LN INDUSTRIES SA DIVISION INSTRUMENTATION
46 chemin de l'Etang, Case Postale 256 CH - 1219 CHATELAINE-GENEVE SUISSE
Tél.: ++41 22 9793700 Fax : ++41 22 9793720 email : info.instrum@lnindustries.com

Mass Flow Controller
Gas Mixer
(for portable and 19' rackable)

SONIMIX 7000-2L (Basic Model)
SONIMIX 7000-2LxR (Multi Range Model)
SONIMIX 7000-xL (Multi Gas Model)

Distribution and service by :

Operating Manual
SONIMIX 7000

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1. Introduction :

The SONIMIX 7000 is a family of different type of Gas mixers / Gas Blenders working with the Mass Flow controller technology (MFC).

The SONIMIX 7000 is available in different versions:

- The Basic Model
- The Multi Range Model
- The Multi gas Model

The basic Model is a binary mixer built with only 2 MFC. This model is able to generate concentrations from 10% to 100% (+ the Zero) of the cylinders concentration.

By binary mixture we understand a mixture of one component (for example CO, CO_2, NO,… in a balance) together with the same balance.

For example, with a cylinder of	1000 ppm of CO/N_2
The basic Model will generate following concentrations:	100 ppm to 1000 ppm CO /N_2

Hint: With the help of our GasCal software, it is possible to use the SONIMIX 7000 Basic Model with multi components gas cylinders or to use a different balance for the balance of the cylinder and the balance of the mixture.

As standard, this device is delivered in a portable casing. (If requested, the device can be built in a 19' Inch casing for rack integration.

The Multi-range Model is **a binary mixer** built with 2 to 5 MFC.

The difference with the basic Model is mainly the extended dilution range:

For example with 3 MFC and a cylinder of	1000 ppm of CO/N_2
The multi range Model will generate from	10 ppm to 1000 ppm CO/N2
For example with 4 MFC and a cylinder of	1000 ppm of CO/N_2
The multi range Model will generate from	1 ppm to 1000 ppm CO/N2

By binary mixture we understand a mixture of one component (for example CO, CO_2, NO,… in a balance) together with the same balance.

For example, with a cylinder of	1000 ppm of CO/N_2
The basic Model will generate following concentrations:	100 ppm to 1000 ppm CO /N_2

Hint: With the help of our GasCal software, it is possible to use the SONIMIX 7000 Basic Model with multi components gas cylinders or to use a different balance for the balance of the cylinder and the balance of the mixture.

As standard, this device is delivered in a portable casing up to 3 MFC. If more than 3 MFC are used, then a 19' Inch rack casing will be used. (In any cases, if requested, the device can be built in a 19' Inch casing.)

The **Multi gas Model** has been developed to mix different gas cylinders simultaneously in order to generate multi components mixtures. The SONIMIX 7000 Multi gas can be built with 3 to 6 MFC depending of the applications. The archived concentrations depend of the different values of the MFC.

For example with the 3 following cylinders and MFC configuration:

Full range MFC 1: 100 ml/min to 1000 ml/min used with a 1000 ppm cylinder of CO/N_2
Full range MFC 2: 100 ml/min to 1000 ml/min used with a 1000 ppm cylinder of CO_2/N_2
Full range MFC 3: 100 ml/min to 1000 ml/min used with a 100% cylinder of N_2

The Multi range Model will be able to generate (for example) :

100 ppm CO/N_2
100 ppm CO_2/N_2
Balance N_2

Again, the SONIMIX 7000 restricted the use to one common Balance for all the Line.

We encourage the user of the Multi gas Model to use it with GasCal. The software will highly increase the functionality of the SONIMIX 7000.

As standard, this device is delivered in a 19’ Inch casing for rack integration.

Global remark:

All the MFC are linearized in 10 points. This procedure is accessible to the users that have at their disposal a voltmeter or a MOLBLOC system to linearize each MFC.

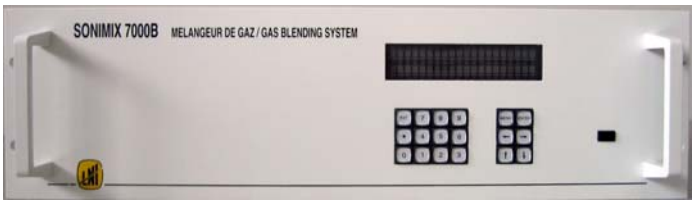
This function can also be used by notified body as METAS/ LNE/UKAS or NIST to verify or linearize the MFC.

The SONIMIX 7000 applications are the following:

- Calibration of analysers
- Linearity check of the analysers
- Generation of complex mixtures
- Generation of mixture for interference determination and measurement. (quenching)

2. Presentation :

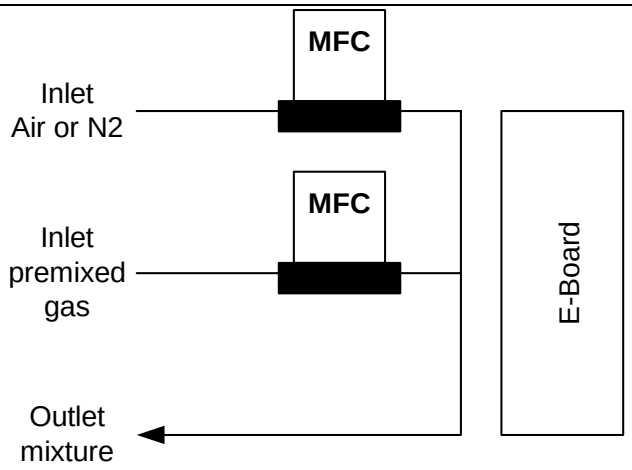
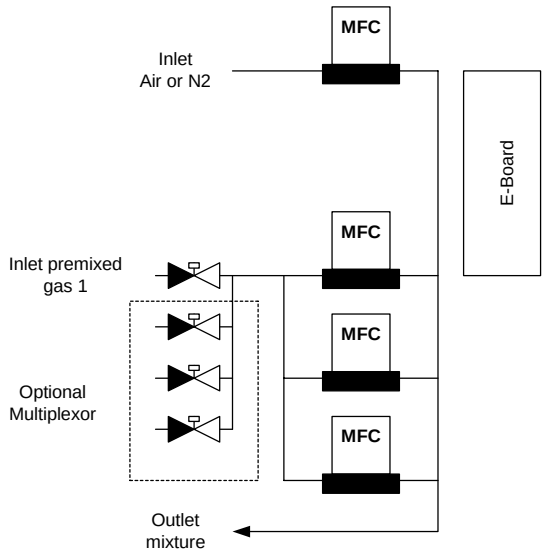
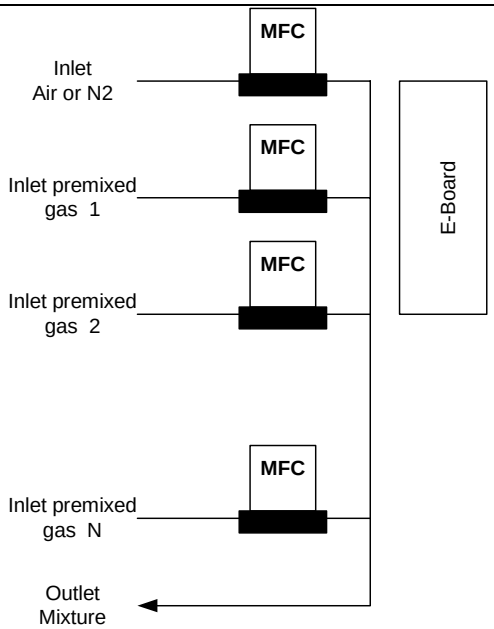
The SX 7000 looks as follow:

<table>
<tr><td colspan="2">Front panel :</td></tr>
<tr><td>Portable casing (less than 4 MFC)</td><td>19’ Casing for rack</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">The front face is composed of :</td></tr>
<tr><td>ON / OFF switch
1 Keyboard
1 VFD display with 2x20 characters
1 outlet « mixture » (¼ stainless steal swagelock fitting)</td><td>ON / OFF switch
1 Keyboard
1 VFD display with 2x20 characters</td></tr>
<tr><td colspan="2">Back panel :</td></tr>
<tr><td rowspan="2"> 
</td><td>Here a Basic or Multi Range Model
  </td></tr>
<tr><td>Here a Multi Gas Model
 
</td></tr>
<tr><td colspan="2">The back panel is composed of</td></tr>
<tr><td>1 Inlet for Air or Nitrogen
1 Inlet for premixed gas
1 outlet for the purge and the by pass
D’une sortie pour la purge et l’excès
(swagelok stainless steal ¼ fitting)
1 power supply protected by a 1 A fuse
1 fan</td><td>1 Inlet for Air or Nitrogen
1 or more Inlet(s) for premixed gas
1 outlet « mixture » (¼ stainless steal swagelock fitting)
1 outlet for the purge and the by pass
(swagelok stainless steal ¼ fitting)
1 power supply protected by a 1 A fuse
1 fan.</td></tr>
<tr><td colspan="2">Dimensions :</td></tr>
<tr><td>½ 19’, 3HE/84TE, 500 mm</td><td>19’, 3HE/84TE, 500 mm</td></tr>
</table>

3. Functioning parameters and characteristics :

	VALUES
Number of lines	2 to 6 depending on the Model
Carrier (balance)	Air or N2
Diluted	All sort of pure gas (if dry and non corrosive) Pre mixture of dry corrosive gases such as < 1000 ppm Cl2, SO2, H2S, NO
Flow controllers component	Mass flow controllers (MFC)
Functioning modes	Fixed Mode : concentration and global flow Free mode : independent flows
Concentration in fixed mode	10% and 100% of the MFC scale of each diluted line
Mixture outflow in fixed mode	from 1 to 5 Nl/min (strongly depend on models and settings)
Mixture outflow in free mode	from 1 to 10 NL/min (at 10Nl/min, the concentration adjustment is limited at 50%)
Inlet pressure	3 +/- 0.3 bar rel
Outlet pressure	Atmospheric Pressure.
MFC calibration	Through volumetric system MOLBLOC/MOLBOX
Precision of the measured outflow during the calibration	Better than 0.2% rel
Precision of the final mixture	Better than 1.5% relative
Repeatability	Better than 0.2% FS
Intrinsic MFC precision	1% FS
MFC repeatability	0.2% FS
Start up time	30 to 45 minutes
Stabilisation time	< 3 minutes
Functioning temperature	from 15°C to 45°C
Ambient Humidity	No constraint
Instrument position	Horizontal
Tightness	Guaranteed better than 10^-7 stdcc/sec He, verified by a spectrometer He
Power supply	230V/50Hz
Size	300 x 150 x 350 mm
Weight	Approx. 7 Kg

Fluidics :

Basic Model	
Multi Range	
Multi Gas	

4. Installation and important notes

Before using the SONIMIX 7000 it is necessary to connect the different tubing (fluidics) and connect the device to the power supply. Please check if your power supply is compatible with the one installed on your device.

For the electrical connections it is sufficient to connect the SONIMIX 7000 to the main power supply (110V or 220 V AC) Please check if your power supply is compatible with the one installed on your device.

One 110V/220V switch located to the back panel of the device able to select the correct voltage

If the wrong voltage is selected the device can be damaged

The SONIMIX 7000 can be connected to the different gas cylinders. In order to avoid problems, please check the following points:

Never connect the SONIMIX to a gas-cylinder without pressure reducer.

Use a pressure reducer compatible with the nature of the used gas.

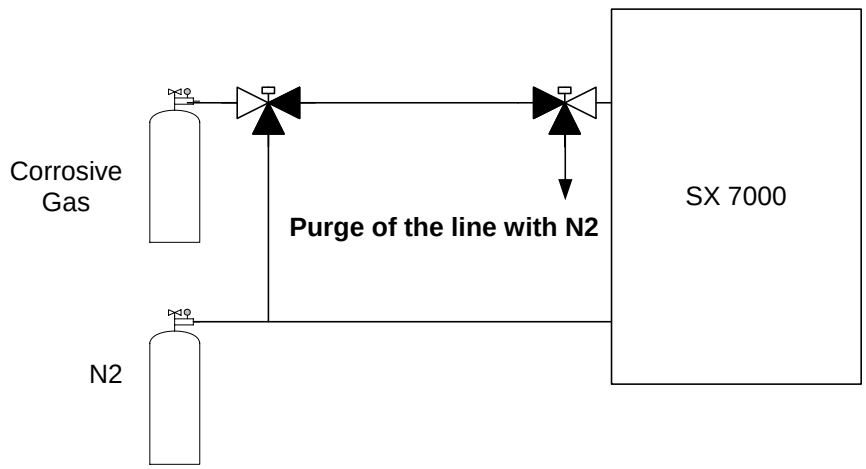
In general we recommend the use of electropolisched stainless steal tube if you want to obtain the best analytical results. (The use of Teflon or PTFE tubes can be used with certain gases or at certain concentrations). In case of doubt, please contact LN Industries or one of it's agent.

If you intend to use Air as Balance, use a Zero Air Generator or a cylinder. Please never connect a compressor directly to the SONIMIX. The humidity contained in such compressed air will damage the instrument.

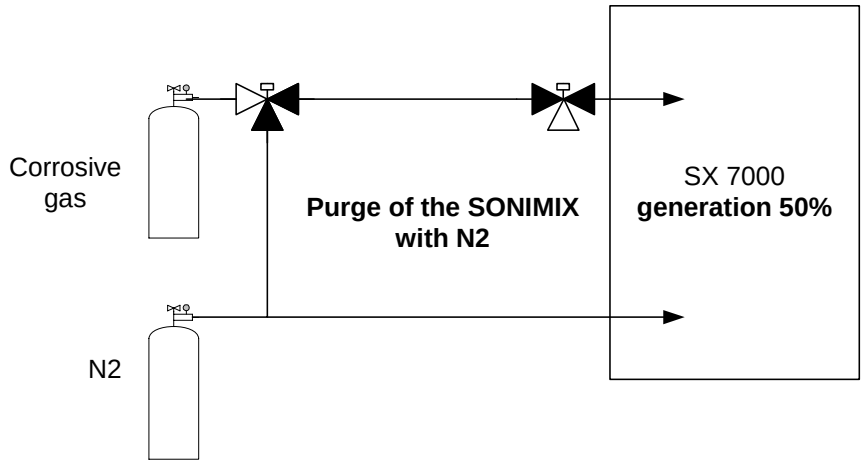
Be careful when you use corrosive gases such as NH3, HCl, H2S or NO2 at concentrations higher than 1000 ppm.

For smaller concentrations, it is highly recommended to purge and rinse correctly the line with Nitrogen.

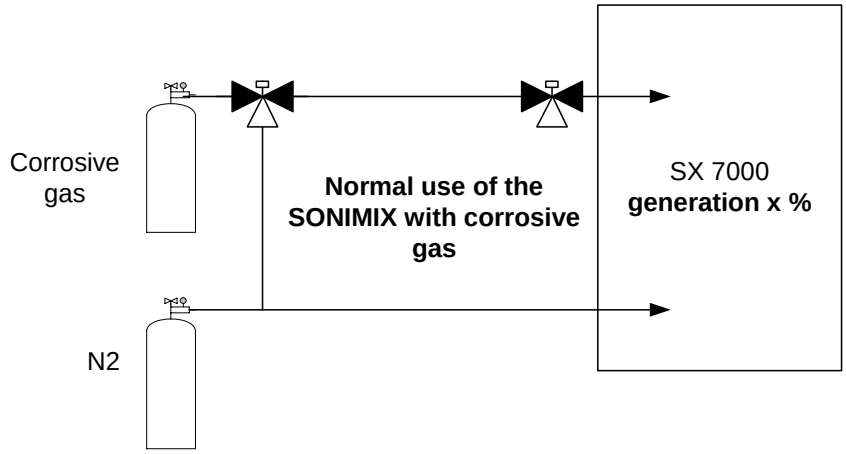
Ideally, a 3/2 valve should be placed at the outlet of the pressure reducer and an other one at the inlet of the SONIMIX. Before using a corrosive gas, it is necessary to purge the line with Nitrogen by opening the 2 3/2 valves.



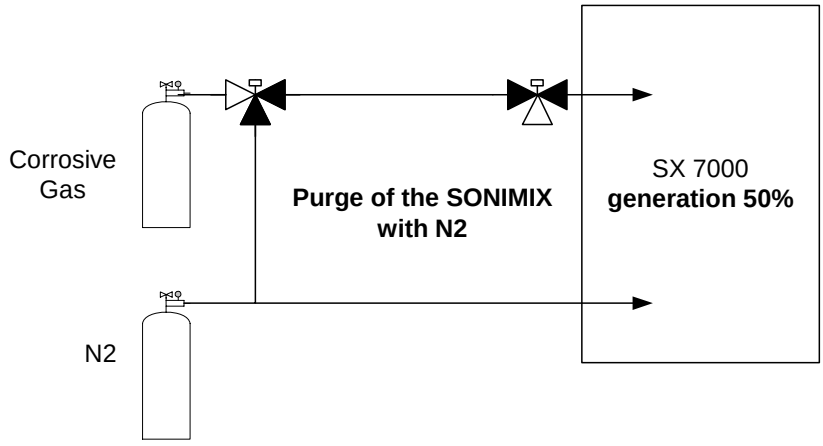
Then close the 3/2 valve place near the SONIMIX and generate a dilution point (50%) during 5 minutes (if the tube do not exceed 3 metres). This will fill the SONIMIX with dry Nitrogen.



Then, close the 3/2 valve located near the pressure reducer, set the right pressure and start to make your mixtures.



Once the use of the SONIMIX 7000 with corrosive gases is finished, it is necessary to rinse the device as follow :
Open the 3/2 valve placed near the pressure reducer and set the right pressure to the nitrogen line.
Generate a dilution point (50%) during 5 minutes (if the tube does not exceed 3 metres).



Then, set the SONIMIX 7000 to stand by and remove the Nitrogen pressure.
Now you can connect the SONIMIX to an other gas cylinder.

Do not forget that the SONIMIX should be used horizontally and that the SONIMIX needs 45 minutes of start up time (from switch on of the device)

We strongly recommend to all the SONIMIX users to purchase the GasCal PC software.
GasCal increase the SONIMIX functionalities (easy use of the instrument, possibility to use multi-component cylinders, automatisation of linearization and respectabilities.

If you send back the device for repair or calibration, please use the original box to avoid any damage to the instrument during transport.

5. Description of the menus and sub-menus :

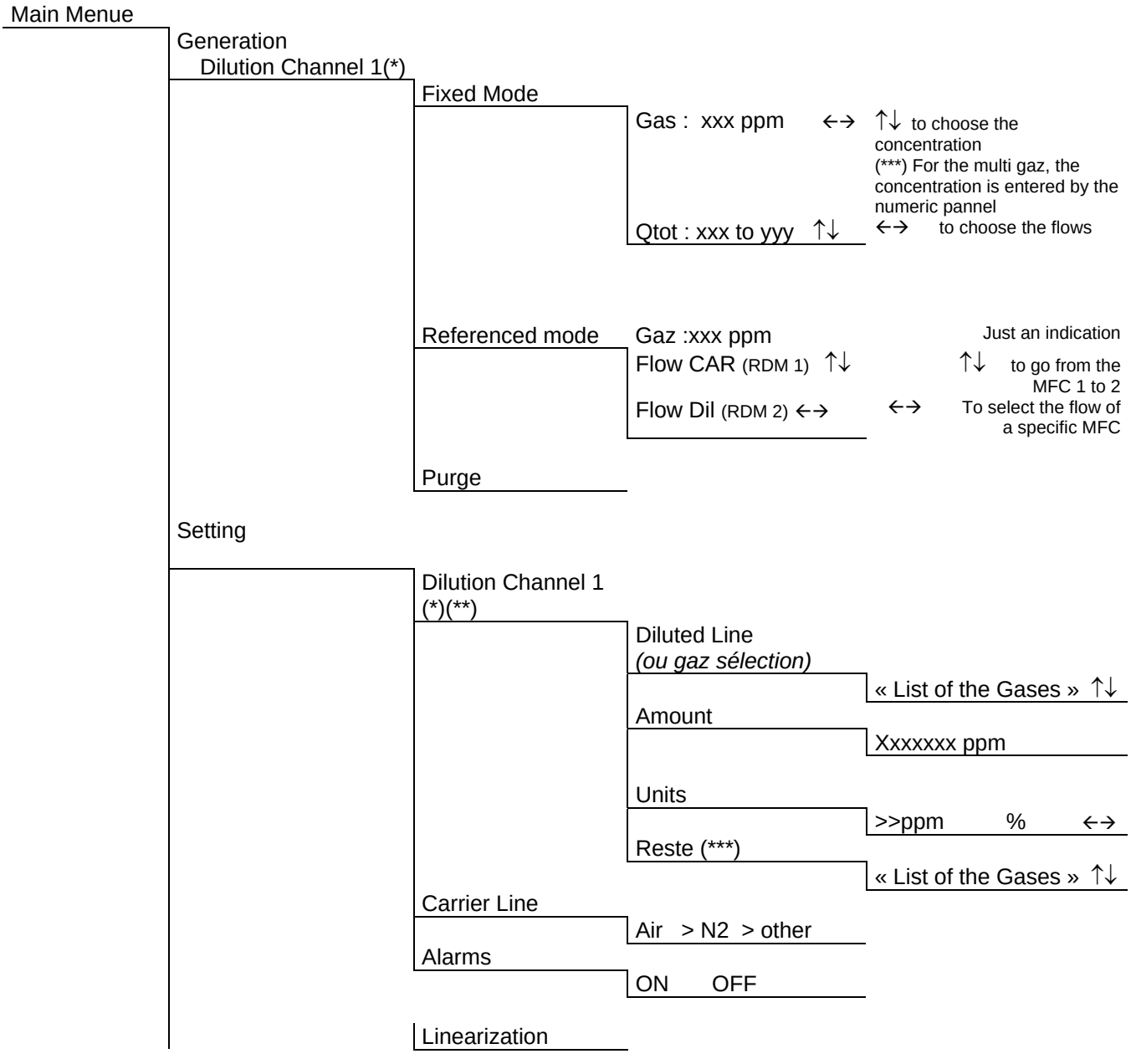
Due to the large number of possible configuration of the SONIMIX 7000, it is not possible to describe in the detail all the possible configurations.

As the software is very similar for all configurations, we have decided to describe in the detail the basic model only and to make some specific notes for the other models.
The user interface is done through a keyboard and VFD display. The selection of the different menus and sub menus is done through the interface.

The key “enter” is used to enter in a menu or sub-menu and the key “menu” is used to go out of a specific menu.
To go from a menu to an other, the up/down arrows are used

The selection of some numeric values is done by the numeric panel or by using the Left/Right arrows.

Global descriptions of the menus :



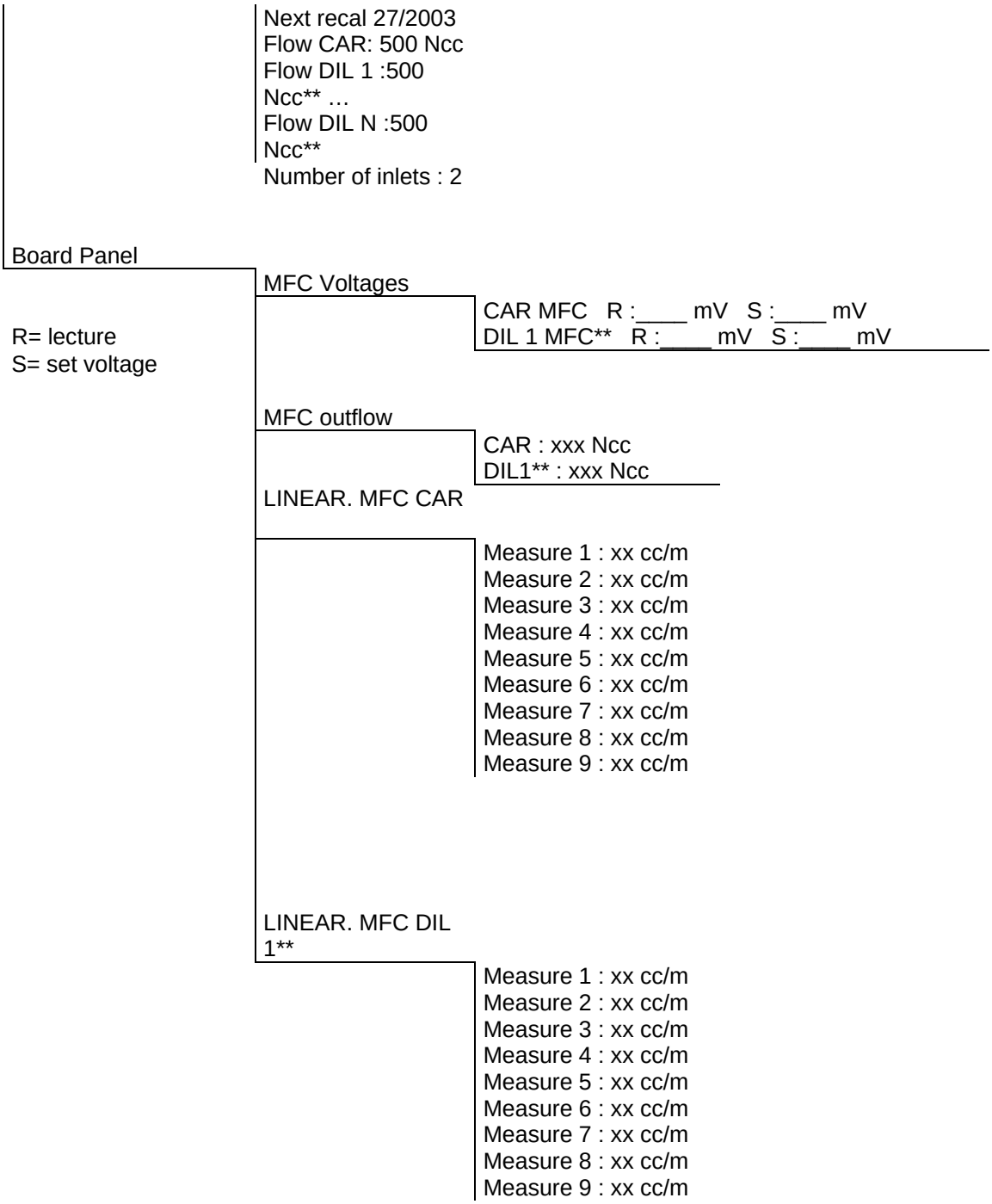
- Password :****
- MFC CAR ↑↓
  - Pt :1 00 :00
    Measure 1 :___cc/m
    Pt :2 00 :00
    Measure 2 :___cc/m
    Pt :3 00 :00
    Measure 3 :___cc/m
    Pt :4 00 :00
    Measure 4 :___cc/m
    Pt :5 00 :00
    Measure 5 :___cc/m
    Pt :6 00 :00
    Measure 6 :___cc/m
    Pt :7 00 :00
    Measure 7 :___cc/m
    Pt :8 00 :00
    Measure 8 :___cc/m
    Pt :9 00 :00
    Measure 9 :___cc/m
- MFC DIL 1**
  - Pt :1 00 :00
    Measure 1 :___cc/m
    Pt :2 00 :00
    Measure 2 :___cc/m
    Pt :3 00 :00
    Measure 3 :___cc/m
    Pt :4 00 :00
    Measure 4 :___cc/m
    Pt :5 00 :00
    Measure 5 :___cc/m
    Pt :6 00 :00
    Measure 6 :___cc/m
    Pt :7 00 :00
    Measure 7 :___cc/m
    Pt :8 00 :00
    Measure 8 :___cc/m
    Pt :9 00 :00
    Measure 9 :___cc/m

***(If more than 2 MFC have been installed Following menus Will appear :*

MFC DIL 2
…
MFC DIL N)

- Languages
  - Français ↑↓
    English ↑↓
- RS 232 settings
  - Baud Rate ↑↓
    Byte size ↑↓
    Stop Bit ↑↓
    Parity ↑↓
- Purge Time (***)
  - MFC x : yy s ↑↓

- Features
  - Model Sx7000
    By LN Industries
    SN 1885
    Software version :
    V1.0
    Prod. date :27/2002



(*) Dilution Channel 1 to N menu do appear only if more than 1 inlet for the diluted gas are installed.
(**) In the MULTIGAS Model « Dilution Channel X » is replaced by « CST MFC : x »
(***) Only valid for the MULTIGAS model

Reminder : The navigation trough the different menus of the SONIMIX 7000 is done as follow :

A) « ENTER » Is used to enter in a specific menu
B) « MENU » Is used to go out of a specific menu
C) ←→ and ↑↓ is used to navigate from a menu to an other or to navigate through a list.

6. How to use the SONIMIX 7000 :

6.1 Parameterisation

Before to start doing mixtures, it is necessary to insert in the SONIMIX the values of the different cylinders that will be used.

To do that, it is necessary to go in the « parameterisation » \ « Dilution Channel »*. Then it is necessary to enter the nature of the gas present in the cylinder (using the list of the gases), its concentration (AMOUNT) in ppm as well as its balance** (AIR or N_2)

- ** Only if more of 1 inlet is installed (for a multi range or a basic model)*
- *** For a multi range or a basic Model the balance of the diluted gas must be the same of the balance of the mixture. In consequence the balance must be defined in the " carrier line " sub-meunu*

As example :

1. Go in the following Menu : **MAIN MENU\PARAMETRISATION\DILUTION CHANNEL1*\DILUTED LINE**
2. Press « ENTER »
3. With the arrows « ↑↓ » Choose the type of the gas present in the cylinder
4. Validate your selection by « ENTER »
5. With the arrow « ↓ » go in the sub menu **\AMOUNT**
6. Press « ENTER »
7. Type the concentration of the gas present in the cylinder (pay attention the units are in ppm)
8. Validate your selection by « ENTER »
9. With the arrow « ↓ » go in the sub menu **\UNITS**
10. Press « ENTER »
11. With the arrows « ←→ » Choose your unit (ppm or %)
12. Validate your selection by « ENTER »
13. Press « MENU »
14. With the arrows « ↓ » go in the sub menu **\CARRIER LINE**
15. Press « ENTER »
16. With the arrow « ←→ » and « ↑↓ » Choose your carrier (Balance) gas (Air,N2 or other)
17. Validate your selection by « ENTER »
18. To go back to the MAIN MENU : press « MENU »

Each time to change a gas cylinder (new type of gas or new concentration) you have to insert the new value in the SONIMIX. The SONIMIX will use this information to calculate the final concentrations.

NB For a SONIMIX 7000 multi gas or multi range installed with more than 1 inlet for the diluted line, The user have to perform the same procedure for all dilution channel (inlets)

Following the same procedure, it is possible to:

Activate the alarms:
MAIN MENU\PARAMETRISATION\ALARMS

Perform the RS 232 settings
MAIN MENU \PARAMETRISATION\ RS 232 SETTINGS

Linearize the Mass Flow Controllers
MAIN MENU \PARAMETRISATION\LINEARISATION
Pay attention: The sub-menu « LINEARISATION » is reserved to authorized person and is protected by a pass word. All modification in this menu will influence the functioning of the SONIMIX 7000. A complete chapter is devoted to that topic. In case of doubt or questions, do not hesitate to contact LNI people.

To change the language
MAIN MENU \PARAMETRISATION\LANGUAGE

The SONIMIX able the user to choose 2 different generation modes :

- Fixed Mode
- Free Mode

A) Fixed Mode: In this mode you have to enter the different final concentrations and tht total desired outflow.
The SONIMIX 7000 will set the different mass flow controller to the correct value in function of the requested concentration, flow and setting of cylinders.

B) Free Mode : In this mode, you select the flow desired for each MFC. The SONIMIX 7000 will calculate the outlet concentration in function of the requested concentration, flow and setting of cylinders.

6.2 Fixed mode Generation

First of all, select the « fixed mode »:

1. Go in the menu **MAIN MENU \GENERATION\ DILUTION CHANNEL 1*\FIXED MODE**
2. Press « ENTER »
3. With the arrow « ←→ » choose the desired concentration (upper line). On the lower line appear the corresponding flow ranges that you will able to select
4. Once the concentration is set, use the arrow « ↑↓ » to set the desired flow. (NB by default the software select the middle value between the maximum and minimum flow range)
5. Validate your selection by « ENTER » and the mixture will start.

You will see on the display which gas is used (Gas/Balance), what is the concentration, the unit and a timer.

To change the concentration or the flow:

6. Press « MENU »
7. With the arrow « ←→ » choose the desired concentration (upper line).
8. Once the concentration is set, use the arrow « ↑↓ » to set the desired flow. Validate your selection by « ENTER » and the new mixture will start.

6.3 Free mode Generation

First of all, select the « free mode »:

1. Go in the menu : **MAIN MENU \GENERATION\ DILUTION CHANNEL 1*\FREE MODE**
2. Press « ENTER »
3. With the arrow « ↑↓ choose the desired MFC (CAR, DIL1,…)
4. With the arrow « ←→ » set the flow of the desired MFC (lower line). On the upper line the concentration is automatically calculated in function of the flow and cylinders parameters. (NB in the multi gas Model, the different concentrations is not shown. For that model we strongly recommend the use of GasCal.
5. Validate your selection by « ENTER » and the mixture will start

You will see on the display which gas is used (Gas/Balance), what is the concentration, the unit and a timer.

To change the concentration or the flow :

9. Press « MENU »
10. With the arrows « ↑↓ choose the desired MFC (CAR, DIL1…)
11. With the arrows « ←→ » set the flow of the desired MFC (lower line). On the upper line the concentration is automatically calculated in function of the flow and cylinders parameters.
12. Validate your selection by « ENTER » and the mixture will start

6.4 Other menus

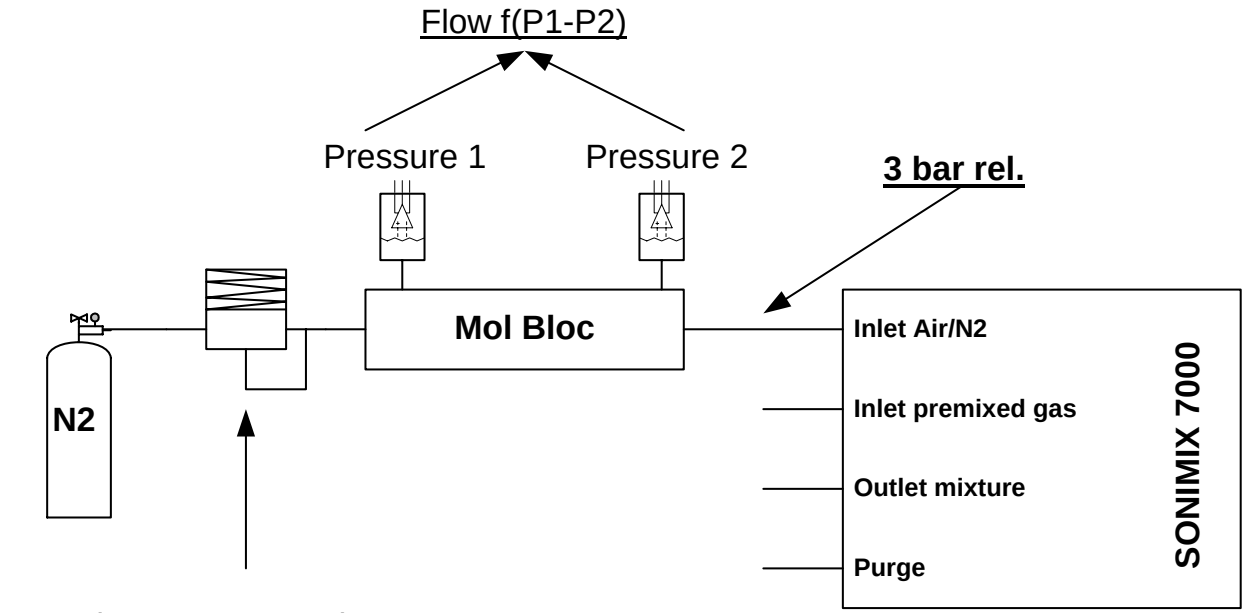
The menu « feature » gives the different features of the gas divider as serial number, number of MFC, Flow of the MFC…

The menu « Board panel » able the user to see all the SONIMIX 7000 functioning parameters such as MFC voltage (setting and read out), linearization value of the MFC…

This menu is also available during the mixing process. Once you are generating your mixture, just press « enter » to access to that menu while the device is functioning. To go out of that « Board panel », press « menu ».

7. Calibration of the MFC by MOLBLOC :

7.1 Fluidics



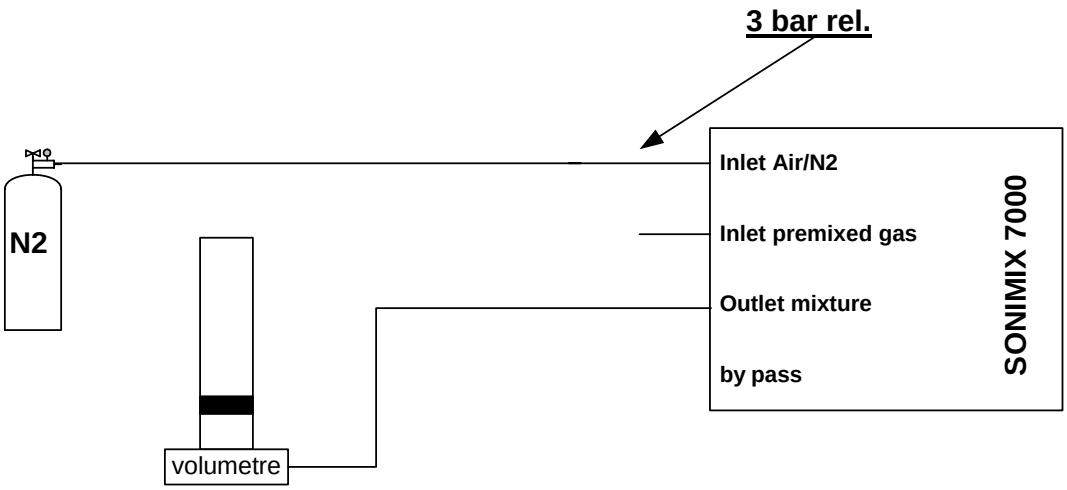
Set the pressure so that the pressure at the inlet of the SONIMIX 7000 is 3 bar realtif

7.2 Procedure:

1. Make the fluidic connections as described
2. Go in the Menu : **MAINMENU\PARAMETRISATION\LINEARISATION**
3. Press « ENTER »
4. Enter the password : ____
5. Validate by « ENTER »
6. With the arrow « ↑↓ » select the MFC you want to be calibrated (CAR, DIL, …)
7. Press « ENTER »
8. Le SONIMIX 7000 show « Pt : 1 00 : 00 »
9. Set the LNI pressure regulator in a way to get 3 bar at the inlet of the SONIMIX
10. Wait that the flow values given by the Mol Bloc are stable
11. Press « MENU »
12. Le SONIMIX 7000 shows « Measure : 1 _____ Ncc/min »
13. Insert the value given by the MOLBLOC in the SONIMX using the keyboard
14. Validate by « ENTER »
15. → Go to the point 9 of this procedure and repeat it for the flow 2 to 9 of the MFC 1
16. The MFC 1 is now linearized
17. To Linearize the MFC 2, disconnect the tube from the Air/N2 inlet of the SX 7000 and connect it to the Diluted inlet
18. With the arrow « ↑↓ » select the MFC you want to be calibrated (CAR, DIL, …)
19. → Go to the point 8 of this procedure to measure the flow 1 to 9 of the MFC 2
20. The MFC 2 is now linearized

8. Calibration of the MFC by a VOLUMETRE :

8.1 Fluidics



1. Make the fluidic connections as described
2. Go in the Menu : **MAINMENU\PARAMETRISATION\LINEARISATION**
3. Press « ENTER »
4. Enter the password : ____
5. Validate by « ENTER »
6. With the arrow « ↑↓ » select the MFC you want to be calibrated (CAR, DIL, …)
7. Press « ENTER »
8. Le SONIMIX 7000 show « Pt : 1 00 : 00 »
9. Wait that the flow values given by the VOLUMETRE is stable
10. Press « MENU »
11. Le SONIMIX 7000 shows « Measure : 1 _____ Ncc/min »
12. Insert the value given by the VOLUMETRE in the SONIMX using the keyboard
13. Validate by « ENTER »
14. → Go to the point 9 of this procedure and repeat it for the flow 2 to 9 of the MFC 1
15. The MFC 1 is now linearized
16. To Linearize the MFC 2, disconnect the tube from the Air/N2 inlet of the SX 7000 and connect it to the Diluted inlet
17. With the arrow « ↑↓ » select the MFC you want to be calibrated (CAR, DIL, …)
18. → Go to the point 8 of this procedure to measure the flow 1 to 9 of the MFC 2
19. The MFC 2 is now linearized

9. Verification of the Linearization of the MFC with a VOLUMETRE or a MOLBLOC :

9.1 Fluidics :

I you measure with a MOLBLOC : use the fluidics described in 7.1
I you measure with VOLUMETRE : use the fluidics described in 8.1

To perform the check you have to go in the free mode :

1. Go in the menu : **MAIN MENU\GENERATION\ DILUTION CHANNEL*\FREE MODE**
2. Press « ENTER »
3. With the arrows « ↑↓ » select the MFC you would like to check (CAR, DIL1,…)
4. With the arrows « ←→ » choose the considered Flow (lower line).
5. Validate by « ENTER »
6. Compare the value given by the SONIMIX with the value given by the Molbloc or Volumetre

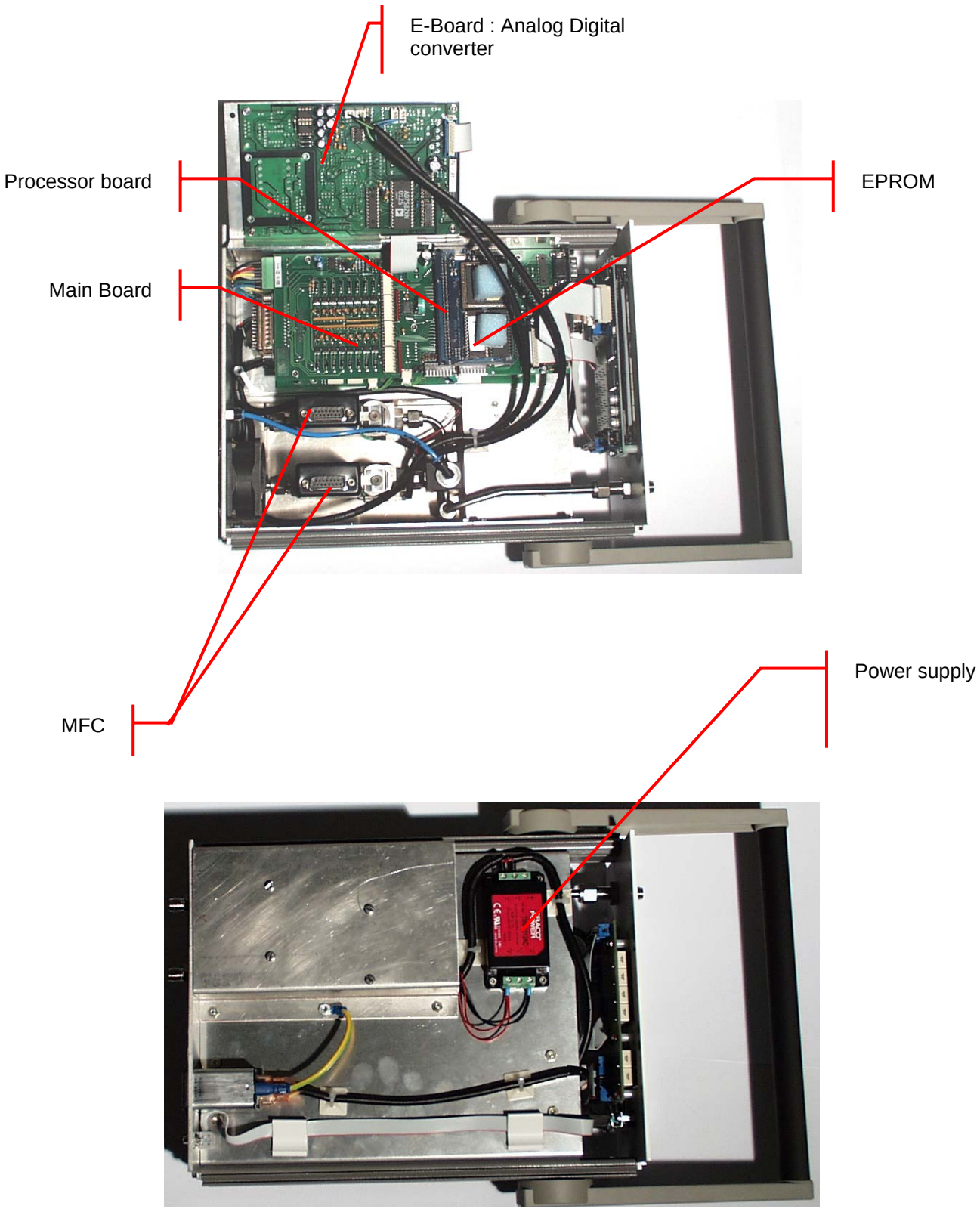
ATTENTION

In order to check correctly the SONIMIX, you should with the Help of the measured flow MFC 1 and MFC 2 to calculate the concentration and compare it with the value given by the SONIMIX

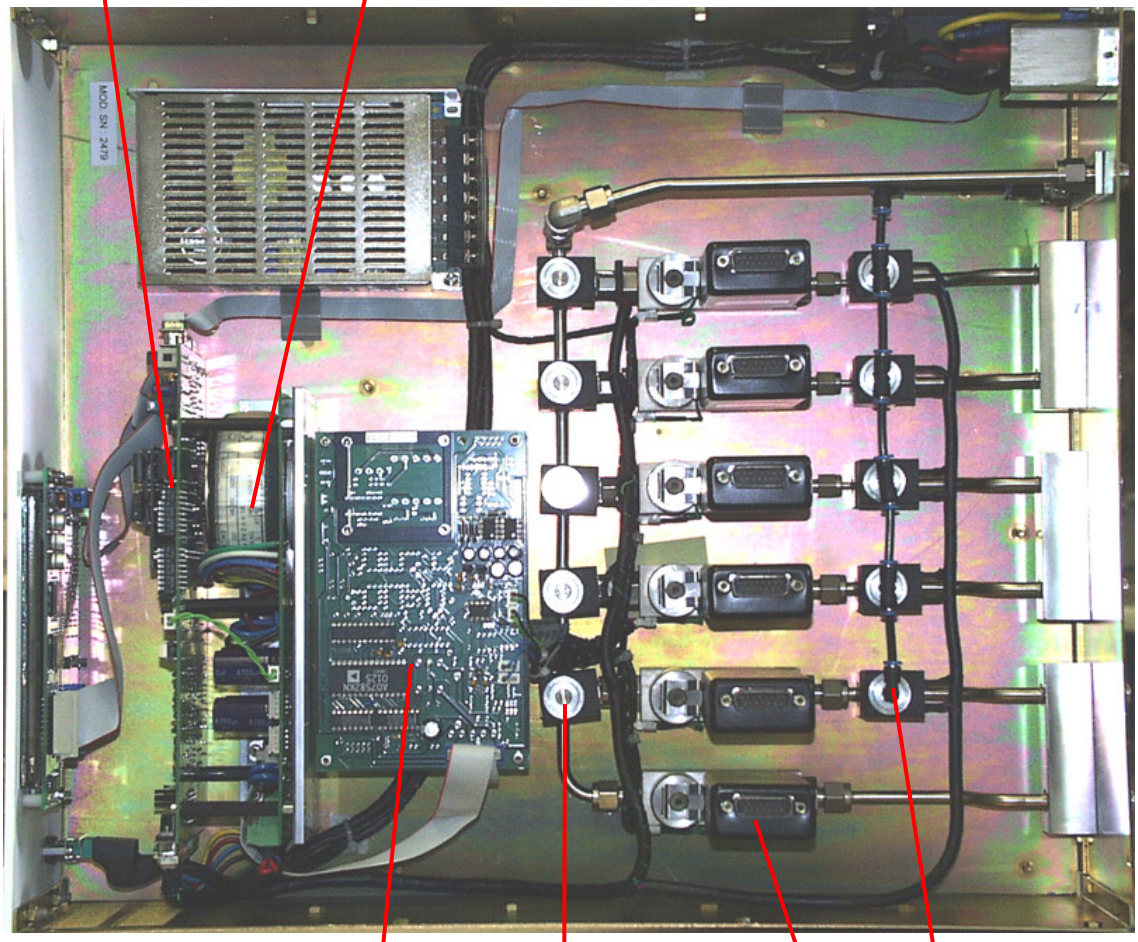
Some parameters as normalisation, atmospheric pressure, ambient temperature have an influence to the flow, but disappeared when you calculate a concentration.

10. Internal structures

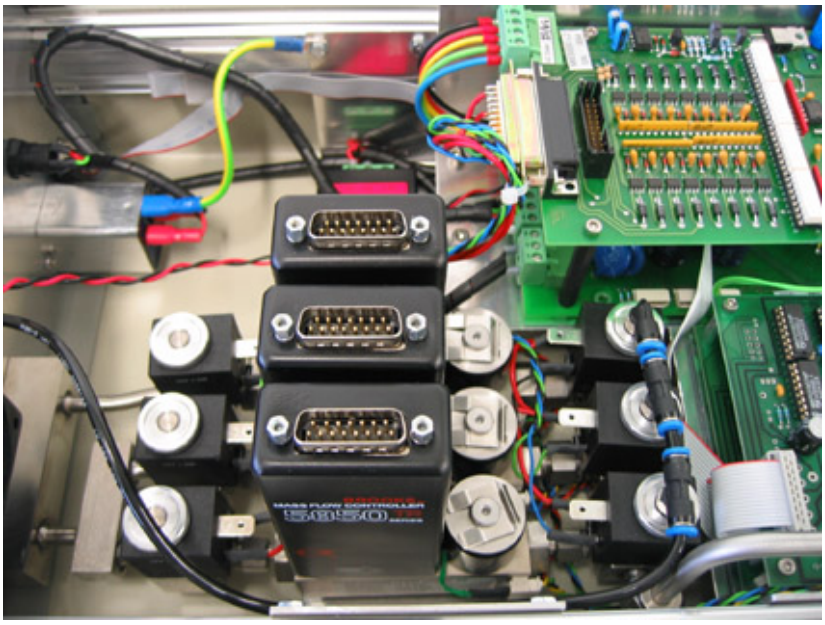
In the following only the basic Model will be displayed as the components such as MFC, Valves, E-Board of the different SONIMIX 7000 model are very similar



Here the SONIMIX 7000 6L multigaz is display



Here the SONIMIX 7000 2L2R multi range is display



11. Gas Coefficient

As all the calibrations of the MFC are performed with Nitrogen and the nature of the gas has an influence to the generated flow, some corrections must be performed. The processor of the SONIMIX 7000 or the PC software GasCal calculates for you all the influences due to the use of different type of gases.
These calculations are performed in function of the coefficient depending of the nature of the gas, the concentration of the cylinders and linearization of the MFC.

The calculations presented in the following line are already performed by the SONIMIX.

The ratio of two different Gases coefficient is Equal the ratio of two MFC voltages for the same flow.

$$\frac{C_1}{C_2} = \frac{W_1}{W_2} \qquad \text{(Equation 1)}$$

$C_i =$ Coefficient of the Gas i

$W_i =$ MFC voltage when used with a gas i at a given flow Q

During the measure of a flow Q of a gas I, the MFC voltage is given by :

$$W = \frac{KN}{\rho\, C_p} \qquad \text{(Equation 2)}$$

$C_p =$ Specific Heat of the gas i [Cal/(g*C)]

$\rho =$ Density of the gas i @ 0°C [g/litres]

$K =$ Constant depending of the MFC

$N =$ Correction Number depending of the molecular structure of the gas (see table)

Using Equation 1 and 2 we get:

$$\frac{C_1}{C_2} = \frac{\dfrac{KN_1}{\rho_1 C_{p1}}}{\dfrac{KN_2}{\rho_2 C_{p2}}} \qquad \text{(Equation 3)}$$

Taking the Nitrogen as reference, the coefficient C_{p2} and the correction Number *N2* can be defined as = 1.
This gives for a specific gas i (compared to Nitrogen):

$$C_{gazi} = \frac{\rho_{N2} C_{pN2} N_{gazi}}{\rho_{gazi} C_{pgazi}} \qquad \text{(Equation 3)}$$

Which give when replacing the density and the specific heat of the nitrogen by their numerical value, we obtain:

$$C_{gazi} = \frac{0.3108 \cdot N_{gazi}}{\rho_{gazi} C_{pgazi}}$$

To calculate the conversion factor of a mixture of an n gas, the following formula has to be used:

$$C_{mélange} = \frac{0.3108 \cdot \left(\frac{Z_{gaz1}}{Z_{tot}} N_{gaz1} + \cdots + \frac{Z_{gazi}}{Z_{tot}} N_{gazi} + \cdots + \frac{Z_{gazn}}{Z_{tot}} N_{gazn} \right)}{\left(\frac{Z_{gaz1}}{Z_{tot}} \rho_{gaz1} C_{pgaz1} + \cdots + \frac{Z_{gazi}}{Z_{tot}} \rho_{gazi} C_{pgazi} + \cdots + \frac{Z_{gazn}}{Z_{tot}} \rho_{gazn} C_{pgazn} \right)}$$

Where $\frac{Z_{gaz1}}{Z_{tot}}$ is the gas i concentration in the mixture

Table of constants:

GAZ	Cp	N	ρ
	[Cal/(g°C)]		[G/l @ 0°C]
C4H8	0.3930	0.88	2.4603
Air	0.2389	1	1.293
NH3	0.5005	0.88	0.76
Ar	0.1245	1.01	1.782
CO2	0.2017	0.94	1.964
CO	0.2488	1	1.25
CF4	0.1659	0.88	3.926
He	1.2418	1.01	0.1786
H2	3.4224	1	0.0899
CH4	0.5318	0.88	0.715
NO	0.2378	1	1.339
N2	0.2488	1	1.25
O2	0.2196	1	1.427
C3H8	0.3991	0.88	1.967
SO2	0.1489	0.94	2.8580
SF6	0.1588	0.88	6.5160