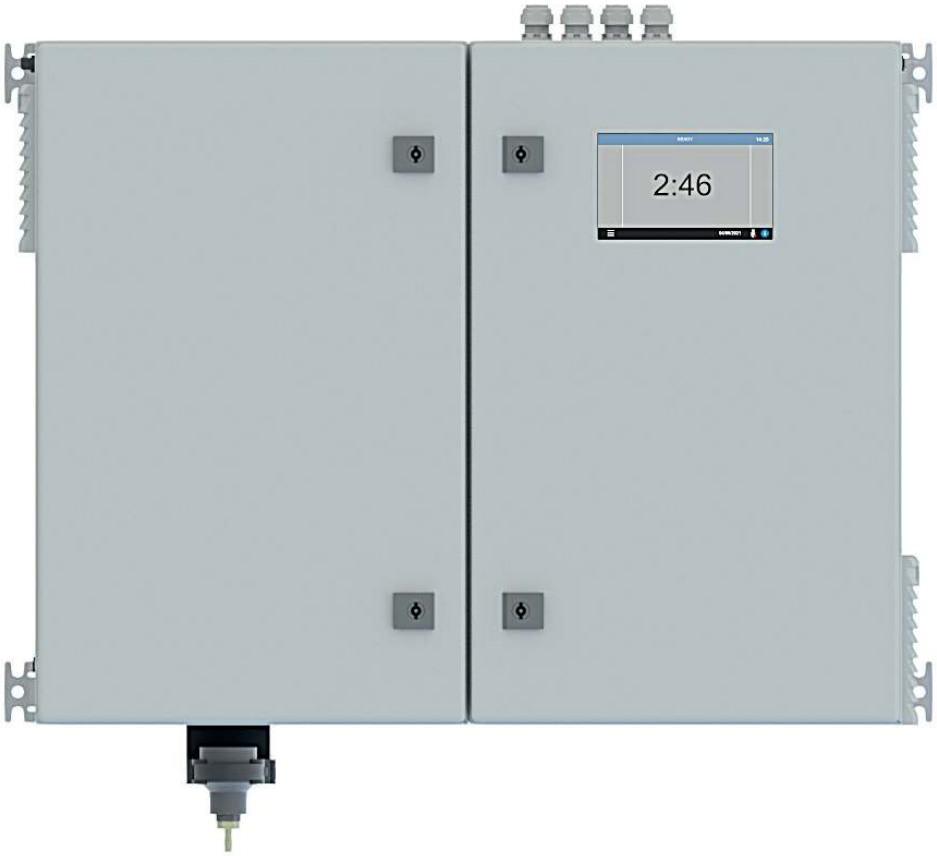
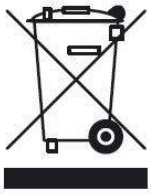
# USER MANUAL




## 3S-DI

## Digester for total phosphorus analysis

3S Analyzers S.r.l. Italy www.3s-analyzers.eu November 2023



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

## 1.1 Warnings and safety information

Before installing and operating the analyzer, read this manual thoroughly. Please pay particular attention to all the labels applied to the analyzer 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 analyzer can carry out service activities on the equipment.

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This symbol indicates the existence of a risk of electric shock and/or electrocution. Only operators qualified for these activities can perform maintenance and control operations on the equipment bearing this label, always after unplugging it.

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This symbol is used to present an hazard of ultraviolet radiation. It is absolutely necessary to wear eyes protection to operate with the UV lamp labelled with this symbol. Never look directly at a lighted UV lamp. UV radiation exposure can cause severe and permanent damage skin and eyes. The UV lamp must not be removed from its housing while the device is operated.

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

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 analyzer 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 analyzer 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 analyzer.
All the components of the analyzer are placed within a panel closed by a door with a special key, supplied only to maintenance operators.
The analyzer must, then, be used under operating conditions with both lower and upper doors closed.

# 2 - GENERAL INFORMATION

## 2.1 Technical Specifications

| | |
|---|---|
| Working principle | Oxydation of phosphorus compounds in the sample to phosphate via the UV/persulfate method |
| Operating frequency | Batches with freely settable frequency |
| Power Supply | 110-230 VAC, 50/60 Hz, 80 VA |
| Temperature | 5 - 50 °C (41 - 122 °F) |
| Humidity | Max 85% RH |
| Case | Painted steel. |
| Protection Grade | IP54 (indoor only) |
| Mounting | Wall mount (standard) or panel (optional). |
| Dimensions | 604 x 380 x 210 mm (23.6 x 14.8 x 8.2 in) |
| Weight | Approx. 30 Kg (66 lbs) |
| Output signals | Relay to signal digestion completed |

## 2.2 Instrument description

This module is an accessory for the 3S colorimetric phosphate analyzer. It allows analysis of all forms of phosphorus through complete digestion of the sample. Digestion takes place inside the reactor of the instrument where the sample is mixed with acid/persulfate and treated with heat and UV radiation. The sample thus processed can be directly analyzed using the 3S colorimeter analyzer for phosphate ion (blue or yellow method). The module also allows dilution of the sample thus extending the maximum range of the 3S phosphorus analyzer.

## 2.3 Application

Phosphorus can be found in different forms, ortho, poly, and included in organics. Further classification can be made if phosphorus is found dissolved or suspended (filtering with 0.45 micron filter). In total phosphorus analysis, polyphosphates and organic phosphorus are converted to orthophosphate. Organic phosphorus is converted to orthophosphate by oxidation with UV/persulfate; polyphosphates are converted by digestion with sulfuric acid. Then all forms are converted to orthophosphate after treatment with acid and persulfate and analyzed as such.

The instrument can be used for the analysis of total phosphorus in those samples that contain it in forms other than the phosphate ion (phosphines, phosphites, organic derivatives) or when it is present in oligomeric forms (polyphosphates).

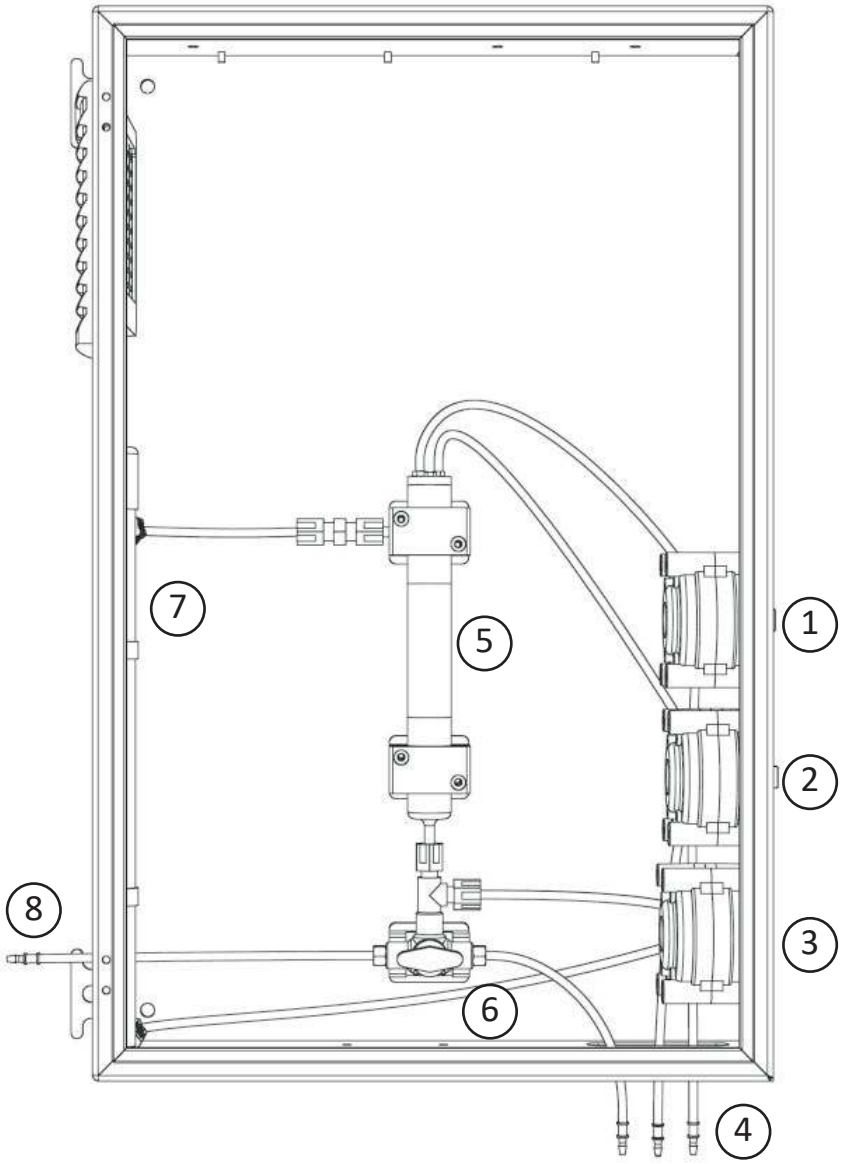
The instrument is also suitable in conjunction with other colorimetric techniques where it is necessary to convert the analyte to the highest oxidation states or to remove the organic matrix.

## 2.4 Instrument components

All electronic components are located inside the case in which provides protection from conditions usually found in industrial facilities such as moisture and dust.

Inside the left compartment of the instrument can be found the motherboard that connects the power supply, microprocessor, and peripherals. A series of terminals provide the user with input and output connections. The user interface is provided by a touchscreen display installed on the front panel. A basic knowledge of the user interface is required to operate and configure the instrument.

Inside the right side of the instrument can be found the hydraulic components that enable the instrument to operate on the sample. A list of the installed components and their locations can be found on the following page.




| | |
|---|---|
| 1 | Sample peristaltic pump |
| 2 | Reagent peristaltic pump |
| 3 | Digestion peristaltic pump |
| 4 | Drain and sample/reagent intakes |
| 5 | Heated reactor |
| 6 | Manual valve |
| 7 | UV lamp |
| 8 | To the analyzer |

# 3 - INSTALLATION

## 3.1 Opening the package

Caution:
please take all the precautions required for handling and lifting the box containing the analyzer. Its weight is about 30 kg (66 lbs).

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 other than this user manual.

| | |
|---|---|
| A | Digester for total phosphorus analysis |
| B | Startup kit |
| C | Tank for digester reagent |

The startup kit contains:

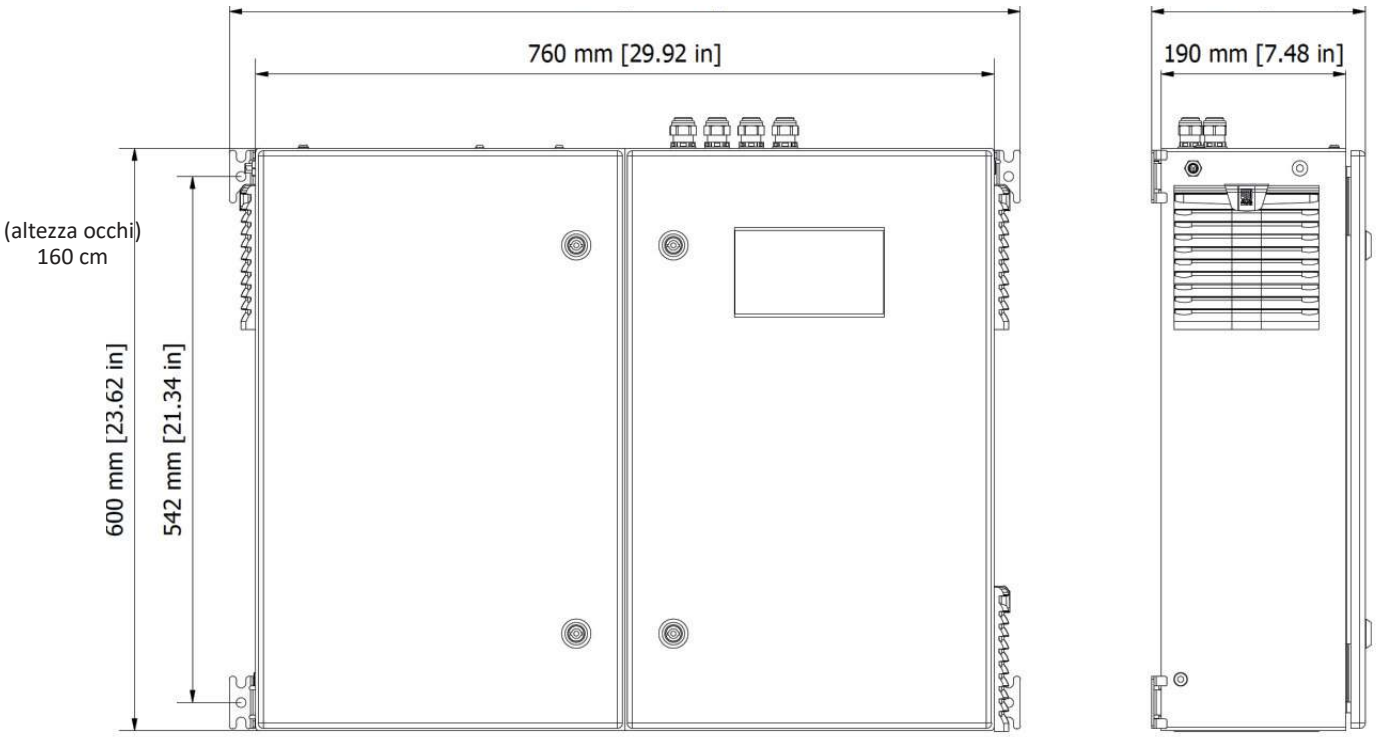
| |
|---|
| Norprene tubing size 1/4 " OD for sample (1 m) |
| Norprene tubing size 1/4 " OD for analyzer connection (0.4 m) |
| Norprene tubing size 1/8" OD with 30 cm straw for reagents |
| Silicone tubing 2 m for drain connection |
| Key for the instrument's door |

## 3.2 Product code

The product code is an alphanumeric code that identifies your 3S Analyzer product and its configuration. The code for the instrument described in this manual is:

A46DIGUN00

## 3.3 Wall mounting dimensions



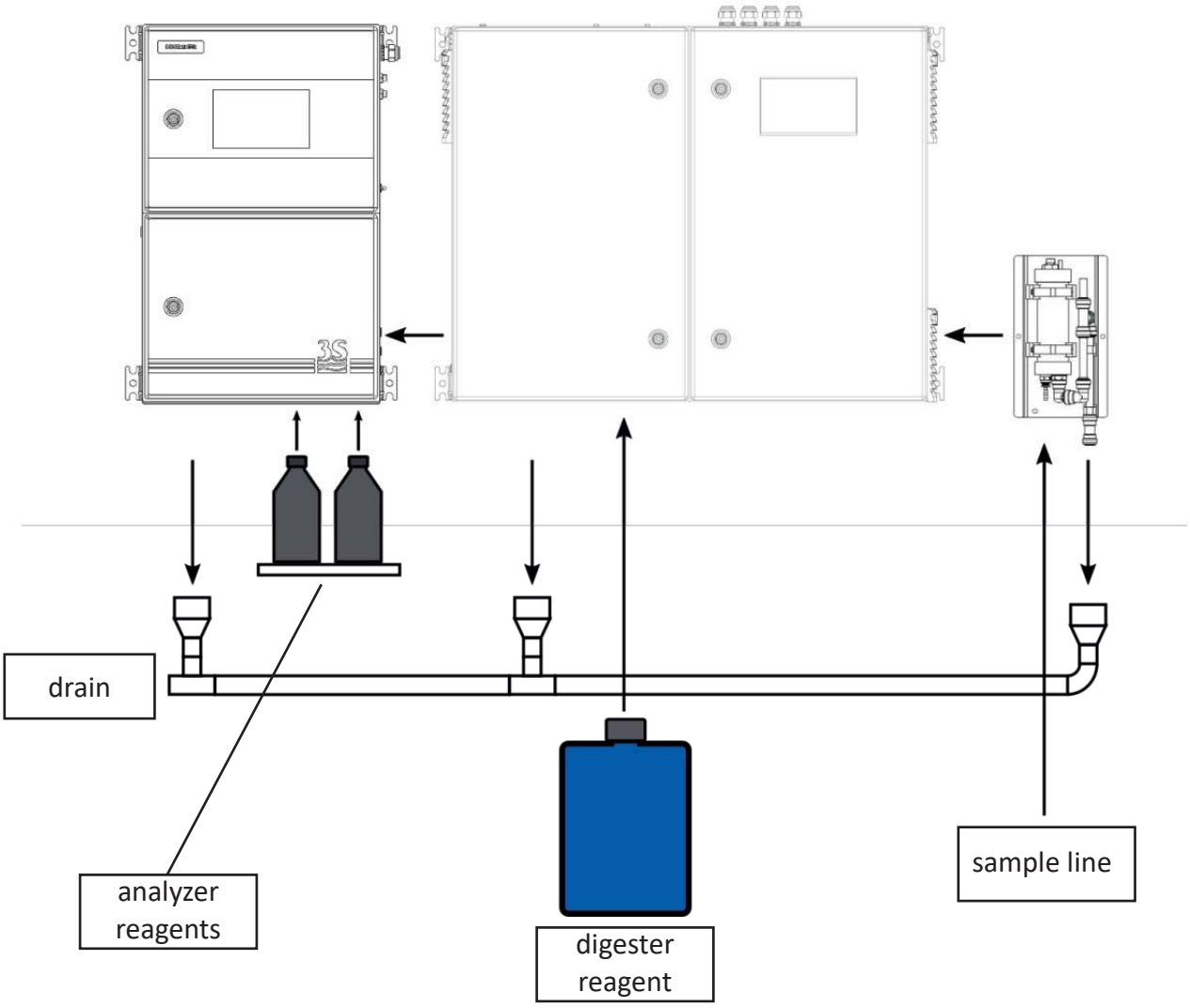

## 3.4 Hydraulic connections to sample, reagents and drain

The digester and sample vessel should be installed vertically on the wall or on a suitable stand. Use suitable screws to support the weight of the instrument (not provided in the package) and secure them to the side flanges of the instrument and in the holes of the sample vessel. Mount the instrument so that the display is at eye level (160 cm, 63 in).

Since the sample outlet connections are on the left side of the digester, we recommend installing the instrument toward the right side of the colorimetric analyzer. Consider also providing space around the instruments so that opening the door is easy for inspection or maintenance. A minimum distance of 10 cm is required between the instrument and any other obstruction.

The sample container can be mounted near the digester, preferably on the right side.

The analyzer reagents must be within 40 cm from the bottom side of the analyzer to not stress the miniature peristaltic pumps of the instrument. The installer should provide a shelf and secure the bottles in position. The digester reagent tank can say at floor level.




The installer should also provide a drain line without any backpressure to allow the free flow of liquids.
Now proceed with the following connections:

1. Connect the sample reservoir to drain, the vessel has a side arm for draining excess liquid to maintain a constant flow, the side arm must be connected to the drain with the included 10 mm OD flexible pipe (push-fit connection).

2. Connect digester and analyzer drains, to the same drain line or to a waste container.

3. Connect the sample line to the to the bottom of the sample reservoir with a 6 mm flexible tubing (push-fit connection).

4. Connect the the digester sample inlet pipe to the steel straw of the sample reservoir with the provided rubber pipe.

5. Connect the digester outlet to the analyzer sample inlet with the provided rubber pipe.

6. Connect both sets of reagents with the plastic straws and pipes provided with the instruments startup kits.

## 3.5 Electrical connection to the analyzer

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

1. Use up to 2 cables with a maximum diameter (including insulation) of 12 mm.

2. Run the cables through the 2 free PG13.5 cable glands on the upper right wall of the instruments.

3. Strip the insulation from each conductor and insert it into the removable screw terminal that makes up the terminal block at the top of the instruments. Use a screwdriver with a cutting width of 3 mm and ensure proper retention of the conductor inside the clamp.

4. Pay attention to the tight sealing of the cable glands to avoid dust and moisture infiltration.

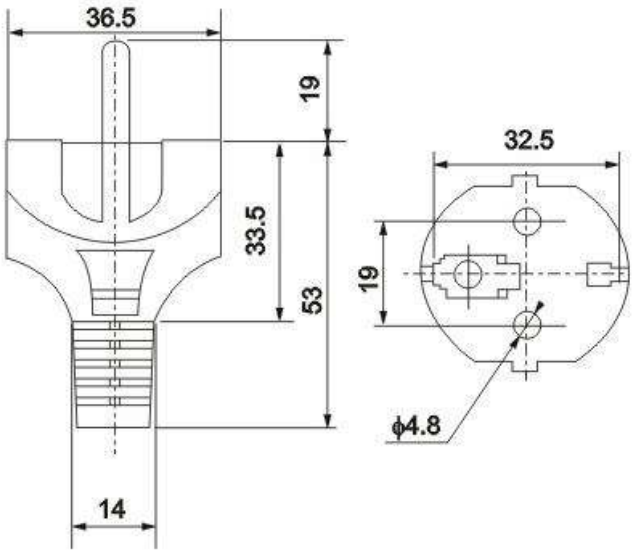
5. The END OF CYCLE termiinal should be connected to the 3S colorimetric phosphate analyzer by connecting the COM contact of the digester with the (-) REMOTE INPUT contact of the analyzer and the NO contact of the digester with the (+) REMOTE INPUT contact of the analyzer.

The START INPUT connection is optional and provides a way to control the digester remotely.
The terminal block connections are summarized in the table below.

| TERMINAL | DIGESTORE SIDE CONNECTION | FUNCTION |
|---|---|---|
| 1 - 7 | N.C. | Not connected |
| 8<br>9 | - remote input<br>+ remote input | START INPUT |
| 10<br>11<br>12 | NO<br>COM<br>NC | END OF CYCLE<br>(relay) |

## 3.6 Power supply connection

The instrument cable is 2.5 m long, with european plug CEE7/7 SCHUKO.




The instrument in accordance with electrical safety standards IEC EN 61010-1, has passed the following safety tests:

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

In addition to these factory tests performed by the manufacturer, the installer should:
- check the power cord for signs of damage that may have occurred during unpacking or wall mounting of the instrument.
- check the goodness of the grounding conductor present in the socket where the power cable will be connected
- provide adequate overload and surge protection for the line where the instrument's power cord will be connected
- check compliance with any applicable safety regulations on the power line.

## 3.7 Remote input

Using this connection, the user can remotely control the function of the instrument. This contact functions as an SPDT switch and requires a voltage-free connection. When the contact is closed, the instrument will start its routine and when it is opened, it will return to standby.
The remote input signal will then start the digester, which will notify the analyzer when the digestion process is complete to start the resulting colorimetric analysis.

## 3.8 Sample level sensor connection

A level sensor is present inside sample recirculation to detect the presence or absence of sample.
If the sample needed for analysis is missing, the instrument will go into standby mode. When sample flow is restored, the sensor sends a signal to the instrument and online analysis resumes automatically, without the need for external intervention.
The level sensor is connected to the instrument by a wire with a connector that must be plugged into the left side of the digester.
The socket can be identified by a label.

LEVEL SWITCH

Here is the contact logic:

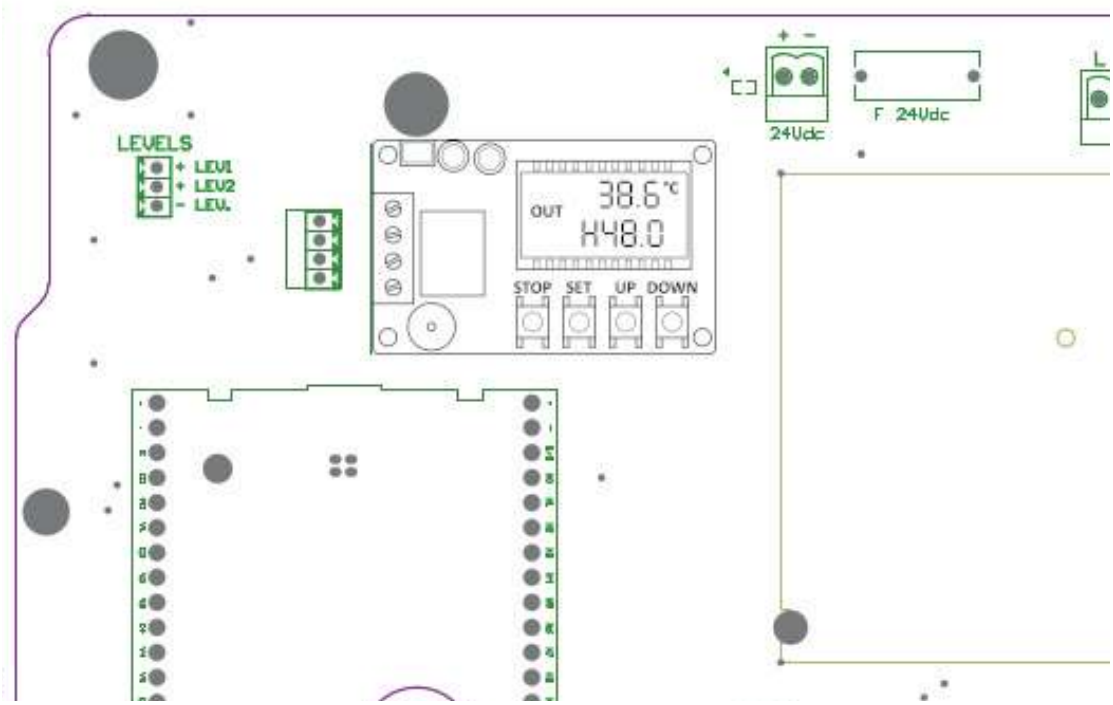
| | |
|---|---|
| SAMPLE PRESENT | Open contact |
| SAMPLE MISSING | Closed contact |

## 3.9 Heated reactor with thermostat

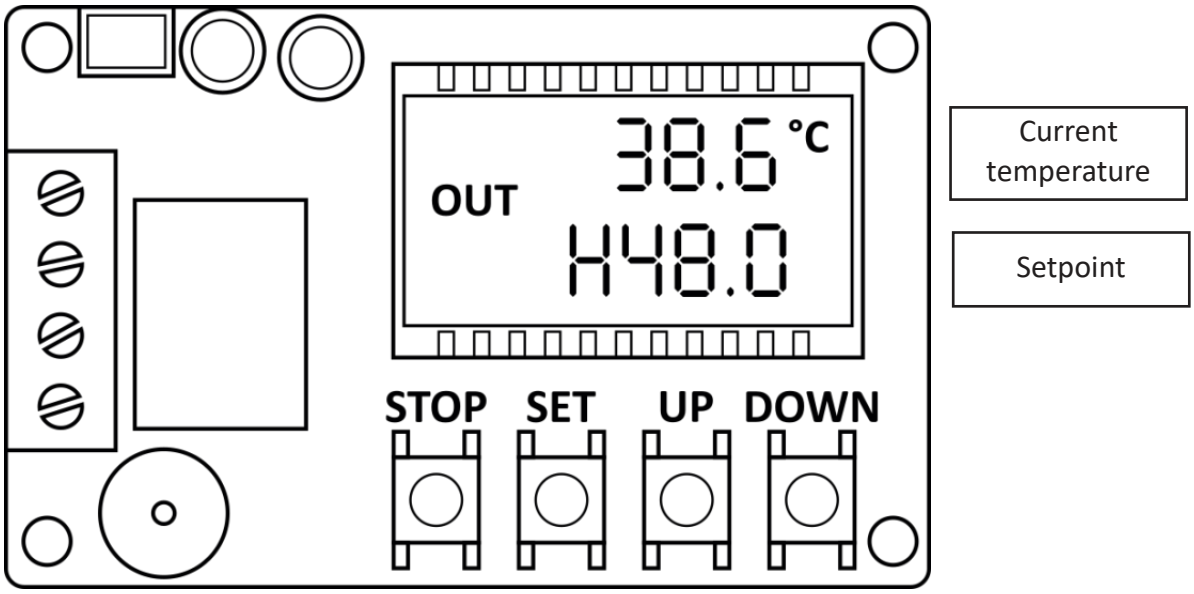
The instrument is equipped with a thermostat to control the temperature of the reactor. The thermostat is installed on the main board on the left of the power supply unit.
To set the temperature of the cell block, the user must open the upper compartment of the analyzer and reach the thermostat.

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

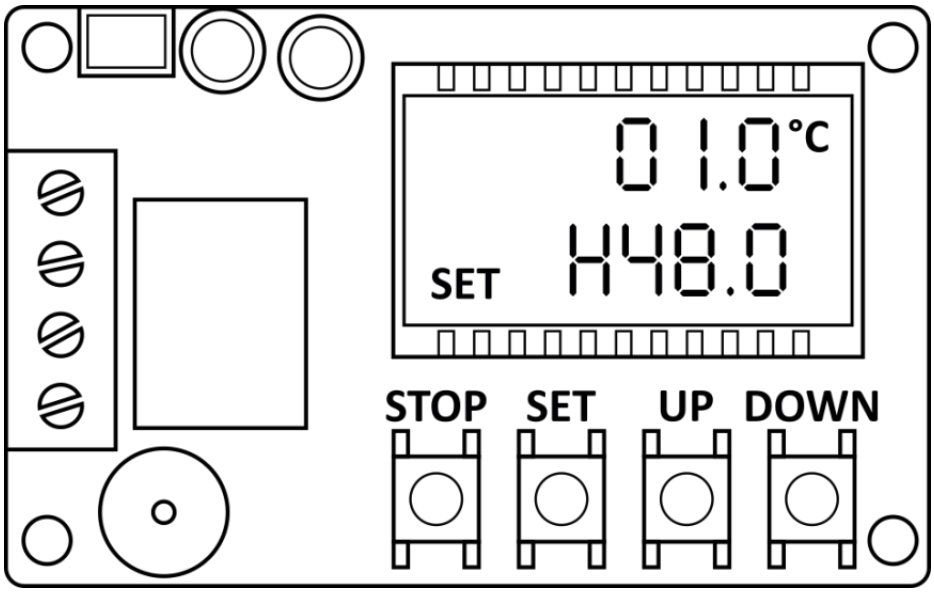
Location of the thermostat module on the man PCB.




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.

## 3.10 Analyzer configuration

The analyzer combined with the digester needs only minimal configuration to be used.

Go to the CONFIGURATION > REMOTE INPUT menu and select ONLINE.
Make sure that the digester waiting interval is greater than the analysis duration time. You can check the duration of the analysis from the CONFIGURATION > CYCLE TIME page in your analyzer.
The analyzer analysis cycle must be configured to work with an amount of sample of 80 mL. Here is an example of an analysis cycle for total phopshorus using the **blue method** (cell diameter 26 mm, sample 1: digested sample, sample 2: rinse water).

| STEP | OPERATION | DURATION (sec) |
|---|---|---|
| 1 | DRAIN | 5 |
| 2 | SAMPLE 1 | 13 |
| 3 | DRAIN | 5 |
| 4 | SAMPLE 1 | 13 |
| 5 | DRAIN | 5 |
| 6 | LEVEL JUMP 1 | 1 |
| 7 | SAMPLE 1 | 16 |
| 8 | WAIT | 50 |
| 9 | INITIAL MEAS | 10 |
| 10 | REA 2 | 10 |
| 11 | REA 1 | 10 |
| 12 | MIX | 300 |
| 13 | WAIT | 60 |
| 14 | ABSORBANCE | 2 |
| 15 | RESULT A | 2 |
| 16 | WAIT | 0 |
| 17 | LEVEL JUMP 1 | 1 |
| 18 | DRAIN | 5 |
| 19 | RINSE 1 | 25 |
| 20 | SAMPLE 2 | 20 |
| 21 | DRAIN | 5 |
| 22 | SAMPLE 2 | 20 |
| 23 | DRAIN | 5 |
| 24 | SAMPLE 2 | 20 |

The following is an example of an analysis cycle that uses the **yellow method** and dilution to reach higher ranges.

| STEP | OPERATION | DURATION (sec) |
|---|---|---|
| 1 | DRAIN | 5 |
| 2 | RINSE 1 | 25 |
| 3 | GRAB 1 | 30 |
| 4 | DRAIN | 5 |
| 5 | SAMPLE 2 | 11 |
| 6 | DRAIN | 5 |
| 7 | SAMPLE 2 | 11 |
| 8 | DRAIN | 5 |
| 9 | SAMPLE 2 | 1 |
| 10 | DRAIN | 5 |
| 11 | LEVEL JUMP 1 | 1 |
| 12 | RELEASE 2 | 12 |
| 13 | WAIT | 70 |
| 14 | INITIAL MEAS | 2 |
| 15 | REA 1 | 9 |
| 16 | MIX | 300 |
| 17 | WAIT | 30 |
| 18 | ABSORBANCE | 2 |
| 19 | RESULT A | 2 |
| 20 | WAIT | 0 |
| 21 | DRAIN | 5 |
| 22 | RINSE 1 | 20 |
| 23 | SAMPLE 2 | 12 |
| 24 | DRAIN | 5 |
| 25 | SAMPLE 2 | 12 |
| 26 | DRAIN | 5 |
| 27 | SAMPLE 2 | 12 |
| 28 | DRAIN | 5 |
| 29 | SAMPLE 2 | 11 |

**Timing requirements**

• The sampling part of the analysis cycle must be shorter than 120 seconds

• The entire cycle must be longer than 180 seconds, after that time a RINSE operation must be programmed to empty the digester from the remaining liquid.

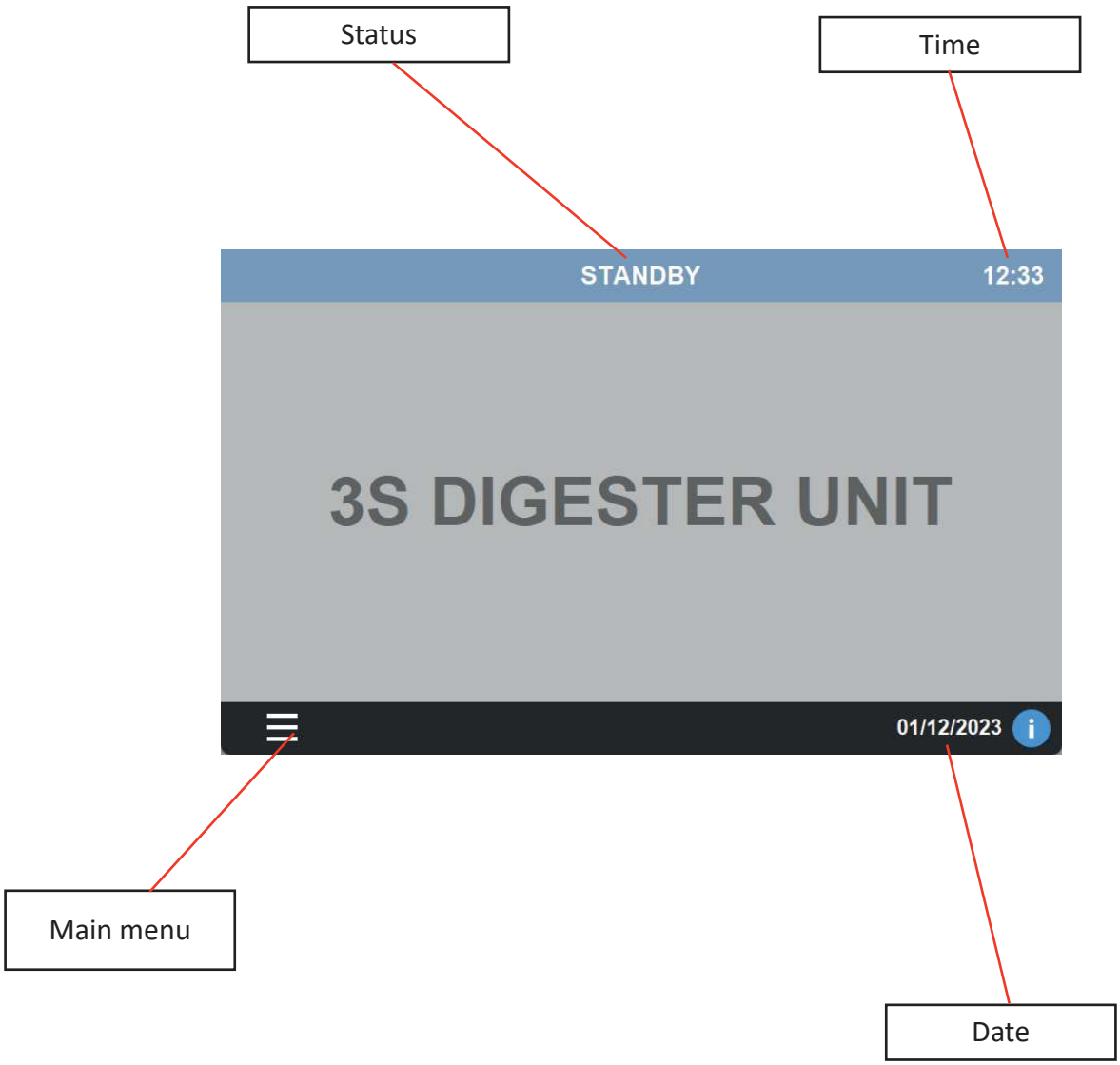
• The digester running frequency must be longer than the colorimeter analysis cycle.

# 4 - USER INTERFACE

## 4.1 Power on

After establishing the power connection, the user can turn on the device.
The analyzer takes a couple of seconds to start up, during which the splashscreen is shown, followed by the main screen.

The following page will be seen:



## 4.2 Main menu

Press on the MENU symbol to access all functions of the analyzer. A brief description of the graphical interface will follow in the next paragraphs.


## 4.3 Access

The instrument has 2 levels of security, each level allowing access to more advanced functions.

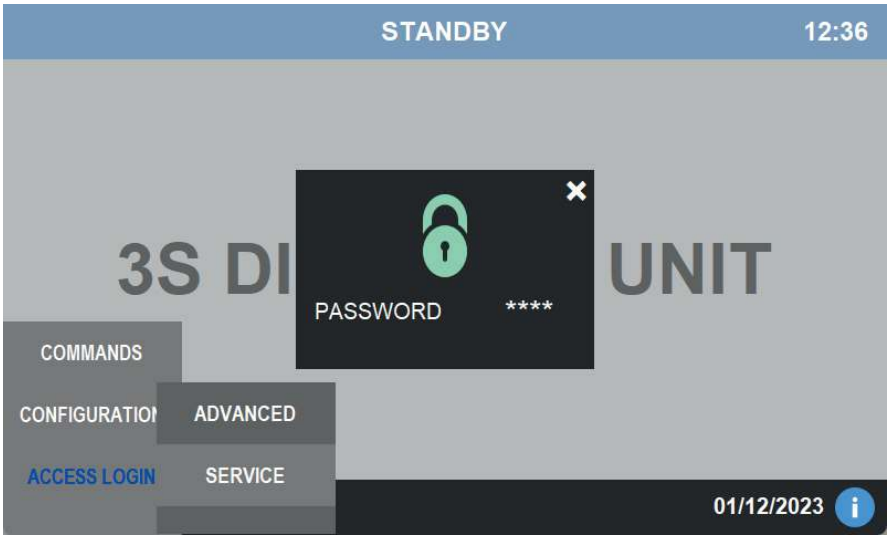
The two levels are:

| | |
|---|---|
| SERVICE | This level allows the user to make calibrations and change basic settings. The password for this level is **1111** |
| PASSWORD | This level allows the user to make calibrations and change any settings. Operate with caution when logged in with this level. |

Please, contact the 3S Analyzers customer service or your local distibutor to receive your service level password. You can write it here.

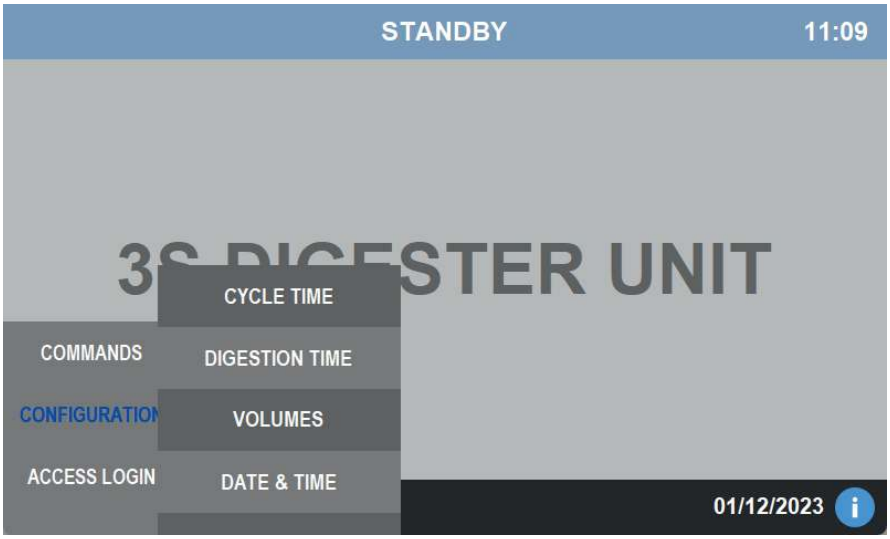
SERVICE PASSWORD _____

To access the analyzer menu with the required level, press on ACCESS LOGIN in the main menu, then choose between the two options. A new window will appear, press on **** to show the numeric pad and enter the password. If successful, the padlock will turn green.



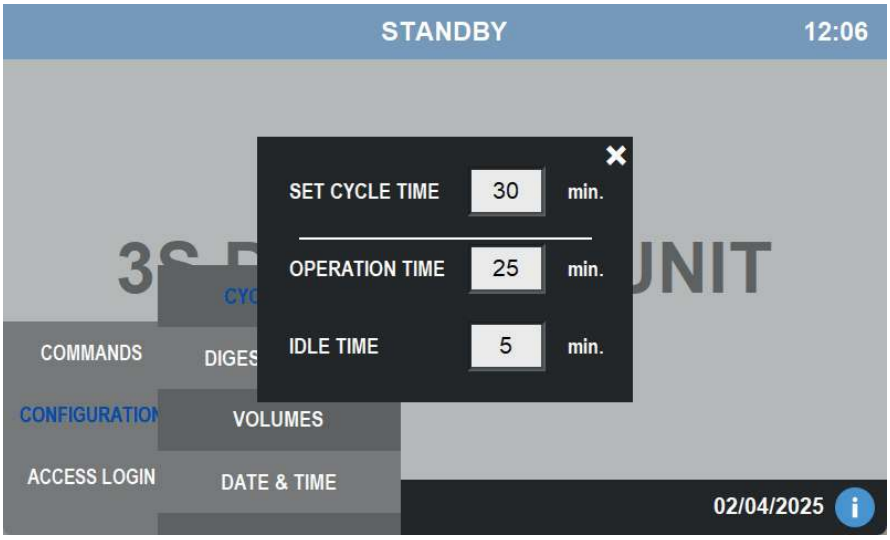
## 4.4 Configuration

This menu contains the main configuration of the instrument.



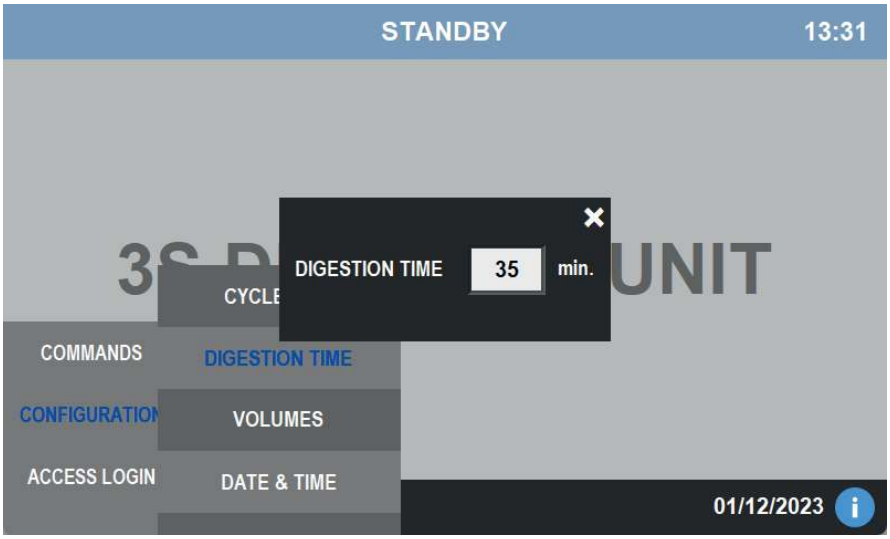

### Cycle Time

In this window you can manage the waiting time between analyses. Simply enter the total duration time of a cycle and the waiting time will be calculated automatically.



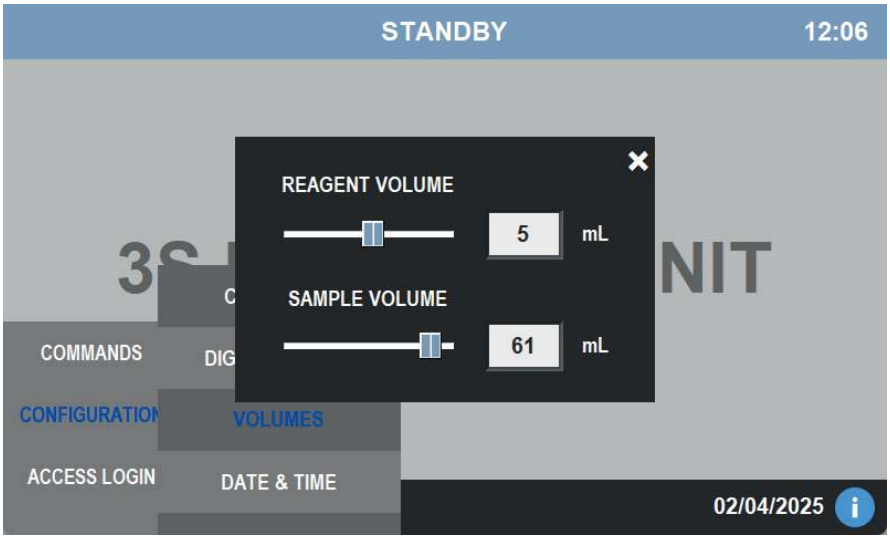
## Digestion Time

In this window the user can choose the duration of the digestion period. Depending on the sample, a longer or shorter time may be required.



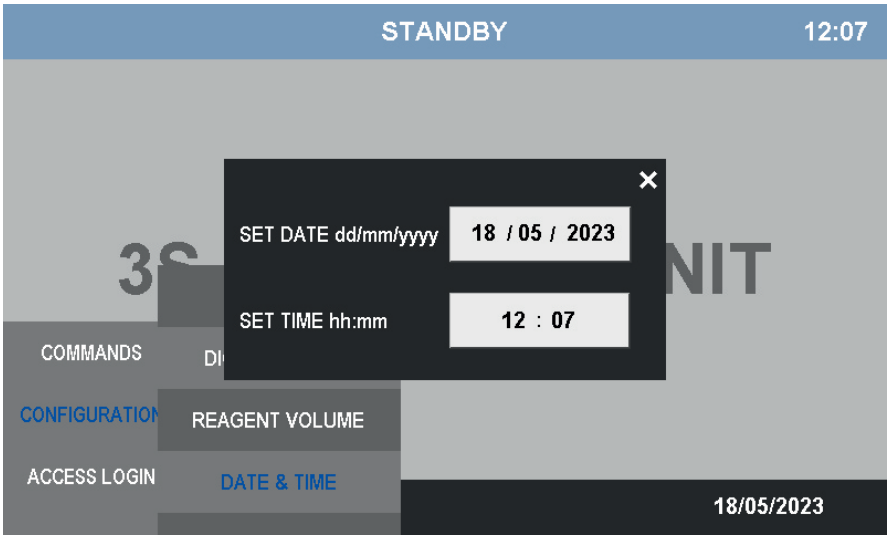

## Volumes

In this window the user can set the volumes of reagent and sample that will be used for digestion.



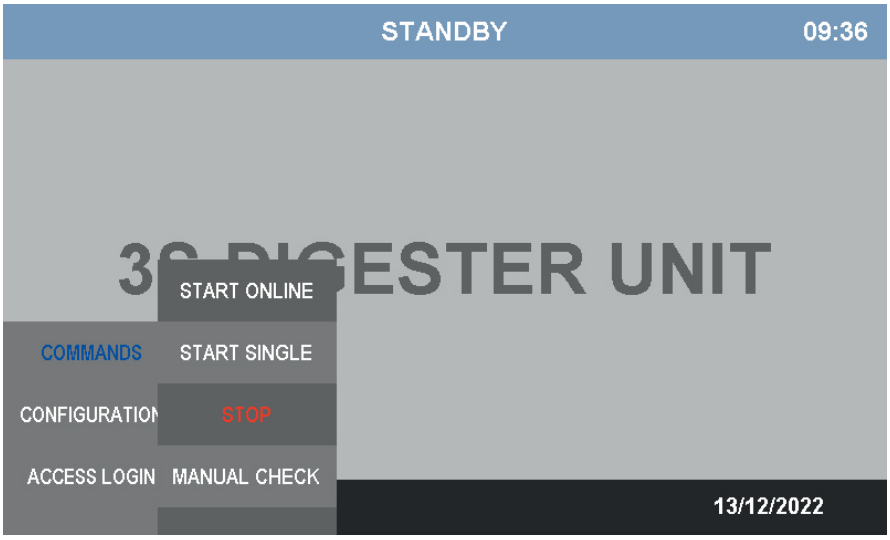
### Date & Time

The current date and time can be set on this page.




## 4.5 Commands

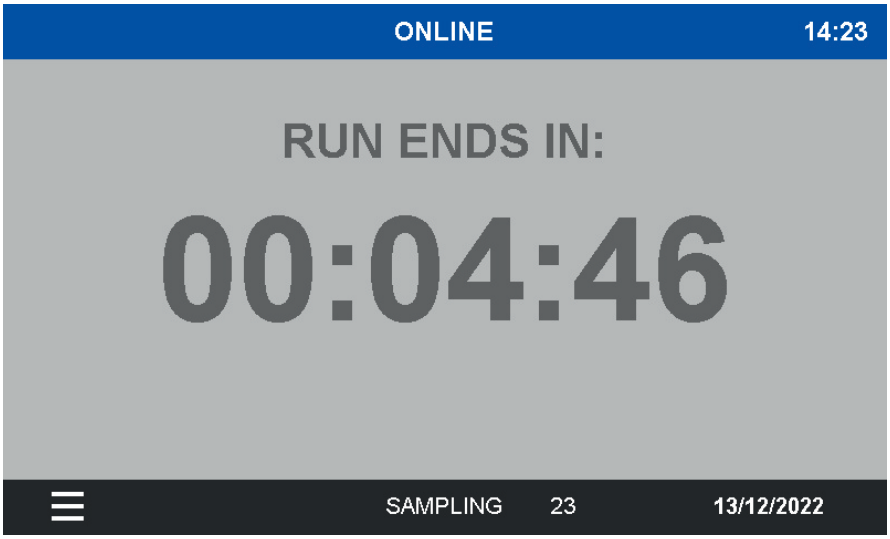
The COMMANDS menu contains the two commands for making calibrations.



## Start Online

Holding this button for 2 seconds will start the online cycle. The digestion operations will be interspersed with a waiting time that can be set from the CONFIGURATION > CYCLE TIME screen.

The time remaining at the end of the digestion procedure is always indicated when it is in progress. The blue status bar indicates continuous online analysis.




## Start Single

Holding this button for 2 seconds will start a single digestion cycle. When finished, the instrument will return to standby, ready to receive new commands.

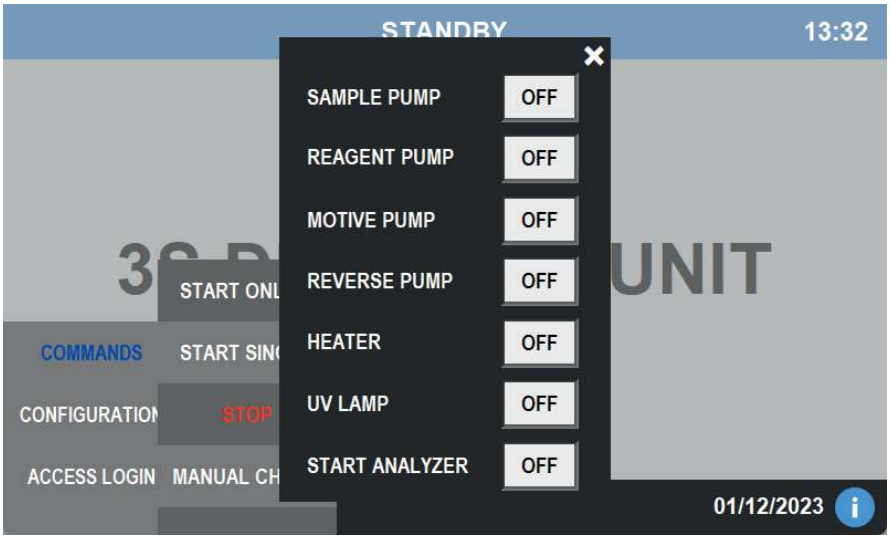
The green color of the status bar indicates that a single digestion is in progress.

## Stop

Pressing the STOP button will return the instrument to the STANDBY condition. All operations will be stopped and the instrument will have to be restarted manually.

## Manual Check

The manual check page allows the user to manually start individual components to check their proper operation or for any maintenance tasks.
Press the button next to the component you want to test to operate it. Multiple components can be started at the same time. A timeout is set to prevent prolonged use of the functions.



# 5 - MAINTENANCE

## 5.1 Cleaning

Depending on the sample, the instrument requires more or less frequent cleaning. The instrument works under strongly acidic and oxidizing conditions; the reagents themselves contribute to the cleaning of the instrument. It is sufficient to start digestion operations on a clean sample (demineralized water) to perform an automatic cleaning operation.
If the heated reactor becomes dirty, it can be cleaned using a pipe cleaner.

## 5.2 Peristaltic pumps tubing replacement

There are 3 peristaltic pumps in the instrument, one for sampling, one for reagent addition, and one for sample handling inside the instrument.
To ensure optimal operation of the instrument, replacement of the tubes is recommended every 3 to 6 months, depending on the frequency of use of the instrument.

## 5.3 Reagent solution information and consumption

The suggested reagent for the standard operation of the total phosphorus digester is:

**10 % $H_2SO_4$ + 0.25 M sodium persulfate**

The consumption of the reagent and the analysis frequency are settable by the user through the graphical interface. With the standard consumption of 5 mL/analysis and 1 analysis every hour the monthly consumption will be around 5 L/month.
Keep the reagent in a dark tank and avoid to store it near heat sources. A gas venting cap is strongly advised for storage.
Follow the reccommendation given by H and P phrases collected in the next page before handling the chemicals.

The ordering code for the reagent solution is:

| | |
|---|---|
| A46TPDRSZ-5 | TP DIGESTION REAGENT READY TO USE 5 L |

**Sodium persulfate ($Na_2S_2O_8$, CAS # 7775-27-1)**



H272 May intensify fire; oxidizer.
H302 Harmful if swallowed.
H315 Causes skin irritation.
H317 May cause an allergic skin reaction.
H334 May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H335 May cause respiratory irritation.

P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P220 Keep away from clothing and other combustible materials.
P261 Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P312 IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell.
P302 + P352 IF ON SKIN: Wash with plenty of water.

**Sulfuric acid ($H_2SO_4$, CAS # 7664-93-9)**

H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.

P234 Keep only in original packaging.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
P304 + P340 + P310 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/ doctor.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P363 Wash contaminated clothing before reuse.

## 5.4 Reagent solution preparation

Before proceeding to the preparation of the solution, read the material safety data sheets supplied with each chemical to take all the necessary precautions when handling them. Chemicals must be handled by qualified personnel trained on hazards and dangers to avoid accidents.

Wear hands and eyes protection and every other PPE required by your company or by the owner of the site.

For the preparation of 5 L digester reagent solution:

1. Fill a 5000 mL beaker to 2/3rds capacity with demineralized water.
2. Add 298 g of sodium persulfate. Stir until fully dissolved.
3. Slowly add 580 mL of concentrated sulfuric acid (95 - 98%). Warning, exothermic.
4. Fill the beaker to 5 L mark with demineralized water. Let the solution cool down before proceeding to the next step.
5. Transfer the solution to the reagent container provided with the analyzer

Store the solution in dark container at a temperature less than 20 °C (68 °F).