

OPERATING MANUAL

Vortex Insertion Meter



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1. GENERAL INFORMATION

1.1 General

Vortex Shedding is not new. Da Vinci observed vortex shedding in 1513. Von Karman provided an empirically determined formula for it in 1911-1912. One observes it as eddies downstream of a rock or a piling in a fast moving stream. Yet, it wasn't until it was successfully developed and installed in the late 1960's that this significant development in the science of flow measurement was given considerable attention by industry.

1.2 Principles of Operation

With the controlled use of an obstruction installed in a given pipeline, vortices are generated downstream of the obstruction when fluid or gas flows through a pipe. A vortex is a swirling low pressure eddy which forms alternately from side to side of the bluff body. With each eddy, there is formed a corresponding high pressure pulse opposite the bluff body. (See Figure 1.) These pulses are directly proportional to the velocity of a given fluid. Each pulse represents given volumetric units of fluid for a given line size. Since each pulse represents a unit volume, the output is therefore linear with respect to flow rate.

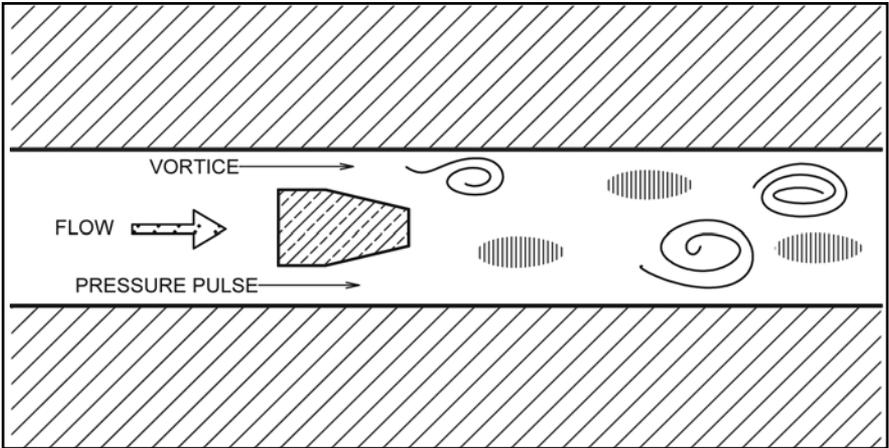


FIGURE 1

1.3 Sensor Operation

Two pressure sensing devices are mounted internally in proximity to the stainless steel bluff body. The sensors are piezo electric crystals. The crystals convert the pressure pulses created by the vortices into voltage signals without the need of excitation current or voltage. The sensor crystals are never in direct

contact with the fluid. The piezo crystals are encapsulated in a stainless steel module. These sensor assemblies can be replaced if the need ever arises.

1.4 Calibration Factor

The frequency at which vortices are shed is a linear function of fluid velocity, and therefore, a measure of flow. In the range covered by the particular flow meter, vortex frequency is insensitive to specific gravity, viscosity, and temperature of the fluid and depends only upon the width (d) in inches and shape of the flow element, and the inside diameter (D) of the pipeline in inches.

The frequency is: $F = SV/d$

where :
F = Karman vortex frequency
S = constant (Strouhal Number)
V = fluid velocity at the flow element
d = face width of the element

The frequency relationship is accurately linear and reproducible, eliminating the need for “wet calibration.” (See Figure 2.)

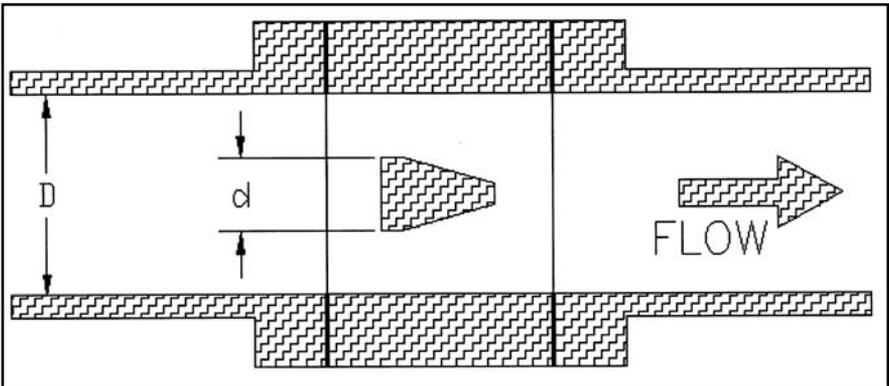


FIGURE 2

2. HANDLING AND STORAGE

2.1 Handling Precautions

The vortex flow meter has been tested and configured at the factory. When the instrument is received, it should be inspected for damage due to mishandling during shipment. If damage is evident, report it to the carrier immediately and have them present when the case is opened. They are responsible for any damage during shipment. If you have any problems or questions, consult the factory or your local representative.

2.2 Storage

After receiving the vortex insertion flow meter, care should be taken to avoid unnecessary damage. If the meter is not scheduled to be installed soon after delivery, the following steps should be observed:

- A) After inspection, the meter should be repacked into its original packing.
- B) If the meter being stored has been previously installed, care should be taken to remove all process fluids and corrosives.
- C) Select a clean, dry site free of mechanical vibration, shock and chemical corrosives.

3. INSTALLATION

3.1 Installation

The Aalborg® vortex flow meter is designed to operate under a wide variety of conditions. To ensure its longevity of operation, precautions should be taken before and during its installation.

3.2 Selecting the Installation Site

- A) The vortex meter requires a minimum of 20 straight diameters upstream and 5 straight unobstructed diameters of downstream piping. One diameter is equal to the internal pipe diameter. This is necessary to ensure regulated formation of vortices. (See Figure 3 for the piping requirements chart for various piping recommendations.)
- B) Choose a site with minimal mechanical vibrations.
- C) Avoid areas of high humidity or corrosive atmosphere where possible.
- D) When installing the meter, choose a site which is accessible and allows ease of wiring and maintenance.

PIPING TABLE

TYPICAL PIPING		Recommended Straight Pipe Length "A"		REMARKS
		Without Vanes	With Vanes	
ALL FITTINGS IN SAME PLANE		15D*	15D	Closed branch
		20D	15D	Elbow, Tee, Branch pipe
		25D	15D	Elbow, 2 places
		25D	15D	Long-radius bends
FITTINGS IN TWO PLANES		30D 25D	15D 15D	Elbow Long-radius bend
		40D 35D	20D 20D	Elbow Long-radius bend
VARIED SECTION		20D	15D	Contracting pipe
		40D	20D	Expanding pipe
VALVES		Recommend Meter Be Installed Upstream		Regulating, reducing valves Ball, check valves Shut-off valve

FIGURE 3



Note : Straight pipe length on the downstream side to be 5 pipe diameters minimum. *D = Pipe internal diameter.

3.3 Piping Guidelines

To ensure the high accuracy of flow measurement specified on the identification sheet, piping and installation instructions must be followed carefully.

- A) The pipe immediately up and down stream of the flow meter must be of sufficient length, straight and free of obstructions. Refer to the piping requirements chart for exact dimensions (Figure 3).
- B) It is recommended that straightening vanes be used on all vortex meters, but it is not necessary.
- C) When the vortex meter is being used as a controller, it is recommended that any regulating valve be located downstream of the flow meter.
- D) Weld beads on the internal wall of the pipe before or after the flow meter should be ground flush with the pipe wall before the meter is installed.
- E) Proper style and proper size gaskets should always be used when installing the flow meter.
- F) The meter can be rotated around the pipe in any direction.

3.4 Temperature and Pressure Taps (Optional)

Installation of temperature and pressure transducers (if used) should be in accordance with the manufacturer's specifications.

- A) The temperature transducer should be installed between 2.5 and 3.5 diameters from the downstream side of the wafer body. Consult the factory for the exact dimensions, or refer to additional information at the end of this manual.
- B) The pressure transducer should be installed between 2.0 and 3.5 diameters from the upstream side of the wafer body. Consult the factory for the exact dimensions.

3.5 Orientation

The Insertion Model flow meter uses piezo-electric sensing elements with no moving parts. This eliminates wear and allows for vertical or horizontal installation.

3.6 Insertion Meter Installation Procedure

- A) The Insertion Model will be inserted into the center line of the pipe for line sizes 3 inches and larger. For sizes which are larger than 24 inches, a one-third diameter insertion depth is used.
- B) Please refer to your configuration to verify the proper installation drawing.
- C) The Insertion Model inserts through a 1-1/2 inch hole, the weldolet, nipple and valve. The valve must be threaded full bore 1-1/2 inches in size.
- D) When the flange version is used, a flange is supplied. This flange has an overall height of 3 inches. This must be taken into account when installing the nipple. The overall height is given on the drawings.
- E) When screwing in the 1-1/2 inch NPT threads into the valve, do not use the large nut on the top of the seal assembly to tighten the meter in the valve. Use the machined hex on the seal assembly. The large nut is only used to tighten down on a split ring, which holds the bar in place, keeping it from being pushed out of the line.
- F) After installing the meter, check for alignment. There is a mark on the top of the bar nearest the electronics which should face exactly upstream. This mark is aligned with the element and will give proper alignment of the element in the flow while facing upstream. If this mark does not face upstream after installing the meter, the bar must be rotated. There are flats on the top of the bar next to the electronics which accommodate a one inch open ended wrench. The bar can be turned until the mark faces upstream. If the assembly is too tight to rotate the bar, the large nut on the seal assembly can be loosened.



CAUTION: DO NOT LOOSEN THE NUT UNLESS THE LINE IS DEPRESSURIZED OR A HOT-TAP MECHANISM HAS BEEN INSTALLED PROPERLY ON THE METER SHAFT.

- G) After aligning the mark, keep your 1 inch open-ended wrench on the flats on top of the bar, holding it in place, then tightening down on the larger nut on the seal. This will prevent the bar from turning when completing the final tightening on the split ring nut.



IMPORTANT NOTE: For final check, make certain that the meter has not come loose from its 1-1/2 inch NPT connection and be sure that the split ring nut and seal assembly are firmly in place.



SAFETY PRECAUTIONS: Please keep clear of the meter when the line is being pressurized. This is a good safety procedure for the installation of any equipment in a pressurized line.

3.7 Installation and Use of Insertion Tool

The purpose of the insertion tool is to remove or install a meter during flow. The insertion tool should be installed prior to making any adjustments to the meter itself. The insertion tool is a separate device which can be installed on any Insertion Model meter regardless of whether it is metering liquids, gases or steam.

- A) The bottom assembly is clamped around the seal assembly. This piece is bolted together just below the machined step on the seal, thus insuring that the bottom piece will not move during its operation.
- B) Attach the upper two pieces of the tool to the meter shaft 2" down from the top of the shaft.
- C) Make certain that all nuts, bolts and couplings are tightened securely.
- D) Recheck steps A through C to assure that everything is tightened and corresponds to the drawing on the insertion tool. If the above steps check out OK, open the valve.

E)



EXTREMELY IMPORTANT: This step is very important so that no leakage, which could cause injury, occurs.

Loosen the nut on the split ring on the top of the seal assembly making sure not to loosen the entire seal assembly out of the piping. (The larger of the hex nuts is the split ring assembly.) This should be completely loosened. This can be accomplished by holding the seal assembly in place and then loosening the large hex nut on the split ring assembly. The split ring nut should be loosened completely.



CAUTION: After the nut is completely removed, the pressure is now against the insertion tool. Do not stand in the direction of extraction as personal injury could occur.

- F) The meter can now be removed or inserted by putting a wrench on top of the threaded shaft of the insertion tool and turning the shaft until the meter is extracted from or inserted into the pipe.



CAUTION: The shaft will not go completely through the seal assembly, therefore, when the shaft stops extracting, do not apply additional force or damage could occur.

- G) After the meter has been extracted, the valve should be closed, and the entire seal assembly unscrewed from the piping. The entire meter and extraction tool is then removed from the pipe.



CAUTION: Remove the seal assembly slowly. There may be an amount of pressurized fluid in the nipple, or the valve may not be sealing properly.

- H) When reinstalling or removing the meter, repeat the entire procedure starting with step A.

4. ELECTRONICS



WARNING!

WIRING THE TRANSMITTER WITH THE POWER ON MAY RESULT IN INTERNAL DAMAGE OR LOSS OF MEMORY! PLEASE MAKE ALL WIRING CONNECTIONS BEFORE SWITCHING ON THE POWER.

4.1 Description

The Smart Transmitter is supplied with all vortex flow meter. It is designed to be locally mounted or wall mounted, remote from the meter, for easy user access. The local keypad/display can be programmed to display various process variables: instantaneous volumetric and mass flow rate, total flow, temperature*, pressure* and density* in engineering units.

The flow rate can be displayed in 30 different volumetric and 25 mass flow engineering units. Flow meter parameters and functions can be programmed remotely via the RS-232/RS-485 interface or locally via LCD/KeyPad using multi level menus. Vortex flow meters support various functions including: two programmable flow Totalizers, low, high or range flow, temperature* and pressure* Alarms, two digital programmable optically isolated outputs, two programmable (for different process variables: volumetric flow, mass flow, temperature*, pressure*) 4-20 mA analog outputs, programmable optically isolated flow rate Pulse output, battery backed Real Time Clock [RTC], programmable process Variable Data Log

(total 15872 records) with date and time stamp, extensive Diagnostic events log and register, and feature a password protected access to the process parameters to ensure against tampering or resetting.

(* - optional feature)



NOTE: For Insertion flow meter optional temperature and pressure sensors support is not available.

4.2 Specifications

Fluid Types: Steam, Gas, Liquid.

Flow Accuracy (Including Linearity): $\pm 1\%$ of AR.

Repeatability: $\pm 0.25\%$ of full scale.

Ambient Temperature: $-12\text{ }^{\circ}\text{C}$ to $65\text{ }^{\circ}\text{C}$ ($-15\text{ }^{\circ}\text{F}$ to $149\text{ }^{\circ}\text{F}$).

Fluid Temperature: $-20\text{ }^{\circ}\text{C}$ to $232\text{ }^{\circ}\text{C}$ std./to $260\text{ }^{\circ}\text{C}$ opt.
($-3\text{ }^{\circ}\text{F}$ to $450\text{ }^{\circ}\text{F}$ std./to $500\text{ }^{\circ}\text{F}$ opt).

Flow Response Time: Adjustable based on Noise Redaction Filter (NRF) and Damping settings (minimum 1000 ms).

Analog Output Signals: Linear 4-20 mA, self-powered (sourcing type, non-isolated), 600 ohms maximum loop resistance.

Optically Isolated Outputs: UCE @ 40Vdc, ICE @ 150 mA (Voltage – Isolation: 5000 Vrms).

Optically Isolated Flow Pulse Output: UCE @ 60Vdc, ICE @ 50 mA (Voltage – Isolation: 5000 Vrms).

Flow Meter Input Power: 15 to 30 Vdc, 100 mV maximum peak to peak output noise. Power consumption: +15Vdc (150 mA maximum); +24Vdc (100 mA maximum); Circuit board have built-in polarity reversal protection, 300mA resettable fuse provide power input protection. 115 or 230 Vac transformer (optional).

Communication Interface: RS-232 standard (RS-485 optional).

Communications Parameters (RS-232/RS-485):

Baud rate:	.....	9600 baud
Stop bit:	.....	1
Data bits:	.....	8
Parity:	.....	None
Flow Control:	.....	None

Display: Local 2x16 characters LCD. In the process mode can be set to display statically or dynamically (with preset interval time) up to 13 different combinations of the process and diagnostic parameters.

Key Pad: 4 push button key pad.

CE Compliance: EMC Compliance with 89/336/EEC as amended.

Emission Standard: EN 55011:1991, Group 1, Class A

Immunity Standard: EN 55082-1:1992

(* - optional feature)

4.3 Handling and Storage

The smart transmitter has been tested and programmed at the factory. When the transmitter is received, it should be inspected for damage due to mishandling during shipment. If damage is evident, report it to the carrier immediately and have them present when the carton is opened. The carrier is responsible for any damage during shipment. If you have any problems or questions, consult the factory or your local representative.

After receiving the unit, handle with care to avoid any unnecessary damage. If the unit is not scheduled to be installed immediately after delivery, the following steps should be observed:

- A) After inspection, the transmitter should be repacked into its original packing.
- B) Select a clean, dry place to store the meter.
- C) Avoid areas of extreme temperatures. The unit should be stored in an area that falls between -15°F and +149 °F.

4.4 Mounting

The transmitter enclosure for remote option has two mounting feet for easy wall mounting. The enclosure should be located within 100 feet from the pipeline sensor, and ideally should be at eye level for easy viewing and access to the keypad for programming.

High-Temperature Installations:

Install the meter body so the electronics are positioned to the side of or below the pipe. Insulation may be required around the pipe to maintain a temperature below 149 °F (65 °C).



WARNING:

Some of the IC devices used in the transmitter are static sensitive and may be damaged by improper handling. When adjusting or servicing the transmitter, use of a grounded wrist strap is recommended to prevent inadvertent damage to the integral solid state circuitry.

4.5. Wiring Connections

The transmitter module fits snugly within the enclosure, but will slide out by hand without the necessity of a tool for removal.



CAUTION: Make proper grounding connections before switching on power. Grounding the flow meter and transmitter modules is one of the most important procedures of Vortex installation. Proper grounding ensures correct and accurate flow measurement.

Use dedicated Grounding Clamp on the meter and transmitter body (see pages 110-113) to make the proper connection to building protective earth.

The TB1 – TB4 terminals accept 14 to 24 gauge wires, but 18 gauge shielded wire (Belden 8760) or 20 gauge shielded wire (Belden 9154) is recommended. When making wiring connections, cable glands should be fitted and sealed to prevent moisture entering the enclosure.



NOTE: For remote transmitter option use shielded twisted pair cable in order to reduce EMI on sensors signals. Use 24 AWG or larger wire and do not exceed 100 feet (30 meters). Use supplied cable termination kit to properly terminate the transmitter end of the signal cable.

The termination kit includes:

1. Molex 3 position Connector Housing (P/N: 50-57-9403) 1 ea.
2. Molex Female Connector Terminals (P/N: 16-02-1114) 3 ea.

Make sure to connect terminal #4 on the meter side to pin #2 (central pin) on the Molex connector (see APPENDIX D on page 111 for more details)

4.5.1 Power Supply Connections

The power supply requirements for Vortex flow meter are: 15 to 30 Vdc 100 mV maximum peak to peak output noise, (unipolar power supply)

Terminal TB1,	Pin 1	-----	DC Power (+)
Terminal TB1,	Pin 2	-----	DC Power (-)
Terminal TB1,	Pin 3	-----	GND, building protective earth (connect to dedicated GND clamp inside of the enclosure).



CAUTION: Do not apply power voltage above 30Vdc. Doing so will cause Vortex meter damage or faulty operation.



Make sure power is OFF when connecting or disconnecting any cables in the system.

The (+) and (-) power inputs are each protected by a 300mA M (medium time-lag) resettable fuse. If a shorting condition or polarity reversal occurs, the fuse will cut power to the flow transducer circuit. Disconnect the power to the unit, remove the faulty condition, and reconnect the power. The fuse will reset once the faulty condition has been removed.

Use of the Vortex flow meter in a manner other than that specified in this manual or in writing from Aalborg, may impair the protection provided by the equipment.

4.5.2 Analog 4-20 mA Output Signals Connections



CAUTION: When connecting the load to the output terminals, do not exceed the rated values shown in the specifications. Failure to do so might cause damage to this device. Be sure to check if the wiring and the polarity of the power supply is correct before turning the power ON. Wiring error may cause damage or faulty operation.

Vortex Flow Meters are equipped with two calibrated 4-20 mA output signals (which can be assigned to any of four process variables: Volumetric Flow, Mass Flow, Temperature*, Pressure*).

This linear output signal by default represents 0-100% of the selected process variable full scale range. User may adjust 4mA and 20 mA settings individually for each output if different range of the process variable is required (see Paragraph 5.3.12.4)



WARNING: The 4-20 mA current loop output is self-powered (sourcing type, non-isolated). Do NOT connect an external voltage source to the output signals.

Terminal TB3, Pin 1	-----	(+) Plus 4-20mA Analog Output#1
Terminal TB3, Pin 2	-----	(-) Minus 4-20mA Analog Output#1
Terminal TB3, Pin 3	-----	(+) Plus 4-20mA Analog Output#2
Terminal TB3, Pin 4	-----	(-) Minus 4-20mA Analog Output#2

4.5.3 Programmable optically isolated Output Signals Connections

Optocoupler #1 - Terminal TB4 (pins 6 and 5):

Terminal TB4 Pin 6	-----	Plus (+) (passive)
Terminal TB4 Pin 5	-----	Minus (-) (passive)

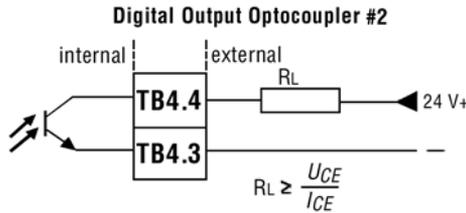
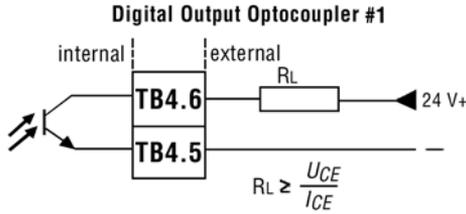
Optocoupler #2 - Terminal TB4 (pins 4 and 3):

Terminal TB4 Pin 4	-----	Plus (+) (passive)
Terminal TB4 Pin 3	-----	Minus (-) (passive)



WARNING: Optically isolated outputs require application of external DC voltage across terminals. Do not exceed maximum allowed limits for voltage and current provided below:

2 V U_{CE} 40 V
0.2 mA I_{CE} 150 mA



4.5.4 Programmable optically isolated Flow Pulse Output Signal Connections

Terminal TB4 (pins 2 and 1):

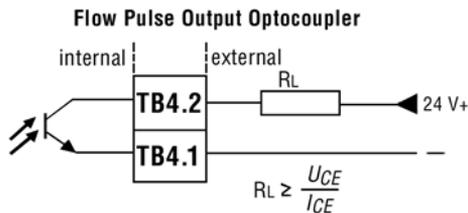
Terminal TB4 Pin 2 ----- Plus (+) (passive)

Terminal TB4 Pin 1 ----- Plus (-) (passive)



WARNING: Optically isolated Flow Pulse output require application of external DC voltage across terminals. Do not exceed maximum allowed limits for voltage and current provided below:

2 V U_{CE} 60 V
0.2 mA I_{CE} 50 mA



4.5.5 Communication Parameters and Connections

The digital interface operates via RS-232 (optional RS-485) and provides access to applicable internal data including: flow, temperature*, pressure*, totalizers and alarm settings, flow calibration settings, process fluid parameters and engineering units selection.

Communication Settings for RS-232/RS-485 communication interface:

Baud rate: **9600 baud**
Stop bit: **1**
Data bits: **8**
Parity: **None**
Flow Control: **None**

RS-232 communication interface connection:

Crossover connection has to be established:

Terminal TB2 Pin 1 (Tx-)	-----	RS-232 RX (pin 2 on the DB9 connector)
Terminal TB2 Pin 2 (Rx+)	-----	RS-232 TX (pin 3 on the DB9 connector)
Terminal TB2 Pin 3	-----	RS-232 SIGNAL GND (pin 5 on the DB9 connector)

RS-485 communication interface connection:

The RS485 converter/adaptor must be configured for: multidrop, 2 wire, half duplex mode. The transmitter circuit must be enabled by TD or RTS (depending on which is available on the converter/adaptor). Settings for the receiver circuit should follow the selection made for the transmitter circuit in order to eliminate echo.

Terminal TB2 Pin 1 (Tx-)	-----	RS-485 T(-) or R(-)
Terminal TB2 Pin 2 (Rx+)	-----	RS-485 T(+) or R(+)
Terminal TB2 Pin 3	-----	RS-485 GND (if available)

5. LCD KEYPAD OPERATION: DATA ENTRY AND CONFIGURATION

5.1 Display Indications

Initially, after the power is first turned on, the Banner Screen is shown for 1 second, then flow meter model number is shown in the first line of the display and the revisions for EEPROM table and firmware in the second line. Subsequently the actual process information is displayed.

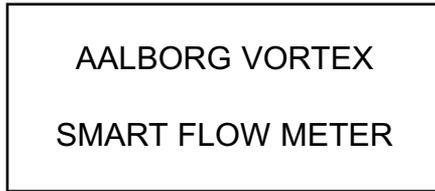


Figure 5.1: Vortex meter first Banner Screen

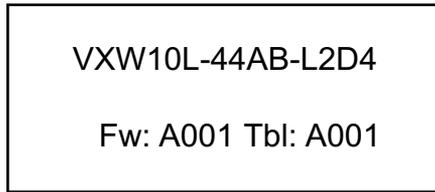


Figure 5.2: Vortex meter second Banner Screen



NOTE: Actual content of the LCD screen may vary depending on the model.

Based on flow meter configuration (with or without Temperature/Pressure option), different parameters may be displayed in the Process Information (PI) screen by pressing the **Up** or **Dn** pushbuttons.

Process Information screens can be configured to be static or dynamic (see Paragraph 5.3.11 “Display Menu”). Using Screen Mask settings user can enable (unmask) or disable (mask) up to 13 different process variable combinations (see Figure 5.4). In the static mode pressing **Up** button, pages through the PI screens in the forward direction, pressing **Dn** button, pages through the PI screens in the reverse direction. When the last PI screen is reached, the firmware “wraps around” and scrolls to the initial PI screen once again.

In the dynamic mode firmware initiates automatic screen sequencing with user adjustable screen Cycle Time (see Paragraph 5.3.11.2 “Display Menu”). When the last PI screen is reached, the firmware “wraps around” and scrolls to the initial PI screen once again.

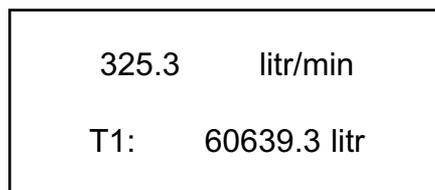


Figure 5.3: Vortex meter initial PI Screen



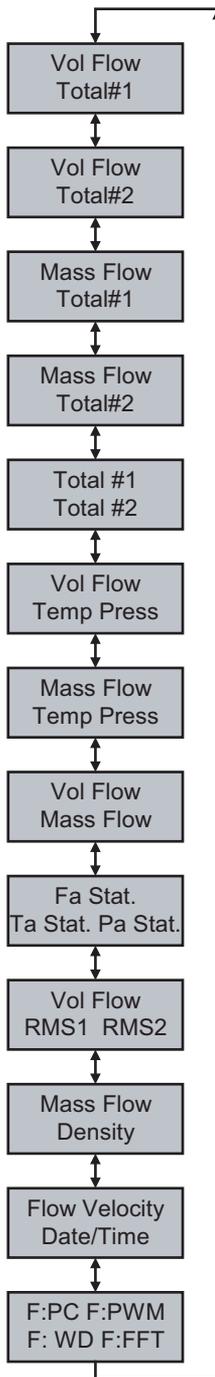
NOTE: Actual content of the LCD screen may vary depending on the model.

Process Information Mode Screens



NOTE: For devices without Temperature and Pressure measurement hardware, the screens with T/P process info will display static data entered during meter configuration procedure via Process Fluid menu (see Paragraph 5.3.9).

Figure 5.4: Vortex meter Process Information Screens



5.2 Menu Sequence

The listing below gives a general overview of the standard top-level display menu sequence when running firmware version A001. The **ESC** pushbutton is used to toggle between the process mode (PI screens) and the Setup menus.

The listing in Section 5.2 shows the standard display menu sequence and sub-menus using the **UP** button to move through the menu items. The first message displayed the first time the **ESC** button is pressed after the meter is powered up is “**Prog. Protection ON**”. Thereafter, pressing the **ESC** button while the flow meter is in monitoring mode (PI screens) will display the parameter that was last exited. Program Protection may be turned “**off**” by pressing the **ENT** pushbutton when the Program Protection menu is displayed. The firmware will prompt with “**Change Prog Prot**”. Pressing **UP** or **DN** button will toggle current protection status. If password is set to any value more than zero, the firmware will prompt with “**Enter Prot Code**”. User has to enter up to 3 digits program protection code, in order to be able to access password protected menus. Once correct password is entered, program protection is turned off until unit is powered up again.

When the last menu item is reached, the firmware “wraps around” and scrolls to the first item on the menu once again (see Figure 5.5). The menu items in the first column are upper-level configuration mode functions. Submenu selections are shown on the Figure 5.6). The allowable selections of sub-menu items which are selected by tabular means are shown in detail in Section 5.3.

Figure 5.5 Upper level 1 Setup Menu structure.

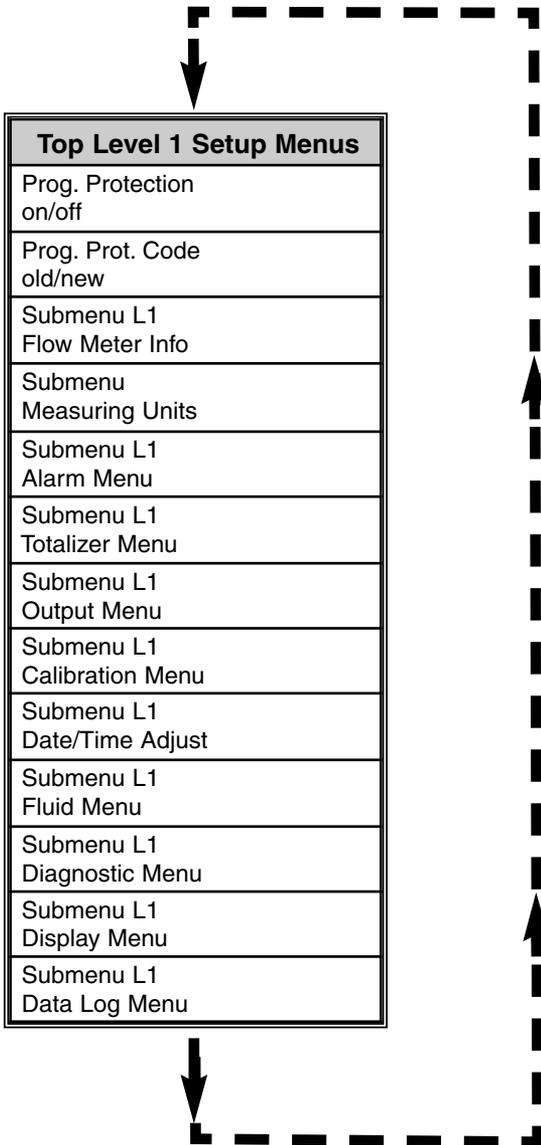
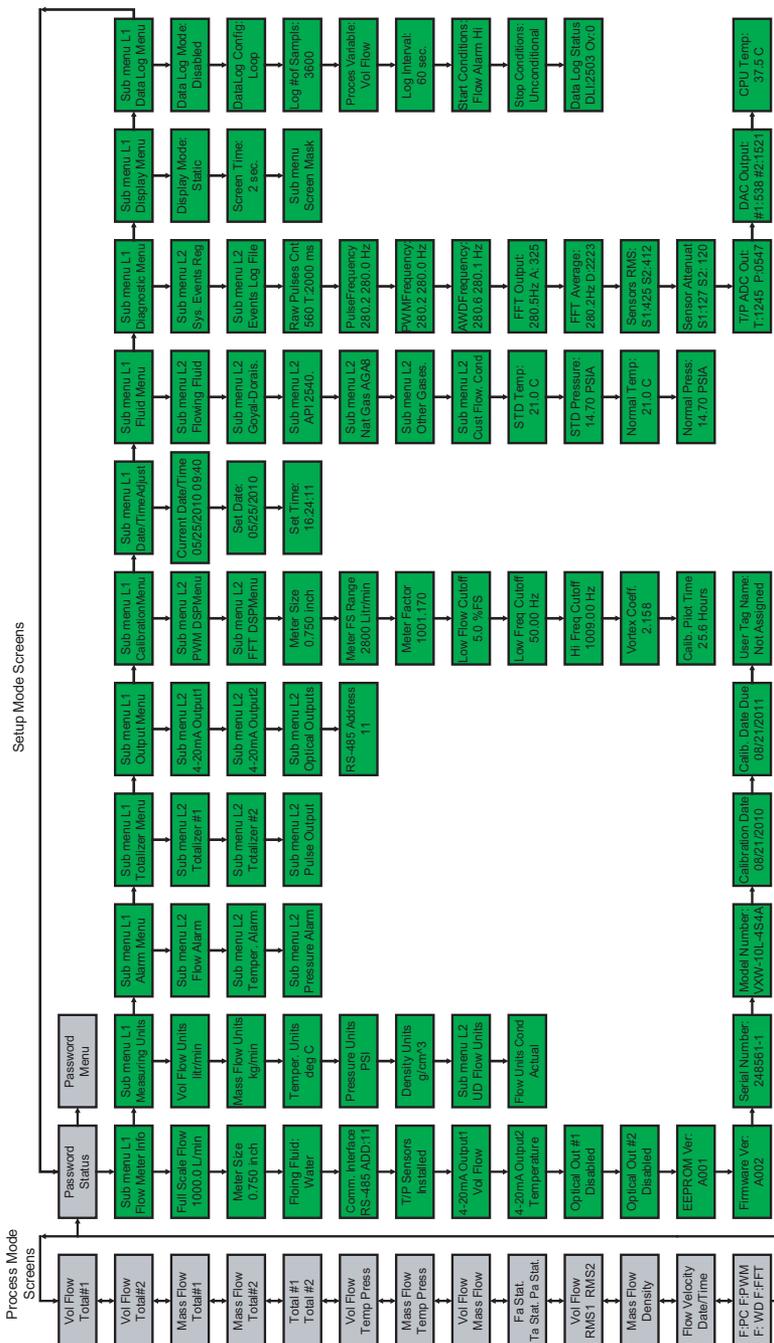


Figure 5.6 Setup Menu structure
SETUP MENUS



5.3 Parameter Entry

There are two methods of data entry:

- Direct numerical number entry.
- Tabular Input from a table menu.

If menu with direct numerical entry is selected use **Up** button to increment digit value from 0-9. Use **Dn** button to move cursor to another digit position. When desired value is entered use ENT button to accept (save in the EEPROM) new value.

If menu with tabular entry is selected, the available menu options can be set with the **Up** and **Dn** buttons and are accepted by pressing ENT button.



NOTE: During data entry the input values are checked for acceptability. If data is not acceptable, it is rejected and a message is generated indicating that the new data has not been accepted.

5.3.1 Submenu Program protection

After power has been turned on, programming parameters may only be changed by turning program protection “OFF”. There are two ways to turn off the program protection:

1. If program protection code (PP-code) is set to “0” (factory default), the program protection is turned off by pressing ENTER key.
2. If a PP-code (1 to 255) other than “0” has been entered, this code must be entered in order to turn the program protection “OFF”.

The PP-code can be changed after the program protection has been turned off.

Prog. Protection code -----

In order to protect device configuration parameters when changing the PP-code the old PP-code must be entered after ENTER has been pressed.

Old PP-code ? ----- 0

Press ENTER key after entry of old PP-code.



New PP-code ?

0

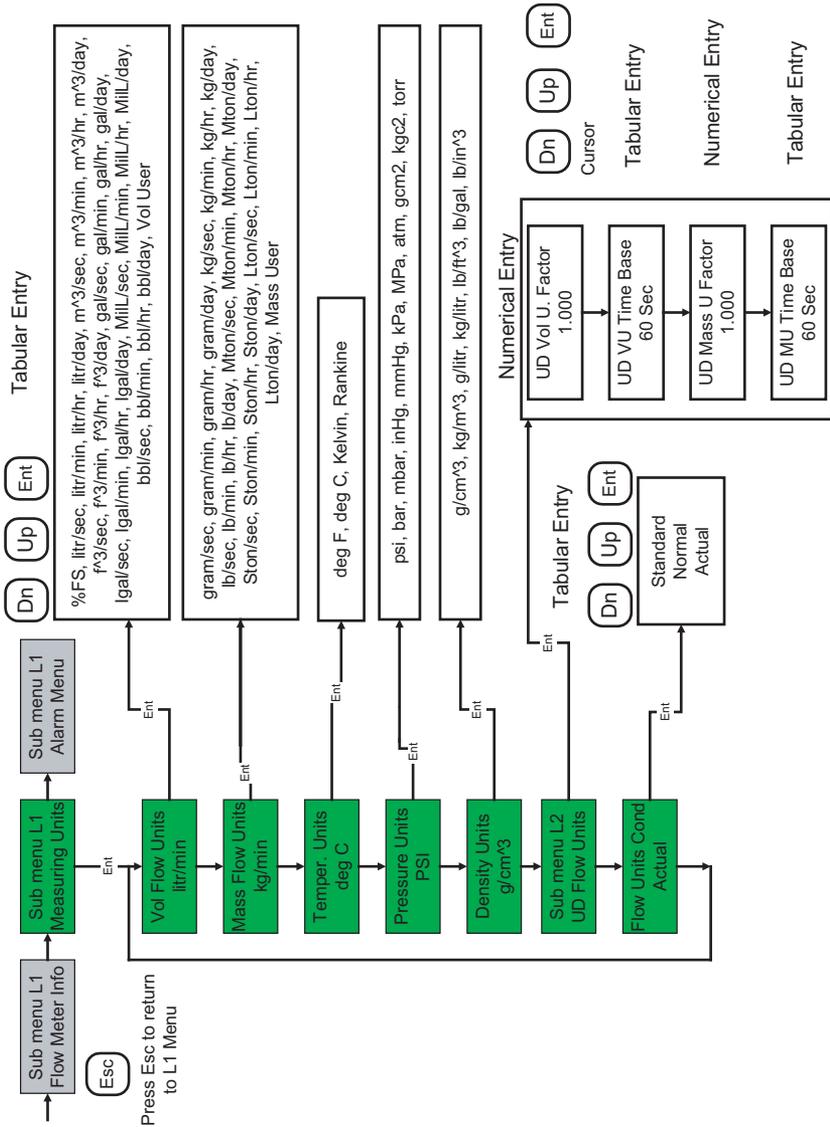
Now enter the new PP-code (0-255) and press ENTER key. The **new** PP-code is now valid to turn off the program protection. If the PP-code is forgotten, it can be restored only via digital communication interface.

5.3.2 Submenu Flow Meter Info

This submenu contains information about the meter main configuration parameters. These items are informational only, not password protected and may not be changed (read only).

5.3.3 Submenu Measuring Units

Figure 5.7 Submenu L1 Measuring Units structure.



Use the Measuring Units Menu to configure the flow meter with the desired units of measurement. These are global settings and determine what appears on all process information screens and data log records. Units should be selected to meet your particular metering needs.



NOTE: Program the Measuring Units first because later menus may be based on the units selected.

The instantaneous flow rate may be simultaneously displayed in Volumetric and Mass engineering units. In addition to conventional flow units user defined flow engineering units may be configured for Volumetric and Mass flow units. Before using Volumetric User defined flow unit make sure proper conversion factor of the new unit with respect to one liter is set (the default entry is 1.00 Liter). Before using Mass User defined flow unit make sure proper conversion factor of the new unit with respect to one gram is set (the default entry is 1.00 gram) Also proper time base values for both User Defined Units have to be set. The following selections are available: 1 second, 60 seconds (1 minute), 3600 seconds (1 Hour), 86400 seconds (1 Day). The default entry is 60 seconds.

The Volumetric flow rate for Gases may be shown with following units conditions: Standard, Normal, and Actual. The temperature and pressure for Standard and Normal conditions can be programmed in the Flowing Fluid menu (see Paragraph 5.3.9.1). By default Standard conditions are: 70°F and 14.7 PSIA, Normal conditions are 0 °C and 101.3 KPa.

For flow meters with T/P hardware installed the actual process temperature and pressure derived from corresponding sensors. For flow meters without T/P hardware the actual process temperature and pressure should be preset in the Flowing Fluid menu (see Paragraph 5.3.9.1).



NOTE: Your flow meter is pre-programmed at the factory for your application's process fluid and T/P conditions and does not require any reprogramming unless your process fluid or T/P conditions are changed.



NOTE: If Gas is selected as flowing fluid, when Standard Volumetric units are selected the prefix S will precede engineering units name on the PI screens (for example: Slitr/min). When Normal Volumetric units are selected the prefix N will precede engineering units name on the PI screens (for example: Nlitr/min). For Actual Volumetric units there will be no prefix in front of engineering unit name (for example: litr/min). Flow Units Conditions settings only applicable for Volumetric Flow units. For Liquids the Flow Units conditions are always Actual.

5.3.4 Submenu L1 Alarm Menu

5.3.4.1 Submenu L2 Flow Alarm

Vortex flow meter provides the user with a flexible alarm/warning system that monitors the Fluid Flow for conditions that fall outside configurable limits as well as visual feedback for the user via the LCD or via an optically isolated outputs. The flow alarm has several attributes which may be configured by the user via LCD/Keypad or digital communication interface. These attributes control the conditions which cause the alarm to occur and to specify actions to be taken when the flow rate is outside the specified conditions. Flow Alarm can be assigned to Volumetric or Mass Flow reading.

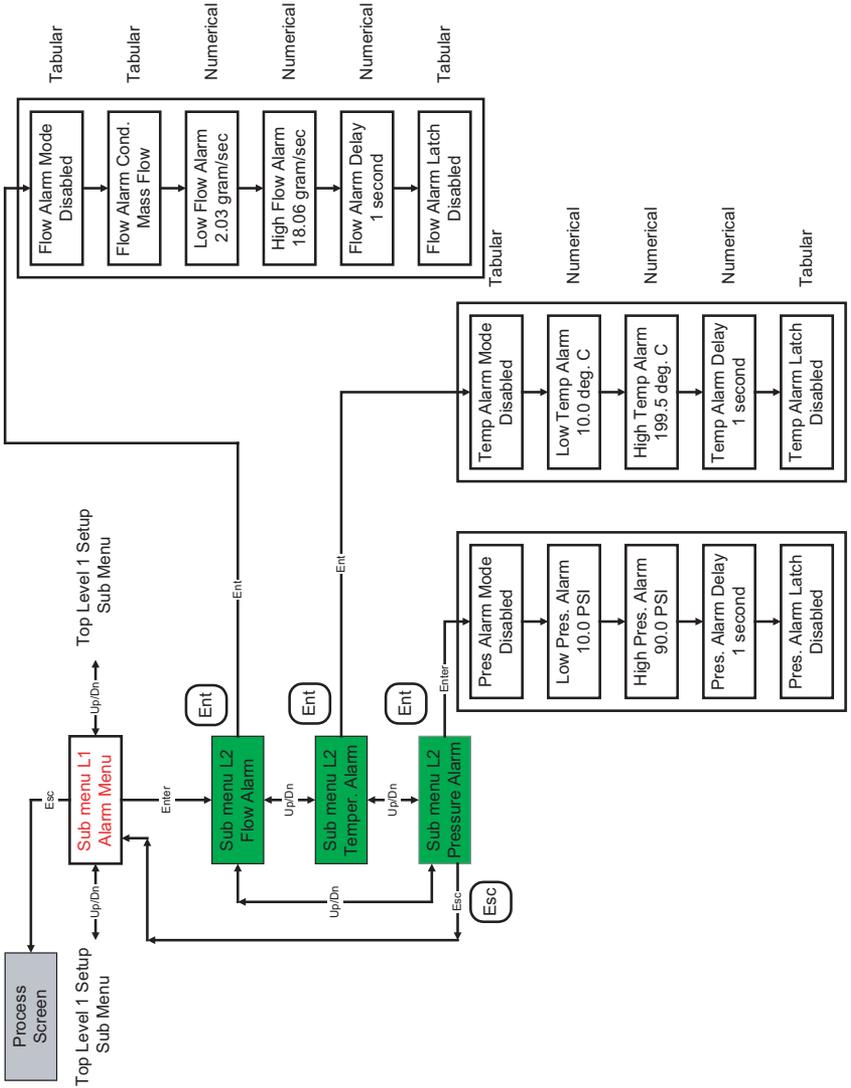
Flow Alarm conditions become true when the current flow reading is equal or higher/lower than corresponding values of high and low flow alarm levels. Alarm action can be assigned with preset delay interval (0-3600 seconds) to activate the optically isolated output (separate for High and Low alarm). Latch Mode control feature allows each optical output to be latched on or follow the corresponding alarm status.

Following settings are available for Flow Alarm (see Figure 5.8):

a) Flow Alarm Mode Tabular entry

This function determines whether Flow Alarm is Enabled or Disabled. The following selections are available: Enabled or Disabled. The default entry is Disabled. Alarm Mode selections can be set with the **Up** and **Dn** buttons and are accepted by pressing ENT button.

Figure 5.8 Submenu L1 Alarm Menu structure.



b) Flow Alarm Conditions Tabular entry

Flow Alarm can be assigned to Volumetric or Mass Flow reading.



NOTE: If Flow Alarm Conditions were changed, make sure to adjust Low and High Flow Alarm settings in corresponding flow Engineering Units.

c) Low Flow Alarm Numerical entry

The limit of required Low Flow Alarm value can be entered in increments of 0.1% from 0 - 100%F.S.



NOTE: Note: The value of the Low Flow Alarm must be less than the value of the High Flow Alarm.

If a Low Alarm occurs, and one of the two optical outputs is assigned to the Low Flow Alarm Event (see paragraph 5.3.5.2) the optically isolated output will be activated when the flow is less than the Low Flow Alarm value.

The Low Flow Alarm condition is also indicated on the corresponding Process Information Screen by displaying L character.

d) High Flow Alarm Numerical entry

The limit of required High Flow Alarm value can be entered in currently active Volumetric or Mass Flow units.



NOTE: The value of the High Flow Alarm must be more than the value of the Low Flow Alarm.

If a High Alarm occurs, and one of the two optical outputs is assigned to the High Flow Alarm Event (see Section 5.3.6.2) the optically isolated output will be activated when the flow is more than the High Flow Alarm value. The High Flow Alarm condition is also indicated on the corresponding Process Information Screen by displaying H character.

e) Flow Alarm Action Delay Numerical entry

The Flow Alarm Action Delay is a time in seconds that the Flow rate value must remain above the high limit or below the low limit before an alarm condition is indicated. Valid settings are in the range of 0 to 3600 seconds.

f) Flow Alarm Action Latch Tabular entry

The Flow Alarm Action Latch settings controls Latch feature when optically isolated outputs are assigned to Flow Alarm event. Following settings are available: Disable or Enabled.

By default, flow alarm is non-latching. That means the alarm is indicated only while the monitored flow value exceeds the specified set conditions. If

optically isolated output is assigned to the Flow Alarm event, in some cases, the Flow Alarm Latch feature may be desirable.

5.3.4.2 Submenu L2 Temperature Alarm (*optional)

Vortex flow meter with T/P option provides the user with a flexible alarm/warning system that monitors the Fluid Temperature for conditions that fall outside configurable limits as well as visual feedback for the user via the LCD or via an optically isolated outputs.

The temperature alarm has several attributes which may be configured by the user via LCD/Keypad or digital communication interface. These attributes control the conditions which cause the alarm to occur and to specify actions to be taken when the temperature value is outside the specified conditions.

Temperature Alarm conditions become true when the current temperature reading is equal or higher/lower than corresponding values of high and low temperature alarm levels. Alarm action can be assigned with preset delay interval (0-3600 seconds) to activate the optically isolated output (separate for High and Low alarm). Latch Mode control feature allows each optical output to be latched on or follow the corresponding alarm status.

Following settings are available for Temperature Alarm (see Figure 5.8):

a) Temperature Alarm Mode Tabular entry

This function determines whether Temperature Alarm is Enabled or Disabled. The following selections are available: Enabled or Disabled. The default entry is Disabled. Alarm Mode selections can be set with the **Up** and **Dn** buttons and are accepted by pressing ENT button.

b) Low Temperature Alarm Numerical entry

The limit of required Low Temperature Alarm value can be entered in currently active Temperature Engineering units.



NOTE: The value of the Low Temperature Alarm must be less than the value of the High Temperature Alarm.

If a Low Temperature Alarm occurs, and one of the two optical outputs is assigned to the Low Alarm Event (see Section 5.3.6.2) the optically isolated output will be activated when the process temperature is less than the Low Temperature Alarm value. The Low Temperature Alarm condition is also indicated on the corresponding Process Information Screen by displaying L character.

c) High Temperature Alarm Numerical entry

The limit of required High Temperature Alarm value can be entered in currently active Temperature Engineering units.



NOTE: The value of the High Temperature Alarm must be more than the value of the Low Temperature Alarm.

If a High Alarm occurs, and one of the two optical outputs is assigned to the High Alarm Event (see Section 5.3.6.2) the optically isolated output will be activated when the process Temperature is more than the High Temperature Alarm value.

The Temperature Alarm condition is also indicated on the corresponding Process Information Screen by displaying H character.

d) Temperature Alarm Action Delay Numerical entry

The Temperature Alarm Action Delay is a time in seconds that the Temperature reading value must remain above the high limit or below the low limit before an alarm condition is indicated. Valid settings are in the range of 0 to 3600 seconds.

e) Temperature Alarm Action Latch Tabular entry

The Temperature Alarm Action Latch settings controls Latch feature when optically isolated outputs are assigned to Temperature Alarm event. Following settings are available: Disable or Enabled.

By default, Temperature alarm is non-latching. That means the alarm is indicated only while the monitored Temperature value exceeds the specified set conditions. If optically isolated output is assigned to the Temperature Alarm event, in some cases, the Temperature Alarm Latch feature may be desirable.

5.3.4.3 Submenu L2 Pressure Alarm (*optional)

Vortex flow meter with T/P option provides the user with a flexible alarm/warning system that monitors the Fluid Pressure for conditions that fall outside configurable limits as well as visual feedback for the user via the LCD or via an optically isolated outputs.

The Pressure alarm has several attributes which may be configured by the user via LCD/Keypad or digital communication interface. These attributes control the conditions which cause the alarm to occur and to specify actions to be taken when the pressure value is outside the specified conditions. Pressure Alarm conditions become true when the current pressure reading is equal or higher/lower than

corresponding values of high and low pressure alarm levels. Alarm action can be assigned with preset delay interval (0-3600seconds) to activate the optically isolated output (separate for High and Low alarm). Latch Mode control feature allows each optical output to be latched on or follow the corresponding alarm status. Following settings are available for Pressure Alarm (see Figure 5.8):

a) Pressure Alarm Mode Tabular entry

This function determines whether Pressure Alarm is Enabled or Disabled. The following selections are available: Enabled or Disabled. The default entry is Disabled. Alarm Mode selections can be set with the **Up** and **Dn** buttons and are accepted by pressing ENT button.

b) Low Pressure Alarm Numerical entry

The limit of required Low Pressure Alarm value can be entered in currently active Pressure Engineering units.



NOTE: The value of the Low Pressure Alarm must be less than the value of the High Pressure Alarm.

If a Low Pressure Alarm occurs, and one of the two optical outputs is assigned to the Low Alarm Event (see paragraph 5.3.5.2) the optically isolated output will be activated when the process pressure is less than the Low Pressure Alarm value. The Low Pressure Alarm condition is also indicated on the corresponding Process Information Screen by displaying L character.

c) High Pressure Alarm Numerical entry

The limit of required High Pressure Alarm value can be entered in currently active Pressure Engineering units.



NOTE: The value of the High Pressure Alarm must be more than the value of the Low Pressure Alarm.

If a High Alarm occurs, and one of the two optical outputs is assigned to the High Alarm Event (see paragraph 5.3.5.2) the optically isolated output will be activated when the process Pressure is more than the High Pressure Alarm value. The Pressure Alarm condition is also indicated on the corresponding Process Information Screen by displaying H character.

d) Pressure Alarm Action Delay Numerical entry

The Pressure Alarm Action Delay is a time in seconds that the Pressure reading value must remain above the high limit or below the low limit

before an alarm condition is indicated. Valid settings are in the range of 0 to 3600 seconds.

e) Pressure Alarm Action Latch Tabular entry

The Pressure Alarm Action Latch settings controls Latch feature when optically isolated outputs are assigned to Pressure Alarm event. Following settings are available: Disable or Enabled.

By default, Pressure alarm is non-latching. That means the alarm is indicated only while the monitored Pressure value exceeds the specified set conditions. If optically isolated output is assigned to the Pressure Alarm event, in some cases, the Pressure Alarm Latch feature may be desirable.

5.3.5 Submenu L1 Totalizer Menu

5.3.5.1 Submenu L2 Totalizer#1 and Totalizer#2 Menus

Vortex flow meter provides the user with two independent Programmable Flow Totalizers. Each Totalizer can be configured for Volumetric or Mass flow.

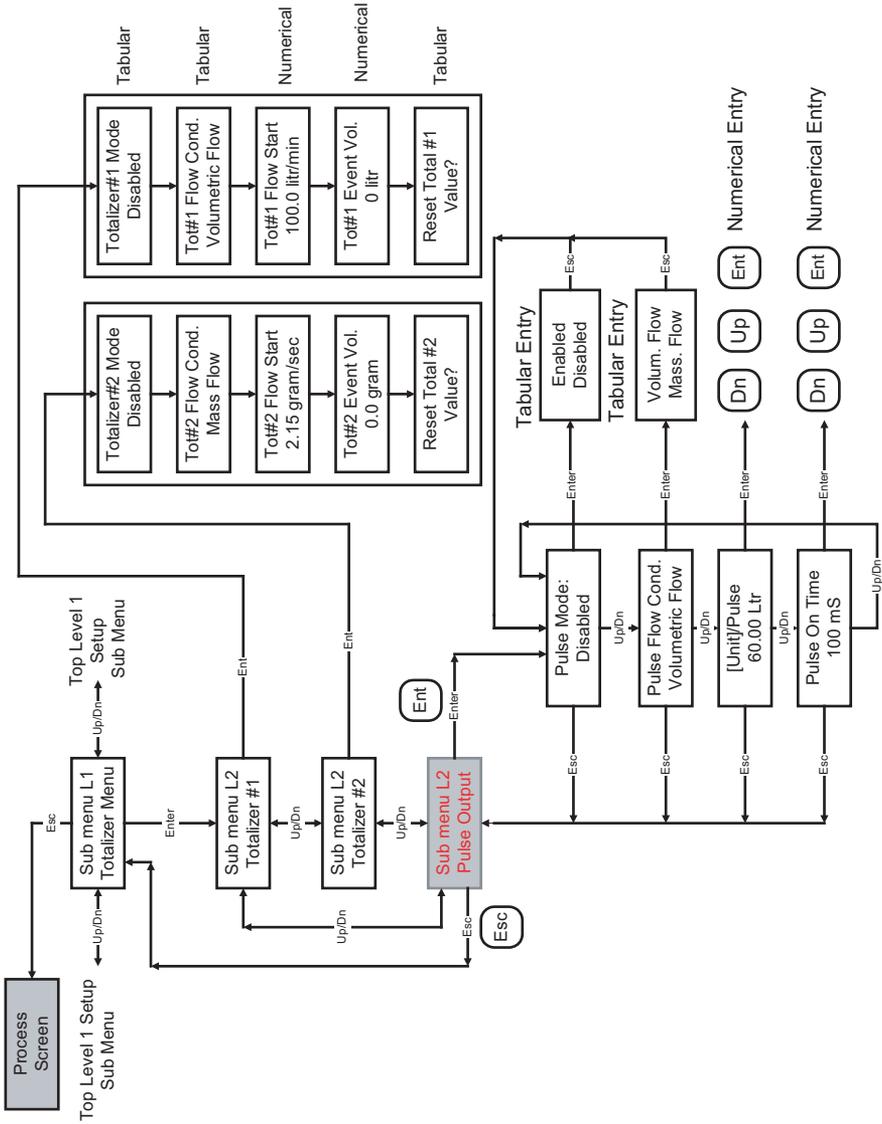
The total volume of the flowing fluid is calculated by integrating the actual instantaneous fluid flow rate with respect to time. The Totalizers value are stored in the Battery Backed RAM and saved every 1 second. In case of power interruption the last saved Totalizers values will be loaded on the next power on cycle, so Totalizers reading will not be lost. The LCD/keypad and digital communication interface commands are provided to:

- Enable/Disable totalizing the flow
- configure totalizer to Volumetric or Mass flow process variable
- start the totalizer at a preset flow rate (in current Vol. or Mass flow units)
- assign action at a preset total volume (Event Volume)
- reset the totalizer to ZERO



NOTE: Before enabling the Totalizer, ensure that all totalizer settings are configured properly. Totalizer Start values have to be entered in currently active Volumetric or Mass flow engineering unit. The Totalizer will not totalize until the process flow rate becomes equal to or more than the Totalizer Start value. Totalizer Event values must be entered in currently active volume or mass based engineering units. If the Totalizer Event at preset total volume feature is not required, then set Totalizer Event value to zero (default settings).

Figure 5.9 Submenu L1 Totalizer Menu structure.



The Totalizers reading can be reset by pressing ENTER button. A typical display with flow meter Totalizer#1 Reset screen is shown below.

Reset Total #1
Value?

The next conformation screen will appear only for 2 seconds.

Press Ent key to
reset Totalizer!

If during these two seconds user will press ENTER button again, the Totalizer#1 volume will be reset to zero. Following screen will appear for two seconds

Press Ent key to
The Totalizer has been reset!

5.3.5.2 Submenu L2 Pulse Output Menu

The flow Pulse Output is operating independently from totalizers and based on configuration settings (see Figure 5.9) can provide pulse frequency proportional to instantaneous fluid flow rate.

The LCD/keypad and digital communication interface commands are provided to:

- Enable/Disable Pulse Output
- configure Pulse Output for Volumetric or Mass flow process variable
- configure the Unit/Pulse value (in current Vol. or Mass flow units)
- configure Pulse Active On Time (50 - 13000 ms)



NOTE: The Pulse Output minimum Active On time is a 50 millisecond (.05 second). The Optical Pulse Output cannot operate faster than one pulse every 100 millisecond (.1 second). A good rule to follow is to set the Unit/Pulse value equal to the maximum flow in the same units per second. This will limit the pulse rate to no faster than one pulse every second.

For example: Maximum flow rate = 1200 kg/min

(1200 kg/min = 20 kg/sec)

If unit per pulse is set to 1200 kg per pulse, the Optical Pulse Output will pulse once every minute.

If unit per pulse is set to 20 kg per pulse, the Optical Pulse Output will pulse once every second.

The Optically isolated Pulse Output incorporate Pulse output queue, which accumulate pulses if the Pulse Output is accumulating process flow faster than the pulse output hardware can function. The queue will allow the pulses to “catch up” later if the flow rate decreases. A better practice is to slow down the Pulse Output by increasing the value in the Unit/Pulse setting in the Pulse Output menu (see Figure 5.9).

5.3.6.1 Submenu L2 Analog 4-20mA Menus

Vortex Flow Meters are equipped with two channels programmable analog 4-20 mA outputs. Each channel can be individually assigned to one of the following process variables: Volumetric Flow, Mass Flow, Temperature*, Pressure*. By default channel #1 is set to Volumetric Flow and channel #2 is set for Mass flow. For each channel 4 mA and 20 mA points, which define the flow meter output range, can be preset to maximize resolution of analog output. The meter is most accurate when operated within the expected flow ranges for your application. Setting the range to the limits of expected readings will maximize flow meter performance.



NOTE: Your Vortex Flow Meter was calibrated at the factory for the specified fluid and full scale flow range: 4mA – 0%F.S. and 20mA – 100%F.S. (see device’s label or calibration data sheet). There is no need to adjust the Flow Meter 4-20 mA range limits settings, unless adjustment for specific range is needed.

When adjusting 4-20mA limits, the value of the limits have to be entered in currently selected (global) for particular process variable engineering units.

5.3.6.2 Submenu L2 Digital Optical Outputs Menus

Two sets of optically isolated digital outputs are provided to actuate user supplied equipment. These are programmable via digital interface or LCD/Keypad such that the outputs can be made to switch when a specified event occurs (e.g. when a low or high flow alarm limit is exceeded or when the totalizer reaches a specified value) or may be directly controlled by user.

The user can configure each optical output action from 14 different options:

- Disabled: No Action (output is not assigned to any events and not energized)
- Low Flow Alarm
- High Flow Alarm
- Range between H&L Flow alarm settings
- Totalizer #1 reading exceed set limit
- Totalizer #2 reading exceed set limit
- Low Temperature alarm (*T/P option only)
- High Temperature alarm (*T/P option only)
- Range between High and Low Temperature alarm (*T/P option only)
- Low Pressure alarm (*T/P option only)
- High Pressure alarm (*T/P option only)
- Range between High and Low Pressure alarm (*T/P option only)

- Diagnostic: Output will be energized when any of the Diagnostic or System events are active
- Manual On Control: Output will be energized until Disabled option will be selected.

By default both optically isolated outputs are disabled.

5.3.6.3 Submenu L2 RS-485 Address Menus

The standard Vortex flow meter comes with an RS-232 interface. For the optional RS-485 interface, two hexadecimal characters of the address must be assigned. By default each flow meter is shipped with RS-485 address 11. When more than one device is present on RS-485 bus each device should have unique address. The two characters of address in the hexadecimal representation can be changed from 00 to FF.



NOTE: Address 00 is reserved for global addressing. Do not assign, the global address for any device. When command with global address is sent, all devices on the RS-485 bus execute the command but do not reply with an acknowledge message.



NOTE: Do not assign the RS-485 address for two or more devices on the same RS-485 bus. If two or more devices with the same address are connected to the one RS-485 network, a communication collision will take place on the bus and communication errors will occur.

RS-485 address setting is not used for Vortex flow meter with RS-232 interface.

5.3.7 Submenu L1 Calibration Menu

The Calibration Menu contains the calibration coefficients for the flow meter, DSP algorithm settings and Noise Reduction Filters parameters. These values should be changed only by properly trained personnel. The Pipe ID, Vortex Meter Calibration Factor, Full Scale Range and Low Flow Cutoff are set at the factory. Consult the factory for help with these settings if the meter is showing erratic flow rate.



NOTE: Your Vortex Flow Meter was calibrated configured at the factory for the specified fluid, flowing conditions, and full scale flow range (see device's label or calibration data sheet). There is no need to adjust the Flow Meter calibration factor, unless adjustment for specific installation or flowing conditions high or low frequency off is needed. Any alteration of the flow meter calibration factor will VOID calibration warranty supplied with instrument.

5.3.7.1 Submenu L2 PWM DSP Menu

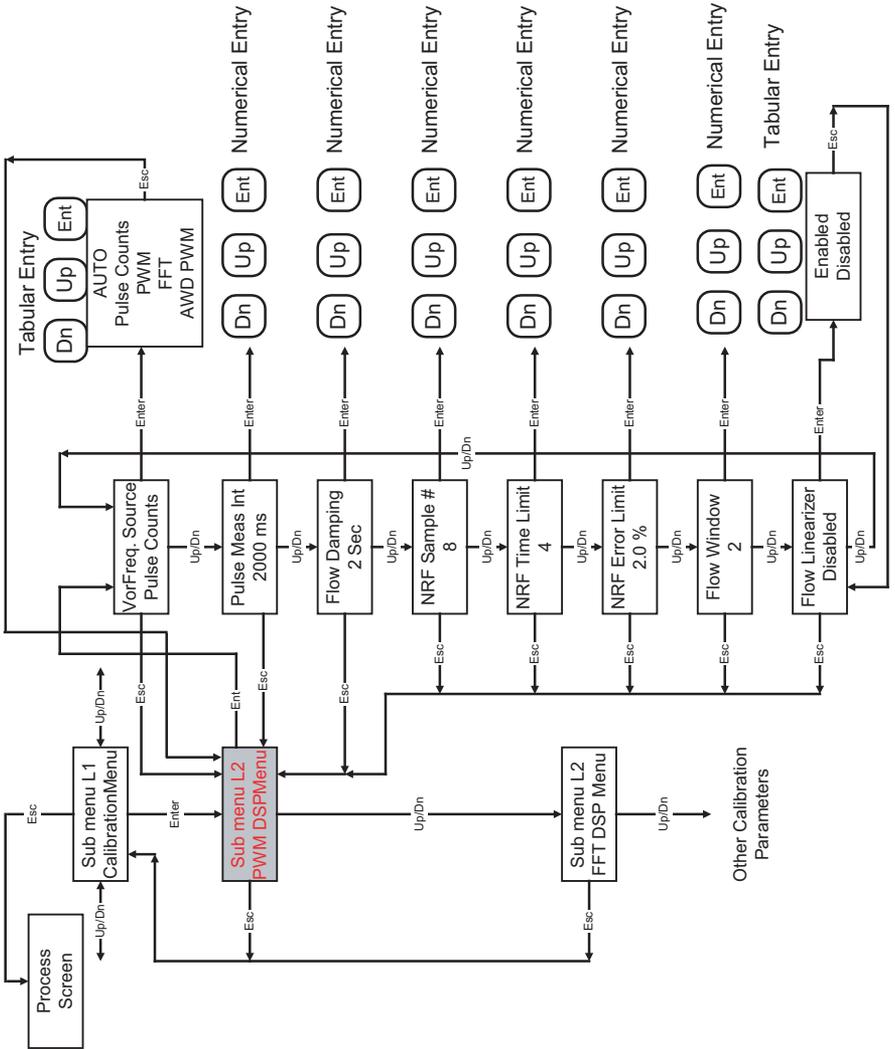
Digital Signal Processing software algorithm can be set to calculate flow rate based on five different methods:

- a) Auto
- b) number of pulses over preset measure interval
- c) PWM (pulse width measurement)
- d) FFT
- e) AWD (Analog Watchdog circuitry, for troubleshooting only)

By default Vortex Frequency source is set to Auto. In this mode flow meter automatically switching source to best suited algorithm.

All methods calculates frequency of the pulses from the flow meter sensor. The number of pulses over preset measure interval method convenient when pulsating flow or especially noisy signals are encountered. This method allows to get stable average flow rate if pulse measure interval is set to values equal or more than 2000 ms. This parameters effects the flow update rate. With higher value of the pulse measure interval, the and stability of the flow measurement improves, but response time become longer. A suggested pulse measure interval value of 2000 seconds is a good starting point for most applicable process fluids. With lower settings the response time of the meter will be shorter, but and stability will degrade. The pulse measure interval settings are only related to the number of pulses over preset measure interval method. Pulse measure interval can be selected between 500 and 60000 ms.

Figure 5.11 Submenu L2 PWM DSP Menu structure.



The **Flow Damping** value can be selected between 0 and 99 seconds. The value represents the response time for a 0 - 66 % step flow rate change. When damping value set to 0 it is disabled.

A **Noise Reduction Filter** algorithm (running average of the individual flow inputs) is available in the flow meter when pulsating flow or especially noisy signals are encountered.

There are three parameters that make up **Signal Processing Control**:

- Number of Samples
- Time Limit
- Error Limit

They are described individually below.

Number of Samples [NRF]: The sample number value can be selected between 1 and 32. The number of samples value represents the number of previous individual inputs used to calculate the average value. Eventually the number of samples in the running average also affects the response time. The more samples is used, the more inertial flow output reading will be to the actual flow change. A suggested nominal number of 16 samples is a good starting point for most applicable process fluids.

Time Limit: can be selected between 0 and 99 seconds. The value represents the response time of the running average flow rate change. The higher the Time Limit the longer the response time of the filter. If noise reduction filter is not desired it may be disabled by setting Time Limit parameter to zero. By default unit shipped from the factory with Time Limit value set to 6.

Error Limit: can be selected between 0.0 and 100.0 % of full scale. The value represents the difference of the signal sample from previous measured value. Error Limit is configured to reject noise spikes within the flow range while allowing normal frequency variation of the vortex signal. The factory setting 2.0% of full scale optimizes noise rejection in most applications.



NOTE: NRF settings only applicable to PWM algorithm.

The **Turbulence Flow Window** parameter is used to define turbulence conditions. The value represents the difference between two consecutive measurements in % of full scale. If the difference between two consecutive measurements will be higher than value set for **Turbulence Flow Window** parameter, the Turbulence Event will be triggered. Default settings are 30.

The **Flow Linearization** algorithm may be used to improve linearity of the flow measurement. The Flow Linearization table is built during factory calibration procedure and stored in the device EEPROM. The Flow Linearizer can be used with all flow measurement algorithms. By default unit shipped from the factory with disabled Flow Linearizer.

5.3.7.2 Submenu L2 FFT DSP Menu

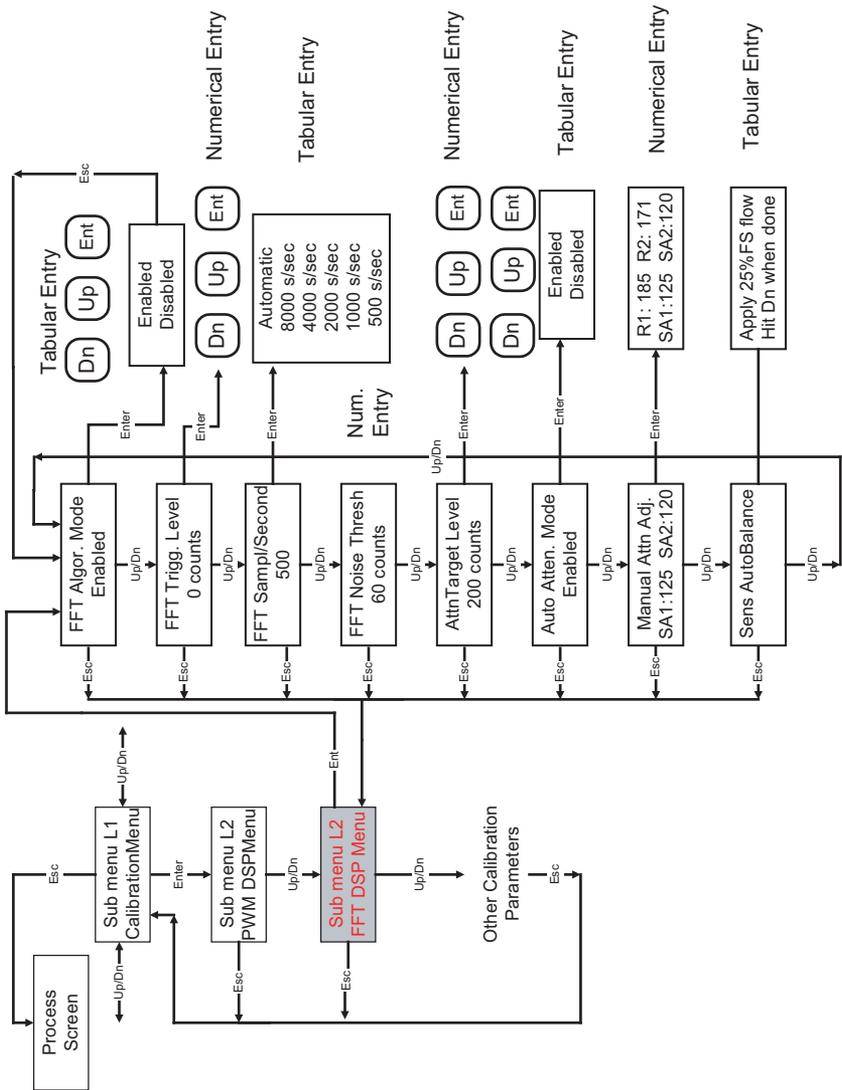


NOTE: Do not adjust FFT DSP parameter unless directed to do so by a AALBORG Technical Support Representative.

FFT Trigger Level is used to define lowest amplitude of the harmonic to be considered as valid vortex signal. When set to zero the FFT Trigger Level will be determine automatically as $\frac{1}{4}$ of the signal amplitude.

FFT Sample/Second defines the number of samples per second for Analog to Digital Converter (ADC) taken from a continuous analog signal to make a discreet signal. This is tabular entry. When set to **Automatic** mode, the sample rate will be switched automatically to keep best resolutions (default settings).

Figure 5.12 Submenu L2 FFT DSP Menu structure.



FFT Noise Threshold is configured to reject noise within the flow range while allowing normal amplitude variation of the vortex signal. Signals of amplitude lower than the Trigger Level setting are filtered out. The factory setting optimizes noise rejection in most applications.

Attenuator Target Level defines the target RMS level for the sensor signals. If Auto Attenuation is enabled the DSP algorithm will constantly adjust attenuation to keep sensors RMS output within Attenuator Target Level value. Default factory setting value (200) works for most applications.

Manual Attenuation Adjustment allows you to manually adjust the sensors RMS output individually for each sensor. This feature mostly useful only for troubleshooting procedure.



NOTE: Manual Attenuation Adjustment will work properly only when Auto Attenuation is disabled.

Sensor Auto Balancing procedure designed to automatically balance sensors RMS output.



NOTE: Your Vortex Flow Meter sensors were adjusted at the factory for the best balance. There is no need to perform Auto Balancing procedure, unless new sensors are installed or PCB electronics is replaced. Any alteration of the flow meter sensor balancing settings will VOID calibration warranty supplied with instrument. Do not adjust FFT DSP parameter unless directed to do so by an AALBORG Technical Support Representative.

5.3.7.3 Submenu Meter Size

The Meter Size or pipe I/D (for insertion type) is preset at the factory and should not be changed unless meter body or PCB electronics are replaced or meter is being installed in to the pipe with different internal diameter for insertion flow meter.

5.3.7.4 Submenu Meter Full Scale Range

The Meter Full Scale Range in Litr/min is preset at the factory and should not be changed unless meter body or PCB electronics are replaced or meter is reconfigured for different application.



NOTE: Do not adjust Meter Full Scale Range parameter unless directed to do so by an AALBORG Technical Support Representative.

5.3.7.5 Submenu Meter Calibration Factor

The Meter Calibration Factor is preset at the factory for the given process conditions (at STD temperature, and pressure), meter body size / pipe ID and requested full scale range. It should only be changed if you replace parts of the flow meter or your process conditions installation parameters or full scale flow rate are changed. Contact your Aalborg representative for details.

5.3.7.6 Submenu Meter Low Flow Cut Off

The low flow cut-off can be selected between 0.0 and 10.0 % of the full scale range. Flows less than the cut-off value are internally driven to zero and not totalized. The analog 4-20mA outputs if assigned to flow rate are set to 4.00 mA. The switching threshold for the low flow cut-off has 1.0 %F.S. hysteresis.

5.3.7.7 Submenu Meter Low Frequency Cut Off

Low Frequency Cut Off value in Hz is preset at the factory and should not be changed. Adjustments may be required only if you are experiencing problems. Contact your Aalborg representative for details.

5.3.7.8 Submenu Meter High Frequency Cut Off

High Frequency Cut Off value in Hz is preset at the factory and should not be changed. Adjustments may be required only if you are experiencing problems. Contact your Aalborg representative for details.

5.3.7.9 Submenu Meter Vortex DSP Filter Coefficient

Vortex DSP Filter Coefficient is used for internal DSP algorithm and related to signal strength, density, and velocity for a given application. Adjustments may be required only if you are experiencing problems. Contact your Aalborg representative for details.

5.3.7.10 Submenu Meter Calibration Pilot Timer

The Pilot Calibration timer accumulates operational hours since last time unit was calibrated. The value of the timer may be reset by the user by pressing ENTER button. Once ENTER button is pressed the next conformation screen will appear only for 2 seconds. If during these two seconds user will press ENTER button again, the Calibration Timer value will be reset to zero.

5.3.8 Submenu L1 Date/Time Adjust Menu

Use the Time and Date Menu to enter the correct time and date into the flow meter's memory. The parameters are used in the PI Mode, Data Log and the alarm and system Log files. Note: Time is displayed and can be set only in military format. For example, 2:00 PM has to be entered as 14:00:00 in the Set Time menu.



NOTE: The Date and Time settings are stored in battery backed SRAM. If Lithium 3Vdc battery is removed, or CPU board is disconnected from Terminal board, the Date and Time settings will be reset to zero. For correct operation of Data Log and System Events Log features the correct date and time have to be entered.

5.3.9 Submenu L1 Fluid Menu

Use the Fluid Menu to configure the flow meter for use with common gases, liquids and steam or change temperature and pressure parameters for Standard, Normal and Actual units. Your flow meter is pre-programmed at the factory for your application's process fluid, and flowing temperature/pressure conditions.

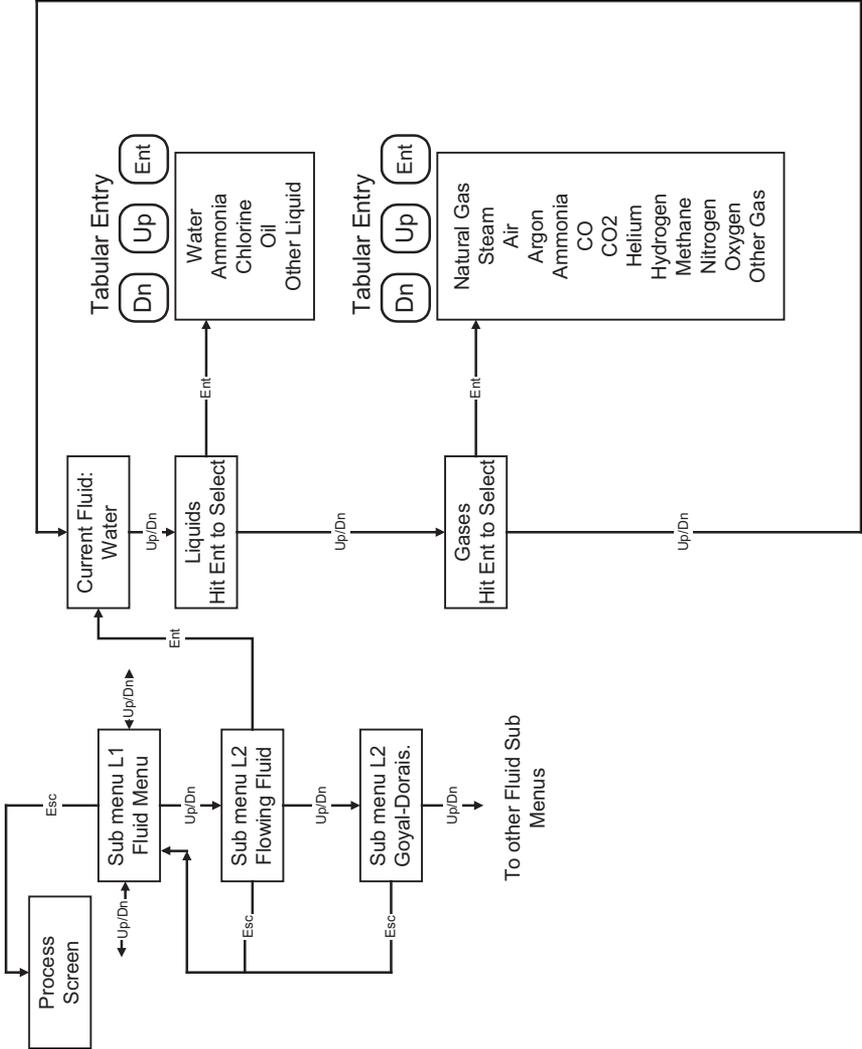


NOTE: Your Vortex Flow Meter was calibrated at the factory for your application's process fluid and flowing conditions (see device's label or calibration data sheet). There is no need to adjust the Fluid parameters unless other fluid type, flowing conditions or temperature and pressure settings for Standard/Normal units are needed. Any alteration of the flow meter fluid parameters will VOID calibration warranty supplied with instrument affect accuracy of the process variable.

5.3.9.1 Submenu L2 Flowing Fluid Menu

Your flow meter is pre-programmed at the factory for your application's process fluid. If different fluid is required it can be set, using Flowing Fluid menu.

Figure 5.13 Submenu L2 Flowing Fluid Menu structure.



Changing of the flowing fluid settings will affect the way how flow meter calculates fluid **Density** and therefore will affect Mass flow rate reading. For 3 liquids: **Water, Ammonia and Chlorine** and for 10 real gases: **Air, Argon, Ammonia, CO, CO₂, Helium, Hydrogen, Methane, Nitrogen, Oxygen** all parameters required for density calculation are preprogrammed at the factory and stored in flow meter ROM memory. When listed above fluids are selected, there is no need to enter or change any additional parameters, meter will calculate Density and Mass flow rate automatically based on actual (temperature and pressure) flowing conditions.



NOTE: For flow meters equipped with optional T/P hardware the temperature and pressure measurements are taken from temperature and pressure transducers. If flow meter is not equipped with optional T/P transducers the actual flowing Temperature and Pressure have to be entered using Sub Menu L2 “Actual Flowing Conditions” (see paragraph 5.3.9.6).



NOTE: Before selecting “Other Liquid” menu selection make sure correct parameters required for fluid density calculation are entered in Sub Menu L2 Goyal-Doraiswamy (see paragraph 5.3.9.2).



NOTE: Before selecting “Oil” menu selection make sure correct parameters required for fluid density calculation are entered in Sub Menu L2 API 2540 (see paragraph 5.3.9.3).



NOTE: If “Natural Gas” or “Other Gas” menu selection has to be made, make sure correct parameters required for fluid density calculation are entered in Sub Menu Nat Gas AGA8 or Sub Menu Other Gas correspondingly (see paragraphs 5.3.9.4 and 5.3.9.5).

5.3.9.2 Submenu L2 Goyal-Doraiswamy Menu

If “**Other Liquid**” is selected as flowing fluid the flow meter is using Goyal-Doraiswamy equation for fluid density calculation. Following parameters related to flowing liquid have to be entered:

Molecular Weight	(Lb/LbMol)
Critical Pressure	(PSIA)
Critical Temperature	(deg. R)
Critical Compressibility Factor	(no units)

See Richard W. Miller, *Flow Measurement Engineering Handbook (Second Edition, 1989)*, page 2-67 for definition and use of the Goyal-Doraiswamy equation.

5.3.9.3 Submenu L2 API 2540 Menu

If “Oil” is selected as flowing fluid the flow meter is using **API 2540** equation for fluid density calculation. Following parameters related to flowing Oil have to be entered:

Oil Density @ 60 °F	(kg/m ³)
Constant K0	(no units)
Constant K1	(no units)

See Richard W. Miller, *Flow Measurement Engineering Handbook (Second Edition, 1989)*, page 2-76 for definition and use of the **API 2540** equation.



NOTE: If “Oil” was not selected at factory as your process flowing fluid the default settings for API 2540 equation are made for Crude oils and JP4 as following:

Oil Density @ 60 °F	898.0 kg/m ³
Constant K0	341.0957
Constant K1	0.0

5.3.9.4 Submenu Nat Gas AGA8 Menu

If “**Natural Gas**” is selected as flowing fluid the following parameters related to flowing Natural Gas have to be entered:

AGA Density Mode density calculation algorithm can use different input data based on available by user parameters. User can make one of the following selections (tabular entry):

- use density of Natural Gas @ reference Temperature and Pressure (Lb/Ft³) provided by gas supplier
- use relative density “Gr” of Natural Gas @ reference Temperature and Pressure (real specific gravity)

Manufacture Density density of Natural Gas @ reference Temperature and Pressure (Lb/Ft³) provided by gas supplier

Relative Density relative density “Gr” of Natural Gas @ reference Temperature and Pressure (real specific gravity)

Molecular Fracture of N2 (no units)

Molecular Fracture of CO2 (no units)

Reference Temperature reference Temperature for manufacture or relative density (deg. F)

Reference Pressure reference Pressure for manufacture or relative density (PSIA)

5.3.9.5 Submenu Other Gases Menu

If “**Other Gas**” is selected as flowing fluid the following parameters related to flowing Gas have to be entered:

Specific Gravity Mode density calculation algorithm can use different specific gravity data based on available by user parameters. User can make one of the following selections (tabular entry):

- use specific gravity as ratio of molecular weight “G” [(g/mol)/(g/mol)] and compressibility factor Z @ actual flowing temperature and pressure
- use real specific gravity as ratio of densities @ actual flowing temperature and pressure $Gr = \frac{(Gas)}{(Air)}$

al
(Air)

Mol Weight Ratio	Specific Gravity as ratio of molecular weight G = $Mw(\text{gas})/Mw(\text{air})[(g/mol)/(g/mol)]$ (numerical entry)
Density Ratio	Real specific Gravity as density ratio Gr = (Gas)/(Air) _@ actual flowing temperature and pressure (numerical entry)
Compress. Z @ TP ture	Compressibility factor Z @ actual flowing temperature and pressure (numerical entry)
Other Mol Weight	Molecular Weight of Gas Mw (Lb/Lb mol) (numerical entry)
Critical Temp (F)	Critical Temperature of the Gas (deg. F) (numerical entry)
Crit. Press PSIA	Critical Pressure of the Gas (PSI) (numerical entry)

5.3.9.6 Submenu Cust Flow. Cond Menu



NOTE: Your flow meter is pre-programmed at the factory for your application's process flowing temperature and pressure (see device's label or calibration data sheet). There is no need to adjust Customer Flowing Conditions settings, unless application's flowing temperature or pressure are changed.

Actual customer Flowing Conditions Menu includes following parameters:

Cust STD Density (for factory settings only) Density of the flowing fluid at standard temperature and pressure (g/cm^3). This static parameter is used only for internal volumetric and mass flow units conversion and is not related to dynamic Density calculated by Vortex flow meter.



NOTE: Changing Cust STD Density parameter will affect settings for Flow Alarm settings, Totalizer start flow and 4-20mA output limits (if mass flow is selected as process variable).

Cust. Temp (F) customer application actual flowing temperature (deg. F)

Cust. Press (PSIA) customer application actual flowing pressure (PSIA)



NOTE: For flow meters equipped with optional T/P hardware the temperature and pressure measurements are taken from temperature and pressure transducers. If flow meter is not equipped with optional T/P transducers the actual flowing Temperature and Pressure have to be entered in the “Cust. Temp (F)” and “Cust. Temp (F) Pressure (PSI)” menus.



NOTE: The Vortex Flow meter allows you to measure Standard, Normal or Actual Flow Units. Actual Temperature and Pressure Flowing Conditions equal to the Actual Flow Units Temperature and Pressure parameters.

5.3.9.7 Submenu STD Temp. (F)

Defines Standard Flow Units Temperature in deg. F. By default Standard Flow Units temperature is set to 70 °F.

5.3.9.8 Submenu STD Pres. (PSIA)

Defines Standard Flow Units Pressure in PSIA. By default Standard Flow Units pressure is set to 14.7 PSIA.



NOTE: The Vortex Calibration Factor is calculated and entered for Standard conditions (70 °F and 14.7 PSIA). Consult the factory or your local representative for new Vortex Calibration Factor if standard temperature or pressure conditions flow range has to be changed.

5.3.9.9 Submenu NORM Temp. (C)

Defines Normal Flow Units Temperature in deg. C. By default Normal Flow Units temperature is set to 0 °C.

5.3.9.10 Submenu NORM Pres. (KPA)

Defines Normal Flow Units Pressure in KPa. By default Normal Flow Units pressure is set to 101.3 KPa.

5.3.10 Submenu L1 Diagnostic Menu

Diagnostics Menu can be used for troubleshooting purposes and provides information about the meter internal variables. These items (except System Events Reg. and SysEvent LogFile submenus) are informational only and may not be changed (read only).

Vortex Flow Meters are equipped with a self-diagnostic alarm Event Register which is available via digital interface and on screen LCD indication.

The following diagnostic events are supported:

Table 5.1

Event Number	Diagnostic Alarm Event Description	LCD bit Code
1	CPU Temperature too High	0
2	Vortex Frequency above High Frequency Cut Off	1
3	High Flow Alarm	2
4	Low Flow Alarm	3
5	High Fluid Temperature Alarm*	4
6	Low Fluid Temperature Alarm*	5
7	High Fluid Pressure Alarm*	6
8	Low Fluid Pressure Alarm*	7
9	Totalizer#1 exceed set event volume limit	8
10	Totalizer#2 exceed set event volume limit	9
11	Optical Pulse Output Queue overflow	A
12	Flow Turbulence	B
13	Flow rate below Low Flow Cut Off setting	C
14	Event Log File overflow	D
15	Data Log overflow	E
16	One or more of the 8 System Log Events was registered	F



NOTE: Any Alarm events that may have occurred (Event 0 to Event F) are stored in the internal register. All detected events remain stored until the register is manually reset (by pressing ENTER key or by means of the digital communication interface). The Alarm Event Register is mapped to the SRAM (volatile memory). In case of power interruption the Event Register will be automatically reset.

a) Event Register Status

Each alarm event has fixed designated position on the LCD screen. Most significant event code (F) is set on the right side of the LCD and least significant event code (0) is set on the left side of the LCD. If event is not present (not active) it is represented on the LCD as dot (.) character. If event is present (or was detected in the past) it is represented on the LCD with corresponding character. A typical display with Alarm Events Register Status without any detected events is shown below.

Event Reg Status
.....

In the example shown below, event 1 with LCD bit code 2 (High Flow Alarm) and event 10 with LCD bit code A (Totalizer#2 exceed set event volume limit) have occurred since the last reset.

Event Reg Status
.. 2 A

 **NOTE:** Each Alarm Event can be individually masked (disabled) using Event Reg Mask menu selection (see Figure 5.14). If alarm event is masked (disabled) it will not be registered in the Event Register Status even actual event has occurred.

In order to reset (clear) Event Register press Ent button. Following screen will appear just for two seconds.

Press Ent key to
Clear events Reg

If during these two seconds user will press Ent button again, the Alarm Event Register will be cleared.

b) Alarm Events List

This menu selection provides list of the descriptions and corresponding LCD bit code for all supported events.

Events List
Press Enter Key

If ENTER is pressed again, the description for each error is displayed:

Events List
0-CPU Temp. High

The shown above Event List selections can be scrolled with the **Up** and **Dn** buttons. By pressing ENT or Esc buttons user may exit from scrolling mode.

c) Alarm Events Register Mask

With this menu selection user may individually mask (disable) any Alarm Event. A typical display with Alarm Events Register Mask selection is shown below.

Events List
0-CPU Temp. High

In the example shown above, event 2 with LCD bit code 1 (Vortex Frequency above High Frequency Cut Off) is masked with asterisk. In order to change event mask settings user should press Ent button. The flashing cursor will appear on the left of the LCD screen (on the 0 event position). Use **Dn** [Cursor] button to move to desired event code. Use **Up** button to change mask status (asterisk represent masked event). Use Ent button to accept and save new mask settings in flow meter's non volatile memory.

Vortex Flow Meters are equipped with programmable Event Log File feature which is available via digital interface and LCD/KeyPad. The Event Log File menu allows user assign any of 24 different System and Alarm Events to be recorded with Date/Time stamp in to flow meter non volatile memory.



NOTE: Each Alarm Event can be individually masked (disabled) using Event Log Mask menu selection (see Figure 5.15). If alarm event is masked (disabled) it will not be recorded in to the Event Log File, even actual event has occurred. System Events (see table 5.x) can not be masked therefore will be always recorded in to the Event Log File.

System Event List (unmaskable)

Table 5.2

Event Number	System Event Description
16	PEZO SENS. FAULT
17	TEMP SENS. FAULT*
18	PRES SENS. FAULT*
19	SERIAL COMM. ERROR
20	EEPROM ACCESS ERROR
21	BATTERY FAILURE
22	POWER ON EVENT
23	PASSWORD EVENT
24	FATAL ERROR

Event Log file can store total up to 511 records. Each record includes date/time stamp and event code (see Tables 5.1 and 5.2). If event is not masked in the Event Mask Register, when actual Event occurred, the record will be made in the Log file and corresponding bit in the internal flag register will be updated (set). The second record of the same Event code may occur only if corresponding Event bit was reset in the flag register (for example if Low Flow Alarm conditions was activated and flow rate increased above Low Flow Alarm threshold settings).

a) Event Log Status

With this menu selection user may check how many total events are recorded in the Event Log file. The Overflow counter (OF) indicates how many times Event Log index was wrapped around back to zero. Pressing Enter key from Event Log Status screen will allow customer to list and review all recorded events. The Event record will display Date and Time on the first line of the LCD and Event code on the second. Pressing Enter key one more time will momentarily (for 2 seconds) replace Event code with detailed description of the corresponding event. Pressing **UP** or **DN** button will allow to list all other Events in the Event Log file.

When the last Log file item is reached, the following prompt “#241 has no Data” will be displayed on the second line of the LCD (#241 is for example only, actual number may be different).

b) Event Log Configuration

If Event Log configured to “Loop Off” mode, the Event Log file will be locked (disabled) when last event with index 511 is recorder. If Event Log configured to “Loop On” mode, when last index (511) is reached, the firmware “wraps around” Event Log index back to 0 and new records will overwrite old Events records.

c) Event Log Mask

With this menu selection user may individually mask (disable) any Alarm Log Event. A typical display with Alarm Events Log Mask selection is shown below.



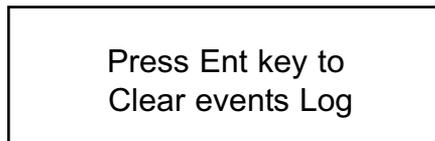
In the example shown above, all alarm events except #7 with LCD bit code 6, #10 with LCD bit code 9, #13 with LCD bit code D, #15 with LCD bit code F are masked with asterisk. In order to change Log event mask settings user should press Enter button. The flashing cursor will appear on the left of the LCD screen (on the 0 event position). Use **Dn** [Cursor] button to move to desired event code. Use **Up** button to change mask status (asterisk represent masked event). Use Enter button to accept and save new Event Log mask settings in flow meter’s non volatile memory.



NOTE: System Events (see table 5.2) can not be masked therefore will be always recorded in to the Event Log File.

d) Clear Event Log

In order to reset (clear) Event Log File press Ent button. Following screen will appear just for two seconds.



If during these two seconds user will press **Dn** button again, the Event Log file will be cleared (all records will be deleted).

5.3.10.3 Submenu Raw Pulse Counts

This menu selection provides number of pulses from the flow sensors within specific measurement interval (read only).

5.3.10.4 Submenu Pulse Frequency

This menu selection provides raw and averaged values of the frequency from the flow sensors (read only).

5.3.10.5 Submenu PWM Frequency

This menu selection provides raw and averaged values of the frequency from DSP PWM algorithm (read only).

5.3.10.6 Submenu AWD Frequency

This menu selection provides raw and averaged values of the frequency from DSP AWD algorithm (read only).

5.3.10.7 Submenu DSP FFT Output

This menu selection provides vortex frequency and amplitude from DSP FFT algorithm (read only).

5.3.10.8 Submenu DSP FFT Output

This menu selection provides instantaneous vortex frequency and amplitude from DSP FFT algorithm (read only).

5.3.10.9 Submenu DSP FFT Average

This menu selection provides averaged vortex frequency and DC amplitude from DSP FFT algorithm (read only).

5.3.10.10 Submenu Piezo Sensors RMS

This menu selection provides averaged signal RMS value for both piezo sensors (read only).

5.3.10.11 Submenu Sensor Attenuation

This menu selection provides attenuation level for both piezo sensor amplifiers (read only).

5.3.10.12 Submenu T/P ADC Output

This menu selection provides raw value of the ADC counts for RTD and pressure sensor circuitry (read only). The reading only applicable for meters with optional T/P sensors.

5.3.10.13 Submenu DAC Outputs Value

This menu selection provides current value of the DAC registers for each analog 4-20 mA output circuitry (read only).

5.3.10.14 Submenu CPU Temperature

This menu selection provides current value of the PCB and CPU temperature in °C (read only).

5.3.11 Submenu L1 Display Menu

Use the Display Menu to set the cycle time for automatic screen sequencing used in the PI mode, change the PI screen between static and dynamic modes, enable or disable particular screen displayed in the PI mode.

5.3.11.1 Submenu Display Mode

Process Information screens can be configured to be static (manual control) or dynamic (automatic sequencing). In the static mode pressing **Up** button, pages through the PI screens in the forward direction, pressing **Dn** button, pages through the PI screens in the reverse direction. When the last PI screen is reached, the firmware “wraps around” and scrolls to the initial PI screen once again.



NOTE: PI screens which are masked in the Display Mask register (see. Paragraph 5.3.11.3) will be skipped.

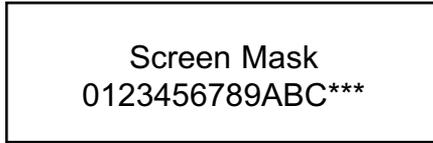
In the dynamic mode firmware initiates automatic screen sequencing with user adjustable screen Cycle Time (see Paragraph 5.311.2 “Display Menu”). When the last PI screen is reached, the firmware “wraps around” and scrolls to the initial PI screen once again.

5.3.11.2 Submenu Screen Cycle Time

This menu selection defines time interval in seconds for each PI screen to be displayed in the dynamic mode (automatic sequencing). Screen Cycle Time can be set to any value in the range between 1 to 300 seconds (numerical entry).

5.3.11.3 Submenu Screen Mask

Using Screen Mask settings user can enable (unmask) or disable (mask) up to 13 [0-C] different process variable combinations (see Figure 5.4). By default unit is shipped from factory with all PI screens enabled. A typical display with Screen Mask selection is shown below.



In the example shown above, all PI screens are enabled. Each PI screen assigned to corresponding bit in the PI Screen Register. In order to change PI Screen mask settings user should press Enter button. The flashing cursor will appear on the left of the LCD screen (on the 0 screen position). Use **Dn** [Cursor] button to move to desired PI screen code. Use **Up** button to change mask status (asterisk represent masked event). Use Enter button to accept and save new PI Screen mask settings in flow meter's non volatile memory.

5.3.12 Submenu L1 Data Log Menu

Vortex Flow Meters are equipped with programmable Data Log feature which is available via digital interface and LCD/Keypad. The Data Log menu allows user to assign one of the four process variables (Vol. Flow, Mass Flow, Temperature, and Pressure) to be recorded with selected interval time based on configurable conditions. Data Log can store total up to 15,871 records. Each record includes date/time stamp and process variable value in currently active engineering units.

5.3.12.1 Submenu Data Logger Mode

Using Data Logger Mode settings user can enable or disable data log functionality (tabular entry). By default unit shipped from the factory with Data Logger Mode set to disable.

5.3.12.2 Submenu Data Log Configuration

Using Data Logger Mode settings user can set data log to one of the following configuration:

- Loop On (default settings),
- Loop Off,
- Number of Samples

If Data Log configured to “Loop Off” mode, the Data Log will be locked (disabled) when last record with index 15,871 is recorder. If Data Log configured to “Loop On” mode, when last index (15,871) is reached, the firmware “wraps around” Data Log index back to 0 and new records will overwrite old data records. If Data Log configured to Number of Samples the Data Log will be locked (disabled) when record index will be equal to value set in the Submenu Log # of Samples (see next paragraph).

5.3.12.3 Submenu Log # of Samples

This menu entry allows user set exact number of samples to be taken (recorded) when data log configured in to the “Number of Samples” mode (numerical entry). By default “Number of Samples” parameter is set to maximum allowable value: 15,871.

5.3.12.4 Submenu Process Variable

This menu entry allows user to assign one of the four process variables (Vol. Flow, Mass Flow, Temperature, and Pressure) to be recorded in to the data log (tabular entry). By default the “Process Variable” parameter is set to Volumetric Flow.

5.3.12.5 Submenu Samples Interval

This menu entry allows user to select desired data log sample rate. Samples Interval can be set to any value in the range between 1 to 3600 seconds (numerical entry). The Samples Interval value directly affects how long flow meter can collect the PI data. For example: if “Samples Interval” value set to 1 second, the user can collect data as long as 4 hours and 24 minutes; if “Samples Interval” value set to 180 second (3 minutes), the user can collect data as long as 33 days 1 hour and 36 minutes.

5.3.12.6 Submenu DL Start Condition

This menu entry allows user to select when Data Logger will start recording PI data (tabular entry). Following settings are available:

- Unconditional (default settings)
- High PV Alarm
- Low PV Alarm

When set to “Unconditional”, the flow meter will start collect selected Process Variable data as soon as user enables data log. When set to “High PV Alarm”, the flow meter will start collect selected Process Variable data only if Data Log is enabled and High Alarm Condition for corresponding PV is detected. When set to “Low PV Alarm”, the flow meter will start collect selected Process Variable data only if Data Log is enabled and Low Alarm Condition for corresponding PV is detected.

5.3.12.7 Submenu DL Stop Condition

This menu entry allows user to select when Data Logger will stop recording PI data (tabular entry). Following settings are available:

- Unconditional (default settings)
- High PV Alarm
- Low PV Alarm

When set to “Unconditional”, the flow meter will stop collect selected Process Variable data only if **Log # of Samples** limit is reached (when log is configured to “Number of Samples” mode) or last index (15,871) is reached (when log is configured to Loop Off mode). When set to “High PV Alarm”, the flow meter will stop collect selected Process Variable data only if Data Log is enabled and High Alarm Condition for corresponding PV is detected. When set to “Low PV Alarm”, the flow meter will stop collect selected Process Variable data only if Data Log is enabled and Low Alarm Condition for corresponding PV is detected.

5.3.12.8 Submenu Data Log Status

This menu selection provides current Data Log index and overflow counter values (read only). A typical display with Data Log Status is shown below.

Data Log Status
Ind: 60 OF: 0

In order to reset (clear) Data Log press **Enter** button. Following screen will appear just for two seconds.

Press Ent key to
clear Data Log

If during these two seconds user will press **Enter** button again, the Data Log index and overflow counter will be reset to zero.



NOTE: The PV data recorded in to the Data Log are only accessible via digital communication interface. Use ASCII Interface Command Set (see APPENDIX B) or Aalborg supplied Communication Utility to retrieve (read) PV data from the meter.

6. ANALOG CIRCUITRY CALIBRATION

6.1 Analog 4-20 mA output Circuitry calibration



NOTE: The 4-20 mA analog outputs available on the Vortex Flow Meter were calibrated at the factory. There is no need to perform analog output calibration unless the CPU or TERM PCB was replaced. Any alteration of the analog output scaling variables in the EEPROM table will VOID calibration warranty supplied with instrument.



NOTE: It is recommended to use the Aalborg®supplied calibration and maintenance software for analog output calibration. This software includes an automated calibration procedure which may radically simplify calculation of the offsets and spans variables and, the reading and writing for the EEPROM table.

The Vortex 4-20 mA analog output calibration involves calculation and storing of the offset and span variables in the EEPROM for both output channels. The following is a list of the EEPROM variables used for analog outputs computation:

Analog Output#1 variables:

Index	Name	Description
32	Out1_Scale_mA -	Analog 4-20 mA Output #1 Scale
33	Out1_Offset_mA -	Analog 4-20 mA Output #1 Offset

Analog Output#2 variables:

Index	Name	Description
34	Out2_Scale_mA -	Analog 4-20 mA Output #2 Scale
35	Out2_Offset_mA -	Analog 4-20 mA Output #2 Offset

6.1.1 Initial setup

Power up the Vortex Flow Meter for at least 15 minutes prior to commencing the calibration procedure. Make sure absolutely no flow takes place through the meter. Establish digital RS-485/RS-232 communication between PC (communication terminal) and Vortex flow meter. The commands provided below assume that calibration will be performed manually (w/o Aalborg®supplied calibration and maintenance software) and the device has RS-485 address 11. If Aalborg®supplied calibration and maintenance software is used, skip the next section and follow the software prompts.

Enter Backdoor mode by typing: !11,MW,1000,1[CR]

Unit will respond with: !11,BackDoorEnabled: Y

Disable DAC update by typing: !11,WRITE,4,Y[CR]

Unit will respond with: !11,DisableUpdate: Y

where: [CR] Carriage return character
(equals pressing Enter key on the PC key board).

6.1.2 Analog 4-20 mA channel#1 output calibration

1. Connect a certified high sensitivity multi meter set for the current measurement to pins 1 (+) and 2 (-) of the TB3 terminal connector.
2. Write 4000 counts to the DAC1 channel: !11,WRITE,0,4000[CR]
3. Read current with the meter and designate it to **Reading_4000_mA** variable.
4. Write 400 counts to the DAC1 channel: !11,WRITE,0,400CR]
5. Read current with the meter and designate it to Reading_400_mA variable.
6. Calculate **Out1_Scale_mA** value:

$$\mathbf{Out1_Scale_mA = 3600 / (Reading_4000_mA - Reading_400_mA)}$$

7. Calculate **Out1_Offset_mA** value:

$$\mathbf{Out1_Offset_mA = - (Reading_4000_mA/10 - Reading_400_mA) X Out1_Scale_mA}$$

8. Save **Out1_Scale_mA** in to the EEPROM: !11,MW,32,Y[CR]
Save **Out1_Offset_mA** in to the EEPROM: !11,MW,33,Z[CR]

Where: Y – the calculated **Out1_Scale_mA** value.
Z – the calculated **Out1_Offset_mA** value.

6.1.3 Analog 4-20 mA channel#2 output calibration

1. Connect a certified high sensitivity multi meter set for the current measurement to pins 3 (+) and 4 (-) of the TB3 terminal connector.
2. Write 4000 counts to the DAC2 channel: !11,WRITE,1,4000[CR]
3. Read current with the meter and designate it to **Reading_4000_mA** variable.
4. Write 400 counts to the DAC1 channel: !11,WRITE,1,400CR]
5. Read current with the meter and designate it to **Reading_400_mA** variable.
6. Calculate Out2_Scale_mA value:

$$\text{Out2_Scale_mA} = 3600 / (\text{Reading_4000_mA} - \text{Reading_400_mA})$$

7. Calculate **Out2_Offset_mA** value:

$$\text{Out2_Offset_mA} = - (\text{Reading_4000_mA}/10 - \text{Reading_400_mA}) \times \text{Out2_Scale_mA}$$

8. Save **Out2_Scale_mA** in to the EEPROM: !11,MW,34,Y[CR]
Save **Out2_Offset_mA** in to the EEPROM: !11,MW,35,Z[CR]

Where: Y – the calculated **Out2_Scale_mA** value.
Z – the calculated **Out2_Offset_mA** value.

6.2 Temperature and Pressure Sensors Calibration*



NOTE: If your flow meter is equipped with optional Temperature and Pressure sensors, then they were calibrated at the factory. There is no need to perform Temperature and Pressure sensors calibration unless the CPU / TERM PCB or actual Temperature or Pressure sensor was replaced. Any alteration of the temperature or pressure input scaling variables in the EEPROM table will VOID calibration warranty supplied with instrument.



NOTE: If recalibration of the Temperature or Pressure sensors is required, it is recommended to use the Aalborg® supplied calibration and maintenance software for analog output calibration. This software includes an automated calibration procedure which may radically simplify calculation of the offsets and spans variables and, the reading and writing for the EEPROM table.

7. START UP

7.1 Cautions Prior to Start Up

In general, it is good practice to purge the line slowly to prevent unnecessary damage to the meter.

Once the pipeline is pressurized, check the flow meter and flanges for leaks.

The temperature and pressure transducers should also be checked for leaks.

The meter may give erratic outputs during purging the line if the power has been turned on before purging the line.

The Vortex flow meter does not have the capability of measuring two phase flow. In liquid applications, the line should be totally purged of air before powering the flow meter.

During start up, remember that the meter will not read accurately until the flow rate meets or exceeds the minimum flow rates stated on the I.D. sheet. The maximum and minimum flow rates for a specific flow meter can be found on the meter I.D. sheet.

8. TROUBLESHOOTING

8.1 Common Conditions

Your Vortex Flow Meter was thoroughly checked at numerous quality control points during and after manufacturing and assembly operations. It was calibrated according to your desired flow and pressure conditions for a given fluid. It was carefully packed to prevent damage during shipment. Should you feel that the instrument is not functioning properly, please check for the following common conditions first:

Are all cables connected correctly?

Are there any leaks in the installation?

Is the power supply correctly selected according to requirements?

When several meters are used a power supply with appropriate current rating should be selected. Were the connector pinouts matched properly?

When interchanging with other manufacturers' equipment, cables and connectors must be carefully wired for correct pin configuration.

8.2 Troubleshooting Guide

NO.	INDICATION	LIKELY REASON	SOLUTION
1	LCD Display remains blank when unit is powered up. No response when flow is introduced from analog 4-20 mA.	Power supply is bad or polarity is reversed.	Measure voltage on pins 1 and 2 of the TB1 screw terminal connector. If voltage is out of specified range, then replace power supply with a new one. If polarity is reversed (reading is negative) make correct connection.
		PC board is defective.	Return flow meter to factory for repair.
2	LCD Displays flow reading, but 4-20 mA output signal does not change (always the same or reading around 4.0 mA).	Volumetric or Mass Flow PV is no assigned to corresponding 4-20mA output	Using Key Pad, navigate to Submenu L1 "Output Menu" and select one of the Submenu L2 options: "4-20mA Output1" or "4-20mA Output2" (see paragraph 5.3.6.1). Make sure that parameter "4-20mA Output1 Mode" or "4-20mA Output2 Mode" is set to Volumetric or Mass Flow.
		External loop is open or load resistance more than 600 Ohm	Check external connections to pins 1 and 2 (for channel #1), 3 and 4 (for channel #2) of the TB3 screw terminal connector. Make sure the loop resistance is less than 600 Ohm.
		Flow output 4-20 mA schematic is burned out or damaged.	Using Key Pad, navigate to Submenu L1 "Diagnostic Menu" and select "Submenu DAC Outputs". Record the #1 and #2 counts values and consult the factory with findings.
3	Fluid flows through the Vortex flow meter, but LCD Display reading and the corresponding 4-20 mA flow output signal do not respond to flow.	The fluid flow rate is below set Low flow cut-off value. Sensors or PC board is defective.	<p>Check settings for Low flow cut-off value and make required adjustment (see paragraph 5.3.7.6 "Submenu Meter Low Flow Cut Off").</p> <p>Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Remove electronics assembly unit. Disconnect the vortex sensor connector from the CPU board (the CPU board is the board with LCD display) via cut out in the terminal board. Measure the resistance from each outside pin to the center pin (meter ground) – each should be open. Measure the resistance from the center pin to the meter ground (metal enclosure or pipe) – this should be grounded to the meter. With the sensor connector still disconnected from PCB, using Key Pad, navigate to Submenu L1 "Diagnostic Menu" and select "Pulse Frequency" or "PWM Frequency" screen. Hold a finger on the metal part of the small screwdriver and touch exposed outside pins of the sensor connector on the CPU board. The meter should read electrical noise, 60 or 50 Hz for example. If it is true, re-install vortex sensor connector back and check flow meter with flow conditions. If necessary contact factory for additional help.</p>

NO.	INDICATION	LIKELY REASON	SOLUTION
4	There is no actual fluid flow through the Vortex meter (no flow conditions), but LCD Display reading some flow rate.	Sensors wires are disconnected from CPU board.	Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Remove electronics assembly unit. Disconnect the vortex sensor connector from the CPU board (the CPU board is the board with LCD display) via cut out in the terminal board. Make sure two wires from the sensor are firmly attached to outside pins of the connector and wire from the center of the connector is attached to the grounding terminal screw inside of the electronics assembly enclosure.
		Vortex flow meter not properly grounded.	Make sure flow meter enclosure case (external Grounding terminal) is directly connected to earth ground with minimal impedance (see pages110-113).
		Flow Meter is too sensitive to the external noise or vibration.	Using Key Pad, navigate to Submenu L1 “Diagnostic Menu” and record following parameters: “FFT Output”, “FFT Average”, “Sensors RMS” and consult the factory with findings.
5	Erratic Flow rate Reading	The flow rate may be too low, just at the cutoff of the meter range, and the flow cycles above and below the cutoff making an erratic output.	The meter range is provided with product label attached to the meter body (based on customer’s application flowing conditions when the meter was ordered). Consult the factory if necessary to confirm the meter range based on current operating conditions. It may be possible to lower the low flow cutoff to increase the meter range.
		Mechanical installation may be wrong.	Verify the straight run is adequate as described in Paragraph 3.3 “PIPING GUIDELINES”. For in-line meters, make sure the meter is not installed backwards and there are no gaskets protruding into the flow stream. For insertion meters, verify the insertion depth and flow direction.
		The meter may be reacting to actual changes in the flow stream.	The displayed flow rate values can be smoothed using the Flow damping and NRF time constant parameters in the PWM DSP Menu (see paragraph 5.3.7.1).

NO.	INDICATION	LIKELY REASON	SOLUTION
6	The Temperature* reading on the LCD is not correct (out of the device measurement range: -20 to 260C) * - for devices with T/P option.	RTD connector got loose and is not connected to the PCB board.	Check RTD connector on the terminal PCB, make sure it is firmly attached to the header J3.
		RTD sensor is defective	With power applied to the flow meter, navigate to Submenu L1 "Diagnostic Menu" and select "T/P ADC Out" menu option. The T value should be around 840 counts at room temperature (20 - 25 °C). Using ESD precautions and hazardous area precautions, remove the electronics enclosure window cover. Remove electronics assembly unit. Disconnect the RTD temperature sensor connector from the header J3 on the terminal board. Measure the resistance across the outside pins of the temperature sensor connector. It should read approximately 109 ohms at room temperature (higher resistance at higher temperatures). Contact factory with finding.
7	The Pressure* reading on the LCD is not correct (out of the device measurement range or does not react on pressure change in the process line) * - for devices with T/P option.	Pressure sensor connector got loose and is not connected to the PCB board.	Check pressure connector on the terminal PCB, make sure it is firmly attached to the header J2.
		Pressure sensor is defective	With power applied to the flow meter, navigate to Submenu L1 "Diagnostic Menu" and select "T/P ADC Out" menu option. The P value should be around 900* counts at ambient pressure (14.7 PSIA) * this value only applicable for pressure sensor with full scale range 100 PSIA. Consult factory if your flow meter has different pressure range.
8	The Flow Meter Diagnostic Alarm Event with code 0 – "CPU Temp. High" is active.	MCU temperature is too high (overload).	Disconnect power from the Vortex flow meter. Make sure the ambient temperature is within specified range (below 65 °C). Let the device cool down for at least 15 minutes. Apply power to the flow meter and check Diagnostic Alarm Event. If overload condition will be indicated again the unit has to be returned to the factory for repair.
9	The Flow Meter System Event with code 24 - "Fatal Error" is active.	Fatal Error (EEPROM or SRAM corrupted)	Cycle the power on the Vortex flow meter. If System Event with code 24 indicating again the unit has to be returned to the factory for repair.

APPENDIX A

AALBORG® VORTEX METER EEPROM Variables Rev.P002 [07/08/2010]

Note: indexes 0-19 are write protected (manufacture and calibration specific data)

INDEX	NAME	DATA TYPE	NOTES
0	BlankEEPROM[10]	char[10]	Do not modify. Table Revision [PROTECTED]
1	SerialNumber[20]	char[20]	Serial Number [PROTECTED]
2	ModelNumber[20]	char[20]	Model Number [PROTECTED]
3	SoftwareVer[10]	char[10]	Firmware Version [PROTECTED]
4	ManufReservedF1	float	Manufacture Specific float data [PROTECTED]
5	ManufReservedF2	float	Manufacture Specific float data [PROTECTED]
6	MeterCalFactorM	float	Original Manuf. Assigned Meter Cal Factor [PROTECTED]
7	MeterSize	float	Original Manuf. assigned size of the meter [inch] [PROTECTED]
8	ReservedText[12]	char[12]	Reserved for Manufacture Specific Text Info [PROTECTED]
9	ManufReservedF3	float	Manufacture Specific float data [PROTECTED]
10	ManufReservedF4	float	Manufacture Specific float data [PROTECTED]
11	ManufReservedF5	float	Manufacture Specific float data [PROTECTED]
12	ManufReservedF6	float	Manufacture Specific float data [PROTECTED]
13	ManufReservedUI1	uint	Manufacture Specific uint data [PROTECTED]
14	ManufReservedUI2	uint	Manufacture Specific uint data [PROTECTED]
15	ManufReservedUI3	uint	Manufacture Specific uint data [PROTECTED]
16	ManufReservedUI4	uint	Manufacture Specific uint data [PROTECTED]
17	ManufReservedSI1	int	Manufacture Specific int data [PROTECTED]
18	ManufReservedSI2	int	Manufacture Specific int data [PROTECTED]
19	ManufReservedSI3	int	Manufacture Specific int data [PROTECTED]
20	TimeSinceCalHr	float	Time elapsed since last calibration in hours
21	ProtectionCode	uint	Program Parameters Protection Code [0-255]
22	DPTreshLevel	uint	Auto DP attenuator threshold level (+/- counts from target)
23	BackLightMode	uint	Reserved for future implementation**
24	LCD_Diagnostic	uint	LCD Diagnostic Mode: [0, 1]
25	Address485	char[4]	Two hexadecimal characters address for RS485 only [01-FF]
26	LCD_Mode	uint	Main Process screen mode: 0-Static,1-Dynamic
27	LCD_Static_Mode	uint	Type of the static LCD screen: 0-12
28	LCD_AUTO_Mode_Mask	uint	Mask of the AUTO LCD screen: hex 0x01 - 0xFF
29	LCD_Cycle_Tim	uint	Time in seconds for each var. to be displayed in AUTO mode
30	Out4_20mA_Mode1	uint	Process Variable assignment to 4-20mA output channel #1: [0-5]
31	Out4_20mA_Mode2	uint	Process Variable assignment to 4-20mA output channel #2: [0-5]

INDEX	NAME	DATA TYPE	NOTES
32	Out1_Scale_mA	float	Analog 4-20 mA Out #1 Scale
33	Out1_Offset_mA	float	Analog 4-20 mA Out #1 Offset
34	Out2_Scale_mA	float	Analog 4-20 mA Out #2 Scale
35	Out2_Offset_mA	float	Analog 4-20 mA Out #2 Offset
36	F_AlarmMode	uint	Flow Alarm Mode (0=Disabled, 1=Enabled)
37	F_LowAlarmPFS	float	Low Flow Alarm in PFS [0-1.00]
38	F_HiAlarmPFS	float	High Flow Alarm in PFS [0-1.00]
39	F_AlmDelay	uint	Delay in seconds 0-3600 for Flow Alarm action
40	F_AlarmLatch	uint	Flow Alarm Latch
41	F_AlarmCond	uint	Flow Alarm Conditions (0 = Volumetric, 1 = Mass)
42	T_AlarmMode	uint	Temp Alarm Mode (0=Disabled, 1=Enabled)**
43	T_LowAlarm_C	float	Low Temp Alarm in deg C**
44	T_HiAlarm_C	float	High Temp Alarm in deg C**
45	T_AlmDelay	uint	Delay in seconds 0-3600 for Temp Alarm action **
46	T_AlarmLatch	uint	Temp Alarm Latch**
47	Total1_Cond	uint	Totalizer #1 Flow Conditions: 0 – Volumetric, 1 - Mass
48	P_AlarmMode	uint	Pressure Alarm Mode (0=Disabled, 1=Enabled)**
49	P_LowAlarm_Pa	float	Low Pressure Alarm in PSIA**
50	P_HiAlarm_Pa	float	High Pressure Alarm in PSIA**
51	P_AlmDelay	uint	Delay in seconds 0-3600 for Pressure Alarm action
52	P_AlarmLatch	uint	Pressure Alarm Latch**
53	Total2_Cond	uint	Totalizer #2 Flow Conditions: 0 – Volumetric, 1 - Mass
54	FlowUnits_Vol	uint	Current Volumetric Flow Units of Measure [0-29]
55	FlowUnits_Mass	uint	Current Mass Flow Units of Measure [0-24]
56	TempUnits	uint	Current Temperature Units of Measure [0-3]
57	PressureUnits	uint	Current Pressure Units of Measure [0-10]
58	DensityUnits	uint	Current Density Units of Measure [0-6]
59	FFToPC_RMS	uint	Sensor RMS value switch threshold [0-4095]
60	Vol_Flow_Cond	uint	Actual, Std or Normal Volumetric Flow Units of Measure [0-2]
61	UDUnitKfactor	float	User defined Vol Unit K-Factor to L/min
62	UDUnitTimeBase	int	User defined Vol Unit Time base 1, 60, 3600, 86400 (sec.)
63	Out4_20mAHold	uint	4-20mA Output Assignment Hold (first 16 bit only)
64	UDMassUnitTimeBase	uint	User defined Mass Unit Time base 1, 60, 3600, 86400 (sec.)
65	UDMassUnitKfactor	float	User defined Mass Unit K-Factor to gramm/min
66	OptOut1_Config	uint	Optical Output #1 Configuration (function) [0-13]
67	OptOut2_Config	uint	Optical Output #2 Configuration (function) [0-13]

INDEX	NAME	DATA TYPE	NOTES
68	Total1_Mode	uint	Totalizer#1 mode (0-Disabled, 1-Enabledd)
69	Total1_FlowStart	float	Start totalizer at flow [0-1.0 notation %F.S.]
70	Total1_VolStop	float	Totalizer Event volume in %*s, 0 = disable
71	Out1_4mA_Value	float	4-20mA Output#1 4 mA Value (in EEPROM stored units)
72	Out1_20mA_Value	float	4-20mA Output#1 20 mA Value (in EEPROM stored units)
73	Total1_ConfLock	uint	Totalizer#1 reading lock (0-can be reset, 1-can not be reset)
74	Total1_Volume_BkUp	float	Totalizer#1 backup volume in %s (saved from BB SRAM every 6 min.)
75	Total2_Mode	uint	Totalizer#2 mode (mode (0-Disabled, 1-Enabledd)
76	Total2_FlowStart	float	Start totalizer#2 at flow [0-1.0 notation %F.S.]
77	Total2_VolStop	float	Totalizer#2 Event volume in %*s, 0 = disable
78	Out2_4mA_Value	float	4-20mA Output#2 4 mA Value (in EEPROM stored units)
79	Out2_20mA_Value	uint	4-20mA Output#2 20 mA Value (in EEPROM stored units)
80	Total2_ConfLock	uint	Totalizer#2 reading lock (0-can be reset, 1-can not be reset)
81	Total2_Volume_BkUp	float	Totalizer#2 backup volume in %s (saved from BB SRAM every 6 min.)
82	Flow_Pulse_Mode	uint	Flow Pulse Output Mode (0=Dis'd, 1=En'd)
83	Pulse_Units_Cond	uint	EU type (0 -volumetric based, 1 - mass based)
84	FFT_Damping	uint	FFT Damping (1-99 seconds)
85	Units_Per_Pulse	float	Pulse output scaling (units per pulse)
86	Active_Low_Time	float	Number of ms output will be active when pulse is developed
87	FlowLinearizer	uint	Flow Linearizer mode (1-En'd, 0 – Dis'd)
88	FlowTbl[0].FlowPFS	float	Flow Linearizer Index 0 PFS (must be 0.0)
89	FlowTbl[0].LinCounts	uint	Flow Linearizer Index 0 Counts (must be 0)
90	FlowTbl[1].FlowPFS	float	Flow Linearizer Index 1 PFS [0.0 – 1.0]
91	FlowTbl[1].LinCounts	uint	Flow Linearizer Index 1 Counts
92	FlowTbl[2].FlowPFS	float	Flow Linearizer Index 2 PFS [0.0 – 1.0]
93	FlowTbl[2].LinCounts	uint	Flow Linearizer Index 2 Counts
94	FlowTbl[3].FlowPFS	float	Flow Linearizer Index 3 PFS [0.0 – 1.0]
95	FlowTbl[3].LinCounts	uint	Flow Linearizer Index 3 Counts
96	FlowTbl[4].FlowPFS	float	Flow Linearizer Index 4 PFS [0.0 – 1.0]
97	FlowTbl[4].LinCounts	uint	Flow Linearizer Index 4 Counts
98	FlowTbl[5].FlowPFS	float	Flow Linearizer Index 5 PFS [0.0 – 1.0]
99	FlowTbl[5].LinCounts	uint	Flow Linearizer Index 5 Counts
100	FlowTbl[6].FlowPFS	float	Flow Linearizer Index 6 PFS [0.0 – 1.0]
101	FlowTbl[6].LinCounts	uint	Flow Linearizer Index 6 Counts
102	FlowTbl[7].FlowPFS	float	Flow Linearizer Index 7 PFS [0.0 – 1.0]
103	FlowTbl[7].LinCounts	uint	Flow Linearizer Index 7 Counts

INDEX	NAME	DATA TYPE	NOTES
104	FlowTbl[8].FlowPFS	float	Flow Linearizer Index 8 PFS [0.0 – 1.0]
105	FlowTbl[8].LinCounts	uint	Flow Linearizer Index 8 Counts
106	FlowTbl[9].FlowPFS	float	Flow Linearizer Index 9 PFS [0.0 – 1.0]
107	FlowTbl[9].LinCounts	uint	Flow Linearizer Index 9 Counts
108	FlowTbl[10].FlowPFS	float	Flow Linearizer Index 10 PFS [0.0 – 1.0]
109	FlowTbl[10].LinCounts	uint	Flow Linearizer Index 10 Counts
110	PulseMeasInt	uint	Flow Pulse Measure Interval in mS [500-60000]
111	FlowMeasureMode	uint	Flow measure mode [0-4]
112	Flow_NRF_NSAMPLE	uint	Flow NRF Number of Samples [1-32] for PWM
113	Flow_NRF_ErrLimit	float	Flow NRF Error Value [0.05 10.0]%F.S. for PWM
114	Flow_NRF_TimeLimit	uint	Flow NRF Time Interval for PWM [0-199], 0-dis'd
115	Flow_Damping	uint	Reading Damping 1-99 (sec.) for PC mode
116	Flow_Window	uint	Flow running average window for PC mode [0-100], 0-dis'd
117	FlowAWD_NRF_NSAMPLE	uint	Flow NRF Number of Samples [1-32] for AWD
118	FlowAWD_NRF_ErrLimit	float	Flow NRF Error Value [0.05 10.0]%F.S. for AWD
119	FlowAWD_NRF_TimeLimit	uint	Flow NRF Time Interval for AWD [0-199], 0-dis'd
120	Min_Freq_PWM	uint	Minimum measure Frequency for PWM model
121	Max_Freq_PWM	uint	Maximum measure Frequency for PWM model
122	Min_Freq_AWD	uint	Minimum measure Frequency for AWD model
123	Max_Freq_AWD	uint	Maximum measure Frequency for AWD mode
124	AWD_DC_Offset	uint	AWD DC offset for AWD mode (def. 2225 counts)
125	AWD_Tresh_PFS	uint	AWD threshold in % of Average DC offset for AWD mode (1 - 80)
126	FFT_DSP_Enable	uint	FFT algorithm Enable/Disable
127	FFT_Sample_Rate	uint	FFT Sample Frequency: 0-Auto, 1 - 8000, 2 - 4000, 3 - 2000, 4 - 1000, 5 - 500Hz
128	FFT_Trigger_Level	uint	FFT Trigger level counts (0-4095)
129	FFT_NoiseTreshold	float	FFT Noise threshold counts (0-4000)
130	DP_Channel_1	uint	Sensor#1 DP master attenuator setting (original)
131	DP_Channel_2	uint	Sensor#2 DP master attenuator setting (original)
132	Auto_Att_Mode	uint	Signal Auto Attenuation Mode: 0-Dis'd, 1-Enb'd
133	Auto_Att_Target_Level	float	Signal Auto Attenuation Target level (RMS counts)
134	Meter_Pipe_ID	float	Meter or Pipe Internal Diameter (inch)
135	Meter_FS_Range	float	Meter Full Scale range in L/min
136	MeterCalFactor	float	Calibration Factor:[Hz/l/min] (for STD conditions)
137	Vortex_Coeff_Ck	float	Manuf. Specific settings (do not change)
138	LowFlowCutOff	float	Meter low flow cut off [0 - 25.0 %F.S.]
139	Low_Freq_CutOff	float	Meter Low Frequency cut off (Hz)
140	High_Freq_CutOff	float	Meter High Frequency cut off (Hz)

INDEX	NAME	DATA TYPE	NOTES
141	FluidName[20]	char[20]	Other Fluid Name
142	CalibratedBy[20]	char[20]	Calibration technician name
143	CalibratedAt[20]	char[20]	Calibration Location
144	DateCalibrated[12]	char[12]	Calibration date
145	DateCalibrationDue[12]	char[12]	Date calibration due
146	UserTagName[20]	char[20]	User Defined Device Tag Name or Number
147	DiagEventMask	uint	Mask for Diagnostic Events Register
148	DiagEventLogMask	uint	Mask for Diagnostic Events Log
149	DiagEventLogMode	uint	Diagnostic Events Mode: 0 - stop when full, 1-loop over
150	DE_LoopOverCnt	uint	Diagnostic Events Log Loop Over Counter
151	RMS_25PFS_MinCounts	uint	Minimum allowed counts for sensor's RMS reading on 25%FS
152	FlowingFluidType	uint	Type of the flowing Fluid: Liquid-0, Gas-1
153	Mole_Weight	float	Goyal-Dorais Molecular Weight, lbm/(lbm•mol)
154	Goyal_Crit_P	float	Goyal-Dorais critical pressure (PSIA)
155	Goyal_Crit_T	float	Goyal-Dorais critical temperature (deg. F)
156	Goyal_Zc	float	Goyal-Dorais critical compressibility
157	AGA8_Density_Mode	uint	Density mode: 0- Manuf. Density, 1- Relative Density @ TP
158	AGA8_ManufDensity	float	Nat Gas Density @ TP specified by gas manufacture (Lb/Ft^3)
159	API2540_Density_60	float	API2540 Oil Density at 60F (Kg/m^3)
160	API2540_K0	float	API2540 related coefficient (no units)
161	API2540_K1	float	API2540 related coefficient (no units)
162	Other_Rel_Dens	float	Other Gas Relative Density Gr (Real Specific Gravity at TP)
163	Other_RefTemp_F	float	Other Gas Reference temperature for Gr
164	AGA8_Rel_Density	float	AGA8 Natural gas Relative Density at ref. TP
165	AGA8_MoleFract_N2	float	AGA8 Natural gas molecular fracture for N2
166	AGA8_MoleFract_CO2	float	AGA8 Natural gas molecular fracture for CO2
167	AGA8_RefTemp_F	float	AGA8 Natural gas reference temperature (deg. F)
168	AGA8_RefPres_PsIA	float	AGA8 Natural gas reference pressure (PSIA)
169	FlowingGasIndex	uint	Type of the flowing Gas [0-12]
170	Other_Spec_Gravity	float	Ratio of Molec. Weight Mgas/Mair g/mol)/(g/mol)
171	Other_Compress_Z	float	Other gas Compressibility factor Z @ TP
172	Other_SG_Mode	uint	Other gas specific gravity mode :0-Ratio of molecular weight, 1- Relative Density Gr @ ref. TP
173	STD_Temp_F	float	STD Temperature (deg. F)
174	STD_Press_PsIA	float	STD Pressure (PSIA)
175	NORM_Temp_C	float	NORMAL Temperature (deg. C)
176	NORM_Press_KPA	float	NORMAL Pressure (KPA)
177	Fluid_Density	float	Fluid Density @ STD g/cm^3

INDEX	NAME	DATA TYPE	NOTES
178	Flowing_Temp_F	float	Customer's flowing Temperature (deg. F) for meters with no TP hardware option
179	Flowing_Pres_PSIA	float	Customer's flowing Pressure (PSIA) for meters with no TP hardware option
180	FlowingLiquidIndex	uint	Type of the flowing Liquid [0-4]
181	Other_RefPres_PSIA	float	Other Gas Reference pressure for Gr (PSIA)
182	Other_MolWeight	float	Other Gas Molecular Weight (Lb/LbMol)
183	Fluid_Reserved4;	float	Reserved parameters for future extention
184	Fluid_Reserved5;	float	Reserved parameters for future extention
185	RTD_InScale	float	Temperature RTD sensor input Scale**
186	RTD_InOffset	float	Temperature RTD sensor input Offset**
187	RTD_LinearMode	uint	RTD Linearizer: 0 – Disabled, 1 - Enabled**
188	RTD_NRF_NSsample	uint	RTD NRF Number of Samples [1-32] **
189	RTD_NRF_ErrLimit	float	RTD NRF Error Value [0.05 10.0]%F.S. **
190	RTD_NRF_TimeLimit	uint	RTD NRF Time Interval [0-199], 0-dis'd**
191	PS_InScale	float	Pressure sensor input Scale**
192	PS_InOffset	float	Pressure sensor input Offset**
193	PS_FS_Range	float	Pressure sensor full scale range in Pa**
194	PS_LinearMode	uint	RTD Linearizer: 0 – Disabled, 1 - Enabled**
195	PS_NRF_NSsample	uint	Pressure sensor NRF Number of Samples [1-32] **
196	PS_NRF_ErrLimit	float	Press. sensor NRF Error Value [0.05 10.0]%F.S. **
197	PS_NRF_TimeLimit	uint	Pressure sensor RTD NRF Time Interval [0-199], 0-dis'dv
198	PS_Tbl [0].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
199	PS_Tbl [0].Temperature	float	Ambient Temperature [0 - 100C] **
200	PS_Tbl [1].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
201	PS_Tbl [1].Temperature	float	Ambient Temperature [0 - 100C] **
202	PS_Tbl [2].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
203	PS_Tbl [2].Temperature	float	Ambient Temperature [0 - 100C] **
204	PS_Tbl [3].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
205	PS_Tbl [3].Temperature	float	Ambient Temperature [0 - 100C]**
206	PS_Tbl [4].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
207	PS_Tbl [4].Temperature	float	Ambient Temperature [0 - 100C] **
208	PS_Tbl [5].PFS_Pressure	float	Pressure rate in PFS [0.0-1.0] **
209	PS_Tbl [5].Temperature	float	Ambient Temperature [0 - 100C] **
210	DL_Mode	uint	Data Logger mode: 0 - Off, 1- On
211	DL_Config	uint	Data Logger configuration: 0 - Loop, 1 - No Overwrite, 2-Number of Samples
212	DL_NumSampl	uint	Data Log Number of samples to collect for (conf 2)

INDEX	NAME	DATA TYPE	NOTES
213	DL_ProcVar	uint	Data Log Current Process Variable selector [0-3]
214	DL_Interval	uint	Data Log Sample Interval Time in seconds
215	DL_LoopOverCn	uint	Data Log Loop Over Counter
216	DL_StartCond	uint	Data Log Start Conditions: 0 - Unconditional, 1-High Flow Alarm, 2 – Low Flow Alarm
217	DL_StopCond	uint	Data Log Stop Conditions: 0 - Unconditional, 1-High Flow Alarm, 2 – Low Flow Alarm
218	EEMagicNumber	uint	Number used to verify EEPROM integrity

** Not supported in some hardware configurations

RS232/RS485 The standard VORTEX METER comes with an RS232 interface. The protocol described below allows communication with the unit using either a custom software program or a “dumb” terminal. All values are sent as printable ASCII characters. For RS-232 interface, the start character and two characters of address have to be omitted. For the RS485 interface the start character is always ‘!’ and two characters of address are follow. The command string is terminated with a carriage return (line feeds are automatically stripped out by the VORTEX METER):

RS-485: !<Addr><Cmd>Arg1,Arg2,Arg3,Arg4<CR> Example: !12,VF<CR>

RS-232: <Cmd>,Arg1,Arg2,Arg3,Arg4<CR> Example: VF<CR>

Where: ! Start character **
Addr RS485 device address in the ASCII representation of hexadecimal (00 through FF are valid). **
Cmd The one or two character command from the table below.
Arg1 to Arg4 The command arguments from the table below. Multiple arguments are comma delimited.
CR Carriage return character.

**** Default address for all units is set to 11 hex. Do not submit start character and device address for RS-232 option.**

Several examples of commands follow. All assume that the VORTEX METER has been configured for address 18 (12 hex) on the RS485 bus:

1. To get a volumetric flow reading:
 The device will reply: !12,VF<CR>
 !12,50.0<CR> (Assuming the flow is at 50.0% FS)
2. To get current Flow Alarm status:
 The device will reply: !12,FA,S<CR>
 !12,FAS:N<CR> > (Assuming no alarm conditions)
3. To get Totalizer#1 reading:
 The device will reply: !12,T,1,R<CR>
 !12,T1R:93.5<CR> (Assuming the Totalizer#1 reading is 93.5)
4. Set the volumetric flow high and low alarm limit to 90% and 10% of full scale flow rate: !12,FA,C,V:90.0;10.0<CR>
 The device will reply: !12, FAC:V:90.0;10.0<CR>

AALBORG VORTEX METER ASCII SOFTWARE INTERFACE COMMANDS

NOTE: AN “**” INDICATES POWER UP DEFAULT SETTINGS. AN “***” INDICATES OPTIONAL FEATURE NOT AVAILABLE ON ALL MODELS.

		COMMAND SYNTAX						
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Volumetric Flow	Requests the current volumetric flow reading in current EU	1	VF					<Value> (Actual volumetric flow in current engineering units)
Mass Flow	Requests the current mass flow reading in current EU	2	MF					<Value> (Actual mass flow in current engineering units)
Density	Requests the current Density reading in current EU	3	D					<Value> (Actual density in current EU)
Temperature /Pressure**	Requests the current temperature and pressure reading in current EU	4	TP					<T_Value>, <P_Value> Example: 22.5,14.7
Diagnostic Events Register	Read/Reset current status of Diagnostic Events Register See list of the Diagnostic Events below.	5	DE	NO ARGUMENT (read status)				DE:0x10 0x10 – diagnostic word (16 bits wide) DE:0x0
Diagnostic Mask	Display/Set Diagnostic Events Mask register See list of the Diagnostic Events below.	6	DM	NO ARGUMENT (read current Diagnostic Events Mask register)				DM:0x9FFF 0x9FFF – diagnostic mask (16 bits wide). Set bit - Enable Clear bit - Disable DM:0x9FFF

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Meter Info	Requests meter configuration info: <ul style="list-style-type: none"> - full scale range (L/min) - Meter size (inches) - T/P option support (Y,N) - 4-20 mA Output #1 configuration - 4-20 mA Output #2 configuration 	7	MI					MI: 1000.0,0.75,Y,V,M 1000.0 – full scale L/min 0.75 – meter size [inch] Y – T/P supported N – T/P not supported V – volumetric flow M – mass flow T – Temperature P – Pressure D – Density O – Off (Disabled)
Flow Alarms	Sets / reads the status of the flow alarms. Note: High and Low limits for Volumetric flow configuration have to be entered in fraction %FS notation (0.0 – 1.0). High and Low limits for Mass flow configuration have to be entered in the currently active mass flow units. High alarm value has to be more than Low alarm value. Alarm conditions: Flow > High Limit = H Flow < Low Limit = L Low < Flow < High = N	8	FA	C (flow configuration) A (action delay in sec) E (enable alarm) D (disable alarm)* R (read current status) S (Read current settings)	V-volum. flow M-mass flow <Value> [0-3600]	<Value> (high limit)	<Value> (low limit)	FAC:V,0.9,0.1 FAA:<Value (sec)> FA:E FA:D FAR:N (no alarm) FAR:H (high alarm) FAR:L (low alarm) FAS:M,C,H,L,D,B where: M – mode (E/D) C – Configuration (V/M) H – High settings value L – Low settings value D – Action Delay (sec) B – Latch mode (0-1) FAL:<Value> where: Value = 0 – 1

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Temperature Alarms**	Sets / reads the status of the temperature alarms. Note: High and Low limits have to be entered in the °C. High alarm value has to be more than Low alarm value. Alarm conditions: Temp. > High Limit = H Temp. < Low Limit = L Low < Temp. < High = N	9	TA	H (high temp. limit) L (low temp. limit) A (action delay in seconds) E (enable alarm) D (disable alarm)* R (read current status) S (Read current settings) B Block (Latch) mode	<Value> (-20.1-260 °C) <Value> (-20.1-260 °C) <Value> (0-3600 sec.)			TAH:<Value [°C]> TAL:<Value [°C]> TAA:<Value [Sec]> TA:E TA:D TAR:N (no alarm) TAR:H (high alarm) TAR: L (low alarm) TAS:M,L,H,D,B where: M – mode (E/D) L – Low settings (°C) H – High settings (°C) D – Action Delay (sec) B – Latch mode (0-1) TAB:<Value> where: Value = 0 – 1

COMMAND NAME	DESCRIPTION	NO.	COMMAND SYNTAX					
			COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Pressure Alarms**	Sets / reads the status of the pressure alarms. Note: High and Low limits have to be entered in the Pa units. High alarm value has to be more than Low alarm value. Alarm conditions: Pressure > High Limit = H Pressure. < Low Limit = L Low < Press. < High = N	10	PA	H (high press. limit)	<Value> (0-Max.Press.)			PAH:<Value [Pa]>
				L (low press. limit)	<Value> (0-Max.Press.)			PAL:<Value [Pa]>
				A (action delay in seconds)	<Value> (0-3600 sec.)			PAA:<Value [sec]>
				E (enable alarm)				PA:E
				D (disable alarm)*				PA:D
				R (read current status)				PAR:N (no alarm) PAR:H (high alarm) PAR: L (low alarm)
				S (Read current settings)				PAS:M,L,H,I,D,B where: M – mode (E/D) L – Low settings (Pa) H – High settings (Pa) D – Action Delay (sec) B – Latch mode (0-1)
				B Block (Latch) mode	<Value> (0-disabled*) (1-enabled)			PAB:<Value> where: Value = 0 – 1

COMMAND NAME	DESCRIPTION	NO.	COMMAND SYNTAX						
			COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE	
Optical Outputs	Assigns action of the two optical outputs. The optical output becomes active when the condition specified by an Argument 2 becomes true. Argument 2: D - no action (disabled*) FL - low flow alarm FH - high flow alarm FR - Range between High & Low alarms T1 - Tot#1 reading > limit T2 - Tot#2 reading > limit TL - low temp. alarm TH - high temp. alarm TR - Range between High & Low temp. alarms PL - low press. alarm PH - high press. alarm PR - Range between High & Low press. alarms DE - Diagnostic Events M - Manual On (enabled)	11	0	1 (output #1) 2 (output #2)	D* FL FH FR T1 T2 TL TH TR PL PH PR DE M S (read current settings)				01:D or 02:D 01:FL or 02:FL 01:FH or 02:FH 01:FR or 02:FR 01:MT or 02:MT 01:PT or 02:PT 01:TL or 02:TL 01:TH or 02:TH 01:TR or 02:TR 01:PL or 02:PL 01:PH or 02:PH 01:PR or 02:PR 01:DE or 02:DE 01:M or 02:M 01:D or 02:D

COMMAND NAME	DESCRIPTION	NO.	COMMAND SYNTAX					
			COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Totalizers	Sets and controls action of the flow Totalizers. NOTE: Start totalizer at Flow value has to be entered for Volumetric and Mass flow conditions in fraction %FS notation (0.0 – 1.0) Limit volume has to be entered: -for Volumetric flow conditions in currently selected volume EU -for Mass flow conditions in currently selected mass EU If Totalizer hit limit event is not required, set "Limit Volume" value (argument 4) to zero. Totalizers reading is stored in EEPROM (non volatile) memory. Power cycle will not affect Totalizers reading.	12	T	1 (Totalizer #1) 2 (Totalizer #2)	Z (Reset to zero) V – Volumetric. Flow Condition M – Mass. Flow Condition D (disable totalizer)* E (enable totalizer) R (read current totalizer volume) S (setting status)	<value> (start totalizer at flow) Fraction %FS not. (0.0 – 1.0) <value> (start totalizer at flow) Fraction %FS not. (0.0 – 1.0)	<value> (Limit volume in current Volumetric E.U.) <value> (Limit volume in current Mass based E.U.)	T1:Z or T2:Z T1V:0.1, 0.0 or T2V:0.1, 0.0 T1M:0.1, 0.0 or T2M:0.1, 0.0 T1:D or T2:D T1:E or T2:E T1R:<value> or T2R:<value> (in current EU) T1S:Mode,Condition,StartFlow,LimitVolume or T2S:Mode,Condition,StartFlow,LimitVolume

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Pulse Output	Sets and controls action of the programmable Pulse Output circuitry. NOTE: Unit/Pulse value has to be entered:-for Volumetric flow conditions in currently selected volume EU -for Mass flow conditions in currently selected mass EU EU has to be not time based.	13	P	C (flow configuration)	V-volum. flow M-mass flow	<Value> (Unit/Pulse) Volumetric flow - current Volumetric E.U. Mass flow - current mass EU (example: 10 liter/pulse)		PCV:<value>,<value> Example: PCV:V,10 Or PCM:<value>,<value> Example: PCM:M,2.5
	It is recommended to set the unit/pulse value equal to the maximum flow in the same units per second. This will limit the pulse to no faster than one pulse every second. Example: Maximum flow rate: 1200 liter/min (1200 liter/min = 20 liters per second) If Unit/Pulse is set to 20 liters per pulse, the output will pulse once every second.			T (Pulse active Time in ms) [10 -13000 ms]	<value> [10 -13000 ms]			PT:<value> Example: PT:1000
				D (disable pulse output)* E (enable pulse output)				P:D P:E
				Q (read current pulse output Queue value)				PQ:<value> (number of pulses)
				S (setting status)				PS:Mode,FlowConditions, Unit/Pulse,PulseTimeInterval
Fluid Density for standard conditions	Read and set Fluid Density for standard conditions in g/cm3 NOTE: it is not measured density.	14	FD	(New Density Value) 0.0001 Density 10.0 g/cm3 No Argument (Returns Current Density in g/cm3)				FD:<value> Example: FD:1.293 FD:<value> Example: FD:1.293

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Units of measure	<p>Set units of measure for flow rate, temperature, pressure, density, and totalizer reading.</p> <p>Note: The units of the totalizer output are not per unit time.</p> <p>For Volumetric user defined units: k-Factor value represents conversion value from L/min.</p> <p>For Mass user defined units: k-Factor value represents conversion value from g/min.</p> <p>Time base argument: S - seconds M – minutes H – hours D- days</p> <p>Density argument: Y - use density N – do not use density</p> <p>Temperature, Pressure and Density EU only supported if T/P hardware is installed.</p> <p>lgal - Imperial Gal MilL – million liters Bbl - Barrels</p>	15	U	V	% (% F.S.)* ltr/min ltr/hr ltr/day m^3/sec m^3/min m^3/hr m^3/day f^3/sec f^3/min f^3/hr f^3/day gal/sec gal/min gal/hr gal/day lgal/sec lgal/min lgal/hr lgal/day MilL/sec MilL/min MilL/hr MilL/day bb/sec bb/min bb/hr bb/day VOLUSER (user defined) No Argument (status)			UV: % UV: ltr/sec UV: ltr/min UV: ltr/hr UV: ltr/day UV: m^3/sec UV: m^3/min UV: m^3/hr UV: m^3/day UV: f^3/sec UV: f^3/min UV: f^3/hr UV: f^3/day UV: gal/sec UV: gal/min UV: gal/hr UV: gal/day UV: lgal/sec UV: lgal/min UV: lgal/hr UV: lgal/day UV: MilL/sec UV: MilL/min UV: MilL/hr UV: MilL/day UV: bb/sec UV: bb/min UV: bb/hr UV: bb/day UV: VOLUSER <F>, <T> UV: <EU name>

COMMAND NAME	DESCRIPTION	NO.	COMMAND SYNTAX					
			COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
			M	gram/sec gram/min gram/hr gram/day kg/sec kg/min kg/hr kg/day lb/sec lb/min lb/hr lb/day Mton/sec Mton/min Mton/hr Mton/day Ston/sec Ston/min Ston/hr Ston/day Lton/sec Lton/min Lton/hr Lton/day				UM:gram/sec UM:gram/min UM:gram/hr UM:gram/day UM:kg/sec UM:kg/min UM:kg/hr UM:kg/day UM:lb/sec UM:lb/min UM:lb/hr UM:lb/day UM:Mton/sec UM:Mton/min UM:Mton/hr UM:Mton/day UM:Ston/sec UM:Ston/min UM:Ston/hr UM:Ston/day UM:Lton/sec UM:Lton/min UM:Lton/hr UM:Lton/day
				MASSUSER (user defined)	<k-factor value>	<Time Base>	<F>,<T>	
			T**	No Argument (status)			UM:<EU name> UT:F UT:C UT:K UT:R UT:<EU name>	
				No Argument (status)			UT:<EU name>	

COMMAND NAME	DESCRIPTION	NO .	COMMAND SYNTAX						RESPONSE
			COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE	
				P**	psi				UP:psi
					bar				UP:bar
					mbar				UP:mbar
					inHg				UP:inHg
					mmHg				UP:mmHg
					kPa				UP:kPa
					MPa				UP:MPa
					atm				UP:atm
					gcm2				UP:gcm2
					kgc2				UP:kgc2
					torr				UP:torr
					No Argument (status)				UP:<EU name>
				D**	g/cm^3				UD:g/cm^3
					kg/m^3				UD:kg/m^3
					g/litr				UD:g/litr
					kg/litr				UD:kg/litr
					lb/ft^3				UD:lb/ft^3
					lb/gal				UD:lb/gal
					lb/in^3				UD:lb/in^3
					No Argument (status)				UD:<EU name>

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Calibration Settings	Sets/Reads Calibration related variables. Argument 1 = T Hours since last time unit was calibrated. NOTE: has to be reset to zero after calibration.	19	CS	S Meter Size/Pipe ID [inches]	<Value> [inches]			CSS:<value> Example: CSS:0.75
				F Meter Full Scale Range in liter/min	No Argument (Returns Current Meter Size settings)			CSS:<value> Example: CSS:0.75
					<Value> [liter/min]			CSF:<value> Example CSF:1000.0
					No Argument (Returns Current Meter FS Range)			CSF:<value> Example: CSF:1000.0
				C Meter Calibration Factor Hz/liter/min (for STD conditions)	<Value> [Hz//min]			CSC:<value> Example CSC:1.0
					No Argument (Returns Current Meter Calibration Factor)			CSC:<value> Example CSC:1.0
				O Meter Low and High Frequency Cut Off [Hz]	<Low Cut off Value> (Hz)	<High Cut off Value>(Hz)		CSO:<Low CutOff Value>,<High CutOff Value>
					No Argument (Returns Current Cut off Values settings)			CSO:<Low CutOff Value>,<High CutOff Value>
				L Meter Low Flow Cut Off in % of full scale	<Value> (%FS)			CSL:<value> Example: CSL:5.0
					No Argument (Returns Current value)			CSL:<value> Example: CSL:5.0
				T Calibration/Maintenance Timer	No Argument (read timer)			CST:<value> Example: CST:1024.2
					Z Set Cal. Timer to Zero			CSTZ

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
PWM DSP Settings	Sets/Reads PWM DSP related variables. Argument1 = V: Display/Change Meter Vortex Frequency Source Following Vortex Frequency sources are supported: 0 - Automatic 1 - Pulse Counts 2 - PWM 3 - FFT 4 - AWD PWM	20	PW	V Read/Change Meter Vortex Frequency Source 0 - Automatic 1 - Pulse Counts 2 - PWM 3 - FFT 4 - AWD PWM	<New Source> 0-4 No Argument (Returns Current Vortex Frequency source settings)			PWV:<value> Example: PWMV:0 PWV:<value> Example: PWMV:0
			I	Pulse Measure Interval	<new value> in mS [500-60000]			PWI:<value> Example: PWI:2000
			D	Flow NRF Damping [0-99 sec.]	No Argument (Returns Current set.)			PWI:<value> Example: PWI:2000
			F	NRFilter Parameters: NRF Sample Numb. NRF Time Limit NRF Error Limit	<new value> [1-32] No Argument (Returns Current set.)	<new val.> [0-32]	<new val.> [0.0-100.0%]	PWD:<value> Example: PWF:4,8,0,0
			W	Turbulence Flow Window 0 - Disabled	<new value> [0-99] No Argument (Ret. Current settings)			Example: PWF:4,8,0,0
			L	Flow Meter Linearizer E - Enable D - Disable	<New Value> E or D No Argument (Ret. Current settings)			PWW:<value> Example: PWW:0 PWW:<value> Example: PWW:0
								PWL:<value> Example: PWL:E PWL:<value> Example: PWL:E

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
FFT DSP Settings	Sets/Reads FFT DSP related variables. FFT Sample/Second: 0 – Automatic 1 – 8000 samples/sec 2 – 4000 samples/sec 3 – 2000 samples/sec 4 – 1000 samples/sec 5 – 500 samples/sec	21	FT	M FFT Algorithm Mode: E- Enable D- Disable T FFT Trigger Level: 0 – Auto [1-4095] - Manual S FFT Sample/Second (manufacture only, do not change*) D FFT Damping (manufacture only, do not change*) N FFT Minimum Noise Threshold for Auto (manufacture only, do not change*) A Attenuation Mode and Target Level	<New Value> E or D No Argument (Ret. Current settings) <new value> [0-4095] No Argument (Ret. Current settings) <new value> [0-5] No Argument (Ret. Current settings) <New Value> E or D No Argument (Ret. Current settings) <new value> [0-5000] No Argument (Ret. Current settings)			FTM:<value> Example: FTM:E FTM:<value> Example: FTM:E FTT:<value> Example: FTT:60 FTT:<value> Example: FTT:60 FTS:<value> Example: FTS:1 FTS:<value>,<SF> Example: FTS:1,1000 FTD:<value> Example: FTF:D FTD:<value> Example: FTF:D FTN:<value> Example: FTN:500 FTN:<value> Example: FTN:500 FTA:<value> <value> Example: FTA:M,1000 FTA:<value>,<value> Example: FTA:M,1000

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
4-20mA Analog Output Settings	Sets/Reads Analog Outputs assignment, 4mA and 20mA Values. NOTE: 4mA and 20mA values have to be entered in corresponding to Argument 2 type EU (for Volum. in %FS). 0 - Disabled. 1-Volum. Flow: Current active volumetric flow EU. 2-Mass Flow: Current active volumetric flow EU. 3-Temperature: deg. C 4-Pressure: Pa.	22	A0	<Value> Channel: 1 or 2	<Value> Mode: [0-4] 0 - Disabled 1-Vol. Flow 2-Mass Flow 3-Temp. ** 4-Pressure **	<Value> 4mA value (in EU related to Mode value)	<Value> 20mA value (in EU related to Mode value)	Ch1 AO1:0,0,100 Ch2 AO2:2,0,0,26.0
Data Log	Reads Data Log entries, Sets Mode and Configuration of the data logger. Argument 1 = C DL Configuration (Argument2): 0 - Loop Enabled 1 - Loop Disabled 2 - Loop Disabled, number of samples to record DL Configuration (Argument3): Number of samples: [1-15871] (has to be submitted for all options, but only applicable for Argument 2 value 2), Argument 1 = V. Process Variable: 0-Volumetric Flow 1-Mass Flow 2-Temperature ** . 3-Pressure ** Argument 1 = T 0 - Unconditional 1 - PV Alarm High Event 2 - PV Alarm Low Event	23	DL	M Mode: E - DL Enable D - DL Disable C Configuration V Process Variable I Sample Interval in sec. T DL Start/Stop conditions Thresholds	<Value> E or D No Argument (Ret. Current settings) <Value> [0-2] No Argument (Ret. Current settings) <Value> [0-3] No Argument (Ret. Current settings) <Value> [1-3600] (Ret. Current settings) <Value> Start Cond[0-2] (Ret. Current settings)			DLM:<value> Example: DLM:E DLM:<value> Example: DLM:E DLC:<value><value> Example: DLC:0,1024 DLC:<value><value> Example: DLC:0,1024 DLV:<value> Example: DLV:0 DLV:<value> Example: DLV:0 DLI:<value> Example: DLI:1 DLI:<value> Example: DLI:1 DLT:<value><value> Example: DLT:0,0 DLT:<value><value> Example: DLT:0,0

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Natural Gas AGA8 equation related parameters	Sets/Reads Natural Gas AGA8 equation related parameters.	27	NG	M Mode: 0- Gas Density @ TP 1 – Real Spec. Gravity @ TP. D Gas Density @ TP (Lb/Ft ³). G Real Spec. Gravity @ TP (no units). F Molecular Fracture for N2 and CO2. Sum (N2 & CO2) ≤ 0.15. R Reference Temperature and Pressure (TP).	<Value> 0 or 1 No Argument (Ret. Current settings) <Value> (0.001-999.0) No Argument (Ret. Current settings) <Value> (0.001-999.0) No Argument (Ret. Current settings) <Value> N2 Mol. Fract. [0.0 – 0.15] No Argument (Ret. Current settings) <Value> Ref. Temp. (Deg. F) [-459–99999] No Argument (Ret. Current settings) <Value> 0 or 1 No Argument (Ret. Current settings)			NGM:<Value> Example:NGM:0 NGM:<Value> Example: NGM:0 NGD:<Value> Example: NGM:0.4994 NGD:<Value> Example: NGM:0.4994 NGG:<Value> Example: NGG:0.309 NGG:<Value> Example: NGG:0.309 NGF:<Value><Value> Example: NGF:0.006,0.004 NGF:<Value><Value> Example: NGF:0.006,0.004 NGR:<Value><Value> Example: NGR:50.0,100.0 NGR:<Value><Value> Example: NGR:50.0,100.0 NGM:<Value> Example: NGM:0 OGM:<Value> Example:OGM:0 OGG:<Value> Example: OGG:0.309 OGG:<Value> Example: OGG:0.309
Other Gas	Sets/Reads Other Gas equation related parameters. Mode: determines which parameter will be use in the equation.	28	OG	M Specific Gravity Mode: 0- ratio of molecular weight G. 1 – Ratio of Densities Gr at flowing TP. G Spec. Gravity Gr as Ratio of Densities at flowing TP (no units).	<Value> 0 or 1 No Argument (Ret. Current settings) <Value> 0 or 1 No Argument (Ret. Current settings)			NGM:<Value> Example: NGM:0 OGM:<Value> Example:OGM:0 OGG:<Value> Example: OGG:0.309 OGG:<Value> Example: OGG:0.309

COMMAND SYNTAX								
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
				R Spec. Gravity G as ratio of molecular weight. (no units)	<Value> (0.001-999.0) No Argument (ret. cur. set.)			OGR:<Value> Example: OGR:0.105
				C Critical Temperature and Pressure	<Value> Crit. Temp. (Deg. F) [-459-99999] No Argument (ret. cur. set.)	<Value> Crit. Pressure (PSIA) [0-99999]		OGR:<Value> Example: OGR:0.105 OGC:<Value><Value> Example: OGC:50.0,100.0
				Z Compressibility factor at flowing TP (applies only for T/P meters)	<Value> [0.0 – 1.0] No Argument (ret. cur. set.)			OGC:<Value><Value> Example: OGC:50.0,100.0 OGZ:<Value> Example: OGZ:0.325
				W Molecular weight (Lb/LbMol) (applies only for Ratio of Densities mode)	<Value> [0.0 – 9999.9] No Argument (ret. cur. set.)			OGW:<Value> Example: OGW:18.3581 OGW:<Value> Example: OGW:18.3581
Flowing Units Parameters	Sets/Reads Temperature and Pressure parameters for STD, NORMAL, and Customer Actual units. NOTE: Actual Units parameters equal to the Actual Flowing Conditions. Customer Actual Units Temperature and Pressure can be used to change flow conditions for meters without T/P option.	29	FP	S Standard Units Temperature and Pressure	<Value> STD Temp. (Deg. F) [-459-99999] No Argument (ret. cur. set.)	<Value> STD Pressure (PSIA) [0-99999]		FPS:<Value><Value> Example: FPS:70.0,14.7 FPS:<Value><Value> Example: FPS:70.0,14.7
				N Normal Units Temperature and Pressure	<Value> NORM Temp. (Deg. C) [-273-99999] No Argument (ret. cur. set.)	<Value> NORM Press (KPa) [0-99999]		FPN:<Value><Value> Example: FPN:0.0,101.3 FPN:<Value><Value> Example: FPN:0.0,101.3
				C Customer Actual Units Flowing Temperature and Pressure (see Note in description)	<Value> Actual Temp. (Deg. F) [-459-99999] No Argument (ret. cur. set.)	<Value> Act. Pressure (PSIA) [0-99999]		FFC:<Value><Value> Example: FFC:50.0,100.2 FFC:<Value><Value> Example: FFC:50.0,100.2

		COMMAND SYNTAX						
COMMAND NAME	DESCRIPTION	NO.	COMMAND	ARGUMENT 1	ARGUMENT 2	ARGUMENT 3	ARGUMENT 4	RESPONSE
Read EEPROM Memory	Reads the value in the specified memory location.	30	MR	0 to 218 (Memory Table Index)				<memory value>
Write EEPROM Memory	Writes the specified value to the specified memory location. Use Carefully, can cause unit to malfunction. (Note: Some addresses are write protected!)	31	MW	20 to 218 (Memory Table Index)	<Value>			MW,XXX,<Value> where: XXX= Table Index Example: MW,176,101.3

UART Error Codes:

- 1 - Not Supported Command or Back Door is not enabled.
- 2 - Wrong # of Arguments.
- 3 - Address is Out of Range (MR or MW commands).
- 4 - Wrong # of the characters in the Argument.
- 5 - Attempt to Alter Write Protected Area in the EEPROM.
- 6 - Proper Command or Argument is not found.
- 7 - Wrong value of the Argument.
- 8 - Reserved.
- 9 - Manufacture specific info EE KEY (wrong key or key is disabled).

Diagnostic and System events codes and bit position:

Code	Event Description	Bit position
0	CPU Temp. High	0x0000001
1	Freq > HiLimit	0x0000002
2	High Flow Alm.	0x0000004
3	Low Flow Alarm	0x0000008
4	High Temp Alm.	0x0000010
5	Low Temp Alm	0x0000020
6	High Pres Alm.	0x0000040
7	Low Press Alm.	0x0000080
8	Tot#1 > Limit	0x0000100
9	Tot#2 > Limit	0x0000200
10	OptPulse Queue	0x0000400
11	Flow Turbulen.	0x0000800
12	Flow < Cut Off	0x0001000
13	Event Log Over	0x0002000
14	Data Log Over.	0x0004000
15	System L Event	0x0008000

System Events:

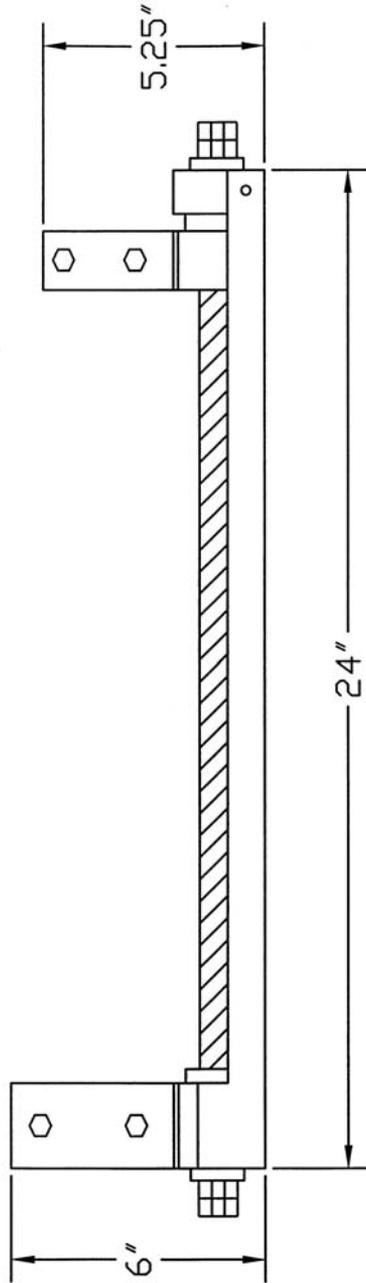
16	PEZO SENS. FAULT	0x0010000
17	TEMP SENS. FAULT	0x0020000
18	PRES SENS. FAULT	0x0040000
19	SER. COMM. ERROR	0x0080000
20	EEPROM ACC ERROR	0x0100000
21	BATTERY FAILURE	0x0200000
22	POWER ON EVENT	0x0400000
23	PASSWORD EVENT	0x0800000
24	FATAL ERROR	0x1000000

Liquids	Name	Index
	Water	0
	Ammonia	1
	Chlorine	2
	Oil	3
	Other Liquid	4
Gases		
	Natural Gas	0
	Steam	1
	Air	2
	Argon	3
	Ammonia	4
	CO	5
	CO2	6
	Helium	7
	Hydrogen	8
	Methane	9
	Nitrogen	10
	Oxygen	11
	Other Gas	12

APPENDIX C
MECHANICAL DRAWINGS

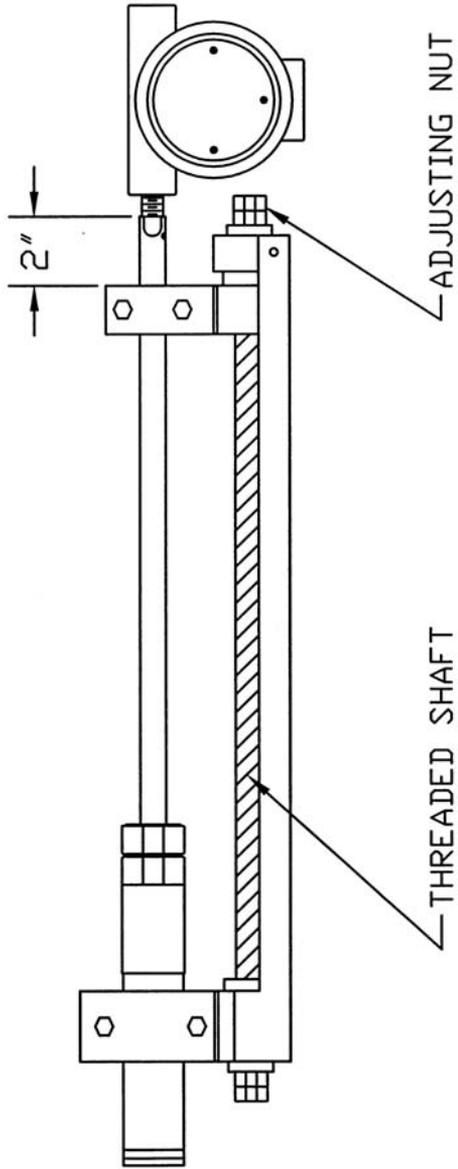
Insertion Model Flow Meter

INSERTION TOOL - SHORT VERSION

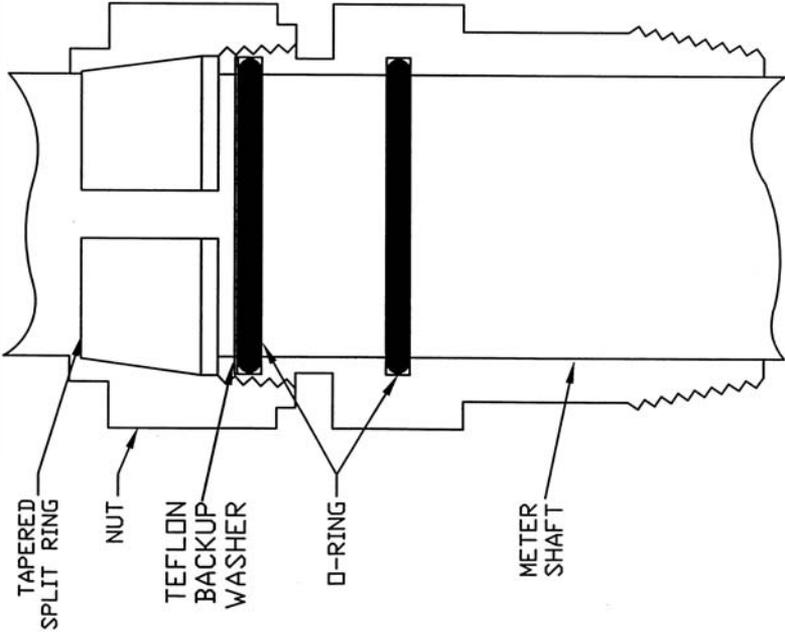


Insertion Model Flow Meter

HOT TAP INSERTION TOOL / CLAMP ON INSERTION TOOL



Insertion Model Flow Meter



SEAL ASSEMBLY

Seal is not dependent on tightness of nut!
No metal to metal seal.

The O-rings seal the meter shaft.
The higher the pressure, the tighter the seal.

The tapered split ring grips the meter shaft.
The higher the pressure, the stronger the grip.

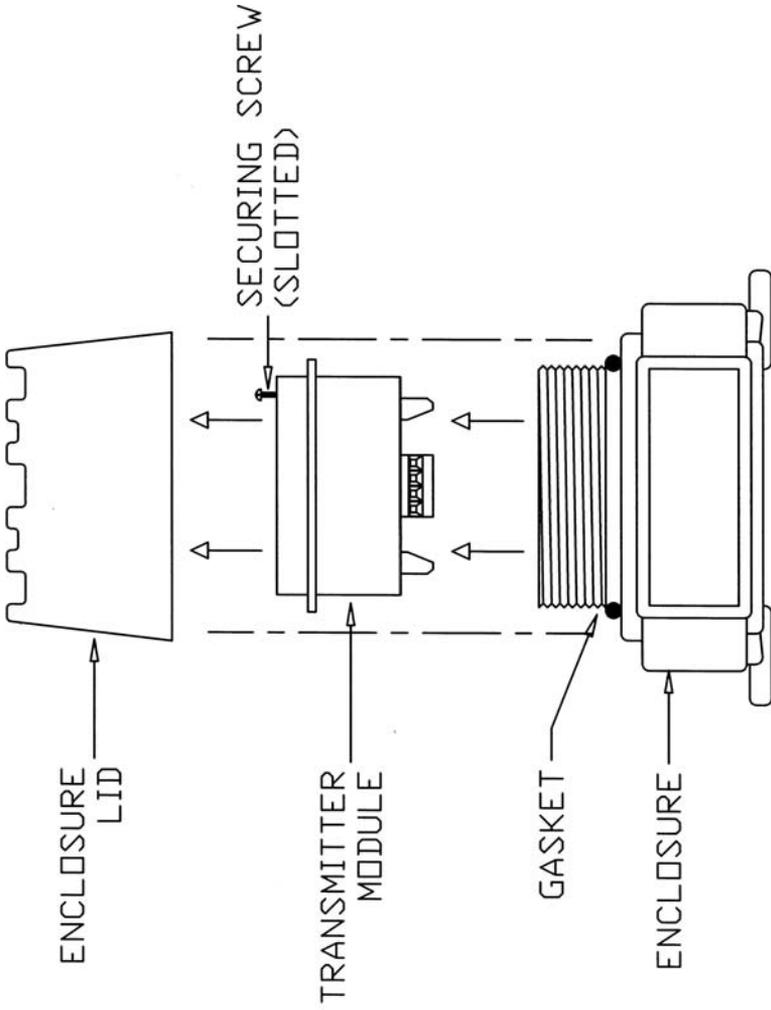
The meter shaft is held by the friction grip of tapered split ring and nut.

Seal is unaffected by vibration.

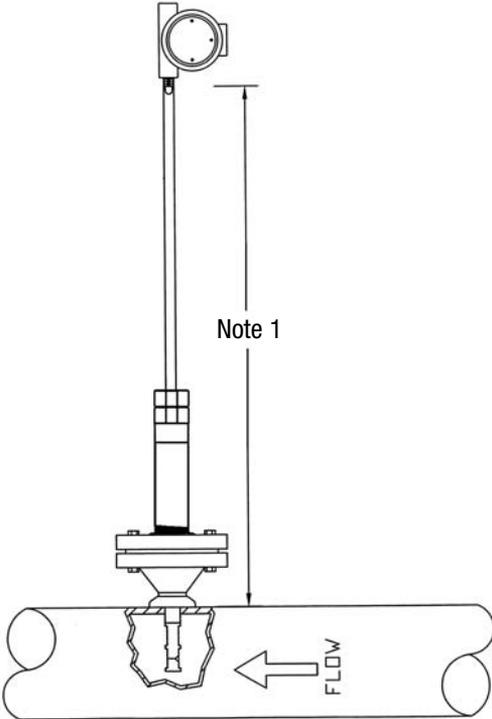
Insertion Model Flow Meter

TRANSMITTER ASSEMBLY

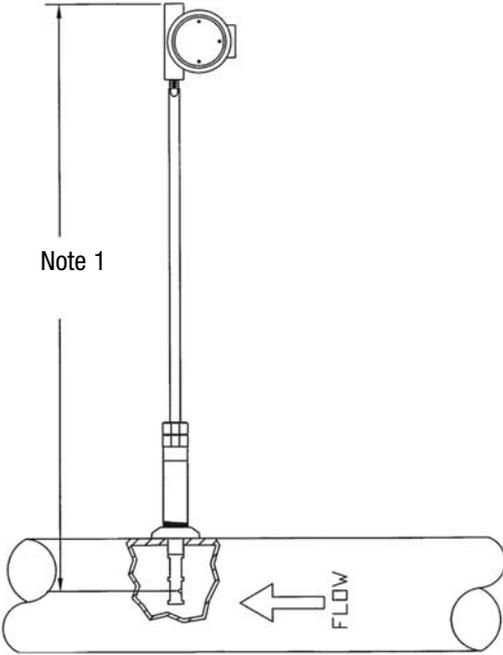
NO T/P OPTION



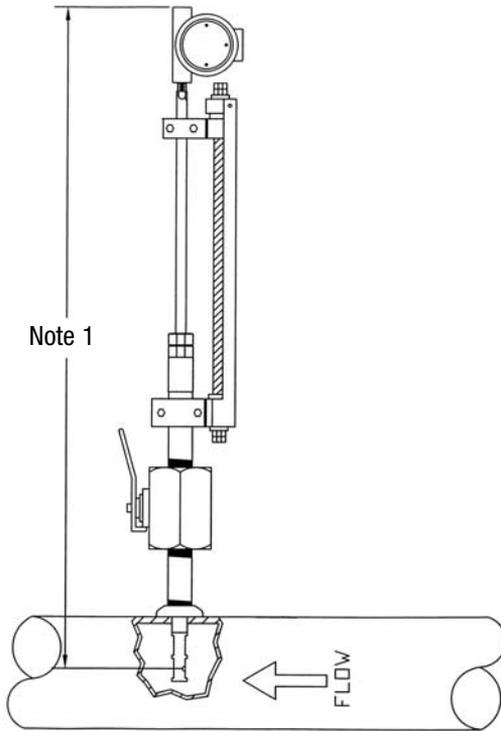
Flanged Insertion Meter



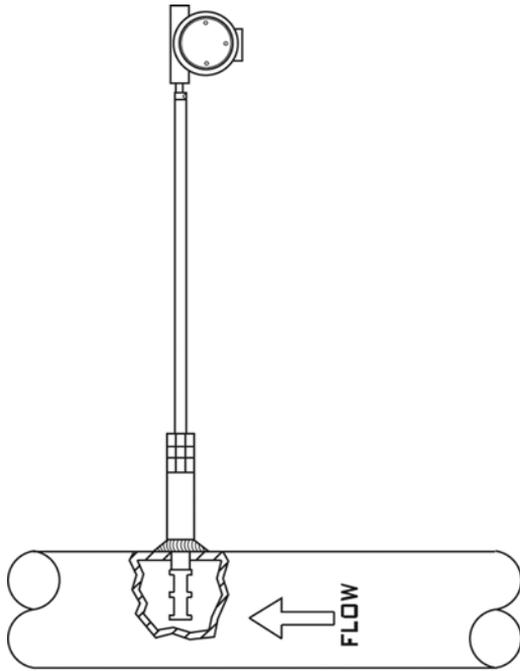
1-1/2" MNPT Insertion Meter



1-1/2" Insertion Meter Assembly with Insertion Tool and Ball Valve



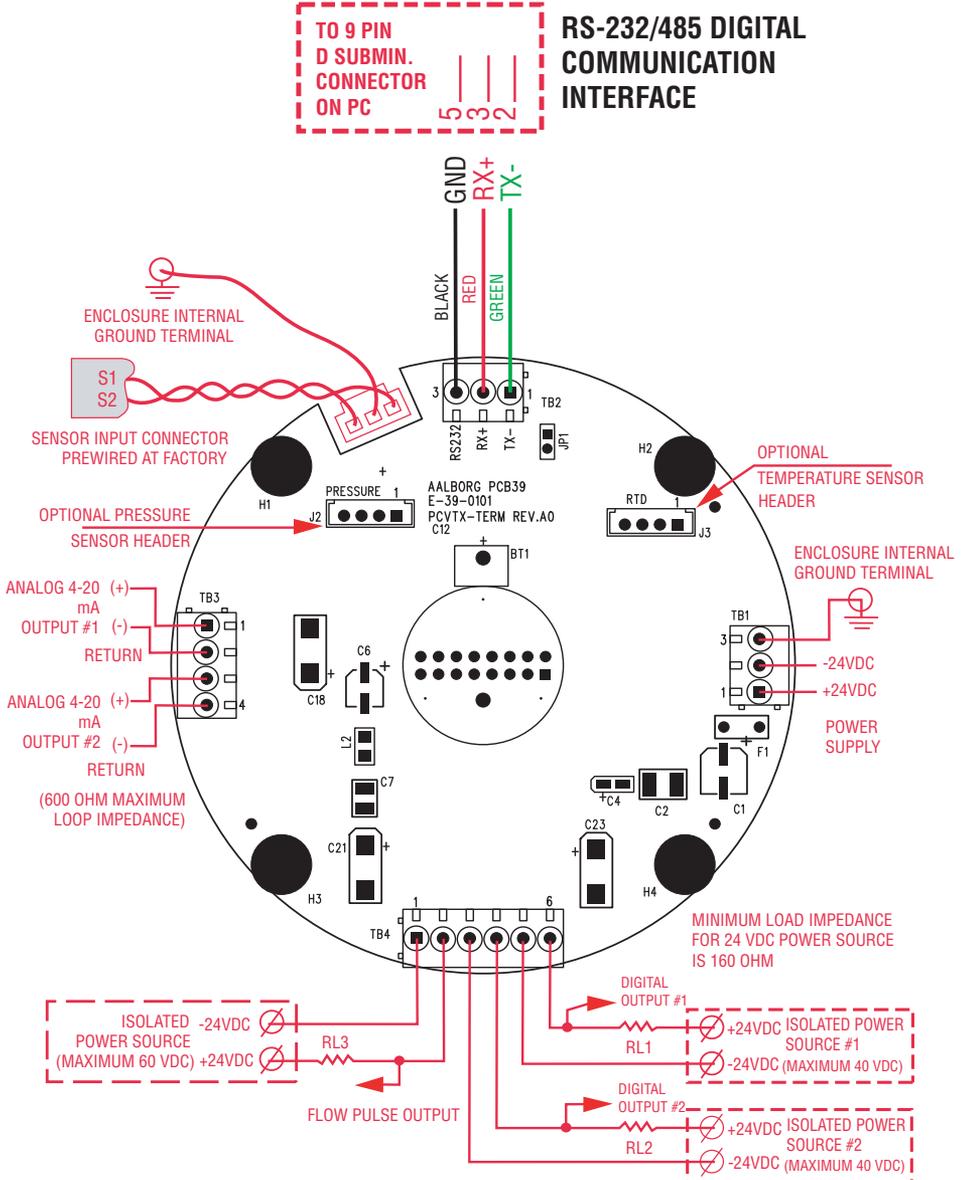
1-1/2" Welded Insertion Meter



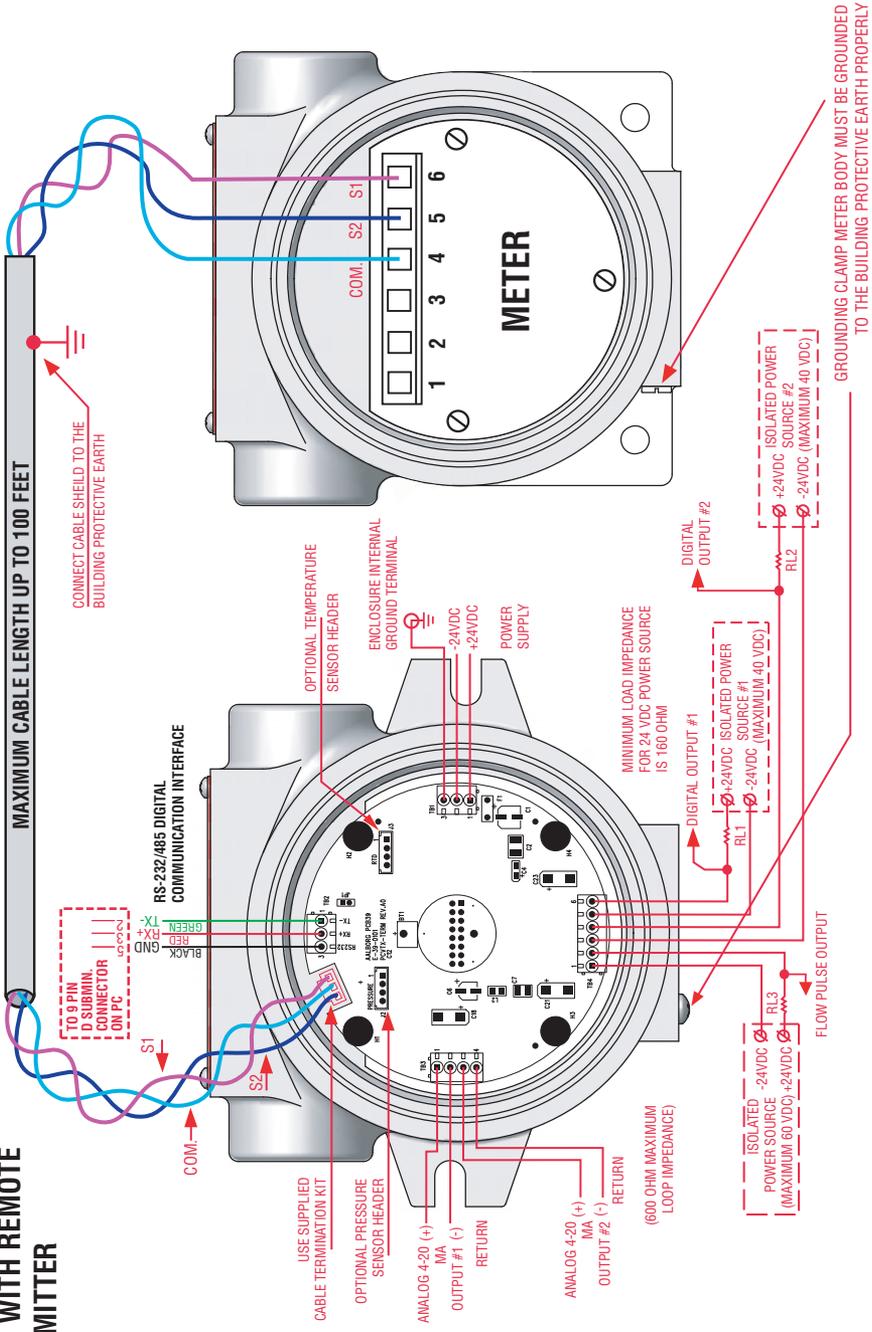
Note 1: Length dependent on pipe diameter, thickness, and mounting.

APPENDIX D ELECTRICAL INTERCONNECT OPTIONS

24 VDC WITH LOCAL TRANSMITTER



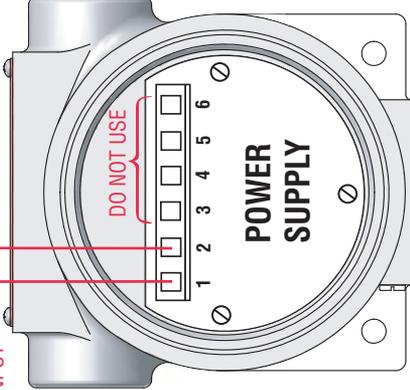
24 VDC WITH REMOTE TRANSMITTER



110VAC AND 220VAC WITH REMOTE TRANSMITTER

WARNING: AC/DC POWER SUPPLY IS NOT UNIVERSAL. MAKE SURE YOU APPLY CORRECT AC VOLTAGE ACCORDING TO POWER SUPPLY AC VOLTAGE RATING.

110 VAC
220 VAC
POWER
INPUT



RED
BLACK

COM. →

S1 →

S2 →

RS-232/485

RED
BLACK

ENCLOSURE
INTERNAL
GROUND TERMINAL

DIGITAL OPTOCOUPLER
OUTPUTS

ANALOG 4-20 mA
OUTPUTS

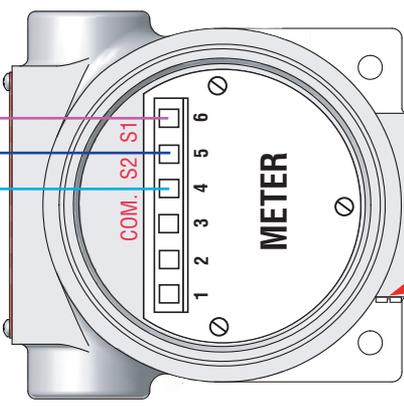
GROUNDING CLAMP METER BODY MUST BE GROUNDED
TO THE BUILDING PROTECTIVE EARTH PROPERLY

INTERCONNECT

MAXIMUM CABLE LENGTH UP TO 100 FEET

CONNECT CABLE SHIELD TO THE
BUILDING PROTECTIVE EARTH

DC POWER
PREWIRED AT FACTORY



METER

COM. S2 S1

1 2 3 4 5 6

110VAC AND 220VAC WITH LOCAL TRANSMITTER

WARNING: AC/DC POWER SUPPLY IS NOT UNIVERSAL. MAKE SURE YOU APPLY CORRECT AC VOLTAGE ACCORDING TO POWER SUPPLY AC VOLTAGE RATING.

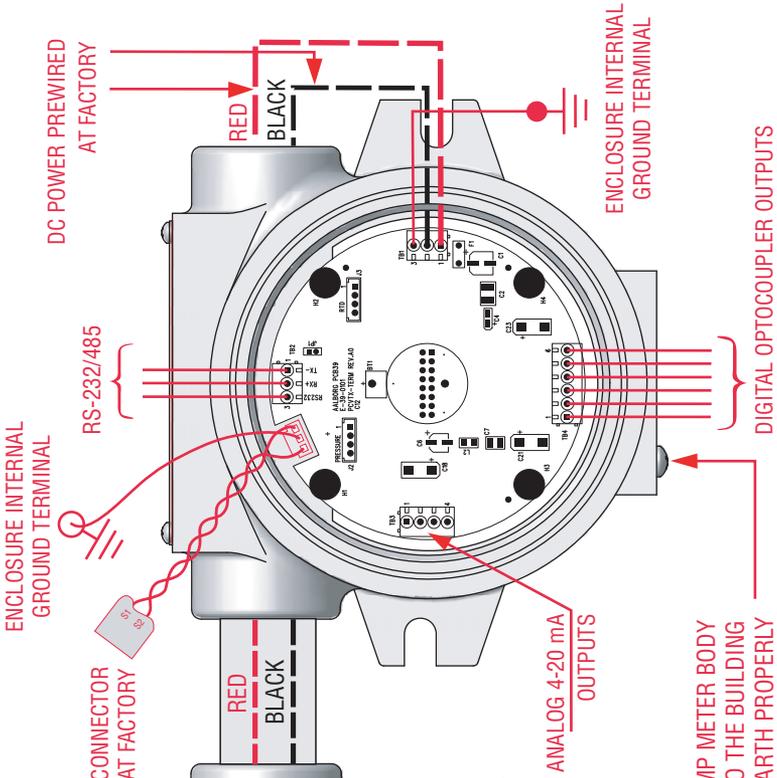
110 VAC
or 220 VAC
POWER
INPUT

SENSOR INPUT CONNECTOR
PREWIRED AT FACTORY

DO NOT USE

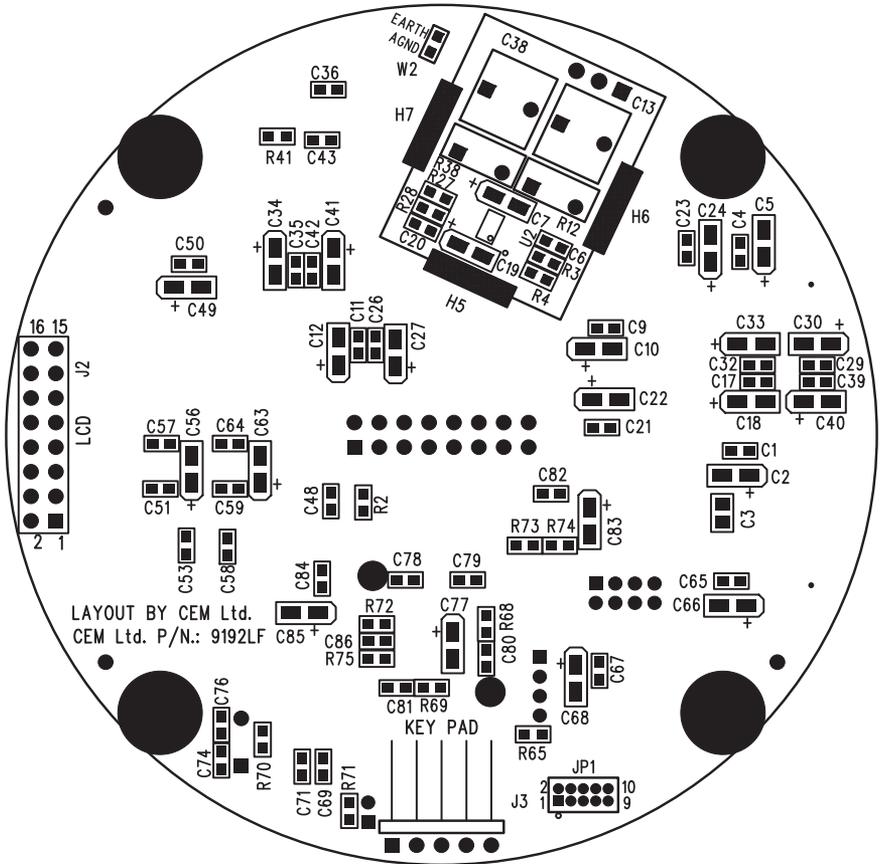
POWER
SUPPLY

INTERCONNECT



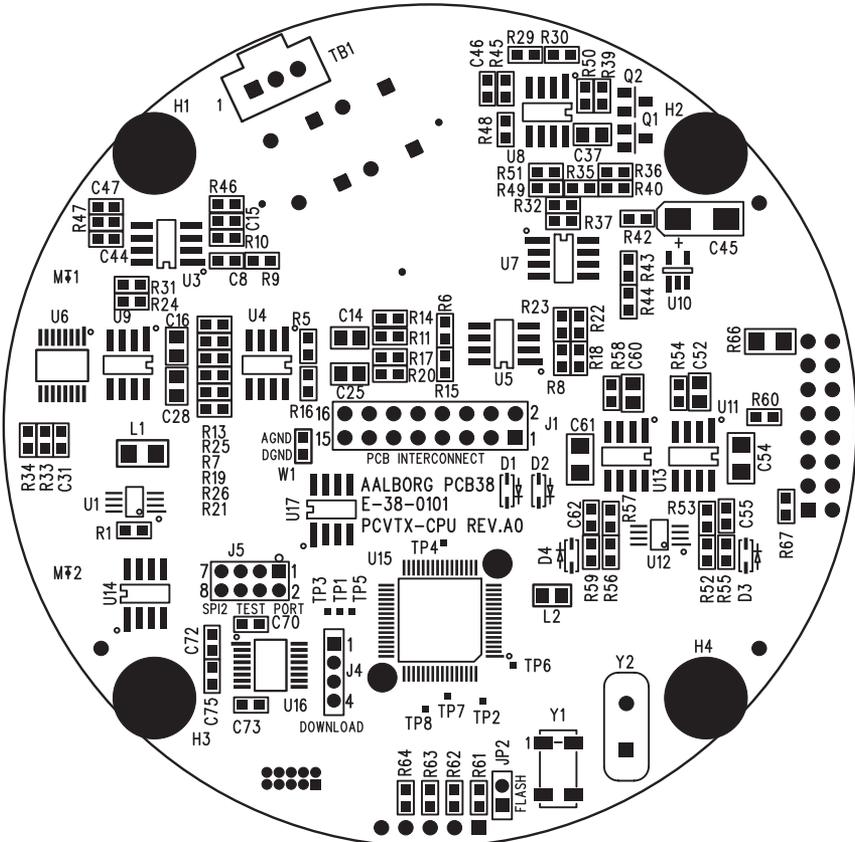
APPENDIX E CIRCUIT DIAGRAMS

PCVTX-CPU TOP SIDE



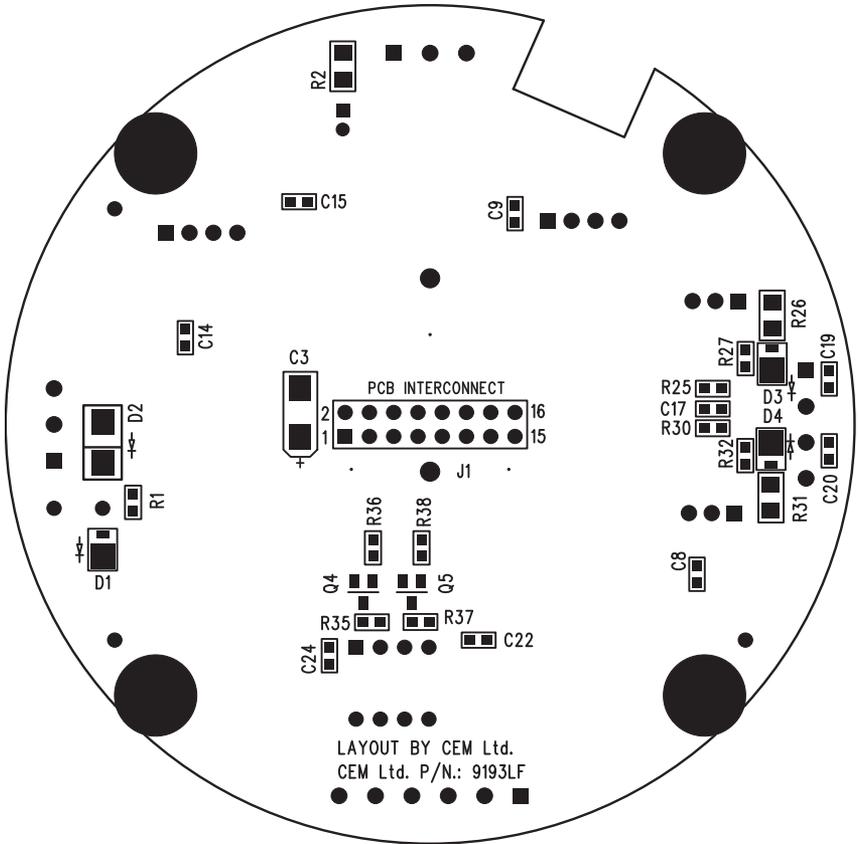
VIEW FROM PRIMARY SIDE

PCVTX-CPU BOTTOM



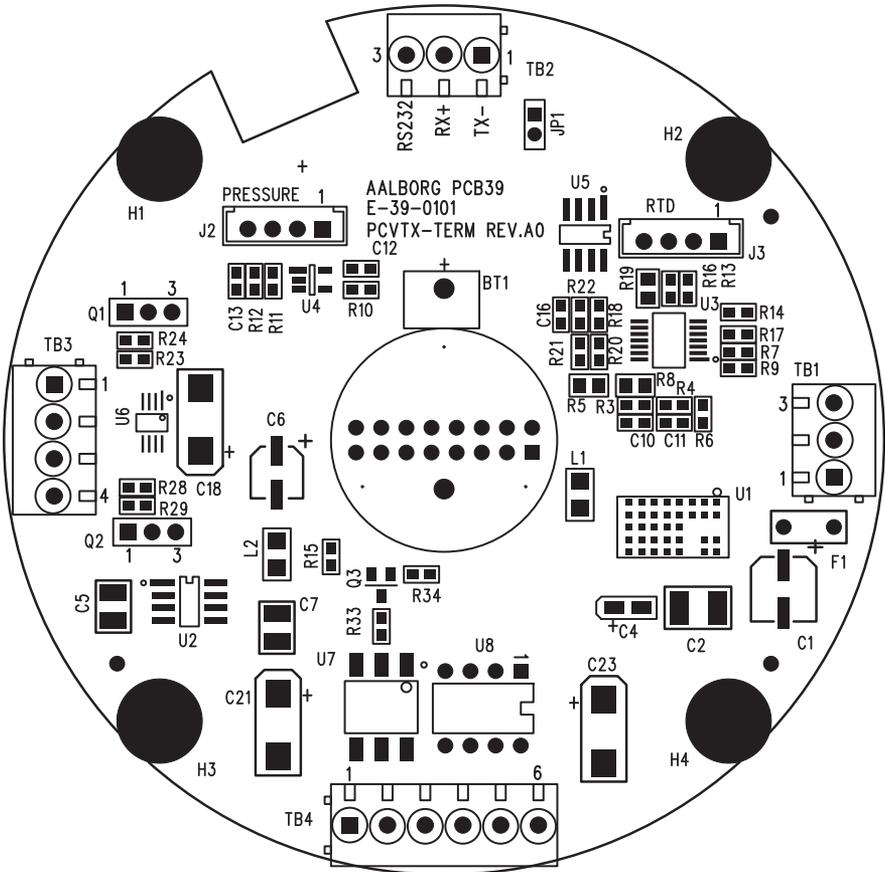
VIEWED FROM PRIMARY SIDE

PCVIX-TERM BOTTOM



VIEWED FROM PRIMARY SIDE

PCVTX-TERM TOP



VIEWED FROM PRIMARY SIDE

WARRANTY

Aalborg® Vortex Systems are warranted against parts and workmanship for a period of one year from the date of purchase. Calibrations are warranted for up to six months after date of purchase, provided calibration seals have not been tampered with. It is assumed that equipment selected by the customer is constructed of materials compatible with gases used. Proper selection is the responsibility of the customer. It is understood that gases under pressure present inherent hazards to the user and to equipment, and it is deemed the responsibility of the customer that only operators with basic knowledge of the equipment and its limitations are permitted to control and operate the equipment covered by this warranty. Anything to the contrary will automatically void the liability of Aalborg® and the provisions of this warranty. Defective products will be repaired or replaced solely at the discretion of Aalborg® at no charge. Shipping charges are borne by the customer. This warranty is void if the equipment is damaged by accident or misuse, or has been repaired or modified by anyone other than Aalborg® or factory authorized service facility. This warranty defines the obligation of Aalborg® and no other warranties expressed or implied are recognized.