calibration* screen in order to refresh the Delta fields display.

The “Convert. management OFF/ ON” field allows to activate (or not) the use of the coefficient in the NO_2 calculation. The factor is programmable from 90 to 100%; it is determined during a calibration (see § 3.4.3.3).

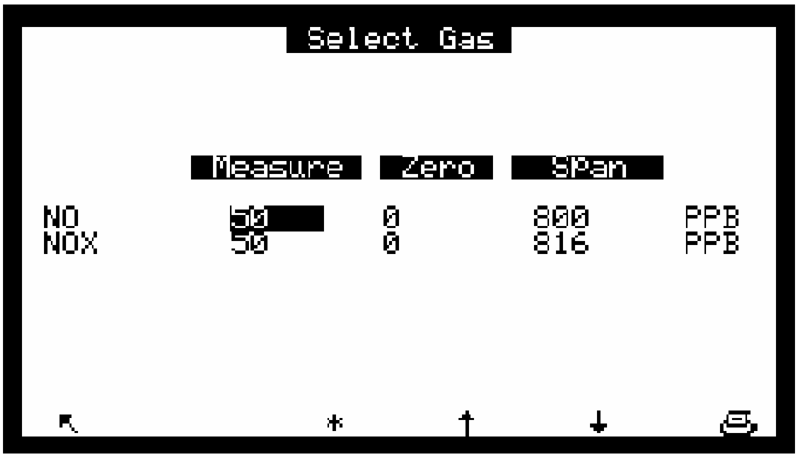


"P. Sam", "P. Cha", "T0" are the conditions of pressure and temperature recorded during last automatic calibration.

3.3.3.2 Span ⇨ SELECT GAS

This screen is used to associate a span gas concentration to each gas inlet.

These concentrations are the reference values for manual or automatic auto-calibration cycles.



3.3.3.3 Span ⇨ CYCLES

This screen is used to program the period and the duration of the automatic cycles, **the durations programmed are also those of the manually launched cycles.**

The possible automatic cycles are:

– ZERO : zero air measurement

– SPAN : span gas measurement.

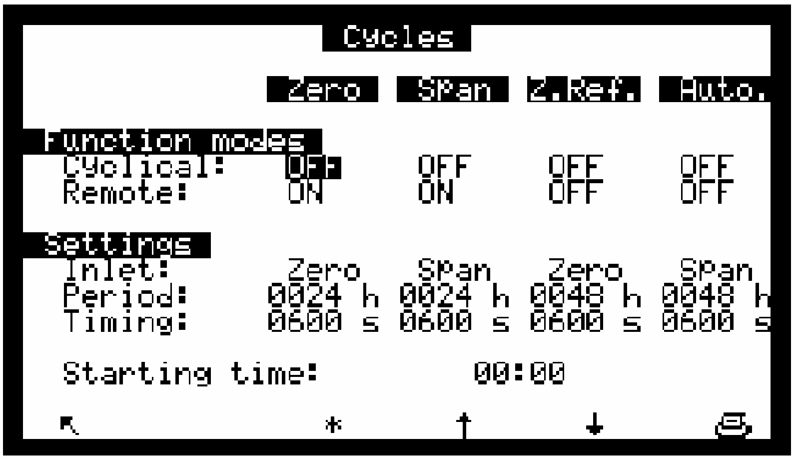
– Z.Ref. : automatic zero adjust

– AUTO : automatic span factor adjust

The “Remote” fields are used to configure remote controls of cycles (ESTEL board option), ZERO, SPAN, ZERO REFERENCE and AUTO. The states programmed in the “Cyclical” fields (ON = active, OFF = inactive) governs the analyzer reaction when a dry contact is closed on the remote controls inputs (see Table 3-1).

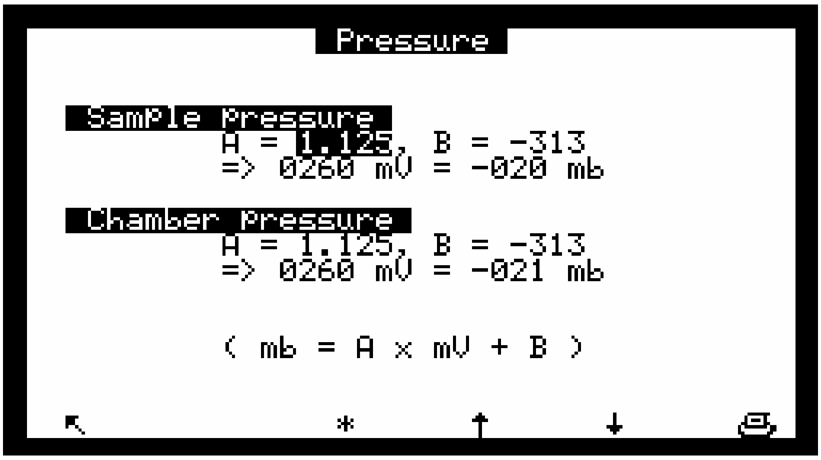
The “Inlet” fields allow to select gas inlets used during the automatic sequences. The reference concentrations for automatic calibration are those programmed in the previous menu.

The “Starting time” field is used to program the hour when the cycles are launched. If 24 h ZERO cycle, 24 h AUTO cycle and 24 h SPAN cycle are programmed, the following sequence is launched on starting time: ZERO, ZERO REFERENCE, AUTO, then SPAN.



3.3.3.4 Span ⇨ PRESSURE

This screen is used to program the calibration curve of the pressure sensors



Pressure sensors calibration:

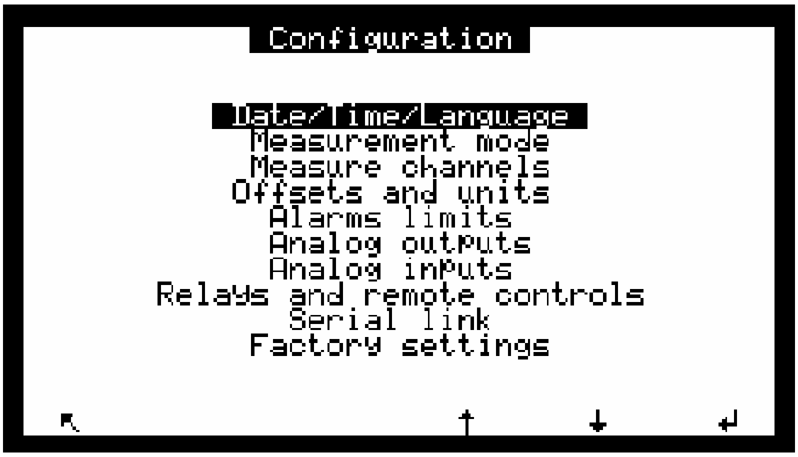
– Connect a span pressure sensor in parallel with the pressure sensor to be calibrated.

In the "Pressure" field, enter the slope value (A) and its intercept (B) with vertical axis.

3.3.4 CONFIGURATION

This menu is used to access the following functions:

- Response time programming
- Dilution function programming
- Analog outputs configuration
- Unit change and offset adjustment
- Alarm thresholds, activation and assignment of the alarm relays programming
- Serial link programming
- Reset of the main programmable parameters



3.3.4.1 Configuration ⇨ DATE/TIME/LANGUAGE

This screen is used to set the internal clock of the analyzer, as well as to choose the displayed language from French, English, German, Italian and Spanish. It also shows the software version number to remind in case of software dysfunction.

3.3.4.2 Configuration ⇨ MEASUREMENT MODE

This screen is used to program:

– the operating mode, autonomous or associated with a NH3 converter (rack).

Three operating modes are available:

- NO/NO2: including Black, NO and NOx sequences.

  NO2 is calculated from NOx and NO values: NO2 = NOx – NO

- NH3: including Black, NOx and Ny sequences.

  NH3 is calculated from Ny and NOx values: NH3 = Ny – NOx

- NO/NO2/NH3: including Black, NO, NOx and Ny sequences.

Only select NH3 or NO/NO2/NH3 modes if $CNH3_{S2}$ rack option is available.

Modifications of this programming mode imply modifications of many other screens as *CONFIGURATION ⇨ Measure channels* or *STORED DATA*.

– the response time: by default, its value is 11, which corresponds to an automatic TR. For more details about this function, refer to § 2.4.

– The "Zero Adjust" fields are used to adjust to zero the measurements on zero gas. These values are systematically added to measurements. They can be programmed with 0.1 intervals within the +5, -5 range. These zero adjusts are automatically refreshed when a Z.Ref. cycle is executed.

– The “Converter life time” field is used to reset a daily counter which, when on zero, launches a filter alarm message. The programmed value depends on the analyzer working conditions. The value programmed in factory, 720 days, corresponds to the recommended maintenance frequency.

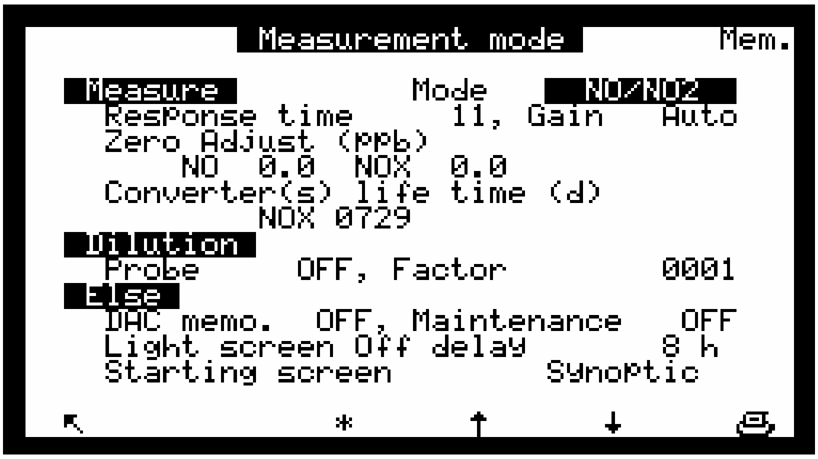
– This screen gives also an access to the Dilution function : to measure very high concentrations (ex. founded in industrial environment), it is necessary to bring them to values corresponding to the range of analyzer by inserting a dilution system in the sampling line in order to get :

$$C_{analyzer\ inlet} = C_{SAMPLE} / K\ dilution$$

The real concentration display is obtained by applying a "K Dilution" multiplying coefficient to the measured concentration.

– “DAC memo” field: when this field is ON, the analog outputs are latched during Zero, Span cycles, et c., in order not to disrupt data loggers.

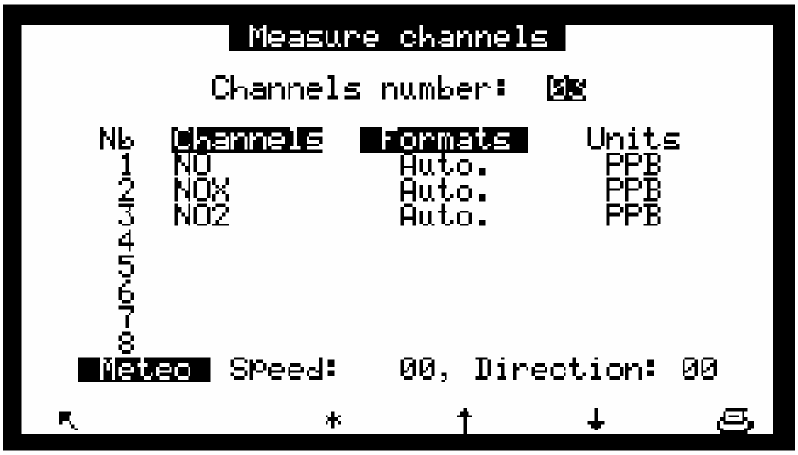
– “Maintenance” field: is used to trigger one of the alarm relays (see § 3.3.4.5 and Table 3-1). The maintenance mode is reminded on the *Measurement* screens.



– "Starting screen" field allows to choose measurement mode displayed on starting-up the unit.

3.3.4.3 Configuration ⇨MEASURE CHANNELS

This screen is used to select the parameter, the display format and the unit for each measure channel. The programming of measure channels allows to display (screen *MEASUREMENT ⇨ Instantaneous* or screen *MEASUREMENT ⇨ Average*) and to store (menu *STORED DATA*) other parameters than the one displayed by default (NO, NO_x, NO_2). It enables to store MUX channels and analog inputs (ESTEL option).



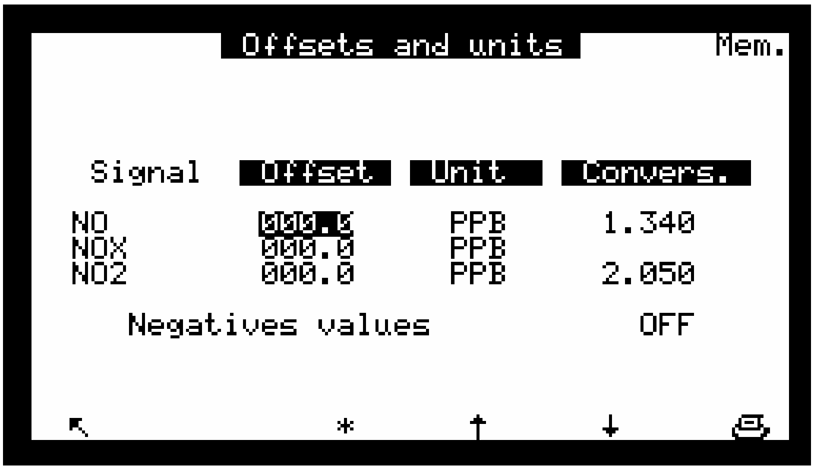
- The "Channels" fields are used to choose the parameter among 8 possibilities offered.
- The "Formats" fields are used to choose the display format among 4 possibilities (X.XXX, XX.XX, XXX.X, XXXX). "Auto" manages the comma in order to display the best resolution at any time.

The "Units" fields refer to the units programmed in screen *CONFIGURATION ⇨ Offsets and units*, or *CONFIGURATION ⇨ Analog inputs.*

Ordering of channels defines ordering of values in RS frame.

3.3.4.4 Configuration ⇨OFFSETS AND UNITS

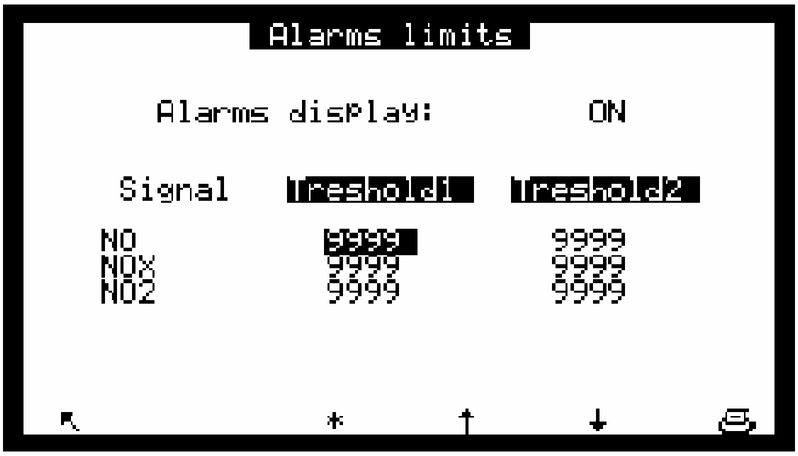
This screen is used to program the offset. This value is added to the measurements. It is also used to program the conversion factors from PPM to mg/m^3.



"Negative values": authorizes or not the display of negative values.

3.3.4.5 Configuration ⇨ALARM LIMITS

2 limits are programmable for the 3 programmed parameters: Threshold 1 and Threshold 2, allowing to activate relays and alarm messages. When the "Alarms display" field is “OFF”, displays and alarm relays are inhibited.



3.3.4.6 Configuration ⇨ ANALOG OUTPUTS

This screen allows to choose the analog outputs parameters (only when ESTEL board option is available: 2 optional ESTEL board are possible) from:

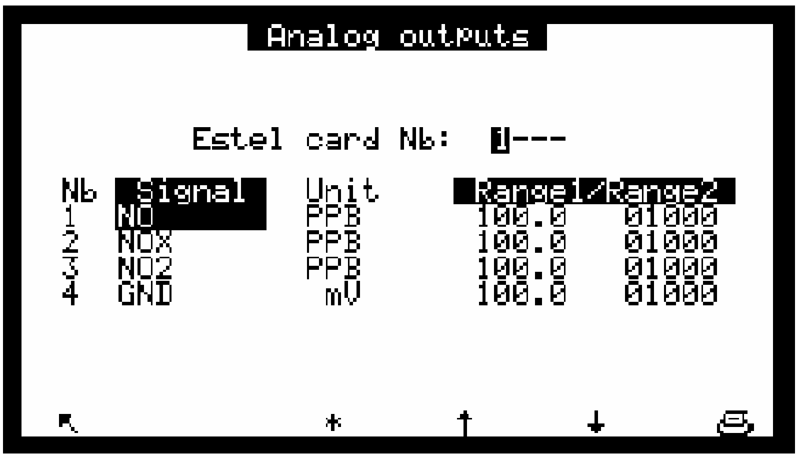
- The NO concentration
- The NOx concentration
- The NO2 concentration
- From MX01 to MX16, the 16 channels multiplexer
- The external inputs

The chosen parameters correspond to the analog outputs.

This screen is used to program the ranges for each displayed parameter. The ranges correspond to the analog output full scale.

Scale 1 corresponds to the analyzer standard range. The analyzer switches to scale 2 when scale 1 is exceeded. It switches again to scale 1 when measurement decreases below 85 % of the full scale 1.

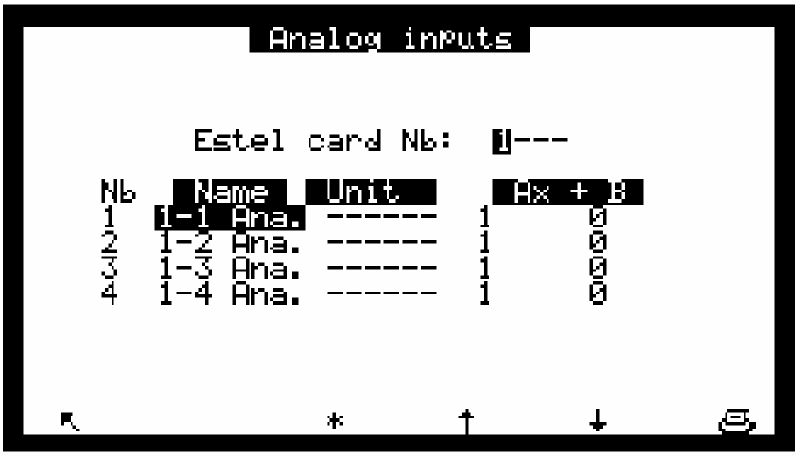
This screen is also used to choose the parameters unit among ppm, mg/m^3, mV, °C or hPa.



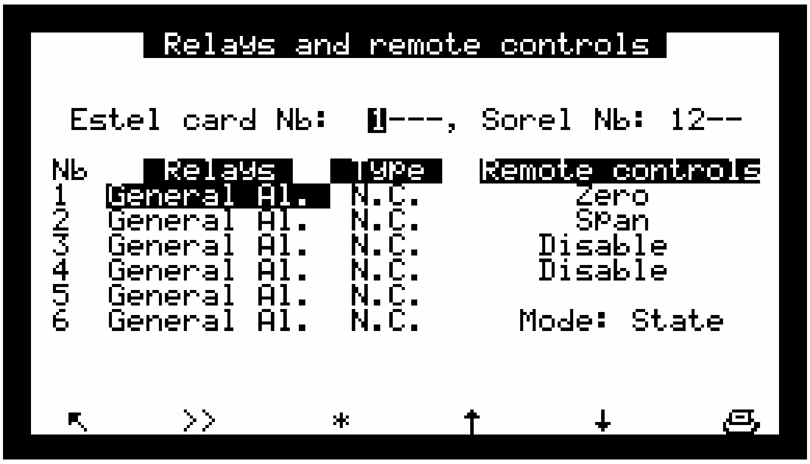
3.3.4.7 Configuration ⇨ ANALOG INPUTS

This screen is used to program names, units and span curves of the external analog inputs.

- "ESTEL card" field enables to select the board to be programmed: each ESTEL board has 4 analog inputs.
- "Name" fields enable to name each parameter with 8 alphanumeric digits.
- "Unit" fields enable to choose unit of each parameter from: none, ppt, ppb, PPM, µg/m^3, mg/m^3, gr/m^3, µg/Nm^3, mg/Nm^3, gr/Nm^3, µg/Sm^3, mg/Sm^3, gr/Sm^3, %, µgr, mgr, gr, mV, U, °C, °K, hPa, mb, b, l, Nl, Sl, m^3, l/min, Nl/min, Sl/min, m^3/h, Nm^3/h, Sm^3/h, m/s or km/h, in a toggle menu.
- "aX + b" fields enable to enter the span curve for each parameter.



3.3.4.8 Configuration ⇨ RELAYS AND REMOTE CONTROLS



This screen allows to configure the function of each input / output of the Estel board(s).

- "Estel card Nb:" field allows to choose what board to configure.
- "Sorel Nb:" field allows to choose what board to configure.
- "Relays" fields allows to control the relays according to the following situations :

• Disable ⇨ Relay not assigned	• General alarm ⇨ Any operating fault triggers the relay
• Ch.1 > Thrs.1⇨ Limit 1 channel 1 exceedance triggers the relay	• Ch.1 > Thrs.2 ⇨ Limit 2 channel 1 exceedance triggers the relay
• Ch.2 > Thrs.1 ⇨ Limit 1 channel 2 exceedance triggers the relay	• Ch.2 > Thrs.2 ⇨ Limit 2 channel 2 exceedance triggers the relay
• Ch.3 > Thrs.1⇨ Limit 1 channel 3 exceedance triggers the relay	• Ch.3 > Thrs.2 ⇨ Limit 2 channel 3 exceedance triggers the relay
• Temperature ⇨ Abnormal temperature in the analyzer triggers the relay	• Flow rate / pressure ⇨ Abnormal flow rate or pressure
• Converter ⇨ Converter temperature default	• Overrange ⇨ Range 2 exceedance triggers the relay
• Calibration ⇨ Delta % > 5% between new and former span coefficient after an AUTO cycle	• Maintenance ⇨ Relay triggered when the analyzer is in maintenance mode
• Scale 1/Scale 2 ⇨ Switching from range 1 to range 2	

- The "Type" fields enable to control (NC) or not (NO) the relays when alarms are OFF.

  "State" or "Front" mode allows to configure working remote controls mode.

Comparison between both modes:

- "State" mode: control is activated as long as remote control is active. When remote control falls down, control is no more active.
- "Rise" mode: control is activated when a remote control activation is detected. When it is down, control remains active. It is necessary to re-activate the same remote control to make down the previous remote control.

  Example: activate the "Measurement" remote control following to a "Zero" remote control in order to go back to "Measurement" mode.

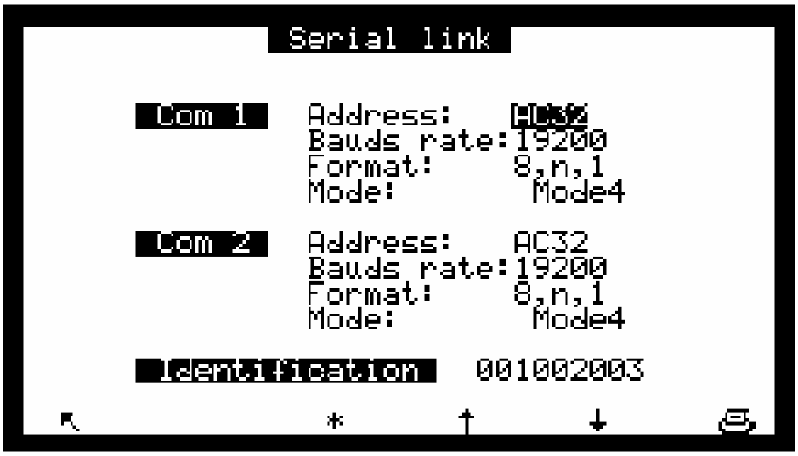
3.3.4.9 Configuration ⇨ SERIAL LINK

This screen is used to configure the serial links (COM 1 and 2).

The address is made of 4 digits used to define the analyzer code for remote transmission or when the instrument is integrated into a network.

The baud rate, format and communication mode of the 2 channels are programmable from:

- Baud rate: 1200, 2400, 4800, 9600, 19200, 38400 (limited to 19200 bds at present time)
- Format : 7n1, 7o1, 7e1, 7n2, 7o2, 7e2, 8n1, 8o1, 8e1, 8n2, 8o2, 8e2
- Communication mode: Mode 4, impress. to send measurements to printer in real time, Jbus, Special1, and Special2.

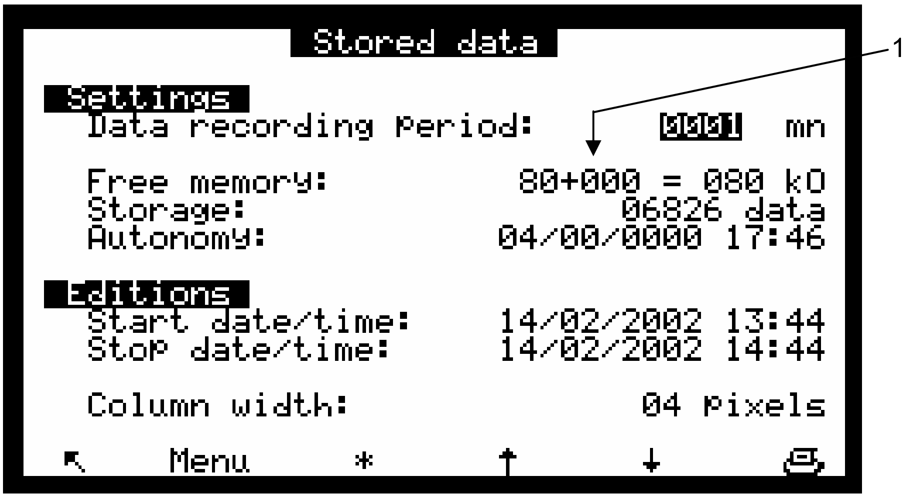


3.3.4.10 Configuration ⇨ FACTORY SETTINGS

When this item is selected, pressing down the ↵ key displays the screen shown here below:

3.3.5 STORED DATA

The access to stored data management is directly done from Main Menu. The stored data consists in the average of analyzer measurements within a defined time interval.



This screen enables to meter data recording period from 1 to 1440 min (i.e. 24 hours) and informs about memory status:

- Free memory: from 80 Ko in standard operation, it can be increased to 464 Ko in adding a 384 Ko memory board (optional). This board is automatically detected when switching on the analyzer and it is indicated on the screen (1).
- Storage: it is the possible records number, it depends on free memory.
- Autonomy: it is the duration (days, months, years, hours, minutes) while memory can store data, considering free space and data recording period. In the here-above example: 4 days, 17 hours, 46 minutes.

Data can be edited in the form as tabular or histogram: this screen allows to program date and hour of edition beginning, date and hour of edition end, column width of histogram.

Menu key gives access to table or histogram data display, printing functions, and memory reset-to-zero.

<u>Stored data edition in the form as tabular</u>

This screen presents stored data list according to parameters defined in the previous screen. The running mode (measurement, zero, calibration…), during a memorization period, is coded in the status column. The status codes meaning are:

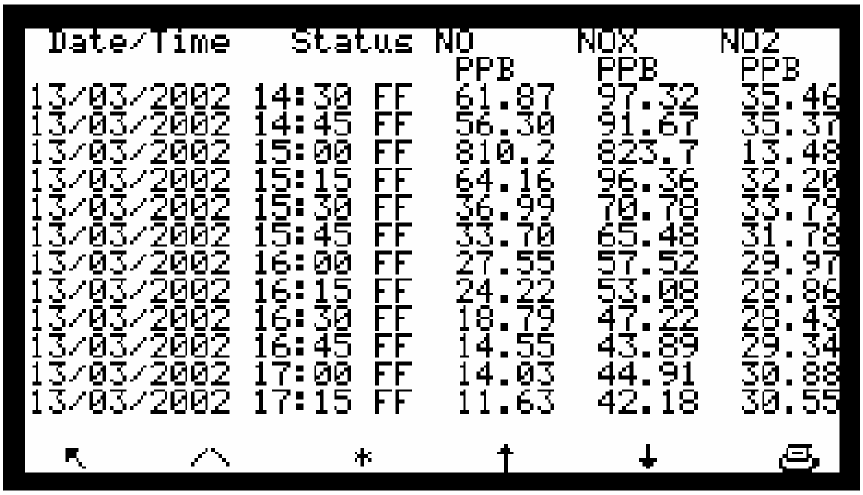
00	Measurement valid
01	Range 2 over shooting
02	General alarm
04	Calibration fault
08	Zero measurement
10	Span measurement
20	Maintenance
40	Less than 2/3 of valid measurements during the average period
80	Power supply failure
FF	Configuration modification

The displayed status code corresponds to the summation of the status codes (hexadecimal numbers) that occurs during the memorization period.

Example: with an average period of 20 min:

5 min of zero and 15 min of measurement give the 00 status code and the displayed measurement is the average measurement of 15 min.

11 min of zero and 9 min of measurement give the 08 status code and the displayed measurement is the zero average of 11 min.



Definition of the specific keys to this screen:

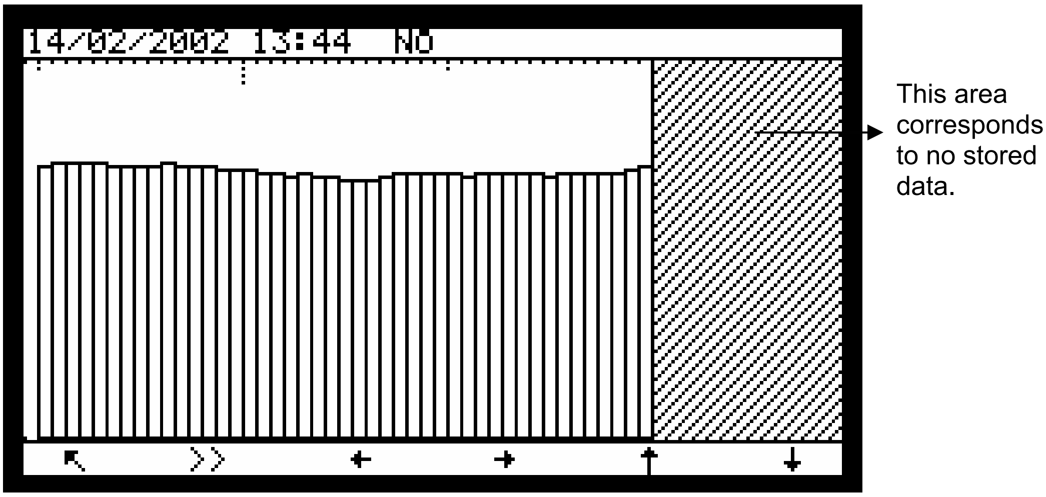
↑ ↓ Selects the previous or the next page.

∧ ∨ Selects stored data beginning or end.

✳ Displays the other measure channels if more than 3 channels are programmed in *CONFIGURATION* ⇨ *Measure channels* screen

Stored data edition in the form as histogram

This screen displays records in the form as columns; each column corresponds to the measurements average within the data-recording period as defined in *STORED DATA* screen. Only one channel is displayed at once. The information line gives date and hour of first record, the channel name, and, alternatively blinking, full scale with unit, and data recording period.



Definition of the specific keys to this screen

↖ Returns to previous menu.

← Displays previous stored data plotting.

→ Displays next stored data plotting.

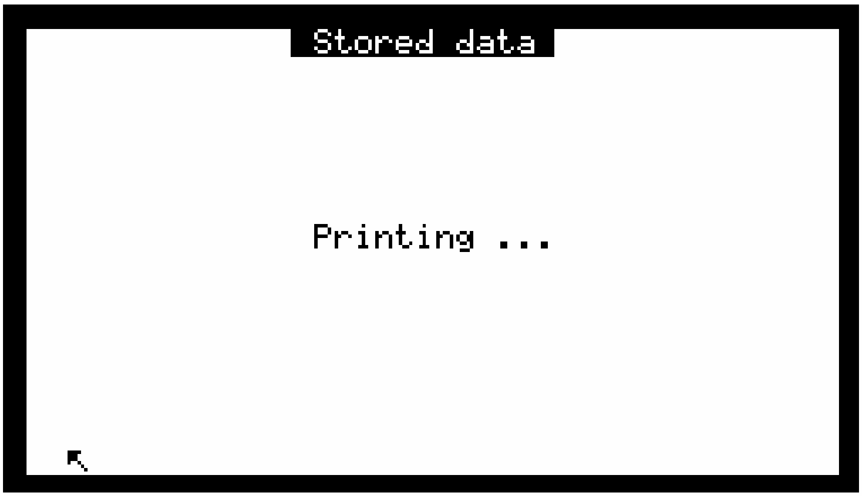
↑ X 2 zoom in

↓ 1/2 zoom out.

>> Selects the next measure channel, when more than one measure channel is programmed.

Stored data printing

To print data, press down the Print key found in "Menu" function of "Stored data" screen. The blinking message "Printing …" indicates printed data output. Data printing can be suspend at any time, pressing down F1 key. When printing is finished, the screen displays the message "Printing finished". When none communication port is programmed on printer output (serial port), the error message "Printing not set" is displayed.



```
----------------------------------
AC32M[4.0]
17-08-2000
----------------------------------
                NO       NOX        NO2
HH:MM status  PPB       PPB        PPB
00:00    00  11.0      16.0       6.0
00:10    00  11.4      16.6       6.3
00:20    00  11.0      13.8       3.8
00:30    00  11.3      14.1       3.8
00:40    00  10.4      15.2       5.9
00:50    00  11.0      16.4       6.4
01:00    00  10.9      14.8       4.9
01:10    00  10.1      15.7       6.6
01:20    00  10.9      13.5       3.7
01:30    00  11.3      16.7       6.4
01:40    00  11.6      16.0       5.4
01:50    00  11.2      13.8       3.5
02:00    00  10.9      13.8       3.9
02:10    00  11.3      15.8       5.6
02:20    00  11.4      16.6       6.1
02:30    00  11.9      15.5       4.6
02:40    00  10.4      14.1       4.7
02:50    00  10.9      14.0       4.1
03:00    00  10.7      15.7       5.9
03:10    08  1.0       1.0        1.0
03:20    00  11.0      15.7       5.7
03:40    00  11.0      16.4       6.4
03:50    00  10.3      13.9       4.6
04:00    00  11.1      13.7       3.5
04:10    00  11.9      16.3       5.4
04:20    00  11.0      16.5       6.5
04:30    00  11.9      13.4       2.5
04:40    00  10.4      16.5       7.1
04:50    00  10.7      14.6       4.9
```

Figure 3-7 - Printout example

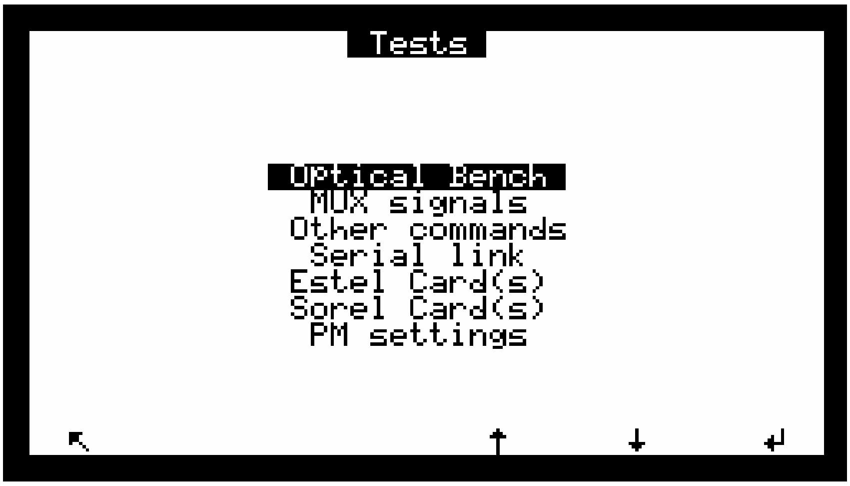
Memory reset to zero

Pressing down the [Reset] key enables to empty storage memory. **This action is irreversible**: before to do it, the software asks you to confirm. If your answer is "YES", the software resets end edition dates and hours to the current dates and hours.

3.3.6 TESTS

This screen gives access to the following functions:

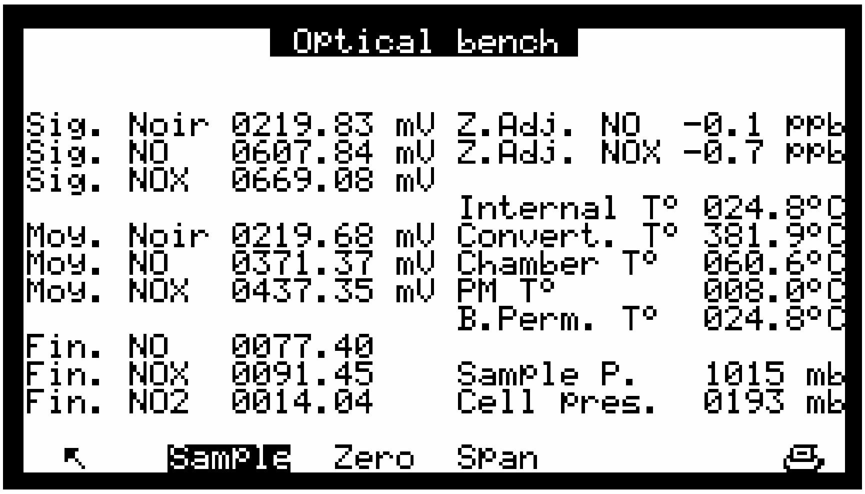
- Checking of optical and flow parameters when maintenance operations occurs,
- Serial link checking,
- Checking of the ESTEL board working (when option available)
- Checking of the SOREL board working (when option available)



3.3.6.1 Tests ⇨ OPTICAL BENCH

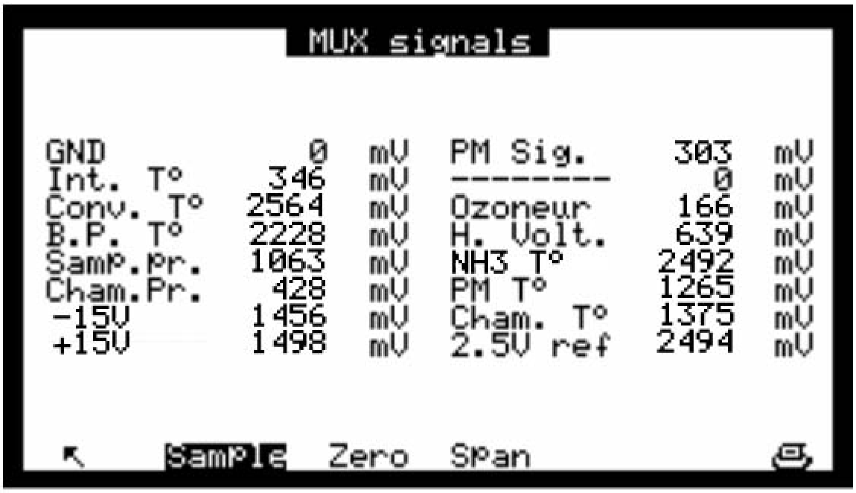
This screen is used to follow-up the measurement parameters periodically or occasionally.

- Sig. NOIR = instantaneous reference signal
- Sig. NO = instantaneous NO signal
- Sig. NOX = instantaneous NOx signal
- Moy. NOIR = average reference signal
- Moy. NO = average NO signal
- Moy. NOx = average NOx signal
- Fin. NO = NO measurement
- Fin. NOx = NOx measurement
- Fin. NO2 = NOx - NO
- Z.Adj. NO and NOx = remind of NO and NOx Zero adjustments (Configuration ⇨ Measurement mode)
- Internal T° = temperature inside the analyzer
- Convert. T° = temperature of the converter oven
- Chamber T° = temperature of the chamber
- PM T° = temperature of the photo multiplier tube
- B. Perm. T° = temperature of the permeation bench (when option available)
- Sample P. = sample pressure at analyzer inlet
- Cell Pres. = Vacuum pressure in the chamber.



3.3.6.2 Tests ⇨ MUX SIGNALS

This screen is used to check the multiplexer signals.



NOTE : The read value "XXXX mV" will be checked according to the acceptable limits listed in the following table.

Table 3-2 - MUX signals (Acceptable limits on the multiplexer 1 to 16 channels)

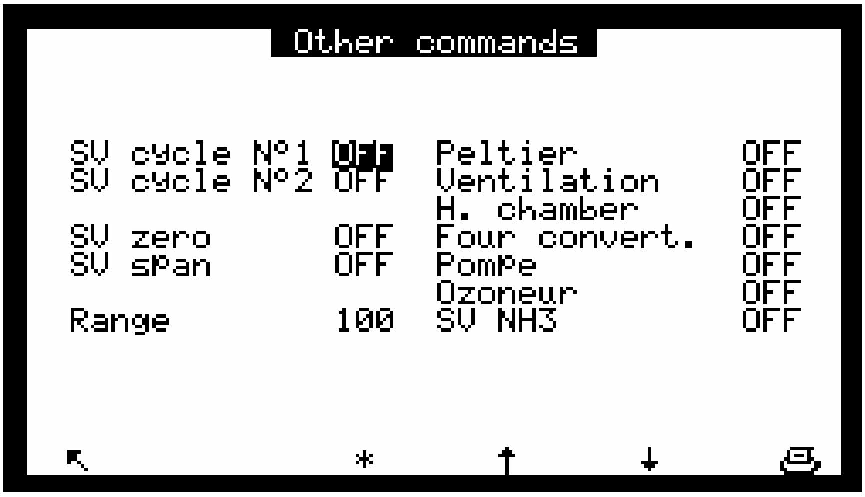
Channel	Display	Parameters	Lower Limit	Normal	Upper limit
1	GND	Analog ground	0 mV	0	+ 10 mV
2	Int. T°.	Internal temperature of the analyzer	50 mV	250 mV	500 mV
3	Conv. T°.	Converter temperature given by the temperature probe PT100 ohms	2426 mV	2563 mV	2765 mV
4	B. P. T°.	Check of the permeation bench temperature (optional)	2205 mV	2231 mV	2256 mV
5	Sam. Pr.	Sample pressure*	408 mV	530 mV	610 mV
6	Cham. Pr.	Vacuum pressure inside the measurement chamber*	133 mV	250 mV	433 mV
7	- 15 V	V ref. – 15 V	- 1600 mV	- 1500 mV	- 1200 mV
8	+ 15 V	V ref. + 15 V	+ 1200 mV	+ 1500 mV	+ 1600 mV
9	PM sig.	Measurement signal at the PM amplifier output	0 mV	—	9999 mV
10	O2	(option)	—	—	—
11	Ozone generator	Signal proportional to the H. Volt. applied between both ozone generator electrodes.	100 mV	200 mV	250 mV
12	H. Volt.	Voltage applied to the photo-multiplier tube	500 mV	750 mV	950 mV
13	T° NH3	(option rack NH3)	0 mV	15 mV	30 mV
14	PM T°	Photo multiplier temperature signal	1240 mV	1270 mV	1300 mV
15	Cham. T°	Measurement signal of the temperature chamber.	1350 mV	1400 mV	1450 mV
16	2.5 V ref.	Check of the analog / digital converter	2440 mV	2500 mV	2550 mV

* : the values depend on atmospheric pressure

3.3.6.3 Tests ⇨ OTHER COMMANDS

The selection of this menu makes ineffective some commands and regulations. When the instrument is again in measurement mode, some alarms could occur.

This screen enables to check that the MODUL board is working correctly.

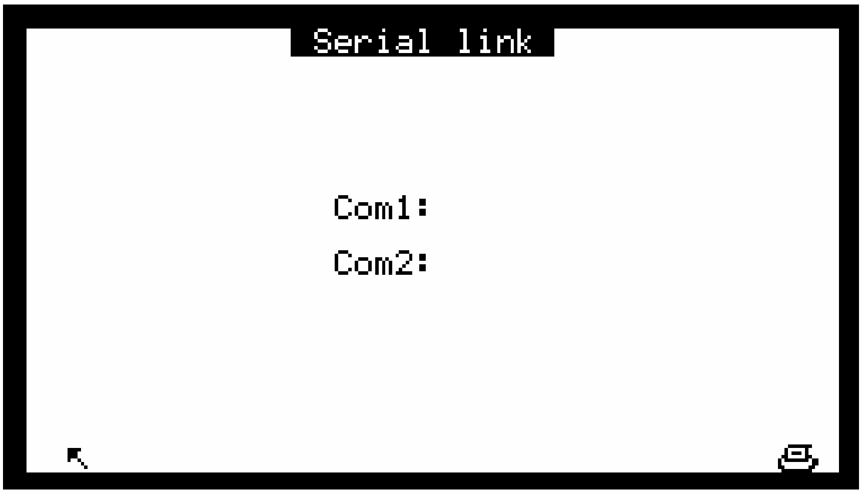


3.3.6.4 Tests ⇨ SERIAL LINK

This screen enables to check the serial links.

When the serial link is not connected, the connections to do on the DB 25 connector to carry out the test are:

- 2-3 Com1 Emission/Reception
- 14-16 Com2 Emission/Reception

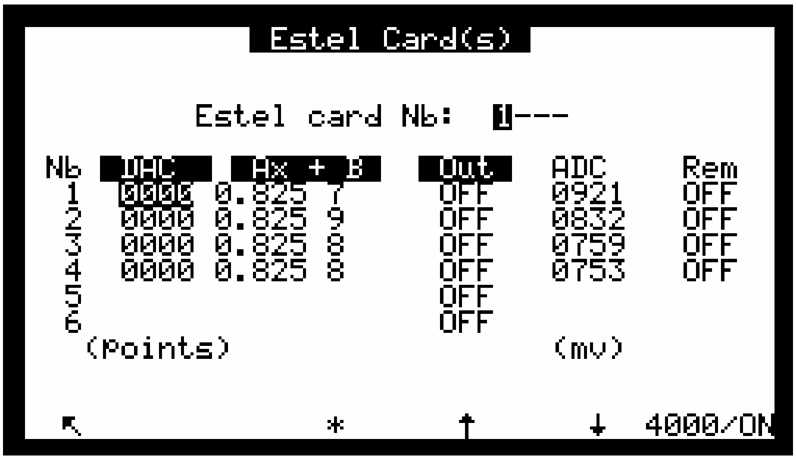


"OK" is displayed when the board is working correctly.

3.3.6.5 Tests ⇨ ESTEL BOARD(S)

This screen is only displayed when the option ESTEL board is available.

It is used to set the analog outputs and to monitor the working state of remote controls and analog inputs.



The "Estel card Nb:" field is used to select the board to be tested.

The "DA.C" (digital to analog converter) fields are used to program the number of points generated at analog output.

The "Ax + b" fields are used to program the span curves of each output. These coefficients are calculated according to the value measured at the output.

The "Out" fields are used to control the relays manually.

The "AD.C" & "Rem" fields are used to read the status of these inputs.

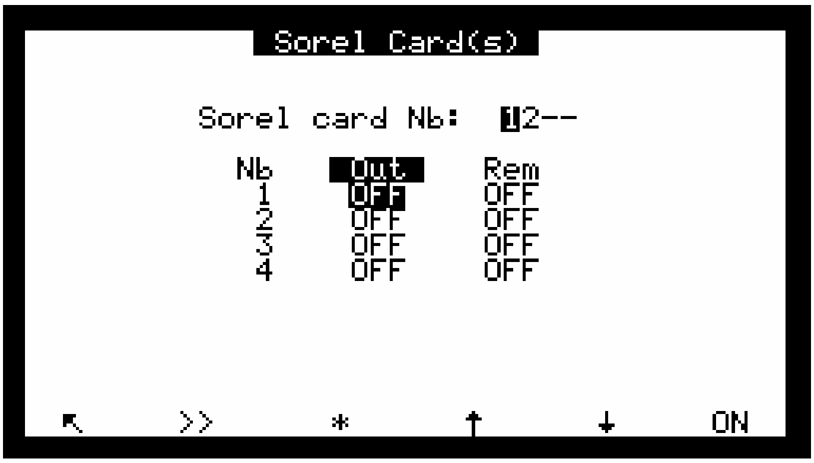
Definition of this screen specific keys:

0/OFF Gives 0 pt on all analog outputs and opens all relays contacts

4000/ON Gives the full scale (4000 pts) on all analog outputs and closes all relays contacts.

3.3.6.6 TESTS ⇨ SOREL BOARD

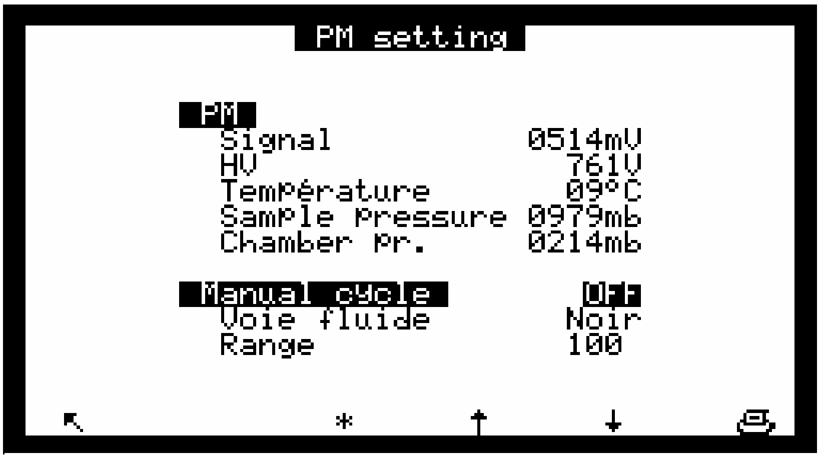
This screen is only displayed when the option SOREL board is available. It enables to check manually the relays and remote controls of this board.



The "Sorel card Nb:" field enables to select what Sorel board to check (when several boards of this type are available in the device).

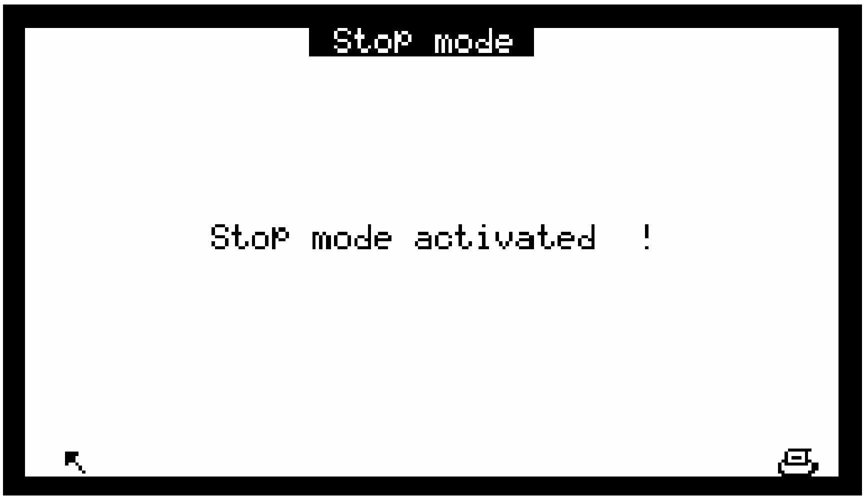
3.3.6.7 TESTS ⇨ PM SETTING

This screen enables to check, manually or automatically, potentials of the various sequences (NO, NOx, Noy) as a function of PM tube amplifier gains.



3.3.7 STOP MODE

This screen is used to activate the "Stop mode", when pump assembly and ozone generator are OFF. To return to measurement mode, it is necessary to press down the "Sample" key in any screen of Measurement Menu (see § 3.3.2).



3.4 CALIBRATION

Use of the analyzer as a reference method for EPA reporting requires periodic multi point calibration and subsequent zero / span checks as described below. All gases for multi point calibration and span checks must be traceable to NIST standards.

When performing multi point calibration, the user must follow the procedure described in the Code of Federal Regulations, Title 40, part 50, appendix F. For more details the user may also refer to USEPA Technical Assistance document EPA-600/4-75-003.

3.4.1 GENERAL

To ensure the accuracy of the measurements performed using the AC32M analyzer, the unit must be regularly checked, calibrated and adjusted according to the quality assurance plan of the user.

– Check the zero and a scale point:

  This operation consists of comparing the analyzer response for zero air to the gas standards used.

  This check is used to measure the analyzer drift in time without modifying the calibration factors.

  The internal zero or the "SPAN" inlet can be used to carry out this operation.

  Periodicity: generally 24 hours in automatic cycle mode.

– Two-point calibration:

  This procedure is used to check and correct the monitor response to the zero and to a span point at about 80 % of the full scale of the measurement range used.

  Periodicity: monthly, or more frequently if the installation allows it.

– Multi-point calibration :

  This is a complete verification operation of the analyzer characteristics (linearity, converter efficiency, etc.).

  Periodicity: quarterly, or consequently to out-of-tolerance calibration results (± 5 %) or to an intervention on the analyzer.

Note about gas generator devices:

For devices generating pressurized gas, an excess gas system is required to deliver the gas to the monitor inlet at atmospheric pressure. These devices must be made of neutral components to the gas used. When using the monitor in automatic cycle mode with a cylinder, a shut-off solenoid valve, remote controlled by the monitor, should be used. (see *Figure 3-8*).

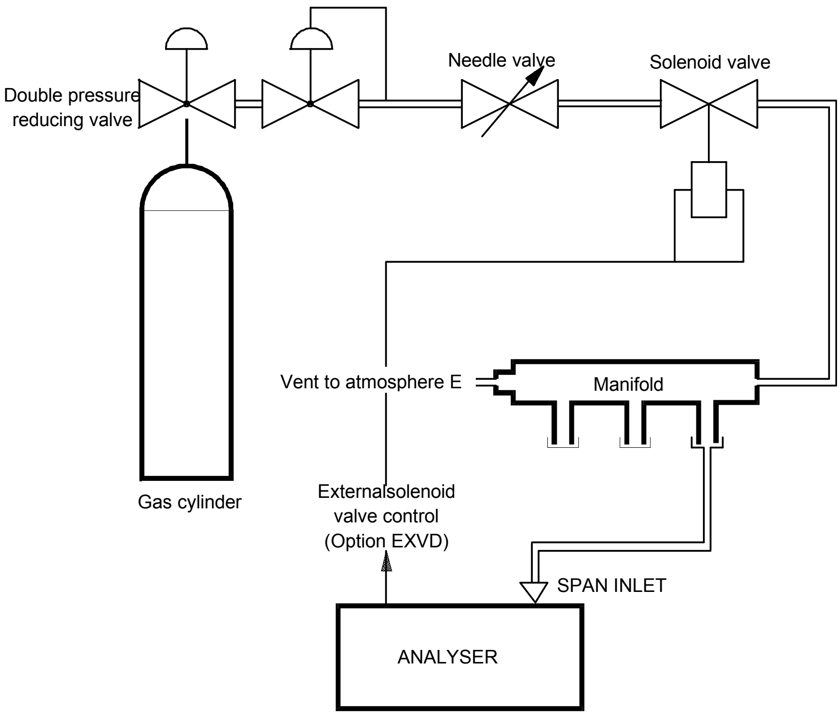


Figure 3-8 - Pressurized gas connection example.

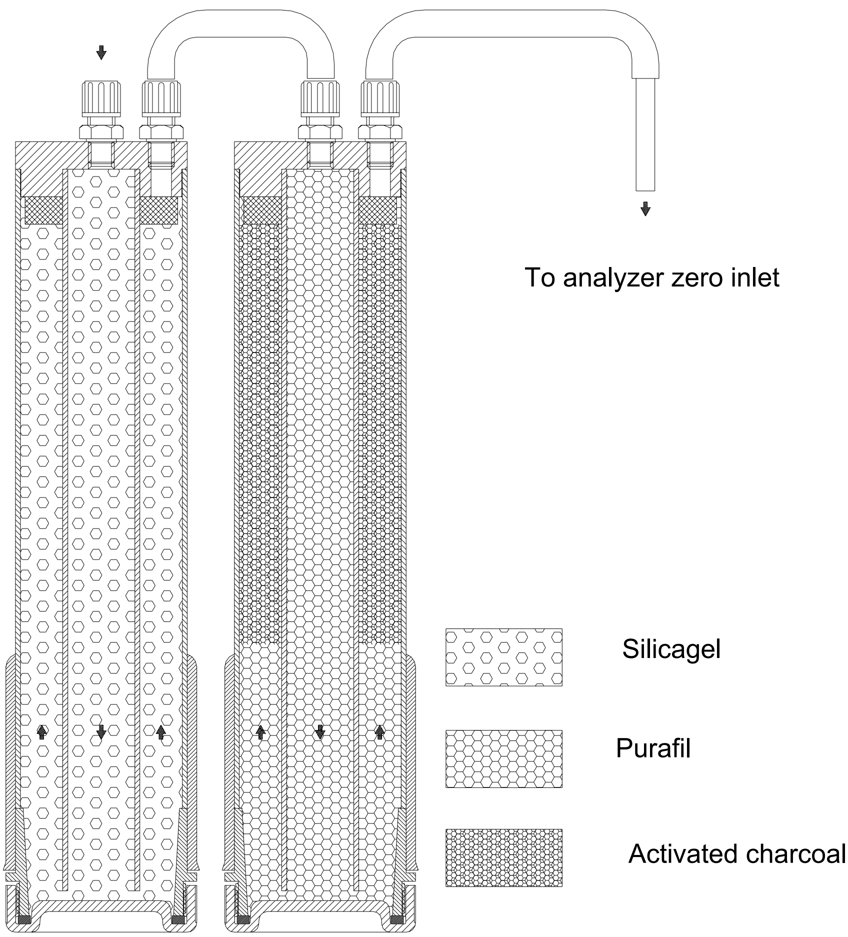


Figure 3-9 - Filtering columns

3.4.2 ZERO AND SCALE POINT CHECK

3.4.2.1 DEVICES

– "Zero" air :

The “Zero” air required quality is obtained using a filtering columns set (Figure 3-9) filled in with:

- 450 cc Silica gel
- 225 cc Purafil and 225 cc Activated charcoal (22-631-362 mesh)

– Scale point:

- NOx in N_2 cylinder, with a less than 10 ppm concentration, connected to the analyzer span gas" inlet.
- Internal permeation bench fitted with NO_2 tube (this set is connected to the analyzer "span gas" inlet). The concentration generated by the bench is written on the check sheet.
- Portable calibrator (VE3M type) fitted with a NO2 tube and connected to the analyzer "span gas" inlet.

NOTE : When the analyzer is fitted with an internal permeation bench, the sample inlet must be used to connect the span cylinder or the portable calibrator.

3.4.2.2 PROCEDURE

– Zero check:

- Select the analyzer "zero air" inlet using the [Zero] key and wait for the measurement to stabilize. The reading must be less than or equal to 1ppb.

– Scale point check:

- Select the "span gas" inlet using the [Etal] or the [Sample] key (as per above note) and wait for the measurement to stabilize. The obtained results are compared to the concentration generated by the device used taking into account its accuracy.

3.4.2.3 USE OF AUTOMATIC CYCLES

To program the cycles, see § 3.3.3.3 *Span ⇨ Cycles*.

– Zero cycle:

- The "zero air" generator is permanently connected to the analyzer "zero air" inlet. The recommended duration of the zero check is 600 seconds.

– Calibration cycle:

- The scale point generator is permanently connected to the analyzer "span gas" inlet. The NOx concentration must be below the full scale of the range used for the measurement. The recommended duration of the check is 600 seconds.

3.4.3 TWO-POINT CALIBRATION

3.4.3.1 EQUIPMENT REQUIRED

– "Zero" air:

- The filtering columns described above can be used here or, for better precision, a zero air generator with molecular sieve, or cylinder of synthetic air. These devices are connected to the "sample" or "zero air" inlets of the monitor.

– Scale point:

- NO in N_2 cylinder titrated around 80 % of the full scale of the measurement range used (accuracy ±1%). For reasons of titre stability in time, the analyzer can be calibrated using its 10ppm range. In this case, the device is connected to the analyzer "sample" or "span gas" inlets. For greater accuracy, it is advised to use a NO certified into NOx cylinder.

NOTE : When the analyzer is fitted with an internal permeation bench, the sample inlet must be used to connect the span cylinder or the portable calibrator.

3.4.3.2 PROCEDURE

– Zero check:

- Select inlet using the [Sample] or [Zero] keys and wait for the measurement to stabilize. The analyzer response must be less than or equal to 1ppb.

NOTE : By virtue of its design the AC32M doesn't require a zero adjust, however a small level of zero air signal can occur (due for instance to chamber wall luminescence). The capability of correcting for this is offered with AC32M using the "Configuration ⇨ Measurement mode" menu § 3.3.4.2. to adjust manually Zero, Z.NO and Z.NOx.

REMARQUE : If measurements are close to zero, because of background noise, the analyzer base line could be shifted artificially for consistent measurements reading. This shift is done using the OFFSET function (see § 3.3.4.4 *Configuration ⇨ Offset and unit*).

– Span adjust

- automatic: Program the NO and NOx span concentration values written on the cylinder certificate in the Span ⇨ Selected gas menu. Select the gas inlet connected to the span and use the [Auto] key to start the automatic calibration adjustment. The analyzer modifies its K span factors automatically when the programmed countdown reaches 0000s. (see Span ⇨ Cycles menu).
- manual: Program the NO and NOx span concentration values written on the cylinder certificate in the *SPAN ⇨ Selected gas* menu. Select the gas inlet connected to the span. Wait for the measurement to stabilize. Select the K NO and NOx fields in the *SPAN ⇨ Calibration* screen and program the new span factors as follow :

$$K' = \frac{K \times \text{titration}}{\text{Read value (without offset)}}.$$

Validate to record the new factor.

WARNING : Validation of new coefficient erases the previous.

It is strongly advised to carry out automatic calibration because this method enables to compensate pressure variation of sample and chamber compared to the reference pressures. They are memorized at the moment of device calibration (see § 3.3.3.1).

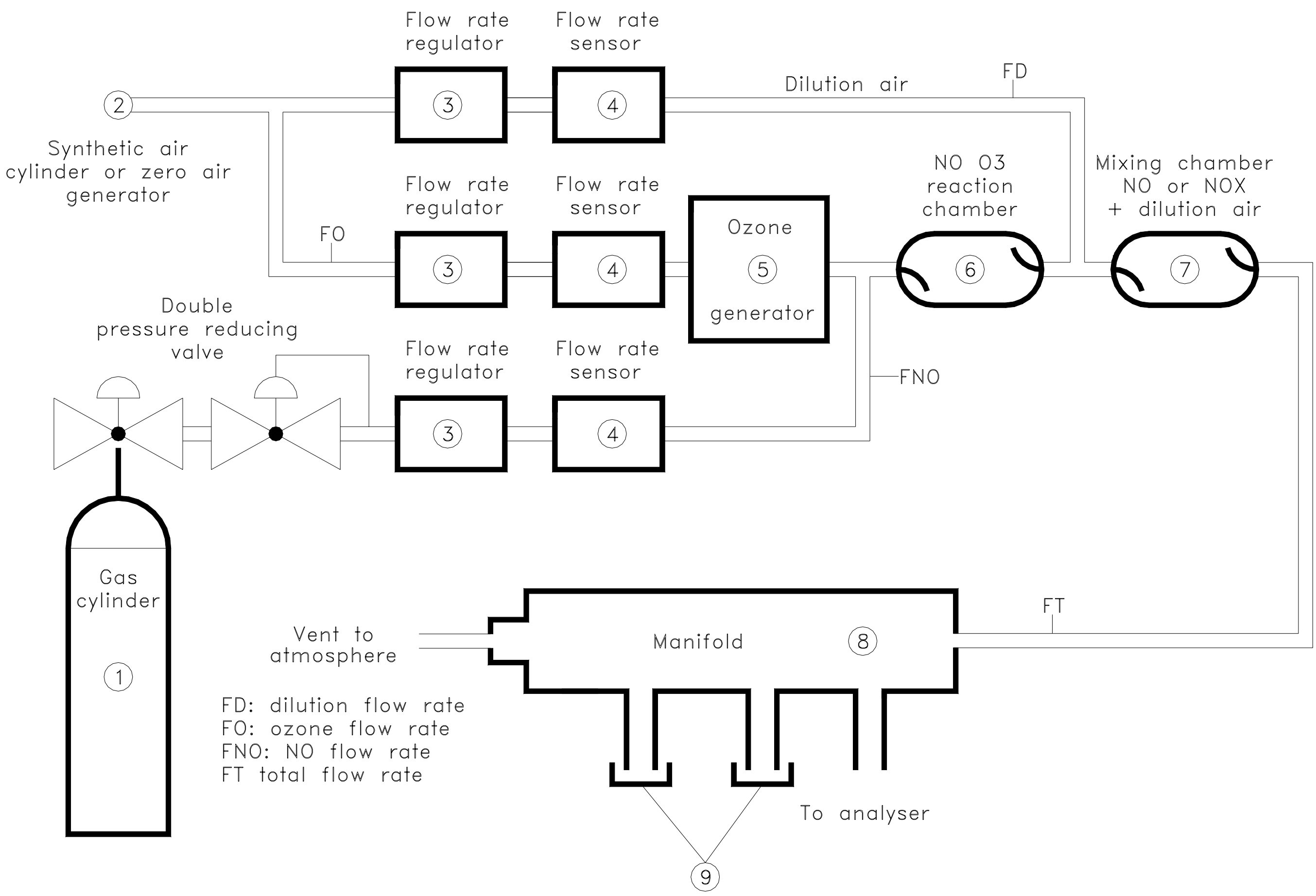


Figure 3-10 - Typical calibration diagram

3.4.3.3 USE OF THE AUTO-CAL CYCLE

To program the cycle, see § 3.3.3.3 *SPAN ⇨ Cycles*. To program concentration, see § 3.3.3.2 *SPAN ⇨ Gas select*. The gas generation system is permanently connected to the analyzer span inlet. The recommended time for an auto-calibration is 600 seconds.

3.4.4 CALIBRATION (GENERAL GUIDELINES)

In general, the means required for calibration are important enough and it is often necessary to return the analyzer to the laboratory.

NOTE : When the analyzer is fitted with an internal permeation bench, the sample inlet must be used to connect the span gas generator.

3.4.4.1 DEVICE

The minimum device is a set with a diluter with an ozone generator for checking the NO_2/NO converter (MGC101 type calibrator), a NO in N_2 cylinder which NOx contained concentration is certified (accuracy ±1%) and a "zero air" generator.

Materials in contact with zero and span gas must be made of PTFE, glass or stainless steel.

The gas is applied to the analyzer sample inlet at atmospheric pressure.

Calibration requires precision gas generation of 3 o 4 (example: 20%, 50%, and 80% of the full scale used). The dilution air must be the same as the one used for the zero measurement.

3.4.4.2 PROCEDURE

Firstly, proceed to a two point calibration (see § 3.4.3) adjusting the diluter NO concentration output [NO]gen to 90% of the full scale of the used range.

NOTE : Verify that NOx (NO + NO2 impurities) generated concentration + an eventual programmed offset does not exceed the NOx programmed full scale, if that is the case, decrease the NO concentration until obtaining a NOx concentration equal to 95% of the NOx programmed full scale.

Generate several additional concentrations (at least five evenly spaced points across the remaining scale are suggested to verify linearity), wait for stabilization (10 min) between 2 points.

For each generated concentrations record the exact NO and NOx and the analyzer's NO / NOx responses.

Compare the analyzer's responses to the generated concentrations, verify that responses are within generated concentrations ±0.4ppb or generated concentration ±1% (taking into account the gas generator accuracy).

[NO]resp = [NO]gen ± 0.4 ppb (for [NO]gen < 40 ppb)

[NO]resp = [NO]gen ± 1% (for [NO]gen > 40 ppb)

[NOx]resp = [NOx]gen ± 0.4 ppb (for [NOx]gen< 40 ppb)

[NOx]resp = [NOx]gen ± 1% (for [NOx]gen> 40 ppb)

Where [NO]resp [NOx]resp are the analyzer's responses in ppb

[NO]gen [NOx]gen are the generated concentrations in ppb.

If analyzer's responses are out of the bounds, a complete maintenance must be performed.

NOTE : For more information about calibration procedure refer to EPA CFR40 Part 50 appendix F.

3.4.5 CHECKING CONVERSION EFFICIENCY OF MOLYBDENUM OVEN WITH G.P.T.

The gas phase titration (GPT) method with NO in excess allows to check the NO/NO2 conversion efficiency from a NO concentration used as reference.

It uses the following reaction: $NO+O_3 \rightarrow NO_2+O_2$, allowing the NO_2 gas quantitative analysis as a function of NO variation concentration.

NOTE : For operation of the analyzer under U.S.EPA designation as a reference method, the converter efficiency must be 96% or higher.

3.4.5.1 DEVICE

"Zero" air generator.

Diluter fitted with an O_3 generator using photolysis (MGC101).

NO in N_2 cylinder. The concentration is chosen in order to obtain, after dilution, a NO concentration of about 90% of the measurement full scale used.

3.4.5.2 PROCEDURE

After checking the analyzer zero, the following operations must be carried out:

Once analyzer calibration is done, adjust concentration [NO]OUT to 90% of the full scale of the used range.

Note NO and NOx concentration readings [NO]ORIG and [NOx]ORIG.

Adjust the diluter to generate an ozone concentration in order to observe a decrease in NO concentration of about 90 %. Thus, approximately 80 % of full scale of NO2 is generated.

Wait for stabilization (10 min.).

Note NO and NOx concentration readings [NO]REM, and [NOx]REM.

Calculate the converter efficiency as follows:

- $$\beta = \frac{[NO_2]_{CONV}}{[NO_2]_{OUT}}$$

where : $[NO_2]_{CONV}$ is the quantity of NO_2 that has been converted

$$[NO_2]_{CONV} = [NO_2]_{OUT} - ([NO_x]_{ORIG} - [NO_x]_{REM})$$

and $[NO_2]_{OUT}$ is the quantity of NO_2 that has been generated

$$[NO_2]_{OUT} = [NO]_{ORIG} - [NO]_{REM} + \frac{F_{NO} \times [NO_2]_{IMP}}{F_T} = [NO]_{ORIG} - [NO]_{REM} + \frac{F_{NO} \times ([NO_X]_{STD} - [NO]_{STD})}{F_{NO} + F_O + F_D}$$

$[NO]_{STD}$: is the NO concentration in the cylinder

$[NO_X]_{STD}$: is the NOx concentration in the cylinder

F_T : is the total flow rate of the diluter.

F_{NO} :is the NO flow rate

F_O : is the ozone flow rate

F_D : is the dilution flow rate

Figure 3.9 schematically represents NO, NO2 and NOx concentration during the GPT procedure.

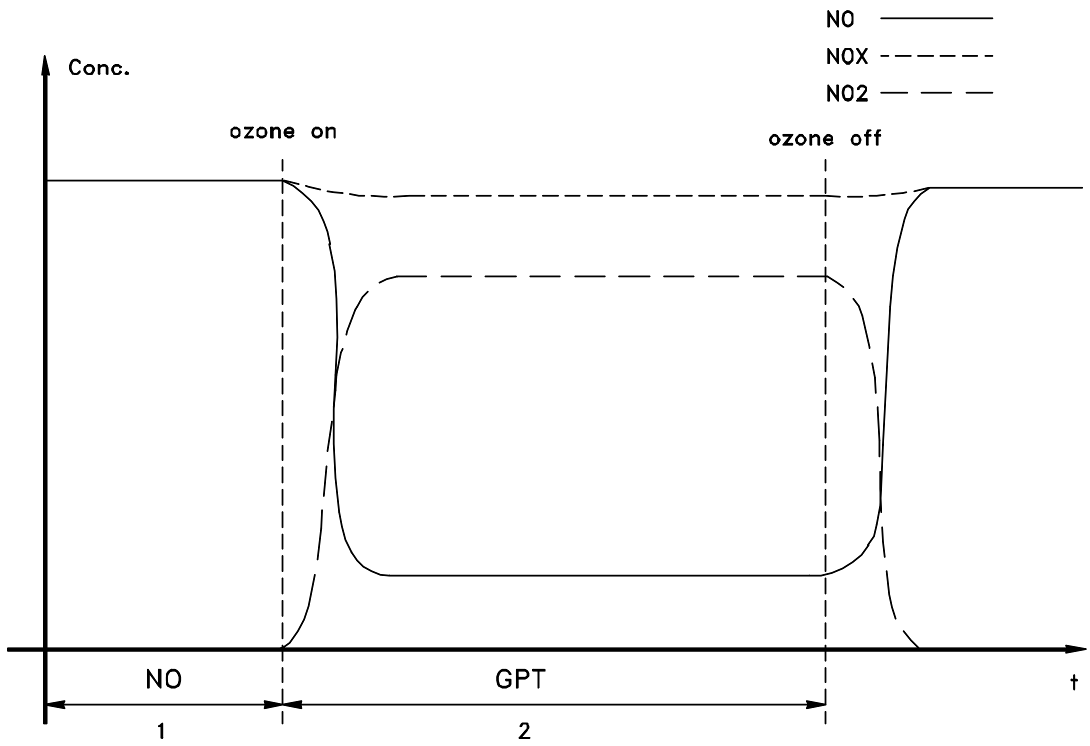


Figure 3-11 - GTP concentration diagram

3.4.6 INTERNAL NO2 PERMEATION OVEN (OPTIONAL)

The span point check can be performed using a permeation oven equipped with a NO2 source.

NOTE : For operation of the analyzer under U.S.EPA designation as a reference method, the permeation oven must not be used for calibration

– Principle

- The NO_2 used is maintained in a state of liquid/vapor phase equilibrium in a closed cylindrical tube fitted with a polymer diaphragm. Due to the differential partial pressure of the gas on either side of the diagram and the diaphragm permeability, gas is diffused toward the outside of the tube. The weight of the gas diffused per unit of time, called “permeation rate” depends on several parameters; type of gas, thickness, surface and nature of diaphragm, partial gas pressure on either side of diagram, temperature.

– Setup

- The permeation tube is placed in a block which is thermostat-controlled to 50°C (± 0,1°C) continuously purged with a carrier gas whose flow rate is limited by a restrictor (0.2 mm) at about 17 l/h. The rinsing gas is filtered by two filtering columns (Silicagel and Purafil / activated vegetable charcoal) connected to the monitor zero air inlet. The permeation oven outlet (PTFE plug) is connected to the monitor span gas inlet. When this inlet is selected, the monitor sampling flow rate is added to the purge flow rate and the analyzer measures the concentration generated by the oven.

– Procedure

- The internal oven is selected using the span key, or automatically on a calibration cycle. Once stabilized, the NO2 measured by the monitor must be compared to the concentration recorded on the checklist.
- Since NO2 permeation is very sensitive to the quality of the carrier air, the conditions of filtering columns should be checked periodically.
- The oven temperature is displayed on the *TESTS⇨ Optical bench* screen.
- The range of set operation temperature is 10 to 30°C (ambient temperature).
- When setting into service or following an extended shutdown period, the stabilization time is about 24 hours.
- The permeation source supplied with the monitor has a lifetime of about 16 months. If the analyzer is not used, the source should be removed from the oven, and placed in its original package with desiccant bags, then stored in a cool, ventilated place.

– To maintain the best precision than possible, the following specifications should be checked regularly:

- Flow rate of oven carrier gas,
- Rate of permeation tube (theoretically constant).

A differential weighing with an accurate balance should be performed to the 10^{th}, or better to the 100^{th} of mg.

Calculation of permeation (P) and (CG) concentration rates generated by oven:

- m0 = Initial weight of the tube (ng)
- m1 = Final weight of the tube.
- m0 - m1 = Weight of NO2 diffused (ng)
- t = Time between two weightings (min)
- P = (m0 - m1) / t = tube permeation rate (ng/min)
- F = Total real air flow rate passing through the oven (CC/min)

- Km = Molar coefficient, for NO_2 = 0.532
- CG = Km x P / F = Concentration of span gas generated (ppm)

REMARQUE : Each time the permeation tube is changed, the calculation should be repeated, or more simply, the concentration generated by the new tube can be determined by reading the concentration on the oven just following a calibration adjustment operation on the analyzer.

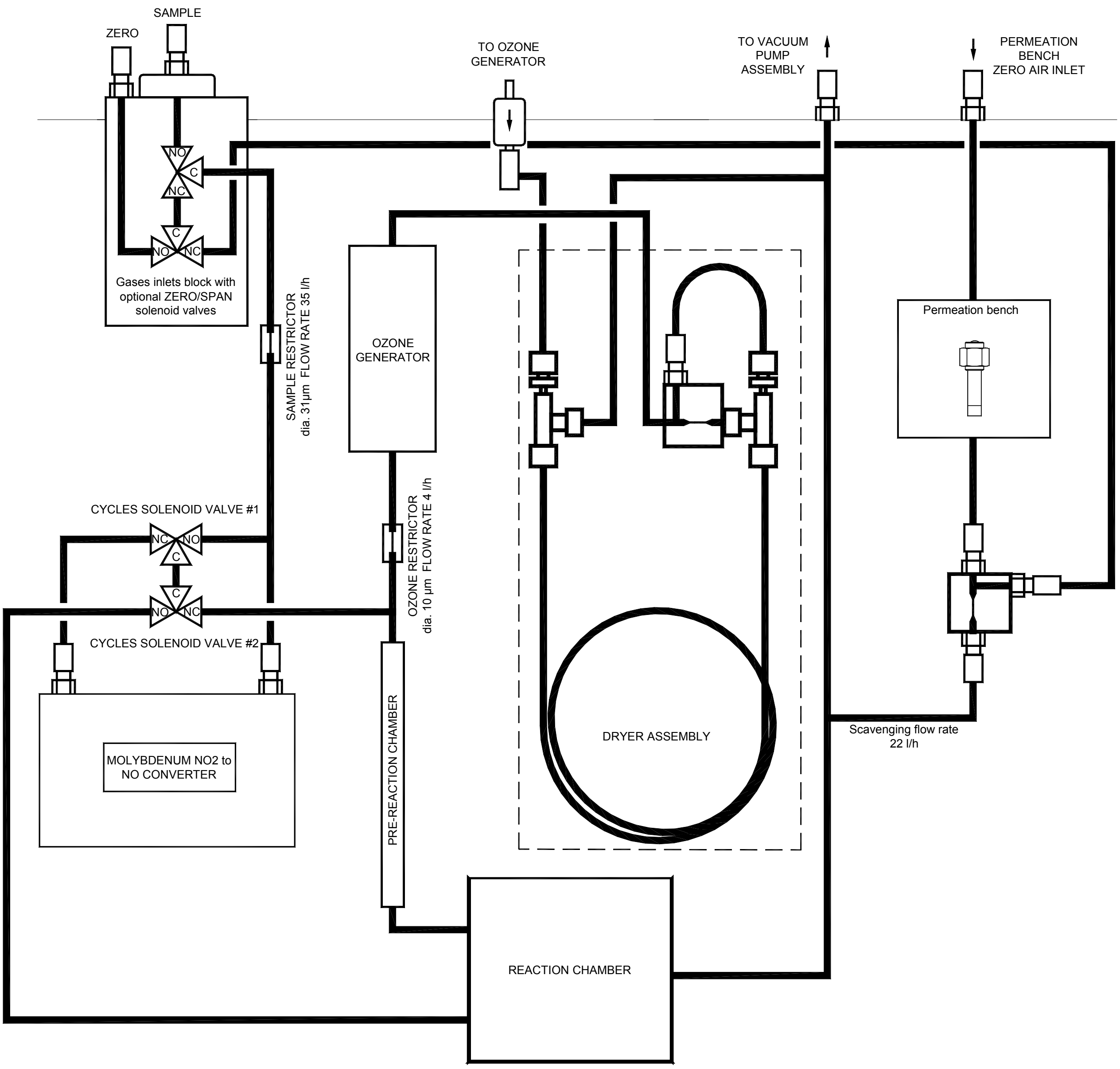


Figure 3-12 - Principle diagram of flow rate with permeation oven

3.4.7 PRESSURE SENSORS CALIBRATION

Connect a reference pressure sensor in parallel to the pressure sensor to be calibrated.

Enter the slope (A) and the intercept (B) values in the pressure calibration window field.

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CHAPTER 4

PREVENTIVE MAINTENANCE

4 PREVENTIVE MAINTENANCE

4.1 SAFETY INSTRUCTIONS

Safety instructions must be observed at any time by the users.

Whenever possible, cut off the power supplies sources when performing any work inside the instrument.

Take the necessary precautions when handling dangerous products (i.e. gloves, protective masks…) like high pressurized gas (cylinders kept in store rack and in a well-ventilated place).

Frequently check that there is no leak in pipes.

Only qualified people should intervene on the analyzer.

As concerning safety, the manufacturer shall not be responsible for any consequences resulting from:

- use of the monitor by non-qualified people,
- use of the monitor under conditions other than those specified in this document,
- modification of the monitor by the user,
- no maintenance of the monitor.

A systematic periodic inspection is required.

4.2 MAINTENANCE CALENDAR

Due to its design, the AC32M requires only very limited maintenance.

However, regular maintenance must be carried out to guarantee that the stated characteristics are maintained under continuous operation.

During the period following initial starting-up, before putting into definitive operation, it is necessary to carefully monitor evolution of the installation, by a daily visit. After this short period of 5 days, a weekly inspection visit is sufficient: it will enable to exactly define maintenance calendar for operation site.

Periodicities are given as information and can vary according to operating conditions.

Nature of operations	Periodicity	Sheet No.
– **Replacement of filters:** • Sample inlet filter • Protection filter of built-in fans	Monthly	**4.3.1**
– **Checking of fluid parameters and span factors**	Monthly	**4.3.2**
– **Cleaning of measurement chamber**	Depends on results of sheet 4.3.2	**4.3.3**
– **Cleaning of ozone generator electrodes**	Six-monthly	**4.3.4**
– **Flow rate and air tightness checking**	Six-monthly	**4.3.5**
– **Pumping assembly checking:** • Replacing the Charcoal cartridge • Replacing the diaphragm • Replacing the valves • Checking the compressor assembly • Servicing the T4.4 BECKER vanes pump	Quarterly Annually Annually Six-monthly Annually	**4.3.6**
– **Molybdenum converter**	Annually	**4.3.7**
– **Active charcoal cartridge replacement of KNF and Becker pumps**	6 months	**4.3.8**

Annual checking

Analyzer return to laboratory for complete cleaning (measurement chamber, restrictors, ozone generator, fluid circuit…), and checking of the whole metrological parameters.

– In particular, the conversion coefficient of $NO_2 \rightarrow NO$ converter is specifically controlled (see section 3.4.5).

– Check tightness at connectors carefully.

4.3 MAINTENANCE OPERATIONS SHEETS

WARNINGS

– **DURING UNDER VOLTAGE INSPECTION, VOLTAGE AT THE OZONE GENERATOR TERMINALS IS ABOUT 5000 VOLTS.**

– **DO NOT USE TRICHLORETHYLÈNE OR ACETONE FOR CLEANING OF SEALS AND ELECTRODES.**

MAINTENANCE SHEET

<table>
<tr><td colspan="2">ANALYZER serial No:</td><td colspan="2">OPERATION SHEET: 4.3.1</td></tr>
<tr><td colspan="2">Scope : Replacement of filters</td><td>PAGE: 1/1</td><td colspan="2">Periodicity: monthly</td></tr>
<tr><td colspan="3" rowspan="2">
– <u>Sample inlet filter :</u>
Filter PTFE - 5 µ - ∅ 47 mm - Ref. : F05-11-842 — to be replaced

– <u>Protection filter of built-in fans :</u>
Dust filter of 24V fan, small model - F05-IDN-10G — to be replaced
Dust filter of fan, large model - V04-PA-001 — to be replaced

– <u>Required tools</u>
• None

– <u>Types of operations</u>
C : Cleaning   R: Replacement performed
</td><td>Types of operations</td><td>Dates</td></tr>
<tr><td></td><td></td></tr>
</table>

MAINTENANCE SHEET

ANALYZER serial No:	OPERATION SHEET: 4.3.2	
Scope : Checking of fluid parameters and span factors	**PAGE: 1/2**	**Periodicity: monthly**

– **Cleaning the measurement chamber**

The need for cleaning the measurement chamber is determined by regular monitoring the fluid and optical parameters in test mode and changes in the span coefficients.

– **Inspection of fluid parameters**

- Using a flow meter, check that the flow rate is 42 l/h at the sample inlet and 8l/h at the ozone generator inlet.
- The pressure is checked in the *TESTS* ⇨ *Optical bench* menu and must correspond to value indicated in Table 3-2 (MUX signals).
- Check that PM assembly is properly ventilated (operation of fan and cleanliness of acrylic filter).
- The here-below table summarizes flow rate values according to the analyzer options :

– **Inspection of the K span factors (see *Span* ⇨ *Factors* screen)**

- If the factors are higher than 5.00, clean the measurement chamber (see sheet No 4.3.3).

	AC32M standard	AC32M + Permeation bench	AC32M + Sample dryer.	AC32M + Rack $CHN3_{S2}$	AC32M + Rack $CNH3_{S2}$ + NH3 Permeation bench
Sample inlet	42 l/h ± 2 l/h	42 l/h ± 2 l/h	64 l/h ± 4 l/h	60 l/h ± 4 l/h (NO, NOx, Black) 42 l/h (Ny way)	60 ± 4 l/h 42 ± 2 l/h
Zero inlet	42 l/h ± 2 l/h	42 l/h ± 2 l/h	42 ± 2 l/h	60 l/h ± 4 l/h (NO, NOx, Black) 42 l/h (Ny way)	60 ± 4 l/h 42 ± 2 l/h
Span inlet	42 l/h ± 2 l/h	—	42 l/h ± 2 l/h	60 l/h ± 4 l/h (NO, NOx, Black) 42 l/h (Ny way) ± 2 l/h	—
Measurement chamber inlet	42 l/h ± 2 l/h	42 l/h ± 2 l/h	42 l/h ± 2 l/h	19 ± 2 l/h	19 ± 2 l/h
Ozone generator dryer inlet	8 l/h ± 1 l/h	8 l/h ± 1 l/h	8 l/h ± 1 l/h	8 l/h ± 1 l/h	8 ± 1 l/h
Ozone inlet of measurement chamber	4 l/h ± 1 l/h	4 l/h ± 1 l/h	4 l/h ± 1 l/h	4 l/h ± 1 l/h	4 ± 1 l/h
Permeation bench inlet	—	19 ± 2 l/h 60 ± 5 l/h in span way			60 ± 4 l/h

– Required tools

- 1 0-50 l/h flow meter

MAINTENANCE SHEET

ANALYZER serial No:	**OPERATION SHEET: 4.3.2**	
Scope : Measurement of parameters	**PAGE: 2/2**	**Periodicity : monthly**

Flow rate		Signal test	Span coefficients		Chamber cleaning		Dates
Sample inlet	Ozone generator inlet	Pressure	K NO	K NOx	YES	NO	

MAINTENANCE SHEET

ANALYZER serial No:		**OPERATION SHEET: 4.3.3**	
Scope :	**Cleaning of measurement chamber**	**PAGE: 1/2**	**Periodicity: See No 4.3.2 sheet**

DATES

– **Chamber cleaning**

- Switch off the analyzer and disconnect the mains cable.
- Put off the protective covers.
- On the MODULE board (Fig. 5-1), disconnect the ozone generator control (J8), the converter control and the temperature (J11), the 24 VCC (J24), the zero and span SV (J17-J18) and the display cord.
- Disconnect the sample inlet fitting of the chamber (Figure 4-1 Mark No 3).
- Disconnect tubes of converter oven.
- Loosen the 3 fixing screws (located at the left front part of the measurement block between SV and heat sink, and at lower part of the Module board).
- Put the whole towards front to release the screw heads, hang it up vertically, turn it carefully in order to put it on the rear part.
- Dismount (without disconnecting) both pressure sensors.
- Unscrew the 4 fixing screws of the chamber. (Figure 4-1 Mark No 1)
- Turn the measurement chamber assembly carefully and loosen the 4 holding screws (Figure 4-2 Mark No.1) of the quartz window (Figure 4-2, Mark No 2).
- Clean the window and the chamber using a Q-tip moistened with alcohol.

– **Injectors cleaning**

- Injectors are located behind fittings of ozone inlet (Figure 4-1 Rep.2) and sample (Figure 4-1 Rep.3) inlet.
- Put down fittings, unscrew injectors, dip them in an alcohol solution, and dry them blowing compressed air on. Replace the seals.
- Make sure not to tighten the injectors strongly when assembling again, to avoid crushing the seals.
- Re-assemble the fittings after changing Teflon tape.

Following this maintenance operation, the analyzer must be calibrated, the flow rate and air tightness must be checked

– **Flow rate check :**

- Using a flow meter, check that the flow rate is 42 l/h on the sample inlet.

– **Tightness check**

- Using a vacuum meter connected to the sample inlet, connect zero air inlet and ozone generator inlet until the vacuum pressure reaches a maximum of ≅ 60 cm Hg, cut off the pump supply. If air tightness is correct, negative pressure should not decrease. In case of looses, check the fluid circuits, fittings, seals, et c..

– **Required tools**

- Open-end wrench 7/16
- Flat-tip screwdriver 5,5 x 100
- Q-tip
- Alcohol solution
- Screw M2,5, length 20 mm, for removal of lower seals
- Flow meter and vacuum meter
- Teflon tape

MAINTENANCE SHEET

ANALYZER serial No:		OPERATION SHEET: 4.3.3	
Scope :	Cleaning the measurement chamber	PAGE: 2/2	Periodicity : See 4.3.2 sheet

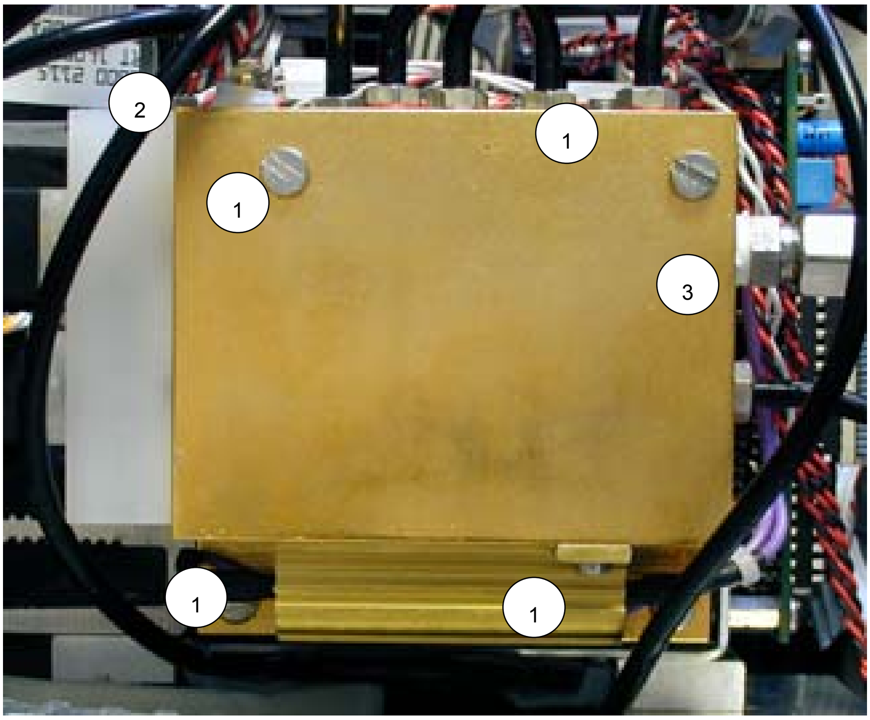


Figure 4-1 – Measurement chamber settling

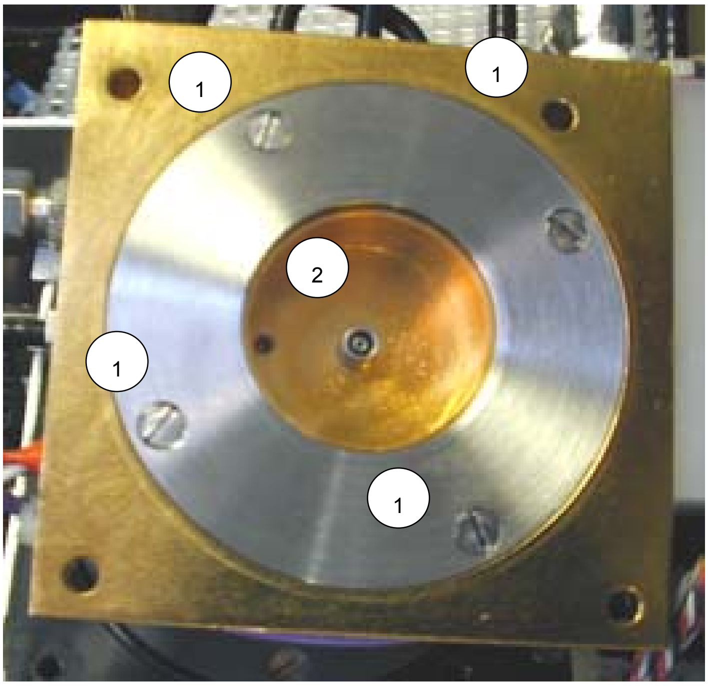


Figure 4-2 - Detail of the measurement chamber

MAINTENANCE SHEET

ANALYZER serial No:	OPERATION SHEET: 4.3.4	
Scope: Cleaning of ozone generator electrodes	FOLIO : 1/1	Periodicity: Six-monthly

– **Cleaning the electrodes**

- Switch off the analyzer and disconnect the mains cable.
- Remove analyzer cover, ozone generator assembly cover and fluid fittings (1).
- Disconnect the plugs (2 and 3) connecting the ozone generator to the transformer (red and black marks) then put ozone generator assembly out of its case.
- De-assemble the connection (4) from the central electrode (5).
- Unscrew the right side (6) tap.
- Take off the central electrode
- Check there is no corrosion on the stainless steel electrode and clean its outside surface using an alcohol solution.
- Check there is no crack on the glass electrode and clean its inner surface.
- Check O-rings (8 et 7), and change them if necessary. Replace also O-rings of the opposite side (putting off the left side tap).
- When putting up again, be careful to place the longer part of the central electrode (see detail A Mark No 1) on the same side of the plug (3).
- Change the ozone generator filter (Figure 1.5b) Reference: IDN10G.

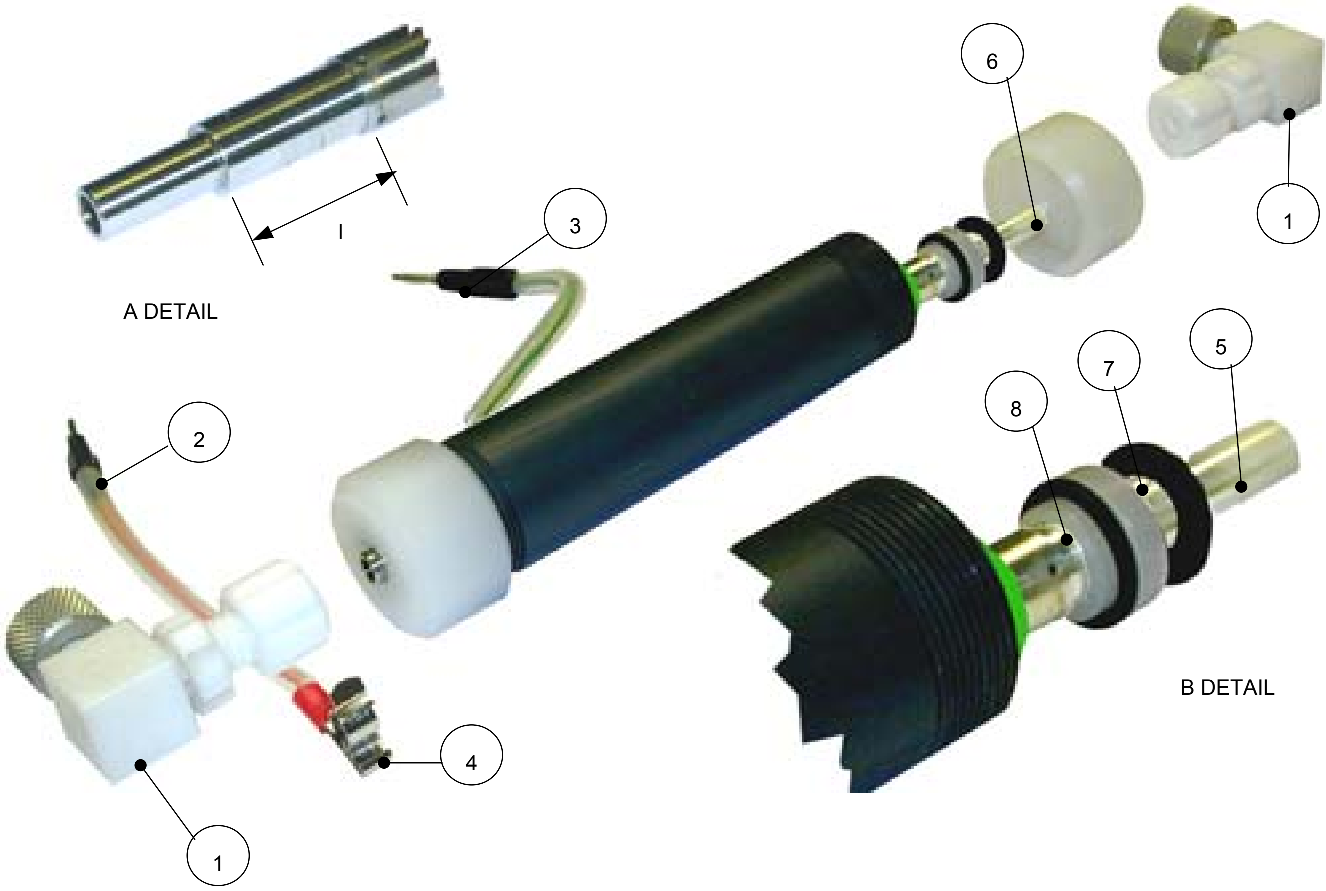


Figure 4-3 – Exploded overview of the ozone generator

Types of operations : **F : Filter change** **S :Seal change** **C : Cleaning**

MAINTENANCE SHEET

ANALYZER serial No:	OPERATION SHEET: 4.3.5	
Scope: Flow rate and air tightness checking	PAGE: 1/1	Periodicity: Six-monthly

4 l/h flow rate of ozone generator	Dates

- **Flow rate checking**
  - Using a flow meter, check that the flow rate is 8 l/h on the dust protection filter inlet (Figure 1.4 – Mark 3).
- **Air tightness checking**
  - Connect a vacuum meter to the ozone generator inlet.

    Plug the zero air and sample inlets; as soon as negative pressure reaches its maximum, cut off pump supply.

    If air tightness is correct, the negative pressure should not decrease.

- **Tools required**
  - Flow meter 0-50 l/h
  - Flat-tip screwdriver 5,5 x 100
  - Soft rag
  - Alcohol solution

CAUTION - DANGERS

- **WHEN PERFORMING CHECKS WITH UNIT POWERED ON, VOLTAGE AT OZONE GENERATOR TERMINALS IS ABOUT 5.000 VOLTS.**
- **DO NOT USE TRICHLORETHYLENE OR ACETONE TO CLEAN SEALS AND ELECTRODES.**

MAINTENANCE SHEET

ANALYZER serial No:	OPERATION SHEET: 4.3.6	
Scope: Pumping assembly checking	PAGE: 1/4	Periodicity: Annually

- **Every 3 months (see Figure 4-4)**
  - Change the filtering cartridge (1).
- **Every year (see Figure 4-5)**
  - Check and change, if necessary, the pump valves and diaphragm.
  - Dust off impellers of pump fan.
- **Replacing the diaphragm, follow here-below order:**
  - Before de-assembling, mark with a pencil the position between the casing (15) and the cylinder head (16).
  - Unscrew the four hex socket screws (12) and remove the cylinder head (16).
  - Loosen the screw (5), remove the clamping disk (3) and the diaphragms (4).
  - Remove the 4 screws (13) and remove the cover (9).
  - Place the connecting rod (6) in half-stroke position turning the wheel (14), set up the new assembly of diaphragms (4) with flat side underneath.
  - Put the disk (3) in place on the diaphragms (4) and strongly tighten the assembly using the screw (5).
  - Position the head (16) as marked before de-assembling, then secure with the hex socket screws (12) operating regularly in criss-cross order.
  - Check that there is no stiff point in the analyzer working by hand-turning the runner (14); put the cover on (9), and fix it up with the 4 screws (13).
- **Replacing the valves**
  - Head de-assembling: see above instructions.
  - Unscrew the screws (10), remove the cover (9) and the seal (17), unscrew the nut (11) by using a socket wrench, take the screw out (1), replace the valves (7) and (8).
  - Fix the new valves on using the screw (1), the washer (2) and the nut (11). Fix the cover (9) up with the seal (17), and block it using the screws (10). Strongly tighten.
  - Install the cylinder head and check correct operation as detailed.
- **Required tools**
  - 11 mm flat wrench
  - male wrenches for 3 et 4 mm hexagon socket screw
  - 5,5 x 100 slot screw screwdriver
  - pencil
  - 5,5 socket wrench

Types of operations	Dates

Types of operations:

D : Change diaphragm V : Change valves CA : Change cartridge

MAINTENANCE SHEET

ANALYZER serial No:	**OPERATION SHEET: 4.3.6**	
Scope : Pumping assembly checking	**PAGE: 2/4**	**Periodicity: Six-monthly**

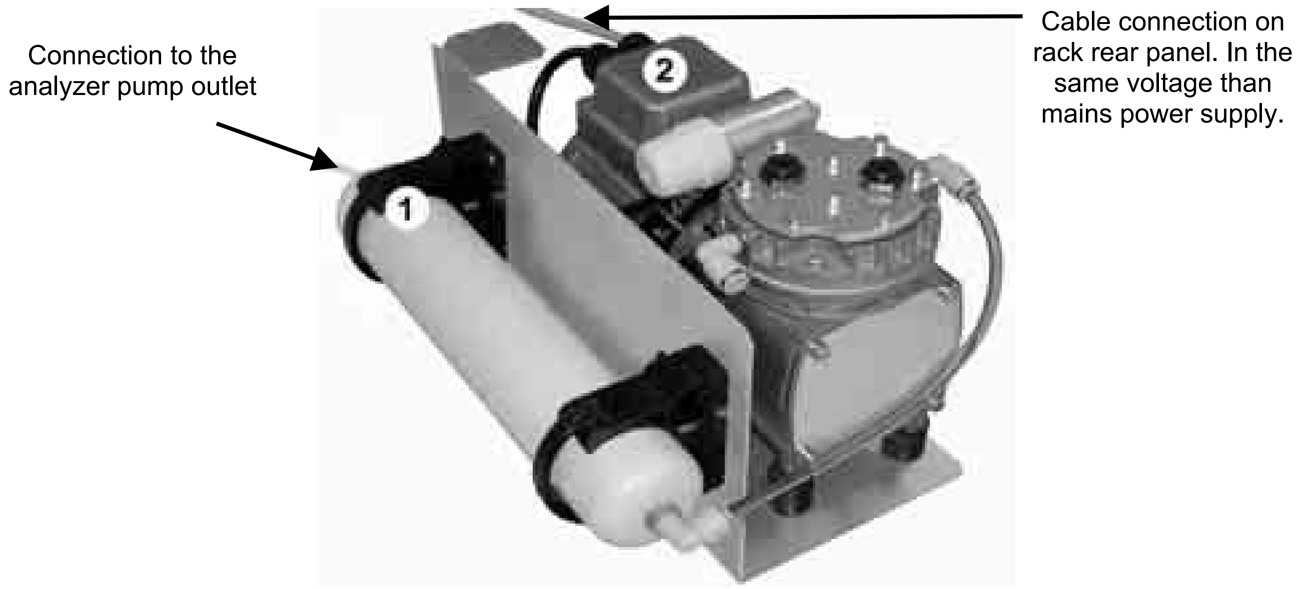


Figure 4-4 – KNF Pumping assembly

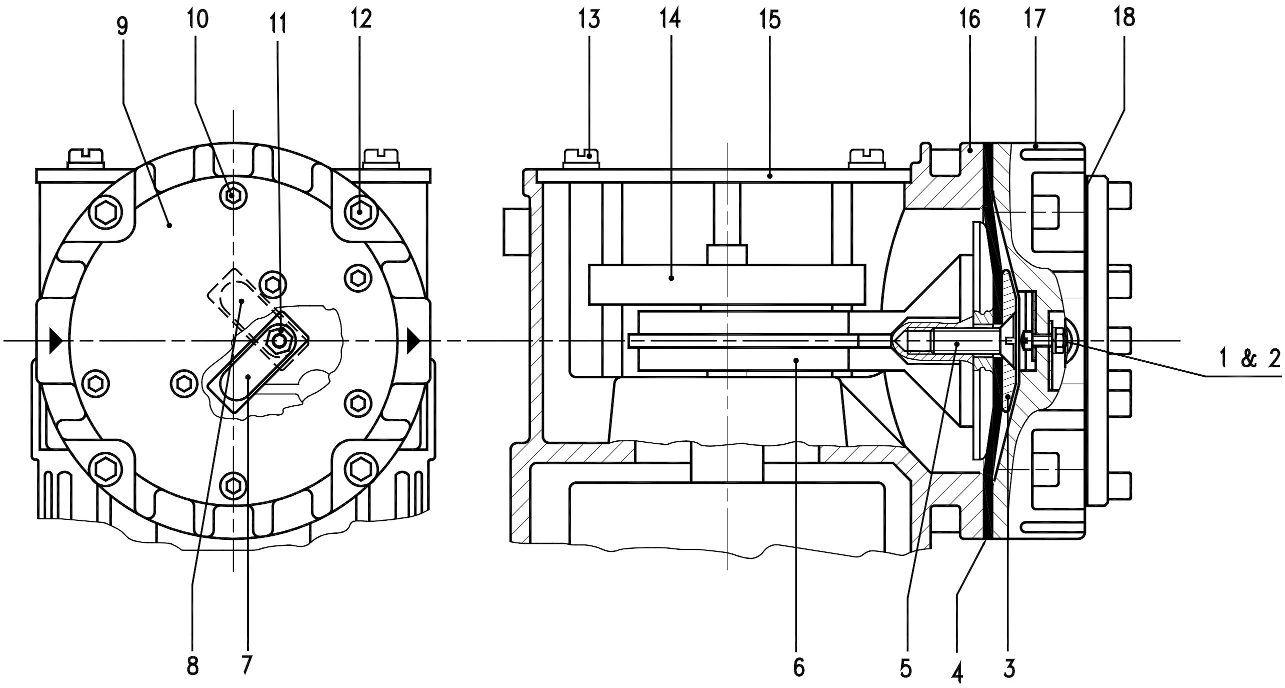


Figure 4-5 – Detail of KNF pump

MAINTENANCE SHEET

ANALYZER serial n°:	OPERATION SHEET : 4.3.6	
Scope : Servicing the T4.4 BECKER vanes pump	PAGE : 3/4	Periodicity : 1 year

Maintenance periodicity :

- Check carbon vanes : every 3000 hours operation,
- Change carbon vanes and filter cartridge every year

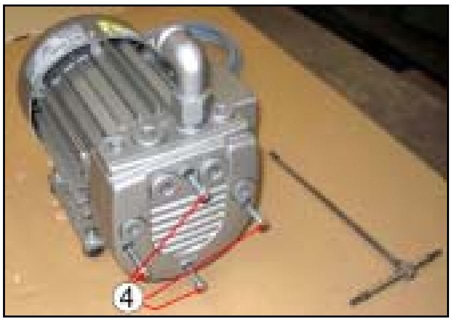
Necessary details :

- 1 set of 5 carbon vanes, Ref. : 90138700005
- 1 filter cartridge, Ref. : 90958000000
- 1 exhaust filter, Ref. : 74000301000

VT4.4 BECKER VACUUM PUMP

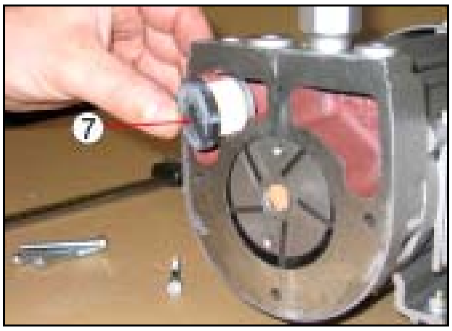
NECESSARY TOOLS : (1) BRT 4 wrench, (2) calliper square

STEP 1 : remove the exhaust filter (3)



STEP 2 : unscrew the 4 screws fixing the flask.

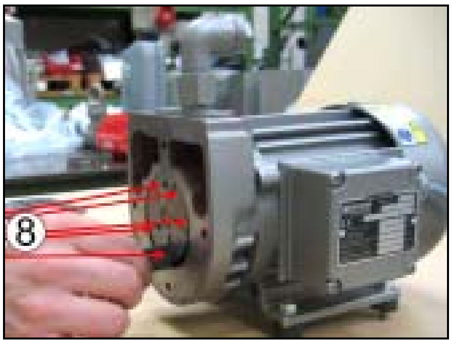
STEP 3 : remove the flask to have access to the filter cartridge (5) and the carbon vanes (6).



STEP 4 : remove the filter cartridge (7)

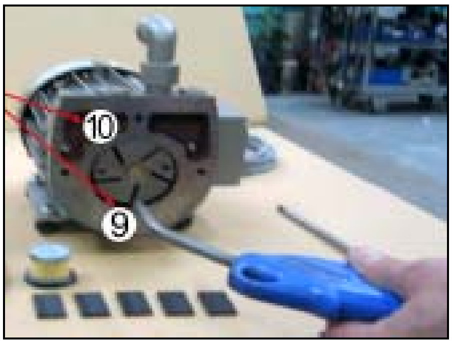
MAINTENANCE SHEET

ANALYZER serial n°:	OPERATION SHEET : 4.3.6	
Scope : Servicing the T4.4 BECKER vanes pump	**PAGE : 4/4**	**Periodicity : 1 year**

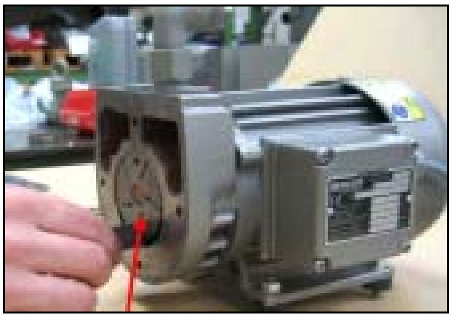


STEP 5 : remove the vanes (8). There are **5 vanes**.

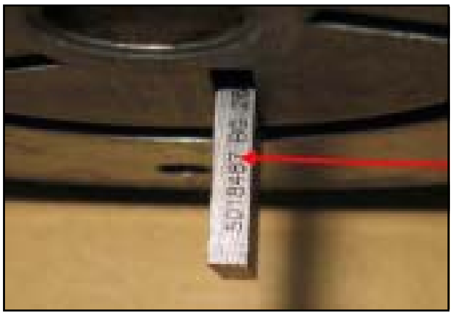
STEP 6 : check vane height. Change them **if H < 11 mm**



STEP 7 : vacuum dust from pump body (9) and cartridge filter (10).



STEP 8 : Re-install the 5 vanes.



The **marked side** of the vanes must be **upward oriented**.

STEP 9 : reassemble the filter cartridge (11). Change it each time you do a vanes change.

STEP 10 : before re-assembling, clean the flask with a dry cloth

STEP 11 : screw on the flask (4 screws).

STEP 12 : Remount the exhaust filter (3). Change it on each vanes change.

Figure 4–6 - Maintenance of the T4.4 BECKER vanes pump

MAINTENANCE SHEET

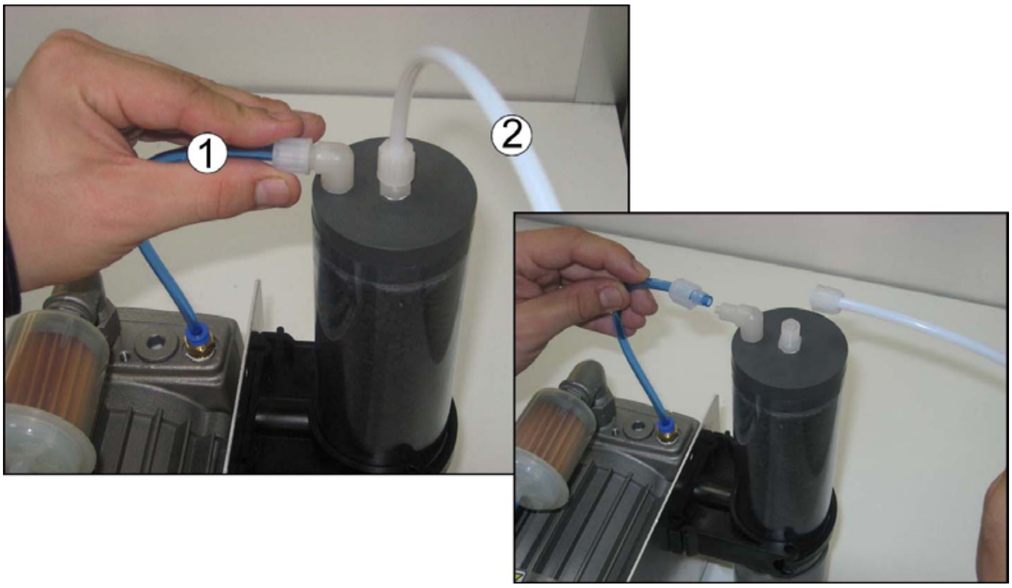
ANALYZER serial No:	**OPERATION SHEET: 4.3.7**		
Scope : Molybdenum converter	**PAGE: 1/1**	**Periodicity: Annually**	
Service life of molybdenum cartridge: 4000 ppm/h, i.e. 2 years depending on use. – **<u>Replacing the molybdenum cartridge</u>** • Switch off the analyzer and disconnect the mains cable. • Wait for the converter to cool down. • Remove the cover. • Unscrew the fluid connections. • Remove the insulation material and put the cartridge and heating ring assembly out of the analyzer. • Disconnect the 4 wires connecting the converter to the regulation board located on the converter side. • Using an hexagon socket head wrench, loosen the tightening screws of the heating ring, • Remove the converter body, • Place the new converter body, • Tighten again the fixing screws of the ring, • Connect again the 4 wires linking the converter to the regulation board, • Screw again the fluids connection and connect again the new converter wires. – **<u>Checking the temperature</u>** • When the temperature is reached, the measured value, i.e. 340°C, have to be checked in the *TESTS ⇨ Optical bench* menu. – **<u>Checking the fluid</u>** • See Sheet No 4.3.2. – **<u>Required tools</u>** • gloves • 0-050 l/h flow meter • 7/16" flat wrench • hexagon socket head wrench n°3 • 5,5 x 100 flat blade screw driver	**Sample inlet flow rate 42 l/h**	**Oven temperature**	**Dates**

MAINTENANCE SHEET

ANALYZER serial N°:	OPERATION SHEET: 4.3.8	
Scope : Active carbon cartridge replacement of KNF and Becker pumps	**PAGE : 1/3**	**Periodicity : 6 months**

Dates

- Consumables required : Filter ring Ref. : F05-5004-C
  Activated carbon, 1 kg Ref. : SAV-K-000073-A
- Switch off the analyzer, disconnect the mains power cord and the power supply cord of the pump.
- Unscrew the polyurethane (1) and Teflon (2) tubes 4/6 mm of the filter cartridge (inlet and outlet of the cartridge).



- Using the flat screwdriver, unclip the flat fixing clip (3) of the filter cartridge. Remove the cartridge from the pump support.

FICHE MAINTENANCE

ANALYZER serial N°:	**OPERATION SHEET: 4.3.8**	
Scope : Active carbon cartridge replacement of KNF and Becker pumps	**PAGE : 2/3**	**Periodicity : 6 months**

Dates

- Unscrew the bottom of the filter cartridge (4) and empty the worn activated carbon (5) and the filters.

- Using the positioning tube, position the external (6) and internal (7) new filters located in the bottom of the cartridge.

FICHE MAINTENANCE

ANALYZER serial N°:	**OPERATION SHEET: 4.3.8**	
Scope : Active carbon cartridge replacement of KNF and Becker pumps	**PAGE : 3/3**	**Periodicity : 6 months**

Dates

- Fill in the cartridge with activated carbon (8) and screw up the bottom.

- Clip again the cartridge on the pump support and screw again the pipes on the cartridge.

System assembled with the KNF pump

System assembled with the BECKER pump

- Re connect the pump assembly to the analyzer and switch on again.

– **Tools required**
  - Flat screwdriver

4.4 AC32M MAINTENANCE KIT

MAINTENANCE KIT for 1 year	**A01-K-AC32-K1**
On-line filter	F05-IDN-10G
Charcoal cartridge kit	F05-K-0011-A
MERKEL O-ring diam 35, cord 2	G06-035.0-2.0-V
Nylon seal, diam 5	G12-D661-M5
Box of Teflon filtering diaphragms (25 units)	SAV-K-000042-A
Seals set for ozone generator	SAV-K-000089-A
SAV kit for AC32M KNF pumping assembly	SAV-K-000090-A
Grid with filter for fan	V04-PA-001
SAV kit for AC32M Becker pumping assembly	SAV-K-000098-B

4.5 SPARE PARTS LIST

VARIOUS ELECTRICAL ELEMENTS	
Mains supply cord	D02-CS-002-A
Socket with mains supply filter	S02-PF-870-002
Time delay fuse	S01-TT02.00-A
24 V fan with cable – small model	D01-0758-A
24 V fan – large model	V03-0005-A
90 x 90 mm fan cable	D01-0747-A
FLUID CIRCUIT	
Pressure sensor of chamber	C06-0291-A
Sample pressure sensor board	C06-C6-0291-A
3-way solenoid valve with cable	D01-0749-A
Dust filter for 60 x 60 mm fan	F05-IDN-10G
Dust filter for 90 x 90 mm fan	V04-PA-001
Crossing elbow (pump output)	F03-1.0201.10-T
Teflon tube 4/6	F04-TF-004-006
Teflon tube 1/4 (black)	F04-TF-1-6-004
EQUIPPED ZERO SPAN BLOCK	P06-1051-A
PTFE filtering diaphragm (box of 25 units)	F05-11-842
O-ring seal, 44 mm diameter, cord 2	G06-044.0-2.0-V
O-ring seal, 41 mm diameter, cord 3	G06-041-0-3.0-V
Nylon seal	G12-D661-M5
Simple male fitting	F03-1.0100-32-B

<u>**NO-NOX PM BLOCK**</u>	**P10-1411-A**
Measurement chamber assembly	**P10-1166-A**
Heating resistor with cable	D01-0745-A
0.1 ozone injector + AC32 seal	A01-K-C0035-A
0.31 sampling injector + AC32 seal	A01-K-C0036-A
Insulation seal for injector	P06-0009-A
Simple male fitting	F03-SO51121-6-A
Male elbow	F03-SO52421-A
6-4 stainless steel bushing	F03-SO5001-6-4
Window O-ring	G06-035.0-2.0-V
Stainless steel Poral filter (MOTT)	F05-1200-170-A
Nylon seal	G12-D661-M5
Barbed fittings M5	P02-1006-C
Window flange	P02-1137-A
Reaction chamber	P02-1282-A
PM insulation window	P08-0001-B
PT1000 temperature probe with cable	D01-0765-A
Solenoid valve assembly for AC32M	**P10-1167-A**
3-way solenoid valve with cable	D01-0749-A
O-ring seal, 1.78 diam, 1.78 cord	G06-001.7-1.7-V
O-ring seal, 4.47 diam, cord 1.78	G06-004.4-1.7-V
Nylon seal	G12-D661-M5
Barbed fittings M5	P02-1006-C
Footing of solenoid valve	P06-0954-A
AC32M PM Block	
O-ring seal, 35 diam, cord 2	G06-035.0-2.0-V
O-ring seal, 52 diam, cord 2	G06-052.0-2.0-V
O-ring seal, 65 diam, cord 2	G06-065.0-2.0-V
Filter flange	P06-0791-A
Optical filter	P08-0002-A
Sole PM tube	M02-T9828
Board assembly of preamplifyer-HT footing (PM tube included)	P10-1178-A

MODULE FOR CONVERTER OVEN **(COMPLETE WITH BOX AND BOARD)**	
Additional charge for Molybdenum oven	F05-0140-A
Supply cable of converter	D01-0853
Control board of 24 V oven	SAV-K000099-A
Heating ring 24V PT100	T01-CC-60-25
OZONE GENERATOR ASSEMBLY	**P10-1165-A**
Ozone generator, body without casing, board and transformer	P10-1163-A
Equipped glass ozone generator tube	A01-K-C00374-A
Central electrode	P02-1384-A
O-ring seal, 8 diam, cord 3	G06-008.0-3.0-V
O-ring seal, 10.82 diam, cord 1.78	G06-010.8-1.7-V
TS 616E transformer with cable	B01-5001-B
Ozone generator supply board	C04-0273
Ozone generator cable with clip	D01-0756-A
End spacer	P06-0951-A
End stopper	P06-0952-A
PVC external tube for ozone generator	P06-0953-A
Crossing body for Teflon partition	P06-0049-A
Nut for Teflon fitting	P06-0356-A
Alumimium nut for Teflon fitting	P02-1438-A
Seals kit for ozone generator	SAV-K-000089-A
DRYER ASSEMBLY FOR OZONE GENERATOR	**P10-1153-A**
0.1 injector + seal	A01-K-C0035-A
Permapure dryer	F05-PERM-003-A
On-line filter	F05-IDN-10G
Poral stainless steel filter (MOTT)	F05-1200-170-A
Drying distributor device	P06-0916-A
Nozzle for drying restrictor	P02-1446

PUMP ASSEMBLY / CHARCOAL FILTER

KNF suction pump (230 V 50 Hz) with cable		V02-0003-A
KNF suction pump (115 V 60 Hz) with cable		SAV-K-000051-A
Impeller Becker pump with cable (230 V 50/60 Hz)		V02-0051-A
Impeller Becker pump with cable (115 V 60 Hz)		V02-0052-A
Set of 2 stainless steel valves for pump (KNF)		V02-N022-5-0340
Set of 3 Teflon diaphragms for pump (KNF)		V02-N026-11-2-A
Servicing kit for AC32M AC31M pump KNF (2 valves and 3 diaphragms)		A01-K-000090-A
Activated carbon assembly :	Filter ring	F05-5004-C
	Activated carbon 1 kg	SAV-K-000073-A
	Installation kit	F05-0225-A-SAV
Charcoal cartridge kit		F05-K-0011-A
Servicing kit for impeller pump		SAV-K-000098-A

ELECTRONIC CIRCUITS

AC32 ENVIROBUS board	C01-0324-A
Supply cable for module board	D01-0743-A
24 V 150 W power supply	B05-S-150-24
Power supply cable of power supply board	
SBT board	C06-0309-A
Mains cable SBT board / AC32 filter	D01-0815-1
Fuse	S01-TT05.00-A
Control board of permeation bench	SAV-K-000100-A
ESTEL board (optional)	C02-0232-
Link between Module board and ESTEL board	D01-0751-A
SOREL board (option)	C06-0314-B
RS4I board	C02-0271-A
LCD display interface board	C06-0127-D
Equipped LCD display	I03-0002-A
Link between interface board and AC32M Module board	D01-0744-A
French LCD keyboard	I02-0009-A
English LCD board	I02-0008-A

KITS	
AC32 maintenance kit for 1 year (with KNF pump)	A01-K-AC32-K1
List of recommended spare parts for AC32 (with KNF pump)	A01-K-C0033-A
AC32 maintenance kit for 1 year (with Becker pump)	AC32-04-K
List of recommended spare parts for AC32 (with Becker pump)	AC32M-04-RSP
Seals assembly for AC32 ozone generator	A01-K-C0037-A
Pump servicing kit for AC32M AC31M (KNF)	SAV-K-000098-A
Box of Teflon filtering diaphragms (25 units)	SAV-K-000042-A
LIST OF RECOMMENDED SPARE PARTS	**A01-K-C0033-A**
Detailed content here-below:	
D0.1 injector with seal	A01-K-C0035-A
Flow limiter	A01-K-C0036-A
Seals assembly for AC32 ozone generator	A01-K-C0037-A
Ozone generator tube with aluminum electrode	A01-K-C0038-A
SV cabling	D01-0749-A
Black Teflon tube (2 sets of 4 units)	F04-TFN-1.6-004
PM insulation window	P08-0001-B
SEALS ASSEMBLY FOR AC32M OZONE GENERATOR	**A01-K-C0037-A**
Detailed content here-below:	
MERKEL o-ring, diam 8, cord 3	G06-008.0-3.0-V
MERKEL o-ring, diam 10.82, cord 1.78	G06-010.8-1.7-V
PUMP SERVICING KIT FOR AC31M AC32M (KNF)	**SAV-K-000090-A**
Detailed content here-below:	
Set of 2 stainless steel valves for pump	V02-N022-5-0340
Set of 3 Teflon diaphragms	V02-N026-11-2-A
SERVICING KIT FOR BECKER PUMP	**SAV-K-000098-B**
BOX OF TEFLON FILTERING DIAPHRAGMS (25 UNITS)	**SAV-K-0000042-A**
NO2 PERMEATION BENCH (OPTIONAL)	
1 additional charge of silicagel	X01-0002A
Purafil (1 kg)	X01-0003A
NO2 permeation tube	140-653-0081

SAMPLE DRYER OPTION

1 permapure sample dryer	F05-PERM-004-A
Injector	F02-0011-A
Stainless steel porous filter	F05-1200-170-A
Permapure dryer	F05-PERM-004-A
Nozzle (dryer AC32M)	P02—1446-B
Upper seal for injector tightness	P06-0009-A
Distributor (built-in dryer AC32M)	P06-0916-A

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CHAPTER 5

CORRECTIVE MAINTENANCE

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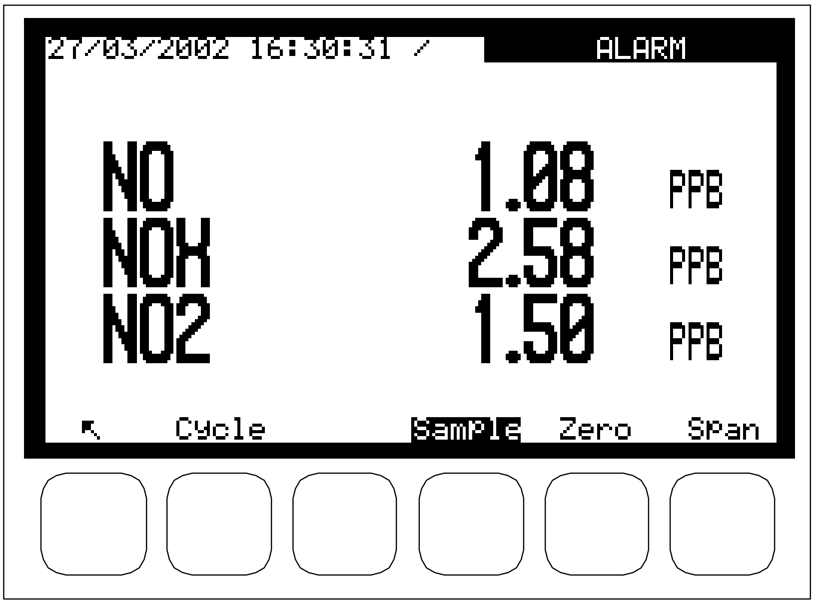
5 CORRECTIVE MAINTENANCE

Corrective maintenance of the analyzer should only be performed by qualified people using the information provided in this document.

The monitor automatically and continuously self-tests its main components. Any malfunction detected is indicated by a clear message on the display.

Table 5-1 summarizes the main faults indicated by the instrument with the corresponding corrective possible actions.

In case of an operating fault, the ALARM message blinks on the top right corner.



To check which operating fault is present, select the menu *MEASUREMENT ⇨ Alarms display.*

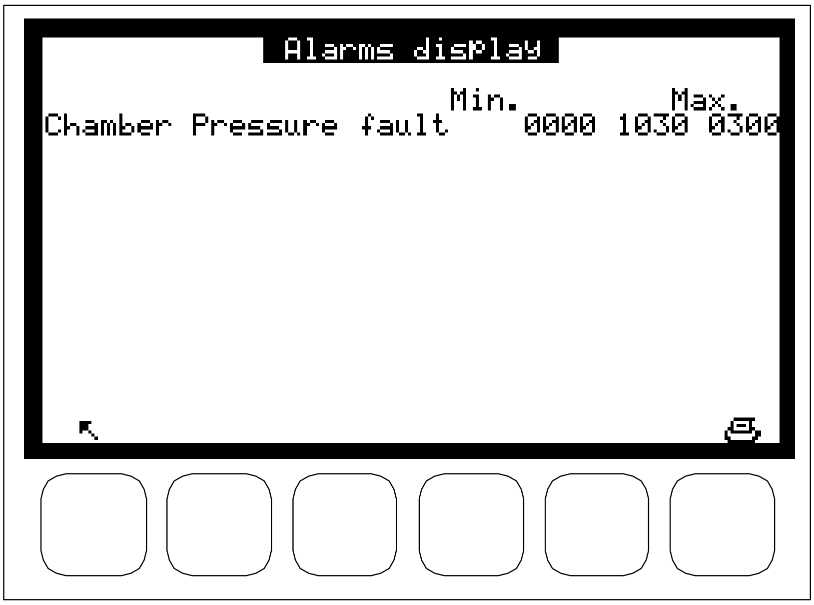


Table 5-1 – List of faults and corrective actions

ALARM MESSAGE	CAUSE	POSSIBLE ACTIONS
Sample pressure fault	– Pump assembly – Sample inlet dirty / clogged	– Check connection sense – Change Teflon filter – Disconnect sample line at filter block level. – Check sample flow rate according to flow rate values indicated in the maintenance sheet 4.3.2 (these flow rate values depend on analyzer options). – Check temperature of measurement chamber (around 60° C).
Peltier T° fault	– PT1000 temperature sensor. – Peltier module out of order – Power supply out of order	– If PT1000 Ohms or Peltier module are faulty, send back PM assembly to factory. – Check wiring at J 14 connector. Check contact at J15 connector. – Check voltage at J14 and J15.
Chamber pressure fault	– Pump must be serviced – Leak of fluid circuit – Injectors are dirty / clogged – Pump out of order	– Check sample flow rate according to flow rate values indicated in the maintenance sheet 4.3.2 (these flow rate values depend on analyzer options). – Clean injectors – Check pump connections – Disconnect pump, turn pump fan of a ¼ turn, then connect pump again. – Check temperature of measurement chamber (around 60° C)
Ozone generator fault	– Ozone generator must be serviced – Ozone generator connection – Fuse of ozone generator board out of order – Ozone generator faulty	– – Check J8 connector – Replace fuse of ozone generator board by a fuse of equivalent value (to protect module board). If fuse is out of order, before switching-on the analyzer, check that there is no short-circuiting contact between both electrodes of ozone generator (high voltage). – Carry out maintenance of ozone generator – Check J2 and J3 pressure sensors connection

ALARM MESSAGE	CAUSE	POSSIBLE ACTIONS
Optical T°C Fault	– Temperature probe out of order – Heating element out of order – Connectics problem – Analyzer does not operate in standard conditions 5°C < Temp.< 40°C	– Check probe temperature at J12 connector level : 1,077 kΩ at 20°C – Check resistor at J13 connector terminal (15 Ω) – Check links with Module board at J13 and J12 connectors
Range exceedance	– Measurement value exceeds the programmed range 2.	– Program an other range. – Check programming of ESTEL board, especially range 2.
Calibration Fault	– Calibration – Difference of +/- 50 % between 2 spans	– Refer to chapter 3.4. – Check flow rates: • Sample flow rate: according to values of flow rate indicated in the maintenance sheet 4.3.2 (these values of flow rate depend on analyzer options). • Ozone generator flow rate: 8 l/h (at Permapure inlet) 4 l/h (at ozone generator inlet) – Check programming of span gas concentration. – Check operation of ozone generator.
GND fault	– Ground continuity failure	– Check that Module board is correctly fixed on PM block – Check fixation of PM block – Check fixation of rear panel – Disconnect all the cables, (J24) 24V power supply excepted.
Internal temperature fault	– 10°C > T° > 55°C	– Ambient temperature too low or too high. – Fan filter dirty / clogged.

ALARM MESSAGE	CAUSE	POSSIBLE ACTIONS
Temperature converter fault	– Heating element out of order	– Check resistor value : 10 Ohms +/-2
	– 24 V power supply faulty	– Power supply board out of order – Check connectics of power supply between converter board and power supply board
	– Wiring failure on Module board	– Check wiring with Module board at (J11)
	– Temperature probe	– Check power supply at temperature probe terminals
Autonomy Converter	– The daily down-counter of autonomy converter reached 0000	– Carry out converter maintenance. – Reset the down-counter (*CONFIGURATION ⇨ Measurement mode* screen)
Threshold exceedence (V _ / T _)	– Exceedence of one of the programmed thresholds for one of the parameters.	– Program a higher threshold or wait for the measurement to decrease. – Check alarm limit programmation
Fault of signal NO, NOx, Ny	– Signal exceeds 9999 mV	– Check light tightness,
	– PM sees light	
	– Important concentration	– Switch to zero air,
	– Gain not adapted to concentration,	– Change gain (cf. §3.3.4.2),
	– Adjustment of PM preampli board,	– Adjust preampli gain,
	– PM preampli out of order	– Preampli board out of order

Cut-out power supply is protected from short circuits. In such a case, it is necessary to dis-connect / re-connect the mains power cord to reset.

SYMPTOMS (NO DEFAULT DISPLAY)	POSSIBLE CAUSES	ACTIONS
The instrument does not react when switched on.	– Mains faulty.	– Check mains power supply.
	– Mains cable faulty.	– Test continuity of mains cable.
	– Connector incorrectly plugged in.	
	– General fuse out of order.	– Check fuse in mains power supply block.
The instrument does not exit warm-up.	– Microprocessor board faulty.	– Check display flashing. If no flashing, check if the microprocessor board is in place. Change it when necessary. If flashing, wait for 15 minutes and possible fault display.
	– Reset circuit is blocked up.	– Check fuses.
	– Micro 5V is faulty.	

WARNING

WHEN THE ANALYZER IS POWERED ON,
VOLTAGE AT OZONE GENERATOR TERMINALS IS ABOUT 5000 VOLTS.

Table 5-2 – Test points, configuration and connection of MODULE board

Jumpers mark	Test point / Type of signal
PT2	PM signal
PT3	Signal of chamber pressure
PT4	Signal of sample pressure
PT5	A/D Run
PT6	A/D Status
PT7	H.T. Info
PT8	GND
PT9	GND

Jumpers mark	Test points / type of signal
PT10	MUX output
PT11	+24VCC power supply
PT12	+5VCC power supply
PT13	+15VCC power supply
PT14	-15VCC power supply
PT16	+ Reset to Zero (test)
PT17	Empty RAM
S1	Location of display cord

Jumper marks	Connections
J1	Option
J2	Sample pressure
J3	Chamber pressure
J4	Pre-ampli PM Info_H.T
J5	Option
J6	SV cycle 1
J7	SV cycle 2
J8	Ozone generator
J9	Alarm of NH3
J10	SV control of NH3
J11	Converter temperature – Converter control
J12	Chamber temperature
J13	Chamber heating
J14	PM temperature
J15	PM cooling
J16	Fan
J17	Zero SV
J18	Calibration SV

Jumper marks	Connections
J19	Permeation bench
J20	Bus i2C of ESTEL board
J21	Synchron bus
J22	RAM extension option
J23	Bus i2C of RS4i board
J24	24VCC power supply
J25	Not used (24V ON)
J26	Not used
J27	Not used
J28	Not used
J29	Not used
J30	Not used
J31	Not used
J32	Not used
J33	Not used
J34	DEL option of stand-by screen
J35	Strap maintenance
J36	Not used

Jumpers mark		Pins	Nature of operations
SW2 clock		1 2 3	Built-in clock A/D = CLK/2
		1 2 3	Built-in clock A/D = CLK (by default)
ST 1			(by default)
			Reset microprocessor
SW3 power supply		1 2 3	Put i2C bus under 5V voltage
		1 2 3	Put i2C under 24 V voltage

Jumpers mark		Pins	Nature of operations
SW4 clock		1 2 3	Built-in of micro = CLK/2
		1 2 3	Built-in clock of micro = CLK (by default)
ST 2			Inactivates watch dog
			Activates watch dog (by default)

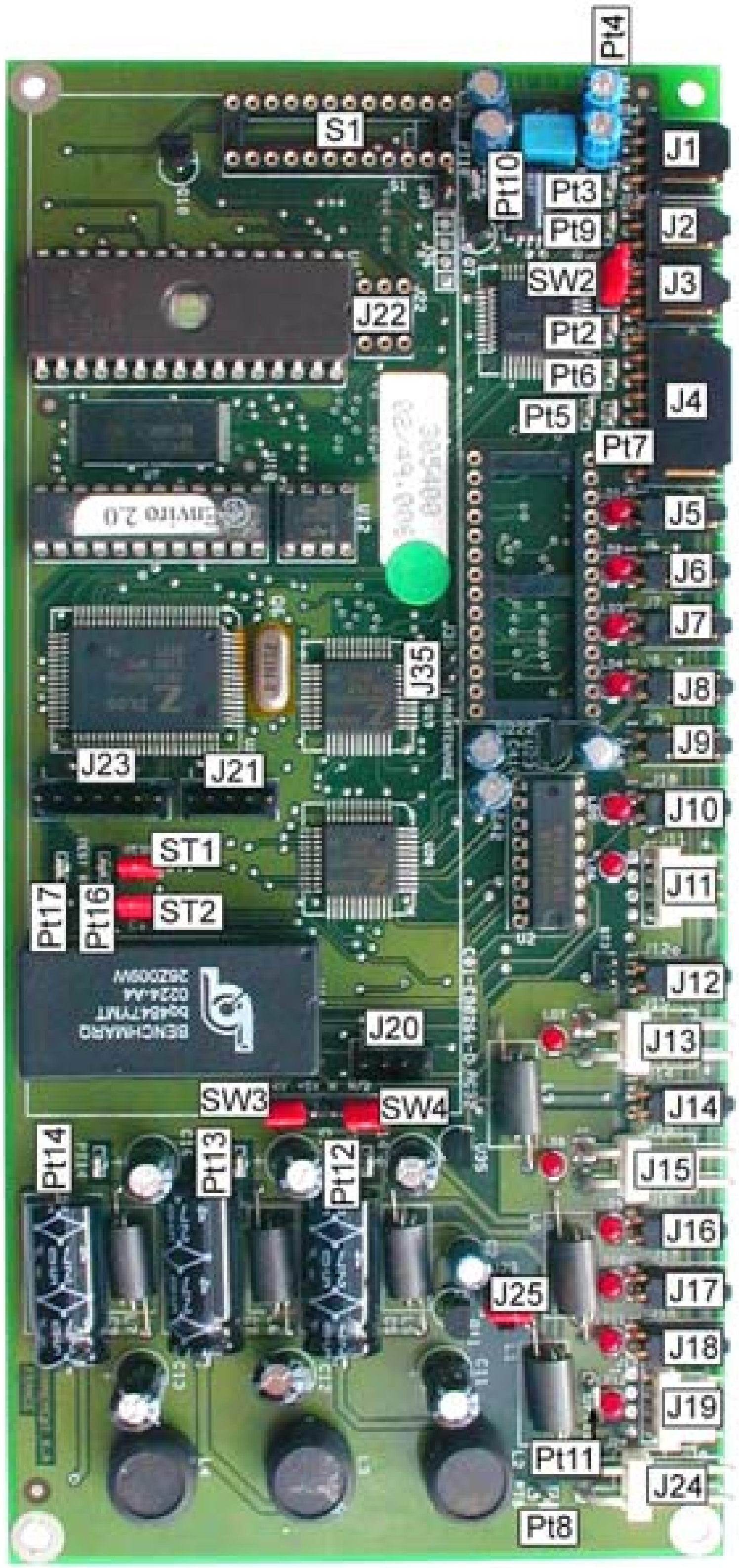


Figure 5-1 – Configuration of MODULE board

Table 5-3 – RS4i board configuration

Jumpers marks	Symbols	Nature of operations
SW1, SW2	● ▬	RS422 standard on channel 1
SW3	▬ ●	RS232 standard on channel 1
ST1	▬	Load RX bus RS422 active
	● ●	Load RX bus RS422 inactive
ST2	▬	Load TX bus RS422 active
	● ●	Load TX bus RS422 inactive
ST3	▬	Referenced mode to ground
	● ●	Insulated-from-ground mode

NOTE : ***Channel 2 is RS232 in standard.***

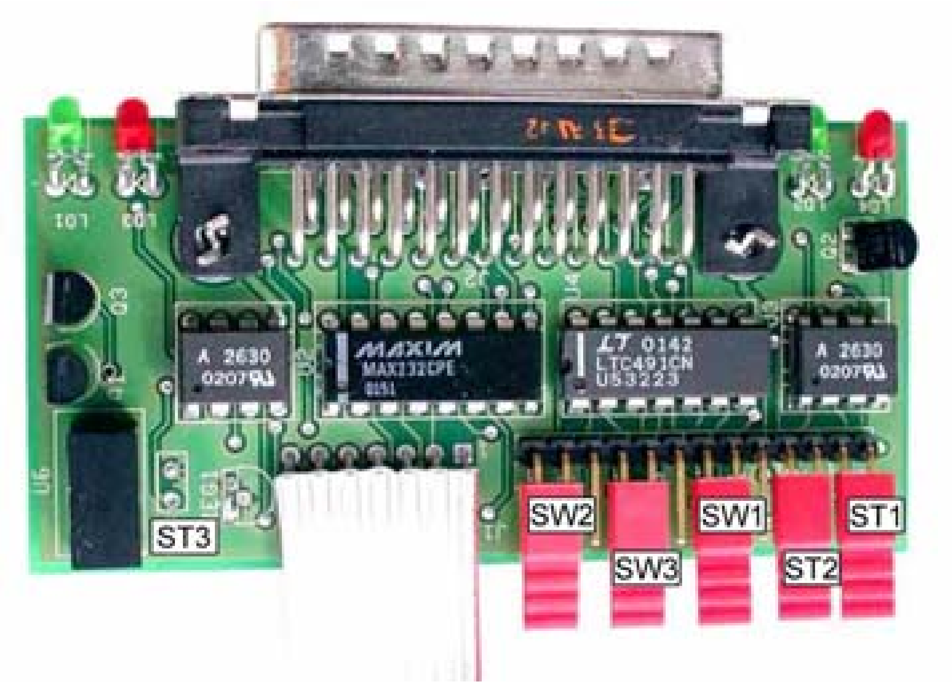
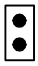


Figure 5-2 – RS4i board configuration

Table 5-4 – Configuration of keyboard interface board

Jumpers mark	Symbols	Nature of operations
ST1		Inhibited keyboard
		Activated keyboard
ST3		Built-in 15 V power supply of LCD
		15 V power supply of analyzer LCD
P1	LCD contrast by potentiometer adjustment	

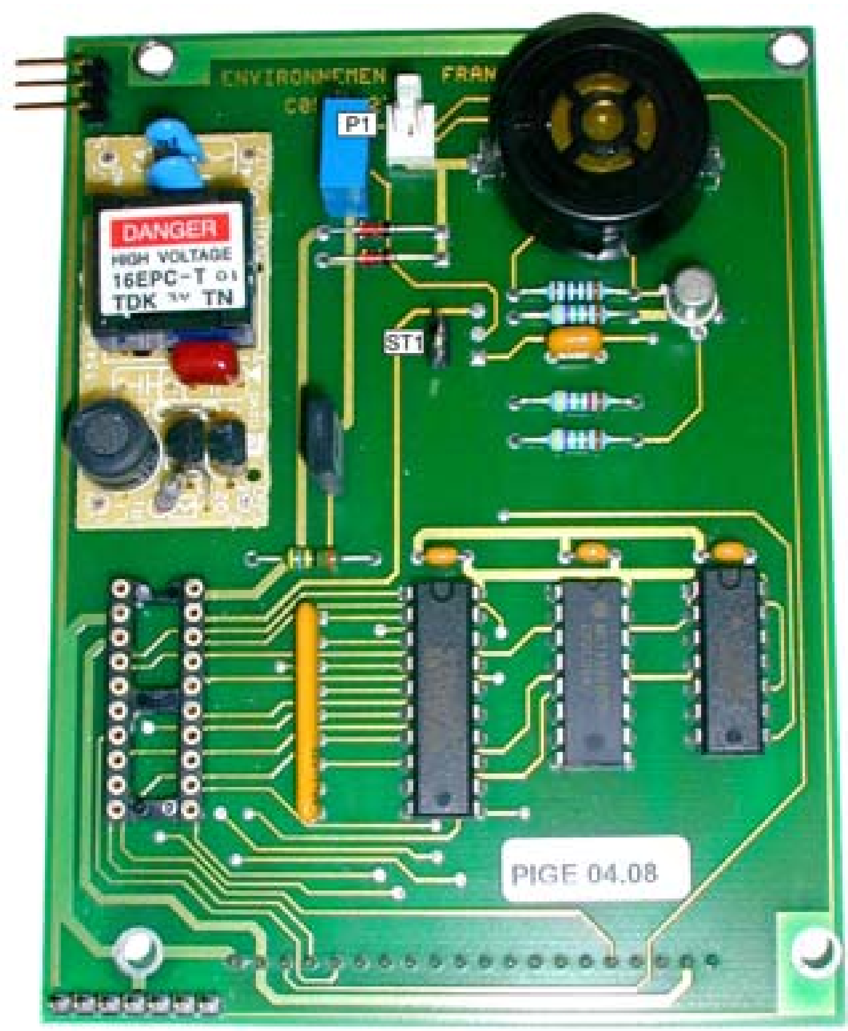


Figure 5-3 – Keyboard interface board

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CHAPTER 6

APPENDIX

ESTEL board

SOREL board

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ESTEL Board

INPUTS / OUTPUTS BOARD

OPTION OF 2M ANALYZERS

- June 2009 -

Environnement S.A
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ESTEL BOARD

Up-to-date:

Pages	Up-to-date	Pages	Up-to-date	Pages	Up-to-date
1	05-2004	9	06-2009	17	06-2009
2	05-2004	10	06-2009	18	06-2009
3	05-2004	11	06-2009		
4	05-2004	12	06-2009		
5	05-2004	13	06-2009		
6	05-2004	14	06-2009		
7	05-2004	15	06-2009		
8	06-2009	16	06-2009		

1. ESTEL BOARD

ESTEL board is a universal board of logic and analog inputs/outputs for the 2M series analyzers. It is optional: it is possible to install up to 2 ESTEL boards in an analyzer.

1.1 FUNCTION AND USE

The ESTEL board has 4 functions:

- 4 Analog inputs,
- 4 Analog outputs,
- 6 Relays,
- 4 Remote controls.

The ESTEL board enables dialog with the measurement module and relieves it of the Inputs/Outputs functions. It enables remote control and/or remote signalling of certain functions as: "measurement", "zero", "calibration", "alarm".

The analog inputs are used to connect independent monitors in order to follow-up, for example, weather parameters.

The analog outputs enable to send numeric parameters (gas concentration to be analyzed, MUX channels) to analog independent peripherals in order, for example, to store and process several data of several months.

Equipped with an ESTEL board, the analyzer can work as an autonomous unit of analysis.

1.2 TECHNICAL CHARACTERISTICS

Management by specialized micro controller:

- 4 analog inputs of 12 bits, 0-2,5 volts full scale,
- 4 not-insulated analog outputs, configurable into: 0-1 volts, 0-10 volts, 0-20 mA, 4-20 mA (maximum load of 1000 Ohm).
- 4 insulated by optocoupler logic inputs,
- 6 potential-free contacts for remote signalling,
- only one power supply of 8 to 24 volts,
- i2C communication visualization using a LED.

Electric connection:

- 4-point connector for link with Module boards of 2M series,
- Inputs / Outputs centralized on only one female connector SUB D 37 points. This connector is screwed on the rear panel of the analyzer.
- Option of external connection, see paragraph 1.6

Voltage and current on relays:

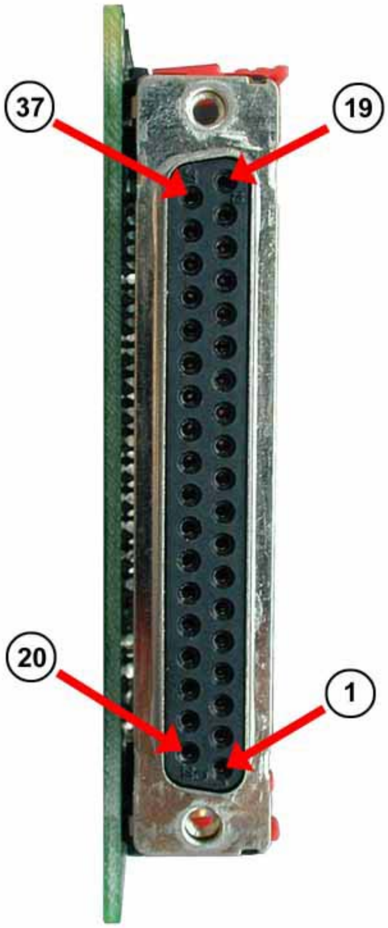
- Maximum voltage by relay contact : 50 volts
- Maximum current by relay contact : 1 Ampere at 24 V D.C. (resistive load)

Remote controls:

- By dry contact between (1-4) Remote control and ground Remote control.

1.3 CONFIGURATION

PIN N°	CONNECTION
1 + 20 GND	Analog output 1
2 + 21 GND	Analog output 2
3 + 22 GND	Analog output 3
4 + 23 GND	Analog output 4
5 + 24 GND	Analog input 1
6 + 25 GND	Analog input 2
7 + 26 GND	Analog input 3
8 + 27 GND	Analog input 4



PIN N°	CONNECTION
14-33	Relay contact 1
13-32	Relay contact 2
12-31	Relay contact 3
11-30	Relay contact 4
10-29	Relay contact 5
9-28	Relay contact 6
15 + 34 GNDI	Remote control 1
16 + 35 GNDI	Remote control 2
17 + 36 GNDI	Remote control 3
18 + 37 GNDI	Remote control 4
19	5 VCC or + 24 VCC

(*) according to SW5 jumper position

GND: ground

GNDI: insulated ground

Table 1 - Configuration of ESTEL board_index A

Jumpers mark	Symbols	Nature of operations
ST1, ST2, ST8		ESTEL selection, board N° 1
		ESTEL selection, board N° 2
		ESTEL selection, board N° 3
		ESTEL selection, board N° 4
ST3		0 V to ground (default)
		Floating 0 V
DAC1 DAC2 DAC3 DAC4		0-1 V, idem for the 4 DAC.
		0-10 V, idem for the 4 DAC.
		0-20 mA, idem for the 4 DAC.
		4-20 mA, idem for the 4 DAC.
P1, P2, P3, P4	4 mA adjustment in 4-20 mA mode	

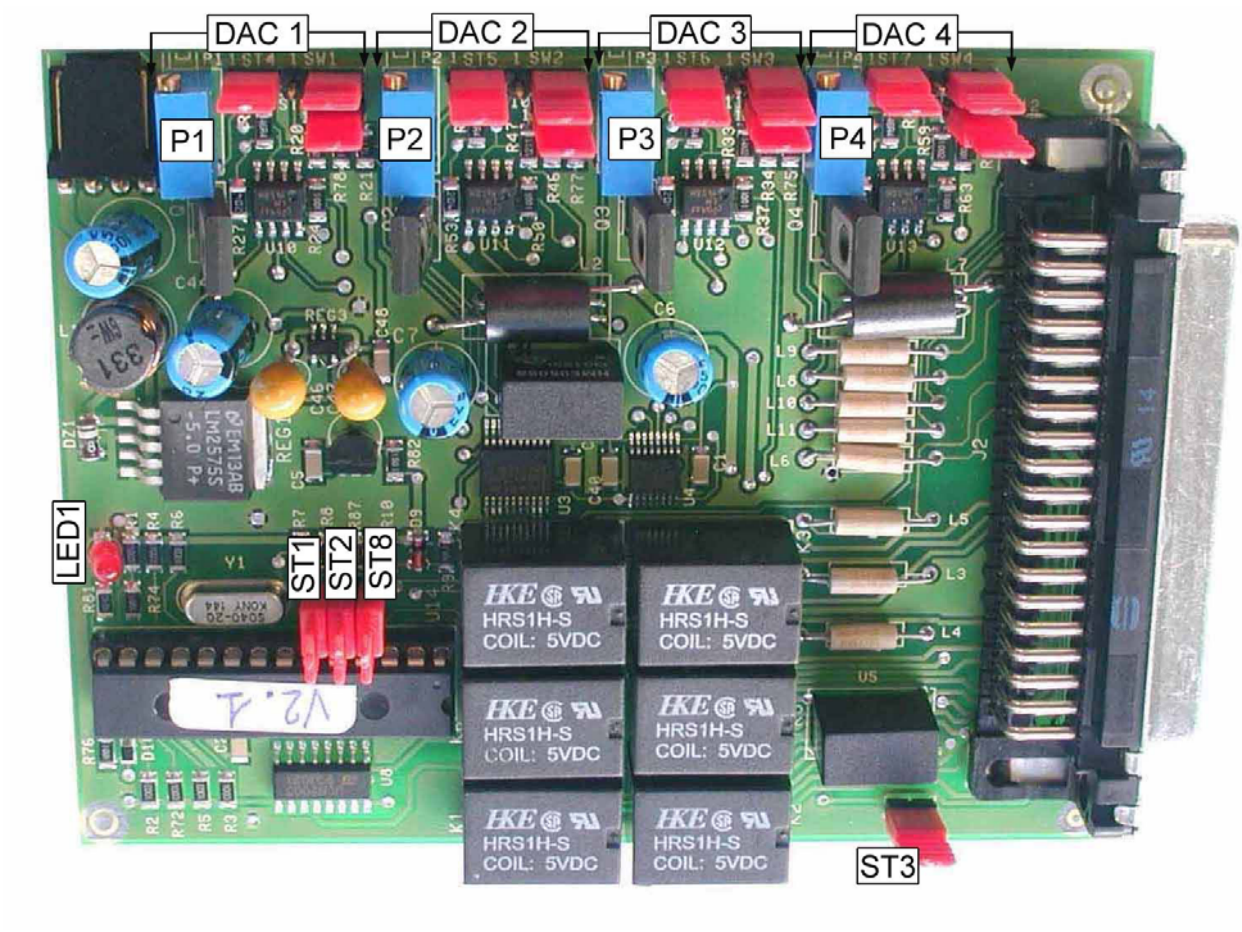


Figure 1 - ESTEL board_index A

Table 2 - Configuration of ESTEL board_index B

Jumpers mark	Symbols	Nature of operations
ST7, ST6, ST5	▮ ▮ ▮	ESTEL selection, if 1 board
	▮ : ▮	ESTEL selection, if 2 boards
	: ▮ ▮	ESTEL selection , if 3 boards
	: : ▮	ESTEL selection, if 4 boards
ST8	▬	0 V to ground (default)
	••	Floating 0V
DAC 1	•• / •▬ ▬ ••	0-1 V (or optional 2,5 V and 10 V) idem for the 4 DAC
DAC 2	▬ / •▬ •• ••	0-10 V, idem for the 4 DAC
DAC 3	•• / •▬ •• ▬	0-20 mA, idem for the 4 DAC
DAC 4	•• / ▬• •• ▬	4-20 mA, idem for the 4 DAC
SW5	▬• •▬	Output 5 V Output 24 V } on pin 19

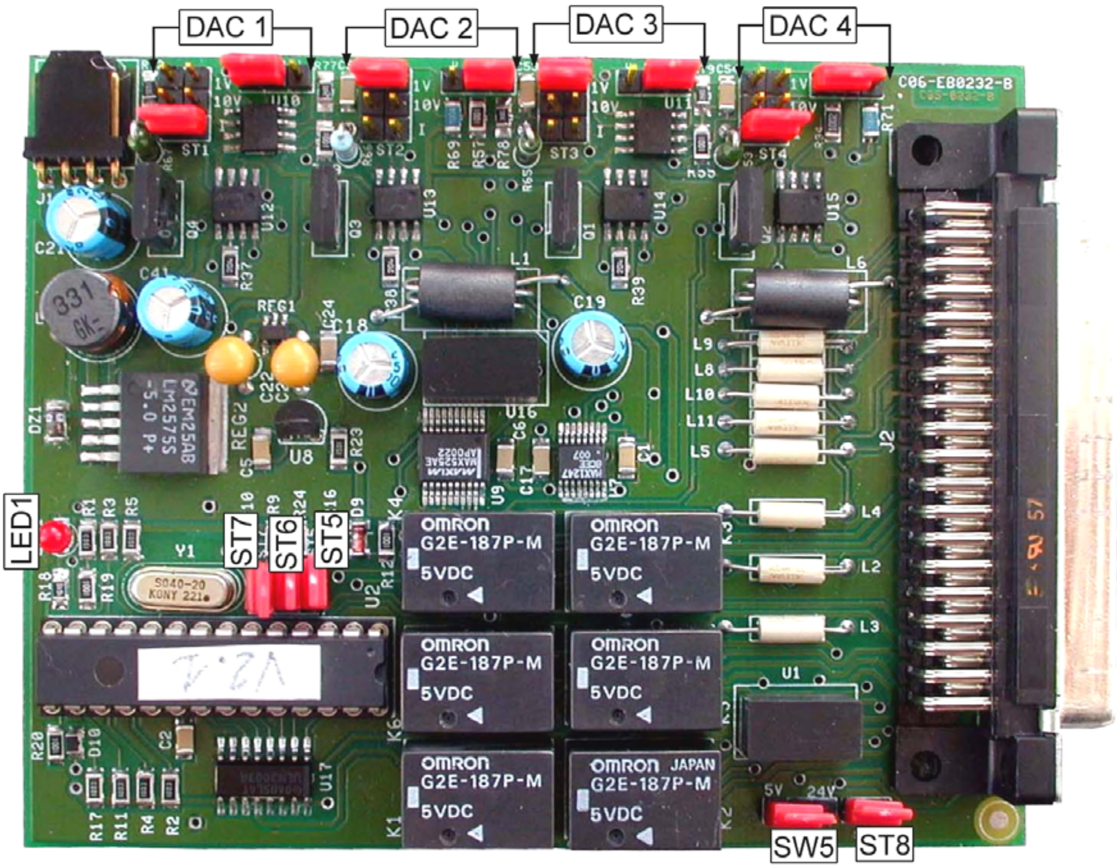


Figure 2 – ESTEL board-index B

Specific configuration of output 0-5 volts instead of 0-10 volts

There are 4 possible configurations for 0-5 volts output:

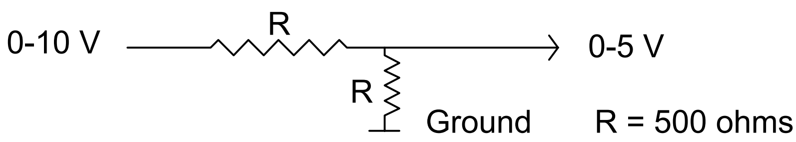
- Board configured into 0-10 volts with addition of a by-2 divider bridge :

The user (customer) carries out himself the operation at input of his acquisition system.

Operating mode:

Connect each analog output, previously configured into 0-10 volts, to ground through 2 resistances of equal value within 500 and 1000 ohms.

Take off the divided-by-2 signal at terminals of the resistance that is connected to the ground.



- Board configured into 0-10 Volts with adjustment of half gain :

In menu *Tests* ⇨ *ESTEL boards*, adjust the A and B coefficients of each channel in order to obtain 0-5V at analog output for 0-4000 pts resolution of analog-to-digital converter.

- Board configured into 0-20 MA

The user (customer) carries out himself the operation at output of his acquisition system.

Operating mode:

Connect each analog output, previously configured into 0-20 mA, to ground using a 250 0hms resistance, tolerance 1 %.

Voltage, thus generated, is equal to U_{mV} = 250 x I_{mA}, that is to say 5 V for I = 20 mA.

Note: place resistance the nearest possible of receiver equipment.

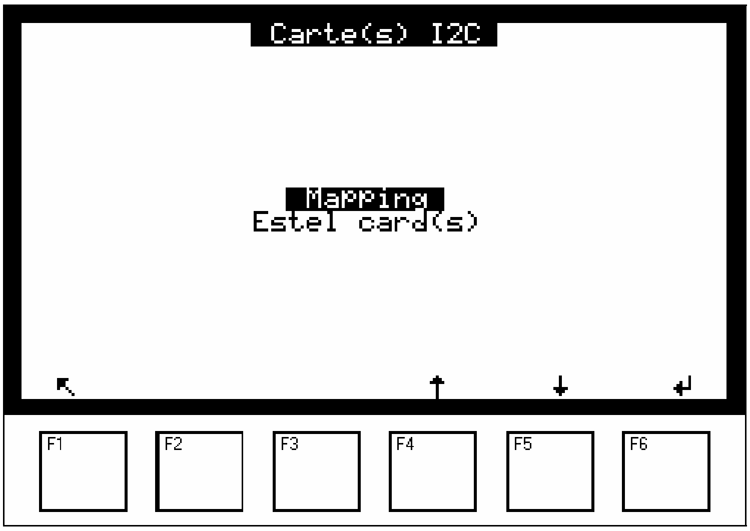
- Modification of gain resistance on ESTEL board

We carry it out if the user (customer) does not accept the other solutions.

1.4 PROGRAMMATION

The ESTEL board programmation is carried out from the « ESTEL board » menu of the « Carte(s) I2C » screen.

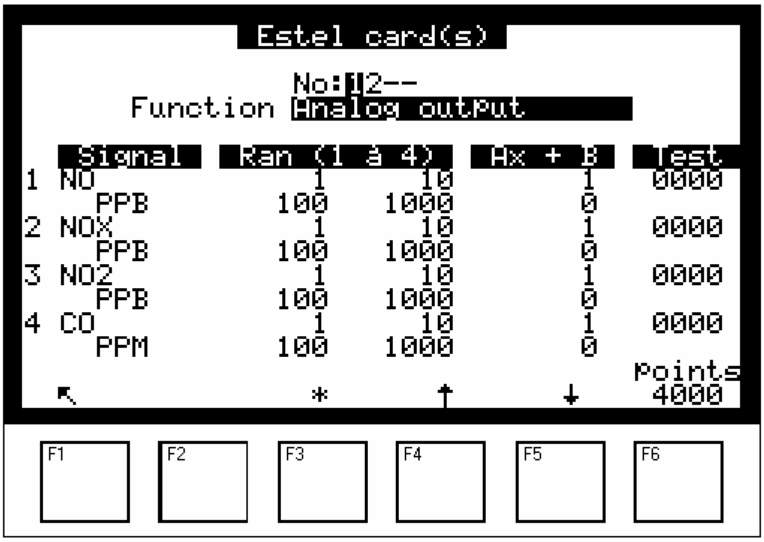
This menu enables to visualize the effective communications of the various modules and to configure the various ESTEL boards.



The analyzer automatically detects the presence of one or several ESTEL boards and offers menus enabling the user to adjust and configure each board.

1.4.1 ESTEL CARD(S) ⇨ Analog output

To access the various screens of the ESTEL board, select the current function and choose the wanted function using the **[↑], [↓]** keys.



<u>« Analog output » Function</u>

This screen enables to assign the parameters to the analog outputs for the ESTEL board whose n° indicated in the field « No » is highlighted. These parameters are:

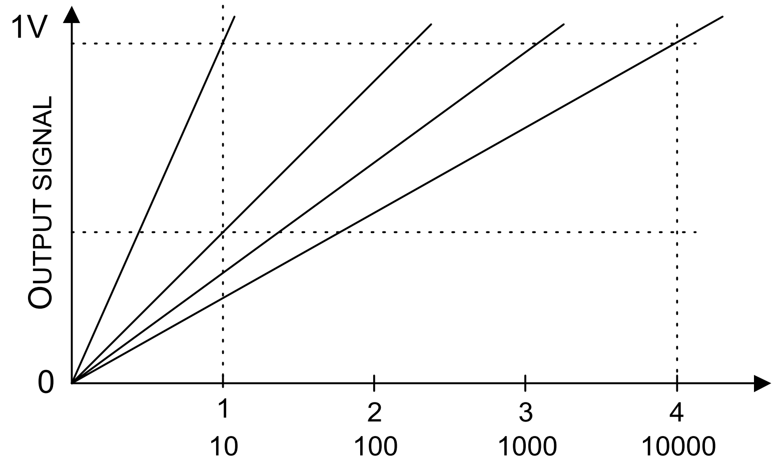
- Concentration of the analyzed gases,
- Auxiliary channels (multiplexer),
- Analog inlets.

REMINDER : On an ESTEL board, analog outputs can be configured into: 0–1 Volt, 0–10 Volt, 0-20 mA, 4–20 mA.

Four ranges are available and correspond to the full scale of the analog output, units are those of the parameters displayed in the « Signal » column.

When signal value is higher than the full scale of the current range, the analyzer switches to the next higher range. It switches again to the lower range when measurement again passes under 85%.

When the user assigns several measurement ranges to only one analog output, he can change the metrological resolution as the here-below curve shows it.



To avoid the ranges switching, the user must assign the same value to the 4 ranges of the parameter he will send to an analog output.

The Ax+B calibration curve is used to adjust the mV signal of the taken-into-account analog output.

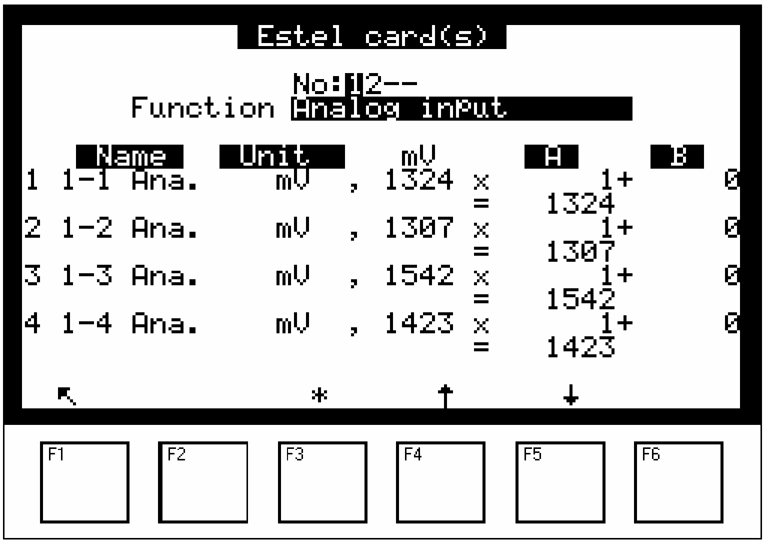
The « Test » column is used to test the 5 analog outputs and to adjust the points number.

For a range 1 :

- 0 point (lower scale of output) ⇨ 0 volt obtained at output,
- 4000 points (higher scale of output) ⇨ 1 volt obtained at output.

F6 key [Points 4000] enables to force the full scale on the whole analog outputs.

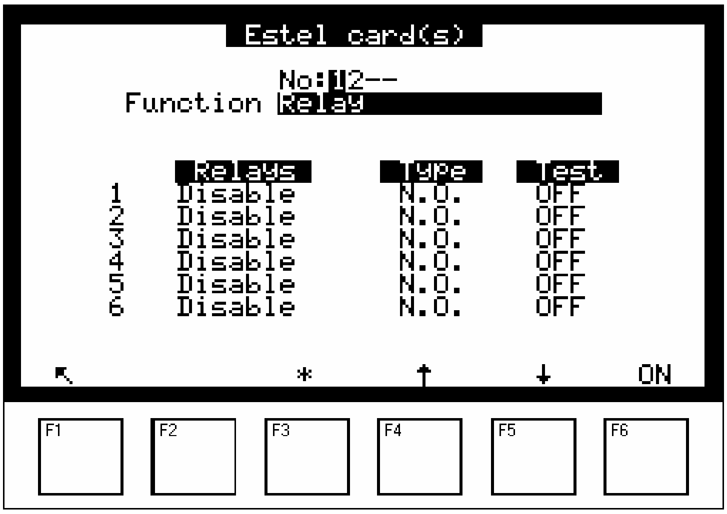
1.4.2 ESTEL CARD(S) ⇨ Analog input



Each ESTEL board has 4 analog inputs : this screen is used to program characteritics of these analog inputs.

- "Name" fields are used to enter a name of 8 alphanumeric digits.
- "Unit" fields are used to select the unit by : none, ppt, ppb, ppm, $µg/m^3$, mg/m^3, gr/m^3, $µg/Nm^3$, mg/Nm^3, gr/Nm^3, $µg/Sm^3$, mg/Sm^3, gr/Sm^3, %, µgr, mgr, gr, mV, U, °C, °K, hPa, mb, b,l, Nl, Sl, m^3, l/min, Nl/min, Sl/min, m^3/h, Nm^3/h, Sm^3/h, m/s ou km/h, in the toggle menu.
- The "Ax + B" fields enable to adjust the calibration curve of each parameter.

1.4.3 ESTEL CARD(S) ⇨ Relay

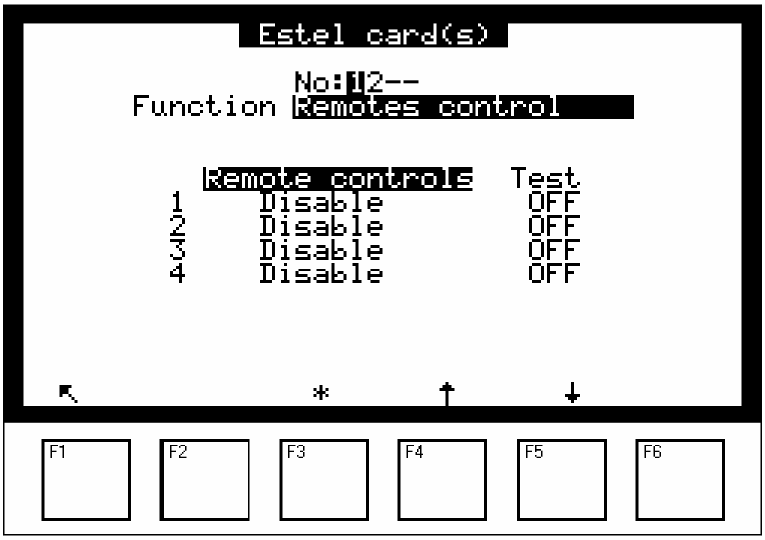


"Relays" fields are used to control relays according to the following conditions:

Disable	⇨ Relay not assigned
General alarm	⇨ Any operating fault triggers the relay
Range over-range	⇨ Scale 2 over range triggers the relay
Flow rate	⇨ Abnormal flow rate triggers the relays
Temperature	⇨ Abnormal temperature in the analyzer triggers the relay
Pressure	⇨ Barometric pressure in chamber
Zero Air	⇨ On Zero, relay is triggered
Span	⇨ On Span, relay is triggered
Zero-Ref	⇨ On Zero-Ref, relay is triggered
Auto Span	⇨ On Auto-Span, relay is triggered
Warm-Up	⇨ On Warm-up, relay is triggered
Stop mode	⇨ In Stop mode, relay is triggered
Alarm control	⇨ Control detection during threshold over range, relay is triggered.
Alarm or Control	⇨ Relay triggered
Module alarm	⇨ Alarm detected on module, relay triggered
Measure	⇨ Relay triggered
Maintenance	⇨ In Maintenance mode, relay is triggered

- The "Type" fields are used to control (NC) or not (NO) the relays when alarms are OFF.
- "Test" fields are used to manually control these relays.

1.4.4 ESTEL CARD(S) ⇨ Remote controls



This screen displays the assignment of remote control inlets.

The available assignment choice are : « Inactive», « Stop mode », « Zero Ref. », « Zero », « Span », « Auto span».

«Test» column is used to display the value read at remote control inlet, for the selected assignment.

1.5 INSTALLATION AND REPLACEMENT OF ESTEL BOARD

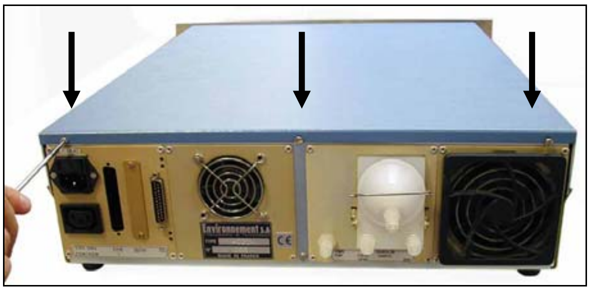
- Switch off the analyzer and unplug the mains cable before any maintenance work of the analyzer,
- Respect connection of ESTEL board / MODULE board at J20 when reassembling.

1.5.1 Switch off the analyzer

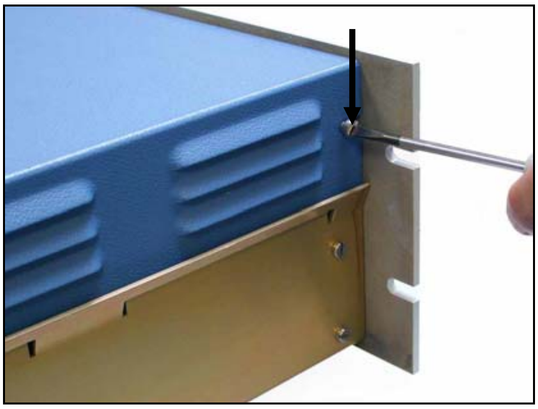
1.5.2 Unplug the mains cable

1.5.3 Put off the cover

(1) Unscrew the screws located on the rear panel of the analyzer

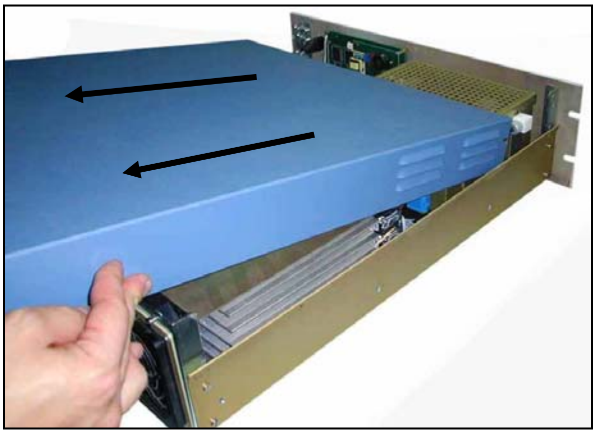


(2) Unscrew the screws located on lateral sides



(3) Lift up the cover

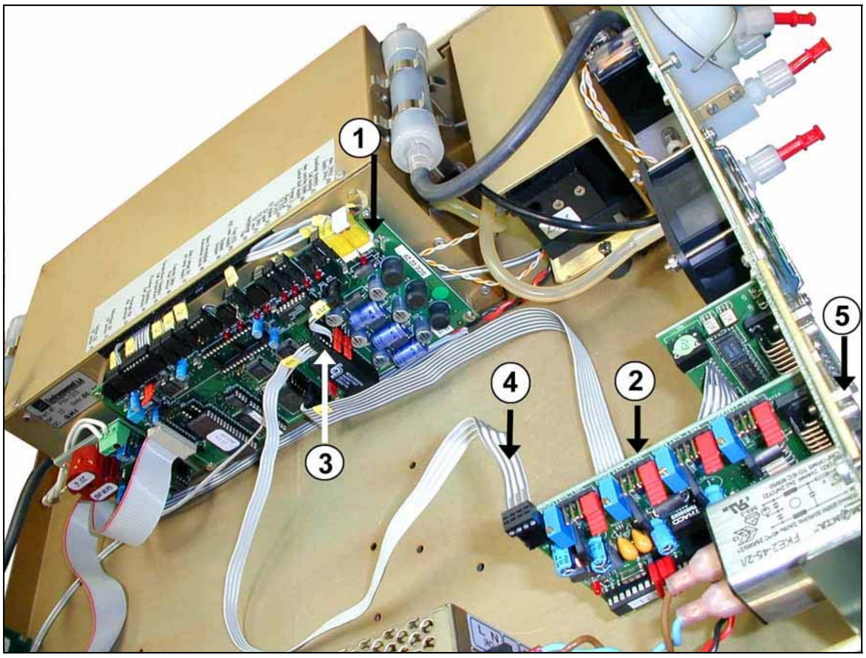
(4) Remove the cover by pulling it backward



If the analyzer is already equipped with an ESTEL board, follow step 1.5.4.

If the analyzer is not equipped with ESTEL board, follow step 1.5.5.

1.5.4 Dismount ESTEL board



(1) Module board

(2) ESTEL board

(3) J20 connector on Module board

(4) Connecting cable between Estel board / Module board

(5) Fixing screw of Estel board on rear panel of the analyzer

Disconnect the connecting cable between ESTEL board (4) / Module board (3).

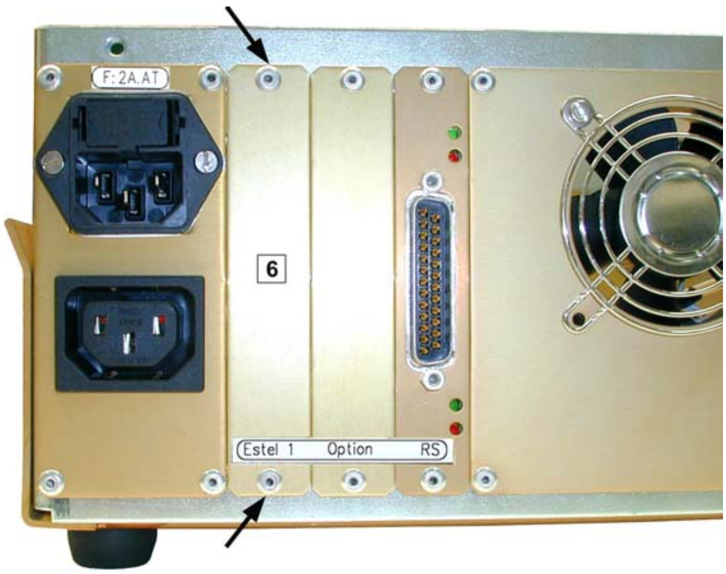
Unscrew the fixing screws (5) of ESTEL board on rear panel of the analyzer.

Remove ESTEL board.

Configure jumpers of the new board making functionality correspondences according to Table 1 or Table 2.

Re-assemble the board.

1.5.5 Unrivet the back plate (6) of rear panel of analyzer



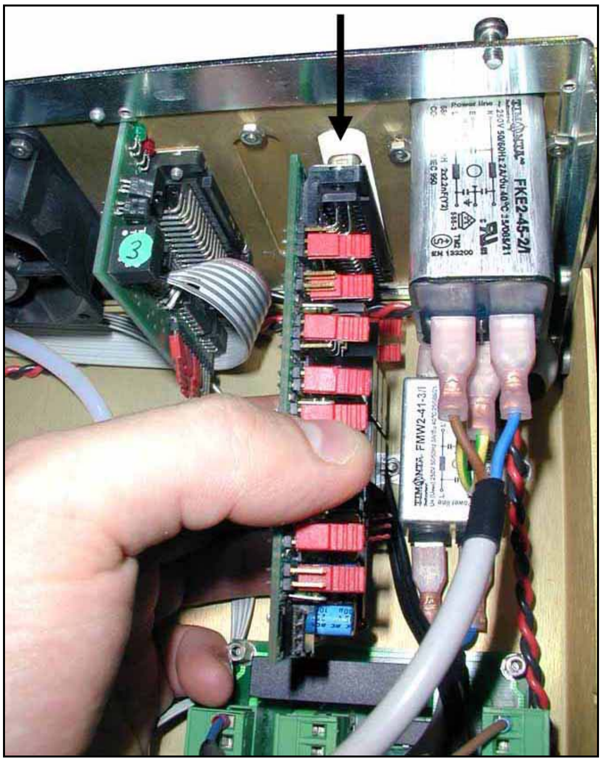
(7)

Then, install at the same place, the new plate (7) delivered with the board

1.5.6 Installation of board inside the analyzer

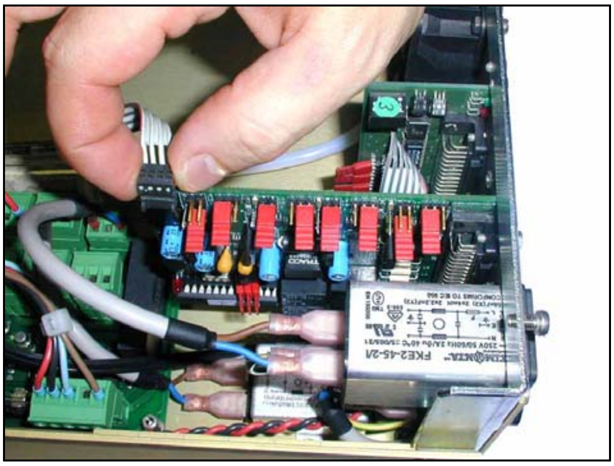
ANALYZER SWITCHED OFF

(1) Vertically insert the board inside its slot.

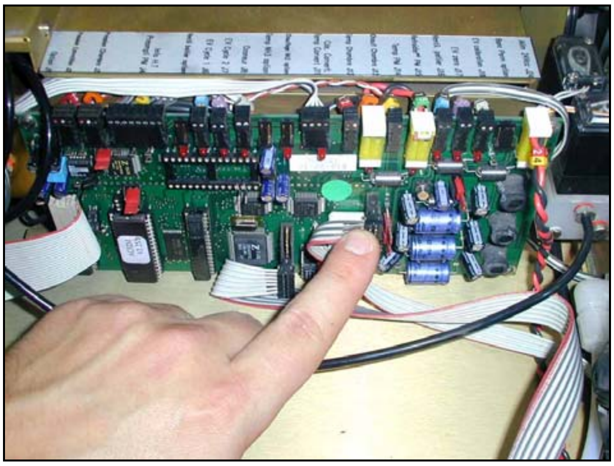


(2) Re-screw the board on the slot

(3) Fit again connector on ESTEL board



(4) Then, re-connect on Module board at **J20**



(5) Replace cover on the analyzer. See 1.5.3 .

(6) Connect mains cable and switch on the analyzer. See 1.5.2 and 1.5.1.

1.6 OPTION OF EXTERNAL CONNECTION

Five different options of ESTEL external connection are available:

DESIGNATION	REFERENCE	MARK
Option of external Estel connection	**P10-1337-A**	Figure 3
• Cable	• D02-INF-37-37M-M-A	(1)
• Tie-point block interface board	• C10-0012-A	(2)
• DIN track	• G13-IB-18066	(3)

DESIGNATION	REFERENCE	MARK
Option of external Estel connection + 4 insulated outputs.	**P10-1338-A**	Figure 4
• Cable	• D02-INF-37-37M-M-A	(1)
• Tie-point block interface board	• C10-0012-A	(2)
• Symmetrical DIN track Limit stop	• G13-IB-18066 D03-103-002-26	(3)
• 2-way galvanic insulator	• I11-Jk2000-2	(4)

DESIGNATION	REFERENCE	MARK
Option of external Estel connection + 1 insulated output	**P10-1350-A**	Figure 4
• Cable	• D02-INF-37-37M-M-A	(1)
• Tie-point block interface board	• C10-0012-A	(2)
• Symmetrical DIN track Limit stop	• G13-IB-18066 D03-103-002-26	(3)
• 1-way galvanic insulator	• I11-Jk2000-1	(4)

DESIGNATION	REFERENCE	MARK
Option of external Estel connection + 2 insulated outputs	**P10-1351-A**	Figure 4
• Cable	• D02-INF-37-37M-M-A	(1)
• Tie-point block interface board	• 10-0012-A	(2)
• Symmetrical DIN track Limit stop	• G13-IB-18066 D03-103-002-26	(3)
• 2-way galvanic insulator	• I11-Jk2000-2	(4)

DESIGNATION	REFERENCE	MARK
Option of external Estel connection + 3 insulated outputs	**P10-1352-A**	Figure 4
• Cable	• D02-INF-37-37M-M-A	(1)
• Tie-point block interface board	• C10-0012-A	(2)
• Symmetrical DIN track Limit stop	• G13-IB-18066 D03-103-002-26	(3)
• 2-way galvanic insulator 1-way galvanic insulator	• I11-Jk2000-2 I11-JK2000-1	(4)

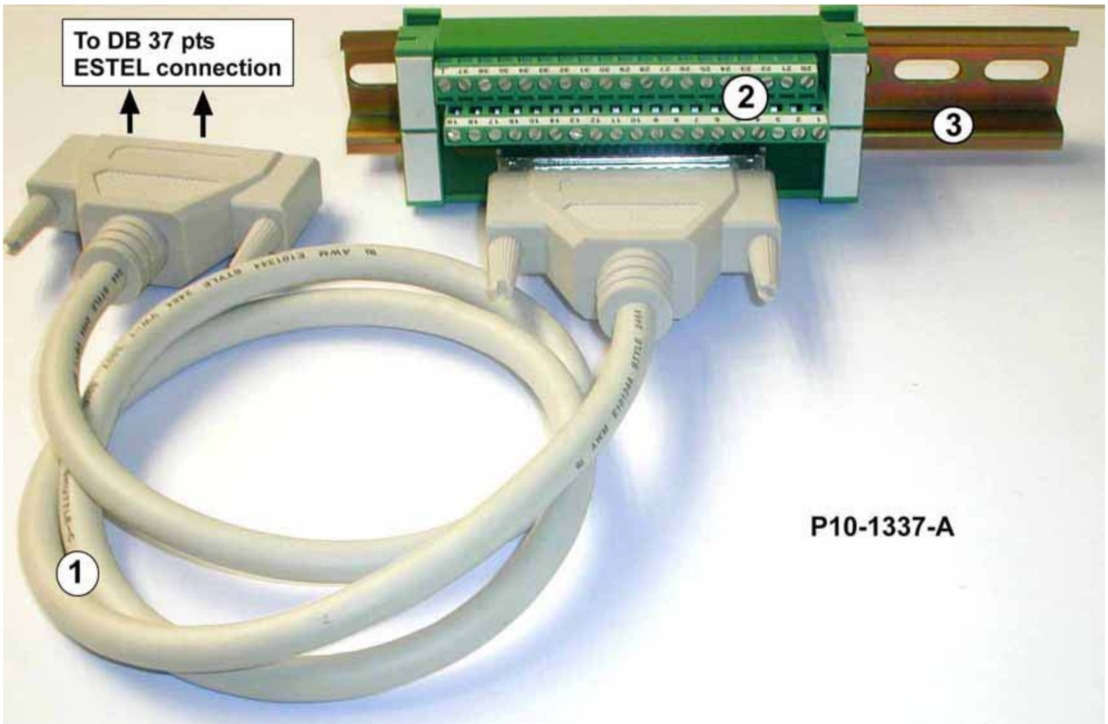


Figure 3 – Option of external connection P10-1337-A

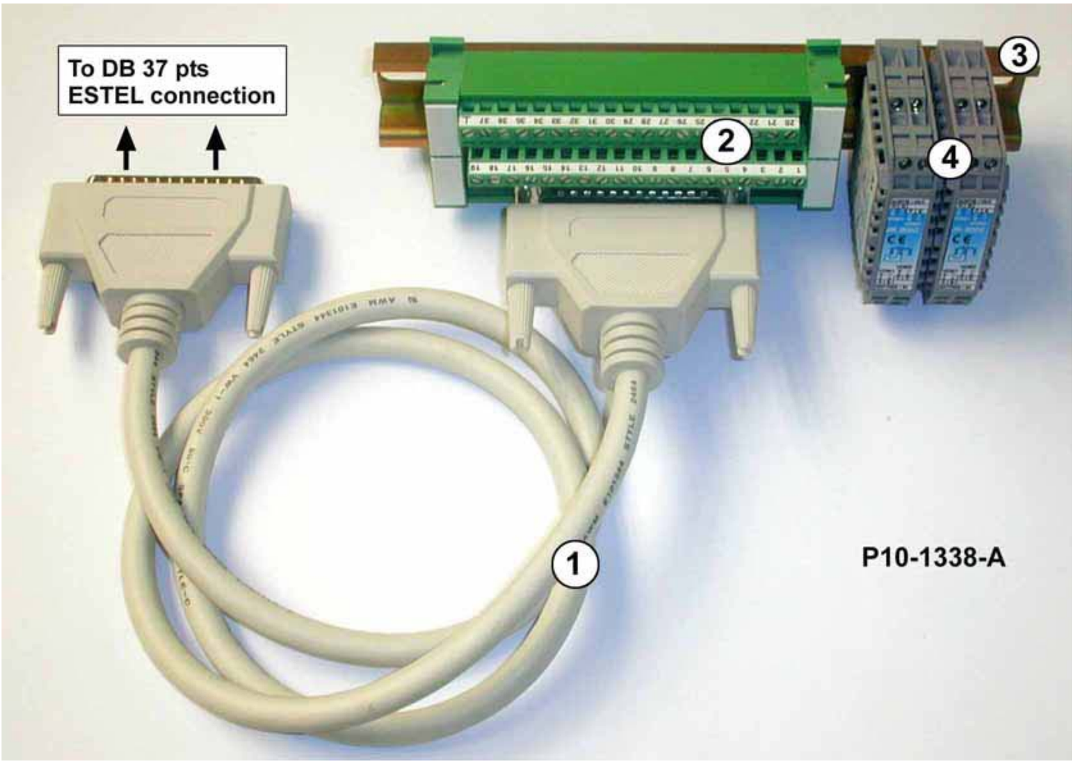


Figure 4 – Option of external connection + 4 insulated outputs P10-1338-A

SOREL Board

BOARD OF LOGIC INPUTS / OUTPUTS

OPTION OF 2M ANALYZERS

- April 2010 -

Environnement S.A
L'instrumentation de l'environnement
111 bd Robespierre, 78300 POISSY - -TEL. 33(0)-1.39.22.38.00 – FAX 33(0)-1.39 65.38.08
http://www.environnement-sa.com

SOREL BOARD

Up-to-date:

Pages	Up-to-date :
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10	05-04

1. SOREL BOARD

SOREL board is a universal board of logic inputs/outputs for the 2M analyzers. It is optional. It is possible to install up to 2 SOREL boards in an analyzer.

1.1 FUNCTION AND USE

SOREL board has 2 functions:

- Relays control (4 in all)
- Remote controls (4 inputs)

SOREL board communicates with measurement module through Bus i2C and relieves it of the Inputs/Outputs functions. It enables the remote control and/or the remote signaling of certain functions as: "measurement", "zero", "calibration" and "alarm".

1.2 TECHNICAL CHARACTERISTICS

Management by specialized micro controller:

- only one power supply of 24 volts,
- 4 logic inputs,
- 4 contacts for remote signaling, potential configurable by the user,
- Visualization of i2C communication using a LED.

Electric connection:

- 4-point connector for link with module boards of 2M series,
- Inputs / Outputs centralized on plug-in connector. This connector in screwed on the rear panel of the analyzer using a back-plate.

Voltage and current on relays:

- Maximum voltage by relay contact: 50 volts D.C.
- Maximum current by relay contact : 1 Ampere at 24 V D.C. (resistive load)

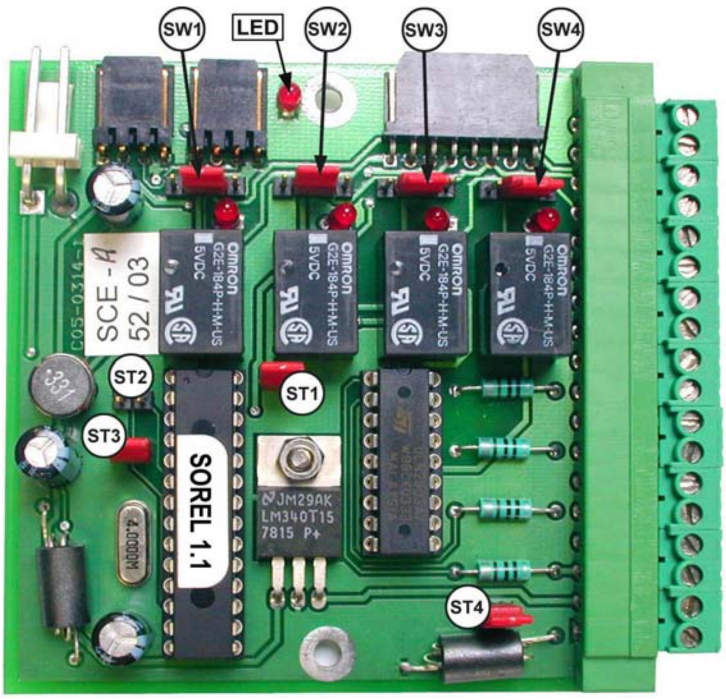
Voltage at logic inputs:

- Maximum voltage 24 V D.C.

1.3 CONFIGURATION

Table 1 - Configuration of SOREL board

JUMPERS MARK	SYMBOLS	NATURE OF OPERATIONS
ST1, ST2, ST3	[■] [■] [■]	SOREL selection, board N° 1
	[■] [● ●] [■]	SOREL selection, board N° 2
	[■] [■] [● ●]	SOREL selection, board N° 3
	[■] [● ●] [● ●]	SOREL selection, board N° 4
	[● ●] [■] [■]	SOREL selection, board N° 5
	[● ●] [● ●] [■]	SOREL selection, board N° 6
	[● ●] [■] [● ●]	SOREL selection, board N° 7
	[● ●] [● ●] [● ●]	SOREL selection, board N° 8
ST4	[■]	0 V to ground (default)
	[● ●]	Floating 0 V
SW1 Relay nb 1 SW2 Relay nb 2 SW3 Relay nb 3 SW4 Relay nb 4	[●■●]	Potential free contact
	[■■]	Referenced contact to 0 V and 24V



18	Relay contact #4 (-)
17	Relay contact #4 (+)
16	Relay contact #3 (-)
15	Relay contact #3 (+)
14	Relay contact #2 (-)
13	Relay contact #2 (+)
12	Relay contact #1 (-)
11	Relay contact #1 (+)
10	GND
9	Remote control #4
8	GND
7	Remote control #3
6	GND
5	Remote control #2
4	GND
3	Remote control #1
2	+15V
1	+24V

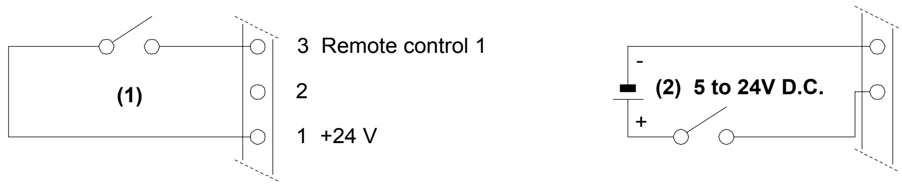


Figure 1 – SOREL board

NOTE: Output relay contacts are normally open when analyzer is switched off.

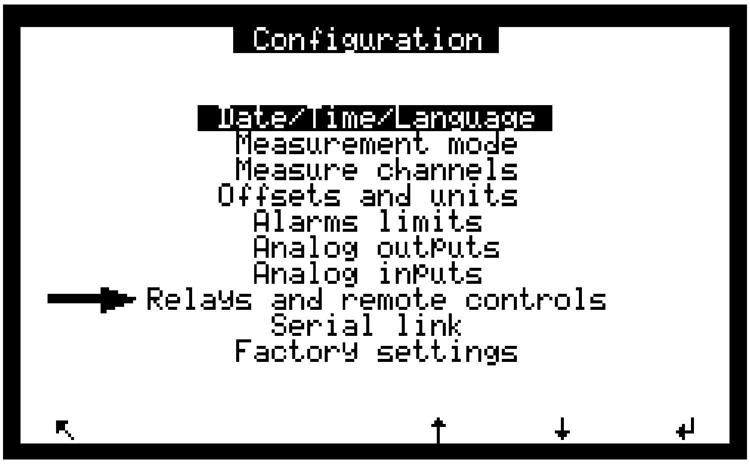
1.3.1 Programmation

The hereafter screens (§ 1.3.1 à § 1.3.3) are given as example.

Refer to technical manual of the analyzer in which SOREL board is installed.

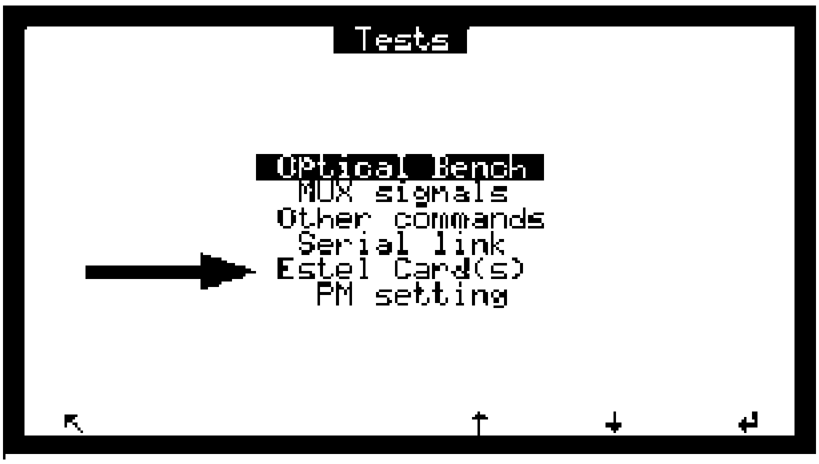
The analyzer automatically detects the presence of one or several SOREL and/or ESTEL boards and offers menus enabling the user to adjust and configure each board.

- In CONFIGURATION menu of main software program, the "Analog outputs", "Analog inputs", "Relays and remote controls" items are only displayed if the SOREL and/or ESTEL board option is available. **Only, the sub-menu "Relay and remote controls is necessary to program the SOREL board.**



- In the TESTS menu of the main program, **the item "ESTEL card" is displayed if one SOREL board at least is detected.**

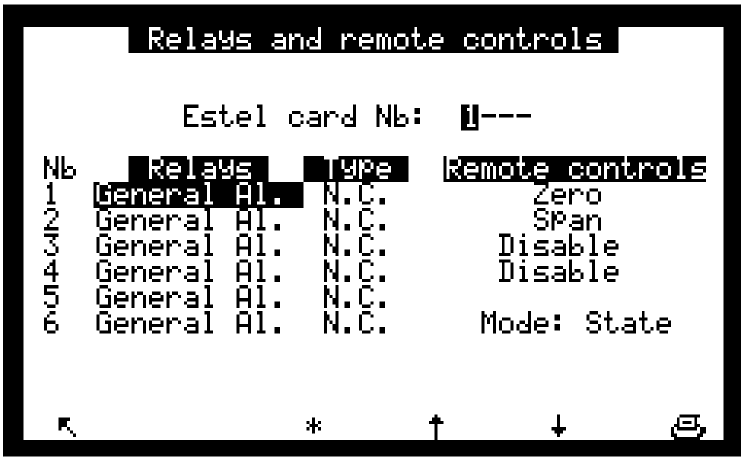
  The same screen as for ESTEL board must be used, but it is necessary not to take into account of data about analog inputs and outputs.



1.3.2 CONFIGURATION ⇨ Relays and remote controls

This screen enables to configure function of each input / output of SOREL and/or ESTEL board(s).

- **SOREL board is displayed as an ESTEL board,**
- The "ESTEL card Nb: " is used to select what board to configure.
- "Relays" fields are used to control the relays according to each analyzer: refer to *CONFIGURATION ⇨ Relays and remote controls* paragraph of the technical manual of your analyzer.



- The "Type" fields are used to program relays into "normally closed" (NC) or "normally open" (NO) when alarms are OFF.
- The "Mode" field is used to configure the working mode of remote controls.

Two different modes are possible:

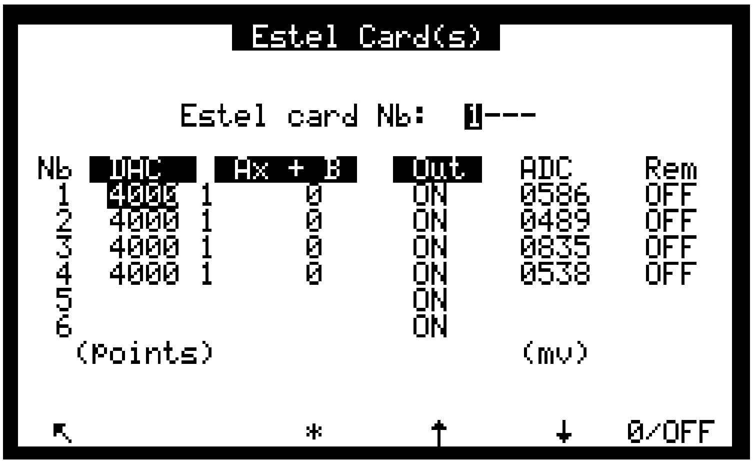
"State" mode: control is activated as long as remote control is active (closed contact).

"Rise" mode: control is activated when state modification of remote control is detected. When it is down, control remains active. A new modification of state de-activates control.

1.3.3 TESTS ⇨ ESTEL card

This screen is used to check operation of remote controls and relays.

Analog functionalities are not active for SOREL board.



The “Estel card Nb:” field is used to select the board to be tested.

The “Out” fields are used to control the relays manually.

The "Rem." fields are used to know state of these logic inputs.

Definition of the specific keys of this screen:

0/OFF Opens all the relay contacts.

4000/ON Closes all the relay contacts.

1.4 INSTALLATION OR REPLACEMENT OF SOREL BOARD

- Switch off the analyzer and unplug the mains cable before any maintenance work in the analyzer,
- Respect connection of SOREL board / MODULE board at J20 when reassembling.

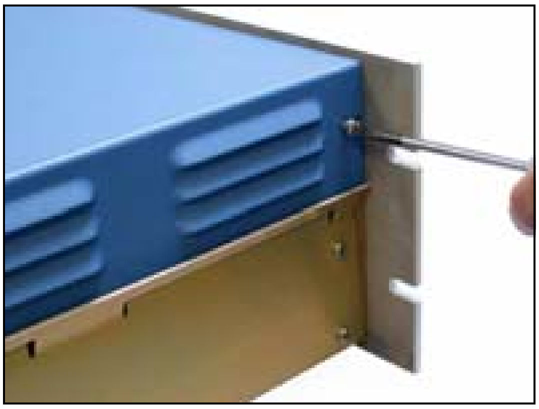
1.4.1 Switch off the analyzer

1.4.2 Unplug the mains cable

1.4.3 Put off the cover

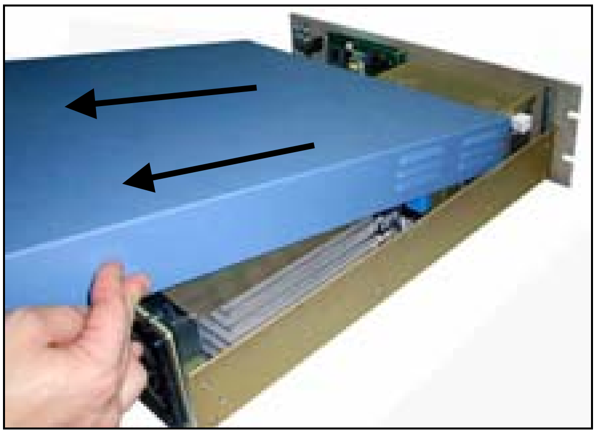
(1) Unscrew the screws located on the rear panel of the analyzer

(2) Unscrew the screws located on lateral sides



(3) Lift up the cover

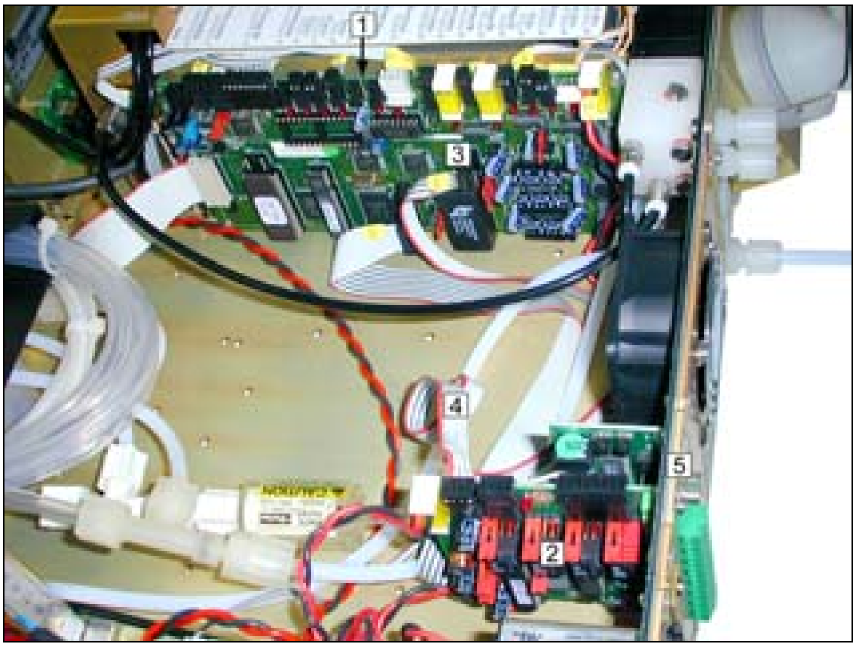
(4) Remove the cover by pulling it backward



If the analyzer is already equipped with a SOREL board, follow step 1.4.4

If the analyzer is not equipped with ESTEL board, follow step 1.4.5

1.4.4 Dismount SOREL board



(1) Module board

(2) SOREL board

(3) Connector J20 on Module board

(4) Connecting cable between Sorel board / Module board

(5) Fixing screw of Sorel board on rear panel of the analyzer

Disconnect the connecting cable between SOREL board (4) / Module (3) board.

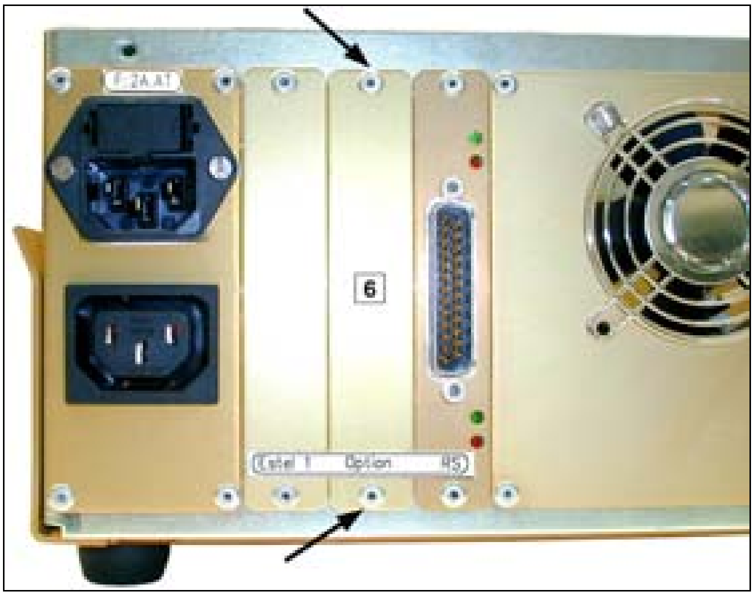
Unscrew the fixing screws (5) of SOREL board on rear panel of the analyzer.

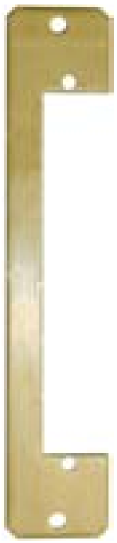
Remove SOREL board.

Configure jumpers of the new board carrying out correspondence of functionalities according to Table 1.

Re-assemble the board.

1.4.5 Unrivet the back plate (6) of rear panel of analyzer





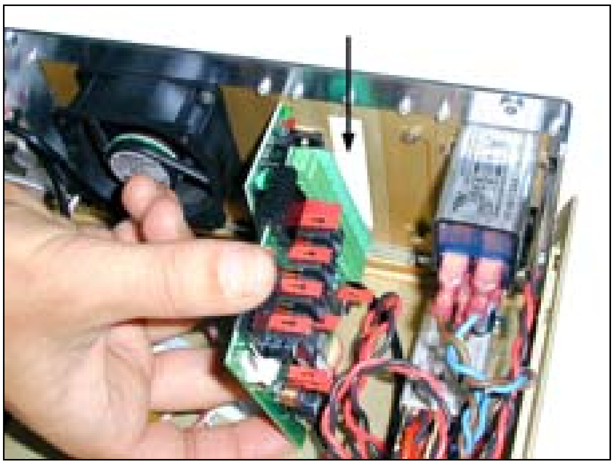
(7)

Then, install at the same place the new plate (7) delivered with the board

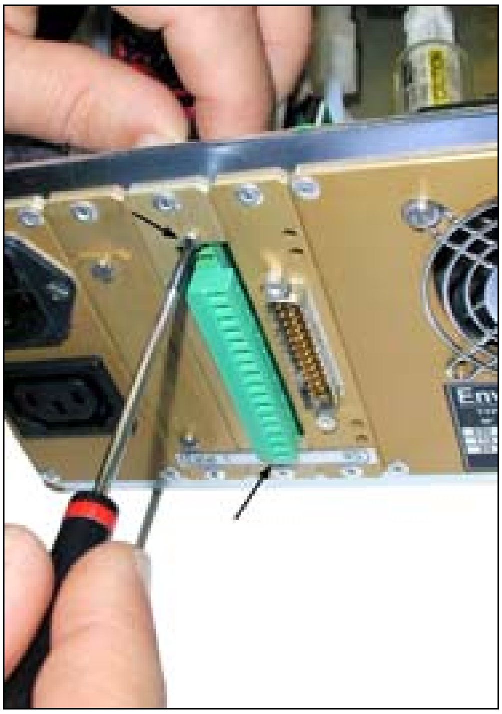
1.4.6 Installation of board inside the analyzer

ANALYZER SWITCHED OFF

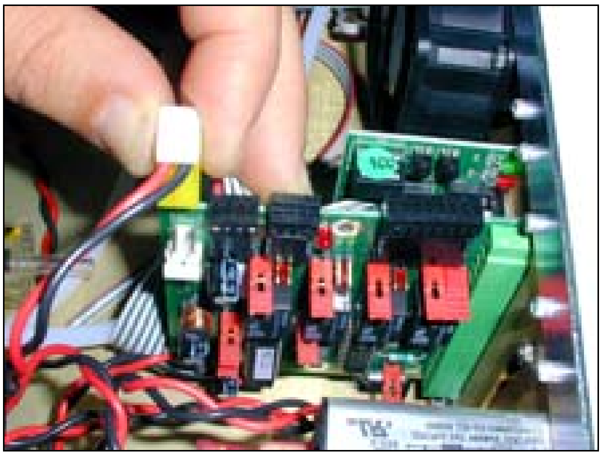
(1) Vertically insert the board inside its slot.



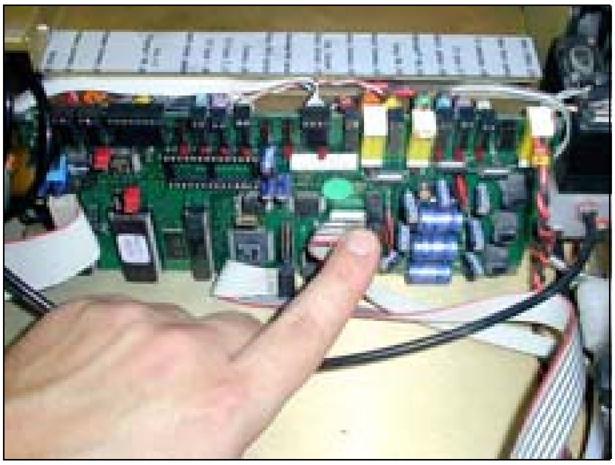
(2) Re-screw the board on back plate



(3) Fit again connector on SOREL board



(4) Then, re-connect on Module board at **J20**



(5) Replace cover on the analyzer. See 1.4.3.

(6) Connect mains cable and switch on the analyzer. See 1.4.2 and 1.4.1.