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P/N 20823-01-EN Rev-15

SONARtrac® Installation Manual
P/N 20822-01-EN Rev.15

CiDRA®

List Of Appendices

1 INTRODUCTION with INSTALLATION CHECKLIST

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1.1 Introduction

SONARtrac® passive sonar process monitoring systems utilize patented sonar array processing techniques to listen to and interpret flow turbulence generated by fluid flow and sound generated by process piping and instrumentation. The clamp-on design eliminates the need for cutting pipe or interrupting process flow during installation. The passive sonar process monitoring system is a platform of products designed to serve a variety of industrial applications.

The Model VF-100 (Volumetric Flow) Flow Monitoring System is a clamp-on system used to measure the volumetric flow rate within process pipes.

The Model HD VF-100 (High Dispersion Volumetric Flow) Flow Monitoring System is designed to provide accurate and reliable process flow measurements for difficult to characterize solid/liquid mixtures and challenging sand/rock slurry flows with varying velocities and densities within process pipes.

The Model PW VF-100 (Process Water Volumetric Flow) system is designed to provide measurement of process water. The transmitter firmware cannot be upgraded to measure gas volume fraction, nor are the PW VF-100 systems certified for use in hazardous areas.

The Model VF-50 (Volumetric Flow) system is designed to provide measurement of water, waste water, and waste water bi-products commonly associated with municipal water systems. The VF-50 cannot be upgraded to measure gas volume fraction.

The Model GVF-100 (Gas Volume (Void) Fraction) Monitoring System is used to measure the gas volume / void fraction (amount of free air /gas) contained in a fluid within process pipes on a real-time basis.

The Model VF/GVF 100 (Volumetric Flow / Gas Volume Fraction) Combined Monitoring System measures the volumetric flow and the gas volume / void fraction in process pipes. This is also available as with the HD option as an HD VF/GVF-100 Process Monitoring System.

The Model TAM-100 (Total Air Monitor) System is a real-time process monitoring system used to determine the non-dissolved gas present in any liquid or continuous process fluid. A small amount of process fluid is continuously diverted through the TAM from a process line sample tap. The process pressure is reduced to near-atmospheric pressure within the TAM. This allows dissolved gas within the fluid to come out of solution. The amount of entrained gas or air within the fluid is then calculated. Typically, the TAM bolts on to an existing plant I-beam or process pipe. The TAM is usually connected to a ~1-inch sample tap and is supplied with about 20 – 30 gpm of process flow. The process liquid is returned to the process once the measurement is made.

The passive sonar series of process monitors consists of sensor heads sized for different pipe diameters, each coupled with a size-independent transmitter.

In addition to models for installations in Ordinary Locations, certain model numbers of passive sonar meters are available with certifications for use in Class I, Division 2, Groups A, B, C, and D environments (per US and Canadian standards). Others are rated for Class I, Zone 2 Group IIB environments (per ATEX Standards). Look for the Hazardous Area certification markings on the Transmitter and Sensor Head labels and install in accordance with the corresponding Control Drawing.

This manual covers the basic installation and setup of SONARtrac® Process Monitoring Systems. In all cases, local safety and operating practices take precedence over the information contained within this document.

The chapter of this manual titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

1.2 Sensor Head Description and Function

The passive sonar sensor head contains no moving parts. The sensor head includes a sensor band and a fiberglass or stainless steel cover assembly to protect the sensor band. The sensor band is wrapped around and clamped onto the process pipe. A multi-conductor cable electrically connects the sensors to an electronic module mounted in the cover assembly. Signals from the electronic module exit through a connector mounted to the outer surface of the cover assembly.

1.3 Transmitter Description and Function

The passive sonar transmitter receives electrical signals from the sensor head. The signals are processed using sonar array processing firmware that displays the calculated results on an integral LCD screen. Results can be transmitted using the 4–20mA analog output, pulse output, alarm output, MODBUS / RTU RS-485/232 interface or optional Foundation Fieldbus™. The electronic assembly is housed in a rugged NEMA 4X enclosure.

1.4 Intellectual Property Notices

Passive Sonar Process Monitoring Products may be covered by one or more of the following granted U.S. Patent(s): 6,354,147; 6,424,872; 6,435,030; 6,443,226; 6,587,798; 6,594,530; 6,601,458; 6,609,069; 6,691,584; 6,732,575; 6,813,962; 6,862,920; 6,889,562; 6,988,411; 7,032,432; 7,058,549; 7,062,976; 7,086,278; 7,110,893; 7,121,152; 7,127,360; 7,134,320; 7,139,667; 7,146,864; 7,150,202; 7,152,003; 7,152,460; 7,165,464; 7,171,315; 7,181,955; 7,197,942; 7,253,742; 7,261,002; 7,275,421; 7,295,933; 7,308,820; 7,322,245; 7,322,251; 7,328,113; 7,330,797; 7,337,075; 7,340,353; 7,343,818; 7,343,820; 7,359,803; 7,363,800; 7,367,239; 7,367,240; 7,379,828; 7,389,687; 7,400,985; 7,426,852; 7,437,946; 7,440,873; 7,454,981; 7,474,966; 7,503,227; 7,516,024; 7,526,966; 7,571,633; 7,587,948; 7,596,987; 7,617,716; 7,657,392; 7,672,794; 7,673,524; 7,690,266; 7,725,270; 7,752,918; 7,793,555; 7,810,400; 7,882,750; 7,962,293; 7,963,175. Other patents are pending; see www.cidra.com for the latest listing of patents.

Third party end-user license agreements (“EULA”) are provided in Appendix G of this document.

*SONARtrac, SONAR*stick and logo are trademarks of CiDRA.

1.5 Warranty

The terms and conditions, including warranty, of the purchase of SONARtrac® Process Monitoring Systems is outlined in the document entitled “CiDRA’s Terms and Conditions of Sale”.

1.6 CiDRA Contact Information

CiDRA Corporate Services, Inc.
50 Barnes Park North
Wallingford, CT, USA 06492

Telephone: 1-203-265-0035
1-877-243-7277 (US and Canada)

Email: www.cidra.com

Sales Support: sales@cidra.com

Customer and Technical Support: customersupport@cidra.com

1.7 Passive Sonar EU Declaration of Conformity

The EU Declaration of Conformity provides the justification for the CE marking of a product. It identifies all of the EU Directives that apply to the product along with the Standards that the product was designed to or tested against to demonstrate compliance with those directives. CE marking is a requirement only for products sold in the European community.

The EU Declarations of Conformity are shipped with the SONAR process monitoring system. There are two separate EU Declarations of Conformity (D of C). The first is for passive sonar products with model numbers and markings for use in ATEX Class I, Zone 2 Hazardous areas. That D of C includes mention of the ATEX Directive. The second D of C is for passive sonar products without markings for use in ATEX Class I, Zone 2 Hazardous areas. The second D of C does not mention the ATEX Directive.

1.8 Installation Checklist

The purpose of this section is to provide a checklist for installing the passive sonar process monitoring system.

1. ___Determine installation location electrical classification rating.
2. ___Ensure equipment to be installed has the correct electrical classification.
3. ___**Read Installation Manual**.
4. ___Clean pipe per Manual Section 5.5.
5. ___Measure pipe using PI Tape and ultrasonic thickness gauge. Or, obtain pipe size measurements from engineering drawings or information printed on the pipe.
6. ___Install sensor band & tighten sensor band screws per Manual Section 5.6.
7. ___Install gray thermal barrier blanket (if supplied) over sensor band per Manual Section 5.6.
8. ___Install sensor band cover per Manual Section 5.7.
9. ___Connect sensor band cable to preamplifier per Manual Section 5.7.
10. ___Connect sensor band cover to transmitter cable connector per Manual Section 5.8.
11. ___Connect 12 pairs of wires from sensor head to transmitter cable to the transmitter per Manual Section 6.3.
12. ___Connect power wires to transmitter per Manual Section 6.3.
13. ___Connect output signal wires per Manual Section 7.3.
14. ___Apply power to system and view Startup screen per Manual Section 9.1.
15. ___If a custom configuration file had been provided, load file per Manual Section 10.4, 10.5
16. ___Go to DIAGNOSTICS menu and perform 'SENSOR CHECK' per Manual Section 9.2. If any sensors indicate fail, re-run 'SENSOR CHECK'. Take corrective action per transmitter screen instructions. If 'TEST FAIL' message persists, contact Customer Support.
17. ___If process is in operation, go to DIAGNOSTICS menu and perform 'GAIN' setup per Manual Section 9.2. If process is not in operation, do not perform this step. Perform this step after process has been started.
18. ___Go to BASIC CONFIG menu and ENTER all parameters per Manual Section 8.1 and 9.4.
19. ___Go to OUTPUT CONFIG menu and configure transmitter outputs per Manual Section 8.2.
20. ___Go to DIAGNOSTICS menu and perform '4-20mA TEST' per Manual Section 8.6 (if 4-20mA Output is being used). Read results from DCS.
21. ___Take a SNAPSHOT using the memory stick and USB Port on the transmitter per Manual Section 10. Post the data on the CiDRA Secure Web Site per Manual Section 11.
22. ___Whenever possible, take a photograph of the installed meter and surrounding piping and equipment. Post the photo on the CiDRA Secure Web Site per Manual Section 11.

Contact CiDRA Customer Support at 203-265-0035 (in the US and Canada 877-243-7277) or customersupport@cidra.com with any questions.

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2 EQUIPMENT SAFETY COMPLIANCE

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2.1 Safety

This equipment is listed with TÜV Rheinland of North America, Inc., a nationally recognized testing laboratory, and certified for ordinary location use per the following US, Canadian, and European standards: UL 61010A-1, CSA C22.2 No. 1010, and IEC/EN 61010.

If so marked, this equipment is certified by Underwriters Laboratories for use in areas that - *under fault conditions* - includes explosive gas atmospheres as defined by Class I, Division 2, Groups A, B, C, and D per compliance with these US and Canadian standards: UL 1604, ANSI/ISA12.12.01, UL 508, CSA C22.2 No. 213, and CSA C22.2 No. 142.

If so marked, this equipment is certified by UL/DEMKO for use in areas that - *under fault conditions* - includes explosive gas atmospheres as defined by ATEX Class I, Zone 2 Group IIB per compliance with EN60079-0, EN60079-11, EN60079-15.

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

2.2 North American Emissions

This equipment is compliant with Class A limits for radiated and conducted radio noise emissions, as defined in Subpart A of Part 15 of the FCC rules, as well as the requirements defined in ICES-003 for Canada.

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

2.3 European Emissions and Immunity

This equipment is compliant with the requirements set forth in EN 61326-1, *Electrical Equipment for Measurement, Control and*

Laboratory Use - EMC requirements as well as EN 55011 *Industrial, Scientific, and Medical (ISM) Radio Frequency Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement*.

For the purpose of Electromagnetic Compatibility (EMC) requirements, this product is categorized as Group 1, Class A ISM equipment. This categorization applies to Industrial, Scientific or Medical equipment that intentionally generates or uses conductively coupled (but not intentionally radiated) radio-frequency energy that is necessary for the internal functioning of the equipment. The level of EMC compliance is consistent with industrial use but not for domestic purposes.

CAUTION

Class A equipment is intended for use in an industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

2.4 CE Marking

Certain models of passive sonar meters are CE marked for Ordinary Location use and others are CE marked for ATEX Class I, Zone 2 use.

In justification of the CE marking, model number-dependent EU Declaration of Conformity documents are shipped with each system.

3 GENERAL SAFETY GUIDELINES

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3.1 Introduction

This manual is intended to be a general installation guide for the passive sonar process monitoring systems. It is not intended to cover the installation details for every process due to the wide variety of applications and processes on which the system can be used. In all cases, local safety and operating practices should take precedence over instructions contained within this manual.

The installer must fully read this manual prior to installing and operating the passive sonar meter.

The safety of any system incorporating this passive sonar meter as an element is the responsibility of the assembler of that system.

Note: ***Items that pertain to systems rated for Class I, Division 2, Groups A, B, C, and D operation are highlighted in italic print.***

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

3.2 Safety Precautions

The following style of Warnings and Cautions are used throughout the manual to draw attention to information regarding personnel safety and equipment care. They are intended to supplement but not replace local or plant safety procedures.

	WARNING **Situation has the potential to cause bodily harm or death.**

	CAUTION **Situation has the potential to cause damage to property or equipment.**

3.3 Definitions of Symbols

The following terms and symbols are used in this document and on the passive sonar meter where safety related issues occur.

3.3.1 General Warning or Caution

Figure 1 General Warning or Caution Symbol

The Exclamation Symbol in Figure 1 appears in Warning and Caution tables throughout this document. This symbol designates an area where personal injury or damage to the equipment is possible.

3.3.2 Earth (Ground) Terminal

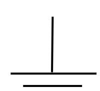


Figure 2 Earth (Ground) Terminal Symbol

The Earth (Ground) Terminal Symbol in Figure 2 appears on labels affixed to the passive sonar meter. This symbol identifies components that are part of the protective earth circuit.

3.3.3 Protective Conductor Terminal

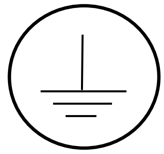


Figure 3 Protective Conductor Terminal Symbol

The Protective Conductor Terminal Symbol in Figure 3 appears on labels affixed to the passive sonar system. This symbol identifies the terminal which is intended for connection to an external protective conductor for protection against electric shock in case of a fault. See section 6 for AC/DC Powered Transmitter for instructions for wiring this protective earth circuit to a local earth ground.

3.3.4 Electric Shock Hazard

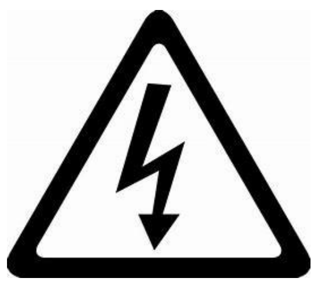


Figure 4 Electric Shock Hazard

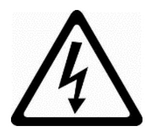
The Electric Shock Hazard warning symbol in Figure 4 appears on a label near the mains power terminals of the Transmitter and in this manual in conjunction with warnings about the hazard of electric shock. Those mains power terminals and the associated wires and fuses are the primary risks of electric shock in the passive sonar flowmeter. The meter, itself, does not generate voltages higher than nominal 24VDC.

3.3.5 General Warnings and Cautions

Observe these rules when operating or servicing this equipment:

- Prior to operation of this equipment, personnel should read the instruction manual thoroughly.
- Trained personnel must carry out service on this equipment.
- Follow all warnings on the unit and in the operating instructions.
- This product should only be powered as described in the manual. Read the instructions for proper input voltage range selection.

- This equipment is grounded through the grounding conductor of the power cord.
- Ensure all power cords, sensor to transmitter cable and signal cables are properly routed to eliminate damage to them. Cable conduit may be desirable to minimize potential damage.
- Do not run power and signal wires in a common conduit.
- Care should be taken when using the operator keypad to avoid touching any electrical connection or contact points.
- Use only the specified fuse(s) with the correct type number, voltage and current ratings as referenced in the appropriate locations in the service instructions or on the equipment.
- Disconnect power to transmitter prior to replacing fuse(s).



- Prior to servicing, lockout all electrical power sources.
- There are no user serviceable parts inside the sensor band. Modification or disassembly may void the system warranty.
- Use only manufacturer specified replacement parts.
- Follow static sensitive device precautions when servicing.
- Do not wear rings or wristwatches when servicing this equipment.
- To preserve the safety of this product, use only manufacturer specified replacement parts, do not perform unauthorized substitutions or modifications, and do not use the passive sonar meter in a manner not specified by manufacturer.
- **Maintenance, Inspection, and Test:** The passive sonar system requires no regular preventative maintenance. However, when performing periodic inspections of the plant, take note of any damage to Transmitter or Sensor Head enclosures, enclosure gaskets, or the insulation of associated cables. If the enclosure damage indicates that protection of the electronics from moisture intrusion is compromised or failure is imminent or if the cable damage suggests that cable shorts or opens are imminent, then take the appropriate corrective action depending on the situation – up to and including removal of the meter from service until repairs have been performed. Contact Customer Support for information regarding repairs and spare parts. If repairs are made, post-repair functional testing could include the diagnostic tests discussed in 8.7, 8.8.2, and 9.2 and the System Info discussed in 10.3.3. Depending on the type of repairs, a snapshot (as described in 10.6.1) might need to be collected and sent to the manufacturer for remote analysis.

- **Moving parts / Pinch Hazards:** The passive sonar flowmeter has few moving parts. Avoid pinching wires or fingers when closing and securing the Transmitter's hinged enclosure cover, when mating and latching the two halves of the Sensor Head's clamshell cover, and when operating the retention latches on the cable connector at the Sensor Head.

3.3.6 Additional Warnings for Installations in Hazardous Areas

In addition to the General Warnings and Cautions, observe these rules when operating or servicing this equipment to mitigate the risks associated with explosive gas atmospheres. (For ATEX Zone 2 installations, additional warnings may be found in the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE2 SAFETY.)

- *Only equipment marked with the appropriate hazardous area rating should be installed in those areas. Verify the system hazardous area rating on the equipment labels.*
- *Install the equipment in locations consistent with the environmental ratings of the equipment. (Refer to labels and Appendix A)*
- *Power Entry and Inputs/Outputs must be installed in accordance with the sections of Article 501 of the National Electrical Code ANSI/NFPA 70 (or the equivalent applicable standard) that define wiring techniques for unrated circuits.*
- *Sensor Head Cable must be installed in accordance with the sections of Article 501 of the National Electrical Code ANSI/NFPA 70 (or the equivalent applicable standard) that define wiring techniques for non-incendive rated circuits.*
- *Use a dampened cloth to wipe sensor band cover and transmitter when installed in hazardous areas to dissipate potential static charge buildup.*

⚠	**WARNING** **Using a dry cloth to clean the transmitter enclosure can cause static discharge, which could result in an explosion in an explosive atmosphere. Always use a damp cloth to clean the transmitter enclosure.**

- *As for any electrical equipment in Hazardous area installations wherein explosive atmospheres might be present, it is especially important to de-power and remove the passive sonar meter from service if its appearance or operating behavior indicates that it is damaged or malfunctioning and/or that its safety features have been otherwise compromised.*
- *Fuse replacement must be performed by trained service personnel. Disconnect power to transmitter prior to replacing fuse(s). Use only the specified fuse(s) with the correct type number, voltage and current ratings as referenced in the appropriate locations in the service instructions or on the equipment.*

⚠	**WARNING** **EXPLOSION HAZARD - DO NOT REMOVE OR REPLACE FUSES UNLESS POWER HAS BEEN DISCONNECTED OR THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS OF FLAMMABLE GASES OR VAPORS.**

⚠	**AVERTISSEMENT** **RISQUE D'EXPLOSION – COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX AVANT DE REPLACER LES FUSIBLES.**

⚠	**WARNING** **EXPLOSION HAZARD - REPAIR AND REPLACEMENT OF INTERNAL CABLING, CIRCUIT BOARDS, OR COMPONENTS ON CIRCUIT BOARDS SHOULD ONLY BE PERFORMED USING FACTORY-APPROVED REPLACEMENT COMPONENTS AND PROCEDURES. UNAUTHORIZED REPAIRS MAY IMPAIR SUITABILITY FOR DIVISION 2.**

⚠	**AVERTISSEMENT** **RISQUE D'EXPLOSION – LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATÉRIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2**

⚠	**WARNING** **EXPLOSION HAZARD - DO NOT DISCONNECT FROM MAINS POWER WHILE CIRCUIT IS LIVE UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITABLE CONCENTRATIONS OF FLAMMABLE GASES OR VAPORS.**

⚠	**AVERTISSEMENT** **RISQUE D'EXPLOSION – AVANT DE DÉCONNECTER L'EQUIPEMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.**

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4 UNPACKING AND PARTS LIST

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4.1 Unpacking

The passive sonar system will typically be packaged in three shipping containers. One box will contain the sensor band and sensor cover assemblies, and installation hardware; the second box will contain the transmitter assembly and installation hardware; and the third box will contain the sensor to transmitter cable assembly.

Note: The original packing materials should be saved whenever possible in the event that the system is removed or relocated.

⚠	**CAUTION** **Use care in unpacking and transporting system. Improper handling may result in damage to system components.**

Whenever possible use the original packing materials to transport the system to the installation site to minimize the likelihood of damage.

⚠	**WARNING** ***Static discharge may occur when handling sensor band and packing material. Remove packing materials when entering hazardous areas. Only install if area is known to be non-hazardous.***

4.2 Inventory of Parts

Table 1 lists the parts contained in the shipping containers.

Description
Passive Sonar Monitoring System
Sensor Head Cable
Installation Hardware
Joining Compound, High Viscosity, Non-Setting, Blue Paste for use with stainless steel covers
Gauge, Spring Gap (used for sensor installation) - included with sensor band assembly
System Installation & Startup Manual
Kit, Parts, Pole Mounting (Option)
Thermal Barrier on select models

Table 1 Passive Sonar System Parts List

4.3 Class I, Division 2 Label

Transmitters and sensor covers rated for use in Class I, Division 2 areas have labels that explicitly identify them as suitable for “Class I, Division 2, Groups A, B, C, and D”. The Transmitter labels will also include a UL listing mark.

WARNING

Use of non- Class I, Division 2 rated equipment in Class I, Division 2 areas may result in a fire or explosion.

Note that in many North American jurisdictions equipment marked for Division 2 can be installed in Zone 2 locations. Consult the National Electric Code (ANSI/NFPA 70 Article 501) or the Canadian Electric Code for guidance on suitability of Class I, Division 2-marked equipment for North American Class I, Zone 2 installations.

4.4 European Zone 2 Rated Equipment

Transmitters and sensor covers rated for use in ATEX Class I, Zone 2 areas have labels that include the ATEX marking codes and a DEMKO certificate number.

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

5 SENSOR INSTALLATION

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5.1 Class I, Division 2, Groups A, B, C, and D Rated Equipment

Installation or removal of Sensor Heads in Hazardous areas should not be performed without a hot work permit indicating that the areas where the sensor band is to be handled are free of explosive gasses.

Check to make sure that the ambient and process temperatures of the installation location are consistent with the temperature ratings of the Sensor Head (see Appendix A).

- *Equipment so marked is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.*
- *WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.*
- *WARNING – EXPLOSION HAZARD –Substitution of components may impair suitability for Class I, Division 2.*
- *WARNING – EXPLOSION HAZARD –Ensure a sensor band shorting plug is installed on the sensor band cable connector during installation and removal from process pipe. Sensor bands with an "R" in the Part Number suffix do not require a shorting plug.*

5.2 European Zone 2 Rated Equipment

Installation or removal of Sensor Heads in Hazardous areas should not be performed without a hot work permit indicating that the areas where the sensor band is to be handled are free of explosive gasses.

Check to make sure that the ambient and process temperatures of the installation location are consistent with the temperature ratings of the Sensor Head (see Appendix A).

Warnings for ATEX Zone 2 equipment are very similar to the warnings for Division 2, above. The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information and warnings for ATEX Class I, Zone 2 installations.

5.3 Installation Tools

The Basic Installation Tool Kit contains all tools required for typical installations. Additional tools may be required based on particular installation needs.

The Expanded Installation Tool Kit contains additions hand tools, precision pipe measurement and pipe wall thickness instruments.

Contact Customer Support for additional information on these items.

⚠	**WARNING** **EXPLOSION HAZARD - Use of power tools for installation may or may not be acceptable for use in hazardous areas. Review the terms of the hot work permit prior to use.**

5.4 Sensor Installation Guidelines

The following are general installation guidelines and recommendations for installing a passive sonar sensor.

- If the installation location is in a hazardous (classified) area, get a Hot Work Permit prior to installation of system.
- Select locations with well-developed flow profiles.
- Requires a full pipe.
- Avoid installation locations directly after piping configurations that cause flow jetting.
- Install flow sensor upstream of control valves, "T"'s, orifice plates, and any other severe source of flow disturbance.
- Locate the sensor upstream of pipe taps such as those used for temperature and pressure sensors.
- Flow system can be installed in locations with entrained air.
- Flow system with gas volume fraction feature can measure the volume fraction to deliver a true liquid flow.
- Good piping practices are required near flanges. This includes good alignment of pipes, and properly sized and installed gaskets that do not disturb the flow profile.

Table 1 lists the recommended installation distances from flow disturbances. These recommendations apply to flow measurement installations.

Feature	Minimum for Repeatable Operation		Standard Meter Specifications	
	Upstream	Downstream	Upstream	Downstream
Elbow	1/2	1/2	15	5
Diffuser (expansion)	2	1	30	5
Pump	10	5	20	5
Shut-off Valve (fully opened)	2-4	5	2-4	5
Valve Variable Position i.e. Control Valve	*	*	40	10

Table 1 Recommended Distances (Pipe Diameters) From Flow Disturbances

Note: The distances from flow disturbances are only guidelines. For any other configuration or application-specific questions, please contact Customer Support.

5.5 Process Piping Considerations

The passive sonar sensor head assembly mounts on the process pipe. There is no need for breaking any process connections or for shutting down the process. The sensor head must be installed in a location that ensures a full pipe during operation.

Check the sensor head label to ensure the sensor head is approved for the area hazard rating in the location where it will be installed.

5.5.1 Pipe Preparation

Remove pipe insulation if it is present.

⚠	**WARNING** **Asbestos containing insulation materials may be present. Asbestos fibers have been known to cause health problems. If unsure of the contents of pipe insulation materials contact the plant representative for that area.**
⚠	**WARNING** **Process Heating Tapes may be present. This may present an electrical shock hazard. Follow plant Lock-out / Tag-out requirements.**
⚠	**WARNING** **Process pipes may be hot. A burn hazard may exist. Use care when working with hot pipes.**

Clean pipe surface using a scraper, sand paper strips, a water rinse and final wipe with a clean rag. The pipe surface under the sensor band assembly should be clean and free of rust and rust spots, grit, grease, protruding weld spots and weld splatter. A good guideline is to clean the pipe as if it were going to be painted.

Remove any pipe tong marks, sharp weld seam material, or other raised or sharp metal on the pipe with a file.

Avoid dents as they can create flow disturbances within the pipe. Select a location that ensures full contact between the sensor head and the pipe.

Painted surfaces are normally satisfactory provided they are smooth and free of chips over 0.25 inch (6.4 mm) diameter. Ensure a smooth painted finish by sanding the area where the sensor will be mounted. Finally, wipe the pipe using a damp cloth rag or paper towel.

5.5.2 Determine the Pipe Inner Diameter (ID)

Record the nominal pipe size based on the pipe size and pipe schedule, as this will be input into the transmitter.

Alternatively, measure and calculate the pipe ID. Accurately measure the pipe outside diameter (OD). Use an ultrasonic thickness measurement gauge to determine the wall thickness (t_w) at a minimum of 4 locations equally spaced around the pipe and average the measurements. Calculate the pipe inner diameter ($ID = OD – (2t_w)$). (There are several vendors of ultrasonic thickness gauges.)

Note: The accuracy of the pipe inner diameter measurement is critical for high accuracy flow rate measurements as there is a direct correlation between this measurement and the reported flow rate.

5.6 Sensor Band Installation

It will be helpful to have a second person available to assist with holding the sensor assembly in position during installation.

Note: Prior to installing the sensor band, remove and save the plastic bag from the sensor band that contains sensor calibration factor labels and the sensor gap gauge tool. These will be used as described later in this manual.

Ensure there is no dirt or other foreign material on the sensor assembly. Remove dirt or foreign matter using a clean cloth dampened with water.

5.6.1 Standard (Non-HD / Non-Segmented) Sensor Band Installations

Position the passive sonar sensor band assembly on the pipe with the polyimide film (amber colored) against the pipe surface. If possible, orient the flow direction arrow on the sensor assembly with the direction of flow within the pipe. **Note:** If this is not possible due to installation constraints, for example access to sensor fasteners, install opposite to flow direction. The transmitter must be re-configured for “reverse flow” during its set up as detailed in Chapter 9 of the manual *Transmitter Startup & Operation*.

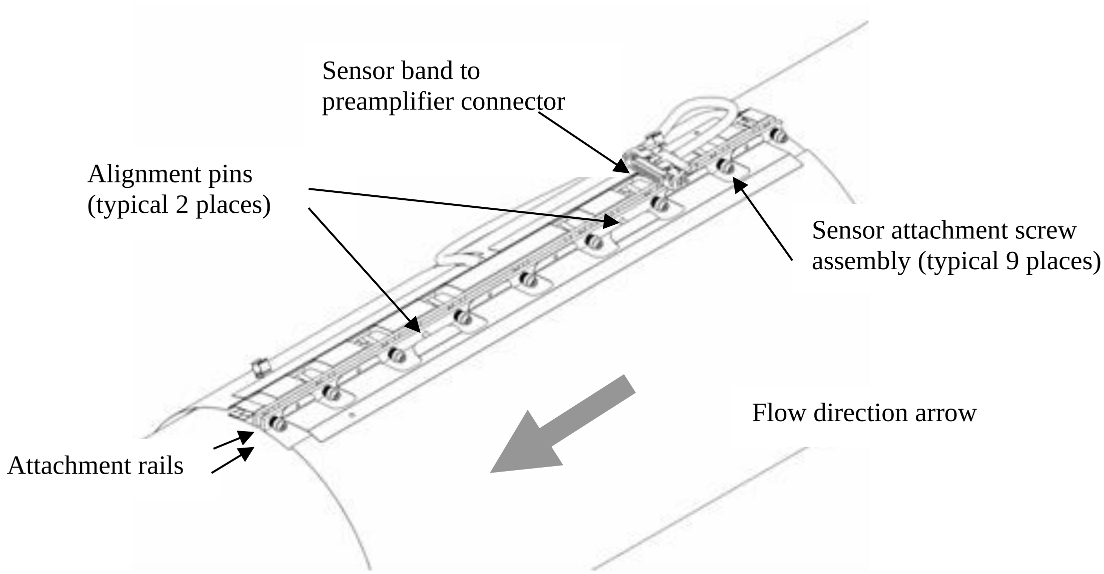

Figure 1 Sensor Band Screw and Alignment Pins

Wrap the sensor band around the pipe and slide the alignment pins on the attachment rail through their mating holes on the opposite attachment rail. If the process pipe has a welded seam, align the gap between the sensor attachment rails along the pipe weld seam. Final positioning can be made after the sensor screws have been started. **Note:** When installing the sensor band keep in mind the requirement for transmitter connector socket assembly orientation as described in Section 5.7. If necessary, due to cover installation constraints, wrap the sensor band over the weld seam.

Carefully start threading the screws into their screw holes (avoid cross threading) by using the hex driver until each screw is engaged about 2 turns. Once all screws are engaged make final positioning of the sensor assembly with respect to pipe weld seam or desired orientation on the pipe.

Section 5.6.3 details the next steps in sensor installation.

Sometimes a compliant layer (elastomeric material) is installed prior to the sensor band. If the system was furnished with a compliant layer, wrap it around the process pipe. The ends of the compliant layer should be positioned at the weld seam on the pipe (if there is one).

On seam welded pipes, an optional weld bead filler (elastomeric strip of material) is sometimes used to fill the gaps on either side of the weld prior to installation of the sensor band. Remove the paper strips covering the adhesive on the weld bead filler and attach the weld bead filler over the pipe seam weld.

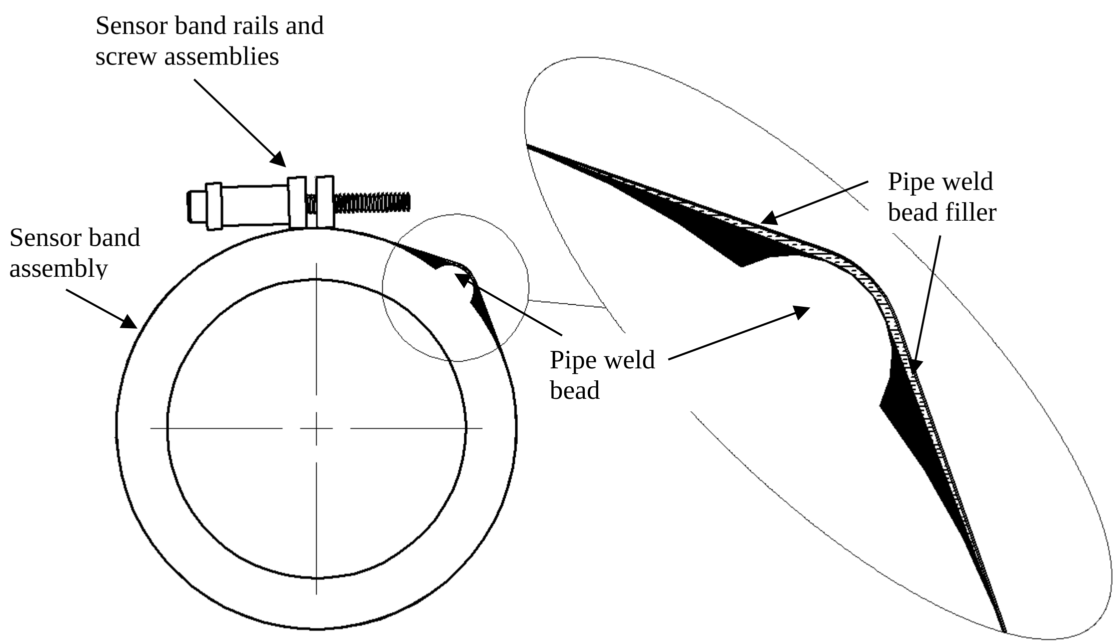

Figure 2 Weld Bead Filler

5.6.2 HD / Segmented Sensor Band Installations

HD or segmented sensor bands are used in certain flow measurement applications. These can include certain slurries flow rate measurements in horizontal oriented pipes.

IMPORTANT: HD or SEGMENTED SENSOR BANDS MUST BE INSTALLED WITH THE FASTENER ATTACHMENT RAILS ON THE TOP OF HORIZONTAL PIPES

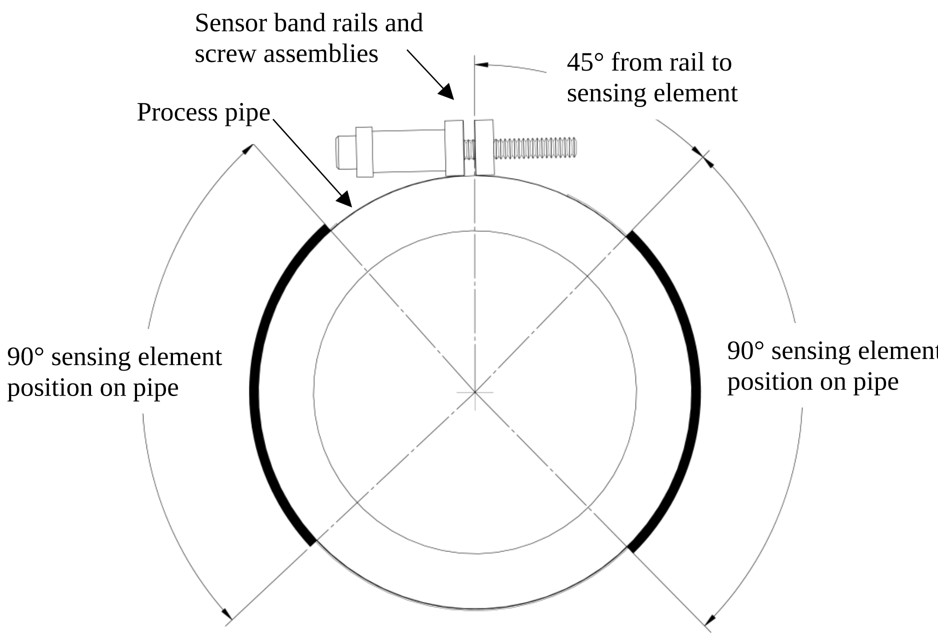

Figure 3 HD Sensor Illustration

Position the passive sonar meter sensor band assembly on the pipe with the polyimide film (amber colored) on the pipe. **Important: The attachment rails on an HD / segmented sensor band must be installed on the top of a horizontal flowing pipe.** Slide the alignment pins on the attachment rail through their mating holes on the opposite attachment rail.

If possible, orient the flow direction arrow on the sensor assembly with the direction of flow within the pipe. **Note:** If this is not possible due to installation constraints, e.g. access to sensor fasteners, install opposite to flow direction. The transmitter must be re-configured for "reverse flow" during its set up as detailed in chapter 9 of the manual *Transmitter Startup & Operation*.

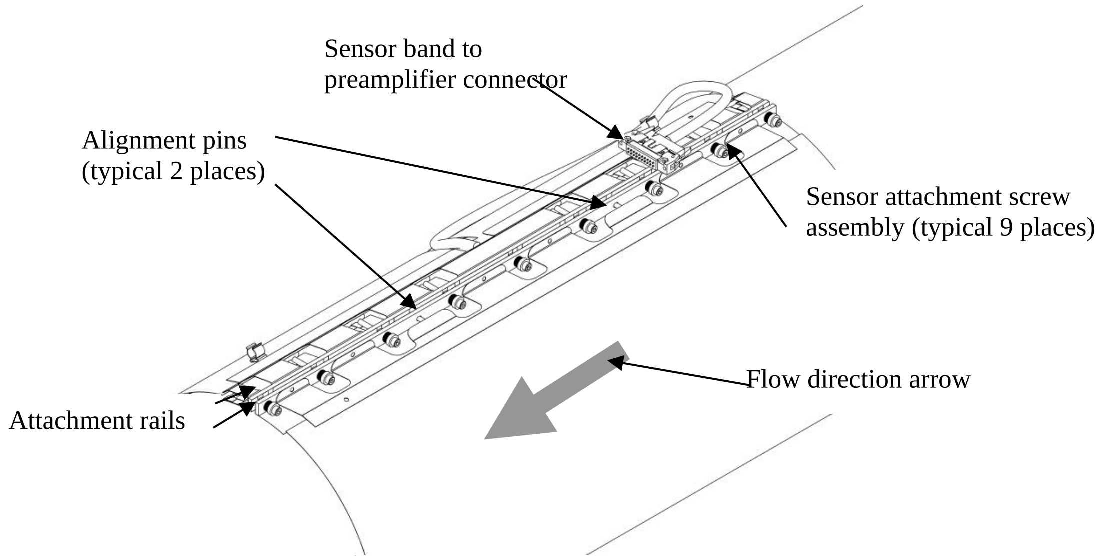

Figure 4 Sensor Band Screw and Alignment Pins

Section 5.6.3 details the next steps in sensor installation

Sometimes, a compliant layer (elastomeric material) is installed prior to the sensor band. If the system was furnished with a compliant layer, wrap it around the process pipe. The ends of the compliant layer should be positioned at the weld seam on the pipe (if there is one).

On seam welded pipes, an optional weld bead filler (elastomeric strip of material) is sometimes used to fill the gaps on either side of the weld prior to installation of the sensor band. Remove the paper strips covering the adhesive on the weld bead filler and attach the weld bead filler over the pipe seam weld. Refer to Figure 2.

5.6.3 Sensor Band Screw Tightening Instructions

The sensor band screws use either a 7/64” (for #6 screw size) or 5/32” (for #10 screw size) hexagonal wrench (Allen key wrench). Refer to Table 2 for size information. Start with the center most screw and tighten screws 3 - 4 turns at a time. **Important:** Alternate the sequence in which screws are tightened. Refer to Figure 5 for the screw tightening sequence. **Note:** Repeat the tightening sequence only until the Belleville disc springs on the screws begin to compress. The sensor screw stack up assembly is illustrated in Figure 6.

Note: Ensure the Belleville washers do not stick to the screw threads.

The sensor band screw size and number of Belleville washers can vary depending on sensor band size and pipe type.

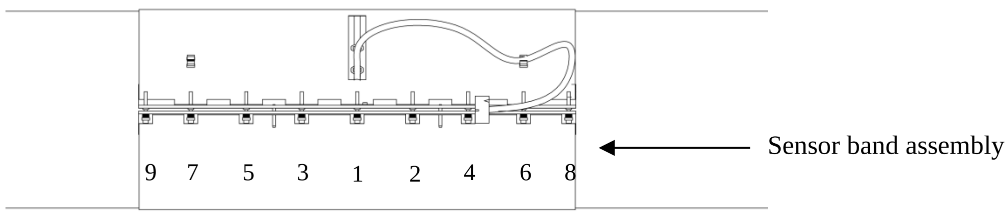

Figure 5 Sensor Band Screw Tightening Sequence

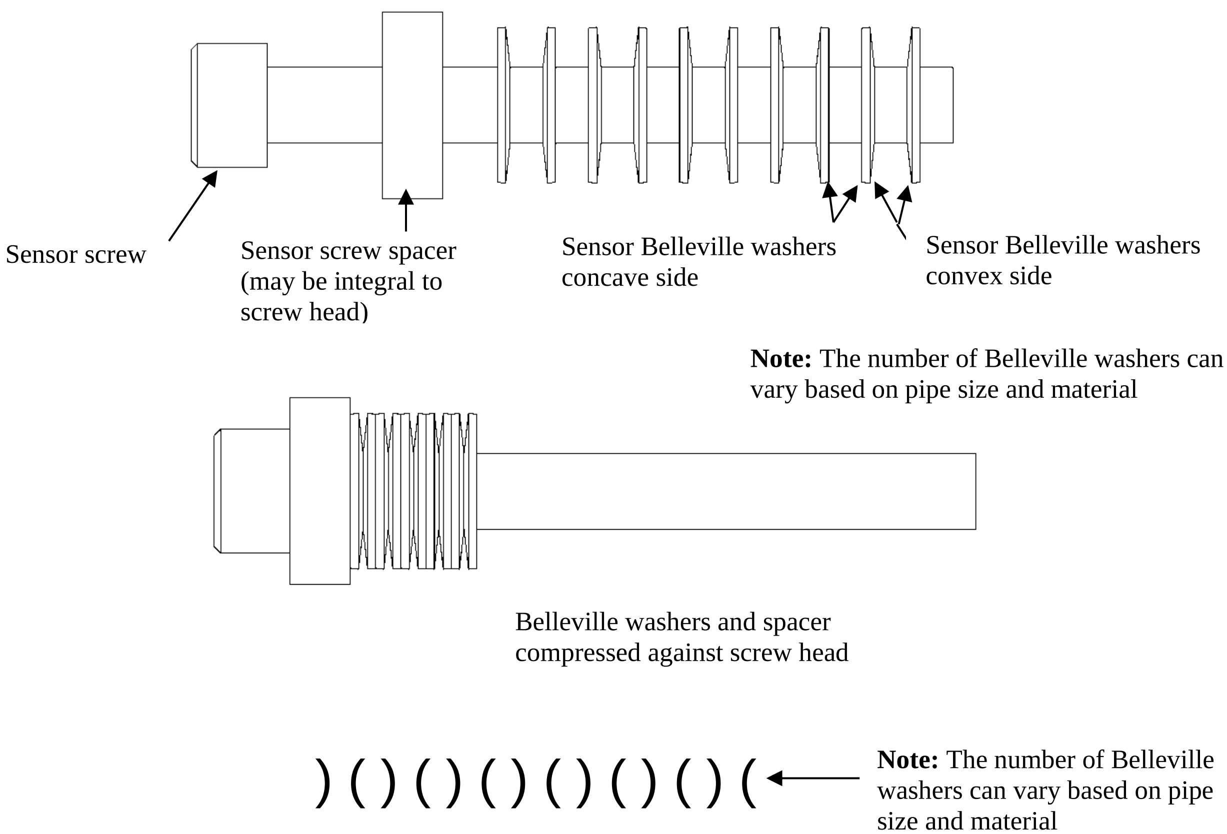

Figure 6 Sensor Band Screw Assembly

Further tightening of the sensor band screws is made while using the sensor band gap gauge tool (shown below) furnished with the sensor band. The gap gauge tool is used to set the compression on the Belleville washers referred to above. The sensor band gap gauge tool used is determined by sensor band size and pipe material.

Most common sensor band gap gauge tools
P/N 20143-01 (left) and P/N 20143-04 (right)

Figure 7   Sensor Band Gap Gauge Tool

Refer to the table on the following page for the appropriate sensor band gap gauge tool based on sensor band part number. Please contact Customer Support if there are any questions.

<table>
<tr><th rowspan="2">Sensor Band Gap Gauge Tool P/N</th><th rowspan="2">Gap Size (Inch) ±.001</th><th colspan="3">Sensor Band</th><th colspan="3">Belleville Washers</th><th rowspan="2">Socket Head Screw Hex Size</th></tr>
<tr><th>Part Numbers</th><th>Pipe Diameter</th><th>Screw Assy Part Number</th><th>Number Of Washers</th><th>Stacked Free Height</th><th>Amount Of Compression</th></tr>
<tr><td>20143-01</td><td>.165</td><td>20380, 20745, 20781, 21312, 21315, 21350, 21352, 21353, 21356, 21309</td><td>2" Thru 4"</td><td>20592-01</td><td>10</td><td>.230</td><td>.065</td><td rowspan="3">#6 Screw, 7/64" Hex</td></tr>
<tr><td>20143-02</td><td>.236</td><td>20409 (Obsolete)</td><td>-</td><td>-</td><td>14</td><td>.322</td><td>.086</td></tr>
<tr><td>20143-03</td><td>.496</td><td>20669, 20991, 21313, 21314, 21316, 21317, 21351, 21354, 21355, 21357</td><td>2" Thru 4"</td><td>20592-26</td><td>30</td><td>.690</td><td>.194</td></tr>
<tr><td>20143-04</td><td rowspan="3">.293</td><td>20380, 20745, 20781, 21312, 21315, 21350, 21352, 21353, 21356, 21309</td><td>5" Thru 17"</td><td>20592-08</td><td rowspan="3">14</td><td rowspan="3">.420</td><td rowspan="3">.127</td><td rowspan="3">#10 Screw, 5/32" Hex</td></tr>
<tr><td>20143-04</td><td>20686, 20690, 20782, 21312, 21315, 21350, 21352, 21353, 21356, 21309</td><td>18" Thru 36"</td><td>20592-06</td></tr>
<tr><td>20143-04</td><td>21059, 21294, 21319, 21321, 21327, 21329, 21335, 21339, 21341, 21347</td><td>38" Thru 60"</td><td>20592-06</td></tr>
<tr><td>20143-05</td><td>.209</td><td>Special Applications</td><td>-</td><td>20592-13</td><td>10</td><td>.300</td><td>.091</td><td>#10 Screw, 5/32" Hex</td></tr>
<tr><td>20143-08</td><td rowspan="3">.627</td><td>20669, 20991, 21313, 21314, 21316, 21317, 21351, 21354, 21355, 21357</td><td>5" Thru 17"</td><td>20592-12</td><td rowspan="3">30</td><td rowspan="3">.900</td><td rowspan="3">.273</td><td rowspan="3">#10 Screw, 5/32" Hex</td></tr>
<tr><td>20143-08</td><td>20900, 21021, 21313, 21314, 21316, 21317,21351, 21354, 21355, 21357</td><td>18" Thru 36"</td><td>20592-10</td></tr>
<tr><td>20143-08</td><td>21288, 21311, 21323, 21325, 21331, 21333, 21337, 21343, 21345, 21349</td><td>38" Thru 60"</td><td>20592-10</td></tr>
</table>

Table 2 Sensor Band Gap Gauge Tool Size Table

Insert the sensor band gap gauge tool over the Belleville washers on the middle sensor screw assembly and tighten the screw until it is snug but the gap gauge tool can still be removed. The following figure illustrates use of the sensor band gap gauge tool. Alternate from screw to screw using the screw tightening sequence shown in Figure 4.

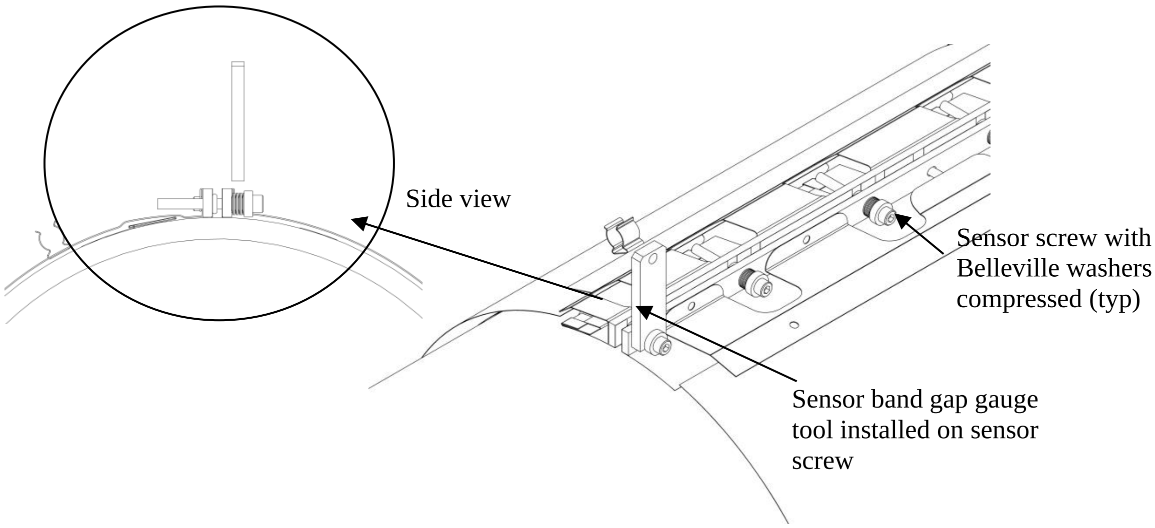

Figure 8   Sensor Band Gap Gauge Tool Installed on Sensor Screw

Note: Ensure the gap gauge tool is perpendicular to the attachment rail to ensure proper tightness. Remove the tool, move to the next sensor screw, and repeat the tightening on each of the sensor screws.

Important: <u>Tighten each screw once only. Do not retighten each screw using the sensor band gap gauge tool.</u>

Final sensor band screw tightening is as follows:

A. For sensor bands sized for 6" and smaller pipe:

1. Tighten screws #1 - 7 an additional one-half turn in the numbered sequence given in Figure5. Do not tighten screw #8 & 9 (screws on either end of the sensor band).

B. For sensor bands sized for 8" and larger pipe:

1. Starting at screw #1 in Figure5, tighten each screw an additional one-half turn in the given numbered sequence.
2. Once all nine screws have been tightened, tighten each screw an additional one-half turn in the given numbered sequence.
3. Once all nine screws have been tightened a second time, tighten screws #1 - 7 an additional one-half turn in the given numbered sequence.

Attach the sensor cable in the retaining clip on the top of the sensor band. The connector on this cable will attach to the sensor cover connector as described later in the manual. The final sensor band assembly is illustrated below.

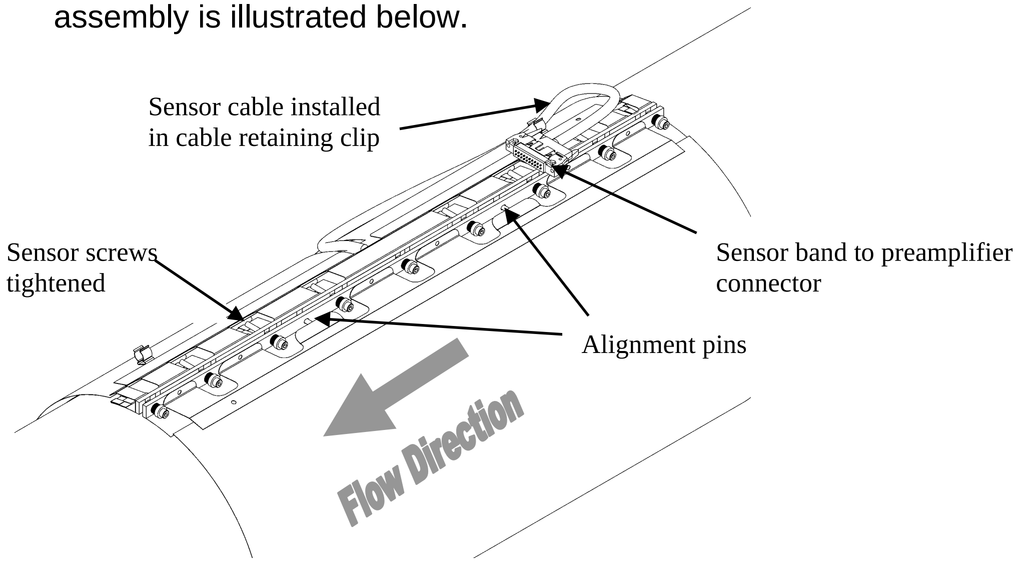

Figure 9 Installed Sensor Band

⚠	**CAUTION** **Over-tightening of fasteners may damage threads on the sensor. Under tightening may affect flow meter performance. Always use the sensor fastener spacer tool to ensure proper fit of the sensor assembly.**

5.6.4 Sensor Band Short Test

Shorting of the sensor band to the process pipe may cause signal interference or electrical faults in the system in some instances. It is also an unsafe condition for installations in hazardous (classified) locations. The sensor band must be electrically isolated from the process pipe.

⚠	**WARNING** **EXPLOSION HAZARD – The sensor band must be electrically isolated from the pipe to prevent ground loops which are considered unacceptable under the hazardous area safety standards.**

Use an ohm meter and verify the sensor band is isolated from the pipe. Measure the resistance between the sensor rails and the pipe to ensure there is no continuity between the sensor band and the process pipe. If the band is shorted to the pipe identify where the short is located and eliminate the short. For example, if a sensor screw is shorting to a pipe weld bead, reposition the sensor band, or file down the weld bead to eliminate the possibility of a short.

5.6.5 Sensor Band Thermal Barrier Installation

Install the sensor band thermal barrier if one was included with the System. Refer to the figure below.

1. Align the slit on the thermal barrier with the sensor band to pre-amplifier cable.
2. Wrap the thermal barrier over the sensor attachment rails.
3. Continue to wrap the thermal barrier around the sensor band.
4. Seal at the Velcro strips and install the straps through the D-rings on the thermal barrier.
5. Retain the sensor band to pre-amplifier cable in the Velcro retention loop.

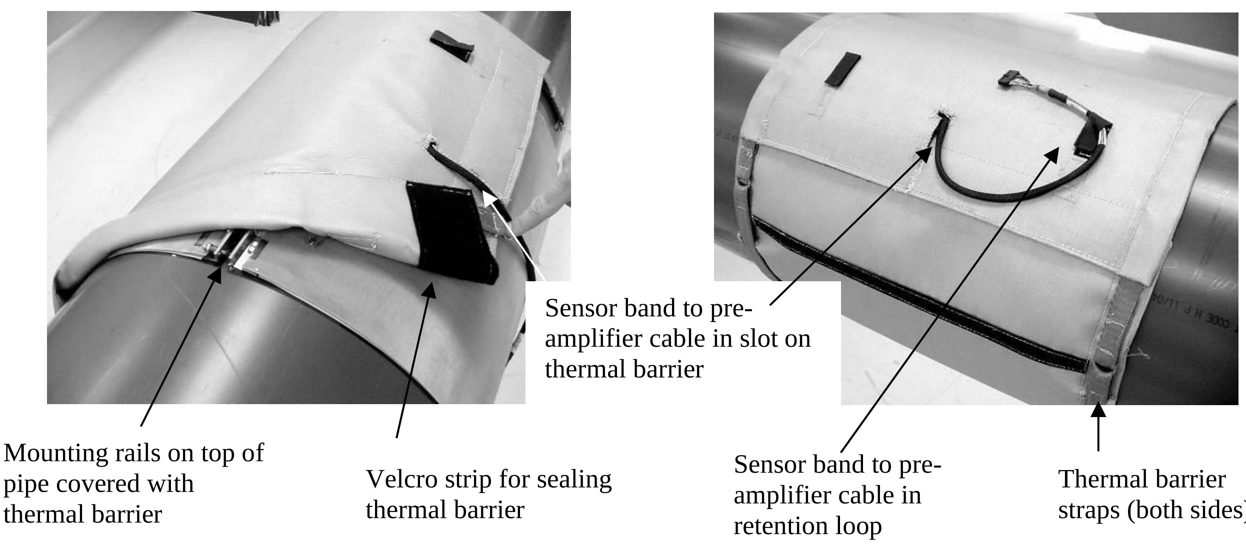

Figure 10 Thermal Barrier Installation Over Sensor Band

5.7 Sensor Cover Installation

The upper sensor cover assembly outside and inside is illustrated in the following figures. Covers are made of fiberglass or stainless steel. Figures 11 and 12, below, show the fiberglass cover style. The layout of the stainless steel cover is essentially the same. The differences in installation will be discussed in the following sections.

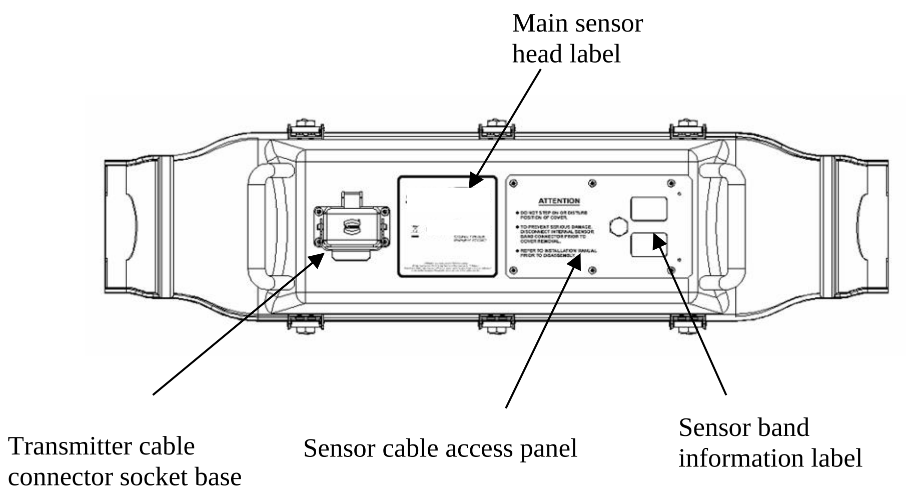

Figure 11 Upper Sensor Cover Assembly Outside View

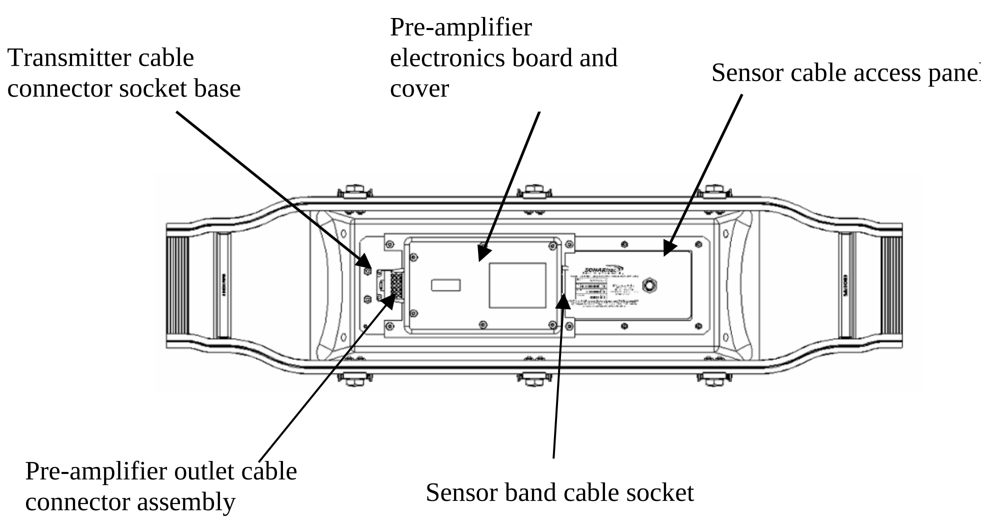

Figure 12 Upper Sensor Cover Assembly Inside View

It is helpful to have a second person available to help when installing the cover assembly. When the sensor head is installed on a horizontal pipe, the sensor cover should be installed such that the transmitter cable connector socket is located within the 105° arcs shown in the following figure. Do not install the cover with the transmitter cable connector socket installed downward. (An electrical pre-amplifier board is mounted on the inside of the upper cover.) The ability to route the sensor band to sensor cover cable may dictate cover orientation. The cable gland on the sensor head to transmitter cable connector, when installed, will face away from the cover.

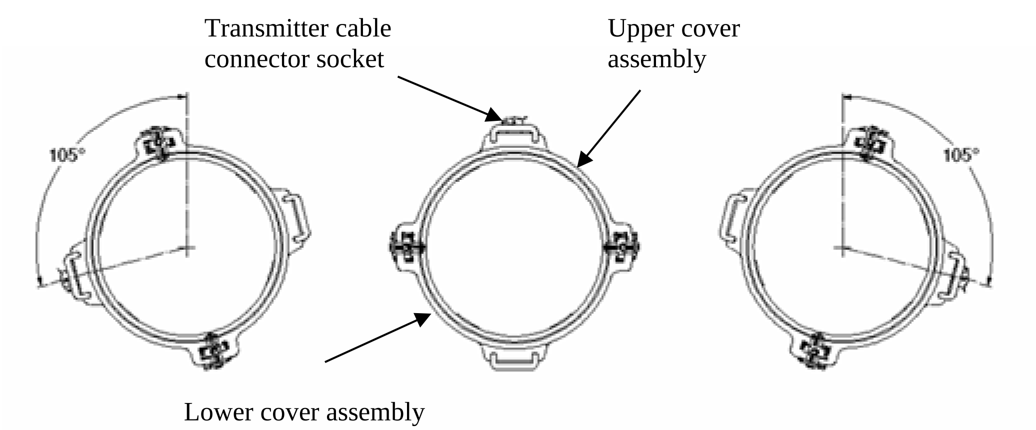

Figure 13 Orientation (Clocking) of Sensor Cover

<u>IMPORTANT: If the sensor head is installed on a vertical pipe, the transmitter cable connector socket should be located so it is facing downward.</u>

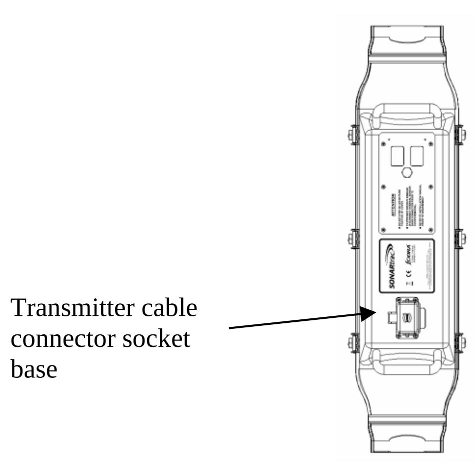

Figure 14 Cover Installed on Vertical Pipe with Connector on Bottom

5.7.1 Fiberglass Cover Model SH-XXX-XX-XA-XXX-XX Installation

The installation procedures for Fiberglass Cover Model Number SH-xxx-xx-xA-xxx-xx (where “x” is any alphanumeric character) is found on the following pages. These covers are recognized by their having latches and keepers to secure the cover halves together. **Note**: These are the only model number covers currently available with ATEX Zone 2 certification.

Important: A banding tool is needed to properly install sensor cover sizes 10-inch and larger. Failure to use a banding tool may result in improper sensor cover to pipe sealing and will void the system warranty. The use of a BAND-IT® Model C00169 Banding Tool (or equivalent) is recommended. The tool is available through Customer Support as P/N 52511-01. This tool is also available in the United States from McMaster Carr Company (telephone 630-833-0300, internet www.mcmaster.com) as their P/N 5424K1. Other suppliers are available worldwide. Contact BAND-IT at 800-525-0758 or 303-320-4555 or www.band-it-idex.com.

Figure 15   BAND-IT® Model C00169 Banding Tool

⚠	**CAUTION** **Use of a BAND-IT® Model C00169 Banding Tool (or equivalent) is necessary for properly installing sensor cover. Failure to use this tool may void system warranty.**

The passive sonar sensor head cover is illustrated in the following figure.

Figure 16   Fiberglass Cover

⚠	**WARNING** **The handles on the cover are designed for holding the cover in place during installation. The handles are not designed or rated for hoisting the cover. Use a proper lifting sling to properly secure cover to lifting rope when hoisting cover.**

Each pipe size has a cover designed to fit that size pipe.

The cover incorporates a connector assembly for the sensor head to transmitter cable, a breather valve, interlocking silicone seals along the cover longitudinal edges, and a thermoplastic elastomer (TPE) radial boot seal at the ends of the cover that seal the cover to the pipe using stainless steel band clamps. Tool operated latches and keepers are used to hold the cover halves together.

5.7.1.1 Cover Installation Procedure

Care must be taken during installation of the sensor band cover to ensure the sensor band cable does not become pinched between the cover halves. The problem may show up as a sensor failure during sensor tests and operation of the meter. This potential problem is most likely to occur in small size meters (<6 inch / <150 mm) due to the length and stiffness of the sensor band cable.

5.7.1.2 Horizontal Pipe Installation

Sensor cover installation on horizontal pipes is as follows:

1. Install the sensor band.
2. Remove the sensor cable access panel from the sensor upper cover assembly.
3. Install the sensor upper cover assembly over the sensor band assembly.
4. Install the sensor lower cover assembly.
    a. Hold the halves in place using the cover latches and strikes as the cover halves are aligned. **Note:** Ensure the sensor cable connector is accessible through the sensor cable access panel. (If necessary, reposition cover or cable connector.)
5. Align the cover halves.
6. Start at the center of the cover and engage the latches and keepers using a ¾-inch wrench or socket to lock them together until all are attached.
7. Install boot seal clamps per Section 5.7.1.4.

5.7.1.3 Vertical Pipe Installation

Important: A Sensor Cover Support Installation Kit is recommended when installing the cover assembly on vertical pipes. Contact Customer Support if you do not have a Sensor Cover Support Installation Kit.

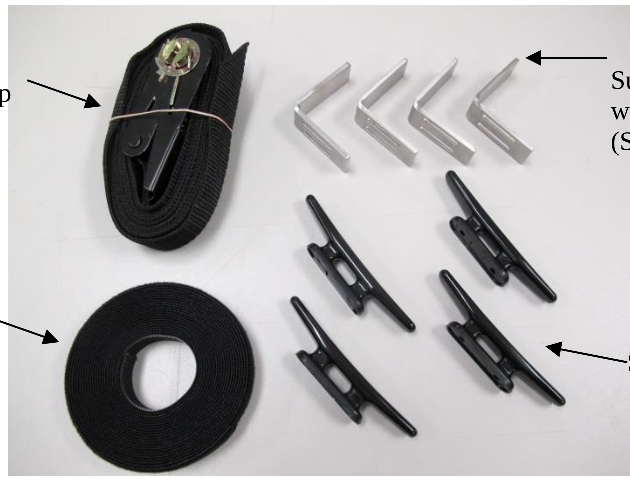

Figure 17   Sensor Cover Support Installation Kit

Installation of the sensor cover on vertical pipes is as follows:

1. Install the sensor band.
2. Mark the pipe at a distance of about 10-inches (254 mm) from the top of the sensor band (or 8-inches (203 mm) from thermal blanket if installed) at 4 locations around the pipe.
3. Cut 2 each 24-inch (610 mm) lengths from the roll of cover upper support strap (hook and loop strap). These will be used as the cover support straps.
4. Install the cover upper support strap and align it with the four marks located at 10-inches above the sensor band assembly. Install the 2 cover support straps so they will align with the lifting handles on each cover half.
5. Mark the pipe at a distance of 7-inches from the bottom of the sensor band (or 5-inches (127 mm) from thermal blanket if installed) at 4 locations around the pipe.
6. Slide the 4 cleats onto the 1” ratcheting strap so the cleat bottom will contact the pipe. (Use fewer cleats for small pipe sizes.) This is the cover lower support strap assembly.
7. Install the cover lower support strap assembly using the 4 marks as alignment guides.
   a. The individual support cleats should be positioned approximately equal distant between them.

b. The cleats should be located such they are ~1/4th of the distance from the cover flanges.
c. Thread the strap loose end through the take-up spindle and pull slack strap through the spindle before tightening using the ratchet.

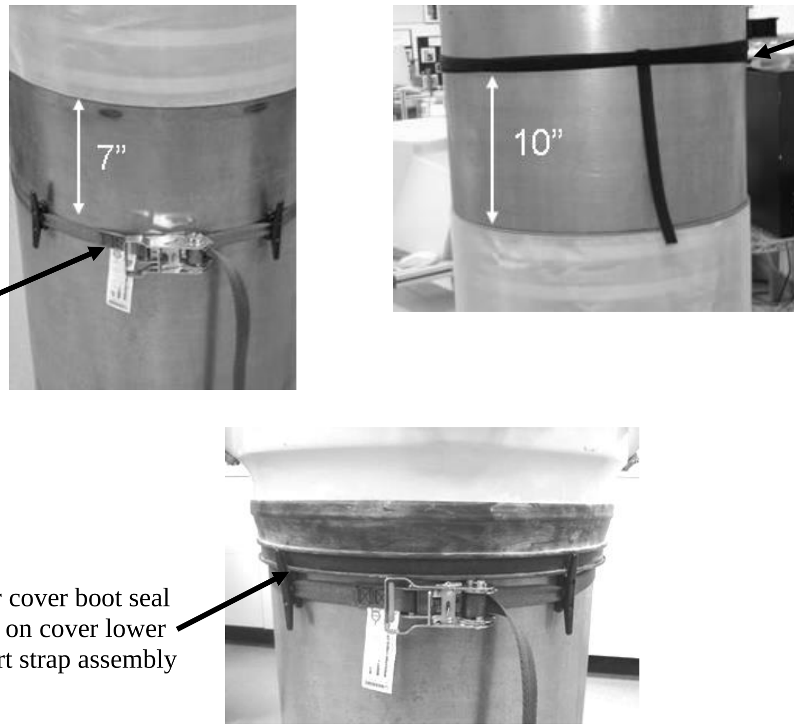

Figure 18 Sensor Cover Support Installation Kit on Pipe

8. Lift the upper sensor cover into place on the cover lower support strap assembly.
9. Install a cover support strap between the cover upper handle and the cover upper support strap.
   a. Cover sizes 2 thru 4-inch (50 – 100 mm) do not have lifting handles. Wrap a length of the hook and loop strap around the cover to hold the halves in place.
10. Repeat above steps with lower cover assembly.
11. Open the access panel to ensure the sensor band cable is accessible.

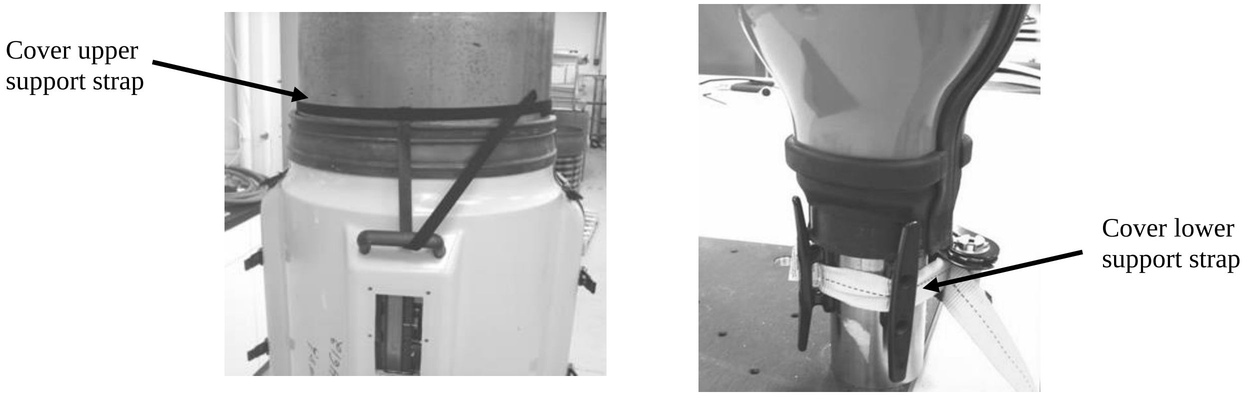

Figure 19 Sensor Cover Installed on Sensor Cover Support Installation Kit

12. Ensure the cover halves are aligned and then buckle the cover latches.
13. Remove the cover support strap (upper) assembly.
14. .***<u>DO NOT REMOVE THE COVER LOWER SUPPORT STRAP. THE COVER WILL SLIP AND DAMAGE THE SENSOR BAND.</u>***
15. Install upper boot seal clamps per Section 5.7.1.4.
16. Install lower boot seal clamps per Section 5.7.1.4.

5.7.1.4 Boot Seal Clamp and Band Installation

The boot seal clamp (or band) is used to seal the cover boot seal to the process pipe. Cover sizes 2-inch through 8-inch use a stainless steel T-bolt saddle clamp. Cover sizes 10-inch and larger use a stainless steel band and buckle fastener. These are illustrated in the following figures.

NOTE: <u>Always install the upper boot seal clamp first on vertical pipe installations.</u>

Figure 20 Tee-Bolt Saddle Clamp

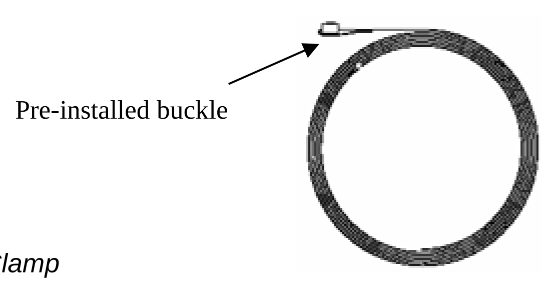

Figure 21 Boot Seal Band

5.7.1.4.1 Tee-Bolt Saddle Clamp

The tee-bolt saddle clamp used on cover sizes up to 8-inch is wrapped around the boot seal. Locate the tightening bolt such that it is in-line with the access cover on the upper cover assembly. Ensure the saddle clamp is located within the groove on the boot seal. Tighten the nut until the seal fits snug to the pipe. Repeat at the opposite end of the pipe.

Figure 22 Tee-Bolt Saddle Clamp

5.7.1.4.2 Boot Seal Band Installation

The boot seal band used on cover sizes 10-inch and larger will be shipped cut to length for the cover size with the retaining buckle pre-installed. The boot seal band should be completely installed on one end of the cover and then repeated on the other end.

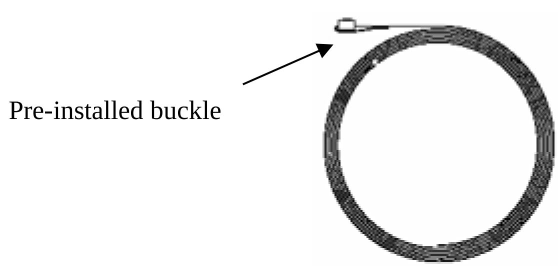

Figure 23 Boot Seal Band

Position the buckle on the band of the cover so it is in line with the handles of the upper cover in the groove on the boot seal.

Wrap the band around the boot seal and pass the end through the buckle on the band. Wrap the band around the boot seal a second time and pass it through the buckle. Pull the band taut and tighten the set-screw to hold the band in place.

Figure 24 Boot Seal Wrapped Around Boot Seal in Groove

Note: Ensure the band is aligned within the grooves on the boot seal and the second wrap of the band is directly over the first wrap.

Install the BAND-IT® Model C00169 tensioning tool by inserting the band through the cutter bar and slide lock.

Note: This tool is asymmetric. The tool will pull in opposite directions when installed on opposite ends of the cover. The cutter handle (positioned either up or down) on the Model C00169 is located outboard with respect to the cover end, when the tool is properly installed. The following figure illustrates proper installation of the tool.

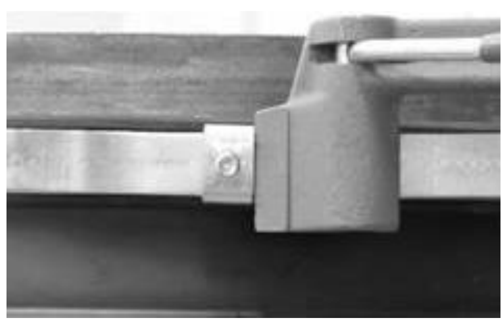

Figure 25 BAND-IT® Model C00169 Tool Use

Verify the band is still aligned within the grooves on the boot gasket and over the first wrap of the band, and the band buckle is positioned in line with the cover handle.

Tension the band until the resistance on the tool handle is constant (i.e. the band does not slide easily through the buckle). The boot seal should be tight against the process pipe. Verify the band is in the boot seal groove. Tighten the band set screw to lock the band in place. The band will be dimpled by the set screw.

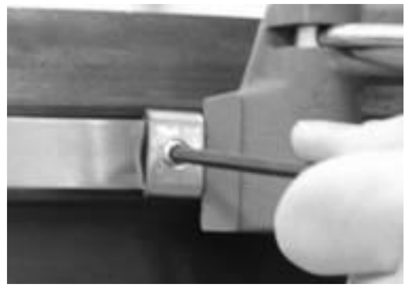

Figure 26   Boot Seal Clamp Tightened

Once the set screw has been fully tightened, loosen the tensioning tool and bend the tool and band up and over the buckle. It is not necessary to cut excess band material (allows for re-tightening of the band if necessary). Place a reverse bend on the end of the band clamp as a safety measure using needle nose pliers.

Figure 27   BAND-IT® Tool Bending Over Retaining Clip

Repeat the band installation procedure for the opposite end of the cover.

Figure 28   Band Clamp Final Installation

Note: Do not cut the end of the metal band.

5.7.2 Stainless Steel Cover Model SH-XXX-XX-02 (or 05 or 09 – 14 or 32) -XXX-XX Installation

This section covers installation of Stainless Steel Covers Model Numbers SH-xxx-xx-02-xxx-xx or SH-xxx-xx-05-xxx-xx or SH-xxx-xx-09-xxx-xx or SH-xxx-xx-10-xxx-xx or SH-xxx-xx-11-xxx-xx or SH-xxx-xx-12-xxx-xx or SH-xxx-xx-13-xxx-xx or SH-xxx-xx-14-xxx-xx or SH-xxx-xx-32-xxx-xx, where “x” is any alphanumeric character.

The stainless steel cover is illustrated in the following figure.

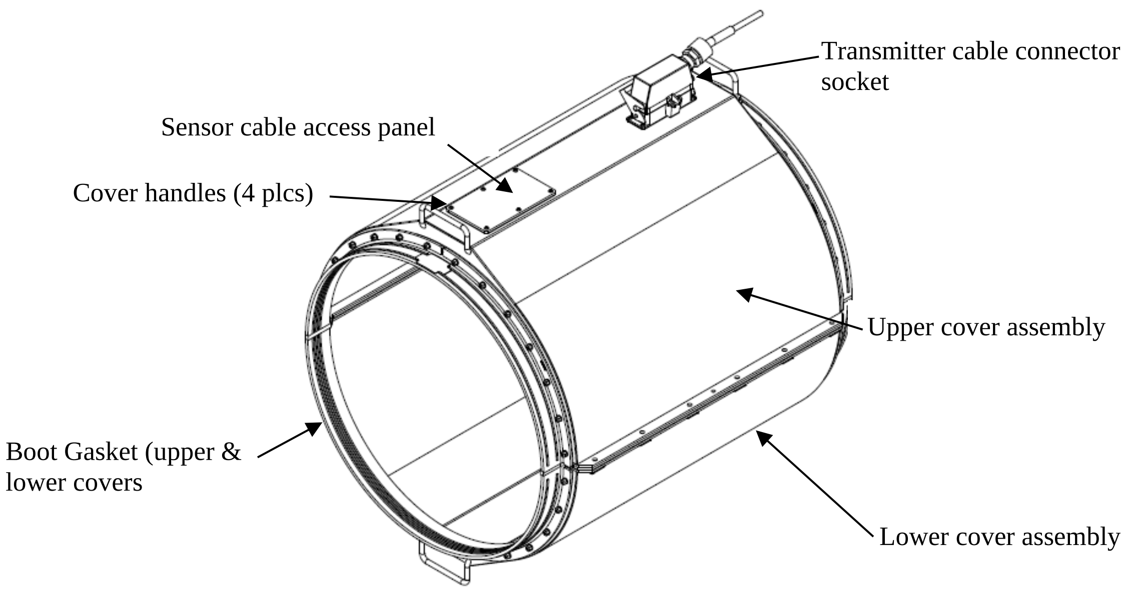

Figure 29 Stainless Steel Cover Assembly

WARNING

The handles on the stainless steel cover are not designed or rated for hoisting the cover. Use a proper lifting sling to properly secure cover to lifting rope when hoisting cover.

Important: <u>A banding tool is needed to properly install stainless steel sensor cover sizes 18-inch and larger.</u> Failure to use a banding tool may result in improper sensor cover to pipe sealing and will void the system warranty. The use of a BAND-IT® Model C00169 Banding Tool (or equivalent) is recommended. The tool is available through Customer Support as P/N 52511-01. This tool is also available in the United States from McMaster Carr Company (telephone 630-833-0300, internet www.mcmaster.com) as their P/N 5424K1. Other suppliers are available worldwide. Contact BAND-IT at 800-525-0758 or 303-320-4555 or www.band-it-idex.com.

Figure 30 BAND-IT® Model C00169 Banding Tool

	CAUTION
	Use of a BAND-IT® Model C00169 Banding Tool (or equivalent) is necessary for properly installing sensor cover. Failure to use this tool may void system warranty.

Remove the sensor cable access panel on the cover and place the upper cover assembly on the pipe. **Note:** Ensure the sensor cable connector is accessible through the sensor cable access panel. (If necessary reposition cover or cable connector.)

Place the lower cover on the pipe and retain the cover halves with spring clamps or vice grips. Install and tighten the cover bolts 1 – 2 turns. (The stainless cover will have a fastener assembly consisting of a bolt with one washer and a serrated nut retained in the lower cover flange.) Continue to tighten the cover bolts until the flanges bottom on the spacers integral to the flange and flange seal.

Apply a coating of the Joining Compound (comes in the Installation Kit) to the flange seal and boot gasket at the edge of the lower cover (4 places). Press the upper boot gasket and Joining Compound coated lower seal edges together.

Apply coating of
joining compound

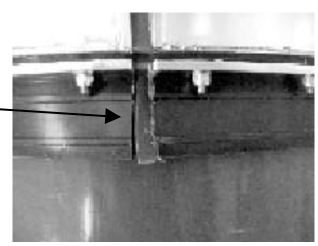

Figure 31 Applying Joining Compound to Gasket Edge

5.7.2.1 Boot Seal Band Installation

The boot seal band will be shipped cut to length for the cover size with the retaining buckle pre-installed. The boot seal band should be completely installed on one end of the cover and then repeated on the other end.

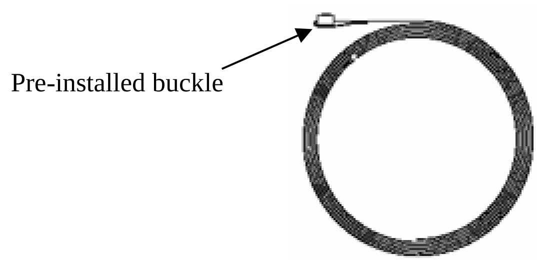

Figure 32 Boot Seal Band Kit

Position the buckle on the band over the seal protector plate located on the top of the upper cover outboard of the handles. **Note:** When installation is complete the buckle must be positioned on the protector plate to protect the seal from being damaged.

Wrap the band around the boot seal and pass the end through the buckle on the band. Wrap the band around the boot seal a second time and pass it through the buckle. Do not pull the band taut.

Note: Ensure the band is aligned within the grooves on the boot seal and the second wrap of the band is directly over the first wrap.

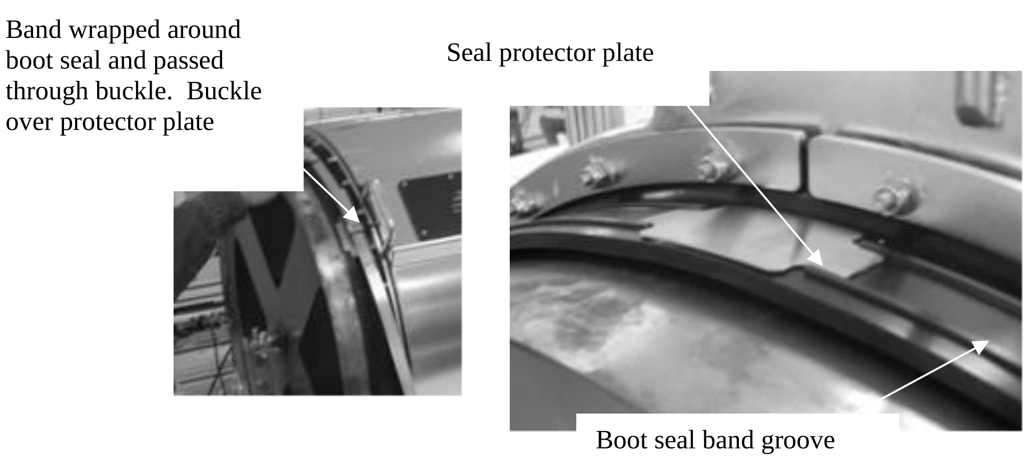

Figure 33 Boot Seal Band Installation

Install the splice protector plates by lifting the band using needle nose pliers or a screwdriver, and slide the plates (2 per end) into position over the flange gasket. Pull the band taut. Tighten the socket head set screw on the band buckle just enough to keep the band in place but loose enough so the band will still slide through the buckle. Repeat on the opposite end of the cover.

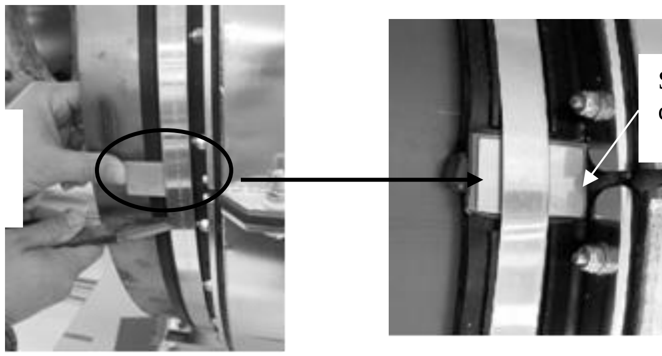

Figure 34   Splice Protector Plate Installation

Install the BAND-IT® Model C00169 tensioning tool by inserting the band through the cutter bar and slide lock.

Note: This tool is asymmetric. The tool will pull in opposite directions when installed on opposite ends of the cover. The cutter handle (positioned either up or down) on the Model C00169 is located outboard with respect to the cover end, when the tool is properly installed. The following figure illustrates proper installation of the tool.

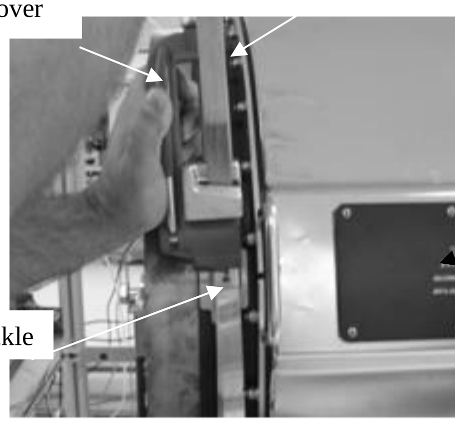

Figure 35   BAND-IT® Model C00169 Tool Use

Verify the band is still aligned within the grooves on the boot seal and over the first wrap of the band, and the band buckle is positioned over the seal protector plate.

Tension the band until the resistance on the tool handle is constant (i.e. the band does not slide easily through the buckle). The boot seal should be tight against the process pipe under the seal protector plate. Verify the band buckle and splice protector plates are still in place.

Tighten the set screw to lock the band in place. The band will be dimpled by the set screw.

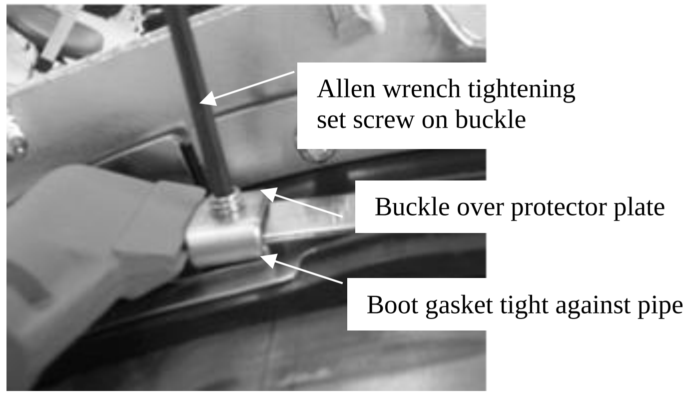

Figure 36 Final Alignment and Securing of Seal Band

Once the set screw has been fully tightened, loosen the tensioning tool and bend the tool and band up and over the buckle. It is not necessary to cut excess band material (allows for re-tightening or re-use of band if necessary).

Repeat the band installation procedure for the opposite end of the cover.

Note: Do not cut the end of the metal band.

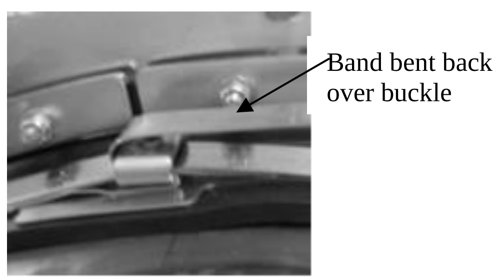

Figure 37 Band Termination

The completed stainless cover assembly is shown below

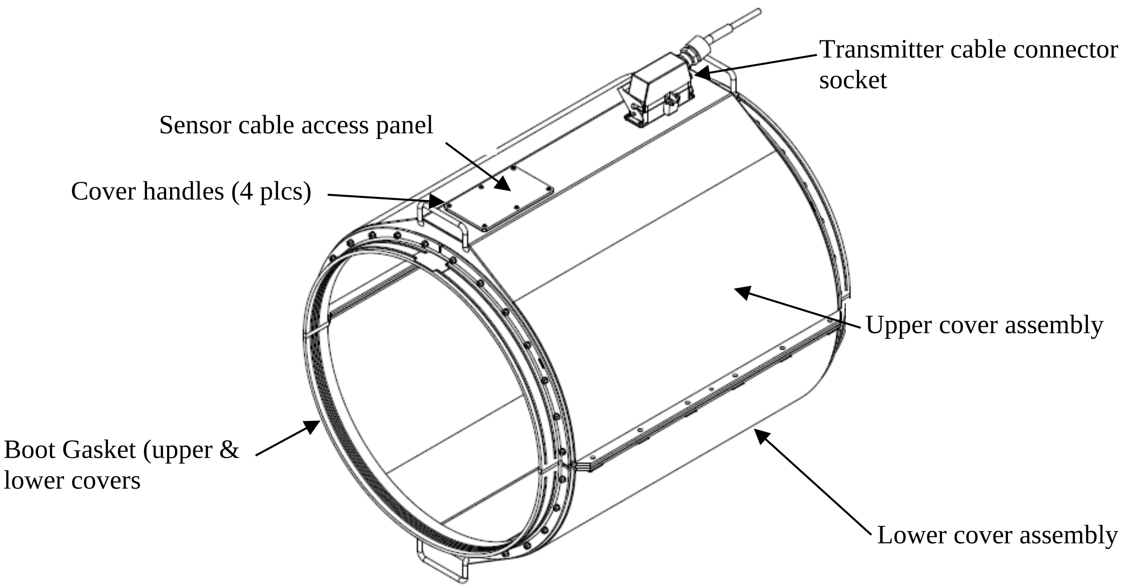

Figure 38 Stainless Steel Cover Assembly

5.7.3 Fiberglass Cover Model SH-XXX-XX-01(or 06)-XXX-XX Installation

These covers are readily identified by their having nut and bolt fasteners along their flange.

Figure 39 Bolted Flange Fiberglass Cover

Contact Customer Support for installation instructions for these systems.

5.7.4 Sensor Assembly Cable Connection

Remove the tape (if it was used) that was temporarily installed to retain the sensor connector under the cover access panel. Install the sensor assembly cable connector into the mating receptacle located inside the access cover plate on the sensor upper cover as shown below. The connector is installed such that the connector key faces away from the pipe. Push the connector into the mating receptacle. The latches on the receptacle will engage to keep the plug from pulling out. Ensure the connector is fully engaged. **Note:** Use care to ensure the sensor cable connector goes on squarely to minimize risk of damaging the contacts.

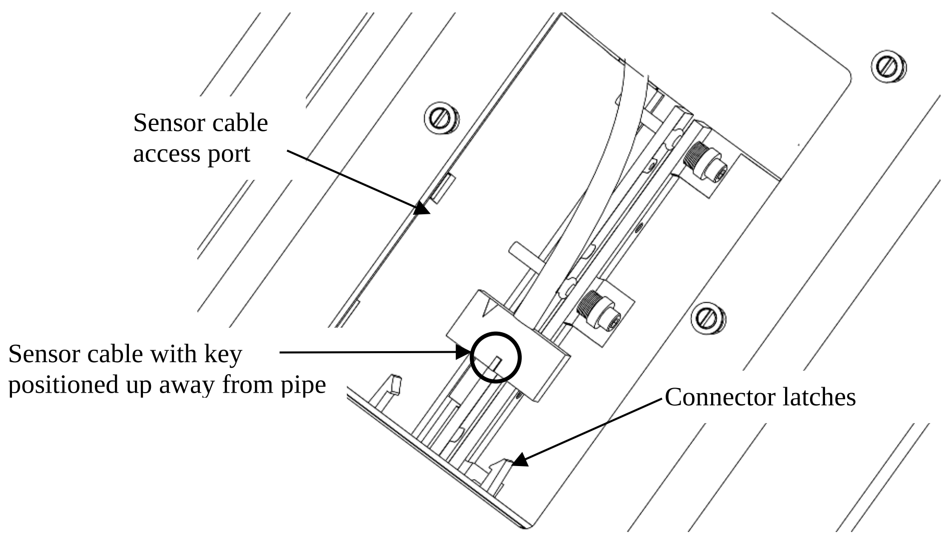

Figure 40 Sensor Assembly Cable Installation

Re-install the sensor cable access panel on the sensor top cover assembly. Tighten the six panel screws to a recommended torque of 14-lb_f-in (1.58-Nm) on fiberglass covers and 7-lb_f-in (0.79-Nm) of stainless steel covers.

5.7.5 Sensor Calibration Label

The sensor band is shipped with four labels enclosed with it. The label lists the sensor part number, serial number, date of manufacture and three calibration factors. This information will be entered into the transmitter during setup. Affix one of the labels to the outside of the access panel of the sensor cover as shown below.

The second label should be installed on the inside of the transmitter cover.

Note: Sensor band information is also found on a label on the sensor cable next to the sensor cable connector.

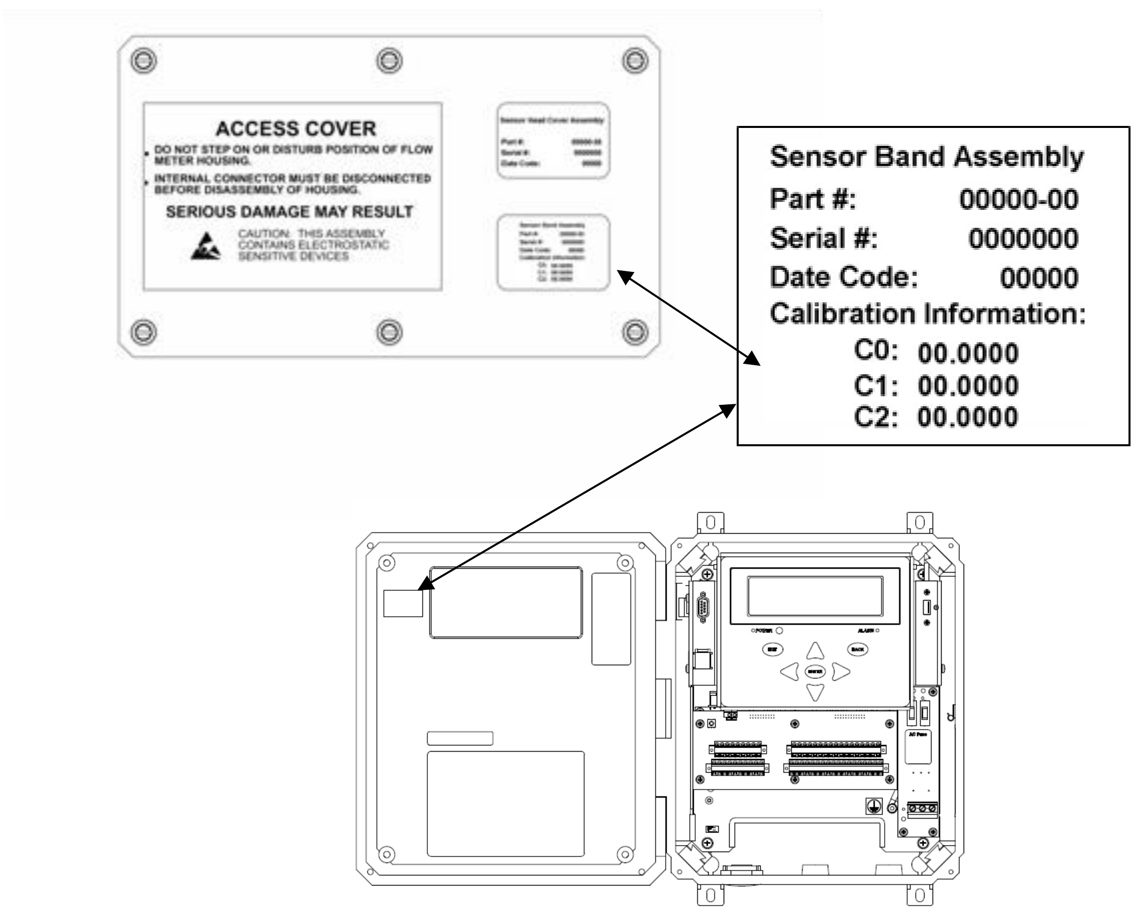

Figure 41 Sensor Calibration Label

5.8 Sensor to Transmitter Cable Connections

The sensor to transmitter cable is used to transmit sensor signals and information between the transmitter and the sensor, and provides electrical power to the sensor pre-amplifier board mounted in the sensor cover.

The sensor to transmitter cable consists of 12 twisted pairs of 20 AWG (0.518 mm^2) conductors with an overall cable shield encased in a PVC jacket. The standard cable has an operating range of -4 ºF to 221 ºF (–20 ºC to 105 ºC). The cable is UL Listed (UL Standard 13, Type PLTC) and CSA Certified (CSA C22.2 No. 214, PCC FT4). The outer diameter of the cable is 0.61 inch (15.5 mm) nominal.

Optional low temperature and armored cables are also available. Please contact your local distributor or Customer Support for more information.

The sensor to transmitter cable is furnished with a connector pre-attached to the sensor head end. The transmitter end can be cut to length and terminated at installation.

The sensor to transmitter cable can be either run in cable trays or through conduit in accordance with local practice.

5.8.1 Sensor End Cable Attachment

Once the cable is run, attach the connector on the sensor cable end to the mating connector on the sensor cover. Align the keyway on the sensor connector and latch in place.

Provide a cable strain relief by attaching the cable to the handle on the sensor cover (if so equipped) using a tie wrap. This will help prevent the cable from twisting or pulling on the connector.

5.9 Installations on Tubing

The sensor head will fit on process tubing as well as pipe. This is accomplished through the use of a sensor band specifically sized for tubing and the use of elastomer strips wrapped around the tube. The elastomer strips serve to increase the tube diameter to that of pipe in the areas of the pipe seal gaskets on the fiberglass cover. **Note:** Covers with spacers are not certified for use in ATEX Zone 2 applications.

WARNING

EXPLOSION HAZARD – The ATEX Zone 2 approval applies to Sensor Heads with integral gaskets sized to fit the pipe. Zone 2 certification prohibits the use of elastomer strips. Contact Customer Support about whether an ATEX Zone 2 solution exists for a particular tubing diameter.

A sensor band specifically sized for use on tube must be ordered (the overall length of the tube-sized sensor band will be shorter than a pipe sized band due to the difference in outside diameter of a specific size tube vs. pipe).

Installation is as follows:

1. Clean the tube where the sensor head will be installed. The overall clean length should be at least 36 inches (91 cm).
2. Measure the overall length of the sensor cover from end seal to end seal and mark this distance on the tube.
3. Install the elastomer strips such that the outer edge of each strip align with the marks on the tube. Orient the elastomer strip so the paper covered adhesive will contact the tube. **NOTE:** For installation on vertically oriented tubes align the upper edge of the upper elastomeric strip ~1/8” (~3mm) above the line in step 2 above.
   a. Remove the paper strips covering the adhesive.
   b. Wrap the elastomer strip $3/4^{ths}$ of the way around the pipe. Pull it taut so it lies smoothly and evenly on the tube.
   c. Apply a bead of the Teflon sealant (provided with the elastomer strip) along the seam at the outside edge of the elastomer strip.
   d. Continue to wrap the elastomer strip overlapping the previous layer.
   e. Once the wrap is complete, apply a bead of the Teflon sealant along the seam.
   f. Install the second strip per the above steps.

4. Continue with installation of sensor head as previously described in the manual.

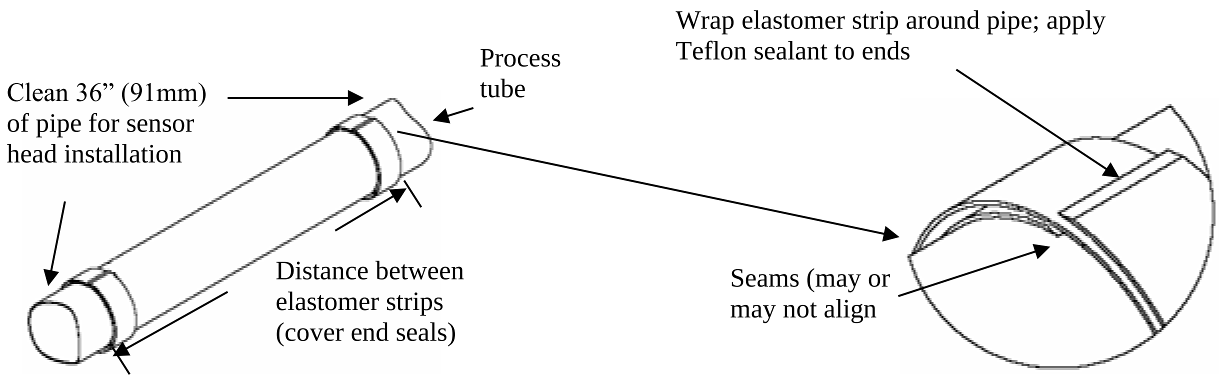

Figure 42 Elastomer Strip Installation on Tubes

5.10 Special Installation Instructions for Covers with Spacers

The passive sonar is able to be installed on non-standard size pipes found at some installation sites. **Note:** Covers with spacers are not certified for use in ATEX Zone 2 applications.

⚠	**WARNING** **EXPLOSION HAZARD – The ATEX Zone 2 approval applies to Sensor Heads with integral gaskets sized to fit the pipe. Zone 2 certification prohibits the use of spacers of any kind. Contact Customer Support about whether an ATEX Zone 2 solution exists for a particular pipe diameter.**

For example, a fiberglass pipe may have an outside diameter of 15 inches due to the fiberglass material layup. In this case, a custom sensor band to fit the pipe circumference would be manufactured. The sensor cover would be modified with the addition of a spacer in order to make a proper seal with the pipe. The following figure illustrates such a cover.

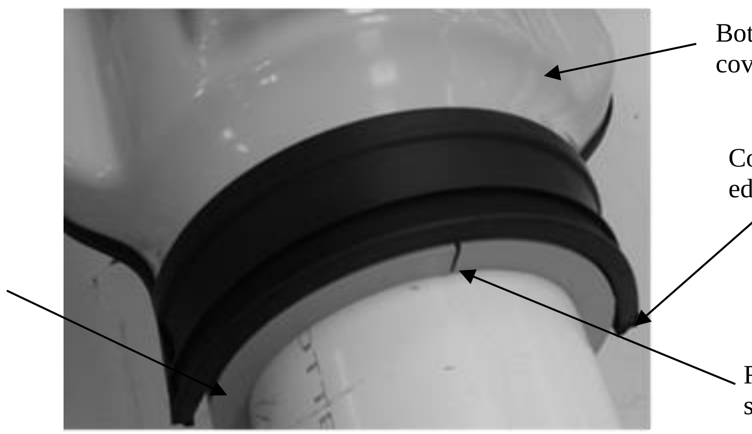

Figure 43 Cover with Spacer

In some cases a rubber skiving kit (lengths of elastomer strips to wrap around the pipe) can be used as a spacer or used in conjunction with the rubber adapter ring shown in the figure above.

Install the elastomer strip in accordance with the instructions in Section 5.9 of this manual.

The following figure illustrates the rubber adapter ring kit that may be used with non-standard size pipes. The kit consists of the rubber adapter rings, a roll of silicone rubber used to support the upper adapter ring on vertical installations, and a tube of RTV sealant.

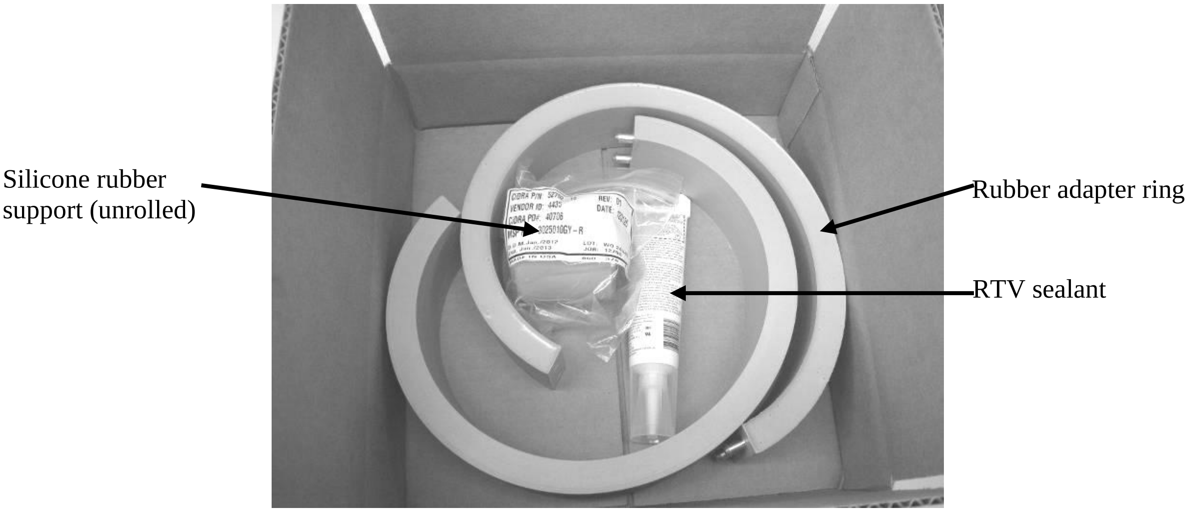

Figure 44 Rubber Adapter Ring Kit

Installation is as follows:

1. Clean the pipe where the sensor head will be installed. The overall clean length should be at least 36 inches (91 cm).
2. Measure the overall length of the sensor cover from end seal to end seal and mark this distance on the pipe.
3. Wrap the rubber adapter ring around the pipe.
4. Install the rubber adapter ring such that the outer edge of each ring aligns with the marks on the pipe. **NOTE:** For installation on vertically oriented pipes align the upper edge of the upper rubber adapter ring ~1/8” (~3mm) above the line in step 2 above.
   a. Install such that the seam of the ring is 90º from the cover boot seal edge (Figure 43) on the lower or rear cover half.
   b. Apply RTV to the seam of the rubber adapter ring where the ends meet. The rubber adapter ring faces will form a seal when the boot seal band or clamp is installed.
   c. When installing on vertical pipe, make a rubber support ring using the silicone rubber included in the Rubber Adapter Ring Kit.
      i. Wrap and stretch a length of the self-fusing silicone rubber around the pipe and then roll it down to form a support for the adapter ring as shown below. A

permanent bond if formed when the silicone rubber contacts itself.

ii. This adapter ring will remain installed on the pipe after the cover is installed.

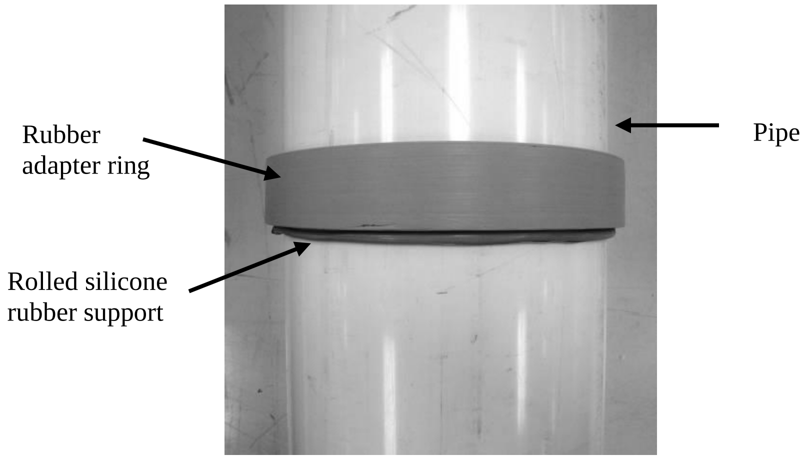

Figure 45 Rubber Adapter Ring Supported by Silicone Rubber Support

iii. Make use of the vertical installation kit shown below for installing the system on vertical pipes.

Figure 46 Sensor Cover Support Installation Kit

iv. Install the cover such that the cover boot seal upper edge is 1/8” (3mm) lower than the upper edge of the rubber adapter ring to prevent pooling of rain or wash-down water.

v. Install the upper spacer and band seal clamp first and then the lower spacer and band seal clamp.

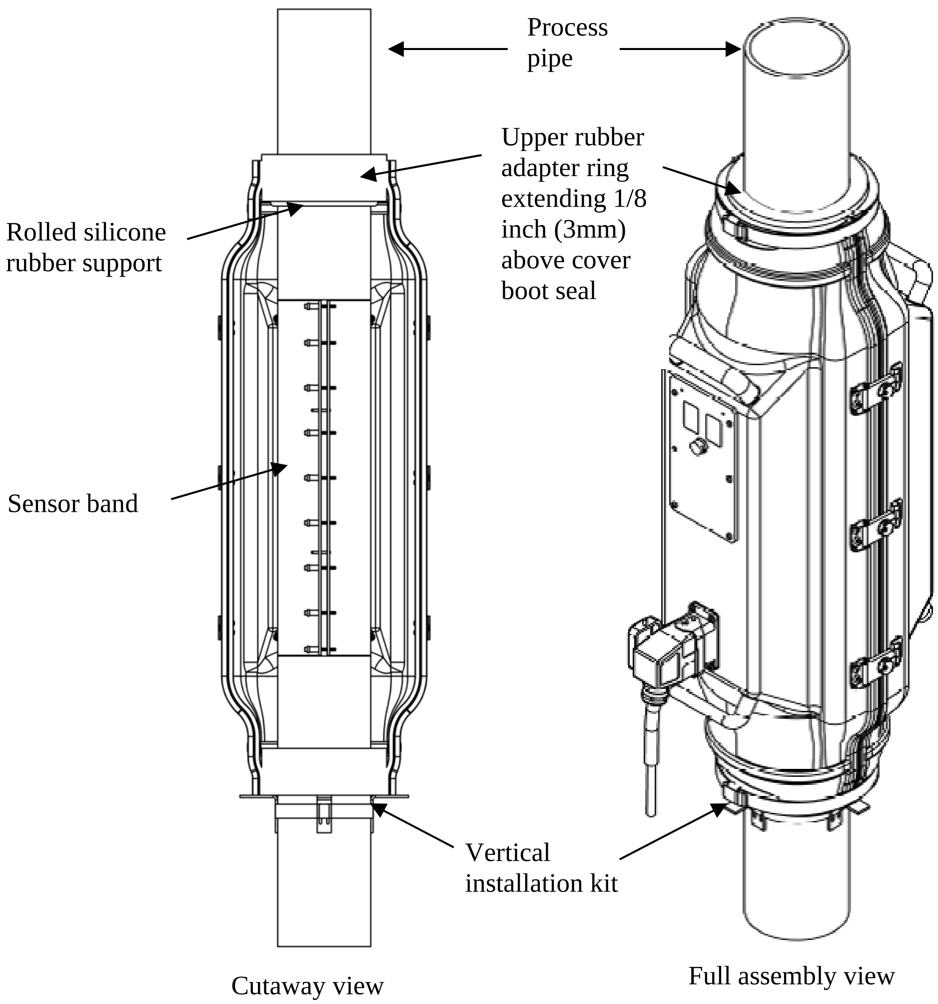

Figure 47 Covers with Spacers

5.11 Safety Issues of Improper Sensor Head Installation

Failure to follow the instructions in the manual can lead to sub-optimal flow measurement performance or in some cases damage to the flowmeter. But the impact on safety depends on the location.

Ordinary Location certified passive sonar meters in Ordinary Locations (no explosive gas), have virtually no ways in which improper installation of the Sensor Head could cause a safety hazard to personnel (fire or electric shock) owing to the low voltages, current, and power going from the Transmitter to the Sensor Head.

Hazardous Location certified passive sonar meters in Hazardous Locations (Class I Div 2 or ATEX Zone 2 – where there is the possibility of explosive gas mixtures) have Sensor Head safety (as regards explosions) that is dependent on <u>maintaining the IP55 rating</u> of the clamshell enclosure, <u>avoiding shorts from the sensor band to the pipe</u>, and (especially for ATEX Zone 2) <u>assuring that the Sensor Head is grounded</u> (e.g. through the ground wire in the cable to the Transmitter which must, in turn, be properly earth-grounded). Any improper installation which compromises either of those 3 issues presents a safety hazard in hazardous locations. Those could include:

- Improper sizing of Sensor Head clamshell to pipe (and note that the rubber adapters to match a pipe to an oversized clamshell are forbidden for ATEX Zone 2 and not recommended for Class I Div 2)
- Improper latching of Sensor Head clamshell halves (including the trapping of unintended objects – like the band umbilical cable – between the seals).
- Improper attachment and/or strain relief of the cable connector at the clamshell (such that leaks can occur at the connector)
- Failure to properly prepare pipe surface or orient band such that the band shorts to the pipe.

6 TRANSMITTER INSTALLATION

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6.1 Preparation

Prior to installing the transmitter, verify that the transmitter is rated for the area where it will be installed. Consider the available power, the ambient temperature, whether it is a Hazardous Area (Explosive gasses) or an Ordinary Location, and whether it is to be wall mounted or pipe mounted. If the markings on the transmitter received are not consistent with the conditions of the area in which it must be installed, contact Customer Support.

In addition to the warnings and cautions in this section (section 6), refer also to the General Safety Guidelines in section 3.

6.1.1 Transmitter Power Requirements

The AC version of the transmitter can accommodate an input voltage of 100 – 240 volts AC, 50/60 Hz, and requires 25 watts of power.

The DC version of the transmitter can accommodate an input voltage of 18 – 36 volts DC and requires 25 watts of power.

Refer to the fuse label in the transmitter or Appendix A for input power fuse ratings.

Only replace fuses with the fuse type indicated on the label inside of the transmitter.

WARNING

Electrical shock hazard. Always disconnect power source prior to removing fuses. Failure to remove power source may result in injury or death.

WARNING

Do not modify the transmitter housing by adding holes or cutouts. This will void the equipment safety rating.

6.1.2 Hazardous Area Installations

- Transmitters and sensor heads marked for Class I, Division2 may only be installed in Class I, Division 2 or non-hazardous locations (Ordinary Locations). Consult the National Electric Code or Canadian Electric Code for the possible authorization for installation in North American (non-ATEX) Class I, Zone 2 locations.
- Transmitters and sensor heads marked for ATEX Class I, Zone 2 may only be installed in ATEX Class I, Zone 2 or non-hazardous locations (Ordinary Locations).

- For installation in Hazardous areas, both the Sensor Head and the Transmitter have to have the same hazardous area approvals even if only one of the two pieces is to be installed in a hazardous area.

	WARNING **EXPLOSION HAZARD - Installation of equipment in hazardous areas must comply with the appropriate control drawing for the particular model numbers. See Control drawings in the appendix of this manual (for Division 2) or the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY (for ATEX Zone 2).**
	WARNING **EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be free of explosive gasses.**
	WARNING **When explosive gases may be present, the transmitter door may be opened only to use the keypad or reset button. Obtain hot work permit and ensure explosive gasses are not present prior to performing any other operation.**
	WARNING **EXPLOSION HAZARD – Substitution of components may void the suitability for hazardous areas.**
	WARNING **Explosion hazard - Do not remove or replace fuses unless power has been disconnected or the area is known to be free of ignitable concentrations of flammable gases or vapors.**
	Avertissement **Risque d’explosion – Couper le courant ou s’assurer que l’emplacement est désigné non dangereux avant de replacer les fusibles.**
	Warning **Explosion hazard - Repair and replacement of internal cabling, circuit boards, or components on circuit boards should only be performed using factory-approved replacement components and procedures. Unauthorized repairs may impair suitability for Division 2.**

⚠	**Avertissement** **Risque d’explosion – La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe i, Division 2**
⚠	**Warning** **Explosion hazard - Do not disconnect from mains power while circuit is live unless the area is known to be free of ignitable concentrations of flammable gases or vapors.**
⚠	**Avertissement** **Risque d’explosion – Avant de déconnecter l’équipement, couper le courant ou s’assurer que l’emplacement est désigné non dangereux.**

6.1.2.1 European Zone 2 Rated Equipment

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

6.1.3 Transmitter Environmental Conditions

See Appendix A for the Transmitter environmental conditions.

For ATEX Class I, Zone 2 marked equipment, somewhat different environmental restrictions apply. Refer to the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY for additional information.

6.2 Transmitter Mounting Instructions

The transmitter is furnished with a Bulkhead (wall or panel surface mount) Installation Kit. An optional Pipe Installation Kit is also available.

The maximum sensor head to transmitter cable length is 375 feet (114 meters).

Select an installation location that allows for easy and safe access to the transmitter. Ensure the local ambient temperature range is within the operating temperature limits of the transmitter. Avoid locations with extreme vibration and locations that are subject to extreme water conditions (for example, direct hose-down). Consider access to power and the related installation requirements of paragraph 6.3.3, Transmitter Electrical Power Cable Installation.

6.2.1 Bulkhead Mounting

The transmitter is attached to the bulkhead or panel with user supplied 1/4-inch (M-6) fasteners through the four panel mounting feet on the transmitter. The mounting dimensions are illustrated in the following figure.

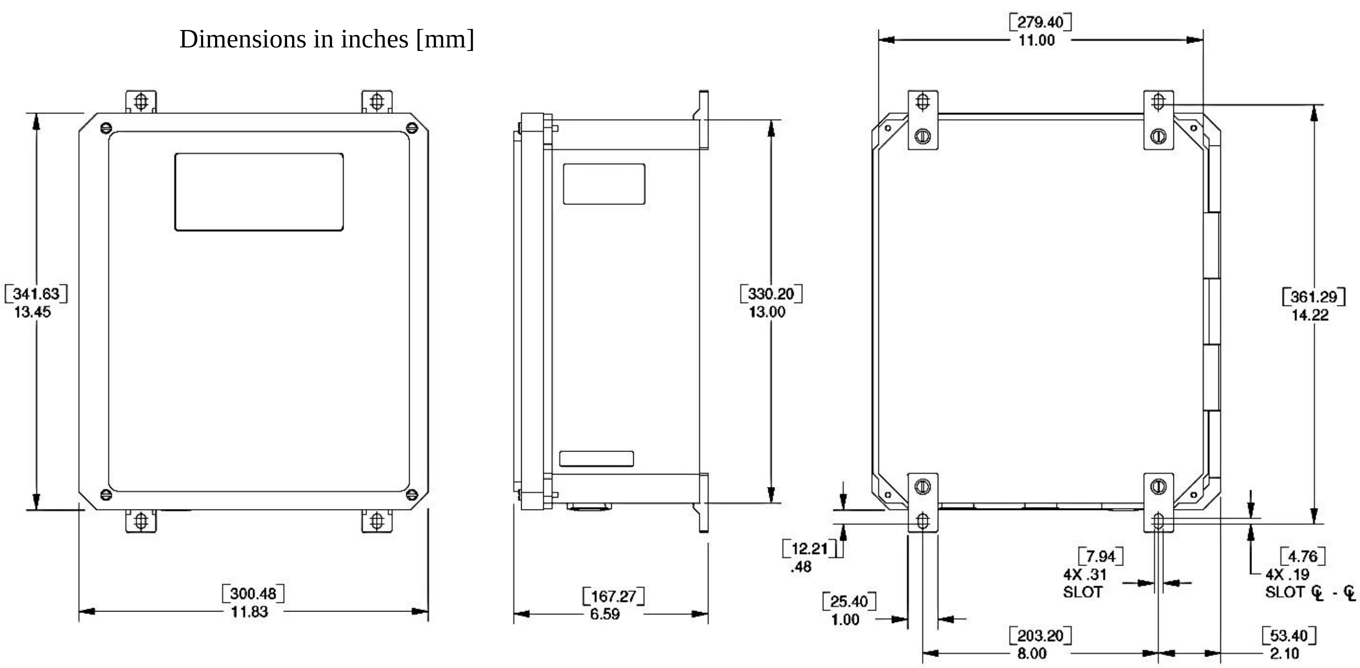

Figure 1 Bulkhead Mount Hole Pattern

6.2.2 Pipe Mounting

The optional Pipe Mount Kit is designed to allow for mounting the transmitter assembly to pipes up to 10-inch (254 mm) diameter and equivalent sized I-beams. The kit consists of two mounting rails, two band clamps, and fasteners. (Additional lengths of clamps can be added for larger diameter pipes and I-beams. Please contact your local distributor or Customer Support for more information.)

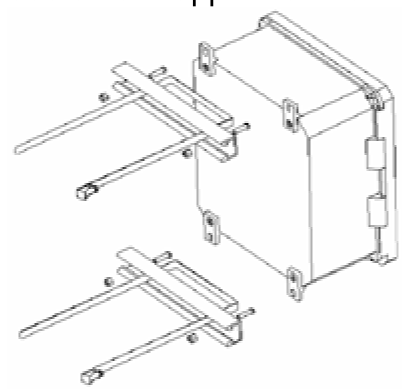

Figure 2 Pole Mount Kit

Attach the mounting rails to the panel mounting feet using the 1/4-20 x 3/4" screws and locknuts supplied with the rails. Slide the band clamps through the slots in the mounting rails as shown. Wrap the clamp around the pipe and feed the band through the clamp and tighten. Excess band material can be removed if desired.

6.3 Transmitter Cable Connections

The following figure illustrates the basic power and signal connections for transmitters with pluggable terminal blocks.

The recommended torque for the terminal screws is 4.4 to 5.3 lb_f-inch (0.5 to 0.6 Nm).

The recommended torque for the screws that secure the terminal blocks to the base is 3.5 to 4.4 lb_f-inch (0.4 to 0.5 Nm).

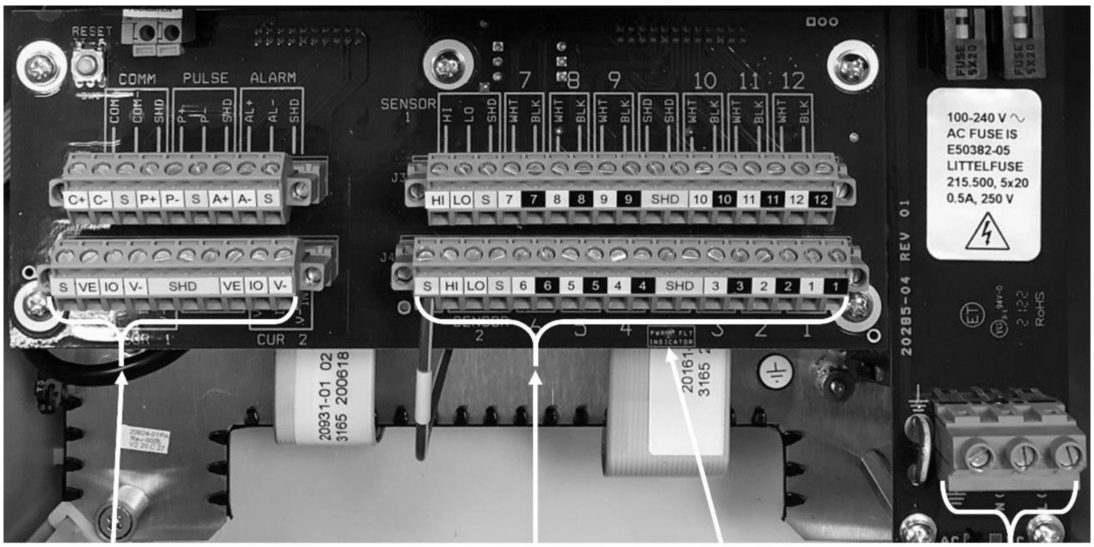

Figure 3 Power and Signal Interconnects

6.3.1 Transmitter Housing Cable Entry

Power, sensor signal, and input /output signal cables enter the transmitter housing through cable glands. The cable glands also provide strain relief for the cables. Always ensure they are fully tightened. The following figure illustrates where each of the cable glands are installed.

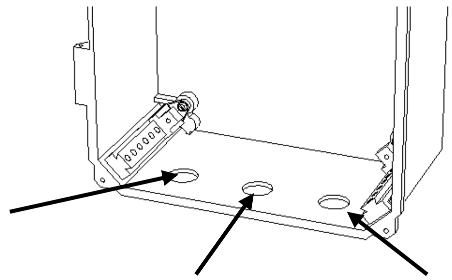

Figure 4 Transmitter Housing Cable Gland Holes

Note: *For Ordinary Locations as well as for Hazardous Locations the four cover sealing screws on the transmitter cover must be securely tightened in order to ensure a proper seal, all cable entries require cable glands, and any unused cable gland holes must be sealed with the gasketed hole plugs that came with the Transmitter. On transmitters installed in Class I Division 2 areas, cable glands rated for NEMA 4X (minimum rating) must be used. Similarly, for ATEX Zone 2, cable glands must be ATEX-certified and at least IP55. See the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY for additional info and requirements*.

⚠	**WARNING** **Transmitter cover screws must be securely tightened and NEMA 4X rated cable glands must be used in Class I Division 2 applications. Failure to do so is a violation of Class I Division 2 certification.**
⚠	**WARNING** **Transmitter cover screws must be securely tightened and ATEX cable glands with IP55 rating must be used in ATEX Class I Zone 2 applications. Failure to do so is a violation of ATEX Class I Zone 2 certification.**

Whenever metal cable glands are used in hazardous areas, always use the grounding tags and connect the wire from those tags to one of the terminals marked “SHD” on the terminal blocks. This will ground the exposed metal cable gland.

6.3.2 Transmitter Output, Sensor and Sensor Head Connections

The following figure shows the layout of the transmitter terminal strip board. This board is divided into three sections.

The Section#1 terminal blocks are for transmitter outputs. These signals are not certified non-incendive field wiring.

The Section #2 terminal blocks are for external sensor inputs (pressure and temperature). For Class I, Zone 2, ATEX rated Transmitter Model TB8-xx-xx-xx-03 these are to be treated as non-incendive field wiring.

The Section #3 terminal blocks are for the cable interface to the sensor head. This consists of 12 twisted pairs of conductors plus a cable drain wire (shield). For Class I, Zone 2, ATEX rated Transmitter Model TB8-xx-xx-xx-03 these are to be treated as non-incendive field wiring.

The recommended torque for the terminal screws is 4.4 to 5.3 lb_f-inch (0.5 to 0.6 Nm).

The recommended torque for the screws that secure the terminal blocks to the base is 3.5 to 4.4 lb_f-inch (0.4 to 0.5 Nm).

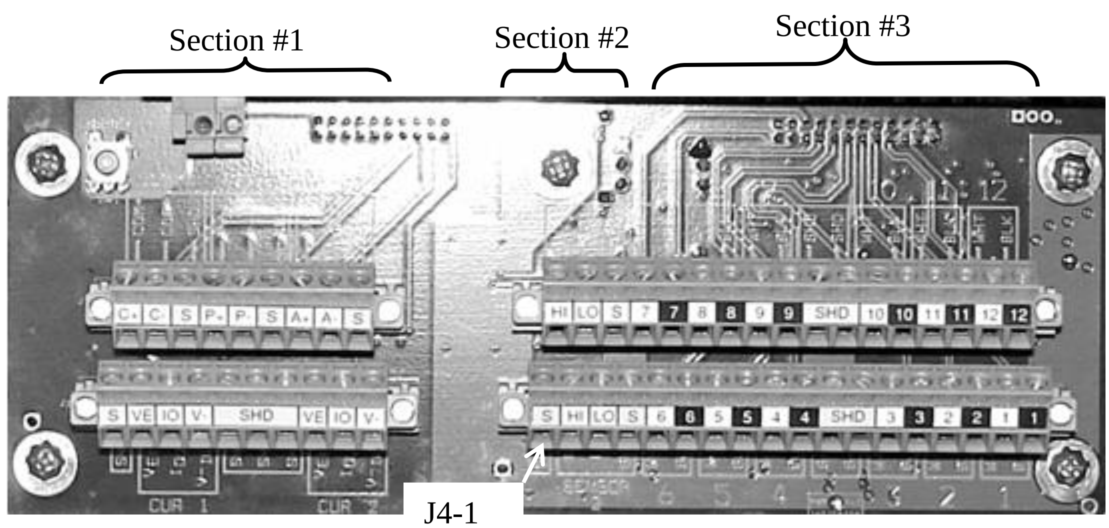

Figure 5 Terminal Board Layout

There is a green wire with a yellow stripe attached to a threaded post on the base plate. The free end of this wire is stripped and must be installed in the terminal J4-1. J4-1 is the left-most terminal of the largest terminal plug (the plug on the lower-right of figure 5) and is marked “S” on a yellow background. This is a redundant electrical connection to the Protective Earth for the terminals marked “SHD” which are to be used for connecting cable shields, drain wires, and grounding tag wires from metal cable glands as specified elsewhere in this manual.

6.3.2.1 Transmitter Output Connections (Section #1)

User supplied data output cable size AWG 22 to AWG 16 (0.326 mm^2 to 1.31 mm^2) is installed through a cable gland in the furthest left hole on the transmitter housing and attached to the appropriate terminal block connection points. The hole is sized for a 3/4 inch NPT or M25 cable gland fitting (1-1/16 inch (27 mm) hole).

⚠	**WARNING** **For Class I, Division 2 applications, Power Entry and Inputs/Outputs are not certified as Non-incendive and must be installed in accordance with National Electrical Code requirements.**
⚠	**WARNING** **For ATEX Class I, Zone 2 applications, Power Entry and Inputs/Outputs are not certified as Non-incendive and must be installed in accordance with EN60079-14. Refer to the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY for additional info and requirements**

The following figure provides a close-up of the transmitter output terminals (Section #1 of the terminal board) with their functions listed in the following table. These outputs can be connected as appropriate to permit communications between the transmitter and other equipment.

The recommended torque for the terminal screws is 4.4 to 5.3 lb$_f$-inch (0.5 to 0.6 Nm).

The recommended torque for the screws that secure the terminal blocks to the base is 3.5 to 4.4 lb$_f$-inch (0.4 to 0.5 Nm).

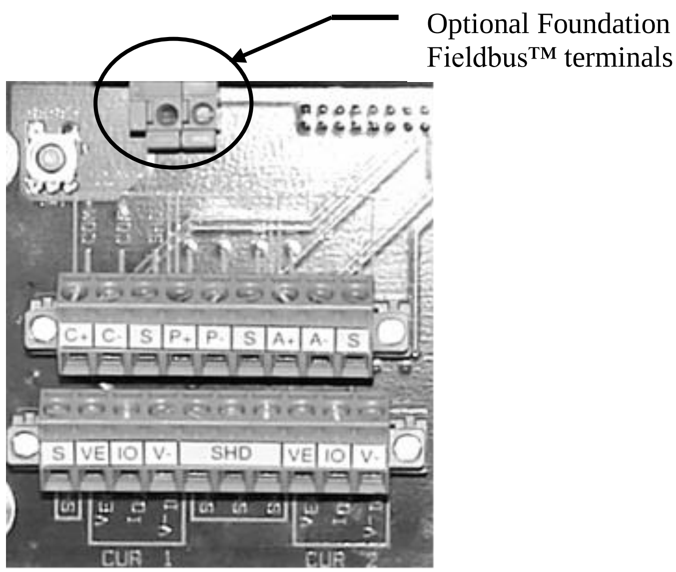

Figure 6 Transmitter Output Terminals

Terminal Label	Type	Comment
CUR 1	4-20mA #1 Output	Internal (self) or external (loop) powered, HART communication capable
CUR 2	4-20mA #2 Output	Internal (self) or external (loop) powered
PULSE	Pulse output	Solid-state relay closure
ALARM	Alarm output – High / Low Output	Solid-state relay closure
COMM	RS-485 or RS 232 Digital Output	MODBUS communications on those units with this option
Foundation	Digital	Optional Foundation Fieldbus™ terminals
SHD	---	Shield Connections

Table 1 List of Transmitter Signal Outputs

6.3.2.2 Transmitter Input Connections (Section #2)

In some cases, a pressure or temperature transducer signal is used as an input to the transmitter (currently not used for VF-100 system). These terminals are shown in the following figures.

The transducers must be 2-wire loop-powered 4-20mA current transmitters. The 2 wires must be "floating" (i.e. not ground-referenced) for safety reasons and because they are powered from +/-12V from the Transmitter.

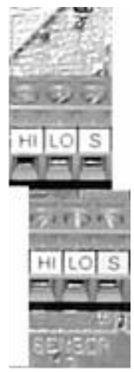

Figure 7 Transmitter Sensor Terminals

When used, the setup of the individual sensors is performed as part of the overall transmitter setup detailed in this manual.

The recommended torque for the terminal screws is 4.4 to 5.3 lb_f-inch (0.5 to 0.6 Nm).

The recommended torque for the screws that secure the terminal blocks to the base is 3.5 to 4.4 lb_f-inch (0.4 to 0.5 Nm).

For Class I, Zone 2, ATEX rated Transmitter Model TB8-xx-xx-xx-03 these are to be treated as non-incendive field wiring.

6.3.2.3 Sensor Head to Transmitter Cable Connections (Section #3)

The sensor head to transmitter cable is used to transmit sensor data and information between the transmitter and the sensor head, and provides power to the electronics mounted in the sensor cover.

Note: All armored cables and ATEX non-armored cables are equipped with a ground ring wire assembly. This ground wire is connected to any of the SHD terminals in Section #3 of the terminal board shown in Figure 5.

The sensor head to transmitter cable is furnished with a connector attached to the sensor head end. The transmitter end is cut to length and terminated at installation.

The connector on the sensor head end of the cable can be one of two similar-looking connectors but of noticeably different size. The two connector types are not interchangeable. The cable delivered with the passive sonar system should have a connector which is matched to the one on the sensor head.

The sensor head to transmitter cable can be either run in cable trays or through conduit in accordance with local practice.

Sensor Head End Cable Attachment - Once the cable is run, attach the connector on the sensor cable end to the mating connector on the sensor cover. Align the keyway on the sensor connector and latch in place. Strain relief the cable by attaching it to a handle on the sensor cover, a pipe, or other structure so no force is applied to the sensor connector.

Transmitter End Cable Attachment - **Note:** Each wire pair may be numbered on the white wire only. Care should be taken to ensure the black non-numbered conductor stays matched with its numbered white conductor.

⚠	**CAUTION** **Ensure each numbered white conductor and its corresponding black conductor remain as a set to ensure proper operation of the meter.**

⚠	**WARNING** **For Class I, Division 2 applications, the SENSOR HEAD TO TRANSMITTER CABLE must be installed in accordance with National Electrical Code requirements for Non-incendive circuits.**
⚠	**WARNING** **For ATEX Class I, Zone 2 applications, the SENSOR HEAD TO TRANSMITTER CABLE must be installed in accordance with EN60079-14 for Non-incendive circuits. Whether armored or unarmored cable, the cable gland must be ATEX certified and IP55. Refer to the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY for additional information and requirements**

6.3.2.3.1 Non-armored cable installation

Remove 10 - 12 inches (25 – 30 cm) of outer jacket from the transmitter end of the cable. Remove the over-foil, being careful not to damage the drain wire, to expose the 12 numbered pairs of conductors. Strip 3/8 inch (8mm) of insulator from each conductor. Twist each set of conductors together. It may be helpful to install wire number markers on each of the 12 sets of conductors to readily identify them.

Install the gland nut and gland on the cable and install in the center hole in the bottom of the transmitter box. Tighten the gland nut on to the cable sheathing.

The following figure shows the portion of the terminal board to which the sensor head is connected. Each terminal block set (of 2 terminals) is numbered to match the numbered wires found in the sensor head cable. In addition, the colors of each wire in each of the 12 sets are labeled on the terminal board, BLK=black and WHT=white. Insert a 3/8 inch (8mm) stripped portion of each wire into the corresponding terminal block location and tighten the locking screw taking care to not tighten on the wire insulation. The recommended torque for the terminal screws is 4.4 to 5.3 lb_f-inch (.5 to .6 Nm). The overall cable shield wire can be attached to any one of the four SHD terminals on this block.

Once all wires are installed, bundle them together using a tie wrap. This will keep them separated from others wires in the transmitter box.

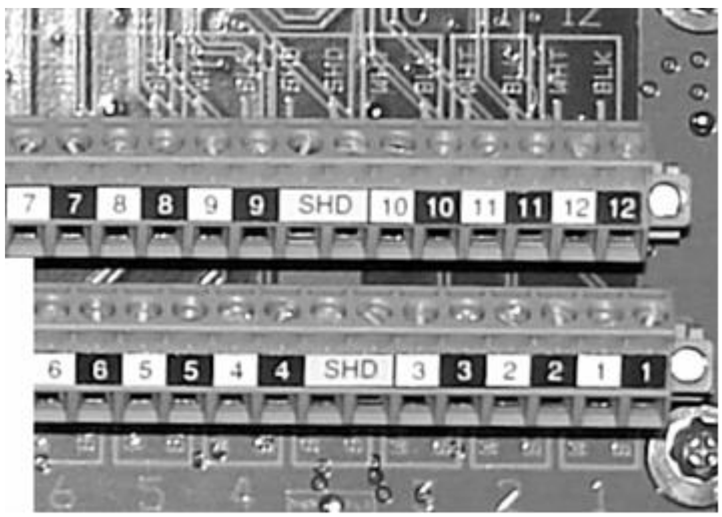

Figure 8 Transmitters With Pluggable Terminal Blocks

The following table lists the cable connector pin-out for cables equipped with the NEMA 4X rated connector shown below.

Wire Pair #	**Transmitter Terminal #**	**Function**	**SENSOR HEAD CONNECTOR PIN NUMBER**	
1 Wht/Blk	1	Sensor #1 Input	1 - Wht	13 - Blk
2 Wht/Blk	2	Sensor #2 Input	2 - Wht	14 - Blk
3 Wht/Blk	3	Sensor #3 Input	3 - Wht	15 - Blk
4 Wht/Blk	4	Sensor #4 Input	4 - Wht	16 - Blk
5 Wht/Blk	5	Sensor #5 Input	5 - Wht	17 - Blk
6 Wht/Blk	6	Sensor #6 Input	6 - Wht	18 - Blk
7 Wht/Blk	7	Sensor #7 Input	7 - Wht	19 - Blk
8 Wht/Blk	8	Sensor #8 Input	8 - Wht	20 - Blk
9 Wht/Blk	9	Spare – unused	---	---
10 Wht/Blk	10	Wht – RS 485 Hi / Blk – RS485 Low	12 - Wht	24 - Blk
11 Wht/Blk	11	Wht – '-12 V' / Blk – Gnd	9 - Wht	21 - Blk
12 Wht/Blk	12	Wht – '+12 V' / Blk – Gnd	10 - Wht	22 - Blk

Table 2 Sensor to Transmitter Cable Terminal Connections NEMA 4X Connector

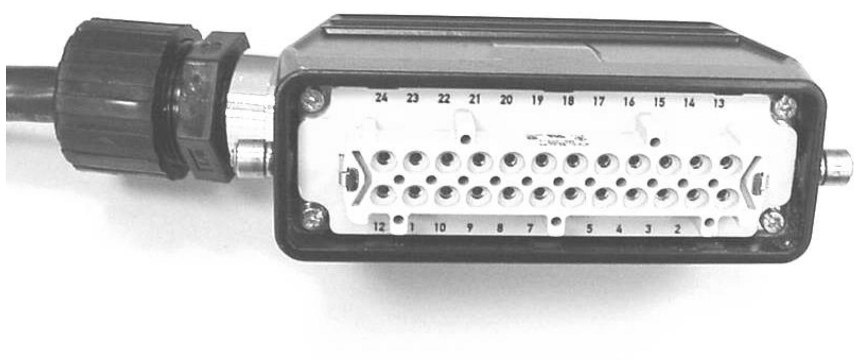

Figure 9 NEMA 4X Rated Connector

The following table lists the cable connector pin-out for cables equipped with the IP-65 rated connector shown below.

Wire Pair #	Transmitter Terminal #	Function	SENSOR HEAD CONNECTOR PIN NUMBER	
1 Wht/Blk	1	Sensor #1 Input	15 - Blk	16 - Wht
2 Wht/Blk	2	Sensor #2 Input	13 - Blk	14 - Wht
3 Wht/Blk	3	Sensor #3 Input	11 - Blk	12 - Wht
4 Wht/Blk	4	Sensor #4 Input	9 - Blk	10 - Wht
5 Wht/Blk	5	Sensor #5 Input	7 - Blk	8 - Wht
6 Wht/Blk	6	Sensor #6 Input	5 - Blk	6 - Wht
7 Wht/Blk	7	Sensor #7 Input	3 - Blk	4 - Wht
8 Wht/Blk	8	Sensor #8 Input	1 - Blk	2 - Wht
9 Wht/Blk	9	Spare – unused	---	---
10 Wht/Blk	10	Wht – RS 485 Hi / Blk – RS485 Low	23 - Wht	24 - Blk
11 Wht/Blk	11	Wht – '-12 V' / Blk – Gnd	19 - Wht	20 - Blk
12 Wht/Blk	12	Wht – '+12 V' / Blk – Gnd	17 - Wht	18 - Blk

Table 3 Sensor to Transmitter Cable Terminal Connections IP-65 Connector

Figure 10 IP-65 Rated Connector

6.3.2.3.2 Armored cable installation

For those installations that will use armored cable between the sensor head and transmitter, install the P/N 20448-01 transmitter housing stiffener plate (shipped with the armored cable) in the transmitter housing. Ensure the plate is installed with the bent edge up and located toward the front of the transmitter housing. The stiffener plate is held in place by the cable gland fittings.

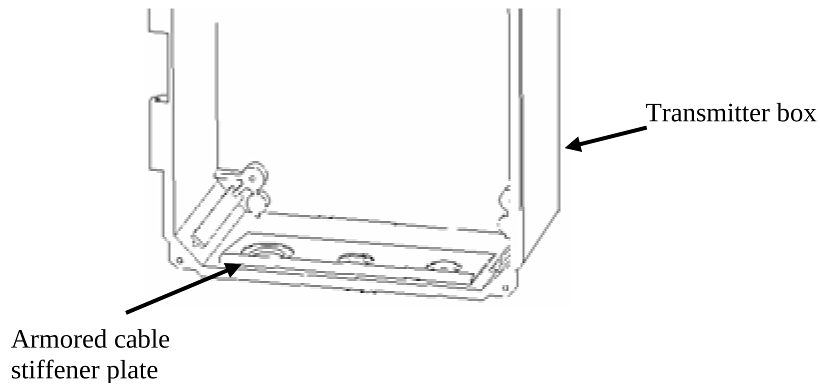

Figure 11 Armored Cable Stiffener Plate Installation

Armored cable is shipped with the appropriate connector pre-installed on the cable and with the cable prepared for installation in the transmitter. Armored cable installation is similar to the non-armored installation except for the following.

- Cut the cable to desired length (if necessary) using a hacksaw to cut through the armor and remove about 14” (36 cm) of outer jacket from the transmitter end of the cable.
- Cut the armor 1-3/8” (35mm) from the outer jacket using a Roto-Split® (or equivalent) armor cutter. Twist the armor off of the cable.

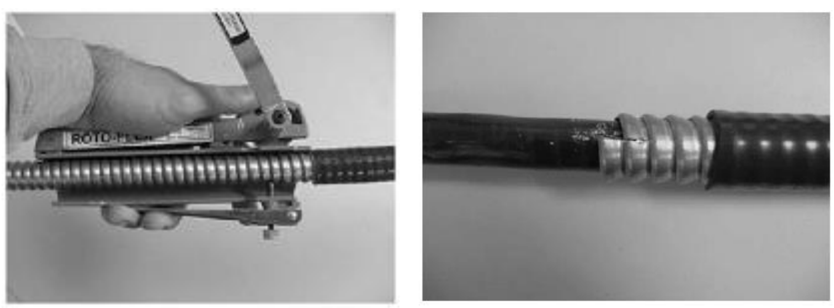

Figure 12 Removal of Cable Armor

- Install the armored cable connector by first sliding the connector over the cable. Referring to the following figure, hand-tighten the entry component to the connector body and then final tighten 1-1/2 rotations using 1-5/8” wrenches. Hand-tighten and then final tighten the compression nut to the connector body 1 rotation using 1-5/8” wrenches. Cut and remove the inner cable outer sheath about 3/4" (19mm) from the end of the entry component. Remove foil wrap, clear Mylar wrap and filler back to inner cable outer sheath. Twist each pair of conductors to keep them together as pairs.

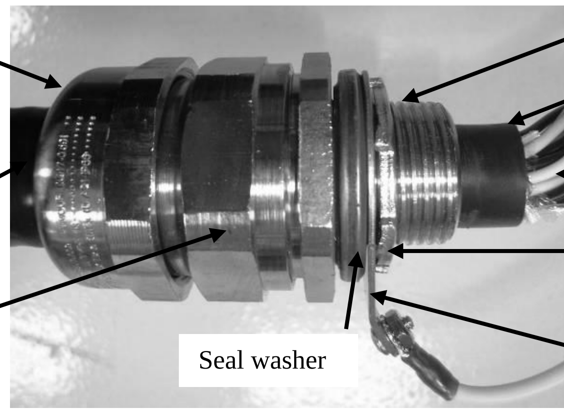

Figure 13 Armored Cable Connector Installed

- Install the seal washer on the connector assembly entry component. Insert the cable and entry component into the middle hole in the transmitter box (stiffener plate previously installed.) Install the ground ring wire assembly and secure the connector assembly with the lock nut. Attach the ground ring wire assembly any available SHD terminal on the Section #3 terminal block. Strip and install the individual conductors and drain wire per non-armored cable installation instructions.

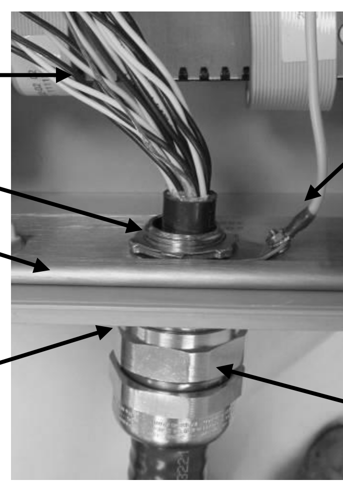

Figure 14 Armored Cable Installation

6.3.3 Transmitter Electrical Power Cable Installation

The right-most hole in the bottom of the transmitter box is used to bring electrical power into the transmitter box. The hole is sized for a 3/4 inch NPT (M25).

The system installation should include a marked and appropriately-rated switch or circuit breaker within close proximity of the Transmitter and within easy reach of the operator. The function of this switch is to provide a safe means for power to be removed from the transmitter. The transmitter must not be installed in a position that makes it difficult to operate the switch or breaker.

6.3.3.1 AC-Powered Passive Sonar System

The AC version of the passive sonar system will accept 100 – 240 VAC, 50/60 Hz power. Power cables of size AWG 18 minimum to AWG 10 maximum (0.82 mm^2 to 5.26 mm^2), with a ground conductor, are required.

⚠	**WARNING** **Always use a non-current-carrying safety ground. Failure to use a non-current-carrying safety ground could result in injury or death.**
⚠	**WARNING** **For Class I, Division 2 applications, Power Entry and Inputs/Outputs must be installed in accordance with National Electrical Code requirements.**
⚠	**CAUTION** **Always use a non-current carrying safety ground attached to the ground terminal on the input power terminal block. Failure to do so could result in poor system operation.**

Feed electrical power wires through the fitting. Referring to the following figure, attach the ground wire (green) to the Ground terminal (⏚), hot (black - U.S., brown - Eur) to the L (+) terminal, and neutral (white – U.S., blue – Eur) to the N (-) terminal.

The recommended torque for the terminal screws is 4.4 to 5.3 lb_f-inch (0.5 to 0.6 Nm).

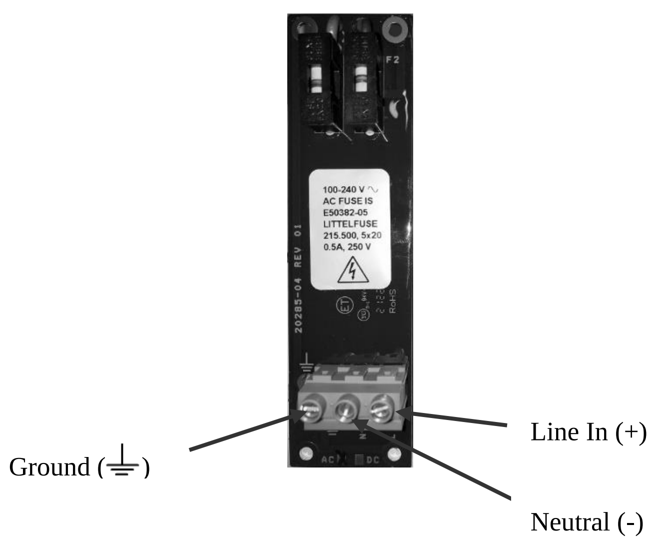

Figure 15 Transmitter AC Power Input Connections

6.3.3.2 DC-Powered Passive Sonar System

Any voltage within the range of 18 – 36 VDC can be applied to the DC version of the passive sonarsystem. Power cables of size AWG 18 minimum to AWG 10 maximum (0.82 mm^2 to 5.26 mm^2), with a ground conductor, are required.

⚠	**WARNING** **For Class I, Division 2 installations, a non-current carrying safety ground attached to the ground terminal on the input power terminal block is required, and Power Entry and Inputs/Outputs must be installed in accordance with National Electrical Code requirements.**
⚠	**CAUTION** **Always use a non-current carrying safety ground attached to the ground terminal on the input power terminal block. Failure to do so could result in poor system operation.**

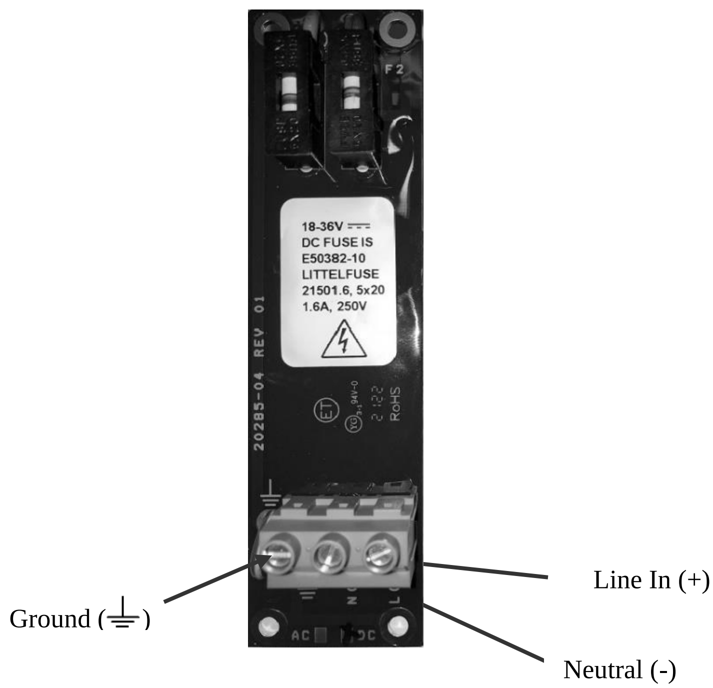

Figure 16 Transmitter DC Power Connection

Feed electrical power wires through the fitting. Referring to the previous figure, attach the ground wire to the Ground (⏚) terminal, DC+ to the L (+) terminal, and DC- to the N (-) terminal.

The recommended torque for the terminal screws is 4.4 to 5.3 lb$_f$-inch (0.5 to 0.6 Nm).

6.3.4 Sensor Calibration Label

The sensor band is shipped with four labels attached to it. The label lists the sensor band part number, serial number, date of manufacture and three calibration factors. This information will be entered into the transmitter during setup.

If not done previously, install the Sensor Band Assembly label on the inside of the transmitter cover (the other label goes on the sensor head access panel).

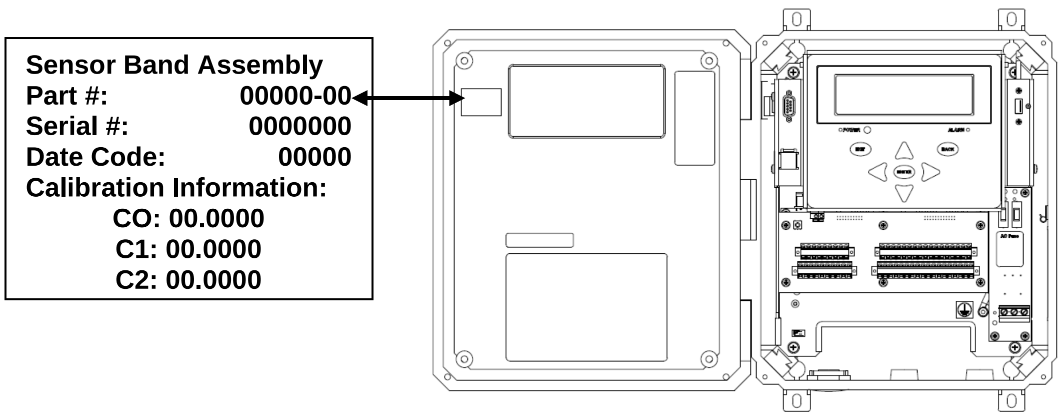

Figure 17 Sensor Calibration Label

6.4 Safety Issues of Improper Transmitter Installation

The main safety issues of improper installation with the Transmitter in Ordinary Location (no explosive gasses or dusts) are issues which compromise the IP55 rating of the Transmitter enclosure, or issues involving improper wiring of the terminals. These issues can increase the risk of electric shock or fire. Note that wiring should always be performed with the power OFF.

Improper wiring can include:

- Inadequately secured wires that can come out of their terminals. Loose wires can short to other wires or terminals.
- Secured wires with excessive insulation removed exposing the bare wire beyond the terminals. This increases the risk of electrical contact with personnel or with loose wires.
- Secured wires installed in the wrong terminals. Care must be taken to avoid this. Depending on the miswire, the result could range from a safe but temporarily non-functional state to an unsafe state and/or permanent damage to the circuitry.
- Wire gauges or number of wires or type of wires inserted into a terminal that are outside the ratings of the terminal. Note that putting multiple wires in terminals is not recommended, but when the terminal's ratings permit it, extra care must be taken to assure that all wires are adequately secured.
- Applying voltages or currents that are beyond the ratings permitted by this manual.
- Not assuring that the Protective Earth terminal is adequately tied to earth potential.

Compromise of the IP55 ratings of the Transmitter enclosure can include:

- Failure to protect the Transmitter from precipitation and dust EVERY time the enclosure cover is open (and failure to quickly clean it up and thoroughly dry it out– with the power OFF – if it ever gets polluted inside despite the attempt at protection).
- Failure to properly close the enclosure cover.
- Allowing foreign objects to be trapped in the gasket seals of the enclosure cover or allowing those seals to become damaged.
- Failure to use cable glands with the appropriate ratings (including IP ratings to maintain the IP55 rating of the Transmitter enclosure) that are designed for the cable diameter and the cable entry hole diameter and which are properly installed with all their appropriate sealing components.
- Failure to use an adequately rated hole plugs to seal unused cable entry holes. E.G. the Transmitter is shipped with one

light-colored plastic hole plug that will maintain the IP rating if used in a hole not occupied by a cable/gland in the permanent installation. It is also shipped with red (to attract attention to the fact that they are not for permanent use) temporary shipping hole plugs in the two holes that are intended for the power connections to the Transmitter and for the cable going out to the Sensor Head. Those red temporary plugs have no IP rating and are expected to be discarded and not used in the permanent installation.

Additional safety issues applicable to Hazardous Locations

In addition to the improper installation issues for Ordinary Location, above, which can also increase risk of explosion in Hazardous Locations, note the following additional safety issues of improper installation.

The certification of the equipment has to be applicable to the actual installation location.

- The Ordinary Location passive sonar meter CANNOT BE USED in ANY Hazardous Location wherein explosive gases or dusts may be present.
- The US/Canada Class I, Div 2 passive sonar meter can also be used in US/Canada Class 1 Zone 2 (per the NEC and CEC electric codes), but CANNOT BE USED in Class II (Explosive Dust) nor in Class I, Div 1, nor in European Zones 2, 1, 0, 20, 21, or 22, nor in US/CAN Zone 1, or Zone 0, nor for gasses wherein its T4A (120C) peak temperature rating is too high for the thermal explosion thresholds of the explosive gasses, nor outside the defined range of ambient temperatures (see Appendix A), nor in environments wherein IP55 is not adequate to keep the internal electronics dry (e.g. not when submersion is a possibility).
- Similarly, the ATEX Zone 2 passive sonar meter CANNOT BE USED in ATEX Zones 1, 0, 20, 21, 22, nor in US/CAN Class I Zones 2, 1, 0, nor in US/CAN Class I Divisions 1 or 2, nor in US/Canada Class II, nor with gas group IIC gasses, nor for gasses wherein its T4 (135C) peak temperature rating is too high for the thermal explosion thresholds of the explosive gasses, nor outside the defined range of ambient temperatures (see Appendix A), nor in environments wherein IP55 is not adequate to keep the internal electronics dry (e.g. not when submersion is a possibility).
- Furthermore, both the Transmitter and the Sensor Head should have compatible certification markings, and the cable (and its cable glands and connector) used between them should be the

one provided by CiDRA that was approved for that type of certified system.

- ATEX-certified cable glands should be used with the ATEX Zone 2 passive sonar Transmitter as discussed in the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY.

Other Hazardous Location risks:

- In hazardous locations, the Transmitter cover should be secured with the four screws rather than the latches. That both provides a more robust seal and makes it less likely that the enclosure will be opened on a whim or by unauthorized personnel. There are also ways to secure the cover with a padlock if desired.
- Not properly installing and strain-relieving the cables/conduit entering the Transmitter. Improper orientation and support of the cables/conduit from pulling and twisting can cause a failure of the seals at the cable entries, can result in tension on the wires at the terminals, or can deform the bottom of the enclosure in ways that compromise the cover seal. Proper use of the optional stiffener plate in the bottom of the Transmitter may help.
- Exceeding the maximum cable length permitted for hazardous locations (see applicable Control Drawings). Note that energy stored in cable inductance and capacitance is an explosion risk that increases with longer cable lengths.
- Not following the Control Drawing applicable to the location/certification (e.g. as regards the suitability and limitations on the use of certain customer I/O signals in the hazardous location)
- Not grounding exposed metal glands and armor of armored cables (especially an ATEX concern)
- Explosion risk of rubbing non-metallic enclosures with a non-wetted rag due to static electric charge generation (especially an ATEX concern). Note that even sparks from electro-static discharges are potentially capable of causing an explosion.
- Doing any installation or maintenance work or using the diagnostic ethernet or USB memory card interfaces on equipment in a hazardous location without first using a gas sensor to verify the absence of explosive gasses in the area. Note that this is a standard safety policy at well-run industrial facilities.

7 TRANSMITTER FUNCTIONS

Table of Contents

List of Figures

List of Tables

7.1 Introduction

The following section of this manual will present the transmitter layout and menus in the passive sonar system.

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

7.2 Transmitter Layout

The following pages illustrate the passive sonar system transmitters.

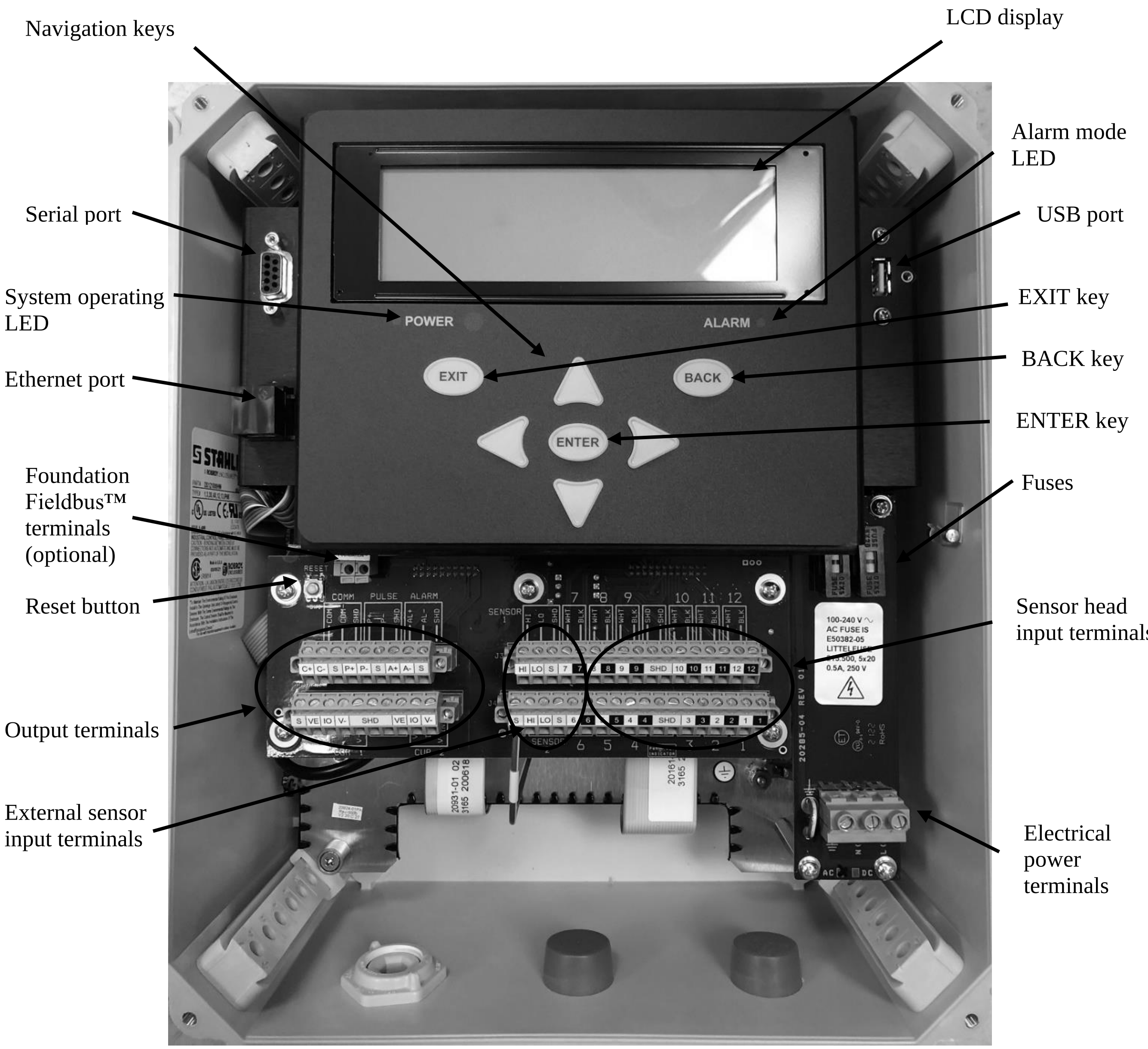

Figure 1 Transmitter Layout

7.3 Transmitter Output Definitions

The following figures show a diagram of the output portion of the terminal board. The outputs of the transmitter are connected to provide communication between the transmitter and other equipment.

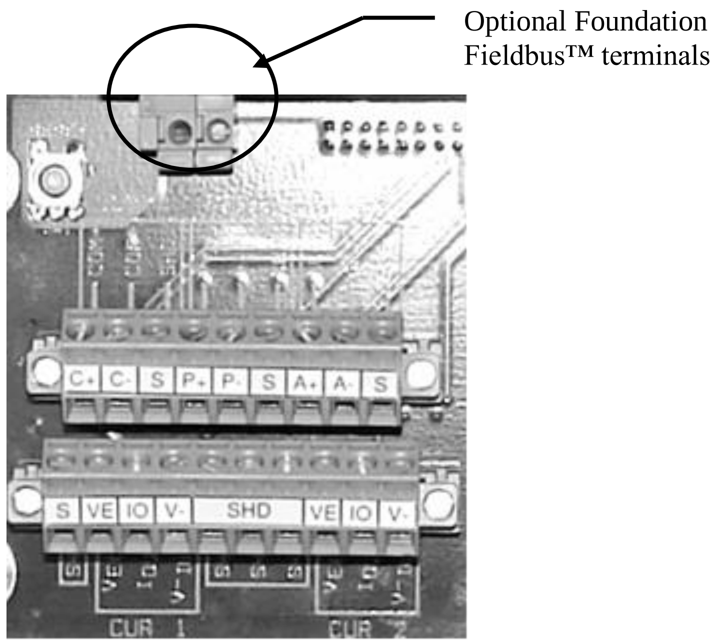

Figure 2 Transmitter Output Terminals

7.3.1 COMM

This denotes the connection point for serial digital communications. Either RS232 or RS485 communications is supported with baud rates settable between 2400 and 115200 baud (8 bits, no parity, 1 stop bit). The communications type (RS232/485) as well as the baud rate can be set by the front panel keypad as listed in a later section of the manual.

The RS-485 is the half-duplex two-wire type for multi-drop.

Note: If intermittent RS-485 communication problems are observed, it may be necessary to put bus terminations of 120 ohms at the extreme ends of the bus between COM+ and COM-. If necessary, follow best practices in selecting the resistor and in connecting it reliably to the bus.

Note: RS-232/485 is not available if Foundation Fieldbus communication is present.

WARNING

EXPLOSION HAZARD - It is a violation of the Hazardous Area ratings of the passive sonar meter transmitter to install the bus termination resistor physically within this enclosure.

7.3.1.1 MODBUS

COMM connection also serves as the connection point for MODBUS communications. The passive sonar meter transmitter supports both MODBUS ASCII and MODBUS RTU formats. Refer to chapter of this manual titled *Use of Modbus® Protocol with Passive Sonar Meter Transmitters.*

Note: MODBUS is not available if Foundation Fieldbus™ communication is present.

7.3.2 PULSE

Pulse output is an isolated solid-state switch-closure-type output which occurs between P+ and P- whenever conditions are met that are determined by the pulse output settings within the transmitter. The maximum applied voltage between P+ and local ground and P- and local ground shall be within the range of +30V / -10V. The load current shall be a maximum of 100mA. Typical turn on time is 1 msec. Typical turn off time is 0.1 msec. Refer to the following figure and example.

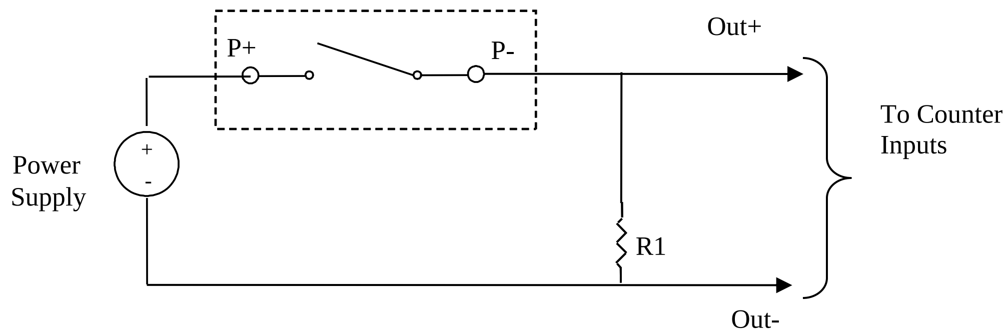

Figure 3 Pulse Switch Closure

For sizing R_1 refer to the following example.

Power Supply = 24V
Choose a value for R_1 so as to not exceed 100mA
R_1 = 24V / 100mA = 240Ω
Therefore, R_1 should be sized to be greater than
240Ω so the current does not exceed 100mA

Note: Recommended minimum swing pulse is 1 msec. At the 0.5 msec pulse width setting, the voltage across the solid-state relay will be approximately 50% of power supply voltage.

7.3.3 ALARM

The alarm output consists of an electrically isolated switch closure occurs between AL+ and AL- whenever the limits specified in the transmitter setup for Alarm are met. These limits can be changed or disabled through the local keypad and display. The maximum applied voltage between AL+ and local ground and AL- and local ground shall be within the range of +30V / -10V. The load current shall be a maximum of 100mA.

The '**EXIT**' key is used to clear alarms while in the Operational Mode.

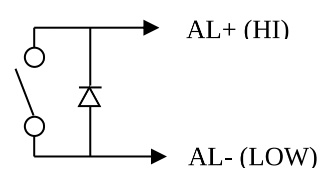

Figure 4 Alarm Switch Closure

7.3.3.1 **External Alarm Circuits:**

The following is a circuit example when the load is 100mA maximum

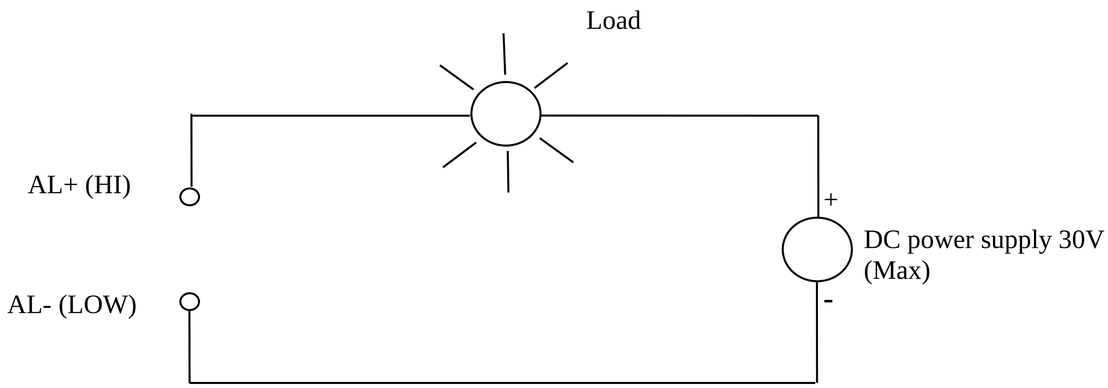

Figure 5 Example Alarm Circuit Diagram With Load 100mA Maximum

The following is a circuit example when the load is greater than 100mA.

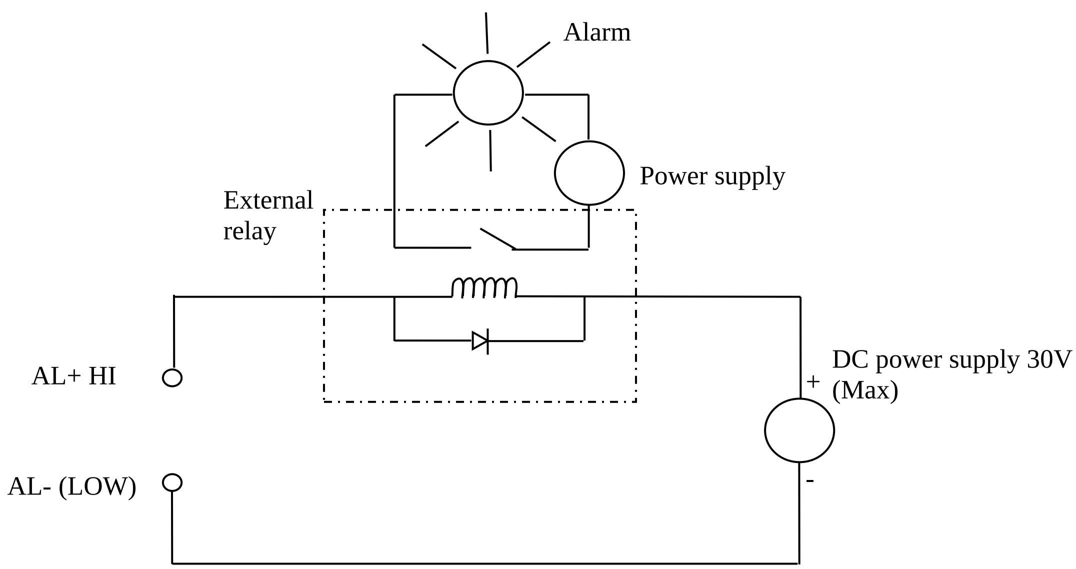

Figure 6 Example Alarm Circuit Diagram With Load Greater Than 100mA

7.3.4 CUR1 (Primary 4-20mA Output)

These terminals are used for connection to the primary 4-20mA output from the transmitter. The transmitter can be configured such that an external supply can be used for power (i.e. the 4-20mA loop current is driven externally) or such that the transmitter itself will power the loop (internal power). A combination of power wiring and internal software settings will ensure that the 4-20mA output will function properly. The following figures show proper wiring for internal and external power. The software configuration must be set to match the external wire connections for proper operation of this output. The primary 4-20mA output is the only 4-20mA output that supports HART communication.

7.3.5 CUR2 (Secondary 4-20mA Output)

These terminals are used for connection to the secondary 4-20mA output from the transmitter. As with the primary 4-20mA line, the transmitter can be configured such that an external supply can be used for power or such that the transmitter itself will power the loop. A combination of power wiring and internal software settings will ensure the 4-20mA output will function properly. The software configuration must be set to match the external wire connections for proper operation of this output.

7.3.5.1 Internally Powered 4-20mA Loop Configuration

The connections for a 4-20mA interface configured as “Internally Powered” are shown below. The maximum value of R_L is 500 Ohms. The voltage across R_L must be measured differentially. The V^-_{INT} connection is tied to a –10V reference internal to the transmitter and must not be connected to ground in the plant control system.

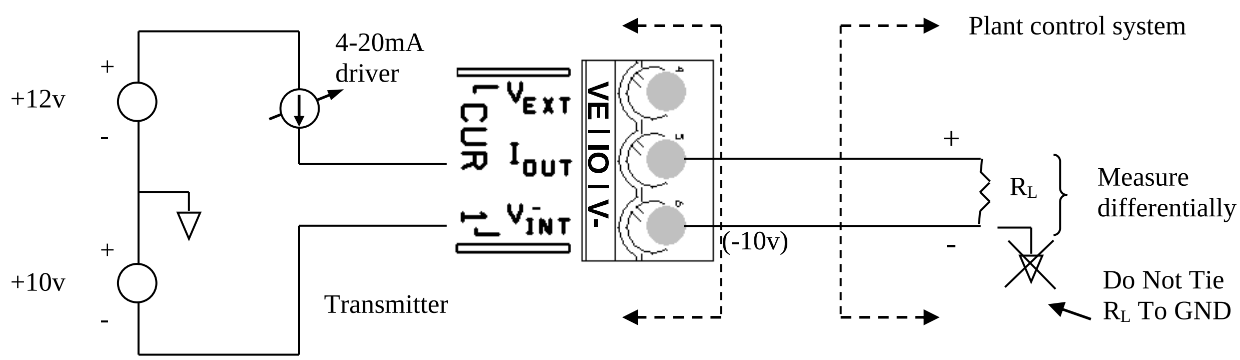

Figure 7 Internally (Transmitter) Powered 4–20mA Loop

7.3.5.2 **Externally Powered 4-20mA Loop Configuration**

The connections for a 4-20mA interface configured as "Externally Powered" are shown below. The maximum value of V_{EXT} should be chosen such that the maximum applied voltage between V_{EXT} and local ground and I_{OUT} and local ground shall be within the range of +30V / -10V and current limited to 100mA. The maximum value of R_L is determined by the following equation:

$$R_{L\,Max} = (V_{EXT} – 8.35) / (0.022)$$

For example, with V_{EXT} = 24VDC:
$R_{L\,Max}$ = (24-8.35) / (0.022) = 711 Ohms

In the externally powered configuration the 4-20mA interface is capacitively isolated from the rest of the transmitter electronics provided that the applied voltages are within +30V / -30V.

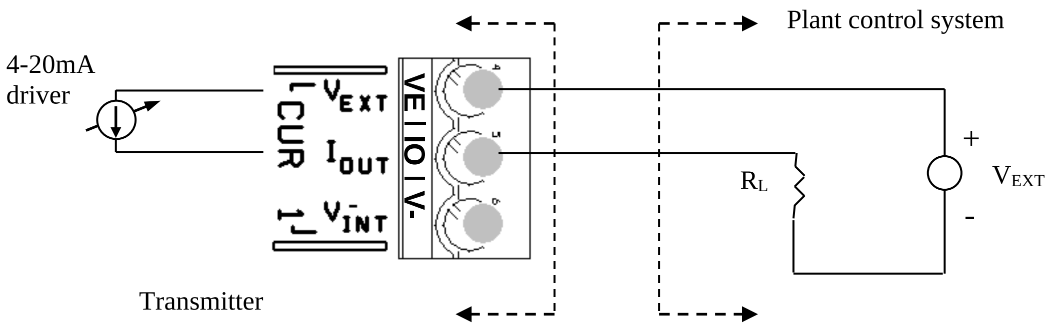

Figure 8 Externally Powered 4–20mA Loop

7.3.6 SHD

The three SHD (shield) terminals should only be used for grounding shields of any output wiring such as connections to CUR 1 or CUR2. These should not be used for the SENSOR 1 or 2 shields or for the Sensor Head to Transmitter cable shield. Only one end of the shield wire should be connected to eliminate shield currents.

7.3.7 Fieldbus

Optional Foundation Fieldbus communications are available on passive sonar meter transmitters. Refer to chapter within this manual titled *USE OF FOUNDATION FIELDBUS® AND PROFIBUS PA PROTOCOL WITH PASSIVE SONAR PROCESS FLOW MONITORING SYSTEMS*.

7.4 Transmitter Input Definitions

The Gas Volume / Void Fraction calculations use inputs of pressure and temperature. These inputs can be made through the use of pressure and temperature transducers, or alternatively, an assumed value for pressure and temperature can be input into the transmitter during its setup. **Note:** These sensor inputs are not used for VF-100 or HD-VF-100 meter operation.

Two transmitter terminal blocks (shown below) are provided for pressure and temperature transducers.

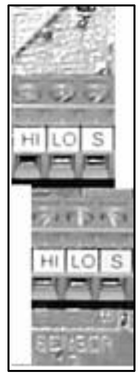

Figure 9 Transmitter Sensor Terminals

SENSOR 1 & 2 – Used in certain installations for inputs from user-supplied loop powered 4-20mA pressure or temperature transmitters which the passive sonar system transmitter supplies with a nominal +/-12V. The pressure or temperature transmitter electrical connections must be isolated from ground ("floating").

When used in Hazardous area installations, be certain to follow the wiring instructions contained in the Control Drawings for the passive sonar system transmitter as well as the Control Drawings for the Hazardous area-rated pressure or temperature transmitters. The Class I, Division 2 passive sonar meter transmitter Control Drawings can be found in an appendix of this manual. The ATEX Class I, Zone 2 passive sonar system transmitter Control Drawings can be found in Sections 13.17 and 13.18 in the chapter titled *SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY*. Note that certain hazardous-area-rated models of passive sonar system transmitter consider this interface to be Non-incendive field wiring with entity parameters and that certain other hazardous-area-rated models of passive sonar system transmitter do not consider this interface to be Non-incendive field wiring.

7.5 Keypad

The keypad controls used to set up and access the user input screens are illustrated in the following figure.

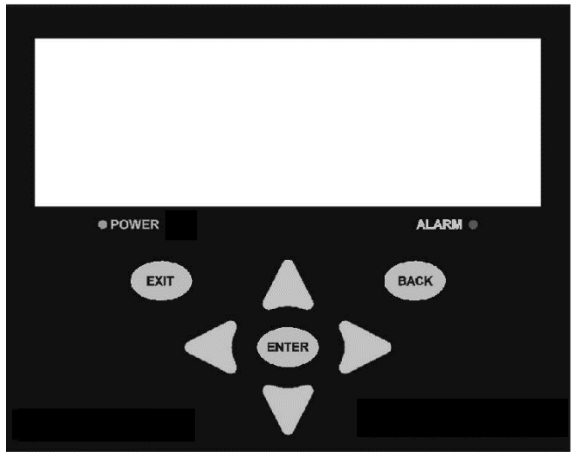

Figure 10 Transmitter Front Panel Keyboard

The passive sonar system display has 2 distinct modes: the **operational mode** where the measured parameters are displayed and the **menu mode** where various system parameters can be set. In each of these modes the keypad will have different functions. The following table shows the function of each key in the keypad depending on the display mode. Menu traversal rules are based on the following table.

Key	Operational Mode	Menu Mode		Dialog Box
		Navigation	Editing	
Up	Enter Menu Mode	Cycle Menu Item	Change current value at cursor position	Exit Dialog
Down	Enter Menu Mode	Cycle Menu Item	Change current value at cursor position	Exit Dialog
Left	Enter Menu Mode	NA	Change cursor position	Exit Dialog
Right	Enter Menu Mode	NA	Change cursor position	Exit Dialog
EXIT	Clears Alarm	Exit Menu	Exit Menu	Exit Dialog
BACK	Enter Menu Mode	Exit Menu from Main Menu or back up one level in menu tree	Exit editing mode without saving	Exit Dialog
ENTER	Enter Menu Mode	Change menu level or start editing	Exit editing mode and save current value	Exit Dialog

Table 1 Keypad Functions in Operational and Menu Modes

7.6 Transmitter Display

The transmitter display functions in two distinct modes: an operational mode and a menu mode. These two modes will be explained in the following sections.

7.6.1 Operational Mode

The transmitter screen displays the status of the passive sonar meter system. A few typical screen messages and their interpretation follow.

7.6.1.1 System Start

The transmitter displays the startup progress as it loads firmware into various parts of the system and the Ethernet IP address of the transmitter as it starts up. Once startup is complete, the display will clear and begin displaying measurements. Full system startup is discussed in Section 10.

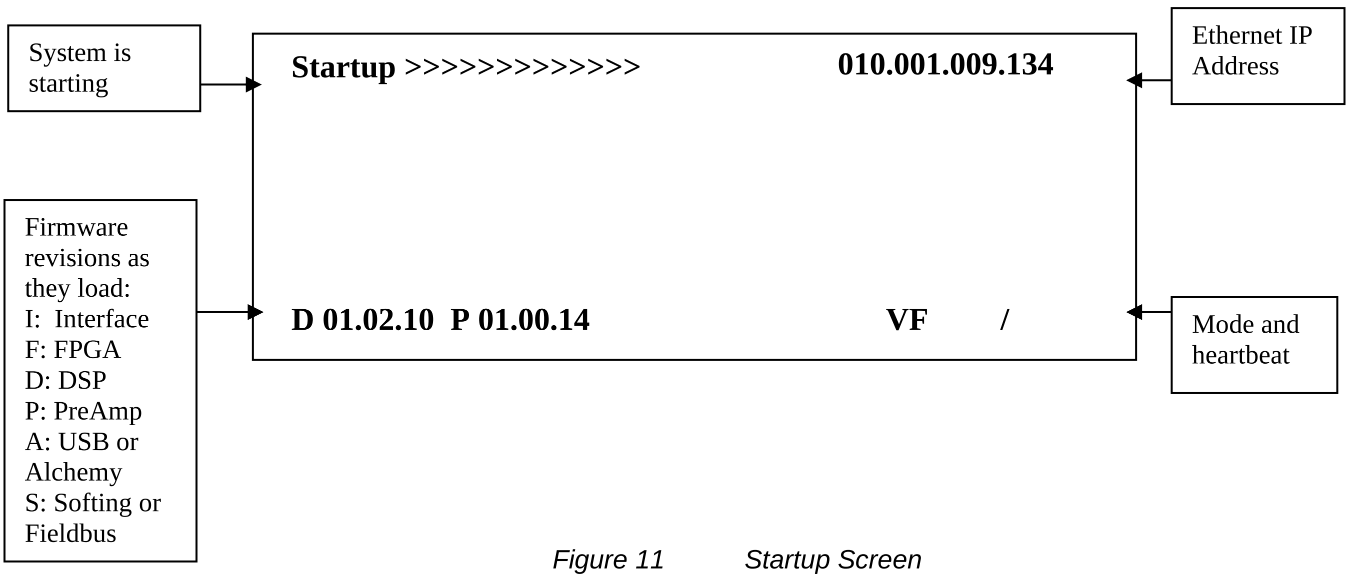

Figure 11   Startup Screen

If internal configuration parameters are changed in the menu screens once the menu is exited, the display will clear and show the 'Startup >>>>' display. This indicates that the system is restarting with the new parameters and is beginning to make measurements. Flow measurements will be displayed when the startup procedure is complete.

7.6.1.2 **Operating Transmitter Display**

In operating mode the display screen is split into three distinct portions. The majority of the screen is devoted to a 2-line measurement display as illustrated below. The bottom portion of the screen will display status and configuration information.

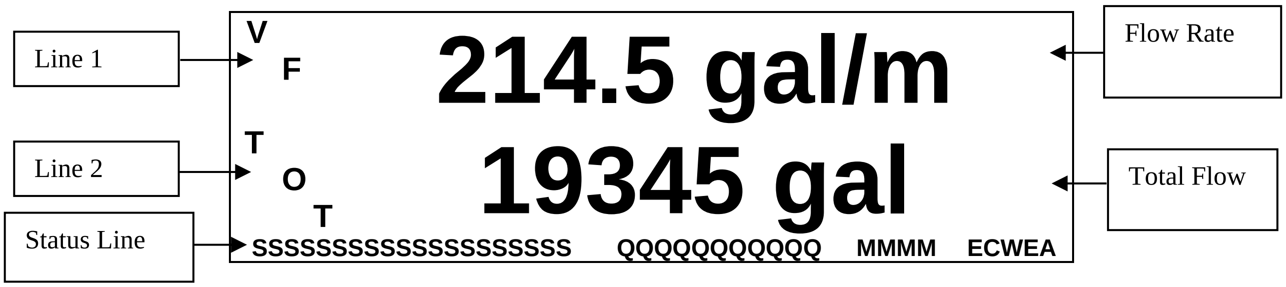

Figure 12 Operating Transmitter Display

7.6.1.2.1 Line 1 / Line 2

Either line may be configured to display any of the values listed below.

Value	Units
Flow Rate(1)	Users selectable list of values
Gas Volume Fraction(2)	Percent (%)
Speed Of Sound(2)	Feet per Second (fps) or Meters per Second (mps)
Blank	Line is blank
Totalizer(1)	Users selectable list of values

(1) not available on GVF only meters
(2) not available on VF only meters

Table 2 Line 1 and Line 2 Values

7.6.1.2.2 Status Line

The code for information in the status line shown in Figure 12 is defined as follows:

ID	Characters	Description	Values
S	20	Status Messages	See Status Messages Table below
Q	11	Quality Field	See Quality Field Message Table below
M	4	Mode	See Operating Mode Message Table below
E	1	Ethernet Communication	E – Ethernet activity present
C	1	Other Communications	H - Hart Message received M - MODBUS communications M (reverse) – MODBUS in write mode F – Fieldbus F (reverse) – Fieldbus in write mode S - Serial Activity Blank - No Activity
W	1	Write Protect	W – Write Protected or [blank] – Not Write Protected
E	1	Event Log Updated	! – Event Log Updated or [blank] – No change to Event Log since last check
A	1	Activity	|/-\ (Cycle changes indicate activity)

Table 3 Status Line Code

- **Status Messages - 'S':**

A number of status messages can be displayed in the 20 character status message field. They are as follows:

Status Message	Description
INITIALIZE MODE	DSP is acquiring data to calculate a measurement
VF INITIALIZE MODE	DSP is acquiring data to calculate a flow measurement
BELOW MIN VF QUALITY	Quality of measured sensor data is below a configured minimum for a Vortical Flow measurement
GVF INITIALIZE MODE	DSP is acquiring data to calculate a GVF measurement
INVALID SOS DATA	DSP is acquiring data to calculate a SOS measurement
BELOW MIN SS QUALITY	Quality of measured sensor data is below a configured minimum for a GVF measurement
BELOW MIN QUALITY	Quality of measured sensor data is below a configured minimum for VF and SOS measurement
SENSOR OVERLOAD	DSP indicates sensors are overloaded
DSP FAILURE - n	A DSP communication error occurred

Table 4 Status Line Messages

- **Quality Messages ‘Q’:**

The Quality Field is a diagnostic field that can be used to view certain quality values in the transmitter. The factory default is none. If more than one quality is selected, the transmitter will cycle through each. The options for display are volumetric flow, pressure and temperature (if used), band temperature, and a 3-level quality metric. The 3-level fields represent a Red/Yellow/Green setting for the quality of the output data. The yellow quality is the bounded value where data can be considered valid, but is not fully reliable. Red indicates unusable, and green indicates a good measurement.

Quality Message	**Description**
VF ‘-1 to +1’	Quality metric of the measurement is between –1 and +1; +1 is the most robust measurement system can make
SOS ‘-1 to +1’	Quality metric of the measurement is between –1 and +1; +1 is the most robust measurement system can make
RED	Quality metric is below the minimum quality factor entered into the transmitter or the meter is in startup mode
YEL	Quality metric indicates measurement is usable but not highly reliable
GRN	Quality metric indicates measurement is highly reliable
SPL	Sound Pressure Level Average
B	Band temperature (°C)
T	Process temperature (either from remote sensor or programmed into system, °C) (if used)
P	Process pressure (either from remote sensor or programmed into system, Psia) (if used)

Table 5 Quality Message Definitions

- **Operating Mode Messages – ‘M’:**

The four character mode field is used to display the operating mode of the system. Their definitions are as follows:

Mode Message	**Description**
‘IDL’	Idle / Stop Mode
‘RAW’	Transferring raw data
‘SNG’	Performing a single measurement
‘VF’	Running in VF Mode
‘GVF’	Running in GVF Mode
‘STR’	Running in Streaming Mode
[blank]	Measuring VF and GVF

Table 6 Mode Message Definitions

- **Ethernet (E):**

Indicates an active Ethernet connection to the transmitter.

- **Communications:**

A symbol here indicates communications activity with the transmitter. No received serial messages for 10 seconds will clear the activity indicator.

H - Hart Message Received
M - MODBUS Communications (reverse M indicates write mode)
F - Fieldbus Communications (reverse F indicates write mode)
S - Serial Activity
Blank - No Activity

- **Write Protect (W):**

Indicates configuration changes cannot be made to the transmitter. Write Protect can be turned on and off by the menu, HART, or MODBUS. Default is OFF.

- **Event Log Update (!):**

A failure event has been saved in the Event Log, accessible from the front panel menu. Blank means no change to event log since last accessed.

- **Activity (/-\l):**

Indicator will cycle during normal system operation

7.6.1.3 Display Examples

The following figure shows an example display when the system is operating and detects a flow rate that is below the system minimum flow threshold setting. As seen, a <Min indication is given on the volumetric flow line and the totalizer value shown on line 2 will not increase. In addition, a status message will indicate the system condition.

Figure 13 Flow Rate Is Less Than Minimum Configuration

The following figure shows the display when the system is collecting data to calculate a measurement. The ‘------‘indicates the system is unable to make a measurement, or an internal parameter was changed that has caused the system to re-initialize.

V
F ------ gal/min
T
O
T 19345 gal
VF INITIALIZE MODE VF /

Figure 14 Initialization Mode

In the following display the system is making a measurement. The GVF reading is 2.016 % Entrained Air. The flow rate is at 932.7 gallons per minute. The quality metric applied to the sound speed (GVF) measurement (SQ) is .72.

G
V
F 2.016 %
V
F 932.7 gal/m
SQ .72 /

Figure 15 VF/GVF Screen

7.6.2 Menu Mode

This mode of operation permits the user to adjust various settings on the passive sonar meter transmitter as well as perform multiple diagnostic tests. The menu system is set up in a tree format, with seven top level categories (illustrated in bold print below) that can each have up to two levels of sub menus. The menu structure for each product is shown in the tables on the following pages.

BASIC CONFIG

SENSOR SERIAL #	
PIPE SIZE	ID/Wall
	Size/Sch
	OD/Wall
FLUID PROPERTIES	
	Specific Gravity
	Viscosity (Pa s)
CALIBRATION	C0
	C1
	C2
FLOW DIRECTION	Forward
	Reverse
SET DATE/TIME	MM/DD/YY HH:MM:SS
SET DATE FORMAT	US / Euro / ISO 8601

OUTPUT CONFIG

4-20mA CH 1	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
4-20mA CH 2	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
PULSE	Multiplier
	Width (ms)
	Lowcut
	Output Sel
ALARM CONTROL	
	Warning
	Critical
	Manual Clear
ALARM WARN THRESH	
	Flw Min/Max
ALARM CRIT THRESH	
	Flw Min/Max
FLOW DAMPING	
	State
	Time Const (S)
FLOW NOISE FILTER	
	State
	Magnitude
FLOW SPIKE FILTER	
	State
	No Flow Len
	Length
FLOW SPIKE FILTER ADV	
	Up Count
	Down Count
	Percent
	Percent Len
UNDETERMINED VALUE	

INPUT CONFIG

SENSOR #1	Units
	Scale (per mA)
	Offset (mA)
SENSOR #2	Units
	Scale (per mA)
	Offset (mA)

CUSTOMIZE

DISPLAY	Line 1
	Line 2
	Contrast
SENSOR SETUP	State
FLOW UNITS	Volume
	Time
	User Vol Label
	User Vol Base
	User Vol Scale
	User Time Label
	User Time Base
	User Time Scale
FLOW CUTOFF RANGE	
	Low End
	High End
TOTALIZER	Units
	Lowcut Enable
	Lowcut
	Multiplier
	Reset
WR PROTECT MODE	

COMMUNICATIONS

ETHERNET	IP Address
	Subnet Mask
FRONT PANEL SERIAL	
	Baud Rate
INTERNAL SERIAL	Config
	Baud Rate
	Data Bits
	Parity
	Stop Bits
HART	Preambles
	Resp Preambles
	Univ Cmd Rev
	Polling Address
	Find Device Arm
MODBUS	Mode
	Address
	ACSII Timeout
RESET COMMS	

DIAGNOSTICS

SENSOR CHECK	
4-20mA TEST	
GAIN	Autoset Gain
	Check/Set Gain
	Test Gain
SELF TEST	RAM Test
	DPRAM Test
KEYBOARD TEST	
CLEAR HISTORY	
MONITOR	Passkey
	System
	Sensor
PULSE TEST	
ALARM TEST	

INFO

REVISIONS
DIAGNOSTIC
CONFIGURATION
EVENT LOG
SENSOR MAX/MIN

Table 7 Passive Sonar System Volumetric Flow Menu Diagram Software Release 04.10.XX

BASIC CONFIG

SENSOR SERIAL #	
PIPE SIZE	ID/Wall
	Size/Sch
	OD/Wall
PIPE MATERIAL	
FLUID PROPERTIES	
	Spec Gravity
	SOS (ft/s)
PRESSURE	
TEMPERATURE	
PRESSURE SEL	
TEMPERATURE SEL	
ALTITUDE	
SET DATE/TIME	MM/DD/YY HH:MM:SS
SET DATE FORMAT	US / Euro / ISO 8601

OUTPUT CONFIG

4-20mA CH 1	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
4-20mA CH 2	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
PULSE	Multiplier
	Width (ms)
	Lowcut
	Output Sel
ALARM CONTROL	
	Warning
	Critical
	Manual Clear
ALARM WARN THRESHOLD	
	GVF Min/Max
ALARM CRIT THRESHOLD	
	GVF Min/Max
GVF DAMPING	State
	Time Const (S)
GVF NOISE FILTER	
	State
	Magnitude
GVF SPIKE FILTER	
	State
	No Flow Len
	Length
GVF SPIKE FILTER ADV	
	Up Count
	Down Count
	Percent
	Percent Len
UNDETERMINED VALUE	

INPUT CONFIG

SENSOR #1	Units
	Scale (per mA)
	Offset (mA)
SENSOR #2	Units
	Scale (per mA)
	Offset (mA)

CUSTOMIZE

DISPLAY	Line 1
	Line 2
	Contrast
SENSOR SETUP	State
SOS UNITS	Units
WR PROTECT MODE	

COMMUNICATIONS

ETHERNET	IP Address
	Subnet Mask
FRONT PANEL SERIAL	
	Baud Rate
INTERNAL SERIAL	Config
	Baud Rate
	Data Bits
	Parity
	Stop Bits
HART	Preambles
	Resp Preambles
	Univ Cmd Resp
	Polling_Address
	Find Device Arm
MODBUS	Mode
	Address
	ACSII Timeout
RESET COMMS	

DIAGNOSTICS

SENSOR CHECK	
4-20mA TEST	
GAIN	Autoset Gain
	Check/Set Gain
	Test Gain
SELF TEST	RAM Test
	DPRAM Test
KEYBOARD TEST	
CLEAR HISTORY	
MONITOR	Passkey
	System
	Sensor
PULSE TEST	
ALARM TEST	

INFO

REVISIONS
DIAGNOSTIC
CONFIGURATION
EVENT LOG
SENSOR MAX/MIN

Table 8 Passive Sonar System Gas Volume / Void Fraction Menu Diagram Software Release 04.10.XX

BASIC CONFIG

SENSOR SERIAL #	
PIPE SIZE	ID/Wall
	Size/Sch
	OD/Wall
PIPE MATERIAL	
FLUID PROPERTIES	
	Specific Gravity
	SOS (ft/s)
	Viscosity (Pa-s)
PRESSURE	
TEMPERATURE	
PPRESSURE SEL	
TEMPERATURE SEL	
ALTITUDE	
CALIBRATION	C0
	C1
	C2
FLOW DIRECTION	Forward/Reverse
OP MODE	VF/GVF/VF&GVF
SET DATE/TIME	MM/DD/YY hh:mm:ss
SET DATE FORMAT	US / Euro / ISO 8601

OUTPUT CONFIG

4-20mA CH 1	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
4-20mA CH 2	Output Sel
	Power Sel
	Low End
	High End
	Out Of Range
	Overrange Rail
	4mA Trim
	20mA Trim
PULSE	Multiplier
	Width (ms)
	Lowcut
	Output Sel
ALARM CONTROL	
	Warning
	Critical
	Manual Clear
ALARM WARN THRESHOLD	
	Output Sel
	Flw/GVF Min/Max
ALARM CRIT THRESHOLD	
	State
	Flw/GVF Min/Max
VF & GVF DAMPING FILTER	
	State
	Time Const (S)
GVF & VF NOISE FILTER	
	State
	Magnitude
GVF & VF SPIKE FILTER	
	State
	No Flow Len
	Length
GVF & VF SPIKE FILTER ADV	
	Up Count
	Down Count
	Percent
	Percent Len
UNDETERMINED VALUE	

INPUT CONFIG

SENSOR #1	Units
	Scale (per mA)
	Offset (mA)
SENSOR #2	Units
	Scale (per mA)
	Offset (mA)

CUSTOMIZE

DISPLAY	Line 1
	Line 2
	Contrast
SENSOR SETUP	State
FLOW UNITS	Volume
	Time
	User Vol Label
	User Vol Base
	User Vol Scale
	User Time Label
	User Time Base
	User Time Scale
SOS UNITS	Units
FLOW CUTOFF RANGE	
	Low End
	High End
TOTALIZER	Input
	Units
	Lowcut Enable
	Lowcut
	Multiplier
	Reset
WR PROTECT MODE	

COMMUNICATIONS

ETHERNET	IP Address
	Subnet Mask
FRONT PANEL SERIAL	
	Baud Rate
INTERNAL SERIAL	Config
	Baud Rate
	Data Bits
	Parity
	Stop Bits
HART	Preambles
	Resp Preambles
	Univ Cmd Resp
	Polling_Address
	Find Device Arm
MODBUS	Mode
	Address
	ACSII Timeout
RESET COMMS	

DIAGNOSTICS

SENSOR CHECK	
4-20mA TEST	
GAIN	Autoset Gain
	Check/Set Gain
	Test Gain
SELF TEST	RAM Test
	DPRAM Test
KEYBOARD TEST	
CLEAR HISTORY	
MONITOR	Passkey
	System
	Sensor
PULSE TEST	
ALARM TEST	

INFO

REVISIONS
DIAGNOSTIC
CONFIGURATION
EVENT LOG
SENSOR MAX/MIN

Table 9 Passive Sonar System Volumetric Flow and Gas Volume / Void Fraction Menu Diagram Software Release 04.10.XX

When the display is in operational mode, any key pressed (except EXIT) will enter menu mode. In this mode the keypad is used for traversing the menu tree and for modifying system parameters in the above tables. In menu mode the screen is divided into four lines of information. The following figure shows an example of a typical menu screen.

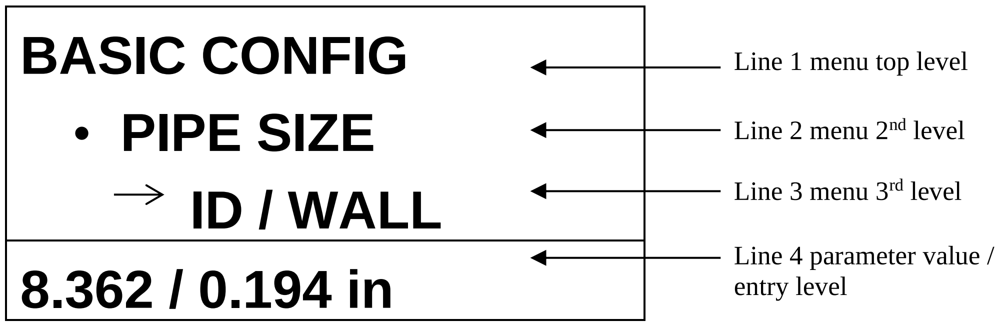

Figure 16 Typical Menu Screen

The top three lines of text represent the three levels of the menu. The arrow shown to the left of “INNER DIAM” in this example shows which level of the menu is currently selected. The fourth line of the display shows the current value of the menu parameter. When a value is shown on the fourth line, pressing the ‘ENTER’ key will permit editing of this value.

The following figure shows an example of the screen while editing the ‘INNER DIAM.’ parameter. When editing a parameter two different editing modes are used. This figure shows an example of editing a parameter by digits, where each digit is adjusted individually. In this mode the left & right arrow keys are used to move between digits and the up & down arrow keys will increment or decrement the digit.

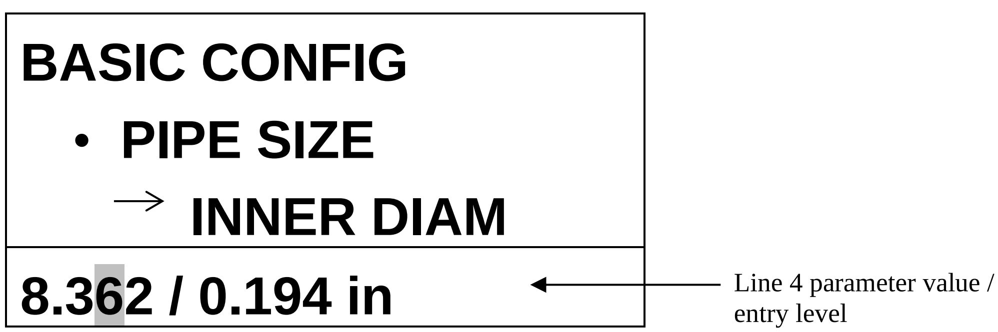

Figure 17 Editing Parameter By Digits

The following figure shows an example of the second type of parameter editing. In this case the whole parameter is highlighted and the up and down arrow keys will cycle between the available settings.

When editing a parameter the 'ENTER' key will accept and save the current value. Alternatively the 'BACK' key will return the current parameter to the value before editing was begun. The 'EXIT' key will also revert to the previous value (similar to the 'BACK' key) and will exit Menu mode. While in Menu mode the screen will return to operational mode and resume operation after 5 minutes of inactivity.

OUTPUT CONFIG

- **4-20mA Ch1**
  - → **POWER SEL.**

INTERNAL

Figure 18 Editing Whole Parameter

The following tables detail the full menu tree.

Table 10 VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Basic Config	Sensor Serial #		0000000	Serial number of sensor band
	Pipe Size	ID/Wall	ID: 0.1- 100 in (2.54-2540mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe inner diameter and wall thickness
		Size/Sched	2 to 36" size; schedule	Pipe size & schedule
		OD/Wall	OD: 0.1- 300 in (2.54-7260mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe outer diameter and wall thickness
	Fluid Properties	Liq Spec Gravity	0 - 999999	Enters the liquid specific gravity; default water 0.997
		Viscosity	0.0000 e-38 to 9.9999 e+38	Enters the liquid viscosity in Pa-sec; default water $8.9008e^{-4}$
	Calibration Coefficients	C0 term	0.0000 e-38 to 9.9999 e+38	First term coefficient
		C1 term	0.0000 e-38 to 9.9999 e+38	Second term coefficient
		C2 term	0.0000 e-38 to 9.9999 e+38	Third term coefficient
	Flow Direction		Forward, Reverse	Sets direction of flow relative to 'Flow Direction' arrow on sensor band
	Set Date/Time	MM/DD/YY HH:MM:SS	Based on Format	Current date/time; Note: Unit does not adjust for daylight savings. Manually adjust as required.
	Set Date Format		US(MM/DD/YY) EURO (DD/MM/YY) ISO8601(YY-MM-DD)	Format of date display on transmitter

Table 10 (page 2) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Output Config	4-20mA Ch1& Ch2	Output Sel	Flow Rate, Flow Quality, Blank	Parameter to output
		Power Sel	Internal, External	Power supply for 4-20mA current
		Low End	Based on 'output sel'	Low end output (4mA)
		High End	Based on 'output sel'	High end output (20mA)
		Out of Range	Hold, >20mA, <4mA, 4mA	Behavior when meter reading is out of range or meter has no reading
		Overrange Rail	Enable, Disable	'Enable' causes the output to go to full (20mA) or min (4mA) when system over ranges
		4mA Trim	2 to 6	Adjust 4mA output
		20mA Trim	18 to 22	Adjust 20mA output
	Pulse	Multiplier	0 - 999999	Multiplier on output
		Width (ms)	.5,1,20,33,50,100	Pulse width
		Lowcut	0% to 100%	Low end cutoff
		Output Sel	Flow Rate, Flow Quality, Totalizer, Flow Rate%	Parameter to output
	Alarm Control	Warning	Off/On/Equation Input	Activates alarm warning function
		Critical	Off/On/Equation Input	Activates alarm critical function
		Manual Clear	Enable / Disable	Allows for manual or automatic alarm clearing
	Alarm Warning Threshold	Flw Min	0-100% of range	Used to set the minimum and maximum values for a warning alarm
		Flw Max		
	Alarm Critical Threshold	Flw Min	0-100% of range	Used to set the minimum and maximum values for a critical alarm
		Flw Max		
	Flow Damping Filter	State	Enable, Disable	Enable Damping
		Time Constant (s)	0-600 seconds; default is 3	Smoothes output due to rapid changes in flow
	Flow Noise Filter	State	Enable, Disable	Enable noise filtering
		Magnitude	Low, High	Amount of damping

Table 10 (page 3) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Output Config (cont.)	Flow Spike Filter	State	Enable, Disable	Enable spike filtering
		No Flow Len	1-60	Number of good measurements during initialization before VF spike filter passes measurements as ‘good’
		Length	0 – 60 readings	Defines the number of consecutive valid measurements before displaying flow rate
	Flow Spike Filter Adv	Up Count	1-60	Number of counts to INCREMENT the VF Bad Quality counter when measured VF quality is below the minimum
		Down Count	1-60	Number of counts to DECREMENT the VF Bad Quality counter when measured VF quality is below the minimum
		Percent	0 – 100 %	Defines percent difference of the previous measurement over the range below which the flow rate is deemed valid
		Percent Len	2-60	Number of good measurements before VF spike filter passes measurements as ‘good’
	Undeter-mined Value		Bad Reading, Zero	Used with Fieldbus to output a value (0) when the quality falls below the minimum specified

Table 10 (page 4) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Input Config	Sensor #1	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output
	Sensor #2	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output

Table 10 (page 5) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Customize	Display	Line 1	Flow Rate, Totalizer, Flow Rate %, Blank	Parameter displayed on line 1
		Line 2	Flow Rate, Totalizer, Flow Rate %, Blank	Parameter displayed on line 2
		Contrast	0 to 1000 (default 170)	Contrast of display
	Sensor Setup	State	On/off	Enable / disable each sensor
	Flow Units	Volume	gal, l, m^3, user, ft^3, igal, ft, m	Flow units
		Time	d, h, m, s, user	Time units
		User Vol Label	User defined	Custom flow volume label, 3 chars
		Use Vol Base	gal, l, m^3, ft^3, igal, ft, m	Base units for custom volume label
		User Vol Scale	0.0000 e-38 to 9.9999 e+38	Scale factor on custom volume base
		User Time Label	User defined	Custom time label
		User Time Base	d, h, m, s	Base units for custom time label
		User Time Scale	0.0000 e-38 to 9.9999 e+38	Scale factor on custom time base
	Flow Cutoff Range	Low End	0% to 100% (3 to 30 ft/s)	Under this value ‘<min flow’ will be displayed
		High End	0% to 100% (3 to 30 ft/s)	Over this value ‘>max flow’ will be displayed
	Totalizer	Units	gal, l, m^3, ft^3, user def	Units for totalizer
		Lowcut Enable	Enable, Disable	Turns totalizer lowcut on / off
		Lowcut	0% to 100% (3 to 30 ft/s)	Flow values below this will not be used for totalizer
		Multiplier	M, k, 1	Total Multiplier
		Reset		Reset totalizer value
	Wr Protect Mode		Enable, Disable	When enabled no other parameters can be changed

Table 10 (page 6) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Communications	Ethernet	IP Address	0.0.0.0 to 255.255.255.255	Current IP address
		Subnet Mask	0.0.0.0 to 255.255.255.255	Current Subnet Mask
	Front Panel Serial	Baud Rate	2400 to 115200	Serial baud rate for front panel serial port
	Internal Serial	Config	RS232 or RS485	Serial communications protocol type
		Baud Rate	2400 to 115200	Serial baud rate for internal serial port
		Data Bits	8, 7	Internal RS232/RS485 serial port data bits
		Parity	Even, odd, none	Internal RS232/RS485 serial port parity
		Stop bits	1 or 2	Internal RS232/RS485 serial port stop bits
	HART	Preambles	5 - 20	# Preamble chars ahead of MSG
		Resp. Preambles	5 - 20	# Preambles in response from transmitter. Change to match HART communicator
		Univ. Cmd. Rev.	5 or 6	Major protocol Revision 5, or Revision 6
		Polling Address	0 - 15	Non-zero for multi-drop connections =0 for single connection
		Find Device Arm	Enable, Disable	When 'Enabled", makes transmitter respond to HART "Find Device" command
	MODBUS (if ON – No Fieldbus)	Mode	RTU, ASCII	Transmission mode select
		Address	001-247	Device address select
		ASCII Timeout	04-99	ASCII timeout select
	Reset Comms			Resets communications ports without re-booting transmitter

Table 10 (page 7) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Diagnostics	Sensor Check		PASS or FAIL. (Indicate which sensors failed test)	Performs health check on each sensor
	4-20mA Test		Test 4-20mA outputs from 4 to 20mA	Manual testing of 4-20mA output #1 and 2
	Gain	Autoset Gain	1.0, 4.65, 21.55, 98.65	Provides auto adjustment of pre-amplifier setting based on the current process operating condition
		Check/Set Gain	1.0, 4.65, 21.55, 98.65	Provides for manual checking and setting of pre-amplifier gain. Autoset Gain can override set point
		Test Gain	PASS or FAIL	Test preamp to determine if gain falls within range of AGC parameters
	Self Test	RAM Test	PASS or FAIL	System memory test
		DPRAM Test	PASS or FAIL	Dual port memory test
	Keyboard Test		Red LED illuminates indicating key is functional	Test keyboard operation
	Clear History	Reset		Resets data history
	Monitor	Passkey		Factory Technical Support diagnostic feature
		System Monitor		
		Sensor Monitor		
	Pulse Test			Provides for testing the pulse output
	Alarm Test			Provides for testing the alarm output

Table 10 (page 8) VF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Info	Revisions			Provides a list of installed hardware and software
	Diagnostic			Provides a list of key system temps, volts, status
	Configuration			Summary of the system setup
	Event Log			Log of system events (i.e. errors, sensor over ranges, etc.)
	Sensor Max/Min			Maximum and minimum sensor signal amplitudes

Table 11 GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Basic Config	Sensor Serial #		0000000	Serial number of sensor band
	Pipe Size	ID/Wall	ID: 0.1- 100 in (2.54-2540mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe inner diameter and wall thickness
		Size/Sched	2 to 36" size; schedule	Pipe size & schedule
		OD/Wall	OD: 0.1- 300 in (2.54-7260mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe outer diameter and wall thickness
	Pipe Material		SST, CS, PVC, Custom	Enters the pipe modulus, kilo-Pascal (kPa)
	Fluid Properties	Spec Gravity	0 - 999999	Enters the specific gravity; default water at 25 °C and 14.7 PSIa
		SOS (ft/s)	0 - 999999	Sound speed in media of interest; ft/sec; default water at 25 °C and 14.7 PSIa
	Pressure		+/- 0-999999	Process pressure; PSIg, BARg, kPag
	Temperature		-999 to +999C -1766 to 1830F	Process temperature; °C or F
	Pressure Sel		Fixed, Sensor #1 or #2, Protocol	Allows for selecting a fixed pressure input or using the inputs of sensor #1 or #2 or using Modbus input
	Temperature Sel		Fixed, Sensor #1 or #2	Allows for selecting a fixed temperature input or using the inputs of sensor #1 or #2 or using Modbus input
	Altitude		-50,000 to +50,000	Process pipe altitude above / below sea level; feet or meters
	Set Date/Time	MM/DD/YY HH:MM:SS	Based on Format	Current date/time; adjust for daylight savings as required
	Set Date Format		US(MM/DD/YY) EURO (DD/MM/YY) ISO8601(YY-MM-DD)	Format of date display on transmitter

Table 11 (page 2) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Output Config	4-20mA Ch1& Ch2	Output Sel	SOS, GVF, SOS Quality, Blank	Parameter to output
		Power Sel	Internal, External	Power supply for 4-20mA current loop
		Low End	Based on 'output sel'	Low end output (4mA)
		High End	Based on 'output sel'	High end output (20mA)
		Out of Range	Hold, >20mA, <4mA, 4mA	Behavior when meter reading is out of range or meter has no reading
		Overrange Rail	Enable, Disable	'Enable' causes the output to go to full (20mA) or min (4mA) when system over ranges
		4mA Trim	2 to 6	Adjust 4mA output
		20mA Trim	18 to 22	Adjust 20mA output
	Pulse	Multiplier	0 - 999999	Multiplier on output
		Width (ms)	.5,1,20,33,50,100	Pulse width
		Lowcut	0 % to 100 %	Low end cutoff
		Output Sel	GVF, SOS, SOS Quality	Parameter to output
	Alarm Control	Warning	Off/On/Equation Input	Activates alarm warning function
		Critical	0 % to 100 % Off/On/Equation Input	Activates alarm critical function
		Manual Clear	Enable / Disable	Allows for manual or automatic alarm clearing
	Alarm Warning Threshold	GVF Min	0-100% of range Off/On/Equation Input	Used to set the minimum and maximum values for a warning alarm
		GVF Max		
	Alarm Critical Threshold	GVF Min	0-100% of range Off/On/Equation Input	Used to set the minimum and maximum values for a critical alarm
		GVF Max		
	GVF Damping	State	Enable, Disable	Enable Damping
		Time Constant (s)	0-600 seconds; default is 3	Smoothes output due to rapid changes in flow
	GVF Noise Filter	State	Enable, Disable	Enable noise filtering
		Magnitude	Low, High	Amount of damping

Table 11 (page 3) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Output Config (cont.)	GVF Spike Filter	State	Enable, Disable	Enable spike filtering
		No GVF Len	1-60	Number of good measurements during initialization before GVF spike filter passes measurements as 'good'
		Length	0 – 60 readings	Defines the number of consecutive valid measurements before displaying flow rate
	GVF Spike Filter Adv	Up Count	1-60	Number of counts to INCREMENT the GVF Bad Quality counter when measured VF quality is below the minimum
		Down Count	1-60	Number of counts to DECREMENT the GVF Bad Quality counter when measured GVF quality is below the minimum
		Percent	0 – 100 %	Defines percent difference of the previous measurement over the range below which the flow rate is deemed valid
		Percent Len	2-60	Number of good measurements before GVF spike filter passes measurements as 'good'
	Undeter-mined Value		Bad Reading, Zero	Used with Fieldbus to output a value (0) when the quality falls below the minimum specified

Table 11 (page 4) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Input Config	Sensor #1	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output
	Sensor #2	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output

Table 11 (page 5) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Customize	Display	Line 1	Blank, GVF, SOS	Parameter displayed on line 1
		Line 2	Blank, GVF, SOS	Parameter displayed on line 2
		Contrast	0 to 1024 (default 170)	Contrast of display
	Sensor Setup	State	On/off	Enable / disable each sensor
	SOS Units	Units	ft/sec, m/sec	Sound speed units
	Wr Protect Mode		Enable, Disable	When enabled no other parameters can be changed

Table 11 (page 6) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Communications	Ethernet	IP Address	0.0.0.0 to 255.255.255.255	Current IP address
		Subnet Mask	0.0.0.0 to 255.255.255.255	Current Subnet Mask
	Front Panel Serial	Baud Rate	2400 to 115200	Serial baud rate for front panel serial port
	Internal Serial	Config	RS232 or RS485	Serial communications protocol type
		Baud Rate	2400 to 115200	Serial baud rate for internal serial port
		Data Bits	8, 7	Internal RS232/RS485 serial port data bits
		Parity	Even, odd, none	Internal RS232/RS485 serial port parity
		Stop bits	1 or 2	Internal RS232/RS485 serial port stop bits
	HART	Preambles	5 - 20	# Preamble chars ahead of MSG
		Resp. Preambles	5 - 20	# Preambles in response from transmitter. Change to match HART communicator
		Univ. Cmd. Rev.	5 or 6	Major protocol Revision 5, or Revision 6
		Polling Address	0 - 15	Non-zero for multi-drop connections =0 for single connection
		Find Device Arm	Enable, Disable	When ‘Enabled”, makes transmitter respond to HART “Find Device” command
	MODBUS	Mode	RTU, ASCII	Transmission mode select
		Address	001-247	Device address select
		ASCII Timeout	04-99	ASCII timeout select
	Reset Comms			Resets communications ports without re-booting transmitter

Table 11 (page 7) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Diagnostics	Sensor Check		PASS or FAIL. (Indicate which sensors failed test)	Performs health check on each sensor
	4-20mA Test		Test 4-20mA outputs from 4 to 20mA	Manual testing of 4-20mA output #1 and 2
	Gain	Autoset Gain	1.0, 4.65, 21.55, 98.65	Provides auto adjustment of pre-amplifier setting based on the current process operating condition
		Check/Set Gain	1.0, 4.65, 21.55, 98.65	Provides for manual checking and setting of pre-amplifier gain. Autoset Gain can override set point
		Test Gain	PASS or FAIL	Test preamp to determine if gain falls within range of AGC parameters
	Self Test	RAM Test	PASS or FAIL	System memory test
		DPRAM Test	PASS or FAIL	Dual port memory test
	Keyboard Test		Red LED illuminates indicating key is functional	Test keyboard operation
	Clear History	Reset		Resets data history
	Monitor	Passkey		Factory Technical Support diagnostic feature
		System Monitor		
		Sensor Monitor		
	Pulse Test			Provides for testing the pulse output
	Alarm Test			Provides for testing the alarm output

Table 11 (page 8) GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Info	Revisions			Provides a list of installed hardware and software
	Diagnostic			Provides a list of key system temps, volts, status
	Configuration			Summary of the system setup
	Event Log			Log of system events (i.e. errors, sensor over ranges, etc.)
	Sensor Max/Min			Maximum and minimum sensor signal amplitudes

Table 12 VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Basic Config	Sensor Serial #		0000000	Serial number of sensor band
	Pipe Size	ID/Wall	ID: 0.1- 100 in (2.54-2540mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe inner diameter and wall thickness
		Size/Sched	2 to 36" size; schedule	Pipe size & schedule
		OD/Wall	OD: 0.1- 300 in (2.54-7260mm) Wall 0 – 100 in (0 to 2540 mm)	Pipe outer diameter and wall thickness
	Pipe Material		SST, CS, PVC, Custom	Enters the pipe modulus, kilo-Pascal (kPa)
	Fluid Properties	Spec Gravity	0 - 999999	Enters the specific gravity; default water at 25 °C and 14.7 PSIa
		SOS (ft/s)	0 - 999999	Sound speed in media of interest; ft/sec; default water at 25 °C and 14.7 PSIa
		Viscosity	0.0000 e-38 to 9.9999 e+38	Enters the liquid viscosity in Pa-sec; default water at 25 °C and 14.7 PSIa
	Pressure		+/- 0-999999	Process pressure; PSIg, BARg, kPag
	Temperature		-999 to +999C -1766 to 1830F	Process temperature; °C or F
	Pressure Sel		Fixed, Sensor #1 or #2, Protocol	Allows for selecting a fixed pressure input or using the inputs of sensor #1 or #2 or using Modbus input
	Temperature Sel		Fixed, Sensor #1 or #2	Allows for selecting a fixed temperature input or using the inputs of sensor #1 or #2 or using Modbus input
	Altitude		-50,000 to +50,000	Process pipe altitude above / below sea level; feet or meter
	Calibration	C0 term	0.0000 e-38 to 9.9999 e+38	First term coefficient
		C1 term	0.0000 e-38 to 9.9999 e+38	Second term coefficient
		C2 term	0.0000 e-38 to 9.9999 e+38	Third term coefficient

Table 12 (page 2) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Basic Config (continued)	Op Mode		Flow/GVF/SOS	Sets the operational mode
	Flow Direction		Forward, Reverse	Sets direction of sensor head relative to flow
	Set Date/Time	MM/DD/YY HH:MM:SS	Based on format	Current date/time; adjust for daylight savings as required
	Set Date Format		US(MM/DD/YY) EURO (DD/MM/YY) ISO8601(YY-MM-DD)	Format of date display on transmitter

Table 12 (page 3) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Output Config	4-20mA Ch1& Ch2	Output Sel	SOS, GVF, Flow Rate, True Liquid Flow, SOS Quality, Flow Quality, Blank	Parameter to output
		Power Sel	Internal, External	Power supply for 4-20mA current
		Low End	Based on 'output sel'	Low end output (4mA)
		High End	Based on 'output sel'	High end output (20mA)
		Out of Range	Hold, >20mA, <4mA, 4mA	Behavior when meter reading is out of range or meter has no reading
		Overrange Rail	Enable, Disable	'Enable' causes the output to go to full (20mA) or min (4mA) when system over ranges
		4mA Trim	2 to 6	Adjust 4mA output
		20mA Trim	18 to 22	Adjust 20mA output
	Pulse	Multiplier	0 - 999999	Multiplier on output
		Width (ms)	.5,1,20,33,50,100	Pulse width
		Lowcut	0 % to 100 %	Low end cutoff
		Output Sel	GVF, SOS, Flow Rate, True Liquid Flow, Flow Quality, SOS Quality	Parameter to output
	Alarm Control	Warning	Off/On	Activates alarm warning function
		Critical	0 % to 100 % Off/On	Activates alarm critical function
		Manual Clear	Enable/Disable	Allows for manual or automatic alarm clearing
	Alarm Warning Threshold	Flw Min	0-100% of range Off/On/Equation Input	Used to set the minimum and maximum values for a warning alarm
		GVF Min		
		Flw Max		
		GVF Max		
	Alarm Critical Threshold	Flw Min	0-100% of range Off/On/Equation Input	Used to set the minimum and maximum values for a critical alarm
		Flw Max		
		GVF Min		
		GVF Max		

Table 12 (page 4) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	**Level 2**	**Level 3**	**Range**	**Description**
Output Config (cont)	Flow & GVF Damping	State	Enable, Disable	Enable Damping
		Time Constant (s)	0-600 seconds; default is 3	Smoothes output due to rapid changes in flow
	Flow & GVF Noise Filter	State	Enable, Disable	Enable noise filtering
		Magnitude	Low, High	Amount of damping
	VF & GVF Spike Filter	State	Enable, Disable	Enable spike filtering
		No Flow / GVF Len	1-60	Number of good measurements during initialization before VF (GVF) spike filter passes measurements as 'good'
		Length	0 – 60 readings	Defines the number of consecutive valid measurements before displaying flow rate
	VF & GVF Spike Filter Adv	Up Count	1-60	Number of counts to INCREMENT the VF (GVF) Bad Quality counter when measured VF (GVF) quality is below the minimum
		Down Count	1-60	Number of counts to DECREMENT the VF (GVF) Bad Quality counter when measured VF (GVF) quality is below the minimum
		Percent	0 – 100 %	Defines percent difference of the previous measurement over the range below which the flow rate is deemed valid
		Percent Len	2-60	Number of good measurements before VF (GVF) spike filter passes measurements as 'good'
	Undeter-mined Value		Bad Reading, Zero	Used with Fieldbus to output a value (0) when the quality falls below the minimum specified

Table 12 (page 5) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Input Config	Sensor #1	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output
	Sensor #2	Units	PSIg, None, F, C, BARg, kPag	Parameter input
		Scale	0.0000 e-38 to 9.9999 e+38 per mA	Input range divided by mA range
		Offset	0.0000 e-38 to 9.9999 e+38 per mA	Correction due to a non-zero mA minimum output

Table 12 (page 6) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Customize	Display	Line 1	Flow Rate, Totalizer, Flow Rate %GVF, SOS, True Liquid Flow, Blank	Parameter displayed on line 1
		Line 2	Flow Rate, Totalizer, Flow Rate %GVF, SOS, True Liquid Flow, Blank	Parameter displayed on line 2
		Contrast	0 to 1000 (default 170)	Contrast of display
	Sensor Setup	State	On/off	Enable / disable each sensor
	Flow Units	Volume	gal, l, m^3, user, ft^3, igal, ft, m	Flow units
		Time	d, h, m, s, user	Time units
		User Vol Label	User defined	Custom flow vol label
		Use Vol Base	gal, l, m^3, ft^3, igal, ft, m	Base units for custom volume label
		User Vol Scale	0.0000 e-38 to 9.9999 e+38	Scale factor on custom volume base
		User Time Label	User defined	Custom time label
		User Time Base	d, h, m, s	Base units for custom time label
		User Time Scale	0.0000 e-38 to 9.9999 e+38	Scale factor on custom time base
	SOS Units	Units	Feet or meters	Units of measure
	Flow Cutoff Range	Low End	0% to 100% (3 to 30 ft/s)	Under this value ‘<min flow’ will be displayed
		High End	0% to 100% (3 to 30 ft/s)	Over this value ‘>max flow’ will be displayed
	Totalizer	Units	gal, l, m^3, ft^3, user def	Units for totalizer
		Lowcut Enable	Enable, Disable	Turns totalizer lowcut on / off
		Lowcut	0% to 100% (3 to 30 ft/s)	Flow values below this not used for totalizer
		Multiplier	M, k, 1	Total Multiplier
		Reset		Reset totalizer value
		Input	Vol Flow	Totalized flow basis
	Wr Protect Mode		Enable, Disable	When enabled no other parameters can be changed

Table 12 (page 7) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Communications	Ethernet	IP Address	0.0.0.0 to 255.255.255.255	Current IP address
		Subnet Mask	0.0.0.0 to 255.255.255.255	Current Subnet Mask
	Front Panel Serial	Baud Rate	2400 to 115200	Serial baud rate for front panel serial port
	Internal Serial	Config	RS232 or RS485	Serial communications protocol type
		Baud Rate	2400 to 115200	Serial baud rate for internal serial port
		Data Bits	8, 7	Internal RS232/RS485 serial port data bits
		Parity	Even, odd, none	Internal RS232/RS485 serial port parity
		Stop bits	1 or 2	Internal RS232/RS485 serial port stop bits
	HART	Preambles	5 - 20	# Preamble chars ahead of MSG
		Resp. Preambles	5 - 20	# Preambles in response from transmitter. Change to match HART communicator
		Univ. Cmd. Rev.	5 or 6	Major protocol Revision 5, or Revision 6
		Polling Address	0 - 15	Non-zero for multi-drop connections =0 for single connection
		Find Device Arm	Enable, Disable	When ‘Enabled”, makes transmitter respond to HART “Find Device” command
	MODBUS (if ON – No Fieldbus)	Mode	RTU, ASCII	Transmission mode select
		Address	001-247	Device address select
		ASCII Timeout	04-99	ASCII timeout select
	Reset Comms			Resets communications ports without re-booting transmitter

Table 12 (page 8) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Diagnostics	Sensor Check		PASS or FAIL. (Indicate which sensors failed test)	Performs health check on each sensor
	4-20mA Test		Test 4-20mA outputs from 4 to 20mA	Manual testing of 4-20mA output #1 and 2
	Gain	Autoset Gain	1.0, 4.65, 21.55, 98.65	Provides auto adjustment of pre-amplifier setting based on the current process operating condition
		Check/Set Gain	1.0, 4.65, 21.55, 98.65	Provides for manual checking and setting of pre-amplifier gain. Autoset Gain can override set point
		Test Gain	PASS or FAIL	Test preamp to determine if gain falls within range of AGC parameters
	Self Test	RAM Test	PASS or FAIL	System memory test
		DPRAM Test	PASS or FAIL	Dual port memory test
	Keyboard Test		Red LED illuminates indicating key is functional	Test keyboard operation
	Clear History	Reset		Resets data history
	Monitor	Passkey		Factory Technical Support diagnostic feature
		System Monitor		
		Sensor Monitor		
	Pulse Test			Provides for testing the pulse output
	Alarm Test			Provides for testing the alarm output

Table 12 (page 9) VF/GVF Transmitter Menu Tree Software Release 04.10.XX

Level 1	Level 2	Level 3	Range	Description
Info	Revisions			Provides a list of installed hardware and software
	Diagnostic			Provides a list of key system temps, volts, status
	Configuration			Summary of the system setup
	Event Log			Log of system events (i.e. errors, sensor over ranges, etc.)
	Sensor Max/Min			Maximum and minimum sensor signal amplitudes

Each of the system parameters listed above can be accessed and modified using the front panel keypad. Any changes made to these parameters will be saved in non-volatile memory and will not be lost when power is removed from the transmitter.

Several of the parameters have direct links to other parameters found in different locations in the menu structure. Therefore, it is possible that by changing the value of one parameter it will automatically change the other linked parameter. An example of this occurs in the 'Pipe Size' sub-menu. Each of the parameters under this sub-menu: 'ID/Wall', 'Size/Sched', and 'OD/Wall' are directly linked to the others and they all address the inner diameter of the pipe. In this case only one of these parameters can be active at a time. Whenever one of these is selected it becomes the active parameter and the others are blanked (this is shown by ----- under these parameters). To change which parameter is used by the flow system, a different one can be selected, making it the active parameter, and a value entered.

8 TRANSMITTER MENUS

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8.1 Introduction

The following pages present the steps necessary to setup the passive sonar system transmitter.

Whenever a transmitter front panel entry is made, transmitter operation may be interrupted and output to the plant control or data logging system will be interrupted. It is recommended that the process control room be alerted prior to accessing the transmitter front panel.

	WARNING **When explosive gases may be present, the transmitter door may be opened only to use the keypad or reset button. Obtain hot work permit and ensure explosive gasses are not present prior to performing any other operation.**
	CAUTION **Loss of transmitter output signal may occur when accessing transmitter front panel keys. Contact process control room and advise them the transmitter may be off line.**

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

8.2 Basic Config Menu

These inputs **must be made** when installing a system.

8.2.1 Sensor Serial

A Sensor Serial Number assigned to each sensor band. This identifier is found on the sensor band, and on the label previously attached to the sensor cover access panel and the transmitter.

8.2.2 Pipe Size

The Pipe Size input based on the pipe the system is installed on. Input can be '**ID/Wall** (pipe inner diameter / wall thickness)', '**OD/Wall**' (pipe outer diameter / wall thickness) or '**Size/Sched**' (pipe size / schedule). User selectable units of inch or millimeter are available.

8.2.3 Pipe Material (Systems with GVF)

Pipe Material is used to input the modulus of the process pipe material in units of kilo Pascal (kPa). Menu selections for steel, stainless steel, PVC and custom values for other pipe materials are selectable from the menu.

8.2.4 Fluid Properties

8.2.4.1 Specific Gravity

The Specific Gravity default is water at 25 ºC and 14.7 PSIa. Refer to Appendix E for unit conversions and Appendix F for other temperatures and pressures. Custom user selectable values can also be set.

8.2.4.2 SOS – (Systems with GVF)

Speed Of Sound (SOS) is used to input the nominal sound speed of the process fluid. Default is water at 25 ºC and 14.7 PSIa in units of feet per second; custom values can be input. Refer to Appendix F for additional values for water at different temperatures and pressures.

8.2.4.3 Viscosity (Systems with Flow)

The Viscosity default is water at 25 ºC and 14.7 PSIa in units of Pascal-second. Refer to Appendix E for unit conversions and Appendix F for other temperatures and pressures. Custom user selectable values can also be set.

8.2.5 Pressure (Systems with GVF)

The Pressure input is an important parameter for accurate GVF measurement. If the process pressure is constant, input the normal process operating pressure into the transmitter in units of PSIg, Barg or kPag.

For applications where the process pressure varies, it is recommended that a correction for pressure be performed in the process control system. Alternatively, a pressure transmitter can be input to the passive sonar system transmitter as described in **Pressure Sel** below.

If a plant control system is used to correct for pressure, the correction at the control system is made as follows:

$$GVF_{act} = GVF_{meas} * [(P_{proc} + P_{atm})/ (P_{trans} + P_{atm})]$$

Where: GVF_{act} = the GVF corrected for pressure
GVF_{meas} = the GVF reported by the transmitter
P_{atm} = 14.696 if at sea level, correct for elevation if necessary (PSIa)
P_{proc} = the pressure from the pressure transducer (PSIg)
P_{trans} = the pressure input to the transmitter (PSIg)

If a pressure transmitter is connected to the passive sonar system transmitter, the calculation above is performed by the transmitter unit and no pressure correction should be made in the process control system.

8.2.6 Temperature (Systems with GVF)

The Temperature input is used to input the approximate or average process / fluid temperature (in ºC or ºF). A temperature transmitter can be input to the passive sonar system transmitter as described in **Temperature Sel** below.

This input has minimal effect on GVF calculation. Therefore, an approximate process temperature value is usually sufficient.

8.2.7 Pressure Sel (Systems with GVF)

Pressure Sel is used to select if the pressure values for calculating GVF will be fixed (that is, assumed to be steady state and use the values input earlier during GVF set up), or if the values will be based on a pressure transducer. If the values are based on a pressure transducer, user must configure the sensor inputs in the '**Input Config**' menu.

8.2.8 Temperature Sel (Systems with GVF)

Temperature Sel is used to select if the temperature values for calculating GVF will be fixed (that is, assumed to be steady state and use the values input earlier during GVF set up), or if the values will be based on a temperature transducer. If the values are based on a temperature transducer, user must configure the sensor inputs in the '**Input Config**' menu.

8.2.9 Altitude (Systems with GVF)

Altitude is used to calculate the atmospheric pressure corrected for elevation. Enter the elevation above or below sea level in units of feet or meters.

The following equation is used within the transmitter to correct for elevation.

$$P_{atm} = 14.696 * [1 - ((Alt * 10^{-3})/145.45)]^{5.2561}$$

Where: P_{atm} = absolute atmospheric pressure corrected for altitude (psi)
Alt = altitude (feet)

8.2.10 Calibration (Systems with Flow)

Calibration factors are specific to a given pipe size and wall thickness. The value for '**C0**' term, '**C1**' term, and '**C2**' term are found on the sensor band, and on the label that attaches to the sensor cover access panel and inside the transmitter door.

8.2.11 Flow Direction- (Systems with Flow)

The Flow Direction input ('**Forward**' or '**Reverse**'**)** is used if the sensor is installed with flow indicating arrows opposite the actual flow within the process pipe. It is also used if the flow within the pipe is reversed.

8.2.12 Set Date/Time

The Date / Time are entered in the transmitter in order to set the time stamp that will be applied to data downloaded stored in the transmitter. Whenever possible, the time and date should to be synchronized to the process control system. **Note:** The time is not automatically updated to reflect daylight savings time.

8.2.13 Set Date Format

The Set Date Format allows for setting on the time and date in US format ((MM/DD/YY HH:MM:SS), European format (DD/MM/YY HH:MM:SS), or ISO8601 format (YY-MM-DD HH:MM:SS).

8.3 Output Config Menu

These inputs are used to configure the various outputs from the transmitter.

8.3.1 4-20mA (CH 1 & CH 2)

Several selections are available for setup of the current outputs under the 4-20mA setup menu screens.

8.3.1.1 Output Sel

The Output Sel sub-menu selection permits selection of the parameter to output on the 4-20mA channels.

8.3.1.2 Power Sel

The power Sel selection is used to specify whether ‘**Internal**’ (i.e. transmitter) power or ‘**External**’ (i.e. loop) power is used for the 4-20mA current output.

8.3.1.3 **Low End** and **High End**

The Low End and High End menu selections allow the user to change the ranges that are output on the 4-20mA channel.

- Flow rate output corresponds to the flow values for the 4mA and 20mA current settings. The specific flow rates that correspond to the two limits in the current output are set by the user, who specifies a percentage of the total flow range of thesystem.
- GVF output corresponds to the GVF values for the 4mA and 20mA current settings. The specific GVF values that correspond to the two limits in the current output are set by the user, who specifies a percentage between 0% and 100%.

The following figure shows an example screen shot of a user specified High End setting. The user settable percentage is located on the left side of the bottom line of the display, with the corresponding flow value shown on the right. The percentage represents a point within the output range of thesystem. In the example shown (8-inch schedule 40 pipe and the system maximum flow rate of 30 ft/sec or 4677.8 gpm), the high end of the 20mA output is scaled to 053.44% that is equivalent to 2499.8 (2500) gpm.

```
OUTPUT CONFIG
   ·4-20mA CH1
   → HIGH END
053.44%  2499.8gal/m
```

Figure 1 Output Configuration Example Screen

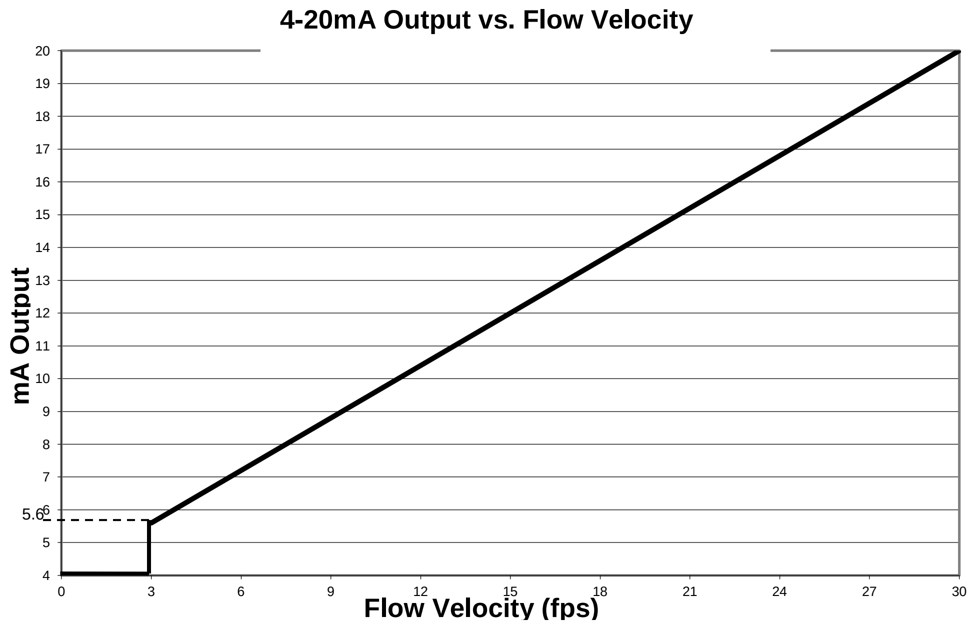

Figure 2 4-20mA Output Set to 0 – 30 fps

Note: For a 4-20mA flow setting of 0-100% of range (assuming a meter range of 3 to 30 ft/sec), the system Low Flow Cut Off of 3.0 fps, from the 4–20 mA output will be 5.6mA. At flows less than 3.0 fps, greater than 30.0 fps, or if the meter is not working, the display will read as configured in the setup of the '**Out of Range**' (i.e. 'Hold' (at last value), <4mA, 4mA or >20mA) and the '**Overrange Rail**' parameters.

8.3.1.4 Out of Range

The Out of Range menu selection permits the user to specify the 4-20mA output behavior when the system cannot measure a valid flow rate or GVF / SOS value. The settings allow a less than 4mA output ('**<4mA**' actual output of ~3mA), a greater than 20mA output ('**>20mA**' actual output of ~21mA), a constant 4mA output ('**4mA**'), and a hold last valid reading output ('**Hold**').

8.3.1.5 Overrange Rail

The Overrange Rail selection is used to select the output behavior when the flow velocity (and corresponding flow rate) or GVF / SOS goes below or above the '**Low End**' or '**High End**' settings made earlier, but is still within the overall measurement range of the system. Default is '**Enable**', where the 4-20mA output will go to either minimum or full scale. If this option is '**Disabled**', the system will output as previously set up in '**Out of Range**' when the system goes below or above the range.

8.3.1.6 4mA and 20mA Trim

The Trim function allows the user to adjust the transmitter 4-20mA outputs to match the plant standard or loop control. The following message screen will appear when this menu item is selected.

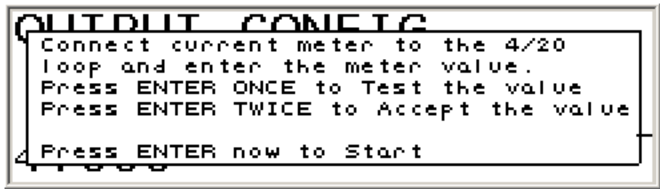

Figure 3 4-20mA Trim Start Message

Press ‘ENTER’ to start the test and adjust the Line 4 value to that shown on the system. Press ‘ENTER’ and the system should read 4mA. Press ‘ENTER’ and adjust the 20mA value to that shown on the system. Press ’ENTER’ and the system should read 20mA. Press ‘ENTER’ to accept the values and then the ‘BACK’ key to leave this input.

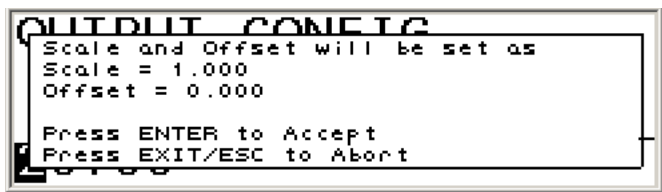

Figure 4 4-20mA Trim Setup

These measurements will calculate and apply an offset and slope (can be viewed on the ‘INFO>CONFIGURATION>4-20mA Channel 1 (or 2)’ screen) for the selected channel.

8.3.2 Pulse

The passive sonar system Pulse output utilizes a solid-state relay closure to output a pulse train corresponding to the selected measurement parameter. The solid-state relay is rated for +30VDC to –10VDC, 100mA maximum. An external user supplied power source (pull-up) is connected to the (+) and (-) terminals under the word “Pulse” on the terminal board. The Pulse Output can be configured to output a pulse frequency or a number of pulses for one of the following measurement parameters:

- **Flow Rate (VF):** Outputs a frequency corresponding to flow rate (systems with Flow).
- **Flow Rate %:** Outputs a frequency corresponding to % of VF full-scale range (systems with Flow).
- **Total Flow (Totalizer):** Outputs a series of pulses corresponding to the total number of flow units counted over the previous update interval (systems with Flow).

- **Speed of Sound (SOS):** Outputs a frequency corresponding to SOS (systems with GVF).
- **Gas Volume Fraction (GVF):** Outputs a frequency corresponding to GVF (systems with GVF).
- **Quality (GVF or VF):** Outputs a frequency corresponding to the measurement system calculated quality metric.

Menu options for configuring the output include a multiplier, a pulse width, and a low cut setting (see descriptions below).

8.3.2.1 Multiplier

The Multiplier is used to scale the pulse output where:

scaled pulse quantity = (pulse output parameter) / multiplier value

8.3.2.2 (Pulse) Width

(Pulse) Width sets the width of the Pulse output in seconds (0.5ms, 1ms, 20ms, 33ms, 50ms, and 100ms). **Note**: **Recommended minimum pulse width is 1 ms.** At the 0.5 ms pulse width setting, voltage swing across the solid state relay will be ~50% of power supply voltage.

8.3.2.3 LowCut

Lowcut sets the level below which the Pulse output will turn off.

Care must be taken to configure the multiplier and pulse width to allow the full range of the pulse output to be:

1. Measurable by the user's equipment. There may be a limitation on the minimum pulse width the user's equipment can detect.
2. Less than the maximum pulses per second allowed by the transmitter.

The maximum number of pulses per second that can be output is based on the selected **(Pulse) Width** (see table below):

Max Pulses = 500/Pulse Width

Pulse Width	Pulse Per Second Maximum
0.5 ms	1000
1.0 ms	500
20 ms	25
33 ms	15.15
50 ms	10
100 ms	5

Table 1 Maximum Pulse Per Second Based On Pulse Width

The **Info>Configuration>Pulse Output** selection on the transmitter menu displays the currently configured max/min pulse range, and will indicate an over range condition if one exists (i.e. settings exceed maximum pulses per second capability).

Warning: Settings Produce > Max PPS!

8.3.2.4 Output Sel

Output Sel is used to select the measurement to be output. Selections are as follows:

- **Flow Rate, Flow Rate %,** and **True Liquid Flow** generate a different pulse output than Totalizer (Total Flow). These will output a pulse frequency based on the current measurement.

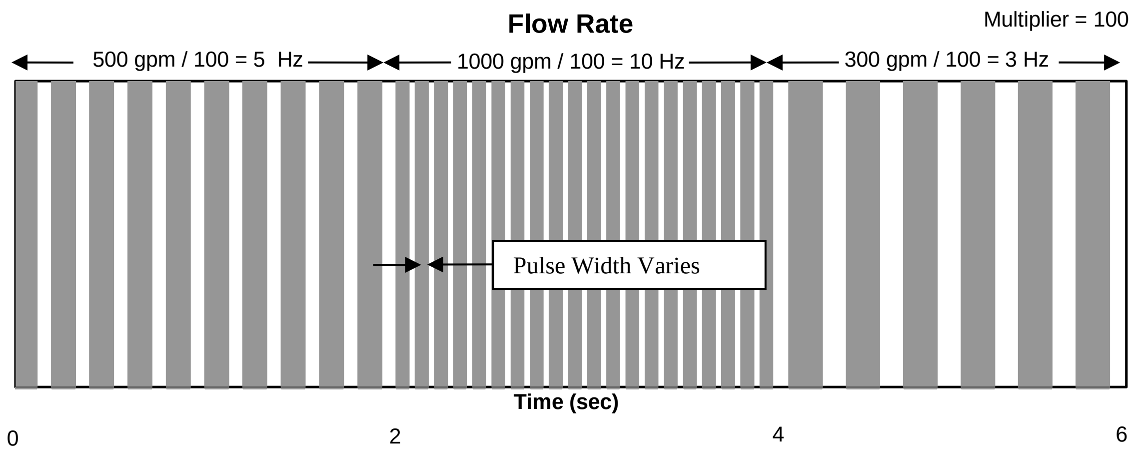

Figure 5 Flow Rate, Flow Rate %, and True Liquid Flow Pulse Output

Totalizer (or Total Flow) will output a number of pulses based upon the total gallons (or flow units) counted during the previous update interval (i.e. the display update time is defaulted to 2 seconds). In effect, the Total Flow measurement is a pulse counter, updated at the same rate as the display.

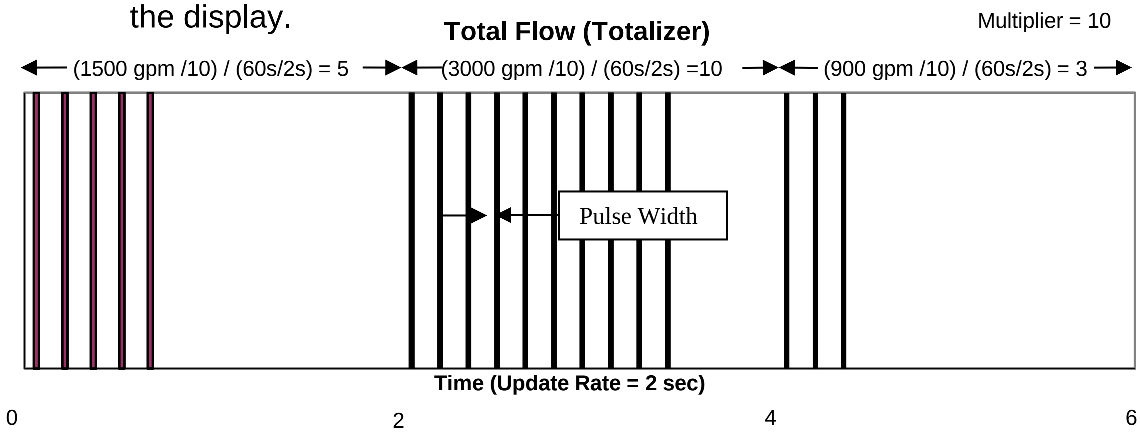

Figure 6 Total Flow Pulse Output

The following is an example of Pulse settings applied to Flow Rate:

Pulse Output: Flow Rate
(Default setting, based on 8” schedule 40 pipe)

Min Flow: 513.575 gal/m
Max Flow: 5135.751 gal/m

Pulse Output: Flow Rate
Multiplier: 100
Pulse Width: 1 ms
Low cutoff: 0% or 513.5 gal/m (no cutoff)

Min Pulses: 5.136 Pulses per second
Max Pulses: 51.357 Pulses per second

In the above example, the Pulse output frequency indicates the flow rate in gallons per minute, divided by 100. The output will therefore vary between 5.136 and 51.357 PPS (Hz), based on the Flow Rate reading.

The following is an example of Pulse settings applied to Total Flow:

Output: Total Flow
Flow Rate: 400 gal/min
Pulse Output: Totalizer
Multiplier: 10
Pulse Width: 1 ms
Low cutoff: 0% or 270.1 gal/m (no cutoff)

In the above example, Pulse output would be 400 gpm / 10 = 40 pulses per minute.

The following is an example of Pulse settings applied to Gas Volume Fraction:

Pulse Output: GVF
Multiplier: 1
Pulse Width: 1ms
Low cutoff: 0.000%

Min Pulses: 0 Pulses per second
Max Pulses: 100 Pulses per second

In the above example, the Pulse output frequency will vary between 0 and 100PPS (Hz), corresponding to 0 to 100% GVF.

8.3.3 Alarm Control

The Alarm Control menu is used to activate the ‘**Warning**’ and ‘**Critical**’ alarm functions. Once turned ‘**On**’ it is used to select the parameters that will activate the alarm.

8.3.3.1 Warning

Warning indicates an alarm condition has entered a range of condition(s) where the integrity of readings may be suspect. This is indicated by the transmitter red LED and alarm output relay blinking on and off.

8.3.3.2 Critical

Critical indicates an alarm condition in which the output of the system can no longer be considered valid. This is indicated by the red alarm LED on the transmitter being constantly on and constant relay closure output to the DCS.

The measurement result should be discarded and closed loop controls switched to manual during a critical alarm.

The alarm can be cancelled either manually or will clear automatically when the alarm condition is no longer present depending on the menu option selected (see below).

8.3.3.3 Manual Clear

The Manual Clear function under ‘**Alarm Control**’ has options of ‘**Disable**’ and ‘**Enable**’. In the ‘**Disable**’ mode the alarm will automatically clear when the alarm condition no longer exists. In the ‘**Enable**’ mode, the alarm must be reset manually by opening the front door of the transmitter and pressing the ‘**Exit**’ button.

8.3.4 Alarm Warn Threshold and Alarm Crit Threshold

These menu selections are used to set the flow rate and gas volume fraction alarm set points. All other parameters must be set using the Configure menu options in the passive sonar system software utilities or by a configuration file change using the USB Port.

The following table lists the alarm parameters with their default values.

Alarm Parameter	Condition	User Entry	Warning Default Value	Critical Default Value
Band Temperature	TMP>	Y	> 80 °C	> 90 °C
	TMP<	Y	< 0 °C	< 0 °C
RMS Sound Pressure Level	SPL>	Y	> 200 dB	> 200 dB
	SPL<	Y	< 50 dB	< 80 dB
Volumetric Flow Quality	VFQ<	Y	< 0.3	< 0.2
Speed Of Sound Quality	SSQ<	Y	< 0.03	< 0.01
Event log updated	LOG	N		
Sensor overload	OVL	N		
Volumetric Flow or True Liquid Flow	FLW>	Y	> 30 ft/s	> 30 ft/s
	FLW<	Y	< 3.2 ft/s	< 3 ft/s
Gas Volume Fraction	GVF>	Y	> 100 %	> 100%
	GVF<	Y	< 0%	< 0%
Sensor Failure	FAIL	N		

Table 2 Alarm Triggers

Note: The alarm trigger for Flow (VF or TLF) and Gas Volume Fraction (GVF) can be set from the transmitter menu. All other values must be set using passive sonar system software utility or by configuration file change through the USB Port.

Up to three alarm triggers can be selected. For example, an alarm output may be programmed like this:

Warning = TMP I LOG I VF
(Warning = Band Temperature or Event Log Updated or VF)

Critical = FAIL I OVL & LOG
(Critical = Sensor Fail or Sensor Overload and Event Log Updated

8.3.5 VF & GVF Damping (Filter)

The Damping (Filter) is used to reduce the noise of a signal through the use of a first order lag filter with a fixed time constant. The time constant of the filter is set by the user.

8.3.5.1 State

State is used to '**Enable**' or '**Disable**' this option.

8.3.5.2 Time Constant

Time Constant is used input range of values that can be applied. Ranges of 0 – 600 seconds can be input with 3 seconds as the factory default.

Care must be taken when choosing the time constant for the damping filter as the response time for the reported measurement will increase as the magnitude of the time constant is increased.

If the time response of the reported measurement is critical then the '**VF & GVF Noise Filter**' should be used instead of the damping filter.

8.3.6 VF & GVF Noise Filter

The VF & GVF Noise Filter has been designed to provide both steady state noise attenuation and quick transient response. Under steady state conditions the filter will use a long time constant in order to attenuate noise on the signal. Once the measurement begins to ramp up or down, the filter will reduce the filter time constant to allow the meter output to track the changes with a faster response time.

8.3.6.1 State

State is used to '**Enable**' or '**Disable**' this option. Factory default is 'Disable'.

8.3.6.2 Magnitude

The Magnitude choices are '**Low**' or '**High**'. The high setting differs from the low setting with more damping in both the transient and steady state condition.

8.3.7 VF & GVF Spike Filter

The VF & GVF Spike Filter is used when the transmitter is in a "No Flow" condition displaying dashes and when outputting flow (GVF) data.

The VF & GVF Spike Filter menu can be used in conjunction with the '**Flow (GVF) Spike Flt Adv**' filter menu where additional items are selectable.

8.3.7.1 State

State is used to '**Enable**' or '**Disable**' this option. Factory default is 'Disable'.

8.3.7.2 No Flow (GVF) Length

No Flow (GVF) Length is used when the device is in a "No Flow" ("No GVF") condition displaying dashes. It defines the required number of consecutive measurements with good quality before a measurement is deemed valid and displayed. This will eliminate spurious spikes that sometime occur during process non-flowing condition due to noise.

8.3.7.3 Length

Length defines the number of bad quality readings that are allowable before the transmitter goes into a "No Flow" ("No GVF") output state and displays dashes on the transmitter display (-------). Prior to going into this state the output will "Hold" the last valid value.

Note: This can be used with the '**Flow (GVF) Spike Flt Adv**' settings as discussed below. For example, if the measurements with bad quality are not consecutive then more than 'Filter Length' measurements with bad quality are required to force the 'No Flow' ('No GVF') condition. The actual number depends upon the values for the 'Up Count' and the 'Down Count' and the number of measurements with bad quality compared to the number of measurements with good quality. For more information see the definitions of 'Up Count' and 'Down Count'.

8.3.8 Flow (GVF) Spike Flt Adv

Flow (GVF) Spike Flt Adv menu provides additional spike filter menu selections.

8.3.8.1 Up Count

Up Count is used in conjunction with the '**Down Count**' parameter and is used when the device is 'Holding' a previous measurement due to a new measurement with bad quality. Each time a measurement with bad quality is made, 'Up Count' is added to an entity called the quality counter and each time a measurement with good quality is made 'Down Count' is subtracted from the quality counter. If the quality counter becomes less than or equal to zero then the current measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.

8.3.8.2 Down Count

This parameter is used in conjunction with the '**Up Count**' parameter and is used when the device is 'Holding' a previous measurement due to a new measurement with bad quality. Each time a measurement with bad quality is made 'Up Count' is added to an entity called the quality counter and each time a measurement with good quality is made 'Down Count' is subtracted from the quality counter. If the quality counter becomes less than or equal to zero then the present measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.

8.3.8.3 Percent (VF only)

This parameter is used in conjunction with the 'Percent Len' parameter. After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times ('Percent' / 100).

The allowable Reading-to-Reading Variation (RRV) is the device Maximum Measurable Value (MaxMV) in ft/sec minus the device Minimum Measurable Value (MinMV) in ft/sec times the '**Percent**' ('**Delta**' for GVF) input by the user to be used for the filter; or:

RRV = [(MaxMV – MinMV) * Percent]

For example, in a device with a velocity MaxMV of 30 fps and velocity MinMV of 3 fps and a 'Percent' of 10%, reading variations greater than 2.7 fps will be rejected.

RRV = [(30 – 3) * 0.10] = 2.7 fps

Therefore, measured points that have measurement variations greater than 2.7 fps will not be displayed or outputted until the number of consecutive readings that do not vary by more than RV is greater than that set by '**Filter Len**'.

8.3.8.4 Delta (GVF only)

This parameter is used in conjunction with the 'Percent Len' parameter. After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 100 % for GVF) times (‘Percent’ / 100).

The allowable Reading-to-Reading Variation (RRV) is the device Maximum Measurable Value (MaxMV) in % GVF minus the device Minimum Measurable Value (MinMV) in % GVF times the ‘**Delta**’ input by the user to be used for the filter; or:

RRV = [(MaxMV – MinMV) * Delta]

For example, in a device with a GVF MaxMV of 100% GVF and GVF MinMV of 0% and a ‘Percent’ of 5%, reading variations greater than 5% will be rejected.

RRV = [(100 – 0) * 0.05] = 5%

Therefore, measured points that have measurement variations greater than 5% will not be displayed or outputted until the number of consecutive readings that do not vary by more than RV is greater than that set by ‘**Filter Len**’.

8.3.8.5 Percent Len

The Percent Len (Filter Percentage Window Length) is used in conjunction with the ‘Percent’ or ‘Delta’ parameter. After ‘Percent Len’ measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and (‘Percent Len’ - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times (‘Percent’ / 100).

8.3.8.6 Example VF Spike Filter

The following is an example of application of the Spike Filter

8.3.8.6.1 Settings:

No Flow Length = 5
Filter Length = 3
Up Count = 3
Down Count = 2
Percent = 20%
Percent Length = 3
Flow Max = 30 ft/s
Flow Min = 3 ft/s
Measurement Range = (Flow Max – Flow Min) = 27 ft/s

8.3.8.6.2 No Flow Condition

When the device first powers up it starts in what is called a No Flow Condition. While in a No Flow Condition the device displays dashes. This condition is maintained until **No Flow Length** consecutive good quality measurements have been made. In this example, the device will display dashes until the 5th measurement of 5 consecutive good quality measurements is made. At this time the 5th measurement is displayed and the device enters Normal Mode.

8.3.8.6.3 Normal Mode

While in Normal Mode the device displays each new measurement unless one (in order of priority) of the following conditions occurs at which time it will hold the previously displayed measurement:

1. The new measurement has a bad quality
2. The difference between the maximum and the minimum of the new measurement and the previous **Percent Length-**1 measurements is greater than **Percent**/100 * **Measurement Range**

Condition 1) puts the device into Filter Mode 1 which as stated below forces the display to hold the previously displayed measurement. Condition 2) puts the device into Filter Mode 2 which also forces the display to hold the previously displayed measurement.

Note: Filter Mode 1 and Filter Mode 2 can be bypassed by setting **Filter Length** = 0 This setting forces the device to operate in either the No Flow Condition or in Normal Mode, and while in Normal Mode any bad quality measurement will force the device back into the No Flow Condition.

8.3.8.6.4 Filter Mode 1

While in Filter Mode 1 the device keeps track of the number of good quality measurements and bad quality measurements in a counter called the quality counter. Every time a bad quality measurement is made **Up Count** is added to the quality counter and every time a good quality measurement is made **Down Count** is subtracted from the quality counter. This process enables the user to choose the ratio of good to bad quality measurements required before the device stops holding a previous measurement and starts displaying new measurements in Normal Mode. The **Filter Length** parameter also provides the user with a give-up point where the device exits Filter Mode 1 and re-enters the No Flow Condition. In this example the user requires a ratio of 3:2 (**Up Count** to **Down Count**) or 1.5 good quality measurements for each bad quality measurement before the device re-enters Normal Mode. Also, the device will give up holding and start displaying dashes by re-entering the No Flow Condition if 3 (**Filter Length**) consecutive bad quality measurements are made or the above mentioned quality counter exceeds 9 (**Filter Length** * **Up Count**) or the display has held the same value for 7 (**Filter Length** * (1 + **Up Count**/**Down Count**)) measurements.

8.3.8.6.5 Filter Mode 2

While in Filter Mode 2 the device stores the present and the previous **Percent Length** -1 good quality measurements and finds the minimum and maximum of these points. The device exits Filter Mode 2 and re-enters Normal Mode if the difference between the minimum and maximum of these points is less then [(**Percent**/100) x **Measurement Range**]. Otherwise the device continues to hold. Filter Mode 2 exits to Filter Mode 1 if any new measurement has a bad quality. Filter Mode 2 also has a give up point where instead of re-entering the No Flow Condition the device will re-enter Normal Mode. This point is reached if the device has been holding the same measurement for **Percent Length***2 new measurements. In this example, Filter Mode 2 exits and re-enters Normal Mode if the difference between the maximum and the minimum of the present measurement and the previous 2 (**Percent Length**-1) measurements is less than 5.4 ft/s (20%/100 * 27ft/s: (**Percent**/100***Measurement Range**)). Also in this example, the same transition occurs if the device has been holding the same measurement for 6 (**Percent Length***2) measurements. In each case the measurement at the transition point will be displayed.

8.3.9 Undetermined Value

The Undetermined Value option allows for the option of the transmitter to output “0” (zero) on all outputs when the quality of the measurement is below the minimum quality value selected or the flow rate falls below the minimum set point or above the maximum set point (unless setting “OVERRANGE RAIL” is set to “Enable”).

Note: The “as shipped” from factory Default will be “Bad Reading”.

- “Bad Reading” (Default) – Set MODBUS registers to NaN (Fieldbus uses this as a flag to set status of outputs to “Uncertain or Bad”), display dashes, set 4-20mA outputs to out of range setting.
- “Zero” –Sets the MODBUS registers to 0 (Fieldbus will then output a 0 and indicate a “Good” status), display 0, and 4-20 mA outputs to 0 value, if applicable.

When the “Zero” option is selected, the outputs will be as follows:

- MODBUS (Foundation Fieldbus and Profibus): Change register values to 0, not NaN
- Display: Display a 0 instead of dashes
- 4-20: Output the mA value for 0 (not 0mA).
- Data History: Change display values to 0, not NaN
- HART: No change to its code, but will report 0 for reported values

- Results Messages: No change – results as reported from algo as before (was never NaN)

The following MODBUS, Foundation Fieldbus, and Profibus input registers that are currently set to QNAN when the quality is below minimum will now read “0”:

Register Number / Name	**Register Number / Name**
1 / Flow Rate	21 / SOS Flow Rate
9 / GVF	25 / TLF
15 / SOS	

Table 3 Alarm Triggers

The following is an example of the transmitter display showing bad quality of both VF and SOS measurements in the new ‘Zero’ mode. Both VF and GVF measurements are showing ‘0.00’ and these values were approached using the damping filter; dropping gradually from their ‘good’ values all the way past the ‘flow cutoff’ value.

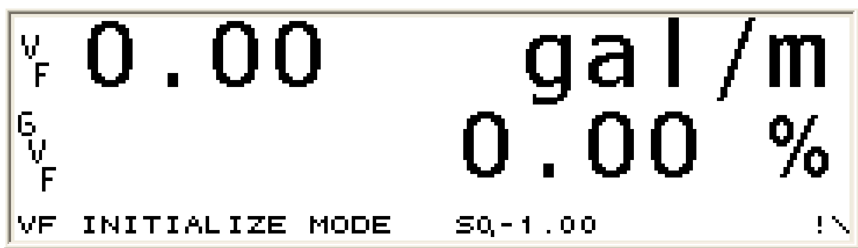

Figure 7 Flow Rate, Flow Rate %, and True Liquid Flow Pulse Output

It is important to note that when “Zero” is selected, the transmitter display will read 0 but there may still be flow (below SONARtrac ability to read) in the system.

8.4 Input Config Menu

The Input Config menu is used when optional external sensors (for example a pressure or temperature sensor) are powered by and input to the transmitter. The transmitter has the ability to display, store and transmit these values using serial communications, but not output them using the 4-20mA outputs. **Note:** When these sensor inputs are used the ’**Temperature Sel**’ and ‘**Pressure Sel**’ menu options under the ‘**Basic Config**’ menu must be used to designate which sensor input is used for a particular measurement.

These inputs are not normally used with VF and TAM systems.

8.4.1 Sensor 1 & 2

Sensor 1 & 2 are typically user supplied loop powered 4-20mA pressure or temperature transmitters which the passive sonar meter transmitter supplies with a nominal +24V. The pressure or temperature transmitter electrical connections must be isolated from ground ("floating").

8.4.1.1 Units

Units allows for setting the sensor units to ‘**None**’ (not used) ‘**F**’ (temperature degrees F), ‘**C**’ (temperature degrees C), ‘**Barg**’ (pressure in Bars gauge), ‘**kPag**’ (pressure in kilo Pascals gauge), ‘**PSIg**’ (pressure in pounds per square inch gauge).

8.4.1.2 Scale

Scale sets the range of input in units of measure (‘**Units**’) per mA. For example a pressure transducer has a range of 0-100 psi and an output of 4-20 mA. For this transducer the scale will be:

scale = range / (mA High output – mA Low output)
scale = 100 psi / 16mA
scale = 6.25 psi/mA

8.4.1.3 Offset

Offset allows for setting an offset in mA due to a non-zero milliamp sensor output range. The offset is calculated by the equation y=mx+b where: y is a value within the transducer range, m is the transducer scale, x is the milliamp output at the ‘y’ value, and b is the offset.

For example, a 0-100 psig pressure transducer with a 4-20 mA output will have a –25 psi offset.

y=mx+b
100 psi = (100psi / 16mA) x (20mA) +b
100 psi – 125 psi = b
-25 psi = b = ‘**Offset**’

8.5 Customize Menu

The Customize menu is used to configure the transmitter to meet user requirements for local display of measurement parameters.

8.5.1 Display

The display parameters are used to customize the displayed units and appearance of the display.

8.5.1.1 Line 1 and Line 2

Line 1 and Line 2 set the outputs of the display lines to '**Totalizer**', '**Flow Rate %**', '**Flow Rate**', '**True Liquid Flow**', '**GVF**', '**SOS**', and '**Blank**' (depending upon system configuration).

8.5.1.2 Contrast

Contrast is used to adjust the screen appearance due to lighting conditions. Normally this is set to 170.

8.5.2 Sensor Setup

8.5.2.1 State

State is used to turn individual sensors '**On**' or '**Off**'. Normal operating condition is with all sensors set to '**On**'. Sensors should only be turned off under the direction of Technical Support Personnel.

8.5.3 Flow Units (Systems with Flow)

8.5.3.1 Volume

The menu selectable units for '**Volume**' are '**gal**' (gallons), '**l**' (liters), '**m^3**' (cubic meters), '**user**' (user defined), '**iga**' (imperial gallons), '**ft^3**' (cubic feet), '**ft**' (feet), '**m**' (meter).

8.5.3.2 Time

The menu selectable units for '**Time**' are '**s**' (second), '**m**' (minute), '**h**' (hour), '**d**' (day), '**user**' (user defined).

In both the '**Volume**' and '**Time**' selections custom user labels can be input by the user by selecting '**user**' from the menu. The user defined labels are then input using the '**User Volume / Time**', '**Base**', and '**Scale Factors**'.

8.5.4 SOS Units (Systems with GVF)

The menu selectable SOS Units are '**ft**' (feet) and '**m**' (meter). The units of time measure are fixed to be in seconds. Hence, the output of SOS is in units of '**ft/s**' or '**m/s**'.

8.5.5 Flow Cutoff Range (Systems with Flow)

The flow cutoff range ‘**Low End**’ and ‘**High End**’ are used to set the low end and high end, respectively, of flow rates that will be displayed on the transmitter. Flow under or over the set points will be displayed as ‘**<Min Flow**’, ‘**>Max Flow**’, as appropriate.

8.5.6 Totalizer (Systems with Flow)

Selections under this menu are used to configure the totalizer functions.

8.5.6.1 Units

Units submenu is used to select the transmitter displayed units. Options are ‘**gal**’ (gallons), ‘**m**^{3}’ (cubic meters), ‘**VF Vol Units**’ (volumetric flow display units), ‘**l**’ (liters) ‘**ft**^{3}’ (cubic feet).

8.5.6.2 Lowcut Enable

Lowcut Enable turns the lowcut function on or off.

8.5.6.3 Lowcut

Lowcut sets the flow values that will no longer be used for totalization. Flow below this value will not be totalized.

8.5.6.4 Multiplier

Multiplier selects the multiplier applied to the displayed totalized units. Selections of ‘M’ (x 1,000,000), ‘k’ (x 1,000), ‘1’ (x 1) are available. **Note:** This selection does not affect the pulse output when ‘**Totalizer**’ is selected. Set the pulse output multiplier in the ‘**Pulse**’ setup menu.

8.5.6.5 Reset

Reset sets the totalizer display to zero.

8.5.6.6 Input (Systems with Flow and GVF)

Input is used to select ‘**volumetric flow**’ or ‘**true liquid flow**’ to totalize.

8.5.7 Wr Protect Mode

When this is ‘**Enabled**’ no other parameters can be changed. The user must ‘**Disable**’ this option before making any menu changes. Default is ‘**Disable**’.

8.6 Communications Menu

8.6.1 Ethernet

Ethernet option is used to view and set the IP address and Subnet Mask of the transmitter.

8.6.2 Front Panel Serial

Front Panel Serial is used for setting up the 'Baud Rate' of the serial port used to download or upload system data.

8.6.3 Internal Serial

Used for setting up the serial port configuration for use with MODBUS communications.

8.6.4 HART

Settings used for configuring the protocol when using HART. Default is for single device addressing.

8.6.5 MODBUS

Settings used for configuring the protocol when using MODBUS. Refer to the chapter titled *Use of Modbus® Protocol with Passive Sonar Transmitters* for additional information for transmitters equipped with MODBUS protocol.

8.6.6 Fieldbus

Settings used for configuring the protocol when using Fieldbus. Refer to the chapter titled *Use of Foundation Fieldbus and Profibus PA with Process Flow Monitoring Systems* for additional information for transmitters equipped with Fieldbus protocol.

8.6.7 Reset Comms

Reset Comms is used to re-initialize the communications ports without losing data history (as would happen by re-initializing the transmitter). This can be used to restart acquiring data if, for example, the Ethernet cable was removed from the Ethernet port while the StFSU program was still running or if there was no activity on the USB port.

8.7 Diagnostics Menu

8.7.1 Sensor Check

Selecting '**Diagnostics>Sensor Check**' on the transmitter menu will perform tests on all 'ON' sensors. (Individual sensors may be turned off in the 'Customize>Sensor Setup>State' menu. Sensors should never be turned off unless directed to do so by Technical Support Personnel.) The test will take several seconds to perform. After the test is completed, the screen will display results.

The following are examples of test results.

Test Results: PASS	
1:OK	2:OK
3:OK	4:OK
5:OK	6:OK
7:OK	8:OK

Figure 8 Test Passes Display Example

In the above figure the results indicate all sensors pass the test.

Test Results: FAIL: Continuity	
1:SWITCH WT/BK	2:SWITCH WT/BK
3:OK	4:OK
5:OK	6:OK
7:DISCONNECTED	8:OK

Figure 9 Test Failed

In previous figure the sensor band failed the test. Sensor 1 and 2 are either mis-wired between their terminals or reversed (wht to blk). Sensor 7 is disconnected (open circuit).

If an error is noted when the sensor test is first run, repeat the test to confirm the fault.

If the error occurs at first power up, verify wiring termination at the transmitter terminal block. If a 'disconnect' error is seen after a system has been in service, verify the sensor to transmitter cable is not damaged or that a wire in the transmitter has not loosened from its terminal block.

8.7.2 4–20 Test

4-20mA Test allows the user to send out discrete milliamp signals from 4-20mA Output #1 and #2 to the control system. The 4-20mA outputs are settable in one milliamp increments.

8.7.3 Gain

The sensor pre-amplifier is located within the sensor cover. The electronic ‘Gain’ (amplification) applied to the sensor outputs can be accessed through the transmitter ‘Diagnostics’ menu. Transmitter based gain control functions are provided through three sub-menus – ‘**AUTOSET GAIN**’, ‘**CHECK/SET GAIN**’, and ‘**TEST GAIN**’. Gain adjustments should be made to the system when the process is operating “normally”.

8.7.3.1 AUTOSET GAIN

Autoset Gain performs an automatic test and adjustment of the pre-amplifier gain setting. It automatically cycles through the pre-determined gain settings in order to find the optimal gain setting based on the flow conditions at that time. AUTOSET GAIN should be run while the process is operating at normal conditions to avoid making an incorrect gain setting.

8.7.3.2 Check/Set Gain

Check/Set Gain enables the user to check the current gain setting in the pre-amplifier and to manually set it to one of four settings: 1, 4.65, 21.55, and 98.65.

8.7.3.3 Test Gain

Test Gain performs a test of the system electronics to determine if the gain setting is optimal. Test results inform the user if the gain is correct or if there is too much or too little gain. TEST GAIN should be run while the process is operating at normal conditions to avoid getting an incorrect gain value.

8.7.4 Self Test

Self Test is a ‘PASS/FAIL’ test performed on the system RAM and DPRAM (internal memory).

8.7.5 Keyboard Test

Keyboard Test tests the function of each of the keyboard keys. The alarm LED will light for each key pressed to indicate that the key is functioning properly

8.7.6 Clear History

Clear History will delete transmitter stored Data History and re-start saving of transmitter data.

8.7.7 Monitor

Monitor displays a set of various '**System**' or '**Sensor**' parameters, updated at the display update rate. Used by Factory Technical Support personnel.

8.7.8 Pulse Test

Pulse Test is used to test the functionality of the pulse output. Set the Pulses Per Second and the Pulse Width and the output will update immediately. Refer to Section 8.3.2.3 Table 1 for the maximum pulse rate at a given pulse width.

8.7.9 Alarm Test

The Alarm Test allows the user to set the Alarm Output to a known state.

8.8 Info Menu

The '**Info**' menu allows the user to get detailed information on the flow monitoring system. The ↑ and ↓ keys scroll through the pages in the Info menu.

8.8.1 Revisions

Revisions provides a multi-page list of installed system revisions, hardware / software serial / model numbers and part numbers.

8.8.2 Diagnostics

Diagnostics provides a multi-page list of system, temperatures, voltages, and status messages.

8.8.3 Configuration

Configuration provides a multi page list (summary) of system setup parameters.

8.8.4 Event Log

Event Log displays a list of events, stored in non-volatile memory. Every event (up to 65,535 occurrences) is stored in the transmitter event log file. The latest 10 events are time stamped.

Pressing the up and down arrow keys will page up and down through all events. Pressing the '→' arrow will display a prompt to erase the 'Event Log'. Press '→' arrow again to erase. To cancel the erase function, press any key other than '**ENTER**'.

8.8.5 Sensor Max/Min

Sensor Max/Min lists the current sensor minimum and maximum measurements as well as the peak sensor values since the last peak history reset. The possible range of sensor values is 0 to +/- 32768. A '!' at the start of a line indicates that the sensor is currently overloaded. This may indicate the sensor is not working properly or that the pre-amplifier gain is too high and should be reduced. Pressing the 'ENTER' key will refresh the display. Pressing the '→' arrow key will display a prompt to erase the sensor peak history. Press '→' arrow again to erase.

1:	0/	1	Peaks:	-39/1507	
2:	-1/	1	Peaks:	-19/1120	
3:	-1/	1	Peaks:	-54/1358	
! 4:	-1/	32768	Peaks:	-60/32768	← Overload
5:	0/	1	Peaks:	-53/1121	
6:	-1/	2	Peaks:	-50/1667	
7:	0/	2	Peaks:	-35/1667	
8:	-1/	1	Peaks:	-53/1263	

Figure 10 Sensor Max/Min Display

8.9 Resetting Processor

If it is necessary to reset the processor (system hangs up) press the switch on the upper left edge of the terminal board. This is equivalent to cycling power.

8.10 Resetting to Factory Defaults

Note: It is recommended that factory defaults be reset only by factory qualified service personnel. All factors (Basic Config, Output Config, etc.) must be re-entered following a Reset to Factory Defaults.

To '**Reset to Factory Defaults**', **press** and **hold** the '**EXIT**' key while pressing the reset switch on the upper left edge of the terminal board.

Alternatively, switch transmitter **Power OFF** and **press** and **hold** the '**EXIT**' key while turning **Power On**. Hold the '**EXIT**' key until the screen prompt is shown. If you decide you do not want to reset factory defaults, either cycle power or press any key other than '**ENTER**'.

9 TRANSMITTER STARTUP & OPERATION

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9.1 Initial Start-up

At initial power up the Green LED will light and the transmitter will display startup progress; load firmware into the system, load system parameters, and the heartbeat indicator will activate as the transmitter begins to collect data from the sensor head. Once startup is complete, the display will clear and begin displaying measurements. The following figure illustrates an initial system startup screen.

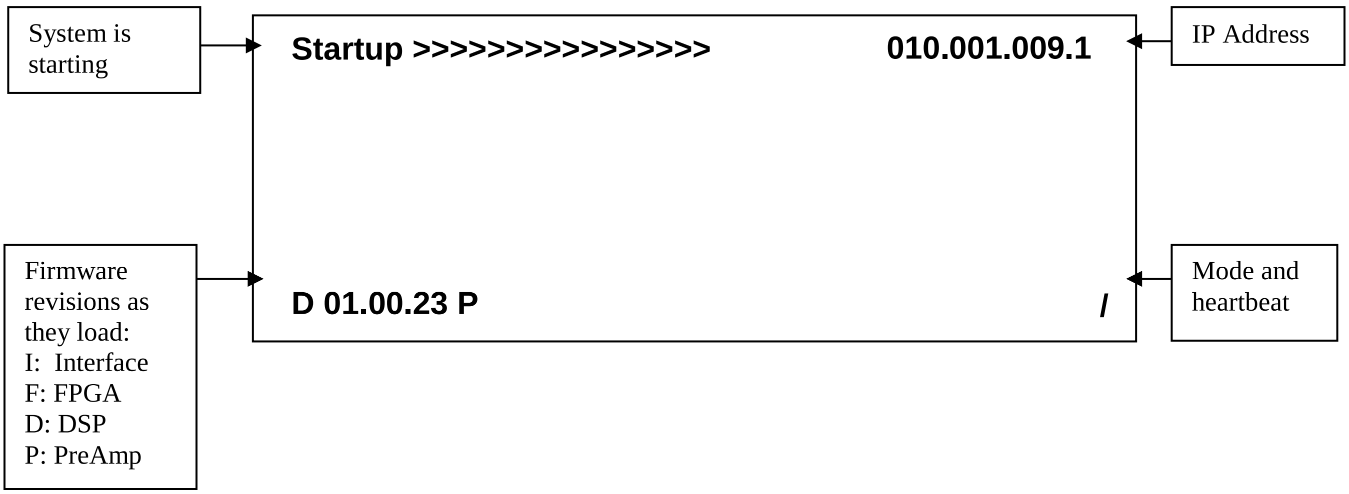

Figure 1 System Start Display

The display will clear and show the ‘Startup >>>>’ if internal configuration parameters are changed in the menu screens. This indicates that the system is restarting with the new parameters and is beginning to make measurements. Once the startup procedure is complete, the system measurements will be displayed.

WARNING

When explosive gases may be present, the transmitter door may be opened only to use the keypad or reset button. Obtain hot work permit and ensure explosive gasses are not present prior to performing any other operation.

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

9.2 Initial Diagnostic Checks

9.2.1 Process On-Line

The passive sonar meter can be installed and configured with the process in operation. Ideally, configuration is made with the process operating at normal flow rates and operating conditions.

If the process is on-line (flowing) the following system checks should be made.

9.2.2 Sensor Test

A Sensor Test all 'ON' sensors. Individual sensors may be turned off in the 'Customize>Sensor Setup>State' menu. Sensors should never be turned off unless directed to do so by Technical Support Personnel. The test will take several seconds to perform. After the test is completed, the screen will display test results.

If the initial test displays results that indicate sensor(s) failed, repeat the test. If the error message persists, contact Customer Support.

A Sensor Test is made as follows:

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- The '**Basic Config**' menu is displayed on Line 1 of the display.
- Press the ↓ key to scroll to the '**Diagnostics**' menu on Line 1. Press the '**ENTER**' key to access the options available under that menu.
- '**Sensor Check**' will appear on Line 2 of the display.
- Press the '**ENTER**' key to start the sensor test. Each of the sensors will be tested. If any sensor does not PASS, repeat the test. Individual sensor faults will be displayed on the display and along with the recommended corrective action.
- Perform any recommended corrective measures and perform a Sensor Test. Repeat as necessary.
- Press the '**EXIT**' key to return to 'Operational Mode'.

9.2.3 Gain

An electronic '**Gain**' (amplification) is applied to the sensor outputs. Transmitter based gain control functions are provided through three sub-menus – '**AUTOSET GAIN**', '**CHECK/SET GAIN**', and '**TEST GAIN**'. Gain adjustments should be made to the system when the process is operating "normally".

The sensor head pre-amplifier gain sub-menus is accessed as follows:

9.2.3.1 Autoset Gain

‘**Autoset Gain**’ performs an automatic test and adjustment of the pre-amplifier gain setting. It automatically cycles through pre-determined gain settings in order to find the optimal gain setting based on the flow conditions at that time.

Autoset Gain is accessed as follows:

- Press any key except ‘**EXIT**’ on the keypad to enter the ‘Menu Mode’.
- The ‘**Basic Config**’ menu is displayed on Line 1 of the display.
- Press the ↓ key to scroll to the ‘**Diagnostics**’ menu on Line 1. Press the ‘**ENTER**’ key to access the options available under that menu.
- ‘**Sensor Check**’ will appear on Line 2 of the display.
- Press the ↓ key to scroll to ‘**Gain**’ on Line 2 of the display.
- Press the ‘**ENTER**’ key to access the options available under that menu.
- ‘**Autoset Gain**’ will appear on Line 3 of the display.
- Press the ‘**ENTER**’ key and ‘**Autoset Gain**’ will start. The gain will automatically be set to its optimal setting.

  If the message reads “Insufficient Gain Detected…” or “Excessive Gain Detected…” rerun the test. If that message is repeated, contact Technical Support.

- Press the ‘**EXIT**’ key to return to ‘Operational Mode’.

9.2.3.2 Check / Set Gain

Check / Set Gain allows the user to check the current gain setting in the pre-amplifier and to manually set it to one of four settings 1, 4.65, 21.55, and 98.65.

- Press any key except ‘**EXIT**’ on the keypad to enter the ‘Menu Mode’.
- The ‘**Basic Config**’ menu is displayed on Line 1 of the display.
- Press the ↓ key to scroll to the ‘**Diagnostics**’ menu on Line 1. Press the ‘**ENTER**’ key to access the options available under that menu.
- ‘**Sensor Check**’ will appear on Line 2 of the display.
- Press the ↓ key to scroll to ‘**Gain**’ on Line 2 of the display.
- Press the ‘**ENTER**’ key to access the options available under that menu.
- ‘**Autoset Gain**’ will appear on Line 3 of the display.
- Press the ↓ key to scroll to ‘**Check/Set Gain**’ on Line 3 of the display.

- Press the '**ENTER**' key and '**Gain=XXXX   Set=YYYY**' will appear on Line 4 of the display.
- Press the '**ENTER**' key and the '**Set**' value will be highlighted.
- Press the ↓ key to scroll to a new '**Set**' value.
- Press the '**ENTER**' key and the '**Set**' value will be entered in the pre-amplifier.
- Press the '**EXIT**' key to return to 'Operational Mode'.

9.2.3.3 Test Gain

'**Test Gain**' performs a test of the system electronics to determine if the gain setting is optimal. Test results inform the user if the gain is correct, or, if there is too much or too little gain; however, it does not reset the gain. Resetting gain must be done using the '**Autoset Gain**' or '**Check / Set Gain**' commands. '**Test Gain**' should be run while the process is operating at normal conditions to avoid getting an incorrect gain value.

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- The '**Basic Config**' menu is displayed on Line 1 of the display.
- Press the ↓ key to scroll to the '**Diagnostics**' menu on Line 1. Press the '**ENTER**' key to access the options available under that menu.
- '**Sensor Check**' will appear on Line 2 of the display.
- Press the ↓ key to scroll to '**Gain**' on Line 2 of the display.
- Press the '**ENTER**' key to access the options available under that menu.
- '**Autoset Gain**' will appear on Line 3 of the display.
- Press the ↓ key to scroll to '**Test Gain**' on Line 3 of the display.
- Press the '**ENTER**' key and '**Test Gain**' will start. Results will be shown on the display. Take appropriate action.
- Press the '**EXIT**' key to return to 'Operational Mode'.

9.2.4 Sensor Max / Min

A sensor Max / Min Test is performed as follows:

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- The '**Basic Config**' menu is displayed on Line 1 of the display.
- Press the ↓ key to scroll to the '**Info**' menu on Line 1. Press the '**ENTER**' key to access the options available under that menu.
- '**Revisions**' will appear on Line 2 of the display.

- Press the ↓ key to scroll to '**Sensor Max / Min**' on Line 2 of the display.
- Press the '**ENTER**' key and a series of values will be displayed.

  The current sensor minimum and maximum measurements as well as the peak sensor values since the last peak history reset will be displayed. A '!' at the start of a line indicates that the sensor is currently overloaded. This may indicate the sensor is not working properly or the pre-amplifier gain is too high and should be reduced. Pressing the '**ENTER**' key will refresh the display. Pressing the '→' arrow key will display a prompt to erase the sensor peak history. Press the '→' arrow again to erase the peak values.

  Sensors typically have peak values of -32768 and +32767. Values within the <u>range of about -/+2000 to -/+8000</u> are considered to be "ideal" when the process is operating at normal conditions. **Note**: In most cases the passive sonar system will operate properly outside of the "ideal" range of values.

  Sensor minimum and maximum values should be within about +/-30% of each other. If one or more sensors are outside of these values, contact Technical Support.

- Press the '**EXIT**' key to return to 'Operational Mode'.
- If the '**Sensor Max / Min**' values are outside of their "ideal" range adjust the gain per the procedures in Section 9.2.3.

9.3 Process Off-Line

Sometimes the passive sonar system is installed with the process off-line. In this case, it is not possible to verify the proper gain setting in the transmitter.

If the process is off-line (not flowing) the following system checks should be made.

9.3.1 Sensor Test

A Sensor Test all 'ON' sensors. (Individual sensors may be turned off in the 'Customize>Sensor Setup>State' menu. Sensors should never be turned off unless directed to do so by Technical Support Personnel.) The test will take several seconds to perform. After the test is completed, the screen will display test results.

A Sensor Test is made as follows:

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- The '**Basic Config**' menu is displayed on Line 1 of the display.

- Press the ↓ key to scroll to the ‘**Diagnostics**’ menu on Line 1. Press the ‘**ENTER**’ key to access the options available under that menu.
- ‘**Sensor Check**’ will appear on Line 2 of the display.
- Press the ‘**ENTER**’ key to start the sensor test. Each of the sensors will be tested. If any sensor does not PASS, repeat the test. Individual sensor faults will be displayed on the display and along with the recommended corrective action.
- Perform any recommended corrective measures and perform a Sensor Test. Repeat as necessary.
- Press the ‘**EXIT**’ key to return to ‘Operational Mode’.

9.4 Operating Menu Setup

9.4.1 Flow System Initial Setup

In order to conduct measurements, the '**Basic Config'** setup must be completed. If power goes off, this setup will remain in memory and does not have to be re-entered.

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- When '**Basic Config**' menu is displayed on Line 1 of the display press the '**ENTER**' key to enter the options available under that menu.
- **'Sensor Serial #**' will appear on Line 2 of the display. Press the '**ENTER**' key and the current sensor serial number entered in the transmitter will be displayed on Line 4 of the display. The user can then use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change position) to enter the sensor band serial number found on the sticker attached to the sensor band. Once all digits are entered, press the '**ENTER**' key to save to memory. '→**Sensor Serial #**' will again be displayed on Line 2.
- Next, press the ↓ key to scroll to the '**Pipe Size**' menu on Line 2. Press the '**ENTER**' key to access the options available under that menu. Note: it is necessary to select only one of the following options.
- The first choice on the '**Pipe Size**' menu is '→**ID / Wall**' shown on Line 3 of the display. If this value is known it can be entered here. Press the '**ENTER**' key and the current saved inner diameter and wall thickness will be shown on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe inner diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory.
- The second choice on the '**Pipe Size**' menu is '**Size/Sched**' (pipe Size / Schedule). If this value is known, press the '**ENTER**' key. Use the arrow keys to enter the values and then press the '**ENTER**' key to save to memory.
- The third choice on the '**Pipe Size**' menu is '**OD / Wall**' displayed on Line 3. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe outer diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory. **Note**: Once a pipe size has been entered, re-entering the 'Pipe **Size**' menu and selecting '**Size/Sched**' may cause errors in scaled output values.

- Following the entering of ‘Pipe Size’ press the ‘**BACK**’ key and ‘→**Pipe Size**’ will be displayed on Line 2. At this point the user can either press the ‘**ENTER**’ key to re-enter the ‘**Pipe Size**’ menu or press the ↓ key to move to the next menu item.
- Pressing the ↓ key will next display ‘→**Fluid Properties**’ on Line 2. Press the ‘**ENTER**’ key and ‘→**Specific Gravity**’ will appear on Line 3 and the current value on Line 4. To change the Line 4 value press ‘**ENTER**’ and use the arrow keys to enter the new value. Water at 25 ºC (0.997) is the default. Appendix E lists values for water at various temperatures. Once the new value has been entered on Line 4, press ‘**ENTER**’.
- If no change is made (or after a change in Specific Gravity has been made) pressing the ↓ key will next display ‘→**Viscosity (Pa s)**’ on Line 3 and the current value on Line 4. To change the Line 4 value press ‘**ENTER**’ and use the arrow keys to enter the new value. Pure water at 25 ºC (8.9008 e^{-04}) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press ‘**ENTER**’.
- Pressing the ↓ key will next display ‘→**Calibration**’ on Line 2. Press the ‘**ENTER**’ key and ‘→**C0**’ will appear on Line 3 and a numerical value on Line 4. Press the ‘**ENTER**’ key and use the **arrow keys** to enter the calibration factors that will accompany the sensor. Once the ‘C0’ value is entered press the ‘**ENTER**’ key to store that value to memory. Line 3 will show ‘→**C0**’; press the ↓ key to move to ‘→**C1**’, press ‘**ENTER**’, and use the **arrow keys** to enter ‘C1’ values. Once the values are entered, press ‘**ENTER**’ and press the ↓ key to move to ‘→**C2**’ and enter those values and press ‘**ENTER**’ and the ‘**BACK**’ key.
- The display will show ‘→**Calibration**’ on Line 2. Press the ↓ key to scroll to ‘→**Flow Direction**’ on Line 2. If it is necessary to change the flow direction (if the sensor was installed with the Flow Direction arrow on the band opposite the actual flow direction within the pipe or the process flow has changed direction) press the ‘**ENTER**’ key and toggle the ↑ or ↓ to change flow direction. Once changed press the ‘**ENTER**’ key.
- Press the ↓ key to scroll to ‘→**Set Date/Time**’ on Line 2. Press the ‘**ENTER**’ key and the current saved date and time will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the date and time. **Note:** Time is in 24 hour format. Once the date and time have been set press the ‘**ENTER**’ key.
- Press the ↓ key to scroll to ‘→**Set Date Format**’ on Line 2. Press the ‘**ENTER**’ key and the current date format will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓) to scroll to the

desired format. Press the ‘**ENTER**’ key to set the desired date format followed by the ‘**BACK**’ key.

- At this point ‘**Basic Config**’ is displayed on Line 1 of the display. The user can re-enter this menu if desired by pressing the ‘**ENTER**’ key or by pressing the ↑ or ↓ arrows to move to other Level 1 menus.
- Press the ‘**EXIT**’ key to return to ‘Operational Mode’.

Entry of inputs to the other Level 1 menus is by the same process as used in ‘Basic Config’.

9.4.2 GVF System Initial Setup

In order to conduct measurements, the '**Basic Config'** setup must be completed. If power goes off, this setup will remain in memory and does not have to be re-entered.

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- When '**Basic Config**' menu is displayed on Line 1 of the display press the '**ENTER**' key to enter the options available under that menu.
- '→**Sensor Serial #**' will appear on Line 2 of the display. Press the '**ENTER**' key and the current sensor serial number entered in the transmitter will be displayed on Line 4 of the display. The user can then use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change position) to enter the sensor band serial number found on the sticker attached to the sensor band. Once all digits are entered, press the '**ENTER**' key to save to memory. '→**Sensor Serial #**' will again be displayed on Line 2.
- Next, press the ↓ key to scroll to the '**Pipe Size**' menu on Line 2. Press the '**ENTER**' key to access the options available under that menu. Note: it is necessary to select only one of the following options.
- The first choice on the '**Pipe Size**' menu is '→**ID / Wall**' shown on Line 3 of the display. If this value is known it can be entered here. Press the '**ENTER**' key and the current saved inner diameter and wall thickness will be shown on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe inner diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory.
- The second choice on the '**Pipe Size**' menu is '**Size/Sched**' (pipe Size / Schedule). If this value is known, press the '**ENTER**' key. Use the arrow keys to enter the values and then press the '**ENTER**' key to save to memory.
- The third choice on the '**Pipe Size**' menu is '**OD / Wall**' displayed on Line 3. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe inner diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory.
- Following the entering of 'Pipe Size' press the '**BACK**' key and '→**Pipe Size**' will be displayed on Line 2. At this point the user can either press the '**ENTER**' key to re-enter the '**Pipe Size**' menu or press the ↓ key to move to the next menu item.

- Pressing the ↓ key will next display '→**Pipe Material**' on Line 2. Press the '**ENTER**' key and the pipe modulus for Steel, PVC, or Stainless Steel (SS) pipe or 'Custom' will be displayed. Use the ↑ and ↓ arrow keys to scroll through the list of values. Press '**ENTER**' to select the material that corresponds to the pipe material. Selecting Steel, PVC, or SS will automatically enter the modulus for the selected pipe material. Selecting 'Custom' allows the user to enter the modulus of other pipe materials using the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character). Press the '**ENTER**' key to set the new value.
- If no change is made (or after a change in Pipe Material has been made) pressing the ↓ key will next display '→**Fluid Properties**' on Line 2. Press the '**ENTER**' key and '→**Specific Gravity**' will appear on Line 3 and the current value on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Pure water at 25 ºC (0.997) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press '**ENTER**'.
- If no change is made (or after a change in Specific Gravity has been made) pressing the ↓ key will next display '→**SOS**' on Line 3 and the current value on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Pure water at 25 ºC (4910.4 ft/s) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press '**ENTER**'.
- Once the Fluid Properties have been entered press the '**BACK**' key and↓ key and '→**Pressure**' will be displayed on Line 2 and the current process pressure setting on Line 4. Note: The units are PSIg. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. This will result in a fixed pressure being used for GVF calculations. If a Pressure Transducer will be used to input process pressure into the transmitter, it is not necessary to enter a pressure.
- Pressing the ↓ key will next display '→**Temperature**' on Line 2 and the current process temperature setting on Line 4. Note: The units are user selectable as degrees C or F. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. This will result in a fixed temperature being used for GVF calculations. If a Temperature Transducer will be used to input process temperature into the transmitter, it is not necessary to enter a temperature.
- Pressing the ↓ key will next display '→**Pressure Sel**' on Line 2. If an external pressure sensor will not be used to input pressure to the transmitter, **'Fixed**' appears on line 4. If set to '**Fixed**' pressure input use the ↓ key to scroll to the next menu item. However, if an

external pressure sensor will be used to input pressure to the transmitter press ‘**ENTER**’ and use the ↓ key to select either ‘**Sensor #1**’ or ‘**Sensor #2**’. (‘Sensor #1’ or ‘Sensor #2’ refers to the sensor input the pressure transducer is wired to on the terminal block in the transmitter enclosure.) If the Modbus input is to be used to input pressure to the transmitter use the ↓ key to select ‘**Protocol**’. Once the selection is made, press ‘**ENTER**’.

- Pressing the ↓ key will next display ‘→**Temperature Sel**’ on Line 2. If an external temperature sensor will not be used to input temperature to the transmitter, **‘Fixed**’ appears on line 4. If using ‘**Fixed**’ temperature input, use the ↓ key to scroll to the next menu item. However, if an external temperature sensor will be used to input pressure to the transmitter press ‘**ENTER**’ and use the ↓ key to select either ‘**Sensor #1**’ or ‘**Sensor #2**’. (‘Sensor #1’ or ‘Sensor #2’ refers to the sensor input the temperature transducer is wired to on the terminal block within the transmitter box.) If the Modbus input is to be used to input temperature to the transmitter use the ↓ key to select ‘**Protocol**’. Once the selection is made, press ‘**ENTER**’.
- Pressing the ↓ key will next display ‘→**Altitude**’ on Line 2 and the selected value above (or below) sea level on Line 4. To change the Line 4 value press ‘**ENTER**’ and use the arrow keys to enter the new value. Note: if an external pressure transducer that reads pressure in ‘absolute’ value (e.g. PSIa, BARa, or KPaa) is used, an altitude correction is not necessary.
- Press the ↓ key to scroll to ‘→**Set Date/Time**’ on Line 2. Press the ‘**ENTER**’ key and the current saved date and time will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the date and time. **Note:** Time is in 24 hour format. Once the date and time have been set press the ‘**ENTER**’ key.
- Press the ↓ key to scroll to ‘→**Set Date Format**’ on Line 2. Press the ‘**ENTER**’ key and the current date format will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓) to scroll to the desired format. Press the ‘**ENTER**’ key to set the desired date format followed by the ‘**BACK**’ key.
- At this point ‘**Basic Config**’ is displayed on Line 1 of the display. The user can re-enter this menu if desired by pressing the ‘**ENTER**’ key or by pressing the ↑ or ↓ arrows to move to other Level 1 menus.
- Press the ‘**EXIT**’ key to return to ‘Operational Mode’.

Entry of inputs to the other Level 1 menus is by the same process as used in ‘Basic Config’.

9.4.3 Flow/GVF Initial Setup

In order to conduct measurements, the '**Basic Config'** setup must be completed. If power goes off, this setup will remain in memory and does not have to be re-entered.

- Press any key except '**EXIT**' on the keypad to enter the 'Menu Mode'.
- When '**Basic Config**' menu is displayed on Line 1 of the display press the '**ENTER**' key to enter the options available under that menu.
- '→**Sensor Serial #**' will appear on Line 2 of the display. Press the '**ENTER**' key and the current sensor band serial number entered in the transmitter will be displayed on Line 4 of the display. The user can then use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change position) to enter the sensor serial number. Once all digits are entered, press the '**ENTER**' key to save to memory. '→**Sensor Serial #**' will again be displayed on Line 2.
- Next, press the ↓ key to scroll to the '**Pipe Size**' menu on Line 2. Press the '**ENTER**' key to access the options available under that menu. Note: it is necessary to select only one of the following options.
- The first choice on the '**Pipe Size**' menu is '→**ID / Wall**' shown on Line 3 of the display. If this value is known it can be entered here. Press the '**ENTER**' key and the current saved inner diameter and wall thickness will be shown on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe inner diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory.
- The second choice on the '**Pipe Size**' menu is '**Size/Sched**' (pipe Size / Schedule). If this value is known press the '**ENTER**' key. Use the arrow keys to enter the values and then press the '**ENTER**' key to save to memory.
- The third choice on the '**Pipe Size**' menu is '**OD / Wall**' displayed on Line 3. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the pipe inner diameter. Units can be inches or millimeters. Once all digits are entered, press the '**ENTER**' key to save the value to memory.
- Following the entering of 'Pipe Size' press the '**BACK**' key and '→**Pipe Size**' will be displayed on Line 2. At this point the user can either press the '**ENTER**' key to re-enter the '**Pipe Size**' menu or press the ↓ key to move to the next menu item.

- Pressing the ↓ key will next display '→**Pipe Material**' on Line 2. Press the '**ENTER**' key and the pipe modulus for Steel, PVC, or Stainless Steel (SS) pipe or 'Custom' will be displayed. Use the ↑ and ↓ arrow keys to scroll through the list of values. Press '**ENTER**' to select the material that corresponds to the pipe material. Selecting Steel, PVC, or SS will automatically enter the modulus for the selected pipe material. Selecting 'Custom' allows the user to enter the modulus of other pipe materials using the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character). Press the '**ENTER**' key to set the new value.
- If no change is made (or after a change in Pipe Material has been made) pressing the ↓ key will next display '→**Fluid Properties**' on Line 2. Press the '**ENTER**' key and '→**Specific Gravity**' will appear on Line 3 and the current value on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Pure water at 25 ºC (0.997) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press '**ENTER**'.
- If no change is made (or after a change in Specific Gravity has been made) pressing the ↓ key will next display '→**SOS**' on Line 3 and the current value on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Pure water at 25 ºC (4910.4 ft/s) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press '**ENTER**'.
- If no change is made (or after a change in Specific Gravity has been made) pressing the ↓ key will next display '→**Viscosity (Pa s)**' on Line 3 and the current value on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Pure water at 25 ºC (8.9008 e^{-04}) is the default. Appendix F lists values for water at various temperatures. Once the new value has been entered on Line 4, press '**ENTER**'.
- Once the Fluid Properties have been entered press the '**BACK**' key and↓ key and '→**Pressure**' will be displayed on Line 2 and the current process pressure setting on Line 4. Note: The units are PSIg. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. This will result in a fixed pressure being used for GVF calculations. If a Pressure Transducer will be used to input process pressure into the transmitter, it is not necessary to enter a pressure.
- Pressing the ↓ key will next display '→**Temperature**' on Line 2 and the current process temperature setting on Line 4. Note: The units are user selectable as degrees C or F. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. This will result in a fixed temperature being used for GVF

calculations. If a Temperature Transducer will be used to input process temperature into the transmitter, it is not necessary to enter a temperature.

- Pressing the ↓ key will next display '→**Pressure Sel**' on Line 2. If an external pressure sensor will not be used to input pressure to the transmitter, **'Fixed**' appears on line 4. If set to '**Fixed**' pressure input, use the ↓ key to scroll to the next menu item. However, if an external pressure sensor will be used to input pressure to the transmitter press '**ENTER**' and use the ↓ key to select either '**Sensor #1**' or '**Sensor #2**'. ('Sensor #1' or 'Sensor #2' refers to the sensor input the temperature transducer is wired to on the terminal block in the transmitter enclosure.) If the Modbus input is to be used to input pressure to the transmitter use the ↓ key to select '**Protocol**'. Once the selection is made, press '**ENTER**'.
- Pressing the ↓ key will next display '→**Temperature Sel**' on Line 2. If an external temperature sensor will not be used to input temperature to the transmitter, **'Fixed**' appears on line 4. If using '**Fixed**' temperature input, use the ↓ key to scroll to the next menu item. However, if an external temperature sensor will be used to input temperature to the transmitter press '**ENTER**' and use the ↓ key to select either '**Sensor #1**' or '**Sensor #2**'. ('Sensor #1' or 'Sensor #2' refers to the sensor input the temperature transducer is wired to on the terminal block within the transmitter box.) If the Modbus input is to be used to input temperature to the transmitter use the ↓ key to select '**Protocol**'. Once the selection is made, press '**ENTER**'.
- Pressing the ↓ key will next display '→**Altitude**' on Line 2 and the selected value above (or below) sea level on Line 4. To change the Line 4 value press '**ENTER**' and use the arrow keys to enter the new value. Note: if an external pressure transducer that reads pressure in 'absolute' value (e.g. PSIa, BARa, or KPaa) is used, an altitude correction is not necessary.
- Pressing the ↓ key will next display '→**Calibration**' on Line 2. Press the '**ENTER**' key and '→**C0**' will appear on Line 3 and a numerical value on Line 4. Press the '**ENTER**' key and use the **arrow keys** to enter the calibration factors that will accompany the sensor. Once the 'C0' value is entered press the '**ENTER**' key to store that value to memory. Line 3 will show '→**C0**'; press the ↓ key to move to '→**C1**', press '**ENTER**', and use the **arrow keys** to enter 'C1' values. Once the values are entered, press '**ENTER**' and press the ↓ key to move to '→**C2**' and enter those values and press '**ENTER**' and the '**BACK**' key.
- The display will show '→**Calibration**' on Line 2. Press the ↓ key to scroll to **'→Flow Direction**' on Line 2. If it is necessary to change the flow direction (if the sensor was installed with the Flow

Direction arrow on the band opposite the actual flow direction within the pipe or the process flow has changed direction) press the '**ENTER**' key and toggle the ↑ or ↓ to change flow direction. Once changed press the '**ENTER**' key.

- The display will show '→**Flow Direction**' on Line 2. Press the ↓ key to scroll to '**OP Mode**'. If '**Flow/GVF/SOS**' is not displayed, press the '**ENTER**' key and then scroll using the ↓ key to select '**Flow/GVF/SOS**'. Then press the '**ENTER**' key.
- Press the ↓ key to scroll to '→**Set Date/Time**' on Line 2. Press the '**ENTER**' key and the current saved date and time will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓ to scroll through the values and ← and → to change character) to enter the date and time. **Note:** Time is in 24 hour format. Once the date and time have been set press the '**ENTER**' key.
- Press the ↓ key to scroll to '→**Set Date Format**' on Line 2. Press the '**ENTER**' key and the current date format will be displayed on Line 4 of the display. Use the arrow keys (↑ and ↓) to scroll to the desired format. Press the '**ENTER**' key to set the desired date format followed by the '**BACK**' key.

At this point '**Basic Config**' is displayed on Line 1 of the display. The user can re-enter this menu if desired by pressing the '**ENTER**' key or by pressing the ↑ or ↓ arrows to move to other Level 1 menus.

- Press the '**EXIT**' key to return to 'Operational Mode'.

Entry of inputs to the other Level 1 menus is by the same process as used in 'Basic Config'.

9.4.4 Transmitter Setup Template

The following table provides a template for recording the transmitter setup for future reference. Additionally, a Data Snapshot (refer to Section 10) should be taken and kept on file. The Data Snapshot should be obtained with the passive sonar meter system configured and the process operating at normal conditions.

Table 1 Transmitter Setup Template

Transmitter Serial Number: _______________				**Software Revision: ___________**		
Basic Config		**As Left**		**Output Config (continued)**		**As Left**
Sensor S/N				Pulse	Multiplier	
Pipe Size	ID / Wall				Width (ms)	
	Size/Sched				Lowcut	
	OD / Wall				Output Sel	
Pipe Material				Alarm Control	Warning	
Fluid Properties	Specific Gravity				Critical	
	SOS				Manual Clear	
	Viscosity (Pa s)			Alarm Warn Thresh	FLW Min / Max	
Pressure					GVF Min / Max	
Temperature				Alarm Crit Thresh	FLW Min / Max	
Pressure Sel					GVF Min / Max	
Temperature Sel				Flow Damping	State	
Altitude					Time Constant	
Calibration	C0			Flow Noise Filt	State	
	C1				Time Constant	
	C2			Flow Spike Filt	State	
Flow Direction					Length	
Op Mode					Percent	
Date / Time					Percent Len	
Date Format					No Flow Len	
Output Config		**As Left**			Up Count	
4-20mA Ch1	Output Sel				Down Count	
	Power Sel			GVF Damping	State	
	Low End				Time Constant	
	High End			GVF Noise Filt	State	
	Out of Range				Time Constant	
	Overrange Rail			GVF Spike Filt	State	
4-20mA Ch2	Output Sel				Length	
	Power Sel				Percent	
	Low End				No Flow Len	
	High End				Up Count	
	Out of Range				Down Count	
	Overrange Rail					

Table 1 (page 2) Transmitter Setup Template

Input Config		**As Left**
Sensor #1	Units	
	Scale	
	Offset	
Sensor #2	Units	
	Scale	
	Offset	
Undetermined Value		
Customize		**As Left**
Display	Line 1	
	Line 2	
	Contrast	
Sensor Setup	State	
Flow Units	Volume	
	Time	
	User Vol Label	
	User Vol Base	
	User Vol Scale	
	User Time Label	
	User Time Base	
	User Time Scale	
SOS Units	Units	
Flow Cutoff	Low End	
	High End	
Totalizer	Units	
	Lowcut Enable	
	Lowcut	
	Multiplier	
	Input	
Wr Protect Mode		

Communications		**As Left**
Ethernet	IP Address	
	Subnet Mask	
Front Panel Serial	Baud Rate	
Internal Serial	Config	
	Baud Rate	
	Data Bits	
	Parity	
	Stop Bits	
HART	Preambles	
	Resp Preambles	
	Univ Cmd Rev	
	Polling Address	
	Find Arm Device	
MODBUS	Mode	
	Address	
	ASCII Timeout	
Diagnostics		**As Left**
Gain	Gain Check	

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10 TRANSMITTER USB PORT

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10.1 Introduction

The USB port allows the user to interface with the transmitter without the use of a computer. Information is stored on a USB memory stick and then transferred to a computer for storage or transfer. **Note**: The USB port cannot be used for communications between the transmitter and a computer; it is for use only with a memory stick.

WARNING

EXPLOSION HAZARD - DO NOT USE USB PORT UNLESS IT IS KNOWN THAT EXPLOSIVE GASSES ARE NOT PRESENT. When explosive gases may be present, the transmitter door may be opened only to use the keypad or reset button. Obtain hot work permit and ensure explosive gasses are not present prior to performing any other operation.

The USB port and the USB memory sticks are not rated for use in hazardous areas. Therefore, the assumption must be made that during insertion, removal, or use of the memory stick a condition could be created which could lead to the ignition of explosive gasses or vapors if they were present. Always obtain a hot work permit that verifies that explosive gasses are not present throughout the time that the USB memory stick is installed in the Transmitter.

Certain models of the passive sonar system transmitter have a cover over the USB port which is located to the right of the LCD display. The USB port cover is a retained sliding cover that is secured with a retained screw. To open the cover, loosen the screw until it pops up, and slide the cover to the right.

Figure 1 USB Port Cover

When finished using the USB port, remove the USB memory stick, slide the cover to the left, and secure it again with the screw. This tool-operable cover is required by certain hazardous area certifications as a feature which forces the user to pause and consider the consequences of using the USB stick in a potentially hazardous area.

An interruption in data output from the transmitter to a data control system will occur when using some of the functions of the USB port and memory stick. It is recommended that the process control room be alerted when using the USB data port.

⚠	**CAUTION** **Loss of transmitter output signal may occur when using USB port. Contact process control room and advise them the transmitter may be off line during memory stick operations.**

The following table shows the menu structure that becomes available when using a memory stick inserted in the USB port. Detailed information for each menu item follows. Navigation through the menus is accomplished with the transmitter front panel keys.

The chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY provides additional information for ATEX Class I, Zone 2 installations.

Level 1	Level 2	Level 3	Range	Description
Save Snapshot				Automatically creates a zip file of 5 minutes Raw Data; 1 day of Data History; System Info, current Configuration, Event Log
Load Configuration				Automatically loads a Configuration File from the memory stick
Advanced Functions	System Config	File for Save	Alpha numeric entry	Allows for naming and saving the current Configuration File
		Save Config		Saves the named file
		Load Config	Alpha numeric named files	Allows for retrieving and loading a Configuration File
	Raw Data	Duration	1, 5, 10, 30, 60, 120, 240 minutes	Selects the time duration of data to save to a Raw Data file
		Save		Starts and saves Raw Data File
	Data History	Decimation	None, 2, 5, 10, 50, 100, 500, 1000	Determines the frequency of data points to be saved
		Length	Everything, 1, 2, 5, 10, 30, 50, 100, 250, 500 days	Number of days of data to be saved (limited to size of data file in transmitter)
		Save As Text		Saves Data History as a Text File
		Save As Zip		Saves Data History as a Zip File
		Clear History		Clears Data History file in transmitter
	Manage Files	Delete File/Dir	Scroll through list of files on the memory stick	Deletes specific files or directories
		Erase All		Deletes all files on memory stick
		Disk Info		Lists memory stick space used, available, total
	Set Date/Time			Sets transmitter date and time

Table 1 USB Port Menu

10.2 USB Port File Naming Convention

Files collected from the transmitter using the USB Port are automatically named to readily identify them. They are named in accordance with the following naming convention:

ssss_nnnnnnnnYYMMDDhhmmss.ext

The following table details the naming convention:

Characters	Description
ssss	Last four digits of transmitter serial number
nnnnnnnn	name string, optional
YY	year
MM	month
DD	day
hh	hour
mm	minute
ss	second
ext	file extension (.txt, .ini, .bin)

Table 2 USB Port File Naming Convention

Examples of files named in accordance with this file naming convention are given in the following table.

Table 3

File Name	Description
0208_DataHistory050614110247.txt	Data History text file from Transmitter Serial Number 208 acquired on Year: 2005, Month: June, Day: 14, Hour 11, Minute 02, Second: 47
0208_050614110812.bin	Raw data binary file from Transmitter Serial Number 208 acquired on Year: 2005, Month: June, Day: 14, Hour: 11, Minute: 08, Second: 12
0208_SysInfo050614110812.txt	System Information text file from Transmitter Serial Number 208 acquired on Year: 2005, Month: June, Day: 14, Hour: 11, Minute: 08, Second: 12
0208_Config050614110812.ini	Configuration encrypted binary file from Transmitter Serial Number 208 acquired on Year: 2005, Month: June, Day: 14, Hour: 11, Minute: 08, Second: 12
0208_EventLog050614110813.txt	Event Log text file from Transmitter Serial Number 208 acquired on Year: 2005, Month: June, Day: 14 Hour: 11, Minute: 08, Second: 13

Table 3 USB Port File Name Examples

10.3 Save Snapshot

Save Snapshot is a one-step download of a pre-determined data set from the transmitter. The data set is comprised of Raw Data, Data History, System Info, Configuration, and Event Log files. Download of Snapshot takes about 15-18 minutes.

10.3.1 Raw Data

Raw Data, is as the name implies, a set of unprocessed data from the sensor head.

A raw data file (5 minutes duration) is downloaded during Snapshot.

10.3.2 Data History

Data History is a compilation of system information that is saved within the transmitter. The data history file contains the data output from the transmitter as well as some system information that can be used for diagnostic purposes. The duration (number of days) of data stored in data history is primarily determined by the system data update rate. Under default setup (2 second update rate) approximately 28 days of data will be stored.

A data history file of the last 24 hours is downloaded during Snapshot.

10.3.3 System Info

System Info (information) is a list of system hardware and software revisions and versions, system diagnostic information, and system setup information.

A system info file is downloaded during Snapshot.

10.3.4 Configuration

Configuration is a full list of the transmitter setup parameters. The file is encrypted for security purposes.

A configuration file is downloaded during Snapshot.

10.3.5 Event Log

Event Log lists a history of the abnormal operations within the system that may affect its performance. Every event (up to 65,535 occurrences) is stored in the transmitter event log file. The latest 10 events are time stamped.

An event log file is downloaded during Snapshot.

10.4 Load Configuration

Load Configuration is a one-step command used to upload a configuration file to the transmitter from the USB memory stick.

In Load Configuration mode the transmitter will only load files with a file name consisting of the last four digits of the transmitter serial number followed by '_LoadConfig.ini'. For example, a configuration file for transmitter serial number 2000234 must be named '0234_LoadConfig.ini' for it to be recognized and uploaded by this utility. The Advanced Functions menu allows for loading of alternatively named configuration files.

10.5 Advanced Functions

Advanced Functions provides the user with a menu of options for saving data to and uploading data from the USB memory stick. It also allows for updating system firmware and managing files on the USB memory stick, and setting the date and time in the transmitter. These options are discussed below.

10.5.1 System Config

System Config function allows naming, saving and loading configuration files. (In Snapshot mode a configuration file is automatically saved.)

- **File For Save** allows the user to give a custom name to the file. If this option is not selected the file will be saved using the transmitter serial number and a date / time stamp.
- **Save Config** saves the file using the name previously specified.
- **Load Config** allows the user to load a configuration file from a list of '.ini' files. Note that files do not have to be 'transmitter serial number specific', as they must be when using the Load Configuration function.

10.5.2 Raw Data

Raw Data function allows the user to download Raw Data from the system. (In Snapshot mode a 5-minute Raw Data file is automatically created.)

- **Duration** allows the user to select options of 1, 5, 10, 30, 60, 120 and 240 minutes of continuous raw data.
- **Save** is used to save the Raw Data files.

10.5.3 Data History

Data History function allows the user the option of selecting the amount of transmitter Data History to be downloaded. (In Snapshot mode only the last 24 hours of Data History is saved.)

These files can then be opened and analyzed using a spreadsheet program.

- **Decimation** allows the user to determine the frequency of data points to be downloaded. For example, the user can decide to download all data (decimation None), every other reading (decimation 2), every 5th reading (decimation 5) or every 10th, 50th, 100th, 500th, or 1000th reading (decimation 10, 50, 100, 500, or 1000 respectively). In most cases none is selected.
- **Length** allows for selecting the time duration to be downloaded. Choices of everything, 1 day, 2, 5, 10, 30, 50, 100, 250, 500 days are selectable.
- **Save As Text** creates a text file of the data.
- **Save As Zip** creates a zip file of the data.
- **Clear History** erases the Data History from the transmitter.

10.5.4 Manage Files

Manage Files function allows the user to manage the files that reside on the USB memory stick.

- **Delete File / Dir** allows for deleting single files or directories from the USB memory stick.
- **Erase All** removes all files and directories on the USB memory stick.
- **Disk Info** lists the disk space available, used and total capacity on the USB memory stick.

10.5.5 Set Date / Time

Set Time / Date allows the user to change the time and date that is stored in the transmitter. The format of the date will be consistent with the format (US, ISO8601, or Euro) selected during setup of the transmitter.

10.6 USB Memory Stick – Basic Functions

The following sections provide instructions on the use of the USB memory stick. The Basic Functions menu enables the user to collect a Snapshot and to Load Configuration files. Additional capabilities are provided in the Advanced Functions section.

10.6.1 Save Snapshot

The purpose of the Snapshot file is to collect system information that will be used to optimize the system performance. A Snapshot will:

- Collect one day of Data History (information stored in the transmitter)
- Collect 5 minutes of Raw Data (unprocessed sensor data)
- Collect System Info (pipe size, input and output setup, etc.)
- Collect Configuration Data (system parameters)
- Collect Event Log Data
- Create a .zip file of the data collected

To collect a Snapshot, insert the memory stick into the USB port. Once the memory stick is recognized by the transmitter the following screen will appear.

Figure 2 Snapshot Save Screen

Press '**ENTER**' on the keypad and the following screen will appear.

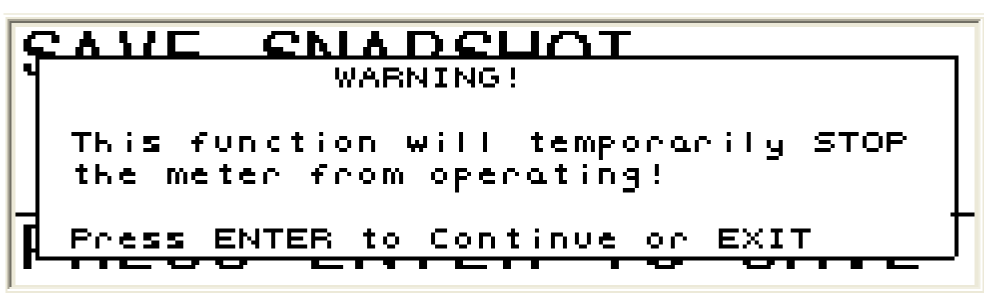

Figure 3 Snapshot Save Warning Screen

Press '**ENTER**' on the keypad to continue and run the Snapshot or press '**EXIT**' to return to the previous menu.

The Snapshot will take about 13 - 15 minutes to download and save to the memory stick.

Once the Snapshot is complete the following screen will be displayed.

Figure 4 Snapshot Save Complete Screen

The memory stick can be removed and the transmitter will return to normal operation.

If '**ENTER**' is selected the transmitter screen will return to the Save Snapshot Screen and another Snapshot can be taken, or the memory stick can be removed and the transmitter will return to normal operation.

To summarize the **Snapshot** procedure:

- **Insert** the memory stick in the USB Port.
- When Figure 1 appears press '**ENTER**'.
- When Figure 2 appears press '**ENTER**'.
- When Figure 3 appears, remove the memory stick or press '**ENTER**' and scroll to additional menus.

10.6.2 Load Configuration

Load Configuration is used to load a new configuration file into the transmitter. To use this command, the configuration file **MUST** have the specific name of **ssss_LoadConfig.ini** where ssss is the last four digits of the transmitter serial number (found on the inside cover of the transmitter). For example, in order for the Load Configuration menu item to recognize the file to be loaded into transmitter Serial Number 3000355, the file **MUST** be named **0355_LoadConfig.ini**. If that file name is not found an error message will appear. However, the new configuration file can still be loaded as described in the Advanced Functions portion of this document.

Insert the memory stick into the USB port. Figure 1 will appear. Press the ‘↓’ and the following screen will appear.

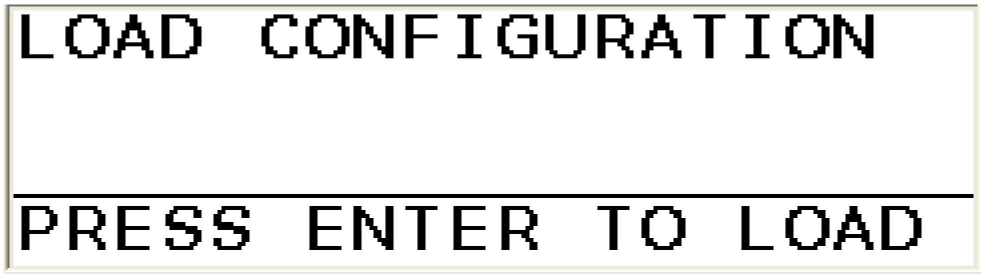

Figure 5   Load Configuration Screen

Press ‘**ENTER**’ and the following screen will appear.

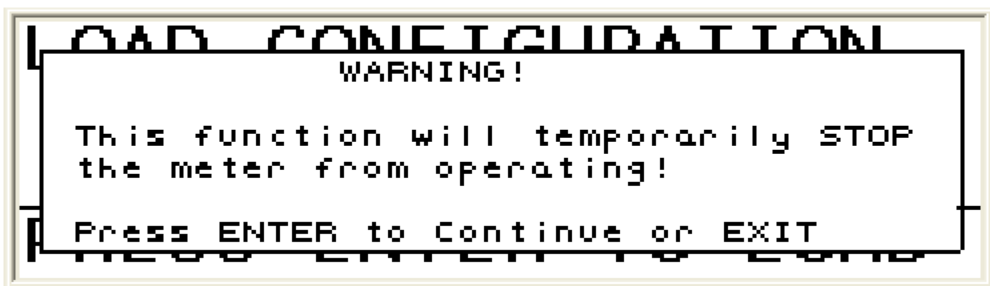

Figure 6   Load Configuration Warning Screen

Press ‘**ENTER**’ and the following screen will appear. The purpose is to confirm that a new configuration file is to be loaded.

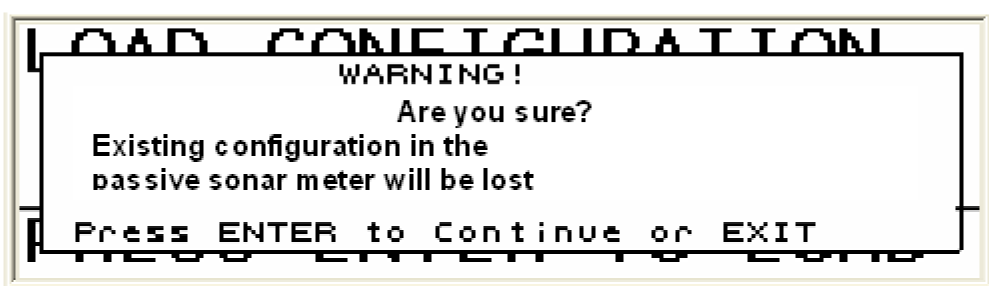

Figure 7   Load Configuration Second Warning Screen

Press ‘**ENTER**’ again and the transmitter will select and load the appropriate file.

Once the file has been loaded the following message will be displayed.

Figure 8 Load Configuration Complete Screen

If there is no file or the file name is not per the criteria in this section, the following message will be displayed. In that case load the file per the instructions in Advanced Functions as described in the following sections.

Figure 9 Load Configuration Error Screen

To summarize the **Load Configuration** procedure:

- **Insert** the memory stick in the USB Port.
- When Figure 1 appears press '↓' key.
- When Figure 4 appears press '**ENTER**'.
- When Figure 5 appears press '**ENTER**'.
- When Figure 6 appears press '**ENTER**'.
- When Figure 7 appears either remove the memory stick or press '**ENTER**' to return the menu.
- If Figure 8 appears press '**ENTER**' and scroll to the '**ADVANCED FUNCTIONS**' menu to load the new configuration file.

10.7 USB Memory Stick – Advanced Functions

The Advanced Functions menu enables the user to:

- Save or Load System Configuration files
- Download a user selectable amount of Raw Sensor Data
- Download a user selectable amount of Data History from the transmitter
- Manage (delete specific or all) the files on the memory stick
- Set Date / Time in the transmitter

10.7.1 Advanced Functions – 'System Config'

System Config allows the user to Save the existing transmitter configuration file, or to Load a different configuration file.

10.7.1.1 'SAVE' Config Files

To save the existing transmitter configuration file:

- **Insert** the memory stick in the USB Port.
- Once the '**Save Snapshot**' screen appears press the '↓' key two times. '**Advanced Functions**' will appear on Line 1 of the display.
- Press the '**ENTER**' key and '→**System Config**' will appear on Line 2 of the display.
- Press the '**ENTER**' key and '→**File For Save**' will appear on Line 3 of the display. Line 4 will display the recommended name of the file to be saved (the name will be the last four digits from the serial number of the transmitter, a date/time stamp will automatically be added to the save name).
  - If a different '**File For Save**' name is desired, press the '**ENTER**' key and the numbers and letters on Line 4 of the display will become active. Use the transmitter '←' and '→'arrow keys to move to each digit and use the '↑' and '↓' arrow keys to change each digit. Press '**ENTER**' when the file naming is complete.
- Press the '↓' key and '→**Save Config**' will appear on Line 3 of the display.
- Press the '**ENTER**' key and the transmitter configuration file will be saved.
- Remove the memory stick to resume normal system operation or press '**ENTER**' to return to the menu.

10.7.1.2 'LOAD' Config Files

To '**LOAD**' a configuration file from the memory stick to the transmitter:

- **Insert** the memory stick in the USB Port.
- Once the '**Save Snapshot**' screen appears press the '↓' key two times. '**Advanced Functions**' will appear on Line 1 of the display.
- Press the '**ENTER**' key and '→**System Config**' will appear on Line 2 of the display.
- Press the '**ENTER**' key and '→**File For Save**' will appear on Line 3 of the display.
- Press the '↓' two times and '→**Load Config**' will appear on Line 3 of the display.
- Press the '**ENTER**' key and Line 4 will become active. Use the '↑' and '↓' arrow keys to scroll to the desired Config File.
- Press the '**ENTER**' key and a warning will be displayed.
- Press the '**ENTER**' key a second time a second warning will be displayed.
- Press the '**ENTER**' key a third time and the configuration file will load and the '**Load Complete**' screen will be displayed.
- Remove the memory stick to resume normal system operation or press '**ENTER**' to return to the menu.

10.7.2 Advanced Functions – 'Raw Data'

Raw data is raw sensor output data that is used by the transmitter or by Technical Support Personnel. To download raw data from the process monitoring system to the memory stick:

- **Insert** the memory stick in the USB Port.
- Once the '**Save Snapshot**' screen appears press the '↓' key two times. '**Advanced Functions**' will appear on Line 1 of the display.
- Press the '**ENTER**' key and '→**System Config**' will appear on Line 2 of the display.
- Press the '↓' key and '→**Raw Data**' will appear on Line 2 of the display.
- Press the '**ENTER**' key and '→**Duration**' will appear on Line 3 of the display.
- Press the '**ENTER**' key and '**1 Minute**' will appear on Line 4 of the display. Press the '**ENTER**' key and then use the '↓' key to scroll

to the desired amount of Raw Data to be collected. Press the '**ENTER**' key.

- Press the '↓' key and '→**Save**' will appear on Line 3 of the display.
- Press the '**ENTER**' key and a warning screen will be displayed.
- Press the '**ENTER**' key and the Raw Data will be stored in a folder on the memory stick. (The folder can then be 'zipped' using a computer for file transfer.)
- Remove the memory stick to resume normal system operation or press '**ENTER**' to return to the menu.

10.7.3 Advanced Functions – 'Data History'

The Data History file is a text file from the transmitter internal data memory. At a transmitter data capture rate of 2 seconds, almost a month of data can be stored on the transmitter and subsequently downloaded through the USB Port to a memory stick. To download the Data History:

- **Insert** the memory stick in the USB Port.
- Once the '**Save Snapshot**' screen appears press the '↓' key two times. '**Advanced Functions**' will appear on Line 1 of the display.
- Press the '**ENTER**' key and '→**System Config**' will appear on Line 2 of the display.
- Press the '↓' key two times and '→**Data History**' will appear on Line 2 of the display.
- Press the '**ENTER**' key and '→**Decimation**' will appear on Line 3 of the display and '**None**' on Line 4.
    - '**Decimation**' is used to set the <u>frequency</u> of data to download. A decimation of '**None**' will download every data point in the selected duration of data to be downloaded. A decimation of **2** will download every other data point (at a data capture rate of 2 seconds this will download data logged at 4 second intervals). A decimation of **5** will download every 5th data point (at a data capture rate of 2 seconds this will download data logged at 10 second intervals).
- To select the frequency of data to be downloaded, press the '**ENTER**' key and '**None**' will be highlighted on Line 4 of the display. Press the '**ENTER**' key and then use the '↑' and '↓' key to scroll to the desired amount of **Decimation** to be applied. Press the '**ENTER**' key.
- Press the '↓' key and '→**Length**' will appear on Line 2 of the display and '**1 Day**' will appear on Line 4.

- ‘**Length**’ is used to select the amount of data going back in history to be downloaded. **1 Day** will download the last 24 hour period of data. **2 Days** will download the last 48 hours of data. **Everything** will download the full data history.

- To select the length of data to be downloaded, press the ‘**ENTER**’ key and ‘**1 Day**’ will be highlighted on Line 4 of the display. Press the ‘**ENTER**’ key and then use the ‘↑’ and ‘↓’ key to scroll to the desired duration of data to be downloaded. To collect all data stored on the meter, select **Everything** and then press the ‘**ENTER**’ key.
- Press the ‘↓’ key and ‘→**Save As Text**’ will appear on Line 3 of the display. If a text file of the data is desired, press the ‘**ENTER**’ key and a Data History file (date and time stamped) will be created. If a .zip file is preferred,
- Press the ‘↓’ key and ‘→**Save As Zip**’ will appear on Line 3 of the display. Press the ‘**ENTER**’ key and a zipped Data History file (date and time stamped) will be created.
- The Data History stored in the transmitter can be cleared by using the ‘↓’ key and scrolling to ‘→**Clear History**’ and pressing the ‘**ENTER**’ key. Perform this function only if you want to remove all Data History from the transmitter.
- Remove the memory stick to resume normal system operation or press ‘**ENTER**’ to return to the menu.

10.7.4 Advanced Functions – ‘Manage Files’

The Manage Files selection enables the user to delete files from the memory stick and determine the amount of space available for data on the memory stick.

- **Insert** the memory stick in the USB Port.
- Once the ‘**Save Snapshot**’ screen appears press the ‘↓’ key two times. ‘**Advanced Functions**’ will appear on Line 1 of the display.
- Press the ‘**ENTER**’ key and ‘→**System Config**’ will appear on Line 2 of the display.
- Press the ‘↓’ key three times and ‘→**Manage Files**’ will appear on Line 2 of the display.
- Press the ‘**ENTER**’ key and ‘→**Delete File/Dir**’ will appear on Line 3 of the display.
- Press the ‘**ENTER**’ key and a file name will appear on Line 4 of the display.

- If that file is to be deleted, press the '**ENTER**' key. A Warning Message will be displayed confirming the file will be deleted. Press the '**ENTER**' key and that file will be deleted.
- If the user does not want to delete that particular file press '**EXIT**' and '→**Delete File/Dir**' will appear on Line 3 of the display.
- Press the '**ENTER**' key and scroll to the files to be deleted.
- If all files are desired to be removed press the '↓' key when '→**Delete File/Dir**' is displayed and '→**Erase All**' will be displayed.
- Press the '**ENTER**' key and a Warning Message will be displayed. Press the '**ENTER**' key to erase all files or press '**EXIT**' to return the menu structure.
- Press the '↓' key two times when the '→**Delete File/Dir**' is displayed. '→**Disk Info**' will be displayed on Line 3 of the transmitter.
- Press the '**ENTER**' key and the space **Free** and **Used,** and memory stick **Capacity** will be displayed.
- Remove the memory stick to resume normal system operation or press '**ENTER**' to return to the menu.

10.7.5 Advanced Functions – 'Set Date/Time'

The transmitter Date and Time can be set when using the USB Port.

- **Insert** the memory stick in the USB Port.
- Once the '**Save Snapshot**' screen appears press the '↓' key two times. '**Advanced Functions**' will appear on Line 1 of the display.
- Press the '**ENTER**' key and '→**System Config**' will appear on Line 2 of the display.
- Press the '↓' key four times and '→**Set Date/Time**' will appear on Line 2 of the display.
- Press the '**ENTER**' key and the '**Date Code**' (format selected during transmitter setup) and '**HH:MM:SS**' will appear on Line 3 of the display and the current date and time set in the transmitter will be highlighted on Line 4 of the display.
- Use the arrow keys to select and scroll to the desired date and time. Press the '**ENTER**' key to set the revised date and time in the transmitter.
- Remove the memory stick to resume normal system operation or press '**ENTER**' to return to the menu.

10.8 Transmitter Programming

The transmitter can be re-programmed through use of a memory stick. However, the sequence of key strokes varies depending upon the version of firmware currently installed in the transmitter. Therefore, directions for re-programming of the transmitter using a memory stick will be addressed on a case-by-case basis.

Contact Customer Support for assistance.

11 POSTING DATA ON WEB SITE

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11.1 Introduction

The CiDRA web site provides information about passive sonar system products and a link to allow uploading of data for review by Technical Support Personnel.

The ‘**Resource Center**‘ drop-down menu contains links to Technical Support, Application Notes, Manuals for Product Installation and Startup, Technical Bulletins, Data Sheets, etc.

The link titled ‘**Technical Support**’ can be used to upload data for analysis and to request technical assistance on installed products from Technical Support Personnel.

Also, once a product is installed we recommend that a Snapshot be taken and a copy of it sent to CiDRA for archiving. CiDRA will then have a record of the system setup for reference should any issues requiring technical support arise in the future.

11.2 Technical Support Request

The Technical Support section is accessed by opening the computer Internet Browser and typing ‘**www.cidra.com**’ in the address line. This will open CiDRA’s home page. On the Home Page, select the ‘**Resource Center**‘ drop-down menu and then ‘**Technical Support**’ as shown below.

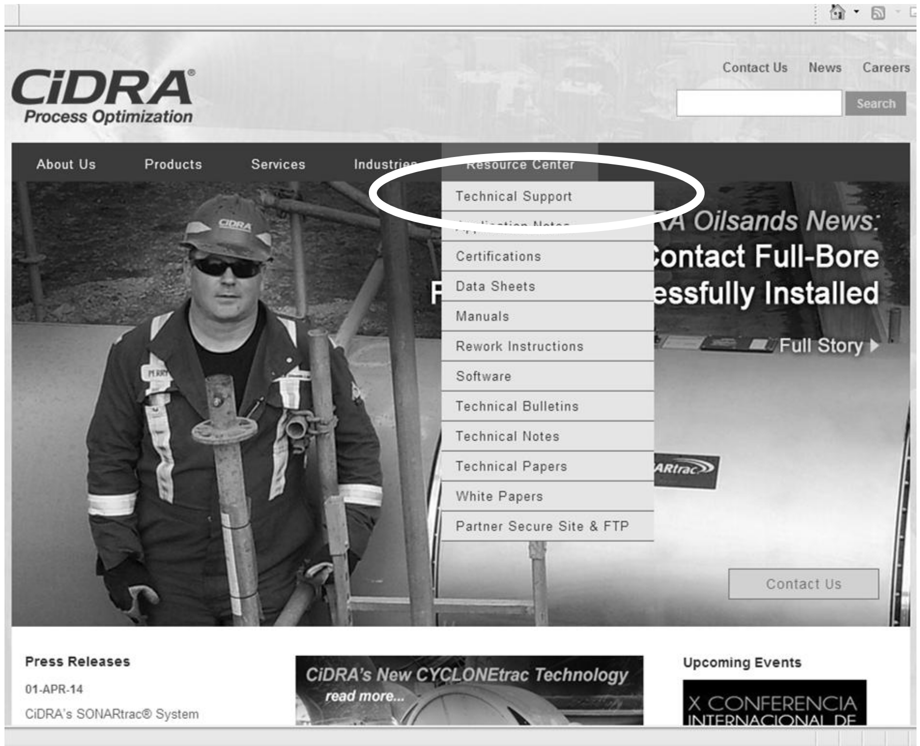

Figure 1 CiDRA Web Site Home Page – Technical Support Request

The Technical Support link will direct the user to the following page

Figure 2 Technical Support Request Form (Part 1)

Once filled in, press '**Continue**'.

Part 2 of the Technical Support Request Form will then appear. Fill out at least all the sections with an asterisk (*). Then select '**Click to Submit**'.

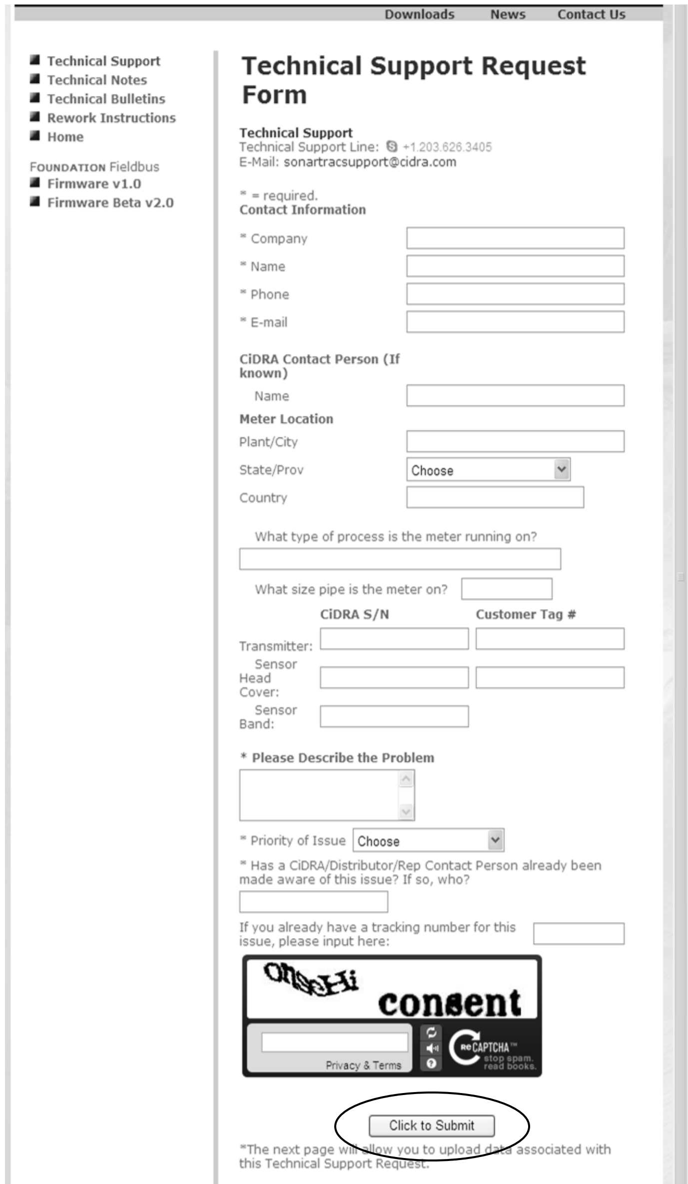

Figure 3   Technical Support Request Form (Part 2)

The Technical Support Request Form will be routed to the Technical Support Team.

The user will then be directed to the following page that is used to upload data if desired.

Figure 4 Technical Support Request Form (Part 3)

Browse for the data file and then select **Upload** to upload the file to Technical Support. Please note: all data files uploaded are accessible only by CiDRA Technical Support Personnel. Uploaded data is not visible to other customers or users of the web site.

Once the data file has been uploaded the following screen will appear.

Figure 5 Data Uploaded Screen

Following upload, Technical Support is immediately notified of the uploaded files and will take appropriate action.

12 SENSOR HEAD REMOVAL AND PROCESS PIPE REWORK PROCEDURE

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12.1 Introduction

Sometimes it may become necessary to remove and reinstall the sensor head. Process pipes are sometimes rotated, replaced, welded or cleaned. The following sections will describe sensor head removal procedures.

12.2 Sensor Removal

WARNING

EXPLOSION HAZARD - In hazardous areas, a hot work permit should be obtained to ensure explosive gasses are not present in the locations where the sensor band will be handled

If removal of the sensor is required, the following procedure should be followed.

1. Specific details regarding the removal of the passive sonar system should be discussed with a sales or manufacturer's representative prior to removal.
2. Obtain Hot Work Permit if required.
3. Turn off electrical power to the system. Follow lock-out / tag-out procedures as required.
4. Unlatch and disconnect the sensor to transmitter cable connector from the sensor cover. Close cable connector cover on sensor head cover.

5. Protect cable connector from dirt, water, etc. (example, wrap it in a protective plastic bag).
6. Remove the rain seal(s) or boot gasket fenders (stainless steel covers) from the sensor head (if equipped).
7. Open the sensor cable access panel located on the cover by loosening the six screws (they should not be fully removed from the cover as they are captive screws).
8. Disconnect the sensor band to cover electrical connector by unlatching the connector locks and sliding the connector back as shown below.

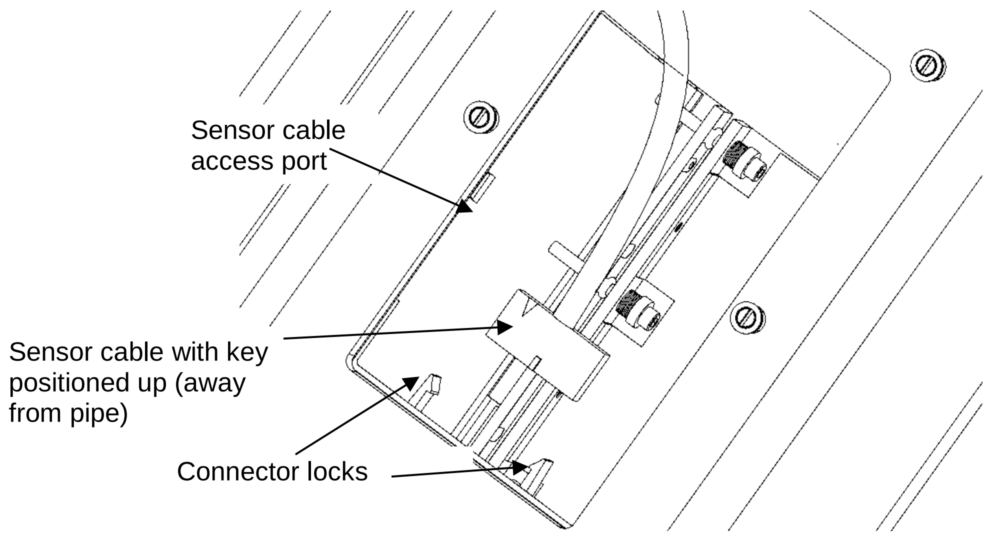

Figure 1 *Sensor Cable Connector Removal*

9. For fiberglass covers with latches securing the cover halves together:
   a. Remove the lower and upper boot seal clamp or band clamp.
   b. Open the latches used to secure each half of the cover.
   c. Remove each cover half.
10. For covers with bolted flanges either fiberglass or stainless steel:
    a. Install spring clamps or vice grips on both cover flanges to keep cover from sliding or separating while removing the cover bolts.
    b. Remove the lower and upper boot seal clamp or band clamp.

c. Remove the sensor cover bolts, nuts, and washers and then remove the cover from the pipe. Replace sensor cable access cover.

12. Remove the sensor band thermal blanket (if so equipped).
13. Use a hex driver or Allen wrench to loosen each screw a couple of turns in the number sequence shown in the following figure until they are all loosened. Repeat loosening the screws per the numbered sequence. While the screw threads are still engaged in the attachment rails a few turns, spread the sensor rails apart and then continue to loosen the screws until they are no longer engaged in the threads. (**NOTE:** Ensure the O-ring that keeps the screws from coming out of the rails is not removed from the screw.) Use care to keep the fastener assembly intact. If the spacers or Bellville washers do come off the screw, refer to the sensor band screw figure in the Sensor Installation section of the manual for proper stack-up of components. **Note: If any parts are lost during sensor band removal, (Bellville washers or screws) do not attempt to re-install the sensor band without these parts. The sensor band will be damaged. Contact Customer Support for replacement parts.**

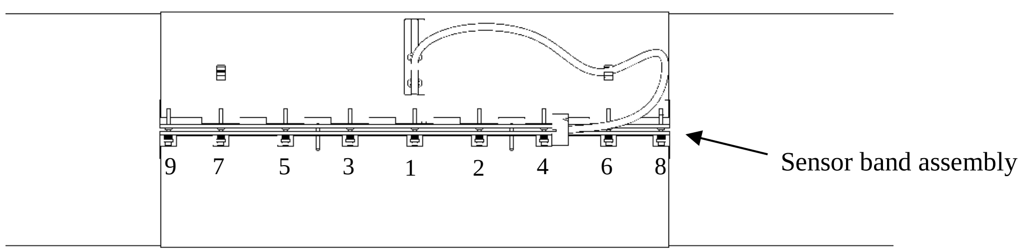

Figure 2 *Sensor Fastener Loosening Sequence*

⚠	**CAUTION** **Do not re-install sensor band or cover if any parts (screws, Belleville Washers, nuts, etc.) are missing. This may result in damage to the system. Contact Customer Support for assistance.**

14. Remove the sensor band assembly from the pipe.
15. Slide the screw and washer assembly O-ring down the screw to retain the screws in their holes.
16. The original packaging should be used when storing / transporting the system. Contact Customer Support for sensor packaging. If the original packaging is not available, wrap the sensor band around a suitable sized mandrel or lay the sensor band in the bottom of the cover and move it to an area where it will not be

damaged. **Use care to not put permanent creases in the sensor band.**

17. Remove any optional accessories (compliant sheet, weld bead filler, etc.) from the pipe and replace if damaged.
18. Inspect and replace sensor band screws prior to re-installation of sensor band if they are damaged.
19. Inspect and replace fiberglass cover gaskets as required.
20. Inspect and replace stainless steel cover flange gaskets as required.

    Reinstall sensor head per Section 5 of this manual.

12.3 Pipe Rotation

Process pipes that are subject to erosion on one side of the pipe are sometimes rotated to extend the life of the pipe prior to replacement.

The **HD series** sensor cover and sensor band must be removed and re-installed on the process pipe.

Note: The standard series of flow meters do not necessarily have to be removed during pipe rotation unless the resulting sensor cover orientation lies outside the criteria found in Section 5.7 of this manual.

CAUTION

In all cases, never remove the process pipe and place it on the ground without being supported when the sensor head is installed on the pipe. The sensor head will be damaged.

Sensor removal and re-assembly for HD series sensor heads is as follows:

1. Remove the sensor head assembly in accordance with Section 12.2 of this manual. Be sure to remove the sensor cable from the preamplifier board prior to removing the cover.
2. Rotate process pipes.
3. Re-measure the process pipe inside diameter and enter the new diameter in the transmitter for greatest flow reading accuracy.
4. Re-install flow meter sensor assembly following the instructions in Section 5 Sensor Installation.

12.4 Pipe Replacement

Whenever a process pipe is replaced the sensor assembly must be removed and re-installed.

12.5 Pipe Cleaning

If a pipe is cleaned, do not exceed the sensor head temperature limit or it may be damaged. Remove the sensor head prior to cleaning. Contact Customer Support for advice if necessary.

12.6 Pipe Welding

If a pipe is welded near an installed sensor head, do not exceed the sensor head temperature limit or it may be damaged. Remove the sensor head prior to welding. Contact Customer Support for advice if necessary.

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13 SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY

Notes:

- This section adds safety requirements specific to ATEX Zone 2 passive sonar meters. For Ordinary Location and Class I Division 2 passive sonar meters, the required safety information is in the other sections of the manual and this section can be safely ignored.
- 20909-01C Rev 06 is a document controlled by UL/DEMKO as part of the ATEX Zone 2 certification and cannot be revised without going back for re-certification. It was created in English as a stand-alone document, but is included here inserted into this chapter of the larger manual, so the page number, section number, and footer formats in this section differ from those of the other chapters in the larger manual. If this chapter is fully translated into another language, it includes a faithful translation of the original English 20909-01C Rev 06.
- Note that Section 7.3.2, Barometric Pressure, of 20909-01C Rev 06 limits the max altitude of the ATEX Zone 2 sonar process monitoring system to 1950m, which is the default limit for ATEX equipment without additional review of suitability for higher altitudes. See further discussion of this issue in the Altitude section of Appendix A of the larger manual.

To assemble the PDF of this Chapter 13, append the PDF of the UL/DEMKO-controlled 20909-01C Rev 06 to the PDF of these introductory pages.

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SONAR
PROCESS MONITORING SYSTEM

SUPPLEMENT FOR
ATEX ZONE 2 SAFETY

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List of Tables

1 SCOPE

This Zone 2 explosive gas location safety supplement includes the information mandated by EN60079-0:2012, EN60079-15:2010 and EN60079-11:2012 for the ATEX Zone 2 certification of either of the following sets of equipment:

1) System comprised of Transmitter TB8-xx-xx-xx-03 with Sensor Head SH-xxx-xx-xA-xxx-03, or,
2) Transmitter TB8-xx-xx-xx-04 with separately certified sensor head (see appropriate separate manual for the separately certified Sensor Head).

   (where “x” in the above markings can be any character).

This supplementary manual is to be read first, but used in conjunction with the main Process Monitoring System Installation and Startup Manual that contains more specific instructions for installation and operation. In the event of a conflict between the safety instructions of this manual and those of the main manual, the instructions of this manual take precedence.

Note: This is a UL/DEMKO controlled document.

2 MARKINGS

The following explains the hazardous area markings that can be found on the equipment.

2.1 Transmitter [TB8-xx-xx-xx-03] for use with Sensor Head [SH-xxx-xx-xA-xxx-03]:

Ex II 3 G Ex ic nA [ic] IIB T4 Gc -20C<=T_{amb}<=+57C IP55
DEMKO 07 ATEX 0608105X

This particular model of transmitter can be installed in a safe area or an area that is classified as an Equipment Group II (not in mines), explosive gas (not explosive dusts or fibers), ATEX Zone 2 location with explosive gas group IIA or IIB. Its enclosure has been tested to IP55 (the second-to-highest dust rating and the rating for low-pressure water jets). It is intended for an operating ambient air temperature range of -20 ºC to +57 ºC. If installed properly, it will not produce a hot-spot temperature in excess of 135 ºC during normal operation.

The transmitter includes certain energy-limited interfaces (see list to determine which interfaces are energy-limited) that allow wires from these interfaces to be routed in Zone 2 areas with a reduced possibility of explosion. This, for example, permits the convenience of being able to disconnect the sensor head cable connector from the sensor head cover with the power ON with a reduced risk of generating a spark with sufficient energy to trigger an explosion if an explosive atmosphere happens to be present.

Note: In Zone 2, explosive atmospheres are not expected to be present except under fault conditions. If the operator is aware that a fault condition exists at the facility that makes it likely that an explosive atmosphere is present, then extra caution is indicated.

2.2 Sensor Head [SH-xxx-xx-xA-xxx-03]:

-40C<=T_{amb}<=+100C IP55
ONLY TO BE USED WITH TRANSMITTER TB8-xx-xx-xx-03
FOR ATEX MARKING SEE LABEL ON TB8 TRANSMITTER

This particular model of sensor head can be installed in a safe area or an area that is classified as an Equipment Group II (not in mines), explosive gas (not explosive dusts or fibers), ATEX Zone 2 location with explosive gas group IIA or IIB. Its enclosure has been tested to IP55 (the second-to-highest dust rating and the rating for low-pressure water jets). It is marked for an operating ambient air temperature range of –40 ºC to +100 ºC.

The +100 ºC rating relates to the safety aspect only and is intended to include the effects of heating from the pipe on which it is mounted. To achieve good operating performance in addition to safety, the pipe can be at temperatures up to 100 ºC, but the air temperature in the vicinity of the pipe should be no greater than 60 ºC. If the pipe temperature is greater than 60 ºC, it is recommended that there be no coverings or obstructions that would prevent free air movement around the outside surface of the sensor head enclosure. If installed properly, it will not produce a hot-spot temperature in excess of 135 ºC during normal operation.

This sensor head is only to be used with Transmitter TB8-xx-xx-xx-03 (not TB8-xx-xx-xx-04), which provides an energy-limited interface to it. This permits the convenience of being able to disconnect the sensor head cable connector from the sensor head cover with the power on with a reduced risk of generating a spark with sufficient energy to trigger an explosion if an explosive atmosphere happens to be present.

Note: In Zone 2, explosive atmospheres are not expected to be present except under fault conditions. If the operator is aware that a fault condition exists at the facility that makes it likely that an explosive atmosphere is present, then extra caution is indicated.

2.3 Transmitter [TB8-xx-xx-xx-04]:

II 3 G Ex ic nA IIB T4 Gc -20C<=T_{amb}<=+57C IP55
DEMKO 07 ATEX 0608105X

This particular model of transmitter can be installed in a safe area or an area that is classified as an Equipment Group II (not in mines), explosive gas (not explosive dusts or fibers), ATEX Zone 2 location with explosive gas group IIA or IIB. Its enclosure has been tested to IP55 (the second-to-highest dust rating and the rating for low-pressure water jets). It is intended for an operating ambient air temperature range of -20 ºC to +57 ºC. If installed properly, it will not produce a hot-spot temperature in excess of 135 ºC during normal operation.

The transmitter includes no energy-limited interfaces. It cannot be used in conjunction with the SH-xxx-xx-xA-xxx-03 Sensor Head. It can only be used with a separately certified sensor head and the wiring to that sensor head must be selected and installed in accordance with rules for incendive wires in hazardous areas.

Note: In Zone 2, explosive atmospheres are not expected to be present except under fault conditions. If the operator is aware that a fault condition exists at the facility that makes it likely that an explosive atmosphere is present, then extra caution is indicated.

3 ATEX ZONE 2 SPECIAL CONDITIONS OF USE RELATED TO THE SYMBOL “X”

These Conditions of Use are those specifically identified by certain clauses in standards EN60079-0:2012, EN 60079-15:2010 and EN60079-11:2012 and are linked to the DEMKO certificate via the suffix “X” in the certificate number (DEMKO 07 ATEX 0608105X).

3.1 Transient Protection

Provision shall be made external to the apparatus to prevent the rated voltage being exceeded by transient disturbance of more than 40%.

3.2 Electrostatic Charging

The non-metallic materials the transmitter and the sensor head enclosures are constructed from have a high enough surface resistivity that there is a risk of the generation of electrostatic sparks from rubbing those enclosures during operations such as cleaning. Such sparks could potentially ignite explosive gas atmospheres if they were present.

To mitigate this risk, the transmitter and sensor head enclosures should not be rubbed except with a clean rag dampened with water or a water-based cleanser (non-flammable solvent). The dampened rag will reduce the generation of charges from rubbing and facilitate the discharging of surface charges that may be generated.

3.3 Cable Glands

Cable glands to be ATEX approved for gas groups IIB or IIC or marked for group II, have at least IP55 rating, be sized for the cable and mounting hole where installed, and have temperature rating of at least -20ºC to +60ºC.

3.4 Control Drawings

Installation shall be per Control Drawing 20907-01C for complete system (TB8-xx-xx-xx-03 Transmitter used with SH-xxx-xx-xA-xxx-03 Sensor Head) or per Control Drawing 20908-01C for the TB8-xx-xx-xx-04 Transmitter.

3.5 Environment

This equipment will be used in an area not more than Pollution Degree 2 as defined by IEC 60664-1.

4 STANDARDS

See the CE Declaration of Conformity shipped with the sonar process monitoring system for the complete and up-to-date set of directives and standards to which this equipment complies.

Specific to ATEX Zone 2, this equipment is in conformity with Directive 94/9/EC “Equipment Intended for Use in Potentially Explosive Atmospheres (ATEX)” per the application of standards:

EN60079-0:2012 “Electrical Apparatus for Explosive Gas Atmospheres – Part 0: General Requirements”

and

EN 60079-15:2010 “Electrical Apparatus for Explosive Gas Atmospheres – Part 15: Construction, Test and Marking of Type of Protection “n” Electrical Apparatus“.

and

EN 60079-11:2012 “Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"”

5 CONTROL DRAWINGS

The control drawings define how the Zone 2 hardware can be installed into hazardous areas. Refer to the following drawings:

Control Drawing	System	Reference Annex
20907-01C	System including TB8-xx-xx-xx-03 Transmitter and SH-xxx-xx-xA-xxx-03 Sensor Head	Annex B
20908-01C	Transmitter TB8-xx-xx-xx-04 Transmitter and separately certified Sensor Head (with separate Control Drawing)	Annex C

Table 1 Control Drawings

6 SPECIFICATIONS

6.1 Electrical Parameters

The mains power connections are made to the transmitter only. There is a DC-powered transmitter (TB8-xx-06-xx-xx) that requires 18-36VDC at 25W max. There is an AC-powered transmitter (TB8-xx-05-xx-xx) that requires 100-240VAC, 50-60Hz at 25W max.

These signals can also be found in Table 2, below. Electrical parameters of other signals can be found in tables 3, 4, and 5.

6.2 Maximum Surface Temperatures

All three components of the sonar process monitoring system covered by this manual have temperature classification “T4”. This means that when properly installed and operating normally they will not produce hot spot temperatures in excess of 135 ºC.

<table>
<tr><td colspan="3">The following signals are not energy-limited for any of the transmitter models. Some models may have one-piece screw terminal blocks and others may have two-piece pluggable terminal blocks with either screw or spring clip terminals. These terminals will accept 0.20 to 3.31 mm^2 (24-12 AWG) conductor size. Conductor size 0.82 mm^2 (18 AWG) or larger cross section is recommended.</td></tr>
<tr><th>POWER ENTRY BOARD</th><th>DC TRANSMITTER (TB8-xx-06-xx-xx) LIMITATION</th><th>AC TRANSMITTER (TB8-xx-05-xx-xx) LIMITATION</th></tr>
<tr><td>L (+)</td><td>+18 to +36 VDC</td><td>100 to 240 VAC, 50-60Hz</td></tr>
<tr><td>N (-)</td><td>RTN</td><td>Neutral</td></tr>
<tr><td>GND (⏚)</td><td>Connect to protective earth</td><td>Connect to protective earth</td></tr>
</table>

Table 2 Mains Power Connections

The following signals are not energy-limited for any of the transmitter models.

***Note**: These signals are not present on every model. Some models may have one-piece screw terminal blocks and others may have two-piece pluggable terminal blocks with either screw or spring clip terminals. These terminals will accept 0.325 to 1.31 mm^2 (22-16 AWG) conductor sizes.*

CUSTOMER I/O	OUTPUT IS LIMITED TO	LIMIT INPUT TO
COMM – COM+	RS-232 or RS-485 signal levels	RS-232 or RS-485 signal levels
COMM – COM-	RS-232 or RS-485 signal levels	RS-232 or RS-485 signal levels
COMM – SHD	Ground	Ground shields at one end only
PULSE – P+	Isolated solid state relay closure	-10V to +30V, 100mA
PULSE - P-	Isolated solid state relay closure	-10V to +30V, 100mA
PULSE – SHD	Ground	Ground shields at one end only
ALARM – AL+	Isolated solid state relay closure	-10V to +30V, 100mA
ALARM – AL-	Isolated solid state relay closure	-10V to +30V, 100mA
ALARM – SHD	Ground	Ground shields at one end only
CUR 1 – VEXT	Not an output	+15V to +30V, 100mA
CUR 1 – IOUT	21mA	500 ohm (max) to GND or VINT-
CUR 1 – VINT-	-10V	Not an input
SHD	Ground	Ground shields at one end only
SHD	Ground	Ground shields at one end only
SHD	Ground	Ground shields at one end only
CUR 2 – VEXT	Not an output	+15V to +30V, 100mA
CUR 2 – IOUT	21mA	500 ohm (max) to GND or VINT-
CUR 2 –VINT-	-10V	Not an input

Table 3 Customer I/O Connections

The following signals are not energy-limited for any of the transmitter models. ***Note**: These signals are not present on every model. Also, some models may have one-piece screw terminal blocks and others may have two-piece pluggable terminal blocks with either screw or spring clip terminals. These terminals will accept 0.325 to 1.31 mm^2 (22-16 AWG) conductor sizes.*		
FIELDBUS CONNECTOR	**OUTPUT IS LIMITED TO**	**LIMIT INPUT TO**
A (Polarity is self-correcting)	Isolated and bus powered	+30VDC, 100mA from bus
B (Polarity is self-correcting)	Isolated and bus powered	+30VDC, 100mA from bus

Table 4 Fieldbus Connections

All of the following signals are energy-limited for the TB8-xx-xx-xx-03 transmitter only. For the TB8-xx-xx-xx-04 Transmitter they are not energy-limited. **Note**: These signals are not present on every model. Some models may have one-piece screw terminal blocks and others may have two-piece pluggable terminal blocks with either screw or spring clip terminals. These terminals will accept 0.325 to 1.31 mm^2 (22-16 AWG) conductor sizes. Conductor size 0.52 mm^2 (20AWG) or larger cross section is recommended.		
I/O NAME	**OUTPUT IS LIMITED TO**	**LIMIT INPUT TO**
Sensor 1 - HI	+12V, 48mA	Passive 4-20mA transducer
Sensor 1 - LO	-12V, 48mA	Passive 4-20mA transducer
Sensor 1 - SHD	Ground	Ground shields at one end only
Sensor 2 - HI	+12V, 48mA	Passive 4-20mA transducer
Sensor 2 - LO	-12V, 48mA	Passive 4-20mA transducer
Sensor 2 - SHD	Ground	Ground shields at one end only
1 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
1 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
2 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
2 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
3 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
3 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
4 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
4 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
5 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
5 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
6 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
6 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
7 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
7 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
8 – WHT	+/-8.5V, 43mA from Sensor Head	Connect only to sensor head cable
8 – BLK	+/-8.5V, 22mA from Sensor Head	Connect only to sensor head cable
9 – WHT	Ground	Connect only to sensor head cable
9 – BLK	Ground	Connect only to sensor head cable
10 – WHT	RS-485 bus levels	Connect only to sensor head cable
10 – BLK	RS-485 bus levels	Connect only to sensor head cable
11 – WHT	-12V nom (-14.25V max), 180mA	Connect only to sensor head cable
11 – BLK	Ground	Connect only to sensor head cable
12 – WHT	+12V nom (+14.25V max), 180mA	Connect only to sensor head cable
12 – BLK	Ground	Connect only to sensor head cable
SHD	Ground	Use for drain wire of sensor head cable
SHD	Ground	Use for orange communication wire, if present.
SHD	Ground	Provisional
SHD	Ground	Provisional

Table 5 Sensor Connections

7 OPERATING CONDITIONS UNDER WHICH THIS PRODUCT MAY BE SAFELY USED

7.1 Scope

These are the criteria under which it is safe to install the ATEX Zone 2 rated products:

The system comprised of: Transmitter TB8-xx-xx-xx-03 with Sensor Head SH-xxx-xx-xA-xxx-03, or

The system comprised of: Standalone Transmitter TB8-xx-xx-xx-04 with separately certified sensor head

7.2 Hazardous Rating Location of Facility Where It Is To Be Installed

7.2.1 System including TB8-xx-xx-xx-03 Transmitter

The TB8-xx-xx-xx-03 Transmitter must be installed in an area that is rated as Non-Hazardous or ATEX Zone 2. The SH-xxx-xx-xA-xxx-03 Sensor Head must be installed in an area that is rated as Non-Hazardous or ATEX Zone 2. The cable connecting the TB8-xx-xx-xx-03 Transmitter and the SH-xxx-xx-xA-xxx-03 Sensor must be routed through areas that are rated Non-Hazardous or ATEX Zone 2 and must not exceed 114 meters (375 feet) in length.

The cable between the Transmitter and Sensor Head should be installed per the applicable electric codes of that jurisdiction and/or per the guidance of EN 60079-14 for this Zone 2 intrinsically safe [ic] (energy limited) associated apparatus field wiring. The Sensor 1 and Sensor 2 inputs are also intrinsically safe [ic] (energy limited) associated apparatus field wiring.

None of the other wiring is intrinsically safe field wiring. This wiring must be wired per the applicable electric codes of that jurisdiction and/or per the guidance of EN 60079-14 wiring techniques for Zone 2 incendive wiring if any part of that wiring is in a Zone 2 area. Cable glands used should preserve the IP 55 and ATEX rating of the enclosure. Refer to paragraph 8.3.1 for information on the selection of cable glands.

7.2.2 System including TB8-xx-xx-xx-04 Transmitter

The TB8-xx-xx-xx-04 Transmitter must be installed in an area that is rated as Non-Hazardous, or ATEX Zone 2. All of its interfaces must be treated as incendive and wired per the applicable electric codes of that jurisdiction and/or per the guidance of EN 60079-14 wiring techniques for Zone 2 incendive wiring if any part of the wiring is in a

Zone 2 area. Cable glands used should preserve the IP 55 and ATEX rating of the enclosure. Refer to paragraph 8.3.1 for information on the selection of cable glands.

7.3 Installation Site Ambient Temperature, Pressure, Humidity

7.3.1 Temperature

The transmitter (TB8-xx-xx-xx-03 or TB8-xx-xx-xx-04) must be installed in a location where the ambient temperature during operation will be within -20 ºC to +57 ºC.

The sensor head (SH-xxx-xx-xA-xxx-03) must be installed in a location where the ambient temperature during operation will be within -40 ºC to +60 ºC.

The process temperature of the fluid in the pipe on which the sensor head is mounted must stay within -40 ºC to +100 ºC during operation.

The cable used to connect the transmitter to the sensor head must have a temperature rating consistent with the ambient temperatures along the path over which it is routed. Cable installers should observe the cable’s minimum installation temperature rating.

7.3.2 Barometric Pressure

The range of ambient air pressure over which validity of the Zone 2 certification of equipment so marked applies is 80 to 110 kPa (0.8 to 1.1 bar) (11.76 to 16.17 PSIA). This ambient air pressure range translates into an altitude range of approximately +1950 meters to -700 meters (+6400 feet to -2300 feet).

The safety standards assume the air in the vicinity of this equipment has normal oxygen content, typically 21% by volume. If nearby sources of excess oxygen are present, please consult with CiDRA Customer Support prior to installation.

7.3.3 Humidity

The sonar process monitoring system certification is based on Pollution Degree 2. This means the electrical circuitry inside the enclosures is expected to be exposed to only dry non-conductive pollution that will only temporarily become conductive due to condensation.

The IP55 enclosures are suitable for installation outdoors where there can be wide fluctuations in temperature and moisture levels in the environment.

Condensation on circuit boards should be avoided. In the continuous-operating mode of operation for which this equipment was designed, the heat generated on those circuit boards will help keep them free of condensation. Care should be taken during commissioning to verify that the electronics do not have accumulated condensed water or frost on them prior to powering them.

7.4 Water Spray and Dust

Both transmitters (TB8-xx-xx-xx-03 or TB8-xx-xx-xx-04) and the sensor head (SH-xxx-xx-xA-xxx-03) are rated IP55. This means that they offer the next-to-highest degree of protection against dust and protection against low-pressure water jets (but not against high pressure jets or immersion).

The installation location must be consistent with the IP ratings of these enclosures. Installation and operating procedures must be designed to ensure that the electronics inside the enclosures stay clean and dry. Installers must take care to assure that the seals mate properly, the latches are latched tightly, and that appropriate accessories (for example, cable glands with the appropriate ratings – see paragraph 8.3.1) are properly selected and installed.

These flow meters are for permanent installations. Cables must be routed and installed by means that protect them from damage. They should be secured near their terminations to prevent pulling and twisting at the cable glands.

Note: The explosion protection certification is for explosive gasses but not for explosive dusts or flyings.

7.5 Explosive Gasses

If so marked, the sonar process monitoring system is rated for Zone 2 use in explosive gas group IIA or IIB.

The T4 rating of the sonar process monitoring system means that if it is operated within the allowed range of ambient temperatures, the hot spot temperatures should not exceed 135 ºC under normal operating conditions.

7.6 Condition of piping

The Zone 2 safety of the sensor head is dependent, in part, on keeping the electronics underneath the clamp-on sensor head cover clean and dry. This means that leaks in the piping under the sensor head cover are not anticipated.

Inspect the pipe prior to installation and periodically thereafter for evidence of impending pipe leaks and take appropriate preemptive action. The specifics of the pipe inspections and the frequency of the periodic monitoring depend on the customer’s knowledge of their facility and the history of pipe leaks.

7.7 Chemical Environment

The materials used to construct the sonar process monitoring system are resistant to damage from chemicals expected in target applications.

If there are any known chemical agents in the intended installation location that the installer believes may pose a special threat of chemical attack on metallic or non-metallic materials, please consult with Customer Support personnel prior to installation.

Notify Customer Support and, if necessary, take the affected equipment out of service if routine inspections reveal the enclosures, gaskets, or other system components are being chemically degraded in their installed environment.

7.8 Mains Power

Mains power must be available at the transmitter location. Mains power is not required at the sensor head location because it is powered by low voltages created by the transmitter.

The mains power must be within the range of voltages and currents required by the particular transmitter. The DC powered transmitter (TB8–xx-06-xx-xx) requires voltage within the range of 18 to 36 VDC. The AC powered transmitter (TB8-xx-05-xx-xx) requires voltage in the range of 100 to 240VAC, 50 to 60Hz. Both types have a 25W maximum input power rating and both have a requirement for power quality with limited amplitude voltage spikes (see paragraph 3.1).

The mains power should wired per the applicable electric codes of the facility in which it is installed and/or per the guidance of EN 60079-14. Cable glands used should preserve the IP 55 and ATEX rating of the enclosure. See paragraph 8.3.1 for information on the selection of cable glands.

8 SUPPLEMENTARY INSTRUCTIONS FOR SAFE ASSEMBLY AND INSTALLATION

8.1 Use Control Drawing, Install Per Code

Ensure installation is consistent with the requirements of the Control Drawing (see Annex B or C, depending on transmitter model number) and that the markings on the equipment are consistent with the classifications of the installation locations.

Use cables and cable installation techniques consistent with applicable electric codes of the facility in which it is installed and/or per the guidance of EN 60079-14.

8.2 Make Correct Terminal Block Connections

Transmitter terminal block connections are as shown in Tables 2, 3, 4, and 5.

8.3 Use Cable Glands and/or Conduit Entries

Cable entering the transmitter enclosure shall utilize cable glands or shall enter using conduit with appropriate conduit fittings to maintain the Zone 2 and IP55 ratings of the transmitter enclosure.

8.3.1 Selection of Cable Glands

Cable glands shall be ATEX-approved for Group II or Group IIB or IIC gasses, have at least an IP55 rating, be appropriately constructed and sized for the cable and mounting hole where they are to be installed, and used in a manner consistent with the gland manufacturer's instructions. See drawing 20885-01C (Annex A) for a list of recommended glands and corresponding cable size limitations.

8.3.2 Selection of Conduit Fittings

Conduit entries shall be constructed and mounted such that they do not alter the type of protection and the specific characteristics of the electrical apparatus. They shall be locked into the unthreaded holes at the bottom of the transmitter or into an adaptor plate designed to be fitted in or on the bottom of the transmitter enclosure.

8.4 Wire With Power OFF

All wiring operations should be performed with dead circuits.

8.5 Wire Securely to Terminals and Route Neatly

Refer to the Process Monitoring System Installation and Startup Manual for the proper wire insulation strip length for each terminal block. The proper strip length will be long enough to guarantee that the terminal grips the bare wire and not the insulation, yet short enough to minimize the risk of shorting exposed bare wires projecting from adjacent terminals.

After stripping the insulation, twist strands of stranded wire together prior to inserting into terminal so that all strands are gripped by the terminal.

Securely tighten the terminal.

Tug gently on wire after installation to ensure the wire is being well gripped by the terminal.

Route the wire neatly in the lower portion of the transmitter and secure with wire ties to keep the wires from getting pinched when the cover closes, to keep the wires away from the circuit boards, and to keep the three groupings of wire separated from each other (mains power, incendive customer I/O, and sensor signals). Do not store excessive amounts of excess wire inside the transmitter.

8.6 No Foreign Objects

Do not store tools or extraneous loose items inside the transmitter or sensor head enclosures.

8.7 Avoid Leaky Pipes

Do not install the sensor band on pipes that are likely to leak. If there is doubt, perform the appropriate pipe inspections to look for evidence of an impending leak prior to installation of the sensor band. (See also paragraph 7.6.)

8.8 Seal Sensor Head Cover

Ensure sensor head cover gaskets are in good condition and mate properly to each other and to the pipe. Connect all latches and properly install the clamps on the boot gaskets.

8.9 Secure The Access Panel.

Use the access panel opening to access the sensor band cable connector and connect it to the preamplifier. This operation is performed after the sensor head cover is secured onto the pipe. Afterwards, securely re-install the access panel to seal that opening.

9 SUPPLEMENTARY INSTRUCTIONS FOR SAFELY PUTTING INTO SERVICE

9.1 Prior to Applying Power

Perform a final inspection of the installation. Use the installation instructions and the Control Drawing to aid in the inspection.

Verify the absence of condensation or frost inside the enclosures.

Verify the customer input / output connections are made properly and are connected to remote circuits operating within the allowed ranges of voltage and current (refer to Table 3).

Verify that Sensor #1 and #2 inputs (if used) are connected to passive (not active) 4-20mA transducers (reference Table 4).

9.2 Apply Power

Apply power and verify a normal startup sequence as defined in the main Installation and Startup manual. If the startup sequence is abnormal, then remove power until ready to perform troubleshooting.

9.3 Perform Setup

Perform the system setup procedures as defined in the main manual.

9.4 Verify Proper Operation

Verify proper operation of the sonar process monitoring system and its configuration prior to using the system as a feedback element in a process control loop.

10 SUPPLEMENTARY INSTRUCTIONS FOR SAFE USE (NORMAL OPERATION WITH NO OPERATOR INTERVENTION)

10.1 Keep Enclosures Closed During Use

10.1.1 Transmitter

Verify the following:

- The transmitter cover should be tightly closed and all 4 screws installed to secure the cover.
- Cable glands should be properly installed and snug in their mounting holes in the enclosure and snug around their cables.
- Cables shall be prevented from applying pulling or twisting forces on the cable glands.

10.1.2 Sensor Head

Verify the following:

- All sensor head latches should be snugly mated.
- Clamps should be snugly installed on the boot seals.
- The cable connector shall be snugly latched onto the mating connector.
- The cable shall be installed with a drip loop (if necessary) such that water will not run along the cable toward the connector
- The cable shall be installed such that the connector will not be subjected to twisting or pulling forces.

10.2 Periodic Inspections

Include the sonar process monitoring system in periodic inspections of the facility.

10.2.1 Transmitter Inspections

Verify the absence of the following:

- Loose hardware or fittings
- Damage to enclosure
- Damage to seals
- Dirt or moisture inside enclosure

10.2.2 Sensor Head Inspections

Verify the absence of the following:

- Loose or damaged latch hardware
- Loose or damaged boot seal clamps
- Damage to enclosure
- Damage to seals
- Loose or damaged access cover (including screws and seals)
- Loose handles
- Loose or damaged electrical connector or seals at the connector
- Evidence from the condition of the pipe that a pipe leak under the Sensor Head might occur before the next inspection (reference paragraph 7.6).

10.2.3 Cables Inspections

Verify the absence of the following:

- Damaged cables
- Improperly installed cables (for example, cable is under tension or too tight bend radius)
- Loose cable management elements (strain reliefs, clamps, etc.)

10.3 Problems Found During Inspection

If inspections turn up serious problems, remove the sonar process monitoring system from service until repairs can be made.

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11 SUPPLEMENTARY INSTRUCTIONS FOR SAFE ADJUSTMENT

11.1 General

Note: Making adjustments to the meter usually interrupts normal function of the meter and its outputs. If the meter is being used in a control loop, this can cause the loop to “open”.

Inform Control Room Personnel that adjustments to the meter are going to be made to allow them to put the control loop into a manual mode of operation until adjustments are complete and the meter is ready to be brought back “on line” in the control loop.

11.2 Transmitter Adjustments

11.2.1 Use of Keypad and RESET Switch

The Zone 2 certification permits the transmitter cover to be opened for short periods of time while the power is ON for the purpose of making software configuration adjustments using the keypad or the RESET button.

This is permitted without the necessity of testing first to be certain that no hazardous gasses are present. However, it is essential that when using the keypad or the RESET switch the wiring within the transmitter not be intentionally or unintentionally disturbed and that the circuitry inside the transmitter be kept clean and dry.

11.2.2 Use of USB Memory Stick Interface

The USB connector is for use of a USB memory stick and is intended only for short-term infrequent use. The USB connector may only be used if the area is known to be free of explosive gas mixtures during the time immediately prior to, during, and after use of the memory stick.

The USB connector is behind a tool-enabled cover. Close and secure this cover over the USB connector after use of the USB interface.

11.2.3 Use of RJ45 Ethernet Connector Interface

This is a diagnostic interface and intended only for short-term infrequent use. The RJ45 Ethernet connector may only be used if the area is known to be free of explosive gas mixtures during the time immediately prior to, during, and after use of the Ethernet interface to connect to a laptop computer for diagnostic purposes.

11.2.4 Use of DB9 RS232 Connector Interface

This is a diagnostic interface and intended only for short-term infrequent use. The DB9 RS232 connector may only be used if the area is known to be free of explosive gas mixtures during the time immediately prior to, during, and after use of the RS232 interface to connect to a laptop computer for diagnostic purposes.

11.3 Sensor Head Adjustments

In normal operation there are no adjustments that need to be made at the sensor head.

12 SUPPLEMENTARY INSTRUCTIONS FOR SAFE MAINTENANCE, SERVICING AND EMERGENCY REPAIR

12.1 General

12.1.1 UOS, OFF And No Explosive Gasses Present

All maintenance, service, and repair should be performed with dead circuits and after testing to make sure that no explosive gas mixtures are present, unless otherwise stated (UOS).

12.1.2 Notify Control Room

Note: In most cases, servicing will interrupt normal functioning of the meter and its outputs. If the meter is being used in a control loop, this can cause the loop to "open". Inform Control Room Personnel that the meter will be "off-line" so the control loop can be placed into a manual mode of operation until adjustments are complete and the meter is ready to be brought back "on line" in the control loop.

12.2 Transmitter

12.2.1 General

12.2.1.1 Ensure There Are No Explosive Gases Present

No connection or disconnection of wiring at any of the terminal blocks in the transmitter shall be performed in the hazardous area without first testing to make sure that no explosive gas mixtures are present.

12.2.1.2 Keep Clean and Dry

Keep the inside of the transmitter enclosure clean and dry.

12.2.2 Mains Power OFF

Wiring of the mains power terminal blocks shall only be performed with the mains power wiring in a de-powered and locked-out safe state.

12.2.3 Fuse Replacement

The two fuses on the power entry board are the only user serviceable fuses. They may only be replaced with the mains power wiring in a de-powered and locked-out safe state. Use only the replacement fuses indicated on the fuse warning label.

12.2.4 Sensor Terminal Blocks

The Sensor Terminal blocks should be wired with the mains power OFF. This ensures that these signals are all de-powered.

12.2.5 Customer Input / Output and Fieldbus Terminal Blocks

To the extent possible, ensure that the equipment on the far end of these lines is de-powered before servicing the associated terminal block connections. If unsure about whether the remote equipment is de-powered, ensure that no explosive gas mixtures are present before servicing.

12.2.6 Electrical Circuitry and Electro-Static Discharge (ESD)

Take simple ESD precautions to protect the electronics such as touching a grounded metal object prior to reaching into the transmitter or sensor head enclosures and avoiding touching the circuit boards with hands, gloves, or sleeves when servicing the system.

12.3 Sensor Head

12.3.1 General

Ensure the inside of the sensor head cover remains clean and dry during installation and inspection.

12.3.2 Sensor Head Electrical Connector

Properly re-install the sensor head connector if it is removed for inspection or troubleshooting.

Note: This cable connector can be removed with the power ON and without the necessity of testing first to be certain that no hazardous gasses are present. Close and latch the dust cover over the connector half that remains on the sensor head cover whenever the sensor head electrical connector on the cable is removed from the sensor head cover. Prevent contamination of the de-mated cable connector. Prior to mating the cable to the cover connector, inspect both halves to ensure they are clean and dry.

12.3.3 Access Panel

Properly re-install the access panel after every time it is opened.

12.3.4 Sensor Band

12.3.4.1 Use of Access Panel

The access panel must be used to gain access to and disconnect the sensor band cable connector from the preamplifier before the sensor head cover can be removed from the pipe. Failure to do this will damage the sensor band.

12.3.4.2 Safety Procedure for Damaged Sensor Bands

The sensor band should be removed from service and taken out of the hazardous area if it has mechanical damage. The damaged sensor band must be treated as a potentially incendive device – even when it is disconnected from a power source. The damaged sensor band should not be handled in or transported through any areas where explosive gas mixtures may be present.

13 SUPPLEMENTARY INSTRUCTIONS FOR SAFE DISASSEMBLY OR DISPOSAL

13.1 Most Warnings Same As For Maintenance

Most warnings are the same as those in Supplementary Instructions for Safe Maintenance, Servicing, and Emergency Repair, in paragraph 12, above. Additions and modifications are described below.

13.2 General

13.2.1 Dead Circuits

Power must be disconnected and testing performed to ensure that no explosive gas mixtures are present during disassembly and/or disposal

13.2.2 Disposal Issues

Refer to Process Monitoring System Installation and Startup Manual for disposal instructions (WEEE considerations).

13.3 Sensor Band

13.3.1 Damaged Sensor Bands

The sensor band should be removed from service and taken out of the hazardous area if it has mechanical damage. The damaged sensor band must be handled as a potentially incendive device even when it is disconnected from a power source. The damaged sensor band should not be handled in or transported through any areas where explosive gas mixtures may be present.

13.3.2 Undamaged Sensor Bands

Handle the band carefully to avoid damaging it (no sharp bend radii and avoid actively flexing it or allowing it to be bumped during transport). If there is any doubt about whether the sensor band might be damaged, follow the handling and transport procedures for damaged sensor bands, above. The original packing foam mandrel packing material should be used for storage. Do not store the sensor band in a hazardous area.

14 TRAINING

Contact CiDRA Customer Support for availability and scheduling of training courses.

15 CONTACT INFORMATION

CiDRA Corporate Services
50 Barnes Park North
Wallingford, Connecticut USA 06492

Telephone numbers

1-877-243-7277	Toll-free in US and Canada
203-265-0035	Elsewhere
203-265-7861	Fax

Email:

customersupport@cidra.com

Annex A 20885-01C, CERTIFICATION, CABLE GLAND, ZONE 2

REVISIONS			
REV	DESCRIPTION	DRAWN	CHECKED
01	INITIAL RELEASE / E07-0041.	JMD 04/23/07	J. DIENER 04/23/07
02	ADDED "GAS GROUP II" TO LAST PARAGRAPH ALLOWING "OTHER" CABLE GLANDS. ZONE B-4 / E09-0074	R. NIEZ 7-1-10	M. FOSS 7-1-10
03	CHANGED "GAS GROUP IIC" TO "GAS GROUP IIB OR IIC" IN LAST PARAGRAPH / E13-0013	DAR 04-26-13	RDH 04-26-13

GLAND MODEL NUMBER FAMILY	Manufacturer Name	P/N:	Range of Cable Outer Sheath Dia. (mm)	Range of Armoured Cable Inner Sheath Dia.
A2F	CMP-Products	25RA2F-7	11.1 - 19.9	N/A
A2F	CMP-Products	25RA2F-5	11.1 - 19.9	N/A
A2F	CMP-Products	25A2F-7	11.1 - 19.9	N/A
A2F	CMP-Products	25A2F-5	11.1 - 19.9	N/A
A2F	CMP-Products	25A2F-075-7	11.1 - 19.9	N/A
A2F	CMP-Products	25A2F-075-5	11.1 - 19.9	N/A
501/421	Hawke International	501/421/B/M25/S	9.5 - 15.4	N/A
501/421	Hawke International	501/421/B/M25	13.0 - 20.2	N/A
501/421	Hawke International	501/421/B/3/4"NPT/S	9.5 - 15.4	N/A
501/421	Hawke International	501/421/B/3/4"NPT	13.0 - 20.2	N/A
HSK-K-EX	Hummell	1.291.2501.31	9.0 - 16.0	N/A
HSK-K-EX	Hummell	1.291.2501.30	13.0 - 18.0	N/A
HSK-K-EX	Hummell	1.291.2501.51	9.0 - 16.0	N/A
HSK-K-EX	Hummell	1.291.2501.50	13.0 - 18.0	N/A
HSK-K-EX	Hummell	1.291.3401.71	9.0 - 16.0	N/A
HSK-K-EX	Hummell	1.291.3401.70	13.0 - 18.0	N/A
HSK-M-EX	Hummell	1.610.2500.31	10.0 - 16.0	N/A
HSK-M-EX	Hummell	1.610.2500.30	14.0 - 18.0	N/A
HSK-M-EX	Hummell	1.640.2500.31	10.0 - 16.0	N/A
HSK-M-EX	Hummell	1.640.2500.30	14.0 - 18.0	N/A
HSK-M-PVDF-EX	Hummell	1.660.2500.31	10.0 - 16.0	N/A
HSK-M-PVDF-EX	Hummell	1.660.2500.30	14.0 - 18.0	N/A
HSK-M-EMV-EX	Hummell	1.616.2500.51	10.0 - 16.0	N/A
HSK-M-EMV-EX	Hummell	1.616.2500.50	14.0 - 18.0	N/A
HSK-M-EMV-EX	Hummell	1.646.2500.51	10.0 - 16.0	N/A
HSK-M-EMV-EX	Hummell	1.646.2500.50	14.0 - 18.0	N/A
HSK-M/MZ-Ex-d	Hummell	1.622.2500.50	13.0 - 18.0	N/A
HSK-M/MZ-Ex-d	Hummell	1.628.2500.50	13.0 - 18.0	N/A
T3CDS	CMP-Products	25T3CDS-5	18.0 - 26.2	11.1 -19.9
T3CDS	CMP-Products	25T3CDS-075-5	18.0 - 26.2	11.1 -19.9
T3CDS	CMP-Products	25T3CDS-PG21-5	18.0 - 26.2	11.1 -19.9
T3CDS	CMP-Products	25ST3CDS-7	14.0 - 22.0	11.1 -19.9
T3CDS	CMP-Products	25ST3CDS-075-7	14.0 - 22.0	11.1 -19.9
T3CDS	CMP-Products	25ST3CDS-PG21-7	14.0 - 22.0	11.1 -19.9
U 2. UNI Dicht EEx	Pflitsch	22553di16exzu	11.5 - 15.5	N/A
U 2. UNI Dicht EEx	Pflitsch	22553dp16exzu	11.5 - 15.5	N/A
U 2. UNI Dicht EEx	Pflitsch	22553di16ex	11.5 - 15.5	N/A
U 2. UNI Dicht EEx	Pflitsch	22553dp16ex	11.5 - 15.5	N/A

NOTES:

THE CABLE GLANDS USED IN THE CABLE ENTRY HOLES OF THE TRANSMITTER ENCLOSURE SHALL BE ONE OF THE FOLLOWING:

TYPE A2F CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY CMP PRODUCTS LIMITED OF THE UNITED KINGDOM. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER SIRA 02ATEX1057X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE 501/421 CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY HAWKE INTERNATIONAL OF THE UNITED KINGDOM. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER BASEEFA06ATEX0056X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE HSK-K-EX 129*.**0*.** CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY HUMMEL ELEKTROTECHNIK GMBH OF GERMANY. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER DMT 02 ATEX E 047 X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE HSK-M-EX 1610.****.**, AND TYPE HSK-M-EMV-EX 1616.****.** CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY HUMMEL ELEKTROTECHNIK GMBH OF GERMANY. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER DMT 03 ATEX E 051 X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE HSK-M-EX, HSK-M-PVDF-EX, AND HSK-M-EMV-EX CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY HUMMEL ELEKTROTECHNIK GMBH OF GERMANY. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER KEMA 99ATEX6971X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE HSK-M-EX-d AND HSK-MZ-EX-d CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY HUMMEL ELEKTROTECHNIK GMBH OF GERMANY. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER KEMA 99ATEX6968X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE T3CDS CABLE GLANDS FOR STEEL-WIRE-ARMOURED, STRIP-ARMOURED, OR BRAID-ARMOURED CABLES MANUFACTURED BY CMP PRODUCTS LIMITED OF THE UNITED KINGDOM. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER SIRA 00ATEX1148X. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

TYPE U 2. UNI DICHT EEx e II CABLE GLANDS FOR UNARMOURED CABLE MANUFACTURED BY PFLITSCH GMBH & CO KG OF GERMANY. THESE ARE ATEX CERTIFIED GLANDS UNDER CERTIFICATE NUMBER PTB 98 ATEX 3109. SEE TABLE FOR A PARTIAL LIST OF THE CABLE GLANDS IN THIS FAMILY.

ANY OTHER ATEX-APPROVED GAS GROUP II OR GAS GROUP IIB OR IIC CABLE GLAND WITH MINIMUM ENVIRONMENTAL RATINGS OF IP55 AND AN AMBIENT TEMPERATURE RANGE OF -20C TO +60C USED IN ACCORDANCE WITH THE MANUFACTURER'S GUIDELINES ON CABLE TYPES AND SIZES, TEMPERATURES, AND ANY SPECIAL CONDITIONS OF USE REQUIREMENTS.

CERTIFICATION DRAWING

MATERIAL:	HEAT TREAT:	FINISH:
NA	NA	NA

CIDRA ENGINEERING CAD FILE NUMBER: 20885-01c.SLDDRW

UNLESS OTHERWISE SPECIFIED
~~PART MUST BE FREE OF BURRS AND/OR FLASH~~
~~BREAK SHARP EDGES .002-008~~
~~FILLET RADII .005 MAX~~
~~DIMENSIONS ARE IN INCHES & APPLY AFTER FINISH~~
~~SURFACE FINISH 63/ MAX~~

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APPROVAL	BY	DATE
DRAWN	JMD	2/14/07
CHECKED	J. DIENER	2/14/07
ENGRG	C. WINSTON	2/15/07
MFG	J. CIPRIANO	2/15/07

TOLERANCES
.XXX ±.005 FRAC ±1/64
.XX ±.01 ANGLES ±1°
INTERPRET DWG PER ASME Y14.5M-1994
DIMS IN PARENTHESIS () ARE REF ONLY
DO NOT SCALE DWG

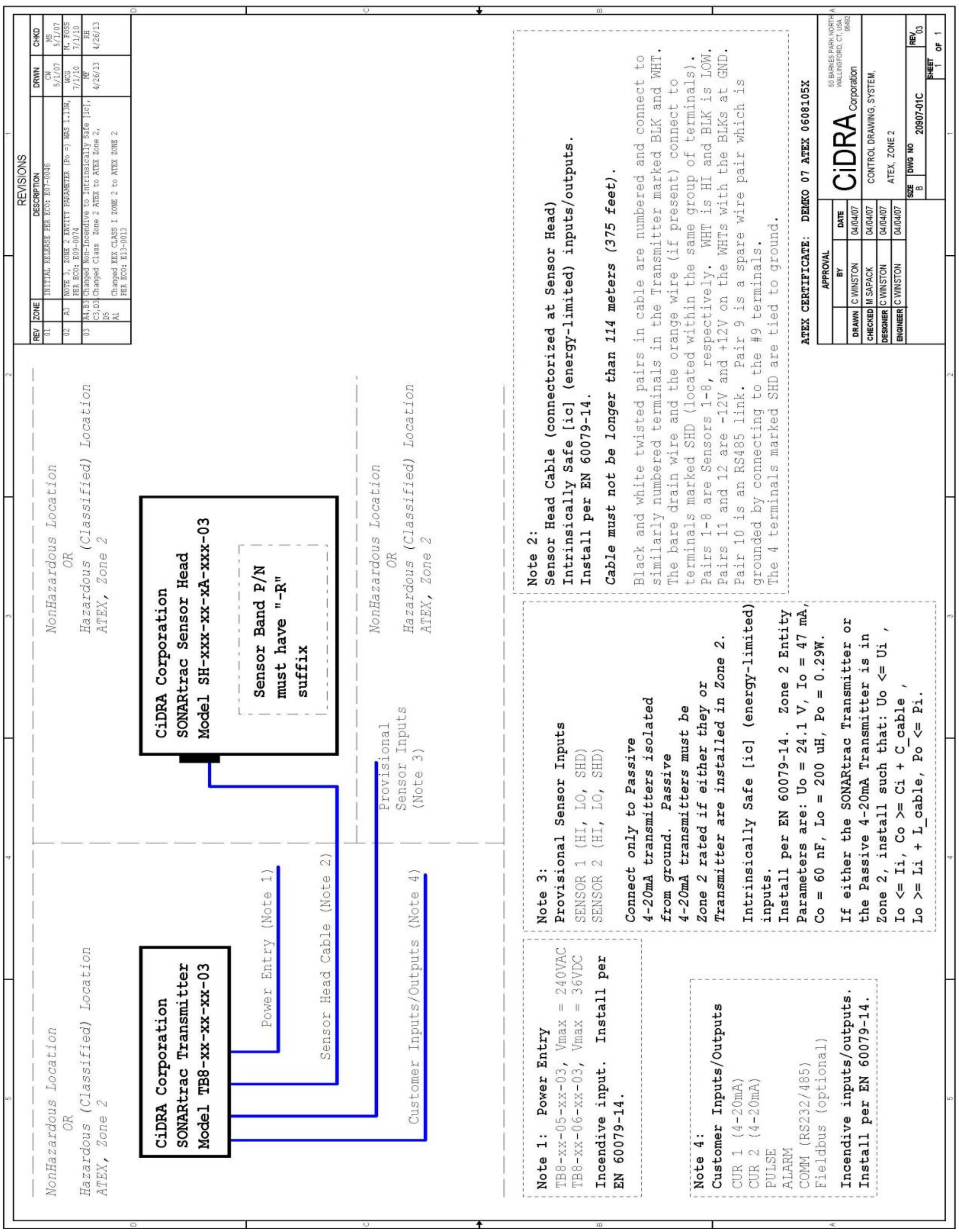
CIDRA 50 BARNES PARK NORTH WALLINGFORD CT, USA 06492

CERTIFICATION, CABLE GLAND, ZONE 2

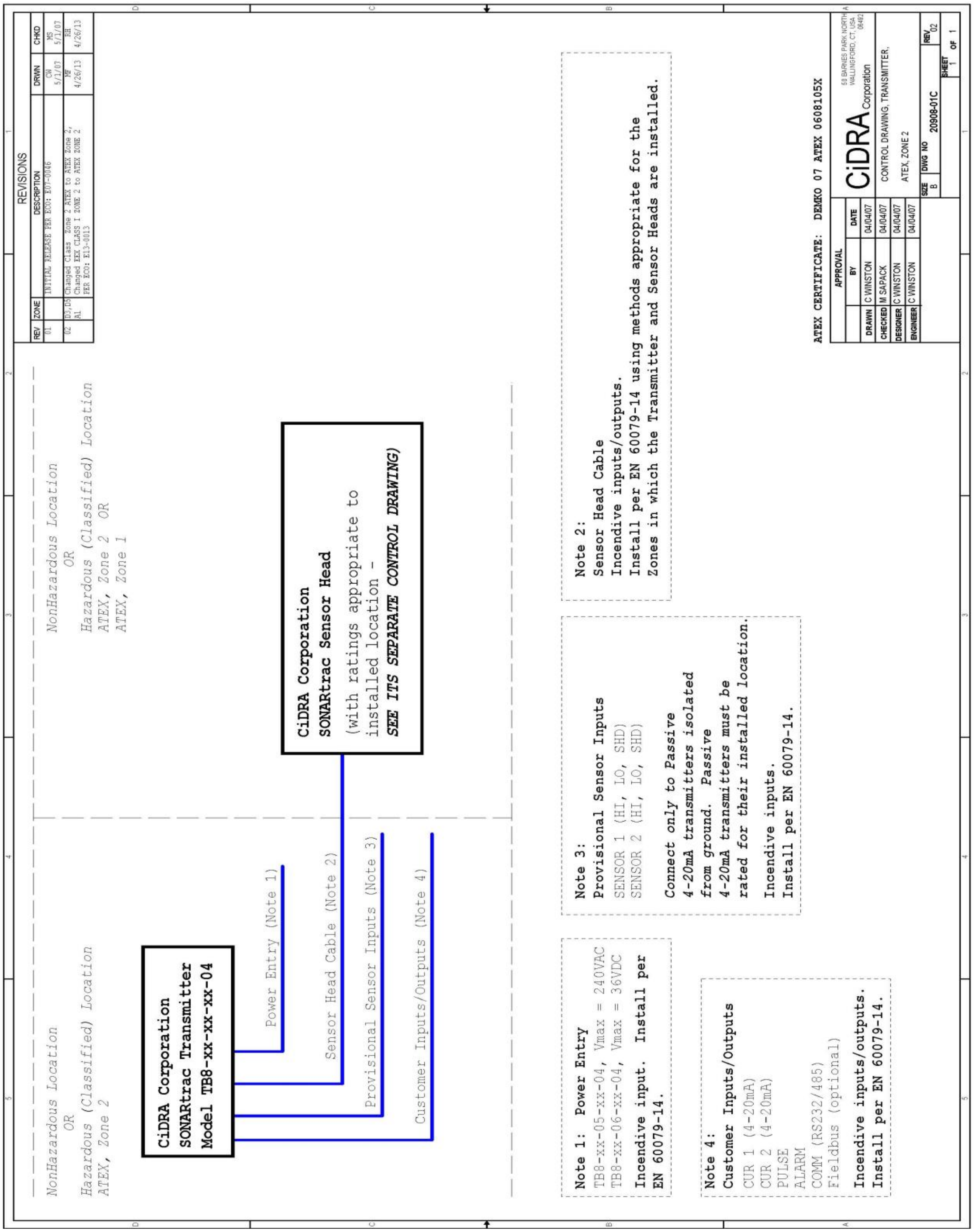
D DWG NO 20885-01c REV 03

SCALE: NTS SHEET 1 OF 1

Annex B 20907-01C, CONTROL DRAWING, SYSTEM, ATEX ZONE 2



Annex C 20908-01C, CONTROL DRAWING, TRANSMITTER, ATEX ZONE 2



14 38-INCH DIAMETER AND LARGER SENSOR HEAD SUPPLEMENTAL INSTALLATION & STARTUP MANUAL

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14.1 Introduction

This chapter is intended to supplement the information in Chapter 5, Sensor Installation, of this manual. The information contained in this supplement pertains to installing and startup of 38-inch diameter and larger passive sonar sensor head assemblies. There are sensor head installation differences between the 38-inch and larger sizes vs. the smaller sizes, and there are different transmitter settings that must be used.

The Installation Manual, in particular Chapter 5, should be read and understood prior to installing the 38-inch and larger sensor head.

For additional information, contact your local sales agent or CiDRA Corporate Services Customer Support by telephone at (203) 265-0035, in the US or Canada at 1-877-243-7277 (1-877-CIDRA77), or by E-Mail at: customersupport@cidra.com.

14.2 Sensor Head Installation

The following figures illustrate the 38-inch and larger sensor band installation.

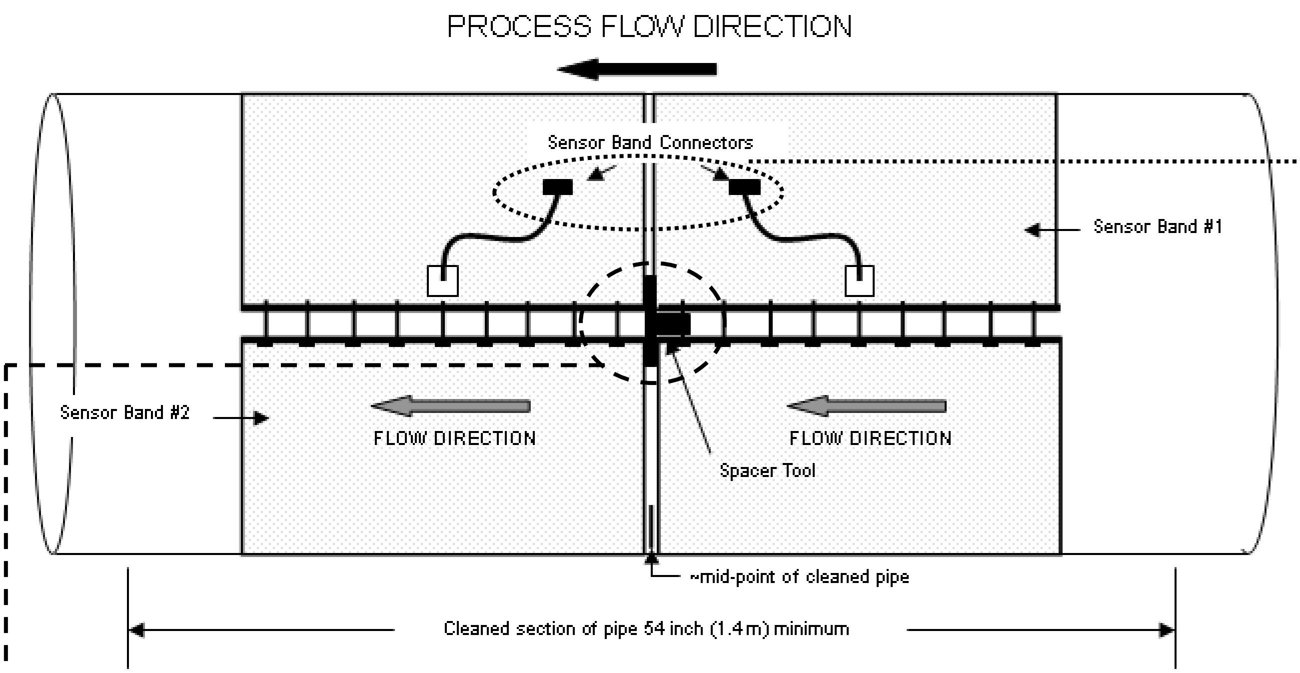

Figure 1 Sensor Band Installation

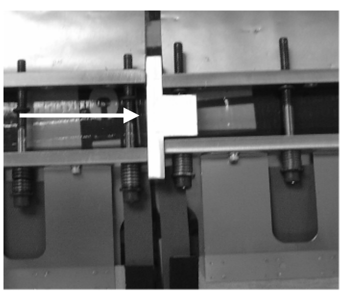

Figure 2 Sensor Band Spacer Tool Installed on Bands

Figure 4 "Y" Connector Plugged into Sensor Band Connectors (P2 Upstream Band, P3 Downstream Band, P1 to Pre-Amp)

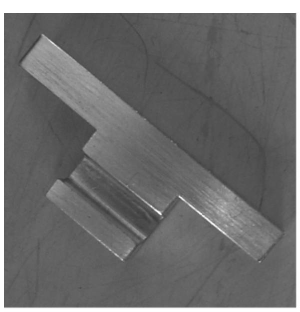

Figure 3 Sensor Band Spacer Tool

Figure 5 "Y" Connector Plug Assembly Close-up

The 38-inch and larger sensor head uses 2 sensor bands that are electrically coupled together.

Note: The upstream sensor band (with respect to process flow direction) is referred to as Band #1. The downstream sensor band (with respect to process flow direction) is referred to as Band #2.

14.2.1 Process Pipe Cleaning and Marking

Clean the process pipe a minimum distance of 54-inch along the pipe surface.

Place a reference mark at the center of the cleaned pipe surface.

14.2.2 Sensor Band Installation

Install the sensor bands as follows:

1. Install Band #1 with the downstream edge of the sensor band aligned within ¼-inch (6.4mm) of the mid-point reference mark placed on the pipe. (Figure 1) Refer to Chapter 5 for sensor band installation instructions.
2. Tighten the sensor band fasteners per the tightening instructions in Chapter 5 (slowly tighten screws alternating from side to side).
3. Wrap Band #2 around the process pipe and insert the sensor band alignment pins in their corresponding holes.
4. Insert the recess in the Sensor Band Spacer Tool over the downstream sensor band screw on sensor band #1. The edge of the tool should be flush with the sensor band #1 rails. (Figures 1, 2, 3)
5. Align the attachment rails of sensor band #2 flush against the sensor band spacer tool. The rails of the two sensor bands should be aligned within ~¼-inch (6.4mm). (Figure 2)
6. Tighten sensor band #2 per Chapter 5 of this Manual.
7. Remove the sensor band spacer tool.
8. Install the sensor band insulating blanket. Carefully thread the sensor band connector cable assemblies through the opening on the blanket.
9. Install the sensor band connector #1 and #2 into their respective connectors on the “Y” Connector Plug Assembly. (Figures 1, 4, 5)
10. Remove the sensor band cover electronics access panel. Refer to Section 5 of the Installation & Startup Manual for cover installation details.

Figure 6   Sensor Bands Installed on Pipe

Figure 7   54" and 16" Installed Sensor Heads

14.3 Transmitter Startup

The following changes must be made in the configuration file when setting up the 38-inch and larger sensor head system.

14.3.1 Flow Tab

Use the Field Service Utility (FSU). Manually input either the pipe **Outer Diameter** or **Inner Diameter** and the **Wall Thickness**. There are no values for pipe sizes greater than 36 inches in the pipe Size / Schedule menu selection.

14.3.2 Sensor Tab

Use the FSU. The sensor spacing values must be changed to reflect those used with the 38-inch and larger sensor. Refer to the following Table for the new values:

Sensor #	Standard Product Spacing (ft)	38-inch and larger Sensor Band Spacing (ft)
1	0.0	0.0
2	0.2	0.4
3	0.4	0.8
4	0.6	1.2
5	0.8	1.6
6	1.0	2.0
7	1.2	2.4
8	1.4	2.8

Table 1 Sensor Spacing

14.3.3 Flow Algo Tab

Use the FSU. De-select Dynamic Nyquist in the Operating Mode section. Set the Nyquist High value to 0.65 and the Nyquist Low value to 0.05 to start in the Flow section. Additional changes may be necessary.

14.3.4 USB Port

Alternatively, the transmitter changes can be saved to a USB stick and loaded through the USB Port.

15 USE OF FOUNDATION FIELDBUS AND PROFIBUS PA WITH PASSIVE SONAR PROCESS FLOW MONITORING SYSTEMS

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List of Figures

List of Tables

15.1 Introduction

This document is intended as an overview of configuration and use of FOUNDATION Fieldbus and Profibus PA on the passive sonar process flow monitoring system transmitter.

National Instruments Configurator will be used to demonstrate the functionality available using FOUNDATION Fieldbus protocol, but other Fieldbus configuration tools may also be used. Refer to Appendix A for example.

Siemens SIMATIC PDM will be used to demonstrate the functionality available using Profibus PA protocol, but other Profibus configuration tools may also be used. Refer to Appendix B for example.

15.2 FOUNDATION Fieldbus and Profibus PA Block Definitions

15.2.1 Resource Blocks

Resource blocks contain the hardware specific characteristics associated with a device; they have no input or output parameters. The algorithm within a resource block monitors and controls the general operation of the physical device hardware. The execution of this algorithm is dependent on the characteristics of the physical device, as defined by the manufacturer. As a result of this activity, the algorithm may cause the generation of events. There is only one resource block defined for a device. For example, when the mode of a resource block is "out of service," it impacts all of the other blocks.

15.2.2 Transducer Blocks

Transducer blocks connect function blocks to local input/output functions. They read sensor hardware and write to effector (actuator) hardware. This permits the transducer block to execute as frequently as necessary to obtain good data from sensors and ensure proper writes to the actuator without burdening the function blocks that use the data. The transducer block also isolates the function block from the vendor specific characteristics of the physical I/O.

15.2.3 Analog Input Blocks

The Analog Input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes. The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output parameter (OUT) reflects the process variable (PV) value and status. In Manual mode, OUT may be set manually. The Manual mode is reflected on the output status. A discrete output (OUT_D) is provided to indicate whether a selected alarm condition is active. Alarm detection is based on the OUT value and user specified alarm limits.

15.2.4 Analog Output Blocks

The Analog Output (AO) function block assigns an output value to a field device through a specified I/O channel. The block supports mode control, signal status calculation, and simulation.

15.2.5 PID Block

A Proportional/Integral/Derivative (PID) Function Block is not available.

15.3 Configuration & Connection

15.3.1 Configuration

There are no configuration settings necessary on the passive sonar transmitter for FOUNDATION Fieldbus or Profibus PA. The protocol itself enables devices to be automatically assigned addresses, etc. The transmitter firmware forces communication to be set to the required baud rate to work with the Softing FBK Fieldbus or Profibus interface hardware. Loading an INI file cannot change these settings.

15.3.2 Connection

If so equipped, the transmitter hardware includes a two-conductor connector designated for Fieldbus / Profibus. The connections are not polarity sensitive.

Fieldbus / Profibus terminals

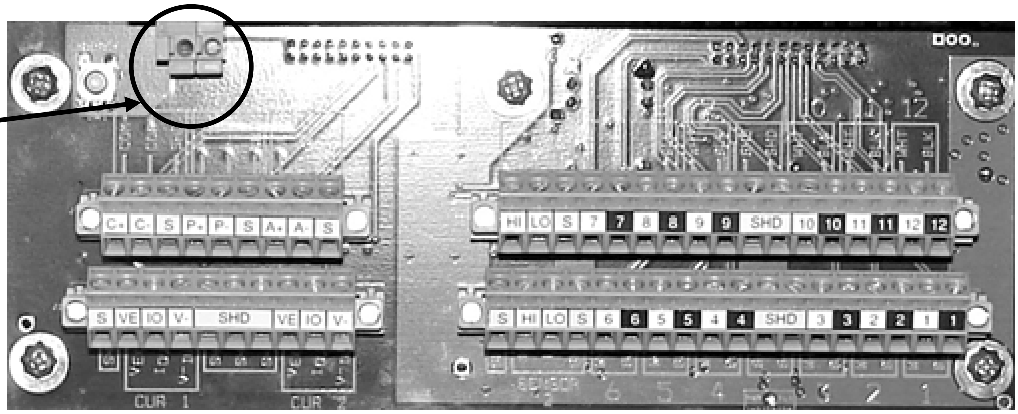

Figure 1 Fieldbus / Profibus Terminals on Connector Board

Transmitters that support Fieldbus / Profibus will not support RS-232/RS-485 communications or Modbus on the COM+/COM- terminal connections as these signals are used for the Fieldbus interface and are not available as an external communications interface.

15.4 Making Changes to Transmitter Using A Fieldbus Host

To change the configuration to the transmitter using a Fieldbus or Profibus Host, perform the following steps:

- Place the Transducer Block Out Of Service (OOS)
- Write any changes to the variables in the Transducer Block
- Place the Transducer Block to Auto Mode

When transmitter is placed into Auto Mode, it will validate any changes made. Invalid changes will be returned to their previous value.

15.5 Input, Output and Transducer Blocks

15.5.1 Analog Input Blocks

The following table lists the analog input blocks.

Channel	Analog Input Block	Data Type
1	FLOW_RATE	Float
2	GVF	Float
3	SOS	Float
4	SENSORHEAD_TEMPERATURE	Float
5	TOTAL_FLOW	Float
6	OUTPUT_1	Float
7	OUTPUT_2	Float
8	OUTPUT_3	Float
9	OUTPUT_4	Float

Table 1 Analog Input Blocks

15.5.2 Analog Output Blocks

The following table lists the analog output blocks.

Channel	Analog Output Block	Data Type
10	PRESSURE_INPUT	Float
11	TEMPERATURE_INPUT	Float
12	INPUT_1	Float
13	INPUT_2	Float
14	INPUT_3	Float

Table 2 Analog Output Blocks

15.5.3 Transducer Block

Table 3 on the following pages list all transducer block variables.

Table 3 Transducer Block Configurations

Parameter / Structure Name	**Data Type**	**Access**	**Help**
CONTROL			
WRITE_CONTROL	Unsigned16	R/W	Controls ability to write and commit changes to transmitter configuration.
RESET_TOTALIZER	Unsigned16	R/W	Resets all totalizers to zero.
CLEAR_ALARM	Unsigned16	R/W	Clear any existing alarms.
CLEAR_DATA_HISTORY	Unsigned16	R/W	Clears the data history memory.
DEVICE_INFO			
PSN_TRANSMITTER_S/N	Octet String	R	Transmitter Serial Number
PSN_MODEL_NUMBER	Octet String	R	Transmitter Model Number
PSN_SOFTWARE_REVISION	Octet String	R	Transmitter Software Revision
PSN_ALCHEMY_SOFTWARE_REVISION	Octet String	R	Alchemy Software Revision
PSN_SENSORHEAD_S/N	Octet String	R	Sensor head Serial Number
PSN_PREAMP_SOFTWARE_REVISION	Octet String	R	Preamp Software Revision
PSN_PREAMP_SERIAL_NUMBER	Octet String	R	Preamp Serial Number
PIPE_INFORMATION			
PIPE_DIAMETER_INPUT_MODE	Unsigned Char	R/W	Selects method used to set pipe dimensions.
PIPE_DIAMETER_UNITS	Unsigned Char	R/W	Selects units used for 'Pipe ID'.
PIPE_ID	Float	R/W	Pipe Inside Diameter Measurement. Will only be applied if 'Inside Diameter' is selected for 'Pipe Diameter Input Mode'.
PIPE_OD	Float	R/W	Pipe Outside Diameter Measurement. Will only be applied if 'Outside Diameter / Wall Thickness' is selected for 'Pipe Diameter Input Mode'.
PIPE_OD_WALL_UNITS	Unsigned Char	R/W	Selects units used for 'Pipe OD' and 'Pipe Wall Thickness'. Will only be applied if 'Outside Diameter / Wall Thickness' is selected for 'Pipe Diameter Input Mode'.

Table 3   Transducer Block Configurations (Page 2)

PIPE_WALL_THICKNESS	Float	R/W	Pipe wall thickness measurement in selected units.
PIPE_SIZE	Unsigned Char	R/W	Selects pipe size. Will only be applied if 'Size / Schedule' is selected for 'Pipe Diameter Input Mode'.
PIPE_SCHEDULE	Unsigned Char	R/W	Selects pipe schedule. Will only be applied if 'Size / Schedule' is selected for 'Pipe Diameter Input Mode'.
SOS_PIPE_WALL_THICKNESS_UNITS	Unsigned Char	R/W	Selects units used for 'SOS Pipe Wall Thickness'.
SOS_PIPE_WALL_THICKNESS	Float	R/W	SOS pipe wall thickness measurement in units selected by 'SOS Pipe Wall Thickness Units'.
SOS_PIPE_MODULUS_SELECTION	Unsigned Char	R/W	Selects either a pre-defined modulus* or the option to enter a custom value. Select 'Custom' to enter a value in 'SOS Pipe Modulus'.
SOS_PIPE_MODULUS	Float	R/W	SOS pipe modulus value.
FLUID_PROPERTIES			
FLOW_VISCOSITY	Float	R/W	Viscosity in Pascal seconds of the fluid at the operating conditions. Used for Reynolds correction.
SOS_GAS_CONSTANT_SELECTION	Unsigned Char	R/W	Selects use of pre-defined SOS Gas Constant or a custom value* entered in 'SOS Gas Constant'.
SOS_SPECFIC_GRAVITY_SELECTION	Unsigned Char	R/W	Selects use of pre-defined SOS Specific Gravity or a custom value* entered in 'SOS Specific Gravity'.
SOS_LIQUID_SOUND_SPEED_SELECTION	Unsigned Char	R/W	Selects use of pre-defined SOS Liquid Sound Speed or a custom value* entered in 'SOS Liquid Sound Speed'
SOS_GAS_CONSTANT	Float	R/W	Gas constant value used in GVF calculation.
SOS_SPECIFIC_GRAVITY	Float	R/W	This parameter (internally multiplied by 1000 kg/m^3) is used to set the 'SOS Liquid Density'. For example* Specific Gravity = 1.1 equates to density of 1.1 * 1000 kg/m^3
SOS_LIQUID_SOUND_SPEED	Float	R/W	Pure phase liquid SOS for process fluid in ft/sec. Used for GVF calculation. Default setting is for water* and is close enough for most fluid/gas applications.
SOS_POLYTROPIC_EXPONENT	Float	R/W	Polytrophic exponent in GVF calculations.
SOS_LIQUID_DENSITY	Float	R	Calculated from 'SOS Specific Gravity'.

Table 3   Transducer Block Configurations (Page 3)

ENVIRONMENT			
SOS_TEMPERATURE_INPUT_SELECTION	Unsigned Char	R/W	Selects the source of the temperature used in GVF calculations. 'Fixed' uses 'SOS Process Temperature'* 'Sensor 1' uses the 4-20mA input channel 1* 'Sensor 2' uses 4-20mA input channel 2* Protocol uses values written to Fieldbus AO Channel 11.
SOS_PRESSURE_INPUT_SELECTION	Unsigned Char	R/W	Selects the source of the pressure used in GVF calculations. 'Fixed' uses 'SOS Process Pressure'* 'Sensor 1' uses the 4-20mA input channel 1* 'Sensor 2' uses 4-20mA input channel 2* Protocol uses values written to Fieldbus AO Channel 10.
SOS_TEMPERATURE_UNITS	Unsigned Char	R/W	Selects units used for input of 'SOS Process Temperature'.
SOS_PRESSURE_UNITS	Unsigned Char	R/W	Selects units used for input of 'SOS Process Pressure'.
SOS_PROCESS_TEMPERATURE	Float	R/W	Constant temperature for GVF calculations when 'Fixed' is selected for 'SOS Temperature Input Selection'. In configured units.
SOS_PROCESS_PRESSURE	Float	R/W	Constant pressure for GVF calculations when 'Fixed' is selected for 'SOS Pressure Input Selection'. In configured units.
ALTITUDE_UNITS	Unsigned Char	R/W	Selects units used for entry of 'Altitude'.
ALTITUDE	Float	R/W	Altitude correction applied to SOS pressure. In configured units.
DISPLAY			
FLOW_VOLUME_UNITS	Unsigned Char	R/W	Selects units used to display and log flow volume.
FLOW_TIME_UNITS	Unsigned Char	R/W	Selects units used to display and log flow time.
FLOW_LOW_CUTOFF_PCT	Float	R/W	Low flow cutoff as a % of flow measurement range (defined by 'Flow Min' and 'Flow Max'). Will not display or output flow reading if flow rate is below this setting.

Table 3 Transducer Block Configurations (Page 4)

FLOW_HIGH_CUTOFF_PCT	Float	R/W	High flow cutoff as a % of flow measurement range (defined by Flow Min and Flow Max). Will not display or output flow reading if flow rate is above this setting.
FLOW_CUSTOM_BASE_VOLUME_UNIT	Unsigned Char	R/W	Selects volume units used in calculation of a custom unit.
FLOW_CUSTOM_BASE_TIME_UNIT	Unsigned Char	R/W	Selects time units used in calculation of a custom unit.
FLOW_CUSTOM_VOLUME_UNIT_LABEL	Octet String	R/W	Three character string used for display and logging of a custom flow volume unit.
FLOW_CUSTOM_TIME_UNIT_LABEL	Octet String	R/W	Two character string used for display and logging of a custom flow time unit.
FLOW_CUSTOM_VOLUME_UNIT_MULTIPLIER	Float	R/W	Scale applied to 'Flow Custom Base Volume Unit' for calculation of a custom volume unit.
FLOW_CUSTOM_TIME_UNIT_MULTIPLIER	Float	R/W	Scale applied to 'Flow Custom Base Time Unit' for calculation of a custom time unit.
FLOW_QUALITY_DELTA	Float	R/W	Delta change from minimum quality at minimum flow (MIN_QUALITY) to minimum quality at max flow (MIN_QUALITY+ 'Flow Quality Delta'). Zero (0) indicates no variable quality.
GVF_DECIMAL_PLACES	Unsigned Char	R/W	Sets the number of decimal places used to display GVF on the front panel.
SOS_MEASUREMENT_UNITS	Unsigned Char	R/W	Selects units used for display and log of SOS.
SOS_QUALITY_DELTA	Float	R/W	Delta change from SOS minimum quality at minimum SOS (SOS_MIN_QUALITY) to minimum quality at max SOS (SOS_MIN_QUALITY+ 'SOS Quality Delta'). Zero (0) indicates no variable quality.
SYSTEM			
SYSTEM_CONFIG_MODE	Unsigned Long	R/W	Sets operating mode of the transmitter. VF Mode = 0* SOS Mode = 1* Both Mode = 2.

Table 3   Transducer Block Configurations (Page 5)

UPDATE_RATE	Unsigned Long	R/W	Sets transmitter update rate. Defines time units in number of blocks. This parameter will set the update rate in seconds (nominally). Actual update rate (in seconds) can be calculated by taking (BLOCK_SIZE / SAMPLE_FREQ) * UPDATE_RATE (VF mode) or (BLOCK_SIZE / SOS_SAMPLE_FREQ) * UPDATE_RATE (SOS mode).
SENSORS_IN_USE	Unsigned Long	R/W	Sets number of sensors. Always leave set to 8. Do not use this parameter to disable a sensor* use NUM_SENSORS_USED parameter to set which sensors to use in calculations.
TRANSMITTER_GAIN	Float	R/W	Set gain stage before A/D converter in transmitter. This is NOT sensor head gain (preamp gain). It is normally not a parameter which is modified. Use with caution. Choose one of the following values: 1.0* 5.0* 20.0* 24.0* 48.0* 52.0* 67.0* 71.0* 202.0* 207.0* 221.0* 225.0* 250.0* 254.0* 269.0* 272.0
SPL_THRESHOLD	Float	R/W	This value is the threshold that the Average SPL must break in order for any SOS or VF calculations to be performed. A quality of -2 is reported if this threshold is not met. Set this value to 0 to disable SPL.
WRITE_PROTECT	Unsigned Char	R/W	Enable or disable modifications to the transmitter FLASH memory. When modifying this* change only this for proper operation.
IDLE_TIMEOUT	Short	R/W	If the transmitter is in idle mode* and no communications are detected on a serial or Ethernet port for this time period* transmitter will automatically go to run mode. A setting of 0 disables this.
ETHERNET_IDLE_TIMEOUT	Short	R/W	If no communications are detected on the Ethernet port for this time period* transmitter will automatically close the connection. A setting of 0 disables this timeout.
SYSTEM_DYNAMIC			
SPL_AVERAGE	Float	R	The average SPL measurement from all active sensors.

Table 3 Transducer Block Configurations (Page 6)

SPL_STD_DEV	Float	R	The standard deviation of the SPL measurements from all active sensors.
PREAMP			
PREAMP_GAIN	Unsigned Char	R/W	Gain selection for the preamp. Set a value 0 thru 3 to choose gain listed by 'Preamp Gain 0'* 'Preamp Gain 1'* 'Preamp Gain 2' or 'Preamp Gain 3'
PREAMP_AUTO_GAIN_MODE	Unsigned Long	R/W	Preamp Auto Gain Mode
PREAMP_CHARGE_GAIN	Float	R	Charge gain as read from the preamp.
PREAMP_GAIN_0	Float	R	Preamp Gain 0 as read from the preamp.
PREAMP_GAIN_1	Float	R	Preamp Gain 1 as read from the preamp.
PREAMP_GAIN_2	Float	R	Preamp Gain 2 as read from the preamp.
PREAMP_GAIN_3	Float	R	Preamp Gain 3 as read from the preamp.
FLOW_ALGORITHM			
FLOW_SAMPLE_FREQ	Float	R/W	Set A/D sample frequency in samples per second. Enter one of the following: 3906.25* 2055.921.
FLOW_CHANNEL_SKEW	Float	R/W	Flow Channel Skew
FLOW_FREQ_MIN	Float	R/W	Set minimum frequency for k-w processing. Normally set by DSP. User modified if using single or fixed modes or auto mode with VF_OP_MODE_SETTINGS set to 1 (FIXED_FREQUENCY). Go to Idle mode* then set this parameter* then select single/fixed.
FLOW_FREQ_MAX	Float	R/W	Set maximum frequency for k-w processing. Normally set by DSP. User modified if using single or fixed modes or auto mode with VF_OP_MODE_SETTINGS set to 1 (FIXED_FREQUENCY). Go to Idle mode* then set this parameter* then select single/fixed.
FLOW_RATE_MIN	Float	R/W	Minimum valid flow rate reading in configured display units.
FLOW_RATE_MAX	Float	R/W	Maximum valid flow rate reading in configured display units.
FLOW_MIN_QUALITY	Float	R/W	Minimum quality threshold for VF display and output.

Table 3 Transducer Block Configurations (Page 7)

FLOW_NYQUIST_HIGH	Float	R/W	Define high end of frequency range to use for determining flow velocity. Defined by: FREQUENCY_MAX = (Measured Velocity * VF_NYQUIST_HIGH) / Sensor Spacing. Example: (10 ft/sec*0.7) / 0.2 = 35Hz
FLOW_NYQUIST_LOW	Float	R/W	Define low end of frequency range to use for determining flow velocity. Defined by: FREQUENCY_MIN = (Measured Velocity * VF_NYQUIST_LOW) / Sensor Spacing. Example: (10 ft/sec*0.3) / 0.2 = 15Hz
FLOW_CENTROID_WIDTH	Float	R/W	Define width of peak to use in calculation of flow rate.
FLOW_VEL_SEARCH_LIMIT_LOW	Float	R/W	Define low end of velocity search range to use for determining flow velocity. Defined by: Velocity_Min = (FREQ_MAX * Sensor Spacing) / VF_SEARCH_LIMIT_LOW. Example: at 10ft/sec* (10 ft/sec*0.7) / 0.2 = 35Hz then (35Hz * 0.2) / 0.9 = 7.78 ft/sec. This defines the start ft/sec search point for the actual flow velocity peak. Must be set greater than value set for VF_NYQUIST_HIGH.
FLOW_VEL_SEARCH_LIMIT_HIGH	Float	R/W	Define high end of velocity search range to use for determining flow velocity. Defined by: Velocity_Max = (FREQ_MIN * Sensor Spacing) / VF_SEARCH_LIMIT_HIGH. Example: at 10ft/sec* (10 ft/sec*0.3) / 0.2 = 15Hz then (15Hz * 0.2) / 0.15 = 20 ft/sec. This defines the start ft/sec search point for the actual flow velocity peak. Must be set less than value for VF_NYQUIST_LOW.
FLOW_NYQUIST_INITIAL_VALUE	Float	R/W	This parameter selects the k value (from k-w) where the algorithm initially searches for the flow rate.
FLOW_DECIMATION	Unsigned Long	R/W	Flow Decimation
FLOW_WINDOW_TYPE	Unsigned Long	R/W	Algorithms always use Hanning window. Windows raw data samples of NFFT size* then zero pads* then computes FFT.
FLOW_DETREND	Unsigned Long	R/W	Enable/disable detrend of time series data of NFFT size before windowing and zero padding. 0 - Do not detrend time series data* 1 - Detrend time series data.

Table 3 Transducer Block Configurations (Page 8)

FLOW_NORMALIZATION	Unsigned Long	R/W	Enable/disable normalization of sensor data. 0 - No normalization* 1 - Normalize data. Normalization performed in frequency domain.
FLOW_DIFFERENCING	Unsigned Long	R/W	Enable/disable differencing of sensors. 0 - No differencing* 1 - difference sensors using first order differencing. (i.e. Ch1=S1-S2* Ch2=S2-S3...Ch7=S7-S8). 2 - second order differencing (i.e. Ch1=S1-2*S2+S3* Ch2=S2-2*S3+S4...) Calculation performed in frequency domain.
FLOW_DIRECTION	Unsigned Long	R/W	Define flow direction.
FLOW_WINDOW_SIZE_MULTIPLIER	Unsigned Long	R/W	Default values are normally OK. Define target number of passes through array per calculation for volumetric flow. Use with caution.
FLOW_PEAK_SEARCH_MODE	Unsigned Long	R/W	0 - Velocity search limits set to FLOW_MIN and FLOW_MAX* 1 - Velocity search limits defined by VF_SEARCH_LIMIT_LOW and VF_SEARCH_LIMIT_HIGH.
FLOW_OPERATING_MODE	Unsigned Long	R/W	Determines which VF parameters to fix or calculate during a VF calculation and whether or not to use Linear/Log KW diff. Bit Mapped Values: 0: Dynamic frequency adjust in auto run mode (original calculation) 1: Fixed frequency in auto run mode 2: Fixed blocks in auto run mode 4: Dynamic Nyquist calculation enable 8: Reserved for future use 16: Linear KW diff enable 32: Log KW diff enable
FLOW_QUALITY_MODE	Unsigned Long	R/W	0 selects original VF quality calculation* 1 selects new VF quality calculation.
FLOW_ALGORITHM_DYNAMIC			
FLOW_DATA_LENGTH	Unsigned Long	R/W	Define number of blocks used for calculations.
FLOW_WINDOW_SIZE	Unsigned Long	R/W	Number of points used in FFT. Actual FFT size is next 2^n higher value. Value of NFFT is zero padded to next larger 2^n FFT size. This value is normally set by the DSP.

Table 3 Transducer Block Configurations (Page 9)

FLOW_WINDOW_OVERLAP	Unsigned Long	R/W	Define overlap of FFT windows. This value is normally set by DSP to half of NFFT.
FLOW_WINDOW_AVERAGES	Unsigned Long	R/W	Default values are normally OK. In general* for slower flow rates* use more FFT averages* for faster flow rates* use fewer FFT averages. This parameter affects the number of blocks used (there is a 20 block maximum due to DSP memory limitations). Use with caution.
FLOW_CALIBRATION			
FLOW_CAL_COEFF_C0	Float	R/W	Volumetric flow calibration coefficient C0.
FLOW_CAL_COEFF_C1	Float	R/W	Volumetric flow calibration coefficient C1.
FLOW_CAL_COEFF_C2	Float	R/W	Volumetric flow calibration coefficient C2.
SOS_ALGORITHM			
SOS_SAMPLE_FREQ	Float	R/W	Set sample frequency for SOS mode. This parameter must be set for SOS* and overrides the SAMPLE_FREQ setting if running in SOS mode. Enter one of the following: 3906.25* 2055.921.
SOS_FREQ_MIN	Float	R/W	Minimum frequency to use for SOS calculation. Typically in the 100 to 500hz range. Depends upon the data quality as seen on the k-w plot. SOS_FREQ_MIN and SOS_FREQ_MAX set the frequency range over which the SOS calculation will be performed. The larger this range* the longer the calculations will take.
SOS_FREQ_MAX	Float	R/W	Maximum frequency to use for SOS calculation. Typically in the 800 to 1500hz range. Depends upon the data quality as seen on the k-w plot. SOS_FREQ_MIN and SOS_FREQ_MAX set the frequency range over which the SOS calculation will be performed. The larger this range* the longer the calculations will take.

Table 3 Transducer Block Configurations (Page 10)

SOS_MIN	Float	R/W	Minimum SOS value to search for. If too much energy (such as from a high velocity vortical ridge) causes the algorithms to calculate a sound speed below that of the main SOS ridge* this parameter may need to be increased. Care must be taken not to set this higher than the expected minimum SOS for the application.
SOS_MAX	Float	R/W	Maximum SOS value to search for. If too much energy along the 0 k value on the k-w plot and algorithms are calculating SOS_MAX* even when SOS ridge indicates an SOS below this value* may need to decrease this parameter. Care must be taken not to set this lower than the expected maximum SOS for the application.
SOS_MIN_QUALITY	Float	R/W	Minimum quality threshold for SOS/GVF display and output.
SOS_CENTROID_WIDTH	Float	R/W	Define width of peak to use in calculation of SOS.
SOS_FREQUENCY_THRESHOLD	Float	R/W	This value selects the threshold that the second derivative of a power array (generated at a specific frequency over all k-space values) must break in order for the specific frequency point to be considered a valid frequency point.
SOS_MIN_K	Float	R/W	This value sets the lower limit in k-space that is used in the SOS auto frequency determination code. This value is equal to the first k-space bin after 0: PI/deltaX/50 (there are 50 bins from 0 to PI/deltaX).
SOS_MAX_K	Float	R/W	This value sets the upper limit in k-space that is used in the SOS auto frequency determination code. This value is equal to the last k-space bin: PI/deltaX.
SOS_SEARCH_LIMIT	Float	R/W	This value is the +/- percentage of the estimated SOS value (calculated using the auto frequency calculation code) that determines the lower (Estimated SOS * 0.5) and upper (Estimated SOS * 1.5) SOS search limits.
SOS_LAMBDA_DIAM	Float	R/W	Used to calculate the SOS dynamic frequency maximum used when calculating SOS.SOS Max Freq = (Max SOS search)/(Lambda Diameter * (Pipe Diameter/12)).

Table 3   Transducer Block Configurations (Page 11)

SOS_TOTAL_DATA	Unsigned Long	R/W	Calculates SOS Samples from this value and SOS Sample Frequency: SOS Samples = SOS Total Data * SOS Sample Freq.
SOS_WINDOW_SIZE	Unsigned Long	R/W	Number of FFT points to use in SOS calculation. Usually set to 1/8 or 1/4 of the sample frequency
SOS_WINDOW_OVERLAP	Unsigned Long	R/W	Number of sample point overlap between successive FFTs. Recommended to set this to 50% of SOS_FFT_POINTS.
SOS_SUB_ARRAY_SIZE	Unsigned Long	R/W	SOS Sub Array Size
SOS_NORMALIZATION	Unsigned Long	R/W	0 selects NO normalization in the frequency domain. 1 selects normalization in the frequency domain.
SOS_DIFFERENCING	Unsigned Long	R/W	0 selects NO differencing in the frequency domain. 1 selects 1st order differencing in the frequency domain. 2 selects 2nd order differencing in the frequency domain.
SOS_OPERATING_MODE	Unsigned Long	R/W	Determines which ridge to use for SOS calculation. Also determines which SOS parameter to leave fixed or calculate and whether or not to use Linear/Log KW diff. Bit Mapped Values: 0: Use right and left ridge averaged 1: Use right ridge only 2: Use left ridge only 4: Enable SOS auto frequency calculation 8: Enable SOS power weighting to auto frequency calculation 16: Linear KW diff enable 32: Log KW diff enable.
SOS_SELECTION_THRESHOLD	Unsigned Long	R/W	SOS Selection Threshold
SOS_MIN_FREQ_POINTS_(AUTO_FREQ)	Unsigned Long	R/W	This value selects the minimum number of frequency points that will be used in the SOS calculation. If this number is not met then the calculation is not performed and an error is reported.
SOS_ALGORITHM_DYNAMIC			
SOS_VALID_FREQ_PTS_RIGHT	Unsigned Long	R	The number of frequency points used from the right ridge of the k-w plot.
SOS_VALID_FREQ_PTS_LEFT	Unsigned Long	R	The number of frequency points used from the left ridge of the k-w plot.

Table 3 Transducer Block Configurations (Page 12)

ANALOG_SECTION			
ANALOG_SENSOR_INPUT_UNITS_1	Unsigned Char	R/W	Selects units used in translating the mA measured on Sensor 1 input to units used internally.
ANALOG_SENSOR_INPUT_UNITS_2	Unsigned Char	R/W	Selects units used in translating the mA measured on Sensor 2 input to units used internally.
ANALOG_SENSOR_INPUT_SCALE_1	Float	R/W	Sets multiplier used to scale the sensor input 1 value.
ANALOG_SENSOR_INPUT_SCALE_2	Float	R/W	Sets multiplier used to scale the sensor input 2 value.
ANALOG_SENSOR_INPUT_OFFSET_1	Float	R/W	Sets offset applied to the input sensor input 1 value.
ANALOG_SENSOR_INPUT_OFFSET_2	Float	R/W	Sets offset applied to the input sensor input 2 value.
ANALOG_SENSOR_1_1ST_ORDER_DAMPING_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables 1st order damping filter for sensor input 1.
ANALOG_SENSOR_2_1ST_ORDER_DAMPING_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables 1st order damping filter for sensor input 2.
ANALOG_SENSOR_1_DAMPING_TAU	Float	R/W	Damping time in seconds for the damping filter for sensor input 1.
ANALOG_SENSOR_2_DAMPING_TAU	Float	R/W	Damping time in seconds for the damping filter for sensor input 2.
INPUT_UNITS			
PRESSURE_INPUT_UNITS	Unsigned Char	R/W	Selects units for pressure read from Fieldbus AO Channel 10.
TEMPERATURE_INPUT_UNITS	Unsigned Char	R/W	Selects units for temperature read from Fieldbus AO Channel 11.
INPUT_1_UNITS	Unsigned Char	R/W	Selects units for input 1 read from Fieldbus AO Channel 12.
INPUT_2_UNITS	Unsigned Char	R/W	Selects units for input 2 read from Fieldbus AO Channel 13.
INPUT_3_UNITS	Unsigned Char	R/W	Selects units for input 3 read from Fieldbus AO Channel 14.
FLOW_NR_FILTER			
FILTER_FLOW_NR_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables the flow noise reduction filter.

Table 3 Transducer Block Configurations (Page 13)

FILTER_FLOW_NR_FILTER_MAGNITUDE_SELECTION	Unsigned Char	R/W	Selects flow noise reduction filter magnitude.
FLOW_DAMPING_FILTER			
FILTER_FLOW_1ST_ORDER_DAMPING_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables flow 1st order damping filter.
FILTER_FLOW_DAMPING_TAU	Float	R/W	Sets tau value for flow 1st order damping filter.
FLOW_SPIKE_FILTER			
FILTER_FLOW_SPIKE_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables flow spike filter.
FILTER_FLOW_SPIKE_FILTER_NO_FLOW_LENGTH	Unsigned Char	R/W	Defines the required number of consecutive measurements with good quality before a measurement is deemed valid and displayed.
FILTER_FLOW_SPIKE_FILTER_LENGTH	Unsigned Char	R/W	This parameter is used when the device is 'Holding' a previous measurement due to a new measurement with bad quality. The definition of this parameter is the required number of consecutive measurements with bad quality before the device enters the 'No Flow' state and displays dashes.
FILTER_FLOW_SPIKE_FILTER_UP_COUNT	Unsigned Char	R/W	Each time a measurement with bad quality is made 'Up Count' is added to the quality counter. If the counter becomes less than or equal to zero then the present measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.
FILTER_FLOW_SPIKE_FILTER_DOWN_COUNT	Unsigned Char	R/W	Each time a measurement with good quality is made 'Down Count' is subtracted from the quality counter. If the quality counter becomes less than or equal to zero then the present measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.

Table 3 Transducer Block Configurations (Page 14)

FILTER_FLOW_SPIKE_FILTER_PERCENTAGE	Float	R/W	After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times ('Percent' / 100).
FILTER_FLOW_SPIKE_FILTER_FILT_PCT_WINDOW_LEN	Unsigned Char	R/W	After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times ('Percent' / 100).
GVF_NR_FILTER			
FILTER_GVF_NR_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables the GVF noise reduction filter.
FILTER_GVF_NR_FILTER_MAGNITUDE_SELECTION	Unsigned Char	R/W	Selects GVF noise reduction filter magnitude.
GVF_DAMPING_FILTER			
FILTER_GVF_1ST_ORDER_DAMPING_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables GVF 1st order damping filter.
FILTER_GVF_DAMPING_TAU	Float	R/W	Sets tau value for GVF 1st order damping filter.
GVF_SPIKE_FILTER			
FILTER_GVF_SPIKE_FILTER_ENABLE	Unsigned Char	R/W	Enables or disables GVF spike filter.
FILTER_GVF_SPIKE_FILTER_NO_FLOW_LENGTH	Unsigned Char	R/W	Defines the required number of consecutive measurements with good quality before a measurement is deemed valid and displayed.

Table 3 Transducer Block Configurations (Page 15)

FILTER_GVF_SPIKE_FILTER_LENGTH	Unsigned Char	R/W	This parameter is used when the device is 'Holding' a previous measurement due to a new measurement with bad quality. The definition of this parameter is the required number of consecutive measurements with bad quality before the device enters the 'No Flow' state and displays dashes.
FILTER_GVF_SPIKE_FILTER_UP_COUNT	Unsigned Char	R/W	Each time a measurement with bad quality is made 'Up Count' is added to an entity called the quality counter. If the quality counter becomes less than or equal to zero then the present measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.
FILTER_GVF_SPIKE_FILTER_DOWN_COUNT	Unsigned Char	R/W	Each time a measurement with good quality is made 'Down Count' is subtracted from the quality counter. If the quality counter becomes less than or equal to zero then the present measurement is displayed. If the quality counter becomes greater than or equal to ('Filter Length' x 'Up Count') then the device is forced into a 'No Flow' condition and displays dashes.
FILTER_GVF_SPIKE_FILTER_PERCENTAGE	Float	R/W	After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times ('Percent' / 100).
FILTER_GVF_SPIKE_FILTER_FILT_PCT_WINDOW_LEN	Unsigned Char	R/W	After 'Percent Len' measurements with good quality have been displayed a new measurement with good quality is deemed valid and displayed when the difference between the maximum and minimum of the present measurement and ('Percent Len' - 1) previous consecutive measurements is less than the measurement range (default of 27fps for Flow) times ('Percent' / 100).

Table 3 Transducer Block Configurations (Page 16)

SENSOR			
SENSORHEAD_SERIAL_NUMBER	Octet String	R/W	Sensor head Serial Number
SENSOR_THRESHOLD_MAX	Long	R/W	Sets maximum threshold for sensor health diagnostics (in A/D counts).
SENSOR_THRESHOLD_MIN	Long	R/W	Sets minimum threshold for sensor health diagnostics (in A/D counts).
SENSOR_SPACING			
SENSOR_1_LOCATION	Float	R/W	Starting point for sensor 1. Typically 0.
SENSOR_SPACING_1_2	Float	R/W	Distance in feet between sensor 1 and sensor 2.
SENSOR_SPACING_1_3	Float	R/W	Distance in feet between sensor 1 and sensor 3.
SENSOR_SPACING_1_4	Float	R/W	Distance in feet between sensor 1 and sensor 4.
SENSOR_SPACING_1_5	Float	R/W	Distance in feet between sensor 1 and sensor 5.
SENSOR_SPACING_1_6	Float	R/W	Distance in feet between sensor 1 and sensor 6.
SENSOR_SPACING_1_7	Float	R/W	Distance in feet between sensor 1 and sensor 7.
SENSOR_SPACING_1_8	Float	R/W	Distance in feet between sensor 1 and sensor 8.
SENSOR_SCALE_FACTOR			
SENSOR_SCALE_FACTOR_1	Float	R/W	Scaling factor in volts per PSI for sensor 1.
SENSOR_SCALE_FACTOR_2	Float	R/W	Scaling factor in volts per PSI for sensor 2.
SENSOR_SCALE_FACTOR_3	Float	R/W	Scaling factor in volts per PSI for sensor 3.
SENSOR_SCALE_FACTOR_4	Float	R/W	Scaling factor in volts per PSI for sensor 4.
SENSOR_SCALE_FACTOR_5	Float	R/W	Scaling factor in volts per PSI for sensor 5.
SENSOR_SCALE_FACTOR_6	Float	R/W	Scaling factor in volts per PSI for sensor 6.
SENSOR_SCALE_FACTOR_7	Float	R/W	Scaling factor in volts per PSI for sensor 7.
SENSOR_SCALE_FACTOR_8	Float	R/W	Scaling factor in volts per PSI for sensor 8.
MEASURED_VALUES			
FLOW_QUALITY	Float	R	Measured flow quality.
FLOW_RATE_UNFILTERED	Float	R	Measured flow rate in ft/s without any filtering applied.
PRESSURE	Float	R	Pressure as used in calculation of GVF in configured units.

Table 3 Transducer Block Configurations (Page 17)

TEMPERATURE	Float	R	Temperature as used in calculation of GVF in configured units.
SOS_QUALITY	Float	R	Measured SOS quality.
SOS_UNFILTERED	Float	R	Measured SOS in ft/s without any filtering applied.
SOS_FLOW_RATE	Float	R	Measured SOS flow rate.
SOS_FLOW_QUAL	Float	R	Measured SOS flow quality.
TLF	Float	R	Measured True Liquid Flow in configured flow units.
TOTAL_TLF	Float	R	Measured total TLF.
TLF_UNFILTERED	Float	R	Measured TLF in ft/s without any filtering applied.
ANALOG_4_20MA_INPUT_1	Float	R	Measured analog input 1 in mA.
ANALOG_4_20MA_INPUT_2	Float	R	Measured analog input 2 in mA.
TOTAL_FLOW_FRACTION	Float	R	Floating point fraction to be added to 'Total Flow Carry' * 100 to calculate full resolution total flow.
TOTAL_TLF_FRACTION	Float	R	Floating point fraction to be added to 'Total TLF Carry' * 100 to calculate full resolution total TLF.
TOTAL_FLOW_CARRY	Unsigned Long	R	Signed long portion (* 100) to be added to 'Total Flow Fraction' to calculate full resolution total flow.
TOTAL_TLF_CARRY	Unsigned Long	R	Signed long portion (* 100) to be added to 'Total TLF Fraction' to calculate full resolution total TLF.
SYSTEM_STATUS	Unsigned Long	R	Refer to manual for description of individual bits.
SENSOR_MAX_MIN			
SENSOR_1_MAX	Long	R	Sensor 1 maximum in A/D bins.
SENSOR_2_MAX	Long	R	Sensor 2 maximum in A/D bins.
SENSOR_3_MAX	Long	R	Sensor 3 maximum in A/D bins.
SENSOR_4_MAX	Long	R	Sensor 4 maximum in A/D bins.
SENSOR_5_MAX	Long	R	Sensor 5 maximum in A/D bins.
SENSOR_6_MAX	Long	R	Sensor 6 maximum in A/D bins.
SENSOR_7_MAX	Long	R	Sensor 7 maximum in A/D bins.
SENSOR_8_MAX	Long	R	Sensor 8 maximum in A/D bins.
SENSOR_1_MIN	Long	R	Sensor 1 minimum in A/D bins.
SENSOR_2_MIN	Long	R	Sensor 2 minimum in A/D bins.

Table 3 Transducer Block Configurations (Page 18)

SENSOR_3_MIN	Long	R	Sensor 3 minimum in A/D bins.
SENSOR_4_MIN	Long	R	Sensor 4 minimum in A/D bins.
SENSOR_5_MIN	Long	R	Sensor 5 minimum in A/D bins.
SENSOR_6_MIN	Long	R	Sensor 6 minimum in A/D bins.
SENSOR_7_MIN	Long	R	Sensor 7 minimum in A/D bins.
SENSOR_8_MIN	Long	R	Sensor 8 minimum in A/D bins.
SENSOR_ALPHA			
SENSOR_ALPHA_1	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_2	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_3	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_4	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_5	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_6	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_7	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
SENSOR_ALPHA_8	Float	R	Relative scale factor between signal magnitudes acquired from each sensor.
FIELDBUS_INFO			
FIRMWARE_REVISION	Octet String	R	Softing FBK firmware revision
PD_TAG	Octet String	R	Fieldbus Physical Device Tag
DEVICE_ID	Octet String	R	Fieldbus device ID
NODE_ADDRESS	Unsigned Char	R	Fieldbus node address
BLOCK_MODE_RB	Unsigned Char	R	Resource Block Mode
BLOCK_MODE_TB	Unsigned Char	R	Transducer Block Mode

Appendix A EXAMPLE OF USING FOUNDATION FIELDBUS HOST

A1 Connection Setup

The following hardware was used for this example of a connection setup:

- Softing FG-100 FF/HSE Linking Device
- Relcom FCS-PH-PL Fieldbus Power Hub
- 24V Bench power supply
- Transmitter with Fieldbus

The hardware was connected as follows:

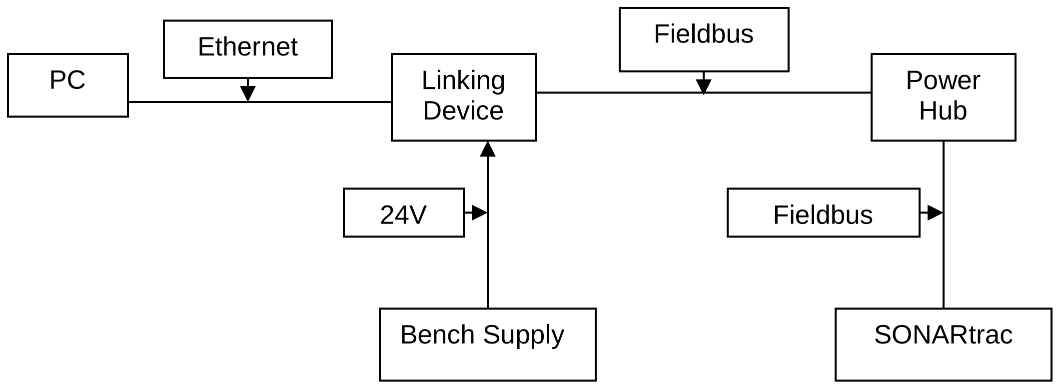

Figure 2 Example Connection Setup

A2 Using National Instruments Configurator

Tools provided by National Instruments (NI) allow a user to import 'DDL' (Device Description Language) files to the Configurator program to define how a device will appear. These are very similar to HART DDL files. **Note**: This document is not intended as a tutorial on the NI Configurator; please reference the NI manual for that program.

Prior to running Configurator, you must first run the 'Interface Configuration Utility' provided with Configurator. This allows you to import the required files, and only needs to be done once. You may then run Configurator.

Prior to connecting the transmitter to the Fieldbus, the Configurator will show a screen similar to the following:

Figure 3 NI-FBUS Configurator

Once connected, a process will start where an address will be assigned to the transmitter. This may take few minutes. An hourglass will appear on the device icon while this is being done:

Figure 4 SONAR Icon With Hourglass

The display on the transmitter will display an ‘F’ to indicate it is connected to a Fieldbus network:

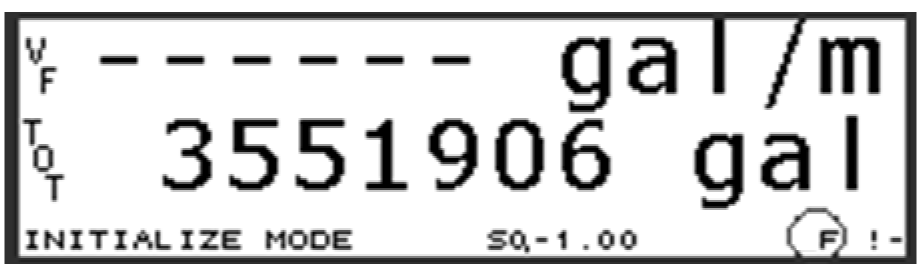

Figure 5 Fieldbus Connection Indicated on Transmitter Display

Once the connection process is completed, the hourglass will be removed:

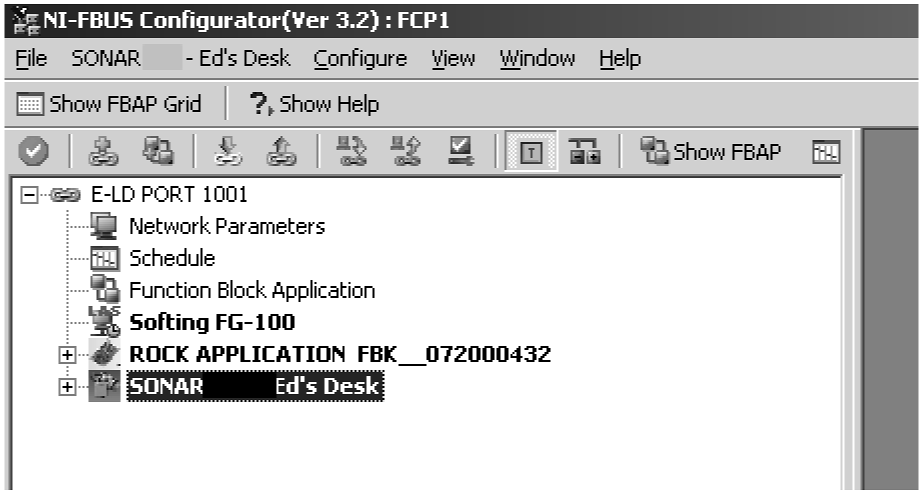

Figure 6 NI-FBUS Configurator Display Example

Opening the SONAR object by clicking on the '+' sign will open up all the included 'Function Blocks' available:

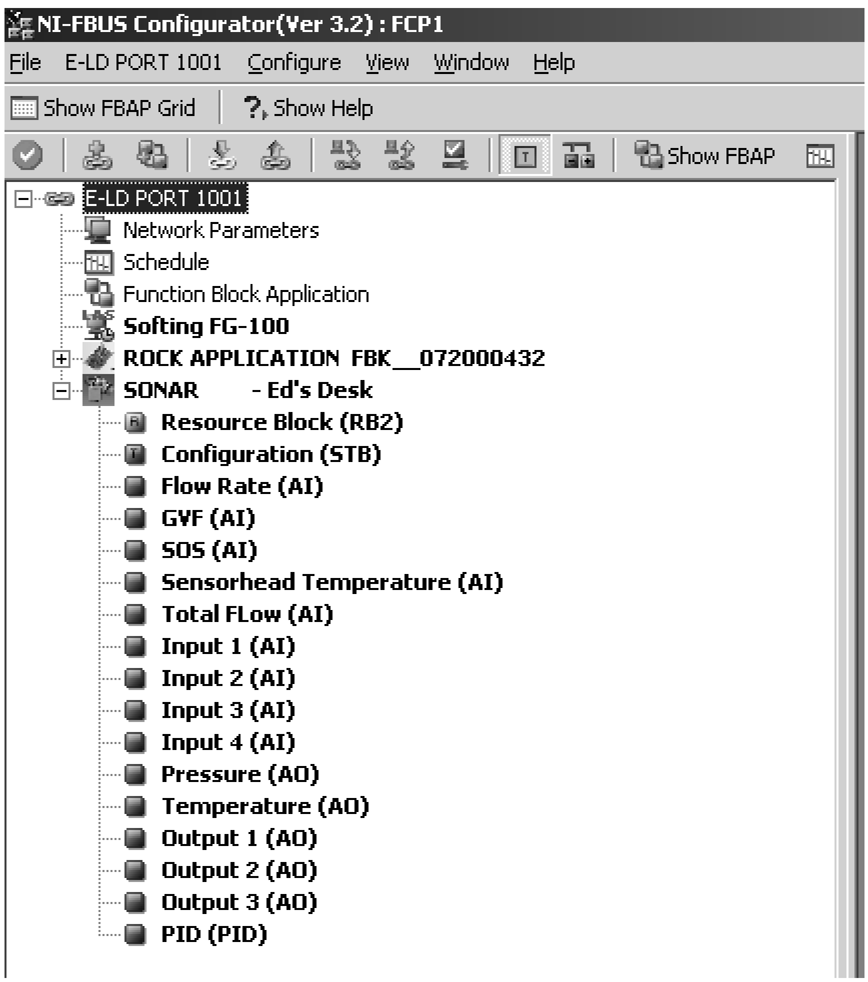

Figure 7 Opening Function Blocks Example

Note: For this example descriptive names have been given to the device. By default, the Function Blocks will be given generic names.

On the setup an image to be displayed has been assigned and the manufacturer info file (“mfr_info.txt”, part of the Configurator program), which includes information about SONARtrac and CiDRA has been modified. Double-clicking on the SONARtrac icon brings up the following dialog box:

Figure 8 Dialog Box Example

The dialog box includes a picture the user may change, a link to the CiDRA website and a description of the device. The files necessary for this can be found as part of the Fieldbus DDL files.

A3 Changing Settings With Configurator

Double-clicking on the ‘Configuration (STB)’ or ‘Transducer Block’ brings up the following dialog:

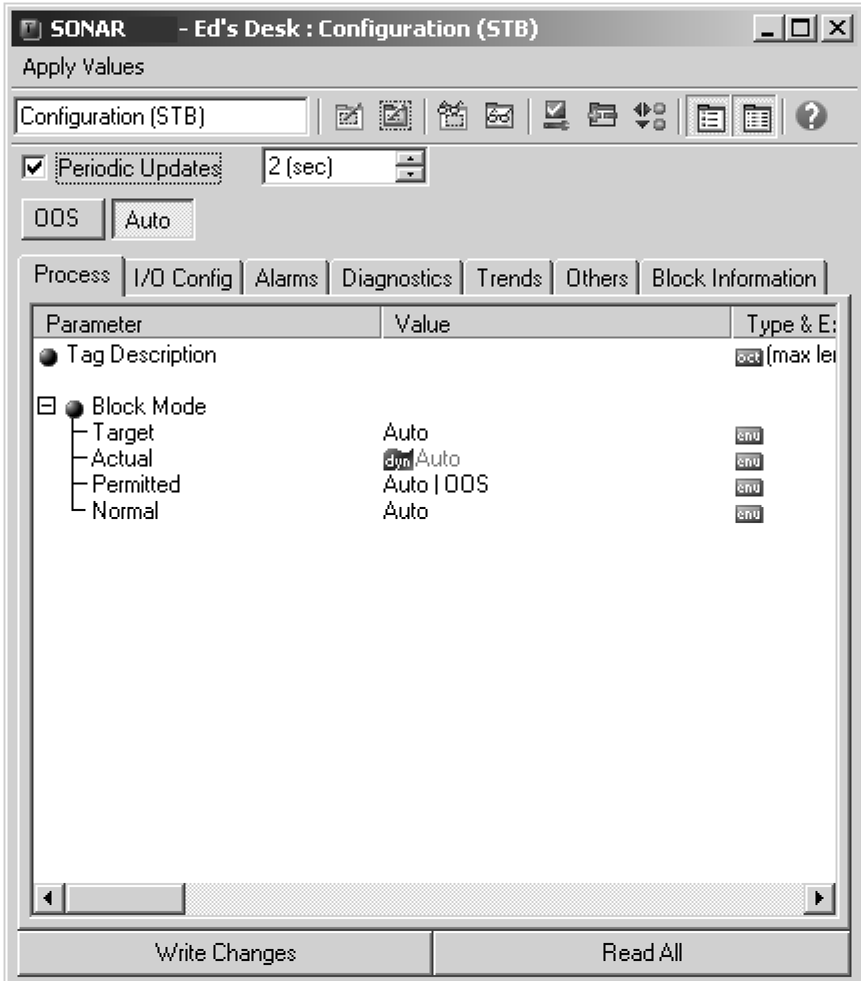

Figure 9 Configuration (STB) Example

Clicking on the ‘Others’ tab and expanding the window will list all the available settings for the transmitter shown on the following page. The full list is found in Section 5.

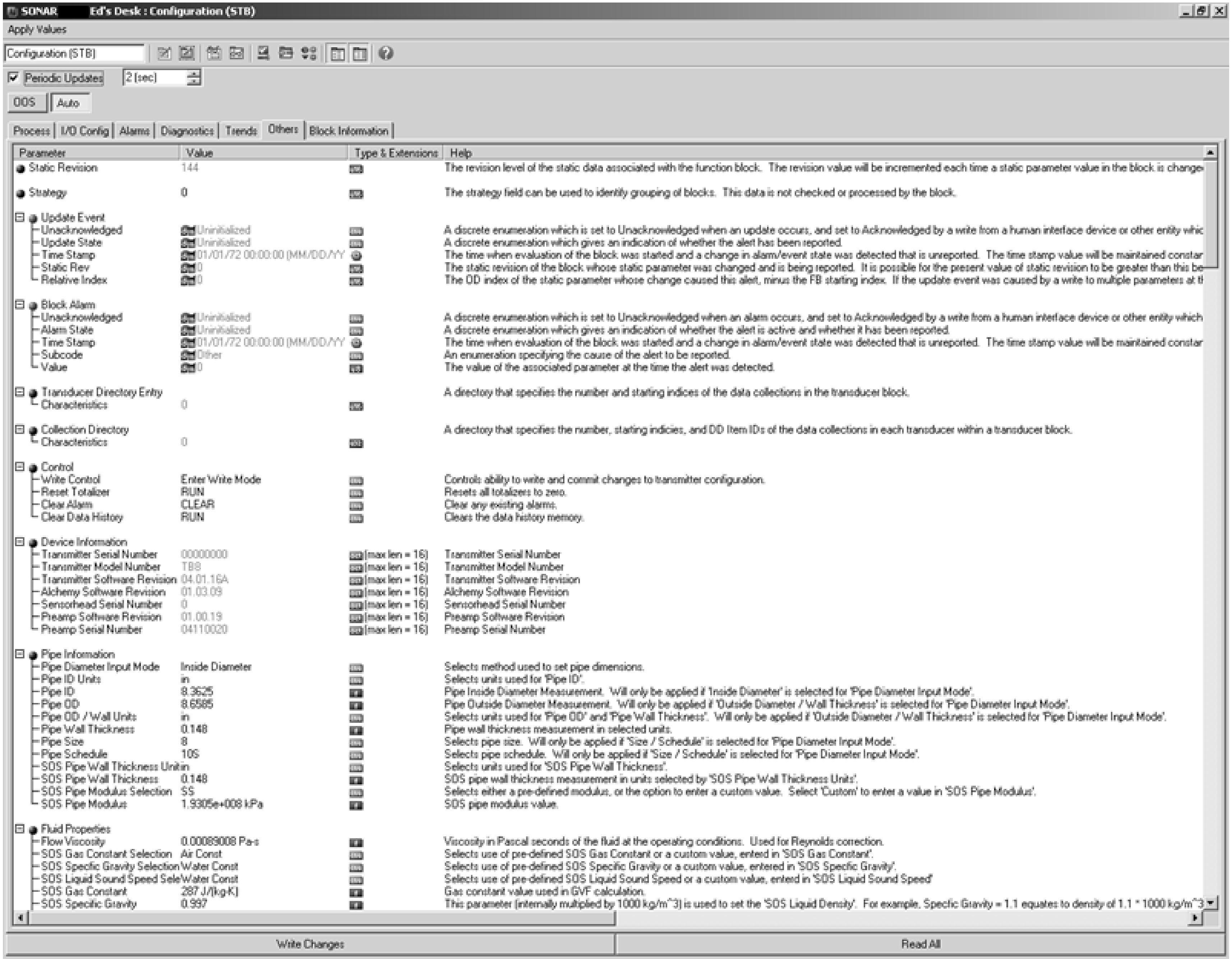

Figure 10 Partial List of Available Settings

The top-left of the window shows the current state of the Transducer Block – OOS (Out Of Service) or Auto:

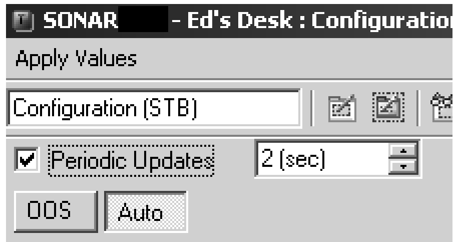

Figure 11 Transducer Block State

'**Auto**' indicates the device is running normally.

The bulk of the window lists the parameters, grouped by function, their current value, the type and help text, as read out of the DDL file. Values in gray are read-only.

To change a setting, you must first click on the 'OOS' button. The transmitter display will indicate it is OOS by changing the 'F' indication to a reverse 'F':

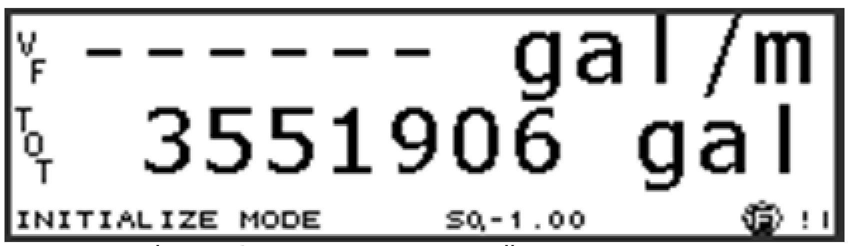

Figure 12 Reverse 'F' Indicator

The user may then select one or more settings to change by clicking on them, changing a value, and then clicking the ‘Write Changes’ button when done.

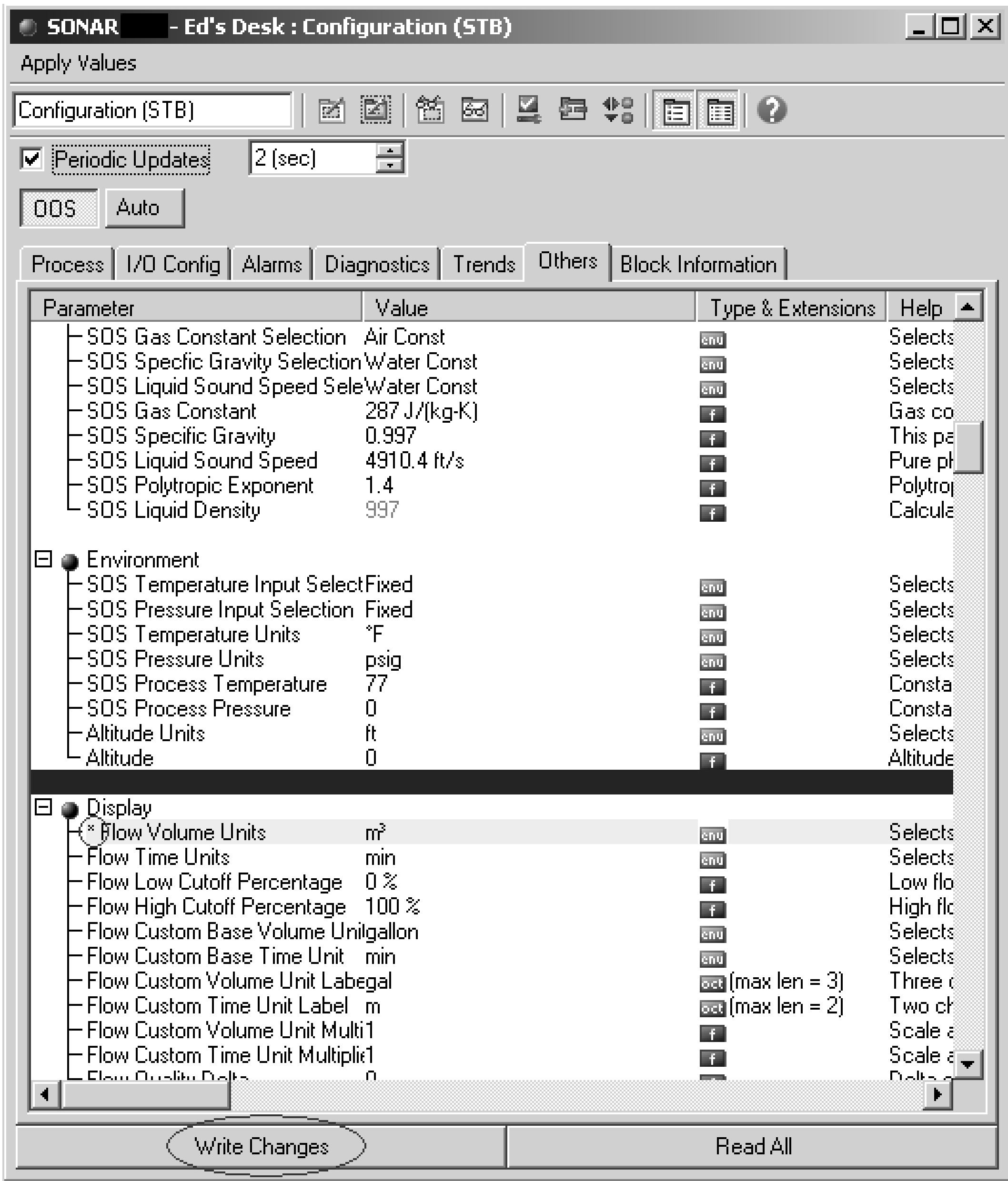

Figure 13   Selecting Settings, Changing Values and Writing Changes

The asterisk next to the setting indicates it will be modified. If you select more than one thing to change, the modified parameters will be highlighted in yellow.

Once the changes are written, the asterisk and yellow highlight will be removed.

It is important to note that ‘written’ simply indicates that changes have been sent and acknowledged by the transmitter, but NOT written to FLASH yet.

A3.1 Changes to FLASH

To write the changes to FLASH, click the ‘Auto’ button. All changes must be accepted before hitting the ‘Auto’ button, or changes will not be written, and Configurator will indicate an error has occurred.

When the ‘Auto’ button is clicked, the transmitter validates all changes made and will modify anything that is invalid back to its previous value. The only way this is indicated is that Configurator will show the previous value.

No error messages are displayed. The user must confirm that changes were accepted by inspecting what Configurator shows after returning to ‘Auto’ state and the device is given time to update the Configurator display.

A3.2 Undoing Changes

To undo changes without saving them, click the ‘Auto’ button, then the ‘Read All’ button. Configurator will remove the asterisk and refresh the value that was changed.

A4 Creating a Function Block Application (FBAP) to Transmitter

This example requires the addition of another Softing FBK board running their 'Rock' application, and will have the Rock send pressure values to the transmitter. Simply connect the Rock device to the Fieldbus power hub.

Using Configurator:

- Click the "Show FBAP" button
- Drag "Analog Input" from Rock to FBAP
- Drag "Analog Output 1" from SONARtrac to FBAP
- Select wiring tool and wire OUT from Rock AI to CAS IN on SONARtrac AO as shown:

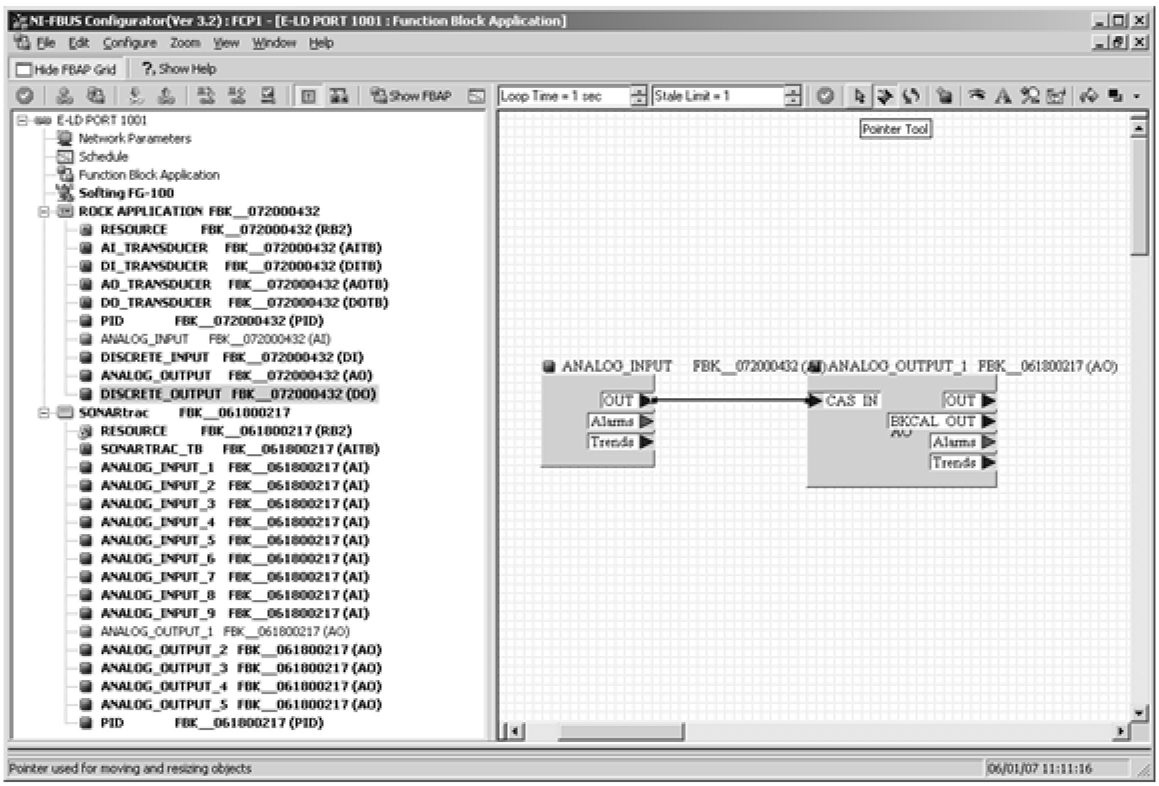

Figure 14 Creating a Function Block Application (FBAP) to Transmitter

Double click the AI block in the FBAP window

(If TARGET>MODE_BLK is not OOS, click auto, then OOS quickly to change TARGET in MODE_BLK to OOS)

- On the Process Tab, set CHANNEL to 0x0002
- On the Scaling Tab, set L_TYPE to Indirect
- Click the Write Changes button
- Click Auto button
- Close AI window

Double click the SONARtrac AO block in the FBAP window

- On the Process Tab, set CHANNEL to 10 (0x000a)
- On the Options tab, set SHED_OPT to “normal shed normal return” (sic)
- Click Write Changes button
- Click Auto button
- Close AO window

A5 Download the Configuration

- Click ‘Configure’ on main menu
- Select ’Download Configuration…’
- Check the ‘Clear Device’ checkbox
- Click the ‘Download’ button

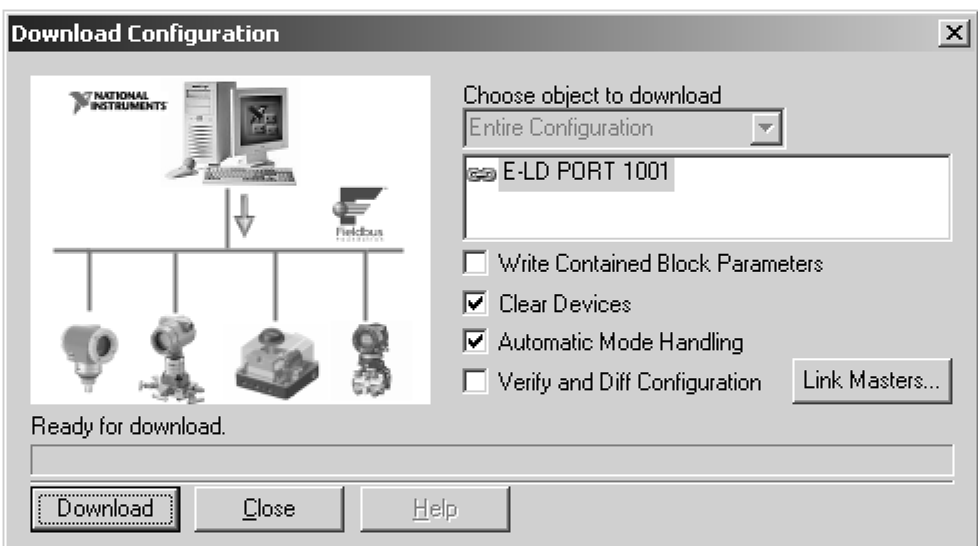

Figure 15 Download Configuration

The ‘Pressure Input Select’ in the transmitter must be configured using Configurator, the transmitter front panel, or INI editor for the transmitter to use the pressure input. The pressure can also be displayed on the transmitter front panel if desired.

When completed, verify the transmitter is receiving pressure from the Rock device – the pressure value ramps from 0 to 100.

The user can also disconnect and re-power the setup to see that the transmitter is still receiving pressure, as this is now saved in the FLASH of the Fieldbus devices.

Note that this configuration is specific to the two Fieldbus devices (transmitter and Rock device) downloaded to. If you change to a different transmitter, for example, you must download a new FBAP to the Rock and that transmitter.

Appendix B EXAMPLE OF USING PROFIBUS HOST

B1 Connection Setup

Note: The default address is 126. User should change address from 126 to an unused address following connection to the Profibus Network.

The following hardware were used for this example

- Siemens CP 5611 Profibus interface card
- Siemens FDC 157 DP/PA Coupler
- Bench power supply
- Passive sonar transmitter with Fieldbus / Profibus

The connection used was:

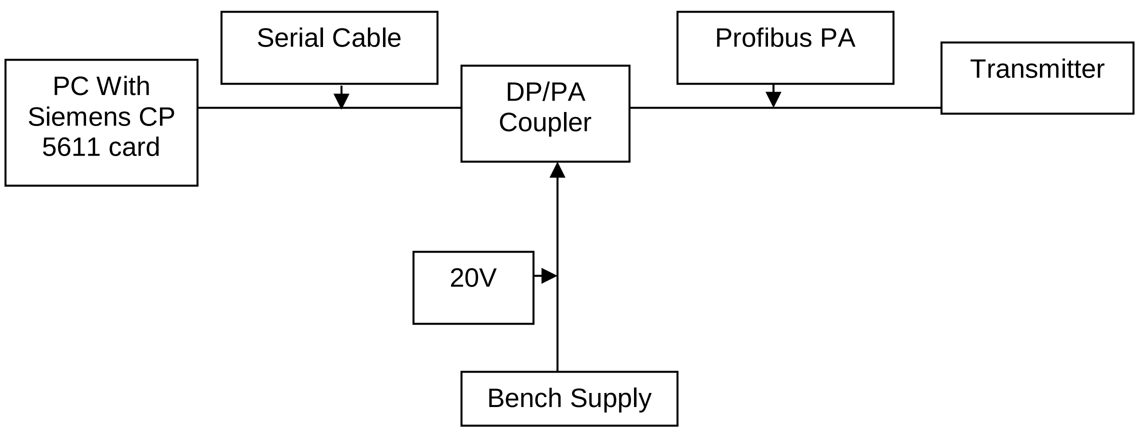

Figure 16 Example Connection Setup

B2 Making Changes to Transmitter Using a Profibus Host

To change the configuration of transmitter using a Profibus Host, perform the following steps:

- Place the Transducer Block Out Of Service (OOS)
- Write any changes to the variables
- Place the Transducer Block to Auto Mode

When the transmitter is placed into Auto Mode, it will validate any changes made. Invalid changes will be returned to their previous value.

B3 Using SIMATIC Manager / PDM

Note: This document is not intended as a tutorial on SIMATIC; reference the Siemens manual for that program.

Tools provided by Siemens allow a user to import 'EDDL' (Enhanced Device Description Language) files to the SIMATIC program to define how a device will appear.

The user must run 'Manage Device Catalog…'. This allows the user to import the required files, and only need to be done once.

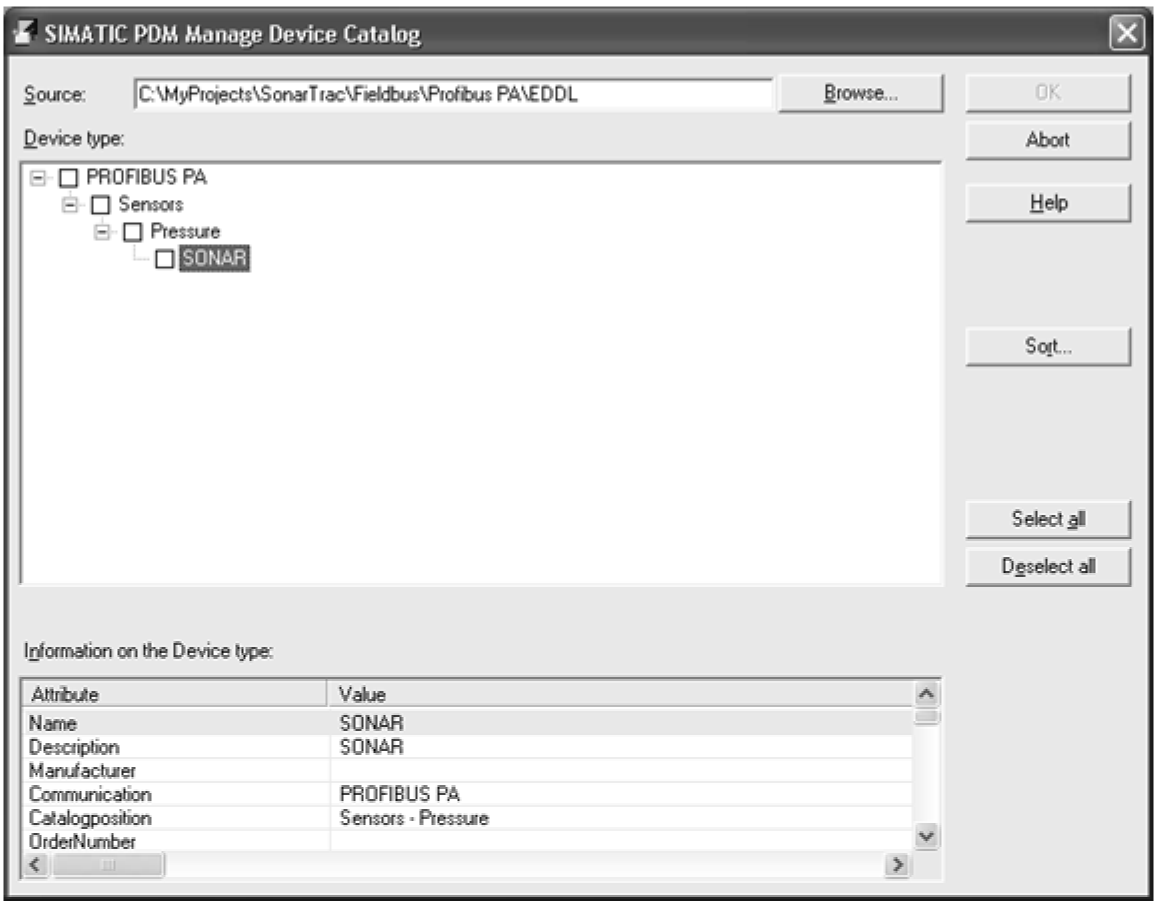

Figure 17 Using SIMATIC Manager / PDM

Setup the communication to the DP/PA coupler using the ‘Set PG/PC Interface’ option. The following are the settings for the Coupler used in this example:

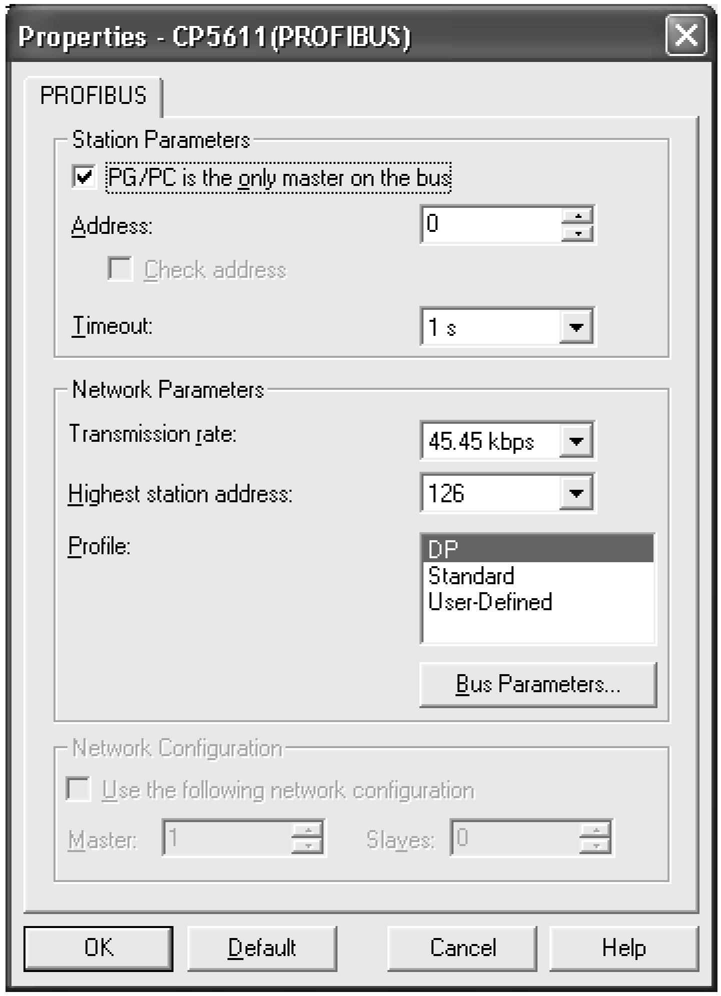

Figure 18   Communications Setup

Create a new project in SIMATIC Manager, or add the device to an existing project:

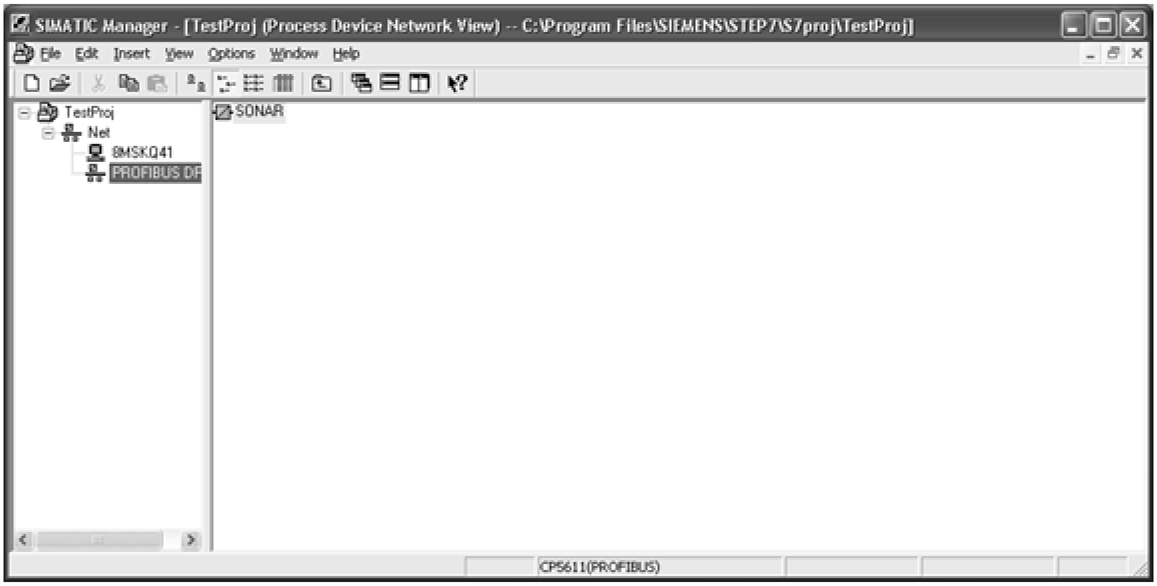

Figure 19 Setting up Project

Opening the device will launch SIMATIC PDM which will then allow modifying and displaying all the variables available in the transmitter.

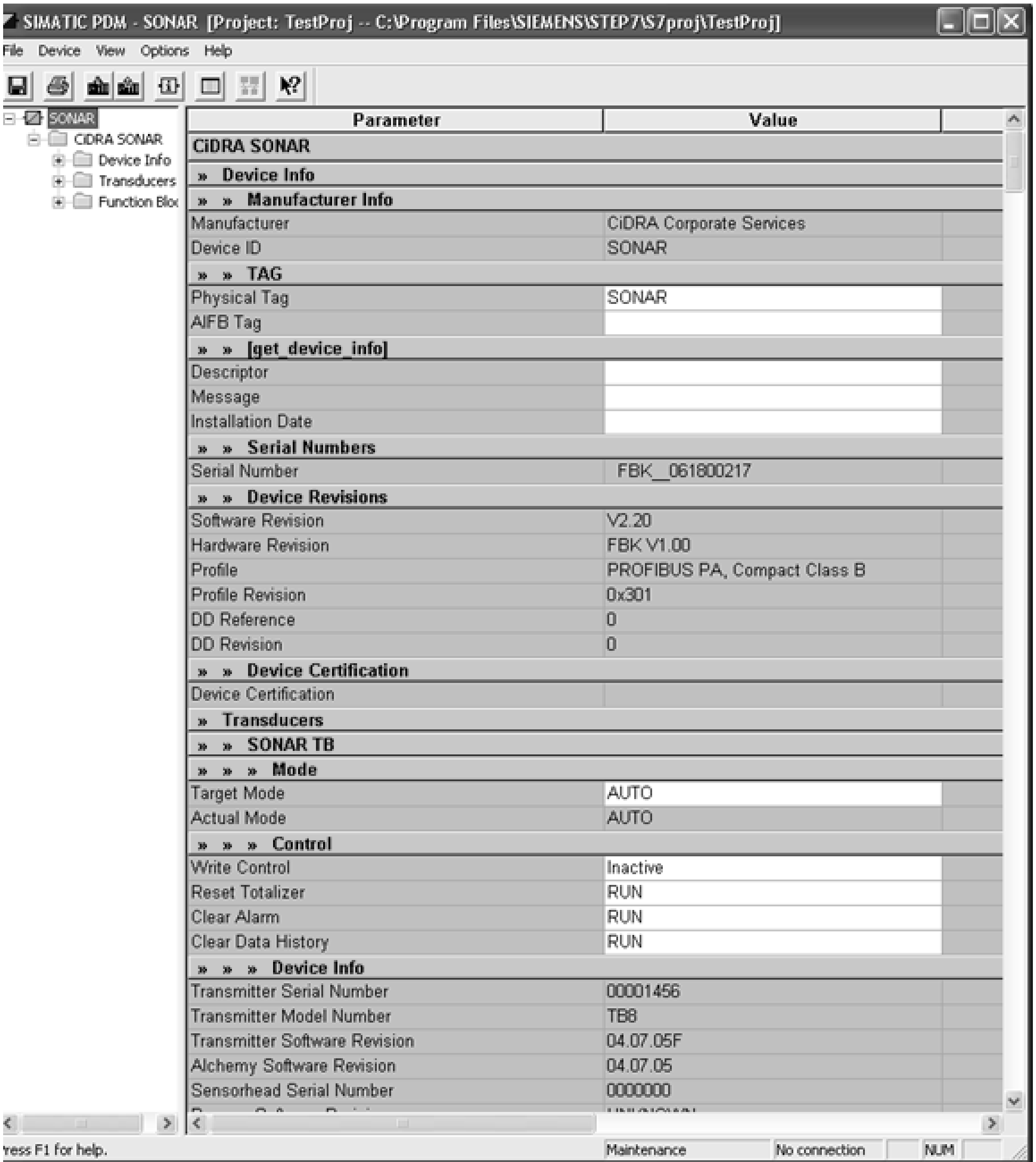

Figure 20 Transmitter Variables

Update the information by clicking on ‘Upload to PG/PC’. Data will be read from the transmitter. The ‘PA’ LED will flicker on the DP/PA coupler.

B4 Changing Transmitter Settings with SIMATIC

To modify settings, you must first change the ‘Target Mode’ to ‘OOS’:

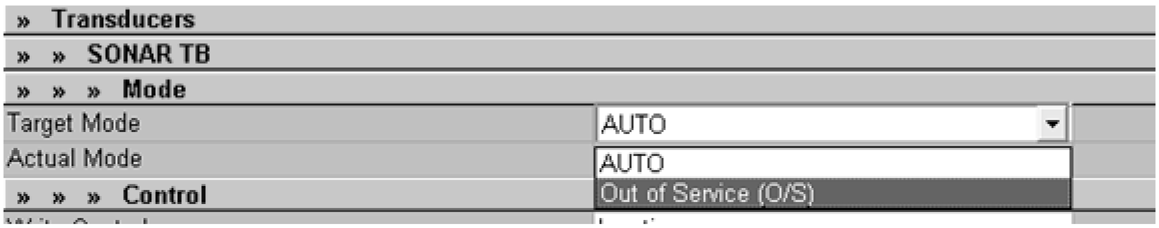

Figure 21 Changing Target Mode to ‘OOS’

Select OOS from the drop down and click the ‘Download to Device’ button to update the Target Mode. The ‘P’ indicator on the transmitter will change to reverse to indicate ‘write mode’ is enabled. Click the ‘Upload to PG/PC’ button again to update the ‘Actual Mode’.

Note: ***Failing to ‘Upload’ after making changes may cause errors ‘Downloading’ to the device due to a mismatch between the device and SIMATIC.***

Now the user can change any transmitter settings by either typing in new values or selecting options from a dropdown.

B5 Saving Changes to FLASH

When all changes are complete, click ‘Download to Device’, ‘Upload to PG/PC’, then set ‘Target mode’ to ‘Auto’, and ‘Download’ again. The reverse ‘P’ will change and the changes will be set in the meter.

When ‘Target Mode’ to ‘Auto’ is set, the transmitter validates all changes made and will modify anything that is invalid back to its previous value. If a value is invalid, the user may receive an error from SIMATIC. Perform an ‘Upload to PG/PC’ to read back what is currently set in the transmitter.

16 Use of Modbus® Protocol with Passive Sonar Transmitters

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List of Tables

16.1 Transmitter Modbus Configuration Overview

16.1.1 Introduction

Modbus is an application layer messaging protocol that provides client/server communication between devices connected on different types of buses or networks.

Modbus has been industry's serial de facto standard since 1979 and enables millions of automation devices to communicate. Support for the simple and elegant structure of Modbus continues to grow.

Modbus is a request/reply protocol and offers services specified by function codes. Modbus function codes are elements of Modbus request/reply messages.

This document describes the Modbus configuration options available in the passive sonar transmitter.

16.1.1.1 Passive Sonar Transmitters That Support Modbus

The following transmitter model numbers will support Modbus protocol:

TB8-XX-XX-1X-XX where x can be any alpha-numeric character. The '1' indicates the transmitter firmware supports Modbus communications.

16.1.1.2 Modbus Variants Supported by Transmitter

The passive sonar transmitter supports the following Modbus variants:

Media
- Asynchronous serial transmission over RS-232 or RS-485

Transmission Modes
- RTU
- ASCII

Serial Settings
- 7 / 8 Data Bits
- EVEN / ODD / NO Parity
- 1 / 2 Stop Bits
- 2400 / 9600 / 19200 / 38400 / 57600 / 115200 Baud

Other Modbus Options
- Device Address (001 – 247)
- ASCII Timeout (1 – 99 Seconds)

Transmission modes, serial settings and other options are available from the transmitter front panel menu.

A configuration setting is available to swap 32 bit values (for example, floating point numbers) for compatibility with Modbus masters that may require it.

16.1.2 Configuration Settings

16.1.2.1 Transmission Modes

- RTU (Default)
- ASCII

16.1.2.1.1 RTU

In RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows higher data throughput than ASCII mode for the same baud rate. Each message must be transmitted in a continuous stream of characters.

The default parity mode in the transmitter is EVEN parity.

16.1.2.1.2 ASCII

In ASCII (American Standard Code for Information Interchange) mode, each 8–bit byte in a message is sent as two ASCII characters. This mode is used when the physical communication link or the capabilities of the device do not allow conformance with RTU mode requirements.

Note: This mode is less efficient than RTU since each byte needs two characters.

Example:
The byte 0X5B is encoded as two characters: 0x35 and 0x42 (0x35 ="5" and 0x42 ="B" in ASCII).

Even parity and no parity also are supported. The default parity mode in the transmitter is EVEN parity.

16.1.2.2 Serial Communications Settings

16.1.2.2.1 Configuration

- RS-232
- RS-485 (Default)

16.1.2.2.2 Data Bits

- 7 bits
- 8 bits (Default)

The Data Bits setting should match the Transmission Mode as follows. The ability to set the Data Bits independent of Transmission Mode is to allow for maximum flexibility.

- RTU 8 Data Bits

- ASCII 7 Data Bits

16.1.2.2.3 Parity

- EVEN (Default)
- ODD
- NONE

16.1.2.2.4 Stop Bits

- 1 (Default)
- 2

16.1.2.2.5 Baud Rate

- 2400
- 9600 (Default)
- 19200
- 38400
- 57600
- 115200

Note: The Modbus specification requires the use of 2 Stop Bits when No Parity is selected.

16.1.2.3 Modbus Options

16.1.2.3.1 Device Address

Device Address is the address that a Modbus master will use to communicate with the transmitter.

- Range: 1 – 247 (Default = 1)

16.1.2.3.2 ASCII Timeout

ASCII Timeout is the amount of time in seconds the transmitter will wait before processing an ASCII Transmission Mode Modbus message before a CR/LF termination. This may be increased to allow for manual entry of an ASCII message on a terminal.

- Range: 1 – 99 Seconds (Default = 4)

16.1.3 Transmitter Menus

16.1.3.1 Serial Settings

Only the internal RS-232/RS-485 serial port on the transmitter supports Modbus.

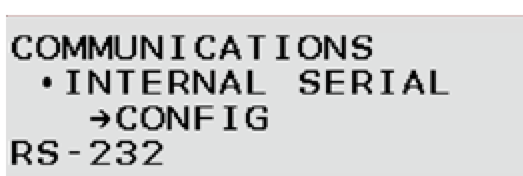

Figure 1 RS-232 / RS-485 Configuration

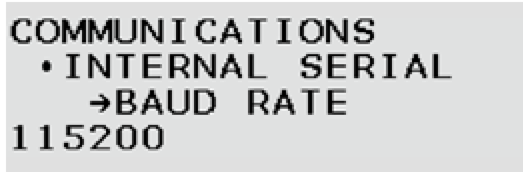

Figure 2 Baud Rate

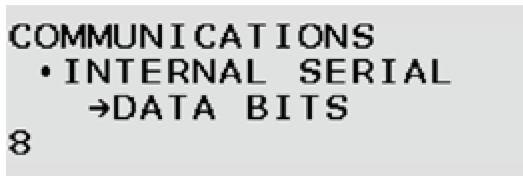

Figure 3 Data Bits

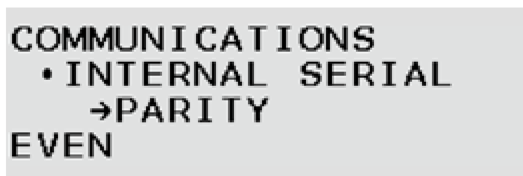

Figure 4 Parity

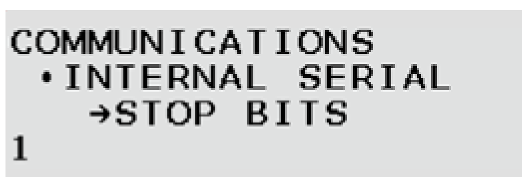

Figure 5 Stop Bits

16.1.3.2 Modbus Options

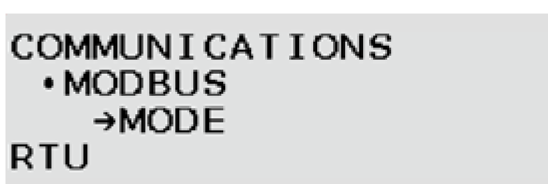

Figure 6 Transmission Mode

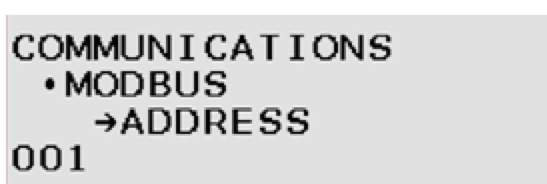

Figure 7 Device Address

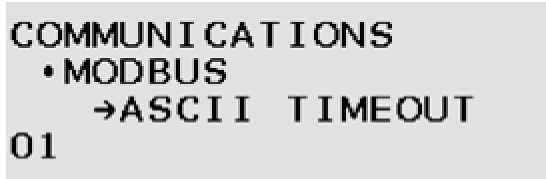

Figure 8 ASCII Timeout

16.2 Transmitter Modbus Register Overview

16.2.1 Introduction

The chapter will describe the MODBUS registers available in the transmitter, and how to read and write them.

Registers are arranged in groups by format (i.e. float, char) to facilitate reading and writing in blocks, and function (User, Algorithm, Filter etc.).

Multiple register values (for example, Floating Point values) by default are arranged to conform to IEEE specifications for Floating Point numbers. There is an option available through the meter configuration to swap the two registers for compatibility.

16.2.2 Making and Saving Changes

In order to change Holding Registers, first write a value of 0x55AA to Holding Register 4 (the ‘Run Mode’ Register to ‘Write Enabled’). Changes to any Holding Register(s) can then be made.

In order to validate changes and commit them to FLASH, write a value of 0xEDF1 (‘Commit Changes’) to the Run Mode register (address 4). An error will be returned after a Commit if any of the Holding Register changes are invalid (outside bounds, etc.).

16.2.3 Passwords

Password functions are available, but by default are disabled. A user would write their password to the Password Input Holding Register (Register 0) to set the access level for the session. Sessions timeout after a configurable number of seconds of no valid reads or writes. Passwords consist of single register integer values that range from 1 thru 65535 (0xFFFF hex).

All passwords are set to 0, disabling the password feature by default.

Passwords affect Read/Write access to Holding Registers. Input Registers are always readable.

The three levels of access are:

- Administrator Ability to set any passwords, as well as read or write Holding Registers

- Level 1 Ability to Read or Write any Holding Registers, as well as setting Level 1 or Level 2 passwords
- Level 2 Ability to Read Holding Registers, as well as setting the Level 2 password.

To use all three levels of access, set the Administrator password first, log in as Administrator, then set Level 1, and then Level 2.

If any password is set to something other than 0, and others are set to 0, then only the non-zero password will function. If a Level 2 password is first set, you will not be able to log in as an Administrator, but only read holding registers. In some instances this may be a desirable mode.

16.2.4 Transmitter Modbus Supported Function Codes

The transmitter supports these Modbus Function Codes:

Code	Sub Code	Function
01		Read Coils
02		Read Discrete Inputs
03		Read holding Registers
04		Read Input Registers
05		Write Single Coil
06		Write Single Registers
07		Read Exception Status (Serial only)
08		Diagnostics (Serial only)
08	00	Return Query Data
08	01	Restart Communications Option
08	02	Return Diagnostic Register
08	03	Change ASCII Input Delimiter
08	04	Force Listen Only Mode
08	10	Clear Counters and Diagnostic Register
08	11	Return Bus Message Count
08	12	Return Bus Communications Error Count
08	13	Return Bus Exception Error Count
08	14	Return Slave Message Count
08	15	Return Slave No Response Count
08	16	Return Slave NAK Count
08	17	Return Slave Busy Count
08	18	Return Bus Character Overrun Count
08	20	Clear Overrun Counter and Flag
11		Get Communications Event Counter (Serial only)
12		Get Communications Event Log (Serial only)
15		Write Multiple Coils
16		Write Multiple Registers
17		Report Slave ID (Serial only)
22		Mask Write register
23		Read/Write Multiple registers
43	14	Read Device Identification

Table 1 Supported Modbus Function Codes

The transmitter does NOT support these Modbus Function Codes:

Code	Sub Code	Function
20		Read File Record
21		Write File Record
24		Read FIFO Queue

Table 2 Non-Supported Modbus Function Codes

16.2.5 Other Registers

Coils and Discreet inputs are not used in the transmitter. All configurations are performed with Holding Registers, and measurements read from Input Registers.

16.2.6 Diagnostics

08/02 Read Diagnostic Register

- Diagnostic Register Bits

Bit Number	Description
0	STATUS_BIT_DEFAULTS
1	STATUS_BIT_DSP_DEAD
2	STATUS_BIT_DSP_NO_RESP
3	STATUS_PREAMP_FAILURE
4	SOS_SINGULAR_MATRIX_ERR
5	VF_SINGULAR_MATRIX_ERR
6	VFCENTROID_DIV0_ERROR
7	SOSCENTROID_DIV0_ERROR
8	NO_VALID_FREQ_POINTS
9	SENSOR_OVERLOAD_ERROR
10	VF_DATA_OVERANGE
11	SOS_DATA_OVERANGE
12	unused
13	unused
14	unused
15	unused

Table 3 Diagnostic Register Bits

16.2.7 Other Functions

16.2.7.1 17 Read Slave ID

Slave ID returned by this command is based on the software revision of the transmitter as follows (for example):

Software version V4.01.02 returns a Slave ID of 40102.

16.2.7.2 43/14 Read Device Identification

This function code returns three string objects as follows (for example):

CiDRA Corp1
TB8-XX-XX-XX-XX
V4.01.02

16.3 Modbus Registers

16.3.1 Modbus Input Registers

Note: Float values may be set to QNAN if transmitter is not configured to generate those values. (QNAN means 'Quiet Not A Number', a computing term for an IEEE floating point representation for the result of a numerical operation which cannot return a valid number value.)

Table 4 Modbus Input Registers

Address	Size	Type	Value	Description	Notes
1	2	Float	Flow Rate as Displayed	Flow Rate as it appears on the LCD.	See Note 1.
3	2	Float	Total Flow	Total Flow.	
5	2	Float	VF Quality	Measured flow quality.	
7	2	Float	Flow Rate	Measured flow rate in ft/s without any filtering applied.	As reported by DSP.
9	2	Float	GVF as Displayed	GVF as it appears on the LCD.	See Note 1.
11	2	Float	Pressure	Pressure as used in calculation of GVF in configured units.	
13	2	Float	Temperature	Temperature as used in calculation of GVF in configured units.	
15	2	Float	SOS as Displayed	SOS as it appears on the LCD.	See Note 1.
17	2	Float	SOS Quality	Measured SOS quality.	
19	2	Float	SOS	Measured SOS in ft/s without any filtering applied.	As reported by DSP.
21	2	Float	SOS Flow Rate as Displayed	SOS Flow Rate as it appears on the LCD.	See Note 1.
23	2	Float	SOS Flow Rate Quality	Measured SOS flow quality.	
25	2	Float	TLF as Displayed	TLF as it appears on the LCD.	See Note 1.
27	2	Float	Total TLF	Measured total TLF.	
29	2	Float	TLF	Measured TLF in ft/s without any filtering applied.	
31	2	Float	Band Temperature	Temperature measured by the sensor band.	

Note 1: Will be set to QNAN when not displayed and in "Bad Reading" mode. Will be set to zero (0) if in "Zero" mode for undetermined value.

Table 4 Modbus Input Registers (continued)

Address	Size	Type	Value	Description	Notes
33	2	Float	4-20mA Input 1	Measured analog input 1 in mA.	
35	2	Float	4-20mA Input 2	Measured analog input 2 in mA.	
37	2	Float	4-20mA Channel 1	Value output on 4-20mA Channel 1.	
39	2	Float	4-20mA Channel 2	Value output on 4-20mA Channel 2.	
41	2	Float	Sensor Alpha 1	Relative scale factor between signal magnitudes acquired from each sensor.	
43	2	Float	Sensor Alpha 2	Relative scale factor between signal magnitudes acquired from each sensor.	
45	2	Float	Sensor Alpha 3	Relative scale factor between signal magnitudes acquired from each sensor.	
47	2	Float	Sensor Alpha 4	Relative scale factor between signal magnitudes acquired from each sensor.	
49	2	Float	Sensor Alpha 5	Relative scale factor between signal magnitudes acquired from each sensor.	
51	2	Float	Sensor Alpha 6	Relative scale factor between signal magnitudes acquired from each sensor.	
53	2	Float	Sensor Alpha 7	Relative scale factor between signal magnitudes acquired from each sensor.	
55	2	Float	Sensor Alpha 8	Relative scale factor between signal magnitudes acquired from each sensor.	
57	2	Float	PreAmp Charge Gain	Charge gain as read from the preamp.	
59	2	Float	PreAmp Gain 0	Preamp Gain 0 as read from the preamp.	
61	2	Float	PreAmp Gain 1	Preamp Gain 1 as read from the preamp.	
63	2	Float	PreAmp Gain 2	Preamp Gain 2 as read from the preamp.	
65	2	Float	PreAmp Gain 3	Preamp Gain 3 as read from the preamp.	
67	2	Float	Total Flow Fraction	Floating point fraction to be added to 'Total Flow Carry' * 100 to calculate full resolution total flow.	Fractional part of totalizer. Add this number to Total Flow Carry * 100 to calculate full total.

Table 4   Modbus Input Registers (continued)

Address	Size	Type	Value	Description	Notes
69	2	Float	Total TLF Fraction	Floating point fraction to be added to 'Total TLF Carry' * 100 to calculate full resolution total TLF.	Fractional part of totalizer. Add this number to Total TLF Carry * 100 to calculate full total.
71	2	Float	Output 1	Spare Output 1.	
73	2	Float	Output 2	Spare Output 2.	
75	2	Float	Output 3	Spare Output 3.	
77	2	Float	Output 4	Spare Output 4.	
1001	2	Long	System Status	Refer to manual for description of individual bits.	
1003	2	Long	Sensor 1 Max	Sensor 1 maximum in A/D bins.	
1005	2	Long	Sensor 2 Max	Sensor 2 maximum in A/D bins.	
1007	2	Long	Sensor 3 Max	Sensor 3 maximum in A/D bins.	
1009	2	Long	Sensor 4 Max	Sensor 4 maximum in A/D bins.	
1011	2	Long	Sensor 5 Max	Sensor 5 maximum in A/D bins.	
1013	2	Long	Sensor 6 Max	Sensor 6 maximum in A/D bins.	
1015	2	Long	Sensor 7 Max	Sensor 7 maximum in A/D bins.	
1017	2	Long	Sensor 8 Max	Sensor 8 maximum in A/D bins.	
1019	2	Long	Sensor 1 Min	Sensor 1 minimum in A/D bins.	
1021	2	Long	Sensor 2 Min	Sensor 2 minimum in A/D bins.	
1023	2	Long	Sensor 3 Min	Sensor 3 minimum in A/D bins.	
1025	2	Long	Sensor 4 Min	Sensor 4 minimum in A/D bins.	
1027	2	Long	Sensor 5 Min	Sensor 5 minimum in A/D bins.	
1029	2	Long	Sensor 6 Min	Sensor 6 minimum in A/D bins.	
1031	2	Long	Sensor 7 Min	Sensor 7 minimum in A/D bins.	
1033	2	Long	Sensor 8 Min	Sensor 8 minimum in A/D bins.	
1035	2	Long	Total Flow Carry	Signed long portion (* 100) to be added to 'Total Flow Fraction' to calculate full resolution total flow.	Carry part of totalizer. Add this number * 100 to Total Flow Fraction to calculate full total.
1037	2	Long	Total TLF Carry	Signed long portion (* 100) to be added to 'Total TLF Fraction' to calculate full resolution total TLF.	Carry part of totalizer. Add this number * 100 to Total TLF Fraction to calculate full total.

Table 4 Modbus Input Registers (continued)

Address	Size	Type	Value	Description	Notes
1501	16	String	Transmitter S/N	Transmitter Serial Number.	
1517	16	String	Model Number	Transmitter Model Number.	
1533	16	String	Software Revision	Transmitter Software Revision.	
1549	16	String	Alchemy Software Revision	Alchemy Software Revision.	
1565	16	String	Sensor head S/N	Sensor Head Serial Number.	
1581	16	String	PreAmp Software Revision	Preamp Software Revision.	
1597	16	String	PreAmp Serial Number	Preamp Serial Number.	
1613	16	String	DSP Hardware P/N	DSP Hardware P/N.	
1629	16	String	DSP Software P/N	DSP Software P/N.	
1645	16	String	DSP Hardware Revision	DSP Hardware Revision.	
1661	16	String	DSP Software Revision	DSP Software Revision.	
1677	16	String	FPGA Revision	FPGA Revision.	
1693	16	String	Transmitter Board S/N	Transmitter Board S/N.	
1709	16	String	Hardware P/N	Hardware P/N.	
1725	16	String	Software P/N	Software P/N.	
1741	16	String	Hardware Revision	Hardware Revision.	
1757	16	String	Alchemy Hardware Revision	Alchemy Hardware Revision.	
1773	16	String	Alchemy S/N	Alchemy S/N.	
1789	16	String	Alchemy Bootloader Revision	Alchemy Bootloader Revision.	
1805	16	String	Alchemy Bootloader P/N	Alchemy Bootloader P/N.	

Table 4 Modbus Input Registers (continued)

Address	Size	Type	Value	Description	Notes
1821	16	String	Alchemy Compatibility Revision	Alchemy Compatibility Revision.	
1837	16	String	PreAmp Software P/N	PreAmp Software P/N.	
1853	16	String	PreAmp Software Date	PreAmp Software Date.	
1869	16	String	PreAmp Hardware P/N	PreAmp Hardware P/N.	
1885	16	String	PreAmp Hardware Revision	PreAmp Hardware Revision.	
1901	16	String	PreAmp Hardware Date	PreAmp Hardware Date.	
1917	16	String	PreAmp Bootloader P/N	PreAmp Bootloader P/N.	
1933	16	String	PreAmp Bootloader Revision	PreAmp Bootloader Revision.	
2001	4	Double	Total Flow (Double Precision)	Total Flow (Double Precision).	
2005	4	Double	Total TLF (Double Precision)	Total TLF (Double Precision).	

16.3.2 Modbus Holding Registers

Table 5 Modbus Holding Registers

Address	Size	Type	Value	Description	Values
1	1	Char	Password Input	Password entry, when passwords are configured.	0 – 65535.
4	1	Char	Write Control	Controls ability to write and commit changes to transmitter configuration.	Write 0x55AA to enable write access, write 0xEDF1 to commit changes.
10	1	Char	Set Password 0	Sets Password 0.	0 – 65535.
11	1	Char	Set Password 1	Sets Password 1.	0 – 65535.
12	1	Char	Set Password 2	Sets Password 2.	0 – 65535.
20	1	Char	Reset Totalizers	Resets all totalizers to zero.	Any Write.
21	1	Char	Clear Alarm	Clear any existing alarms.	Any Write.
22	1	Char	Reset Data History	Clears the data history memory.	Any Write.
1001	1	Char	PIPE_DIAM_SELECT	Selects method used to set pipe dimensions.	0 = ID/Wall (Uses DISP_PIPE_DIAM and WALL_THICKNESS), 2 = Size/Sched (Uses PIPE_SS_SIZE and PIPE_SS_SCHED), 3 = OD/Wall (Uses PIPE_OD and WALL_THICKNESS).
1002	1	Char	PIPE_DIAM_UNITS	Selects units used for 'Pipe ID'.	0 = Inches, 1 = millimeters
1003	1	Char	PIPE_OD_UNITS	Selects units used for 'Pipe OD'.	0 = Inches, 1 = millimeters
1004	1	Char	PIPE_SS_SIZE	Selects pipe size. Will only be applied if 'Size / Schedule' is selected for 'Pipe Diameter Input Mode'.	0=2,1=2.5,3,3.5,5,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36
1005	1	Char	PIPE_SS_SCHED	Selects pipe schedule. Will only be applied if 'Size / Schedule' is selected for 'Pipe Diameter Input Mode'.	0=5S,1=10,10S,20,30,40,40S,60,80,80S,STD,XS
1006	1	Char	SOS_PIPE_WALL_THICKUNITS	Selects units used for 'SOS Pipe Wall Thickness'.	0 = Inches, 1 = millimeters
1007	1	Char	SOS_PIPE_MODULUS_SEL	Selects either a pre-defined modulus or the option to enter a custom value. Select 'Custom' to enter a value in 'SOS Pipe Modulus'.	0 = 1.9305e8 kPa (SS), 1 = 2.0684e8 kPa (Steel), 2 = 3.4473e6 kPa (PVC), 3 = Custom
1008	1	Char	SOS_GAS_CONSTANT_SEL	Selects use of pre-defined SOS Gas Constant or a custom value entered in 'SOS Gas Constant'.	0 = 287 Jkg/K (Air), 1 = Custom

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1009	1	Char	SOS_LIQUID_SPEC GRAV_SEL	Selects use of pre-defined SOS Specific Gravity or a custom value entered in 'SOS Specific Gravity'.	0 = 0.997 (Water), 1 = Custom
1010	1	Char	SOS_LIQUID_SOS_ SEL	Selects use of pre-defined SOS Liquid Sound Speed or a custom value* entered in 'SOS Liquid Sound Speed'	0 = 4910.4 ft/s (Water), 1 = Custom
1011	1	Char	TLF_TEMP_INPUT_ SEL	Selects the source of the temperature used in GVF calculations. 'Fixed' uses 'SOS Process Temperature', 'Sensor 1' uses the 4-20mA input channel 1, 'Sensor 2' uses 4-20mA input channel 2, Protocol uses values written to register 5003.	0 = Fixed, 1 = Sensor 1, 2 = Sensor 2, 3 = Protocol
1012	1	Char	TLF_PRESS_INPUT _SEL	Selects the source of the pressure used in GVF calculations. 'Fixed' uses 'SOS Process Pressure', 'Sensor 1' uses the 4-20mA input channel 1, 'Sensor 2' uses 4-20mA input channel 2, Protocol uses values written to register 5001.	0 = Fixed, 1 = Sensor 1, 2 = Sensor 2, 3 = Protocol
1013	1	Char	SOS_TEMP_UNITS	Selects units used for input of 'SOS Process Temperature' degrees.	0 = C, 1 = F
1014	1	Char	SOS_PRESS_UNIT S	Selects units used for input of 'SOS Process Pressure'.	0 = PSIg, 1 = kPAg, 2 = BARg
1015	1	Char	ALTITUDE_UNITS	Selects units used for entry of 'Altitude'.	0 = ft, 1 = m
1016	1	Char	DISP_LINE1	Selects measured value to be displayed on line 1 of the LCD.	0 = Flow Rate, 1 = Flow Rate%, 2 = Totalizer, 3 = SOS, 4 = GVF, 5 = Blank, 6 = TLF
1017	1	Char	DISP_LINE2	Selects measured value to be displayed on line 2 of the LCD.	0 = Flow Rate, 1 = Flow Rate%, 2 = Totalizer, 3 = SOS, 4 = GVF, 5 = Blank, 6 = TLF
1018	1	Char	VOL_UNITS	Selects units used to display and log flow volume.	0 = m^3, 1 = l, 2 = gal, 3 = m, 4 = ft, 5 = iga, 6 = ft^3, 7 = user
1019	1	Char	TIME_UNITS	Selects units used to display and log flow time.	0 = d, 1 = h, 2 = m, 3 = s, 4 = user
1020	1	Char	CUST_VOL_UNITS	Selects volume units used in calculation of a custom unit.	0 = m^3, 1 = l, 2 = gal, 3 = m, 4 = ft, 5 = iga, 6 = ft^3
1021	1	Char	CUST_TIME_UNITS	Selects time units used in calculation of a custom unit.	0 = d, 1 = h, 2 = m, 3 = s
1022	3	Char	CUST_VOL_LABEL	Three character string used for display and logging of a custom flow volume unit.	Any Alpha

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1025	2	Char	CUST_TIME_LABEL	Two character string used for display and logging of a custom flow time unit.	Any Alpha
1027	1	Char	GVF_DECIMAL_PLACES	Sets the number of decimal places used to display GVF on the front panel.	0 - 6
1028	1	Char	SOS_VOL_UNITS	Selects units used to display and log SOS.	0 = ft, 1 = m
1029	1	Char	DATE_FORMAT	Selects date format	0 = US (mm/dd/yyyy), 1 = Euro (dd/mm/yyyy), 2 = International (yyyy-mm-dd)
1030	1	Char	DEBUG_SETTINGS	Selects debugging options	0 = 255
1031	1	Char	WRITE_PROTECT	Enable or disable modifications to the transmitter FLASH memory. When modifying this change only this for proper operation.	0 = Disable, 1 = Enable
1032	1	Char	Pre Amp Gain	Gain selection for the preamp. Set a value 0 thru 3 to choose gain listed by 'Preamp Gain 0', 'Preamp Gain 1', 'Preamp Gain 2,' or 'Preamp Gain 3'	0 - 3
1033	1	Char	TLF_SENSOR_INPUT_UNITS_1	Selects units used in translating the mA measured on Sensor 1 input to units used internally.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg, 4 = C, 5 = F
1034	1	Char	TLF_SENSOR_INPUT_UNITS_2	Selects units used in translating the mA measured on Sensor 2 input to units used internally.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg, 4 = C, 5 = F
1035	1	Char	PRESS_INPUT_UNITS	Selects units for pressure read from register 5001 - Pressure Input.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg
1036	1	Char	TEMP_INPUT_UNITS	Selects units for temperature read from register 5003 - Temperature Input.	0 = None, 4 = C, 5 = F
1037	1	Char	EXTERN_INPUT_UNITS_0	Selects units for value read from register 5005 - External Input 1.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg, 4 = C, 5 = F
1038	1	Char	EXTERN_INPUT_UNITS_1	Selects units for value read from register 5007 - External Input 2.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg, 4 = C, 5 = F
1039	1	Char	EXTERN_INPUT_UNITS_2	Selects units for value read from register 5009 - External Input 3.	0 = None, 1 = PSIg, 2 = kPAg, 3 = BARg, 4 = C, 5 = F
1040	1	Char	VF_NR_MAGNITUDE_SEL	Selects flow noise reduction filter magnitude.	0 = Low, 1 = High
1041	1	Char	GVF_NR_MAGNITUDE_SEL	Selects GVF noise reduction filter magnitude.	0 = Low, 1 = High

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1042	16	Char	SENSORHEAD_SER_NUMBER	Sensor Head Serial Number.	Any Alpha
1058	1	Char	TOT_UNITS	Selects units used to display and log total flow.	0 = gal, 1 = m3, 2 = ft3, 3 = l, 4 = VF_VOL_UNITS
1059	1	Char	TOTALIZER_MULT	Selects totalizer multiplier.	0 = 1, 1 = k, 2 = M
1060	1	Char	TOT_LOW_CUT_ENABLE	Enables or disables totalizer lowcut.	0 = Disable, 1 = Enable
1061	1	Char	TLF_TOTALIZER_INPUT_SEL	Selects source of totalizer - VF or TLF.	0 = VF, 1 = TLF
1062	1	Char	PRIMARY_420_OUT_OF_RANGE	Selects 4-20mA Channel 1 Out Of Range action.	0 = Hold, 1 = <4ma, 2 = =4ma, 3 = >20ma
1063	1	Char	PRIMARY_420_POWER_SEL	Selects 4-20mA Channel 1 External or Internal 4-20mA, power.	0 = Internal, 1 = External
1064	1	Char	PRIMARY_420_OUTPUT_SEL	Selects metric to be output on 4-20mA Channel 1.	0 = Flow Rate, 1 = SOS, 2 = GVF, 3 = Blank, 4 = TLF, 5 = Flow Quality, 6 = SOS Quality
1065	1	Char	420_OVERRANGE_MODE_01	Selects 4-20mA Channel 1 Overrange rail.	0 - Use PRIMARY_420_OUT_OF_RANGE setting when output is below/ above lowcut/highcut % (do not rail), 1 - Rail 4-20mA output if metric is below/above lowcut/highcut % for channel 1
1066	1	Char	SECONDARY_420_OUT_OF_RANGE	Selects 4-20mA Channel 2 Out Of Range action.	0 = Hold, 1 = <4ma, 2 = =4ma, 3 = >20ma
1067	1	Char	SECONDARY_420_POWER_SEL	Selects 4-20mA Channel 2 External or Internal 4-20mA power.	0 = Internal, 1 = External
1068	1	Char	SECONDARY_420_OUTPUT_SEL	Selects metric to be output on 4-20mA Channel 2.	0 = Flow Rate, 1 = SOS, 2 = GVF, 3 = Blank, 4 = TLF, 5 = Flow Quality, 6 = SOS Quality

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1069	1	Char	420_OVERRANGE_MODE_02	Selects 4-20mA Channel 2 Overrange rail.	0 = Use PRIMARY_420_OUT_OF_RANGE setting when output is below/ above lowcut/highcut % (do not rail), 1 = Rail 4-20mA output if metric is below/above lowcut/highcut % for channel 1
1070	1	Char	PULSE_OUTPUT_SEL	Selects metric output on pulse.	0 = Flow Rate, 1 = SOS, 2 = GVF, 3 = Flow Rate %, 4 = Totalizer, 5 = TLF, 6 = Flow Quality, 7 = SOS Quality
1071	1	Char	PULSE_WIDTH	Selects pulse width.	0 = 0.5, 1 = 1, 2 = 20, 3 = 33, 4 = 50, 5 = 100
1072	1	Char	ALARM_WARN_EXPR_0	Boolean expression used for warning alarm.	0 = OFF, 1 = ON
1073	1	Char	ALARM_WARN_EXPR_1	Boolean expression used for warning alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF
1074	1	Char	ALARM_WARN_EXPR_2	Boolean expression used for warning alarm.	0 = Blank, 1 = OR, 2 = AND
1075	1	Char	ALARM_WARN_EXPR_3	Boolean expression used for warning alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF
1076	1	Char	ALARM_WARN_EXPR_4	Boolean expression used for warning alarm.	0 = Blank, 1 = OR, 2 = AND
1077	1	Char	ALARM_WARN_EXPR_5	Boolean expression used for warning alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF
1078	1	Char	ALARM_CRIT_EXPR_0	Boolean expression used for critical alarm.	0 = OFF, 1 = ON
1079	1	Char	ALARM_CRIT_EXPR_1	Boolean expression used for critical alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1080	1	Char	ALARM_CRIT_EXPR_2	Boolean expression used for critical alarm.	0 = Blank, 1 = OR, 2 = AND
1081	1	Char	ALARM_CRIT_EXPR_3	Boolean expression used for critical alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF
1082	1	Char	ALARM_CRIT_EXPR_4	Boolean expression used for critical alarm.	0 = Blank, 1 = OR, 2 = AND
1083	1	Char	ALARM_CRIT_EXPR_5	Boolean expression used for critical alarm.	2 = Blank, 3 = TMP, 4 = SPL, 5 = VQ, 6 = SQ, 7 = LOG, 8 = OVL, 9 = FAL, 10 = FLW, 11 = GVF
1084	1	Char	ALARM_MANUAL_CLR	Disables or enables manual clearing of alarms from front panel with the ESC/EXIT Key.	0 = Disable, 1 = Enable
1501	2	Float	DISP_PIPE_DIAM	Pipe Inside Diameter (ID).	
1503	2	Float	PIPE_OD	Pipe Outside Diameter (OD).	
1505	2	Float	WALL_THICKNESS	Pipe Wall Thickness.	
1507	2	Float	VISCOSITY	Viscosity in Pascal seconds of the fluid at the operating conditions. Used for Reynolds correction.	
1509	2	Float	ALTITUDE_ABOVE_SEA_LEVEL	Altitude Above Sea Level in units defined by 'ALTITUDE_UNITS'.	
1511	2	Float	LOW_FLOW_CUT_OFF	Low flow cutoff as a % of flow measurement range (defined by FLOW_MIN and FLOW_MAX). Will not display or output flow reading if flow value is below this setting.	
1513	2	Float	HIGH_FLOW_CUT_OFF	High flow cutoff as a % of flow measurement range (defined by FLOW_MIN and FLOW_MAX). Will not display or output flow reading if flow value is above this setting.	
1515	2	Float	CUST_VOL_SCALE	Multiplier for base flow units to create custom display.	
1517	2	Float	CUST_TIME_SCALE	Multiplier for base time units to create custom display.	
1519	2	Float	VF_QUALITY_DELTA	Delta change from minimum quality at minimum flow (MIN_QUALITY) to minimum quality at max flow (MIN_QUALITY+ VF_QUALITY_DELTA).	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1521	2	Float	SOS_QUALITY_DELTA	Delta change from SOS minimum quality at minimum SOS (SOS_MIN_QUALITY) to minimum quality at max SOS (SOS_MIN_QUALITY+ SOS_QUALITY_DELTA).	
1523	2	Float	YELLOW_QUALITY_PERCENT	Percentage of VF quality or SOS quality (depending on op mode) below which the display will indicate a 3 level of 'YEL', if configured to display 3 level quality.	
1525	2	Float	TOTAL_LOW_CUT	Define low limit of totalizer. Input as % of flow rate. Readings below this value will not be totalized.	
1527	2	Float	REYNOLDSC0	Volumetric flow calibration coefficient C0.	
1529	2	Float	REYNOLDSC1	Volumetric flow calibration coefficient C1.	
1531	2	Float	REYNOLDSC2	Volumetric flow calibration coefficient C2.	
1533	2	Float	TLF_SENSOR_INPUT_SCALE_1	Sets multiplier used to scale the 4-20mA input Sensor 1.	
1535	2	Float	TLF_SENSOR_INPUT_SCALE_2	Sets multiplier used to scale the 4-20mA input Sensor 2.	
1537	2	Float	TLF_SENSOR_INPUT_OFFSET_1	Sets offset used to calculate the 4-20mA input Sensor 1 value.	
1539	2	Float	TLF_SENSOR_INPUT_OFFSET_2	Sets offset used to calculate the 4-20mA input Sensor 2 value.	
1541	2	Float	PRIMARY_420_HIGH_END	Define high (20mA) end of primary 4-20mA output.	
1543	2	Float	PRIMARY_420_LOW_END	Define low (4mA) end of primary 4-20mA output.	
1545	2	Float	PRIMARY_420_SCALE	Multiplier applied to primary 4-20mA output for calibration purposes	
1547	2	Float	PRIMARY_420_OFFSET	Constant offset applied to primary 4-20mA output for calibration purposes.	
1549	2	Float	SECONDARY_420_HIGH_END	Define high (20mA) end of primary 4-20mA output.	
1551	2	Float	SECONDARY_420_LOW_END	Define low (4mA) end of primary 4-20mA output.	
1553	2	Float	SECONDARY_420_SCALE	Multiplier applied to primary 4-20mA output for calibration purposes.	

Table 5   *Modbus Holding Registers (continued)*

Address	Size	Type	Value	Description	Values
1555	2	Float	SECONDARY_420_OFFSET	Constant offset applied to primary 4-20mA output for calibration purposes.	
1557	2	Float	PULSE_MULT	Pulse output multiplier.	
1559	2	Float	PULSE_LOW_CUT	Define measurement value below which pulse output will not be updated.	
1561	2	Float	ALARM_WARN_TEMP_<	Min band temperature threshold for warning alarm in degrees C.	
1563	2	Float	ALARM_WARN_TEMP_>	Max band temperature threshold for warning alarm in degrees C.	
1565	2	Float	ALARM_WARN_SPL_<	Min SPL threshold for warning alarm in dB.	
1567	2	Float	ALARM_WARN_SPL_>	Max SPL threshold for warning alarm in dB.	
1569	2	Float	ALARM_WARN_VF_QUAL_<	Min VF Quality threshold for warning alarm.	
1571	2	Float	ALARM_WARN_SOS_QUAL_<	Min SOS Quality threshold for warning alarm.	
1573	2	Float	ALARM_WARN_VF_<	Min Vortical Flow Rate threshold for warning alarm in %.	
1575	2	Float	ALARM_WARN_VF_>	Max Vortical Flow Rate threshold for warning alarm in %.	
1577	2	Float	ALARM_WARN_GVF_<	Min Gas Volume Fraction threshold for warning alarm in %.	
1579	2	Float	ALARM_WARN_GVF_>	Max Gas Volume Fraction threshold for warning alarm in %.	
1581	2	Float	ALARM_CRIT_TEMP_<	Min band temperature threshold for critical alarm in degrees C.	
1583	2	Float	ALARM_CRIT_TEMP_>	Max band temperature threshold for critical alarm in degrees C.	
1585	2	Float	ALARM_CRIT_SPL_<	Min SPL threshold for critical alarm in dB.	
1587	2	Float	ALARM_CRIT_SPL_>	Max SPL threshold for critical alarm in dB.	

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
1589	2	Float	ALARM_CRIT_VF_QUAL_<	Min VF Quality threshold for critical alarm.	
1591	2	Float	ALARM_CRIT_SOS_QUAL_<	Min SOS Quality threshold for critical alarm.	
1593	2	Float	ALARM_CRIT_VF_<	Min Vortical Flow Rate threshold for critical alarm in %.	
1595	2	Float	ALARM_CRIT_VF_>	Max Vortical Flow Rate threshold for critical alarm in %.	
1597	2	Float	ALARM_CRIT_GVF_<	Min Gas Volume Fraction threshold for critical alarm in %.	
1599	2	Float	ALARM_CRIT_GVF_>	Max Gas Volume Fraction threshold for critical alarm in %.	
2001	1	Short	IDLE_TIMEOUT_SEC	Set communications idle timeout in seconds.	
2002	1	Short	ETHERNET_IDLE_TIMEOUT	Set Ethernet communications idle timeout in seconds.	
2003	1	Short	CONTRAST	Set front panel LCD display contrast.	
2004	1	Short	STORAGE_ID_0	ID of available values to be saved in storage mode.	
2005	1	Short	STORAGE_ID_1	ID of available values to be saved in storage mode.	
2006	1	Short	STORAGE_ID_2	ID of available values to be saved in storage mode.	
2007	1	Short	STORAGE_ID_3	ID of available values to be saved in storage mode.	
2008	1	Short	STORAGE_ID_4	ID of available values to be saved in storage mode.	
2009	1	Short	STORAGE_ID_5	ID of available values to be saved in storage mode.	
2010	1	Short	STORAGE_ID_6	ID of available values to be saved in storage mode.	
2501	2	Long	MAX_SENSOR_THRESH	Sets maximum threshold for sensor health diagnostics (in A/D counts).	
2503	2	Long	MIN_SENSOR_THRESH	Sets minimum threshold for sensor health diagnostics (in A/D counts).	
2505	2	Long	STORAGE_INTERVAL	Time in seconds between storage writes.	
2507	2	Long	STORAGE_ADDR_1	Address in rabbit controller memory to save to storage.	
2509	2	Long	STORAGE_ADDR_2	Address in rabbit controller memory to save to storage.	
3001	2	Float	VF_LOW_FILTER_DELTA_ARRAY_01	Delta Filter definition for VF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3003	2	Float	VF_LOW_FILTER_DELTA_ARRAY_02	Delta Filter definition for VF.	
3005	2	Float	VF_LOW_FILTER_DELTA_ARRAY_03	Delta Filter definition for VF.	
3007	2	Float	VF_LOW_FILTER_DELTA_ARRAY_04	Delta Filter definition for VF.	
3009	2	Float	VF_LOW_FILTER_DELTA_ARRAY_05	Delta Filter definition for VF.	
3011	2	Float	VF_LOW_FILTER_DELTA_ARRAY_06	Delta Filter definition for VF.	
3013	2	Float	VF_LOW_FILTER_DELTA_ARRAY_07	Delta Filter definition for VF.	
3015	2	Float	VF_LOW_FILTER_DELTA_ARRAY_08	Delta Filter definition for VF.	
3017	2	Float	VF_LOW_FILTER_DELTA_ARRAY_09	Delta Filter definition for VF.	
3019	2	Float	VF_LOW_FILTER_DELTA_ARRAY_10	Delta Filter definition for VF.	
3021	2	Float	VF_LOW_FILTER_TAU_ARRAY_01	Tau Filter definition for VF.	
3023	2	Float	VF_LOW_FILTER_TAU_ARRAY_02	Tau Filter definition for VF.	
3025	2	Float	VF_LOW_FILTER_TAU_ARRAY_03	Tau Filter definition for VF.	
3027	2	Float	VF_LOW_FILTER_TAU_ARRAY_04	Tau Filter definition for VF.	
3029	2	Float	VF_LOW_FILTER_TAU_ARRAY_05	Tau Filter definition for VF.	
3031	2	Float	VF_LOW_FILTER_TAU_ARRAY_06	Tau Filter definition for VF.	
3033	2	Float	VF_LOW_FILTER_TAU_ARRAY_07	Tau Filter definition for VF.	
3035	2	Float	VF_LOW_FILTER_TAU_ARRAY_08	Tau Filter definition for VF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3037	2	Float	VF_LOW_FILTER_TAU_ARRAY_09	Tau Filter definition for VF.	
3039	2	Float	VF_LOW_FILTER_TAU_ARRAY_10	Tau Filter definition for VF.	
3041	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_01	Delta Filter definition for VF.	
3043	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_02	Delta Filter definition for VF.	
3045	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_03	Delta Filter definition for VF.	
3047	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_04	Delta Filter definition for VF.	
3049	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_05	Delta Filter definition for VF.	
3051	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_06	Delta Filter definition for VF.	
3053	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_07	Delta Filter definition for VF.	
3055	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_08	Delta Filter definition for VF.	
3057	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_09	Delta Filter definition for VF.	
3059	2	Float	VF_HIGH_FILTER_DELTA_ARRAY_10	Delta Filter definition for VF.	
3061	2	Float	VF_HIGH_FILTER_TAU_ARRAY_01	Tau Filter definition for VF.	
3063	2	Float	VF_HIGH_FILTER_TAU_ARRAY_02	Tau Filter definition for VF.	
3065	2	Float	VF_HIGH_FILTER_TAU_ARRAY_03	Tau Filter definition for VF.	
3067	2	Float	VF_HIGH_FILTER_TAU_ARRAY_04	Tau Filter definition for VF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3069	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_05	Tau Filter definition for VF.	
3071	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_06	Tau Filter definition for VF.	
3073	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_07	Tau Filter definition for VF.	
3075	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_08	Tau Filter definition for VF.	
3077	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_09	Tau Filter definition for VF.	
3079	2	Float	VF_HIGH_FILTER_ TAU_ARRAY_10	Tau Filter definition for VF.	
3081	2	Float	VF_DAMPING_TAU	Damping time in seconds for the damping filter for VF.	
3083	2	Float	VF_SPIKE_FILTER_ PERCENT	Defines delta of the previous measurement over the range below which the flow rate is deemed valid.	
3085	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_01	Delta Filter definition for GVF.	
3087	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_02	Delta Filter definition for GVF.	
3089	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_03	Delta Filter definition for GVF.	
3091	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_04	Delta Filter definition for GVF.	
3093	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_05	Delta Filter definition for GVF.	
3095	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_06	Delta Filter definition for GVF.	
3097	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_07	Delta Filter definition for GVF.	
3099	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_08	Delta Filter definition for GVF.	
3101	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_09	Delta Filter definition for GVF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3103	2	Float	GVF_LOW_FILTER_ DELTA_ARRAY_10	Delta Filter definition for GVF.	
3105	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_01	Tau Filter definition for GVF.	
3107	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_02	Tau Filter definition for GVF.	
3109	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_03	Tau Filter definition for GVF.	
3111	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_04	Tau Filter definition for GVF.	
3113	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_05	Tau Filter definition for GVF.	
3115	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_06	Tau Filter definition for GVF.	
3117	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_07	Tau Filter definition for GVF.	
3119	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_08	Tau Filter definition for GVF.	
3121	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_09	Tau Filter definition for GVF.	
3123	2	Float	GVF_LOW_FILTER_ TAU_ARRAY_10	Tau Filter definition for GVF.	
3125	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_01	Delta Filter definition for GVF.	
3127	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_02	Delta Filter definition for GVF.	
3129	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_03	Delta Filter definition for GVF.	
3131	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_04	Delta Filter definition for GVF.	
3133	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_05	Delta Filter definition for GVF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3135	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_06	Delta Filter definition for GVF.	
3137	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_07	Delta Filter definition for GVF.	
3139	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_08	Delta Filter definition for GVF.	
3141	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_09	Delta Filter definition for GVF.	
3143	2	Float	GVF_HIGH_FILTER _DELTA_ARRAY_10	Delta Filter definition for GVF.	
3145	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_01	Tau Filter definition for GVF.	
3147	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_02	Tau Filter definition for GVF.	
3149	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_03	Tau Filter definition for GVF.	
3151	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_04	Tau Filter definition for GVF.	
3153	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_05	Tau Filter definition for GVF.	
3155	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_06	Tau Filter definition for GVF.	
3157	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_07	Tau Filter definition for GVF.	
3159	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_08	Tau Filter definition for GVF.	
3161	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_09	Tau Filter definition for GVF.	
3163	2	Float	GVF_HIGH_FILTER _TAU_ARRAY_10	Tau Filter definition for GVF.	
3165	2	Float	GVF_DAMPING_TA U	Damping time in seconds for the damping filter for GVF.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3167	2	Float	GVF_SPIKE_FILTER_PERCENT	Defines delta of the previous measurement over the range below which the flow rate is deemed valid.	
3169	2	Float	S1_DAMPING_TAU	Damping time in seconds for the damping filter for Sensor 1 input.	
3171	2	Float	S2_DAMPING_TAU	Damping time in seconds for the damping filter for Sensor 2 input.	
3501	1	Short	S1_1ST_ORDER_DAMPING_FILTER_ENABLE	Enables or Disables damping filter for Sensor 1 4-20mA input.	0 = Disable, 1 = Enable
3502	1	Short	S2_1ST_ORDER_DAMPING_FILTER_ENABLE	Enables or Disables damping filter for Sensor 2 4-20mA input.	0 = Disable, 1 = Enable
3503	1	Short	VF_NR_FILTER_ENABLE	Enables or Disables Noise Reduction Filter of the VF Flow Rate.	0 = Disable, 1 = Enable
3504	1	Short	VF_LOW_FILTER_ARRAY_LEN	Defines the length of the delta array for VF.	
3505	1	Short	VF_HIGH_FILTER_ARRAY_LEN	Defines the length of the delta array for VF.	
3506	1	Short	VF_1ST_ORDER_DAMPING_FILTER_ENABLE	Enables or Disables 1st Order Damping Filter of the VF Flow Rate.	0 = Disable, 1 = Enable
3507	1	Short	VF_SPIKE_FILTER_ENABLE	Enables or Disables Spike Filter of the VF Flow Rate.	0 = Disable, 1 = Enable
3508	1	Short	VF_SPIKE_NO_FLOW_LEN	Number of good measures during initialization before VF spike filter passes measurements as ‘good’.	
3509	1	Short	VF_SPIKE_FILTER_LEN	Defines the number of consecutive valid measurements before displaying flow rate.	
3510	1	Short	VF_SPIKE_UP_COUNT	Number of counts to INCREMENT the VF Bad Quality counter when measured VF quality is below the minimum.	
3511	1	Short	VF_SPIKE_DOWN_COUNT	Number of counts to DECREMENT the VF Bad Quality counter when measured VF quality is below the minimum	

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
3512	1	Short	VF_SPIKE_PCT_WINDOW_LEN	Number of good measures before VF spike filter passes measurements as 'good'.	
3513	1	Short	GVF_NR_FILTER_ENABLE	Enables or Disables Noise Reduction Filter of the GVF.	0 = Disable, 1 = Enable
3514	1	Short	GVF_LOW_FILTER_ARRAY_LEN	Defines the length of the delta array for GVF.	
3515	1	Short	GVF_HIGH_FILTER_ARRAY_LEN	Defines the length of the delta array for GVF.	
3516	1	Short	GVF_1ST_ORDER_DAMPING_FILTER_ENABLE	Enables or Disables 1st Order Damping Filter of the GVF.	0 = Disable, 1 = Enable
3517	1	Short	GVF_SPIKE_FILTER_ENABLE	Enables or Disables Spike Filter of the GVF.	0 = Disable, 1 = Enable
3518	1	Short	GVF_SPIKE_NO_FLOW_LEN	Number of good measures during initialization before GVF spike filter passes measurements as 'good'.	
3519	1	Short	GVF_SPIKE_FILTER_LEN	Defines the number of consecutive valid measurements before displaying.	
3520	1	Short	GVF_SPIKE_UP_COUNT	Number of counts to INCREMENT the GVF Bad Quality counter when measured GVF quality is below the minimum.	
3521	1	Short	GVF_SPIKE_DOWN_COUNT	Number of counts to DECREMENT the GVF Bad Quality counter when measured GVF quality is below the minimum.	
3522	1	Short	GVF_SPIKE_PCT_WINDOW_LEN	Number of good measures before GVF spike filter passes measurements as 'good'.	
4001	2	Float	PIPE_DIAM	Define pipe ID in inches.	
4003	2	Float	SOS_PIPE_WALL_THICK	SOS pipe wall thickness measurement in units selected by 'SOS Pipe Wall Thickness Units'.	
4005	2	Float	SOS_PIPE_MODULUS	SOS pipe modulus value.	
4007	2	Float	SOS_GAS_CONSTANT	Gas constant value used in GVF calculation.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4009	2	Float	SOS_SPECIFIC_GRAVITY	This parameter (internally multiplied by 1000 kg/m^3) is used to set the 'SOS Liquid Density'. For example, Specific Gravity = 1.1 equates to density of 1.1 * 1000 kg/m^3.	
4011	2	Float	SOS_LIQUID_SOS	Pure phase liquid SOS for process fluid in ft/sec. Used for GVF calculation. Default setting is for water and is close enough for most fluid/gas applications.	
4013	2	Float	SOS_SPECFIC_HEAT_RATIO		
4015	2	Float	SOS_LIQUID_DENSITY	Calculated from 'SOS Specific Gravity'.	
4017	2	Float	SOS_TEMPERATURE	Constant temperature for GVF calculations when 'Fixed' is selected for 'SOS Temperature Input Selection'. In configured units.	
4019	2	Float	SOS_PRESSURE	Constant pressure for GVF calculations when 'Fixed' is selected for 'SOS Pressure Input Selection'. In configured units.	
4021	2	Float	GAIN		
4023	2	Float	SPL_THRESHOLD	This value is the threshold that the Average SPL must break in order for any SOS or VF calculations to be performed. A quality of -2 is reported if this threshold is not met. Set this value to 0 to disable SPL.	
4025	2	Float	SPL_AVG	The average SPL measurement from all active sensors.	
4027	2	Float	SPL_STD_DEV	The standard deviation of the SPL measurements from all active sensors.	
4029	2	Float	SAMPLE_FREQ	Set A/D sample frequency in samples per second. Enter one of the following: 3906.25 or 2055.921.	
4031	2	Float	CHANNEL_SKEW	Flow Channel Skew.	
4033	2	Float	FREQ_MIN	Set minimum frequency for k-w processing. Normally set by DSP. User modified if using single or fixed modes or auto mode with VF_OP_MODE_SETTINGS set to 1 (FIXED_FREQUENCY). Go to Idle mode, then set this parameter, then select single/fixed.	

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4035	2	Float	FREQ_MAX	Set maximum frequency for k-w processing. Normally set by DSP. User modified if using single or fixed modes or auto mode with VF_OP_MODE_SETTINGS set to 1 (FIXED_FREQUENCY). Go to Idle mode, then set this parameter, then select single/fixed.	
4037	2	Float	FLOW_MIN	Minimum valid flow rate reading in configured display units.	
4039	2	Float	FLOW_MAX	Maximum valid flow rate reading in configured display units.	
4041	2	Float	MIN_QUALITY	Minimum quality threshold for VF display and output.	
4043	2	Float	VF_NYQUIST_HIGH	Define high end of frequency range to use for determining flow velocity. Defined by: FREQUENCY_MAX = (Measured Velocity * VF_NYQUIST_HIGH) / (Sensor Spacing). Example: (10 ft/sec * 0.7) / 0.2 = 35Hz	
4045	2	Float	VF_NYQUIST_LOW	Define low end of frequency range to use for determining flow velocity. Defined by: FREQUENCY_MIN = (Measured Velocity * VF_NYQUIST_LOW) / (Sensor Spacing). Example: (10 ft/sec*0.3) / 0.2 = 15Hz	
4047	2	Float	VF_CENTROID_WIDTH	Define width of peak to use in calculation of flow rate.	
4049	2	Float	VF_SEARCH_LIMIT_LOW	Define low end of velocity search range to use for determining flow velocity. Defined by: Velocity_Min = (FREQ_MAX * Sensor Spacing) / (VF_SEARCH_LIMIT_LOW). Example: at 10ft/sec* (10 ft/sec*0.7) / 0.2 = 35Hz then (35Hz * 0.2) / 0.9 = 7.78 ft/sec.	
4051	2	Float	VF_SEARCH_LIMIT_HIGH	Define high end of velocity search range to use for determining flow velocity. Defined by: Velocity_Max = (FREQ_MIN * Sensor Spacing) / (VF_SEARCH_LIMIT_HIGH). Example: at 10ft/sec* (10 ft/sec*0.3) / 0.2 = 15Hz then (15Hz * 0.2) / 0.15 = 20 ft/sec.	
4053	2	Float	VF_NYQUIST_INIT_VAL	This parameter selects the k value (from k-w) where the algorithm initially searches for the flow rate.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4055	2	Float	SOS_SAMPLE_FREQ	Set sample frequency for SOS mode. This parameter must be set for SOS and overrides the SAMPLE_FREQ setting if running in SOS mode. Enter one of the following: 3906.25 or 2055.921.	3906.25or 2055.921
4057	2	Float	SOS_FREQ_MIN	Minimum frequency to use for SOS calculation. Typically in the 100 to 500hz range. Depends upon the data quality as seen on the k-w plot. SOS_FREQ_MIN and SOS_FREQ_MAX set the frequency range over which the SOS calculation will be performed.	
4059	2	Float	SOS_FREQ_MAX	Maximum frequency to use for SOS calculation. Typically in the 800 to 1500hz range. Depends upon the data quality as seen on the k-w plot. SOS_FREQ_MIN and SOS_FREQ_MAX set the frequency range over which the SOS calculation will be performed.	
4061	2	Float	SOS_MIN	Minimum SOS value to search for. If too much energy (such as from a high velocity vortical ridge) causes the algorithms to calculate a sound speed below that of the main SOS ridge; this parameter may need to be increased.	
4063	2	Float	SOS_MAX	Maximum SOS value to search for. If too much energy along the 0 k value on the k-w plot and algorithms are calculating SOS_MAX even when SOS ridge indicates an SOS below this value; may need to decrease this parameter.	
4065	2	Float	SOS_MIN_QUALITY	Minimum quality threshold for SOS/GVF display and output.	
4067	2	Float	SOS_CENTROID_WIDTH	Define width of peak to use in calculation of SOS.	
4069	2	Float	SOS_FREQ_THRESH	This value selects the threshold that the second derivative of a power array (generated at a specific frequency over all k-space values) must break in order for the specific frequency point to be considered a valid frequency point.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4071	2	Float	SOS_K_MIN	This value sets the lower limit in k-space that is used in the SOS auto frequency determination code. This value is equal to the first k-space bin after 0: PI/deltaX/50 (there are 50 bins from 0 to PI/deltaX).	
4073	2	Float	SOS_K_MAX	This value sets the upper limit in k-space that is used in the SOS auto frequency determination code. This value is equal to the last k-space bin: PI/deltaX.	
4075	2	Float	SOS_SEARCH_LIMIT	This value is the +/- percentage of the estimated SOS value (calculated using the auto frequency calculation code) that determines the lower (Estimated SOS * 0.5) and upper (Estimated SOS * 1.5) SOS search limits.	
4077	2	Float	SOS_LAMBDA_DIAMETER	Used to calculate the SOS dynamic frequency maximum used when calculating SOS. SOS Max Freq = (Max SOS search) / ((Lambda Diameter * (Pipe Diameter/12)).	
4079	2	Float	SENSOR_SPACING_1	Starting point for sensor 1. Typically 0.	
4081	2	Float	SENSOR_SPACING_2	Distance in feet between sensor 1 and sensor 2.	
4083	2	Float	SENSOR_SPACING_3	Distance in feet between sensor 1 and sensor 3.	
4085	2	Float	SENSOR_SPACING_4	Distance in feet between sensor 1 and sensor 4.	
4087	2	Float	SENSOR_SPACING_5	Distance in feet between sensor 1 and sensor 5.	
4089	2	Float	SENSOR_SPACING_6	Distance in feet between sensor 1 and sensor 6.	
4091	2	Float	SENSOR_SPACING_7	Distance in feet between sensor 1 and sensor 7.	
4093	2	Float	SENSOR_SPACING_8	Distance in feet between sensor 1 and sensor 8.	
4095	2	Float	SENSOR_SCALE_1	Scaling factor in volts per PSI for sensor 1.	
4097	2	Float	SENSOR_SCALE_2	Scaling factor in volts per PSI for sensor 2.	
4099	2	Float	SENSOR_SCALE_3	Scaling factor in volts per PSI for sensor 3.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4101	2	Float	SENSOR_SCALE_4	Scaling factor in volts per PSI for sensor 4.	
4103	2	Float	SENSOR_SCALE_5	Scaling factor in volts per PSI for sensor 5.	
4105	2	Float	SENSOR_SCALE_6	Scaling factor in volts per PSI for sensor 6.	
4107	2	Float	SENSOR_SCALE_7	Scaling factor in volts per PSI for sensor 7.	
4109	2	Float	SENSOR_SCALE_8	Scaling factor in volts per PSI for sensor 8.	
4501	2	Long	OP_MODE	Sets operating mode of the transmitter. VF Mode = 0, SOS Mode = 1, Both Mode = 2.	
4503	2	Long	UPDATE_RATE	This parameter will set the update rate in seconds (nominally). Actual update rate (in seconds) can be calculated by taking (BLOCK_SIZE / SAMPLE_FREQ) * UPDATE_RATE (VF mode), or, (BLOCK_SIZE / SOS_SAMPLE_FREQ) * UPDATE_RATE (SOS mode).	
4505	2	Long	NUM_CHANNELS	Sets number of sensors. Always leave set to 8. Do not use this parameter to disable a sensor use NUM_SENSORS_USED parameter to set which sensors to use in calculations.	
4507	2	Long	DECIMATION	Flow Decimation.	
4509	2	Long	WINDOW_TYPE	Algorithms always use hanning window. Windows raw data samples of NFFT size then zero pads then computes FFT.	
4511	2	Long	DETREND_FLAG	Enable/disable detrend of time series data of NFFT size before windowing and zero padding.	0 = Do not detrend time series data, 1 = Detrend time series data.
4513	2	Long	VEL_NORM_FLAG	Enable/disable normalization of sensor data.	0 = No normalization, 1 = Normalize data. Normalization performed in frequency domain.
4515	2	Long	VEL_DIFF_FLAG	Enable/disable differencing of sensors.	0 = No differencing, 1 = difference sensors using first order differencing. (i.e. Ch1=S1-S2* Ch2=S2-S3...Ch7=S7-S8). 2 - second order differencing (i.e. Ch1=S1-2*S2+S3* Ch2=S2-2*S3+S4...).
4517	2	Long	FLOW_DIR	Define flow direction.	0 = reverse flow, 1 = normal flow

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4519	2	Long	TRANSIT_TIME_MULT	Default values are normally OK. Define target number of passes through array per calculation for volumetric flow. Use with caution.	
4521	2	Long	VF_PEAK_SEARCH_MODE	0 = No differencing, 1 = difference sensors using first order differencing. (i.e. Ch1=S1-S2* Ch2=S2-S3...Ch7=S7-S8). 2 - second order differencing (i.e. Ch1=S1-2*S2+S3* Ch2=S2-2*S3+S4...).	
4523	2	Long	VF_OP_MODE_SETTINGS	0 = Dynamic frequency adjust in auto runmode (original calculation), 1 = Fixed frequency in auto run mode, 2 = Fixed blocks in auto run mode, 4 = Dynamic Nyquist calculation enable, 8 = Reserved for future use, 16 = Linear KW diff enable, 32 = Log KW diff enable.	
4525	2	Long	VF_QUALITY_MODE	0 = original VF quality calculation, 1 = new VF quality calculation.	
4527	2	Long	NUM_BLOCKS	Define number of blocks used for calculations.	
4529	2	Long	NFFT	Number of points used in FFT. Actual FFT size is next 2^n higher value. Value of NFFT is zero padded to next larger 2^n FFT size. This value is normally set by the DSP.	
4531	2	Long	WINDOW_OVERLAP	Define overlap of FFT windows. This value is normally set by DSP to half of NFFT.	
4533	2	Long	FFT_AVGS	Default values are normally OK. In general for slower flow rates use more FFT averages; for faster flow rates use fewer FFT averages. This parameter affects the number of blocks used (there is a 20 block maximum due to DSP memory limitations). Use with caution.	
4535	2	Long	SOS Total Data	Calculates SOS Samples from this value and SOS Sample Frequency: SOS Samples = SOS Total Data * SOS Sample Freq.	
4537	2	Long	SOS_FFT_POINTS	Number of FFT points to use in SOS calculation. Usually set to 1/8 or 1/4 of the sample frequency.	
4539	2	Long	SOS_WINDOW_OVERLAP	Number of sample point overlap between successive FFT's. Recommended to set this to 50% of SOS_FFT_POINTS.	

Table 5 Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4541	2	Long	SOS_SUB_ARRAYS	SOS Sub Array Size	
4543	2	Long	SOS_NORMALIZE_FLAG	0 = NO normalization in the frequency domain. 1 = normalization in the frequency domain.	
4545	2	Long	SOS_DIFFERENCING_FLAG	0 = NO differencing in the frequency domain. 1 = 1st order differencing in the frequency domain. 2 = 2nd order differencing in the frequency domain.	
4547	2	Long	SOS_OP_MODE_SETTINGS	Determines which ridge to use for SOS calculation. Also determines which SOS parameter to leave fixed or calculate and whether or not to use Linear/Log KW diff.	0 = Use right and left ridge averaged, 1 = Use right ridge only, 2 = Use left ridge only, 4 = Enable SOS auto frequency calculation, 8 = Enable SOS power weighting to auto-frequency calculation, 16 = Linear KW diff enable, 32 = Log KW diff enable.
4549	2	Long	SOS_SELECT_NUM	SOS Selection Threshold.	
4551	2	Long	SOS_MIN_FREQ_PTS	This value selects the minimum number of frequency points that will be used in the SOS calculation. If this number is not met then the calculation is not performed and an error is reported.	
4553	2	Long	SOS_NUM_PTS_LEFT	The number of frequency points used from the left ridge of the k-w plot.	
4555	2	Long	SOS_NUM_PTS_RIGHT	The number of frequency points used from the right ridge of the k-w plot.	
4557	2	Long	AGC_THRESHOLD_HIGH	Upper threshold limit for sensor readings. Used to detect High Threshold sensor readings during AGC mode functions.	
4559	2	Long	AGC_THRESHOLD_LOW	Lower threshold limit for sensor readings. Used to detect Low Threshold sensor readings during AGC mode functions.	
4561	2	Long	AGC_PERCENT_THRESHOLD_HIGH	Represents the percentage value of High Threshold faults required to be detected before asserting an Excessive Gain condition during AGC functions.	

Table 5   Modbus Holding Registers (continued)

Address	Size	Type	Value	Description	Values
4563	2	Long	AGC_PERCENT_THRESHOLD_LOW	Represents the percentage value of Low Threshold faults required to be detected before asserting an Insufficient Gain condition during AGC functions.	
4565	2	Long	AGC_SAMPLE_WINDOW	Represents the time window in seconds during which AGC High and Low Threshold faults will be counted. This is a sliding time window when used during Auto Gain Adjust functions and a One-Shot time window during Gain Test functions.	
4567	2	Long	AGC_RUN_MODE	For future use only. This parameter will be used to specify if the AGC functions should be executed in a Continuous mode, or in Single Execution mode.	
5001	2	Float	Pressure Input	External pressure measurement input.	No write control required on these inputs, just write to them.
5003	2	Float	Temperature Input	External temperature measurement input.	No write control required on these inputs, just write to them.
5005	2	Float	External Input 1	External Input 1.	No write control required on these inputs, just write to them.
5007	2	Float	External Input 2	External Input 2.	No write control required on these inputs, just write to them.
5009	2	Float	External Input 3	External Input 3.	No write control required on these inputs, just write to them.
5501	32	Short	Softing Firmware Rev	Firmware revision of the Softing board.	
5533	32	Short	PD Tag	Fieldbus PD Tag.	
5565	32	Short	Device ID	Fieldbus Device ID.	
5597	1	Short	Node Address	Fieldbus Node Address.	
5598	1	Short	RB Block Mode	Fieldbus Resource Block Mode.	
5599	1	Short	TB Block Mode	Fieldbus Transducer Block Mode.	

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Appendix A PASSIVE SONAR SYSTEM SPECIFICATIONS

A1 Physical Specifications

A1.1 Power Requirements

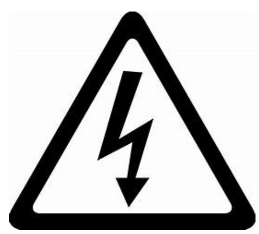
AC Version: 100 to 240 Volts AC, 50/60 Hz, 25 watts

DC Version: 18-36 Volts DC, 25 watts

Transmitter is rated for transient overvoltage Category II.

A1.2 Fuse Protection

Fuse replacement should be performed only by trained service personnel using the proper replacement fuse (defined below) and only after removing power from the Transmitter. Proper fuse replacement is an electrical shock and fire hazard issue in ordinary locations as well as an explosion hazard issue in hazardous (classified) locations.



WARNING

Explosion Hazard - Do not remove or replace fuses unless power has been disconnected or the area is known to be free of ignitable concentrations of flammable gases or vapors.

AVERTISSEMENT

Risque d'Explosion – Couper le courant ou s'assurer que l'emplacement est désigné non dangereux avant de replacer les fusibles.

WARNING

Explosion Hazard - Repair and replacement of internal cabling, circuit boards, or components on circuit boards should only be performed using factory-approved replacement components and procedures. Unauthorized repairs may impair suitability for Division 2.

AVERTISSEMENT

Risque d'Explosion – La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de classe i, Division 2

Each Transmitter includes two 5mm x 20mm cartridge fuses on the Power Entry board next to the terminal block connections for mains power. Different models require different fuses, though all are rated for 250VAC. In all cases, the fuse information is included on a label inside the Transmitter enclosure. Below are the fuse requirements by Transmitter model number.

Transmitter Model #	Rating	Part Number	Vendor P/N	Notes
TB8-xx-05-x1-xx	1 A	52105-10	Bussmann S506-1A	1
TB8-xx-06-x1-xx	3.15 A	52105-15	Bussmann S506-3.15A	2
TB8-xx-05-x2-xx	0.5 A	E50382-05	Littelfuse 215.500	3
TB8-xx-06-x2-xx	1.6 A	E50382-10	Littelfuse 21501.6	4

Where "x" = any alphanumeric character

Notes:

1) Or any UL and VDE (IEC60127-2-3) recognized 5x20 time-delay fuse rated 1A, 250V, with a minimum 35A breaking capability.
2) Or any UL and VDE (IEC60127-2-3) recognized 5x20 time-delay fuse rated 3.15A, 250V, with a minimum 35A breaking capability.

3) Or Littelfuse 215.500P; or Bel Fuse 5HT500 or 5HT500-R. These are 1500A breaking ceramic fuses and are the only fuses permitted under the ATEX Zone 2 certification. For Ordinary Location Transmitters (TB8-xx-05-x2-01) ONLY, any UL and VDE (IEC60127-2-3) recognized 5x20 time-delay fuse rated 0.5A, 250V, with a minimum 35A breaking capability.

4) Or Littelfuse 21501.6P; or Bel Fuse 5HT1.6 or 5HT1.6-R; or Schurter 0001.2506; or Ferraz Shawmut UDA1.60; or Cooper/Bussmann S505-1.6A or S505-1.6-R. These are 1500A breaking ceramic fuses and are the only fuses permitted under the ATEX Zone 2 certification. For Ordinary Location Transmitters (TB8-xx-06-x2-01) ONLY, any UL and VDE (IEC60127-2-3) recognized 5x20 time-delay fuse rated 1.6A, 250V, with a minimum 35A breaking capability.

A1.3 Environmental Ratings

A1.3.1 Temperature

Transmitter and Sensor unit are rated for indoor and outdoor use.

Transmitter (Operating)	-4°F to +140°F (-20°C to +60°C) [-4°F to +135°F (-20°C to +57°C) For Zone 2 (TB8-xx-xx-xx-03)]
Transmitter (Storage)	-22°F to +176°F (-30°C to +80°C)
Sensor Head Process Temperature	-40°F to +212°F (-40°C to +100°C)
Sensor Head Ambient Temperature	-40°F to +140°F (-40°C to +60°C)
Sensor Head (Storage)	-40°F to +185°F (-40°C to +85°C)

A1.3.2 Humidity

0 – 95%, non-condensing

A1.3.3 Altitude

Transmitter and Sensor unit are rated for installations up to an altitude of 5000m* (16404ft).

* The 5000m rating absolutely applies to Ordinary Location flowmeters. Officially, the limitation for Hazardous Location (explosive gasses) Class I Division 2 and ATEX Zone 2 passive sonar flowmeters is the default 2000m applicable to those Hazardous

Location standards. The Ordinary Location standards also have 2000m as their default max altitude, but after initial Ordinary Location safety certification, the flowmeter was returned to TUV Rheinland for re-certification up to 5000m. Because the air at higher altitudes is not as good of an insulator, the minimum spacing requirements of the safety standards are increased at high altitudes. TUV Rheinland verified that the flowmeter has spacings wide enough to justify the 5000m rating for Ordinary Location Safety. The Hazardous Location safety standards don't specifically address the spacing issues at high altitudes, but they are concerned about peak pressures during an explosion – which tend to be higher with higher initial gas densities (i.e. lower ambient temperatures and higher ambient air pressure). But higher ambient air pressure is associated with LOWER altitudes (those below the default minimum altitude of 700m below sea level) AND the flowmeter does not use a hazardous location method of protection wherein its enclosures are trying to contain explosive pressures. So, though the passive sonar flowmeter has not been sent back to UL/DEMKO for Class I Division 2 and ATEX Zone 2 re-certification for 5000m max altitude, it is our belief that the existing equipment would be judged to be safe in hazardous locations for that 5000m max altitude without any further changes required in its design.

Note: It is beyond the scope of the Ordinary Location and Hazardous Location safety standards, but another effect of increased altitude is decreased convection cooling effectiveness. To address this issue, a good rule of thumb is to reduce the allowed maximum ambient temperature by 1 degree C per each additional 305m (1000 ft) above 2000m (6562 ft) altitude. E.G. if the equipment is nominally rated for a 60C max ambient, then for altitudes up to 2000m it is OK for a 60C max ambient, but at an altitude of 5000m consider limiting the max ambient to 50C.

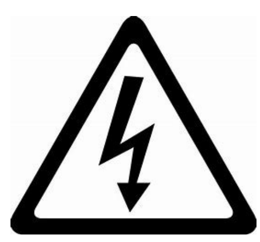
A1.3.4 Outdoor Use, Pollution Degree, Ingress Protection, and Wet Locations

The passive sonar meter is rated for installation and use OUTDOORS where it will be exposed to sunlight, wind, dust, temperature swings, humidity, and precipitation WITH THE ENCLOSURE COVERS TIGHTLY CLOSED AND THE INTENDED FITTINGS PROPERLY INSTALLED IN ALL ENCLOSURE OPENINGS (e.g. cable entry holes).

The passive sonar meter is intended to be installed in outdoor locations where Pollution Degree 3 or 4 (conductive wet or dry pollutantion) exists OUTSIDE of the enclosure, while the INSIDE of the enclosure is expected to remain at Pollution Degree 2 (no pollution, or non-conductive pollution, or dry pollution that is temporarily conductive only due to occasional condensation). The Ingress Protection rating of the enclosures helps assure this in conjunction with the care taken by the user whenever the enclosure is opened.

The Ingress Protection rating applies to enclosures with covers tightly closed and with cables, cable glands, and connectors properly installed. The Transmitter of the passive sonar meter is IP66 (and NEMA 4X) for the Ordinary Location and Class I, Division 2 versions, but for ATEX Zone 2 is considered IP55. The Transmitter enclosure rating is maintained only if the cable glands and fittings have equivalent or better IP ratings. The fiberglass Sensor Head enclosure of the passive sonar meter is IP55. The stainless steel Sensor Head enclosure has not been IP tested. When mounted on horizontal or angled non-vertical pipes, the Sensor Head enclosure should be oriented such that the cable connector is above the pipe. IP55 testing involves both a dust test and a water jet test with water jets spraying the enclosures from every direction.

The passive sonar meter can be safely located in Dry and in Wet Locations. Wet Locations are defined here as environments with the possibility of water or other conductive liquids on surfaces or personnel such that the resistance from the equipment to earth through a person touching the equipment will be lowered due to the presence of that liquid at the contact points between the person and the equipment and/or between the person and earth. The greatest risk of electric shock in either dry or wet locations is due to the power cable entering the Transmitter. Consequently, a label that warns of the electric shock risk has been placed near the power entry terminals.



NOTE: It is assumed that the user will take appropriate precautions whenever the covers are opened for installation, maintenance, or commissioning to be certain that the inside of the electronics enclosures always remain clean and dry.

A1.4 Construction Materials

- **Sensor Head - 3 styles**

  Fiberglass enclosure with PTFE gasket material for sizes 2 to 36 inch.

  Fiberglass enclosure with TPE gasket materials for sizes 2 to 30 inch. [Note: This style has passed IP55 testing and is the only style available with ATEX Class I, Zone 2 certification.]

  Stainless steel enclosure with silicone end seals for sizes 18 inches and above.

- **Transmitter**

  Fiberglass enclosure with NEMA 4X rating.

  Urethane gasket material.

  Acrylic viewing window. Note: Window not available in models with ATEX Class I, Zone 2 certification.

- **Sensor to Transmitter Cable**

The standard sensor to transmitter cable consists of 12 twisted pairs of 20 AWG conductors with an overall shield, encased in a PVC jacket. The standard cable has an operating range of -4ºF – +221ºF (–20ºC to +105ºC). The cable is UL Listed (UL Standard 13, Type PLTC) and CSA Certified (CSA C22.2 No. 214, PCC FT4). The outer diameter of the cable is 0.61 inch (15.5 mm) nominal.

Optional low temperature and armored cables are also available. Please contact Customer Support for more information.

Cable Type	**25 ft cable weight**		**Weight per additional foot**	
	lbs	kg	lbs	kg
Standard	5.75	2.61	.23	.10
Armored	12.6	5.72	.45	.20

The passive sonar flow system is configured such that the transmitter is always located remotely from the sensor head. The maximum length of the cable connecting the sensor head to the transmitter depends on installation location classification (up to 500 feet long for Ordinary Locations and up to 375 feet for Hazardous Locations).

- **Electrical Connections**

Holes sized for 3/4 inch NPT fittings (1-1/16 inch diameter) are located on the base of the transmitter enclosure. The sensor to transmitter cable is terminated to the screw terminal blocks within transmitter enclosure.

Note: All connector glands used on the transmitter enclosure should be rated to NEMA 4X to maintain transmitter rating of NEMA 4X. For ATEX Zone 2 Transmitters, further gland requirements can be found in the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY.

A single cable connection is made between the transmitter and the sensor head. Sensor head connection is made with a connector that is factory installed on one end of the supplied cable. There are two different sizes of connector used on passive sonar sensor heads. The cable supplied with the system will have the properly sized mating connector.

A1.5 Sensor Band Compatibility

The sensor band assemblies are interchangeable with all sensor head cover assemblies of the same pipe diameters. System calibration factors are included for each sensor band assembly. All sensor head assemblies, independent of pipe size, are electrically compatible with all transmitters. Care must be taken to ensure compatibility of sensor heads and transmitters used in hazardous areas. Follow the instructions in the applicable Control Drawing governing transmitter and sensor head compatibility. The Class I, Division 2 Control Drawing can be found in Appendix C of this manual. The ATEX Class I, Zone 2 Control drawing can be found in the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY.

A1.6 Analog Output Adjustment

Two separate 4-20mA output signals scalable over stated range of meter. Primary 4-20mA output HART compatible.

A1.7 Auxiliary Output Function

Serial Communication for Modbus, (optional) Foundation Fieldbus, Pulse Relay, Alarm Relay

A1.8 Analog Output Test

Yes (under Diagnostic Menu)

A1.9 Software Lockout

Yes (under Customize Menu)

A1.10 Envelope Drawings

Detailed envelope drawings and information is available from the manufacturer upon request.

A1.11 Hazardous Area Classification

System models exist which are rated for use in Class I, Division 2, Groups A, B, C, and D, or for ATEX Class I, Zone 2, Group IIB. The markings on those models clearly indicate their suitability for use in those environments. Installation must be in accordance with the appropriate Control Drawing. The Class I, Division 2 Control Drawing can be found in Appendix C of this manual. The ATEX Class I, Zone 2 Control drawing can be found in the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY.

A2 PERFORMANCE SPECIFICATIONS

A2.1 Turn-on Time

30 minutes to rated accuracy from power up

25 seconds from power interruption

A2.2 Start-up Time

25 seconds from zero flow

A2.3 Low / High Flow Cutoff

Adjustable between 3 and 30 ft/sec in liquids. At process flow rates below and above these values, the output will register a ‘<min flow’ or’>max flow’ indication.

A2.4 Flow Rate Range

The passive sonar flow system is capable of measuring signals from process liquid fluids traveling at velocities between 3 ft/s and 30 ft/s (1.0 m/s to 10 m/s) and air / gas.

A2.5 Accuracy

Flow rate accuracy is +/-1.0% of flow rate from 3 to 30 ft/sec (1 to 10m/s) in liquids for system size 2 – 36 inch. Consult factory for accuracy of larger sizes.

A2.6 Repeatability

+/- 0.3 % of reading

A2.7 Update Rate

2 seconds (default)

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Appendix B PASSIVE SONAR EU DECLARATION OF CONFORMITY

The EU Declaration of Conformity is shipped with each delivered system.

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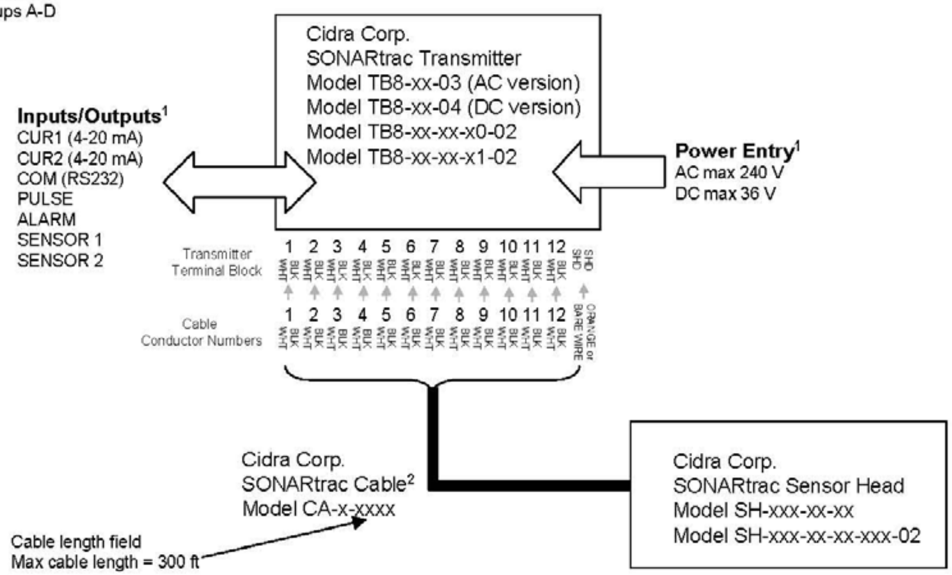
Appendix C SYSTEM CONTROL DRAWING PASSIVE SONAR SYSTEM, NON-INCENDIVE

The system control drawing for installation in Class I Division 2, Groups A, B, C, and D is found on the following pages.

The system control drawing for installation in ATEX Class I, Zone 2, Group IIB can be found in an appendix of the chapter titled SONAR PROCESS MONITORING SYSTEM SUPPLEMENT FOR ATEX ZONE 2 SAFETY.

Hazardous (Classified) Location
Class 1, Division 2, Groups A-D



REVISIONS			
REV	DESCRIPTION	DRAWN	CHECKED
01	PRELIMINARY RELEASE - APPROVAL PENDING	JMD 01/23/04	J. DIENER 01/23/04
02	ADDED: TRANSMITTER TERMINAL BLK WIRING BLOCK DIAGRAM.	JMD 02/02/04	J. DIENER 02/02/04
03	ADDED: CLARIFICATION FOR CABLE AND SHIELD IDENTIFIERS. INITIAL RELEASE P03-0185	JMD 02/05/04	J. DIENER 02/05/04
05	REVISION 04 WAS INCORPORATED INTO REV 05. REV 04 WAS NEVER RELEASED. REVISED: NOTE 1 & 2 NEC ARTICLE NO. 501.10 WAS 501.4 ADDED: MODEL NO. TB8-XX-XX-XX-02. P05-0027	JMD 05/09/05	J. DIENER 05/09/05
06	LIMITED RANGE OF MODEL NO.S CONTROLLED - MODEL NO. TB8-XX-XX-X0-02 AND TB8-XX-XX-X1-02 WAS TB8-XX-XX-XX-02. E07-0091	JMD 08/13/07	J. DIENER 08/13/07

Transmitter Terminal block wiring

Terminal Block	1		2		3		4		5		6		7		8		9		10		11		12			
	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	WHT	BLK	SHD	SHD
Cable	Sensor #1		Sensor #2		Sensor #3		Sensor #4		Sensor #5		Sensor #6		Sensor #7		Sensor #8		SPARE		485							
	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW			HI	LOW	-12 V	GND	+12 V	GND	GND	GND

[1] Power Entry and Inputs/Outputs must be installed in accordance with Article 501.4(B)(1) of the National Electrical Code ANSI/NFPA 70

[2] Sensor Head Cable must be installed in accordance with Article 501.4(B)(3) of the National Electrical Code ANSI/NFPA 70

UNCONTROLLED COPY
VERIFY UP TO DATE REVISION IN ORACLE

NOTES: UOS

MATERIAL:	HEAT TREAT:	FINISH:
NA	NA	NA

CIDRA ENGINEERING CAD FILE NUMBER: 20332-01.SLDDRW

UNLESS OTHERWISE SPECIFIED
~~PART MUST BE FREE OF BURRS AND/OR FLASH~~
BREAK SHARP EDGES .002-.008
FILLET RADII .005 MAX
DIMENSIONS ARE IN INCHES & APPLY AFTER FINISH
SURFACE FINISH 63/ MAX

APPROVALS	BY	DATE
DRAWN	JMD	01/23/04
CHECKED	J. DIENER	01/23/04
ENGRG	M. DAVIS	01/23/04
MFG		

TOLERANCES
.XXX ±.005 FRAC ±1/64
.XX ±.01 ANGLES ±1°
INTERPRET DWG PER ASME Y14.5M-1994
DIMS IN PARENTHESIS ( ) ARE REF ONLY
DO NOT SCALE DWG

CiDRA® 50 BARNES PARK NORTH WALLINGFORD CT, USA 06492

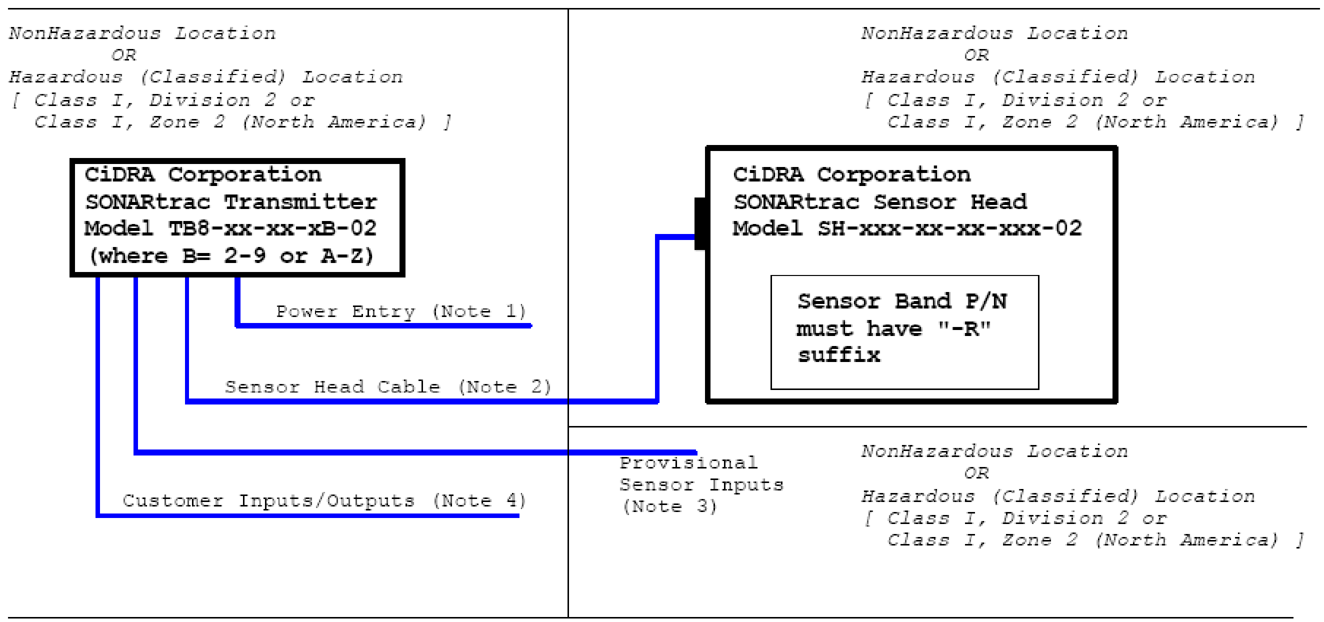
SYSTEM CONTROL DRAWING, SONARTRAC, NON-INCENDIVE

B DWG NO 20332-01 REV 06

SCALE: 1:1 SHEET 1 OF 1

REVISIONS

REV	ZONE	DESCRIPTION	DRWN	CHKD
01		INITIAL RELEASE PER ECO E07-0084	CW 8/3/07	MS 8/3/07



Note: NEC/CEC is shorthand for the Hazardous (Classified) Area wiring standards that apply to the jurisdiction of the installation: Article 501 of the National Electric Code ANSI/NFPA 70 for USA or the Canadian Electric Code for Canada.

Note 1: Power Entry
TB8-xx-05-xx-02, Vmax = 240VAC
TB8-xx-06-xx-02, Vmax = 36VDC
Incendive input. Install per NEC/CEC.

Note 4:
Customer Inputs/Outputs
CUR 1 (4-20mA)
CUR 2 (4-20mA)
PULSE
ALARM
COMM (RS232/485)
Fieldbus (optional)
Incendive inputs/outputs. Install per NEC/CEC.

Note 3:
Provisional Sensor Inputs
SENSOR 1 (HI, LO, SHD)
SENSOR 2 (HI, LO, SHD)

Connect only to Passive 4-20mA transmitters isolated from ground. Passive 4-20mA transmitters must be Division 2 rated if either they or Transmitter are installed in Division 2.

Non-Incendive (energy-limited) inputs. Install per NEC/CEC.
Division 2 Entity Parameters are:
Uo = 24.1 V, Io = 47 mA,
Co = 60 nF, Lo = 200 uH, Po = 1.13W.

If either the SONARtrac Transmitter or the Passive 4-20mA Transmitter is in Division 2, install such that: Uo <= Ui , Io <= Ii, Co >= Ci + C_cable , Lo >= Li + L_cable, Po <= Pi.

Note 2:
Sensor Head Cable (connectorized at Sensor Head)
Non-Incendive (energy-limited) inputs/outputs.
Install per NEC/CEC.

Cable must not be longer than 114 meters (375 feet).

Black and white twisted pairs in cable are numbered and connect to similarly numbered terminals in the Transmitter marked BLK and WHT. The bare drain wire and the orange wire (if present) connect to terminals marked SHD (located within the same group of terminals). Pairs 1-8 are Sensors 1-8, respectively. WHT is HI and BLK is LOW. Pairs 11 and 12 are -12V and +12V on the WHTs with the BLKs at GND. Pair 10 is an RS485 link. Pair 9 is a spare wire pair which is grounded by connecting to the #9 terminals. The terminals marked SHD are tied to chassis ground.

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APPROVAL	BY	DATE
DRAWN	C WINSTON	04/04/07
CHECKED	M SAPACK	04/04/07
DESIGNER	C WINSTON	04/04/07
ENGINEER	C WINSTON	04/04/07

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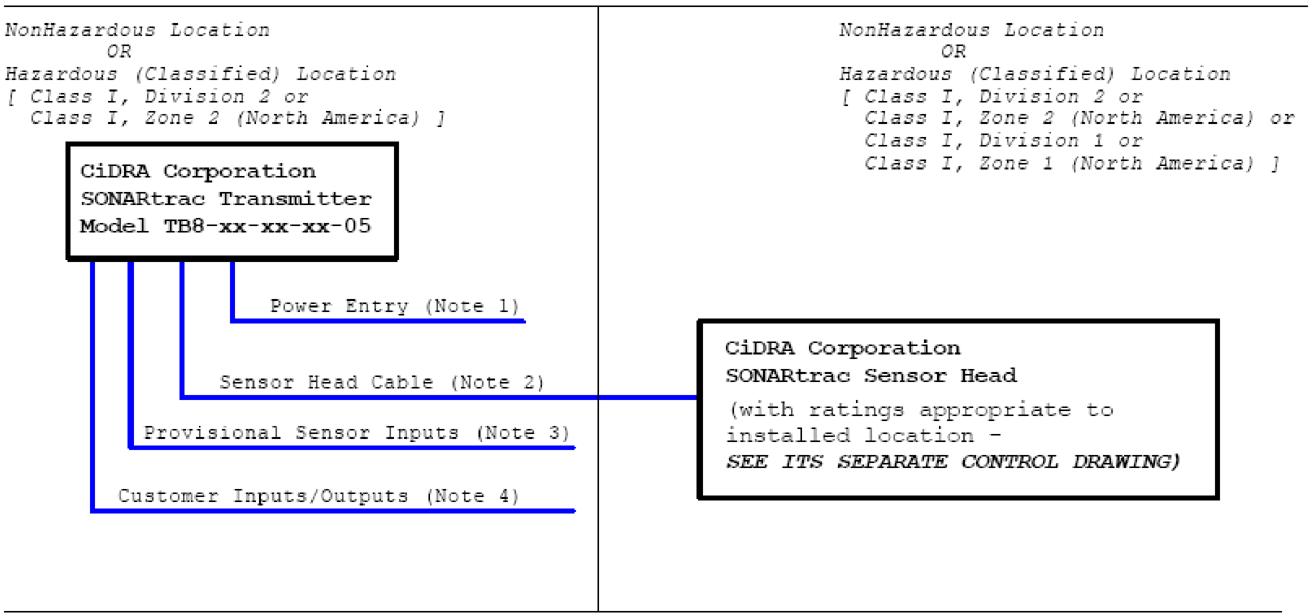
WALLINGFORD, CT, USA
06492

CONTROL DRAWING, SYSTEM,
CLASS I, DIVISION 2

SIZE B | DWG NO 20944-01C | REV 01
SHEET 1 OF 1

REVISIONS				
REV	ZONE	DESCRIPTION	DRWN	CHKD
01		INITIAL RELEASE PER ECO E07-0084	CW 8/3/07	MS 8/3/07



Note 1: Power Entry
TB8-xx-05-xx-04, Vmax = 240VAC
TB8-xx-06-xx-04, Vmax = 36VDC

Incendive input. Install per NEC/CEC

Note 4:
Customer Inputs/Outputs
CUR 1 (4-20mA)
CUR 2 (4-20mA)
PULSE
ALARM
COMM (RS232/485)
Fieldbus (optional)

Incendive inputs/outputs.
Install per NEC/CEC.

Note 3:
Provisional Sensor Inputs
SENSOR 1 (HI, LO, SHD)
SENSOR 2 (HI, LO, SHD)

Connect only to Passive 4-20mA transmitters isolated from ground. Passive 4-20mA transmitters must be rated for their installed location.

Incendive inputs.
Install per NEC/CEC.

Note 2:
Sensor Head Cable
Incendive inputs/outputs.
Install per NEC/CEC using methods appropriate for the Divisions in which the Transmitter and Sensor Heads are installed.

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Note: NEC/CEC is shorthand for the Hazardous (Classified) Area wiring standards that apply to the jurisdiction of the installation: Article 501 of the National Electric Code ANSI/NFPA 70 for USA or the Canadian Electric Code for Canada.

APPROVAL	BY	DATE
DRAWN	C WINSTON	04/04/07
CHECKED	M SAPACK	04/04/07
DESIGNER	C WINSTON	04/04/07
ENGINEER	C WINSTON	04/04/07

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06492

CONTROL DRAWING, TRANSMITTER,
CLASS I, DIVISION 2

SIZE B | DWG NO 20945-01C | REV 01
SHEET 1 OF 1

Appendix D: SAFETY DATA SHEETS

The following are links to the Material Safety Data Sheets for chemicals used with the passive sonar process monitoring system. Copies of these Safety Data Sheets are also available on www.cidra.com under the Resource Center Tab.

Product: Loctite 515 Flange Sealant
Product: Loctite 243 Threadlocker
Henkel: MSDS search page
http://www.henkelna.com/adhesives/msds-search-5120.htm

Product: Hylomar Advanced Formulation, Hylomar Advanced Formulation HV
Hylomar Advanced Fomulation
http://www.igsind.com/msds/Hylomar_Advanced_MSDS.pdf

Product: Formula 8 Joint & thread PTFE Paste Sealer
PTFE Pipe Sealant
http://www.fluoramics.com/msds_listing.shtml

Product: RTV 108
RTV 108
http://www.momentive.com/products/home.aspx?id=20786

Product: Sono 600 (Contains Refined Peanut Oil)
Sono 600
http://www.magnaflux.com/NewsDownloads/tabid/396/Default.aspx?EntryId=12411

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Appendix E: CONVERSION FACTORS

Dynamic Viscosity Units Conversion		
To Convert From:	**To:**	**Multiply By:**
$(lb_f\text{-sec})/ft^2$	Pa-sec	4.788 026 e+01
$(lb_f\text{-sec})/in^2$	Pa-sec	6.894 757 e+03
$(kg_f\text{-sec})/m^2$	Pa-sec	9.806 650 e+00
Poise	Pa-sec	1 e-01
Centipoises	Pa-sec	1 e-03
$lb_f/(ft\text{-sec})$	Pa-sec	1.488 164 e+00
$lb_f/(ft\text{-hr})$	Pa-sec	4.133 789 e-04
$(dyne\text{-sec})/cm^2$	Pa-sec	1.0 e-01

Pipe Modulus Units Conversion		
To Convert From:	**To:**	**Multiply By:**
lb_f/in^2	kPa	6.894 757 e+00

Length Units Conversion		
To Convert From:	**To:**	**Multiply By:**
Feet	meters	3.048 e-01
Inch	meters	2.54 e-02

Temperature Units Conversion		
To Convert From:	**To:**	**Multiply By:**
degree F	degree C	$T_C = (T_F – 32)/1.8$
degree C	degree F	$T_F = (1.8 * T_C)+32$

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Appendix F: PHYSICAL PROPERTIES OF WATER

Water at 14.7 psia (sea level)			
Temperature (C)	Specific Gravity	Sound Speed. (ft/s)	Viscosity (Pa*s)
0	0.9998	4601.2	1.7909E-03
5	1.0000	4679.2	1.5176E-03
10	0.9997	4748.4	1.3055E-03
15	0.9991	4809.6	1.1372E-03
20	0.9982	4863.4	1.0014E-03
25	0.9971	4910.5	8.8988E-04
30	0.9957	4951.4	7.9718E-04
35	0.9940	4986.4	7.1917E-04
40	0.9922	5016.1	6.5286E-04
45	0.9902	5040.9	5.9596E-04
50	0.9880	5061	5.4676E-04
55	0.9857	5076.8	5.0390E-04
60	0.9832	5088.5	4.6633E-04
65	0.9806	5096.5	4.3320E-04
70	0.9778	5100.9	4.0384E-04
75	0.9748	5101.9	3.7769E-04
80	0.9718	5099.8	3.5430E-04
85	0.9686	5094.7	3.3330E-04
90	0.9653	5086.8	3.1437E-04
95	0.9619	5076.1	2.9725E-04
100	0.9584	5062.9	2.8180E-04

Water at 24.7 psia (10 psig)			
Temperature (C)	Specific Gravity	Sound Speed. (ft/s)	Viscosity (Pa*s)
0	0.9999	4601.5	1.7907E-03
5	1.0000	4679.5	1.5175E-03
10	0.9997	4748.8	1.3054E-03
15	0.9991	4810	1.1372E-03
20	0.9982	4863.8	1.0013E-03
25	0.9971	4910.9	8.8986E-04
30	0.9957	4951.8	7.9717E-04
35	0.9941	4986.8	7.1917E-04
40	0.9922	5016.5	6.5286E-04
45	0.9902	5041.3	5.9597E-04
50	0.9881	5061.4	5.4677E-04
55	0.9857	5077.2	5.0391E-04
60	0.9832	5088.9	4.6634E-04
65	0.9806	5096.9	4.3321E-04
70	0.9778	5101.3	4.0385E-04
75	0.9749	5102.4	3.7771E-04
80	0.9718	5100.3	3.5432E-04
85	0.9686	5095.2	3.3332E-04
90	0.9653	5087.2	3.1439E-04
95	0.9619	5076.6	2.9727E-04
100	0.9584	5063.3	2.8173E-04

Water at 64.7 psia (50 psig)			
Temperature (C)	Specific Gravity	Sound Speed. (ft/s)	Viscosity (Pa*s)
0	1.0000	4603	1.7900E-03
5	1.0001	4681	1.5171E-03
10	0.9999	4750.2	1.3051E-03
15	0.9993	4811.4	1.1370E-03
20	0.9984	4865.3	1.0012E-03
25	0.9972	4912.4	8.8980E-04
30	0.9958	4953.3	7.9714E-04
35	0.9942	4988.4	7.1917E-04
40	0.9924	5018.1	6.5288E-04
45	0.9904	5042.9	5.9601E-04
50	0.9882	5063	5.4682E-04
55	0.9858	5078.8	5.0397E-04
60	0.9833	5090.6	4.6640E-04
65	0.9807	5098.6	4.3328E-04
70	0.9779	5103.1	4.0392E-04
75	0.9750	5104.1	3.7778E-04
80	0.9719	5102.1	3.5439E-04
85	0.9688	5097	3.3339E-04
90	0.9655	5089.1	3.1446E-04
95	0.9620	5078.5	2.9734E-04
100	0.9585	5065.3	2.8181E-04

Water at 114.7 psia (100psig)			
Temperature (C)	Specific Gravity	Sound Speed. (ft/s)	Viscosity (Pa*s)
0	1.0002	4604.8	1.7892E-03
5	1.0003	4682.8	1.5165E-03
10	1.0000	4752.1	1.3047E-03
15	0.9994	4813.3	1.1368E-03
20	0.9985	4867.2	1.0011E-03
25	0.9974	4914.3	8.8972E-04
30	0.9960	4955.2	7.9711E-04
35	0.9943	4990.3	7.1918E-04
40	0.9925	5020.1	6.5291E-04
45	0.9905	5044.9	5.9605E-04
50	0.9883	5065.1	5.4688E-04
55	0.9860	5080.9	5.0404E-04
60	0.9835	5092.7	4.6648E-04
65	0.9809	5100.7	4.3336E-04
70	0.9781	5105.2	4.0401E-04
75	0.9751	5106.4	3.7787E-04
80	0.9721	5104.3	3.5448E-04
85	0.9689	5099.3	3.3348E-04
90	0.9656	5091.4	3.1456E-04
95	0.9622	5080.9	2.9743E-04
100	0.9587	5067.7	2.8190E-04

Reference: E.W. Lemmon, M.O. McLinden and D.G. Friend, "Thermophysical Properties of Fluid Systems" in NIST Chemistry WebBook, NIST Standard Reference Database Number 69, Eds. P.J. Linstrom and W.G. Mallard, March 2003, National Institute of Standards and Technology, Gaithersburg MD, 20899 (http://webbook.nist.gov).

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Appendix G END USER LICENSE AGREEMENT

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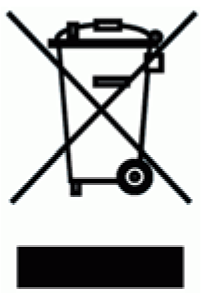
Appendix H: SPARE PARTS LIST

The following is a list of spared parts for passive sonar systems. Contact Customer Support for items not found on this list, and for price and availability. Please have the transmitter serial number available when contacting Customer Support.

Kit Part Number	**Title**	**Description**
S-20170-01	Kit, Spare Fiberglass Cover Bolts	Replacement set of 13 stainless steel bolts (tin plated), washers, lock-washers and lock-nuts used on fiberglass cover assemblies equipped with bolted flange covers.
S-20352-TAB	Spare Boot Seal Clamp and Band Kit for use with Stainless Steel Covers and Gen-2 Fiberglass Covers	Replacement boot seal clamps and stainless steel bands and buckles used to secure the boot seal on Gen-2 fiberglass covers and stainless steel cover assemblies. The –TAB designates the cover (pipe) size. Example, S-20352-20 is replacement bands and buckles for a 20-inch cover. Specify cover size when ordering.
S-20574-TAB	Bolted Flange Fiberglass Cover Replacement Seals	Replacement EPTFE seals used on the bolted flange style fiberglass cover assemblies. The S-20574-08-02 is used on fiberglass covers 8-inch to 2-inch size. The S-20574-16-10 is used on fiberglass covers 16-inch to 10-inch size.
S-20592-TAB	Spare Sensor Band Tension Screw and Spring Set	Replacement set of 9 screws, stop washers, spring washers and retaining rings; hex power bit; spiral tap (used to clean / chase screw hole threads) used on sensor bands. Refer to Table 2 in Chapter 5 of this manual for a list of sensor band screw sizes. Contact Customer Support with questions. Provide Customer Support with the sensor band serial number and transmitter serial number.
S-20618-TAB	Spare Sensor Band Gap Gauge Tool	Replacement gap gauge tool. Refer to Table 2 in Chapter 5 of this manual for a list of sensor band gap gauge tools. Contact Customer Support with questions. Provide Customer Support with the sensor band serial number and transmitter serial number.
S-20621-01	Spare Hardware and Gasket Replacement Kit, Stainless Steel Cover	Replacement stainless steel cover flange gaskets, spacers, cover bolt / washer / nut sets, splice protector plates and joining compound.
S-20714-TAB	Spare Kit, Electronics Access Cover Screw and Washer Assembly	Replacement self-sealing screws with Viton O-rings and retaining washers for use on the electronics access cover.
S-20622-TAB	Spare Kit, Preamplifier Assembly	Replacement preamplifier assembly. Please provide sensor cover and transmitter serial number to Customer Service.

Kit Part Number	Title	Description
S-20276-02	Kit, Stainless Steel Cover Seal	Provides the elastomer and sealants needed to replace the seals on a stainless steel style sensor head cover.
S-20554-TAB	Kit, Spacer, Elastomer, Tube & Cover , Assembly of	Provides the spacer used to fit a standard size cover to a tube or to non-standard size pipe.
S-20812-01	Spare, Base Connector Assembly, G-2 Cover	Spare sensor head to transmitter cable connector base located on the sensor cover.
S-20841-01	Spare, Cover with Single Vent, Access, Assembly of	Provides the electronics access cover on G-2 sensor covers.
S-20888-01	Spare, Cover with Santoprene Gasket, Electronics Access	Provides the electronics access cover on sensor covers.
S-21028-01	Kit, Spare Sensor Head Contact Crimping and Removal Tool	Used to remove and insert contact pins in the Harting Connector used on the sensor head to transmitter cable.
S-21085-TAB	Kit, G-2 Cover Latch Replacement	Replacement latches for the G-2 cover assembly. Not for use with riveted latch assemblies
S-21136-TAB	Kit, spacer, Cast Silicone Cover	Provides the spacer used to fit a standard size cover to non-standard size pipe.

Appendix I: DIRECTIVE 2002/96/EC ON WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)



This symbol pictured here and on the transmitter of your passive sonar system (if purchased after August 13, 2005), indicates that at its end-of-life your passive sonar system is considered to be Waste Electrical and Electronic Equipment (WEEE) in applicable countries of the European Union. Where applicable WEEE must be kept separate from other municipal waste streams and returned for proper disposal to the producer or a licensed WEEE recycler. Since slightly different WEEE laws have been implemented throughout the European Union, once your passive sonar system has reached its end-of-life, contact customer support for information regarding disposal policies and procedures.

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Appendix J TROUBLESHOOTING PROCEDURES

Introduction

The Section lists problems that may be encountered when installing passive sonar systems as well as actions to take to correct the problems. In the case where all troubleshooting techniques have been utilized, but the unit is still not working properly, please contact Customer Support.

Troubleshooting equipment installed in Hazardous Areas

Many of the troubleshooting techniques suggested in this procedure involve actions that may be unsafe to perform in the presence of explosive gasses or vapors. As a general rule, all troubleshooting should be performed in non-hazardous areas or with hot work permits that assure that explosive gas concentrations are not present.

WARNING

Explosion Hazard - When explosive gases may be present, the transmitter door may be opened only to use the keypad or reset button. Obtain hot work permit and ensure explosive gasses are not present prior to performing any other operation.

System Faults:

Item No	PROBLEM	POSSIBLE CAUSE	DIAGNOSTIC METHOD	DIAGNOSTIC RESULT	COMMENTS
1	System does not come on or was working and stopped working	No power to system	Check input power with volt meter	Yes - there is power and power is within system specs of 100 - 240 volts (AC units) or 18 – 36 volts (DC units)	See Below
				No - power to system or power is below spec	Check external wiring / circuit breakers, etc. to ensure power and that power is within specification. Connect to alternate power source
			Check status of fuse(s)	Fuse(s) bad	Replace fuse(s) and see if blown fuse fault recurs. If problem recurs contact Customer Support.
				Fuse(s) good	See below
			Is the green LED lit	Yes	There is power to system but still does not come on Contact Customer Support.
				No	There is no power to the LED Contact Customer Support.
2	Screen is blank	Screen is not working	Verify if there is power to system	No	Troubleshoot per item 1
				Yes	See below
			Is the ambient temperature below or above the operating range of the screen (-20ºC to +85)?	Yes	Screen is located in an area outside of the temperature specifications. Relocate transmitter.
				No	See below
			Are system signal outputs (4-20 mA, etc) in operation and functional	Yes – continue to use system with DCS output	Possible damaged or faulty screen. Contact Customer Support.
				No	Contact Customer Support.

System Faults (page 2):

Item No	PROBLEM	POSSIBLE CAUSE	DIAGNOSTIC METHOD	DIAGNOSTIC RESULT	COMMENTS
3	The display has random lines or makes no sense	BOOT and / or MAIN software is corrupt	Display shows lines or random characters	---	Contact Customer Support.
4	System keeps turning on and off	Low or poor quality power to system	Verify power source for transmitter is stable and within operating range of system	Power fluctuates	Connect to stable power source
				Power is good and stable at between 100 – 240 volt (AC units) or 18 – 36 volt (DC units)	See below
		Poor connections at 'Power Input' terminal block in transmitter	Verify power connections to transmitter	Wire(s) not properly installed	Reconnect power cable
				Wires installed properly	Problem may be internal to transmitter. Contact Technical Support.
5	The system keeps re-booting on its own	Poor power source for system	Verify power source for transmitter is stable and acceptable	Power fluctuates	Connect to stable power source
				Power is good and stable at between 100 – 240 volt (AC units) or 18 – 36 volt (DC units)	See below
		System memory error or problem	Run 'RAM TEST' and 'DPRAM TEST' in 'SELF TEST' in DIAGNOSTICS menu	Fail either or both RAM and DPRAM test	Faulty RAM/DPRAM. Contact Customer Support.
				Pass both RAM and DPRAM tests	Acquire Snapshot, Upload to secure Website, and contact Customer Support.

System Faults (page 4):

System Faults (page 3):

Item No	PROBLEM	POSSIBLE CAUSE	DIAGNOSTIC METHOD	DIAGNOSTIC RESULT	COMMENTS
6	Screen is light or dark in color	Incorrect screen contrast setting	Check screen setting in 'DISPLAY / CONTRAST in CUSTOMIZE menu. Normal setting is 170	No – the contrast setting is not 170	Adjust contrast setting up or down as necessary. If problem persists contact Customer Support.
				Yes – contrast is set to 170	Try adjusting contrast. If this does not work contact Customer Support.
7	The 4–20mA input on plant data system does not work	Incorrect wiring	Verify 4-20mA is wired to proper connector terminals in the transmitter (internal or external power)	No – system is not connected to appropriate terminals	Reconnect wires; refer to section 8 of Transmitter Installation Manual
				yes	See below
			Verify 'POWER SEL' on '4 -20mA CH1' (or 2) in OUTPUT CONFIG menu (internal or external) is set to correspond with the wiring option above	No – incorrect 'Power Sel' option.	Correct output option
				Yes	See below
		Broken lead between transmitter and plant data system or faulty 4-20mA supply	Verify 4-20mA output on transmitter and at data system Select '4-20mA TEST' under the DIAGNOSTIC menu to output discrete 4 to 20 mA signal in 1mA increments.	Yes, output from transmitter and input to plant system	Wiring is good
				No signal at plant data system	Suspect wiring problem
				No signal from transmitter	Suspect faulty 4-20mA output. Acquire Snapshot, Upload to secure Website, and contact Customer Support.

Item No	PROBLEM	POSSIBLE CAUSE	DIAGNOSTIC METHOD	DIAGNOSTIC RESULT	COMMENTS
8	The 4–20mA display in control room does not match the flow rate on the system	Wrong Range settings at transmitter or DCS	Verify the range settings are the same	Yes - Ranges of transmitter and DCS are the same	See below if problem persists
				No – range settings are different	Re-range the DCS or the transmitter
		The transmitter output trim needs to be adjusted	Scroll to '4mA TRIM' in the 4-20 mA CH 1(2) submenu under the OUTPUT CONFIG menu in order to access trim function. Press ENTER and follow instructions	Yes – the output is correct	See below
				No – the output needs to be adjusted	Input values per transmitter screen values. If problem persists see below
		Signal is being affected by PLC card	Disconnect input signal lines from PLC card. Connect current system to leads. Output discrete mA signals using '4-20mA TEST' under the DIAGNOSTIC menu.	Yes – the current meter readings match the transmitter output values	A 4-20mA signal isolator may be required. Contact Customer Support.
				No – the current readings do not match the transmitter values	See below
		The 4-20mA values generated by the transmitter in '4-20mA Test' do not match the signals seen at the end of the signal cable	Connect current system at the 4-20mA terminals in the transmitter and output discrete signals using '4-20mA Test'	Yes - the signals output from the transmitter match the current meter readings	Plant wiring may have a problem. Verify integrity of signal wires.
				No – the output from the meter does not match the current meter readings	Contact Customer Support.

System Faults (page 5):					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
9	The Display is Frozen (reads same value all the time)	Transmitter left in Idle Mode	Is Heart Beat Indicator Turning in Lower Right Corner	Yes – Heart Beat Indicator is Turning	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
				No- Heart Beat Indicator is not turning	Cycle power to transmitter
		Transmitter is hung up	Cycle power to transmitter. Does the display update?	Yes – Display updates	Meter is properly functioning
				No – Display is still frozen	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
10	The Display Reads Preamp Failure and there is no flow reading	Possible faulty Preamp or bad connection	Verify wiring and connectors are properly connected	No – wiring / connector fault found	Correct fault
				Yes – all wiring and connectors is correct	Acquire Snapshot, Upload to secure Website, and contact Customer Support.

System Faults (page 6):					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
11	The display reads “Invalid Mode”	Improper Op Mode selected or Display Settings selected	Under Basic Menu, Verify Op Mode is set to FLOW for Flow Meter or GVF/SOS for Entrained Air Meter or FLOW/GVF/SOS for combined meter operation	No – Op Mode is not set to VF for Flow Meter or GVF for Entrained Air Meter	Reset to proper operating mode
				Yes – proper operating mode is selected	See below
			Under Customize Menu verify Display Line 1 set to Flow Rate for Flow Meter or GVF for Entrained Air Meter, etc.	No – Display Line 1 is not set to Flow Rate for Flow Meter or GVF for Entrained Air Meter,.	Change Display line 1 to appropriate mode
				Yes – display is set correctly	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
12	The signal output from the system is noisy	Need to use Damping or Noise Reduction Filter	See Filter Section of manual for more information on filtering	Yes – with filtering enabled, the signal is less noisy	Employ filtering at the transmitter or at the DCS
				No – with filtering enabled, the signal is still noisy	Acquire Snapshot, Upload to secure Website, and contact Customer Support.

Flow System Faults					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
13	The signal output from the meter has spikes during no flow conditions or drops out during flow conditions	Need to use Spike Filter	See Filter section of Manual in order to turn on filtering	Yes – With filtering Enabled, signal is less noisy	Use this as new transmitter configuration
				No – With filtering enabled, signal is still noisy	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
14	Flow does not seem correct	Improper pipe size entered	Verify pipe size input in transmitter 'PIPE SIZE' in BASIC CONFIG menu	Yes – correct size entered	See below
				No – incorrect pipe size entered	Re-enter correct pipe size
		Improper calibration coefficients entered	Verify coefficients in transmitter 'CALIBRATION' in BASIC CONFIG menu 'match sensor band coefficients (on label in transmitter or on sensor band cable)	Yes – correct values entered	See below
				No – incorrect values entered	Re-enter correct coefficients
		All sensors are not turned on	Verify sensors are turned on in 'SENSOR SETUP / ENABLE' in CUSTOMIZE menu	Yes – all sensors are on	See below
				No – some or all are turned 'Off'	Turn on all sensors in Customize menu unless some were purposely turned off. If problem persists, Acquire Snapshot, Upload to secure Website, and contact Customer Support.

Flow System Faults (page 2)					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
14 (cont.)	Flow does not seem correct	Sensor to transmitter wiring may be faulty	Run 'SENSOR CHECK' in DIAGNOSTICS menu	Yes – passes all tests	See below
				No – fails one or more tests	Verify and correct fault indicated on screen. If problem persists, Acquire Snapshot, Upload to secure Website, and contact Customer Support.
		One or more sensors may be faulty	Run 'SENSOR MAX/MIN' in INFO menu	Yes – all sensors are within 30% of each other (process must be flowing at nominal flow rate)	See below
				No – one or more sensors vary from the others by >30%	Potential sensor failure. Acquire Snapshot, Upload to secure Website, and contact Customer Support.
		Incorrect viscosity or density settings	Verify correct settings in BASIC CONFIG menu	Yes – the proper settings are input	See below
				No - the settings are not correct	Correct inputs in BASIC CONFIG menu
		System is in 'Initialize Mode'	Is the system 'Heartbeat' (indicated by a spinning '\I/-') on bottom right of screen active	Yes	System is operational and communicating with DSP.
				No	The system is designed to reset automatically after 30 minutes. If reset does not occur, cycle power to system. If this recurs, contact Customer Support.

Flow Syatem Faults (page 3)					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
14 (cont.)	Flow does not seem correct	A cable connection between the sensor and transmitter is cut or disconnected	Run 'SENSOR CHECK' under DIAGNOSTIC menu	Pass	This indicates all sensors are good and functional.
				Fail	1. Verify wire connections in transmitter are all good. 2. Verify cable is not cut or damaged. 3. Verify cable connector on sensor head is connected. 4. Remove sensor head access panel per Installation Manual and ensure sensor to pre-amplifier connector is properly connected. 5. If system does not function, acquire Snapshot, upload to secure Website, and contact Customer Support.
15	The flow rate displayed is a series of dashes (------)	System 'Quality Metric' is below set point	The default value of VQ (if displayed on the transmitter front panel) is 0.2.	Value is equal to or greater than 0.2 consistently	Indicates system is above minimum threshold for making a reading
				Value is less than 0.2	Indicates system is below minimum threshold to make a reading. Acquire Snapshot, Upload to secure Website, and contact Customer Support.
		Sensors are saturating	Go to 'EVENT LOG' in INFO menu and press ENTER	Yes - A message of 'Sensor Over' will be present if a sensor has been saturated	1. Go to 'GAIN' on DIAGNOSTICS menu. 2. Press ENTER and scroll to AUTOSET GAIN and press ENTER 3. GAIN will be adjusted to proper level
				No message for 'Sensor Over'	See below

Flow System Faults (page 4)					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
15 (cont.)	The flow rate displayed is a series of dashes (------)	Undefined	Take s 'SNAPSHOT' using software utility or SONARstick	Post on secure Web site in Technical Support area	Contact Customer Support.
		Process operating flow is less than the system programmed minimum flow setting	Is the process flow rate < 3 ft/sec	Yes	System normal specification is a low flow cutoff of 3 ft/sec
				No	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
16	The flow rate displayed is '> max flow'	Process operating flow is greater than the system programmed maximum flow setting	Is the process flow rate > 30 ft/sec	Yes	System normal specification is a maximum flow cutoff of 30 ft/sec. If this is a gas flow application, contact Customer Support for instructions.
				No	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
17	The Flow Reading is erratic	Sensors are saturating	Select and run 'AUTOSET GAIN' found in GAIN submenu of DIAGNOSTICS menu	Yes -The reading is less erratic.	Use this as new transmitter configuration
				No – The reading is still erratic	Acquire Snapshot, Upload to secure Website, and contact Customer Support..
		The flow is at or below min flow rate of the system	Select 'LOW END' under FLOW CUTOFF RANGE submenu of CUSTOMIZE menu and determine if that value is zero	Yes – the value is set to zero	The operation may be outside the measurement capability of the meter. Contact Customer Support.
				No – the value is not set to zero	Lower the low end cutoff.

Flow System Faults (page 5)					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
18	The Flow Reading is erratic	The system is mounted too close to an elbow or obstruction	If possible move system to a longer straight run of process pipe.	Yes – The reading is less erratic	
				No – The reading is still erratic.	Acquire Snapshot, Upload to secure Website, and contact Customer Support.

GVF System Faults:					
Item No	**PROBLEM**	**POSSIBLE CAUSE**	**DIAGNOSTIC METHOD**	**DIAGNOSTIC RESULT**	**COMMENTS**
19	The GVF System Displays dashes “-----“	The acoustics at the measurement location are too low	Contact Technical Support.		
20	The GVF Reading is erratic	Signals may be saturated	Select and run ‘AUTOSET GAIN’ found in GAIN submenu of DIAGNOSTICS menu	Yes – this corrected the problem	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
				No – the problem persists	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
21	The GVF System always reads 50% GVF or some other value that is not correct	Transmitter setup parameters are incorrect	Verify setup parameters to ensure they are correct	Yes – the setup parameters are correct	The actual GVF of the fluid is >50% or what is indicated on the transmitter
				Yes – the setup parameters are correct but the GVF is definitely incorrect	Acquire Snapshot, Upload to secure Website, and contact Customer Support.
				No – the setup parameters are not correct	Correct transmitter input parameters in BASIC CONFIG menu

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