RHOSONICS

Model 9670

Ultrasonic Suspended Solids (TSS) and dissolved solids (TDS) Analyzer

MANUAL

TABLE OF CONTENTS

1. PREFACE 4

1.1 PURPOSE 4
1.2 SYMBOLS AND CONVENTIONS 5
1.3 ABOUT THIS MANUAL 5
1.3.1 CONVENTIONS 5

2. INSTALLATION 6

2.1 INTRODUCTION 6
2.2 ANALYZER INSTALLATION 6
2.2.1 SPLIT TYPE INSTALLATION 6
2.2.2 WEATHER PROOF HOUSING INSTALLATION 8
2.3 SENSOR INSTALLATION 9
2.4 INSTALLING THE CABLES 9

3. CONFIGURATION. 12

3.1 INTRODUCTION 12
3.1.1 TOUCH SCREEN FUNCTIONS 12
3.1.2 PREPARATIONS 12
3.2 ANALOG OUTPUT CONFIGURATION 13
3.2.1 PROCEDURE 13
3.2.2 OUTPUT SOURCE 13
3.2.3 OUTPUT SCALING 13
3.2.4 ERROR COMMUNICATION THROUGH ANALOG OUTPUTS 14
3.2.5 DECAY TIME 14
3.3 DISPLAY CONFIGURATION 15
3.3.1 SELECTING THE RESULTS 15
3.3.2 SETTING THE DISPLAY RESOLUTION 15
3.3.3 DISPLAY SMOOTHING 16
3.3.4 GRAPH SCALING 16
3.3.5 BACKLIGHT TURN OFF TIME 16
3.4 SENSOR PARAMETERS 16
3.4.1 INTRODUCTION 16
3.4.2 PROCEDURE 16
3.4.3 INSTRUCTIONS: 17
3.4.4 AUTO DEAD TIME 17
3.5 ALARM CONFIGURATION. 17
3.5.1 INTRODUCTION 17
3.5.2 PREPARATION. 18
3.5.3 PROCEDURE 18
3.6 TROUBLE SHOOTING 18
3.6.1 PREPARATION. 18
3.6.2 MEMORY STICK LOGGING 19
3.6.3 PROCEDURE TO STOP LOGGING ON USB MEMORY STICK 19
3.6.4 VERIFYING THE ULTRASONIC SIGNAL WAVEFORM 21
3.6.5 FACTORY DIAGNOSTICS TO USB 23
3.6.6 HARD COPYING SCREENS 23

4. LIQUID SELECTION AND EDITING 25

4.1 LIQUID (PRODUCT) SELECTION 25
4.1.1 PURPOSE: 25
4.1.2 PROCEDURE (MANUAL SELECTION): 25
4.1.3 PROCEDURE (REMOTE SELECTION): 25
4.2 EDITING LIQUIDS (POLYNOMIAL CALIBRATIONS) 25
4.2.1 INTRODUCTION 25
4.2.2 PURPOSE: 26
4.2.3 PREPARATION FOR EDITING LIQUID PARAMETERS 26
4.2.4 PROCEDURE 26
4.2.5 ADJUSTING INDIVIDUAL ALARM TRIP POINTS. 26
4.2.6 ADJUSTING POLYNOMIALS. 26

5. CALIBRATION 28

5.1 TYPES OF CALIBRATION 28
5.2 BACKGROUND AND FUNCTIONS OF ZERO AND CLEAR LIQUID CALIBRATION. 29
5.3 CALIBRATION PROCEDURE AND FIRST SETUP 29
5.3.1 CALIBRATION MENU 29
5.4 TEMPERATURE OFFSET 30
5.4.1 PURPOSE 30
5.4.2 WHEN NEEDED 30
5.4.3 PROCEDURE 30
5.5 ZERO (WATER) CALIBRATION 30
5.5.1 PURPOSE 30
5.5.2 WHEN NEEDED 31
5.5.3 PROCEDURE 31
5.6 LIQUID CALIBRATION (ZERO TSS AND SG) 31
5.6.1 PURPOSE 31
5.6.2 WHEN NEEDED 31
5.6.3 PROCEDURE 31
5.7 HIGH DENSITY OR FIELD CALIBRATION 32
5.7.1 PURPOSE 32
5.7.2 WHEN NEEDED 32
5.7.3 PROCEDURE HIGH DENSITY CALIBRATION 32
5.8 FIELD (SAMPLE) CALIBRATION 33
5.8.1 PURPOSE 33
5.8.2 WHEN NEEDED 33
5.8.3 PROCEDURE 33

6. AUTOMATION AND COMMUNICATION. 34

6.1 REMOTE PRODUCT SELECTION 34
6.1.1 PURPOSE 34
6.2 BINARY PRODUCT SELECTION 34
6.2.1 PURPOSE 34
6.3 PRODUCT SELECTION THROUGH RS232 34
6.3.1 PURPOSE 34
6.3.2 METHOD 34
6.4 EXTERNAL HOLD FUNCTION 35
6.4.1 PURPOSE 35
6.5 AUTOMATIC CALIBRATION 35

6.5.1 AUTO DEAD TIME CALIBRATION 35
6.5.2 AUTOMATIC ZERO CALIBRATION 35

7. MAINTENANCE 36

7.1.1 INTRODUCTION 36
7.1.2 INSTRUMENT MAINTENANCE 36
7.1.3 4-20 MA INPUT CALIBRATION 37
7.1.4 4-20 MA OUTPUT CALIBRATION 37
7.1.5 QUICK TROUBLE SHOOTING 38

8. FREQUENTLY ASKED QUESTIONS 39

8.1.1 INSTALLATION QUESTIONS 39
8.1.2 OPERATION QUESTIONS 39

9. TECHNICAL SPECIFICATIONS 41

9.1 OPERATION CHARACTERISTICS 41
9.2 OPTIONS 41
9.3 SUPPLEMENTAL CHARACTERISTICS 41
9.3.1 ANALYZER WITH TOUCH SCREEN DISPLAY 41
9.4 ENVIRONMENTAL CONDITIONS 42
9.4.1 INGRESS PROTECTION 42
9.4.2 TEMPERATURE 42
9.4.3 HUMIDITY 42
9.4.4 STORAGE CONDITIONS 42

10. TECHNOLOGY 43

10.1 MEASUREMENT SEQUENCE 43
10.2 ULTRASONIC VELOCITY OF SOUND 43
10.3 OTHER ULTRASONIC VARIABLES 43
10.4 ATTENUATION 44
10.5 CONVERSION OF MEASURING PARAMETERS 44

11. APPENDICES 45

11.1 OPERATING SOFTWARE STRUCTURE FOR LEVEL 1, 2 AND 3 IN THE CONFIGURATION MENU 45
11.2 LIST OF SPARE PARTS 45
11.3 OPTIONS 46
11.4 APPENDIX A: SOUND SPEED OF WATER AT 0 TO 100 °C 46

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 / aluminium housing. To prepare the installation, please refer to the figures below.

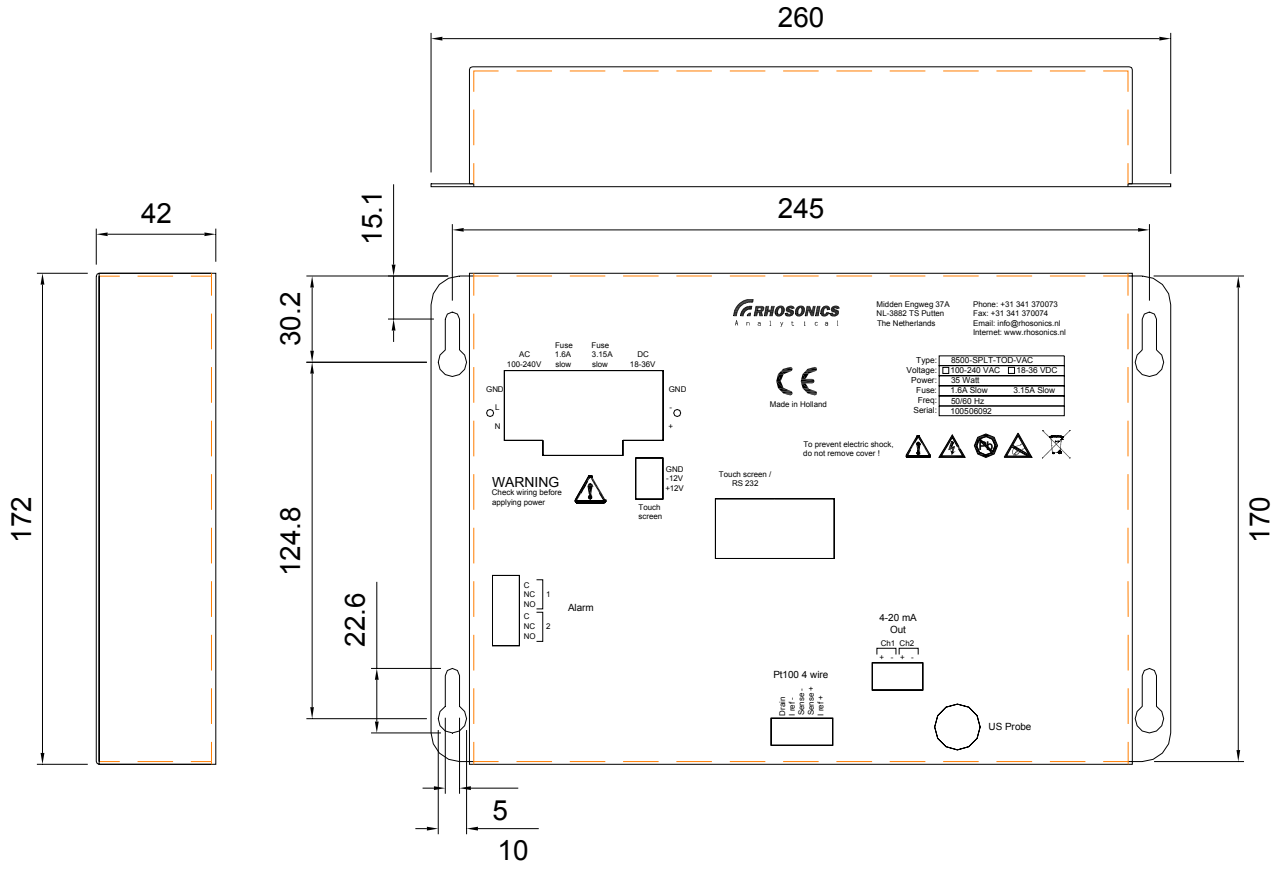


Figure 1: Steel / Aluminium housing for split unit analyzer

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.

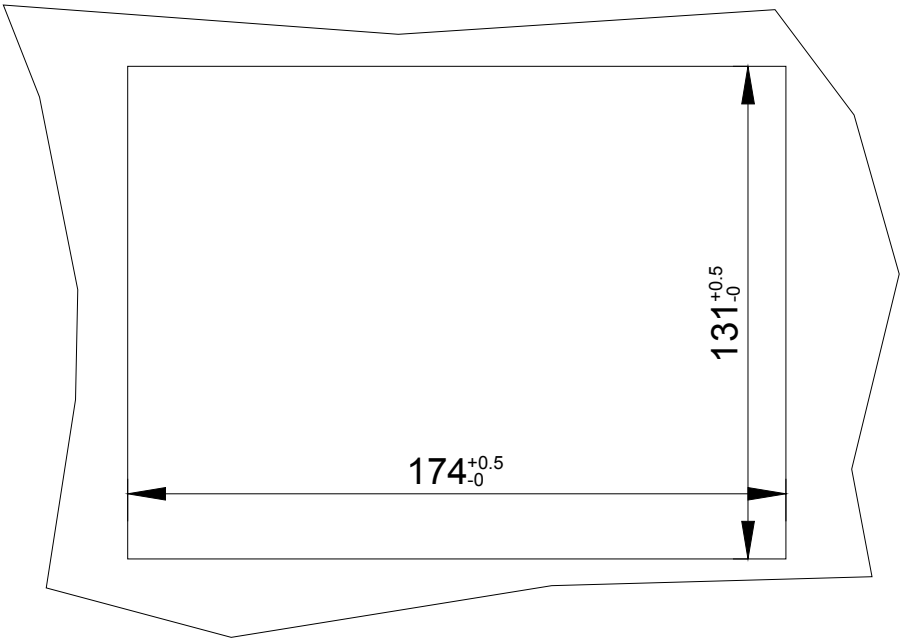
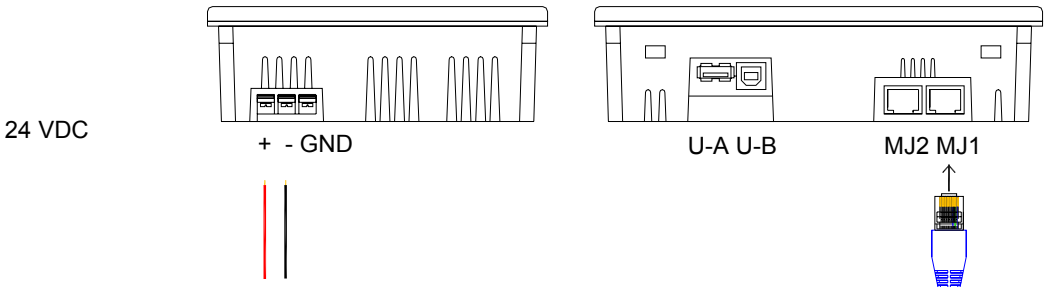


Figure 2: Panel cut-out for display installation

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

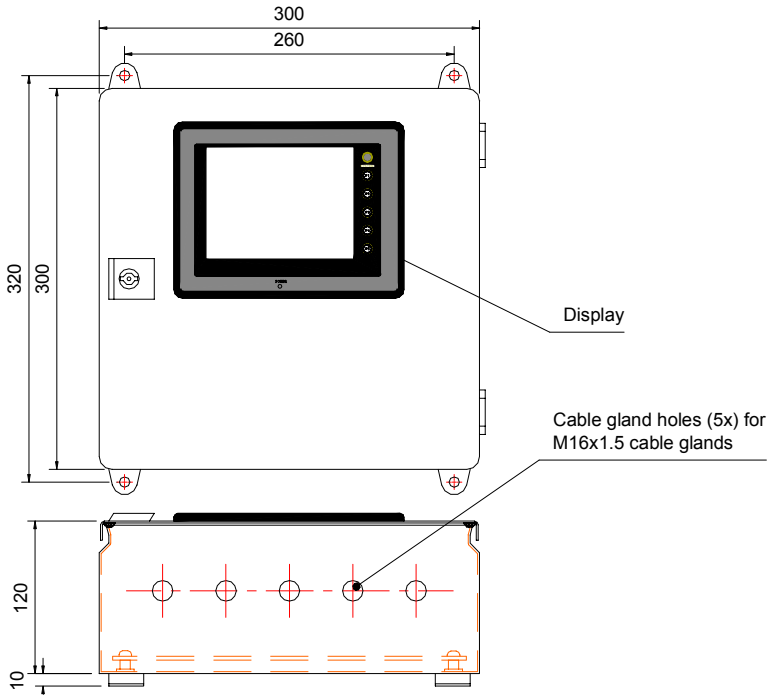


Figure 4: Weather proof housing

The general appearance of the PCB is given in figure 5.

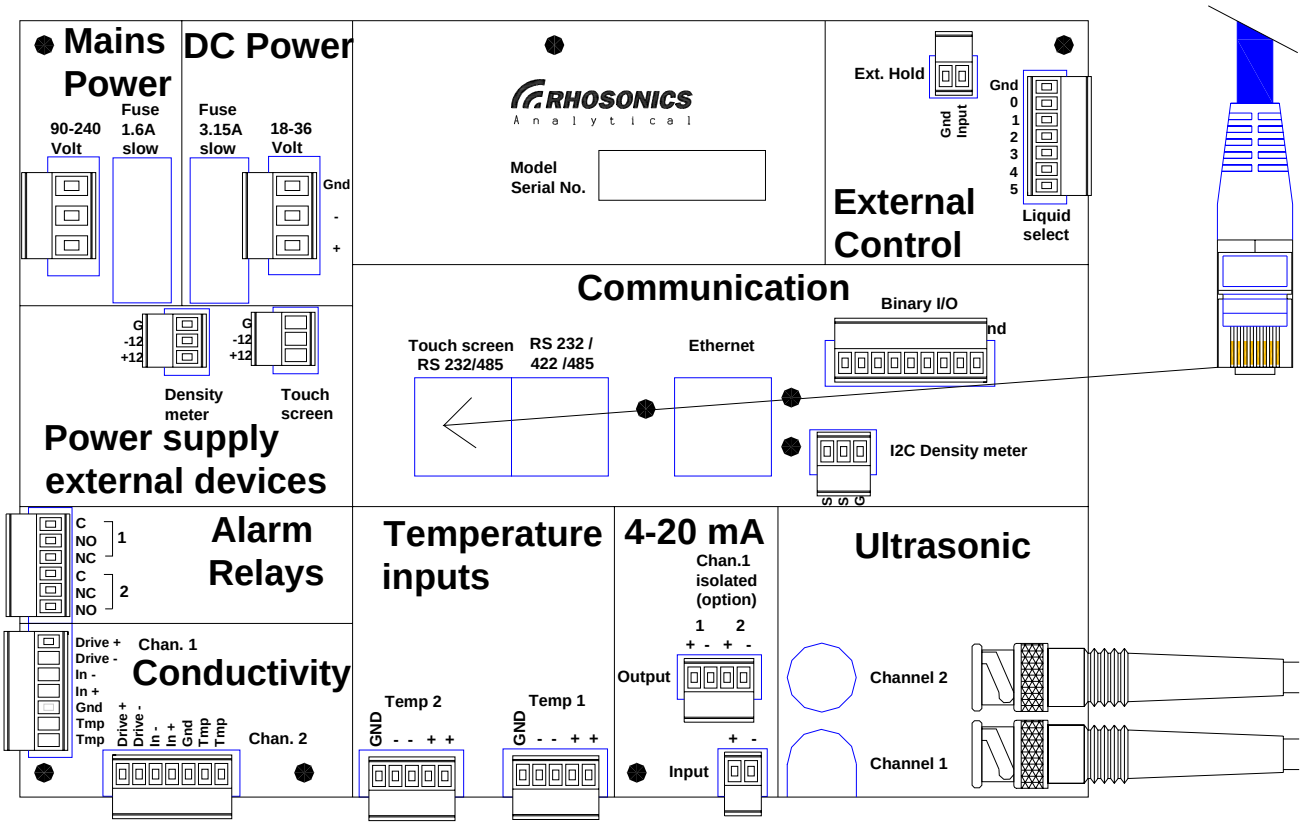


Figure 5: PCB layout with all cable connections.

2.3 Sensor installation

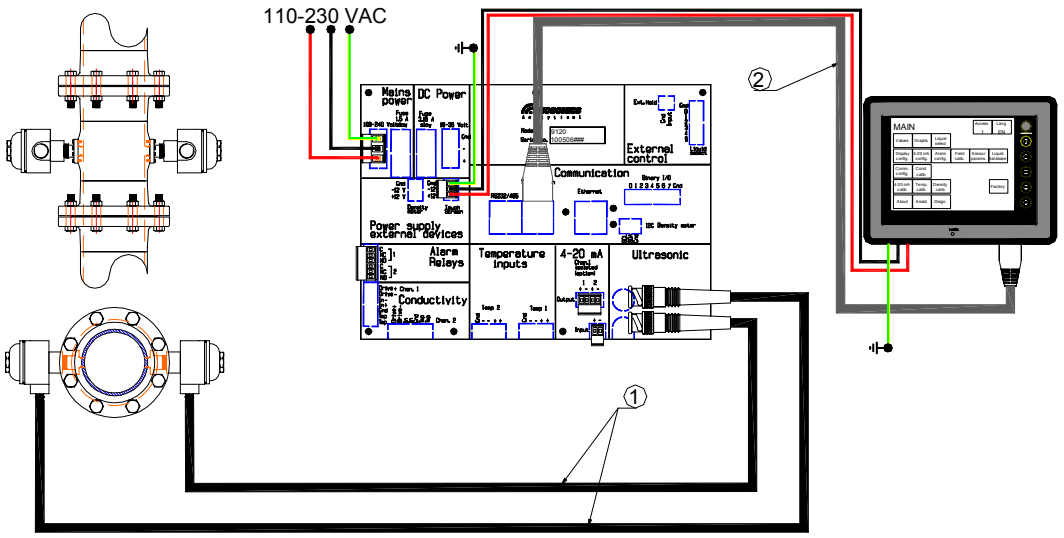
Preparation.
It is important that the sensor is installed in a straight pipe run, preferably with minimally 5 diameters of straight pipe run upstream, and 3 pipe diameters of straight pipe run downstream.
In addition, the probe must be installed in a vertical pipe, or sidewise in a horizontal pipe. This 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.

Summary:

- Install the probe or spool section with 5xD length of straight pipe length upstream and 3xD of straight pipe length downstream.
- Avoid installation near dosing valves.
- Vertical pipe installation is preferred.
- Horizontal pipe installation: Sensors must be installed sidewise.

2.4 Installing the cables

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



Process pipe with flow and ultrasonic cell

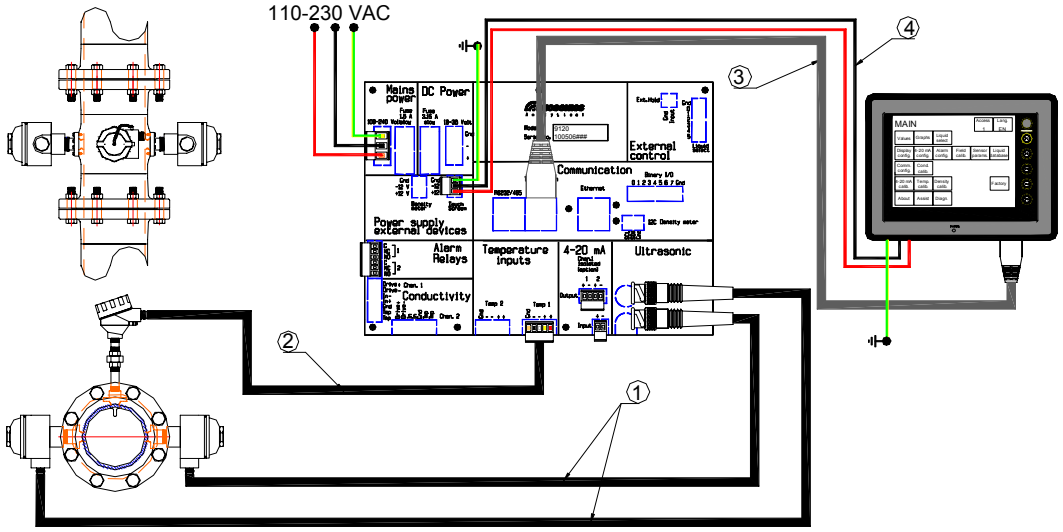
Rhosonics Analyzer

Display (Touch screen)

①Ultrasonic coax cables
②Cat 6 patch cable (no standard cable)

Figure 6: Schematic cabling overview analyzer with ultrasonic cell

NOTE: The ultrasonic sound path must be horizontal at all times. This implies that the transducers must be installed at either side of the pipe, NEVER on the top and bottom.



Process pipe with flow and ultrasonic cell

Rhosonics Analyzer

Display (Touch screen)

①Ultrasonic coax cables
②Temperature sensor cable
③Cat 6 patch cable (no standard cable)
④Power cable 24 VDC

Figure 7: Schematic cabling overview analyzer with ultrasonic cell and temperature sensor

NOTE: The ultrasonic sound path must be horizontal at all times. This implies that the transducers must be installed at either side of the pipe, NEVER on the top and bottom.

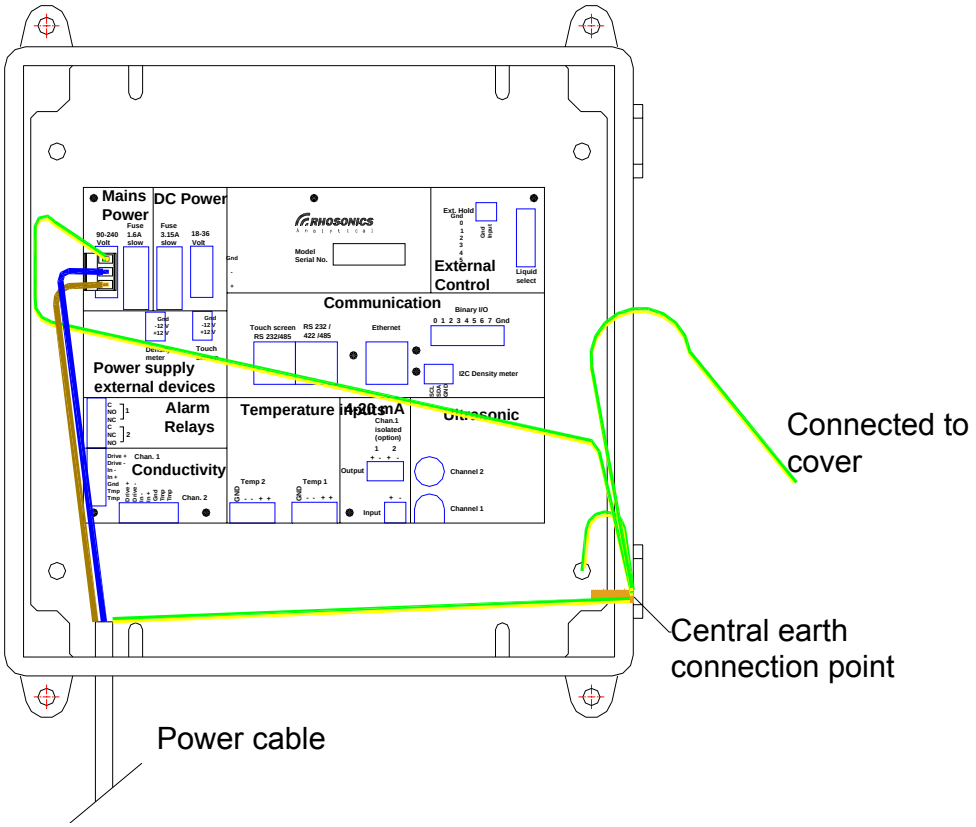
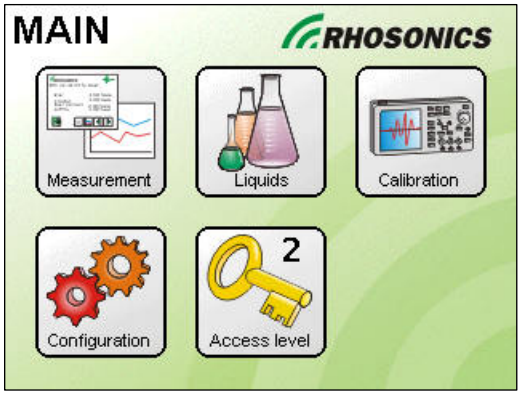


Figure 8: Schematic overview for earth cables inside WPF housing

3. Configuration.



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

Figure 9: *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. 4~20 mA input, for external compensation, i.e. CO2 compensation.
4. Display, i.e. choice of results to be displayed
5. 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

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.

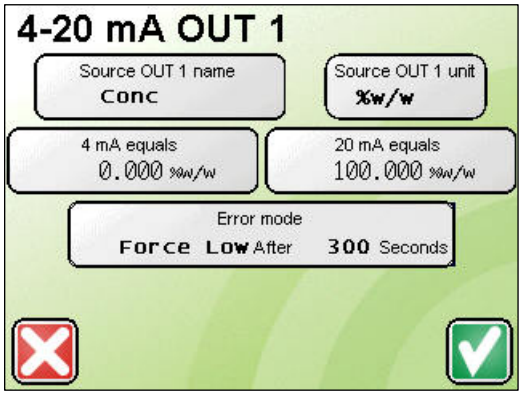
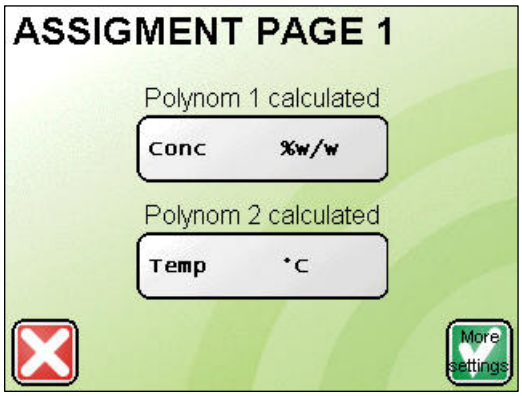


Figure 10: *4-20 mA OUT 1* page

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 value's



If you choose for *Calculated Polynom:*
► Press **[Polynom 1 or 2 calculated]**
You will be returned to the *4-20 mA OUT #* 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 *4-20 mA OUT #* menu.

Figure 11: *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.

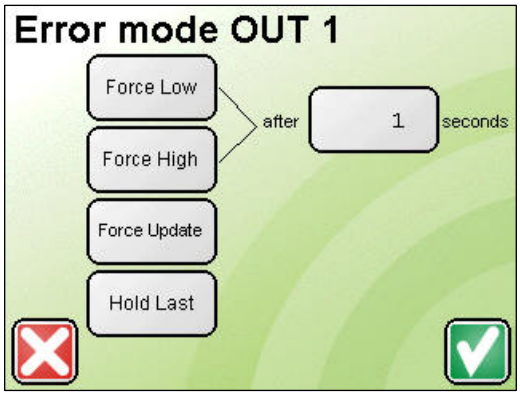
- Force Low: force output to 3mA after XXX seconds
- Force High: force output to 20mA after XXX seconds
- Force Update: force output to maintain measurement (only for Temp and Gain)
- Hold last: Hold last correct measured value

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 12: *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

NOTE
When you wish to output temperature, set to “**Force update**” (no time can be set).

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.

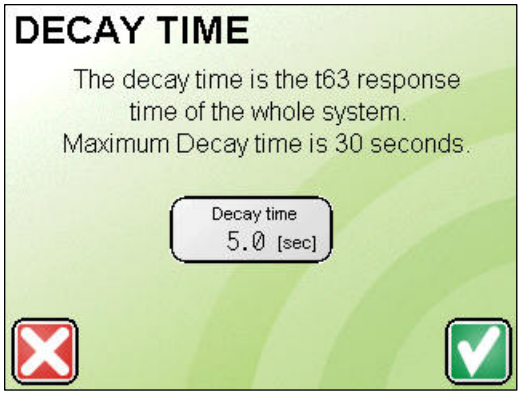


Figure 13: *DECAY TIME* page

3.3 Display configuration

Purpose:

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

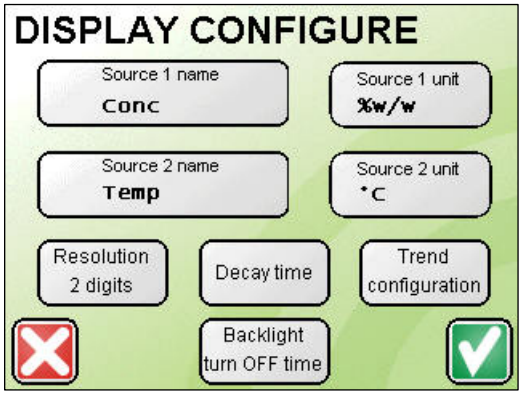
3.3.1 Selecting the results

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 the *Source 1* menu
► Here you can choose between the *Calculated polynomial* (the concentration) and one of the measured value's



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 14: *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.

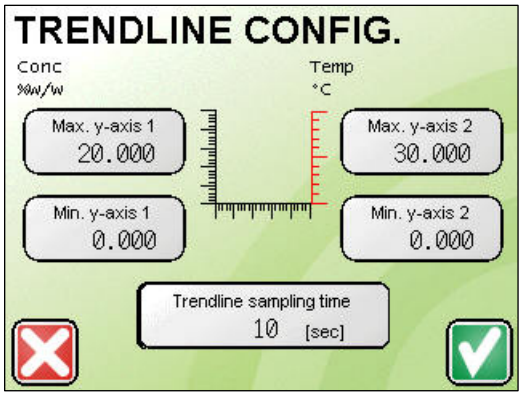
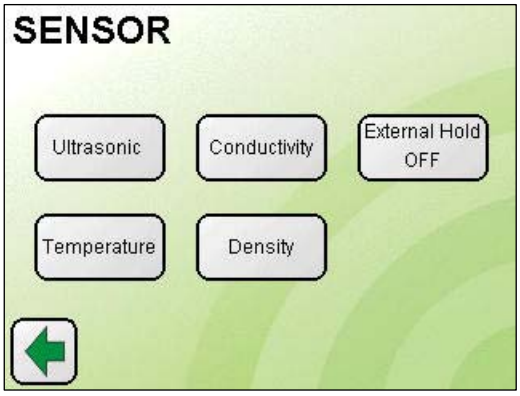


Figure 15: *DISPLAY CONFIGURATION GRAPH 1* page

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 16: *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 *ON* or *OFF* (see next section for details)
► Press **[Accept]** (automatic return to the *Sensor parameters* page)

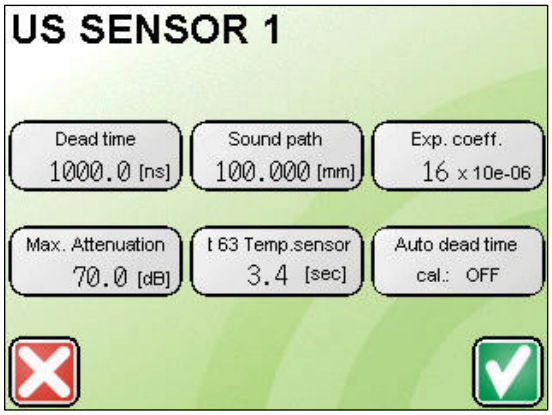


Figure 17: *ULTRASONIC PROBE CONFIGURATION* page

3.4.4 Auto dead time

3.4.4.1 Introduction

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 Advantages.

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 Procedure.

► 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.
► 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 value’s

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.

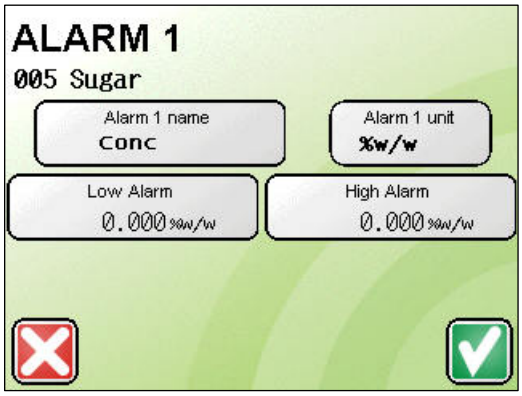


Figure 18: *ALARM 1* page

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.

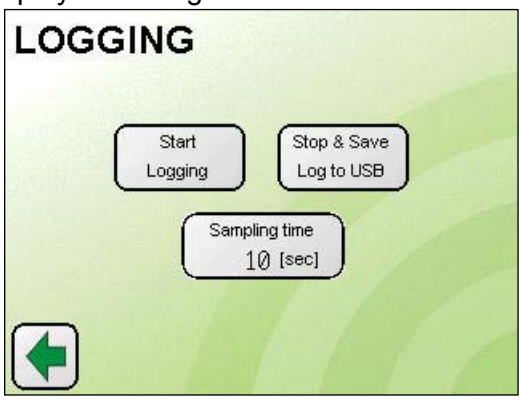


Figure 19: *LOGGING* page

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

The following table shows the data arrangement in the CSV-file on the USB stick.

Name	Description	Value @ Normal operation
Polynoom 1	**Calculated value 1 (i.e. Concentration)**	**0-100 %w/w, 0-350 g/l Salt, etc.**
Temperature sensor 1	**Temperature sensor 1 [°C]**	**In between the Min. temp and Max. temp on the Liquid Datasheet**
Sound speed sensor 1	**Sound speed sensor 1 [m/s]**	**In between the Min. speed and Max. speed on the Liquid Datasheet**
Attenuation sensor 1	**Attenuation sensor 1 [dB]**	**<60 dB**
Polynoom 2	**Calculated value 2 (i.e. Concentration second component)**	**0-100 %w/w, 0-250 g/l Acid, etc.**
Conductivity sensor 1	**Conductivity sensor 1 [mS/cm]**	**0-1000 mS/cm**
Frequency Density-meter	**Frequency Density-meter [Hz]**	**NA**
Density at T°C	**Density at measured temperature [g/dm3]**	**800-1200 g/dm3**
Alcohol Vol%	**Alcohol Vol%**	**0-15 Vol%**
Real Extract	**Real Extract**	**0-25 %w/w**
Original Extract	**Original Extract**	**0-25 %w/w**
Temperature sensor 2	**Temperature sensor 2 [°C]**	**In between the Min. temp and Max. temp on the Liquid Datasheet**
Sound speed sensor 2	**Sound speed sensor 2 [m/s]**	**In between the Min. speed and Max. speed on the Liquid Datasheet**
Attenuation sensor 2	**Attenuation sensor 2 [dB]**	**<60 dB**
Conductivity sensor 2	**Conductivity sensor 2 [mS/cm]**	**0-1000 mS/cm**
Amplitude	**Amplitude of the signal**	**NA**
Attenuation per metre sensor 1	**Calculated attenuation per centimetre sensor 1 [dB/m]**	**> 0.002 dB/m**
Attenuation per metre sensor 2	**Calculated attenuation per centimetre sensor 2 [dB/m]**	**> 0.002 dB/m**
Temperature sensor 3	**Temperature sensor 3 [°C]**	**In between the Min. temp and Max. temp on the Liquid Datasheet**
Temperature sensor 4	**Temperature sensor 4 [°C]**	**In between the Min. temp and Max. temp on the Liquid Datasheet**
Error number	**Error number**	**0**
Reference echo amplitude	**Amplitude of the reference echo**	**1000-1400**
Interface echo amplitude	**Amplitude of the interface echo**	**2000-2600**
Near gate amplitude	**Amplitude of the near gate**	**0-800**
Far gate amplitude	**Amplitude of the far gate**	**0-50**

Figure 20: *USB data arrangement in *.csv file*

NOTE: The data which are not applicable for the analyzer will be “0”.

3.6.4 Verifying the Ultrasonic Signal Waveform

3.6.4.1 Purpose

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 Procedure

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

Some examples and explanations are given below:

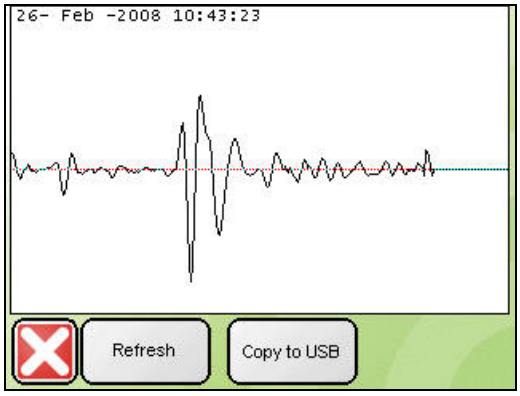


Figure 21: *Example of a “good” echo.*

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 ultrasonics 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.

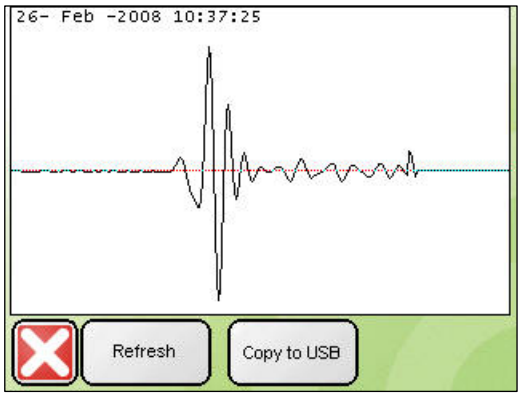


Figure 22: *Example of a "good" echo with PEEK window sensors.*

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.

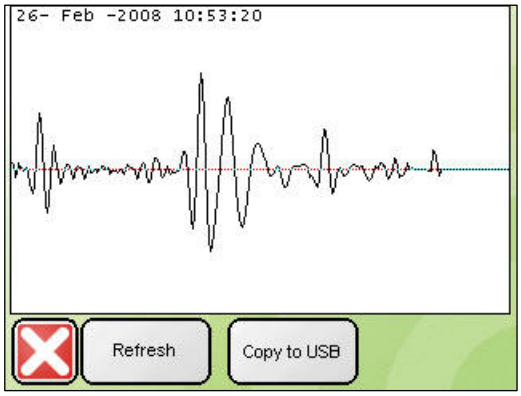


Figure 23: *Example of a "fair" echo.*

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.

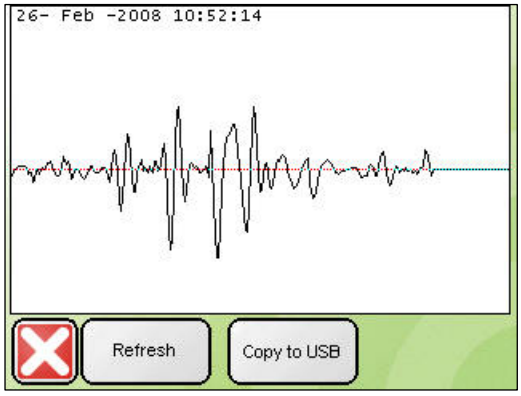


Figure 24: *Example of a "poor" echo.*

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

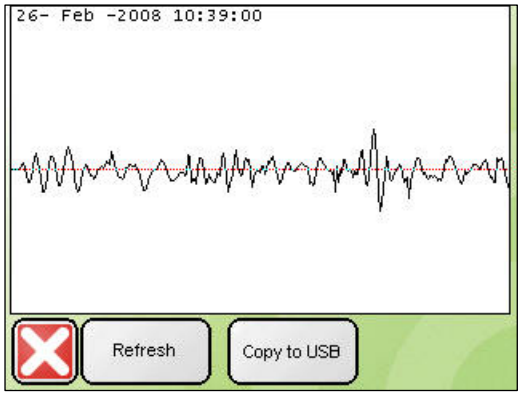


Figure 25: *Example of "Bad" echo.*

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 centre conductor and shield (infinite ohms).
- Ask another person to connect the centre conductor with shield at the other end and check the resistance (should be less than 1 ohm per 10 metre 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 “**Factory Diag 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.

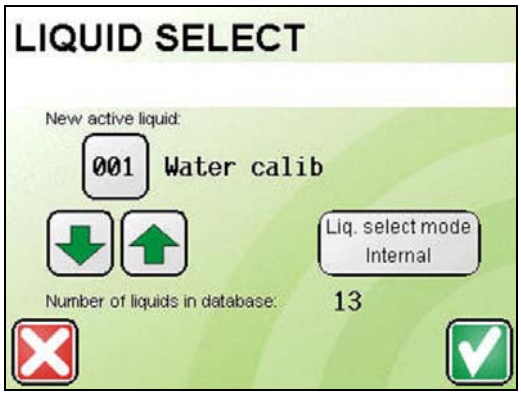


Figure 26: *LIQUID SELECT* page

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
Temperature offset	Temperature Correction	**Factory if Pt100 is used** **6 months if no Pt100 is used**
Zero calibration	Sound speed adjustment	Factory
Liquid Calibration	Zero Attenuation, density, temp.	Never (TDS only, i.e. NaOH) Monthly, (if density or TSS is needed)
High density cal.	Slope correction for density measurement	Never (TDS only, i.e. NaOH) Monthly, (if density or TSS is needed)
Field calibration	Correction of TDS slope curve	Once, with target sample
4~20 mA output	Zero/span of analog output	Factory, after repair
Polynomial calibration	Optimal linearization & compens.	Once, by factory
Probe calibration	Entering probe data from probe calibration data sheet (PCDS)	Replacement/repair of probe

5.2 Background and Functions of Zero and Clear Liquid Calibration.

The Rhosonics Model 9670 analyzer works with special US sensors, which measure the following parameters by ultrasonic means:

- Temperature
- Internal transducer efficiency
- External transducer efficiency (acoustic impedance)
- Density of the liquid
- Sound speed of the liquid
- Attenuation of the liquid.

For calibrating purposes, the analyzer needs to be told about parameters that can be known in an easy way. These known parameters are:

- **Temperature**
- **Density of the liquid, expressed in terms of SG. (Water SG = 1000)**
- **The clarity of the liquid, which should be preferably clear (<10 g/l TSS)**

As for any calibration, it is essential to use **certified equipment**, **and liquids of which the properties are known**.
For an inline TSS measurement, the density and temperature information is not critical. In fact, the temperature may differ up to 5 ºC from reality. The SG information may be different up to 10 g/l. The purpose of measuring SG and temperature is primarily to aid the system with determining acoustic effects on sound propagation, which in turn affect the accuracy of the attenuation measurement, the parameter that is most sensitive to the presence of suspended solids.

5.3 Calibration procedure and first setup

Preparation

1. Your probe(s) must be installed. (not necessary for temperature calibration)
2. The water or clear liquid must be known: SG (1000 for water) and the temperature (+/- 1 °C, or +/- 5 °C if you don't care about temperature or sound speed measurement)
3. If you use tap water: this is not going to stay gas free during your test. Make it gas free by boiling or use water from a portable container. If you do not, you may experience a gradually increase in attenuation reading.
4. If you use the actual process liquid:
   Besides being free of TSS, it must be free of gas bubbles.

IMPORTANT: WITHOUT A CALIBRATED AND CERTIFIED REFERENCES, EXECUTATION OF BELOW PROCEDURES WILL LEAD TO ERRATIC RESULTS

5.3.1 Calibration menu

The calibration menu is accessible with Access Level 2, from the main menu.
It appears as follows:

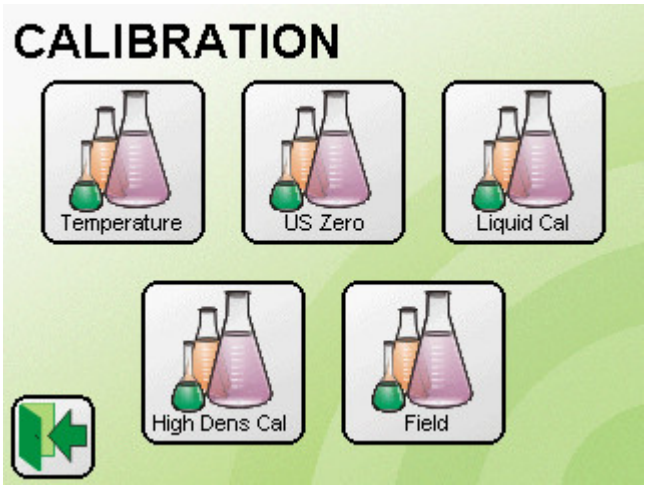


Figure 27: *CALIBRATION* page

5.4 Temperature offset

5.4.1 Purpose

To calibrate the ultrasonic temperature measurement. Only its offset is corrected, its span needs no calibration.

5.4.2 When needed

It is necessary when you first connect the sensors to the analyzer. Also, when you swap the sensor on channel 1, it is necessary to recalibrate the temperature.

5.4.3 Procedure

NOTE: You need to **know the "certified temperature**". This temperature value should be within +/- 5 ºC for TSS measurement, +/- 1 ºC for density and SG, and +/- 5 ºC or better for high wt% TDS measurements, +/- 0,1 ºC for low TDS measurements.
IMPORTANT: Wait 10 minutes with the probe in water at a stable temperature.

► From the *Calibration* menu, press **Temperature**.
► Enter the **Certified temperature** menu.
► Press the **OK** button to start the 60 second count down.
During this time, make sure that the temperature is does not change. In addition, it is recommended to perform this calibration only when the temperature has been stable for at least one hour.
► After 60 seconds, you will see the temperature reading approximate your certified temperature to within +/- 0,1 ºC. Press the **OK** button to leave the menu.

This completes the temperature calibration. Span calibration is not necessary, as this is automatically realized during the procedure.

5.5 Zero (water) calibration

5.5.1 Purpose

The main purpose is to improve the accuracy of the TDS measurement. For this calibration we recommend using water with less than 0,2 x the accuracy you require. This calibration applies an adjustment factor to the sound path, as the sound speed of water is known to the analyzer at each temperature. For obvious reasons, this calibration can only be successful when the temperature measurement is calibrated in advance.

5.5.2 When needed

NOTE: THIS IS NORMALLY NOT NEEDED

It is recommended for small sound paths (< 100 mm) and for applications where you want to measure SG, density and TDS. If you have realized a temperature calibration in water, it is little effort to do this calibration sequentially.
When your purpose is to measure the TSS only, and when your pipe or sound path length is larger than 100 mm, then you may safely skip this calibration.

NOTE: Gas free, stirred (not shaken) or flowing water is needed. The main goal is to obtain a straight temperature profile along the sound path, as to realize a constant sound velocity. Water that stands still has temperature, hence sound speed gradients.

5.5.3 Procedure

► From the *Calibration* menu, press **US Zero**.
► When the temperature is constant, press the **OK** button to start the 60 second count down.
► After 60 seconds, you will see the calibration factor change slightly, near 1. If no error messages occur, you can be sure that the calibration was successful, as the analyzer checks the stability during the 60 seconds procedure. Press the **OK** button to leave the menu.
► If an error occurs, calibration was not possible due to instability of the temperature or the sound speed. In that case, correct this and repeat the procedure.

5.6 Liquid Calibration (Zero TSS and SG)

NOTE: THIS PROCEDURE IS NOT NECESSARY WHEN THE SYSTEM ONLY IS USED FOR TDS, IE wt% of NaOH etc.

5.6.1 Purpose

For accurate measurement of SG, as well as for zeroing the TSS indication. OR:
To force the total suspended reading to a specific value.

5.6.2 When needed

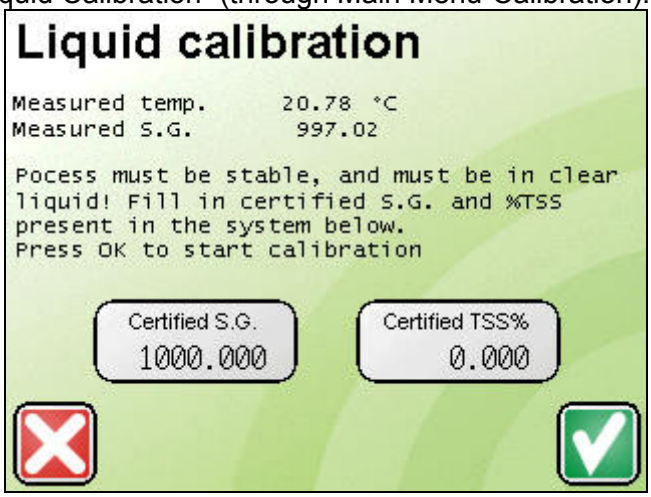
- During first installation
- Following a temperature and/or water calibration
- When a probe is replaced.
- At regular intervals.
- When there is reason to believe that an offset error exists.

5.6.3 Procedure

If your probes are installed in Flow-Through spool section, first make sure that there are little or no solids in the pipe. You need to know the SG of the liquid within +/- 10 SG units (1000

for water), as well as the amount of solids. These calibration constants are called **certified temperature** and **certified TSS solids**.
The procedure can be done in water, when there is no way to calibrate under real process conditions. When you have done the calibration in water, SG reading, as well as the temperature need no further calibration. However, if the SG or the temperature largely differs from water at ambient conditions, it is highly recommended to perform this procedure.

- ► Press “Liquid Calibration” (through Main Menu-Calibration). The following menu appears:



- ► Now enter the certified **SG**. In case of water, enter SG=**1000**..
- ► Enter the certified TSS solids. Water = 0.000% solids.
- ► Press “V” to start the calibration sequence.
  The next menu indicates a counter that counts back from 60 seconds. Wait until it reads -1. The S.G. and certified TSS will now approach the correct values.
- ► You now may press OK (**V**). The correct factors are automatically determined when the counter stops. The density reading should be stable within +/- 3 SG units.

5.7 High density or field calibration

NOTE: THIS PROCEDURE IS NOT NECESSARY WHEN THE SYSTEM ONLY IS USED FOR TDS, IE wt% of NaOH etc.

5.7.1 Purpose

The high density calibration or field calibration applies an additional SPAN factor. The purpose to assure a correct reading within the low and the high calibration points.

5.7.2 When needed

This calibration can be done following the standard or low calibration, and is preferably done within 30 days after completing the low point calibration. Both calibrations do not affect each other and each time the low or the high calibration is done, a new offset and span factor are automatically determined. The analyzer determines a calibration factor and stores this factor in its database. It is known as the “New factor”, which is normally between 0.75 and 1.5

5.7.3 Procedure High Density Calibration

- ► Press “High Density Calibration” (through Main Menu-Calibration)
- ► Enter the certified **SG (x1000)**. The certified SG must be at least 10% higher than the entered SG for the Low Point or Clear Liquor Calibration.

► Press the Start button.
The next menu indicates a counter that counts back from 60 seconds. Wait until it reads -1. The density will now be corrected within +/- 0.1 °C and the SG within +/- 0.1%.
► The correct factors are determined when the counter stops. Press OK (**V**). The density reading should be stable within +/- 1 g/l.

NOTE: When you are calibrating under actual process conditions, the density may fluctuate more than +/1 g/l, due to natural variations in the density of the slurry.

5.8 Field (Sample) calibration

5.8.1 Purpose
The field calibration is necessary for a particular type of slurry. The installed polynomial calibration provides linearization of the Attenuation per meter reading versus concentration. The field calibration corrects this error. This correction can be considered as “slope” correction of the programmed calibration. The final purpose is to make the analyzer read correctly at the target concentration.

5.8.2 When needed
After installation, and when the product is flowing. The field calibration is intended to be a specific calibration for your specific product. The system must have been calibrated using the clear liquor, or calibrated in water, according to the “Clear Liquid Calibration” procedure.
For your convenience, the analyzer determines a calibration factor and stores this factor in its database. It is known as the “New factor”, which is normally between 0.75 and 1.5

5.8.3 Procedure
The procedure “Product calibration check” has to be performed to determine the necessary field calibration data.

- During stable processing, read the concentration from the display.
- Take a sample for laboratory analysis.(immediately after taking the reading)
- After laboratory analysis of the sample, you have 2 numbers, i.e. an “**Indicated value**” (averaged reading of display) and a “**Laboratory value**”.
- Enter the field calibration menu (through *Calibration- Field calibration* menu.
- Enter the 2 values in their appropriate fields.

The selected product has now been calibrated. Before and after this procedure, you will be able to see the “New factor”.
This factor may be of interest to note, as this should be a constant, only related to the measured slurry, and not to the state of the transducers. Therefore, when you have performed the zero calibration correctly, there should be no significant change before and after this procedure.
You can repeat this procedure for your other products in your plant. Make sure that first select the appropriate product type in the Liquid Select menu before you start the procedure, in order to prevent undesired correction of a previously calibrated product.

6. Automation and communication.

The Rhosonics analyzer has several features to minimize operator interference. Most of them are related to remote product switching and regular calibration routines.

CAUTION:

Be aware that changing of any data can stop the communication. Do not change any data if you do not fully understand the effect of all actions to the performance of the analyzer.

6.1 Remote product selection

6.1.1 Purpose

The analyzer can store up to 200 different product calibrations. Remote product selection greatly enhances the reliability, since it is no longer necessary that an operator manually selects the desired product calibration. There are 2 ways to achieve this.
The binary product selection method is most simple, however the number of products to be selected is limited to 63.
The RS232 product selection requires an RS232 and is more complex, however product selection is extended to 200 different products.

6.2 Binary product selection

6.2.1 Purpose

A 7-bit binary input allows remote product selection up top 63 different liquids.
The logic levels are 0 and 24 Volts (15 to 32 Volts). Therefore, a PLC is ideally suited to be used as remote switch.
The procedure is as follows:

- Through the *Configuration-Liquid-Select* menu, activate “Remote Liquid Selection”
- Wire the connector for binary input. Pin “0” corresponds to the least significant digit, Pin 7 with the most significant digit.

Note that when you disconnect the Binary Liquid Selection connector, all inputs will be pulled high, so that product #63 is automatically selected.
Product # 00 corresponds to no liquid at all, however activates the “Water Calibration” feature. See Chapter “Calibration” for more details about this feature.

6.3 Product selection through RS232

6.3.1 Purpose

When you run more than 63 products, each requiring an individual calibration or alarm setting, the product selection through RS232 is recommended.

6.3.2 Method

The Rhosonics analyzer can be driven through the Touch Screen display. The communication protocol is ModBus over RS232.
Please consult the factory if you intend this feature.

6.4 External Hold function

6.4.1 Purpose

External HOLD is useful during product stand still. Due to the heating of the pipe, the temperature of the liquid may not be stable. The External Hold function will stop the measurement and freeze all outputs.

6.5 Automatic calibration

6.5.1 Auto dead time calibration

The purpose of this feature is to reduce small errors, both operator and system errors. Since this feature automatically looks for ideal process conditions to perform this calibration, it is highly recommended. It reduces maintenance intervals.
See the Chapter configuration in this manual for details about how to activate this setting.

6.5.2 Automatic Zero Calibration

This feature is also known as Water Calibration.
As explained in the calibration section, it is necessary to Zero the instrument at regular intervals. This procedure can also be done by remote control.
When the Automatic Zero Calibration feature is activated, the analyzer will perform a Zero Calibration upon an external signal. This signal is given through the Binary Product Selection, by setting all inputs to 0 volts (Binary 0).
There are 3 conditions where the analyzer will automatically perform this calibration:

- The “Remote Product Calibration” must be active.
- Product #000 must be selected.
- When the analyzer decides that the measured parameters are all stable during at least 60 seconds.

When not all 3 conditions are met, the zero calibration is not adjusted.

IMPORTANT
It must be made sure that the process liquid really contains water with a concentration of less than 0.01 wt% of dissolved solids during automatic zero calibration.

7. Maintenance

7.1.1 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.

7.1.2 Instrument maintenance

The operation of the probe 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. By comparing these data with previous observations, you may be able to anticipate probe failures. The following table lists 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
Gain/attenuation	The attenuation measurement.	Once during normal operation, during problems
Att. In dB/cm	The attenuation per cm sound path, the basis for analysis	
Sound speed	The speed measurement	For factory assistance, during problems
Time (transit time)	The transit time, and the variation	Only during problems

Of the above measurements, the sound speed and the temperature may not be available. In fact, the Rhosonics Model 9620 analyzer does not use the sound velocity for analysis. The sound speed is depending on the DISSOLVED solids only, and NOT depending on the amount of total solids. Therefore, the sound speed is an indication of the amount of dissolved solids only.
The analyzer has more difficulties measuring the sound speed when the amount of SUSPENDED solids increases. This is due to the much higher attenuation.
This is visible by the appearance of all sorts of error messages.
The following error messages may occur during normal operation, which do NOT affect the measurement the attenuation, which is basically an accurate measurement of the amount of absorption of the ultrasonic sound waves due to particles.

Error message	Meaning	ACTION
No trigger in window (with low solids)	The sound speed is different than expected. Perhaps due to the DISSOLVED component concentration.	If you expect higher dissolved solids, increase the Cmax value in the liquid edit menu. Cmax is 1550 plus 15x dissolved wt%. Do NOT adjust speed in other cases, as the response time will increase.
No trigger in window (with dense slurry)	This is not abnormal with high solids concentrations.	Check if this message is also present with low suspended solids. If so, see above.
Bad Signal	The sound speed cannot be	Quite normal when concentrations are

to Noise Ratio	measured, due to S/N ratio. This does NOT mean that the attenuation cannot be determined.	high. Check whether this message still is present with low concentrations. This can mean cable or sensor failure.
Signal too large at start of echo	Same as above	Same as above
Signal too low	Same as above	Same as above

NOTE:
It is not unusual that an error message constantly occurs at high solids concentrations. This is particularly true with large pipe diameters, above 4 inch.

7.1.3 4-20 mA INPUT Calibration

It is normally NOT necessary to (re)calibrate the analog input.
If there is a doubt about the conversion of analog input current into the reading of the compensation 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:
Via the 4-20 mA calibration page the two 4-20 mA Outputs and the 4-20 mA Input can be calibrated.
To calibrate the 4-20 mA Outputs and 4-20 mA Input a calibrated digital multi meter (DMM) with a current accuracy of at least +/- 0.01 mA is required.

7.1.4 4-20 mA OUTPUT calibration

It is normally NOT necessary to (re)calibrate the analog ouputs.
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
► 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.

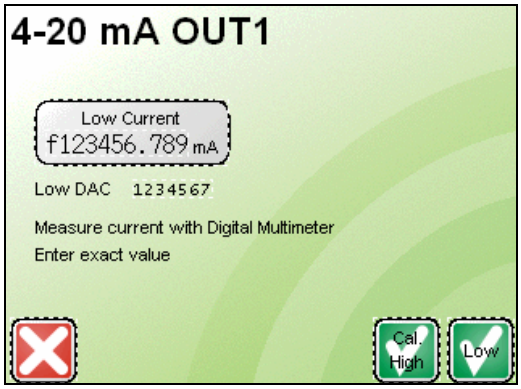


Figure 28: *4-20 mA OUT 1 CALIBRATION* page 1

7.1.5 Quick trouble shooting

If anything fails, please take some time to follow the below trouble shooting list.

- ► Check the functioning of the US system. Enter the secondary measurement screen and find the "*Probe Attenuation*".
  Its reading should be less than 30 dB and very stable (at least in clear liquid). If it is higher, check the following.
- ► Is the temperature indication stable? If YES, then the probe on Channel 1 is OK. (sensor on Channel 1 is ultrasonically measured for temperature)
- ► Swap the Channel 1 / Channel 2 probes. Now you can see if there is a stable temperature reading. (It may differ very much, probes are not completely identical, but the indication should be stable).
- ► NO stable temperature. (very large variations): Your probe should read a temperature, regardless of the presence of a liquid. The probe (connected to Channel 1) may be defective. Check if you can realize a stable temperature with the other sensor, (swap the 2 coax cables of the instrument), next run the temperature calibration to see if the temperature reading starts working.
  If yes: this probe/cable is OK, the other apparently not.
  .

8. Frequently asked questions

8.1.1 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: Our analyzer has a probe with 10 meter cable length. We want to install the controller unit further away. Is this possible?
A: Yes, extension cables are available. There is no need to readjust the analyzer after installing a longer cable or cable extensions.

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 20 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.

Q: In our process, our liquid is constantly used, re-used and recycled. Our production makes that the liquid is agitated and / or injected with air or other gas to improve the process. Can we simply insert a probe in the buffer tank or the tank where the process takes place?
A: The system is capable to operate in liquids, where occasional gas bubbles are present. The analyzer is NOT suitable in liquids, saturated with gas, or liquids with finely dispersed gas. See next question for solutions.

Q: How can I measure in bubble-rich liquids?
A: Your sample take-off point should be located as low as possible in your (buffer) tank. Pump your sample to a bubble removal system. This may be a simple settling tank, or an active removal system. Refer to the FAQ section “Corrosive liquids” for specific solutions.

8.1.2 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 field 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: We are using the analyzer in a blending installation. When the production has stopped for more than several minutes, the analyzer indicates gives a slight misreading, sometimes leading to alarming situations. This also happens when the product starts flowing again. What is happening and what can we do about it?
A: When the liquid is flowing, the temperature is in equilibrium in the entire pipe line. When the product is standing still, the cold pipe line may either be heated or cooled slowly due to differences in temperature with the ambient environment. Although the temperature of the liquid is measured at a point which is considered representative for the ultrasonically measured product, unpredictable temperature gradients may lead to incorrect temperature compensation, resulting in deviation in the concentration reading.
You can solve this problem by using the optional “External Hold” option. An external 24 Volt DC signal can stop the analyzer, so that the outputs and alarms are no longer updated. See the sections “Installation” and “Automation and communication” for details.
Another method is to insulate the pipe line, so that it is not heated from the outside. For best results, the entire pipe line (upstream) must be isolated.

9. Technical specifications

9.1 Operation characteristics

Temperature circuit:	
Resolution	± 0.001 °C (24 hours warm-up)
Reproducibility	± 0.005 °C (24 hours warm-up)
Range	-10 °C through 110 °C
Sound speed circuit:	
Resolution	± 0.002 m/s
Reproducibility	± 0.01 m/s
Range	200 m/s through 3000 m/s
4-20mA Outputs (2x):	
Resolution	± 0.002 % of FS
Repeatability	± 0.02 % of FS
Output current & load	± 4-20 mA into 450 Ω
Alarm outputs (2x):	
Type	SPDT, adjustable low-low high alarm (2x)
Ratings	± 250 VAC - 2A max.
Interfaces:	
Serial interface	RS232, RS422, RS485 (optional)
Ethernet	Ethernet available as option
Concentration	
Resolution	± typically better than 0.1% of FS
Repeatability	± 0.2 % of FS Accuracy depends on the application, and can be stated by the factory, upon request.
Storage of product calibrations	
Calibration polynomials for liquids	2 (standard), 200 (optional)
Measurement Units:	
Concentration	% weight by weight (wt% or % w/w)

9.2 Options

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

- 100-240 VAC 50/60 Hz power supply converter **or** a 24 VDC power supply
- 4-20 mA Output 1 with non-isolated output (standard) **or** isolated output

9.3 Supplemental characteristics

9.3.1 Analyzer with touch screen display

Dimensions (weather proof housing)	235x200x90 mm, (HxWxD)
Dimensions (split unit)	160x125x60 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 (weather proof housing)	± 2.8 kg
Weight (split unit)	± 1.4 kg
Power consumption	Maximum 30 W (boot), 5 Watts (normal)

9.4 Environmental conditions

WARNING:

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

9.4.1 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

9.4.2 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.

9.4.3 Humidity

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

9.4.4 Storage conditions

Temperature: -40ºC to +75ºC

10. Technology

10.1 Measurement sequence

- 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
- Calculate concentration 1
- Calculate concentration 2
- Update display
- Update 4-20 mA Outputs

10.2 Ultrasonic velocity of sound

The sound speed of a liquid is very dependant 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. Typical velocities may vary between 1000 and 2500 m/s, however some liquids have sound speeds down to 300 m/s. Solutions, like acids and salts, hydrocarbon liquids, as well as food products, like beer, oils, and sauces have sound speeds that vary upon their concentration. In addition, non-aqueous solutions, such as mixtures of hydrocarbons and slurries have their own, typical sound speed, which is very predictable and reproducible.

All liquids have a fixed relationship between sound speed and physical properties:

$$c = \sqrt{\frac{K}{\rho}}$$

In this equation, K is the module of compression and the Greek symbol for Rho stands for density. In practical applications, the contribution of K to the change of sound speed is very much larger than that of the density. This phenomenon is making the Model 9530 specifically suitable for applications where the change in density with concentration is relatively small.

10.3 Other ultrasonic variables

Besides the sound velocity, there are other sound parameters present in a liquid. One of them is the attenuation to ultrasound. There are several factors that affect the attenuation. The viscosity of a liquid is attenuating ultrasonic waves by absorbing the mechanical energy, converting it to thermal energy. Measuring the attenuation, in some cases, may be the only way of in-line determination of viscosity.
Gas bubbles in a liquid also attenuate sound waves. In this case the sound is scattered by the small voids in the liquid, reducing the energy of the transmitted energy. The effect is similar to the behavior of light in a thick fog. Solid particles can affect either the sound speed or the attenuation. This all depends on many factors, and cannot always be predicted. In many cases, however, an empirical calibration gives an accurate means of measuring the sought parameter.
For ternary analysis using the sound velocity and conductivity, the attenuation is not important and although it is measured, it is not being used for the calculation of the end result.

10.4 Attenuation

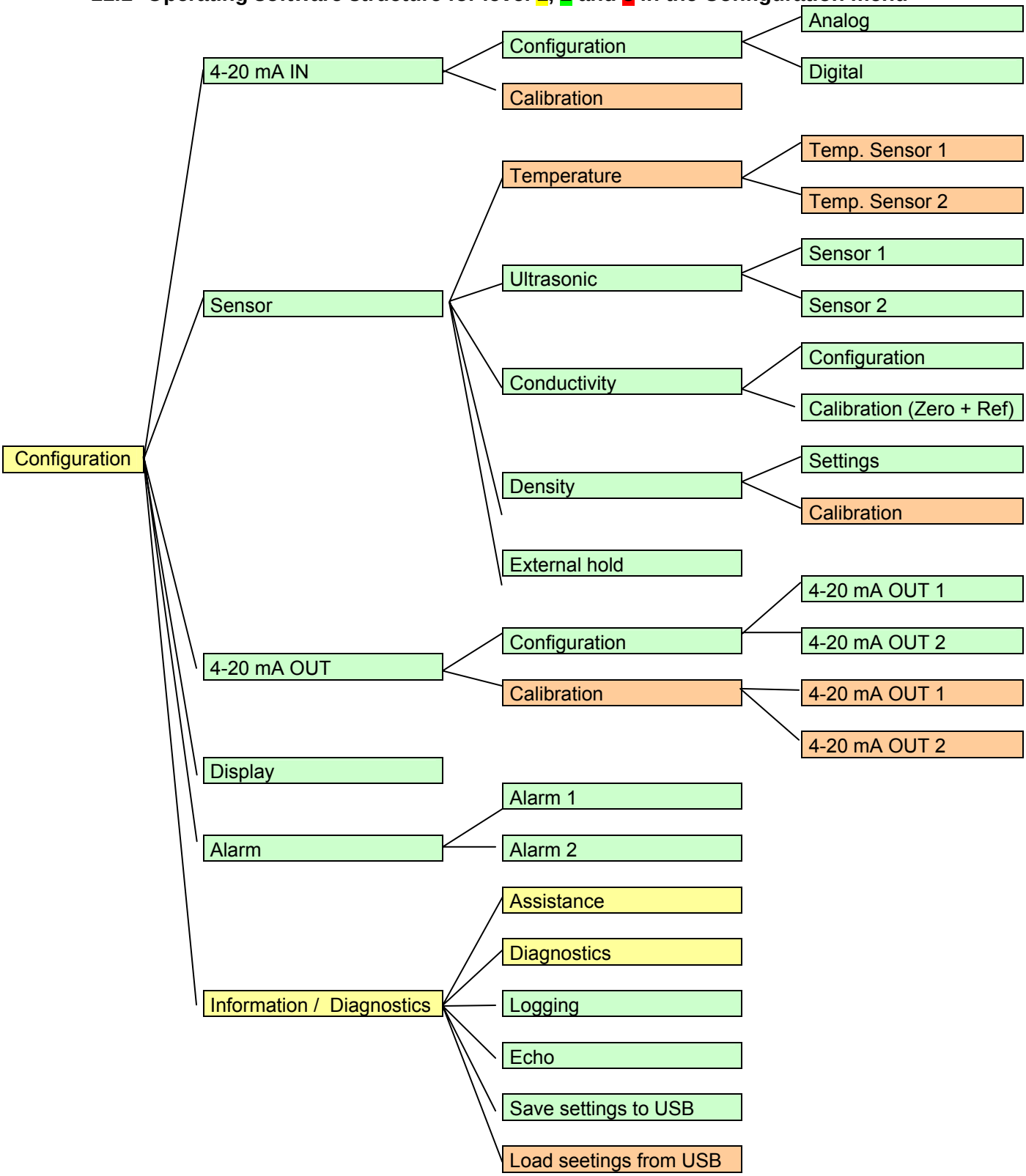
Many years of research and field testing have shown that measurement of ultrasonic attenuation in slurry is directly proportional to the percentage of suspended solids. The Model 9610 and 9620 measure the absorption of the signal in order to produce a digital display of suspended solids, plus an analogue output.
The basic principle is that ultrasonic sound waves are scattered by suspended solids, causing attenuation of the transmitted ultrasound. The analyzer measures the intensity of the ultrasound and converts this in terms of attenuation. Each 20 dB of attenuation equals a factor of 10. So 60 dB means that the signal is attenuated by a factor of 1000.

10.5 Conversion of measuring parameters

In order to translate the measured sound attenuation into a concentration or density parameter, Model 9620 first normalizes this attenuation in terms of dB/cm. The relationship between attenuation per cm and concentration is fairly linear. Normally, each wt% of solids in 1 cm of sound path, attenuates the signal by 0.2 dB. There is a slight non-linearity, which is corrected by the polynomial calibration. You may wish to correct linearity, provided that you have made many reference measurements, with attenuation per cm versus the concentration that you have determined in the laboratory. With the Excel curve fit function, it is easy to determine the exact relationship between concentration and dB/cm.
Normally, there is no need to correct this and any adjustments should preferably made through the zero and Field Sample Calibration routines, leaving the polynomial calibration untouched.
The temperature and the concentration have an effect on the sound speed, which in turn changes the shape of beam. When the sound speed increases, the beam divergence (beam spread) increases as well. In addition, density of the liquid, together with the sound speed, determine its acoustic impedance, which in turn determines how much energy is transmitted/reflected at each boundary. For example, more energy is transferred when the liquid density is higher, which is also the case when the sound speed is higher. Some of the Model 96XX series analyzers measure the sound speed as well, and use the sound speed for TDS measurement as well as for correcting for changes in sound transfer (from sensor to liquid, as well as for beam spread loss).
The Models 9630, 9660, 9670 and 9780 use a proprietary algorithm to measure the attenuation of the intensity of the sound waves, as well as to correct for the physical changes that cause the sound beam to attenuate. The purpose of this correction is to make the essential attenuation more accurate and to avoid drift factors. In order to make the system independent of aging of the sensor, it measures its own transmitted energy as well, making the analysis of suspended solids virtually independent of all drift factors.

11. Appendices

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



11.2 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

11.3 Options

No options

11.4 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]