SMC-ATMF8000 Series Thermal Mass Flowmeter

OPERATING MANUAL

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Section A

GETTING STARTED

Getting Started

UNPACKING YOUR SMC METER

Your SMC 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 SmartMeasurement as soon as possible. Please save shipping container and packaging materials (including PVC tube probe protector on SMC Insertion Flow Meters) in case the unit needs to be returned for any reason.

MAINTENANCE

SMC 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 SmartMeasurement, Inc. for instructions. In general, it is recommended that your SMC 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.

CALIBRATION

SMC ATMF 8000 has continuous diagnostics. The raw calibration milliwats (mw) is always displayed in the upper left hand corner of the meter's display. 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. 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 the meter's performance, 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. See "Sensor Functionality and Zero Calibration Self Check" on page 46.

CAUTION cable glands shipped with 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.

CAUTION Installer must supply proper ground and bond wire for the transmitter and the sensor per appropriate electrical codes

INSTALLATION AND MOUNTING

- Check the Certificate of Conformance included with your SMC 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 recommended that there be a minimum of 10 pipe diameters of straight run upstream of elbows, or obstructions (such as valves, blowers, reducers, etc.), and that there be a minimum of 3 to 5 pipe diameters of straight run downstream of probe location.
- 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[1], 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 SMC 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.
- For Remote Style Meters (SRP) be sure the Remote Electronics is matched with the Transmitter's Junction Box and its attached Probe or Flow Body. There will be Metal Serial Number Tags on both the Transmitter as well as the Remote Electronics enclosure. Do not mismatch the serial numbers of the Remote Electronics and the Junction Box, or calibration errors will occur.

LOCATING PROPER WIRING DIAGRAM

1) Look at the sticker on your meter. The first three digits after the "ATMF-8000Ix" describe the basic model that you have. Refer to the appropriate page numbers below for your wiring diagram.
2) SP-I: see page 14
3) SP-R: see page 17 for input/output terminals; see page 19 (Junction Box Wiring Terminals for Remote Style Meters)

WIRING

Remove the rear cap and follow diagram on page 14 (SP-I) and page 17 (SP-R). CAUTION: Do not open display side!

Note: See "Approvals" page for Hazardous Location Approvals (DC Powered Meters Only)

1 The Integral Style of SMC ATMF 8000 Insertion Meters have the Display oriented as shown on page 14. If an alternate orientation of the display, or enclosure is required (ie. installation into a vertical pipe), please furnish a sketch or drawing, and specify "ROTATE" on purchase order. However, if it is later determined that the *enclosure* needs to be rotated, that procedure can be done in the field. However, if the *display* needs to be rotated, then the meter must be sent back to SMC to be modified. Do not attempt this in the field. An RMA will be required prior to returning the meter (see page 51). The procedure for rotating the enclosure is as follows: Clamp the enclosure of the ATMF 8000 in a vise with the probe pointing up to the ceiling. Then take a 7/8 wrench and turn the probe to the proper orientation. Lock the probe into its new position with a set screw (not provided).

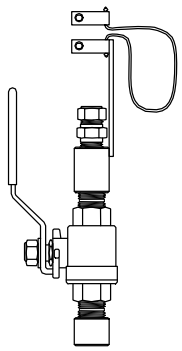
Insertion Flow Meter Application

FLOW PROFILE AND INSTALLATION CONSIDERATIONS

Insertion Flow Meters, 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 9) and INSTALLATION DEPTH CHART (page 10).

SMC VALVE ASSEMBLY OPERATION

Valve assemblies (SVA05 and SVA05LP) are an optional mounting hardware for Insertion Style Flow Meters (see pages 30 and 31). They allow the removal of insertion-style meters for service, cleaning, recalibration, relocation, etc. without the need to "shut-down" 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 9 & 10.) 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.



NOTE: Detailed Drawings are shown on pages 30 & 31.

A threaded half coupling (¾" 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 SmartMeasurement) may be required.

FLOW CONDITIONING AND STRAIGHT RUN

Although a minimum of 10 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 SMC In-Line Flow Meters, ½" and larger, and also available as assemblies for Insertion Flow Meters, see page 8), 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.

DISTURBANCE	Diameters Without Conditioning[1]	Diameters With SMC Conditioning[2]
One 90˚ Elbow	25	3
Two 90˚ Elbows in the same plane	36	5
Two 90˚ Elbows in different planes	62	9
Reduction in flow area (1/4)	18	3
Expansion in flow area (4/1)	84	10

1 Most Flow Meter Manufacturers recommend a minimum of 10 pipe diameters. However, in a worst case scenario, the more conservative literature on the subject is as shown in this table.

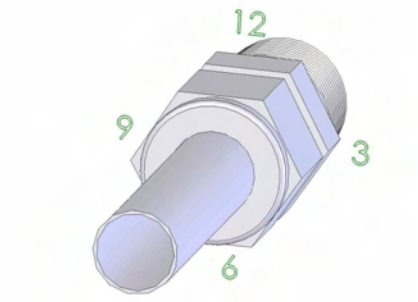
2 This chart applies to In-Line Flow Meters from ½" to 4", as well as to SMC optional Insertion Flow Conditioner (see page 13).

COMPRESSION FITTING OPERATION

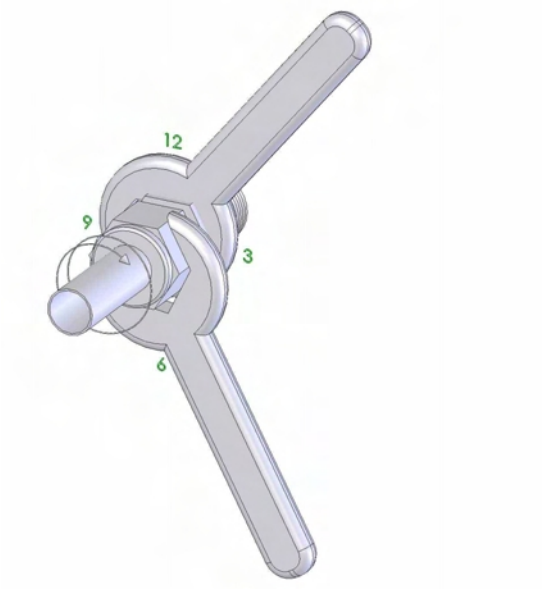
A bored-through tube fitting, properly sized to accommodate an insertion probe's particular OD, can be provided by the user or purchased as an option from SmartMeasurement (see page 38). Prior to installation, a clearance hole to accommodate the insertion probe assembly must be drilled in the pipe/duct. A fitting (½" 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 9 & 10.)

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 9 & 10.
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 $1^{1/4}$ turns to the 9 o'clock position.

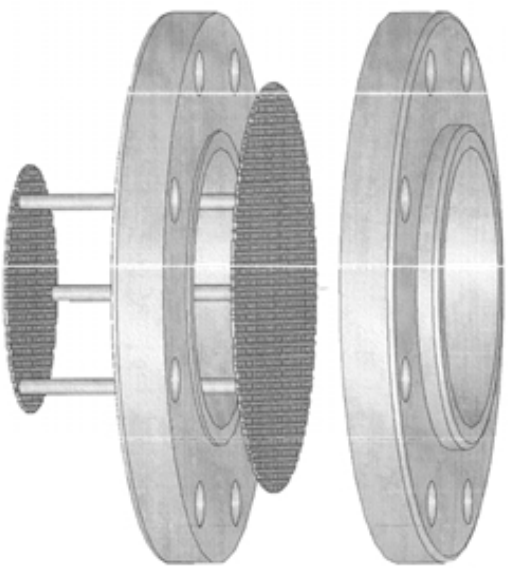


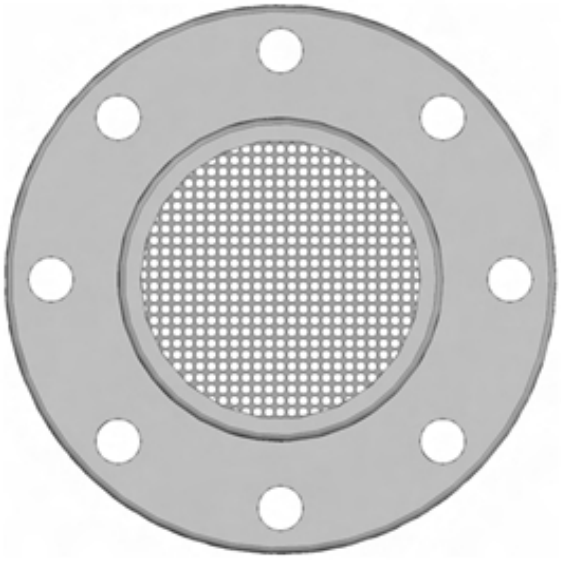
Insert the probe shaft tubing into the compression fitting to the position indicated in the Probe Insertion guidelines.



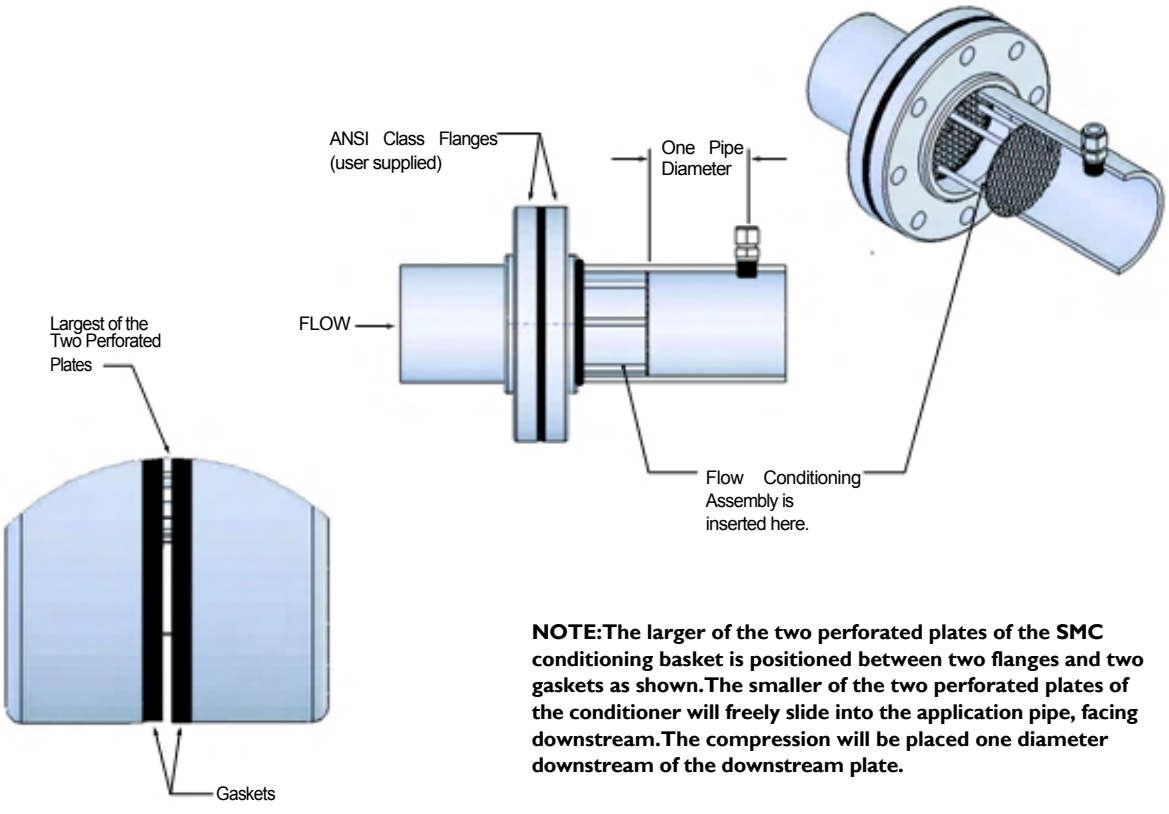
While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

CAPTIVE FLOW CONDITIONERS
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 SMC 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]

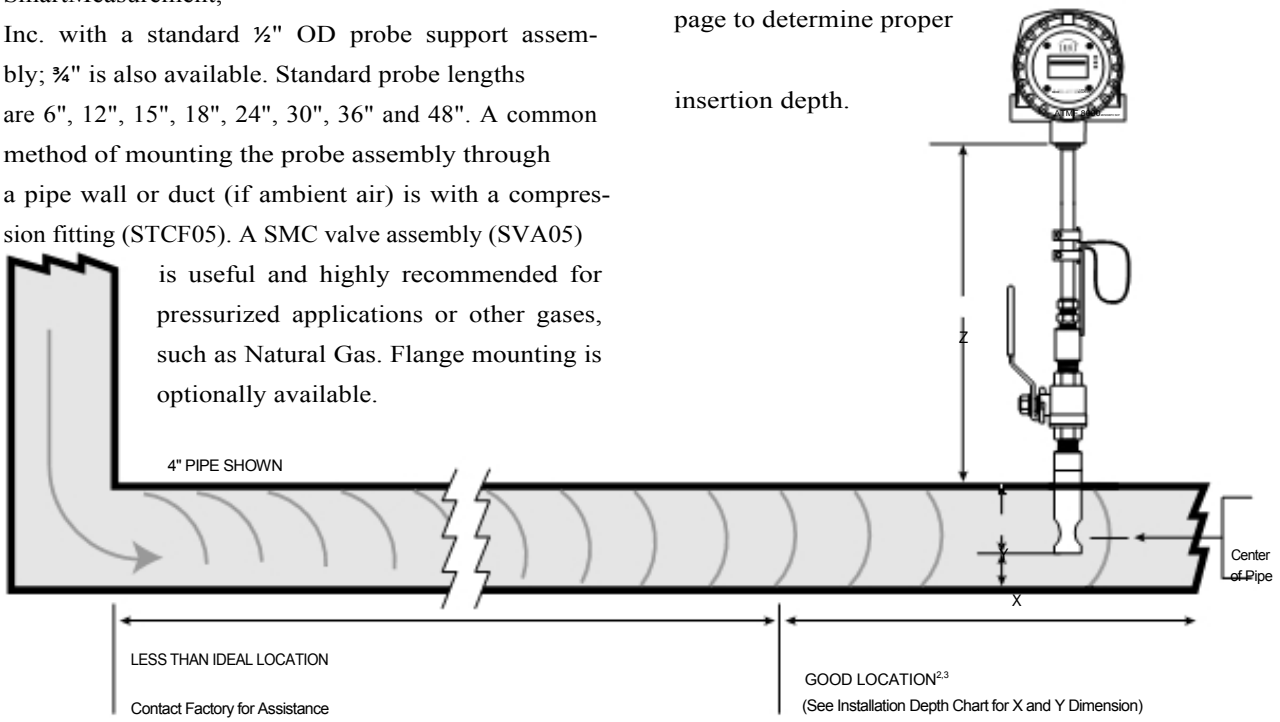
Choose the longest straight-run section of pipe available to allow a uniform, well-developed flow profile. Allow for a *minimum* ten (10) diameters of straight-run upstream of the sensors, and three (3) diameters straight-run downstream of the sensors. Avoid, if possible, installations immediately downstream 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 13) are installed (contact SMC for assistance if needed). Refer to page 13 to see the benefits of incorporating Flow Conditioners.

Insertion styles are available through SmartMeasurement, Inc. with a standard ½" OD probe support assembly; ¾" 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 SMC valve assembly (SVA05) is useful and highly recommended for pressurized applications or other gases, such as Natural Gas. Flange mounting is optionally available.

SMC insertion style flow meters can be assembled and calibrated for use in virtually any size pipe or duct (as small as 1"). SMC 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 15.

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.



1. SIP Industrial Meter shown in drawing. Note, probe is not bi-directional.
2. Probe should be inserted per Installation Depth Chart (see following page), so sensors are in the center of the pipe.
3. The portion of the probe that remains outside of the pipe, is simply the factory ordered probe length (i.e. "-15" = 15 inches) minus the "Y" dimension.

INSTALLATION DEPTH CHART
Methods for Probe Insertion to Pipe Center

METHOD 1

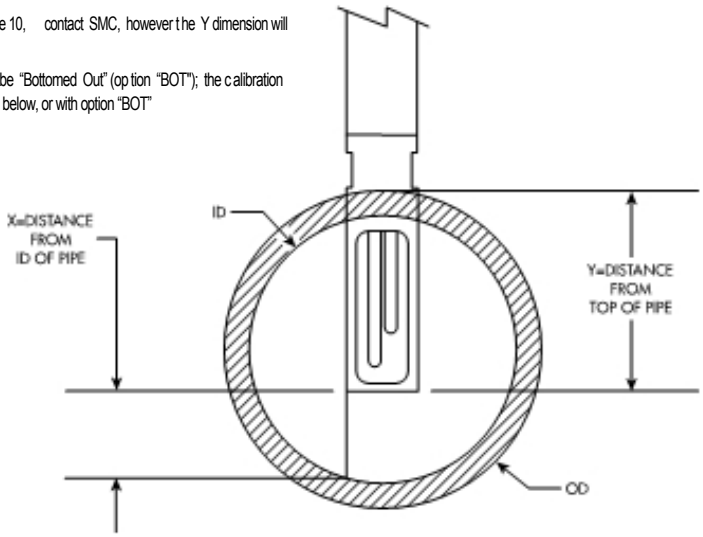
Using charts below, select pipe size (column 1), determine X. Insert probe until the end touches the bottom of the pipe (ID), mark probe as it exits top of fitting. Lift probe distance "X" and tighten compression fitting.

METHOD 2

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

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

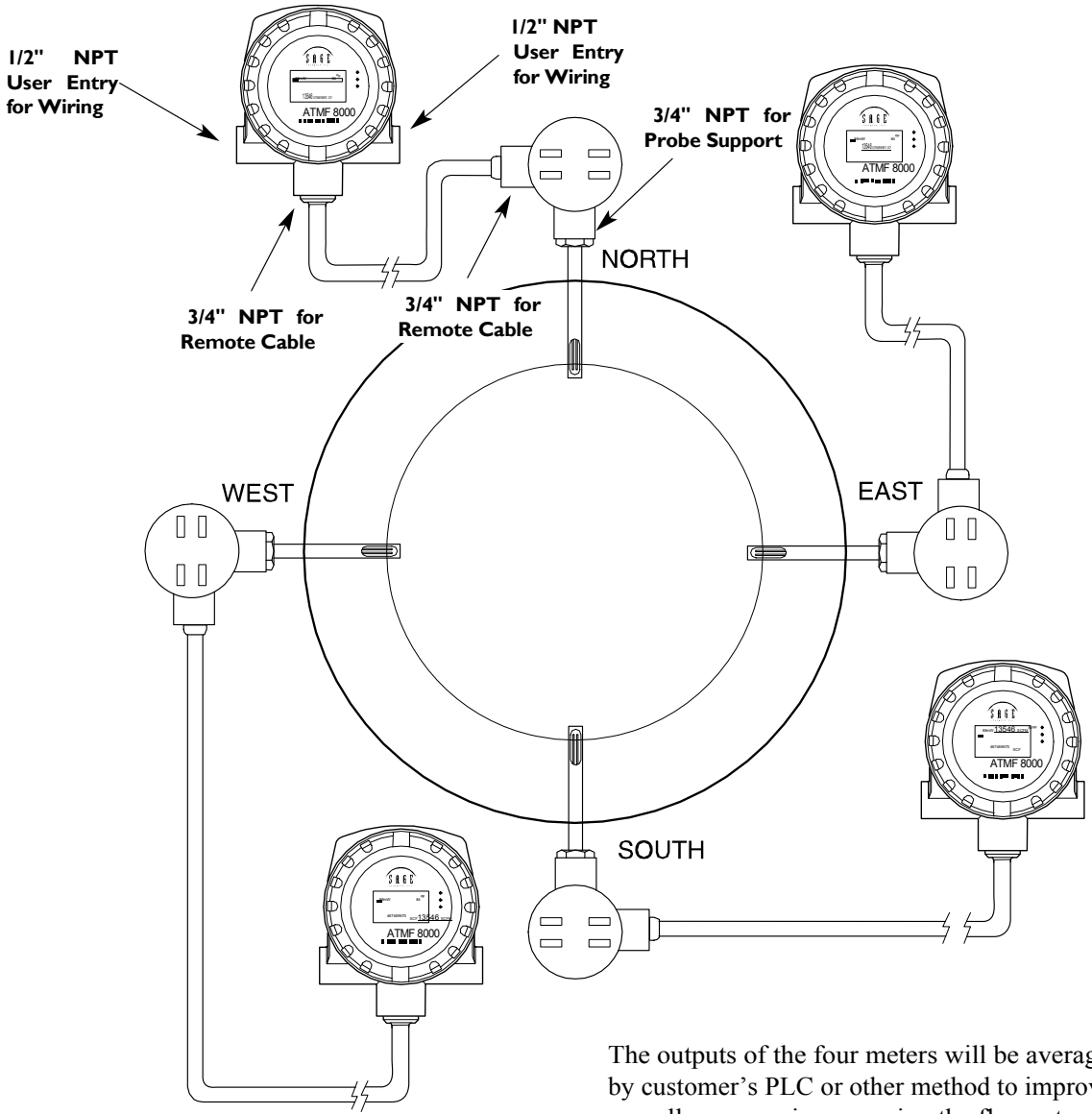
2 The 1" Pipe Size needs to have the Probe "Bottomed Out" (option "BOT"); the calibration method for the 1½" Pipe is either as shown below, or with option "BOT"



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

CONFIGURATION FOR UTILIZING FOUR (4) SMC 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

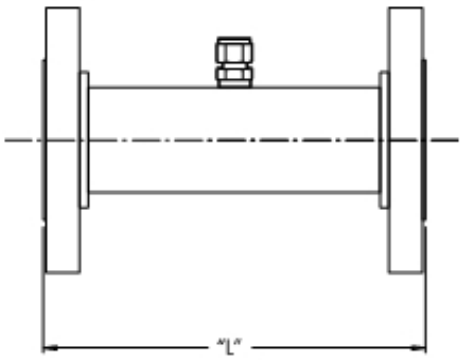
IN-LINE FLOW METERS

In-line mounting styles are available through SMC Metering, Inc. in sizes from ¼" pipe through 4" pipe. Threaded male NPT ends are standard up to 2-½"; 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.

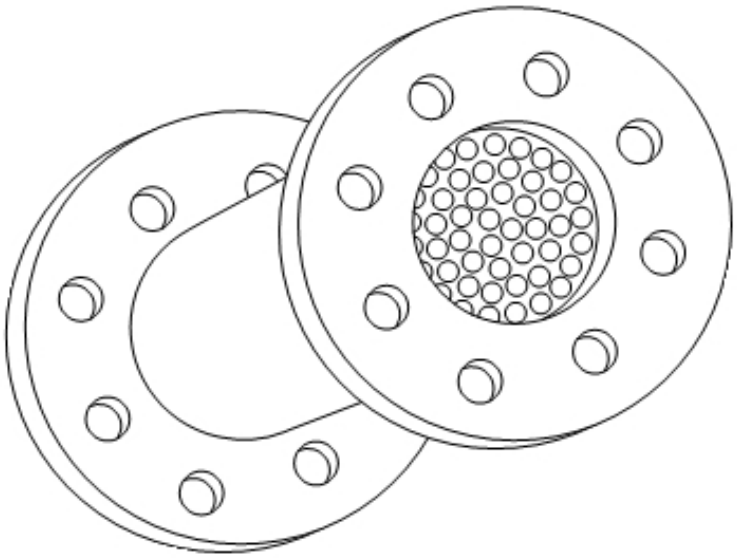
The in-line style flow meter assembly flow section is typically specified to match the user's flow conduit and is plumbed directly in the flow line by threading, flanging, welding, etc. DO NOT USE REDUCERS. It includes the sensing element (a self-heated flow sensor and a temperature/reference sensor)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

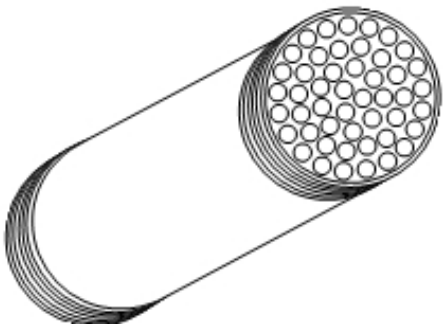
All in-line Flow Meters, ½" and up have built-in Flow Conditioners. See Table (page 6) for Upstream Straight run requirements. *Note,* the ¼" and ⅜" do not have Flow Conditioners and thus require more straight run.

FLOW CONDITIONING SCREENS FOR IN-LINE FLOW BODIES ½" AND UP[1]



LENGTH "L" SAME AS NON-FLANGED METER (See table on page 35. 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.)





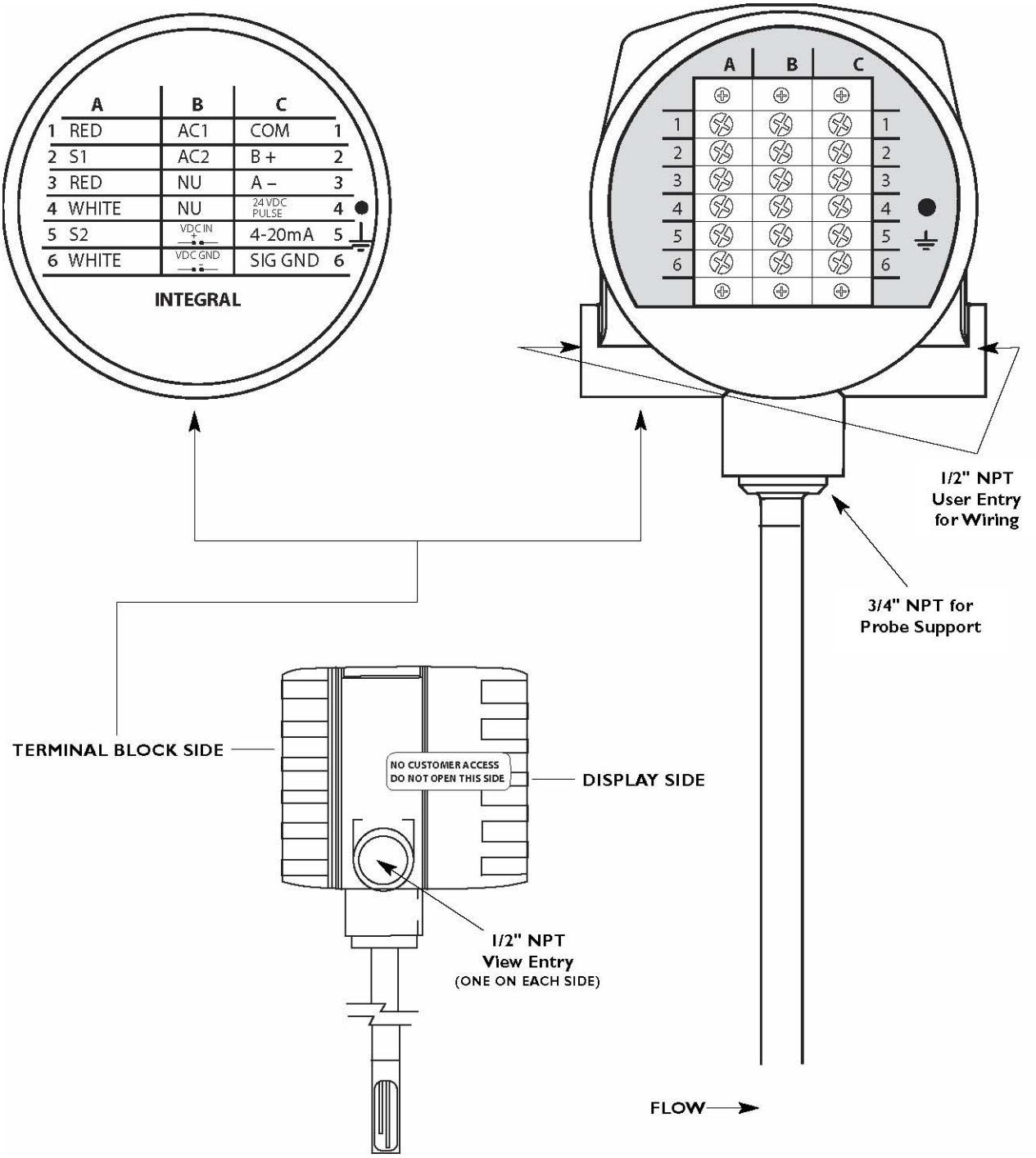
Screens shown with NPT fitting.

1 Note, Flow conditioning is also available for Insertion Meter applications (see page 13)

ATMF8000 Integral (Series SP-I)

(SEE FOLLOWING PAGES FOR TERMINAL HOOKUP) INSIDE COVER VIEW INSIDE BODY VIEW

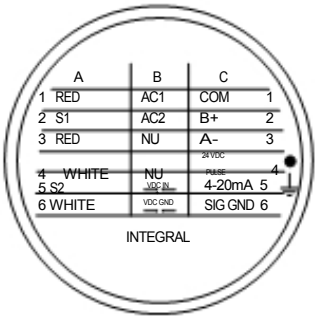
REV. 09-SIP/SRP



24 V_{DC} ATMF 8000 Integral Terminals (Series SP-I)

(APPROVED FOR HAZARDOUS SERVICE[6])

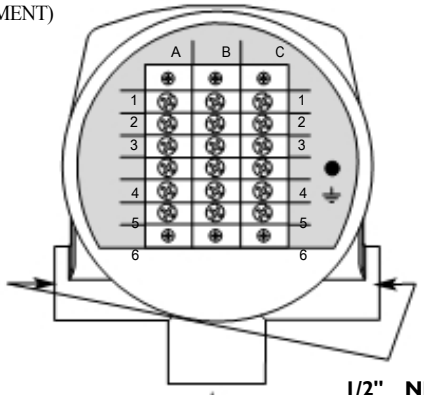
INSIDE COVER VIEW



A1 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A2 - NO WIRE
A3 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A4 - WHITE - TEMPERATURE SENSOR WIRE
A5 - NO WIRE
A6 - WHITE - TEMPERATURE SENSOR WIRE
B3 - JUNCTION FOR ISOLATED PULSE
** B4 - 4-20 mA RETURN (-) AND PULSE SOURCE
* B5 - VDC IN - VOLTAGE DC - POSITIVE (+)
B6 - VDC GND - VOLTAGE DC - GROUND (-)[1]
C1 - COM - RS485 MODBUS GROUND[1,2]
C2 - B(+)-RS485_D1
C3 - A(-)-RS485_D0
** C4 - 24 VDC PULSE - 0 TO 24 VDC PULSE OUTPUT[3,4]
C5 - 4-20 mA - 4 TO 20 mA SIGNAL DRIVE[5]
C6 - VDC GND - VOLTAGE DC - GROUND (-)

EXTERNALLY POWERED 4-20 mA BY CUSTOMER (+)
CUSTOMER RETURN (-)

INSIDE BODY VIEW



3/4" NPT for Remote Cable (ON REMOTE STYLE SRP)

1/2" NPT User Entry for Wiring

*B4 and B5 JUMPER
Remove jumper for Externally Sourced 4-20 mA. In this mode, user supplies 9-27 Volts to externally power the 4-20 mA loop, and the 4-20 mA loop becomes optically isolated.

**Along with removing B4 & B5 Jumpers, it is necessary to connect C4 Resistive Jumper to Terminal B3 instead of C6. In this mode, Pulse Output is optically isolated. Pulsed Output voltage will depend on customer source voltage. Use SMC Resistive Jumper only!

DESCRIPTION	TERMINALS			NOTES
DC Input Power: 24 V_{DC}[7,8]	B5 +VDC	B6 -VDC GND		
Internally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	C6 Return		Do not remove any Jumpers
Internally Powered: Pulsed Output	C4 24 / 0	C6 GND		Do not remove any Jumpers
Externally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	B4 4-20 mA EXTERNAL SOURCE		Remove B4 & B5 Jumper
Externally Powered[9]: Pulsed Output	C4 24 / 0	B3 JUNCTION FOR PULSE RETURN		Remove B4 & B5 Jumper and Connect C4 Resistive Jumper to B3
MODBUS	C2 RS485(+)	C3 RS485(-)	C1 MODBUS GROUND (REQ'D)	

NOTE: The ATMF 8000 draws 2.4 watts maximum (i.e. ≅ 100mA @24V_{DC})

1 Specify the SMC ATMF 8000 PLUS option in order to have the Modbus Ground (Terminal C1, COM) isolated from the 24 V_{DC} SMC Power Supply Ground (Terminal B6). All other features of ATMF 8000 PLUS are identical to the standard SMC ATMF 8000, except other voltage available. *(See footnote 8)*

2 It is important to connect the Ground when using Modbus communications, or ground loop problems may develop. Improper wiring can also damage internal circuitry

3 **Note,** if customer externally powers the 4-20 mA by removing the jumper, the Pulse voltage output is also effected: The voltage output of the Pulse will follow the customer power (i.e. 24 V_{DC} external power will result in a 24 V_{DC} Pulse; 12 V_{DC} external power will result in a 12 V_{DC} Pulse)

4 Pulse width 250 msec default (adjustable with Addresser PLUS software)

5 Using SMC Addresser, a Low Flow Cutoff (LFC), commonly referred to as Min Cutoff or Zero Cutoff can be entered into the FLOW MIN Functions. In Versions 1.82 or higher, the Low Flow Cutoff and the 4-20 mA Scaling are independent of each other. For example: A Low Flow Cutoff (LFC) of 10 SCFM on a Meter with a Full Scale of 100 SCFM will report 0 on the Display and 4 mA on the output. The output will remain at 4 mA until the LFC is exceeded: (ie: 25 SCFM=8 mA). Thus the 4 mA will always be zero based

6 Class I, Div 2, Groups A,B,C,D,T4 and ATEX Ex na IIC T4

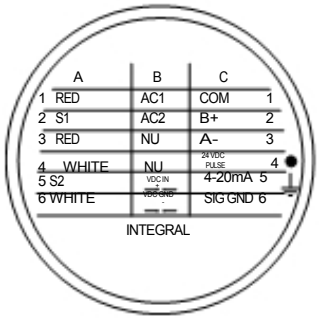
7 24 V_{DC} ±10%

8 Other DC voltages (5 V_{DC}, 12 V_{DC}, 48 V_{DC}) available on ATMF 8000 PLUS. Contact SMC

9 Assumes the 4-20 mA is Externally Powered

AC Powered ATMF 8000 and DC Powered ATMF 8000 PLUS Integral Terminals (Series SP-I)[6]

INSIDE COVER VIEW



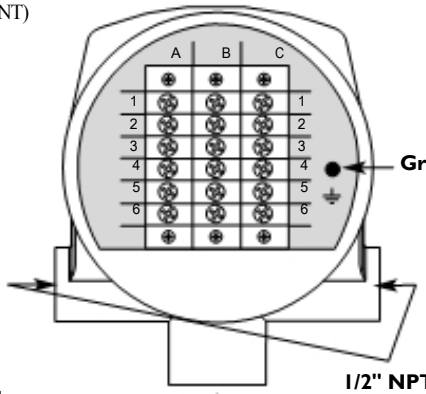
A1 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A2 - NO WIRE
A3 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A4 - WHITE - TEMPERATURE SENSOR WIRE
A5 - NO WIRE
A6 - WHITE - TEMPERATURE SENSOR WIRE

B1 - AC1 - AC VOLTAGE
B2 - AC2 - AC VOLTAGE
** B3 - JUNCTION FOR ISOLATED PULSE
B4 - 4-20 mA RETURN (-) AND PULSE SOURCE
* B5 - VDC IN - VOLTAGE DC - POSITIVE (+)
B6 - VDC GND - VOLTAGE DC - GROUND (-)[1]

C1 - COM - RS485 MODBUS GROUND[1,2]
C2 - B(+)-RS485_D1
C3 - A(-)-RS485_D0
** C4 - 24 VDC PULSE - 0 TO 24 VDC PULSE OUTPUT[3,4]
C5 - 4-20 mA - 4 TO 20 mA SIGNAL DRIVE[5]
C6 - VDC GND - VOLTAGE DC - GROUND (-)

EXTERNALLY POWERED 4-20 mA BY CUSTOMER
CUSTOMER RETURN

INSIDE BODY VIEW



*B4 and B5 JUMPER
Remove jumper for Externally Sourced 4-20 mA. In this mode, user supplies 9-27 Volts to externally power the 4-20 mA loop, and the 4-20 mA loop becomes optically isolated.

**Along with removing B4 & B5 Jumpers, it is necessary to connect C4 Resistive Jumper to Terminal B3 instead of C6. In this mode, Pulse Output is optically isolated. Pulsed Output voltage will depend on customer source voltage. Use SMC Resistive Jumper only!

NOTE: The ATMF 8000 draws 2.4 watts maximum (i.e. ≅ 100mA @24V_{DC})

DESCRIPTION	TERMINALS			NOTES
AC Input Power: 115 V_{AC}/230 V_{AC}	B1 AC1	B2 AC2		Connect Ground Wire to Grounding Lug
DC Input Power: 24 V_{DC}[7,8]	B5 +VDC	B6 -VDC GND		
Internally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	C6 Return		Do not remove any Jumpers
Internally Powered: Pulsed Output	C4 24 / 0	C6 GND		Do not remove any Jumpers
Externally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	B4 4-20 mA EXTERNAL SOURCE		Remove B4 & B5 Jumper
Externally Powered[9]: Pulsed Output	C4 24 / 0	B3 JUNCTION FOR PULSE RETURN		Remove B4 & B5 Jumper and Connect C4 Resistive Jumper to B3
MODBUS	C2 RS485(+)	C3 RS485(-)	C1 MODBUS GROUND (REQ'D)	Modbus Ground (Common) is Isolated from the B6 Power Supply Ground

1 Specify the SMC ATMF 8000 PLUS option in order to have the Modbus Ground (Terminal C1, COM) isolated from the 24 V_{DC} SMC Power Supply Ground (Terminal B6). All other features of ATMF 8000 PLUS are identical to the standard SMC ATMF 8000, except other voltage available. *(See footnote 8)*

2 It is important to connect the Ground when using Modbus communications, or ground loop problems may develop. Improper wiring can also damage internal circuitry

3 **Note,** if customer externally powers the 4-20 mA by removing the jumper, the Pulse voltage output is also effected: The voltage output of the Pulse will follow the customer power (i.e. 24 V_{DC} external power will result in a 24 V_{DC} Pulse; 12 VDC external power will result in a 12 V_{DC} Pulse)

4 Pulse width 250 msec default (adjustable with Addresser PLUS software)

5 Using SMC Addresser, a Low Flow Cutoff (LFC), commonly referred to as Min Cutoff or Zero Cutoff can be entered into the FLOW MIN Functions. In Versions 1.82 or higher, the Low Flow Cutoff and the 4-20 mA Scaling are independent of each other. For example: A Low Flow Cutoff (LFC) of 10 SCFM on a Meter with a Full Scale of 100 SCFM will report 0 on the Display and 4 mA on the output. The output will remain at 4 mA until the LFC is exceeded: (ie: 25 SCFM=8 mA). Thus the 4 mA will always be zero based

6 This version does not have Hazardous Approvals

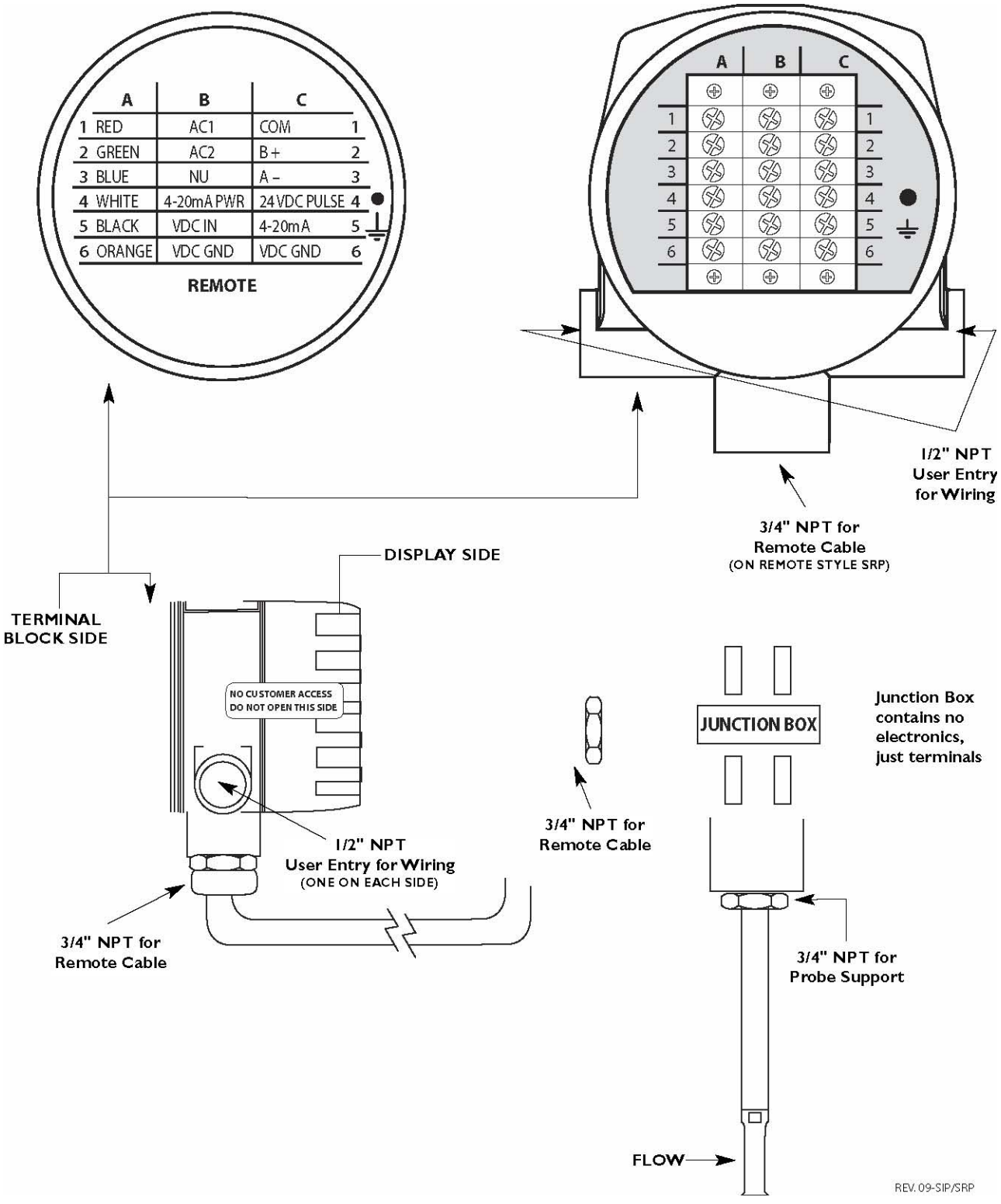
7 24 V_{DC} ±10%

8 Other DC voltages (5 V_{DC}, 12 V_{DC}, 48 V_{DC}) available on ATMF 8000 PLUS. Contact SMC

9 Assumes the 4-20 mA is Externally Powered

ATMF8000 Remote (Series SP-R)

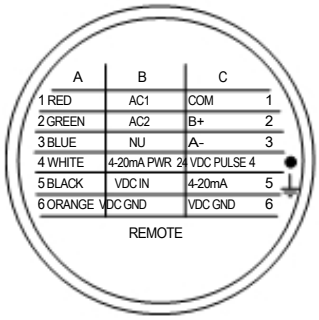
(SEE FOLLOWING PAGES FOR TERMINAL HOOKUP) INSIDE COVER VIEW INSIDE BODY VIEW



24 V_{DC} ATMF 8000 Remote Terminals (Series SP-R)

(APPROVED FOR HAZARDOUS SERVICE[6])

INSIDE COVER VIEW



EXTERNALLY POWERED 4-20 mA BY CUSTOMER

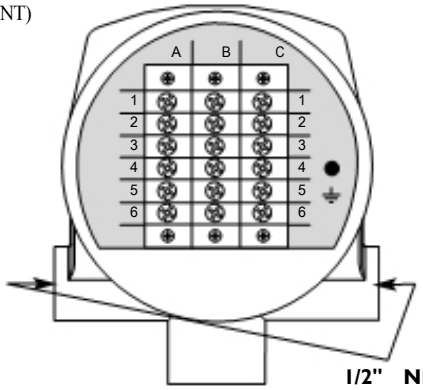
CUSTOMER RETURN

A1 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT) A2 - GREEN - SENSE WIRE
A3 - BLUE - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A4 - WHITE - TEMPERATURE SENSOR WIRE
A5 - BLACK - SENSE WIRE
A6 - ORANGE - TEMPERATURE SENSOR WIRE

** B3 - JUNCTION FOR ISOLATED PULSE
B4 - 4-20 mA RETURN (-) AND PULSE SOURCE
* B5 - VDC IN - VOLTAGE DC - POSITIVE (+)
B6 - VDC GND - VOLTAGE DC - GROUND (-)[1]

C1 - COM - RS485 MODBUS GROUND[1,2] C2 - B(+)-RS485_D1
C3 - A(-)-RS485_D0
** C4 - 24 V_{DC} PULSE - 0 TO 24 V_{DC} PULSE OUTPUT[3,4] C5 - 4-20 mA - 4 TO 20 mA SIGNAL DRIVE[5]
C6 - VDC GND - VOLTAGE DC - GROUND (-)

INSIDE BODY VIEW



3/4" NPT for Remote Cable (ON REMOTE STYLE SRP)

1/2" NPT User Entry for Wiring

*B4 and B5 JUMPER
Remove jumper for Externally Sourced 4-20 mA. In this mode, user supplies 9-27 Volts to externally power the 4-20 mA loop, and the 4-20 mA loop becomes optically isolated.

**Along with removing B4 & B5 Jumpers, it is necessary to connect C4 Resistive Jumper to Terminal B3 instead of C6. In this mode, Pulse Output is optically isolated. Pulsed Output voltage will depend on customer source voltage. Use SMC Resistive Jumper only!

NOTE: The ATMF 8000 draws 2.4 watts maximum (i.e. ≅ 100ma @24VDC)

DESCRIPTION	TERMINALS			NOTES
DC Input Power: 24 V_{DC}[7,8]	B5 +VDC	B6 - VDC GND		
Internally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	C6 Return		Do not remove any Jumpers
Internally Powered: Pulsed Output	C4 24 O 	C6 GND		Do not remove any Jumpers
Externally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	B4 4-20 mA EXTERNAL SOURCE		Remove B4 & B5 Jumper
Externally Powered[9]: Pulsed Output	C4 24 O 	B3 JUNCTION FOR PULSE RETURN		Remove B4 & B5 Jumpers and Connect C4 Resistive Jumper to B3
MODBUS	C2 RS485(+)	C3 RS485(-)	C1 MODBUS GROUND REQ'D)	

1 Specify the SMC ATMF 8000 PLUS option in order to have the Modbus Ground (Terminal C1, COM) isolated from the 24 V_{DC} SMC Power Supply Ground (Terminal B6). All other features of ATMF 8000 PLUS are identical to the standard SMC ATMF 8000, except other voltage available. *(See footnote 8)*

2 It is important to connect the Ground when using Modbus communications, or ground loop problems may develop. Improper wiring can also damage internal circuitry

3 **Note,** if customer externally powers the 4-20 mA by removing the jumper, the Pulse voltage output is also effected: The voltage output of the Pulse will follow the customer power (i.e. 24 VDC external power will result in a 24 V_{DC} Pulse; 12 V_{DC} external power will result in a 12 V_{DC} Pulse)

4 Pulse width 250 msec default (adjustable with Addresser PLUS software)

5 Using SMC Addresser, a Low Flow Cutoff (LFC), commonly referred to as Min Cutoff or Zero Cutoff can be entered into the FLOW MIN Functions. In Versions 1.82 or higher, the Low Flow Cutoff and the 4-20 mA Scaling are independent of each other. For example: A Low Flow Cutoff (LFC) of 10 SCFM on a Meter with a Full Scale of 100 SCFM will report 0 on the Display and 4 mA on the output. The output will remain at 4 mA until the LFC is exceeded: (ie: 25 SCFM=8 mA). Thus the 4 mA will always be zero based

6 Class I, Div 2, Groups A,B,C,D,T4 and ATEX Ex na IIC T4

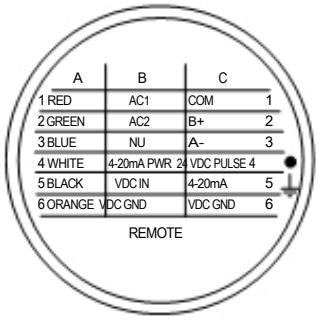
7 24 V_{DC} ±10%

8 Other DC voltages (5 V_{DC}, 12 V_{DC}, 48 V_{DC}) available on ATMF 8000 PLUS. Contact SMC

9 Assumes the 4-20 mA is Externally Powered

AC Powered ATMF 8000 and DC Powered ATMF 8000 PLUS Remote Series Terminals (Series SP-R)[6]

INSIDE COVER VIEW



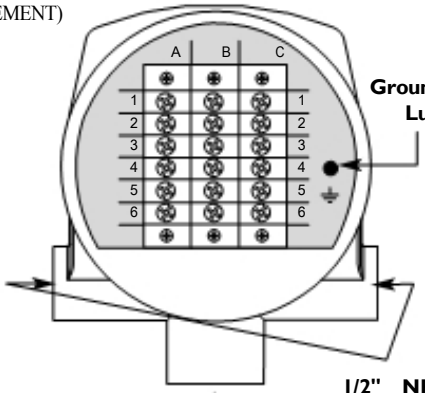
A1 - RED - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A2 - GREEN - SENSE WIRE
A3 - BLUE - VELOCITY SENSOR WIRE (HEATED ELEMENT)
A4 - WHITE - TEMPERATURE SENSOR WIRE
A5 - BLACK - SENSE WIRE
A6 - ORANGE - TEMPERATURE SENSOR WIRE

B1 - AC1 - AC VOLTAGE
B2 - AC2 - AC VOLTAGE
** B3 - JUNCTION FOR ISOLATED PULSE
B4 - 4-20 mA RETURN (-) AND PULSE SOURCE
* B5 - VDC IN - VOLTAGE DC - POSITIVE (+)
B6 - VDC GND - VOLTAGE DC - GROUND (-)[1]

C1 - COM - RS485 MODBUS GROUND[1,2]
C2 - B(+)-RS485_D1
C3 - A(-)-RS485_D0
C4 - 24 V_{DC} PULSE - 0 TO 24 VDC PULSE OUTPUT[3,4]
** C5 - 4-20 mA - 4 TO 20 mA SIGNAL DRIVE[5]
C6 - V_{DC} GND - VOLTAGE DC - GROUND (-)

EXTERNALLY POWERED
4-20 mA BY CUSTOMER
CUSTOMER RETURN

INSIDE BODY VIEW



(ON REMOTE STYLE SRP)

*B4 and B5 JUMPER
Remove jumper for Externally Sourced 4-20 mA. In this mode, user supplies 9-27 Volts to externally power the 4-20 mA loop, and the 4-20 mA loop becomes optically isolated.

**Along with removing B4 & B5 Jumpers, it is necessary to connect C4 Resistive Jumper to Terminal B3 instead of C6. In this mode, Pulse Output is optically isolated. Pulsed Output voltage will depend on customer source voltage. Use SMC Resistive Jumper only!

DESCRIPTION	TERMINALS			NOTES
AC Input Power: 115 V_{AC}/230 V_{AC}	B1 AC1	B2 AC2		Connect Ground Wire to Grounding Lug
DC Input Power: 24 V_{DC}[7,8]	B5 + VDC	B6 - VDC GND		
Internally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	C6 Return		Do not remove any Jumpers
Internally Powered: Pulsed Output	C4 24 O	C6 GND		Do not remove any Jumpers
Externally Powered: 4-20 mA	C5 4-20 mA SIGNAL DRIVE	B4 4-20 mA EXTERNAL SOURCE		Remove B4 & B5 Jumper
Externally Powered[9]: Pulsed Output	C4 24 O	B3 JUNCTION FOR PULSE RETURN		Remove B4 & B5 Jumpers and Connect C4 Resistive Jumper to B3
MODBUS	C2 RS485(+)	C3 RS485(-)	C1 MODBUS GROUND (REQ'D)	Modbus Ground (Common) is Isolated from the B6 Power Supply Ground

NOTE: The ATMF 8000 draws 2.4 watts maximum (i.e. ≅ 100ma @24V_{DC})

1 Specify the SMC ATMF 8000 PLUS option in order to have the Modbus Ground (Terminal C1, COM) isolated from the 24 VDC SMC Power Supply Ground (Terminal B6). All other features of ATMF 8000 PLUS are identical to the standard SMC ATMF 8000, except other voltage available. *(See footnote 8)*

2 It is important to connect the Ground when using Modbus communications, or ground loop problems may develop. Improper wiring can also damage internal circuitry

3 **Note,** if customer externally powers the 4-20 mA by removing the jumper, the Pulse voltage output is also effected: The voltage output of the Pulse will follow the customer power (i.e. 24 V_{DC} external power will result in a 24 V_{DC} Pulse; 12 V_{DC} external power will result in a 12 V_{DC} Pulse)

4 Pulse width 250 msec default (adjustable with Addresser PLUS software)

5 Using SMC Addresser, a Low Flow Cutoff (LFC), commonly referred to as Min Cutoff or Zero Cutoff can be entered into the FLOW MIN Functions. In Versions 1.82 or higher, the Low Flow Cutoff and the 4-20 mA Scaling are independent of each other. For example: A Low Flow Cutoff (LFC) of 10 SCFM on a Meter with a Full Scale of 100 SCFM will report 0 on the Display and 4 mA on the output. The output will remain at 4mA until the LFC is exceeded: (ie: 25 SCFM=8 mA). Thus the 4mA will always be zero based

6 This version does not have Hazardous Approvals

7 24 V_{DC} ±10%

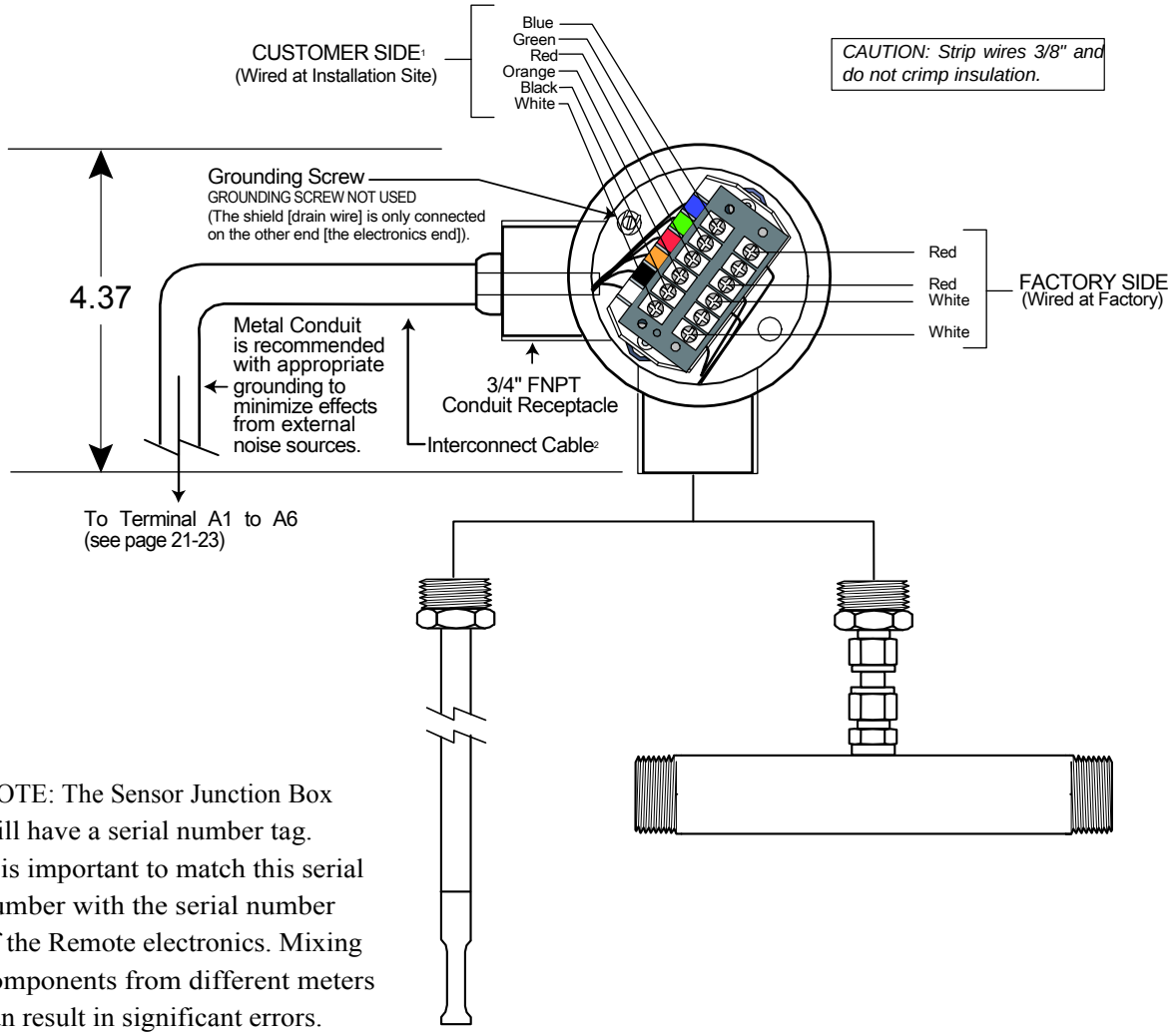
8 Other DC voltages (5 V_{DC}, 12 V_{DC}, 48 V_{DC}) available on ATMF 8000 PLUS. Contact SMC

9 Assumes the 4-20 mA is Externally Powered

Junction Box Wiring Terminals for Remote Style Meters (Series SP-R)

(THERE ARE NO ELECTRONICS INSIDE JUNCTION BOX)

SEE THE PREVIOUS PAGE FOR THE OTHER END OF THE REMOTE WIRING HOOKUP (the electronics side).



NOTE: The Sensor Junction Box will have a serial number tag. It is important to match this serial number with the serial number of the Remote electronics. Mixing components from different meters can result in significant errors.

1 NOTE: There are hidden jumpers (underneath the terminal strip) that short together the Blue and Green wires, and also short together the Black and Orange wires. These extra wires are part of the meter's Lead Length Compensation circuitry, allowing the user to change the length of the interconnect cable (from 0 to 1000 feet) without effecting the accuracy. 25 feet of cable are initially supplied (for cabling longer than 1000 feet, contact SMC).

2 SMC supplies 25 feet of cable for the interconnect wires between the Junction Box and the Remote Enclosures: Carroll (manufacturer), Part #C0783, 20 gauge, 6 conductor, foil shielded, grey PVC jacket.

CAUTION: Cable and cable glands are not for use in hazardous area environments. Power, ground, outputs, shielded cable, seal fittings and conduits are to be supplied by customer.

Section B

STYLES AND FEATURES

Principle of Operation of the Thermal Mass Flow Meter

SMC 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 “job” of the SMC 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 SMC National Institute of Standards certified (NIST) calibration facility. By accomplishing these two critical objectives, the SMC 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

SMC ATMF 8000™ THERMAL MASS FLOW METER FOR GASES

SMC"s ATMF 8000 is the top selling meter in our Product Line. The SMC ATMF 8000 Thermal Mass Flow Meter features a bright, high contrast, photo-emissive OLED display of Flow Rate, Total and Temperature in a robust, yet lightweight, dual-compartment industrial enclosure. The flow rate is also displayed graphically in a horizontal bar graph format. The rear compartment is completely separated from the electronics, and has large, easy-to-access, well marked terminals, for ease of customer wiring (see photo below). It is powered by 24 V_{DC} (12 V_{DC} optional, or 115/230 V_{AC}). The power dissipation is under 2.5 watts (e.g. under 100 mA at 24 V_{DC}).

The SMC ATMF 8000 Flow Meter is offered in Integral or Remote Style (which has lead-length compensation up to 1000 feet as well as an Explosion Proof Junction Box). Specify any standard probe length or flow body size. It has a 4-20 ma output as well as a Pulsed Output of Totalized Flow (solid state transistor drive). In addition, SMC ATMF 8000 supports full Modbus® compliant RS485 RTU communic ations (IEEE 32 Bit Floating Point).

SMC's ATMF 8000 is CE a pproved, and CSA, UL and ATEX approved for Hazardous Service[3] (see Approvals tab on the website).

CONTINUOUS DIAGNOSTICS & FIELD CONFIGURABILITY

The SMC ATMF 8000 has continuous diagnostics. The raw calibration milli-watts (mw) is always displayed in the upper left hand corner of the meter's display. 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. This in-situ diagnostic procedure not only checks the sensor performance and the "live zero" calibration point, but it also 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, in addition, verifies that the sensor is free from contamination, even without inspection.

Although the ATMF8000 is fully configured upon shipment, for the pipe and process conditions requested, there are three strategies if changes are needed: SMC DONGLE; the SMC ADDRESSER software program; or the SMC ADDRESSER PLUS ad vanced program. Contact SMC for details.

MAJOR BENEFITS OF THERMAL MASS FLOW METERS

- Direct Mass Flow - No need for separate temperature or pressure transmitters
- High Accuracy and Repeatability - Preci sion 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 - Will not impede the flow or waste energy
- No Moving Parts - Eliminates costly bearing replacements, and prevents undetected accuracy shifts
- Dirt Insensitive - Provides sustained performance
- Low cost-of-ownership
- Ease of installation and convenient mounting hardware

SPECIFIC BENEFITS OF THE SMC ATMF 8000

- High contrast photo-emissive OLED display with numerical Flow Rate, Total and Temperature, as well as Graphical Flow Indicator
- Photocell activated Screen Saver to extend display life
- Calibration milliwatts (mw) is continuously displayed, providing for ongoing diagnostics, and in-situ calibration check
- Modbus® compliant RS485 RTU communications
- Isolated 4-20 mA output[2]
- Rugged, user-friendly packaging with easy terminal access
- Option for Solar Energy use (12VDC models)
- Low power dissipation, under 2.5 Watts (e.g. under 100 ma at 24 VDC)
- Powerful state-of-the-art microprocessor technology for high performance mass flow measurement and low cost-of-ownership
- Proprietary digital sensor drive circuit provides enhanced signal stability and unaffected by process temperature & pressure changes
- Remote Style has Lead-Length Compensation. Allows remote electronics up to 1000 feet from probe; Explosion Proof Junction Box has no circuitry, just terminals
- Field reconfigurability via SMC ADDRESSER or SMC DONGLE
- Flow conditioning built into In-Line flow meters (1/2" and up)
- Captive Flow Conditioners for Insertion Meter applications, if required

1 Note, a built-in photocell continuously monitors the ambient light, and adjusts the display brightness for optimum long-term life, and also senses motion which automatically switches display from Screen Saver mode to Normal mode

2 Available on new SMC ATMF 8000s (EXP4 Style)

3 Only available with 24V_{DC} powered meters

SMC ATMF 8000™ Styles and Specifications

SmartMeasurement 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. SMC 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.

Our experienced application engineers,many of whom have worked in the Thermal Mass Flow marketplace since its inception, will assist you in choosing the proper gas Flow Meter for your application - and they will be pleased to offer installation guidance to assure that the meter(s) selected will perform as accurately as possible. Additionally,our Service Staff stand ready to support you with any after-sale assistance that you may require.

SP-I SERIES - INTEGRAL

Optional SVA05 Isolation Valve Assembly

Optional Programmable Dongle

SP-R SERIES - REMOTE

Mounting Hardware (included)

ATMF 8000 SIP/SRP

Accuracy[4] is ±0.5% of Full Scale ±1% of reading with a turn-down of 100 to 1 and resolution as much as 1000 to 1.Repeatability is 0.2%.The Flow Meter is SMC Metering,Inc.ATMF 8000 Series,with the trade name SMC ATMF 8000™.

The electronics has an isolated 4 to 20 ma output proportional to Mass Flow Rate as well as pulsed outputs of Totalized Flow (24 VDC solid state transistor drive). In addition,Modbus RS485 RTU communications is standard (IEEE 32 Bit Floating Pt).

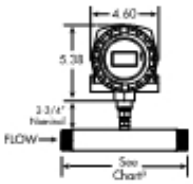
INTEGRAL STYLE ELECTRONICS

Electronics is Integral Style,with rugged windowed dual compartment enclosure with local display.The display is a high contrast photo-emissive OLED display with Screen Saver,and it displays Mass Flow Rate,Totalized Flow and Temperature as well as a graphical representation of Flow Rate in a horizontal bar graph format.In addition, the calibration milliwatts (mw) is continuously displayed, providing ongoing diagnostics.

REMOTE STYLE ELECTRONICS

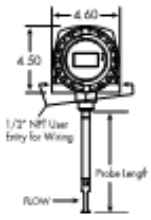
Electronics is Remote Style, with rugged windowed dual compartment enclosure with display.The display is a high contrast photo-emissive OLED display with Screen Saver, and it displays Mass Flow Rate,Totalized Flow and Temperature as well as a graphical representation of Flow Rate in a horizontal bar graph format.In addition, the calibration milliwatts (mw) is continuously displayed, providing ongoing diagnostics. Includes Remote Mounting Hardware.

The Flow Element's Junction Box is Explosion Proof (Class 1, Div 1, Groups B, C, D), and does not have any electronics - only a wiring terminal block.The Junction Box is connected to the Remote Electronics by 25 feet of lead-length compensated cable.The cable (6-conductor) can be lengthened or shortened without affecting accuracy (max loop resistance 10 ohms, over 1000 feet), if grounded properly.



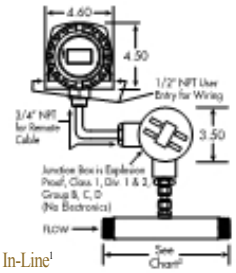
SIP In-Line[1]

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.



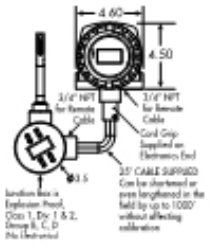
SIP Insertion[2]

Flow Element is Insertion Style, consisting of a 1/2" OD probe (¾" optional) with lengths up to 36" long (typically 15" long) suitable for insertion into the center of a process pipe.



SRP In-Line[1]

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.



SRP Insertion[2]

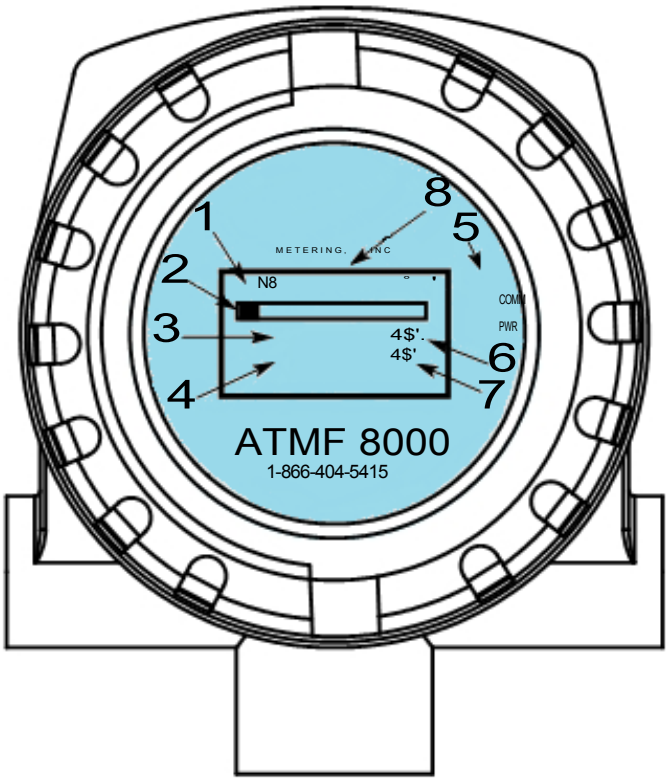
Flow Element is Insertion Style, consisting of a 1/2" OD probe (¾" optional) with lengths up to 36" long (typically 15" long) suitable for insertion into the center of a process pipe.

ENGINEERING SPECIFICATIONS OF OPTIONAL SMC ATMF 8000 PLUS

This is an optional version of SMC ATMF 8000 offering a separate ground for the $24V_{DC}$ Power Supply (optional 5 V_{DC} or 12 V_{DC} Power Supplies) which isolates the Modbus ground from the power supply ground. All other features of ATMF 8000 PLUS are identical to the standard SMC ATMF 8000, except Approvals do not apply at this time.

1 Male NPT ends are standard, with flanged ends, tube, or butt weld optionally available
2 Mounting hardware such as Isolation Valve Assemblies, Compression Fittings, and Flanges, are optional
3 Chart of Flow Body length is on page 10 of the "SMC Gas Flow Meters" brochure (see "In-Line Flow Meters")
4 Enhanced accuracy available upon request, especially if turndown limited. Contact SMC

SMC ATMF 8000 Organic (OLED) Display[1,2,3]



1 **Raw Calibration milliwatts (mw) for Diagnostics and Periodic "Zero Flow" Calibration Check**

2 **Graphical Indication of Percentage of Full Scale Flow Rate**

3 **Flow Rate**

4 **Totalized Flow (Consumption) (Value is Retained during Power Outage or Power Cycling)**

5 **Flashes with each pulsed output of consumption**

6 **Engineering Units of Flow Rate (the last digit can be S(seconds), M(minute), H(hour)**

7 **Engineering Units of Consumption**

8 **Photocell activated Screen Saver extends display life**

1 Upon start-up, the Revision No., Serial No., and Modbus ID will display for a few seconds. Also the output configurations symbol is momentarily displayed

2 Note, a built-in photocell continuously monitors the ambient light, and adjusts the display brightness for optimum long-term life, and also senses motion which automatically switches display from Screen Saver mode to Normal mode

3 To view display, wave hand over display or use a flashlight. The Flow Meter displays for one minute, then the Screen Saver resumes

Approvals

HAZARDOUS LOCATION APPROVALS

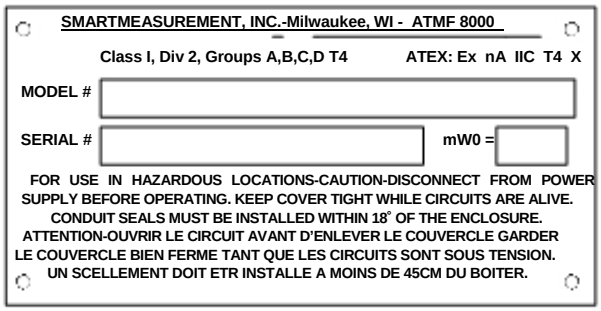
All 24 V_{DC} Powered SMC ATMF 8000 Meters (SP-I Integral Insertion, ATMF8000 In-Line, SP-R Remote Insertion, ATMF8000 Remote In-Line) are approved for Class 1, Div 2, Groups A, B, C, D, T4 and ATEX: Ex nA IIC T4. AC Powered Meters are not approved.

Testing is in accordance with the following Safety Standards:

- UL1604, Third Edition, 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, Non-incendive 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 above mentioned Approvals

1) Repair of the product (or replacement of components) is not possible by the user
2) As noted on the following label (see below) it will contain the following markings: Ex symbol, nA symbol IIC, temperature class
3) All ATMF 8000 DC meters will be marked with "X"
   which means that these Special Conditions of Use will apply:
   a) The completed meter must be installed with a rigid or flexible metal conduit in order to satisfy approval conditions.
   b) The meter has been approved for use with the electronics enclosure in an ambient temperature from -20˚C < Ta < 65˚C.
4) SmartMeasurement considers a linear correction suitable for temperatures exceeding the temp code rating of 40 °C (104 °F) thus no customer correction is needed.



CE CONFORMANCE

All AC & DC Powered SmartMeasurement, Inc. Series SIP (SMC ATMF 8000-Integral) and Series SRP (SMC ATMF 8000-
Remote) 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

CE

MEDICAL CONFORMANCE

Contact SmartMeasurement if Medical CE Conformance
is required. (AC Powered SMC ATMF 8000 Meters only.)
The Standard is to IEC 60601-1-2:2007 Edition 3

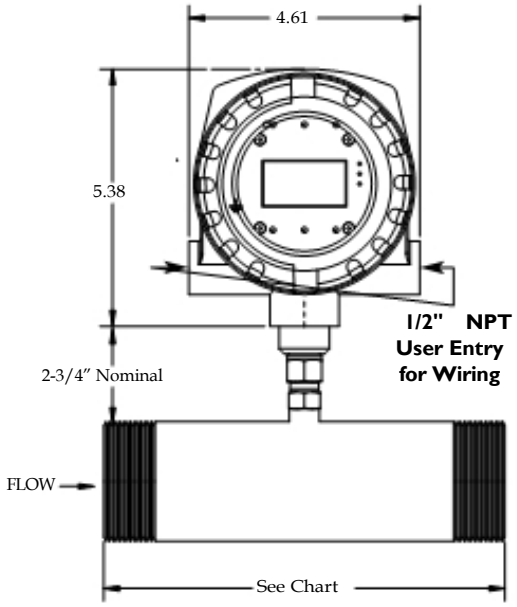
Section C

DRAWINGS

SP-I Integral Type 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)



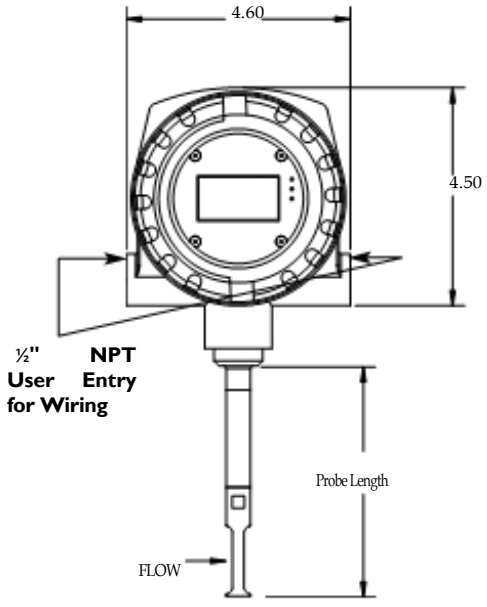
CAUTION:
Do not rotate the Enclosure of In-Line Style Meters relative to the Flow Tube, or the calibration may be effected since the sensors may become misaligned.

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"

Depth: DC Enclosure depth is 4.35"
AC Enclosure depth is 5.35"

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". Standard probe is ½" diameter (3/4" optional - recommended for 36" or 48")

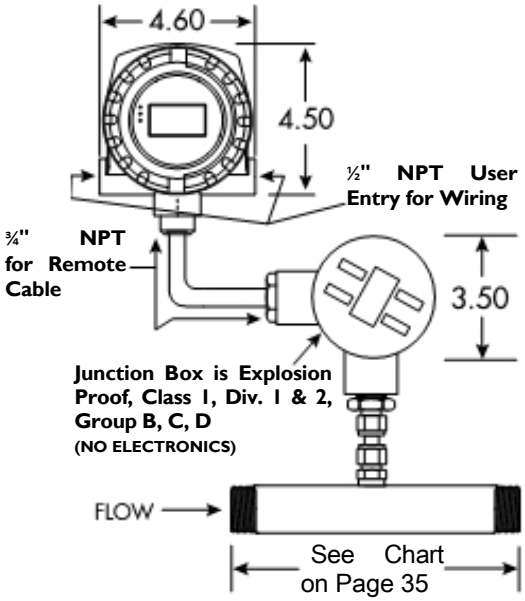


1 NPT Fittings standard
2 Flanged Mounting available for high pressure operation
3 Flow Conditioning built in to Flow Meter Pipe Sizes ½" and up. Contact SMC for optional ¼" tube flow body.

SP-R Series Remote Type Mass Flow Meters

IN-LINE STYLE[1,3,4]

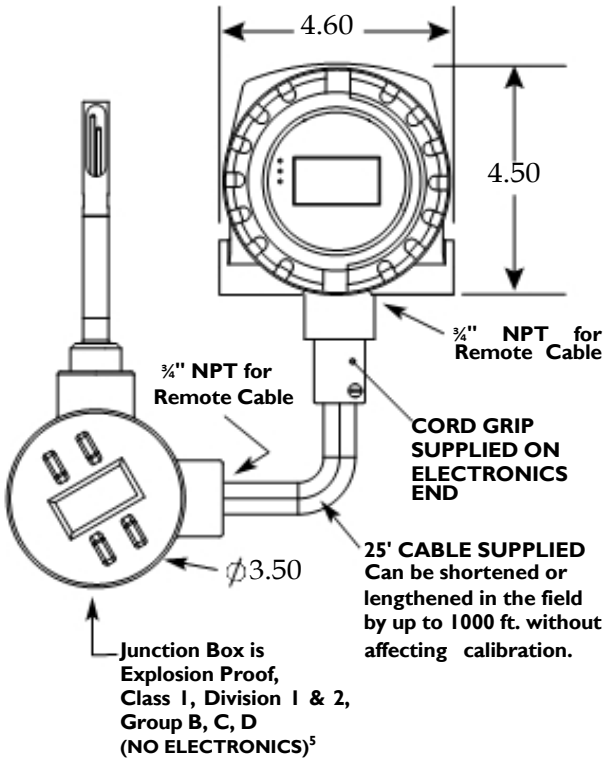
150#, 300#, or 600# flanged ends are optionally available. (150# flange recommended on 3" and 4" Flow Bodies)



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

INSERTION STYLE[2]

150#, 300#, or 600# flanged mounting is optionally available. Available probe lengths (C) are 6", 12", 15", 18", 24", 30", 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 SMC for optional 1/4" tube flow body.

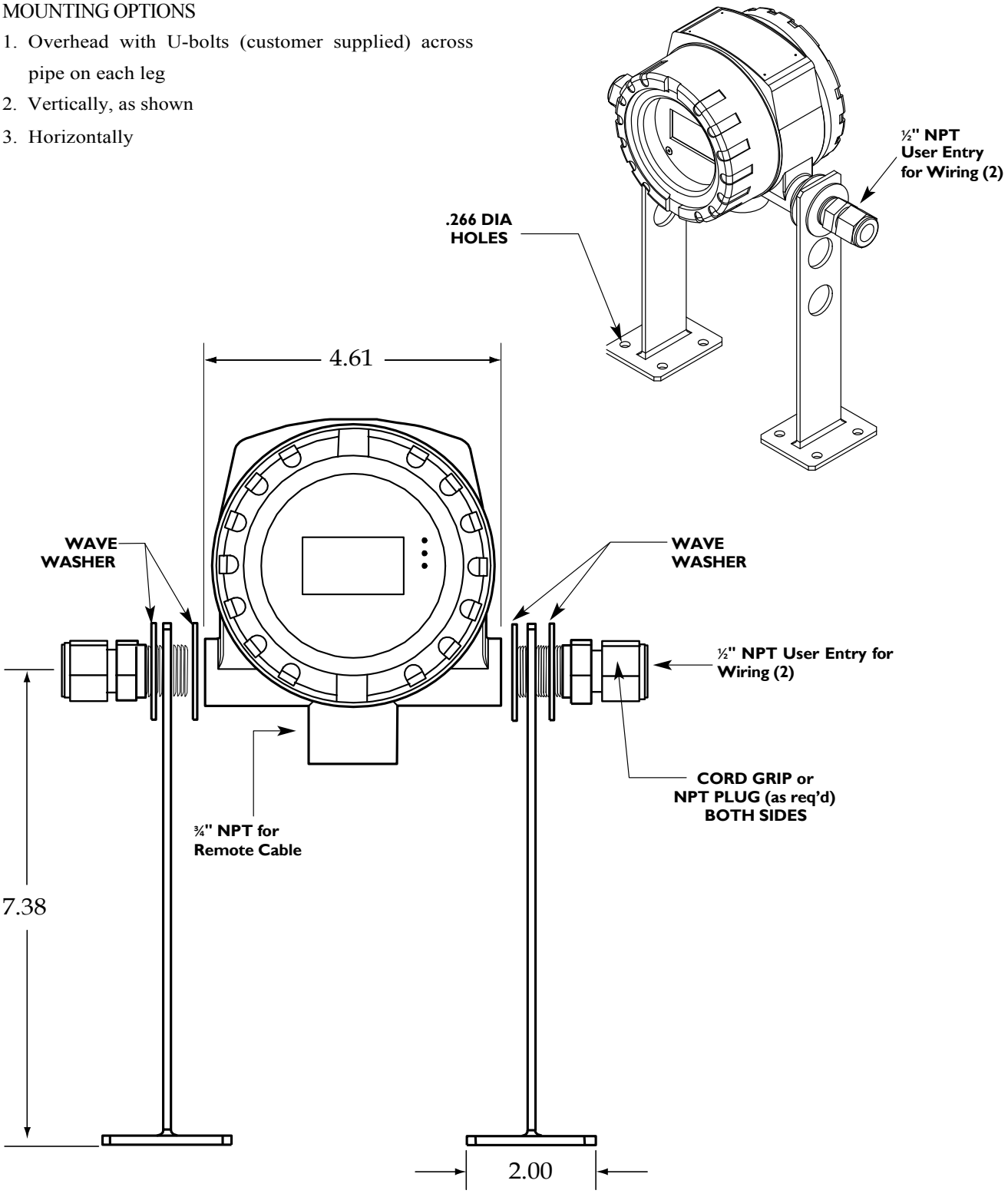
4 See Chart on page 35.

5 Junction Box has the following certifications: Class I, Groups B,C,D; Class II, Groups E,F,G; Class III; 4X, 7BCD, 9EFG; FM Standard 3615; UL Standard 1203; CSA Standard C22.2 No. 30; and NEMA Compliance

SMC ATMF 8000 Remote Bracket Layout

MOUNTING OPTIONS

1. Overhead with U-bolts (customer supplied) across pipe on each leg
2. Vertically, as shown
3. Horizontally

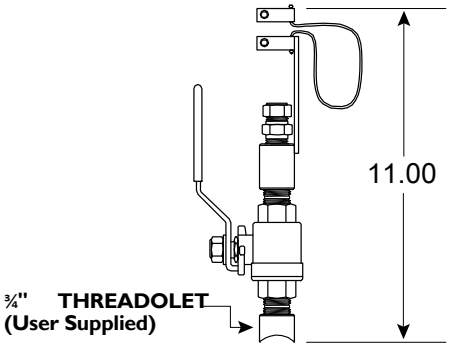


Mounting Hardware[3]

SVA05 SERIES ISOLATION VALVE ASSEMBLY FOR INSERTION METERS[4]

(for Low Pressure SVA05 see page 39)

Used for pressures to 650 psig[1] (shown for use with ½" diameter insertion meters). 150# or 300# flanged mounting is optionally available. Available sizes are ½" x ¾" NPT (SVA05 shown), and ¾" x 1" NPT for use with ¾" diameter insertion meters (SVA07).

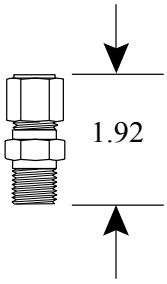


PROBE LENGTH (with sensor)	SAFETY CHAIN LENGTH[2]
12"	8.25"
15"	11.25"
18"	14.25"
24"	20.25"

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 SMC Isolation Valve Assembly will thread into the user's 3/4" threadolet.

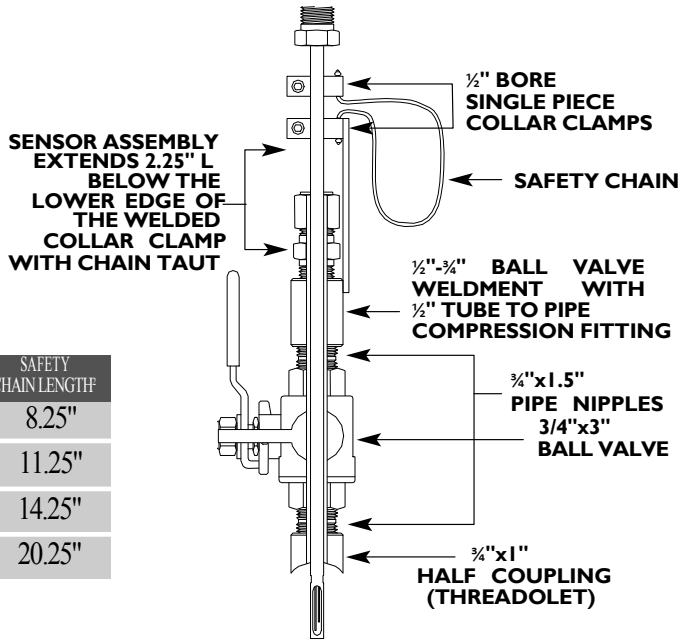
STCF SERIES TEFLON FERRULE COMPRESSION FITTING

½" tube x ½" 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 ¾" tube x ¾" pipe size.

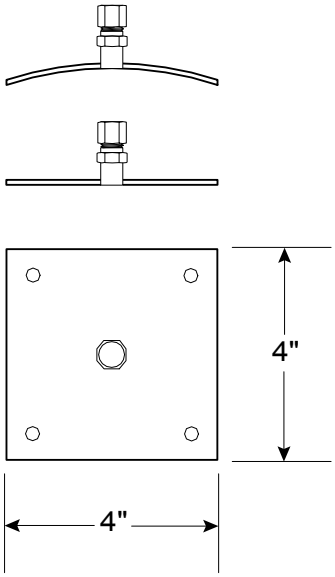


SVA05 SERIES ISOLATION VALVE ASSEMBLY DETAIL[5,6]

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

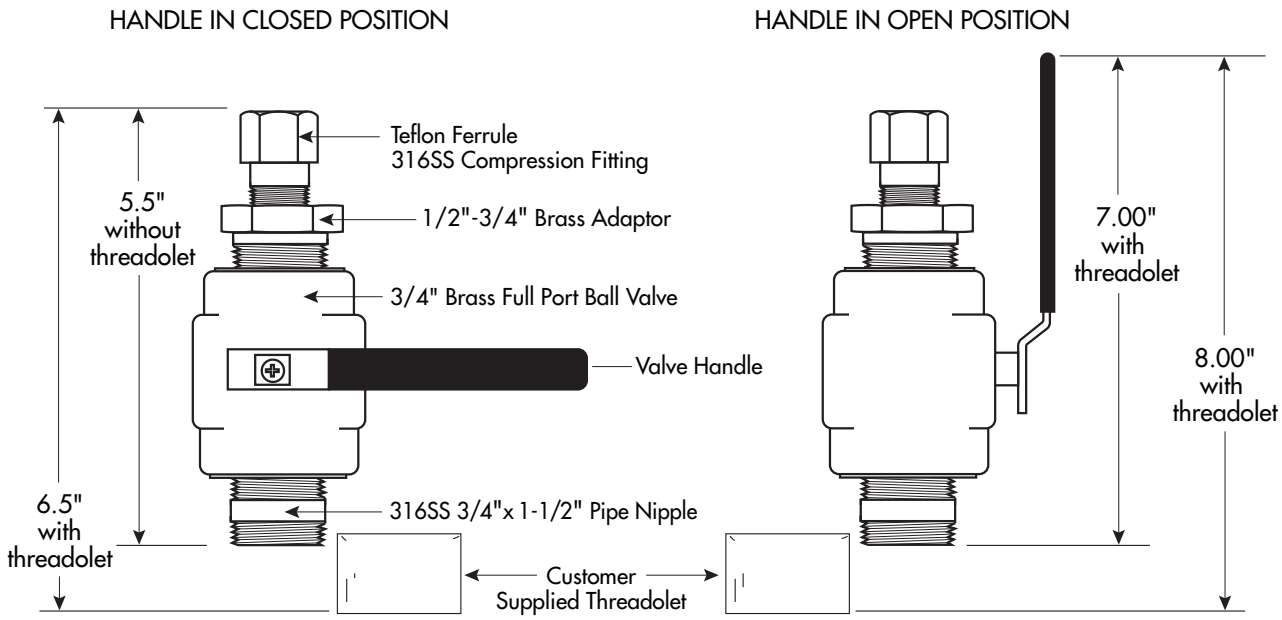


MOUNTING PLATE FOR THIN WALLED DUCTS (INCLUDES STCF05 COMPRESSION FITTING)



1 At 650 psig, force exerted on 1/2" diameter probe is approx. 125 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, 200 °F, unless high temperature models ordered.
5 Hot Tapping is feasible by removing Weldment (upper portion of assembly temporarily removed)
6 See page 46. SVA05 can be utilized for Sensor Functionality and Zero Self Check.

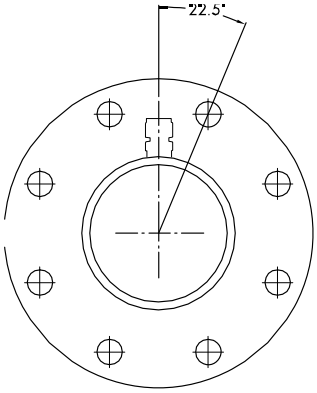
SVA05LP Low Pressure Isolation Valve Assembly



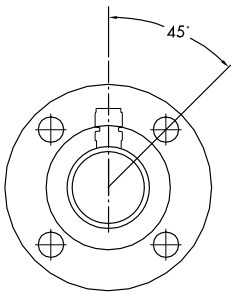
NOTES AND CAUTIONS

- **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)

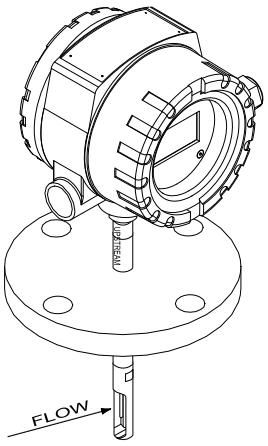


Flanges for 3½" pipe sizes and up, have 8 bolt holes



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

Flanged Mounting for Insertion Meter (OPTIONAL)



Section D

DIAGNOSTICS

Common Diagnostics

SYMPTOM: Display failure, or pixels extremely dim.
CORRECTIVE ACTION: Contact Factory. Certain types of failures are under long term warranty. Please note that the 4-20 ma will still function normally.

SYMPTOM: Display fading, or partially fading.
CORRECTIVE ACTION:

a) Some fading, particularly with those characters that are lit up most frequently, is normal. The flow meter will continue to function properly, and flow meter accuracy and outputs will not be effected.

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

c) Note, in late 2009, the SMC ATMF 8000 was modified to incorporate a built-in photocell. The purpose of the photocell is to adjust the display brightness with ambient lighting. The brighter the surrounding lighting conditions, the brighter the display. Lower ambient lighting conditions, such as a factory environment, will dim the display. The display will be dimmest if operated in low ambient lighting, or at night. The photocell circuit is designed to extend the life of the display, and to minimize fading.

d) Note, in early 2010, a further enhancement was added to further extend the life of the display. The above mentioned built-in photocell also senses motion which automatically switches display from Screen Saver mode to Normal mode.

SYMPTOM: Erratic Readings.
POSSIBLE CAUSES: If a large Motor or Generator or Variable Frequency Drive (VFD) is nearby 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, than it is likely that the source of the noise was the problem.

b) To prevent subsequent problems, if a Remote Style Meter, move the enclosure as far away as possible from the source (the Motor or VFD).

c) If an Integral Style Meter, mount the meter in a different location (further from the source) or move the source further from the meter.

SYMPTOM: Erratic Readings on a Remote Meter.
POSSIBLE CAUSE: In some cases, analog noise is induced into the Remote cable causing erratic, or climbing readings.
SUGGESTED CORRECTIVE ACTION:

a) Be sure the remote cable is installed in metal conduit and grounded on one end (in some cases, grounding *both* ends may be required).

b) Also, avoid coiled cable, especially if not in metal conduit.

c) Also, if extra cable exists, move the extra cable as far away as possible from any source of analog noise, such as large motors or VFDs.

SYMPTOM: Meter reading zero continuously, or Full Scale continuously, or temperature reading is abnormally low (hundreds of degrees below zero).
POSSIBLE CAUSES/SUGGESTED CORRECTIVE ACTION:

a) It is likely that a wire is loose. But in rare cases, a sensor could fail (i.e., if a standard sensor, HT01 or HT02 sensor exceeds a process temperature of 450˚F.)

b) Check for continuity to be sure the wiring is making good contact at the terminals of the Junction Box.

c) Also, to verify that the electronics and the sensor serial number are the same, note the following: The sensor's serial number will come up upon power up, right after Initializing on the Display. If the serial number doesn't agree with the Junction Box labels, that would affect calibration (in other words, sensors and electronics are a matched pair—mixing them up will cause false readings). Also metal Serial Number Tags are fastened to both the electronics and the Junction Box. They must have identical Serial numbers.

d) To check if a sensor has failed on a remote style meter, it is easy to use the Junction Box to do so. You must Power Down (shut off power), but you do not need to remove the probe from the pipe. Refer to page 24.

e) An Ohm Meter is required to check across the sensor leads of the Flow Sensor. Look at the drawing of the Junction Box. Disconnect the red wires on the Factory Side to isolate and measure the resistance. If the reading is infinity or a short, it means that sensor has failed.

f) Now check the Temperature Sensor. Disconnect the white wires on the Factory Side to isolate and measure the resistance. If you have infinity or a short, it means that sensor is burned out. Note: *Normally the sensors will read approximately 110 ohms at 70˚ F. At higher temperatures they should read a higher resistance, but both sensors should have a similar value.*

g) On integral style meters (SIP), there is no Junction Box. In that case, refer to the ATMF 8000 Integral Terminals on page 19 and check the sensor wires. Remove the appropriate wires first (red pair for flow, then white pair for temperature). Measure their resistance. If reading infinity or short, it means that sensor has failed.

SYMPTOM: Meter Railing (Pegging) or Reading High
POSSIBLE CAUSES/SUGGESTED CORRECTIVE ACTION:

a) Insufficient straight run (i.e. flow profile is disturbed, causing errors).

b) Possible jet effect if upstream pipe is smaller than meter flow body or if valve is too close upstream to meter.

c) Not following Probe Insertion Guideline.

d) If sensor is inserted in reverse ("Upstream" mark is facing downstream) Meter may over-report (or under-report) by as much as 30%.

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

f) A downstream valve too close to the meter (flow may be reflecting back).

g) Possibly caused by water droplets condensing out of gas stream (which generally causes output to spike; but if droplets are near continuous, output may rail).

h) Meter is miswired, especially in Remote Style application.

i) Possibly caused by water droplets condensing on inside of pipe wall, which roll down or hit sensor causing output to spike; but if droplets are near continuous, output may rail. Note: *Recommend installation 45˚ from vertical (see drawing on page 68).*

j) Possibly caused by water droplets condensing out of gas stream and filling the cavity containing the sensing elements (usually due to probes mounted below horizontal in saturated pipes).

k) Sensor may be contaminated. Remove probe, wipe off or clean with a solvent. Reinsert.

l) Using a different gas or gas mix than the meter was specified and calibrated for.

m) If a Remote Style Meter (SRP), be sure Serial Numbers of Junction Box and Remote Electronics are identical (if not, errors in calibration are inevitable). To confirm, verify that Junction Box Serial Number Tag has identical Serial Numbers to Tag on Remote Enclosure.

n) Meter may appear to be reading high if user is comparing SMC flow meter readings (SCFM) to an uncorrected volumetric device (ACFM). For example, at constant volume, a decrease in gas temperature will increase the mass flow (SCFM). That is completely normal.

SYMPTOM: Reading Low
POSSIBLE CAUSES:

a) Insufficient straight run (i.e. flow profile is disturbed, causing errors).

b) Poor flow profile Upstream (insufficient upstream straight run).

c) Not following Probe Insertion Guideline.

d) If sensor is inserted in reverse ("Upstream" mark is facing downstream) Meter may over-report (or under-report) by as much as 30%.

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

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

g) Using a different gas or gas mix than the meter was specified and calibrated for.

h) If a Remote Style Meter (SRP), be sure Serial Numbers of Junction Box and Remote Electronics are identical (if not, errors in calibration are inevitable). To confirm, verify that Junction Box Serial Number Tag has identical Serial Numbers to Tag on Remote Enclosure.

i) Meter may appear to be reading low if user is comparing SMC flow meter readings (SCFM) to an uncorrected volumetric device (ACFM). For example, at constant volume, an increase in gas temperature will lower the mass flow (SCFM). That is completely normal.

j) On most models, the Totalizer will not start counting for 10 seconds after power up so any flow data will not be accumulated during this time.

k) Insufficient power supply—most products require minimum 100 ma.

l) Excessive load on the 4-20 ma. (To check if problem is due to 4-20 ma output device, temporarily remove device, and observe if display reads as expected).

SYMPTOM: Totalizer can take up to 10 seconds to update its reading when flow meter is first powered up, or a channel is changed.
CORRECTIVE ACTION: None. This slight delay is completely normal.

SYMPTOM: Display does not have power
POSSIBLE CAUSE: Mis-wiring

SYMPTOM: 4-20 mA output not tracking the flow rate display
POSSIBLE CAUSE:

a) In normal operation (Self Powered) B4 and B5 must be jumpered to supply power to loop. See pages 14 and 17.

b) In Externally Powered mode, the jumper must be removed. Verify that 9 to 27 Volts DC is supplied to externally power the loop as per page 14 or 17.

Sensor Functionality and Zero Calibration Self Check

SMC ATMF 8000 has continuous diagnostics. The raw calibration milliwatts (mw) is always displayed in the upper left hand corner of the meter's display. 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. 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[1]
   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 SMC 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 38.
   a) Loosen Lower Collar Clamp completely
   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 milliwatts (mw) on the top of the meter's display. Check the observed reading (after a few minutes of "no flow" stabilization) against the 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 the meter is still in calibration.
4. A value greater than 5 milliwatts, but less than or equal to 10 milliwatts, 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 and 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 the probe, and clean the sensor (use an appropriate non-corrosive solvent to remove the 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 SMC 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. We would recommend this second check if there is any question at all about the first check (while in the pipe) or if it's mWo value is anywhere around 10 mW. The sensor should be removed from the pipe, cleaned, and inserted vertically into a clean dry container such as a water bottle. This would allow a field check very similar to the air mWo check that is done at SMC, and more than likely will give the same results that we recorded here at SMC.
9. For CAR[2] compliance for the quarterly QA/QC, 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 SMC "zeros" the meter in a horizontal pipe. If you have a vertical pipe, mW will be slightly lower at zero (also see note 4).

2 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.

Section E

MODBUS

Modbus Register Listing

SMC ATMF 8000 REV. 1.80-1.83

UINT32	IEEE Float	SCALED INT32*		
Reg Offset	Reg Offset	Reg Offset	Reg Description	Type
256			format flag	UINT8
256			modbus unit_id	UINT8
257			output mode sel	UINT8
257			fix_pt selection	UINT8
257			bRun	UINT1
257			bTotal	UINT1
257			bEEProm	UINT1
257			bReset	UINT1
257			bLeadEn	UINT1
257			bDAClo	UINT1
257			bDAChi	UINT1
	514	770	CAL_VAL	FLOAT
	516	772	K-FACTOR	FLOAT
	518	774	VREF	FLOAT
	520	776	LOAD_RES	FLOAT
TEMP	522	778	COEFF A	FLOAT
TEMP	524	780	COEFF B	FLOAT
TEMP	526	782	COEFF C	FLOAT
TEMP	528	784	COEFF D	FLOAT
	530	786	DISP A	FLOAT
	532	788	DISP B	FLOAT
	534	790	DISP C	FLOAT
	536	792	DISP D	FLOAT
FLOW	538	794	COEFF A	FLOAT
FLOW	540	796	COEFF B	FLOAT
FLOW	542	798	COEFF C	FLOAT
FLOW	544	800	COEFF D	FLOAT
FLOW	546	802	COEFF E	FLOAT
FLOW	548	804	COEFF F	FLOAT

UINT32	IEEE Float	SCALED INT32*		
Reg Offset	Reg Offset	Reg Offset	Reg Description	Type
	550	806	iir filter coeff	FLOAT
	552	808	flow_min	FLOAT
	554	810	flow_max	FLOAT
	556	812	PULSE COUNT	FLOAT
	558	814	temp_max	FLOAT
302			dac1_min	UINT16
304			dac1_max	UINT16
306			serial number	UINT32
308			RATE string	ASCII
310			TOTAL string	ASCII
312			current totalizer	UINT32
314			ADC0	UINT32
316			ADC1	UINT32
318			ADC2	UINT32
320			ADC3	UINT32
	578	834	current flow	FLOAT
	580	836	current temp	FLOAT
	582	838	rtd_mWatts	FLOAT
	584	840	rtd_res	FLOAT
	586	842	ref_res_r	FLOAT
	588	844	ref_res_d	FLOAT
	590	846	dac_smooth	FLOAT
	592	848	lead	FLOAT
	594	850	oheat	FLOAT
	596	852	bv	FLOAT
	598	854	fv	FLOAT
	600	856	tv	FLOAT
	602	858	lv	FLOAT

*SCALED INT32 register contents form INT32 values by multiplying the IEEE FLOAT x 1000
ex. FLOAT -> 112.768 = SCALED INT32 -> 112768

SmartMeasurement Modbus Protocol Rev. 1.80-Rev. 1.83

SMC ATMF 8000 Meters support communication with other devices via MODBUS® protocol using RTU transmission mode. The Modbus protocol defines a message structure that controllers will recognize and use, regardless of the type of networks over which they communicate. It establishes a common format for the layout and contents of message fields. Transactions use a master-slave technique, in which only one device (the master) can initiate transactions (called queries). The other devices (the slaves) respond by supplying the requested data to the master and by taking the action requested in the query. SMC Meters operate as slaves to other Modbus devices and default to 19200-8-E-1, however, the following modes may also be software selectable:

9600-8-N-1	(Baud-Bits-Parity-Stop)
9600-8-E-1	
9600-8-O-1	
19200-8-N-1	
19200-8-E-1	(Default)
19200-8-O-1	

MESSMC FRAMING

Messages start with a silent interval of at least 3.5 character times followed by 4 fields and then followed by another silent interval of at least 3.5 character times. The first field contains the device address. The second field contains the function code. The third field contains the data and byte counts. The fourth field contains the CRC value.

ADDRESS FIELD

The address field contains one byte. SMC ATMF 8000
Meters will transmit response packets to addresses which are between 1 to 240 decimal (inclusive). Modbus packet writes may be sent to broadcast address 00, however the ATMF 8000 will not reply with a response packet.

FUNCTION CODE FIELD

The function code field contains one byte. See the section titled *Function Codes Supported by SMC ATMF 8000.*

DATA FIELD

The data field contains four or more bytes. This information is used by the Meter to take the action defined by the function code, or to read or write data to one or many registers.

CRC FIELD

The CRC-16 (cyclical redundancy check) field is two bytes, containing a 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, the message will be discarded.

Function Codes Supported by ATMF8000 page 2 of 6

03 (0X03) READ HOLDING REGISTERS

Identical operation as code 04 READ INPUT REGISTERS described below, except READ only.

04 (0X04) READ INPUT REGISTERS

Reads the binary contents of the specif ed register. This is READ/WRITE register. ATMF8000 values are typically 32 bits wide (4 bytes) and contain a single IEEE754 f oating point value. Modbus registers are 16 bits wide (2 bytes) so a minimum of 2 Modbus registers are required to transfer all f oating point bits to the master. See section titled *ATMF8000 Floating Point Format.*

Query

The query message specif es the starting register address and the quantity of registers to be read.

0x03 READ MULTIPLE HOLDING REGISTERS or 0x04 READ MULTIPLE INPUT REGISTERS

REG ADDR HI (RH) is set to: 01 for INTEGER access of integral values 02 for IEEE754 f oating point 03 for Scaled (x1000) long integer of f oating point value

REG ADDR LO (RL) is the starting address index into the register structure. See section titled ATMF8000 Register Index Values.

–QUERY–	–RESPONSE–
SA – SLAVE ADRESS	SA
04 – FUNC CODE	04
RH – REG ADDR HI	BC – # of data bytes to follow
RL – REG ADDR LO	DATA0
00 – # OF REGS HI	DATA1
CT – # OF REGS LO	DATAn

CT is the register count needed to transfer data. Typically this byte is set to 02 to request 1 full IEEE754 f oating point value. (Modbus single registers are 16 bits wide, ATMF8000 f oating point values are 32 bits wide.)

DATA0-DATAn are bytes in binary format returned from the slave device representing the contents of the selected register(s).

NOTE: *values indicated with 0x prefix are in hexadecimal, otherwise in decimal notation.*

page 3 of 6

16 (0x10) WRITE REGISTERS

Writes the binary contents of the specified register into the meter. SMC ATMF 8000 values are typically 32 bits wide (4 bytes) and contain a single IEEE754 floating point value. Modbus registers are 16 bits wide (2 bytes) so a minimum of 2 Modbus registers are required to transfer all floating point bits into the meter. See section titled *SMC Floating Point Format.*

Query

The query message specifies the starting register address and the quantity of registers to be written.

16 (0x10) WRITE MULTIPLE REGISTERS

-QUERY-	-RESPONSE-
SA - SLAVE ADRESS	SA
0x10 - FUNC CODE	0x10 - 16 FUNC CODE
RH - REG ADDR HI	RH - REG ADDR HI
RL - REG ADDR LO	RL - REG ADDR LO
00 - # OF REGS HI	00 - # REGS HI
CT - # OF REGS LO	CT - # REGS LO
BC - BYTES COUNT	CH - CRC MSB
DATA0	CL - CRC LSB
DATA1	
DATAn	
CH - CRC MSB	
CL - CRC LSB	

REG ADDR HI (RH) is set to:

- 01 for INTEGER access of integral values
- 02 for IEEE754 floating point
- 03 for Scaled (x1000) long integer of floating point value

REG ADDR LO (RL) is the starting addre ss index into the register structure. See section titled SMC Register Index Values.

CT is the register count needed to transfer data. Typically this byte is set to 02 to request 1 full IEEE754 floating point value.

BC is the actual number of bytes that follow.

DATA0-DATAn are bytes in b inary format transmitted to the slave device representing the contents of the selected register(s).

page 4 of 6

NOTE: THIS PAGE APPLIES TO REV. 1.81-1.83

17 (0x11) REPORT SLAVE IDENTIFICATION*

This query requests from the specified slave address a detailed identification packet with a run status, and SMC ATMF 8000 and firmware revision response. (ATMF 8000
will not respond to broadcast slave address 00.)

Query

The query message specifies the slave address, function code, and CRC check words.

17 (0x11) REPORT SLAVE ID

-QUERY-	-RESPONSE-
SA - SLAVE ADRESS	SA
11 - FUNC CODE	11
CL - CRC LSB	BC - BYTES COUNT, 19
CH - CRC MSB	SD - SLAVE ID (DEVICE SPECIFIC), 0x5A
	RS - RUN STATUS INDICATOR, 0xFF
	ASCII Text - SMC ATMF 8000 v1.81x
	CH
	CL

Response

The SMC ATMF 8000 will respond with an echo of the slave address and function code. The byte count will be 19 (0x13) to allow the master to account for all the remaining bytes that follow.

REPORT SLAVE ID Example: (Slave Address = 0x30 = 48, default)
Master Query -> 30 11 D5 BC
ATMF 8000 Response -> 30 11 13 5A FF 53 61 67 65 20 50 72 69 6D 65 20
76 31 2E 38 31 20 F1 2B
ASCII translation-> SMC ATMF 8000 v1.81

*Not implemented in revision 1.80

SMC REGISTER INDEX VALUES

DATA TYPE	VALUE	SIZE	ADDRESS INDEX	DESCRIPTION
Byte	slave_ad	1 BYTE	1	Modbus Slave Address*
float	flow_rate;	1 IEEE754	578	actual flow rate
float	flow_temp;	1 IEEE754	580	process temperature
float	rtd_mWatts;	1 IEEE754	582	sensor power reading
float	rtd_res;	1 IEEE754	584	actual sensor probe resistance
float	ref_res_r;	1 IEEE754	586	actual temperature probe resistance
integ	totalizer;	1 uLONG	312	actual displayed total

*NOTE: SMC ATMF 8000 Meters are factory programmed with the MODBUS slave address = 48 (0x30). It may be extremely useful to be able to write to an unknown slave address with a simple broadcast command. Be sure only one SMC ATMF 8000 is connected during any broadcast writes using slave address = 0.

Writing into unspecified registers (not defined above) can render the un it non-functional or overwrite factory calibration data yielding incorrect operation.

EXAMPLE MODBUS PACKET

Query

This packet will request of the addressed slave to respond by sending b ack the contents of registers 578 to 582 (incl usive). Three registers: flow rate through RTD mWatts in IEEE754 floating point format.

0x30 - SMC ATMF 8000 SLAVE ADDRESS (0x30 = 48, default)
0x04 - READ INPUT REGS FUNCTION CODE
0x02 - STARTING REGISTER HI BYTE (0x01 = 256, 0x02 = 512, 0x03 = 768) 0x42 - STARTING REGISTER LO BYTE (512 + 66 = register access = 578) 0x00 - COUNT MSB (ALWAYS ZERO)
0x06 - COUNT OF ALL DESIRED REGISTERS 0xD5
- CRC HI BYTE
0x85 - CRC LO BYTE

SMC Register Output Format

INTEGER REPRESENTATION

Computer systems hosting a MODBUS network typically store integer values to represent non-fractional quantities.

All registers addressed above 256 (0x0100-0x1FF) will transfer 16 bit integral quantities in response to all master queries. MODBUS requires that the register count reflects each 16 bit registers transmitted to ensure that no bytes are missing in the transfer of integer quantities. (Note: Most SMC ATMF 8000 registers
are IEEE754 quantities; integer representations of these registers will require significant translation.)

IEEE754 FLOATING POINT

Computer systems hosting a MODBUS network typically store single precision floating point data in the standard IEEE754 format.

All registers addressed above 512 (0x0200-0x02FF) will transfer full 32 bit single precision quantities in response to all master queries. MODBUS requires that two 16 bit registers are transmitted to ensure that no bytes are missing in the transmission of 32 bit quantities.

SCALED DECIMAL REPRESENTATION

Computer systems hosting a MODBUS network may choose represent single precision floating point values as scaled long integers (32 bit values). The SMC ATMF 8000 will convert floating point registers to integral units by multiplying the value by 1000.

Ex. Floating point value 1234.567 will be converted to integral value 1234567

All registers addressed above 768 (0x0300-0x03FF) will transfer full 32 bit scaled integer quantities in response to all master queries. MODBUS requires that two 16 bit registers are transmitted to ensure that no bytes are missing in the transmission of 32 bit quantities.

For more information on the MODBUS protocol, see: http://www.modbus.org/tech.php

SMC ADDRESSER PLUS SOFTWARE

Addresser PLUS is a convenient software kit that includes Addresser PLUS software, as well as an optically isolated ULINX RS485 to USB converter. The Addresser PLUS is a READ/WRITE Program with drop-down menus for convenient user interface between your PC or laptop and the Modbus Terminals of the SMC ATMF 8000. Contact SMC for ordering information and instructions.

Section F

APPENDIX

SMC ATMF 8000™ Field Programmable "Dongle"

Although virtually any setting on SMC ATMF 8000 can be changed by users who have Modbus® capability (see pages 14 and 17 for terminal connections), not all customers have that capability to communicate with the ATMF 8000 using its Modbus Compliant RS485 Communications. However, users do not need to have a Modbus host or any special skill, since they can also change configurations in the field by using the patent pending SMC "Dongle".

The SMC ATMF 8000 device known as a "Dongle", was developed to facilitate making changes on SMC ATMF 8000 Flow Meter settings in the field. Simply contact SMC and specify your requirement (such as the new Full Scale, new Pipe Area, etc), and the device will be programmed at SMC and sent directly to you within a few days (there is a slight fee for this service). The patent-pending Dongle can also be configured as a Reset Totalizer device (i.e. it can be used repeatedly, with any SMC ATMF 8000 to easily reset the Totalizer). The Dongle can also be programmed to change Engineering Units, Filter Response and numerous other parameters.

In fact, Dongles can also be used to provide multiple gas calibrations. In this case, the requirements must be specified at the time of ordering. For example, one meter can be calibrated for four different gases with totally different calibration ranges, by providing four Dongles with the Flow Meter. When a different gas calibration is needed, simply upload the data from the appropriate Dongle. It only takes a few seconds to do so.

Dongles come with a convenient well marked cable that is connected to the RS485 terminals. Simply remove the rear cover, connect the Dongle, and push the button on the Dongle. An LED will illuminate, and within 3 seconds the light will go out signaling that the data transfer is complete.[1] Remove the Dongle, close the cover, and you will notice that the new settings have been uploaded (or in the case of a Totalizer-Reset Dongle, you will notice that the Totalizer has zeroed).

1 If the light does not go out, it will be necessary to repeat procedure. Remove finger for a few seconds and then push button again.

Correction Factors For Variation From Original Digester Gas Calibration

SMC 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 th e composition changes after delivery. The following examples assume that the initial calibration was set up for 60% CH_4 and 40% CO_2.

a) 65% CH_4 and 35% CO_2: Multiply reading by 0.982 to correct it for new composition

b) 70% C H_4 and 30% CO_2: Multiply reading by 0.965 to correct it for new composition

c) 55% CH_4 and 45% CO_2: Multiply reading by 1.0185 to correct it for new composition

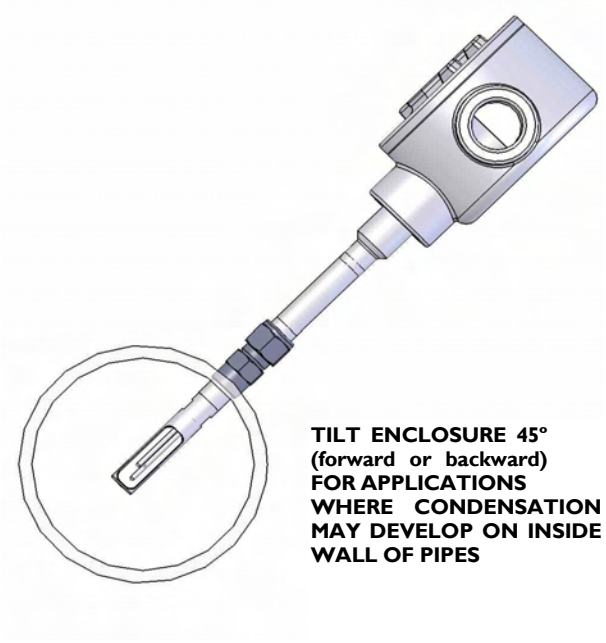
For smaller changes, the corrections are linear in between

d) Also, if 100% sat urated with H_2O 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)

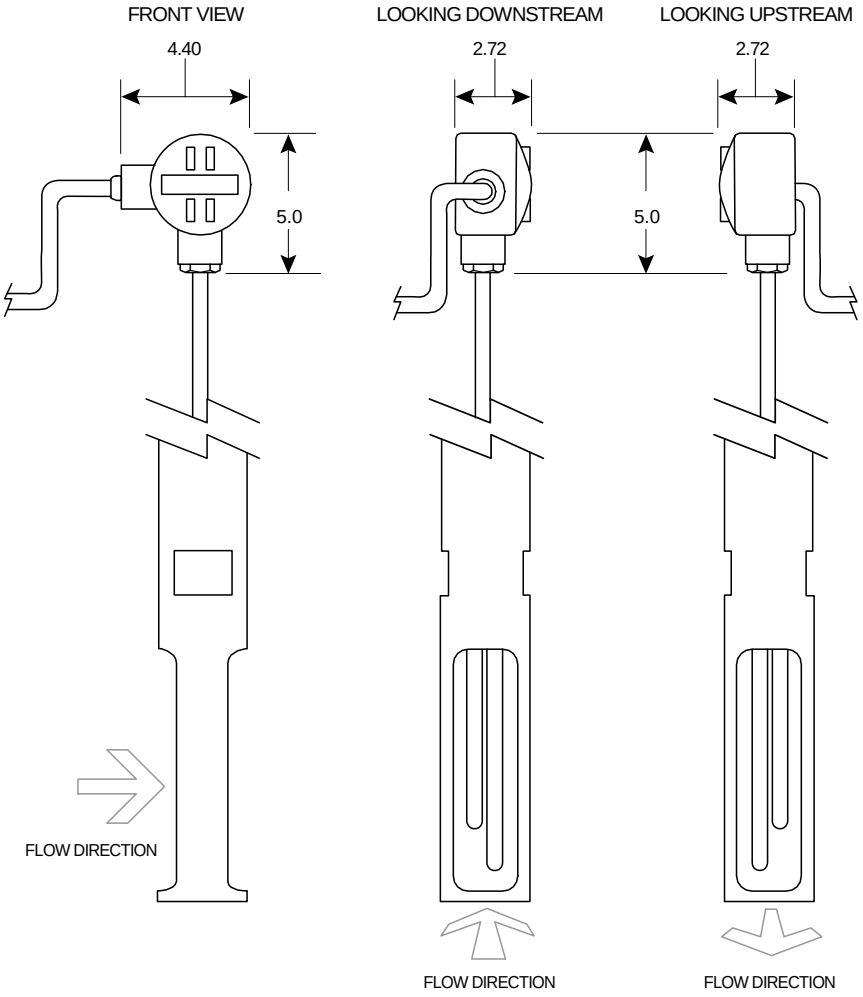
Also, use the 45 degree mounting method in order to avoid droplets from hitting the sensor and causing spikes (see above right)

Installations Where Pipe Condensation May Develop



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

J-Box and Upstream Orientation



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.

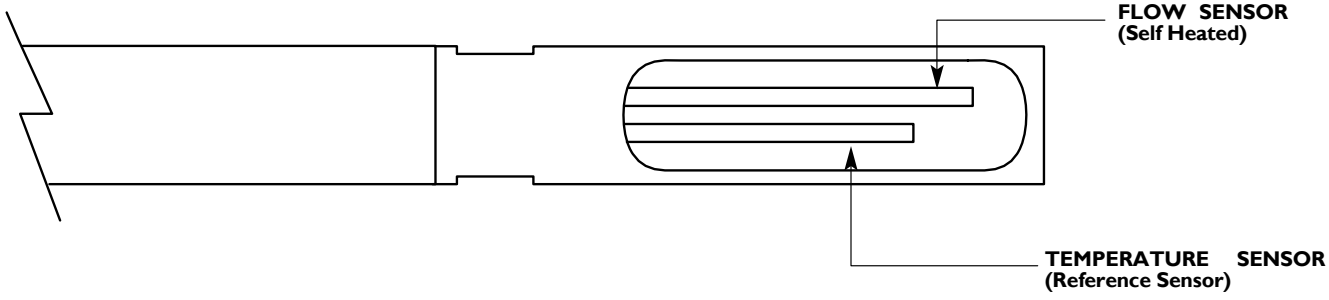
- The sensors are RTDs, which are resistance temperature detectors. They consist of highly stable reference-grade platinum windings. In fact, we use the same material that is used as Platinum Resistance Standards at the NIST.

- 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 SMC proprietary 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.



Section G

HART

Totalizer

Total Units [Fast Key 3,2,2,1]
Displays the units of measurement for the totalized value.

Total [Fast Key 3,2,2,2]
Displays the totalized value in the selected units of measurement.

Pulse Output

Pulse Count [Fast key 3,2,3,1]
Provides the number of units per pulse. Example will be a Pulse Count of 100 and units are set to SCF, then one pulse is equivalent to 100 SCF.

Pulse Duration [Fast Key 3,2,3,2]

HART

Poll Address [Fast Key 3,2,4,1]
Used multi drop installations to identify an individual instrument. Values can range between 1 and 15. If used in a multi drop configuration the 4-20mA output will be set to 4 mA. The default setting is a Poll Address = 0 with the 4-20 mA analog signal operational.

Loop Current Mode [Fast Key 3,2,4,2]
Allows the user to select whether the loop current is enabled (active) or disabled (fixed at 4mA) regardless of the poll address setting.

Number of Request Preambles [Fast Key 3,2,4,3]
Required HART command – indicates the number of preambles required by the instrument for HART communication.

DEVICE INFORMATION

Tag [Fast Key 3,3,1]
Enter an 8 digit tag which can be used to identify the instrument

Long Tag [Fast Key 3,3,2]
Enter up to a 32 digit tag which can be used for any purpose desired by the user.

Descriptor [Fast Key 3,3,3]
A 16 character entry which can be used for additional identification of the instrument.

Message [Fast Key 3,3,4]
A 32 character entry which can be used for identification or other purposes.

Date [Fast Key 3,3,5]
Enter date code; often used to enter last date a configuration change had been made.

Meter S/N [Fast Key 3,3,6]
Factory entry of the serial number of the instrument

Final Assembly num [Fast Key 3,3,7]
User entered identification which may be used for future reference

REVISIONS:

- **Universal Revision Number** [Fast key 3,3,8,1]
  Identifies the HART specification used in the design of the instrument.
- **Field Device Revision Number** [Fast Key 3,3,8,2]
  Provides the instrument revision for HART compatibility
- **Software Revision Level** [Fast Key 3,3,8,3]
  Provides the software revision used by the instrument
- **Hardware Revision Level** [Fast Key 3,3,8,4]
  Provides the Hardware revision level of the instrument

FACTORY

Flow Factors and TC Factors
Displays factory entered calibration values for the instrument

Long Tag [Fast Key 1,2,2]
A value entered by the user

Manufacturer [Fast Key 1,2,3]
The name of the Manufacturer of the flow meter. In this case it is Sage Metering

Model [Fast Key 1,2,4]
Manufacturer's model number of the flow meter.

Device Id [Fast Key 1,2,5]
Factory entered number which is unique for each instrument

DIAGNOSTICS
Device Status [Fast Key 2,1]
Will indicate any standard diagnostics message

Sensor Status

Flow Below Cutoff [Fast Key 2,2,1]
Diagnostics menu indicating that the measured flow rate is less than the low flow cutoff

Loop Diagnostics

Loop Test [Fast Key 2,3,1]
Permits the user to drive the mA output to a desired value.

D/A Trim [Fast Key 2,3,2]
Used to calibrate the 4-20 mA output from the flow meter to match the system loop.

Flow Test [Fast Key 2,3,3]
Permits user to enter a value for the RTD Power with the display showing expected flow rate based on original calibration. Useful diagnostics test to insure that the flow meter is matching the original calibration curve.

DEVICE SETUP

Basic Setup
K Factor [Fast Key 3,1,1]
Enter a K factor which will provide a linear adjustment of the flow rate. May be used to correct for different pipe size, varying gas composition, or installation effects which change the performance of the flow meter.

PV Damping [Fast Key 3,1,2]
Provides smoothing of normally occurring flow fluctuations. Value between 0.001 to 0.999; the lower the value providing greater smoothing (time averaging).

Low Flow Cutoff [Fast Key 3,1,3]
Enter a minimum value of the flow rate. Flow rates measured below this value will be shown as zero flow. Useful to disregard any false readings which might occur during a no flow condition

Flow Rate Units [Fast Key 3,1,4]
Units of measurement of the flow rate. This is a text entry. Any change in units of measurement from original calibration must also apply a K factor

Temperature Units [Fast Key 3,1,5]
Displays the units of measurement of the gas temperature

Total Units [Fast Key 3,1,6]
Four digit entry. The first three digits will represent the units of measurements of total flow and the fourth digit will be "C" or "F" to identify units of measurement of the temperature reading.

OUTPUT

Analog Output
PV URV [Fast Key 3,2,1,1]
Enter the Upper Range Value for the Primary Variable (flow rate). The URV must be in the identified units of measurement and must be within the calibration range of the instrument. Consult Sage Metering if assistance is requied.

HART

Following reviews the various parameters used in the HART menu structure and provides fast keys for accessing this information:

PRIMARY VARIABLE - READ ONLY
Provides information regarding the Primary Variable (Flow)

PV Measurements
Flow Rate [Fast Key 1,1,1,1]
Actual measurement of the flow rate in the reference unit of measurement

PV Loop Current [Fast Key 1,1,1,2]
Analog value output ranging between 4 and 20 mA representing the flow rate. The 4 and 20 mA loop can be verified by using the Loop Test described below in the Diagnostic section [Fast Key 2,3,1].

PV % of Range [Fast Key 1,1,1,3]
Provides the value of the flow rate representing the % of range between the LRV (Lower Range Value) and the URV (Upper Range Value).

Flow Rate Units [Fast Key 1,1,1,4]
Units of measurement associated with the flow rate.

Flow Rate Parameters
Low Flow Cutoff [Fast Key 1,1,2,1]
Any measured flow rate below this value will be set to 0.

PV URV [Fast Key 1,1,2,2]
Upper Range Value of the Primary Variable. Represents the 20 mA value

PV LRV [Fast Key 1,1,2,3]
Lower Range Value of the Primary Variable. Represents the 4 mA value. Value is 0.

PV Damping [Fast Key 1,1,2,4]
Primary Variable Damping factor. Used to smooth out normal occurring fluctuations in the flow rate. Values range between .001 and .999 which represents no smoothing. Lower values increase damping.

K Factor [Fast Key 1,1,2,5]
K Factor is a linear adjustment factor which may be used to adjust the flow rate for various reasons requested by the user. Default is 1.

Dynamic Variables
Flow Rate [Fast Key 1,1,3,1]
Displays the current flow rate measured by the flow meter.

Total [Fast Key 1,1,3,2]
Displays the total flow measured by the instrument.

RTD Power [Fast Key 1,1,3,3]
Measurement of the power in mW corresponding to the measured flow rate. Useful for diagnostic purposes

Temperature [Fast Key 1,1,3,4]
Displays the gas temperature where the sensor is located

Flow Rate Units [Fast Key 1,1,3,5]
Units of measurement of the flow rate

Total Units [Fast Key 1,1,3,6]
Units of measurement of the total flow

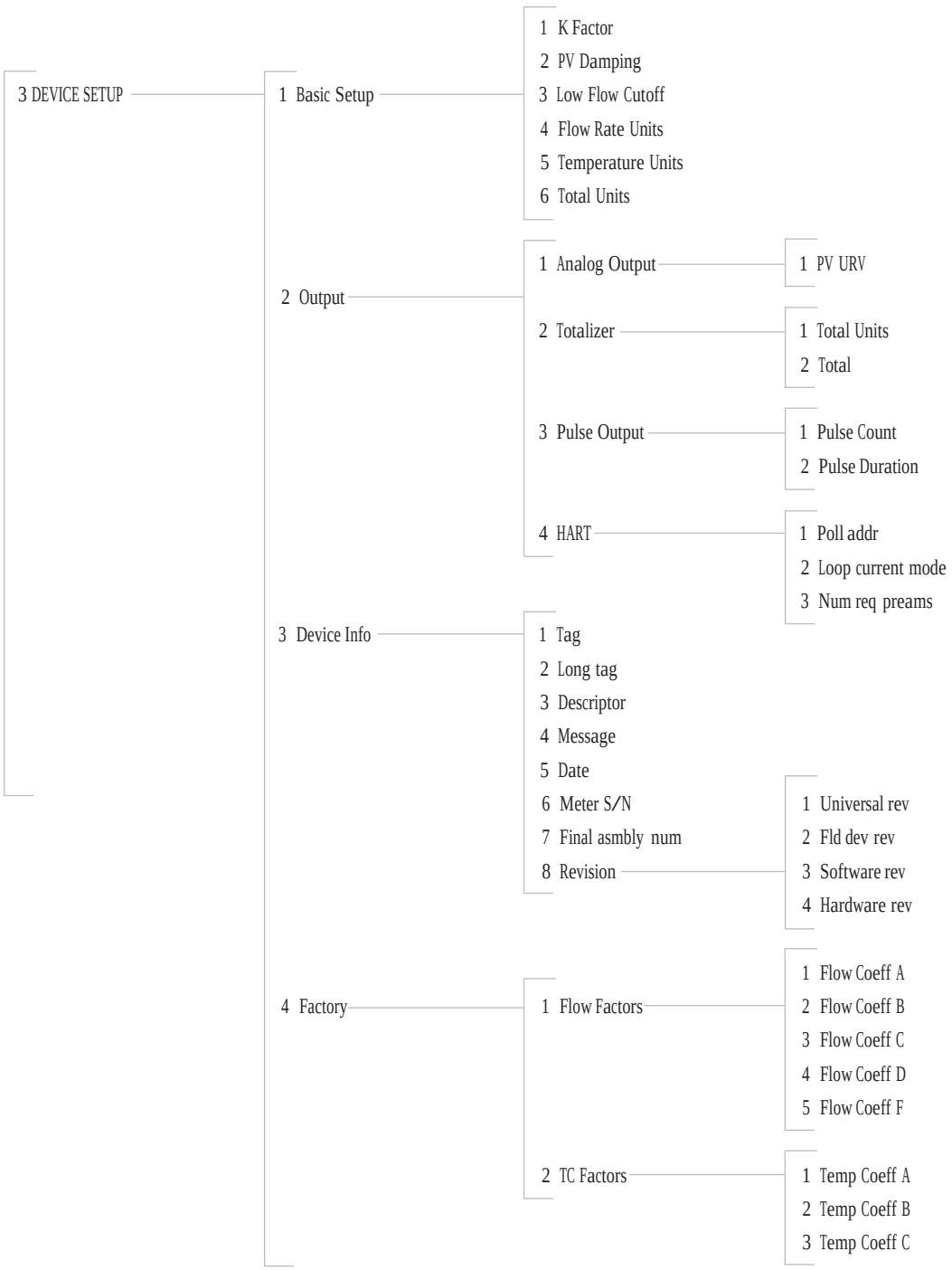
Loop Current Bargraph [Fast Key 1,1,4]
Displays a graphic chart showing the mA output of the flow rate vs. time – Range between 4 and 20 mA

Percent Range Bargraph [Fast Key 1,1,5]
Displays a graphic chart showing the flow rate as a % of range between the LRV and URV

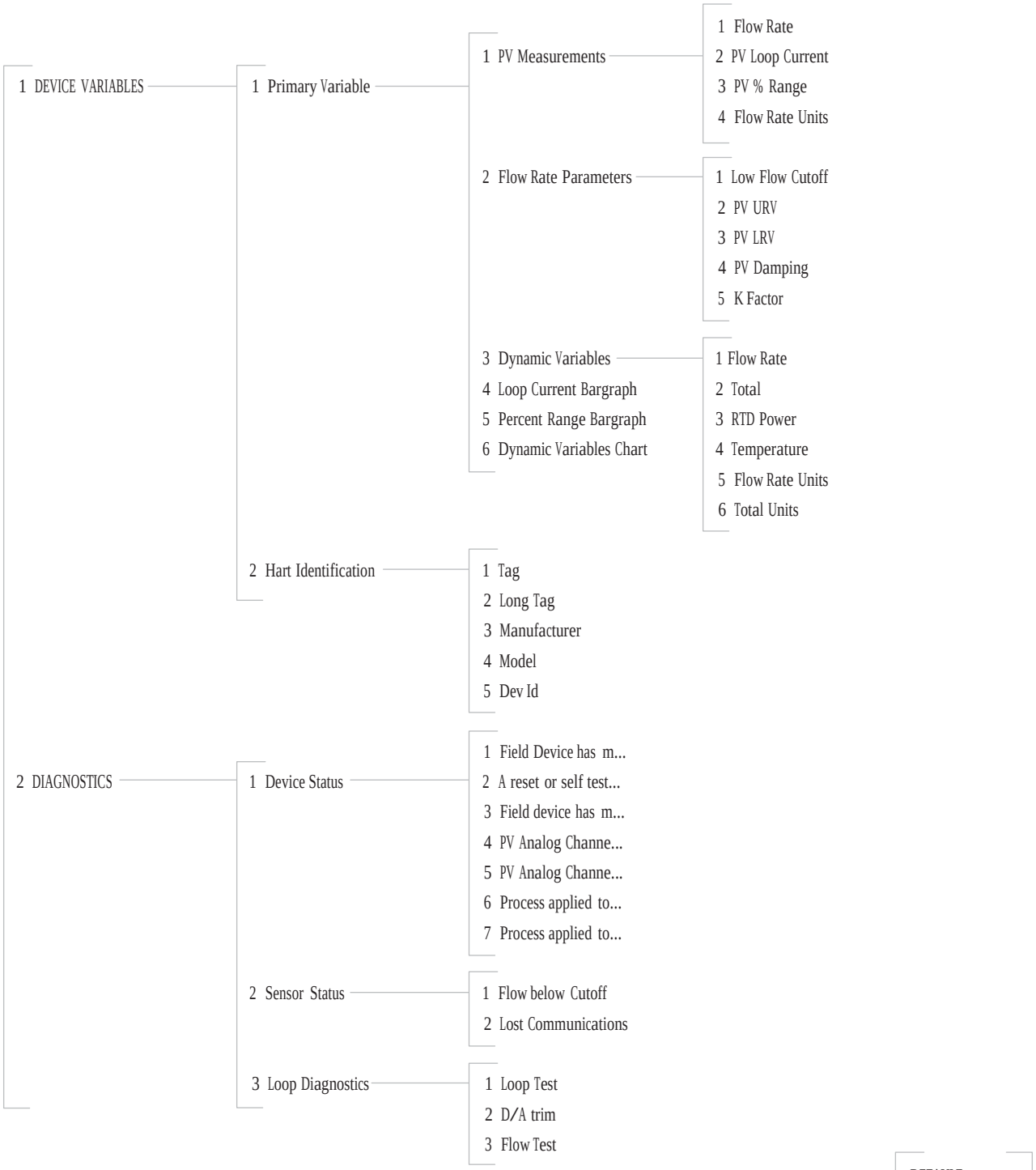
Dynamic Variables Chart [Fast Key 1,1,6]
Displays a graphic chart showing flow rate in selected units of measurement vs. time

HART IDENTIFICATION

Tag [Fast Key 1,2,1]
A Tag value entered by the user to identify the flow meter. Up to 8 digits in length

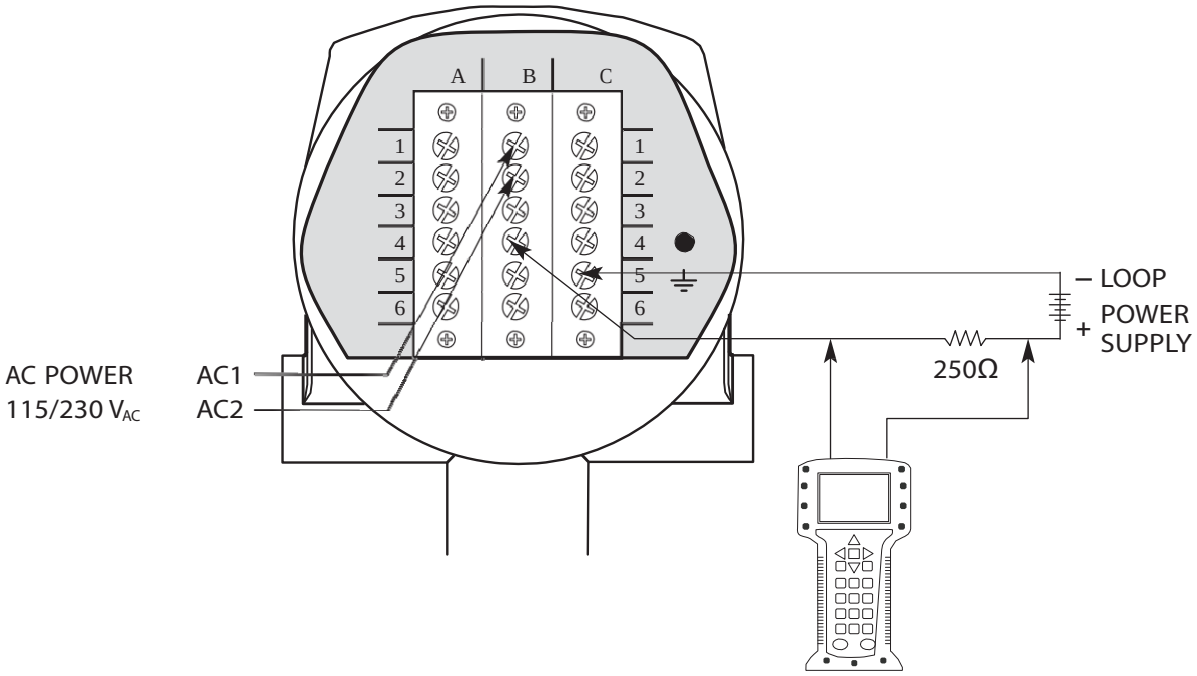

3 DEVICE SETUP
1 Basic Setup
1 K Factor
2 PV Damping
3 Low Flow Cutoff
4 Flow Rate Units
5 Temperature Units
6 Total Units
2 Output
1 Analog Output
1 PV URV
2 Totalizer
1 Total Units
2 Total
3 Pulse Output
1 Pulse Count
2 Pulse Duration
4 HART
1 Poll addr
2 Loop current mode
3 Num req preams
3 Device Info
1 Tag
2 Long tag
3 Descriptor
4 Message
5 Date
6 Meter S/N
7 Final asmbly num
8 Revision
1 Universal rev
2 Fld dev rev
3 Software rev
4 Hardware rev
4 Factory
1 Flow Factors
1 Flow Coeff A
2 Flow Coeff B
3 Flow Coeff C
4 Flow Coeff D
5 Flow Coeff F
2 TC Factors
1 Temp Coeff A
2 Temp Coeff B
3 Temp Coeff C

HART Menu Tree

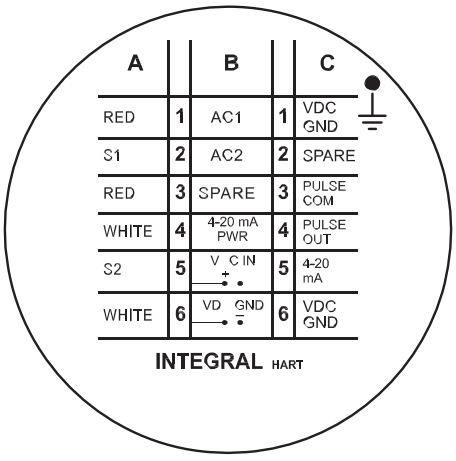


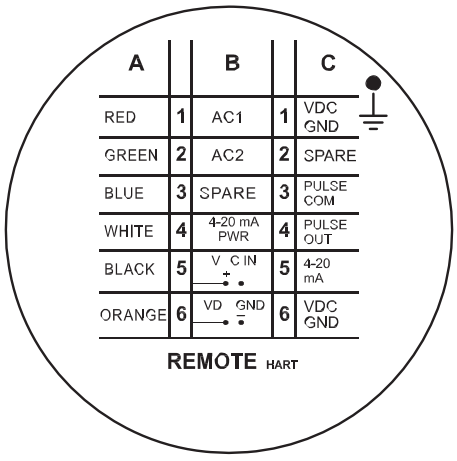
DEFAULT:
PV = Flow
SV = Temperature
TV = Total

AC INPUT POWER WIRING



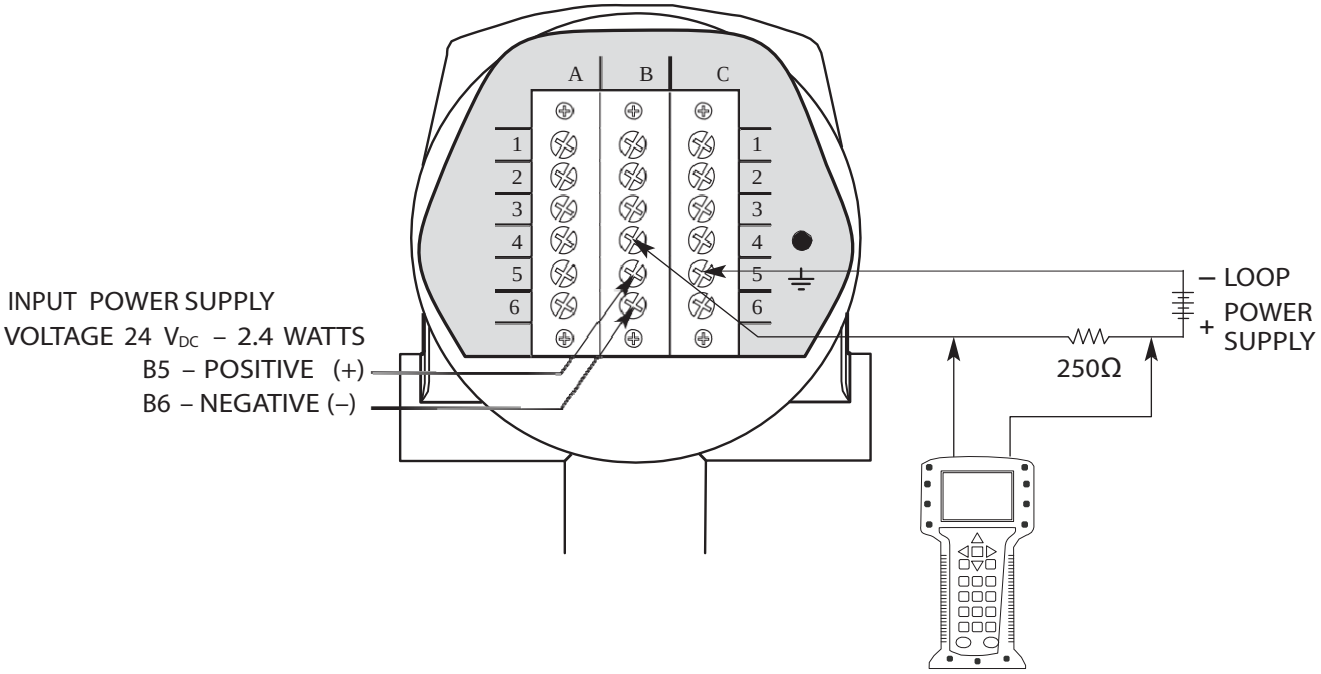
1. Turn off power source.
2. Open terminal block cover.
3. Input Power connections:
   a. Connect the hot wire to B1 and the second wire to B2
   b. Ground to grounding lug as indicated
4. Insure that the jumper between B4 and B5 is removed.
5. Connect 4-20 mA wiring:
   a. Connect positive (+) lead to B4
   b. Connect negative (-) lead to C5
6. Connect a HART field calibrator as shown insuring that there is a minimum of 250 Ω resistance in the loop.



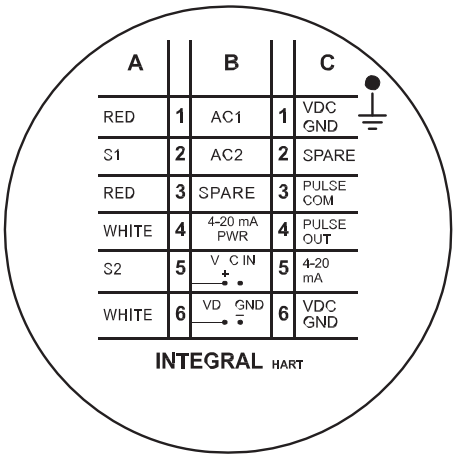


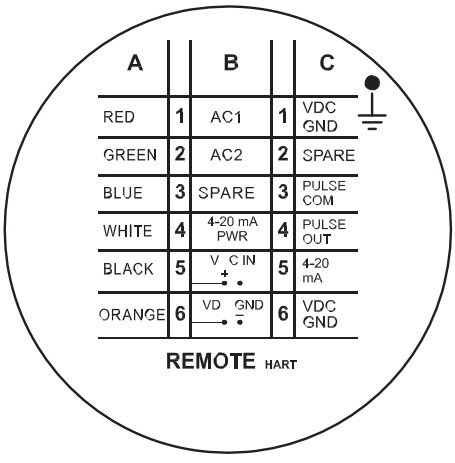
Wiring Instructions

DC INPUT POWER WIRING



1. Turn off power source.
2. Open terminal block cover.
3. Input Power connections (requires maximum of 2.4 watts):
   a. Connect the positive lead (+) to terminal B5 and the Negative lead (-) to B6
4. Insure that the jumper between B4 and B5 is removed.
5. Connect 4-20 mA wiring:
   a. Connect positive (+) lead to B4
   b. Connect negative (-) lead to C5
6. Connect a HART field calibrator as shown insuring that there is a minimum of 250 Ω resistance in the loop.





HART

HART communications are optionally provided on some versions of the SMC ATMF800 Thermal Mass Flow Meter. HART is designated by the code "HART" in the model number.

NOTE: HART will only be available if the 4-20 mA output is externally powered. A minimum resistance of 250 ohms is required between the power supply and the flow meter.

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