RHOSONICS
Proven Process Insights

MANUAL
MODEL 9585
COD METER

ULTRASONIC ANALYZER FOR COD APPLICATIONS

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1. Preface

1.1 Purpose
This manual explains the installation, configuration, operation and calibration of your Rhosonics Inline Process Analyzer.
For ease of reading and understanding, the manual is organized in logical steps, divided over several chapters and sections. Where necessary, the manual provides additional information about the above mentioned issues, and gives you all the answers regarding ultrasonic inline concentration analysis in the added section with Frequently Asked Questions.

1.2 Symbols and conventions
The following words and symbols indicate special messages:

WARNING:

This symbol indicates that failure to follow directions in the warning could result in bodily harm.

CAUTION:

This symbol indicates that failure to follow directions could result in damage to the equipment or loss of information.

IMPORTANT:
This word indicates that the text that follows contains clarifying information or specific instructions.

NOTE:
This word indicates that the text that follows contains comments, sidelights or interesting points of information.

1.3 About this manual

1.3.1 Conventions
- The symbol ► indicates a step to be performed
- Text represented as **[Bold]** indicates the (drawn) button on the touch screen display to be pressed
- Text in *ITALIC* refers to text displayed on the touch screen display
- Pages on the touch screen display are represented as figures; normally these figures are shown if the page is mentioned for the first time.
- The picture shown in the manual might differ from the picture shown on the display

2. Installation

2.1 Introduction

Purpose:
Installation of analyzer control unit, probe(s), cells, and cables.

2.2 Analyzer installation

The installation depends on the version. Whether you have purchased the split type, with separate display and control unit on PCB, the Weatherproof or the Panel Mount version.

2.2.1 Split type installation

The split type version consists of 2 units, one of which is the controller PCB, which is mounted in a steel / aluminum housing. To prepare the installation, please refer to the figures below.

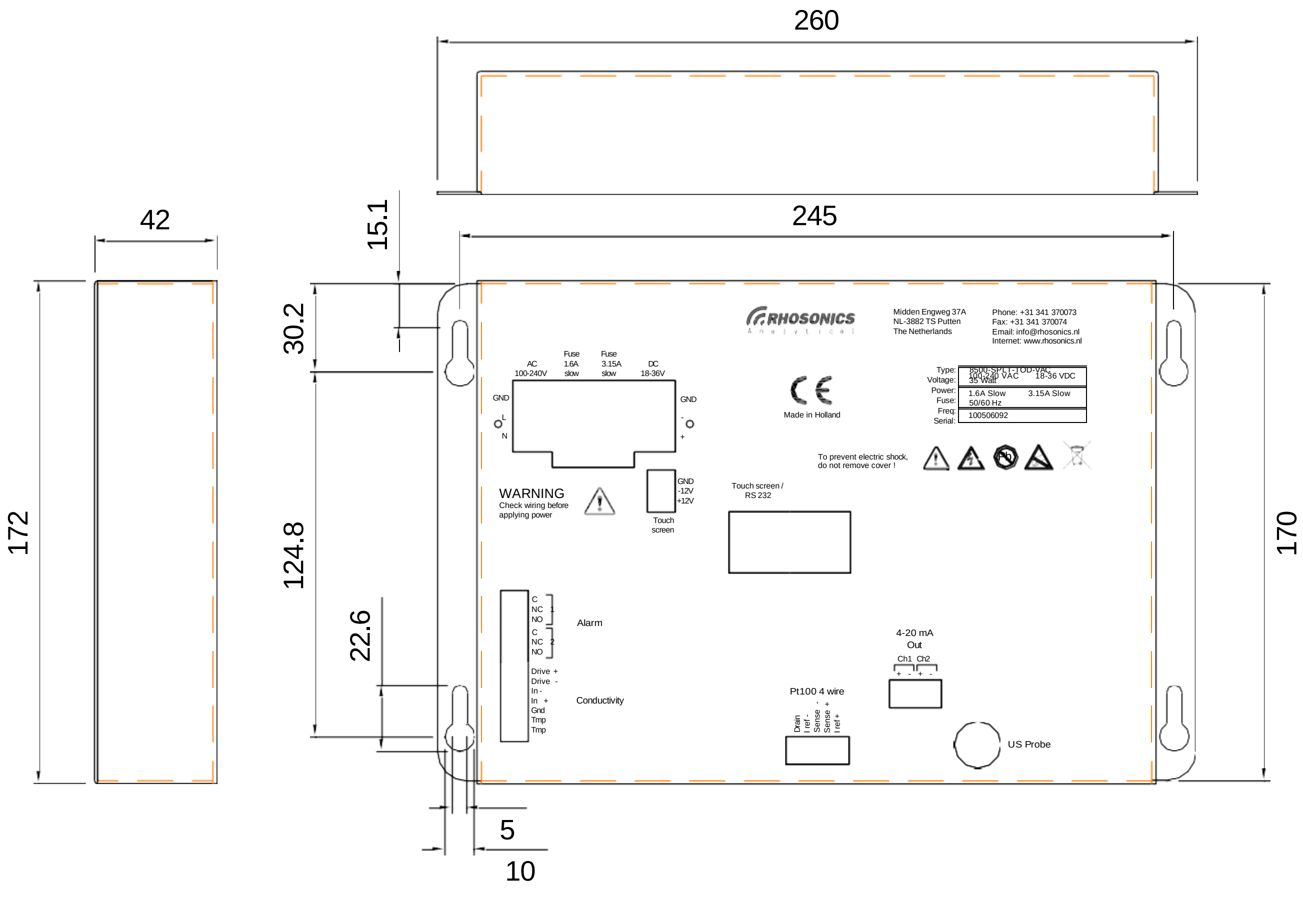


Figure 1: Steel / Aluminum housing for split unit analyzer

The above figure shows the dimensions of the housing of the PCB for installation.

2.2.1.1 Display installation.

The display is a Touch Screen type, which can be easily installed in a panel. For cut-out details, please refer to the below figure.

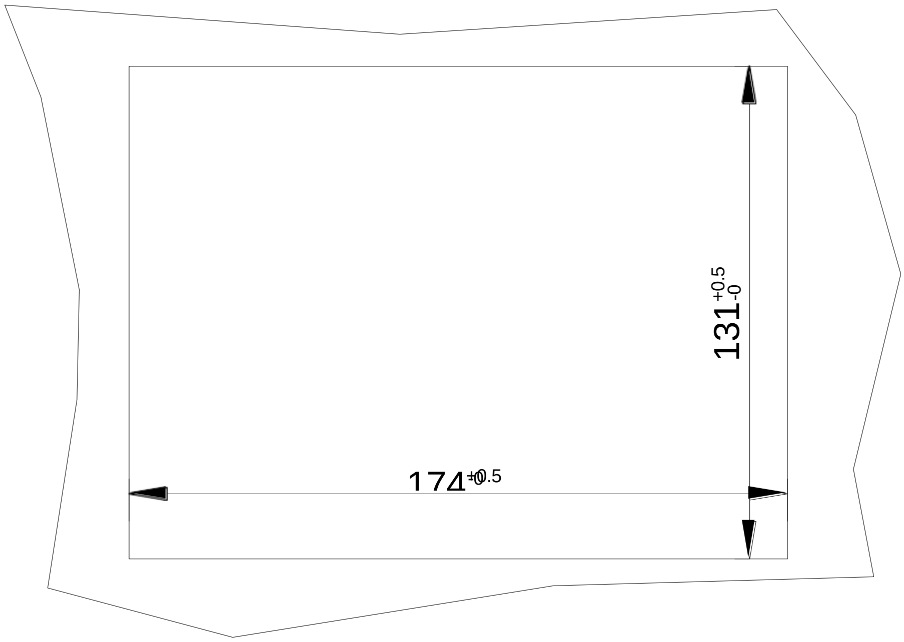
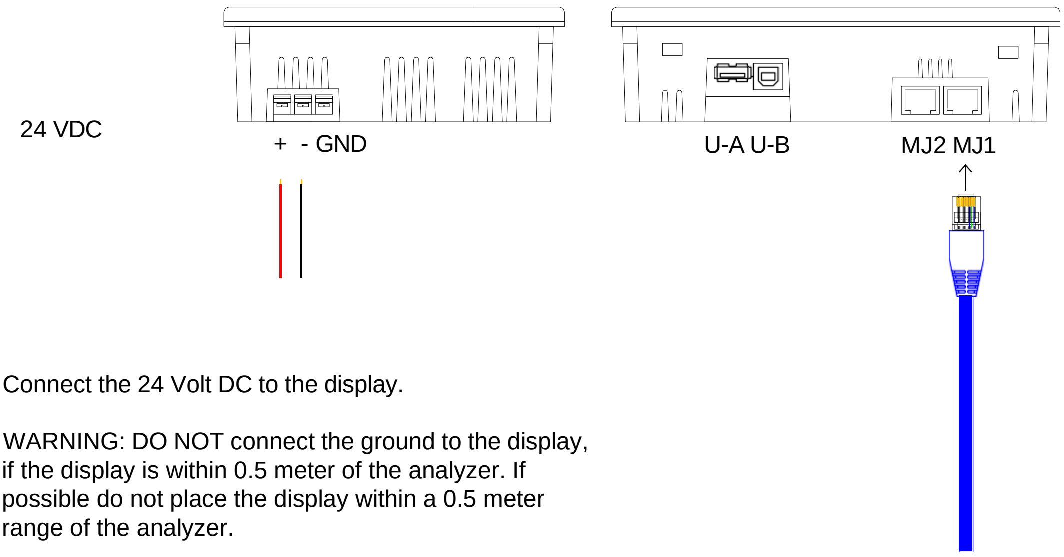


Figure 2: Panel cut-out for display installation

2.2.1.2 Touch Screen connections

The touch screen has 2 major connections, i.e. the 24 Volt power supply, and the connection with the PCB control unit.
The connection with 24VDC is realized through screw-type terminals.
The connection with the PCB control unit must be established with the special cable.

NOTE: Do not use any other cables, like Ethernet cables, as they may cause malfunctioning or damage to the analyzer.



Connect the 24 Volt DC to the display.

WARNING: DO NOT connect the ground to the display, if the display is within 0.5 meter of the analyzer. If possible do not place the display within a 0.5 meter range of the analyzer.

Connector U-B is used for updating the display software.

Connector U-A is used for an USB stick connection

Connector MJ2 is not used.

Figure 3: Connection overview display

WARNING: A TOO TIGHT FIT OF THE SCEEN MAY CAUSE DAMAGE AFTER INSTALLATION

NOTE: There are two different types of displays, so the ports can be located at other places on the display than is shown in the drawing.

2.2.2 Weather proof housing installation

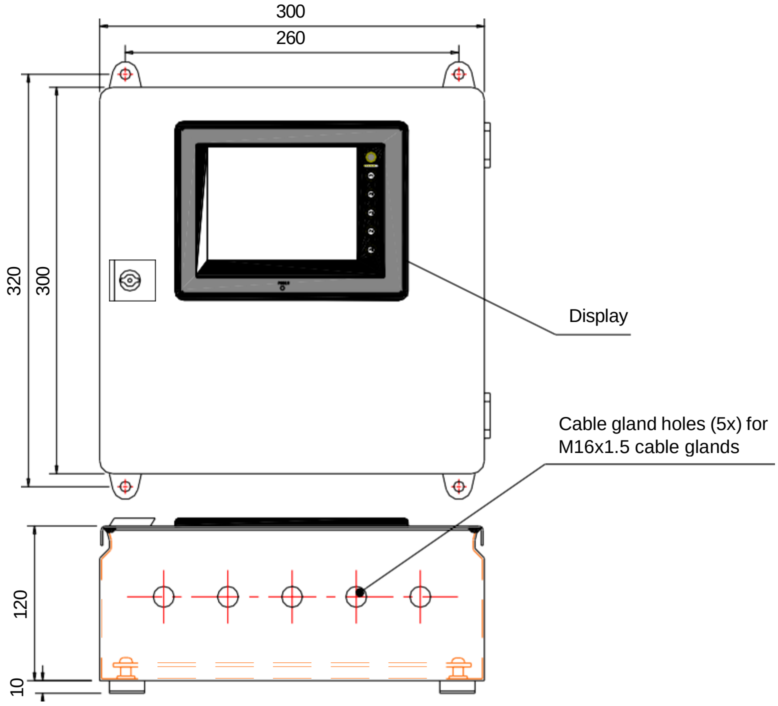


Figure 4: Weather proof housing

2.3 Sensor installation

Preparation.

It is important that the sensor is installed in a straight pipe run, preferably with minimally 5 diameters of straight pipe run upstream, and 3 pipe diameters of straight pipe run downstream.

In addition, the probe must be installed in a vertical pipe, or sidewise in a horizontal pipe. This implies that the probe must not be installed on top of the pipe, nor on the bottom, as eventual gas bubbles may accumulate on the sensor surface(s).

Installation on a vertical pipe section is preferred, as gas bubbles are always able to escape.

2.3.1 Vertical sensor installation (preferred)

Preferred installation is vertical upstream. In this case the chances on gas /air is lowest. The sensor connections are indicated on the spool with stickers. In case that due to circumstances confusion arises on sensor connection, the blue junction box for the ultrasonic sensor has to be in between the conductivity and the temperature sensor. (The ultrasonic signal must reflect on the opposing side of the spool.)

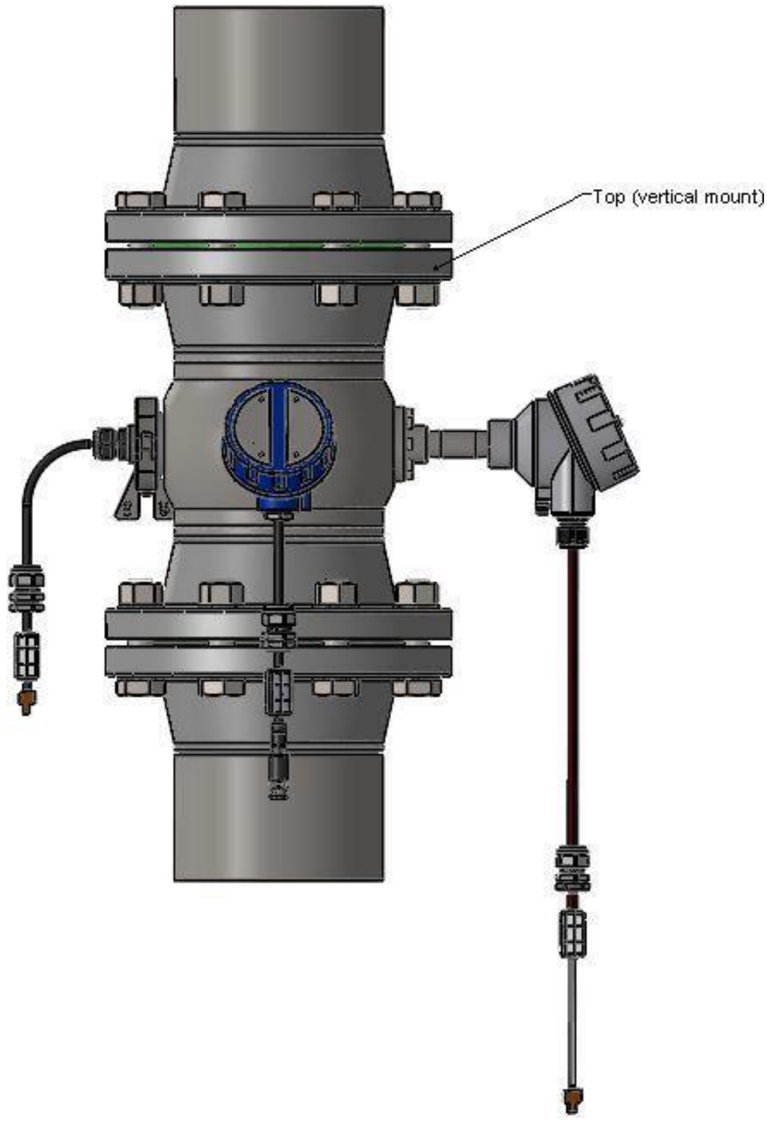


Figure 5: Vertical sensor installation

2.3.2 Horizontal sensor installation

The sensor connections are indicated on the spool with stickers. In case that due to circumstances confusion arises on sensor connection, the blue junction box for the ultrasonic sensor has to be in between the conductivity and the temperature sensor. (The ultrasonic signal must reflect on the opposing side of the spool.)
On horizontal sensor installation there is a possibility of gas/air in the top part of the pipe, this is a problem for the sensors. The ultrasonic is mounted between 60-75° from a vertical imaginary line.
Temperature sensor is least sensitive for air/gas that is why it is mounted closest to the top.

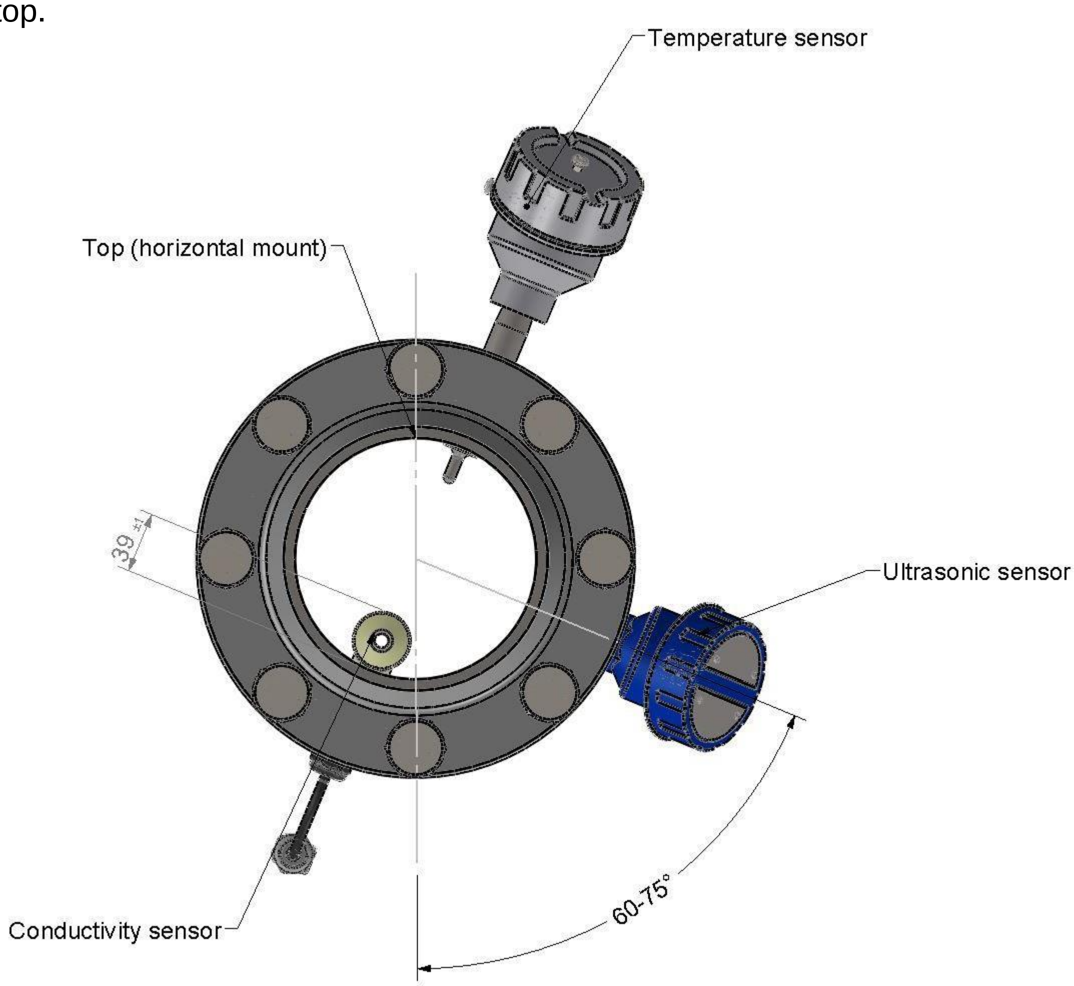


Figure 6: Horizontal sensor installation

2.3.3 Summary sensor installation:

- 5D of pipe length upstream, 3D pipe length downstream of probe location point.
- Do not mount directly after a point where the liquid is likely not homogeneous (i.e. after a CO_2 dosing point, after a component dosing valve)
- Installation in vertical pipe is best, in case of installation in horizontal pipe: install sensor from one side of the pipe. Never install the sensor on the top or on the bottom of the pipe.

2.4 Installing the cables

Refer to figure below for general mounting overview of the cables.

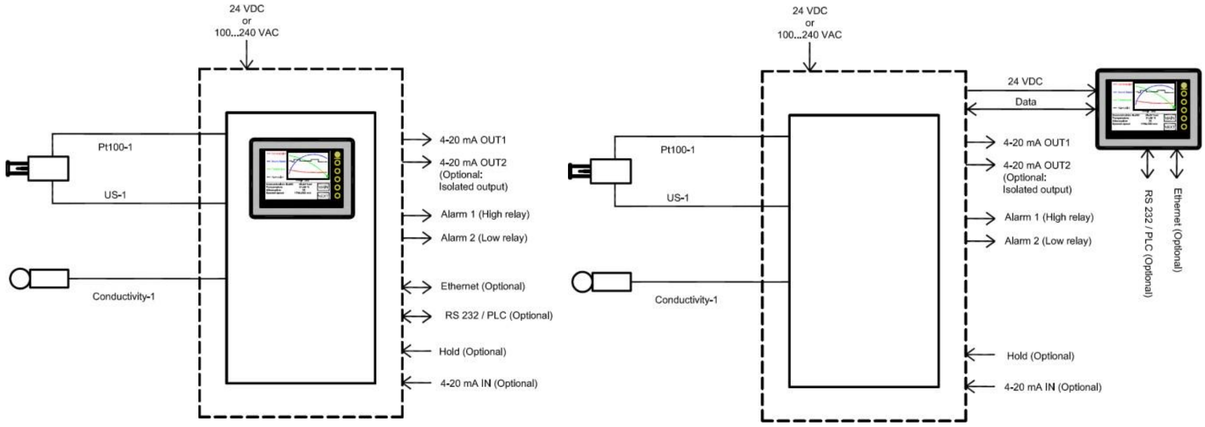


Figure 7: system overview WPF-housing (left) and SPLIT-unit (right)

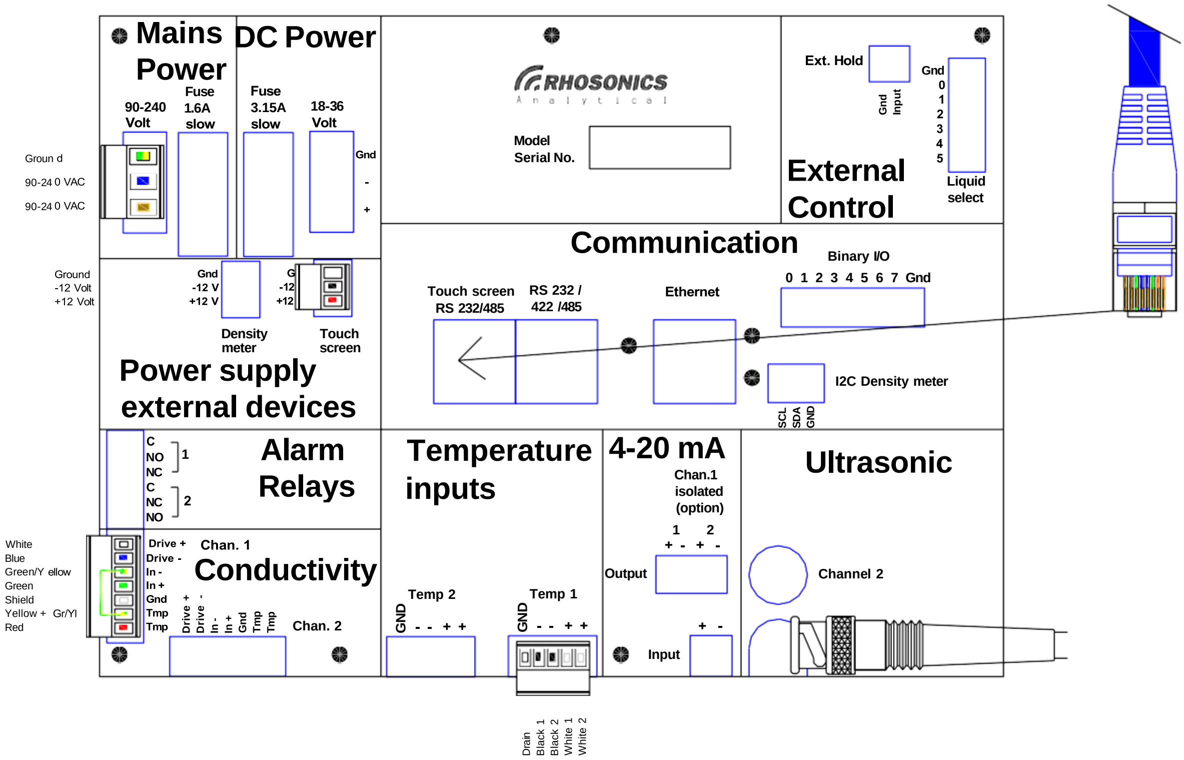


Figure 8: Cabling overview analyzer with ultrasonic/conductivity sensor and temperature sensor.

WARNING:

The 4-20 mA output is an active output Do not connect another active 4-20 mA output to the Rhosonics 4-20 mA output, otherwise the analyzer will be damaged beyond repair.

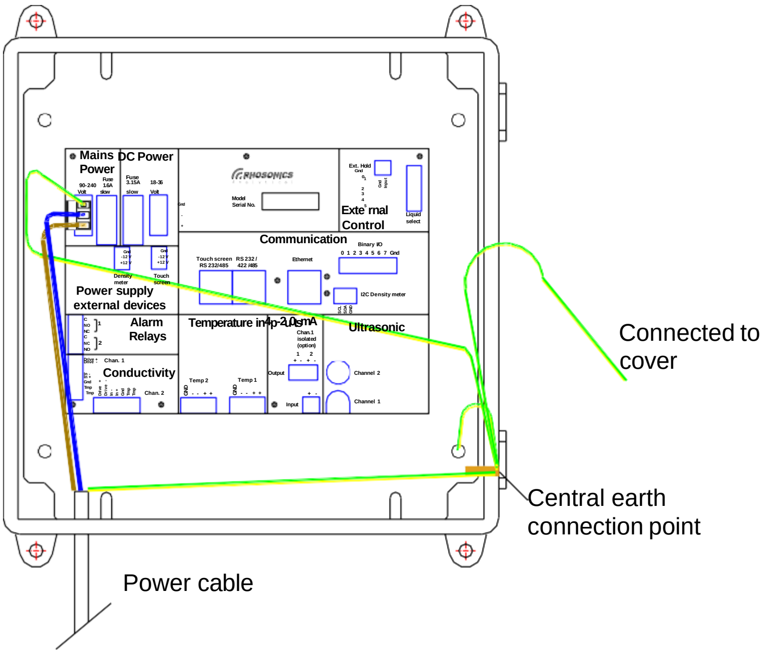


Figure 9: Schematic overview for earth cables inside WPF housing (90-240 VAC)

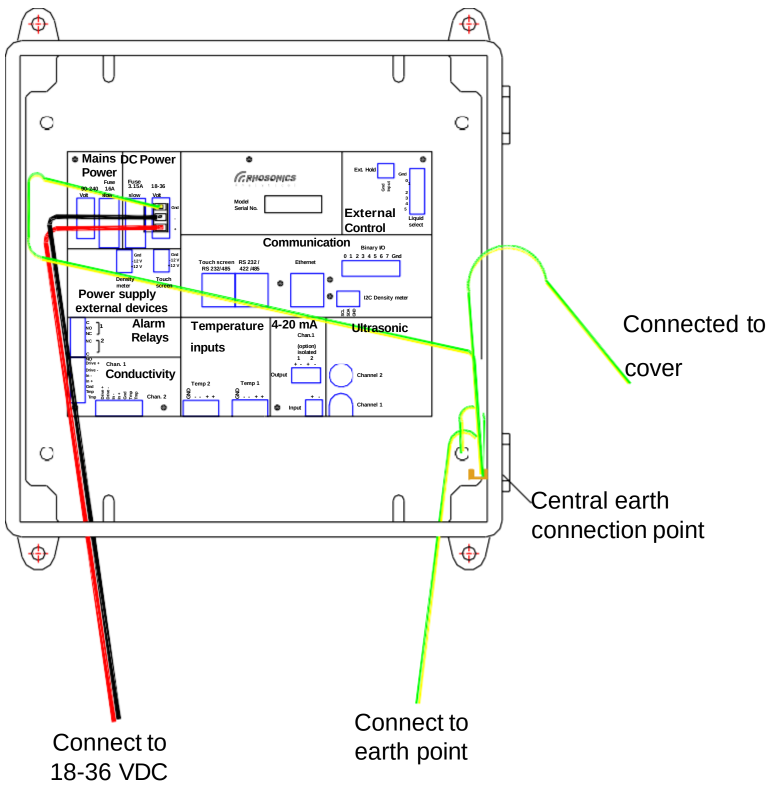


Figure 10: Schematic overview for earth cables inside WPF housing (18-36 VDC)

Note:
When the housing is not connected to protected earth (PE) the case and for example, a nearby lightning strike the entire system can be lifted electrically.
The consequence of this is that sensitive sensor inputs and outputs connected to DCS system become defective.

3. Configuration.

Configuration can be done through the configuration menu, by pressing the exit icon on the main measurement screen:

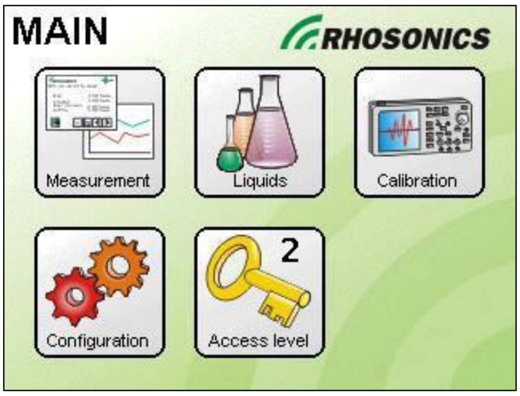


Figure 11: *MAIN MENU* page

NOTE: The shown icons depend on your access level.

3.1 Introduction

Once you have chosen the configuration mode, you will be able to establish specific operating parameters of the analyzer. These parameters include:

1. Sensors, including parameters of the probe
2. 4~20 mA output, including scaling, source choice and error handling
3. Display, i.e. choice of results to be displayed
4. Alarm output setting, i.e. type, trip points, and choice of source

3.1.1 Touch Screen Functions

NOTE: The backlight will automatically turn off after 30 minutes. To turn it on back again, simply touch the screen at any location.

The touch screen display has the following functions:

- to display measurement results in values or graphics
- to change parameters and/or sources, like for instance the selected liquid

The LED located at the bottom side of the display area lights if the display is powered up.

At the right side of the display six buttons are located with the following functions:

- **[SYSTEM]** : NA
- **[F1]** : changes the access level to access level 1 and changes the page to the first measurement page
- **[F2]** : turns the backlight OFF (touching the screen will turn the backlight on)
- **[F3], [F4]** : NA
- **[F5]** : saves the current page of the display to the USB stick

3.1.2 Preparations

WARNING:

The 4-20 mA output is an active output Do not connect another active 4-20 mA output to the Rhosonics 4-20 mA output, otherwise the analyzer will be damaged beyond repair.

Before attempting to configure the transmitter, define the following:

The desired output settings for the 2   4~20mA outputs, i.e.

- What measured value you wish to transmit through the 2 pcs 4~20 mA outputs.
- The scaling of these parameters.
- What to do when the system detects problems, i.e. gas bubbles.

Consider which parameters you wish to be viewed during normal operation.

- I.e. Concentration for 1st parameter shown
- I.e. Temperature for 2nd parameter shown

Consider which parameters need to be monitored by the alarms.

- What measured value (i.e. concentration) you wish to check.
- Whether you wish to use 2 alarms for hi-hi lo-lo configuration.
- If the analyzer is used for several different products: alarm trip points for each product.

3.2 Analog Output configuration

This section describes how you can configure your 4~20mA outputs:
With these settings, you can set the following:

- To choose the result to transmit through the 4~20 mA outputs.
- The scaling of these parameters.
- What the system should do when the system detects problems, i.e. gas bubbles.

Access level 2 is required (supervisor).
The access code is 7410.

3.2.1 Procedure

Through the main menu, chose configure, then outputs.
Both outputs can be configured, as per below.

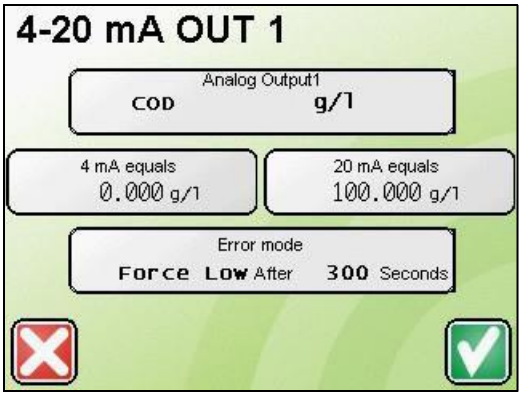
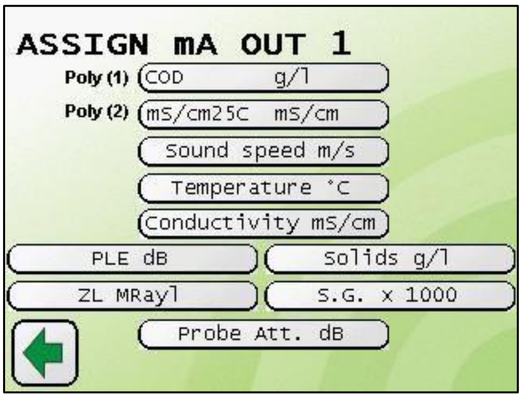


Figure 12: *4-20 mA OUT 1* page

3.2.2 Output source

► From the *Configuration* menu, press **[4-20 mA OUT]**
► Choose **[Configuration]** and **[4-20 mA OUT 1 or 2]**
► On the *4-20 mA OUT #* menu, press **[Source OUT # name]** to go the *Assignment page 1* menu
► Here you can choose between the *Calculated polynomial* (the concentration) and one of the measured values



If you chose for one of the *Measured values*:
►Press the button of the desired value
You will be returned to the *4-20 mA OUT #* menu.

Figure 13: *ASSIGNMENT PAGE 1* page

3.2.3 Output Scaling

The analog output is of the 4~20 mA type.
When you wish to scale your output to a range of 10 to 15 wt%, the procedure is as follows:

► Press **[4 mA Equals]**
► Enter the value 10 (wt %), the lowest value, corresponding to 4 mA
► Press **[Enter]** (automatic return to the *4~20 mA OUT1 or 2* page)
► Press **[20 mA Equals]**
► Enter the value 15 (wt %), the highest value, corresponding to 20 mA
► Press **[Enter]** (automatic return to the *4~20 mA OUT 1* or 2 page)

CAUTION:

Scaling the output to a high range, i.e. 0~100 wt%, results in loss of accuracy. The accuracy of the output is 0,05 % of scale. Choosing a smaller range (difference between low and high value) results in a better resolution. In the above example, the accuracy of the output is 0,1% of (15-10), which equals 0,0025 wt%.

3.2.4 Error communication through analog outputs

During an inline analysis, conditions may not always be perfect to perform a correct measurement. The analyzer automatically detects when the liquid is not homogeneous, or when gas bubbles are present, generates errors and initially holds its last valid reading.
In most processes, upset conditions may occur incidentally, due to not completely dissolved gases. The analyzer freezes the measurement during these conditions. Too long freezing may lead to a constant output, which in turn may lead to the conclusion that the process is perfect. To signal a too long duration of upset process conditions, the analyzer can react to these errors in four different modes.

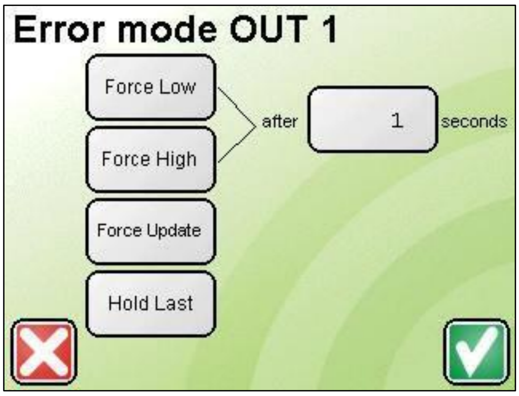
- Force Low: force output to 3mA after XXX seconds
- Force High: force output to 21mA after XXX seconds
- Force Update: force output to maintain measurement (only for Temp and Gain)
- Hold last: Hold last correct measured value

Determine first:
- How long do I allow the system not to signal any upset process conditions?

- What milli-Amp value do I wish to receive when erratic conditions continue for a too long period of time?

From the analog output menu, press *Error Mode*

Figure 14: *ERROR MODE OUT 1* page



Example: The output should force low when 120 seconds of continuous loss of signal occurs.

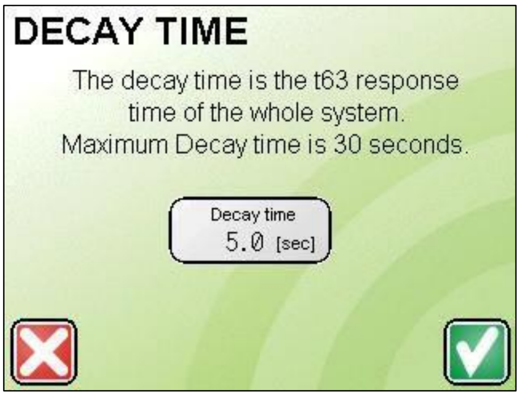
► Press **[Error Mode]** on the 4~20 mA output 1 or 2 menu.
► On the *Error mode OUT 1* page, press the button of your choice:
► Press the [Force Low]
► Enter "120" (via pop up keypad)
► Press **[Enter]**
► Press **[Accept]**

After the specified number of seconds, the 4~20 mA OUT will be forced to the specified level (Low level is 3 mA, High level is 21 mA).
Repeat this procedure for 4~20 mA OUT 2

3.2.5 Decay time

Smoothing is strongly recommended, since it gives you more accuracy. In addition, rapid changes in concentration are being smoothed, hence the output value more represents the "bulk" value of the liquid. When fast response is not required, we strongly recommend setting the τ63 time between 5 and 20 seconds. Since smoothing affects the response time, the best setting is a trade-off between accuracy and response time.
A decay rate of 5 seconds is recommended for most applications.

Figure 15: *DECAY TIME* page



3.3 Display configuration

Purpose:
- Define the parameters you wish to be viewed during normal operation.
- Define damping.
- Define the resolution on the display.

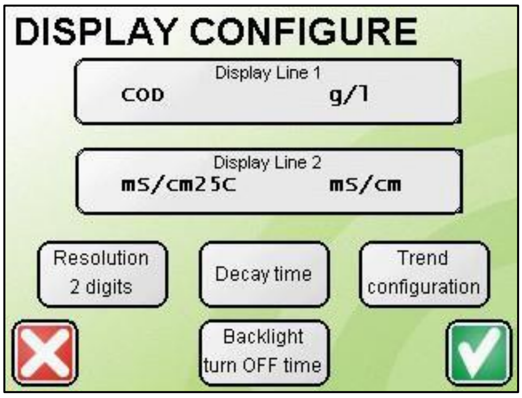
3.3.1 Selecting the results

Normally, you wish to view the concentration as main parameter, and the temperature as second parameter (shown small). Should your analyzer be capable of measuring more chemical components, you may wish to select another component. In addition, it is possible to view other, secondary parameters, such as sound speed or Ultrasonic attenuation, for specific evaluations.
The procedure is as follows:

Example: Concentration, i.e. Original Extract in ºP must be the primary measurement result. The temperature should be shown in smaller numbers, as secondary result.

NOTE: This procedure does not affect the output and alarm configurations.

► From the *Configuration* menu, press **[Display]**
► On the *Display configuration* menu, press **[Source 1 name]** to go the *Source 1* menu
► Here you can choose between the *Calculated polynomial* (the concentration) and one of the measured values



If you choose for *Calculated Polynom:*
► Press **[Polynom 1 or 2 calculated]**
You will be returned to the *Display configure* menu.

If you chose for one of the *Measured values*:
► Press the button **[More settings]**
► Press the button of the desired value
You will be returned to the *Display configure* menu.

Figure 16: *DISPLAY CONFIGURE* page

NOTE: The same steps have to be followed to set Source 2

3.3.2 Setting the display resolution

This menu allows you to toggle between 2 digits and 3 digits resolution. This setting does not affect the output resolution. The 3-digit resolution may be selected when additional readout accuracy is required, which is useful during field calibrations. For additional readout accuracy, it is recommended to apply some display smoothing too. See next section for details.

► On the *Display configuration* menu, press **[Resolution]**
► Press **[2Digits]** or **[3 Digits]** on the *Resolution* page (automatic return to the *Display configuration* page)

3.3.3 Display smoothing

This setting is the same as the decay time for the analog outputs. The result is that concentration values are smoothened before they are sent to the output.
A decay rate of 5 seconds is recommended for most applications.

3.3.4 Graph scaling

Purpose:
During normal operation of the analyzer, you can activate additional screens, such as the graphs, allowing you to see the trend of the results as configured in the previous section. The graphs show the trend of the results over the last 15 minutes of operation.
The scaling of the graph is done in this section.

- Define the scales of the 2 graphs (Y-axis starting and ending points).
- The plotted results are those which were configured in the display menu.

Once you have reached the menu through *Configuration – Display:*
► Press **[Trend configuration]**
► Press **[Min/Max value y-axis 1/2]**
Now you can enter the values that should correspond to minimum and maximum of the y-axis 1 and y-axis 2 (via pop-up keypad)
► Press **[Trendline sampling time]**
Now you can enter the time that should correspond to the time a trend value is written on the graph.

NOTE: The graph will plot the results which are monitored by the display. Should you wish to plot other results, then this is only possible by changing the display source value.

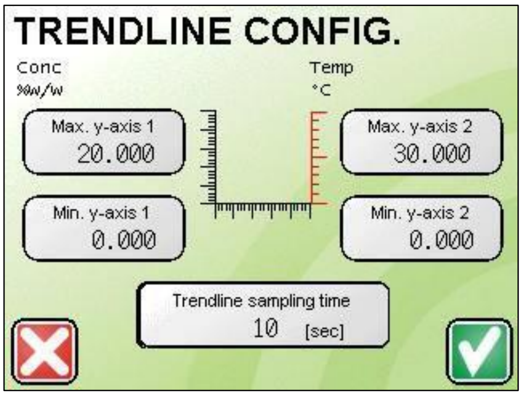


Figure 17: *DISPLAY CONFIGURATION GRAPH 1* page

3.3.5 Backlight turn off time

This setting allows you to set the time that the backlight has to be turned OFF automatically. If the backlight doesn't have to be turned OFF, enter 0 minutes. Touching the screen will turn the backlight ON. The set time has a fixed cycle and starts when the display is powered ON, so it can happen that if you touched the screen the backlight is turned OFF within the set time.

3.4 Sensor parameters

3.4.1 Introduction

When replacing a probe, it is necessary to enter the probe constants as supplied on the Probe Calibration Data Sheet (PCDS).

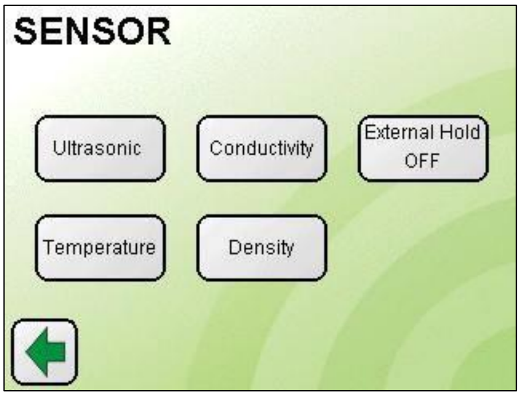


Figure 18: *SENSOR* page

3.4.2 Procedure

- Obtain the Probe Calibration Data Sheet. The serial number of the probe is indicated on the sheet.
- From the main menu, choose Configuration – Sensor – US sensor
- Check or modify the data as indicated on the data sheet

NOTE: If a probe is replaced, the previous data sheet is no longer valid.

3.4.3 Instructions:

► On the *Configuration menu*, press **[Sensor]**
► On the *Sensor menu* Press **[Ultrasonic]**
The following menu appears:
► Enter the appropriate values and confirm with **[Enter]** to return to this page.
► Press **[Auto Dead time Cal.]** to choose <u>*ON*</u> or <u>*OFF*</u> (see next section for details)
► Press **[Accept]** (automatic return to the *Sensor parameters* page)

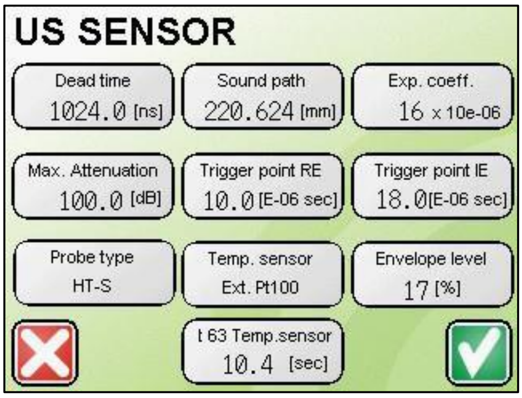


Figure 19: *ULTRASONIC PROBE CONFIGURATION* page

3.4.4 Auto dead time

3.4.4.1 <u>Introduction</u>

The auto dead time function takes care of variations in the "dead time", a probe-specific variable which is determined in the factory and is used to measure precisely the actual transit time in the liquid. The dead time is an important value and may change in time.
The instrument has a built-in feature that performs this vital calibration automatically during normal process conditions, carefully checking that the necessary circumstances are meeting the same conditions as in the factory, during the final calibration and quality control procedure.
When leaving the "Ultrasonic Probe Configuration" page the setting of the auto dead time is automatically set to "OFF".

3.4.4.2 <u>Advantages.</u>

The Auto-dead-time enhances the reliability of the measurement, as it continuously checks and adapts the dead time value without operator attention and the need to return the probe to the factory for recalibration. When the Ultrasonic connecting cable is replaced with the same, a longer or a shorter cable, there is no need to manually adjust the dead time.

3.4.4.3 <u>Procedure.</u>

► With the sensor in water, free of gas bubbles, with a low concentration solids and dissolved components.
► Press *Auto Dead Time* and select *ON*.
When the probe is installed in a filled pipe line, and process conditions are considered to be stable, which is determined by the analyzer, it will perform continuous measurement of the system dead time. You are still able to enter a number in the *Dead Time* field, however the instrument will automatically correct the entered value to the correct value. The Auto Dead Time is only working if the "Ultrasonic Probe Configuration" page is displayed.
► The value of the dead time has to change after pressing ON but this can take a minute.
► When the number in the field is giving a stable value (normally between 1100 and 1200), Press *Auto Dead Time* and select *OFF* or leave the page.

3.5 Alarm configuration.

3.5.1 Introduction
Alarm relays are provided for monitoring specific measured concentrations. The analyzer allows you to define which parameters are monitored, and at what values the relays should be possible. In addition, you may select whether the alarms are activated during fault conditions (Normal) or activated when no alarm is present (inverted operation).

3.5.2 Preparation.
- Determine which value you wish to monitor with each alarm.
- Determine whether you wish the alarm relay contacts to be activated during normal operation (no alarm) or during a fault condition. This decision has consequence for the alarm wiring, as a Normally Open (NO) contact will be closed when the value falls within the low and high limit.
- Determine high and low trip points for each alarm.

NOTE
The analyzer has a database with specific set points for each individual beer type. As the adjustment of the set points is liquid type dependant, the procedure for changing the set points is covered in chapter "Liquid selection and editing", paragraph "Editing liquids".

3.5.3 Procedure
► Through the *Configuration* menu, press **[Alarm]**
► After choosing *Alarm 1* or *Alarm2,* press **[Alarm 1/2 name/unit]** to choose the parameter to be monitored.
► Here you can choose between the *Calculated polynomial* (the concentration) and one of the measured values

If you choose for *Calculated Polynom:*
► Press **[Polynom 1/2 calculated]**
You will be returned to the *Alarm 1 or 2* menu.

If you chose for one of the *Measured values*:
► Press the button **[More settings]**
► Press the button of the desired value
You will be returned to the *Alarm 1 or 2* menu.

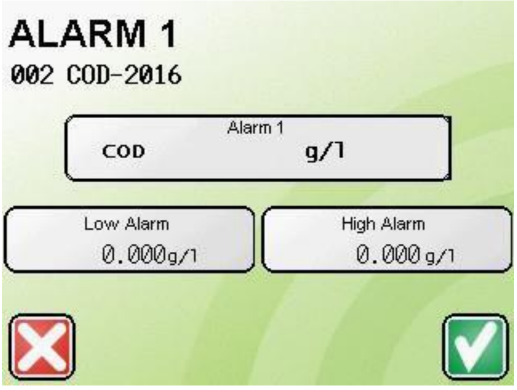


Figure 20: *ALARM 1* page

NOTE: Usually this would be the main parameter, i.e. concentration in %w/w.

► Press **[Low Alarm]**
► Enter the value that should correspond to low alarm (via pop up keypad)
► Press **[Enter]** (automatic return to the *Alarm 1* page)
► Press **[High Alarm]**
► Enter the value that should correspond to high alarm (via pop up keypad)
► Press **[Enter]** (automatic return to the *Alarm 1* page)
► Press **[Accept]** (after pressing Accept it may take up to 10 seconds to return to the *Alarm configuration* page)

Repeat these steps for *Alarm 2* if desired.

IMPORTANT:
Changes made to the alarm settings of an individual liquid will remain valid until the alarm settings for this liquid are changed again.

3.6 Trouble shooting

3.6.1 Preparation.

- For trouble shooting, it is important to record as much data as possible
- Use of the memory stick feature allows you to log measurement data
- The memory stick can be used to download all settings of the analyzer
- The memory stick can be used to download a typical waveform, which can be useful for trouble shooting
- Record other observations, i.e. pipe full/empty and/or laboratory gathered samples with results and time tag, in order to compare with the analyzer results
- For factory back-up, you can send stored files with your comments, facilitating fast response from the factory

3.6.2 Memory Stick Logging

- ► Slide the empty USB memory stick in the U-A connector of the display
- ► Check that the USB memory stick flashes, indicating write/read actions
- ► Wait until the continuous flashing stops (the display is making folders on the USB stick, this should take about 5 minutes)
- ► Open “Logging” in the Information / Diagnostics menu
- ► Enter the log sampling time
- ► Press “Start logging”. The main measurement page should indicate that the logging process is active.

All main data, detail data, and a time tag is recorded in a temporary file on the memory stick.

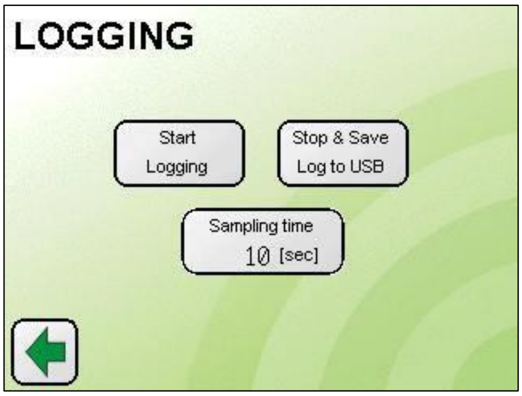


Figure 21: *LOGGING* page

IMPORTANT
Never take out the memory stick without stopping the log process first
ALWAYS wait until the memory stick stops flashing (may take several minutes)
The data will be stored in the following folder: RHO\SAMPLE\. In this folder, you will find folders, indicating the day in the format YYMMDD. After day, the last data is assembled in a .CSV file, and a new folder is created for the next day of logging.
The .CSV files can be easily opened with Excel. The stored .BIN files are temporary files and cannot be opened, converted or used otherwise.

3.6.3 Procedure to stop logging on USB memory stick

- ► Press “Stop & Save Log to USB”
- ► Wait until the page “Saving data to USB” is disappeared from the screen, this may take up to 5 minutes
- ► Remove USB stick and check the log data with Excel

3.6.4 Verifying the Ultrasonic Signal Waveform

3.6.4.1 <u>Purpose</u>

The purpose is to verify the proper operation of the analyzer with regard to the ultrasonic echo. Its visualized waveform (time vs. amplitude plot) can be an aid to identify problems which are related to the process (gas bubbles, faulty cable etc.) When you are asked by the factory or your sales agent to submit a waveform for diagnostics purposes, please follow this procedure.

NOTE: Please read the previous section to learn details about the memory stick that can be used.

3.6.4.2 <u>Procedure</u>

- ► Open “Echo” in the Information / Diagnostics menu
- ► Press “Refresh” and an echo will be displayed

Some examples and explanations are given below:

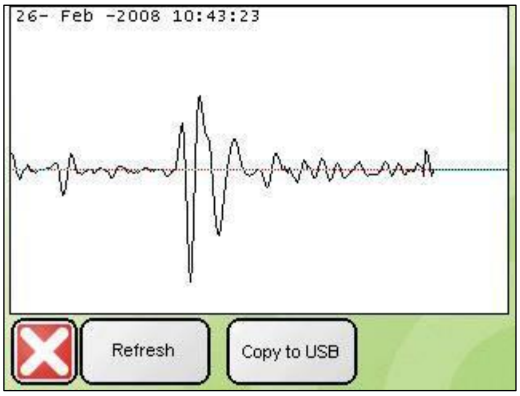


Figure 22: *Example of a “good” echo.*

The x-axis is the time axis, typically the total span is 15 microseconds. With large sound paths, the total span could be up to 100 microseconds.
The Y-axis is the amplitude of the sensor at a given time.
From left to right, you should see a horizontal line, with little “noise”. The actual echo should begin with a large negative going peak. After the echo (about 2 periods wide), some noise occurs which is normal.

- ► Press “Copy to USB” to copy the echo displayed to an USB memory stick.
- ► You may repeat several times with intervals of your choice (for instance when something unexpected happens). Please make notes of the unexpected situations and record the time and date. A maximum of 100 waveforms can be stored on the memory stick.
- ► Remove the USB stick (AFTER you have stopped the logging, if applicable, as indicated in the previous section).
- ► You may view echo’s with a program capable of reading JPG-files (i.e. Paint)

NOTE:
The data will be stored on the USB stick in the following folder: RHO\HDCOPY\. In this folder, the JPG-file will be stored as HD595~00.JPG. The ~00 is the number of the echo stored on the USB stick. If more than 100 echoes are stored, the first JPG-file will be overwritten.

3.6.4.3 Examples of ultrasonic waveforms

Please refer to the previous section for a general explanation. This echo is extremely good, as there is no noise before the echo (left = before). The system will measure the time based on the first negative going ½-period, which is clearly identifiable.

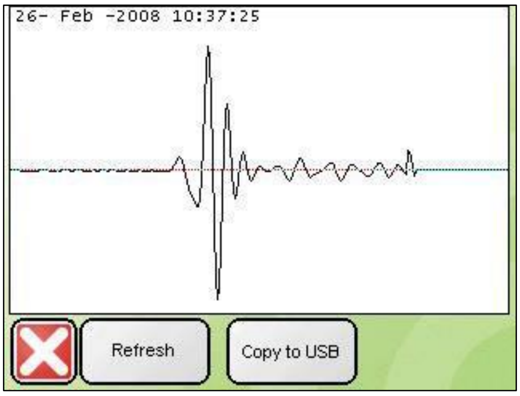


Figure 23: *Example of a "good" echo with PEEK window sensors.*

This waveform has more noise before (left side of) the arrival of the echo. When noise further increases, the analyzer will disregard it and will try to get a better return echo. The system makes up to 30 measurements including echo evaluations per second.

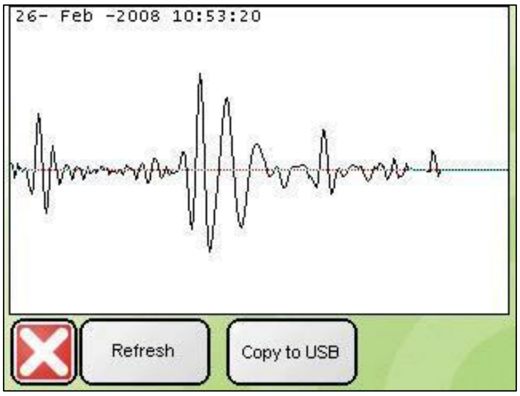


Figure 24: *Example of a "fair" echo.*

This waveform has a lot of noise before (left side of) the arrival of the echo. The echo is barely identifiable in the middle of all the noise.
This echo is typical for gas bubbles adhering to the probe surface, what happens with liquids with dissolved air at ambient pressure conditions.

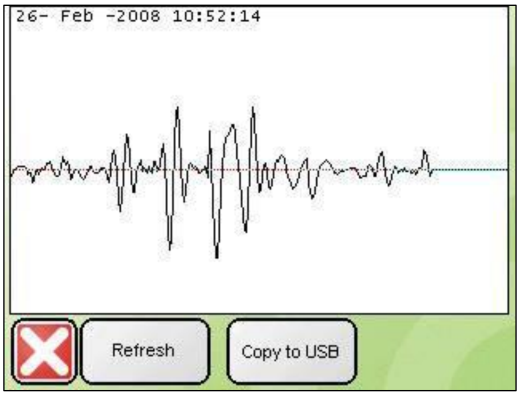


Figure 25: *Example of a "poor" echo.*

This waveform is only noise and no echo,
The echo is not identifiable in the noise.
This echo is typical for a defective probe or cable and/or false probe settings.

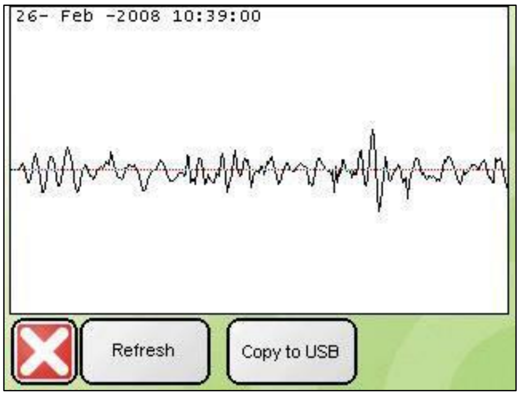


Figure 26: *Example of "Bad" echo.*

ACTIONS:

- ► Press "Refresh" and wait until a new echo will appears. (2 seconds)
- ► Repeat this a couple of times.
- ► The echo pattern either changes significantly, OR the echo pattern remains the same.

Repeatable echo pattern:
When the echo pattern remains the same, then gas bubbles may adhere to the probe. Remove gas bubbles and prevent this from happening again. One way to prevent this is to increase the pressure, or to take other measures to prevent gas bubbles to adhere to the probe surface.

Random echo pattern:
When the echo pattern changes each 2 seconds after pressing "Refresh", then you may have a cable problem (ground or shield), OR your probe may be defective, OR the liquid may contain suspended gases.

- ► If possible, shut down the pump to see it there is improvement. If yes, then it is likely that the pump causes cavitations, or the probe is mounted at the suction side of the pump, which may cause flashing.
- ► When suspended gases are not the problem, check the continuity of the cable (coax) with a universal ohm meter. Disconnect the cable at both ends, then check the resistance between center conductor and shield (infinite ohms).
- ► Ask another person to connect the center conductor with shield at the other end and check the resistance (should be less than 1 ohm per 10 meter of cable).
- ► If the cable is OK, verify the probe by immersing it in water.
- ► With "Liquid select", switch to "1 – Water".
- ► Check the waveform. If the situation is still the same, then your probe is defective. If the situation is now normal, the problem is caused by the liquid as explained above. Please consult your distributor to discuss the problem and possible solutions.

3.6.5 Factory diagnostics to USB

3.6.5.1 Purpose

For trouble shooting purposes, the factory or the service engineer of your sales representative may ask you to copy the factory settings to a USB stick and send these settings to Rhosonics.

3.6.5.2 Preparation.

NOTE: Please read the previous section(s) to obtain information about the type of memory stick to be used.

1. Press “**Save settings to USB”** in the Information / Diagnostics screen
2. Wait until the page “Saving data to USB” is disappeared from the screen, this may take up to 60 seconds
3. Remove USB stick and open the folder RHO\RECIPE on the USB stick

3.6.6 Hard copying screens

3.6.6.1 Purpose

For trouble shooting purposes, the factory or the service engineer of your sales representative may ask you to copy relevant screens to the USB stick, in order to be better able to see what you are seeing on your screen(s).

3.6.6.2 Procedure.

You can make a screen shot of all individual pages by just pressing F5 on the right hand pane of the touch screen.
Each time, a unique image is stored in the \RHO\HDCOPY of the USB stick. By copying relevant pages, either during calibration or during operation, it will be easy to communicate specific pages of interest to the USB stick.
Once you are done with copying display images to the USB stick, you may take out the stick and view the images on your PC, e-mail them to your service agent, etc.

4. Liquid Selection and Editing

4.1 Liquid (product) selection

4.1.1 Purpose:
To make one previously stored liquid calibration the new and active calibration. When your analyzer is used for one specific type of liquid only, the liquid select procedure may not be of interest to you.

4.1.2 Procedure (manual selection):
The *Liquid Selection* menu is accessible through the *Liquid* menu on the *Main Menu.*

► Press **[Liquid select]** to get access to the selection menu.
The active calibration appears. Information is given about the liquid number and the name of the active liquid calibration.

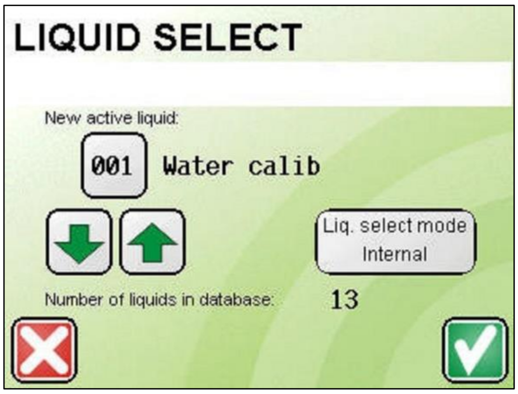


Figure 27: *LIQUID SELECT* page

You may now wish to select another liquid by scrolling through the list with *Previous* and *Next*. If you know the number of the calibration, you can also directly change the number by pressing the liquid number and enter the number of your choice.

4.1.3 Procedure (remote selection):
You can choose for remote selection through this menu.
An active connection between an external selection device, such as a PLC or remote switch is required to make this work correctly.

Choose *Remote selection* when your system is wired for remote product selection. Otherwise, leave this setting to manual.

4.2 Editing liquids (polynomial calibrations)

4.2.1 Introduction
For a proper operation, it is vital that you obtain right calibration data sheet for your liquid. The polynomial constants, in conjunction with the built-in algorithm, compute the concentration from both sound speed and temperature data. These essential data have been established in the factory and sometimes may need to be changed, for instance when the liquid recipe is changed.

This section describes how you can edit existing polynomial calibrations and how to enter new constants from an existing data sheet (sent by the factory).

4.2.2 Purpose:

- To select previously stored liquids, with their specific settings.
- To add new and modify existing liquid names and factors.
- To edit alarm trip points for each liquid type.
- To restore field calibration data or duplicate field calibration data from other analyzers into this analyzer.
- To edit polynomial constants according to Liquid Datasheet sent by Rhosonics

4.2.3 Preparation for editing liquid parameters

- Obtain the liquid data sheet from the factory
- If applicable, obtain the desired alarm trip points for the variables you wish to monitor.

4.2.4 Procedure

► Through the *Liquids* menu, choose *Liquid edit.*
► Select the liquid number that you wish to edit or want to use for a new liquid.
► Edit the name. You may use characters and numbers. The maximum length is 16.
► Edit the minimum and maximum sound speed, as given on the liquid data sheet. This will overwrite the minimum and maximum sound speed of the selected liquid in the liquid database. Be aware that incorrect setting of the minimum and maximum sound speed can make a proper measurement impossible.
► Press **[More settings]** or **[Main]** to save the minimum and maximum sound speed and to go to the next page or go back to the Main menu (after pressing **[More settings]** or **[Main]** it may take up to 10 seconds to enter the next page)
► Edit the Laboratory and Indicated values after pressing **[More settings]**
► Press **[More settings]** or **[Main]** to save the Laboratory and Indicated values and to go to the next page or go back to the Main menu (after pressing **[More settings]** or **[Main]** it may take up to 10 seconds to enter the next page)

Next step (after pressing **[More settings]**) is the adjustments of the alarm trip points. This is explained in the next section.

4.2.5 Adjusting individual alarm trip points.

You may adjust the alarm trip points for each stored product.
The source of the alarm, i.e. concentration or temperature etc., is determined in the configuration menu.

► Press **[Low Alarm]**
► Enter the value that should correspond to low alarm (via pop up keypad)
► Press **[Enter]**
► Press **[High Alarm]**
► Enter the value that should correspond to high alarm (via pop up keypad)
► Press **[Enter]**
► Press **[Accept]**

Repeat these steps for *Alarm 2* if desired.

Next step is (after pressing **[More settings]**) the editing of the polynomials of the liquid, which calculate the concentration. This is explained in the next section.

4.2.6 Adjusting polynomials.

CAUTION:

Changing polynomials may lead the incorrect concentrations. Only perform this action if Rhosonics asked you to do so.

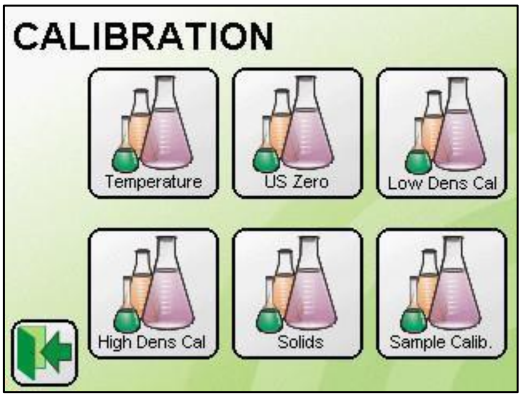
Rhosonics may send you a new Liquid Datasheet with new liquid polynomials to improve the concentration calculation. To enter the new polynomial values into a liquid follow the next steps.

► Select the liquid number that you wish to edit
► (Optional) Edit the name. You may use characters and numbers. The maximum length is 16.
► Edit the minimum and maximum sound speed
► Press **[More settings]**
► Make sure Laboratory and Indicated value are 1 for any NEW set of data to be entered.
► Press **[More settings]**
► (Optional) edit alarm low and high trip points.
► Press **[More settings]**
Now you get to the most important part, editing the polynomial data.

► Edit ALL parameters exactly as indicated on the data sheet (below)
► Press on each square with a parameter, then
► For each parameter, Enter the corresponding value from the Liquid Datasheet through pop-up screen, and always start with the NUMBER first, then the + or – sign.
► Double check everything. Check the minus signs! And the exponents.
► Press pressing **[More settings]**)
This step is optional. Only set Q and R settings when the factory has given instructions to do so. So normally, press **[Main]**

5. Calibration

You may calibrate the analyzer in order to assure optimal analysis results. This section describes the different calibration routines, and the intervals which are required.



5.1 Types of calibration

The following table lists the different types of calibration, their purpose and the interval required to perform these calibrations.

Calibration type	Purpose	Interval
Zero calibration	Calibrate the ultrasonic sensor	Rarely, probe repl.
Sample Caleb.	Make reading equal to laboratory result, at target level.	Once, after startup. 3 month interval
Temperature offset	Proper temperature compensation	Monthly check, 12-months calibration
Low Dens Cal	None for COD	Factory
High Dens Cal	None for COD	Factory
Solids	Optional for monitoring solids	Once, after startup. 3 month interval
Conductivity probe	Initial calibration	Factory, after repair
4~20 mA output	Zero/span of analog output	Factory, after repair
Temperature electronic	Electronic basic calibration	Factory, after repair
Polynomial calibration	Optimal linearization & compensation	Once, by factory
Probe calibration	Entering probe data from probe calibration data sheet (PCDS)	Replacement/repair of probe

There are calibrations to be performed after you have installed the analyzer.
These procedures are discussed in detail in the following sections.

5.2 Temperature offset

5.2.1 Purpose
The analysis result and the linearity highly depend on the integrity of the temperature circuit. The temperature offset calibration provides a simple and effective way to apply corrections to the temperature measurement, should this be necessary.

5.2.2 When needed
Check the temperature reading regularly, and perform a calibration when the reading error exceeds 0.5 ºC. It is advised to calibrate the temperature sensor with a laboratory calibrated sensor, as other temperature sensors in the same process may lack accuracy or may not be representative for the temperature at the installation location of the probe.

5.2.3 Procedure
- ► Read the temperature as indicated by the analyzer
- ► Read the temperature as indicated by your laboratory device.
- ► Calculate how much higher or lower the analyzer should read.
- ► Add this value (subtract if negative) to the current offset value of the probe.
- ► Enter this value through the menu *Configuration-Sensor-US sensor 1*
- ► Check that your correction had the desired effect.

NOTE
After this calibration, the zero calibration MUST be performed.

5.3 Zero (water) calibration (ultrasonic sensor)

5.3.1 Purpose
The zero calibration is necessary as any error at zero concentration may lead to an offset at all results.
The final purpose is to make the analyzer read zero when the probe is in pure water (DIW).

5.3.2 When needed
This calibration is usually performed in the factory. It may be repeated after installation, or prior to installation if it is not possible to fill the pipe line with pure water.
This type of calibration is rarely needed for Model 9585.

5.3.3 Procedure
The zero calibration is one that is easily done, but it can also be done incorrect. Be careful when you perform this procedure, and make sure that you are working with pure water (<<0,01 g/l TDS)

- ► Start the procedure in the menu *Configuration-Calibration-US Zero calibration*
- ► After 60 seconds the procedure is finished
- ► Press **[Accept]**

NOTE
After this calibration, the Sample Calibration MUST be performed. The conductivity calibration is optional.

5.4 Low Dens Cal
This is the low density calibration. It has no purpose for the COD measurement.
It is advised not to use it.

5.5 High Dens Cal

This is the high density calibration. It has no purpose for the COD measurement.
It is advised not to use it.

5.6 Solids (Calibration)

NOTE: THIS PROCEDURE IS NOT NECESSARY WHEN THE SYSTEM ONLY IS USED FOR MEASURING DISSOLVED COMPONENTS.

5.6.1 Purpose

For accurate measurement of solids. Zero and span are adjusted

5.6.2 When needed

- After cleaning of the probe
- When a probe is replaced.
- When there is reason to believe that an offset error exists.
- Calibration for a particular type of solids

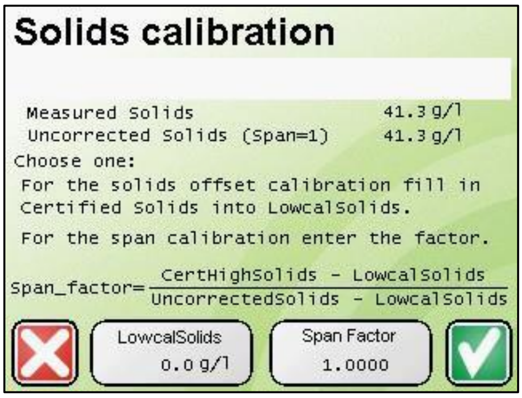
5.6.3 Procedure

For tank sensors:

- ► Install your sensor in a bucket of clean water.

For inline sensors:

- ► Fill the pipe with clean, degassed water or clean process liquid
- ► Verify that no gas bubbles are present (reading should be stable and no air bubbles should accumulate on the sensor head
- ► Press “Solids calibration” (through Main Menu-Calibration). The following menu appears:
- ► Now enter 0.



Repeat the procedure if solids calibration is desired at a particular solids level.
Now, enter the solids level or enter a multiplier factor.

5.7 Conductivity sensor calibration

5.7.1 Purpose

To initially adjust offset and span factors for a specific sensor / electronics combination.

5.7.2 When needed

This procedure is only needed when a probe is replaced.
The zero offset and span factor are initially calibrated by the factory, so the procedure is only needed when the conductivity probe is replaced.
Please note that a solution with a known conductivity is necessary to perform this calibration. Therefore, the procedure is only recommended when a probe is replaced. To correct analysis results and to make them match laboratory results, the Field Sample Calibration procedure is a far better tool to optimize your analysis results.

Zero calibration: **ONLY** necessary when the zero reading is higher than 1 mS/cm, otherwise skip this step.
Reference calibration: **ONLY** do this when you can test your sensor under laboratory conditions, otherwise skip this step.

5.7.3 Procedure

IMPORTANT:
Please read the previous section before you start this procedure.

- ► Start the procedure in the menu "*Configuration-Sensor-Conductivity Sensor-Calibration"* menu.

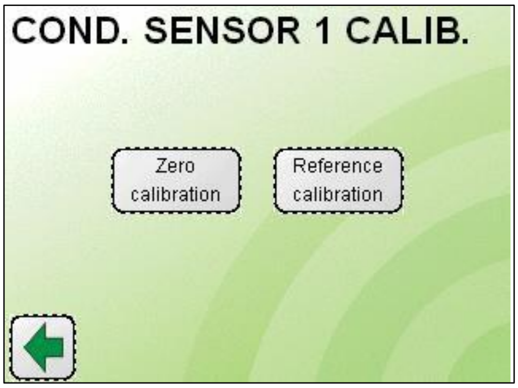


Figure 30: *COND. SENSOR 1 CALIBRATION* page

- ► Hold the probe in air, then press **[Zero calibration]**.
- ► Read the instructions on the screen. Basically, hold the probe in air and wait about one minute before you press **[Accept]**
- ► Reference calibration: only do this when you can test your sensor under laboratory conditions, otherwise skip this step.
- ► Hold the probe in your certified reference sample
- ► Press **[Reference calibration]**.
- ► Read the instructions on the screen. Wait for 5 minutes before completing this procedure.
- ► Enter the conductivity value of your reference sample.
- ► Enter the current liquid temperature measured with the analyzer. The ultrasonic sensor has to be in the same liquid, to measure the temperature.
- ► Press **[Accept]**

IMPORTANT
After you have finalized this calibration, **the analyzer will read the uncompensated conductivity ONLY.**
The reason is that the liquid calibration has its own specific temperature compensation, which is not a constant factor, as it depends on the concentration levels of both components. The system only applies a constant temperature correction during conductivity calibration, assuming that most calibrations are done using solutions of NaCl.

5.8 Sample calibration

5.8.1 Purpose

The sample calibration is intended as a fine tuning tool to provide additional accuracy to the existing concentration calibration system.

5.8.2 When needed

The equipment has been verified prior to shipping. After installation, this calibration procedure needs to be carried out improve the accuracy of the COD analyzer. The adjustments which are described in this procedure are only possible when the process is running.

5.8.3 Basic procedure of calibration

There are 2 ways to perform a calibration to improve the accuracy of the COD analyzer:

- ✧ Simple Sample calibration
- ✧ Collecting data over time and make a Sample calibration with average deviations

To perform the following calibrations, first make sure that the process is running and constant.

5.8.4 Sample calibration (simple)

Goal is to perform the Sample calibration you need to verify a sample on Chemical Oxygen Demand (COD) and Conductivity at 25°C (Cond@25°C).

1. Take a sample and enter Calibration➔ Sample calibration, do not leave the screen until the sample is verified by the laboratory
2. Verify the sample on COD (in g/l) and Cond@25°C (in mS/cm)
3. Enter the correct certified COD and Cond@25°C and press Accept
4. Check if COD and Cond@25°C reading is approximate to your certified COD and Cond@25°C.
5. If not satisfied with the result you can perform another Sample calibration.

Notes:

- The Rhosonics analyzer is calculating the COD with polynomial 1 and is correcting it for salts with Conductivity with polynomial 2.
- COD is calculated in gram per liter, so the verified value should be entered in gram per liter as well.
- Conductivity is calculated and corrected to the conductivity at 25 °C, so the verified value should be entered in mS/cm@25°C. Most (portable) conductivity sensors are indicating in mS/cm@25°C.

5.8.5 Sample calibration (average deviations)

Goal is to determine the average COD and Cond@25°C deviation over a longer period of time and enter these deviations using a Sample calibration.

5.8.5.1 <u>Determine the average deviations</u>

There are 2 steps to determine the average deviation of both calculated values (COD and Cond@25°C).
First step is taking samples retrieve indicated data of the analyzer:

- By hand
- Using the log file

<u>By hand</u>

1. Take a sample and note the COD value and the Cond@25°C on the analyzer at the same time
2. Determine the COD and Cond@25°C of the sample in the laboratory
3. Collect these data in a datasheet (i.e. Excel)
4. Repeat step 1 to 3 for at least 10 times on different times
5. Go to chapter "Calculating average deviations"

<u>Using Log file</u>

Make sure the Logging is on, see manual how to start and stop logging.

1. Take a sample and note the time (indicated on the analyzer)
2. Determine the COD and Cond@25°C of the sample in the laboratory
3. Collect these data in a datasheet (i.e. Excel)
4. Repeat step 1 to 3 for at least 10 times on different times
5. When enough data are collected, please retrieve data from the log file at corresponding times. Below is an example of a (part of a) log file with highlighted data (yellow) you will need.

			Sound speed [m/s]	Temperature [°C]	Attenuation [dB]	Error number	Conductivity [mS/cm]	SG	Solids [g/l]	tof LE	tof RE	tof IE	Power LE	Power RE	Power IE	ZI
			1520.312	31.465	25.008	0	0.947	1088.307	10.271	202704.2	10231.2	18546.8	-17.469	-18.280	-13.483	1.647
			1520.362	31.497	24.974	0	0.944	1088.396	10.278	202697.6	10231.1	18546.8	-17.464	-18.273	-13.477	1.647
			1520.31	31.525	25.031	0	0.936	1088.112	10.319	202704.7	10231.2	18546.8	-17.481	-18.275	-13.476	1.646
			1520.23	31.533	25.102	0	0.928	1088.371	10.359	202715.3	10231.0	18546.7	-17.493	-18.273	-13.474	1.647
			1520.141	31.532	25.053	0	0.927	1088.301	10.404	202727.2	10231.1	18546.6	-17.510	-18.273	-13.473	1.646
			1520.073	31.51	25.031	0	0.928	1087.654	10.411	202736.3	10231.1	18546.6	-17.517	-18.277	-13.471	1.645
			1520.037	31.486	25.053	0	0.931	1087.900	10.442	202740.9	10230.9	18546.5	-17.523	-18.273	-13.468	1.646
			1519.828	31.442	25.046	0	0.923	1088.529	10.416	202768.7	10231.0	18546.3	-17.511	-18.270	-13.470	1.646
			1519.739	31.415	25.092	0	0.921	1088.318	10.517	202780.4	10231.0	18546.2	-17.544	-18.266	-13.464	1.646
			1519.732	31.392	25.077	0	0.922	1087.828	10.501	202781.3	10230.9	18546.1	-17.544	-18.273	-13.465	1.645

Below the yellow part of the log file is magnified.

	Measured	
Date + time	COD [g/l]	Cond@25°C
12-08-16 11:57:25	16.619	2.312
12-08-16 17:44:33	4.562	8.153
12-08-16 23:59:09	2.123	0.817
13-08-16 6:03:50	15.321	0.321
13-08-16 12:12:00	16.302	7.253
13-08-16 17:58:06	2.315	1.548
14-08-16 0:12:14	16.216	10.653
14-08-16 5:58:27	18.251	9.251
14-08-16 11:58:34	1.236	0.824
14-08-16 11:58:40	16.008	1.587

6. Find the indicated COD and Cond@25°C data at corresponding times of taking a sample
7. Collect these data in the datasheet of point 3.
8. Go to chapter "Calculating average deviations"

The second step is calculate the average deviations of the COD and Cond@25°C.

Calculating average deviations

1. Arrange the datasheet with measured values (analyzer) and real values (laboratory values) like below.
2. Calculate the difference for each sample
3. Calculate the Average for COD and Cond@25°C

	Measured		Laboratory		Calculation (Lab-measured)	
Date + time	COD [g/l]	Cond@25°C	COD [g/l]	Cond@25°C	COD [g/l]	Cond@25°C
12-08-16 11:57:25	16.619	2.312	15.389	2.217	-1.23	-0.095
12-08-16 17:44:33	4.562	8.153	4.593	8.563	0.031	0.41
12-08-16 23:59:09	2.123	0.817	0.796	0.765	-1.327	-0.052
13-08-16 6:03:50	15.321	0.321	16.352	0.396	1.031	0.075
13-08-16 12:12:00	16.302	7.253	15.698	8.654	-0.604	1.401
13-08-16 17:58:06	2.315	1.548	3.698	1.265	1.383	-0.283
14-08-16 0:12:14	16.216	10.653	13.852	10.945	-2.364	0.292
14-08-16 5:58:27	18.251	9.251	16.459	9.469	-1.792	0.218
14-08-16 11:58:34	1.236	0.824	2.981	0.685	1.745	-0.139
14-08-16 11:58:40	16.008	1.587	15.234	1.259	-0.774	-0.328
				Average	-0.390	0.150

5.8.5.2 Entering the average deviations into the analyzer

1. Go to Sample calibration
2. Note the indicated value for COD and Cond@25°C
3. Correct the indicated values according the following equations

$$COD_{result} = COD_{indicated} + COD_{Average\ Deviation}$$

$$Cond@25°C_{result} = Cond@25°C_{indicated} + Cond@25°C_{Average\ Deviation}$$

In our example this is:

$$COD_{result} = 7.569 - 0.390 = 7.179$$

$$Cond@25°C_{result} = 1.295 + 0.150 = 1.445$$

4. Press OK

Note:
In time the conditions of the Rhosonics sensors will change, so Rhosonics recommend to perform a Sample calibration (Simple or Average deviations) on regular base (i.e. once a month, once a year, once every 2 years).

5.8.6 Undo Sample Calibration Procedure

Procedure

- ► Enter the Calibration menu, and press **[Sample Calibration]** (Access level 2 required) OR press the **[Sample Calibration]** (Access level 2 required) on the second measurement page.
- ► The measured parameters are now stored in the system, and will be used to compute new calibration constants later on.
- ► Press Accept to go to next page.
  One is for Poly (1): COD. This value will be used to correct the first analysis result of the Model 9585.
  The second will be the result of Poly(2): mS/cm25C (equivalent conductivity at 25°C)
- ► Fill in for both Laboratory values: 9999.
- ► Press **[Accept]**.
- ► The display will automatically return to the measurement page and the original factory values are restored.

6. Maintenance

6.1 Introduction

Most maintenance is covered by the Chapter "Calibration" of this manual.
The table in this chapter gives an overview of the most common maintenance requirements of the system.

6.2 Trouble shooting

The operation of the probes and the system can be checked by following the procedure as described in the Calibration Chapter of this manual. In addition, it is useful practice to record some values for later reference, or should problems occur.
By comparing these data with previous observations, you may be able to anticipate probe or system failures. The following table is listing some useful information sources.
When you need factory assistance to solve a problem, monitoring the values as mentioned in the table will help to find the source of the problem.

Measurement	What to record	Interval
Time (transit time)	The transit time, and the variation of it.	Should be other than zero. Only required if problems occur
Gain/attenuation	The attenuation reading. Should be lower than 60.	Once during normal operation, thereafter if problems occur.
Sound speed	The speed measurement	For factory assistance, during problems
Temperature	Zero/span of analog output	Once during normal operation, and for factory assistance
Conductivity	The conductivity and its min/max value during normal operation. (uncompensated)	Once during normal operation, thereafter if problems occur.

6.3 Probe cleaning

The probes are constructed so that they can be easily replaced for cleaning or flushed by purging the sample system with water or clear process liquid.
Replace packing glands and/or O-rings, using O-ring material which is suitable for the process. (I.e. Viton for most acids, Kalrez, etc.) Original O-rings are available from the factory.
Probes can be cleaned using a suitable detergent, using a brush with nylon hairs. After cleaning, the probes must be calibrated. See section "Calibration" for instructions.
The conductivity probes are usually made of PEEK. They do not have any electrodes, making them virtually maintenance free. After cleaning the probe with a commercially available detergent, inspect the probe surface and make sure that it is not cracked. The hole in the middle must be completely free of foreign materials. Replace the O-rings before reinstallation.
The orientation of the conductivity probe must be such, that axis of the hole in the middle is same as the pipe axis, and must be vertical. Note that the flow direction is ideally bottom-up, because in that position occasional gas bubbles are allowed to escape from the top of the cell(s) quite easily. Otherwise, when the sample fluid contains high concentrations of suspended solids, like metal oxides, a top-down orientation is better to avoid accumulation of solids inside the cells. In any case, the presence of solids the installation of additional filters, trapping devices, settling tanks, etc. in order to extend service intervals.

6.4 4-20 mA OUTPUT calibration

It is normally NOT necessary to (re)calibrate the analog outputs.
If there is a doubt about the analog conversion of the concentration value, or in case you wish to do a system loop calibration, this procedure may be followed.
Note that the sole purpose of this calibration is to calibrate the electronic output, which is normally drift free.

Procedure to calibrate the 4-20 mA OUT 1:

► On the *Main* page, press **[Configuration]**
► On the *Configuration* page, press **[4-20 mA OUT]** to enter the *4-20 mA OUT calibration* page

Figure 34: *4-20 mA OUT 1 CALIBRATION* page 1

► On the *4-20 mA OUT* page, press **[4-20 mA OUT1 or 2]** to enter the *4-20 mA OUT 1 or 2 calibration*
► Connect the current input of a DMM to the 4-20 mA OUT1 of the analyzer, mind the polarity
► Switch the DMM to current measurement with a range of minimal 25 mA
► On the *4-20 mA OUT 1 calibration* page 1, press **[Low current]**
► Observe the *Low DAC* value, wait till the *Low DAC* value is stable
► Enter the exact current measured by the DMM (via pop up keypad)
► Press **[Enter]** (automatic return to the *4-20 mA OUT 1 calibration* page 1)
► Press **[Accept Low]**
► On the *4-20 mA OUT 1 calibration* page 1, press **[Calibrate High value]** to enter the *4-20 mA OUT 1 calibration* page 2
► On the *4-20 mA OUT 1 calibration* page 2, press **[High current]**
► Observe the *High DAC* value, wait till the *High DAC* value is stable (±10)
► Enter the exact current measured by the DMM (via pop up keypad)
► Press **[Enter]** (automatic return to the *4-20 mA OUT 1 calibration* page 2)
► Press **[Accept High]** (automatic return to the *4-20 mA calibration* page)

NOTE:
Repeat this procedure to calibrate 4-20 mA OUT2.

7. Frequently asked questions

7.1.1 Installation questions

Q: Do I need to calibrate the analyzer prior to installation?
A: The analyzer has been calibrated and tested in the factory. There is no need to (re)calibrate the analyzer before installation, because all specific adjustments and calibrations can be done with a fully installed analyzer.

Q: I want to install the analyzer in a pipe line close to a pump. Is this possible?
A: Yes, but install the analyzer downstream of the pump. If cavitation can be expected, it is better to stay at least 5 pipe diameter length away from the pump.

Q: What is the effect of pressure?
A: There is no noticeable effect of pressure, as long as the pressure does not increase above 10 bars. The sound speed may be affected above this pressure, but in case you are running the analyzer at a higher pressure, this must have been discussed before delivery.
If the pressure is atmospheric or lower, then there is an increasing risk of gas bubbles. If installation in an atmospheric tank is required, we recommend installing the probe near the bottom of the tank, as to avoid build-up of gas bubbles on the sensor surfaces. In certain cases, degas systems can be installed to avoid these problems. Contact the factory or your local agent to discuss possible solutions.

7.1.2 Operation questions

Q: I just installed the analyzer and I am getting all kinds of error messages. How is this possible?
A: After power-up, the analyzer will try to make a valid measurement. As the analyzer has an automatic system to detect the presence of liquid and gas bubbles in the pipe line, it is likely that the pipe is not (completely) filled with liquid. Make sure that product is in the pipe line. Also check the above recommendations in the FAQ installation section.
Some error messages do not necessarily mean that there is malfunction of the analyzer. For instance, if the purpose of the instrument is to measure the suspended solids, specific errors may occur due to the fact that the analyzer fails to make a proper sound speed measurement. Attenuation measurements do not depend on signal quality.

Q: How can I check that the analyzer is working properly?
A: The analyzer will show no error message on the top of the measurement screen.
You can also check the detail measurement screen and compare the values with the values which are considered to be normal, as described in the section “normal operation” in this manual.

Q: How can I calibrate the analyzer?
A: Instrument calibration, i.e. electronic circuits, probes, outputs etc. have been calibrated in the factory and do not need calibration after installation.
When you replace a probe, you will need to enter the probe data, as given in the calibration data sheet, in the configuration menu.
Zero calibration in pure water (<100 mg/l TDS) is recommended every month. Refer to the section “Calibration” in this manual for details.
Polynomial calibration is provided by the factory, while the calibration data already is installed in the analyzer during the final factory test procedure.
A sample calibration at the target concentration is recommended after commissioning, by taking a sample and enter the correct concentration into the analyzer. Unless the product formula changes, this procedure is only required once.

Q: During certain process conditions, it can happen that gas bubbles are present in the liquid. How does this affect the measurement?

A: The Rhosonics Ultrasonic Analyzer automatically detects the presence of product and gas bubbles. It will then freeze the measurement until a next valid measurement is possible. Due to its unique method of operation, the analyzer continues to operate reliably during upset process conditions. The analyzer will not be able to measure when gas bubbles are continuously present or when gas bubbles adhere to the surface of the sensor, which will be the case when measurement are done under atmospheric conditions.

Q: How can I see that I am having gas bubbles in the pipe line?
A: Depending on the amount of gas bubbles, you will see occasional or frequent error messages in the measurement screen. The detail measurement screen provides information about specific ultrasonic parameters, such as the measured (ultrasonic) attenuation, which should normally be at a level between 20 and 50, and constant.

Q: From our tank, we recycle the liquid, using a pump. Can we put the sensors in the main line?
A: The measurement is ideally done while the liquid is pressurized. Sufficient pressure, i.e. 3 to 6 bars, helps to reduce gas bubbles. From this point of view, placing the sensors in the main stream helps reduce this problem.

7.1.3 Calibration (Ultrasonic + Conductivity system)

Q: Can I use water to check the proper operation?
A: Yes, you can. Please check out the Calibration section.

Q: Is it necessary to frequently calibrate the conductivity probe?
A: No, as the Sample Calibration basically replaces the conductivity calibration. Only perform conductivity probe calibration when you suspect conductivity errors larger than 20% of reading. Again, the Sample Calibration fully compensates any error of this magnitude.

Q: The analyzer is reading different concentrations than analyzed in the laboratory. How is this possible and what can I do about it?
A: The algorithm has been established in the factory with at least 9 different samples, each composed of a mix of the 2 chemicals you are measuring. In a real process situation, by-products can be formed, which can affect the readings. You can easily correct this by using the “Sample Calibration” routine. This routine is preferably done at the target concentration.

Q: Do I need to calibrate the 4~20 mA outputs and input?
A: The analyzer has been designed and produced using high quality and drift free components, and calibrated in the factory with high precision methods. Therefore, there is no need to (re)calibrate the outputs.

Q: How can I check that the 4~20 mA outputs are working correctly?
A: Through the “Configuration-Output” menu, you will be able to check the output with the output calibration menu. By selecting the “Low” and the “High” choices alternatively, you can check that the output is indeed providing the amount of current. The output currents have been recorded by the factory and are visible in the appropriate menu items. You can verify these numbers with the indication of your calibrated mA-meter.

8. Technical specifications

8.1 Operation characteristics

<u>Temperature circuit:</u>

Resolution	± 0.001 °C (24 hours warm-up)
Reproducibility	± 0.005 °C (24 hours warm-up)
Range	0 °C through 110 °C (32 °F to 230 °F)

<u>Sound speed circuit:</u>

Resolution	± 0.002 m/s
Reproducibility	± 0.01 m/s
Range	500 m/s through 3000 m/s

<u>Conductivity circuit:</u>

Resolution	± 1 µS/cm (if option is installed)
Accuracy	± 0.5% of reading, 0.1% of span
Non-linearity	± 0.1% of span
Range	0~100 µS/cm up to 0~20000 mS/cm

<u>4-20mA Outputs (2x):</u>

This is an active output.

Resolution	± 0.002 % of FS
Repeatability	± 0.02 % of FS
Output current & load	± 4-20 mA into 450 Ω

<u>Alarm outputs (2x):</u>

Type	SPDT, adjustable low-low high alarm (2x)
Ratings	± 250 VAC - 2A max.

<u>Interfaces:</u>

Serial interface	RS232, RS422, RS485 (optional)
Ethernet	Ethernet available as option

<u>Storage of product calibrations</u>

Calibration polynomials for liquids	1 (standard), 30 (optional)

<u>Measurement Units:</u>

Conductivity	mS/cm
Concentration	%
Solids	g/l

8.2 Options

On customer request the factory will equip the analyzer with either a:

- 100-240 VAC 50/60 Hz converter **or** a 24 VDC converter
- 4-20 mA Output 1 with <u>non-isolated</u> output **or** <u>isolated</u> output

8.3 Supplemental characteristics

8.3.1 Analyzer with touch screen display

Dimensions	235x200x90 mm, (HxWxD)
Dimensions	240x160x60 mm, (HxWxD)
Display effective area	115x86 mm (WxH)
Display resolution and color	320x240 (WxH) monochrome LCD (8 levels)
Touch switch	Analog resistance film type
Weight	± 2.8 kg
Weight	± 1.4 kg
Power consumption	Maximum 35 W (boot), 24 Watts (normal)
Fuse (AC)	1,6AT
Fuse (DC)	3,15AT

8.4 Environmental conditions

WARNING:

To prevent electrical fire or shock hazards, do not expose the instrument to rain or excessive moisture.

8.4.1 Ingress Protection

External touch screen display front side: IP65 (when using gasket)
External touch screen display rear side: IP20
Control unit front side: IP20/55
Control unit rear side: IP20/24
Sensor: IP68

8.4.2 Temperature

To meet and maintain the specifications listed in section 3.1 Operation characteristics, the analyzer should be operated within -30ºC to +20°C of the reference temperature.
The reference temperature is the temperature in which the analyzer was last calibrated. The factory temperature is from 18ºC to 25ºC. Operating the analyzer beyond these limits is possible, but requires modification to meet the specifications listed in section 3.1.
Consult the factory for details.

8.4.3 Humidity

Relative humidity < 95% at 40ºC (non condensing)

8.4.4 Storage conditions

Temperature: -40ºC to +75ºC

9. Technology

9.1.1 Measurement sequence

The Model 9585 employs 3 fundamental components. One of which is an inline ultrasonic sensor, the second is an inline electrodeless conductivity probe and the third is formed by the controller, which is driving the sensors, and computes the chemical % based on the measured parameters.
Its measuring sequence is as follows:

- Send pulse to transmitter
- Receive echoes within echo window from receiver
- Check validity of echo
- Determine transit time and strength of echo
- **Measure temperature**
- **Calculate sound speed**
- **Measure conductivity**
- Calculate concentration 1
- Calculate concentration 2
- Update display
- Update 4-20 mA Outputs

9.2 Ultrasonic velocity of sound

The sound speed of a liquid is very dependent on its composition. Most water-based solutions conduct sound energy and therefore possess a sound speed, which is largely depending upon the concentration of the components. In fact all liquids possess the ability to propagate sound waves and therefore can be characterized using ultrasonic technology.
Pure water, without any ingredients, has a specific speed of sound. At room temperature, the sound velocity of water is near 1500 m/s.
When salts are added to water, normally the sound velocity will change drastically, in most cases between 5 to 10 m/s per weight %. The relationship between concentration and sound velocity is well defined, and usually follows a remarkable straight line, making it an ideal parameter for accurately measuring salts, in particular at high concentrations.
Caustic solutions also have a significant effect on the sound velocity. This is particularly true for KOH and NaOH, where the sound velocity increases with an incredible 25 m/s per weight %.
The temperature has some effect too, however the Rhosonics 9585 measures the temperature accurately and automatically compensates for this effect.
Acids, in particular at concentrations below 20%, have a lot less effect on sound velocity.
When used in binary systems with both acid and salt, the sound speed is for 90% dependant on the concentration of the salt in the solution.

9.2.1 Conductivity

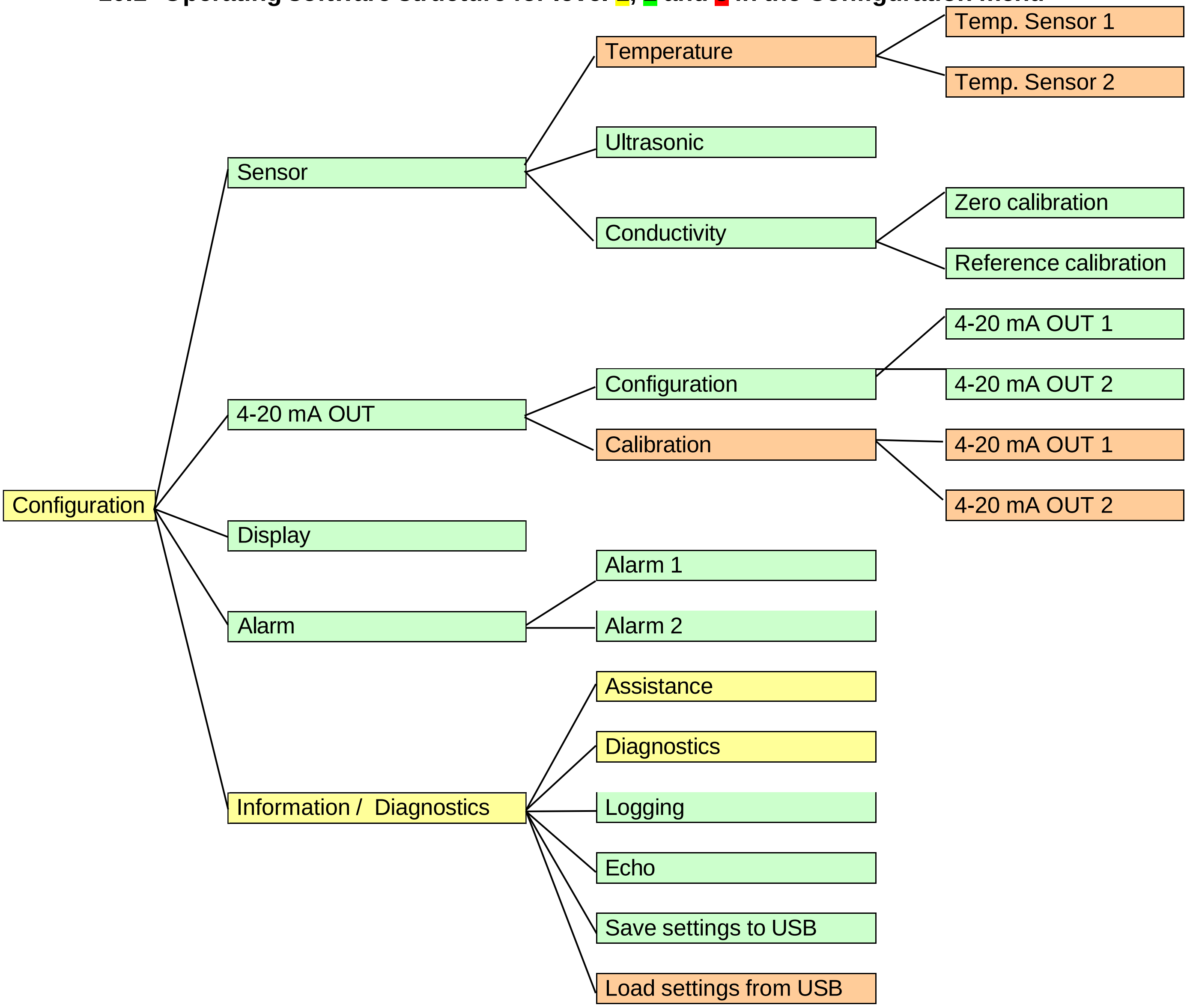
The conductivity is measured with an electrodeless conductivity probe. This probe does not have any electrodeless, usually made of PEEK, making it well suitable for corrosive and dirty liquids.
The conductivity depends greatly on the presence of free ions. In acids, there mobility of ions is much larger than in salt solutions. When there is an acid plus a salt component is present in the liquid, the conductivity in a specific acid concentration may increase when salt is added, but with the same addition of salt, it may decrease at higher acid concentrations.
In addition, the temperature has an effect too.

9.2.2 Combining sound speed and conductivity

Although the relationships are quite complex, Rhosonics has described specific algorithms to describe the exact relationships between the chemical parameters and the temperature, versus the sound velocity and the conductivity. For each salt-acid, or caustic/salt, or alcohol/solid combination, one specific relationship exists. The parameters which describe this relationship have been programmed in the factory and do not need to be changed. For each combination of sound speed, temperature and conductivity, there is a specific value for the salt and the acid concentration.
The Rhosonics algorithm basically defines conductivity and the sound velocity, based on the concentration of the two components and the temperature. By reverse modelling, Model 9585 calculates the concentration of both components from the measured variables.

10. Appendices

10.1 Operating software structure for level 1, 2 and 3 in the Configuration menu



10.2 List of spare parts

- Fuses Ø5x20 mm, 1.6 A (110-240 VAC), slow-blow (not 1.5A as mentioned on the yellow cover plate)
- Fuses Ø5x20 mm, 3.15 A (18-30 VDC), slow-blow

10.3 Options

No options

10.4 Appendix A: Sound speed of water at 0 to 100 °C

T [°C]	c [m/s]	T [°C]	c [m/s]	T [°C]	c [m/s]	T [°C]	c [m/s]
0	1402.388	25	1496.687	50	1542.551	75	1555.133
1	1407.367	26	1499.323	51	1543.619	76	1555.081
2	1412.232	27	1501.883	52	1544.636	77	1554.991
3	1416.985	28	1504.37	53	1545.601	78	1554.862
4	1421.628	29	1506.784	54	1546.517	79	1554.696
5	1426.162	30	1509.127	55	1547.382	80	1554.492
6	1430.589	31	1511.399	56	1548.199	81	1554.251
7	1434.912	32	1513.603	57	1548.967	82	1553.974
8	1439.132	33	1515.738	58	1549.687	83	1553.66
9	1443.251	34	1517.806	59	1550.36	84	1553.31
10	1447.27	35	1519.81	60	1550.986	85	1552.924
11	1451.191	36	1521.745	61	1551.566	86	1552.504
12	1455.016	37	1523.618	62	1552.101	87	1552.048
13	1458.747	38	1525.428	63	1552.59	88	1551.558
14	1462.384	39	1527.176	64	1553.035	89	1551.034
15	1465.931	40	1528.863	65	1553.437	90	1550.476
16	1469.387	41	1530.489	66	1553.794	91	1549.884
17	1472.755	42	1532.066	67	1554.109	92	1549.259
18	1476.036	43	1533.564	68	1554.381	93	1548.602
19	1479.231	44	1535.015	69	1554.611	94	1547.912
20	1482.343	45	1536.409	70	1554.799	95	1547.19
21	1485.372	46	1537.746	71	1554.947	96	1546.436
22	1488.319	47	1539.028	72	1555.053	97	1545.651
23	1491.187	48	1540.256	73	1555.12	98	1544.834
24	1493.976	49	1541.43	74	1555.146	99	1543.987
						100	1543.109

Table 4. Sound speed of water [m/s] at different temperatures [°C]

RHOSONICS
Proven Process Insights

ADDRESS
Hoge Eng West 30
3882 TR Putten

CONTACT
+31 341 37 00 73
info@rhosonics.com