R990 MicroGC with OBC

User manual

Version 1.4

Dear user,

Thank you for choosing this SRA Instruments product.

This manual contains all the necessary information for the correct use of your instrument. Should you need further information or if you encounter any problems, please contact our After Sales Service:

Hotline: +33 (0)4 78 44 22 09
E-mail : service@sra-instruments.com

SRA INSTRUMENTS ANALYTICAL SOLUTIONS	SRA Instruments 210 rue des Sources 69280 Marcy l'Etoile FRANCE	Tel : +33 (0)4 78 44 29 47 info@sra-instruments.com www.srainstruments.com

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1. Introduction

For reasons of clarity, this manual does not contain all detailed information on all types of coupling.
In addition, it cannot describe every possible case concerning installation, use and maintenance.

If you require additional information about this device or if you encounter problems that are not addressed in this manual, you can contact SRA Instruments for assistance.

The content of this manual is not part of any previous or existing agreement, commitment or legal status and does not change these. All the commitments of SRA Instruments are contained in the respective sales contracts, which also contain the only and entire applicable warranty terms. These warranty conditions in the contract are neither extended nor limited by the content of this manual.

2. Safety instructions

Important information

This instrument is designed for chromatographic analysis of appropriately prepared samples. It must be operated using appropriate gases or solvents and within specified maximum ranges for pressure, flows, and temperatures as described in this manual. If the equipment is used in a manner not specified by SRA Instruments, the protection provided by the equipment may be impaired.

It is the responsibility of the customer to inform SRA Instruments after-sales service if the instrument has been used for the analysis of hazardous samples, prior to any instrument service being performed or when an instrument is being returned for repair.

2.1 For your protection

Warnings:

Warning: Shock hazard

Do not replace components while the power cable is plugged in. To avoid injuries, always turn off power before touching them. Install the R990 MicroGC so that access to the power cable is easy. Make sure that you connect the cable to an earth socket, otherwise there is a lethal hazard.

Warning: Hot surfaces

Several parts of the R990 MicroGC work at temperatures high enough to cause severe burns. These parts include, among others:

- the oven
- the columns

You must be extremely careful to avoid touching these heated surfaces. Do not use the instrument if the R990 MicroGC is disassembled.

Warning: Electrostatic discharge is a threat to electronics

Electrostatic discharge (ESD) can damage the printed circuit boards of the R990 MicroGC. If you must hold an electronic card wear a grounded wrist strap and hold it only by its edges.

Warning: Use of gases

Do not use gases that can form an explosive mixture. Avoid using hydrogen as the carrier gas or purge gas for your analyses.

Warning concerning the use of hydrogen

When using hydrogen (H_2) as the carrier gas, be aware that hydrogen gas can create a fire or explosion hazard. Be sure that the supply is turned off until all connections are made.

Hydrogen is highly flammable. Leaks, when confined in an enclosed space, may create a fire or explosion hazard.
In any application using hydrogen, leak test all connections, lines, and valves before operating the instrument. Always turn off the hydrogen supply at its source before working on the instrument.

- Hydrogen is combustible over a wide range of concentrations.
  At atmospheric pressure, hydrogen is combustible at concentrations from 4 % to 74.2 % by volume.
- Hydrogen has the highest burning velocity of any gas.
- Hydrogen has a very low ignition energy.
- Hydrogen that is allowed to expand rapidly from high pressure into the atmosphere can self-ignite.
- Hydrogen burns with a nonluminous flame which can be invisible under bright light.

Warnings related to chemical products

When handling or using chemicals for preparation or use within the MicroGC, all applicable local and national laboratory safety practices must be followed. This includes, but is not limited to, correct use of Personal Protective Equipment, correct use of storage vials, and correct handling of chemicals, as defined in the laboratory's internal safety analysis and standard operating procedures. Failure to adhere to laboratory safety practices could lead to injury or death.

2.2 Safety and regulatory information

This instrument and its accompanying documentation comply with the CE specifications and the safety requirements for electrical equipment for measurement, control, and laboratory use.

This device has been tested and found to comply with the limits required by regulations. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy. If it is not installed and used in accordance with the user manual, it may cause harmful interference to radio communications.

NOTICE: This instrument has been tested per applicable requirements of EMC Directive as required to carry the European Union CE Mark. As such, this equipment may be susceptible to radiation/interference levels or frequencies, which are not within the tested limits.

CE This symbol confirms that the R990 complies with all electrical safety regulations.

2.3 General safety precautions

Follow the following safety practices to ensure safe equipment operation:

- Perform periodic leak checks on all supply lines and pneumatic plumbing.
- Do not allow gas lines to become kinked or punctured.
  Place lines away from foot traffic and extreme heat or cold.
- Avoid exposure to potentially dangerous voltages. Disconnect the instrument from all power sources before removing protective panels.
- When it is necessary to use a non-original power cord and plug, make sure the replacement cord adheres to the colour coding and polarity described in the manual and all local building safety codes.
- Replace faulty or frayed power cords immediately with the same type and rating.
- Place this instrument in a location with enough ventilation to remove gases and vapours. Make sure there is enough space around the instrument so that it can cool sufficiently.
- Before plugging the instrument in or turning the power on, always make sure that the voltage and fuses are set appropriately for your local power source.
- Do not turn on the instrument if there is a possibility of any kind of electrical damage. Instead, disconnect the power cord and contact SRA Instruments.
- The supplied power cord must be inserted into a power outlet with a protective ground connection. When using an extension cord, make sure that the cord is also properly grounded.
- Do not change any external or internal grounding connections, as this could endanger you or damage the instrument.
- The instrument is properly grounded when shipped. You do not need to make any changes to the electrical connections or to the instrument chassis to ensure safe operation.
- When working with this instrument, follow the regulations for Good Laboratory Practices (GLP). Take care to wear safety glasses and appropriate clothing.
- Do not place containers with flammable liquids on this instrument. Spilling liquid over hot parts may cause fire.
- This instrument may use flammable or explosive gases, such as hydrogen gas under pressure. Before operating the instrument be sure to be familiar with and to follow accurately the operation procedures prescribed for those gases.
- Never try to repair or replace any component that is not described in this manual without the assistance of SRA Instruments. Unauthorized repairs or modifications will result in rejection of warranty claims.
- Always disconnect the AC power cord before attempting any type of maintenance.
- Use the proper tools when working on the instrument to avoid endangering yourself or damaging the instrument.
- Do not attempt to replace the battery or a fuse in this instrument with parts not specified in the manual.
- Damage can result if the instrument is stored under unfavourable conditions for prolonged periods. (For example, damage will occur if stored while subject to heat, water, or other conditions exceeding the allowable operating conditions).
- Do not shut off column flow when the oven temperature is high since this may damage the column.
- This instrument has been designed and tested in accordance with recognized safety standards and designed for use indoors.

- If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired.
- Substituting parts or performing any unauthorized modification to the instrument may result in a safety hazard.
- Changes or modifications not expressly approved by the responsible party for compliance could void the user's authority to operate the equipment.

2.4 To begin with

- Check that the operating voltage of the instrument is compatible with the one of your electrical network before switching it on. Otherwise the device may be damaged.
- Use only gases and solvents specified in the operating procedures.
- Do not open the instrument without the permission of SRA Instruments.
- Eliminate from the environment of the instrument: vibrations, magnetic effects, and explosive gases.
- The R990 MicroGC must only be used indoors; it is designed for use at room temperature and under conditions where no condensation can occur. Install the R990 MicroGC on a rigid and stable surface.
- Have your instrument serviced by SRA Instruments.

3. Transport, cleaning, and disposal of the instrument

3.1 Shipping instructions

If your MicroGC must be shipped for any reason, it is very important to follow these additional shipping preparation instructions:

- Place all the vent caps on the back of the MicroGC.
- Always include the power supply.
- Include, if used, the inlet filter(s).

3.2 Cleaning

To clean the surface of the MicroGC:

1. Switch the MicroGC off.
2. Remove the power cable.
3. Put protection plugs on the sample and carrier gas inlets.
4. Put protection plugs on the column vents.
5. Use a soft brush (not hard or abrasive) to carefully brush away all dust and dirt.
6. Use a soft, clean cloth dampened with mild detergent to clean the outside of the instrument.
    - Never clean the inside of the instrument.
    - Never use alcohol or thinners to clean the instrument; these chemicals can damage the case.
    - Be careful not to get water on the electronic components.
    - Do not use compressed air to clean the instrument.

3.3 Instrument disposal

When the MicroGC or its parts have reached the end of their useful life, dispose of them in accordance with the environmental regulations that are applicable in your country.

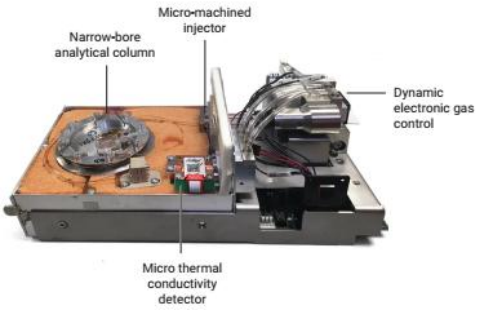
Do not throw away this equipment. Contact a competent recycling organism.

4. Instrument overview

4.1 Presentation

The R990 MicroGC is a rack in which a maximum of 4 analytical channels of 990 MicroGC are associated. It is available in 2 versions : with or without on-board computer (OBC).

Rack 5U



Analytical channel

4.2 Operating principle

The R990 MicroGC can be equipped with 1 to 4 independent analytical channels (1 channel = 1 module). Each channel is a miniaturized and complete GC, including:

- A micro-machined injector
- An analytical column of small diameter
- A micro catharometer (µ TCD)
- An electronic gas control

} **Module**

Chapter 8 provides a detailed overview of how a MicroGC analytical module works.

4.3 Front view

The front panel is composed of :

- A power switch
- A LED indicating the power on and the status of the MicroGC
- One USB 3.2 port
- A touch screen TFT 7” - 24 bit - 1024 x 600 pixels
- A nameplate with the characteristics of the device

LED state definitions:

LED state	**Indication**
Red - solid	Recoverable error
Red - blinking	Critical error
Yellow - solid	System in **not ready** or **stabilizing** status
Yellow - blinking	System in **flushing** or **column cleaning** status
Green - solid	System in **ready** status: all heated zone, column pressure, and TCD statuses are within **ready** window
Green - blinking	System in **run** status

4.4 Back view

4.4.1 Gas inlets and vents

#	Designation	Connector type	Recommendations	Optional
1	Sample inlets 1 & 2	Inert 1/8" male tube fitting + sintered	Pressure 1 relative bar max ; gas	no
2	Carrier gas inlets	Inert 1/8" male tube fitting + sintered	Pressure 5.5 bar ; Purity 99.9995 %	no
3	Reference and analysis vents	1/8" male tube fitting	Atmospheric pressure	no
4	Backflush vents	1/8" male tube fitting	Atmospheric pressure	no
5	Sample vents	1/8" male tube fitting	Atmospheric pressure	no
6	3-way 2-position electro valve	1/8" male tube fitting	Pressure 1 relative bar max ; gas	yes
7	Multi-position valve type VICI (4 to 16 ways)	1/8" male tube fitting	Pressure 1 relative bar max	yes
8	Genie filter	1/16" male tube fitting	Pressure 1 relative bar max	yes

Remark: For trace analysis, the recommended gas purity is 99.9999 %.

Notes:
(1) The 3-way electro valve is used to select the sample or calibration channel. It is controlled by the MicroGC main board (relay 1).
(2) The multi-position valve is controlled by the COM 2 port of the R990.
(3) Possibility of sulfinert treatment for the Genie filter.

4.4.2 Communication

#	Connector type	Source	Designation	Use
1	USB 2.0 (x 2)	OBC	Keyboard and mouse plug	Maintenance operations
2	LAN	OBC	Ethernet plug	Control, display and Modbus
3	SUB-D9 male (x2)	OBC	COM 01 and COM 03 ports configurable as RS 232 / RS 485 or RS 422	VICI or Modbus
4	VGA Screen out	OBC	Screen plug	Maintenance operations
5	SUB-D9 male	OBC	COM 02 port (RS 232)	VICI or Modbus
6	SUB-D25 female	MicroGC main board	Digital input/output	Control of instrument or external components
7	Power In + switch + fuse		Power supply	

Optional :

Connector type	Source	Designation	Use
Screw connector with 4 analog inputs 0-10 V or 0-20 mA (individually configurable)	MicroGC mainboard	Analog inputs	External sensor
Screw connector with 4 x 4-20 mA	ADAM module	Digital outputs	Transmission of results
Screw connector with 4 x 5 A - 250 V relays	ADAM module	Relay outputs	Control of external equipment

4.5 Inside view

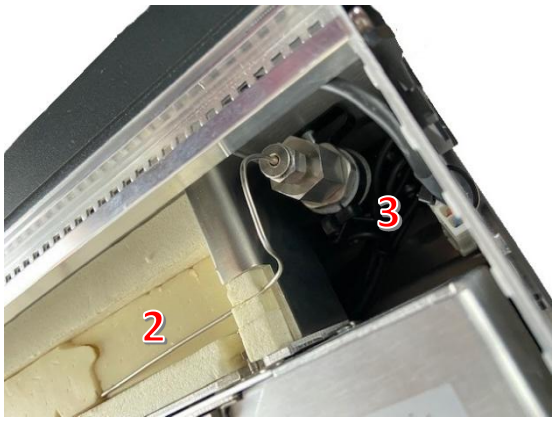
4.5.1 Top view

1 : Analytical modules
2 : Heated sample distribution manifold

3 : Pressure sensor (option)

It uses an analog input 0-10 V of the MicroGC main board.
It allows to measure the pressure of the sample at its entry in the chromatograph.

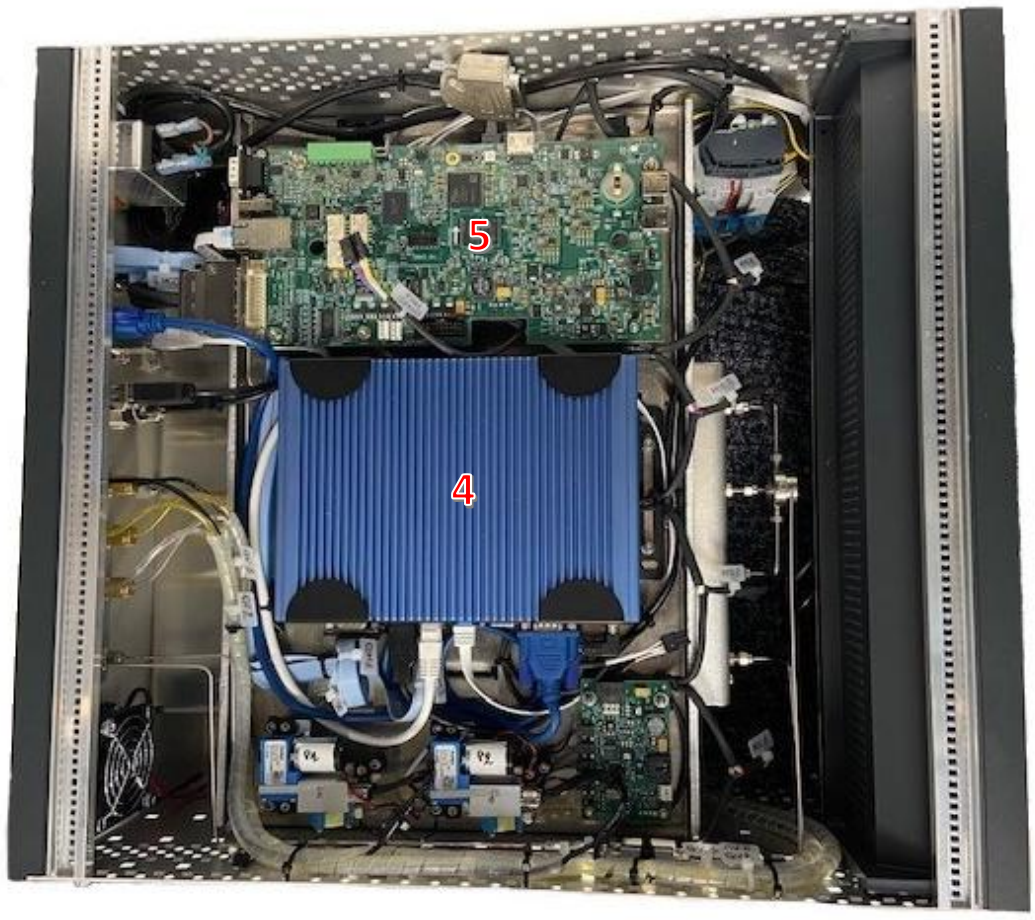
Measurement range: -1 to 1.5 relative bar
Accuracy: +/- 60 mbar



! Warning: the pressure is indicated in absolute bars in the Soprane CDS software.

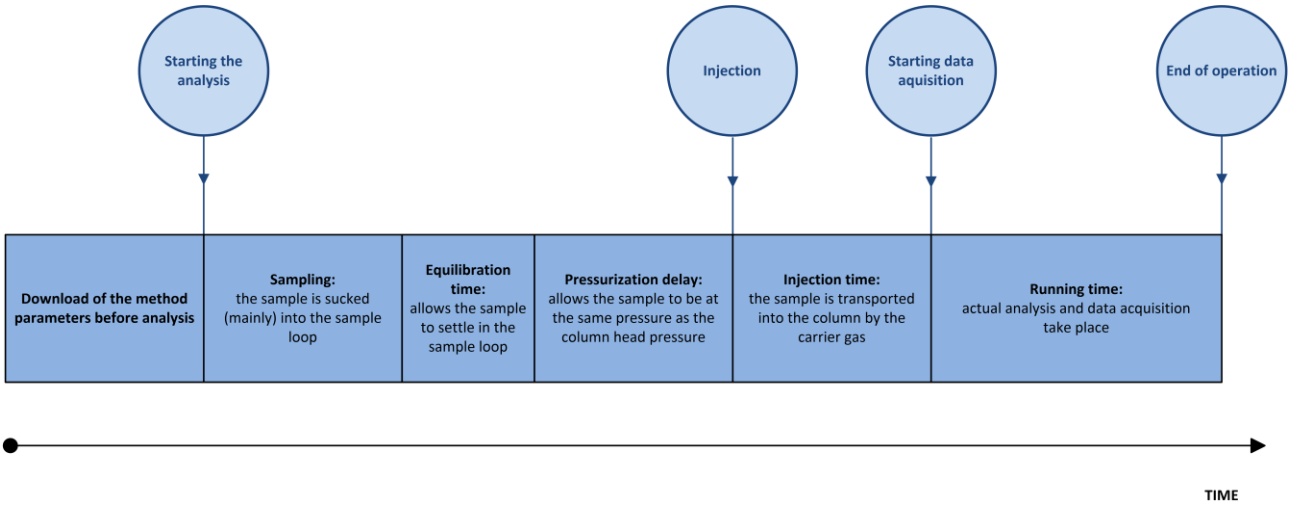
4.5.2 Bottom view

4 : OBC
5 : MicroGC mainboard



4.6 MicroGC cycle with constant pressure

The timing diagram below provides an overview of the cycle of the MicroGC at constant pressure.
This description is only for one channel. In most cases, when a two- or three-channel system is used, the sequence is the same, but the timing settings can differ. If the sample time on channel A and channel B or C are different, the longest time will be used. Also, the run time can be specified per channel; the data acquisition stops per channel as soon as the run time has elapsed. The total analysis time depends on the longest run time.



5. Installation and use

This chapter describes how to install and use the instrument.

5.1 Pre-installation requirements

Prepare the installation site as described in the “R990 MicroGC Installation prerequisites” manual.

5.2 Inspect the shipping packages

The MicroGC will arrive in one large box and one or more smaller cartons. Inspect the cartons carefully for damage or signs of rough handling. Report damage to the carrier and to SRA Instruments.

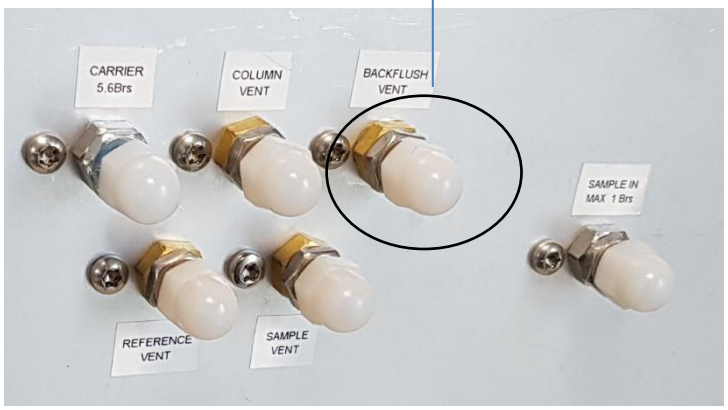
5.3 Unpack the MicroGC

Unpack the MicroGC and accessories carefully and transfer them to the work area using proper handling techniques. Inspect the instrument and accessories carefully for damage or signs of rough handling. Report damage to the carrier and to SRA Instruments.

Warning: Avoid back strain or injury by following all safety precautions when lifting heavy objects.

! This instrument has been protected during shipment by protective caps (see picture below). Before use, remove these caps, including those on the back panel

Protective shipping caps



5.4 Provide the necessary tools and accessories for installation

5.4.1 Tools

- 1/8" copper or stainless-steel tubing for carrier gas connection
- 1/8" stainless-steel tubing for sample connection
- 1/8" nuts, and ferrules
- Two 7/16" wrenches
- 5/16" wrench
- (1/4" wrench)
- Torx T-20 screwdriver

5.4.2 Accessories

Electronic leak detector (optional).

Note: Do not use a liquid leak detector: liquid can contaminate the analyzer.

5.5 Recommendations before installation

Venting

Avoid discharging gaseous effluents into an area that may experience pressure fluctuations (wind or releases with variable temperature). Changes in pressure can affect the stability of the baseline and the sensitivity of the analyzer. For releases outside atmospheric pressure (e. g. glove boxes) please contact SRA Instruments to find a suitable solution.

Tubes

- The diameter of the tubes depends on the distance between the gas cylinder and the analyzer, and the total flow rate required. The use of 1/8" tube is correct for a line length of less than 5 m. Beyond that, or when several analyzers are connected to the same gas inlet, the use of 1/4" tube is preferable.
- Do not use sealings: they may contain volatile materials that may contaminate the distribution system.

Optimization of gas purity

To get the best carrier gas quality on your analyzer:

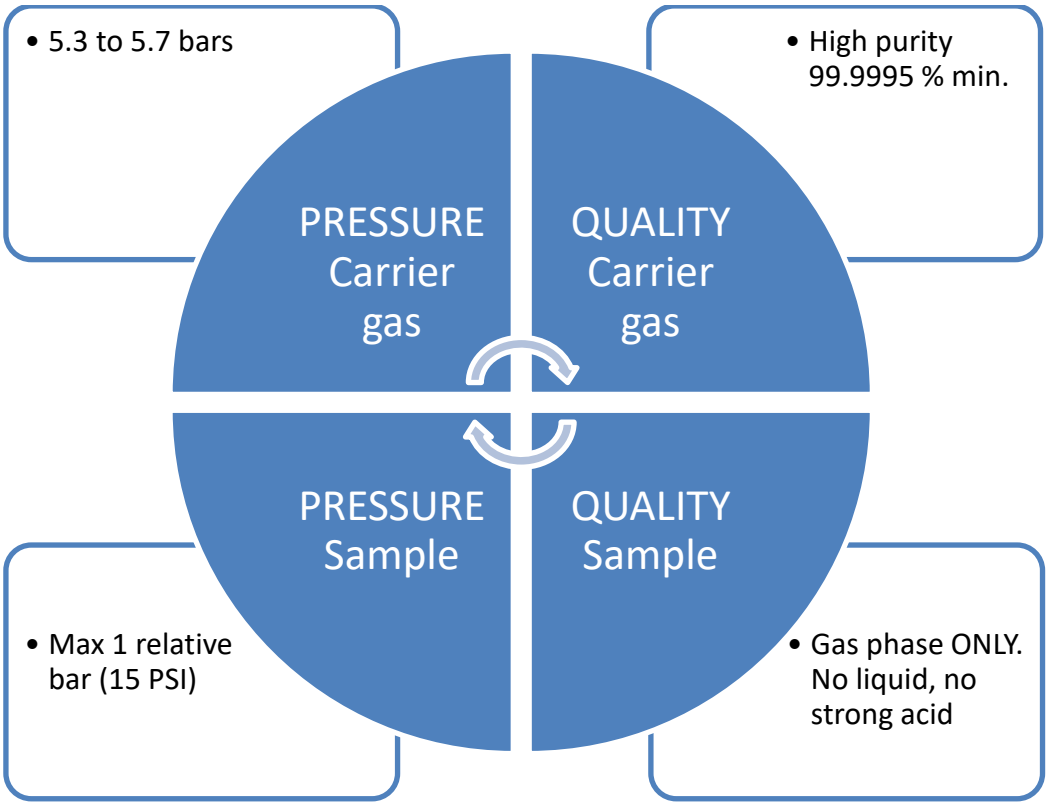
- Use a pressure reducer adapted to your needs.
- Use suitable tubes and ferrules.
- Purge correctly dead volumes before connecting the tube to your analyzer.
- Confirm the absence of leaks with an electronic detector.
- Always send to MicroGC a purge method (with TCD OFF) to purge the dead volumes of the analyzer and column before setting the detector ON.

5.6 R990 MicroGC installation: the 4 golden rules

MicroGC technology is easy to use. No chemical or analytical knowledge is required for basic use and setup. However, as with any analysis instrument, there are important rules to follow to protect your instrument and its functionality.

These rules can be presented as "the 4 golden rules":

- Carrier gas pressure
- Carrier gas quality
- Sample pressure
- Sample quality



Not respecting these rules highly increases the risk of damaging your instrument. All standard procedures for using MicroGC are derived from these 4 golden rules: the quality of the carrier gas will require a tube purge to ensure this level of quality.

5.6.1 Step 1 : Connect the carrier gas(es)

Install gas regulators and set pressures

Carrier gas cylinders should have a two-stage pressure regulator to adjust the carrier gas pressure to 550 kPa ± 10 kPa (80 psi ± 1,5 psi). Set cylinder regulator pressure to match the gas inlet pressure.

Connect carrier gas to the MicroGC

The MicroGC supports the use of helium, nitrogen, argon, and hydrogen. The recommended purity for carrier gas is 99.9995 % minimum. Connect the carrier gas via the **Carrier Gas In 5.5 Bar** (1 or 2) and turn on the gas flow.

Important:

Do not use any kind of plastic tubing since air will diffuse through the tubing, which may cause noisy baselines and decreased sensitivity. The metal tubing must be cleaned for MicroGC use. Buy clean tubes intended for chromatography.

The use of helium as a carrier gas with the MicroGC configured for Ar/N_2 will decrease the detector sensitivity (about 10 times), invert peaks, without any other incidence.

Using argon as a carrier gas with the MicroGC configured for He will destroy the TCD filaments.

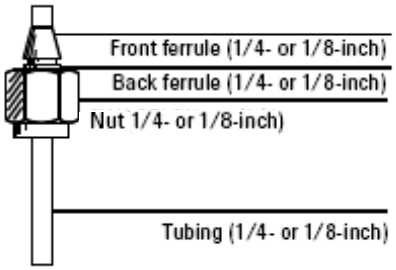
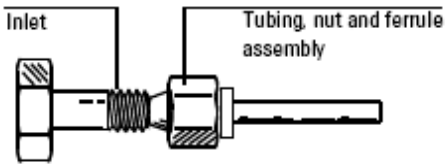
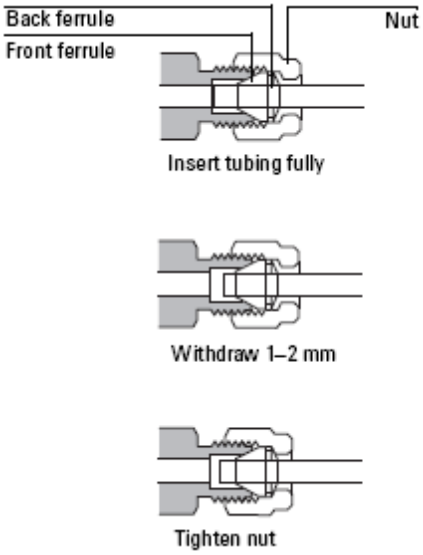
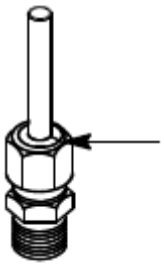
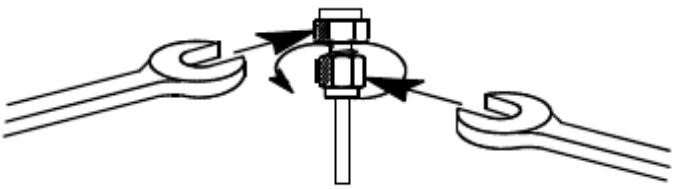
The carrier gas must circulate before the analyzer is switched on.

5.6.2 Tube fittings

Pneumatic connections use tube fittings. If you are not familiar with this type of fitting, read the procedure below.

Equipment required:

- 1/8" preconditioned copper tube
- 1/8" nut and ferrules
- Two 7/16" wrenches

Insert the 1/8" nut and the 2 ferrules.	
Make sure the ferrule is in contact with the inlet, then secure the nut by hand.	
Insert the tube as far as possible into the female part, then remove it from 1 to 2 mm.	
Mark the position of the nut with a pencil.	
Use two 7/16" wrenches to tighten the nut. Tightening requires 3/4 turn with a 1/8" nut.	

5.7 Sample lines

WARNING

The sample must be clean and dry. Although the internal filter removes many particulate contaminants, samples containing aerosols, excessive amounts of particulate matter, high water concentrations and other contaminants can damage your instrument. The presence of acids (HF, HCl, H_2SO_4 and HNO_3) is prohibited.

The inlet pressure of the sample must be less than 1 relative bar and its temperature must not exceed 100 °C.

5.7.1 Introduction

Sample conditioning shall be carried out in the immediate proximity in such a way as to reduce lines.
Sampling consists of volumes and transfer lines directly connected to the inlet at the MicroGC back panel.

5.7.2 Sampling modes

You will need suitable mounting equipment to connect the sample to the MicroGC or an accessory.

Sampling and conditioning are essential points for good analysis and correct results. It is important to study this part as well as possible.

Sample with pressure greater than one atmosphere

The best solution is to use a secondary loop close to the MicroGC and at a pressure close to atmospheric pressure. This method offers better results than a direct sample connection to the MicroGC inlet.
When calibrating, simply connect the standard mixture instead of the sample.
If it is necessary to work under pressure, keep in mind that the sample and standard must be at the same pressure.

Sample available at atmospheric pressure

In this case, the MicroGC suction pumps will allow the sample to circulate for an adjustable time in the loops of the injectors of the analytical modules before injection. Here are some examples of samples at atmospheric pressure:

- Atmospheric air: e.g. online monitoring of atmospheric pollution
- Tedlar bag**:** you can adapt a syringe needle on the analyzer sample inlet, the exiting needle will be put in the septum of the bag which will be presented.
- Container with septum: same possibilities as with the Tedlar bag, but in this case, you can only perform several injections, because after the pressure will decrease.

5.8 Sample release outlet

In the case of the use of 2 different carrier gases (Argon & Helium), we recommend that you do not group the outlets together. Different types of carrier gases must have different exhausts. Leave these outputs at a constant (almost) atmospheric pressure to avoid "peaks" on the TCD signal.

5.9 Using the touch screen

The Rack 990 front panel application is a simplified representation of MicroGC conditions and also allows the start of analyses/sequences; display of chromatograms is not provided.

This chapter briefly introduces the features of the application; for more details see Appendix 1 (Chapter 14).

The main window consists of a general control panel on the left and a frame on the right displaying the data corresponding to the tab selected in the panel.

Tabs of the banner :

Status: by default the application displays the current status of the instrument, by module. For each module, the status (ready, not ready) of the different elements (injector, column, carrier gas ...) is indicated.

Analysis: it is possible to start an analysis or a sequence directly through the application by selecting this tab.

Results: you can access different types of results: results of compounds, results of specific calculations according to standards. It is also possible to visualize the display of analog inputs as well as customized calculations in Excel.

Administrator (or Login) : to directly start the analysis from the "Analysis" tab, you must have the necessary rights (defined by the administrator in Soprane CDS).

Settings: several parameters can be configured by clicking on this tab: language, name of the analyzer, method, sampling channel, etc.

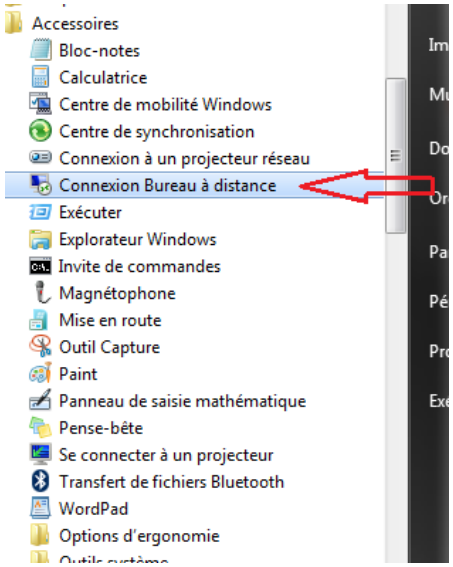
5.10 Remote control of the R990

5.10.1 Remote control of the OBC

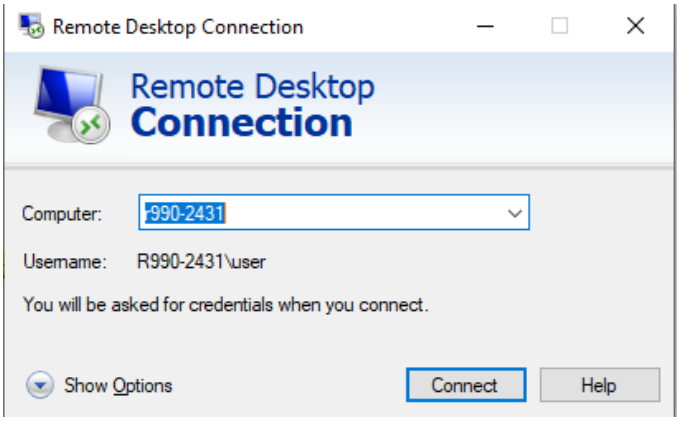
The R990's on-board computer can be remotely controlled via a network link using the Windows "Remote Desktop" command.

To access it:

- Click on the "Start" menu of your computer
- Go to "All Programs", "Accessories".
- Click on "Remote Desktop Connection"



- Then enter the name of the on-board computer. By convention, it is called R990-XXXX; replace XXXX with the serial number of the device.



- The OBC will ask for a login and a password depending on the chosen session : see chapter 6.2.

5.10.2 Connecting a monitor to the OBC

The R990 has a VGA output on the back of the rack to connect a monitor with a VGA cable.

You can also connect a keyboard/touchpad to an USB port on the analyzer.

6. Start-up procedure

The start-up procedure includes the different steps presented in the paragraphs below.

6.1 Start-up the chromatograph

After connecting and supplying the R990 with carrier gas, you can install the power supply and switch on the analyzer. The switch is located on the rear panel.

The 'POWER' LED lights up. For the moment, the carrier gas does not circulate in the columns.

6.2 Launch the software

To access the analyzer's PC (On board Computer), connect the monitor, keyboard, and mouse directly to the instrument. You can also use the Windows remote control tool via the Ethernet link (see § 5.10.1).

To do this, you must enter the following login and password depending on the session:

User session:
LOGIN : R990-XXXX\user, with XXXX as the serial number of the analyzer.
PASSWORD : Operator

Admin session:
LOGIN : R990-XXXX\admin, with XXXX as the serial number of the analyzer.
PASSWORD : MICROGC-SRA

After one minute, you will be able to launch Soprane CDS software to start your analyses if it has not started automatically.

When configuring your analyzer in our factory, we usually use helium as the carrier gas for testing. You can start Soprane Setup to examine the configuration if necessary.

For this, refer to Soprane CDS software User manual.

6.3 Load the PURGE method

When you turn the MicroGC on, it will load the last method used before turning the instrument off.

The entire internal pneumatic circuit contains air. If you correctly followed the procedure to connect the carrier gas to the instrument, you purged the external tubing and connection. It is now necessary to purge internal manifolds, regulators, and column by loading a "purge" method.

For each module, load a method of this type:

- Injector: 30 °C
- Column: 30 °C
- Pressure: 30 PSI
- Detector: OFF

Other parameters have no incidence because no analysis will be done with this method.

The carrier gas is now circulating and purging the whole system including the detector.

Let the MicroGC purge during approximately 10 minutes.

6.4 Load the test method

At first startup, perform a checkout to make sure the MicroGC is functioning properly.

A test method for each standard column type has been provided in the sections listed in the table below.

! If you ordered a Molsieve column, make sure it is conditioned before use. See § 8.4.1 for parameters.

Column type	Table
Molsieve 5A	Table 1 on page 30
CP-Sil 5 CB	Table 2 on page 31
CP Sil 13 CB and CP Sil 19 CB	Table 3 on page 32
PoraPlot 10 m	Table 4 on page 33
Hayesep A 40 cm	Table 5 on page 34
COx 1 m and Al_2O_3/KCl	Table 6 on page 35
MES (NGA) and CP-WAX 52 CB	Table 7 on page 36

Use the data system to set up the checkout parameters for each GC channel. Apply the checkout method settings to the MicroGC and allow the instrument to stabilize at the initial operating conditions. Monitor the instrument status using the data system's status display (refer to the data system help for details).

Each test method has been designed to determine if the instrument channel is functioning properly and includes an example test chromatogram.

6.5 Perform a series of run

1. Create a short sequence of at least three runs using the test sample and method.
2. Run the sequence.
3. After the first run, the results for each channel should become similar to the example chromatograms.

7. Stop procedure

There are different possibilities for which you will need to stop your R990:

- Short time stops (less than 2 weeks)
- Long stops (more than 2 weeks).

7.1 Short time stops (less than 2 weeks)

To maintain peak operating performance, we recommend that you let the instrument turned on with carrier gas flowing through the system.

To do this, create a method that:

- Turns off the detector filament
- Maintains a small carrier gas purge flow through the system
- Lowers the column temperature

7.2 Long stops of R990

To shut down the R990:

1. Load a method with these parameters:
    - Injector: OFF
    - Column: OFF
    - Pressure: 30 PSI
    - Detector: OFF
2. Wait until the column temperature is below 60 °C.
3. Turn off the power and unplug any accessory power cord.
4. As soon as the analyzer is turned off, no more gas circulates in the MicroGC. Only then, you can turn off the carrier gas supply.

These procedures help prevent column contamination and degradation.

7.3 Moving the analyzer

Here are some useful recommendations if you want to move your analyzer.

- Follow the shutdown procedure described in section 7.2.
- Disconnect the sample and carrier gas connections. Put plugs on the inlets.
- Pack the analyzer properly, taking care to protect the front panel and screen.
- The analyzer is heavy; it is better to be at 2 to lift it.
- Be sure to observe the storage temperatures during transport.
- Ensure that the instrument is adequately protected from moisture and condensation.
- Do not place heavy loads directly on the instrument.

8. The MicroGC analytical module

The R990 MicroGC can include 1 to 4 analytical modules. A module contains a gas regulator, an injector, a column and a µ-catharometer (see diagram below).

This chapter provides a brief analysis of the major components of the MicroGC and the backflush option.

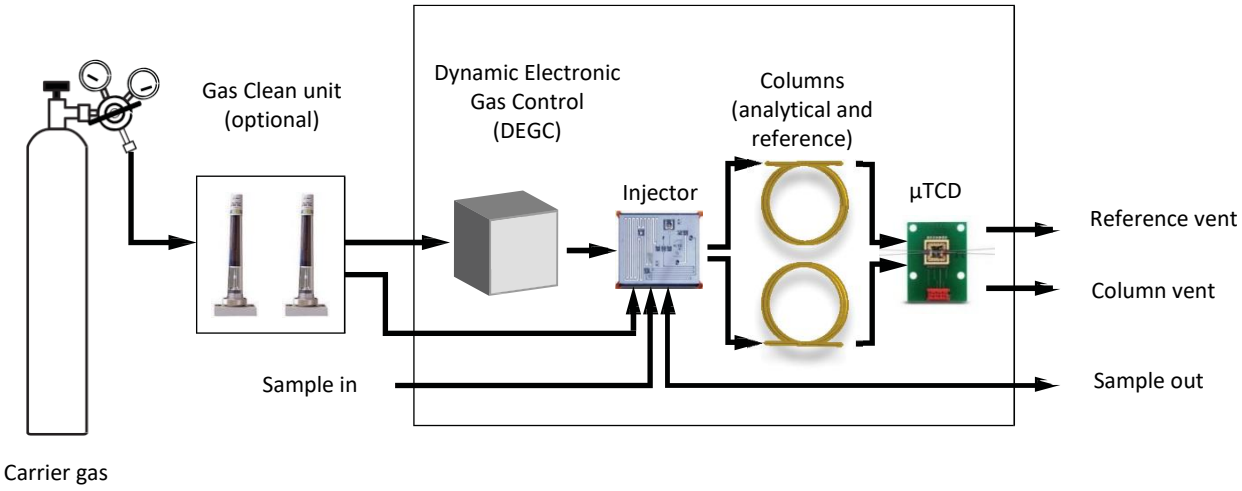


Diagram of an analytical module

8.1 Dynamic Electronic Gas Control (DEGC)

The MicroGCs have built-in regulators that can be adjusted to get a constant or programmed pressure control, which, once constant or programmed pressure control is obtained, results in a constant and programmed flow through the injector, column, and detector. The pressure range is from 50 to 350 kPa (7 to 50 psi). This pressure sets a continuous flow of carrier gas of about 0.2 to 4.0 mL/min (depending on column length and type).

8.2 Inert sample path

The R990 MicroGC is equipped with an Ultimetal™-treated sample path. This deactivation method ensures the integrity of the sample and helps to achieve the best detection limits possible.

The deactivation is applied to tubing running from the sample inlet to the modules.

8.3 Injector

The injector has a built-in 10-µL sample loop that is filled with the gaseous sample. The pressure of the sample should be between 0 and 100 kPa (0 to 15 psi) and the sample temperature between 0 and 110 °C.

When the chromatographic data system sends a START command, the vacuum pump draws the gas sample through the loop and the injector injects the gas sample from the sample loop into the gas stream. A typical injection time is 40 milliseconds (ms). This equals an average injection volume of 1µL. Injection time will be rounded to a multiple of 5 ms. The practical minimum value is 40 ms. A value between 0 and 10 milliseconds might result in no injection.

8.4 Column

A variety of column configurations are possible on the MicroGC. The columns you require for your specific analyses have been installed at the factory. Other configurations are, of course, possible, but altering the GC channels is a delicate matter that can only be handled by an SRA Instruments technician. The table below shows several standard columns as supplied in the MicroGCs and selected applications. Other columns are available by contacting Agilent Technologies.

Column/Phase type	Target components
Molsieve 5Å	Permanent gases (N_2/O_2 separation), methane, CO, NO, and so forth. (20 m required for O_2-Ar baseline separation). Natural gas and biogas analysis. Optional Retention Time Stability (RTS) configuration.
Hayesep A	Hydrocarbons C_1–C_3, N_2, CO_2, air, volatile solvents, natural gas analysis.
CP-Sil 5 CB	Hydrocarbons C_3–C_{10}, aromatics, organic solvents, natural gas analysis
CP-Sil 19 CB	Hydrocarbons C_4–C_{10}, high boiling solvents, BTX.
CP-WAX 52 CB	Polar volatile solvents, BTX.
PLOT Al_2O_3/KCl	Light hydrocarbons C_1–C_5 saturated and unsaturated. Refinery gas analysis
PoraPLOT U	Hydrocarbons C_1–C_6, halocarbons/freons, anesthetics, H_2S, CO_2, SO_2, volatile solvents. Separation of ethane, ethylene, and acetylene.
PoraPLOT Q	Hydrocarbons C_1–C_6, halocarbons/freons, anesthetics, H_2S, CO_2, SO_2, volatile solvents. Separation of propylene and propane, coelution of ethylene and acetylene.
CP-COx	CO, CO_2, H_2, Air (coelution of N_2 and O_2), CH_4.
CP-Sil 19CB for THT	THT and C_3–C_6 in Natural Gas Matrix.
CP-Sil 13CB for TBM	TBM and C_3–C_{6+} in Natural Gas Matrix.
MES NGA	Unique column specially tested for MES in natural gas (1 ppm).

! All columns except the HayeSep A (160 °C) and MES (110 °C) columns can be used up to 180 °C, the maximum temperature of the column oven.
Exceeding this temperature will cause the column to lose efficiency instantly and the column module will need replacement. All channels have a built-in protection that prevents a setpoint above the maximum temperature.

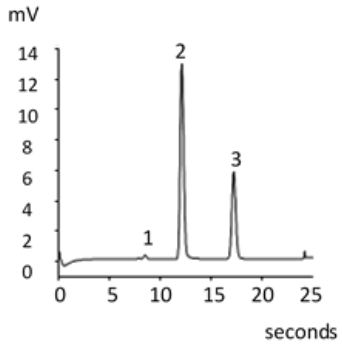
8.4.1 Molsieve 5Å columns

The Molsieve 5Å column is designed to separate: hydrogen, carbon monoxide, methane, nitrogen, oxygen, and some noble gases. Higher molecular weight components have much higher retention times on this column.

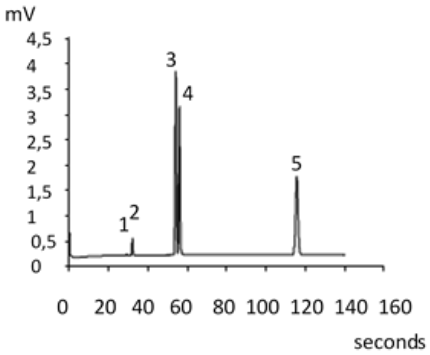
Parameter	4 m column	10 m column	20 m column
Column temperature	110 °C	40 °C	40 °C
Injector temperature	110 °C	50 °C	50 °C
Column pressure	100 kPa (15 psi)	150 kPa (21 psi)	200 kPa (28 psi)
Sample time	30 s	30 s	30 s
Injection time	40 ms	40 ms	40 ms
Run time	25 s	140 s	210 s
Detector sensitivity	Auto	Auto	Auto
Peak 1	Hydrogen 1.0 %	Neon 18 ppm	Neon 18 ppm
Peak 2	Argon/Oxygen 0.4 %	Hydrogen 1.0 %	Hydrogen 1.0 %
Peak 3	Nitrogen 0.2 %	Argon 0.2 %	Argon 0.2 %
Peak 4	_____	Oxygen 0.2 %	Oxygen 0.2 %
Peak 5	_____	Nitrogen 0.2 %	Nitrogen 0.2 %

- Table 1 -

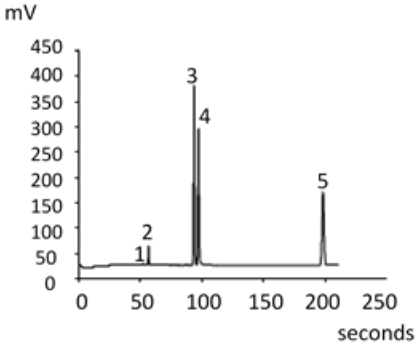
Molsieve 5Å 4 m



Molsieve 5Å 10 m



Molsieve 5Å 20 m



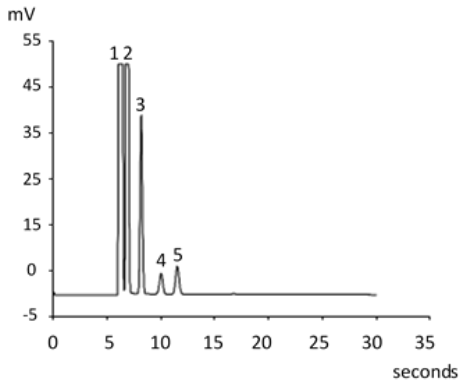
8.4.2 CP-Sil 5 CB columns

The natural gas components, mostly hydrocarbons, separate in the same order on the non-polar and medium-polar CP-Sil CB columns. Nitrogen, methane, carbon dioxide, and ethane are not separated on these columns. They produce a composite peak. For separation of these components, consider a PoraPLOT U or HayeSep A column.

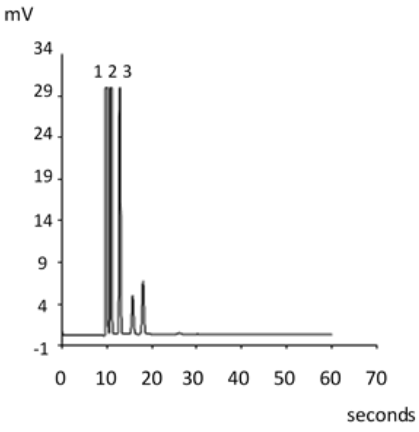
Parameter	4 m column	6 m column
Column temperature	50 °C	50 °C
Injector temperature	110 °C	110 °C
Column pressure	150 kPa (21 psi)	150 kPa (21 psi)
Sample time	30 s	30 s
Injection time	40 ms	40 ms
Run time	30 s	30 s
Detector sensitivity	Auto	Auto
Peak 1	Composite balance	Composite balance
Peak 2	Ethane 8.1 %	Ethane 8.1 %
Peak 3	Propane 1.0 %	Propane 1.0 %
Peak 4	i-Butane 0.14 %	i-Butane 0.14 %
Peak 5	n-Butane 0.2 %	n-Butane 0.2 %

- Table 2 -

CP Sil 5 CB 4 m



CP Sil 5 CB 6 m

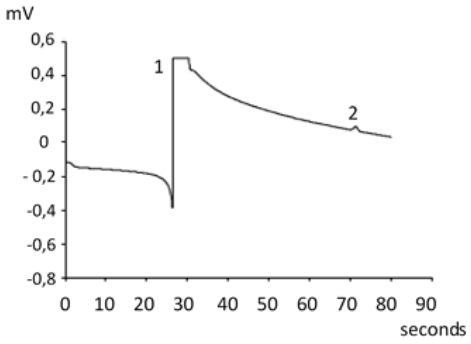


8.4.3 CP Sil 13 CB and CP Sil 19 CB columns

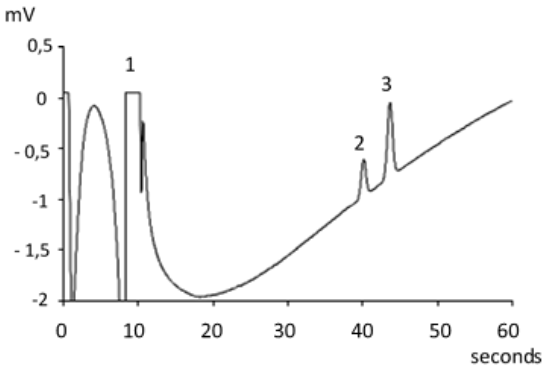
Parameter	CP-Sil 13 CB 12 m (TBM)	CP-Sil 19 CB 6 m (THT)
Column temperature	40 °C	85 °C
Injector temperature	50 °C	85 °C
Column pressure	250 kPa (38 psi)	200 kPa (25 psi)
Sample time	30 s	30 s
Injection time	255 ms	255 ms
Run time	80 s	35 s
Detector sensitivity	Auto	Auto
Peak 1	Methane balance	Helium balance
Peak 2	TBM 6.5 ppm	THT 4.6 ppm
Peak 3	_____	n- nonane 4.5 ppm

- Table 3 -

CP Sil 13 CB 12 m (TBM)



CP Sil 19 CB 6 m (THT)

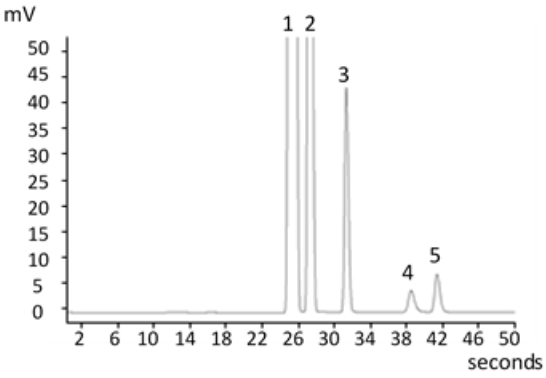


8.4.4 PoraPlot 10 m column

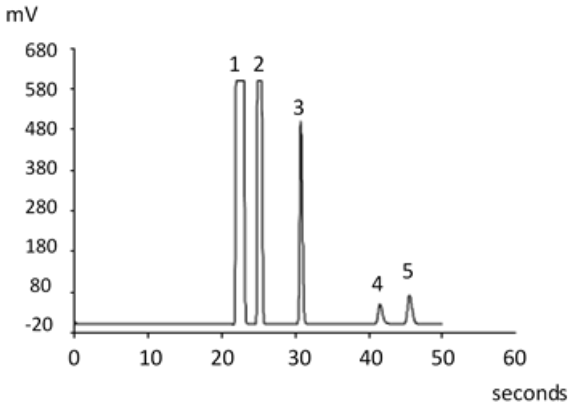
Parameter	PoraPlot U 10 m	PoraPlot Q 10 m
Column temperature	150 °C	150 °C
Injector temperature	110 °C	110 °C
Column pressure	150 kPa (21 psi)	150 kPa (21 psi)
Sample time	30 s	30 s
Injection time	40 ms	40 ms
Run time	100 s	50 s
Detector sensitivity	Auto	Auto
Peak 1	Composite balance	Composite balance
Peak 2	Ethane 8.1 %	Ethane 8.1 %
Peak 3	Propane 1.0 %	Propane 1.0 %
Peak 4	i-Butane 0.14 %	i-Butane 0.14 %
Peak 5	n-Butane 0.2 %	n-Butane 0.2 %

- Table 4 -

PoraPlot U 10 m



PoraPlot Q 10 m



8.4.5 Hayesep A 40 cm column

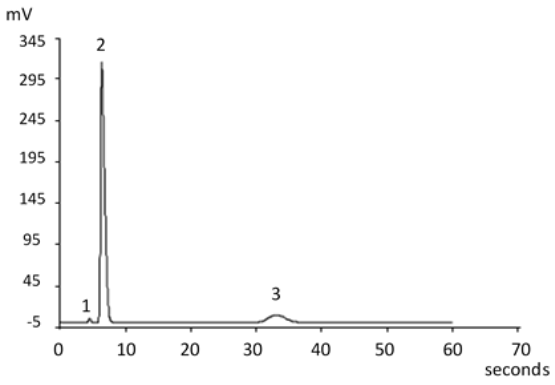
The HayeSep A column separates oxygen, methane, carbon dioxide, ethane, acetylene, ethylene, and selected sulfur gases. Nitrogen coelutes with oxygen. Components with a higher molecular weight than propane have long retention times on this column.

! Maximum allowable column temperature is 160 °C.

Parameter	Hayesep A 40 cm
Column temperature	50 °C
Injector temperature	110 °C
Column pressure	150 kPa (21 psi)
Sample time	30 s
Injection time	40 ms
Run time	60 s
Detector sensitivity	Auto
Peak 1	Nitrogen 0.77 %
Peak 2	Methane balance
Peak 3	Ethane 8.1 %

- Table 5 -

Hayesep A 40 cm

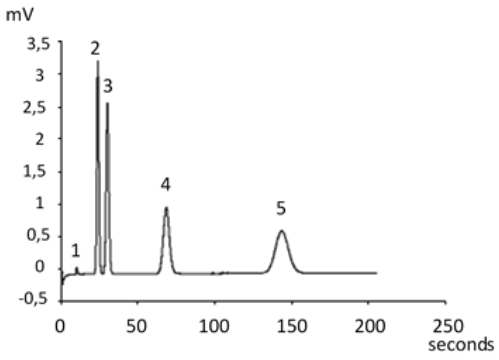


8.4.6 COx and Al_2O_3/KCl columns

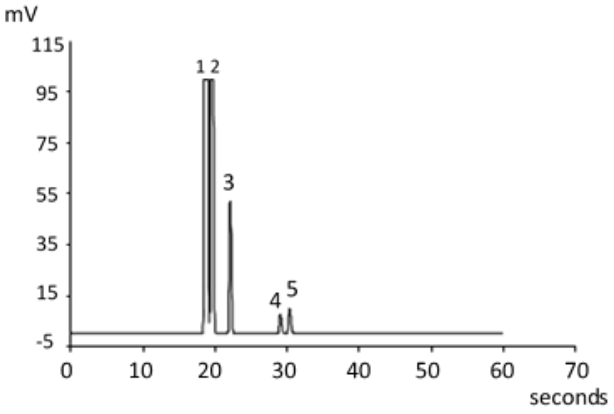
Parameter	COx 1 m	Al_2O_3/KCl 10 m
Column temperature	80 °C	100 °C
Injector temperature	110 °C	110 °C
Column pressure	200 kPa (28 psi)	150 kPa (21 psi)
Sample time	30 s	30 s
Injection time	40 ms	40 ms
Run time	204 s	60 s
Detector sensitivity	Auto	Auto
Peak 1	Hydrogen 1.0 %	Composite balance
Peak 2	Nitrogen 1.0 %	Ethane 8.1 %
Peak 3	CO 1.0 %	Propane 1.0 %
Peak 4	Methane 1.0 %	i-Butane 0.14 %
Peak 5	CO_2 1.0 %	n-Butane 0.2 %
Helium balance		

- Table 6 -

COx 1 m



Al_2O_3/KCl 10 m

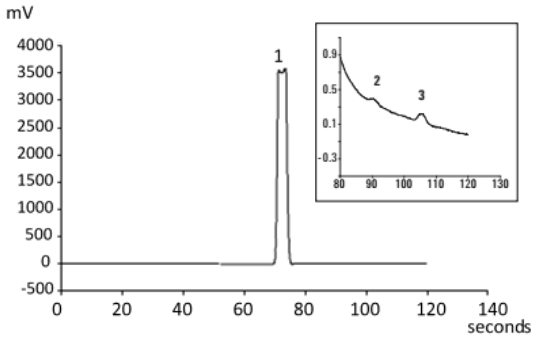


8.4.7 MES (NGA) and CP-WAX 52 CB columns

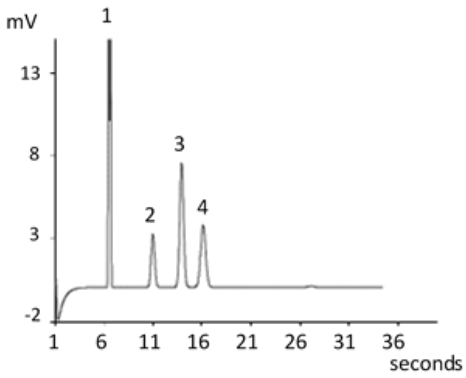
Parameter	MES 10 m (NGA)	CP-WAX 52 CB 4 m
Column temperature	90 °C	60 °C
Injector temperature	110 °C	110 °C
Column pressure	70 kPa (10 psi)	150 kPa (21 psi)
Sample time	30 s	30 s
Injection time	500 ms	40 ms
Run time	120 s	35 s
Detector sensitivity	Auto	Auto
Peak 1	Nitrogen balance	Nitrogen 0.75 %
Peak 2	n-Decane 11.2 ppm	Acetone 750 ppm
Peak 3	MES 14.2 ppm	Methanol 0.15 %
Peak 4		Ethanol 0.30 %
		Helium balance

- Table 7 -

MES 10 m (NGA)



CP-WAX 52 CB 4 m



8.4.8 Column conditioning

Follow this procedure to make sure that any water that might be present inside the analytical column is removed before the TCD is switched on.
Also follow this procedure if the MicroGC module has been stored for a long period.

! The detector filaments may be damaged by improper conditioning. Follow this procedure to avoid damaging the detector filaments.

Column conditioning procedure

1. Switch off the TCD filaments in the method.
2. Set the column temperature of the module to the maximum temperature (110 °C, 160 °C or 180 °C depending on the column limit). Leave the filaments off.
3. Set the temperature of the injector to 80 °C.
4. Download this method to the MicroGC.
5. Run the downloaded method to condition the column, preferably overnight.

This will assure you that all the water has been removed from the column and no damage will occur to the TCD filaments.

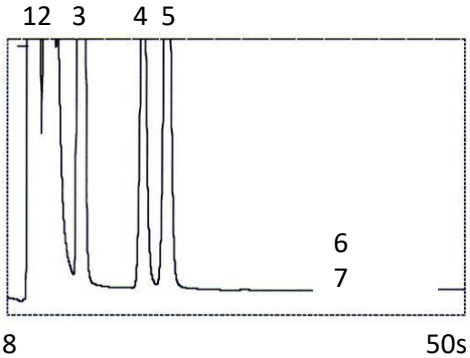
Nitrogen and oxygen merging in Molsieve columns

On a properly activated column, nitrogen and oxygen will be well separated. However, in time you will find that these two peaks begin to merge together. This is caused by water and carbon dioxide present in the sample or carrier gas, adsorbing to the stationary phase.

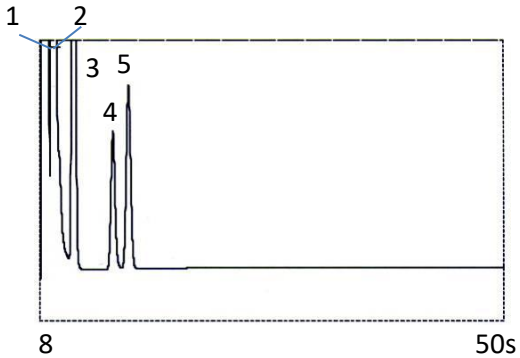
To restore the column efficiency, condition the column, as described above, for about an hour. After reconditioning, you can test the column performance by injecting plain air. If you have a proper separation between nitrogen and oxygen again, the column separation power has been restored. If the MicroGC frequency of use is very high, you might consider routinely leaving the oven temperature at 180 °C overnight. The longer the reconditioning period, the better the column performance.

8.5 Backflush option

The analytical modules of the R990 MicroGC can be optionally equipped with a backflush. This has the advantage of protecting the stationary phase of the column from moisture and carbon dioxide. In addition, the analysis times are reduced since late elution compounds, which are therefore of no interest, do not enter the analytical column.



Natural gas analysis, straight



Natural gas analysis, with backflush at 8 seconds

A backflush system always consists of a pre-column and an analytical column. The two columns are coupled at a *pressure point*, which makes it possible to invert the carrier gas flow direction through the pre-column at a preset time, called the *backflush time*. See Figure 2.

The injector, the two columns and the detector are in series.

The sample is injected onto the pre-column where the pre-separation takes place; injection takes place in normal mode. See Figure 1.

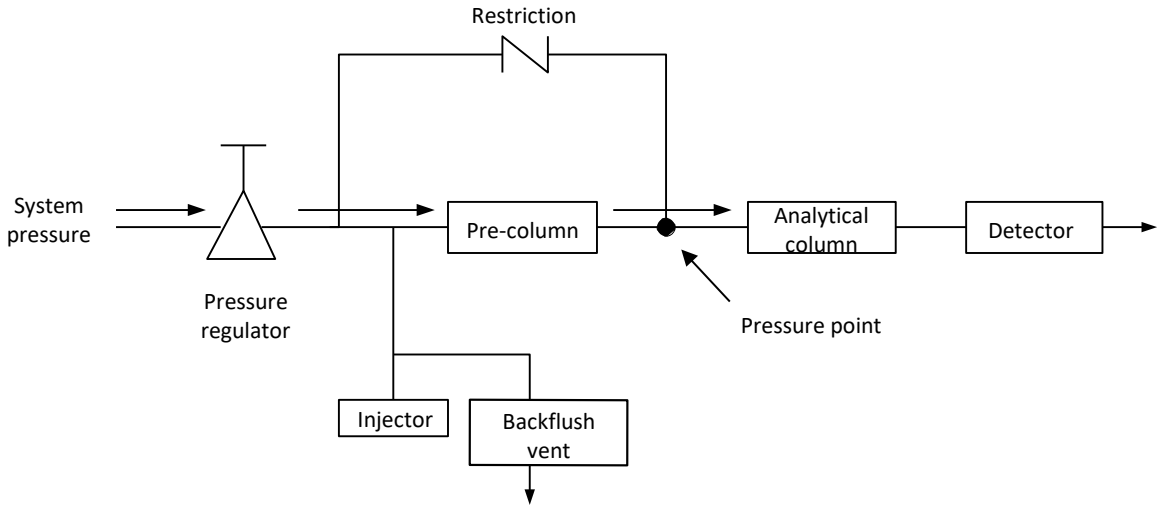


Figure 1

When all compounds to be quantified are transferred to the analytical column, the backflush valve switches (at the backflush time). On the pre-column, the flow inverts and all compounds left on the pre-column now backflush to the vent. On the analytical column the separation continues because there the flow is not inverted. See Figure 2.

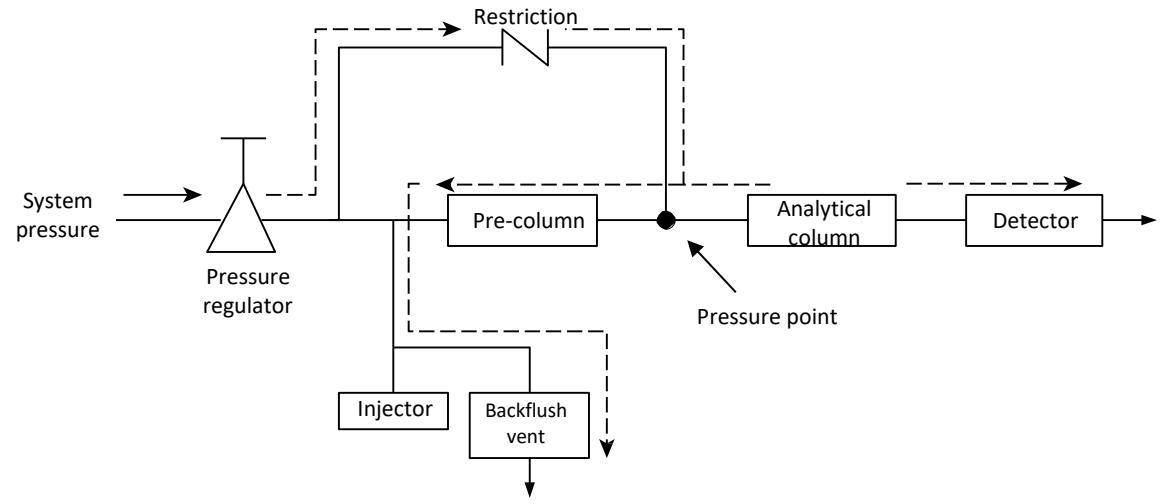


Figure 2

The standby mode is the backflush configuration (if the instrument is equipped with the optional backflush valve).

Backflushing saves the time required to elute high boiling components that are not of interest and ensures that the pre-column will be in good condition for the next run.

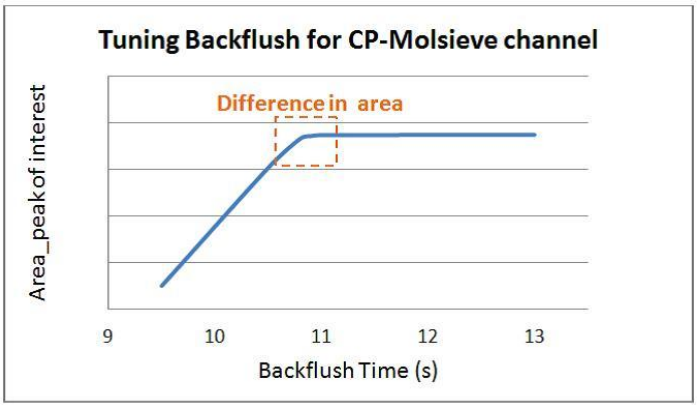
8.5.1 Tuning the backflush time (except on a HayeSep A channel)

Tuning the backflush time is necessary for each new channel. This chapter describes how to tune the backflush time on all channels except HayeSep A.

Tuning procedure for the backflush time

1. Set the backflush time to 0 seconds and analyze the checkout sample or a proper sample for the specific channel. The goal of this is to identify the components in the calibration standard.
2. Change the backflush time to 10 seconds and perform a run.
   The following can be observed:
   • When the backflush time is set too early, the peaks of interest are partially or totally backflushed.
   • If the backflush time is set too late, the unwanted components are not backflushed and show up in the chromatogram.
3. Perform runs with different backflush times until there is no huge difference in the peak of interest. To fine tune the backflush time, set smaller steps (for example 0.10 seconds) until you find the optimal backflush time.

The figure below shows a simple example of tuning the backflush time for the CP-Molsieve 5A channel.



Effect of the backflush time on the peak of interest

8.5.2 To disable backflush

To disable backflush, set the **Backflush Time** to **0**. This puts the system in normal mode during the entire run

8.6 Backflush to Detector

Backflush to detector is an advanced technique to elute high boiling point compounds as a group through the reference column and show as a single peak on the chromatogram just before the low boiling point compounds. The benefit of this technique is that the analysis time is reduced. In some cases, the analysis could even be done on just one channel.

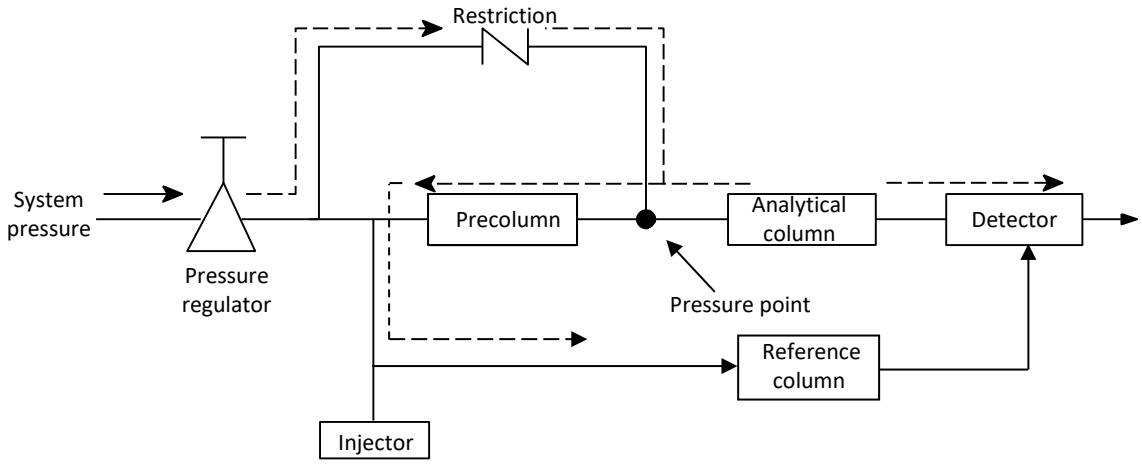
The R990 MicroGC offers two types of backflush to detector channels. A CP-Sil 5 CB for natural gas analysis and Al_2O_3 for refinery gas analysis. The backflush to detector channel is factory tuned to group the C6+ components.

8.6.1 CP-Sil 5 CB Backflush to detector

The CP-Sil 5 CB backflush to detector MicroGC channel is configured with an 8 m CP-Sil 5 CB analytical column and a 0.5 m CP-Sil 5 CB precolumn. It elutes C6+ in natural gas as one peak through the reference column and shortens analysis time to 90 seconds. It is compliant with GPA2172 for calorific value calculation.

8.6.2 Al_2O_3 Backflush to detector

The Al_2O_3 back flush to detector MicroGC channel is configured with a 10 m Al_2O_3/KCl analytical column and a 1 m CP-Sil 5 CB precolumn. It elutes C6+ in refinery gas as one peak through the reference column and shortens analysis time to 210 seconds.



8.6.3 Tuning the backflush time

To set the proper backflush time for each new backflush to detector channel, follow either the "8 m 5CB BF2D procedure" or the "10 m Al_2O_3/KCl BF2D procedure".

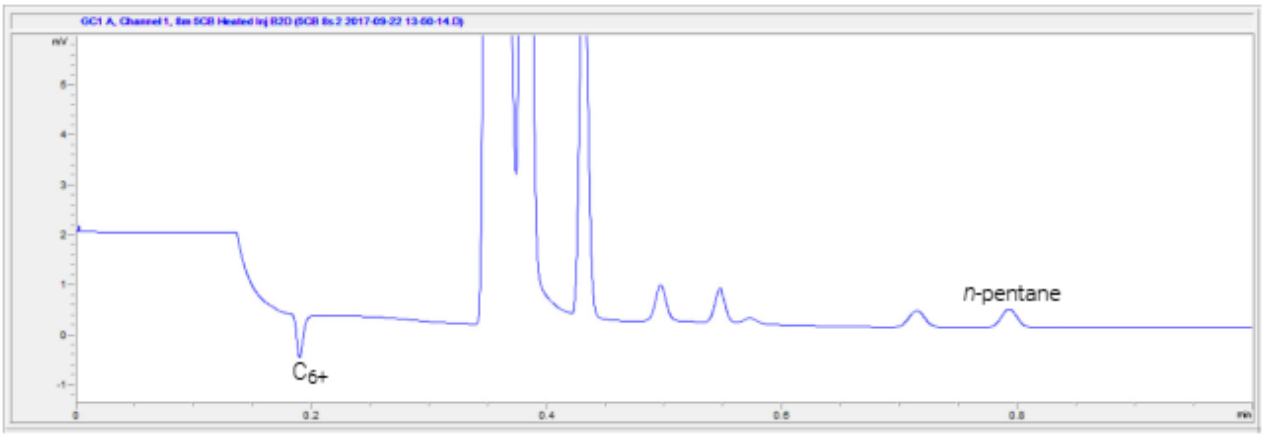
a) 8 m 5CB BF2D procedure

Parameter	Settings
Column pressure	150 kPa
Injection temperature	110 °C
Column temperature	72 °C
Injection time	40 ms
Run time	90 s
Sample gas	NGA gas

- 8 m 5CB BF2D settings -

1. Set backflush (BF) time to 0 seconds. Start a run to obtain the peaks of all eluted components. Record the retention time (RT) of n-pentane and 2,2-dimethylbutane.
2. Set run time to a value which is 10 seconds longer than the RT of 2,2-dimethylbutane. Set BF time to 5 seconds. Start a run again.
3. Increase BF time by 0.5 seconds steps and start a run. Observe the peak height of 2,2-dimethylbutane. Continue increasing BF time until the 2,2-dimethylbutane peak is observed (peak height > 3 µV).

4. Finely tune the BF time, find the data point when the 2,2-dimethylbutane peak is observed. Decrease BF time by 0.1 seconds steps, and start a run until the peak disappears (peak height < 3 µV). Set BF time for this channel to that value minus 0.2 seconds. A typical "clean cut" time range of 8m 5CB BF2D channel is approximately 0.3-0.5 seconds (see chromatogram below).



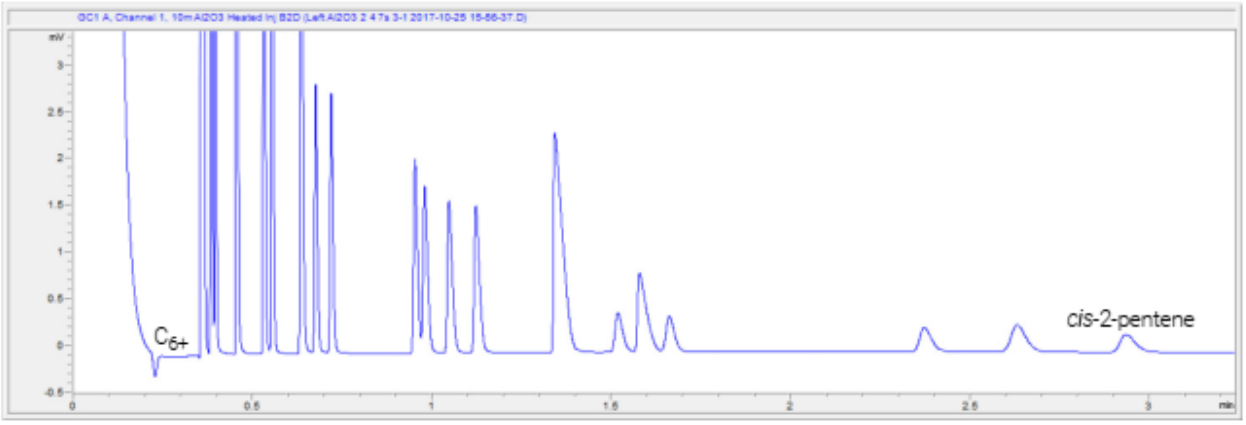
- 8 m 5CB column for natural gas analysis -

b) <u>10 m Al_2O_3/KCl BF2D procedure</u>

Parameter	Settings
Column pressure	300 kPa
Injection temperature	100 °C
Column temperature	90 °C
Injection time	40 ms
Run time	600 s
Sample gas	RGA gas

- 10 m Al_2O_3/KCl BF2D settings -

1. Set backflush (BF) time to 0 seconds. Start a run to obtain the peaks of all eluted components. Record the retention time (RT) of cis-2-pentene and n-hexane.
2. Set run time to a value which is 10 seconds longer than the RT of n-hexane. Set BF time to 5 seconds. Start a run.
3. Increase BF time by 0.5 seconds steps and start a run. Observe the peak height of n-hexane. Continue increasing BF time until the n-hexane peak is observed (peak height > 3 µV).
4. Finely tune the BF time, find the data point when the n-hexane peak is observed. Decrease BF time by 0.1 seconds steps and start a run until the peak disappears (peak height < 3 µV). Set BF time for this channel to that value minus 0.4 seconds. A typical "clean cut" time range of 8m 5CB BF2D channel is approximately 1-2 seconds (see chromatogram below).



- 10 m Al_2O_3 column for refinery gas analysis -

8.6.4 To disable backflush

To disable backflushing, set the **Backflush Time** to **0**. This puts the system in normal mode during the entire run.

8.6.5 Set invert signal time

Invert signal time enables the backflush to detector channel to plot the signal from a negative peak to a positive peak in the selected time interval.

Refer to the software manual to see how to invert the signal.

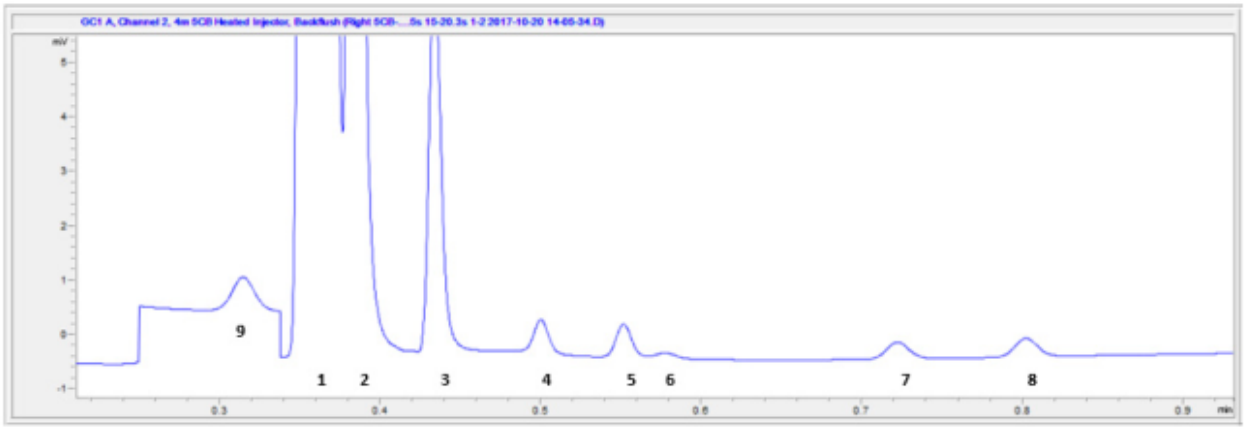
8.6.6 Checkout information

Method settings	8 m 5 CB BF2D	10 m Al_2O_3/KCl BF2D
Carrier gas	Helium	Helium
Column temperature (°C)	72	90
Injector temperature (°C)	110	100
Column pressure (kPa)	150	300
Sample inlet temperature (°C)	110	100
Sample time (s)	30	30
Injection time (ms)	40	40
Run time (s)	90	600
Detector sensitivity	Auto	Auto

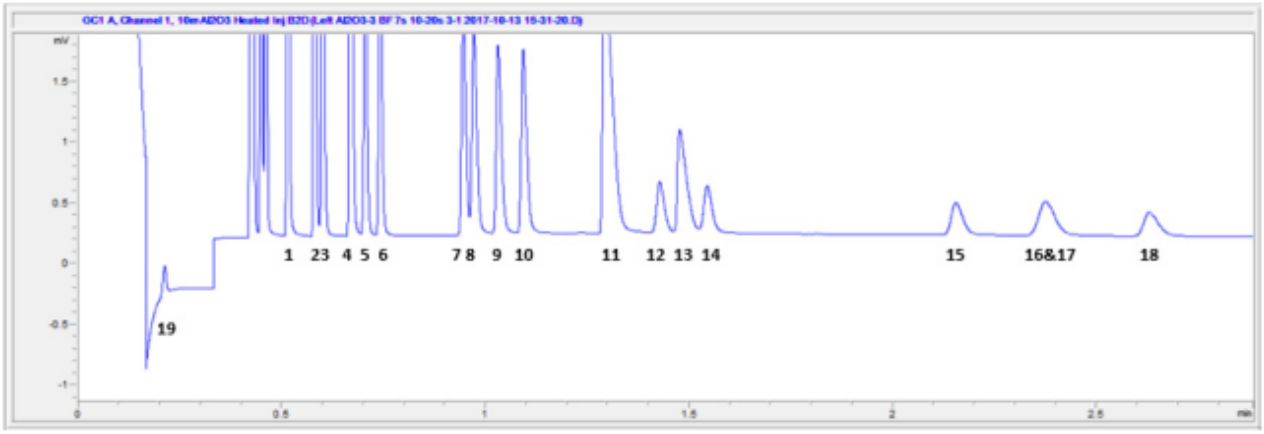
- 8 m 5CB BF2D and 10 m Al_2O_3/KCl BF2D instrument method parameters -

Peak identification	5 CB BF2D 8 m	Al_2O_3/KCl BF2D 10 m
Peak 1	Composite balance	Propane 1.99 %
Peak 2	Ethane 4.06 %	Propylene 0.980 %
Peak 3	Propane 0.520 %	Acetylene 1.06 %
Peak 4	i-Butane 0.0502 %	Propadiene 1.01 %
Peak 5	n-Butane 0,0495 %	i-Butane 0.295 %
Peak 6	Neopentane 0.0101 %	n-Butane 0.295 %
Peak 7	i-Pentane 0.0306 %	trans-2-Butylene 0.303 %
Peak 8	n-Pentane 0.0306 %	i-Butylene 0.295 %
Peak 9	C6+	i-Butylene 0.307 %
Peak 10		cis-2-Butylene 0.306 %
Peak 11		Methyl acetylene 1.01 %
Peak 12		i-Pentane 0.104 %
Peak 13		1,3-Butadiene 0.311 %
Peak 14		n-Pentane 0.097 %
Peak 15		trans-2-Pentene 0.098 %
Peak 16		2-Methyl-2-butene 0.046 %
Peak 17		i-Pentene 0.097 %
Peak 18		cis-2-Pentene 0.094 %
Peak 19		C6+

- 8 m 5CB BF2D and 10 m Al_2O_3/KCl BF2D peak identification -



- 8m 5CB BF2D for natural gas analysis -



- 10 m Al_2O_3/KCl BF2D for refinery gas analysis -

8.6.7 Calorific value calculation (C6+)

For calorific value calculation and application setup, please refer to the software manual.

8.7 µ-catharometer

Each Micro GC channel is equipped with a catharometer (µTCD).

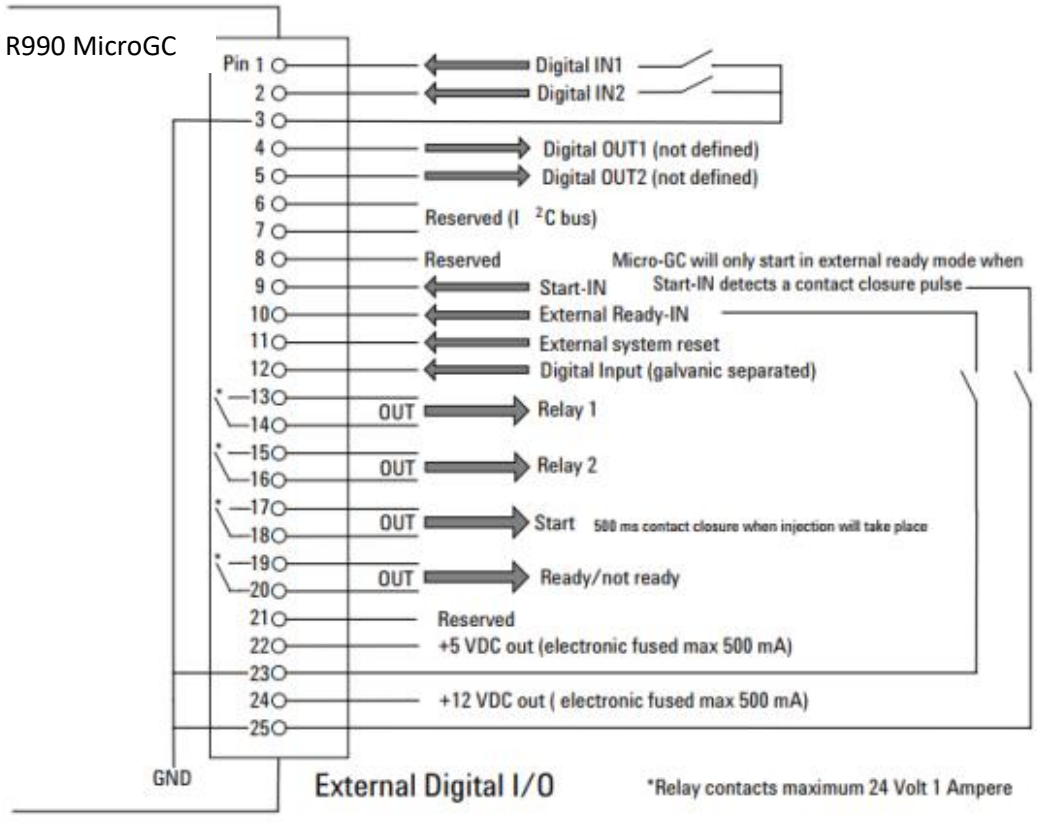
This detector responds to the difference in thermal conductivity between a reference cell (carrier gas only) and a measurement cell (carrier gas containing sample components). The construction of a µTCD is such that the changing thermal conductivity of the carrier gas stream, due to components present, is compared to the thermal conductivity of a constant reference gas stream

9. Communications

This chapter describes the input and output ports accessible inside the R990 MicroGC for interfacing with external devices.

9.1 External digital I/O (SUB-D25)

Connections between the MicroGC and external devices are made with the appropriate cable to the external digital I/O port. SRA Instruments strongly recommends the use of shielded cabling for this purpose.



9.2 SUB-D9 pinout

SUB-D9 pinout according to the configuration of each port :

Pin number	RS232	RS485
1		485D-
2	RX	485D+
3	TX	
4		
5	GND	

10. Errors

10.1 Error handling

During operation, a series of events and error messages are generated indicating start or finishing of certain actions and procedures as well as smaller and fatal errors somewhere in the instrument. This section describes how the MicroGC reacts to these events or messages.

The following error classes as well as the subsequent actions are available:

Class 0 *Internal info*: These are events indicating a certain procedure has started or finished. In no way do they influence the proper functioning of the instrument.

Class 1 *Advisory warning*; the instrument continues: These are the less critical advisory warnings not requiring immediate action by the user. The ongoing run may be minimally affected by it and thus need not be stopped. Class 1 error messages indicate certain malfunctions of the instrument. Some errors of this type keep the instrument from becoming ready.

Class 2 *Recoverable errors for logging*; instrument shutdown, red LED on: These are recoverable errors for which the user needs immediate warning (a pop-up or warning may appear in the data system and the red LED lights). The run in progress is stopped since its results will be definitively wrong. Corrective action by the user or the instrument service may be required. This kind of error can be cleared without power cycle.

Class 3 *Critical errors for logging*; instrument shutdown, red LED on: These are critical errors for which the user needs immediate warning. The red LED lights. An instrument shutdown occurs. Corrective action by the user or service is required. This kind of error can only be cleared with a power cycle.

Class 4 *Fatal errors for logging*; instrument shutdown, red LED on, Auto Reboot: These are fatal errors for which the user needs immediate warning. The red LED lights. An instrument shutdown and auto reboot occur.

All errors, regardless of class, are available to the data system under instrument status (for troubleshooting). All Class 1 and higher errors are also logged in the instrument's flash memory.

All errors are identified by numbers built from the error class and a number. Events are not numbered.

10.2 Error list

The GC error code is indicated as CLNN in which:

C = error class (severity)
L = location
NNN = error number or event number.

The Error class can be one of the following values:

- 0 = diagnostic info
- 1 = advisory warning
- 2 = recoverable error
- 3 = critical error
- 4 = fatal error

There are 5 locations:

- 0 = main board
- 1 = channel 1
- 2 = channel 2
- 3 = channel 3
- 4 = channel 4

The table below lists the possible errors:

Error code	Class	Error message	Recommended action
1	INFO	Init Passed	No action (initialization successful).
2	RECOVERABLE	Init Error	Restart the instrument. If the error persists, contact technical support.
3	RECOVERABLE	Pressure too low, chan = %d	Check the gas source and pressure of affected channel. Re-establish sufficient pressure, then restart analysis.
4	CRITICAL	Pressure too high, chan = %d	Stop the instrument and check the gas system (regulator, obstruction). Only resume once pressure has returned to normal.
5	RECOVERABLE	Pressure cannot reach its setpoint, chan = %d	Check for leaks or the gas source. Once the problem has been solved, restart the system.
6	INFO	Pressure restored, chan = %d	No action (pressure back to normal).
7	RECOVERABLE	Sample line temperature fault, chan = %d	Check that the channel sample line is heating correctly. Restart after cooling. If the problem persists, consider replacing the sample line heater.
8	RECOVERABLE	Sample line heater sensor fault, chan = %d	Check sample line temperature sensor connection. If the error persists, contact support to replace the sensor or module.
9	CRITICAL	Sample line heater is open, chan = %d	Stop the instrument. The sample line heater is defective (open circuit). Replace this module before resuming.
10	CRITICAL	Sample line heater is short, chan = %d	Stop the instrument. The sample line heater is short-circuited. Contact support for repair or replacement.
11	WARNING	Sample line heating too slow, chan = %d	Wait until the temperature is reached. Check that the environment is not too cold. If slowness persists, schedule maintenance.
12	INFO	Sample line temperature is restored, chan = %d	No action (sample line temperature normalized).
13	RECOVERABLE	Injector temperature fault, chan = %d	Check that the channel injector heats up correctly. Restart when cooled. If the problem persists, the injector module may need to be replaced.
14	RECOVERABLE	Injector heater sensor fault, chan = %d	Check the injector temperature sensor connection. If the error continues, contact support to replace the sensor or module.
15	CRITICAL	Injector heater is open, chan = %d	Stop the analysis. The injector heater (%d channel) is off (open circuit). Replace the injector module before resuming.

Error code	Class	Error message	Recommended action
16	CRITICAL	Injector heater is short, chan = %d	Stop the analysis. The injector heater (%d channel) is short-circuited. Have this module repaired or replaced before resuming.
17	RECOVERABLE	Injector heating too slow, chan = %d	Wait for the injector to reach the desired temperature. If it regularly takes too long, check the injector insulation or contact a technician.
18	INFO	Injector temperature is restored, chan = %d	No action (injector temperature restored).
19	RECOVERABLE	Column temperature fault, chan = %d	Check that the channel column is heating correctly. Let it cool down, then heat it up again. If the problem persists, you may need to replace the column module.
20	RECOVERABLE	Column heater sensor fault, chan = %d	Check the column temperature sensor connection. If the error persists, consider replacing the sensor or the module (contact support).
21	CRITICAL	Column heater is open, chan = %d	Stop the analysis immediately. The column heater (%d channel) is faulty (open circuit). Replace this module before resuming.
22	CRITICAL	Column heater is short, chan = %d	Stop the analysis immediately. The column heater (%d channel) is short-circuited. Contact support for repair or replacement.
23	RECOVERABLE	Column heating too slow, chan = %d	Let the column reach its temperature. If heating remains consistently slow, check the ambient temperature and the condition of the column. Contact a technician if necessary.
24	INFO	Column temperature is restored, chan = %d	No action (normal column temperature).
25	RECOVERABLE	Aux zone temperature fault, chan = %d	Check the heating of the channel's auxiliary zone. Restart if necessary. If the error persists, have the affected heating module checked or replaced.
26	RECOVERABLE	Aux zone heater sensor fault, chan = %d	Check the connection of the auxiliary zone temperature sensor. If the error continues, contact support to replace the sensor or module.
27	CRITICAL	Aux zone heater is open, chan = %d	Stop the instrument. The auxiliary zone heater (%d channel) is faulty (open circuit). Replace the associated component or module before resuming.
28	CRITICAL	Aux zone heater is short, chan = %d	Stop the instrument. The auxiliary zone heater (%d channel) is short-circuited. Have the affected module replaced before restarting.
29	WARNING	Aux zone heating too slow, chan = %d	Wait for the auxiliary zone to warm up. Check ambient conditions. If slowness persists frequently, schedule maintenance.
30	INFO	Aux zone temperature is restored, chan = %d	No action (auxiliary zone at temperature).
31	RECOVERABLE	Inlet %d temperature fault	Check the heating of the %d channel inlet. Let it cool down, then restart this channel. If the error persists, have the inlet module checked or replaced.

Error code	Class	Error message	Recommended action
32	RECOVERABLE	Inlet %d sensor fault	Check the connection of the %d channel inlet sensor. If the error continues, contact a technician to replace the sensor or module.
33	CRITICAL	Inlet %d is open	Stop the instrument. The %d channel inlet heater is open (faulty). Replace inlet component or module before resuming.
34	CRITICAL	Inlet %d is short	Stop the instrument. Short circuit in %d channel inlet heater. Have inlet module replaced before resuming.
35	RECOVERABLE	Inlet %d heating too slow	Wait for %d channel inlet temperature to stabilize. If heating is frequently too slow, consider channel maintenance.
36	INFO	Inlet %d temperature is restored	No action (inlet temperature normalized).
37	RECOVERABLE	Spare heater 1 temperature fault	Check operation of auxiliary heater 1. Restart the instrument. If the error persists, have the module checked or replaced.
38	RECOVERABLE	Spare heater 1 sensor fault	Check the connection of auxiliary heater sensor 1. If necessary, have this sensor or module replaced.
39	CRITICAL	Spare heater 1 is open	Stop using auxiliary heater 1. Its circuit is open (faulty). Replace module before resuming.
40	CRITICAL	Spare heater 1 is short	Stop using auxiliary heater 1. It is short-circuited. Contact support for replacement or repair.
41	RECOVERABLE	Spare heater 1 heating too slow	Let auxiliary heater 1 reach its setpoint. If it's regularly slow, schedule a check of this module.
42	INFO	Spare heater 1 temperature is restored	No action (heater 1 temperature restored).
43	RECOVERABLE	Spare heater 2 temperature fault	Check operation of auxiliary heater 2. Restart the instrument. If the problem continues, consider replacing this module.
44	RECOVERABLE	Spare heater 2 sensor fault	Check the connection of auxiliary heater sensor 2. If the error recurs, have this sensor or module replaced.
45	CRITICAL	Spare heater 2 is open	Stop the instrument. Auxiliary heater 2 is disconnected (open circuit). Replace defective component before restarting.
46	CRITICAL	Spare heater 2 is short	Stop the instrument. Auxiliary heater 2 is short-circuited. Have this module repaired or replaced before resuming operation.
47	RECOVERABLE	Spare heater 2 heating too slow	Wait for auxiliary heater 2 to stabilize. If slowness persists frequently, schedule maintenance on this component.
48	INFO	Spare heater 2 temperature is restored	No action (heater 2 temperature restored).
49	INFO	Self-testing cycle start	No action (self-test cycle in progress).
50	INFO	Self-testing cycle end	No action (self-test cycle completed).
51	RECOVERABLE	License lost due to key detached	Check the license key. Reconnect it if it has become detached, then restart the instrument to re-establish the license.
52	INFO	License restored	No action (license restored).

Error code	Class	Error message	Recommended action
53	INFO	Wait for preconditions of flush cycle	No action (waiting for purge conditions).
54	INFO	Start one flush cycle	No action (start of a purge cycle).
55	INFO	One cycle of flush passed	No action (one purge cycle completed).
56	WARNING	Flush cycles aborted	Check purge conditions (carrier gas, pressure). Rerun the procedure if necessary.
57	INFO	Start Column clean	No action (start of column cleaning).
58	INFO	Column clean passed	No action (column cleaning successful).
59	WARNING	Column clean aborted	Check whether column cleaning has been interrupted (temperature/pressure). Restart the operation if necessary.
60	INFO	Temperature equilibrating after column heating	No action (thermal balancing in progress).
61	INFO	Temperature equilibrating passed	No action (temperature stabilized).
62	INFO	TCD Calib, chan = %d	No action (TCD calibration in progress on the channel).
63	INFO	TCD Calib Success, chan = %d	No action (TCD calibration successful on the channel).
64	RECOVERABLE	TCD Calib Failed, chan = %d	Rerun TCD detector calibration for the channel concerned. If it still fails, check the detector or contact a technician.
65	WARNING	reserved	No action (code reserved).
66	INFO	Detector Enabled, chan = %d	No action (detector activated on the channel).
67	INFO	Detector Disabled, chan = %d	No action (detector deactivated on the channel).
68	WARNING	TCD temperature limit activated, chan = %d	The TCD detector has reached its temperature limit (%d channel). Let it cool down and check that analysis conditions are normal.
69	WARNING	TCD temperature limit deactivated, chan = %d	No action (TCD temperature limit deactivated on the channel).
70	WARNING	Channel unit changed, chan = %d	No action (channel unit modified).
71	CRITICAL	Adc Mux Offset is out of range, chan = %d	Restart the instrument. If the error persists on the %d channel, contact support (internal ADC fault).
72	INFO	reserved	No action (code reserved).
73	WARNING	Stream select failed	Check the stream selector (VICI) and its connections. Restart the selection. If the error persists, have the valve checked.
74	INFO	Stream select ok	No action (successful stream selection).
75	RECOVERABLE	Ambient temperature too high	Ambient temperature is too high. Improve cooling or move the instrument to a cooler location, then let it cool down before resuming.
76	INFO	Ambient temperature error cleared	No action (ambient temperature back to normal).
77	RECOVERABLE	Ambient pressure too high	Ambient pressure is too high. Use the instrument in an environment with normal pressure. Resume operation once pressure has returned to acceptable range.
78	INFO	Ambient pressure error cleared	No action (ambient pressure back to normal).

Error code	Class	Error message	Recommended action
79	WARNING	Battery 1 lower power	Battery 1 low. Plan to recharge or replace it soon.
80	INFO	Battery 1 power restored	No action (battery 1 recharged/power restored).
81	WARNING	Battery 2 lower power	Battery 2 low. Plan to recharge or replace it soon.
82	INFO	Battery 2 power restored	No action (battery 2 recharged/power restored).
83	RECOVERABLE	Low power supply	Power supply is low. Check power source (mains or battery). Connect to mains or replace/recharge battery for stable voltage.
84	INFO	Main Power Supply restored	No action (main power supply restored).
85	CRITICAL	Internal power failure, chan = %d	Internal power failure (%d channel). Restart the instrument. If the error persists, contact technical service.
86	INFO	reserved	No action (code not used).
87	INFO	Loading Mainboard Eds	No action (loading data from main card).
88	INFO	Loading Channel Controller %d Eds	No action (loading %d channel controller data).
89	INFO	Loading Analytical Module %d Eds	No action (loading %d analytical module data).
90	WARNING	Mainboard EDS logging error	The EDS log of the main board could not be updated. Restart the instrument. If the error continues, contact technical support.
91	WARNING	CCB EDS logging error, chan = %d	The EDS log of the %d channel controller could not be updated. Restart the instrument. If the problem persists, contact support.
92	WARNING	AMI EDS logging error, chan = %d	The EDS log of the %d analytical module could not be updated. Please restart. If the error persists, contact support.
93	CRITICAL	Channel Controller EDS validation failed, chan = %d	Invalid EDS data for the %d channel controller. Restart the instrument. If the error persists, reconfigure or replace the module, or contact support.
94	CRITICAL	Analytical Module EDS validation failed, chan = %d	Invalid EDS data for the %d analytical module. Restart and re-download the module configuration. If the error persists, contact support for assistance.
95	CRITICAL	Mainboard EDS validation failed	Invalid EDS data on main board. Restart the instrument. If the error persists, contact technical support.
96	WARNING	CCB EDS option section checksum incorrect, chan = %d	EDS data (options section) corrupted on the %d channel controller. Restart and reconfigure if possible. If the error persists, contact support.
97	WARNING	CCB EDS logbook section checksum incorrect, chan = %d	EDS data (log section) corrupted on the %d channel controller. Restart. If the error continues, contact support.
98	WARNING	CCB EDS protected section checksum incorrect, chan = %d	EDS data (protected section) corrupted on the %d channel controller. Restart the instrument. If recurrence, contact the technical service.
99	WARNING	CCB EDS option2 section checksum incorrect, chan = %d	EDS data (option2 section) corrupted on the %d channel controller. Restart and check configuration. Contact support if necessary.

Error code	Class	Error message	Recommended action
100	WARNING	AMI EDS option section checksum incorrect, chan = %d	EDS data (options section) corrupted on the %d analytical module. Restart and re-download configuration. If the problem persists, contact support.
101	WARNING	AMI EDS logbook section checksum incorrect, chan = %d	EDS data (log section) corrupted on the %d analytical module. Restart. If the error persists, contact a technician.
102	WARNING	AMI EDS protected section checksum incorrect, chan = %d	EDS data (protected section) corrupted on the %d analytical module. Restart. If this persists, technical support required.
103	WARNING	AMI EDS option2 section checksum incorrect, chan = %d	EDS data (option2 section) corrupted on the %d analytical module. Restart and reconfigure. If recurrence, contact support.
104	WARNING	Mainboard EDS option section checksum incorrect	EDS data (options section) corrupted on the motherboard. Restart the instrument. If the error recurs, contact support.
105	WARNING	Mainboard EDS logbook section checksum incorrect	EDS data (log section) corrupted on the motherboard. Reboot. If persistent, contact support.
106	WARNING	Mainboard EDS protected section checksum incorrect	EDS data (protected section) corrupted on the motherboard. Restart the system. If the error persists, contact technical support.
107	WARNING	CCB EDS option struct version invalid, chan = %d	Invalid EDS structure version (options) for the %d channel controller. Update firmware or reconfigure channel. Otherwise, contact support.
108	WARNING	CCB EDS protected struct version invalid, chan = %d	Invalid EDS structure version (protected) on the %d channel controller. Make sure the software is up to date. Contact a technician if necessary.
109	WARNING	CCB EDS option2 struct version invalid, chan = %d	Invalid EDS structure version (option2) for the %d channel controller. Update configuration or contact support.
110	WARNING	AMI EDS option struct version invalid, chan = %d	Invalid EDS structure version (options) on the %d analytical module. Update module or software. Otherwise, contact support.
111	WARNING	AMI EDS protected struct version invalid, chan = %d	Invalid EDS structure version (protected) on the %d analytical module. Update software or contact technical support.
112	WARNING	AMI EDS option2 struct version invalid, chan = %d	Invalid EDS structure version (option2) on the %d analytical module. Update or contact support.
113	WARNING	Mainboard EDS option struct version invalid	Invalid EDS structure version (options) on the motherboard. Update instrument firmware or contact support.
114	WARNING	Mainboard EDS protected struct version invalid	Invalid EDS structure version (protected) on the motherboard. Update internal software or contact support.
115	INFO	Start Run Request!	No action (request to start analysis received).
116	RECOVERABLE	Not ready to start run!	The instrument is not ready. Check that all conditions are met (temperature, doors closed, etc.), then try again.
117	INFO	Run started!	No action (analysis started).
118	INFO	Run completed	No action (analysis completed successfully).
119	WARNING	Abort run!	The analysis has been interrupted. Check the cause of the interruption before starting a new analysis.

Error code	Class	Error message	Recommended action
120	INFO	Anyapp report generated!	No action (report generated).
121	WARNING	Anyapp report failed to store!	Failure to save report. Check storage space or connection, then try again.
122	INFO	Automation Start	No action (start of automation).
123	WARNING	Automation is aborted	Automation has been interrupted. Check parameters or errors, then restart if possible.
124	INFO	Sequence Started	No action (sequence started).
125	INFO	Sequence Quit	No action (sequence completed).
126	INFO	Calibration block started	No action (start of calibration block).
127	INFO	Calibration block quit	No action (calibration block completed).
128	INFO	Verification block started	No action (start of verification block).
129	INFO	Verification block quit	No action (verification block completed).
130	INFO	Recalculate!	No action (recalculation performed).
131	INFO	Clear all calibration curves	No action (all calibration curves have been reset).
132	WARNING	FTP storage failure	FTP storage failed. Check your network connection and FTP server settings, then try again.
133	WARNING	USB storage failure	USB storage failure. Check the USB drive (connection, available space), then try again.
134	INFO	Channel board %d is detected	No action (%d channel card detected).
135	INFO	Pump board %d is detected	No action (%d pump card detected).
136	INFO	Field case is detected	No action (field case detected).
137	CRITICAL	IOC communication error	Internal communication error (IOC). Restart MicroGC. If the error persists, contact support (possible electronic fault).
138	FATAL	IOC fatal error	Fatal IOC controller error. The instrument restarts. If this happens again, contact technical support.
139	CRITICAL	Mainboard CAN bus ID is not correct	Address conflict on the motherboard CAN bus. Switch the instrument off and on again. If the error continues, contact a technician.
140	FATAL	IOC GPIO init failed	IOC controller I/O initialization failed (fatal error). Let the instrument restart. If the error recurs, technical service required.
141	FATAL	IOC CAN bus init failed	IOC controller CAN bus initialization failed (fatal error). The instrument will restart. If the error persists, contact support.
142	CRITICAL	IOC CAN bus id conflict detected	ID conflict on IOC CAN bus. Restart the system. If the error persists, have the modules configuration checked by a technician.
143	FATAL	IOC ISR error	IOC controller (ISR) internal error. The instrument will restart. If this happens frequently, contact support for diagnosis.

Error code	Class	Error message	Recommended action
144	CRITICAL	IOC I2C bus init error	IOC I2C bus initialization error. Restart the instrument. If the error does not disappear, technical intervention is required.
145	WARNING	TCD Autozero health check failure, chan = %d	Autozero of TCD detector failed on the %d channel. Perform a manual autozero. If the error persists, check the detector or contact a technician.
146	WARNING	TCD Autozero health check warning, chan = %d	Warning: autozero TCD out of range on the %d channel. Recalibrate detector zero soon and monitor its performance.
147	INFO	TCD Autozero warning cleared, chan = %d	No action (TCD autozero warning raised on the channel).
148	FATAL	IOC communication host	Fatal host communication error. Instrument restarts. Check the PC link after rebooting. If recurring, contact support.
149	FATAL	Internal watchdog error	Internal fatal error (watchdog). The instrument will restart automatically. If this happens again, have the instrument diagnosed by the technical service.
150	FATAL	OOA Timer not available	Fatal error: OOA timer unavailable. Let the instrument restart. If the error reappears, contact technical assistance.
151	FATAL	OOA event loop stuck	Fatal error: OOA event loop blocked. Let the instrument restart. If recurring, call support.
152	CRITICAL	Internal fatal software error	Critical internal software error. Restart the system. If the problem persists, contact technical support.
153	CRITICAL	Field case initialization failure	Field case initialization failed. Check its connection. Restart the instrument. If the error persists, have the box checked by a technician.
154	INFO	reserved	No action (code reserved).
155	CRITICAL	Field case gas cylinder %d low pressure	%d gas cylinder (field case) almost empty. Replace or recharge this cylinder before resuming.
156	INFO	Field case gas cylinder %d pressure restored	No action (%d cylinder pressure restored).
157	INFO	Field case valve %d switches to use gas cylinder	No action (%d valve switched on internal cylinder).
158	INFO	Field case valve %d switches to use external gas	No action (%d valve switched on external gas source).
159	WARNING	Field case battery %d over temperature	%d battery in field case overheating. Switch off the instrument and let it cool down. Check ventilation, then restart when cooled.
160	WARNING	Field case battery %d over current	Overvoltage on %d field case battery. Switch off the instrument. Check the battery and its connections. Replace the battery if necessary.
161	WARNING	Field case battery %d over voltage	Voltage overload on %d field case battery. Switch off the instrument. Check charging circuit. Restart with a good battery.
162	WARNING	Field case battery %d cell short	Short-circuited cell in %d field case battery. Replace this battery immediately (safety risk).
163	WARNING	Field case battery %d cell open	Faulty cell (open circuit) in %d field case battery. Replace battery, capacity reduced.

Error code	Class	Error message	Recommended action
164	WARNING	Field case battery %d NTC open	Temperature sensor (NTC) disconnected for %d field case battery. Check sensor connector. Replace the battery if necessary.
165	WARNING	Field case battery %d gauge failed	%d battery (field case) gauge circuit failure. Replace or recalibrate battery.
166	WARNING	Field case battery fan open	Battery fan (field case) disconnected or out of order. Check the fan connection and replace it if necessary.
167	WARNING	Field case mainboard fan open	Main board fan (field case) defective or disconnected. Check and replace it if necessary.
168	WARNING	Field case switch valve %d open	%d field case switching valve not working (open circuit). Check its wiring and replace it if necessary.
169	WARNING	Field case pump %d not detected	The %d pump in the field case is not detected. Check its connection. Replace or repair the pump if necessary.
170	WARNING	Pump %d open	%d (internal) pump not connected or out of order (open circuit). Check connections and replace the pump if necessary.
171	WARNING	Pump valve %d open	%d pump valve defective (permanently open). Inspect the valve and replace it if necessary.
172	WARNING	Pump board fan %d open	%d pump card fan out of order or disconnected. Check and replace this fan if necessary.
173	CRITICAL	Channel %d is lost	Loss of communication with channel %d. Check module connection. Restart the instrument. If the channel remains inactive, contact support.
174	CRITICAL	Pump board %d is lost	Loss of communication with %d pump card. Check connection. Restart. If the error persists, call in a technician.
175	CRITICAL	Field case is lost	Communication lost with the field case. Check connection (cables/connectors). Restart. If the problem continues, maintenance required.
176	INFO	Start leak detection process	No action (start of leak detection process).
177	WARNING	Channel %d is found leak	Leak detected in %d channel. Check and retighten the connections on this channel to eliminate the leak.
178	INFO	Leak detection process finished	No action (leak test completed).
179	INFO	Leak detection process to be aborted	No action (leak detection process interrupted).
180	INFO	Extension board %d detected	No action (%d expansion card detected).
181	CRITICAL	H2 Pressure too low, chan = %d	H2 pressure on %d channel is too low. Check hydrogen source (cylinder, valve). Restore pressure and resume analysis.
182	CRITICAL	H2 Pressure too high, chan = %d	H2 pressure on %d channel is too high. Switch off H2 supply. Check the regulator or pipes. Resume when pressure returns to normal.
183	CRITICAL	H2 Pressure cannot reach its setpoint, chan = %d	H2 pressure in %d channel does not reach set point. Check availability of H2 (cylinder, leaks). Correct supply and try again.

11. Technical data

11.1 Power supply

100-240 VAC, 50-60 Hz
300 W max

11.2 Dimensions and weight

11.2.1 Dimensions

Desktop case model (equipped with feet, without 19" mounting bracket) :
Width: 448.9 mm
Height: 236.7 mm
Depth: 495.5 mm

19" rack model (without feet, with 19" mounting bracket) :
Width: 482 mm
Height: 221.5 mm
Depth: 495.5 mm

11.2.2 Weight

1 analytical module + OBC : 18 kg
2 analytical modules + OBC : 20 kg
3 analytical modules + OBC : 22 kg
4 analytical modules + OBC : 24 kg

11.3 Working conditions

- Relative humidity : 0 to 95 % / Storage: Relative humidity 10 to 95 %; Temperature -40 °C to +70 °C
- No condensation
- Room temperature :
  - The operating temperature of the Micro GC is 0-50 °C.
  - The MicroGC automatically shuts down if the ambient temperature exceeds 70 °C.
- Ambient pressure : The MicroGC automatically shuts down if the ambient pressure is greater than 120 kPa.
- Maximum operation altitude : certified up to 2000 meters above sea level.
- Indoors use

11.4 Chromatographic modules

- Up to 4 modules
- 1 or 2 carrier gases

11.4.1 Carrier gases

- Compatible with helium, hydrogen, nitrogen, and argon with 1/8" Swagelok fittings.
- Inlet pressure: minimum = 550 ± 20 Kpa (80 ± 3 psi) 5.5 bars
- Minimum purity: 99.9995 % (for trace analysis 99.9999% is recommended)

11.4.2 Sample and injection

- Gas or vapor samples only
- Sample pressure: from atmosphere to 14.5 psi max (1 bar)

11.4.3 Injector

- Micro-machined injector without moving parts
- Injection volume from 1 to 10 µL
- Heated injector up to 110 °C, including a heated sample transfer line.
- Optional back-flush

11.4.4 Column

Temperature range, up to 180 °C, isothermal

11.4.5 Detector

- Micro-machined thermal conductivity detector (TCD)
- Dual channel (sample flow and reference flow)
- Internal volume per 200 nL channel
- Filaments, oven

11.4.6 TCD operating range

- Concentration, from 1 ppm to 100 %.
- Dynamic linear range, 10^6

11.4.7 TCD detection limits

Detection limits are typical for selected components, as long as the column length and conditions used are appropriate.

- 0.5 ppm for WCOT capillary columns between 4 and 10 m long.
- 2 ppm for PLOT columns

11.4.8 Repeatability

< 0.5 % RSD for propane at 1 % molar level for WCOT columns at constant temperature and pressure.

11.5 Embedded computer (OBC)

- **Intel core i3 Processor**
- **256 GB SSD**
- **8 GB RAM**
- **Windows 10**
- **Ports** (connected to the on-board computer)
    - 1 x Ethernet
    - 1 x USB 3.2 front panel
    - 2 x USB 2.0 back panel
    - 2 SUB-D9 male RS232-RS422-RS485 *
    - 1 SUB-D9 male RS232 *
    - 1 VGA

    ** VICI valve or Modbus via Soprane CDS*

11.6 Modbus (optional)

- **Serial communication RS232 or RS485**
  - RTU
  - ASCII 16 bits
  - ASCII 32 bits (Daniel)
  - JBUS option
  - Configurable slave number

- **LAN communication**
  - Port 502 configurable
  - Configurable slave number
  - RTU
  - ASCII 16 bits
  - ASCII 32 bits (Daniel)

11.7 Inputs / Outputs

- **Digital input/output**
  - SUB-D25 female connector
  - 2 x digital inputs
  - 2 x digital outputs
  - 2 x output relays (24 V - 1 A maximum)
  - Voltages available : 1 x 5 V - 1 x 12 V (500 mA max)
  - Control signals : 1 x start in - 1 ready in - 1 ready out - 1 start out

Optional

- **Analog input**
  - Screw connectors with 4 analog inputs 0-10 V ou 0-20 mA (individually configurable)

- **Digital or analog input/output** (choice between the following possibilities)
  - 4 x 4-20 mA outputs
  - 4 x relay outputs (5 A - 250 V)
  - Customized configuration on demand

11.8 Driving software

Soprane CDS by default

12. EU declaration of conformity

We,

SRA Instruments
210 Rue des Sources
69280 MARCY L'ETOILE
FRANCE

As a manufacturer, declare under our sole responsibility that the instrument type

R990 Rackable MicroGC analyzer with embedded computer	

to which this declaration relates, meets the Essential Health and Safety Requirements applicable to it and which are defined by the following Directives and subsequent additions and / or changes:

1/ Directive 2014/35/EU, Annex I
2/ Directive 2014/30/EU, Annex I

Compliance with the above requirements has been ensured by applying the following standards:

1/ Directive 2014/35/EU – Low voltage

- NF EN 61010-1:2010+A1:2019 "Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements"
- NF EN IEC 61010-2-081:2020 "Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-081: Particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes"

2/ Directive 2014/30/EU – Electromagnetic compatibility

- NF EN IEC 61326-1:2021 "Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements"
- NF-EN 61000-4-2:2009 "Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test"
- NF EN IEC 61000-4-3:2020 " Electromagnetic compatibility (EMC) – Part 4-3 : Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test"

In accordance with the above-mentioned directives (Module A), the above-mentioned equipment is subject, regarding design and production aspects, to *internal production control*: **E FAB 28**

Marcy l'Etoile, 20 January 2023

Legal representative,
Armando MILIAZZA

210 rue des Sources
69280 MARCY L'ETOILE
Tél. 04.78.44.29.47
Fax.04.78.44.29.62
www.sra-instruments.com
SIRET 342 068 731 00054

13. Frequently Asked Questions

13.1 My detector is in default status, what should I do?

If the detector displays default in Soprane Status:

1. Check that you have correctly purged columns by downloading a purge method before starting the detector, that the carrier gas tubing is tight and of quality, connected with a stainless steel tube at 5.6 bars pressure.
2. Check that a carrier gas flow is present at the columns output (on the back of the MicroGC). If it's not the case on one of the two outputs, contact SRA Instruments after-sales service.
3. Check that the carrier gas used is correctly configured in Soprane Setup software.

If all these verifications are carried out and correct, please, download again the purge method and look at the status.
If the detector is again in default, contact SRA Instruments after-sales service.

13.2 My pressure sensor is in default status, what should I do?

1. Check that the carrier gas tubing is correctly fed, tight and with a pressure at 5.6 bars.
2. If there are two carrier gas inputs on the MicroGC, check that the two inputs are correctly connected.
3. If necessary, check that the carrier gas is effectively coming at the carrier gas tubing output, at the MicroGC inlet.
4. Check that the columns outputs are at atmospheric pressure and not blocked.

If all these verifications are carried out and correct, download again the method and look at the status.
If the pressure sensor is again in default, please contact SRA Instruments after-sales service.

13.3 I change the carrier gas, what should I do?

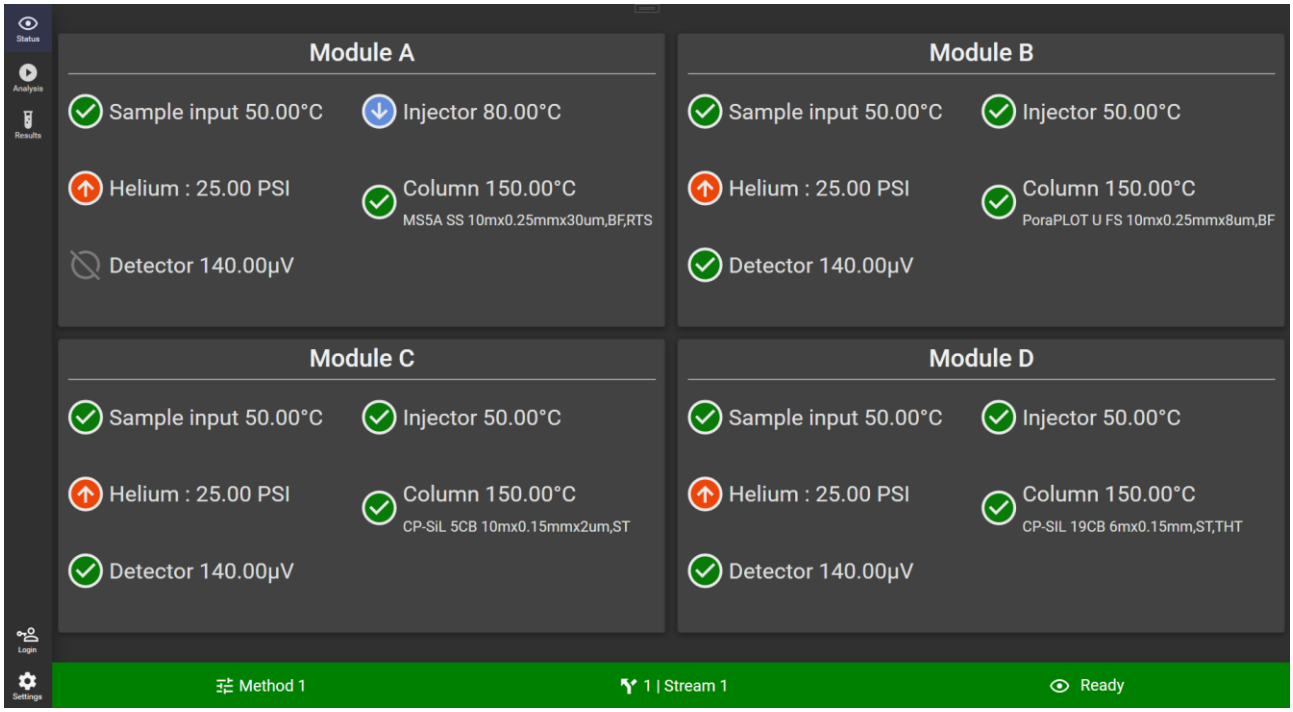
Before changing of carrier gas type, follow the procedure to switch off your MicroGC.
Then, configure the carrier gas type as it is described in section 5.6.
It is then highly advised to carry out a bake out during minimum one night to purge all the columns and to rebalance the column with the use of a new gas.
Do not forget that a bad carrier gas configuration can irremediably damage the detector.

14. Appendix 1 : Using the front panel application

The Rack 990 front panel application is a simplified representation of MicroGC conditions and allows the start of analyses/sequences; chromatogram display is not provided.

14.1 Instrument status display

By default, the application displays the current status of the instrument by modules.
To access the status of the instrument, select the "Status" tab.



Each element of the modules can be of different colors to indicate the status:

The element is ready and has reached its set point.

The element is not ready, it has not reached its set point: the current value is too high.

The element is not ready, it has not reached its set point: the current value is too low.

The element is deactivated.

At the bottom of the window, the method, the sampling channel, and the status of the instrument are displayed in a banner whose color varies according to the status of the MicroGC:

Color of the banner	MicroGC status
Blue	Sampling / PreRun / Analysis Running / Waiting for final Data Points / PostRun
Orange	Flushing / Stabilizing / Error recovery / Error / Broken / Waiting for Ready
Grey	Not connected
Green	All other statuses

14.2 Start of analyses/sequences

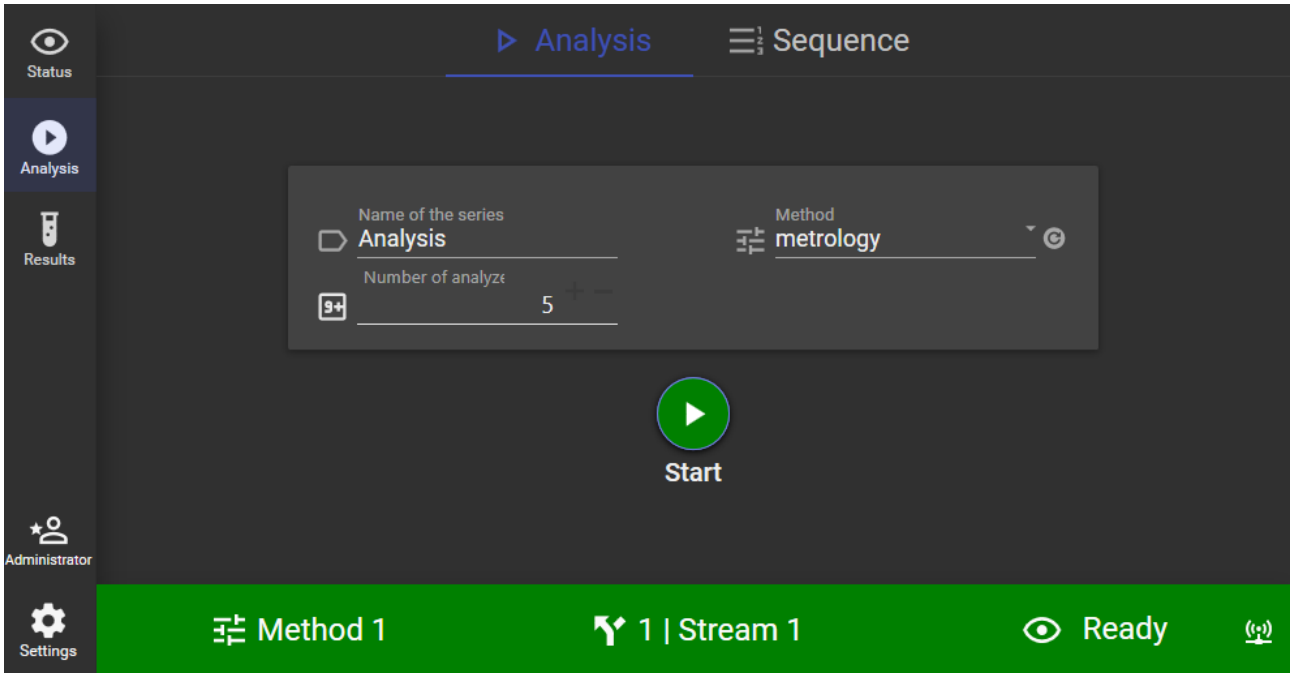
This chapter implies to have the necessary rights (defined by the administrator in the Soprane CDS software).

14.2.1 Analyses

It is possible to start an analysis directly via the application by selecting the "Analysis" tab in the vertical menu and "Analysis" in the horizontal menu.

The fields to be filled in are :

- The name of the analysis series
- The method
- The number of analyses to perform

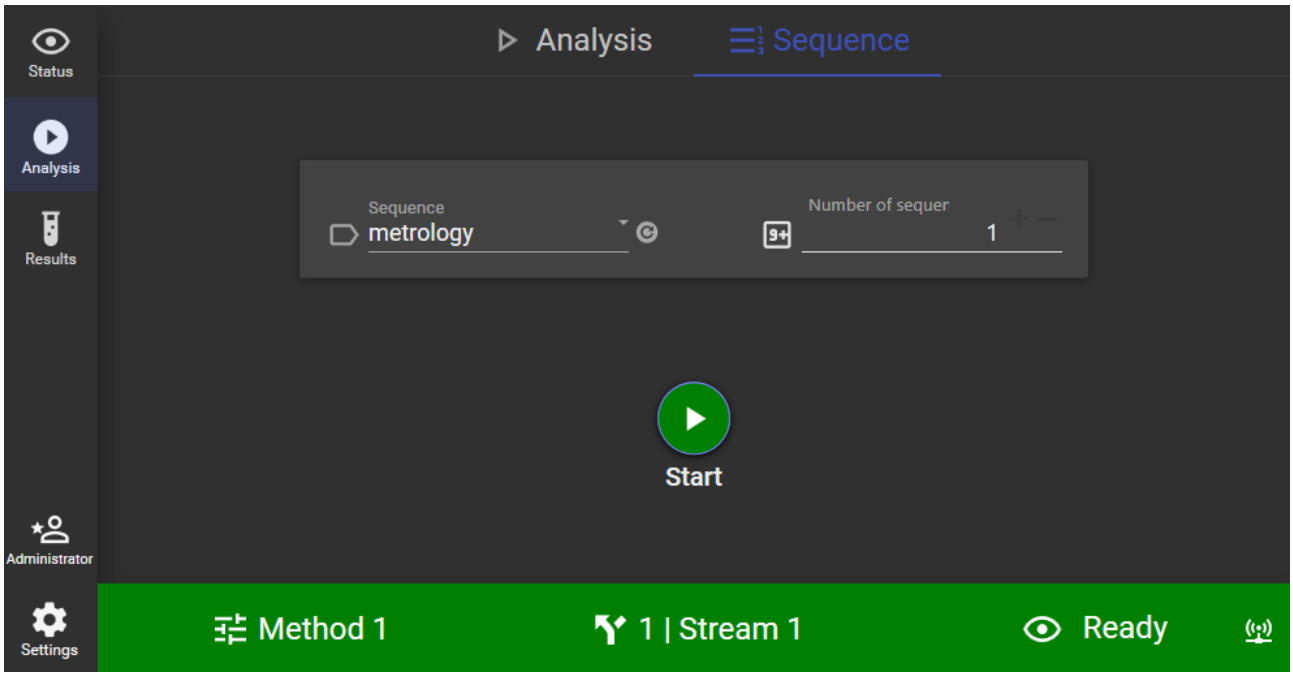


14.2.2 Sequences

It is also possible to start a sequence directly via the application by selecting the "Analysis" tab in the vertical menu and "Sequence" in the horizontal menu.

The fields to be filled in are :

- The name of the analysis sequence
- The number of repetitions of the sequence



14.3 Display of results

To access the results of the analysis, select the "Results" tab in the vertical menu.

The results can be of different types:

- Compound results
- Results of the calculation standards:
  - Natural gas (ISO 6976:2016)
  - Combustion
  - GLP (ISO 8973)
- Analog inputs of the analysis
- Customized calculations on Excel

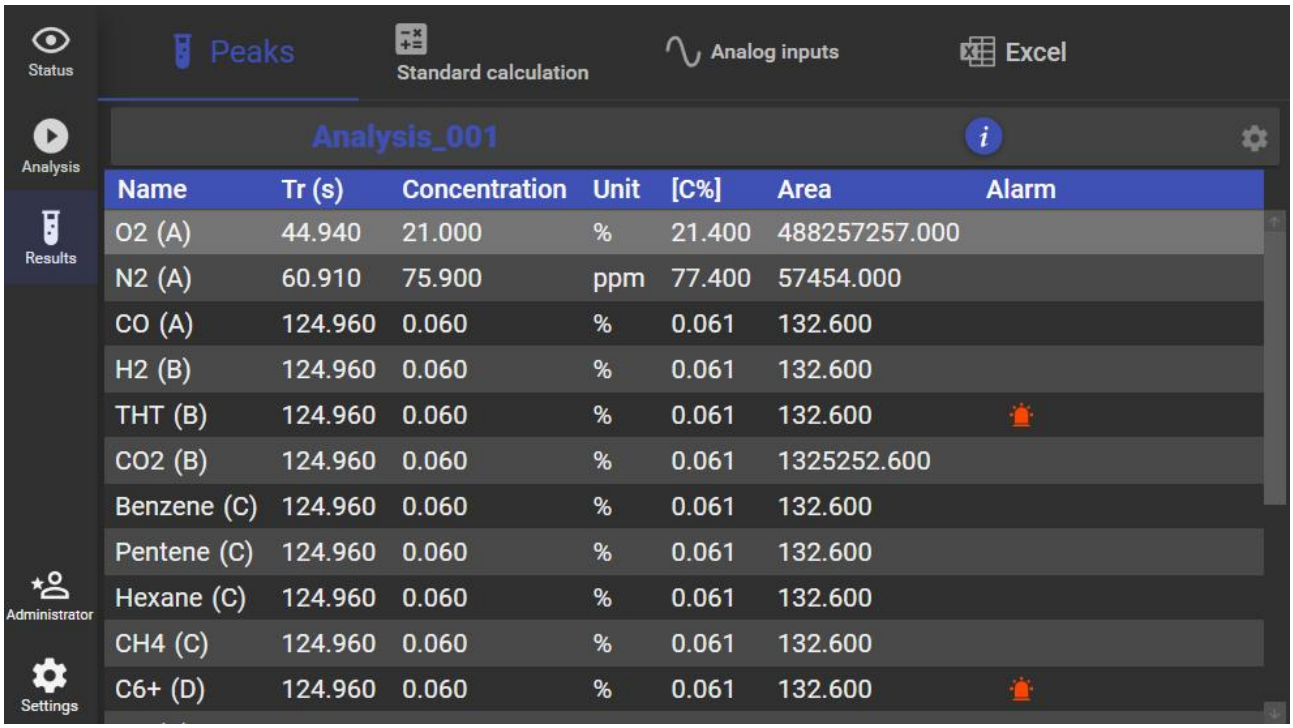
Note: in the following displays, it is possible to configure the values to be displayed by clicking on the button ⚙.

14.3.1 Display of compounds

The display of compound results is available by selecting the "Peaks" tab.

The table will display the following values:

- The name and module of the compound
- The retention time
- The concentration
- The unit of concentration
- The normalized concentration
- The surface area
- The alarm (a red icon is displayed in case of a default ; the line remains empty if there is no default).



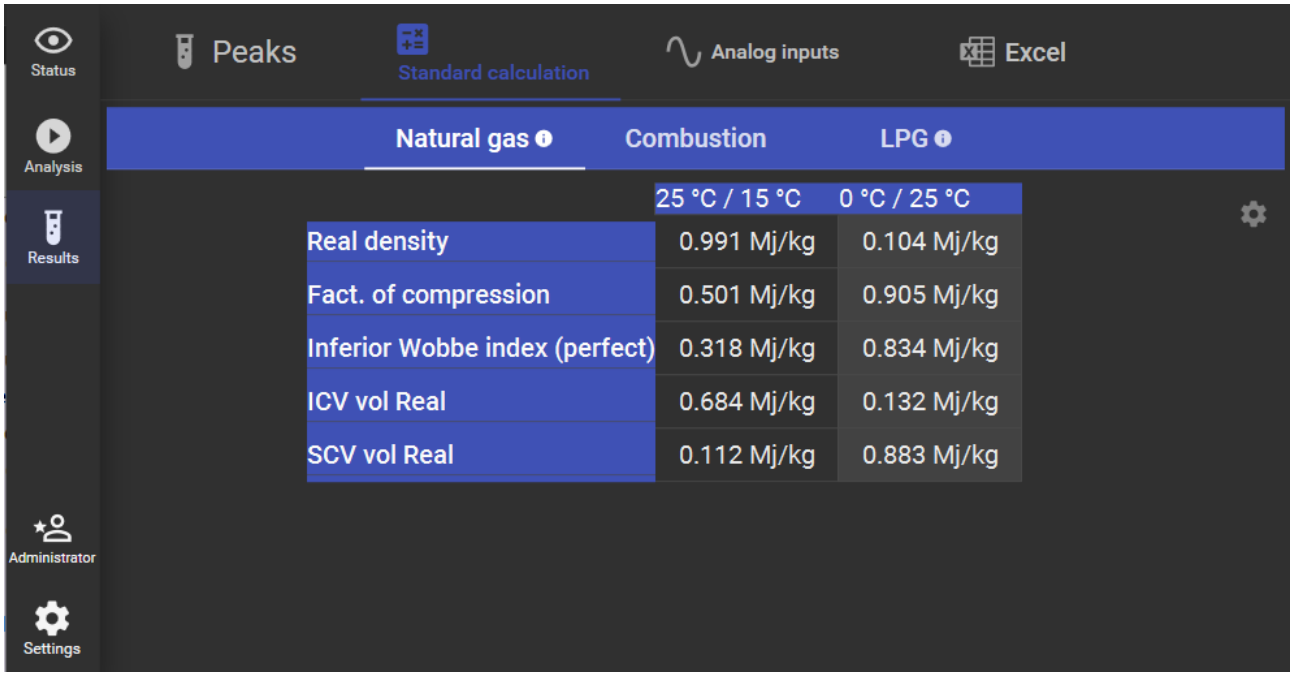
Name	Tr (s)	Concentration	Unit	[C%]	Area	Alarm
O2 (A)	44.940	21.000	%	21.400	488257257.000	
N2 (A)	60.910	75.900	ppm	77.400	57454.000	
CO (A)	124.960	0.060	%	0.061	132.600	
H2 (B)	124.960	0.060	%	0.061	132.600	
THT (B)	124.960	0.060	%	0.061	132.600	
CO2 (B)	124.960	0.060	%	0.061	1325252.600	
Benzene (C)	124.960	0.060	%	0.061	132.600	
Pentene (C)	124.960	0.060	%	0.061	132.600	
Hexane (C)	124.960	0.060	%	0.061	132.600	
CH4 (C)	124.960	0.060	%	0.061	132.600	
C6+ (D)	124.960	0.060	%	0.061	132.600	

14.3.2 Specific calculations

The display of the results of specific calculations is available by selecting the "Standard calculation" tab.

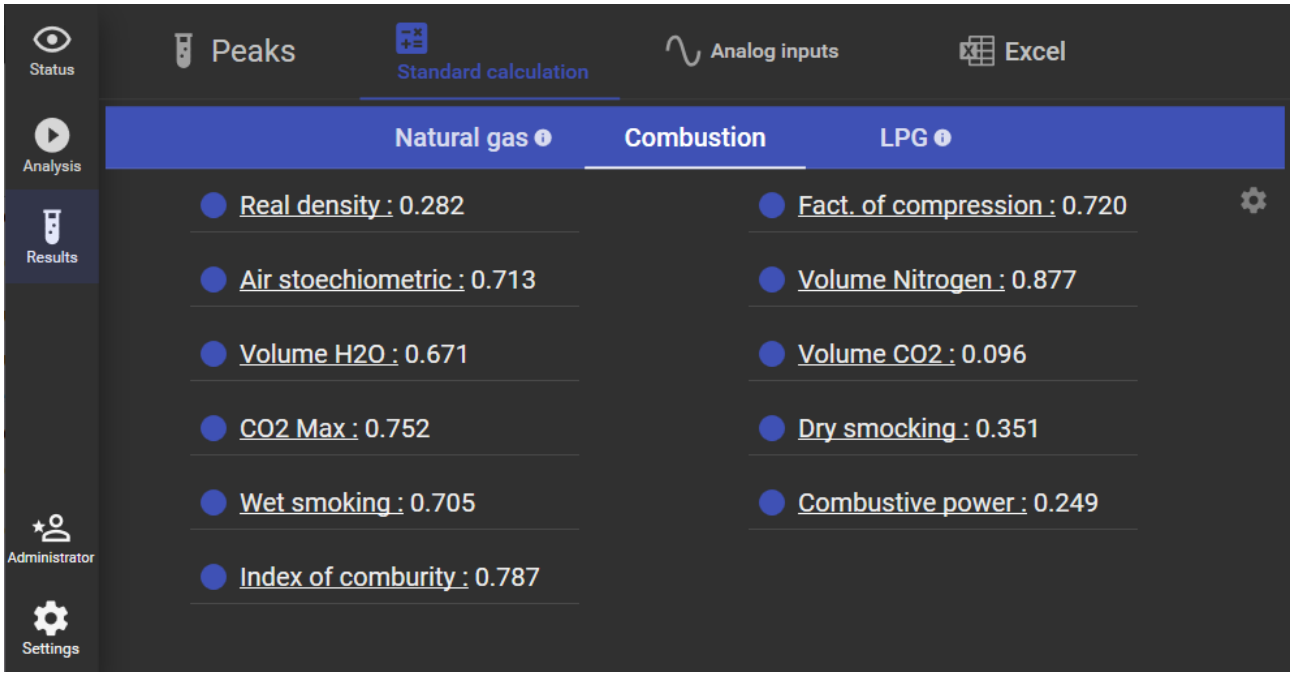
A sub-menu allows you to select the desired calculation standard.

- Natural gas (ISO 6976:2016)

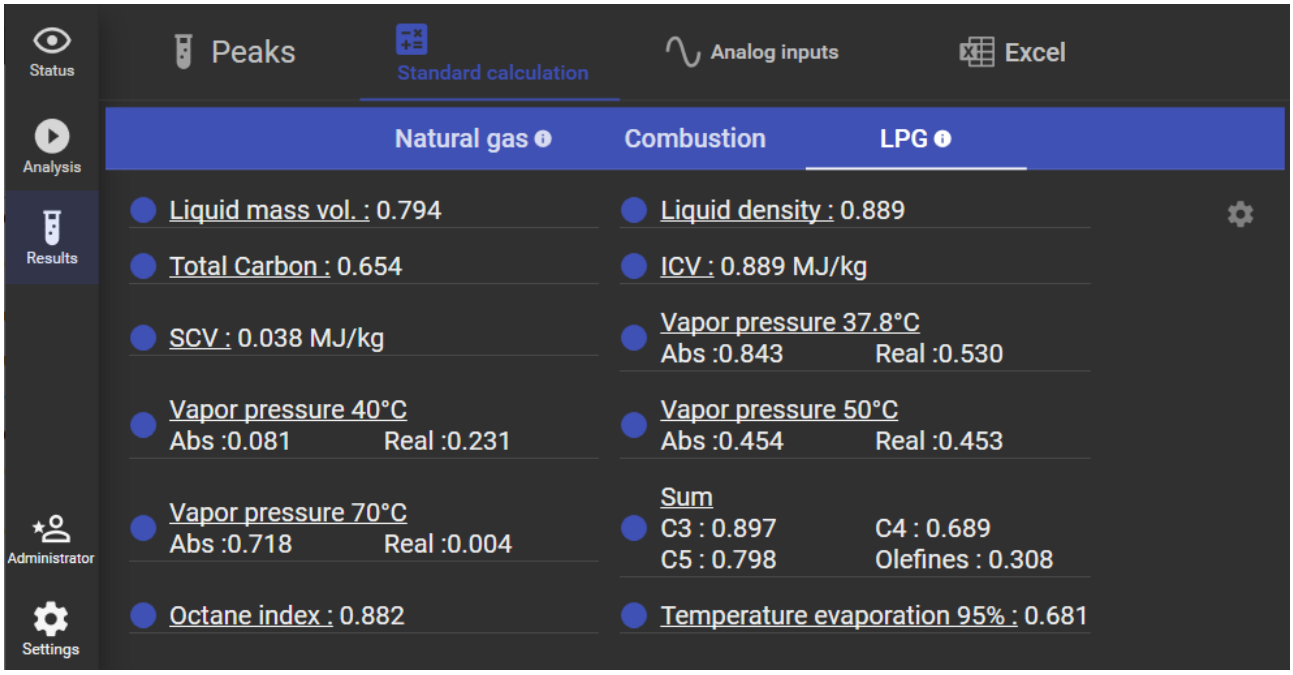


	25 °C / 15 °C	0 °C / 25 °C
Real density	0.991 Mj/kg	0.104 Mj/kg
Fact. of compression	0.501 Mj/kg	0.905 Mj/kg
Inferior Wobbe index (perfect)	0.318 Mj/kg	0.834 Mj/kg
ICV vol Real	0.684 Mj/kg	0.132 Mj/kg
SCV vol Real	0.112 Mj/kg	0.883 Mj/kg

- Combustion

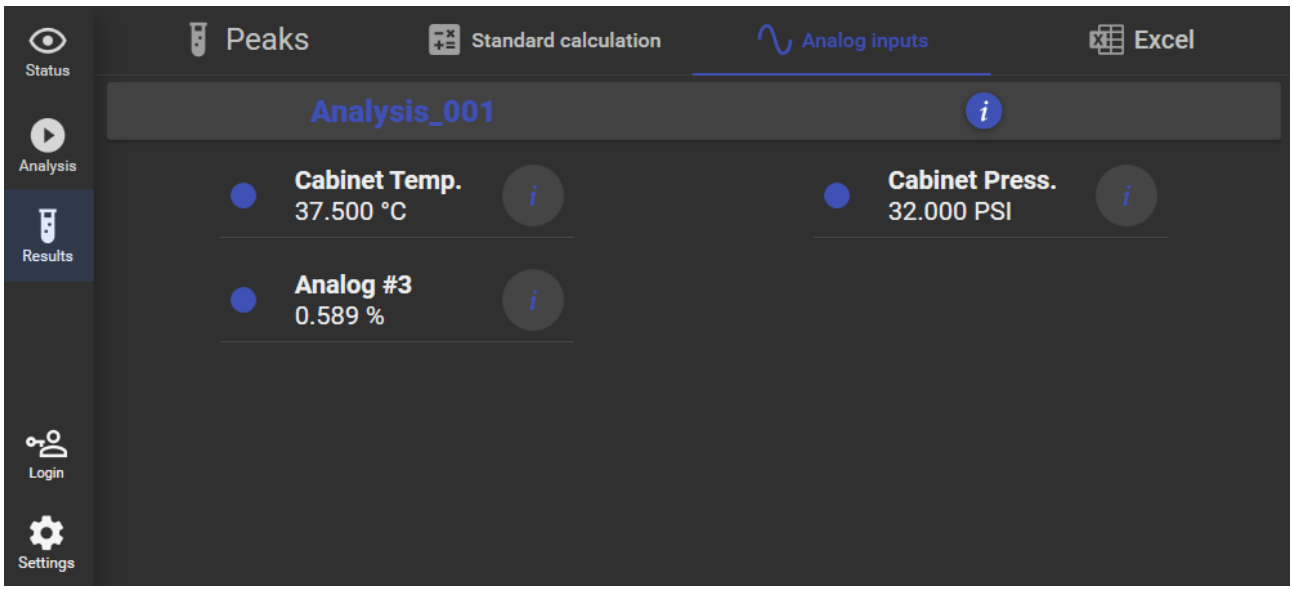


- LPG



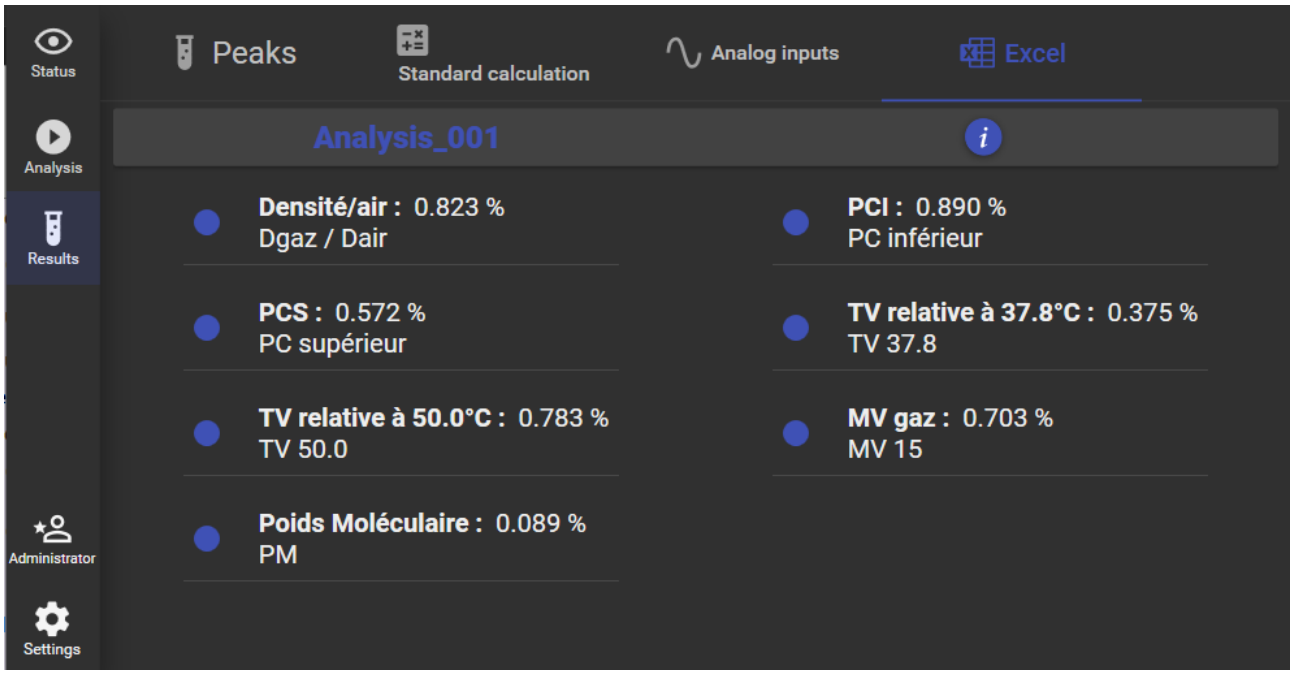
14.3.3 Analog inputs

The display of the analog inputs is available by selecting the "Analog inputs" tab.



14.3.4 Customized calculations in Excel

The display of customized calculations in Excel for the analysis is available by selecting the "Excel" tab.



14.4 Application settings

Several parameters can be configured by clicking on "Settings" in the vertical menu.

Here are the elements that can be configured:

- The language (French/English)
- The name of the analyzer to connect to (by default * will connect to the first instrument detected)
- Display of the method name
- Display of the sampling stream
- Dynamic display of the status (in progress: displays the results of the previous analysis; out of analysis: displays the status of the instrument)
- Change of theme