SAGE THERMAL GAS MASS FLOW METER

User Manual

For "Basic" Model SIB

DOCUMENT NUMBER 100-0245
REVISION 08 - SIB (SAGE BASIC)

Make the Wise Choice.
Choose Sage Flow Meters.

SAGE
METERING, INC.

SAGE METERING, INC.
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Monterey, CA 93940
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Welcome

We are pleased that you have purchased a Sage Metering Mass Flow Meter for your requirement. We hope that you are satisfied with the performance, operation and design of our highly precise, NIST traceable Thermal Gas Mass Flow Meter.

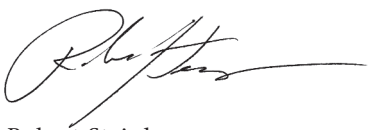
Sage Metering is your source for monitoring, measuring and controlling the gas mass flow in your industrial process, building management system or environmental application. Our high performance, NIST Traceable,Thermal Mass Flow Meters will help increase productivity, reduce energy costs, maximize product yields, and/ or help reduce environmental insult. Sage provides high quality In-Line and Insertion Thermal Mass Flow Meters for a wide variety of 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, have no moving parts, require little if any maintenance, have negligible pressure drop and have 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, flare gas, hydrogen, argon, carbon dioxide and other gases and gas mixes.

Sage “Basic” is our most economical Thermal Mass Flow Meter, providing a 4-20 mA output proportional to mass flow rate, and pulsed outputs of consumption. The Flow Meter is provided in a small rugged “blind” enclosure, and is powered by 24VDC (100 mA maximum current)

Please let us know if we can assist you in any way with your Sage Meter, or if you have any questions about its installation, operation, or features. Simply phone us at 866-677-SAGE (7243), or visit our website at www.sagemetering.com to contact a factory representative in your area. This manual is available on the website under the Knowledge Base section.

Sincerely,



Robert Steinberg
President

Section A

GETTING STARTED

Getting Started

UNPACKING YOUR SAGE METER

Your Sage flow meter is a sensitive, yet rugged, precision built electronic instrument. Upon delivery, care should be taken when opening the shipping container and removing your meter. The meter should be inspected for any damage that may have occurred during transit. If damage is found, please contact the carrier immediately to place a claim for damaged goods. The contents of the container should be checked against the packing list for any discrepancies. If there are any questions as to the contents or configuration of the equipment including calibration ranges, or, mounting hardware, contact Sage Metering as soon as possible. Please save shipping container and packaging materials (including PVC tube probe protector on Sage Insertion Flow Meters) in case the unit needs to be returned for any reason.

MAINTENANCE

Sage thermal mass flow meters essentially require little or no maintenance. While the sensing element is somewhat resistant to dirt and particulate build up, it may become necessary to clean it from time to time if mounted in extremely dirty environments. NOTE: ALWAYS REMOVE THE POWER PRIOR TO ANY CLEANING OR MAINTENANCE. A detergent or appropriate non-corrosive solvent for removing the buildup may be required. A soft brush can be used to 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, Inc. for instructions. **In general, it is recommended that your Sage Thermal Mass Flow Meter be returned to the factory if cleaning, repair, or recalibration is needed. This is usually the most cost-effective and reliable alternative.**

INSTALLATION AND MOUNTING

- Check the Certificate of Conformance included with your Sage Thermal Mass Flow Meter for system pressure, temperature, gas composition, power input, and signal output.
- It is recommended that the flow meter be inserted in a location of maximum straight run. It is suggested that there be a minimum of 15 pipe diameters of straight run upstream, and 5 diameters downstream, depending on the conditions. See chart on page 10. Note, obstructions such as valves, blowers, expanders and PVC and HDPE pipes will require additional straight run (contact factory for assistance).
- Check the orientation[1]: Standard calibration flow direction is left to right when facing the flow meter. Gas flow direction is marked with an arrow on in-line flow meters; UPSTREAM is marked on insertion probes.
- Do not rotate probe or errors may occur. If enclosure is facing incorrectly, rotate the enclosure 180˚, but do not rotate the probe. The UPSTREAM mark still needs to be facing Upstream.
- Hook up the system per the wiring diagram provided with your Sage flow meter (see inside of rear compartment cover for terminal designation). Double check that wiring for the proper power and signal connections are correct.
- Check that all plumbing and electrical hook-ups are in accordance with OSHA, NFPA, and all other safety requirements.

Insertion Flow Meter Application

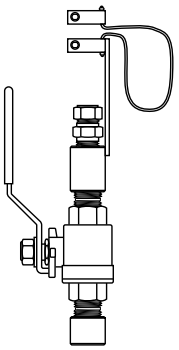
FLOW PROFILE AND INSTALLATION CONSIDERATIONS

Insertion Flow Meters, although generally easier to install that In-Line Flow Meters, require proper installation, and a well developed flow profile, in order to perform properly. Please refer to the section on the following pages titled PROBE INSERTION GUIDELINE DRAWING (page 13) and INSTALLATION DEPTH CHART (page 14).

SAGE VALVE ASSEMBLY OPERATION

Valve assemblies (SVA05 and SVA05LP) are an optional mounting hardware for Insertion Style Flow Meters (see pages 28). They allow the removal of insertion-style meters for service, cleaning, recalibration, relocation, etc. without the need to "shutdown" your process. The probe insertion depth is adjustable to permit sensor to be located at center to optimize measurement accuracy. (Refer to PROBE INSERTION GUIDELINE DRAWING and CHART, pages 13 & 14.) The ball valve will seal off leaks of the process gas at the point of insertion after the probe assembly has been removed. The assembly includes a valve, threadolet, compression fitting with Teflon ferrule, a cable restraint, and two collar clamps.

A threaded half coupling (3/4" FNPT) properly sized to accommodate the isolation valve retractor assembly must be fitted to the pipe/duct to which the insertion probe will be inserted. **Avoid T-Fittings since they will disturb the flow profile, and effectively 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.**



NOTE: Detailed Drawings are shown on pages 28 & 29.

FLOW CONDITIONING AND STRAIGHT RUN

Although a minimum of 15 pipe diameters of upstream straight run is commonly recommended, to absolutely assure that the flow profile is well developed at the point of measurement, either use Flow Conditioners (standard in Sage In-Line Flow Meters, 1/2" and larger, and also available as assemblies for Insertion Flow Meters, see page 12), or consider additional straight run. The Chart below provides examples of the amount of straight run that would virtually assure that there are no flow disturbances at the point of measurement.

IMPORTANCE OF FLOW CONDITIONING
Recommended Pipe Diameters Upstream

DISTURBANCE	WITHOUT FLOW CONDITIONING	*WITH* FLOW CONDITIONING[1]
	Minimum Industry Recommendation	Sage Recommendation
One 90˚ Elbow	15	3
Two 90˚ Elbows in the same plane	20	5
Two 90˚ Elbows in different planes	At least 40	9
4:1 Area Reduction	15	3
4:1 Area Expansion	At least 30	10
Multiple Disturbance	To Be Determined	TBD

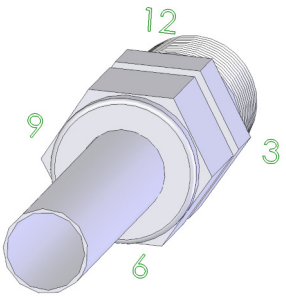
1 This column applies to In-Line Flow Meters, which come standard with built-in Flow Conditioners, as well as Insertion Meters, when provided with upstream Captive Flow Conditioners (see page 12).

COMPRESSION FITTING OPERATION

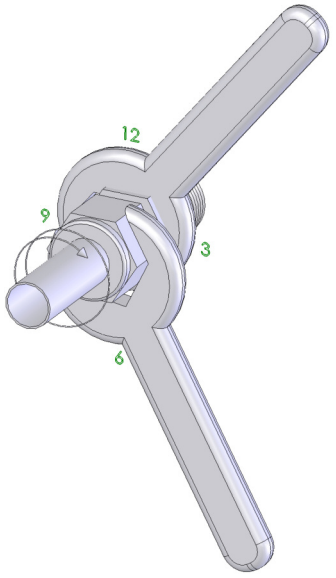
A bored through tube fitting, properly sized to accommodate an insertion probe's particular OD, can be provided by the user or purchased as an option from Sage Metering (see page 28). Prior to installation, a clearance hole to accommodate the insertion probe assembly must be drilled in the pipe/duct. A fitting (1/2" FNPT) is then welded in place or threaded into the half-threadolet which has been welded to the pipe/duct. The probe insertion depth is adjustable to permit sensor to be located at center, to optimize measurement accuracy. (Refer to PROBE INSERTION GUIDELINE DRAWING and CHART, pages 13 & 14.)

INSTALLATION INSTRUCTIONS

1. Insert tubing into the tube fitting.
2. Make sure that the tubing is positioned properly per the PROBE INSERTION GUIDELINE DRAWING AND CHART, pages 13 & 14.
3. **Due to the variations of tubing diameters, a common starting point is desirable. Therefore, tighten the nut until the tubing will not turn by hand or move axially in the fitting.**
4. Scribe the nut at the 6 o'clock position.
5. While holding fitting body steady, tighten the nut 1¼ turns to the 9 o'clock position.

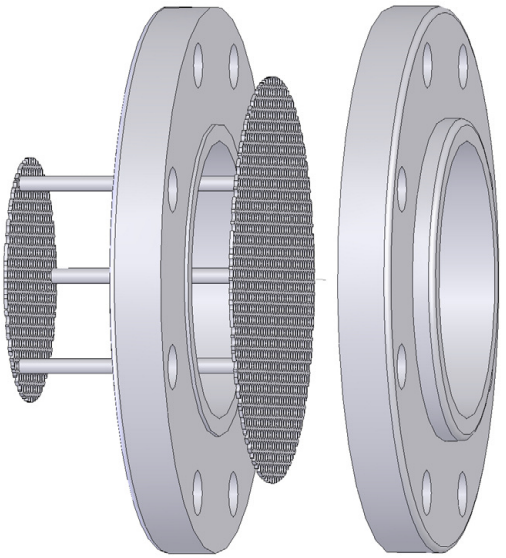


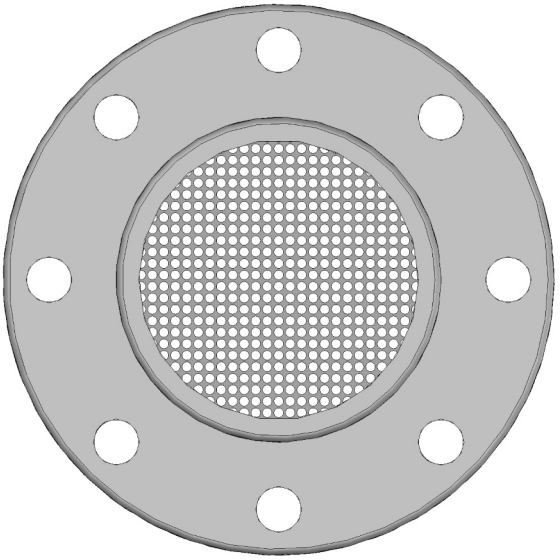
Insert the probe shaft tubing into the compression fitting to the position indicated in the Probe Insertion guidelines.



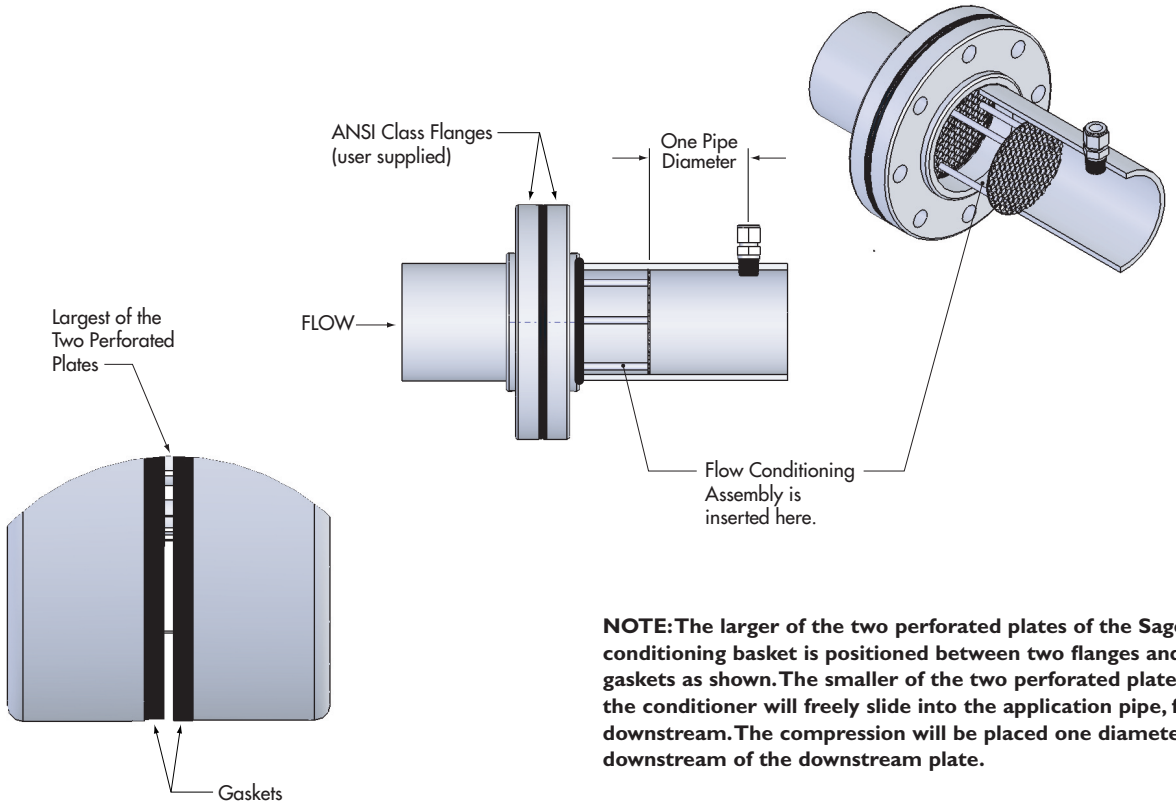
While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

CAPTIVE FLOW CONDITIONER ASSEMBLY
Can Be Installed in Conjunction with Insertion Style Flow Meters





Front View of one of the Conditioning Plates



NOTE: The larger of the two perforated plates of the Sage conditioning basket is positioned between two flanges and two gaskets as shown. The smaller of the two perforated plates of the conditioner will freely slide into the application pipe, facing downstream. The compression will be placed one diameter downstream of the downstream plate.

PROBE INSERTION GUIDELINE DRAWING[1]

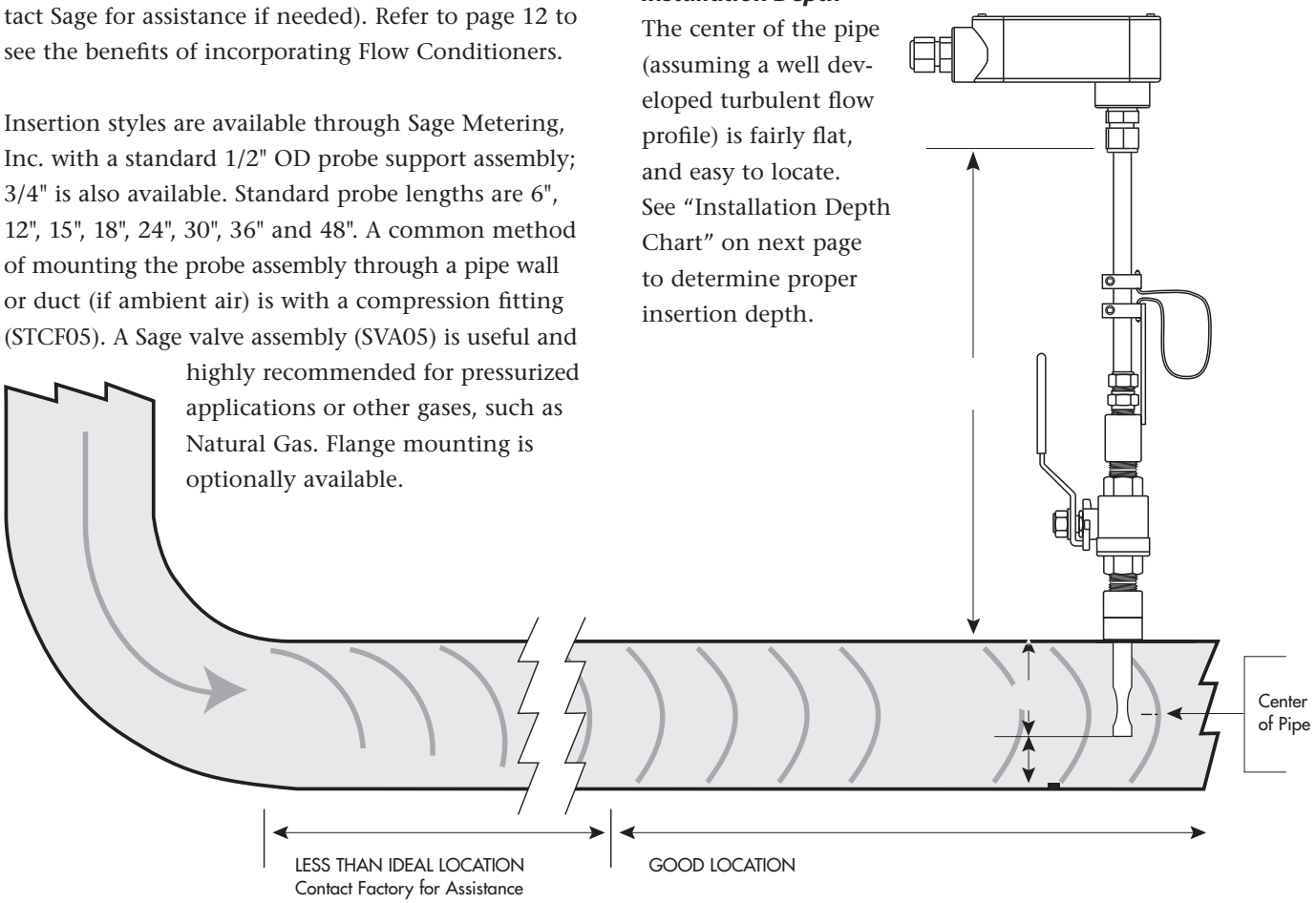
Choose the longest straight-run section of pipe available to allow a uniform, well-developed flow profile. Allow for a ***minimum*** of 15 pipe diameters of straight run upstream, and 5 diameters downstream, depending on the conditions. See chart on page 10. Note, obstructions such as valves, blowers expanders and PVC and HDPE pipes will require additional straight run (contact 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 nonuniform flow profiles and swirls. Otherwise signal output errors could result, unless significantly more straight run is provided, or in the absence of sufficient straight run, Flow Conditioners (page 12) are installed (contact Sage for assistance if needed). Refer to page 12 to see the benefits of incorporating Flow Conditioners.

Insertion styles are available through Sage Metering, Inc. with a standard 1/2" OD probe support assembly; 3/4" is also available. Standard probe lengths are 6", 12", 15", 18", 24", 30", 36" and 48". A common method of mounting the probe assembly through a pipe wall or duct (if ambient air) is with a compression fitting (STCF05). A Sage valve assembly (SVA05) is useful and highly recommended for pressurized applications or other gases, such as Natural Gas. Flange mounting is optionally available.

Sage insertion style flow meters can be assembled and calibrated for use in virtually any size pipe or duct (as small as 1"). 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; microprocessor meter board, and 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. The "sensing point" or active part of the sensor (0.5" from the end of the probe) should be positioned as per the drawing below and the Installation Depth Chart on page 14.

Installation Depth

The center of the pipe (assuming a well developed turbulent flow profile) is fairly flat, and easy to locate. See "Installation Depth Chart" on next page to determine proper insertion depth.



INSTALLATION DEPTH CHART
Methods for Probe Insertion to Pipe Center

METHOD 1

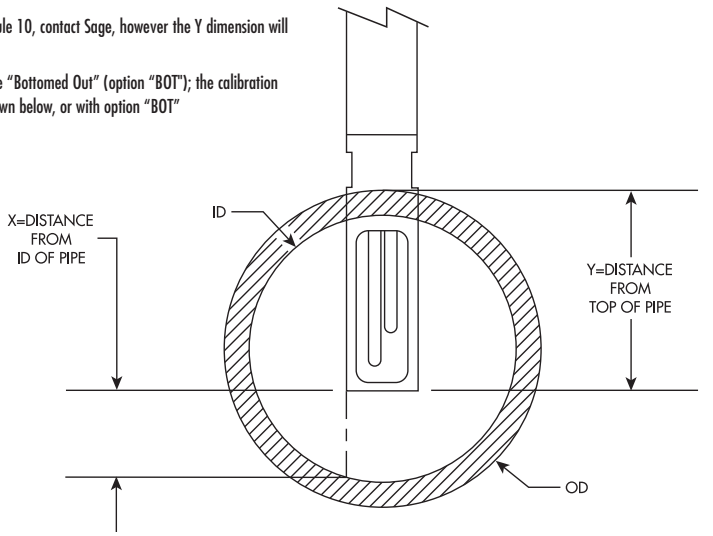
Using charts below, select pipe size (column 1), determine X. Insert probe until the end touches the bottom of the pipe (ID), mark probe as it exits top of fitting. Lift probe distance "X" and tighten compression fitting.

METHOD 2

Using charts below[1], select pipe size (column 1), determine Y. Subtract Y from the factory supplied probe length. That difference Z (see drawing on page 13) should be outside of the pipe, and is measured from the bottom of the enclosure of the probe weld to pipe OD.

1 For other Pipe Schedules, such as Schedule 10, contact Sage, however the Y dimension will be the same for any Schedule Pipe

2 The 1" Pipe Size needs to have the Probe "Bottomed Out" (option "BOT"); the calibration method for the 1½" Pipe is either as shown below, or with option "BOT"

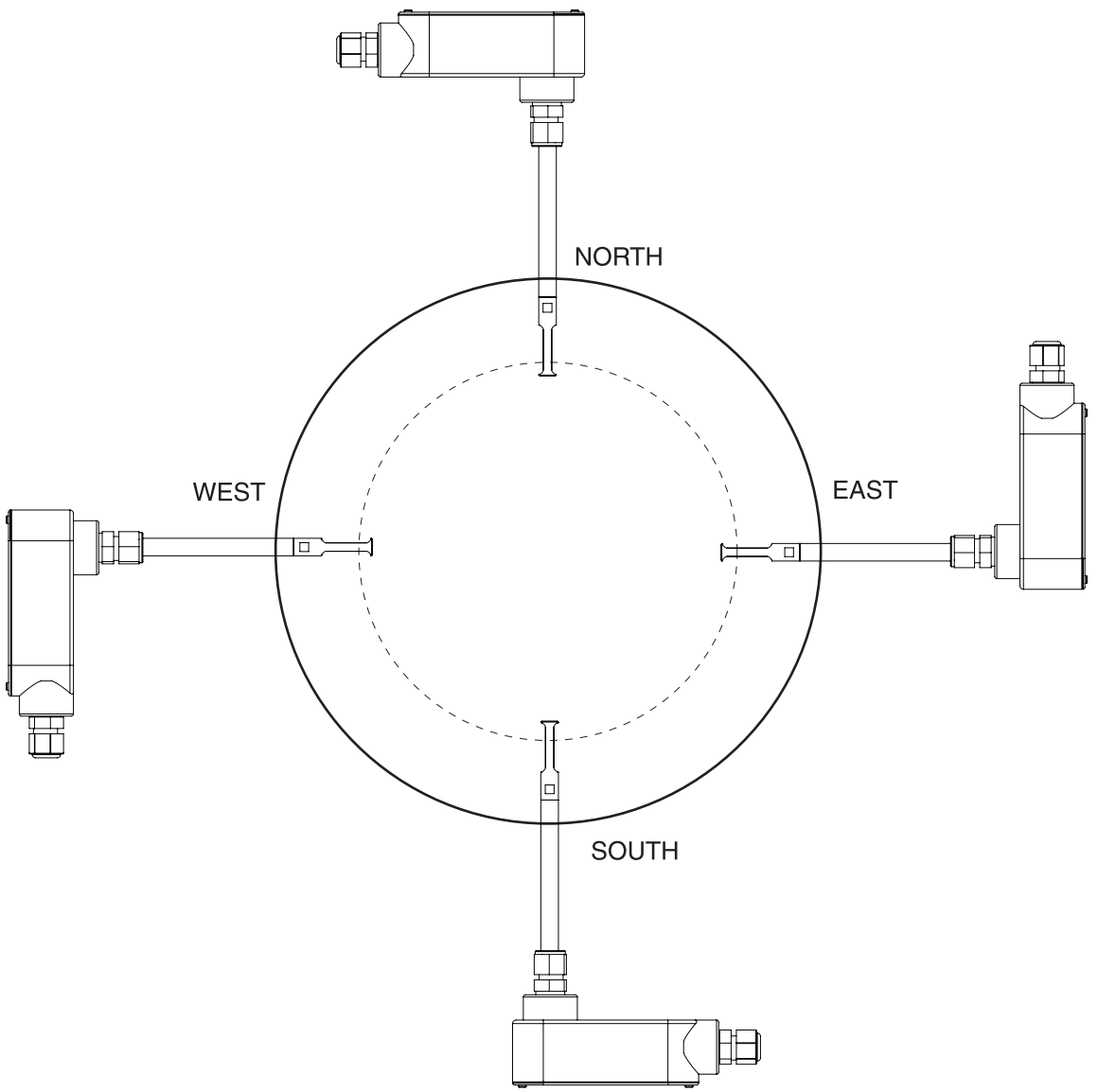


SCHEDULE 40 PIPE[2]					
PIPE SIZE	OD	ID	X	Y	PIPE AREA
1"	CONSULT FACTORY				
1.5"	1.900	1.610	.20"	1.56"	0.0141
2"	2.375	2.067	.40"	1.82"	0.0233
2.5"	2.875	2.469	.60"	2.07"	0.0332
3"	3.500	3.068	.90"	2.38"	0.0513
4"	4.500	4.026	1.40"	2.86"	0.0884
6"	6.625	6.065	2.40"	3.95"	0.2006
8"	8.625	7.981	3.40"	4.90"	0.3474
10"	10.750	10.020	4.40"	6.00"	0.5476
12"	12.750	11.938	5.50"	7.00"	0.7773
14"	14.000	13.124	6.00"	7.50"	0.9394
16"	16.000	15.000	7.00"	8.60"	1.2272
18"	18.000	16.876	8.00"	9.60"	1.5533
24"	24.000	22.625	10.75"	12.60"	2.7919

SCHEDULE 80 PIPE[2]					
PIPE SIZE	OD	ID	X	Y	PIPE AREA
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
10"	10.750	9.750	4.25"	6.00"	0.5185
12"	12.750	11.374	5.13"	7.00"	0.7056
14"	14.000	12.500	5.70"	7.50"	0.8522
16"	16.000	14.312	6.60"	8.60"	1.1172
18"	18.000	16.124	7.50"	9.60"	1.4180
24"	24.000	21.562	10.25"	12.60"	2.5357

Large Stack or Duct Applications

CONFIGURATION FOR UTILIZING FOUR (4) SAGE INSERTION MASS FLOW METERS FOR LARGE ROUND PIPES OR DUCTS LARGER THAN 36" TO MINIMIZE EFFECTS OF VARYING FLOW PROFILES
(It is recommended that Factory be contacted to assist with applications of this nature)



The outputs of the four meters will be averaged by customer's PLC or other method to improve overall accuracy in measuring the flow rate. (For medium sized round pipes [18" to 36"], two meters, on the opposite side of the same diameter, may be sufficient [insert parallel to an upstream 90 degree bend for optimal benefit.]) Note, in this configuration, each sensor needs to be averaged.

In-Line Flow Meter Application

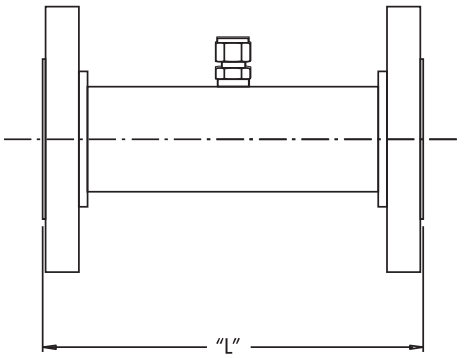
IN-LINE FLOW METERS

In-line mounting styles are available through Sage Metering, Inc. in sizes from 1/4" pipe through 4" pipe. Threaded male NPT ends are standard up to 2-1/2"; ANSI 150lb flanged ends are recommended for 3" and 4" models. Contact the factory if optional end mounting styles are required. Pipe sizes in excess of 4" require the insertion style mass flow meter.

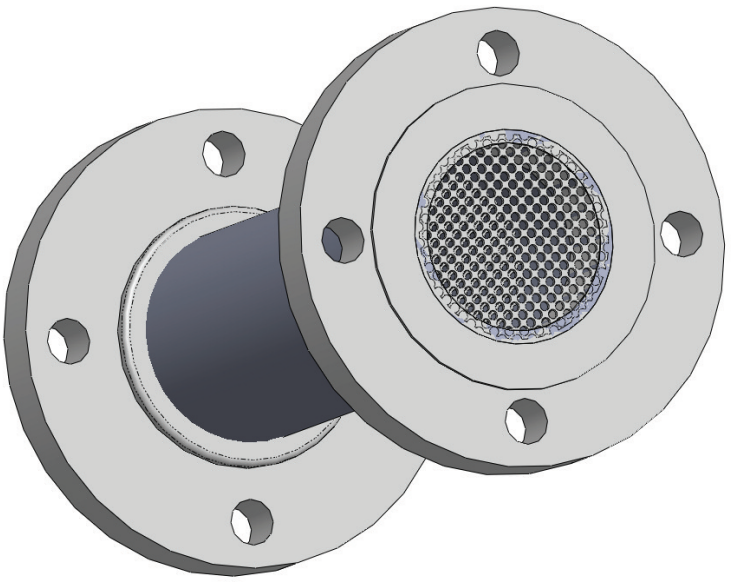
The in-line style flow meter assembly flow section is typically specified to match the user's flow conduit and is plumbed directly in the flow line by threading, flanging, welding, etc. DO NOT USE REDUCERS. It includes the sensing element (a self-heated flow sensor and a temperature/reference sensor) 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. See Table (page 10) for Upstream Straight run requirements. ***Note,*** the 1/4" and 3/8" do not have Flow Conditioners and thus require more straight run.

FLOW CONDITIONING SCREENS FOR IN-LINE FLOW BODIES 1/2" AND UP[1]



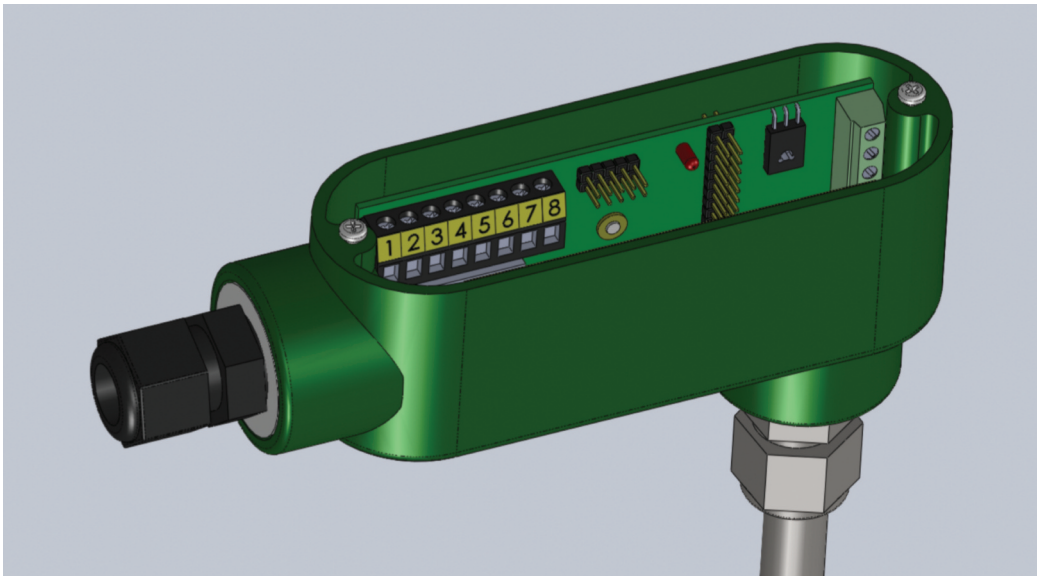
LENGTH "L" SAME AS NON-FLANGED METER (See table on page 27. For example, 1"x8" flow body has an 8" length. The length will be the same whether an NPT flow body, or whether flanged. If a flanged flow body, the 8" dimension will be a Face-to-Face dimension.)



Screens shown with NPT fitting.

1 Note, Flow conditioning is also available for Insertion Meter applications (see page 12)

Terminal Hookup (Series SIB)

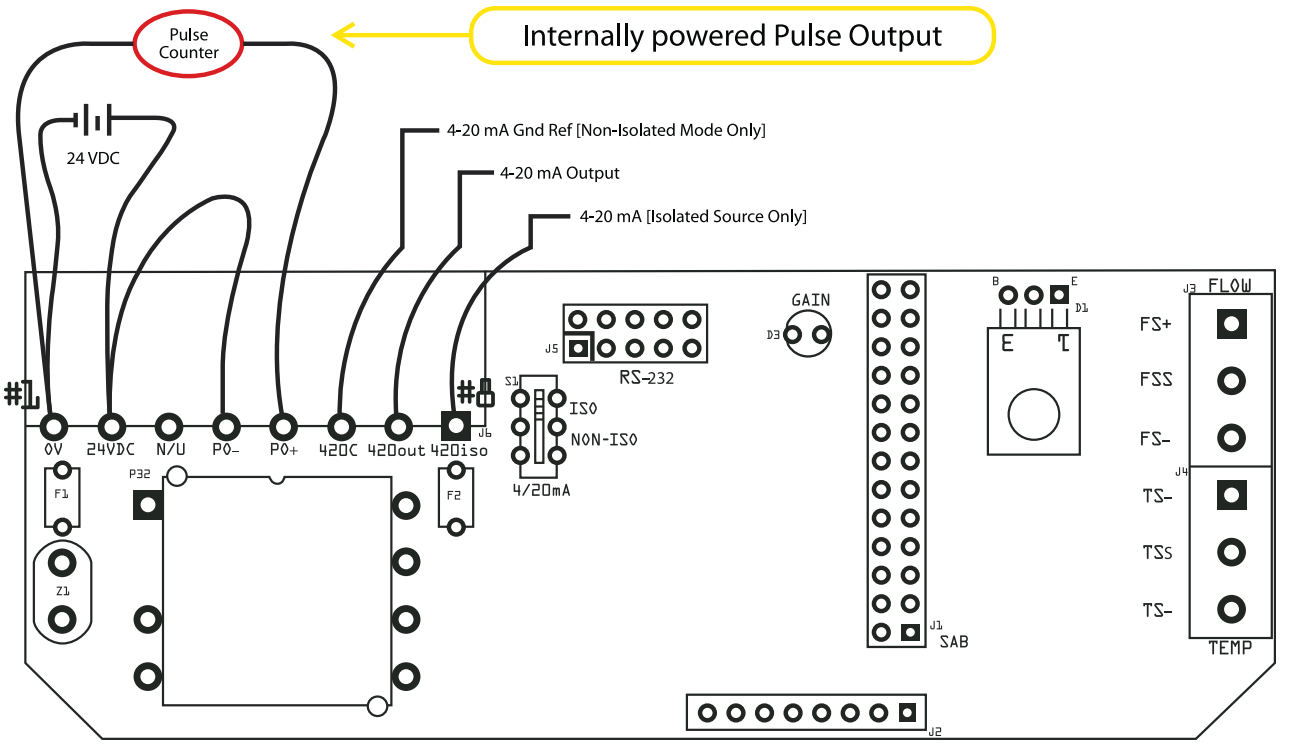


TERMINAL #	DESCRIPTION
1	24VDC Ground
2	24VDC In
3	Not in Use
4	Pulse Relay Common
5	Pulse Relay, Normally Open
6	4-20mA Ground Non-Isolated Only
7	4-20mA Output Drive
8	4-20mA Source Input Isolated Mode Only (Externally Powered)

For Isolated Mode (Externally Powered), slide selector switch in upward direction *(not shown)*.

NORMAL 4–20mA	EXTERNALLY POWERED 4–20mA
Terminals 6 & 7	Terminals 7 & 8

Terminal Hookup (Series SIB) Wiring Diagram



Section B

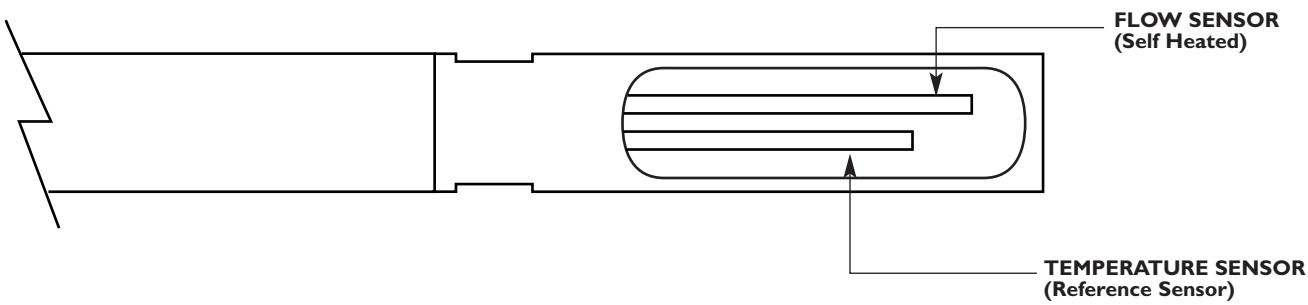
STYLES AND FEATURES

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 are driven by a proprietary sensor drive circuit. One of the sensors is self-heated (flow sensor), and the other sensor (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.

It is essential that this constant temperature differential be maintained, even if there are wide fluctuations in gas temperature. It is the function of the Sage proprietary sensor drive circuit to maintain 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 gas being measured.



Features and Benefits

SAGE "BASIC" COMPRESSED AIR FLOW MONITORING

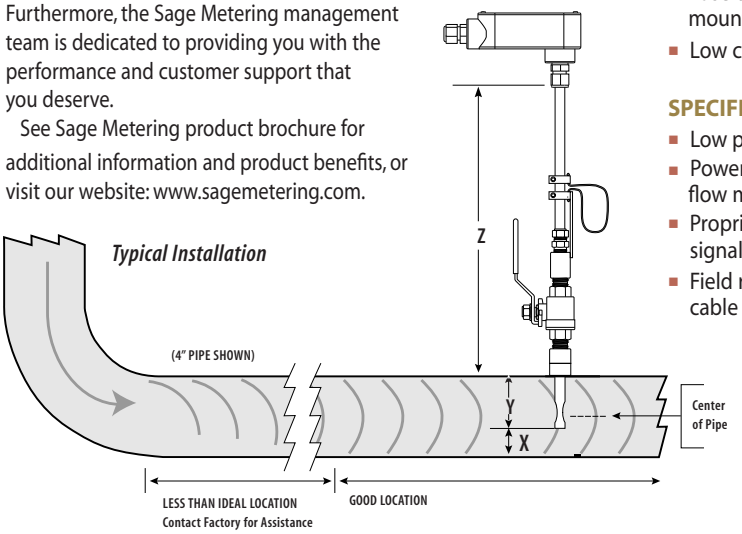
Compressed air generally uses more electricity than any other type of equipment. Sage Basic Insertion Style Thermal Mass Flow Meters can help identify leaks in a compressor system, track overall usage to improve plant efficency, and help departments reduce consumption. Thousands of dollars can be saved; for example, if a compressor system running at 100 psi had leaks as small as .05 square inches, it would pass 100 CFM of unused compressed air. Based on 24 hours and 12 cents a KW/H, the annual wasted power would exceed $20,000!

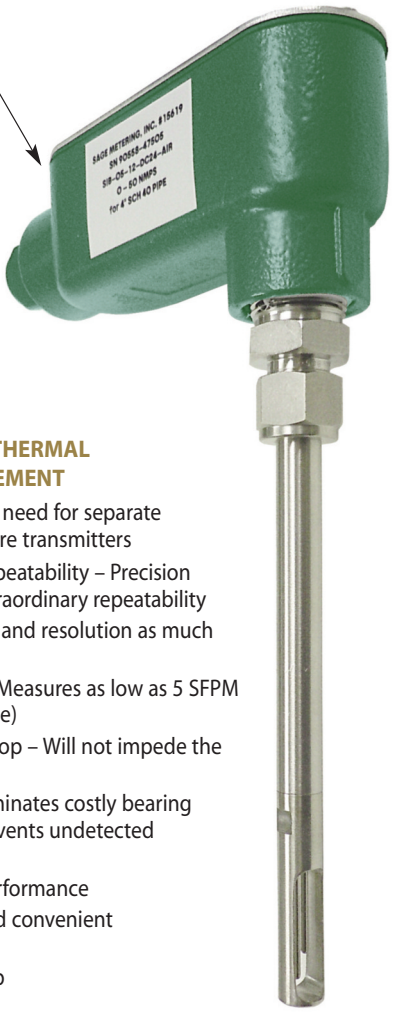
Sage Insertion Meters measure direct mass flow and have the sensitivity to detect even a few SCFM out of a thousand SCFM, so detecting leaks is an easy matter. The ease of installation and low cost, allow many check points in your compressed air piping. Simply insert the probe into the installed mounting hardware, such as a Sage Isolation Valve Assembly, to the recommended insertion depth. It has a 4-20mA output of Mass Flow Rate as well as a Pulsed Output of Totalized Flow. For additional information, contact Sage Metering at 866-677-7243 to assist you with your application.

OTHER "BASIC" THERMAL MASS FLOW METER APPLICATIONS

In addition to compressed air flow, other common Thermal Mass Flow applications in your manufacturing process include air injection, air purging, blow molding air, blower air, drying air flow, combustion air flow and vent air flow. Additional applications include natural gas boiler or furnace flow, natural gas for combustion control; and natural gas sub-metering for departmental billing, cost accounting, or monitoring production efficiencies. Many of these applications will help comply with environmental regulations, increase productivity, as well as reduce energy costs. Sage has over 10 years of experience in delivering high performance, NIST traceable, In-Line and Insertion Thermal Mass Flow Meters for a wide variety of industrial and environmental needs. Furthermore, the Sage Metering management team is dedicated to providing you with the performance and customer support that you deserve.

See Sage Metering product brochure for additional information and product benefits, or visit our website: www.sagemetering.com.





MAJOR BENEFITS OF THERMAL MASS FLOW MEASUREMENT

- Direct Mass Flow – No need for separate temperature or pressure transmitters
- High Accuracy and Repeatability – Precision measurement and extraordinary repeatability
- Rangeable over 100: 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 – Will not impede the flow nor waste energy
- No Moving Parts – Eliminates costly bearing replacements and prevents undetected accuracy shifts
- Provides sustained performance
- Ease of Installation and convenient mounting hardware
- Low cost-of-ownership

SPECIFIC BENEFITS OF SAGE THERMAL MASS FLOW METERS

- Low power dissipation, under 2.5 Watts (e.g. under 100 mA at 24 VDC)
- Powerful state-of-the-art microprocessor for high performance mass flow measurement and sustained performance
- Proprietary hybrid-digital sensor drive circuit provides enhanced signal stability and reproducibility
- Field reconfigurability via optional Addresser software and cable assembly

See Sage Metering Product Brochure for additional information and product benefits, or visit us at www.sagemetering.com

Styles and Specifications

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 will help increase productivity, reduce energy costs, maximize product yields, and/or help reduce environmental insult. Sage provides high quality In-Line and Insertion Thermal Mass Flow Meters for a wide variety of industrial, commercial, and environmental monitoring needs.

Our experienced application engineers, many of whom have worked in the Thermal Mass Flow marketplace since its inception, will assist you with your flow meter application. Additionally, our Service staff stands ready to support you with any after-sale assistance that you may require.

SAGE "BASIC" SIB SERIES SPECIFICATIONS

STYLES: In-Line or Insertion Integral

INSERTION STYLE: 1/2" SS Probe; Lengths 6" to 30". Minimum pipe size: 1"

IN-LINE STYLE: Flowbodies available from 1/4" to 4", with Flow Conditioners (1/2" or larger)

SENSOR: Two reference grade Platinum RTDs clad in 316SS sheath

MATERIAL: Wetted metal components: 316SS

POWER: 24VDC (100 mA max)

POWER DISSIPATION: <2.5 W

ELECTRONICS: Microprocessor based (Hybrid-Digital)

ELECTRONICS ENCLOSURE: NEMA 3R (Rainproof)

TURNDOWN: 100 to 1

RESOLUTION: 1000 to 1

LOW END SENSITIVITY: 5 SFPM

FLOW ACCURACY: +/– 0.5% of Full Scale +/- 1% of Reading

FLOW REPEATABILITY: 0.2%

FLOW RESPONSE TIME: 1 second time constant

GAS TEMPERATURE RANGE: –40° to 200°F

GAS PRESSURE: 500 PSIG

FLOW OUTPUT: 4 to 20 mA for Rate (Switchable between Internally or Externally Powered)

TOTALIZER: 24VDC Pulse for Totalized Value

AMBIENT TEMPERATURE: –40° to 150°F

RECONFIGURABILITY AND/OR IN-SITU CALIBRATION CHECK: See "OPTIONS"

PRINCIPLE OF OPERATION OF THE THERMAL MASS FOW METER

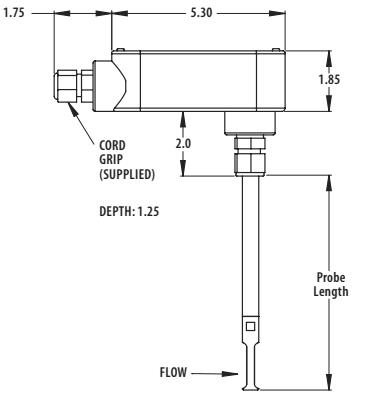
Sage Thermal Mass Flow Meters have two sensors featuring reference grade platinum windings (RTDs). The two RTDs are clad in a protective 316SS sheath and are driven by a proprietary sensor drive circuit. One of the sensors is self-heated (flow sensor), and the other sensor (temperature/reference sensor) 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.

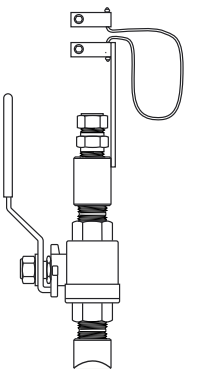
OPTIONS

- Sage Basic Software and Cable Assembly (specify BASICCOM for Reconfigurability or Calibration Check)
- Flanged Ends for In-Line Flow Meters. Contact Sage
- Captive Flow Conditioners for Insertion Flow Meters. Contact Sage

SIB SERIES – INSERTION

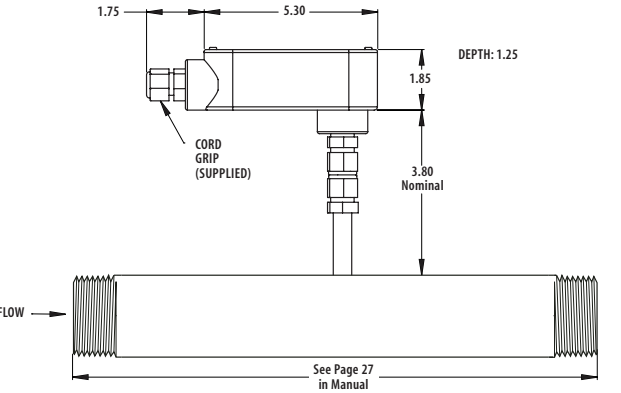


Sage "Basic" Economical Insertion Thermal Mass Flow Meter



Optional SVA05 Isolation Valve Assembly

SIB SERIES – IN-LINE



Sage "Basic" Economical In-Line Thermal Mass Flow Meter

1 *Enhanced accuracy available upon request, especially if turndown limited. Contact Sage*
2 *The 4–20mA Output is initially set up to be non-isolated (internally powered). If you require isolated outputs (externally powered), slide the selector switch and follow wiring instructions in manual.*

IMPORTANCE OF FLOW CONDITIONING
Recommended Pipe Diameters Upstream

DISTURBANCE	*WITHOUT* FLOW CONDITIONING	*WITH* FLOW CONDITIONING*
	Minimum Industry Recommendation	Sage Recommendation
One 90˚ Elbow	15	3
Two 90˚ Elbows in the same plane	20	5
Two 90˚ Elbows in different planes	At least 40	9
4:1 Area Reduction	15	3
4:1 Area Expansion	At least 30	10
Multiple Disturbance	To Be Determined	To Be Determined

* *This column applies to In-Line Flow Meters, which come standard with built-in Flow Conditioners, as well as Insertion Meters, when provided with upstream Captive Flow Conditioners.*

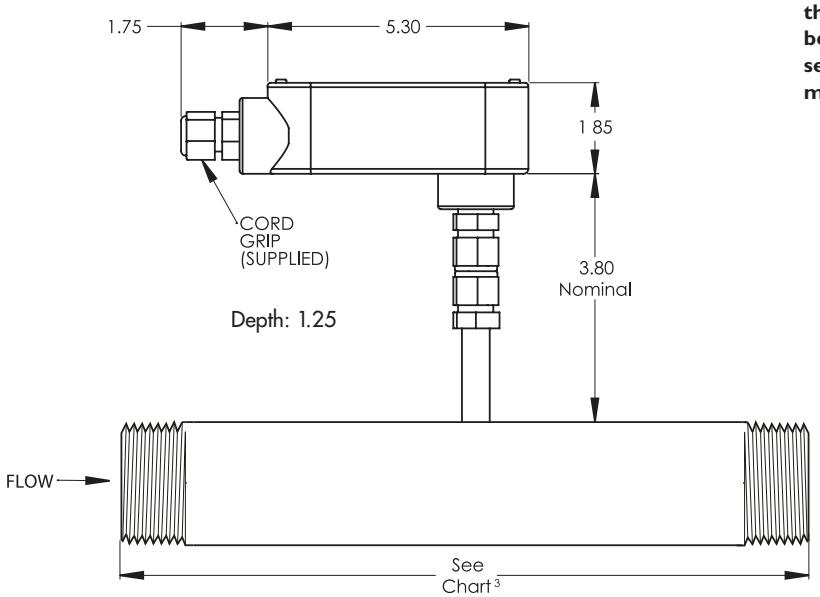
Section C

DRAWINGS

SIB 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)

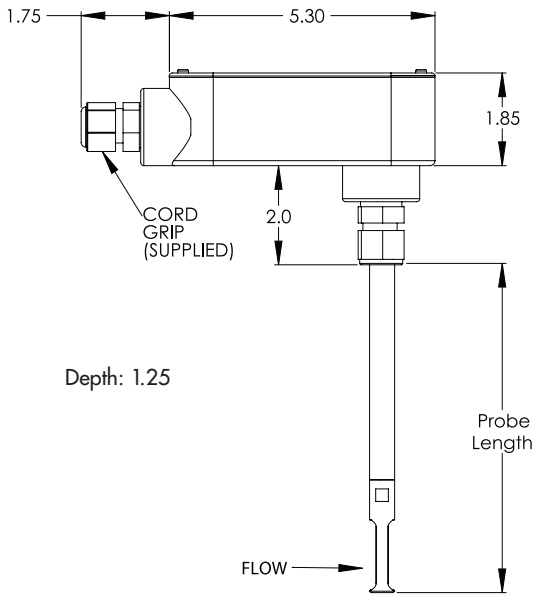


CAUTION:
Do not rotate the Enclosure of In-Line Style Meters relative to the Flow Tube, or the calibration may be effected since the sensors may become misaligned.

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# or 300# flanged mounting is optionally available (see page 30). Available probe lengths are 6", 12", 15", 18", 24", 30", 36" or 48". Standard probe is 1/2" diameter (3/4" optional – recommended for 36" or 48")



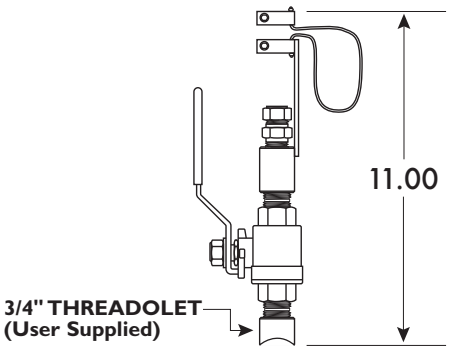
1 NPT Fittings standard
2 Flanged Mounting available for high pressure operation
3 Flow Conditioning built in to Flow Meter Pipe Sizes 1/2" and up. Contact Sage for optional 1/4" tube flow body.

Mounting Hardware[3]

SVA05 SERIES ISOLATION VALVE ASSEMBLY FOR INSERTION METERS[4]

(for Low Pressure SVA05 see page 29)

Used for pressures to 250 psig[1] (shown for use with 1/2" diameter insertion meters). 150# or 300# flanged mounting is optionally available. Available sizes are 1/2" x 3/4" NPT (SVA05 shown), and 3/4" x 1" NPT for use with 3/4" diameter insertion meters (SVA07).

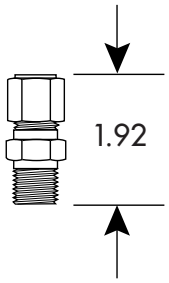


PROBE LENGTH (with sensor)	SAFETY CHAIN LENGTH[2]
12"	8.25"
15"	11.25"
18"	14.25"
24"	20.25"

NOTE: User needs to weld a 3/4" female threadolet (of appropriate radius) to mate with existing pipe after a 3/4" hole has been drilled in pipe. The 3/4" Male Coupling of the Sage Isolation Valve Assembly will thread into the user's 3/4" threadolet.

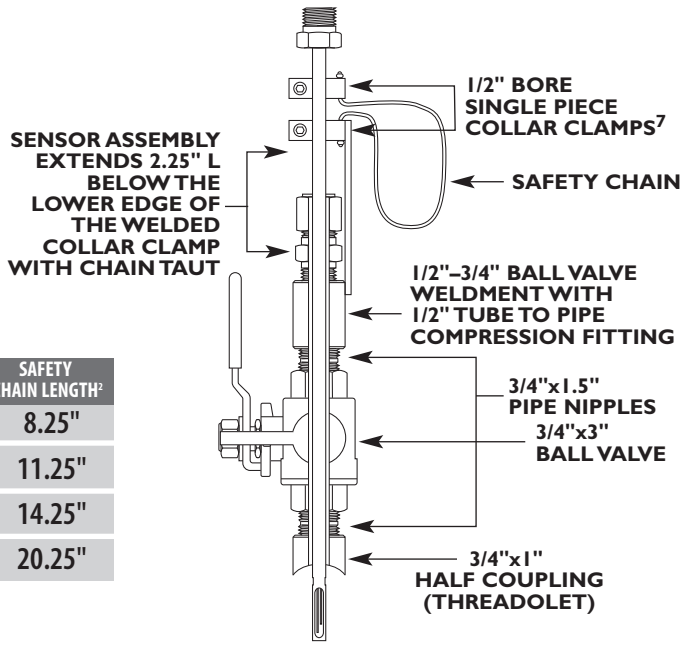
STCF SERIES TEFLON FERRULE COMPRESSION FITTING

1/2" tube x 1/2" pipe fitting (shown, not to scale), is used for low pressure insertion applications to 125 psig (Stainless Steel Ferrule optional for higher pressure applications – up to 225 psig). Also available in 3/4" tube x 3/4" pipe size.

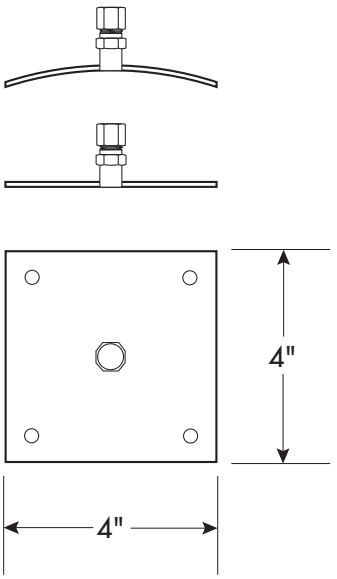


SVA05 SERIES ISOLATION VALVE ASSEMBLY DETAIL[5,6]

Cut away view of probe inserted through isolation ball valve assembly.

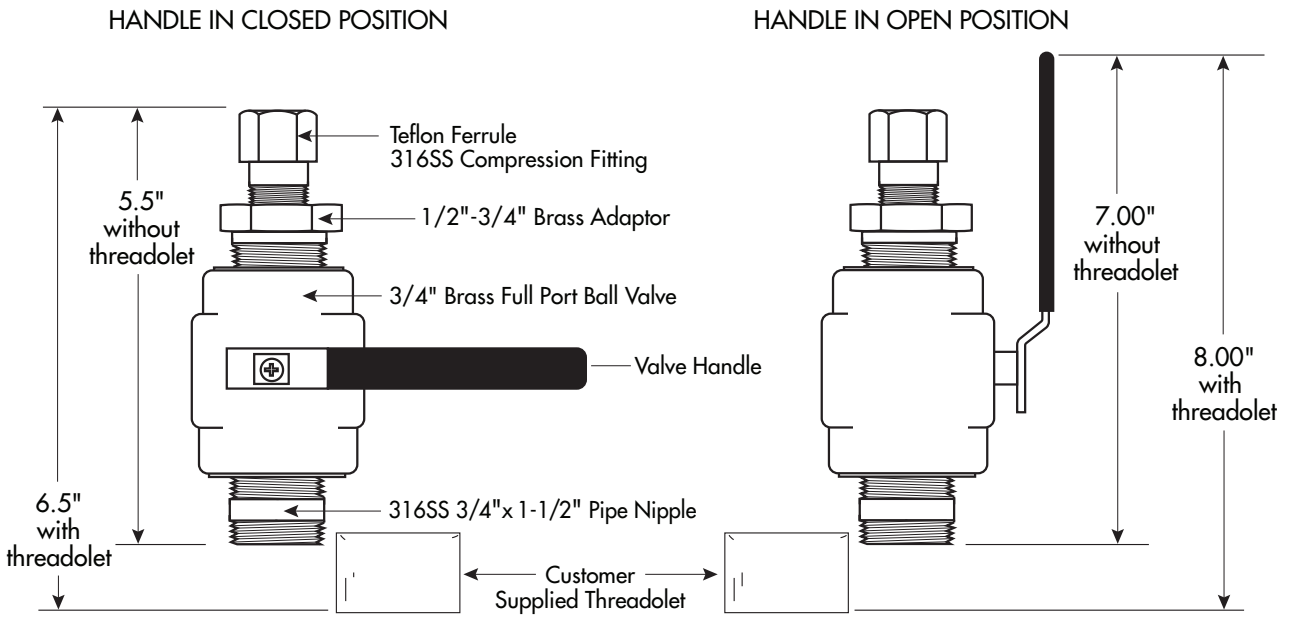


MOUNTING PLATE FOR THIN WALLED DUCTS (INCLUDES STCF05 COMPRESSION FITTING)



1 At 250 psig, force exerted on 1/2" diameter probe is 50 lbs.
2 Safety chain is designed to prevent probe from accidentally escaping from assembly during removal from 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 factory for details.
4 Maximum gas temperature, 200F, unless high temperature models ordered.
5 Hot Tapping is feasible by removing Weldment (upper portion of assembly temporarily removed)
6 See page 33. SVA05 can be utilized for Sensor Functionality and In-Situ Calibration Check.
7 The allen wrench for SVA05 is ¾ (it is ⅜ for SVA07).

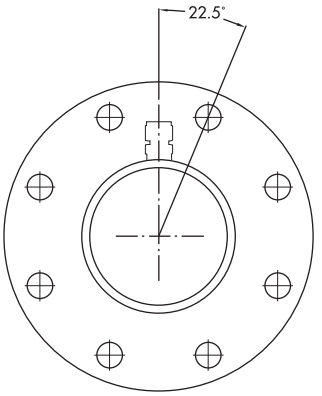
SVA05LP Low Pressure Isolation Valve Assembly



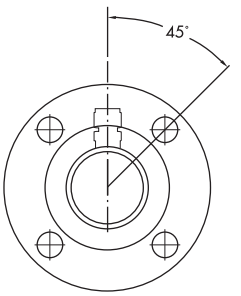
NOTES AND CAUTIONS

- **Suitable for low pressure Air or Natural Gas applications (maximum 50 PSIG)**
- **Assumes ½" Insertion Probe inserted to center of a Pipe (see Sage Probe Insertion Guidelines)**
- **Teflon Ferrule permits ease of Probe insertion or removal**
- **Exercise caution when loosening Ferrule nut during insertion and removal of Probe, since this model has no Safety Chain**
- **Note, maximum upward force is 20% of pipe pressure (i.e., 10 Lbs with 50 PSIG)**
- **The Assembly will be shipped with a plastic sleeve that protects the 3/4" pipe nipple**
- **It is the Customer's responsibility to weld a Female Threadolet with correct diameter to pipe**

Flanged Ends for In-Line Meter (OPTIONAL)

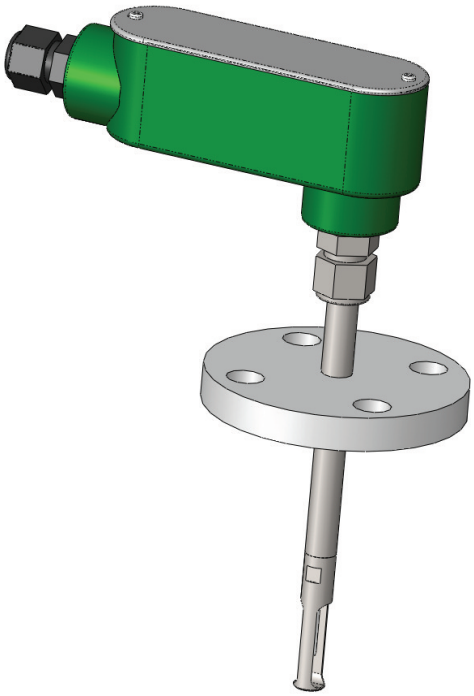


Flanges for 3½" pipe sizes and up, have 8 bolt holes



Flanges for 3" pipe sizes and smaller have 4 bolt holes

Flanged Mounting for Insertion Meter (OPTIONAL)



Section D

IN-SITU
CALIBRATION CHECK

In-Situ Calibration Check

RECOMMENDED ON A QUARTERLY BASIS FOR EPA 40 CFR 98 PERIODIC CALIBRATION VERIFICATION, CAR[1] PROTOCOLS, AND CDM[2] PROTOCOLS

Sage Basic has diagnostics available. You will require the optional BASICCOM software program and cable assembly. At any time, you can check this reading at a "no flow" condition and compare the reading to the original reported "zero flow" value noted on the last few lines of your meter's Certificate of Conformance or the flow meter's data tag. Open up Sage software, and select the "Meter" Tab. Click on the "Real-Time" button to view the milliwatts (mw). This diagnostic procedure not only checks the sensor performance and the "live zero" calibration point, but it verifies that the sensor is clean. It essentially provides a means to validate that the meter is operating properly, verifies that there is no shift or drift, and eliminates the need for annual factory calibrations. This simple field diagnostic procedure also verifies that the sensor is free from contamination, even without inspection.

1. Verify that meter has no gas flow[3]
   Close appropriate valves in the process to have a "no flow" condition so you can check the "live zero" mw output of the actual gas (it should be checked at the same pressure as noted on Certificate of Conformance).

   If it is not possible to close valves in the process (e.g. natural gas supply must be kept flowing), a user with a Sage SVA05 or SVA07 Isolation Valve Assembly can check "zero" of the actual gas and pressure without shutting off the gas supply. Refer to SVA SERIES ISOLATION VALVE ASSEMBLY DETAILS ON PAGE 28.
   a) Loosen lower Collar Clamp completely[4]
   b) Slightly loosen compression fitting until Probe can be lifted
   c) Lift Probe until Safety Chain is taut
   d) Tighten compression fitting
   e) Close Valve
   f) Check zero mw as per "2" below

   Optionally, do an ambient air check by removing probe and covering up sensor by capping the sensor with a plastic bag, empty plastic water bottle or other means of preventing flow (see 8).
2. Observe the raw mw by selecting the "Real Time" button on the meter tab of the Addresser. After one to three minutes of "no flow" stabilization, check the observed reading against the flow meter's data tag or last line(s) of your Meter's Certificate of Conformance.
3. A value within 5 milliwatts of the original Factory value (assuming the same gas is checked at same pressure) indicates that meter is still in calibration.
4. A value greater than 5 mw, but less than or equal to 10 mw, also indicates that the meter is still in calibration, but this reading may have been influenced by one or more of the following factors: gas composition, pressure, dirt, non-zero conditions, and sensor orientation. Any of these factors can have an effect on mWo. It is a very sensitive data point; that is why it is such a good check.
5. Note, if all of the above factors were remedied, it would be expected that the mW zero would report less than or equal to 5 milliwatts.
6. Note, in some cases, contamination of the sensor is the only cause of the additional heat transfer during the "no flow" test. Remove probe, and clean the sensor (use an appropriate non-corrosive solvent to remove build up). A soft brush can be used to gently clean the sensing surface, using caution to avoid damaging the sensor elements (the RTD's).
7. In summary, if a technician in the field were able to simulate Sage calibration conditions, he too would find that the mWo would be within one mW or very close to that. Since this is not always

possible, we are finding that after considering all of the field variables, a mWo in the field that is within 10 mW is an acceptable value (see 9). This would allow for a check to be done in the pipe under application conditions.

8. Note, if desired, a second check can be conducted as well but using ambient air: This validation method requires that the sensor be removed from the pipe and inserted in a container such as an empty plastic water bottle.
9. For CAR[1] compliance Sage recommends a quarterly In-Situ Calibration Check for the following Protocols:
   U.S. Landfill Protocol, Version 4.0, Par. 6.2
   Mexico Landfill Protocol, Version 1.1, Par. 6.2
   U.S. Livestock Protocol, Version 3.0, Par. 6.2
   U.S. Livestock Protocol, Version 4.0, Par. 6.3
   Mexico Livestock Protocol, Version 2.0, Par. 6.2
   As per the protocols, the maximum allowable drift is 5%. Percent drift can be determined by multiplying the mW change from factory value (see 2) by 1.0% (i.e. each mW change equals 1% drift).

1 CAR is the Climate Action Reserve. The Climate Action Reserve is a national offsets program working to ensure integrity, transparency and financial value in the U.S. carbon market. It does this by establishing regulatory-quality standards for the development, quantification and verification of greenhouse gas (GHG) emissions reduction projects in North America. The Climate Action Reserve operates alongside its sister program, the California Climate Action Registry (California Registry), which was created by the State of California in 2001 to address climate change through voluntary calculation and public reporting of emissions.
2 CDM Methodologies, ACM 0001, "Methodological tool to determine the mass flow of a greenhouse gas in gaseous stream" (EB61 Report, Annex 11, Page 1).
3 Sage "zeros" the meter in a horizontal pipe. If you have a vertical pipe, mW will be slightly lower at zero (also see note 4).
4 The allen wrench to loosen collar clamp is 7/64 on the SVA05 (it is 3/16 on the SVA07).

Section E

WARRANTIES AND SERVICE WORK

Warranties and Service Work

LIMITED WARRANTY

Sage Metering's products are warranted against faulty materials or workmanship for one year from the date of shipment from the factory. Sage's obligation is limited to repair, or at its sole option, replacement of products and components which, upon verification by Sage at our factory in Monterey, California, prove to be defective. Sage shall not be liable for installation charges, for expenses of Buyer 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; and does not cover Sage products which have been altered without Sage authorization or which have been 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 (www.sagemetering.com) on a link "General Terms" on the Footer of any page on the website.

CANCELLATION / RETURN POLICY

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

1) If credit card order or non-credit card order is cancelled within 7 days of issuance of purchase order or date order was placed (which ever is earlier), there will be a 10% cancellation fee.

2) If credit card order or non-credit card order is cancelled after 7 days, but prior to shipment, there will be a 20% cancellation fee. (If order is cancelled due to late delivery, the cancellation fee will be waived. Late delivery is defined as shipping a meter 7 days or later than the delivery date acknowledged by Sage Metering at time of placing order).

3) If a credit card customer decides to return the equipment after shipment for credit, credit will not be issued if equipment is damaged or if equipment is returned after four (4) months of shipment. If equipment is not damaged, then equipment can be returned after issuance of a Return Meter Authorization (RMA) by Sage. **Returned package must be insured by customer and must reference proper RMA# on outside of package,** or package may be rejected (i.e., package will be returned unopened). Credit Card customers will be charged a 30% re-stocking fee (70% balance will be credited back). Customer is responsible for return shipping charges and any damage if improperly packaged.

continued on next page

4) If a non-credit card customer decides to return the equipment after shipment for credit, credit will not be issued if equipment is damaged or if 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 will advise of the restocking fee. **Returned package must be insured by customer and must reference proper RMA# on outside of package,** or package may be rejected (i.e., package will be returned unopened). Customer is responsible for return shipping charges and any damage if improperly packaged.

RETURNING YOUR SAGE METER

A Return Material Authorization Number (RMA#) must be obtained prior to returning any equipment to Sage Metering for any reason. RMA#s may be obtained by calling Sage Metering at 866-677-7243 or 831-242-2030 between 8:00 am and 5:00 pm Monday through Friday.

A Sage RMA Form (see page 40) must be filled out and included with the meter being returned to Sage Metering. RMA Form is also accessible by clicking the "Contact" tab of the Sage website (www.sagemetering.com).

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

A purchase order is required prior to an RMA being issued. Most repairs or recalibrations can be quoted over the phone. For equipment that must be evaluated, an Evaluation purchase order in the amount of $150 is required. Once an evaluation is completed and a quote has been issued, you can choose to proceed with the work or have the unit returned with only the evaluation and freight fee billed.

In accordance with 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. For your reference, the requirements for packaging and labeling hazardous substances are listed in DOT regulations 49 CFR 172, 178, and 179.

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

2. A Material Safety Data Sheet (MSDS) is required for all process fluids and gases that have been in contact with the equipment. This includes fluids or gases used in cleaning the equipment. A Decontamination Statement is also required for each meter returned using a different gas or fluid. Both the MSDS and the Decontamination Statement are to be attached to the OUTSIDE of the shipping container. If both documents are not attached, you will be called, and the equipment sent back to you at your expense.

3. The decontamination Statement must include the following required information

   A. A list of all chemicals and process fluids used in the equipment, including decontamination fluids or gases.

   B. The model and serial number of the equipment being returned.

   C. A company officer or other authorized person's signature on the statement.

Return Shipping Address:

Sage Metering, Inc.
8 Harris Court, Building D1
Monterey, CA 93940

RETURN MATERIAL AUTHORIZATION

RMA # _____

Date _____

RETURN CUSTOMER INFORMATION

Customer's Name _____ Fax # _____

Customer's Contact Name _____ Phone # _____

Email Address _____

CUSTOMER'S RETURN ADDRESS

Bill to: _____ Ship to: _____

RETURN PRODUCT INFORMATION

Model No. _____ Serial No(s). _____

FLOW: MIN _____ NORMAL _____ MAX _____

TEMP: MIN _____ NORMAL _____ MAX _____

PRESSURE: MIN _____ NORMAL _____ MAX _____

GAS _____ LINE SIZE _____

REASON FOR RETURN / DESCRIPTION OF SYMPTOMS

(All non-warranty repairs could be subject to a minimum evaluation charge)

Recommended steps to be used to duplicate problem/symptoms _____

Sage Metering Technical Contact _____

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

SAGE METERING, INC.

8 Harris Court, Building D-1 / Monterey, California 93940

PHONE: 831-242-2030 / FAX: 831-655-4965

Section F

ADDRESSER SOFTWARE

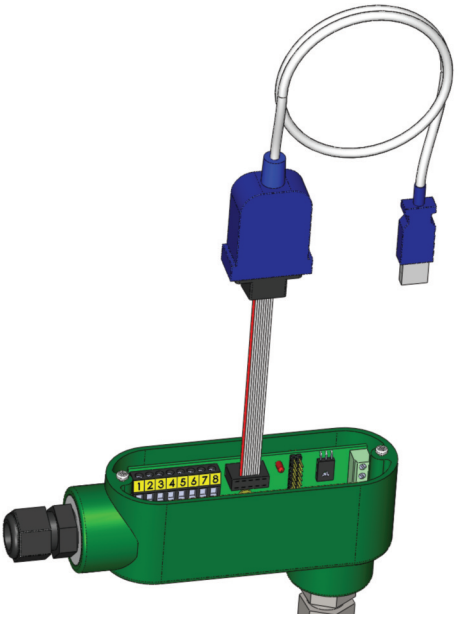
Optional Software

SAGE BASIC SOFTWARE AND CABLE ASSEMBLY

BASICCOM is a convenient software program and cable assembly that provides the option for reconfigurability or for a calibration check (see page 33). The software is a READ/WRITE Program with drop-down menus for convenient user interface between your PC or laptop and the Sage Basic.

SAGE ADDRESSER TECHNICAL ASSISTANCE

Visit our website at www.sagemetering.com and under the "Knowledge Base" tab select "Service Manuals and Guides" or contact customer service at 866-677-7243 (831-242-2030) for assistance.



Sage BASIC shown with optional BASICCOM RS232 to USB Cable Assembly that is accompanied with software disc.

SAGE SOFTWARE TYPICAL PRINTOUT (Version 3.14)

Parameter	Decimal Date	Hex Format
Calib mW Val	44.91799	8433AC08
K-Factor	1.000000	7F000000
Lead Gain Val	0.992098	7E7DFA22
Flow Load Res	20.10000	8320CCCD
Temp Calib[A]	–3.07714	80C4F000
Temp Calib[B]	1.144714	7F128600
Temp Calib[C]	–0.00121	759F7000
Temp Calib[D]	0.000003	6C3F3400
Temp Disp Null	0.000000	00000000
Temp Disp Gain	1.000000	7F000000
Amp Null Val	–0.16634	7CAA56DE
Amp Gain Val	1.008498	7F011676
Flow Coeff[A]	–20.7094	83A5ACF2
Flow Coeff[B]	0.720296	7E38654E
Flow Coeff[C]	–0.00880	789033FC
Flow Coeff[D]	0.000067	710D75E4
Flow Coeff[E]	0.000000	00000000
Flow Coeff[F]	0.000000	00000000
Filtering	0.500000	7E000000
Min Flow/LFC	0.000000	00000000
Full Scale	1200.000	89160000
Min Temp	40.00000	84200000
Units/Pulse	100.0000	85480000
DAC1 Min	725.0000	000002D5
DAC1 Max	3674.000	00000E5A
Serial Number	5.0042.00	0000C37B
Flow Units	12964504	4D464353
Total Units	11790099	46464353
Output Config	8.000000	00000008
Puls Dur	250.0000	000000FA

Section G

APPENDIX

Correction Factors For Variation From Original Digester Gas Calibration

Sage can calibrate for any Digester Gas, Bio Gas or Landfill Gas Mix. However, it may be helpful to have correction factors for a typical calibration, in the event that the composition changes after delivery. The following examples assume that the initial calibration was set up for 60% CH4 and 40% CO2.

a) 65% CH4 and 35% CO2: Multiply reading by 0.982 to correct it for new composition

b) 70% CH4 and 30% CO2: Multiply reading by 0.965 to correct it for new composition

c) 55% CH4 and 45% CO2: Multiply reading by 1.0185 to correct it for new composition

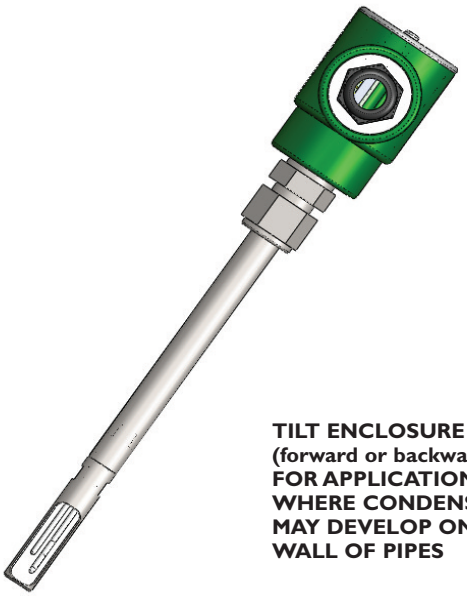
For smaller changes, the corrections are linear in between

d) Also, if 100% saturated with H2O vapor (non-condensing), multiply readings by 1.042

e) If 50% saturated with water, multiply reading by 1.021
(Water vapor correction is linear in between)

Also, use the 45 degree mounting method in order to avoid droplets from hitting the sensor and causing spikes (see above right)

Installations Where Pipe Condensation May Develop



TILT ENCLOSURE 45° (forward or backward) FOR APPLICATIONS WHERE CONDENSATION MAY DEVELOP ON INSIDE WALL OF PIPES

What is a Thermal Mass Flow Meter?

- What is a Thermal Mass Flow Meter? It is a meter that directly measures the gas mass flow based on the principle of conductive and convective heat transfer.

- All Meters have probes (Insertion Style) or Flow Bodies (In-Line Style) that support a pair of sensors, which are in contact with the gas.

- The sensors are RTDs, which are resistance temperature detectors. They consist of highly stable reference-grade platinum windings. In fact, we use the same material that is 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 up 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.