

SMARTLINK® METER

Digital Self-checking Thermal Mass Flow Meter



- Precise, repeatable mass flow measurement for fuel, air and combustion streams
- Displays instantaneous standard rate and totalized flow without calculations
- Advanced calibration extends accuracy over wider ranges of fluid temperatures
- Thermal mass flow technology provides reliable measurements with no moving parts
- Provides excellent accuracy over a wide turndown range
- Redundancy and an alarm output for “on-line” self-checking and fail-safe operation
- Monitors, displays, and outputs air/fuel ratio when two meters are electrically “linked”
- Viewable flow totalizer without batteries or external equipment
- In-line flow body incorporates conditioning screens to reduce straight-run piping requirements, eliminating many installation problems common to insertion type meters
- Large, convenient local display for ease of use. No PC or other interface necessary for configuration and operation
- Fail-safe alarm, limit and analog outputs for easy integration into PLC or DCS systems
- Factory Mutual (FM) approved for Hazardous Locations, Class I, II Division 2, Groups A, B, C, D, E, F, G and Class I, Zone 2, Group IIC

Product overview

SMARTLINK® METER is a highly accurate and repeatable mass flow meter well suited for monitoring fuel and air. The meter is built with a rugged NEMA 4X (IP66) enclosure for industrial applications. The design is based on a well established thermal mass flow sensing principle and innovative electronics that provide many self-checking functions to ensure measurement integrity.

The meter uses a constant temperature differential (ΔT) technique with two matched, platinum RTD (Resistive Temperature Device) elements in a rugged, stainless probe assembly. One RTD measures fluid temperature and an "intelligent" bridge circuit heats the second RTD element, maintaining a constant temperature differential above the temperature of the process fluid. Based on the amount of power delivered to the heated element, the precise mass flow rate is established by the on-board microprocessor. The highly integrated sensor probe and electronic design permits fully automated factory calibration, providing every manufactured unit with out-of-the-box measurement accuracy.

SMARTLINK® METER incorporates an input/output (I/O) module with analog 4-20mA current loops for monitoring flow and air/fuel ratio or fluid temperature. A redundant system design is employed for "on-line" flow meter test functions and fail-safe alarm, limit, and test status indication. A liquid crystal display (LCD) and a membrane switch keypad provide easy meter configuration and local viewing of meter status. Each unit is calibrated for air or natural gas and includes an "in-line" flow body that conditions the fluid velocity profile and sets the depth of the probe assembly for proper measurement in the flow stream.

Available SMARTLINK® METER models and sizes

In-line natural gas meters				
Model number	Nominal flow body size (in)	Minimum flow (scfh) [1]	Maximum flow (scfh) [1]	Max DP @ STP [1] [2] (" wc)
0200 SLM	2	160	8,000	10.0
0300 SLM	3	360	18,000	10.0
0400 SLM	4	640	32,000	11.4
0600 SLM	6	1500	75,000	10.9

[1] STP (Standard Temperature and Pressure) conditions for scfh (Standard Cubic Feet per Hour) units are 60°F and 14.73 psia as per ANSI/API MPMS (Manual of Petroleum Measurement Standards), 14.3.1

[2] Stated differential pressures (DP) assume STP conditions and the maximum rated in-line meter flow rate with a natural gas density of 0.0425 lb/ft³.

In-line air meters				
Model number	Nominal flow body size (in)	Minimum flow (scfh) [1]	Maximum flow (scfh) [1]	Max DP @ STP [1] [2] (" wc)
0800 SLM	8	2800	140,000	12.1
1200 SLM	12	6200	310,000	12.0
1600 SLM	16	9700	485,000	11.8
2000 SLM	20	15,000	750,000	11.0
2400 SLM	24	22,000	1,100,000	11.7
2800 SLM	28	30,000	1,500,000	11.7

[1] STP (Standard Temperature and Pressure) conditions for scfh (Standard Cubic Feet per Hour) units are 60°F and 14.73 psia as per ANSI/API MPMS (Manual of Petroleum Measurement Standards), 14.3.1

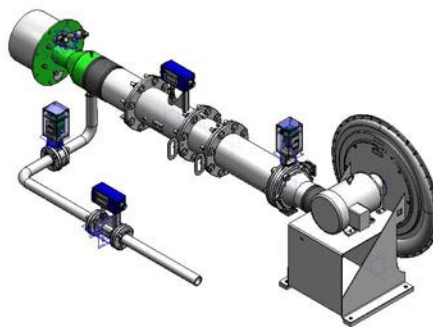
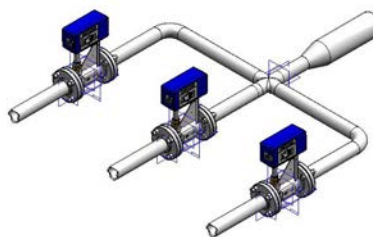
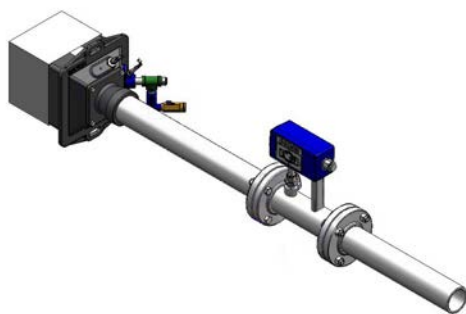
[2] Stated differential pressures (DP) assume STP conditions and the maximum in-line meter flow rate with an air density of 0.076 lb/ft³ and 25% RH (relative humidity)

Typical applications

SMARTLINK® METER is a rugged, industrial instrument for use with natural gas and air. In addition to single stream combustion flows and totalization, SMARTLINK® METER can be installed in sets to monitor ratios or relative flows. With intelligent, self-monitoring features, the meter provides ease of use and enhanced information on processes.

Typical SMARTLINK® METER installations also may include:

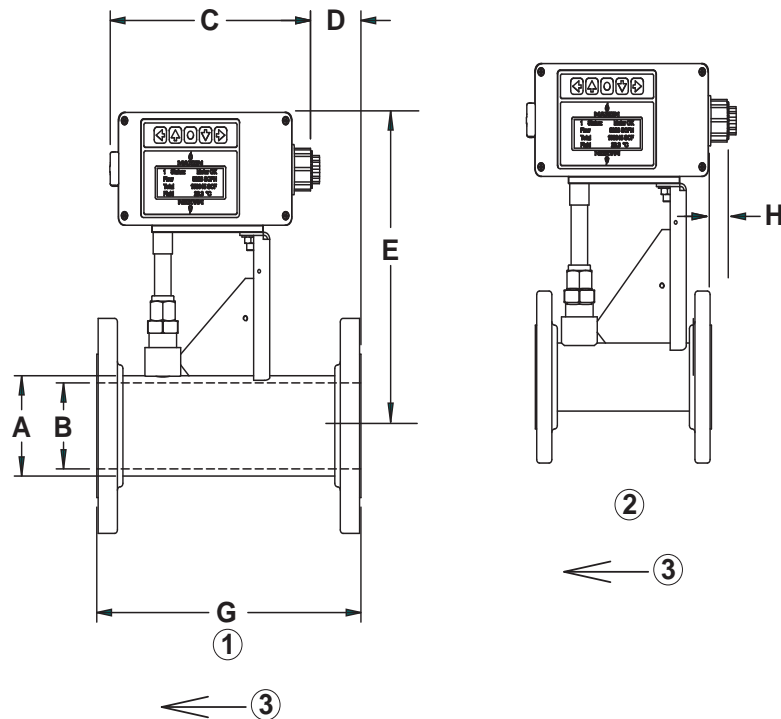
- Measuring gas consumption on industrial furnaces, ovens, oxidizers, or process heaters, especially in facilities with multiple combustion systems on one gas company meter
- Checking or controlling air and fuel ratio to industrial burners for efficiency optimization
- Verifying or controlling air and fuel ratio to industrial burners for emissions compliance
- Monitoring air and fuel ratio for products sensitive to reducing atmospheres or oxidizing environments
- Measuring burner air and fuel flows for set-up and adjustment
- Monitoring critical gas flows to alarm maximum or minimum rates
- Measuring and monitoring relative rates of process gases or combustion gases for critical process heating appliances
- Verification of gas usage to identify optimization targets or to expose wasted fuel within in-plant piping and equipment



Dimensions and weights

Natural gas models

- 1) Over raised faces
- 2) Drawing of 0200 SLM only
- 3) Flow direction right to left

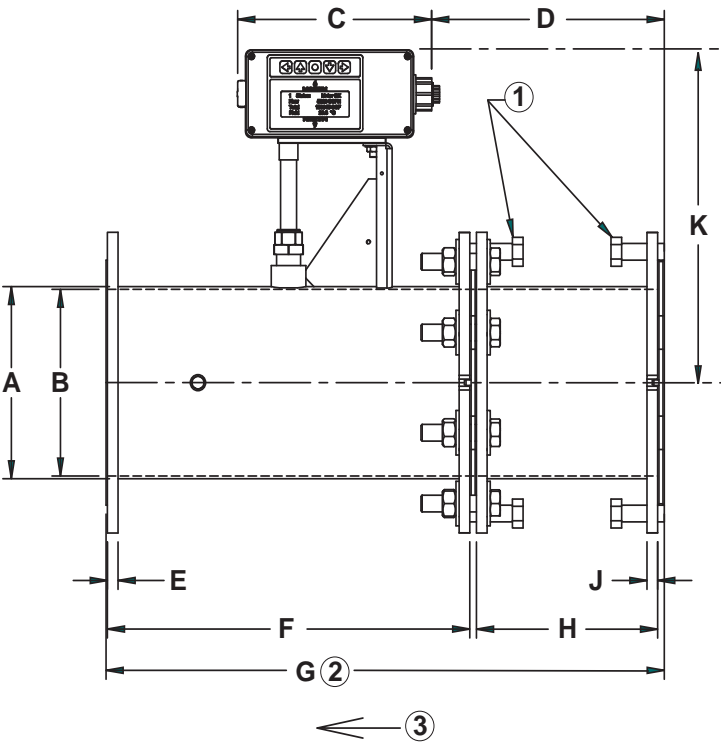


Dimensions in inches unless stated otherwise

Model	Nominal size	A	B	C	D	E	G	H	Approx. weight lb
0200 SLM	2.0	2.4	2.0	9.1	-	10.9	8.0	0.7	19
0300 SLM	3.0	3.5	3.0	9.1	2.3	10.9	12.0	-	32
0400 SLM	4.0	4.5	3.9	9.1	5.3	10.9	16.0	-	49
0600 SLM	6.0	6.6	6.0	9.1	11.3	11.8	24.0	-	83

Air models

- 1) Jack bolts
- 2) Over gaskets
- 3) Flow direction from right to left



Dimensions in inches unless stated otherwise												
Model	Nominal size	A	B	C	D	E	F	G	H	J	K	Approx. weight lb
0800 SLM	8.0	8.6	8.4	9.1	10.9	0.5	17.0	26.2	8.5	0.5	14.9	74.0
1200 SLM	12.0	12.8	12.5	9.1	18.9	0.5	25.0	38.2	12.5	0.5	14.9	142.0
1600 SLM	16.0	16.0	15.8	9.1	25.9	0.5	32.0	48.7	16.0	0.5	16.4	225.0
2000 SLM	20.0	20.0	19.8	9.1	33.9	0.5	40.0	60.7	20.0	0.5	18.4	299.0
2400 SLM	24.0	24.0	23.8	9.1	41.9	0.5	48.0	72.7	24.0	0.5	20.4	401.0
2800 SLM	28.0	28.0	27.8	9.1	49.9	0.5	48.0	76.7	28.0	0.5	22.4	497.0

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Specifications

Product description

SMARTLINK® METER is a highly accurate and repeatable mass flow measurement device for industrial process applications. The design is based on a well established thermal mass flow sensing principle and an innovative redundant architecture that provides continuous and user-commanded diagnostic functions to ensure measurement integrity for combustion system performance and safety. This advancement in technology eliminates difficult field validation techniques and extends accuracy over wider ranges of fluid temperature.

The meter uses a constant temperature differential (ΔT) technique with two reference-grade, platinum RTD (Resistive Temperature Device) elements welded in a rugged stainless probe assembly. One RTD measures fluid temperature and an “intelligent” bridge circuit heats the second RTD element, maintaining a constant temperature differential above the temperature of the process fluid. Based on the amount of power delivered to the heated element, the mass flow rate is calculated by the on-board microprocessor. The highly integrated sensor probe and electronic design permits fully automated factory calibration, providing every manufactured unit with out-of-the-box, measurement accuracy.

SMARTLINK® METER incorporates an input/output (I/O) module with analog 4-20mA current loops for monitoring flow and air/fuel ratio or fluid temperature. System redundancy is employed for “on-line” flow meter test functions and fail-safe alarm, limit, and test status indication. A 4x20 character liquid crystal display (LCD) and a membrane switch permit simple meter configuration and local viewing of meter status without opening the NEMA 4X (IP66) rated enclosure. Each unit is calibrated for air or natural gas and includes an “in-line” flow body that conditions the fluid velocity profile and sets the depth of the probe assembly for proper measurement in the flow stream.

SMARTLINK® METER provides a turnkey, reliable flow measurement solution with advanced diagnostics tailored for combustion systems. The product offering is simple to select, order, and commission. The subsequent application guidelines, model information, and specification sections will help ensure proper meter selection.



Application guidelines

SMARTLINK® METER has been specifically designed to meet the demanding requirements of flow measurement for industrial combustion systems. The following list of application questions should be carefully reviewed as a first step in the product selection process. Prior to configuring a model number, a thorough review of the product specifications should also be performed to ensure all flow measurement requirements can be satisfied.

Flow measurement application questions

1. Can the cost of flow metering be justified by one or more of the following application benefits?

- Monitoring natural gas usage for allocation and tracking of fuel operating costs
- Monitoring air/fuel ratio for periodic burner tuning to optimize fuel efficiency and/or maintain low emission performance
- Monitoring air/fuel ratio to ensure safe combustion system commissioning and operation
- Fully-metered air/fuel ratio control for repeatable, optimized burner performance to reduce fuel consumption and maintain consistent product quality

2. Is the combustion system fired on natural gas and air?

SMARTLINK® METERS are accurately calibrated for measurement of natural gas and air. Measuring flow for other gas hydrocarbons and oxygen is not yet supported.

3. Is the combustion fuel and air flow range addressed by the product's offerings?

Fuel and air flow monitoring for burner capacities ranging from 4-75 MBtu/h can be supported.

4. Does the natural gas supply have a heating value /chemical constituency that does not significantly vary over time and is the supply free of condensing moisture?

Thermal mass flow meters are calibrated for a specific gas type and chemical mixture. Gas sources with widely varying heating values (as found in oil field gas supplies or local gas distribution with inert gas additives during peak periods of gas usage) should be avoided. In addition, condensing moisture on the meter's probe causes momentary spikes in the output flow reading and water droplets must be eliminated for proper use, particularly in flow control applications.

5. If air flow measurement is required, is the combustion air non-preheated?

SMARTLINK® METERS do not currently support pre-heated combustion air. The maximum fluid temperature specification is 212°F which is intended to address fan heat-of-compression in hot ambient process environments.

6. Is there adequate room for the up and downstream flow meter piping requirements?

Depending on the piping configuration, 3 to 5 undisturbed upstream and 1 to 3 downstream diameters are required for accurate and repeatable flow measurement. (Refer to piping requirements section for detailed configuration drawings and special cases.)

7. If the application is combustion air/fuel ratio control, is the sensor response time adequate for the speed required to change burner firing rate (or process temperature)?

For a step change in flow rate, SMARTLINK® METER achieves 63% of the final value in 1 to 2 seconds and 95% of its final value in 5 to 10 seconds.

8. For air flow measurement, can the combustion blower provide the additional pressure drop across the flow meter's integrated flow conditioning screens?

The pressure drop across the air meter flow body at its maximum calibrated flow is approximately 12" wc at Standard Temperature and Pressure (STP = 60°F and 14.73 psia). Therefore, the maximum flow body pressure for the application is calculated as follows:

$$DP (\text{max @STP}) = \left(\frac{\text{Application max flow}}{\text{Calibrated max flow}} \right)^2 \times 12" \text{ wc.}$$

Flow specifications

In-line natural gas meters				
Model number	Nominal flow body size (in)	Minimum flow (scfh)	Maximum Flow (scfh)	Max DP @ STP [1] [2] (" wc)
0200 SLM	2	160	8,000	10.0
0300 SLM	3	360	18,000	10.0
0400 SLM	4	640	32,000	11.4
0600 SLM	6	1500	75,000	10.9

[1] STP (Standard Temperature and Pressure) conditions for scfh (Standard Cubic Feet per Hour) are 60°F and 14.73 psia as per ANSI/API MPMS (Manual of Petroleum Measurement Standards), 14.3.1

[2] Stated differential pressures (DP) assume STP conditions and the maximum rated in-line meter flow rate with a natural gas density of 0.0425 lb/ft³

In-line air meters				
Model number	Nominal flow body size (in)	Minimum flow (scfh)	Maximum flow (scfh)	Max DP @ STP [1] [2] (" wc)
0800 SLM	8	2800	140,000	12.1
1200 SLM	12	6200	310,000	12.0
1600 SLM	16	9700	485,000	11.8
2000 SLM	20	15,000	750,000	11.0
2400 SLM	24	22,000	1,100,000	11.7
2800 SLM	28	30,000	1,500,000	11.7

[1] STP (Standard Temperature and Pressure) conditions for scfh (Standard Cubic Feet per Hour) are 60°F and 14.73 psia as per ANSI/API MPMS (Manual of Petroleum Measurement Standards), 14.3.1

[2] Stated differential pressures (DP) assume STP conditions and the maximum in-line meter flow rate with an air density of 0.076 lb/ft³ and 25% RH (relative humidity)

Product specifications

Performance specifications	
Flow accuracy [1]	± 2% of reading over 5%-100% (20:1 turndown) of flow range in calibration flow stand
Flow turndown	50:1
Flow response time	1-2 seconds to 63% of final value
Temperature accuracy	+/- 1°F

[1] Less than ± 2% additional "installed" error due to fluid temperature variation, gas constituency, upstream piping, and flow body differences.

Operating specifications			
Process fluids	Natural gas, air		
Units of measure Note 1: Selectable from user display	Abbreviation	Definition	User display abbreviation
	scfh	Standard Cubic Feet per Hour	SCFH
	scfm	Standard Cubic Feet per Minute	SCFM
	sfpm	Standard Feet per Minute	SFPM
	sfps	Standard Feet per Second	SFPS
	lb/h	Pounds per Hour	LB/H
	lb/m	Pounds per Minute	LB/M
	lb/s	Pounds per Second	LB/S
	m ³ _(n) /h	Normal Cubic Meters per Hour	NM3H
	m ³ _(n) /m	Normal Cubic Meters per Minute	NM3M
	m _(n) /m	Normal Meters per Minute	NMPM
	m _(n) /s	Normal Meters per Second	NMPS
	l _(n) /h	Normal Liters per Hour	NLPH
	l _(n) /m	Normal Liters per Minute	NLPM
	kg/h	Kilograms per Hour	KG/H
	kg/m	Kilograms per Minute	KG/M
	kg/s	Kilograms per Second	KG/S
	m _(st) /m	Standard Meters per Minute	SMPM
	m _(st) /s	Standard Meters per Second	SMPS
Reference conditions (for volumetric / velocity readings)	Temperature and pressure conditions for flows displayed in "Standard" volumetric, "Standard" velocity, and all mass flow rate units: 60°F and 14.73 psia per ANSI/API MPMS (Manual of Petroleum Measurement Standards), 14.3.1 Temperature and pressure conditions for flows displayed in "Normal" volumetric and "Normal" velocity flow units: 32°F and 14.696 psia		
Reference densities (for mass rate readings)	Air models: 0.076 lbs/ft ³ Natural gas models: 0.042 lbs/ft ³		
Maximum flow body pressure drop (at reference conditions)	11.4" wc (Gas models at max flow rate) 12.1" wc (Air models at max flow rate)		
Maximum fluid pressure (flow body limit)	100 psi (Gas models) 5 psi (Air models)		
Process fluid temperature range	-40°F to +212°F		
Electronics ambient temperature range	-40°F to +158°F (for measurement only; see User Display temperature range for viewing LCD)		

Operating specifications (continued)

User display	<p>4 line x 20 character Liquid Crystal Display (LCD) -4°F to 122°F temperature range for viewing only; meter measures and outputs flow rate over wider electronics ambient temperature stated above</p> <p>Meter status information: Mode of Operation, Flow Rate, Alarm Status, Process Fluid, Totalized Flow and Time, Fluid & Electronic Housing Temperature, Ratio Status, 4-20mA Output A & B Status, 4-20mA Input A Status, Relay Drive Output Status, Event Log Display, Passcode Entry, Manufacturing Data, and Calibration Data</p> <p>User commands: Totalizer Reset, Meter/Flow Test, Outputs ON Test, Outputs OFF Test, Set-up Reset (to factory defaults), Event Log Reset, All Tests OFF</p> <p>Meter configuration settings: Flow Units, Temperature Units, Analog Output-B Setup, Flow Input Multiplier (X-Factor), 20mA Ratio Setup, AC Filter (50/60Hz), 21.5mA Alarm Enable, Flow Filter, Flow Bias, Flow Cutoff, Low & High Limit Flow Output A, Low & High Limit Output B, 20mA Output A (Flow) and B Full Scale %, and Change Passcode</p>
Keypad	5-Key Membrane Switch Assembly for display navigation
Flow totalizer	9-digit total displayed in user-selectable flow rate engineering units

Electrical specifications	
Power Input	Standard DC Model: 24VDC, 0.2A Optional AC Model: 115/230VAC (50/60Hz), 0.04/0.02A
Analog outputs	<p>Two linearized 4-20mA outputs; External 24VDC (maximum) loop power is required for factory default setting; Internal (meter) 24VDC loop power is user switch selectable for local diagnostic purposes only; 750 ohm maximum loop resistance for 24VDC loop power supply; User selectable NAMUR-43 compatible alarm output state -- 21.5mA is output to indicate any meter alarm condition</p> <p>Analog Output A: Flow rate 4mA = 0 flow; 20mA = 100% full scale flow (factory default setting); 20mA % full scale definition is user adjustable</p> <p>Analog Output B: User configurable for 1 of the 3 following settings</p> <p>1. Ratio AI/AO = $\left[\frac{\text{Flow rate input (analog in)}}{\text{Flow rate output (analog out)}} \right]$</p> <p>Factory default setting; 4mA = 0, 20mA = 20; 20mA ratio max is user adjustable</p> <p>2. Ratio AO/AI = $\left[\frac{\text{Flow rate output (analog out)}}{\text{Flow rate input (analog in)}} \right]$</p> <p>Factory default setting; 4mA = 0, 20mA = 20; 20mA ratio max is user adjustable</p> <p>3. Fluid Temperature; 4mA = -50C, 20mA = 110C; 20mA % full scale is user adjustable</p>
Analog input	One linearized 4-20mA flow rate input (from an external meter) used for ratio calculation
Solid-state outputs	<p>Three, fail-safe open collector relay drive outputs: Relay Drive Output A: Meter/Flow Test Active (OFF state) Relay Drive Output B: Meter Alarm (OFF state) Relay Drive Output C: Limit Indication (OFF state)</p> <p>30VDC and 100mA (open collector maximum ratings) Current through each output is returned to Relay (Drive) Return, Terminal #1, of the 12-position, low voltage wiring block. All outputs are de-energized if microprocessor or firmware execution halts</p>
Solid-state input	<p>5-24VDC @ 10mA (max) Input A: Start Meter/Flow Test; Momentary ½ second ON state required; Test lasts 0.5 to 3 minutes depending on flow rate</p>

Physical specifications	
Electronics enclosure	IP66, NEMA 4X, 12, and 13
Electrical conduit connection	¾" watertight conduit hub (provided with meter)
Piping requirements [1] [2]	<p>Gas meter installations should include an upstream drip leg, Y-strainer (with 100 mesh stainless steel screen), and a high-turndown regulator (such as a Sensus 243-RPC, 441-57S with "V-wing" option). The Y-strainer prevents debris from clogging the regulator as well as the meter's flow conditioning screens and moisture reaching the sensor element. Proper sizing of the regulator, using upstream/downstream pressures and min/max flows required, is essential for preventing low flow regulator "chatter" which affects meter performance. Follow all regulator installation requirements for location of the downstream sense line.</p> <p>Air meter installations with a process or combustion fan should include an inlet filter to minimize the collection of debris on the removable flow conditioning screens. If air flow control is performed using a valve, a surge-less fan should be specified to ensure flow pulsations do not affect meter performance. (See detailed drawings for customer installation of NPT fitting to pressure check for air flow body screen blockage.)</p> <p>The symbol "Ø" represents the internal pipe diameter of the meter flow body. The following up and downstream piping lengths are specified as <u>minimum</u>. Straight lengths <u>greater</u> than those specified are recommended to minimize installation-related flow measurement error.</p> <p>Minimum undisturbed <u>upstream</u> straight length - diameters (Ø) for the following configurations upstream of the meter:</p> <p>One 90° elbow: 3Ø or 12 inches, whichever is greater</p> <p>Two 90° elbow (same plane): 3Ø or 12 inches, whichever is greater Reduction: 3Ø or 12 inches, whichever is greater Expansion: 5Ø or 12 inches, whichever is greater Control valve: 5Ø (only recommended for air installations when valve must be installed close to fan outlet to prevent surge/pulsations) Two 90° elbow (in different planes): 5Ø or 12 inches, whichever is greater Combustion blower outlet: 5Ø</p> <p>Minimum undisturbed <u>downstream</u> straight length diameters (Ø): 2Ø or 6 inches, whichever is greater, for all downstream configurations except the following: Control valve: 3Ø or 12 inches, whichever is greater Combustion blower inlet: Not recommended</p>
Process fluid connections	Natural Gas models: ANSI 150# flanges Air models: ½" thick flanges with ANSI bolt patterns Meter-to-Flow Body: Swagelok Compression Fitting (provided with meter)
Wetted materials	Probe Assembly: 316 Stainless Steel (1.4401); hydrostatic tested to 500 psi Flow Body: Carbon Steel (1.0037) Flow Conditioning Screens: 316 Stainless Steel (1.4401)
Vibration	3G peak, 10-500Hz, 3 axes per EN60068-2-6:1998

[1] Refer to piping drawings within installation section for more detail

[2] The symbol "Ø" represents the internal pipe diameter of the flow body

Physical specifications (continued)	
Electromagnetic compatibility (EMC)	<p>Immunity: EN61000-4-2, Electrostatic Discharge EN61000-4-3, Radiated Electromagnetic Fields EN61000-4-4, Electrical Fast Transient/Burst EN61000-4-5, Surge Immunity EN61000-4-6, Conducted Immunity EN61000-4-11, Voltage Dips & Interruptions Frequency Variations, $\pm 5\%$ Power Supply Reductions, +10/-15%, <20%</p> <p>Emissions: EN55011 Group 1, Class B VCCI, Class B ICES-003, Class B CNS 13428, Class B FCC Part 15, Class B</p> <p>Harmonics & Flicker: EN61000-3-2, Section 2, Limits for Harmonic Current Emissions EN61000-3-3, Section 3, Limitations of Voltage Fluctuations and Flicker</p> <p>Other EMC Specifications: NAMUR NE-21, Version: 10.02.2004 Electromagnetic compatibility of industrial process and laboratory control equipment</p> <p>Stress levels, frequency ranges, and dwell times were increased to address the following additional application-specific EMC requirements: EN12067-2:2004 Gas/air ratio controls for gas burners and gas appliances, Part 2: Electronic types; Section 8.6. EN298:2003 Automatic gas burner control systems for gas burning appliances with or without fans; Sections 8.2-8.8. ISO 23550:2004 Safety and control devices for gas burners and gas-burning appliances -- General requirements; Section 8 ISO/CD 23552-1 (2004-08-11) Safety and control devices for gas and oil burners and gas and oil appliances -- Particular requirements -- Part 1: Fuel air/ratio controls, electronic type; Section 8</p> <p>Independent NVLAP-Accredited Test Lab: Sypris Test & Measurement, Inc Test Reports T-42067-33, T-41954-33, and T-42067-13</p>
Hazardous location approvals	<p>Factory Mutual (Project ID. 3027670): Non-incendive for Class I, Division 2, Groups A, B, C, D Class I, Zone 2, Group IIC; Class II, Division 2, Groups F, G Dust Ignition Proof for Class II, III, Division 1, Groups E, F, and G Hazardous (Classified) indoor/outdoor (Type 4X, 12, 13) location</p>
Electrical safety approvals	<p>Factory Mutual (Project ID. 003027657): IECCE CB Scheme Test Certificate No. USFM-014 IEC 61010-1 (edition 2) Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General requirements</p>
CE compliance	<p>EMC Directive, 89/336/EEC as amended by 92/31/EEC and 93/68/EEC Low Voltage Directive, 73/23/EEC</p>

Model number descriptions

A MAXON SMARTLINK® METER can be accurately defined by the model number that appears on the unit product label. The example below shows a typical SMARTLINK® METER configured for measuring natural gas, with a maximum flow range of 8000 scfh, 24VDC input power voltage, and an LCD display mounted in the standard, upright position. The other fields in the model number are currently forced to a default selection but are provided for future product options.

SMARTLINK® METER model number													
Size	Series	-	Fluid	Sensor Calibration (temp. and velocity)	Sensor Material	Power Input Voltage	I/O Configuration	LCD Display Position	Software Version	-	Flow Body and Screen Material	End Connections	Hardware - Gaskets & Fasteners
0200	SLM	-	N	1	S	A	1	U	02	-	A	A	1

SIZE

NATURAL GAS MODELS:

0200 - 2"
0300 - 3"
0400 - 4"
0600 - 6"

AIR MODELS:

0800 - 8"
1200 - 12"
1600 - 16"
2000 - 20"
2400 - 24"
2800 - 28"

SERIES

SLM - SMARTLINK® METER

FLUID

N - Natural gas (N.G.)
A - Air
X - Special

SENSOR CALIBRATION

1 - Std vel/temp range
* - Flow body only
X - Special

SENSOR MATERIAL

S - 316 stainless
* - Flow body only
X - Special

POWER INPUT VOLTAGE

A - 24VDC
B - 100-240 VAC
* - Flow body only
X - Special

I/O CONFIGURATION

1 - Analog/digital I/O module
* - Flow body only
X - Special

LCD DISPLAY POSITION

U - Upright
I - Inverted
* - Flow body only

SOFTWARE VERSION [1]

02 - Standard software
** - Flow body only

FLOW BODY & SCREEN MATERIAL

A - CS body 304; SS screen (Air)
B - CS body; CS screen (N.G.)
* - Sensor only
X - Special

END CONNECTIONS

A - ANSI 150# rated flange (N.G.)
B - ANSI 1/2" thick flange (Air)
* - Sensor only
X - Special

HARDWARE-GASKETS & FASTENERS

1 - Fiber gasket (Air)
2 - None (N.G.)
* - Sensor only
X - Special

[1] The latest version is the default

Additional ordering choices

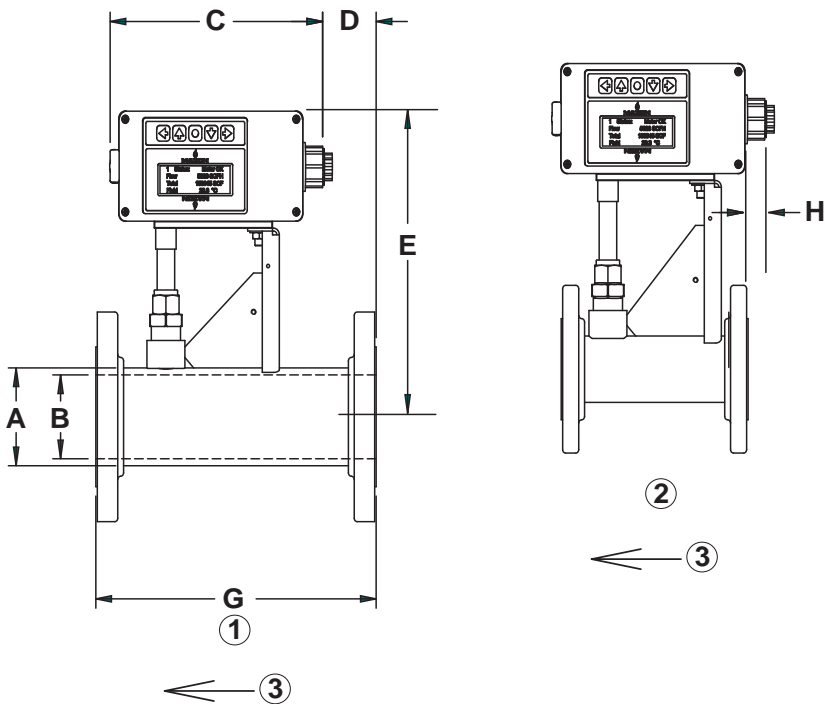
(not included in Model Number fields above):

1. Sensor, flow body, or both required
2. Tagging options: ALW (Aluminum Wire-on), NONE, SSP (Stainless Steel Permanent), SSW (Stainless Steel Wire-on)
3. Screen position: 0 (N/A, gas flow body), * (N/A - Sensor Only), L (Left), R (Right), T (Top), B (Bottom)
4. Instruction language: E (English), F (French), G (German)

Dimensions and weights

Natural gas models

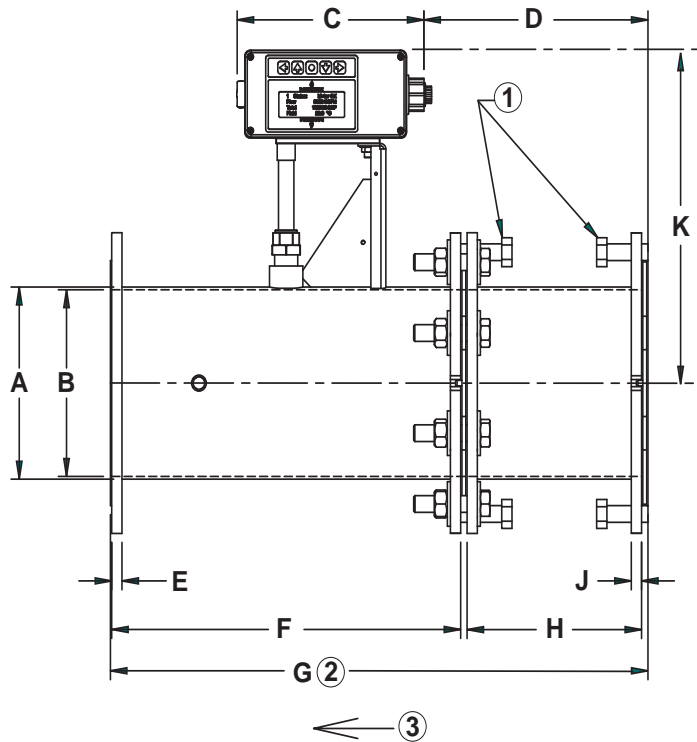
- 1) Over raised faces
- 2) 0200 SLM only
- 3) Flow direction



Dimensions in inches unless stated otherwise									
Model	Size	A	B	C	D	E	G	H	Weight lb
0200 SLM	2"	2.4	2	9.1	-	10.9	8	0.7	19
0300 SLM	3"	3.5	3	9.1	2.3	10.9	12	-	32
0400 SLM	4"	4.5	3.9	9.1	5.3	10.9	16	-	49
0600 SLM	6"	6.6	6	9.1	11.3	11.8	24	-	83

Air models

- 1) Jack bolts
- 2) Over gaskets
- 3) Flow direction

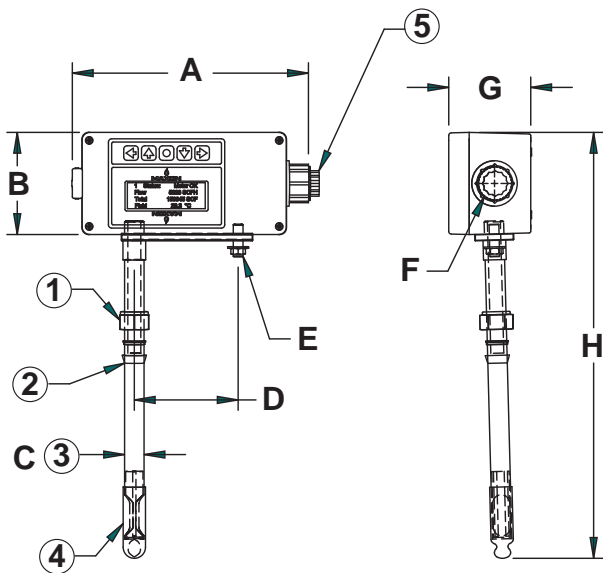


Dimensions in inches unless stated otherwise

Model	Size	A	B	C	D	E	F	G	H	J	K	Weight lb
0800 SLM	8"	8.6	8.4	9.1	10.9	0.5	17	26.2	8.5	0.5	14.9	74
1200 SLM	12"	12.8	12.5	9.1	18.9	0.5	25	38.2	12.5	0.5	14.9	142
1600 SLM	16"	16	15.8	9.1	25.9	0.5	32	48.7	16	0.5	16.4	225
2000 SLM	20"	20	19.8	9.1	33.9	0.5	40	60.7	20	0.5	18.4	299
2400 SLM	24"	24	23.8	9.1	41.9	0.5	48	72.7	24	0.5	20.4	401
2800 SLM	28"	28	27.8	9.1	49.9	0.5	48	76.7	28	0.5	22.4	497

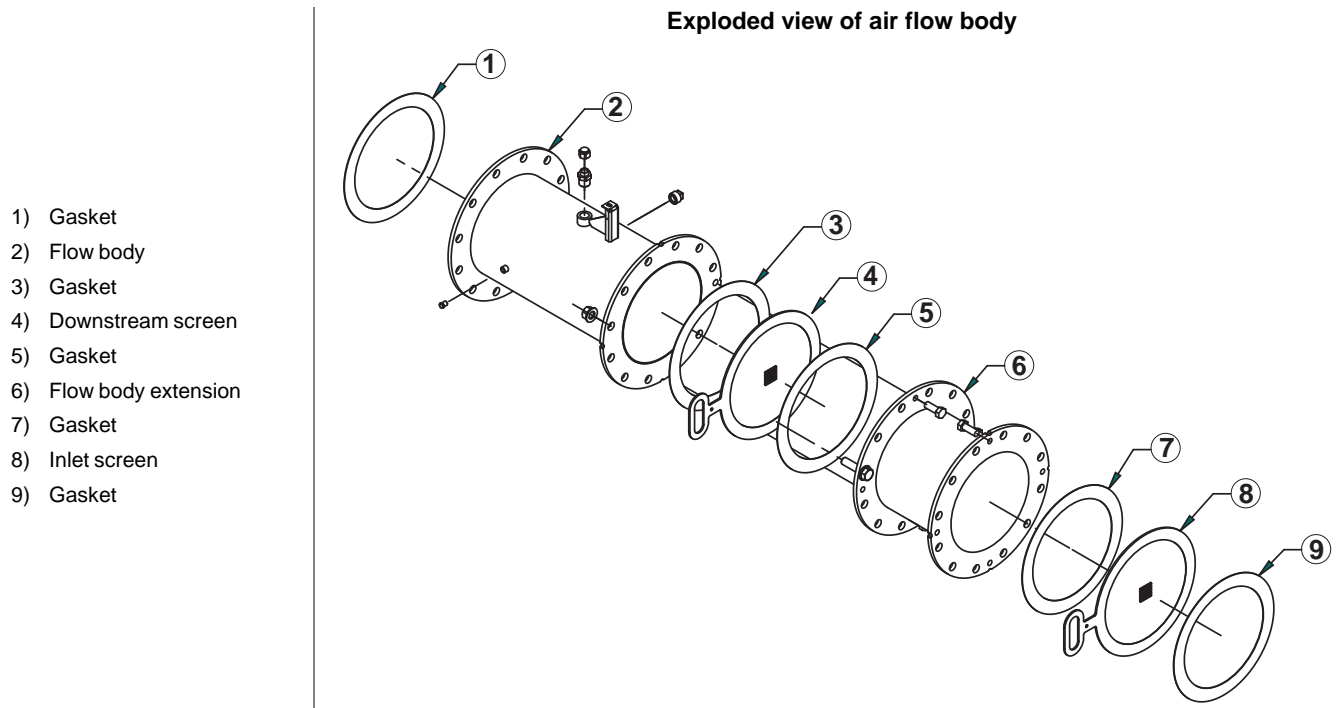
Electronic sensor assembly

- 1) Compression fitting
- 2) Ferrules
- 3) 3/4" dia. probe
- 4) Shipping cap
- 5) Conduit fitting plug



Dimensions in inches unless stated otherwise									
Model	Size	A	B	C	D	E	F	G	H
0800 SLM	8"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4
1200 SLM	12"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4
1600 SLM	16"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4
2000 SLM	20"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4
2400 SLM	24"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4
2800 SLM	28"	9.1	3.9	0.75	4.0	3/8 - 24	3/4 NPT	3.2	16.4

Air flow body



Meter accessories

Accessories
Power supply, 115-230 VAC input, 24VDC output, 50 watt
Cable for 4-20mA wiring, 18 AWG, 2-conductor with shield
1/8 DIN analog input panel meter, 24VDC input power
Mating 150# raised-face, threaded steel flange pair (with hardware and gaskets) for 2" gas meter
Mating 150# raised-face, slip-on, steel flange pair (with hardware and gaskets) for 3" gas meter
Mating 150# raised-face, slip-on, steel flange pair (with hardware and gaskets) for 4" gas meter
Mating 150# raised-face, slip-on, steel flange pair (with hardware and gaskets) for 6" gas meter
Mating ANSI bolt pattern, ½" thick flange pair for 8" air meter
Mating ANSI bolt pattern, ½" thick flange pair for 12" air meter
Mating ANSI bolt pattern, ½" thick flange pair for 16" air meter
Mating ANSI bolt pattern, ½" thick flange pair for 20" air meter
Mating ANSI bolt pattern, ½" thick flange pair for 24" air meter
Mating ANSI bolt pattern, ½" thick flange pair for 28" air meter

Installation instructions

BELGIUM

Maxon International BVBA
Luchthavenlaan 16-18
1800 Vilvoorde, Belgium
Tel: 32.2.255.09.09
Fax: 32.2.251.82.41

Safety symbols



Caution, risk of danger
(ISO 7000 - 0434)



Hot Surface
(IEC 60417 - 5041)



Protective Earth
(IEC 60417-5019)

Product terminology

Flow body - The flanged assembly with integrated flow conditioning screens. All air meters have flow bodies with removable conditioning screens.

Flow sensor - The housed, electronic sensor probe assembly that is inserted into the Flow Body

"Normal" conditions - Temperature and pressure reference conditions for flows displayed in "Normal" volumetric and "Normal" velocity flow rate units. For this product, "Normal" Conditions = 32° F and 14.696 psia per ISO 10780. (This definition varies widely based on industry, manufacturer, and geographic location.)

"Standard" conditions - Temperature and pressure reference conditions for flows displayed in "Standard" volumetric, "Standard" velocity, and all mass flow rate units. For this product, "Standard" Conditions = 60 °F and 14.73 psia per ANSI/API MPMS, 14.3.1. (This definition varies widely based on industry, manufacturer, and geographic location.)

"Standard" density - The density of the calibration reference gas at "Standard" conditions. This value is used for calculation in all displayed mass flow rate units (LB/H, LB/M, LB/S, KG/H, KG/M, and KG/S).

Velocity profile - The variation of fluid velocity over a cross-section area of pipe. SMARTLINK® METER is a point velocity sensing device. The flow conditioning screens in the flow body (along with proper field installation) ensure that a turbulent flow is developed and the velocity profile across the pipe is reasonably "flat", creating a good average velocity at the point of sensing.

Thermal profile - The variation of fluid temperature over a cross-section area of pipe. The flow conditioning screens in the flow body minimize thermal profiles by creating a turbulent flow and a good average temperature.

Abbreviations


Fcal: Product label field indicating the "flow calibration" range

Gcal: Product label field indicating the "gas calibration" type

LCD: Liquid Crystal Display

Ref: Product label field indicating flow sensor assembly "reference" serial number

General safety considerations

	<p>SMARTLINK® METER is designed and manufactured in accordance with ANSI/ISA 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use (12 July 2004). To ensure hazard-free operation after shipment, all instructions contained in this documentation must be thoroughly read and followed. Proper and safe operation of the mass flow meter requires installation, commissioning, and maintenance by qualified personnel and operation within the design limits provided by the technical specifications. The meter is intended for mass flow measurement of only the process fluid type specified on the product label. The flow sensor assembly is not intended to be used as an "insertion" type meter because calibration is dependent on the velocity profile established by the conditioning screens in the flow body. IMPROPER INSTALLATION OR USE OF THIS PRODUCT COULD RESULT IN BODILY INJURY, DEATH, OR DAMAGE TO OTHER EQUIPMENT.</p>
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Storage, handling and product verification

Store flow meter shipment in a safe, dry, indoor location until ready for installation. Handle flow meter assembly with care during transport, unpacking, and lifting. After removal from shipment packaging, verify there is no physical damage to the flow sensor or flow body assemblies. A brass plug fitting (for capping the flow body after sensor removal) and a protective plastic cap (for the sensor probe when removed from the flow body) are provided along with a product instruction manual. On the flow sensor assembly and flow body product labels, locate the two fields, "Gcal" and "Fcal" that indicate the two important meter calibration parameters: fluid (or gas) type and the maximum flow range, respectively. Verify the process gas (or fluid) and flow range indicated on both labels are the same. (This ensures the flow sensor assembly is inserted in the proper flow body.) In addition, verify the fluid (or gas) of the intended installation matches the gas indicated on both labels.

Mechanical installation

Piping

To minimize measurement error due to velocity profile disturbances (see Product terminology on page 10-30.9-22), the piping requirements provided in the following drawings should be followed. Additional up and downstream lengths (beyond the minimum required lengths) are recommended. Failure to provide adequate up and downstream straight runs will result in a repeatable measurement but with a reduction in accuracy that cannot be quantified.

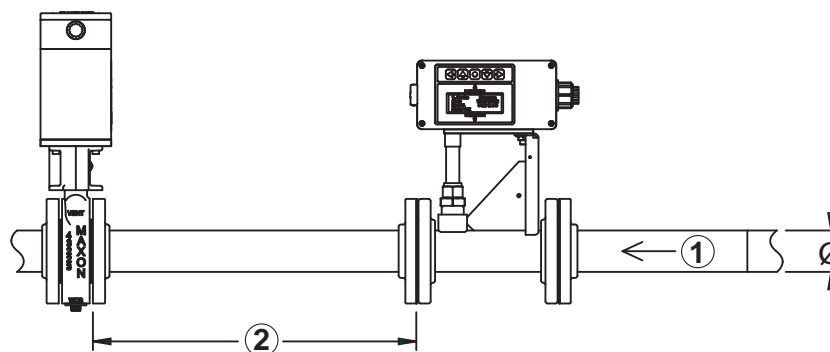
Gas meter installations should include an upstream drip leg, Y-strainer (with 100 mesh stainless steel screen), and a high-turndown regulator (such as a Sensus 243-RPC, 441-57S with "V-wing" option). The Y-strainer prevents debris from clogging the regulator as well as the meter's flow conditioning screens and moisture reaching the sensor element. Proper sizing of the regulator, using upstream/downstream pressures and min/max flow requirements, is essential for preventing low flow regulator "chatter" which affects meter performance. Follow all regulator installation requirements for location of the downstream sensing line.

Air meter installations with a process or combustion fan should include an inlet filter to minimize the collection of debris on the removable flow conditioning screens. If air flow control is performed using a valve, a surge-less fan should be specified to ensure flow pulsations do not affect meter performance.

If a large temperature difference (i.e. 50° F or greater) exists between the fluid and the ambient conditions surrounding the pipe, a thermal gradient (see Product terminology on page 10-30.9-22) will develop across the diameter of the flow body causing a measurement error. Although the conditioning screens in the flow body minimize the thermal gradient, insulation with an R-factor greater than 12 (or 2 in fiberglass or thicker) should be installed around the flow body and 3 or more upstream pipe diameters.

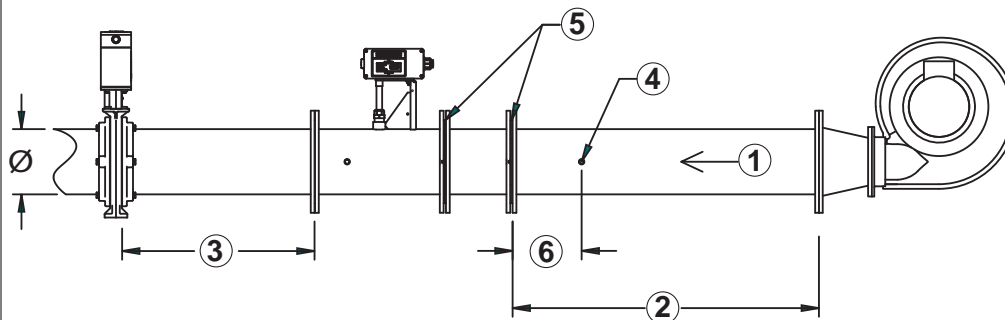
Before a control valve

- 1) Flow direction
- 2) For any type of downstream control valve, a minimum undisturbed straight length of $3 \times \text{Ø}$ or 12 inches, whichever is greater.



Combustion blower outlet with control valve

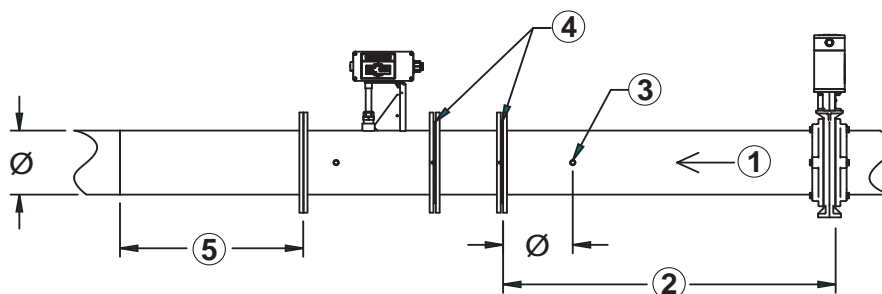
- 1) Flow direction
- 2) $5 \times \text{Ø}$
- 3) For any type of downstream control valve, a minimum undisturbed straight length of $3 \times \text{Ø}$ or 12 inches, whichever is greater.
- 4) Recommended 1/4" NPT fitting by others to detect screen blockage by differential pressure measurement in air applications only
- 5) Flow condition screens
- 6) $1 \times \text{Ø}$



After a control valve

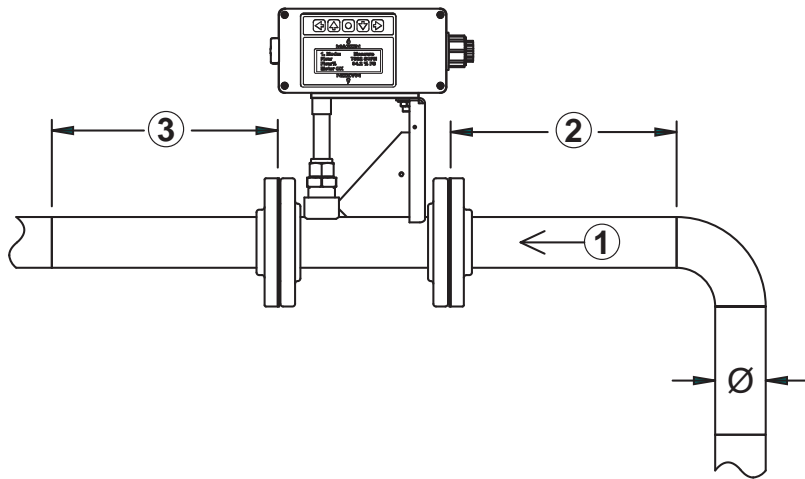
(Only recommended for air meter installations that require valve installation close to fan outlet to prevent surging/pulsations)

- 1) Flow direction
- 2) $5 \times \text{Ø}$
- 3) Recommended 1/4" NPT fitting by others to detect screen blockage with differential pressure measurement in air applications only
- 4) Flow condition screens
- 5) For any type of downstream control valve, a minimum undisturbed straight length of $3 \times \text{Ø}$ or 12 inches, whichever is greater.



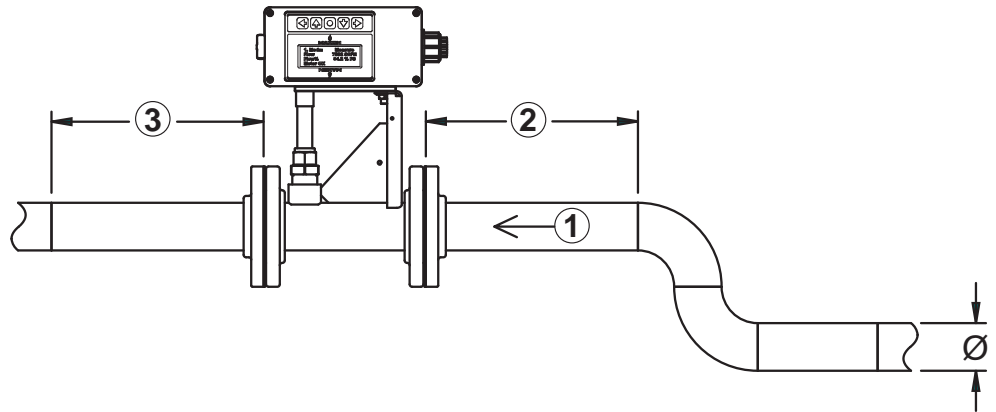
One 90° elbow

- 1) Flow direction
- 2) $3 \times \text{Ø}$ (or 12 inches, whichever is greater)
- 3) For all downstream configurations (except with a control valve), a minimum undisturbed straight length of $2 \times \text{Ø}$ or 6 inches, whichever is greater.



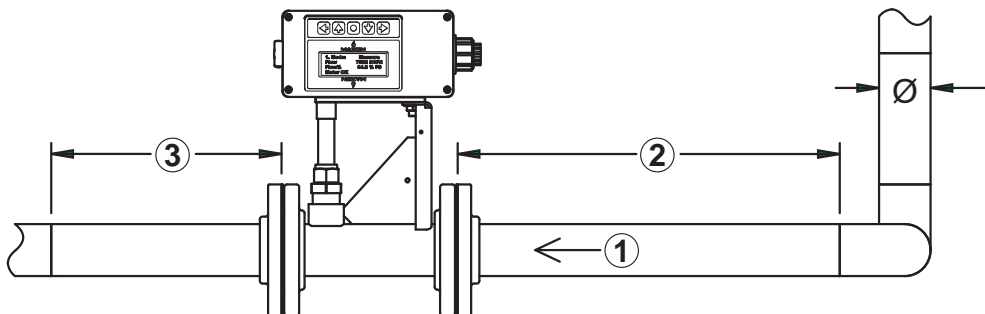
Two 90° elbows (one plane)

- 1) Flow direction
- 2) $3 \times \text{Ø}$ (or 12 inches, whichever is greater)
- 3) For all downstream configurations (except with a control valve), a minimum undisturbed straight length of $2 \times \text{Ø}$ or 6 inches, whichever is greater.



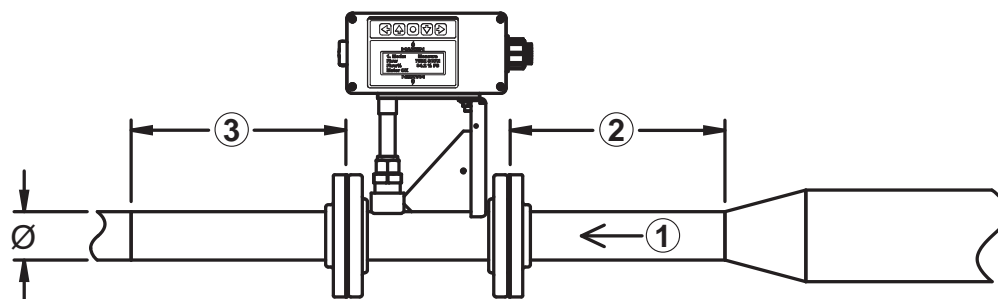
Two 90° elbow (two planes)

- 1) Flow direction
- 2) 5xØ or 12 inches, whichever is greater
- 3) For all downstream configurations (except with a control valve), a minimum undisturbed straight length of 2xØ or 6 inches, whichever is greater.



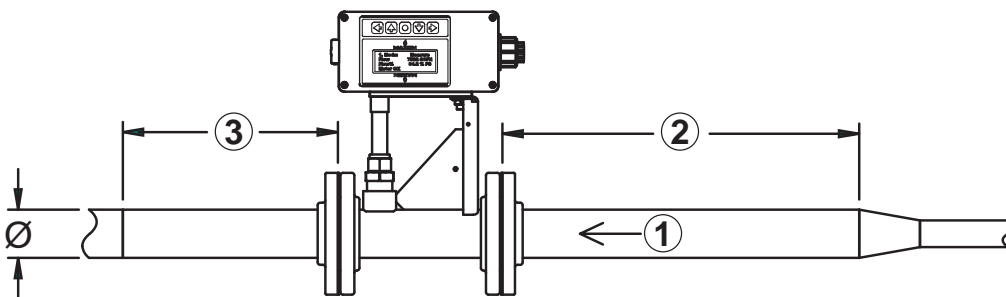
Reduction

- 1) Flow direction
- 2) 3xØ (or 12 inches, whichever is greater)
- 3) For all downstream configurations (except with a control valve), a minimum undisturbed straight length of 2xØ or 6 inches, whichever is greater



Expansion

- 1) Flow direction
- 2) 5xØ or 12 inches, whichever is greater
- 3) For all downstream configurations (except with a control valve), a minimum undisturbed straight length of 2xØ or 6 inches, whichever is greater



Flow body and LCD orientation

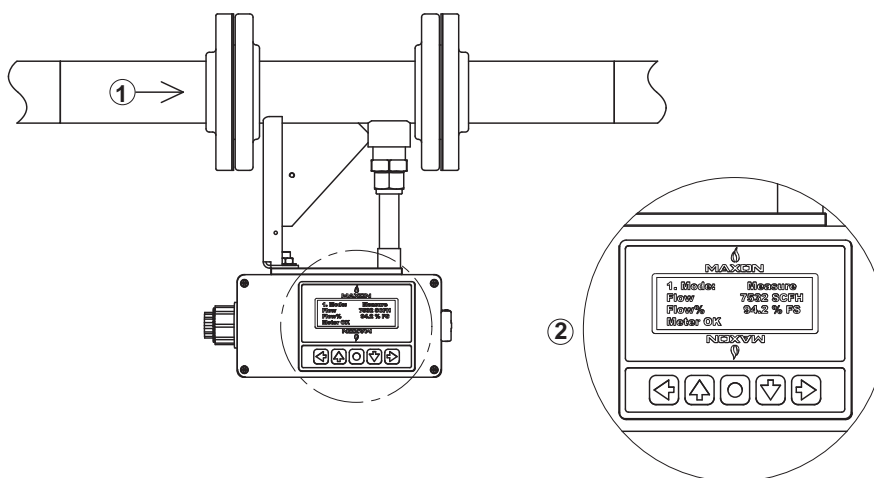
The flow body must always be mounted with the flow conditioning screens and sensor bracket upstream of the stainless probe assembly. This flow orientation requirement is indicated on the flow body with the inscribed flow direction arrow above the MAXON logo.

The flow body can be mounted in any vertical or horizontal orientation without a reduction in measurement accuracy. However, to access, view, and navigate the user display, the flow body (and LCD) orientations are shown for each of four possible flow directions. When possible, order SMARTLINK® METERS with the LCD orientation which is most convenient for the required installation.

If the LCD orientation needs to be changed after shipment, turn power off to the unit and open the flow sensor enclosure. With a small Phillips screwdriver, remove the four screws that retain the LCD electronics module to the standoffs. Unplug the module by lifting it straight out from the main electronics board. Rotate the module 180° and plug it back into the main board, making certain all pins are properly seated in the connector. Reinstall and tighten the four screws.

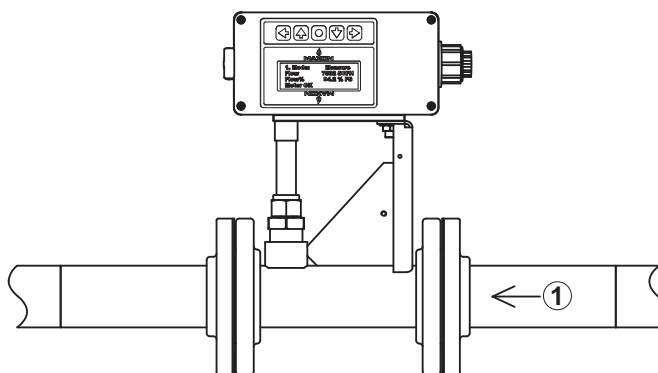
- 1) Flow direction
- 2) Keypad definitions are automatically changed so menu navigation up/down arrow keys are correct

Left to right flow: LCD position “inverted”

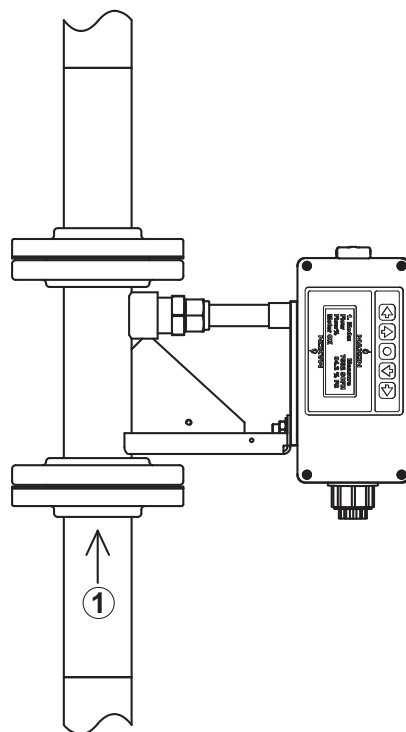


Right to left flow: LCD position “upright”

- 1) Flow direction

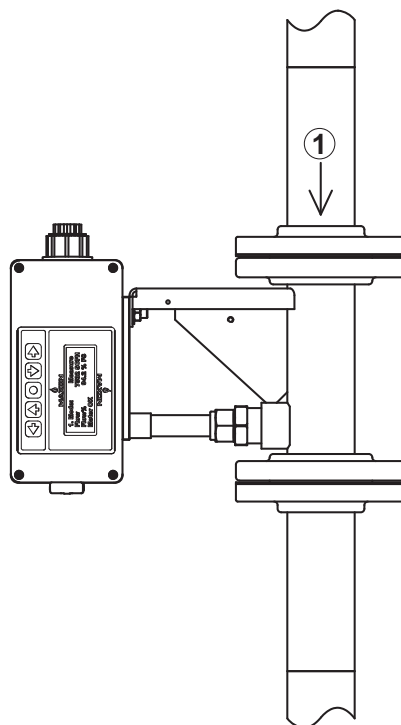


Bottom to top flow: LCD position “upright”



- 1) Flow direction
- 2) LCD orientation may want to be inverted if meter is only accessible on the right hand side.

Top to bottom flow: LCD position “upright”



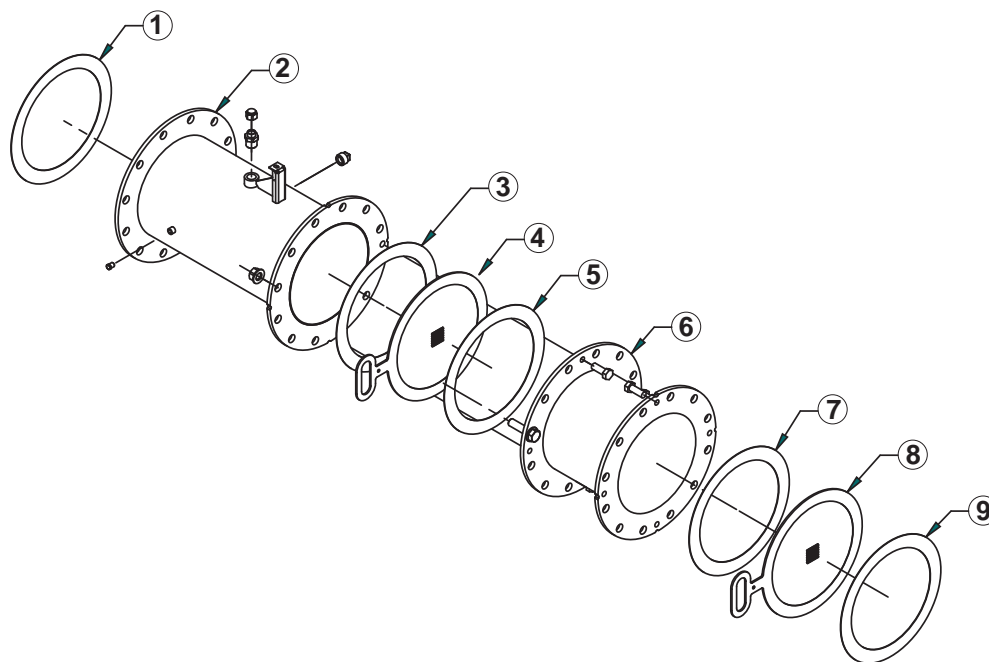
- 1) Flow direction
- 2) LCD orientation may want to be inverted if meter is only accessible on the left hand side.

Air flow body assembly and screen position

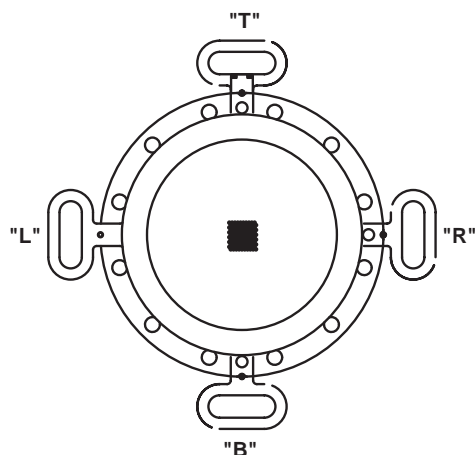
A SMARTLINK® METER for air flow measurement includes a flow body with two removable flow conditioning screens. The inlet screen and gaskets are shipped as loose items and require installation as shown in the exploded view below. The conditioning screens are keyed with an alignment pin and can be installed in one of four different 90° positions (L = left, R = right, T = top, or B = bottom) depending on flow body access needs. Install the inlet screen with the same orientation (i.e. handle position) as the downstream screen, making sure the alignment pin is securely seated in the slot of the adjacent flow body flange.

- 1) Gasket
- 2) Flow body
- 3) Gasket
- 4) Downstream screen
- 5) Gasket
- 6) Flow body extension
- 7) Gasket
- 8) Inlet screen
- 9) Gasket

Exploded view of air flow body



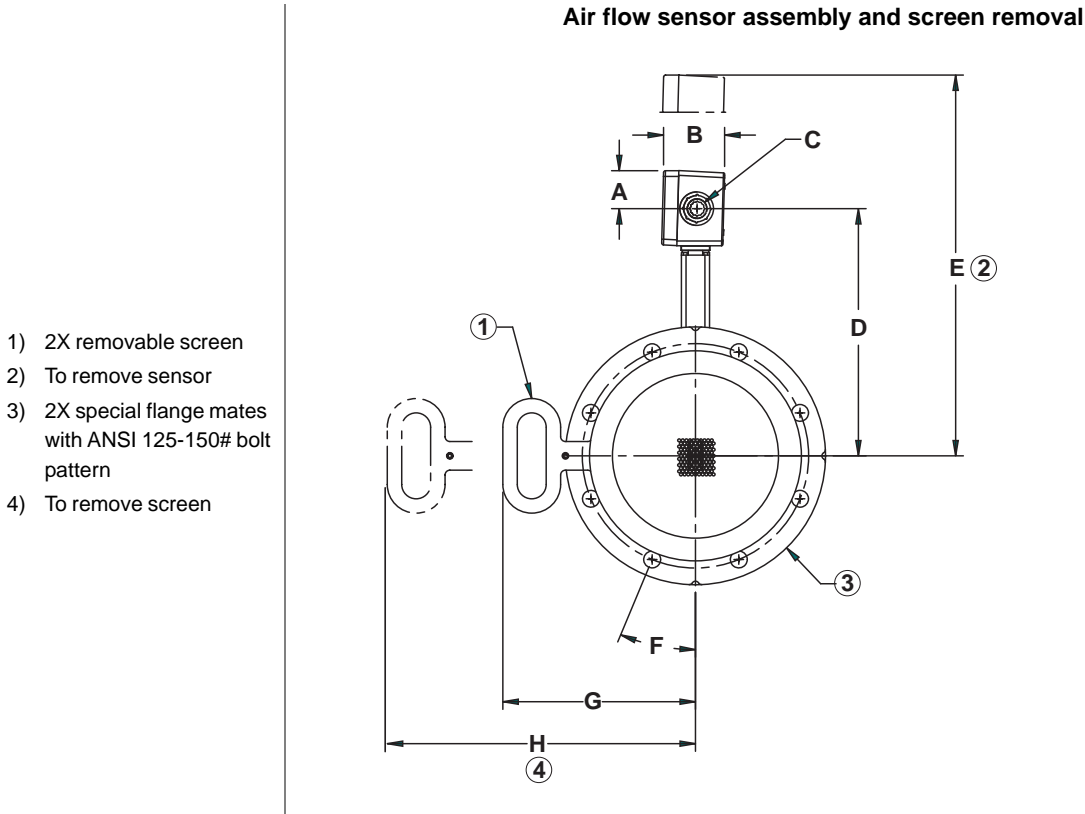
Screen position options



- T = Top
R = Right
B = Bottom
L = Left

Flow sensor insertion

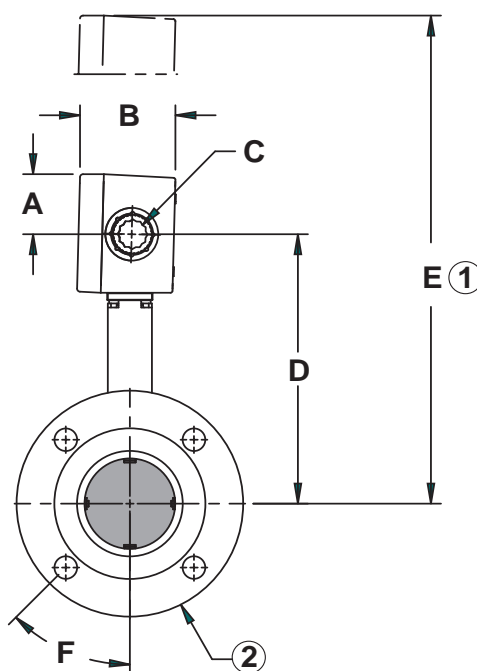
As shown in the following figures, flow sensor assembly removal (and insertion) clearances are required.



Dimensions in inches unless stated otherwise									
Model	Size	A	B	C	D	E	F	G	H
0800 SLM	8"	2.0	3.2	3/4 NPT	12.9	23.4	22.5°	10	22.5
1200 SLM	12"	2.0	3.2	3/4 NPT	12.9	25	15°	13	31.1
1600 SLM	16"	2.0	3.2	3/4 NPT	14.4	27.1	11.2°	15.3	37.7
2000 SLM	20"	2.0	3.2	3/4 NPT	16.4	29.1	9°	17.2	44
2400 SLM	24"	2.0	3.2	3/4 NPT	18.4	31.1	9°	19.5	50.3
2800 SLM	28"	2.0	3.2	3/4 NPT	20.4	33.1	7.5°	21.8	56.7

Gas flow sensor assembly removal

- 1) To remove sensor
- 2) 2X 150# RF ANSI flange



Dimensions in inches unless stated otherwise

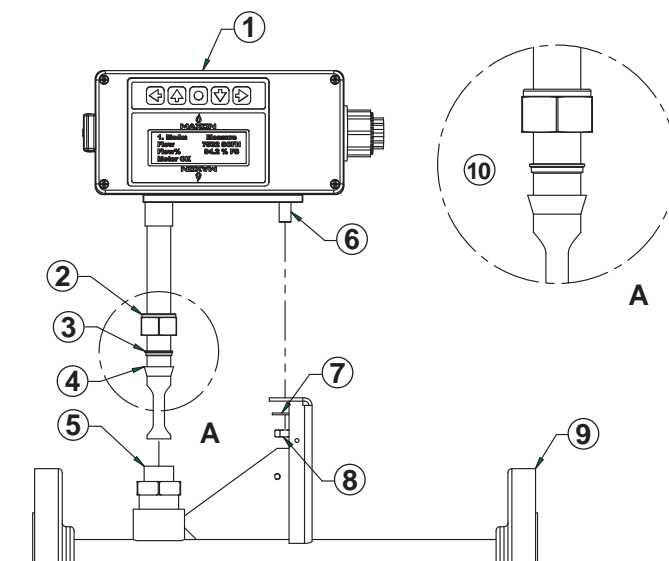
Model	Size	A	B	C	D	E	F
0200 SLM	2"	2.0	3.2	3/4 NPT	8.9	16.2	45°
0300 SLM	3"	2.0	3.2	3/4 NPT	8.9	16.8	45°
0400 SLM	4"	2.0	3.2	3/4 NPT	8.9	17.3	22.5°
0600 SLM	6"	2.0	3.2	3/4 NPT	9.8	18.4	22.5°

If the flow sensor assembly is provided separately or removed during flow body installation, the following procedure should be followed when re-inserting the sensor into the flow body:

1. Verify the compression brass nut, large, and small ferrule are positioned on the probe assembly in the correct order as shown in the following figure. Remove the 3/8"-24 hex nut and flat washer from the threaded stud. (If installed, remove the compression plug fitting from the flow body and the plastic protective cap from the sensor probe.)
2. Verify the threaded stud engages the hole in the flow body mounting bracket and that the bottom of the bar with the threaded stud is seated flush with the top of the bracket.
3. Verify the tank fitting ferrules are properly seated, thread the tank fitting nut onto the body and hand tighten. Tighten the fitting nut with a 1-1/8" wrench by turning the nut 2 turns. Bolt the threaded stud in place using a 3/8"-24 hex jam nut and flat washer. Using a 9/16" wrench, torque to 10-12 ft-lb.

Flow sensor assembly insertion hardware

- 1) Sensor assembly
- 2) Brass hex nut
- 3) Brass ferrule (small)
- 4) Brass ferrule (large)
- 5) Brass tank fitting
- 6) 3/8" stud
- 7) 3/8" flat washer
- 8) 3/8" hex nut
- 9) Gas or air flow body
- 10) Detail



Pipe purging and leak testing

Prior to installation of a gas or air flow body, the upstream piping should be purged to clear out any dust, debris, oil or other foreign material that would collect on the flow conditioning screens or probe assembly and cause measurement error. Assemble the flow body to the mating flanges, gaskets, and hardware in compliance with all local and national piping codes. Leak test all flanges and fittings in the flow stream with a soapy liquid after pressurizing the piping.

Flow sensor conduit connection and enclosure

To maintain the water-tight environmental rating of the enclosure (IP66 / NEMA 4X) after termination of all electrical connections, close the flow sensor assembly enclosure lid, tighten the four screws, and properly seal the flow meter conduit hub to a flexible or rigid conduit.

Electrical installation

Electrical safety



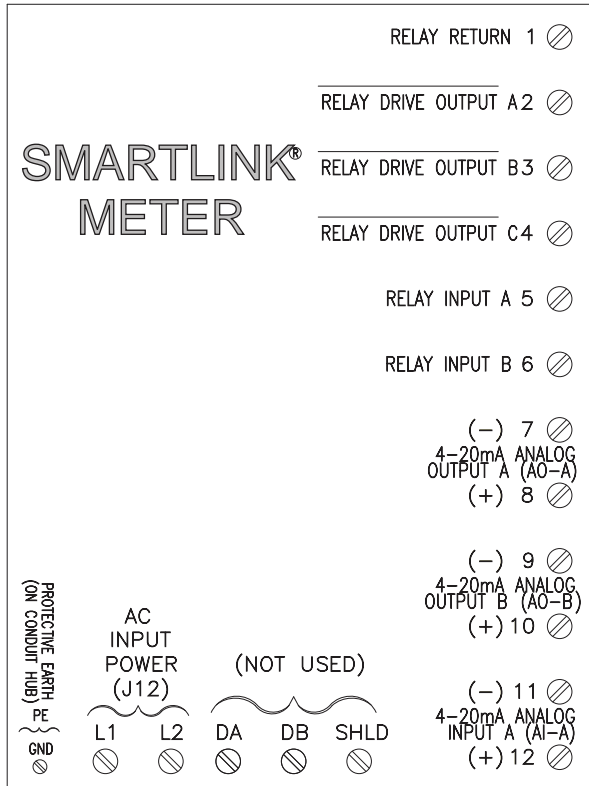
SMARTLINK® METER is designed and manufactured in accordance with ANSI/ISA 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use (12 July 2004). To ensure a hazard-free installation, all flow meter wiring and protective earth grounding shall be done in accordance with national and local electrical codes. In addition, the insulation for all meter wiring must have minimum voltage and temperature ratings of 300 VAC and 158°F, respectively. All electrical installation work must be performed with the power off.

Wiring terminals and requirements

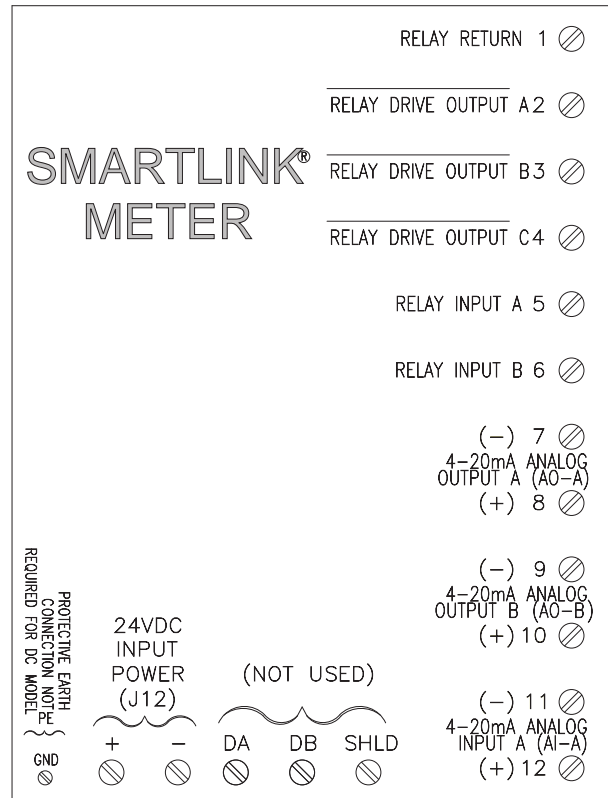
To access the field wiring compartment for power and low-voltage meter connections, unscrew the 4 screws on the meter enclosure and open the hinged door. Pass all customer-supplied wires into the enclosure through the 3/4" conduit hub.

The two diagrams below (for the AC and DC model) indicate each wiring terminal and the following reference table identifies each terminal's signal type, function, and wiring requirement. Many applications will not require connections to all low voltage terminals.


AC model wiring terminals



DC model wiring terminals



Wiring requirement summary	
Terminal reference (Signal name)	Termination connector, signal type, function, electrical/wiring requirements
	Note 1: Minimum wire rating of 300 VAC and 158°F Note 2: Wire size 16-22 AWG Note 3: No length restrictions (other than voltage drop considerations)
Power / Ground Terminals (AC model only)	2-position power connector (labeled "L1 L2")
L1 (AC mains - hot) L2 (AC mains - neutral)	AC mains power input - Connect terminals to AC mains source - No product configuration required for 115 or 230 VAC operation 115-230 VAC (50/60 Hz); 0.04 - 0.02 amps Note 1, 2, 3
PE (protective earth)	Protective earth ground - Connect external earth ground to meter conduit hub screw terminal lug Note 1, 2
Power Terminals (DC model only)	2-position power connector (labeled "+ -")
+ (+24VDC) - (-24VDC)	DC power input - Connect terminals to external 24VDC power supply, ±5% regulation 24VDC, 0.2 amps (max) Note 1, 2, 3
Low Voltage Terminals	12-position input/output (I/O) connector
#1 (relay return)	Input/output relay return Common (return) for low voltage terminals #2 through #6 - Connect to external 24VDC common used with output and input relays 30VDC (max), 340mA (max with all I/O energized) Note 1, 2, 3
#2 (relay drive output A) #3 (relay drive output B) #4 (relay drive output C)	Solid-state digital outputs; open collector type; terminal #1 is common (return) #2 (RO-A): NO Meter/Flow Test Active (ON state) #3 (RO-B): NO Meter Alarm (ON state) #4 (RO-C): NO Limit Condition (ON state) - Fail-safe output design: With the output terminal connected to the minus (-) terminal of a DC relay coil, a meter alarm, limit or flow test active condition is indicated when the open collector relay driver output is in the OFF state, resulting in 24 VDC measured from the output terminal to Relay Return. An open collector relay driver output ON state will result in 0.3 VDC measured from the output terminal to Relay Return. - Connect to external electro-mechanical (or solid-state) relays with transient suppression and a coil rating of 24VDC @ 100 mA max, OR Connect to a PLC or DCS, 24VDC current sourcing input - Terminal #1 must also be connected to (-) or Common of external 24VDC supply used to energize relay coil (or to source the current for the PLC/DCS input) - Reference operating instructions for configuration of Terminal #4 output function 30 VDC max @ 100 mA (max) Note 1, 2, 3
#5 (relay input A) #6 (relay input B)	Solid-state digital inputs; optically isolated type; terminal #1 is common (return) #5: (RI-A) Activate Meter/Flow Test (Momentary ON, 1 second minimum) #6: (RI-B) Future Use - Connect to the switched side of an electro-mechanical relay contact with ONLY DC voltage, OR Connect to PLC/DCS, 24VDC digital current sourcing output - Terminal #1 must also be connected to (-) or Common of external 24VDC supply used to energize one side of relay contact or PLC/DCS input Minimum ON state requirement: 5VDC @ 2mA Maximum terminal ratings: 30VDC @ 20mA max Note 1, 2, 3

Wiring requirement summary (continued)	
Terminal reference (Signal name)	Termination connector, signal type, function, electrical/wiring requirements
Note 1: Minimum wire rating of 300 VAC and 158°F Note 2: Wire size 16-22 AWG Note 3: No length restrictions (other than voltage drop considerations)	
Low Voltage Terminals	12-position input/output (I/O) connector
#7 (analog output A-) #8 (analog output A+) #9 (analog output B-) #10 (analog output B+)	<p>Analog 4-20mA Outputs</p> <p>Analog Output A (AO-A) indicates Meter Flow Rate 4mA = 0 Flow; 20mA = 105% Full Scale Flow (Factory Default)</p> <p>Analog Output B (AO-B) indicates 1 of 3 (user display selected) values: 1.) Ratio AI/AO: Flow Rate Input (Analog In) ÷ Flow Rate Output (Analog Out) 4mA = 0, 20mA = 20 (Factory Default) 2.) Ratio AO/AI: Flow Rate Output (Analog Out) ÷ Flow Rate Input (Analog In) 4mA = 0, 20mA = 20 (Factory Default) 3.) Fluid Temperature 4mA = -50C, 20mA = 110C (Factory Default)</p> <ul style="list-style-type: none"> - External 24VDC (max) loop power recommended for all applications - Verify loop power switch is set to (factory default) "EXT. 24V MAX." position - Internal 24VDC loop power is recommended for standalone meter checkout only - Galvanic isolation between outputs requires separate, isolated loop power supplies - 20mA % Full Scale definition for each output is user display adjustable - 20mA Ratio maximum is user display adjustable - NAMUR-43 compatible alarm output is user display enabled; Any meter alarm is indicated by a 21.5mA signal on both analog outputs, AO-A and AO-B - Reference operating instructions for proper configuration of Flow Rate Input for Ratio AI/AO or Ratio AO/AI output configurations <div style="text-align: center;">  <p>Selection of internal 24VDC loop power while external loop power is connected may cause permanent damage to the meter.</p> </div> <p>Maximum loop resistance: 750 ohm with 24VDC loop power supply Max loop power: 24VDC Max loop current: 21.5 mA Minimum loop current: 4 mA Maximum wire length: 1000 feet maximum length Recommended wire: Belden 82760, 18AWG, 2-conductor, twisted-pair, 20AWG shield drain wire, 100% shield coverage, 300VAC and 75C insulation rating Shield wire termination on external equipment end</p>
#11 (analog input A-) #12 (analog input A+)	<p>Analog 4-20mA (Isolated) Input</p> <p>Analog Input (AI) is used in 1 of 2 possible user selected modes: 1.) Input represents External Meter Flow Rate when Analog Output-B is configured for either Ratio AI/AO or Ratio AO/AI configuration options: 4mA = 0 Flow; 20mA = External Meter 20mA Flow (External Meter 20mA Flow is defined as 105% Full Scale Output Flow scaled by user display Flow Input Multiplier, "FlowIN X-Factor") 2.) Input terminals are disabled when Analog Output-B configuration is set for Fluid Temperature. This configuration permits the internal Analog Input (AI) hardware to "self-check" the Analog Output A (AO-A) hardware by comparing the intended output current to the measured input current. This continuous "Flow MA Test" is enabled by setting the user Analog Input switch hardware (located in the meter wiring compartment) to the "Test" position.</p> <ul style="list-style-type: none"> - Reference operating instructions for proper configuration of flow input multiplier factor, "FlowIN-X Factor", for Ratio AI/AO or Ratio AO/AI configurations <p>180 Ohm impedance; 3.6VDC burden @ 20mA Maximum wire length: 1000 feet maximum length Recommended wire: Belden 82760, 18AWG, 2-conductor, twisted-pair, 20AWG shield drain wire, 100% shield coverage, 300VAC and 75C insulation rating Shield wire termination on external equipment end</p>
Communication terminals	3-position network connector
DA (data A) DB (data B) Shield	NO CONNECTION (for factory use ONLY)

Input power and grounding

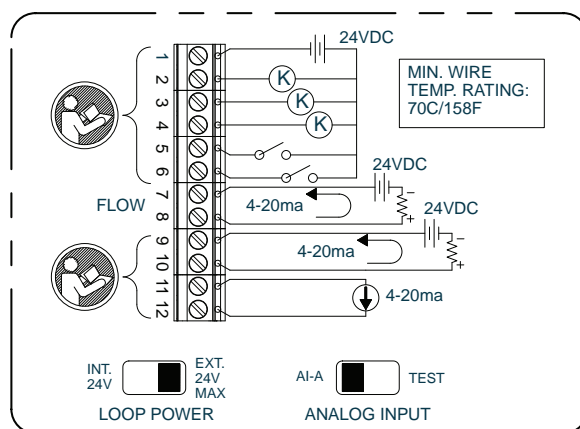
SMARTLINK® METER can be ordered for operation with either 24VDC input power or for connection to a mains supply, 115-230VAC, 50/60Hz. The product label on the flow sensor enclosure indicates if the meter was manufactured with the AC or DC power input option. The two-position power input connector on the main electronics board is also labeled to indicate the power input option.

For the AC model, connect two wires from the mains supply to the power connector, labeled "L1 L2". The wires connected to the meter L1 and L2 terminals should correspond to the same connections of the AC source. Product configuration is NOT required to select between 115VAC and 230VAC operation. Connect an earth ground wire to the conduit hub terminal that is labeled with the protective earth symbol. Provide a switch and non-time delay (North America), quick-acting, high breaking capacity, type F (Europe), ½ amp, 250 V fuse, or circuit breaker as part of the installation. The switch or circuit break shall be located in close proximity of the meter, be in easy reach of the operator, and shall be marked as the disconnecting device for the meter.

For the 24VDC model, connect two wires from a 24VDC supply (with $\pm 5\%$ voltage regulation) to the power connector, labeled "+24V -". The polarity of each wire from the DC power source must match the meter's connection polarity. No protective earth ground wire is required for the DC model. Verify the supply has the capacity required to power the connected meter(s) and the associated interface relays, output current loops, and all other externally connected equipment.

Low voltage wiring

The field wiring label shown below is adhered to the enclosure lid as an aid for termination of all meter low-voltage circuits. This label, along with the following installation checklist, should be used to ensure correct termination of the low-voltage signals required by the application.



■ Loop power selection

A loop power selection switch is provided in the field wiring compartment below the power input connector. (The loop power selection switch and its factory default position is represented in the lower left corner of the field wiring label.) For all field applications, it is recommended that external, 24VDC (max) loop power is provided for the two 4-20mA output circuits. Therefore, the loop power switch should remain in the (factory default) "EXT. 24V MAX." position. If both analog outputs are used and galvanic isolation is required between each 4-20mA output, a separate, isolated loop power source should be provided for each current loop.



Selection of internal 24VDC loop power while external loop power is connected may cause permanent meter damage. Internal 24VDC loop power is recommended for standalone meter checkout ONLY. The switch position for internal loop power is indicated as "INT. 24V".

■ Output current loop wiring

Verify correct polarity connections to external loop power and current loop measurement equipment. Although a number of possible wiring configurations exist, the convention indicated on the field wiring label is recommended:

- Connect the positive (+) terminal of the external 4-20mA measurement device to the positive (+) meter output terminal (#8 or #10).
- Connect the positive (+) terminal of the external 24VDC supply to the negative (-) meter output terminal (#7 or #9).
- Connect the negative (-) terminal of the loop supply to the negative (-) or common terminal of the external 4-20mA measurement device.

A PLC/DCS, multi-channel analog input card may include separate connections for internal or external loop power and this would eliminate the need for any external series connection of the loop supply as described above.

■ Relay (drive) output wiring

Each solid-state, open collector, relay drive output (meter terminals #2, #3, and #4) should be connected to a 24VDC relay coil with transient suppression and a maximum ON current of 100mA. It is also possible to connect these outputs directly to a PLC/DCS, 24VDC sourcing input channel. Relay Return, Terminal #1, must be connected to the common or negative (-) of the external 24VDC supply used to energize the relay coil or used to source the current for the PLC/DCS input.

■ Relay input wiring

Connect Terminal #5 to the switched side of an electromechanical relay contact with DC voltage ONLY, when closed. Direct connection to a PLC/DCS, 24VDC digital current sourcing output channel is also acceptable. Relay Return, Terminal #1, must be connected to the common or negative (-) of the 24VDC supply that is "switched" in by the relay contact or the PLC/DCS output module. If a relay output and input are required by the application, the same DC supply must be used due to the meter's single Relay R return terminal for both functions.

■ Input current loop wiring

If "standalone" ratio monitoring is required by the application without a PLC or DCS, an external flow meter will require connection to the input current loop for "local" meter measurement of the second flow. The current source shown on the field wiring label can be replaced by the 2nd meter's externally powered, 4-20 mA flow output current loop with connection to Analog Input A (- / +), Terminals #11 and #12. (The following section provides a more detailed electrical drawing of this ratio monitoring application and the associated current loop connections required.)



Maintain the integrity of the MAXON enclosure by using NEMA 4X or IP66 rated dust- and water-tight electrical connectors. Use cable-sealing grips and strain-relief loops for any cord or cable. Use internal sealing materials on all conduit connections. Moisture can have a harmful effect on device internals if permitted to enter through wiring connectors. Ensure that the device connection is not at a low point of the conduit to avoid condensation run-off into the housing; install a drip loop if necessary. Make sure that the access cover plate is in place and securely fastened. All cover screws should be tightened using an alternate cross-corner tightening pattern. Cover screws should be checked periodically to ensure adequate sealing protection.

Typical electrical installations

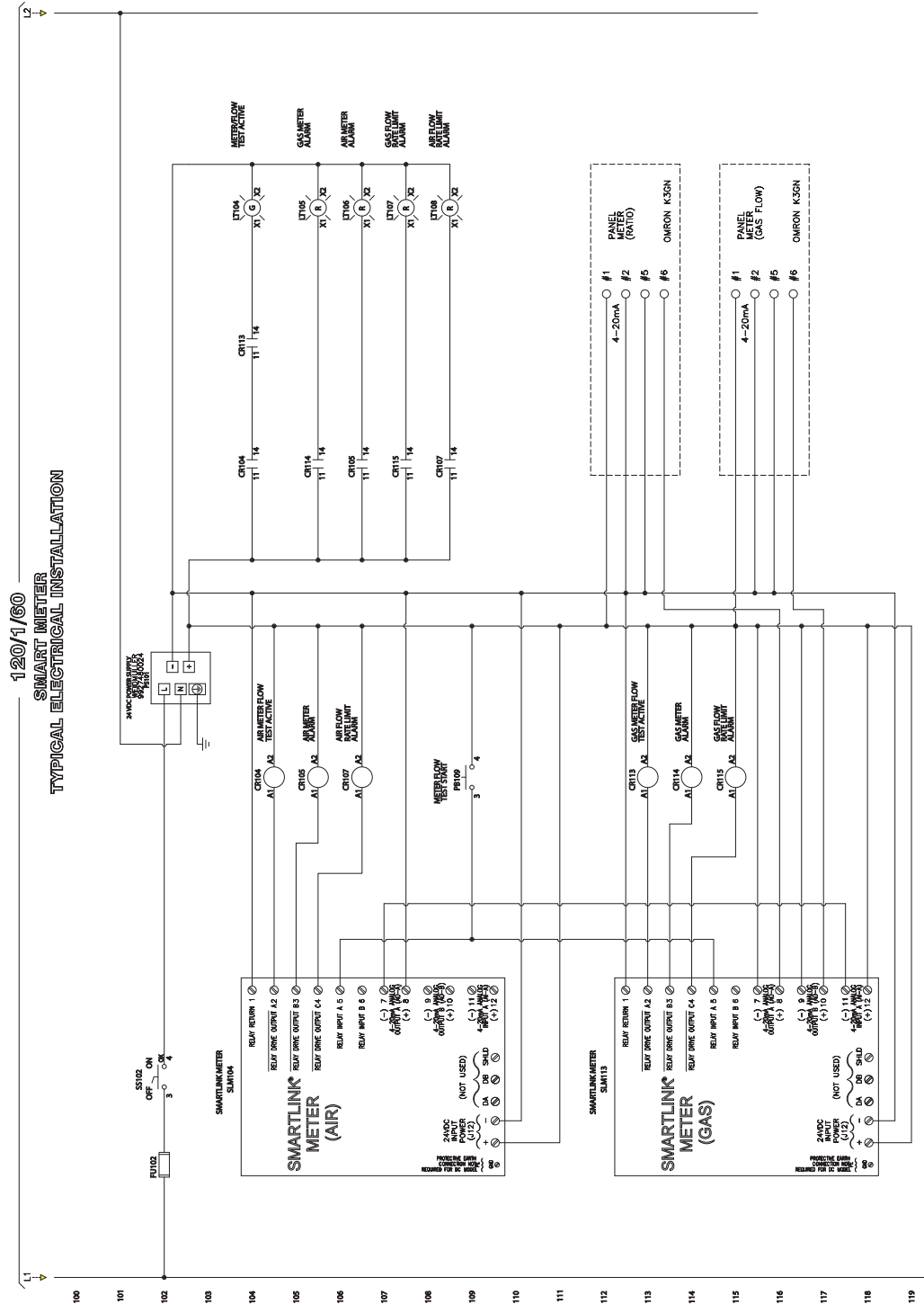
The following two schematics represent "typical" electrical installations of SMARTLINK® METER.

The first electrical drawing consists of a single, 24VDC natural gas meter interfaced to alarm relays, a meter test switch, and a remote panel display.

The second drawing includes two 24VDC powered, SMARTLINK® METERS used to monitor the air/fuel ratio of a combustion system. The 4-20mA flow output from the air meter is connected to the gas meter's 4-20mA input for measurement of an external flow. The gas meter is configured to output a 4-20mA ratio and to de-energize a relay if the ratio exceeds a user-selected window limit condition. A momentary switched 24VDC is connected to each meter's input that activates an "on-line" flow/meter self test. The flow and ratio output current loops, output relay coils, and both (air and gas) meters are powered using the same 24VDC power supply.

[illegible]

SMARTLINK® METER (24VDC, ratio monitor) - Typical electrical installation



Commissioning instructions

After completing the mechanical and electrical installation of the flow meter, the following commissioning checklist procedure should be performed.

- Check the product ratings for gas type, flow range, power input, and maximum pressure on the meter label match the application for which it is being installed.
- Check the flow body size for a correct match with the installed flow sensor by comparing the flow range on the sensor label to the flow range on the body label.
- Confirm the intended direction of flow through the meter matches the direction indicated by the arrow inscribed above the MAXON logo on the flow body.
- Verify the proper upstream and downstream piping requirements are provided.
- For air meter installations, confirm proper position of the air flow body extension with respect to the direction of flow and the 2 removable screens have been installed in the same orientation.
- Check that all flow meter related mechanical and electrical installation work meets applicable code and safety requirements.
- Check for Loop Power selector switch placement in the rightmost "EXT. 24V MAX." factory default position. (The switch is located on the left side of the field wiring compartment below the power connector.)
- Check for display illumination, a '0' flow reading, and a "Meter OK" message (on Menu #1) after turning power on and waiting for a 30-second start-up period to complete.
- Consult the instructions on meter operation to determine if the factory configuration requires adjustment for the installed application (i.e. 4-20mA output configuration, flow filtering, etc.). If the meter's "built-in" ratio monitoring or limit output functions are used by the application, meter configuration via the user display MUST be performed by the commissioning engineer for proper operation.
- Verify proper function of all wired inputs and outputs (after meter configuration is completed) by using the 4-20mA output and input status menu screens. With all external process control disabled or in a manual mode, zero and span all external equipment inputs connected to the meter's 4-20mA outputs using the Test Output ON/OFF commands.
- Check for a reasonable and stable flow output on Menu #1 with no meter alarms after a steady process flow is enabled. If available, use other process measurements (such as burner differential pressure) to validate the flow reading as described in the maintenance section.
- Confirm proper meter operation by executing the flow/meter test command. Refer to the operation instructions on use of the flow/meter test command.
- Check for secure installation of the enclosure lid and that passcode protection of the meter configuration has been enabled if required for the application.

Operating instructions

General

This section describes the basic operation of the meter and how to use the display for:

- Viewing meter status and manufacturing/calibration information,
- Executing meter test and configuration commands, and
- Configuring the meter for specific functions such as limit and ratio outputs, signal filtering, and selection of displayed measurement units.

Meter 100% full-scale flow output

Discussions in the following material related to the meter's 4-20mA flow output and its configuration refer to % Full Scale (FS).



The following meter 100% Full Scale definition applies to all MAXON SMARTLINK® METERS:

Meter 100% Full Scale Flow = Calibrated Max Flow Rate (on sensor label) + 5%

The 5% "buffer" permits most closed-loop control applications to properly operate at the maximum calibrated flow rate printed on the label that is used for product selection. All meters are shipped with the 20mA Flow Output set to represent 100% Full Scale. Although the 4-20mA flow output can be "scaled" to represent lower 20mA flow rates, the 100% Full Scale flow rate of the meter cannot be exceeded or changed and the maximum application measurement flow must be less than (or equal to) the calibrated maximum flow rate on the product label.

Modes of operation

The meter has four distinct modes of operation:

Startup mode is entered after the meter is powered ON. During this period, the electronics are initialized and power is applied to the RTD probe assembly. This mode is displayed as "Startup" on Menu #1 and is active for about 10 seconds after power is applied.

Measurement mode is entered after startup initialization is complete. In the first ½ minute of this mode (and during the 10-second startup period), the flow output may be non-zero while the RTD assembly stabilizes in temperature. This mode is displayed as "Measure" on Menu #1 and is active if the meter is powered ON and no Input/Output or Flow Test command is being executed. Measurement mode is automatically re-entered after a Flow Meter Test cycle is completed or when any Input/Output Test command is turned OFF.

Flow meter test mode is user-initiated by a user command or when a digital input is turned ON. This mode is displayed as "Flo-Test" on Menu #1 and provides a complete "self-check" of the meter electronics and RTD sensor assembly. Reference the section on User Commands for more detailed information.

Input/output test mode is user-initiated by display commands for checkout of the electrical connections, I/O hardware, and external equipment after meter installation. This mode is displayed as "I/O Test" on Menu #1. Reference the section on User Commands for more detailed information.

Display Overview

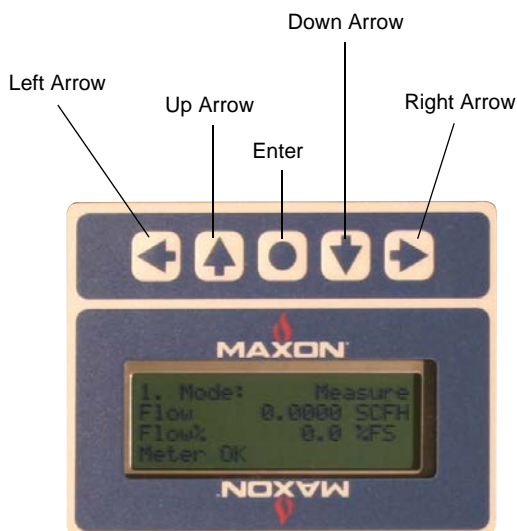
Menu navigation

User display menus are all numbered and divided into three categories: Meter Status (1.-1.12), User Commands (2.-2.6), and User Configuration (3.-3.16). Refer to the table below for a summary of the user display functions within each of the categories.

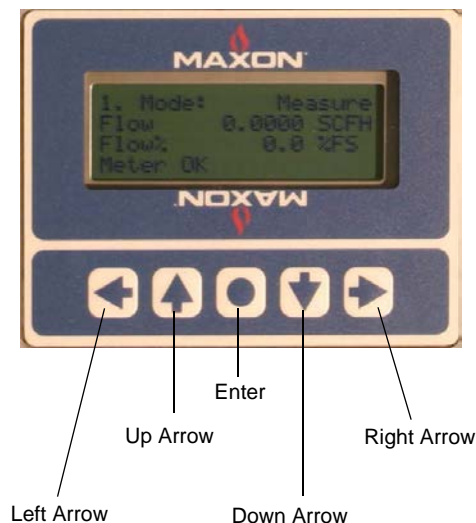
User display menu summary		
Meter status	User commands	User configuration
1. Mode: Measure	2. Totalizer Reset	3. Flow Units
1.1 Flow Totalizer	2.1 Meter/Flow Test	3.1 Temp Units
1.2 Meter Status	2.2 Output ON Test	3.2 Output-B Setup
1.3 Ratio Status	2.3 Output OFF Test	3.3 FlowIN X-Factor
1.4 Output A: Flow	2.4 Setup Reset	3.4 20mA Ratio AO-B
1.5 Output B: Ratio	2.5 Reset Event Log	3.5 AC Filter
1.6 Input A: Flow	2.6 All Tests OFF	3.6 21.5mA Alarm
1.7 Relay Outputs		3.7 Flow Filter
1.8 Event Log		3.8 Flow Bias
1.9 Passcode Entry		3.9 Flow Cutoff
1.10 Unit Mfg Data A		3.10 LO Limit A-Flow
1.11 Unit Mfg Data B		3.11 HI Limit A-Flow
1.12 Calibration		3.12 LO Limit B
		3.13 HI Limit B
		3.14 20mA Flow
		3.15 20mA OutB
		3.16 Passcode

The meter keypad is shown in the two figures below. The LCD can be installed in two positions and the arrow keys will automatically change functions. (Refer to the mechanical installation section on LCD orientation for instructions on how to change the LCD orientation.)

Keypad functions with LCD “upright”



Keypad functions with LCD “inverted”



The four arrow keys: LEFT, UP, RIGHT, and DOWN are used to select the desired menu display as follows:

1. The RIGHT arrow key is used to select the first display in the "next" menu column (or category). If Menu #1.4, Output A: Flow is displayed and the RIGHT arrow key is pressed, Menu #2. Totalizer Reset is displayed. When any Menu #3.x item is selected and the RIGHT arrow key is pressed, the display will "wrap" to Menu #1. Mode.
2. The LEFT arrow key is used to select the first display in the "previous" menu column (or category). If Menu #2.1 Meter/Flow Test is displayed and the LEFT arrow key is pressed, Menu #1. Mode is displayed. When any Menu #1.x item is selected and the LEFT arrow key is pressed, the display will "wrap" to Menu #3. Flow Units.
3. The UP arrow key is used to move "up" the menu column to a lower item number. When the first item in a column is selected and the UP arrow is pressed, the display will "wrap" to the last item in the column.
4. The DOWN arrow key is used to move "down" the menu column to a higher item number. When the last item in a column is selected and the DOWN arrow is pressed, the display will "wrap" to the first item in the column.
5. Pressing the LEFT and RIGHT arrow keys simultaneously forces the first item in the column to be displayed. If both keys are held down longer, Menu #1 is selected and the LCD is electronically re-initialized.

Executing commands

All user commands (Menu #2.-2.6) are executed by pressing the ENTER key. Command execution is only permitted if the meter is "unlocked", i.e. not passcode protected.

Changing/entering data

Changing/entering numeric data is required to modify specific meter configuration parameters (Menu #3.3, #3.4, and #3.8-3.16) or for meter passcode entry (Menu #1.9). All five keys: (LEFT), (UP), (RIGHT), (DOWN), and (ENTER) are used in the following procedure:

1. Press ENTER to begin the change procedure. The first digit that can be changed is indicated by a flashing cursor.
2. The UP and DOWN arrow keys are used to select a digit (0-9), a decimal (for non-integer values), - minus sign (for negative values), and a blank character to delete digits in all but the first position.
3. Use the RIGHT and LEFT arrow keys to select the digit to be changed or entered.
4. Press ENTER to save the modified data.
5. If NO data change is desired after beginning to edit, press the LEFT arrow key until the cursor stops blinking and the previous screen is displayed.
6. Changing user configuration data is only permitted if the meter is "unlocked", i.e. not passcode protected.

Changing selections

Changing a selection is required to modify specific meter configuration parameters (Menu #3.1, #3.2, #3.5-3.7). The four keys: LEFT, UP, DOWN, and ENTER are used in the following selection change procedure:

1. Press ENTER and the cursor will flash indicating that a change can be made.
2. The UP and DOWN arrow keys are used to make a selection from a list of options.
3. Press ENTER to save the modified selection.
4. If NO selection change is desired after beginning to scroll the list of options, press the LEFT arrow key until the cursor stops blinking and the previous screen is displayed.
5. Changing user configuration data is only permitted if the meter is "unlocked", i.e. not passcode protected.

Meter configuration

All meters are shipped with the following configuration:

- Flow rate displayed in scfh
- Temperatures displayed in °F
- Analog Output-A (Flow) 20mA = meter 100% FS (i.e. calibration flow max + 5%)
- 4-20mA Output-B (Ratio, AI/AO) enabled; NOT configured for external flow input
- 60Hz data acquisition rejection filtering
- 21.5mA current loop alarm function disabled
- No filtering of flow output signal (i.e. fastest response)
- No flow output bias
- All limit output functions disabled
- Passcode protection disabled

Refer to the sections below for guidance on specific configuration functions.

Flow measurement and total units

The meter's mass flow rate out, 4-20mA input/output definitions, and calibration range, are displayed in one of the following "Standard" or "Normal" units as selected by the Menu #3 Flow Units configuration setting. For each flow rate unit, the flow total is displayed in the corresponding volumetric units. (Note the reference conditions and densities below for all SMARTLINK® METER flow rate units. These definitions vary widely across industries, manufacturers, and geographic regions.)

Summary of display, flow, and totalizer units		
Flow display units	Flow unit description	Totalizer display units
SCFH	Standard cubic feet per hour	scf
SCFM	Standard cubic feet per minute	scf
SFPM	Standard feet per minute	scf
SFPS	Standard feet per second	scf
LB/H	Pounds per hour	lbs
LB/M	Pounds per minute	lbs
LB/S	Pounds per second	lbs
NM3H	Normal cubic meters per hour	nm ³
NM3M	Normal cubic meters per minute	nm ³
NMPM	Normal meters per minute	nm ³
NMPS	Normal meters per second	nm ³
NLPH	Normal liters per hour	nl
NLPM	Normal liters per minute	nl
KG/H	Kilograms per hour	kg
KG/M	Kilograms per minute	kg
KG/S	Kilograms per second	kg
SMPM	Standard meters per minute	sm ³

Reference conditions	<p>Temperature and pressure conditions for flows displayed in "Standard" volumetric, "Standard" velocity, and all mass flow rate units: 60°F and 14.73 psia per ANSI/API MPMS, 14.3.1</p> <p>Temperature and pressure conditions for flows displayed in "Normal" volumetric and "Normal" velocity flow units: 32°F and 14.696 psia</p>
Reference densities	<p>Air models: 0.076 lbs/ft³</p> <p>Natural gas models: 0.042 lbs/ft³</p>

20mA flow output scaling

Analog Output-A (AO-A) is a 4-20mA current loop that is configured at the factory to output 4mA at 0 flow and 20mA at the meter's 100% Full Scale (FS) flow rate. As defined for all SMARTLINK® METERS:

$$\text{100\% Meter Full Scale (FS) Flow} = \text{Calibrated Max Flow Rate (on sensor label)} + 5\%$$

The meter full scale flow rate can be calculated as shown above or can be found as the "MAX" value on Menu #1.12 Calibration. As an example, a SMARTLINK® METER for natural gas, Model 0200 SLM, has a maximum calibrated operating flow rate of 8000 scfh and a maximum 100% meter full scale range of 8400 scfh, 5% higher than the calibrated operating range. As shipped, this unit would have a 20mA output that will represent 8400 scfh.

The 4 and 20 mA flow definitions as well as the actual mA output current can be displayed on Menu #1.4 Output A- Flow. Using either of the following formulas with consistent units, verify the flow rate on Menu #1 corresponds to the current output level displayed on Menu #1.4 and the calculated or displayed flow in any external equipment interfaced to the output:

$$\text{Flow Rate Output (mA)} = 4\text{mA} + 16\text{mA} \times \left[\frac{\text{Flow rate}}{20\text{mA flow rate}} \right]$$

Or

$$\text{Flow Rate} = \left[\frac{(\text{mA flow rate out} - 4\text{mA})}{16 \text{ mA}} \right] \times 20\text{mA flow rate}$$

A scaling parameter is provided to set the 20mA output at any specific value less than the 100% Full Scale flow rate. The parameter, "20MA Flow" can be changed on Menu #3.14 as a percent of the meter's full scale flow rate using the following formula:

$$\text{Required 20mA Flow (\%FS) Configuration Parameter} = 100\% \times \left[\frac{\text{Required 20mA flow rate}}{100\% \text{ meter full scale flow}} \right]$$

Modifying the 20mA meter output definition is not typically required but is provided as a convenience for setting a "custom" full scale range on remote monitoring or display equipment. The 4mA definition of zero flow cannot be modified.

Flow mA test

A continuous check on the flow output (AO-A) can be performed if ratio monitoring (i.e. Analog Input-A) is NOT required by the application. To enable this "Flow MA Test", Analog Output-B must be setup for Fluid Temperature (Menu #3.2) and the "AI-A" switch, located in the wiring compartment, must be set to the "TEST" position. This configuration permits the internal Analog Input (AI) hardware to monitor the Analog Output A (AO-A) hardware by comparing the intended output current to the measured input current. If the flow output hardware fails or the loop circuit is open, the meter alarm is activated (output terminal #3). This function is intended to protect against single-point failures in the flow output hardware when air or fuel measurements are used for safety-critical combustion control applications.

Ratio monitor

To configure SMARTLINK® METER as a "standalone" ratio monitor for combustion applications, the following procedure must be performed:

1. An external, second meter's 4-20mA flow output must be connected to the primary meter's 4-20mA input (analog input-A, terminal #11 and #12). Configure the flow measurement units of the second meter to be the same as the primary meter (configured for ratio monitoring). DO NOT select any velocity flow rate units for ratio monitoring. On the external meter, verify the 21.5mA alarm function is disabled on Menu #3.6 and record the 20mA flow output definition on Menu #1.4 in the selected flow units.
2. On the primary meter, Analog Output-B (AO-B) must be configured for ratio output using Menu #3.2. The parameter, "Output-B Setup", must be set to either "AI / AO" or "AO / AI". The two configuration options are defined as follows:

- a. "AI/AO" =
$$\frac{\text{Flow rate of Analog Input-A (ext. 2nd meter)}}{\text{Flow rate of Analog Output-A}}$$

This (AI/AO) is the factory default configuration and is used for an external air meter to calculate air/fuel ratio; for combustion systems, this is the process variable of interest.

$$b. "AO/AI" = \frac{\text{Flow rate of Analog Output-A}}{\text{Flow rate of Analog Input-A (ext. 2nd meter)}}$$

This configuration is used for an external gas meter to calculate air/fuel ratio.

- For the primary meter to calculate ratio, the 4-20mA input current (AI-A) representing the flow of the 2nd, external meter, must be properly configured. The configuration parameter, "FlowIN-X Factor" must be setup as follows:

$$\text{"FlowIN-X Factor"} = \frac{\text{External meter 20mA flow rate}}{\text{Meter 100\% full scale flow rate}}$$

The meter 100% full scale flow rate is displayed as the "MAX" value on Menu #1.12 Calibration. Refer to the previous section for a complete discussion on full scale meter flow rate. The external meter's 20mA Flow Rate definition was recorded in Step #1, above. Calculate the parameter, "FlowIN-X Factor", using the equation above and enter this value in Menu #3.3.

- Verify the 20mA input flow rate (on Menu #1.6) now matches the 20mA output flow rate (on Menu #1.4 of the 2nd, external meter). If the two flow rates are not the same, repeat Step #3.
- If the application ratio exceeds 20:1, change the configuration parameter, "20MA Ratio AO-B" on Menu #3.5 to a value equal to or greater than the largest ratio required for monitoring. Verify the configuration parameter, "20MA OutB" is set to 100% FS and the desired ratio output at 20mA is displayed on Menu #1.5.
- With both meters operational and reading a non-zero flow rate, verify the external meter flow rate matches the input flow rate on the primary meter.
- Using either of the following formulas below, verify the ratio on Menu #1.3, Ratio Status, corresponds to the current output displayed on Menu #1.5, Output-B: Ratio and the calculated/displayed ratio in any external equipment interfaced to Analog Output-B:

$$\text{Ratio Output (mA)} = 4\text{mA} + 16\text{mA} \times \left[\frac{\text{Ratio}}{20\text{mA ratio}} \right]$$

Or

$$\text{Ratio} = \frac{(\text{mA ratio output} - 4\text{mA})}{16 \text{ mA}} \times 20\text{mA ratio}$$

- If any changes are made to the external meter's 20mA output definition, repeat Step #3, 4, 6, and 7.

Although not required, the following additional configuration and output options should be considered for all safety-critical air/fuel ratio monitoring and control applications. (Refer to the respective operating instruction section for each topic below):

- Configuration of the meter limit output function: An acceptable air/fuel ratio operating "window" can be created through setup of the HI / LO Limit (Output) B parameters in Menu #3.10 and #3.11.
- Passcode protection of meter configuration: Selection of a meter passcode (other than 0) on Menu #3.16 will eliminate tampering by "locking" all meter configuration parameters and test functions. Passcode protection is strongly recommended for all closed-loop air/fuel ratio control applications.
- Meter alarm outputs: Terminal #3 (from both the primary and external meter) can be monitored by external PLC/DCS equipment or connected to relays and lamp indicators to ensure that invalid ratio measurements are not used if a meter failure occurs.
- Redundant ratio outputs: The second meter can also be setup for ratio monitoring so that redundant ratio outputs can be monitored by external PLC/DCS or equipment or remote displays to ensure that invalid ratio measurements are not used if a meter failure occurs.
- Flow measurement filtering: For applications in which the air and fuel flow rates change substantially (i.e. fast firing rate modulation), the flow rate outputs from each meter may need to be additionally filtered by selecting the 2 or 4 second value on Menu #3.7. The filtering should be set the same for both meters and all control loops that utilize the flow and ratio outputs will need to accommodate these slower sensor response times.

Temperature output

If ratio monitoring is NOT required by the application, SMARTLINK® METER can be configured to monitor and output fluid temperature using the following procedure:

1. Change the parameter, "Output-B Setup", to "Fluid Temp" on Menu #3.2. This configures Analog Output-B (AO-B) for fluid temperature.
2. With the meter operational and reading a non-zero flow, verify the mA output current and the 4 and 20 mA fluid temperature definitions on Menu #1.5. Menu #1.5 will be titled, "Output B-Temp" when the meter is configured for fluid temperature output.
3. Using either of the following formulas with consistent units, verify the fluid temperature (on Menu #1.2 Meter Status) corresponds to the current output level displayed on Menu #1.5 and the calculated or displayed temperature in the external equipment interfaced to the output:

$$\text{Temperature Output (mA)} = 4\text{mA} + 16\text{mA} \times \left[\frac{(\text{Fluid temp} - 4\text{mA temp})}{(20\text{mA temp} - 4\text{mA temp})} \right]$$

Or

$$\text{Temperature (°C or °F)} = 4\text{mA Temp} + [20\text{mA Temp} - 4\text{mA Temp}] \times \left[\frac{(\text{mA temp output} - 4\text{mA})}{16 \text{ mA}} \right]$$

A scaling parameter is provided to set the 20mA temperature output at any specific value less than the 100% full scale temperature of 230°F. The parameter, "20mA OutB" can be changed on Menu #3.15 using either of the following formulas:

$$\text{Required 20mA OutB (\%FS)} = 100\% \times \frac{[\text{Required 20mA °F temp} - (-58°F)]}{288°F}$$

Or

$$\text{Required 20mA OutB (\%FS)} = 100\% \times \frac{[\text{Required 20mA °C temp} - (-50°C)]}{160°C}$$

Modifying the 20mA meter output definition is not typically required but is provided as a convenience for setting a "custom" full scale range on remote monitoring or display equipment. The 4mA temperature definition is always set to -58°F and cannot be modified.

Limit output

SMARTLINK® METER includes a fail-safe limit output that can be used to notify plant personnel or external PLC/DCS monitoring equipment of high and low levels of flow and ratio (or fluid temperature).

To enable a High and/or Low Flow Limit condition, the following configuration parameters need to be set using the following formulas:

$$\text{HI Limit A-Flow \%FS (Menu \#3.11)} = \frac{100\% \times \text{required HI threshold flow rate}}{100\% \text{ meter full scale flow rate}}$$

$$\text{LO Limit A-Flow \%FS (Menu \#3.10)} = \frac{100\% \times \text{required LO threshold flow rate}}{100\% \text{ meter full scale flow rate}}$$

For an example, a SMARTLINK® METER for natural gas, Model 0200 SLM, has a 100% meter full scale range of 8400 scfh . If a limit output is required by the application to "trip" at 7000 scfh or higher, then the HI Limit A-Flow %FS is calculated as follows: $83.3\% = 100\% \times 7000 \text{ scfh} \div 8400 \text{ scfh}$. The limit output is fail-safe and therefore is normally turned ON when the condition does NOT exist. A HI Limit Flow condition will also be indicated on the user display when the measured flow rate is equal to or greater than 7000 scfh . To avoid chattering limit relays, a fixed hysteresis of 2% FS is applied to all limits. Therefore, the HI Flow Limit condition will remain active until the flow rate drops below 81.3% or 6832 scfh . Both High and Low Flow Limits can be enabled at the same time.

When Analog Output-B is setup for ratio, High and/or Low Ratio Limit configuration parameters can be set with the following formulas:

$$\text{HI Limit B \%FS (Menu \#3.13)} = 100\% \times \frac{\text{Required HI threshold ratio}}{20\text{mA ratio AO-B (Menu \#3.4)}}$$

$$\text{LO Limit B \%FS (Menu \#3.12)} = 100\% \times \frac{\text{Required LO threshold ratio}}{20\text{mA ratio AO-B (Menu \#3.4)}}$$

When Analog Output-B is setup for fluid temperature, High and/or Low Temperature Limit configuration parameters can be set with the following formulas:

$$\text{HI Limit B \%FS (Menu \#3.13)} = 100\% \times \frac{(\text{Required HI threshold fluid temp} - 58^{\circ}\text{F})}{288^{\circ}\text{F}}$$

Or

$$100\% \times \frac{(\text{Required HI threshold fluid temp} - 50^{\circ}\text{C})}{160^{\circ}\text{C}}$$

$$\text{LO Limit B \%FS (Menu \#3.12)} = 100\% \times \frac{(\text{Required LO threshold fluid temp} - 58^{\circ}\text{F})}{288^{\circ}\text{F}}$$

Or

$$100\% \times \frac{(\text{Required LO threshold fluid temp} - 50^{\circ}\text{C})}{160^{\circ}\text{C}}$$

HI Limit, LO Limit, or both conditions (for Flow on Analog Output-A and Ratio or Fluid Temperature on Analog Output-B) can be enabled at the same time although only one hardware limit output is provided. Scaling of the 20mA Flow, Ratio, or Fluid Temperature outputs DO NOT affect the limit thresholds. All meters are shipped with limit functions disabled.



Note that a -1.00 %FS disables the LO Limit functions and 110 %FS disables the HI Limit functions. Although designed as a fail-safe signal, the limit output, is NOT intended to replace combustion permissive functions such as high and low gas pressure switches.

Flow measurement filtering

For applications that require a "smoother" flow output signal with additional time averaging for display or control, a configurable output filter is provided. The filter configuration parameter, "Flow Filter" on Menu #3.6, is adjustable in 2 second increments, from 0 seconds to 8 seconds. The factory default setting is 0 seconds. With no filtering and an instantaneous step change in flow, the meter will achieve 63% of its final value in 1 to 2 seconds. The output requires approximately 5 to 10 seconds to reach 95% of the final value after a step change in flow. The flow filtering time period directly adds to the overall meter response time and it is this total response time that must be accounted for in the tuning of all flow control applications.

Meter passcode protection

The meter can be "Locked" to prevent tampering with the configuration and execution of all user commands. To enable the "Lock" function, change the parameter, "Passcode", on Menu #3.16, to a non-zero, 1, 2, 3, or 4-digit number. This number should be remembered or written down for future reference. Once the passcode is changed, the unit will be in a "Locked" state even after cycling power.

To "Unlock" the unit when in a "Locked" state, go to Menu #1.9, Passcode Entry, and enter the passcode. The meter will automatically return to a locked state approximately 50 minutes after the last key is pressed or if the power is cycled.

If the passcode is forgotten, go to Menu #1.9 and enter the master passcode of 911. After the 911 passcode is entered, additional factory diagnostic information (Menu #4.1 to #4.9) is displayed.

To disable the "Lock" function, first enter the previously stored (valid) passcode on Menu #1.9 and then change the stored passcode back to 0 on Menu #3.16.

50/60Hz rejection filter

The configuration parameter, "AC Filter", on Menu #3.5, is used to select the data acquisition filter for rejection of electrical noise at AC frequencies. For an AC or 24VDC model, the appropriate filter, 50Hz or 60Hz, should be selected based on the local AC mains frequency.

Flow cutoff

The configuration parameter, "Flow Cutoff", on Menu #3.9, can be used to "zero" the meter at flow rates below the minimum calibration point shown on Menu #1.12. Depending on fluid temperature, flow body orientation, and gas pressure, small convective flows are created around the heated RTD element. If the meter display does not indicate zero flow when it is certain that no flow exists, "Flow Cutoff" can be increased to approximately 1 to 2% Full Scale (FS) of the meter's 100% full scale flow rate. Refer to the beginning section of the operating instructions for a discussion on meter full scale flow.

21.5mA alarm

The configuration parameter, "21.5mA Alarm", on Menu #3.6, is used to select a NAMUR-43 compatible output signaling convention for indication of a meter alarm (and NOT a limit condition). The normal current range for Analog Output-A (Flow) and Analog Output-B (Ratio or Fluid Temperature) is 4mA to 20mA. If a meter alarm is active and the "21.5MA Alarm" parameter is set to "Enabled", both analog outputs will be driven to a 21.5 mA current level. If this alarm signaling function is utilized, make sure the external PLC/DCS equipment includes an analog module that accepts a current loop signal 21.5mA or greater.

DO NOT enable the 21.5mA Alarm if the meter's flow output-A is connected to a 2nd meter's input for ratio monitoring.

Flow bias

SMARTLINK® METER is intended to measure flow accurately after proper field installation. The configuration parameter, "Flow Bias", on Menu #3.8, can be used to scale the flow output for the following reasons:

1. The flow units used by the customer are referenced to different standard conditions or a different reference density if mass rate units are selected. (Reference Appendix B for conversion factors needed to display flow rates with alternative reference conditions.)
2. The flow output wants to be "matched" to a secondary measurement that is used for periodic meter field validation.

The flow bias is applied directly to the actual meter flow output as a scale factor or multiplier term. It will scale all flows displayed by the same amount, including the 4 and 20mA flow output definitions, with the exception of the "MAX" calibrated flow on Menu #1.12. All HI and LO Limit conditions are NOT affected because thresholds are set in % Full Scale.

If a more accurate secondary flow measurement is available (such as positive displacement or Coriolis flow instrument), the flow bias can also be used to minimize field measurement errors that are typically less than 2% of reading and include the following:

- Velocity profile disturbances due to upstream piping configuration
- Varying gas "constituents" (i.e. chemical mixture)
- Fluid pressure
- Humidity (in air)
- Thermal gradients due to large body/fluid temperature differences

Temperature measurement units

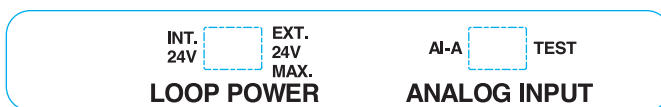
The configuration parameter, "Temp Units", on Menu #3.1, is used to select displayed temperature units of °F or °C.

Wiring compartment configuration switches

Two switches in the field wiring compartment are provided for the following configuration settings:

1. **Loop Power:** "EXT. 24V MAX." should always be the selected position for field installations. "INT. 24V" is used only for standalone meter 4-20mA output testing. (Refer to the electrical connections section for more details on external loop power.)
2. **Analog Input:** The "AI-A" (or Analog Input A) position should be selected if Analog Output-B is configured for ratio monitoring. The "AI-A" configuration permits the measurement of a 2nd, external flow (needed for a ratio calculation) on Analog Input-A. The "Test" position enables the continuous Flow MA Test on the flow output hardware and associated loop circuit. (Refer to the section of the operating instructions on the 4-20mA Flow Output for more detailed information on the Flow mA Test.)

Wiring compartment configuration switches



Meter configuration menu summary

The following table summarizes all configuration parameter screens and their associated factory default, options or typical range.

Configuration menu summary	
Configuration menus	Parameter (default), options or typical range
3. Flow Units To Change Item: Press [ENTER] SCFH	(SCFH), SCFM, SFPM, SFPS, LB/H, LB/S, NM3H, NM3M, NMPM, NMPS, NLPH, NLPM, KG/H, KG/M, KG/S, SMPM, SMPS
3.1 Temp Units To Change Item: Press [ENTER] °F	(°F), °C
3.2 Output-B Setup To Change Item: Press [ENTER] Ratio AI/AO	(AI / AO), AO / AI, Fluid Temp
3.3 FlowIN X-Factor To Change Item: Press [ENTER] 1.000	(1.000), Gas with Ext. Air: ~10.00 to 25.00; Air with Ext. Gas: ~0.040 to 0.1000
3.4 20MA Ratio AO-B To Change Item: Press [ENTER] 20.0	(20.0), 2.0 to 100
3.5 AC Filter To Change Item: Press [ENTER] 60Hz	(60Hz), 50Hz
3.6 21.5MA Alarm To Change Item: Press [ENTER] Disabled	(Disabled), Enabled
3.7 Flow Filter To Change Item: Press [ENTER] 0 SECS	(0 SECS), 2 SECS, 4 SECS, 6 SECS, 8 SECS
3.8 Flow Bias To Change Item: Press [ENTER] 1.00	(1.00), 0.95 to 1.05, if required
3.9 Flow Cutoff To Change Item: Press [ENTER] 0.5 %FS	(0.5 %FS), 0.5 to 2.0%
3.10 LO Limit A-Flow To Change Item: Press [ENTER] -1.00 %FS	(-1.00 %FS, LO Flow Limit Disabled), To Enable LO Flow Limit, $x \geq 0.0$ %FS
3.11 HI Limit A-Flow To Change Item: Press [ENTER] 110 %FS	(110 %FS, HI Flow Limit Disabled), To Enable HI Flow Limit, $x \leq 100.00$ %FS
3.12 LO Limit B To Change Item: Press [ENTER] -1.00 %FS	(-1.00 %FS, LO Limit B Disabled), To Enable LO Limit B, $x \geq 0.0$ %FS
3.13 HI Limit B To Change Item: Press [ENTER] 110 %FS	(110 %FS, HI Limit B Disabled), To Enable HI Limit B, $x \leq 100.00$ %FS
3.14 20 MA Flow To Change Item: Press [ENTER] 100 %FS	(100 %FS), 10 - 99 %FS, if required
3.15 20 MA OutB To Change Item: Press [ENTER] 100 %FS	(100 %FS), 10 - 99 %FS, if required
3.16 Passcode To Change Item: Press [ENTER] 0	(0), Any 1, 2, 3, or 4-digit positive number

Meter status

Meter status is viewable on the user display and includes mode of operation, flow rate, totalized flow and time, fluid type, ratio or fluid temperature, housing temperature, output current levels, 4mA/20mA output definitions, relay output states, passcode entry, alarm/limit status and event log, and manufacturing/calibration data.

All meter status information is displayed on Menu #1. through #1.12 as summarized in the table below.

Summary of meter status menus		
1. Mode: Measure Flow 7534 SCFH Flow% 89.7 %FS Meter OK	1.4 Output A: Flow AO-A 18.4 MA 4mA= 0.00 SCFH 20mA= 8400 SCFH	1.8 Event Log Change Item: ENTER ALARM:Meter Flo-Test Event Total: 0
1.1 Flow Totalizer Fluid Natural Gas Total 0 SCF Time 59.571 HRS	1.5 Output B: Ratio AO-B 14.8 MA 4mA= 0.00 20mA= 20.0	1.9 Passcode Entry User Setup:UNLOCKED Press [ENTER] 0
1.2 Meter Status Fluid 76.3°F Housing 82.3°F Meter OK	1.6 Input A: Flow AI-A 15.1 MA 4mA= 0.00 SCFH 20mA= 147000 SCFH	1.10 Unit Mfg Data A SMARTLINK Meter Maxon Corporation SMN10SSAIU-CSSA-101
1.3 Ratio Status Flow 7534 SCFH AI-A 102062 SCFH Ratio 13.5	1.7 Relay Outputs A: No Flow Test 1 B: No Alarms 1 C: No Limits 1	1.11 Unit Mfg Data B S/N-Main: 0604-068 S/N-Probe: 0612-052 S/W Version: 1.01
		1.12 Calibration: Min 420 SCFH Max 8400 SCFH Date 02/15/06

Note 1: Display indicates ratio function is disabled when AO-B is setup for "Fluid Temp"

Note 2: Display indicates fluid temperature when AO-B is setup for "Fluid Temp"

Alarm and limit conditions

Meter alarm and limit conditions are shown on the fourth line of the LCD on Menu #1 and Menu #1.2. When no alarm or limit condition exists, "Meter OK" will be displayed. Alarm conditions indicate a meter hardware failure, software fault, or an over-temperature condition. Each alarm/limit condition and its associated display message are listed in the table below.

Refer to the section of the operating instructions on limit output configuration for setting all limit output functions.

Alarm and limit condition summary	
Alarm or limit condition	Display message
Meter/Flow Test Alarm	"ALARM: Meter Flo-Test"
Meter Flow MA Test Alarm	"ALARM: Meter Flow-MA"
Meter Flow Hardware	"ALARM: Meter H/W-Flow"
Meter Temperature Hardware	"ALARM: Meter H/W-Temp"
Housing (Over) Temperature	"ALARM: Temp Housing"
Fluid (Over) Temperature	"ALARM: Temp Fluid"
Meter Voltage Hardware	"ALARM: Meter H/W-VDC"
Meter Software/Math	"ALARM: Meter S/W-Math"
Meter Resistance Hardware	"ALARM: Meter H/W-Ohms"
Meter Watchdog Reset	"ALARM: Meter Reset"
High Flow Limit, Analog Output-A	"LIMIT: HI OutA-Flow"
Low Flow Limit, Analog Output-A	"LIMIT: LO OutA-Flow"
High Ratio Limit, Analog Output-B	"LIMIT: HI OutB-Ratio"
Low Ratio Limit, Analog Output-B	"LIMIT: LO OutB-Ratio"
High Fluid Limit, Analog Output-B	"LIMIT: HI OutB-Fluid"
Low Fluid Limit, Analog Output-B	"LIMIT: LO OutB-Fluid"

Event log

The meter includes an event log of all alarm and limit conditions. The log holds the number of occurrences or "counts" for each event and is cleared when power is cycled or by executing an event log reset command, using Menu #2.5.

User commands

The following table summarizes all user commands. Command execution is inhibited if the meter is in a "Locked" state.

2. Totalizer Reset Execute: [ENTER] Total 1034 SCF Time 127.982 HRS	2.1 Meter/Flow Test Set Test ON: [ENTER] Flow Alarm 0 CNTS Error 0.0 %R	2.2 Output ON Test Set Test ON: [ENTER] Output A&B: 20 MA Relay Drives: ON	2.3 Output OFF Test Set Test OFF: [ENTER] Output A&B: 4 MA Relay Drives: OF	2.4 Setup Reset Execute: [ENTER] Reset User Setup to All factory defaults
2.5 Reset Event Log Execute: [ENTER] Reset history of all Alarm & Limit events	2.6 All Tests OFF Execute: [ENTER] Test Mode 0			

Meter/flow test

The Meter/Flow Test command can be initiated by the user display (on Menu #2.1) or a hardware input momentary ON pulse (i.e. 1 second, minimum ON duration). The test is a complete "self-check" of the meter electronics and RTD probe assembly and can be performed while the unit is measuring flow. The meter operating mode displayed during the test is shown as "Flo-Test" on Menu #1 and is active for 40 seconds to 2.5 minutes. During this mode, flow measurement and the 4-20mA output remain active, however, the fluid temperature is assumed to be the same value throughout the test. Because the ambient temperature sensing RTD is used as a velocity sensing RTD, the test should be performed only when the gas temperature and flow rate is steady and greater than 20% of full scale. In addition, all control loops that utilize the flow output should be disabled during the test. After the test completes, the meter will remain in the "Flo-Test" operating mode until the fluid temperature RTD has stabilized which can take up to approximately 2 minutes depending on flow rate. While observing the display after command execution, a test failure is indicated by a "Flow Alarm" count of 1 or more. If the test fails or the error percentage is greater than 2% just before being reset to 0%, refer to the maintenance instructions below on how to properly clean the RTD elements and when to send the flow sensor back for re-calibration. The Flow Alarm count can be reset using the "Reset Event Log" command on Menu #2.5.

Input/output tests

Two input/output test commands are provided on the user display for checkout of the electrical connections, I/O hardware, and external equipment after meter installation. These commands should only be executed when the outputs are not being used for monitoring and control purposes since normal operating output states are overridden. The "Output ON Test", on Menu #2.2, turns on all relay drive outputs and sets both 4-20mA signals to 20mA. Conversely, the "Output OFF Test", on Menu #2.3, turns off all relay drive outputs and sets both 4-20mA signals to 4mA. Each command can be "toggled" off as prompted on the display. In addition, the command, "All Tests OFF", on Menu #2.6, will turn either input/output command off as well as the meter/flow test.

Maintenance



Before removing a flow sensor, flow body, or flow conditioning screen, make sure there is no pressure in the line and power is turned off to the meter. For combustible gases, be sure the line is completely purged before removing the probe.

Because SMARTLINK® METER has no moving parts and includes advanced diagnostics, periodic/preventative maintenance activities are limited to the following:

Sensor probe and conditioning screen inspection

When a meter is first installed, the two RTD elements of the sensor probe and the flow conditioning screens should be inspected for dirt build-up in the first several months of operation and a cleaning schedule established as required. For gas meters, pressure taps can be installed up and downstream of the flow body to assist in determining flow conditioning screen blockage. For air meters, one pressure tap is provided downstream of the second flow conditioning screen. An additional pressure tap should be installed upstream of the flow body extension as shown in the section on piping requirements. If taps are installed, a differential pressure measurement can be made at 50% full scale flow or higher to determine if screens are significantly blocked. For properly installed natural gas piping and combustion air applications with appropriate inlet filtering, a typical inspection/cleaning period is every 6 to 12 months.

The inspection of the flow conditioning screens on gas meters will require removal of the body from the line. The flow conditioning screens for air meters are removable. For screen removal, provide temporary support for the air flow body. Loosen and remove the flange bolts on half of the flow body surrounding the handle. Use 3 to 5 jack bolts to spread the flanges. Remove the screens by grasping and pulling the handle outward from the body. Clean and replace each screen, making certain the alignment pin fits in the adjacent flange. Replace and tighten all flange bolts.

To inspect the flow sensor probe, turn power off to the device, depressurize and/or purge the pipe of any hydrocarbon gas. Remove the 3/8" jam nut on the threaded stud of the flow body mast, and loosen the brass compression nut fitting. Remove the flow meter from the flow body. Inspect the two RTD elements sheathed in stainless steel. If coated with any foreign material or film, carefully clean both RTD "stings" with water or alcohol (ethanol) and a soft brush until they appear clean again. Reinstall the flow sensor per the installation instructions on flow sensor insertion.

Alarm/event log monitoring and meter/flow test execution

The following flow sensor maintenance procedures must be performed before each scheduled probe and flow conditioning screen inspection:

SMARTLINK® METER includes "built-in" diagnostics for detection of meter hardware failures, software faults, and over-temperature conditions. An event log can be displayed with the total number of alarm occurrences or "events." While measuring flow and before powering down the meter for probe inspection, view Menu #1 for any existing alarm conditions and check the event log on Menu #1.8 for alarm conditions that may have occurred since the last meter power-up. If the meter is remotely mounted (and not easily accessible) or is periodically powered down (clearing the event log), wire the alarm relay drive output to an external relay and lamp to indicate when an alarm condition is active and continuously monitor the alarm output with a PLC/DCS system.

After checking for meter alarms, execute the Meter/Flow Test command on Menu #2.1 which performs a complete "self-check" of the meter electronics and RTD probe assembly while the unit is measuring flow. (Refer to the operating instructions on User Commands for more detailed information on use of the Meter/Flow Test.)

If the Meter/Flow Test fails or other alarm conditions exist (or were recorded in the event log), take the corrective action recommended in the troubleshooting section below.

Field validation of meter reading and spare meter comparison

Perform field validation of the flow meter reading after each scheduled probe and flow conditioning screen inspection. For the majority of combustion applications, gas and air flow rates can be approximated by measuring differential pressures across burner orifices. To perform field validation of the meter reading, place the process temperature controller in manual mode and drive the burner to a specific firing rate, 20% to 100% of burner rated capacity. Using the technical product manual of the installed burner, estimate the flow rates using the differential pressure measurements and compare these flows to the meter readings. If the difference between calculated and measured flow rate is greater than ~10% (of reading) or there is a "shift" in the error percentage (from the previous validation) of ~5% or greater, refer to the troubleshooting section for corrective action. If process conditions permit, it is important to perform this field validation process each time at the same flow rate or set of flow rates (if validation of more than one flow rate is desired).

If flow cannot be derived from secondary measurements, perform field validation by meter output comparison with a spare flow sensor. The output of the primary meter should be recorded at a specific set of process conditions (i.e. burner firing rate, control valve position, or variable speed drive frequency, etc.). Power down the primary sensor, remove from the flow body, and replace with the spare flow sensor which must match the primary sensor's calibration range and gas type. Re-establish the same process conditions and compare the spare sensor output to the recorded value. If the comparison error exceeds $\pm 5\%$ of reading, return the primary sensor to MAXON for factory re-calibration.

Factory calibration

For applications which do not use meter flow outputs for closed-loop control, factory re-calibration is not required if the following preventative maintenance activities are performed successfully on the same schedule as probe and flow conditioning screen inspection:

- Field validation of meter reading,
- Alarm and event log monitoring, and
- Meter/flow test execution.

For applications which use meter flow outputs for safety-critical closed-loop combustion control, factory re-calibration of the meter is recommended every three years or on a more frequent interval based on plant QA requirements, ISO compliance, or sensor probe erosion (due to fine abrasives, trace amounts of H_2S , etc.). Factory re-calibration, however, can be eliminated if the field validation process uses a second, spare flow meter for comparison to the installed meter. (Refer to the field validation process instructions above when using a spare flow meter.) Re-calibration requires only the return of the flow sensor and not the flow body.

Troubleshooting and corrective action



The SMARTLINK® METER electronics and sensor probe assembly is calibrated as an integrated precision mass flow meter. Interchanging sensor probe or electronics will produce incorrect outputs and negate the factory calibration. Do not remove the electronic boards or probe assembly (other than the LCD module for orientation changes). Board level inspection and replacement is performed only at the factory.

Contact MAXON sales for return equipment authorization (REA). When a meter is returned to MAXON, place the red plastic protective cap over the end of the probe, package the meter to prevent shipping damage, and indicate on the return authorization what specific alarms/test failures occurred and under what operating conditions.

The following table should be used to identify a possible cause and corrective action.

Meter problem	Possible causes and corrective actions
One or more of following alarms: "ALARM: Meter H/W-Flow" "ALARM: Meter H/W-Temp" "ALARM: Meter H/W-VDC" "ALARM: Meter S/W-Math" "ALARM: Meter H/W-Ohms" "ALARM: Meter Reset"	a.) Permanent electronic hardware/software failure or sensor probe assembly damage. b.) Non-permanent electronic hardware/software fault due to voltage transient. Re-power unit. If alarm events re-occur, record alarms and operating conditions, i.e. flow, gas temperature, etc. Return flow sensor to MAXON.
Flow MA (AO-A) test alarm: "ALARM: Meter Flow-MA"	a.) Incorrect 4-20mA wiring or Loop Power switch position: Verify the following: no open circuit exists in field-wiring, correct voltage and polarity for external loop power, maximum loop resistance of 750 Ohms, and "EXT. 24V MAX" position of Loop Power switch in wiring compartment. b.) Permanent electronic hardware failure: If problem still exists after verifications listed above, remove all field wiring and connect a jumper across AO-A output terminals. Select "INT 24V" for Loop Power switch position. If alarm condition still exists, return flow sensor to MAXON.
Fluid temperature alarm: "ALARM: Temp Fluid"	a.) Fluid temperature is out of permissible operating range: Increase/decrease fluid temperature to be within flow meter specified range. b.) Permanent electronic hardware or temperature RTD wire/probe assembly failure: Indicated by a non-realistic temperature reading; return flow sensor to MAXON.
Housing temperature alarm: "ALARM: Temp Housing"	a.) Housing temperature exceeds electronic temperature operating range: Correct out-of-range ambient temperature condition surrounding flow sensor enclosure. b.) Permanent electronic hardware failure: Indicated by a non-realistic temperature; return flow sensor to MAXON.
Meter/Flow Test failure indicated by event counts or alarm display: "ALARM: Meter Flo-Test"	a.) Test performed at zero or low flows: Reset event log and re-start test at flow rates 20% full scale or higher. (Refer to operating instructions for test condition requirements.) If test can only be performed at no or low flows, initiate 2nd or 3rd test immediately after error % is reset to zero and display prompts for setting test "ON". Test should pass on 2nd or 3rd attempt with no or low flow. b.) Foreign material build-up on probe assembly: Inspect and clean probe assembly as described in maintenance instructions. Re-test and verify test passes. c.) Permanent electronic or probe assembly failure: Re-test and verify alarm continues to occur. Return flow sensor to MAXON.

Meter problem	Possible causes and corrective actions
Field validation of meter reading fails (high or low) and/or flow reading fluctuates significantly	<p>a.) Flow conditioning screens filled with debris: Clean screens and re-validate meter reading.</p> <p>b.) Missing flow conditioning screen: For air meters, verify both removable screens are installed.</p> <p>c.) Flow body extension is not correctly installed: For air meters, verify extension is positioned upstream of spool piece with flow sensor support bracket (mast).</p> <p>d.) Flow body in backwards: Verify flow direction is consistent with direction arrow on flow body.</p> <p>e.) Sensor probe assembly needs cleaning: Clean RTD elements of probe assembly as described in maintenance instructions.</p> <p>f.) Flow disturbance due to insufficient up or downstream straight-run piping: Correct flow body installation as described in piping requirements section.</p> <p>g.) Meter requires calibration or electronics/probe assembly is damaged: First verify that validation failure is not due to causes listed above. Perform Meter/Flow Test and field validation with spare sensor, if available. Return to MAXON if field validation indicates output difference with spare sensor.</p>
Flow reading "spikes" high	Condensing moisture on probe: Find and remove moisture source. Add insulation around pipe if moisture saturated gas condenses on cool pipe and flow body walls.
Flow reading does not read zero at zero flow	Convective flows around heated RTD element at higher gas pressures: Increase the zero cut-off configuration parameter to 1-2% FS (full scale).
No 4-20 mA signal	<p>a.) Incorrect 4-20mA wiring or Loop Power switch position: Verify the following: no open circuit exists in field-wiring, correct voltage and polarity for external loop power, maximum loop resistance of 750 Ohms, and "EXT. 24V MAX" position of Loop Power switch in wiring compartment.</p> <p>b.) Permanent electronic hardware failure: If problem still exists after verifications listed above, remove all field wiring and connect a jumper across AO-A output terminals. Select "INT 24V" for Loop Power switch position. If alarm condition still exists, return flow sensor to MAXON.</p>
4-20 mA output saturates before reaching full scale flow, ratio, or fluid temperature	Incorrect configuration setting: Set 20 mA Flow or 20 mA Out-B configuration parameters to 100% FS (full scale).
LCD characters change slowly or characters are unreadable (dark)	LCD viewing temperature range is exceeded: Electronics for flow measurement works over -40°F (-40°C) to +158°F (+70°C) but LCD viewing is limited to -4°F (-20°C) to +122°F (+50°C).
Keypad does not work	Keypad ribbon connector disconnected from main electronics board: Re-attach ribbon connector to main board.

Appendix A: Display menu summary

Meter status	User commands	User configuration
1. Mode: Measure Flow 7534 SCFH Flow% 89.7 %FS Meter OK	2. Totalizer Reset Execute: [ENTER] Total 1034 SCF Time 127.982 HRS	3. Flow Units To Change Item: Press [ENTER] SCFH
1.1 Flow Totalizer Fluid Natural Gas Total 0 SCF Time 59.571 HRS	2.1 Meter/Flow Test Set Test ON: [ENTER] Flow Alarm 0 CNTS Error 0.0 %R	3.1 Temp Units To Change Item: Press [ENTER] °F
1.2 Meter Status Fluid 76.3°F Housing 82.3°F Meter OK	2.2 Output ON Test Set Test ON: [ENTER] Output A&B: 20 MA Relay Drives: ON	3.2 Output-B Setup To Change Item: Press [ENTER] Ratio AI/AO
1.3 Ratio Status (Note 1) Flow 7534 SCFH AI-A 102062 SCFH Ratio 13.5	2.3 Output OFF Test Set Test OFF: [ENTER] Output A&B: 4 MA Relay Drives: OFF	3.3 Flow/IN X-Factor To Change Item: Press [ENTER] 1.000
1.4 Output A: Flow AO-A 18.4 MA 4ma= 0.00 SCFH 20ma= 8400 SCFH	2.4 Setup Reset Execute: [ENTER] Reset User Setup to All factory defaults	3.4 20MA Ratio AO-B To Change Item: Press [ENTER] 20.0
1.5 Output B: Ratio (Note 2) AO-B 14.8 MA 4ma= 0.00 20ma= 20.0	2.5 Reset Event Log Execute: [ENTER] Reset history of all Alarm & Limit events	3.5 AC Filter To Change Item: Press [ENTER] 60Hz
1.6 Input A: Flow AI-A 15.1 MA 4ma= 0.00 SCFH 20ma= 147000 SCFH	2.6 All Tests OFF Execute: [ENTER] Test Mode 0	3.6 21.5MA Alarm To Change Item: Press [ENTER] Disabled
1.7 Relay Outputs A: No Flow Test 1 B: No Alarms 1 C: No Limits 1		3.7 Flow Filter To Change Item: Press [ENTER] 0 SECS
1.8 Event Log Change Item: [ENTER] ALARM:Meter Flo-Test Event Total: 0		3.8 Flow Bias To Change Item: Press [ENTER] 1.00
1.9 Passcode Entry User Setup:UNLOCKED Press [ENTER] 0		3.9 Flow Cutoff To Change Item: Press [ENTER] 0.5 %FS
1.10 Unit Mfg Data A SMARTLINK Meter Maxon Corporation SMN10SSAIU-CSSA-101		3.10 LO Limit A-Flow To Change Item: Press [ENTER] -1.00 %FS
1.11 Unit Mfg Data B S/N-Main: 0604-068 S/N-Probe: 0612-052 S/W Version: 1.01		3.11 HI Limit A-Flow To Change Item: Press [ENTER] 110 %FS
1.12 Calibration: Min 420 SCFH Max 8400 SCFH Date 02/15/06		3.12 LO Limit B To Change Item: Press [ENTER] -1.00 %FS
		3.13 HI Limit B To Change Item: Press [ENTER] 110 %FS
		3.14 20MA Flow To Change Item: Press [ENTER] 100 %FS
		3.15 20MA OutB To Change Item: Press [ENTER] 100 %FS
		3.16 Passcode To Change Item: Press [ENTER] 0

Note 1: Display indicates ratio function is disabled when AO-B is setup for "Fluid Temp"

Note 2: Display indicates fluid temperature when AO-B is setup for "Fluid Temp"

Appendix B: Flow rate conversion factors

The following table provides the conversion factor for displaying mass flow rate referenced to several alternative "Standard" or "Normal" conditions. This table was created using the following two general equations:

$$Q = Q_S \times \left(\frac{P_S}{P} \right) \times \left(\frac{T}{T_S} \right)$$

$$Q = Q_N \times \left(\frac{P_N}{P} \right) \times \left(\frac{T}{T_N} \right)$$

Where:

Q = Mass Flow Rate at alternate reference conditions, P and T

Q_S = Mass Flow Rate referenced to "Standard" conditions, (60°F and 14.73 psia)

Q_N = Mass Flow Rate referenced to "Normal" conditions, (32°F and 14.696 psia)

P_S = "Standard" pressure reference condition of 14.73 psia

T_S = "Standard" temperature reference conditions of 519.67 °R (60°F)

P_N = "Normal" pressure reference condition of 14.696 psia

T_N = "Normal" temperature reference condition of 491.67 °R (32°F)

P = Alternative pressure reference condition in psia

T = Alternative temperature reference condition in ° R, (°Rankin = °F + 459.67)

Conversion factor for flow rate referenced to alternative conditions		Reference temperature	Reference Pressures				
From MAXON "Standard conditions" (60°F and 14.73 psia)	From MAXON "Normal conditions" (32°F and 14.696 psia)	°F	psia	ATM	mmHg	Bar	kPa
0.998	1.057	60	14.696	1.000	760	1.013	101.325
1.000	1.055	60	14.730	1.002	762	1.016	101.560
0.996	1.055	59	14.696	1.000	760	1.013	101.325
1.017	1.077	70	14.696	1.000	760	1.013	101.325
0.932	1.013	32	14.504	0.987	750	1.000	100.000
0.944	1.000	32	14.696	1.000	760	1.013	101.325
0.996	1.055	59	14.696	1.000	760	1.013	101.325
1.013	1.073	68	14.696	1.000	760	1.013	101.325
1.030	1.092	77	14.696	1.000	760	1.013	101.325
1.017	1.106	77	14.504	0.987	750	1.000	100.000
1.000	1.087	68	14.504	0.987	750	1.000	100.000
.0983	1.069	59	14.504	0.987	750	1.000	100.000