PCF Elettronica Mod. C 2011

dual HOT FID
portable VOC monitor

Particularly suited for
NMH continuous monitoring
at emissions

(Working procedure according to CEE CEN 264 # 326 and UNI EN 12619:2013)

SERVICE MANUAL
BASIC INSTRUCTIONS

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1.0 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. For this matter the FID is the detector that mostly meets the needs.
The Mod. C 2011, Dual Hot FID portable VOC monitor has been studied, developed and manufactured to monitor Volatile Organic Carbon (VOC) according to CEE CEN 264 and UNI EN 12619:2013 procedures at emissions.
The whole carbon compounds are detected in a specially developed Flame Ionisation Detector (FID detector).
PCF Elettronica FID detector is very well known for its stability as well as for its low maintenance in 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 as well as in industrial emissions there is a 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 the 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 numbers responds proportionally to the number of atoms in the molecule, so

Concentration ppm	Species	FID response
1	CH_4	1
1	C_2H_6	2
1	C_3H_8	3
1	C_6H_6	6

In other words, once the instrument response is normalised to methane, 1 ppm of propane will approximately generate a signal as 3 ppm of methane.

1.1 Introduction

The present manual reports most of the information included already in the "Operating Manual", namely - the following sections:

- General description of the analyser component parts
- Description of commissioning start up procedure
- Description of the Hard-Ware
- Description of electronics
- Description of the Soft-Ware
- Analyser maintenance procedure
- Trouble shootings.

The operations of the instrument are controlled by separate PCBs, namely:

- the electrometer PCBs, which supply the high voltage to the FIDs and amplify the micro current out of the polarised electrodes;
- the auxiliary PCB, that lights the FID flame and controls the digital info of the instrument.

The data management is performed by a powerful colour video graphic DAS (Data Acquisition System) with six analogue channel inputs.

The main features of the DAS are represented by

- availability of set - up SW packages in different languages (Korean as well);
- the most up - to - date serial communications;
- TUV certification of data-manipulation security. The latter feature is particularly interesting for Public Authorities, Consultants, and Auditors.

For more info about T RSG35, the mini Data Acquisition System, please refer to:

https://www.e-direct.endress.com/us/en/graphic-data-manager-ecograph-t-rsg35

As option, the analogue data of the video graphic may be expanded to record external parameters, e.g., temperatures, pressures, flow rates, oxygen concentration, etc. ..

Recorded data may be:

- visualised on the colour display,
- downloaded to a PC through the Serial communication port,
- it is possible to download them on an MMC card, with a suitable adapter, or a USB flash memory.

DAS (Data Acquisition System)
Colour video graphic

Lodging of the DDC card
and/or the USB flash memory

2.0 OPERATING PRINCIPLE

The PCF Elettronica Mod. C 2011, Dual Hot FID portable VOC monitor detects and records the Total Volatile Organic HC, the Methane concentration as well as the NMHC concentration in a wide range of concentrations and sample conditions without any possibilities of water condensation or limitation in the ranges, from few hundreds of ppb up to thousands of ppm.

The instrument can be either employed at stacks (the sample is kept at constant high temperature: ≥ 180°C) and/or for air quality monitoring. In the latter case, **for higher LDL** it is better to supply Zero Air from an external source (Gas Cylinder).

The monitor is calibrated either in laboratory or in the field through traceable gas cylinders and/or equivalent supports, the calibration gas must always be supplied in vented conditions.

The Flame Ionisation Detector (FID) is based on a proprietary micro flame, based on H_2 and Pure Air, where the organic compounds are oxidised and a correspondent number 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 FID is universally recognised as the detector for all species of HC.

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).

To stabilise the flame as well as the response of the detector the sample is diluted in Pure Air before reaching the flame.

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 described procedure are managed by the electronics and 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 serial port and, memorised on a Flash Memory built in the instrument, may be downloaded via serial connections to a remote data collection device. The full capacity of the inbuilt Memory card is higher than a few Gbytes.

Particularly interesting is TUV certification of data-manipulation security.

The data recorded by the DAS (Data Acquisition System) cannot, in any way, be manipulated by the operator!

Suggested standard supply includes the 316 SS sampling probe, according to UNI 10391 norms, as well as 3 m heat traced sampling line, or electrically heated probe, to meet 13526 standards and regulations.

3.0 TECHNICAL SPECIFICATIONS

-	Measuring ranges (standard)	: 0-100 ppmV or mgC/m^3 : 0-1,000 ppmV or mgC/m^3 : 0-10,000 ppmV or mgC/m^3

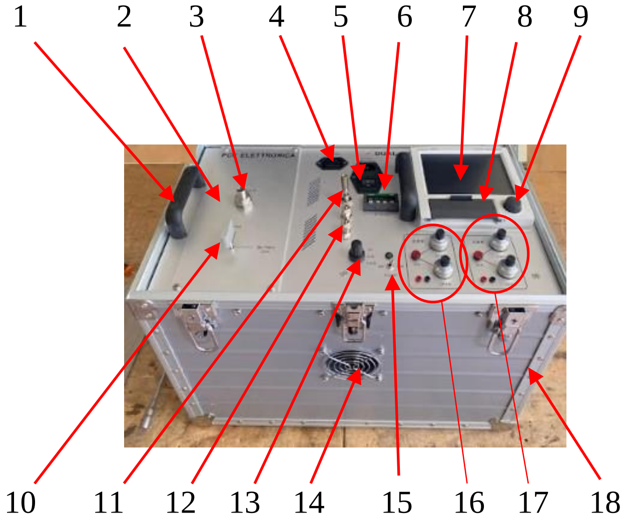
(other ranges possible on request, starting from 0-20 mgC/m^3)

-	Background noise	: ± 0.2% of full scale deflection (FSD)
	- Lower Detectable Limit (LDL)	: ± 0.4% of FSD
-	Sensitivity	: ± 0.4% of FSD
-	Linearity	: ± 1% of FSD
-	Zero stability (24 hours)	: ± 1% of FSD
-	Span drift (24 hours)	: ± 1% of FSD
	(Sensitivity to temperature)	: (for 10°C room temperature variation)
-	Response time	: 1 second
-	Lag time	: 2 seconds
-	Precision	: ± 1% of FSD
-	Sample flow rate	: 800 ml/min.
-	Operating temperature	: 0 - 40 °C
	video display	: 320 x 200 pixel 5.5" colour TFT = LCD graphic
-	Data storage	: in built 64 Mb, or higher, compact flash memory
-	Data management	: standard SW package for Win 10, Win 11
	- Instrument configuration	: from front panel
	Services Hydrogen	: ≅ IP 56 ml/min from external gas cylinder
	Air	: ≅ 5000 ml/min from in built generator
-	Suggested calibration gas cylinder	: 40 ppm CH4+10 ppm propane, air balance
	- Mounting Transportable configuration	: reinforced aluminium case with strip for easy
	- Dimensions	: 600x400x500 mm (16"x12"x 6",WxDxH)
-	Weight	: 18 Kg
-	Standard power supply (to be specified in order)	: 220/110 Vac, 50/60 Hz
	- Power consumption	: 800 VA (when heating up)
	- Pneumatic connections	: 1/4" or 4/6 mm, 1/2 mm plastic or SS tubes

4.0 GENERAL DESCRIPTION

PCF Elettronica Mod. C 2011, Dual Hot FID portable VOC monitor is an extremely compact instrument studied, developed and manufactured for operation at emissions or industrial installations where just the power supply and the hole for the insertion of the probe must be available.
The hydrogen consumption is quite low (56 ml/min.) and the zero air generator is in-built into the instrument.

4.1 Top view description

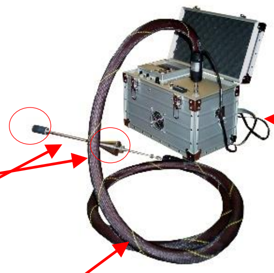


Mod. C 2011, Dual Hot FID TVOC/CH_4/NMHC portable monitor

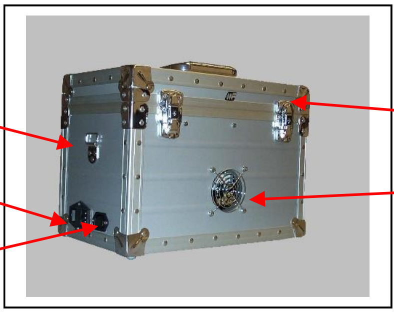
Figure captions

1- Extraction handle.
2- Heated analysis chamber/compartment.
3- Heated sampling line input.
4- Heated line power supply socket.
5- Mains supply with ON/OFF switch.
6- Heated pump temperature control.
7- Endress & Hauser T RSG 35 Video Graphic Display (144 x 144 mm).
8- Download/Upload compartment.
9- Programming knob.
10- CH_4 bypass manual valve.
11- H_2 input.
12- Zero Air input.
13- Measuring range selection knob.
14- Inner compartment cooling fan.
15- Sample Pump switch.
16- (VOC) control compartment.
17- (CH4) control compartment.
18- External reinforced aluminium case.

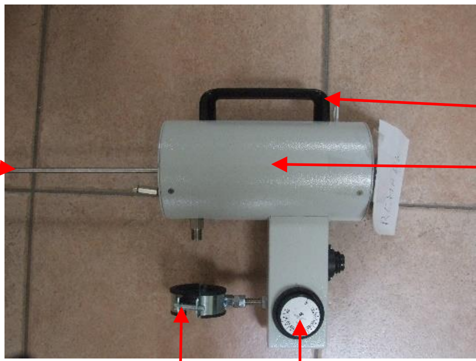
Mod. C 2011, portable monitor
in its measuring configuration
(similar to any of 2000 Series monitor)



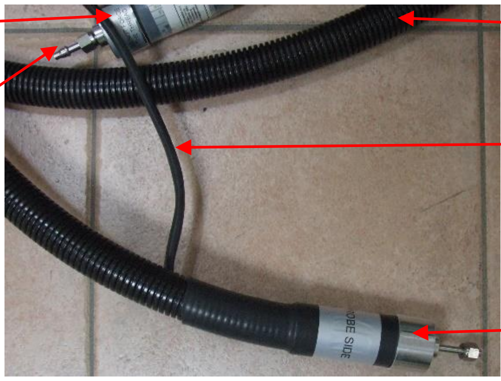
Mod. C 2011 with closed case
Material: anodised aluminium
Thickness: 10/12 mm
Reinforced edges and angles
Weight: ≈ 10 Kg



The heated filter sampling probe
Dimensions of holder: 27 x 21 x10 cm
Weight: ≈ 2 Kg

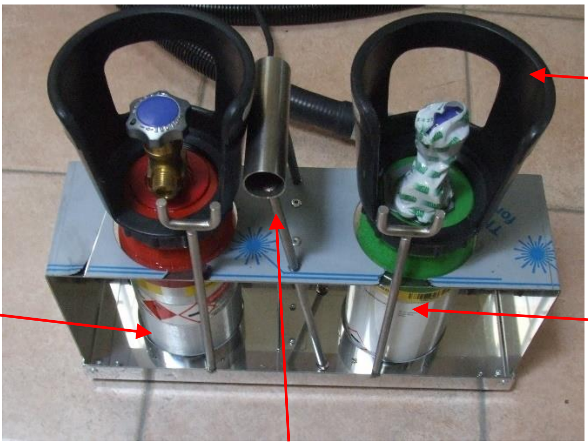


Electrically heated line
Power: 60 W/m
Weight: .3 Kg/m
Teflon internal tube: 4/6 mm
Diameter tube: Ø36 mm
Diameter metal heading: Ø 45 mm



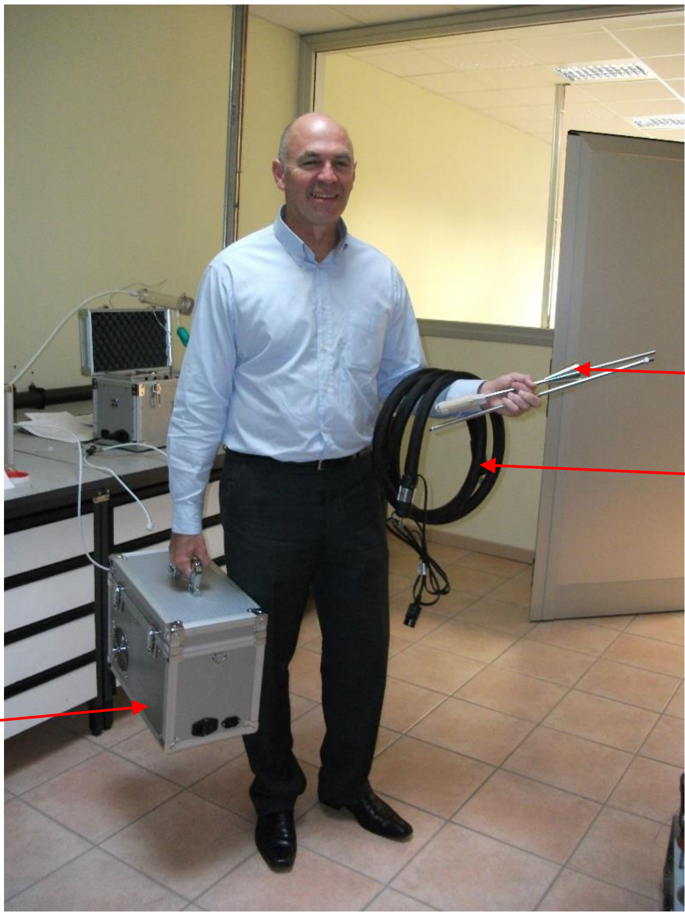
Two positions basket

Dimensions: 50x40x15 cm (WxHxD)
Weight: 6 Kg with the G.C.



Double stage pressure reducer

The monitor and its accessories carried by the operator

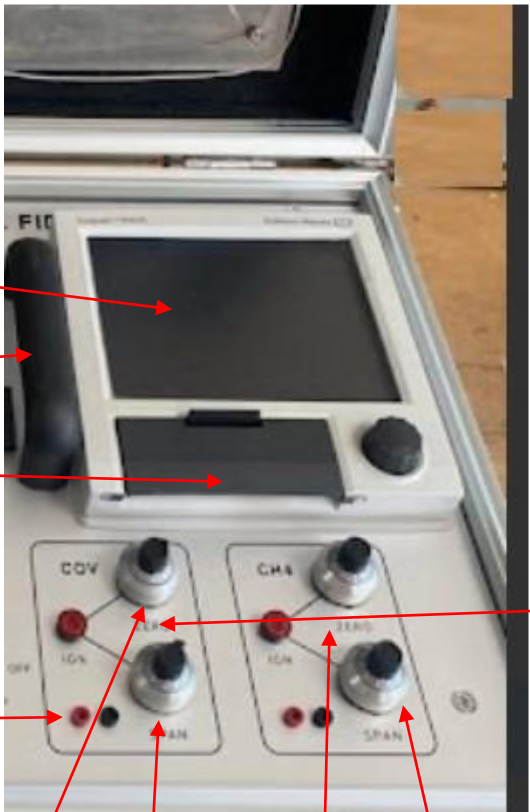


4.3 The view of component parts

The great development in the field of integrated circuits, as well as the use of very high integrated chips, haves greatly reduced the room occupied by electronics that manages all the instrument firmware. The most important unit of the Mod. C 2011, Dual Hot FID Total VOC portable monitor as for all the component of the portable family is represented by the DAS (Data Acquisition System). The latter is a video graphic unit that basically manages the data acquisition and normalisation of the measurements, the display of engineered value, the data memorisation and communication with the surrounding.

The electrometer PCB as well as the auxiliary PCB are the only boards developed separately from the DAS. The electrometer PCB it is a very high gain, high impedance analogue amplifier and is located as near as possible to FID detector, to avoid possible interferences. The auxiliary PCB takes care of FID management and control.

Top view of Mod. C 2011,
Dual Hot FID portable TVOC, CH4 and NMH monitor
(particular)



Notes: 1- When sampling from the environment (room temperature) the heated sample line is not necessary. It would be enough using a Teflon tube (4/6 mm) with a particulate filter on the top.
2- When the FID is ON the LED is OFF and vice versa

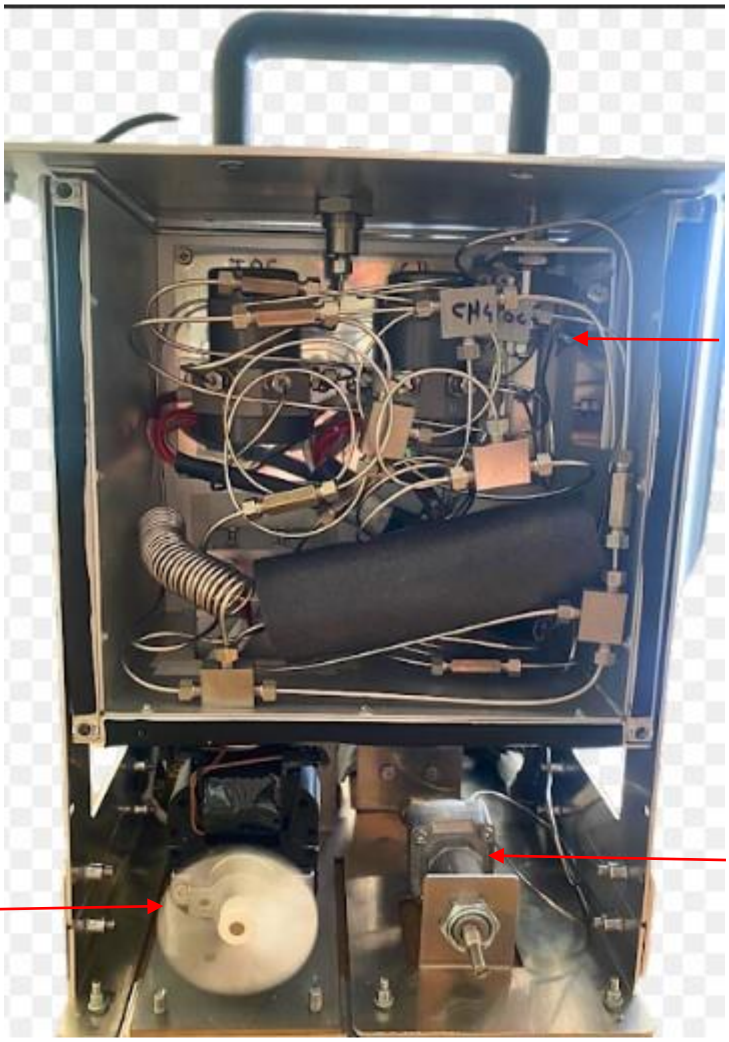
Extracted monitor,
left hand side view
(covered heated compartment)

Heated compartment (covered)

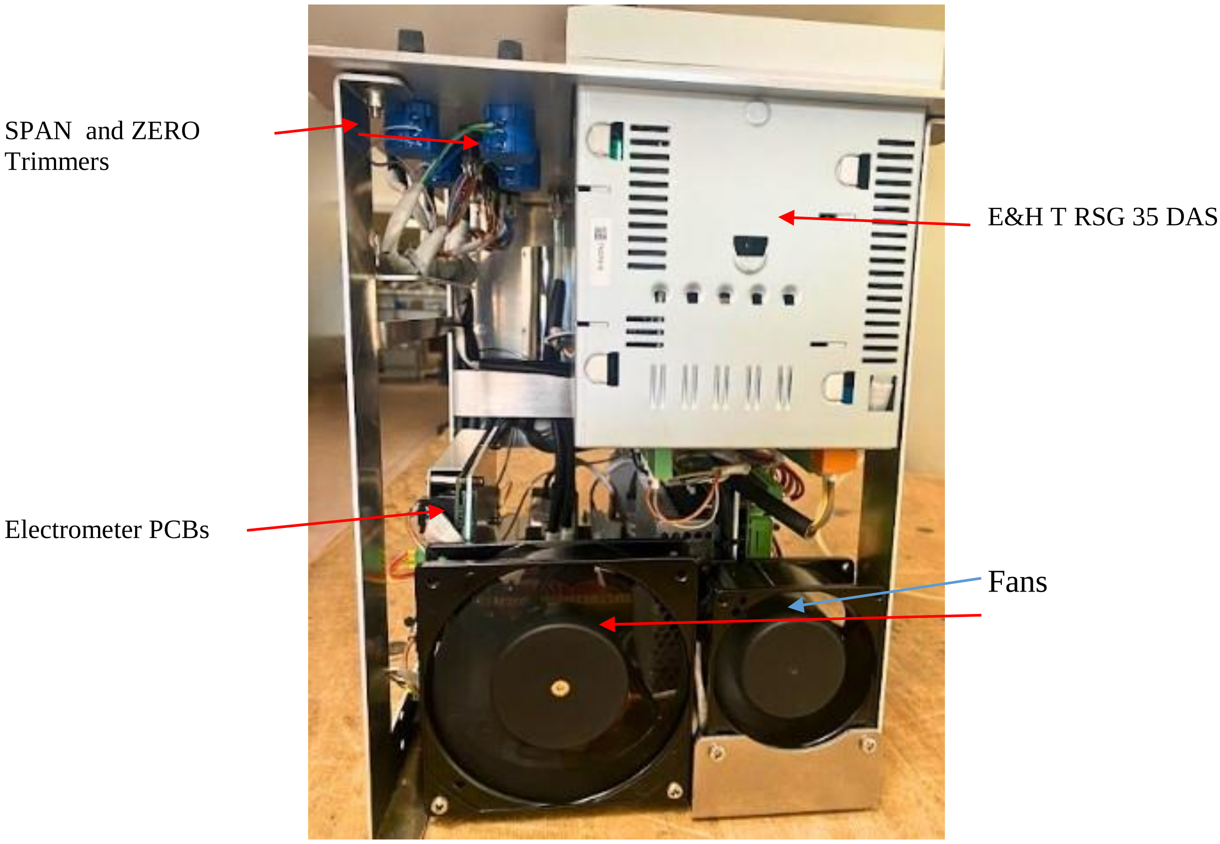
Heated Sampling Pump

H_2 Pressure Regulator

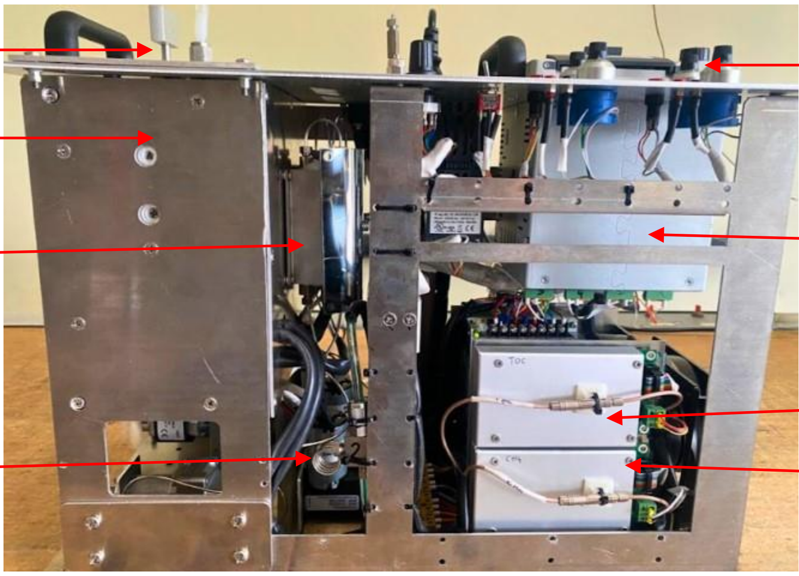
Extracted monitor,
left hand side view
(uncovered heated compartment)



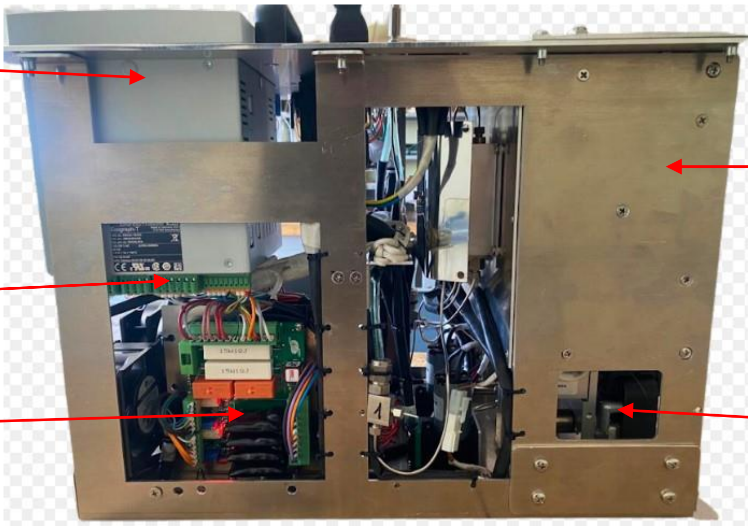
**Extracted monitor,
right hand side view**



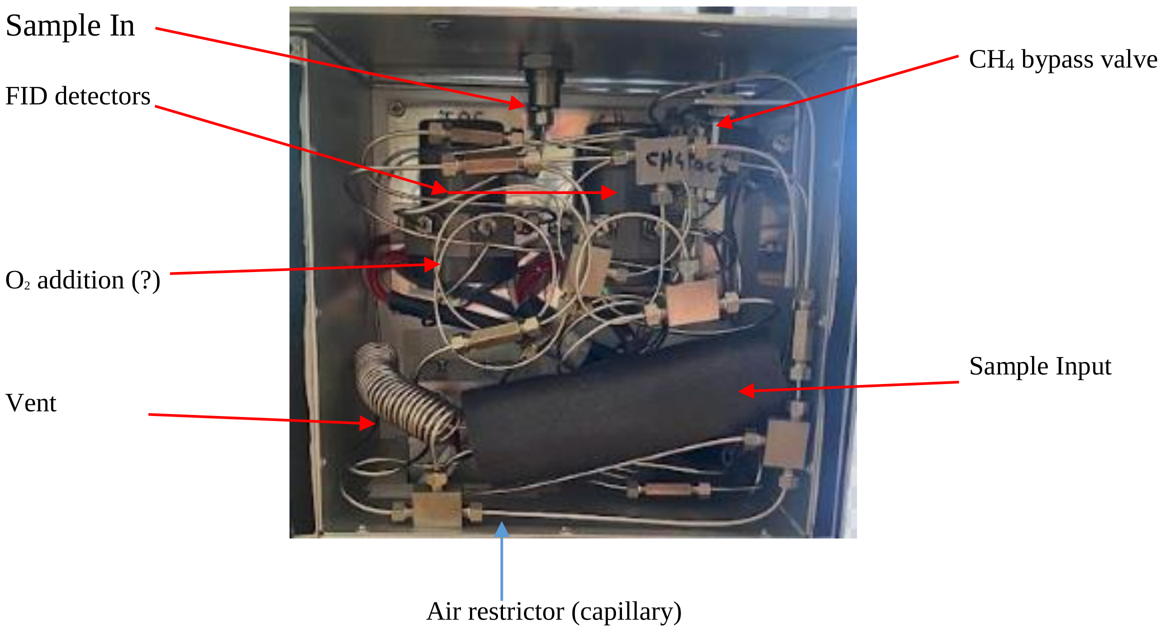
Extracted monitor,
front view



Extracted monitor,
back view



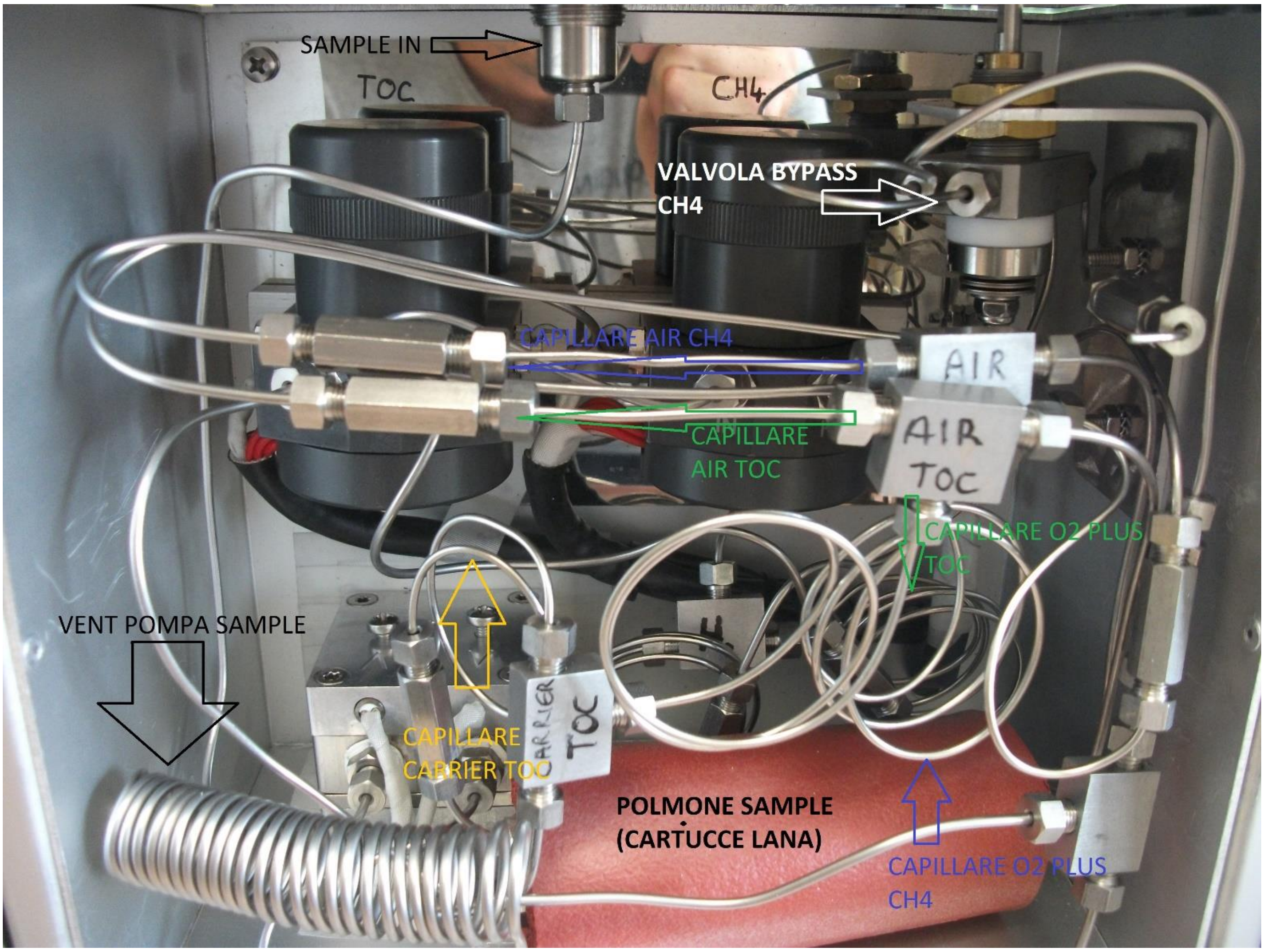
Temperature controlled (180°C) room



Flow rates check points:

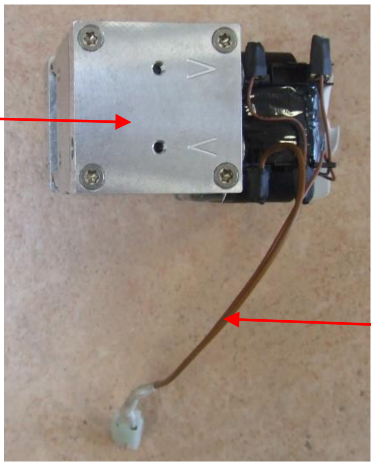
1) Flow rate check point of Pure Air to VOC FID
2) Flow rate check point of Pure Air to CH_4 FID
3) Flow rate check point of H_2 to VOC FID
4) Flow rate check point of H_2 to CH_4 FID
5) Flow rate check point of Sample to VOC FID
6) Flow rate check point of Sample to CH_4 FID
7) Flow rate check point of O_2 PLUS to VOC FID
8) Flow rate check point of O_2 PLUS to CH_4 FID

Further info on the heated compartment



Heated sampling pump

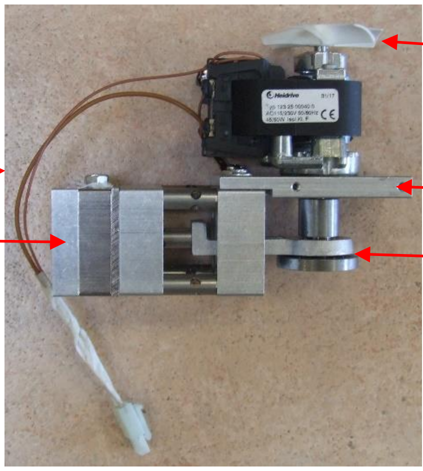
Top view



Heated head

Power Supply cord

Side view



Fan

Electric motor

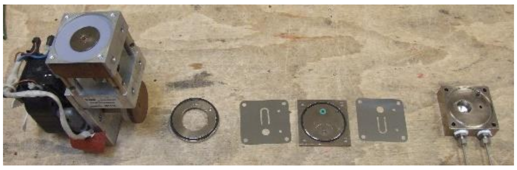
Power Supply cord

Pump bracket

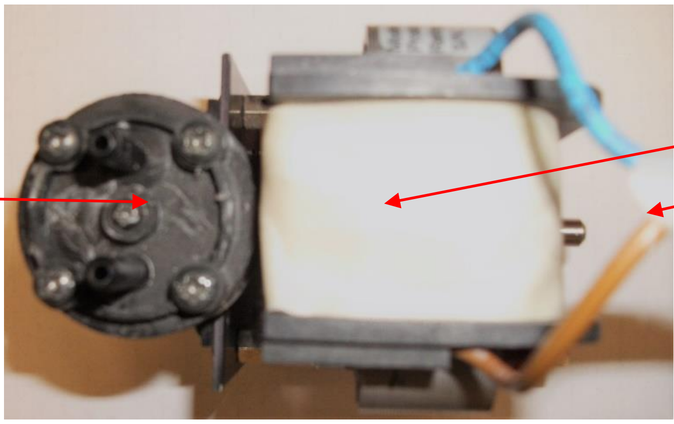
H.T. heated head

Pump shaft

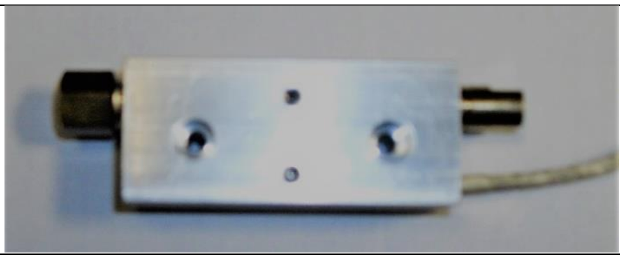
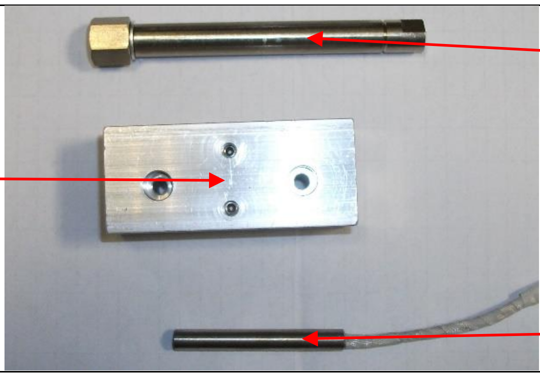
Disassembled heated pump



Air compressor



Disassembled air compressor

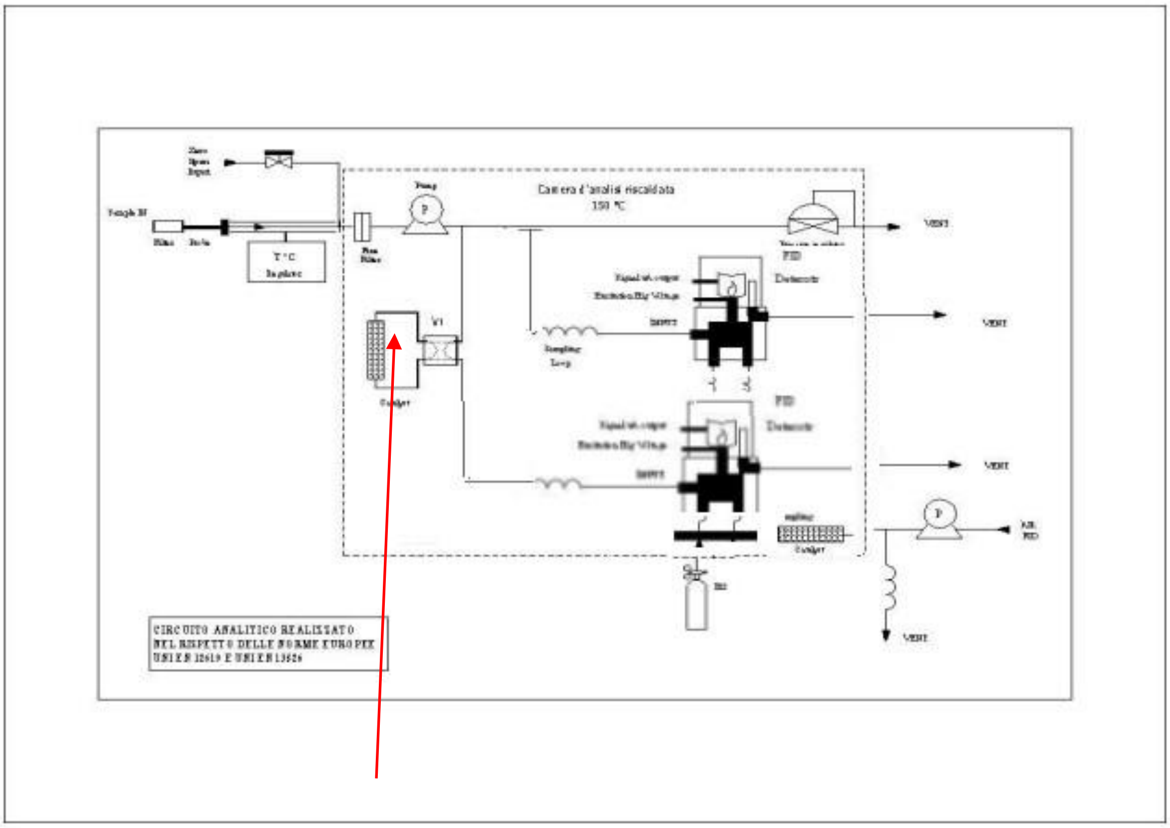
	High-Temperature scrubber	
		
	High-Temperature scrubber (disassembled)	
Aluminium heat buffer		Reactor Heating resistor

5.0 ANALYTICAL SCHEMATICS

ACCORDING TO CEE CEN 264 # 326 AS WELL AS UNI EN 12619:2013 PROCEDURES AND REGULATIONS

5.1 Analysis phase

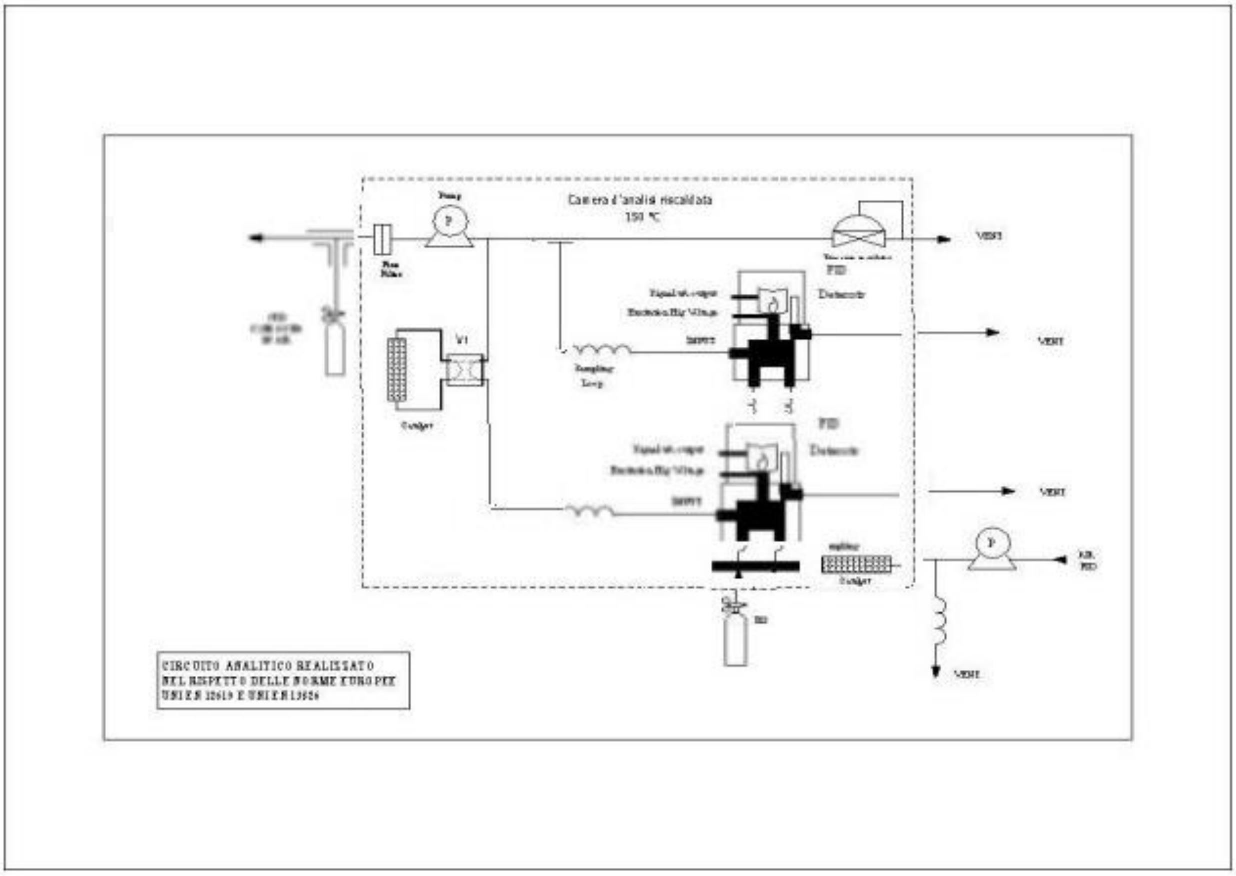
In the Analysis Phase the single pump recirculates the sample in analysis in both CH_4 (with the catalytic scrubber) and in the VOC circuit. The VOC and CH_4 content in the sample is measured at the same time.
The NMH concentration is calculated from the difference between VOC value and CH_4 value.



Methane bypass
manual valve

5.2 Calibration phase

In the calibration phase the calibrator mixture is supplied to the monitor under vent condition (atmospheric pressure). The mixture is circulated inside the monitor by the sampling pump.

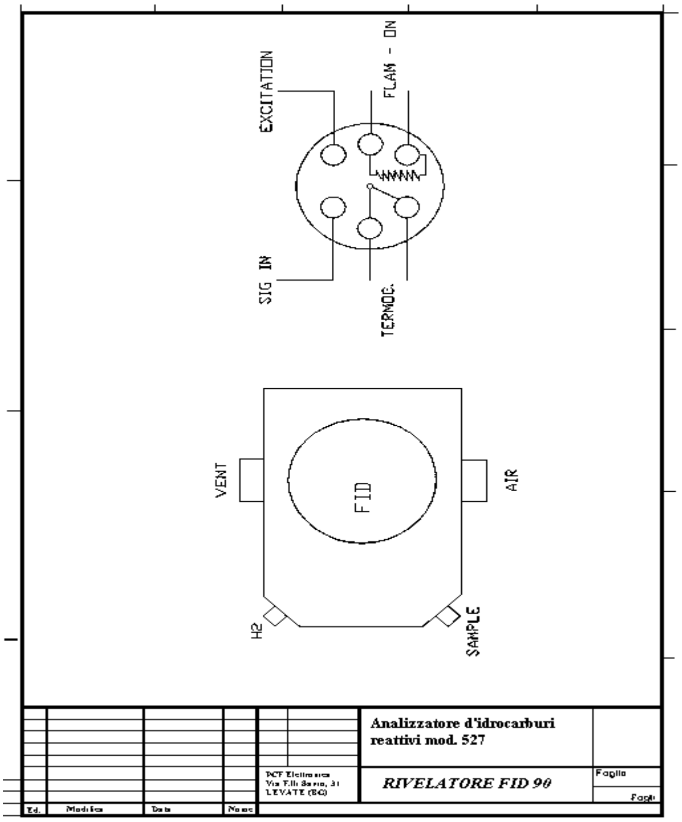


6.0 FLAME IONISATION DETECTOR (FID)

The FID is the core of the Mod. C 2011 dual Hot FID portable monitor. Both FID detector of the monitor work in the same condition, for same concentration each detector should give the same response (signal).

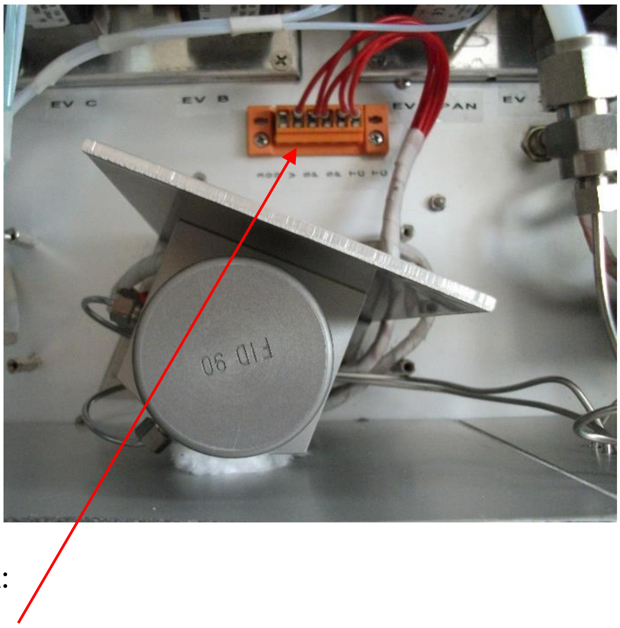
It shows a central nozzle that receives, through a capillary, hydrogen, (about 25 ml/min). Again, through a capillary, the nozzle is reached by the carrier gas carrying the sample compounds. The nozzle is polarised, from an external power supply by a positive voltage of 300 Vdc with very low electrical currents. A metallic ring on the top of the nozzle collects the ionisation current and takes it to the input of the 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 time, with the risk of jeopardising the measurements' qualities.

Inside the detector is 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 commanding the automatic switching off of the hydrogen flow when the flame is OUT.

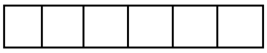


5.1 The pictures of the FID detector

The pictures below show an FID detector as it looks mounted in an instrument.
Please note the pneumatic as well as the electrical connections.



The connection block:

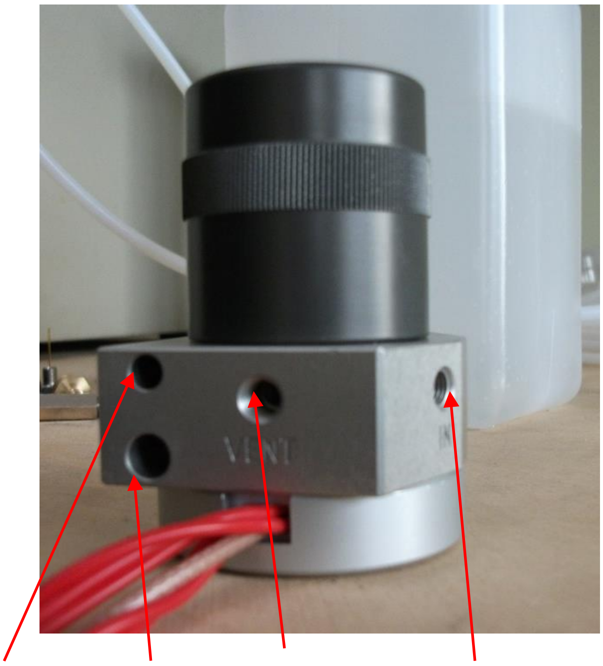


1 2 3 4 5 6

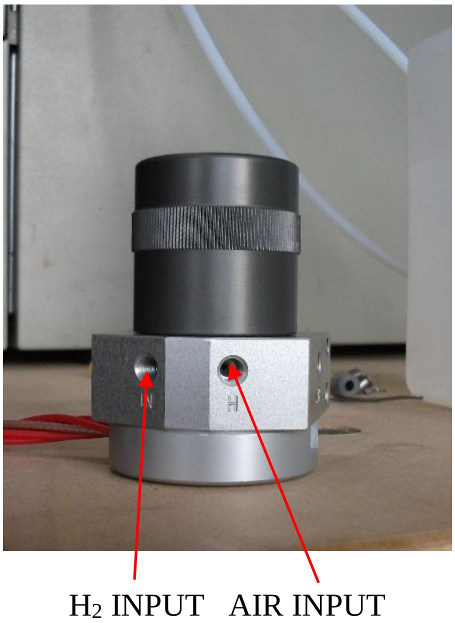
Pos.1 -	No connection
Pos. 2 –	300 Vdc Power Supply to FID polarising electrode
Pos. 3-4	Connections of the lighting resistance (0.1 Ohm when cool)
Pos. 5-6	J Type Thermocouple to detect FID micro flame (4.5 mV OFF, 31 mV ON)

- Top view of the FID detector installed in the instrument with the removed cap

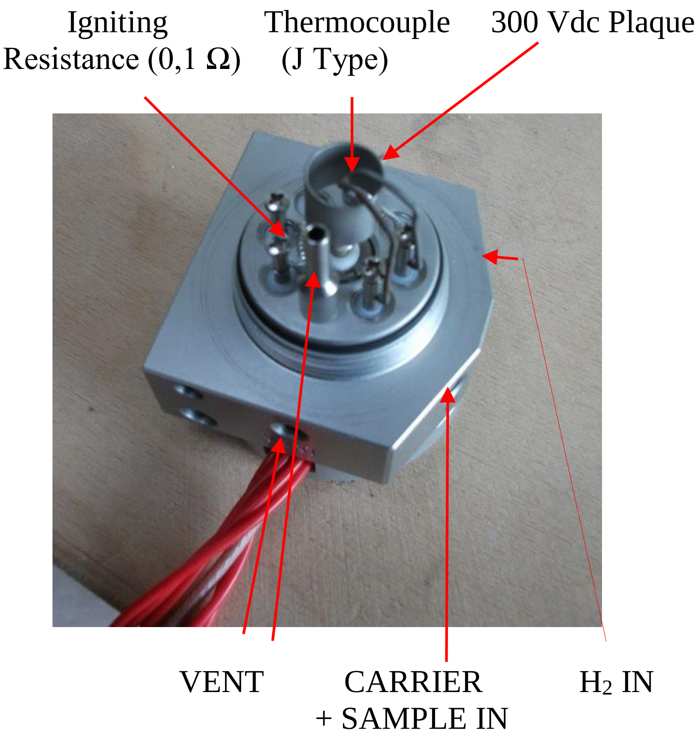
The dismounted FID detector, on a bench, with a cap on.



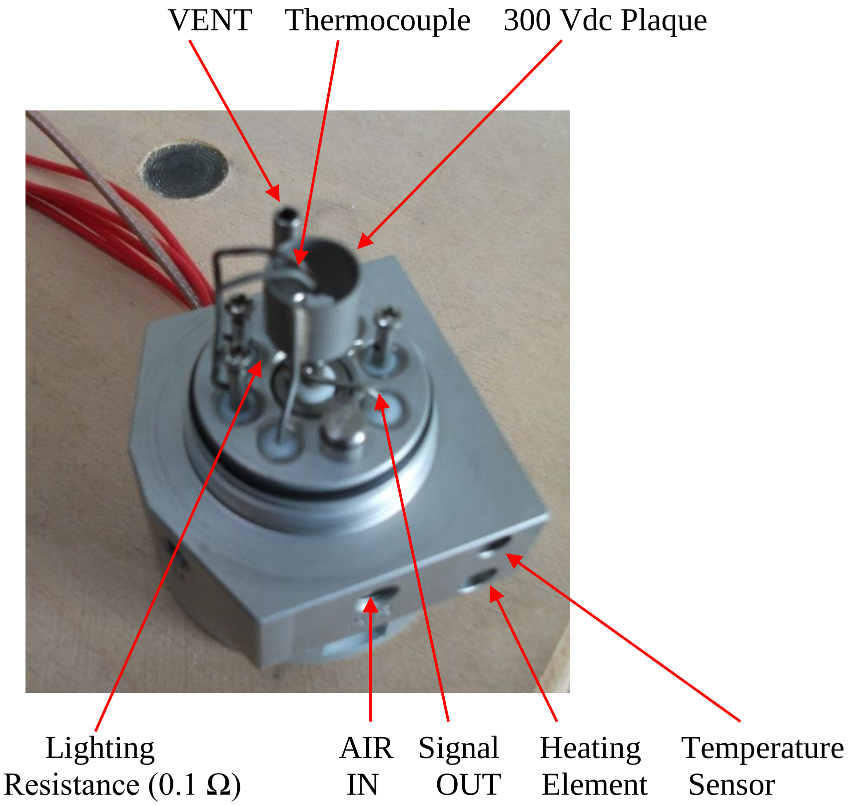
Temperature Sensor　Heating Element　VENT　CARRIER + SAMPLE IN



- Top view of the FID without the protective cap



- A different top view of the FID without the protective cap



7.0 ELECTRONICS

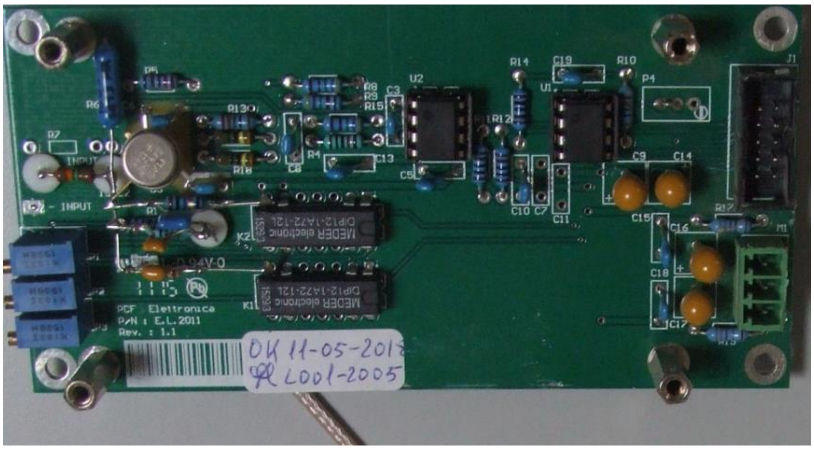
An high voltage is supplied to the electrodes of the FID and the relevant micro current, generated by the ionised carbon atoms and, measured through an electronic circuit.
The same PCB .... includes the high voltage supply circuit as well as the amplification and measuring circuit of the generated ion current.

7.1 The FID Power Supply and Amplification PCB

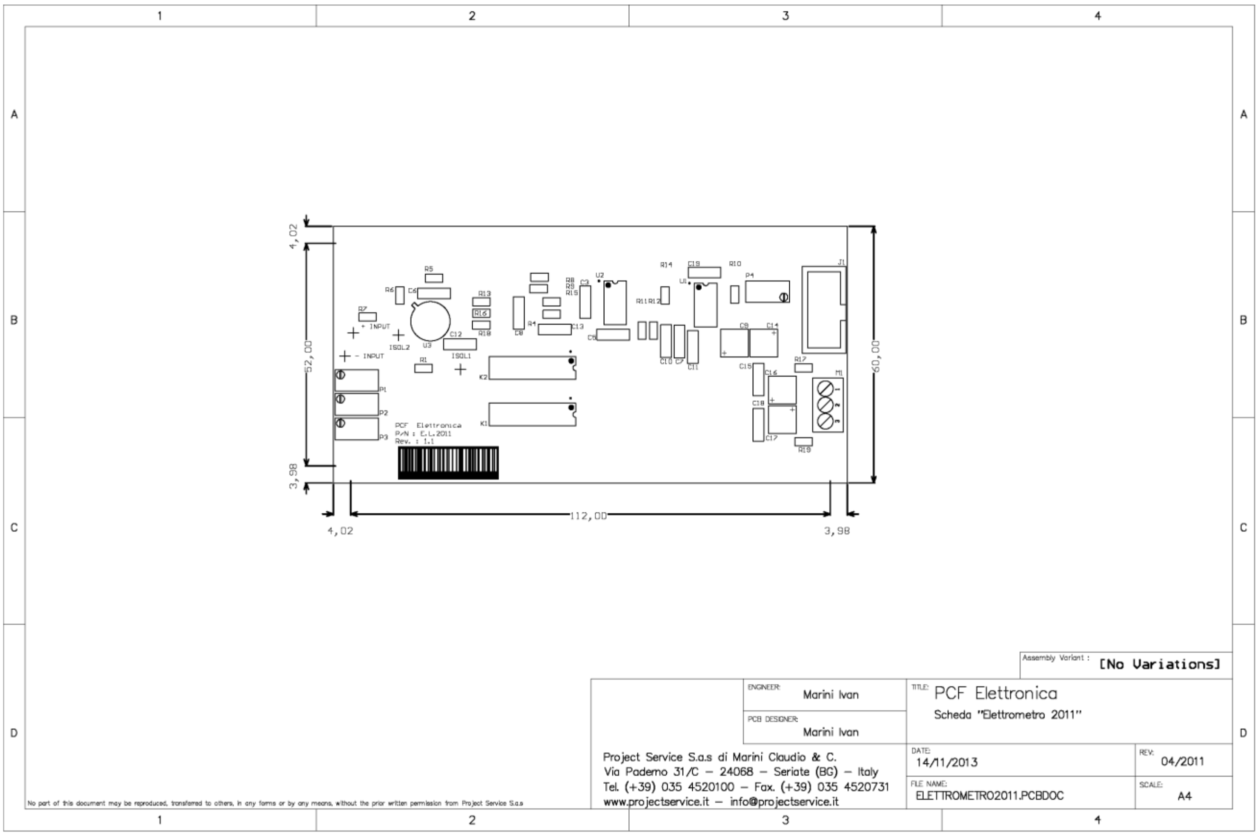
Here below is showed a picture of the FID supply (300 Vdc) and amplification PCB. The printed circuit is protected by a cover to avoid electromagnetic interferences. The cable connecting the PCB to the FID is coaxial with very high insulation. Please avoid modifying the length and the location of the same cable.

The electrometer board is protected by a metal shield in order to avoid electrical interferences on the very low currents involved in the measurements.

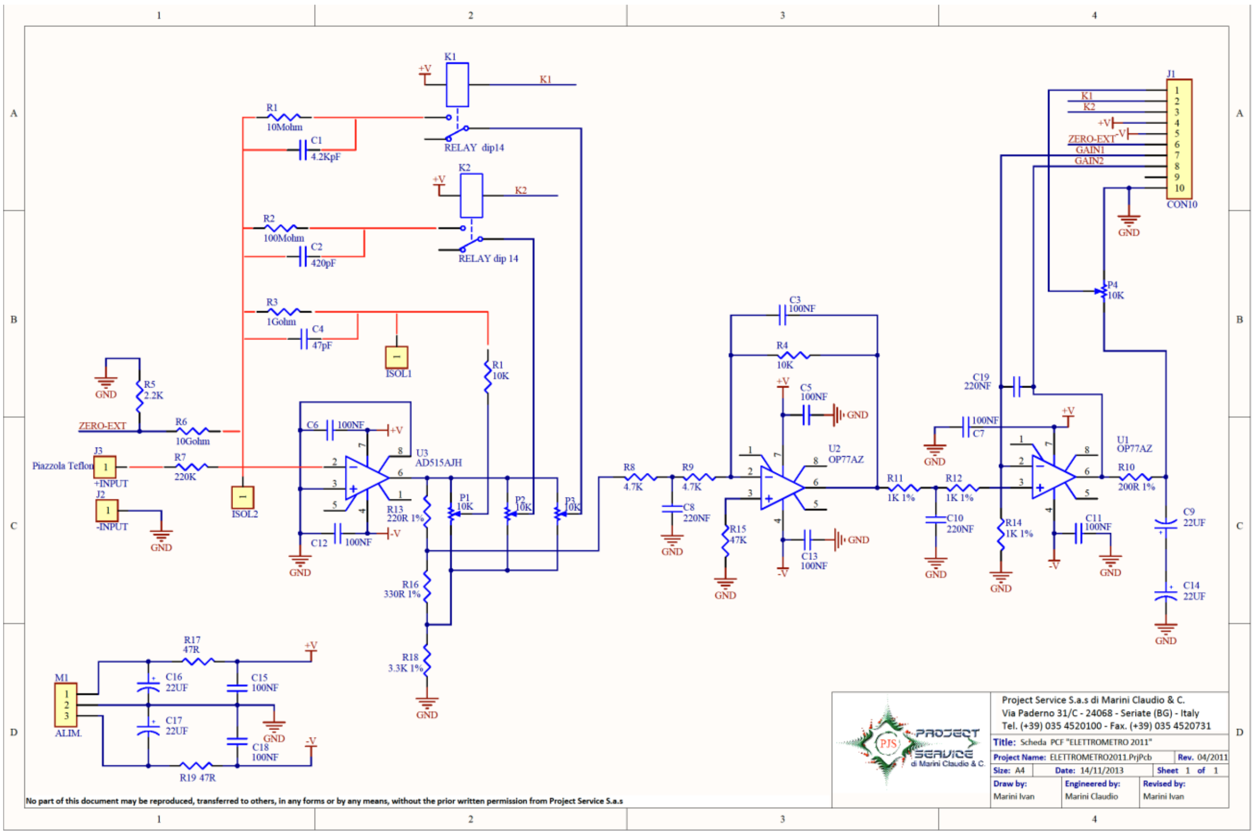
The PCB with mounted electronic components



The PCB with the lay out of the electronic components



The electronic circuit schematics

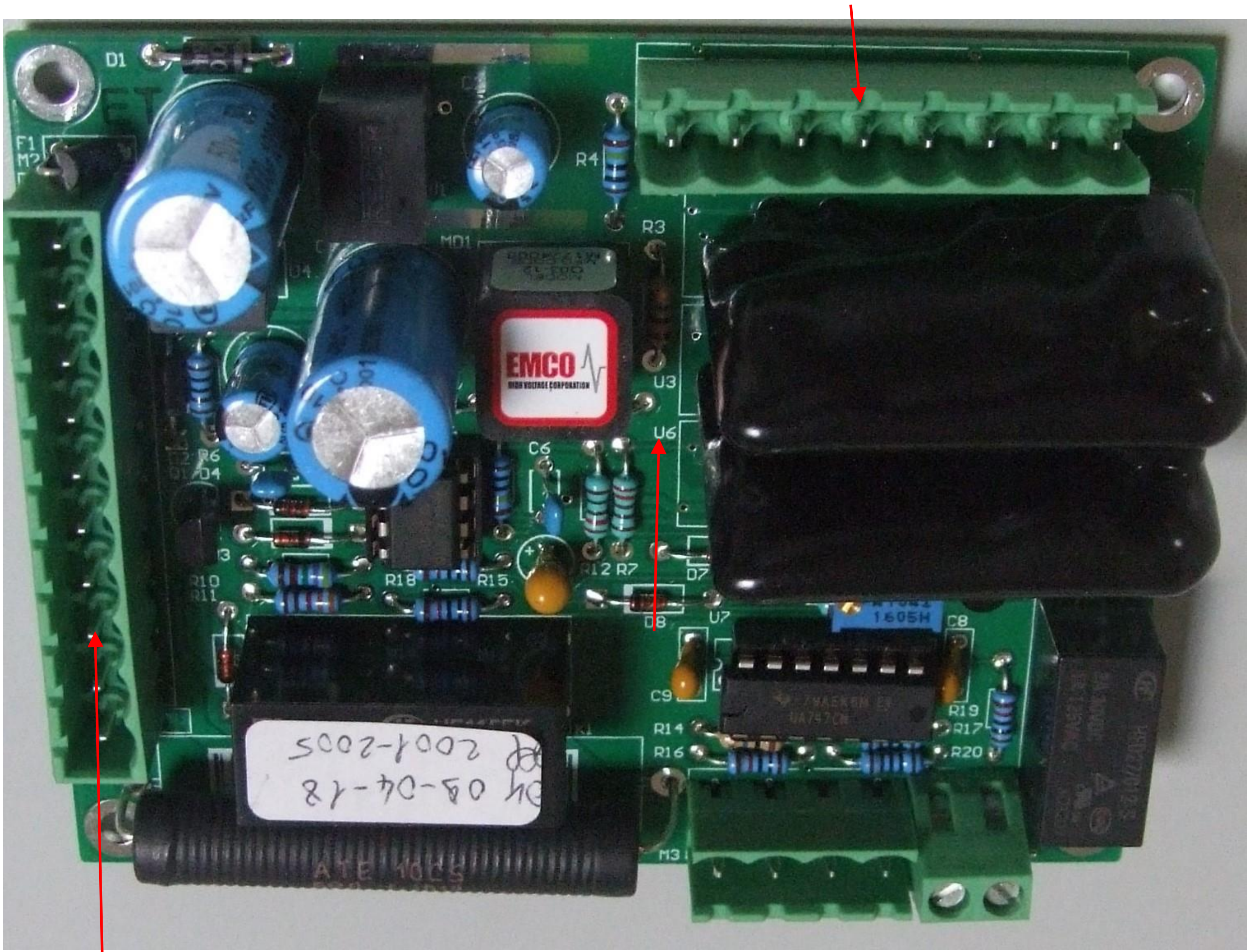


7.2 The Power supply PCB (also called Auxiliary and Service Board)

It is intended to supply power to the instrument services as well as to FID electrometer PCB board.

The Power supply PCB, mounted board

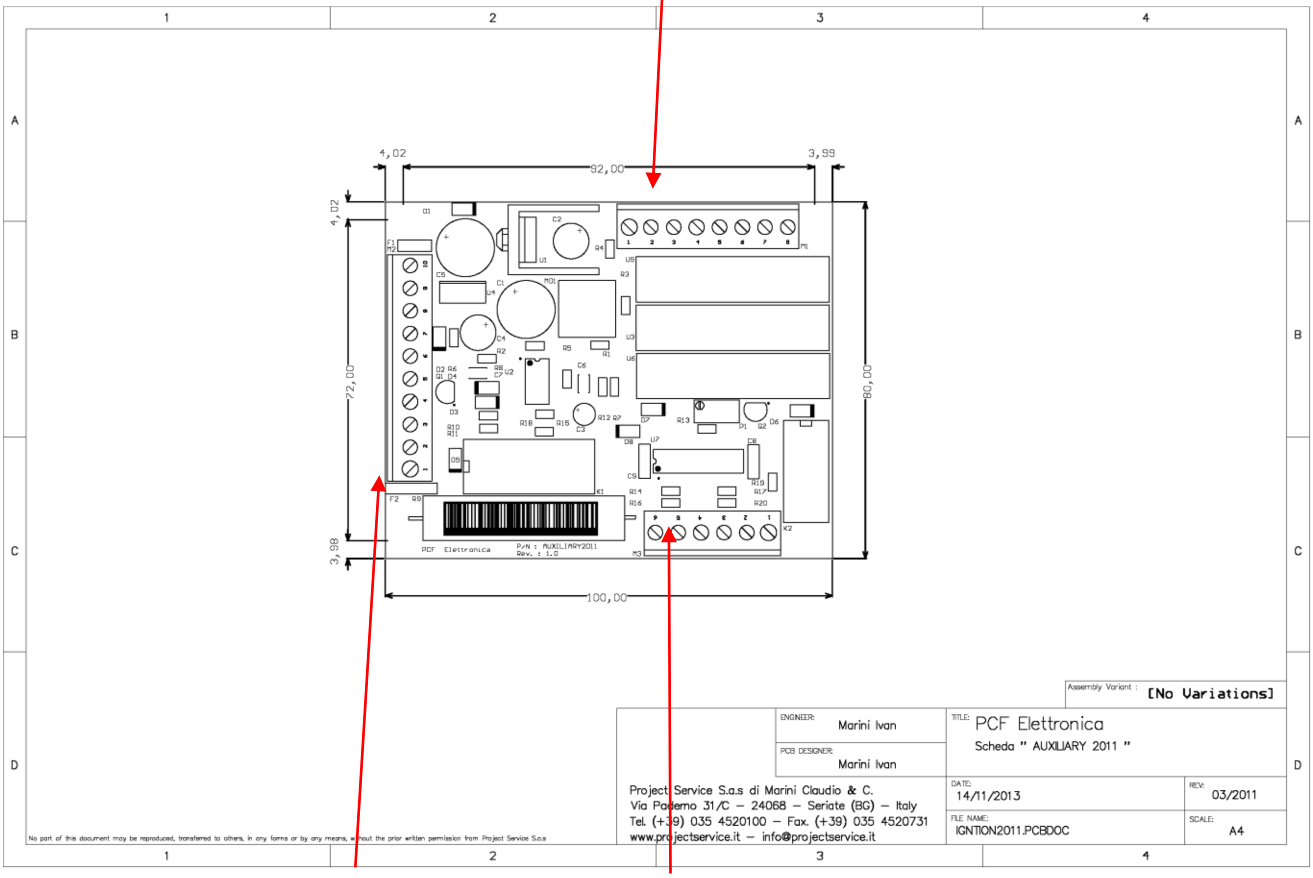
I/O block 2 (see below)



I/O block 3 (see below)

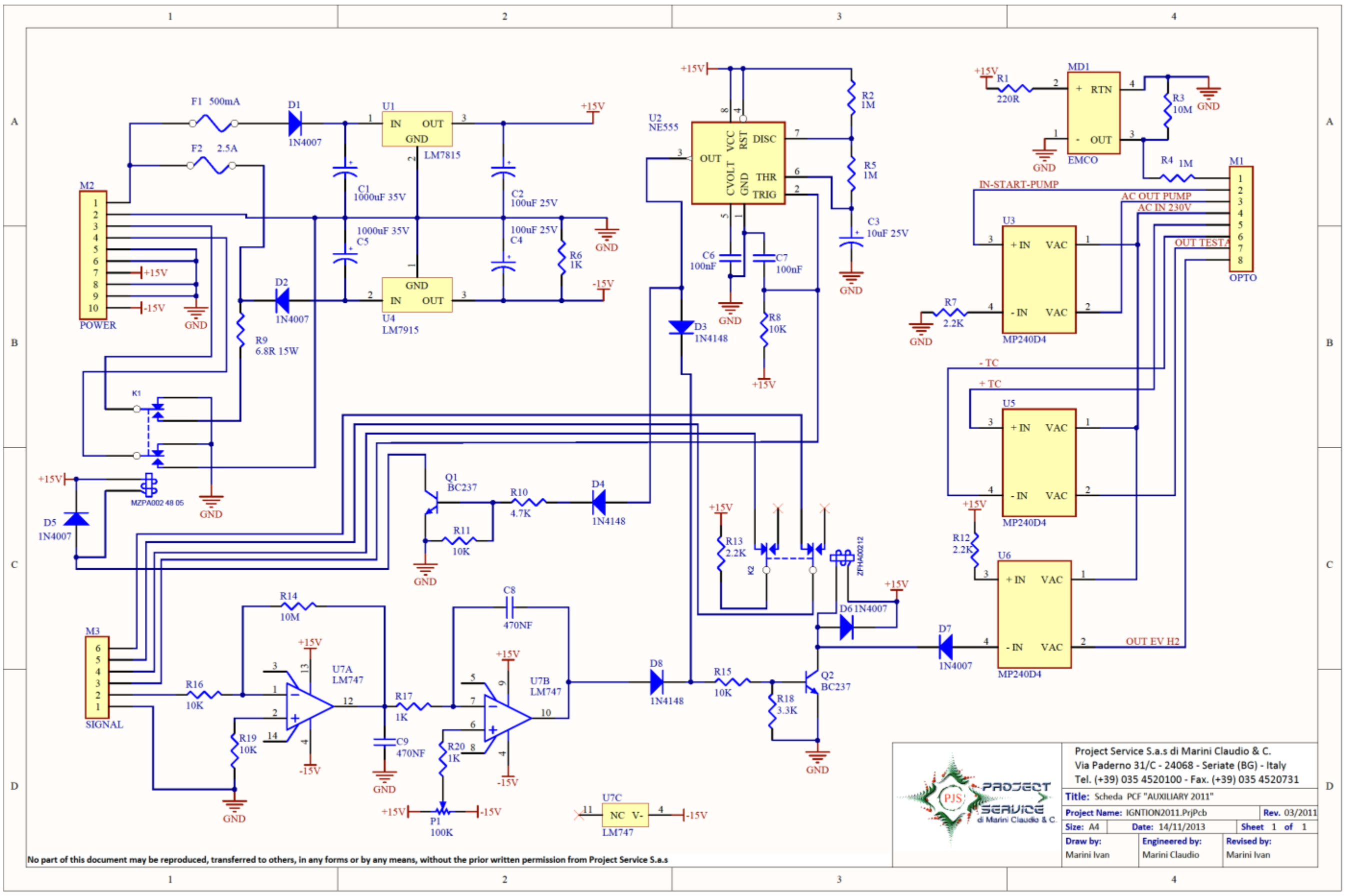
I/O block 1 (see below)

I/O block 2 (see below)



I/O block 3 (see below) I/O block 1 (see below)

The Power supply PCB, schematics



The section of flame ignition circuit

Figure captions

<u>Screw block 1 (6 positions):</u>

Pos. 1-2:	FID thermocouple
Pos. 3-4:	Ignition indication LED ON/OFF (when OFF is lighted)
Pos. 5-6:	Ignition ON/OFF (when OFF the contact is closed)

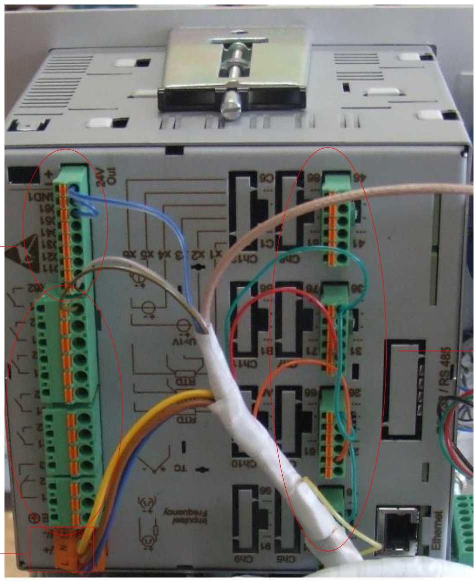
<u>Screw block 2 (6 positions):</u>

Pos. 6:	300 Vdc to FID, the return is through the instrument ground.
Pos. 1, 2, 3, 4, 5:	Not connected (not in use)

<u>Screw block 3 (10 positions):</u>

Pos. 1-2:	18Vac from main transformer
Pos. 3-4:	Power to the FID lighting resistance (0.1 Ohm)
Pos. 7:	+ 15 Vdc → to Mass Flow Meter Pos. 7
Pos. 8, 9:	Ground → to Mass Flow Meter Pos. 5
Pos. 10:	- 15 Vdc → to Mass Flow Meter Pos. 6

The back wiring of signals



7.4 The Data Acquisition System

In all the Models of 2000 family we mounted the Endress & Hauser universal graphic data manager:

https://www.ie.endress.com/en/Field-instruments-overview/System-Components-Recorder-Data-Manager/Ecograph-T-RSG35-Universal-Graphic-Data-Manager

7.5 **The temperature regulator**

The temperature regulator mounted in the instrument to control is supplied by ASCON.
For further Info please open the Operating Manual of the item from the Original Manufacturer:

http://www.ascontecnologic.com/images/PRODOTTI/AutomazioneIndustriale/Regolatori/PDF/C1/MIU_C1_EN.pdf

8.0 COMMISSIONING AND STARTING UP THE INSTRUMENT

8.1 Commissioning

- Connect the H_2 adduction gas from the two stages gas reducer of H_2 gas cylinder to the relevant connection located on the cover of analysis chamber and adequately indicted.
- Connect the heat traced line adducting gas sample to the instrument sample connection. The plug of the heating resistance must be connected to relevant socket located at the right bottom side of the instrument.
- Plug in the power supply cable to mains (220 V 50 Hz, 500 VA).

8.2 Starting up

- Move mains switch into ON position. By switching ON the instrument, green bulb will be lit.
- Wait approximately 20 minutes for the heating up and the conditioning of the instrument.
- Check that the manual switch for switching of air supply to FID detector is set to correct position according to the selected supply of combustion air to the monitor, (namely whether by UPP air gas cylinder or by in built air compressor and selective scrubber).
- Open the H_2 gas cylinder regulating the hydrogen pressure supply to the correct value indicate in the final test table.
- Switch on the sample pump **(Attention please: do not switch on the sample pump when instrument is cool, its Teflon head works properly only when heated up, working cool could cause its seizing)[1].**
- Press IGN push button and keep it pressed till IGN “OK” appears on the video graphic display. Wait about 20-30 seconds.
- If flame stays ON,the writing “Fiamma (Flame) OK” should be indicated on the video graphic display.
- In case on video graphic display IGN “Off” is shown, it means that FID flame is not correctly switched on. Repeat the above described operations till flame is correctly switched on.
- With the flame switched ON, wait approximately 10 minutes for the stabilisation of the electronics of the instrument; then zero the display with the ZERO potentiometer knob, making sure that the instrument is sampling clean ambient air (see Chap. 6).
- Insert the sampling Probe into the sampling hole.

8.3 Switching off the monitor

- Extract the sampling probe from the duct/stack
- Leave the monitor to operate for about ten minutes in ambient air (clean and dry sample).
- Move Pump switch lever on to “OFF” position.
- Close the tap of hydrogen gas cylinder
- Move the mains switch lever to “OFF” position.

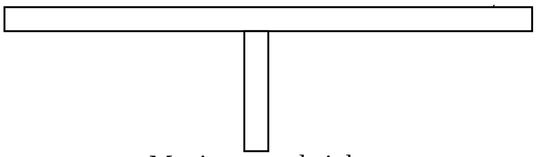
9.0 CALIBRATION (ZERO AND SPAN)

9.1 ZERO calibration

1- Make sure that the monitor is sucking clean air at ambient pressure, vent condition, and wait 2-3 minutes for stabilisation.
2- Zero the display with the ZERO knob.

9.2 SPAN calibration

1- Disconnect the heat traced line from the inlet connection of monitor.
2- Check the zero, unless was just performed.
3- Set the switch “Pompa Sample” (“Sample Pump”) to “OFF”.
4- Connect the output of two stage reducer of gas calibration cylinder. The connection must be performed under vent condition, i.e. at atmospheric pressure:



The suggested calibration mixture is the same used in our laboratories to perform the final checking of the instrument and outlined in the “instrument final check record”

5- Move the “Pompa Sample (“Sample Pump”) on to “ON” position; the-instrument will start sucking the ambient air.
6- Open standard gas cylinder tap to guarantee an excess of STD (Standard, calibration, gas) through the vent terminal of “T” tube.
7- Wait for about 60 seconds for measurement stabilisation then set, by “SPAN” potentiometer knob, the indicated measured value to the correct STD, calibration, value of gas cylinder.

VOC (Volatile Organic Carbon concept)
As described in chap. 1.0, FID detector response is proportional to the carbon concentration that flows through high temperature flame.
Therefore at the same ppm concentration, an organic molecule with 1 carbon atom counts for 1 whereas an organic molecule with 2 carbon atoms counts for 2 etc.
The calibration should be done in term of either Carbon Atom ppm or CH_4 equivalent concentration.

Example (we refer to suggested calibration cylinder concentration in specs)
Suppose the STD, standard or calibration gas mixture, contains 40 ppm of methane (CH_4) and 10 ppm of C_3H_8 (propane).
We must keep in mind that 1 ppm of propane (C_3H_8) corresponds to 3 ppm of methane (CH_4) as having three carbon atoms in each molecule, it produces a response three times higher in the FID detector (FID detector response is approximately proportional to the content of carbon atoms independently from chemical bonding)

Therefore 10 ppm of propane (C_3H_8) are approximately equivalent to 30 ppm of methane (CH_4).
In our calibration mixture we will count 40 ppm methane + 30 ppm equivalent of propane = 70 ppm methane (Carbon) equivalent.

The instrument must be set calibrated to Total VOC = 70 ppm
Or, as alternative (please note the general formula to convert ppm into mg/Nm^3):

$$70\ ppm * \frac{12\ (Carbon\ Molecular\ Weight)}{22{,}414\ (Molecular\ Volume)} = 37{,}45\ mg/Nm^3\ VOC$$

NOTE:

1- *Instead of a mixture of Methane and Propane the calibration gas cylinder could very well contain either only Methane (e.g. 70 ppm) or just propane 15 ppm (for a Methane equivalent of approximately 75 ppm).fd*
2- *The calibration gas cylinder mixture must always be balanced with air, as the nitrogen could produce a lower signal In the FID detector. For emission applications, the suggested gas cylinder mixture for calibration is 40 pp of methane (CH4) + 10 ppm of propane (C_3H_8) with air balance.*

8- Once set the signal displayed to the correct calibration (standard) value, close the tap of calibration gas cylinder, then move the “Pompa Sample” switch to “OFF” position.
9- Wait about two minutes then zero the display with ZERO knob potentiometer.
10- Disconnect the T tube for the calibration of monitor from sample inlet and connect to the same inlet the heat traced line carrying the sample gas under measurement.
11- Move the “Pump Sample” switch on to “ON” position.
12- Now the monitor is correctly set to perform measurements of Total VOCs.

10.0 MONITOR MAINTENANCE PROCEDURES

All the operations described in the present section must be performed with mains 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.

10.1 Suggested maintenance schedule

Basically PCF Elettronica Mod. C 2011 is a quite simple VOC (NMH) monitor with tested parts to last 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 multimeter and

Time	Operations	Actions (if necessary)
Commissioning	Check: Power Supply Gas Supplies (quality and pressure) Service gas pressure	
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	Scrubbing efficiency Check H_2 capillary Air capillary Carrier capillary	Replace catalyst Replace

10.2 Trouble shooting

Events	Actions
Completely dead display:	
- Check the mains power supply	Connect power supply
- Check the fuse on the power supply socket	Eventually replace the fuse
- Check display lamps	Replace lamps if necessary
- Micro processor PCB not working	Replace micro processor PCB
FID flame does not ignite LED always on	
- Wrong hydrogen and air pressures	Check hydrogen and air supply and set the correct hydrogen and air pressures
- Lack of hydrogen supply	Check hydrogen cylinder, opening tap and pressure
- Clogged H_2 or Air capillaries	Check flow rate and replace if necessary
- FID air compressor not working	Either maintain or replace air compressor
- Ignition spiral is broken	Replace FID
- FID thermocouple broken	Replace FID
- Transformer not working	Replace transformer
- Auxiliary services PCB is not working	Replace auxiliary services PCB
Dead output signals	
- FID detector not working	Replace FID detector
- Electrometer board not working	Replace electrometer board
- Auxiliary services PCB not working	Replace auxiliary services PCB
RS 232 signal working , 0-10 Vdc signal not present	
- Check external connection	Restore external connection
- Electrometer PCB not working	Replace electrometer PCB
Lack of FID air gas pressure	
Supply air cylinder (if present) empty or with closed interception valve	Open the gas cylinder or replace it
- FID air compressor not working	Either maintain or replace FID air compressor
- Leakage in the relevant circuit	Find and mend the leakage
- Pressure regulator not working	Replace pressure regulator
- Manometer not working	Replace manometer
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 pressure regulator
- Manometer not working	Replace manometer
- Auxiliary services PCB not working	Replace auxiliary services PCB
No circulation of sample gas	

Sample adduction line either interrupted or clogged	Maintain heat trace sample line and/or probe ceramic filter
Sampling pump not working	Either maintain or replace sampling pump
Auxiliary services card not working	Replace auxiliary services PCB

11.0 SPARE PARTS

Code Number	Description
095020114	Sample capillary
095020115	Hydrogen capillary
095020116	Air capillary
095020120	Catalytic scrubber (HC into CO_2)
095020121	Scrubber sub assembly
095020125	FID detector sub assembly
095020127	Air compressor oil less pump
095020128	Sample sucking heated head pump
095020130	Red LED
095020132	Return push button
095020133	Lever switch
095020134	Zero and Span potentiometer
095020135	Display microprocessor PCB
095020136	Power supply transformer
095020137	Mains power supply socket
095020138	Cooling fan
095020141	Electrometer PCB
095020144	Auxiliary services PCB
095020146	Stabilised Power Supply PCB
095020147	Display microprocessor PCB
095020150	PT 100 temperature detector
095020152	FID detector heating resistance
095020153	Catalytic converter heating resistance
095020155	Sintered filter
095020156	Sampling probe ceramic filter
095020157	Ceramic filter gasket
095020163	ZERO – SPAN potentiometer
095020164	Multi-turn potentiometer knob
095020170	SS sampling probe
095020180	Heat traced sampling line (standard length 3 m)

41-6021	**Suggested consumables set (including)** n.**2** ceramic filter for sampling probe n.1 heated pump rebuild kit n.1 air pump rebuild kit n.1 fuse set
41-6022	**Suggested spare parts set (including)** n.1 sample capillary n.1 hydrogen capillary n.1 pressure regulator n.1 catalist replacement n.1 Seal set n.1 Flame ON temperature sensor

PCF ELECTRONICA
MOD. C 2011
Portable Dual HOT FID VOC (NMH) MONITOR

FINAL CHECK RECORD

H_2 Gas cylinder pressure …………… Bar
To FIDs, flow rate ……………. ml/min (FID CH_4 channel)
….………… ml/min (FID VOC channel)

AIR To FIDs, flow rate ……………. ml/min (FID CH_4 channel)
…………….. ml/min (FID VOC channel)

SAMPLE To FIDs, flow rate …………….. ml/min (FID CH_4 channel)
…………… ml/min (FID VOC channel)

OVEN ………………… °C

CALIBRATION PARAMETERS

Calibration mixture used to calibrate the monitor: CH_4 + C_3H_8, air balance

Gas cylinder: ………………….. Certification N# ……….

Dilution device: THERMO ELECTRON Mod. 146 Dilution system

Traceable
gas mixture: CH_4 __________ ppm VOC __________ mg/Nm^3
C3H8 __________ ppm VOC __________ mg/Nm^3

Traceable
gas mixture: Total (CH_4+C_3H_8) __________ ppm VOC __________ mg/Nm^3

Measure
gas mixture: Total (CH_4+C_3H_8) __________ ppm VOC __________ mg/Nm^3

Set point of SPAN: _____________Notches
Set point of ZERO: _____________Notches

Service Engineer………………………….. Date:……………….

Here below please find some of the experimentally obtained FID responses.

Organic Compound	*Molecular Weight*	*Relative Sensitivity*	*Response Factor [1]*	*Response against Methane*	*Response against Propane*	*ppm to mg/m³ conversion factor*	*ppm to mgC//m³ conversion factor*
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
Isopentane	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
2,3-dimethyl Butane	86.17848	1.03	88.7638	5.5887	2.0540	3.8449	3.2153
2-methyl Pentane	86.17848	1.05	90.4874	5.6973	2.0939	3.8449	3.2153
3-methyil Pentane	86.17848	1.04	89.6256	5.6430	2.0739	3.8449	3.2153
2,2-dimethyl Pentane	100.2056	1.02	102.2097	6.4353	2.3651	4.4707	3.7511
2,3-dimethyl Pentane	100.2056	0.99	99.2035	6.2461	2.2956	4.4707	3.7511
1,1,2-trimethyl cycle hexane	126.2438	0.98	123.7189	7.7896	2.8629	5.6324	4.8229
Cycle 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
Para Xylene	106.1689	1.00	106.1689	6.6846	2.4567	4.7367	4.2870
Meta Xylene	106.1689	1.04	110.4157	6.9520	2.5550	4.7367	4.2870
Ortho Xylene	106.1689	1.02	108.2923	6.8183	2.5059	4.7367	4.2870
1,2,3-trimethyl Benzene	120.1960	0.98	117.7921	7.4164	2.7257	5.3625	4.8229
N propyl Benzene	120.1960	1.01	121.3980	7.6435	2.8091	5.3625	4.8229
n- butyl Benzene	134.2231	0.98	131.5386	8.2819	3.0438	5.9884	5.3588
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
Iso propanol	60.09661	0.53	31.8512	2.0054	0.7370	2.6812	1.6076
n-Butanol	74.12370	0.66	48.9216	3.0802	1.1320	3.3070	2.1435
Iso butanolo	74.12370	0.68	50.4041	3.1735	1.1663	3.3070	2.1435
sec-Butano	74.12370	0.63	46.6979	2.9402	1.0806	3.3070	2.1435
ter-Butanol	74.12370	0.74	54.8515	3.4536	1.2693	3.3070	2.1435
Methyl-iso-buthyl-carbinol	88.15079	0.74	65.2316	4.1071	1.5095	3.9328	2.6794
1-Hexanol	102.17790	0.74	75.6116	4.7607	1.7496	4.5587	3.2153
1-Octanol	128.21610	0.85	108.9837	6.8618	2.5219	5.7204	4.2870
1-Decanol	154.25440	0.84	129.5737	8.1582	2.9983	6.8821	5.3588
Butyrraldehyde	72.10776	0.62	44.7068	2.8148	1.0345	3.2171	2.1435
1-Eptaldehyde	114.18900	0.77	87.9255	5.5360	2.0346	5.0945	3.7511
1-Octaldehyde	128.21610	0.80	102.5729	6.4582	2.3735	5.7204	4.2870
Decanal	156.27030	0.80	125.0162	7.8713	2.8929	6.9720	5.3588
Formic acid	46.02589	0.01	0.4603	0.0290	0.0107	2.0534	0.5359
Acetic acid	60.05298	0.23	13.8122	0.8696	0.3196	2.6793	1.0718
Propionic acid	74.08007	0.40	29.6320	1.8657	0.6857	3.3051	1.6076
Butyric acid	88.10716	0.48	42.2914	2.6628	0.9786	3.9309	2.1435
Hexanoic acid	116.16130	0.63	73.1816	4.6077	1.6934	5.1825	3.2153
Eptanoic acid	130.18840	0.61	79.4149	5.0001	1.8377	5.8084	3.7511
Octanoic acid	144.21550	0.65	93.7401	5.9021	2.1691	6.4342	4.2870
Methyl acetate	74.08007	0.20	14.8160	0.9328	0.3428	3.3051	1.6076
Ethyl acetate	88.10716	0.38	33.4807	2.1080	0.7747	3.9309	2.1435
Isopropyl acetate	102.13430	0.49	50.0458	3.1510	1.1581	4.5567	2.6794

sec-Buthyl-acetate	116.16130	0.52	60.4039	3.8031	1.3977	5.1825	3.2153
Iso-buthyl acetate	116.16130	0.54	62.7271	3.9494	1.4515	5.1825	3.2153
Acetonitrile	41.05291	0.39	16.0106	1.0081	0.3705	1.8316	1.0718
Dimethyl formamide	73.09534	0.41	29.9691	1.8869	0.6935	3.2611	1.6076
Trimethyl amine	59.11188	0.46	27.1915	1.7120	0.6292	2.6373	1.6076
Ter-Buthyl amine	73.13897	0.54	39.4950	2.4867	0.9139	3.2631	2.1435
Diethyl amine	73.13897	0.61	44.6148	2.8090	1.0324	3.2631	1.0718
Aniline	93.12939	0.75	69.8470	4.3977	1.6163	4.1550	3.2153
Acetone	58.08067	0.59	34.2676	2.1576	0.7930	2.5913	1.6076
Tetrahydrofuran	72.10776	0.76	54.8019	3.4504	1.2681	3.2171	2.1435
Isopropyl ether	102.17790	0.70	71.5245	4.5033	1.6551	4.5587	3.2153
2-Butoxyethanolo	118.17730	0.60	70.9064	4.4644	1.6408	5.2725	3.2153

[1] – response factor = relative sensitivity x molecular weight

APPENDIX 1

1.1 The Data Acquisition System

With Mod. C2011 the NMH value is read in real time on the display.

In all the Models of 2000 family we mounted the Endress & Hauser universal graphic data manager:

https://www.ie.endress.com/en/Field-instruments-overview/System-Components-Recorder-Data-Manager/Ecograph-T-RSG35-Universal-Graphic-Data-Manager

Specifically, in Mod. C 2011 we mounted Mod. T RSG 35 with four analogue channel inputs. Of the latter, three are employed to record and memorize ranges x1, x10, x100 and the last one is free for possible memorization of other analogue input from outside (temperature, flow rates, pressure, etc.).
A special SW version is mounted to calculate in real time the NMH value as the difference between the Total VOC and Methane values:
NMH = Total VOC – CH_4

In order to operate correctly the T RSG 35, please read carefully the Operating Manual for the sections of interest:

https://portal.endress.com/wa001/dla/5000629/3842/000/05/BA01146REN_0617.pdf

1.2 Useful basic info on Data management

1.2.1 The very simple commands and data storage of the unit.

DAS Mod. T RSG 35

Three measuring ranges
(x1, x10, x 100)

Access to data storage

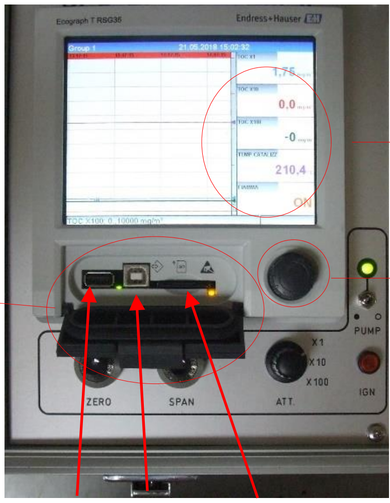
Colour Video Graphic Display

Programming knob
(Rotate + push, it is very simple)

Note: With the above indicated knob you select the main functions of the DAS and you confirm them by pressing the central part of the same. If you make any mistake you may return backwards.

DAS Mod. T RSG 35
(With open data storage compartment)

Data Storage compartment
(with open door)



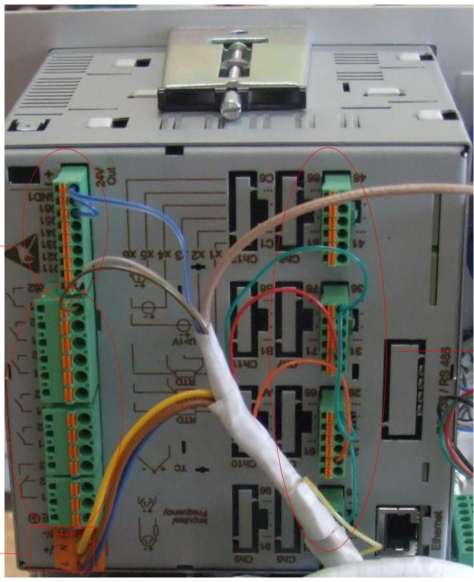
Measuring ranges
(x1, x10, x100)

Programming knob

USB flash Memory   USB remote connection   MD card

1.2.2 The fundamental steps in data management

The back wiring of signals



The basic configuration of I/O data have been set in the factory.

1.2.3 Some of the most frequently requested configuration modifications

<u>The polling time for the data (interval time of sampling)</u>

Operate as follows (select from the basic video display):

- Operation
- Set-up
- Advanced set up
- - ApplicationSignal group
- Save cycle
- ………

Whenever you select “**Back”** you return back **of one step of the sequence.**

<u>Programming the initial time of analysis (naming the file of next data)</u>

Operate as it follows (select):

- Operation from basic videata
- SD/MC card or flash memory
- Save measurement values
- From ….. (insert date and time)

<u>Programming the mean values</u>

Operate as it follows (select):

- Operation (from basic videata)
- Set up
- Adv. Set up
- Application
- Signal analysis
- Select the value.

NOTE: In the instrument you received you have recorded the tests and calibration data. Use the memorised data to practice in data management.

1.3 Data memorisation and down loading

All the data as well as the instrument configuration are saved on the SD (MC) and/or USB flash memory.
If you extract the SD (MC) or USB flash memory you may read the recorded data from a PC.
The data are read with two fundamental programs:

- **FILE DATA MANAGER** supplied with the instrument.

You must install it in your PC to be able to read the recorded data in the unchangeable format.

- **EXCEL** (Microsoft). The data may be read and managed only if they were not memorised in protected configuration (unchangeable format).

You may also read the data directly from the USB port directly connected to PC (USB remote connection).

Now:

1) If you use FILE DATA MANAGER the data must be recorded in protected format:

- On line connection
- New device
- USB
- Next
- Next
- (Configuration + data are downloaded)
- New
- Take the interested file on the right side of the window
- You may select the data to be shown
- Next
- Selct all
- next
- Date interval
- …….

2) If you intend to use EXCEL the data must be recorded in a not protected file and start from basic videata:

- Export
- EXCEL
- Next
- Create a new folder (cartella, with a name)
- Select file to be exported
- Move it to the right
- Next
- Select
- Next
- Select time interval
- Give a name to the file to be saved
- …….

APPENDIX 2

GAS CONNECTIONS
CAUTION WITH THE HYDROGEN SOURCE (VERY IMPORTANT!)

ATTENTION! DO NOT APPLY A PRESSURE HIGHER THAN THE INDICATED ONE:

H_2= 3,0 Bar max.

Air (optional) = 5,0 Bar max.

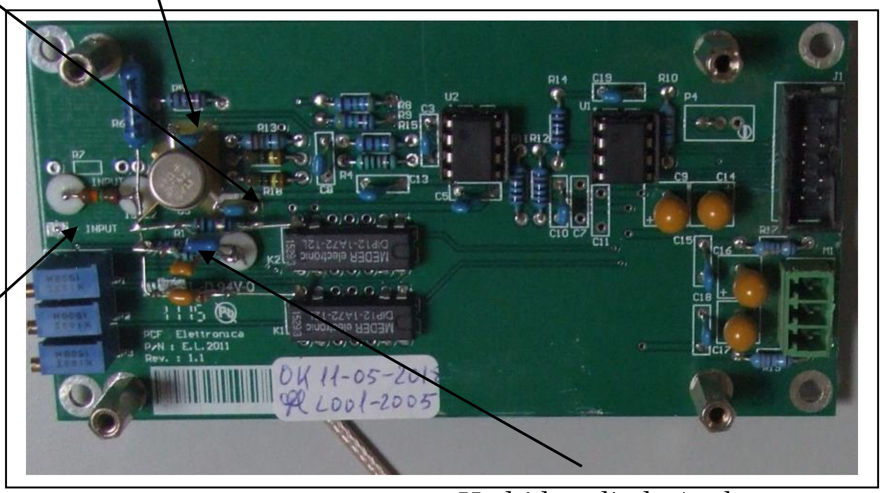
When wiring the hydrogen supply pipe to the analyzer it is necessary to be very careful. The connection **must be manually screwed** and only at the end, when you are sure that the fitting is screwed to the end, it must be blocked with the key (8 mm) provided.

You do not have to force for any reason the connection plug to avoid damaging the screw of the same and necessitate its replacement with the consequent impossibility to use the instrument as well as to avoid hydrogen losses.

The customer must make sure that all the hydrogen cylinders used are in compliance with the safety standards laid down for the accommodation of the same.

AN INSTRUMENT UNCORRECTLY INSTALLED IS UNABLE TO PROPERLY OPERATE AND MAY BE A DANGER FOR THE OPERATOR

THE HYDRIDE CARTRIDGE, in built in the instrument.
The hydride cartridge is foreseen as option as constitution of the compressed H_2 mini cylinder.



APPENDIX 3

HYDRIDE CYLINDER WITH HYDROGEN RELASE AT LOW PRESSURE

QUICK START MANUAL
[Note: as the hydride cylinder is not of our production it could slightly change in dimensions and/or specifications]

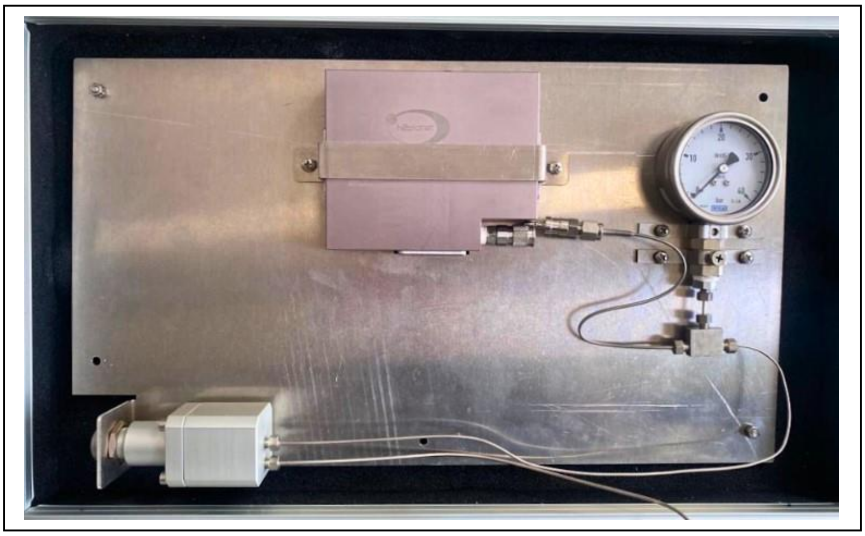
A) Hydrogen refilling procedure

1. Place the hydrides cartridge as to facilitate connection to a hydrogen source such as pressurized cylinders or electrolysers compatible (hydrogen generators).
   Avoid working in awkward positions with short tubes.
2. Open the black knob of the hydride cartridge safety valve by turning it clockwise.
3. Purge a small amount of air/hydrogen mixture from the **special pipe** connected to the source of hydrogen, by the use of the supplied interception valve, or by a short pressure applied to the end supplied male connector, **before connecting it to the hydride cylinder**. This should eliminate polluting gases such as nitrogen or oxygen present in the air.
4. Connect the hydrogen source through the appropriate pipe and a provided pressure regulator, ensuring that the chosen source (cylinder or H_2 generator) has a minimum pressure of 10-15 bars. Use a pressure regulator with dual-stage secondary stage that reaches at least 30 bar to speed up charging. **Never exceed 30 bar pressure, this could cause irreparable damage to the device.**
5. If possible, gently place the hydride cylinder in a bath of cold water (10-15 ° C), preferably in a horizontal position, ensuring that the filling hose is not choked and that the quick connector at the connection point is not under water .
6. If applicable, gradually increase the pressure up to a maximum of 30 bar (keep still around 20 bar). The cartridge should start to heat to effect the adsorption of hydrogen and for the increase of pressure.
7. When immersed in a water bath, as to completely fill the cylinder, keep the water temperature the more possibly also constant with the progress of charging. The walls of the cylinder will heat up and consequently also the water will warm.
8. If the refilling is via industry standard cylinders at pressures of 25 bar, after about 20 minutes the cartridge will be charged. Otherwise the cartridge will be charged after about 30 minutes, if the process is carried out with pressures of 15 bar. In the case of charging with H_2 generators, wait until the hydrogen flow toward the cartridge falls in the neighbourhood of 10-20 cc/min; at that point you will have the certainty of the filled cartridge.
9. Disconnect the quick coupler from the cylinder by pulling out the female attack ring on the cartridge. Do not force in any way the connector; eventually, in case of difficulty in extracting, pull out at the same time the male connector or, even better, contact our. Technical Support.

Always close, when not in use, the cartridge black knob, turning it clockwise.

B) Hydrogen desorption procedure

1. Connect the quick coupling kit by connecting an end of the same to the quick connection of the cylinder and the other to the device you want to cater.
2. Open the black knob of the hydride cartridge safety valve by turning it counter clock wise.
3. Turn on the device to cater, in our case FID detector, to begin to use the stored hydrogen.
4. After use close the hydride cartridge safety valve black knob by turning it clockwise and disconnect it as in step 9 of the charging.



The Hydride Device mounted on the aluminium cover inside the VOC portable monitor

The Hydride Device connected to the H_2 Input connector of the monitor

C) Description of a hydride cylinder

The technical characteristic of supplied cylinder may change without notice.
The definitive specifications of the installed hydride cylinder will be described in the enclosed operating manual to the instrument.

The special connecting SS tube for filling the Hydride Canister with H2, from an external gas cylinder