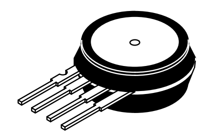
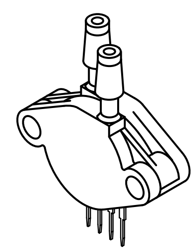
MPX12 SERIES

10 kPa Uncompensated Silicon Pressure Sensors

**0 to 10 kPa (0 – 1.45 psi)
35 mV FULL SCALE SPAN
(TYPICAL)**



**BASIC CHIP
CARRIER ELEMENT
CASE 344–15, STYLE 1**



**DIFFERENTIAL
PORT OPTION
CASE 344C–01, STYLE 1**

NOTE: Pin 1 is the notched pin.

PIN NUMBER			
1	Gnd	3	V_S
2	$+V_{out}$	4	$-V_{out}$

The MPX12 series device is a silicon piezoresistive pressure sensor providing a very accurate and linear voltage output — directly proportional to the applied pressure. This standard, low cost, uncompensated sensor permits manufacturers to design and add their own external temperature compensating and signal conditioning networks. Compensation techniques are simplified because of the predictability of Motorola's single element strain gauge design.

Features

- Low Cost
- Patented Silicon Shear Stress Strain Gauge Design
- Ratiometric to Supply Voltage
- Easy to Use Chip Carrier Package Options
- Differential and Gauge Options

Application Examples

- Air Movement Control
- Environmental Control Systems
- Level Indicators
- Leak Detection
- Medical Instrumentation
- Industrial Controls
- Pneumatic Control Systems
- Robotics

Figure 1 shows a schematic of the internal circuitry on the stand–alone pressure sensor chip.

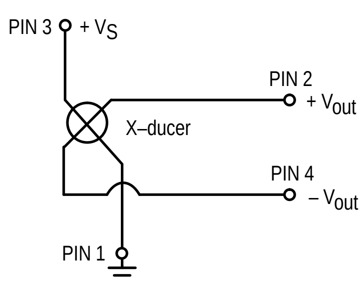


Figure 1. Uncompensated Pressure Sensor Schematic

VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE

The differential voltage output of the X–ducer is directly proportional to the differential pressure applied.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure side (P1) relative to the vacuum side (P2). Similarly, output voltage increases as increasing vacuum is applied to the vacuum side (P2) relative to the pressure side (P1).

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Overpressure(8) (P1 > P2)	P_{max}	75	kPa
Burst Pressure(8) (P1 > P2)	P_{burst}	100	kPa
Storage Temperature	T_{stg}	–40 to +125	°C
Operating Temperature	T_A	–40 to +125	°C

OPERATING CHARACTERISTICS (V_S = 3.0 Vdc, T_A = 25°C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Unit
Differential Pressure Range(1)	P_{OP}	0	—	10	kPa
Supply Voltage(2)	V_S	—	3.0	6.0	Vdc
Supply Current	I_o	—	6.0	—	mAdc
Full Scale Span(3)	V_{FSS}	45	55	70	mV
Offset(4)	V_{off}	0	20	35	mV
Sensitivity	ΔV/ΔP	—	5.5	—	mV/kPa
Linearity(5)	—	–0.5	—	5.0	$\%V_{FSS}$
Pressure Hysteresis(5) (0 to 10 kPa)	—	—	± 0.1	—	$\%V_{FSS}$
Temperature Hysteresis(5) (–40°C to +125°C)	—	—	± 0.5	—	$\%V_{FSS}$
Temperature Coefficient of Full Scale Span(5)	TCV_{FSS}	–0.22	—	–0.16	$\%V_{FSS}$/°C
Temperature Coefficient of Offset(5)	TCV_{off}	—	±15	—	μV/°C
Temperature Coefficient of Resistance(5)	TCR	0.21	—	0.27	$\%Z_{in}$/°C
Input Impedance	Z_{in}	400	—	550	Ω
Output Impedance	Z_{out}	750	—	1250	Ω
Response Time(6) (10% to 90%)	t_R	—	1.0	—	ms
Warm–Up	—	—	20	—	ms
Offset Stability(9)	—	—	±0.5	—	$\%V_{FSS}$

MECHANICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Weight (Basic Element, Case 344–15)	—	—	2.0	—	Grams
Common Mode Line Pressure(7)	—	—	—	690	kPa

NOTES:

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self–heating.
3. Full Scale Span (V_{FSS}) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
4. Offset (V_{off}) is defined as the output voltage at the minimum rated pressure.
5. Accuracy (error budget) consists of the following:
   - Linearity: Output deviation from a straight line relationship with pressure, using end point method, over the specified pressure range.
   - Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
   - Pressure Hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure, at 25°C.
   - TcSpan: Output deviation at full rated pressure over the temperature range of 0 to 85°C, relative to 25°C.
   - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to 85°C, relative to 25°C.
   - TCR: Z_{in} deviation with minimum rated pressure applied, over the temperature range of –40°C to +125°C, relative to 25°C.
6. Response Time is defined as the time for the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
7. Common mode pressures beyond specified may result in leakage at the case–to–lead interface.
8. Exposure beyond these limits may cause permanent damage or degradation to the device.
9. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

TEMPERATURE COMPENSATION

Figure 2 shows the typical output characteristics of the MPX12 series over temperature.

The X–ducer piezoresistive pressure sensor element is a semiconductor device which gives an electrical output signal proportional to the pressure applied to the device. This device uses a unique transverse voltage diffused semiconductor strain gauge which is sensitive to stresses produced in a thin silicon diaphragm by the applied pressure.

Because this strain gauge is an integral part of the silicon diaphragm, there are no temperature effects due to differences in the thermal expansion of the strain gauge and the diaphragm, as are often encountered in bonded strain gauge pressure sensors. However, the properties of the strain gauge itself are temperature dependent, requiring that the device be temperature compensated if it is to be used over an extensive temperature range.

Temperature compensation and offset calibration can be achieved rather simply with additional resistive components, or by designing your system using the MPX2010D series sensor.

Several approaches to external temperature compensation over both −40 to +125°C and 0 to +80°C ranges are presented in Motorola Applications Note AN840.

LINEARITY

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off}$ + sensitivity x P over the operating pressure range (Figure 3). There are two basic methods for calculating nonlinearity: (1) end point straight line fit or (2) a least squares best line fit. While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

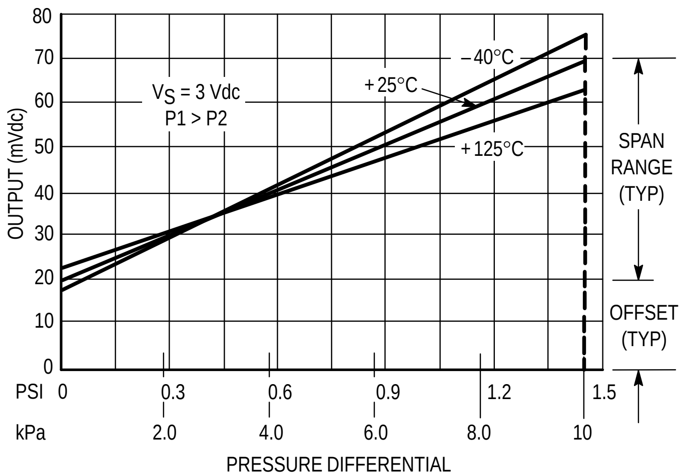


Figure 2. Output versus Pressure Differential

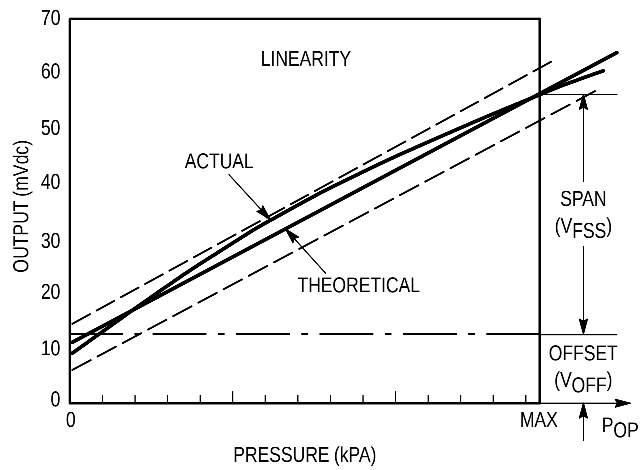


Figure 3. Linearity Specification Comparison

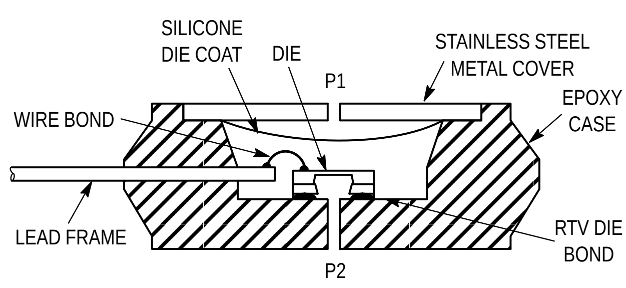


Figure 4. Cross–Sectional Diagram (not to scale)

Figure 4 illustrates the differential or gauge configuration in the basic chip carrier (Case 344–15). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX12 series pressure sensor operating characteristics and internal reliability and qualification tests are based on use of dry air as the pressure media. Media other than dry air may have adverse effects on sensor performance and long term reliability. Contact the factory for information regarding media compatibility in your application.

PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Motorola designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing silicone gel which isolates the die from the environment. The Motorola MPX pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using the table below:

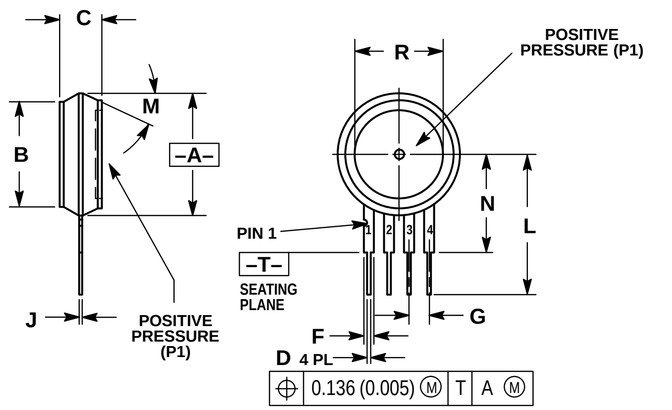
Part Number	Case Type	Pressure (P1) Side Identifier
MPX12D	344–15	Stainless Steel Cap
MPX12DP	344C–01	Side with Part Marking
MPX12GP	344B–01	Side with Port Attached
MPX12GS	344E–01	Side with Port Attached
MPX12GSX	344F–01	Side with Port Attached

ORDERING INFORMATION

MPX12 series pressure sensors are available in differential and gauge configurations. Devices are available in the basic element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

			MPX Series	
Device Type	Options	Case Type	Order Number	Device Marking
Basic Element	Differential	Case 344–15	MPX12D	MPX12D
Ported Elements	Differential	Case 344C–01	MPX12DP	MPX12DP
	Gauge	Case 344B–01	MPX12GP	MPX12GP
	Gauge Stove Pipe	Case 344E–01	MPX12GS	MPX12D
	Gauge Axial	Case 344F–01	MPX12GSX	MPX12D

PACKAGE DIMENSIONS



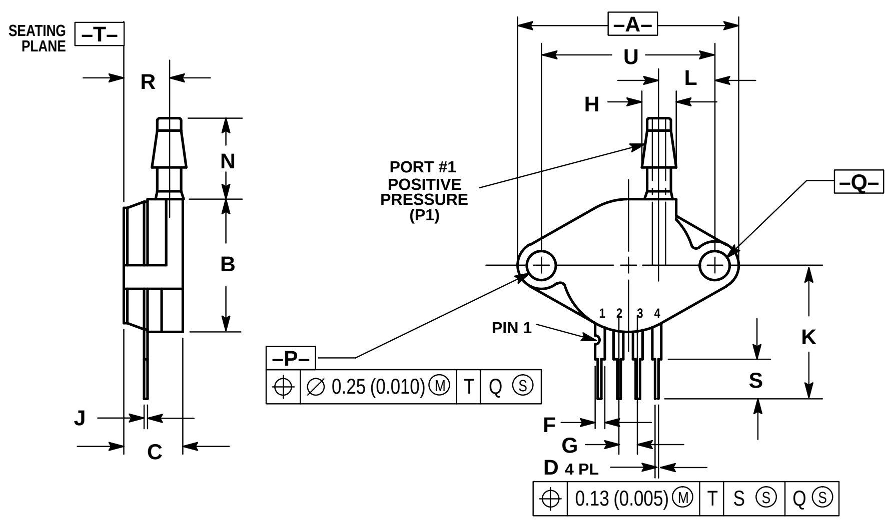
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION –A– IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.595	0.630	15.11	16.00
B	0.514	0.534	13.06	13.56
C	0.200	0.220	5.08	5.59
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.40
L	0.695	0.725	17.65	18.42
M	30° NOM		30° NOM	
N	0.475	0.495	12.07	12.57
R	0.430	0.450	10.92	11.43

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 344–15
ISSUE W



NOTES:

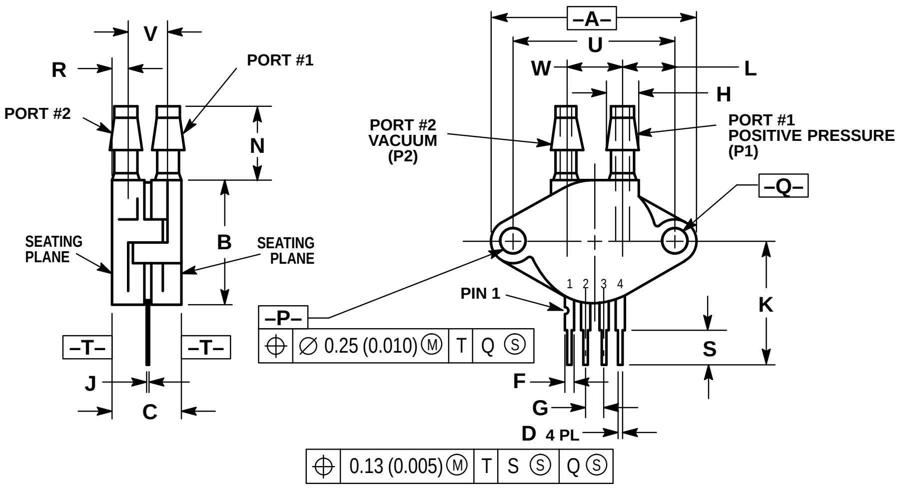
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.145	1.175	29.08	29.85
B	0.685	0.715	17.40	18.16
C	0.305	0.325	7.75	8.26
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.93
J	0.014	0.016	0.36	0.41
K	0.695	0.725	17.65	18.42
L	0.290	0.300	7.37	7.62
N	0.420	0.440	10.67	11.18
P	0.153	0.159	3.89	4.04
Q	0.153	0.159	3.89	4.04
R	0.230	0.250	5.84	6.35
S	0.220	0.240	5.59	6.10
U	0.910 BSC		23.11 BSC	

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 344B–01
ISSUE B

PACKAGE DIMENSIONS — CONTINUED

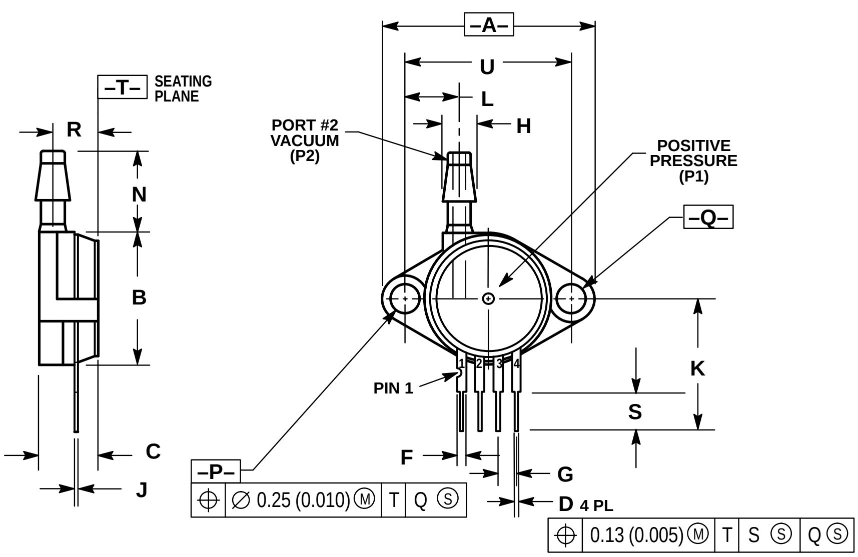


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.145	1.175	29.08	29.85
B	0.685	0.715	17.40	18.16
C	0.405	0.435	10.29	11.05
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.93
J	0.014	0.016	0.36	0.41
K	0.695	0.725	17.65	18.42
L	0.290	0.300	7.37	7.62
N	0.420	0.440	10.67	11.18
P	0.153	0.159	3.89	4.04
Q	0.153	0.159	3.89	4.04
R	0.063	0.083	1.60	2.11
S	0.220	0.240	5.59	6.10
U	0.910 BSC		23.11 BSC	
V	0.248	0.278	6.30	7.06
W	0.310	0.330	7.87	8.38

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 344C–01
ISSUE B



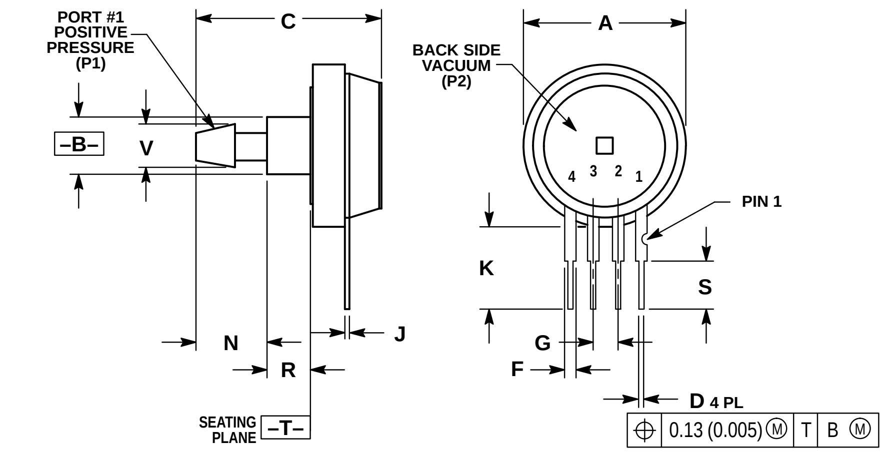
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.145	1.175	29.08	29.85
B	0.685	0.715	17.40	18.16
C	0.305	0.325	7.75	8.26
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
H	0.182	0.194	4.62	4.93
J	0.014	0.016	0.36	0.41
K	0.695	0.725	17.65	18.42
L	0.290	0.300	7.37	7.62
N	0.420	0.440	10.67	11.18
P	0.153	0.159	3.89	4.04
Q	0.153	0.158	3.89	4.04
R	0.230	0.250	5.84	6.35
S	0.220	0.240	5.59	6.10
U	0.910 BSC		23.11 BSC	

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 344D–01
ISSUE B

PACKAGE DIMENSIONS — CONTINUED

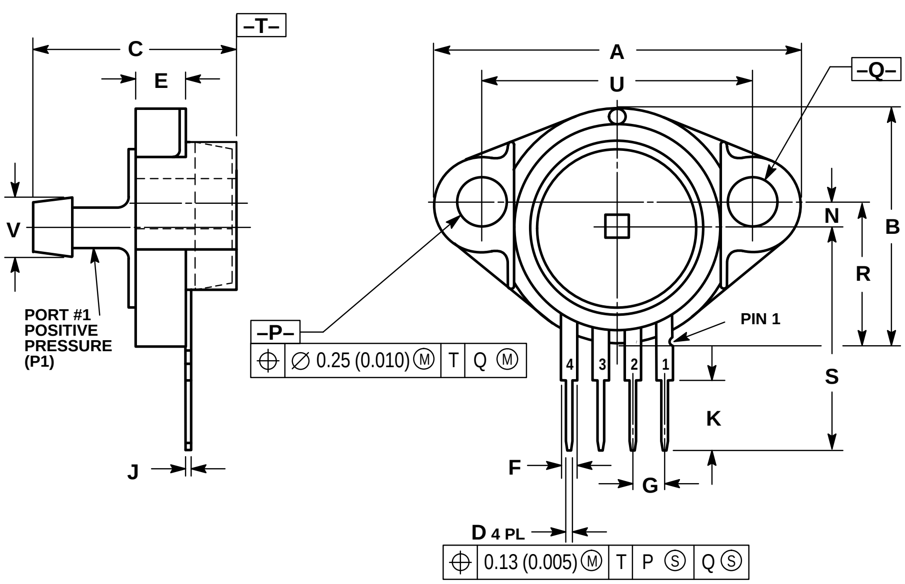


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.690	0.720	17.53	18.28
B	0.245	0.255	6.22	6.48
C	0.780	0.820	19.81	20.82
D	0.016	0.020	0.41	0.51
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.345	0.375	8.76	9.53
N	0.300	0.310	7.62	7.87
R	0.178	0.186	4.52	4.72
S	0.220	0.240	5.59	6.10
V	0.182	0.194	4.62	4.93

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

CASE 344E–01
ISSUE B



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	1.080	1.120	27.43	28.45
B	0.740	0.760	18.80	19.30
C	0.630	0.650	16.00	16.51
D	0.016	0.020	0.41	0.51
E	0.160	0.180	4.06	4.57
F	0.048	0.064	1.22	1.63
G	0.100 BSC		2.54 BSC	
J	0.014	0.016	0.36	0.41
K	0.220	0.240	5.59	6.10
N	0.070	0.080	1.78	2.03
P	0.150	0.160	3.81	4.06
Q	0.150	0.160	3.81	4.06
R	0.440	0.460	11.18	11.68
S	0.695	0.725	17.65	18.42
U	0.840	0.860	21.34	21.84
V	0.182	0.194	4.62	4.92

STYLE 1:
PIN 1. GROUND
2. V (+) OUT
3. V SUPPLY
4. V (–) OUT

CASE 344F–01
ISSUE B

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ASIA / PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park, 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298