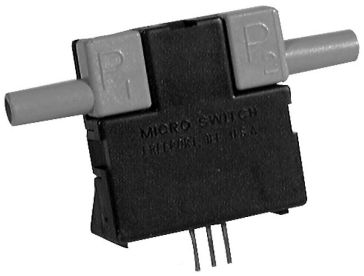
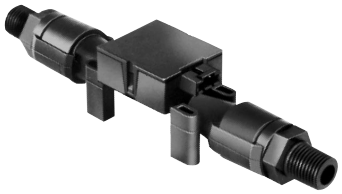
Airflow Sensors
Microbridge Mass Airflow



AWM 1000/2000/3000 Series

AWM 40000 Series



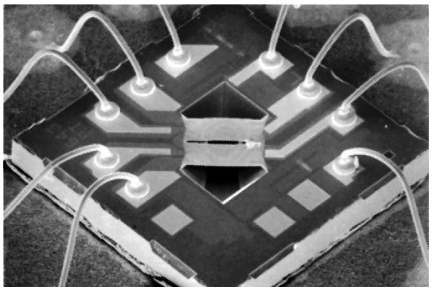
AWM 5000 Series

FEATURES
- State-of-the-art silicon micromachining
- Sensitive to low flows – 0.1 sccm to 20 SLPM
- Adaptable for use with higher flows (See Application Note 2 page 128.)
- Fast response time
- Analog output
- Low power consumption
- Repeatable response
- Laser-trimmed interchangeability
- Accurate, cost effective flow sensing
- In-line printed circuit board terminals
- Standard 0.100″ (2,54mm) mounting centers
- Accurate sensing of low pressure 0.001″ to 4.0″ H_2O (.003 to 10mBar)

APPLICATIONS
- Damper control for heating, ventilation, and air conditioning systems
- Gas analyzers
- Low vacuum control
- Process control
- Medical respirators and ventilators
- Oxygen concentrators
- Leak detection equipment
- Vent hoods
- Anesthesia control
- Gas metering
- Gas chromatography

OPERATION
The microbridge mass airflow sensor operates on the theory of heat transfer. Mass airflow is directed across the surface of the sensing elements. Output voltage varies in proportion to the mass air or other gas flow through the inlet and outlet ports of the package. The specially designed housing precisely directs and controls the airflow across the microstructure sense element. Mechanical design of the package allows it to be easily mounted to printed circuit boards.

The microbridge mass airflow sensor has a unique silicon chip based on advanced microstructure technology. It consists of a thin-film, thermally isolated bridge structure containing heater and temperature sensing elements. The bridge structure provides a sensitive and fast response to the flow of air or other gas over the chip. Dual sensing elements positioned on both sides of a central heating element indicate flow direction as well as flow rate. Laser trimmed thick film and thin film resistors provide consistent interchangeability from one device to the next.



The microbridge mass airflow sensor uses temperature-sensitive resistors deposited within a thin film of silicon nitride. They are suspended in the form of two bridges over an etched cavity in the silicon, shown below. The chip is located in a precisely dimensioned airflow channel to provide a repeatable flow response. Highly effective thermal isolation for the heater and sensing resistors is attained by etching the cavity space beneath the flow sensor bridges. The small size and thermal isolation of the microbridge mass airflow sensor are responsible for the extremely fast response and high sensitivity to flows.

Dual Wheatstone bridges control airflow measurement — one provides closed loop heater control, the other contains the dual sensing elements. The heater circuit minimizes shift due to ambient temperature changes by providing an output proportional to mass flow. The circuit keeps the heater temperature at a constant differential (160°C) above ambient air temperature which is sensed by a heat-sunk resistor on the chip. The ratiometric voltage output of the device corresponds to the differential voltage across the Wheatstone bridge circuit.

NOTICE
Dust contamination may be possible in some applications, the effects of which can be minimized. By design, dust particles that may be present in the air stream will flow past the chip parallel to the chip surface. In addition, the microstructure chip produces a thermophoretic effect, which repels micrometer-sized dust particles away from the bridge structure.

Dust adherence to chip edges and channel surfaces can be prevented using a simple filter. A disposable five-micron filter used in series on the upstream side of the airflow device will provide adequate filtering in most applications. For a list of possible filter sources, see Filter Manufacturers, page 126.

CAUTION
PRODUCT DAMAGE

AWM Series Microbridge Mass Airflow Sensors are **NOT** designed to sense liquid flow and will be damaged by liquid flow through the sensor.

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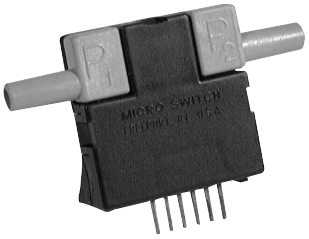
Microbridge Mass Airflow/Unamplified



FEATURES
- Cost-effective microbridge technology
- Accurate, repeatable airflow sensing
- Bi-directional sensing capability
- Low differential pressure sensing

Take advantage of microbridge mass flow sensor technology. The AWM1000 series mass flow sensor provides all of the outstanding performance benefits of the standard AWM2000 series in a more cost-effective sensor platform. This device provides accurate, repeatable flow sensing. Sensor to sensor interchangeability specifications are approximately twice as large as compared to the AWM2000 series.

The heater control circuit in Figure 1 and the sensing bridge supply circuit in Figure 2 are both required for operation per specification. These two circuits are **NOT** on board the sensor and must be supplied in the application. The differential amplifier circuitry in Figure 3 may be useful in providing output gain and/or introducing voltage offsets to the sensor output (Ref. Equation 1).

NOTE: For applications involving sensing hydrogen (H_2) gas or helium (He) gas, see Application Note 3, page 131.

Figure 1
Heater Control Circuit

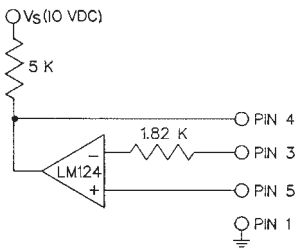


Figure 2
Sensing Bridge Supply Circuit

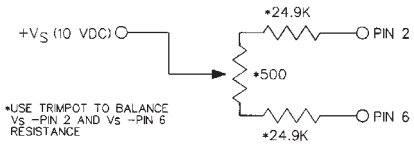
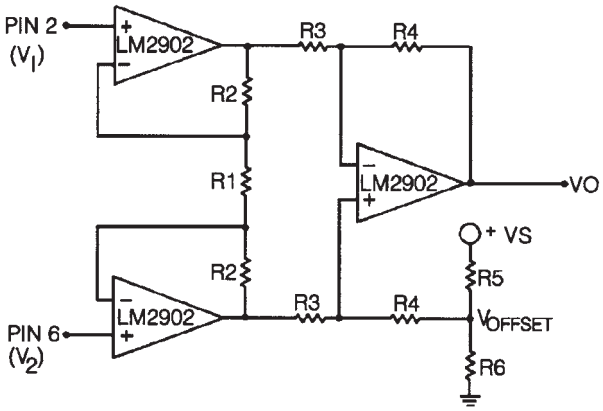


Figure 3
Differential Instrumentation Amplifier Circuit



Equation 1:

$$V_o = \left(\frac{2R_2+R_1}{R_1}\right)\left(\frac{R_4}{R_3}\right)\left(V_2-V_1\right)+V\ \text{offset}$$

$$\text{where } V\ \text{offset} = V_s\left(\frac{R_6}{R_6+R_5}\right)$$

Airflow

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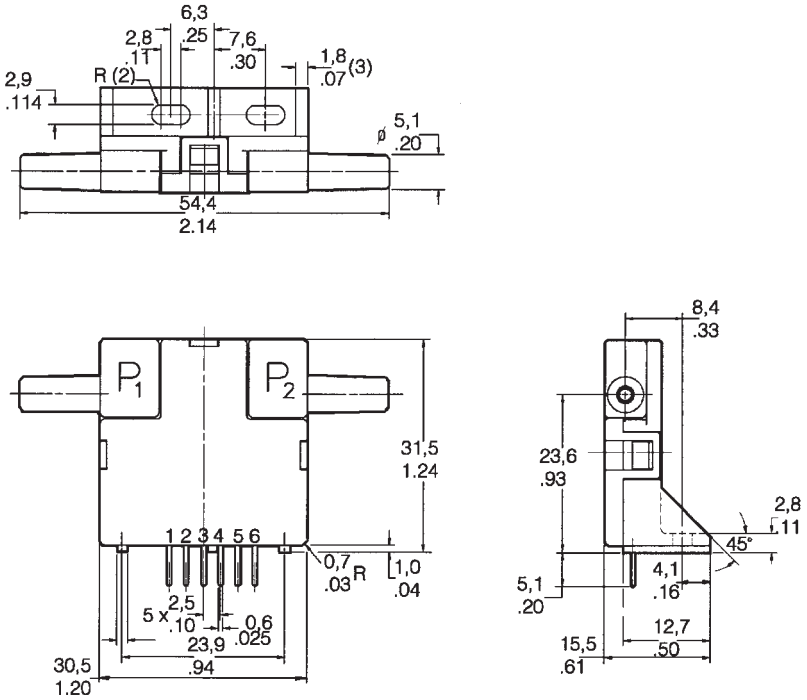
Microbridge Mass Airflow/Unamplified

AWM1000 SERIES ORDER GUIDE (Performance Characteristics @ 10.0 ±0.01 VDC, 25°C)

Catalog Listings	AWM1100V	AWM1200V	AWM1300V
Flow Range (Full Scale)	±200 sccm		+1000 sccm to −600 sccm
Pressure Range (See Application Note #1)		±4.0″ H_2O (10 mBar)	
Output Voltage @ Trim Point	30 mV @ 100 sccm	20 mV @ 2.0″ H_2O	50 mV @ 650 sccm
Null Voltage Shift, Typ. +25 to −25°C, +25 to 85°C	±0.7 mV (max.)	±0.7 mV (max.)	±0.7 mV (max.)
Output Voltage Shift, Max. +25 to −25°C +25 to +85°C	±4% Full Scale ±4% Full Scale	+22% Reading (Note 2) −22% Reading	±4% Full Scale ±4% Full Scale
Repeatability & Hysteresis, Max.	±1% Full Scale	±1% Full Scale	±1% Full Scale
	Min.	**Typ.**	**Max.**
Excitation (VDC) (Note 1)	8.0	10±0.01	15
Power Consumption (mW)	—	30	50
Null Voltage (mV)	−1.0	0.0	+1.0
Response Time (msec)	—	1.0	3.0
Common Mode Pressure (psi)	—	—	25
Sensor Resistance (kΩ) Pin 2-Pin 1, Pin 6-Pin 1	—	5	—
Sensor Current (mA) Pin 2-Pin 1, Pin 6-Pin 1	—	0.3	0.6
Temperature Range	Operating: −25° to +85°C (−13° to +185°F); Storage: −40° to +90°C (−40° to +194°F)		
Termination	2,54 mm (.100″) centers, 0,635 mm (0.025″) square		
Weight (grams)	10.8		
Shock Rating	100 g peak (5 drops, 6 axes)		

Notes:
1. Output Voltage is ratiometric to supply voltage.
2. Temperature shifts when sensing differential pressure correlates to the density change of the gas over temperature. See Application Note 1.
3. Maximum allowable rate of flow change to prevent damage: 5 SLPM/1.0 sec.

MOUNTING DIMENSIONS (for reference only)



NOTE: Positive flow direction is defined as proceeding from Port 1 (P1) to Port 2 (P2) and results in positive output (Pin 6 > Pin 2). Negative flow direction is defined conversely and results in negative output (Pin 6 < Pin 2). Do not exert a force greater than 4.54 kg (10 lbs.) in any direction.

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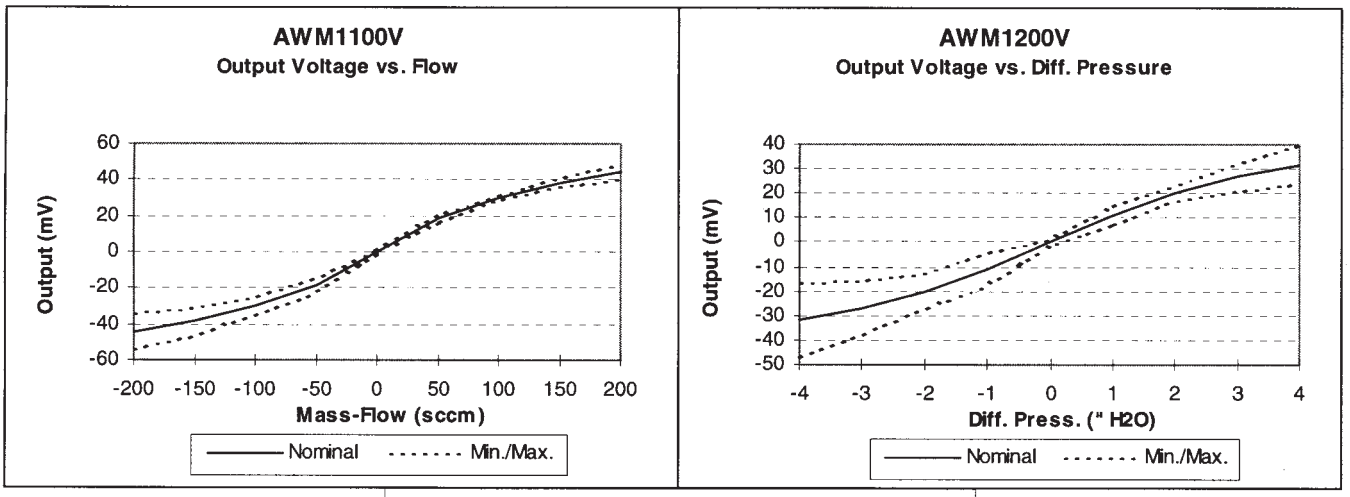
Microbridge Mass Airflow/Unamplified

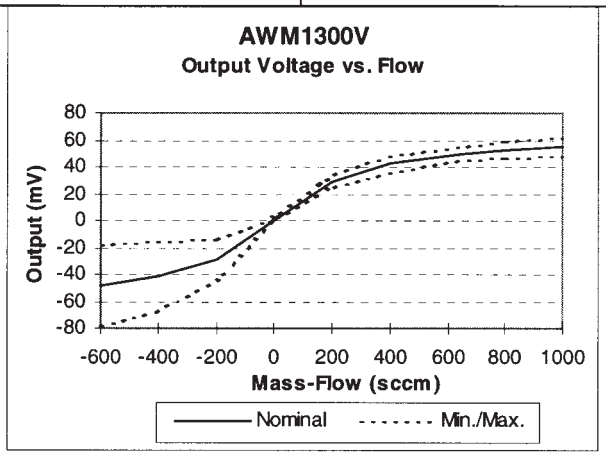
OUTPUT FLOW VS INTERCHANGEABILITY (Note 1) **Performance Characteristics @ 10.0 ±0.01 VDC, 25°C**

AWM1100V				AWM1200V (Note 2)				AWM1300V			
Press mBar	**Flow sccm**	**Nom. mV**	**Tol. ±mV**	Flow sccm	**Press. ″ H_2O**	**Nom. mV**	**Tol. ±mV**	Press mBar	**Flow sccm**	**Nom. mV**	**Tol. ±mV**
0.49	**200**	44.25	4.25	120	**4.00**	31.75	8.0	3.4	**1000**	55.50	7.0
0.35	**150**	38.75	3.00	90	**3.00**	26.75	6.0	2.4	**800**	52.90	6.0
0.21	**100**	30.00	1.00	60	**2.00**	20.00	3.0	1.8	**650**	50.00	5.0
0.09	**50**	18.40	2.00	30	**1.00**	11.20	4.0	0.83	**400**	42.50	6.0
0	**0**	0.00	1.00	0	**0.00**	0.00	1.0	0.31	**200**	29.20	5.0
−0.09	**−50**	−18.40	3.90	−30	**−1.00**	−11.20	7.0	0	**0**	0.00	1.5
−0.21	**−100**	−30.00	5.00	−60	**−2.00**	−20.00	7.0	−0.31	**−200**	−28.90	15.0
−0.35	**−150**	−38.75	7.65	−90	**−3.00**	−26.75	11.0	−0.83	**−400**	−41.20	26.0
−0.49	**−200**	−44.25	9.75	−120	**−4.00**	−31.75	15.0	−1.6	**−600**	−48.20	30.0

Notes:
1. Numbers in **BOLD** type indicate calibration type, mass flow or differential pressure. Tolerance values apply to calibration type only.
2. Differential pressure calibrated devices are not recommended for flow measurement. Use flow calibrated devices for flow measurement.

OUTPUT CURVES





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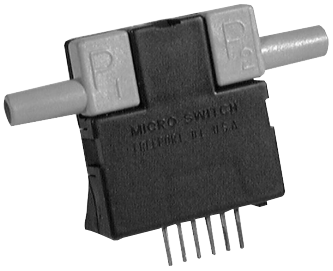
Microbridge Mass Airflow/Unamplified



FEATURES
- Bidirectional sensing capability
- Actual mass air flow sensing
- Low differential pressure sensing

The AWM2000 Series microbridge mass airflow sensor is a passive device comprised of two Wheatstone bridges. The heater control circuit in Figure 1 is required for operation per specifications. The sensing bridge supply circuit in Figure 2 is also required for operation per specifications. These two circuits are **not on board** the package and must be supplied in the application. The differential amplifier in Figure 3 is a useful interface for the sensing bridge. It can be used to introduce the gain and to introduce voltage offsets to the sensor output as referenced in Equation 1.

Note: For applications sensing hydrogen or helium, see Application Note 3, page 131.

Figure 1
Heater Control Circuit

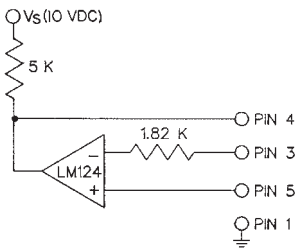


Figure 2
Sensing Bridge Supply Circuit

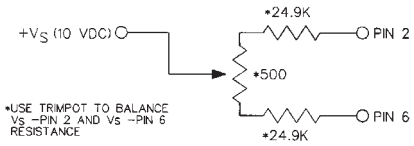
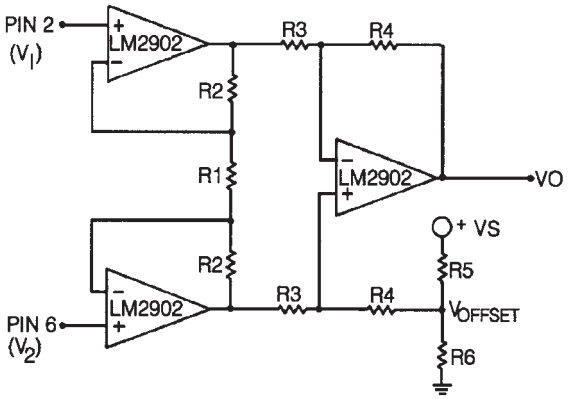


Figure 3
Differential Instrumentation Amplifier Circuit



Equation 1:

$$V_o = \left(\frac{2R_2+R_1}{R_1}\right)\left(\frac{R_4}{R_3}\right)\left(V_2-V_1\right)+V\ \text{offset}$$

$$\text{where } V\ \text{offset} = V_s\left(\frac{R_6}{R_6+R_5}\right)$$

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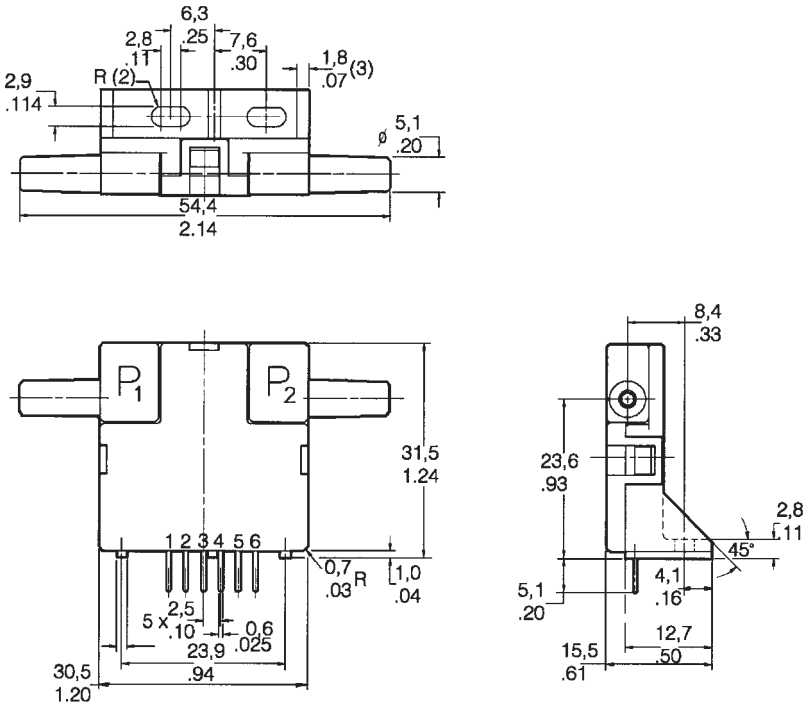
Microbridge Mass Airflow/Unamplified

AWM2000 SERIES ORDER GUIDE (Performance Characteristics @ 10.01 ±0.01 VDC, 25°C)

Catalog Listings	AWM2100V	AWM2150V	AWM2200V	AWM2300V
Flow Range (Full Scale)	±200 sccm	±30 sccm		±1000 sccm
Pressure Range (See Application Note #1)			±4.0″ H_2O (10 mBar)	
Output Voltage @ Trim Point	30 mV @ 100 sccm	11.8 mV @ 25 sccm	20 mV @ 2″ H_2O	50 mV @ 650 sccm
Null Voltage Shift, Typ. +25° to −25°C, +25° to 85°C	±0.20 mV	±0.20 mV	±0.20 mV	±0.20 mV
Output Voltage Shift, Max. +25° to −25°C +25° to +85°C	+2.5% Reading −2.5% Reading	+5% Reading −5% Reading	+22% Reading (Note 2) −22% Reading	+5% Reading −5% Reading
Repeatability & Hysteresis, Max.	±0.35% Reading	±0.35% Reading	±0.35% Reading	±1% Reading
	Min.	**Typ.**	**Max.**	
Excitation (VDC) (Note 1)	8.0	10±0.01	15	
Power Consumption (mW)	—	30	50	
Null Voltage (mV)	−1.0	0.0	+1.0	
Response Time (msec)	—	1.0	3.0	
Common Mode Pressure (psi)	—	—	25	
Sensor Resistance (kΩ) Pin 2-Pin 1, Pin 6-Pin 1	—	5	—	
Sensor Current (mA) Pin 2-Pin 1, Pin 6-Pin 1	—	—	0.6	
Temperature Range	Operating: −25° to +85°C (−13° to +185°F); Storage: −40° to +90°C (−40° to +194°F)			
Termination	2,54 mm (.100″) centers, 0,635 mm (0.025″) square			
Weight (grams)	10.8			
Shock Rating	100 g peak (5 drops, 6 axes)			

Notes:
1. Output Voltage is ratiometric to supply voltage.
2. Temperature shifts when sensing differential pressure correlates to the density change of the gas over temperature. See Application Note 1.
3. Maximum allowable rate of flow change to prevent damage: 5.0 SLPM/1.0 sec.

MOUNTING DIMENSIONS (for reference only)



NOTE: Positive flow direction is defined as proceeding from Port 1 (P1) to Port 2 (P2) and results in positive output (Pin 6 > Pin 2). Negative flow direction is defined conversely and results in negative output (Pin 6 < Pin 2). Do not exert a force greater than 4.54 kg (10 lbs.) in any direction.

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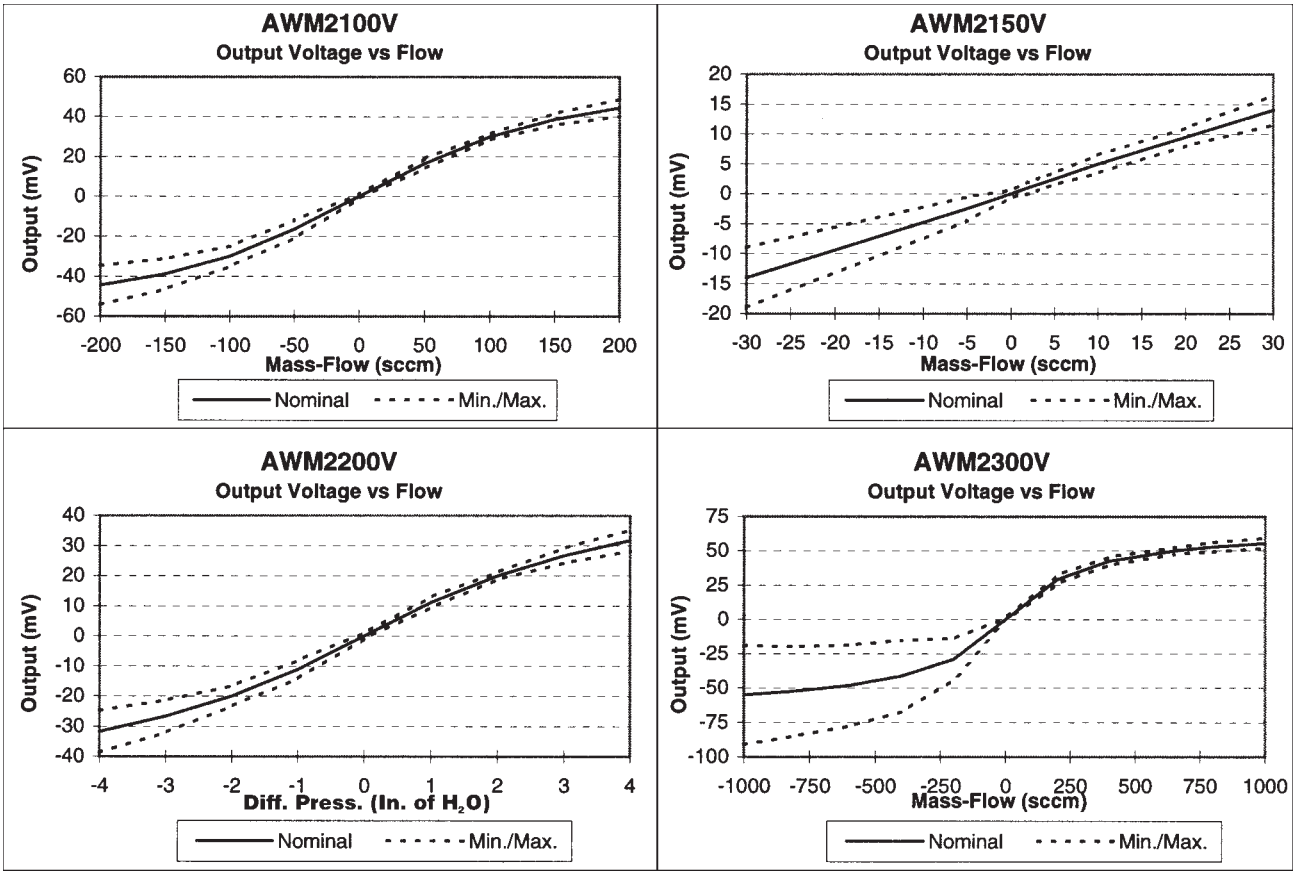
Microbridge Mass Airflow/Unamplified

OUTPUT FLOW VS INTERCHANGEABILITY (Note 1) **Performance Characteristics @ 10.0 ±0.01 VDC, 25°C**

AWM2100V				AWM2150V				AWM2200V (Note 2)				AWM2300V			
Press. mBar	**Flow sccm**	**Nom. mV**	**Tol. ±mV**	Press. μBar	**Flow sccm**	**Nom. mV**	**Tol. ±mV**	Flow sccm	**Press. ″ H_2O**	**Nom. mV**	**Tol. ±mV**	Press. mBar	**Flow sccm**	**Nom. mV**	**Tol. ±mV**
0.49	**200**	44.50	4.25	53	**30**	14.0	2.5	120	**4.00**	31.75	3.50	3.4	**1000**	55.50	3.70
0.35	**150**	38.75	3.00	36	**20**	9.5	1.5	90	**3.00**	26.75	2.50	2.4	**800**	52.90	3.50
0.21	**100**	30.00	1.50	17	**10**	5.0	1.5	60	**2.00**	20.00	1.20	1.8	**650**	50.00	2.50
0.09	**50**	16.50	2.50	9.8	**5**	2.5	1.0	30	**1.00**	11.20	1.80	0.83	**400**	42.50	3.00
0.00	**0**	0.00	1.00	7.4	**4**	2.0	1.0	0	**0.00**	0.00	1.00	0.31	**200**	29.20	3.20
−0.09	**−50**	−16.50	4.50	6.2	**3**	1.5	1.0	−30	**−1.00**	−11.20	3.00	0	**0**	0.00	1.00
−0.21	**−100**	−30.00	5.00	5	**2**	1.0	1.0	−60	**−2.00**	−20.00	3.30	−0.31	**−200**	−28.90	15.00
−0.35	**−150**	−38.80	7.65	2.5	**1**	0.5	0.8	−90	**−3.00**	−26.75	5.30	−0.83	**−400**	−41.20	26.00
−0.49	**−200**	−44.50	9.75	0	**0**	0.0	0.6	−120	**−4.00**	−31.75	7.00	−1.6	**−600**	−48.20	29.50
				−9.8	**−5**	−2.5	2.0					−2.4	**−800**	−52.20	32.50
				−53	**−30**	−14.0	5.0					−3.4	**−1000**	−55.00	36.00

Notes:
1. Numbers in **BOLD** type indicate calibration type, mass flow or differential pressure. Tolerance values apply to calibration type only.
2. Differential pressure calibrated devices are not recommended for flow measurement. Use flow calibrated devices for flow measurement.

OUTPUT CURVES



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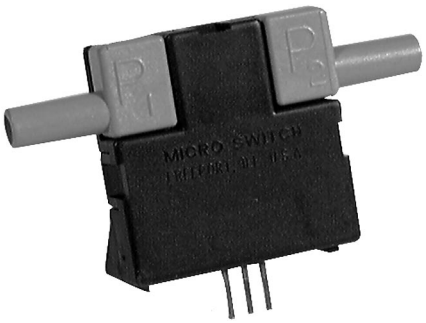


FEATURES

- Laser trimmed for improved sensor interchangeability
- Flow sensing up to 1.0 SLPM
- Low differential pressure sensing

Like the AWM2000 Series, the dual Wheatstone bridges control airflow measurement. The AWM3000 Series is amplified; therefore, it can be used to increase the gain and to introduce voltage offsets to the sensor output. The schematic in Figure 3 depicts the amplification circuitry on board the sensor. Also, the heater control circuit (see Figure 1) and the sensing bridge supply circuit (see Figure 2) are on board the package.

Figure 1
Heater control circuit

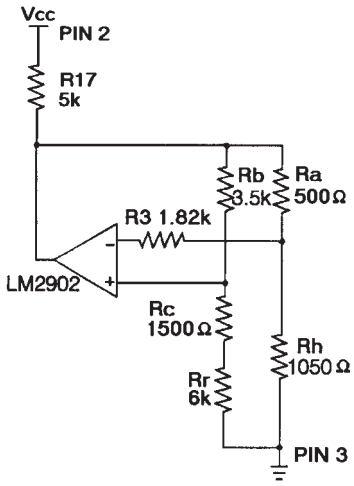


Figure 2
Sensing bridge supply circuit

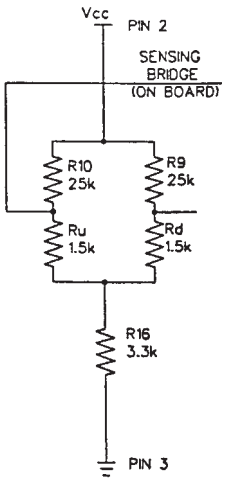
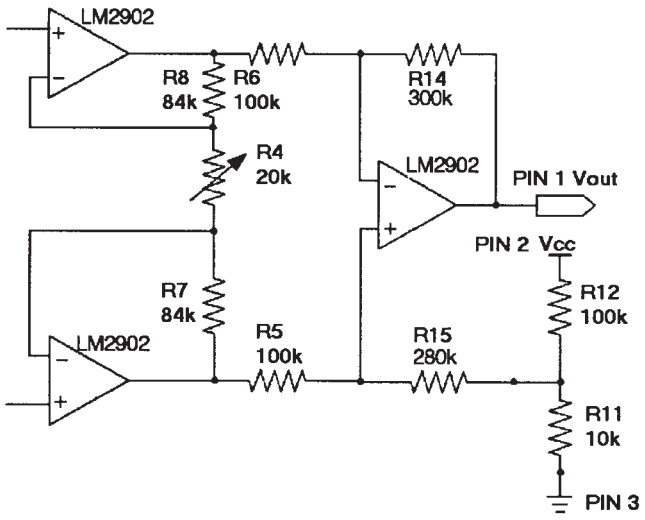


Figure 3
Differential instrumentation amplifier circuit



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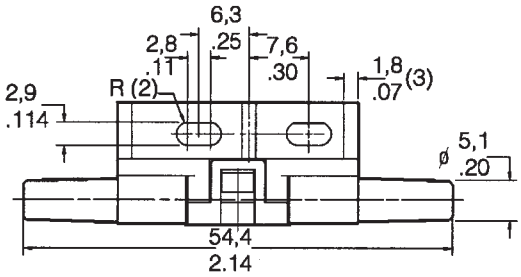
Microbridge Mass Airflow/Amplified

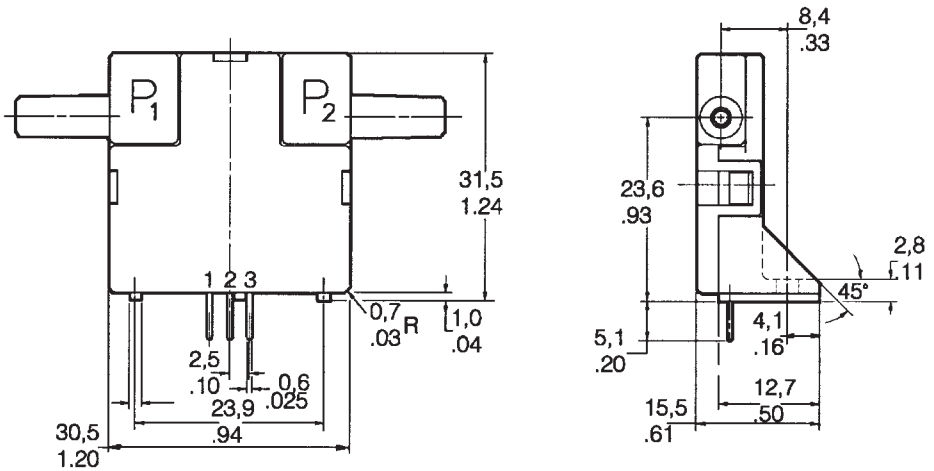
AWM3000 SERIES ORDER GUIDE (Performance Characteristics @ 10.01 ±0.01 VDC, 25°C)

Catalog Listings	AWM3100V	AWM3150V	AWM3200V	AWM3300V
Flow Range (Full Scale)	+200 sccm	+30 sccm		+1000 sccm
Pressure Range (See Application Note 1)			+2.0″ H_2O (5 mBar)	
Output Voltage @ Trim Point	5 VDC @ 200 sccm	3.4 VDC @ 25 sccm	5 VDC @ 2″ H_2O	5 VDC @ 1000 sccm
Null Voltage	1.00 ±0.05 VDC	1.00 ±0.10 VDC	1.00 ±0.08 VDC	1.00 ±0.10 VDC
Null Voltage Shift, Typ. +25° to −25°C, 25° to +85°C	±25 mV	±100 mV	±25 mV	±25 mV
Output Voltage Shift, Max. +25° to −25°C +25° to +85°C	−4% Reading +4% Reading	±5% Reading ±5% Reading	+24% Reading (Note 3) −24% Reading	−5% Reading +5% Reading
Repeatability & Hysteresis, Max.	±0.50% Reading	±1% Reading	±0.50% Reading	±1% Reading
	Min.	**Typ.**	**Max.**	
Excitation VDC (Note 2)	8.0	10±0.01	15	
Power Consumption (mW)	—	50	60	
Response Time (msec) (Note 1)	—	1.0	3.0	
Common Mode Pressure (psi)	—	—	25	
Temperature Range	Operating: −25° to +85°C (−13° to +185°F); Storage: −40° to +90°C (−40° to +194°F)			
Termination	2,54 mm (.100″) centers, 0,635 mm (0.025″) square			
Weight (grams)	10.8			
Shock Rating	100 g peak (5 drops, 6 axes)			

Notes:
1. Initial warm-up time for signal conditioned circuitry is 1 minute max.
2. Output Voltage is ratiometric to supply voltage.
3. Temperature shifts when sensing differential pressure correlates to the density change of the gas over temperature. (See Application Note 1.)
4. Maximum allowable rate of flow change to prevent damage: 5 SLPM/1 sec.

MOUNTING DIMENSIONS (for reference only)





Note: Positive flow direction is defined as proceeding from Port 1 (P1) to Port 2 (P2) and results in positive output. Do not exert a force greater than 4.54kg (10 lbs.) in any direction.

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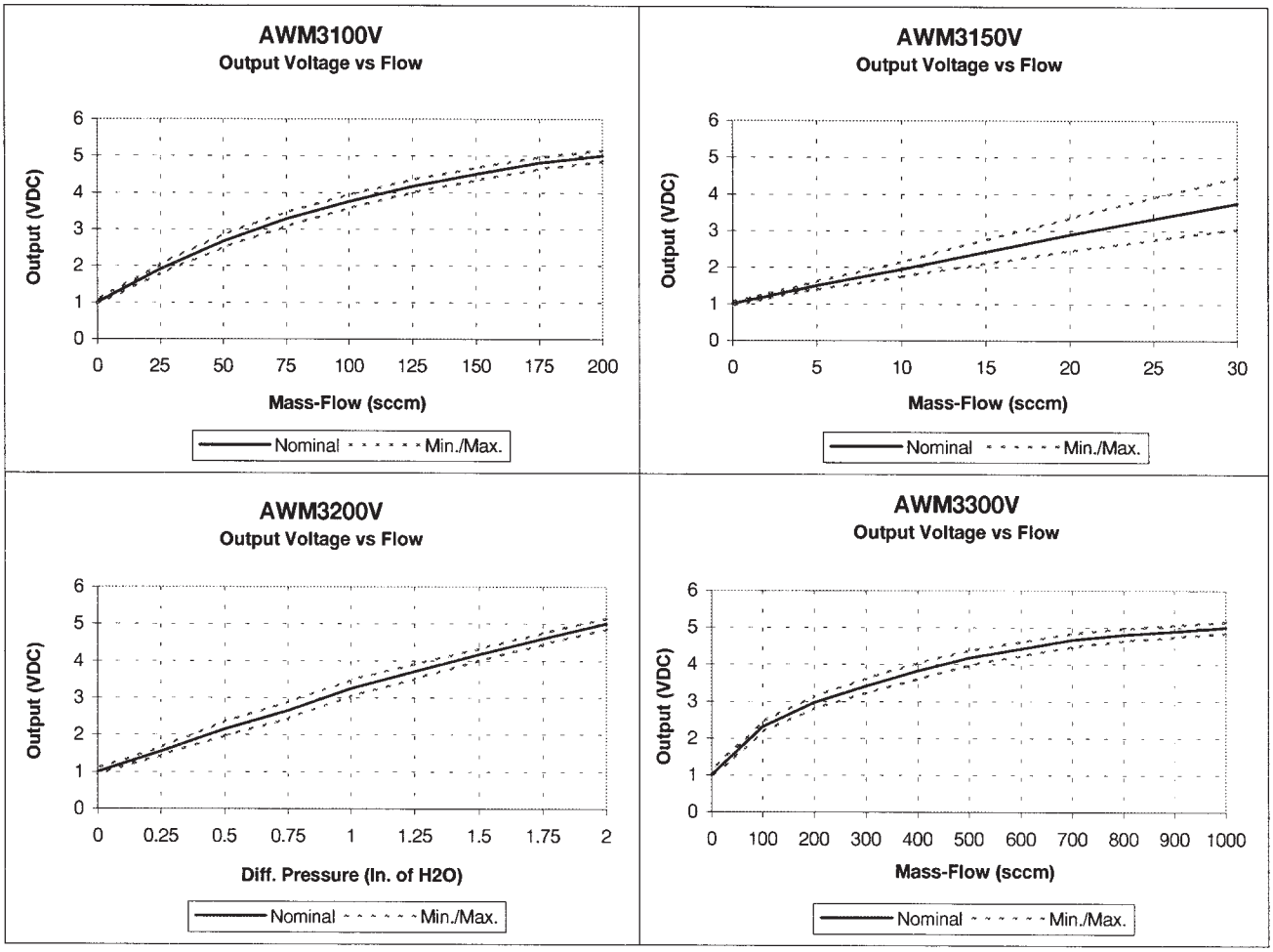
Microbridge Mass Airflow/Amplified

OUTPUT FLOW VS INTERCHANGEABILITY (Note 1) **Performance Characteristics @ 10.0 ±0.01 VDC, 25 C**

AWM3100V				AWM3150V				AWM3200V (Note 2)				AWM3300V			
Press. mBar	**Flow sccm**	**Nom. VDC**	**Tol. ± VDC**	Press mBar	**Flow sccm**	**Nom. VDC**	**Tol. ± VDC**	Flow sccm	**Press ″ H_2O**	**Nom. VDC**	**Tol. ± VDC**	Press. mBar	**Flow sccm**	**Nom. VDC**	**Tol. ± VDC**
0.49	**200**	5.00	0.15	2.50	**30**	3.75	0.70	60.0	**2.00**	5.00	0.15	3.40	**1000**	5.00	0.15
0.42	**175**	4.80	0.16	1.70	**20**	2.90	0.45	53.0	**1.75**	4.59	0.15	2.90	**900**	4.90	0.16
0.35	**150**	4.50	0.17	0.84	**10**	1.95	0.20	46.0	**1.50**	4.16	0.16	2.40	**800**	4.80	0.17
0.28	**125**	4.17	0.18	0.42	**5**	1.50	0.10	38.0	**1.25**	3.70	0.20	2.00	**700**	4.66	0.18
0.21	**100**	3.75	0.19	0.34	**4**	1.40	0.08	30.0	**1.00**	3.25	0.22	1.60	**600**	4.42	0.19
0.14	**75**	3.27	0.19	0.26	**3**	1.30	0.08	23.0	**0.75**	2.65	0.22	1.20	**500**	4.18	0.20
0.09	**50**	2.67	0.17	0.17	**2**	1.20	0.07	16.0	**0.50**	2.15	0.19	0.80	**400**	3.82	0.21
0.04	**20**	1.90	0.13	0.08	**1**	1.10	0.06	8.0	**0.25**	1.55	0.11	0.54	**300**	3.41	0.19
0.00	**0**	1.00	0.05	0.00	**0**	1.00	0.05	0.0	**0.00**	1.00	0.08	0.31	**200**	2.96	0.17
												0.12	**100**	2.30	0.14
												0.00	**0**	1.00	0.10

Notes:
1. Numbers in **BOLD** type indicate calibration type, mass flow or differential pressure. Tolerance values apply to calibration type only.
2. Differential pressure calibrated devices are not recommended for flow measurement. Use flow calibrated devices for flow measurement.

OUTPUT CURVES



Airflow

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Microbridge Mass Airflow/Amplified

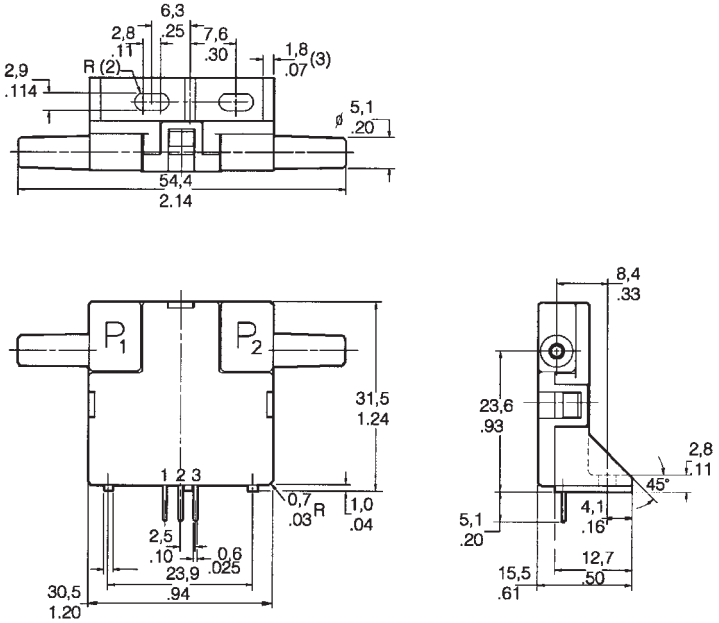
AWM3000 SERIES ORDER GUIDE (Performance Characteristics @ 10.01 ±0.01 VDC, 25°C)

Catalog Listings	AWM3200CR*	AWM3201CR*	AWM3303V
Flow Range (Full Scale)			±1000 sccm (1 SLPM)
Differential Pressure Range	0 - 2″ H_2O (5 mBar)	0 - 0.5″ H_2O (1.25 mBar)	
Output Type	4 - 20 mA DC (linear)	4 - 20 mA DC (linear)	1 - 5 VDC (Note 2)
Output @ Trim Point	20.0 ±1 mA DC @ 2″ H_2O	20.0 ±1 mA DC @ .05″ H_2O	5.00 ±0.150 VDC
Null Output	4.00 ±0.3 mA DC	4.00 ±0.4 mA DC	3.00 ±0.050 VDC
Null Shift +25° to −25°C, +25° to +85°C	±2 mA DC (max.)	±2 mA DC (max.)	±.050 VDC (max.)
Output Shift +25° to −25°C +25° to +85°C	 +24% Reading −31% Reading (Note 3)	 +32% Reading −32% Reading (Note 3)	 −5% Reading +5% Reading
Linearity Error	±5% Reading	±5% Reading	N/A
External Output Load	100 - 300 Ω (Note 4)	100 - 300 Ω (Note 4)	N/A
Response Time (Note 1)	60 msec (max.)	60 msec (max.)	3 msec (max.)
Repeatability & Hysteresis, Max.	±0.50% Reading	±0.50% Reading	±1% Reading
Excitation VDC	10 ±0.01	10±0.01	8-15
Power Consumption (mW)	—	50	100
Common Mode Pressure (psi)	—	—	25
Calibration Gas	Nitrogen		
Temperature Range	Operating: −25° to +85°C (−13° to +185°F); Storage: −40° to +90°C (−40° to +194°F)		
Termination	2,54 mm (.100″) centers, 0,635 mm (0.025″) square		
Weight (grams)	10.8		
Shock Rating	100 g peak (5 drops, 6 axes)		

Notes:
1. Initial warm-up time for signal conditioned circuitry is 1 minute max.
2. Output Voltage is ratiometric to supply voltage.
3. Temperature shifts when sensing differential pressure correlates to the density change of the gas over temperature.
4. Output load connected from V_{OUT} to GND (current sinking).
5. Maximum allowable rate of flow change to prevent damage: 5.0 SLPM/1.0 sec.

* A 5 micron filter must be used on differential pressure sensors.

MOUNTING DIMENSIONS (for reference only)



Note: Positive flow direction is defined as proceeding from Port 1 (P1) to Port 2 (P2) and results in positive output. Do not exert a force greater than 4.54kg (10 lbs.) in any direction.

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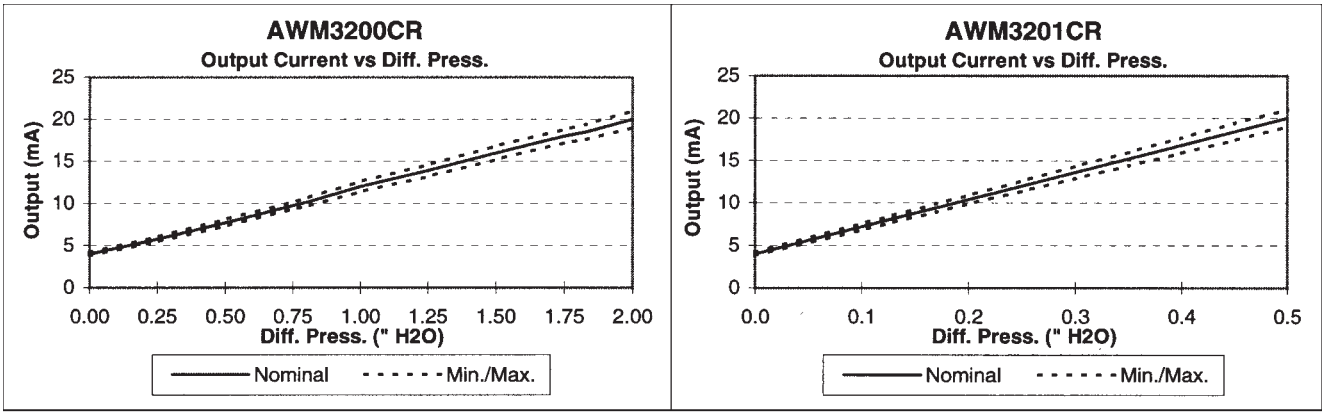
Microbridge Mass Airflow/Amplified

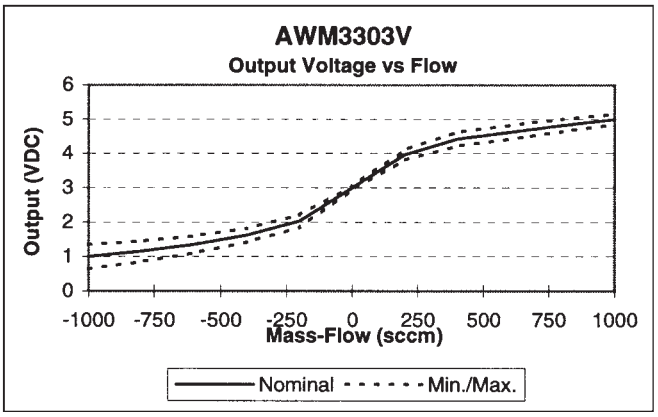
OUTPUT FLOW VS INTERCHANGEABILITY (Note 1) **Performance Characteristics @ 10.0 ± 0.01 VDC, 25 C**

AWM3200CR (Note 2)				AWM3201CR (Note 2)				AWM3303V			
Flow sccm	**Press. ″ H_2O**	**Nom. mA DC**	**Tol. ± mA DC**	Flow sccm	**Press. ″ H_2O**	**Nom. mA DC**	**Tol. ± mA DC**	Press mBar	**Flow sccm**	**Nom. VDC**	**Tol. ± VDC**
0	**0.00**	4.00	0.3	0	**0.00**	4.0	0.4	3.49	**1000**	5.00	0.15
7	**0.25**	5.75	0.3	35	**0.10**	7.2	0.4	2.42	**800**	4.82	0.18
15	**0.50**	7.70	0.4	42	**0.13**	8.0	0.4	1.59	**650**	4.67	0.20
22	**0.75**	9.75	0.4	53	**0.17**	9.4	0.5	0.83	**400**	4.42	0.20
25	**0.81**	10.21	0.5	61	**0.20**	10.4	0.5	0.31	**200**	3.96	0.15
30	**1.00**	12.00	0.6	71	**0.25**	12.0	0.6	0.00	**0**	3.00	0.05
37	**1.25**	13.90	0.7	81	**0.30**	13.6	0.7	-0.31	**-200**	2.03	0.18
45	**1.50**	16.00	0.8	87	**0.35**	15.2	0.8	-0.83	**-400**	1.62	0.20
52	**1.75**	18.00	0.8	97	**0.40**	16.8	0.9	-1.59	**-600**	1.35	0.25
55	**1.83**	18.50	0.9	105	**0.45**	18.4	1.0	-2.42	**-800**	1.15	0.30
60	**2.00**	20.00	1.0	113	**0.50**	20.0	1.0	-3.44	**-1000**	1.00	0.35

Notes:
1. Numbers in **BOLD** type indicate calibration type, mass flow or differential pressure. Tolerance values apply to calibration type only.
2. Differential pressure calibrated devices are not recommended for flow measurement. Use flow calibrated devices for flow measurement.

OUTPUT CURVES





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Microbridge Mass Airflow/Unamplified and Amplified

FEATURES

- Manifold mount/o-ring sealed
- Ceramic flow-tube (non-outgassing), 0-1000 sccm
- Plastic flow tube, 0-6 SLPM
- High common mode pressure (150 psi ceramic flow-tube only)
- Operating temperature up to 125°C (unamplified only)
- High stability at null and full-scale

The AWM40000 Series mass flow sensor family is based on proven microbridge technology and includes both amplified signal conditioned devices and unamplified sensor only devices.

When using the unamplified devices (AWM42150VH and AWM42300V), the heater control circuit in Figure 1 and the sensing bridge supply circuit in Figure 2 are both required for operation per specification. These two circuits are **NOT** on board the sensor and must be supplied in the application. The differential amplifier circuitry in Figure 3 may be useful in providing output gain and/or introducing voltage offsets to the sensor output (Ref. Equation 1).

The amplified devices (AWM43300V and AWM43600V) can be used to increase output gain and introduce voltage offsets. The differential instrumentation amplifier circuitry, heater control circuitry and sensing bridge supply circuitry are all provided onboard the amplified sensors.

Figure 1
Heater Control Circuit

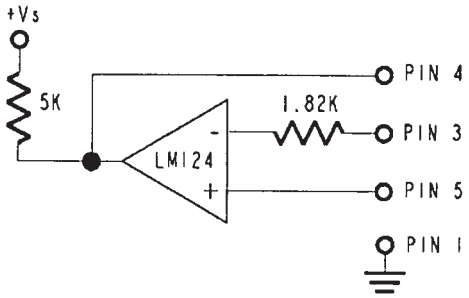


Figure 2
Sensing Bridge Supply Circuit

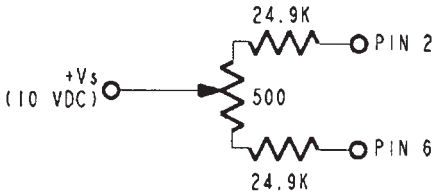
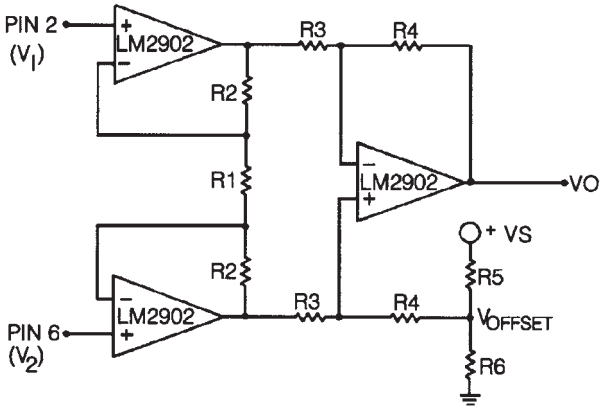


Figure 3
Differential Instrumentation Amplifier Circuit



Equation 1:

$$V_o = \left(\frac{2R_2+R_1}{R_1}\right)\left(\frac{R_4}{R_3}\right)\left(V_2-V_1\right)+V\ \text{offset}$$

$$\text{where } V\ \text{offset} = V_S\left(\frac{R_6}{R_6+R_5}\right)$$

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Microbridge Mass Airflow/Unamplified and Amplified

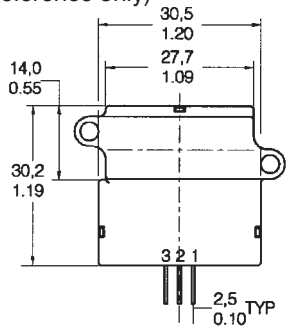
AWM40000 SERIES ORDER GUIDE (Performance Characteristics @ 10.01 ±0.01 VDC, 25°C)

Catalog Listings	AWM42150VH	AWM42300V	AWM43300V	AWM43600V
Flow Range (Full Scale)	±25 sccm	±1000 sccm	+1000 sccm	+6 SLPM
Output Voltage @ Trim Point	8.5 mV ±1.5 mV @ 25 sccm	54.7 mV ±3.7 mV DC @ 1000 sccm	5 V ±0.15 VDC @ 1000 sccm	5 V ±0.15 VDC @ 6 SLPM
Null Voltage	0.0 ±1.0 mVDC	0.0 ±1.5 mVDC	1.0 ±0.05 VDC	1.0 ±0.05 VDC
Null Voltage Shift +25° to −25°C, +25° to +85°C	±0.20 mVDC	±0.20 mVDC	±0.025 VDC	±0.025 VDC
Output Voltage Shift +25° to −25°C +25° to +85°C	+2.5% Reading typ. −2.5% Reading typ.	+2.5% Reading max. −2.5% Reading max.	−5.0% Reading max. +6.0% Reading max.	−6.0% Reading max. +6.0% Reading max.
Power Consumption (mW)	60 (Max.)	60 (Max.)	60 (Max.)	75 (Max.)
Repeatability & Hysteresis	±0.35% Reading (3)	±0.50% Reading	±0.50% Reading	±1.00% Reading
Pressure Drop @ Full Scale (in H_2O)	0.008″ H_2O (Typ.)	1.02 (Typ.)	1.02 (Typ.)	8.00 (Typ.)
	Min.	**Typ.**	**Max.**	
Excitation VDC	8.0	10±0.01	15	
Response Time (msec)	—	1.0	3.0 (Note 1)	
Common Mode Pressure (psi) (max.)	—	—	150 psi (10 Bar)	25 psi (1.7 Bar)
Output Load	NPN (Sinking): 10 mA PNP (Sourcing): 20 mA			
Temperature Range	Operating: −40° to +125°C (−40° to +251°F) Storage: −40° to +125°C (−40° to +251°F)		Operating: −25° to +85°C (−13° to +185°F) Storage: −40° to +90°C (−40° to +194°F)	
Calibration Gas	Nitrogen			
Ratiometricity Error	±0.30% Reading			
Weight (grams)	14 g			11 g
Shock Rating	100 g peak (5 drops, 6 axes)			
Termination	2,54 mm (.100″) centers, 0,635 cm (0.025″) square			

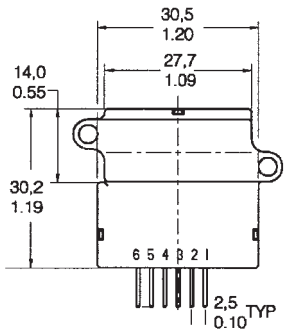
Notes:
1. Response time is typically 1 msec from 10 to 90%.
2. Repeatability & Hysteresis tolerances reflect inherent inaccuracies of the measurement equipment.
3. Maximum allowable rate of flow change to prevent damage: 5.0 SLPM/1.0 sec.

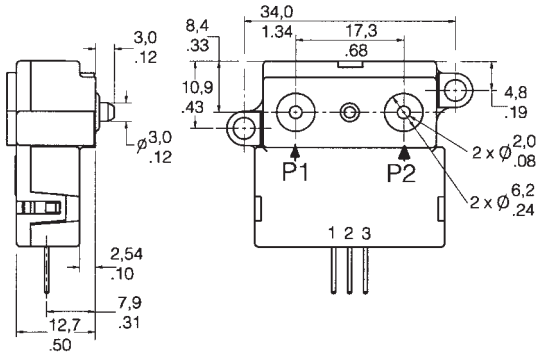
MOUNTING DIMENSIONS (for reference only)

Amplified Sensors



Unamplified Sensors





Note: Positive flow direction is defined as proceeding from Port 1 (P1) to Port 2 (P2), and results in positive output.

Airflow

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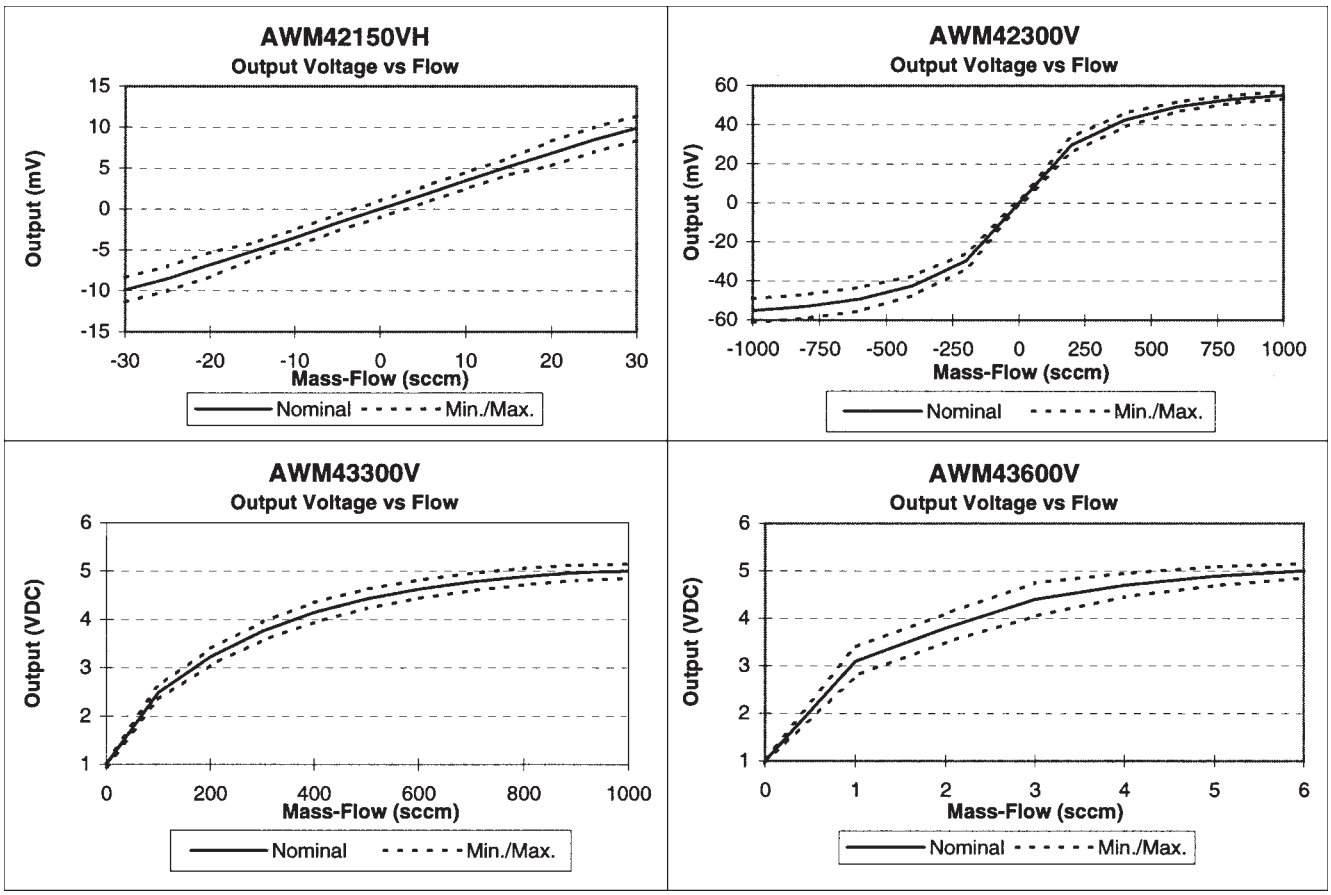
Microbridge Mass Airflow/Unamplified and Amplified

OUTPUT FLOW VS INTERCHANGEABILITY (Note 1) **Performance Characteristics @ 10.0 ± 0.01 VDC, 25°C**

AWM42150VH				AWM42300V				AWM43300V				AWM43600V			
Press μBar	**Flow sccm**	**Nom. mV**	**Tol. ± mV**	Press. mBar	**Flow sccm**	**Nom. mV**	**Tol. ± mV**	Press. mBar	**Flow sccm**	**Nom. VDC**	**Tol. ± VDC**	Press. mBar	**Flow SLPM**	**Nom. VDC**	**Tol. ± VDC**
20	**30**	9.9	1.5	2.23	**1000**	54.7	2.00	2.23	**1000**	5.00	0.15	20.0	**6**	5.00	0.15
17	**25**	8.5	1.5	1.52	**800**	53.0	2.0	1.87	**900**	4.97	0.16	14.7	**5**	4.89	0.20
14	**20**	6.8	1.5	0.94	**600**	49.3	2.5	1.52	**800**	4.89	0.17	9.07	**4**	4.70	0.25
10	**15**	5.2	1.0	0.49	**400**	42.5	3.5	1.16	**700**	4.78	0.18	6.40	**3**	4.40	0.35
7	**10**	3.5	1.0	0.19	**200**	29.8	4.0	0.94	**600**	4.63	0.19	3.35	**2**	3.80	0.30
3	**5**	1.7	1.0	0.00	**0**	0.0	1.5	0.71	**500**	4.43	0.20	1.17	**1**	3.10	0.30
0	**0**	0.0	1.0	-0.19	**-200**	-29.8	4.0	0.50	**400**	4.15	0.21	0.00	**0**	1.00	0.05
				-0.49	**-400**	-42.5	5.0	0.33	**300**	3.76	0.19				
				-0.94	**-600**	-49.3	6.0	0.19	**200**	3.23	0.17				
				-1.52	**-800**	-53.0	6.0	0.08	**100**	2.49	0.14				
				-2.23	**-1000**	-55.2	6.0	0.00	**0**	1.00	0.05				

Notes:
1. Numbers in **BOLD** type indicate calibration type, mass flow or differential pressure.
   Tolerance values apply to calibration type only.



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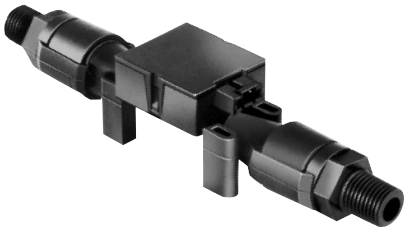
High Flow Mass Airflow/Amplified



FEATURES
- Linear voltage output
- Venturi design
- Remote mounting capability
- Active laser trimming improves interchange ability
- Separate gas calibration types:
  – Ar (argon)
  – N_2 (nitrogen) or
  – CO_2 (carbon dioxide)

In-Line Flow Measurement
AWM5000 Series Microbridge Mass Airflow Sensors feature a venturi type flow housing. They measure flow as high as 20 standard liters per minute (SLPM) while inducing a maximum pressure drop of 2.25″ H_2O. The microbridge chip is in direct contact with the flow stream, greatly reducing error possibilities due to orifice or bypass channel clogging.

Rugged, Versatile Package
The rugged plastic package has been designed to withstand common mode pressures up to 50 psi, and the small sensing element allows 100 gs of shock without compromising performance. The included ''AMP'' compatible connector provides reliable connection in demanding applications.

On-board Signal Conditioning
Each AWM5000 sensor contains circuitry which performs amplification, linearization, temperature compensation, and gas calibration. Figure 1 (Heater Control Circuit) and Figure 2 (Sensor Bridge Circuit and Amplification Linearization Circuit) illustrate the on-board electrical circuitry for the AWM5000 Series. A 1 to 5 VDC linear output is possible for all listings regardless of flow range (5, 10, 15, or 20 SLPM) or calibration gas (nitrogen, carbon dioxide, nitrous oxide, or argon). All calibration is performed by active laser trimming.

Figure 1

Heater Control Circuit

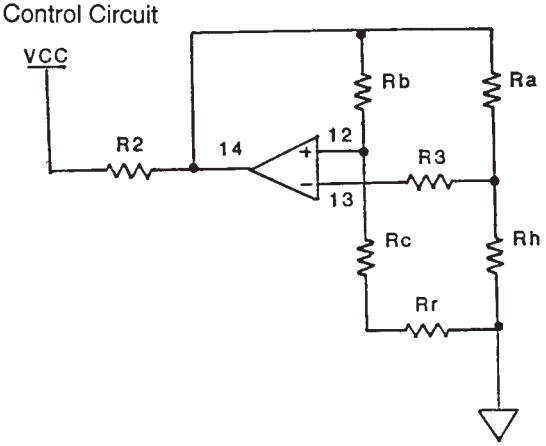
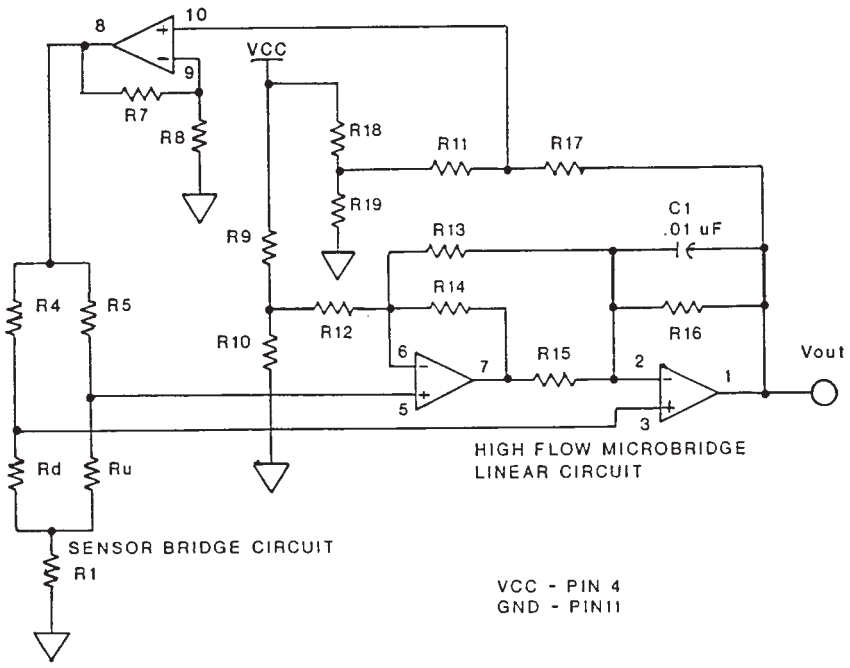


Figure 2

Sensor Bridge Circuit and Amplification Linearization Circuit



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Highflow Mass Airflow/Amplified

SPECIFICATIONS (Performance Characteristics @ 10.0 ±0.01 VDC, 25°C)

	AWM5101	AWM5102	AWM5103	AWM5104
Flow Range (Note 3)	0-5 SLPM	0-10 SLPM	0-15 SLPM	0-20 SLPM
Suffix - Calibration gas	**VA** - Argon (Ar)	**VC** - Carbon dioxide (CO_2)	**VN** - Nitrogen (N_2)	
	Min.	**Typ.**	**Max.**	
Excitation VDC	8	10±0.01	15	
Power consumption (mW)	—	—	100	
Response time (msec)	—	—	60	
Null output VDC	0.95	1	1.05	
Null output shift −20° to 70°C	—	±0.050 VDC	±.200 VDC	
Common Mode Pressure (psi)	—	—	50	
Temperature range	−20° to +70°C, (−4° to 158°F)			
Weight	60 grams (2.12 oz.)			
Shock ratings	100 g peak, 6 msec half-sine (3 drops, each direction of 3 axes)			
Output @ laser trim point	5 VDC @ Full Scale Flow			
Output voltage shift +20° to −25°C, +20° to 70°C	Suffix VA or VN ±7.0% Reading, Suffix VC ±10.0% Reading			
Linearity error (2)	±3.0% Reading (max.)			
Repeatability & Hysteresis	±0.5% Reading (max.)			
Connector (Included) —Four pin receptacle	MICRO SWITCH (SS12143)/AMP (103956-3)			
Leak rate, max	0.1 psi/min. at static condition, (Note 2)			

Notes:
1. Linearity specification applies from 2 to 100% full scale of gas flow range, and does not apply to null output at 0 SLPM.
2. The AWM5000 series product has a leakage spec of less than 0.1 psi per minute at 50 psi common mode pressure. If during installation, the end adapters are twisted with respect to the flowtube, this may compromise the seal between the o-ring and the flowtube and may cause a temporary leak. This leak might be as high as 1 psi or might remain in specification. It will self-reseal as the o-ring takes a new set. Approximately 85% of the leakage will dissipate in 24 hours. Within 48 hours, complete recovery will take place.
3. SLPM denotes standard liters per minute, which is a flow measurement referenced to standard conditions of 0°C/1 bar (sea level), 50% RH.

NOTICE

AWM5000—Chimney Effect

AWM microbridge mass airflow sensors detect mass airflow caused by heat transfer. The thermally isolated microbridge structure consists of a heater resistor positioned between two temperature sensing resistors.

The heater resistor maintains a constant temperature, 160°C above ambient, during sensor operation. Airflow moving past the chip transfers heat from the heater resistor. This airflow warms the downstream resistor and cools the upstream resistor. The temperature change and the resulting change in resistance of the temperature resistors is proportional to the mass airflow across the sensing element.

When the sensor is mounted in a vertical position, under zero flow conditions, the sensor may produce an output that is the result of thermally induced convection current. This occurrence is measurable in the AWM5000 Series, particularly in the 5 SLPM versions. When designing the sensor into applications where null stability is critical, avoid mounting the sensor in a vertical position.

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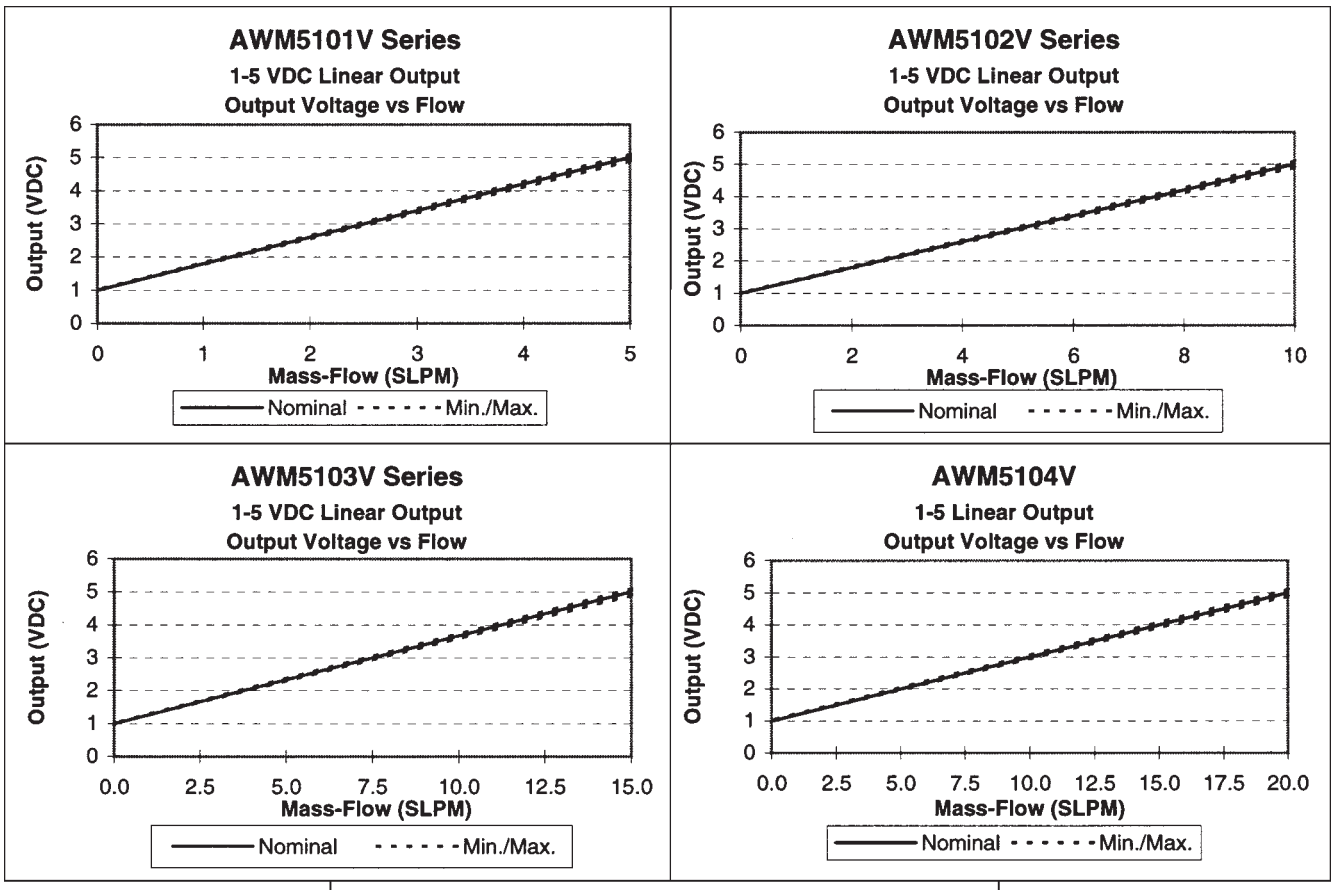
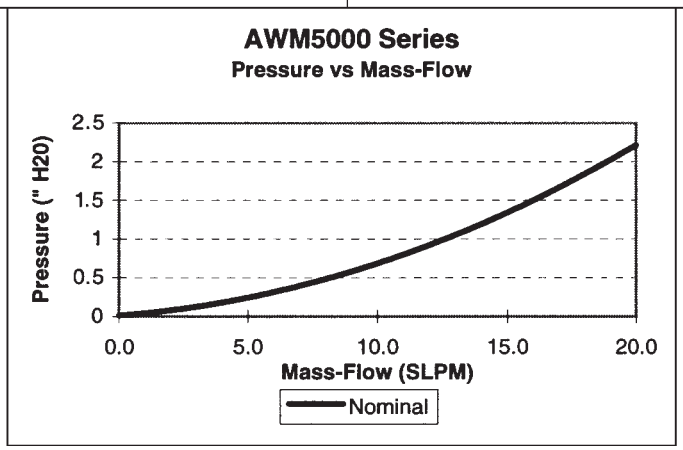
High Flow Mass Airflow/Amplified

OUTPUT CURVES (Performance Characteristics @ 10.0 ±0.01 VDC, 25°C)





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Highflow Mass Airflow/Amplified

AWM5000 ORDER GUIDE

Catalog Listing	Flow Range
AWM5101VA	5 SLPM, Argon calibration
AWM5101VC	5 SLPM, CO_2 calibration (2)
AWM5101VN	5 SLPM, N_2 calibration (1)
AWM5102VA	10 SLPM, Argon calibration
AWM5102VC	10 SLPM, CO_2 calibration (2)
AWM5102VN	10 SLPM, N_2 calibration (1)
AWM5103VA	15 SLPM, Argon calibration
AWM5103VC	15 SLPM, CO_2 calibration (2)
AWM5103VN	15 SLPM, N_2 calibration (1)
AWM5104VA	20 SLPM, Argon calibration
AWM5104VC	20 SLPM, CO_2 calibration (2)
AWM5104VN	20 SLPM, N_2 calibration (1)

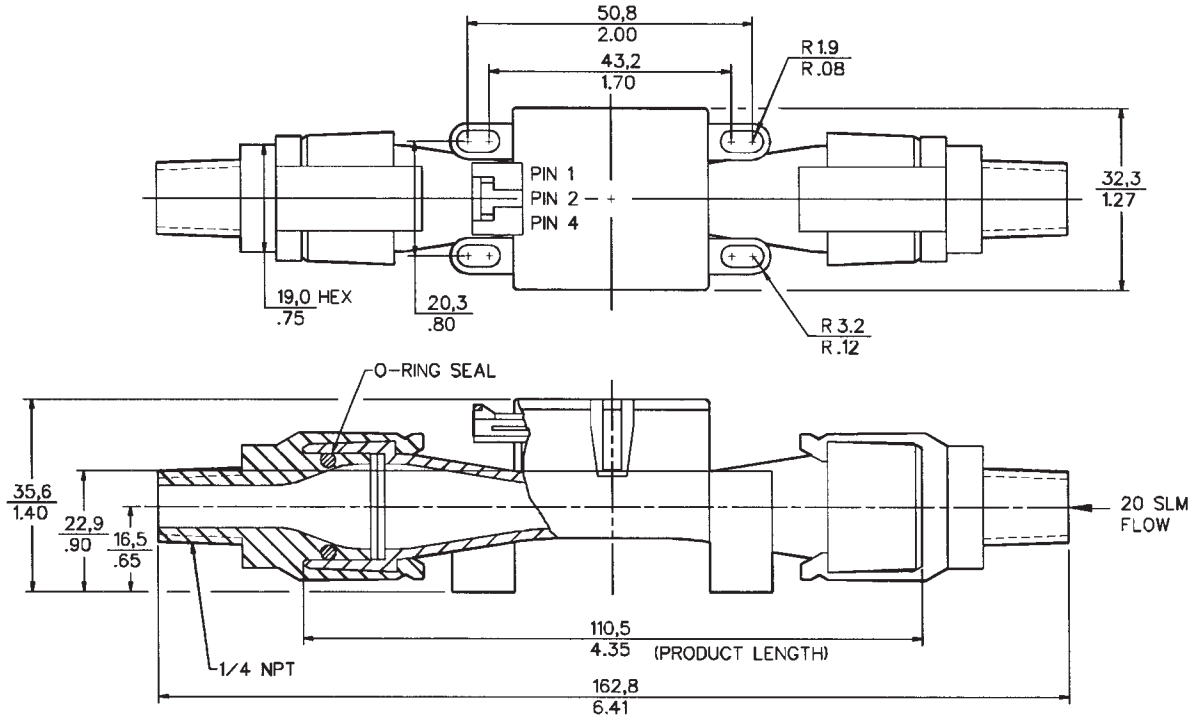
CONNECTOR ORDER GUIDE

Catalog Listing	Description
SS12143	Four pin Electrical connector Connectors use Amp 103956-3

Note: All listings have 1 - 5 VDC linear output with 10 VDC supply over given flow range for a specific calibration gas.
1. N_2 calibration is identical to 0_2 and air calibration.
2. CO_2 calibration is identical to N_2O calibration.
3. For additional gas correction factors, see Application Note 3.

OUTPUT CONNECTIONS
Pin 1 + Supply voltage
Pin 2 Ground
Pin 3 No connection
Pin 4 Output voltage
Arrow on bottom of housing indicates direction of flow.

MOUNTING DIMENSIONS (for reference only)



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