INSTALLATION AND INSTRUCTION MANUAL

PHASE DYNAMICS, INC.

Razor Water in Hydrocarbon Analyzer

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WARRANTY

This Phase Dynamics product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Phase Dynamics will, at its option, either repair or replace products which are defective.

For warranty service or repair, this product must be returned to Phase Dynamics. Buyer shall prepay shipping charges to Phase Dynamics and Phase Dynamics shall pay shipping charges to return the product to the Buyer. However, Buyer shall pay ALL shipping charges, duties, and taxes for products returned to (or from) Phase Dynamics from (or to) a country other than the contiguous states of the United States of America.

Phase Dynamics warrants that its software and firmware designated by Phase Dynamics for use with an instrument will execute its programming instructions when properly installed on that instrument. Phase Dynamics does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

ATTENTION

The Analyzer Module is a sealed unit. Opening the unit will void the warranty. Any information contained within this document that refers to the internal configuration of the analyzer module is for authorized factory technician use only.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer; Buyer supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

EXCLUSIVE REMEDIES

The remedies provided herein are Buyer's sole and exclusive remedies. Phase Dynamics shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

SAFETY INFORMATION

THIS PRODUCT AND RELATED DOCUMENTATION MUST BE REVIEWED FOR FAMILIARIZATION WITH SAFETY MARKINGS AND INSTRUCTIONS BEFORE OPERATION.

SAFETY LABELS

WARNING:

Denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION:

Denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not precede beyond a CAUTION sign until the indicated conditions are fully understood and met.

ATTENTION:

Denotes an important step or technical note. It calls attention to an important procedure or note.

Contents

1 Overview

1.1 Analyzer Description

The Phase Dynamics Razor analyzer is a microwave device that measures the percentage of water in a flowing hydrocarbon liquid stream. The measurement technique is based on a principle known as load-pull. The system is designed with no moving parts and is calibrated for the highest accuracy over a broad range of water cuts, and temperatures.

Analyzer Specifications

The following table resumes all the specification for Razor Analyzers.

Ranged To	0-20%	20% -Inversion
Uncertainty	0.15% (0-5%) 0.20% (5-10%) 0.35% (10-20%)	0.5%
Repeatability	+/- 0.05%	+/- 0.5%
Resolution	0.01%	0.01%
Salinity	Not affected by Salinity	Not affected by Salinity
Fluid Temperature	0 - 104°C (32 - 220°F)	
Fluid Temperature Compensation	Automatic with Built-In Temperature Probe	
Minimum Flow Speed	2 feet per second (0.6 m per second)	
Maximum Flow Speed	14 feet per second (4.25 m per second)	
Power Requirements	24VDC (18-28VDC), 5 Watts Typical, 10 Watts Maximum	
Ambient Temperature Range	-40 to 60°C (-40 to 140°F) for electronics	
Analog Output	1x 4-20mA Isolated	
Analog Input	1 x 4-20mA Isolated	
Digital Output	1 x MODBUS RS-485 RTU port	
Relay	1 x Normally open dry contact – 24VDC 0.5A Max.	
USB	Used for memory stick data storage	

- All factory and production sequences are ISO 9001:2008 Certified.
- Optional Certifications: CSA (Pending FM, ATEX/PED)
- Area Classifications:
    - Explosion Proof Enclosure
        - Class 1, Div 1, Groups C & D.
        - EEx d IIB T6 89°C
        - NEMA 7
- Process Connections: 2, 3, 4, 6 inch flange sizes up to ANSI 900.
- Materials of wet parts: Stainless Steel 316/316L Standard

1.2 Electronics

The electronics is based on a DSP programmed to read from the oscillator all the parameters needed to calculate the water cut of the fluid and to perform the control of the peripherals. The system is operated

through four optical sensors on the front panel with a two-line LCD for visualization. Data logging capability is available. The flash drive can be connected via the USB port from the front display.

The electronics is composed by 6 boards:

1. Display board (Part number 2000-00076-000B)
2. Processor board (Part number 2000-00079-000E)
3. Power Supply board (Part number 2000-00078-000E)
4. Signal Conditioning board (Part Number 2000-00080-000E)
5. Back board (Part Number 2000-00081-000C)
6. RF board (Part Number 2000-00077-000F)

The RF board is mounted inside the probe.

2 Installation

2.1 Razor Mounting Considerations

The Razor analyzer can be mounted on horizontal or vertical lines. The display can also be rotated on 90 degrees increments.

ATTENTION:
Regardless of installation mode, the Analyzer **should** be neither the highest point nor the lowest point of the piping system. Being the highest point may contribute to the accumulation of gas, being the lowest point to the accumulation of water and/or sediments inside the Analyzer.

The Razor Analyzer measurement is carried by a microwave signal confined inside the "cage" (the slotted part of the probe).

The following section will define more clearly some of the considerations for installation:

1. Regardless of installation mode, the Analyzer should be neither the high point nor the low point of the piping system. This prevents gas, oil, water or sand from accumulating and affecting good measurement. Being the high point may contribute to the accumulation of gas. Mounting in the low point can allow the accumulation of water and/or sediment inside the Analyzer.

2. The general recommendation for all flow regions where the product is well mixed (greater that 2 ft/second or low water in very heavy viscous oil) is to mount the Analyzer horizontally, parallel to the ground, in the center plane of the pipeline. The goal is that everything which goes into the Analyzer can go back out.

3. For a good measurement, every Analyzer needs to see a flow as homogeneously mixed as possible. A good mixture is usually guaranteed by a turbulent flow regime, and a minimum flow velocity of 2 feet/second is recommended. If the flow has a lower velocity, mixture needs to be obtained by some other means, such as installation near a pump, a valve or an elbow. Elbows can either help to mix or act as a separator depending upon viscosity and density of the oil. Static mixers are normally only used in pipelines with percentages of water below 5%. This is because the mixer requires a given range of flow rates in order to be effective. Low flow rates and mixers are not acceptable as there is no mixing in this case. In well testing and other higher water situations the mixer can flash gas due to the pressure drop across it.

4. To prevent possible vibration damage to the ceramic that covers the central conductor in some models, we recommend that the maximum flow velocity not exceed 14 feet/second.

5. A critical issue in Razor installations is that the cage area is in full contact with the active flow. Razor Analyzers are not available with flange ratings of Class 1500 and higher.

6. The only way to validate any Analyzer is to compare its readings with the result of samples analyzed in the laboratory. A sample port must be installed near the Analyzer. This sample port can be located either upstream or downstream of the Analyzer. Analyzer and sample port need to be close enough that the operator reading the Analyzer screen can communicate with the operator taking the sample. Long sample lines will bias the results.

2.2 Horizontal Installations

These analyzers are maintenance free therefore there is no need to periodically remove them from the service. The connecting flange sizes are available in 2, 3, 4 and 6 inch diameter.

ATTENTION:
A **critical** issue in insertion installations is that the active part of the measurement section has to be in full contact with the active flow. See section 8 for dimensions

The razor analyzer can also be mounted horizontally at 45 degrees or in an elbow. These two installations some times are the only way to properly mount them due to the mechanical dimensions of both the measurement section and the pipeline.

Figure 2.1 shows a typical installation on an elbow. Figure 2.2 shows three different options for a horizontal installation on a pipe of large diameter (greater than 16 inches).

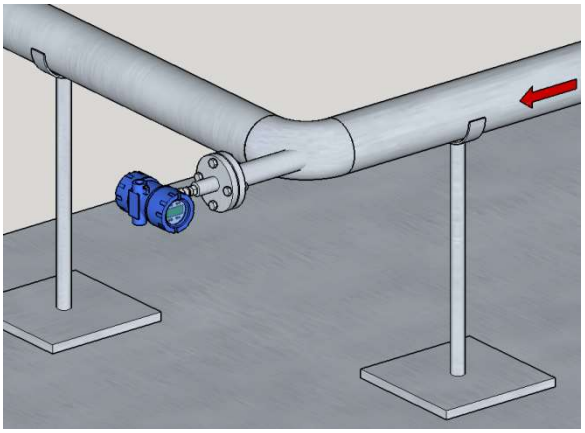

Figure 2.1

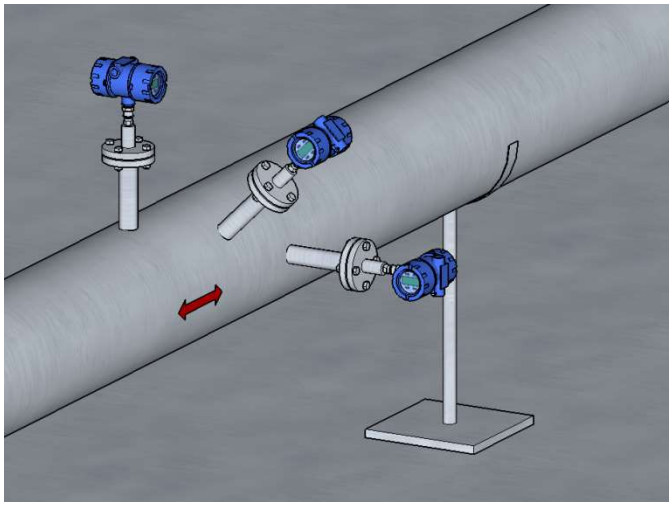

Figure 2.2

2.3 Vertical Installations

Vertical installations provide very good measurements. They are highly recommended when the flow speed is close or below 2 feet/second. The preferred flow direction is from bottom to top because it guaranties a liquid full pipe condition.

A **critical** issue in Razor installations is that the active parts of the Measurement Section have to be in full contact with the active flow.

The flange ratings and pipe wall thicknesses **require** individual analysis, in order to confirm acceptable clearances and sufficient insertion depths. Razor Analyzers cannot be used – and are not available with flange ratings of Class 1500 and higher.

The Razor analyzer can be mounted on vertical pipes with diameters larger than 16 inches. The direction of the flow is not critical but depending on the process, some directions are preferred. For example in processes with presence of sand, a downward flow is preferable. In processes with gas, an ascending flow is preferred.

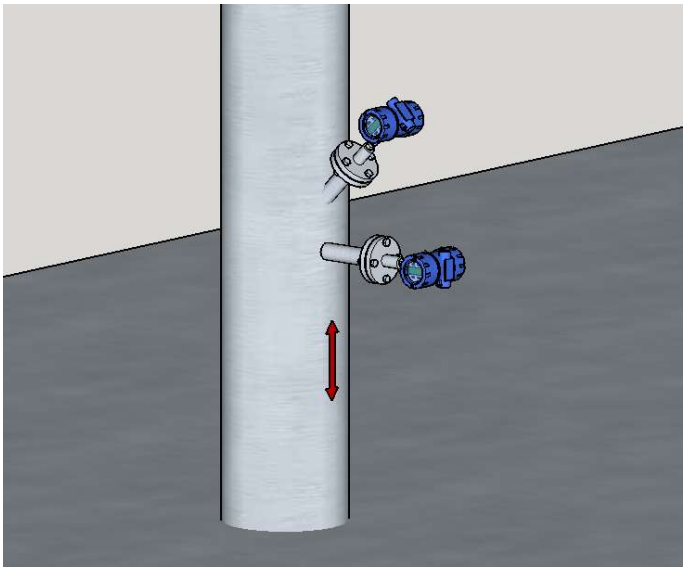

Figure 2.3

2.4 Installations in Tanks

The Razor analyzer can be installed in tanks to measure the water content at the depth it is mounted. This is useful to control the level of the interphase. For such applications the analyzer can be mounted at 90 degrees of at 45 Degrees as shown in figures 2.4 and 2.5.

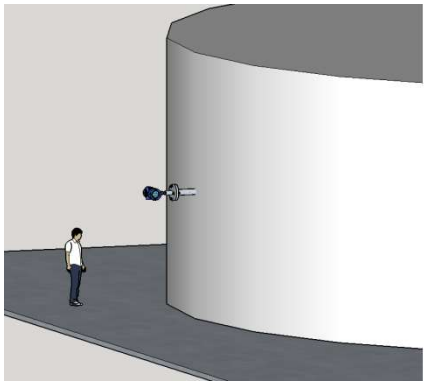

Figure 2.4

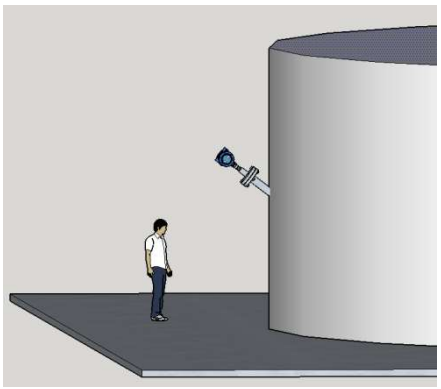

Figure 2.5

2.5 Sampling Port

Since the only way to validate Analyzers is to compare its readings with the result of samples analyzed in the laboratory. A sample port must be installed near the Analyzer (Figure 2.1). This sample port can be located either upstream or downstream of the Analyzer. Analyzer and sample port need to be close enough so that the operator reading the Analyzer screen can communicate with the operator taking the sample, and the flow regime is the same at the sample port and at the Analyzer. A recommended sample port is a bore through fitting welded to the pipeline with a ¼ inch tubing cut as a quilt inserted to the center of the flow. The sample valve should be a quarter turn ball valve so a good extraction flow rate can be obtained.

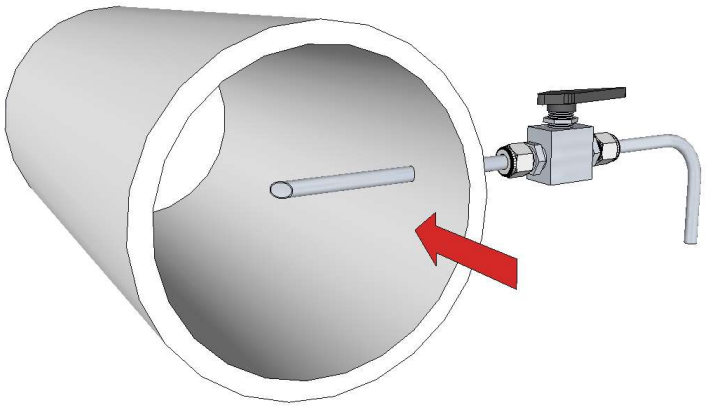

Figure 2.6

3 Electrical Wiring

3.1 Power Supply Connection

The power supply for the Phase Dynamics analyzer is DC (24 Volts). The power consumption of the unit is 5 Watts typical, 10 Watts Maximum. The gauge of the wires has to be calculated to keep the voltage drop across the line to less than 5%.

On the back board, there are 3 terminals marked as ⏚ (Protected Earth o P.E.), +24VDC and GND. The wire gauges accepted by the terminal strip are 12 to 28 AWG. It is important to connect an uninterrupted earth wire to the ⏚ terminal to prevent electric shock hazard.

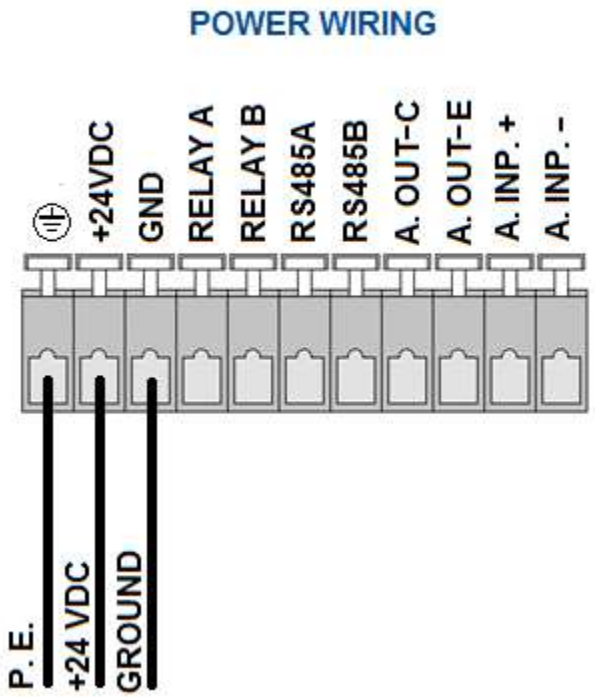

Figure 2.7

3.2 Signals Wiring

The wire gauges accepted by the terminal Strip J1 are 12 to 28 AWG.

3.2.1 Analog Output

ATTENTION:
The Analog Output is ISOLATED and needs to be externally powered.

The analyzer has 1 Analog Output. On the back board there are 2 terminals marked as A. Out-C and A. Out-E. The analog output is passive. External power supply is required. The same power that feeds the analyzer can be used to power the analog output. In that case keep in mind that the negative terminal of the Razor analyzer is internally connected to earth ground.

The connection can be done by using an external power supply. The typical voltage for the external power supply is 24VDC but acceptable values are 8 to 28 VDC.

Figure 2.8a shows the analog output connected to a passive analog input and using an external power supply. Figure 2.8 b shows the analog output connected to a passive analog input but using the same

power supply that feeds the analyzer. The negative terminal of the Razor analyzer is internally connected to earth. This could be a problem if the input of the analog input is also connected to earth. Figure 2.8 c shows the analog output connected to an active analog input.

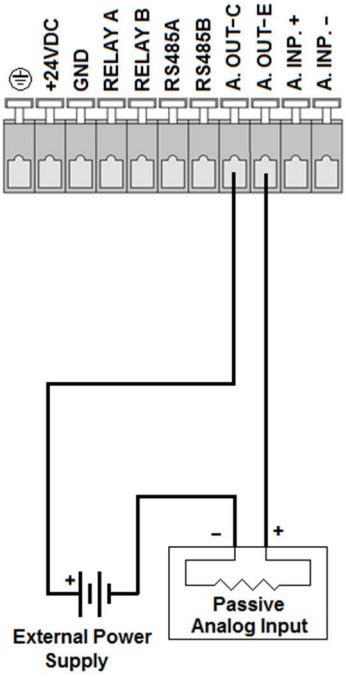

Figure 2.8a – Razor's A.O. to Passive A.I.

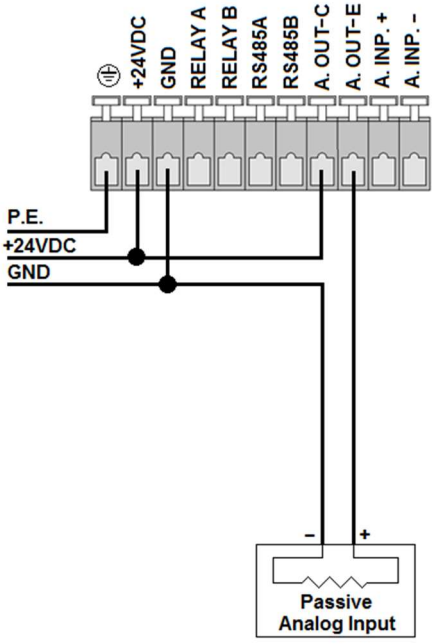

Figure 2.8b – Razor's A.O. to Passive A.I.

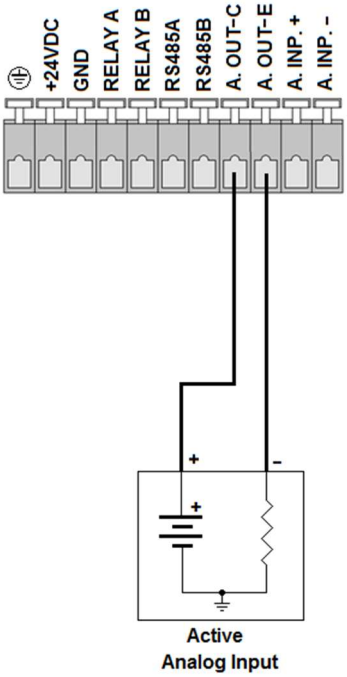

Figure 2.8c - Razor's A.O. to Active A.I.

3.2.2 MODBUS® Communication Port

The analyzer has 1 RS-485 port with MODBUS® RTU protocol normally used for communication with SCADA system. On the back board, there are 2 terminals marked as RS485A and RS485B. A 120 Ohms termination resistor can be added by setting the switches S1-1 and S1-2.

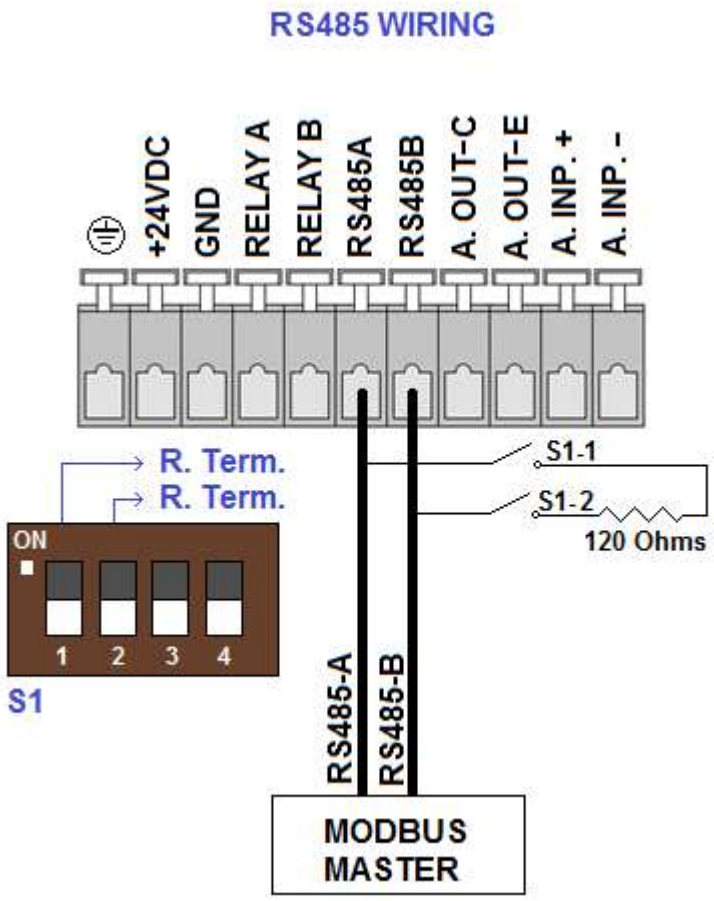

Figure 2.9

3.2.3 Relay

The analyzer has 1 configurable relay with Normal Open switch. The terminals for the relay are on the back board and are identified as RELAY A and RELAY B. The maximum rating of this contact is 24VDC 0.5Amp.

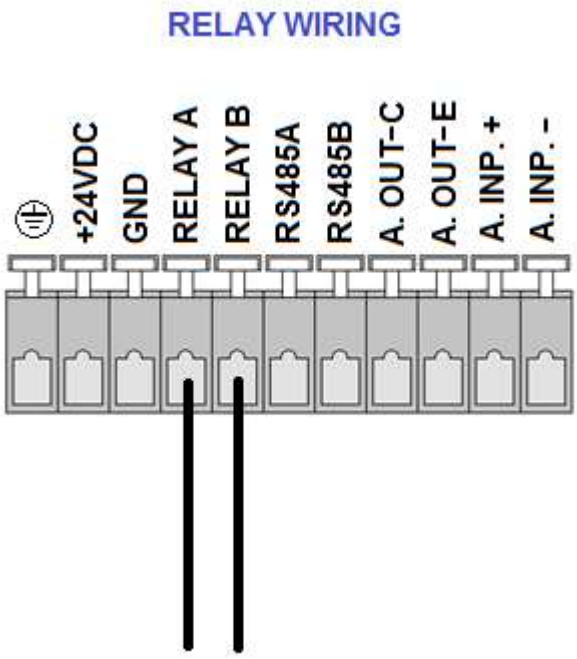

Figure 2.10

3.2.4 Analog Input

The analyzer has 1 Analog Input. The terminals are on the back board and are identified as A. INP + and A. INP -. This input is galvanically isolated from the ground. It can be connected to an active Analog Output as shown on Figure 2.11a or to a Passive Analog output as shown on Figure 2.11b. The external power supply on Figure 2.11b can be the same used to feed the Razor. In this case, keep in mind that the negative power terminal of the Razor is connected to Earth Ground. Always check the installation manual of the device to be connected to the Razor analyzer.

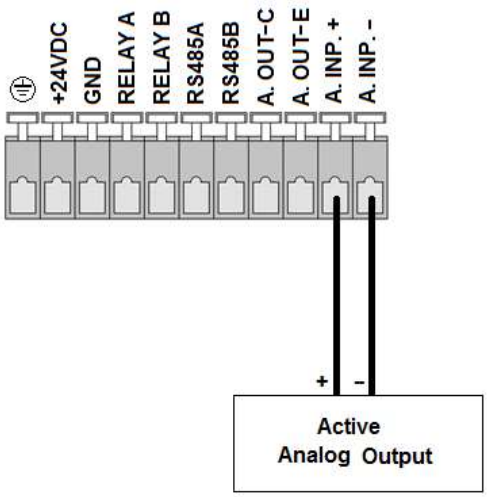

Figure 2.11a - Razor's A.I. to Loop Powered A.O.

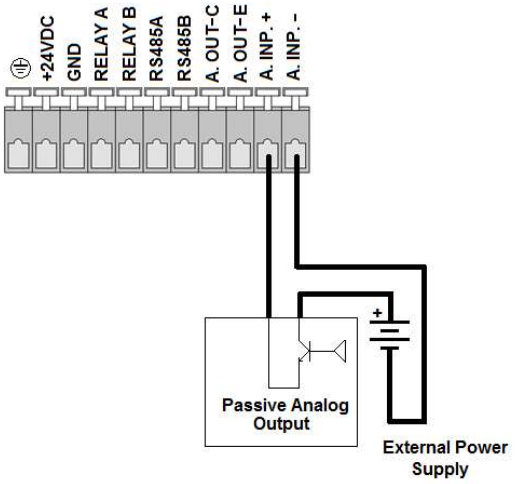

Figure 2.11b - Razor's A.I to Active A.O.

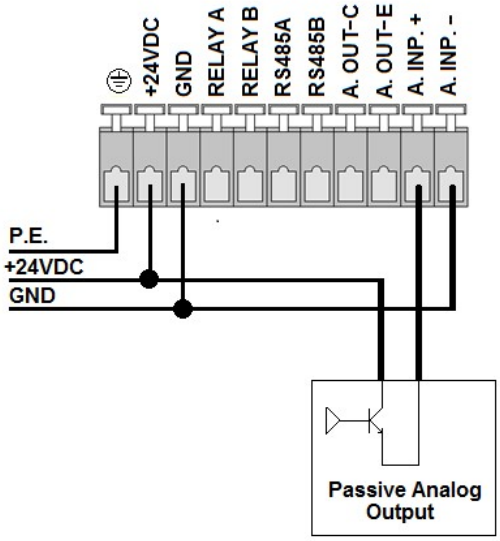

Figure 2.11c – Razor's A.I. to Loop Powered A.O. (Using Razor's Power Supply)

4 Principle of Operation – Mid Range Razor Analyzers

The following sections describe, in detail, the specific operation of the Phase Dynamics load-pull system and how it is used to measure water content.

4.1 Calibration

During factory calibration, every single Mid-Range Razor analyzer is calibrated on the oil phase from 0% water to inversion at constant temperature. Inversion is the point where the emulsion changes from Oil Phase to Water Phase. In hydrocarbons this happens when the water content is about 78-80%. A fluid is in Oil Phase when is composed by small drops of water surrounded by oil. A fluid is in Water Phase when is composed by drops of oil surrounded by water.

4.2 Detailed Description of Frequency Response

The load-pull system relates the frequency of an oscillator connected to the probe to water content. During factory calibration, coefficients are derived to relate the measured frequency to water content for a given temperature. The water content is calculated as follows;

Water content	=	$O3 \times (\text{Frequency} + \text{Oil Index})^3$
	+	$O2 \times (\text{Frequency} + \text{Oil Index})^2$
	+	$O1 \times (\text{Frequency} + \text{Oil Index})$
	+	$O0$
	+	Oil Adjust

Where Frequency is the measured oscillator frequency,
O3, O2, O1 and O0 are the oil constants,
Oil Index is a frequency index value, and
Oil Adjust is a linear offset value.

The factory default values for Oil Index and Oil Adjust are zero (0). In this case the above equation simplifies to;

Water content = $O3 * Freq^3 + O2 * Freq^2 + O1 * Freq + O0$.

Figure 3.1 shows a typical factory calibration curve for constant temperature.

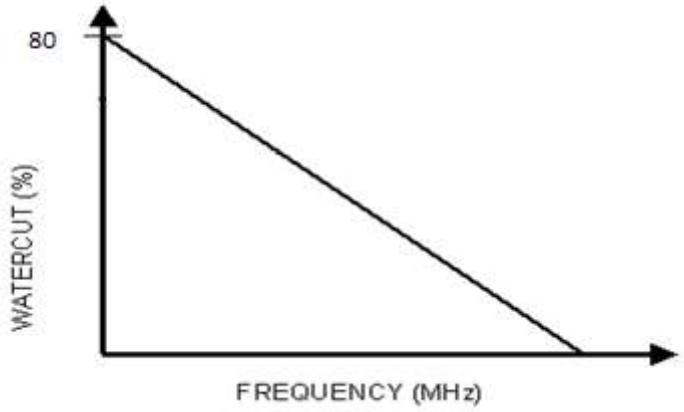

Figure 3.1 - Factory Calibration, Frequency versus Water Content

To compensate for the effect of the difference between the density of the oil used for factory calibration and the density of the actual crude oil, a linear offset factor called Oil Adjust may be added to or subtracted from the computed water content. The effect of Oil Adjust is as shown in Figure 3.2

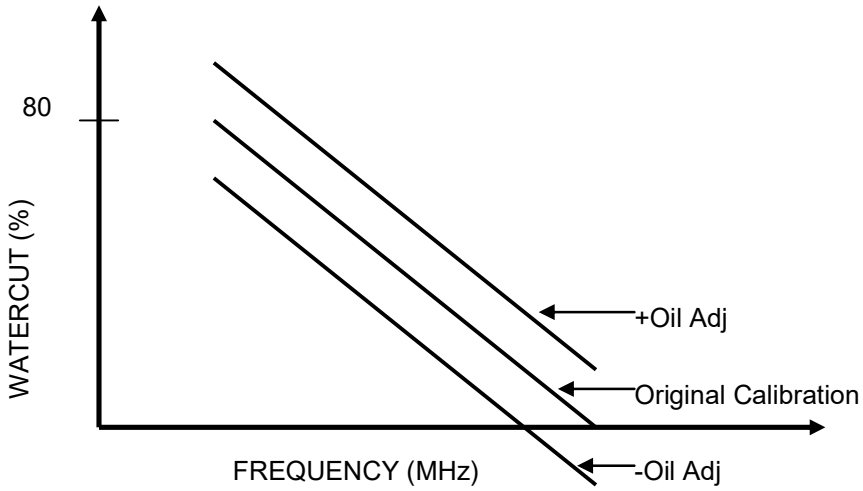

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Figure 3.2 - Effect of Changing Oil Adjust

The Phase Dynamics Water in Hydrocarbon Analyzer includes an operational feature which allows the instrument to determine an over range condition for the measured water content. The reflected power signal from the oscillator module is measured and compared to a threshold value; it is a DC voltage indicative of the signal level reflected from the measurement section. Typically, the measured level will be above the threshold value when the measured water content is within range. For the over range condition, the reflected power level will be below the threshold value.

The reflected power threshold level (RP Threshold) may be frequency and is given by;

RP Threshold = P1 x Frequency + P0

Where:
Frequency: Is the measured oscillator frequency,
P1 is the slope of the threshold curve, and
P0 is the intercept of the threshold curve.

When the reflected power is below the RP Threshold the analyzer indicates 100% water cut and High Water Cut alarm.

4.3 Temperature Compensation

Compensation for temperature effects must be included for best performance of the analyzer. Temperature changes the permittivity of most materials; this change in permittivity presents a changing load to the oscillator, which changes its frequency. Thus, without temperature compensation, a changing

process temperature would cause changes in frequency, which would lead to errors in the calculated water content.

The system is temperature compensated for the electronics and the changing fluid properties. This is obtained through Embedded Electronics which are circuits uniquely installed within the antenna portion.

There is a Temperature Adjust feature which is just an offset used to adjust the probe temperature measured value to match the actual liquid temperature, if necessary.

5 Two Lines LCD Menu Description and IR Sensors Operation

There are 4 “Keys” to interact with the analyzer. They are called “STEP”, “BACK”, “VALUE” and ENTER”. To refer to these keys on this manual, they are noted as [STEP], [BACK], [VALUE] and [ENTER]. In general, their functions are:

The [STEP] key is the general key to access the menus and submenus. Also, in edition mode it moves the blinking digit to the next available digit.

NOTE: The underlined characters in the representations of the screens stand for blinking digits.

The [BACK] key is used to return to previous menus and submenus. It is also used to exit a submenu WITHOUT saving the changes.

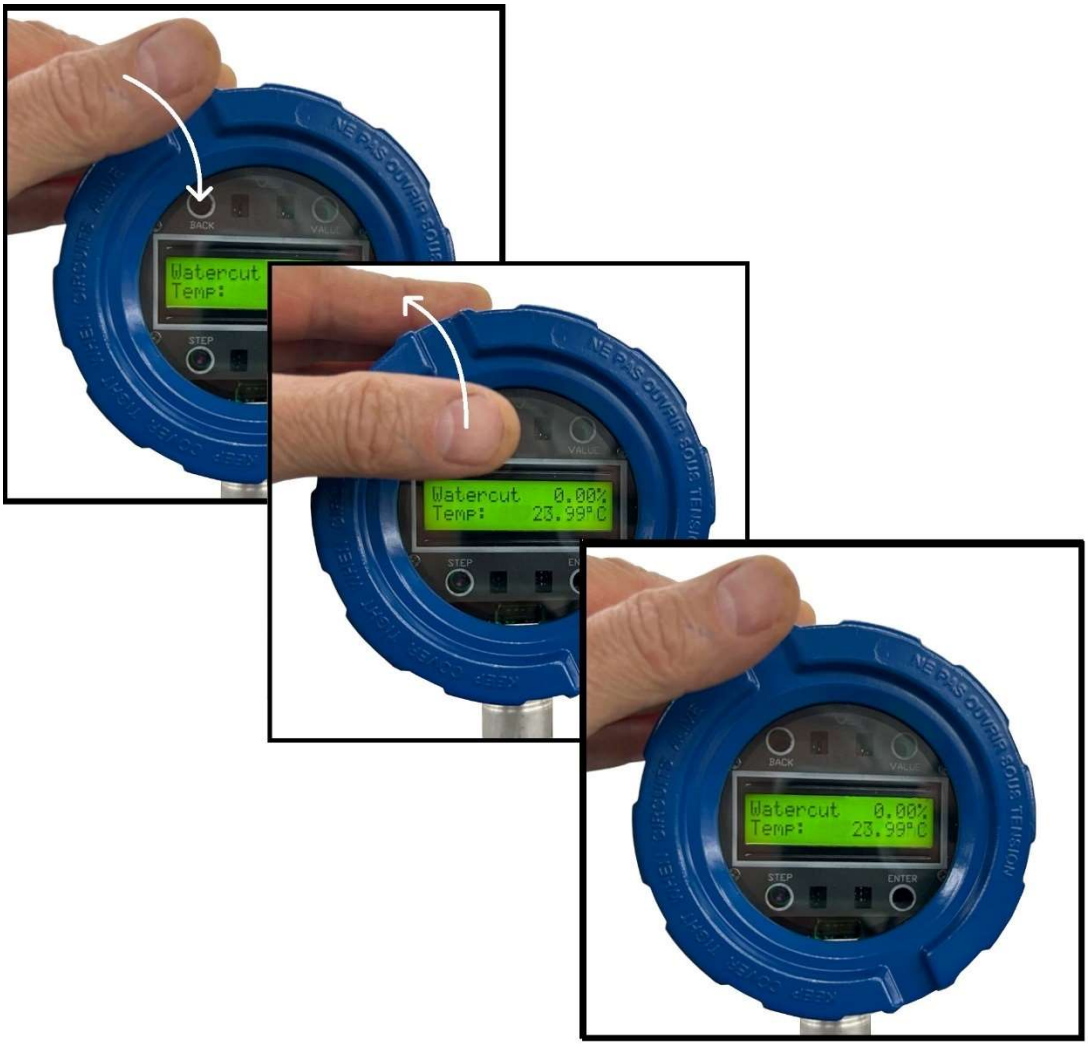
The [VALUE] key, allows the user to increase the blinking digit in one unit every time is pressed. It is also use to change selections like for example units.

The [ENTER] key is used to ACCEPT changes or selections and exit the edition mode.

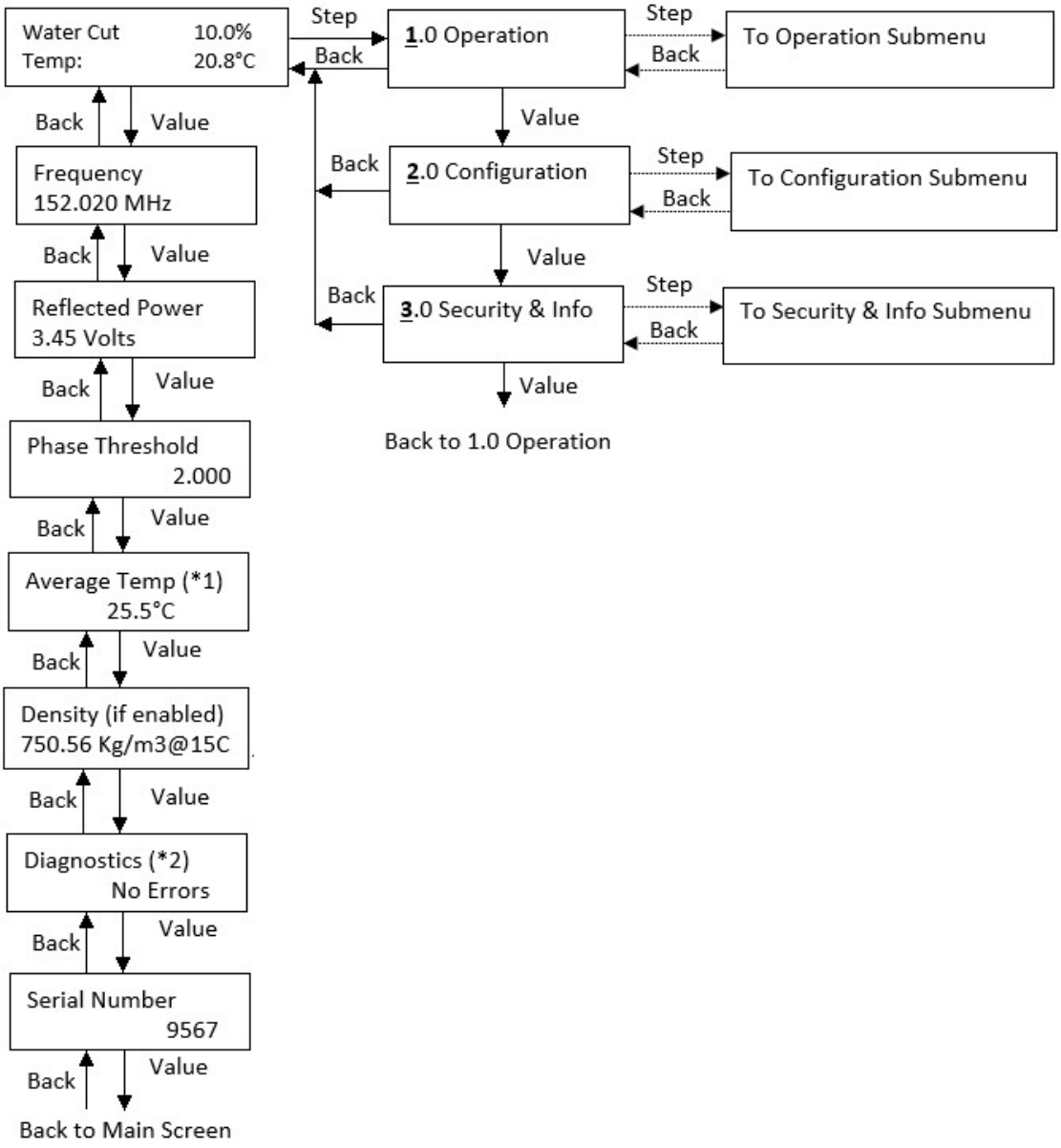
From the main screen different screens with current measurements and statuses can be browsed by pressing [VALUE]. The browsing order can be reversed by pressing [BACK]. Also, from the main screen a set of configuration screens can be accessed by pressing [STEP]. These screens are divided in 3 main sections. 1.0 Operation, 2.0 Configuration and 3.0 Security and Info.

The “Keys” are 4 infrared sensors that sense the reflection of an infrared light into the operator’s finger. The infrared sensors are under the white circles labeled as BACK, VALUE, STEP and ENTER.

To activate each sensor, you need to “wave” your thumb over the corresponding sensor (Circle). The following sequence of pictures describes the “Thumb Waving” operation over the BACK key. Start with your thumb outside of the glass area. Then pivot your thumb until you located in front of the BACK key circle. Then quickly pivot it back to the original position. If you keep your finger over the circle, is equivalent to press the key multiple times.



The following chart shows the basic navigation through the basic information screens by pressing [BACK] or [VALUE] from the main screen, or, the navigation through the Operation, Configuration and Security menus by pressing [STEP] from the main screen.



5.1 Technician and Locked Modes

There are two modes for the panel. Technician Mode and Locked Mode. On Technician Mode, all the editable parameters can be modified. On Locked mode, all parameters can be viewed but only a few of them, used for operation, can be changed. The parameters that can be edited on Loscked mode are all under the 1.0 Operation menu and they are:

Stream Number
Oil Adjust
Oil Capture
Sample
Reset Average Temperature

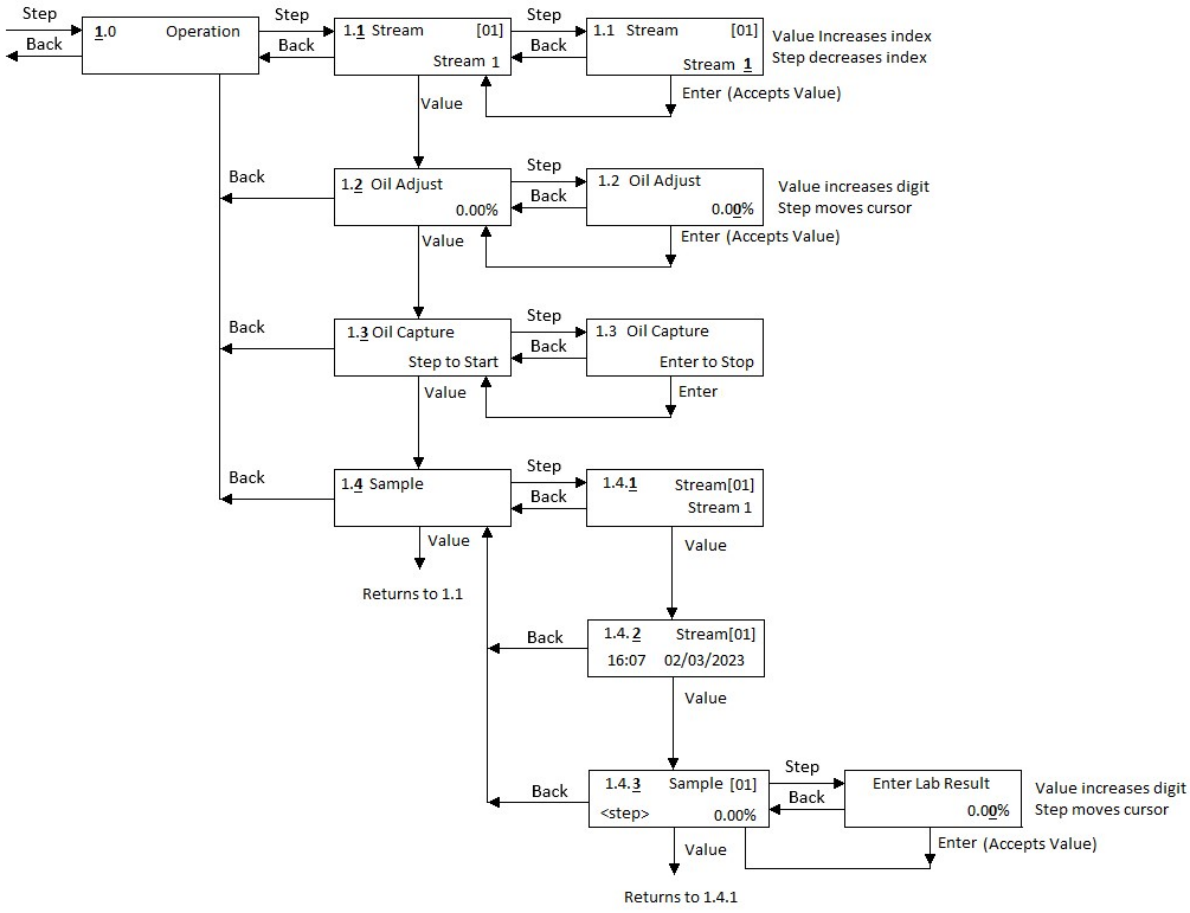
When the unit is Locked, the Technician mode can be accessed with a password. See section 5.13.3

5.2 Key logic

All menus and submenus have an index number. Once accessed, one of the digits on the index will be blinking. Pressing [VALUE] will increase that digit. Pressing [STEP] will access a deeper level on the same submenu. [BACK] will return on level back or can also be used to exit from an edition WITHOUT accepting the changes. [ENTER] accepts a change and exits a submenu.

The following flow diagrams show the operation of all the menus and submenus.

5.3 Operation Submenu 1.0



5.3.1 Stream (1.1):

This screen shows the Stream configuration currently used (1 to 60). Press [VALUE] to skip this menu. Press [STEP] to enter into edition mode. Use [STEP] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [BACK] to exit without saving.

5.3.2 Oil Adjust (1.2):

This is an offset added to the water cut. It is necessary to compensate for constant density changes in the oil. See chapter 6 – “Operation” for more information. Press [VALUE] to skip this menu or press

[STEP] to start the edition mode. Press [STEP] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [BACK] to exit without changes.

5.3.3 Oil Capture (1.3):

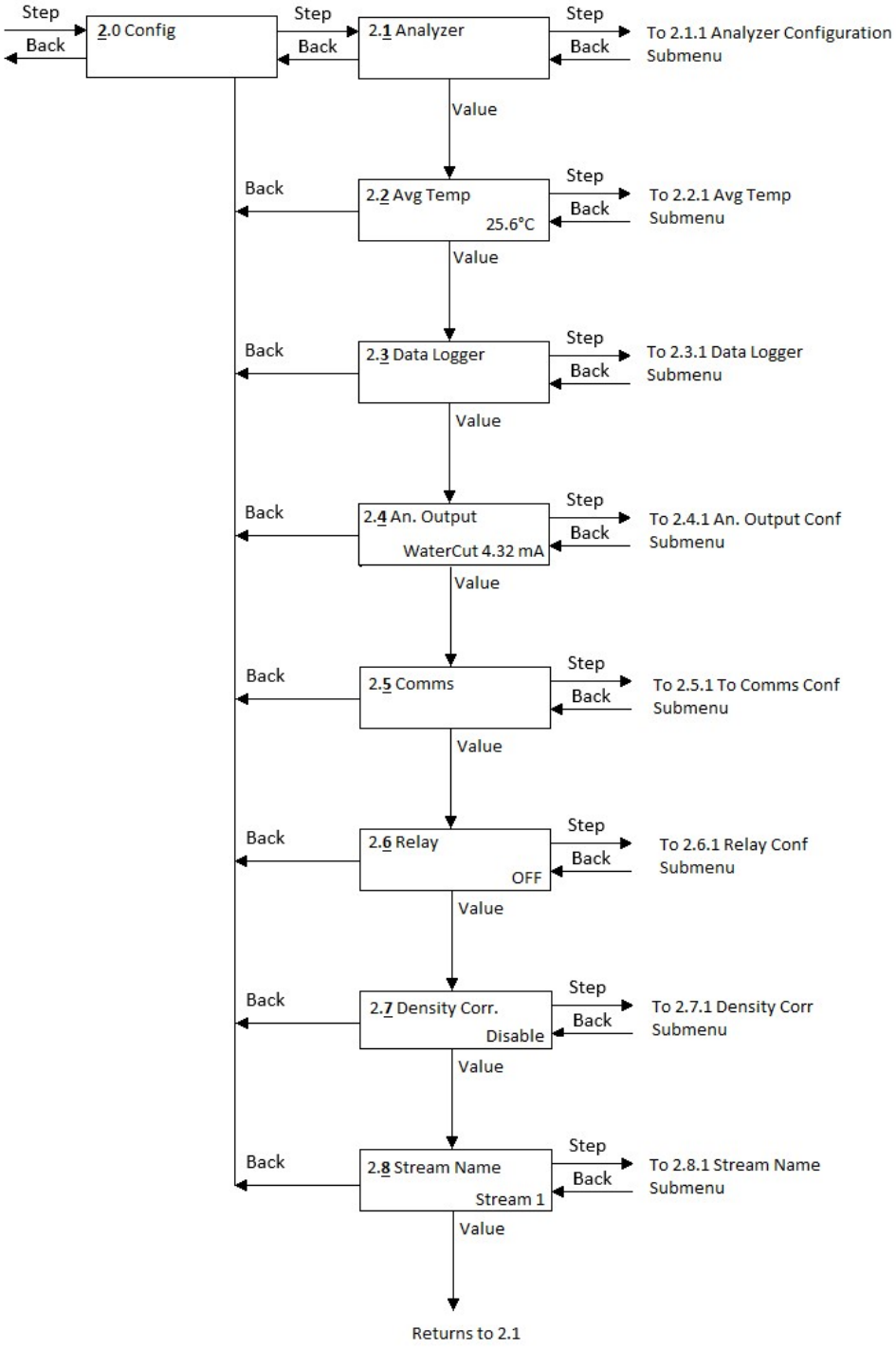
This is a very useful command to be used when the water cut offset needs to be adjusted. At the same time that a sample is taken, activate this command to capture current data. The offset (Oil Adjust) will be automatically calculated after the actual water cut is entered on the "Sample Result" submenu. The actual value is obtained through a laboratory analysis of the sample taken. See chapter 6 for more information. Press [VALUE] to skip this menu or press [ENTER] to start a new capture. While a capture is running a "ENTER to Stop" message is flashing. User has to press ENTER again to stop the capture. The automatic calculation of the Oil Adjust will not be done until the laboratory result is not entered on the "Sample Result" Submenu.

5.3.4 Sample (1.4):

Enter the water cut corresponding to the captured sample described on the "Oil Capture" command. If no capture data is stored, the current reading will be used. Press [VALUE] to skip this menu or use [STEP] to start the edition mode. Press [STEP] to move the cursor and [VALUE] to change the digits. When the changes are done, press [ENTER] to accept them or [BACK] to exit without changes.

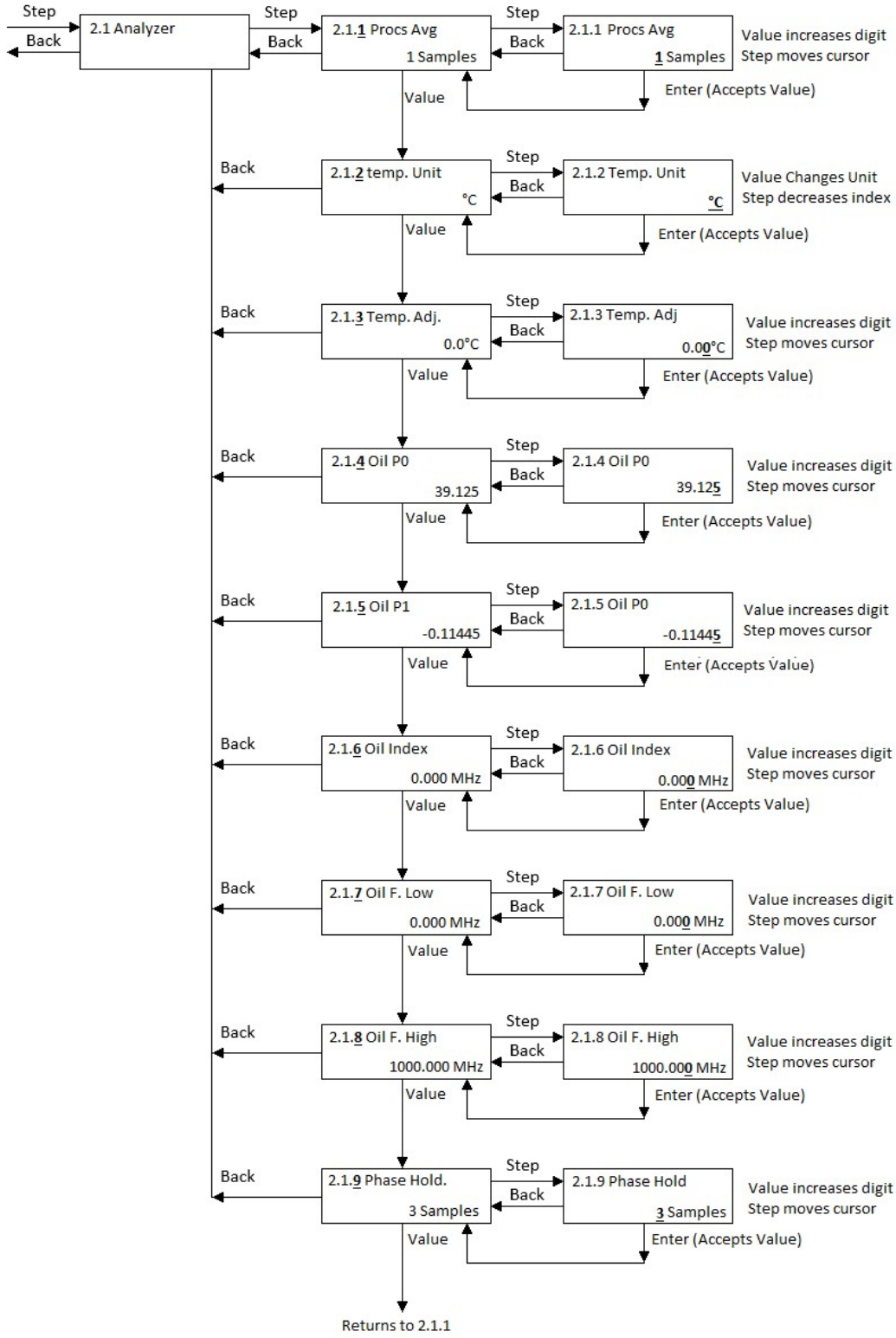
5.4 Configuration Submenu: 2.0

The configuration submenu 2.0 groups all the configurations of the device. This includes the Analyzer, the Analog input and output, Data logger, etc. Configurations can always be seen but they can only be changed in Technician Mode. The following is the full Configuration Menu Tree.



5.5 *Analyzer Configuration Submenu 2.1*

This Submenu groups all the configuration parameters related with the water cut measurement.



5.5.1 Proc. Avg. (2.1.1):

Process Averaging, is the number of samples computed to calculate the water cut. Acceptable range is from 1 to 300. Values other than 1 will dampen the reading accordingly. Press [VALUE] to skip this menu. Press [STEP] to enter into edition mode. To edit the current number, press [VALUE] to change the digits. Use [STEP] to move the cursor. When the changes are done, press [ENTER] to accept or [BACK] to exit without saving.

5.5.2 Temp. Unit (2.1.2):

This submenu allows the user to change the main screen temperature unit. The available options are: °C and °F, Press [VALUE] to skip this menu or use [STEP] to enter into edition mode. Then press [VALUE] to change the units and [ENTER] to accept the changes or [BACK] to exit without saving.

5.5.3 Temp. Adj. (2.1.3):

Default is 0. Enter here a value to offset the temperature value. Press [STEP] to skip this menu or press [STEP] to enter into edition mode. Use [VALUE] to change the blinking digit. Use [STEP] to move the cursor. When the changes are done, press [ENTER] to accept or [BACK] to exit without saving.

5.5.4 Oil Po (V) (2.1.4):

The Razor Analyzer only measures when the fluid is in Oil Phase (Water droplets surrounded by oil). The determined the phase a threshold is used. Such threshold line is determined by the equation:

Threshold = Frequency(MHz) * P1 + P0

The value of P1, P0, are determined during factory calibration and should not be changed unless instructed by Phase Dynamics. See section 4.2 for more information.

Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

a) Oil P1 (V/MHz) (2.1.5):

Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

b) Oil Index (MHz) (2.1.6):

The Oil Index is an offset that is added to the measured frequency of the Oscillator. This parameter should not be changed unless instructed by a Phase Dynamics specialist. The default value is 0. Acceptable value for this parameter is between -1000 to 1000. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

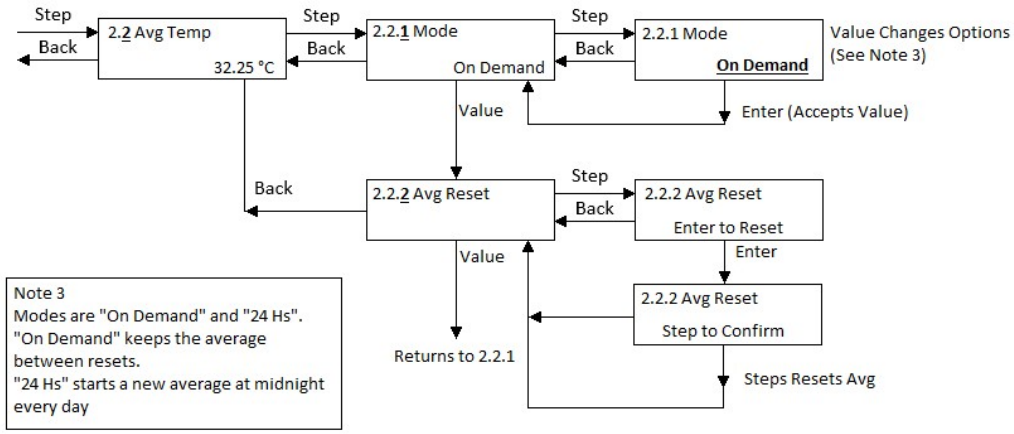
c) Oil Frequency Low (MHz) (2.1.7):

This value along with the threshold given by P0 and P1 are used to detect the fluid is in water phase. This parameter should not be changed unless instructed by a Phase Dynamics specialist. The default value is determined during calibration and if different for each unit. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

d) Oil Frequency High (MHz) (2.1.8):

Frequencies over this limit will cause the analyzer to read zero. This parameter should not be changed unless instructed by Phase Dynamics. The default value is 1000MHz. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.5.5 Average Temp Submenu 2.2



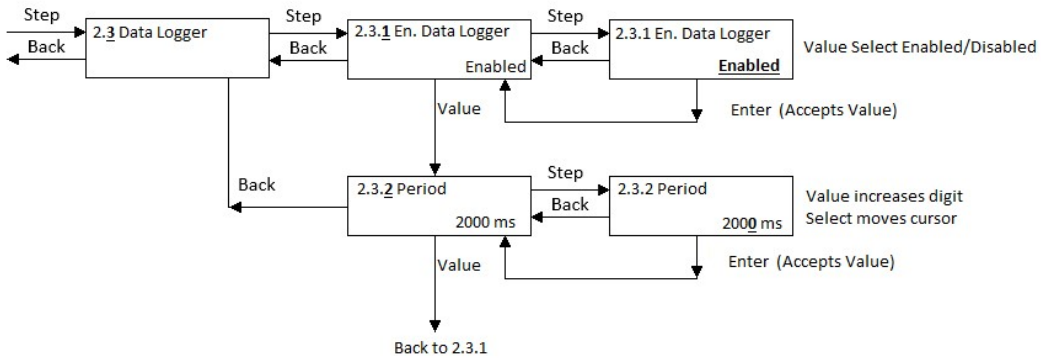
a) Average Temp Mode (2.2.1):

This submenu allows the selection of two averaging modes. On Demand and 24 Hs. On Demand performs the averaging between Temperature Average Resets. 24 Hs resets the average every night at midnight. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [VALUE] to select one of the two options. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

b) Average Reset (2.2.2):

This Submenu allows the user to reset the Temperature Averaging process when the mode is On Demand. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [ENTER] to reset the average and start a new one. Press [STEP] to confirm the reset.

5.6 Data Logger Submenu 2.3



5.6.1 Enable Logger (2.3.1):

This Menu allows the user to enable the data logging feature. The electronic has a USB port that can be used for data logging. The connector is inside the front display.

When a USB drive is inserted in the port, a folder named with the serial number is created. Inside this folder there are 3 subfolders: ALARM, DATA and EVENT.

When the data logger is enabled, a new comma separated values file is created every day at midnight. This file in inside the Subfolder DATA. The name of the file is:
LOG-YYYY-MMDD.CSV
Where YYYY is year, MM is Month and DD is Day
For example: LOG-2020-0527.CSV

The beginning of the file includes the current configurations of the unit. Then there is a header indicating the meaning of each column.

LOG-2000-0101.csv - Notepad

File Edit Format View Help

```
Serial Number,0
Firmware Version,01.03.11.02:6,
Hardware Version,0:0:0:0:0

Temp Adj,-500.000000000
Temp Unit,C
Proc. Averaging,1
Oil Index,270.000000000
P0,31.328571400
P1,-0.114285700
T0,0.000000000
T1,0.000000000
Oil Low,0.000000000
Oil High,1000.000000000
D0,24.600000000
D1,-0.028600000
D2,0.000000000
D3,0.000000000
Dens. Correction mode,Disable
Phase Holdover,3


Date,Time,Watercut,Raw WC,Cap WC,User Temp,Unit,Emulsion Phase,Diagnostics,Frequency,Reflected Power,Phase Threshold,Stream Select,Oil Adjust,Display Density,Unit,Input Density,Unit,Density in Kg/m3@15C,Density Correction mode
01/01/2000,01:50:58,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:01,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:03,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:05,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:07,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:09,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:11,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:13,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:15,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:17,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
01/01/2000,01:51:19,-16.170902238,-16.170902238,0.000000000,79.975000000,C,Oil,7Events  2Alarms,270.000000000,10.237187500,0.471432400,1,0.000000000,0.000000000,Kg/m3-15,0.000000000,Kg/m3-15,0.000000000,Disable
```

Inside the Subfolder ALARM a file called:

ALARM-YYYY-MMDD.CSV is created. Where

YYYY is the Year, MM the month and DD the day.

The files shows the day and time a variable entered into alarm and the time they recovered. For example:

Date, Time, Type, Alarm, Value, Min, Max
01/01/2000,00:04:24, Watercut, Normal, 0.70902238, 0.000000000, 100.000000000
01/01/2000,00:04:10, Watercut, Low, -0.170902238, 0.000000000, 100.000000000
01/01/2000,00:03:38, Temperature, Normal,79.975000000, -10.000000000,90.000000000
01/01/2000,00:04:09, Frequency, Normal, 270.000000000, 235.000000000,285.000000000

In the example above, the water cut went below the valid range (0-100) at 00:04:10. Then the water cut came back to normal at 00:04:24

Inside the Subfolder EVENT, there is a file that contains all the events. This are for example configuration changes.

Date, Time, Event, Description, Value, Value
01/01/2000,00:03:38, User Data, TEMPERATURE_CONFIG.user_adjust, 0.000000000, -500.000000000
01/01/2000,00:04:09, User Data, OIL_CONFIG.index, 0.000000000, 270.000000000

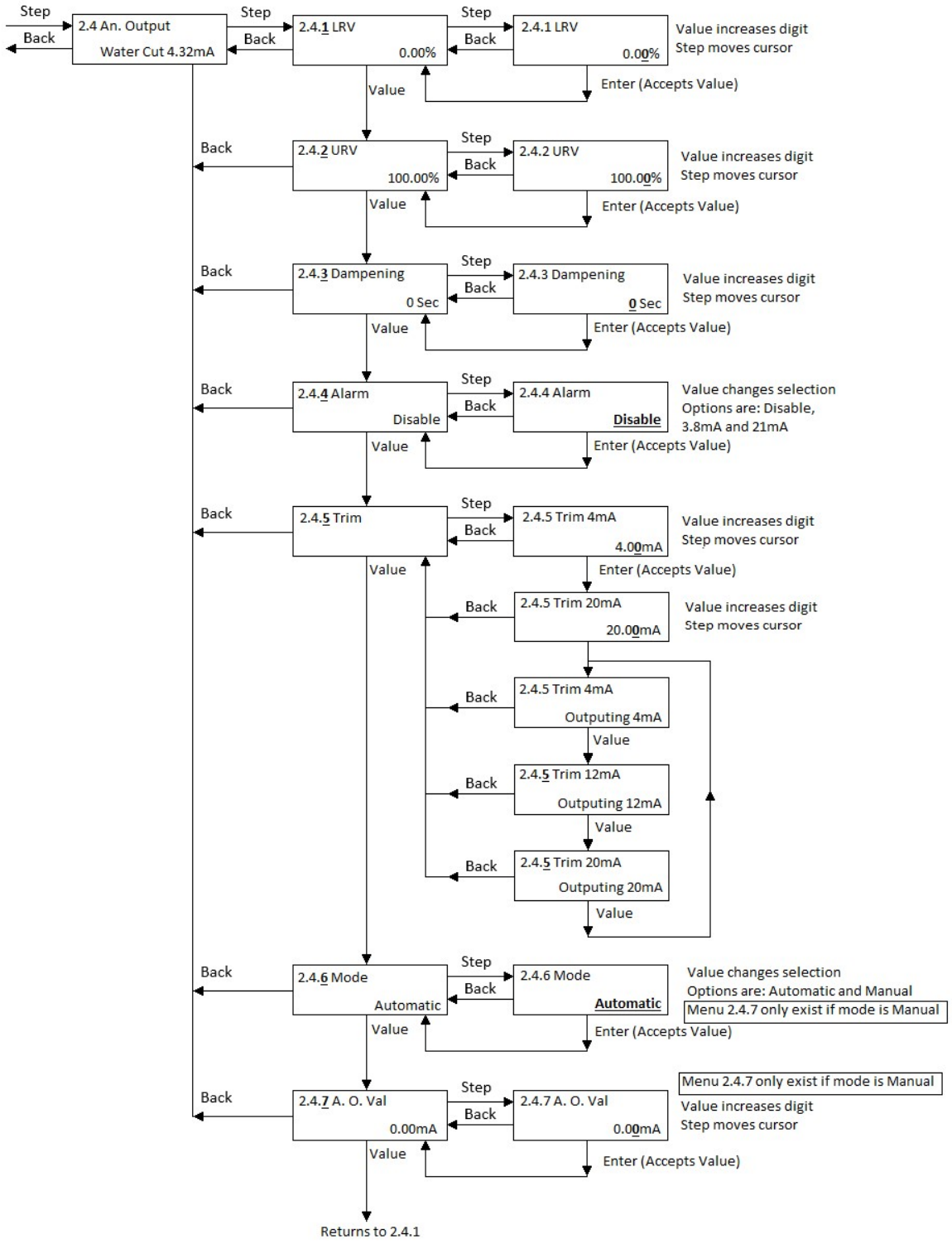
In the example above, the Temperature Adjust parameter was changed from 0 to -500 at 00:03:38 and the value of Oil Index was changed from 0 to 270 at 00:04:09.

The Alarms and Events are stored in memory in an array with 60 positions. When there are more than 60 events or alarms, the array is overwritten. If at any time a USB drive is inserted in the port, all the recorded ALARMS and EVENTS (up to a depth of 60 of each) are copied into the drive.

5.6.2 Logging Sample Period (2.3.2):

This screen allows user to change the data logging period. The minimum is 250 msecs and the Maximum 120000 msecs. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.7 Analog Output Configuration Submenu 2.4



5.7.1 Analog Output LRV (2.4.1):

This screen shows the current Analog Output "Lower Range Value". This is the value that is associated with a current of 4mA. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.7.2 Analog Output URV (2.4.2):

This screen shows the current Analog Output "Upper Range Value". This is the value associated with 20mA. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.7.3 Dampening (seconds) (2.4.3):

This screen shows the current Dampening Time of the Analog Output in Seconds. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.7.4 Analog Output Alarm (2.4.4):

This screen shows the current that will be at the analog output in the event of critical conditions that don't allow to calculate a valid value of water cut. These conditions are:

Frequency low (Frequency lower than 235MHz)
Frequency high (Frequency higher than 285MHz)
Temperature High (Temp Higher than 90 °C or 194°F)

The next 2 conditions are only checked if Density Correction is enabled.

Density High (Density Higher than 1100 Kg/m3 or 152 API or 85lbs/ft3)
Density Low (Density lower than 500Kg/m3 or -3API or 38lbs/ft3

The options for this mode are:
Disable (no alarm)
3.8mA (The current at the output will be 3.8mA in case of a critical alarm)
21mA (The current at the output will be 21mA in case of a critical alarm)

Press [VALUE] to skip or press [STEP] to enter into edition mode then use [VALUE] to select between the 2 options. 4mA or 20mA. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.7.5 Trim (2.4.5):

a) Trim 4 mA:

This submenu allows the trimming of the analog output. If trimming is needed connect a mA meter on the Analog Output terminals. Then press [STEP] to enter into edition mode and enter on that screen the value read on the mA meter. Press [VALUE] to change the digits and use [STEP] to move the cursor. Press [BACK] to cancel or [ENTER] after the reading is changed to go to the Trim 20mA section.

b) Trim 20mA:

Now read the value in the mA meter and enter it in the bottom line by using [SELECT] and [VALUE]. When done, press [BACK] to cancel of [ENTER] to accept the change.

c) Outputting 4mA:

The Analog Output will force 4.00mA into the Output. Press [BACK] to exit or [VALUE] to force 12mA

d) Outputting 12mA:

The Analog Output will force 12mA into the output. Press [BACK] to exit or [VALUE] to go to force 20mA.

e) Outputting 20mA:

The Analog Output will force 20mA into the output. Press [BACK] to exit or [VALUE] to go to force 4mA.

5.7.6 Mode (2.4.7):

There are 2 modes for the Analog Output. Automatic and Manual. In Automatic mode the Analog Output gives 4mA for the minimum setting (LRV) and 20mA for the maximum (URV). In Manual mode the user can enter any desired value for the Analog Output Current. This Manual mode is very useful for testing the current loop.

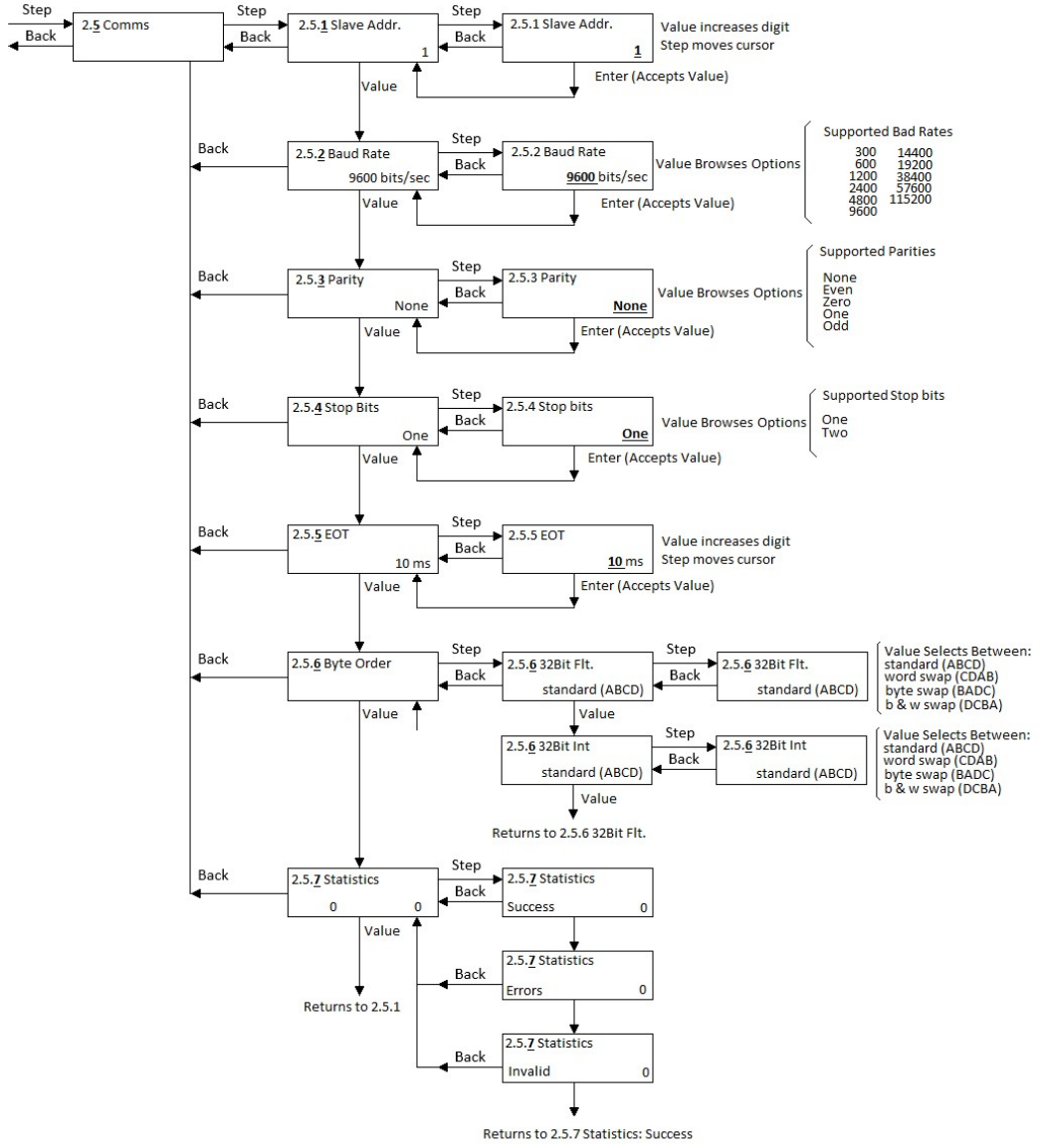
This screen shows the current mode. Press [VALUE] to skip or press [STEP] to enter into edition mode then use [VALUE] to select between the 3 options. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.7.7 Analog Output Value (2.4.8)

This screen is only shown when Manual Mode is selected. [STEP] to enter into edition mode, press [VALUE] to change the blinking digit or [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving. The selected value of current will be sent to the analog output.

If the AO Alarm is not disable, then a critical condition will cause the Analog Output to output the corresponding alarm level overwriting the manual mode. To be able to change the value manually, disable the alarm in menu 2.4.4.

5.8 Communication Configuration Submenu 2.5



5.8.1 Slave Address (2.5.1):

This screen shows the current Slave Address. The default value is 1. Values from 1 to 255 are allowed. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Press [STEP] to move the cursor and [VALUE] to change the blinking digit. After the changes have been done, press [ENTER] to accept the changes or [BACK] to exit without saving.

5.8.2 Baud Rate (2.5.2):

The default value is 9600. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode and then press [VALUE] change to the desired baud rate. Available options are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 125200. After the baud rate has been selected, press [ENTER] to accept or [BACK] to exit without saving.

5.8.3 Parity (2.5.3)

The default setting is None. Press [VALUE] to skip this menu or press [STEP] to enter into browsing mode and then press [VALUE] to find the desired option. Available options are:

- NONE
- ODD
- EVEN
- MARK/1
- SPACE/0

After reaching the desired one, press [ENTER] to accept or press [BACK] to exit without saving.

5.8.4 Stop Bits (2.5.4)

This screen shows the current selection for the number of stop bits. The default is "One". Valid options are One and Two. Press [VALUE] to skip this menu or press [STEP] to enter into browsing mode and then press [VALUE] to find the desired option and then [ENTER] to accept the change or [BACK] to exit without saving.

5.8.5 EOT (2.5.5)

This screen shows the current selection for EOT. EOT stands for End of Transmission. This is the time the device "waits" before sending a response to a request. The default value is 10msec. The minimum allowed is 1msec and the maximum 999msec. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode and then press [STEP] and [VALUE] to change the value and then [ENTER] to accept the change or [BACK] to exit without saving.

5.8.6 Byte Order (2.5.6)

The floating-point and numbers are composed by 32 bits (4bytes). There are 4 IEEE formats in which these bytes can be sent.

For Floating-Points the options are:

Standard (ABCD) [Default]
Word Swap (CDAB)
Byte Swap ((BADC)
Byte and Word Swap (DCBA)

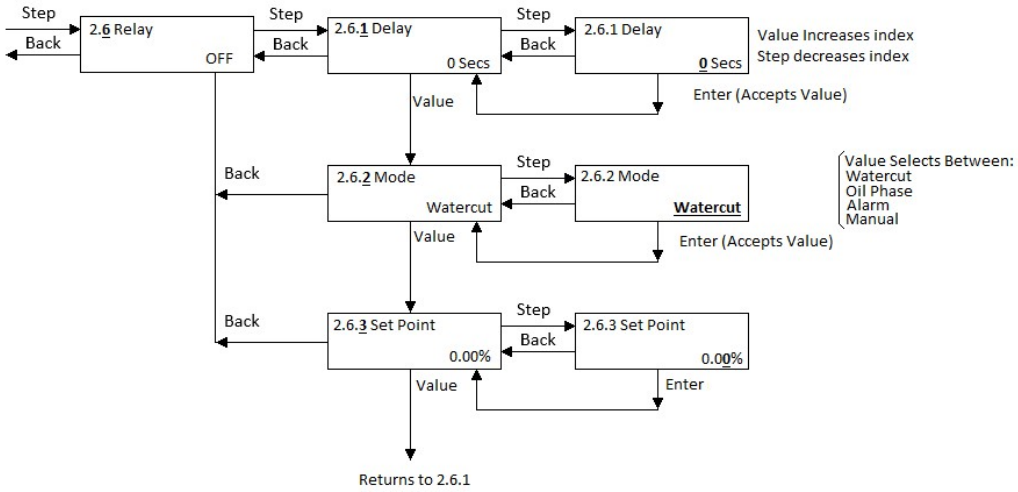
Same options are available for 32 bits integer (also known as long integers)
Press [VALUE] to skip this menu and go the 32 Bits Integer options or press [STEP] to enter into browsing mode and then press [STEP] and [VALUE] to change the selection and then [ENTER] to accept the change or [BACK] to exit without saving.

The options for 32 bits integers are the same but the configuration is stored separately. Default selection for 32 bits integers is ABCD.

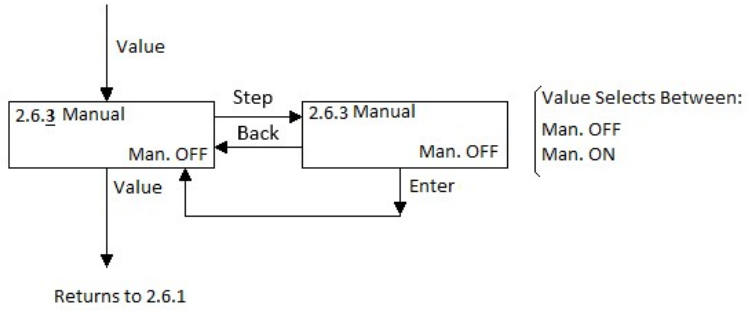
5.8.7 Statistics (2.5.7):

This screen shows information about the traffic in the communication channel. Pressing [Value] repeatedly will browse through several statistics like: Successful packages count, Errors, Invalid packages count. Press [BACK] at any time to exit the Communication Statistics Submenu.

5.9 Relay Configuration Submenu 2.6



If Manual Mode is selected, then the submenu 2.6.3 becomes:



5.9.1 Delay (2.6.1):

This screen shows the current Delay in seconds for the relay activation. The default value is 0. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.9.2 Mode (2.6.2):

This screen shows the current Relay Mode. Press [VALUE] to skip this menu or press [STEP] to enter into browsing mode. Then press [VALUE] to change the options. When finished, press [ENTER] to accept or [BACK] to exit without saving. The available options are:

- Water Cut: The relay contact closes if Water Cut is higher than the set point.
- Phase: The relay contact closes if the fluid is in Water Phase.
- Alarm: The relay contact closes under any alarm condition.

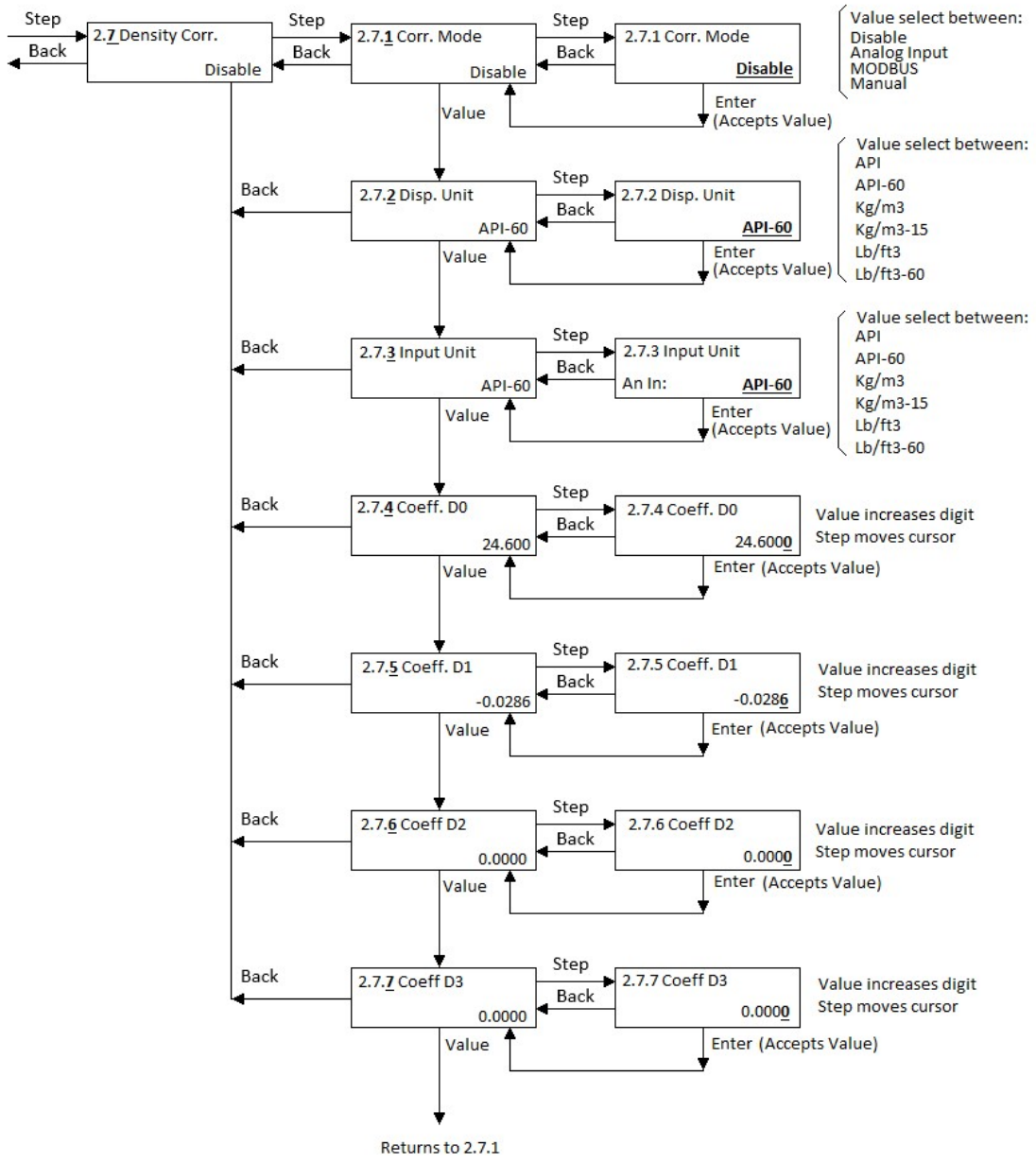
- Manual: The relay contact can be close in menu 2.6.3. This is useful to test the relay connection with the control room.

5.9.3 Variable / Relay Status (2.6.3):

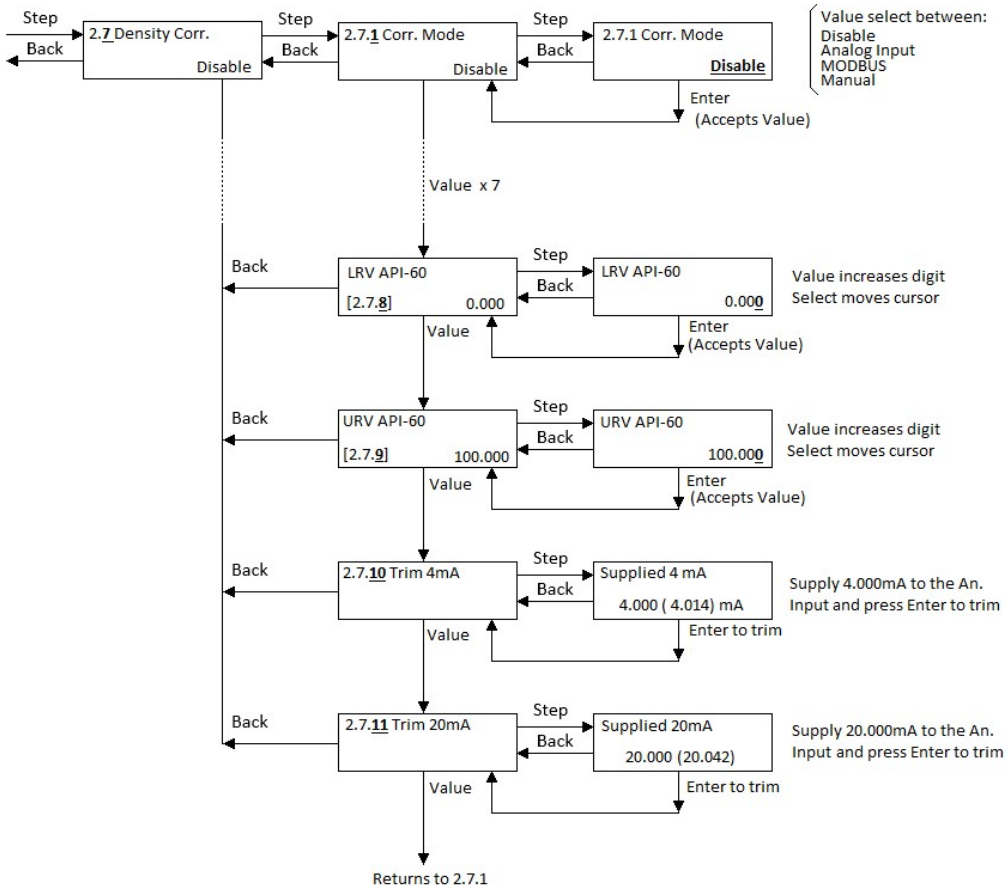
This submenu is Mode dependent.

- If Mode is “Alarm” this submenu doesn’t exist.
- If mode Water Cut this menu shows the set point to trigger the relay.
- If mode is Phase the relay will activate when the fluid is in Water Phase.
- If mode is Manual then this screen will show the current status of the relay. Press [VALUE] to skip or [STEP] to enter into edition mode. Once into edition mode, press [VALUE] to toggle the status between On and Off. Press [BACK] to exit. The relay status will stay in the condition left until the mode is changed or the status is changed again manually of via MODBUS.

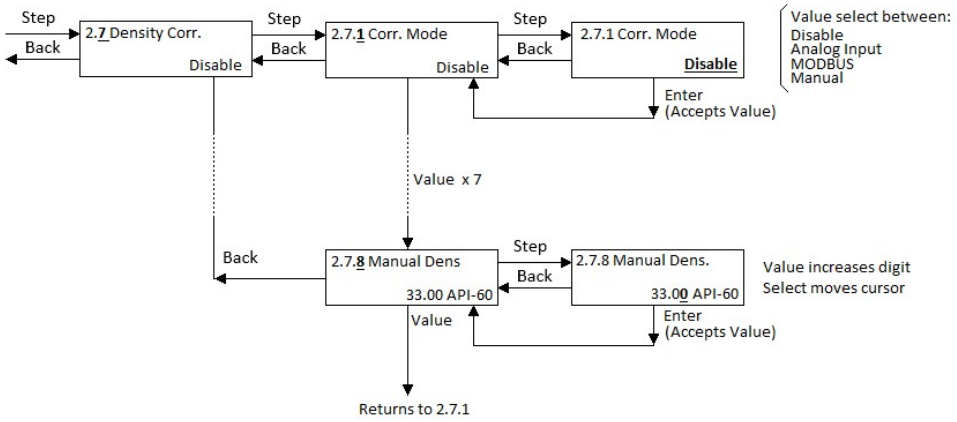
5.10 Density Correction Configuration Submenu 2.7



If Density Correction Mode is “An. Input” then the following submenus are added:



If Density Correction Mode is “Manual” then after 2.7.7 the following extra submenu is added:



5.11 Density Correction Calculation

The density correction is calculated as:

$$\text{Correction} = D_0 + D_1 \times d + D_2 \times d^2 + D_3 \times d^3$$

Where:

d is the live density at standard conditions. If the provided density in not in standard conditions, the value is corrected by the software.

D0: Offset (Default is 24.6)
D1: lineal term (Default is -0.0286)
D2: Quadratic term (Default is 0.0)
D3: Cubic term (Default is 0.0)

5.11.1 Density Correction Enabled (2.7.1)

This screen shows the current status of the Density Correction Function. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Possible options are: Disable, Manual, Analog Input and Modbus. Then press [VALUE] to select browse the options. When finished, press [ENTER] to accept or [BACK] to exit without saving.

In Manual mode the user can enter the density of the dry crude oil and let the Razor calculate the proper correction. In Analog input or in Modbus mode a live density value can be supplied to perform a real time correction.

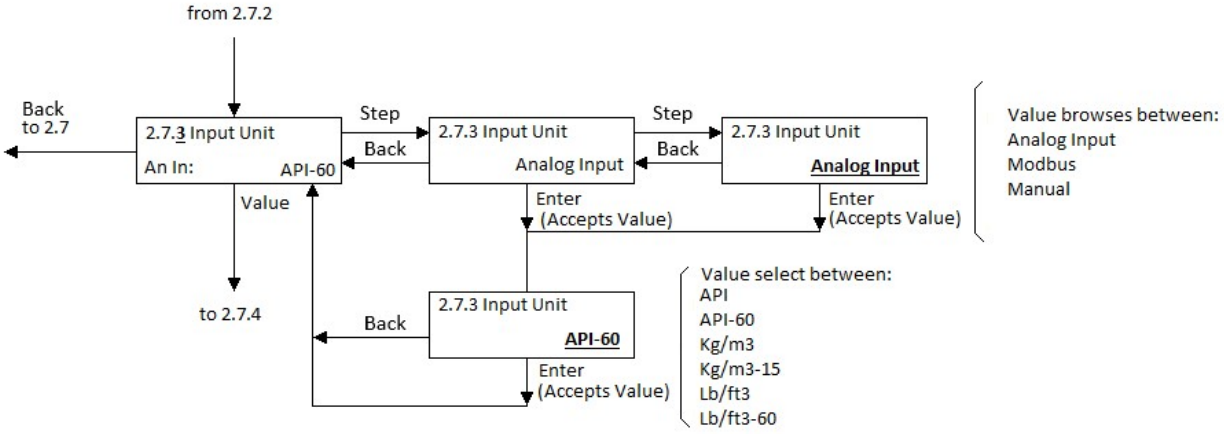
5.11.2 Display Units (2.7.2):

When Density Correction is enabled the value of the current supplied density is shown converted to the density unit selected in this submenu. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to select between the available units. When finished, press [ENTER] to accept or [BACK] to exit without saving.

Available units are:
Kg/m3
Kg/m3_15°C
API
API_60°F
Lb/ft3
Lb/ft3_60°F

5.11.3 Input Units (2.7.3)

This menu specifies the density unit of the customer supplied density signal. The units are configured independently for each input. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to select between the available input. When finished, press [ENTER] to accept or [BACK] to exit without saving. After the Input mode has been selected, press [VALUE] to select the desired unit.



5.11.4 Coefficient D0 (2.7.4):

This screen shows the current value for D0. Default is +24.60. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.11.5 Coefficient D1 (2.7.5):

This screen shows the current value for D1. Default is -0.0286. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.11.6 Coefficient D2 (2.7.6):

This screen shows the current value for D2. Default is 0.00. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.11.7 Coefficient D3 (2.7.7):

This screen shows the current value for D3. Default is 0.00. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.11.8 Submenu 2.7.8 (LRV or Dens. Value depending on mode):

a) If the Density Correction mode is “Analog Input” then this screen is used to configure the Lower Range Value of the Analog Input. Before changing this limit, make sure the “Input Unit” is configured accordingly. This is the density value corresponding to 4mA. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

b) If the Density Correction mode is “Manual” then this screen is used to enter the Density Value that will be used for the correction. The value should be entered in the “Input Units”. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

5.11.9 URV (2.7.9):

This screen is only shown when the option “Analog Input” is selected on Menu 2.7.1. Before changing this limit, make sure the “input Unit” is configured accordingly. This is Upper Range Value of the Analog Input. This is the density value corresponding to 20mA. Press [VALUE] to skip this menu or press [STEP] to enter into edition mode. Then press [VALUE] to change the blinking digit. Press [STEP] to move the cursor. When finished, press [ENTER] to accept or [BACK] to exit without saving.

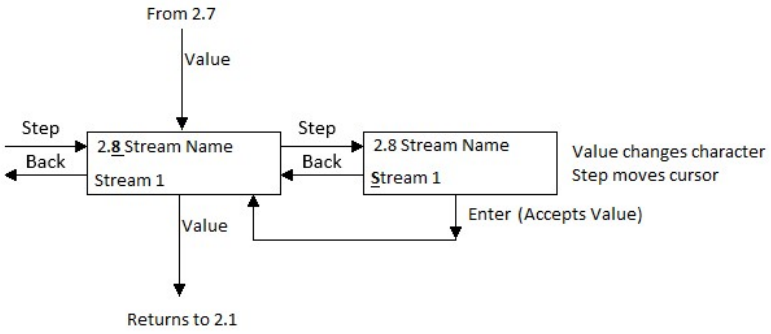
5.11.10 Trim 4mA (2.7.10):

This menu allows the trimming of lower end of the Analog Input. Press [VALUE] to skip. The trimming is done at the factory but in case of being necessary apply a current of 4 mA to the Analog input and then press [STEP] to start the trimming. Then press [ENTER] to perform the trimming or press [BACK] to exit without trimming.

5.11.11 Trim 20mA (2.7.11):

This menu allows the trimming of the upper end of the Analog input. Press [VALUE] to skip. The trimming is done at the factory but in case of being necessary apply a current of 20mA to the Analog Input and then press [STEP] to start the trimming. Then press [ENTER] to perform the trimming or press [BACK] to exit without trimming.

5.12 Stream Names Submenu 2.8

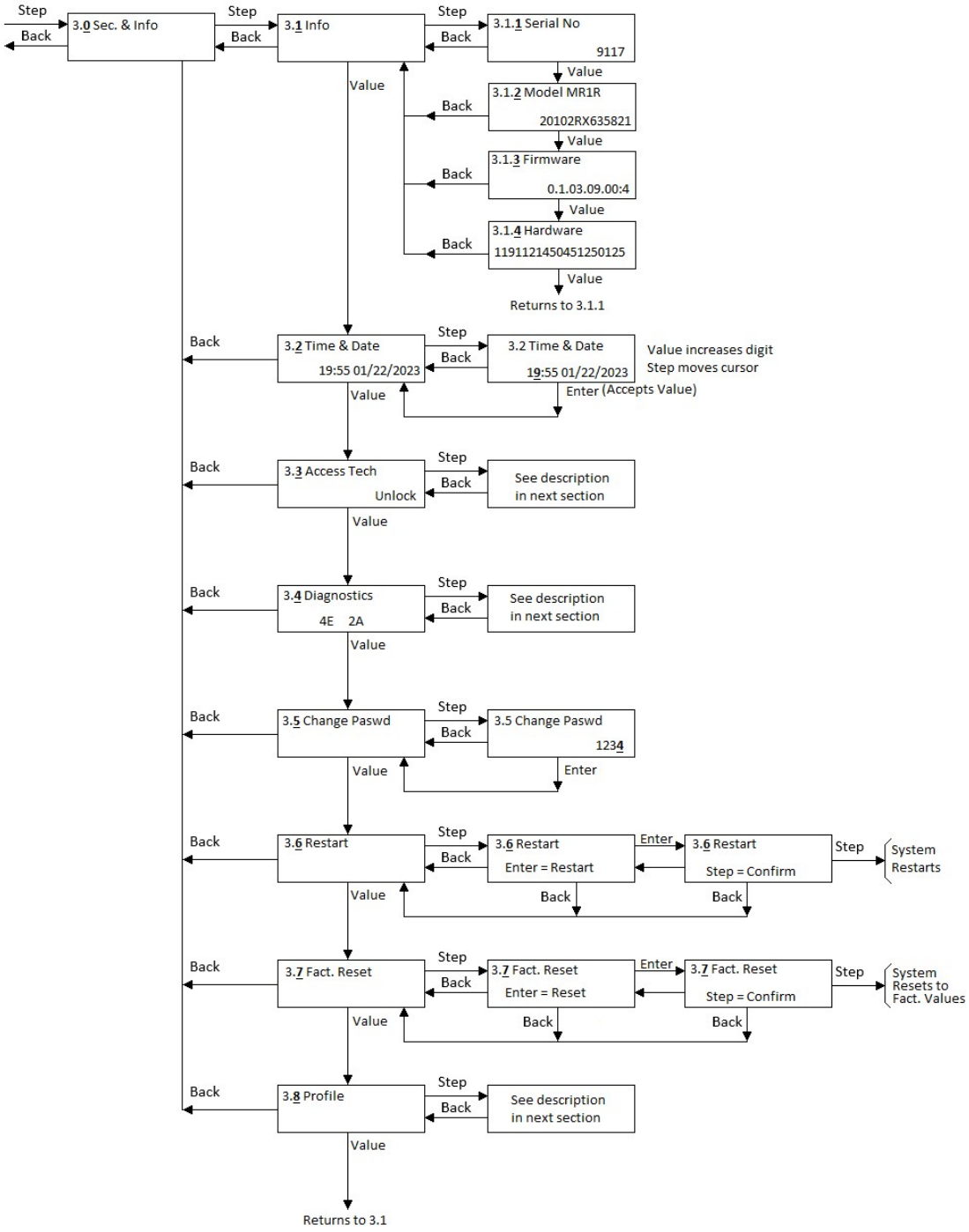


The name of the 60 streams can be edited. The factory names are Stream 1 to 60 but any name of up to 16 characters can be used. To edit the names, use the common edition procedure using STEP and VALUE and then ENTER to accept the changes. Since the edition goes through all the alphabet, is a little hard to change them. Phase Dynamics can provide a configuration file with names already preloaded. Send us the list with the names of your wells and we will send the corresponding configuration file that can be easily uploaded to the unit.

5.13 Security and Info Submenu 3.0

This menu groups all the information such as serial number, model code, time and date,

access to tech mode, password change and diagnostics.



5.13.1 Info (3.1)

Press [STEP] to enter into this submenu. Then press [VALUE] to browse through several information screens. These are:

- Serial Number
- Model Code

- Firmware Version
- Hardware Version

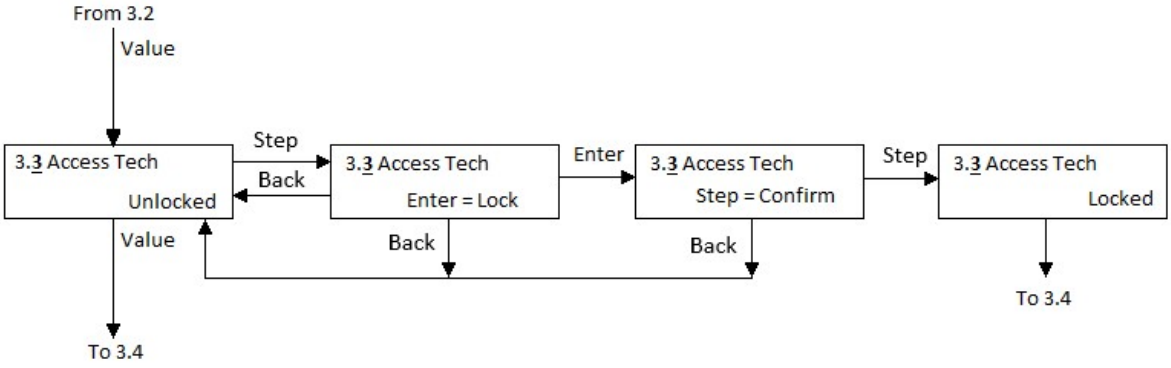
5.13.2 Time and Date (3.2)

This submenu shows the current Time and Date in the system Real Time Clock (RTC). The RTC has a battery that keeps it running even without power. The expected battery like is around 8 years. To change the time and/or date, press [STEP] to enter into edition mode, then [STEP] to move the cursor and [VALUE] to change the blinking digits. When done, press [ENTER] to accept the changes or [BACK] to exit without saving.

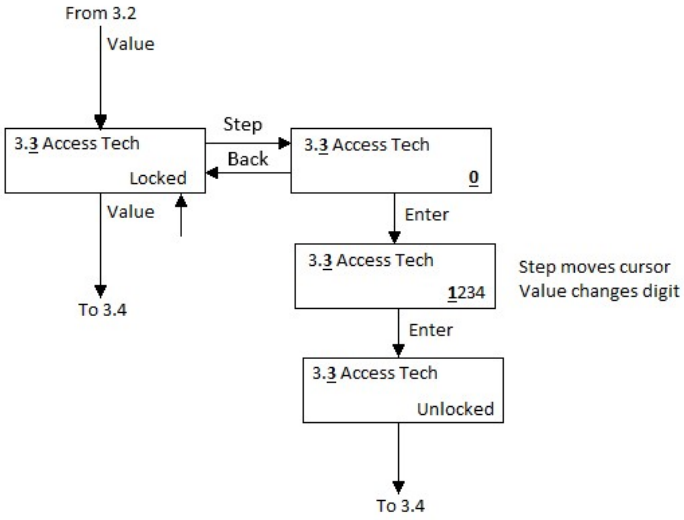
5.13.3 Access Tech Submenus 3.3

The system can be locked by the user. When locked, only Submenus under "1.0 Operation" can be edited. The rest of the menus can be seen but no changes are allowed.

The default password is "0" which means no password. If the Submenu 3.3 is accessed in this condition, the message no password is shown. In order to lock the unit, go to the menu 3.5 first and change the password. Once that is done, the unit will be automatically locked. Then, to unlock it, use the Submenu 3.3. When the Tech Mode is accessed with a password, the configurations become editable but unit locks itself up after 60 seconds of inactivity. To permanently unlock the unit, change the password back to 0.
When the unit is Unlock, the Submenu 3.3 behaves like this:

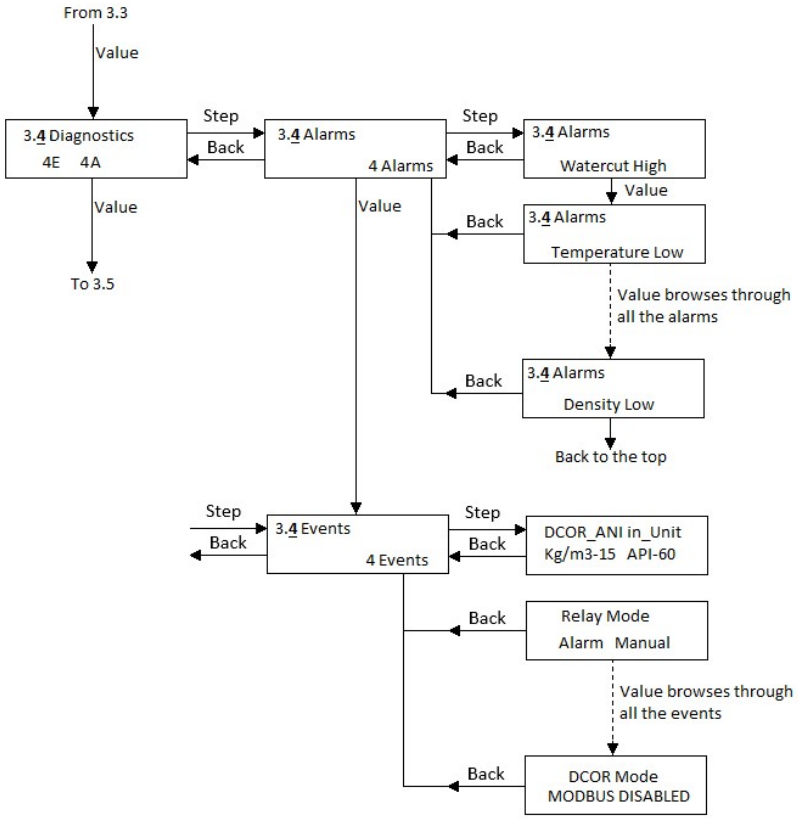


When the unit is Locked, the submenu 3.3 behaves like this:



5.13.4 Diagnostics Submenu 3.4

The Diagnostics Submenu 3.4 indicates the number of Events and Alarms that have been recorded. In the example below, there are 4 Events (4E) and 4 Alarms (4A). The diagram below shows how to browse through all the alarms and events.

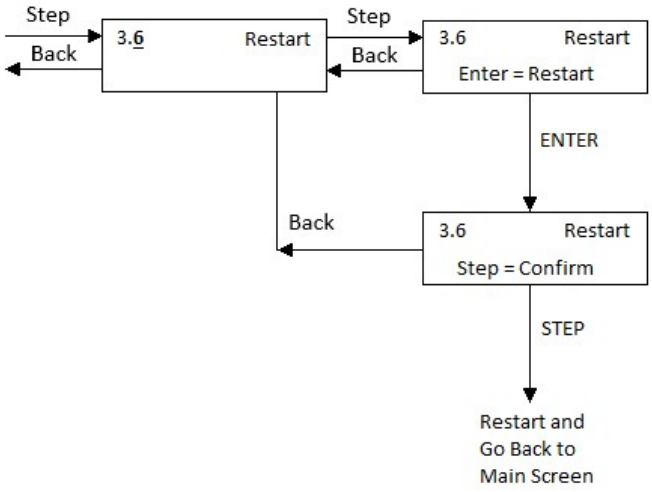


5.13.5 Change Technician Password (3.5):

The default technician password is 0. Press [STEP] to skip this menu or press [STEP] to enter into edition mode. Use [STEP] and [VALUE] to enter the new password and then press [ENTER] to accept it or press [BACK] to exit without saving.

A Reset to Factory Defaults will reset the password to the factory value 0.

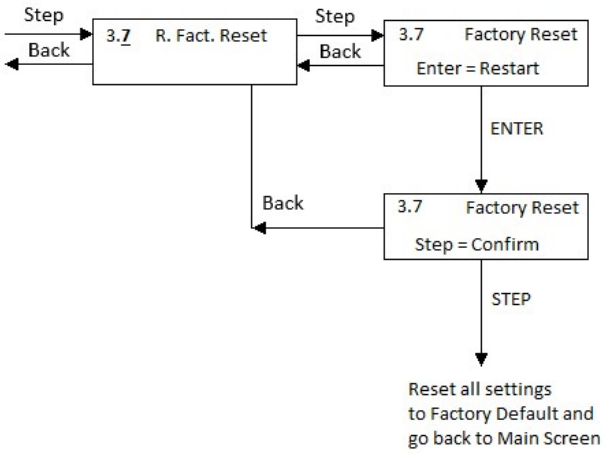
5.13.6 Reset Submenu (3.6):



5.13.7 System Restart (3.6):

This menu reboots the analyzer CPU. Press [VALUE] to skip or press [STEP] to enter into edition mode and then press [ENTER]. After that press [STEP] to confirm or [BACK] to cancel.

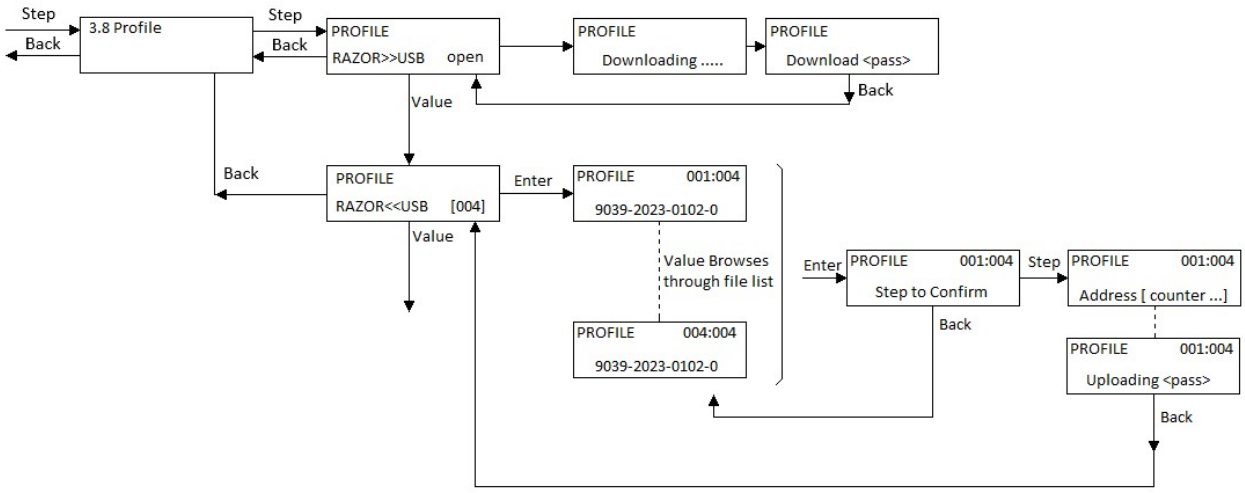
5.13.8 Reset Factory Defaults Submenu 3.7



5.13.9 Factory Reset (3.7):

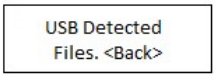
This menu allows the user to restore the configuration to the factory default configuration. Press [VALUE] to skip or [STEP] to enter into selection mode and then press [ENTER]. After that press [STEP] to confirm or [BACK] to cancel

5.14 Profile Submenu 3.8

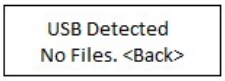


5.14.1 Download/Upload Configuration Submenu

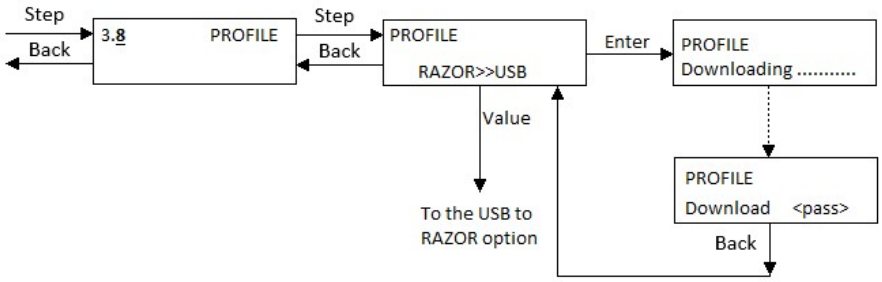
After inserting a USB drive with valid configuration files, the screen will show the following message:



If no files are detected, the message will say:



To Download a configuration file from the Razor to the USB drive go to menu 3.8 and follow the next procedure:



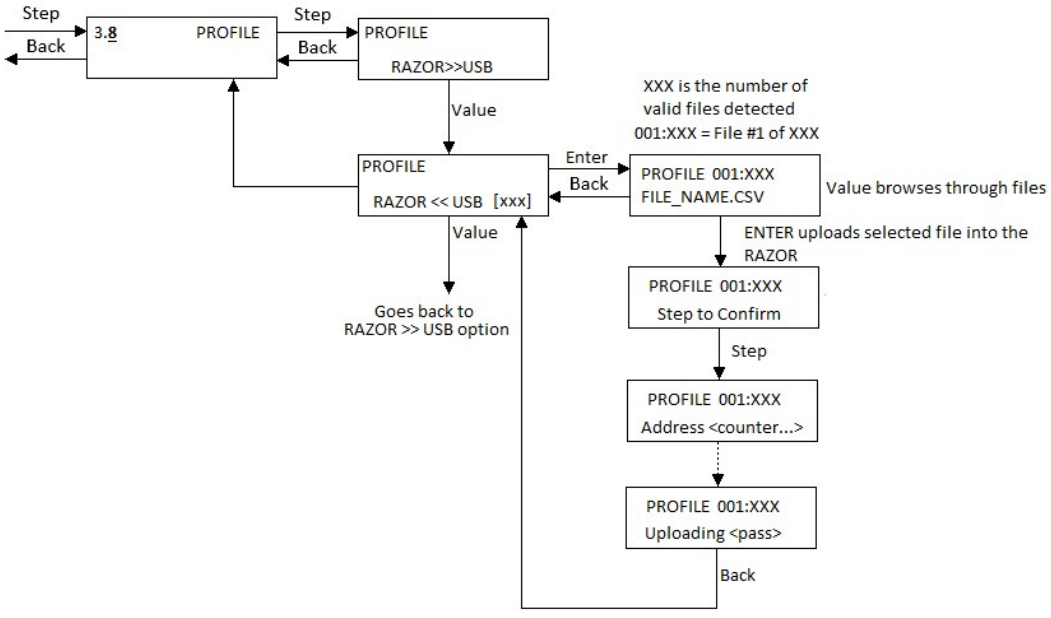
The configuration file will be downloaded into the USB drive the name of the file will have this format:

XXXX-YYYY-MMDD-HHMMSS.CSV

Where:

XXXX is the serial number of the Razor
YYYY is the current year
MMDD are current month and day
HHMMSS are current hour, minutes and seconds
The extension will always be CSV (Comma separated values)

To upload a configuration from the USB drive to the RAZOR, go to menu 3.8 and follow the next procedure:



6 Operation

The Phase Dynamics Analyzers are calibrated at the factory over a broad range of water cuts and temperatures. These calibrations are converted to equations that are saved in the microprocessor memory. The processor reads the oscillator frequency and temperature from the measurement section and calculates water cut. Since the reading of the analyzer is affected by the density of the oil, an offset has to be introduced to match the analyzer reading with the actual fluids water content.

The offset used to correct the readings is called "Oil Adjust". According to the application, it might be necessary to use more than one value. For example, if multiple streams are going to be measured individually, each one of them might need a different offset. To make these applications easier to handle, the analyzer has 60 memories called "Streams". Each one of them can store a different value for "Oil Adjust". In this way the operator will only need to recall the "Stream" number instead of changing "Oil Adjust" values. These "Oil Adjust" values are introduced only once and then validated every now and then by taking samples. If the memories (Streams) are used, each one of them is assigned to a different well, oil type, oil area (for truck or ship unloading applications), etc. The Stream number can be changed manually by the operator through the front display using the menu called "Stream" or remotely via MODBUS®.

6.1 Oil Adjust Calculations

There are 2 ways to calculate the necessary Oil Adjust: Manually or Automatically.

6.2 Manual Calculation

The calculation of this offset is very easy. For this calculation it is necessary to know the current value of "Oil Adjust".

a) Make sure the "Stream" (memory) is selected properly
b) Prepare to take a sample
c) Wait for a steady reading on the analyzer
d) Take a sample and at the same time have a helper to write down the current analyzer water cut reading. As an example, let's say that the reading was 30%
e) Take the sample to the laboratory. For this example, the laboratory result was equal to 28%
f) Browse through the menu and find the current value of "Oil Adjust". For this example, let's say it is equal to 1%

The raw water cut read by the analyzer was:

Raw Water Cut = Analyzer Reading – Oil Adjust

For this example

Raw water Cut = 30 – 1 = 29%

The actual difference between the raw reading and the actual water cut is:

Difference = Lab Result – Raw Water Cut

For this example

Difference = 28 – 29 = -1%

This difference is the value we need the analyzer offset to be. Changing the "Oil Adjust" to -1% will correct the measurement for this particular case.

The equation to calculate the new Oil Adjust value is then:

New Oil Adjust = Laboratory Result – Analyzer reading + Old Oil Adjust value

New Oil Adjust = Laboratory Result – Analyzer reading + Old Oil Adjust value

For this example:

New Adjust Oil = 28 – 30 + 1 = -1%

Remember the Oil Adjust value is stored in the current "Stream". Changing the Stream number will change the Oil Adjust value to the one preset for that particular Stream number.

6.3 Automatic Calculation

The analyzer has a feature that calculates the value of Oil Adjust automatically without the need of an operator doing any calculation.

Please follow this procedure to perform an automatic calculation:

a) Make sure the "Stream" (memory) is selected properly
b) Prepare to take a sample
c) Wait for a steady reading on the analyzer
d) Ask a helper find the "Oil Capture" screen (Submenu 1.3) by browsing through the menu.
e) Ask your helper to press [ENTER] to initiate a data capture in the analyzer and at the same time take a sample.
f) After the sample is taken ask your helper to press [ENTER] again to stop the data capture. Make sure the data capture was at least 4 seconds long. The analyzer can be brought back to the main screen. The data capture is stored in the selected "Stream" number.
g) Take the sample to the laboratory.
h) When the result is obtained browse through the menu and find the "Sample" screen (Submenu 1.4). Press [STEP] to enter into edition mode. The screen will ask for the Stream Number. Enter here the Stream Number under which the Capture was performed and press [ENTER]. Then the screen will show the time and date that capture was done. Verify that the time stamp is correct and press [ENTER] to continue. On the next screen enter the laboratory result and press [ENTER] to confirm or [BACK] to cancel.
i) The analyzer will calculate the necessary Oil Adjust and save it in the currently selected Stream.

6.4 Regular Operation

The operation of the analyzer depends on the particular application.

a) Single Stream: The analyzer can be operated on default Stream number 1 all the time. If the density of that single stream never changes then the calculation of a single Oil Adjust will be proper to operate the analyzer.
b) Multiple Streams: After the individual offset (Oil Adjust) for each stream have been determined and entered, all is needed is to change the Stream number every time the stream is changed.

7 Instrument Repair and Service

7.1 Assistance and Factory address

Product maintenance agreements and other customer assistance agreements are available for this Phase Dynamics analyzer.

Phase Dynamics, Inc.
1251 Columbia Drive
Richardson, TX 75081
Phone: 972-680-1550
Email: techsupport@phasedynamics.com

7.2 Electrostatic Discharge (ESD)

All of the printed circuit board assemblies contain electronic components, which are sensitive to electrostatic discharge. Components damaged by ESD greatly increase the likelihood of a system error or failure.

Care should be taken to prevent damage from electrostatic discharge when working with the system. The technician should be wearing a ground strap. Boards removed from the system should be kept in anti static bags.

CAUTION

Protect circuit boards and terminals from ESD at all times.

7.3 Returning Items to the Factory

Please call or email Phase Dynamics prior to returning any equipment for service or repair. A return merchandise authorization (RMA) number may be required prior to shipment. Please include the following information with returned items:

1. Company name, address, telephone number
2. Key contact name, address, telephone number, fax number, email address
3. Serial number of item(s) being returned
4. A completed copy of the Troubleshooting Worksheet
5. Return merchandise authorization (RMA) number (if required)

7.4 Returning the Analyzer to the Factory

Please clean the measurement section of any and all dangerous or hazardous materials before returning to the factory.

Pack the analyzer and measurement section in the original shipping carton. If the original carton is missing, contact Phase Dynamics.

Place a packing slip on the outside of the carton containing both the return authorization and the serial number.

7.5 Troubleshooting Worksheet

The next few pages contain the Troubleshooting Worksheets. Please complete the form prior to contacting Technical Support.

PHASE DYNAMICS INC
1251 COLUMBIA DR.
RICHARDSON, TX 75081
PHONE: 972 680 1550
EMAIL: techsupport@phasedynamics.com

RAZOR TROUBLESHOOTING WORKSHEET

RMA NUMBER	
PDI CONTACT	
MEASUREMENT SERIAL NUMBER	

Company and Contact Information			
DATE		PHONE	
COMPANY		FAX	
CONTACT PERSON		EMAIL	
ADDRESS			
ADDRESS			

Process and Analyzer Data	
Actual Process Value (Water Cut)	%
Process Temperature	□°C - □ °F
Analyzer Reading (Indicated Water Cut)	%
Analyzer Frequency	MHZ
Analyzer Reflected Power	V
Density (Please indicate density unit)	
Typical Flow Rate (Please indicate Flow rate unit)	
Oil P1	V/MHZ
Oil P0	V
Oil Frequency High	MHZ
Oil Frequency Low	MHZ
Oil Adjust	%
Oil Index	MHZ
Present Alarms or Diagnostics Messages	

24 VDC Only on Back Board

Signal Name	Terminal Strip	Probe		Measure Voltage	Expected Voltage Range
		+	-		
24VDC	J1	+24VDC	GND		18 to 28 VDC

DESCRIPTION OF THE PROBLEM:

NOTES:

8 MODBUS® RTU

The Phase Dynamics Analyzer can communicate with MODBUS®-compatible hosts in a multi-drop RS-485 2-wire network. This appendix specifies the mapped addresses for the available data types, the implemented function codes, diagnostics, and other operational characteristics within the Analyzer.

Valid Function Codes	*Address (Data) Type*	*Access*	*Description*
01,05,15	Coil	Read/Write	Single ON/OFF, Bit (Boolean)
02	Discrete Input	Read-Only	Single ON/OFF, Bit (Boolean)
03,04,16	Floating-Point & Long Integer	Read-Only &Read/Write	Single Precision IEEE 754 Floating-Point Format or Long Integer Format using two consecutive 16-bit Registers
04	Input Register	Read-Only	Integer Format using a single 16-bit Register
03,06,16	Holding register	Read/Write	Integer Format using a single16-bit Register
03,04,06,16	ASCII Characters	Read-Only & Read/Write	Two ASCII Characters packed in a single 16-bit register

8.1 Floating-Point / Long Integer Format

All floating-point register pairs are in the IEEE 754 Floating-Point Format. The standard byte transmission order is high to low per the following table:

A	**B**	**C**	**D**
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

4 byte-orders can be configured independently for Floating-Point registers and Long Integers. These formats are:

Standard (ABCD) [Default]
Word Swap (CDAB)
Byte Swap ((BADC)
Byte and Word Swap (DCBA)

To configure the byte order for floating-point and long integer, see section 5.8.6 Byte Order

8.2 Integer / ASCII-Pair Format

All word and ASCII byte-pair registers are transmitted high byte first and then low byte (AB).

8.3 MODBUS® Tables

8.3.1 Floating Point Table

The registers are ***not*** zero-based. For a zero-based system, subtract 1 to each address.

ID	Access	Description
3	Read Only	Water Cut
5	Read Only	Temperature
7	Read Only	Emulsion Phase
11	Read Only	Serial number as a float
13	Read Only	Firmware version as a float
15	Read/Write	Oil Adjust
19	Read Only	Frequency
23	Read Only	Average Water Cut
25	Read Only	Raw Water Cut
29	Read Only	Average Temperature
31	Read/Write	Temperature Adjust
35	Read/Write	Process Averaging
37	Read/Write	Oil Index
39	Read/Write	Oil P0
41	Read/Write	Oil P1
43	Read/Write	Oil Low
45	Read/Write	Oil High
47	Read/Write	Oil Capture Period
49	Read/Write	AO LRV
51	Read/Write	AO URV
55	Read/Write	Baud Rate
57	Read/Write	Reflected Power Low Alarm
59	Read/Write	Reflected Power High Alarm
61	Read Only	Oil Reflected Power
63	Read/Write	Frequency F0
65	Read/Write	Frequency F1
67	Read/Write	Water Cut minimum
69	Read/Write	Water Cut Low Alarm
71	Read/Write	Water Cut maximum
73	Read/Write	Stream
75	Read Only	Average Oil Reflected Power
77	Read/Write	Water Cut High Alarm
79	Read Only	Oil Sample
81	Read/Write	Temperature High Alarm
83	Read/Write	Temperature Low Alarm
85	Read/Write	Density Minimum

ID	Access	Description
87	Read/Write	Density Low Alarm
89	Read/Write	Density Maximum
91	Read/Write	Density High Alarm
93	Read/Write	Primary Seal Broken Low Alarm
95	Read/Write	Primary Seal Broken High Alarm
97	Read/Write	Oil Curve Break
99	Read/Write	Frequency Low Alarm
101	Read/Write	Frequency High Alarm
105	Read/Write	AO Manual Value
107	Read Only	AO Trim Lo
109	Read Only	AO Trim Hi
113	Read Only	Density Units
115	Read Only	Density Adjust
117	Read/Write	Density D3
119	Read/Write	Density D2
121	Read/Write	Density D1
123	Read/Write	Density D0
125	Read/Write	AI lrv unit kg/m3
127	Read/Write	AI lrv unit kg/m3 15c
129	Read/Write	AI lrv unit API
131	Read/Write	AI lrv unit API 60f
133	Read/Write	AI lrv unit lbs/f3
135	Read/Write	AI lrv unit lbs/f3 60f
137	Read/Write	AI urv unit kg/m3
139	Read/Write	AI urv unit kg/m3 15c
141	Read/Write	AI urv unit API
143	Read/Write	AI urv unit API 60f
145	Read/Write	AI urv unit lbs/f3
147	Read/Write	AI urv unit lbs/f3 60f
151	Read/Write	Relay Set point
155	Read Only	Oil Density
157	Read/Write	Oil Density Modbus
159	Read Only	Oil Density AI
161	Read/Write	Oil Density Manual
163	Read Only	Oil Density AI LRV
165	Read Only	Oil Density AI URV
169	Read Only	AI Trim Low
171	Read Only	AI Trim High
173	Read Only	AI Measured
175	Read Only	AI Trimmed
179	Read/Write	Oil T0

ID	Access	Description
181	Read/Write	Oil T1
183	Read Only	Phase Threshold

8.3.2 16 bits Integers Table

ID	Access	Description
201	Read Only	Serial number
202	Read Only	Analyzer mode
203	Read/Write	AO Dampening
204	Read/Write	Slave Address
205	Read/Write	Stop Bits
207	Read Only	RTC Secs
208	Read Only	RTC Min
209	Read Only	RTC Hour
210	Read Only	RTC Day
211	Read Only	RTC Month
212	Read Only	RTC Year
213	Read Only	RTC SECS IN
214	Read/Write	RTC Min IN
215	Read/Write	RTC Hour IN
216	Read/Write	RTC DAY IN
217	Read/Write	RTD Month IN
218	Read/Write	RTC Year IN
223	Read/Write	Logging Period
224	Read/Write	Password
225	Read Only	Number of Success communication packages
228	Read/Write	Phase Holdover
229	Read/Write	Relay Delay
230	Read/Write	AO Alarm Mode
231	Read/Write	Density Correction Mode
232	Read/Write	Relay Mode
233	Read Only	Diagnostics
234	Read/Write	Modbus EOT
235	Read/Write	Temperature Unit
237	Read/Write	Density Input Unit Analog Input
238	Read/Write	Density Input Unit Modbus
239	Read/Write	Density Input Unit Manual
240	Read/Write	Density Display Unit
241	Read/Write	Water Cut min/max enable
242	Read/Write	Splash Duration

ID	Access	Description
243	Read/Write	Technician Relock Duration
244	Read/Write	Parity
245	Read/Write	Modbus 32-bit float byte order
246	Read/Write	Modbus 32-bit integer byte order
247	Read/Write	Menu Button, 1=Back, 2=Value, 3=Step, 4=Enter
249	Read Only	Cursor Line
250	Read Only	Cursor column

8.3.3 Long Integers Table (32 bits Integers)

ID	Access	Description
301	Read Only	Serial Number Measurement Section
303	Read Only	Serial Number Back Board
305	Read Only	Serial Number Safety Barrier
307	Read Only	Serial Number Power Supply Board
309	Read Only	Serial Number Processor Board
311	Read Only	Serial Number Display Board
313	Read Only	Serial Number RF Board
315	Read Only	Serial Number Assembly
317	Read Only	Model Code (0-3)
319	Read Only	Model Code (4-7)
321	Read Only	Model Code (8-11)
323	Read Only	Model Code (12-15)
325	Read Only	Model Code (16-19)
327	Read/Write	[LiveStream].description[0-3]
329	Read/Write	[LiveStream].description[4-7]
331	Read/Write	[LiveStream].description[8-11]
333	Read/Write	[LiveStream].description[12-15]
335	Read Only	Frequency Task Sleep Time
337	Read Only	LCD Line 1 characters 0-3
339	Read Only	LCD Line 1 characters 4-7
341	Read Only	LCD Line 1 characters 8-11
343	Read Only	LCD Line 1 characters 12-15
345	Read Only	LCD Line 2 characters 0-3
347	Read Only	LCD Line 2 characters 4-7
349	Read Only	LCD Line 2 characters 8-11
351	Read Only	LCD Line 2 characters 12-15

8.3.4 Coils Table

ID	Access	Description
1	Read Only	Relay Status
2	Read Only	Water Cut Alarm High or Low
3	Read Only	Temperature Alarm High or Low
4	Read/Write	Stop Oil Capture
5	Read/Write	Initiate Oil Capture
6	Read/Write	Enable Data logger
7	Read Only	Density Alarm High or Low
8	Read Only	Frequency Alarm High or Low
9	Read Only	Reflected Power Alarm High or Low
10	Read Only	AO Alarm
11	Read Only	Primary Seal Broken Alarm
12	Read Only	Critical Alarm(s)
14	Read/Write	AO Mode
17	Read/Write	Average Temperature Reset
18	Read/Write	Average Temperature Mode
19	Read Only	Oil Phase
21	Read/Write	Relay Switch in Manual Mode
22	Read Only	Unlocked
23	Read/Write	Technician Unlock / Technician Lock
25	Read/Write	Processor Board Soft Reset
26	Read/Write	Restore Factory Profile Data