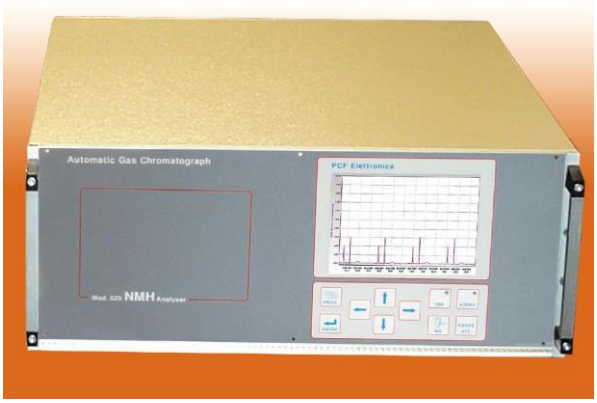
PCF Elettronica's THC mod. 529/T
Total Hydro Carbon Monitor

A STRIPPED VERSION OF MOD. 529 NMH
(Non Methane Hydrocarbon Analyser)
SHOWING
AN EXCLUSIVE INJECTION SYSTEM
A PROPRIETARY AND EXCLUSIVE
FLAME IONISATION DETECTOR



Operating manual

Contents:

1. FOREWORDS

The FID detector is generally known as the most linear and stable sensor for detection of organic compounds. Particularly in environmental monitoring, where a mix of hydrocarbons are present in the sample, the measuring equipment requires a detector possibly equally sensitive to all types of compound. Mod. 529/T Total Hydro Carbon monitor has been studied, developed and manufactured to monitor the Total fraction of Hydro-Carbons (THC) in ambient air samples.

PCF Elettronica's FID detector is very well known for its stability as well as for its low maintenance in the time.

It's generally known that organic compounds in hydrogen flame ionise. The quantity of carbon ions generated are proportional to the total quantity of carbon passing through the hydrogen flame.

The carbon (methane) equivalent concept.
In the environment there is very high number of different organic compounds so the response of the instrument detector cannot be referred to a single compound. The measurements must be considered in terms of equivalent response, .i.e. the response of the detector is "normalised" (referred to) to a single compound.
The characteristics of FID detector, i.e. approximately proportional to organic carbon concentration in the sample, makes the purpose easy. At first approximation the same concentration in air of compounds with different carbon atom number responds proportionally to the number of atoms in the molecule, so:

Concentration ppm	Species	FID response
1	CH4	1
1	C2H6	2
1	C3H8	3
1	C6H6	6

In other words, once the instrument response is *normalised* to *methane* (or carbon) *equivalent*, 1 ppm of propane will approximately generate a signal as 3 ppm of methane (actually the signal is not exactly three times but more likely 2.75 times).

Please check on the attachments the full list of response of the most common hydrocarbon compounds to FID detector.

1.1 INTRODUCTION

The present manual includes the following sections:

- general description of the analyser component parts
- description of commissioning start up procedure
- thorough description of firmware
- analyser maintenance procedure
- trouble shooting.

The in built firmware that controls the analytical cycle is fully described, the CONFIGURATION MENU should not be entered but left to service purposes.
The operative functions, the status, the temperatures as well as the analytical data are managed by an industrial micro processor, while the analytical programs is permanently recorded on EEPROM.
Thanks to a "*MMC Card"* built in the instrument, showing a minimum capacity of 512 Mbytes; access to the cards it's possible from the front panel door:

Such instrument firmware allows data banking for all analytical data, these can be successively downloaded through the RS 232 serial connection.
Up to four analogue 0-1 Vdc or 4-20 mA signals, relevant to the concentration of four components are available on the analogue output PCB for Mod. 529/T THC monitor only one of these analogue outputs are in use.
A LCD graphic digital display shows the analysis progress, the instrument operating status, the measured values, the recorded menus, that may be selected by the front panel key board, according the need and the variables of analytical program as well as the actual output of FID signal.

2.0 OPERATING PRINCIPLE

The PCF Elettronica's Mod. 529/T Total Hydro Carbon monitor detects and records total concentration of hydrocarbons (also referred to as VOC) in a wide range of ambient conditions without any possibilities of water condensation or limitation in the ranges, from few tens of ppb up to hundreds of ppm.

The instrument can be either employed in automatic monitoring systems or in a transportable version for air quality monitoring.

The basic analytical cycle is capable to measure continuously THC (Total Hydro Carbons, i.e. any type of hydrocarbon compound present in the environment), in a discrete sampling mode. The full analytical cycle is calibrated through traceable gas cylinders. A pulling membrane pump fills a capillary (sampling loop), whose content is cyclically injected directly into the FID detector. Cyclically a fix quantity of air sample is directly injected into FID to detect the Total-Hydro-Carbons (THC), the chromatogram schematic given later is representative of the FID response in time.

The Flame Ionisation Detector (FID) is base on an hydrogen micro flame, where the organic compounds are oxidised and a correspondent amount of ions are produced. The detector is therefore insensitive to the compounds structure and the generated ions quantity is just proportional to the carbon amounts present in the sample.

The actual procedure for the detection of carbon atoms in the sample foresees the mixing of the combustion hydrogen with the sample flow; this mixture is successively burnt in a micro flame with oxygen excess (hydrocarbon free air in large stoichiometric excess).

The electrical charges, generated by the combustion of the organic substances in gas sample are collected by two polarised metallic electrodes and converted in electrical current. Successively these ionisation micro-currents are converted in an electrical circuit into voltage drops directly proportional to the currents generated in the flame.

The values obtained by the above describe procedure are managed by the electronics then showed on a digital display as well as made available at the outputs as analogue signals for local or remote recording and control.

The same concentration values are available through the RS 232 serial port and, memorised on a Flash Memory in built in the instrument, may be downloaded via RS-232 to a remote data collection device. The full capacity of the in built Memory card is higher than 512 Mbytes.

3.0 TECHNICAL SPECIFICATIONS

- Active range : 0-10,000 ppm (mg/m^3)
- Measuring ranges THC : (six ranges 0- 10/20/50/100 /200/500 ppm) (others available on request, within the active range)
- Units : ppm or mg/m^3
- Background noise : 0,01 ppm
- Lower Detectable Limit (LDL) : < 0.02 ppm
- Zero stability (24 hours) : < 0.01 ppm
- Span drift (24 hours) : < 0.02 ppm
- Measuring cycle : 30 seconds
- Response time : 30 seconds
- Linearity : better than 1% full scale
- Precision : ± 0.5 %
- Sample flow rate : 500 ml/min
- Operating temperature range : 0 - 40°C
- Display : 640 x 200 pixel colour LCD graphic display touch control.
- Information on display : Zero level
  : Controlled Temperature Chamber temperature
  : Date and Time Chromatogram
  : Performed analysis number
- Instrument configuration : from front panel
- Analogue outputs THC : 0-1Vdc/4-20 mA
- Serial outputs : RS 232 (9 pin connector) Configurable either for remote connection or for local printer connection

- Zero drift		: automatic compensation
- Zero/Span		: set from front panel and/or remote control
- Services	Hydrogen	: 25- ml/min
	Pure Air	: 250-300 ml/min
	Service Air	: 4.5 Bar (63 psi)
- Calibration gas cylinder		: 7 ppm CH_4, air balance (proportionally higher for ranges higher than 10 ppm)
- Sampling pump		: WISA WIDO
- Mounting		: standard 19" rack and/or transportable bench top
- Dimensions		: 480x250x560 mm (19"x10"x22", WxHxD), 5U
- Weight		: 15 Kg
- Standard power supply		: 230/110 Vac 50/60 Hz (to be specified in order)
- Power consumption		: 300 VA
- Pneumatic connections		: 1/4" or 4/6 mm and 1/2 mm

3.0 FRONT PANEL DESCRIPTION

The front panel (see above figure) shows on the right hand side the touch screen colour video graphic display as well as control key board. The operator can freely chose either to use the control key board or the touch screen facility. In the latter case we suggest to touch the screen either with a finger or with a stick (wood or plastic).

Access to the manometer set with relevant pressure reducers to allow the setting of instrument service gas pressures is allowed through a small door on the left hand side of the panel. Along with manometers and pressure reducers the gas chromatographic column by pass valve is also available (whenever needed).

The **H_2** (hydrogen) manometer gauge, as combustible gas for the FID flame, is located on the left hand side; the **Air** gauge (air to FID), as the combustion gas for the flame, stays in the middle and, finally, the **Carrier** gas gauge, for the regulation of the carrier gas through the chromatographic column (whenever present) can be found on the right hand side.

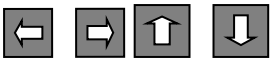
On top of each gauge a trimmer allows the regulation and setting of the gas pressures.

Please remember that pressures/flows are connected to FID response and therefore to calibration.

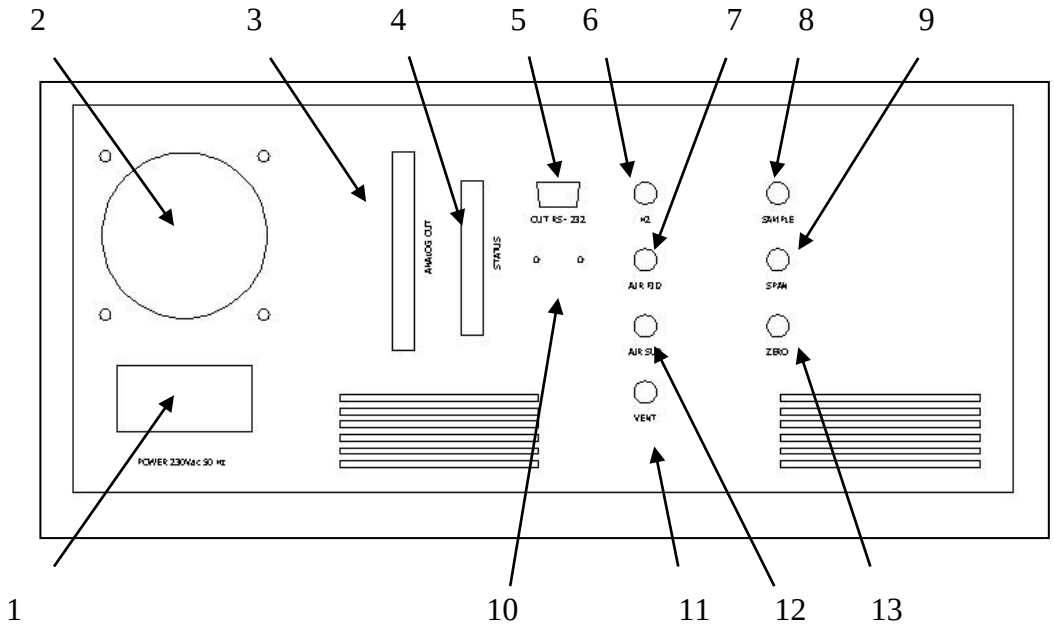
Keep the setting of the pressures/flow as much constant as possible, better if at the same value indicated in the FINAL CHECK RECORDS supplied with each instruments.

By opening the left hand side door access to MMC memory card slot is allowed, on this card analytical data, instrument set up and analytical method, that supervises the automatic procedure of desired analysis. This card can be extracted and easily read by any reading support connected to a PC.

The key board is located on the lower part of the panel. As the implemented software is realised according to the menu driven procedure, the keys are reduced to a limited number:

- Four arrow keys  allow the cursor movement through the different menus.
- The **ENTER** button (or CONFIRM), to confirm the choice made by the operator.
- The **NO** button (or ABORT), to skip any wrong selections.
- The **PROG** button allows access to the PARAMETERS configuration menu.
- The **IGN** button allows the manual switching of the flame.

4.0 REAR PANEL



The rear panel (see figure above) includes the following items:

1. Input Power supply, 220/110 Vac, 50/60/Hz, 3 pin socket (1).
2. Cooling fan (2).
3. Analogue signal output standard 13 pin female Cannon connector (3).
4. Instrument status and alarm output standard 25 pin male Cannon connector (4).
5. RS-232 output, standard 9 pin female Cannon connector (11).
6. H_2, input of hydrogen supply from U.P.P. gas cylinder or hydrogen generator (6).
7. FID AIR, gas connection for FID air supply (7).
8. SAMPLE IN, gas connection for the sample gas input (8)
9. SPAN, gas connection for the calibration gas input (9)
10. F.I.D. OUTPUT, Flame Ionisation Detector analogue output gas connection for discharge of sampled gas (10).
11. VENT, gas connection for the gases coming out of detector (11),
12. AIR SUP, gas connection for service air (5 Bar), intended for auxiliary services, pneumatic controls, automatic sampling valve etc. (12).
13. ZERO AIR, gas connection for Zero air supply, same as FID AIR (13).

6.0 INSIDE VIEW

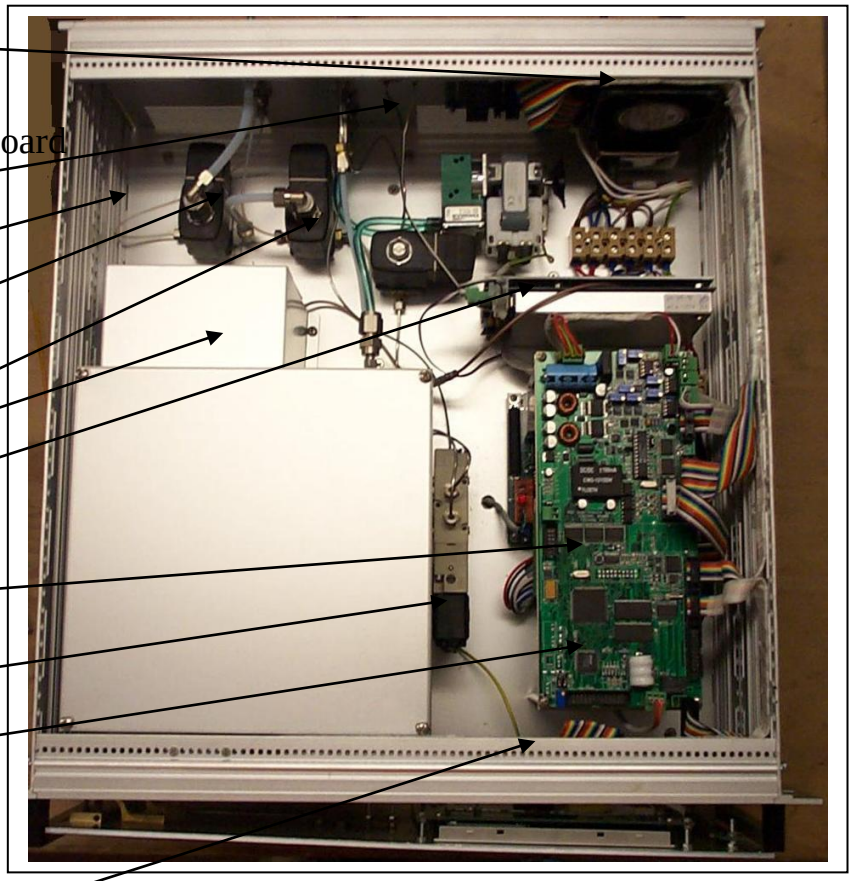
The great development in the field of integrate circuits, thanks to the use of very high integrated chips, has dramatically reduced the room occupied by electronics that manages all the instrument firmware. Inside the instrument we find the main Mother Board located on the left hand side, while the PCB carrying key board and LCD display is on the inner front panel, on the rear the PCB with all status and alarm signals, the analogue outputs and the connectors for remote connection.

The electrometer, the only electronic part that differs from the core electronics as it is a very high gain analogue amplifier, is located on the right hand side of equipment (as near as possible to FID detector).

The analysis chamber is the part that takes the largest room inside the instrument. It is located in the corner between the bottom and the right hand side and takes one third of the whole instrumental room. Within the chamber the whole analytical circuit, the chromatographic column, the sampling and gas flow rate control capillaries, the ten port rotation valve as well as the FID detector are positioned.

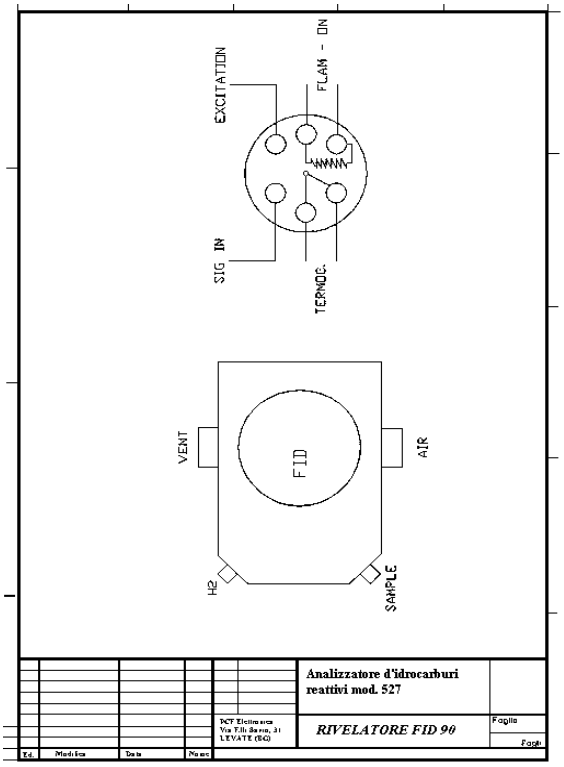
In case of hydrogen as carrier gas is selected the thermally controlled analytical chamber will be continuously flushed with ambient air.

1) 230 Vac 50 Hz
   Power supply connector
2) Analogue & alarms output board
3) Zero EV
4) Span EV
5) H2 intercepting EV
6) FID Detector
7) Electrometer
8) Motherboard
9) Inject e back flush EV
10) Motherboard



11) Electric trafo and e aux. serv. board (located under the mother board)

6.1 FLAME IONISATION DETECTOR (FID)



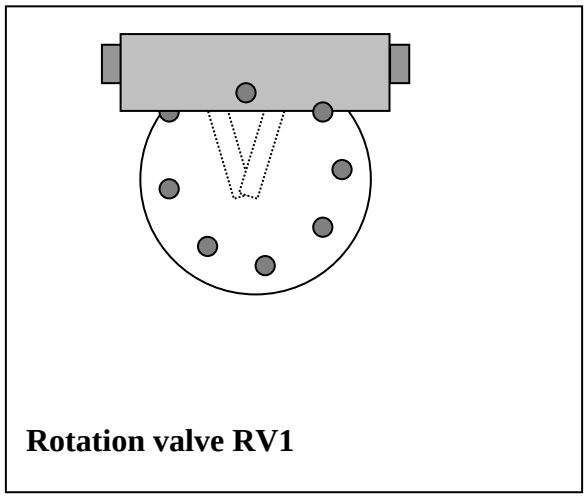
The FID is the core of the NMH analyser.

It shows a central nozzle that receives through a capillary hydrogen, about 25 ml/min, again through a capillary the nozzle is reached by the carrier gas carrying the sample compounds. The nozzle is polarised, from an external power supply by a positive voltage of 300 Vdc with very low electrical currents. A metallic ring on the top of the nozzle collect the ionisation current and takes it to the input of electrometer circuit. An air flow rate of about 230 ml/min, controlled by a third capillary, is supplied to the detector as combustion gas. The quality of the combustion air must be very good (carbon content lower than 0.1 ppm) and stable in the time, with the risk of jeopardising the measurements qualities.

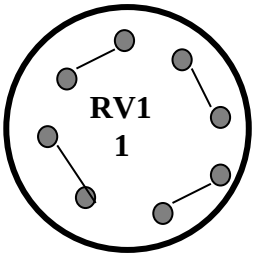
Inside the detector are further located a Nickel spiral for the automatic switching of the flame as well as a thermocouple that detects when the flame is ON or OFF therefore command the automatic switching off the hydrogen flow when the flame is OUT.

The amplified FID electrical signal may be measured and/or recorded on strip chart recorder from 30-27 pins (normalised 0-1 Vdc signal).

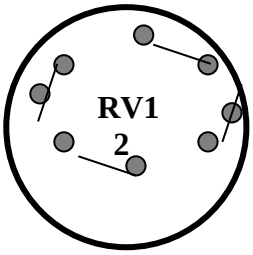
6.2 BIMATIC ROTATION VALVE



Rotation valve RV1



Sampling phase



Injection phase

The mod. RSV 108-8 high temperature valve is an 8 port rotation valve, specially designed, developed and manufactured by PCF Elettronica, intended to interconnect the pneumatic circuits at controlled temperature (some 80°C).

The switching is performed by compressed air piloted by a 4 way solenoid pilot valve and is dedicated to the automatic sampling of the sample.

In the description pneumatic circuits the two different positions, i.e. exited and not excited, the sampling and the injection phase respectively, of commutation valve in the different phases of analysis are shown.

7.0 WORKING MODE

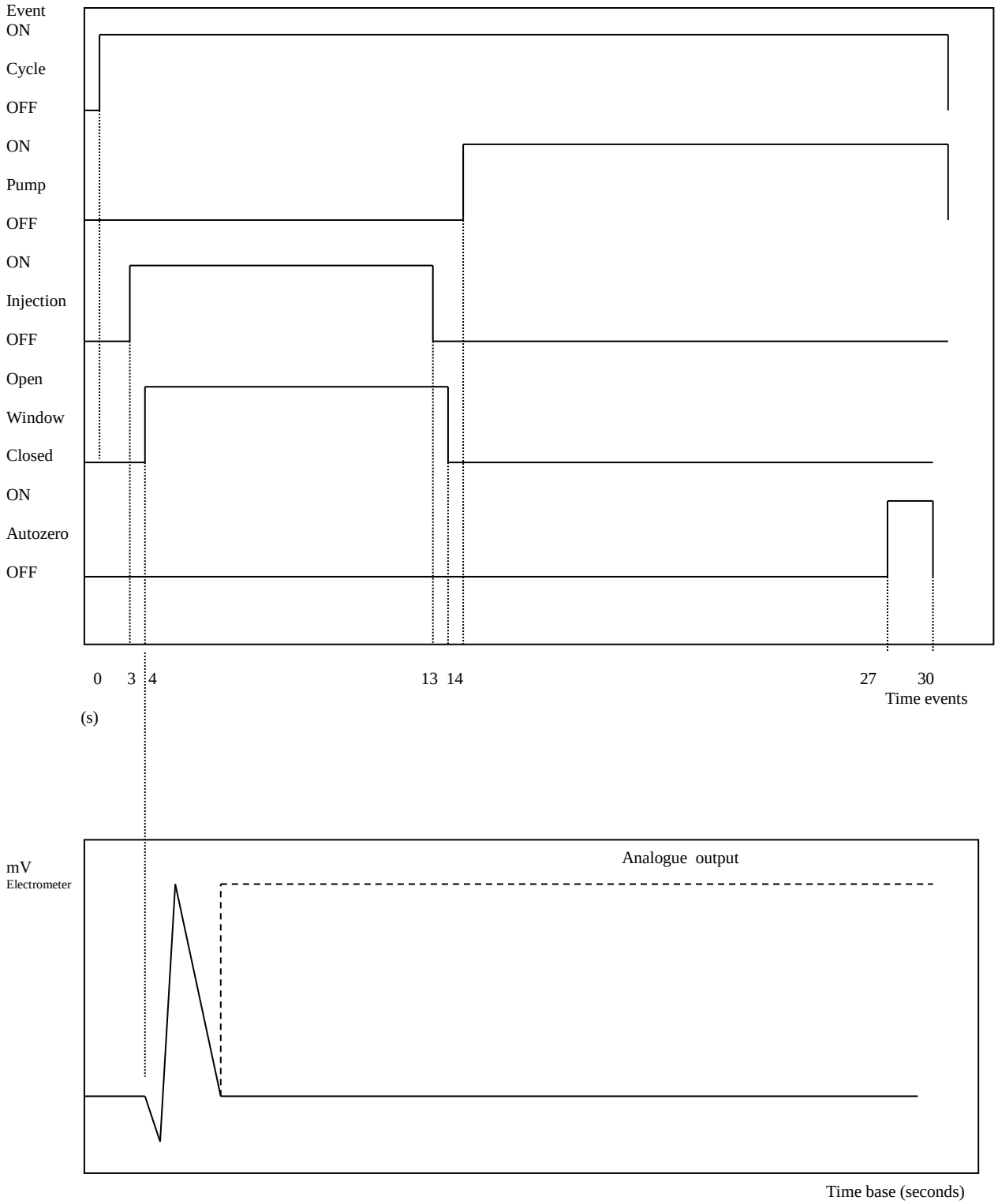
Basically the sucking pump fills the sampling loop (0.6 ml) and cyclically the carrier gas (air) by rotation of the eight-port valve inject the sampled quantity into the FID.
The instrument is intended to work with ambient air samples, therefore no water condensation conditions should be possible. In order to avoid any condensation the sampling eight port valve is kept at controlled temperature (usually at 80 °C) All the parts inside the instrument in contact with the sample are in resistant material (Teflon and SS).

The operating phases
In the below table the fundamental operations of the instrument are outlined:

- F1 = Cycle length (not modifiable)
- F2 = Sampling pump
- F3 = Auto Zero
- F9 = Inject
- F10 = Not in use
- F11 = Not in use

Step	Elapsed time (s)	Event	RSV2 position	Gas flow	Electrometer output
	0	Cycle start			
Phase 1 Sampling phase	0 to 4 seconds		Base position 1-2 3-4 5-6 7-8 ports connected	Sample gas flows through sample loop and then the pump or air ejector. Carrier gas flows into the FID detector	Nearly zero.
Phase 2 Injection and integration phase	4 to 14 seconds	Sample injection Back flush of sampling line	Active position 1-8 7-6 5-4 3-2 ports are connected	Sample gas flows directly to the pump or air ejector Carrier gas flows through sampling loop and then to FID detector	At the injection a small undershoot of electric signal then a peak, whose area is proportional to total quantity of carbon content in the 0.6 ml sample The electronics out put signal is continuous updated at every injection and peak integration
Phase 1 Sampling phase	14 to 27 seconds 27-30	Flushing of FID detector Auto-zero	Base position 1-2 3-4 5-6 7-8 ports are connected	Sample gas flows through sample loop and then the pump or air ejector. Carrier gas flows into the FID detector	Nearly zero.
	30	Cycle end			

These steps in a time base diagram can be summarised as follows:



Flows of gases
The flows of gases are schematised in next two figures, the sampling and the injection phase respectively:

Phase 1: gas sampling

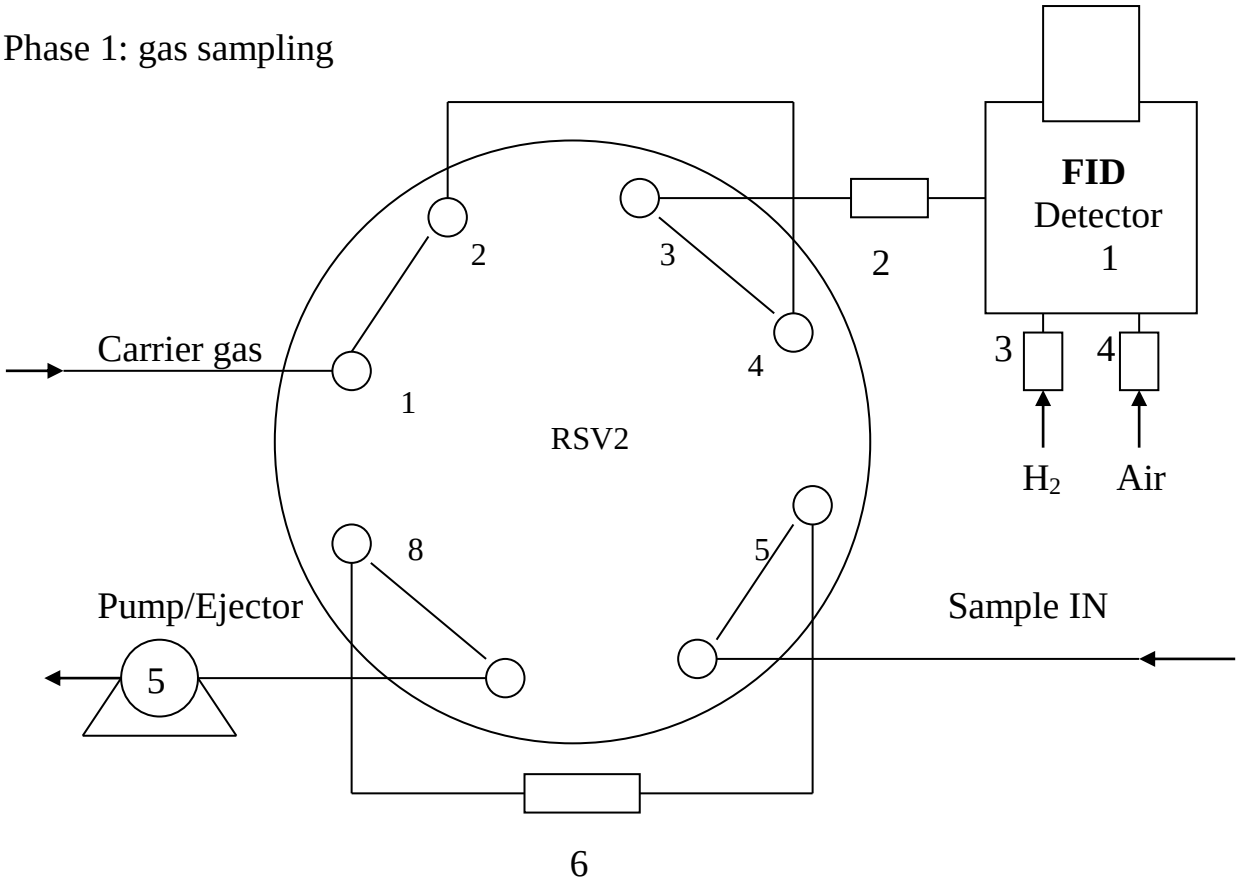


Figure captions:
1- Hot FID detector
2- Carrier gas capillary
3- Hydrogen gas capillary
4- Combustion air capillary
5- Sampling pump/ejector
6- Sampling loop (0.6 ml)

Phase 2: sample injection

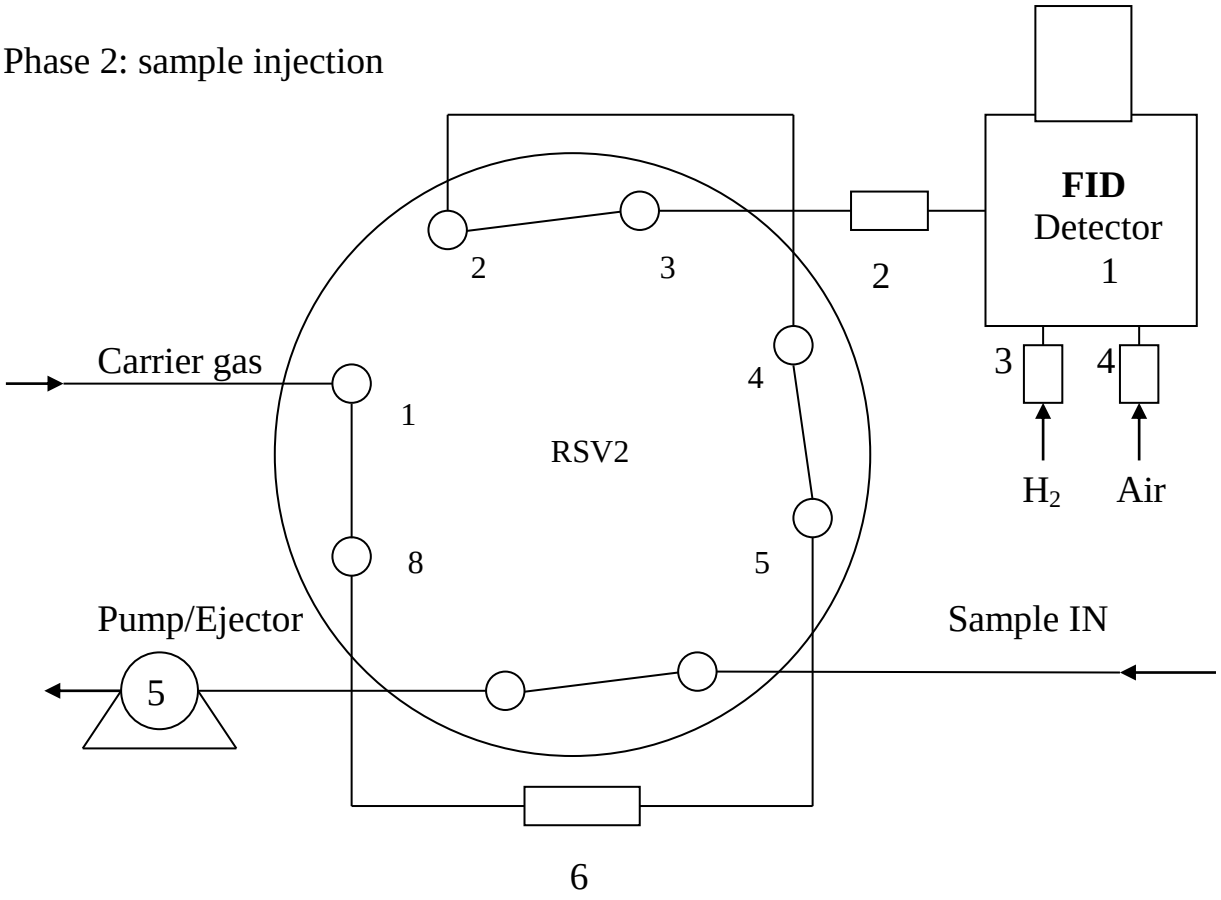


Figure captions:
1- Hot FID detector
2- Carrier gas capillary
3- Hydrogen gas capillary
4- Combustion air capillary
5- Sampling pump/ejector
6- Sampling loop

- "**ZERO**" check is performed by introducing a sample free from carbon compounds.
  As a carrier gas is employed ultra pure AIR (an air with the content of carbon compound lower than 0.1 ppm), it is not required to introduce further air to check the ZERO, it's enough to keep the pump OFF, this operation introduces just U.P.P. carrier air filling the loops S1 and S2 respectively, free from any interference from external sample.

- "**SPAN**" Calibration/Check is performed by introducing in the circuit, by the activation of a special solenoid valve, the content of a gas cylinder of known concentration and repeating the described cycle operations. By operating on the key board, on the electronic regulators controlled by micro computer the sensitivity of the instrument can be adjusted (ADJ); the set sensitivity values are then memorised.

The versatility of user friendly firmware both from the analytical point of view and the program configuration, allows, by choosing the suitable chromatographic column and the relevant software program to detect specific compounds both in air quality monitoring and at emissions. This is a great advantage with respect to the instrumentation actually available on the market.

8.0 FIELD COMMISSIONING AND INSTRUMENT START UP

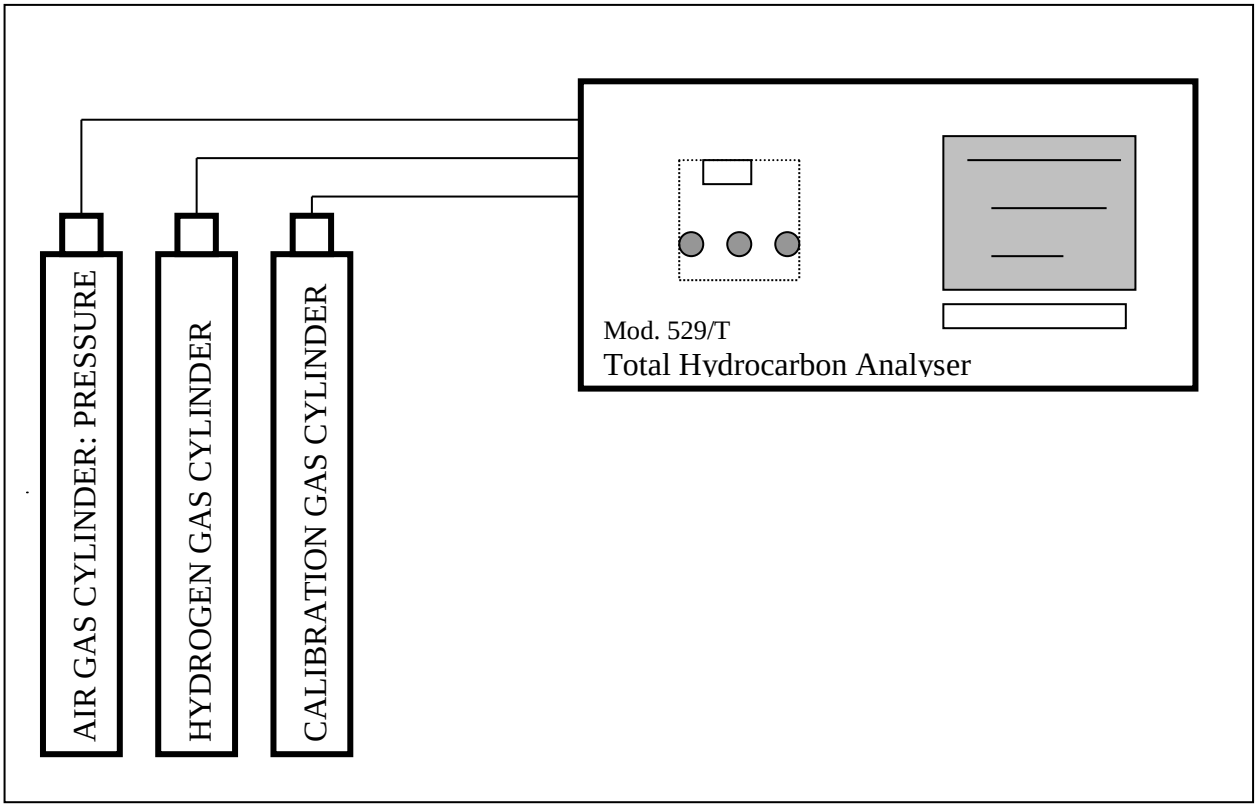
- Connect the plumbing between the cylinder gas pressure reducers and the relevant gas connectors located on the analyser rear panel and indicated as Hydrogen, FID air, Air Sup(ply).
- Connect the power cord to the main power supply (220/110 Vac, 50/60 Hz, 300 VA.
- Open the cylinder interception valve and regulate the relevant output pressure from cylinders as follows:

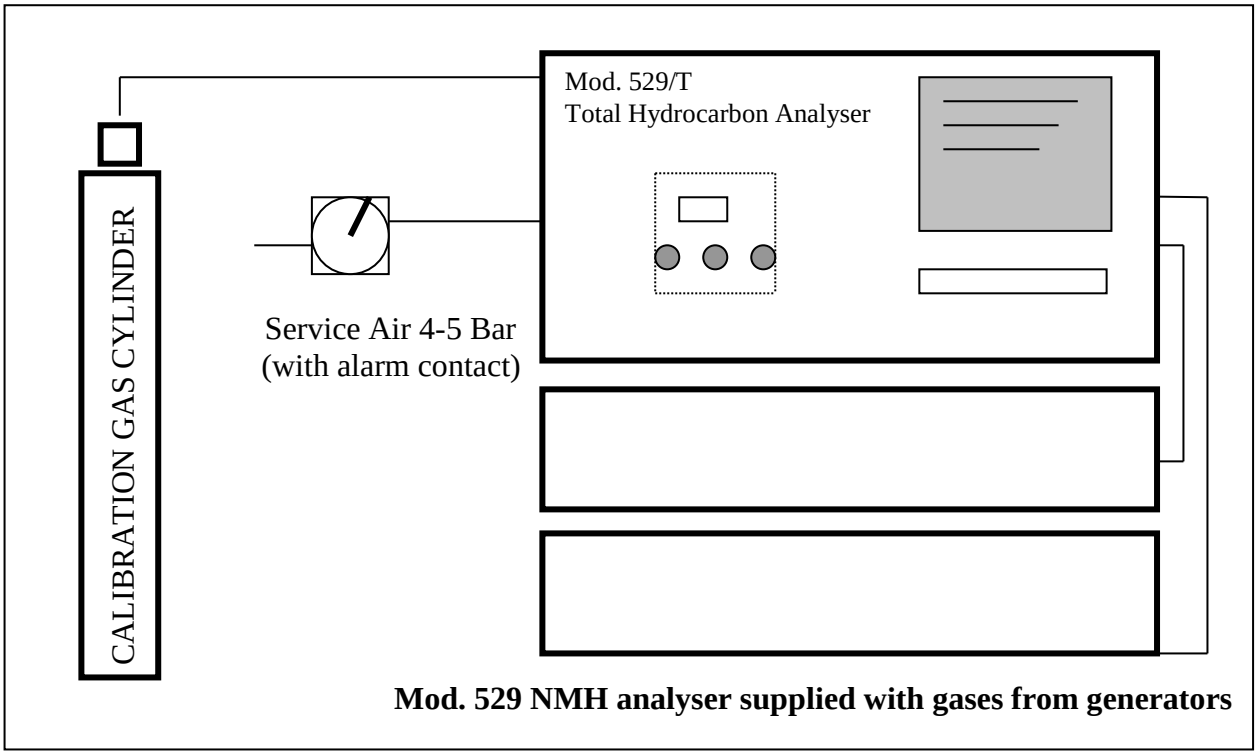
  pure Air 4-5 bar,

  hydrogen 2 Bar,

  if for the servo commands a separated compress air is used, regulate it to 5 Bar.
- The relevant pressure on the manometers located on the instrument front panel, instead, must be set according to the values indicated in the instrument final check card, that goes with each instrument. Please note that the pressure of H_2 is only visible in the condition of **FLAME ON** or the **IGN** push button pressed.
- Switch the Power switch, on the rear panel of the instrument, in to position **ON** (indication I), now the instrument is **ON**, the display is **ON**, the start up procedure is running and the working display is on the screen.
- Press "**ENTER**" push button, the heating procedure of analysis chamber is started.
- As the instrument reaches the temperature set it starts the control of **FLAME ON**, if the flame is off the **FLAME OFF** condition is displayed.
- In the status of **FLAME OFF** press **IGN** switch button, set the hydrogen pressure to the value indicated in the final check record. Wait about 20-30 seconds.
- When FID flame in **ON**, the instrument enter into the **STAND-BY** mode and the red LED on top of **IGN** push button stays off.
- In case the red LED switches on, the instrument automatically shows on the display an alarm of **FLAME OFF** accompanied by a chime sound. In these conditions the flame is off. Repeat the operation described above to reach the **FLAME ON** condition ("**STAND-BY**" will be on the screen).

- If on the display any alarm messages are shown, as long as all alarm conditions are not erased the indication "**STAND-BY**" will not be displayed.
  NOTE: in occasional conditions, it is necessary to reduce drastically the carrier gas pressure to switch on the flame.
- Once the flame is **ON** wait for 10-15 minutes then take the Sample (Carrier) manometer to pressure set written in the enclosed final check record.
- Wait further 5 minutes then press the push button **AUTOZERO**.
- Then press "**ENTER**" push button. The instrument starts the analysis cycle(s).





Mod. 529 NMH analyser supplied with gases from generators

9.0 IN BUILT FIRMWARE

(Do not use the part screened)

At the switching on the front page (**home page**) is displayed.
From this **basic level** the operator can operate on three options.

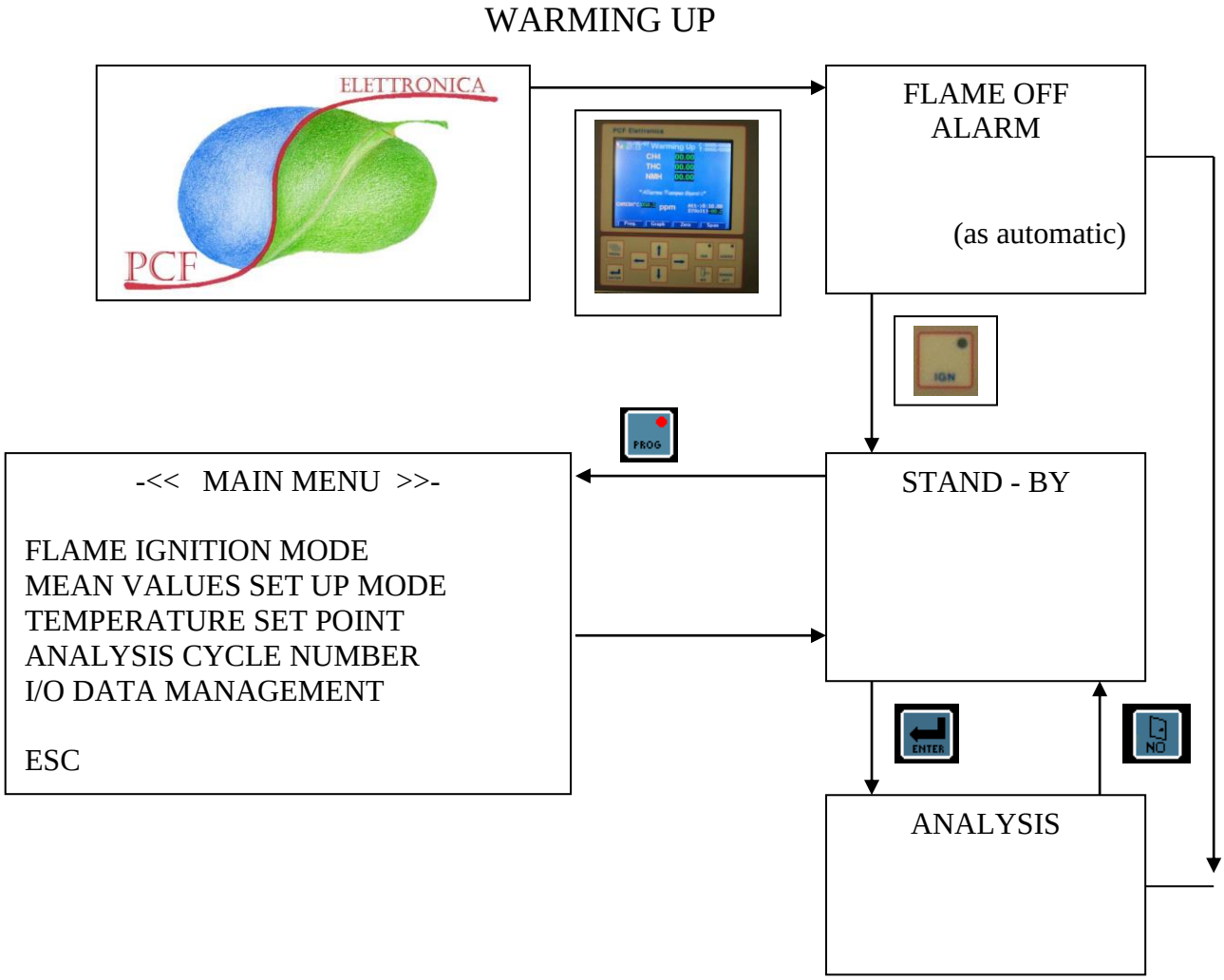
- As first option, press **ENTER** button, starts the conditioning (warm up) procedures (about 10 minutes), the running video display is shown.
  At this point the FID flame must be ignited:
  i) If the instrument is in MANUAL mode, the FID flame must be ignited manually by pressing IGN push button.
  ii) Otherwise when the instrument is in AUTOIGNITION mode, FID flame is ignited automatically.
  As soon as the flame is ON the instrument enters into the STAND-BY condition, by pressing **ENTER** the analytical cycles are performed.
- As second option, press **PROG** button, gives access to the "**PARAMETERS**" menu, that allows setting of all process variables required for the automation of the analysis.
- As third option (**do not enter this section of menu unless strictly necessary**), for access press in sequence all four arrows (see "MENU GENERAL STRUCTURE, sec. 9.1, described later on), allows access to "**CONFIGURATION**" (CONFIG) menu, where all working parameters of the instrument are available, e.g. analytical program, instructions to peak integration, measuring room temperature and base line linearity, modes and **I/O** controls.

Attention! The modification of parameters included in the **CONFIG** menu may cause a variation in basic analytical mode, in retention times, in area integral calculation, in temperature linearity curves. We suggest to avoid any access or variations in "CONFIGURATION" menu without previously contacting PCF Electronica's technical service, reporting difficulties and/or necessities.

9.1 MENU GENERAL DESCRIPTION

At the switching on of the instrument the basic display (LOGO page) is shown on the screen including the PCF Elettronica's logo. From this level it is possible to

i) switch ON the flame and perform analysis,
ii) have access to "**PARAMETERS** " or
iii) "**CONFIGURATION**" menu, as indicated here below (home page).

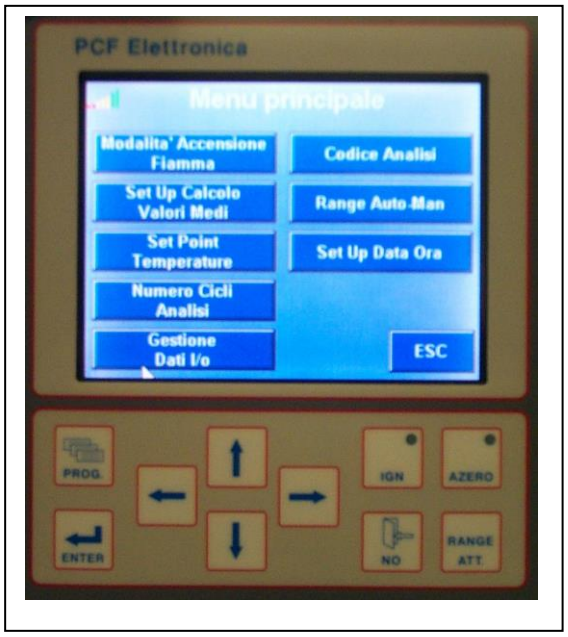


- Access to "MAIN MENU " by pressing "PROG" push button.
- To start he analysis procedure press "ENTER" push button.
- To return to home page (basic videata) "NO" push button must be successively pressed.

9.2 PARAMETERS MENU

From HOME page by pressing "**PROG**" button the program enters into "MAIN MENU". As usual if the instrument is performing regular analytical cycle, it will conclude the cycle, then on the screen the FRONT page will be shown:

- ☐ FLAME IGNITION MODE
- ☐ MEAN VALUES SET UP MODE
- ☐ TEMPERATURE SET POINT
- ☐ ANALYSIS CYCLE NUMBER
- ☐ I/O DATA MANAGEMENT
- ☐ ANALYSIS CODE
- ☐ AUTO/MANUAL RANGE
- ☐ DATE/TIME SET UP MODE

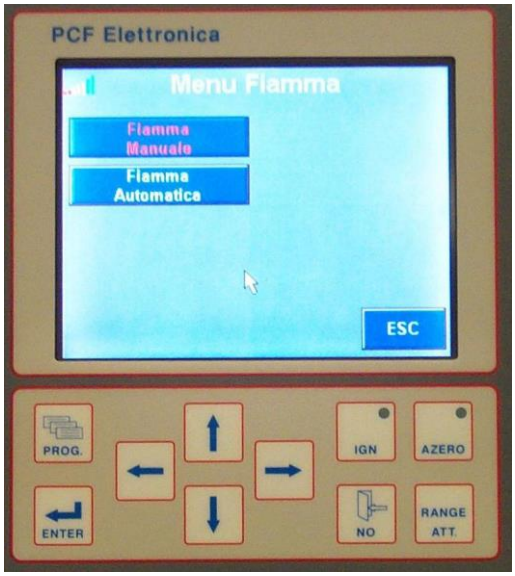


The "MAIN MENU" options are selected either by touching with a finger (wood or plastic stick the relevant option on the screen (touch screen) or by moving the cursor up and down on the display with arro⇩⇧s confirming, as from figure, by **ENTER** button once selected the desired function

AUTOMATIC FLAME IGNITION (only if the instrument is programmed for) "optional"

This option allows to configure the instrument for the automatic mode of FID igniting.

If manual FID flame ignition is selected, operator must follow the steps previously indicated in sect. 8.0 of the present manual. Otherwise if the automatic flame ignition is selected, the instrument, following the automatic operations (as previously described in 8.0 section) the firmware will both ignite automatically the FID flame and start the analysis procedure.



In case of mains POWER OFF, the instrument, in the "AUTOMATIC" configuration, at power on conditions will ignite the flame and start the analysis cycles.
The "AUTOMATIC" flame ignition procedure foresees 5 flame ignition attempts. After five attempts if the flame is still OFF the instrument stops any further attempt and will show a flame OUT alarm. An intervention in the field of operator to start again the instrument will be required.

MEAN VALUES SET UP MODE (AVERAGING)
This MENU function allows to select an averaging time for the measured values.
The operator will set the interval time (in minutes) in the relevant window as well as activate the function.
Whenever this function is activated, at the end of the set interval time, the software will compute the mean value of each measurements and it will memorize them in a special text file of MMC card, easily down loaded into an electronic file.

TEMPERATURE SET POINT

As the analysis are performed in constant temperature condition, this configuration allows to set the chamber temperature of the gas chromatographic column.

ANALYSIS CYCLE NUMBER

This option allows the setting of finite number of analysis. The activation of this option makes visible on the display the analysis number performed by the format "**N. AN.: XXXX**"; as the instrument reaches the set value of analysis, the "**STAND-BY**" condition will be active.
By digiting "0000" the number of cycles performed by the instrument will be infinite, i.e. the instrument will run continuously. By pressing, during the operation, the "**NO**" key the instrument, at the end of the current cycle, will enter the "**STAND-BY**" condition. To start the continuous cycling press **ENTER** button, the instrument will start working continuously

I/O DATA MANAGEMENT

This option allows access to the I/O data management menu. It includes a second step menu with four choices::

- ☐ PRINTER MANAGEMENT
- ☐ DOWN LOAD CONFIG
- ☐ SAVE CONFIG
- ☐ ERASE ANALYSIS FILES

The first choice, PRINTER MANAGEMENT, allows the down loading of analysis data on the printer through the RS232 serial port.

The second choice, DOWN LOAD CONFIG, allows the down loading (whenever present on MMC card) of a new analytical recipe. Analytical recipes can be memorized on MMC card. In this way the same instrument can easily be reconfigured for different analysis (applications).

The third choice, SAVE CONFIG, allows the saving of default configuration, whenever some modifications have been carried out (normally this choice is not used by operator).

Mod. 529/T analyser saves automatically, in a text file memorised on the MMC card, all analytical data as well as calculated mean values.
The forth choice allows the erasing of useless files.

AUTO/MANUAL RANGE

It's possible to select auto ranging mode for the analyser. By selecting this option the analyser will change automatically the measuring range, by reducing the amplification coefficient, whenever a single component reaches the full scale value. Vice-versa the analyser whenever all measured components are lower than 5% of actual measuring range the analyser will reduce automatically the range by increasing the amplification coefficient.

DATE AND TIME SET UP

The selection of this option makes possible the updating of date and time. This operation is very important for a correct data banking of data on flash memory; successively for a correct reading and interpretation when analytical data are downloaded on Personal Computer or any other Data Base.

9.3 ANALYTICAL START UP

As the instrument is switched ON it starts a series of initialisation processes followed by WARM UP procedure. Within this phase the analytical chamber is warmed up to set temperature and conditioned (the set up of chamber temperature was described in 9.3 chapter).

Within the warm up phase it's possible by pressing "PROG" push button, either on display (touch screen) or on key board perform the desired set ups according to the described options of "MAIN MENU", see previous chapter.

During this warming up phase it is not possible to perform any operations, but returning to the front basic page by pressing **NO** button.

As the instrument reaches the temperature set values, it performs a FLAME ON check, eventually signalling the case of FLAME OUT condition; if the H_2, FID Air and CARRIER gas pressures are correct, according to the values reported in the **factory test certificate**, operator may proceed to the flame ignition by pressing IGN key located on the upper part of key board.

With the FLAME ON condition and with no alarm conditions whatsoever the instrument shows on the screen the page "**STAND-BY**". Press **ENTER** button to start analytical cycles.

Whenever any alarm conditions are present it is mandatory to trouble shoot the alarm causes in order to resume the monitoring procedure.

If the instrument has been programmed for continuous working mode (see section 9.2 for analytical cycles numbers), the analysers performs continuous analysis up to, by pressing **NO** button, the operator interrupts the measuring operations; at this point, completed the current analysis, the instrument returns in the "**STAND-BY**" condition.
If the automatic ignition mode was selected (the instrument must include this option), there is no need to perform any operations to bring the instrument in the full working conditions, as, once reached the temperature sets and performed no alarm condition checks, the instrument ignites the flame and starts the analytical cycle by passing the "**STAND-BY**" condition.
If a finite number of cycles were programmed, the instrument, once carried out the programmed number of analysis, returns in the "**STAND-BY**" condition, while whenever the **NO** button is pressed the instrument stops once terminated the current analysis; with a new **ENTER** command it starts counting the analysis cycles from the beginning. As the analysis are performed operator can check the status on the display as well as the cycle counting on the top left hand side of display.
On the LCD video display the voltage level at the electrometer output, the selected range with relevant measuring unit, as well as the actual working and possible alarm conditions occurred during the operation are shown.

10.0 ANALYSER CALIBRATION

Whenever either a check of or a full calibration is required the instrument must be in the **analysis mode**. Only with the instrument in analysis mode the "**SPAN**" and "**ZERO**" function can be activated.
In order to start these procedures the relevant icons must be selected on the lower part of the screen by moving around with **arrow push buttons**.
If the "**ZERO**" or "**SPAN**" command is selected the instrument performs the given command at the end of the current analysis cycle.
Whenever the **NO** button is pressed the instrument enters in "**STAND-BY**" condition only at the end of the current analysis cycle, aborting the selected procedure either of "**ZERO**" or "**SPAN**".
Always press **ENTER** button to resume the monitoring cycle.

10.1 "SPAN" CALIBRATION PROCEDURE

The instrument is on line; it is working regularly on sample gas.

1- Connect to “SPAN”, on the rear panel of the instrument, the calibration gas source, namely gas cylinder, permeation tube or multipoint calibrator.

2- Open the valve of calibration gas cylinder and check/regulate a flow of 20-40 ml/min that is getting out of “VENT” output on the rear panel of the instrument. Better if the calibrating gas mixture is in the vented conditions: i.e. a **T** connection with slightly low over flow.

3- From front panel display select “SPAN” procedure, by touching the icon on the screen.
At the end of running analytical cycle the instrument enters the calibration procedure and start a new analytical cycle.

4- Select the correct measuring range to cover calibration concentration values by relevant push button.

5- Press “ENTER” push button and set the calibration concentration values (the certified values reported on the gas cylinder) confirming them by pressing “OK” icon on screen.

6- Operator must wait 3-5 full analysis cycles. Then as on the display “press PROG for calibrating” will be shown., by pressing “PROG” push button the instrument will compute automatically the correcting factors and the measurements will be shown according to the new values of calibration.

7- The new calibration has been concluded. Press “NO” and the instrument will exit the Span Procedure and re-enter into the analysis.

8- The calibration gas source can be closed.

Example:
Gas cylinder contains 7 ppm of CH_4, air balance.
The suitable range can be 10 ppm full scale.

The regulations of amplifier gain level (*allowed only within the calibration procedure*) must be carried out in order to set calibration values shown on the display according to the certified traceable gases.

The "**SPAN**" regulations (gain adjustments) on the relevant channel are carried out by selecting channel number relevant to each compound by pressing **ENTER** button, then employing the arrow keys (**UP** and **DOWN**) to set the amplification value.

The gain factor shown on display allows an amplification value between value 1 when is set on 01.00 and value 10 if set at 10.00; the ratio is fully linear.

NOTE: do not go with the amplification value lower than 01.00 as it would mean a gain factor lower than 1.
At the end of calibration procedure **shut** the calibration gas cylinder.

10.1 "ZERO" CALIBRATION PROCEDURE

Select the "ZERO" check procedure; once the instrument carries out the current analysis cycle, with the new analytical cycle the instrument enters into "ZERO" mode.

The "ZERO" mode consist in a certain number of analysis in "Blank", i.e. a UPP air is introduced into the chromatographic column, that exactly the same air used as carrier in order to evaluate the base line behaviour with no sample in the instrument.

The "ZERO" regulation on the present type of chromatograph does not make sense, as the auto zero function carries out an instrumental zero before any analysis.

11.0 ANALYSER MAINTENANCE PROCEDURE

(CONCISE INFORMATION, EXTENSIVE INFO IN THE SERVICE MANUAL)

All the operations described in the present section must be performed with main power supply to the instrument OFF (disconnect the mains plug) and with the H_2, Air, Span, Service gases intercepted by the main manometers on the gas cylinders.

REPLACEMENT OF INPUT SILICA WOOL FILTER

- Open the measuring chamber. If the instrument is just switched off wait for the cooling down to about room temperature.

- With an 8 mm spanner disconnect the silica wool holder "F" inserted between the "sample-in" connection and the "U2" SPAN solenoid valve.

- Open the filter older by employing two 17 mm spanner; either replace the steel sintered filter or wash it in a ultrasonic bath with a solvent at 80°C. Mount back everything with great care taking special care to the tightness of the pneumatic connections.

- Open the measuring chamber. If the instrument is just switched off wait for the cooling down to about room temperature.

- Bring the analyser into measuring mode (again following the standard procedures previously described in this manual) and leave the instrument to work for about an hour without performing any setting.

- Perform a calibration check and eventually adjust the Calibration values. ….

11.1 CAPILLARY FLOW RATE CHECK

The check of capillary flow rate is a very delicate operation, therefore it must be performed with the maximum care and attention.
The Capillary flow rate check is performed with the instrument ON and all the service gases connected and pressurised.

FID AIR capillary check
By employing an 8 mm spanner disconnect the 2 mm steel tube connected to FID detector through the "AIR" tagged input; then by a soap bubble flow meter and or by a digital flow meter check that flow rate corresponds to the value indicated in the final check table.
In case for the same air pressure the flow rate differs from the reported one in the check table restore the correct flow rate by varying the pressure of FID air operating on the relevant pressure regulator located on instrument front panel. If the correct flow rate cannot easily restored replace the capillary.
When the check is completed connect back the steel tube to FID detector.
In the operation of connecting the steel tube to the FID detector a special care and attention must be given to the correct screwing of the connection in order to both avoid any damage to the thread as well as to have a tight connection.
The tightness of all connection are fundamental for a correct working condition of the instrument.

CARRIER flow rate check
By employing an 8 mm spanner disconnect the 2 mm steel tube connected to FID detector through the "IN" tagged input; then by a soap bubble flow meter and/or by a digital flow meter check that flow rate corresponds to the value indicated in the final check table.
In case for the same air pressure the flow rate differs from the reported one in the check table restore the correct flow rate by varying the pressure of Carrier air operating on the relevant pressure regulator located on instrument front panel. If the correct flow rate cannot easily restored replace the capillary.
When the check is completed connect back the steel tube to FID detector.
In the operation of connecting the steel tube to the FID detector a special care and attention must be given to the correct screwing of the connection in order to both avoid any damage to the thread as well as to have a tight connection.
The tightness of all connection are fundamental for a correct working condition of the instrument.

H_2 flow rate check

By employing an 8 mm spanner disconnect the 2 mm steel tube connected to FID detector through the "**H_2**" tagged input. Then turn in the right direction (clock wise) Px trimmer located on the mother board till the **H_2** interception valve is active (take note of the turns required).

Then by a soap bubble flow meter and/or by a digital flow meter check that flow rate corresponds to the value indicated in the final check table.

In case for the same air pressure the flow rate differs from the reported one in the check table restore the correct flow rate by varying the hydrogen pressure operating on the relevant pressure regulator located on instrument front panel. If the correct flow rate cannot easily restored replace the capillary.

When the check is completed connect back the steel tube to FID detector, rotate Px trimmer located on the mother board (see service manual) to left direction (anti clock wise) of the same turn number till the safety solenoid valve opens again.

In the operation of connecting the steel tube to the FID detector a special care and attention must be given to the correct screwing of the connection in order to both avoid any damage to the thread as well as to have a tight connection.

The tightness of all connection are fundamental for a correct working condition of the instrument.

11.2 SUGGESTED MAINTENANCE SCHEDULE

Basically PCF's Mod. 529/T THC (Total Hydro Carbon) analyser is a very simple process gas chromatograph with tested parts to last years without maintenance.
The ten port valve, the most sophisticated part in the instrument, should last more than three years without maintenance.
For a good performance in the field it is suggested to commission the instrument since the beginning with the correct gas qualities and pressure as well as to check regularly its working conditions.

For a good commissioning of the instrument we recommend:
- standard tool case
- digital multi meter and
- strip chart recorder (0-10 Vdc).

Time	Operations	Actions (if necessary)
Commissioning	Check: Quality of ZERO AIR Power Supply Gas Supplies (quality and pressure) Service Gas pressure Analogue outputs	
Monthly	Sample flow	Replace or clean filters Front filter and/or Sintered filter
Every 3 months	Sample flow Membrane pump	 Rebuild pump
Every 6 months	Calibration check	Change coefficients
Every year	Retention times Check H2 capillary Air capillary Carrier capillary	Adjust retention times Replace
Every 3 years	Rotation valve	Maintain or replace

11.3 TROUBLE SHOOTING

Instrument completely dead:

- Check the mains power supply	Connect power supply
- Check the fuse on the power supply socket	Eventually replace the fuse
- Mother Board is not working	Replace Mother Board

The flame does not ignite

- Mother Board is not working	Replace Mother Board
- Lack of Hydrogen or Air	Supply Hydrogen and Air
- Ignition spiral is broken	Replace FID
- Thermocouple is broken	Replace FID
- Clogged H_2 or Air capillaries	Check flow rate and replace if necessary
- Transformer not working	Replace transformer
- Wrong hydrogen and air pressures	Set the correct hydrogen and air pressures

Auto zero does not perform

- Electrometer board not working	Replace electrometer
- Mother Board not working	Replace Mother Board
- Key Board not working	Replace key board

Output signals dead

- FID detector not working	Replace FID detector
- Electrometer board not working	Replace electrometer board
- Output signal board not working	Replace output signal board
- Mother board not working	Replace Mother board

4-20 mA signal not present

Check external connection	Restore external connection
4-20 mA board not working	Replace 4-20 mA board

Lack of Carrier gas pressure

- Supply air cylinder either empty or with closed interception valve	Open the gas cylinder or replace it
- Leakage in the relevant circuit	Find and mend the leakage
- Pressure regulator not working	Replace it
- Manometer not working	Replace it

Lack of FID Air pressure

- Supply air cylinder either empty or with closed interception valve	Open the gas cylinder or replace it
- Leakage in the relevant circuit	Find and mend the leakage
- Pressure regulator not working	Replace it
- Manometer not working	Replace it

Auto zero function not operative

- Electrometer board not working	Replace electrometer board
- Mother Board not working	Replace Mother Board
- Key Board not working	Replace key Board

No variations on output signals

- FID detector not working	Replace FID detector
- Electrometer board not working	Replace electrometer board
- Output signal board not working	Replace output signal board
- Mother Board not working	Replace Mother Board

Missing 4-20 mA signal

- Check the external interconnection	Restore the interconnection
- 4-20 mA output signal board not working	Replace it

No pressure on carrier gas

- Air gas cylinder either empty or closed	Open the air gas cylinder or replace it
- Leakage in the relevant circuit	Amend the leakage
- Pressure regulator not working	Replace pressure regulator
- Manometer not working	Replace manometer

No pressure on FID Air

- Air gas cylinder either empty or closed	Either open the air gas cylinder or replace it
- Leakage in the inner pneumatic circuit	Amend the leakage
- Pressure regulator not working	Replace pressure regulator
- Manometer not working	Replace manometer

No hydrogen pressure

- Hydrogen gas cylinder either empty or closed	Either open the air gas cylinder or replace it
- Leakage in pneumatic circuit	Amend the leakage
- Pressure regulator not working	Replace pressure regulator
- Intercepting solenoid valve not working	Replace solenoid valve
- Mother Board not working	Replace Mother Board
- Manometer not working	Replace manometer

No circulation of sample

- Adduction sample line either intercepted or clogged	Restore correct sample flow
- Membrane pump not working	Either replace or repair membrane pump
- Mother Board not working	Replace Mother Board
- Rotation valves not working properly	Replace rotation valves
- Clogging in the analytical circuit	Find and amend the clogging cause and restore the correct flow

Low calibration values

- New calibration procedure must be performed	Carry out a new calibration
- Sampling loops partially clogged	Replace sampling loops
- Defective rotation valves	Replace rotation valves
- Gas chromatographic column not active any more	Replace GC column

No reproducible values

- Check quality of ZERO AIR Feed FID AIR and CARRIER with the air from a certified gas cylinder and measure the quality of air generated by a zero air generator as sample	- Maintain scrubber of zero air generator or if not enough reduce the quantity of air passed through zero air generator

12.0 RS-232 SERIAL COMMUNICATIONS AND ELECTRICAL CONNECTIONS

The standard RS 232 serial communication system takes place in sequence at the end of each measuring cycle; the instrument, at the cycle end, gives a characters string carrying data of last performed analysis.

The serial communication takes place in ASHI code at 9600 baud rate, no parity bit, 8 start bit 1 stop bit.
RS 232 serial output port connection scheme (11)
7 = GND
3 = RX
2 = TX

ELECTRICAL CONNECTIONS

Analogue output connector M1 (1)

1 - Out signal channel 1 (0 – 1 Vdc).
2 - GND
3 - Out signal channel 2 (not in use).
4 - GND
5 - Out signal channel 3 (not in use).
6 - GND
7 - Out signal channel 4 (not in use).
8 - GND

Analogue output connector M2 (2)

1 - Out signal channel 5 (not in use).
2 - GND
3 - Out signal channel 6 (not in use).
4 - GND
5 - Out signal channel 7 (not in use).
6 - GND
7 - Out signal channel 8 (not in use).
8 - GND

Digital input connector M3 (3)

1 - Input ZERO check.
2 - Input SPAN check/calibration.
3 - Input remote analysis START
4 - GND

Status alarm connector M4 (4)

1 - 2 Out of service
3 - 4 ZERO status
5 - 6 SPAN status
7 - 8 Range 1.

Status alarm connector M5 (5)

1 - 2 Range 2.
3 - 4 Range 3.
5 - 6 Range 4.
7 - 8 (not in use).

13.0 SPARE PART LIST

Code Number	Description
09520114	Sample capillary
09520115	Hydrogen capillary
09520116	Air capillary
09520120	Pressure regulator
09520121	Bar gauge
09520125	FID detector sub assembly
09520130	Red LED
09520131	Green LED
09520132	Return switch
09520133	Stable switch
09520134	SPAN potentiometer
09520135	Digital display
09520136	Power supply transformer
09520137	Power supply socket
09520138	Cooling fan
09520141	Electrometer PCB
09520147	4-20 mA output PCB
09520143	Function programming PCB
09520144	Auxiliary services PCB
09520145	Temperature regulator PCB
09520146	Stabilised Power Supply PCB
09520150	PT 100 temperature gauge
09520152	FID detector heating resistance
09510116	Eight port Bimatic rotation valve
09510123	Rotation valve rebuild kit
09514822	Stainless steel tubing (10 m)
09514123	Seal set
09514124	Stainless steel pneumatic connections
09510112	SPAN solenoid valve
09514125	Fuse set
09510351	Sampling pump
09514126	Sampling pump rebuild kit
09510201	Hydrogen interception solenoid valve
09514127	Sintered filter
09510202	Rotation valve pilot solenoid valve
09514128	Flame ON temperature sensor

09514129	Flame ignition resistance
09514130	Mains switch
	Mother Board PCB
	IN/OUT Status PCB
09510336	Electrometer amplifier PCB
09510502	Key board PCK
	Digital Display PCB

Consumables set (including)

09510213	N.1 Carrier gas capillary
09510123	N.1 RSV rebuild kit
09514126	N.1 Sampling pump rebuild kit

Spare parts set (including)

09510943	N.1 Chromatographic column
09510221	N.1 Pressure regulator
09510115	N.1 Rotation valve

PCF ELECTRONICA
MOD. 529/T
AUTOMATIC GAS CHROMATOGRAPH

When instrument is checked in our laboratories before shipment final reports are produced that in copy accompany the equipment. Please keep the document with the original operating manual enclosed with the instrument.

14.0 FINAL CHECK RECORDS

CARRIER	Bar ……	ml/min ……
H_2	Bar ……	ml/min ……
AIR	Bar ……	ml/min ……
SAMPLE	Bar ……	ml/min ……

OVEN ……°C

CALIBRATION PARAMETERS

Range:	Component	
		: …… ppm
10	THC	: …… ADJ
		: …… ppm
20	THC	: …… ADJ
		: …… ppm
50	THC	: …… ADJ
		: …… ppm
100	THC	: …… ADJ
		: …… ppm
200	THC	: …… ADJ
		: …… ppm
500	THC	: …… ADJ

Service Engineer: _____ Date: _____

Attachment 1- Extract of FID response factors for the most common organic components

Compound	*Molecular weight*	*Relative Sensitivity*	*Response factor [1]]*	*Relative response to Methane*	*Relative response to Propane*	*Conversion factor ppm - mg/m³*	*Conversion factor ppm - mg**C**/m³*
Methane	16.04303	0.99	15.8826	**1.0000**	0.3675	0.7158	0.5359
Ethane	30.07012	0.98	29.4687	1.8554	0.6819	1.3416	1.0718
Propane	44.09721	0.98	43.2153	2.7209	**1.0000**	1.9674	1.6076
Butane	58.12430	1.09	63.3555	3.9890	1.4660	2.5932	2.1435
Pentane	72.15139	1.04	75.0374	4.7245	1.7364	3.2190	2.6794
Hexane	86.17848	1.03	88.7638	5.5887	2.0540	3.8449	3.2153
Heptane	100.2056	1.00	100.2056	6.3091	2.3188	4.4707	3.7511
Octane	114.2327	0.97	110.8057	6.9765	2.5640	5.0965	4.2870
Nonane	128.2598	0.98	125.6946	7.9140	2.9086	5.7223	4.8229
Iso-pentane	72.15139	1.05	75.7590	4.7699	1.7531	3.2190	2.6794
2,2-dimethyl Butane	86.17848	1.04	89.6256	5.6430	2.0739	3.8449	3.2153
2-methyl Pentane	86.17848	1.05	90.4874	5.6973	2.0939	3.8449	3.2153
2,2-dimethyl Pentane	100.2056	1.02	102.2097	6.4353	2.3651	4.4707	3.7511
1,1,2-trimethyl cyclic hexane	126.2438	0.98	123.7189	7.7896	2.8629	5.6324	4.8229
Cyclic heptane	98.18963	1.01	99.1715	6.2440	2.2948	4.3807	3.7511
Benzene	78.11472	1.12	87.4885	5.5084	2.0245	3.4851	3.2153
Toluene	92.14181	1.10	101.3560	6.3816	2.3454	4.1109	3.7511
Ethyl Benzene	106.1689	1.03	109.3540	6.8851	2.5304	4.7367	4.2870
p-Xylene	106.1689	1.00	106.1689	6.6846	2.4567	4.7367	4.2870
m-Xylene	106.1689	1.04	110.4157	6.9520	2.5550	4.7367	4.2870
o-Xylene	106.1689	1.02	108.2923	6.8183	2.5059	4.7367	4.2870
Acetylene	26.03824	1.07	27.8609	1.7542	0.6447	1.1617	1.0718
Ethylene	28.05418	1.02	28.6153	1.8017	0.6622	1.2516	1.0718
Methanol	32.04243	0.23	7.3698	0.4640	0.1705	1.4296	0.5359
Ethanol	46.06952	0.46	21.1920	1.3343	0.4904	2.0554	1.0718
n-Propanol	60.09661	0.60	36.0580	2.2703	0.8344	2.6812	1.6076