Pressure Sensors, Accelerometers, and Custom Microstructures

IC SENSORS

Products Databook

Consistent with Measurement Specialties, Inc. policy of continually updating and improving its products, the type designation and data are subject to change, unless otherwise arranged. No obligations are assumed for notice of change of future manufacture of these devices or materials.

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North America Toll Free: 1-800-745-8008
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IC SENSORS DIVISION

OVERVIEW

Measurement Specialties IC Sensors Division Product Line

The IC Sensors Division of Measurement Specialties, Inc. utilizes state-of-the-art silicon micromachining technology to manufacture OEM components for physical measurement and control. These products include pressure sensors, accelerometers, and custom silicon microstructures.

Silicon's excellent semiconductor properties have made it the basic building material of the electronics industry. But silicon also has excellent physical properties that make it an ideal building material for mechanical devices. Silicon has a tensile strength greater than steel and is almost perfectly elastic, making it a wonderful material for use in MEMS products. It is free of hysteresis, and its crystalline structure is well-suited to the fabrication of miniature precision products.

These silicon micromachined products have several advantages over their conventionally manufactured counterparts: they are generally much smaller, their performance is higher due to the precise dimensional control in the fabrication, and costs are lower because thousands can be produced at one time.

While IC Sensors products have been technology leaders, the Company's real strength has been in bringing products to market. Today, IC Sensors offers the broadest line of micromachined pressure sensors, accelerometers, and custom structures in the industry.

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Silicon micromachining is a powerful outgrowth of semiconductor process technology. Integrated circuit manufacturing techniques are supplemented by silicon etching processes to create very precise,miniature mechanical structures. These silicon microstructures can have electronic features that allow physical inputs to be converted into electrical signals. Similarly, electronic signals can be applied to these devices to provide control functions.

Silicon is the material of choice due to its unique combination of excellent electronic and mechanical properties. Silicon has the hardness of steel, the thermal conductivity of diamond, exhibits piezoresistive properties, is lightweight, has low thermal expansion, and is relatively inert. Unprecedented dimensional control can be achieved through the use of conventional processing techniques, which also open up the possibility of large scale batch manufacturing, enabling very low cost devices to achieve extraordinary performance levels.

Structures that can be fabricated with silicon micromachining include purely mechanical structures in addition to sensors and actuators. Silicon micromachining provides a higher level of dimensional control than can be obtained from traditional machining or molding technologies. The most significant benefit, however, is the capability to combine these precise mechanical structures with electronic features to create sensors and actuators.

The capability to design new devices and processes using this base technology is our primary strength. Our experience in transferring state-of-the-art designs into manufacturing is unsurpassed in the world.

UNMATCHED BREADTH OF PRODUCT LINES

IC Sensors has developed and commercialized three product areas based on silicon micromachining technology, offering an unmatched range of standard products with a strong custom design capability.

Pressure sensors were the first products produced by the Company. A broad range of package styles is available, including PC Board mountable versions, stainless steel housings, disposable medical devices, and complete industrial transmitters.

The third product line for IC Sensors involves custom silicon micromachining. Here, micromachining technology is applied to meet specific customer requirements.

- Detection cantilevers for atomic force microscopes
- Pressure arrays for non-invasive blood pressure monitoring
- Flow restrictors for drug infusion control
- Inertial guidance accelerometers
- Optical filters for telecommunications
- Electrically deflectable mirrors for bar code scanners and displays
- Fiber-optic aligners
- Read/write coils for optical disk drives
- Chemical and gas sensors
- Optical Switching

The advantages of silicon microstructures compared to alternate technologies such as plastic molding, metal machining, or glass drilling are the precision of the etched features, the cost of the batch fabricated component, and the repeatability of the dimensions from part-to-part.

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PRESSURE

PRESSURE SELECTION GUIDE

PRESSURE SELECTION GUIDE—PC MOUNTABLE

(Please refer to specification sheets for additional information)

TYPE	PC MOUNTABLE					
PACKAGE	**Surface Mount**	**HIT 8-pin DIP**		**Ultrastable HIT 8-pin DIP**		
MODEL	1451 	1471 	1210 	1220 	1230 	1240 
PRESSURE REFERENCE						
Gage	•	•	•	•	•	•
Absolute	•	•	•	•	•	•
Differential			•	•	•	•
RANGE						
0-1 PSI			•	•		
0-5 to 0-100 PSI	•	•	•	•		
0-15 to 0-100 PSI				•	•	
0-5 to 0-250 PSI	•	•				
OUTPUT						
0-60 mV (typ.w / 3Vdc supply)	•	•				
0-50 mV				•		•
0-100 mV (typ)			•		•	
COMPENSATION						
Integral, offset, gain set and temperature compensation			•		•	
Integral, offset, current set and temperature compensation				•		•
PERFORMANCE						
±0.1% Non-linearity			•	•	•	•
±0.25% Non-linearity	•	•				
±0.5% Span temperature zero error (typ.)	•	•				
±0.5% Span temperature span error (typ.)	•	•				
±0.5% Temperature zero and span error over 0 to 50°C comp range			•	•		
±0.5% Temperature zero and span error over - 20 to 85°C comp range					•	•

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PRESSURE SELECTION GUIDE—PC MOUNTABLE (continued)

(Please refer to specification sheets for additional information)

TYPE	PC MOUNTABLE			
PACKAGE	TO-8			
MODEL	13 	23 	33 	43 
PRESSURE REFERENCE				
Gage	•	•		•
Absolute	•			•
Differential			•	
RANGE				
0-1 PSI	•	•	•	•
0-5 to 0-100 PSI				
0-15 to 0-100 PSI				
0-5 to 0-250 PSI	•	•	•	•
OUTPUT				
0-60 mV (typ.w / 3Vdc supply)				
0-50 mV				
0-100 mV (typ)	•	•	•	•
COMPENSATION				
Integral, offset, gain set and temperature compensation	•	•	•	•
Integral, offset, current set and temperature compensation				
PERFORMANCE				
±0.1% Non-linearity	•	•	•	•
±0.25% Non-linearity				
±0.5% Span temperature zero error (typ.)				
±0.5% Span temperature span error (typ.)				
±0.5% Temperature zero and span error over 0 to 50°C comp range	•	•	•	•
±0.5% Temperature zero and span error over - 20 to 85°C comp range				

PRESSURE SELECTION GUIDE—PC MOUNTABLE

(Please refer to specification sheets for additional information)

TYPE	PC MOUNTABLE			
PACKAGE	TO-8			
MODEL	17 	27 	37 	47 
PRESSURE REFERENCE				
Gage	•	•		•
Absolute	•			•
Differential			•	
RANGE				
0-1 PSI				
0-5 to 0-100 PSI				
0-15 to 0-100 PSI				
0-5 to 0-250 PSI	•	•	•	•
OUTPUT				
0-60 mV (typ.w / 3Vdc supply)				
0-50 mV				
0-100 mV (typ)	•	•	•	•
COMPENSATION				
Integral, offset, gain set and temperature compensation	•	•	•	•
Integral, offset, current set and temperature compensation				
PERFORMANCE				
±0.1% Non-linearity	•	•	•	•
±0.25% Non-linearity				
±0.5% Span temperature zero error (typ.)				
±0.5% Span temperature span error (typ.)				
±0.5% Temperature zero and span error over 0 to 50°C comp range				
±0.5% Temperature zero and span error over - 20 to 85°C comp range	•	•	•	•

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MODEL 1451

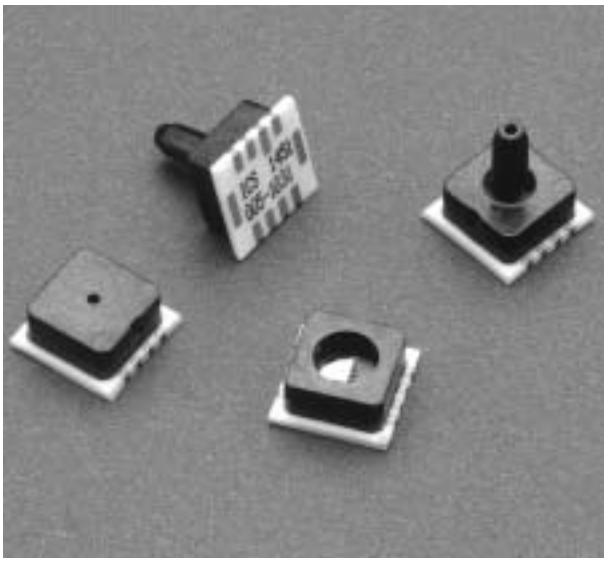
PC Board Mountable Pressure Sensor

0-60 mV Output

Gage and Absolute Pressure

Low Cost

- Altitude Measurement
- Barometric Pressure
- Medical Instrumentation
- Consumer Appliances
- Tire Pressure



FEATURES

- Surface Mount Package
- ±0.25% Pressure Non-linearity
- 3 Pressure Port Options
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psig
0 to 5	●	●
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 250	●*	
0 to 500	●*	

* N and W option only

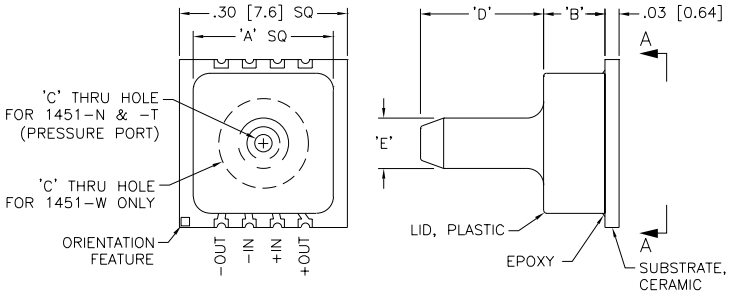
DESCRIPTION

The Model 1451 is a piezoresistive silicon pressure sensor packaged in a surface mount configuration. It is intended for high volume applications where small size, light weight, low cost, and compatibility with automated assembly equipment are required.

The pressure sensor is available with a gage or absolute pressure sensing chip that is attached to a surface mountable ceramic substrate. A cap is attached to the ceramic substrate, protecting the chip and providing the pressure port.

The devices are shipped in plastic anti-static shipping tubes for use with automated production equipment. The drawing shows a standard tube version. Caps are also available with a narrow hole or a large hole to interface with the pressure media.

DIMENSIONS



MODEL 1451 LID TABULATION			
	1451–N (NARROW HOLE)	1451–W (WIDE HOLE)	1451–T (TUBE)
'A'	.25 [6.4]	.25 [6.4]	.25 [6.4]
'B'	.110 [2.79]	.110 [2.79]	.110 [2.79]
'C'	ø.031 [0.78]	ø.160 [4.06]	ø.031 [0.78]
'D'	———	———	.220 [5.59]
'E'	———	———	ø.090 [2.29]

ALL DIMENSIONS ARE IN INCHES [mm]

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MODEL 1451

PERFORMANCE SPECIFICATIONS

Supply Voltage: 3 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	30	60	120	mV	
Zero Pressure Output	–25		25	mV	
Pressure Non-linearity	–0.25		0.25	% Span	1
Pressure Hysteresis	–0.1		0.1	% Span	
Input & Output Resistance	3500	5000	6000	Ω	
Temperature Coefficient - Span		–0.20		%/°C	2
Temperature Coefficient - Zero		+0.05		%/°C	2
Temperature Coefficient - Resistance		+0.25		%/°C	2
Thermal Hysteresis - Zero	–0.2		0.2	% Span	2
Supply Voltage		3	12	Volts DC	
Response Time (10% to 90%)		1.0		msec	3
Output Noise		1.0		µV p-p	4
Long Term Stability		0.5		±% Span/year	
Pressure Overload			3X	Rated	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-Corrosive Gases				
Weight	0.3 g				

Notes

1. Best Fit Straight Line.
2. Over the temperature range 0-50°C with respect to 25°C.
3. For a zero-to-full scale pressure step change.
4. 10 Hz to 1 kHz.
5. For sensors above 100 psi applications, the entire sensor is required to be inside the pressure chamber.
6. Gel fill coating is only offered with the wide hole option.

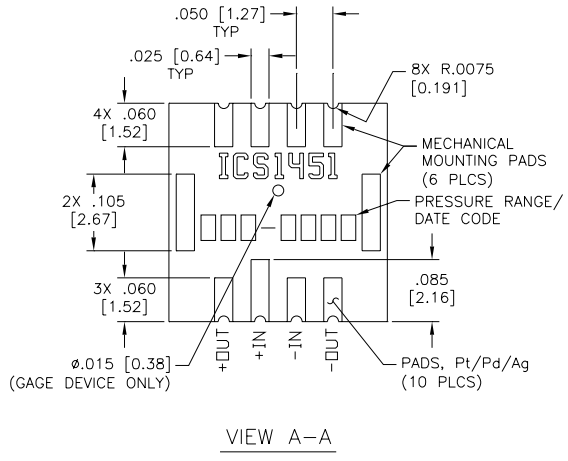
ORDERING INFORMATION

1451 - 015 A - T F

- F — Coating (F = Gel Fill, Blank = No Coating)
- T — Port (T = Tube, N = Narrow Hole, W = Wide Hole)
- A — Type (A = Absolute, G = Gage)
- 015 — Pressure Range
- 1451 — Model

CONNECTIONS

Bottom View (View A-A)



VIEW A–A

MODEL 1471

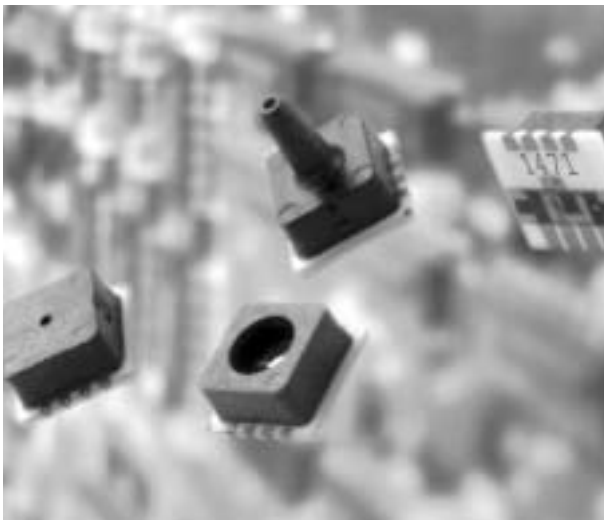
PC Board Mountable Pressure Sensor

0-60 mV Output

Gage and Absolute Pressure

Low Cost

- Altitude Measurement
- Barometric Pressure
- Medical Instrumentation
- Consumer Appliances
- Tire Pressure



DESCRIPTION

The Model 1471 is a piezoresistive silicon pressure sensor, calibrated at room temperature. Packaged in a surface mount configuration, it is intended for high volume applications where small size, light weight, low cost, and compatibility with automated assembly equipment are required.

The pressure sensor is available with a gage or absolute pressure sensing chip that is attached to a surface mountable ceramic substrate. A cap is attached to the ceramic substrate, protecting the chip and providing the pressure port.

The devices are shipped in plastic anti-static shipping tubes for use with automated production equipment. The drawing shows a standard tube version. Caps are also available with a narrow hole or a large hole to interface with the pressure media.

FEATURES

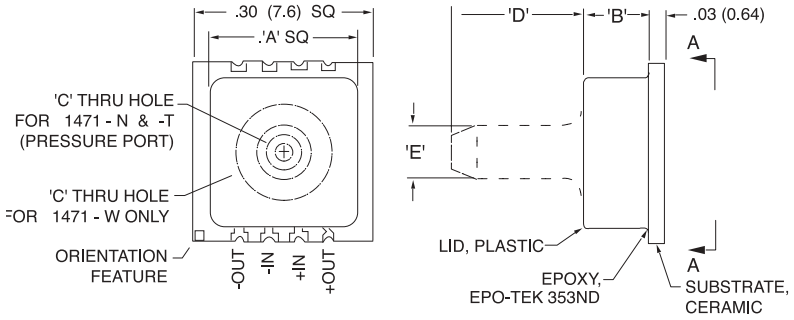
- Surface Mount Package
- ±0.25% Pressure Non-linearity
- 3 Pressure Port Options
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psig
0 to 5	●	●
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 250	●*	
0 to 500	●*	

* N and W option only

DIMENSIONS



MODEL 1471 LID TABULATION			
	1471 - N (NARROW HOLE)	1471-W (WIDE HOLE)	1471-T (TUBE)
'A'	.25 (6.4)	.25 (6.4)	.25 (6.4)
'B'	.110 (2.79)	.110 (2.79)	.110 (2.79)
'C'	Ø.031 (0.78)	Ø.160 (4.06)	Ø.031 (0.78)
'D'	———	———	.220 (5.59)
'E'	———	———	Ø.090 (2.29)

ALL DIMENSIONS ARE IN INCHES (mm)

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MODEL 1471

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	10	13	16	mv/V	1, 2
Zero Pressure Output	–0.5		0.5	mv/V	1
Pressure Non-linearity	–0.25		0.25	% Span	3
Pressure Hysteresis	–0.1		0.1	% Span	
Output Resistance	3500	5000	6000	Ω	
Input Resistance	3500		25000	Ω	
Temperature Coefficient - Span		–0.20		%/°C	4
Temperature Coefficient - Zero		+0.05		%/°C	4
Temperature Coefficient - Resistance		+0.25		%/°C	4
Thermal Hysteresis - Zero	–0.2		0.2	% Span	4
Supply Voltage		5	12	VDC	
Response Time (10% to 90%)		1.0		msec	5
Output Noise		1.0		µV p-p	6
Insulation Resistance (50 VDC)	50			MΩ	
Long Term Stability		0.5		±% Span/year	
Pressure Overload	3X			Rated	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-Corrosive Gases				
Weight	0.3 g				

Notes

1. Trimmed at room temperature. Does not include temperature dependence of offset and span
2. For absolute pressure sensor. Offset limit will be ±5mv/V
3. Best Fit Straight Line
4. Over the temperature range 0-50ºC with respect to 25º C
5. For a zero-to-full scale pressure step change
6. 10Hz to 1kHz
7. For sensor above 100 psi applications, the entire sensor is required to be inside the pressure chamber
8. Gel fill coating is only offered with the wide hole port option.
9. Tighter accuracy or other outputs can be achieved. Please contact factory

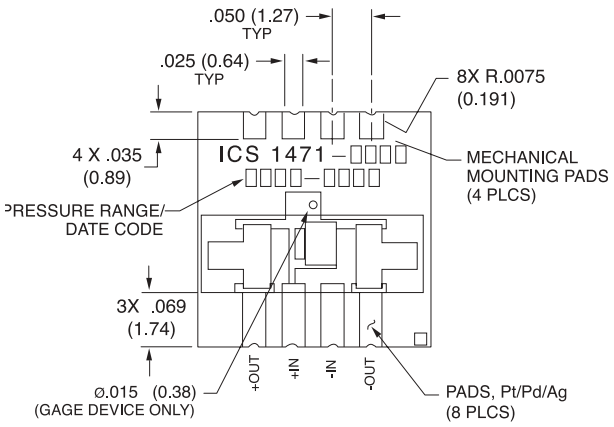
ORDERING INFORMATION

1471 - 015 A N F

- F — Coating (F-Gel Fill, Blank-No Coating
- N — Port (T=Tube, N=Narrow Hole, W=Wide Hote
- A — Type (A=Absolute, G= Gage)
- 015 — Pressure Range
- 1471 — Model

CONNECTIONS

Bottom View (View A-A)



MODEL 1210 Low Pressure

PC Board Mountable Pressure Sensor

0-1 PSI

0-100 mV Output

Gage and Differential

Low Cost

- Medical Instruments
- Air Flow Measurement
- HVAC
- Process Control
- Factory Automation
- Leak Detection

DESCRIPTION

The Model 1210 is a temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration and intended for cost sensitive applications where excellent performance and long-term stability are required.

Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to adjust the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

The sensing element used in the low pressure Model 1210 includes a double bossed design that produces a sensor output of 100 mV (typical) at 1 PSI.

The 1210 is also available in ranges up to 0-100 PSI. For a compensated sensor using a current set resistor instead of a gain set resistor, please refer to the Model 1220.

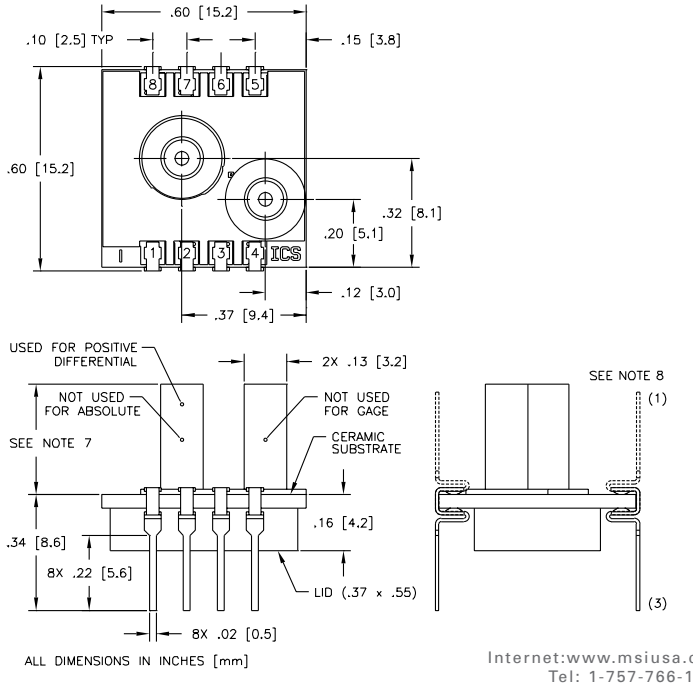
FEATURES

- Dual-in-line Package
- ±0.3% Non-linearity
- 1.0% Temperature Performance (typical)
- 1.0% Interchangeable Span (provided by gain set resistor)
- Temperature Compensated
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psid	psig
0 to 1	●	●

DIMENSIONS



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MODEL 1210 Low Pressure

PERFORMANCE SPECIFICATIONS

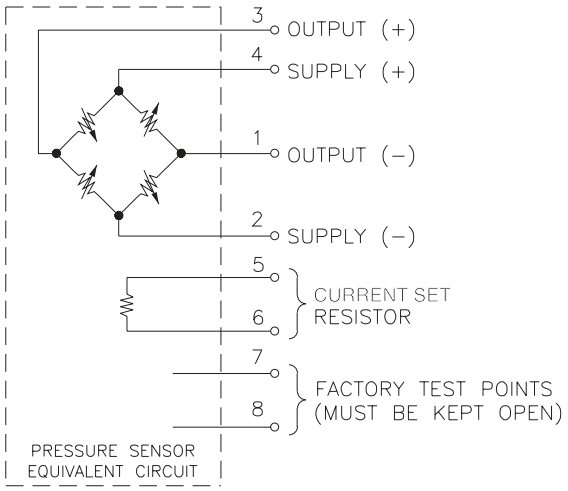
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE 0 -1 psi MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	65	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4
Temperature Error - Zero		0.5	1.0	±%Span	4
Thermal Hysteresis - Zero		0.1		±%Span	4
Supply Current		1.5	2.0	mA	
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-Corrosive Dry Gases Compatible with Wetted Materials				9
Weight	3 Grams				

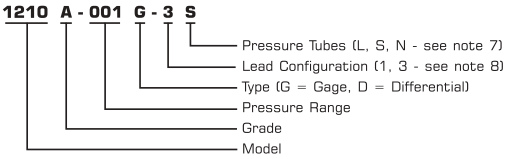
Notes

1. Output span of unamplified sensor.
2. For most models, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Check specific product data sheets for details.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1kHz.
7. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
8. Lead pins can either be in the same or the opposite direction as the pressure tube. See Dimensions drawing for lead configurations.
9. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

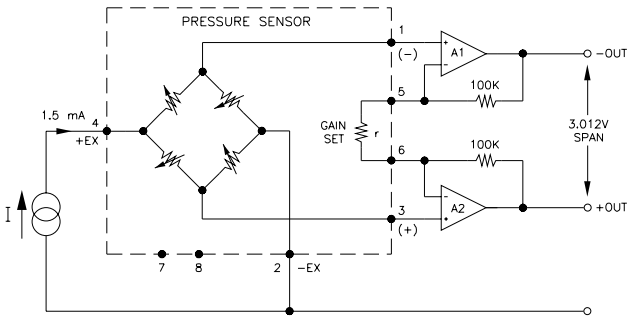


FIGURE 1: GAIN SET CIRCUIT

Nov 2002

MODEL 1220 Low Pressure

PC Board Mountable Pressure Sensor

0-1 PSI

0-50 mV Output

Low Cost

Temperature Compensated

- Medical Instruments
- Air Flow Measurement
- HVAC
- Process Control
- Factory Automation
- Leak Detection

DESCRIPTION

The Model 1220 is a temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration and intended for cost sensitive applications where excellent performance and long-term stability are required. The 1220 is a fixed voltage referenced, current set version, designed for 1% interchangeability to provide a 50 mV span at 1 PSI.

Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to adjust the gain of an external differential amplifier. This provides sensitivity interchangeabilityof ±1%.

The sensing element used in the low pressure Model 1220 includes a double bossed design that produces a sensor output of 100 mV (typical) at 1 PSI.

The 1220 is also available in ranges up to 0-100 PSI. For a compensated sensor using a gain set resistor as opposed to a current set resistor, please refer to the Model 1210.

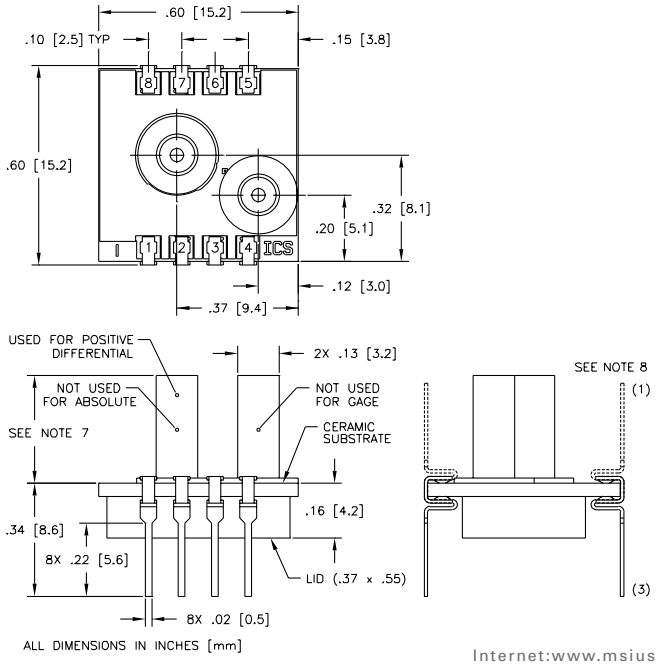
FEATURES

- Dual-in-line Package
- ±0.3% Non-linearity
- 1.0% Temperature Performance (typical)
- 1.0% Interchangeable Span (provided by current set resistor)
- Temperature Compensated
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psi
0 to 1	●

DIMENSIONS



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MODEL 1220 Low Pressure

PERFORMANCE SPECIFICATIONS

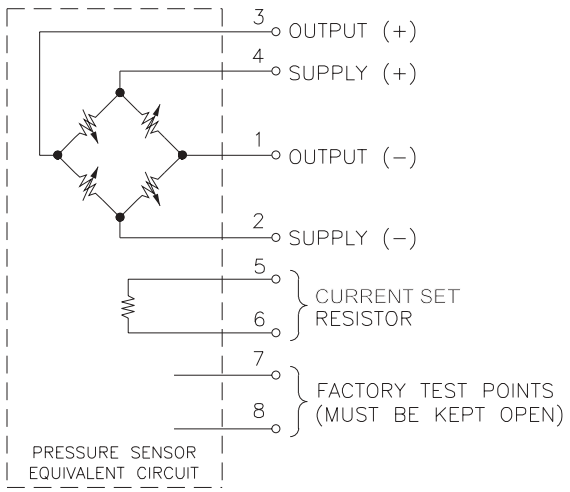
Supply Voltage: See application schematic
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE 0 - 1 psi MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	49.5	50	50.5	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4
Temperature Error - Zero		0.5	1.0	±%Span	4
Thermal Hysteresis - Zero		0.1		±%Span	4
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				9
Weight	3 Grams				

Notes

1. Output span of unamplified sensor.
2. Compensation resistors are in an integral part of the sensor package; no additional external resistors are required.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1kHz.
7. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
8. Lead pins can either be in the same or the opposite direction as the pressure tube. See Dimensions drawing for lead configurations.
9. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

CONNECTIONS



ORDERING INFORMATION

1220 A - 001 G - 3 S

- Pressure Tubes (L, S, N - see note 7)
- Lead Configuration (1, 3 - see note 8)
- Type (G = Gage, D = Differential)
- Pressure Range
- Grade
- Model

APPLICATION SCHEMATIC

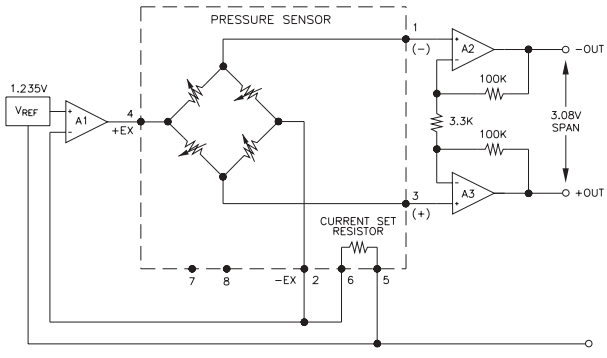


FIGURE 1: CURRENT SET CIRCUIT

July 2003

MODEL 1210

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage, Differential and Absolute

Temperature Compensated

- Process Control
- Medical Instrumentation
- HVAC
- Barometric Pressure
- Air Flow Management
- Avionics

DESCRIPTION

The Model 1210 is a temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration. It is intended for cost sensitive applications where excellent performance and long-term stability are required.

Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Gage, absolute, and differential pressure ranges from 0-2 PSI to 0-100 PSI are available. Multiple lead and tube configurations are also available for customizing the package for specific applications.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For a compensated sensor using a current set resistor as opposed to a gain set resistor, please refer to the Model 1220.

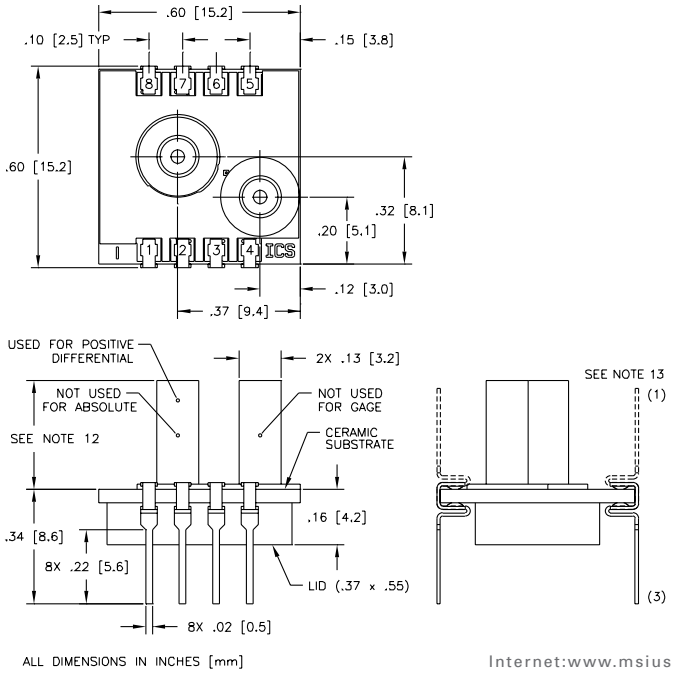
FEATURES

- Dual-in-line Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psid	psig	psia
0 to 2		●	●
0 to 5	●	●	●
0 to 15	●	●	●
0 to 30	●	●	●
0 to 50	●	●	●
0 to 100	●	●	●

DIMENSIONS



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MODEL 1210

PERFORMANCE SPECIFICATIONS

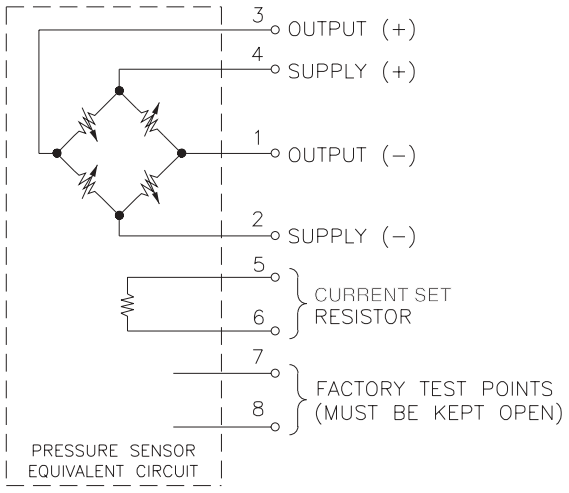
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.05	0.1	±% Span	3
Pressure Hysteresis		0.01	0.1	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2, 4
Temperature Error - Zero		0.1	0.5	±% Span	1, 2, 4
Thermal Hysteresis - Zero		0.1		±% Span	
Supply Current		1.5	2.0	mA	5
Response Time		1.0		msec	6
Output Noise		1.0		µV p-p	7
Output Load Resistance	2			MΩ	8
Insulation Resistance (50 VDC)	50			MΩ	
Pressure Overload			3X	Rated	9
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				10
Weight	3 grams				

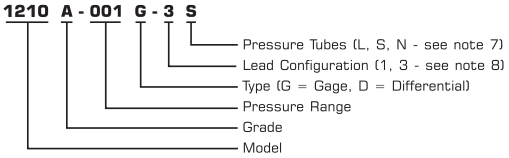
Notes

1. For 2 psi output span is 30-60 mV and TC zero temperature error is ±1%.
2. Compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 7 and 8 must be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. Guarantees input/output ratiometricity for span.
6. For a zero-to-full scale pressure step change.
7. 10 Hz to 1kHz.
8. Prevents increase of TC-Span due to output loading.
9. 3X or 200 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
10. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
11. Soldering of lead pins: 250°C for 5 seconds, maximum.
12. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
13. Lead pins can either be in the same or the opposite direction as the pressure tube. See Dimensions drawing for lead configurations.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

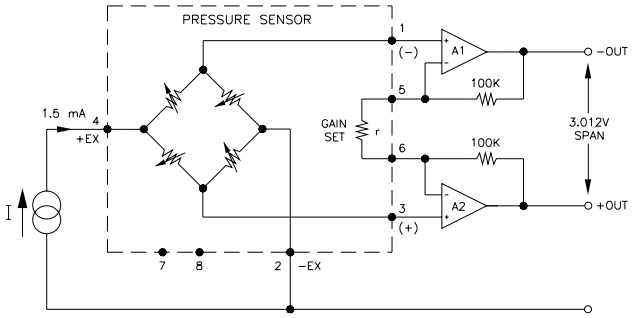


FIGURE 1: GAIN SET CIRCUIT

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MODEL 1220

PC Board Mountable Pressure Sensor

0-50 mV Output

Gage, Differential and Absolute

Temperature Compensated

- Process Control
- Medical Instrumentation
- HVAC
- Barometric Pressure
- Air Flow Management
- Avionics

DESCRIPTION

The Model 1220 is a temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration and intended for cost sensitive applications where excellent performance and long-term stability are required.

Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by setting the current drive to the sensor bridge, resulting in an interchangeability of ±1% prior to amplification.

Gage, absolute, and differential pressure ranges from 0-2 PSI to 0-100 PSI are available. Multiple lead and tube configurations are also available for customizing the package for specific applications.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For a compensated sensor using a gain set resistor as opposed to a current set resistor, please refer to the Model 1210.

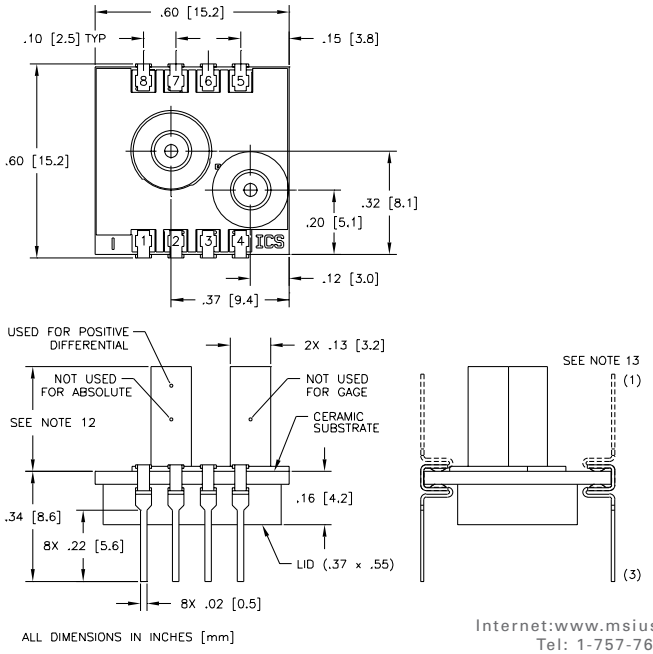
FEATURES

- Dual-in-line Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psid	psig
0 to 2		•	•
0 to 5	•	•	•
0 to 15	•	•	•
0 to 30	•	•	•
0 to 50	•	•	•
0 to 100	•	•	•

DIMENSIONS



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MODEL 1220

PERFORMANCE SPECIFICATIONS

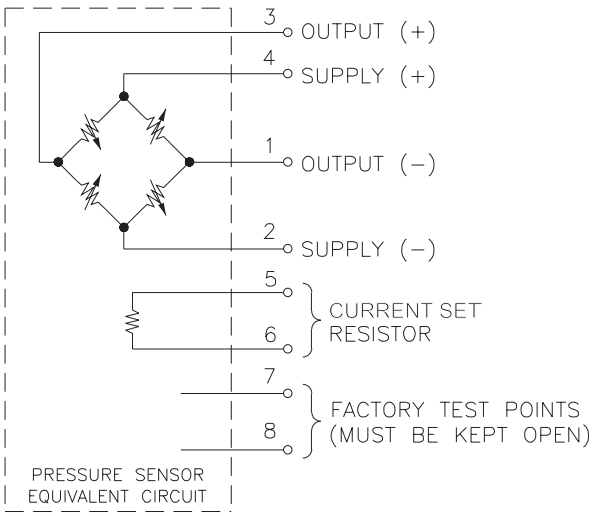
Supply Voltage: See application schematic.
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	49.5	50.0	50.5	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.05	0.1	±% Span	3
Pressure Hysteresis		0.01	0.1	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2, 4
Temperature Error - Zero		0.1	0.5	±% Span	1, 2, 4
Thermal Hysteresis - Zero		0.1		±% Span	
Supply Current			2.0	mA	
Response Time		1.0		msec	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	
Pressure Overload			3X	Rated	8
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				9
Weight	3 grams				

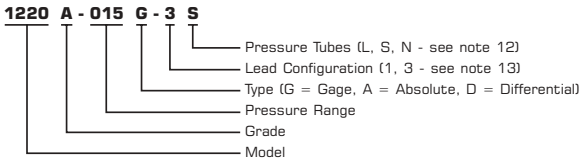
Notes

1. For 2 psi output on a 5 psi sensor span is 20.0 mV ± 1%, amplified span is 1.232V and TC zero temperature error is ±1.25%.
2. Compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 7 and 8 must be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Prevents increase of TC-Span due to output loading.
8. 3X or 200 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
9. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
10. Soldering of lead pins: 250°C for 5 seconds maximum.
11. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
12. Lead pins can either be in the same or the opposite direction as the pressure tube. See Dimensions drawing for lead configurations.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

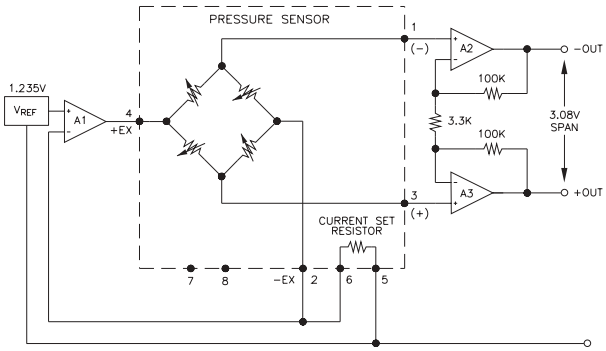


FIGURE 1: CURRENT SET CIRCUIT

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MODEL 1230 Ultrastable

PC Board Mountable Pressure Sensor

0-100 mV Output

Absolute, Differential, and Gage

Wide Temperature Range

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection

DESCRIPTION

The Model 1230 is a high performance temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration. It is intended for cost sensitive applications where excellent performance and long-term stability are required.

Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed thick film resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations, for interchangeability of ±1%, by programming the gain of an external differential amplifier.

Differential and gage pressure ranges from 0-15 PSI to 0-100 PSI are available. Absolute pressure ranges of 0-15 PSIA to 0-30 PSIA are available. Multiple lead and tube configurations are available for different applications. Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For a compensated sensor using a current set resistor as opposed to a gain set resistor, please refer to the Model 1240.

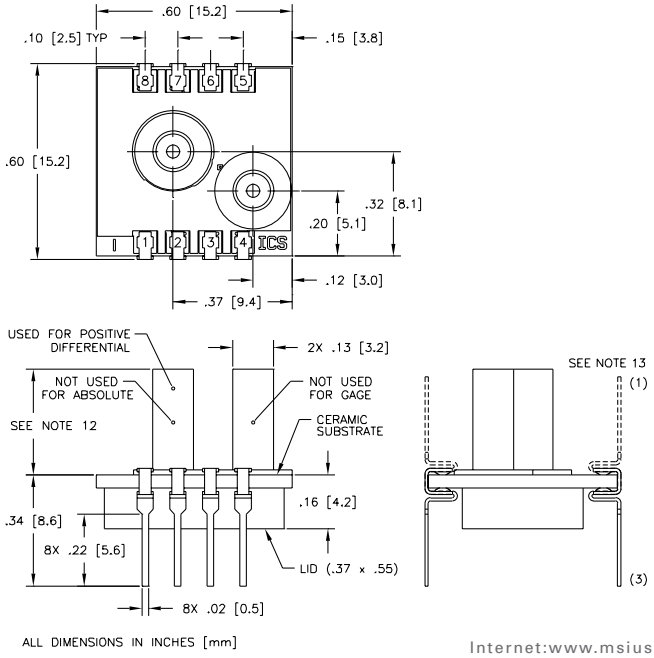
FEATURES

- Dual-In-Line Package
- -20°C to +85°C Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psid	psig
0 to 15	•	•	•
0 to 30	•	•	•
0 to 50	•	•	•
0 to 100	•	•	•

DIMENSIONS



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MODEL 1230 Ultrastable

PERFORMANCE SPECIFICATIONS

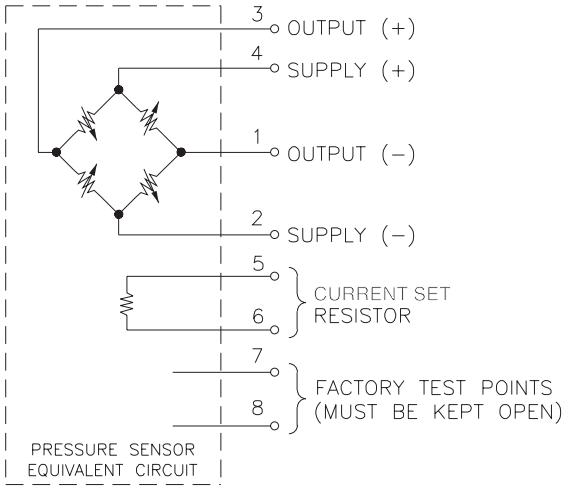
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistant		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	13
Short Term Stability of Span		0.05		±% Span	13
Long Term Stability of Offset		0.1		±% Span	14
Long Term Stability of Span		0.1		±% Span	14
Supply Current	0.5	1.5	2.0	mA	
Response Time (10% to 90%)		1.0		msec	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	
Pressure Overload			3X	Rated	8
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				9
Weight	3 grams				

Notes

1. Output span of unamplified sensor.
2. Best Fit Straight Line.
3. For Model 1230, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 7 and 8 must be kept open.
4. Temperature range: -20°C to +85°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1kHz.
7. Prevents increase of TC-Span due to output loading.
8. 3X or 200 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
9. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
10. Soldering of lead pins: 250°C for 5 seconds, maximum.
11. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
12. Lead pins can either be in the same or the opposite direction as the pressure tube. See Connections/Dimensions drawing for lead configurations.
13. Normalized offset bridge voltage: 7 days.
14. 1 year.

CONNECTIONS



ORDERING INFORMATION

1230 - 015 G - 3 S

- Pressure Tubes (L, S, N - see note 12)
- Lead Configuration (1, 3 - see note 13)
- Type (G = Gage, A = Absolute, D = Differential)
- Pressure Range
- Model

APPLICATION SCHEMATIC

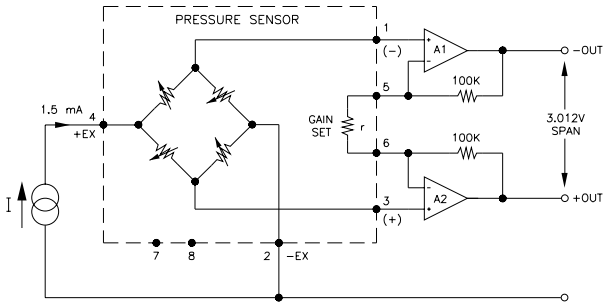


FIGURE 1: GAIN SET CIRCUIT

MODEL 1240 UltraStable

PC Board Mountable Pressure Sensor

0-50 mV Output

Absolute, Differential, and Gage

Temperature Compensated

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection

FEATURES

- Dual-In-Line Package
- -20°C to +85°C Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psid	psig
0 to 15	•	•	•
0 to 30	•	•	•
0 to 50	•	•	•
0 to 100	•	•	•

DESCRIPTION

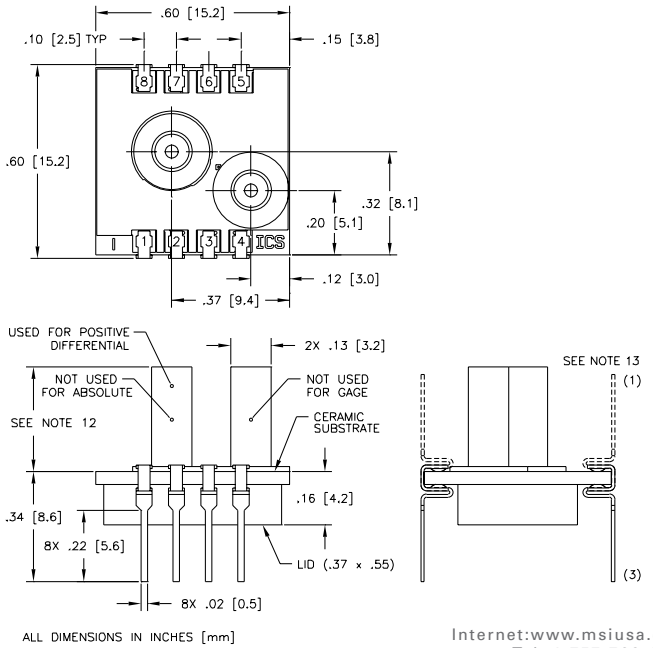
The Model 1240 is a high performance temperature compensated, piezoresistive silicon pressure sensor packaged in a dual-in-line configuration and intended for cost sensitive applications where excellent performance and long-term stability are required.

Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations, for interchangeability of ±1%.

Gage and Differential pressure ranges from 0-15 PSI to 0-100 PSI are available. Absolute pressure ranges of 0-15 PSIA and 0-30 PSIA are available. Multiple lead and tube configurations are also available for customizing the package for specific applications.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For a compensated sensor using a gain set resistor as opposed to a current set resistor, please refer to the Model 1230.

DIMENSIONS



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MODEL 1240 UltraStable

PERFORMANCE SPECIFICATIONS

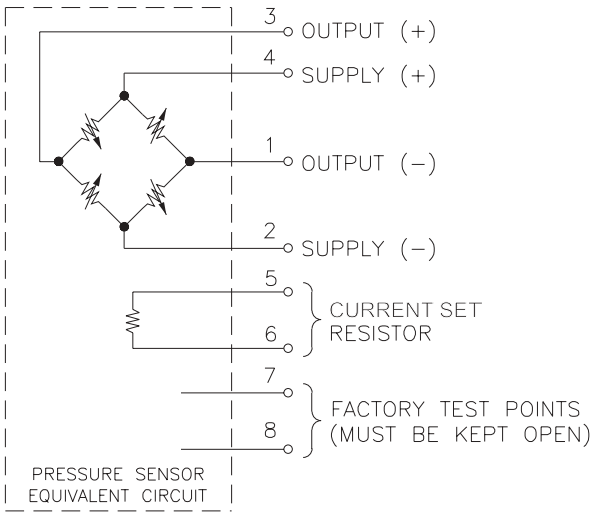
Supply Voltage: See application schematic.
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	49.5	50.0	50.5	mV	1, 3
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistant		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	13
Short Term Stability of Span		0.05		±% Span	13
Long Term Stability of Offset		0.1		±% Span	14
Long Term Stability of Span		0.1		±% Span	14
Response Time (10% to 90%)		1.0		msec	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	
Pressure Overload			3X	Rated	8
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				9
Weight	3 grams				

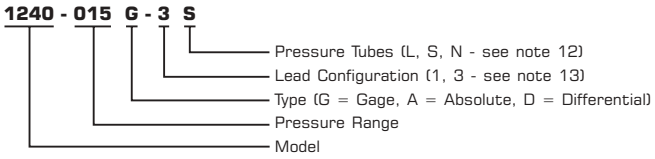
Notes

1. Output span of unamplified sensor using current set resistor.
2. Best Fit Straight Line.
3. Compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 7 and 8 must be kept open.
4. Temperature range: -20 to +85°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Prevents increase of TC-Span due to output loading.
8. 3X or 200 psi maximum, whichever is less.
9. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
10. Soldering of lead pins: 250°C for 5 seconds maximum.
11. Tube length: L=470 ± 5 mil, S=300 ± 3 mil, N=no tube.
12. Lead pins can either be in the same or the opposite direction as the pressure tube. See Connections/Dimensions drawing for lead configurations.
13. Normalized offset bridge voltage: 7 days.
14. 1 year.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

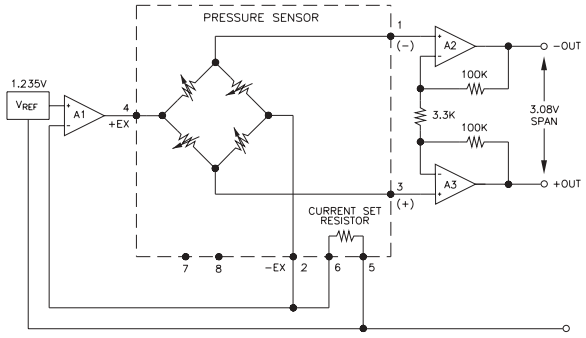


FIGURE 1: CURRENT SET CIRCUIT

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MODEL 13 Low Pressure

PC Board Mountable Pressure Sensor

0-1 PSI

0-100 mV Output

Temperature Compensated

Low Cost

- Medical Instrumentation
- HVAC
- Factory Automation
- Process Control
- Avionics
- Air Flow Management

DESCRIPTION

The Model 13 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Integral temperature compensation is provided over a range of 0-50°C using a laser-trimmed ceramic compensation board. An additional laser-trimmed resistor is included which can be used to adjust the gain of an external differential amplifier and provide sensitivity interchangeability of ±1%.

The sensing element used in low pressure Model 13 has a double bossed design that produces a high sensor output of 100 mV (typical) at 1 PSI.

This package style is also available in ranges up to 0-250 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. For additional information regarding uncompensated sensors, please contact the factory.

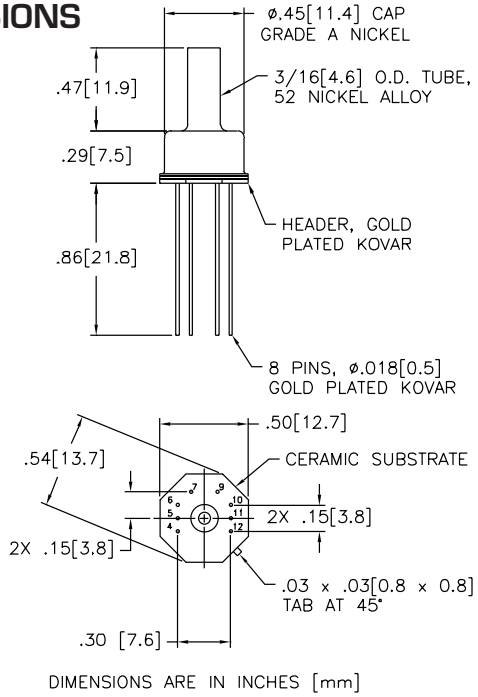
FEATURES

- Solid State Reliability
- 100mV Output Span
- Interchangeable
- Temperature Compensated
- Low Power

STANDARD RANGES

Range	psig
0 to 1	•

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 13 Low Pressure

PERFORMANCE SPECIFICATIONS

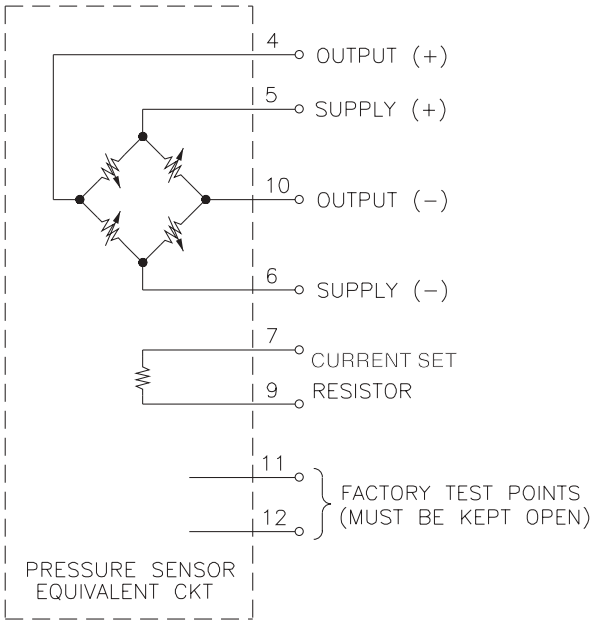
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE				
	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	65	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4, 5
Temperature Error - Zero		0.5	1.0	±%Span	4, 5
Thermal Hysteresis - Zero		0.1		±%Span	4
Supply Current		1.5	2.0	mA	
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	7
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				8
Weight	3 Grams				

Notes

1. Output span of unamplified sensor.
2. For most models, compensation resistors are in an integral part of the sensor package; no additional external resistors are required. Test pins ust be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Between case and sensing element.
8. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

CONNECTIONS

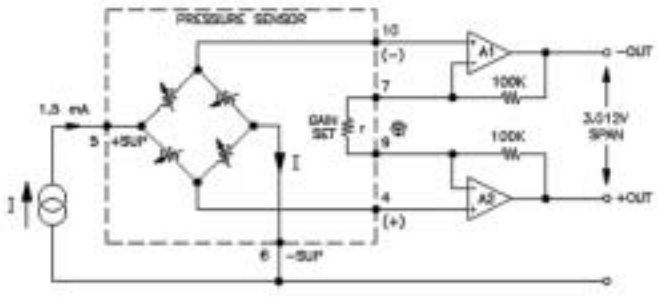


ORDERING INFORMATION

13A - 001 G

- Type (G = Gage)
- Pressure Range
- Model

APPLICATION SCHEMATIC



MODEL 23 Low Pressure

PC Board Mountable Pressure Sensor

0-1 PSI

0-100 mV Output

Low Cost

Temperature Compensated

- Medical Instrumentation
- HVAC
- Factory Automation
- Process Control
- Avionics
- Air Flow Management

DESCRIPTION

The Model 23 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Integral temperature compensation is provided over a range of 0-50°C using a laser-trimmed ceramic compensation board.

An additional laser-trimmed resistor is included which can be used to adjust the gain of an external differential amplifier and provide sensitivity interchangeability of ±1%.

The sensing element used in low pressure Model 23 has a double bossed design that produces a high sensor output of 100 mV (typical) at 1 PSI.

The Model 13 is also available in ranges up to 0-250 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. For additional information regarding uncompensated sensors, please contact the factory.

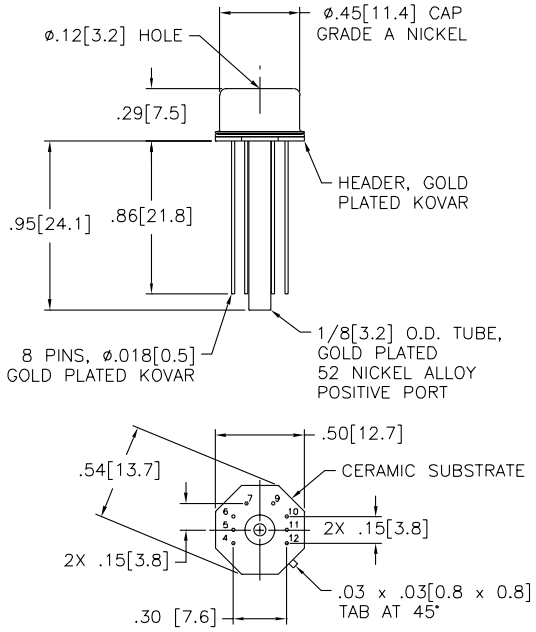
FEATURES

- Solid State Reliability
- 100mV Output Span
- Interchangeable
- Temperature Compensated
- Low Power

STANDARD RANGES

Range	psig
0 to 1	•

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 23 Low Pressure

PERFORMANCE SPECIFICATIONS

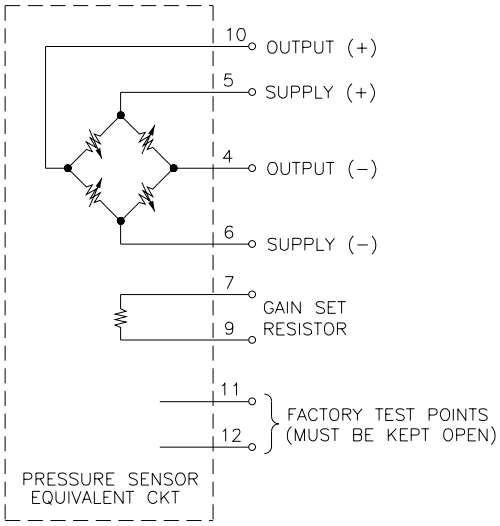
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE 0 - 1 psi			UNITS	NOTES
	MIN	TYP	MAX		
Full Scale Output Span	65	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4, 5
Temperature Error - Zero		0.5	1.0	±%Span	4, 5
Thermal Hysteresis - Zero		0.1		±%Span	4
Supply Current		1.5	2.0	mA	
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	7
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				8
Weight	3 Grams				

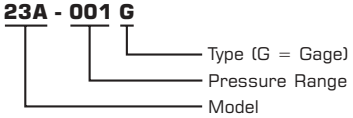
Notes

1. Output span of unamplified sensor.
2. For most models, compensation resistors are in an integral part of the sensor package; no additional external resistors are required. Test pins ust be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Between case and sensing element.
8. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

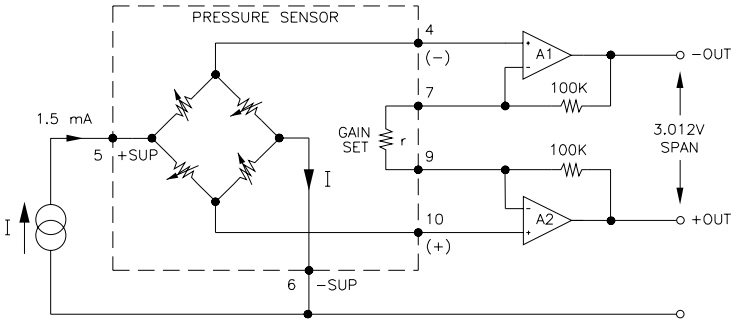


FIGURE 1: BOTTOM ENTRY FOR GAGE

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Pressure

MODEL 33 Low Pressure

PC Board Mountable Pressure Sensor

0-1 PSI

0-100 mV Output

Low Cost

Temperature Compensated

- Medical Instrumentation
- HVAC
- Factory Automation
- Process Control
- Avionics
- Air Flow Management

DESCRIPTION

The Model 33 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Integral temperature compensation is provided over a range of 0-50°C using a laser-trimmed ceramic compensation board. An additional laser-trimmed resistor is included which can be used to adjust the gain of an external differential amplifier and provide sensitivity interchangeability of ±1%.

The sensing element used in low pressure Model 33 has a double bossed design that produces a high sensor output of 100 mV (typical) at 1 PSI.

The Model 33 is also available in ranges up to 0-250 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. For additional information regarding uncompensated sensors, please contact the factory.

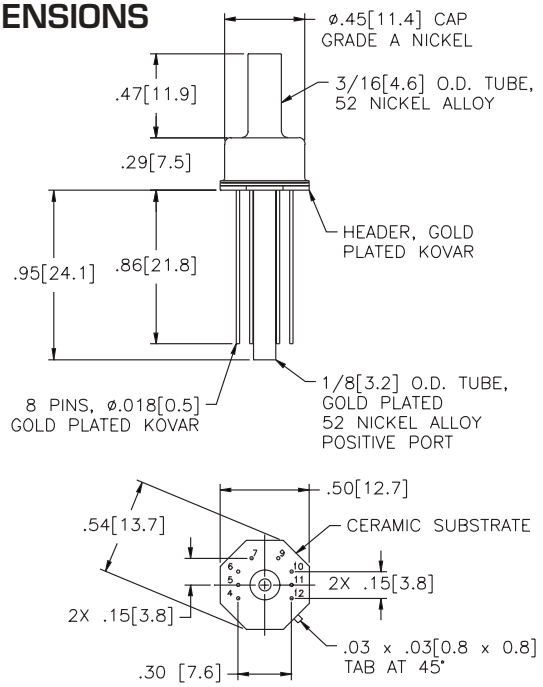
FEATURES

- Solid State Reliability
- 100mV Output Span
- Interchangeable
- Temperature Compensated
- Low Power

STANDARD RANGES

Range	psid
0 to 1	•

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 33 Low Pressure

PERFORMANCE SPECIFICATIONS

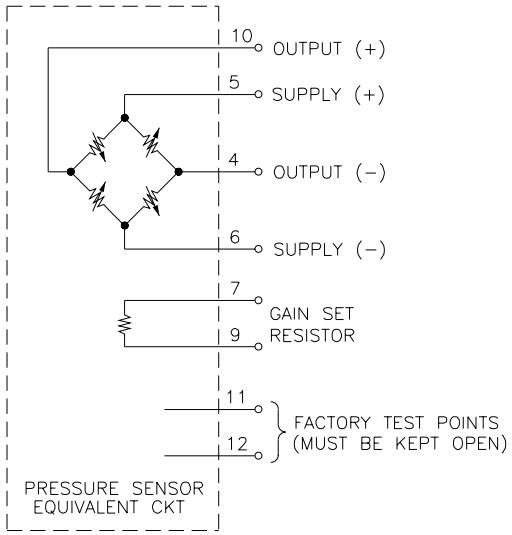
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE 0 - 1 psi MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	65	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4
Temperature Error - Zero		0.5	1.0	±%Span	4
Thermal Hysteresis - Zero		0.1		±%Span	4
Supply Current		1.5	2.0	mA	
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	7
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				8
Weight	3 Grams				

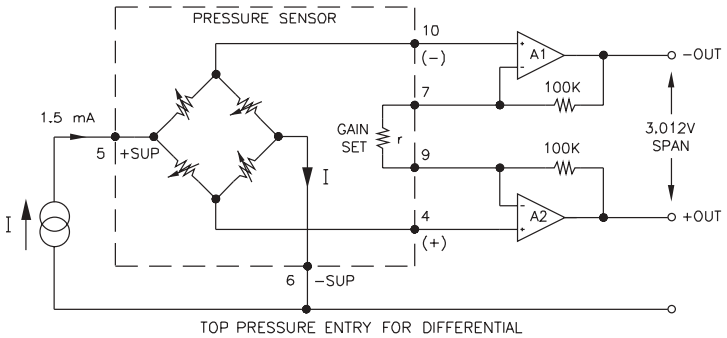
Notes

1. Output span of unamplified sensor.
2. For most models, compensation resistors are in an integral part of the sensor package; no additional external resistors are required. Test pins ust be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Between case and sensing element.
8. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

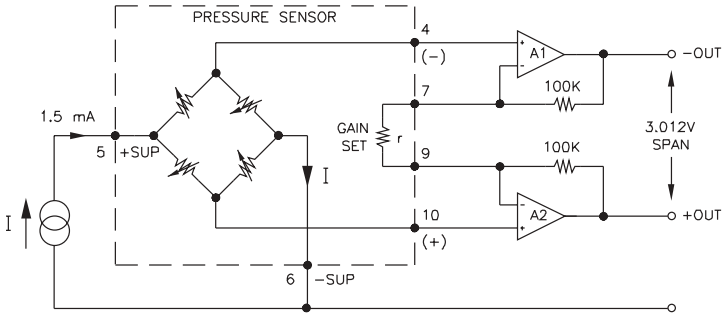
CONNECTIONS



APPLICATION SCHEMATIC



TOP PRESSURE ENTRY FOR DIFFERENTIAL



BOTTOM PRESSURE ENTRY FOR DIFFERENTIAL

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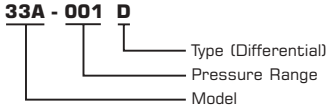
ORDERING INFORMATION



MODEL 43 Low Pressure

PC Board Mountable Pressure Sensor

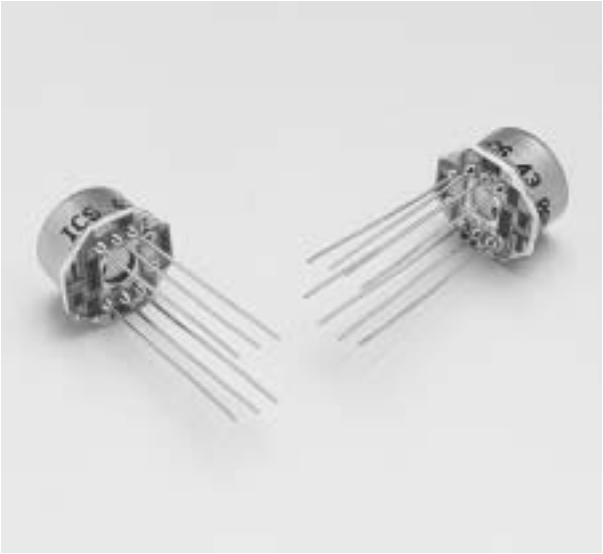
0-1 PSI

0-100 mV Output

Low Cost

Temperature Compensated

- Medical Instrumentation
- HVAC
- Factory Automation
- Process Control
- Avionics
- Air Flow Management



DESCRIPTION

The Model 43 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Integral temperature compensation is provided over a range of 0-50°C using a laser-trimmed ceramic compensation board. An additional laser-trimmed resistor is included which can be used to adjust the gain of an external differential amplifier and provide sensitivity interchangeability of ±1%.

The sensing element used in low pressure Model 43 has a double bossed design that produces a high sensor output of 100 mV (typical) at 1 PSI.

The Model 43 is also available in ranges up to 0-250 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. For additional information regarding uncompensated sensors, please contact the factory.

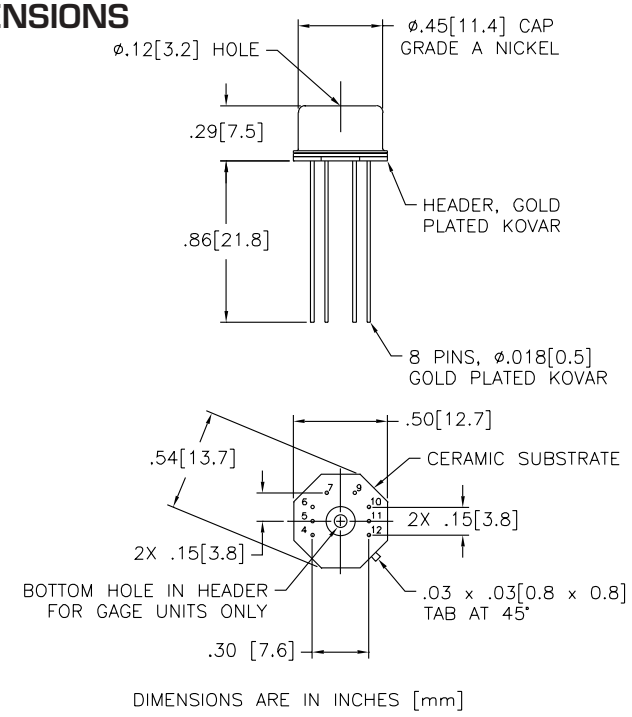
FEATURES

- Solid State Reliability
- 100mV Output Span
- Interchangeable
- Temperature Compensated
- Low Power

STANDARD RANGES

Range	psig
0 to 1	•

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 43 Low Pressure

PERFORMANCE SPECIFICATIONS

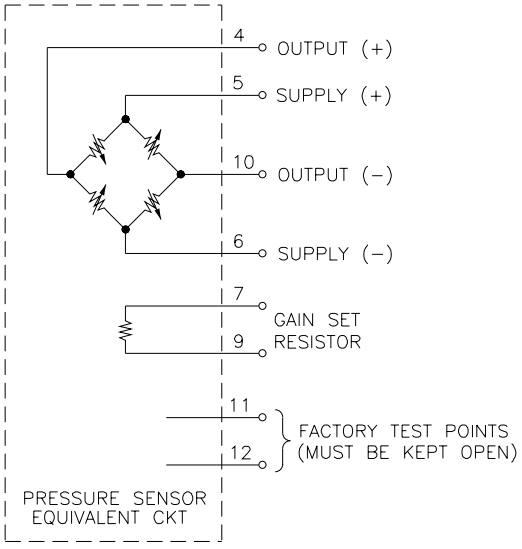
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	PRESSURE RANGE 0 - 1 psi			UNITS	NOTES
	MIN	TYP	MAX		
Full Scale Output Span	65	100	150	mV	1
Zero Pressure Output			2	±mV	2
Pressure Non-linearity		0.2	0.3	±%Span	3
Pressure Hysteresis		0.01	0.05	±%Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.5	1.0	±%Span	4, 5
Temperature Error - Zero		0.5	1.0	±%Span	4, 5
Thermal Hysteresis - Zero		0.1		±%Span	4
Supply Current		1.5	2.0	mA	
Response Time (10% to 90%)		1.0		mS	5
Output Noise		1.0		µV p-p	6
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	7
Long Term Stability		0.2		±%Span/yr	
Pressure Overload			10	psi	
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				8
Weight	3 Grams				

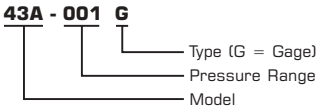
Notes

1. Output span of unamplified sensor.
2. For most models, compensation resistors are in an integral part of the sensor package; no additional external resistors are required. Test pins ust be kept open.
3. Best Fit Straight Line.
4. Temperature range: 0-50°C in reference to 25°C.
5. For a zero-to-full scale pressure step change.
6. 10 Hz to 1 kHz.
7. Between case and sensing element.
8. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

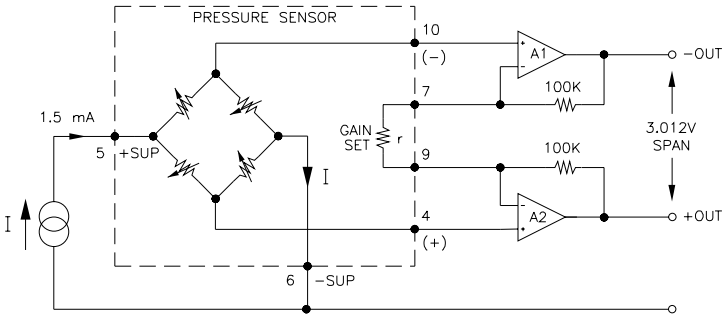


FIGURE 1: TOP ENTRY FOR GAGE UNIT

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MODEL 13 Medium Pressure

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage and Absolute Pressure

Temperature Compensated

- Medical Instrumentation
- HVAC
- Barometric Pressure
- Process Control
- Vacuum Measurement
- Air Flow Management

FEATURES

- TO-8 Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 2	•	
0 to 5	•	•
0 to 10	•	•
0 to 15	•	•
0 to 30	•	•
0 to 50	•	•
0 to 100	•	•
0 to 250	•	•

DESCRIPTION

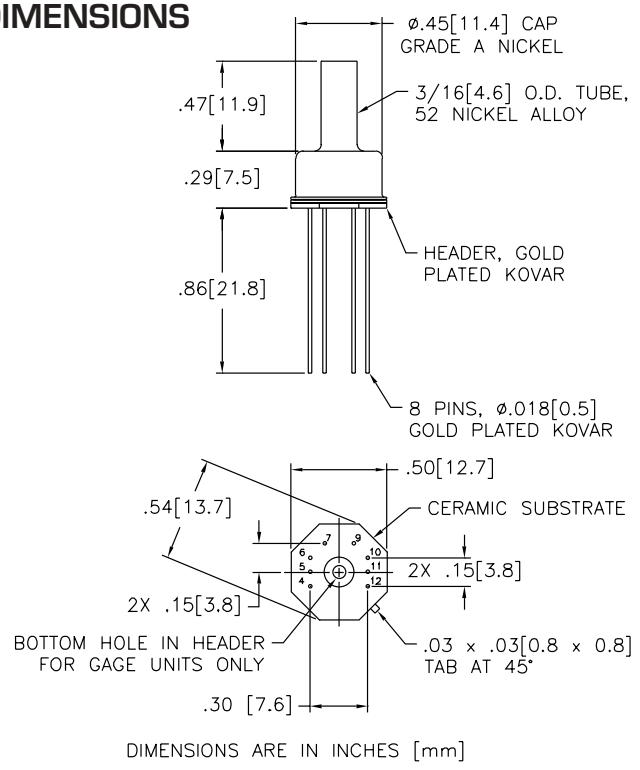
The Model 13 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Gage and absolute pressure ranges from 0-2 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors.

An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 13 Medium Pressure

PERFORMANCE SPECIFICATIONS

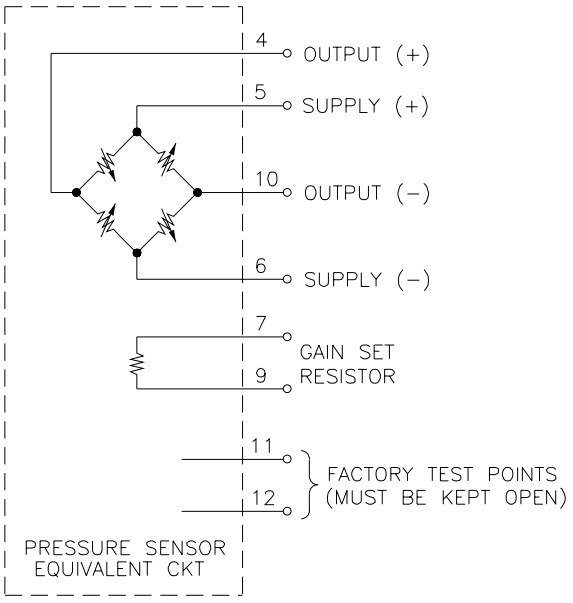
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	
Full Scale Output Span (2 psi version)	30		60	mV	
Zero Pressure Output			2	±mV	
Pressure Non-linearity		0.05	0.10	±% Span	1
Pressure Hysteresis		0.01	0.05	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2
Temperature Error - Zero		0.1	0.5	±% Span	1, 2
Thermal Hysteresis - Span		0.1		±% Span	2
Thermal Hysteresis - Zero		0.1		±% Span	2
Supply Current		1.5	2.0	mA	3
Response Time		1.0		msec	4
Output Noise		1.0		µV p-p	5
Output Load Resistance	2			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	8
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Acceleration	50g Max				
Shock	1000g Peak for 0.5mS				
Vibration	20g Peak at 10 to 2000 Hz				
Media	Non-corrosive Gases				9
Weight	3 grams				

Notes

1. Best Fit Straight Line. For 2 psi output span is 30-60 mV and TC zero temperature error is ±1.25%.
2. Temperature range 0-50°C in reference to 25°C.
3. Guarantees input/output ratiometricity for span.
4. For a zero-to-full scale pressure step change.
5. 10 Hz to 1 kHz.
6. Prevents increase of TC Span due to output loading.
7. Between case and sensing element.
8. 3X not to exceed 500 psi on ranges: 0-10 psi to 0-250 psi; 20 psi for 2 psi and 5 psi versions.
9. For Top Entry versions, wetted materials are silicon, aluminum, gold, RTV, glass, and nickel. For Bottom Entry versions, wetted materials are silicon, RTV, gold, and glass.

CONNECTIONS

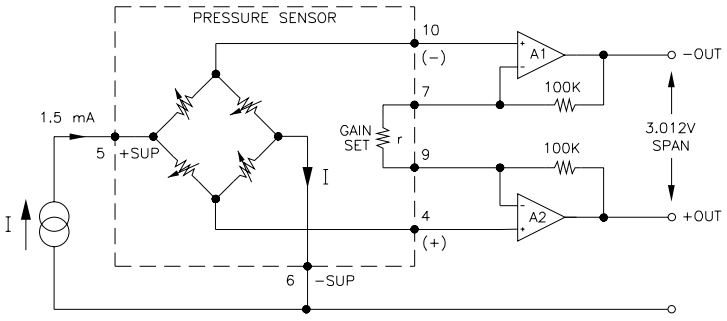


ORDERING INFORMATION

13A - 015 G

- Type (G = Gage) (A = Absolute)
- Pressure Range
- Model

APPLICATION SCHEMATIC



Nov 2002

MODEL 23 Medium Pressure

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage Pressure

Temperature Compensated

- Medical Instrumentation
- HVAC
- Process Control
- Vacuum Measurement
- Air Flow Management

FEATURES

- TO-8 Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig
0 to 2	•
0 to 5	•
0 to 10	•
0 to 15	•
0 to 30	•
0 to 50	•
0 to 100	•
0 to 250	•

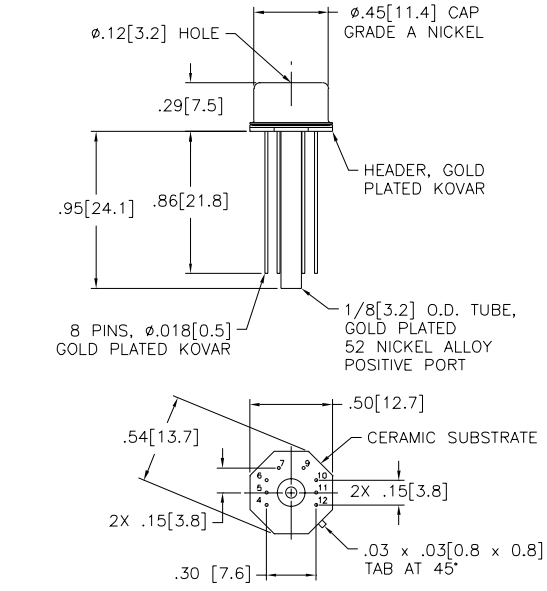
DESCRIPTION

The Model 23 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Gage pressure ranges from 0-2 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. Please contact customer service for additional information.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

20 Series.eps

Internet:www.msiusa.com
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North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

MODELS 23 Medium Pressure

PERFORMANCE SPECIFICATIONS

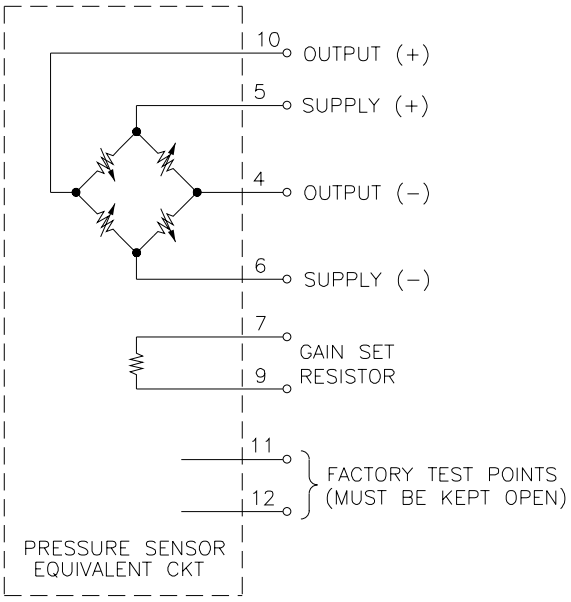
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	
Full Scale Output Span (2 psi version)	30		60	mV	
Zero Pressure Output			2	±mV	
Pressure Non-linearity		0.05	0.10	±% Span	1
Pressure Hysteresis		0.01	0.05	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2
Temperature Error - Zero		0.1	0.5	±% Span	1, 2
Thermal Hysteresis - Span		0.1		±% Span	2
Thermal Hysteresis - Zero		0.1		±% Span	2
Supply Current		1.5	2.0	mA	3
Response Time		1.0		msec	4
Output Noise		1.0		µV p-p	5
Output Load Resistance	2			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	8, 10
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Acceleration	50g Max				
Shock	1000g Peak for 0.5mS				
Vibration	20g Peak at 10 to 2000 Hz				
Media	Non-corrosive Gases				9
Weight	3 grams				

Notes

1. Best Fit Straight Line. For 2 psi output span is 30-60 mV and TC zero temperature error is ±1.25%.
2. Temperature range 0-50°C in reference to 25°C.
3. Guarantees input/output ratiometricity for span.
4. For a zero-to-full scale pressure step change.
5. 10 Hz to 1 kHz.
6. Prevents increase of TC Span due to output loading.
7. Between case and sensing element.
8. For top side application, 3X not to exceed 500 psi on ranges: 0-10 psi to 0-250 psi; 20 psi for 2 psi and 5 psi versions.
9. For Top Entry versions, wetted materials are silicon, aluminum, gold, RTV, glass, and nickel. For Bottom Entry versions, wetted materials are silicon, RTV, gold, and glass.
10. If top entry is used for gage; 3X not to exceed 100 psi.

CONNECTIONS



ORDERING INFORMATION

23A - 015 G

- Type (G = Gage)
- Pressure Range
- Model

APPLICATION SCHEMATIC

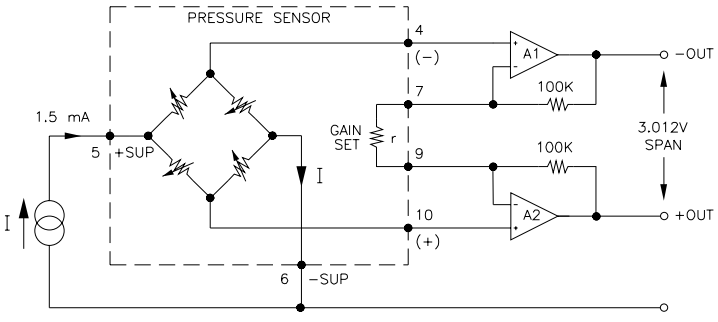


FIGURE 1: BOTTOM ENTRY FOR GAGE

Nov 2002

MODEL 33 Medium Pressure

PC Board Mountable Pressure Sensor

0-100 mV Output

Differential Pressure

Temperature Compensated

- Medical Instrumentation
- HVAC
- Process Control
- Vacuum Measurement
- Air Flow Management

FEATURES

- TO-8 Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psid
0 to 2	●
0 to 5	●
0 to 10	●
0 to 15	●
0 to 30	●
0 to 50	●
0 to 100	●
0 to 250	●

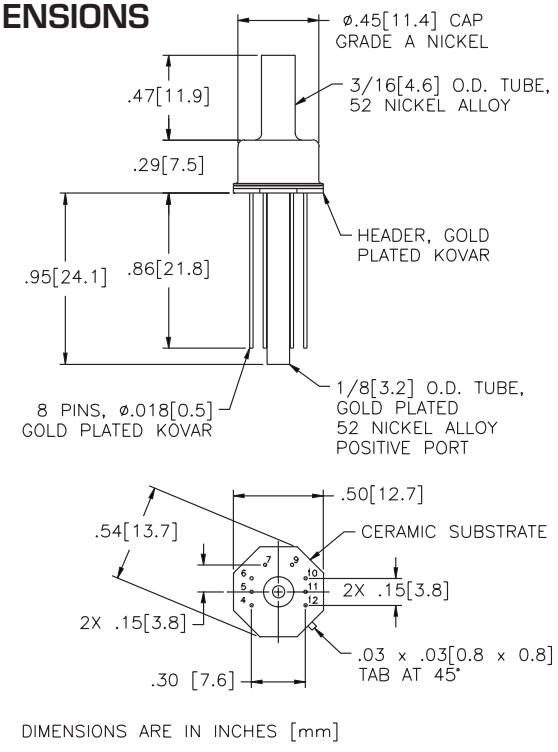
DESCRIPTION

The Model 33 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Differential pressure ranges from 0-2 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. Please contact the factory for additional information.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

MODEL 33 Medium Pressure

PERFORMANCE SPECIFICATIONS

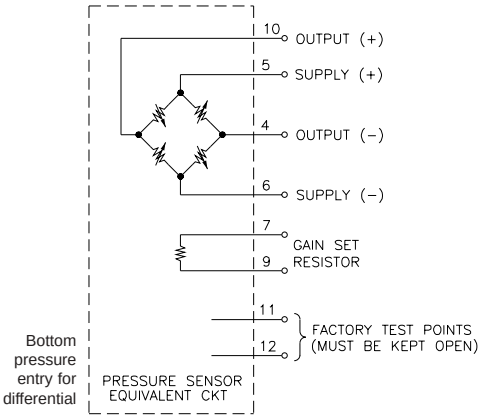
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	
Full Scale Output Span (2 psi version)	30		60	mV	
Zero Pressure Output			2	±mV	
Pressure Non-linearity		0.05	0.10	±% Span	1
Pressure Hysteresis		0.01	0.05	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2
Temperature Error - Zero		0.1	0.5	±% Span	1, 2
Thermal Hysteresis - Span		0.1		±% Span	2
Thermal Hysteresis - Zero		0.1		±% Span	2
Supply Current		1.5	2.0	mA	3
Response Time		1.0		msec	4
Output Noise		1.0		µV p-p	5
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	6
Pressure Overload			3X	Rated	7, 9
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Acceleration	50g Max				
Shock	1000g Peak for 0.5mS				
Vibration	20g Peak at 10 to 2000 Hz				
Media	Non-corrosive Gases				8
Weight	3 grams				

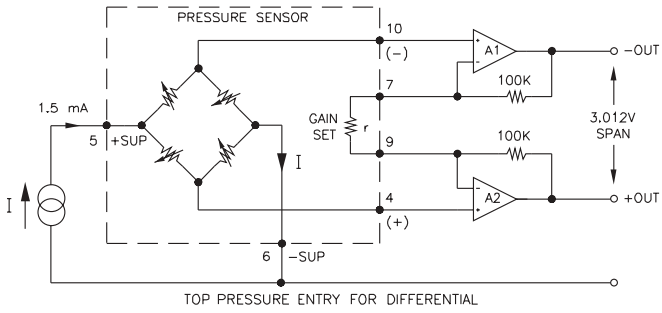
Notes

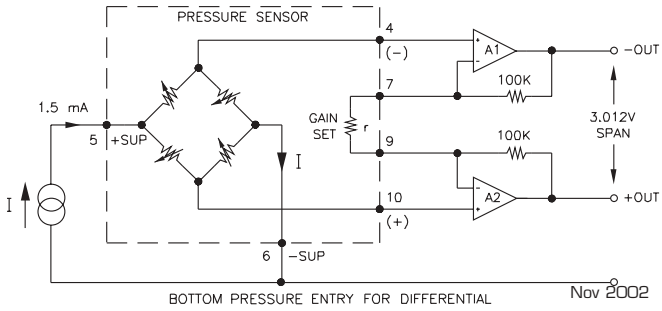
1. Best Fit Straight Line. For 2 psi output span is 30-60 mV and TC zero temperature error is ±1.25%.
2. Temperature range 0-50°C in reference to 25°C.
3. Guarantees input/output ratiometricity for span.
4. For a zero-to-full scale pressure step change.
5. 10 Hz to 1kHz.
6. Between case and sensing element.
7. For top side application, 3X not to exceed 500 psi on ranges: 0-10 psi to 0-250 psi, 20 psi for 2 psi and 5 psi versions.
8. For top entry versions, wetted materials are silicon, aluminum, gold, RTV, glass, and nickel. For bottom entry versions, wetted materials are silicon, RTV, gold, and glass.
9. For backside application, 3X not to exceed 100 psi on all ranges.

CONNECTIONS



APPLICATION SCHEMATIC





ORDERING INFORMATION

33A - 015 D

- D = Type (D = Differential)
- 015 = Pressure Range
- 33A = Model

Nov 2002

MODEL 43 Medium Pressure

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage and Absolute Pressure

Temperature Compensated

- Medical Instrumentation
- HVAC
- Process Control
- Vacuum Measurement
- Air Flow Management

DESCRIPTION

The Model 43 is a temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability.

Gage and absolute pressure ranges from 0-2 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of 0-50°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI. For sensors in a dual-in-line package please refer to the Models 1210 and 1220. Please contact the factory for additional information.

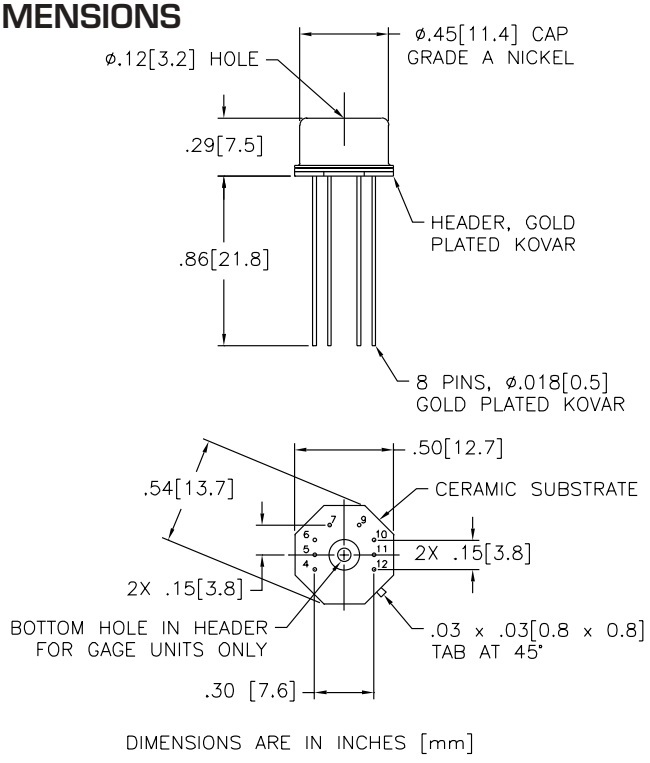
FEATURES

- TO-8 Package
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 2	•	
0 to 5	•	•
0 to 10	•	•
0 to 15	•	•
0 to 30	•	•
0 to 50	•	•
0 to 100	•	•
0 to 250	•	•

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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Fax: 1-757-766-4297

MODELS 43 Medium Pressure

PERFORMANCE SPECIFICATIONS

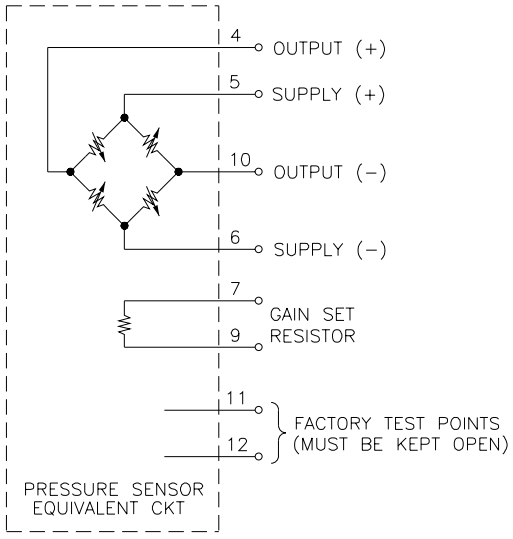
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	
Full Scale Output Span (2 psi version)	30		60	mV	
Zero Pressure Output			2	±mV	
Pressure Non-linearity		0.05	0.10	±% Span	1
Pressure Hysteresis		0.01	0.05	±% Span	
Input & Output Resistance	2500	4400	6000	Ω	
Temperature Error - Span		0.3	0.5	±% Span	2
Temperature Error - Zero		0.1	0.5	±% Span	1, 2
Thermal Hysteresis - Span		0.1		±% Span	2
Thermal Hysteresis - Zero		0.1		±% Span	2
Supply Current		1.5	2.0	mA	3
Response Time		1.0		msec	4
Output Noise		1.0		µV p-p	5
Output Load Resistance	2			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	6
Pressure Overload			3X	Rated	7
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Acceleration	50g Max				
Shock	1000g Peak for 0.5mS				
Vibration	20g Peak at 10 to 2000 Hz				
Media	Non-corrosive Gases				8
Weight	3 grams				

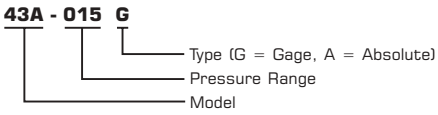
Notes

1. Best Fit Straight Line. For 2 psi output span is 30-60 mV and TC zero temperature error is ±1.25%.
2. Temperature range 0-50°C in reference to 25°C.
3. Guarantees input/output ratiometricity for span.
4. For a zero-to-full scale pressure step change.
5. 10 Hz to 1 kHz.
6. Between case and sensing element.
7. 3X not to exceed 500 psi on ranges: 0-10 psi to 0-250 psi; 20 psi for 2 psi and 5 psi versions.
8. For Top Entry versions, wetted materials are silicon, aluminum, gold, RTV, glass, and nickel. For Bottom Entry versions, wetted materials are silicon, RTV, gold, and glass.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

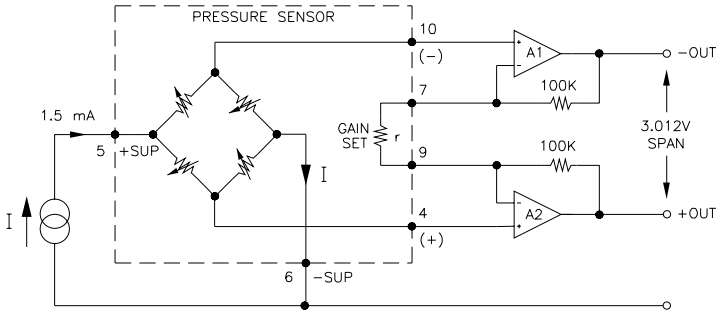


FIGURE 1: TOP ENTRY FOR ABSOLUTE OR DIFFERENTIAL

Nov 2002

MODEL 17 Ultrastable

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage and Absolute Pressure

Wide Temperature Range

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection

FEATURES

- TO-8 Package
- -20ºC to +85ºC Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	•	•
0 to 30	•	•
0 to 50	•	•
0 to 100	•	•
0 to 250	•	•

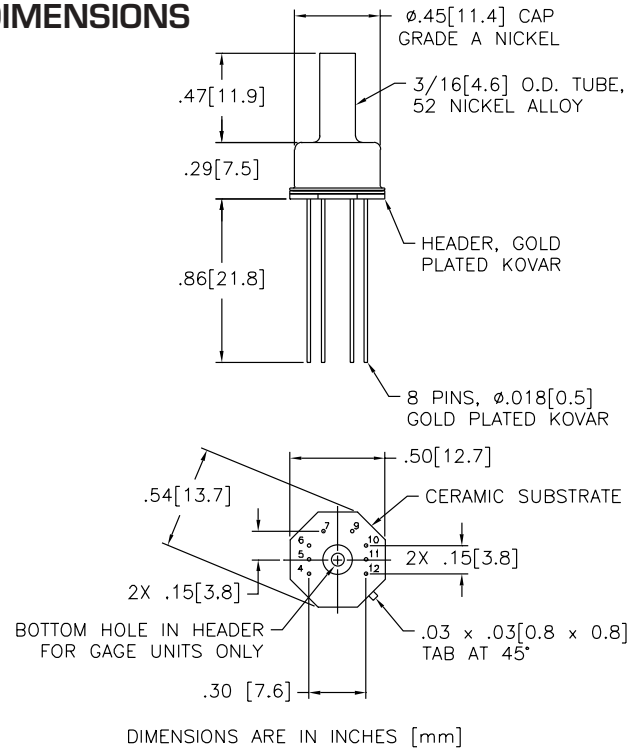
DESCRIPTION

The Model 17 is a high performance, temperature compensated, piezoresistive silicon pressure sensor packaged in TO-8 configurations. It provides excellent performance and long-term stability over wide temperatures.

Gage and absolute pressure ranges from 0-15 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 17 Ultrastable

PERFORMANCE SPECIFICATIONS

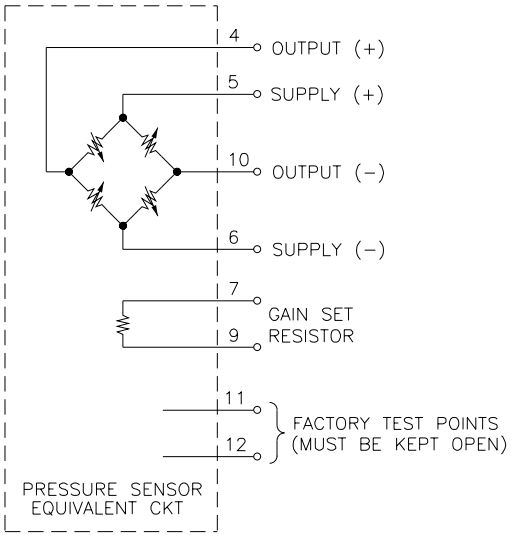
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span, (without gain set resistor)	75	100	150	mV	1
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistance		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	11
Short Term Stability of Span		0.05		±% Span	11
Long Term Stability of Offset		0.1		±% Span	12
Long Term Stability of Span		0.1		±% Span	12
Supply Current	0.5	1.5	2.0	mA	5
Response Time (10% to 90%)		1.0		msec	6
Output Noise		1.0		µV p-p	7
Output Load Resistance	5			MΩ	8
Insulation Resistance (50 VDC)	50			MΩ	13
Pressure Overload			3X	Rated	9
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				10
Weight	3 grams				

Notes

1. Output span of unamplified sensor.
2. Best Fit Straight Line.
3. For Model 17, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 11 and 12 must be kept open. Model 17 is interchangeable only when used with a gain stage.
4. Temperature range: -20°C to +85°C in reference to 25°C.
5. Guarantees input/output ratiometricity for span.
6. For a zero-to-full scale pressure step change.
7. 10 Hz to 1 kHz.
8. Prevents increase of TC-Span due to output loading.
9. 3X or 500 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
10. Wetted materials are glass, ceramic, silicon, RTV, nickel, and gold.
11. Normalized offset bridge voltage: 7 days.
12. 1 year.
13. Between case and sensing element.

CONNECTIONS



ORDERING INFORMATION

17 - 015 G

- Type (G = Gage, A = Absolute)
- Pressure Range
- Model

APPLICATION SCHEMATIC

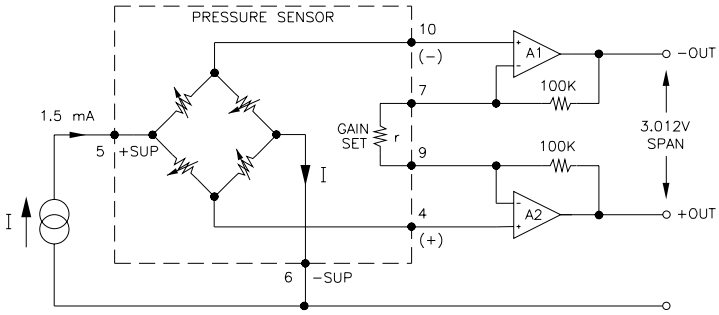


FIGURE 1: TOP ENTRY FOR ABSOLUTE

MODEL 27 Ultrastable

PC Board Mountable Pressure Sensor

0-100 mV Output

Gage Pressure

Wide Temperature Range

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection

FEATURES

- TO-8 Package
- -20ºC to +85ºC Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig
0 to 15	•
0 to 30	•
0 to 50	•
0 to 100	•

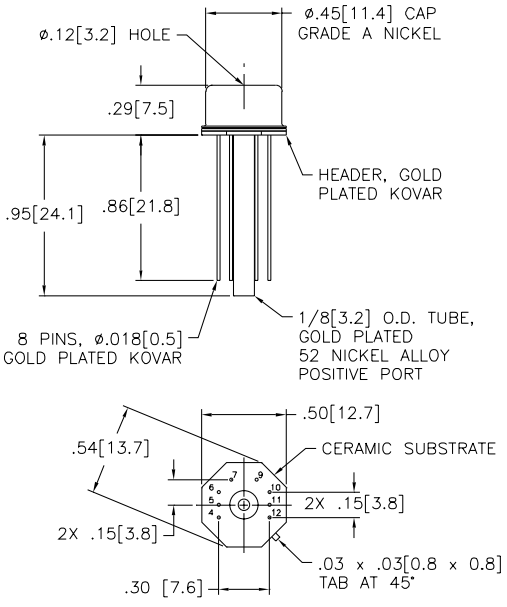
DESCRIPTION

The Model 27 is a high performance, temperature compensated, piezoresistive silicon pressure sensor packaged in a bottom tube TO-8 configuration. It provides excellent performance and long-term stability.

Gage pressure ranges from 0-15 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 27 Ultrastable

PERFORMANCE SPECIFICATIONS

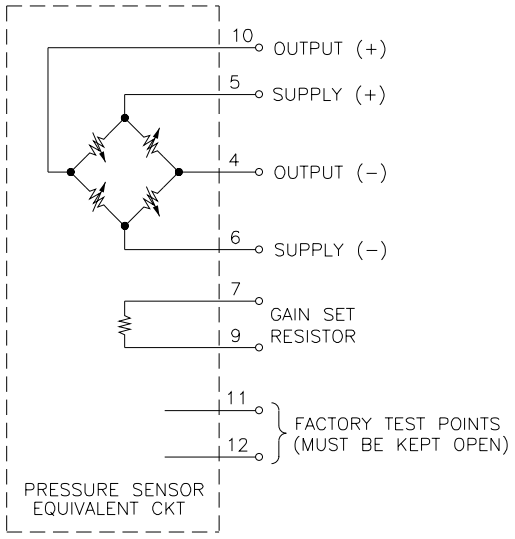
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span, (without gain set resistor)	75	100	150	mV	1
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistance		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	11
Short Term Stability of Span		0.05		±% Span	11
Long Term Stability of Offset		0.1		±% Span	12
Long Term Stability of Span		0.1		±% Span	12
Supply Current	0.5	1.5	2.0	mA	5
Response Time (10% to 90%)		1.0		msec	6
Output Noise		1.0		µV p-p	7
Output Load Resistance	5			MΩ	8
Insulation Resistance (50 VDC)	50			MΩ	13
Pressure Overload			3X	Rated	9, 14
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				10
Weight	3 grams				

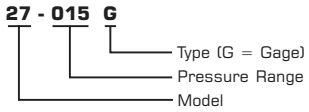
Notes

1. Output span of unamplified sensor.
2. Best Fit Straight Line.
3. For Model 27, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 11 and 12 must be kept open. Model 27 is interchangeable only when used with a gain stage.
4. Temperature range: -20°C to +85°C in reference to 25°C.
5. Guarantees input/output ratiometricity for span.
6. For a zero-to-full scale pressure step change.
7. 10 Hz to 1 kHz.
8. Prevents increase of TC-Span due to output loading.
9. For top side application, 3X or 500 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
10. Wetted materials are glass, ceramic, silicon, RTV, nickel, and gold.
11. Normalized offset bridge voltage: 7 days.
12. 1 year.
13. Between case and sensing element.
14. For backside application, 3X not to exceed 100 psi on all ranges.

CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC

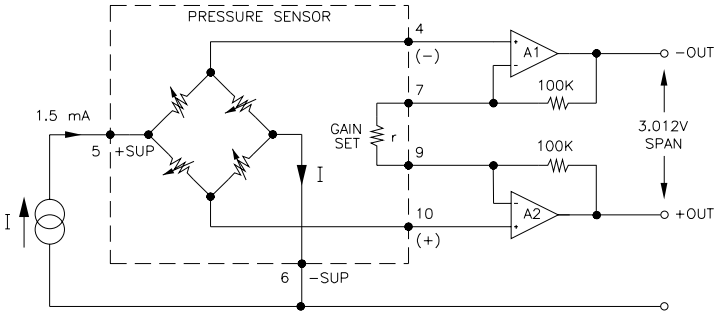


FIGURE 1: BOTTOM ENTRY FOR GAGE

Nov 2002

MODEL 37 Ultrastable

PC Board Mountable Pressure Sensor

0-100 mV Output

Differential Pressure

Wide Temperature Range

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection

FEATURES

- TO-8 Package
- -20ºC to +85ºC Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psid
0 to 15	•
0 to 30	•
0 to 50	•
0 to 100	•
0 to 250	•

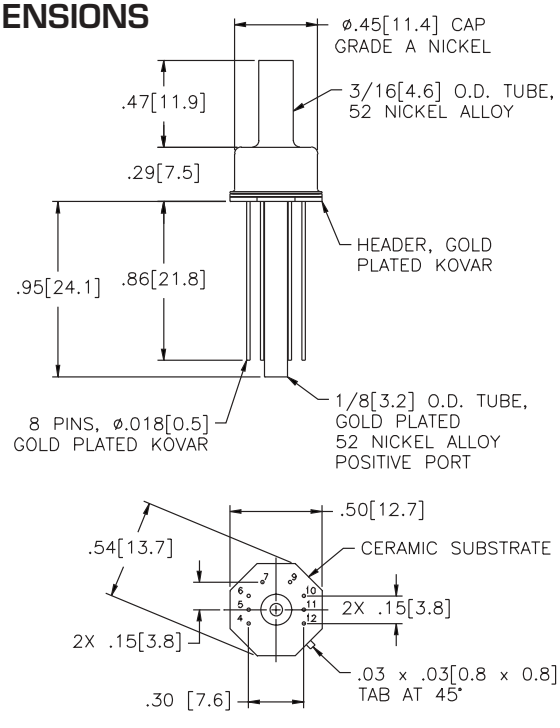
DESCRIPTION

The Model 37 is a high performance, temperature compensated, piezoresistive silicon pressure sensor packaged in a differential TO-8 configuration. It provides excellent performance and long-term stability.

Differential pressure ranges from 0-15 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

Internet:www.msiusa.com
Tel: 1-757-766-1500
North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

MODEL 37 Ultrastable

PERFORMANCE SPECIFICATIONS

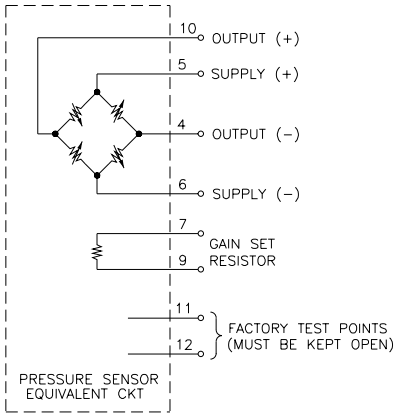
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span, (without gain set resistor)	75	100	150	mV	1
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistance		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	11
Short Term Stability of Span		0.05		±% Span	11
Long Term Stability of Offset		0.1		±% Span	12
Long Term Stability of Span		0.1		±% Span	12
Supply Current	0.5	1.5	2.0	mA	5
Response Time (10% to 90%)		1.0		msec	6
Output Noise		1.0		µV p-p	7
Output Load Resistance	5			MΩ	8
Insulation Resistance (50 VDC)	50			MΩ	13
Pressure Overload			3X	Rated	9, 14
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				10
Weight	3 grams				

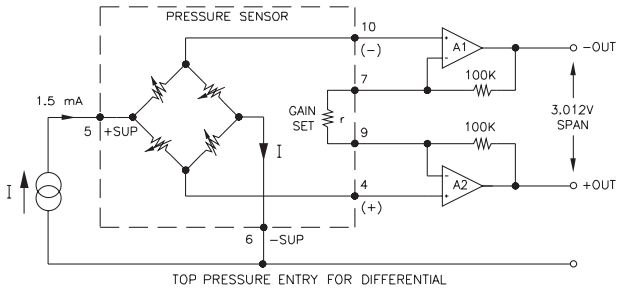
Notes

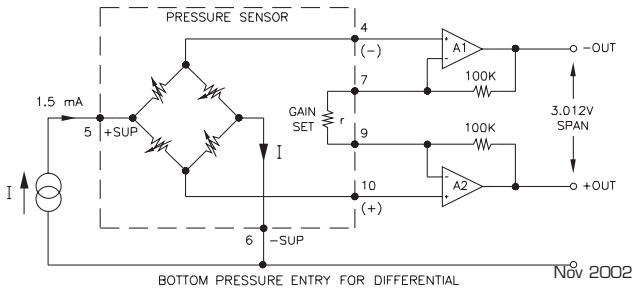
1. Output span of unamplified sensor.
2. Best Fit Straight Line.
3. For Model 37, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 11 and 12 must be kept open. Model 37 is interchangeable only when used with a gain stage as shown in the Gain Set Circuit.
4. Temperature range: -20°C to +85°C in reference to 25°C.
5. Guarantees input/output ratiometricity for span.
6. For a zero-to-full scale pressure step change.
7. 10 Hz to 1 kHz.
8. Prevents increase of TC-Span due to output loading.
9. For top side application, 3X or 500 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
10. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
11. Normalized offset bridge voltage: 7 days.
12. 1 year.
13. Between case and sensing element.
14. For backside application, 3X not to exceed 100 psi on all ranges.

CONNECTIONS



APPLICATION SCHEMATIC





ORDERING INFORMATION

37 - 015 G

- G — Type (G=Gage) (D = Differential)
- 015 — Pressure Range
- 37 — Model

Nov 2002

MODEL 47 Ultrastable

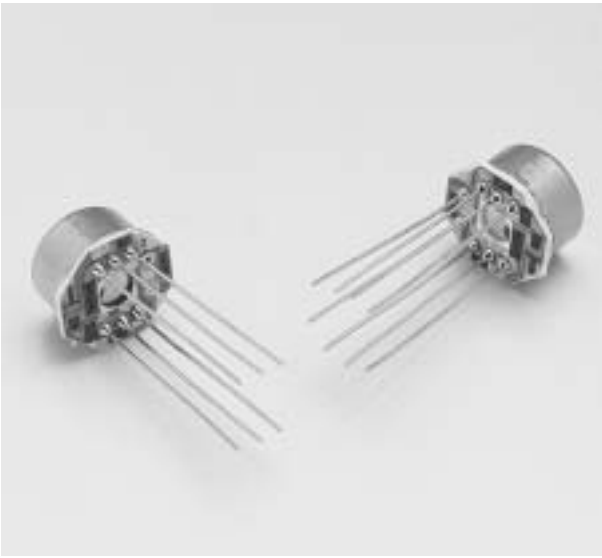
PC Board Mountable Pressure Sensor

0-100 mV Output

Differential Pressure

Wide Temperature Range

- Medical Instrumentation
- Calibration
- Process Control
- Factory Automation
- Air Flow Management
- Leak Detection



FEATURES

- TO-8 Package
- -20ºC to +85ºC Compensated Temperature Range
- ±0.1% Non-linearity
- ±0.5% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	•	•
0 to 30	•	•
0 to 50	•	•
0 to 100	•	•
0 to 250	•	•

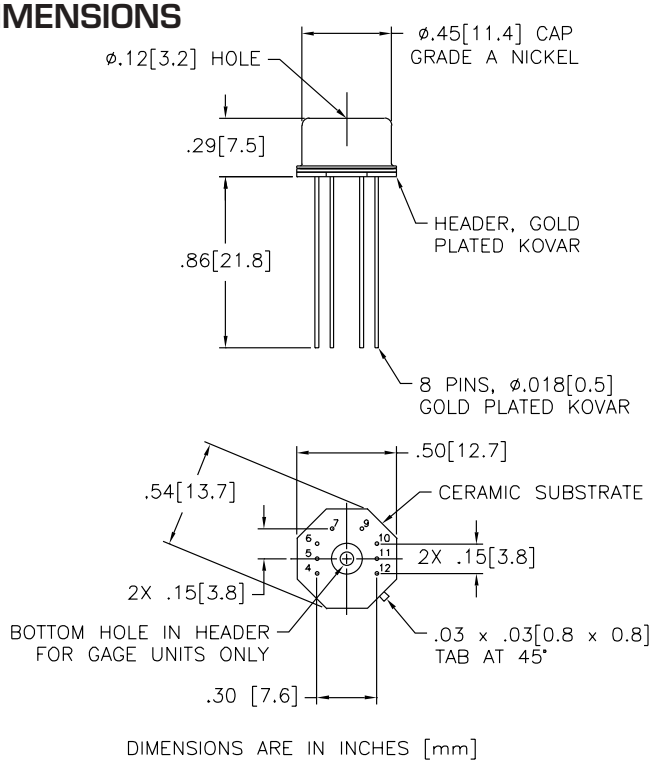
DESCRIPTION

The Model 47 is a high performance, temperature compensated, piezoresistive silicon pressure sensor packaged in a differential TO-8 configuration. It provides excellent performance and long-term stability.

Differential pressure ranges from 0-15 PSI to 0-250 PSI are available. Integral temperature compensation is provided over a range of -20°C to +85°C using laser-trimmed resistors. An additional laser-trimmed resistor is included to normalize pressure sensitivity variations by programming the gain of an external differential amplifier. This provides sensitivity interchangeability of ±1%.

Please refer to the low pressure section for information on products with operating pressures less than 0-2 PSI.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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Tel: 1-757-766-1500
North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

MODEL 47 Ultrastable

PERFORMANCE SPECIFICATIONS

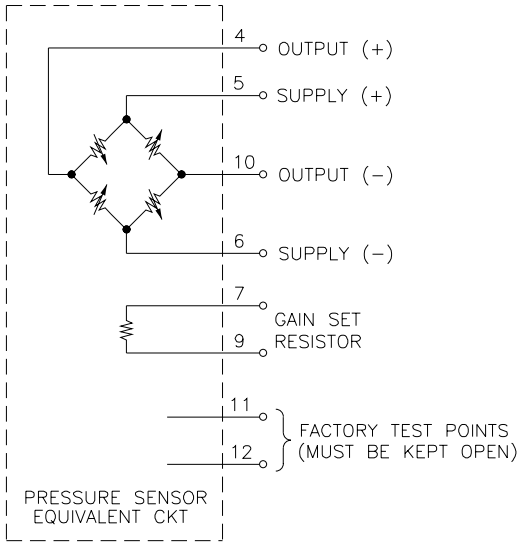
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span, (without gain set resistor)	75	100	150	mV	1
Zero Pressure Output			2	±mV	3
Pressure Non-linearity		0.05	0.1	±% Span	2
Pressure Hysteresis		0.01	0.1	±% Span	
Input Resistance	2500	3500	4500	Ω	
Temperature Error - Span		0.3	0.5	±% Span	3, 4
Temperature Error - Zero		0.1	0.5	±% Span	3, 4
Temperature Coefficient - Resistance		0.145		%/ºC	4
Thermal Hysteresis - Zero		0.05		±% Span	4
Short Term Stability of Offset		0.05		±% Span	11
Short Term Stability of Span		0.05		±% Span	11
Long Term Stability of Offset		0.1		±% Span	12
Long Term Stability of Span		0.1		±% Span	12
Supply Current	0.5	1.5	2.0	mA	5
Response Time (10% to 90%)		1.0		msec	6
Output Noise		1.0		µV p-p	7
Output Load Resistance	5			MΩ	8
Insulation Resistance (50 VDC)	50			MΩ	13
Pressure Overload			3X	Rated	9
Operating Temperature	–40°C to +125°C				
Storage Temperature	–50°C to +150°C				
Media	Non-corrosive Gases Compatible with Wetted Materials				10
Weight	3 grams				

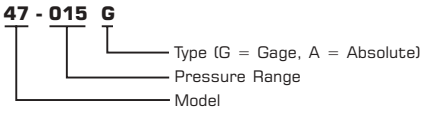
Notes

1. Output span of unamplified sensor.
2. Best Fit Straight Line.
3. For Model 47, compensation resistors are an integral part of the sensor package; no additional external resistors are required. Pins 11 and 12 must be kept open. Model 47 is interchangeable only when used with a gain stage.
4. Temperature range: -20°C to +85°C in reference to 25°C.
5. Guarantees input/output ratiometricity for span.
6. For a zero-to-full scale pressure step change.
7. 10 Hz to 1 kHz.
8. Prevents increase of TC-Span due to output loading.
9. 3X or 500 psi maximum, whichever is less. 20 psi for 2 psi and 5 psi versions.
10. Wetted materials are glass, ceramic, silicon, RTV, nickel, gold, and aluminum.
11. Normalized offset bridge voltage: 7 days.
12. 1 year.
13. Between case and sensing element.

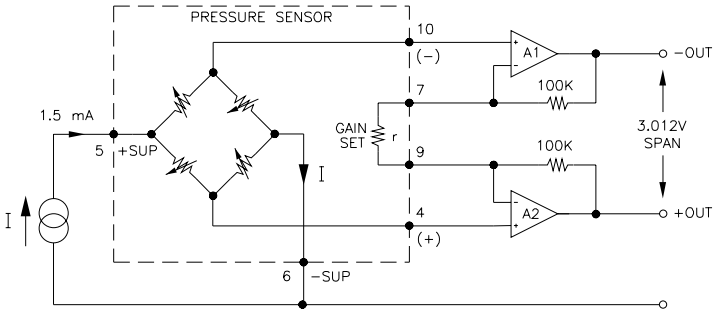
CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC



Dec 2002

Ares Series

PCB Mounted Pressure Transducers

Amplified Output

Differential and Gage Pressure

Temperature Compensated

- HVAC
- Medical Equipment
- Environmental Controls
- Portable Monitors
- Volume OEM Applications

FEATURES

- Very Low Pressure Ranges
- Small Size
- PCB Mountable
- Solder Reflow Capability
- Barbed Pressure Ports
- Dry/Dry Differential Transducer

STANDARD RANGES

Ares Model Number	Operating Pressure	Accuracy %FSO(1)
GA100-005WD	0 to 5" H_2O	0.25%
GA100-010WD	0 to 10" H_2O	0.5%
GA100-015WD	0 to 15" H_2O	0.5%
GA100-001PD	0 to 1 PSI	0.75%
GA200-005WD	0 to 5" H_2O	0.25%
GA200-010WD	0 to 10" H_2O	0.5%
GA200-015WD	0 to 15" H_2O	0.5%
GA200-001PD	0 to 1 PSI	0.75%

Note

1. Includes effects of non-linearity, hysteresis and repeatability.

DESCRIPTION

The Ares Series is a small, low cost pressure transducer, which is able to measure pressures as low as 0 to 5 inches of water, 0 to 10 inches of water, 0 to 15 inches of water, and 0 to 1 psi. Sensitivity to extremely low pressures combined with the small physical size make this device ideally suited for application such as HVAC, medical equipment, and flow monitoring.

The GA100 series has a 4V span from 0.50V to 4.50V and the GA200 series has a 3.75V span from 0.25V to 4.00V.

The plastic housing design for the Ares Series makes the device very user friendly. The housing is designed to be printed circuit board mountable, requiring no additional hardware. Built into the housing are self locking pins which insure a secure fit between the housing and the PCB. The pressure ports are 3/16" barbed ports which mate with industry standard 1/8" or 3/16" ID tubing. These ports are mounted 90° to the printed circuit board to allow other boards to be located above the sensor.

The ARES series utilizes a uniqe sensor circuit design to provide ASIC digital error correction and signal amplification while maintaining an analog signal path. This technique delivers the high level of error correction associated with microprocessor-based circuits, while maintaining a typical bandwitdth of >1 kHz generally found only in analog circuits. The result is a pressure sensor that offers theultimate in low-cost and high accuracy, while preserving the fast response and smooth output inherent to silicon sensors.

The ASIC is a mixed signal CMOS sensor interface that uses differential switched capacitor architecture, and was specifically designed to compensate for the errors associated with piezoresistive silicon sensors. This ASIC design reduces the external parts requirement for calibration, allowing a smaller overall PCB size while maintaining outstanding performance characteristics. Due to its small size, barbed pressure ports, and solder re-flow capability, the Ares pressure transducer is ideally suited for a wide range of applications.

Internet:www.msiusa.com
Tel: 1-757-766-1500
North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

PERFORMANCE SPECIFICATIONS

Specifications for Port A pressure input
Supply Voltage: 5V
Ambient Temperature: 25°C (Unless otherwise specified)

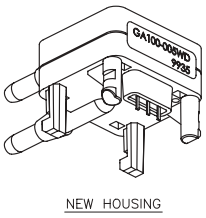
PARAMETERS	GA100 SERIES			GA200 SERIES			UNITS	NOTES
	MIN	TYP	MAX	MIN	TYP	MAX		
Zero Offset	0.450	0.500	0.550	0.200	0.250	0.300	V	
Span	3.975	4.000	4.025	3.725	3.750	3.775	V	1

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Input voltage range	4.75	5.00	5.25	V	2
Proof Pressure to any port			5	psi	
Burst Pressure	10			psi	
Common Mode Pressure			10	psi	
Long Term	-0.5		+0.5	%FSO/year	
Output Impedance			5	Ω	
Temperature Error - Span			1.5	%FSO	3
Temperature Error - Zero			1.5	%FSO	3
Media	Non-ionic, non-corrosive (clean, dry gases)				
Compensated Temperature	0° to 60°C				9
Operating Temperature	-25° to 80°C				
Storage Temperature	-25° to 80°C				
Reflow Temperature	240°C (5 sec max)				

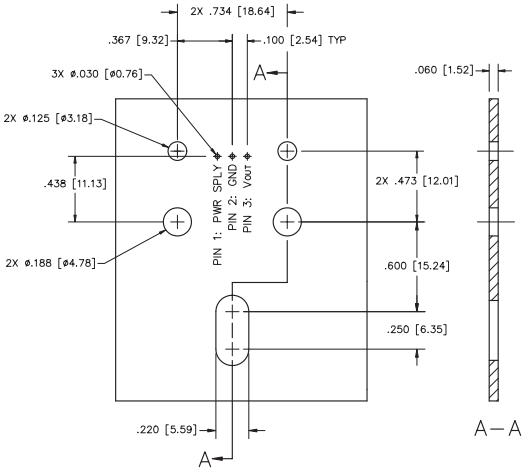
Notes

1. The span is defined as the algebraic difference between the electrical output at full scale pressure voltage and the electrical output at zero pressure.
2. Output is ratiometric to input voltage variation.
3. Over compensated temperature range.
4. Shock: 50g, 11msec, 1/2 sine per Mil Std 202F, Method 213B, Condition A.
5. Vibration: 10g sinusoidal peak to peak per Mil Std 810C.
6. Humidity: 95% non-condensing.
7. For differential applications, the input pressure to Port A must be higher than Port B.
8. Consult factory for custom output options.
9. Units calibrated & compensation at 0º to 60º C.

DIMENSIONS



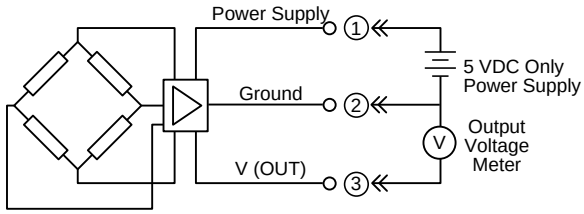
NEW HOUSING



NOTE: OVAL CUT-OUT IS NOT NECCESSARY WHEN MOUNTING SENSOR ON EDGE OF PCB w/PRESSURE PORTS FACING AWAY FROM PCB

CIRCUIT BOARD HOLE PATTERN
COMPONENT SIDE

CONNECTIONS



ORDERING INFORMATION

GA 100 - 005WD

- Pressure Range (005WD=5" H_2O, 010WD=10" H_2O 015WD=15" H_2O, 001PD=1 PSI)
- Output Configuration (100=0.5 to 4.5V, 200=0.250 to 4V)

MEDICAL-DISPOSABLE

BLOOD PRESSURE

MODEL 1620

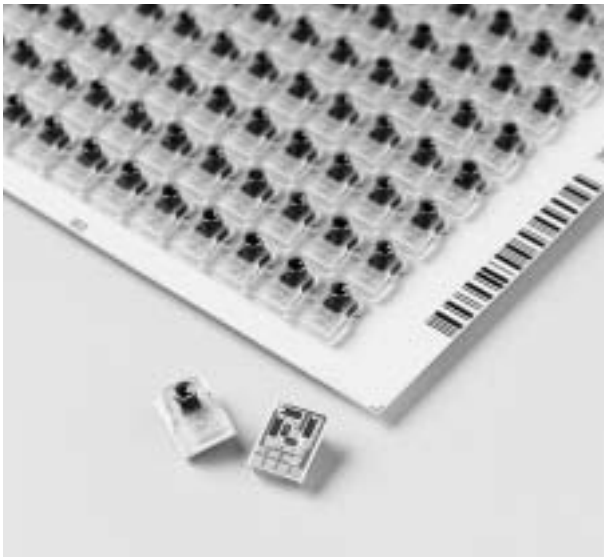
Disposble Blood Pressure Sensor

AAMI Specification

Low Cost

Multiple Configurations

- Disposable Blood Pressure
- Kidney Dialysis Machines
- Medical Instrumentation



DESCRIPTION

The Model 1620 is a fully piezoresistive silicon pressure sensor for use in invasive blood pressure monitoring. The sensor is designed to be used with automated assembly equipment and can be dropped directly into a customer's disposable blood pressure housing. The sensor is designed to meet the requirements as described in the Association for the Advancement of Medical Instrumentation (AAMI) specification for Blood Pressure Transducers.

The pressure sensor consists of a pressure sensing element mounted on a ceramic substrate. Thick-film resistors on the ceramic substrate are laser-trimmed for compensation and calibration.

A plastic cap is attached to the ceramic substrate to provide an easy method of attachment to the customers assembly and protection for the sensing element. A dielectric gel is placed over the sensor to provide electrical and fluid isolation.

The Model 1620 pressure sensors are batch manufactured in a 10x12 element array on a ceramic substrate (120 units per substrate). The products are shipped in anti-static shipping containers. Performance characteristics and packaging can be easily tailored on a special order basis to meet the requirements of specific customers.

FEATURES

- Low Cost Disposable Design
- Solid State Piezoresistive Sensor
- Top Side Pressure Entry
- Compatible with Automated Assembly Equipment
- Integral Dielectric Gel Barrier
- Fully Tested and Compensated

STANDARD RANGE

-30 to 300	mmHg

Internet:www.msiusa.com
Tel: 1-757-766-1500
North America Toll Free: 1-800-745-8008
Fax: 1-757-766-4297

MODEL 1620

PERFORMANCE SPECIFICATIONS

Supply Voltage: 6.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Operating Pressure Range	-30		300	mmHg	
Overpressure			125	PSI	
Zero Pressure Offset			±20	mmHg	
Sensitivity	4.95	5.0	5.05	µV/V/mmHg	
Calibration	97.5	100	102.5	mmHg	1
Linearity & Hysteresis (-30 to 100 mmHg)			1	mmHg	8
Linearity & Hysteresis (>100 to 200 mmHg)			1	% output	8
Linearity & Hysteresis (>200 to 300 mmHg)			1.5	% output	8
Input Impedance	1200		3200	Ω	2
Output Impedance	285		315	Ω	
Output Symmetry	0.95		1.05	ratio	7
Supply Voltage	1	6	10	VDC	
Risk Current (at 120 VAC rms 60 Hz)			2	µA	
Warm-up Time		5		seconds	
Frequency Response	1200			Hz	
Offset Drift			2	mmHg	3
Thermal Span Shift			±0.1	%/°C	4
Thermal Offset Shift			±0.3	mmHg/°C	4
Phase Shift (at 5 kHz)			5	degrees	
Light Sensitivity (3000 Foot Candle)			1	mmHg	
Defibrillator Withstand (400 Joules)			5	discharges	5
Sterilization (ETO)			3	cycles	6
Operating Temperature	+10°C to +40°C				
Storage Temperature	-25°C to +70°C				
Humidity (External)	10 - 90% (non-condensing)				
Operating Product Life	168 hours				
Shelf Life	2 years				
Dielectric Breakdown	10,000 VDC				
Media Interface	Dielectric Gel				
Volume Displacement	4.5 x 10^{-4} $inches^3$				
Weight	0.5 grams				

Notes

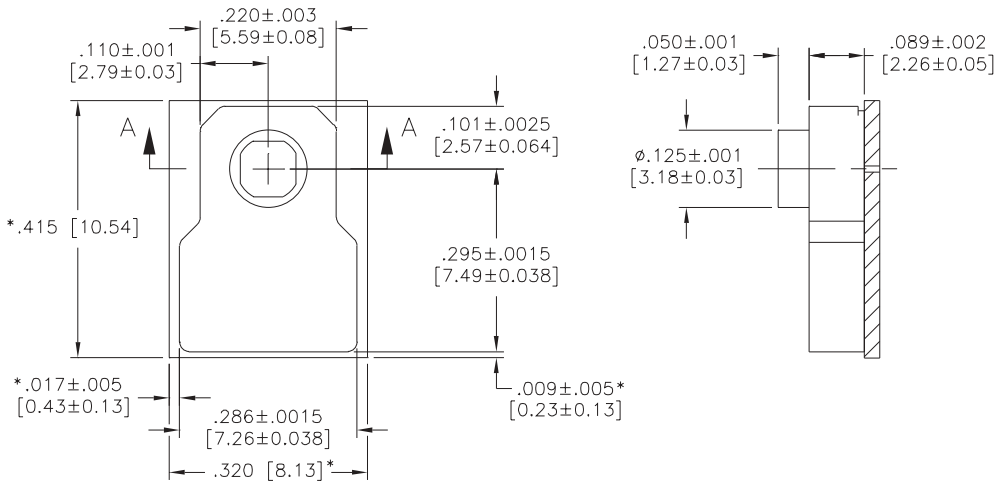
1. Output of sensor with no pressure applied and a 150kΩ resistor shorted across +VIN to +OUT.
2. For input impedance of 350 Ohms ± 5% select pad configuration 1.
3. Over an 8 hour time period and after warm-up.
4. Over operating temperature range (+10°C to +40°C).
5. One discharge per minute performed by customer.
6. Sterilization performed by customer.
7. Defined as common mode symmetry between signal output and either excitation terminal.
8. Best fit straight line.

MODEL 1620

STANDARD PAD CONFIGURATIONS

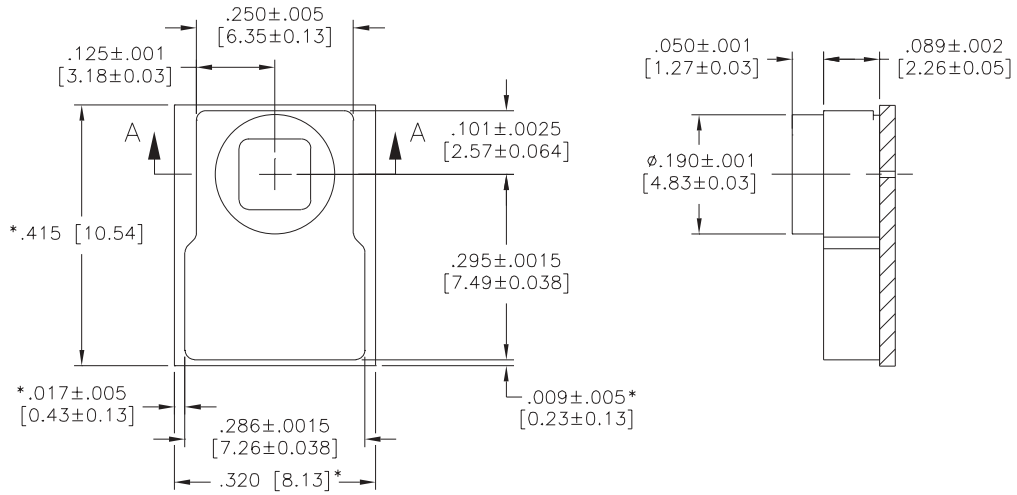
All dimensions are in inches (millimeters).

BODY STYLE N



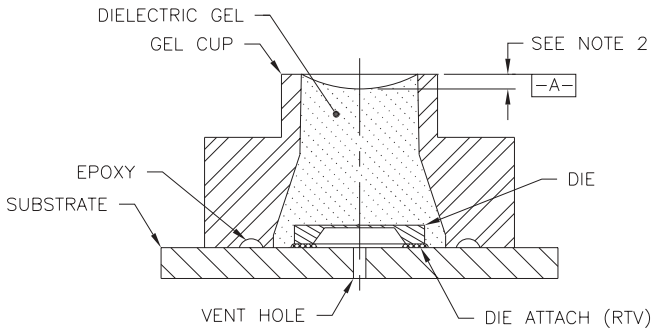
* Dimensions indicated do not include flares.

BODY STYLE W



* Dimensions indicated do not include flares.

SECTION A-A



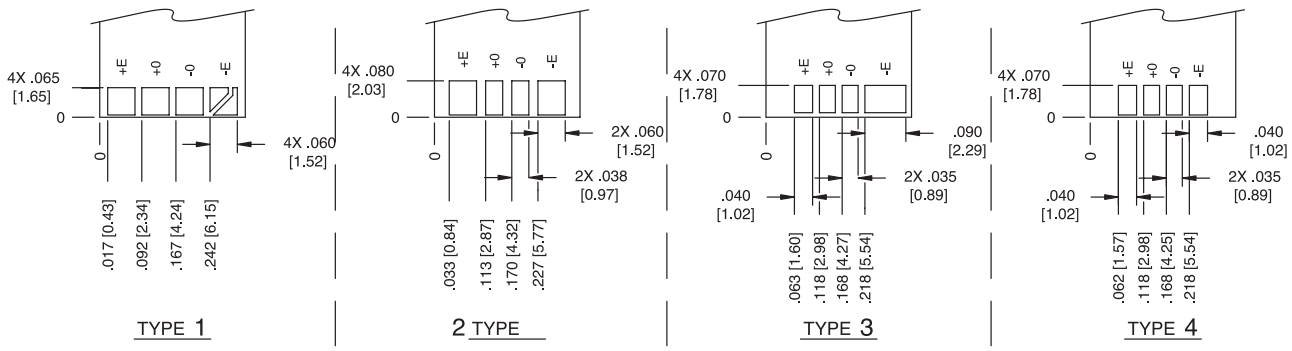
Notes

1. Materials Used:
   Substrate: 96% Alumina
   Transducer (Die): Silicon
   Die Attach Adhesive: Room Temperature Vulcanizer
   Lid Adhesive: Medical Grade UV Curing Adhesive
   Conductor And Contact Pads: Palladium-Silver Alloy
   Wire Bonds And Bond Pads: Gold
   Resistors: Ruthenium-Based Thick Film Paste
   Solder Dams: Green Glass
   Protective Gel Lid: Rad-Stable Polycarbonate Resin
2. Miniscus of Gel:
   Max dimension below surface A = .035"[0.89].
   Max dimension above surface A = .000"[0.000].
3. All dimensions taken at maximum draft.
4. All unspecified fillets and radii are.015"[0.38].
5. All draft angles 1°maximum.

MODEL 1620

STANDARD PAD CONFIGURATIONS

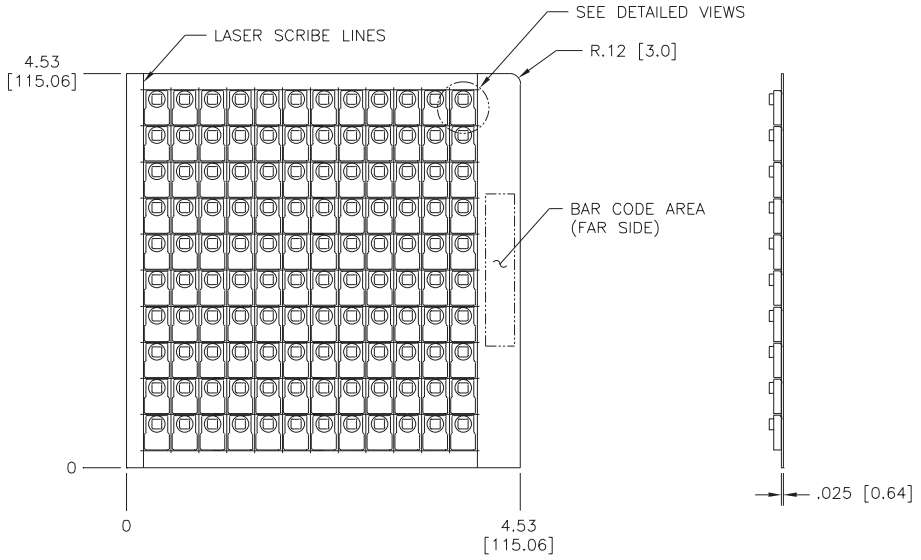
All dimensions are in inches (millimeters).



Note

1. Custom pad configurations not shown here may be special ordered. Call IC Sensors for details.

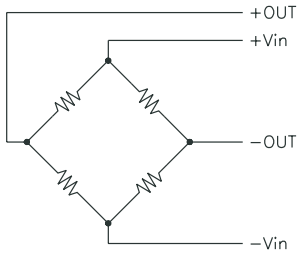
SHIPPING INFORMATION



Notes

1. Sensors are shipped as 120 UP snapstrates and must be singulated by the purchaser.
2. Each place may include units that have failed visual or electrical parameters as well as good units. Bad units are identified with a dot on the backside of the cell location.
3. Plates are shipped in dust free anti-static containers to prevent contamination of the gel surface.

SCHEMATIC DIAGRAM



ORDERING INFORMATION

1620 - 1 - N

- N — Body Style (N = Narrow, W = Wide)
- 1 — Pad Configuration (1, 2, 3, 4)
- 1620 — Model

June 20 01

ISO SELECTION GUIDE

316 Stainless Steel Media Compatibility Products

ISO SELECTION GUIDE —
316 STAINLESS STEEL MEDIA COMPATIBILITY PRODUCTS

(Please refer to specification sheets for additional information)

O-Ring Mount SS Sensors

Model 154N Series–Page 1-58

Model 154N Low Pressure–Page 1-60

- 1 to 500 psi
- 0.10% Accuracy
- 19 mm Diam Portdiameter
- Economical
- Semiflush
- O-ring or Weld Seal
- -20 to +85ºC Compensated Temp. Range

Model 82 Series–Page 1-62

Model 82 Low Pressure–Page 1-64

- 1 to 500 psi
- 0.10% Accuracy
- 19 mm diam Portdiameter
- Thin profile, only .3 inch
- O-ring or Weld Seal
- -20 to +85ºC Compensated Temp. Range

Model 86 Low Pressure–Page 1-68

Model 86 Standard–Page 1-74

- 5 to 500 psi
- 0.10% Accuracy
- 15 mm Diam Portdiameter
- Low Cost
- Thin Profile, only .3 inch
- O-ring or Weld Seal
- -20 to +85ºC Compensated Temp. Range

Flush Mount SS Sensors

Model 84 Series–Page 1-56

- 5 to 250 psi
- 0.10% Accuracy
- 19 mm Diam Portdiameter
- True Flush Diaphragm Mounting
- O-Ring Seal
- 0 to +50ºC Compensated Temp. Range

Model 85 Flush Mount–Page 1-72

- 5 to 500 psi
- 0.10% Accuracy
- 13 mm Diam Portdiameter
- True Flush Diaphragm Mounting
- O-Ring Seal
- 0 to +70ºC Compensated Temp. Range

SS Sensors with Threaded Fittings

85 Low Pressure –Page 1-66

85 Standard –Page 1-70

- 5 to 500 psi
- 0.10% Accuracy
- 13 mm Diam Portdiameter
- 1/4 NPT, 1/4 BSP, 1/8 NPT, 7/16
- UNF Custom Available
- Weld or Port Seal
- -20 to +85ºC Compensated Temp. Range

Model 87N Series–Page 1-76

- 1000 to 5000 psi
- 0.10% Accuracy
- 10 mm Diam Portdiameter
- 1/4 NPT, 1/4 BSP, 1/8 NPT, 7/16 UNF
- Weld or Port Seal
- -20 to +85ºC Compensated Temp. Range

Model 96 Series–Page 1-78

- 15 to 500 psi
- 0.10% Accuracy
- 1/4 NPT Diam Portdiameter
- Small Size
- High Performance
- Low Cost in High Volume
- Port Seal
- -20 to +85ºC Compensated Temp. Range

Weldable SS Sensors Modules

85 Low Pressure –Page 1-66

85 Standard –Page 1-70

- 5 to 500 psi
- 0.10% Accuracy
- 13 mm Diam Portdiameter
- 1/4 NPT, 1/4 BSP, 1/8 NPT, 7/16
- UNF Custom Available
- Weld or Port Seal
- -20 to +85ºC Compensated Temp. Range

Model 87N Series–Page 1-76

- 1000 to 5000 psi
- 0.10% Accuracy
- 10 mm Diam Portdiameter
- 1/4 NPT, 1/4 BSP, 1/8 NPT, 7/16 UNF
- Weld or Port Seal
- -20 to +85ºC Compensated Temp. Range

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MODEL 84

316 SS Pressure Sensor

0-100 mV Output

Gage, Sealed Gage and Absolute

Temperature Compensated

Low Pressure

- Medical Instruments
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

FEATURES

- O-ring Mount
- ±0.25% Pressure Non-linearity
- ±1.0% Temperature Performance
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psis	psia
0 to 5	•		
0 to 15	•	•	•
0 to 30	•	•	•
0 to 50	•	•	•
0 to 100	•	•	•
0 to 250	•	•	•

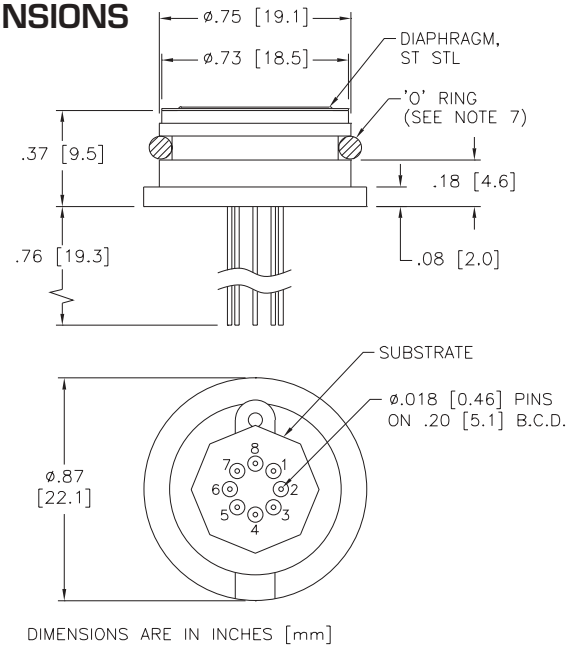
DESCRIPTION

The Model 84 is a media compatible, compensated, piezoresistive silicon pressure sensor packaged in a 316 stainless steel housing. The sensing package utilizes silicon oil to transfer pressure from the 316 stainless steel diaphragm to the sensing element.

The Model 84 is designed for low pressure applications with integral temperature compensation provided from 0°C to +50°C and is intended to be secured in place with an O-ring. A ceramic substrate is included with the package that contains thick film resistors that are laser trimmed after temperature testing to provide temperature compensation and zero offset adjustment. An additional laser-trimmed resistor on the substrate can be used to adjust sensitivity variations by setting the gain of an external differential amplifier to within +1% interchangeability. An uncompensated version is also available.

Alternatives include O-ring models 154N or 86, 1/4 NPT Model 96, and flush mount Models 82 and 85. High pressure sensors are also available.

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]

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MODEL 84

PERFORMANCE SPECIFICATIONS

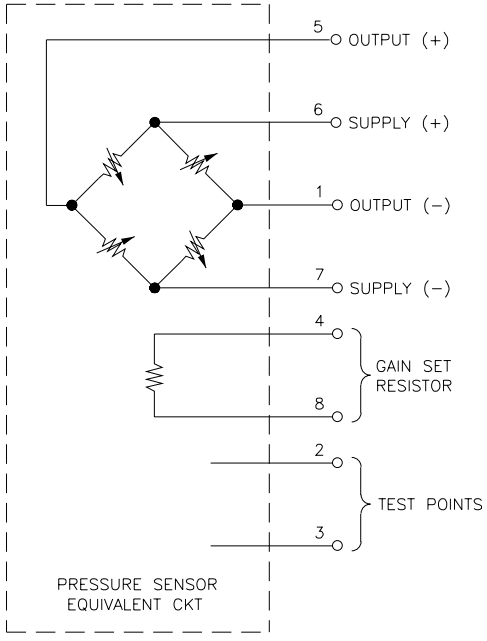
Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	50	100	200	mV	
Zero Pressure Output		1	5	±mV	2, 3, 4
Static Accuracy			0.5	±% Span	5
Input & Output Resistance	2500		6000	Ω	
Temperature Error - Span			1.0	±% Span	1, 2, 3
Temperature Error - Zero			1.0	±% Span	1, 2, 3
Supply Current	0.5	1.5	2.0	mA	
Output Load Resistance	5			MΩ	
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	6
Operating Temperature	–10°C to +80°C				
Compensated Temperature	0°C to +50°C				
Storage Temperature	–40°C to +125°C				
Media	Compatible with 316 Stainless Steel				
Weight	20 grams				

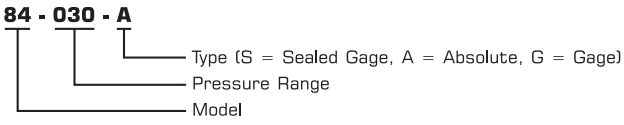
Notes

1. Temperature Range: 0-50°C in reference to 25°C.
2. For amplified output circuits, see Application Note TN003.
3. For Model 84, compensation resistors are an integral part of the sensor package. No additional external resistors are required. Model 84 is interchangeable to within ±1% of the amplifier output span only when used with a gain stage as shown in Application Schematic.
4. Measured at vacuum for absolute (A), ambient pressure for gage (G) and one standard atmosphere for sealed gage (S).
5. Includes repeatability, pressure non-linearity (best fit straight line) and pressure hysteresis.
6. 20 psi for 5 psi version; 3X or 450 psi, whichever is less, for other versions.
7. O-ring dimensions: I.D. 0.614"x 0.070".
8. Between case and sensing element.
9. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

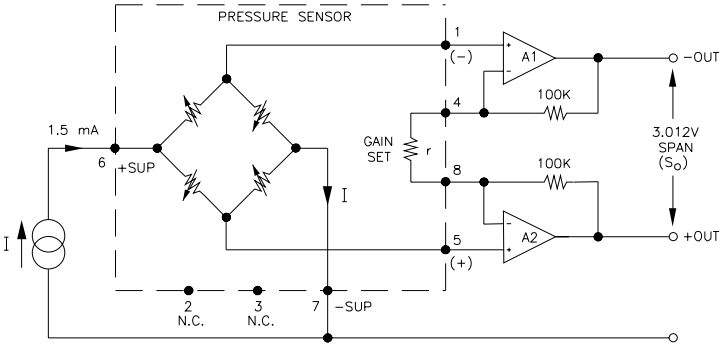
CONNECTIONS



ORDERING INFORMATION



APPLICATION SCHEMATIC



MODEL 154N Ultrastable

316 SS Pressure Sensor

0-100 mV Output

Gage, Sealed Gage and Absolute

Temperature Compensated

- Medical Instruments
- Process Control
- Waste Water Management
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 154N is a media compatible, compensated, piezoresistive silicon pressure sensor packaged in a 316 stainless steel housing. The sensing package utilizes silicon oil to transfer pressure from the 316 stainless steel diaphragm to the sensing element.

The Model 154N is designed for low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust sensitivity variations by setting the gain of an external differential amplifier to within ±1% interchangeability.

Alternatives include cap-ring Models 84 or 86, 1/4 NPT Model 96, and Model 85. High pressure sensors are also available.

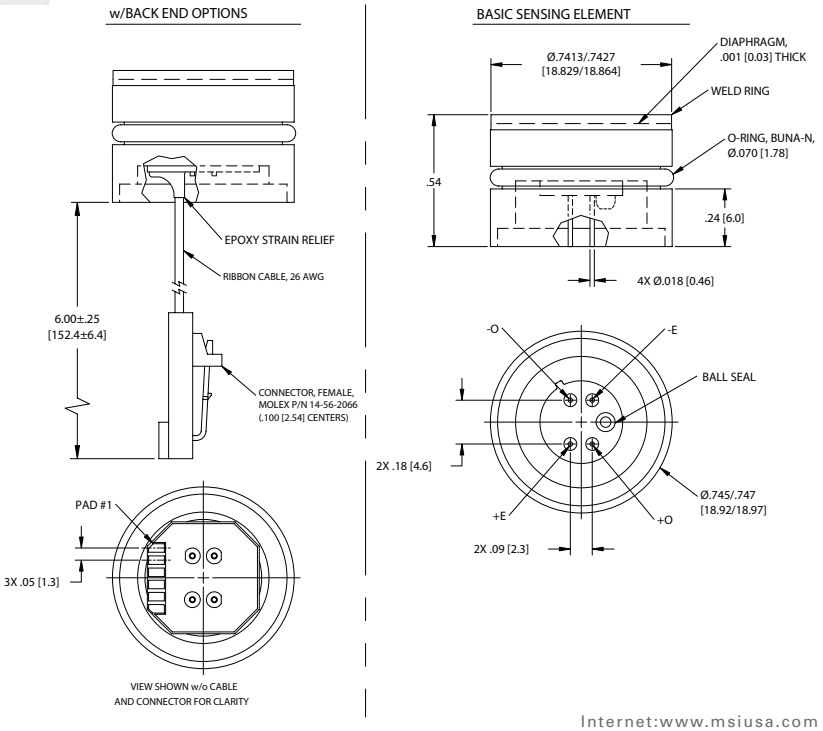
FEATURES

- O-ring Mount
- ±0.1% Pressure Non-linearity
- -20°C To +85°C Compensated Temperature Range
- 1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 5	see low pressure version	
0 to 15	•	•
0 to 30	•	•
0 to 50	•	•
0 to 100	•	•
0 to 300	•	•
0 to 500	•	•

DIMENSIONS



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MODEL 154N Ultrastable

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1.2
Zero Offset	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0.10	% Span	3
Pressure Hysteresis	-0.05	0.02	0.05	% Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span	-0.75		0.75	% Span	4
Temperature Error - Zero	-0.5		0.5	% Span	4, 5
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Zero		0.05		% Span	4
Long Term Stability of Offset		0.1		±% Span/yr.	
Long Term Stability of Span		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	
Compensated Operating Temperature	–20°C to +85°C				9
Operating Temperature Range	–40°C to +125°C				9
Storage Temperature Range	–50°C to +125°C				9
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	24 grams				10

Notes

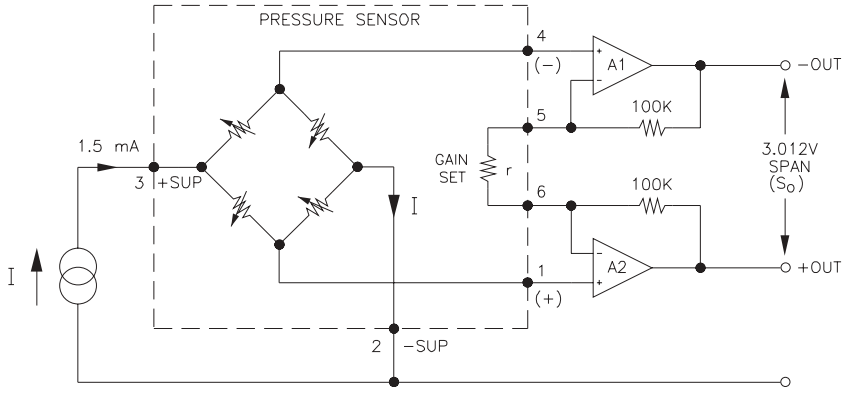
1. For amplified output circuits, 3.012V ± 1% interchangeability with gain set resistor. See Application Note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over Temperature range: -20°C to +85°C Span with respect to +25°C.
5. 15 psi range sensors have a temperature error of ±0.75% (Max) of Zero from -20°C to 85°C.
6. Guarantees output/input ratiometricity.
7. Load resistance to reduce measurement errors due to output loading.
8. Between case and sensing element.
9. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
10. Weight depends upon configuration (cable, connector).
11. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.
12. For pressure ranges < 15 psi, consult factory on performance specifications.

ORDERING INFORMATION

154N - 050 G - C T

- T: Vent (T = Tube, Blank is standard = No Tube)
- C: Electrical (C = Ribbon Cable with Connector, P = Solder Pads, R = Ribbon Cable, L = Leads, Uncompensated)
- G: Type (A=Absolute, G=Gage) (Note 11)
- 050: Pressure Range (5 to 500 psi, 050 = 50 psi) (Note 12
- 154N: Model

APPLICATION SCHEMATIC



CONNECTIONS

Pad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

MODEL 154N Low Pressure

316L SS Pressure Sensor

Millivolt Output

Gage, Sealed Gage and Absolute

Temperature Compensated

- Medical Instruments
- Process Control
- Fresh & Waste Water Measurement
- Partial Vacuum Gas Measurement
- Pressure Transmitters
- Tank Level Systems (RV, Marine & Industrial)

DESCRIPTION

The Model 154N is a media compatible, compensated, piezoresistive silicon pressure sensor packaged in a 316 stainless steel housing. The sensing package utilizes silicon oil to transfer pressure from the 316 stainless steel diaphragm to the sensing element.

The Model 154N is designed for very low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust sensitivity variations by setting the gain of an external differential amplifier to within ±1%
interchangeability.

Sensors are also available with threaded pressure fittings. Please contact the factory for more information.

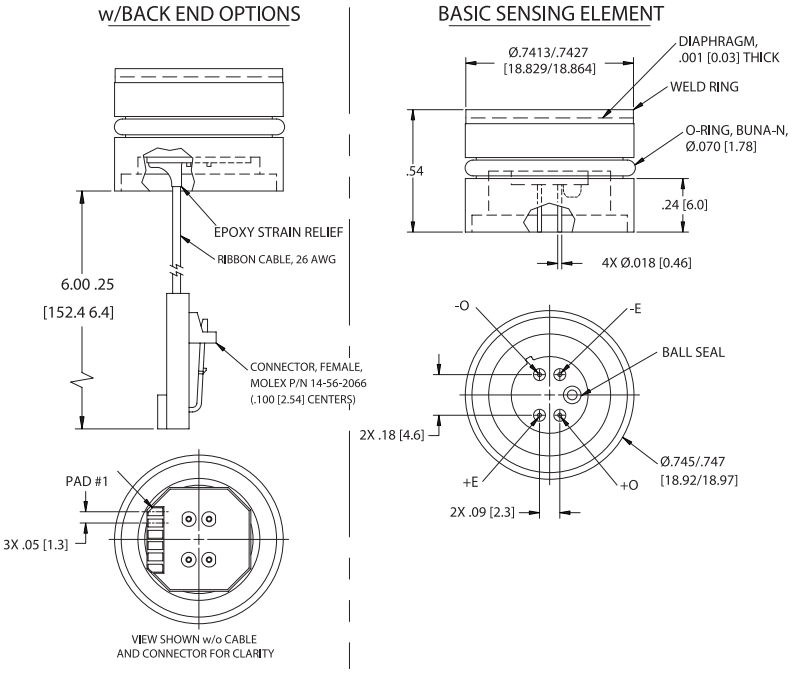
FEATURES

- O-Ring Flush Mount
- ±0.2% Pressure Non-linearity
- 1.0% Interchangeable Span (Provided By Gain Set Resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psig
0 to 1	•	•
0 to 5	•	•

DIMENSIONS



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MODEL 154N Low Pressure

PERFORMANCE SPECIFICATIONS

Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	50	100	125	mV	1, 2
Zero Output	-2	0	2	mV	2, 11
Pressure Non-linearity	-0.2	0	0.2	%Span	3
Pressure Hysteresis		0.02		%Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		30k	Ω	
Temperature Error - Span	-1.0		1.0	%Span	4
Temperature Error - Zero	-1.0		1.0	%Span	4
Thermal Hysteresis - Span		0.05		%Span	4
Thermal Hysteresis - Zero		0.05		%Span	4
Long Term Stability - Offset		.25%		±%Span/yr.	
Long Term Stability - Span		0.1		±%Span/yr.	
Supply Current	0.5	1.5	2.0	mA	5
Output Load Resistance	5			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	
Compensated Operating Temperature	0ºC to 70ºC for 5psi, 0ºC to 50º for 1psi				8
Operating Temperature Range	–20°C to +70°C				8
Storage Temperature Range	–50°C to +125°C				8
Media-Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media-Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	24 Grams				9

Notes

1. For amplified output circuits, 3.012V ± 1% interchangeability with gain set resistor. See Application Note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the compensated temperature range, with respect to +25°C.
5. Guarantees output/input ratiometricity.
6. Load resistance to reduce measurement errors due to output loading.
7. Between case and sensing element.
8. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
9. Weight depends upon configuration (cable, connector).
10. Standard gauge units are not recommended for vacuum applications. For vacuum applications, contact factory.
11. ±2mV for 1psi versions.
12. Stand gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

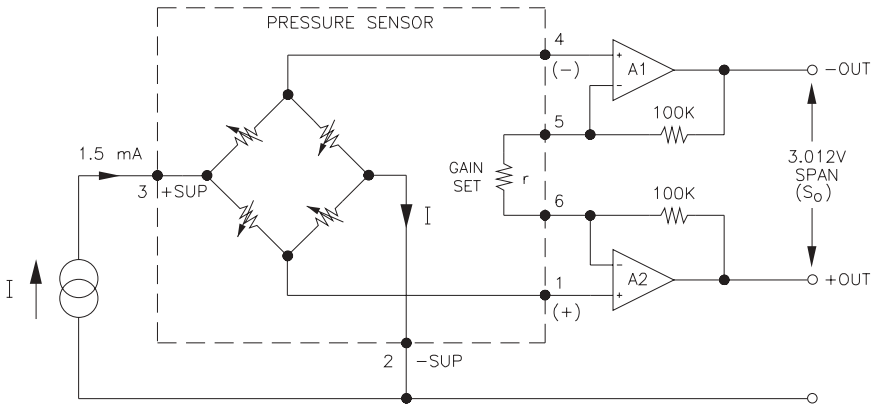
154N - 050 G C T

- T: Vent (T= Tube. Blank is standard = No Tube)
- C: Electrical (C - Ribbon Cable with Connector. P - Solder Pads R - Ribbon Cable L-Loads. Uncompensated)
- G: Type (A=Absolute, G=Gage) (Note 10)
- 050: Pressure Range 001=1psi, 005=5psi
- 154N: Model

CONNECTIONS

Pad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



Nov 2002

MODEL 82 Ultrastable

316 SS Pressure Sensor

High Performance, 19 mm

0-100 mV Output

Absolute and Gage

Low Pressure

- Hydraulic Controls
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 82 is a 19 mm small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. The Model 82 is designed for O-ring mounting. The sensing package utilizes silicon oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element.

The Model 82 is designed for high performance, low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%.

Sensors with threaded pressure fittings, weldable flush sensors and high pressure stainless steel sensors are also available. Please contact the factory for more information.

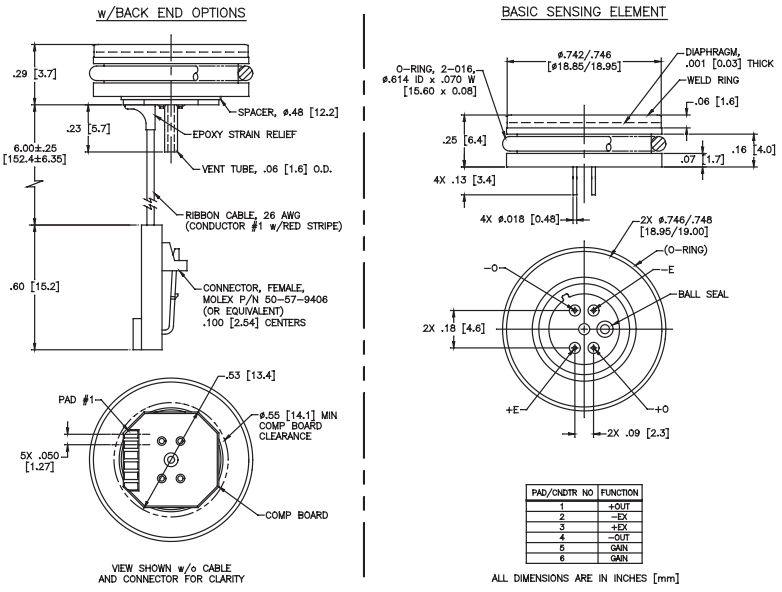
FEATURES

- O-ring Flush Mount
- -20°C To +85°C Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- ±1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 5	see low pressure version	
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 300	●	●
0 to 500	●	●

DIMENSIONS



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MODEL 82 Ultrastable

PERFORMANCE SPECIFICATIONS

All parameters specified at 1.5mA and at 25°C, after 10 second warm up, unless otherwise indicated. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
Zero Pressure Output (Offset)	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0.10	±% Span	3
Pressure Hysteresis	-0.05	0.02	+0.05	±% Span	
Repeatability		0.02		±% Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span (-20 to 85ºC)	-0.75		+0.75	% Span	4
Temperature Error - Offset (-20 to 85ºC)	-0.5		+0.5	% Span	4, 5
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Offset		0.05		% Span	4
Long Term Stability of Span		0.1		±% Span/yr.	
Long Term Stability of Offset		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	
Compensated Temperature Range	–20°C to +85°C				9
Operating Temperature Range	–40°C to +125°C				9
Storage Temperature Range	–50°C to +125°C				9
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	12 grams				

Notes

1. For amplified output circuits see application note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the temperature range –20°C to +85°C with respect to +25°C.
5. 15 psi range sensors have an offset temperature error of ±0.75% (Max) from –20°C to +85°C.
6. Guarantees output/input ratiometricity.
7. Load resistance to reduce measurement errors due to output loading.
8. Between case and sensing element.
9. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
10. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
11. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

82 - 050 G - C T

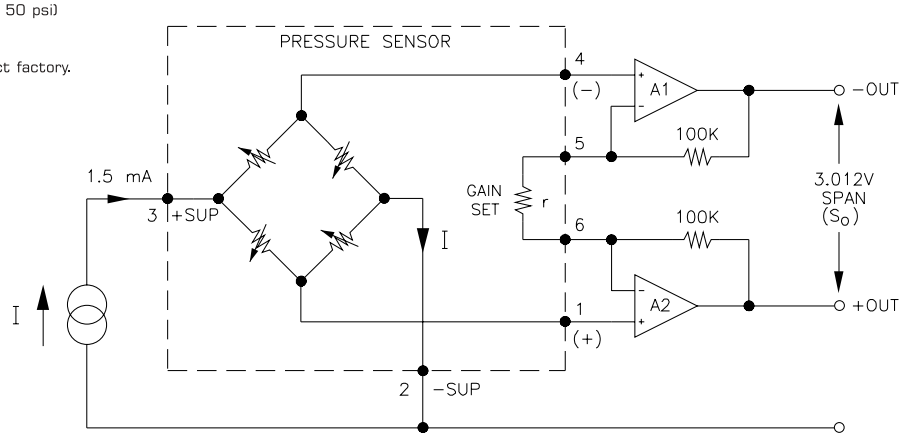
- Vent (T = Tube, Blank is standard = No tube)
- Electrical (C = Ribbon Cable with Connector, R = Ribbon Cable, P = Solder Pads, L = Leads, Uncompensated)
- Type (A = Absolute, G = Gage)
- Pressure Range (15 to 500 psi, 050 = 50 psi)
- Model

For other ranges, process fittings and electrical connections contact factory.

CONNECTIONS

Pad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 82 Low Pressure

316L SS Pressure Sensor

High Performance, 19mm

Millivolt Output

Absolute and Gage Low Pressure

Low Pressure

- Medical Instruments
- Process Control
- Fresh & Waste Water Measurement
- Partial Vacuum Gas Measurement
- Pressure Transmitters
- Tank Level Systems (RV, Marine & Industrial)

DESCRIPTION

The Model 82 LP is a 19 mm small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. The Model 82 is designed for O-ring mounting. The sensing package utilizes silicon oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element.

The Model 82 LP is designed for high performance in very, low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%. Sensors with threaded pressure fittings are also available. Please contact the factory for more information.

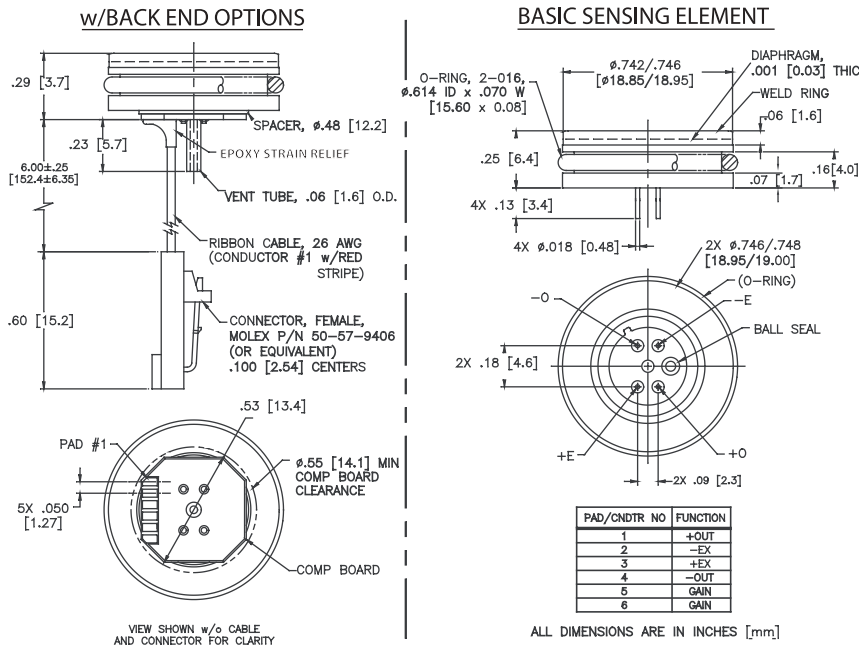
FEATURES

- O-Ring Flush Mount
- ±0.2% Pressure Non-linearity
- 1.0% Interchangeable Span (Provided By Gain Set Resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psig
0 to 1	•	•
0 to 5	•	•

DIMENSIONS



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MODEL 82 Low Pressure

PERFORMANCE SPECIFICATIONS

Supply Current: 1.5mA
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	50	100	125	mV	1
Zero Pressure Output (Offset)	-2	0	2	mV	2, 11
Pressure Non-linearity	-.2		.2	±%Span	3
Pressure Hysteresis		0.02		±%Span	
Repeatability		0.02		±%Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		30k	Ω	
Temperature Error - Span (-20 TO 85ºC)	-1.0		1.0	%Span	4
Temperature Error - Zero (-20 TO 85ºC)	-1.0		1.0	%Span	4
Thermal Hysteresis - Span		0.05		%Span	4
Thermal Hysteresis - Offset		0.05		%Span	4
Long Term Stability - Span		0.1		±%Span/yr.	
Long Term Stability - Offset		.25		±%Span/yr.	
Supply Current	0.5	1.5	2.0	mA	5
Output Load Resistance	5			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	
Compensated Operating Temperature	0ºC to 70ºC for 5psi, 0ºC to 50º for 1psi				8
Operating Temperature Range	–20°C to +70°C				8
Storage Temperature Range	–50°C to +125°C				8
Media-Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media-Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	12 Grams				9

Notes

1. For amplified output circuits see application note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the compensated temperature range with respect to +25°C.
5. Guarantees output/input ratiometricity.
6. Load resistance to reduce measurement errors due to output loading.
7. Between case and sensing element.
8. Maximum storage temperature range for product with standard cable and connector is –20°C to +105°C.
9. Weight depends on configuration
10. Gauge units not recommended for high vacuum applications. For high vacuum applications consult factory.
11. ±2mV for 1psi versions.
12. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

CONNECTIONS

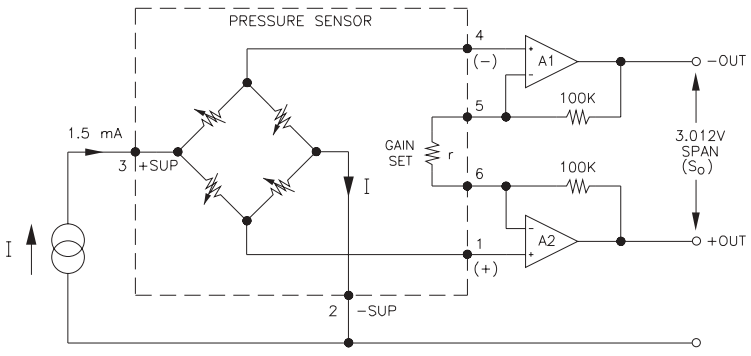
Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

ORDERING INFORMATION

82 - 050 G C T

- T: Vent (T= Tube. Blank is standard = No Tube)
- C: Electrical (C=Ribbon Cable with Connector. R = Ribbon Cable P = Solder Pads L=Leads. Uncompensated)
- G: Type (A=Absolute, G=Gage) (Note 10)
- 050: Pressure Range
- 82: Model

APPLICATION SCHEMATIC



July 2003

MODEL 85 5psi

316L SS Pressure Sensor

High Performance, Small Profile

0-100 mV Output

Absolute and Gage

Low Pressure

- Medical Instruments
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

This ia a micromachined piezoresistive silicon pressure sensor. It is designed for OEM applications where compatibility with corrosive media must be maintained. The sensor chip is mounted on a TO style header, which is resistance welded to a 316 stainless steel package. A 316 stainless steel convoluted isolation diaphragm is welded to the package, sealing a small volume of silicon oil between the diaphragm and the sensor chip. The ISO pressure housing utilizes the oil column to couple the piezoresistive sensor to the isolation diaphragm. A thick film ceramic compensation board with laser-trimmed resistors, and an additional gain set resistor to normalize pressure sensitivity are an integral part of the sensor package. A variety of threaded process fittings are available. Fittings include standards like 1/4 and 1/8 NPT, 1/4 BSP as well as custom process fittings. Electrical options include cable and connector.

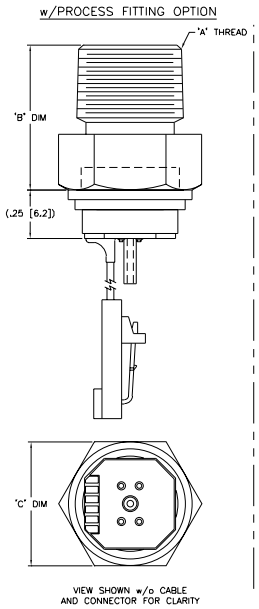
FEATURES

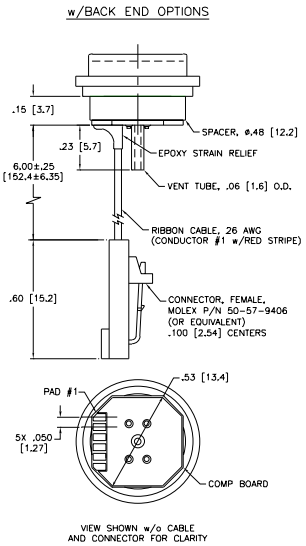
- Weldable and O-ring Flush Mount
- 0ºC To +50ºC Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- +1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 5	●	●

DIMENSIONS





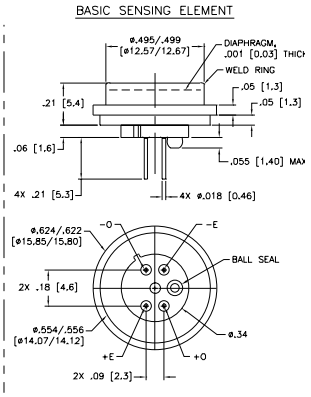


TABLE A	
PAD/CNDTR NO	FUNCTION
1	+OUT
2	−EX
3	+EX
4	−OUT
5	GAIN
6	GAIN

TABLE B		
'A' THREAD	'B' DIM	'C' DIM
1/8−27 NPT	.60 [15.2]	5/8 [15.9] HEX
1/4−18 NPT	.73 [18.5]	5/8 [15.9] HEX
1/4−19 BSP	.73 [18.5]	3/4 [19.0] HEX

DIMENSIONS ARE IN INCHES [mm]
ALL PROCESS WETTED PARTS ARE 316 SERIES STAINLESS STEEL

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MODEL 85 5psi

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	50	100	150	mV	1.2
Zero Offset	-2	0	2	mV	2
Pressure Non-linearity	-0.10		0,10	% Span	3
Pressure Hysteresis	-0.1		0.1	% Span	
Input Resistance	3500		6000	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span	-0.75		0.75	% Span	4
Temperature Error - Zero	-2.5		2.5	% Span	4
Thermal Hysteresis - Span	-0.25		0.25	% Span	4
Thermal Hysteresis - Zero	-0.25		0.25	% Span	4
Long Term Stability of Offset		0.1		±% Span/yr.	
Long Term Stability of Span		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	5
Output Load Resistance	5			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	
Compensated Operating Temperature	0°C to 50°C				8
Operating Temperature Range	–40°C to +125°C				8
Storage Temperature Range	–50°C to +125°C				8
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	13 grams				9

Notes

1. For amplified output circuits, 3.012V ± 1% interchangeability with gain set resistor. See Application Note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over Temperature range: 0°C to 50°C Span with respect to +25°C.
5. Guarantees output/input ratiometricity.
6. Load resistance to reduce measurement errors due to output loading.
7. Between case and sensing element.
8. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
9. Weight depends upon configuration (cable, connector, pressure fitting).
10. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
11. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

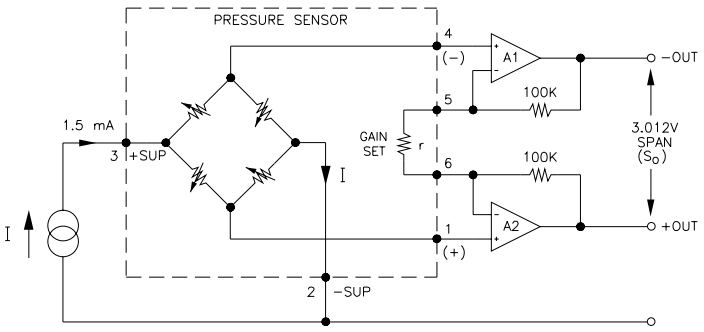
85 - 005 G - 0 C T

- T — Vent (T = Tube, Blank is standard = No Tube)
- C — Electrical (C = Ribbon Cable with Connector, P = Solder Pads, R = Ribbon Cable, L = Leads, Uncompensated)
- 0 — Pressure Port (0 = Weldable, No Thread, 4 = 1/4 - 18 NPT, 5 = 1/4 - 19 BSP, 8 = 1/8 - 27 NPT)
- G — Type (A=Absolute, G=Gage)
- 005 — Pressure Range (5 psi)
- 85 — Model

CONNECTIONS

Pad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 86 5psi

316L SS Pressure Sensor

High Performance, Small Profile

0-100 mV Output

Absolute and Gage

Low Pressure

- Medical Instruments
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 86 is a small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. The Model 86 is designed for O-ring mounting. The sensing package utilizes silicon oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element.

The Model 86 is designed for high performance, low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional lasertrimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%.

Sensors with threaded pressure fittings, weldable flush sensors and high pressure stainless steel sensors are also available. Please contact the factory for more information.

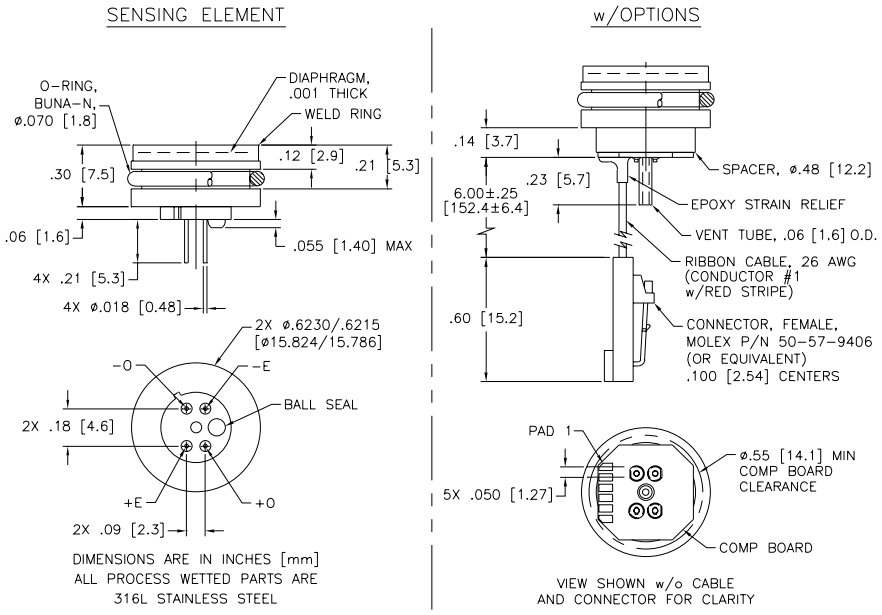
FEATURES

- O-ring Flush Mount
- 0°C To +50°C Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- +1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 5	●	●

DIMENSIONS



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MODEL 86 5psi

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	50	100	150	mV	1.2
Zero Offset	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0,10	% Span	3
Pressure Hysteresis	-0.1		0.1	% Span	
Input Resistance	3500		6000	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span	-0.75		1.5	% Span	4
Temperature Error - Zero	-1.5		1.5	% Span	4
Thermal Hysteresis - Span	-0.25		0.25	% Span	4
Thermal Hysteresis - Zero	-0.25		0.25	% Span	4
Long Term Stability of Offset		0.1		±% Span/yr.	
Long Term Stability of Span		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	5
Output Load Resistance	5			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	
Compensated Operating Temperature	0°C to 50°C				8
Operating Temperature Range	–40°C to +125°C				8
Storage Temperature Range	–50°C to +125°C				8
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	13 grams				

Notes

1. For amplified output circuits, 3.012V ± 1% interchangeability with gain set resistor. See Application Note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over Temperature range: 0°C to 50°C Span with respect to +25°C.
5. Guarantees output/input ratiometricity.
6. Load resistance to reduce measurement errors due to output loading.
7. Between case and sensing element.
8. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
9. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
10. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

86 - 005 G - C T

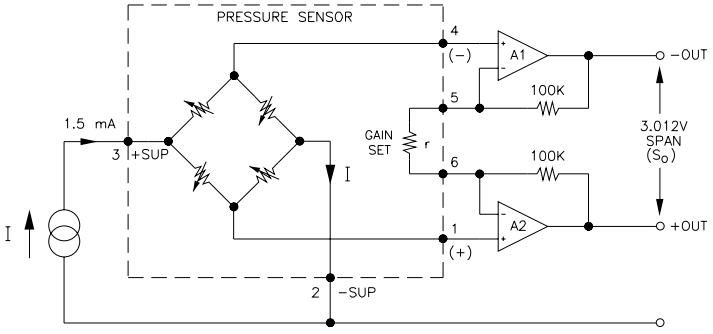
- Vent (T = Tube, Blank is standard = No tube)
- Electrical (C = Ribbon Cable with Connector, R = Ribbon Cable, P = Solder Pads, L = Leads, Uncompensated)
- Type (A = Absolute, G = Gage)
- Pressure Range (5 psi)
- Model

For other ranges, process fittings and electrical connections contact factory.

CONNECTIONS

Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 85 Ultrastable

316L SS Pressure Sensor

High Performance, Small Profile

0-100 mV Output

Absolute and Gage

Low Pressure

- Medical Instruments
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

This is a micromachined piezoresistive silicon pressure sensor. It is designed for OEM applications where compatibility with corrosive media must be maintained. The sensor chip is mounted on a TO style header, which is resistance welded to a 316 stainless steel package. A 316 stainless steel convoluted isolation diaphragm is welded to the package, sealing a small volume of silicon oil between the diaphragm and the sensor chip. The ISO pressure housing utilizes the oil column to couple the piezoresistive sensor to the isolation diaphragm. A thickfilm ceramic compensation board with laser trimmed resistors, and an additional gain set resistor to normalize pressure sensitivity are an integral part of the sensor package. A variety of threaded process fittings are available. Fittings include standards like 1/4 and 1/8 NPT, 1/4 BSP as well as custom process fittings. Electrical options include cable and connector.

FEATURES

- Weldable and O-ring Flush Mount
- -20°C to 85°C Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- ±1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 300	●	●
0 to 500	●	●

DIMENSIONS

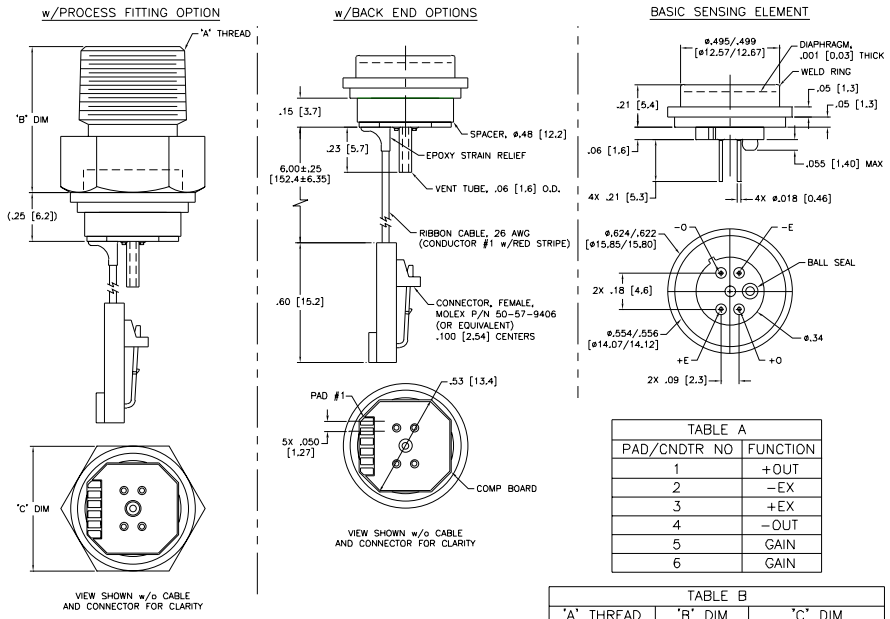


TABLE A	
PAD/CNDTR NO	FUNCTION
1	+OUT
2	−EX
3	+EX
4	−OUT
5	GAIN
6	GAIN

TABLE B		
'A' THREAD	'B' DIM	'C' DIM
1/8−27 NPT	.60 [15.2]	5/8 [15.9] HEX
1/4−18 NPT	.73 [18.5]	5/8 [15.9] HEX
1/4−19 BSP	.73 [18.5]	3/4 [19.0] HEX

DIMENSIONS ARE IN INCHES [mm]
ALL PROCESS WETTED PARTS ARE 316 SERIES STAINLESS STEEL

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MODEL 85 Ultrastable

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1.2
Zero Offset	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0,10	% Span	3
Pressure Hysteresis	-0.5	0.02	0.05	% Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span	-0.75		0.75	% Span	4
Temperature Error - Zero	-0.5		0.5	% Span	4, 5
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Zero		0.05		% Span	4
Long Term Stability of Offset		0.1		±% Span/yr.	
Long Term Stability of Span		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	
Compensated Operating Temperature	-20°C to 85°C				9
Operating Temperature Range	–40°C to +125°C				9
Storage Temperature Range	–50°C to +125°C				9
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	13 grams				10

Notes

1. For amplified output circuits, 3.012V ± 1% interchangeability with gain set resistor. See Application Note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over Temperature range: -20°C to +85°C Span with respect to +25°C.
5. 15 psi range sensors have a temperature error of ±0.75% (Max) of Zero from -20°C to 85°C.
6. Guarantees output/input ratiometricity.
7. Load resistance to reduce measurement errors due to output loading.
8. Between case and sensing element.
9. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
10. Weight depends upon configuration (cable, connector, pressure fitting).
11. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
12. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

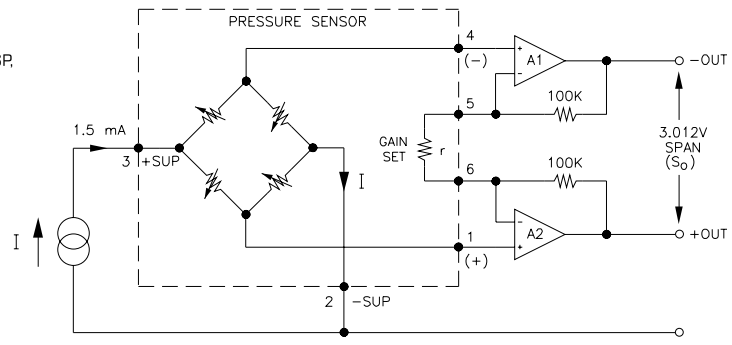
85 - 050 G - 0 C T

- Vent (T = Tube, Blank is standard = No Tube)
- Electrical (C = Ribbon Cable with Connector, P = Solder Pads, R = Ribbon Cable, L = Leads, Uncompensated)
- Pressure Port (0 = Weldable, No Thread, 4 = 1/4 - 18 NPT, 5 = 1/4 - 19 BSP, 8 = 1/8 - 27 NPT)
- Type (A=Absolute, G=Gage)
- Pressure Range (15 to 500 psi, 050 = 50 psi)
- Model

CONNECTIONS

Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 85 Flush Mount

316L SS Pressure Sensor

High Performance Flush Diaphragm

0-100 mV Output

Absolute and Gage

Low Pressure

- Dialysis Machines
- Infusion Pumps
- Medical Systems
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 85 Flush Mount is a small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. It is designed for O-ring mounting where the diaphragm must not be shrouded by weld ring or fitting. The sensing package utilizes silicone oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element. The rugged design can handle pressure spikes to 3X rated pressure in normal operating mode.

The Model 85 Flush Mount is designed for high performance, low-pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%.

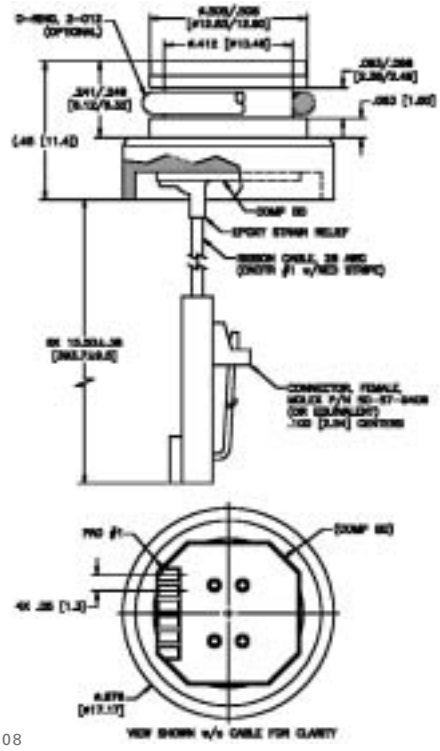
FEATURES

- O-Ring Flush Mount
- -20°C to +85°C Operating Temperature Range
- +0.1% Pressure Non-linearity
- +0.75% Temperature Performance
- +1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 300	●	●
0 to 500	●	●

DIMENSIONS



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MODEL 85 Flush Mount

PERFORMANCE SPECIFICATIONS

All parameter measured at 1.5 mA and at 25∞C, after 10 second warm up, unless otherwise specified.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1. 2
Zero Pressure Output	-2	0	2	MV	2
Pressure Non-linearity	-0.10		0,10	±% Span	3
Pressure Hysteresis	-0.5	0.02	+0.05	±% Span	
Repeatability		0.02		±% Span	
Input Resistance	2000	3500	4500	Ω	
Temp. Error - Span (0 to =70) see note 4	-0.75		+0.75	% Span	4
Temp. Error - Span (0 to =70) see note 4	-0.75		+0.75	% Span	4
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Zero		0.05		% Span	4
Long Term Stability of Offset		0.1		±% Span/yr.	
Long Term Stability of Span		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	5
Output Load Resistance	5			MΩ	6
Insulation Resistance (50 VDC)	50			MΩ	7
Pressure Overload			3X	Rated	
Compensated Operating Range	0°C to +70°C				
Operating Temperature Range	–20°C to +85°C				8
Storage Temperature Range	–50°C to +125°C				8
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	13 grams				9

Notes

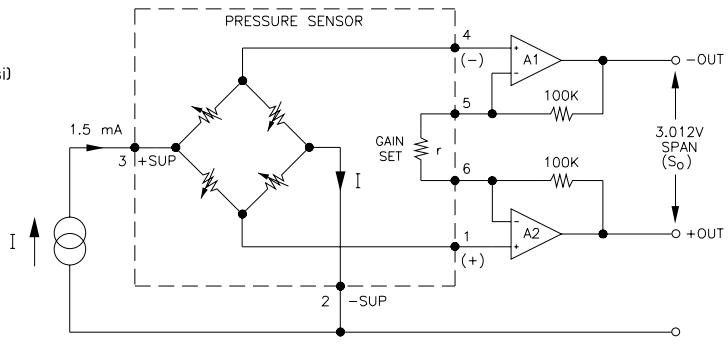
1. For amplified output circuits see application note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the temperature range 0°C to +70°C with respect to +25°C.
5. Guarantees output/input ratiometricity ±2% FS.
6. Required load resistance to prevent measurement errors due to output loading.
7. Between case and sensing element.
8. Maximum temperature spec for product with cable and connector is 0°C to +105°C.
9. Weight depends upon configuration (cable, connector, pressure fitting).
10. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

85 - 050 G - F C T

- T — Vent (T = Tube, Blank is standard = No Tube)
- C — Electrical (C = Cable, R = Ribbon Cable, P = Solder Pads)
- F — F = Flush Diaphragm
- G — Type (A=Absolute, G=Gage)
- 050 — Pressure Range (15 to 500 psi, 050 = 50 psi)
- 85 — Model

APPLICATION SCHEMATIC



CONNECTIONS

Pad. No./Conductor	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

For other pressure fittings and electrical connections contact factory.

Pressure

MODEL 86 Ultrastable

316L SS Pressure Sensor

High Performance, Small Profile

0-100 mV Output

Absolute and Gage

Low Pressure

- Hydraulic Controls
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 86 is a small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. The Model 86 is designed for O-ring mounting. The sensing package utilizes silicon oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element.

The Model 86 is designed for high performance, low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%.

Sensors with threaded pressure fittings, weldable flush sensors and high pressure stainless steel sensors are also available. Please contact the factory for more information.

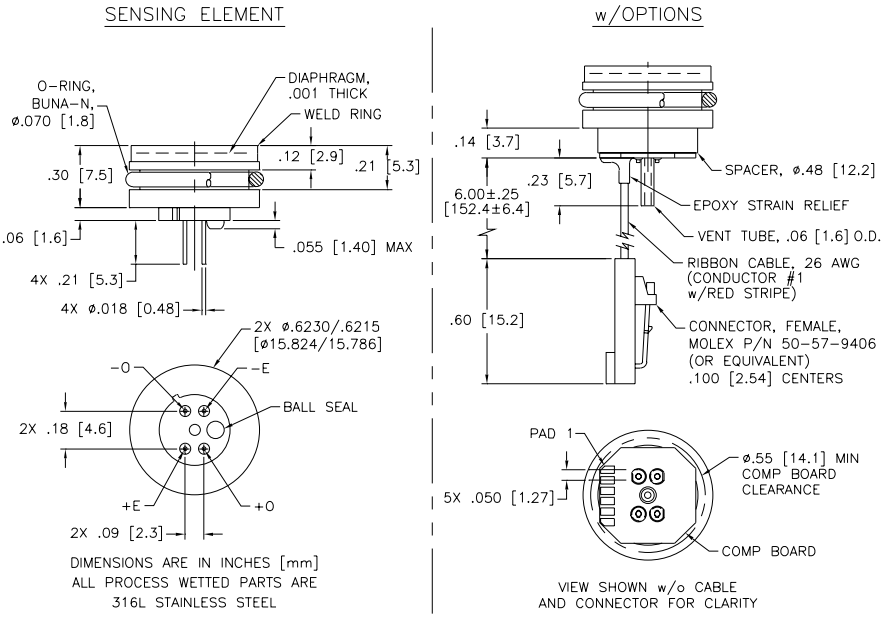
FEATURES

- O-ring Flush Mount
- -20°C To +85°C Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- ±1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 300	●	●
0 to 500	●	●

DIMENSIONS



DIMENSIONS ARE IN INCHES [mm]
ALL PROCESS WETTED PARTS ARE 316L STAINLESS STEEL

VIEW SHOWN w/o CABLE AND CONNECTOR FOR CLARITY

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MODEL 86 Ultrastable

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
ZeroPressure Output (Offset)	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0,10	±% Span	3
Pressure Hysteresis	-0.5	0.02	+0.05	±% Span	
Repeatability		0.02		±% Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span (-20 to 85°C)	-0.75		+0.75	% Span	4
Temperature Error - Offset (-20 to 85°C)	-0.5		+0.5	% Span	4, 5
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Offset		0.05		% Span	4
Long Term Stability of Span		0.1		±% Span/yr.	
Long Term Stability of Offset		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	
Compensated Temperature Range	-20°C to +85°C				9
Operating Temperature Range	–40°C to +125°C				9
Storage Temperature Range	–50°C to +125°C				9
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	13 grams				

Notes

1. For amplified output circuits see application note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the temperature range –20°C to +85°C with respect to +25°C.
5. 15 psi range sensors have an offset temperature error of ±0.75% (Max) from –20°C to +85°C.
6. Guarantees output/input ratiometricity.
7. Load resistance to reduce measurement errors due to output loading.
8. Between case and sensing element.
9. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
10. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
11. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

86 - 050 G - C T

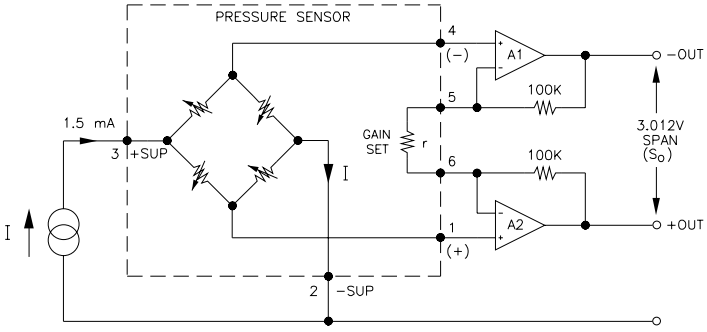
- T — Vent (T = Tube, Blank is standard = No tube)
- C — Electrical (C = Ribbon Cable with Connector, R = Ribbon Cable, P = Solder Pads, L = Leads, Uncompensated)
- G — Type (A = Absolute, G = Gage)
- 050 — Pressure Range (15 to 500 psi, 050 = 50 psi)
- 86 — Model

For other ranges, process fittings and electrical connections contact factory.

CONNECTIONS

Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 87N Ultrastable

316 SS Pressure Sensor

High Performance, Small Profile

0-100 mV Output

Temperature Compensated

Absolute and Sealed Gage

- Hydraulic Controls
- Process Control
- Robotics
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters

DESCRIPTION

This is a micro machined piezoresistive silicon pressure sensor. It is designed for OEM applications where compatibility with corrosive media must be maintained. The sensor chip is mounted in a 316 stainless steel package, sealing a small volume of silicon oil between the diaphragm and the sensor chip. The ISO pressure housing utilizes the oil column to couple the piezoresisteve sensor to the isolation diaphragm. A thick-film ceramic compensation board with laser trimmed resistors, and additional gain set resistor to normalize pressure sensitivity are an integral part of the sensor package. A variety of threaded process fittings are available. Fittings include standards like 1/4 and 1/8 NPT as well as custom process fittings. Electrical options include cable and connector.

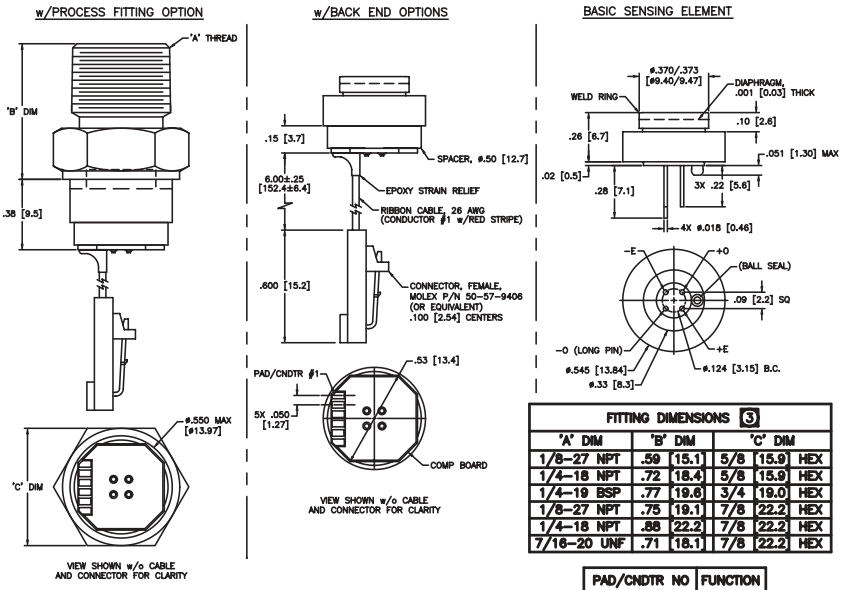
FEATURES

- Weldable, Optional Process Fittings
- ±0.25% Pressure Non-linearity
- ±1.0% Temperature Performance
- ±0.25% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psia	psis
0 to 1000	•	•
0 to 3000	•	•
0 to 5000	•	•

DIMENSIONS



FITTING DIMENSIONS [3]					
'A' DIM	'B' DIM		'C' DIM		
1/8-27 NPT	.59	[15.1]	5/8	[15.9]	HEX
1/4-18 NPT	.72	[18.4]	5/8	[15.9]	HEX
1/4-19 BSP	.77	[19.6]	3/4	[19.0]	HEX
1/8-27 NPT	.75	[19.1]	7/8	[22.2]	HEX
1/4-18 NPT	.88	[22.2]	7/8	[22.2]	HEX
7/16-20 UNF	.71	[18.1]	7/8	[22.2]	HEX

PAD/CNDTR NO	FUNCTION
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

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MODEL 87N Ultrastable

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
Zero Offset	-1	0	1	mV	
Pressure Non-linearity	-0.25		0,25	% Span	2
Pressure Hysteresis		50		µV	
Input Resistance	2000	2750	4000	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span	-0.75		+0.75	% Span	3
Temperature Error - Zero	-0.75		+0.75	% Span	3
Thermal Hysteresis - Span		0.05		% Span	3
Thermal Hysteresis - Zero		0.05		% Span	3
Long Term Stability of Span		0.1		±% Span/yr.	
Pressure Overload			3X	Rated	
Supply Current	0.5	1.5	2.0	mA	
Output Load Resistance	5			MΩ	4
Insulation Resistance (50 VDC)	50			MΩ	5
Compensation Operating Temperature	-20°C to +85°C				6
Operating Temperature Range	–40°C to +125°C				6
Storage Temperature Range	–50°C to +125°C				6
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Liquids and Gases. Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel.				
Weight	11 grams				7

Notes

1. All 3000 psi and 5000 psi parts are tested at 2500 psi.
2. Best fit straight line.
3. Over temperature range -20°C to +85°C, % span, with respect to +25°C.
4. Load resistance to reduce measurement errors due to output loading.
5. Between case and sensing element.
6. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
7. Weight depends upon configuration (cable, connector, pressure fitting).
8. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

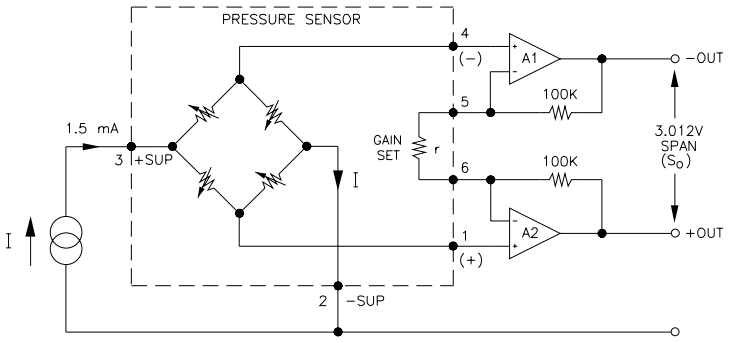
87N - 1000 S - 0 R

- Electrical (C = Ribbon Cable with Connector, P = Solder Pads, R = Ribbon Cable, L = Leads, Uncompensated)
- Pressure Port (0 = Weldable, No Thread, 3 = 7/16 - 20 UNF, 4 = 1/4 - 18 NPT, 5 = 1/4 - 19 BSP, 8 = 1/8 - 27 NPT)
- Type (A = Absolute, S = Sealed Gage)
- Pressure Range (1000 to 5000 psi)
- Model

CONNECTIONS

Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



MODEL 96 UltraStable

316L SS Pressure Sensor

High Performance

0-100 mV Output

Absolute and Gage

Low Pressure

- Hydraulic Controls
- Process Control
- Oceanography
- Refrigeration/Compressors
- Pressure Transmitters
- Level Systems

DESCRIPTION

The Model 96 is a small profile, media compatible, piezoresistive silicon pressure sensor packaged in a 316L stainless steel housing. The Model 96 is available with a standard 1/4 NPT fitting. The sensing package utilizes silicon oil to transfer pressure from the 316L stainless steel diaphragm to the sensing element.

The Model 96 is designed for high performance, low pressure applications. A ceramic substrate is attached to the package that contains laser-trimmed resistors for temperature compensation and offset correction. An additional laser-trimmed resistor is included which can be used to adjust an external differential amplifier and provide span interchangeability to within ±1%.

Sensors with O-ring fittings, and high pressure sensors are also available. Please contact factory for more information.

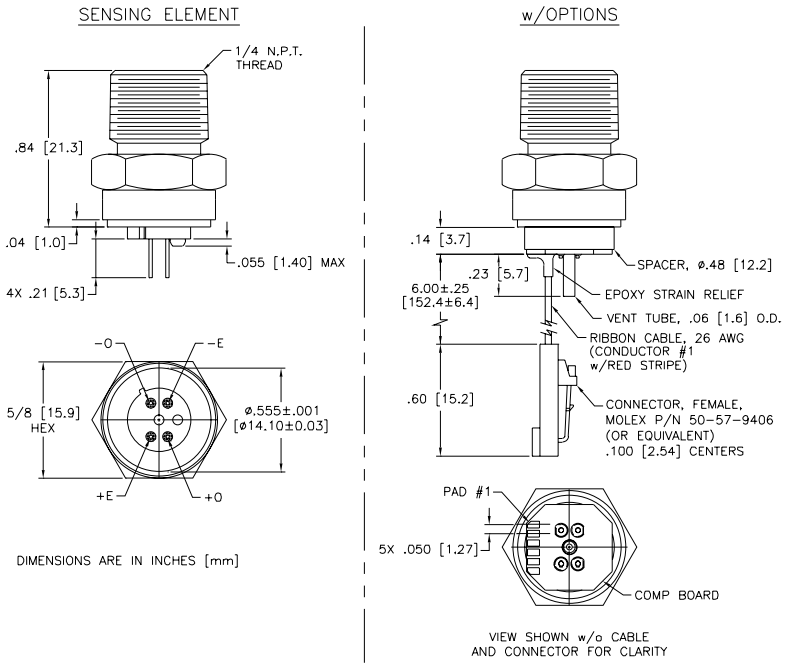
FEATURES

- 1/4 NPT Thread, 5/8" Hex
- -20ºC To +85ºC Compensated Temperature Range
- ±0.1% Pressure Non-linearity
- ±1.0% Interchangeable Span (provided by gain set resistor)
- Solid State Reliability
- Low Power

STANDARD RANGES

Range	psig	psia
0 to 15	●	●
0 to 30	●	●
0 to 50	●	●
0 to 100	●	●
0 to 300	●	●
0 to 500	●	●

DIMENSIONS



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MODEL 96 UltraStable

PERFORMANCE SPECIFICATIONS

All parameters measured at 1.5mA drive and at 25°C after 10 second warm up, unless otherwise specified. Unless specifically indicated, only those parameters indicated as tested are verified on each part. Parameters are specified for the compensated version only.

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	75	100	150	mV	1
ZeroPressure Output (Offset)	-1	0	1	mV	2
Pressure Non-linearity	-0.10		0,10	±% Span	3
Pressure Hysteresis	-0.5	0.02	+0.05	±% Span	
Repeatability		0.02		±% Span	
Input Resistance	2000	3500	4500	Ω	
Output Resistance	4000		25000	Ω	
Temperature Error - Span (-20 to 85°C)	-0.75		+0.75	% Span	4
Temperature Error - Offset (-20 to 85°C)	-0.5		+0.5	% Span	4, 5
Thermal Hysteresis - Span		0.05		% Span	4
Thermal Hysteresis - Offset		0.05		% Span	4
Long Term Stability of Span		0.1		±% Span/yr.	
Long Term Stability of Offset		0.1		±% Span/yr.	
Supply Current	0.5	1.5	2.0	mA	6
Output Load Resistance	5			MΩ	7
Insulation Resistance (50 VDC)	50			MΩ	8
Pressure Overload			3X	Rated	
Compensated Temperature Range	-20°C to +85°C				9
Operating Temperature Range	–40°C to +125°C				9
Storage Temperature Range	–50°C to +125°C				9
Media - Pressure Port	Liquids and Gases compatible with 316L Stainless Steel				
Media - Reference Port	Compatible with Silicon, Pyrex, Gold, Fluorosilicon Rubber and 316L Stainless Steel				
Weight	27 grams				10

Notes

1. For amplified output circuits see application note TN-003.
2. Measured at vacuum for absolute (A), ambient for gage (G).
3. Best fit straight line.
4. Over the temperature range –20°C to +85°C with respect to +25°C.
5. 15 psi range sensors have an offset temperature error of ±0.75% (Max) from –20°C to +85°C.
6. Guarantees output/input ratiometricity.
7. Load resistance to reduce measurement errors due to output loading.
8. Between case and sensing element.
9. Maximum temperature range for product with standard cable and connector is –20°C to +105°C.
10. Weight depends upon configuration (cable, connector, pressure fitting).
11. For gage units used at pressures below atmosphere, the span accuracy is not guaranteed.
12. Standard gauge units are not recommended for vacuum applications. For vacuum applications below 1/2 atmosphere, contact factory.

ORDERING INFORMATION

96 - 050 G - 4 C T

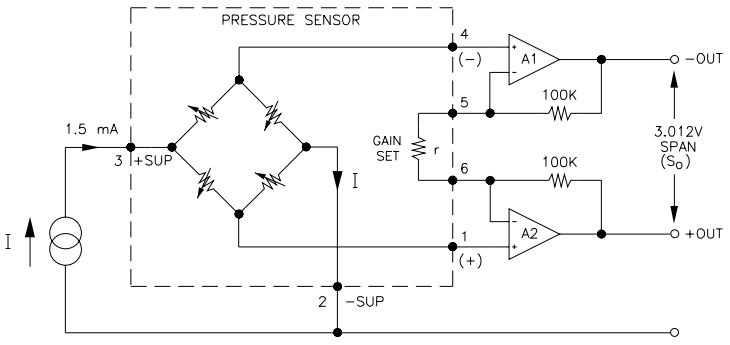
- T = Vent Tube, Blank is standard = No tube
- Electrical (C = Ribbon Cable with Connector, P = Solder Pads, R = Ribbon Cable, L = Lead, Uncompensated)
- Pressure Port (4 = 1/4 NPT)
- Type (A = Absolute, G = Gage)
- Pressure Range (15 to 500 psi, 050 = 50 psi)
- Model

For other pressure ranges, process fittings and electrical connections contact factory.

CONNECTIONS

Rad. No./Cable	Function
1	+OUT
2	-EX
3	+EX
4	-OUT
5	GAIN
6	GAIN

APPLICATION SCHEMATIC



ACCELEROMETERS

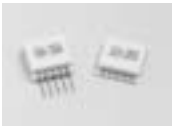
ACCELEROMETERS

SELECTION GUIDE

PC Mountable

ACCELEROMETER SELECTION GUIDE—PC MOUNTABLE

(Please refer to specification sheets for additional information)

FAMILY	ACCELEROMETER			
TYPE	PC Mountable			
PACKAGE	Surface Mount		Adhesive Mount	Bracket Mount
MODEL	3031 	3041 	3022 	3028 
G RANGE				
±2G to ±100G				
±2G to ±500G			•	•
±50G to ±500G	•			
±25G to ±100G				
OUTPUT				
Millivolt Output	•	•	•	•
0.5 to 4.5VDC Output				
PERFORMANCE				
±1.0% Non-linearity	•	•	•	•
±5% Sensitivity error including temperature performance				
Max. ±2.0% (each) Temperature zero and span error over 0 to 50°C comp range	•	•	•	•
Max. ±2.0% (each) Temperature zero and span error over -20 to 85°C comp range				
Max. ±4.0% (each) Temperature zero and span error over -20 to 85°C comp range				
COMPENSATION				
Offset, gain and temperature resistor values provided for external compensation.	•	•	•	•
Offset, gain set and temperature compensation internal to the accelerometer.				

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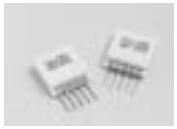
ACCELEROMETER SELECTION GUIDE—PC MOUNTABLE

(Please refer to specification sheets for additional information)

FAMILY	ACCELEROMETER	
TYPE	PC Mountable	
PACKAGE	Adhesive Mount	Bracket Mount
MODEL	3052 	3058 
G RANGE		
±2G to ±100G	•	•
±2G to ±500G		
±50G to ±500G		
±25G to ±100G		
OUTPUT		
Millivolt Output	•	•
0.5 to 4.5VDC Output		
PERFORMANCE		
±1.0% Non-linearity	•	•
±5% Sensitivity error including temperature performance		
Max. ±2.0% (each) Temperature zero and span error over 0 to 50°C comp range	•	•
Max. ±2.0% (each) Temperature zero and span error over -20 to 85°C comp range		
Max. ±4.0% (each) Temperature zero and span error over -20 to 85°C comp range		
COMPENSATION		
Offset, gain and temperature resistor values provided for external compensation.		
Offset, gain set and temperature compensation internal to the accelerometer.	•	•

Model 3031

PC Board Mountable

Millivolt Output

Small Size

Low Cost

- **Vibration/Shock Monitoring**
- **Consumer Electronics**
- **Patient Monitoring**
- **Crash Recorder**

FEATURES

- Surface Mount Package
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (with comp resistors-typical)
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g
±50	●
±100	●
±200	●
±500	●

DESCRIPTION

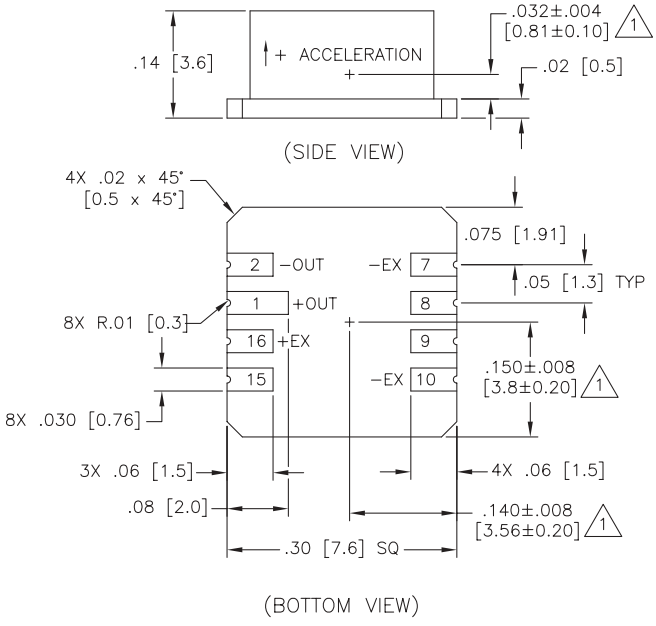
The Model 3031 is a piezoresistive silicon accelerometer in a surface mount package. It is intended for high volume applications where small size, light weight, and low cost are required.

This accelerometer consists of a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams.

Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth.

For non-surface mount accelerometers please see Models 3022, 3028, 3052 or 3058.

DIMENSIONS



1 NOTED DIMENSIONS INDICATE CENTER OF GRAVITY POSITIONS

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Model 3031

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE ±50G	±100G	±200G	±500G	UNITS	NOTES
Frequency Response [MIN]	0-1000	0-1500	0-2000	0-2400	Hz	1
Mounted Resonant Frequency [MIN]	2000	3000	4000	5000	Hz	
Sensitivity (MIN/MAX)	0.6/1.5	0.3/0.6	0.15/0.3	0.06/0.15	mV/g	2

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Zero Acceleration Output		5	25	±mV	
Damping Ratio	0.4	0.7	0.9		
Non-linearity		0.5	1	±% Span	3
Transverse Sensitivity		1	3	±% Span	
Input & Output Resistance	2.5	3.5	6.5	kΩ	
Temperature Error - Span		1.0	2.0	±% Span	4, 5
emperature Error - Zero		1.0	2.0	±% Span	4, 5
Supply Voltage		5.0	10.0	VDC	
Output Noise		1.0		µV p-p	6
Output Load Resistance	5			MΩ	
Acceleration Limits (Any Direction)			20X	Rated	7
Operating Temperature	-40°C to +125°C				
Storage Temperature	-55°C to +150°C				
Weight	0.3 Grams				

Notes

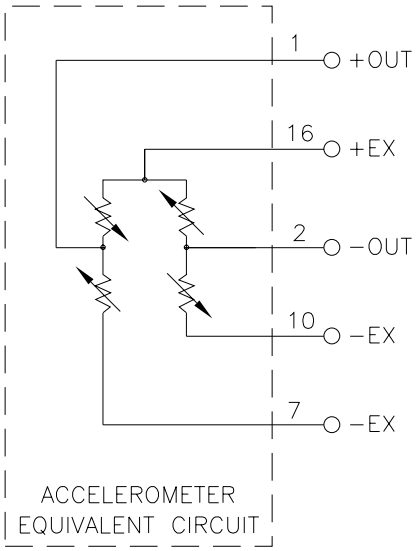
1. The frequency response is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
2. Output voltage increases for positive acceleration; output voltage decreases for negative acceleration.
3. Best Fit Straight Line.
4. Percentage values are with external compensation.
5. Compensated temperature range: 0-50°C in reference to 25°C.
6. 10 Hz to 1 kHz.
7. 20X or 2000g, whichever is less.
8. Solder on pads is 62% Tin, 36% Lead, 2% Silver. Maximum allowable temperature during mounting is 220°C for 1 minute. Contact factory if a higher mounting temperature will be used.

ORDERING INFORMATION

3031 - 100

- 100 — Acceleration Range
- 3031 — Model

CONNECTIONS



Model 3041

PC Board Mountable Accelerometer

Millivolt Output

Hermetic Package

Low Cost

- **Vibration/Shock Monitoring**
- **Consumer Electronics**
- **Motion Control**
- **Crash Recorder**
- **Aerospace**

DESCRIPTION

The Model 3041 is a piezoresistive silicon accelerometer in a surface mount hermetic ceramic package. It is intended for high volume applications where small size, hermetic sealing, light weight, and low cost are required.

This accelerometer consists of a micromachined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the chip provide overrange protection and built-in damping. This robust design provides: durability, high shock resistance, and wide usable bandwidth.

For non-surface mount versions, please see models 3022, 3028, 3052, or 3058.

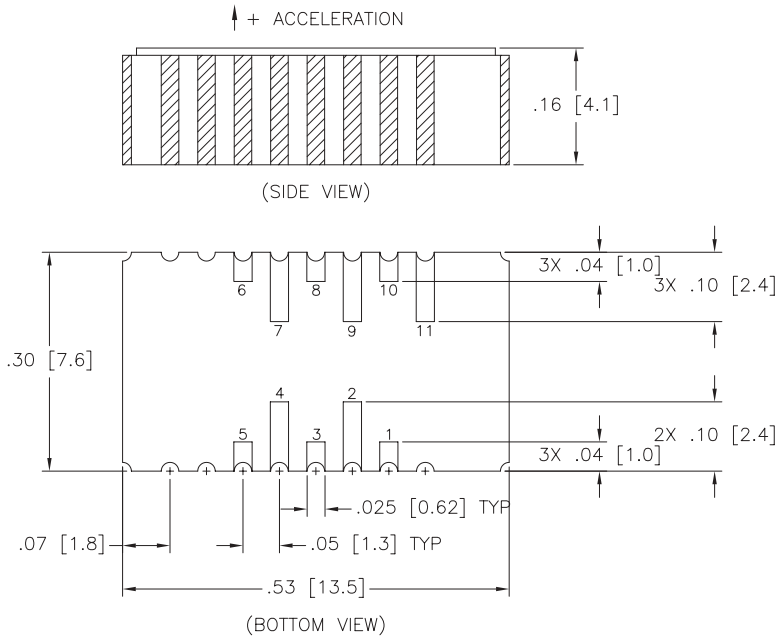
FEATURES

- Surface Mount Package
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (With Compensation Resistors-typical)
- Built-in Damping
- Built-in Over-range Protection
- Dc Response
- Low Power Consumption

STANDARD RANGES

Range	g
±50	●
±100	●
±200	●
±500	●

DIMENSIONS



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Model 3041

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	STANDARD RANGES ±50G	STANDARD RANGES ±100G	UNITS	NOTES
Bandwidth (MIN)	0–1000	0–1500	Hz	1
Sensitivity (MIN/TYP/MAX)	0.60 / 1.00 / 1.50	0.30 / 0.40 / 0.60	mV/g	2

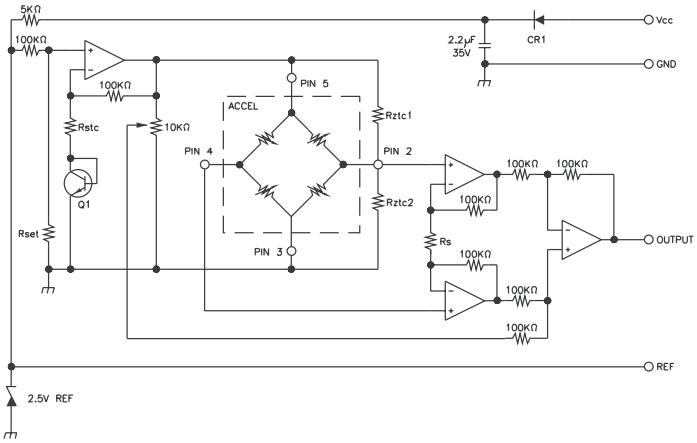
PARAMETERS	STANDARD RANGES ±200G	STANDARD RANGES ±500G	UNITS	NOTES
Bandwidth (MIN)	0–2000	0–2400	Hz	1
Sensitivity (MIN/TYP/MAX)	0.15 / 0.20 / 0.30	0.06 / 0.10 / 0.15	mV/g	2

PARAMETERS	ALL RANGES MIN	ALL RANGES TYP	ALL RANGES MAX	UNITS	NOTES
Zero Acceleration Output		-5 to +5	-25 to +25	mV	
Damping Ratio	0.4	0.7	0.9		3
Non-linearity		0.5	1.0	±% Span	4
Transverse Sensitivity		1	3	±% Span	
Input & Output Resistance	2.5	4.0	6.5	kΩ	
Temperature Error - Span		1.0	2.0	±% Span	5, 6
emperature Error - Zero		1.0	2.0	±% Span	5, 6
Supply Voltage		5.0	10.0	V	
Output Noise		1		µV p-p	7
Output Load Resistance	5			MΩ	
Acceleration Limits (Any Direction)		20X			8
Operating Temperature	-40°C to +85°C				
Storage Temperature	-40°C to +125°C				
Weight	1.5 Grams				

Notes

1. The frequency response is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
2. Output voltage increases for positive acceleration; output voltage decreases for negative acceleration.
3. Damping factor is controlled to within ±10% over operating temperature range. Damping rations are not provided for 100g, 200g, and 500g ranges.
4. Best fit straight line.
5. Percentage values are with external compensation.
6. Compensated temperature range: 0°C to 50°C in reference to 25°C.
7. 10 Hz to 1 kHz.
8. 20X or 2000g whichever is less.

APPLICATION SCHEMATIC



ORDERING INFORMATION

3041 - 050

- 050 — Acceleration Range
- 3041 — Model

CONNECTIONS

Pad	Function
2	-Output
3	- Excitation
4	+Output
5	+Excitation

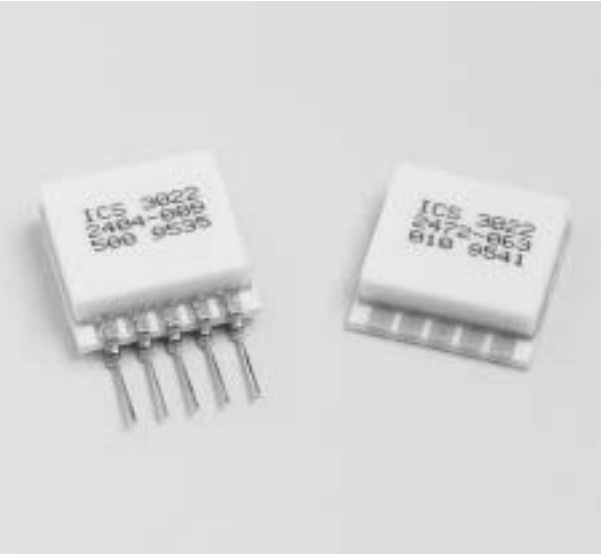
Model 3022

PC Board Mountable Accelerometer

Millivolt Output

Low Cost

- **Vibration/Shock Monitoring**
- **Modal Analysis**
- **Motion Control**
- **Crash Testing**
- **Aerospace**



FEATURES

- Designed for Adhesive Mounting
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (with comp resistors-typical)
- DC Response
- Built-in Damping
- Built-in Over-range Stops
- Low Power
- Pins or No Pins

STANDARD RANGES

Range	g	Range	g
±2	●	±50	●
±5	●	±100	●
±10	●	±200	●
±20	●	±500	●

DESCRIPTION

The Model 3022 is a piezoresistive silicon accelerometer. The package is a ceramic substrate with a sealed ceramic cover. The ceramic provides an excellent bonding surface for the customers application specific adhesive. Each accelerometer includes a detailed calibration sheet, which provides test data and resistor compensation values for each sensor.

The accelerometer consists of a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth. Each sensor is individually serialized.

For an accelerometer with a mounting bracket designed to bolt the sensor to a mounting location, see the Model 3028. Please refer to the Models 3052 and 3058 for accelerometers with integral temperature compensation.

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CALIBRATION DATA

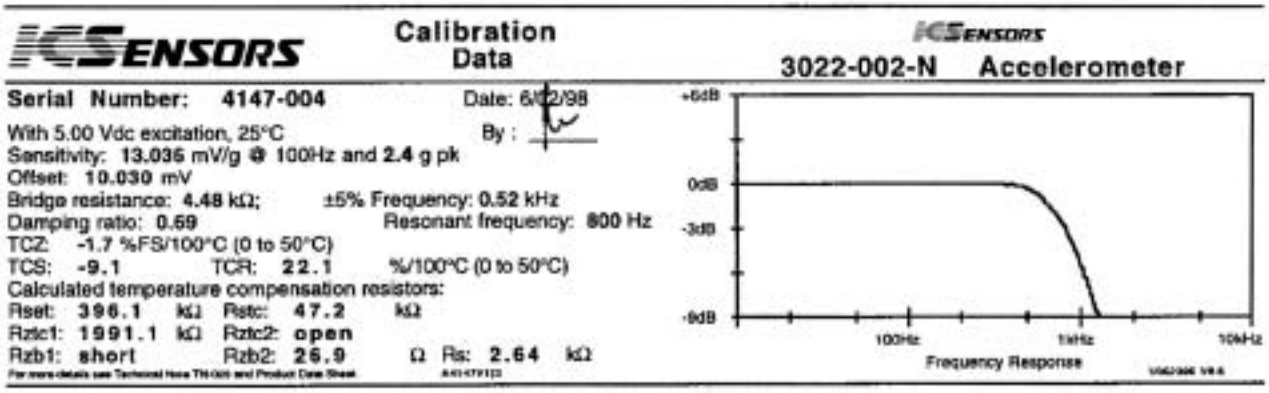

Figure 1. Calibration Data Sheet

A calibration data sheet similar to the sample shown above is included with each unit. The calibration sheet provides the measured test and calibration data for the sensor. In addition to the test data, the values of calibration and temperature compensation resistors are also included.

SIGNAL CONDITIONING

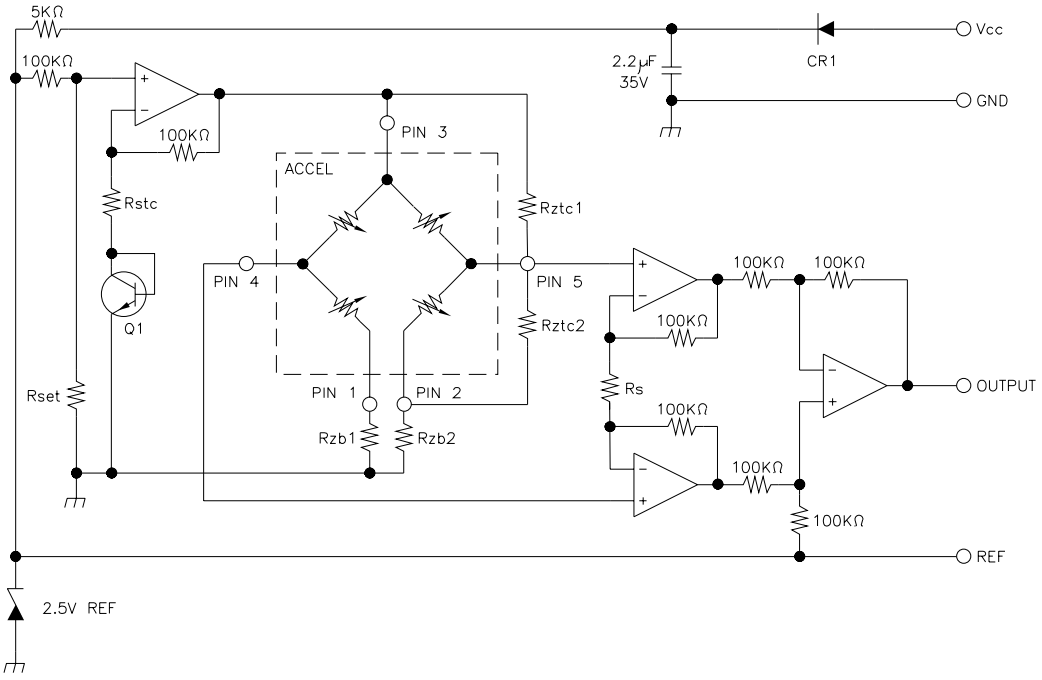

Figure 2. Typical Temperature Compensation and Amplification Circuit (component values specified for each sensor)

Q1: 2N3904
CR1: 1N914 or equivalent
Op Amps: LT1014, LM324 or equivalent

- Rstc sets the excitation voltage ramp to compensate the sensitivity error due to temperature.
- Rset sets the excitation voltage to 5V at 25°C.
- Rzb1, Rzb2 and Rztc1 and Rztc2 calibrate the zero offset and compensate the offset error due to temperature.
- Rs calibrates the output span.
- Vcc must be >8 VDC.

Model 3022

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE ±2G	±5G	±10G	±20G	UNITS	NOTES
Frequency Response [MIN]	0-250	0-300	0-400	0-600	Hz	1, 9
Mounted Resonant Frequency [MIN]	700	800	1000	1500	Hz	8, 9
Sensitivity (MIN/MAX)	8.0/20.0	6.0/15.0	3.0/6.0	1.5/3.0	mV/g	2

PARAMETERS	RANGE ±50G	±100G	±200G	±500G	UNITS	NOTES
Frequency Response [MIN]	0-1000	0-1500	0-2000	0-2400	Hz	1, 9
Mounted Resonant Frequency [MIN]	2000	3000	4000	5000	Hz	8, 9
Sensitivity (MIN/MAX)	0.6/1.5	0.3/0.6	0.15/0.3	0.06/0.15	mV/g	2

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Zero Acceleration Output		5.0	25.0	±mV	9
Damping Ratio	0.4	0.7	0.9		8, 9
Non-linearity		0.5	1.0	±% Span	4
Transverse Sensitivity		1.0	3.0	±% Span	
Input & Output Resistance	2.5	3.5	6.5	kΩ	9
Temperature Error - Span		1.0	2.0	±% Span	3, 5
Temperature Error - Zero		1.0	2.0	±% Span	3, 5
Supply Voltage		5.0	10.0	VDC	
Output Noise		1.0		µV p-p	6
Output Load Resistance	5			MΩ	
Acceleration Limits (Any Direction)		20X		Rated	7
Operating Temperature	-40°C to +125°C				
Storage Temperature	-55°C to +150°C				
Weight	6.5 Grams				
Materials	Alumina ceramic substrate with alumina ceramic cap				

Notes

1. The frequency response is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
2. Output voltage increases for positive acceleration; output voltage decreases for negative acceleration.
3. Percentage values are with external compensation. The uncompensated temperature coefficients are measured and specified with each unit. In addition, the values of the resistors that provide a temperature compensated output are provided with each unit. These resistors are for use in the circuit shown in Figure 2.
4. Best Fit Straight Line. For full scale ranges of 10g or less, the maximum non-linearity is ±2%.
5. Compensated temperature range: 0-50°C in reference to 25°C.
6. 10 Hz to 1 kHz.
7. 400g for ±2g, ±5g, and ±10g versions. 20X or 2000g for other versions, whichever is less.
8. For sensors having a resonant frequency greater than 5 kHz, the calibration data sheet will indicate ">5 kHz." In addition, the damping ratio will indicate N/A.
9. Actual test data for this parameter is included on the calibration sheet provided with each sensor. A sample of this calibration sheet is shown as Figure 1.

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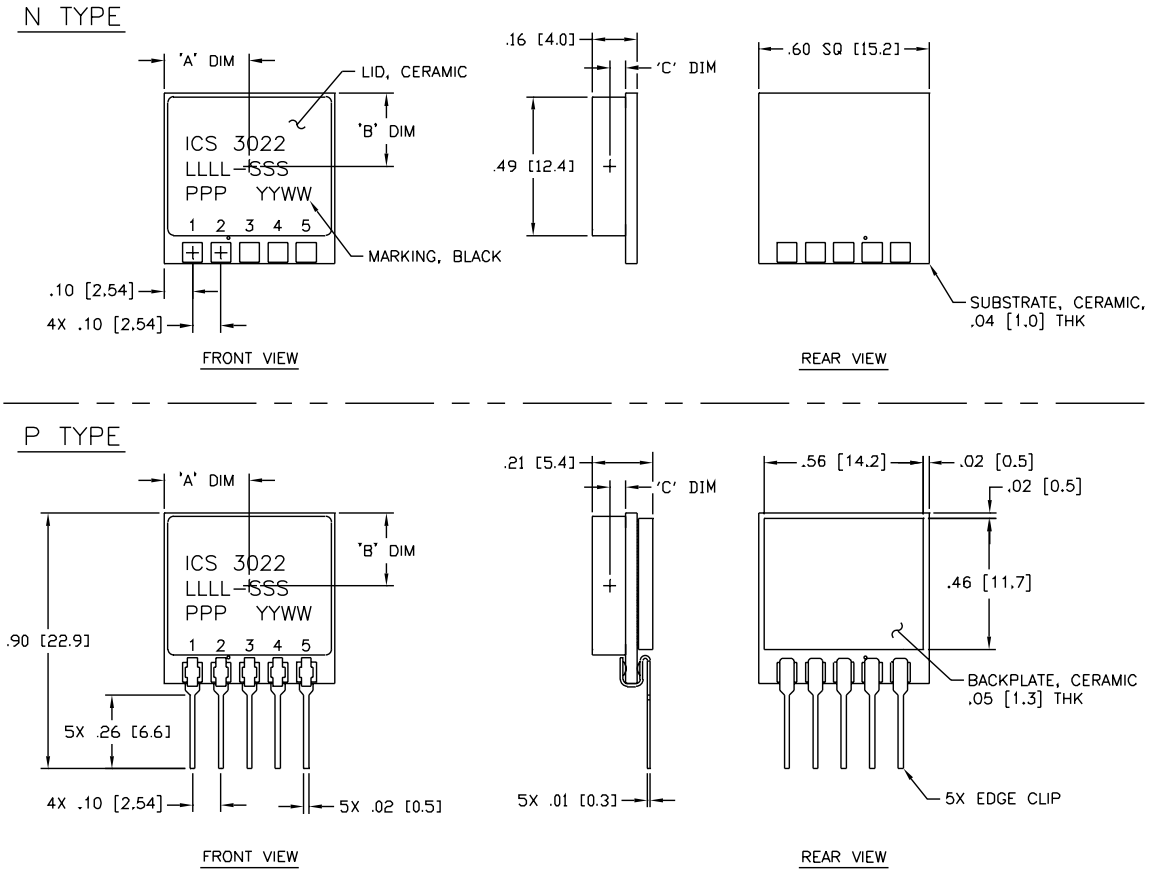
Model 3022

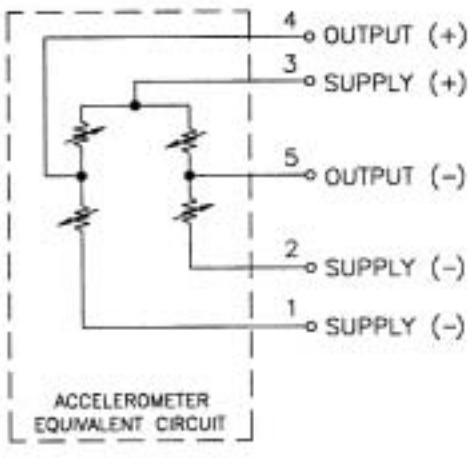
DIMENSIONS



ALL DIMENSIONS ARE IN INCHES [mm]

LTR	2 - 10 g	20 - 500 g
"A" DIM	0.300 ± 0.005	0.265 ± 0.005
	[7.62 ± 0.13]	[6.73 ± 0.13]
"B" DIM	0.250 ± 0.005	0.240 ± 0.005
	[6.35 ± 0.13]	[6.10 ± 0.13]
"C" DIM	0.032 ± 0.004	0.032 ± 0.004
	[0.81 ± 0.10]	[0.81 ± 0.10]

CONNECTIONS



ORDERING INFORMATION

3022 - 005 - P

- P — Electrical Connection (P = Pins, N = None)
- 005 — Acceleration Range
- 3022 — Model

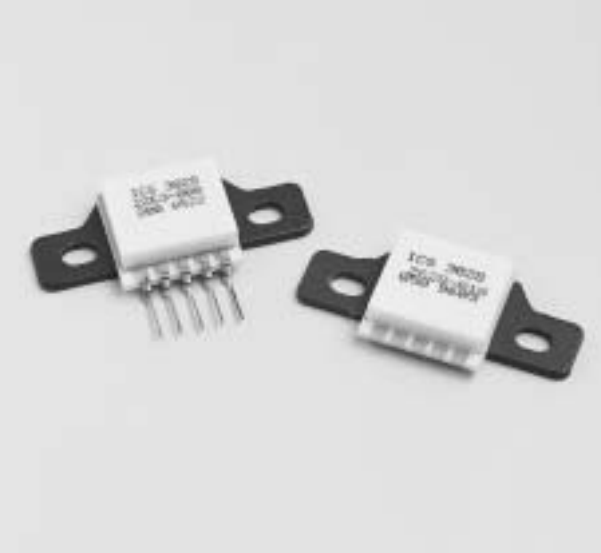
Model 3028

PC Board Mountable Accelerometer

Millivolt Output

Low Cost

- **Vibration/Shock Monitoring**
- **Modal Analysis**
- **Motion Control**
- **Crash Testing**
- **Aerospace**



FEATURES

- Bolt Mount
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (with comp resistors-typical)
- DC Response
- Built-in Damping
- Built-in Over-range Stops
- Low Power
- Pins or No Pins

STANDARD RANGES

Range	g	Range	g
±2	●	±50	●
±5	●	±100	●
±10	●	±200	●
±20	●	±500	●

DESCRIPTION

The Model 3028 is a piezoresistive silicon accelerometer. It is packaged on a ceramic substrate with a metal bracket which can be used to bolt the sensor to the mounting location. A detailed calibration sheet provides test data and resistor compensation values for each sensor.

The accelerometer consists of a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth. Each sensor is individually serialized.

For an accelerometer with an adhesive mount design, see the Model 3022. Please refer to the Models 3052 and 3058 for accelerometers with integral temperature compensation.

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CALIBRATION DATA

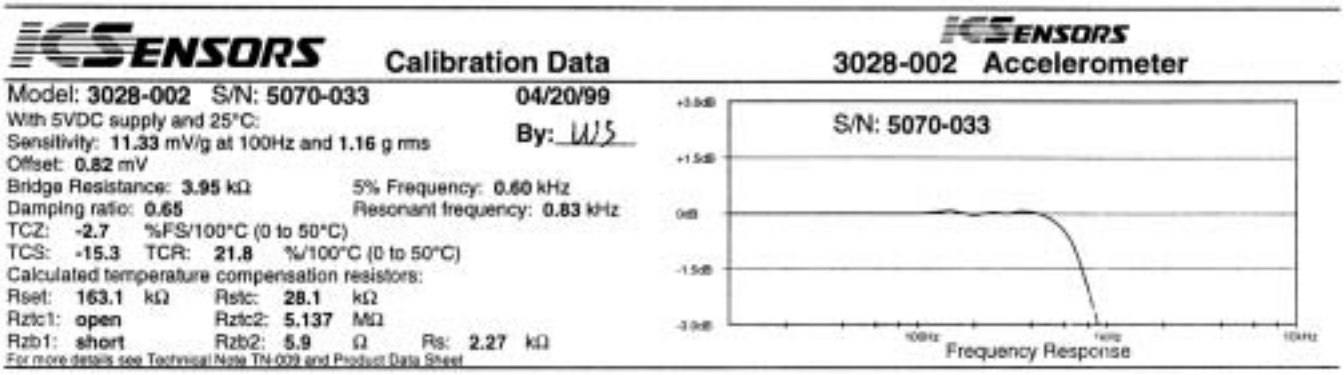

Figure 1. Calibration Data Sheet

A calibration data sheet similar to the sample shown above is included with each unit. The calibration sheet provides the measured test and calibration data for the sensor. In addition to the test data, the values of calibration and temperature compensation resistors are also included.

SIGNAL CONDITIONING

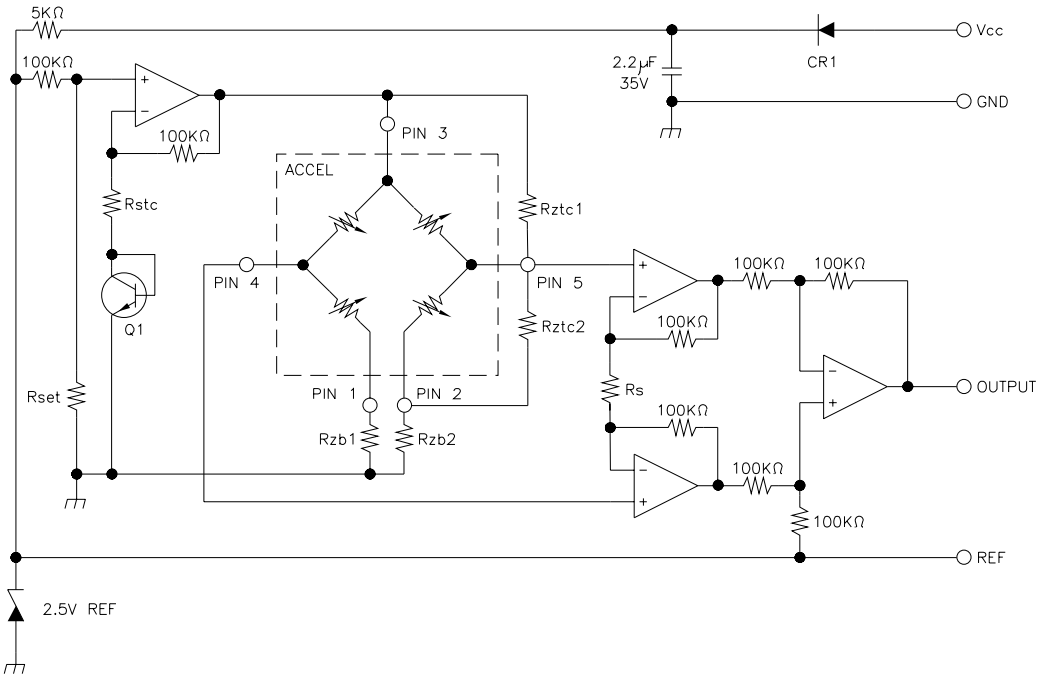

Figure 2. Typical Temperature Compensation and Amplification Circuit (component values specified for each sensor)

Q1: 2N3904
CR1: 1N914 or equivalent
Op Amps: LT1014, LM324 or equivalent

- Rstc sets the excitation voltage ramp to compensate the sensitivity error due to temperature.
- Rset sets the excitation voltage to 5V at 25°C.
- Rzb1, Rzb2 and Rztc1 and Rztc2 calibrate the zero offset and compensate the offset error due to temperature.
- Rs calibrates the output span.
- Vcc must be >8 VDC.

Model 3028

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE ±2G	±5G	±10G	±20G	UNITS	NOTES
Frequency Response [MIN]	0-250	0-300	0-400	0-600	Hz	1, 9
Mounted Resonant Frequency [MIN]	700	800	1000	1500	Hz	8, 9
Sensitivity (MIN/MAX)	8.0/20.0	6.0/15.0	3.0/6.0	1.5/3.0	mV/g	2

PARAMETERS	RANGE ±50G	±100G	±200G	±500G	UNITS	NOTES
Frequency Response [MIN]	0-1000	0-1500	0-2000	0-2400	Hz	1, 9
Mounted Resonant Frequency [MIN]	2000	3000	4000	5000	Hz	8, 9
Sensitivity (MIN/MAX)	0.6/1.5	0.3/0.6	0.15/0.3	0.06/0.15	mV/g	2

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Zero Acceleration Output		5.0	25.0	±mV	9
Damping Ratio	0.4	0.7	0.9		8, 9
Non-linearity		0.5	1.0	±% Span	4
Transverse Sensitivity		1.0	3.0	±% Span	
Input & Output Resistance	2.5	3.5	6.5	kΩ	9
Temperature Error - Span		1.0	2.0	±% Span	3, 5
Temperature Error - Zero		1.0	2.0	±% Span	3, 5
Supply Voltage		5.0	10.0	VDC	
Output Noise		1.0		µV p-p	6
Output Load Resistance	5			MΩ	
Acceleration Limits (Any Direction)		20X		Rated	7
Operating Temperature	-40°C to +125°C				
Storage Temperature	-55°C to +150°C				
Weight (with pins)	8.0 Grams				
Materials	Alumina ceramic substrate with alumina ceramic cap and aluminum base plate				
Mounting/Torque	Two slotted holes for 4-40 screws/6 in - lbs. torque				

Notes

1. The frequency response is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
2. Output voltage increases for positive acceleration; output voltage decreases for negative acceleration.
3. Percentage values are with external compensation. The uncompensated temperature coefficients are measured and specified with each unit. In addition, the values of the resistors that provide a temperature compensated output are provided with each unit. These resistors are for use in the circuit shown in Figure 2.
4. Best Fit Straight Line. For full scale ranges of 10g or less, the maximum non-linearity is ±2%.
5. Compensated temperature range: 0-50°C in reference to 25°C.
6. 10 Hz to 1 kHz.
7. 400g for ±2g, ±5g, and ±10g versions. 20X or 2000g for other versions, whichever is less.
8. For sensors having a resonant frequency greater than 5 kHz, the calibration data sheet will indicate "> 5kHz." In addition, the damping ratio will indicate N/A.
9. Actual test data for this parameter is included on the calibration sheet provided with each sensor. A sample of this calibration sheet is shown as Figure 1.

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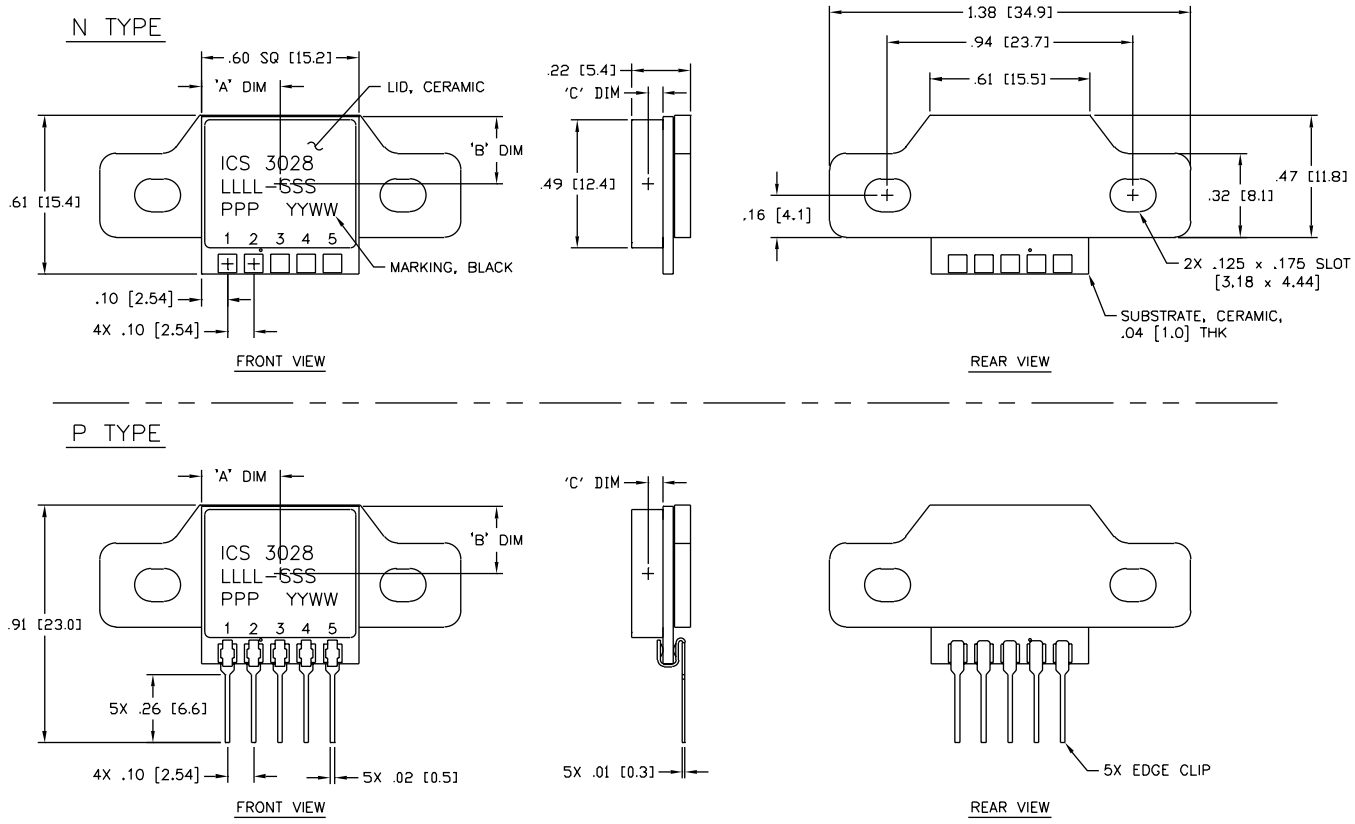
Model 3028

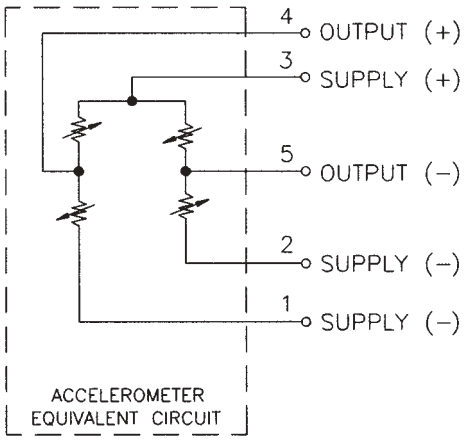
DIMENSIONS



ALL DIMENSIONS ARE IN INCHES [mm]

LTR	2 - 10 g	20 - 500 g
"A" DIM	0.300 ± 0.005	0.265 ± 0.005
	[7.62 ± 0.13]	[6.73 ± 0.13]
"B" DIM	0.250 ± 0.005	0.240 ± 0.005
	[6.35 ± 0.13]	[6.10 ± 0.13]
"C" DIM	0.032 ± 0.004	0.032 ± 0.004
	[0.81 ± 0.10]	[0.81 ± 0.10]

CONNECTIONS



ORDERING INFORMATION

3028 - 005 - P

- P = Electrical Connection (P = Pins, N = None)
- 005 = Acceleration Range
- 3028 = Model

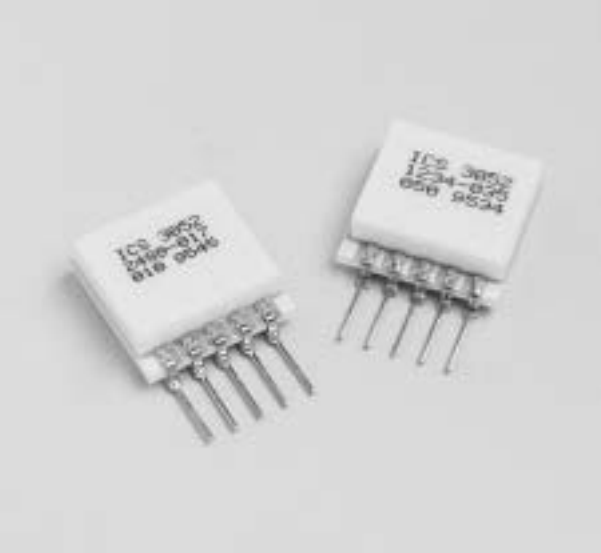
Model 3052

PC Board Mountable Accelerometer

Millivolt Output

Integral Temperature Compensation

- **Vibration/Shock Monitoring**
- **Modal Analysis**
- **Motion Control**
- **Crash Testing**
- **Aerospace**



FEATURES

- Adhesive Mount
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (Typical)
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g	Range	g
±2	●	±20	●
±5	●	±50	●
±10	●	±100	●

DESCRIPTION

The Model 3052 is a piezoresistive silicon accelerometer with integral temperature compensation. It is packaged on a ceramic substrate with an epoxy sealed ceramic cover and is designed for adhesive mounting.

The accelerometer consists of a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth. Each sensor is individually serialized.

For an accelerometer with a mounting bracket which can be used to bolt the sensor to the mounting location see the Model 3058. For uncompensated accelerometers, please refer to the Models 3022 and 3028.

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Model 3052

CALIBRATION DATA

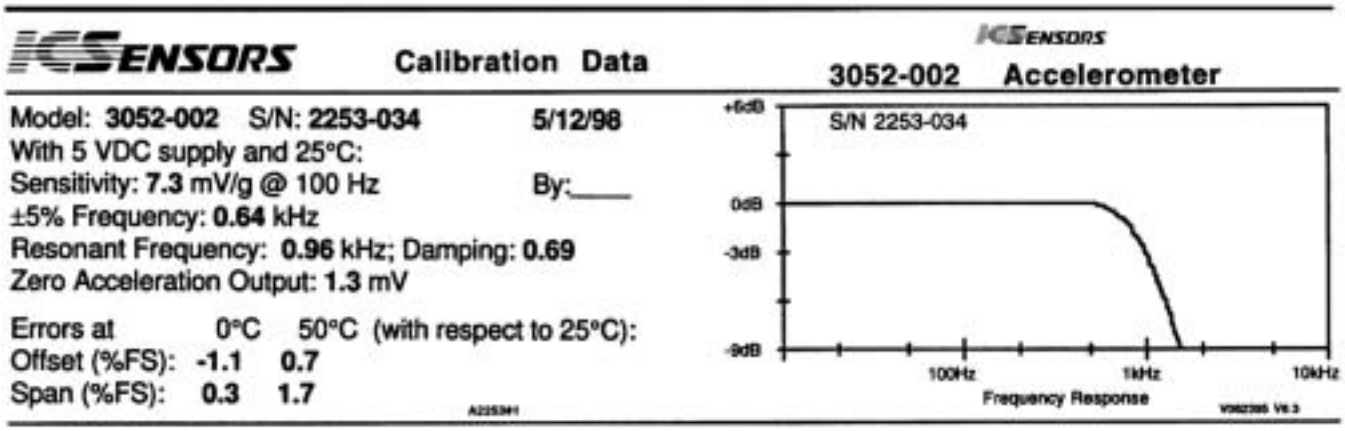
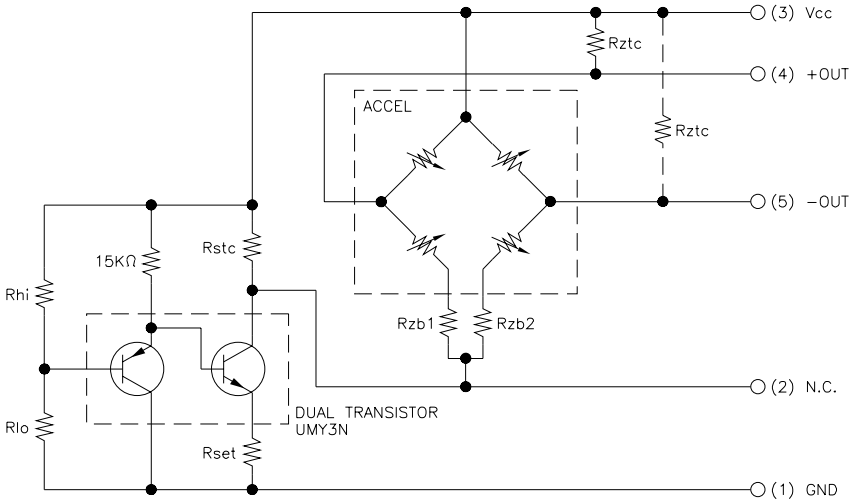
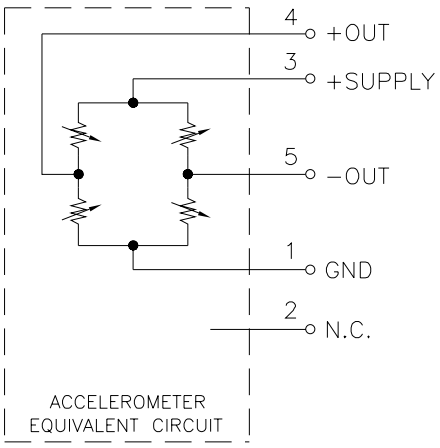


Figure 1. Calibration Data Sheet

A calibration data sheet similar to the sample shown above is included with each unit. The calibration sheet provides the measured test and calibration data for the sensor.

CONNECTIONS





PIN NUMBER	FUNCTION
1	GROUND
2	ICS USE ONLY
3	SUPPLY
4	-OUTPUT
5	+OUTPUT

RESISTOR	FUNCTION	OHMS
R1	Rzb	10-50
R2	Rset	250-350
R3	Rlo	800-1250
R5	Rhi	7.5K-50K
R6	Rstc	3K-99K
R7	Rztc	0.15M-4M

Model 3052

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE ±2g	RANGE ±5g	RANGE ±10g	UNITS	NOTES
Frequency Response [MIN]	0-250	0-300	0-400	Hz	1, 2
Mounted Resonant Frequency [MIN]	700	800	1000	Hz	1
Sensitivity (MIN/MAX)	6.0/9.0	2.4/3.6	1.2/1.8	mV/g	1, 3

PARAMETERS	RANGE ±20G	RANGE ±50G	RANGE ±100G	UNITS	NOTES
Frequency Response [MIN]	0-600	0-1000	0-1500	Hz	1, 2
Mounted Resonant Frequency [MIN]	1500	2000	3000	Hz	1, 4
Sensitivity (MIN/MAX)	0.6/0.9	0.24/0.36	0.12/0.18	mV/g	1, 3

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Zero Acceleration Output		1	2	±mV	1
Damping Ratio	0.4	0.7	0.9		1, 4
Non-linearity		0.5	1	±% Span	5
Transverse Sensitivity		1	3	±% Span	
Output Resistance	2.5	3.5	6.5	kΩ	
Temperature Error - Sensitivity		1.0	2.0	±% Span	1, 6
Temperature Error - Zero		1.0	2.0	±% Span	1, 6
Supply Voltage		5.0	10.0	VDC	
Current		1, 5		mA	
Output Noise		1.0		µV p-p	
Output Load Resistance	5			MΩ	7
Acceleration Limits (Any Direction)		20X		Rated	8
Operating Temperature	-40°C to +125°C				
Compensated Temperature Range	0°C to +50°C				
Storage Temperature	-55°C to +150°C				
Weight	6.5 Grams				

Notes

1. Actual test data for this parameter is included on the calibration sheet included with each sensor. A sample of this calibration sheet is shown as Figure 1.
2. The useful frequency range is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
3. Positive voltage change for positive acceleration; negative voltage change for negative acceleration.
4. For sensors having resonant frequency greater than 5 kHz, the calibration data sheet will indicate ">5 kHz". In addition, the damping ratio will indicate N/A.
5. Best Fit Straight Line. For full scale ranges of 10g or less, the maximum non-linearity is ±2%.
6. Compensated temperature range: 0°C to +50°C in reference to 25°C.
7. Prevents increase of TC-Span and sensitivity decrease due to output loading.
8. 400g for ±2g, ±5g and ±10g versions, 20X or 2000g, whichever is lower, for other versions.

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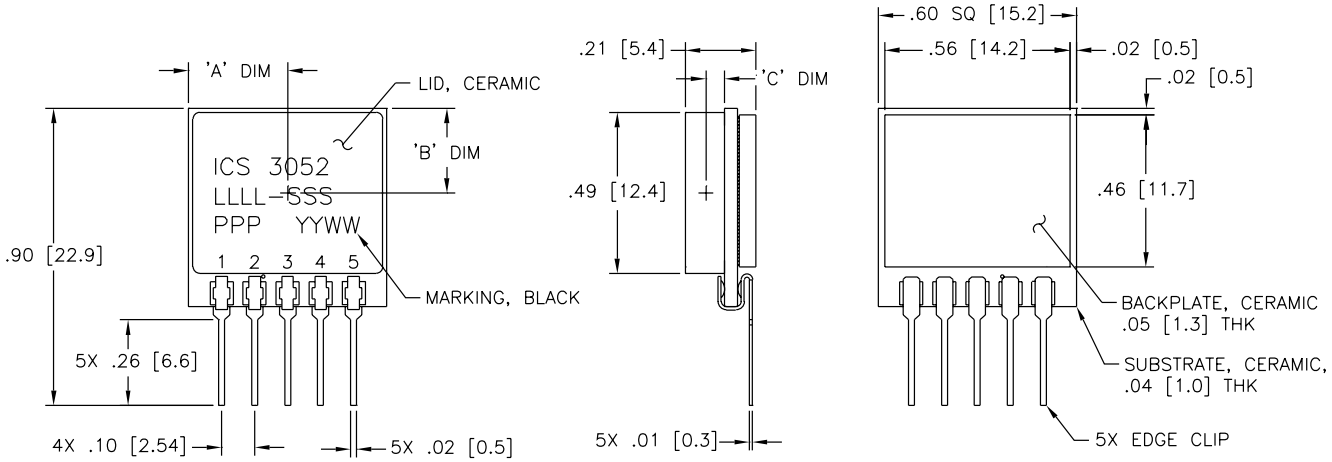
Model 3052

DIMENSIONS



ALL DIMENSIONS ARE IN INCHES [mm]

LTR	2 - 10 g	20 - 500 g
"A" DIM	0.300 ± 0.005	0.265 ± 0.005
	[7.62 ± 0.13]	[6.73 ± 0.13]
"B" DIM	0.250 ± 0.005	0.240 ± 0.005
	[6.35 ± 0.13]	[6.10 ± 0.13]
"C" DIM	0.032 ± 0.004	0.032 ± 0.004
	[0.81 ± 0.10]	[0.81 ± 0.10]

ORDERING INFORMATION

3052 - 005 - P

- P — Electrical Connection (P = Pins)
- 005 — Acceleration Range
- 3052 — Model

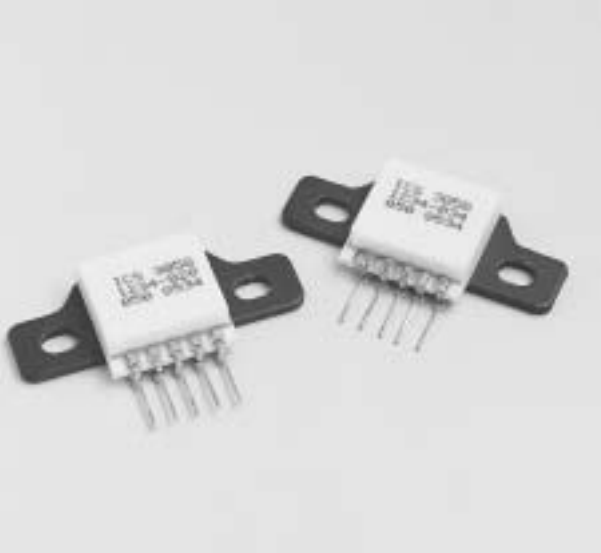
Model 3058

PC Board Mountable Accelerometer

Millivolt Output

Integral Temperature Compensation

- Vibration/Shock Monitoring
- Modal Analysis
- Motion Control
- Crash Testing
- Aerospace



FEATURES

- Adhesive Mount
- ±0.5% Non-linearity (typical)
- ±1.0% Temperature Performance (Typical)
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g	Range	g
±2	●	±20	●
±5	●	±50	●
±10	●	±100	●

DESCRIPTION

The Model 3058 is a piezoresistive silicon accelerometer with integral temperature compensation. It is packaged on a ceramic substrate with a metal bracket which can be used to bolt the sensor to the mounting location.

The accelerometer consists of a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth. Each sensor is individually serialized.

For an accelerometer designed for adhesive mounting, see the Model 3052. For uncompensated accelerometers, please refer to the Models 3022 and 3028.

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Model 3058

CALIBRATION DATA

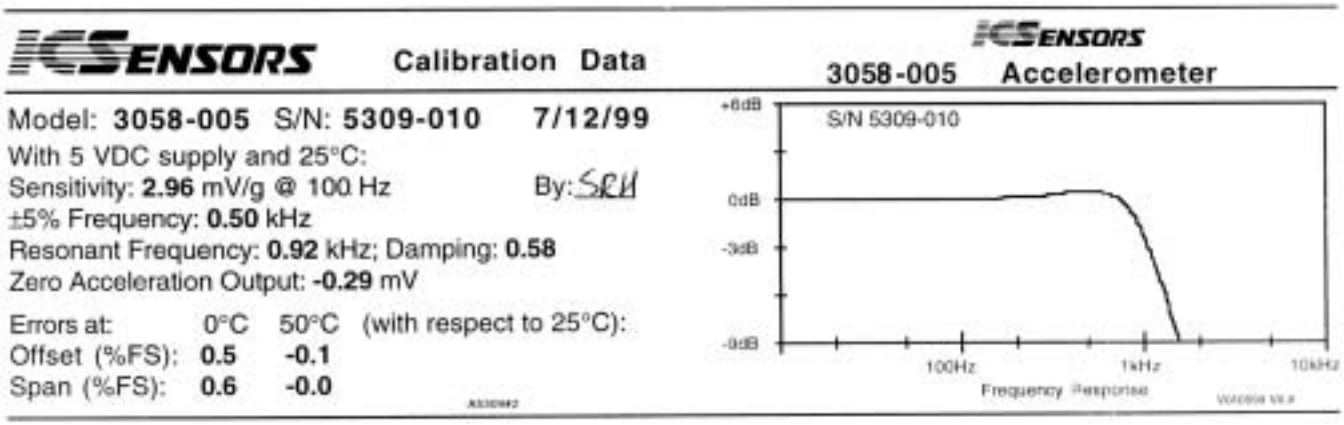
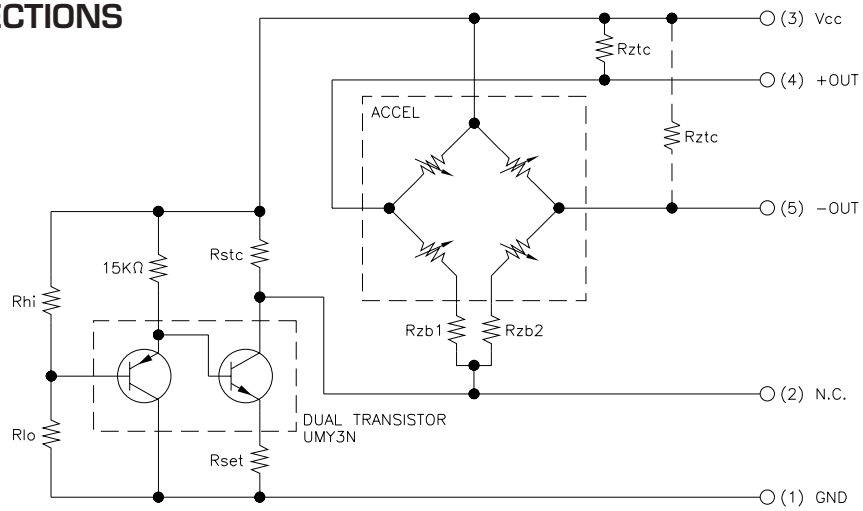
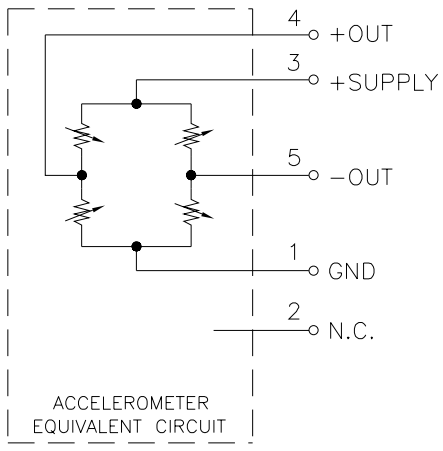


Figure 1. Calibration Data Sheet

A calibration data sheet similar to the sample shown above is included with each unit. The calibration sheet provides the measured test and calibration data for the sensor.

CONNECTIONS





PIN NUMBER	FUNCTION
1	GROUND
2	ICS USE ONLY
3	SUPPLY
4	-OUTPUT
5	+OUTPUT

RESISTOR	FUNCTION	OHMS
R1	Rzb	10-50
R2	Rset	250-350
R3	Rlo	800-1250
R5	Rhi	7.5K-50K
R6	Rstc	3K-99K
R7	Rztc	0.15M-4M

Model 3058

PERFORMANCE SPECIFICATIONS

Supply Voltage: 5.0 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE ±2g	RANGE ±5g	RANGE ±10g	UNITS	NOTES
Frequency Response [MIN]	0-250	0-300	0-400	Hz	1, 2
Mounted Resonant Frequency [MIN]	700	800	1000	Hz	1
Sensitivity (MIN/MAX)	6.0/9.0	2.4/3.6	1.2/1.8	mV/g	1, 3

PARAMETERS	RANGE ±20G	RANGE ±50G	RANGE ±100G	UNITS	NOTES
Frequency Response [MIN]	0-600	0-1000	0-1500	Hz	1, 2
Mounted Resonant Frequency [MIN]	1500	2000	3000	Hz	1, 4
Sensitivity (MIN/MAX)	0.6/0.9	0.24/0.36	0.12/0.18	mV/g	1, 3

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Zero Acceleration Output		1	2	±mV	1
Damping Ratio	0.4	0.7	0.9		1, 4
Non-linearity		0.5	1	±% Span	5
Transverse Sensitivity		1	3	±% Span	
Output Resistance	2.5	3.5	6.5	kΩ	
Temperature Error - Sensitivity		1.0	2.0	±% Span	1, 6
Temperature Error - Zero		1.0	2.0	±% Span	1, 6
Supply Voltage		5.0	10.0	VDC	
Current		1, 5		mA	
Output Noise		1.0		µV p-p	
Output Load Resistance	5			MΩ	7
Acceleration Limits (Any Direction)		20X		Rated	8
Operating Temperature	-40°C to +125°C				
Compensated Temperature Range	0°C to +50°C				
Storage Temperature	-55°C to +150°C				
Weight	6.5 Grams				

Notes

1. Actual test data for this parameter is included on the calibration sheet included with each sensor. A sample of this calibration sheet is shown as Figure 1.
2. The useful frequency range is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.
3. Positive voltage change for positive acceleration; negative voltage change for negative acceleration.
4. For sensors having resonant frequency greater than 5 kHz, the calibration data sheet will indicate ">5 kHz". In addition, the damping ratio will indicate N/A.
5. Best Fit Straight Line. For full scale ranges of 10g or less, the maximum non-linearity is ±2%.
6. Compensated temperature range: 0°C to +50°C in reference to 25°C.
7. Prevents increase of TC-Span and sensitivity decrease due to output loading.
8. 400g for ±2g, ±5g and ±10g versions, 20X or 2000g, whichever is lower, for other versions.

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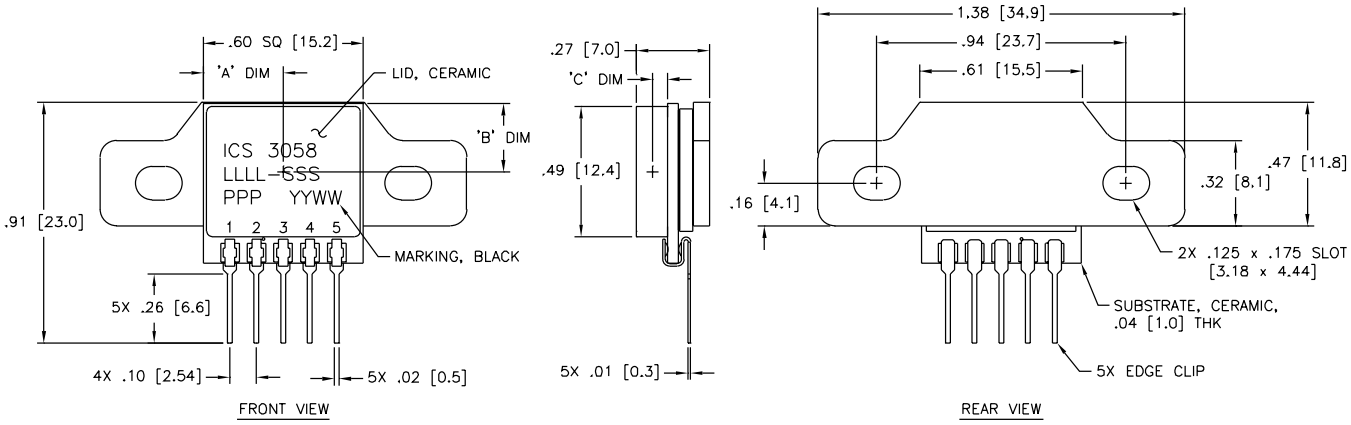
Model 3058

DIMENSIONS



ALL DIMENSIONS ARE IN INCHES [mm]

LTR	2 - 10 g	20 - 500 g
"A" DIM	0.300 ± 0.005	0.265 ± 0.005
	[7.62 ± 0.13]	[6.73 ± 0.13]
"B" DIM	0.250 ± 0.005	0.240 ± 0.005
	[6.35 ± 0.13]	[6.10 ± 0.13]
"C" DIM	0.032 ± 0.004	0.032 ± 0.004
	[0.81 ± 0.10]	[0.81 ± 0.10]

ORDERING INFORMATION

3058 - 005 - P

- P — Electrical Connection (P = Pins)
- 005 — Acceleration Range
- 3058 — Model

ACCELEROMETERS

SELECTION GUIDE

Stand Alone

ACCELEROMETER SELECTION GUIDE—STAND ALONE

(Please refer to specification sheets for additional information)

FAMILY	ACCELEROMETER		
TYPE	Stand Alone Integral Mounting Bracket		
PACKAGE	Single Axis		
MODEL	3140 	3145 	3150 
G RANGE			
±2G to ±100G	•	•	•
±2G to ±500G			
±50G to ±500G			
±25G to ±100G			
OUTPUT			
Millivolt Output			
0.4 to 4.5VDC Output	•	•	•
PERFORMANCE			
±1.0% Non-linearity	•	•	•
±5% Sensitivity error including temperature performance			
Max. ±2.0% (each) Temperature zero and span error over 0 to 50°C comp range			
Max. ±2.0% (each) Temperature zero and span error over -20 to 85°C comp range	•		•
Max. ±4.0% (each) Temperature zero and span error over -20 to 85°C comp range		•	
COMPENSATION			
Offset, gain and temperature resistor values provided for external compensation.			
Offset, gain set and temperature compensation internal to the accelerometer.	•	•	•

Model 3140

Signal Conditioned Accelerometer

0.5 to 4.5 VDC Output

Intergral Temperature Compensation

High Performance

- **Vibration/Shock Monitoring**
- **Geophysical Monitoring**
- **Modal Analysis**
- **Structural Analysis**
- **Elevator Ride Control**

DESCRIPTION

The Model 3140 is a high performance accelerometer intended for instrumentation applications. The 3140 provides a fully signal conditioned output with performance similar to traditional instrumentation accelerometers but at a much lower cost.

The accelerometer consists of a silicon micro machined accelerometer with signal conditioning electronics in a lightweight Valox™ housing that can be easily attached to a mounting surface.

The sensing element is a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide overrange stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth.

A lower cost version of the 3140 is available for applications that do not require the temperature performance offered with the 3140. Please refer to the Model 3145 for additional information.

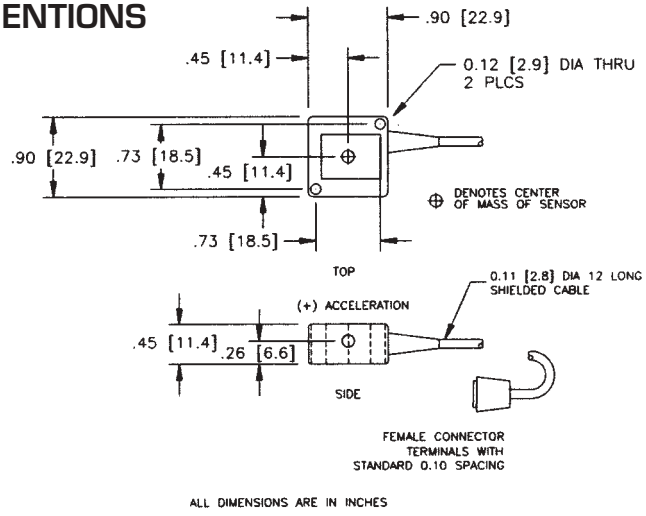
FEATURES

- Bolt Mount
- ±0.5% Non-linearity (typical)
- ±2.0% Temperature Performance
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g
±2	•
±5	•
±10	•
±20	•
±50	•
±100	•

DIMENTIONS



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Model 3140

PERFORMANCE SPECIFICATIONS

Supply Voltage: 12 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE					
	±2g	±5g	±10g	±20g	±50g	±100g
Frequency Response [MIN]	0-200	0-300	0-400	0-500	0-600	0-1500
Mounted Resonant Frequency [MIN]	450	600	950	1500	2750	3000
Sensitivity (MIN/MAX)	1 V/g	400mV/g	200mV/g	100mV/g	40mV/g	20mV/g

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	3.92	4.00	4.08	Volts	1, 2
Zero Acceleration Output	2.46	2.50	2.54	Volts	1, 2
Accuracy		0.5	1.0	±% Span	3
Transverse Sensitivity		1.0	3.0	±% Span	
Temperature Error - Span (-20 to 85°C)		1.0	2.5	±% Span	2, 4
Temperature Error - Zero (-20 to 85°C)		1.0	2.0	±% Span	2, 4
Supply Voltage	8.0	12.0	30.0	Volts	
Supply Current		5.0		mA	
Reference Voltage		2.5		Volts	5
Output Resistance		0.1		Ω	
Output Noise		0.5		mV p-p	6
Output Load Resistance	5			kΩ	
Acceleration Limits		20X		Rated	
Operating Temperature	-20°C to +85°C				
Storage Temperature	-40°C to +125°C				
Weight (Including Cable)	13 Grams				

Notes

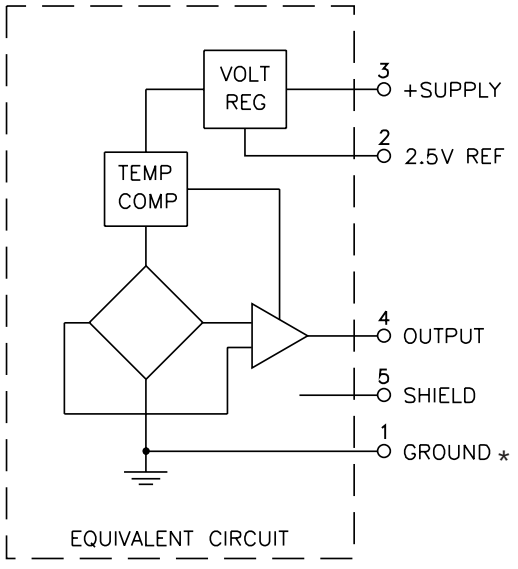
1. The output voltage increases from the Zero Acceleration Output for positive acceleration and decreases for negative acceleration. The sensitivity is then 2V/Range. For example, the ±5g range has a sensitivity of 2V/5g or 400mV/g.
2. Actual test data for this parameter is included on the calibration sheet provided with each sensor.
3. Includes repeatability, hysteresis, and linearity (best fit straight line).
4. Compensated temperature range: -20°C to +85°C in reference to 25°C.
5. Pin 2 provides an optional 2.5V reference which may be used, if desired, to provide a stable zero-g reference. Thus, the full scale differential output between Pin 2 and Pin 4 would be ± 2 VDC. If a single ended output signal is preferred (0.5-4.5 VDC), make no connection to Pin 2. To avoid damage to the internal voltage regulator, do not connect Pin 2 to Pin 1 (gnd). Minimum load resistance connected to Pin 2 without affecting output is 100 k
6. 10 Hz to 1 kHz.
7. To use an alternate electrical connector, refer to the following color code for proper electrical connections: Pin 1 - Green; Pin 2 - Yellow; Pin 3 - Red; Pin 4 - Blue; Pin 5 - Shield. Note: Removing the connector voids the product warranty.
8. The useful frequency range is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.

ORDERING INFORMATION

3140 - 002

- 002 — Acceleration Range
- 3140 — Model

CONNECTIONS



*Notch on connector to indicate pin one.

Model 3145

Signal Conditioned Accelerometer

0.5 to 4.5 VDC Output

Intergral Temperature Compensation

High Performance

- Vibration/Shock Monitoring
- Geophysical Monitoring
- Modal Analysis
- Structural Analysis
- Elevator Ride Control

FEATURES

- Bolt Mount
- ±0.5% Non-linearity (typical)
- ±4.0% Temperature Performance
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g
±2	•
±5	•
±10	•
±20	•
±50	•
±100	•

DESCRIPTION

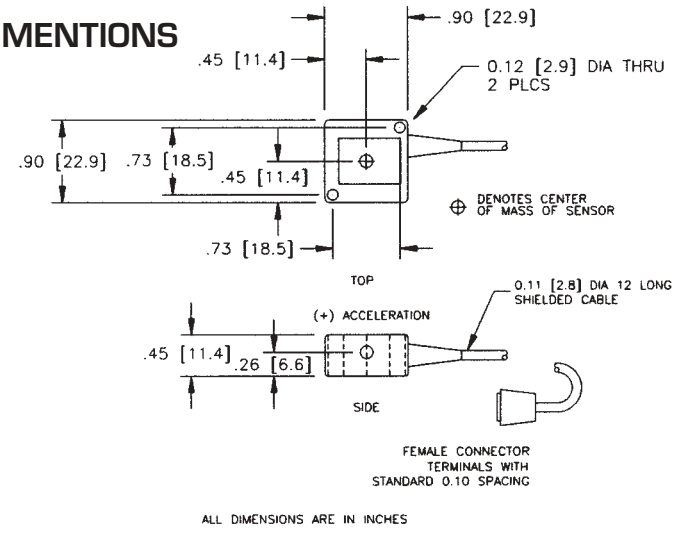
The Model 3145 is a general purpose performance accelerometer intended for instrumentation applications. The 3145 provides a fully signal conditioned output with performance similar to traditional instrumentation accelerometers but at a much lower cost.

The accelerometer consists of a silicon micro machined accelerometer with signal conditioning electronics in a lightweight Valox™ housing that can be easily attached to a mounting surface.

The sensing element is a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth.

A higher performance version of the 3145 is available for critical applications. Please refer to the Model 3140 for additional information.

DIMENTIONS



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Model 3145

PERFORMANCE SPECIFICATIONS

Supply Voltage: 12 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE					
	±2g	±5g	±10g	±20g	±50g	±100g
Frequency Response [MIN]	0-200	0-300	0-400	0-500	0-600	0-1500
Mounted Resonant Frequency [MIN]	450	600	950	1500	2750	3000
Sensitivity (MIN/MAX)	1 V/g	400mV/g	200mV/g	100mV/g	40mV/g	20mV/g

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	3.80	4.00	4.20	Volts	1, 2
Zero Acceleration Output	2.40	2.50	2.60	Volts	1, 2
Accuracy		0.5	1.0	±% Span	3
Transverse Sensitivity		1.0	3.0	±% Span	
Temperature Error - Span (-20 to 85°C)		2.0	4.0	±% Span	2, 4
Temperature Error - Zero (-20 to 85°C)		2.0	4.0	±% Span	2, 4
Supply Voltage	8.0	12.0	30.0	Volts	
Supply Current		5.0		mA	
Reference Voltage		2.5		Volts	5
Output Resistance		0.1		Ω	
Output Noise		0.5		mV p-p	6
Output Load Resistance	2			kΩ	
Acceleration Limits		20X		Rated	
Operating Temperature	-20°C to +85°C				
Storage Temperature	-40°C to +125°C				
Weight (Including Cable)	13 Grams				

Notes

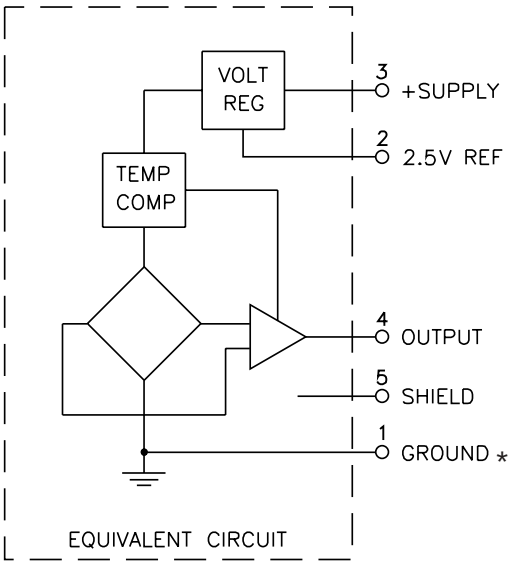
1. The output voltage increases from the Zero Acceleration Output for positive acceleration and decreases for negative acceleration. The sensitivity is then 2V/Range. For example, the ±5g range has a sensitivity of 2V/5g or 400mV/g.
2. Actual test data for this parameter is included on the calibration sheet provided with each sensor.
3. Includes repeatability, hysteresis, and linearity (best fit straight line).
4. Compensated temperature range: -20°C to +85°C in reference to 25°C.
5. Pin 2 provides an optional 2.5V reference which may be used, if desired, to provide a stable zero-g reference. Thus, the full scale differential output between Pin 2 and Pin 4 would be ± 2 VDC. If a single ended output signal is preferred (0.5-4.5 VDC), make no connection to Pin 2. To avoid damage to the internal voltage regulator, do not connect Pin 2 to Pin 1 (gnd). Minimum load resistance connected to Pin 2 without affecting output is 100 k
6. 10 Hz to 1 kHz.
7. To use an alternate electrical connector, refer to the following color code for proper electrical connections: Pin 1 - Green; Pin 2 - Yellow; Pin 3 - Red; Pin 4 - Blue; Pin 5 - Shield. Note: Removing the connector voids the product warranty.
8. The useful frequency range is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.

ORDERING INFORMATION

3145 - 002

- 002 — Acceleration Range
- 3145 — Model

CONNECTIONS



*Notch on connector to indicate pin one.

Model 3150

Signal Conditioned Accelerometer

0.5 to 4.5 VDC Output

Intergral Temperature Compensation

High Performance

- **Vibration/Shock Monitoring**
- **Geophysical Monitoring**
- **Modal Analysis**
- **Structural Analysis**
- **Elevator Ride Control**

DESCRIPTION

The Model 3150 is a high performance accelerometer intended for instrumentation applications. The 3150 provides a fully signal conditioned output with performance similar to traditional instrumentation accelerometers but at a much lower cost.

The accelerometer consists of a silicon micro machined accelerometer with signal conditioning electronics in a lightweight Valox™ housing that can be easily attached to a mounting surface.

The sensing element is a micro machined silicon mass suspended by multiple beams from a silicon frame. Piezoresistors located in the beams change their resistance as the motion of the suspended mass changes the strain in the beams. Silicon caps on the top and bottom of the device are added to provide over-range stops. This design provides for a very low profile, high shock resistance, durability and built-in damping over a wide usable bandwidth.

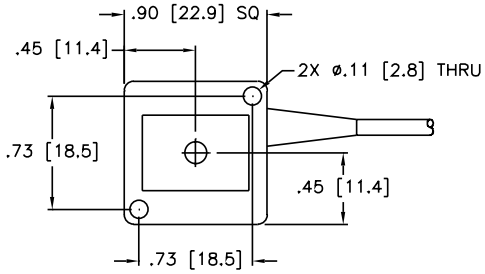
FEATURES

- Bolt Mount
- ±0.5% Non-linearity (typical)
- ±2.0% Temperature Performance
- DC Response
- Built-in Damping
- Built-in Overrange Stops
- Low Power

STANDARD RANGES

Range	g
±2	•
±5	•
±10	•
±20	•
±50	•
±100	•

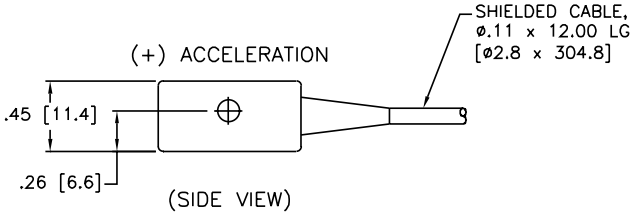
DIMENTIONS



(TOP VIEW)

CNDTR COLOR	FUNCTION
BLK	GND
WHT	REF
RED	+ SUP
BLU	OUT
——	SHIELD

⊕ DENOTES CENTER MASS OF SENSOR



(SIDE VIEW)

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Model 3150

PERFORMANCE SPECIFICATIONS

Supply Voltage: 12 VDC
Ambient Temperature: 25°C (Unless otherwise specified)

PARAMETERS	RANGE						UNITS	NOTES
	±2g	±5g	±10g	±20g	±50g	±100g		
Frequency Response [MIN]	0-200	0-300	0-400	0-500	0-600	0-1500	Hz	2, 7
Mounted Resonant Frequency [MIN]	450	600	950	1500	2750	3000	Hz	2
Sensitivity (MIN/MAX)	1 V/g	400mV/g	200mV/g	100mV/g	40mV/g	20mV/g	mV/g	

PARAMETERS	MIN	TYP	MAX	UNITS	NOTES
Full Scale Output Span	3.80	4.00	4.20	Volts	1, 2
Zero Acceleration Output	2.40	2.50	2.60	Volts	1, 2
Accuracy		0.5	1.0	±% Span	3
Transverse Sensitivity		1.0	3.0	±% Span	
Temperature Error - Span (-20 to 85°C)		2.0	4.0	±% Span	2, 4
Temperature Error - Zero (-20 to 85°C)		2.0	4.0	±% Span	2, 4
Supply Voltage	8.0	12.0	30.0	Volts	
Supply Current		5.0		mA	
Reference Voltage		2.5		Volts	5
Output Resistance		0.1		Ω	
Output Noise		0.5		mV p-p	6
Output Load Resistance	2			kΩ	
Acceleration Limits		20X		Rated	
Operating Temperature	-20°C to +85°C				
Storage Temperature	-40°C to +125°C				
Weight (Including Cable)	13 Grams				

Notes

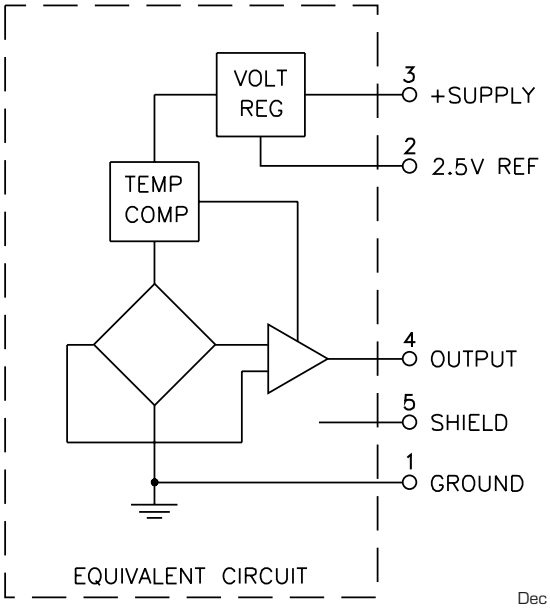
1. The output voltage increases from the Zero Acceleration Output for positive acceleration and decreases for negative acceleration. The sensitivity is then 2V/Range. For example, the ±5g range has a sensitivity of 2V/5g or 400mV/g.
2. Actual test data for this parameter is included on the calibration sheet provided with each sensor.
3. Includes repeatability, hysteresis, and linearity (best fit straight line).
4. Compensated temperature range: –20°C to +85°C in reference to 25°C.
5. Pin 2 provides an optional 2.5V reference which may be used, if desired, to provide a stable zero-g reference. Thus, the full scale differential output between REF and OUTPUT would be ±2 VDC. If a single-ended output signal is preferred (0.5-4.5 VDC), make no connection to REF. To avoid damage to the internal voltage regulator, do not connect REF to GND. Minimum load resistance connected to REF without affecting output is 100 kΩ.
6. 10 Hz to 1 kHz.
7. The useful frequency range is defined as the range of frequencies over which the device sensitivity is within ±5% of the DC value.

ORDERING INFORMATION

3150 - 002

- Acceleration Range
- Model

CONNECTIONS



Dec 2002

APPLICATION NOTES

Signal Conditioning for IC Pressure Sensors

Note: TN-001
Revised: August 1999

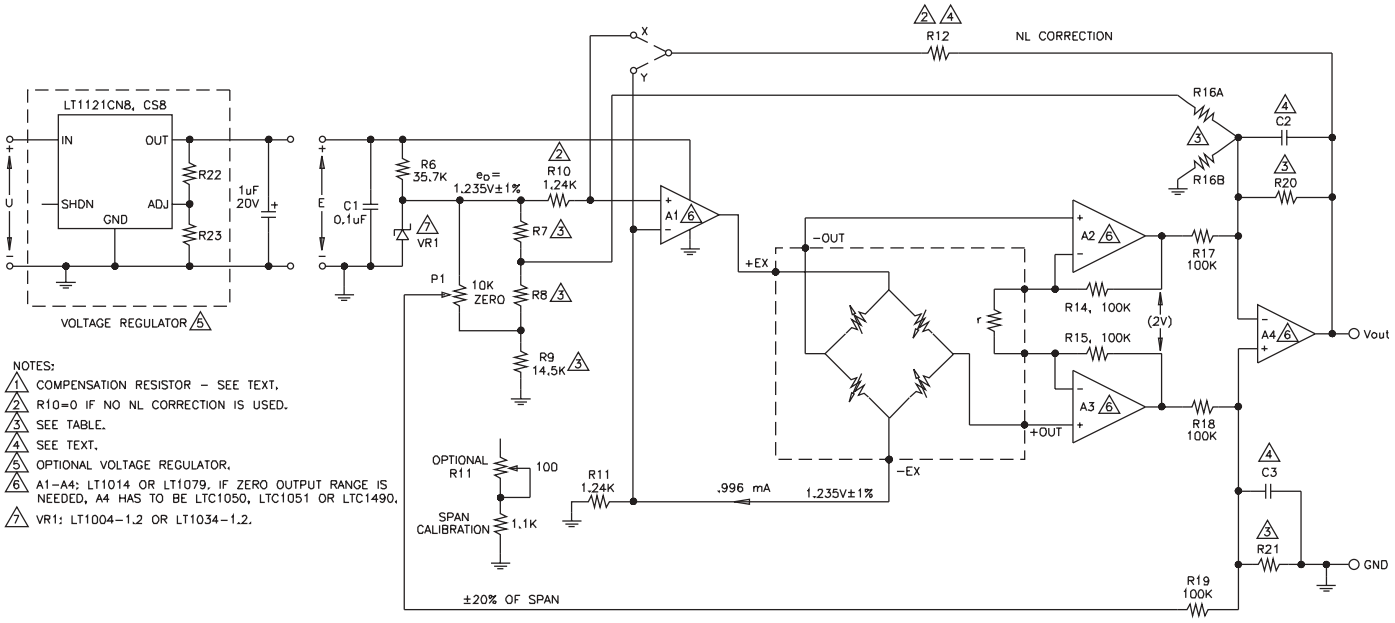
INTRODUCTION

Piezoresistive pressure sensors provide an analog output signal that is proportional to input pressure. The typical fullscale span for this type of integrated sensor is 100 mV which is sufficient for many applications. Various applications do exist however, that require higher level (e.g. 5 volt) output span and thus bring about the need for gain stages and other signal conditioning circuitry.

A basic signal conditioning circuit should provide zero balance adjustment, calibration of pressure sensitivity, temperature compensation of zero and span, signal amplification and voltage regulation. In addition to these basic functions, an active nonlinearity correction and frequency response shaping may be required to enhance sensor performance.

This application note describes an amplification circuit for temperature-compensated pressure sensors, shown in Figure 1. It provides noninteracting zero and span calibration with a single power supply for three-wire voltage output and two-wire current output configurations. This circuit is appropriate for all compensated IC Sensors pressure sensors which utilize constant current excitation (most HIT, TO-8, and ISO products). Several output signal options are shown including live zero (1V) which allows differentiation between transducer failure and zero pressure signal.

The circuit consists of the following functional blocks: sensor assembly, reference voltage source, current source, differential normalizing amplifier, output amplifier, nonlinearity correction loop, frequency response shaping network and optional voltage regulator.



OUTPUT RANGE	R7	R8	R9	R16A	R16B	R20	R21	R22	R23	E_{MIN}	U_{MIN}
1 TO 5V	——	——	4.75K	——	100K	200K	200K	18K	13K	8.9V	10V
1 TO 6V	——	——	4.75K	——	100K	250K	250K	18K	13K	8.9V	10V
0 TO 5V	4.99K	4.99K	3.01K	100K	——	250K	250K	18K	13K	8.9V	10V
0 TO 10V	4.99K	4.99K	3.01K	100K	——	500K	500K	22K	12K	10.1V	11V

Figure 1. Transducer Circuit - Voltage Output

SENSOR ASSEMBLY

The sensor assembly consists of a compensated silicon pressure sensor and gain-set resistor r. The gain-set resistor normalizes the span of the recommended external amplifier, thus creating a low-cost, interchangeable, high level transducer. Please refer to the product data sheet to determine whether a particular model is uncompensated, has temperature compensation on board, or has temperature compensation plus a gain-set resistor on board. For a detailed discussion of passive temperature compensation, please refer to Application Note TN-002, "Temperature Compensation-IC Pressure Sensors." For a discussion on interchangeability, see TN-003. "Gain Programming Using an IC Pressure Sensor."

CONSTANT CURRENT SOURCE

The simplest sensor temperature compensation requires constant current excitation which is built around amplifier A1 as shown in Figure 1. The sensor is connected to the feedback loop of the amplifier. The current in this loop is controlled by the reference voltage e0 (neglecting the nonlinearity correction loop) and by resistor R_{11}:

$$I=e_0/R_{11} \qquad [1]$$

The compliance voltage of this current source is limited by the supply voltage, the output stage saturation of amplifier A1 and the voltage across resistor R11. The required compliance voltage may be derived based on 6.0 kOhm worst case bridge resistance at 25°C and TCR = +0.22%/°C for the compensated sensor.

The reference voltage generator is based on the temperature compensated bandgap reference diode VR_1, whose voltage is used to provide a reference for the constant current source. It also provides a reference for the live zero level in the case of 1 to 5V and 1 to 6V output signal levels and a zeroing voltage across potentiometer P_1.

DIFFERENTIAL NORMALIZING AMPLIFIER

The zero and span temperature compensation for the sensor is calculated based on a no output load condition. Since the bridge resistance changes with temperature, an amplifier input resistance that is too low will introduce an additional temperature error. The differential normalizing amplifier configuration was selected because of its high input resistance and excellent common mode rejection which is virtually independent of circuit component tolerance.

The maximum output voltage of this stage is limited by the input common mode voltage. The output of amplifier A_2 is on a common mode voltage level with zero differential input voltage and it can decrease only to the signal common ground level. The worst case common mode voltage at 1.0 mA excitation current will be about 2.3V in the configuration shown, limiting maximum differential output voltage to about 4.6V. For the circuit shown, a 2.0V span was selected. Gain adjustment covers the input signal range from 33 to 115 mV span at 1.0 mA excitation which corresponds to 50 to 170 mV span at 1.5 mA. Gain K1 is given by:

$$K_1 = 1 + (R_{14} + R_{15})/(R_{13} + P_2) \qquad [2]$$

Denoting minimum required gain by G1, maximum required gain by G_2 and the available worst case (minimum) potentiometer P_2 resistance Rp, the value of symmetrically distributed resistors $R_{14} = R_{15}$ as well as gain adjustment stop R_{13} may be calculated as follows:

$$R_{13} = P\,(G_1 - 1)/(G_2 - G_1) \qquad [3]$$

$$R_{14} = P\,(G_1 - 1)(G_2 - 1)/2(G_2 - G_1) \qquad [4]$$

Common mode rejection (CMR) is relatively important for this stage. Bridge resistance changes with temperature from 0.22%/°C for compensated sensors to 0.27%/°C for uncompensated sensors. Thus, bridge voltage will change with temperature in the constant current excitation mode. For the worst case condition, including 100°C temperature span, the common mode voltage would change by about 0.66V for compensated sensors. Assuming 90 dB worst case differential CMR for this stage (using LT1014), this change would introduce a 0.042%/100°C zero error based on a 50 mV sensor span.

TRANSDUCER CIRCUIT

The differential offset temperature drift of amplifiers A_2-A_3 creates an attendant change in the zero temperature error of the transducer. For example, the LT1014 amplifier has a worst case differential offset drift of 5 μV/°C which translates into a 1%/100°C zero error, assuming a minimum span of 50 mV.

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SECOND STAGE AMPLIFIER

The fixed gain output amplifier has two differential inputs. The first input (R17, R18) processes the output from the normalizing amplifier. The other input (R16, R19) is used to generate a zero bias level for the output options with live zero and provides fine zeroing adjustment of ±20% of the sensor span. Since zeroing is done in the first stage, the change of zero does not affect span.

The gain K_2 of the second stage is set by:

$$K_2 = R_{20}/R_{17} = R_{21}/R_{18} \qquad [5]$$

Common mode rejection of this stage is more important than in the first stage. The common mode voltage change is still 0.66V/100°C worst case at the input (R_{17}/R_{18} resistors). With ±1% tolerance of feedback resistors, about 28 dB CMR may be expected (worst case). That translates to a 1.3%/ 100°C worst case zero drift at the output due to common mode voltage change. With better matching of the feedback resistors, this error decreases and the typical error is about two to four times better than the maximum one.

The temperature drift of the offset voltage is not critical here. Assuming 5 μV/°C drift over the 100°C temperature range, the output zero change is only 0.025%/100°C based on 2V input span.

NONLINEARITY CORRECTION

The optional nonlinearity correction loop is established by resistor R_{12}. This loop feeds back the output voltage in order to control the bridge voltage, thus creating a second order pressure related component in the output signal. This feedback is used to compensate for the sensor's pressure nonlinearity.

For sensors with positive nonlinearity (Figure 2), the feedback is connected to the noninverting input X of amplifier A_1. For negative nonlinearity, the feedback is connected to the inverting input Y.

The value of the feedback resistor R_{12} may be calculated using the following formula:

$$R_{12} = 4R\,(10)^A/S(NL)^B \qquad [6]$$

where: A = 1.9074
B = 0.97242
R - value of resistor R_{10} or R_{11}, whichever is connected to resistor R_{12} for given feedback configuration
S - output signal span (V_2-V_0) driving resistor R_{12}:
4V for 1 to 5V output
5V for 1 to 6V and 0 to 5V outputs
10V for 0 to 10V output
NL - absolute value of terminal based nonlinearity expressed in % of span (Figure 2):

$$NL = \frac{100[V_1 - (V_2 - V_0)(P_1 - P_0) / (P_2 - P_0) - V_0]}{(V_2 - V_0)}$$

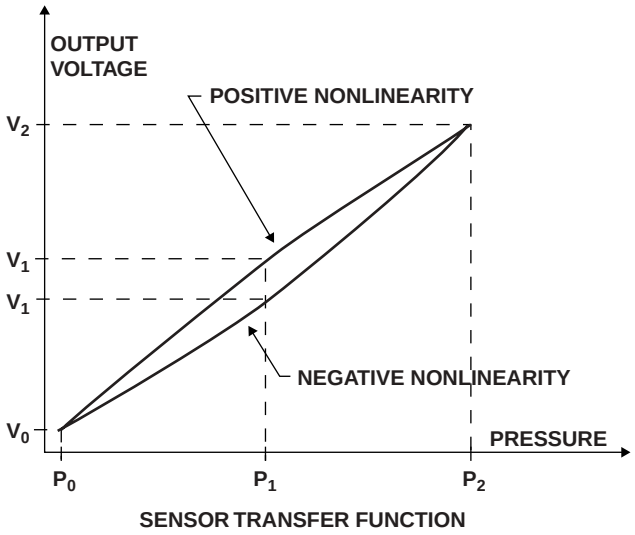

Figure 2. Sensor Transfer Function

FREQUENCY RESPONSE

Frequency response may be shaped by capacitors C2 and C3. The corner frequency for 3 dB drop of sensitivity is given by:

$$f = {}^1/_2 pC_2R_{21} \qquad [7]$$

with the assumption that $C_2 = C_3$ and $R_{21} = R_{20}$. Shaping the frequency response is commonly used to filter out unwanted high frequency noise.

VOLTAGE REGULATOR

The optional voltage regulator (LT1121) provides protection against reverse polarity connection. The device includes current limiting, thermal limiting and shutdown. It extends the operating voltage range and provides for additional voltage regulation making the output independent of the amplifiers power supply rejection ratio. The output voltage is set by resistors R_{22} and R_{23} according to the formula:

$$V_{out} = 3.75V\,(1 + R_{22}/R_{23})$$

RATIOMETRIC APPLICATIONS

For ratiometric applications, the optional voltage regulator should not be used, and reference diode VR1 should be replaced by a resistor. The value of this resistor should not deliver a higher voltage than 1.26V across it at maximum operating power supply voltage in order to avoid saturation of the amplifiers.

Typical performance when using the LT1014 amplifier, is shown in Table 1.

ADDITIONAL INFORMATION

A detailed discussion on sensor compensation techniques (calculating the temperature compensation resistors and the gain-set resistor) can be found in Application Notes TN-002 and TN-003. For other output options, including 4-20mA, please refer to Application Notes APP103 to APP105.

Table 1. Typical Performance

	WITHOUT VOLTAGE REGULATOR		WITH VOLTAGE REGULATOR		
OUTPUT SIGNAL OPTION	VOLTAGE OUTPUT	4 TO 20 mA	VOLTAGE OUTPUT	4 TO 20 mA	UNITS
Supply Voltage	9 to 30V	10 to 30V	11 to 30V	12 to 30V	V
Supply Current	2.4 at 15V	2.4 at 15V	2.7	2.7	mA
Output Voltage or Current Change Due to Supply Change `	0.05[1]	0.05[1]	0.001	0.001	% of Span / 10V
Zero Range	±20	±20	±20	±20	% of Span
Zeroing Resolution	0.01	0.01	0.01	0.01	% of Span
Sensor Span Range (1.0 mA Excitation)	33 to 115	33 to 115	33 to 115	33 to 115	mV
Span Calibration Resolution	0.05	0.05	0.05	0.05	% of Span
Output Noise	<0.01	<0.01	<0.01	<0.01	% of Span
Pressure Nonlinearity, Corrected - See Text	0.02	0.02	0.02	0.02	% of Span
Sensor Excitation	1	1	1	1	mA

Note:

1 Function of Power Supply Rejection rate for the amplifier

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Temperature Compensation IC Pressure Sensors

Note: TN-002
Date: May 1985

INTRODUCTION

Advancements in microelectronic technology have pushed silicon sensors not only toward greater sophistication and lower functional cost but also in the direction of higher performance. The major factor affecting high performance applications is temperature dependence of the pressure characteristics.
This technical note describes one method of compensation for temperature dependence. Also note that IC Sensors also offers factory compensated versions of several sensor products.

INTEGRATED SENSOR DESIGN

In one of the IC Sensors designs, a mechanical spring element in the form of a rectangular diaphragm, which converts pressure into strain, is integrated into the silicon. To fabricate the diaphragm (Figure 1a), a selective anisotropic etching technique is used which simultaneously produces a large number of diaphragms on a single silicon wafer.

In order to isolate the sensing element from package stress, a pyrex constraint plate is bonded to the diaphragm plate. If this constraint plate has an etched hole, then the diaphragm is subjected to the differential input pressure P_1-P_2. If the constraint plate has no hole, then the diaphragm is subjected to the differential pressure P_1-P_2, where P_2 is the pressure at which both plates were sealed together.

To measure the stress in the N-type silicon diaphragm, four P-type resistors (strain gages) are used. Strain gages result from a selective diffusion of boron into the silicon diaphragm (Figure 1b), a process used in the fabrication of monolithic integrated circuits. The bonding between the four strain gages and the diaphragm is done through the atomic structure of silicon. This type of bonding eliminates creep, which is the major source of instability in metallic or bonded types of strain gage sensors.

The interconnections between strain gages is accomplished with low resistivity P^+ diffused layers. This approach helps minimize thermal hysteresis effects.

The electrical insulation (passivation) of the diffused resistors and protection of the conductive diaphragm from input media is provided by a thin layer of silicon dioxide grown on both sides of the diaphragm.

IC Sensors provides several package styles for mounting the sensors and applying pressure. The HIT and TO-8 products could be mounted to printed circuit boards in applications where dry noncorrosive gases are used as media. The isolated diaphragm (ISO) products may be mounted by O-Ring, welding or standard process fitting in applications where liquids or corrosive media are used. Please see the individual data sheets for media compatibility.

A differential pressure across the diaphragm develops a strain field in such a fashion that a part of the diaphragm is in compression and part is in tension. Two of the strain gages are located in an area of compression and the other two in an area of tension. Electrically they are interconnected into a fully active Wheatstone bridge configuration to maximize the output signal (Figure 1c).

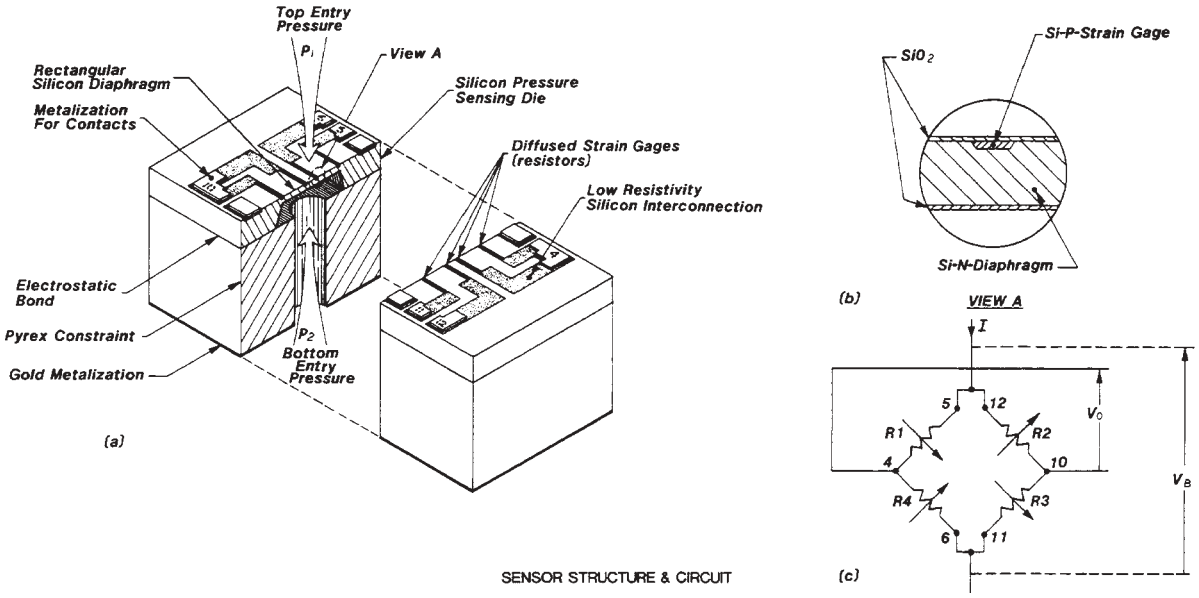


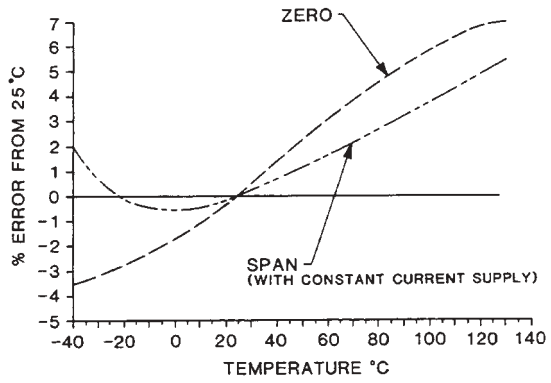
Figure 1. Sensor Structure and Circuit

TEMPERATURE CHARACTERISTICS OF A SENSOR

Change in ambient temperature results in a corresponding change in three sensor parameters: zero pressure output voltage, pressure sensitivity (span), and bridge resistance. These characteristics are shown for a typical sensor in Figures 2 and 3 where zero and span errors are expressed in percent of span at 25°C.

Zero pressure output voltage represents the bridge output voltage without any input pressure. Initial polarity of zero at reference temperature usually enforces the slope of the zero change with temperature, e.g. positive offset tends to increase when the temperature increases, but the correlation is not always a strong one.

Figure 2. Temperature Dependence of Zero and Span

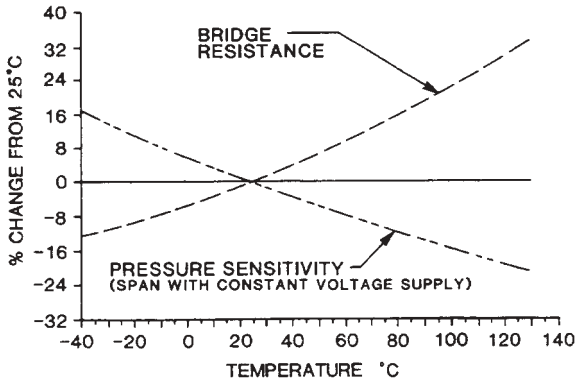


Pressure sensitivity is the normalized span in the voltage excitation mode and is expressed as mV (of span) per one volt (of bridge voltage) per one PSI (of applied pressure). It is independent of the type of supply (voltage or current) or pressure range. This sensitivity or gage factor exhibits a negative temperature slope, decreasing with increasing temperature.

The span is defined as the change of the bridge output voltage from full pressure to low pressure. Span change with temperature is a function of the excitation mode. For a given sensor the span S is a product of normalized pressure sensitivity G, bridge voltage Vb and rated pressure P:

$$S = G \cdot V_b \cdot P \qquad [1]$$

Figure 3. Temperature Dependence of Bridge Resistance



and Pressure Sensitivity

In the constant voltage excitation mode the span temperature coefficient is negative (Figure 3) and directly proportional to pressure sensitivity. It is typically –0.21%/°C for IC Sensors' 5 kΩ process.

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In the constant current (I) excitation mode the bridge voltage is proportional to the bridge resistance Rb and span can be expressed as:

$$S = G \bullet R_b \bullet I \bullet P \qquad [2]$$

Since bridge resistance changes with temperature, the span temperature error is a superposition of both the pressure sensitivity and the bridge resistance temperature coefficients (Figure 3). For IC Sensors 5k, process, the bridge resistance temperature coefficient (TCR) prior to compensation is typically +0.26%/°C. Including a negative temperature coefficient of pressure sensitivity (TCG) of –0.21%/°C, a typical constant current span temperature coefficient is about IC Sensors has optimized several products for other TCR & TCG values. These values are controlled by the ion implant dosages that are used to created strain gage resistors. Please see the individual product data sheets for more information.

For a compensated sensor, which is discussed in more detail in the zero and span sections, the effective TCR is reduced to TCG in amplitude when resistor R5 is added (Figure 8). The temperature sensitivity of bridge resistance is a key design factor in the temperature compensation of lC Sensor products.

ZERO COMPENSATION

Zero pressure output voltage (offset) compensation includes both initial (25°C) offset compensation and temperature error compensation.

Offset compensation includes resistors R_3 and R_4 (Figure 4). If the offset is positive (+O potential at pin 4 higher than -O potential at pin 10) then insertion of resistor R_4 will bring the offset to zero and resistor R_3 should be shorted. When the offset is negative the reverse is true. These resistors do not change the temperature coefficient of zero in constant current mode (Figure 10).

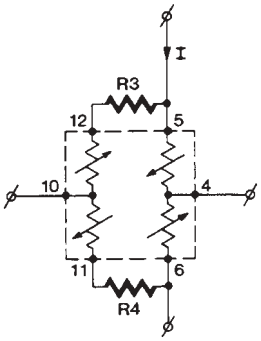

Figure 4. Offset Compensation

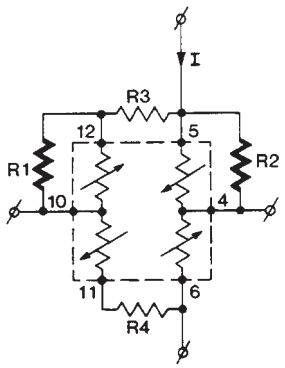

Figure 5. Offset TC

When the temperature coefficient (TC) of offset is positive (+O potential at pin 4 is increasing faster than -O potential at pin 10), a decrease of this TC may be achieved by a decrease of the effective TC of the strain gage connected between +EX pin 12 and -EX pin 10. This may be achieved by a parallel connection of a temperature stable resistor R1 (Figure 5). With a negative coefficient of offset voltage, the decrease of the TC of the other arm will be accomplished by resistor R_2. Only one of these resistors is used for a given sensor, but both of them affect the initial offset, and the value of resistor R_3 or R_4 has to compensate for this change. During standard production testing lC Sensors uses at minimum 3 test temperatures. Based on measured data the computerized sensor model is developed and a set of simultaneous equations is solved which gives the value of the compensating resistors which bring the offset to zero at reference temperature T_r (Figure 6) and equalize the errors at temperatures T_c and Th. This error is a function of the temperature nonlinearity of zero. For sensors with perfectly linear temperature coefficient of offset, the errors at T_c and T_h will also be zero.

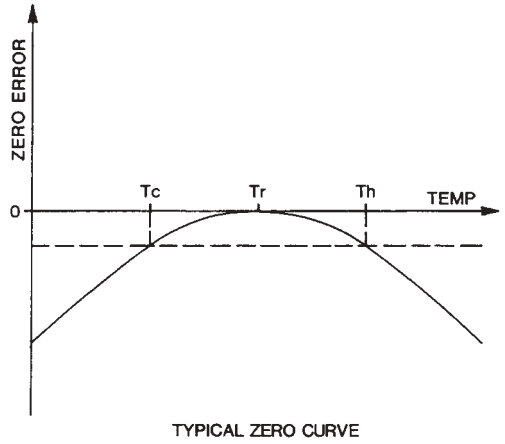

Figure 6. Typical Zero Curve

For standard TO-8 products, T_c = 0°C, T_r = 25°C, T_h =50°C. The typical value of zero pressure output error at both cold and hot temperatures is 0.1% of span. Most of it is due to thermal nonlinearity. In practical applications, inaccuracies in the resistors used for compensation contribute at least this amount of error.

It should be noted that the offset voltage of a bridge is not perfectly proportional to the excitation current. Due to self heating effects the change of excitation current may result in a change of zero pressure output voltage, typically a few hundred microvolts, for a compensated unit.

SPAN TEMPERATURE COMPENSATION

The simplest temperature compensation of span can be achieved by a combination of special wafer processing and constant current excitation. In this mode the span change is a superposition of pressure sensitivity and bridge resistance temperature coefficients. Since these coefficients have different polarities, making them equal in amplitude makes the span internally compensated. The processing required for this type of self compensation limits the cold compensated temperature range due to the nonlinearity of bridge resistance at low temperatures.

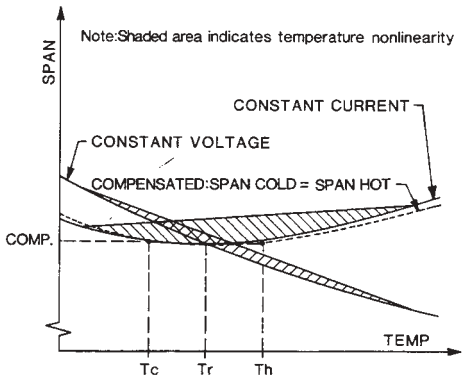

Figure 7. Span vs. Temperature

IC Sensors has developed a process which produces a higher value of bridge resistance temperature coefficient (TCR) than the absolute value of pressure sensitivity temperature coefficient (TCG). Thus in constant voltage mode the span will have a negative TC and in the constant current mode the span will have a positive TC (Figure 7). By decreasing the input resistance of the sensor bridge (Figure 8) with resistor R_5 in parallel to the bridge for constant current operation (or by increasing the input resistance of the sensor bridge with resistor R_5 in series with the bridge for constant voltage operation) the temperature compensation condition can be achieved.

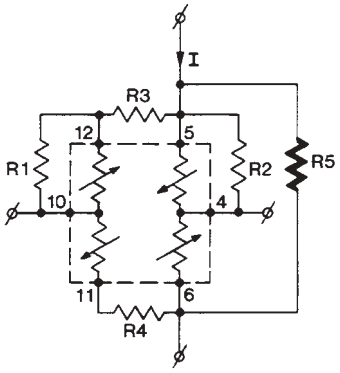

Figure 8. Span TC

The median optimum value of R_5 resistor for IC Sensors 5 kΩ process is equal to 6.6 times the bridge resistance, or 33 kΩ, at 25°C. For a given excitation level this resistor will decrease the output span. For constant current excitation the median loss of uncompensated sensor output will be only 13%. For the same condition, constant voltage excitation would yield an 87% loss of uncompensated sensor output to achieve temperature compensation. This explains why constant current excitation is recommended for this type of sensor.

Temperature nonlinearity of span in constant current mode (Figure 2) is not as good as for constant voltage (Figure 3). IC Sensors standard compensating algorithm was designed to provide equal span at temperatures T_c and T_h (0°C and 50°C for standard TO-8 products). Typical constant current mode span error at –40°C is in the range of +3% of span.

The distribution of span error characteristics from unit to unit is much better than the distribution of zero pressure output temperature errors. Implementation of digital correction, based on the deviation from a typical curve and using bridge voltage as a temperature sensor, would yield an additional major improvement.

REQUIRED PERFORMANCE OF COMPENSATING RESISTORS

The effect of both the tolerance and TCR of these resistors on sensor performance is shown in Figures 9 through 11. A 5000 ohm bridge resistance at 25°C with +0.26%/°C temperature coefficient and 15 mV/V/psi pressure sensitivity at 1.5 mA excitation current with –0.21%/°C temperature coefficient is assumed.

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The expected resistor ranges are:

R1, R2	100 k to 10 MΩ	Typical:	300 kΩ to 1.5 M
R3, R4	0 to 300 Ω	Typical:	0 to 100 Ω
R5	10 k to 300 kΩ	Typical:	15 kΩ to 100 kΩ

For the majority of ranges, 1%, 100 ppm/°C resistors such as RN55D or similar are sufficient for this application.

As an example, let's assume that the computer printout calls for:

R1 = 0.5 MΩ
R2 = Open
R3 = 90 Ω
R4 = Shorted
R5 = 20 kΩ

The effect of a 1% tolerance for resistor R_1 (0.5 MΩ) can be estimated from Figure 9. A 0.19 mV offset change would occur and a 0.06 mV/50°C offset temperature coefficient would be added. A temperature coefficient of 100 ppm/°C for this resistor would contribute an additional 0.12 mV/50°C to the offset temperature coefficient.

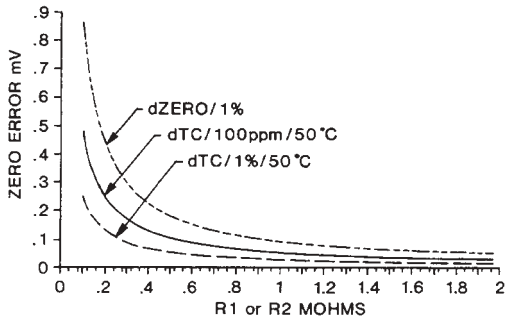

Figure 9. R1 or R2 Resistor Tolerance

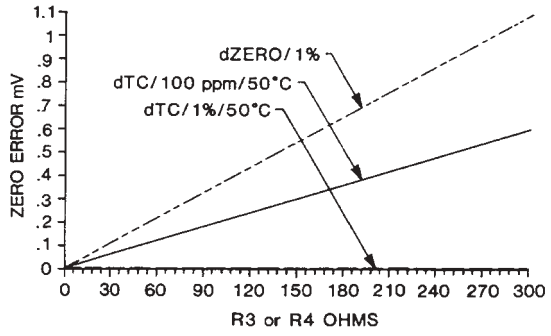

Figure 10. R_3 or R_4 Resistor Tolerance

The effect of resistor R_3 (90) can be estimated from Figure 10. The offset would change 0.33 mV for a 1% resistance deviation and 0.17 mV/50°C due to the effect of 100 ppm/°C temperature coefficient. The offset temperature coefficient is not affected by the tolerance of this resistor.

Both of these resistors (parallel: R_1 or R_2 and series: R_3 or R_4) affect the span value. Assuming that all strain gages have the same pressure sensitivity, a change of the bridge arm resistance by 1% due to the effect of inserting zero compensation resistors, in turn, changes the span by 0.25%.

Resistor R_5 (20 k) does not effect zero compensation. Span error (Figure 11) introduced by a 1% deviation from the calculated value will be equivalent to a 0.19% span change and 0.02%/50°C of additional span temperature coefficient. A temperature coefficient of 100 ppm/°C for resistor R5 would introduce an additional span error of 0.15%/50°C.

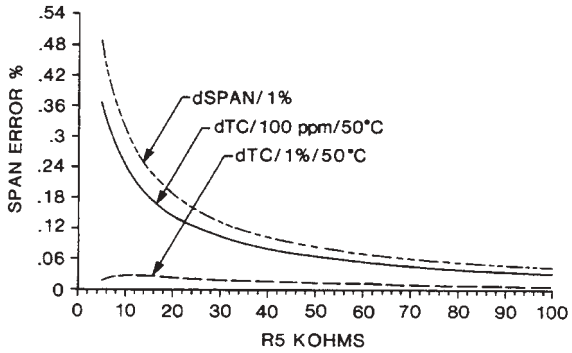

Figure 11. R_5 Resistor Tolerance

To minimize the inventory of external compensating resistor values, it is best to calculate the value of the required resistors when a known error can be tolerated. Assume that a 5 mV offset voltage due to tolerance of R1 or R2 resistor can be tolerated. If 0.5 M (R1) is the starting point, with a 0.19 mV/1% offset sensitivity, a 5 mV limit will be reached after 26 increments of 1% (26) (0.19 mV). Raising 1.01 to the 26th power gives a factor of 1.295 which translates to 648 k. At this resistance value the sensitivity of offset to change in R1 is about 0.16 mV/1%, which is equivalent to 31 increments (5 mV/0.16) of 1%. Raising 1.01 to the 31st power gives a 1.361 factor which translates to 882 k (1.361) (648 k). This value would be stocked along with the 499 k resistor for 5 mV zero increments.

This same approach can be applied to all resistors over the entire range and to all specifications including temperature error. In the example above the worst case assumption was made using the highest error for a given resistance range.

Using the average error for a given range would be more realistic (0.18 mV/1% over 500 k to 698 k range), but it leaves no room for variations of sensor performance due to processing tolerances.

APPENDIX: CALCULATION OF COMPENSATING RESISTOR VALUES

Values of compensating resistors can be calculated based on the results of pressure-temperature testing. The tests include measurements of output voltage (V) and bridge voltage (E) at two temperatures (Tc and Th) and two pressures (P_1 and P2) with constant current (I) excitation:

	$T = T_c$	$T = T_h$
$P = P_1$	V_{0c}, E_c	V_{0h}, E_h
$P = P_2$	V_{1c}	V_{1h}

Where: V_{0c}, V_{0h} — zero pressure output voltage, cold andhot respectively
V_{1c}, V_{1h} — full scale pressure output voltage, cold and hot respectively
E_c, E_h — bridge voltage, respectively cold and hot
P_1, P^2 — input pressure, respectively zero and full scale
T_c, T_h — temperature, respectively cold and hot

ZERO COMPENSATING RESISTORS

To calculate zero compensating resistors lets introduce the variables:

$$A = \frac{V_{0c} + E_c}{1} \qquad B = A - \frac{4V_{0c}(V_{0c}+E_c)}{1\,E_c + 2V_{0c}}$$

$$C = \frac{V_{0h} + E_h}{1} \qquad D = C - \frac{4V_{0h}(V_{0h}+E_h)}{1\,E_h + 2V_{0h}}$$

A simplified value of offset compensating resistor RS that includes the correction for offset change due to bridge arm loading by resistor R1 or R2 may be calculated now as follows:

$$R_S = \left(A+C - \sqrt{(A-C)^2 - 4\,\frac{AB(D-C) - CD(B-A)}{D-B}}\right) \quad [3]$$

The calculated value of resistor RS may be either positive or negative. The polarity of this value is utilized to define the position of the resistor. As was discussed before, balancing of offset can be realized by R3 or R4 resistor (Figure 4). The truth table for these resistors is as follows:

when R_S 0 then: $R_4 = R_S$, $R_3 = 0$ (shorted)
$R_S < 0$ then: $R_3 = R_S$, $R_4 = 0$ (shorted)

The offset temperature slope compensating resistor Rp may then be calculated as follows:

$$R_p = (AB - BR_S)/(B - A + R_S) \quad [4]$$

As before, there are two possible positions of R_p resistor:
when $R_p \geq 0$ then: $R_2 = R_p$, $R1 = \infty$ (Open)
$R_p < 0$ then: $R1 = R_p$, $R_2 = \infty$ (Open)

SPAN COMPENSATING RESISTOR

Temperature compensation of span requires one resistor only. Calculating both the span cold (S_c) and hot (S_h) and the bridge resistance cold (R_c) and hot (R_h):

$$S_c = V_{1c} - V_{0c} \;;\; R_c = E_c/I$$
$$S_h = V_{1h} - V_{0h} \;;\; R_h = E_h/I$$

We can now calculate the value of span compensating resistor R_5 using the following formula:

$$R_s = \frac{R_h S_c - R_c S_h}{S_h - S_c} \quad [5]$$

It should be noted that the procedure outlined here doesnot include the effects of zero compensating resistors on bridge resistance change, but this effect usually is not critical.

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Gain Programming Using an IC Pressure Sensor

Note: TN-003
Revised: August 1999

INTRODUCTION

IC Sensors offers a broad line of pressure transducers with low level output, temperature compensation, and a built-in gain programming resistor.

This laser trimmed resistor programs the gain of an external (customer provided) amplifier to normalize the pressure sensitivity variation of the sensor. This allows the output of the amplifier to be independent of the sensor used, providing interchangeability and high level output at very low cost.

This feature is available on all HIT, TO-8, and isolated diaphragm (ISO) products. Please refer to the individual product data sheets for more information.

BASIC CIRCUIT

The effective electrical model of the transducer, together with a basic signal conditioning circuit, is shown in Figure 1. The pressure sensor is a fully active Wheatstone bridge which has been temperature compensated and offset adjusted by means of thick film, laser trimmed resistors. The excitation to the bridge is a constant current which is supplied through the +EX and -EX pins. The low-level bridge output is at +O and -O, and the amplified span is set by the gain programming resistor (r).

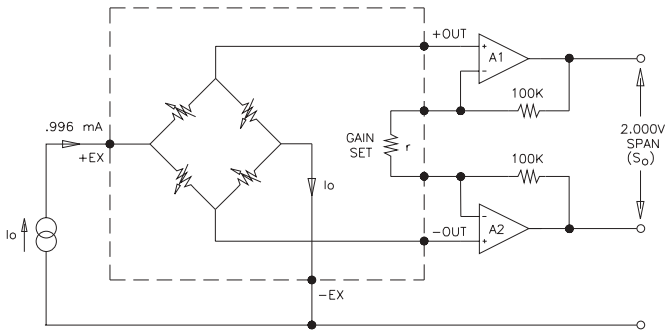

Figure 1. Basic Configuration Gain – Programming Interchangeable Sensor

Resistor r is laser trimmed for each unit using the following algorithm:

$$r = \frac{200S_i}{2\text{-}S_i} \qquad [1]$$

where: S_i - sensor span value (V) at a reference excitation current (I_O = 0.996 mA)
r - resistance in (kΩ)

The output span, So, at the differential output of amplifiers A1- A2 (see Figure 1) is then programmed as follows:

$$S_o = AS_i\left(\frac{r+2R}{r}\right) = 2A\left[\frac{R}{100} + \frac{S_i(100\text{-}R)}{200}\right] \qquad [2]$$

where: $A = I/I_O$, ratio of excitation current I to reference current I_O (Figure 1)
R - feedback resistors, in [kΩ]
S_i - sensor span at the input of the amplifier

If 100k feedback resistors are used, the expression for output span is simplified to:

$$S_O = 2A \qquad [3]$$

and is constant for all sensors independent of sensor span S_i. The output span is also independent of the pressure range of the sensor. For other values of the feedback resistors (R), the output span (S_O) will vary with the sensor span (S_i). Assuming $I = I_O$, we can calculate S_O variations.

Table 1. Output Span (SO) Variation

R	SO(Si=40 mV)	SO(Si=90 mV)	SO variation [±%]
50 K	1.0200	1.0450	1.23
75 K	1.5100	1.5225	0.41
99 K	1.9804	1.9809	0.01
100 K	2.0000	2.0000	0.00
101 K	2.0196	2.0191	0.01
200 K	3.9600	3.9100	0.63
500 K	9.8400	9.6400	1.02

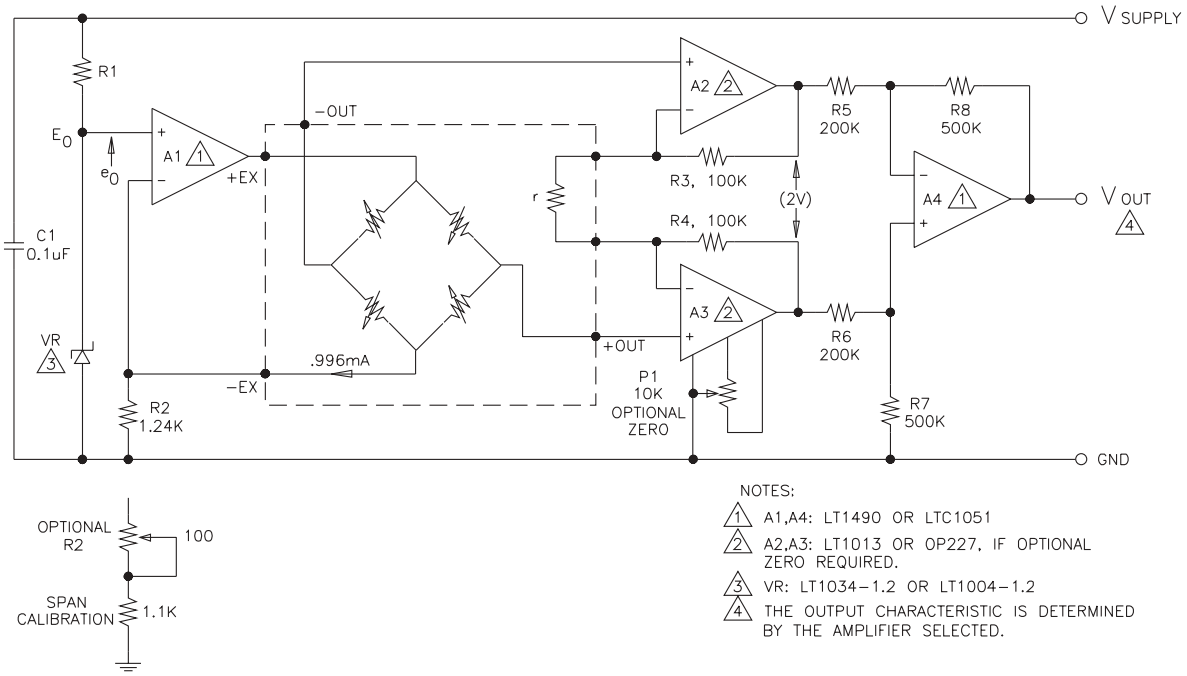

Figure 2. Simple Signal Conditioning Circuit

As shown in Table 1, a large deviation from the optimum feedback resistance of 100 k can be tolerated while still maintaining transducer interchangeability. For the optimum feedback resistance (100 k), calibration accuracy is a function of the accuracy of the excitation current, feedback resistors and sensor trimming. The inaccuracy caused by the excitation current and feedback resistors can be made negligible by the use of precision components. Therefore without pressure testing, a 1% system accuracy can be achieved. The standard gain programming resistor, r, has a TCR 50 ppm/°C and a trimming range of 2.5 to 12.5 kΩ. For volume orders, a custom trimming algorithm can be made to achieve any desired output span.

SIMPLE SIGNAL CONDITIONING CIRCUIT

The signal conditioning circuit shown in Figure 2 provides a precision constant current source for sensor excitation and an instrumentation amplifier with the gain programmed by sensor feedback resister r. To correct for pressure non-linearity or to generate output options other than 0-5V please refer to Technical Note TN-001, "Signal Conditioning for IC Pressure Sensors."

The current source is controlled by the 1% band-gap reference diode, VR. The reference current I_O is defined by:

$$I_O = (E_O - e_O)/R_2 \qquad [4]$$

where: E_O - diode reference voltage: 1.235V ±1% (LT1034-1.2 or LT1004-1.2)
e_O - offset of amplifier A_1
R_2 - feedback resistor

Selecting amplifier A1 with an offset voltage below 1 mV and a ±1% tolerance of resister R_2 delivers current I_O = 0.996 mA with a typical accuracy of 1.08%.

The first differential stage of the instrumentation amplifier A2-A3 may have a zeroing potentiometer (P). For 0P227 amplifiers, the zero range is typically 4 mV in reference to the input with a differential offset below 0.5 mV. This leaves about 3.5 mV zeroing range for the compensation of the sensor offset which typically is below 1 mV.

The second stage of the amplifier provides additional amplification R8/R5 and translates the differential floating voltage from the first stage into a single ended output voltage. Modifying equation [3] the expression for overall span (S) can be found as follows:

$$S = 2 \bullet A \bullet R_8 / R_5 = 5.000V @ A = 1 \qquad [5]$$

The overall accuracy of the span is effected by the accuracy of feedback resisters R_3 through R_8. Using 0.1% resisters such as Mepco/Electra 5063Z, a typical gain error will be about 0.24%. The accuracy error may be decreased when matched thin film resistors are used such as Beckman 694-3-A. The combined

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span error of the entire signal conditioning circuit at a reference temperature will then typically be about 1.1% without any adjustment or pressure testing. This will be superimposed on the sensor's accuracy of 1%.

If additional calibration and normalization are desired, resister R_2 can be replaced with a series combination of a potentiometer and a resistor (Figure 2). The potentiometer can be adjusted to set the bridge excitation current (I) to achieve the exact span voltage (S) with full scale pressure applied to the sensor.

If no pressure source is available, the gain error of the amplifier can be reduced by using the procedure outlined below. This method may be used instead of using the precision resisters discussed above for R_2 through R_8. The sensor span error of 1% will remain however.

Calibration procedure:

- replace resistor r with an external resistor 7.50Ωk 0.1%
- check gain K of the instrumentation amplifier and calculate the gain ratio X (in reference to the ideal gain K_O = 69.028V/V) where $X = K/K_O$
- set current I_O = 0.996/X(mA) by adjusting the potentiometer, thus completing calibration.

Assuming a 6.4 kΩ (50ºC) maximum bridge resistance, a 0.996 mA bridge current and a 1.2V diode reference voltage, it follows that the maximum output voltage of amplifier A_1 can approach 7.7V. Also, the positive saturation voltage at 1 mA output current for the LTC1051 amplifier is 0.5V. Therefore, the minimum excitation voltage, which is a function of the current source and amplifiers used, would be 8.2V (7.7V + 0.5V) for the LTC1051. For the LT1490, the minimum excitation voltage should be 7.9V.

The maximum excitation voltage is limited by the voltage handling characteristics of the specific amplifier used.

ADDITIONAL INFORMATION

For a detailed discussion of the compensation circuit, and for output voltages other than 0-5V, please refer to Application Notes TN-001 and APP-103 to APP-105.

A Simple Pressure Sensor Signal Conditioning Circuit

Note: APP-101
Revised: August 1999

Contributors:
Richard Markell - Linear Technology

INTRODUCTION

A simple signal conditioning circuit should allow the output of the amplifier to be independent of the sensor used, providing interchangeability and high level output at very low cost. A laser trimmed resistor on the sensor's compensation board programs the gain of an external amplifier to normalize the pressure sensitivity variation.

SIMPLE SIGNAL CONDITIONING CIRCUIT

The signal conditioning circuit shown in Figure 1 provides a precision constant current source for sensor excitation and an instrumentation amplifier with the gain programmed by sensor feedback resistor r.

For a detailed discussion of the compensation circuit, and for output voltages other than 0-5V, please refer to Application Notes TN-001 and APP-103 to APP-105.

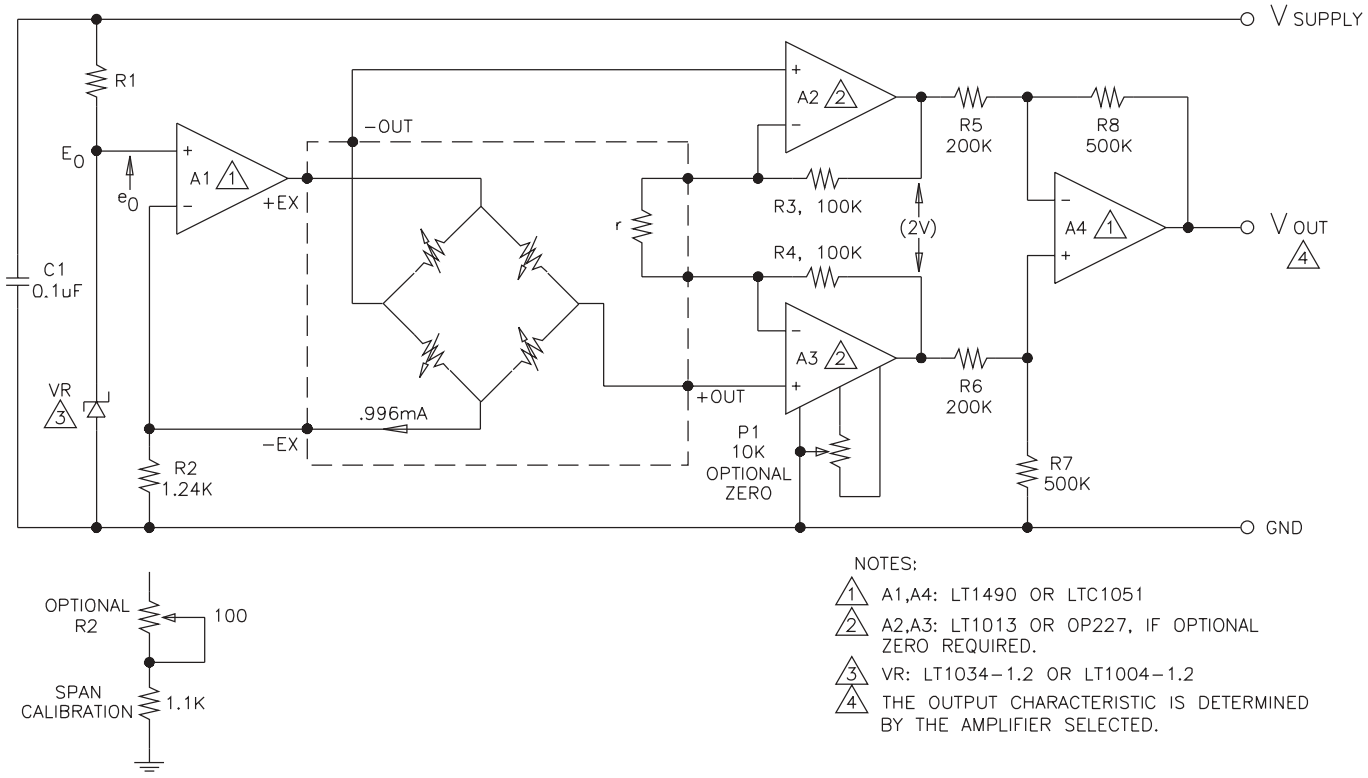

Figure 1. Basic Signal Conditioning Circuit

CIRCUIT DETAILS

The current source is controlled by the ±1% band-gap reference diode, VR. The reference current IO is defined by:

$$I_O = (E_O - e_O)/R_2 \qquad [1]$$

where: EO - diode reference voltage: 1.235V ±1% (LT1034-1.2 or LT1004-1.2)
e_O - offset of amplifier A_1 (~0)
R_2 - current set resistor

Selecting amplifier A_1 with an offset voltage below 1 mV and a ±1% tolerance of resister R_2 delivers current I_O = 0.996 mA with typical accuracy of ±1.4%.

The differential input stage of the instrumentation amplifier, A_3-A_2 has a gain of Gain=1+(R_3+R_4)/r.

The gain set resistor r is trimmed for R_3=R_4=100K and a differential output voltage of 2V.

OPTIONAL ZERO ADJUST

If the optional zero adjustment is required, use OP227 amplifiers instead of the LT1013 and add the zeroing potentiometer P1.

The zero range is typically ±4 mV referenced to the input with a differential offset below 0.5 mV. This leaves about a ±3.5 mV zeroing range for the compensation of the sensor offset which is typically below ±1 mV.

OUTPUT

The output stage of the instrumentation amplifier provides additional amplification R8/R5 and translates the differential floating voltage from the first stage into a single ended output voltage. The equation for the overall output voltage is:

$$V_{out} = 2 \cdot A \cdot R_8 / R_5 = 5.000V \text{ @ } A = 1 \qquad [3]$$

A is the Ratio between the actual excitation current I_O and the specified current.

ACCURACY AND CALIBRATION

The overall accuracy of the span is effected by the accuracy of feedback resisters R_3 through R_8. Using ±1% resistors such as Mepco/Electra 5063Z, the typical gain error will be about ±0.24%. The accuracy error may be decreased when matched thin film resisters are used such as Beckman 694-3-A. The combined span error of the entire signal conditioning circuit at a reference temperature will then typically be about 1.1% without any adjustment or pressure testing. This will be superimposed on the sensor's accuracy of ±1%.

OPTIONAL SPAN CALIBRATION

If additional calibration and normalization is desired, resister R_2 can be replaced with a series combination of a potentiometer and a resistor (Figure 1). The potentiometer can be adjusted to set the bridge excitation current (I) to achieve the exact span voltage (S) with full scale pressure applied to the sensor.

GAIN ERROR

If no pressure source is available, the gain error of the amplifier can be reduced by using the procedure outlined below. This method may be used instead of using the precision resistors discussed above for R_2 through R_8. The sensor span error of ±1% will remain, however.

Calibration procedure:

- replace resistor r with an external resistor 7.50 K ± 0.1%
- check gain K of the instrumentation amplifier and calculate the gain ratio X (in reference to the idea that gain KO = 69.028V/V), where X = K/KO
- set current IO = 0.996/X(mA) by adjusting the potentiometer, thus completing calibration.

Assuming a 6.4 kΩ (50°C) maximum bridge resistance, a 0.996 mA bridge current and a 1.2V diode reference voltage, it follows that the maximum output voltage of amplifier A1 can approach 7.4V. Also, the positive saturation voltage at 1 mA out-put current for the LTC1051 amplifier is 0.5V. Therefore, the minimum excitation voltage which is a function of the current source and amplifiers used would be 7.9V (7.4V + 0.5V) for the LTC1051. For the LT1490, the minimum excitation voltage should be 7.6V. The maximum excitation voltage is limited by the voltage handling characteristics of the specific amplifier used.

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OUTPUT SPAN S_0 VARIATION

Resistor r is laser trimmed for each unit using the following equation:

$$r = \frac{2R_F}{\frac{V_{amp}}{S_i} - 1} \quad [4]$$

where: Si = sensor span value (V) at a reference excitation current (I_O = 0.996 mA)
r = resistance in (k)
R_F = 100K feedback resistor
V_{amp} = amplified output

The output span S_O at the differential output of amplifiers A_3- A_2 (see Figure 1) for any other feedback resistor R in KΩ is given by:

$$S_O = AS\left(\frac{r+2R}{r}\right) = 2A\left[\frac{R}{100} + S_i\frac{(100-R)}{200}\right] \quad [5]$$

where: A = I/I_O, ratio of excitation current I to reference current I_O

If 100 kΩ feedback resistors are used, the expression for output span is simplified to:

$$S_c = 2A \quad [6]$$

and is constant for all sensors independent of sensor span S_i. The output span is also independent of the pressure range of the sensor. For other values of the feedback resistors (R), the output span (S_O) will vary with the sensor span (S_i). Assuming I = I_O, we can calculate S_O variations.

Table 1. Output Span (S_0) Variation

R	SO(Si=40 mV)	SO(Si=90 mV)	SO variation [±%]
50 K	1.0200	1.0450	1.23
75 K	1.5100	1.5225	0.41
99 K	1.9804	1.9809	0.01
100 K	2.0000	2.0000	0.00
101 K	2.0196	2.0191	0.01
200 K	3.9600	3.9100	0.63
500 K	9.8400	9.6400	1.0

As seen in Table 1, a large deviation from the optimum feedback resistance of 100 k is tolerable while maintaining transducer interchangeability.

For the optimum feedback resistance (100 k), calibration accuracy is a function of the accuracy of the excitation current, feedback resistors and sensor trimming. The inaccuracy caused by the excitation current and feedback resistors can be made negligible by the use of precision components. Therefore without pressure testing, a 1% system accuracy can be achieved.

The standard gain programming resistor r has a TCR ≤ ±50 ppm/°C and a trimming range of 2.5 to 12.5 k.Ω For volume orders, a custom trimming algorithm can be made to achieve any desired output span.

Microprocessor Compatible Circuit

Note: APP-103
Revised: August 1999

Contributors:
Richard Markell - Linear Technology

INTRODUCTION

A simple microprocessor compatible circuit is shown in Figure 1. Amplifiers A_1 to A_4 form a basic signal conditioning circuit similar to that described in Application Note APP-101, "A Simple Pressure Sensor Signal Conditioning Circuit."

CIRCUIT

To enable the operation of a single 5V power supply, the current through the sensor has been decreased to 0.66 mA. Furthermore, the voltage across R6 has been decreased to 0.2V (from 1.2V in APP-101), thus allowing increased voltage across the bridge which will be reflected in a higher output span.

A/D

The differential output of amplifiers A_2 and A_3 controls the differential input of analog to digital converter LTC1092.

CALIBRATION

Sensitivity calibration is achieved by adjusting the reference voltage for the A-D converter through amplifier A_4. The span between pins 2 and 3 of the converter will be two times the reference voltage at pin 5.

ADDITIONAL INFORMATION

A detailed discussion of the temperature compensation circuit can be found in Application Note TN-001, "Signal Conditioning For IC Pressure Sensors."

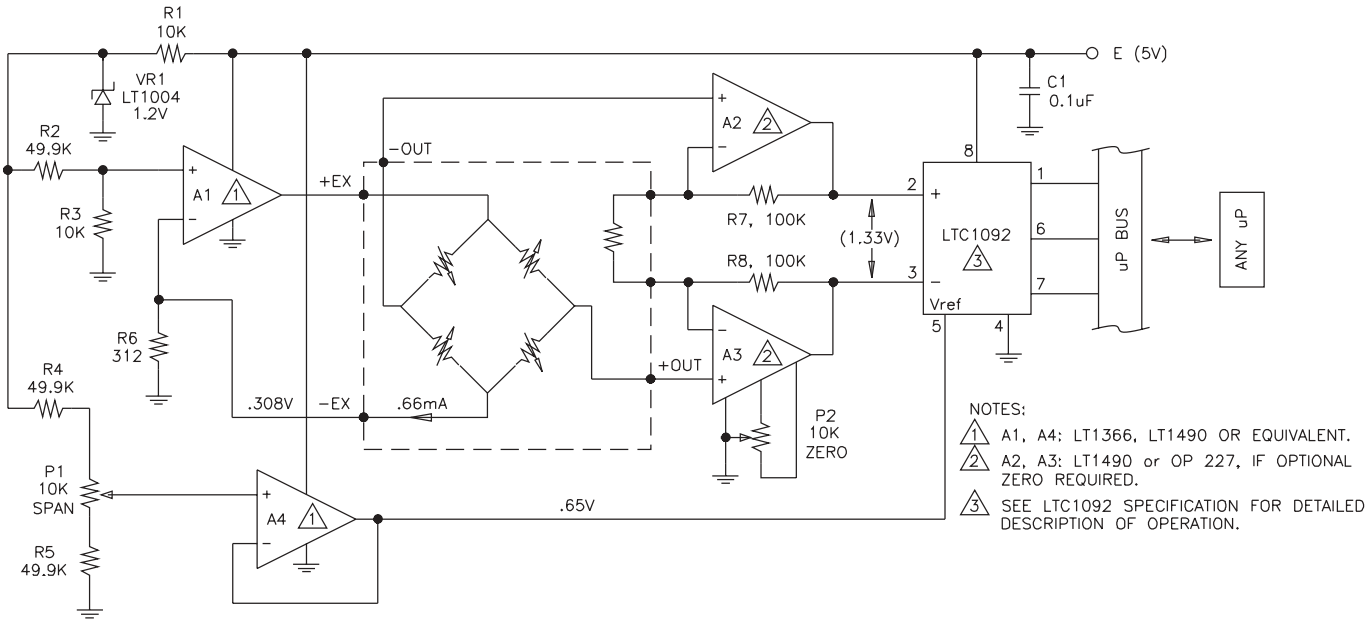

Figure 1. Microprocessor Compatible Transducer

Frequency Output Circuit

Note: APP-104
Revised: August 1999

INTRODUCTION

In Figure 1, a circuit is shown based on V-F converter AD537 from Analog Devices. This simple voltage-to-frequency converter, added to the 1-5V output compensation circuitry described in Application Note TN-001, will yield a pressure transducer with a frequency output proportional to the input pressure.

CIRCUIT DESCRIPTION

The input voltage (1 to 5V) is converted to frequency with a slope defined by resistor R2 and capacitor C1. For the values shown, the output frequency range will be 2.5 to 12.5 kHz. The output resistance is defined by resistor R_1. Capacitor C1 should be a NPO polystyrene or ceramic type to provide both low temperature coefficient and low dielectric absorption. The minimum excitation voltage limit is 4V above the maximum input voltage level.

VOLTAGE REFERENCE

The built-in reference voltage of AD537 at pin 4 can also be used as a reference voltage for the current source and zeroing circuit of the voltage output circuit in App-101 Figure 1, replacing reference diode VR, if basic provisions are made to include a lower voltage (1V instead of 1.235 V) and wider tolerance (5% instead of 1%).

CALIBRATION

Since the total calibration error introduced by the V-F converter may reach ±10%, the gain adjustment should provide for this variation. Alternatively, span calibration can also be achieved by adjusting resistor R_2 in Figure 1 (since R_2 defines the slope of the V-F curve).

ALTERNATIVE SOLUTION

For another solution, utilizing more discrete components, but yielding greater accuracy, see Application Note App-108.

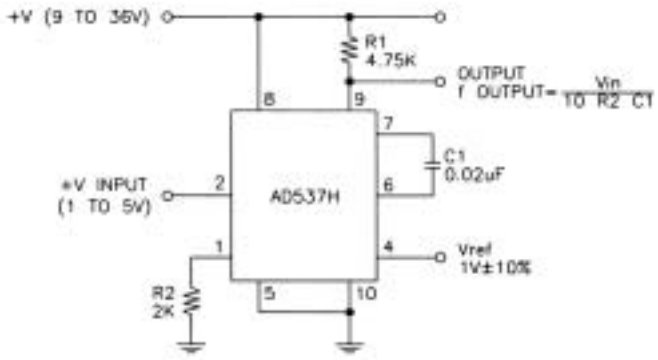

Figure 1. V-F Converter Circuit

4-20 mA Circuit

Note: APP-105
Revised: August 1999

Contributors:
Richard Markell - Linear Technology

INTRODUCTION

A signal conditioning circuit for a two-wire 4 - 20 mA transmitter is shown in Figure 1. Two-wire transmitters are used when the pressure sensor is far away from its associated display or meter, since transmitters are unaffected by voltage drops along the supply and signal lines.

CIRCUIT DESCRIPTION

The two-wire operation is achieved by referencing all signals to the emitter of transistor Q2. Feedback resistors R_{11} - R_{12} control the voltage across resistor R_{14}, drawing a constant current from the input terminals.

CALIBRATION

Zero adjustment is achieved by applying the voltage at the slider of potentiometer P_1 to the second differential input of amplifier A_4, created by resistors R_7 - R_{10}. Span calibration is realized by bridge current change using potentiometer P_2.

FREQUENCY RESPONSE

Frequency response may be shaped by capacitors C_1, C_2 with a 3dB frequency, $f=1/(2\pi R_{11}C_2)$, where $C_1=C_2$, $R_{11}=R_{12}$, and f is measured in Hz.

VOLTAGE REGULATOR

An optional voltage regulator provides reverse polarity protection (CR1), extends the maximum supply voltage limit and eliminates the dependency of the output current on the excitation voltage.

ADDITIONAL INFORMATION

A detailed discussion of the temperature compensation circuit can be found in Application Note TN-001, "Signal Conditioning For IC Pressure Sensors."

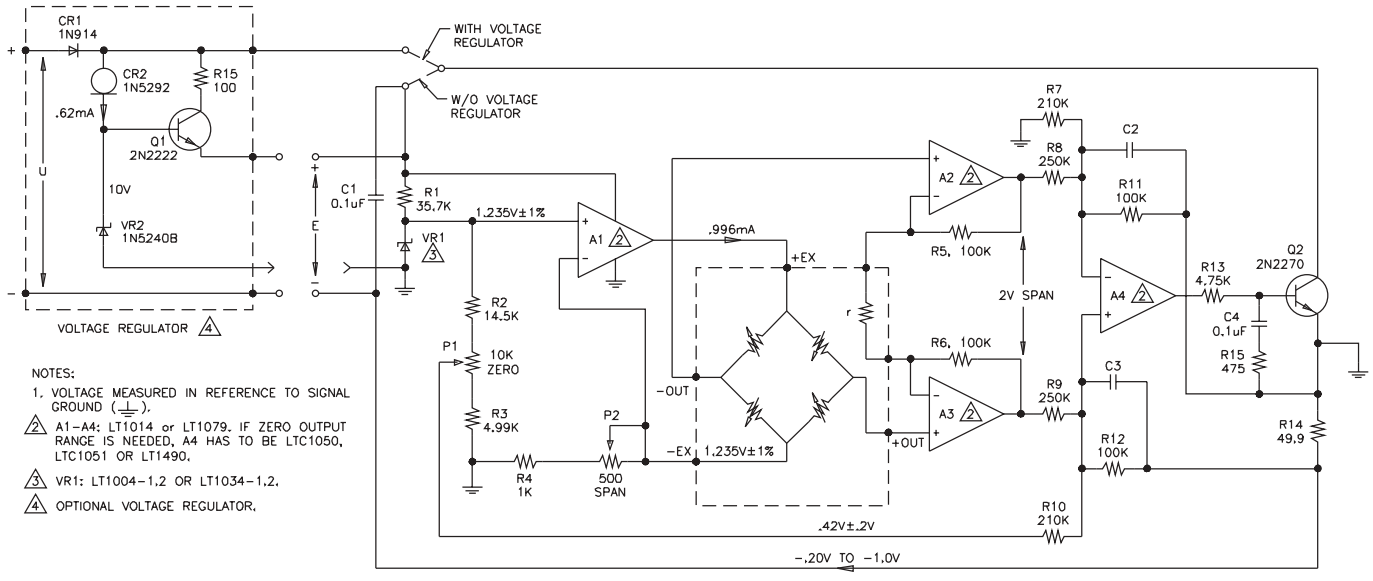

Figure 1. Transducer Circuit - Two Wire Current Transmitter

Low Component Count, Single Supply 0-5V Output, Pressure Amplifier

Note: APP-107
Revised: August 1997

Contributors:
Mitchell Lee - Linear Technology
Arie Ravid - formerly with Linear Technology

INTRODUCTION

There are many possible solutions for any given instrumentation amplifier requirement. The circuit in Figure 1 shows a solution that is low in component count, single supply, 0-5 PSI input to 0-5V output, and better than 1% accuracy over 0-50°C.

CIRCUIT DESCRIPTION

The circuit divides into the following blocks: sensor (or bridge), current source, amplifier and offset adjust.

The sensor (X1) chosen is 0-5 PSI, grade A, Model 12 by IC Sensors. It is a compensated (for low offset), current driven, bridge type sensor.

Some of the sensor specs are:

Full Scale Output Span	75 mV to 150 mV
Zero Pressure Output	1 mV Max
Input and Output Resistance	2500Ω to 6000
Temperature Coefficient-Span	+0.5% Span Max
Temperature Coefficient-Resistance	0.22%/°C Typ
Supply Current	1.5 mA to 2.0 mA Max

Typically, current driven sensors have better temperature characteristics then voltage driven sensors. The current source comprises Q_1, R_2, R_3, U_1, and VR1. R_2 biases VR1, a reference. U_1 regulates the current through R_3 by keeping the voltage across it at VR1 voltage level, namely, 2.5V. The current through R_3 is practically the collector current of Q_1 and the sensor supply current.

The amplifier comprises R_6 to R_{11}, U_{2A} and U_{2A}. The gain of the amplifier is $2(1+R_f/R_s)$ where $R_f=R_6+R_7+R_9+R_{11}$ and $R_s=R_8+R_{10}$. R_{10} is a gain adjustment trim-pot. The gain range reflects the large output range of the sensor.

There are three major offset errors in the circuit: bridge offset, amplifier offset, and amplifier common mode that transforms into offset. The common mode offset error can be the worst of the three. The common mode offset error is lowest when R_6 and R_{11} have the same resistance and when R_7 and R_9 have the same resistance. Worst case common mode is 41 mV in the output for every volt in the input (all resistors are 1%). Since the input voltage can be as high as (1.5 mA)(6000Ω)/2 = 4.5V, the common mode offset voltage can be (4.5V)(41 mV/V) = 184.5 mV in the output.

The offset is nulled by R_4 and R_5. R_5's value is calculated for worst case common mode type offset. R4 is connected across the bridge to compensate for drift caused by the temperature coefficient of the bridge and the common mode of the amplifier. If better adjustment resolution is required of R_4, it is possible to increase the value of R_5. There may be extremely small number of amplifiers that will not calibrate.

Calibration

R_{12} is added to the circuit for the purpose of calibration. While in operation it can be ignored, in calibration it may bec desired to connect a -0.2 volt source to the V- pin of U_2 for adjustment to a true 0V at 0 PSI. Calibrate at room temperature.

The calibration steps are:

1. Connect V_{IN} and V_{NEG}. V_{NEG} can be a 200 mA current sink or -0.2V voltage source.
2. At 0 PSI (atmospheric pressure) adjust R_4 for 0.0V at V_o.
3. Apply 5 PSI pressure source and adjust V_o for 5.0V at V_o.
4. Repeat steps 2 and 3 until output reached the desired level of accuracy.

Testing

1. Calibrate per the previous paragraph.
2. At 0°C (after 20 min soak), read output at 0 PSI and 5 PSI input.
3. At 50°C (after 20 min soak), read output at 0 PSI and 5 PSI input.

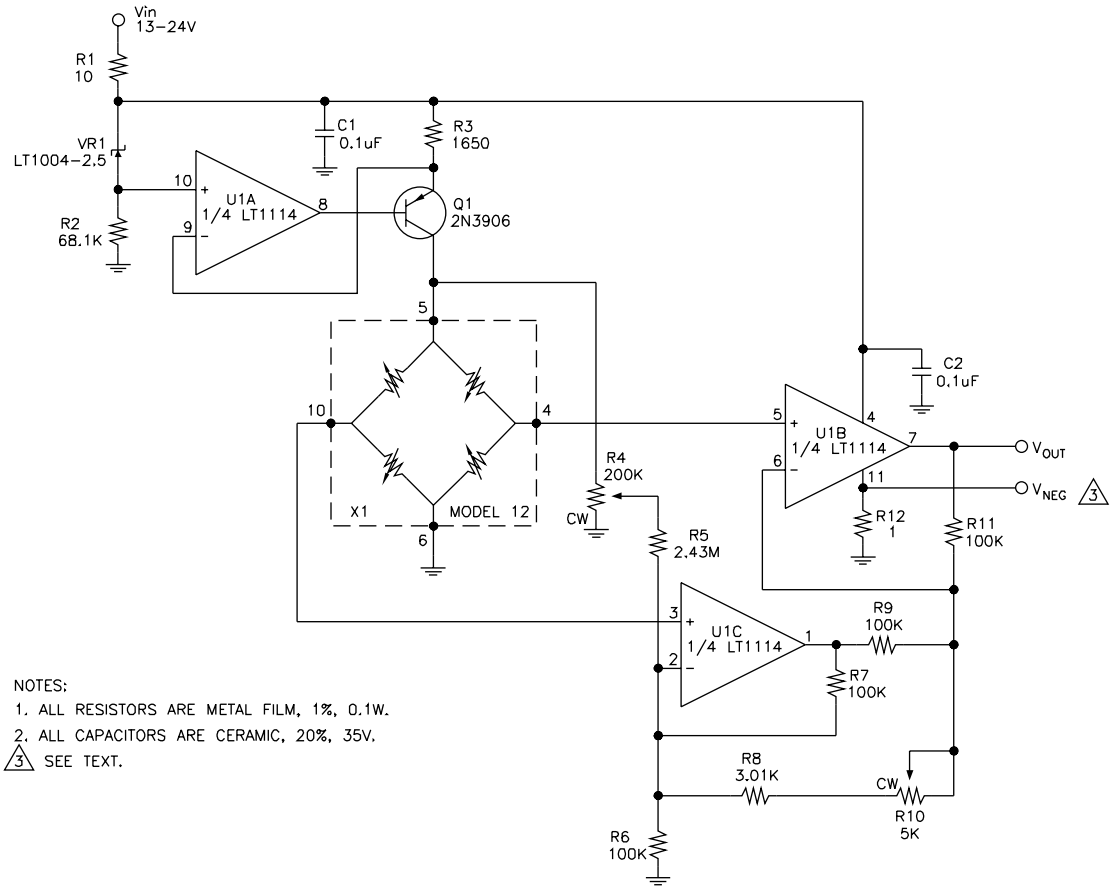

Figure 1. Low Component Count Solution

Water Tank Pressure Sensing, a Fluid Solution

(Water Column Height to Frequency Output)

Contributors:
Richard Markell - Linear Technology

Note: APP-108
Date: August 1997

INTRODUCTION

Liquid sensors require a media compatible, solid state pressure sensor. The pressure range of the sensor is dependent on the height of the column or tank of fluid that must be sensed. This article describes the usage of the Model 90 stainless steel diaphragm, 0 to 15 psig sensor used to sense water height in a tank or column.

Because large chemical or water tanks are typically located outside in "tank farms," it is insufficient to provide only an analog interface to a digitization system for level sensing. This is because the very long wires required to interconnect the system cause IR drops, noise and other corruption of the analog signal. The solution to this problem is to implement a system that converts the analog to digital signals at the sensor. In this application, we implement a "liquid height to frequency converter."

CIRCUIT DESCRIPTION

Voltage Regulator

Figure 1 shows the analog front-end of the system, which includes the LT1121 linear regulator for powering the system. The LT1121 is a micropower low dropout linear regulator with shutdown. For micropower applications of this or other circuits, the ability to shutdown the entire system via a single power supply pin allows the system to operate only when taking data (perhaps every hour), conserving power. In Figure 1, U3 the LT1121, converts 12 volts to 9 volts to power the system. The 12 volts may be obtained from a wall cube or batteries.

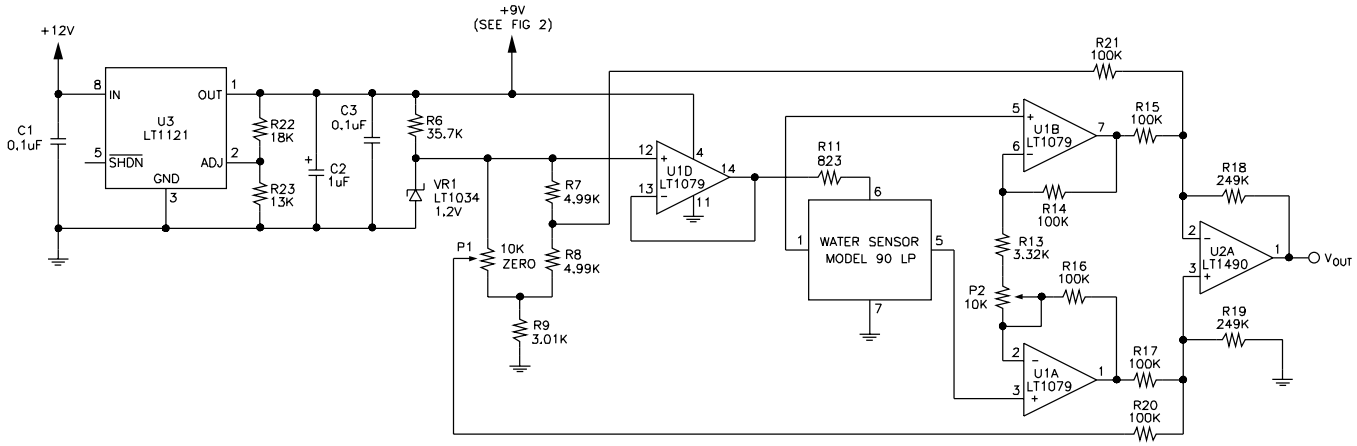

Figure 1. Analog Front-end

Current Source

The LT1034, VR1, a 1.2 volt reference, is used with U1D, 1/4 of a LT1079 quad low power op amp, to provide a 1.5 mA current source to the pressure sensor. The reference voltage is also divided down by R_7, R_8, R_9 and the 10k potentiometer P_1, and used to offset the output amplifier U_{2A}, so that the signals are not swinging around the supply rails.

Analog Amplification and Output Stages

Op amps U_{1A} and U_{1B} (both 1/4 LT1079) amplify the bridge pressure sensor's output and provide a differential signal to U_{2A} (an LT1490). Note that U_{2A} must be a rail-to-rail op amp. The system's analog output is taken from U_{2A}'s output.

Figure 3 plots the output voltage for the sensor system's analog front end versus the height of the water column that impinges on the pressure transducer. Note that the pressure change is independent of the diameter of the water column, so that a tank of liquid would produce the same resulting output voltage.

Voltage to Frequency Conversion

The remainder of the circuitry, shown in Figure 2, allow transmission of analog data over long distances.

The circuit was designed by Jim Williams of Linear Technology Corporation. The circuit takes a DC input from 0 to 5 volts and converts it to a frequency. For the pressure circuit in Figure 1, this translates to approximately 0 to 5000 Hz.

Performance

The voltage-to-frequency converter shown in Figure 2 has very low power consumption (26 microamps), 0.02% linearity, 60 ppm/°C drift and 40 ppm/V power supply rejection.

Voltage to Frequency Operation

In operation, U_3 switches a charge pump, comprising Q_5, Q_6 and the 100pF capacitor, to maintain its negative input at 0V. The LT1004s and associated components form a temperaturecompensated reference for the charge pump. The 100pF capacitor charges to a fixed voltage; hence, the repetition rate is the circuit's only degree of freedom to maintain feedback. The Comparator, U3A, pumps uniform packets of charge to its negative input at a repetition rate precisely proportional to the input-voltage-derived current. This action ensures that circuit output frequency is strictly and solely determined by the input voltage.

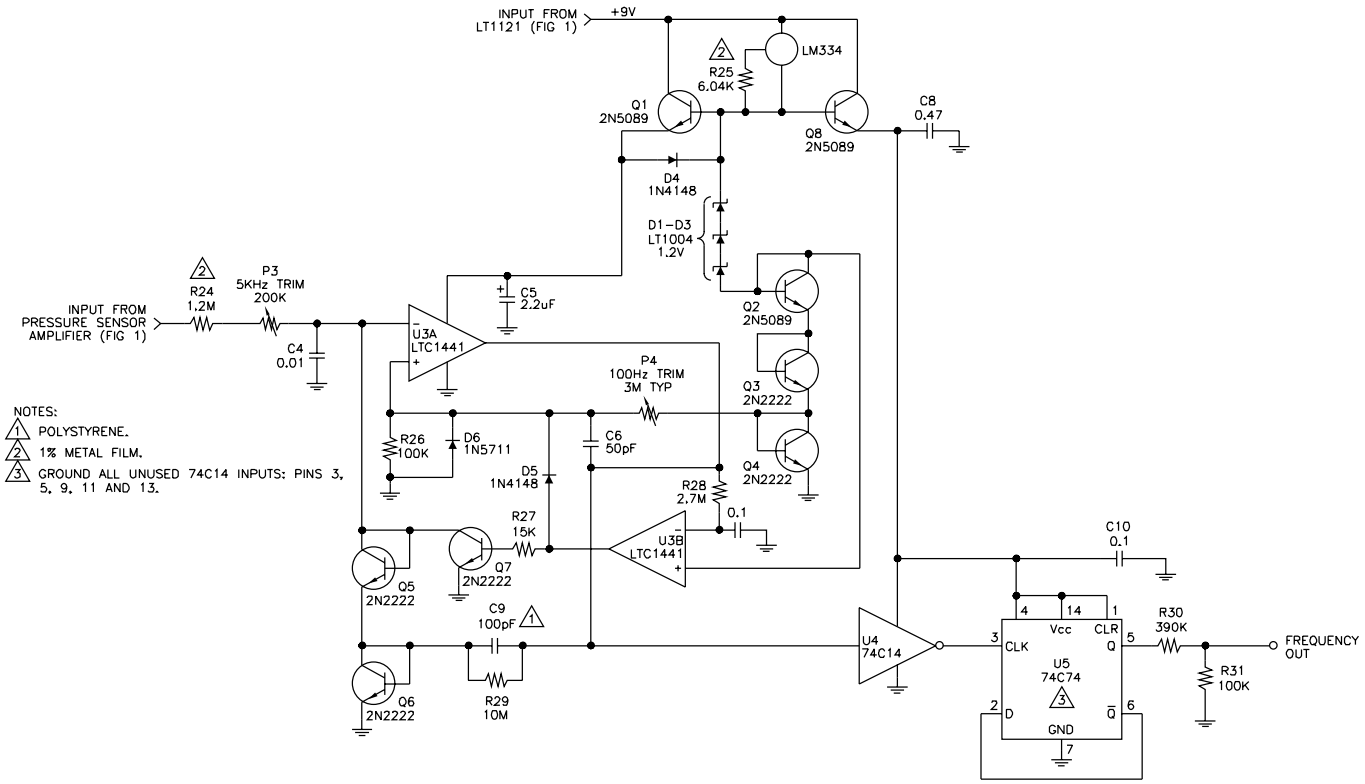

Figure 2. 0.02% V/F converter requires only 26µA supply current.

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Figure 4 shows the output frequency versus column height for two different Model 90 transducers. Note the straight lines, which are representative of excellent linearity.

Low Power Operation

For battery powered operation, the shutdown mode of the LT1121 allows the entire system to be placed into "sleep mode" for, perhaps, 99% of the time and powered up 1% of the time. This method of operation improves battery lifetime tremendously.

CONCLUSION

A cost effective system is shown here consisting of a Model 90 fluid pressure sensor. This sensor's output is fed to signal processing electronics that converts the low level DC output of the bridge-based pressure sensor to a frequency in the audio range, depending on the height of the fluid column impinging on the pressure transducer.

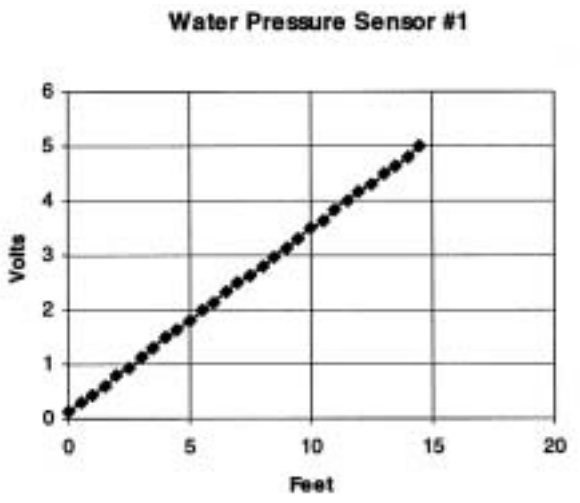

Figure 3. Output Voltage vs. Height of Water Column

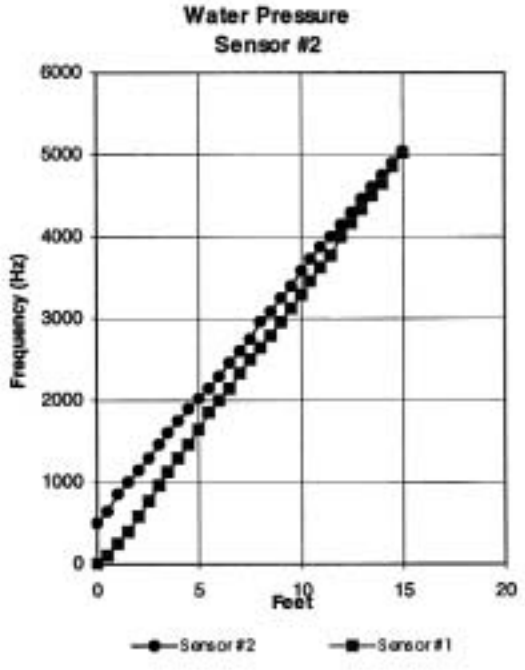

Figure 4. Output Frequency vs. Height of Water Column

The integrator bias circuit is used in the non-servoed, DC coupled mode, to compensate for offsets introduced into the circuit. Accelerometers with built-in temperature compensation are best, or use the temperature compensation network and resistor values R1-R4 supplied by IC Sensors with each accelerometer. The 74HC4066 CMOS switch and the 3-input OR gate give the user the flexibility to reset the integrator when needed. For example, when used in a control loop, it is often required to reset integrators to prevent integrator wind-up, during initialization, or when the control error exceeds certain limits. One-half of the LT1366 Op Amp is used as a power supply splitter to create an artificial ground center reference point for the single-supply Op Amp circuits. The finial LT1366 Op Amp is used as a user adjustable ±1 gain output buffer Amp, which can be set to fixed gains of ±1 using a switch or continuously adjusted between ±1 using the potentiometer as shown in the circuit. This buffer amp also drives capacitive loads presented by cables such as coaxial or shielded cables.

Using Accelerometers to Realize Rate Information

Contributors:
Jim Mahoney - Linear Technology

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Take an accelerometer and integrate its output and you have velocity or rate information. Doing this with real world accelerometers and electronic circuits requires a great deal of care to be successful.

The circuit being presented here uses a micro machined silicon accelerometer such as the ICS3022, and rail-to-rail input-output, single-supply Op Amps (LT1366).

In the circuit presented, the accelerometer's output is fed into a gain of 10 differential amp which can be servoed, (effectively AC coupled), or used as a DC response Amp. The output of the differential amp is RC filtered and fed into an integrator to transform acceleration information into rate information. As an option, the integrator can be AC servoed for AC response. A good starting point for the time constants for both the differential amp and the integrator when used in the AC servoed mode is 100 times the lowest information frequency of interest expected from the accelerometer.

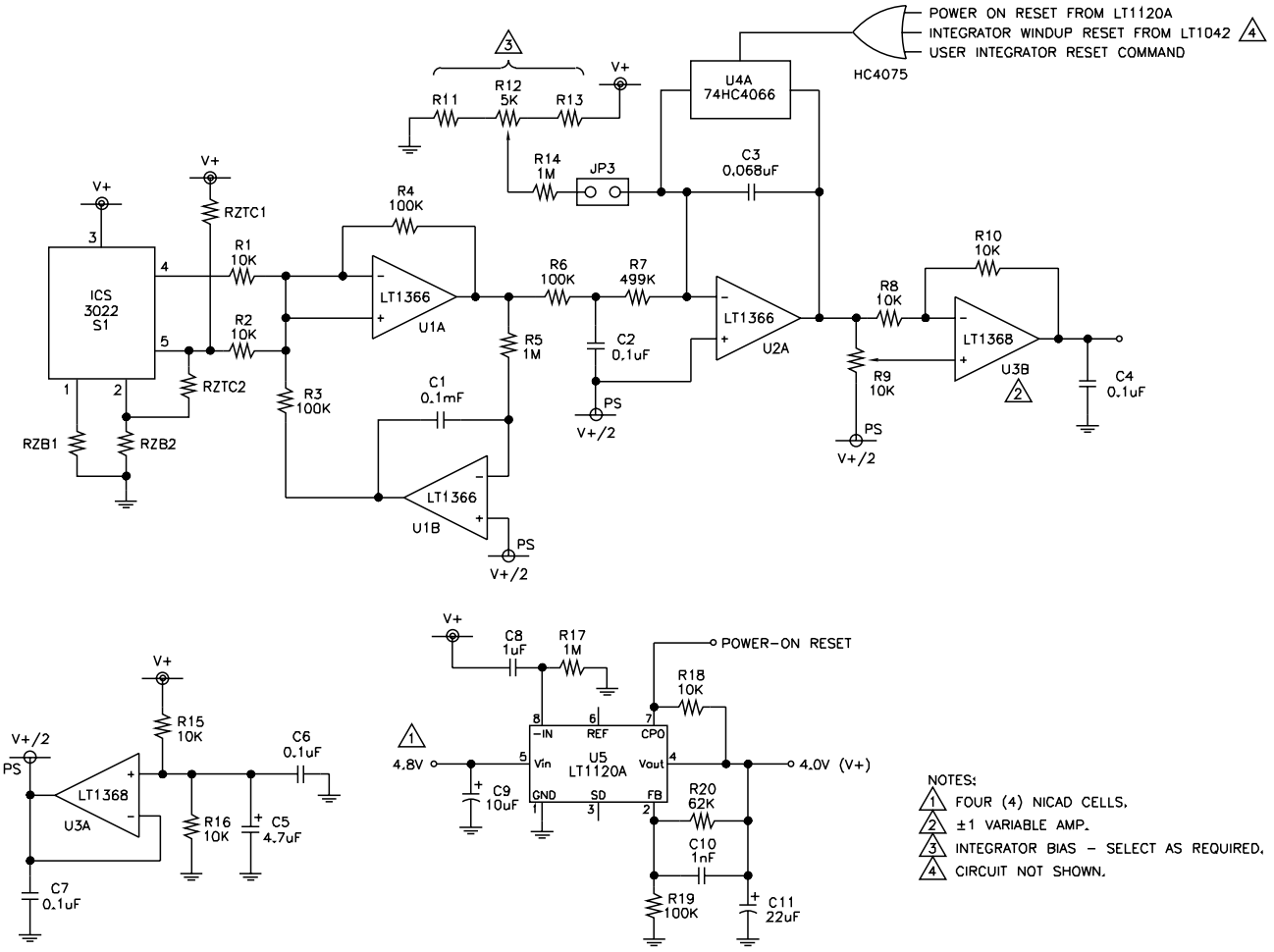

Figure 1.