User Manual for PFD900 Flow Computer

Product Name: PFD900

Author Alexey Likhoded

Contents

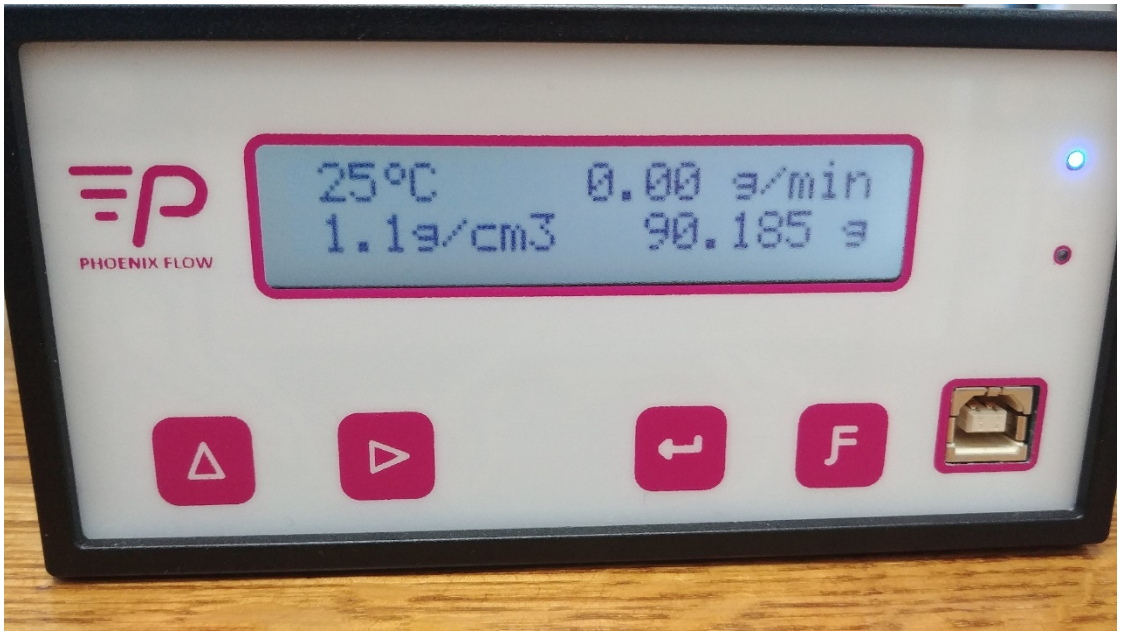
1. Introduction

The purpose of this document is to provide user manual for the PFD900 Flow Computer. This document was written for PFD900 firmware version 2.1.3 and PFD900 Windows Utility v2.5 so parts of this document may not be applicable to later versions.

1.1 Revision History

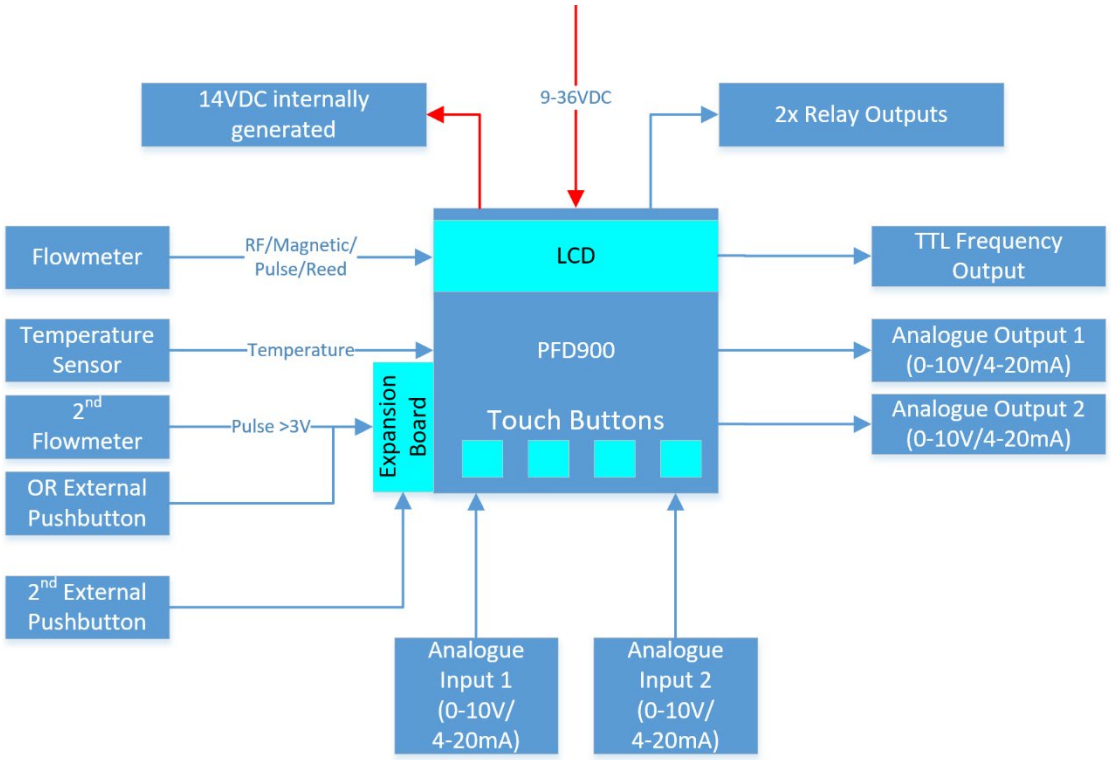
Rev	Sections Affected	Remarks
1	All	Author : Alexey Likhoded Date : April 2017 Initial Issue for firmware/software 1.1.0/v1.8
2	2, 4 and 5	Author : Alexey Likhoded Date : July 2017 Firmware/Software: 1.1.3/v1.9 Changes: - external button interface - internal logging feedback
3	All	Author : Alexey Likhoded Date : March 2018 Firmware/Software: 2.1/2.2 Major software and firmware update
4	All	Author : Alexey Likhoded Date : September 2018 Firmware/Software: 2.1.3/2.5 Major software and firmware update for dual board configuration
4.1	4	Author : Alexey Likhoded Date : January 2019 Firmware/Software: 2.2/2.6 Software and firmware update for bi-directional processing
4.2	4	Author : Alexey Likhoded Date : May 2019 Firmware/Software: 2.2.2/2.8 Software and firmware update: - Standard/Actual Gas calculations - Effective Area calculations - Ability to reset totals/timer on alarm - Analogue input accuracy improvements - Minor improvements
4.3	4.5.2	Author : Alexey Likhoded Date : June 2019 Firmware/Software: 2.2.3/2.8.x Add pulse output functionality

1.2 Product Pictures



For panel mounting, the cut-out dimensions must be 72 x 144mm. The display length is 120mm.

2. System Overview



The PFD900 collects the data from various sensors and converts them into LCD data and/or TTL, Analogue 1 and Analogue 2 outputs and relay outputs.

The unit is fully configurable by the user, and has the ability to perform temperature compensation (where the temperature input can be either from an RTD sensor or a 0-10V sensor), select and store switchable fluid curves, display up to 12 lines of scrollable data (variables and/or constants), provide simple user interface via the touch buttons and generate relay outputs based on user configurable set points.

The analogue outputs use 20bit DACs with accuracy better than ±0.5mV, whereas the analogue inputs use 16bit ADCs with accuracy better than ±1mV.

The RTD circuitry allows the use of 2, 3 or 4 wire sensors.

The mainboard can also be supplied without the display if it is not required, which reduces cost and complexity of the system but still gives the user all the other I/O functionality.

For custom projects, a ribbon cable of custom length can be provided, which allows the user to integrate the LCD display and the mainboard into their own enclosure:

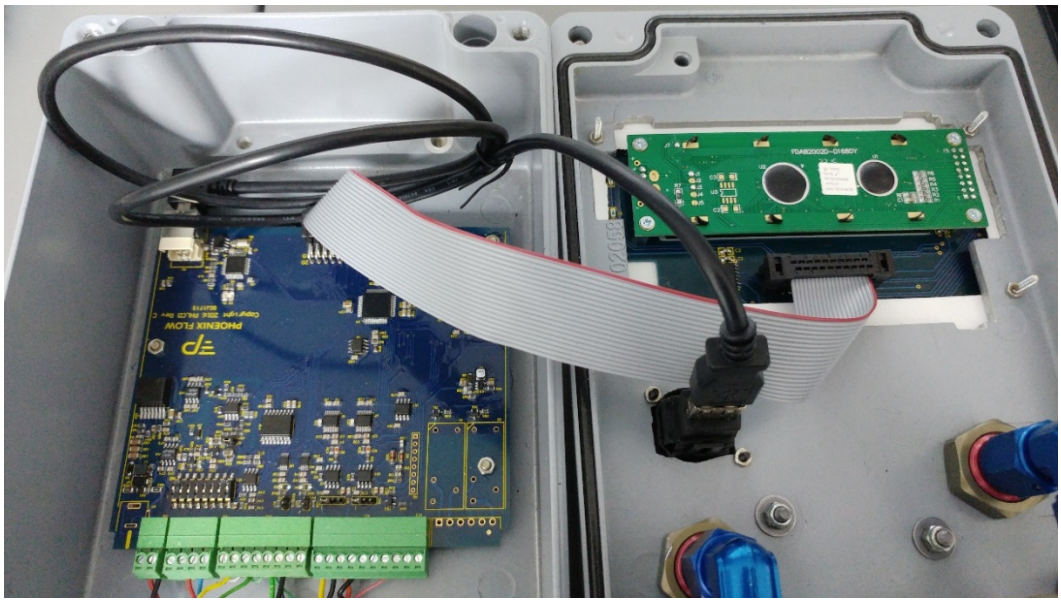


Figure 1: Example of PFD900 Integration into customer specific enclosure

Figure 2: Custom Aluminium Enclosure

Figure 3: Custom Aluminium Enclosure with Mil-Spec connectors

Since firmware version 2.1.3, it is possible to connect two boards together, effectively doubling the I/O interface.

In this case, the master boards interfaces with the display and the buttons, but the variable list is doubled.

The PC Utility version 2.5 and up provides the user the ability to select dual board firmware by entering “DUAL” in the start-up message box.

The PC Utility version 2.6 and up provides the user the ability to select bidirectional measurement. In this case, the lagging input must be connected to the second frequency measurement channel.

2.1 Features and Options

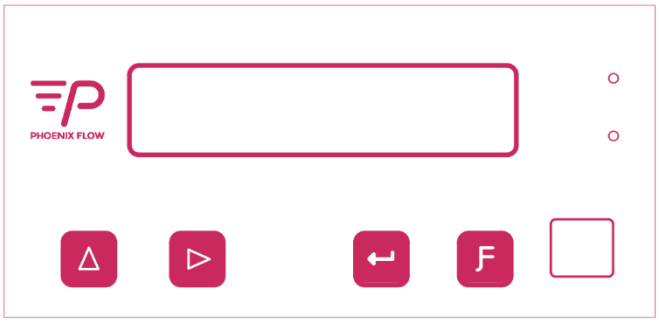
Features

- 2 line 20-character backlit configurable display (12 scrolled lines fully configurable by the user)
- Flow/Mass Rate and Flow/Mass Total as primary functions
- Up to 2 frequency flowmeter channel inputs
- Bidirectional Flow measurement
- Pulse, Magnetic, RF, Reed switch input
- USB interface for PC communication (logging and configuration)
- 0 – 500kHz Frequency input
- High speed processing (1ms latency) using DSP/90MIPS
- Up to 10 programmable and channel assignable 20-point flow linearization curves
- Up to 5 programmable, PT100/Analogue input assignable and user selectable temperature viscosity curves for viscosity compensation
- Up to 5 programmable, PT100/Analogue input assignable and user selectable temperature density curves for mass calculations
- 0 - 4kHz 18-bit Frequency output, either as frequency or pulse output (for total)
- Configurable Alarm set points (Red front LED, Relay Output, Log on Alarm, Switch fluid curve on alarm)
- 9-36VDC PSU (30mA at 24VDC)
- On board data logging or data logging via USB PC Interface
- Analogue Signal Linearization
- Gas equations for Actual to standard conversions etc.

Options

- 2x 20-bit Configurable DAC1220 Analogue Outputs (0-10V/4-20mA)
- 2x 16-bit Configurable ADS8325 Analogue Inputs (0-10V/4-20mA)
- Temperature Compensation using 3/4 wire PT100 RTD or 0-10V/4-20mA Input
- 2x Relay outputs
- 230VAC PSU
- CAN Open/ Modbus
- 2nd linearized flowmeter frequency input (Pulse >3V)
- A-B/A+B or custom functions
- 2x configurable remote buttons
- Dual boards interface (for a total of 4x flowmeter inputs, 4x analogue inputs, 4x analogue outputs, 2x frequency outputs and 2x PT100 inputs)
- *Rapid development for customer s*pecific applications

3. Front Panel Design



3.1 LCD

The LCD displays the variable and constant data as configured by the user. It shows the current location in the 12-line matrix according to the scrolling buttons.

3.2 Buttons

The two leftmost buttons scroll through the Display matrix as configured by the user.

The Function button brings up the function menu (as configured by the user) and each press then scrolls through the menu. Enter button commits the currently selected menu item.

3.3 USB Connector

The USB connector (the square cut-out on the bottom right) is a standard USB type B connector, so any commercially available USB type A to Type B leads are suitable.

3.4 LEDs

The LEDs are the two circles on the right of the display. The top one is blue and it flashes when the PFD900 detects activity on the frequency inputs.

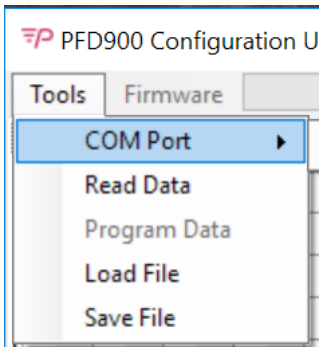
The bottom LED is red, and it lights up when configured by the user based on variable set points

4. PC INTERFACE

4.1 Status Bar

The status bar shows the status of each operation. After all read and write commands, if the status bar is not green all the way to the end, then a communication issue has occured.

4.2 Tools Menu



The Tools Menu provides top level commands that affect all sections of the program.

4.2.1 COM Port

Correct COM port must be selected before any communication between the PC and the PFD display can take place. The selected COM port is highlighted in green and the PC Utility saves the last used port on the local PC so that next time the program is opened the same port is selected (if available).

If the program is started with the display disconnected, then Refresh Ports must be clicked for the program to scan available ports and add the new port to the list so that it can be selected.

4.2.2 Read Data

This button reads all data from the display and fills in all the tables with the received data. It is recommended that before any modification takes place, this operation is performed.

4.2.3 Program Data

This button programs all the data in all tabs into the display. A read back command is always performed at the end of the write cycle, which re-populates the tables with the data received from the unit. This operation helps to identify incorrect user settings, as fields with values that are not allowed by the display will go back to their original or default value.

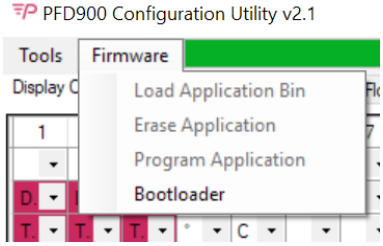
4.2.4 Load File

This button presents user with a file dialog menu which allows the user to select a file to load into the program. This populates every table in every tab. This gives user the ability to restore the unit to a previous known state, to load a template for a suite of displays, or in the case when the flowmeter is sent for calibration this would allow Phoenix Flow Measurement to create a new configuration file with the new calibration data and send it to the customer to update the electronics. File structure is covered in more detail in section 4.9.

4.2.5 Save File

This button saves the current entries in all tables in all tabs into a file that can be loaded into the program later. The file extension is .pfd.

4.3 Firmware Menu



This menu allows the user to update the firmware on the unit. This is a very powerful feature that allows Phoenix Flow to provide firmware updates to the user without the need for the user to return the unit. Firmware updates can include functionality upgrades, specific customer requests, bug fixes etc.

The firmware menu is self-guided; it does not allow the user to select options in the wrong order. The standard order is: Bootloader -> Load Application Bin -> Erase Application -> Program Application.

4.4 Display Configuration Tab

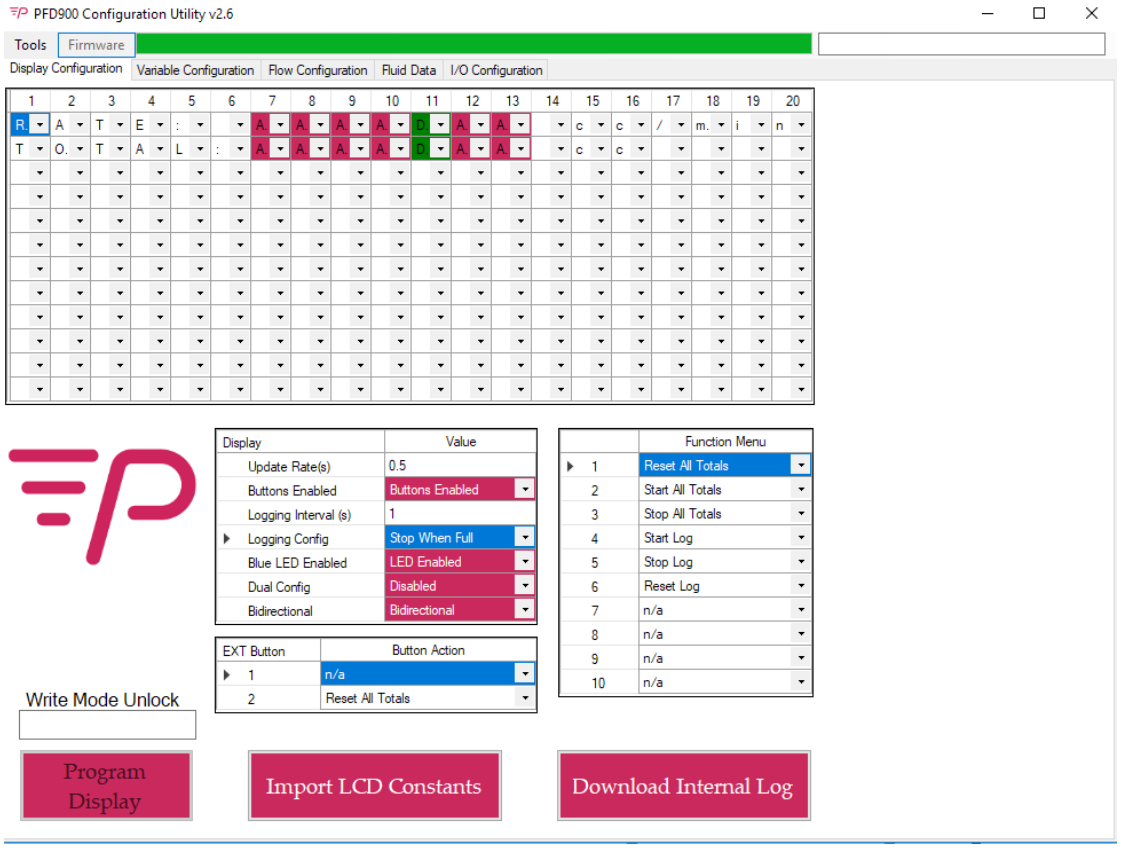


Figure 4: Display Configuration

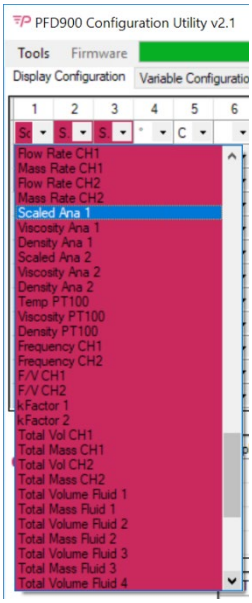
4.4.1 Display Matrix

The display matrix is one of the most powerful features of this product and what makes it unique.

The display onboard the unit is a 20 character 2-line backlit display, however, the user is given 12 lines that can be fully configured and scrolled through.

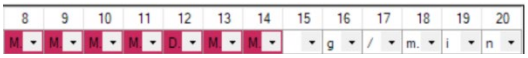
There is 2 parts to the display matrix: the display variables and display constants.

4.4.1.1 Display Variables



When each cell is clicked, a combo box appears that allows this cell to be modified from a list of pre-defined values. All the display variables are located at the bottom of the combo box, so the user must scroll down to get to them. Once a variable is selected, the relevant entry changes colour to signal to the field is now a variable.

The user has full control of how many digits and decimal points are selected. For variable to be created coherently, each consequent cell must have either same variable or a Decimal Point entry. So, for example, if the user wishes to display up to 7 digits for mass rate, with 2 decimal places, then the first 4 entries will be “Mass Rate CH1”, followed by single “Decimal Point” and finally 2 more “Mass Rate CH1” Entries.



The PFD unit auto adjust the number of decimal places if the variable exceeds the number of allocated digits before the decimal point. In this example, if mass rate exceeds 9999.99, then the display will automatically move the decimal point and display 10000.0

Usually, the user would write the variable units after the variable, which is covered in the next section.

The user can insert up to 30 variables in the whole matrix. The user can display the same variables multiple times, which can be useful if for example the user wants the same information to be displayed differently depending on application (such as an application with low flows where many digits/decimal places are required versus an application with high flows, where the number of decimal places/digits can be reduced).

Currently selected fluid and linearization curve labels can also be selected to be displayed. These change when another fluid or flow curve is selected (either by the user using the buttons, or via the configured alarms).

Please note, there is no protection against the user creating variables incorrectly, for example if the user inserts a constant character in the middle of variable (in such case the software will create 2 separate entries for the same variable).

The dual board version of the software allows the user to select the variables from the second board, which have a "_2" text in their name.

4.4.1.2 Display Constants

Anything that is not a decimal point or a variable is treated as a display constant. These fields do not change throughout the operation of the unit. They can be used for identifying the variable (i,e „MASS"), specifying units (i.e. „g/min"), or writing message/instructions (For example, wiring information, calibration due date, or analogue scaling etc).

It has been recognized that entering these fields one letter at a time can be a long process if the user wishes to fill up all 12 lines, hence the PC utility includes a „Import LCD Constants" button, which allows the user to import a text file (.const) that is filled with characters.

For example:

LPH LTR

°C cSt b

Other uses for extra lines, for example, can include wiring information, caliration date, transducer serial numbers, such as the example below:

DSUB WIRING

1:FLO 0-400LPH=0-10V

2:TOTAL 0-10L=0-10V

3:PRESS 0-15BAR=1-6V

4:N/A

6,7,8:GND

CAL DATE 08/04/2016

CAL VISC 3.47 cSt

PRESSURE SN:10659848

Please note: End of Line (Carriage Return) stops the software processing the current line, so the line must be filled with spaces before the carriage return if the user wants to overwrite any existing data in the display matrix with blank spaces.

It is advisable that LCD constants are improted BEFORE the variables are filled in, because existing entries will be overwritten with spaces unless an End of Line is used to skip the processing of particular lines.

For example, the following entry will not modify line 2 of the display matrix:

LPH LTR

DSUB WIRING

1:FLO 0-400LPH=0-10V

If the user wishes to have less than 12 lines, then all the lines below the last line must be left blank (filled with spaces). When there are less than 12 lines used, the unit will scroll back to the beginning (i.e. the first two lines) when the end is reached.

4.4.1 Display Table

Display	Value
Update Rate(s)	1
Buttons Enabled	Buttons Disabled
Logging Interval (s)	0.1
Logging Config	Wrap Around
Blue LED Enabled	LED Disabled
Dual Config	Disabled
Bidirectional	Standard Mode

The display table allows the user to modify some of the top level behaviour of the display itself.

The Update Rate field allows the user to set the update rate of the Visual display. This must not be confused with the internal update rate of the unit.

Buttons Enabled allows the user to enable/disable all front panel touch button functionality.

Logging Interval is discussed in section 4.5. It is recommended that it is not set to anything lower than 0.01s (100 times a second) as lower values will not give user much logging time.

The Logging Config allows the user to select either Wrap Around, or Stop When Full mode. Wrap Around will keep writing to the internal log until stopped using the menu button and hence will only store the last 64,000 numbers.

Stop When Full will do the opposite, and only store the first 64,000 numbers since the start of the log.

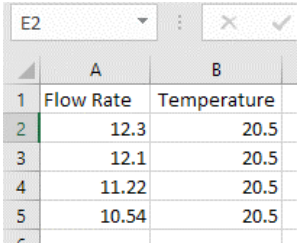
The Blue LED on the front can be disabled completely or left enabled. When enabled, the LED flashes when flow is detected.

The dual board version also allows the user to program the configuration to specify which board is the primary and which is the secondary.

The bidirectional confguration allows the user to configure the unit to measure bidirecitonal flowmeters, where the flowmeter has 2 outputs; one lagging another by 90 degrees. By calculation the phase difference between the 2 inputs, the unit can work out what direction the fluid is flowing.

4.4.2 Downloading Internal Log

The internal log can be downloaded by clicking „Download Internal Log“ button. Clicking this button brings up a file dialog menu, asking the user where to save the file. The file is saved with extension .csv, which can be opened in Excel.



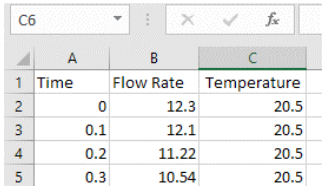
	A	B
1	Flow Rate	Temperature
2	12.3	20.5
3	12.1	20.5
4	11.22	20.5
5	10.54	20.5

Please note, even though the file extension is .csv, the file is separated using semicolon (to make the log file independent of system locale, so that either a comma or a dot can be used). This means that the user may have to select Data Tab in Excel and click on Text->Columns and select semicolon option.

The PC software automatically inserts each column header into the file, as the PFD900 saves information regarding which variables are logged every time a log is started and passes it to the PC Utility together with the log.

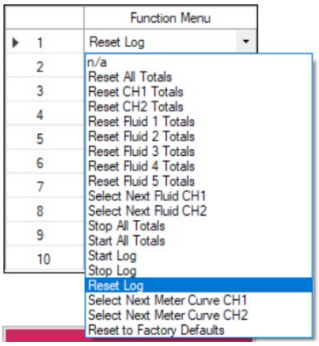
The PC Utility also stitches the log file automatically when „Wrap Around“ configuration is used (internally the unit gets to the end of the buffer and then starts to write at the beginning). This means that the .csv file shows the log data in chronological order.

To maximize the amount of space available for useful logging, the sample number or time is not saved in the log file. However, since the user can read back the display configuration and hence the logging interval, it is very easy to add a new column to Excel and populate it with the correct sample time (starting from 0).



	A	B	C
1	Time	Flow Rate	Temperature
2	0	12.3	20.5
3	0.1	12.1	20.5
4	0.2	11.22	20.5
5	0.3	10.54	20.5

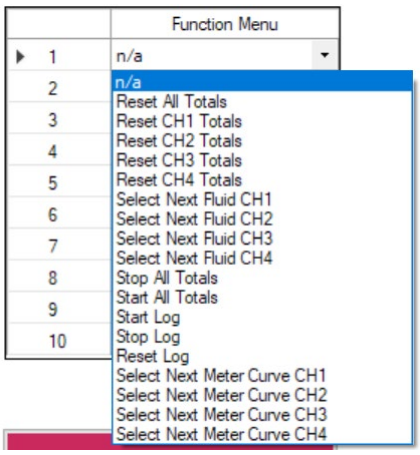
4.4.3 Function Menu



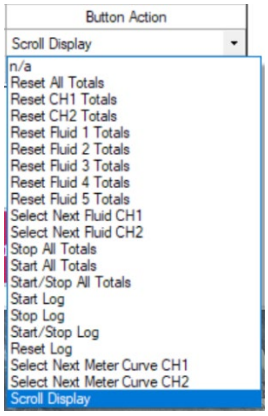
The function menu gives user the control over what the user wants to see and in which order when the function button is pressed. There is up to 10 lines that can be populated. The figure above shows all the available options for single board configuration.

Please note: Select Next Meter Curve CH1/2 selects the next curve assigned to the relevant channel, for example, if CH1 is assigned to curve 1 and CH2 is assigned to curve 2, then advancing CH1 will select the next curve in the list that is assigned to CH1.

The dual board menu does not allow the user to reset fluid totals, as it is not anticipated that this functionality is required due to the complexity of the system.



4.4.4 External Button Configuration



This table allows the user to configure the remote external button(s) function, if the option has been fitted. On most part, the options are very similar to the menu for the touch buttons on the front of the unit.

Please note: the internal addon board can be used in the following configurations:

- To add 2 external buttons
- To add 1 external button and one second frequency channel (Pulse >3V only)
  If the second frequency channel is used, the user cannot use the second remote button

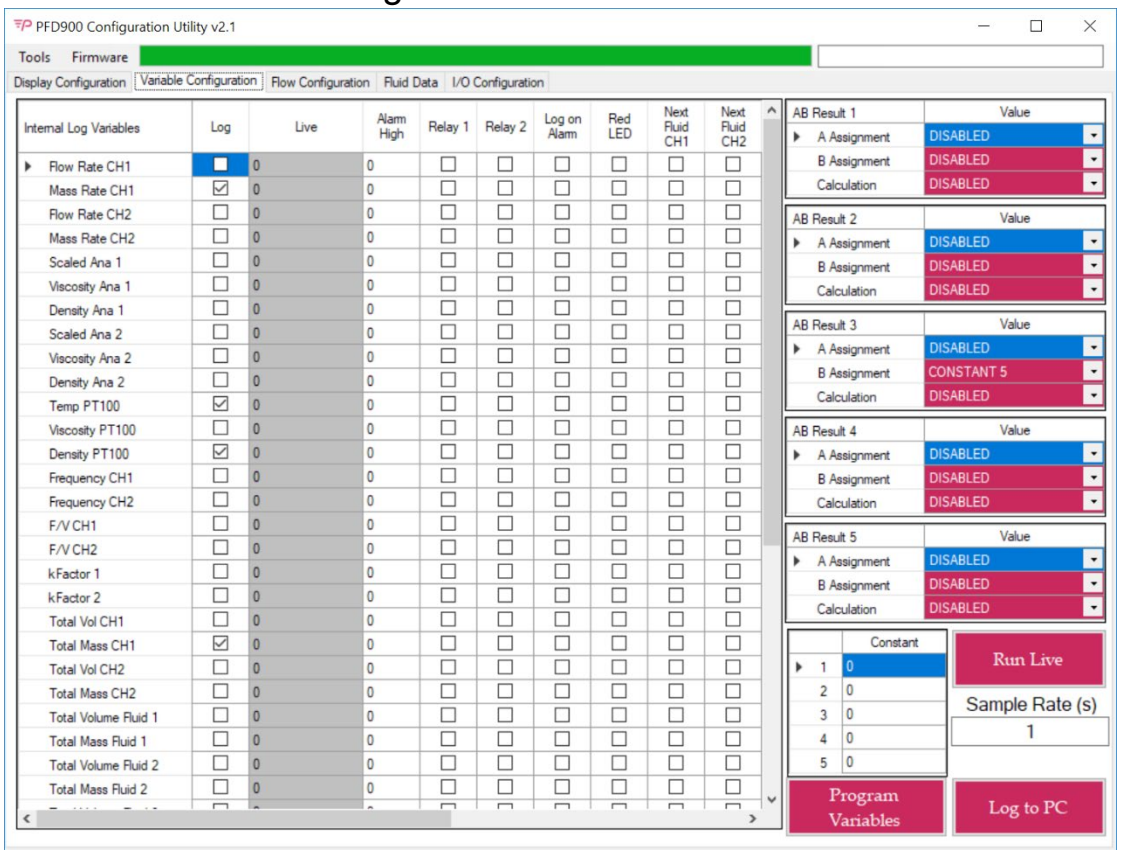
See section 5 for external button wiring information.

4.4.5 Miscellaneous

Write Mode Unlock field is covered in section 4.8.

Program Display button programs the data on this tab and reads it back to ensure it has been programmed successfully.

4.5 Variable Configuration Tab



The full list of variables (excluding labels, covered in the previous section) is as follows:

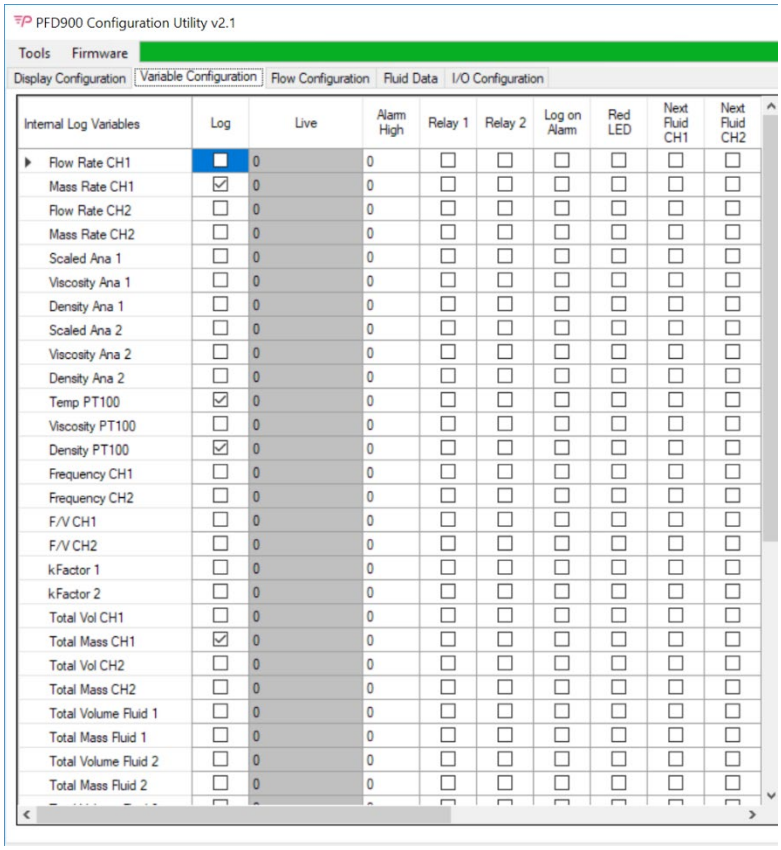
Flow Rate CH1
Mass Rate CH1
Flow Rate CH2 (if the channel is enabled)
Mass Rate CH2(if the channel is enabled)
Scaled Ana 1 (if the channel is enabled)
Viscosity Ana 1 (if a viscosity fluid curve is assigned to this channel)
Density Ana 1 (if a density fluid curve is assigned to this channel)
Scaled Ana 2 (if the channel is enabled)
Viscosity Ana 2 (if a viscosity fluid curve is assigned to this channel)
Density Ana 2 (if a density fluid curve is assigned to this channel)
Temp PT100 (if the channel is enabled)
Viscosity PT100 (if a viscosity fluid curve is assigned to this channel)
Density PT100 (if a density fluid curve is assigned to this channel)
Frequency CH1
Frequency CH2(if the channel is enabled)
F/V CH1
F/V CH2 (if the channel is enabled)
kFactor 1
kFactor 2 (if the channel is enabled)
Total Vol CH1
Total Mass CH1 (if a density curve is assigned to the channel)
Total Vol CH2 (if the channel is enabled)
Total Mass CH2 (if a density curve is assigned to the channel)
Total Volume Fluid 1 (if the fluid is enabled)

Total Mass Fluid 1 (if the fluid is enabled)
Total Volume Fluid 2 (if the fluid is enabled)

Total Mass Fluid 2 (if the fluid is enabled)
Total Volume Fluid 3 (if the fluid is enabled)
Total Mass Fluid 3 (if the fluid is enabled)
Total Volume Fluid 4 (if the fluid is enabled)
Total Mass Fluid 4 (if the fluid is enabled)
Total Volume Fluid 5 (if the fluid is enabled)
Total Mass Fluid 5 (if the fluid is enabled)
AB Result 1 (if the formula is enabled and assigned)
AB Result 2 (if the formula is enabled and assigned)
AB Result 3 (if the formula is enabled and assigned)
AB Result 4 (if the formula is enabled and assigned)
AB Result 5 (if the formula is enabled and assigned)
CONSTANT 1
CONSTANT 2
CONSTANT 3
CONSTANT 4
CONSTANT 5
TIMER

This table is doubled when dual board version is used (each variable has „_2“ after the name).

4.5.1 Variable Table



This table is used to configure the variables; which variables should be logged and the high and low limits that are used to trigger user selected actions.

The log column allows the user to select variables that should be logged in all of the following cases:

- When „Start Log“ is selected from the PFD menu.
- When a variable is configured to „Log on Alarm“ and the configured alarm is active
- When the user clicks on „Log to PC“ from Windows Utility (in this case the configuration does not need to be programmed to the unit)

The internal log has a capacity of 249,856 bytes, which allows the unit to store 62,464 numbers. Therefore, the maximum amount of data captured in terms of time depends on two things: the Logging Interval and the number of variables.

For example, a single variable logged at 1s interval will create 62,464 single entries, corresponding to 62,464 seconds or 17.35 hours. On the other hand, logging 4 variables at 0.01s interval will corresponds to only 156 seconds, or 2 minutes and 36 seconds.

When the display is logging data, the bottom right character of the second line will flash intermitently with a * to provide user with the status.

4.5.2 Live data and Log to PC

This column allows the user to monitor the data from the unit on a laptop/PC via the USB interface. Run Live button makes the PC utility request the live data from the unit ever x seconds, where x is the Sample Rate entered the text box. The minimum that the PC utility will allow is 0.1s due to the maximum baud rate of the serial interface.

Start log button allows the user to log the data via the PC (instead of the internal memory) at the sample rate defined by the text box. The variables that the user wishes to log must be ticked in the Log column. Please note: the PC Utility must in in Run Live mode to log the data.

The file saved is similar to the internal log except the PC utility also includes a date and timestamp with each entry.

1	Time	Frequency	Mass Rate
2	17.4.21 10:58:58.3832	99.987	12.56
3	17.4.21 10:58:59.3748	101.886	13.72

4.5.1 Alarm Configuration

Internal Log Variables	Alarm High	Relay 1	Relay 2	Log on Alarm	Red LED	Next Fluid CH1	Next Fluid CH2	Reset Totals/ Timer
Flow Rate CH1	0	☐	☐	☐	☐	☐	☐	☐
Mass Rate CH1	0	☐	☐	☐	☐	☐	☐	☐
Flow Rate CH2	0	☐	☐	☐	☐	☐	☐	☐
Mass Rate CH2	0	☐	☐	☐	☐	☐	☐	☐
Scaled Ana 1	0	☐	☐	☐	☐	☐	☐	☐
Viscosity Ana 1	0	☐	☐	☐	☐	☐	☐	☐
Density Ana 1	0	☐	☐	☐	☐	☐	☐	☐
Scaled Ana 2	0	☐	☐	☐	☐	☐	☐	☐
Viscosity Ana 2	0	☐	☐	☐	☐	☐	☐	☐
Density Ana 2	0	☐	☐	☐	☐	☐	☐	☐
Temp PT100	0	☐	☐	☐	☐	☐	☐	☐
Viscosity PT100	0	☐	☐	☐	☐	☐	☐	☐
Density PT100	0	☐	☐	☐	☐	☐	☐	☐
Frequency CH1	0	☐	☐	☐	☐	☐	☐	☐
Frequency CH2	0	☐	☐	☐	☐	☐	☐	☐
F/V CH1	0	☐	☐	☐	☐	☐	☐	☐
F/V CH2	0	☐	☐	☐	☐	☐	☐	☐
kFactor 1	0	☐	☐	☐	☐	☐	☐	☐
kFactor 2	0	☐	☐	☐	☐	☐	☐	☐
Total Vol CH1	0	☐	☐	☐	☐	☐	☐	☐
Total Mass CH1	0	☐	☐	☐	☐	☐	☐	☐
Total Vol CH2	0	☐	☐	☐	☐	☐	☐	☐
Total Mass CH2	0	☐	☐	☐	☐	☐	☐	☐
Total Volume Fluid 1	0	☐	☐	☐	☐	☐	☐	☐
Total Mass Fluid 1	0	☐	☐	☐	☐	☐	☐	☐
Total Volume Fluid 2	0	☐	☐	☐	☐	☐	☐	☐
Total Mass Fluid 2	0	☐	☐	☐	☐	☐	☐	☐

This section allows the user to configure the High and Low alarm setpoints for each variable and the relevant action that the unit must perfrom when this condition is trigerred. The table above shows the configuration for the High Alarm; the Low alarm section is identical.

The user is given full control; it is possible to perfrom the same action based on any of the variables going outside of their defined limits within the same configuration. So for example, it is possible to trip relay 1 when Flow Ratefalls below a certain a limit or when the scaled input 1 (connected to a pressure probe, for example) exceeds another limit.

- Relay 1 and 2 columns activate the relevant relay (or both if ticked).
- Log on alarm starts to log *every ticked variable* and stops logging when alarm condition clears
- Red LED activates the red LED on the front of the PFD
- Next Fluid CH1 selects the next fluid from the table CH1 on alarm. When alarm clears, the fluid is decremented.
- Next Fluid CH2 selects the next fluid from the table for CH2. When alarm clears, the fluid is decremented.
- Reset Totals/Timer, resets all totals and timer once the condition is triggered. It does not reset again when the condition clears

More than one action can be selected for each alarm condition.

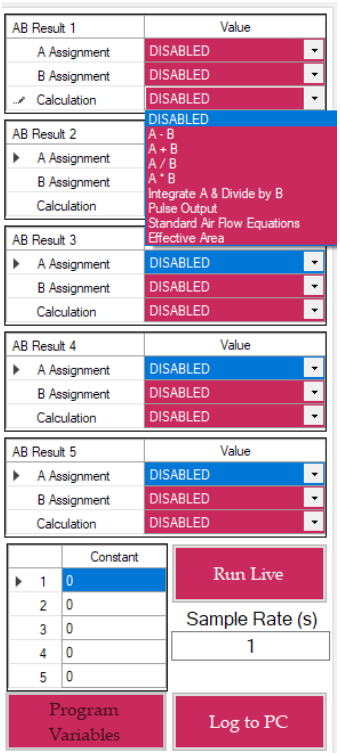
In addition, a columng for filter is available all the way on the right:

Internal Log Variables	Reset Totals/ Timer	Alarm Low	Relay 1	Relay 2	Log on Alarm	Red LED	Next Fluid CH1	Next Fluid CH 2	Reset Totals/ Timer	Filtering (0-99)
Flow Rate CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Mass Rate CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Flow Rate CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Mass Rate CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Scaled Ana 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Viscosity Ana 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Density Ana 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Scaled Ana 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Viscosity Ana 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Density Ana 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Temp PT100	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Viscosity PT100	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Density PT100	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Frequency CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Frequency CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
F/V CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
F/V CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
kFactor 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
kFactor 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Vol CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Mass CH1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Vol CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Mass CH2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Volume Fluid 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Mass Fluid 1	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Volume Fluid 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0
Total Mass Fluid 2	☐	0	☐	☐	☐	☐	☐	☐	☐	0

The grayed out fields are not modifable, because filtering should not be performed on those fields (e.g. total).

The filtering formula is as follows: (new sample)*((100-a)/100)+(old sample)*(a/100)

4.5.2 Formulas and Constants



These tables allow the user to perfrom complex calculations, some examples are given below:

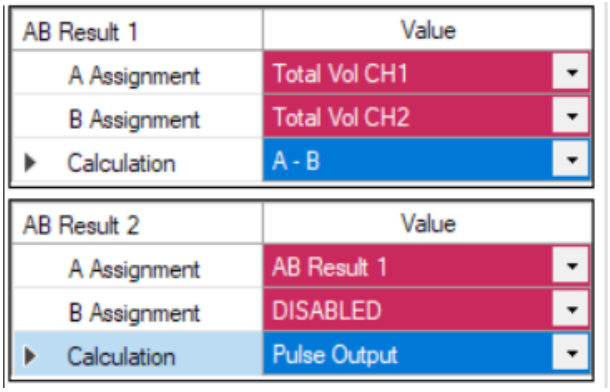
- Calculate gas flow using ideal gas law
- Convert between different units
- Work out fuel usage based on A-B (Ch1 – Ch2)
- Work out total flow where the flow is split
- Work out the ratio of A to B as a fraction and as a percentage (by using constants table and multiplying ratio by 100)
- Perform pressure compensation

The formulas can be cascaded so that the result of the first calculation is fed into the input to the second calculation and so on.

The constants can be used as an input to the any of the formulas.

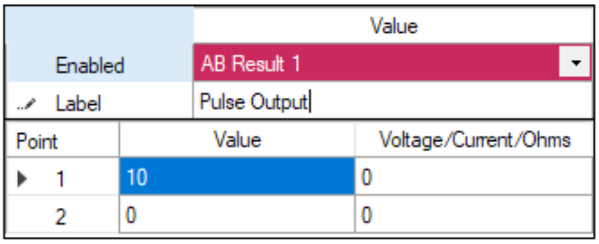
The special formulas are as follows:

- Pulse Output: **This requires the pulse output chip on the board to be programmed for this option at factory when ordering.** Standard output is frequency (e.g. 0-10 LPM = 0-1000 Hz). With the Pulse Output option, if the board is programmed at factory for pulse output, it is possible to set total to pulse output, e.g. 1 Pulse per liter. Pulse output is set to „A assignment“ and „B assignment“ is ignored. To configure pulses per volume quantity, the first field under „Frequency OP“ table is used, e.g. 10 pulses per volume unit:



AB Result 1	Value
A Assignment	Total Vol CH1
B Assignment	Total Vol CH2
Calculation	A - B

AB Result 2	Value
A Assignment	AB Result 1
B Assignment	DISABLED
Calculation	Pulse Output



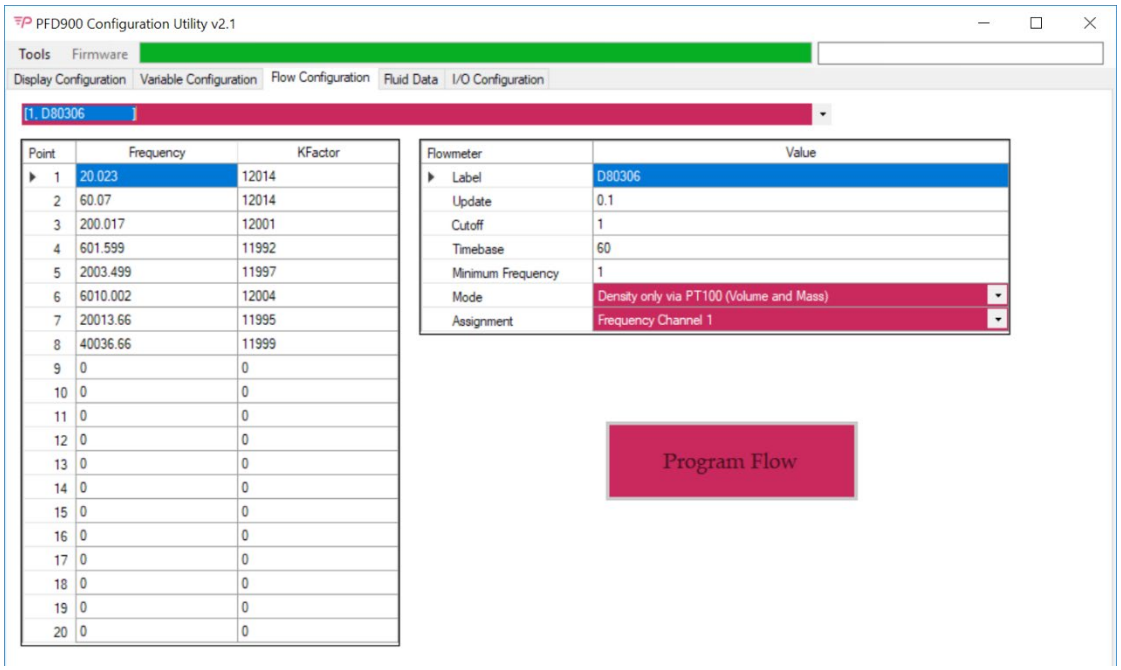
	Value
Enabled	AB Result 1
Label	Pulse Output

Point	Value	Voltage/Current/Ohms
1	10	0
2	0	0

- Standard Air Flow Equations e.g. **SLPM =ALPM*(P1/1.013 BarA)*(293.15˚K/T1) for standard conditions of 20°C and 1.013 BAR.**
  The user can set "standard" conditions and pressure gauge type (gauge or absolute) via the use of Constants, so the equation becomes:
  SLPM =ALPM*((Scaled Analogue 2+Constant 3)/Constant 2)*((Constant 1 + Constant 5)/(Scaled Analogue 1+constant 5)*Constant 4
  Where:
  Constant 1 = Temperature for standard condition, e.g. 20°C
  Constant 2 = Pressure for standard condition, e.g. 1.013 BAR
  Constant 3 = Pressure gauge offset, e.g. 0 if the gauge reads absolute pressure and and 1.013 BAR if the gauge reads pressure above atmospheric
  Constant 4 = Conversion factor if unit conversion is desired, set to 1 for no conversion
  Constant 5 = Temperature offset to convert to °Kelvin (alternatively °Rankine), e.g. 273.15
  The result is always stored in **AB Result 1** (all assignments are ignored)
  The following channels MUST be assigned as follows:
    Frequency channel 1 = Flow Rate in **Actual** units
    Analogue Channel 1 = Temperature input
    Analogue Channel 2 = Pressure input (gauge or absolute)
- Effective Area: this is customer specific and should not be used unless approved by Phoenix Flow Measurement Ltd

4.5.3 Flow Configuration

Please note: for dual board version, each board must be programmed individually with the relevant Flow Configuration, Fluid Data and I/O Configuration tabs.



PFD900 can hold up to 10 flow meter calibration tables. These should be used in the following cases:

- when a selection of different flowmeters is used
- when the same flowmeter is used on different fluids
- when both channels are used for 2 different meters

This tab follows the standard convention of flowmeter tables. The X column in the points table either stores the frequency/viscosity values when “Viscosity Compensated” mode is selected or just frequency when other modes are selected.

The points must be entered in increasing order of X axis and any unused points must be left at 0 as shown above.

The flowmeter label can be used to identify the flowmeter that the display is programmed for. This is stored inside the PFD900 memory as a variable and hence can be dynamically displayed on the LCD matrix.

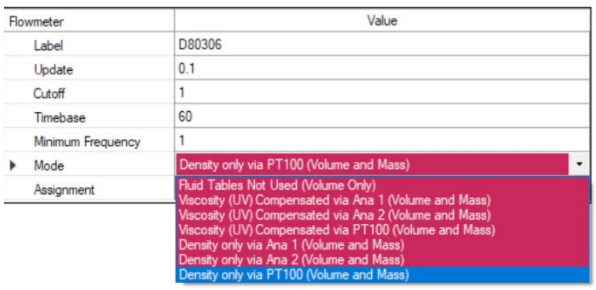
The update rates define the internal processing rate of the unit. There is a tendency to set this as low as possible, but before doing so, the user should be aware of the following:

- Flowmeters (and other sensors) in general do not react very quickly to changes in flow rate/sensory data.
- Fast update rate may result in unstable readings by exposing flow pulsations (from pumps etc.), flow disturbances (from abrupt and frequent flow direction changes due to piping configuration), and rotor imperfections.

The cutoff field specifies how long the flow computer waits without receiving any pulses before setting the flow to 0. This field must not be lower than the update rate.

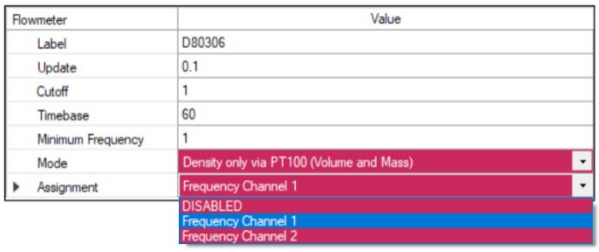
The timebase is set depending on what units the flow curve is programmed in; for example, litres per minute would be timebase 60, litres per hour – timebase of 3600 and litres per second – timebase of 1.

Minimum frequency defines the frequency below which the flowmeter is considered to be unstable/unreliable/uncalibrated. The PFD900 sets flow to 0 when the input frequency is below this value.



The mode field tells the unit whether to

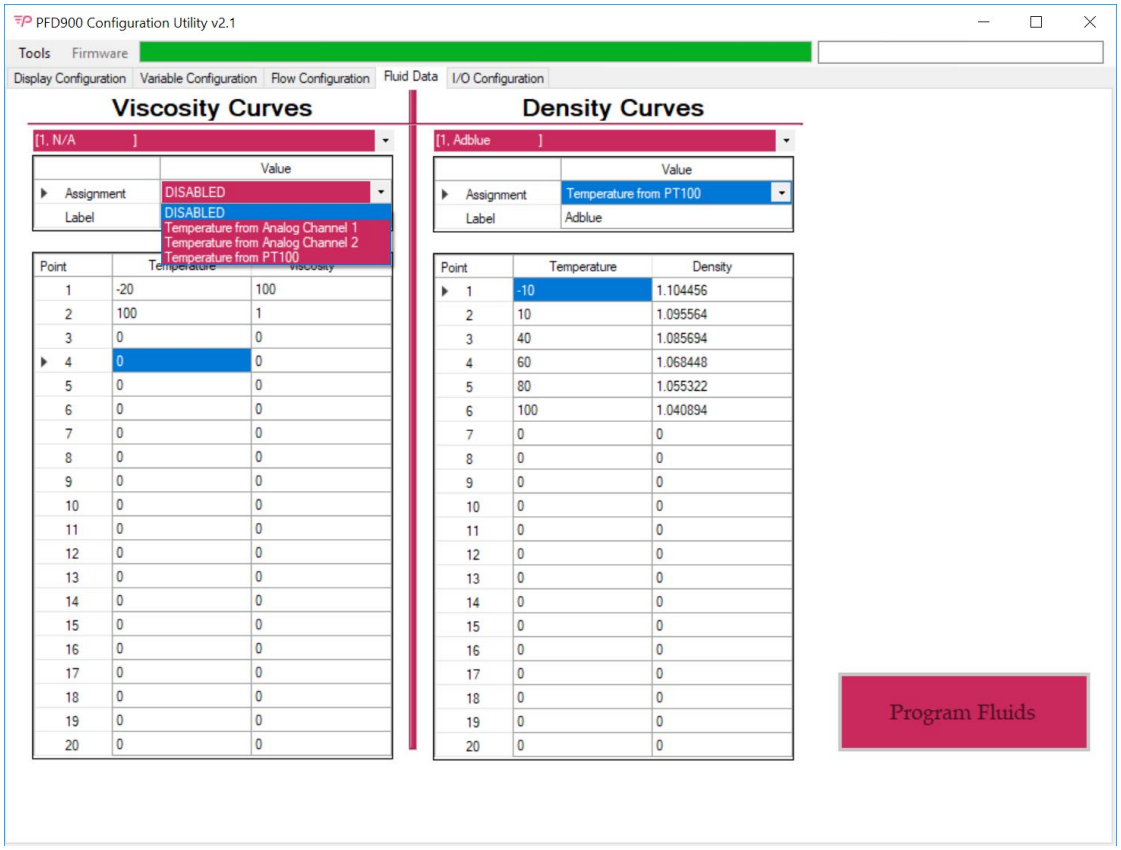
- ignore the fluid tables (volume calculated based on k-factor and input frequency only)
- Use the Viscosity curves to compensate for a change in fluid viscosity vs temperature to calculate both volume and mass (mass calculated based on the temperature vs density table)
- Use only the density curves to calculate volume and mass



The assignment option lets the user assign the current curve to a frequency channel input.

Please note: when frequency channel 2 is assigned to any curves, the second external button is automatically disabled (if the addon board is fitted). The PFD900 also does not validate that the user has assigned only 1 curve to each channel. Unpredictable behaviour may occur if the user assigns multiple curves to the same channel!

4.6 Fluid Data



PFD900 allows the user to create lookup tables for fluid viscosity and density based on fluid temperature.

Up to 5 curves can be programmed for each viscosity and density lookup.

The assignment field for each curve specifies which input channel the fluid is assigned to (in order to read temperature signal).

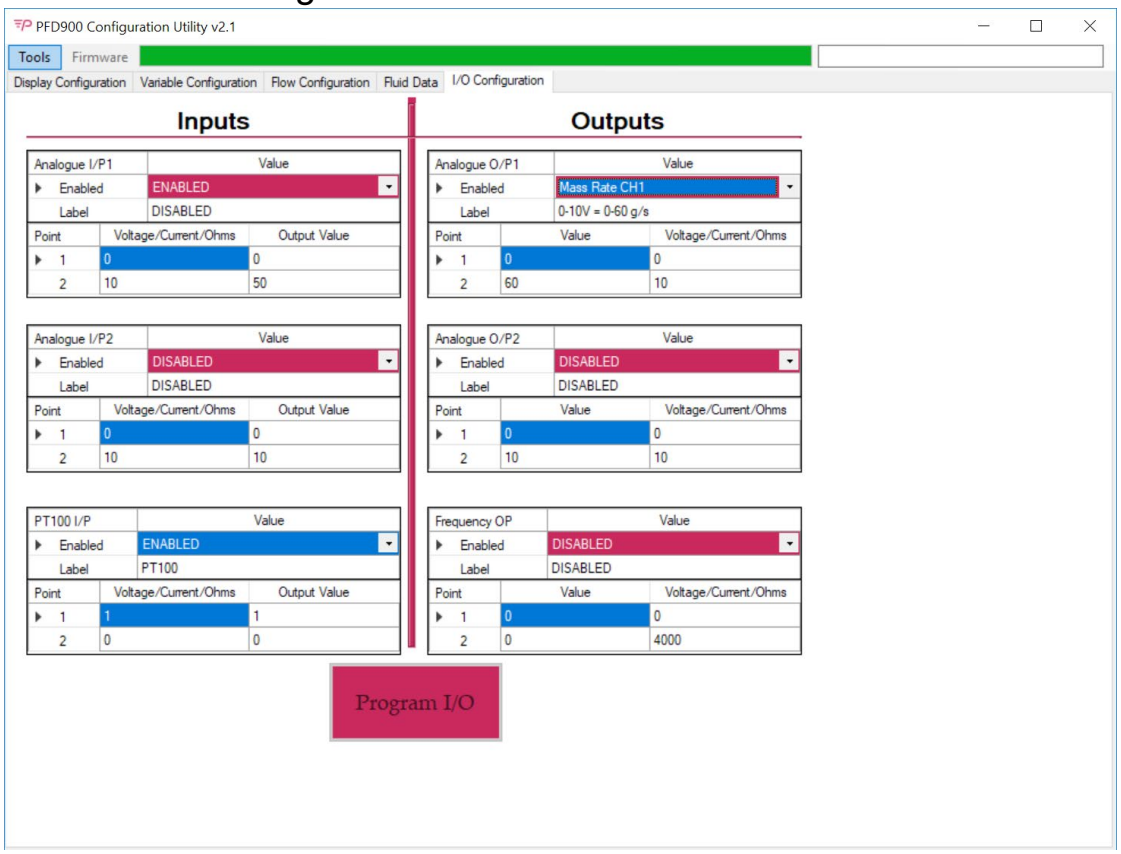
The fluid label is a variable so that the user can insert the currently selected fluid into the display matrix and this field will update automatically whenever a new fluid is selected.

Only one fluid should be assigned to a channel at any one time (but both density and viscosity can be assigned to the same channel).

When the fluid is incremented (either by the user or via an alarm), the next fluid is chosen from the list, regardless of whether the next fluid is assigned to another channel. Therefore, if performing complex fluid switching operations, fluid assignments should be spaced out so that incrementing one channel does not affect the other channel (unless this is the intended behaviour).

Program fluids button programs all the fluid data to the device and does a readback from the unit.

4.7 I/O Configuration



The label field in each case is not used anywhere by the software other than displayed here for information.

4.7.1 Inputs

4.7.1.1 Analogue Inputs

Analogue inputs can be either 0-10V or 4-20mA. The user can select the type using header links inside the unit but the unit is always shipped in the configuration requested by the customer, so the links should not be modifed unless customer requirements have changed. Please note, this does not apply to analogue outputs, as the circuitry is different for 0-10V and 4-20mA.

The input channels are either disabled or enabled, and the scaling is used to configure the Scaled Ana 1 and 2 variables. These are then converted to Viscosity and Density if the fluid curves are assigned to the relevant channels.

4.7.1.2 PT100 Input

The factory calibration is performed using PT100 in degree Celsius, however, it is possible to re-scale the output to change units to Fahrenheit or to change the sensor used.

The default scaling is 1 to 1 for Celcius. The output is saved to PT100 Temperature which is then also converted to Viscosity and Density if the fluid curves are assigned to PT100 channel.

4.7.1.3 Input scaling tables

The input scaling tables allow the user to scale the input voltage/current/ohms to produce a meaningful numeric value. In the following example, a 1-6V pressure sensor has been used, which has been calibrated to produce 0 BAR at 1V and 15BAR at 6V:

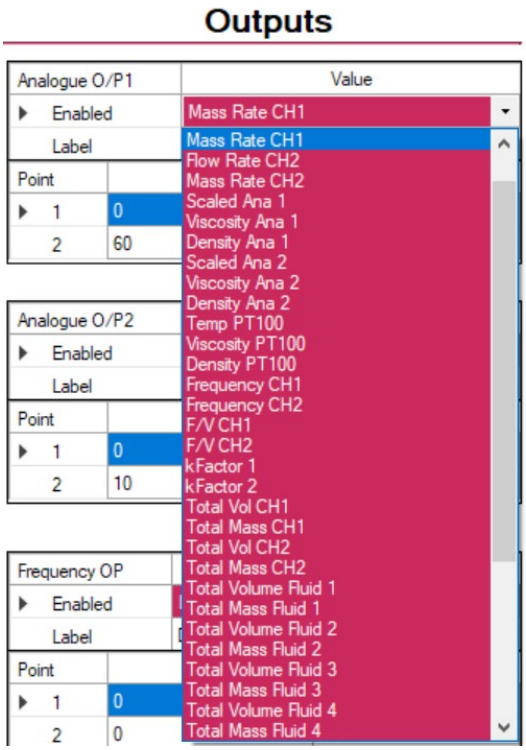
Point	Voltage/Current/Ohms	Output Value
▶ 1	1	0
2	6	15

In the following example, the PT100 is used in defualt values of Celcius.

Point	Voltage/Current/Ohms	Output Value
▶ 1	1	1
2	0	0

4.7.2 Outputs

The output channels can be assigned to any of the variables and scaled as per the user requirements.



The default configuration for the analogues is 0-10V (if fitted), to convert to 4-20mA, an addon board is used that is plugged into pin header on the PCB.

4.8 Write Mode Unlocking

The pass code for write mode unlocking is 885963. Once this is entered, the PC utility will automatically unlock all write buttons and Bootloader Options.

After every write cycle, the PC Utility does a read operation and re-populates the relevant tables with the data read back from the unit. The program itself does not check the read back data against the data sent to be programmed – it is up to the user to check it.

This section is intentionally entered on its' own page so that it can be omitted if the write mode access should not be given to some users.

4.9 Load/Save File Structure

The file structure has been designed to be forward and backward compatible (starting from version 2.1) and it has been designed to enable the user to load in specific sections of configuration is required.

Version 2.2 onwards inserts the software version number as the first line, e.g. [2.2], which is used to work out whether commas are used as separators (version 2.1) or semicolons (version 2.2 onward) and for future data file processing if required.

The structure is then as follows, repeated for each table in the program:

Table name (as used internally by the software)
Number of rows
Number of columns
Table data, separated by semicolons

This means that if the user only wants to load in a single table, it is possible to delete all other tables from the file and leave only the required table. The rest of the tables will not be overwritten.

5. Wiring and H/W Configuration

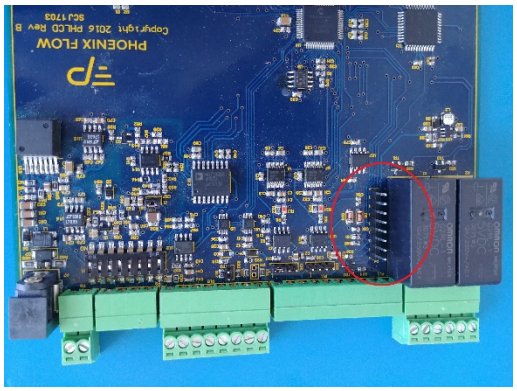
Ensure that the correct DIP switches are set for the interface:

Pulse:	ON	3 4 8	Signal A is positive
	OFF	1 2 5 6 7	Signal B is 0v
RF:	ON	1 4 8	A – 52-54kHz carrier
	OFF	2 3 5 6 7	B – 0v
MAG:	ON	2 4 7	A – positive SINE
	OFF	1 3 5 6 8	B – Reference SINE
REED:	ON	5 6 8	Signal A is positive Debounce approx.1ms
	OFF	1 2 3 4 7	Signal B is 0v

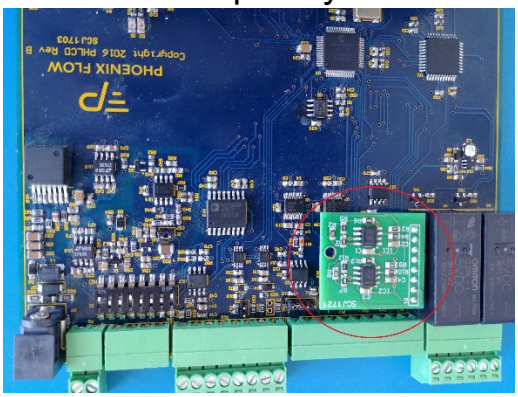
PT100: 4 wire use 1, 2, 3 and 4
3 wire use 1, 2 and 3, terminal 4 should be linked to terminal 3
2 wire use 1 and 3, link terminal 1 and 2: link terminal 3 and 4

5.1 Expansion Connector

The following photo shows the location of the expansion connector for further off-the shelf and customer specific options.



5.2 Remote Button/2nd Frequency Interface



If the remote button interface board has been fitted, then the 10-pin connector wiring becomes as follows:

Option A (Pin 8): Button 1 OR 2nd Frequency channel

Option B (Pin 9): Button 2

The second terminal for both buttons should be connected to 0V (pin 10).