# **Freescale Semiconductor**

MPX12 Rev 11, 07/2009

# 10 kPa Uncompensated Silicon Pressure Sensors

The MPX12 series silicon piezoresistive pressure sensors provide 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 Freescale'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
- Gauge Options
- Durable Epoxy Package

# MPX12 Series

0 to 10 kPa (0 to 1.45 psi) 55 mV Full Scale Span (Typical)

# **Application Examples**

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

	ORDERING INFORMATION								
Device Name	Package		Case # of Ports				Device		
Device Name	Options	No.	None	Single	Dual	Gauge	Differential	Absolute	Marking
Unibody Package	e (MPX12 Serie	es)							
MPX12D	Tray	344	•				•		MPX12D
MPX12DP	Tray	344C			•		•		MPX12DP
MPX12GP	Tray	344B		•		•			MPX12GP
Small Outline Pa	ckage (MPXV1	2 Series)							
MPXV12DP	Tray	1351			•		•		MPXV12DP
MPXV12GP	Tray	1369		•		•			MPXV12GP
MPXV12GW6U	Rail	1735		•		•			MPXV12GW
MPXV12GW7U	Rail	1560		•		•			MPXV12GW
MPAK Package (	MPAK Package (MPXM12 Series)								
MPXM12GS	Rail	1320A		•		•			MPXM12GS
MPXM12GST1	Tape & Reel	1320A		•		•			MPXM12GS



### **UNIBODY PACKAGES**



MPX12D CASE 344-15



MPX12GP CASE 344B-01



MPX12DP CASE 344C-01

### **SMALL OUTLINE PACKAGES**



MPXV12DP CASE 1351-01



MPXV12GP CASE 1369-01



MPXV12GW6U CASE 1735-02



MPXV12GW7U CASE 1560-02

## **MPAK PACKAGE**



MPXM12GS/GST1 CASE 1320A-02

# **Operating Characteristics**

**Table 1. Operating Characteristics** ( $V_S = 3.0 \text{ Vdc}$ ,  $T_A = 25^{\circ}\text{C}$  unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Тур	Max	Unit
Differential Pressure Range <sup>(1)</sup>	P <sub>OP</sub>	0	_	10	kPa
Supply Voltage <sup>(2)</sup>	V <sub>S</sub>	_	3.0	6.0	Vdc
Supply Current	Io	_	6.0	_	mAdc
Full Scale Span <sup>(3)</sup>	V <sub>FSS</sub>	45	55	70	mV
Offset <sup>(4)</sup>	V <sub>off</sub>	0	20	35	mV
Sensitivity	ΔV/ΔΡ	_	5.5	_	mV/kPa
Linearity	_	-0.5	_	5.0	%V <sub>FSS</sub>
Pressure Hysteresis <sup>(6)</sup> (0 to 10 kPa)	_	_	±0.1	_	%V <sub>FSS</sub>
Temperature Hysteresis (-40°C to +125°C)	_	_	±0.5	_	%V <sub>FSS</sub>
Temperature Coefficient of Full Scale Span	TCV <sub>FSS</sub>	-0.22	_	-0.16	%V <sub>FSS</sub> /°C
Temperature Coefficient of Offset	TCV <sub>off</sub>	_	±15	_	μV/°C
Temperature Coefficient of Resistance	TCR	0.21	_	0.27	%Z <sub>in</sub> /°C
Input Impedance	Z <sub>in</sub>	400	_	550	Ω
Output Impedance	Z <sub>out</sub>	750	_	1250	Ω
Response Time <sup>(5)</sup> (10% to 90%)	t <sub>R</sub>	_	1.0	_	ms
Warm-Up Time <sup>(6)</sup>	_	_	20	_	ms
Offset Stability <sup>(7)</sup>	_	_	±0.5	_	%V <sub>FSS</sub>

- 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<sub>FSS</sub>) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum related pressure.
- 4. Offset (V<sub>OFF</sub>) is defined as the output voltage at the minimum rated pressure.
- 5. Response Time is defined as the time form 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.
- 6. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the pressure is stabilized.
- 7. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

# **Maximum Ratings**

Table 2. Maximum Ratings<sup>(1)</sup>

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P <sub>MAX</sub>	75	kPa
Burst Pressure (P1 > P2)	P <sub>BURST</sub>	100	kPa
Storage Temperature	T <sub>STG</sub>	-40 to +125	°C
Operating Temperature	T <sub>A</sub>	-40 to +125	°C

<sup>1.</sup> Exposure beyond the specified limits may cause permanent damage or degradation to the device.

Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.

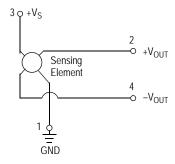


Figure 1. Uncompensated Pressure Sensor Schematic

# **Voltage Output versus Applied Differential Pressure**

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).

# **Temperature Compensation**

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

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 Applications Note AN840.

#### **LINEARITY**

Linearity refers to how well a transducer's output follows the equation:  $V_{OUT} = V_{OFF} + \text{sensitivity} \times P$  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. Freescale's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

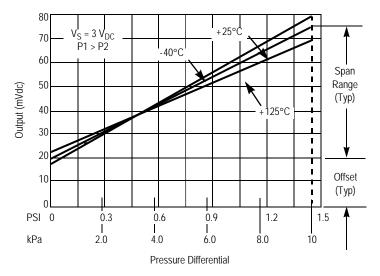


Figure 2. Output vs. Pressure Differential

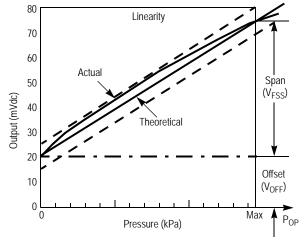


Figure 3. Linearity Specification Comparison

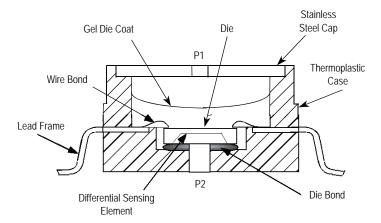


Figure 4. Cross-Sectional Diagram (not to scale)

Figure 4 illustrates the differential/gauge die. A gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

Operating characteristics, internal reliability and qualification tests are based on use of dry clean air as the

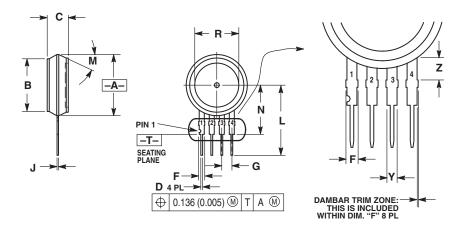
pressure media. Media other than dry clean air may have adverse effects on sensor performance and long term reliability. Contact the factory for information regarding media compatibility in your application.

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

Freescale 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 gel which isolates the die from the environment. Freescale's MPx12 series is designed to operate with positive differential pressure applied, P1 > P2.

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

Part Number	Case Type	Pressure (P1) Side Identifier
MPX12D	344	Stainless Steel Cap
MPX12DP	344C	Side with Part Marking
MPX12GP	344B	Side with Port Attached
MPXV12DP	1351	Side with Part Marking
MPXV12GP	1369	Side with Port
MPXV12GW6U	1735	Side with Port
MPXV12GW7U	1560	Side with Port
MPXM12GS/GST1	1320A	Side with Port Attached



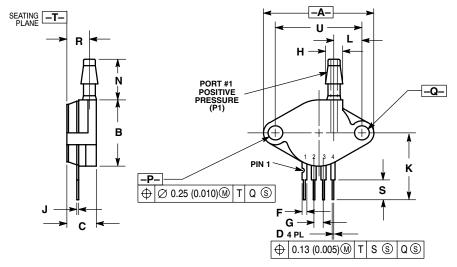
- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: INCH.
- DIMENSION -A- IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

	INC	HES	MILLIN	IETERS	
DIM	MIN	MAX	MIN	MAX	
Α	0.595	0.630	15.11	16.00	
В	0.514	0.534	13.06	13.56	
С	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	
Г	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	
Υ	0.048	0.052	1.22	1.32	
Z	0.106	0.118	2.68	3.00	

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

  PIN 1. V<sub>CC</sub>
  2. SUPPLY
  3. + SUPPLY
  4. GROUND
- STYLE 3: PIN 1. GND 2. -VOUT 3. VS 4. +VOUT

#### **CASE 344-15 ISSUE AA UNIBODY PACKAGE**



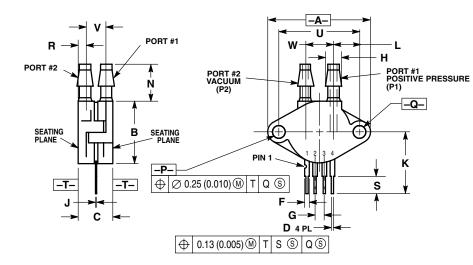
**CASE 344B-01 ISSUE B UNIBODY PACKAGE** 

#### NOTES:

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

	INCHES		MILLIN	METERS	
DIM	MIN	MAX	MIN	MAX	
Α	1.145	1.175	29.08	29.85	
В	0.685	0.715	17.40	18.16	
С	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		
Н	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	
Р	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	C 23.11 BSC		

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

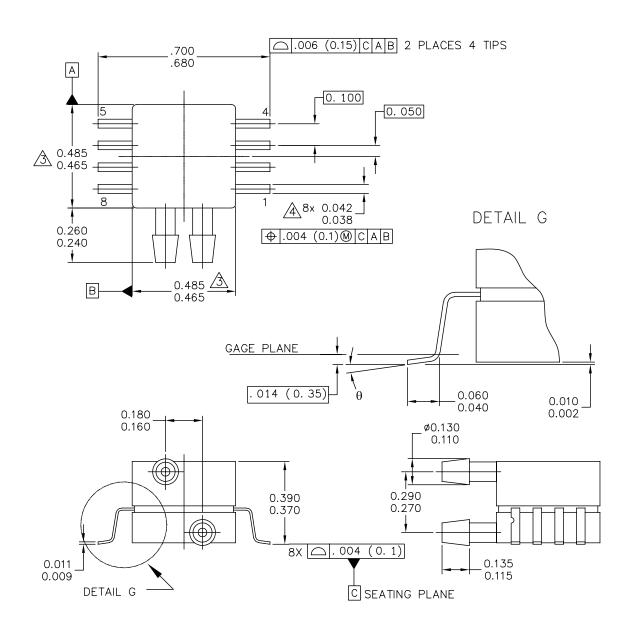


- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

_				
	INC	HES	MILLIN	IETERS
DIM	MIN	MAX	MIN	MAX
Α	1.145	1.175	29.08	29.85
В	0.685	0.715	17.40	18.16
С	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
Ξ	0.182	0.194	4.62	4.93
_	0.014	0.016	0.36	0.41
K	0.695	0.725	17.65	18.42
Г	0.290	0.300	7.37	7.62
N	0.420	0.440	10.67	11.18
Ь	0.153	0.159	3.89	4.04
ø	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
C	0.910	BSC	23.11 BSC	
٧	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 UNIBODY PACKAGE** 



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TITLE:		DOCUMENT NO	): 98ASA99255D	REV: A
8 LD SNSR. DUAL	PORT	CASE NUMBER	2: 1351–01	27 JUL 2005
		STANDARD: NO	N-JEDEC	

CASE 1351-01 ISSUE A SMALL OUTLINE PACKAGE

#### NOTES:

- 1. CONTROLLING DIMENSION: INCH
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.

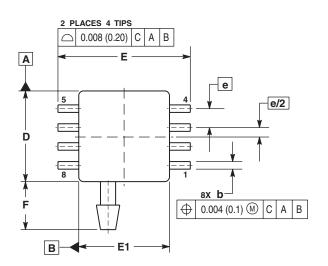
DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PPROTRUSIONS.
MOLD FLASH AND PROTRUSIONS SHALL NOT EXCEED .006 PER SIDE.

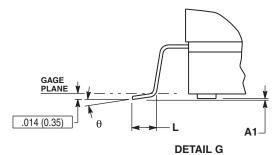
DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

STYLE 1:			STYLE 2:		
PIN	1:	GND	PIN	1:	N/C
PIN :	2:	+Vout	PIN	2:	٧s
PIN .	3:	٧s	PIN	3:	GND
PIN ·	4:	-Vout	PIN	4:	Vout
PIN :	5:	N/C	PIN	5:	N/C
PIN	6:	N/C	PIN	6:	N/C
PIN	7:	N/C	PIN	7:	N/C
PIN	8:	N/C	PIN	8:	N/C

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TITLE:		DOCUMENT NO	): 98ASA99255D	REV: A
8 LD SNSR, DUAL	PORT	CASE NUMBER	R: 1351–01	27 JUL 2005
		STANDARD: NO	N-JEDEC	

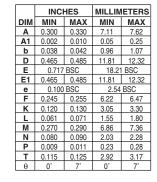
#### CASE 1351-01 ISSUE A SMALL OUTLINE PACKAGE

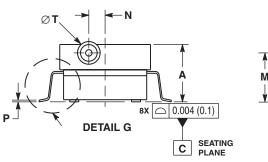


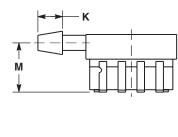


- 1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER
  - ASME Y14.5M, 1994.

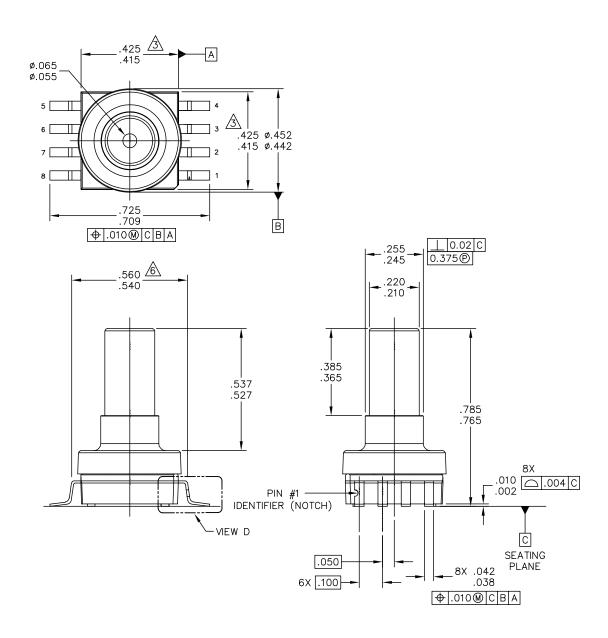
    3. DIMENSIONS "D" AND "E1" DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 (0.152) PER SIDE
  - 4. DIMENSION "b" DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.008 (0.203) MAXIMUM.





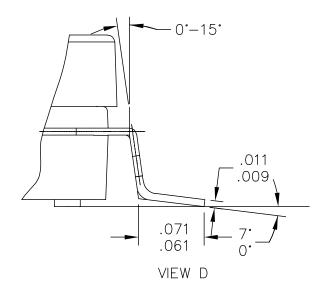


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TITLE:		DOCUMENT NO	): 98ASA10686D	REV: B
SO, 8 I/O, .420 X .4	CASE NUMBER: 1735-02 19 FEB		19 FEB 2009	
.100 IN PITCH	STANDARD: NO	N-JEDEC		

## CASE 1735-02 ISSUE B SMALL OUTLINE PACKAGE



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SO, 8 I/O, .420 X .4	CASE NUMBER	2: 1735−02	19 FEB 2009	
.100 IN PITCH	STANDARD: NO	N-JEDEC		

# CASE 1735-02 ISSUE B SMALL OUTLINE PACKAGE

#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
- 2. CONTROLLING DIMENSION: INCH.

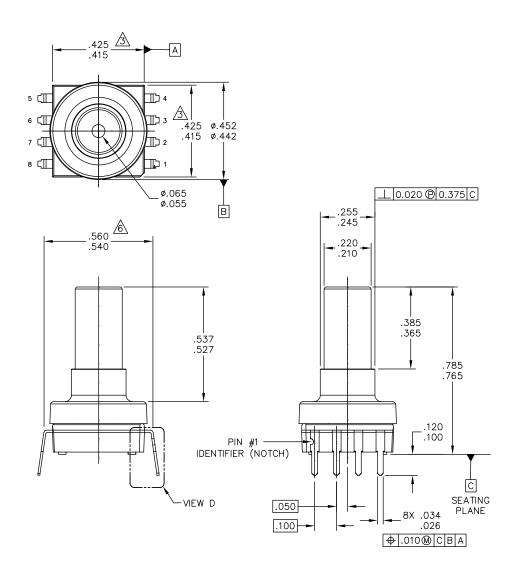
A DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION.

- 4. MAXIMUM MOLD PROTRUSION IS .006.
- 5. ALL VERTICAL SURFACES 5' TYPICAL DRAFT.

6 DIMENSION TO CENTER OF LEAD WHEN FORMED PARALLEL.

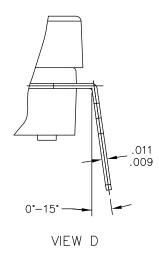
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TITLE: SO, 8 I/O, .420 X .420 PKG, .100 IN PITCH		DOCUMENT NO	): 98ASA10686D	REV: B
		CASE NUMBER	2: 1735–02	19 FEB 2009
		STANDARD: NO	N-JEDEC	

CASE 1735-02 ISSUE B SMALL OUTLINE PACKAGE



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TITLE:		DOCUMENT NO	): 98ASA10611D	REV: D
SO, 8 I/O, .420 X .420 PKG, .100 IN PITCH		CASE NUMBER	2: 1560–03	25 FEB 2009
		STANDARD: NO	N-JEDEC	

### CASE 1560-03 ISSUE D SMALL OUTLINE PACKAGE



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TITLE: SO, 8 I/O, .420 X .420 PKG, .100 IN PITCH		DOCUMENT NO	): 98ASA10611D	REV: D
		CASE NUMBER	2: 1560–03	25 FEB 2009
		STANDARD: NO	N-JEDEC	

# CASE 1560-03 ISSUE D SMALL OUTLINE PACKAGE

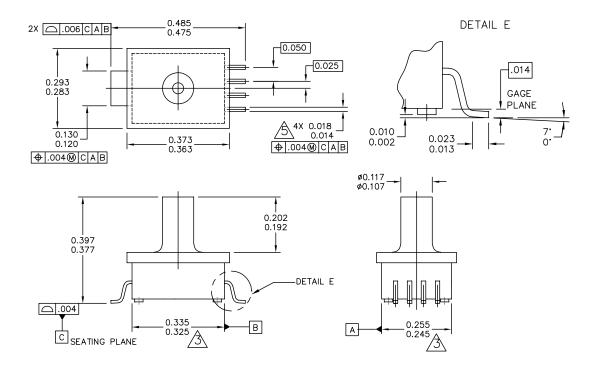
#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
- 2. CONTROLLING DIMENSION: INCH.
- A DIMENSIONS DO NOT INCLUDE MOLD PROTRUSION.
- 4. MAXIMUM MOLD PROTRUSION IS .006.
- 5. ALL VERTICAL SURFACES 5' TYPICAL DRAFT.

6 DIMENSION TO CENTER OF LEAD WHEN FORMED PARALLEL.

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		DOCUMENT NO	): 98ASA10611D	REV: D	
		CASE NUMBER	2: 1560–03	25 FEB 2009	
		STANDARD: NO	N-JEDEC		

### CASE 1560-03 ISSUE D SMALL OUTLINE PACKAGE



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TITLE:  5 LD M-PAC, PORTED		DOCUMENT NO	): 98ARH99087A	REV: A
		CASE NUMBER	R: 1320A-02	22 JUL 2005
		STANDARD: NO	N-JEDEC	

CASE 1320A-02 ISSUE A MPAK PACKAGE

#### NOTES:

- 1. DIMENSIONS ARE IN INCHES.
- 2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
- DIMENSIONS DOES NOT INCLUDE MOLD FLASH OR PROTRUSION. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED .006" PER SIDE.
- 4. ALL VERTICAL SURFACES TO BE 5" MAXIMUM.

DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

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TITLE:	DOCUMENT	NO: 98ARH99087A	REV: A
5 LD M-PAC, POR	TED CASE NUMB	ER: 1320A-02	22 JUL 2005
	STANDARD:	NON-JEDEC	

CASE 1320A-02 ISSUE A MPAK PACKAGE

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