

Steel Mass[®] 640S

Insertion Mass Flow Meter

Instruction Manual



Part Number: IM-64S
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SIERRA[®]

Global Support Locations: We Are Here To Help!

Corporate Headquarters

20 Ryan Ranch Road, Suite 109
Monterey, CA 93940
Phone (831) 373-0200
info@sierrainstruments.com
www.sierrainstruments.com

EMEA Headquarters

Bijlmansweid 2 1934RE Egmond aan den Hoef
The Netherlands
Phone +31 72 5071400
sales@sierrainstruments.nl

Asia Headquarters

Second Floor Building 5, Senpu Industrial Park
25 Hangdu Road Hangtoun Town
Pu Dong New District, Shanghai, P.R. China
Postal Code 201316
Phone: + 8621 5879 8521

Important Customer Notice- Oxygen Service

Unless you have specifically ordered Sierra's optional O₂ cleaning, this flow meter may not be fit for oxygen service. Sierra Instruments, Inc., is not liable for any damage or personal injury, whatsoever, resulting from the use of Sierra Instruments standard mass flow meters for oxygen gas. You are responsible for cleaning the mass flow meter to the degree required for your oxygen flow application. **However, some models can only be properly cleaned during the manufacturing process.**

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Warnings and Cautions

General Safety Information

We use caution and warning statements throughout this book to draw your attention to important information.

Symbol Key		
Symbol	Symbol Meaning	Description
	Warning	This statement 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.
	Caution	This statement appears with information that is important for protecting your equipment's performance. Read and follow all cautions that apply to your application.



Warning!

- **Warning!** Agency approval for hazardous location installations varies between flow meter models. Consult the flow meter nameplate for specific flow meter approvals before any hazardous location installation.
- **Warning!** Hot tapping must be performed by a trained professional. U.S. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit
- **Warning!** All wiring procedures must be performed with the power Off.
- **Warning!** To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. All AC power connections must be in accordance with published CE directives.
- **Warning!** Do not power the flow meter with the sensor jumper wires disconnected. This could cause over-heating of the sensors and/or damage to the electronics.
- **Warning!** Before attempting any flow meter repair, verify that the line is de-pressurized.
- **Warning!** Always remove main power before disassembling any part of the mass flow meter.



Caution!

- **Caution!** Before making adjustments to the Smart Electronics device, verify the flow meter is not actively monitoring or reporting to any master control system. Adjustments to the electronics will cause direct changes to flow control settings.
- **Caution!** All flow meter connections, isolation valves and fittings for hot tapping must have the same or higher pressure rating as the main pipeline.
- **Caution!** Changing the length of cables or interchanging sensors or sensor wiring will affect the accuracy of the flow meter. You cannot add or subtract wire length without returning the meter to the factory for re-calibration.
- **Caution!** When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas flow before installing the meter.
- **Caution!** The AC wire insulation temperature rating must meet or exceed 71°C (158°F).
- **Caution!** Printed circuit boards are sensitive to electrostatic discharge. To avoid damaging the board, follow these precautions to minimize the risk of damage:
 - before handling the assembly, discharge your body by touching a grounded, metal object
 - handle all cards by their edges unless otherwise required
 - when possible, use grounded electrostatic discharge wrist straps when handling sensitive components

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)

Using This Manual

This manual provides information needed to install and operate the Series 640S Smart Insertion Mass Flow Meter. The four chapters of this manual cover these areas:

Chapter 1 includes the introduction and product description

Chapter 2 provides installation and wiring instructions

Chapter 3 describes system operation and programming

Chapter 4 covers troubleshooting and repair

Appendix A covers product specification

Appendix B describes product warranty

Additional Resources

Visit Sierrainstruments.com for additional resources. Note: the most current versions of the iSeries documents can be found at <http://www.sierrainstruments.com/products/downloads/Insertion-Gas-Mass-Flow-Meter-SteelMass-640S>.

Chapter 1 | Introduction

Series 640S SteelMass Mass Flow Meters

Sierra's Series 640S Smart Insertion Mass Flow Meter provides a reliable solution for gas flow measurement applications. Low-flow sensitivity, fast response and outstanding rangeability have made this model the instrument of choice for many critical gas flow applications. For stable and reliable mass flow reading, the meter's rugged SteelTrak™ sensor automatically corrects for changes in gas temperature and pressure which eliminates the need for separate temperature and pressure transducers.

The versatile microprocessor-based transmitter integrates the functions of flow-range adjustment, meter validation and diagnostics in a probe-mounted or remotely-mounted housing. Mass flow rate and totalized flow, as well as other configuration variables are displayed on the meter's optional 2 x 12 LCD display. The meter provides an optical/galvanic isolated flow output, two alarm outputs and one contact input for range or gas selection. The programmable transmitter is easily configured via RS-232 and Sierra's Smart Interface software or through three push buttons built into the device.

The Series 640S is suitable for insertion into pipes or ducts from 1 inch up to 144 inches. The Series 640S Mass Flow Meter's simple installation combines with an easy-to-use interface that provides quick set up, long term reliability and accurate mass flow measurement over a wide range of flows and conditions.

The Series 640S Flow Sensing Principle

Sierra's unique SteelTrak™ sensor probe is responsible for the unsurpassed accuracy, ruggedness and reliability of Sierra industrial flow meters. The immersible SteelTrak sensor consists of two sensing elements—a velocity sensor and a temperature sensor that automatically corrects for changes in gas temperature.

When power is applied to the flow meter, the transducer electronics heats the velocity sensor to a constant temperature differential above the gas temperature and measures the cooling effect of the gas flow. The electrical power required to maintain a constant temperature differential is directly proportional to the gas mass flow rate.

Both sensors are reference-grade platinum resistance temperature detectors (RTDs). The platinum RTD wire is wound on a rugged ceramic mandrel for strength and stability. SteelTrak sensors are clad in a rugged, sealed 316 stainless steel encasement.

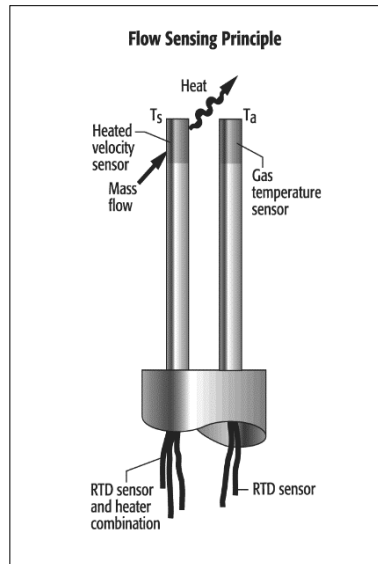


Figure 1.1 Series 640S Sensor Assembly

Instrument Validation

Two simple tests offer full “field-validation” of your Smart mass flow meter. The first test checks the system electronics, linearization and microprocessor functionality and is performed by injecting a known input value and confirming that the flow meter outputs the expected value. The second test verifies that the instrument’s primary sensing elements have not drifted or shifted from their original calibration and is accomplished by measuring the resistance of the velocity and temperature sensors and comparing the results to the NIST-traceable calibration data provided with the flow meter. Together, these tests confirm that your meter is working correctly and the calibration variables did not drift, shift or change values.

Dual Range or Dual Gas Calibration (Optional)

Select one of two factory calibrated flow ranges using a simple external customer-supplied single contact closure.

User Full Scale Flow Rate

Field-configure from 50% to 100% of the factory full scale setting (factory full scale is normally set to 125% of the user-specified maximum flow rate). This adjustment can be made for each flow range.

Alarms

Program high and low or window alarm limits independently for each flow range. The solid state contacts are isolated with one common.

K-Factor Correction


Change the calibration correction factor to compensate for flow profile disturbances or specific application conditions. The K-factor is a multiplication factor applied to the linearized flow signal. You may set the K-factor individually for each flow range.

Dual Output Signals

Smart flow meters offer two separate linear output signals proportional to flow, 0-5 VDC (0-10 VDC optional) and 4-20 mA. The 4-20 mA output can be field-configured as an active loop powered by the flow meter or an optically isolated passive loop requiring an external power supply.

Totalizer

With the optional LCD display, actual mass flow appears on line 1 and the totalized flow on line 2 both in the user-specified engineering units. The totalizer counts only the selected range and when ranges are switched, the value of the non-selected range is stored in memory. You may reset the totalizer using the device buttons or by using a hand-held magnet.

	<p>The totalizer will display a real-time value, but the EPROM requires 6 minutes to store it. Always wait at least 6 minutes to remove power or this most recent flow accumulation may be lost.</p>
---	--

Zero and Span Outputs

Validate and adjust the settings to ensure output circuits are correct.

Time Response Delay

Select from a low response for faster tracking to a high response for a smoother output.

Enclosure Options

Flow meter electronics are available mounted directly to the flow body, or remotely mounted up to 200 feet (60 meters) away. The electronics housing may be used indoors or outdoors.

Display options include a 2 x 12 character LCD display of mass flow rate including totalized mass, or a single-digit LED located on the device printed circuit board. Local operation and reconfiguration is accomplished using the magnetic switches on the display or push buttons on the device. Smart electronics include nonvolatile memory that stores all configuration information. The memory allows the flow meter to function immediately upon power up, or after an interruption in power.

Smart Interface™ Software

Sierra's Smart Interface Windows™-based software is available for connecting your PC directly to the mass flow meter. An RS-232 serial cable is provided with each meter, or is available from the factory. See the Smart Interface User Guide included with the software for operating instructions. Download the software at <https://www.sierrainstruments.com/products/sip/sip.html>.

Chapter 2 | Installation

The Series 640S flow meter is factory calibrated to the specific pipe size shown on the meter's Certificate of Calibration. The factory calibration eliminates the task of calculating the average flow across the pipe to determine the correct insertion depth. Simply insert the flow meter sensor to the centerline position of the pipe. (If the pipe size differs from the meter's calibrated size, return the meter to the factory for re-calibration.)



Agency approval for hazardous location installations varies between flow meter models. Consult the flow meter nameplate for specific flow meter approvals before any hazardous location installation.

When selecting an installation site, make sure that:

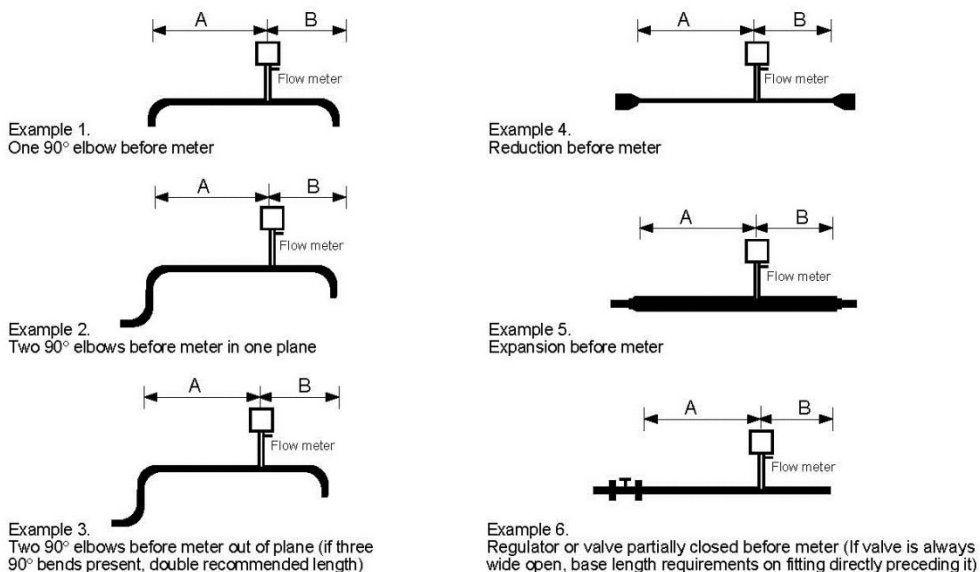
1. Line pressure and temperature will not exceed the flow meter rating. Temperature should not vary more than 200°F (100°C) around the calibration temperature. Line pressure should not vary more than 50 psi (3.4 bar) around the calibrated pressure.
2. The gas temperature and the ambient temperature added together do not equal more than 392°F (200°C). If it does, use a remote sensor probe.
3. The location meets the required minimum number of pipe diameters upstream and downstream of the sensor head (see Figure 2-1 on the next page).
4. Safe and convenient access with adequate clearance. Also, verify the meter is located where the gas is clean and dry and the meter is calibrated for the gas to be measured.
5. When using a CSA, FM or EEx approved flow meter, verify that the cable entry into the instrument meets the specific standard required for that approval.
6. For remote installations, verify the supplied cable length is sufficient to connect the flow meter sensor to the remote electronics. (Do not extend or shorten the supplied cable between the probe and the electronics.)

Also, before installation check your flow system for anomalies such as:

- leaks
- valves or restrictions in the flow path that could create disturbances in the flow profile that might cause unexpected flow rate indications
- heaters that might cause rapid excursions in the measured temperature

Unobstructed Flow Requirements

Select an installation site that will minimize possible distortion in the flow profile. Valves, elbows, control valves and other piping components may cause flow disturbances. Check your specific piping condition against the examples shown below. In order to achieve accurate and repeatable performance install the flow meter using the recommended number of straight run pipe diameters upstream and downstream of the sensor.



Example	A-Upstream ⁽¹⁾ Requirements	B-Downstream ⁽²⁾ Requirements
Example	A	B
1	15 D	5 D
2	20 D	5 D
3	40 D	10 D
4	15 D	5 D
5	30 D	10 D
6	40 D	5 D
(1) Number of diameters (D) of straight pipe required between upstream disturbance and the flow meter.		
(2) Number of diameters (D) of straight pipe required downstream of the flow meter.		

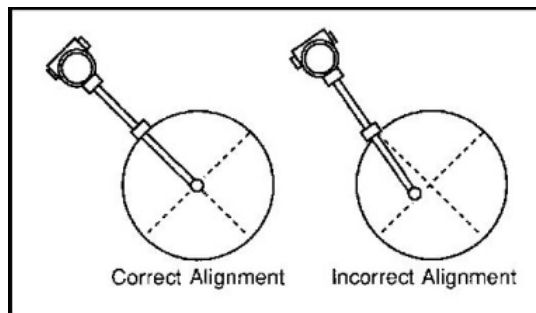
Figure 2.1 Recommended Pipe Length Requirements for Installation

Installing The Flow Meter

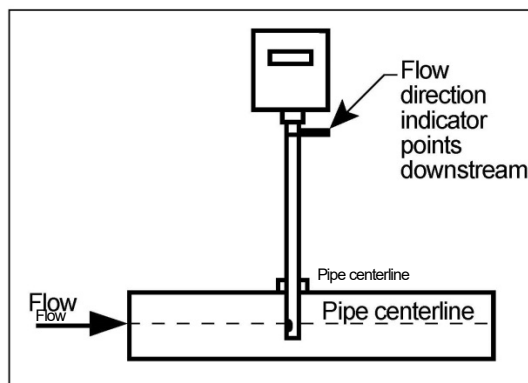
When positioning the flow meter, refer to the flow direction indicator attached to the probe. For proper operation, install the meter with the flow direction indicator pointing downstream in the direction of flow. Installing the meter opposite this direction will result in inaccurate flow measurement



When using toxic or corrosive gases, purge the line with inert gas for a minimum of four hours at full gas before installing the flow meter.



Probe may enter the pipe from any direction as long as the tips are in the center.





Cold Tap Installation

1. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements shown in Figure 2-1.
2. Turn off the flow process gas. Verify that the line is no pressurized.
3. Use a cutting torch or sharp cutting tool to tap into the pipe. The pipe opening must be at least 0.78 inches in diameter. (Do not attempt to insert the sensor probe through a smaller hole.)
4. Remove all burrs from the tap. Rough edges may cause flow profile distortions that could affect flow meter accuracy. Also, obstructions could damage the sensor assembly when inserting into the pipe.
5. Mount the compression or flange fitting on the pipe. Make sure this connection is within $\pm 5^\circ$ perpendicular to the pipe centerline as shown at left.
6. When installed, cap the fitting. Run a static pressure check on the connection. If pressure loss or leaks are detected, repair the connection and re-test.
7. Insert the sensor probe through the compression or flange fitting into the pipe. The correct insertion depth places the centerline of the sensor access hole in the probe at the pipe's centerline.
8. Align the sensor head using the flow direction indicator. Adjust the indicator parallel to the pipe pointing downstream in the direction of flow.
9. Tighten the fitting to lock the flow meter in position. (When a compression fitting is tightened, the position is permanent unless using Teflon ferrules.)
10. If needed, adjust the optional display to the desired orientation. See page 17.

Hot Tap Installation

When positioning the flow meter, refer to the flow direction indicator attached to the probe. For proper operation, install the meter with the flow direction indicator pointing downstream in the direction of flow. Installing the meter opposite this direction will result in inaccurate flow measurement. Low pressure hot taps cannot exceed 150 psig (10 barg) maximum. High pressure hot taps max pressure is flange dependent up to 400 psig (27.6 barg). Make sure the pipe pressure does not exceed these limits before beginning this procedure.

	<p>Hot tapping must be performed by a trained professional. U.S. regulations often require a hot tap permit. The manufacturer of the hot tap equipment and/or the contractor performing the hot tap is responsible for providing proof of such a permit.</p>
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	<p>All flow meter connections, isolation valves and fittings for hot tapping must have the same or higher pressure rating as the main pipeline.</p>
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1. Confirm that the installation site meets the minimum upstream and downstream pipe diameter requirements shown in Figure 2-1.
2. Calculate the flow meter insertion depth as shown in Figure 2-2 for a low pressure tap or Figure 2-3 for a high pressure tap.
3. Weld the process connection on the pipe. Make sure the process connection is within $\pm 5^\circ$ perpendicular to the pipe centerline (see previous page). The pipe opening must be at least 0.88 inches (22 mm) in diameter.
4. Bolt an isolation valve on the process connection. The valve's full open bore must be at least 0.88 inches (22 mm) in diameter.
5. Hot tap the pipe.
6. Close the isolation valve. Run a static pressure. If pressure loss or leaks are detected, repair the connection and re-test.
7. Insert the sensor probe through the isolation valve into the pipe with the flow direction indicator parallel to the pipe pointing downstream in the direction of flow. The correct insertion depth places the sensor at the pipe's centerline. Do not force into the pipe.
8. Tighten the fittings to lock the flow meter in position. If needed, adjust the optional display to the desired orientation. See page 17.

Calculating Insertion Depth for a Low Pressure Tap

Variables

L= Nominal probe length

D= Duct O.D.

C= Duct I.D.

T= Height of “Threadolet” or customer provided “Weldolet”

Formula

$$L \geq 12 + D/2 + T$$

L must be equal to greater than 12 inches plus the height of the “Threadolet” plus half of the duct O.D. (*All dimensions in inches*).

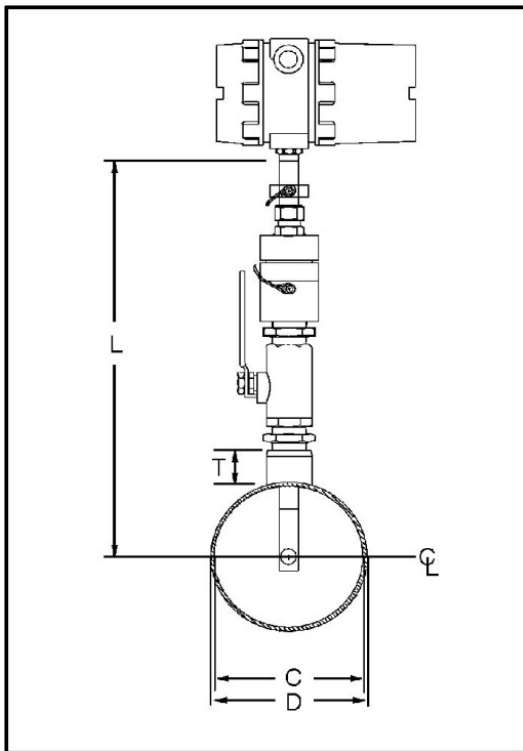


Figure 2-2. Low Pressure Tap Insertion Depth

Calculating Insertion Depth for a High Pressure Tap

Variables

S = Distance from face of mounting flange to outside of duct D = Duct O.D.

P = Minimum probe length

T = Minimum probe travel

R = Allowable probe travel

IN = Inserted position (marker location)

RE = Retracted position (marker location)

Formulas

$P = D/2 + S + 6.75$ (minimum probe length—use next longer whole number length probe)

$T = D/2 + 0.54$

$R = 28.2 - [\text{actual probe length} - S - (D/2)]$ (must be greater than or equal to T)

$IN = (\text{actual probe length} + 2) - (5.5 + S + D/2)$

$RE = IN + T$ (All dimensions in inches.)

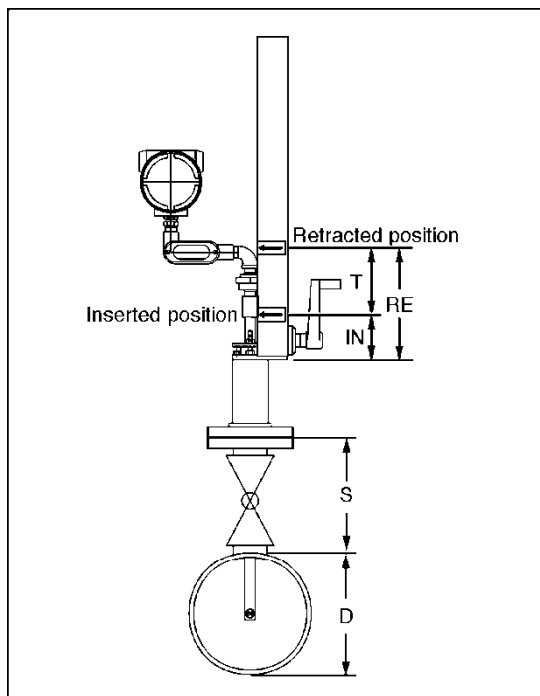


Figure 2-3. High Pressure Tap Insertion Depth

Changing Display Orientation (Hazardous-Area Enclosures Only)

Depending on installation requirements, you may want to change the orientation of the optional display.

1. Use a 1/16-inch hex key to loosen the set screw securing the larger end of the enclosure. Turn cover counterclockwise and remove.
2. Remove 4 screws and standoffs from the display. Release the latch securing the display ribbon cable connector from the display board.
3. Rotate the display board to the desired position. Re-connect the ribbon cable to the display board.
4. Replace the 4 screws and standoffs. Replace the enclosure cover. Tighten set screw.

Wiring Connections- Protection of Your Meter

To protect your investment and be certain of a long reliable service life, we have compiled some guidelines (from experience) that will aid your installation team in properly protecting the electronics from the application environment. These instruments have been designed for and proven reliable in some of the most extreme process conditions in industry: Mining, Oil and Gas, Water, Wastewater etc. The key however is to follow best practices to insure a proper seal to protect the internal components of this precision instrument.



Failure to adhere to these guidelines may result in water damage that is not covered under Sierra's [Warranty Policy](#).

Water penetration can lead to a damaged flow meter. Sierra's "E" HALE ex-proof enclosures are rated to a NEMA4X, IP66 rating. This provides protection against, rain, sleet, snow and splashing water, but water can damage the sensor, electronics or wiring terminals if the meter is not properly installed and maintained.

To minimize the potential for water damage, Sierra Instruments recommends the following:

- Install conduit seals near the enclosures on all ports.
- Use a cable gland design that provides shielded cable termination and an environmental seal against dirt and water.
- Do not bend, kink, or otherwise distort the cable at the entry points to the cable glands.
- Route conduit or cable using a drip loop or drain as close as possible to the enclosure ports unless the cable slopes directly down.

- If the factory cable glands are replaced to install other adapter fittings, conduit fittings, cable glands, or any other modification to the cable entry points be sure to use a good quality thread sealant on all NPT threads as well as verifying they are all tightened and sealed appropriately so as not to leak.
- Be certain to use NPT threads when connecting to the housing. Some electrical fittings are not tapered but will fit in the NPT ports of the enclosure. Sufficient Teflon tape and pipe dope is recommended to insure a leak tight seal.
- If you are uncertain of the conditions the interior of the housing is subjected to over time, a small temporary datalogger can be placed in the housing to record temperature and humidity to establish a baseline. Corrective action can be made based on this data before instrument degradation sets in. Contact Sierra Instruments for suggested sources of small dataloggers.
- Keep the enclosure lids sealed tight using the supplied o-rings.
- As part of the lid o-ring inspections look for any signs of condensation inside of the enclosure. If condensation or signs of condensation/corrosion are found be sure all fittings/seals are securely tightened as well as a desiccant bag can be used and replaced as needed. This can be particularly important if the temperature is cycled.

Wiring Connections - General

For NEMA 4X enclosures, use TB2 for power and signal connections, TB 1 is for sensor connections.

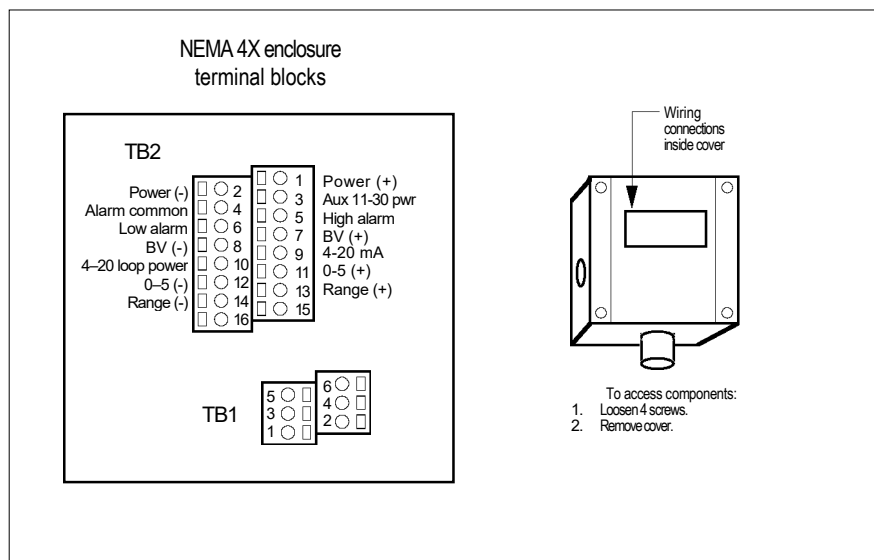


Figure 2.4. Wiring Access NEMA 4X



To avoid potential electric shock, follow National Electric Code safety practices or your local code when wiring this unit to a power source and to peripheral devices. Failure to do so could result in injury or death. All AC power connections must be in accordance with published CE directives.

For Hazardous-Area enclosures, use the terminal blocks located inside the smaller end of the flow meter enclosure for all wiring connections. Make sure to observe all CE compliance requirements for AC wiring connections given on the next page.

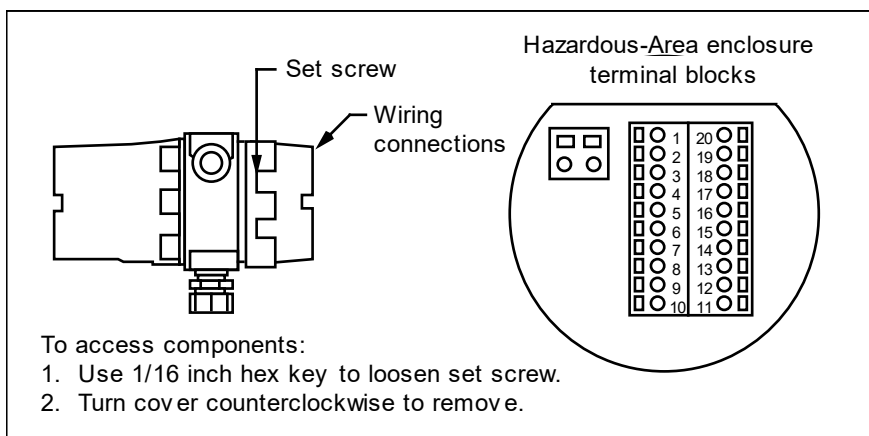


Figure 2-5. Wiring Access Hazardous-Area Enclosures

Input Wiring

AC Power Wiring



All wiring procedures must be performed with the power Off.



The AC wire insulation temperature rating must meet or exceed 71 °C (158°F).

The AC power wire size must be 26 to 16 AWG with the wire stripped 1/4 inch (6 mm). Connect 100 to 240 VAC (300 mA load, maximum) to the Neutral and Line terminals on the small, two-position terminal

block. Connect the ground wire to the safety ground lug. Torque all connections to 4.43 to 5.31 in lbs (0.5 to 0.6 Nm).

For all installations not using solid metal conduit, the ferrite clamp must be installed just above the input power wire entry into the enclosure (Figure 2-7). All EEx installations must use an approved EEx fitting at both cable entries into the enclosure. If conduit seals are used, they must be installed with 18 inches of the enclosure.

The Hazardous-Area enclosure has two separate conduit entries to maintain separation between AC input power and output signal wiring. To eliminate the possibility of noise interference use a separate cable entry for the AC power and signal lines.

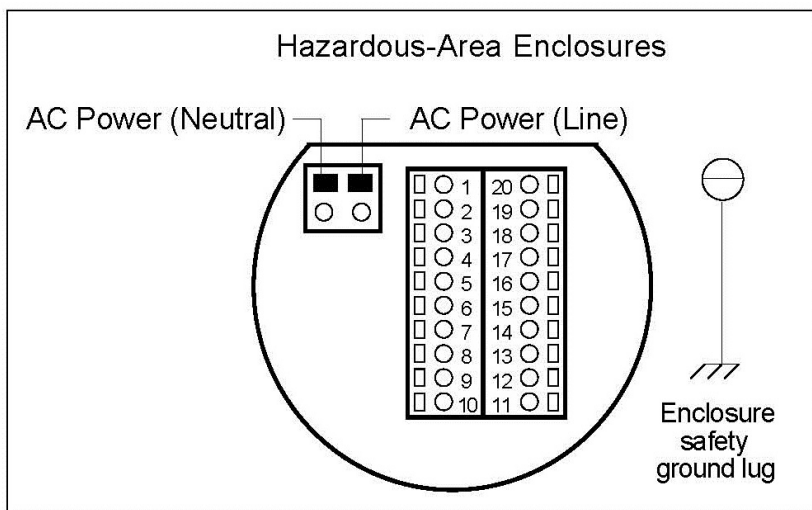


Figure 2-6. AC Input Power Connections

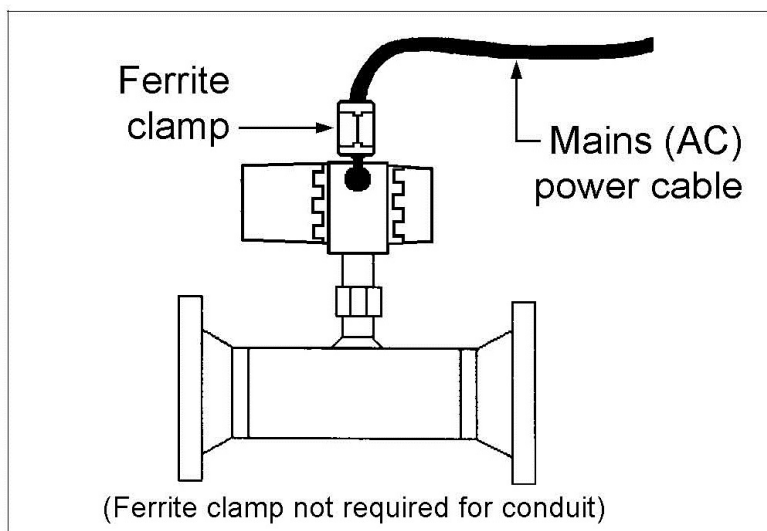


Figure 2-7. Ferrite Clamp Installation

DC Power Wiring



All wiring procedures must be performed with the power Off.

The DC power wire size must be 26 to 16 AWG with the wire stripped 1/4 inch (6 mm). Connect 18 to 30 VDC (625 mA load, maximum) to the terminals marked PWR+ and PWR– on the terminal block. Torque all connections to 4.43 to 5.31 in-lbs (0.5 to 0.6 Nm).

All EEx installations must use an approved EEx fitting at both cable entries into the enclosure. If conduit seals are used, they must be installed within 18 inches of the enclosure.

NEMA 4X Enclosure

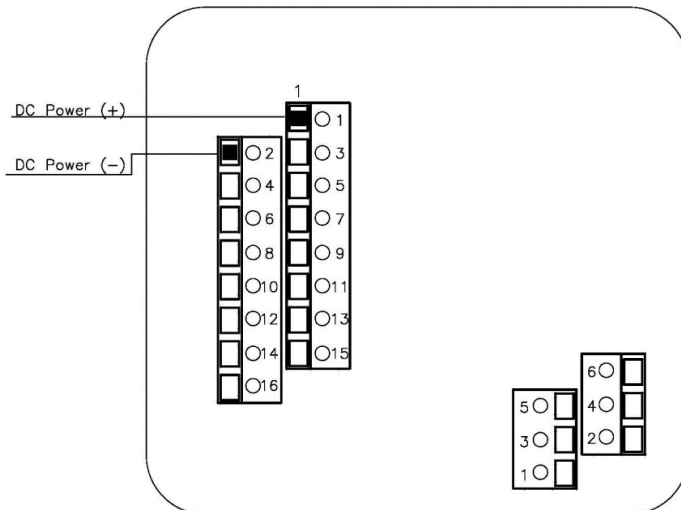


Figure 2-8. DC Input Power Connections

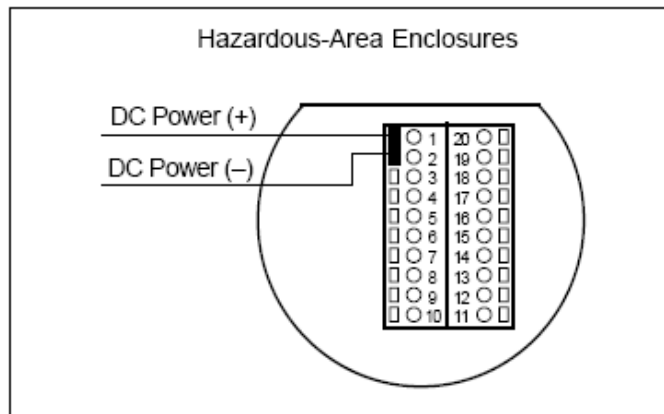


Figure 2.9 DC Input Power Connections

Output Signal Wiring

Output signal cable should be completely screened with a 100% shield. You must use metal cable glands that provide cable screen clamping. The cable screen should be connected to the gland and shielded at both ends over 360 degrees. The shield should be terminated to an earth ground.

All Series 640S flow meters are equipped with either a calibrated 0-5 VDC (0-10 VDC optional) or a calibrated 4-20 mA output signal. This linear output signal represents 0-100% of the flow meter's user full scale.

DC Output Wiring

The 0-5 VDC (0-10 VDC optional) signal can drive a minimum load of 1000 Ohms. Note: the optional 0-10 VDC output signal is not available for power sources below 15 VDC.

For 0-5 VDC or 0-10 VDC connections, connect to the terminals marked Vout (+) and Vout (⌀) as shown below.

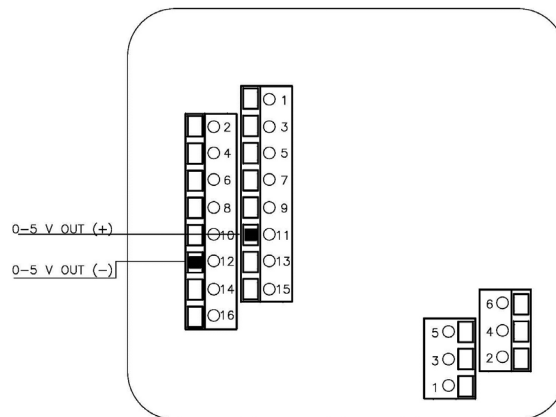


Figure 2-10. DC Output Signal Connections

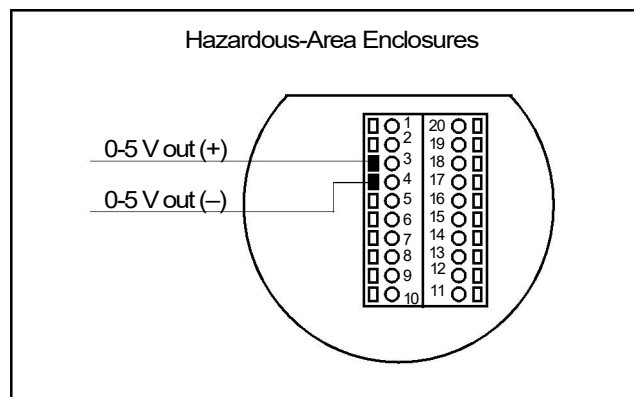


Figure 2-11. DC Output Signal Connections

4-20 mA Output Wiring

The 4-20 mA current loop output can be self-powered (non-isolated) or externally powered (isolated). To use the 4-20 mA isolated output, an external 12 to 36 VDC power supply is required. The maximum loop resistance (load) for both types of current loop outputs is dependent upon the supply voltage and is given in Figure 2-12. For non-isolated outputs the loop voltage (V_s) is equal to the input voltage if DC powered. If AC powered, the loop voltage (V_s) is 24 VDC.

R_{load} is the total resistance in the loop, including the wiring resistance. To calculate R_{max} , the maximum R_{load} for the loop, use the maximum loop current, 20 mA. The voltage drop in the loop due to resistance is 20 mA times R_{load} and this drop is subtracted from the input voltage. Thus:

R_{max} the maximum load resistance = $50 * (V_{supply} - 7.5V)$

To use an external power supply for an isolated 4-20 mA output, connect as shown in Figure 2-13 or Figure 2-15. For an internally powered, non-isolated 4-20 mA output, connect as shown in Figure 2-14 or Figure 2-16.

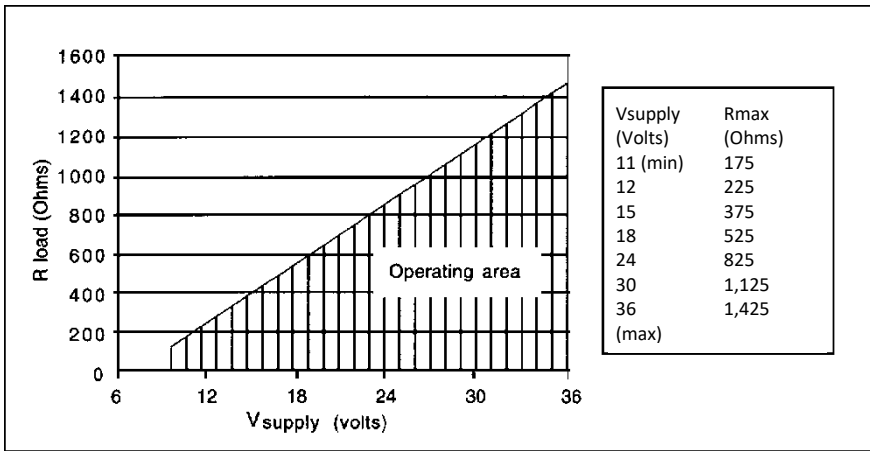


Figure 2-12. Load Resistance Versus Input Voltage

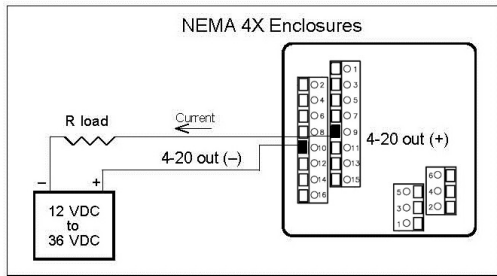


Figure 2-13. Isolated 4-20 mA Current Loop Connections

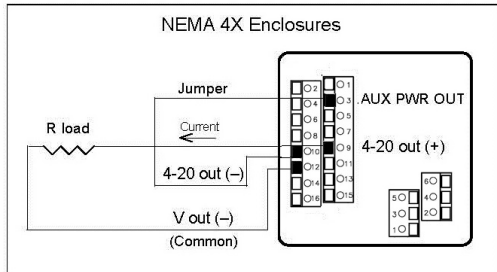


Figure 2-14. Non-Isolated 4-20 mA Current Loop Connections

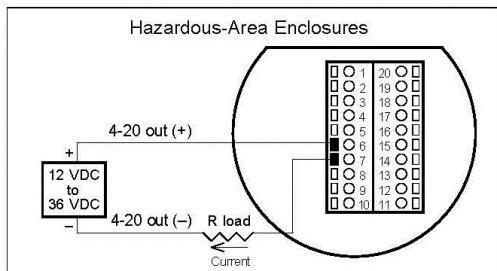


Figure 2-15. Isolated 4-20 mA Current Loop Connections

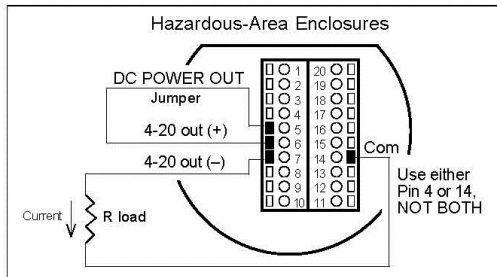


Figure 2-16. Non-Isolated 4-20 mA Current Loop Connections

Alarm Output Wiring

Two alarm outputs (Low Alarm and High Alarm) are included on the flow meter terminal block. The alarm outputs use optical relays that are normally-open single-pole relays with one common connection.

There are two connection options for alarm outputs—the first with a separate power supply (isolated) and the second using the flow meter power supply (non-isolated). Use the first option with a separate power supply if a specific voltage is needed for the alarm output. Use the second (non-isolated) configuration if the voltage at the flow meter's power supply is an acceptable driver voltage for the load connected. (Take into account that the current used by your alarm loads have to come from the flow meter's power supply.) In either case, the voltage of the alarm output is the same as the voltage supplied to the circuit.

To use an external power supply for an isolated alarm output, connect as shown in Figure 2-17 or Figure 2-19. To use the internally powered, non-isolated alarm output connect as shown in Figure 2-18 or Figure 2-20. For a window alarm connect both outputs together.

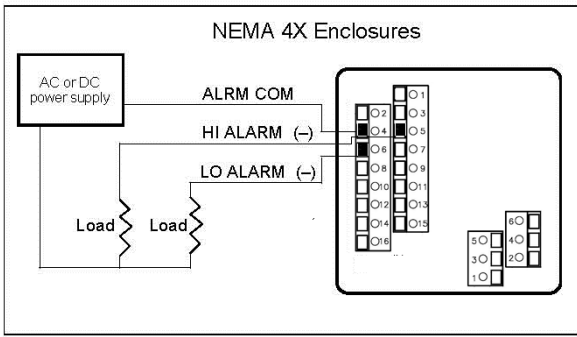


Figure 2-17. Isolated Alarm Output Connections

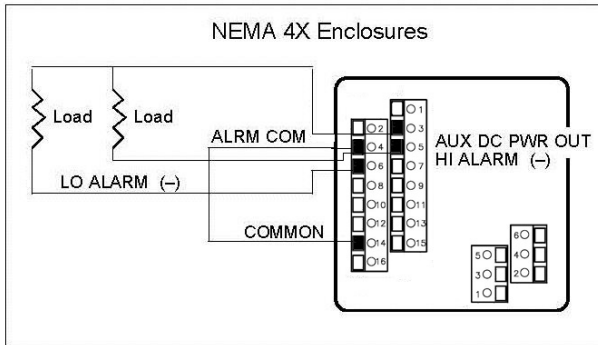


Figure 2-18. Non-Isolated Alarm Connections

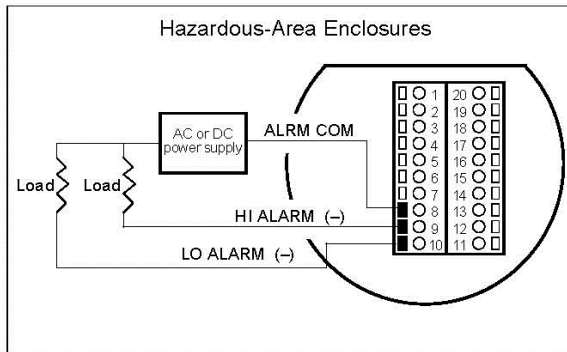


Figure 2-19. Isolated Alarm Output Connections

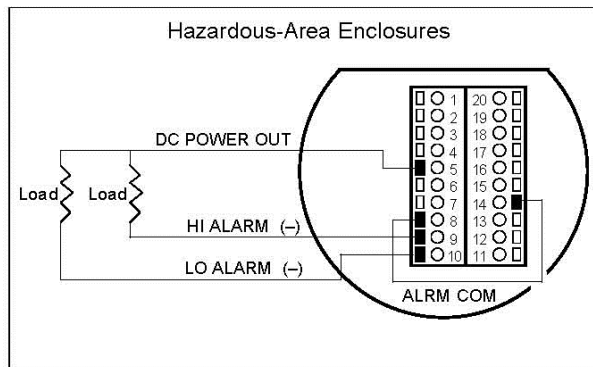


Figure 2-20. Non-Isolated Alarm Connections

Remote Sensor Probe Wiring

When connecting the sensor probe to a remotely mounted flow meter enclosure, use only factory supplied cables. When connecting more than one meter, do not intermix the sensor probes and electronics. The electronics, sensor probes and interconnecting cables supplied by Sierra Instruments are calibrated as a complete precision mass flow circuit.

To connect the sensor probe to a remotely mounted electronics enclosure, see Figure 2-21 or Figure 2-23. To make wiring connections from a sensor probe junction box to a remotely mounted enclosure, see Figure 2- 22 or Figure 2-24.

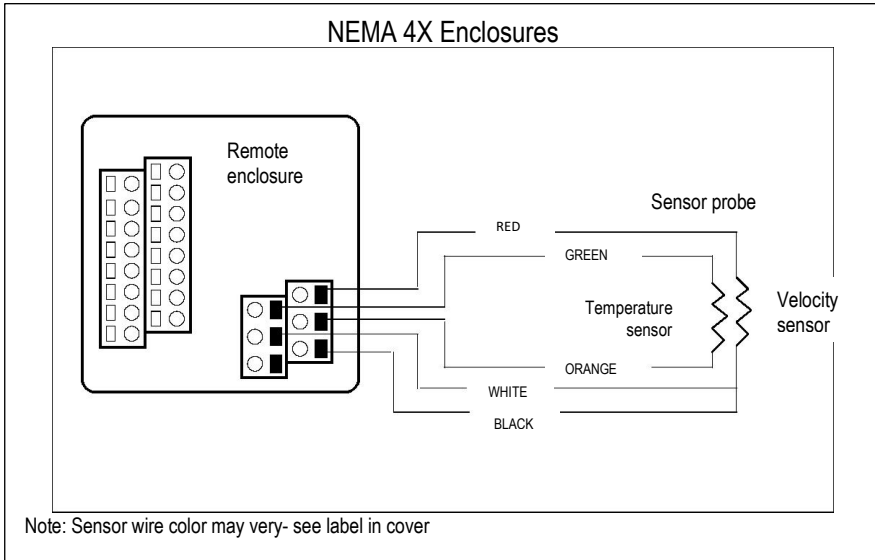


Figure 2-21. Remote Electronics Enclosure to Sensor Connections

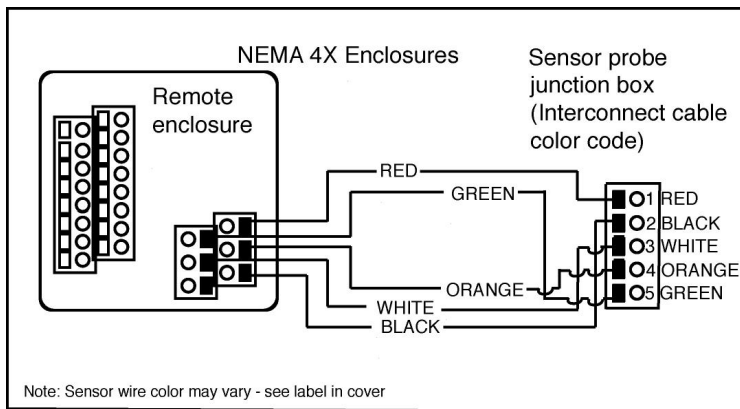


Figure 2-22. Sensor Junction Box to Remote Enclosure Connections

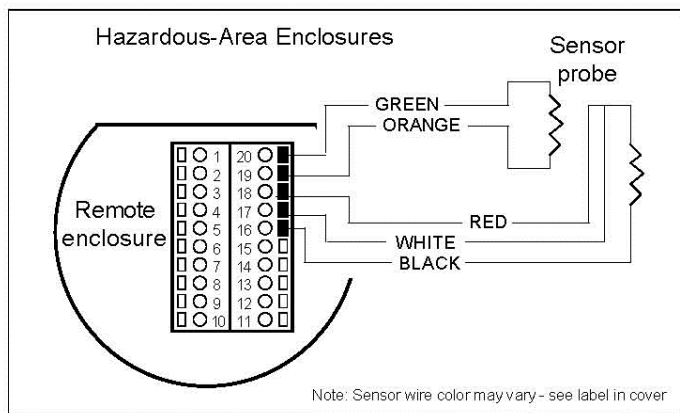


Figure 2-23. Remote Electronics to Sensor Connections

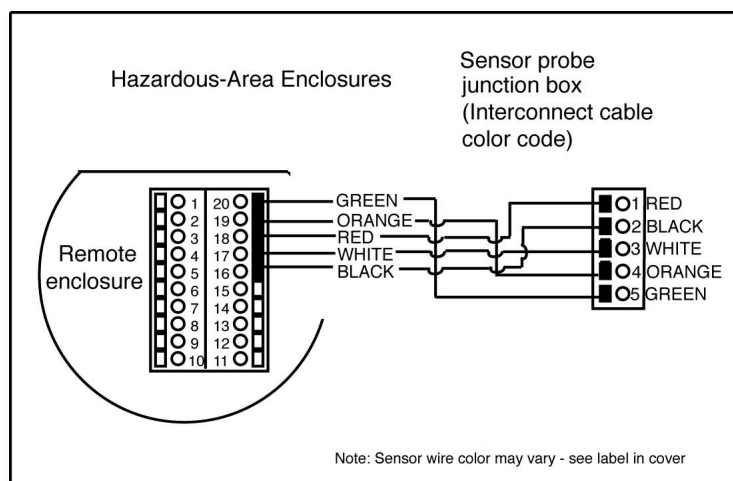


Figure 2-24. Sensor Junction Box to Remote Enclosure Connections

Range Selection Wiring

To access range selection, connect two wires on the terminal strip as shown below. When the switch is closed the device changes to Range 2. Opening the switch returns the device to Range 1.

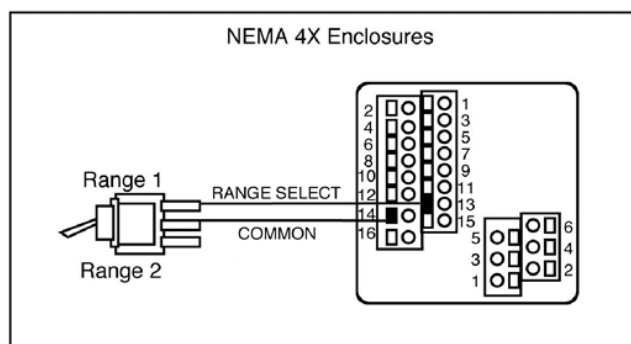


Figure 2-25. Range Selection Wiring

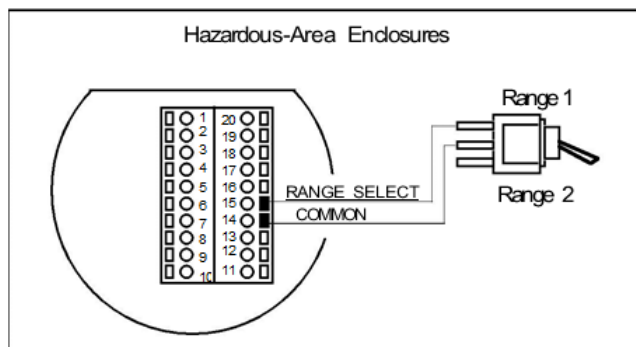


Figure 2-26. Range Selection Wiring

Chapter 3 | Operation

This chapter covers flow meter operation, programming and instrument validation procedures. All instructions include directions for using either the optional LCD display or the internal Smart electronics device for programming. If your meter is not equipped with the optional display, you will need a good quality digital voltmeter or multimeter for programming and validation procedures.

Flow Meter Start Up

When applying power to a flow meter equipped with the optional LCD display you will see the product name, the software version, unit serial number, the range number, the user full scale (UFS), the current flow rate and the totalized flow. Any active alarm will flash on the screen every few seconds.

When applying power to a flow meter without the display, the Smart electronics on-board single-digit LED flashes the revision number of the software in a series of 3 digits followed by the range number. The range number continues to flash every three seconds thereafter.

Record Factory-Set Parameters

You may view parameters using the optional LCD front panel display or by selecting functions on the single-digit LED and viewing the meter's 0-5 VDC output with a digital voltmeter (DVM).

For meters with the LCD display, use a hand-held magnet or the device buttons to select the FUNCTION key. When FUNCTION is selected, the display prompts for a password. Select FUNCTION again to skip the password to view and record the factory settings. To make changes, at the password prompt use the UP arrow until the number 11 is displayed. Select FUNCTION again to continue.

For flow meters without the display, remove the enclosure cover to access the Smart electronics device. Connect the DVM as described on the following pages and record the factory-set parameters.

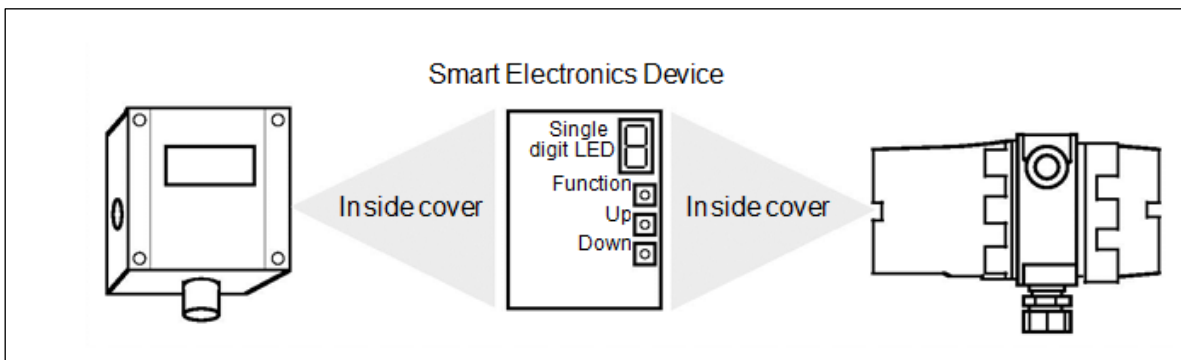


Figure 3-1. Smart Electronics Device Locations

Using the Smart Electronics Basic Features

This section covers the basic features of the Smart electronics and includes instructions on:

- Entering alarm parameters
- Changing the user full scale
- Adjusting the K-factor
- Adjusting the time response speed
- Resetting the totalizer

To access the meter's advanced features of zero and span, turn to page 39. Instrument validation procedures begin on page 41.



Before making any adjustments to the Smart electronics device, verify the flow meter is not actively monitoring or reporting to any master control system. Any adjustment to the electronics will cause direct changes to flow control settings.



Note: when programming the instrument, after 12 seconds of non-activity the meter returns to the Run Mode with any new settings immediately in effect. For units without a display, if the unit "times-out" press the FUNCTION button only to resume adjustments.

Hazardous-Area Enclosure Optional LCD Display

For units with the optional display, you may program the meter with-out opening the enclosure using the magnetic switches to enter the desired system settings

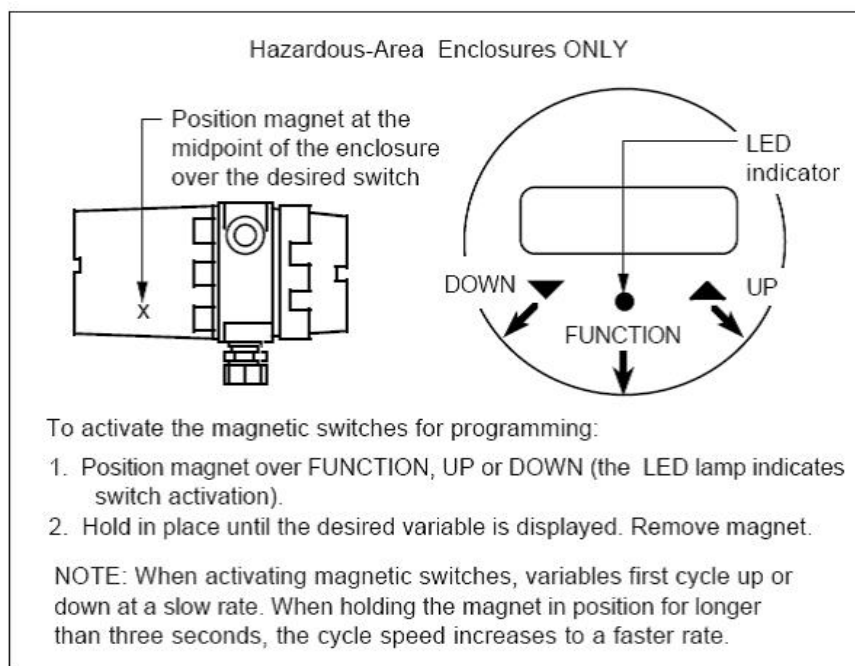
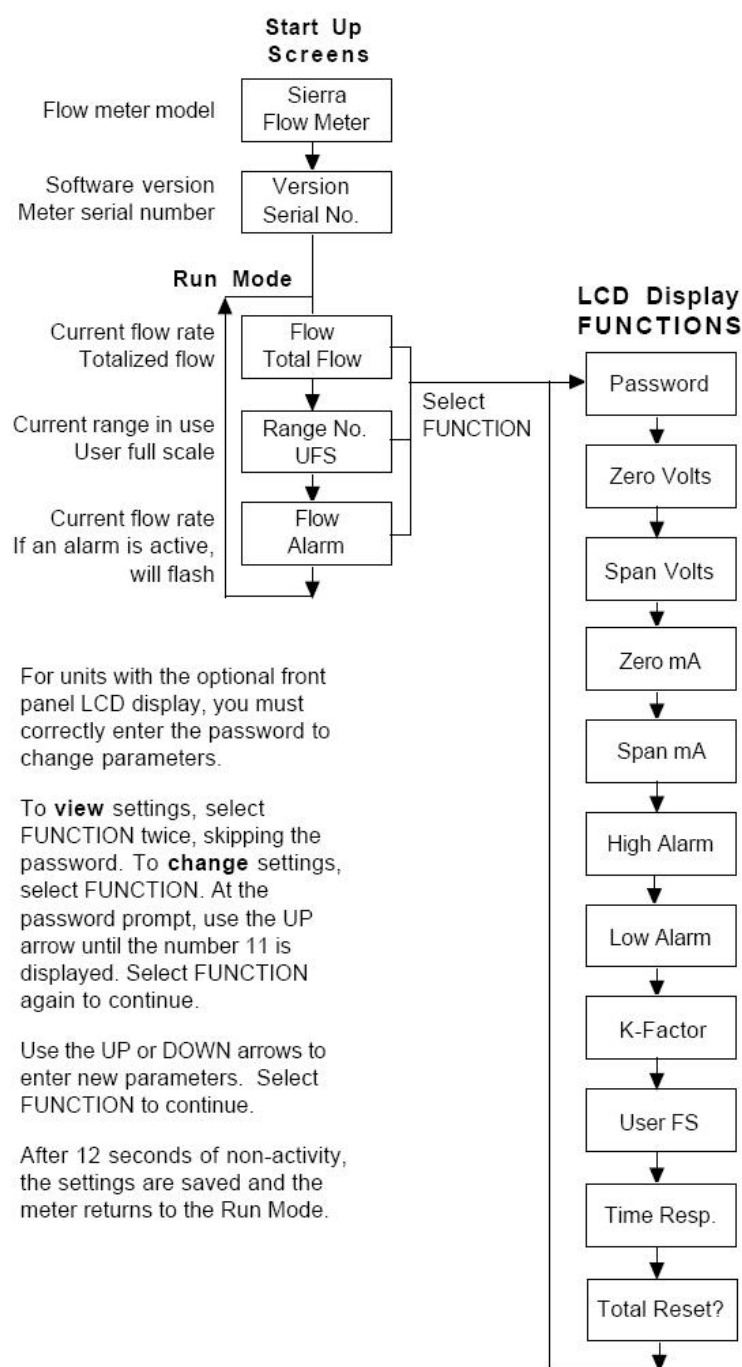


Figure 3-2. Magnetic Switch Operation

LCD Display Programming Menu



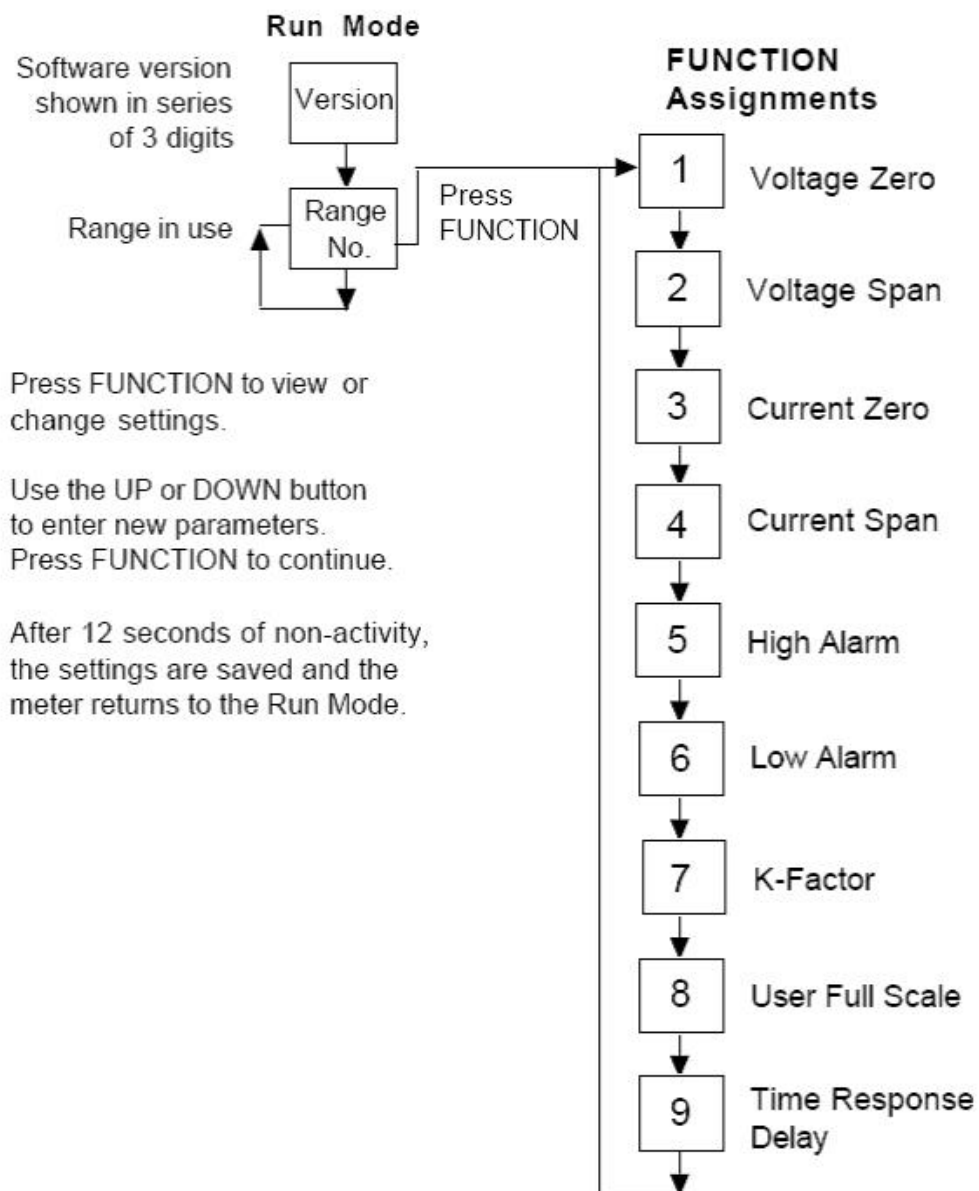
For units with the optional front panel LCD display, you must correctly enter the password to change parameters.

To **view** settings, select FUNCTION twice, skipping the password. To **change** settings, select FUNCTION. At the password prompt, use the UP arrow until the number 11 is displayed. Select FUNCTION again to continue.

Use the UP or DOWN arrows to enter new parameters. Select FUNCTION to continue.

After 12 seconds of non-activity, the settings are saved and the meter returns to the Run Mode.

Single-Digit LED Programming Menu



Entering Alarm Parameters

Use the High Alarm and Low Alarm function to set or adjust alarm trip points. The alarms have a minimum hysteresis of 3% to avoid "chattering." When setting a window alarm, the alarm set points must be at least twice the hysteresis value apart. We suggest at least a 10% separation between window alarm setpoints. If you choose not to use the high alarm for a specific alarm function, Sierra recommends that you set the high alarm at 100% of the user full scale setting which creates an "over-range" indicator. Your flow meter will continue to indicate flow and generate a signal if the flow is over the maximum range, but will not operate within the specified accuracy.



The flow meter must not be reporting or measuring gas flow during adjustments.

Entering Alarms using the LCD Display

Enter alarms setpoints directly in engineering units.

1. Select the desired range. Select FUNCTION, enter the password. Select FUNCTION again until High Alarm or Low Alarm appears on the display.
2. Use UP or DOWN to enter the high or low alarm setpoint value in engineering units.
3. Select FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new parameters are in effect.

Entering Alarms using the Single-Digit LED

When using a DVM to set alarms, the setpoint is a percentage of the flow meter's user full scale.

$$\text{VOLTS} = (\text{ALARM PERCENT} \times 5.0)$$

If you want to alarm at 25% of user full scale, used in Step 3 below, press the UP or DOWN button until 1.25 VDC is present on the DVM. If you want to alarm at 75% of user full scale, press the UP or DOWN button until 3.75 VDC is present on the DVM.

1. Set the DVM to voltage mode and connect between Vout+ and Vout- on the flow meter terminal block.
2. Select the desired range. Press the FUNCTION button until a solid "5" (high alarm) or solid "6" (low alarm) appears on the LED.
3. Adjust the UP or DOWN button until the DVM indicates the de-sired setpoint voltage as described above.
4. Press FUNCTION again to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new alarm parameters are in effect.

K-Factor Adjustment

Entering a K-factor adjusts the meter's output signal without affecting the factory calibration curve. Use the K-factor calibration offset for *additional* flow profile compensation (the factory includes an initial flow profile correction in the calibration curve of the unit).



The flow meter must not be reporting or measuring gas flow during adjustments.

Entering a K-factor using the LCD Display

A K-factor value of 1.000 means the output value is not affected and is the factory default setting. You may enter any number from 0.500 to 5.000.

1. Select the desired range. Select FUNCTION, enter the password. Select FUNCTION again until K - factor appears on the display.
2. Use UP or DOWN to enter the desired K-factor value in engineering units.
3. Select FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new K-factor is in effect.

Entering K-factor using the Single-Digit LED

A K-factor value of 1.000 VDC means the output value is not affected and is the factory default setting. You may enter any value from 0.500 to 5.000 VDC in Step 3 below. If the device indicated output is 3.0 VDC and you know it should be 3.8 VDC then you could “force” the output to the desired 3.8 VDC by adjusting the K-factor to indicate 1.27 VDC ($1.27 = 3.8/3.0$). Use this formula to determine the desired K-factor voltage:

$VOLTS = DESIRED / INDICATED$

1. Set the DVM to voltage mode and connect between Vout+ and Vout– on the flow meter terminal block.
2. Select the desired range. Press the FUNCTION button until a solid “7” appears on the LED.
3. Adjust the UP or DOWN button until the DVM indicates the de-sired K-factor value as described above.
4. Press FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new K-factor is in effect.

User Full Scale Adjustment

The user full scale (UFS) feature adjusts the flow meter output range anywhere within 50% to 100% of the factory full scale (FFS). This feature allows you to re-range the voltage or current output of the meter to accommodate different flow rates. Note: when entering a new user full scale setting for Range 2, it cannot be less than 10% of the Range 1 user full scale.



The flow meter must not be reporting or measuring gas flow during adjustments.

Changing the User Full Scale using the LCD Display

The factory full scale is shown on the flow meter label. If you want a UFS equal to the FFS, adjust the display to match the FFS. If you want to use 50% of FFS, adjust the display to read 50% of the FFS.

1. Select the desired range. Select FUNCTION, enter the password. Select FUNCTION again until *User Full Scale* appears on the display.
2. Use UP or DOWN to enter the desired UFS value in engineering units.
3. Select FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new UFS is in effect.

Changing the User Full Scale using the Single-Digit LED

If the FFS is set to 11,000 sfpm and UFS is set to output 5.0 VDC, or 100%, the flow meter will indicate 5.0 VDC when 11,000 sfpm is present on the probe. If you want 6,000 sfpm for UFS, used in Step 3 below, adjust the UFS to 6000/11000 or 54.55% of factory full scale. Adjust the voltage to 2.73 VDC ($2.73 = 5 \times .5455$). Use this formula to determine the desired UFS voltage:

$$\text{VOLTS} = 5 \times \text{User Full Scale} / \text{Factory Full Scale}$$

1. Set the DVM to voltage mode and connect between Vout+ and Vout– on the flow meter terminal block.
2. Select the desired range. Press the FUNCTION button until a solid “8” appears on the LED.
3. Adjust the UP or DOWN button until the DVM indicates the desired user full scale as described above.
4. Press FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new UFS is in effect.

Time Response Delay Adjustment

Changing the Time Response Delay using the LCD Display

1. Select FUNCTION, enter the password. Select FUNCTION again until *Time Response* appears on the display.
2. Use UP or DOWN to adjust the time response delay from 0.10 to 7.2 seconds.
3. Select FUNCTION again to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new time response setting is in effect.

Changing the Time Response Delay using the Single-Digit LED

1. Set the DVM to voltage mode and connect between Vout+ and Vout– on the flow meter terminal block. Select the desired range. Press the FUNCTION button until a solid “9” appears on the LED.
2. Adjust the UP or DOWN button until the DVM indicates the desired voltage (as shown in the following table).

Volts Indicated on DVM	Time Response (Seconds)	Volts Indicated on DVM	Time Response (Seconds)	Volts Indicated on DVM	Time Response (Seconds)	Volts Indicated on DVM	Time Response (Seconds)
0.5	0.1	1.0	0.3	1.5	0.5	2.0	0.7
2.5	1.2	3.0	1.8	3.5	2.4	4.0	3.6
4.5	4.8	5.0	7.2				

3. Press FUNCTION to advance to the next option, or after 12 seconds of non-activity the meter returns to the Run Mode and the new time response delay setting is in effect.

Totalizer Reset

If your device is equipped with the optional LCD display, reset the totalizer using the magnetic switches or device buttons. If you are unable to open the flow meter enclosure, use a magnet to reset the totalizer as shown below.

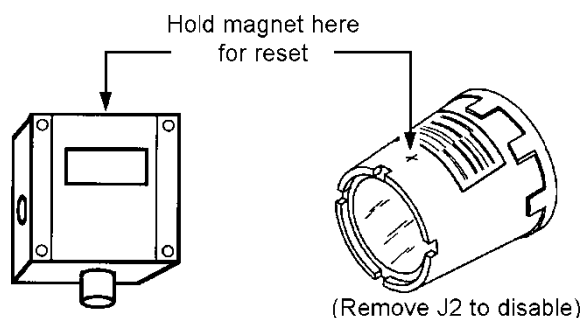
Reset the Totalizer using the LCD Display

1. Select the desired range. Select FUNCTION, enter the password. Select FUNCTION again until *Total Reset?* appears on the display.
2. Select the UP button and then the DOWN button until the display reads "Resetting Totalizer."

Reset the Totalizer without Opening the Enclosure

1. Position a magnet above the enclosure until the display reads "Resetting Totalizer."

For Hazardous-Area enclosures only: To disable the magnetic reset function of the totalizer, remove jumper (J2) from the PCB at the location shown below. (You may not disable the magnetic reset switch on NEMA 4X enclosures.)



Using the Smart Electronics Advanced Features

Zero and span (Function 1 through 4) can be used to validate system operation and calibrate the digital to analog signals on the Smart electronics device. Additionally, these functions can compensate for resistance in long signal cables connected to your data collection or indicating system.



The flow meter must not be reporting or measuring gas flow during adjustments.



Adjusting zero or span will affect meter calibration.

Voltage Zero Adjustments

You must use a certified digital voltmeter to adjust zero and span as the voltmeter acts as a standard. Record the current values as shown on the LCD display or DVM before making any changes to the zero and span settings. Note: when adjusting zero the voltage signal will be driven to 0 VDC and when adjusting span the voltage signal will be driven to 5 VDC (or 10 VDC).

If needed, use Zero Volts (Function 1) to adjust the 0-5 VDC output to 0.0 VDC, or optional 0-10 VDC to 0.0 VDC.

1. Set the DVM to voltage mode and connect between Vout+ and Vout-.
2. Select FUNCTION, enter the password (if so equipped). Select FUNCTION again until Zero Volts appears on the LCD display or a solid "1" appears on the LED. Adjust UP or DOWN until the DVM indicates between 0 and .01 VDC (no less than 0.005, the Smart electronics device cannot drive negative values).
3. After 12 seconds of non-activity, the meter returns to the Run Mode and the new parameter is in effect.

Voltage Span Adjustment

If needed, use Span Volts (Function 2) to adjust the 0-5 VDC output to 5.0 VDC, or optional 0-10 VDC to 10 VDC.

1. Set the DVM to voltage mode and connect between Vout+ and Vout-.
2. Select FUNCTION, enter the password (if so equipped). Select FUNCTION again until Span Volts appears on the LCD display or a solid "2" appears on the LED. Adjust UP or DOWN until the DVM, indicates between 4.99 and 5.01 VDC. (For 0-10 VDC de-vices, the target value is 9.99 to 10.01.)
3. After 12 seconds of non-activity, the meter returns to the Run Mode and the new parameter is in effect.

Current Zero Adjustment



Adjusting zero or span will affect meter calibration.

The 4-20 mA output may be adjusted using a loop calibrator or a certified digital multimeter (DMM). Before making any adjustments, verify that the total loop resistance of the system is within the limits shown in Figure 2-12. For reference, record the current value of the zero setting. Note: when adjusting zero the current signal will be driven to 4 mA.

If adjustment is needed, use Zero mA (Function 3) to adjust the 4-20 mA output to 4.00 mA.

1. Refer to the connection diagram corresponding to your flow meter model on the following page. To ensure best accuracy, measure the total loop resistance of the system and size the load resistance accordingly. (4-20 mA outputs are calibrated at the factory with a 250 Ohm load resistor.) Alternatively, you may simply insert an ammeter (DMM, loop calibrator in read mode) into the existing system's current loop to read the current. (For more information on isolated and non-isolated current loop installations, see Chapter 2.)
2. Select FUNCTION, enter the password (if so equipped). Select FUNCTION again until *Zero mA* appears on the LCD display or a solid "3" appears on the LED. Adjust the UP or DOWN button until the DVM indicates between 3.95 and 4.05 mA.
3. After 12 seconds of non-activity, the meter returns to the Run Mode and the new parameter is in effect. Reconnect wires as before.

Current Span Adjustment

The 4-20 mA output may be adjusted using a loop calibrator or a certified digital multimeter (DMM). Before making any adjustments, verify that the total loop resistance of the system is within the limits shown in Figure 2-12. For reference, record the current value of the span setting. Note: when adjusting span the current signal will be driven to 20 mA.

If adjustment is needed, use Span mA (Function 4) to adjust the 4-20 mA output to 20.00 mA.

1. Connect as above in Step 1 of Current Zero Adjustment.
2. Select FUNCTION, enter the password (if so equipped). Select FUNCTION again until *Span mA* appears on the LCD display or a solid "4" appears on the LED. Adjust the UP or DOWN button until the DVM indicates between 19.95 and 20.05 mA.
3. After 12 seconds of non-activity, the meter returns to the Run Mode and the new parameter is in effect. Reconnect wires as before.

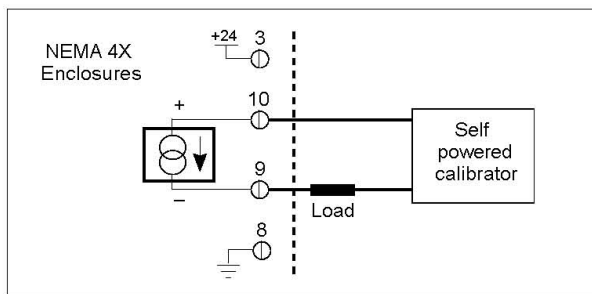


Figure 3-3. Current Adjustment Connections (Isolated)

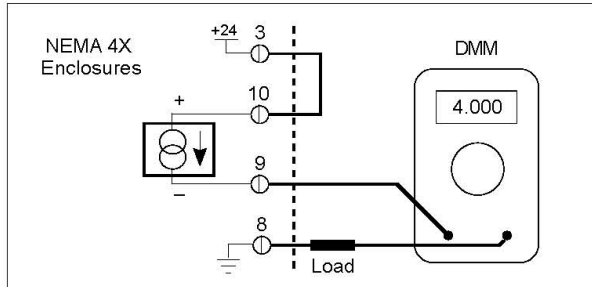


Figure 3-4. Current Adjustment Connections (Non-Isolated)

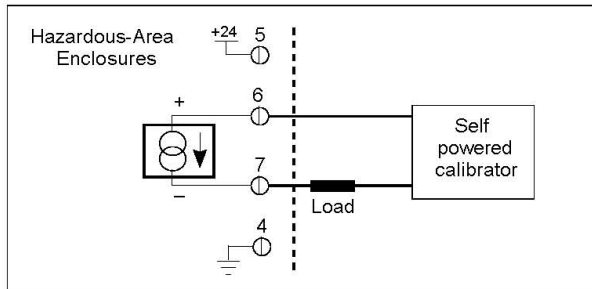


Figure 3-5. Current Adjustment Connections (Isolated)

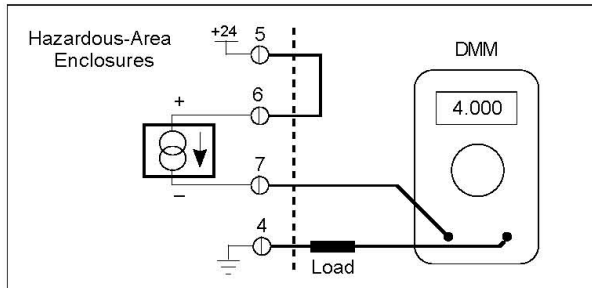


Figure 3-6. Current Adjustment Connections (Non-Isolated)

Instrument Validation

System electronics are verified by injecting a known input value and confirming that the flow meter outputs the expected value. This test confirms that the microprocessor, analog to digital and digital to analog converters, the linearizer and the display are working properly. Sensor validation is accomplished by measuring the resistance of the velocity and temperature sensors and comparing the results to the NIST-traceable calibration data provided with the flow meter. These tests confirm that your meter is working correctly and the calibration variables did not drift, shift or change values.

To perform the instrument validation procedures you will need the following equipment:

- Certified digital multimeter with minimum 4 character resolution, accuracy of at least $\pm 0.1\%$ of range
- Calibration Certificate supplied with the flow meter
- Small pot adjusting tool (screwdriver)

Before beginning the validation procedures, review Figure 3-7 and Figure 3-8 to familiarize yourself with the component locations.

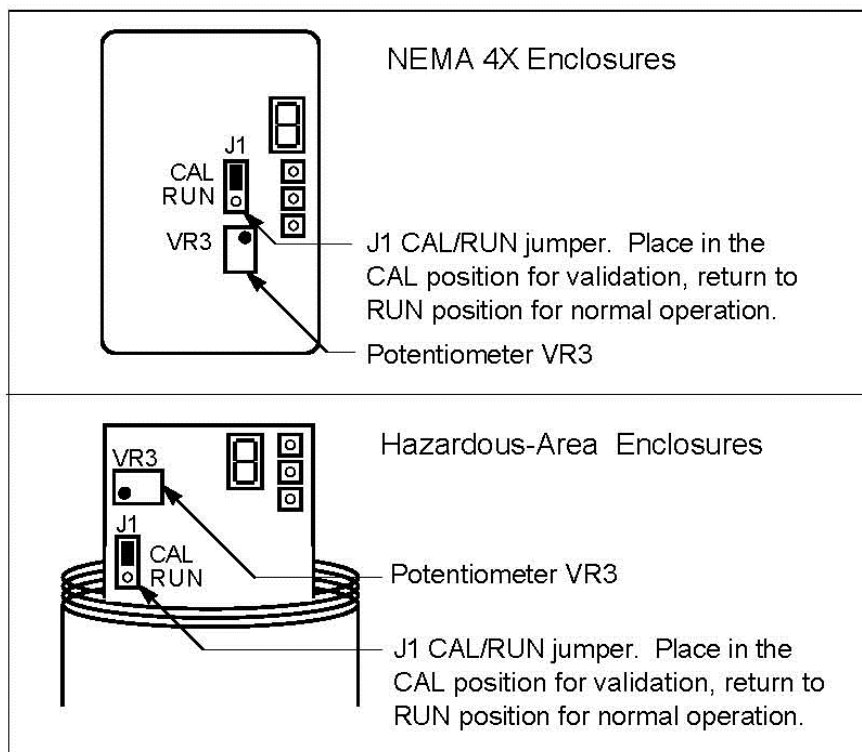


Figure 3-7. Electronics Validation Component Locations

Electronics Validation Procedure



Before beginning this procedure, make sure the flow meter is not actively monitoring or reporting to any master control system. Any adjustment to the electronics will cause direct changes to flow control settings.

1. Verify the flow meter is off line from any remote communications. Make sure the meter's user full scale setting is the same as the factory full scale setting. If not, adjust the user full scale value as needed
2. Locate the Calibration Certificate supplied with the flow meter. Record in Table 3-1 the five bridge voltage values, the output (VDC or mA) values and the indicated flow values.
3. Remove power from the flow meter. Remove the cover(s) of the flow meter enclosure to access the wiring terminal block and the Smart electronics device.
4. Set the multimeter to the 20 volt range. Connect to BV(+) and BV(–) terminals on the flow meter terminal block.
5. Move the J1 Cal/Run jumper on the Smart electronics device to the CAL position. Locate potentiometer VR3 on the Smart electronics device. Turn on power to the flow meter.
6. Adjust potentiometer VR3 until the multimeter matches the first bridge voltage point (the value must be ± 0.002 VDC of the bridge voltage point).
7. Record the resulting flow shown on the optional LCD display in Table 3-1. If not using a display or if you prefer to validate one of the analog output signals, move the multimeter + connection to Vout (+). Record the resulting output voltage in Table 3-1. If using a 4-20 mA calibrated meter, set the multimeter to read current and connect the meter to read the mA signal in your connected loop. Record the resulting current output in Table 3-1.
8. Repeat Step 6 and Step 7 to record the results of the remaining four bridge voltage validation points in Table 1. Compare the values recorded in Table 3-1. Indicated values must be within the flow meter's stated accuracy shown on the Calibration Certificate.
9. When data collection is complete, turn off power to the flow meter. Disconnect the multimeter from the flow meter terminal block.
10. Place the J1 Cal/Run jumper in the RUN position. Make sure the jumper is securely in place before resuming flow meter operation. Replace the flow meter cover(s).

Calibration		Certificate		Values	Validation Test		Results
Sample Point	Bridge Voltage	Indicated Flow	Output (V or mA)	Indicated Flow (LCD)	Flow Meter Stated Accuracy	Output (V or mA)	Flow Meter Stated Accuracy
0%							
25%							
50%							
75%							
100%							

Table 3-1. Electronics Validation Results

Sensor Validation Procedure



Do not power the flow meter with the sensor jumper disconnected. This could cause over-heating of the sensors and/or damage to the electronics.

1. Obtain the Ro and Alpha values for both the temperature and the velocity sensors. To obtain these, use the SIP134 software and provided SIP cable and navigate in the software to Advanced Options/Save Variables to Disk/Start/Save/OPEN FILE (using a text program such as WordPad). Scroll down to Alpha and Ro values for both sensors. Use these in your manual calculations. If you do not have access to the software, contact the factory and supply the serial number and sales order number and we can normally supply these values.
2. Turn off power to the flow meter. Allow a 6 minute cool-down before continuing.
3. Remove the cover of the flow meter enclosure to access the sensor connection points. Remove the four-position jumper from J5, J6, J7 and J8 (see below for location).

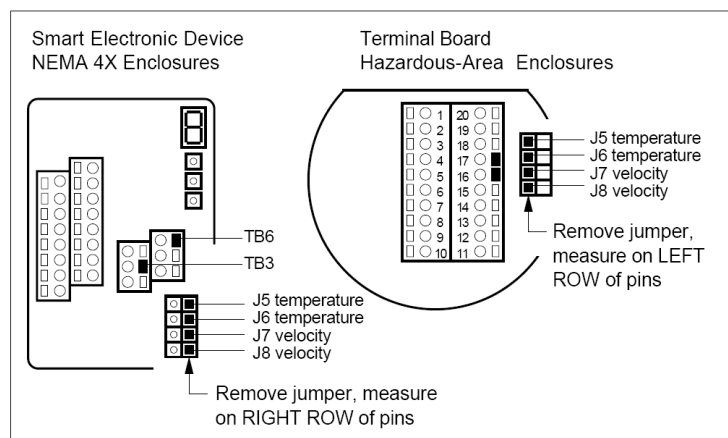


Figure 3-8. Sensor Validation Component Locations

4. Set the multimeter to read Ohms in the 200 Ohm range. Connect to TB3 and TB6 on NEMA 4X enclosures or TB17 and TB18 on Hazardous-Area enclosures. Measure the cable resistance between the terminals. Record the resistance (in Ohms) in Column 1 of Table 3-2.
5. Set the multimeter to read Ohms in the 2K range. Connect to terminals of J5 and J6 (temperature sensor). Measure the resistance between J5 and J6. Record the temperature sensor resistance (in Ohms) in Column 2 of Table 3-2.
6. Set the multimeter to read in the 200 Ohm range. Connect the multimeter to terminals of J7 and J8 (velocity sensor). Measure the resistance between J7 and J8 and record the velocity sensor resistance (in Ohms) in Column 2 of Table 3-2.
7. Calculate R_{final} by subtracting Column 1 from Column 2. Enter the value in Column 3 of Table 3-2.

8. Use the measured resistance values and the R_0 and Alpha R_0 values from the Calibration Certificate to calculate the temperature for each sensor as follows:

$$T = \frac{R_{\text{final}} - R_0}{\text{Alpha} \times R_0}$$

Where

T = degrees Celsius

R_{final} = measured sensor resistance

R_0 = resistance at 0°C (from the Calibration Certificate)

Alpha = value unique to each sensor (from the Calibration Certificate)

9. Compare the results recorded in Column 4 of Table 3-2. The sensors are validated if they are within 10 degrees Celsius of each other.
10. Disconnect the multimeter and replace the four-position jumper on the sensor terminals. Make sure the jumper is securely in place before applying power. Replace cover.

Column 1	Column 2	Column 3	Column 4
Cable Resistance	Temperature Sensor Resistance	R_{final}	T (from equation)
Cable Resistance	Velocity Sensor Resistance	R_{final}	T (from equation)

Table 3-2. Sensor Validation Results

Chapter 4 | Troubleshooting and Repair



Before attempting any flow meter repair, verify that the line is not pressurized.



Always remove main power before disassembling any part of the mass flow meter.

Begin hardware troubleshooting by verifying the following facilities issues are correct. These areas impact system operation and must be corrected prior to performing any flow meter inspections.

1. Verify the incoming power to the flow meter is present and of the correct voltage and polarity.
2. Check the flow meter wiring for correct connections as described in Chapter 2.
3. Verify the flow meter is installed with the correct number of upstream and downstream pipe diameters as shown on page 12.
4. Verify the flow direction indicator is correctly aligned pointing downstream of flow.
5. Make sure there are no leaks in the line being measured.

After verifying the factors above, follow the troubleshooting procedures outlined on the next page. If you need to return the flow meter to the factory, see page 47 for return shipping instructions.

Problem	Possible Cause	Solution
Velocity measurement is erratic or fluctuating	Very erratic or non-uniform flow	Follow installation requirements shown in Chapter 2
	Flow meter installed with less than required minimum pipe diameters upstream and downstream of the sensor	Follow installation requirements shown in Chapter 2
	Insertion sensor probe not mounted securely	Sensor probe must be mounted securely without vibration
	Sensor component broken	Return to factory for replacement
	Malfunction in system electronics	Return to factory for evaluation
	Ground loop	Check wiring, see Chapter 2
	Moisture present in gas flow	Install a water trap or filter upstream of the flow sensor
Velocity measurement seems too high or low	Sensor assembly not aligned correctly to flow	Correct alignment with the flow indicator pointing downstream in the direction of flow
	Sensor probe not inserted to the proper depth	Verify sensing point is located on the centerline of the pipe
No response to the flow from sensor assembly	No power	Turn on the power to the flow meter
	Low flow cutoff too high	Correct low flow cutoff programming using the Smart Interface Software
	Flow rate below meter's minimum flow rating	Contact factory for instructions
	Flow has exceeded the maximum range of the flow meter	Set the user full scale to equal the factory full scale Reduce flow below the maximum range shown on the meter's nameplate or contact the factory for re-calibration advice
	Flow profile distortions	Try to find another location for the meter
	Extremely turbulent flow	Do not place the meter near a ventilator, static mixer or valve
	Sensor failure	Return to factory for evaluation
	Printed circuit assembly defective	Return to factory for evaluation

Returning Equipment to Factory

Factory Calibration—All Models

Sierra Instruments maintains a fully-equipped calibration laboratory. All measuring and test equipment used in the calibration of Sierra transducers are traceable to NIST Standards. Sierra is ISO-9001 registered and conforms to the requirements of ANSI/NCSL-Z540 and ISO/IEC Guide 25.

Instructions for Returning Your Instrument for Service

The following information will help you return your instrument to Sierra Instruments' Factory Service Center and will ensure that your order is processed promptly. Prices may vary depending on the flow range, type of gas and operating pressure of your unit. To request detailed pricing, contact your local Sierra Instruments distributor or contact one of our offices directly.

Please follow these easy steps to return your instrument for factory service:

1. To obtain a Return Materials Authorization (RMA) number from the Sierra Instruments to <http://www.sierrainstruments.com/rma/new.php> to create a Sierra Account.
2. Once you have created an account, click on the Submit New RMA tab and fill in the RMA form and follow the instructions. You will receive an email confirmation once you have submitted your RMA.
3. Print a copy of the RMA (that now includes RMA #) and send a copy of the RMA form along with your meter back to the factory.

If you require service beyond calibration, but do not know which service(s) will be required, describe the symptoms as accurately as possible on the RMA form.

Pack your instrument carefully. Use the original packaging and foam or bubble wrap (packing peanuts NOT recommended) and include a copy of the RMA form (complete with Sierra supplied RMA number) with the unit(s).

Ship the unit(s) to the following address:

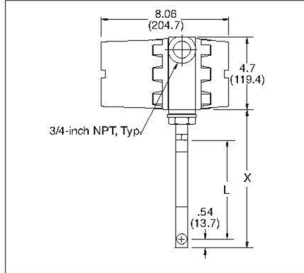
Sierra Instruments, Inc.
Attention: Factory Service Center
20 Ryan Ranch Road, Suite 109
Monterey, CA 93940 USA
RE: RMA# (your number)

Appendix A | Product Specifications

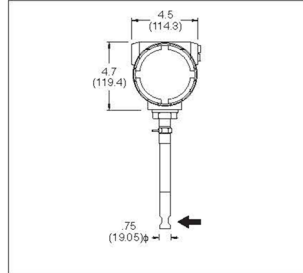
2

HAZARDOUS-AREA LOCATION ENCLOSURE DIMENSIONAL SPECIFICATIONS

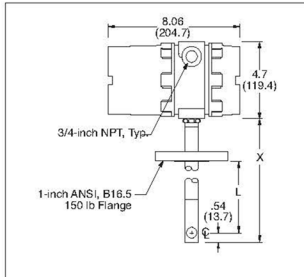
Compression Fitting—Side View (E2)



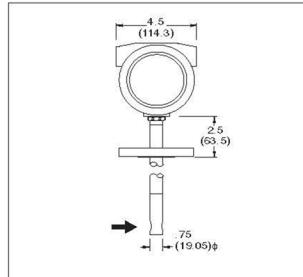
Compression Fitting—Front View (E2)



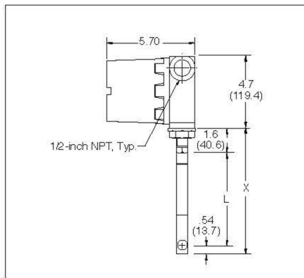
Flange Mounting—Side View (E2)



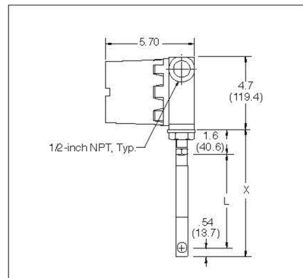
Flange Mounting—Front View (E2)



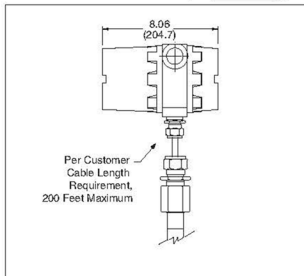
Remote Mount Junction Box—Side View (E4)



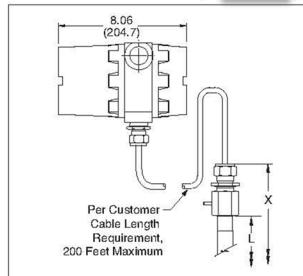
Remote Mount Junction Box—Front View (E4)



Remote Mount—Side View (E3, XXXXXX)



Remote Mount—Front View (E3, XXXXXX)



TABLES

Length Chart (Compressions Fittings)

Code	L	X
L06	6.0 (152.4)	7.5 (190.5)
L09	9.0 (228.6)	10.5 (266.7)
L13	13.0 (330.2)	14.5 (368.3)
L18	18.0 (457.2)	19.5 (495.3)
L24	24.0 (609.6)	25.5 (647.7)
L36	36.0 (914.4)	37.5 (952.5)

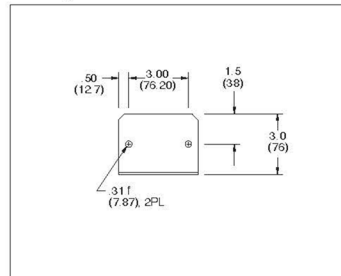
Length Chart (Flange Mounting)

Code	L	X
L06	6.0 (152.4)	9.0 (228.6)
L09	9.0 (228.6)	12.0 (304.8)
L13	13.0 (330.2)	16.0 (406.4)
L18	18.0 (457.2)	21.0 (533.4)
L24	24.0 (609.6)	27.0 (685.8)
L36	36.0 (914.4)	39.0 (990.6)

Length Chart (Remote Mount Junction Box)

Code	L	X
L06	6.0 (152.4)	7.5 (190.5)
L09	9.0 (228.6)	10.5 (266.7)
L13	13.0 (330.2)	14.5 (368.3)
L18	18.0 (457.2)	19.5 (495.3)
L24	24.0 (609.6)	25.5 (647.7)
L36	36.0 (914.4)	37.5 (952.5)

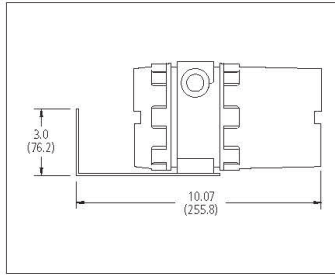
Mounting Holes for Remote Bracket



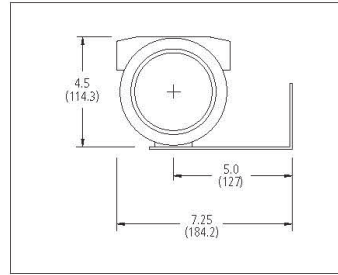
All dimensions are inches. Millimeters are in parentheses. All drawings have a +/- .25-inch (6.4 mm) tolerance. Certified drawings are available on request.

HAZARDOUS-AREA LOCATION ENCLOSURE DIMENSIONAL SPECIFICATIONS

Remote Rear Bracket Mounted Electronics



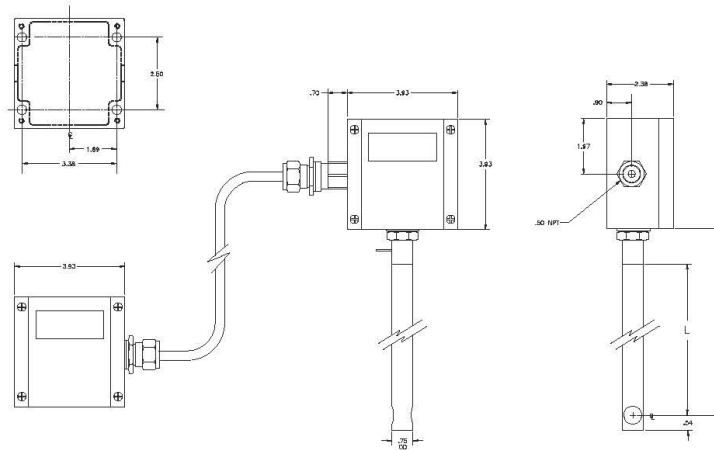
Remote Side Bracket Mounted Electronics




TABLES

Length Chart (NEMA 4X)		
Code	L	X
L06	6.0 (152.4)	7.25 (184.1)
L09	9.0 (228.6)	10.25 (260.3)
L13	13.0 (330.2)	14.25 (361.9)
L18	18.0 (457.2)	19.25 (488.9)
L24	24.0 (609.6)	25.25 (641.3)
L36	36.0 (914.4)	37.25 (946.1)

NEMA 4X DIMENSIONAL SPECIFICATIONS



SELF-CLEANING PURGE OPTION

- Maximum process pressure 100 Psi
- Maximum process temperature 500 F.
- Max pressure purge air: 150 Psi
- Process connection Purge air 1/4" NPTF
- Wetted Process Parts: all 316SS
- The purge gas must be clean and dry. Do not use a liquid to clean the sensor inline
- The purge system is only available with E4 and E2 housings
- The purge system is NOT available with FM  or CSA approval or the high temperature option

Warning: During the purge cycle there will be a high flow over the sensor. This will drive the output of the flow meter to the maximum flow (Output will be 20-26 mA (load dependent) during the purge. Insure that this temporally high output does not effect any alarms or process control systems.

Operation: This is not a continous flow of air, but a blast purge option. The purge nozzle creates a jet stream wich blows deposits from the sensors. The frequency and intensity of the purge is determined by the end user. It can be done with a suitable manual, pneumatic or electric valve (Solenoid). It is also possible to control the purge system automatically (f.i. timer, PLC or HMI).

Note: There is a check valve built Inside the flow meter to prevent the return flow of process gasses into the purge system. Replacement of this valve can only take place in the factory.

Note: Only a 24 VDC power input is available when ordering an internal purge option.

LOW PRESSURE HOT TAP TO 150 PSIG (10 BARG)

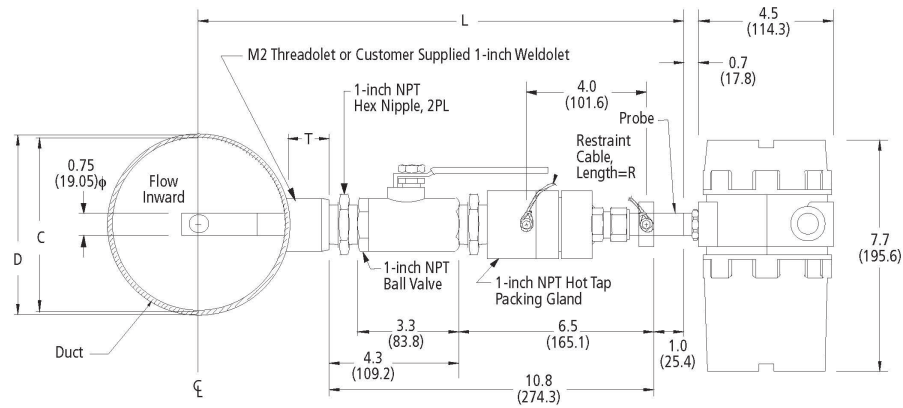
Side View

Variables

L = Nominal Probe Length
 D = Duct O.D.
 C = Duct I.D.
 T = Height of "Threadolet" or Customer Provided Weldolet
 R = Restraint Cable Length

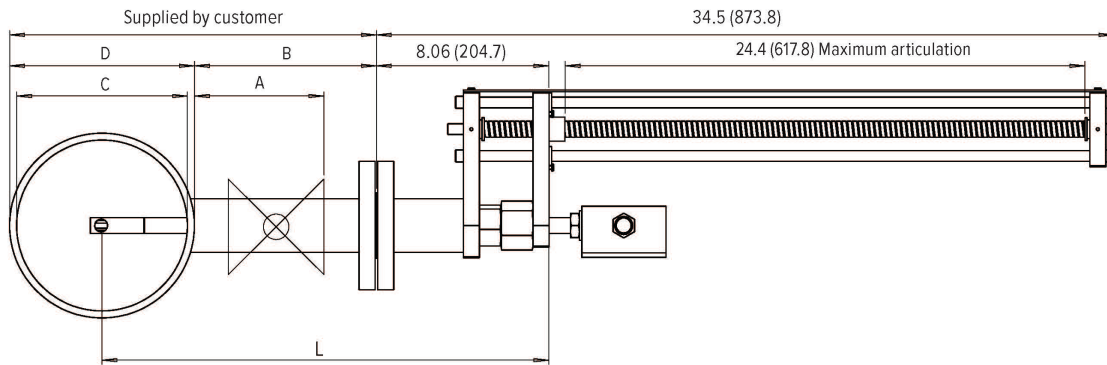
Formula

$L \geq 12 + D/2 + T$
 So L must be equal or greater than 12-inches plus the height of the "Threadolet" plus half the duct O.D.
 $R = D/2 + T + 8.8$



All dimensions are inches. Millimeters are in parentheses. All drawings have a +/- .25-inch (6.4 mm) tolerance. Certified drawings are available on request.

HIGH PRESSURE HOT TAP IS FLANGE DEPENDENT UP TO 400 PSIG (27.6 BARG)



UNOBSTRUCTED FLOW REQUIREMENTS

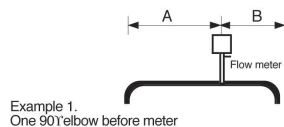
Select an installation site that will minimize possible distortion in the flow profile. Valves, elbows, control valves and other piping components may cause flow disturbances. Check your specific piping condition against the examples shown below. In order to achieve accurate and repeatable performance install the flow meter using the recommended number of straight run pipe diameters upstream and downstream of the sensor. If you cannot meet these requirements please refer to the Flat-Trak™ Model 780S with flow conditioning plates (flow conditioning plates reduce upstream requirements to as little as 2 diameters).

Example - Upstream Requirements (A)

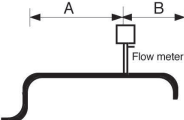
1	15D
2	20D
3	40D
4	15D
5	30D
6	40D

Example - Downstream Requirements (B)

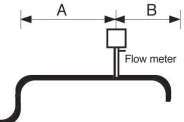
1	5D
2	5D
3	10D
4	5D
5	10D
6	5D



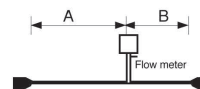
Example 1.
One 90° elbow before meter



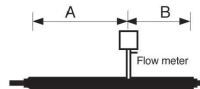
Example 2.
Two 90° elbows before meter in one plane



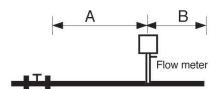
Example 3.
Two 90° elbows before meter out of plane (if three 90° bends present, double recommended length)



Example 4.
Reduction before meter



Example 5.
Expansion before meter



Example 6.
Regulator or valve partially closed before meter (If valve is always wide open, base length requirements on fitting preceding it)

DESCRIPTION

Accuracy of Point Velocity

+/- 1% of reading + 0.5% of full scale.

Note: Overall accuracy of HT meters may be de-rated due to temperature and velocity conditions.

Repeatability

+/- 0.2% of full scale

Temperature Coefficient

+/- 0.02% of reading per °F within +/- 50° F of customer specified conditions

+/- 0.03% of reading per °F within +/- 50° F to 100° F of customer specified conditions

+/- 0.04% of reading per °C within +/- 25° C of customer specified conditions

+/- 0.06% of reading per °C within +/- 25° C to 50° C of customer specified conditions

Pressure Coefficient

.02% per psi for air, consult factory for other gases

Response Time

One second to 63% of final velocity value

OPERATING SPECIFICATIONS

Gases

Most gases compatible with 316 stainless steel

Hastalloy® available

Gas Pressure (2 limitations)

Mechanical design pressure:

Compression fittings: 500 psig (34 barg)

1-inch 150 lb flange (-40° to 250° F): 185 psig (12.8 barg)

Low Pressure Hot Tap: 150 psig (10 barg)

High Pressure Hot Tap: 275 psig (18 barg)

Pressure Drop

Negligible for pipes three inches in diameter or larger

Gas & Ambient Temperature

Gas: -40° F to 350° F (-40° C to 177° C) Gas dependent.

Ambient: -40° F to 120° F (-40° C to 50° C)

Leak Integrity

5 x 10⁻⁹ cc/sec of helium maximum

Power Requirements

18 to 30 VDC (regulated), 625 mA maximum

100 to 240 VAC, 50/60 Hz, 15 watts maximum

625 mA maximum operating current at 24 VDC and full scale flow

Maximum inrush current of 2 Amps at 24 VDC

HIGH TEMPERATURE OPTION

Up to 750° F (400° C) air only; consult factory for other gases

DIGITAL COMMUNICATIONS OPTIONS

Pulse (not available with E2-NR)

Modbus RTU (not available with P3 option)

Output Signal

Linear 0–5 VDC or 0-10 VDC, 1000 ohms minimum load resistance or Linear 4–20 mA proportional to mass flow rate,

700 ohms maximum resistance power supply dependent

User-selectable: Active non-galvanically separated or Passive galvanically separated (loop power required)

Alarms

Hard contact user-adjustable high and low

Dead band adjustable with Smart Interface™ software

Relay ratings: Maximum 400 VDC or VAC (peak), 140 mA

Displays

Alphanumeric 2 x 12 digit backlit LCD

Adjustable variables via on-board switches (password protected) or with Smart Interface™ software

Adjustable variables: Full scale (50 to 100 %)

Time Response (1 to 7 seconds)

Correction factor setting (0.5 to 5)

Zero and span

High and low alarm settings

Totalizer

Eight digits (99,999,999) in engineering units

Resettable by software, on-board switches or external magnet

Software

Smart Interface™ Windows®-based software

Minimum 8 MB of RAM, preferred 16 MB of RAM

RS-232 communication

Additional features: Alarm dead band adjustment

Zero cut-off adjustment

Linearization adjustment

Save / Load configurations

Flow meter validation

PHYSICAL SPECIFICATIONS

Wetted Materials

316 stainless steel

Enclosure

Hazardous-Area Location Enclosure (IP66) or NEMA 4X (IP65)

Both are powder-coated cast aluminum

Electrical Connections

Two 3/4 inch NPT: Hazardous-Area Location Enclosure (IP66)

One 1/2 inch NPT: NEMA 4X Enclosure (IP65)

Mounting (optional)

ANSI 1-inch 150 lb flange

3/4-inch tube compression fitting with 1-inch male NPT

Hot tap systems

Certifications

CE (All enclosures)

CSA (Explosion proof for Class I, Division 1, Groups B, C, D)

FM (Explosion proof for Class I, Division 1, Groups B, C, D; dust-ignition proof for Class II, III, Division 1, Groups E, F, G)

IP65, NEMA 4X T6 -40° C to 50° C ambient

Chinese pattern approval

GOST R/RTN (1ExdIICT6...T2)

ORDERING THE 640S

Features								Options						
640S	-		-		-		-		-		-		-	
Parent	1	2	3	4	5	6	7	8	1	2	3	4	5	

Instructions: To order the 640S please fill in each number block by selecting the codes from the corresponding features below and following pages.

Parent Number	
640S	Steel Mass Industrial Insertion Mass Flow Meter. 18-30 VDC or 100-240VAC input power with 3/4-inch diameter 316SS probe. Includes "Smart Electronics" with PC configuration software. Calibration temperatures up to 350°F (176°C). See gas table for pressure limits. HT option to 750°F (400°C) available (contact factory). CE, FM, CSA, <input type="text"/> approvals. Linear 0-5 VDC, 0-10 VDC or 4-20 mA output signals. Lifetime warranty on Fast Response (FR) sensor

Feature 1: Approvals	
NAA	Non-agency approved meter
<input type="text"/>	
FM	640S with FM Approval. Requires E2 or E4 enclosure. Maximum probe length is 72 inches (1.83 m)
CSA	640S with CSA Approval. Requires E2 or E4 enclosure. Maximum probe length is 72 inches (1.83 m)

Feature 2: Probe Length			
L06	6 inch (15 cm)	L24	24 inch (61 cm)
L09	9 inch (23 cm)	L36	36 inch (92 cm)
L13	13 inch (33 cm)	L42	42 inch (122 cm)
L18	18 inch (46 cm)		
L () M5	Probe with 1 inch, class 150 Flange Specify length between flange face and center of pipe in parentheses. Include M5 option Diagram with ADS. Don't select a probe length from Feature 2. Note 1: Killark seal is required for FM and CSA agency approved meters greater than L13 (33 cm). Adds 6.2 in (157 mm) to probe length listed above.		
L () M9	High pressure hot-tap with removable retractor kit assembly includes probe (probe length L in parentheses). Available in lengths per feature. MINIMUM length is process connection dependent, maximum as desired, removable retractor assembly, packing gland probe seal with a 2-inch ANSI class 150 process connection (other classes available, contact factory) and Conax fitting. Max pressure flange dependent or 500 psig (34.5 barg). Not available with <input type="text"/>		

Note 1: Killark seal is required for FM and CSA agency approved meters greater than L13 (33 cm).
Adds 6.2 in (157 mm) to probe length listed above.

Feature 3: Mounting Accessories	
M0	None. Customer to supply own mounting hardware
M1	Compression fitting 3/4-inch with 1-inch NPT Male
M2 ()	Threadolet 1-inch Female NPT; specify pipe O.D. in parenthesis
M1-M2 ()	Compression fitting plus Threadolet. 3/4-inch probe feed through by 1-inch NPT. Threads into 1-inch Female NPT, which is welded to the pipe. Specify pipe O.D. in parenthesis. We strongly advise to purchase this as a set, since we've seen non compatible NPT threads in the past.
M3	Flat duct bracket. 3/4-inch tube compression fitting
M4 ()	Curved duct bracket. 3/4-inch tube compression fitting. Specify duct O.D. in parentheses
M8 ()	Low pressure hot tap. Includes ball valve and packing gland. Specify duct O.D. in parentheses. Maximum 150 psig (10.3 barg). Maximum temperature 425°F (218°C).
M15	Quick removal Hot-Tap. Includes ball valve and compression fitting. Rated for 40 psig (2.8 barg)

Feature 4: Electronics Enclosure	
E2	Hazardous-area location enclosure (IP66) Mounted directly on probe
E3 ()	Remote probe and flow body 10, 25, 50, 100 feet (select one) away from the probe.
E4 ()	Remote Hazardous-Area Location Enclosure (IP66) with Junction Box
EN2	NEMA 4X (IP65) enclosure. Mounted directly on probe
EN4 ()	Remote NEMA 4X (IP65) Enclosure with Junction Box.

Note: E4, EN4: 10, 25, 50, 100 feet (select one) away from the probe with junction box mounted on probe. Customer may cut cable length with no effect on accuracy.

Feature 5: Input Power	
P2	18–30 VDC
P3	100–240 VAC. Not available with EN enclosures

Feature 6: Output	
V1	0-5 VDC, linear
V3	0-10 VDC, linear
V4	4-20 mA, linear

Feature 7: Display	
NR	No readout
DD	Digital display 2 x 12 digit, backlit, LCD display indicates flow rate and totalized mass in engineering units. Simplifies configuration settings and provides system status information
DD-NRT	Totalizer cannot be reset in the field.

Feature 8: Gas	
0	Air
1	Argon
2	Carbon dioxide
3	Chlorine ¹
4	Digester gas
5	Digester gas ¹
6	Helium
7	Hydrogen
8	Methane
9	Methane ¹
10	Nitrogen
11	Oxygen ¹
12	Propane
13	Propane ¹
14	Ammonia ¹
99	Other--Consult Factory Gas Table

Option 1: Digital Communications

Pulse	Totalizer pulse output (Only available with E2/E3/E4 enclosures WITH DD. Available on ALL EN2 Enclosures)
MB	Modbus RTU with full device description (P2 only); <input type="checkbox"/> FM approvals available

Note: Only MB require DC power (P2).

Option 2: Purge

PURGE	Includes non-return valve, tube and purge nozzle option for cleaning of probe tips. 30-120 psig (2.1- 8.3 barg) external compressed air source required. Uses 1/4-inch compression fitting on purge tube process connection. Available with E2 or E4 only (NAA only). Not available with HT option (Contact factory in this case for external purge solution). Does not include on/off valve. Note: Only a 24 VDC power input is available when ordering an internal purge option.
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Option 3: High Temperature

HT	HT option to 750°F (400°C). Requires remote (E4 or EN4). Contact factory for probe length. Note: Overall accuracy of HT may be de-rated due to temperature and velocity conditions. NAA only.
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Note: ¹Correlation calibration - consult Gas Table for accuracy.

Option 4: Certificates	
MC	Material certificates--US Mill certs on all wetted parts
CC	Certificate of conformance
NACE	NACE certificate for sour gas
LT	Leak test certificate
PT	Pressure test certificate
CO	Stamped Certificate of Origin

Option 5: O2 Cleaning	
O2C	O2 Cleaning. Includes certification. Product cleaned for O2 service. Inspected with Ultra-Violet light only, double-bagged prior to shipment.

Appendix B | Warranty Policy

Limited Warranty Policy- Register Online

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. Register now at www.sierrainstruments.com/register.

Lifetime Limited Warranty on Patented DrySense™ Sensor Technology

In addition to Sierra's standard one (1) year manufacturing warranty on all instruments produced, Sierra also offers a lifetime warranty on all DrySense™ sensors standard with Sierra models 640S, 670S, 780S, 640i, and 780i instruments sold after January 1, 2010. This warranty does not extend to the Model 620S, the BoilerTrak™, the HT (High Temperature) 640S/780S sensor or the 780S UHP (Ultra High Purity) sensors. Learn more about Sierra's warranty policy at www.sierrainstruments.com/warranty