USER MANUAL

3S-CL
Colorimetric Analyzer

3S Analyzers S.r.l. Italy www.3s-analyzers.eu February 2021

Electrical equipment marked with this symbol can not be disposed of through home or public waste disposal systems after 12 August 2005. In accordance with local and national European regulations (EU Directive 2002/96 / EC), users must return the equipment which is unsuccessful or can no longer be used to the manufacturer, which have to provide free of charge disposal.

Note: To return devices at the end of their useful life, accessories supplied by the manufacturer and all auxiliary items for recycling, contact the manufacturer or the vendor of the device to arrange proper disposal.

INDEX

1 - SAFETY INFORMATION

Before installing and operating the analyser, read this manual thoroughly. Please pay particular attention to all the labels applied to the analyser and to all the hazard information indicators in this manual.

This symbol indicates that you must refer to this manual for proper use of the equipment. Only qualified operators, properly trained on the use and maintenance of the analyser can carry out service activities on the equipment.

Only operators qualified for these activities can perform maintenance and control operations on the equipment bearing this label, always after unplugging it.

Parts involved:
- input terminal block in the upper box

This symbol indicates the risk of burns and physical damage caused by the presence of hazardous chemical compounds.
Only operators qualified for these activities can handle and perform service operations that may involve the risk of contact with such compounds. Before carrying out any type of service activities on the analyser, please read the safety data sheets of the different chemicals used and take all precautions specified therein.

Parts involved:
- reagent bottles
- cleaning reagent bottle and the pipes connected to it

The manufacturer shall not be held responsible under any circumstances for improper use of the equipment.
The head of department and the machine operator must comply with the following rules and with the provisions of current legislation on the safety and health of workers.
The use, maintenance, and repair of the analyser are permitted only to persons authorised for such operations. These operators must be physically and mentally capable to perform such activities, which can not be performed under the influence of alcohol and drugs.
When the analyser is not being used it must be protected from voluntary or involuntary activation, after disconnecting the power supply.
Failure to follow the instructions given and/or failure to pay attention to the hazard indicators may cause serious risks of physical damage to operators and breaks or malfunctioning of the analyser.
All the components of the analyser are placed within a panel closed by a door with a special key, supplied only to maintenance operators.
The analyser must, then, be used under operating conditions with both lower and upper doors closed.

2 - GENERAL INFORMATION

2.1 Technical specification

Measure principle	Spectroscopic determination of color development chemical reaction (colorimetric analysis)
Measuring variables	See list of parameters
Analysis frequency	From 6 to 20 minutes (depending on the parameter)
Repeatability	± 1% absorbance (concentration % depending on the parameter)
Power supply	110-230 VAC, 50/60 Hz, 80 VA, optional 24 VDC
Working conditions	Temperature 5 - 45°C (41 - 113 °F), humidity max 85% RH
Cabinet	Epoxy-coated stainless steel
Protection grade	IP54
Mounting	Wall or rack mounting, in vertical position with fixing hinges
Dimensions (H x L x D)	680 x 380 x 242 mm (23.6 x 14.8 x 9.4 in)
Weight	Approx. 20 kg (44 lbs)
Output signals	n. 2 analog outputs 4-20 mA, serial com. ModBUS RTU RS485 / ethernet
Alarms	n. 2 programmable relays, voltage free, NO or NC
Datalogger	Integrated, with USB storage
Automatic functions	Calibration, validation, cleaning
Measurable samples	2
Sample pressure	Atmospheric, flow (max 500 ml/min) goes to a sample reservoir with overflow to drain
Samples connection	To sample reservoir: flexible tubing 6 mm OD
Sample temperature	5 - 45°C (41 - 113°F)
Mantainance frequency	Every 4 months; some parameters or samples require more mantainance

2.2 Analyzer description

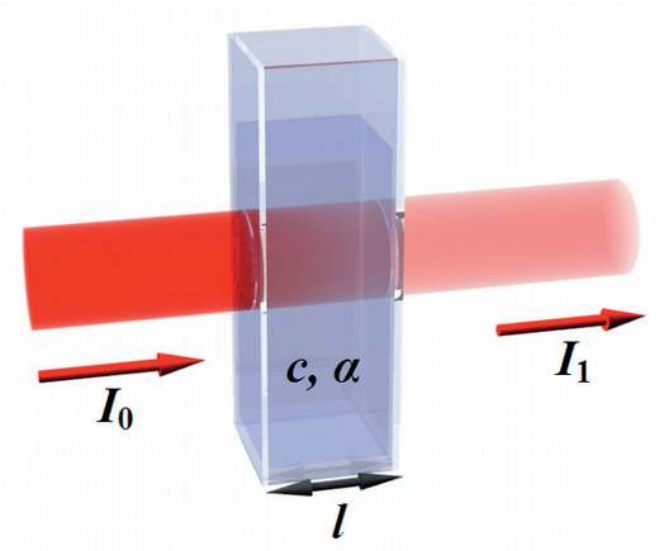
The 3S colorimeter is an online analyzer for batch-wise analysis (a sequence of sampling, analysis and result processing), using colorimetric methods. The analyzer is assembled in two separate enclosures with two lockable doors. The first one, called the LIQUIDS enclosure, includes all the components involved in FLUIDICS movement as well as their mixing and reaction stages (sampling pump, colorimetric reaction cell, reagents pumps,..). Numerous analysis configurations could be programmed, depending on the installed accessories and the number of reagent pumps mounted in the wet section. The second upper enclosure, called the ELECTRICAL enclosure, includes the main power supply, the controller PCB assembly and the touchscreen interface.

2.3 Applications

Refer to the application datasheets in Section 10 for the specific parameter and for the colorimetric measurement used.

2.4 Method description

Colorimetric determinations are based on the color formation after the addition of reagents to the sample or standard solution. The absorbance of the solution is measured at a specific wavelength. The absorbance is related to sample concentration according to 'Beer's law'.
Lambert–Beer law is an empirical relationship that relates the absorption of light to the properties of the material through which the light is travelling.
The law states that there is a logarithmic dependence between the transmission (or transmissivity), T, of light through a substance and the product of the absorption coefficient of the substance, α, and the distance the light travels through the material (i.e. the path length), ℓ. The transmission (or transmissivity) is expressed: $\mathbf{T = I_1 / I_0}$



Absorbance for liquids is defined as the negative logarithm of the transmittance:

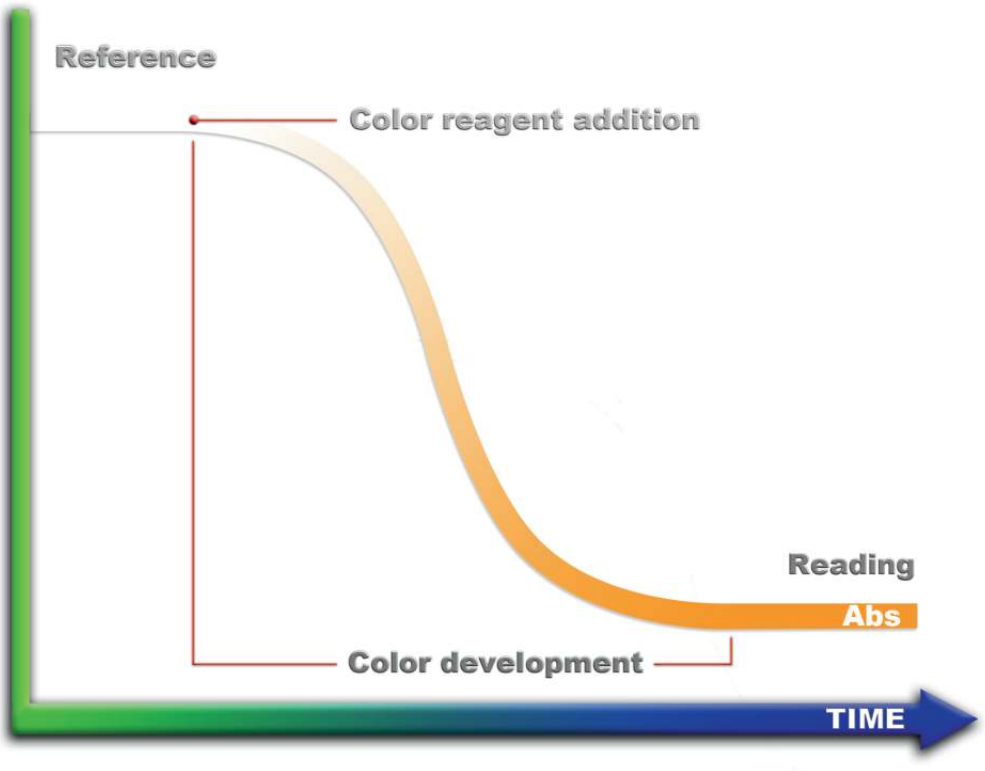
$$A = -\log_{10}T = \log_{10}(1/T) = \log_{10}(I_0/I_1)$$

I_0 light intensity through the sample before colorimetric reaction
I_1 light intensity through the sample after colorimetric reaction

In most cases the absorbance has a linear correlation with the sample concentration. For a linear calibration slope only the blank (zero) and span values (i.e. with zero analyte concentration and the maximum expected concentration) are needed. Multiple analyses of the standard to obtain an average value will produce a more reliable calibration slope.
The typical absorbance range is from 0 to 1, higher absorbances are possible.
An absorbance of 0 at any particular wavelength means that no light of that particular wavelength has been absorbed. The intensities of the sample and reference beam are both the same, so the ratio I_0/I_1 is 1. Log_{10} of 1 is zero. An absorbance of 1 happens when 90% of the light at that wavelength has been absorbed - which means that the intensity is 10% of what it would otherwise be. In that case, I_0/ I_1 is 100/10 (=10) and $\log_{10}$ of 10 is 1.

The methods used are based on the formation of a colored complex of the analyte with a color forming reagent. Light with a specific wavelength is transmitted through the reaction mixture. The absorbance of this light by the formed colour complex, as measured by a photometer, is related to the concentration of the analyte.

Absorbance = log (reference / sensor reading)



3 - INSTALLATION

3.1 Opening the package

Caution:
please take all the precautions required for handling and lifting the box containing the analyser.
The instrument weight is about 20 Kg.

For safety reasons, when removing the packaging of the equipment, please check for any visible defects and, if necessary, inform the supplier.

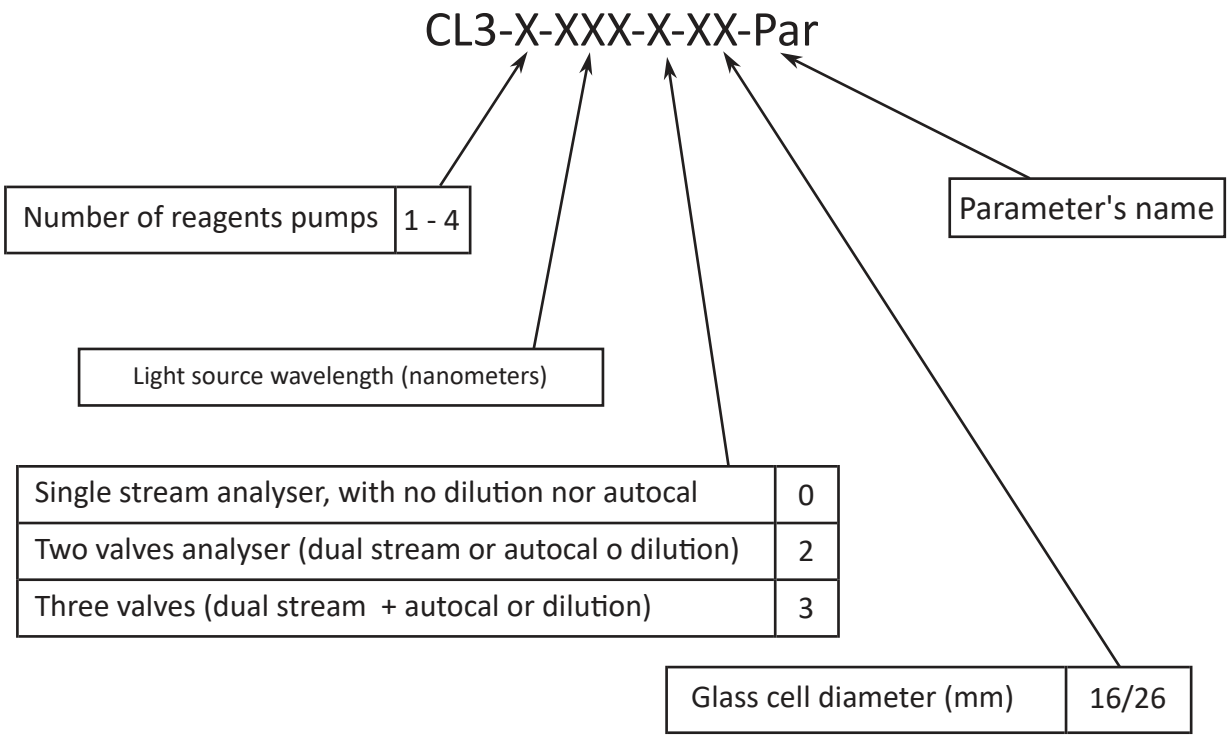
Parts inside the package apart from the user manual:

A	3S Colorimetric analyzer	CL-X-X.....see code format
B	Liquid reservoir with level switch for sample	A46ERLS000
C	Startup kit	A46KIT0001
D	Reagents bottles (empty)	A460110BR*1 (1 to 4)

These are the material present in the start up kit:

Silicone tubing 2 m for drain connection	N° 1
Norprene tubing size 1/8" OD with 30 cm straw for reagents	N° 1 to 4
Norprene tuning size 1/4 " OD for ports 1 - 2 - 3	N° 3
Key for the instrument's door	N° 1

These are the codes to identify the different configuration analysers



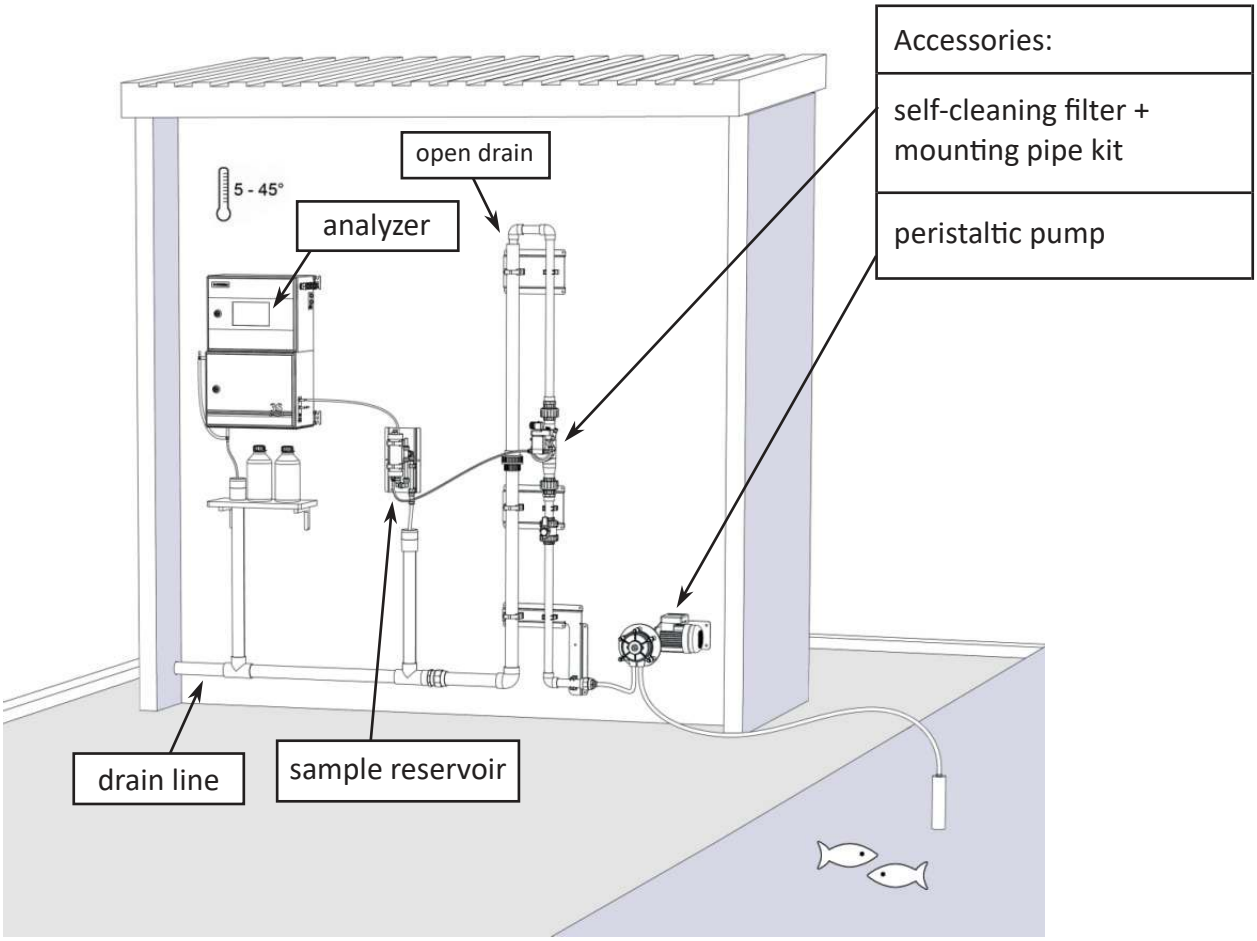
Example:
CL-4-850-2-26-SIO2 = Silica Analyzer, 4 reagents chemistry, LED 850 nm, two inlet ports, 26 mm cell size

Other optional accessories may be included in the package.

Optional accessories		
for Dual Stream option	Fast loop reservoir with level switch for the second sample	A46ERLS000
for Dilution option	Fast loop reservoir with level switch for the dilution water	A46DWLS000
for Autocal option	Bottle for standard solution	A46KHPB1

Other optional components such as the internal dilution option or the total phosphorus oxidation module will be already mounted inside the analyzer.

3.2 Example of sample suction installation



In the example, a large sample quantity is sucked by a peristaltic pump from a reservoir and sent to a self-cleaning filter.

Part of the sample flow passes through the filter (10 - 500 microns) and recirculates inside the sample cylinder before being drained. The unfiltered sample portion is drained as well.

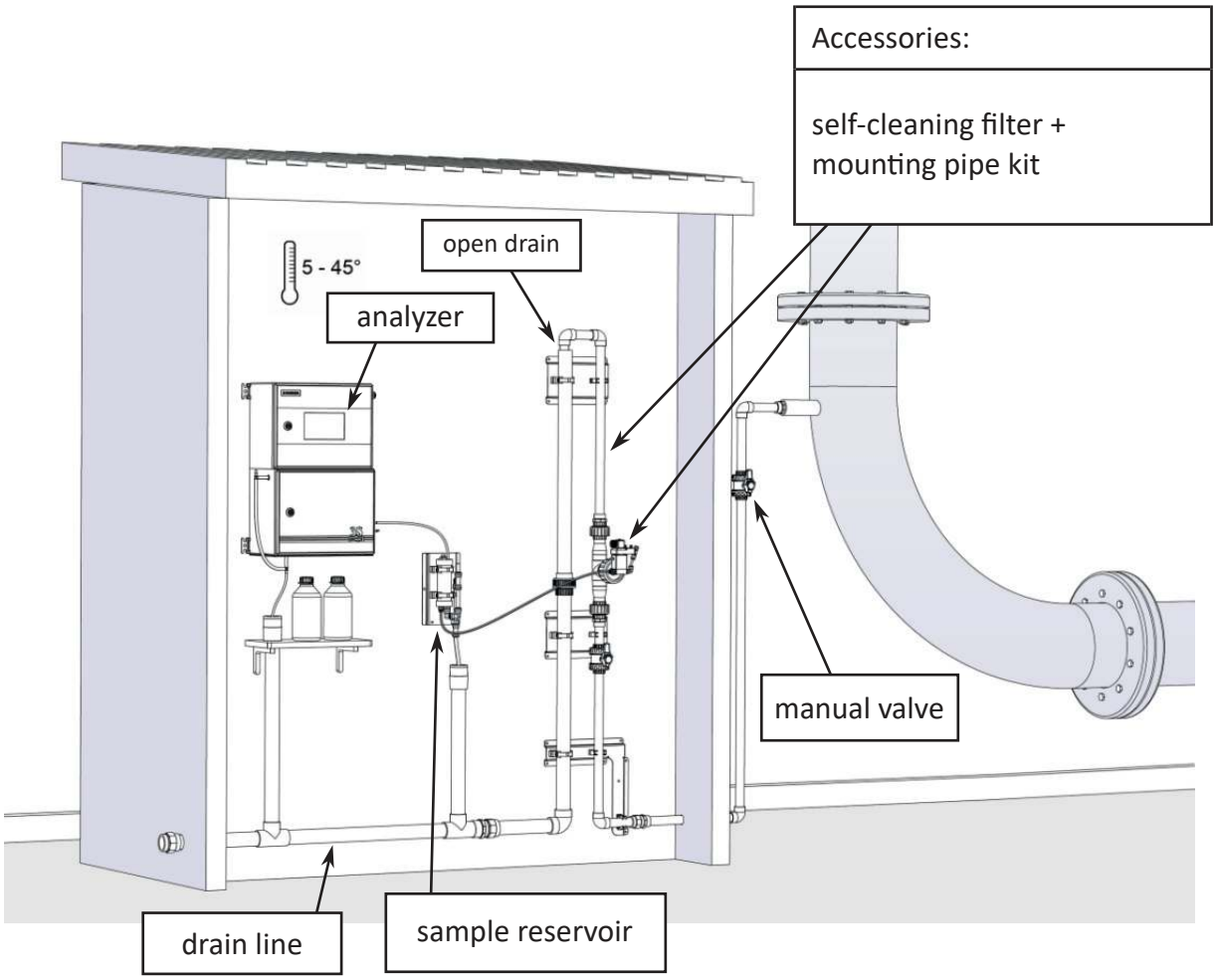
To perform the analysis the instrument collects the sample from the sample reservoir at predefined, regular intervals. If the level of the sample in the cylinder is not enough, the level sensor prevents the analysis to continue. When the sample level in the reservoir is restored, the analyzer restart the online operations autonomously.

The sampling peristaltic pump can run continuously or only for a short period of time before the analysis, in that case one of the analyzer's driven in this case by the analyser itself (control panel operated by the installer) through one of its potential free relay contacts.

The suction line from the tank may need heat tracing to prevent occlusion due to negative temperatures.

The installer shall implement a drain line, which, however, shall not create a backpressure to the free drain of the analyser and recirculation tank.

3.3 Example of sample from pressurized piping



In this example, the sample is taken from a pressurized process pipe and a flow of 500-1000 l/h (adjusted by the sampling valve) crosses the self-cleaning filter to reach the drain line.
The conformation of the pipe where the filter is inserted produces a positive suction head (the drain is in the upper position compared to the height of the filter) which allows the fraction of filtered liquid to escape and reach the recirculation tank.
A filter must be mounted if there are any suspended solids greater than 500 microns.
If the filter is not needed, a sampling needle valve to adjust the maximum flow rate of 500 ml/min must be mounted, from the pipe to directly send liquid to the recirculation reservoir.

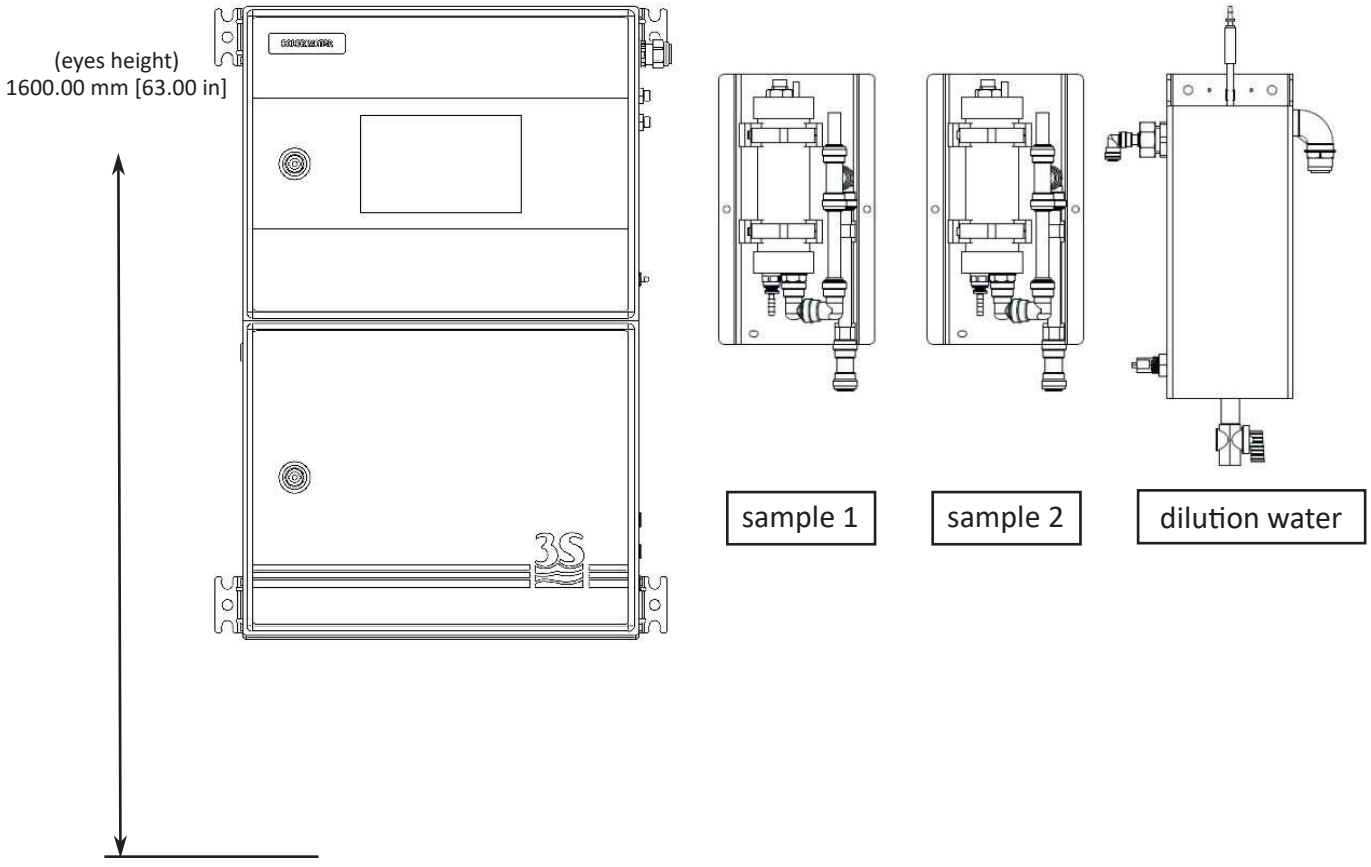
Also in this example, the installer shall implement a drain line, which, however, shall not create a backpressure to the free drain of the analyser and recirculation tank.

3.4 Mounting the instruments

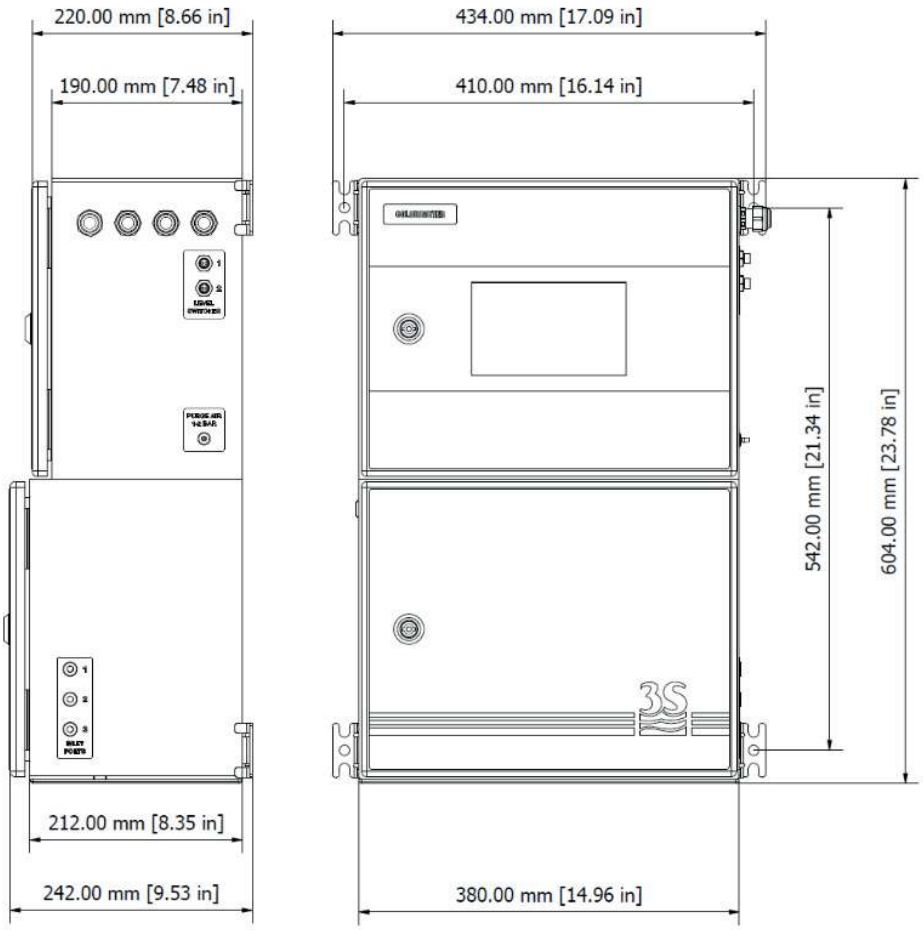
The analyser and the sampling cylinder must be mounted vertically on a wall or support suitable for their weight and not subject to vibrations. Use suitable screws (not included in the supply) to fasten them only on the side brackets (ear clips) of the instrument and in the holes of the tank metal plate. Mount them so as to get the display at eye height (160 cm).
Since the sampling connections and level contact connectors are on the right side of the analyser, install sample reservoir and dilution water sampling to the right of the instrument.
Please consider that the surrounding space must allow easy opening of the doors (upper and lower). The sampling reservoir can be monted below the analyser also, if necessary.
A minimum distance of 10 cm is required between the wall to the right of the instrument and the cylinder.

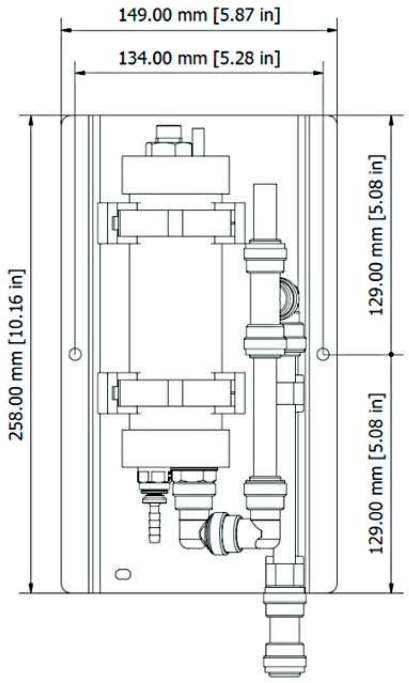
Instrument configuration	Liquid reservoir to install
Standard single stream	1 x A46ERLS000
Dual stream	2 x A46ERLS000
Single stream with dilution	1 x A46ERLS000 + 1 x A46DWLS000
Dual stream with dlution	2 x A46ERLS000 + 1 x A46DWLS000

Standard single stream:

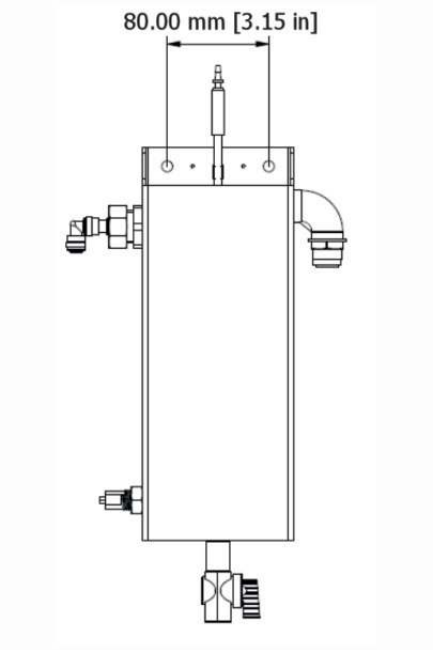


3.5 Wall mounting dimension





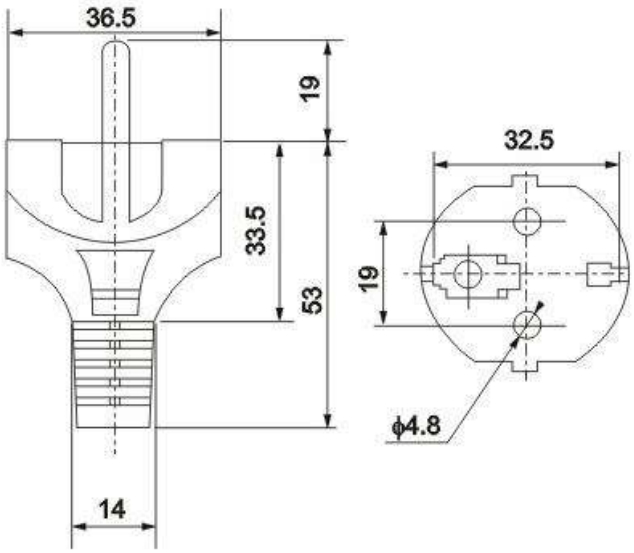
liquid reservoir with level switch
p/n A46ERLS000



dilution water reservoir
p/n A46DWLS000

3.6 Power supply connection

The electrical power is supplied by the analyser's cable , 2,5 mt.llenght with a CEE7/7 SCHUKO Europe plug.



The analyzer, in accordance with CEI EN 61010-1 standard on electrical safety, has passed the following factory safety tests:

-continuity test
-protective earth test
-insulation resist test
-high voltage test AC
-leakage current test

In addition to the tests carried out by the manufacturer, the installer shall:

- make sure that the power cord is not damaged when unboxing the package

- check the condition of the earth conductor of the power cord

- provide adequate over current and over voltage protection on the power supply line

- check for compliance of the power line with any applicable safety standards

3.7 Signal connection to the data acquisition system

To connect the signals and the contacts to the acquisition system, proceed as follows:

- use up to 2 cables with a maximum diameter (insulation included) of 12 mm

- pass the cables into the two free PG13.5 cable glands on the top right side of the instrument

- a hole with a diameter of 30 mm on the top wall (to the left of the cable glands) can be used as an alternative to the 2 PG13.5 cable glands for a larger size cable gland (not supplied)

- remove the electrical insulator from each wire and place it into the terminal making up the terminal block on the top of the instrument. Use a screwdriver with a 3 mm cutting width and make sure that the wire is secured inside the terminal

- make sure that the cable glands are perfectly sealed to prevent dust and moisture infiltration

Please refer to the connection diagram below.

TERMINAL	CONNECTION	NOTES
1 2	D- RS485 D+ RS485	Modbus RTU via RS485 connection
3 4	- INPUT + INPUT	Connect to a SPDT contact
5 6	- 4-20 mA analog signal channel 2 + 4-20 mA analog signal channel 2	max impedence 500 ohm protected by 50 mA fuse
7 8	- 4-20 mA analog signal channel 1 + 4-20 mA analog signal channel 1	
9 10 11 12	NC Relay 2 COM Relay 2 NC Relay 1 COM Relay 1	Load max 5 A, 250 VAC Relay logic can be inverted in software

3.8 Modbus serial protocol

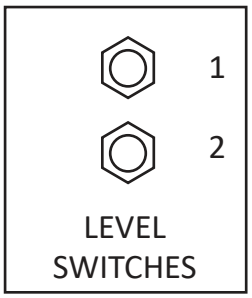
The analyzer can be connected to a Modbus RTU bus either via a two-wire RS485 interface or via Ethernet TCP/IP.
To use the RS485 interface just connect the cables to the user connections terminals (see Section 3.7). The Ethernet interface can be used by plugging in an Ethernet cable to the RJ45 connector on the back of the display.
The analyser exchanges information over the serial line via the Modbus protocol in Slave mode. The connection parameters are totally configurable (see 6.7) and default to the following values:

Baud Rate	9600
Data bits	8
Parity	E
Stop bit	1
Analyzer I.D. (slave, node number)	the last two digits of the serial number (i.e. s/n CL245 = I.D. no. 45)

Address	Format	Alias
900	32 bit float (CD-AB)	Result A
902	32 bit float (CD-AB)	Result B
904	32 bit float (CD-AB)	Validation % A
906	32 bit float (CD-AB)	Validation % B
908	32 bit float (CD-AB)	Calibration Factor A
910	32 bit float (CD-AB)	Calibration Factor B
912	32 bit float (CD-AB)	Reagent 1 %
914	32 bit float (CD-AB)	Reagent 2 %
916	32 bit float (CD-AB)	Reagent 3 %
918	32 bit float (CD-AB)	Reagent 4 %
800	bit	ONLINE flag
801	bit	SINGLE CYCLE flag
802	bit	STOPPED flag
803	bit	EXTRA CYCLE flag
804	bit	LOSS OF SAMPLE 1 flag
805	bit	LOSS OF SAMPLE 2 flag
806	bit	Calibration A error
807	bit	Calibration B error
808	bit	Reagent Low
809	bit	Reference error
940	ASCII (6 words)	Short name (tag)
950	ASCII (6 words)	Unit
960	ASCII (12 words)	Parameter name A
970	ASCII (12 words)	Parameter name B

3.9 Connecting sample level sensor

The sample recirculation tanks positioned to the right of the device, have a level contact showing the presence or absence of the sample. The signal reaches the device through the connector-terminated cable to be plugged into its socket placed on the right side of the analyzer.
A label helps to identify the correct connection.



Below the contact logic :

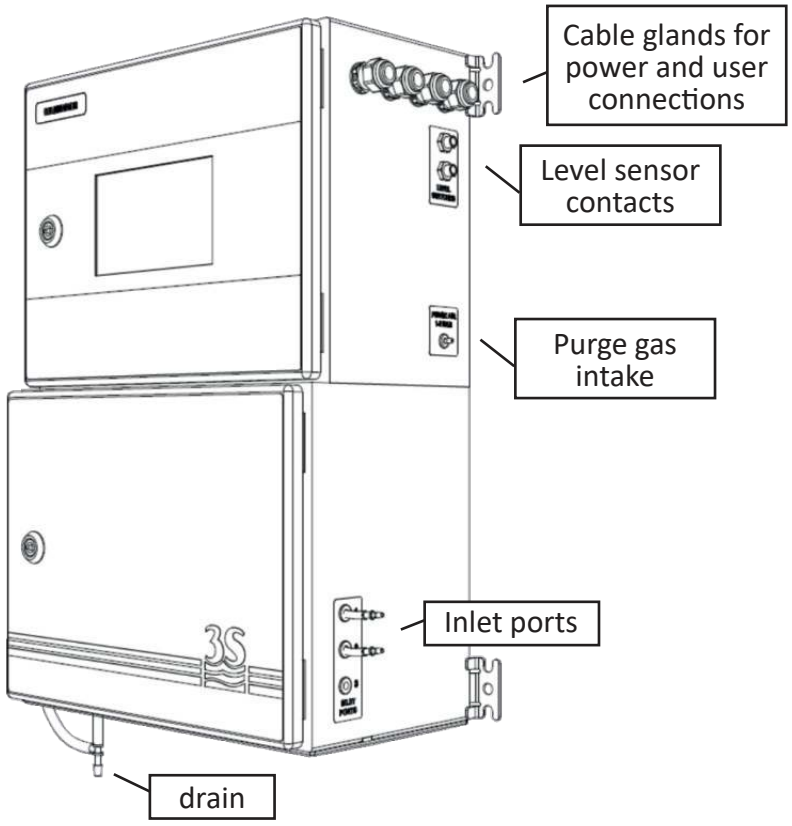
SAMPLE PRESENT	floating element UP	Contact OPEN
SAMPLE NOT PRESENT	floating element DOWN	Contact CLOSED

3.10 Sample/Dilution/Standard solution connection

The analyzer takes samples or standard solutions through a peristaltic pump.
The same pump can pick up to 3 different liquids through 3 clamp valves located in the hydraulic power unit.
The possible configurations are shown below:

CONFIGURATION	VALVES	CONNECTIONS
single channel without autocalibration or dilution	0	port 1: sample
single channel with autocal/val or dilution	2	port 1: sample port 2: autocal/val or dilution
dual channel without autocal/val or dilution	2	port 1: sample 1 port 2: sample 2
dual channel with dilution	3	port 1: sample 1 port 2: sample 2 port 3: dilution water
dual channel with autocal/val	3	port 1: sample 1 port 2: sample 2 port 3: standard solution

For the connections, identify the defined configuration and connect the pipes supplied with the start-up kit (norprene 1/4" OD) to their straight fittings coming out of the 3 inputs on the right side of the hydraulic unit. See the following image for reference.



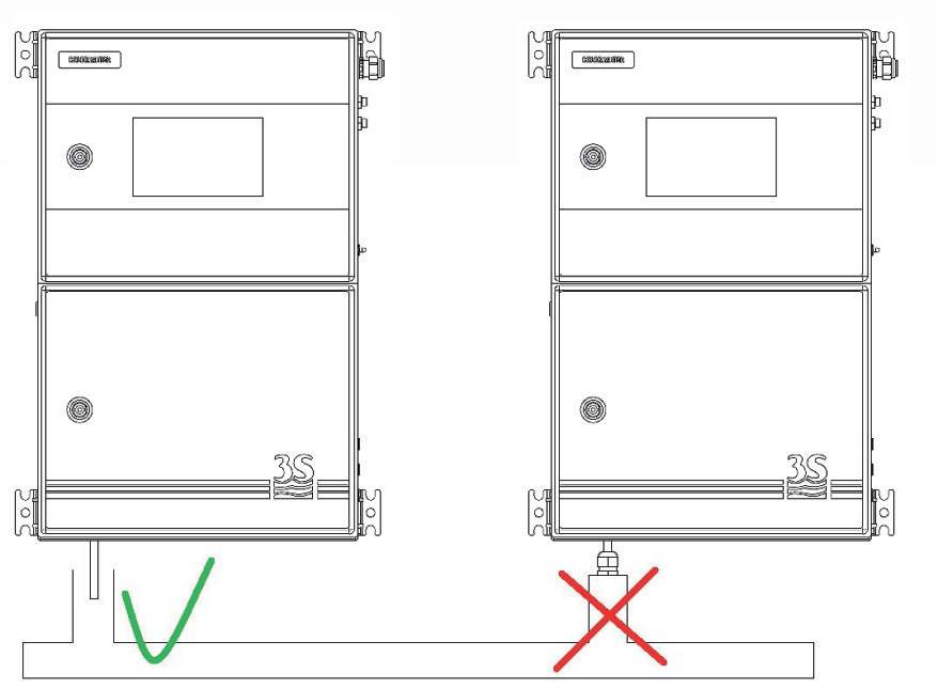
The pump is designed to suck the sample from the sample container and the calibration solution from a bottle placed at the lower level, belo

The tanks can be placed both above or below the suction port, while direct connection to pressurized lines must be avoided to ensure dosage precision and prevent any undesired liquid spills inside the hydraulic unit (max pressure 0.1 bar, 1 meter of water column).

3.11 Reaction cell - waste connection

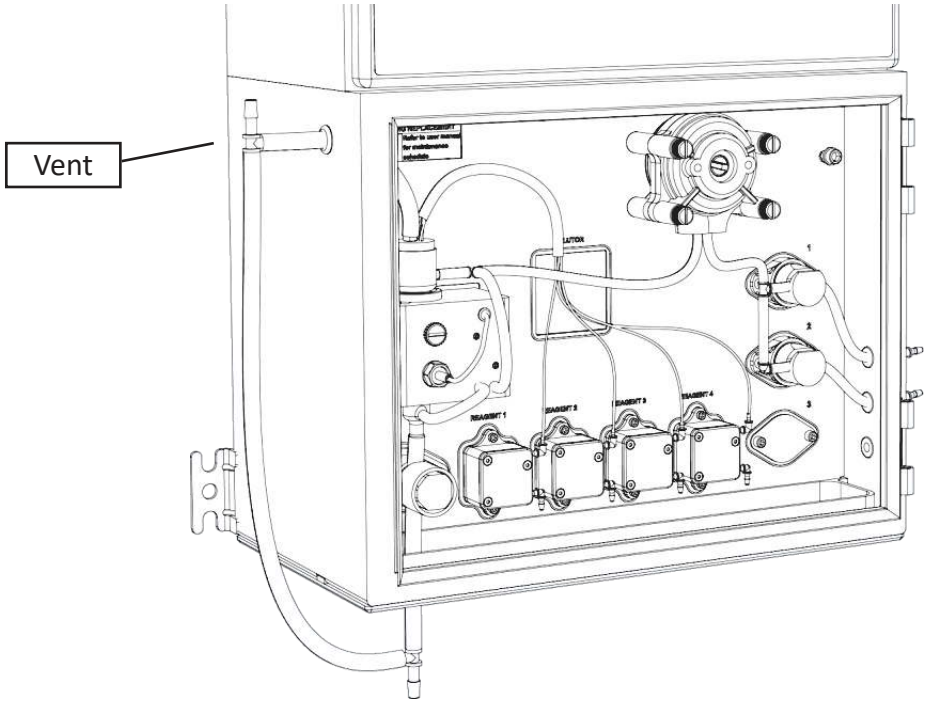
Connection to the drain line is provided by the flexible tube included in the start-up kit to be connected to the 9 mm hose connector located below the analyzer.

Please note that the liquid must be drained by allowing its free fall, therefore any backpressure has to be avoided.



3.12 Reaction cell - vent connection

To ensure the free fall of the liquid contained in the reading cell at the end of the analysis or during all rinsing operations, a hose connector is placed on the cell cap and, through a norprene tube 7/16" OD conveys any vapours outside the lower cabinet (left side).



This vent port can may be conveyed out through an extension tubing, preventing corrosion from gas coming from sample or cleaning solution, especially when the analyser is mounted in a small cabinet

Be aware to avoid counter pression or condensation in the extension tube.

3.13 Reagent solutions connection

To connect the bottles containing the reagents, use the sampling pipes provided with straws included in the start-up kit.
The bottles should be placed below or next to the analyzer at the maximum distance equal to the length of the pipe.
No extension should be made to the pipes, the small head of the peristaltic pumps may not be able to suck the fluid if it's too low.

Please pay close attention when handling the pipes and the reagents' bottles after their first use, as some reagent can be corrosive. Use protective gloves and goggles to prevent any spilled liquid from coming in contact with the eyes and skin.

3.14 Reagents solution consumption

The consumption of the reagents depends on the parameter and analysis frequency, and can be different based on the application. See Section 10 for the details of each parameter.

3.15 Purge gas connection

The analyzer stainless steel enclosure is rated IP54. This makes the analyzer suitable for most industrial conditions. For extreme environments however, where metal corrosion is a real issue, a purge gas line can be connected to the instrument to prevent corrosive gases to enter the analyzer.
The user must provide a purge gas line (nitrogen or clean air, 1 - 2 bar) and connect it to intake on the right side of the analyzer with a 6 mm OD pipe (see picture at page 20 for the exact location).
An internal flow regulator will provide a positive pressure inside the analyzer preventing ambient air to reach sensitive components.
The purge gas line does not replace a proper flushed cabinet required for ATEX areas.

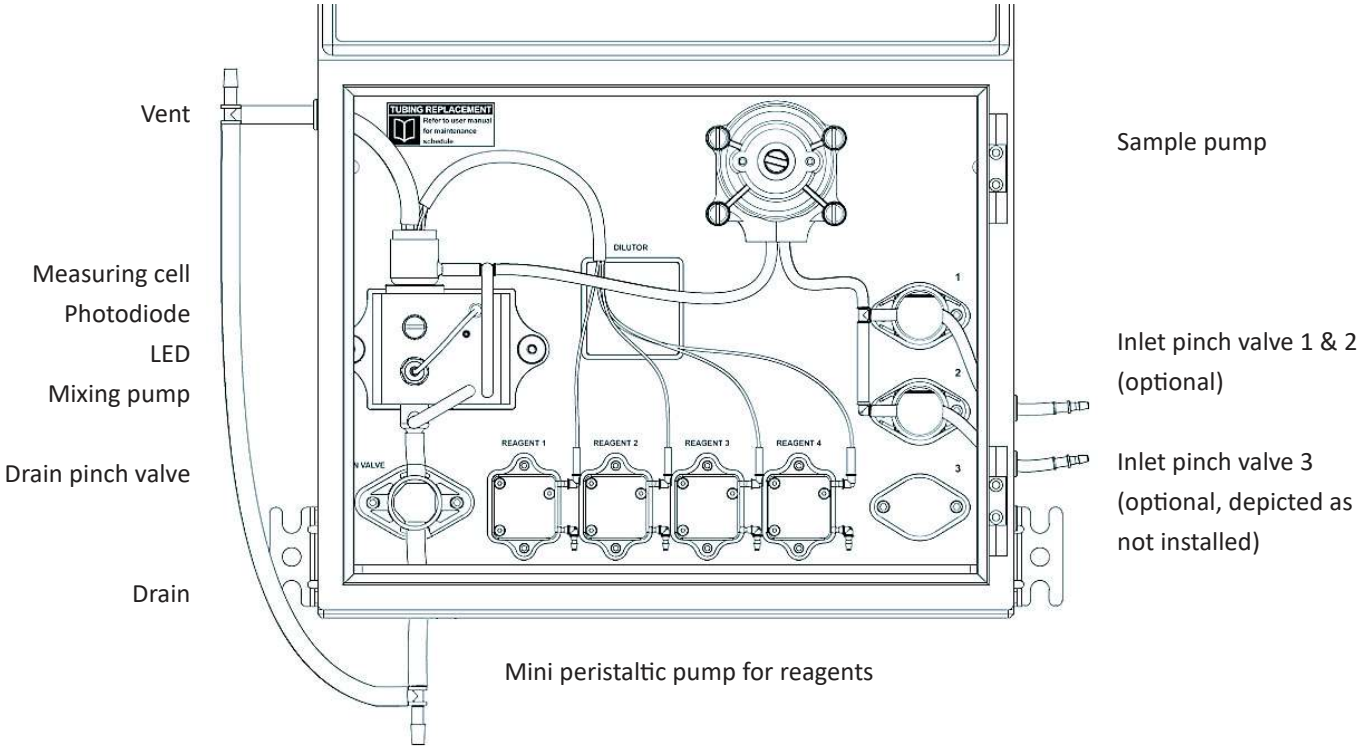
3.16 Power on

After checking for proper power supply, you can turn the device on through the switch located inside the upper compartment.
The analyzer display takes a few seconds to turn on, during which a splash screen appears followed by the main screen. Proceed to Section 6 for details on how to operate the instrument through the graphical user interface.

4 - COMPONENTS

4.1 Knowledge of the standard components

Before using the analyzer, you should identify its standard components. To do this, open the lower compartment.
Here is what you will see:



In some cases your analyzer configuration can differ from the previous pictures:

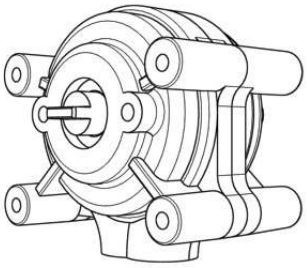
- depending on the number of inlet streams (1 or 2), the presence of dilution or autofunction the number of inlet valves can vary from 0 to 3 (see 3.11)

- depending on the parameter the number of reagent pumps can vary from 1 to 4

- depending on the parameter and the range the glass reaction cell can have different dimension (16 or 26 mm)

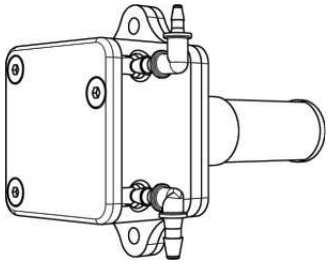
- if your analyzer has been configured to used internal dilution, you will see the additional dilutor module and slightly different tubings arrangement, the dilution module will be placed on the square plate marked "DILUTOR"

4.2 Components description



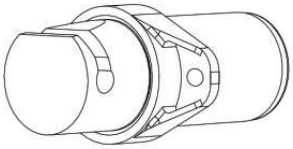
Sampling pump

The 3S Colorimeter mounts a Masterflex® peristaltic pump for sampling. The pump is positioned in the liquid enclosure. The code of the pump is printed on it and the tubing used must have the correct diameter (internal and external) suitable for the pump. The diameters and the material of the tubing is very important, use only 3S spares.



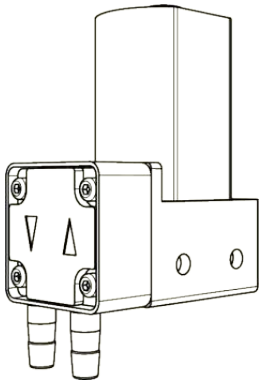
Miniature peristaltic pump

The reagents are dosed with “Miniature Peristaltic Pumps “; up to 4 pumps could be installed in the analyzer, allowing to dose up to 4 different reagents. The pumps are positioned in the liquid enclosure.



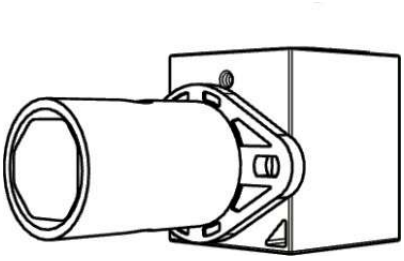
Inlet valves

The inlet valves are responsible to regulate the inlet flows for the sample(s), or optionally, dilution water and standard solution. If the analyzer is single stream without autocalibration or dilution the valves are not necessary and will not be present. Single stream + dilution or autofunction will have 2 valves, dual stream + dilution or autofunction will have 3 valves (see 3.10).



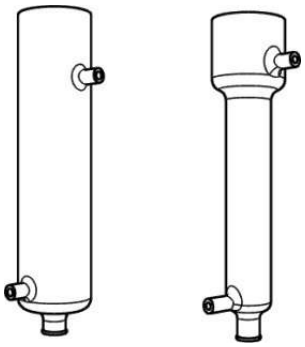
Mixing pump

The sample is mixed with reagents with a membrane mixing pump. The liquid is pumped from the lower part to the upper part of the colorimetric cell. Flow direction (inlet / outlet) of the pump is indicated on it with the symbols Λ and V . The mixing pump is positioned inside the cell mounting block in the liquid enclosure.



Drain pinch valve

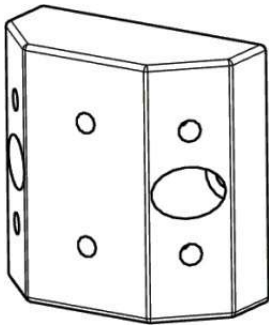
Normally-closed pinch valve is used to close/pinch or open a silicon / norprene tube section in order to close or open the drain of the colorimetric cell. The size (ID and OD) and the material of the tubing is very important, use only 3S spares. The pinch valve is positioned in the liquid enclosure.



Reaction cell

The colorimetric reaction cell is made of glass, the diameter is 16 or 26 mm, depending on the parameter. The cell is positioned inside a thermostatic block secured with a thumb screw. The cell can be easily removed for manual cleaning.

The side arms are used to as inlet/outlet for filling and mixing the sample in the cell. The cell is closed with a cap, secured with a rubber o-ring.



Dilution block (optional)

The 3S-CL analyzer may be equipped with an optional dilution block and a source of (pure) water connected to inlet 3. The dilution allows the instrument to operate with higher ranges. The dilution block collects a precise volume of sample and holds it in a pipe loop. The sample path is then rinsed with water to get rid of all sample traces. Finally, the sample is released and carried into the reaction cell by the dilution water.

Microprocessor

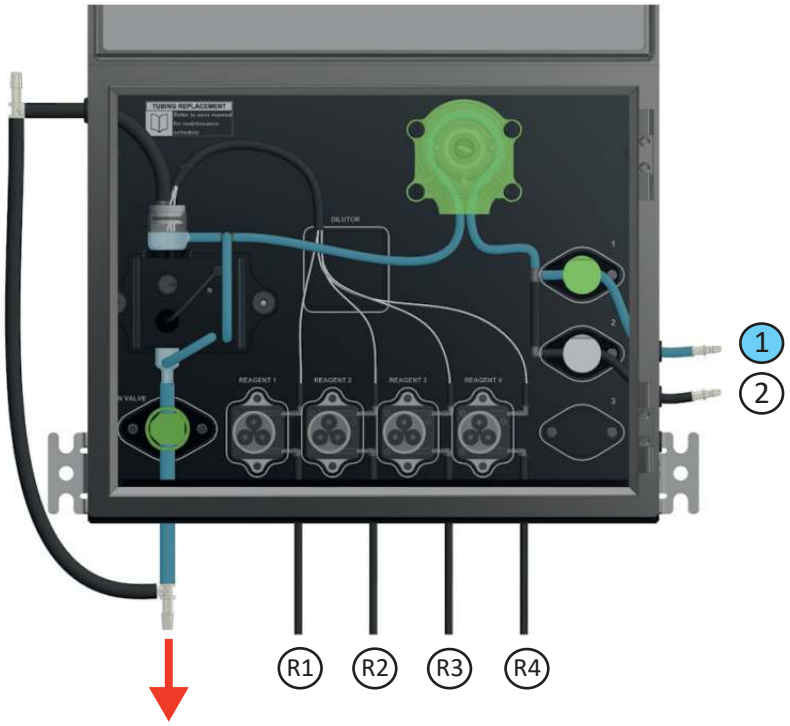
The microprocessor and its PCB assembly are located in the electronic section. It provides full control of the entire analyzing system. It handles the analyzer operations, it collects all the information and data coming from the different analyzer devices and it controls all the I/O apparatus to communicate with the user touchscreen interface and transfer of data.

4.3 Description of the analyzer functions

The instrument can execute various functions to perform the analysis cycle. Some of these functions drive hardware components, others are responsible for calculations or data managing. Listed below you can find the description of all the available functions.

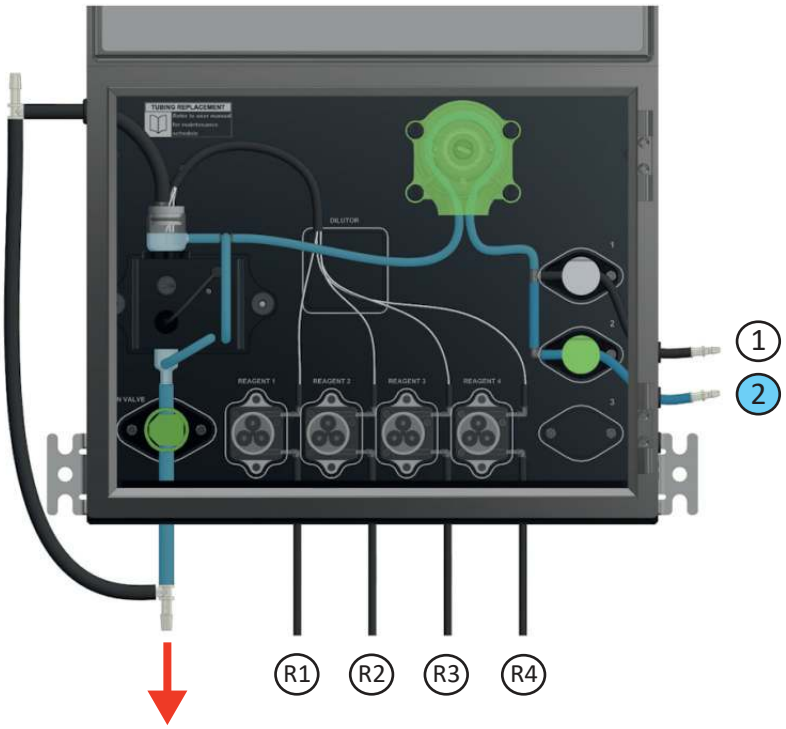
Rinse 1

During this operation the drain pinch valve is open, sample 1 is pulled from the sample reservoir and passes through the cell, but it is discarded immediately since the cell drain is open. The mixer pump is also activated, this helps conditioning all parts of the sample line.



Rinse 2

Similarly to Rinse 1, the drain pinch valve is open, sample 2 is pulled from the sample reservoir and passes through the cell, but it is discarded immediately.

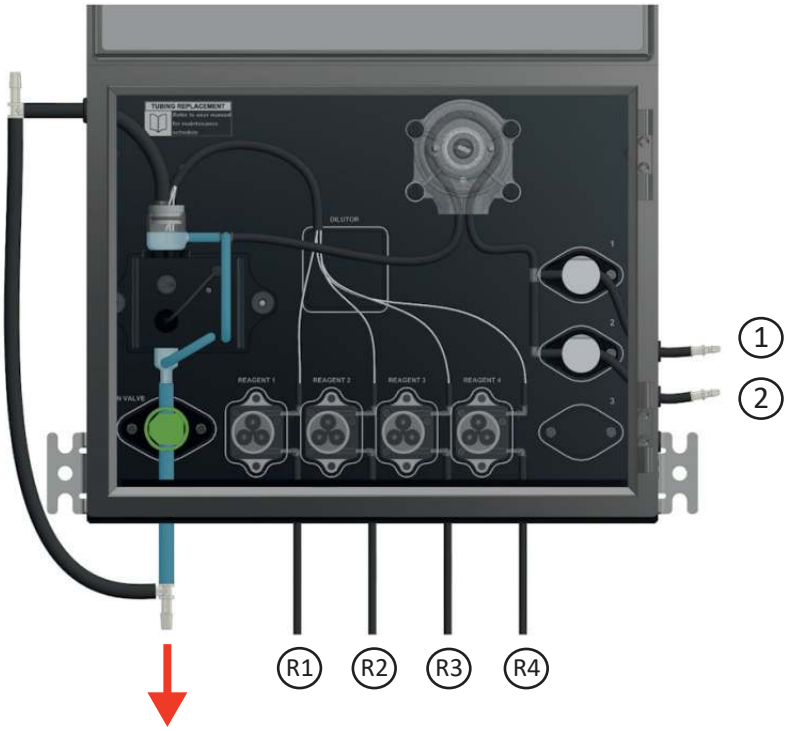


Rinse 3

This function is only available for the dual channel option (additional valve and inlet 3).

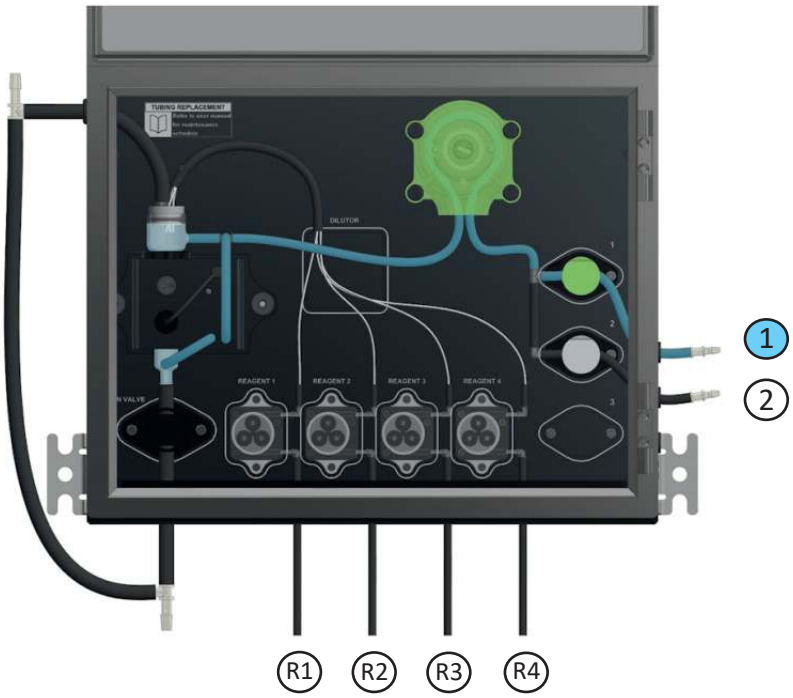
Drain

Open the drain pinch valve and discard the liquid in the cell.



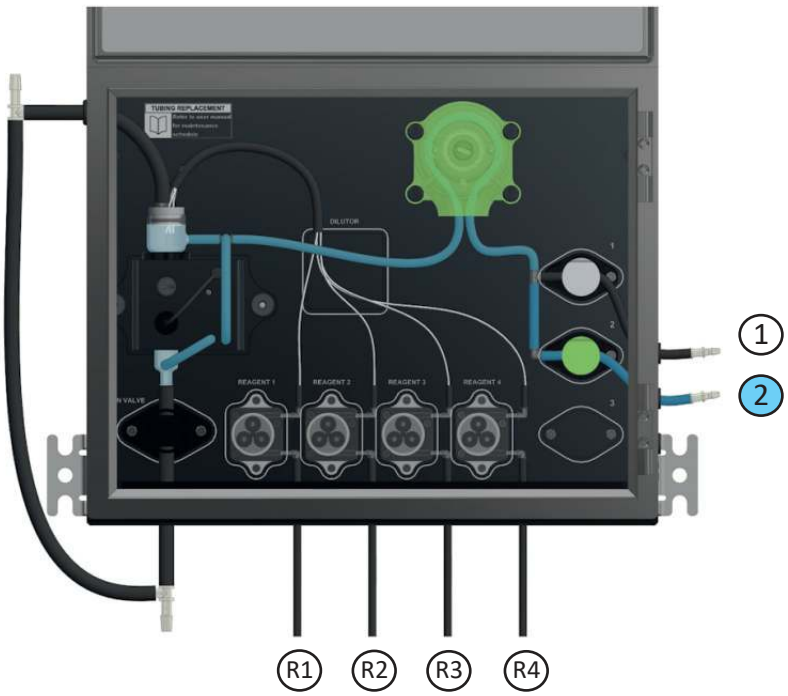
Sample 1

During this function the sample peristaltic pump is activated, the bottom pinch valve is closed and the sample 1 fills the colorimetric cell.



Sample 2

During this function the sample peristaltic pump is activated, the bottom pinch valve is closed and the sample 2 fills the colorimetric cell. Sample 2 is used for the extra cycle operation (i.e. calibration) in case of single channel analyzer or for a second sample stream in case of dual channels analyzer.

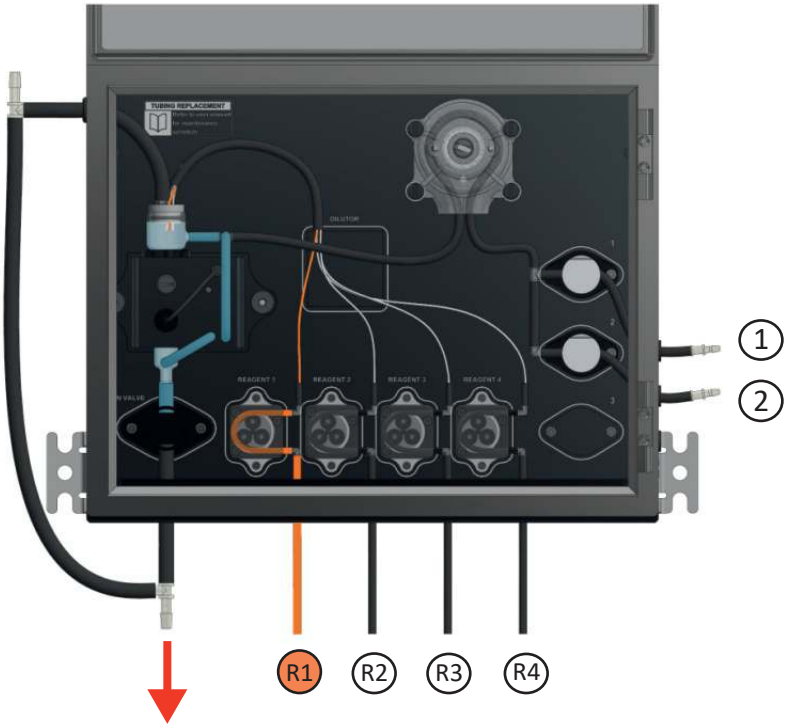


Sample 3

Dual channel option (additional valve and three inlets). The selection valve switches on, the bottom pinch valve is closed and the sample 3 fills the colorimetric cell. Sample 3 is usually dilution water, cleaning solution or standard solution for autocalibration.

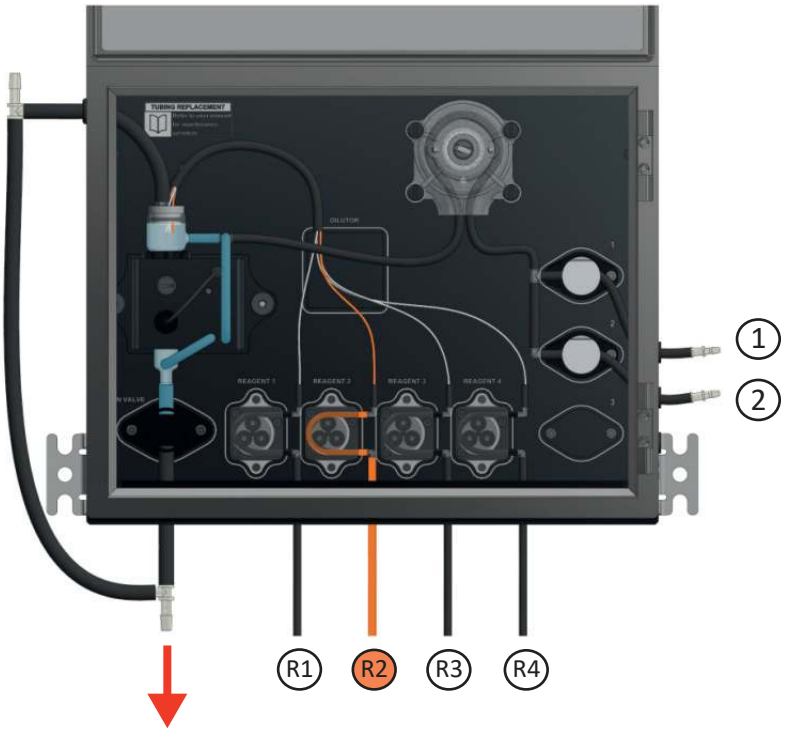
Reag 1

The reagent 1 is pulled from its container by the corresponding miniature peristaltic pump and poured into the reaction cell.



Reag 2

The reagent 2 is pulled from its container by the corresponding miniature peristaltic pump and poured into the reaction cell.



Reag 3
The reagent 3 is pulled from its container by the corresponding miniature peristaltic pump and poured into the reaction cell.

Reag 4
The reagent 4 is pulled from its container by the corresponding miniature peristaltic pump and poured into the reaction cell.

Grab 1
This function is only used if the analyzer is equipped with the dilution module. When the function is activated the main peristaltic pump pulls the sample from inlet 1 and push it through the dilution module.
This module witholds a precise amount of sample while the excess is discarded. The trapped sample can be released into the cell by a subsequent call to a Release function.

Grab 2
This function is only used if the analyzer is equipped with the dilution module. This is equivalent to a Grab 1 operation but the sample is pulled from inlet 2.

Grab 3
This function is only used if the analyzer is equipped with the dilution module. This is equivalent to a Grab 1 operation but the sample is pulled from inlet 3.

Release 1
This function is only used if the analyzer is equipped with the dilution module and a previous call to a Grab function has been made. The dilution water is pulled from inlet 1 and pushed through the dilution module containing a previously trapped sample from a Grab function. The dilution water and sample mixture is then poured into the reaction cell for the analysis. The net result of a Grab+Release combination is that a precise amount of sample is grabbed and witheld by the dilution module and then released into the cell together with a constant amount of dilution water.

Release 2
This function is only used if the analyzer is equipped with the dilution module and a previous call to a Grab function has been made. This function is equivalent to a Release 1 operation but the dilution water is pulled from inlet 2.

Release 3
This function is only used if the analyzer is equipped with the dilution module and a previous call to a Grab function has been made. This function is equivalent to a Release 1 operation but the dilution water is pulled from inlet 3.

Wait
The analyzer waits and do nothing.

Mix
The mixing pump is activated and the liquid in the reaction cell is mixed.

Initial measurement
Acquire the reference value, the first point for the calculation of the absorbance.

Absorbance
Read the current measurement of the sensor and calculate the absorbance.

Blank A
This is the value of absorbance read by the instrument when demineralized water is used as a sample. This value is stored by the instrument and will be subtracted from the absorbance before calculating the concentration.

Blank B
This is the same as Blank A but for channel B.

Result A
Convert the absorbance reading into a concentration reading, taking into account the blank absorbance and the stored calibration factor for channel A.

Result B
Convert the absorbance reading into a concentration reading, taking into account the blank absorbance and the stored calibration factor for channel B.

Calibration
Perform a calibration using the most recent absorbance value measured by the instrument.

Validation
Perform a validation using the most recent absorbance value measured by the instrument.

Relais 1
Activate relay #1. The relay settings can be modified in the CONFIGURATION page of the user interface.

Relais 2
Activate relay #2.Activate relay #1. The relay settings can be modified in the CONFIGURATION page of the user interface.

Level jump 1, 2, 3, 4
Check the sample presence and jump to a predefined step in the cycle. The user can configure the rules for the level jump in the CONFIGURATION > LEVEL JUMP section, see 6.6.

4.4 Manual activation of functions

After opening the lower door, it is possible to observe and distinguish the various operations by activating them manually.
This may help when turning on the analyzer for the first time or even later, during maintenance operations.

For example, it is advisable to use this procedure to verify the correct arrival of the sample, after connecting the different parts, or check the correct operation of the drain.

See section 6.4 for instructions to activate manual function through the graphical user interface.

5 - ANALYSIS CYCLE

5.1 Single cycle, online cycles and extra cycle

The instrument executes its analysis cycle by performing a sequence of operations listed in the analysis program. The program can be accessed from the graphical user interface and can be modified at any time to meet the requirements of the applications. Users are strongly encouraged to contact the 3S Analyzers technical service prior to commit any modification to the program. A program consists of a maximum of 60 inividually configurable steps, every step defines a function, identified by a unique name (see 4.3), and an associated duration.

Using the graphical interface the user can arbitrarily call any function manually for testing or servicing (see 6.4).

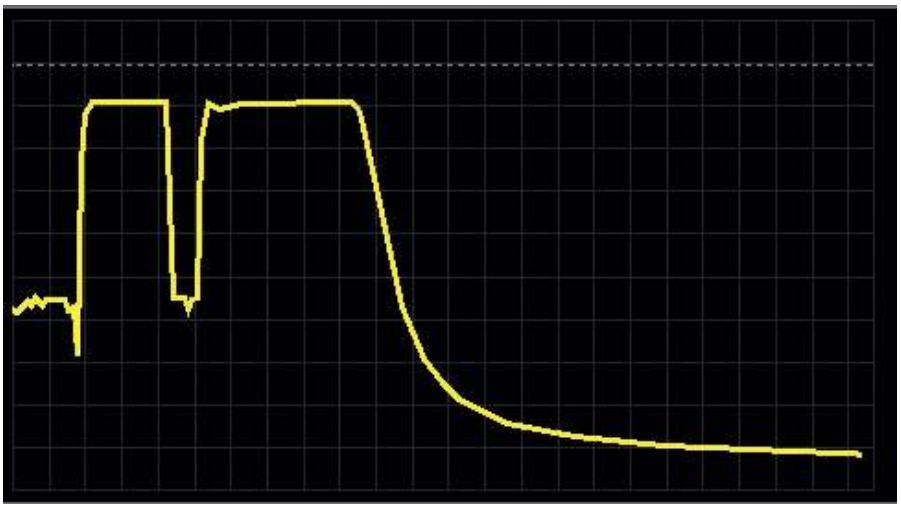
The instrument can perform a single analysis cycle or continuous (online) measurements. In the first case the analyzer will put itself in standby after the analysis cycle is completed while in the second case it will start another analysis after waiting for a predefined amount of time (cycle wait). The wait time between each analysis cycle can be set in the menu of the graphical user interface (see 6.6).

In any case, at the end of the cycle a new result value is calculated, shown and transferred out by mean of an analog output or by serial communication (Modbus RTU protocol).

During online operation an EXTRA cycle can be performed in between the standard analysis cycles, at a predefined frequency. The EXTRA cycle follows a different program and can be used for autocalibration, autovalidation or cleaning. The frequency of the EXTRA cycle can be set in the menu of the graphical user interface (see 6.6).

An analysis sequence in the 3S-Colorimeter would typically have the following structure.

After rinsing the colorimetric reaction cell, a constant amount of sample is grabbed, one or more reagents, such as buffers or masking agents may be added. Then an initial measurement takes place (intitial measurement); in this way interfering factors are eliminated, such as sample inherent color or turbidity, reagents own color and any refractive index variations. The second measurement (absorbance) takes place after the addition of a color forming reagent and the subsequent color development, which may take a certain amount of time, depending on the color reaction characteristics. The typical run sequence of a colorimetric determination is depicted in the following picture.



Cell is drained and refilled several times	Reference measurement	Reagents are added and mixed	Final measurement

You can find a general description of the analysis cycle in the following table:

Drain, conditioning, rinsing and sampling *Drain, rinse and sample functions*	First the cuvette is drained and rinsed (this can also be programmed at the end of the run). In this way the hydraulic line and the colorimetric cell is well rinsed prior to the actual sample taking. Next, a sample is taken.
Addition of reagent(s) *Add reag function*	Depending on the method one or more reagents may be added before the reference.
Mixing and wait *Mix and wait function*	The mixing pump is activated and the liquid is pumped from the lower part to the upper part of the colorimetric cell. The waiting time is programmed in order to eliminate bubbles, and/or suspensions,...
First measurement *Reference function*	Store the value of the light intensity as a REFERENCE. in order to obtain a reference point that includes interfering factors (sample turbidity, colour of sample,..).
Addition of colour reagent(s) *Add reag function*	Depending on the method one or more reagents may be added for the colour development.
Mixing and wait *Mix and wait functions*	The mixing pump is activated and the liquid is pumped from the lower part to the upper part of the colorimetric cell; in this way reagent(s) is mixed. The waiting time is programmed in order to complete the colorimetric reaction
Reading, absorbance and concentration calculation *Read sensor, absorbance, calculation*	Reading of the light intensity after the colorimetric reaction, calculation of the absorbance and of the concentration.
Drain, conditioning, rinsing and sampling *Drain, rinse and sample functions*	Drain and rinse of the hydraulic line and the colorimetric cell.
Waiting time (analysis frequency) *Wait function*	The wait function at the end of the cycle can be used to set the analysis frequency.

5.2 Dilution

The 3S Analyzer colorimeter does not usually need a diluted sample. However, in order to meet our customer requirements the instrument can be provided with the dilution option, in this way the maximum range can be increased to values that would be not possible without dilution. It is necessary to provide a dilution water line and connect it to the supplied external reservoir, the water must be pure and free from contaminants, preferably deionized/ demineralized. See section 3.11 for the instruction to connect the analyzer to the dilution water line.

5.3 Dual stream analysis

If you have purchased the 3S colorimetric analyzer with the dual stream option you can run analyses on two different sample streams. In that case you have to connect the sample inlets to the respective external reservoirs.
The analysis cycle will contain the necessary step to sequencially run the two analyses. The two results will be displayed on the display at the end of the analysis.
The samples level sensors will operate independently and in the case one of the two sample is missing the analysis can still proceed on the available one.
The analyzer will come already configured to run dual stream analyses. A single stream analyzer can be converted in a dual stream one by purchasing the conversion kit, contact the 3S Analyzers customer service to request the kit and the related procedure.

5.4 Dual parameter analysis

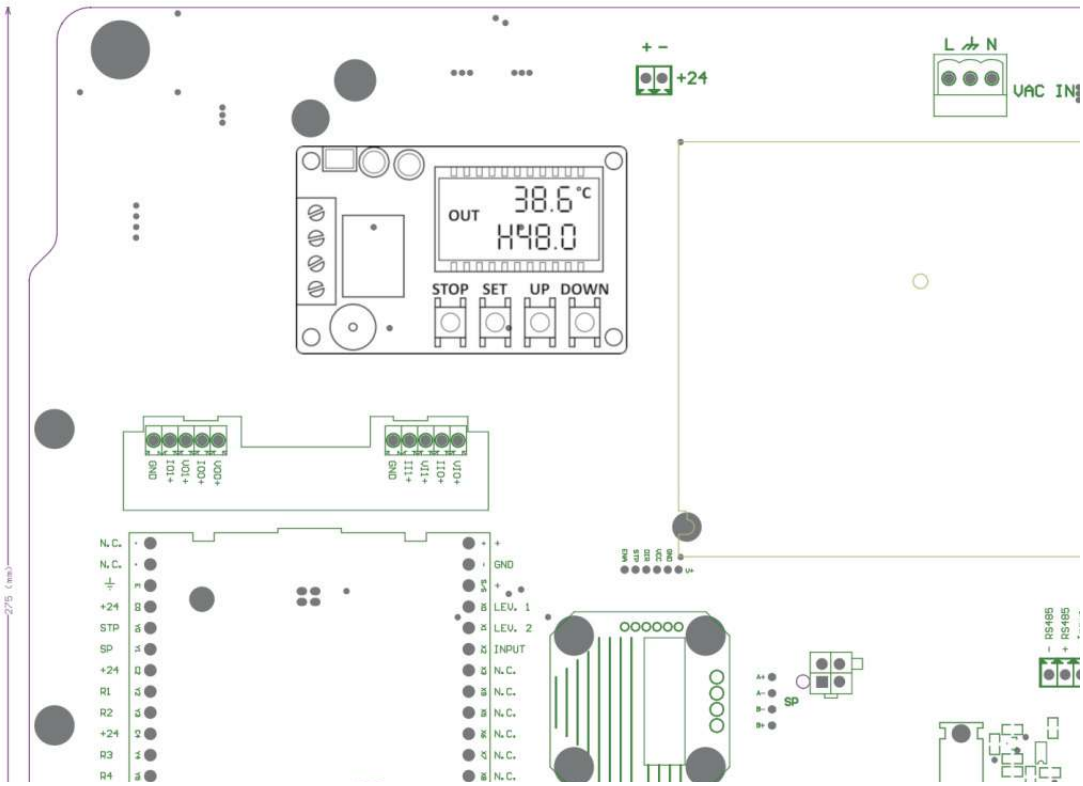
In the dual parameter analysis the instrument is configured to measure two different parameters with a single analysis run. The analyses can be carried out on a single stream or on two separate sample streams if your instrument is also configured as dual channel. The analysis cycle is programmed in the same way of a single parameter analysis but it must contain all the required steps to perform both analyses. On the display both values will be shown.

5.5 Heated cell block with thermostat (optional)

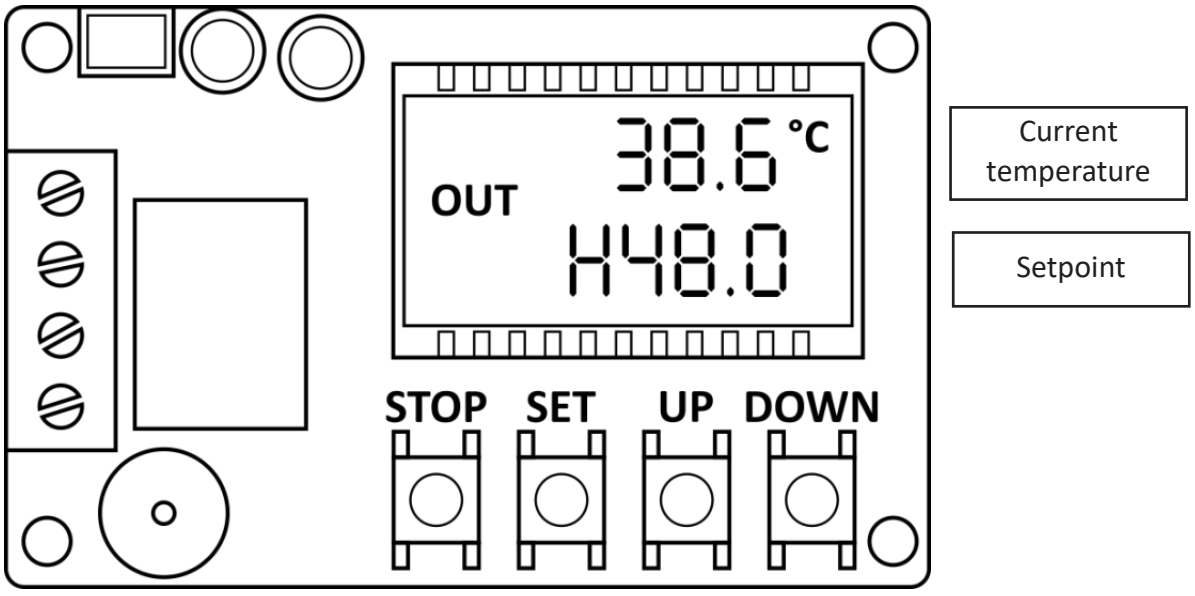
Optionally, a thermostat can be installed on the main board to control the temperature of the cell block. The thermostat is installed on the main board on the left of the power supply unit.
To set the temperature of the cell block, the user must open the upper compartment of the analyzer and reach the thermostat.

Only trained personnel must be allowed to access the electrical enclosure when the analyzer is powered on!

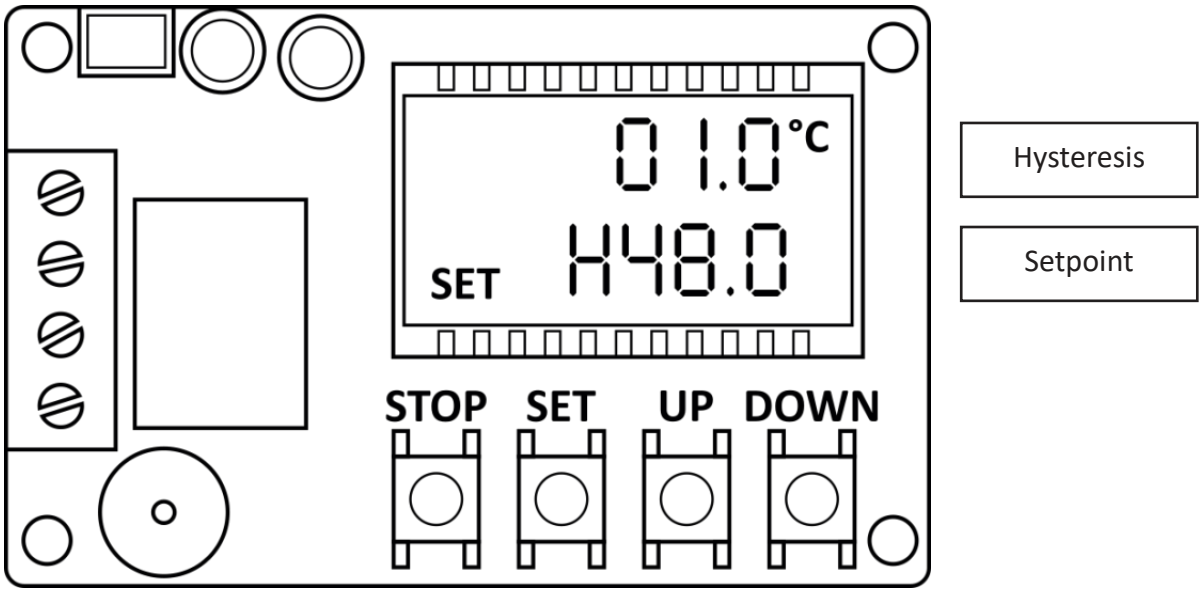
Location of the thermostat module on the man PCB.



The thermostat LCD will show the following information:



To change the temperature setpoint:
- Press SET shortly
- The settings page is shown



- Press SET again to cycle between the settings elements
- Stop when the element you want to modify is blinking
- Press UP/DOWN to modify the value
- Press STOP in case you want to cancel the operation
- Wait a few seconds until the thermostat exits to the main page

Advised settings:

Hysteresis: a value from 0.5 to 1.0 °C
Temperature: set a desired value
H/C: always set to H

The temperature settings are reported in the parameters table at the end of the manual for the methods where the installation of the thermostat is advisable.
Contact the 3S technical service to obtain assistance in choosing the correct temperature for your analyzer.

5.6 Example of measuring and extra cycle programming

The measurement cycle is a sequence of 60 steps, a function as well as a duration in seconds is assigned to each of them in the cycle programming (ANALYSIS SETUP TABLE).
The same happens for an extra cycle which, however, consists of 30 steps and has a different programming (EXTRA).
As an example, the analysis cycle for a silica analyzer is shown in the following table. Please note that in this example, filling times (in seconds) refer to the 24 mm cell (corresponding to 20 seconds), while for the 16 mm cell they correspond to 10 seconds.

STEP	OPERATION	DURATION (sec)
1	DRAIN	5
2	RINSE 1	25
3	SAMPLE 1	24
4	DRAIN	5
5	SAMPLE 1	24
6	LEVEL JUMP 1	1
7	DRAIN	5
8	SAMPLE 1	20
9	REAG 1	15
10	REAG 2	15
11	MIX	300
12	REAG 3	15
13	MIX	30
14	WAIT	20
15	REFERENCE	2
16	REAG 4	15
17	MIX	30
18	WAIT	60
19	ABSORBANCE	1
20	RESULT A	1
21	WAIT	0
22	DRAIN	5
23	SAMPLE 1	24
24	DRAIN	5
25	SAMPLE 1	24
26	DRAIN	5
27	SAMPLE 1	22
28	WAIT	0
29	...	...

The cycle is different depending on the parameter. As you can see the cycle only uses 28 out of the 60 total possible steps, the remaining one are left blank.

In the following table you can see how the cycle continues in case of a double stream analyzer (please note that the cycle continues from step 23).

STEP	OPERATION	DURATION (sec)
23	SAMPLE 2	24
24	DRAIN	5
25	SAMPLE 2	24
26	DRAIN	5
27	SAMPLE 2	24
28	LEVEL JUMP 2	1
29	DRAIN	5
30	SAMPLE 2	20
31	REAG 1	15
31	REAG 2	15
32	MIX	300
33	REAG 3	15
34	MIX	30
35	WAIT	20
36	REFERENCE	2
37	REAG 4	15
38	MIX	30
39	WAIT	60
40	ABSORBANCE	1
41	RESULT B	1
42	WAIT	0
43	DRAIN	5
44	SAMPLE 1	24
45	DRAIN	5
46	SAMPLE 1	24
47	DRAIN	5
48	SAMPLE 1	22
49	WAIT	0
50	...	...

In the table below you can find an example of an analysis cycle that uses dilution. Inlet 1 is connected to dilution water while inlet 2 is connected to the sample. The steps performing the dilution are GRAB (take a small amount of sample and keep it) and RELEASE (uses dilution water to free the trapped amount of sample).
Between a GRAB and a RELEASE operation it's convenient rinse the cell and the sample line with the same dilution water. By doing so we clean the sample line without affecting the sample trapped in the dilution module and we can obtain a clean dilution process.

STEP	OPERATION	DURATION (sec)
1	DRAIN	5
2	RINSE 1	25
3	SAMPLE 1	24
4	DRAIN	5
5	SAMPLE 1	24
6	LEVEL JUMP 1	1
7	LEVEL JUMP 2	1
8	DRAIN	5
9	GRAB 2	20
10	RINSE 1	20
11	RELEASE 1	18
12	REAG 1	15
13	REAG 2	15
14	MIX	20
15	REAG 3	15
16	MIX	30
17	WAIT	20
18	REFERENCE	2
19	REAG 4	15
20	MIX	60
21	WAIT	30
22	ABSORBANCE	1
23	RESULT A	1
24	WAIT	0
25	DRAIN	5
26	SAMPLE 1	24
27	DRAIN	5
28	SAMPLE 1	24
29	DRAIN	5
30	SAMPLE 1	22
31	WAIT	0
32	...	...

The program stored as EXTRA cycle can be used to perform one of the following operation: CLEAN, CALIBRATION, VALIDATION.
The CLEAN cycle is usually characterized on the basis of the sample and the cleaning agent used while CALIBRATION and VALIDATION depend on the parameter.
An example of automatic calibration is reported in the table below, the cycle is very similar to the analysis one but instead of showing the result with RESULT A, we call the CALIBRATION A function.
In the case of automatic calibration of the zero, replace the CALIBRATION A operation with the one referred to as BLANK A. In the case of a double channel analyzer, the cycle can be extended to also calibrate channel B.

STEP	OPERATION	DURATION (sec)
1	DRAIN	5
2	RINSE 1	25
3	SAMPLE 1	24
4	DRAIN	5
5	SAMPLE 1	24
6	LEVEL JUMP 1	1
7	DRAIN	5
8	SAMPLE 1	20
9	REAG 1	15
10	REAG 2	15
11	MIX	300
12	REAG 3	15
13	MIX	30
14	WAIT	20
15	REFERENCE	2
16	REAG 4	15
17	MIX	30
18	WAIT	60
19	ABSORBANCE	1
20	CALIBRATE A	1
21	WAIT	0
22	DRAIN	5
23	SAMPLE 1	24
24	DRAIN	5
25	SAMPLE 1	24
26	DRAIN	5
27	SAMPLE 1	22
28	WAIT	0
29	...	...

5.7 Emergency stop

Any running cycle can be halted by the user by pressing the STOP! key on the COMMANDS page of the user interface, any operation will be immediately stopped. A physical emergency stop button can also be connected to the digital input to provide a way to externally stop the analyzer.
The analyzer operation must be then restored manually by pressing STOP RESET within the COMMANDS menu.

5.8 Loss of sample

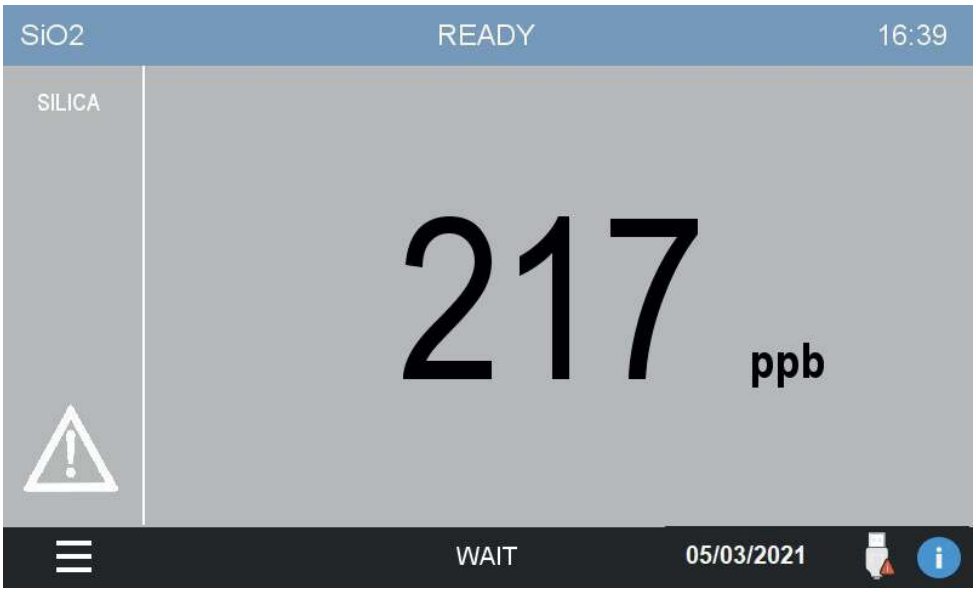
The analyzer uses two level contacts to verify the presence of the sample (see 3.8) by means of level sensors.
In this way if the sample or dilution water needed for the analysis is missing, the analysis will not proceed and the analyzer will put itself in standby. When the sample fills the external reservoir again the level sensor floater will rise up and the analyzer will start online analyses again, without needing any external intervention.

Sometimes a small quantity of sample can be present in the external reservoir thus giving consent to start the analysis even though the sample flow is interrupted. If this happens frequently due to a non-constant sample flow we can force the analyzer to check again for the presence of the sample when te cycle is already running. To do so the LEVEL JUMP operation can be inserted in the analysis cycle at an appropriate place (usually just before the last sampling is performed). In case the sample is missing when the analysis cycle reaches the LEVEL JUMP step, the analyzer automatically proceed to the target step. Usually this means that all the steps in the analysis cycle requiring the sample are not executed and the cycle jumps to the final steps, usually washing and reconditionng the reaction cell with dilution water (if present) or just waiting for the next cycle.
It's important to check this before key points of the analysis, up to 4 Level Jump commands can be inserted in the analysis cycle to make the verification when required.

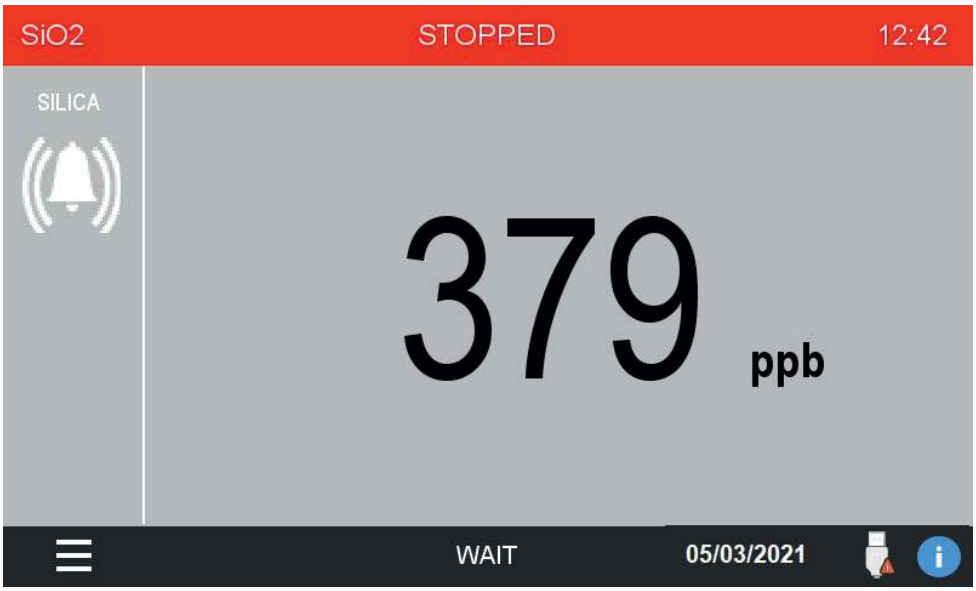
5.9 Warnings and Faults

The analyzer has a Warnings and Faults system to signal anomalies, fault conditions or measurement overpassing the preset threshold.
A warning is considered a condition with low priority that may or may not require user attention to be properly solved. After raising a warning the analyzer proceeds with its normal operations and the analysis cycle is not interrupted.
A fault indicates a more serious condition and always requires user intervention to restore the regular operation of the analyzer.
The user can decide to bound various events to warnings and faults through the graphical user interface. See section 6.6 for instruction on how to do so.
Additionally warning and faults can also have a relay assigned, when the analyzer raises a warning or fault condition the corresponding relay will be activated so that the user can be informed remotely of anomalies in the instrument operation.

The graphical user interface informs the user about the presence of warnings or faults. In case of a warning a triangle with an exclamation mark appears on the bottom left corner. The warning condition will stay on until the souce of the error is removed but the analyzer continues its operation normally.



A fault indicates an unrecoverable condition. The analyzer will stop any operation and will require user intervention to restore the normal analysis routine. The top bar will become red and changes its label to STOPPED. The icon of a ringing bell signals the alarm condition and if the analyzer beep functionality has been turned on you will also hear a beep sound.
After resolving the condition that lead the analyzer to a fault the user must manually restart by tapping on COMMANDS > STOP RESET in the main menu of the graphical user interface (see next chapter).



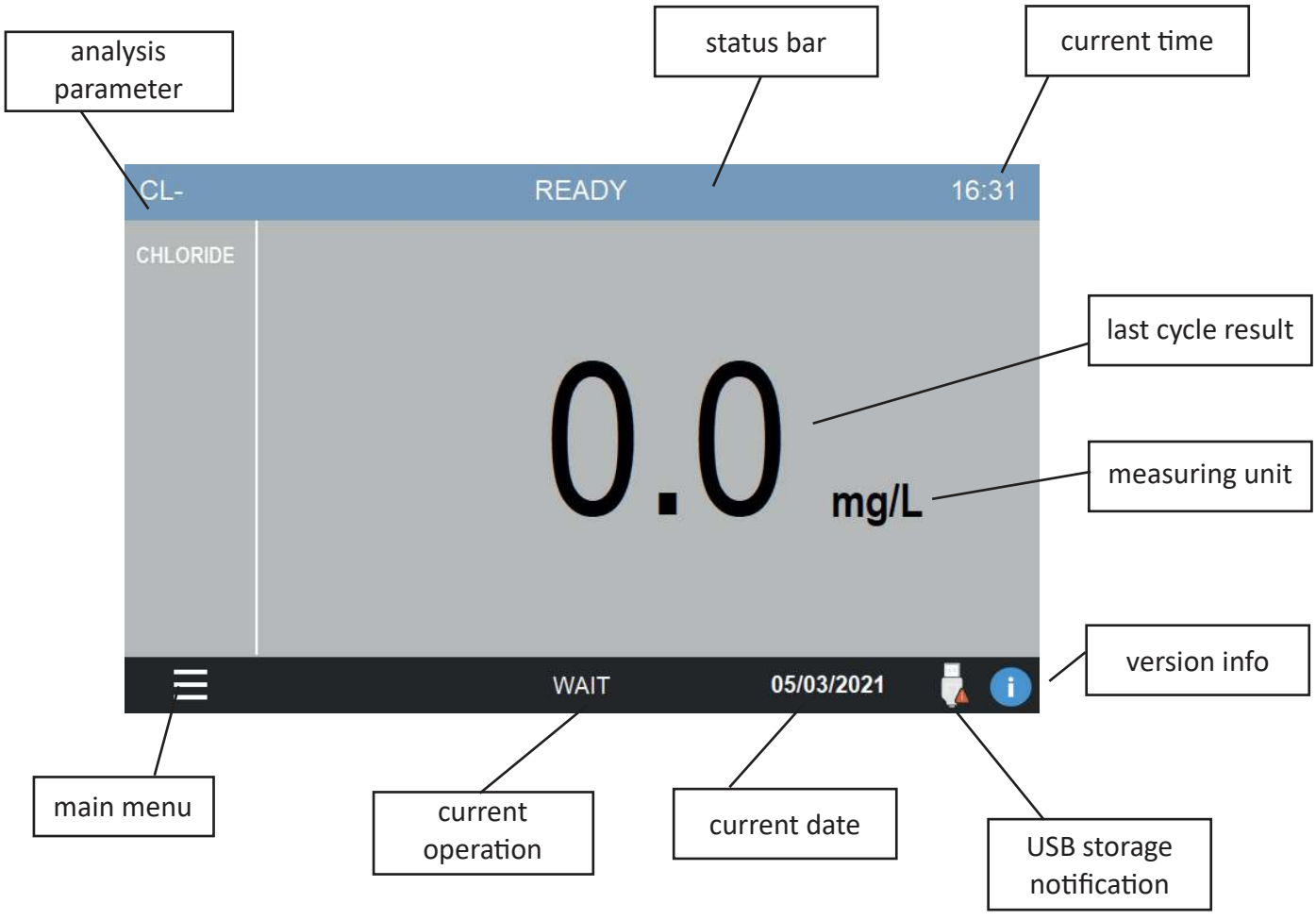
6 - USER INTERFACE

6.1 Power on

After checking for proper power supply, you can turn the device on through the switch located inside the upper compartment.
The analyzer display takes a few seconds to turn on, during which a splash screen appears followed by the main screen.

Please note that the device will restart continuing the same operation that was in course when it was turn off. If the previous shutdown had been caused by a power loss, and the analyser was set to ONLINE (continuous consecutive analysis cycles), when restarting the machine, the analysis cycles will continue from the same point.
If, on the other hand, the analyzer was set to Stand-by before being turned off, it will stay in stand-by.

You will se the following main page:



If the device was set to analyze 2 channels, you see an additional result value for channel B.

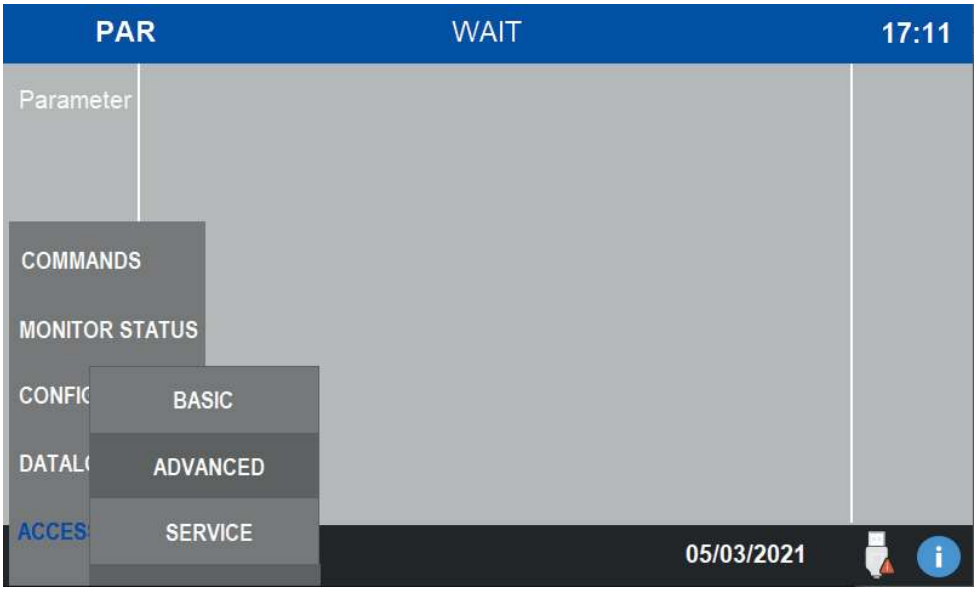
After some minutes of inactivity the screen will go black to save power.

6.2 Main menu

By tapping on the bottom left corner you will access the main menu. All the commands, options and configurations can be accessed from here.

6.3 Gaining access

To prevent undesired modifications to important configuration parameters, the access to the user interface is restricted on a login-based access menu. The user can log himself in by tapping on the ACCESS LOGIN entry of the main menu.



The analyzer has three levels of security, each level allows the user to access more advanced functions. The three levels are:

BASIC	This is the default level, the user can start or stop the analysis cycle and access data and trends but cannot modify calibrations or settings
ADVANCED	This level allows the user to perform calibrations and modify basic settings. The password for this level is **1111**
SERVICE	This level allows the user to perform calibrations and modify any settings. Operate cautiously when logged in with this password.

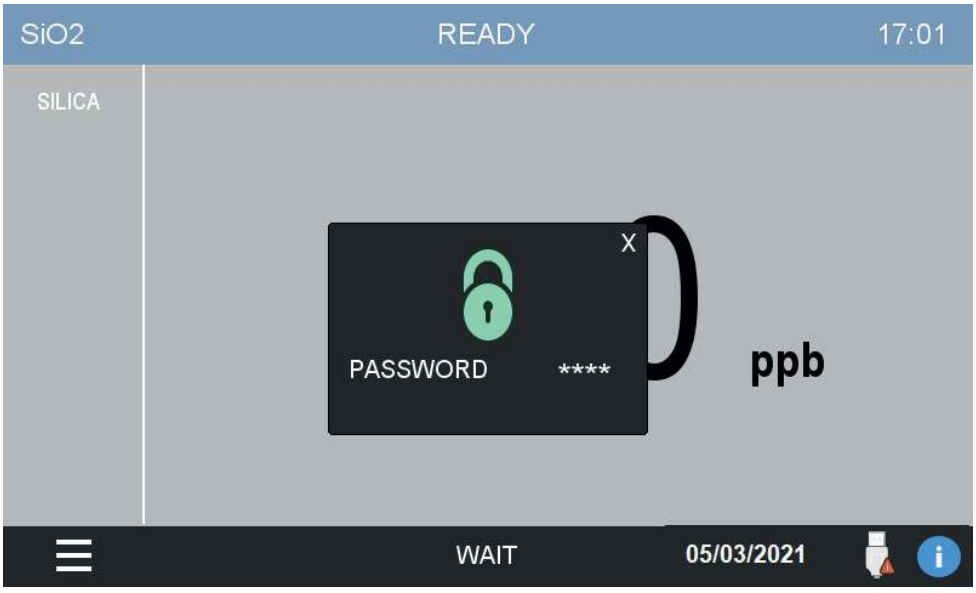
Contact the 3S Analyzers technical service or your local supplier to receive the password for your analyzer. You can write it down below.

SERVICE PASSWORD _____

To access the analyzer menu with the required security level tap on ACCESS LOGIN in the main menu.

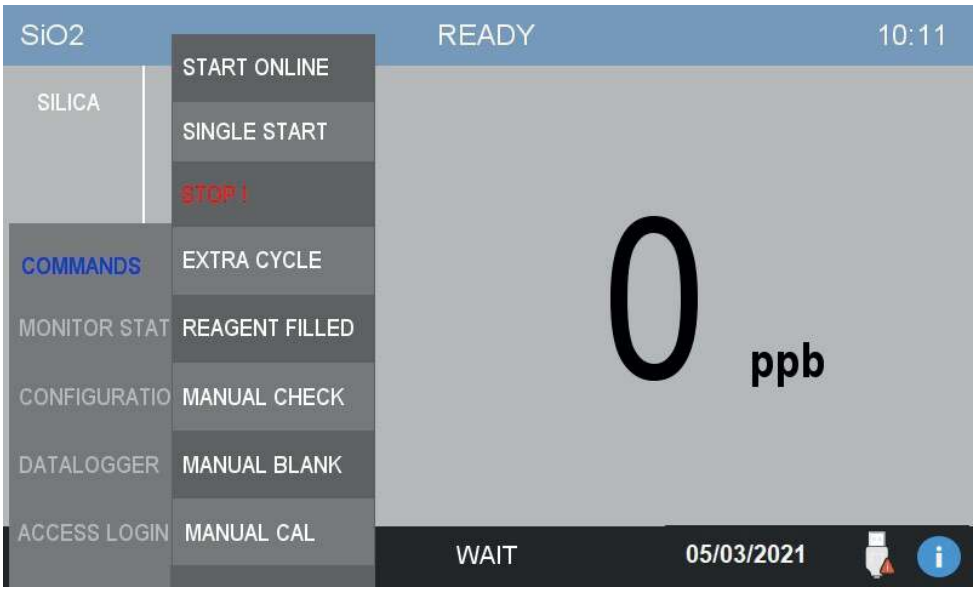
Press on **** to display the numerical pad and enter your password.

If the password for the selected access level is correct, the lock symbol becomes green.



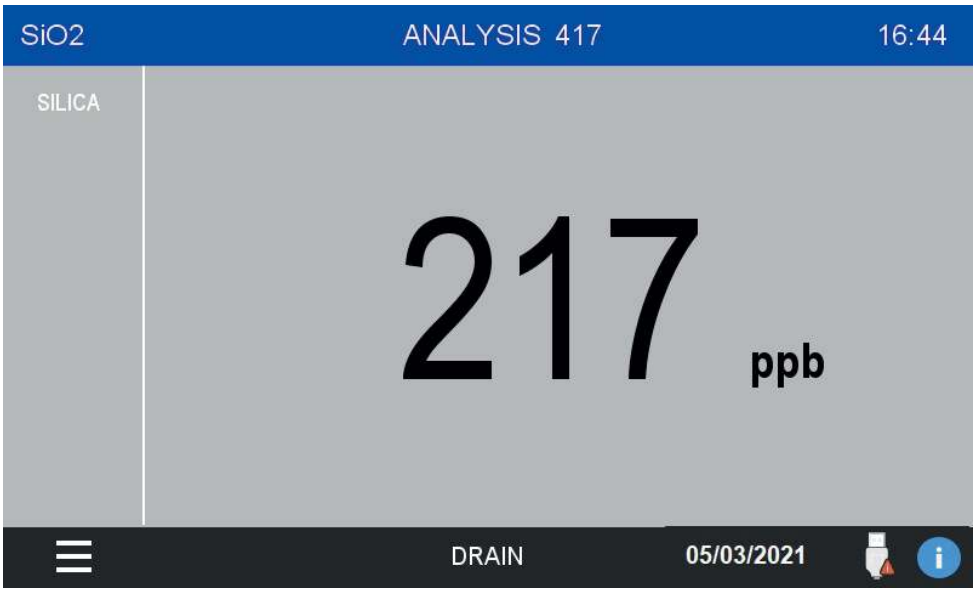
6.4 Commands

In the COMMANDS menu the user can give orders to the analyzer, such as starting a new analysis or perform calibrations.



Start Online

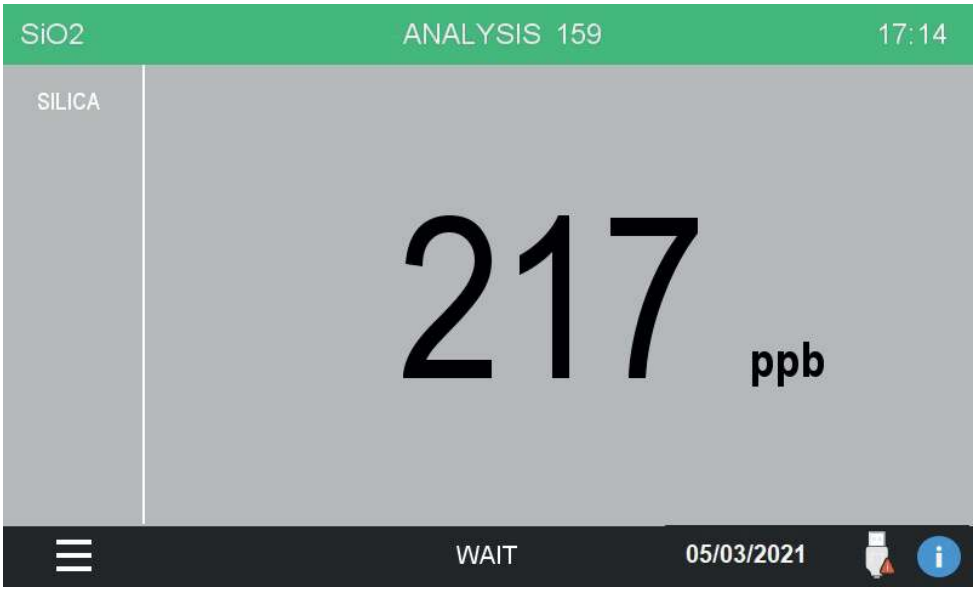
By pressing this button the analyzer will start online analyses.
The ONLINE status is characterized by a dark blue top bar replacing the light blue one present when the analyzer is in standby mode. In the top bar the word ANALYSIS also indicates that the instrument is currently in the middle of an analysis run. A countdown timer shows the time remaining after the end of the analysis cycle.



After the analysis cycle is completed the instrument will wait a predefined wait time before starting a new one. The top bar is still dark blue, the countdown timer indicate the time remaining before the next analysis.

Single Start

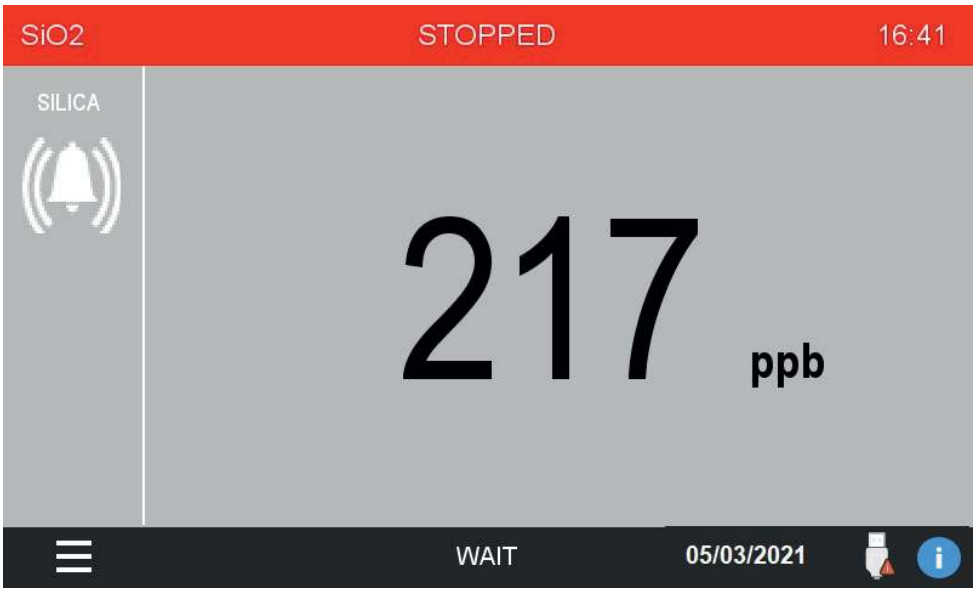
A single analysis cycle can be started by pressing this button. After the measurement is completed the analyzer will stay in standby, ready to receive new orders. The top bar is now green and the timer still indicates the time remaining untile the end of the run.



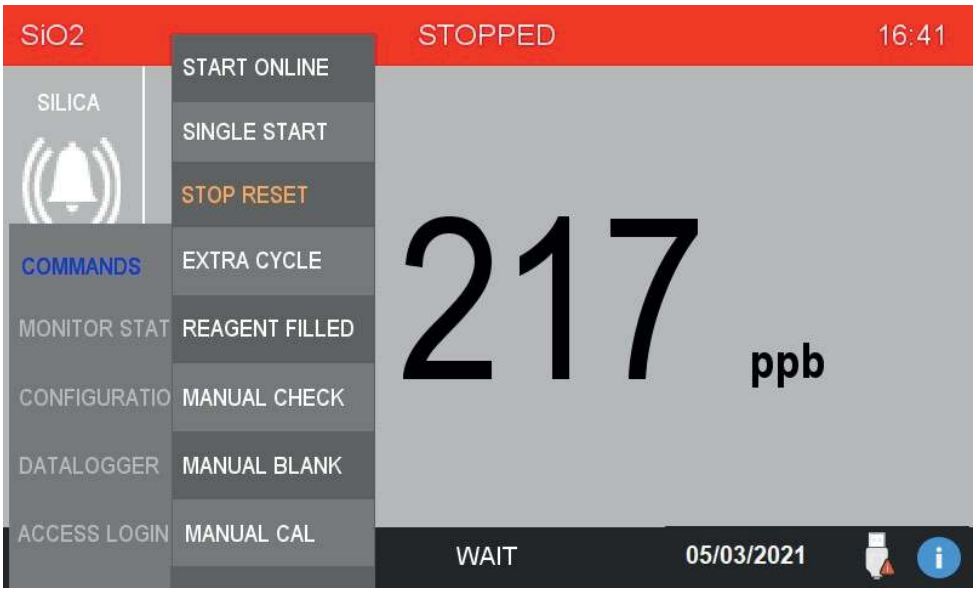
Stop!

Stop any operation and put the analyzer in the STOPPED status. This command is considered an emergency stop thus an alarm condition is raised.

In any alarm condition the top bar becomes red and an icon of a bell appears on the left side of the screen. If the beep option is active an acustic indicator

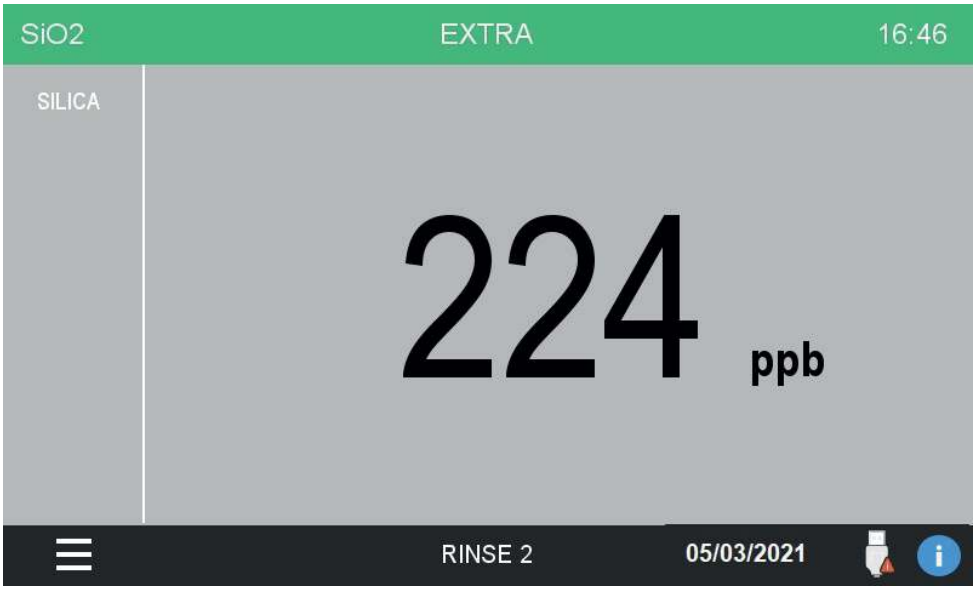


To restore the normal operation condition enter the COMMANDS menu and press STOP RESET.



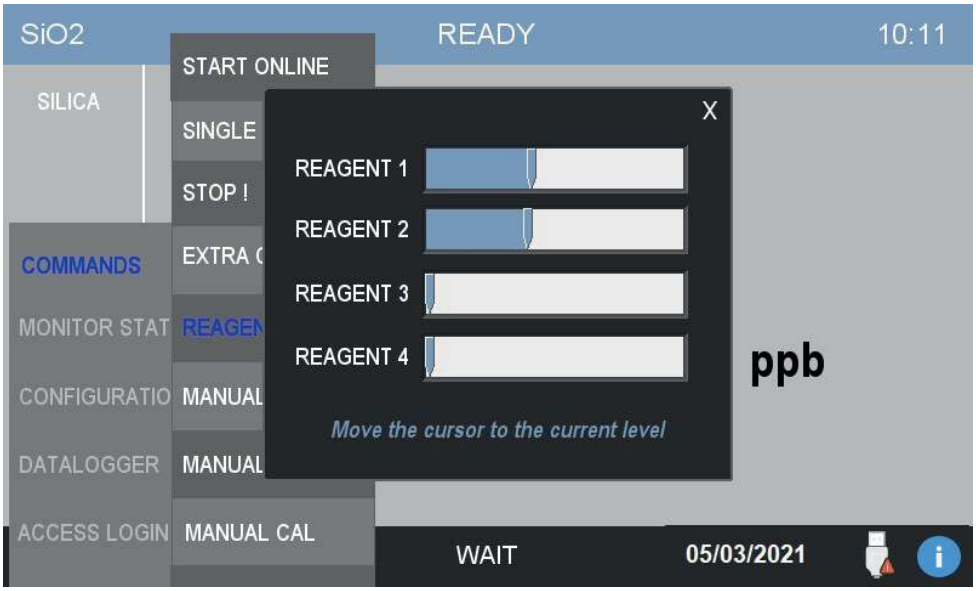
Extra cycle

Run an extra cycle immediately. The analyzer will run the program saved as Extra Cycle, usually an autocalibration, autovalidation or cleaning operation. The extra cycle execution can also be scheduled at a given frequency, see section 6.6 to configure the Extra Cycle settings.



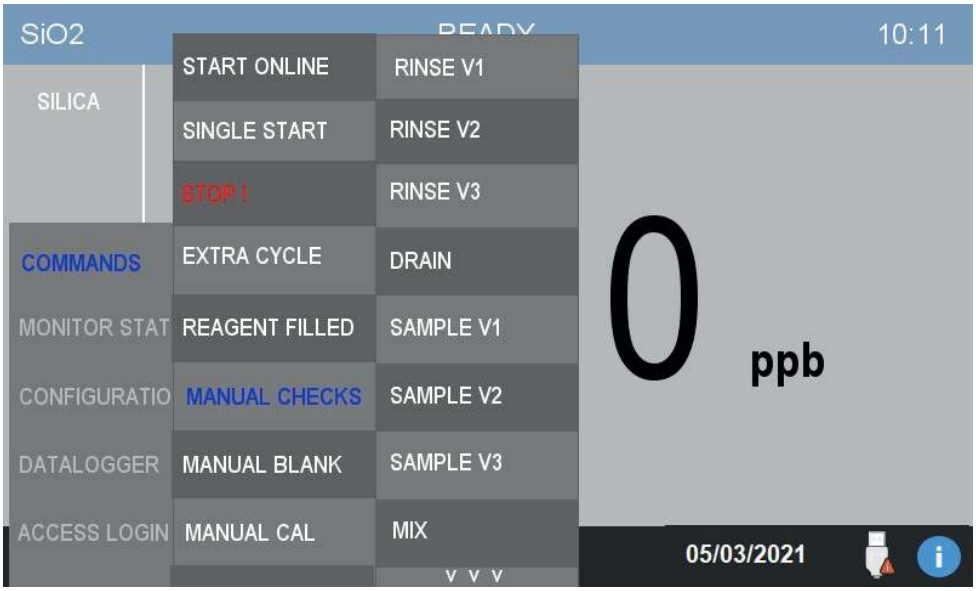
Reagent Filled

Depending on the parameter, the analyzer uses up to four reagents. The analyzer keeps track of each reagent using four separate counters. When the reagents amount falls below a threshold, an alarm is raised and the reagents must be refilled. To aknowledge the effective volume refillment the user must access the REAGENT FILLED menu and manually reset the counters. It is possibile to set the counters to an arbitrary value in the case the reagents are not filled to their maximum capacity.

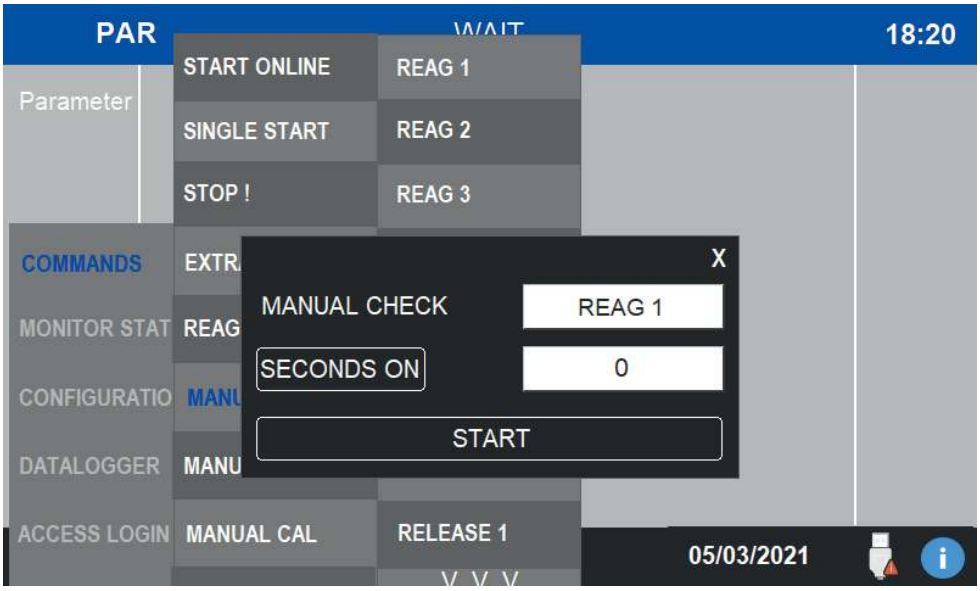


Manual checks

Press this button to access a submenu with the list of every function available to the analyzer. The user can then manually run any function/operation for a specified amount of time. This is usefule for testing or servicing purporses. See Section 4.3 for the list of the operations and their description.

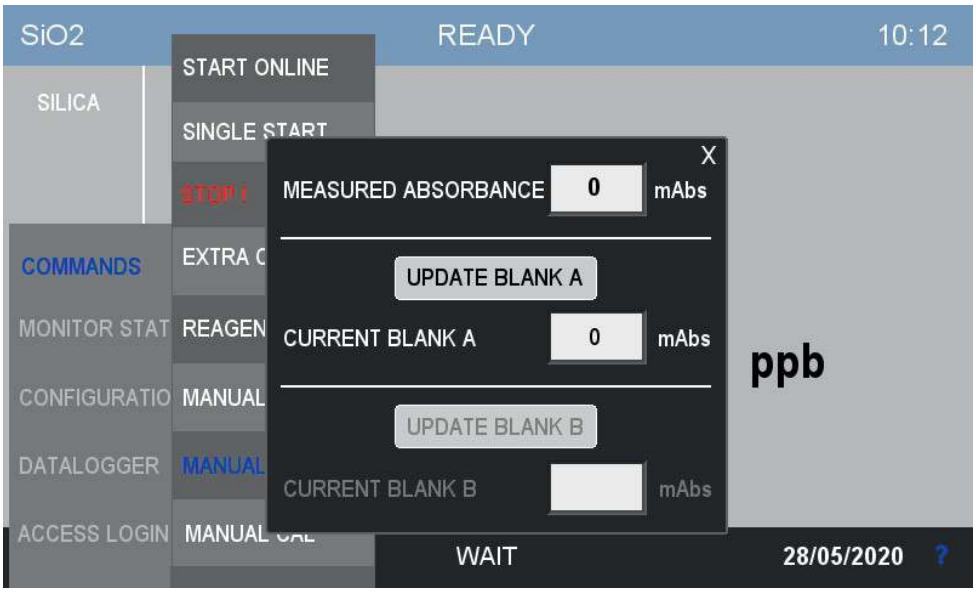


After selecting the desired operation you will be asked for the amount of seconds you want the function to stay on. Enter the value in the field and confirm with OK to run the function.



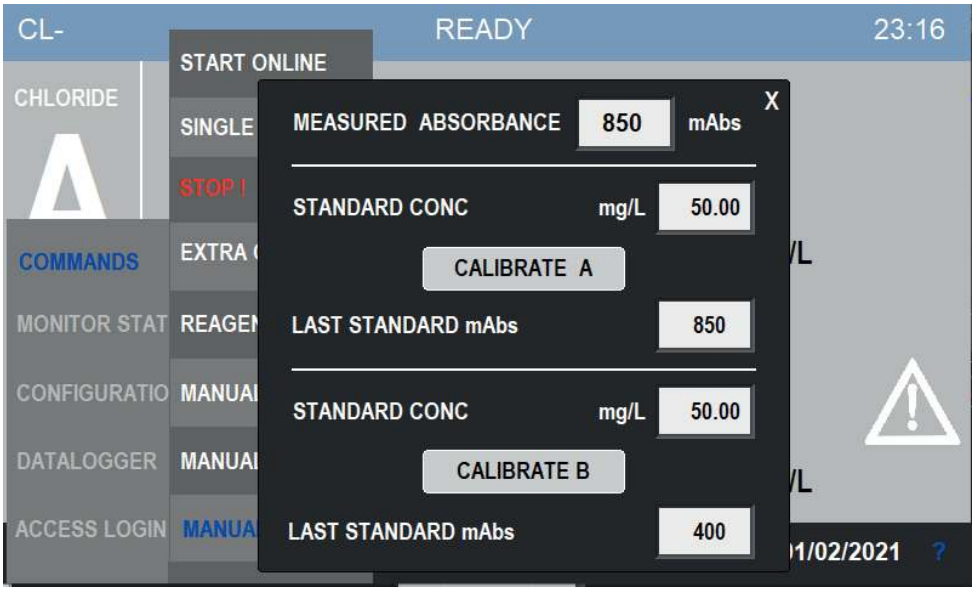
Manual blank

Store the last absorbance value as blank calibration. See Section 8 for more info on how to calibrate the instrument.



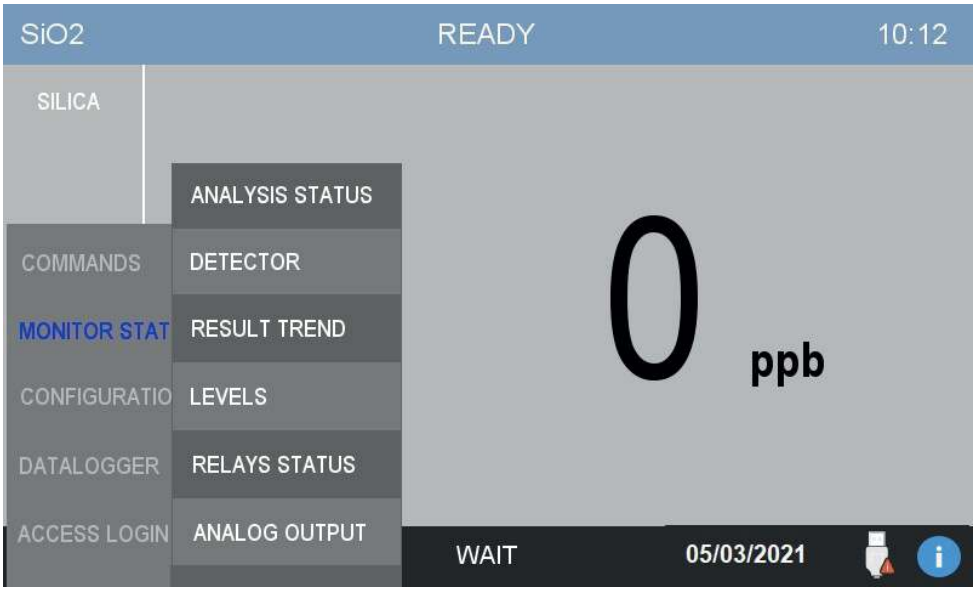
Manual cal

Perform the calibration of the instrument. If the calibration milliabsorbance value falls out of the predefined boundaries, a calibration error will be raised.
See Section 7 for the correct procedure to perform a calibration.



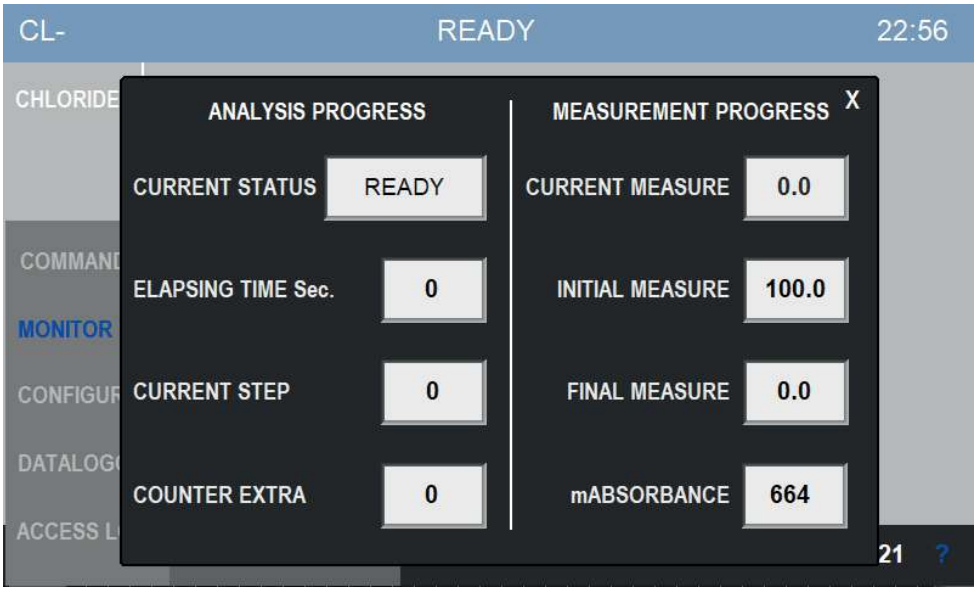
6.5 Monitor status

This menu contains the data representation in grafical form as well as important diagnostic information on the analyzer status.



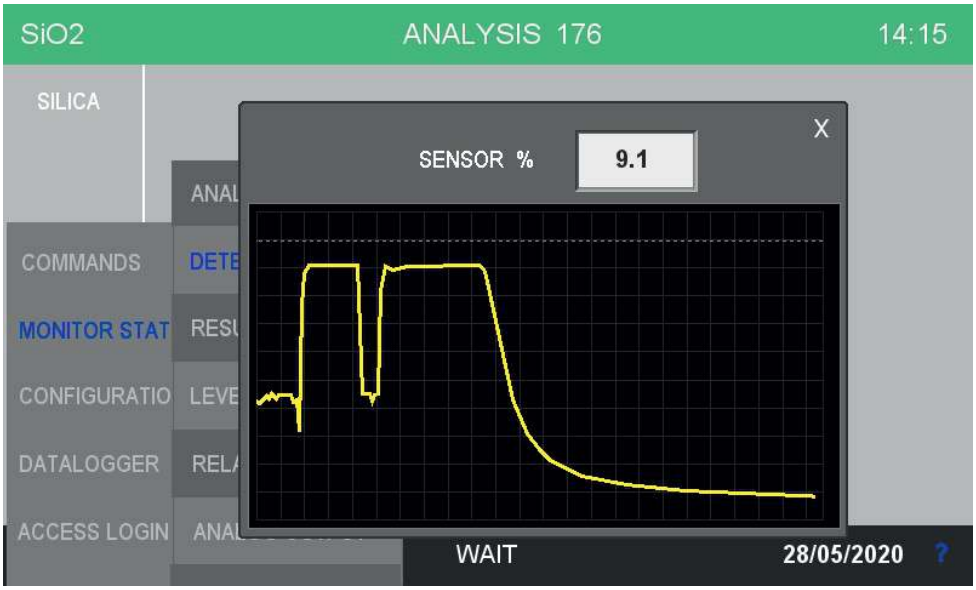
Analysis Status

This window will report data on the current analyzer status.
On the left column the user can find the status of the analyzer (READY, ANALYSIS, IDLE TIME, STOPPED), the number of the step currently running and its elapsing time, and the waiting time between on analysis cycle and the following on (COUNTER EXTRA).
On the right colum there is the current measurment data. The current analysis result, the initial and final transmittivity of the reaction cell and the value of the measurement in milliabsorbance units.



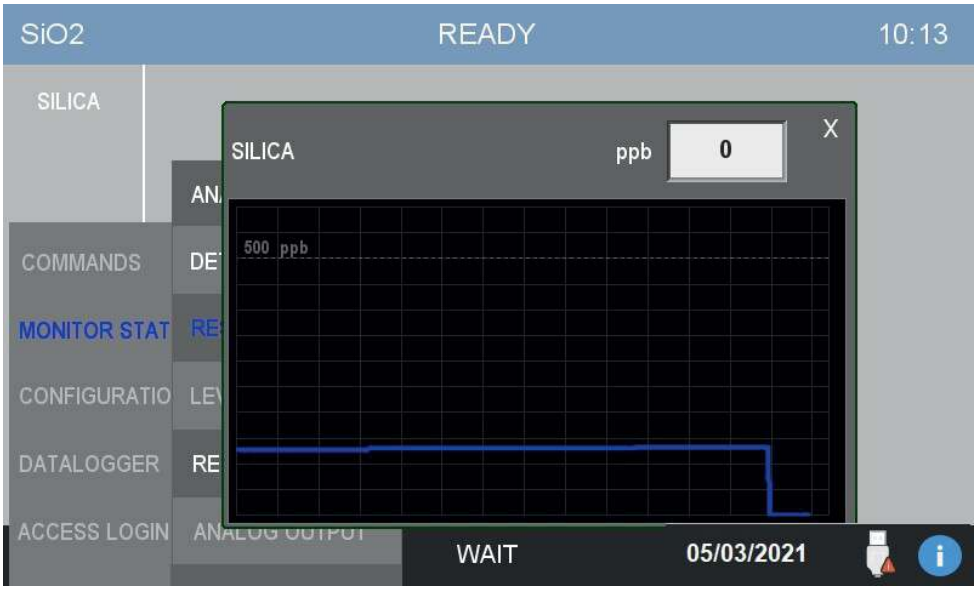
Detector

This windows shows the transmittivity profile of the reaction currently going on in the cell, in a grafical form. This is an important diagnostic tool that can reveal informations about the current analysis such as the chemistry and optics.



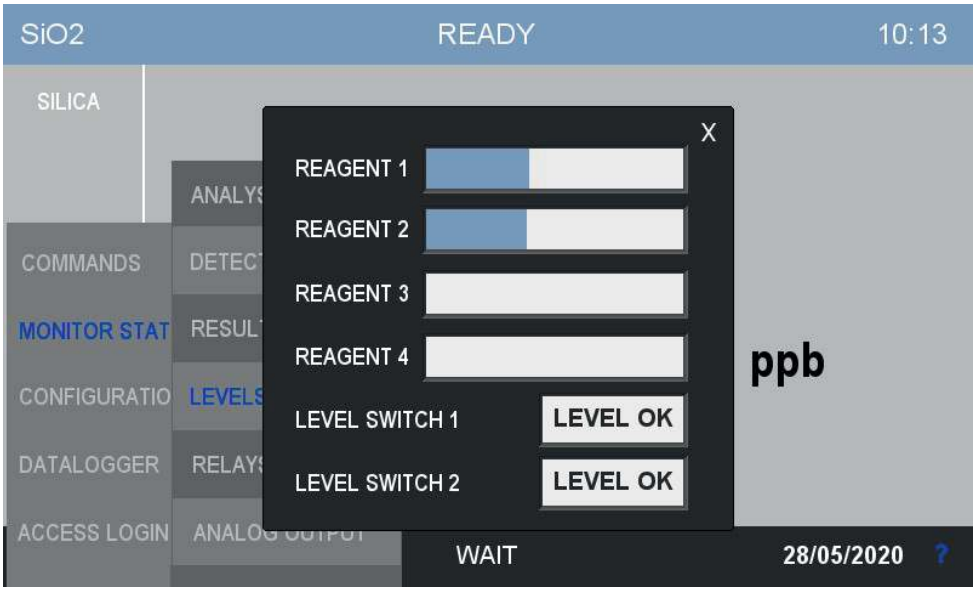
Result trend

This window shows the plot of the most recent analysis results.



Levels

In this window the user can check the current amount of reagents left as well as the presence of the samples. The reagents level must be resetted by the user when reagents are replaced by new ones, see paragraph 6.4 of this chapter for instructions.
The level switches detect the presence of the sample in the inlet streams (1 or 2 depending on the configuration). They must be connected to the level sensors of the external reservoirs in order to operate correctly, see Section 3.9.



Relays status

The analyzer is provided with two output relays to signal anomalies in the analyzer behavior.
Relay A is associated with hard faults, any condition that requires user intervention to fix the problem and restart the analyzer. This includes hardware faults, optical faults or calibration errors.
Relay B is associated with warnings, temporary conditions that will be resolved without user intervention, such as missing sample in the external reservoir.

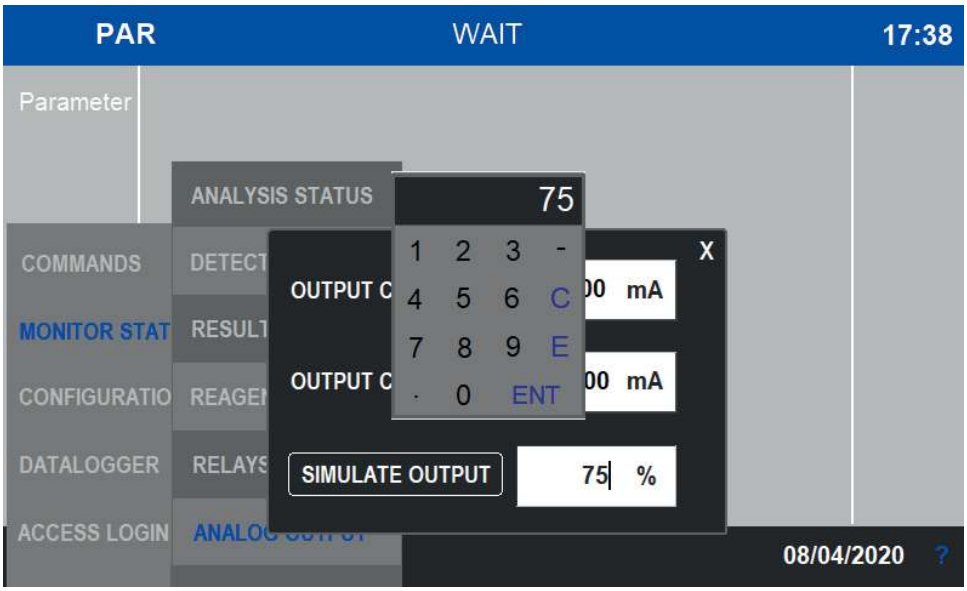
Analog output

The analyzer is provided with two 4-20 mA analog outputs, one for each channel (up to two). The current output value can be monitored in this window.

From the same window is also possible to simulate the output, this is useful to test a new installation or for servicing purposes.

To start the simulation press SIMULATE OUTPUT, a numerical pad will appear allowing the user to enter the value as a percentage of the full scale.

Remember to disable the simulation when you have done with it!



6.6 Configuration

This menu contains the configuration parameters of the analyzer.

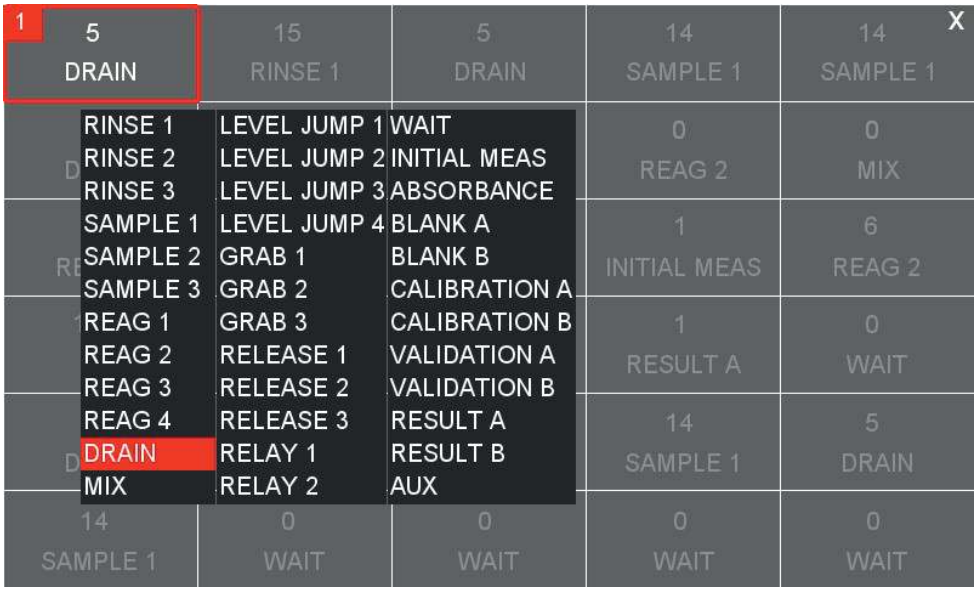
Analysis setup table

The instrument perform the analysis as a sequence of individual steps. Depending on the analysis parameter, up to 60 steps can be programmed. The analysis cycle is already programmed and usually does not require modifications, anyway it is recommended to request assistance from 3S Analyzer before making any change.

After accessing the menu button the following window appears:

1 5 DRAIN	2 15 RINSE 1	3 5 DRAIN	4 14 SAMPLE 1	5 14 SAMPLE 1 X
6 5 DRAIN	7 9 SAMPLE 1	8 6 REAG 1	9 0 REAG 2	10 0 MIX
11 0 REAG 3	12 0 MIX	13 30 WAIT	14 1 INITIAL MEAS	15 6 REAG 2
16 120 MIX	17 130 WAIT	18 2 ABSORBANCE	19 1 RESULT A	20 0 WAIT
21 5 DRAIN	22 14 SAMPLE 1	23 5 DRAIN	24 14 SAMPLE 1	25 5 DRAIN
26 14 SAMPLE 1	27 0 WAIT	28 0 WAIT	29 0 WAIT	30 0 WAIT >

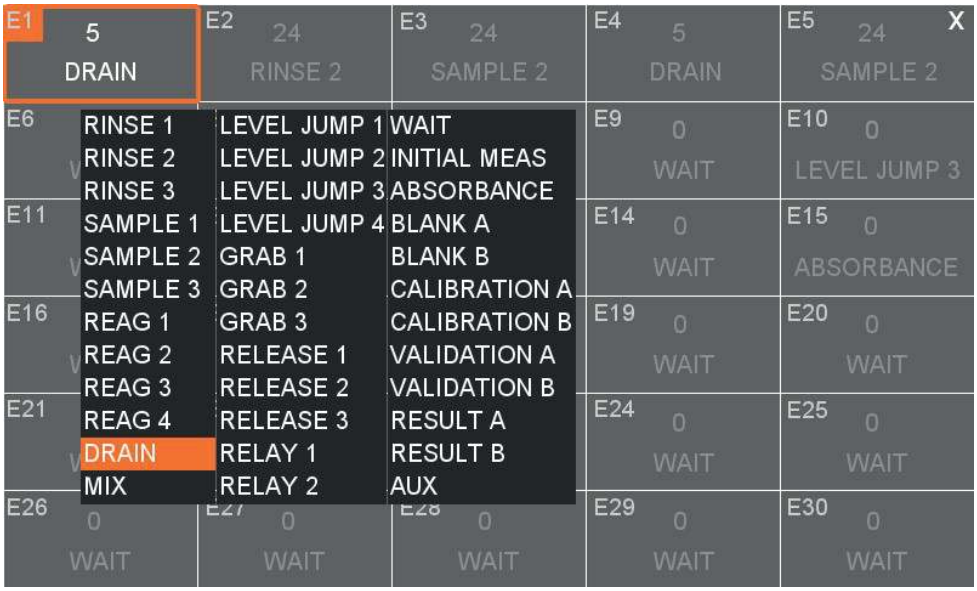
Any step can be reprogrammed individually by pressing the correspondig square.
Steps 30 to 60 can be found in the next page, accessed by pressing the > symbol in the bottom right corner.



After selecting the desired function, press on the number to set the duration time

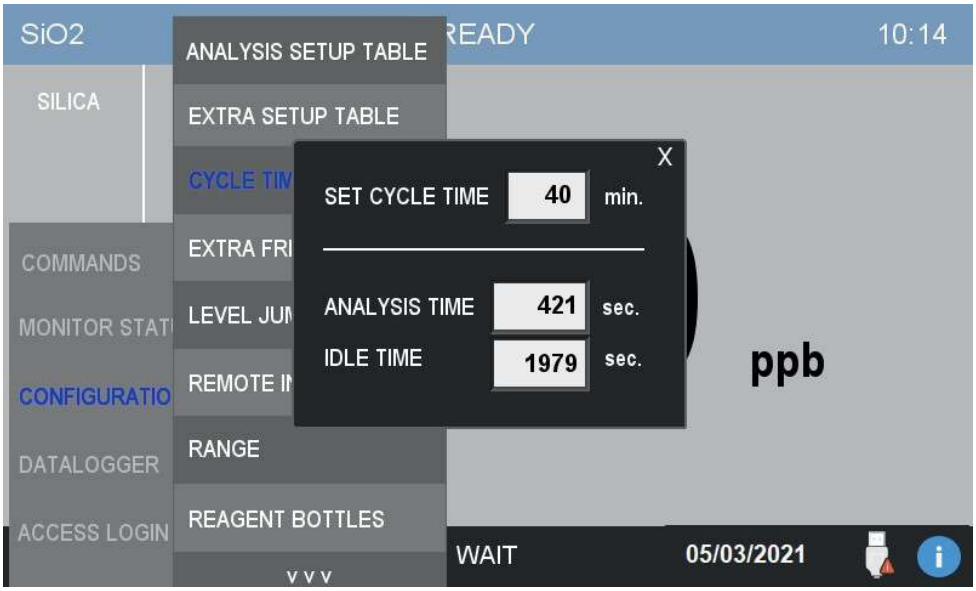
Extra setup table

In the same way it is possible to program the sequence of steps for the extra cycle (up to 30 steps).



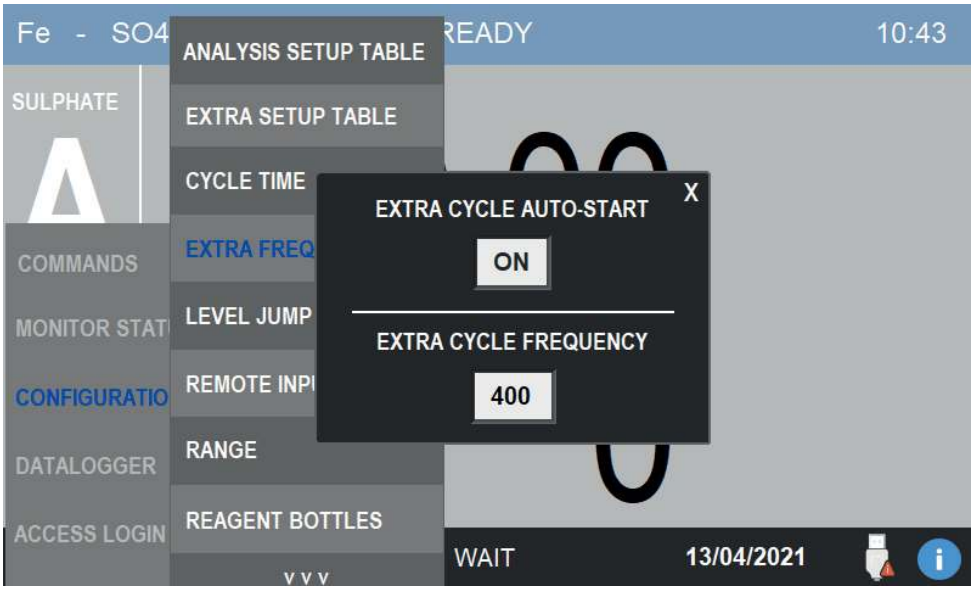
Cycle time

The instrument is able to run batch analysis continuously but it is also possible to set up an arbitrary analysis frequency. In this window the user can set a cycle time that comprises the analysis time and an idle time that the instrument waits before continue to the next analysis. In this way the analysis frequency can be controlled precisely.



Extra cycle frequency

In this window the user can set up the extra cycle frequency. In the following example the instrument will perform an extra cycle every 400 analysis cycles. The automatic execution of the extra cycle cn be turned on and off.



Level jump

When the sample is missing the analyzer has to decide how to behave. The analysis cycle can poll the status of the level sensors to check the presence of the sample, it does this through the Level Jump cycle function. In the analysis table you can insert a Level Jump step, when the step is encountered the analyzer will check the presence of the sample and if this is missing will jump to a step that does not require the sample, usually the final cleaning steps or directly to the end of the cycle.

Up to 4 different level jump events can be programmed in this window. By calling the corresponding event in the analysis cycle the jump is then executed.

Remote input

Some operations of the instrument can be controlled remotely through a digital input, physically located in the screw terminals inside the electrical compartment of the analyzer.
To select the operation controlled by the remote input open the window REMOTE INPUT of the CONFIGURATION menu.

Four operations are possible:

NONE	Remote input disabled.
ONLINE	The analyzer will start continuous analysis.
START EXTRA	An extra cycle is started.
SKIP IDLE	The idle time is bypassed and the following cycle will start.
EMERG. STOP	All operations are halted and the instrument is stopped, the FAULT sytem event will be activated

Range

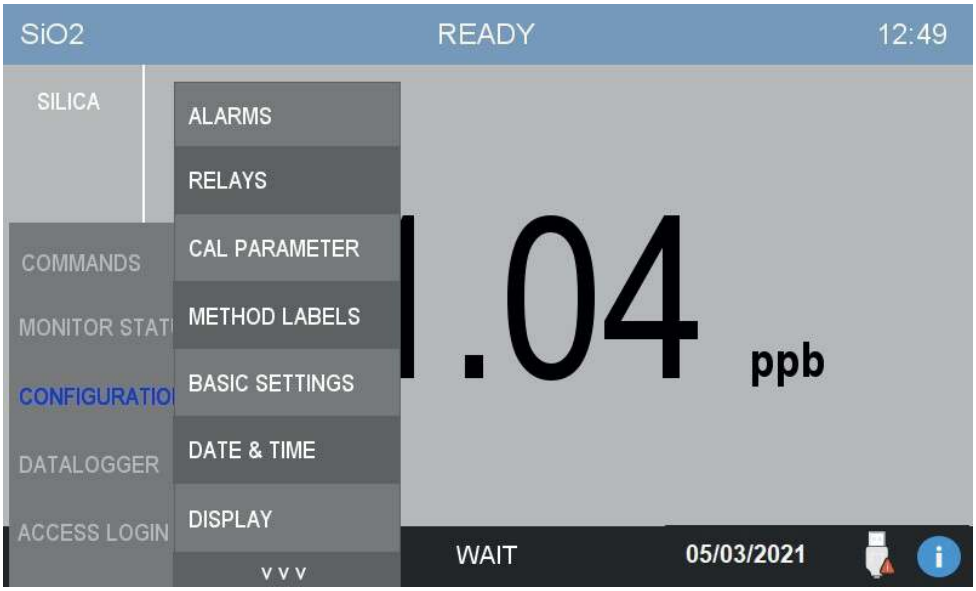
In this window the user can configure the range of the analyzer. In the case of a dual channel analyzer the two ranges can be configured independently. The field only accepts values up to 500. To express a range in the 500 - 1000 interval it is convenient to convert it in the upper measurement units (i.e. 800 ppb can be written as 0.80 ppm). See CONFIGURATION > DISPLAY to set the correct amount of digits after the dot.

In the same window it is possible to select the source of the analog output B. In a dual channel analyzer this is usually set as RESULT B, in a single channel instrument the user can decide to replicate the RESULT A in the second channel or to output the value of the last VALIDATION operation.

Reagent bottles

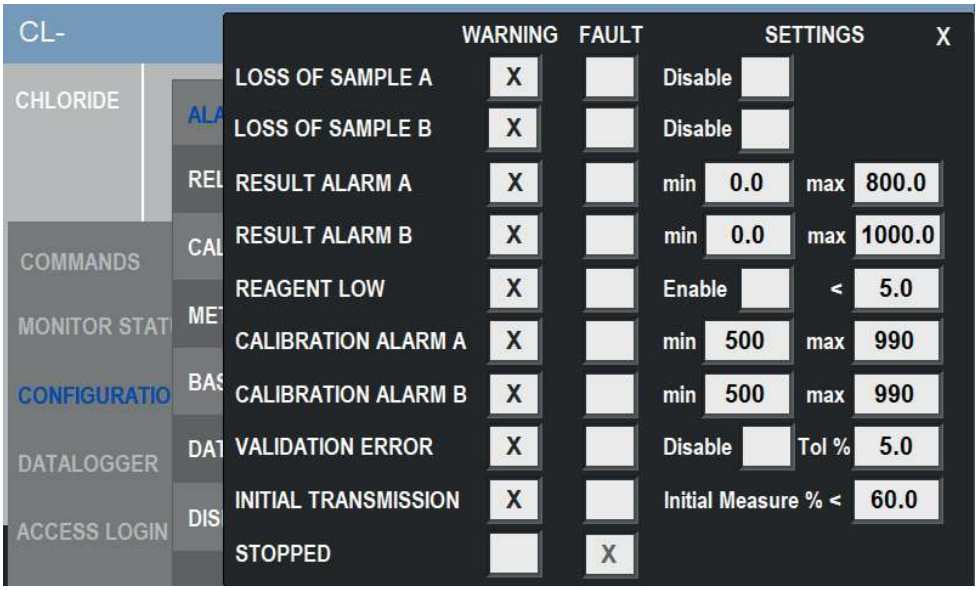
Depending on the parameter, the analyzer uses up to four reagents for the analysis. In order to correctly estimate the reagent consumption the instrument must know the total volume of each reagent. In this window the user can set the volume of the reagent bottles as well as turn on/off the reagent counter (this comes already configured, the operation is needed only if the number of reagents changes for some reason).

By pressing on the arrow at the bottom of the CONFIGURATION menu an additional list of options will appear:



Alarms

The analyzer can incour into events that require user attention or user intervention. In this window the user can bind an event either to a warning or to a fault, or even disable the event completely. The warning or fault will be displayed on the screen and communicated externally through one of the two relays. In the case of fault, the analyzer will completely stop every operation until user intervention. Please check section 9.6 for the explanation of alarms conditions.



Relays

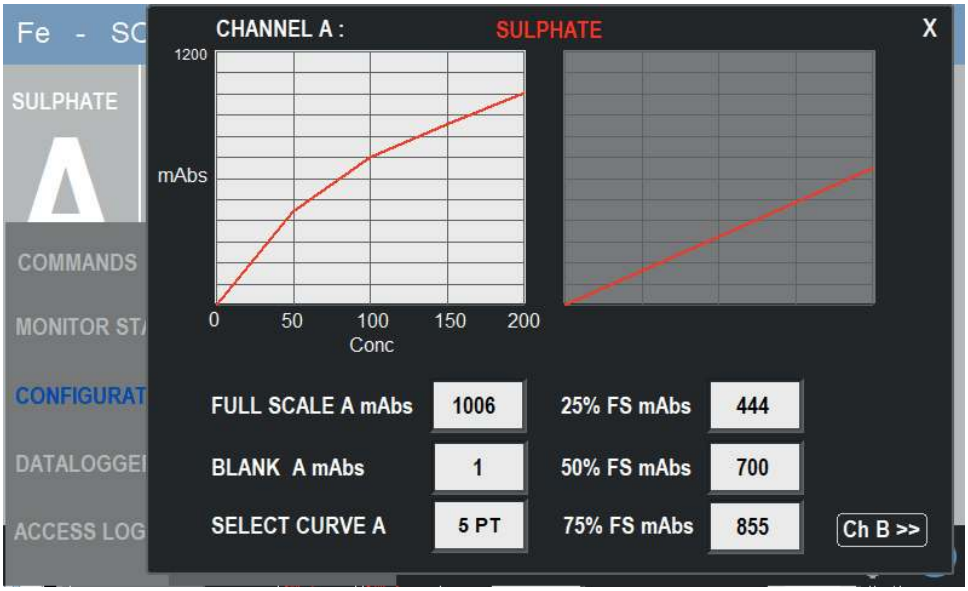
The user can configure the two relays arbitrarily. Both relay can be set either as a warning or as a fault (hard error, analysis will stop). Additionally the relays can be activated by the steps in the analysis cycle table (or extra cycle table). The latter option is useful to operate external equipment (valves, pumps etc.) during the cycle.

By activating the Safe Fail mode, the relays will be normally closed and normally excited, in case of power losses the relays will open thus simulating an alarm condition.

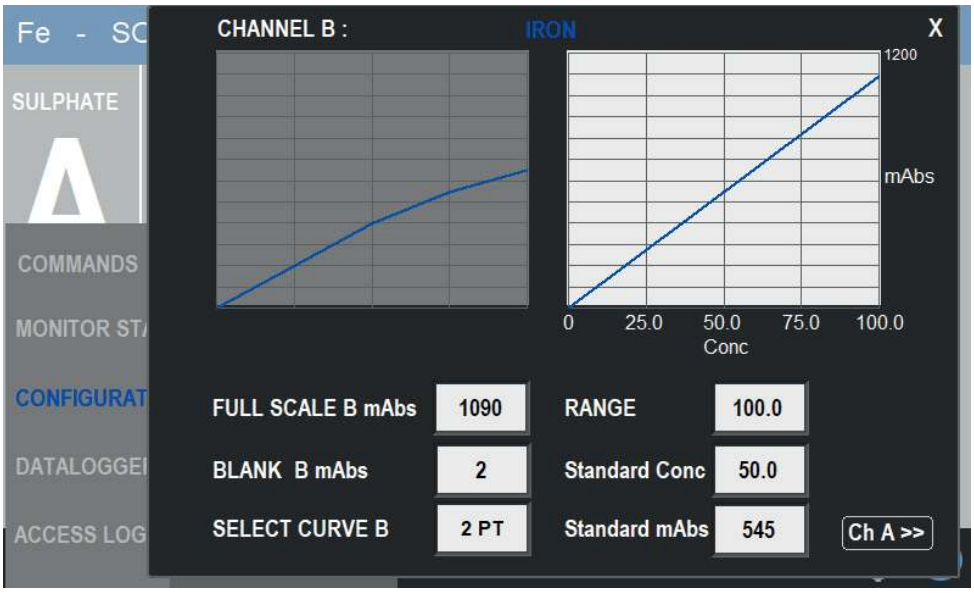
Cal Parameters

The calibration parameters and the calibration curve are shown on this page.

You can read the full scale absorbance FULL SCALA A and the BLANK in mAbs units. In the SELECT CURVE A menu you can choose between a two-point and a five-point calibration curve. For the former only the blank and the span are required. For the latter you'll need a blank and a other four points to cover the whole range of the analyzer.



However the user is not required to calculate the calibration curve, the analyzer is already programmed with the correct calibration curve during the factory tests. Even in the case of a five-point calibration curve it is possible to calibrate the instrument with just a measurement of the blank and a measurement of the span. See section 7.5 for more information.
By pressing the button on the bottom right corner we can access the calibration curves for channel B. This page is only for dual channel, dual calibration analyzers.



Method Labels

This window allows the user to change the name of the analysis parameter (analite). Tap on the fields to open the interactive keyboard.

Basic Settings

Some generic options are collected in this page.

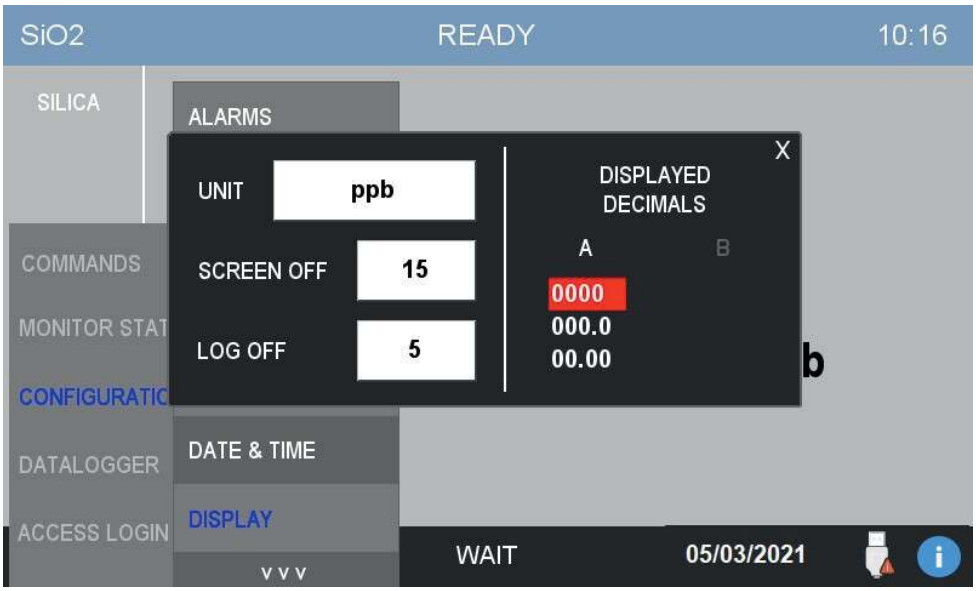
DUAL CHANNEL	This option is required if the analyzer is configured as dual channel.
DUAL CALIBRATION	This option is required for dual parameter analyzers
AUTORESTART	In case the analyzer is abruptly turned off, this option ensures that the analyzer will continue from the last cycle step upon restarting.
RESULT - SKIP IDLE	Skip idle time if the result is within a defined threshold.
BEEP	Turn beep on/off.

Date & time

The current date and time can be set in this window. Press on the fields to activate the numerical pad and enter the new values.

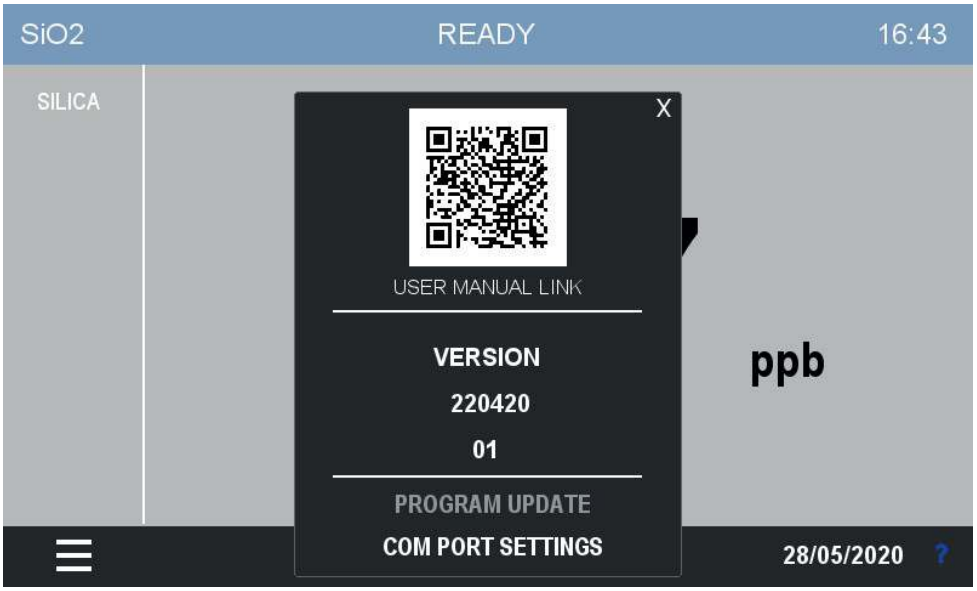
Display

n this window the user can set the measure unit, the time of inactivity before the display backlight turns off (SCREEN OFF), the delay before the user is logged off and the number of decimal digits of the displayed result value.

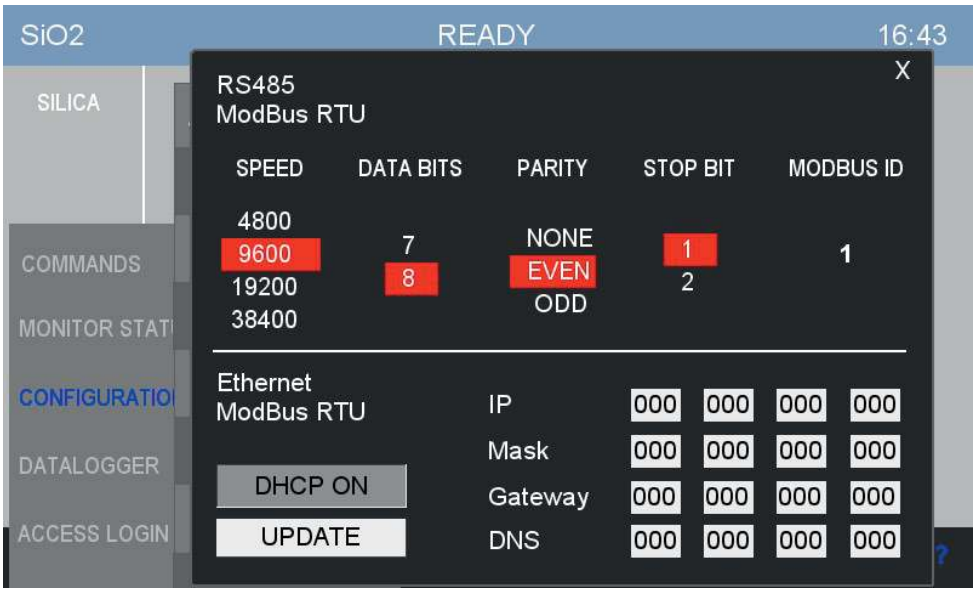


6.7 Version Info and Connection Parameters

By pressing the ? symbol on the bottom right corner you can access a windows containing some informations about the analyzer software version. By scanning the QR code is also possible to download the user manual for your analyzer version.



By pressing PROGRAM UPDATE (grayed out in the picture) you can abilitate the software update procedure. After updating the software remember to turn it off.
By pressing COM PORT SETTINGS the following window appears.



From here you can change the configuration parameter for the Modbus connection. In the upper part you can find the configuration of the connection via RS485, in the bottom part you can set the Ethernet parameters. You are free to set a static IP address or let DHCP decide, in any case remember to press UPDATE after any changes are made.
The commands available for the serial communication are listed in the table in section 3.8.

7 - CALIBRATION

7.1 About the method

Colorimetry is an analytical method that requires calibration before quantitative measurements can be performed. This is done using standard solutions which are analyzed in the same way as the sample.

In order to ensure correct measurement performance, the analyzer should be calibrated periodically, best results are obtained if the analyzer has been recently cleaned and serviced.

Like many other analytical instruments our the analyzer can be calibrated using a two-point calibration. The first point is the blank (zero), which is usually done by analyzing demineralized water. If the analyzer requires dilution it is advisable to calibrate the blank using the same dilution water used for the analysis. The span is registered by analyzing a standard solution of the analite of interest, usually in a concentration that goes from 50 % to 100 % of the full range, freely selectable by the user.

Some parameters or methods may have a calibration curve which is non-linear. In such cases we also provide an alternative five-point calibration curve to better fit experimental data.

In this case the multi-point calibration curve will be already calculated in the factory, we then provide a method to automatically recalibrate the whole curve using only a single point.

7.2 Autocalibration

The analyzer can be programmed to execute a calibration operation automatically. The calibration must be programmed as an EXTRA cycle. The EXTRA cycle must be switched on and its frequency defined, you can do this in the CONFIGURATION > EXTRA FREQUENCY menu of the user interface. The calibration will then run automatically after the defined amount of analysis cycle. Both the zero and the span calibration can be executed automatically via the EXTRA cycle.

The user can also trigger a calibration cycle at any time by pressing COMMANDS > EXTRA CYCLE.

Of course an appropriate standard solution must be connected to the secondary inlet port of the analyzer (see 3.11). Also see section 5.5 for an example of a calibration cycle.

7.3 Blank calibration

The blank calibration is simply performed by analyzing demineralized water. The blank calibration is particularly sensitive to impurities so is advisable to thoroughly clean the analyzer tubing and the reaction cell before starting with the calibration.

Proceed in the following way:

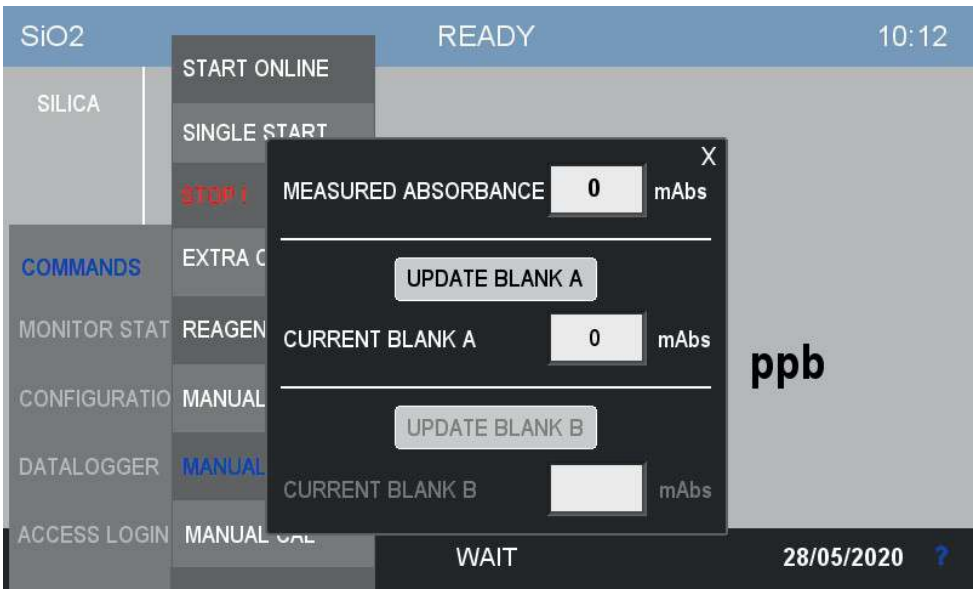
1. Stop any analyzer operation by pressing STOP! on the COMMANDS menu of the user interface. Reset the STOP condition within the same menu.

2. Remove the sample inlet tube from the sample recirculation tank and attach an additional piece of norprene tube (to keep it clean from impurities and dust) from which the calibration liquids will be sucked

3. Place the tube in demineralized water

4. Press START SINGLE within the COMMANDS menu of the user interface, a single cycle will start. Repeat the analysis at least three times

5. If the results are stable, press the MANUAL BLANK button in the COMMANDS menu



Press UPDATE BLANK A to calibrate the instrument.
In case of a dual channel analyzer you can also calibrate the second channel. Usually the two blanks are the same but if one channel is diluted and the other one is not, they can differ for the matrix effect of dilution water.
In fact, if the analyzer requires dilution the steps are the same, make sure to connect demineralized water to the sample inlet and leave the dilution water attached. In this way any discrepancies due to matrix effect of the dilution water can be leveled out. This is valid for both single and double channel analyzers.

7.4 Span calibration (2 points)

It is advisable to prepare a high concentration stock solution which ensures long-term preservation in the fridge. Diluted solution can then be prepared from the stock solution right before the calibration operation.
It is recommended to use pure water and clean glassware when preparing and dilutiong the standard solutions.

After preparing the standard solution, the instrument calibration can be performed with the following steps:

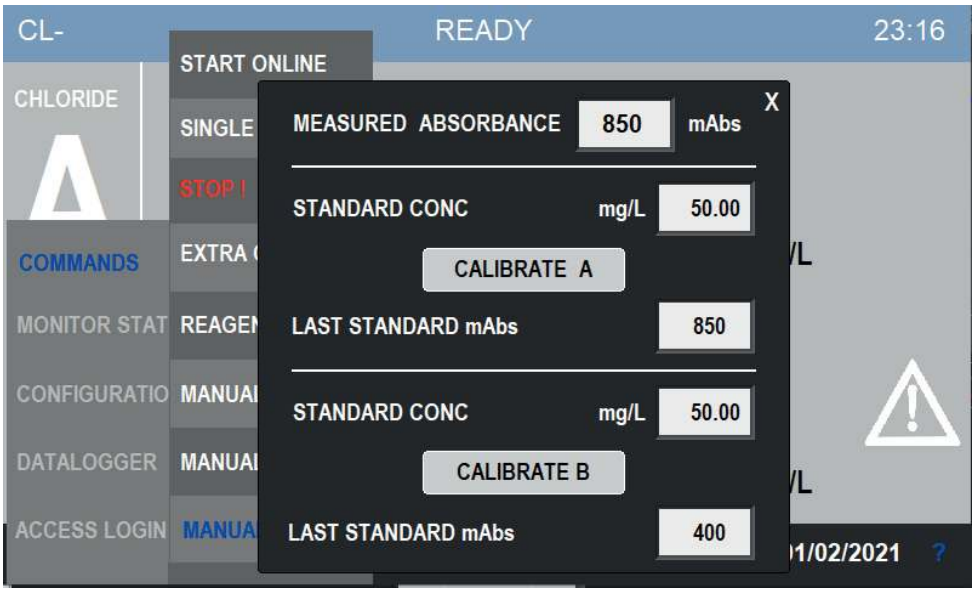
1. Stop any analyzer operation by pressing STOP! on the COMMANDS menu of the user interface. Reset the STOP condition within the same menu.

2. Remove the sample inlet tube from the sample recirculation tank and attach an additional piece of norprene tube (to keep it clean from impurities and dust) from which the calibration liquids will be sucked.

3.Place the tube in the standard solution container.

4. Press START SINGLE within the COMMANDS menu of the user interface, a single cycle will start. Repeat the analysis at least three times.

5. If the results are stable you can proceed with the calibration. Press the MANUAL CAL button within the COMMANDS menu. Check the value of STANDARD CONC and change it accordingly if required.



Press CALIBRATE A to calibrate the instrument.
In case of a dual channel, dual calibration analyzer you can also calibrate the second channel with CALIBRATE B. If the second channel is analyzing the same parameter with the same dilution ratio of the first one you don't need to repeat the calibratrion, the calibration data will be valid for both channels (dual channel, single calibration configuration). Otherwise restart from step 4 and calibrate channel B by referring to the bottom section of the same page.

7.5 Span calibration (5 points)

If your analyzer has a method with a non-linear response a 5-point calibration curve will be used. The calibration curve will be already calculated during our factory testing specifically for your unit. Users are are not required to modify the original calibration curve manually (even if they are free to do so, see the following paragraphs) as we provide a method to rescale the whole curve using only a single value.
Therefore the calibration of a multi-point curve will be identical to the two--point calibration with the exception that the user is required to operate with a standard solution concentration equal to the full scale value of the analyzer.

Proceed as follows:

1. Prepare a standard solution of a concentration equal to the full scale of the analyzer. If in doubt you can check the full scale value by pressing COMMANDS > MANUAL CAL. The value of the full scale will be grayed out since it's not possible to change it.

2. Perform all the steps listed in 7.4. From the user point of view nothing changes in the procedure.

After the calibration is completed you can see the new curv iIn the page CONFIGURATION > CALIBRATIONCURVE.

7.6 Modifying the calibration curve

The calibration curve of the analyzer has been already calculated during the factory testing right before shipping. The end user does not have to recalculate all the five points each time: by performing a calibration at the full scale value, the curve can be recalculated automatically.
Anyway it is possible to recalculate the curve to maximize the analyzer accuracy or to compensate matrix deviations after on-site installation.

To do so, follow these steps:

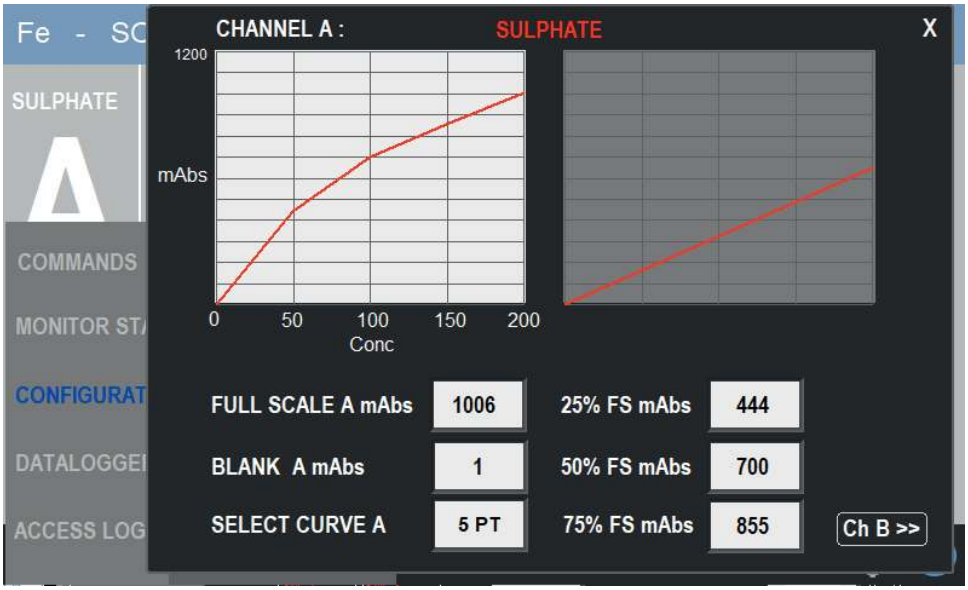
1. Prepare a set of standard solutions at the following concentrations:

- 25 % of full scale
- 50 % of full scale
- 75 % of full scale
- Full scale

2. Perform blank calibration as describe in section 7.3

3. Make an analysis for each one of the standard solutions. You can proceed as in the two-point calibration but do not press the calibrate button at the end of the analysis, instead go to MONITOR STATUS > ANALYSIS STATUS and take note of the mAbs value. Do this for every point to be measured. Repeating and averaging the analysis is not mandatory but advised.

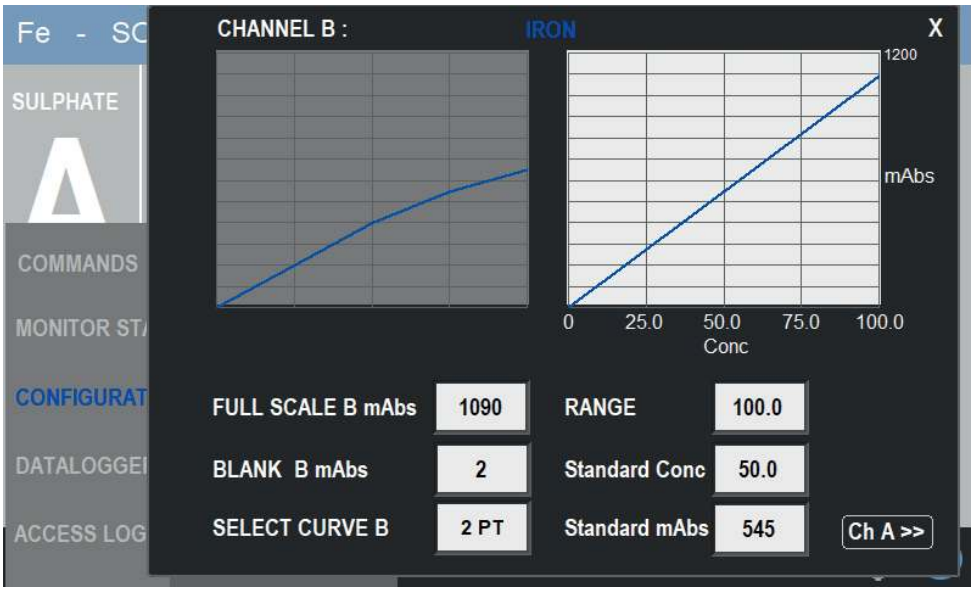
4. Go to CONFIGURATION > CALIBRATION DATA. You will see the following page:



If the analyzer was previously programmed using a two-point calibration curve you'll need to select 5PT from the SELECT CURVE A menu. If you are just updating a previous calibration curve just proceed with the instructions.

5. Insert calibration data.
You can then replace the old calibration data with the new one.
When all the points are insterted the calibration is completed. Further calibrations can be carried out just by calibrating at the full scale concentration, see 7.5.

If the analyzer is configured as dual channel, dual calibration you can access the channel B calibration page by pressing the button in the bottom right corner. Channel B is calibrated exactly in the same way as channel A. The type of calibration (2PT or 5PT) can be selected independently for the two channels, it's very common to have a channel which is linear and the other one that requires the five-point calibration curve.



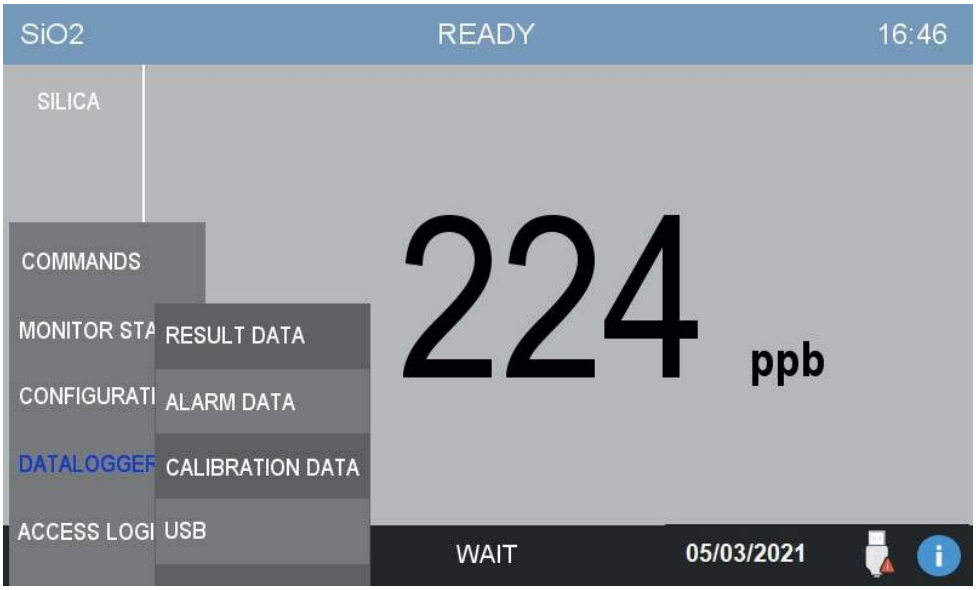
7.7 Validation

A validation operation follows more or less the same steps of a calibration, a standard solution is feeded to the instrument and an analysis is performed. The main difference is that with the validation the result of the analysis is not used to calculated a calibration factor but it is compared to the stored calibration value instead. The result of the validation is a percentage with the 100 % corresponding to a perfect replication of the last calibration factor.
The validation needs a standard solution of the same value of the last calibration stored in the anlyzer.
Like the calibration, the validation can be programmed as the EXTRA cycle and can be run at the necessary intervals. It can be also started manually with COMMANDS > EXTRA CYCLE.
The validation is useful in those cases where the user wants to verify the calibration or more generally the correct function of the analyzer without risking to comprosime the current calibration factor.

8 - DATA STORAGE

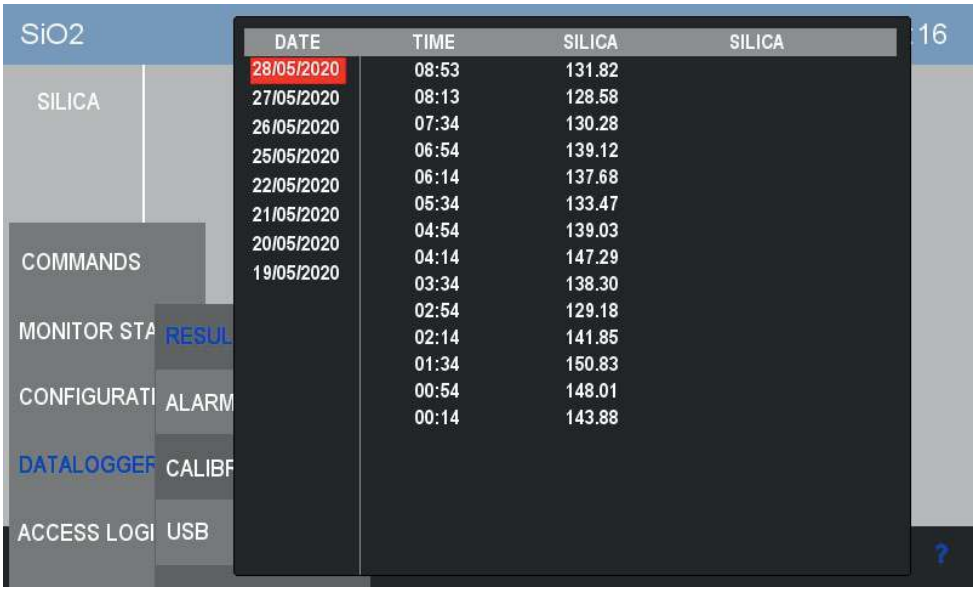
8.1 Datalogger Page

The instrument has an integrated datalogger functionality. At the end of each analysis cycle the results are logged together to the time and date of the analysis.
The data is stored on a removable USB device that must be plugged in on the the back of the HMI display. To reach it, open the electronics compartment and look at the bottom of the display. If the storage unit is removed the data is not saved and the datalogger functionality will not be available. A warning will be displayed on the screen the first time the instrument tries to log a result and the device is not present. The presence of the USB storage is also notified in the bottom right corner.
To access the datalogger press DATALOGGER on the main menu of the graphic interface.



Result Data

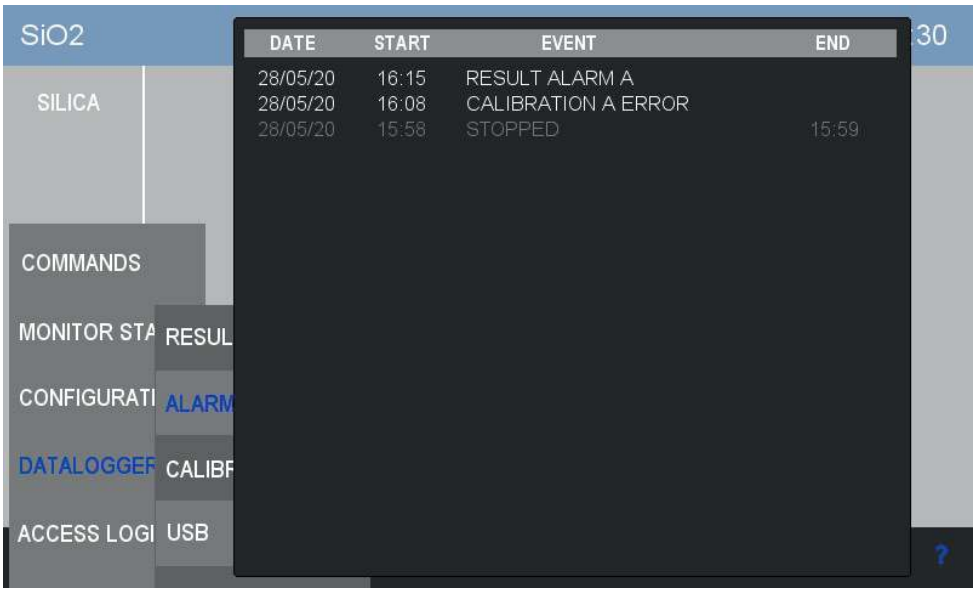
This is the main datalogger page where the analysis results are shown.



In the leftmost column there are the dates the data has been recorded on. By selecting a day the corresponding lists of measures will be displayed. The time column indicates the analysis time whiile the other two columns contains the data for both channels. In the picture the last column is empty because the analyzer has not recorded any data on the second channel. This is the case of a single channels analyzer.

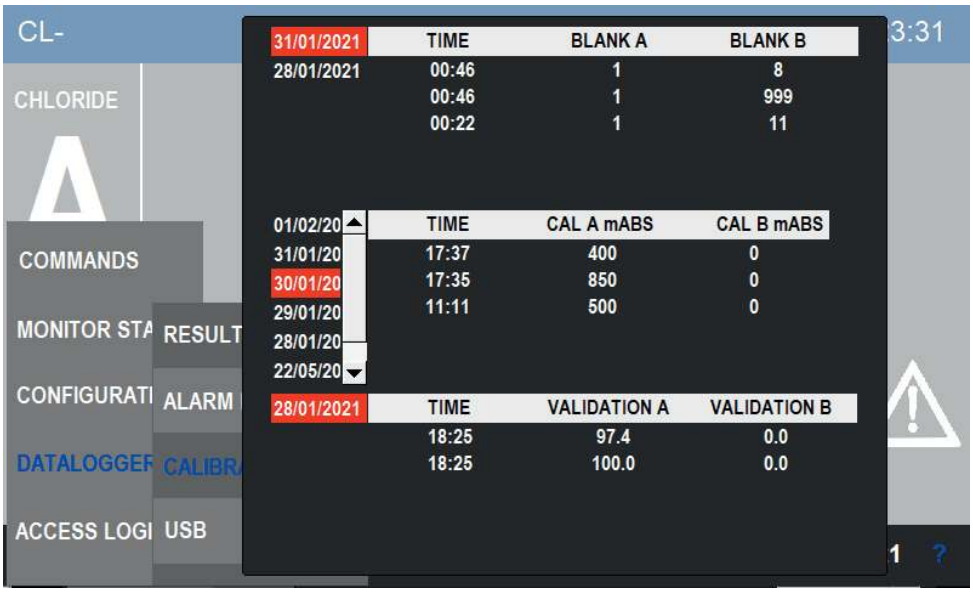
Alarm Data

In this page the analyzer alarm conditions are collected. The column on the left shows the date, the START column show the time the alarm condition started, the EVENT column describe the alarm. When the alarm condition is resolved the corresponding line will be grayed out and the time will be recorded on the END column.
The data present in the Alarm Data page are stored on the analyzer internal memory and wll be recorded even if the exteral storage is removed.



Calibration Data

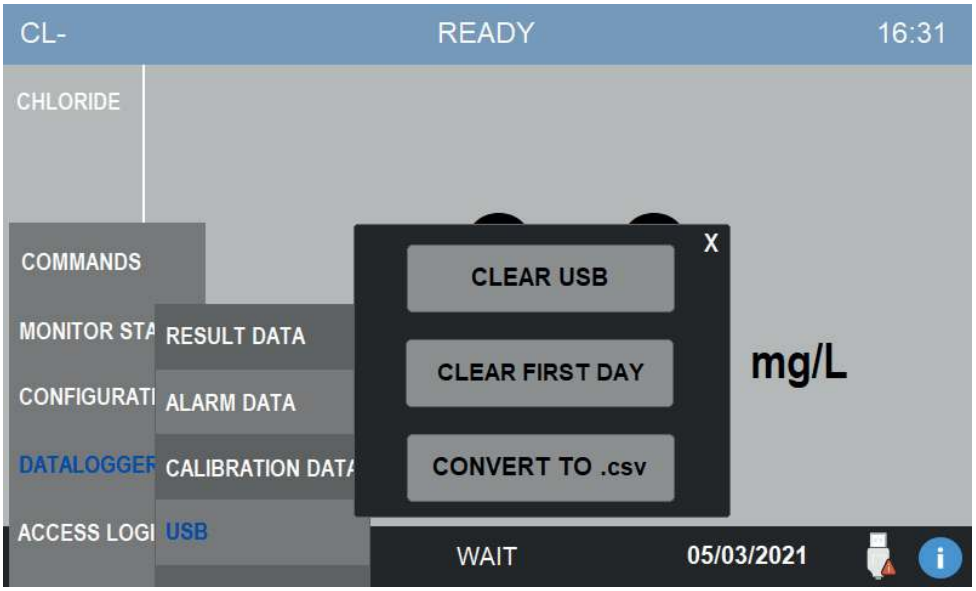
In this page the calibration data is logged. The data about blank calibration is shown in the top section, the data about the span calibration is shown in the middle section. In the bottom section you can find the data about the last validation performed.
In the case of a dual channel, dual calibration analyzer, the data about both channels will be present.
The data present in the Calibration Data page are stored on the analyzer internal memory and wll be recorded even if the exteral storage is removed.



USB

In this page you can clear the data on the external USB device. Is it possible to completely erase the logged data or to selectively erase the data for the oldest day. By pressing the CONVERT button the database is converted to the CSV format in the external USB storage.

After the conversion the USB storage can be unplugged and the data viewed on a personal computer with any spreadsheet software.



9 - MAINTENANCE

9.1 Maintenance operation

Here below the list of the preventive maintenace operations:

COMPONENT	OPERATION	FREQUENCY
DRAIN VALVE	tubing replacement	every 4 months
VALVE 1	tubing replacement	every 4 months
VALVE 2	tubing replacement	every 4 months
VALVE 3	tubing replacement	every 4 months
REAGENT PUMPS	tubing replacement	every 8-12 months depending on duty
SAMPLE PUMPS	tubing replacement	every 4 months
MEASURE CELL	tubing replacement	depending on duty

The frequency of the listed maintenance operations is heavily dependent on the nature of the sample. Samples that contain a high concentration of organic solvents or solid particles such as sand grains may require more frequent cleaning and mantainance.

Important: replace pinch and peristaltic valve tubing using only spare parts provided by the manufacturer to ensure proper sealing.

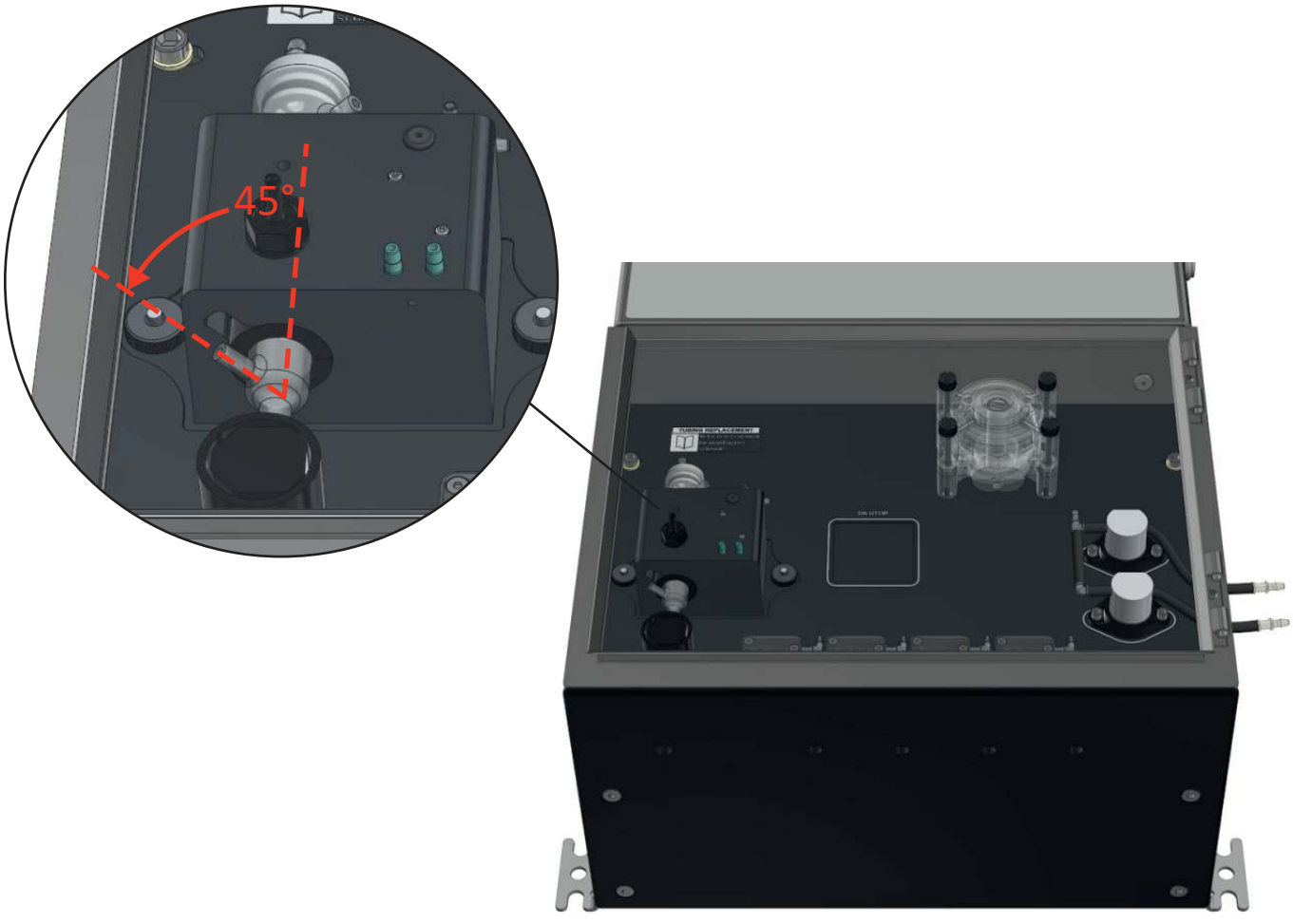
9.2 Dismounting the measure cell

This operation is necessary when the cell is dirty, for example when reading a high absorbance value with clean water.
If the cell is often dirty and requires frequent manual cleaning, you can program an EXTRA cycle for automatic cleaning. Please contact the 3S Analyzers customer service to plan an adequate cleaning cycle for your analyzer since some cleaning reagents may not be compatible with the analysis method.
If your instrument has already a cleaning EXTRA cycle you can increase its frequency in CONFIGURATION > EXTRA FREQUENCY.

To disassemble the cell proceed as follows:

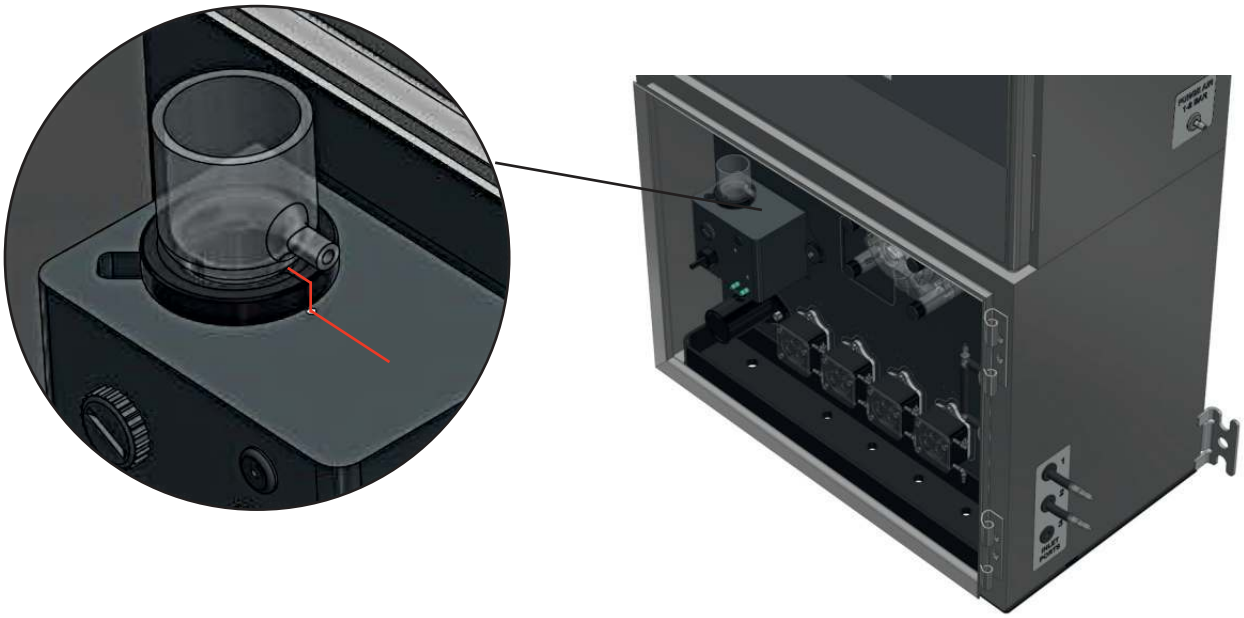
1. After removing any liquid from the cell, carefully remove the cell cap and all pipes connected to it.
Unlock the black plastic round cell holder by unscrewing the cell holding screw.

2. Rotate the cell to align the side tang to the slot in the cell block, as shown.



3. Remove the cell by lifting it. If the analyzer is equipped with a 16 mm cell you will find a plastic adapter around it, in that case open the two plastic shells after loosening the o-ring that keeps them sealed on the cell.

4. After cleaning the cell, reassemble the shells and the o-ring (16 mm cell only), place it back in the cell holder block.
In the case of 16 mm cell with adapter, align the windows of the optical path, as shown below. The separation line between the two black shells should be aligned with the reference point in the cell holder block, otherwise the light will not pass through the liquid as it should.



5. Fix the grub screw by hand or with a screwdriver, while exerting only a slight pressure so as not to force the plastic shells, but enough to prevent them from rotating, IMPORTANT!

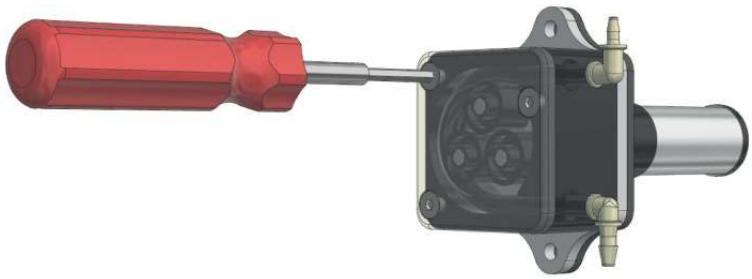
6. Reconnect the tubes and put the cell cap in place.

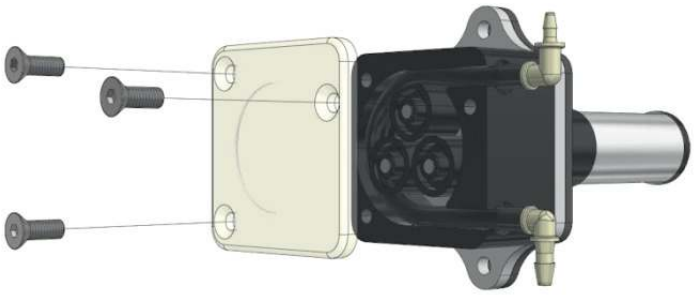
9.3 Reagent pump maintenance

This operation is necessary for the replacement of the cleaning reagent pump tube and rollers.
Although the tube ensures at least 70 hours of operation (it is possible to calculate the operating time considering the frequency of analysis and the operation intervals required by the cycle program), therefore it must be maintained and/or replaced at least every 8-12 months.
Use only the tube provided with the REAGENT PUMP KIT, the kit includes 3 spare tubes and one spare roller.

Proceed as follows:

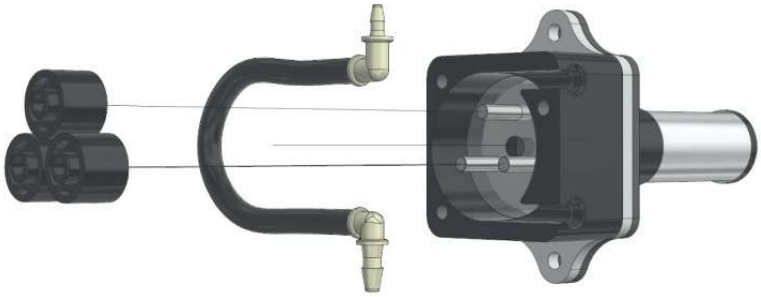
1. Remove the transparent cover by unscrewing the 3 fixing screws with an hexagonal screwdriver



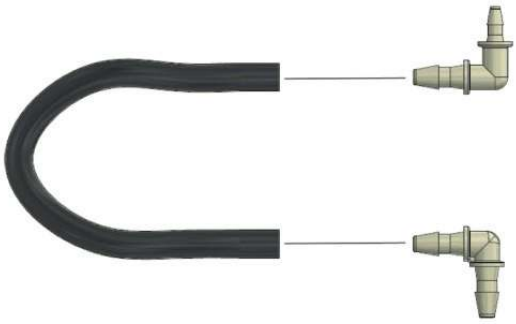


PAY ATTENTION TO THE LIQUID CONTAINED IN THE TUBE WHILE REMOVING THE CONNECTIONS

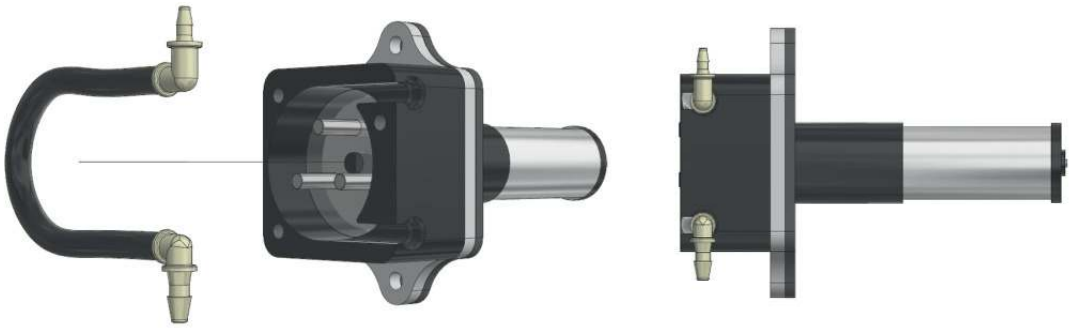
2. Remove the rollers and the tube to be replaced.



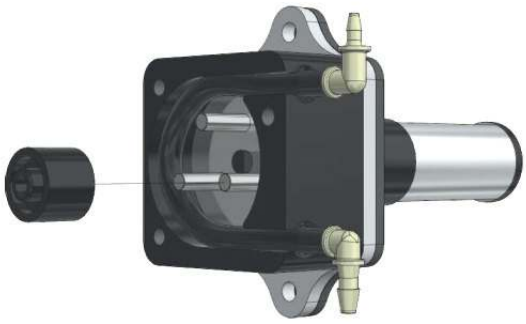
3. Disconnect the fittings and, if necessary, clean or replace them with those provided with the maintenance kit.

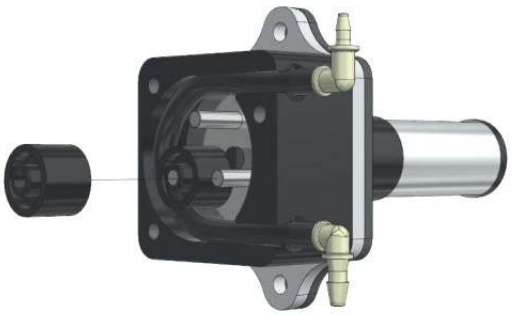


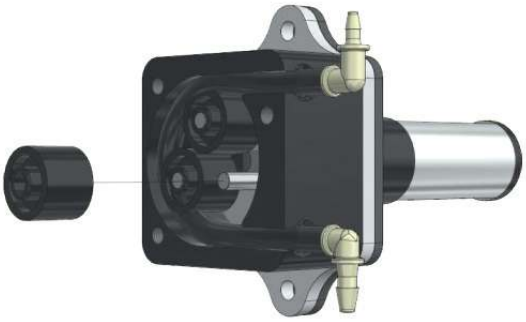
4. Insert the new tube using the fitting (pay attention to the size and direction)



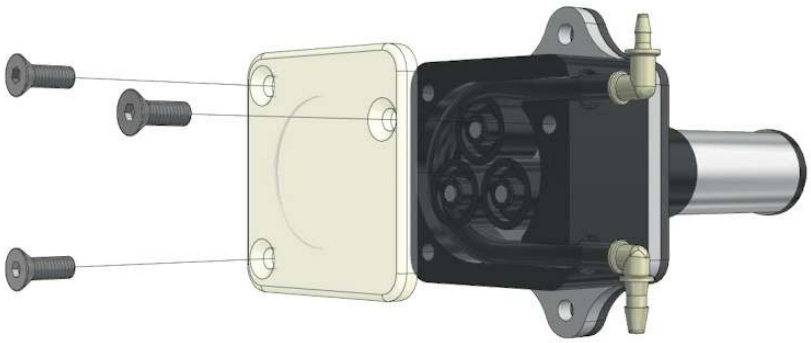
5. Insert the first roller, then operate the pump in manual mode for 1 second (COMMANDS > MANUAL CHECKS, see paragraph 6.4) and insert the second roller. Repeat the same operation for the third roller

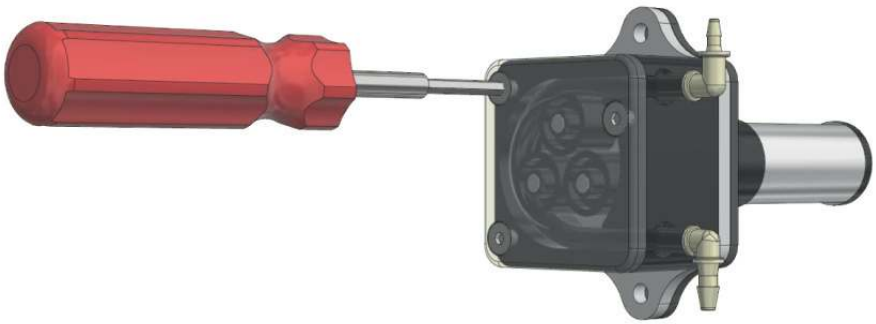




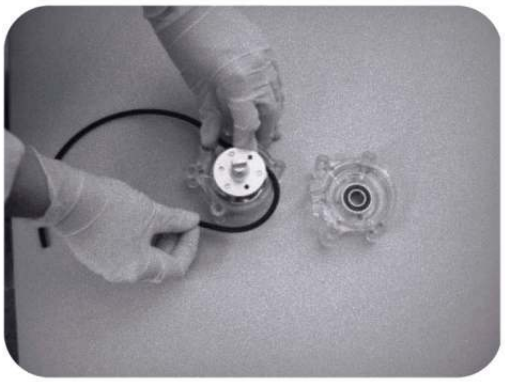


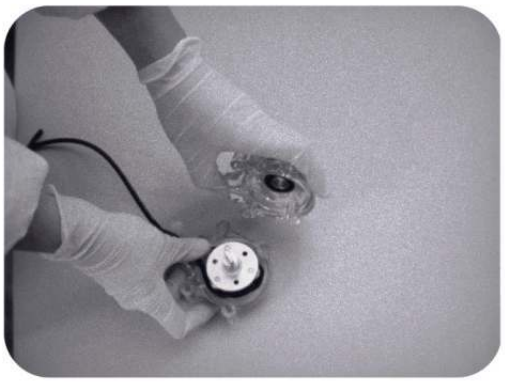
6. Close the transparent cover with the screws.
Reconnect the tubes and operate the pump in manual mode to fill the tube with the cleaning liquid coming from the bottle. Make sure that the liquid reaches the cell, this usually needs 45 seconds.





9.4 Replacing the sample pump tubing





- Stop the analyzer

- Remove the four screws holding the pump head

- Disconnect the pump tubing from its inlet and outlet fittings,
  taking extreme caution of liquid spills

- Remove the pump head

- Separate the two halves taking care of rotor and remove the used tubing taking caution for spills

- Clean the two halves and the rotor with towel paper if necessary

- Place the pump half containing the rotor in one hand and place the rollers in the 2, 6 and 10 o' clock positions. Place tubing in the outer port and against the two rollers as shown, keeping your thumb on the tubing to hold it in place, insert tubing key on the back of the rotor shaft and push in as far as possible. Tubing is now positioned deep into the pump head body. With the key firmly pressed against the rotor, turn counterclockwise and push down while turning until tubing has surrounded the rotor.

- The tubing is now in place. Remove key and position other pump half into the rotor shaft and snap shaft. Be careful not to pinch tubing between plastic pump halves.

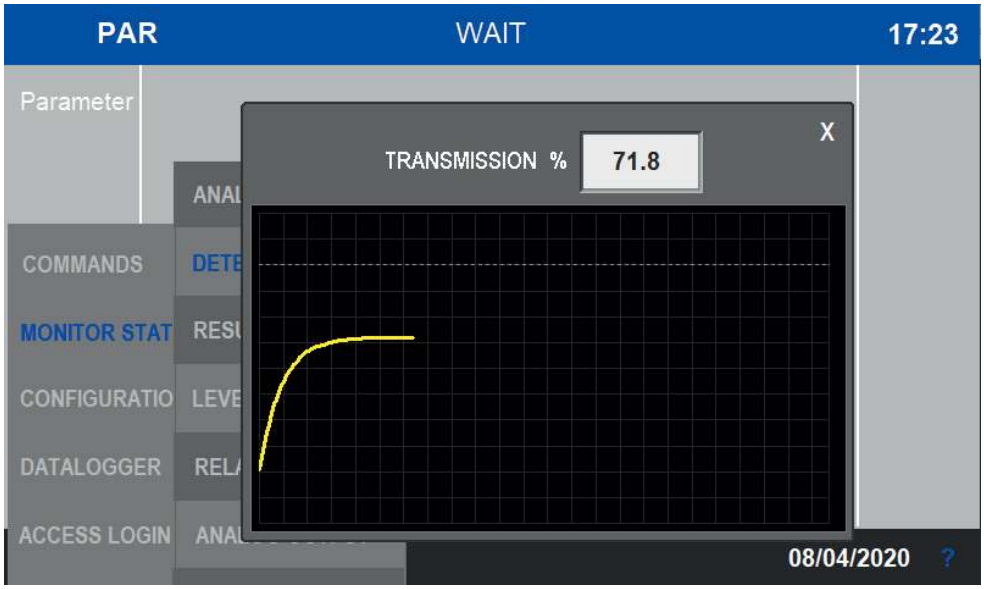
- Check if the pump turns correctly using the key - tightening with fingers the pump head slide it into the mounting screws moving the roller block with the key or with a screwdriver until the shaft aligns with the motor drive

- Put the pump head in place and secure it with the four screws

- Reconnect inlet and outlet to the analyzer tubings

9.5 Regulating the LED light source

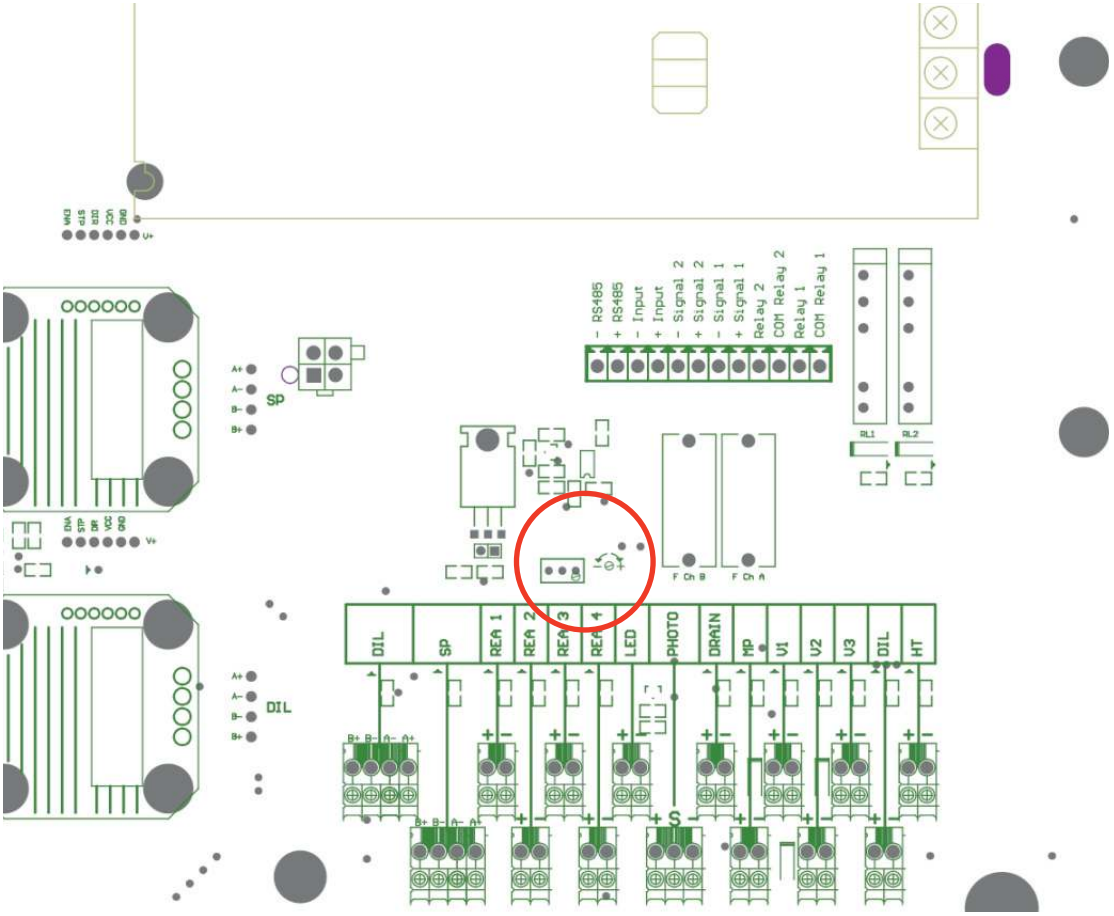
An LED is used as light source for the photometric determination of the absorbance. The intensity of the light source is already calibrated when the analyzer is tested before shipping.
If for some reason the light source is too strong or too low (as indicated by the photodiode reading) the user can recalibrate it easily.
First of all fill the measuring cell with pure water. To do so the user can use the manual function and activate the SAMPLE 1 operation until the cell is filled with water up to 3/4 of its height (the amount of seconds needed varies depending on the cell diameter).
In MONITOR STATUS > DETECTOR you can see the detector signal in real time (the door of the liquid enclosure must be closed!).



In the image you can see a transmission value of 71.8 %. The value is too low, the optimal value is at 100 % (+/- 10 %). In other cases the value of the photodiode reading can be above 100 %. A value of 120 % indicates a complete saturation of the detector response. In these cases the recalibration of the LED light source is required.
Open the electrical enclosure and remove the cover of the main PCB.

Only trained personnel must be allowed to access the electrical enclosure when the analyzer is powered on!

On the main PCB locate a blue multiturn potentiometer, as indicated in the figure below.

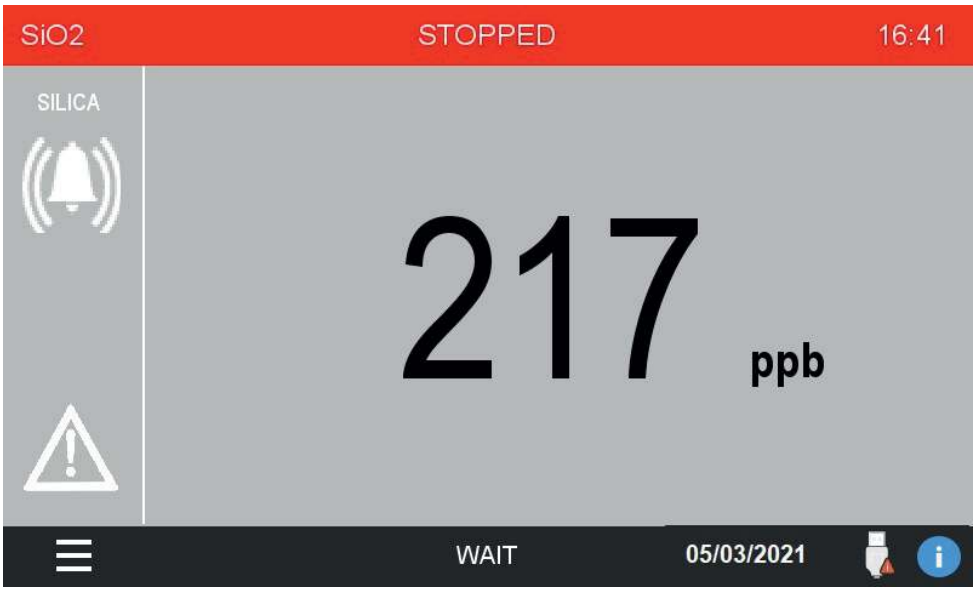


With the help of a thin screwdriver adjust the power of the LED light source until the detector reponse is around 100 %. The markings on the PCB silkscreen indicate the direction the potentiometer must be turned.
It is advisable to recalibrate the instrument afterwards.

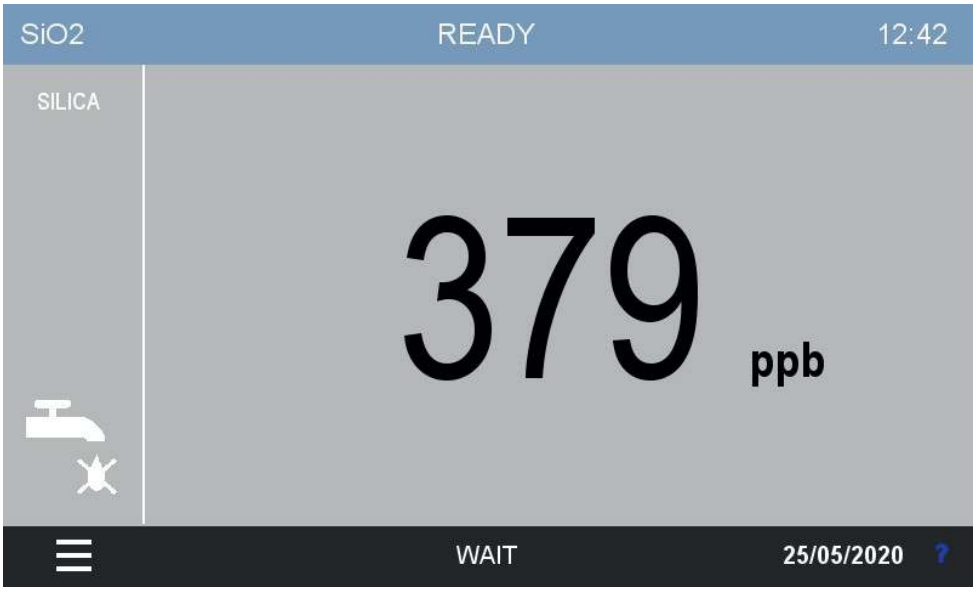
9.6 Alarms and troubleshooting

The analyzer warnings and faults are shown as icons on the main screen when the condition occurs. See section 5.8 for an example of warning and fault conditions. Additionally, the warning and fault messages are stored in the alarm datalogger (see 8.1). When the warning or the fault icons appear the user can check what is going on by opening the alarm datalogger. Alarms that are not active anymore are grayed out and the END column shows the when the error has been resolved. If this is not the case the error is still active and the operator has to intervene to resolve it. In section 6.6, under "Alarms" the user can configure which event is associated with a warning and which events are associated with a fault. A fault is an hard error that requires user intervention to be solved.

Warnings and faults are not mutually exclusive, here is an example of what you will see when a warning and a fault are present at the same time. The red top bar and the bell indicate a fault, the triangle indicates a warning.



A missing sample situation will be indicated by the following icon. The icon can be accompanied by a fault or warning event, as programmed in the alarm settings page.



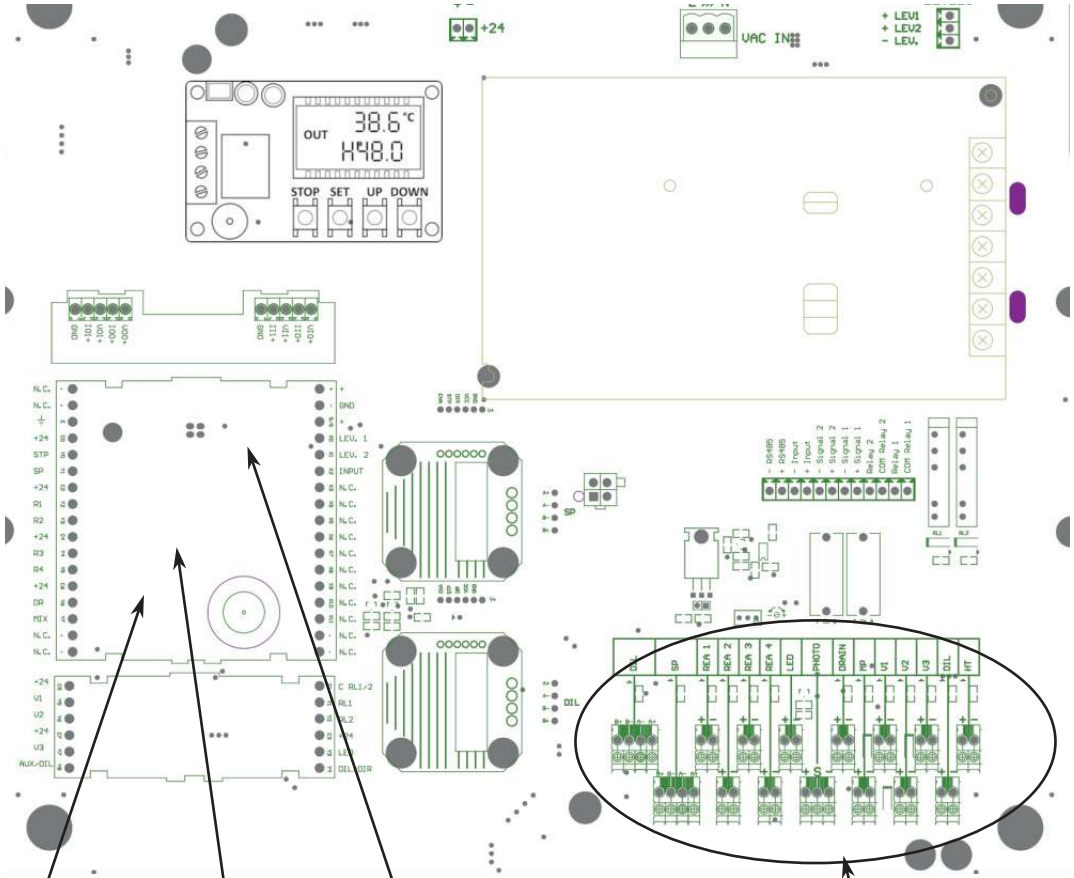
In the following table the user can find a possible solution for the events.

EVENT	CAUSE	SOLUTION
Loss of Sample A, B	The sample is missing	Check the sample line and the sample reservoir
Result Alarm A, B	The value of the result exceeded the preset threshold	User must take action to decrease the amount of analyte in the sample, if it's a cause of concerns
Reagent Low	The reagents level is below the given threshold	Replace the reagents
Calibration Alarm A, B	The calibration of the instrument fell outside of the given limits	Check wether the analyzer is in good working conditions, the cell is clean and the calibration solution is correctly grabbed by the instrument. Eventually check if your calibration solution is at the expected concentration and has been prepared correctly
Validation error	The validation of the instrument fell outside of the given limits	Check wether the analyzer is in good working conditions, the cell is clean and the validation solution is correctly grabbed by the instrument. Eventually check if your validation solution is at the expected concentration and has been prepared correctly
Initial transmission	The initial measurement of the transmitted light through the cell is too low	Check if the cell is correctly filled with sample at the beginning of the analysis. Check if the cell is clean. Check if something is obstructing the light beam through the cell. Check the optical components.
Stopped	The analyzer has been stopped manually	If there aren't other errors or reasons for the analyzer to be offline, you can restart the online operations.

9.7 Electronics checks

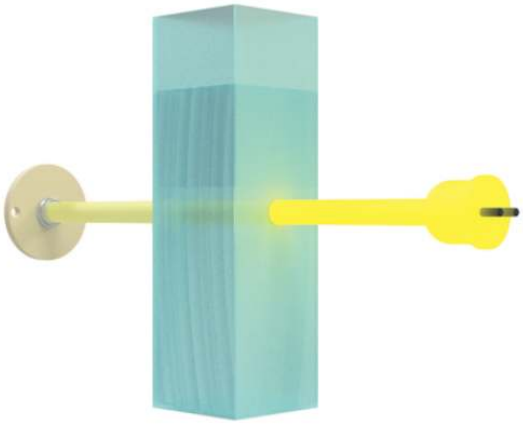
When the metal cover is open by removing the five fixing screws, it is possible to check a few indicator LEDs, as show below.
Note: the electronic board is equipped with internal battery that can last up to a year.
The instrument must be connected to a power supply once every year for 15 minutes in order to keep its programming.
3S Analyzers disclaims any kind of responsability about memory loss due to incorrect storage of the elettronic board.

After removing the cover, do not touch the device with your hands or tools without removing power! Perform only visual inspections while the power is on.



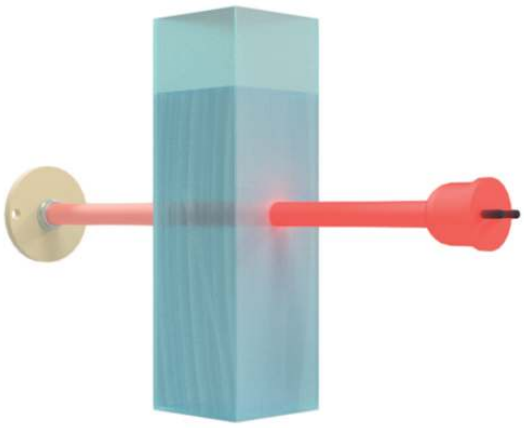
10 - PARAMETERS

10.1 Aluminum



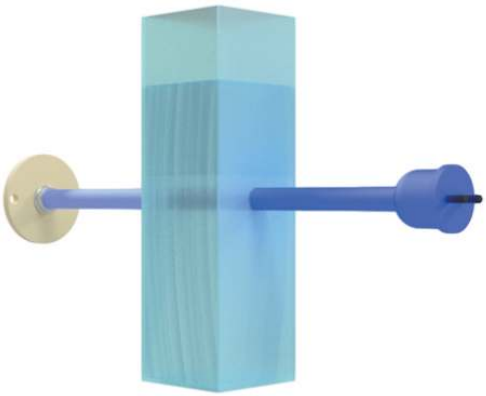
Measured parameter	Al^{3+}
Measuring principle	Differential photometric absorbance. In a pH 6.2 to 6.4 buffered solution pyrocatechol violet and Al(III) ions form a blue dye.
Measuring range	5 to 150 ppb with 26 mm cell 10 to 500 ppb with 16 mm cell up to 20 ppm with internal dilution
Measuring wavelength	572 nm
Reproducibility	± 5 ppb or ± 5%, whichever is greater (26 mm cell) ± 10 ppb or ± 5% up to 250 ppb; ± 20 ppb or ± 5% (250-500 ppb), whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1.7 L for the 16 mm cell 2.5 L for the 26 mm cell
Applications	• Drinking water • Industrial waste water • Municipal waste water • Surface water

10.2 Ammonium



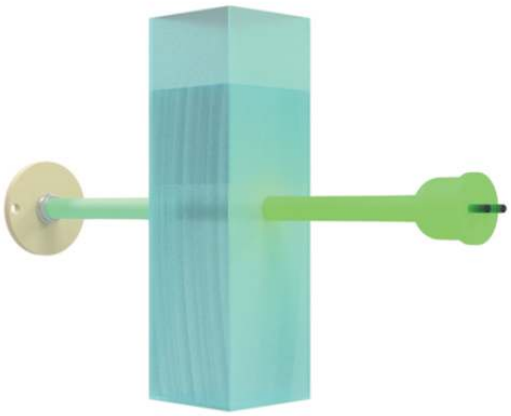
Measured parameter	NH_4^+
Measuring principle	Differential photometric absorbance. Multiple chemistries available (Berthelot, salycilate, indophenol, Nessler, ...)
Measuring range	1 to 500 ppb (26 mm cell) 5 to 1000 ppb (16 mm cell) with low range chemistry 0.2 to 20 ppm (16 mm cell) with high range chemistry up to 500 mg/L with internal dilution
Measuring wavelength	660 nm
Reproducibility	Up to 1000 ppb: ± 5 ppb or ± 5%, whichever is greater ≥ 1 ppm to 500 ppm: better than ± 2% full scale range
Cell type	Heated cell, 26 mm/16 mm Regulated heating (optional): 50 °C
Analysis period	18-20 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (25 minutes analysis frequency)	1 L with 16 mm cell 2 L with 26 mm cell
Applications	• Boiler feed • Cooling water • Drinking water • Surface water • Municipal wastewater • Industrial wastewater

10.3 Chlorides



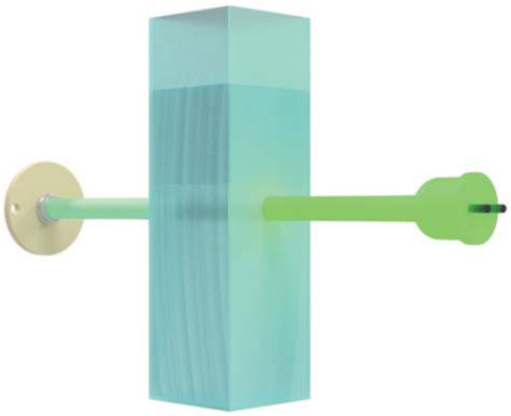
Measured parameter	Cl^-
Measuring principle	Differential photometric absorbance, mercury thiocyanate method
Measuring range	0.2 to 50 ppm for the 26 mm cell, 0.5 to 100 ppm for the 16 mm cell; up to 5000 ppm with internal dilution
Measuring wavelength	470 nm
Reproducibility	Up to 20 ppm: ± 0.3 ppm or ± 5%, whichever is greater ≥ 20 up to 50 ppm: ± 0.5 ppm or ± 5%, whichever is greater (26 mm cell) ± 1 ppm or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6-8 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (25 minutes analysis frequency)	1 L with 16 mm cell 2 L with 26 mm cell
Applications	• Boiler feed • Cooling water • Drinking water • Industrial waste water • Surface water

10.4 Chlorine, total and free, monochloramine



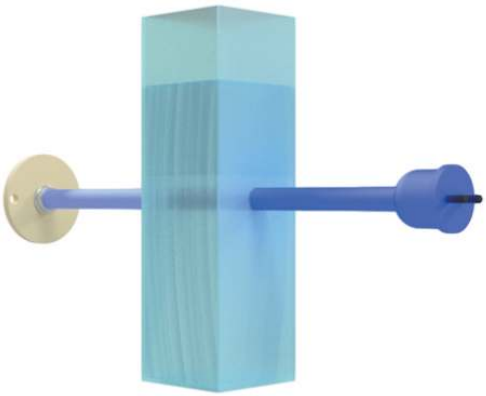
Measured parameter	Cl_2, chlorine total and free, monochloramine
Measuring principle	Differential photometric absorbance. DPD colorimetric (US EPA 4500-CI G and ISO 7393-2 accepted method)
Measuring range	0.01 to 2 ppm for the 26 mm cell 0.02 to 5 ppm for the 16 mm cell up to 200 ppm with internal dilution.n
Measuring wavelength	525 nm
Reproducibility	Up to 1 ppm: ± 0.01 ppm or ± 3%, whichever is greater ≥ 1 ppm to 2 ppm: ± 0.02 ppb or ± 3%, whichever is greater (26 mm cell) up to 5 ppm: ± 0.05 ppm or ± 3%, whichever is greater (16 mm cell).
Cell type	Heated cell, 26 mm/16 mm
Analysis period	3 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (25 minutes analysis frequency)	1 L with 16 mm cell 2 L with 26 mm cell
Applications	• Drinking water • Municipal wastewater • Industrial wastewater • Food and beverage • Power and semiconductor • Reverse osmosis (RO) process

10.5 Chromium



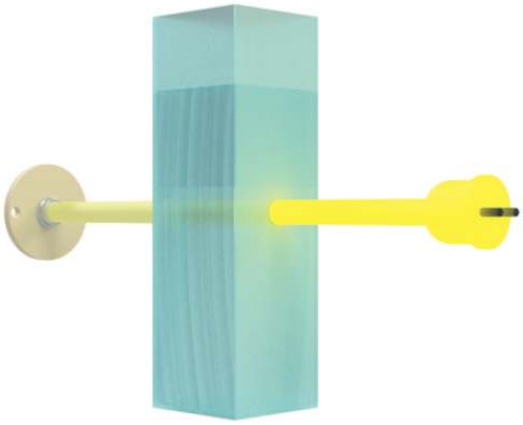
Measured parameter	Cr(III), Cr(VI), total
Measuring principle	Differential photometric absorbance. 1,5-diphenylcarbazide (DPC)
Measuring range	0.5 to 300 ppb for the 26 mm cell 0.01 to 1 ppmfor the 16 mm cell up to 50 ppm with internal dilution
Measuring wavelength	525 nm
Reproducibility	Up to 50 ppb: ± 1 ppb or ± 5%, whichever is greater ≥ 50 ppb to 300 ppb: ± 2 ppb ± 5%, whichever is greater (26 mm cell) ≥ 300 ppb: ± 5 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6-8 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	0.7 L for the 16 mm cell 1 L for the 26 mm cell
Applications	• Drinking water • Industrial wastewate • Surface water

10.6 Copper



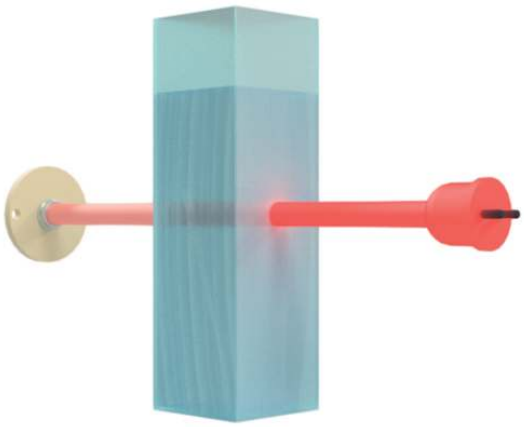
Measured parameter	Cu^{+} / Cu^{2+}
Measuring principle	Differential photometric absorbance. Bathocuproine Method
Measuring range	0.05 to 1 mg/L (26 mm cell) 0,1 to 3 mg/L (16 mm cell) up to 150 mg/L with internal dilution.
Measuring wavelength	470 nm
Reproducibility	± 20 ppb or ± 5%, whichever is greater (26 mm cell) ± 50 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1 L R1, R2 and 2 L R3 for the 16 mm cell 2 L R1, R2 and 4 L R3 for the 26 mm cell
Applications	• Wastewater • Process water • Industrial sewage treatment plants • Ultrapure water treatment

10.7 Cyanides



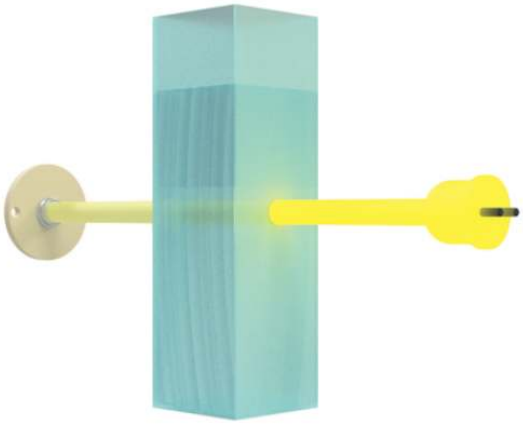
Measured parameter	CN^- cyanide, free
Measuring principle	Differential photometric absorbance
Measuring range	2 to 100 ppb for the 26 mm cell, 10 to 200 ppb for the 16 mm cell; up to 15 ppm with internal dilution
Measuring wavelength	572 nm
Reproducibility	± 4 ppb or ± 5%, whichever is greater (26 mm cell) ± 10 ppb or ± 5%, whichever is greater (16 mm cell).
Cell type	Heated cell, 26 mm/16 mm
Analysis period	15-18 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1.7 L for the 16 mm cell 2.5 L for the 26 mm cell
Applications	• Drinking water • Industrial waste water • Municipal waste water • Surface water

10.8 Formaldehyde



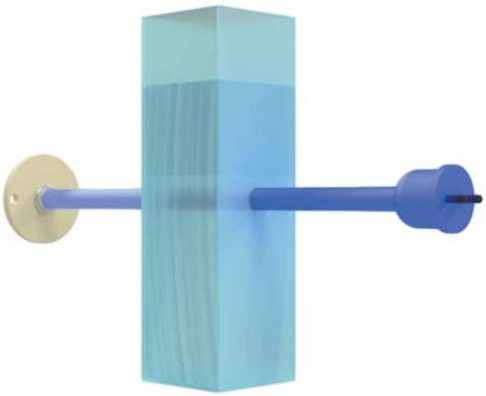
Measured parameter	Formaldehyde, CH_2O
Measuring principle	Differential photometric absorbance, MBTH method
Measuring range	0 to 2 ppm for the 16 mm cell
Measuring wavelength	660 nm
Reproducibility	± 5%, with standard test solutions (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	15 minutes, including conditioning before analysis cycle and rinsing after measuring.
Applications	• Paper and wood industry • Textile • Productions of resins and adhesives • Chemical industry

10.9 Hardness



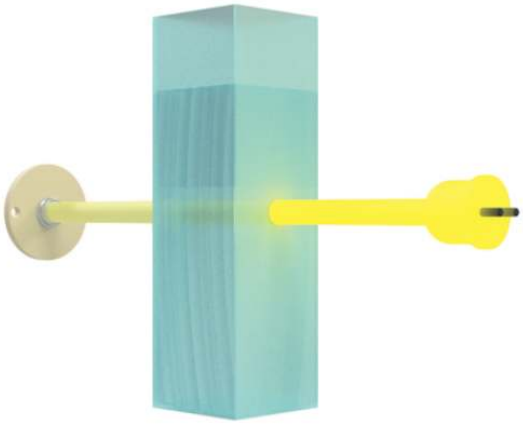
Measured parameter	Hardness as $CaCO_3$
Measuring principle	Differential photometric absorbance. O-cresolphthalein complexone method.
Measuring range	0-500 ppb (26 mm cell) 0-1000 ppb (16 mm cell) up to 50 ppm with internal dilution
Measuring wavelength	572 nm
Reproducibility	± 5 ppb or ± 5%, whichever is greater (26 mm cell) ± 10 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1.7 L for the 16 mm cell 2.5 L for the 26 mm cell
Applications	• Power plants • Cooling water • Water steam cycle • Boiler feedwater • Reversed osmosis • Ion exchangers • Ultrapure water • Drinking water

10.10 Hydrazine



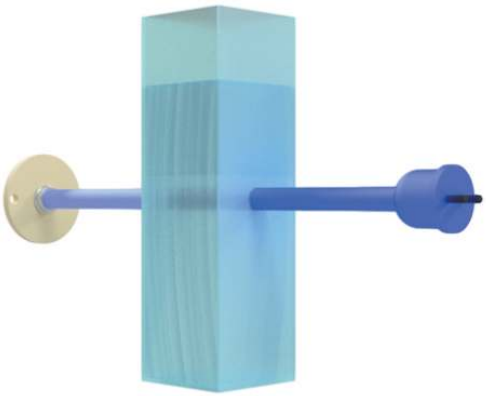
Measured parameter	N_2H_4
Measuring principle	Differential photometric absorbance
Measuring range	0-500 ppb
Measuring wavelength	470 nm
Reproducibility	± 1 ppb or ± 3%, whichever is greater
Cell type	Heated cell, 26 mm/16 mm
Analysis period	10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Applications	• Power plants • Cooling water • Water steam cycle • Boiler feedwater • Control and optimization of oxygen scavenger systems

10.11 Iron (ferrozine method)



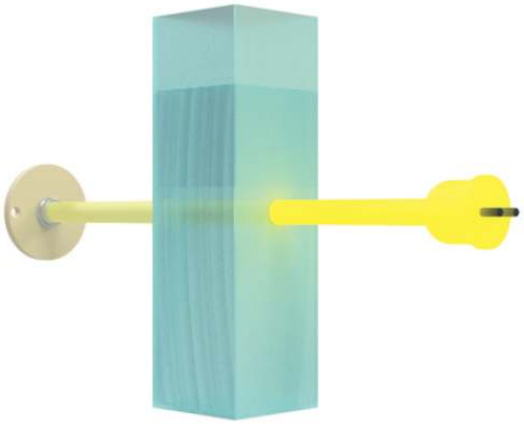
Measured parameter	Fe^{2+}, Fe^{3+}
Measuring principle	Differential photometric absorbance, ferrozine method
Measuring range	2 to 250 ppb (26 mm cell) 9 to 1000 ppb (16 mm cell) up to 20 mg/L with internal dilution.
Measuring wavelength	572 nm
Reproducibility	± 1 ppb or ± 5%, whichever is greater (26 mm cell) ± 5 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	2.5 L for the 16 mm cell 5 L for the 26 mm cell
Applications	• Drinking water • Iron removal and residual coagulant monitoring • Industrial wastewater • Measurement of effluents and wastewaters • Boiler feed water • Corrosion control • Cooling water • Surface water

10.12 Iron (phenantroline method)



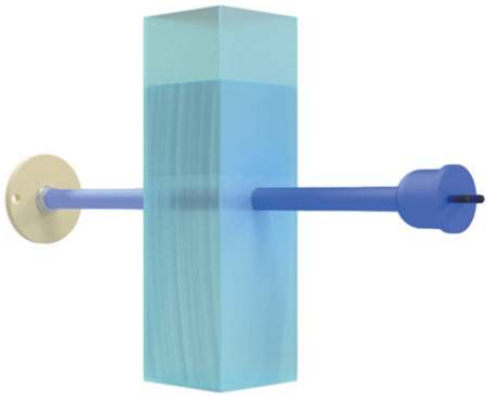
Measured parameter	Fe^{2+}, Fe^{3+}
Measuring principle	Differential photometric absorbance, phenantroline method
Measuring range	0.02 to 3 ppm (26 mm cell) 0.05 to 7 ppm (16 mm cell) up to 200 mg/L with internal dilution.
Measuring wavelength	430 nm
Reproducibility	± 0.02 ppm or ± 5%, whichever is greater (26 mm cell) ± 0.05 ppm or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1 L R1 / 2 L R2 for the 16 mm cell 2 L R1/ 4 L R2 for the 26 mm cell
Applications	• Drinking water • Iron removal and residual coagulant monitoring • Industrial wastewater • Measurement of effluents and wastewaters • Boiler feed water • Corrosion control • Cooling water • Surface water

10.13 Manganese PAN



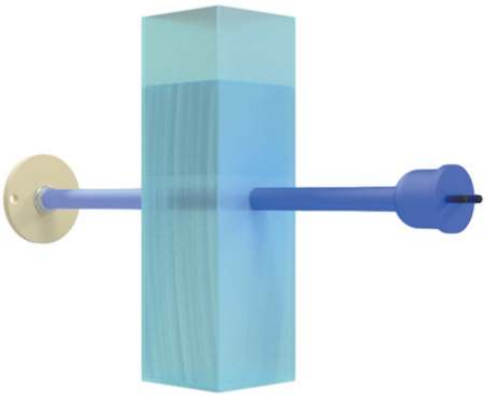
Measured parameter	Mn^{2+}
Measuring principle	Differential photometric absorbance, PAN mehod
Measuring range	1 to 200 ppb Mn2+ for the 26 mm cell, 5 to 1000 ppb Mn2+ for the 16 mm cell; up to 50 ppm Mn2+ with internal dilu on.
Measuring wavelength	572 nm
Reproducibility	± 3 ppb or ± 5%, whichever is greater (26 mm cell) ± 10 ppb or ± 5%, whichever is greater (16 mm cell
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8 - 10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (18 minutes analysis frequency)	less than 2 L
Applications	• Drinking water • Industrial waste water • Municipal waste water

10.14 Manganese LMG



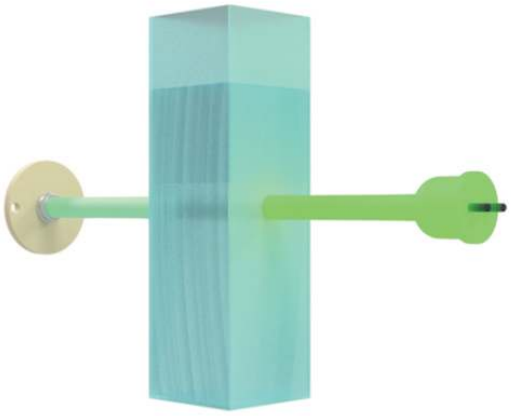
Measured parameter	Mn^{2+}
Measuring principle	Differential photometric absorbance, LMG mehod
Measuring range	1 to 100 for the 16 mm cell, up to 5 ppm with internal dilution
Measuring wavelength	430 nm
Reproducibility	± 1 ppb or ± 9%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	18 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (18 minutes analysis frequency)	less than 2 L
Applications	• Drinking water • Industrial waste water • Municipal waste water

10.15 Nickel



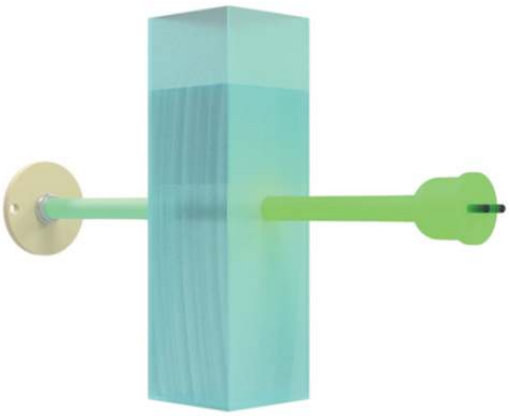
Measured parameter	Ni^{2+}
Measuring principle	Differential photometric absorbance, dimethylglyoxime method
Measuring range	0.01 to 3 ppm (26 mm cell) 0.02 to 6 ppm (16 mm cell) up to 200 mg/L with internal dilution.
Measuring wavelength	470 nm
Reproducibility	± 10 ppb or ± 5%, whichever is greater (26 mm cell) ± 30 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1 L for the 16 mm cell 2 L for the 26 mm cell
Applications	• Wastewater • Process water •Industrial sewage treatment plants •Boiler feed and cooling water •Automotive

10.16 Nitrate



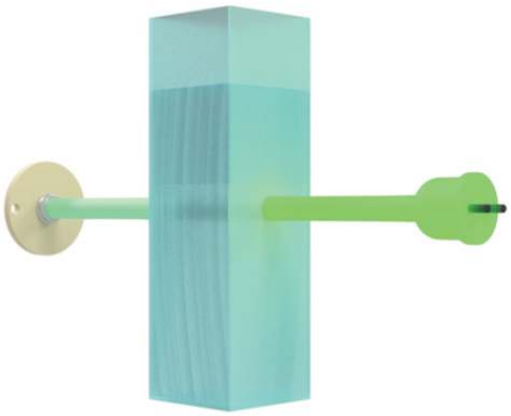
Measured parameter	NO_3^- / $N\text{-}NO_3^-$
Measuring principle	Differential photometric absorbance.
Measuring range	4 - 650 ppb $N\text{-}NO_3$ (2.08 ppm NO_3, 16 mm cell) 2 - 400 ppb $N\text{-}NO_3$ (1.28 ppm NO_3, 26 mm cell) Up to 25 ppm $N\text{-}NO_3$ (80 ppm NO_3) with internal dilution
Measuring wavelength	525 nm
Reproducibility	± 2 ppb or ± 5% whichever is greater (26 mm cell, without dilution) ± 5 ppb or ± 5% whichever is greater (16mm cell, without dilution)
Cell type	Heated cell, 26 mm/16 mm Regulated heating (optional): 37 °C
Analysis period	13 - 14 minutes, including conditioning before analysis cycle and rinsing after measuring.
Applications	• Drinking water • Process optimisation of wastewater treatment plants • Industrial and municipal wastewater • Mineral water monitoring • Surface water

10.17 Nitrite



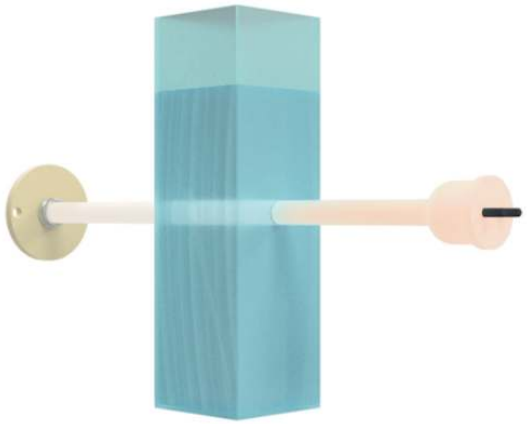
Measured parameter	NO_2 / N-NO_2
Measuring principle	Differential photometric absorbance. Diazotization method.
Measuring range	5 to 500 ppb N-NO_2 (1.6 ppm NO_2) for 26 mm cell 0.02 to 1 ppm N-NO_2 / (3.2 ppm NO_2) for 16 mm cell up to 40 ppm N-NO_2 / 125 ppm NO_2 with dilution
Measuring wavelength	525 nm
Reproducibility	± 5 ppb or ± 5%, whichever is greater up to 150 ppb; ≥ 150 ppb to 600 ppb: ± 10 ppb (26 mm cell) ≥ 600 µg/l: ± 20 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6-8 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1 L for the 16 mm cell 2 L for the 26 mm cell
Applications	• Drinking water • Process optimisation of wastewater treatment plants • Industrial and municipal wastewater • Mineral water monitoring • Surface water

10.18 Phenol



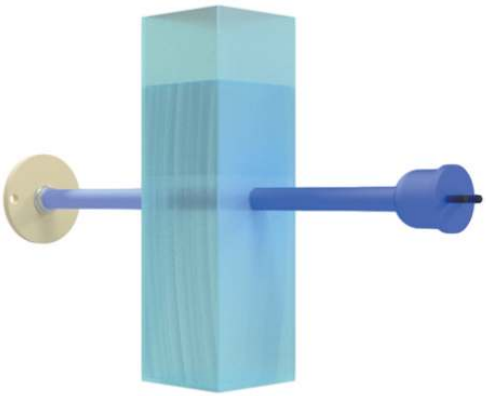
Measured parameter	Phenol
Measuring principle	Differential photometric absorbance. 4-amino-antipyrine method.
Measuring range	5 to 1000 ppb Phenol for the 26 mm cell, 0.1 to 5 ppm Phenol for the 16 mm cell; up to 250 ppm Phenol with internal dilution
Measuring wavelength	525 nm
Reproducibility	± 20 ppb or ± 5%, whichever is greater (26 mm cell) ± 50 ppb or ± 5%, whichever is greater (16 mm cell).
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1 L for the 16 mm cell 2 L for the 26 mm cell
Applications	Industrial wastewater – where the presence of phenolic compounds in the industrial waste water adversely affects aquatic and human life directly or indirectly when discharged into public waterways, water sources or surface water.

10.19 Phosphate (blue method)



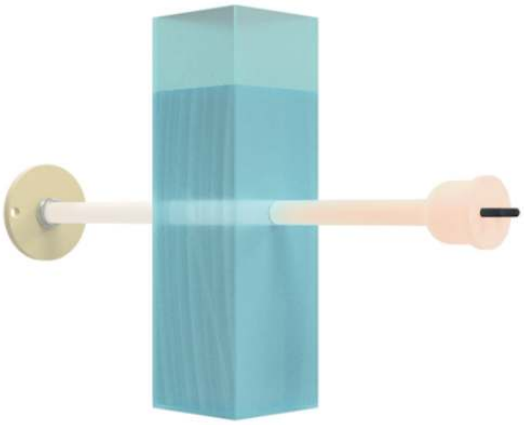
Measured parameter	PO_4^{3-} / P-PO_4^{3-}
Measuring principle	Differential photometric absorbance. Molybdate reacts in acid medium with orthophosphate to form phosphomolybdic acid, which is then reduced to intensely colored molybdenum blue.
Measuring range	0.01 to 4 ppm P-PO_4^{3-} (12.5 ppm PO_4^{3-}) for 26 mm cell 0.05 to 10 ppm P-PO_4^{3-} (30 ppm PO_4^{3-}) for 16 mm cell up to 400 ppm P-PO_4^{3-} (1200 ppm PO_4^{3-}) with internal dilution.
Measuring wavelength	850 nm
Reproducibility	± 5 ppb or ± 5%, whichever is greater (26 mm cell) ± 10 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	2.5 L for the 16 mm cell 5 L for the 26 mm cell
Applications	• Power Utility • Cooling water • Drinking water • Boiler feedwater • Industrial and municipal wastewater • Surface water

10.20 Phosphate (yellow method)



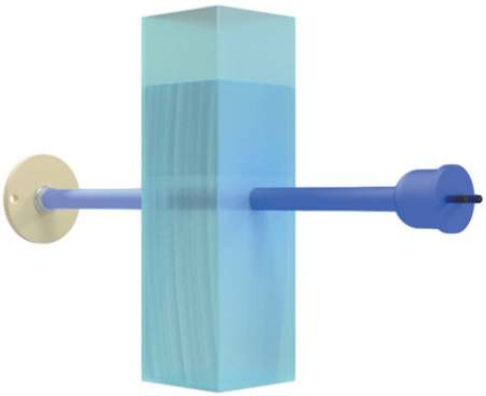
Measured parameter	PO_4^{3-} / P-PO_4^{3-}
Measuring principle	Differential photometric absorbance. Sodium molybdate and ammonium *meta*-vanadate in an acid medium, react with the orthophosphate to form a yellow coloured phospho-vanado-molybdate compound
Measuring range	0.05 to 10 ppm P-PO_4^{3-} (30 ppm PO_4^{3-}) 26 mm cell 0.1 to 16 ppm P-PO_4^{3-} (50 ppm PO_4^{3-}) 16 mm cell up to 640 ppm P-PO_4^{3-} (2000 ppm PO_4^{3-}) with internal dilution
Measuring wavelength	430 nm
Reproducibility	± 200 ppb or ± 5%, whichever is greater (26 mm cell) ± 500 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	2.5 L for the 16 mm cell 5 L for the 26 mm cell
Applications	• Power Utility • Cooling water • Drinking water • Boiler feedwater • Industrial and municipal wastewater • Surface water

10.21 Silica



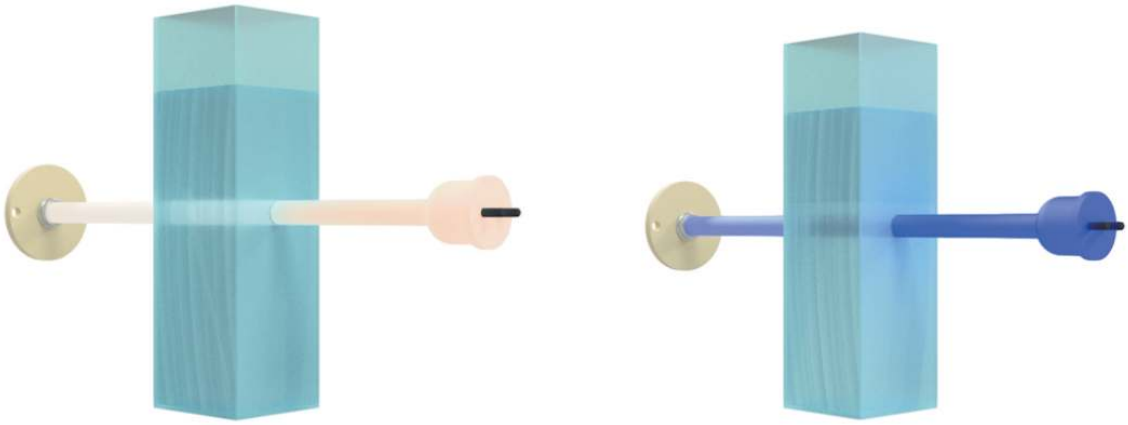
Measured parameter	SiO_2
Measuring principle	Differential photometric absorbance. Soluble silica reacts with the molybdate ion in an acid medium to form a green-yellow colored silico-molybdic acid complex that in its turn is converted to a blue complex
Measuring range	0.5 to 1000 ppb (26 mm cell) 1 to 5000 ppb (16 mm cell) up to 150 mg/L with internal dilution
Measuring wavelength	850 nm
Reproducibility	± 0.5 ppb or ± 5%, whichever is greater (26 mm cell) ± 1 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	8-10 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	2.5 L for the 16 mm cell 5 L for the 26 mm cell
Applications	• Ultrapure water treatment • Cooling water • Water steam cycle • Condensate analysis • High-pressure boiler feedwater • Reversed osmosis • Turbine protection • Demineralization plants

10.22 Sulphate



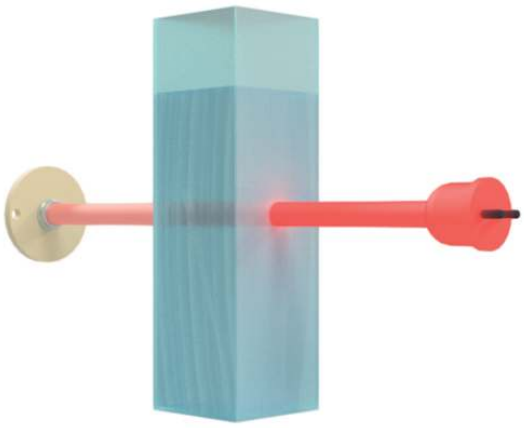
Measured parameter	SO_4^{2-}
Measuring principle	The analyzer uses an adaptation of the turbidimetric method to measure Sulfate. The Sulfate is precipitated as barium sulfate with an excess of barium chloride. A conditioning reagent is added to maintain the barium Sulfate suspension. When the reagent is added to a sample containing Sulfate, it will cause turbidity in the sample.
Measuring range	0.5 to 50 ppm SO_4^{2-} for the 26 mm cell 1 to 200 ppm SO_4^{2-} for the 16 mm cell up to 8000 ppm SO_4^{2-} with internal dilution
Measuring wavelength	430 nm
Reproducibility	± 0.5 ppm or ± 5%, whichever is greater (26 mm cell) ± 1 ppm or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6 - 8 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	2 L for the 16 mm cell 3 L for the 26 mm cell
Applications	• Drinking water • Waste water • Raw water • Process control

10.23 Total Phosphorus



Measured parameter	TP
Measuring principle	Photochemical oxidation and blue or yellow colorimetric method
Measuring range	0 - 2 mg/L TP , 0 - 5 mg/L TP 0 - 10 mg/L TP , 0 - 20 mg/L TP Higher ranges available using external dilution
Measuring wavelength	430 nm or 850 nm
Reproducibility	Better than ± 2% of full scale for standard test solutions
Cell type	Heated cell, 26 mm/16 mm
Analysis period	30 minutes, including conditioning before analysis cycle, oxidation and rinsing after measuring. Oxidation time is settable by the user.
Monthly reagent consumption (15 minutes analysis frequency)	1 L
Applications	• Wastewater treatment plant • Industrial applications • Surface water monitoring • Process control

10.24 Zinc



Measured parameter	Zn^{2+}
Measuring principle	Differential photometric absorbance. Zinc reacts with the reagent zincon in a buffered alkaline solution to form a blue complex.
Measuring range	0.01 to 1 ppm Zn^{2+} for the 26 mm cell 0.02 to 2.5 ppm Zn^{2+} for the 16 mm cell up to 125 ppm Zn^{2+} with internal dilution
Measuring wavelength	660 nm
Reproducibility	± 10 ppb or ± 5%, whichever is greater (26 mm cell) ± 20 ppb or ± 5%, whichever is greater (16 mm cell)
Cell type	Heated cell, 26 mm/16 mm
Analysis period	6 - 8 minutes, including conditioning before analysis cycle and rinsing after measuring.
Monthly reagent consumption (15 minutes analysis frequency)	1.1 L for the 16 mm cell 2 L for the 26 mm cell
Applications	• Drinking water • Industrial waste water • Effluent water • Surface water • Boilers and cooling towers