SAGE METERING

Thermal Mass Flow Meters

MODEL 51

HVAC SERIES

Thermal Mass Flow Meter
for Natural Gas

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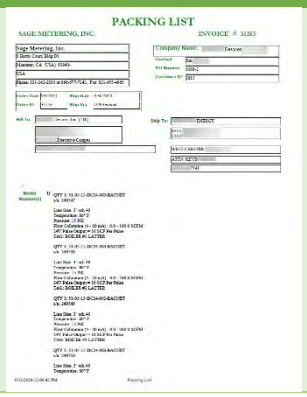
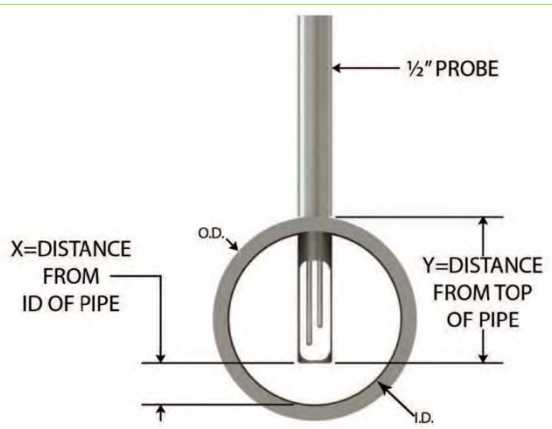
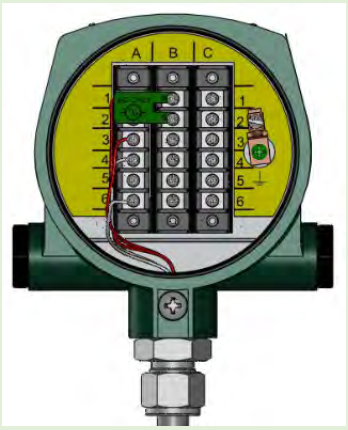
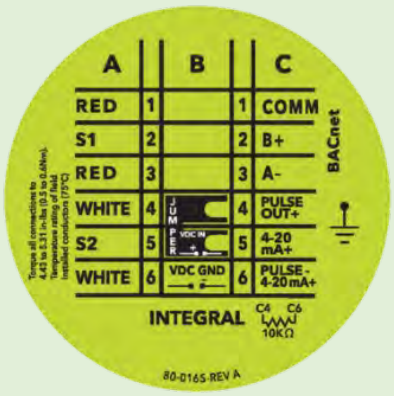
Table of Contents

Quick Start Guide

Step	Description	P & ID Diagram
1	**PACKAGE CONTENTS:** Ascertain that your order has all equipment and accessories; refer to the packing list.	 
2	**INSERTION TYPE FLOW METER DIAMETER CHECK:** Check that the internal pipe diameter (ID) matches the pipe ID shown on the Sage Calibration Certificate.	SAGE **PRODUCT QUALITY CERTIFICATE OF CONFORMANCE** **Product Inspection & Quality Statement** **All individual parts and components which make up the product being provided have been inspected and approved for manufacture. In addition, subassemblies have been inspected, tested, and accepted for final assembly. Each completed assembly has been final tested and approved for shipment.** **Conformance Statement** **SAGE Metering Incorporated certifies this instrument was tested in compliance with ANSI/NCSL Z540 and ISO/IEC 17025 requirements. SAGE Metering, Inc. calibration services are derived from MIL-STD-45662A. Model 51 is Met Labs approved and Met Labs is a Nationally Recognized Testing Laboratory (NRTL) which is recognized by OSHA. The tests are performed using measuring & test equipment with certified NIST traceability. (Applicable NIST numbers are available upon request). Reproduction of the complete certificate is allowed. Parts of the certificate may only be reproduced after written permission is granted by SAGE Metering, Inc.**
3	**FLOW DIRECTION:** Verify the straight-run requirements based on pipe ID and meter type style.	**IMPORTANCE OF FLOW CONDITIONING** **Recommended Pipe Diameters Upstream**

DISTURBANCE	*Without* Flow Conditioning	*With* Flow Conditioning[1]
	Minimum Industry Recommendation	Sage Recommendation
One 90° Elbow	25	3
Two 90° Elbows in the Same Plane	36	5
Two 90° Elbows in Different Planes	62	9
4:1 Area Reduction	18	3
4:1 Area Expansion	84	10
Multiple Disturbance	TBD	TBD

[1] This column applies to in-line flow meters, which come standard with built-in flow conditioners, as well as insertion meters, when installed with upstream Captive Flow Conditioners.

4	**VERIFY CORRECT PROBE DEPTH SETTING:** **1/2-Inch Probe** See 1/2" Probe Diameter Installation.	
5	**POWER SOURCE and 4-20mA WIRING:** Remove the flow meter back cover and verify the wiring connectivity.	 

Welcome

We are pleased you purchased a Sage Metering Mass Flow Meter to meet your requirements. We hope you are satisfied with the performance, operation, and design of our precision NIST-traceable thermal gas mass flow meter.

Sage Metering is your source for monitoring, measuring, and controlling the gas mass flow in your industrial process, building management system, or environmental application. Our high-performance, NIST traceable thermal mass flow meters help increase productivity, reduce energy costs, maximize product yields, and help reduce environmental insult. Sage provides high-quality in-line and insertion thermal mass flow meters for various industrial, commercial, and environmental monitoring needs, including carbon credit verification for greenhouse gas reduction.

Sage meters measure mass flow directly—there is no need for ancillary instrumentation such as temperature or pressure transmitters. Furthermore, our instruments have exceptional signal sensitivity, no moving parts, require little, if any, maintenance, negligible pressure drop, a turndown up to 100 to 1, and resolve as much as 1000 to 1. Sage Flow Meters can measure the mass flow rate and consumption of air, oxygen, natural gas, nitrogen, digester gas, biogas, argon, carbon dioxide, and other gases and gas mixes.

The Sage Model 51 HVAC Series is a line extension of the Sage Prime that is dedicated to HVAC applications. These products provide the same performance as the Prime model with fewer features and less functionality at economical pricing. The 51 HVAC Series is available with a display and integral electronics. The display shows the flow rate, total flow, and gas temperature. The 51 Series is for HVAC customers and is calibrated for natural gas mass flow rate and consumption.

The 51 HVAC Series provides a 4-20 mA and a pulse signal and is powered by 24 VDC. BACnet communications is standard, or Modbus RTU, which is optional.

Insertion style models are available for pipe sizes from 1-1/2" to 8", and in-line style models are available for pipe sizes from ½" to 4", either with NPT or 150 lb flanged fittings.

Please let us know if we can assist you with your Sage meter needs. If you have any questions regarding installation, operation, or features, call 866-677-SAGE (7243) or visit sagemetering.com to contact a factory representative in your area. This manual and other product literature are available to download under Doc-Downloads at https://sagemetering.com/product-literature-downloads/.

Sincerely,

Bob Steinberg

President

SECTION A:

Getting Started

Unpacking Your Sage Meter

Your Sage flow meter is a sensitive yet rugged, precision-built electronic instrument. Upon delivery, take care when opening the shipping container and removing your meter. Inspect the meter for any damage that may have occurred during transit. If there is any damage, please contact the carrier immediately to place a claim for damaged goods.

Check the contents of the container against the packing list for any discrepancies. If there are any questions about the configuration of the equipment, including calibration ranges or mounting hardware, contact Sage Metering for assistance. Please save the shipping container and packaging materials (including the PVC tube probe protector on Sage insertion flow meters) if the unit needs to be returned for any reason.

Maintenance

Sage thermal mass flow meters require little or no maintenance. While the sensing element is somewhat resistant to dirt and particulate buildup, it may become necessary to clean it from time to time if mounted in exceptionally unclean environments. **Note: Always remove the power before any cleaning or maintenance.** A detergent or appropriate non-corrosive solvent for removing the buildup may be required. A soft brush can gently clean the sensing element's surface, using caution to avoid damaging the sensor elements (the RTDs). If any disassembly is necessary, contact Sage Metering for instructions. **When the meter requires cleaning, repair, or recalibration, returning the equipment to the factory has historically proven to be the most cost-effective and reliable choice.**

Calibration

Each flow meter is individually calibrated for the specified gas and flow rate on the application sheet submitted with each order. The unit is factory-configured for the process and installation parameters. A Certificate of Conformance is included with each unit.

CAUTION–The cable glands shipped with the unit are for shipping purposes only. Remove shipping cable glands before installing.

CAUTION–If installing in a Class I hazardous location, the installation must comply with appropriate electrical codes.

Installation and Mounting

EN60079-14 Standard for Electrical Installations

Check the Certificate of Conformance included with your Sage thermal mass flow meter for system pressure, temperature, gas composition, power input, and signal output.

Insert the flow meter in a location providing maximum straight run. Refer to Flow Conditioning and Straight Run on page 10. Note that obstructions such as valves, blowers, expanders, PVC, and HDPE pipes require additional straight runs (contact the factory for assistance).

Check the display orientation—The standard calibration flow direction is left to right when facing the flow meter. The direction of gas flow is marked by an arrow on in-line flow meters, while the **upstream** is marked on insertion probes. If the enclosure is facing *incorrectly*, rotate the enclosure 180˚, but **never** rotate the probe, or errors may occur. The **upstream** mark still needs to be facing upstream. [1]

Hook up the system by referring to the wiring diagram provided with your Sage flow meter (see the inside of the rear compartment cover for terminal designation). Verify that the wiring for the power and signal connections is correct.

Inspect that all the plumbing and electrical hook-ups comply with OSHA, NFPA, and all other safety requirements.

Locating Proper Wiring Diagram

The Sage 51 HVAC Series' electrical wiring is shown on pages 16–18. The electronics cover includes an illustration showing wiring connections.

See page 16 for a wiring diagram. Pages 17 and 18 give wiring connections for the output signals.

Note: Do not open the display side of the enclosure.

[1] The integral-style Sage 51 HVAC Series insertion meter has the display oriented as shown in Figure 6 on page 13. If the enclosure needs to be rotated, this can be performed in the field (see below). If, however, the display needs to be rotated, **do not** attempt this in the field and return the meter to Sage for modification. Complete an RMA instructions before returning the meter (see page 38).

The procedure for rotating the *enclosure* is:

1. Clamp the enclosure of the 51 HVAC Series in a vise with the probe pointing up at the ceiling.
2. Take a 7/8" wrench and turn the probe to the proper orientation.
3. Lock the probe into its new position with a set screw (not provided).

Insertion Flow Meter Application

Flow Profile and Installation Considerations

Insertion flow meters are generally easier to install than in-line flow meters; however, they require proper installation and a well-developed flow profile to perform correctly. Please refer to the following sections: Probe Insertion Guideline (page 13) and Installation Depth Chart (page 14).

Sage Valve Assembly Operation

A valve assembly (SVA05) is optional as mounting hardware for insertion style flow meters (see Figure 1). The hardware allows the removal of insertion style meters for service, cleaning, recalibration, and relocation without the need to shut down the process. The probe insertion depth is adjustable to permit the sensor to be at the center, optimizing measurement accuracy (Figure 6, Figure 7, and Figure 8 on page 14). After removing the probe assembly, the ball valve seals off leaks of the process gas at the insertion point. The assembly includes a valve, threadolet, compression fitting with Teflon ferrule, a cable restraint, and two collar clamps (except for SVA05LP).

Figure 1: Optional Valve Assemblies

A threaded half coupling, as subsequently defined, must be fitted to the pipe/duct to which the insertion probe inserts. **Avoid T-fittings since they disturb the flow profile and reduce the measurement area.** Direct threading together (or with necessary bushings) of the retractor assembly may be required. In other cases, the threadolet must be welded in place, and a clearance hole must be drilled through the pipe/duct to accept the probe assembly. **If the pipe/duct is under pressure during installation, a hot tap drill (not available through Sage Metering) may be required.**

Flow Conditioning and Straight Run

To ensure that the flow profile is well developed at the measurement point, use flow conditioners (standard in Sage in-line flow meters, 1/2" and larger, and optional assemblies for insertion flow meters) or consider an additional straight run. Figure 2 shows the straight run needed to ensure no flow disturbances at the measurement point.

IMPORTANCE OF FLOW CONDITIONING
Recommended Pipe Diameters Upstream

DISTURBANCE	*Without* Flow Conditioning	*With* Flow Conditioning[1]
	Minimum Industry Recommendation	Sage Recommendation
One 90° Elbow	25	3
Two 90° Elbows in the Same Plane	36	5
Two 90° Elbows in Different Planes	62	9
4:1 Area Reduction	18	3
4:1 Area Expansion	84	10
Multiple Disturbance	TBD	TBD

[1] This column applies to in-line flow meters, which come standard with built-in flow conditioners, as well as insertion meters, when installed with upstream Captive Flow Conditioners.

Figure 2: Straight Run Chart

Compression Fitting Operation

A bored-through tube fitting, adequately sized to accommodate an insertion probe's particular OD, can be optionally purchased from Sage or provided by the user (see page 29). Before installation, drill a clearance hole to accommodate the insertion probe assembly in the pipe/duct. A fitting (1/2" FNPT) is then welded in place or threaded into the half-threadolet, which has been welded to the pipe/duct. To optimize measurement accuracy, the probe insertion depth is adjustable to permit the sensor to be located at the center. (Refer to Probe Insertion Guideline Drawing and Charts, pages 13–14.)

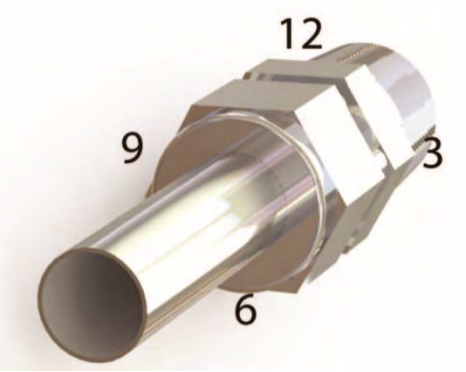


Figure 3 - Insert the probe shaft tubing into the compression fitting to the position indicated in the probe insertion guidelines.

Installation Instructions

1. Insert tubing into the tube fitting.
2. Ensure the tubing is adequately positioned per the Probe Insertion Guideline Drawing and Charts on pages 13-14.
3. Due to the variations in tubing diameters, a common starting point is desirable. Therefore, tighten the nut until the tubing does not turn by hand or move axially in the fitting.
4. Scribe the nut at the six o'clock position.
5. While holding the fitting's body steady, tighten the nut 1 1⁄4 turns to the nine o'clock position.

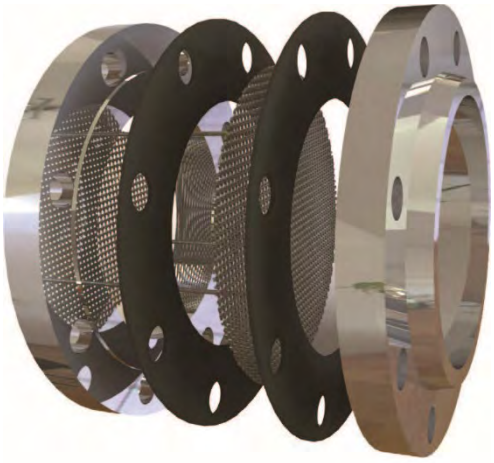
Figure 4 - While holding the fitting's body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

Captive Flow Conditioners

Captive Flow Conditioners are used with insertion style flow meters, if needed.

IMPORTANT—The location of the probe must be one pipe ID diameter (such as 4" in a 4" pipe; 6" in a 6" pipe) downstream of the flow conditioner, or errors occur. The Captive Flow Conditioners are always designed to be separated by one pipe diameter. See Figure 5.

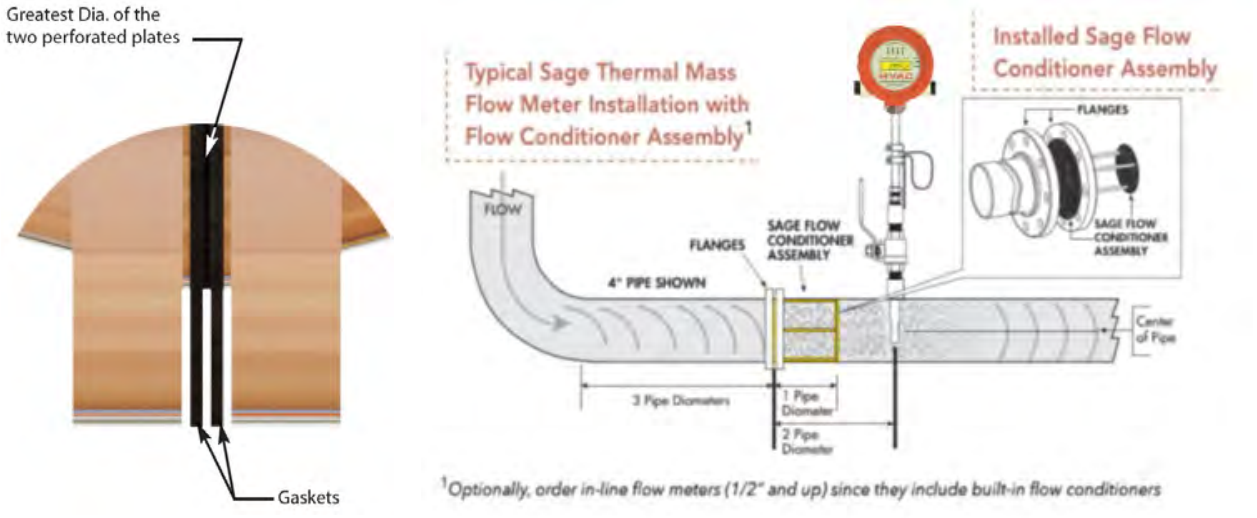
IMPORTANT—When using Captive Flow Conditioners, it is essential to calibrate the accompanying Sage Flow Meter with the flow conditioner. **Do not** order a flow conditioner separate from the flow meter unless the flow meter part number is "–FC."



See Figure 2 on page 10 for straight run requirements.

Front view of conditioning plates

Figure 5 - Captive Flow Conditioners are designed to be separated by one pipe diameter.



NOTE: The larger of the two perforated plates of the Sage flow conditioning assembly is positioned between two flanges and two gaskets as shown. The smaller of the two perforated plates of the conditioner freely slide into the application pipe, facing downstream. Place the probe mounting hardware one pipe diameter downstream of the downstream plate, or errors occur.

Probe Insertion Guideline

Choose the longest straight-run section of pipe available to allow a uniform, well-developed flow profile. See Figure 2 on page 10 for recommended upstream pipe diameters. Note that obstructions such as valves, blowers, expanders, PVC, and HDPE pipes require additional straight runs (contact the factory for assistance). Avoid, if possible, installations immediately downstream of bends, fans, nozzles, heaters, and especially valves, or anything else installed in the line that may cause non-uniform flow profiles and swirls. Otherwise, signal output errors could result unless a significantly more straight run is provided or flow conditioners are installed (contact Sage for assistance if needed). Refer to page 12 for the benefits of incorporating flow conditioners.

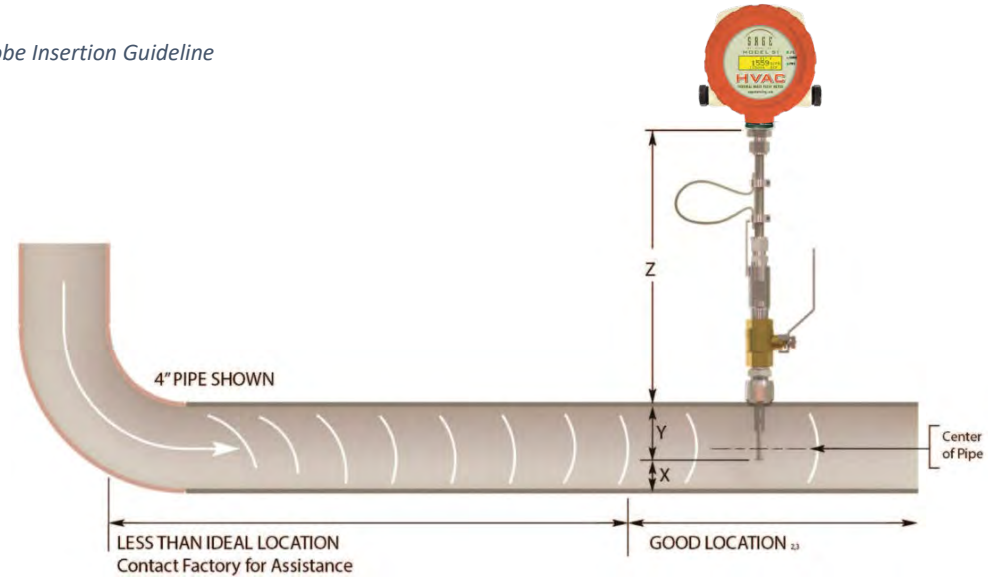
Insertion styles are available with a standard 1/2" OD probe support assembly. Standard probe lengths are 15" or 18". A common method of mounting the probe assembly through a pipe wall or duct (if ambient air) is using compression fitting (STCF05). A Sage valve assembly (SVA05) is useful and highly recommended for pressurized applications or other gases, and a natural gas flange mounting is optionally available.

Sage insertion style flow meters can be assembled and calibrated in virtually any size pipe or duct (as small as 1-1/2"). Sage insertion flow meters include a probe assembly that supports the sensing element (a self-heated flow sensor and a temperature/reference sensor), a sensor drive circuit, a microprocessor meter board, and a transmitter enclosure. The probe assembly must be inserted into the correct position in the process gas flow conduit to allow the gas to flow through the sensor "window" across the sensor element. Position the "sensing point" or active part of the sensor (0.5" from the end of the probe) per Figure 6 and the Installation Depth Chart on page 14.

Installation Depth

1. Figure 6 shows the Model 51 insertion meter.
2. The probe should be inserted per the Installation Depth Chart (See Figures 7 and 8 on page 14) so that the sensors are in the center of the pipe.

Figure 6: Probe Insertion Guideline



Installation Depth Chart

Methods for Probe Insertion to Pipe Center

Method 1

Using the chart (Figure 8), select pipe size (column 1) and determine X. Insert probe until the end touches the bottom of the pipe (ID), mark the probe as it exits the top of the fitting. Lift probe distance "X" and tighten the compression fitting.

Method 2

Using the chart below, select pipe size (column 1) and insert probe distance Y.

Please Note:

1. The 1" pipe size needs to have the probe "Bottomed Out" (option "BOT").
2. For other pipe, such as Schedule 10, contact Sage; however, the Y dimension is the same for any schedule of pipe.

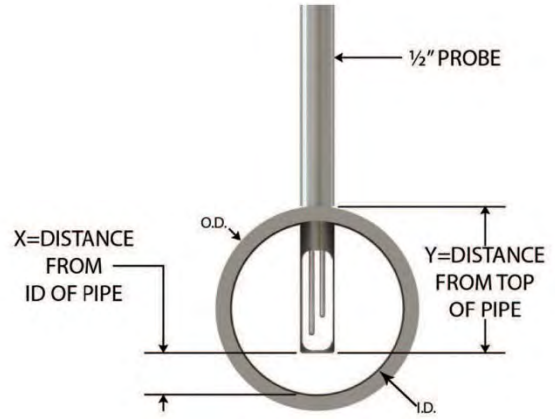


Figure 7: Cross section of a sensor in a pipe

Figure 8 - ½" Probe Diameter Installation Chart

SCHEDULE 40 PIPE[2]					
PIPE SIZE	OD	ID	X	Y	PIPE AREA
1"[1]	CONSULT FACTORY				
1.5"	1.900	1.610	.20"	1.56"	0.0141
2"	2.375	2.067	.40"	1.82"	0.0233
2.5"	2.875	2.469	.60"	2.07"	0.0332
3"	3.500	3.068	.90"	2.38"	0.0513
4"	4.500	4.026	1.40"	2.86"	0.0884
6"	6.625	6.065	2.40"	3.95"	0.2006
8"	8.625	7.981	3.40"	4.90"	0.3474

SCHEDULE 80 PIPE[2]					
PIPE SIZE	OD	ID	X	Y	PIPE AREA
1"[1]	CONSULT FACTORY				
1.5"	1.900	1.500	.15"	1.56"	0.0123
2"	2.375	1.939	.35"	1.82"	0.0205
2.5"	2.875	2.323	.55"	2.07"	0.0294
3"	3.500	2.900	.80"	2.38"	0.0459
4"	4.500	3.826	1.30"	2.86"	0.0798
6"	6.625	5.761	2.25"	3.95"	0.1810
8"	8.625	7.625	3.25"	4.90"	0.3171

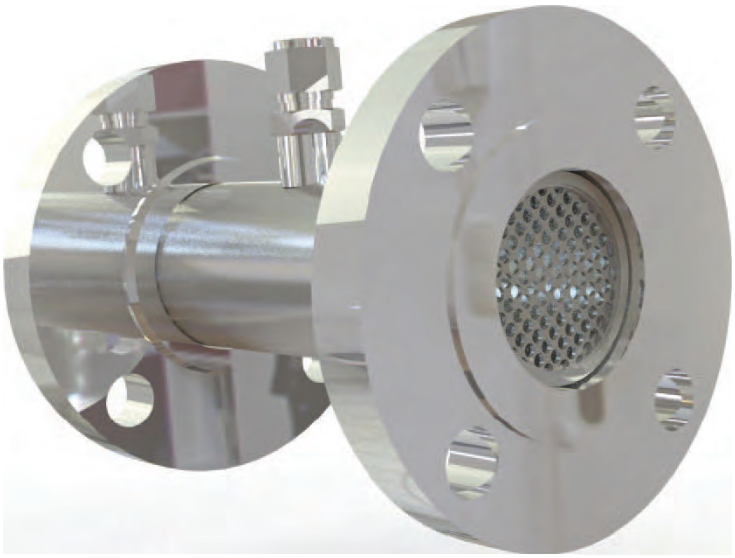
In-Line Flow Meter Application

In-line mounting styles are available in sizes 1/2" through 4" pipes. Threaded male NPT ends are standard, and ANSI 150 lb. flanged ends are optional.

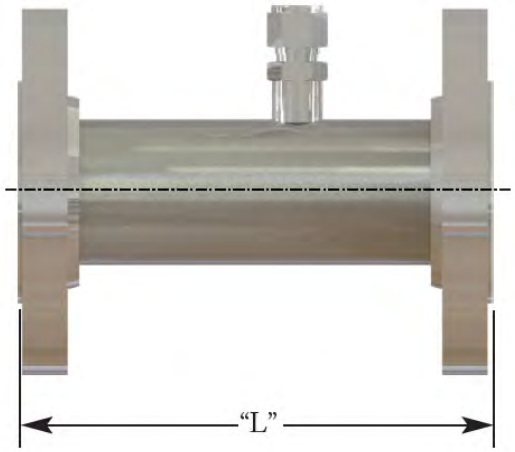
The in-line style flow meter assembly flow section is typically specified to match the user's flow conduit and plumbed directly in the flow line by threading, flanging, or welding. **Do not use reducers.** The meter includes the sensing element (a self-heated flow sensor and a temperature/reference sensor) mounted directly in the specified flow section for exposure to the process gas; a sensor drive circuit, microprocessor meter board, and transmitter enclosure.

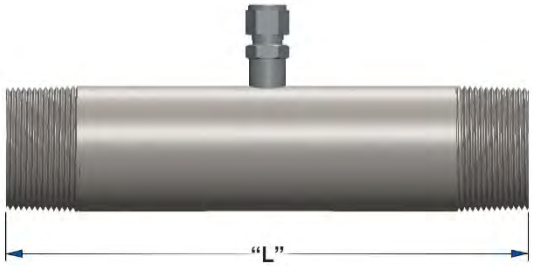
All in-line flow meters, 1/2" and up, have built-in flow conditioners. For upstream straight-run requirements, see Figure 2 on page 10.

Below are flow conditioning screens for in-line flow bodies ½" and up. Flow conditioning is available for insertion meter applications (page 12).



Figures 9 – Above image shows screens with NPT fitting. Left flanged



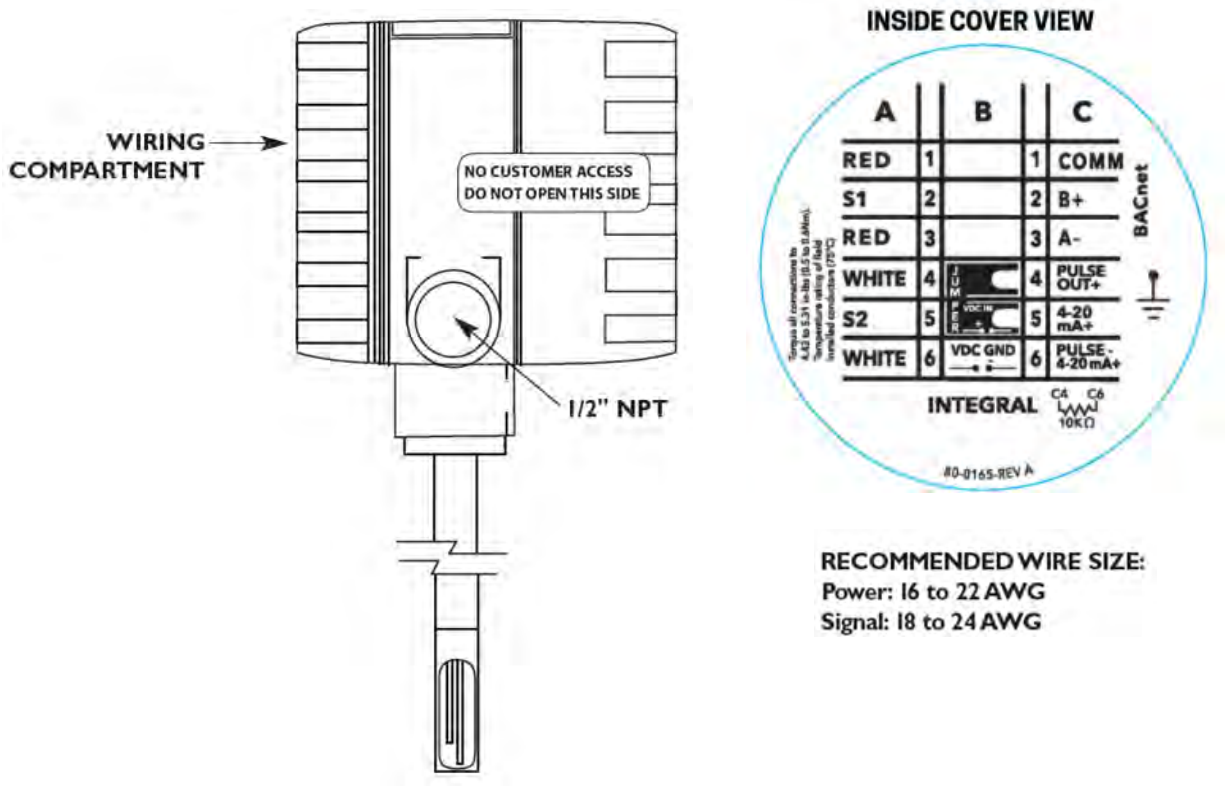


Figures 10 – The length of the **flanged**-*flow body is the same as the NPT- flow body (see page 28).*

Electrical Wiring

All wiring connections are made in the terminal block compartment of the enclosure. An illustration of the wiring connections is found on the inside of the rear cover. All electrical wiring must meet local codes.

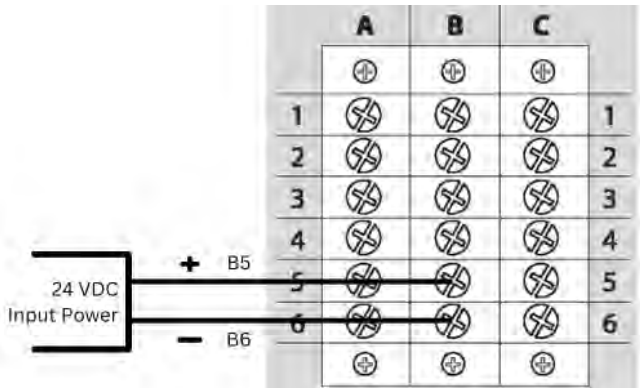
Figure 11: Electrical wiring



Input Power

The Sage 51 HVAC Series requires supplemental power of 24 VDC. Power requirements are 2.4 watts. Hazardous area approval is standard.

Figure 12: Input power



Output Wiring

Both a 4-20 mA and a pulse output are available. These outputs can be either externally or internally powered. The pulse and 4-20 mA outputs share the same power, so both are internally powered or externally powered.

4-20 mA and Pulse Output Using Separate External Power Supplies

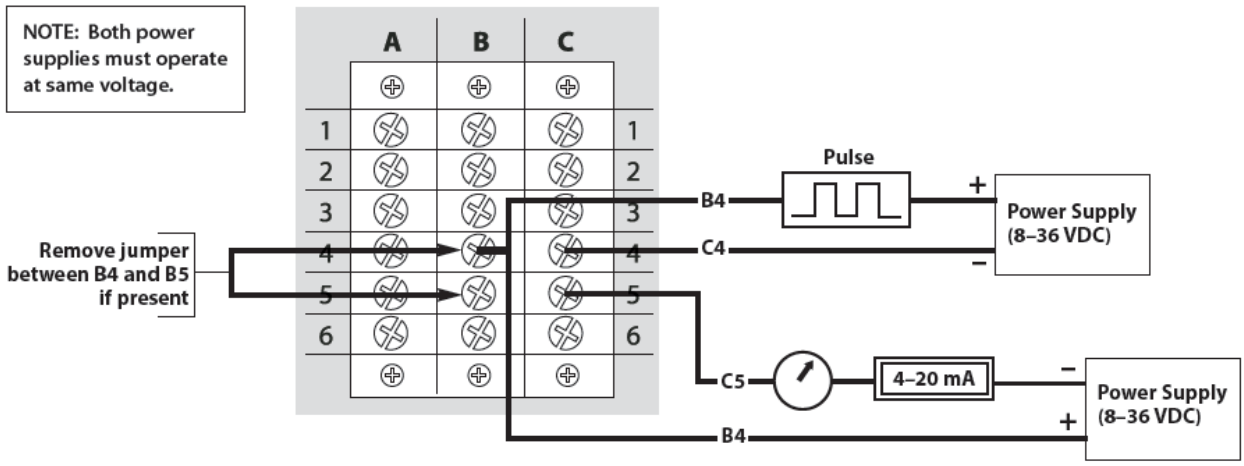
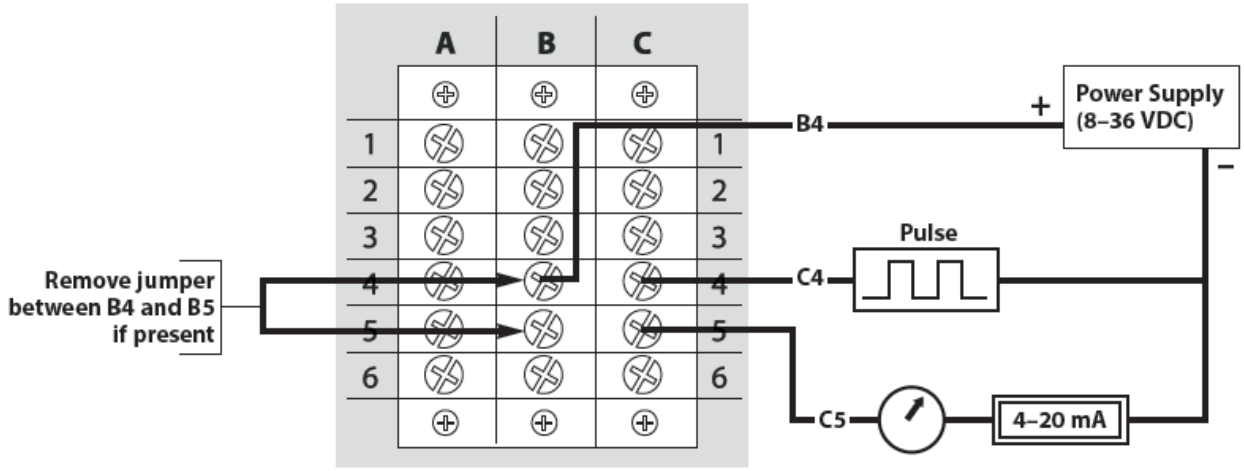


Figure 9: Output wiring with separate power supplies

4-20 mA and Pulse Output Using External Power Supply

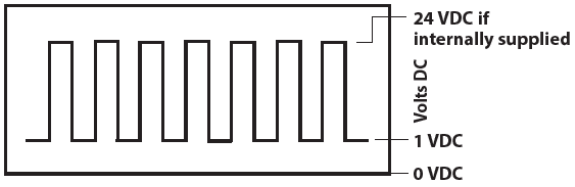
Figure 10: Using one external power supply



Pulse Output

Figure 11: Pulse output

The pulse output is 0–10 Hz. The default pulse width is 250 ms. Externally powered voltage can range between 8 and 36 VDC with a load not exceeding 100 mA. The internally powered voltage is 24 VDC +/– 10%.



Internally Powered

4–20 mA and Pulse

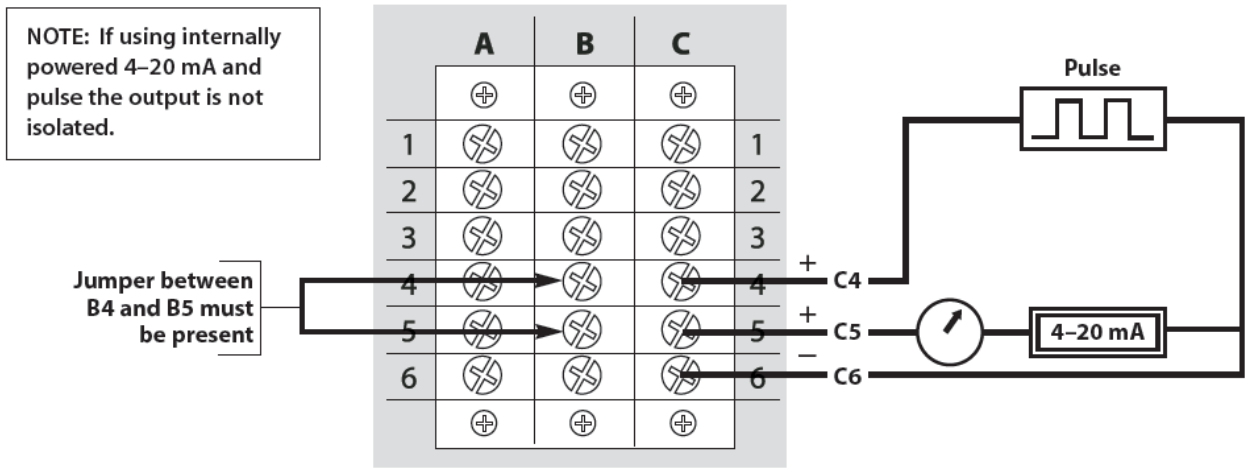


Figure 12: Output wiring— Internally Powered 4–20 mA and pulse

BACnet Connections (Modbus Optional)

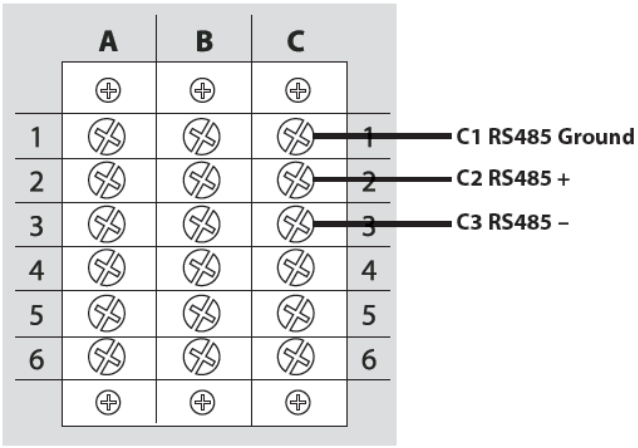


Figure 13: Output wiring BACnet or Modbus connections

Integral Electronics Sensor Connections

Wiring between the sensor and the electronics is completed and tested by Sage. The user rarely accesses these connections.

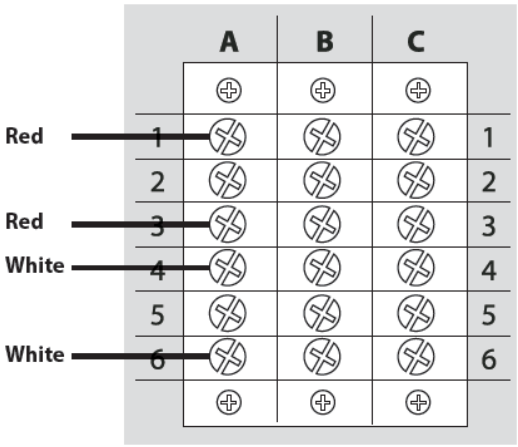


Figure 18: Integral electronic sensor connections

SECTION B:

Styles and Features

Principle of Operation of the Thermal Mass Flow Meter

Sage thermal mass flow meters have two sensors constructed of reference-grade platinum windings (RTDs). The two RTDs are clad in a protective 316SS sheath and driven by a proprietary sensor drive circuit. One sensor is self-heated (flow sensor), while the other (temperature/reference sensor) measures the gas temperature. The pair is referred to as the sensing element and is either installed in a probe as an Insertion style or inserted into a pipe section as an in-line style flow meter.

As gas flows by the flow sensor, the gas molecules carry heat away from the surface, and the sensor cools down as it loses energy. The sensor drive circuit replenishes the lost energy by heating the flow sensor until it is a constant temperature differential above the reference sensor. The electrical power required to maintain a constant temperature differential is directly proportional to the gas mass flow rate and is linearized to be the output signal of the meter.

This constant temperature differential must be maintained, even if there are wide fluctuations in gas temperature. It is the function of the Sage hybrid-digital proprietary sensor drive circuit to keep the differential, whether or not the gas temperature changes or however quickly molecules cool off the flow sensor. It is also necessary to properly calibrate the device with the actual gas (or close equivalent with certain gases) in the Sage National Institute of Standards certified (NIST) calibration facility. By accomplishing these two critical objectives, the Sage meters provide an extremely repeatable (0.2% of Full Scale) and accurate output directly proportional to the mass flow rate of the measured gas.

Figure 14 - One of the sensors is self-heated, and the other sensor measures the gas temperature.

Flow Sizing Drawings

Flow Sizing

The following chart provides the recommended full-scale flow rate for natural gases in various pipe sizes. For the flow rate of other gases, consult Sage Metering.

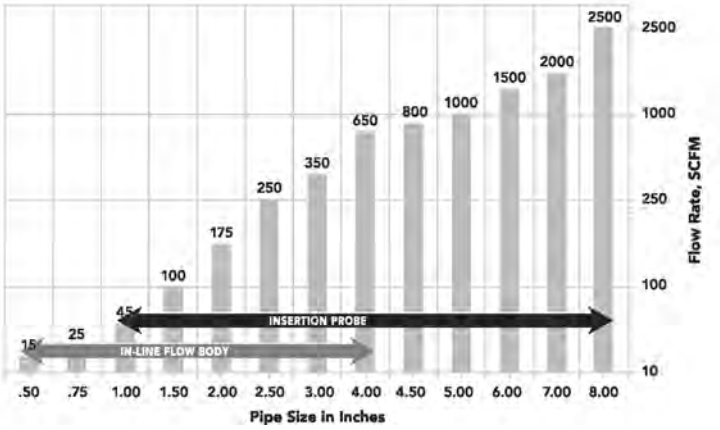
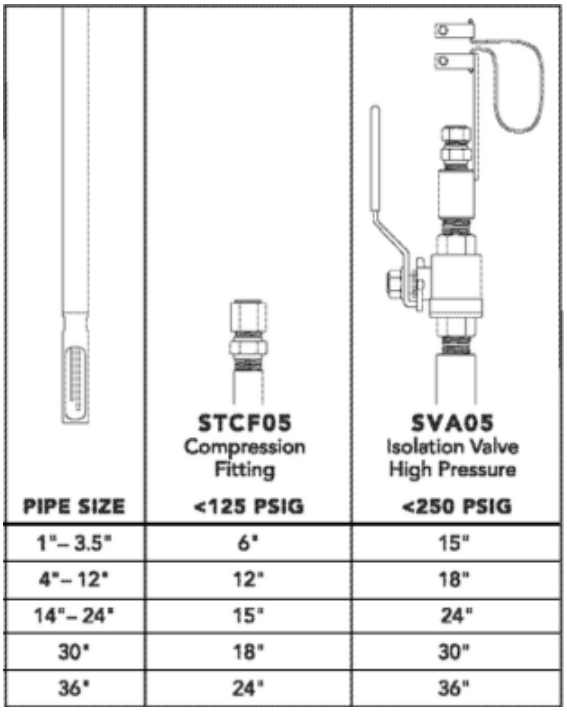


Figure 20: ***Sizing Chart – Natural Gas Maximum Flow Rate***

Fittings and Probe Length Sizing

Sage can provide different fittings for inserting the probe into the pipe. The most popular are the simple low-pressure valve and compression fitting (SVA05LP) and the high-pressure valve and fitting with safety cable (SVA05). Refer to the table for recommended probe lengths for each fitting for various pipe sizes.



PIPE SIZE	STCF05 Compression Fitting <125 PSIG	SVA05 Isolation Valve High Pressure <250 PSIG
1"– 3.5"	6"	15"
4"– 12"	12"	18"
14"– 24"	15"	24"
30"	18"	30"
36"	24"	36"

Figure 21: ***Probe Length of Insertion Probes***

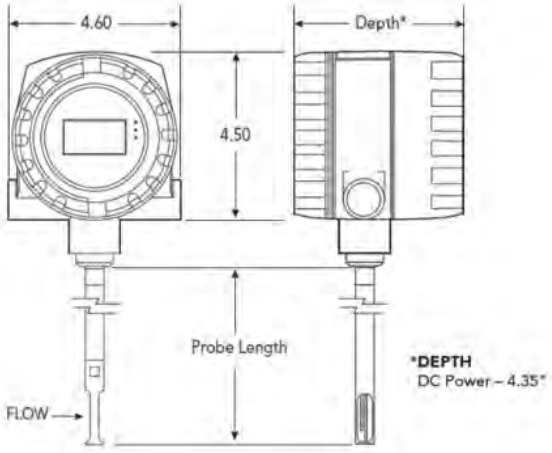


Figure 22: ***Dimensions***

Flow Conditioning

When using an insertion probe, the accuracy depends on the pipe's flow profile. The desired flow profile naturally develops with sufficient straight run of the pipe. In cases of insufficient straight run, Sage Metering provides flow conditioning elements that insert into the pipe.

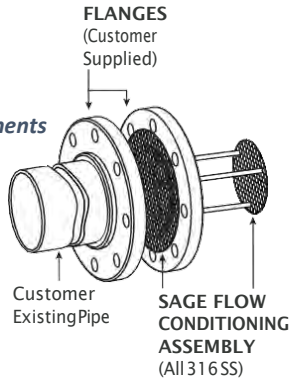


Figure 23: ***Flow Conditioning Elements***

Features and Benefits

SAGE 51 Series Thermal Mass Flow Meter

The Sage 51 HVAC Series of products provide the same performance levels as the Sage Prime with fewer features and economical pricing. The Model 51 is agency-approved for use in Class I Division 2 hazardous areas and is CE-approved. The power dissipation is under 2.5 watts (e.g., under 100 mA at 24 VDC). These units have a 4-20 mA signal output and a pulse output of total flow. BACnet communication is standard and Modbus RTU with RS-485 communication is optionally available.

The Sage 51 HVAC Series is designed for integral electronics. All products can be used with either the ½" insertion probe in pipes 1-1/2" and larger or the in-line flow body with sizes from 1/2" to 8".

The 51 HVAC Series display provides readings of flow rate, total flow, and gas temperature. All units are calibrated in Sage Meterings' NIST-traceable calibration facility with methane gas and come pre-configured from Sage for accurate measurements of natural gas for the specified process pipe.

The 51 HVAC Series uses a two-compartment compact housing with a separate wiring section containing large, easy-to-access terminals to simplify field wiring.

Location Proper Wiring Diagram

See pages 16–19 for electrical wiring. Within the electronics cover, there is an illustration showing the wiring connections. See page 16 for a DC or AC input power wiring diagram. Pages 17 and 18 give wiring connections for the output signals.

Major Benefits of Thermal Mass Meters

- Direct Mass Flow – No need for separate temperature or pressure transmitters
- High Accuracy and Repeatability – Precision measurement and extraordinary repeatability
- Turndown of 100 to 1 and resolution as much as 1000 to 1
- Low-End Sensitivity – Measures as low as 5 SFPM (e.g., 1 SCFM in a 6" pipe)
- Negligible Pressure Drop –does not impede the flow or waste energy
- No Moving Parts – Eliminates costly bearing replacements and prevents undetected accuracy shifts
- Ease of installation and convenient mounting hardware

Specific Benefits of the 51 HVAC Series

- The compact design of the enclosure is only 4-1⁄8 " dia. by 4-1⁄4 " deep (DC Models)
- The display of the 51 HVAC Series shows the flow rate, total flow, and process temperature
- A proprietary digital sensor drive circuit provides enhanced signal stability and is unaffected by process temperature & pressure changes
- BACnet communication is standard
- Modbus-compliant RS485 RTU communications is optional
- Isolated 4-20 mA output and pulsed output of the totalized flow
- Rugged, user-friendly packaging with easy terminal access
- Low power dissipation, under 2.5 Watts (e.g., under 100 mA at 24 VDC)
- Flow conditioning built into in-line flow meters (1/2" and up)
- Captive Flow Conditioners for insertion meter applications, if required

Sage 51 HVAC Series Styles and Specifications (option 1)

SAGE METERING, INC.

SAGE MODEL 51 HVAC SERIES THERMAL MASS FLOW METERS FOR NATURAL GAS

SAGE MODEL 51 HVAC SERIES THERMAL MASS FLOW METER

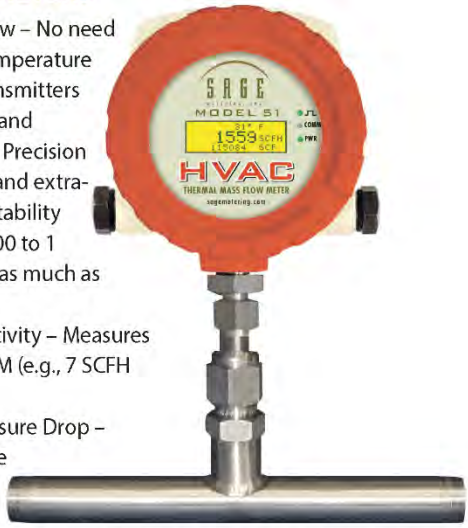
Sage Model 51 HVAC Series of Thermal Mass Flow Meters measures Natural Gas flow rate and consumption in commercial and municipal buildings, as well as college and university campuses, government facilities, hospitals, shopping centers and office buildings and complexes.

The HVAC Industry (Heating, Ventilation and Air Conditioning) provides processes, products, systems, and services that are aimed at heating, ventilating, and air conditioning buildings and facilities while maintaining thermal comfort, acceptable indoor air quality, and reasonable installation, operation, maintenance, and energy. Thus the need for accurate natural gas monitoring is critical, and the cost-effective Model 51 Thermal Mass Flow Meter is the ideal measurement solution.

The HVAC Series is available as an In-Line or Insertion style meter and provides a 4-20 mA analog output proportional to the NG flow rate, as well as pulsed outputs of totalized flow, and includes an easy to read display of flow rate, total, and temperature. In addition, BACnet communication is provided (or optional Modbus RTU) for communicating with energy dash-boards or other software Masters.

All Model 51 HVAC Thermal Mass Flow Meters are temperature-compensated and pressure insensitive, and are configured to provide a 100 to 1 turndown of natural gas with a Full Scale flow rate based on the pipe size specified. Over 165 samples are taken in the Sage NIST calibration facility to guarantee 1% of reading accuracy.

MAJOR BENEFITS OF THERMAL MASS FLOW METERS



- Direct Mass Flow – No need for separate temperature or pressure transmitters
- High Accuracy and Repeatability – Precision measurement and extra-ordinary repeatability
- Turndown of 100 to 1 and resolution as much as 1000 to 1
- Low-End Sensitivity – Measures as low as 5 SFPM (e.g., 7 SCFH in a 2" pipe)
- Negligible Pressure Drop – Will not impede flow or waste energy
- No Moving Parts – Eliminates costly bearing replacements, and prevents undetected accuracy shifts

FLOW METER ADVANTAGES

- Mass flow measurement for Natural Gas
- In-line or Insertion meters
- Easy to install
- High rangeability for low flow and high flow measurement
- High reliability
- Helps reduce energy consumption
- Facilitates LEED credits
- Compact design of enclosure is 4-1/8" dia. by 4-1/4" deep
- BACnet communications or optional Modbus RTU
- Isolated 4-20 mA output of flow rate and pulsed output of Totalized Flow
- Rugged, user-friendly packaging with easy terminal access
- Flow conditioning built into In-Line flow meters (1/2" and up)
- Optional dry contact relay module—specify DCR-DC

POTENTIAL BUYERS

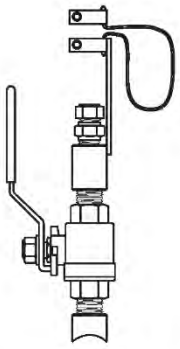
- Mechanical Contractors
- Performance Contractors
- Campuses and Universities
- Energy Service Companies (ESCOs)

SAGE HVAC SERIES STYLES AND SPECIFICATIONS

MODEL 51 (Shown with Optional Mounting Hardware)

Insertion Meter Shown (In-Line also available)

STCF05 Pipe Fitting 1/2" Tube x 1/2" NPT



SVA05 Isolation Valve Assembly

MODEL 51 (Shown with In-Line Flow Body)

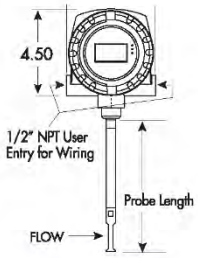
MODEL 51 HVAC SERIES

Standard accuracy is +/– 1% of reading[1] with a turn-down of 100 to 1 and resolution as much as 1000 to 1. Repeatability is 0.2%. The electronics has a 4 to 20 mA[2] output proportional to Mass Flow Rate as well as pulsed outputs of Totalized Flow. In addition, BACnet communications is standard (or optionally Modbus).

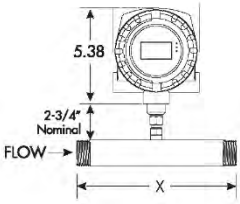
Contact Sage for a complete list of HVAC Part Numbers.

INTEGRAL STYLE ELECTRONICS

Electronics is Integral style, with rugged windowed dual compartment NEMA 4 enclosure with local display. The display is a high contrast photo-emissive OLED display, and it displays Mass Flow Rate, Totalized Flow and Temperature.



Model 51 Insertion[3]
Flow Element is insertion style, consisting of a 1/2" OD probe with lengths up to 18" long (typically 15" long) suitable for insertion into the center of a process pipe



Model 51 In-Line[4]
Flow Element is In-Line style consisting of a choice of 316 Stainless Steel Schedule 40 Flow Bodies sized from 1/4" x 6" long to 4" x 12" long

SAGE MODEL 51 HVAC SERIES THERMAL MASS FLOW METERS FOR GASES

The Sage Model 51 HVAC Series Thermal Mass Flow Meter features a bright, high contrast, photo-emissive OLED (Organic LED) display of Flow Rate, Total and Temperature in a robust, yet lightweight, dual-sided NEMA 4 enclosure. The rear compartment is completely separated from the electronics, and has large, easy-to-access, well marked terminals, for ease of customer wiring. It is powered by 24 VDC. The power dissipation is under 2.5 watts *(e.g. under 100 mA at 24 VDC).*

Specify pipe size and choose SCFM or SCFM units or contact Sage for typical flow rates for your pipe. It has a 4-20 mA output as well as a pulsed output of Totalized Flow pre-configured for your specified pipe size. In addition, Sage Model 51 includes BACnet communications (or optional Modbus).

Sage Model 51 is CE approved, and CSA and UL approved for Hazardous Service.

IN-LINE METER DIMENSIONS	
Pipe Size x Flow Body Length	
1/4" x 6"	1-1/4" x 10"
3/8" x 6"	1-1/2" x 12"
1/2" x 7"	2" x 12"
3/4" x 7"	2-1/2" x 12"
1" x 8"	3" x 12"
	4" x 12"

1 1% of Reading above 500 SFPM (velocity units) for Natural Gas meters
2 For isolated 4-20mA, remove jumper (accessible from rear terminal)
3 Mounting hardware such as Isolation Valve Assemblies or Compression Fittings, and Flanges, are optional
4 Flow Conditioners are built into In-Line style flow bodies from 1/2" to 4"

Sage Metering, Inc. / 8 Harris Court / Bldg D / Monterey, CA 93940 / 866-677-SAGE (7243) / 831-242-2030 / Fax 831-655-4965 / www.sagemetering.com

Sage Display

Available on the Sage 51 HVAC Series.

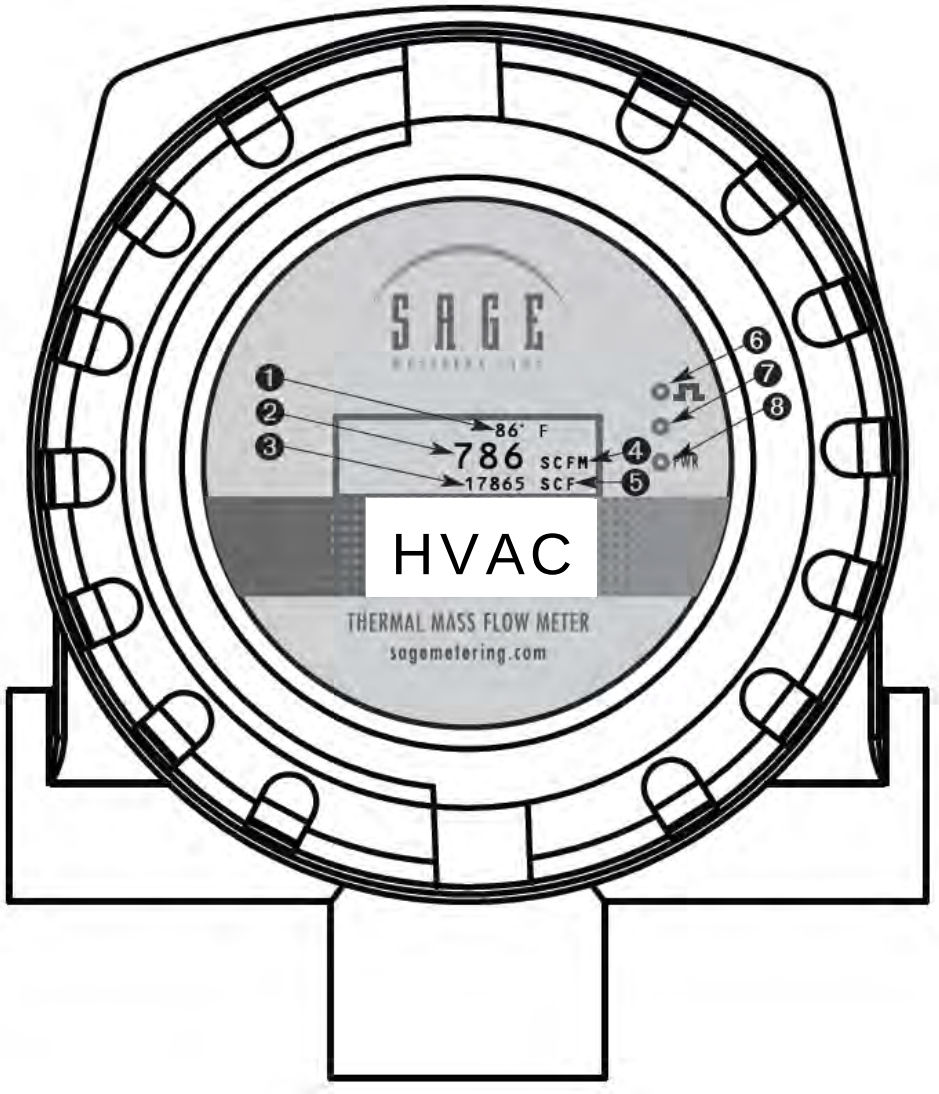


Figure 24: Model 51 display

1. Gas temperature
2. Flow rate
3. Totalized flow
4. Engineering units of flow rate
5. Engineering units of totalized flow
6. Flashes with each pulsed output of consumption
7. Indicates BACnet or optional Modbus is being transmitted
8. Indicates BACnet or optional Modbus is being received

Approvals

Hazardous Location Approvals

All 24 VDC-powered Sage 51 HVAC Series Meters are Class I, Div 2, Groups B, C, D, T4.

Testing under the following safety standards:

- ANSI 12.12.01, Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations
- CSA C22.2 No. 213-M1987 (R1999), First Edition, Nonincendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
- UL/CSA 61010-1, Second Edition, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use–Part 1: General Requirements

The following is required to comply with the approvals mentioned above:

1. Repair of the product (or replacement of components) is not possible by the user
2. As noted on the label shown above, there are the following markings: Ex symbol, nA symbol IIC, temperature class
3. All DC meters are marked with "X," which means that these Special Conditions of Use apply:
   a) The completed meter must be installed with a rigid or flexible metal conduit to satisfy approval conditions.
   b) The meter is approved for use with the electronics enclosure in ambient temperature from -40˚C < Ta < 65˚C.
4. Sage Metering considers a linear correction suitable for temperatures exceeding 40C (104F); thus, no customer correction is needed.

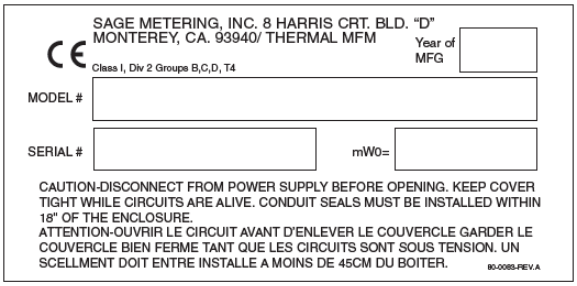


Figure 26: Label

CE Conformance

All AC & DC powered Sage 51 HVAC Series are CE Compliant for the following CE directives:

- EN61000-6-4 for Electromagnetic compatibility
- EN61000-3-2 for Harmonics
- EN61000-3-3 for Flicker
- EN61000-6-2 for Electromagnetic Compatibility (Immunity for Industrial Environments), which includes EN61000-4-2 for ESD
- EN61000-4-3 for Radiated Immunity
- EN61000-4-4 for EFT/B; EN61000-4-5 for Surge
- EN61000 for Conducted Immunity
- EN61000-4-8 for Magnetic Immunity
- EN61000-4-11 for Voltage Interruptions

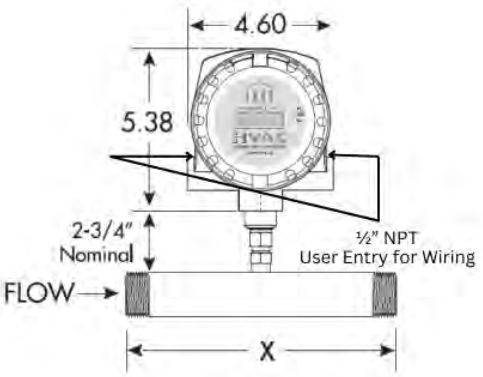
SECTION C:

Drawings

51 HVAC Series Integral Style Mass Flow Meters

In-Line Style[1,3]

150#, 300#, or 600# flanged ends are optionally available. (150# flanges recommended on 3" and 4" flow bodies)



Caution:

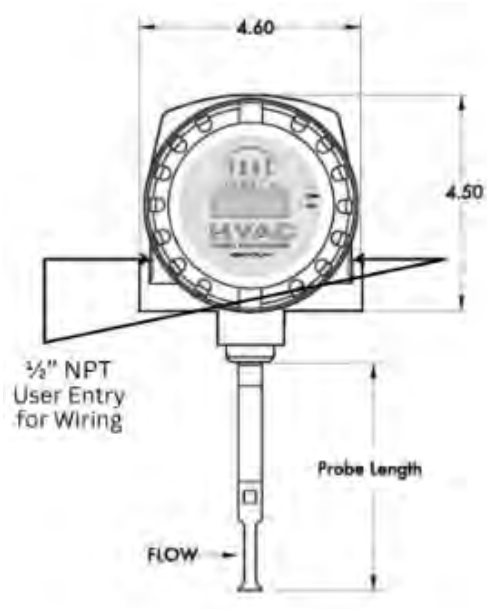
Do not rotate the enclosure of in-line style meters relative to the flow tube, or the calibration may be affected since the sensors may become misaligned.

Depth: Enclosure depth is 4.35".

IN-LINE METER DIMENSIONS
Pipe Size x Flow Body Length (B)[3]
1/4" x 6"
3/8" x 6"
1/2" x 7"
3/4" x 7"
1" x 8"
1-1/4" x 10"
1-1/2" x 12"
2" x 12"
2-1/2" x 12"
3" x 12"
4" x 12"

Insertion Style[2]

150#, 300#, or 600# flanged mounting is optionally available. Available probe lengths are 6", 12", 15", 18", 24", 30", 36" or 48". The standard probe is 1/2" in diameter.

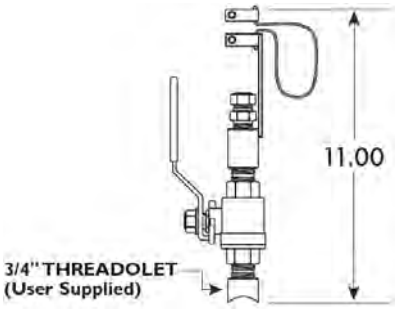


[1] NPT fittings standard
[2] Flanged mounting available for high-pressure operation
[3] Flow conditioning is built into the flow meter for pipe sizes 1/2" and up. Contact Sage for an optional 1/4" tube flow body.

Mounting Hardware[3]

SVA05 Series Isolation Valve Assembly for Insertion Meters[4]

This is used for pressures to 250 psig[1] (shown for use with 1/2" diameter insertion meters). 150# or 300# flanged mounting is optionally available.

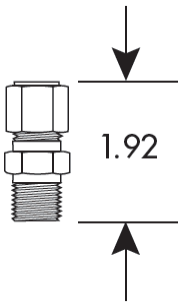


Probe Length (with sensor)	Safety Chain Length[2]
15"	11.25"
18"	14.25"

NOTE: After drilling a 3/4 "hole in the existing pipe, the user needs to weld a 3/4" female threadolet (of appropriate radius) to mate with it. The 3/4" male coupling of the Sage Isolation Valve Assembly threads into the user's 3/4" threadolet.

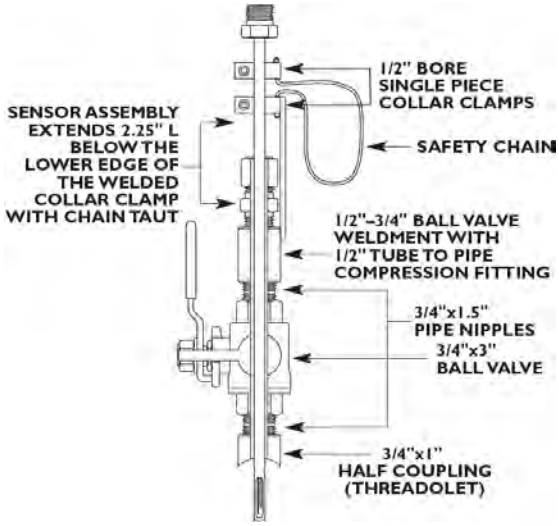
STCF Series Teflon Ferrule Compression Fitting

1/2" tube x 1/2" pipe fitting (shown, not to scale) for low-pressure insertion applications to 125 PSIG (stainless steel ferrule optional for higher pressure applications – up to 225 PSIG).



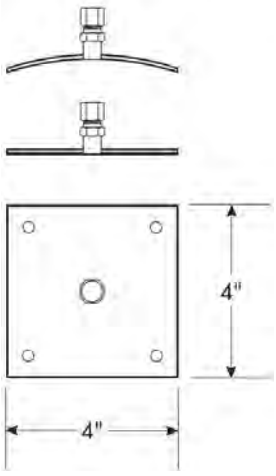
SVA05 Series Isolation Valve Assembly Detail

Cutaway view of a probe inserted through isolation ball valve assembly



Mounting Plate for Thin-Walled Ducts

(Includes STCF05 Compression Fitting)



[1]At 250 PSIG, the force exerted on a 1/2" diameter probe is 50 lbs.
[2]Safety chain prevents the probe from accidentally escaping from the assembly during removal from a pressurized pipe.
[3]Insertion meters can have optional flanged mounting (generally used for high-pressure or very hot gases). This adaptation is not shown. Consult the factory for details.
[4]Maximum gas temperature, 200F, unless a high-temperature model

SECTION D:

Diagnostics

Common Diagnostics

Symptom: The display fails, or the pixels are extremely dim.

Corrective Action: Contact Sage Metering. Certain types of failures are under long-term warranty. Please note that the 4-20 mA still functions.

Symptom: Display fading or partially fading.

Corrective Action:

a) Some fading, particularly with those characters lit up most frequently, is normal. The flow meter continues to function correctly, and the flow meter accuracy and outputs are not affected.

b) In extreme cases, contact the factory for display replacement.

Symptom: Erratic readings

Possible Causes: If a large motor or generator, or variable-frequency drive (VFD) is near the enclosure, it may be inducing sufficient analog noise into the circuitry to temporarily corrupt the data.

Suggested Corrective Action:

a) If a power restart temporarily solves the problem, then the noise source was likely the problem.
b) Mount the meter in a different location (further from the source) or move the noise source away from the meter.

Symptom: The meter reads zero continuously, or full scale continually, or the temperature reading is abnormally low (hundreds of degrees below zero).

Possible Causes/Suggested Corrective Action:

a) A wire is likely to loose. However, in rare cases, a sensor could fail if it exceeds a process temperature of 450˚F.
b) Refer to the integral terminals and check the sensor wires. Remove the appropriate wires first (the red pair for flow, then the white pair for temperature). Measure their resistance. If reading infinity or short, it means that the sensor has failed.

Symptom: Meter railing (pegging) or reading high

Possible Cause/Suggested Corrective Action:

a) There is an insufficient straight run (i.e., flow profile is disturbed, causing errors)
b) A possible jet effect may exist if the upstream pipe is smaller than the meter flow body or if the valve is too close upstream to the meter.
c) Are you following the probe insertion guideline (pages 13 - 14)?
d) If the sensor is inserted in reverse (the “Upstream” mark is facing downstream), the meter may over-report (or under-report) as much as 30%.
e) If the sensor is not aligned correctly, with the “Upstream” mark facing upstream, a rotation greater than ± 5 degrees may cause a change in reading (greater than ± 5 degrees and less than ± 20 degrees causes the meter to over-report; a greater rotation blocks the sensor and causes the meter to under-report).
f) A downstream valve may be too close to the meter (flow may be reflecting back).
g) Water droplets may be condensing out of the gas stream (causing the output to

spike, but if droplets are near-continuous, the output may rail).

h) The meter may be miswired.

i) Water droplets may be condensing on the inside of the pipe wall, rolling down, or hitting the sensor and causing the output to spike. If droplets are near-continuous, the output may rail. Note– *Recommended installation 45˚ from vertical.*

j) Water droplets may condense out of the gas stream and fill the cavity containing the sensing elements (usually due to probes mounted below horizontal in saturated pipes).

k) The sensor may be contaminated. Remove the probe, wipe it off, or clean it with a solvent. Reinsert.

l) Are you using a different gas or gas mix than the meter was specified and calibrated?

m) The meter may appear to be reading high if the user compares Sage flow meter readings (SCFM) to an uncorrected volumetric device (ACFM). For example, at constant volume, a decrease in gas temperature increases the mass flow (SCFM). That is entirely normal.

Symptom: Reading Low

Possible Causes:

a) There is an insufficient straight run (i.e., flow profile is disturbed, causing errors).

b) A poor flow profile upstream (insufficient upstream straight run)

c) Are you following the probe insertion guideline (pages 13-14)?

d) If the sensor is inserted in reverse (the "Upstream" mark is facing downstream), the meter may over-report (or under-report) as much as 20%.

e) If the sensor is not aligned correctly, with the "Upstream" mark facing upstream, a rotation greater than ± 5 degrees may cause a change in reading (greater than ± 5 degrees and less than ± 20 degrees causes the meter to over-report; a greater rotation blocks the sensor and causes the meter to under-report).

f) The sensor may be contaminated. Remove the probe, wipe off, or clean with a solvent. Reinsert.

g) Are you using a different gas or gas mix than the meter was specified and calibrated?

h) The meter may appear to be reading low if the user compares Sage flow meter readings (SCFM) to an uncorrected volumetric device (ACFM). For example, an increase in gas temperature at constant volume lowers the mass flow (SCFM). That is entirely normal.

i) The totalizer does not start counting for 10 seconds after power-up on most models, so any flow data does not accumulate during this time.

j) Do you have a sufficient power supply (most products require a minimum of 100 mA)?

k) Is there an excessive load on the 4-20 mA? (To check if the problem is due to a 4-20 mA output device, temporarily remove the device and observe if the display reads as expected.)

Symptom: The totalizer can take up to 10 seconds to update its reading when the flow meter is first powered up or a channel is changed.

Corrective Action: None. This slight delay is entirely normal.

Symptom: The display does not have power

Possible Cause: Mis-wiring

Symptom: 4-20 mA output not tracking the flow rate display

Possible Causes:

a) In typical operation (self-powered), B4 and B5 must be jumpered to loop. See page 18.
b) In an externally powered mode, the jumper must be removed. Verify that 9 to 27 Volts DC is supplied to power the loop externally as per page 17.

SECTION E:

Warranties and Service Work

Limited Warranty

Sage Metering's products are warranted against faulty materials or handiwork for one year from the factory's shipment date. Sage's obligation is limited to repair, or at its sole option, replacement of products and components that, upon verification by Sage at our factory in Monterey, California, prove defective. Sage shall not be liable for installation charges, for Buyer's expenses for repairs or replacement, for damages from delay or loss of use, or other indirect or consequential damages of any kind. This warranty is extended only to Sage products properly used and properly installed for the particular application for which intended and quoted, and does not cover water damage due to improper use of cord grips or removal of protective caps. It does not cover Sage products that have been altered without Sage authorization or subjected to unusual physical or electrical stress. Sage makes no other warranty, express or implied, and assumes no liability that goods sold to any purchaser are fit for any particular purpose.

Transportation charges for materials shipped to the factory for warranty repair are to be paid by the shipper. Sage will return items repaired or replaced under warranty, prepaid. NOTE: No items will be returned for warranty repair without prior written authorization from Sage Metering, Inc. Sage does not warranty damage due to corrosion.

General Terms and Conditions

Detailed General Terms and Conditions can be found on the Sage website (sagemetering.com) on a link "General Terms" on the Footer of any page on the website.

Cancellation/Return Policy

Cancellation or Return: After issuing a purchase order (by phone, mail, e-mail, or fax) or a credit card order (by phone, mail, e-mail, or fax), there is a cancellation fee for any canceled order. Cancellations must be in writing (by mail, e-mail, or fax):

1. If a credit card order or non-credit card order is canceled within 7 days of issuance of a purchase order or date the order was placed (whichever is earlier), there is a 10% cancellation fee.
2. If a credit card order or non-credit card order is canceled after 7 days but before shipment, there is a 20% cancellation fee. (If an order is canceled due to late delivery, the cancellation fee is waived. Late delivery is defined as shipping a meter 7 days or later than the delivery date acknowledged by Sage Metering when placing the order).
3. If a credit card customer decides to return the equipment after shipment for a credit, the credit is not issued if the equipment is damaged or if the equipment is returned after four months of the shipment. If the equipment is not damaged, it can be returned after Sage issues a Return Meter Authorization (RMA). **The returned package must be insured by the customer and must reference the proper RMA# on the outside of the package**, or the package may be rejected (i.e., the package is returned unopened). Credit card customers are charged a 30% restocking fee (70% balance is credited back). The customer is responsible for return shipping charges and any damage if improperly packaged.

Continued on the next page.

4. If a non-credit card customer decides to return the equipment after shipment for a credit, credit is not issued if the equipment is damaged or if the equipment is returned after 1 month of shipment unless authorized by a representative at Sage Metering, Inc. The Sage representative will issue a Return Material Authorization (RMA) at that time and advise of the restocking fee. **The returned package must be insured by the customer and must reference the proper RMA# on the outside of the package, or the package may be rejected (i.e., the** package returned unopened). The customer is responsible for return shipping charges and any damage if improperly packaged.

Returning Your Sage Meter

Before returning any equipment to Sage Metering, you must obtain a Return Material Authorization Number (RMA#). You may obtain an RMA # by emailing service@sagemetering.com.

See page 38 for RMA information and instructions.

Take special care when packaging your meter for return to the factory. The sensor, in particular, may easily be damaged if it is not prevented from shifting around within the package and if it is not covered to keep it from contacting other package contents. Any damage resulting from improper packaging is the shipper's responsibility.

Per the “Right to Know Act” and applicable US Department of Transportation (DOT) regulations, Sage Metering will not accept delivery of equipment that has been contaminated without written evidence of decontamination and has instituted the following Return/Repair conditions. Strict adherence to these conditions is required. Returned equipment that does not conform to the requirements listed below will not be processed. If Sage Metering finds evidence of contamination, we may, at our option, have the unit returned at your expense. The requirements for packaging and labeling hazardous substances are listed in DOT regulations 49 CFR 172, 178, and 179.

The equipment must be completely cleaned and decontaminated before shipment to Sage Metering. This decontamination includes the sensor, probe, electronics, and enclosures internally and externally. In addition, all packaging must be clean and free from contamination.

Return Shipping Address:
Attention:
Sage Metering, Inc.
8 Harris Court, Building D6
Monterey, CA 93940

RMA (Return Merchandise Authorization)

If a customer needs to return a meter to Sage, please e-mail the Service Department at service@sagemetering.com.

You **must** include the serial number from the meter, the reason for returning, and the symptoms you're experiencing.

The Sage Service Department will e-mail the customer an RMA# to track the return of the meter to Sage and instructions on our RMA process.

Or the customer can call our Service Department at 831.242.2030 or toll-free at 866.677.7243 for assistance.

Service Department hours:

Mon–Fri
6:00 am to 3:30 pm PST

SECTION H:

Appendix

What is a Thermal Mass Flow Meter?

- What is a thermal mass flow meter? A meter that directly measures the gas mass flow based on conductive and convective heat transfer.
- All Meters have probes (Insertion Style) or Flow Bodies (In-Line Style) that support a pair of sensors in contact with the gas.
- The sensors are RTDs, which are resistance temperature detectors. They consist of highly stable reference-grade platinum windings. We use the same material used as Platinum Resistance Standards at the NIST.
- The RTDs are clad in a protective 316 SS sheath for industrial environments.
- One of the RTDs [See Diagram below] is self-heated by the circuitry and serves as the flow sensor. The other RTD acts as a reference sensor and measures the gas temperature. Essentially it is used for temperature compensation.
- The Sage proprietary hybrid-digital sensor drive circuitry maintains a constant overheat between the flow sensor and the reference sensor. As gas flows by the heated sensor (flow sensor), the molecules of flowing gas carry heat away from this sensor, and the sensor cools down as it loses energy. The circuit equilibrium is disturbed, and momentarily, the temperature difference between the heated sensor and the reference sensor has changed. The circuit will automatically (within 1 second) replace this lost energy by heating the flow sensor, so the overheat temperature is restored.
- The current required to maintain this overheat represents the mass flow signal. There is no need for external temperature or pressure devices.