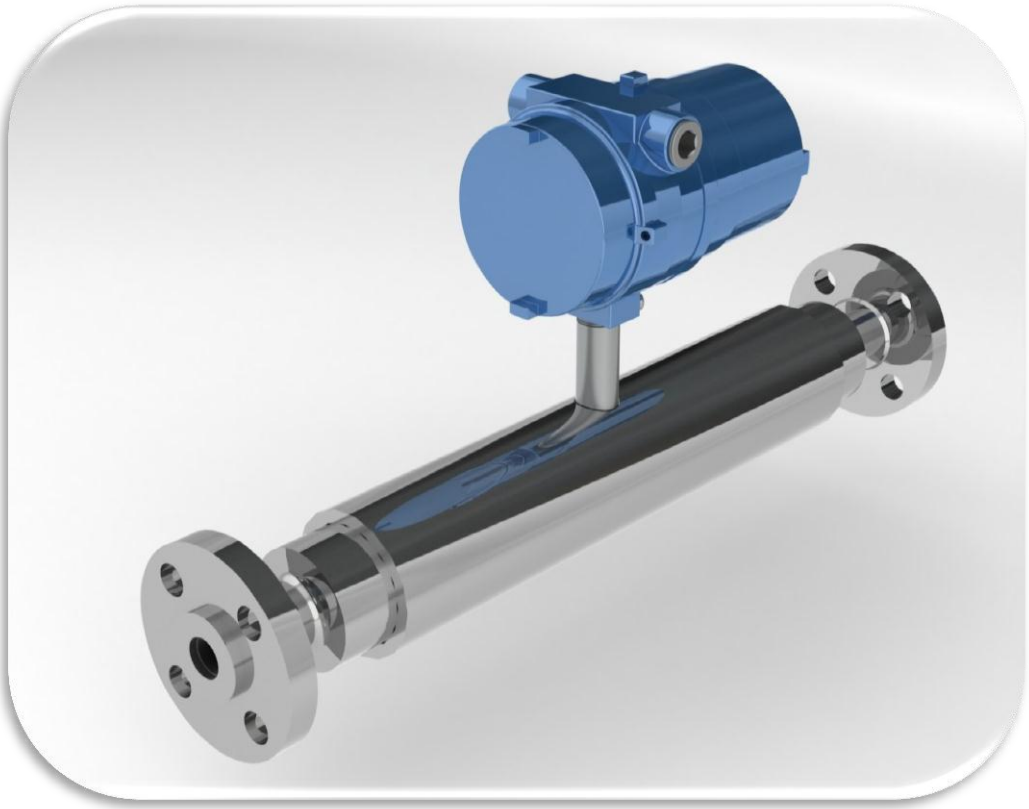
DENSITRAK® SVT OPERATION MANUAL



INTRODUCTION

We sincerely ***THANK YOU*** for your purchase of an ANALYTICAL FLOW TECHNOLOGIES DENSITRAK® SVT Density Meter (Henceforth, SVT).

This manual is intended for the personnel responsible for the installation, operation and/or maintenance of the ANALYTICAL FLOW TECHNOLOGIES SVT density meter.

This manual explains the following topics:

Safety and Precautions
Brief History of ANALYTICAL FLOW TECHNOLOGIES
Principle of Operation
Specifications
Features and Benefits
Installation
Operation
Maintenance
Field Density Output Correction (Error offset)
Troubleshooting

Carefully read this manual prior to installation and operation of this meter to ensure safe and proper operation.

Do NOT discard this manual - Always keep it in a place where you can access it for quick reference. If you lose or require additional copies of this manual refer to the ANALYTICAL FLOW TECHNOLOGIES website (**densitrak.nt-rt.ru**) for a PDF version.

Carefully read ALL Safety Precautions and Important Notes prior to installation and operation of this meter.

THE ANALYTICAL FLOW TECHNOLOGIES SVT MODEL DENSITY METER CAN BE UTILIZED IN MANY VARIOUS FLUID DENSITY MONITORING APPLICATION, SUCH AS:

- Water and Wastewater Treatment
- Petroleum Refinery and Pipeline Applications
- Fluid Product Blending & Interface Detection
- Pulp & Paper Manufacturing
- Chemical Processing
- Power Generation
- …and many more

IMPORTANT SAFETY INFORMATION

SAFETY CAUTIONS

SYSTEM PRESSURE: Do NOT expose meter to pressure greater than the meter and/or flange rating – whichever is lowest.
Do NOT pressure test meter above 1.5 x operating pressure.

MATERIAL COMPATIBILITY: Do NOT expose the meter wetted parts to fluids (chemicals) that are NOT COMPATIBLE with the materials of construction.
Consult ANALYTICAL FLOW TECHNOLOGIES engineers with any questions regarding material compatibility.

EXPLOSION HAZARD: The cables and fittings provided with this meter are not certified for use in hazardous or explosive environments unless specifically noted on the meter and electronics enclosure.

HEAVY OBJECT: Handle the meter with care and request assistance when lifting, moving or installing.
Dropping the meter can cause injuries and/or equipment failure.

ELECTRICAL HAZARD: Remove power source prior to installation or maintenance of the density meter.
Ensure that all electrical connections and or maintenance are performed by properly qualified personnel.

ENVIRONMENT: DO NOT operate meter in situations where continuous line vibration is greater than 0.5g.

IMPORTANT NOTES

INSTALLATION: Do not install the meter in situations where:
- Meter is exposed to excessive vibration
- Meter can become submerged in water or other fluids
- Meter can come in contact with corrosive materials
- Meter is hard to access for periodic maintenance

PROCESS FLUIDS: All process fluids must be compatible with the wetted parts of the meter.

TRANSPORTATION: NEVER transport the meter with hazardous fluids still entrapped in the meter or process connections.
Please notify ANALYTICAL FLOW TECHNOLOGIES of the process fluids utilized in the meter prior to returning to the factory for repair or service.
A CLEANING FEE applies to ALL METERS returned to ANALYTICAL FLOW TECHNOLOGIES that have not been thoroughly cleaned prior to return.

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HISTORY OF ANALYTICAL FLOW TECHNOLOGIES

The DENSITRAK® SVT 1 Inch Diameter liquid density meter was ORIGINALLY designed by Calibron Systems, Inc. of Scottsdale, AZ. Calibron Systems, Inc. was eventually acquired by Honeywell Enraf. Honeywell Enraf licensed the exclusive rights for manufacture and service of the DENSITRAK® meter to Analytical Flow Technologies in March 2010.

Analytical Flow Technologies is owned and operated by Paul Heinritz, who has a long relationship with the DENSITRAK® Densitometer in which he ran the DENSITRAK® product line for Calibron Systems, Inc. and briefly for Honeywell Enraf prior to the DENSITRAK® production move to Pune, India. Analytical Flow Technologies emphasizes American-Made products, along with high quality customer service and support to differentiate itself from the large corporation alternatives.

THEORY OF OPERATION

The liquid density meter uses the spring mass principle for measuring the fluid density. A portion of the measurement tube is energized (transmit sensor) to vibrate and to maintain its natural resonant frequency by using an electrical feedback driving system. A change in the vibrating mass, (as a result of change in the fluid density) shifts the resonant frequency which is interpreted by the receive sensor. The signal is then output to the density processing unit via internal wiring.

An ANALYTICAL FLOW TECHNOLOGIES density processing unit (SPUD) uses algorithms that incorporate temperature (integrated into the meter), pressure (via an external pressure transmitter 4-20mA output) and the shift in frequency to determine the density of the measured fluid.

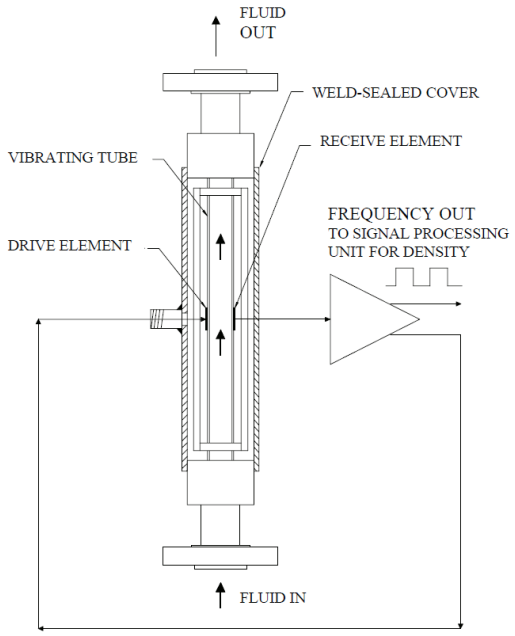


FIGURE 1: SVT OPERATION THEORY

DENSITY EQUATIONS

A simple definition for Density (for a homogeneous object) is the mass of the object divided by the volume of the object. Thus, common units of fluid density are grams per cubic centimeter, kilograms per cubic meter, and pounds per cubic foot.

The hydrometer is probably the most common device used to measure fluid density in which it measures the volume displaced by an object of known mass. The pycnometer is another instrument used for measuring fluid density. However, these devices are mainly restricted for use in laboratories. Another instrument used to determine the density of a liquid is the Vibrating-tube density meter. The density meter is installed in a process flow system where it continuously monitors "real-time" fluid density.

The Vibrating-tube is a method to determine the density of liquids based on an electronic measurement of the frequency of oscillation. The density value is calculated by incorporating frequency of oscillation, fluid and case temperatures and pressure. The equations shown below are utilized by the density processor or flow computer to determine the density of the fluid flowing through the meter.

EQUATION 1: UNCORRECTED (PERIODIC) DENSITY EQUATION

$$D_U = K_0 + (K_1 * T) + (K_2 * T^2)$$

- *D_U = Density of the fluid based on the periodic time (frequency of oscillation) of the meter. It is UNCORRECTED for Temperature and Pressure. Unit = grams per cubic centimeter [gr/cm³]*
- *T = Periodic Time (frequency of Oscillation) of the density meter. Unit = microseconds [µs]*
- *K_0, K_1, K_2 = Density Coefficients. These coefficients vary for each meter and are determined at the factory during the meter calibration process. Refer to the Calibration Certificate included with your meter.*

EQUATION 2: TEMPERATURE CORRECTED DENSITY EQUATION

The temperature correction algorithms are proprietary to Analytical Flow Technologies.

EQUATION 3: PRESSURE CORRECTED DENSITY EQUATION

$$D_{PT} = D_T + K_{Pv} * D_T * P + K_{P0} * P + K_{P1} * P^2$$

- *D_{PT} = Pressure & Temperature corrected Density, [gr/cm³]*
- *D_T = Temperature Corrected Density , [gr/cm³]*
- *K_{Pv}, K_{P0}, K_{P1} = Pressure Correction Density Coefficients – included with Calibration Certificate.*
- *P = Live pressure in Pounds per square inch [PSI_G]*

PRODUCT SPECIFICATIONS

ANALYTICAL FLOW TECHNOLOGIES SVT/1AA0 Product Specifications Chart

Density Operating Range	0.50 – 3.00 grams/cubic centimeter [gr/cm^3]
Maximum Density Span	0.70 gr/cm^3 (range can be extended with reduction in accuracy)
Density Resolution	0.00001 gr/cm^3
Meter Accuracy	0.00075 gr/cm^3
Repeatability[1]	Better than 0.01%
Operating Temperature	Standard: 50°F to 140°F [10°C - 60°C] Optional: 32°F to 203°F [0°C - 95°C]
MAX Temp. Differential	ΔT_{max} = 90°F [50°C]
Operating Pressure	Range: 0 to 2,220 PSI [0 – 153 bar] Hydrostatic Test: 1.5 times line pressure
Flow Rate[2]	MIN: .25 Gallons per Minute (GPM) MAX: 55 GPM
Frequency Signal Output	Nominal 0.30 kHz to 3.0 kHz
Temperature Sensor	100Ω Pt RTD (α = .00385)
Power Requirement	VOLTAGE: 24 V_{DC} CURRENT: 75 mA nom.
Materials of Construction	Standard Wetted Parts: • 316/316L Stainless Steel • HASTELLOY® C276 Non-Wetted Parts: 304 Stainless Steel
Electrical Classification	Standard Explosion-Proof Class I, Division 1, Group D Housing Approved: CSA, FM, EExd, UL
Physical Dimensions	SEE APPENDIX DRAWING Shipping Weight: Approx. 40 pounds

[1] Based on density meter's raw frequency output. Field accuracy of the density reading ultimately depends upon the collective effects (RMS) of all measurements standards of density, temperature, pressure inputted during calibration, operational data collection and processing.

[2] Note: The measuring liquid must be free of air or gas bubbles since they will adversely affect the operating frequency of the Density meter.

BENEFITS AND FEATURES

The ANALYTICAL FLOW TECHNOLOGIES SVT density meter offers a multitude of design features which greatly benefit the customer while also maintaining an affordable price.

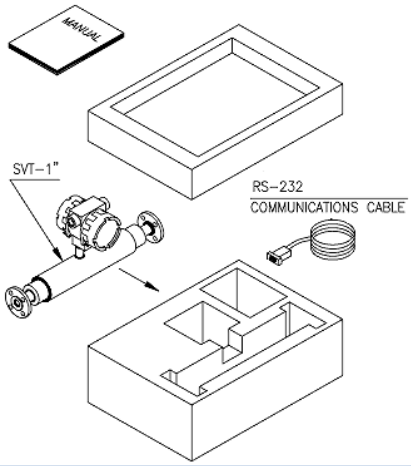
BENEFITS	FEATURES
• **Small, compact design with a variety of flange configurations** • **Free draining/lower pressure drop** • **Safe design integrity.** • **Temperature compensated density.** • **Detects small density changes.** • **No radioactive source.** • **Quick connect can be installed or moved easily.** • **Suitable for narrow range applications.** • **Made & Assembled in the USA**	• **Small, compact design.** • **No moving parts.** • **Dynamic calibration.** • **Outer shell pressure rated above operating pressure.** • **Integral RTD's.** • **High resolution.** • **Non-nuclear.** • **RoHS Compliant.**

UNPACKING

Please verify that ALL of the STANDARD items listed below were included in the meter package.

Use check box to verify.

	Item	Qty
☐	SVT Density Meter w/ Electrical Housing	1
☐	RS232 COM Cable	1
☐	Laminated Calibration Certificate (w/ Calibration Coefficients)	1
☐	Certificate of Conformance	1
☐	User Manual	1



INSTALLATION

Proper installation is crucial to the overall performance of the SVT Density Meter. The accuracy of the meter can be adversely affected by improper installation.

To ensure meter accuracy it is imperative that the items listed below be considered prior to installation of the meter into the system.

Also note that there must be some scheme present in the process flow system to induce sufficient flow through the meter. Refer to the Process Connections section for more detail.

INSTALLATION PLANNING

Prior installation planning is critical for the best metering results. The table below outlines a "checklist" of important items for proper installation planning.

PERFORMANCE - Installation Planning Checklist

☐	All joints and couplings are airtight – GAS Bubbles in process fluid must be avoided
☐	Meter is connected at a sufficient (> 10ft) distance from fluid pump
☐	Pump (if applicable) is oriented so that it pushes fluid through the meter – NOT Pulls
☐	Avoid vibration from surrounding equipment
☐	Fluid should be at sufficient flow rate (> 1 GPM) with little or no cavitations as it enters the meter
☐	Avoid installing in an environment with quick and extreme temperature changes. ALWAYS USE AN INSULATION JACKET FOR OUTDOOR INSTALLATIONS.
☐	Avoid mounting in direct sunlight or near surfaces with extremely high temperatures.
☐	Refer to the meter dimensions prior to choosing a suitable location

SAFETY - Installation Planning Checklist

☐	Ensure SAFE & PROPER handling of the meter during installation
☐	Do NOT drop the meter or expose to extreme impacts
☐	Adhere to all LOCAL electrical safety regulations
☐	Only trained personnel should be allowed to install or maintain the meter
☐	Verify that the process fluid is compatible with the wetted material of the density meter

MAINTENANCE - Installation Planning Checklist

☐	Mount meter in an area that provides sufficient space for proper piping and process connections
☐	Installation of a BYPASS and Valves should be considered between the meter and process connections to facilitate easy removal for periodic maintenance
☐	Plan an adequate location for the REMOTE ELECTRONICS (if applicable) enclosure.

Once you've fully planned your installation, the next step is to unpack and assemble your SVT meter.

INSTALLATION DIMENSIONS

The diagrams below outline the overall mounting dimensions for the SVT Density Meter. Please take these dimensions into consideration. All dimensions shown are in INCHES. Weight is approximately 16 pounds empty of fluids.

SIDE-VIEW DIMENSIONS

All dimensions shown are in INCHES.

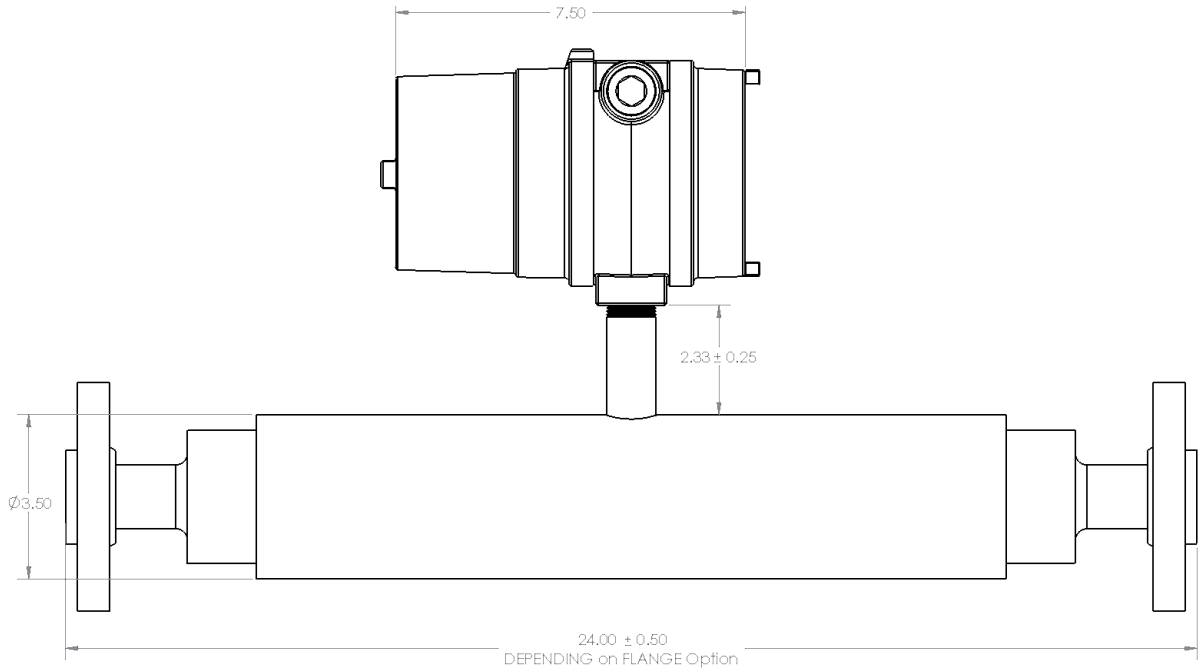


FIGURE 2: DENSITRAK SVT - SIDE VIEW - DIMENSIONS

FRONT-VIEW DIMENSIONS

All dimensions shown are in INCHES.

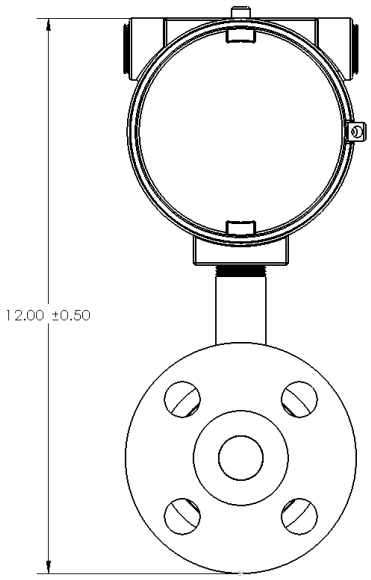


FIGURE 3: DENSITRAK SVT – FRONT VIEW – DIMENSIONS

METER ASSEMBLY/INSTALLATION

The SVT is shipped to the customer essentially fully assembled. The customer must simply attach the INLET and OUTLET flow connections and the electrical cable gland and make the proper electrical connections.

ANTI-SEIZE LUBRICANT: Each DENSITRAK SVT ships with a small tube of anti-seize lubricant. Ensure that all threaded connections are coated with a layer of anti-seize lubricant unless the threaded connection already utilizes Teflon tape.

Install the meter into your Fluid Processing System:

1. Ensure that your piping configuration maintains a consistent flow rate
2. ALWAYS use an SVT Insulation Jacket (AFT P/N 101181) for meters installed outdoors.
3. Clean bore tube with a damp cloth prior to installation.
4. Try to minimize ambient vibration from the system and flow pumps – excessive vibration can adversely affect meter performance.

- KEEP THE PACKAGING IN THE EVENT THE METER NEEDS TO BE RETURNED FOR SERVICE
- DO NOT DISCARD THE LAMINATED CALIBRATION CERTIFICATE

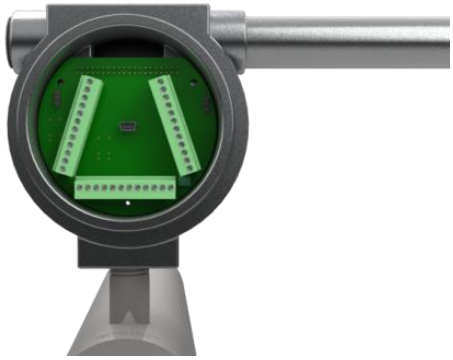
Once the meter is securely mounted in an appropriate location the next step is to connect the electronics.

SVT METER – ELECTRICAL CONNECTIONS

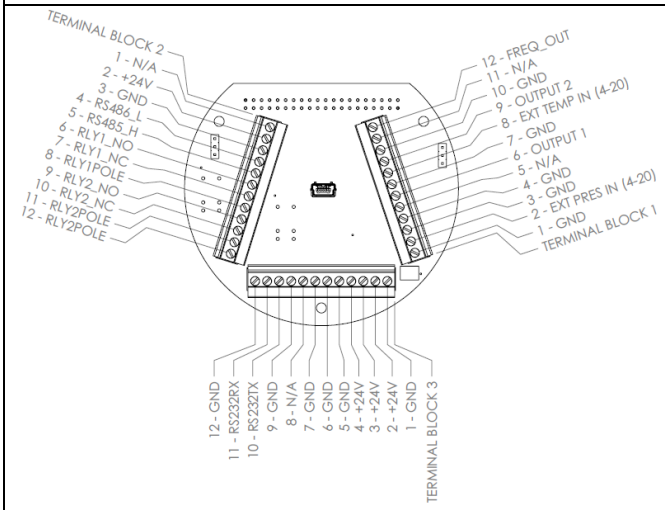
Electrical connections to the SVT meter are very simple – you simply supply DC power (+24 V_{DC}) to the Electronics Package and connect the 4-20mA outputs of the electronics package to your controls.

MODEL SVT EX-PROOF ENCLOSURE ELECTRICAL CONNECTIONS

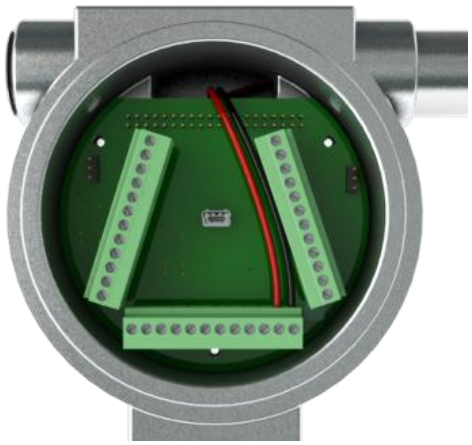
Remove the ELECTRICAL ENCLOSURE COVER, and the ¾ "NPT PLUG from the electronics assembly.



Connect your electronic cabling to the meter via cable gland to either of the ¾ " FNPT ports located on either side of the enclosure.



The customer interface board terminal block wiring locations are shown above. Each interface will be discribed in detail in the following steps.



To power the meter, connect ground to terminal block 3 pin 1 (black) and +24 VDC to terminal block 3 pin 2 (red).

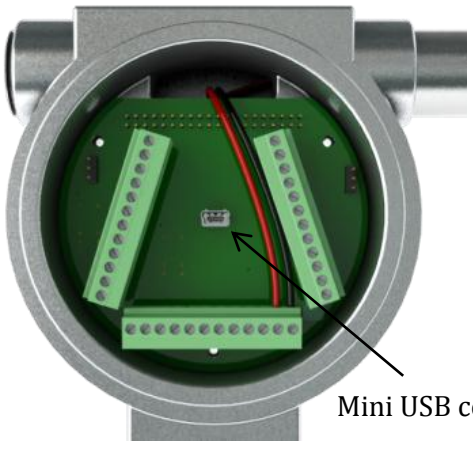
MODEL D625 EX-PROOF ENCLOSURE ELECTRICAL CONNECTIONS COMMUNICATE WITH AND CONNECTING TO METER OUTPUTS

To collect data from the meter make the following connections (to change ouput 1 and 2 refer to sofware manual);

1. Frequency (4-20mA) to terminal block 1 pin 12 (blue)
2. Output 1 (Density 4-20mA) to terminal block 1 pin 6 (purple)
3. Output 2 (Fluid Temp 4-20mA) to terminal block 1 pin 9 (purple)
4. Ground to terminal block 1 pin 10 (green)

To communicate with the meter thruough RS232 make the following connections;

1. RS232RX to terminal block 3 pin 11 (blue)
2. RS232TX to terminal block 3 pin 10 (yellow)
3. Ground to terminal block 3 pin 12 (green)



To communicate with the meter thruough USB connections, connect directly to the mini USB connector in the center of the customer interface board.

To input external pressure (4-20mA) into the meter make the following connections;

1. External PRES(+) to terminal block 1 pin 2 (blue).
2. Ground to terminal block 1 pin 3 (green).

MODEL D625 EX-PROOF ENCLOSURE ELECTRICAL CONNECTIONS
CONNECTING TO METER INPUTS

ELECTRICAL INSTALLATION NOTES

GROUNDING: The meter should ALWAYS be grounded to an adequate earth ground

POWER SUPPLY: Voltage drops due to wiring, barriers, etc. must be considered prior to sourcing a suitable power supply.

WIRE & CABLE: Shielded cable is recommended for all field wiring between the meter and the signal processors.

For intrinsically safe wiring and hazardous installation, refer to National Electrical Code Article 500 and ISA-RP12.1, ISA-S12.4 & ANSI/ISA-RP12.6

METER – PROCESS FLOW INSTALLATION

The ANALYTICAL FLOW TECHNOLOGIES SVT meter can be mounted in a variety of methods, however the meter should be as near to the metering point as possible.

Flow rate through the SVT meter is a critical component for performance – the flow rate should be high enough to achieve temperature stability – but not so high as to cause cavitation's/vibration or severe pressure drop. The recommended flow rates are 1-6 GPM minimum, and 55 GPM maximum.

The diagrams on the following pages are examples of some typical installations. These diagrams are not intended to encompass all possible configurations for installing the SVT Density Meter. Please consult ANALYTICAL FLOW TECHNOLOGIES engineers with any questions regarding your specific installation.

- ANALYTICAL FLOW TECHNOLOGIES Engineers can design a system installation tailored to your specific requirements.

It is critical that you plan your installation according to the "Installation Planning" section outlined earlier in this manual.

Important considerations for proper installation are:

- ✓ Adequate flow through the density meter – some method must be used to ensure proper flow through the meter.
- ✓ Avoid severe vibration – if the meter is to be installed in an area with severe vibration, the use of flexible hoses (tubing) is recommended.
- ✓ Allow adequate distance between the density meter and pump (if installed)
- ✓ Gas/Air bubbles must not be present in the meter during normal operation. Horizontal mounting of the meter is recommended.
- ✓ Locate the meter in a suitable location for convenient access during periodic maintenance.
- ✓ Avoid installing in areas where the temperature effects from the ambient environment are severe. The use of an insulation jacket may be required depending on your installation.

- API Chapter 14, Section 6, outlines density meter and Pycnometer installation for Natural Gas Liquid applications.

INLINE SETUP INSTALLATION

The diagram below is an example of an INLINE INSTALLATION. The meter is simply placed in-line with customer process piping/tubing.

It is recommended that valves be used at the inlet and outlet so the meter can be easily removed for periodic maintenance.

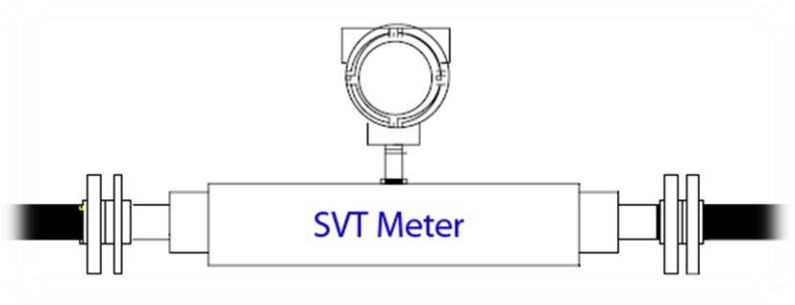


FIGURE 4: IN-LINE DENSITY METER INSTALLATION

ORIFICE / BYPASS SVT INSTALLATION

This installation method incorporates a bypass line. The flow in the pipeline causes flow through the tube which then runs through the meter and dumps back into the customer main-line. To induce flow through the meter it is recommended that some method be employed to create a PRESSURE DIFFERENTIAL between the INLET and OUTLET ports of the Densitometer. An ORIFICE PLATE or VALVE can be incorporated to create the pressure differential across the meter. FIGURE 5 below is a typical installation – however, valves should be employed at the INLET and OUTLET to allow easy REMOVAL for periodic maintenance.

Pressure differential is defined as:

$$\Delta P = P_1 - P_2$$

P_1 = upstream pressure
P_2 = downstream pressure

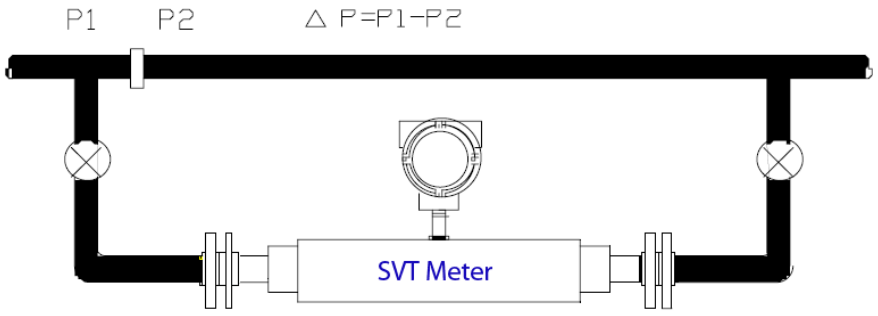


FIGURE 5: TYPICAL DENSITRAK SVT "BYPASS INSTALLATION" SETUP

OTHER INSTALLATION METHODS

MOTOR-DRIVEN PUMP

This installation incorporates a motor driven pump to draw fluid from the customer pipeline. This installation incorporates ball valves at the inlet and outlet of the densitometer to allow for easy meter maintenance and service. The pump is installed so that the fluid is "pushed" through the meter.

TANK INSTALLATION

This installation involves process connections between the density meter and a fluid holding (mixer) tank. The meter can be installed so that the fluid inside the tank is run through the meter and then pumped back up into the tank.

There are numerous other methods in which the meter can be installed into your system. Proper planning of your installation is essential to consistent, accurate, repeatable performance.

METER MAINTENANCE

It is normal for the SVT to accumulate deposits or corrosion after extended use. These deposits adversely influence the natural resonant frequency of the meter and should be removed. The procedure for removing these deposits is fast and easy to perform – and in most cases does not require the meter to be completely removed from the system.

Use a NYLON one inch bore brush at least 24 inches in length with a mild detergent to scrub any residue from the internal resonant tubes. Always thoroughly flush with fresh water prior to re-installation into your system

If the meter ever requires a return to the factory for recalibration or repair, the meter should be cleaned and flushed prior to shipping.

SVT METER MUST BE CLEANED AND RINSED PRIOR TO ANY FACTORY RETURN

DENSITY OUTPUT – FIELD CALIBRATION

The ANALYTICAL FLOW TECHNOLOGIES SVT meter is calibrated at the factory with many various fluids and various flow rates – however, there may be occasions where field calibration (adjustment of the **K_0** density coefficient) is required. Many factors influence whether an adjustment of the **K_0** density coefficient is required, such as:

- ✓ Process pipeline flow rates
- ✓ Noise or vibration in the process pipeline
- ✓ Temperature differential

WHEN TO FIELD CALIBRATE…

If the density meter is CONSISTENTLY displaying a density output reading that is above or below the ACTUAL density of the fluid flowing through the pipe a simple adjustment of the **K_0** density coefficient can be performed so that the meter is calibrated to the actual fluid.

When comparing density readings of any fluids – the temperature (and pressure) of the fluid must be consistent (the same) for each device measuring density.

The **K_0** density coefficient can be found on the Calibration Certificate that was included with your density meter. The **K_0** density coefficient can also be read (and displayed) by the included Windows ® Software that shipped with your meter. The Windows® software is also required when making adjustments to **K_0.**

FIELD CALIBRATION EXAMPLE:

An example of a **K_0** adjustment might be as follows:

Distilled Water at 68°F (and minimal pressure) flowing through the meter reads (outputs) 0.99865 gr/cm^3 on the meter, but we know (from tables, or hydrometer, pycnometer, etc) that distilled water has a density of 0.99740 gr/cm^3 at 68°F. This means that the meter has an *error offset of* ***+0.00125*** *gr/cm^3* at 68°F.

We can correct that error by simply adjusting the **K_0** density coefficient by the amount of the error offset, and then entering the new **K_0** density coefficient into the density processor or flow computer.

EQUATION 4: K_0 DENSITY OFFSET EQUATION

$$K_{0(NEW)} = K_{0(OLD)} + error_{offset}$$

The table below guides you through the **K_0** Coefficient adjustment for the above Example.

CONTACT ANALYTICAL FLOW TECHNOLOGIES ENGINEERS WITH ANY QUESTIONS CONCERNING YOUR SPECIFIC APPLICATION.

EXAMPLE: Field Calibration - K_0 Density Coefficient Offset Adjustment			
Original K_0 Value	$K_{0(old)}$ = -0.433394018		
Meter fluid Temperature	T_{fluid} =	68	°F
Density Reading from SVT Meter	D_{meter} =	0.99865	gr/cm³
Actual Fluid Density[1,2]	D_{actual} =	0.99740	gr/cm³
Density Error Offset (E_{offset})	$E_{offset} = D_{actual} - D_{meter} \rightarrow E_{offset} = .99740 - .99865 \rightarrow E_{offset} = -.00125$		
Compute New K_0 Value	$K_{0(new)} = K_{0(old)} + E_{offset} \rightarrow K_{0(new)} = (-.433394018) + (-.00125)$		
	$K_{0(new)} = -0.434644018$		
Enter $K_{0(new)}$ into the Density processor or flow computer.			

FIELD CALIBRATION WORK TABLE

Field Calibration: K_0 Density Coefficient Offset Work Table		
Original K_0 Value	$K_{0(old)}$ =	
Meter fluid Temperature	T_{fluid} =	°F
Density Reading from SVT Meter	D_{meter} =	gr/cm³
Actual Fluid Density[1,2]	D_{actual} =	gr/cm³
Density Error Offset (E_{offset})	$E_{offset} = D_{actual} - D_{meter} \rightarrow E_{offset}$ =_____-_____	
	E_{offset} =	
Compute New K_0 Value	$K_{0(new)} = K_{0(old)} + E_{offset} \rightarrow K_{0(new)}$ = _____+_____	
	$K_{0(new)}$ =	
Enter $K_{0(new)}$ into the Density processor or flow computer.		

METER TROUBLESHOOTING

Refer to the table below for basic troubleshooting of the SVT Meter

Troubleshooting checklist	
Meter fails to turn on (No audible noise heard)	✓ Verify the +18-32 VDC power supply is properly connected ✓ Verify the cables are secured to the meter properly ✓ Verify customer wiring is connected to the correct pins ✓ INSPECT each terminal connection for broken wires or loose connections
Display fails to function (No LCD Output)	✓ Verify the cables are secured to the meter properly ✓ Verify the electronics enclosure is not damaged (i.e. no obvious cracks, breaks, etc.)
Meter Density output becomes erratic or inconsistent	✓ Corrosion or debris buildup inside the resonant tubes ✓ Clean per the cleaning procedure outlined earlier in this manual
Inconsistent Density Output Readings	✓ Air or gas bubbles are trapped in the system ✓ Purge air from the system ✓ Tighten all flanges, fittings and hoses ✓ Re-orient meter position to alleviate air in tubes ✓ External Vibration or Noise is present in the system
Inconsistent Density Output Readings	✓ Excessive Vibration present in the installation ✓ Install flexible tubing/hoses to the meter to reduce the amount of vibration felt by the meter
Inconsistent Density Output Readings	✓ Verify that the 4-20mA density output range is programmed correctly into the density processor ✓ Verify that your fluid is within the 4-20mA density output range
Incorrect Density Readings	✓ Verify that ALL CALIBRATION COEFFICIENTS are entered into the density processor or flow computer correctly (according to the Calibration Certificate)

Always handle the meter with care during unpacking, installation, service/maintenance, and shipping.

APPENDIX I: CONVERSION FACTORS

DENSITY

Convert From	Convert To	Unit	Multiplication Factor
Grams per Cubic Centimeter gr/cm³	Kilograms per cubic meter	kg/m³	1000.00
	Ounces per gallon	oz/gal	133.5265
	Pounds per cubic foot	lb/ft³	62.42796
	Pounds per cubic inch	lb/in³	0.03612729
Pounds per cubic foot lb/ft³	Grams per Cubic Centimeter	gr/cm³	0.01601846
	Kilograms per Cubic meter	kg/m³	16.01846
	Ounces per gallon	oz/gal	2.138889
	Pounds per cubic inch	lb/in³	0.0005787037

PRESSURE

Convert From	Convert To	Unit	Multiplication Factor
Bar	Pounds per square inch	PSI	14.50377
	Atmosphere	atm	0.9869233
	Kilopascal	kPa	100
	Megapascal	MPa	0.1
	Inches of Mercury		29.52999
Pounds per square inch PSI	Atmosphere	atm	0.06804596
	Kilopascal	kPa	6.894757
	Megapascal	MPa	0.006894757
	Inches of Mercury		2.036021
	Bar		0.06894757

FLOW RATE

Convert From	Convert To	Unit	Multiplication Factor
Gallons per minute GPM	Gallons per hour	GPH	60
	Liters per hour	l/hr	227.1247
	Liters per Minute	l/min	3.785412
	Cubic meters per hour	m³/hr	0.2271247
	Cubic meters per minute	m³/min	0.003785412
	Barrels (US) per minute	BPM	0.0317460
	Barrels (US) per hour	BPH	1.90476
Barrels per hour BPH	Gallons per hour	GPH	31.5000
	Liters per hour	l/hr	119.240
	Liters per Minute	l/min	1.98734
	Cubic meters per hour	m³/hr	0.119240
	Cubic meters per minute	m³/min	0.00198734
	Barrels (US) per minute	BPM	0.0166667

	Gallons per minute	GPM	0.525000

TEMPERATURE

°F = (°C*1.8)+32 °C = (°F-32)/1.8

NOTES

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