



InnovaSonic® 207i

# InnovaSonic® 207i Thermal Energy/BTU Ultrasonic Flow Meter Instruction Manual

Version IM-207i, Rev. G6.3/19



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	<p>Get detailed instructions on the Smart Interface Portal (SIP) software in the <a href="#">Smart Interface Portal instruction manual</a>.</p>
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## Warnings in This Manual

“Warning,” “Attention,” and “Note” statements are used throughout this manual to draw your attention to important information.

Symbol Key		
Symbol	Symbol Meaning	Description
	Warning	“Warning” statements appears with information that is important to protect people and equipment from damage. Pay very close attention to all warnings that apply to your application. Failure to comply with these instructions may damage the meter and cause personal injury.
	Caution	“Attention” indicates that failure to comply with stated instructions may result in damage or faulty operation of the meter.
	Note	“Note” indicates that ignoring the relevant requirements or precautions may result in flow meter damage or malfunction.

### *Receipt of System Components*

When receiving a Sierra mass flow meter, carefully check the outside packing carton for damage incurred in shipment. If the carton is damaged, notify the local carrier and submit a report to the factory or distributor. Remove the packing slip and check that all ordered components are present. Make sure any spare parts or accessories are not discarded with the packing material. Do not return any equipment to the factory without first contacting Sierra Customer Service.

### *Technical Assistance*

If you encounter a problem with your flow meter, review the configuration information for each step of the installation, operation, and setup procedures. Verify that your settings and adjustments are consistent with factory recommendations. Installation and troubleshooting information can be found in the Chapter 2 (Installation) and Chapter 4 (Troubleshooting) of this manual.

If the problem persists after following the troubleshooting procedures outlined in Chapter 4 of this manual, contact Sierra Instruments by fax or by e-mail (see inside front cover). For urgent phone support you may call (800) 866-0200 or (831) 373-0200 between 8:00 a.m. and 5:00 p.m. PST. In Europe, contact Sierra Instruments Europe at +31 72 5071400. In the Asia-Pacific region, contact Sierra Instruments Asia at +8621 5879 8521. When contacting Technical Support, make sure to include this information:



- The flow range, serial number, and Sierra order number (all marked on the meter nameplate)
- The software version (visible at start up)
- The problem you are encountering, and any corrective action taken
- Application information (gas, pressure, temperature and piping configuration)

## Register Your Product Today

### *Warranty Statement*

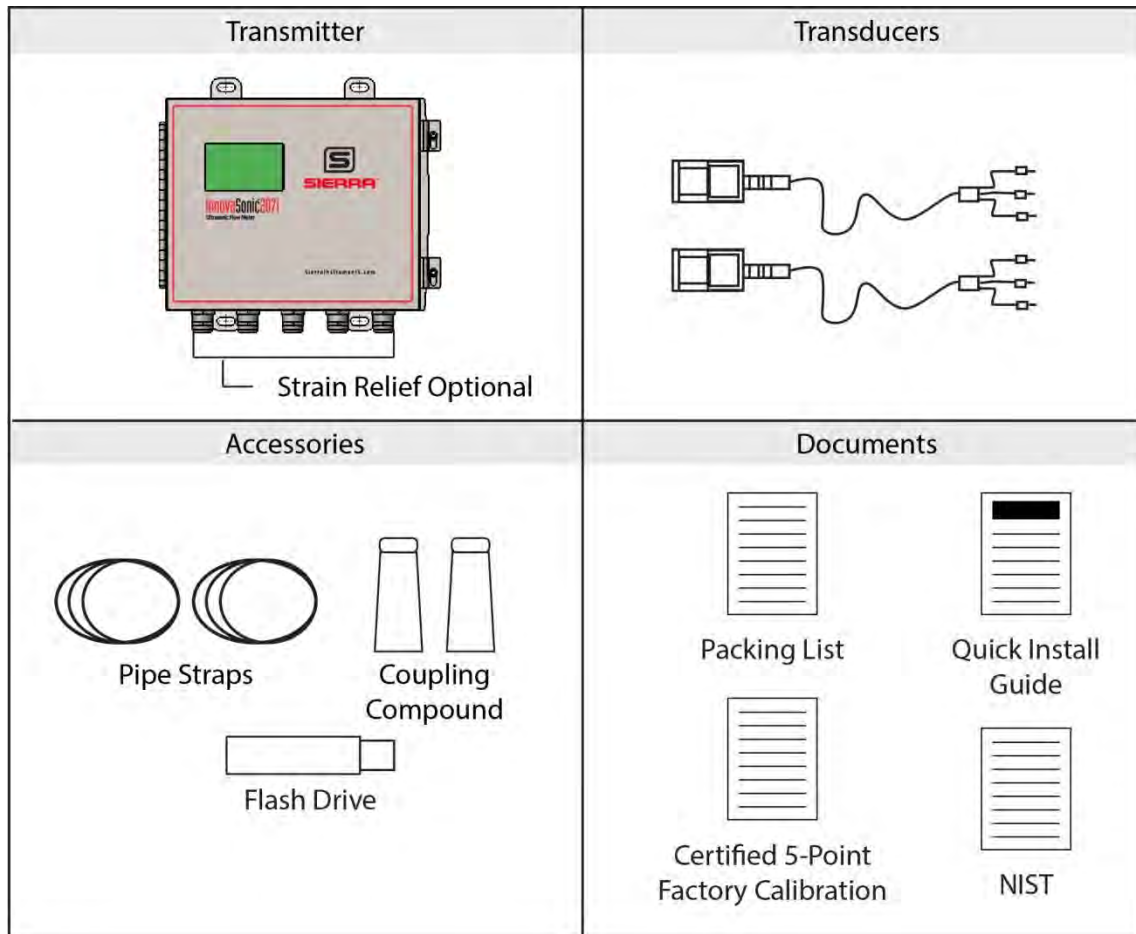
All Sierra products are warranted to be free from defects in material and workmanship and will be repaired or replaced at no charge to Buyer, provided return or rejection of product is made within a reasonable period but no longer than one (1) year for calibration and non-calibration defects, from date of delivery. To assure warranty service, customers must register their products online on Sierra's website. Online registration of all of your Sierra products is required for our warranty process. Read complete warranty policy at [www.sierrainstruments.com/warranty](http://www.sierrainstruments.com/warranty).

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Register now at [www.sierrainstruments.com/register](http://www.sierrainstruments.com/register). Learn more about Sierra's warranty policy at [www.sierrainstruments.com/warranty](http://www.sierrainstruments.com/warranty)

# Product Components

Inspection should be made before installing the InnovaSonic 207i. Check to see if the spare parts are in accordance with the packing list. Make sure that there is no damage to the enclosure or other damage that may have occurred during transportation. Any questions, please contact your representative as soon as possible.



Optional Items if ordered:

- PT100 RTD input boards
- RTD Transducers
- 4-20 mA input boards
- Modbus-RTU slave board
- Shield strain reliefs (cable glands)
- RTD temperature sensors

# 1 Introduction & Product Overview

## 1.1 Introduction

With skyrocketing energy costs, there has never been a better time to invest in the precise flow measurement required to maximize your HVAC system efficiency, meet regulations, and bring down costs.

Designed, built and calibrated by Sierra for non-intrusive liquid flow metering, and optimized for thermal energy / BTU measurement, the Innova-Sonic® 207i transit-time ultrasonic flow meter is the ideal turnkey solution for building and district metering, and submetering.

### **The Flow Engine Behind It All**

At the heart of every 207i is advanced digital signal processing to enhance ultrasonic transit-time flow metering technology and fluid dynamic measurements.

Sierra's Raptor™ 2 OS is the true "Brain" of the instrument and includes a revolutionary, living, learning algorithm set made possible by today's hyper-fast microprocessors. Raptor 2 manages changes in liquid flow, temperature, and pressure.

The result is a proprietary, fundamentally different liquid flow rate calculation using all pertinent variables for the most precise, stable and accurate flow measurement possible.

The OS interfaces with Sierra's software apps to read, adjust and upgrade the meter firmware in the field.

### **Thermal Energy/ BTU Metering**

The 207i calculates thermal energy / BTU flow energy and provides you with the highest accuracy measurements possible to manage energy costs.

A critical element of any thermal energy / BTU flow energy measurement is determining the amount of heat transferred between the cold and hot flow legs of an HVAC process.

Often with only a small difference in temperature between the two flow legs, a precise measurement makes a huge difference. Sierra calibrates the entire flow energy package—flow meter and temperature transmitters—as a system to improve quality.

Raptor 2 takes into account this temperature difference as well as all fluid properties required to accurately measure flow and makes ultra-precise temperature measurements between the cold and hot flow legs.

### **High Accuracy Through Density Compensation**

Raptor 2 also enables vast improvements in liquid flow metering accuracy. Since an ultrasonic flow meter detects the speed of sound in the liquid being measured, a small change in liquid density can have a big impact on accuracy and repeatability.

By adding a temperature input from a transmitter provided by Sierra or by using an external input from an existing transmitter, the 207i can calculate real-time liquid density, assuring the highest accuracy possible.

Accuracy: +/- 0.5% of reading from 0.16 to 40 ft/s (0.05 to 12 m/s).

### **Making it Easier**

With the InnovaSonic 207i's clamp-on sensors, there's no pipe cutting or expensive plumbing.

The 207i features a large backlit display and dual-function keypad with audible feedback. With its visual sensor spacing tool on the display (see photo in center), slightly move the sensors together or apart to position the indicator

line between the “goal posts” and assure optimal signal strength.

Easily connect the 207i to your building management system with Modbus or BACnet communications. With its robust stainless steel enclosure, permanently fasten the transducers to make it a hardened installation, and you’re ready to measure for years to come.

### **It Has Apps**

The InnovaSonic 207i is the first transit-time ultrasonic flow meter to come with a comprehensive software package of apps for ease of use, field upgrades, and calibration validation.

Apps like MeterFit help you optimize signal strength to assure best performance.

Apps like EnergyPro allow you to fully configure your thermal energy / BTU flow energy measurement system, including datalogging and totalization of all energy functions.

Apps like ValidCal Diagnostics make field calibration validation easy.

Sierra has many more apps under development to enhance your product experience.

### **World Class Calibration**

Every flow meter is only as good as its calibration. To assure the highest accuracy possible, each InnovaSonic is calibrated at Sierra’s flow calibration facility in Monterey, California which consistently delivers calibration accuracies of +/- 0.2% of reading.

All calibrations follow the guidelines of ISO 17025 and are directly traceable to national standards such as NIST (United States National Institute of Standards and Technology).

Fully automated, once flow application data is programmed, calibration automation software manages all aspects of flow calibration testing. High-speed time-aligned data acquisition and performance analysis over the entire flow measurement range occurs. A calibration certificate documenting instrument performance is then generated.

### **Service, Commissioning & Training**

The need to deliver fast, localized support to global customers has resulted in the establishment of dedicated Sierra Flow Centers on almost every continent. And they are backed up by technical experts in over 150 locations in more than 50 countries.

Sierra’s team of engineers can commission your flow meter to assure optimal performance and train you to get the most out of your instrument.

We provide lifetime support for all Sierra products and will even get on a plane to provide support when needed.

### **Sierra’s Big-3 Technologies**

The InnovaSonic 207i is one of three advanced flow meter technologies Sierra has developed to help facility managers tackle tough energy management challenges.

For what we call our Big-3, Sierra has become a recognized expert in thermal mass (QuadraTherm®), vortex shedding (InnovaMass®), and transit-time ultrasonic (InnovaSonic®). Sierra is the only company in the USA to manufacture all three flow technologies.

The Big-3 are optimized to be a complete solution for flow energy measurement—facility flows that impact costs like compressed air, natural gas, steam, and hot or chilled water.

As new apps and improvements become available, all Big-3 technologies benefit and are field firmware upgradable.

**Watch the Video**

Watch a complete demonstration video of the 207i to get more in-depth information.  
[sierrainstruments.com/207ivideo](http://sierrainstruments.com/207ivideo)



## 2 Transmitter Installation and Connections



Watch the How to Install & Operate video at [sierrainstruments.com/207i-how-to](http://sierrainstruments.com/207i-how-to)

### 2.1 Mounting the 207i

The 207i should be mounted to a sturdy flat surface, like a wall. Use the mounting tabs as shown (See Figure 1). Depending on the wall material you may need to drill holes to mount anchors first. The dimensions below are shown in inches [millimeters]. Cables should be run through 3/4-inch conduit or the optional shielded strain reliefs (cables glands) as shown below.

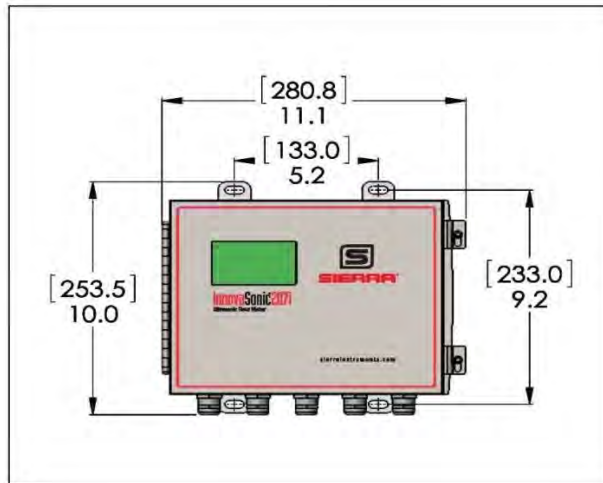


Figure 1. Installation Configuration Front View

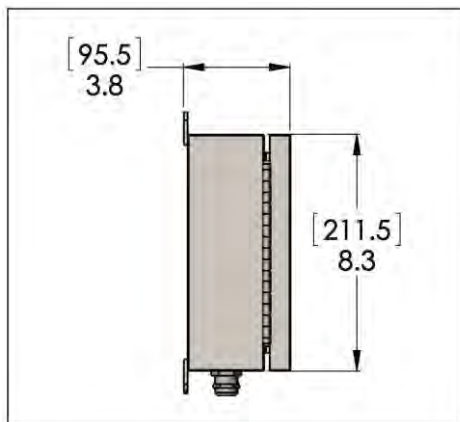


Figure 2. Side View Transmitter Wall Mount

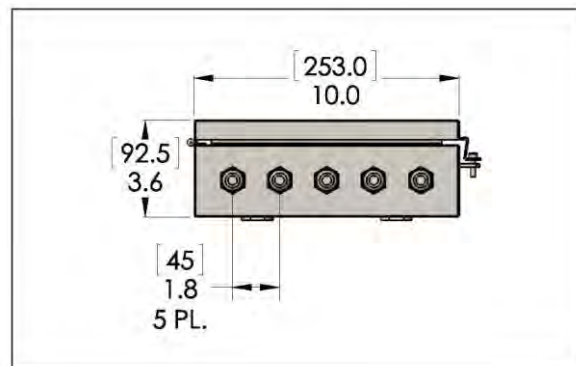


Figure 3. Bottom View Transmitter Wall Mount

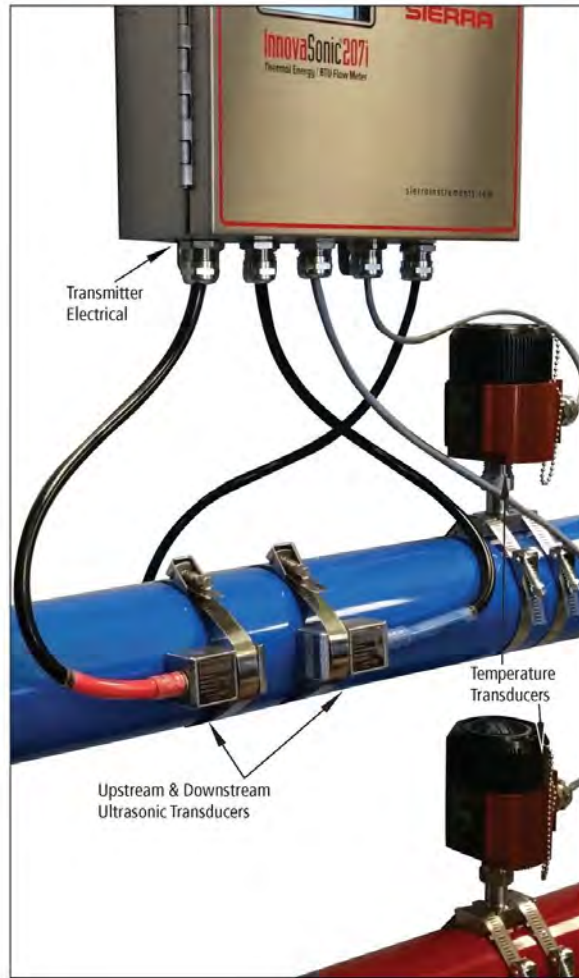


Figure 4. Transmitter Wall Mount with Transducers and RTDs

## 2.2 Connecting the Wiring



**WARNING:** Wire the 207i with the power off. Uses either AC or DC power supply. Verify which you have before wiring!

Please verify which power option you have before connecting power to the unit. The 207i is available with one of two power options:

- Option P2: DC Powered 9-36 VDC, 0.5 Amps. (See Figure 5 DC power-option).
- Option P3: AC Powered 100-240 VAC, 50-60 Hz, .5 Amps. (See Figure 5 AC power-option).
- Open the hinged top cover of the electronics (see Figure 5). The power input terminal block is labeled POWER IN. On the AC power unit, it is labeled E N L, and on the DC powered unit it's labeled E -V +V (See Figure 5).

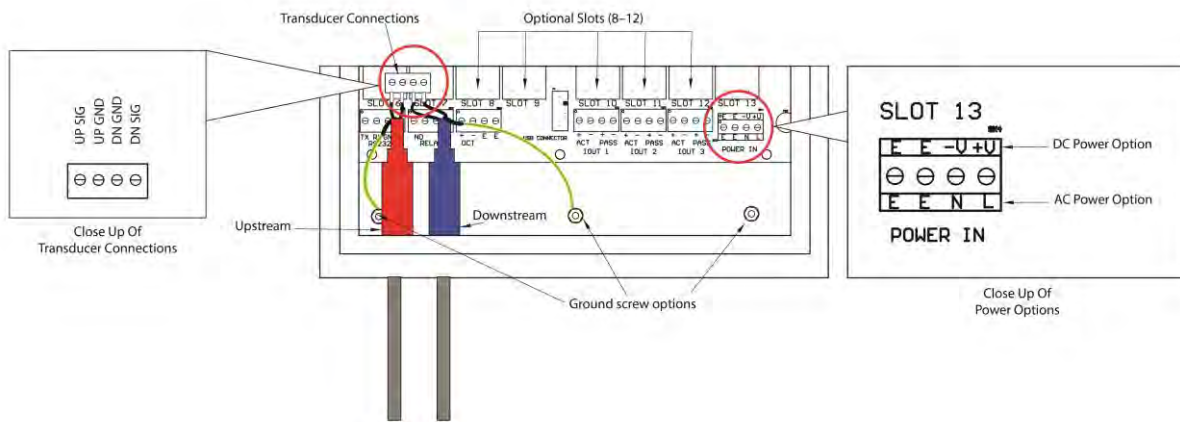


Figure 5. 207i AC and DC Power Options: Minimum Required Wiring



**Note:** The standard 207i is equipped with 3 onboard 4-20 mA current outputs, 1 relay, 1 OCT, RS-232, and USB port. Optional plug in modules can add PT100 RTD inputs, 4-20 mA inputs and Modbus-RTU slave.

### 2.2.1 Power Connections

Verify the power is turned off before connecting it to the 207i.

AC power connections; L to AC Line (hot), N to Neutral, E to safety Earth ground; 100-240 VAC, 50-60 Hz, .5 Amps (See Figure 5). If the AC mains wiring is not installed in conduit, a ferrite core should be installed (CE requirement) just inside of the enclosure with 2 turns (3 passes) of the AC wiring thru it. Ferrite core Wurth Electronics pn 74270095/Digi-Key pn 732-1564-ND or similar should be used.



DC power connections; V+ to DC plus, V- to DC power return, The E connections are optional Earth ground; 9-36 VDC at 0.5 Amps (See Figure 5).

We also recommend a heavy gauge wire to the large E (Earth) or directly to the enclosure for lightening protection.

## 2.2.2 Transducer Connections

Connect the upstream (Red) transducer white wire to the UP SIG terminal on the ultrasonic board, and the black wire to the UP GND terminal. The Green/Yellow wire is the Earth Ground wire. It attaches to the enclosure ground screw as shown (See Figure 5).

Connect the downstream (Blue) transducer white wire to the DN SIG terminal on the ultrasonic board, and the black wire to the DN GND terminal. The green/yellow wire is the Earth Ground wire. It attached to the enclosure ground screw as shown (See Figure 5).

## 2.3 Other Connections

### 2.3.1 Current Outputs

The 207i is equipped with three on board 4-20 mA current outputs labeled IOU1, IOU2, IOU3. These are all optically isolated and have both active (powered by 207i), and passive (powered by PLC) output connections. The operation of these outputs is configured in the Input/Output menu.

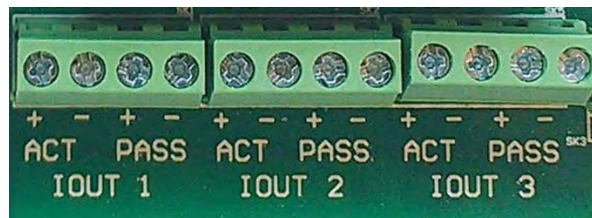


Figure 6. Onboard 4-20mA Current Outputs

- To wire as an Active 4-20 mA output, connect to the terminals marked ACT + -.
- To wire as a Passive 4-20 mA output, connect to the terminals marked PASS + -.
- **Do not connect to both active and passive at the same time!**

### 2.3.2 Relay Output

The 207i is equipped with one relay output that has both Normally Open (N.O.) and Normally Closed (N.C.) connections. The operation of this relay is configured in the Input/Output menu. The relays are rated for 250V AC or DC at 100 mA Max. For normally open operation connect across the NO labeled terminals. For normally closed operation connect across the NC labeled terminals. Both may be used at the same time.



Figure 7. Relay Output



Warning: Do not exceed the maximum current or voltage rating of the relay. 250V AC or DC at 100 mA Max.

### 2.3.3 OCT Output

The 207i is equipped with one opto-isolated OCT (Open Collector Transistor) output. The operation of this OCT is configured in the Input/Output menu. This OCT output has many of the same functions of the relay output but can also be operated at speeds up to 10 KHz and can be used as a frequency output. Both the Collector (+) and Emitter (-) of the NPN transistor is connected to the terminal block. No internal pull-up resistor is provided because many PLC input cards already have built in pull-up resistors. For a 24 VDC pull-up we recommend 1,000 ohms or more. The 207i internal OCT schematic is show below.

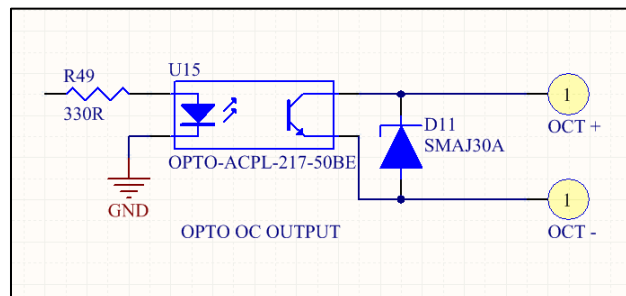


Figure 8. Opto-isolated OCT Internal Wiring



Warning: Do not exceed the maximum ratings of the opto-isolator OCT. 50V DC at 50 mA Max.

### 2.3.4 RS-232 and USB Connections

The 207i is equipped both RS-232 and USB connections. USB, RS-232 or Off can be selected in the MAIN MENU>RS-232>USB>Port. The RS-232 connection is a simple 3-wire connection with no handshake connections (Tx, Rx, Gnd). The USB is functionally the same as the RS-232 connection and uses a FTDI chip to emulate a RS-232 COM port connection. The USB connection is the USB A type connector. So, the cable to connect to a PC would be the A to A type. Drivers for the internal FTDI chip should automatically load using Windows.

Configuration of COM setting and functions of these are done in the 207i MAIN RS-232/USB menu.

Baud Rates; 9600,19.2K,38.4K,57.6K

Parity; None, Even, Odd

### 2.3.5 Optional Current Input Module

The 207i can be ordered with optional current input boards that can be plugged into slots 8 through 13 (See Figure 9). These can be used to input dynamic temperature, pressure, density, and batch triggering. The configuration of these current input modules is done in the Input/Output menu. These are opto-isolated and have both Active and Passive connections.

The active connection allows easy connection to loop powered transmitters by connecting to the terminal marked ACTIVE + or ACTIVE -.

The passive connection allows easy connection to a powered instrument by connecting to the terminal marked PASS + or PASS-.

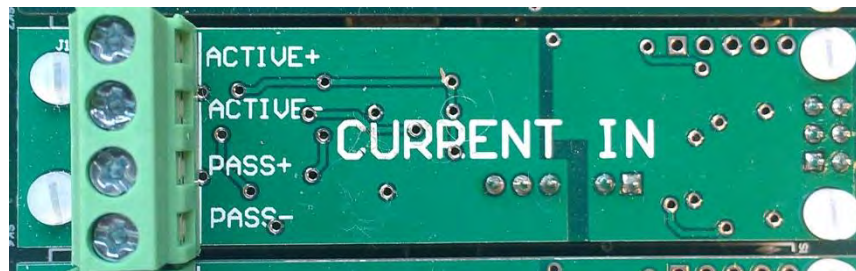


Figure 9. Current Input Module

### 2.3.6 Optional PT100 RTD Input Module

The 207i can be ordered with optional PT100 RTD input boards that can be plugged into slots 8 through 13 (See Figure 10). The module is designed to be used with a common 4-wire PT100 RTDs ( $\beta=100\Omega$   $\alpha=.00385$ ). The configuration of the PT100 input module is done in the Input/Output menu on the display. The terminals are labeled as the four wires RTD would appear in a schematic. The two-wire pairs are used to cancel out any wire resistance. Typically, the RTDs would have two red wires and two white.

## Typical PT100 RTD Connections

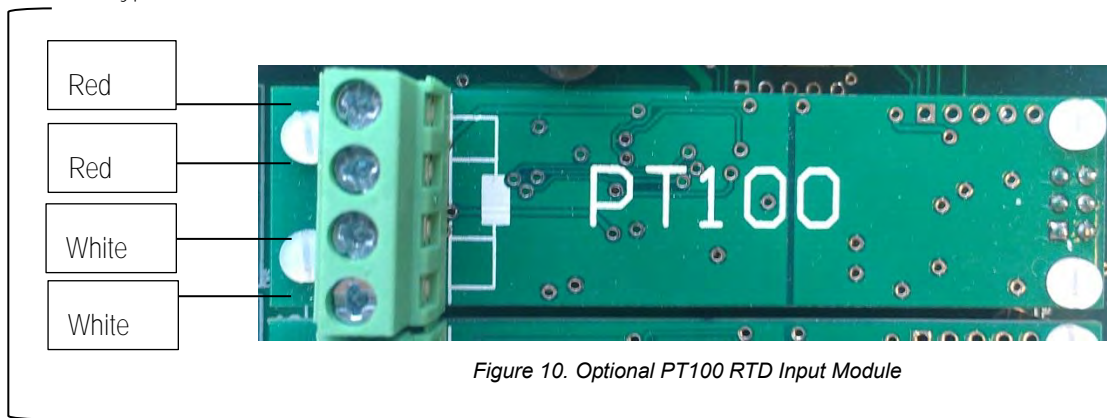


Figure 10. Optional PT100 RTD Input Module

## 2.3.7 Optional Modbus Slave Module

The 207i can be ordered with an optional Modbus-RTU slave communication module (See Figure 11). The module uses an isolated RS-485 transceiver. It also has a 2-color status LED. The LED blinks green when activated, and red every time the Modbus master polls the 207i. Configuration of the Modbus module is done in the Input/Output menu on the display. There the user can activate the Modbus module and select the network Address (1 to 255), Baud rate (9600 or 19.2K), and Parity bit.



Figure 11. Optional Modbus Slave Module

RS-485 networks should be wired in a daisy-chain topology with terminator resistor at both ends. Modbus-RTU uses a 2-wire (half duplex) RS-485 network. We recommend using a shielded twisted pair cable. The signal connections are A- and B+, the C connections are for the cable shield wire. Do not Earth ground the C wire! Although Modbus supports 247 addresses per network, you should not exceed 32 per network segment. A RS-485 repeater may be used to add other segments to your network. See the Appendix C for more information about using the Modbus Module.

### 2.3.8 Optional BACnet Module

BACnet is usually installed in slot 12. However, the BACnet module can be installed in any free slot on the board. Users may install their BACnet module in the field as standard with other option modules. The module has 4 plastic screws, one on each corner that are used to mount the module. The electrical power connections to the 207i are made through the 4-pin connector on the right (See Figure 12). Make sure to power down the 207i before installing any module. Plug the BACnet Module into an open slot, (slot 12 normally) and secure it with the four plastic screws provided. You will need to temporarily remove the **LCD 0** to access the back two screws.

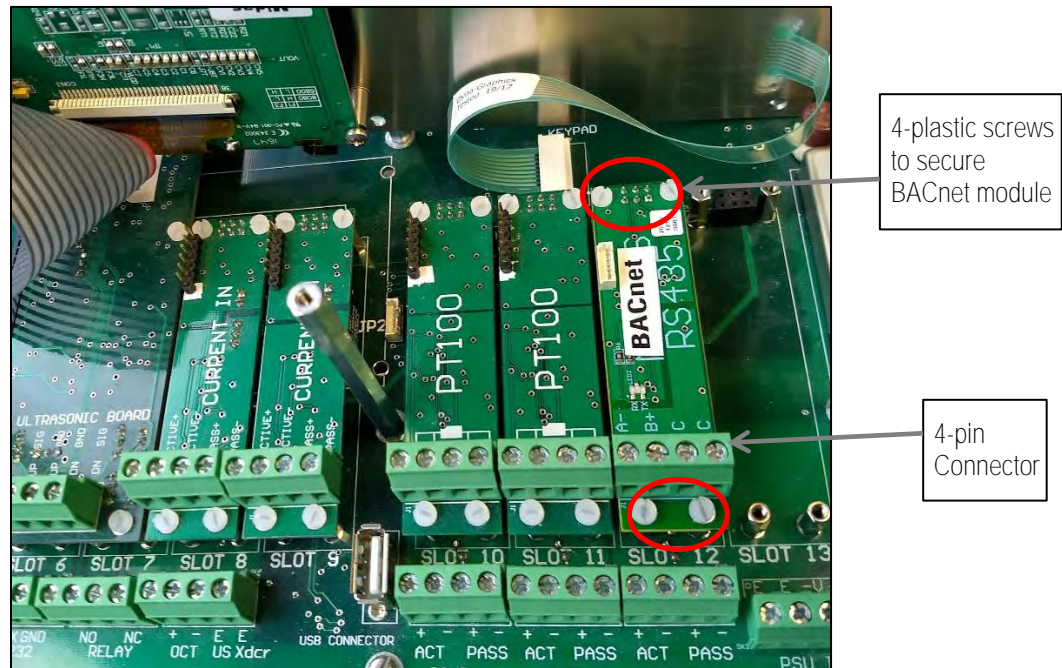


Figure 12. Optional BACnet Module

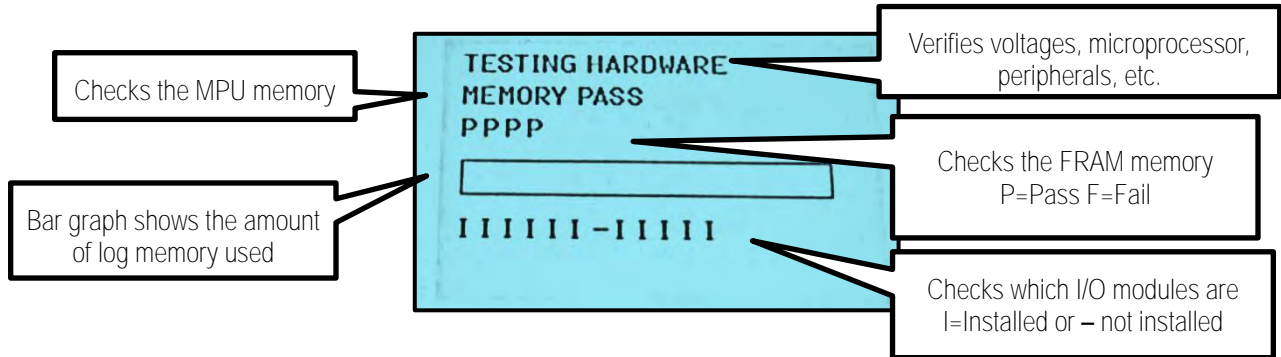
Configuration of the RS-485 (MAC) address and baud rate, is done either with the 207i Smart Interface Portal Software (SIP) or the local keyboard on the meter. See Chapter 3 for SIP and local display configuration instructions.



Warning: Only install 207i option Modules with the 207i powered off and use proper ESD precautions.

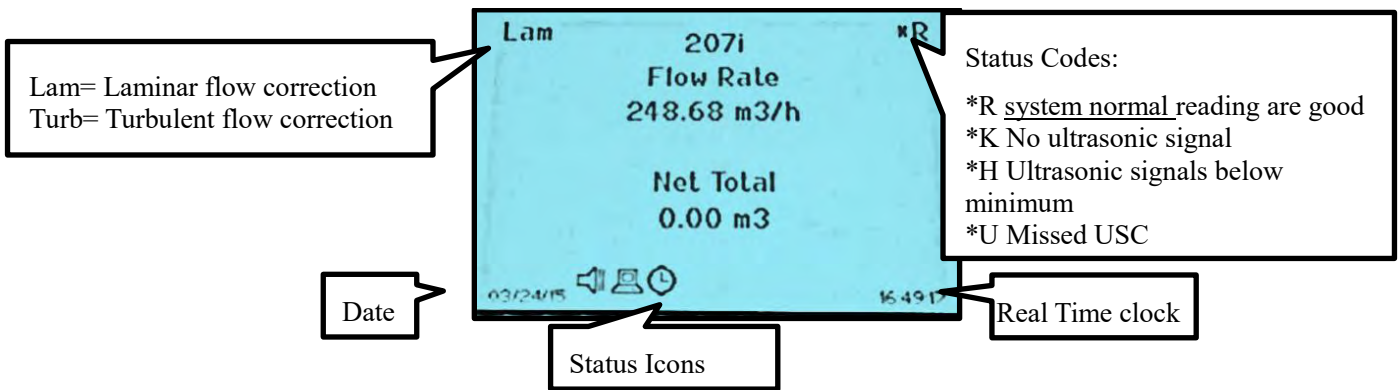
## 2.4 Powering up the 207i

As soon as the 207i is powered up, the self-diagnosis program on the display will start to run and display the following screen:



If any area that fails the checks, FAIL will be displayed in the area that failed.

## 2.5 LCD Display Explanation



Status Icon Definitions:

Buzzer on/off

LCD backlight on/off

RTC active

RS-232/USB active

Data Recording on (Blinks a warning when 95% of memory is used)

CPU error

## 3 Keypad and Menus

### 3.1 Keypad Functions

The InnovaSonic 207i keypad offers 14 dual-function and two dedicated keys:



Primary keypad functions include:


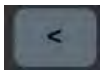



- Use the  to confirm (input) your choices in various menus.
- Use the  to go back to the previous menu screen or leave your current screen. Note: This key is not an undo key.
- Numeric dual-function keys act as a numeric input key when you are in a menu requiring numeric input.
- Use the  and  dual-functions keys for scrolling up or down in a selection list. Alternately, when a +/- input is required these provide a + or - input.
- The  key toggles between RUN mode and MENU mode.

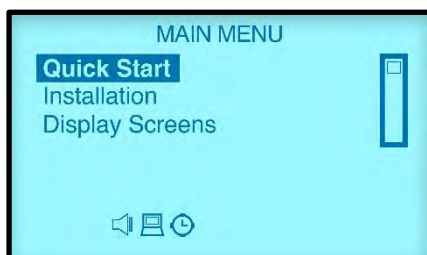


Figure 13. 207i Function Keypad

#### 3.1.1 Overview of Quick Key Functions

##### Quick Start Key

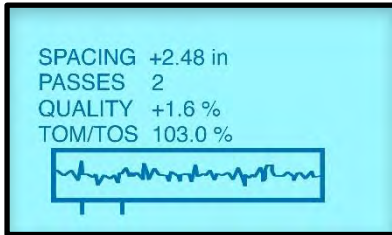
The “Quick Start” key returns to the top of the Main Menu tree. Press **Enter** to start the Quick start wizard. Use the “1” key, if an active menu is requesting a numeric value.





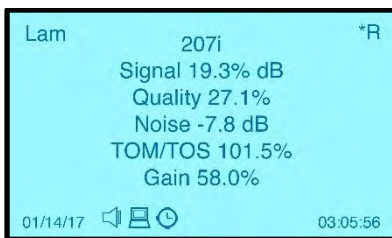
### Xducer Space Key

Opens the xducer spacing setup display screen. If a MemKey for your transducer is installed, the setup screen will start. However, if a MemKey is not installed, you need to select the transducer type and parameters before this setup screen will start. Use the “2” key, if an active menu is requesting a numeric input.



### Signals Key

Opens the ultrasonic signals run display screen. Here you will see: signal (strength), quality, noise, TOM/TOS, and gain. Use “3” key, if an active menu is requesting a numeric input.



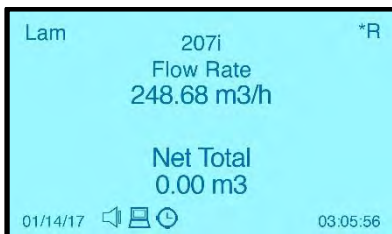
### Run/Menu Key

The “Run/Menu” key toggles between the last active RUN (mode) screen and the last menu view. The 207i only measures flow while in RUN mode. While in RUN (mode), a slight heart beat click will be heard from the Ultrasonic board (USC) board.



### Flow Net Key

Using the “flow net” key will open the flow rate and net total flow display run screen. Use the “4” key, if an active menu is requesting a numeric input.

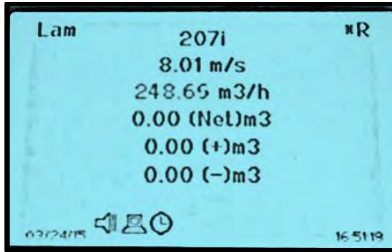






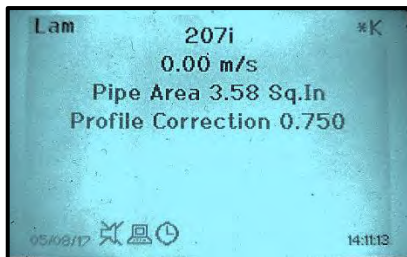
### Flow Totals Key

The “flow totals” key opens the flow velocity, flow rate, net total, pos total, and neg total display “RUN” screen. Use the “5” key, if an active menu is requesting a numeric input.



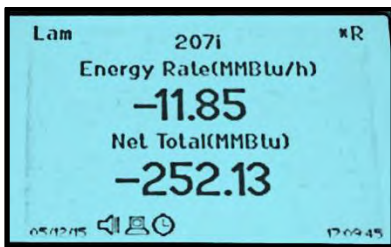
### Vel. Area Key

The “vel. Area” opens the flow velocity, pipe area, and profile correction factor display RUN screen. Use the “6” key, if an active menu is requesting a numeric input.



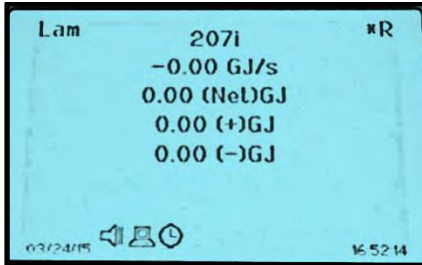
### Energy Rate Key

The “energy rate” key opens the energy rate and energy net total display RUN screen. Use the “7,” if an active menu is requesting a numeric input.

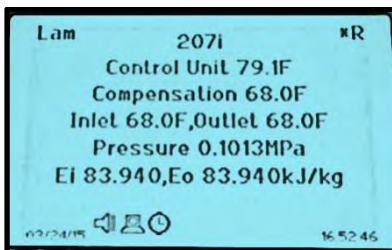


**Energy Totals Key**

The “energy totals” key opens the Energy rate, net total energy, pos total energy, and neg total energy display RUN screen. Use the “8,” if an active menu is requesting a numeric input.

**Temp. Press Key**

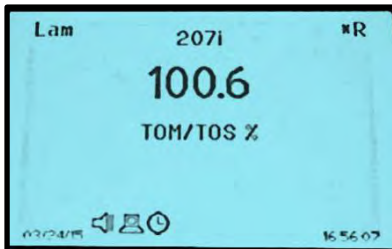
Using the “temp. press” key will open the control unit temperature, compensation temperature, inlet/outlet temperature, pressure, and energy in/ out display RUN screen. Use the (nine) 9 key, if an active menu is requesting a numeric input.

**Diag./ Key**

The “diag.” key opens the ultrasonic diagnostic display run screen. Displays: delta time, transit time, round trip time, delta time offset, and the Speed of Sound of The Fluid calculated, measured. Use the decimal point (.) key, if an active menu is requesting a numeric input.

**TOM/TOS Key**

“TOM/TOS” key displays the calculated speed of sound and measured speed of ratio. 100% ±5 is the accepted range. Use the “0” key when an active menu is requesting a numeric input.



## 4 InnovaSonic 207i Menus






### 4.1 207i Menu Tree Overview

Main Menu	Second Level Menu	Third Level Menu	Fourth Level Menu	
Quick Start	Pipe Outer Diameter	Type value, press Enter		
	Pipe Wall Thickness	Type value, press Enter		
	Pipe Material	Chose value from list, Enter		
	Liner Material	Chose value from list, Enter		
	Fluid Type	Chose value from list, Enter		
	Fluid Temperature	Type value, press Enter		
	Transducer Type	Chose value from list, Enter		
	Transducer Mounting	Chose value from list, Enter		
Installation	Pipe Settings	Pipe Outer Perimeter	Type value, press Enter	
		Pipe Outer Diameter	Type value, press Enter	
		Pipe Wall Thickness	Type value, press Enter	
		Pipe Inner Diameter	Type value, press Enter	
		Pipe Material	Chose value from list, Enter	
		Pipe Roughness	Type value, press Enter	
		Pipe Sound Velocity	Type value, press Enter	
	Liner Settings	Liner Material	Chose value from list, Enter	
		Liner Sound Velocity	Type value, press Enter	
		Liner Thickness	Type value, press Enter	
		Fluid Type	Chose value from list, Enter	
		Fluid Temperature	Type value, press Enter	
	Fluid Settings	Fluid Sound Velocity	Type value, press Enter	
		Fluid Kinematic Viscosity	Type value, press Enter	
		Fluid Density	Type value, press Enter	
		Transducer Settings	Transducer Type	Chose value from list, Enter
			Transducer Mounting	Chose value from list, Enter
	Calibration Settings	Low Flow Cutoff Value	Type value, press Enter	
		Corrected Flow	Reynolds correction on/off	
		Manual Zero Offset	Type offset value, press Enter	
		Manual Scaling Factor	Default 1.000, Type new value	
		Set Zero Calibration	Set zero yes/no	
		Zero Tracking	on/off	
		Energy Calc. Method	Chose value from list, Enter	
		Specific Heat Capacity	Type value, press Enter	
		Inlet Enthalpy	Type value, press Enter	
		Outlet Enthalpy	Type value, press Enter	
		Fluid Pressure	Type value, press Enter	
Display Units	Flow Rate Units	Chose value from list, Enter		

	Flow Rate Time Units	Chose value from list, Enter
	Totalizer Units	Chose value from list, Enter
	Energy Units	Chose value from list, Enter
	Energy Time Units	Chose value from list, Enter
	Measurement Units	Chose Metric or Imperial
	Damping	Type value (1 to 255), press Enter
	Decimal Places	Type value (0 to 3), press Enter
Totalizers Settings	Net Flow totalizer	Chose Yes/No, Enter
	Pos Flow totalizer	Chose Yes/No, Enter
	Neg Flow totalizer	Chose Yes/No, Enter
	Flow totalizer Reset	Chose value from list, Enter
	Period Totalizer Interval	Chose value from list, Enter
	Energy totalizer	Chose Yes/No, Enter
	Energy totalizer Reset	Chose Yes/No, Enter
Factory Defaults	Restore factory defaults	Chose Yes/No, Enter
Display Screens	Flow Rate/ Net total	
	Flow Vel/Rate/Totals	Select a Display RUN screen from list,
	Energy Rate/Net Total	press ENTER
	Energy Rate/Totals	To display the screen
	Temperatures	Press RUN/Menu to toggle between Menus and display screens
	Flow Vel/Area/Corr	
	Period Totalizer	
	I/O Slot Values	
	Signal/Quality/TOM/TOS	
	TOM/TOS	
	Diagnostic Times	
	Flow Correction	
System Settings	Date	Type value, press Enter
	Time	Type value, press Enter
	Date Format	Chose value from list, Enter
	Language	Chose value from list, Enter
	LCD Backlit	Chose Yes/No, Enter
	Buzzer	Chose Yes/No, Enter
	Tag	Type value, press Enter
	Identifier	Type value, press Enter
	Password	Type password, press Enter
	System Lock	Chose Yes/No, Enter
	Test	Installation Chose Yes/No, Enter
		Display Chose Yes/No, Enter
		Keypad Chose Yes/No, Enter
		Memory Chose Yes/No, Enter
		Peripherals Chose Yes/No, Enter
		Ultrasonic Chose Yes/No, Enter
System Info	Model Code	Press Enter to view
	Serial Number	Press Enter to view
	HW Version	Press Enter to view


		SW Version	Press Enter to view
Diagnostics	Enter to show screen		
	Enter to return to menu		
Input/Output	Slot 1 FIXED RELAY OUT	Chose On/Off/Test, Enter	Card type determines options
	Slot 2 FIXED OCT OUT	Chose On/Off/Test, Enter	Card type determines options
	Slot 3 FIXED I out 1	Chose On/Off/Test, Enter	Card type determines options
	Slot 4 FIXED I out 2	Chose On/Off/Test, Enter	Card type determines options
	Slot 5 FIXED I out 3	Chose On/Off/Test, Enter	Card type determines options
	Slot 6 ULTRASONIC	No access	No access
	Slot 7 EMPTY SLOT	No access	No access
	Slot 8 I in	Chose On/Off/Test, Enter	Card type determines options
	Slot 9 I in	Chose On/Off/Test, Enter	Card type determines options
	Slot 10 PT100 4 WIRE	Chose On/Off/Test, Enter	Card type determines options
	Slot 11 PT100 4 WIRE	Chose On/Off/Test, Enter	Card type determines options
	Slot 12 MODBUS RTU SLAVE (or BACnet)	Chose On/Off/Test, Enter	Card type determines options
	Slot 13 EMPTY SLOT	Chose On/Off/Test, Enter	Card type determines options
RS-232/USB	Port	Chose Off/USB/RS-232	
	Mode	Factory use only	
	Baud	Chose value from list, Enter	
	Parity	Chose value from list, Enter	
Datalogger	Interval	Type value, 0= Off, press Enter	
	Erase	Chose Yes/No, Enter	
	Energy Record	Chose Yes/No, Enter	
	Download	Enter to start	
Batching	Flow Batch CTRL	Chose value from list, press Enter	
	Flow Batch Target	Type value, press Enter	
	Flow Batch Controller	Press ENTER to start	
Manual Totalizer Load/Save Setups	Enter to Start	Press ENTER to start	Press RUN/MENU to stop
	Chose Load/Save/Delete	Enter or select name	

### 4.1.1 Detailed Description of Menus


The easiest way to get to the top of the main menu tree is to press the  key. This will work in most cases unless you are in the middle of a menu requesting user input. In that case, the meter will think you are entering the number one. You will need to use the  key to return to an upper level menu. Use the  arrow, down  arrow, and  keys to navigate through the menu system.


## 4.2 Meter Set Up with Quick Start Menu

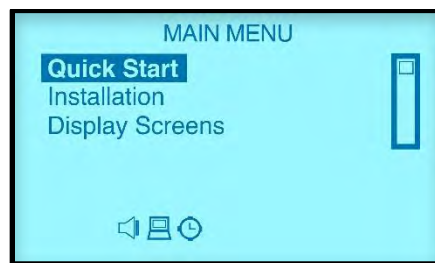


Pressing the  key will bring you to the top of the “MAIN MENU” screen. This menu will guide you through the minimum required settings for measuring flow.




Once on the “Quick Start” main menu, press the  key to start entering the set up parameters for your pipe, fluid, transducer type, and transducer mounting (The meter accuracy is only as good as the parameters you enter), so this is a

critical set up stage. Press the  key to save.




### Step 1: Pipe Outer Diameter

The first screen is the “Pipe Outer Diameter” setting. Enter the pipe outside diameter of your pipe using the numeric side of the keys. This is the actual outside diameter, not just the nominal size. Press the  to save.






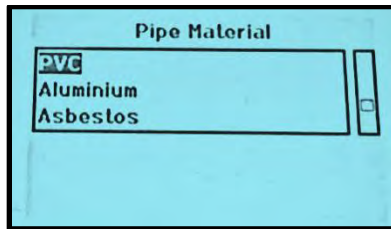
### Step 2: Pipe Wall Thickness.

“Pipe Wall Thickness” is the next setting. Enter the “Pipe Wall Thickness” of your pipe using the numeric side of the keys. This is the actual wall thickness, not just the nominal size. Press the  key to save.






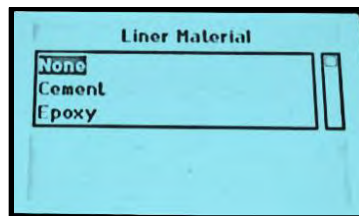
**Step 3: Pipe Material**

“Pipe Material” is the next setting. Using the  and  scroll to the pipe material of your pipe. If your pipe material is not on the list, chose other. You will need to enter the speed of sound of your pipe material. Press the  key to save.



**Step 4: Liner Material**

“Liner Material” is the next setting, if your pipe has a liner (most pipes don’t have a liner). Using the  or  select your “Liner Material” or none. Press  to save.

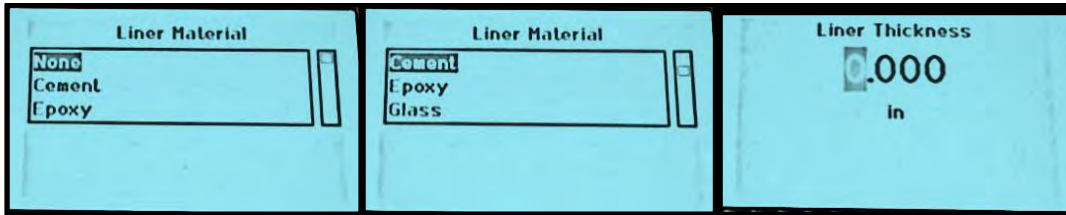


### Step 5: Liner Thickness

If you selected “None” you will skip to the “Fluid Type” menu. If a “Liner Material” menu was selected, a screen will pop up prompting you to enter the “Liner Thickness.” Using the numeric keys, enter the liner thickness and press

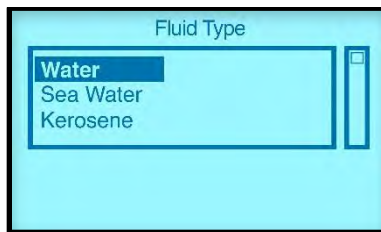


to save.



### Step 5: Fluid Type


“Fluid Type” is the next setting. Using the  and  scroll to fluid in your pipe... Press  to save.

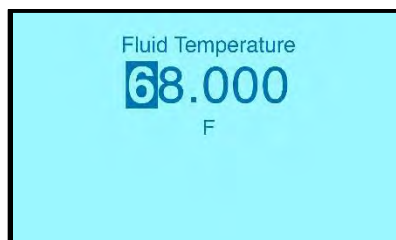


### Step 6: Fluid Temperature



“Fluid Temperature” is the next setting. Then enter your approximate fluid temperature using the numeric side of the




keys. Press the  key to save.

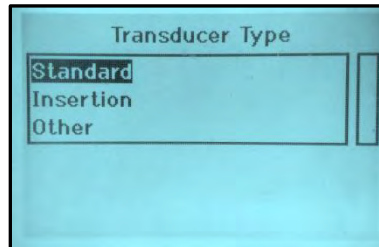


### Step 7: Transducer Type

“Transducer Type” is the next setting. Using the  and  scroll to the appropriate transducer type. Your unit was most likely sent with a Memkey matched to the transducers that were sent with the unit. If a Memkey is

installed the correct selection will already be highlighted. Press the  key to save.





### Step 8: Transducer Mounting

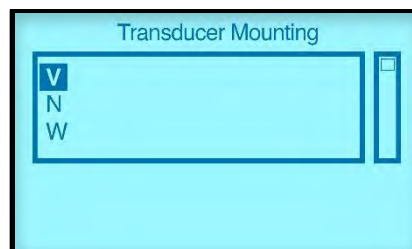
“Transducer Mounting” is the next setting. “Z” represents one pass. The “V” method is the most common method represents two passes. “N” method represents three passes and the “W” method represents four passes. Using the




or select your mounting method. Press



to save and the **RUN** mode will start. See Chapter 6 for details.



### Step 9: Transducer Spacing

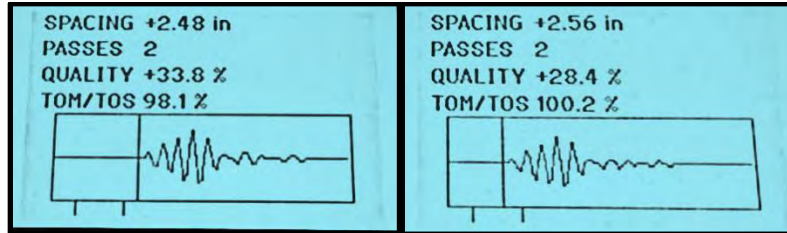
You should now see the “Transducer Spacing” screen. If you are in another screen, you may press the  key at any time to see the “Transducer Spacing” screen. The “Transducer Spacing” screen shows the suggested spacing, the number of passes, quality of the signal and the TOM/TOS (ratio of measured transit time/ calculated transit time), and the scope trace of the returned ultrasonic waveform. Because your transducers are not mounted to the pipe at the correct spacing, the waveform will just look like random noise shown below.



Now mount your transducers to your pipe at the spacing suggested. See Chapter 6 for details on transducer mounting.

Once your transducers are close to the correct spacing, you will see the waveform of the returning ultrasonic signal on the display in the “Transducer Spacing” menu. It will take several seconds for the gain to adjust to the correct range of the returned signal. Wait for the gain to adjust so you see a returned signal as below. The line identifying beginning of

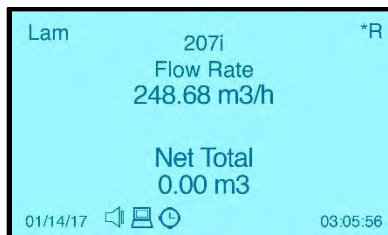
the waveform arrival marker should be between the two goal posts at the bottom of the graph to verify transducers have the correct spacing. You may need to move the transducer closer or further apart to line them up. You will see them move across the screen as you adjust the spacing. Make sure to maintain a layer of ultrasonic coupling compound between the transducer and the pipe while adjusting the spacing.



The correct spacing may also be adjusted by observing the TOM/TOS as it gets close to 100%  $\pm$ 5.

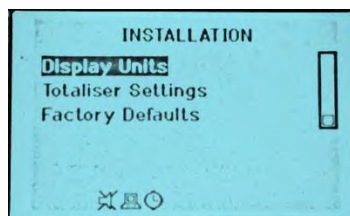
To verify flow rate, you will need to return to the MAIN MENU view by pressing RUN/MENU key or just press a flow


display key like  or  key twice.



### 4.3 Installation Menu

Following the “Quick Start” menu is the “Installation” menu. The “Installation” menu contains more detailed installation settings than those found under the “Quick Start” menu.




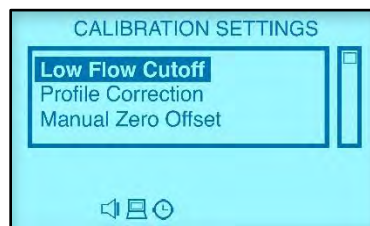
Press  when “Installation” is highlighted to enter the “Installation” menu.

You can enter the same pipe settings, liner settings, fluid settings, and transducer settings under the “Installation” menu as you can under the “Quick Start” menus. These extra settings also allow you to enter a custom pipe material, liner material, fluid and transducer types by selecting “Other.” Note: If a MemKey is installed, the transducer “Other” transducer settings changes will be lost after a power cycle.

### 4.3.1 Calibration Settings



“Calibration Settings” is the next menu group. Press  to enter the Calibration Setting group. From the scroll down menu in the “Calibration Settings” you can choose the following settings: Low Flow Cutoff, Corrected Flow, Manual Zero Offset Manual Scaling Factor, Set Zero Calibration, Zero Tracking, Energy Calc. Method, Specific Heat Capacity, Inlet Enthalpy, Outlet Enthalpy, and Fluid Pressure.



#### 4.3.1.1 Low Flow Cutoff Value

“Low Flow Cutoff Value” is typically set around .01 m/s. Velocities below this value are forced to zero.

#### 4.3.1.2 Profile Correction

“Profile Correction” turns on/off the Reynolds correction. Default is set to on “No”. When turned on “Yes,” the meter measurements are corrected for flow profile using Reynolds Number and pipe wall internal roughness values.

The ability to turn flow profile correction off “No” is useful for benchmarking different types and makes of flowmeters where the sophistication of the manufacturers’ correction algorithms can lead to different results.

#### 4.3.1.3 Manual Zero Offset

“Manual Zero Offset” is a manual zero offset method that is not commonly used. It is only suitable for experienced operators to set zero flow velocity in m/s under conditions when it is not preferable to use other methods. Enter the flow velocity m/s to manually to add or remove to the measured value.




The user is prompted to enter a measurement offset value in m/s. Allowed values are ranged -30.0 to +30.0m/s, default 0.0m/s.

#### 4.3.1.4 Manual Scaling Factor

This factor is used to adjust the flow readings to match a known reading. Only this use if the actual flow readings are known. The default value is 1.000 which means no change to the factory calibration.

#### 4.3.1.5 Set Zero Calibration

This should only be used with zero flow in the full pipe. Set to “No” for normal operation.

Set to “Yes” to zero the meter. After you enter “Yes,” press the  key then press  to start the zero averaging process. After it is done, it will go back to “Set Zero Calibration,” Press  and change back to “No.”

#### 4.3.1.6 Zero Tracking

This is a type of automatic zeroing function. When “Yes” is selected, the meter will start setting a new zero, but only while the velocity is insignificant. Default is on “No”.

When measuring extremely low flows, the meter can mistakenly identify a flow from, for example, a real leak as an erroneous zero offset. To avoid the leak being zeroed out, turn zero tracking Off “No”.

#### 4.3.1.7 Energy Calc. Method

The user is prompted to select the method to be used when making energy calculations from the following list: “SHC” (default), “Enthalpy,” and “Enthalpy Direct.”

#### 4.3.1.8 Specific Heat Capacity” (SHC)

The user can enter a value for the “Specific Heat Capacity” of the fluid flowing in the pipe. Allowed values are ranged 0.0 to 10.0J/(g.K).

The **SHC** (default) method requires specific heat value for the fluid. By default, this value is set to 4.2110 J (g.K) which is water at 68°F (20°C). However, other liquids can be used by entering their SHC at 68°F (20°C). To calculate energy a value for flow rate, specific heat capacity, inlet temperature and outlet temperature of the fluid are needed. Inlet temperature and outlet temperature can be obtained dynamically from PT100 probes or 4- 20mA temperature transmitters. See “Input/Output” menu for setup.

#### 4.3.1.9 Inlet Enthalpy

If the enthalpy direct method of energy calculation is selected, the user can enter a fixed value here. Otherwise, this value is dynamically updated during measurement using knowledge of inlet temperature and fluid pressure.

The user can enter a value for the enthalpy of the fluid flowing in the pipe at the pipe inlet. Allowed values are ranged 0.0 to 1000.0kj/kg, default 83.9kj/kg, water at 68°F (20°C).

#### 4.3.1.10 Outlet Enthalpy

If the enthalpy direct method of energy calculation is selected the user can enter a fixed value here. Otherwise this value is dynamically updated during measurement using knowledge of outlet temperature and fluid pressure.

The user can enter a value for the Enthalpy of the fluid flowing in the pipe at the pipe outlet. Allowed values are 0.0 to

1000.0 kj/kg, default 83.9 kj/kg, water at 68°F (20°C).

#### 4.3.1.11 Fluid Pressure

Pressure can be entered manually fixed (see below), or dynamic from a 4-20mA pressure transmitter, and 4-20 mA Input Module (see “Input/Output” section).

The user can enter a value for the pressure of the fluid flowing in the pipe. Allowed values are ranged 0.1 to 1.0MPa, default 0.10325MPa. (1 Mega Pascal = 145.04 Psia)

### 4.3.2 Display Units

“Display Units” is the next menu group under the “Installation” menu. You will be able to choose the following under this section: “Flow Rate Units,” “Flow Rate Time Units,” “Totalizer Units,” “Energy Units,” “Energy Time Units”, “Measurement Units,” “Damping,” and “Decimal Places,”

#### 4.3.2.1 Measurements Units

Choose either metric or imperial in this section.

- Metric: Millimeters for distance, °C for Temperature, and m/s for velocity.
- Imperial: Inches for distance, °F for temperature, and f/s for velocity.

#### 4.3.2.2 Damping

Under the “Damping” menu, the user is prompted to enter a display damping/averaging time for flow. This is separate to subsequent “Input/Output” damping which is set elsewhere (see “Input/Output” section). Allowed values are ranged 1 to 255s, default 3s.

The damping time can be adjusted to stabilize the flow display. Increasing the damping increases the stability. However, the measurement displayed can be slightly delayed due to over damping. Too much damping may also result in no response to real time fluctuations, especially when flow rate fluctuates wildly.

Therefore, damping should be kept at a minimum and increased just enough to reduce the fluctuation to an acceptable degree.

#### 4.3.2.3 Decimal Places: Two by default 0-3 accepted.

There are two decimal places by default (0-3 accepted).

#### 4.3.2.4 Flow Rates Units

Under the “Flow Rates Units” choose from a scroll down list of the following units:

- Cubic Meters (m3) (default value)
- Liters (l)

- USA Gallons (GAL)
- Imperial Gallons (Imp gal)
- Million Gallons (mg)
- Cubic Feet (cf)
- USA Barrels (US bbl)
- Imperial Barrels (Imp bbl)
- Oil Barrels (Oil bbl)

#### 4.3.2.5 Flow Rate Time Units

Under “Flow Rate Time Units” choose from the scroll down list of the following units:

- \second
- \minute
- \hour (Default)
- \day

#### 4.3.2.6 Totalizer Units

Under “Totalizer Units” choose from the scroll down list of the following units:

- Cubic Meters (m3) (Default)
- Liters (l)
- USA Gallons (GAL)
- Imperial Gallons (Imp gal)
- Million Gallons (mg)
- Cubic Feet (cf)
- USA Barrels (US bbl)
- Imperial Barrels (Imp bbl)
- Oil Barrels (Oil bbl)

#### 4.3.2.7 Energy Units

Under “Energy Units” choose from the scroll down list of the following units:

- Giga Joule (GJ) (Default)
- Mega Joule (MJ)
- Kilo Joule (kJ)
- Kilo Calorie (kcal)
- Million Btu (MMBtu)
- Btu (Btu)
- American Tons (Tons)
- Metric (Tonnes)
- Kilo Watt Hour (kWh)

#### 4.3.2.8 Energy Time Units

Under “Energy Time Units” choose from the scroll down list of the following units:

- \second (Default)
- \minute
- \hour
- \day

### 4.3.3 Totalizer Settings

“Totalizer Settings” is the next menu group under the “Installation” menu.

#### 4.3.3.1 Net, Pos and Neg Flow Totalizers

Under Net, Pos, or Neg Flow Totalizer menus, select “Yes” to activate or “No” to deactivate. Default value is “No” for all three menus. For Net to work properly NEG and POS should also be “Yes”.

#### 4.3.3.2 Flow Totalizer Reset

Under “Flow Totalizer Reset,” the user can reset (zero) flow totalizers by selecting from a scroll down list:

- None (Default)
- All
- Net
- Pos
- Neg

#### 4.3.3.3 Period Totalizer Interval

“Period Totalizer Interval” allows time value selected by the user to reset (zeroes) the totalizer. To use this function, select one of the following time periods to totalize:

- Minute
- Hourly
- Daily (Default)

The 207i displays the total recorded in the previous period on line 2 and the current value being accumulated in the present period on line 1.

#### 4.3.3.4 Energy Totalizer

Select “Yes” to activate or “No” to deactivate the “Net Energy Totalizer.” This value can be a positive or negative number depending whether you are cooling or heating. Default setting is “No.”

#### 4.3.3.5 Energy Totalizer Reset:

Select “Yes” to reset or “No” to not reset. Default setting is “No.”

### 4.3.4 Factory Defaults


“Factory Defaults” is the next menu group under the “**Installation**” Menu. The user is prompted to reload factory defaults and return the meter to its factory configuration.


All parameters including Input/Output settings, RS-232/USB, and datalogger can be reset to factory defaults when you chose reset factory defaults, the following is reset:


- Display contrast is reset to the factory default.
- Tag and Identifier strings are reset to factory values.
- Key code (password) is not defaulted.
- This does not affect datalogger memory. Data is not erased.
- Totalizers are reset to zero.
- Saved Setups are not affected.
- By default, the factory reset is not active “No”.

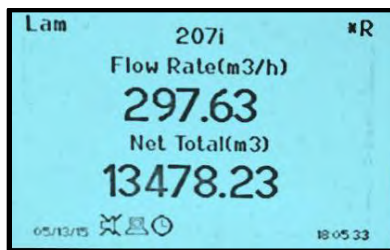
## 4.4 Display Screens


“Display Screens” is the next menu groups under the “Installation Menu” (see section 4.1 for list). These include some other RUN mode display screens that are not accessible using the dual function keys. Once you enter one of these

display screens, you will be sent back to the “Display Screens” menu. Then you will need to press the  key to

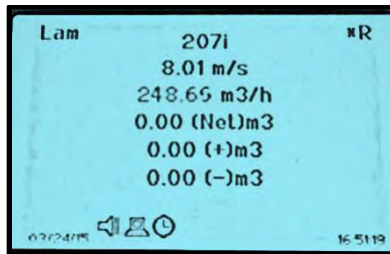
activate the screen. Also, by pressing the  key repeatedly while in any “Display Screen” you can scroll through all of the “Display Screens” even the few advanced diagnostic screens that are not available any other way.


- “**Flow Rate/ Net Total**” (also available using the,  key).

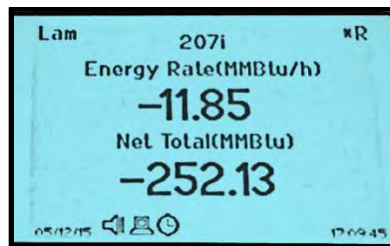



- “**Flow Velocity/Rate/Totals**” (also available using the  key).

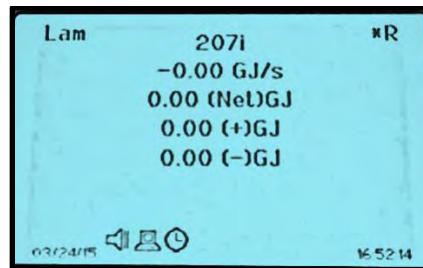





- “Energy Rate/ Net Total” (also available using the  key).




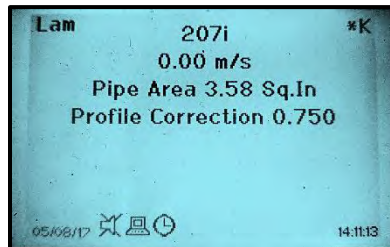
- “Energy Rate/Totals” (also available using the  key).



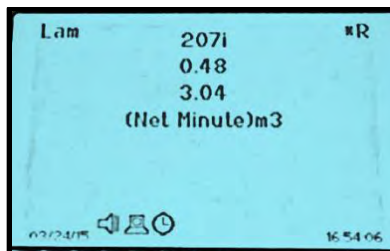
- **“Temperatures”** including “Control Unit” (electronics), “Fluid Compensation,” “Inlet,” and “Outlet” temperatures, “Pressure” and, “Enthalpy” in and out (also available using the  key).



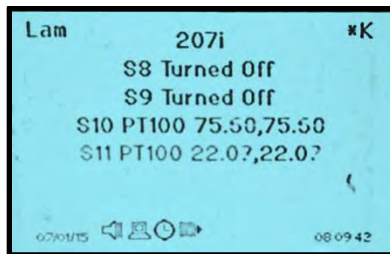
- **“Flow Vel/Area/Corr”** including flow velocity, pipe area, Reynolds correction factor (also available using the  Key).



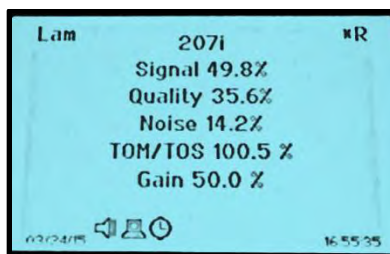
- **“Period Totalizer”** includes current accumulated flow total, last period’s accumulated flow total (time period) total unit. This screen is not available using a dual function key.




- **“IO Slot Values”** shows the status and input values of the “I” in and PT100 slots 8,9,10, and 11... This screen is not available using a dual function key.



- “Signal/Quality/TOM TOS,” plus the signal amplifier gain (also available using the  key).



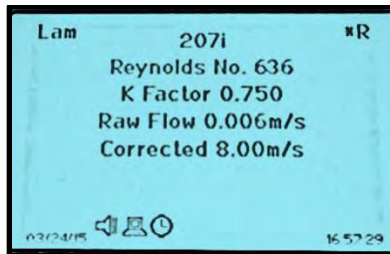
- “TOM/TOS,” in larger characters to aid in spacing adjustment (also available using the  key).



- “Diagnostic Times” screen is used, for factory troubleshooting. This screen is not available using a dual function key.



- **“Flow Correction”** screen is used for factory troubleshooting. This screen is not available using a dual function key.



## 4.5 System Settings

“System Settings” is the next menu group under the “MAIN MENU.” Below is a list of adjustable settings found under the “System Settings” menu.

### 4.5.1 Date

To adjust the date, type in the current date and press “Enter.”

### 4.5.2 Time

To adjust the time, type in the current time and press “Enter.”

### 4.5.3 Date Format

Select the date format you want by choosing between dd/mm/yy, mm/dd/yy, and yy/mm/dd date formats.

### 4.5.4 Language

To select a different language, chose value from list and press “Enter.”

### 4.5.5 LCD Backlit

You can have the LCD backlit by choosing either Yes/No and press “Enter.”.

### 4.5.6 Buzzer

Turn the buzzer on or off by choosing either Yes/No and press “Enter.”

### 4.5.7 Tag

Enter in your tag by typing value and press “Enter.”

### 4.5.8 Identifier

Type value of the “Identifier” and press “Enter.”

### 4.5.9 Password

Type password and press “Enter” to set. (Default 1234)

### 4.5.10 System Lock

Chose “Yes” to lock system.

Chose “No” to unlock the system. NOTE: You will need the password above to unlock the system later.

### 4.5.11 Test

Below is a list of adjustable settings found under “Test” menu.

#### 4.5.11.1 Installation

Under the “Installation” menu, Chose Yes/No and press “Enter.”

- When turned on the meter simulates a slowly ramping flow velocity 0 to 10m/s.
- All subsequent volumetric, mass and heat quantity measurements are made using this velocity.
- All IO modules, data logger, display and RS-232/USB to PC interface respond as programmed to these values.
- The user must remember to turn this test mode off in order to measure normally real flow.

#### 4.5.11.2 Display

Chose Yes/No and “Enter.”

The user is taken through a factory series of tests which fully exercise the meter LCD and its back light (Backlit).

#### 4.5.11.3 Keypad

Press “Enter” to start the test.

The user is taken through a factory series of tests which fully exercise the meter keypad and its audio indicator (Buzzer).

#### 4.5.11.4 Memory

Press “Enter” to start the test.

The user is taken through a factory series of tests which fully exercise the meter system FRAM memory and datalogger flash memory. **Note that after the datalogger test, selecting “Yes” will result in any logged data being erased so download important data before running this test or select “No”.**

#### 4.5.11.5 Peripherals

Press “Enter” to start the tests.

The user is taken through a factory series of tests which fully exercise the meter internal hardware, press “Enter” to continue to the next test.:

- Temperature sensor
- RTC
- Optional plug-in IO modules

This test polls the IO modules that are fitted in the meter and populates the list of available modules. It is useful if the range of fitted modules changes. In addition, the test is automatically run and IO modules are polled at power on.

#### 4.5.11.6 Ultrasonic

Press “Enter” to start the test.

This test polls the meter USC and reads its hardware and software versions. It also pools and reads a MemKey if installed.

### 4.5.12 System Info

Press “Enter” to show the values.

#### 4.5.12.1 Model Code

“Model Code” shows model code of the meter.

#### 4.5.12.2 Serial No.

“Serial No.” shows the unique serial number assigned to the meter during manufacture.

#### 4.5.12.3 HW Version

“HW Version” shows the HW version for the meter and associated USC.

#### 4.5.12.4 SW Version

Shows the SW version for the meter and associated USC.

## 4.6 Diagnostics

“**Diagnostics**” is the next menu group under the “**MAIN MENU.**” This menu allows the user to see a display of diagnostic status of various microprocessor, memory and I/O board slots. I/O slots 1-5 are fixed and located on the Mainboard. Slots 6-13 are optional card slots. Below is a display of the standard I/O configuration, plus a Modbus RTU slave card in Slot 12. Card slot 13 is not being used and is displayed as EMPTY SLOT.

RTC	PASS	Slot 1 FIXED RELAY OUT
MATH	PASS	Slot 2 FIXED OCT OUT
STACK	PASS	Slot 3 FIXED Iout1
ADDR	PASS	Slot 4 FIXED Iout2
OSC	PASS	Slot 5 FIXED Iout3
SPI1	PASS	Slot 6 ULTRASONIC
SPI2	PASS	Slot 7 EMPTY SLOT
I2C2	PASS	Slot 8 In
FRAM	PASS	Slot 9 In
FLASH	PASS	Slot 10 PT100 4 WIRE
TEMP	PASS	Slot 11 PT100 4 WIRE
USC	PASS	Slot 12 MODBUS RTU SLAVE
TIMING	PASS	Slot 13 EMPTY SLOT
IO	PASS	Log Remaining 100.0%

The meter checks that the Ultrasonic Card (USC) that is installed and functioning. Each item is given a simple Pass/Fail indication.

## 4.7 Input/Out Menu

“Input/Output” is the next menu group under the “MAIN MENU.” This menu is where all the inputs and outputs are setup. Selecting the “Input/Output” menu by pressing “ENTER” lets you scroll through a list of available I/O slots. The standard configuration is:

- Slot 1 Fixed Relay Out
- Slot 2 Fixed OCT Out
- Slot 3 Fixed Iout1
- Slot 4 Fixed Iout2
- Slot 5 Fixed Iout2
- Slot 6 ULTRASONIC
- Slot 7 EMPTY SLOT
- Slot 8 | in
- Slot 9 | in
- Slot 10 PT100 4 WIRE
- Slot 11 PT100 4 WIRE

An optional Modbus RTU slave module (or BACnet module) may be fitted:

- Slot 12 MODBUS RTU SLAVE (BACnet)

Any unused slots will appear as empty:

- Slot 13 EMPTY SLOT

### 4.7.1 Configure an I/O Module

To configure an I/O module, scroll to the slot you wish to configure. Press “ENTER” to select.

Note: The Ultrasonic module has no parameters to be configured.

The first item in configuring an I/O card is “Off/On/Test.” This display allows the user to select from the following list:

- Off (Default)
- On
- Test

If a module is turned “Off” then the user is returned to the “MAIN MENU” when “ENTER” is pressed.

Select “On” to turn a module on. Pressing ENTER will prompt more settings appropriate for the module.

Select, “Test” to make the module runs a test routine appropriate for the module type. Pressing ENTER starts the test. For example, a current output module will sequence through a range of current output values. The user can attach an appropriate test device/meter to confirm the module is functioning correctly.

Pressing ENTER stops the test and the user is returned to the “MAIN MENU.”

Once the user turns a module on, it is necessary to follow a sequence that fully programs the module. The 207i will take the user through a sequence that is appropriate for each type of module. The complete sequence must be followed. For this reason the < key will only step back one step.

### 4.7.2 Slot 1 Relay Output (on main board)

From the “MAIN MENU” select Input/Output. Then “Slot 1 FIXED RELAY OUT”. This relay has a NC and a NO contact so an activated relay can be wired to the NO or NC connections.

Select either Off/On/Test:

“Off” disables the Relay

“Test” forces the relay to activate alternately to test the relay.

“On” leads you through the setup for the relay function, you want to perform. Some functions have additional menu selections. See the relay setup menu selections below:

Alarm

Alarm Source

Low Signal  
Not Ready  
System

Velocity  
Rate  
Energy

On Point (enter value for the alarm to turn on)  
Off Point (enter value for the alarm to turn off)

Pulse

Pulse Source



Net  
 Pos  
 Neg  
 Energy

Step (enter the units per pulse)  
 Duration (enter the pulse width in ms)

Frequency

Not available for a relay output

Batch

(relay activates when batch is complete)

### 4.7.3 Slot 2 Open Collector Output (on main board)

From the “MAIN MENU” select Input/Output. Select “Slot 2 FIXED OCT OUT”. This is an Open Collector output. It can operate much faster than the relay output, but cannot handle as much current.

Select either Off/On/Test:

“Off” disables the OCT

“Test” forces the OCT to activate alternately for testing

“On” leads you through the setup menu for the OCT functions you may want to perform. Some functions have additional menu selections. See the OCT setup selections below:

Alarm

Alarm Source

Low Signal  
 Not Ready  
 System

Velocity  
 Rate  
 Energy

On Point (enter value for the alarm to turn on)  
 Off Point (enter value for the alarm to turn off)

Pulse

Pulse Source

Net  
 Pos  
 Neg  
 Energy

Step (enter the units per pulse)  
 Duration (enter the pulse width in ms)

Frequency

Frequency Source

Velocity  
 Rate  
 Energy

Lower Value

Upper Value  
Damping

Batch

#### 4.7.4 Slots 3, (4 or 5) Current Output (on main board)

From the “MAIN MENU” select Input/Output. Select “Slot 3 (4 or 5) FIXED Iout 1(2 or3)”. These are 3 on board 4-20 mA. current loop outputs. They have both Active and Passive connections, both are electrically isolated.

Select either Off/On/Test:

“Off” disables the Iout

“Test” forces the. current loop output to sequence through 4, 12, and 20mA.current output values

“On” leads you through the setup menu for the Iout (current loop) functions you may want to perform. Some functions have additional menu selections. See the Iout setup menu selections below:

Iout Source

Velocity

Lower Value

Upper Value

Damping

Error

Hold (holds last value for Hold time, then drops to 4.00 mA.)

3.8mA/Off (holds last value for Hold time, then drops to 3.80 mA.)

21.0mA/On (holds last value for Hold time, then rises to 21.00 mA.)

Hold (enter time)

Rate

Lower Value

Upper Value

Damping

Error

Hold (holds last value for Hold time, then drops to 4.00 mA.)

3.8mA/Off (holds last value for Hold time, then drops to 3.80 mA.)

21.0mA/On (holds last value for Hold time, then rises to 21.00 mA.)

Hold (enter time)

Energy

Lower Value

Upper Value

Damping

Error

Hold (holds last value for Hold time, then drops to 4.00 mA.)

3.8mA/Off (holds last value for Hold time, then drops to 3.80 mA.)

21.0mA/On (holds last value for Hold time, then rises to 21.00 mA.)

Hold (enter time)

#### 4.7.5 Current Input (Optional Module)

From the “MAIN MENU” select Input/Output. Select “Slot (8 through 13) Iin”. The Iin (current input) module has

both Active and Passive connections, both are electrically isolated.

Select either Off/On/Test:

“Off” disables the Iin module

“Test” starts the Current IP test screen. It displays Reading “ADC” (analog to digital counts) and Ma. (milliamp) value.

“On” leads you through the setup menu for the Iin (current loop input) functions you may want to perform. Some functions have additional menu selections. See the Iin setup menu selections below:

#### Iin Source

Inlet  
 Outlet  
 Comp.  
 Inlet+Comp.  
 Outlet+Comp.  
 Pressure  
 Density  
 AI1 batch  
 AI2 batch

Iin Units (appropriate units will be listed)

degC

degF

K

R

Psi G

Psi A

Bar G

Bar A

g/cc

kg/l

Lbs/ft<sup>3</sup>

Kg/m<sup>3</sup>

Span

0..20mA

4..20mA

Lower Value

Upper value

#### 4.7.6 PT100 Input

From the “MAIN MENU” select Input/Output. Select “Slot (8 through 13) PT100 4 WIRE. You can use any common PT100 4 wire RTD. The inputs are electrically isolated.

Select either Off/On/Test:

“Off” disables the PT100 module

“Test” starts the PT100 Test screen. It displays temperature of the RTD in either °F or °C.

“On” leads you through the setup menu for the PT00 module (RTD input) functions you may want to perform. Some functions have additional menu selections. See the PT100 4 WIRE setup menu selections below:

#### PT100 Source

Inlet

Outlet

Comp.  
Inlet+Comp.  
Outlet+Comp.

PT100 Dynamic  
Dynamic  
Offset  
Fixed  
Value

#### 4.7.7 Modbus RTU

From the “MAIN MENU” select Input/Output. Select “Slot (8 through 13) MODBUS RTU SLAVE”. Setup the Modbus address, Baud, and Parity. The RS-485 connection is electrically isolated.

Select either Off/On/Test:

“Off” disables the MODBUS RTU SLAVE module

“Test” starts a Modbus test signal of 1234.56 on register 40001. The data type is a 32 bit float, low word first.

“On” leads you through the setup menu for the PT00 module (RTD input) functions you may want to perform.

Address 1-247

Baud

9600

19200

Parity

None

Even

Odd



Note: For optional BACnet module, see separate [InnovaSonic 207i BACnet manual](#).

## 4.8 RS-232/USB

“RS-232/USB” is the next menu group under the “MAIN MENU.” This menu allows the user to change serial communication settings for the “RS-232” and USB ports.

### 4.8.1 Port

The user can select which of the two available serial ports are used for communication from the following list:

- Off (Default)
- USB
- RS-232

### 4.8.2 Baud

The user is prompted to select the communication baud rate from the following list:

- 9600
- 19200
- 38400 (Default)
- 57600

### 4.8.3 Parity

The user is prompted to select the communication parity from the following list:

- None (Default)
- Even
- Odd

### 4.8.4 Mode

The MODE settings are for factory use and should be left in the None setting.

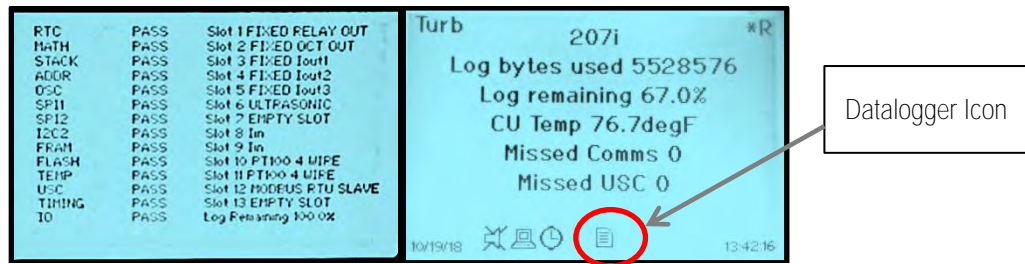
## 4.9 Datalogger

The “Datalogger” is the next section in the “MAIN MENU.” This menu allows the user to edit parameters specific to the meters internal datalogger. The InnovaSonic 207i has a 16MB internal flash datalogger memory.

As soon as the 207i is powered on, a self-diagnostic program will start. As part of this self-diagnostic, the 207i checks the function of the FRAM data memory hardware (four individual chips, successful test indicated by a (P)ass for each) and reads any logged data to check its integrity (Progress bar). If no logged data is found then no progress will show, otherwise the extent that the progress bar crosses the LCD display indicates how much memory is currently full.

A percentage figure of free logger memory remaining can be found in the “Diagnostics” display screen. This information is also shown on the advanced menu display screen for “Memory.” To display this screen, Press Diag., Enter, Enter.

The Datalogger icon (bottom center) on any display screens will blink when the remaining log memory is <5%.



### 4.9.1 Interval

The user is prompted to enter a datalogger interval. Entering a value for “Interval” starts data logging. An interval of zero turns the datalogger off. When the interval is met then all meter measurement/diagnostic values are written to the datalogger memory.

Allowed values are ranged 0 to 255s.

### 4.9.2 Erase

The user is prompted to erase the datalogger memory by selecting On/Off. By default memory is not erased

### 4.9.3 Energy Record

The user is prompted to turn logging of energy rate and totalizers On/Off. By default energy rate and totalizers are not logged.

### 4.9.4 Download

The user is prompted to download the datalogger memory over RS-232/USB by selecting On/Off. By default memory is not downloaded.

Downloading the data logger using this method is not recommended because it requires a Terminal program with its log file feature turned on and ready to go. This would download the entire data logger file which could take hours. We recommend using the Data Logger App in SIP instead, to download the Data Logger.

## 4.10 Batching

“Batching,” is the next menu group under the “MAIN MENU.” The “Batching” function allows the user start and stop a totalizing process. For example, a PLC could send a 4-20mA signal to the 207i to start counting the batch at the same time it starts a pump. Once the target amount has been reached, the Relay on the 207i could signal the PLC to stop the pump.

### 4.10.1 Flow Batch CTRL

The user can select how the batch process is started from the following list:

- Key Input (Default)
- AI1 > 12 mA
- AI1 < 12mA
- AI2 > 12 mA
- AI2 < 12 mA

If Key Input is select the batch process will be started by pressing the ENTER key.

If AI1 or AI2 is selected then the totalizer starts on a signal to the Current Input module. The Current Input module must be set to Batch in the Input/Output menu section.

You can choose whether the batch trigger will be greater than 12 mA or less than 12 mA. For example if AI1 > 12MA was selected, the batch process will start when AI1 is above 12 mA.

### 4.10.2 Flow Batch Target

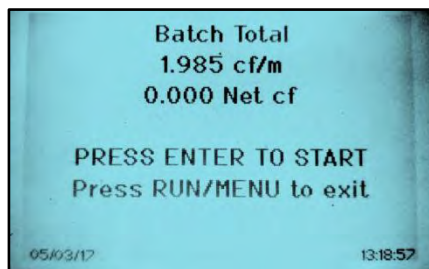
The user is prompted to enter a target value for the batch controller. The value is in the user selected totalizer units, see above.

When the batch totalizer reaches this target then a relay or open collector output can be activated, select “BATCH” in the Relay or OCT in the “Input/Output” menus.

Allowed values are ranged 1.0 to 100000.0, default 1.0.

### 4.10.3 Flow Batch Controller

The user starts the batch process by selecting this menu function and following the instructions on the LCD.

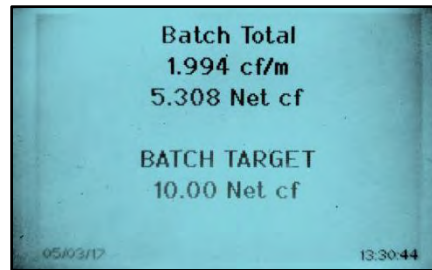


The display will show flow rate and batch total so far.

Example 1: The Key Input “PRESS ENTER TO START” is shown above, press the ENTER key to start the batch process.

Example 2: If AI1 > 12 MA was chosen, “WAITING FOR AI>12mA” will be displayed.

To abort the batch you can press the RUN/MENU key to stop the batch and Exit. While a batch is running you'll see the following screen.



The displayed batch total will accumulate to the target value and when it is reached the end of batch operation will cause the relay or open collector outputs to deactivate if selected.

The 207i will remain in the first Batch Total screen so multiple batches can be ran in an automated process. To quite this screen the "RUN/MENU" button must be pressed.

## 4.11 Manual Totalizer Menu

The "Manual Totalizer" is the next menu group under the "MAIN MENU." This is a simple user input totalizer. Press "ENTER" to open the manual totalizer screen. Press "ENTER" again to start the totalizer then press "MENU" to stop.

## 4.12 Load/Save Setup Menu



"Load/Save" setup is the next menu group under the "MAIN MENU." This allows the user to save or recall a mirror image of the application setup parameters. This menu allows the user to save, load and delete up to 10-meter configurations for different applications.



### 4.12.1 Save Option


Select "Save" from the list and press "ENTER."

A list of 10 available configuration spaces is displayed by name. Empty spaces are shown as \*BLANK\*.

Example:

Use  and  to scroll through the list of names.


Use  to select a configuration space to write to or  to quit.

The user is prompted to enter a unique "Tag" and then "Identifier," press .





A complete mirror image copy of all meter parameters is saved to memory.

#### 4.12.2 Load Option

Select **Load** and press .


A list of 10 available configuration spaces is displayed by name. Empty spaces are shown as \*BLANK\*.

Use  and  to scroll through the list.


Use  to select a configuration space to load or  to quit.



All meter parameters are over written with the stored configuration read from memory.

#### 4.12.3 Delete Option

Select **Delete** and press .

A list of 10 available configuration spaces is displayed by name. Empty spaces are already shown as \*BLANK\*.

Use  and  to scroll through the list.

Use  to select a configuration space to delete or  to quit.

The configuration is deleted and the displayed configuration name (Tag) is changed to \*BLANK\*.

# 5 Measurement Site Selection

When selecting a measurement site, it is important to select an area where the fluid flow profile is fully developed to guarantee a highly accurate measurement. Use the following guidelines to select a proper installation site:

1. Choose a section of pipe that is always full of liquid, such as a vertical pipe with flow in the upward direction or a full horizontal pipe.
2. Ensure enough straight pipe length at least equal to the figure shown below for the upstream and downstream transducers installation.

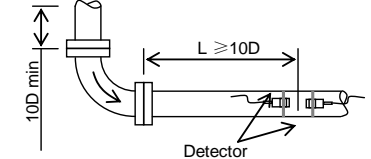
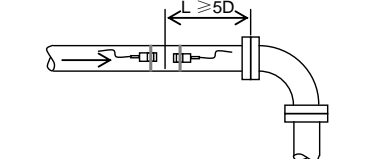
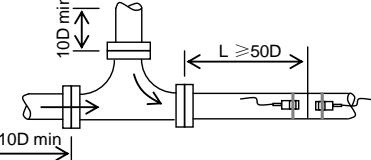
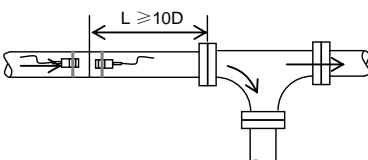
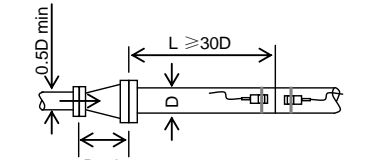
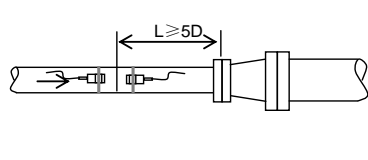
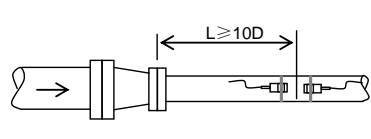
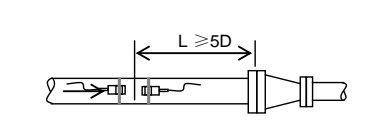
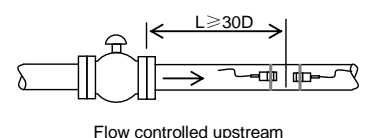
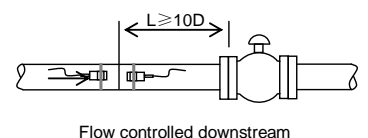
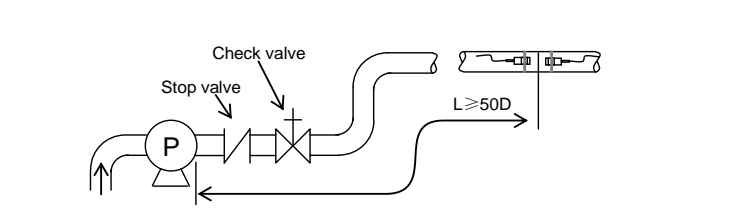
Name	Straight length of upstream piping	Straight length of downstream piping
90° bend		
Tee		
Diffuser		
Reduce		
Valve		
Pump		

Figure 14. Measurement Site Selection

3. Ensure that the pipe surface temperature at the measuring point is within the transducer temperature limits.
4. Consider the inside condition of the pipe carefully. If possible, select a section of pipe where the inside is free of excessive corrosion or scaling.

## 6 Transducer Installation

### 6.1 Installing the Transducers

Before installing the transducers, clean the pipe surface where the transducers are to be mounted. Remove any rust, scale or loose paint and make a smooth surface. Choose a section of sound conducting pipe for installing the transducers. Apply a wide band of sonic coupling compound down the center of the face of each transducer as well as on the pipe surface, and then attach the transducers to the pipe with the straps provided. Typically, it's best to tighten just one clamp completely, and leave the other a little loose so the spacing can be adjusted and tighten them securely.




Note: The two transducers must be mounted at the pipe's centerline on horizontal pipes. Make sure that the transducer mounting direction is parallel with the flow.

During the installation, there should be no air bubbles or particles between the transducer and the pipe wall. On horizontal pipes, the transducers should be mounted in the 3 o'clock and 9 o'clock positions of the pipe section in order to avoid any air bubbles inside the top portion of the pipe (Refer to Transducer Mounting). If the transducers cannot be mounted horizontally symmetrically due to limitation of the local installation conditions, it may be necessary to mount the transducers at a location where there is a guaranteed full pipe condition (the pipe is always full of liquid).

#### 6.1.1 Transducer Spacing

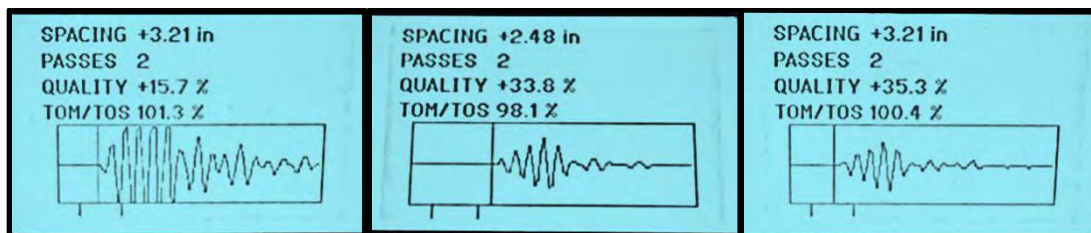
After entering the required pipe and fluid parameters, the spacing is measured between the faces of the two transducers.



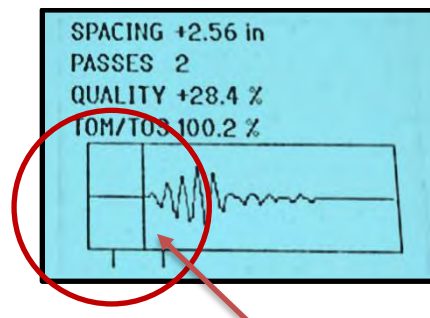
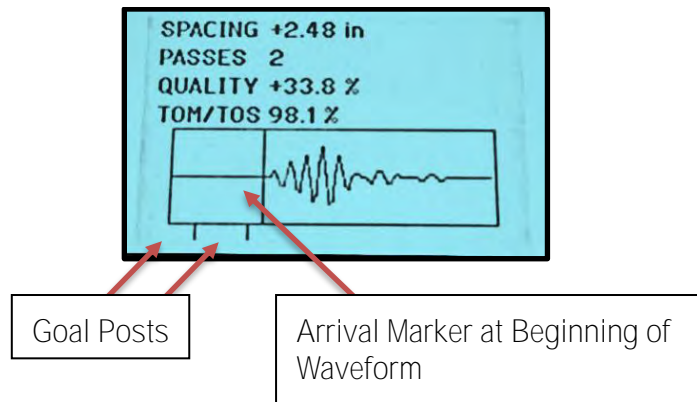
Use the  quick-key to see the suggested spacing, number of passes, signal quality, TOM/TOS, and received signal scope trace. If the transducers are not mounted incorrectly, you'll see random noise as in the screen below.



Once the transducers are close to the proper mounting, you'll see an over ranged wave form. As the 207i adjusts the gain, you see the waveform shrink into view. Once the received waveform and Arrival Marker line appear, move the loose transducer closer or further away to line up with the "goal post" marks at the bottom on the graph as show.



The line identifying beginning of the waveform should be between the two goal post lines at the bottom of the graph.



Transducers are at correct spacing; Beginning of waveform is between the goal posts.



Note: Because of pipe dimension tolerances, pipe sound velocities, exact fluid sound velocities, etc. Expect the suggested spacing to be slightly different than the actual optimum spacing.

### 6.1.2 Transducer Mounting Methods

Four transducer mounting methods are available. They are respectively: **Z Method** (1 pass) **V Method** (2 passes), **N Method** (3 passes) and **W Method** (4 passes). The **V Method** is primarily used on smaller diameter pipes (DN100-400mm, 4 inches to 16 inches). The **Z Method** is used in applications where the **V Method** cannot work due to poor signal or no signal detected. In addition, the **Z Method** generally works better on larger diameter pipes (over DN300mm, 12 inches) or cast iron pipes. The **N & W Methods** are uncommonly used methods. It is used on smaller diameter pipes (below DN50mm, 2 inches).

### 6.1.3 V Method

The **V Method** is considered as the standard method. It usually gives a more accurate reading and is used on pipe diameters ranging from 25mm to 400mm (1 inch to 16 inches) approximately. Also, it is convenient to use, but still requires proper installation of the transducer, contact on the pipe at the pipe's centerline and equal spacing on either side of the centerline.

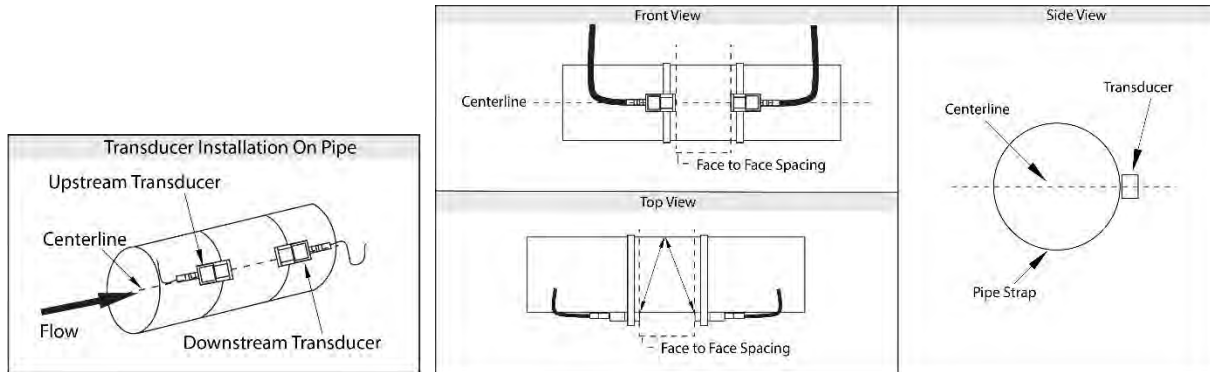


Figure 15. V Method Transducer Mounting

### 6.1.4 Z Method

The signal transmitted in a **Z Method** installation has less attenuation than a signal transmitted with the **V Method**. This is because the **Z Method** utilizes a directly transmitted (rather than reflected) signal which transverses the liquid only once. The **Z Method** is able to measure on pipe diameters ranging from approximately 100mm to 3000mm (4 inches to 120 inches). We recommend the **Z Method** for pipe diameters over 300mm (12 inches).

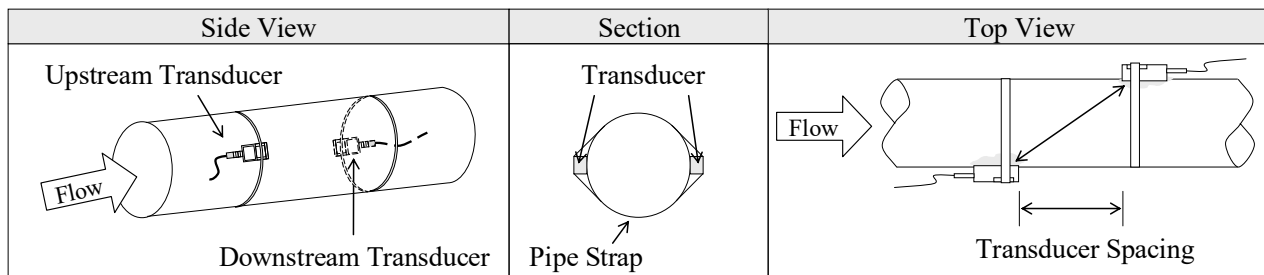


Figure 16. Z Method Transducer Mounting

### 6.1.5 N Method (Not Commonly Used)

With the **N Method**, the sound waves traverse the fluid three times and bounce twice times off the pipe walls. It is suitable for small pipe diameter measurement. The measurement accuracy can be improved by extending the transit distance with the **N Method** (uncommonly used).

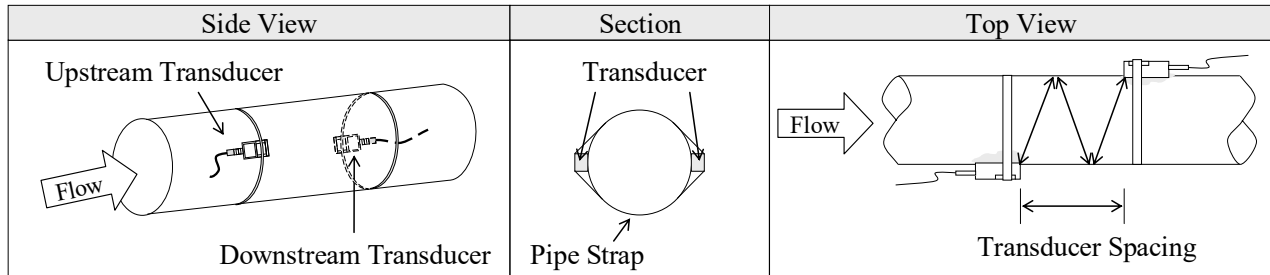


Figure 17. N Method Transducer Mounting

### 6.1.6 W Method (Very Seldom Used)

With the **W Method**, the sound waves traverse the fluid four times and bounce three times off the pipe walls. It is suitable for very clean small pipes. The measurement accuracy can be improved by extending the transit distance with the **W Method** (uncommonly used). Because this method requires four passes, the signal needs a very clean small pipe to work. After four passes the signal can be very small.

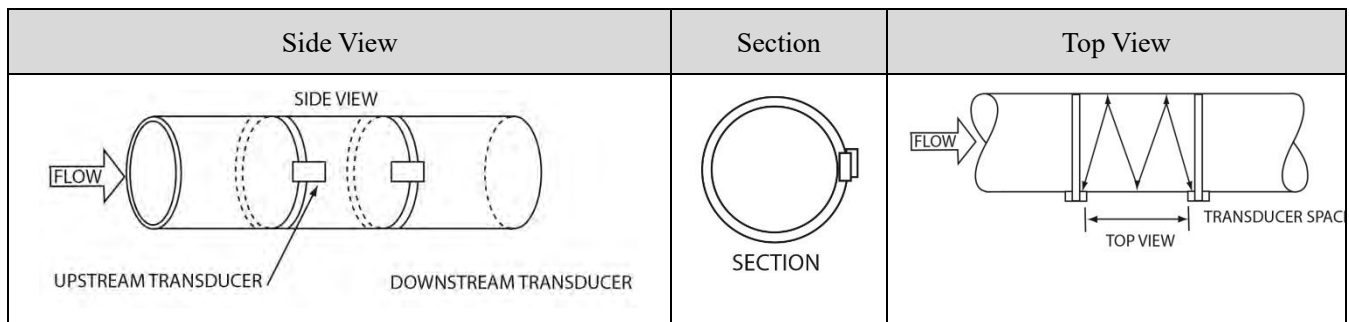


Figure 18. W Method Transducer Mounting


## 6.2 Transducer Mounting Inspection

Check to see if the transducer is installed properly and if there is an accurate and strong enough ultrasonic signal to ensure proper operation. The **tducer space** quick key shows the waveform and related setup values of the transducers. It can be confirmed by checking the detected signal strength, total transit time, delta time as well as transit time ratio.

The “mounting” condition directly influences the flow value accuracy and system long-term running reliability. In most instances, only apply a wide bead of sonic coupling compound lengthwise on the face of the transducer and stick it to the outside pipe wall to get good measurement results. However, the following inspections still need to be carried out to ensure the high reliability of the measurement and long-term operation of the instrument.

## 6.2.1 Testing the Signals



The  dual function key displays five useful signal parameters.



### Standard readings are:

Signal should be > 10 dB

Quality should be > 12.0%

Noise should be < 10 dB

TOM/TOM 100 ±5

- “Signal Strength” is the (amplitude) strength of the received signal. The relevant signal strength should measure > 10 dB. Typical signal strength should measure 20 to 60 dB.
- “Signal Quality” indicates the level of the signal quality, or signal to noise ratio. Without a clean received signal, the meter cannot lock onto the received signal.
- “Noise” is the noise or distortion level of the received signal. This is used to determine the quality. The lower the better. It should be less than +10dB. Typical value is around -8 dB.
- “TOM/TOS” indicates transducer mounting spacing accuracy. The normal transit time ratio should be between 95 to 105 if the installation is correct.

“Gain” is the automatic gain chosen by the 207i to obtain the best signal for the transit-time correlation which determines flow rate.

Poor signals may be due to incorrect spacing, transducer not mounted parallel to pipe center, the pipe is too large for mounting method, or not enough coupling compound.

Adjust the transducer to the best position and check to ensure that enough sonic coupling compound is applied adequately during installation in order to obtain the maximum signal strength.

Normal operation requires signal strength over 20 dB. If the signal strength detected is too low, the transducer installation position and the transducer mounting spacing should be re-adjusted and the pipe should be re-inspected. If necessary, change the mounting to the Z Method, or less passes.



Attention: If the transit time ratio is over  $100\pm 5$ , it is necessary to re-check:



- (1) If the parameters (pipe outside diameter, wall thickness, pipe material, liner, etc.) have been entered correctly.
- (2) If the transducer mounting spacing is accordance with the transducer space display.
- (3) **If the transducer is mounted at the pipe's centerline.**
- (4) If the scale is too thick or the pipe mounting is distorted in shape, etc.

#### Warnings



- (1) Pipe parameters entered must be accurate; otherwise the flow meter will not work properly.
- (2) During the installation, apply enough coupling compounds in order to stick the transducer onto the pipe wall. While checking the signal strength and quality value, move the transducer slowly around the mounting site until the strongest signal and maximum quality value can be obtained. Note that the larger the pipe diameter, the more the transducer may need to be moved.
- (3) Check to be sure the suggested mounting spacing, and number of passes is in accordance with the display on xducer space RUN screen. The transducers need to be **mounted at the pipe's centerline.**
- (4) Pay special attention to those pipes that are formed by steel rolls (pipe with seams), since such pipe can be irregular. If the proper signal strength, quality, and TOM/TOS cannot be achieved you may need to move the transducers to a better section of pipe. Make sure there is indeed fluid in the pipe. You would be surprised how often this happens. Make sure transducers are not very close to a valve or elbow, and there are not too many air bubbles in the fluid. These conditions may cause loss of signal or quality.

## 7 Thermal Energy/BTU Measurement



Watch the How to Install & Operate video at [sierrainstruments.com/207i-how-to](http://sierrainstruments.com/207i-how-to)

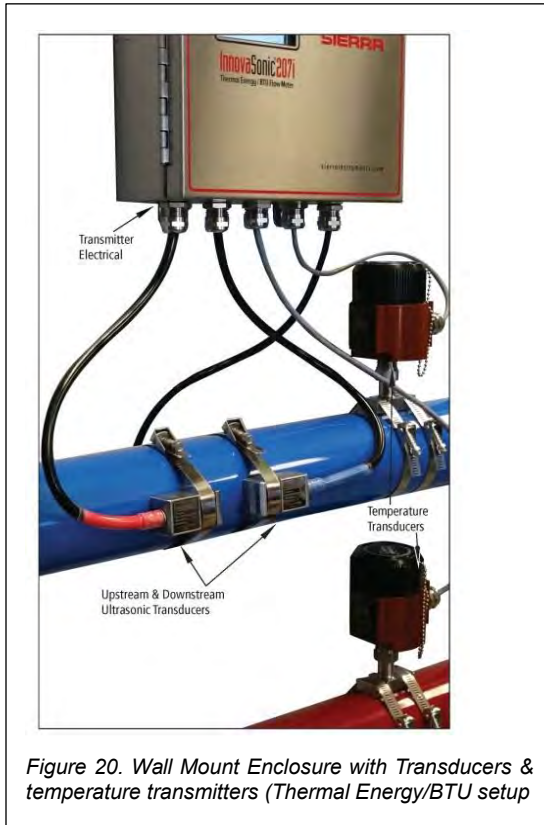
Before proceeding with energy measurement, you should have already established a good liquid flow signal and liquid flow readings. In order to measure energy flow (heat transfer) from a flowing liquid, you need to know the flow rate of the liquid, the inlet temperature of the liquid, the outlet temperature of the liquid, and how much heat energy the liquid can transfer. The 207i can measure the instantaneous energy flow rate and total amount of energy transferred.

The 207i has three methods to calculate the energy activated in the **MAIN/Installation/Calibration Setting/Energy Calc. Method** menu:


**SHC:** SHC or Specific Heat Capacity uses the value in J/g.K of the liquid and requires an inlet and outlet temperature of the liquid. The dynamic temperature of the liquid can be inputted from the PT100 RTD boards or the “I IN” current input boards. The user may input a custom SHC value in the MAIN/Installation/Calibration Setting/Specific Heat Capacity menu.


**Enthalpy:** Uses a fixed enthalpy value for water only. It requires the inlet and outlet temperature of the liquid. The dynamic temperature of the liquid can be inputted from the PT100 RTD boards or the “I IN” current input boards. You may also input a fixed pressure value or a dynamically using a “I IN” input and a pressure transducer.

**Enthalpy Direct:** Allows the customer to enter a fixed enthalpy value based on the liquids enthalpy in kJ/kg at the inlet and outlet temperatures. This method can only be used if the inlet and outlet temperatures are always the same and the liquid flow is the only changing variable. No dynamic temperature inputs or pressures are used. The fixed enthalpy values are entered in the **MAIN/Installation/Calibration Setting/ Inlet Enthalpy** menu.



## 8 Error Diagnosis

The 207i ultrasonic flow meter has advanced self-diagnostics. Some signal problem errors are displayed in the upper right corner of the **LCD**. \*R=good signals, \*K=no signals, \*U=USC error, and \*H=low signals. Hardware error diagnostics are performed upon each power on and would be indicated as F=Failed memory or – indicates a missing slot module. If an unrecoverable error causes the CPU to lock up, the  icon will be displayed at the bottom of the LCD. Recycling the power may reset this error.

If the Main Circuit board gets too hot, the  icon will flash.

At any time, the **Diagnostics** menu under the **MAIN MENU** can be displayed to check all the hardware.

### 8.1 Frequently Asked Questions and Answers

**Question:** New pipe, high quality material, and all installation requirements met: Why is there still no signal detected?

**Answer:** Check pipe parameter settings, installation method and wiring connections. Confirm if the coupling compound is applied adequately, the pipe is full of liquid, transducer spacing agrees with the screen readings, and the transducers are installed in the right direction.

**Question:** Old pipe with heavy scale inside, no signal or poor signal detected: How can it be resolved?

**Answer:** Check if the pipe is full of fluid. Try the **Z Method** for transducer installation or it is necessary to install the transducers on a vertical or inclined pipe with flow upwards instead of on a horizontal pipe.

Carefully select a good pipe section and fully clean it, apply a wide band of coupling compound on each transducer face (bottom), and install the transducers properly.

Slowly and slightly move each transducer with respect to each other around the installation point until the maximum signal is detected. Be careful that the new installation location is free of scale inside the pipe and that the pipe is concentric (not distorted) so that the sound waves do not bounce outside of the proposed area.

For pipe with thick scale inside or outside, try to clean the scale off if it is accessible from the inside. Note: Sometimes this method might not work, and sound wave transmission is not possible because of a layer of scale between the transducers and pipe inside wall.

**Question:** Why is there no I Out (current loop) output?

**Answer:** Check if the desired current output mode is set the Input/Output menu. Are you wired to the Active or Passive I Out terminals? Passive requires an external power source.

**Question:** Why is the I Out output abnormal?

**Answer:** Check to see if the desired current output mode is set in the **Input/Output** menu.

Check to see if the 4-20 mA current values are set properly the Input/Output menu. You can test the 4-20mA output by using the Test selection in the Input/Output menu.

**Question:** Why is the flow rate still displayed as zero while there is fluid obviously inside the pipe and a symbol of “R” displayed on the screen?

**Answer:** Check to see if “Set Zero” was carried out with fluid flowing inside the pipe. If it is confirmed, perform “Set Zero” again with no flow or recover the factory default.

**Question:** With a poor measurement site environment in the plant and the voltage and power supplies fluctuating widely, is the instrument really able to keep running 24 hours a day repeatedly without stopping and last for several years under such conditions?

**Answer:** The InnovaSonic 207i is designed to work with high reliability under such conditions. It is provided with an intelligent signal conditioning circuit and internal correction circuitry. It will work under strong interference conditions and is able to adjust itself with strong or weak sound waves. It will work in a wide band of voltage: 100-240VAC 50-60 Hz or 9V-36VDC voltage.

## 9 Appendix A Product Specifications

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### PERFORMANCE SPECIFICATIONS

#### Fluids

All acoustically conductive liquids with <5% solids or bubbles

#### Quantities Measured

Volumetric flow  
 Totalized volumetric and mass flow  
 Heat energy  
 Totalized energy flow  
 Density  
 Speed  
 Heat capacity  
 Enthalpy  
 Ambient temperature  
 Inlet and outlet temperature via PT 100 or current inputs  
 Pressure (optional)  
 Reynold's number

#### Pipe Size

2 to 236 inches (50 to 6000 mm)

#### Accuracy

Accuracy +/- 0.5% of reading from 0.16 to 40 ft/s  
 (0.05 to 12 m/s)

#### Repeatability

+/- 0.15% of reading > 0.16 ft/s (0.05 m/s)

#### Resolution

0.01 ft/s (0.00025 m/s)

#### Response Time

150 ms measuring cycle

### OPERATING SPECIFICATIONS

#### Flow Velocity Range

Bi-directional flows: 0.16 to 40 ft/s (0.05 to 12 m/s)  
 Note: 0.08 ft/s (0.025 m/s) is the default low flow cut-off

#### Temperature

Ambient electronics: -4°F to 140°F (-20°C to 60°C)  
 Clamp-on transducer: 14°F to 176°F (-10°C to 80°C)  
 High temperature clamp-on transducer: 14°F to 302°F  
 (-10°C to 150°C)  
 Insertion transducer: -40°F to 176°F (-40°C to 80°C)  
 Note: Insertion pressure limited to 300 psig (20 barg)

#### Relative Humidity

Up to 99% RH, (non-condensing)

#### Power Supply

AC powered 100-240 VAC, 50-60 Hz, 0.5 Amps  
 or DC powered 9-36 VDC, 0.5 Amps

#### Analog Output

Analog: active or passive 4-20 mA current loop  
 Accuracy: +/- 0.1% of reading  
 Active loop  $R_{ext} < 750 \text{ Ohm}$   
 Passive loop  $V < 24 \text{ VDC}$ ,  $R_{ext} < 1 \text{ kOhm}$   
 Note: For 1 to 5 VDC output, add 250 Ohm resistor to 4 to 20 mA loop.

#### Digital Output

Pulse output: 0 to 9999 Hz, OCT (min. and max. frequency adjustable)  
 Solid state relay 250 VDC/AC max, 100 mA max, 40 Ohm max on-state resistance no/nc (SPDT)

#### Digital Communications

RS-485, RS-232 and USB proprietary Sierra Protocol, Modbus RTU, BACnet

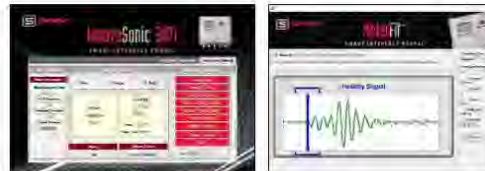
#### Inputs

Upstream and downstream ultrasonic transducers; 1 Mhz  
 Two PT 100 RTD temperature transducers (optional)  
 Two wire or four wire supported  
 Range: -4.0°F to 302°F (-20°C to 150°C)  
 Resolution: 0.018°F (0.01 °K)  
 Accuracy: +/- 0.01% of reading +/- 0.05°F (0.03°K)  
 Configurable current inputs for temperature, pressure, and density

### SOFTWARE

#### Software

Smart Interface Portal (SIP)  
 User-centered software allows for easy installation and field validation via USB or RS-232.



#### Includes Apps like:

Quick Install: Step-by-step meter commissioning and setup  
 MeterFit™: Makes transducer set up easy for a strong signal  
 EnergyPro™: Step-by-step thermal energy/BTU setup  
 ValidCal Diagnostics™: Validate firmware hardware health  
 Checks for:  
 Speed of sound (SOS)  
 Transit time, Delta T  
 Signal strength  
 Quality  
 Noise  
 TOM/TOS  
 Datalogging  
 Internal datalogging

#### Datalogging

Internal datalogging (data accessible via SIP)

**PHYSICAL SPECIFICATIONS****Transmitter Enclosure**

Wall-mounted, NEMA 4X (IP65) 316 stainless enclosure with five 3/4-inch (19 mm) conduit holes pre-drilled across the bottom

**Transducers**

Clamp-on transducers: encapsulated design IP68  
Standard cable length: 30 ft (9 m)  
Maximum cable length: 300 ft (90 m)  
Memkey for automatic detection of sensor characteristics  
Insertion transducers IP68

**Transducer Mounting Methods**

Pipe straps  
Chain  
Pipe clamps

**Keypad**

16 tactile keys with 14 dual-function keys, audible feedback

**Display**

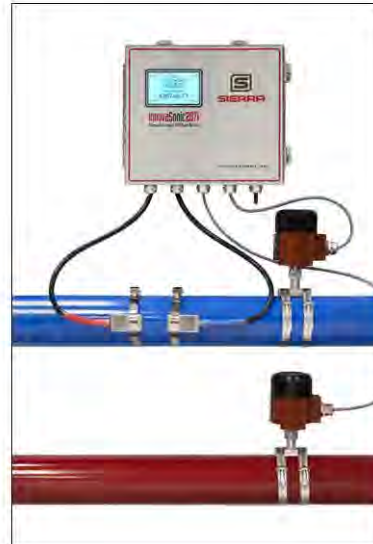
160 x 240 graphic LCD backlit display

**Weights**

Transmitter: approximately 4.7 lb (2.2 kg)  
Transducers: approximately 2 lb (0.9 kg)

207i Transmitter Wall Mount with Transducers and Clamp-On RTDs for Thermal BTU

6

**OPTIONAL RTDS: CLAMP-ON OR INSERTION**

Sierra offers clamp-on or insertion RTDs to make the precise  $\Delta T$  measurement, so thermal energy BTU can be calculated with a high degree of accuracy (See page 10 and 11 for dimensional drawings).

**PERFORMANCE SPECIFICATIONS****Accuracy**

$\pm 0.12\%$  at  $0^\circ\text{C}$   
Complete NIST-traceable calibration certificate

**OPERATING SPECIFICATIONS****Temperature**

Measurements up to  $450^\circ\text{F}$  ( $232^\circ\text{C}$ )

**Type**

PT 100 RTD; 4-Wire; 100 Ohm,  $\alpha = 0.00385$  (standard)

**Stability**

$0.2^\circ\text{C}$  ( $0.4^\circ\text{F}$ ) after 10,000 hours at max temperature (1 year, 51 days, 16 hours continuous)

**Response Time**

$< 5$  seconds  
Typical to reach a 63.2% temperature change

**Humidity**

Excellent moisture resistance for condensing environments

**Calibration**

NIST traceable test data indicating actual vs. standard temperature is supplied with each RTD

**PHYSICAL SPECIFICATIONS****RTD Rating**

NEMA 4X, IP66  
PT 100 platinum RTD 4-wire

**Electrical Connections**

6-position terminal block, 4 used

**Thermowell**

Standard-duty threaded, stepped well  
Threaded, 1/2-inch NPT  
2-inch thermowell insertion length, no lagging extension  
Sensor sheath material: stainless steel 316NUN (nipple union nipple)

**Lead Wire Materials**

Teflon insulated, hermetically sealed

**Wire Size**

24 gauge wire

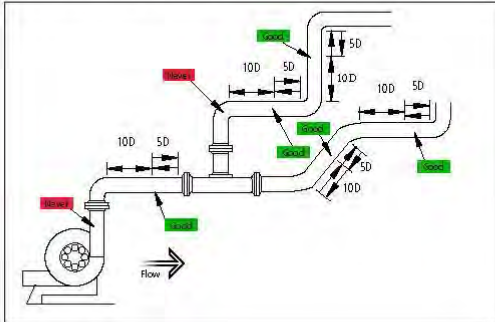
**Pull Force**

Wires will withstand at least 20 lb (90 newtons) of pull force before separating from sensor head

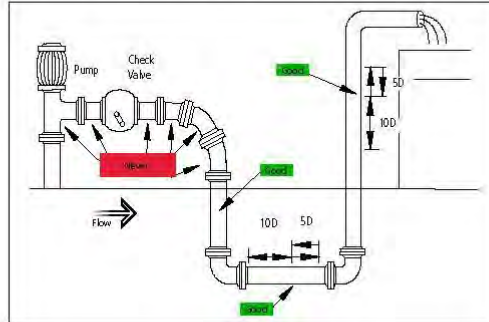
7

**207i OPTIMAL INSTALLATION LOCATIONS**

**Optimal Transducer Installation Examples**

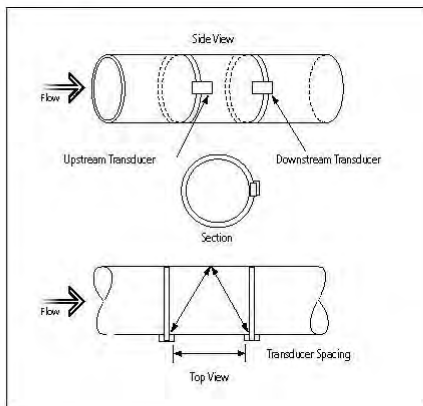


**Transducer Installation For Pump Storage Tanks**

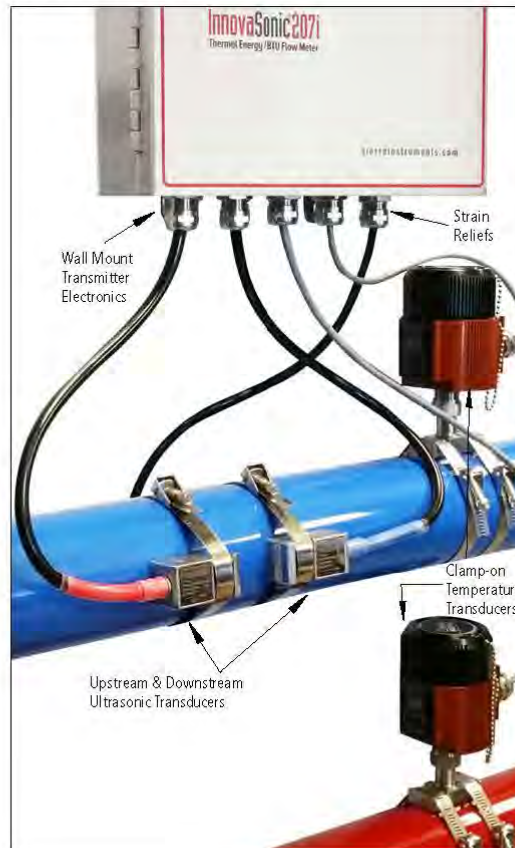


**TRANSDUCER SPACING REQUIREMENTS**

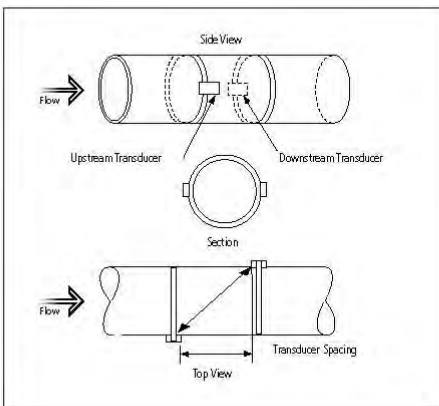
**V Mount**



**Transmitter Wall Mount with Pictured Transducers and Clamp-on RTDs (strain reliefs not included)**



**Z Mount**

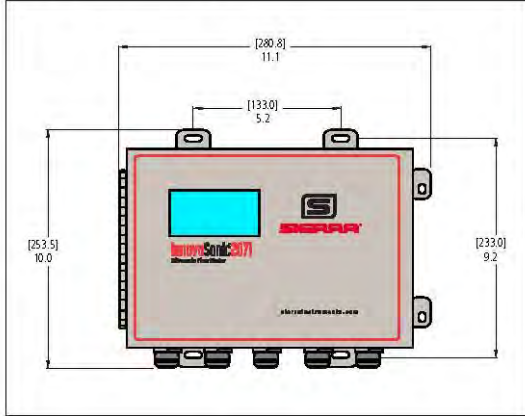




**207i TRANSMITTER DIMENSIONS**

8

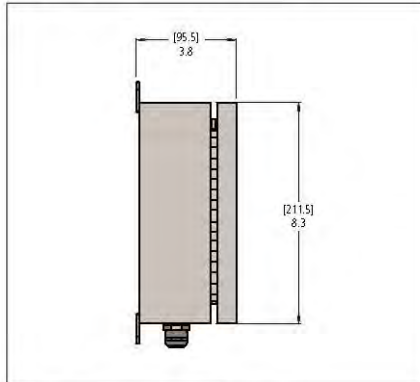
**Front View 207i Transmitter Wall Mount**



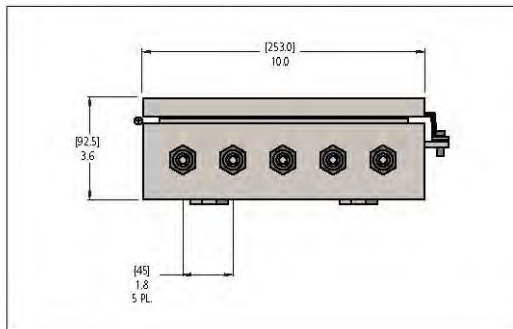
207i Transmitter Mounted With Transducers. Proudly designed, manufactured, and calibrated in the USA.



**Side View 207i Transmitter Wall Mount**



**Bottom View 207i Transmitter Wall Mount**

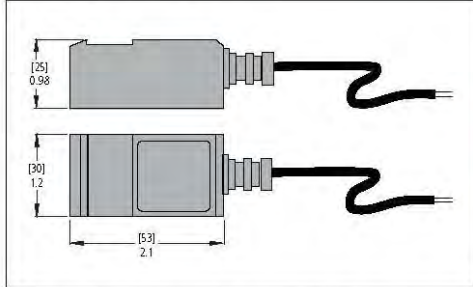


Note: All dimensions are inches (+/- .25-inch significant value). Millimeters are in parentheses. Certified drawings available on request.

9

**CLAMP-ON TRANSDUCER DIMENSIONS**

**207i Clamp-on Transducers**



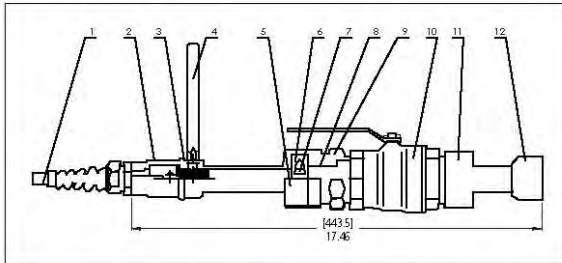
**Clamp-on Transducers**



Notes: Transducer hazardous area classification: Ex d II BT4  
 All dimensions are inches (+/- .25-inch significant value). Millimeters are in parentheses. Certified drawings available on request.

**INSERTION TRANSDUCER DIMENSIONS**

**Standard Insertion Transducer**



Parts List - Standard Insertion Transducers			
No.	Parts	No.	Parts
1	Cable	7	Locking Nut
2	End Connector	8	Locating Sleeve
3	O-Ring	9	Joint Nut
4	Alignment Handle	10	Ball Valve
5	Locking Sleeve	11	Pedestal
6	Locking Collar	12	Sensor

**Standard Insertion Transducer**



**Display For Thermal Energy / BTU Readout**

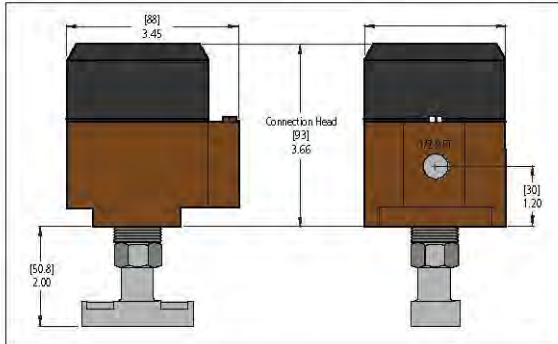


Note: All dimensions are inches (+/- .25-inch significant value). Millimeters are in parentheses. Certified drawings available on request.

CLAMP-ON RTD DIMENSIONS

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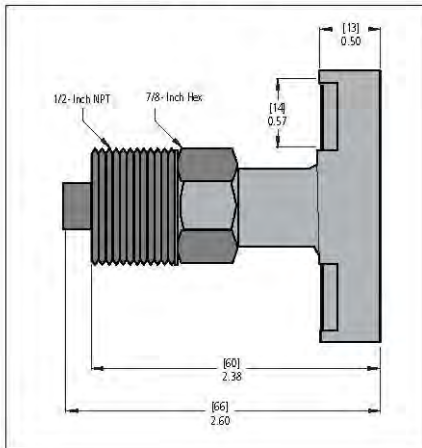
Front View Clamp-on PT 100 RTD



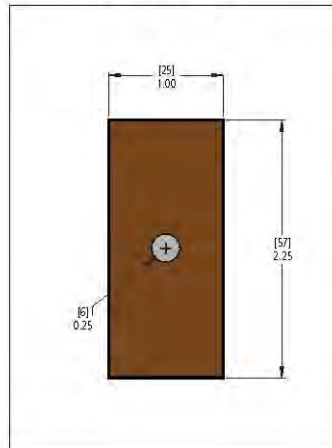
Clamp-on PT 100 RTD



Side View Clamp-on PT 100 RTD



Bottom View Clamp-on PT 100 RTD

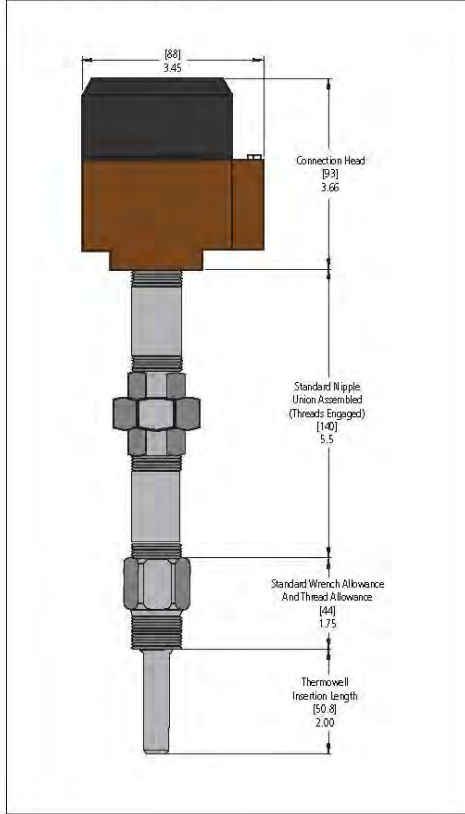


Note: All dimensions are inches (+/- .25-inch significant value). Millimeters are in parentheses. Certified drawings available on request

11

RTDI INSERTION DIMENSIONS

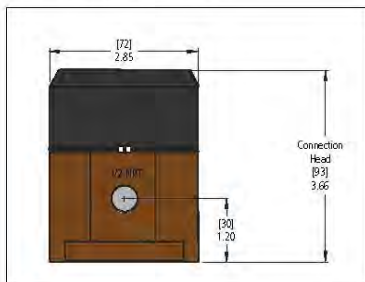
Front View Insertion PT 100 RTD



Insertion PT 100 RTD



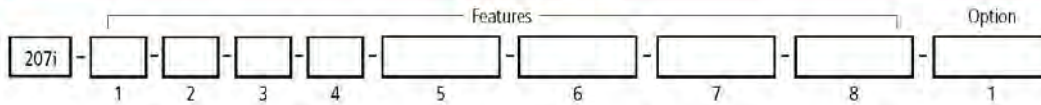
Top View Insertion PT 100 RTD



Note: All dimensions are inches (+/- .25-inch significant value). Millimeters are in parentheses. Certified drawings available on request.

ORDERING THE 207i

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Instructions: To order the 207i, please fill in each number block by selecting the codes from the corresponding features below.

Parent Number	
<b>207i</b>	InnovaSonic® Liquid Flow Meter with Thermal Energy/BTU Capability

Feature 1: Power	
<b>P2</b>	DC powered 9-36VDC at 0.5 Amps
<b>P3</b>	AC powered 100-240 VAC, 50-60 Hz, 0.5 Amps

Feature 7: Transducer Pin	
<b>S</b>	Clamp-on transducer, operating temperature: 14°F to 176°F (-10°C to 80°C) IP 68; transducer hazard area classification Ex d II BT4
<b>H</b>	High temperature clamp-on transducer, operating temperature: 14°F to 302°F (-10°C to 150°C), IP 68; transducer hazard area classification Ex d II BT4
<b>W</b>	Insertion transducer, operating temperature: -40°F to 176°F (-40°C to 80°C), 1.5 inch (38.1 mm) D/A insertion transducer, IP 68 transducers, suitable for pipes 2 to 236 inches (50 to 6000 mm); Note: Insertion pressure limited to 300 psig (20 barg). Insertion transducers include ball valves 1.5-inch (38.1 mm); carbon steel installation seat for ball valve (brass), mounting kit (includes four screws and four plastic bushings) and seal kits (consult factory for other materials).

Feature 3: Transducer Cable	
<b>30</b>	30 ft. (9 m) standard cable length included with S,W,H.
<b>X (in feet)</b>	Special length up to 300 ft. (90 m).

Feature 4: NIST FLOW CAL.	
<b>NIST</b>	<b>NIST traceable flow calibration is standard.</b> See Option 1 below for RTD matching.

Note: 207i has six (6) expansion slots. These slots may be used as required for features below.

Feature 5: PT100 Inputs	
<b>PT100 ( )</b>	Accepts input from PT100 RTD; specify quantity (typically 2) in parenthesis. RTD's themselves may be purchased from Sierra (see accessories below) or are provided by the customer. Up to <b>three</b> PT 100 input modules may be used (for instance, inlet temperature, outlet temperature and compensation temperature).

Feature 6: 4-20mA Inputs	
<b>AI ( )</b>	Accepts analog current inputs from any 4-20 mA transmitter. Specify quantity in parenthesis. This is typically two temperature transmitters but pressure, density or relay inputs for batching may also be configured. Up to <b>three</b> input modules may be used. Note: transmitters are typically supplied by the customer.

Feature 8: Digital Communications	
<b>Modbus</b>	Modbus RS-485 output; outputs Modbus RTU protocol
<b>BACnet</b>	BACnet

Feature 8: Strain Relief	
<b>STRAIN ( )</b>	The 207i enclosure has a row of five ports for wiring to enter/exit the enclosure. These holes may be typically assigned to the two ultrasonic transducers, the two RTD inputs, and power. 1/2-inch NPT strain reliefs for wiring/cable are available and recommended if 1/2-inch conduit is not being used. Specify the strain relief quantity in parentheses.

Accessories (RTDs)	
<b>RTDC ( )-X</b> <b>X= 30 ft.</b> <b>(9 m) unless otherwise specified</b>	Clamp on PT 100 RTD, 4-wire, NEMA 4x enclosure. Maximum operating temperature: 450°F (232°C). Two are typically used for inlet/outlet temperature. Maximum of three. Requires same number of PT100, Feature 5 input modules. Cable length X equals 30 ft. (9 m) standard cable length, otherwise replace X with desired length. Accuracy +/- 5% full scale.
<b>RTDI ( )-X</b> <b>X= 30 ft.</b> <b>(9 m) unless otherwise specified</b>	Insertion PT 100 RTD, 4-wire, NEMA 4x enclosure. Maximum operating temperature: 450°F (232°C). Two are typically used for inlet/outlet temperature. Requires same number of PT100 Feature 5 input modules. Cable length X equals 30 ft. (9 m) standard cable length, otherwise replace X with desired length. Accuracy +/- 5% full scale.

Option 1	
<b>MATCHED RTD</b>	RTD's are matched to each other and then to the electronics and calibrated as a matched system. Available with Feature 5 PT100 with accessories RTDC and RTDI ONLY. Accuracy +/- 1% full scale.

Accessories (Mounting)	
<b>205-2011</b>	Coupling compound (2 x 113.5g tubes) Sil-glyde®
<b>205-2010</b>	Pipe straps 43 inches (1092 mm)

## 10 Appendix B - Flow Application Data

### 10.1 Sound Velocity and Viscosity for Fluids Commonly Used

Fluid	Sound Velocity (m/s)	Viscosity
Water 20°C (68°F)	1482	1.0
Water 50°C (122°F)	1543	0.55
Water 75°C (167°F)	1554	0.39
Water 100°C (212°F)	1543	0.29
Water 125°C (257°F)	1511	0.25
Water 150°C (302°F)	1466	0.21
Water 175°C (347°F)	1401	0.18
Water 200°C (392°F)	1333	0.15
Water 225°C (437°F)	1249	0.14
Water 250°C (482°F)	1156	0.12
Acetone	1190	
Carbine	1121	
Ethanol	1168	
Alcohol	1440	1.5
Glycol	1620	
Glycerin	1923	1180
Gasoline	1250	0.80
Benzene	1330	
Toluene	1170	0.69
Kerosene	1420	2.3

Petroleum	1290	
Retinal	1280	
Aviation kerosene	1298	
Peanut oil	1472	
Castor oil	1502	

## 10.2 Sound Velocity for Various Pipe Materials

<b>Pipe Material</b>	<b>Sound Velocity (m/s)</b>
Steel	3206
ABS	2286
Aluminum	3048
Brass	2270
Cast iron	2460
Bronze	2270
Fiber glass-epoxy	3430
Glass	3276
Polyethylene	1950
PVC	2540
Titanium	3150
Cement	4190
Bitumen	2540
Porcelain enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
PTFE	1450
Rubber	1600

# 11 Appendix C | Modbus RTU Slave Module

## 11.1 Overview

The flow meter has an optional Modbus RTU slave module. This module may be installed at the time of purchase or added later. Modbus RTU uses the standard half-duplex (2 wire) RS-485 multi-drop network. RS-485 can be used to communicate at distances up to 1,200 meters, baud rate dependent with several 207i slaves on one wire pair. This could be up to 32 devices, (207i meters) on one RS-485 segment, and 247 on a whole RS-485 network.

When using digital commutations, the analog current loop and OCT output of flow meter can be free to be used to control the opening of a control valve. The relay output can be used to power-on/off other equipment. The analog input of the system can be used to input signals such as pressure and temperature. These analog values can be read using the Modbus RTU protocol to be used by customer software.

When the 207i flow meter is used in a network environment, various operations can be performed at the host device. Programming of the address ID code, baud rate, and parity is done at the flow meter keyboard or via the 207i Smart Interface Portal (SIP). A command/answer mode is used in data transmission, i.e. the host device issues commands and the flow meter answers correspondingly.

## 11.2 RS-485 2-wire (half-duplex) Network

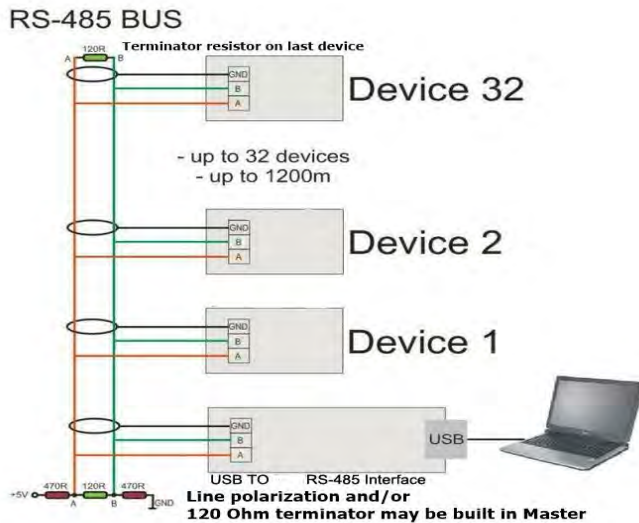
### 11.2.1 General 2-Wire RS-485 Network Topology

Modbus-RTU uses a common 2-wire RS-485 network for its physical layer. RS-485 is simple and robust. For short wire runs and lower baud rates it is very forgiving.

RS-485 only specifies electrical characteristics of the Master and the Slave. It does not specify or recommend any communications protocol or Data Link layer. Unlike proprietary RS-485 based field buses; Modbus uses the same Data Link layer used by PCs. This allows you to be able to use cheap USB to RS-485 adapters as a Modbus master.

The RS-485 bus needs to be wired in a daisy chain pattern between devices. If stub wires are necessary, they cannot be more the 10 cm long.



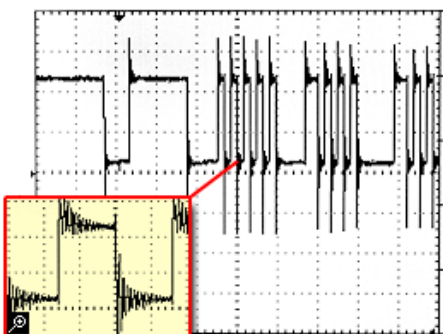


### 11.2.2 Cable

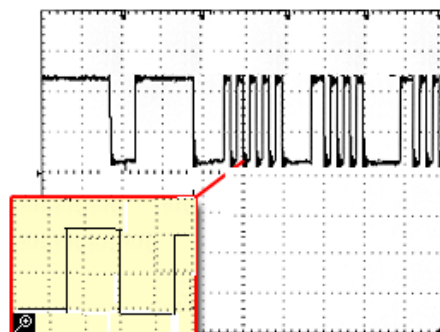
It is recommended to use shielded twisted pair type of cable (reduces radiated and received EMI). Use a 24 AWG shielded twisted pair cable, with low capacitance like Belden 9841.

### 11.2.3 Terminator

Reflections in a transmission line can cause communication errors. To minimize the reflection, it is required to place 120Ω terminator resistors at both ends of the cable. Never place a terminator resistor in the middle of the network. Some Gateways, PLC, and other types of Modbus masters have terminator resistors built-in. If so, do not add another one. Using an Oscilloscope you can see what a reflection looks like, and how it can confuse the data:



Not terminated



Properly Terminated

### 11.2.4 Line Polarization

RS-485 has 3 voltages levels, “1” , “0” , and idle. In noisy environments it may be necessary to polarize the lines to ensure that the idle stays low so all the slave devices on the network stay in the listen mode, waiting for their address to be called.

Most master devices have this already built in. In very noisy cases you may need make circuit do this. However, a commercially available isolated RS-485 repeater in the middle of your wire run will “clean up” the signals and polarize the idle voltage. This is also very useful for long wire runs. A repeater also allows you to add another 32 devices.

.

### 11.2.5 Grounding

We use a RS-485 chip that has 1,500 Volts of isolation. For electrical noise it’s best to keep the shield wire isolated from Earth ground and only connect it to terminal 16 and the signal ground at the Master.

Occasionally you may have no choice but share the Modbus network with a device that has a non-isolated RS-485 chip. Usually you can get by with this. It is best for this non-isolated device to be the first device on the network. If you have trouble, you may need to use an isolated RS-485 repeater to separate it from the rest of the network.

## 11.3 Field Installation of the Modbus or BACnet Module

### 11.3.1 Modbus Field Installation

The Modbus Module will ship with four plastic screws, one on each corner that are used to mount the Module. The electrical power connections to the 207i are made through the 4-pin connector on the right. Make sure to power down the 207i before installing any module. Plug the Modbus Module into an open slot and secure it with the four plastic screws provided. You will need to temporarily remove the LCD to access the back two screws.



Figure 21. Optional Modbus Module

Configuration of the “RS-485” address, “Baud rate,” and “Parity” is done in the “Input/Output” menu under the slot number the Modbus Module was installed.

## 11.4 Communicating with Modbus

Once the 207i is installed, wired to your network, and powered up, it is time to communicate with it. The factory default settings for the Modbus interface are the following:

- Off (disabled)
- Address 1
- Baud rate = 19200
- Parity = Even

The above Modbus settings are the factory defaults and must be changed to use the Modbus module. The changes are done in the **Input/Output** menu.

### 11.4.1 Implemented Commands

The following commands are implemented:

Function	Sub Function	Description
0x03	N/A	Read holding registers
0x04	N/A	Read input registers
0x06	N/A	Write single holding register
0x08		Diagnostics
	0x00	Return query data
	0x01	Restart communications option
	0x02	Return diagnostics Register
	0x04	Force listen only mode
	0x0A	Clear counters
	0x0D	Return bus exception error count
	0x0E	Return slave message count
	0x11	Return slave busy count

### 11.4.2 Data Format Type use for Various Registers

**32 bit real:** IEEE 754 floating point, low word first

**16 bits integer:** Unsigned integer values

**16 bits ASCII:** ASCII encoded characters, high word = 1<sup>st</sup> character (0x4944 = “ID”)

#### Byte Order

The Modbus-RTU standard uses big-endian byte order. The least significant byte is transmitted first and the most significant byte transmitted last on 32-bit real, and 32-bit integers. On Modbus Poll, this is represented as CD AB. This can be adjusted in most server software if needed. For non-standard servers, the byte order can be changed by adding \$1000 (AB CD), \$2000 (DC BA), or \$3000 (CD AB) to the PDU address or 4096, 8192, or 12288 to the register numbers.

To make the byte order and data type selection easier, register \$40001 has a fixed 32-bit float test value of 1234.56.

## 11.5 Modbus Holding Register Overview

PDU Address	Register	Description	03 Read 06 Write	Data Type	No. registers*
\$00	40001	Fixed Test Pattern 1234.56	R	32 bits real	2
\$01	40002	-			
\$02	40003	Flow Velocity	R	32 bits real	2
\$03	40004	-			
\$04	40005	Flow Rate	R	32 bits real	2
\$05	40006	-			
\$06	40007	Flow POS Total	R	32 bits real	2
\$07	40008	-			
\$08	40009	Flow NEG Total	R	32 bits real	2
\$09	40010	-			
\$0A	40011	Flow NET Total	R	32 bits real	2
\$0B	40012	-			
\$0C	40013	Energy Rate	R	32 bits real	2
\$0D	40014	-			
\$0E	40015	Energy POS Total	R	32 bits real	2
\$0F	40016	-			
\$10	40017	Energy NEG Total	R	32 bits real	2
\$11	40018	-			
\$12	40019	Energy NET Total	R	32 bits real	2
\$13	40020	-			
\$14	40021	Delta Time	R	32 bits real	2
\$15	40022	-			
\$16	40023	Time up	R	32 bits real	2
\$17	40024	-			
\$18	40025	Amplitude Up	R	32 bits real	2
\$19	40026	-			
\$1A	40027	Noise	R	32 bits real	2
\$1B	40028	-			
\$1C	40029	Gain	R	32 bits real	2
\$1D	40030	-			
\$25	40031	Quality	R	32 bits real	2
\$26	40032				
\$27	40033	Coff 1	R	32 bits real	2
\$28	40034				
\$29	40035	Coff 2	R	32 bits real	2
\$2A	40036				
\$2B	40037	Coff 3	R	32 bits real	2
\$2C	40038				
\$2D	40039	Compensation Temperature	R	32 bits real	2
\$2E	40040				
\$2F	40041	Inlet Temperature	R	32 bits real	2

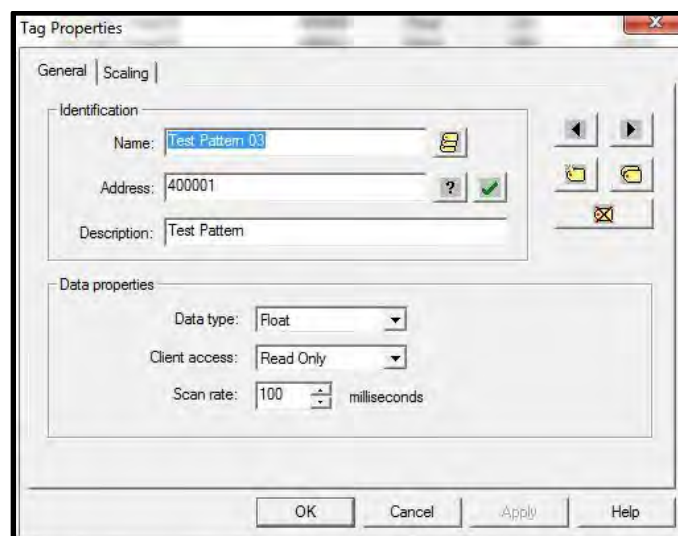
\$30	40042				
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PDU Address	Register	Description	03 Read 06 Write	Data Type	No. registers*
\$31	40043	Outlet Temperature	R	32 bits real	2
\$32	40044				
\$33	40045	Fluid Temperature	R	32 bits real	2
\$34	40046				
\$35	40047	Fluid Pressure	R	32 bits real	2
\$36	40048				
\$37	40049	Inlet Enthalpy	R	32 bits real	2
\$38	40050				
\$39	40051	Outlet Enthalpy	R	32 bits real	2
\$3A	40052				
\$3B	40053	Pipe Area	R	32 bits real	2
\$3C	40054				
\$3D	40055	Fluid Density	R	32 bits real	2
\$3E	40056				
\$3F	40057	Fluid Specific Heat	R	32 bits real	2
\$40	40058				
\$65	40101	Model Code Char 1,2	R	16 bits ASCII	13
\$66	40102	Model Code Char 3,4	R	16 bits ASCII	
\$67	40103	Model Code Char 5,6	R	16 bits ASCII	
\$68	40104	Model Code Char 7,8	R	16 bits ASCII	
\$69	40105	Model Code Char 9,10	R	16 bits ASCII	
\$6A	40106	Model Code Char 11,12	R	16 bits ASCII	
\$6B	40107	Model Code Char 13,14	R	16 bits ASCII	
\$6C	40108	Model Code Char 15,16	R	16 bits ASCII	
\$6D	40109	Model Code Char 17,18	R	16 bits ASCII	
\$6E	40110	Model Code Char 19,20	R	16 bits ASCII	
\$6F	40111	Model Code Char 21,22	R	16 bits ASCII	
\$70	40112	Model Code Char 23,24	R	16 bits ASCII	
\$71	40113	Model Code Char 25,26	R	16 bits ASCII	
\$72	40114	Serial Number Char 1,2	R	16 bits ASCII	4
\$73	40115	Serial Number Char 3,4	R	16 bits ASCII	
\$74	40116	Serial Number Char 5,6	R	16 bits ASCII	
\$75	40117	Serial Number Char 7,8	R	16 bits ASCII	
\$76	40118	Tag String Char 1,2	R	16 bits ASCII	5
\$77	40119	Tag String Char 3,4	R	16 bits ASCII	
\$78	40120	Tag String Char 5,6	R	16 bits ASCII	
\$79	40121	Tag String Char 7,8	R	16 bits ASCII	
\$7A	40122	Tag String Char 9,10	R	16 bits ASCII	
\$7B	40123	ID String Char 1,2	R	16 bits ASCII	5
\$7C	40124	ID String Char 3,4	R	16 bits ASCII	
\$7D	40125	ID String Char 5,6	R	16 bits ASCII	
\$7E	40126	ID String Char 7,8	R	16 bits ASCII	

\$7F	40127	ID String Char 9,10	R	16 bits ASCII	
\$80	40128	Flow Rate Units Char 1,2	R	16 bits ASCII	4
\$81	40129	Flow Rate Units Char 3,4	R	16 bits ASCII	
\$82	40130	Flow Rate Units Char 5,6	R	16 bits ASCII	
\$83	40131	Flow Rate Units Char 7,8	R	16 bits ASCII	
\$84	40132	Flow Total Units Char 1,2	R	16 bits ASCII	4
PDU Address	Register	Description	03 Read 06 Write	Data Type	No. registers*
\$85	40133	Flow Total Units Char 3,4	R	16 bits ASCII	
\$86	40134	Flow Total Units Char 5,6	R	16 bits ASCII	
\$87	40135	Flow Total Units Char 7,8	R	16 bits ASCII	
\$88	40136	Energy Rate Units Char 1,2	R	16 bits ASCII	4
\$89	40137	Energy Rate Units Char 3,4	R	16 bits ASCII	
\$8A	40138	Energy Rate Units Char 5,6	R	16 bits ASCII	
\$8B	40139	Energy Rate Units Char 7,8	R	16 bits ASCII	
\$8C	40140	Energy Total Units Char 1,2	R	16 bits ASCII	4
\$8D	40141	Energy Total Units Char 3,4	R	16 bits ASCII	
\$8E	40142	Energy Total Units Char 5,6	R	16 bits ASCII	
\$8F	40143	Energy Total Units Char 7,8	R	16 bits ASCII	
\$C9	40201	Error Status Flag 1	R	16 bit Integer	1
\$CA	40202	Error Status Flag 2	R	16 bit Integer	1
\$CB	40203	Totalizer Reset	R/W	16 bit Integer	1

### 11.5.1 Registers 40001 to 40058

These are all dynamic read only values from the 207i. They all use an IEEE754 data type which also is called a 32-bit Real or 32-bit Float. Register 40001/40002 is a test number of 12345.67 that can be very useful to make sure the data type and byte order are correct. The specific data at each register number is listed in the table above. Note: Many software packages add a 0 to the register number (400000). KepserversEx Tag setup example:



### 11.5.2 Registers 40101 to 40143

These are all read only strings, with two characters in each 16-bit register. Depending on your host software, you may be able to combine all the registers for a given parameter in to one line on the display. For example, registers 40114 through 40117 contain the 8-digit serial number in an ASCII string. With such host software, you would be able tell it start at 40114 read the next 8 bytes then decode them as one ASCII string. Using KepserverEx OPC server the Tag setup would look like this:



### 11.5.3 Registers 40201 and 40202

These two registers use the 16 bit un-signed data type. They can be used as a status or error flags. When the meter is running without any problems, both of these should be zero (0). The user could mask individual bits in their software if needed.

#### Error Status Flag 1 decoded by bit:

Bit	Function	Description
0 (1)	math_err	Microprocessor math error
1 (2)	stack_err	Microprocessor stack error
2 (4)	address_err	Microprocessor address error
3 (8)	osc_err	Microprocessor oscillator error
4 (16)	spi1_err	Microprocessor SPI1 bus error
5 (32)	spi2_err	Microprocessor SPI2 bus error
6 (64)	rtc_err	Internal control unit Real-time clock error
7 (128)	i2c2_err	Microprocessor I2C2 bus error
8 (256)	ext_fram_err	External FRAM memory error
9 (512)	ext_flash_err	External Flash memory error
10 (1024)	temp_err	Internal control unit thermometer error
11 (2048)	usc_err	Ultrasonic card error
12 (4096)	timing_err	Measurement timing error
13 (8192)	io_err	IO module communication error
14 (16384)	logger_full	Data Logger <5% left

15 (32768) spare15 Spare

#### **Error Status Flag 2 decoded by bit:**

Bit	Function	Description
0 (1)	signal_amplitude_err	Received ultrasonic Signal low
1 (2)	signal_quality_err	Received ultrasonic signal Quality low
2 (4)	dropped_comm_err	Ultrasonic measurement error counter
3 (8)	spare3	Spare
4 (16)	spare4	Spare
5 (32)	spare5	Spare
6 (64)	spare6	Spare
7 (128)	spare7	Spare
8 (256)	spare8	Spare
9 (512)	spare9	Spare
10 (1024)	spare10	Spare
11 (2048)	spare11	Spare
12 (4096)	spare12	Spare
13 (8192)	spare13	Spare
14 (16384)	spare14	Spare
15 (32768)	spare15	Spare

#### *11.5.4 Register 40203*

This read/write register is used to reset the totalizer to zero. It uses a 16 bit un-signed data type. It will always read back zero. To reset a totalizer, write the values below to the register:

- 0 - Do nothing.
- 1 - Reset flow totalizers.
- 2 - Reset energy totalizers.
- 3 - Reset flow and energy totalizers.

#### *11.5.5 Holding Registers Function Code \$04*

Most Modbus slave devices use Holding Registers, function code \$03 to read and function code \$06 to write to a single register. When using Modbus software this is automatically done by using holding registers in the 40000 range. Some older Modbus slave devices use "Input Registers". To read data in an Input Register use Function Code \$04. When using Modbus software this is automatically done by using registers in the 30000 range. The 207i also supports Input Registers. To do this, use the same Holding Register table numbers above in section 11.5. However, the register numbers will be in the 30000 range instead of the 40000 range.



## 12 Appendix E | W110 Insertion Transducer

### 12.1 Overview

Insertion or “wetted” transducers can be used in situations where the ultrasound cannot penetrate the wall of the pipe as with concrete pipe or pipe sizes that are just too big to get a good signal. They can be mounted in the V(2 pass) or Z (1 pass) mounting methods.

#### 12.1.1 V Mounting Method

V method is suitable for pipe diameters ranging from 6 inches (150mm) 48 inches (1200mm). It is mostly used when only one side of the pipe is available (example: the other side is against a wall) at the installation site, See below:

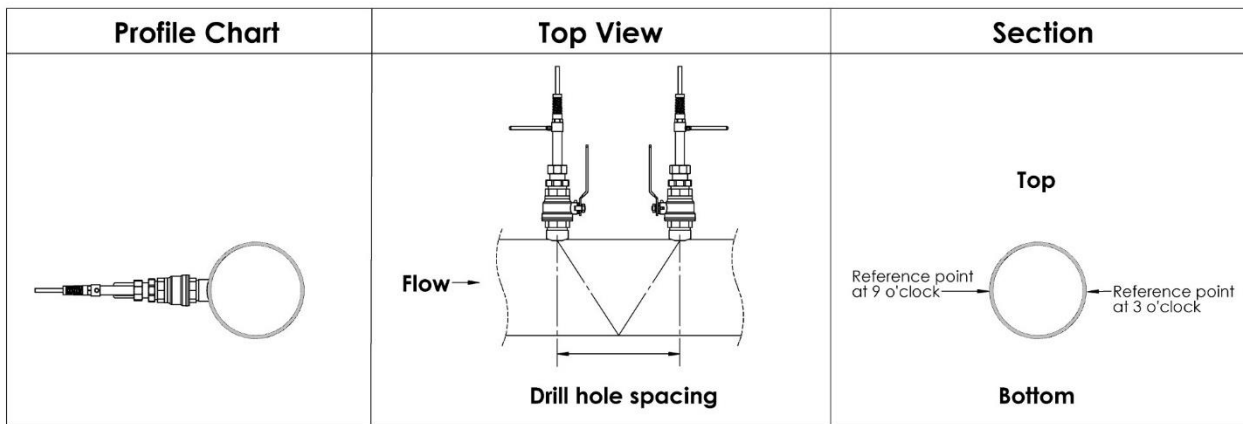


Figure 1

#### 12.1.2 Z Mounting Method

Z method is the most commonly used mounting method for insertion-type ultrasonic flowmeter transducers. It is suitable for pipe diameters ranging from 2 inch (50 mm) to 200 inch (5000 mm). Due to strong signal strength and high measurement accuracy, the Z method is preferable for pipe sections severely rusted or with too much scale formation on the inside wall. When installing the transducer by using the Z method, be sure that the two transducers and the pipeline center axis are in the same plane, but never in the 6 or 12:00 o’ clock positions. See below:

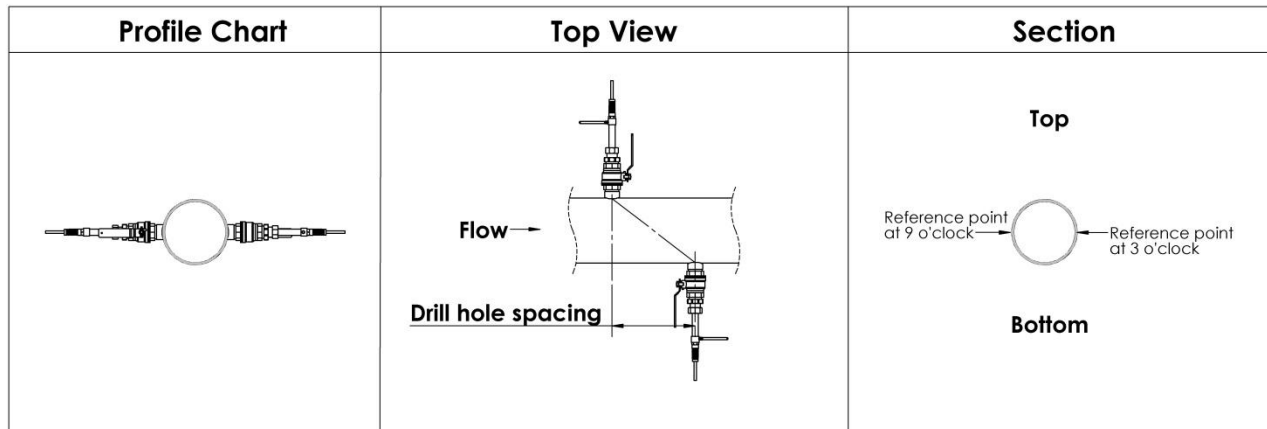


Figure 2

The W110 (39-1986-30) model insertion transducer is installed into pipelines via an isolation ball valve and an O ring seal. This valve allows the transducer to be inserted and removed while the pipe is full of water. It is even possible to hot tap the pipe by welding the threadolet to the pipe first and drilling through the open ball valve using a special hot tap drilling rig that has an appropriate packing gland.

The W110 transducer is rated for a fluid can range of  $-40$  to  $+85^{\circ}\text{C}$ . The Installation height is determined by subtracting the 11.260 inches (286mm), from the pipe wall thickness. It is measured from the Orientation handle to the outside wall of the pipe. Note that the pipe wall thickness must be thick enough to weld the threadolet on and to support the weight of the transducer.

Figure 3 shows a diagram of the Insertion Transducer. The insertion transducer is attached to its included threadolet base which is welded to your pipe section. The threadolet is carbon steel, however a 304 stainless steel version can be special ordered. For some pipes like concrete you will need a saddle which provides an NPT 1.5 inch male thread to connect to the ball valve. When the transducer is removed, the flowing fluid can be contained by shutting off the ball valve. You may need to loosen the O ring compression sleeve to allow the transducer to slide.

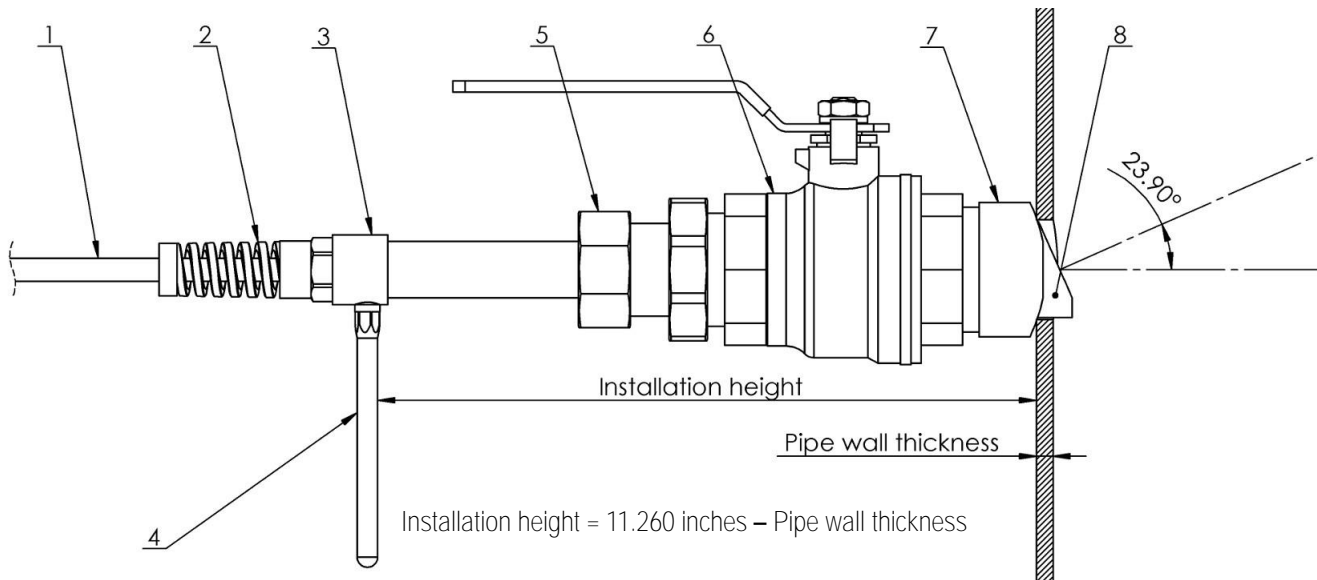


Figure 3 Construction Drawing of W110 Insertion type Transducer

1. Cable
2. Strain relief
3. Connector
4. Orientation handle
5. O ring compression sleeve
6. 1.5 inch NPT Ball valve
7. 1.5 NPT inch Threadolet
8. Transducer probe

## 12.2 Measurement Point Selection

To obtain the strongest signal strength and the most accurate measurement, it is necessary to select an appropriate measurement point before installing the transducer. It should avoid turbulence and other flow profile problems as with clamp-on transducers. Using the “Z” mounting method is preferred, but “V” can be used if necessary.

## 12.3 Determining Transducer Spacing & Transducer Installation

To determine the correct spacing, or center to center points to mount the threadolets, just enter the pipe, fluid, and mounting method information as with clamp-on transducers. The 207i will determine the correct center to center transducer spacing. This will be the spacing between the 2 threadolets. The pipe material, pipe OD and thickness are irrelevant with an insertion transducer but are still used to calculate the inside diameter of the pipe.

Use the Quick Start menu, for example.

Pipe Outer Diameter: 6.658 in.

Pipe Wall Thickness: 0.258 in.

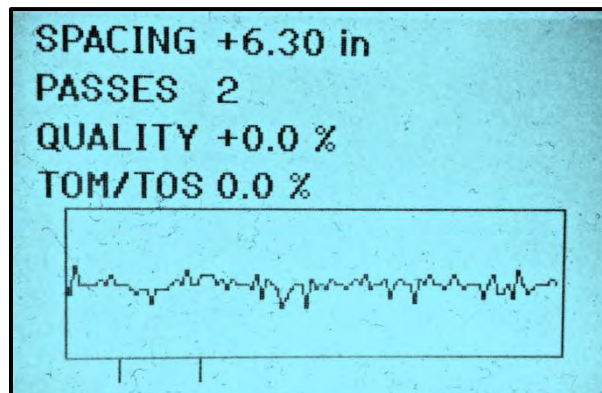
Pipe Material: Carbon Steel

Liner: None

Fluid Type: Water

Fluid Temperature: 68.00 F

Transducer Type: Insertion



The correct spacing will be 6.30 inches.

## 12.4 Attaching the Transducers

Weld the 2 threadolets to the pipe at the correct spacing taking into consideration V or Z mounting. The hole size must be large enough to allow the transducer probe to move through the hole, nominally 1.5 inches.

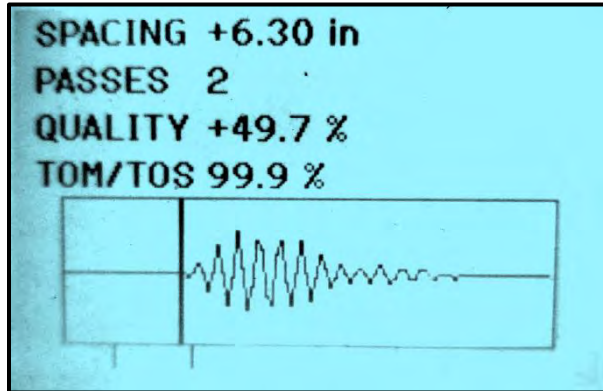
Screw the ball valve on the threadolet use a thread sealer like Teflon tape. Make sure the ball valve handles do not interfere with anything when being opened.

Screw the transducers NPT fitting on the ball valve, use thread sealant. You may need to loosen the O ring compression sleeve to allow the transducer to slide.

When the NPT fitting is tight, the O ring compression sleeve should be just loose enough to allow the transducer to slide, but not allow too much water to leak past the O ring. Open the ball valve and slide the transducer through the open ball valve to the Installation height as shown in figure 3.


In the example from 1.3 above the starting Installation height would be 11.260 minus the wall thickness of .258 or

11.002 inches. Because of tolerances it would be impossible to drill holes, weld, and mount the transducers to the exact tolerances. This Installation height will just be the starting point. Adjust the Installation height of the transducers equally between both transducers. Watch the TOM/TOS number and strive to reach 100.0%. At this time, you should see a good wave form and arrival marker between the goal posts.



Now you should be ready to measure flow. On any of the Flow screens you should see a \*R status, which indicates all the signals are within acceptable limits.

Check for leaks and tighten the O ring compression sleeve just enough to stop any leaks past the O ring. However, do not over tighten the O ring compression sleeve or you may damage the O ring.

	<p><b>IMPORTANT:</b> Be aware the transducer will be pushed out by the water pressure. Example; 100 psig could push 177 pounds of force.</p>
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