MPX2053

50 kPa Temperature Compensated Pressure Sensors

Rev. 11 — 22 April 2021 Product data sheet

1 General Description

The MPX2053 series devices are silicon piezoresistive pressure sensors that provide a highly accurate and linear voltage output directly proportional to the applied pressure. The sensor is a single monolithic silicon diaphragm with the strain gauge and a thin-film resistor network integrated on-chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation.

2 Features and Benefits

- Ratiometric to Supply Voltage
- Differential and Gauge Options
- Temperature Compensated over 0 °C to 85 °C
- Easy-to-Use Chip Carrier Package Options

3 Applications

- Level Indicators
- Medical Diagnostics
- Robotics
- Pressure Switching
- Pump/Motor Controllers
- Non-Invasive Blood Pressure Measurement

4 Ordering Information

Table 1. Ordering information

Device Name	Package options	Case number	Number of ports			Pressure type			Device marking
			None	Single	Dual	Gauge	Differential	Absolute	
Small Outline Package (MPXV2053 series)									
MPXV2053DP	Tray	1351			•		•		MPXV2053DP
Unibody Package (MPX2053 Series)									
MPX2053D	Tray	344	•				•		MPX2053D
MPAK Package (MPXM2053 Series)									
MPXM2053DT1	Tape & Reel	1320	•				•		MPXM2053D
MPXM2053GS	Tube	1320A		•		•			MPXM2053GS
MPXM2053GST1	Tape & Reel	1320A		•		•			MPXM2053GS

Unibody Package

MPX2053D
Case 344-15

Small Outline Package

MPXV2053DP
Case 1351-01

MPAK Packages

MPXM2053DT1
Case 1320-02

MPXM2053GS/GST1
Case 1320A-02

5 Block Diagram

Figure 1 shows a block diagram of the internal circuitry on the stand-alone pressure sensor chip.

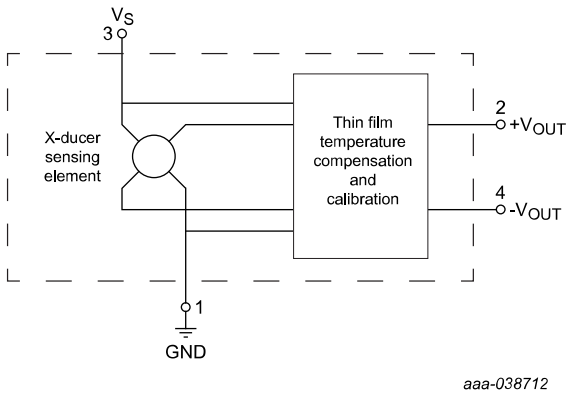


Figure 1. Temperature compensated pressure sensor schematic

6 Pin Information

6.1 MPX2053D

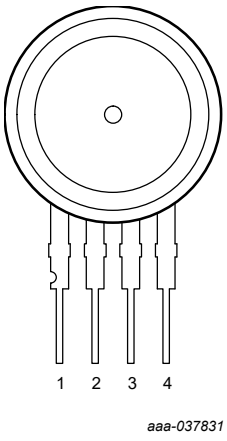


Figure 2. Case 344-15

Table 2. Pin definitions – MPX2053D

Symbol	Pin	Description
GND	1	Ground
$+V_{OUT}$	2	+ Voltage output
V_S	3	Power supply
$-V_{OUT}$	4	– Voltage output

6.2 MPXM2053GS/GST1

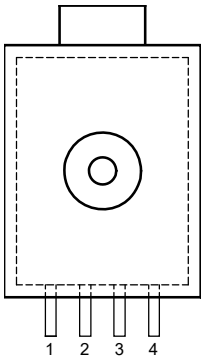


Figure 3. Case 1320A-02

Table 3. Pin definitions – MPXM2053GS/GST1

Symbol	Pin	Description
GND	1	Ground
$+V_{OUT}$	2	+ Voltage output
V_S	3	Power supply
$-V_{OUT}$	4	– Voltage output

6.3 MPXV2053DP

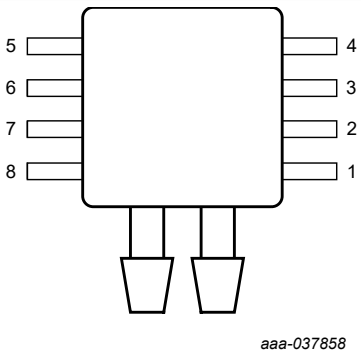


Figure 4. CASE 1351-01

Table 4. Pin definitions – MPXV2053DP

Symbol	Pin	Description
GND	1	Ground
$+V_{OUT}$	2	+ Voltage output
V_S	3	Power supply
$-V_{OUT}$	4	– Voltage output
n.a.	5	—
n.a.	6	—
n.a.	7	—
n.a.	8	—

6.4 MPXM2053DT1

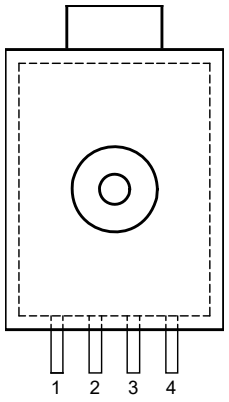


Figure 5. Case 1320-02

Table 5. Pin definitions - MPXM2053DT1

Symbol	Pin	Description
GND	1	Ground
$+V_{OUT}$	2	+ Voltage output
V_S	3	Power supply
$-V_{OUT}$	4	– Voltage output

7 Maximum Ratings

Table 6. Maximum ratings

Exposure beyond the specified limits may cause permanent damage or degradation to the device.
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
P_{max}	Overpressure	P1 > P2	—	—	200	kPa
T_{stg}	Storage Temperature		−40	—	+125	°C
T_A	Operating Temperature		−40	—	+125	°C

8 Operating Characteristics

Table 7. Operating Characteristics (V_S = 10.0 Vdc, T_A = 25 °C unless otherwise noted, P1 > P2)

Characteristic		Symbol	Min	Typ	Max	Unit
Operating Pressure Range	[1]	P_{OP}	0	—	50	kPa
Supply Voltage	[2]	V_S	—	10	16	Vdc
Supply Current		I_o	—	6.0	—	mAdc
Full Scale Span	[3]	V_{FSS}	38.5	40	41.5	mV
Offset	[4]	V_{off}	–1.0	—	1.0	mV
Sensitivity		ΔV/ΔP	—	0.8	—	mV/kPa
Linearity	[5]	—	–0.6	—	0.4	$\%V_{FSS}$
Pressure Hysteresis (0 kPa to 50 kPa)	[5]	—	—	±0.1	—	$\%V_{FSS}$
Temperature Hysteresis (–40 °C to 125 °C)	[5]	—	—	±0.5	—	$\%V_{FSS}$
Temperature Coefficient of Full Scale Span	[5]	TCV_{FSS}	–2.0	—	2.0	$\%V_{FSS}$
Temperature Coefficient of Offset	[5]	TCV_{off}	–1.0	—	1.0	mV
Input Impedance		Z_{in}	1000	—	2500	Ω
Output Impedance		Z_{out}	1400	—	3000	Ω
Response Time (10% to 90%)	[6]	t_R	—	1.0	—	ms
Warm-Up Time	[7]	—	—	20	—	ms
Offset Stability	[8]	—	—	±0.5	—	$\%V_{FSS}$

[1] 1.0 kPa 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 the 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 °C to 85 °C, relative to 25 °C
- TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 °C to 85 °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] Warm-Up Time is defined as the time required for the product to meet the specified output voltage after the pressure has been stabilized.

[8] Offset Stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure Temperature Cycling with Bias test.

9 Characteristics

9.1 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).

9.2 On-chip temperature compensation and calibration

Figure 6 shows the typical output characteristics of the MPX2053 series at 25 °C.

The effects of temperature on full scale span and offset are very small and are shown under Section 8 "Operating Characteristics".

This performance over temperature is achieved by having both the shear stress strain gauge and the thin-film resistor circuitry on the same silicon diaphragm. Each chip is dynamically laser trimmed for precise span and offset calibration and temperature compensation.

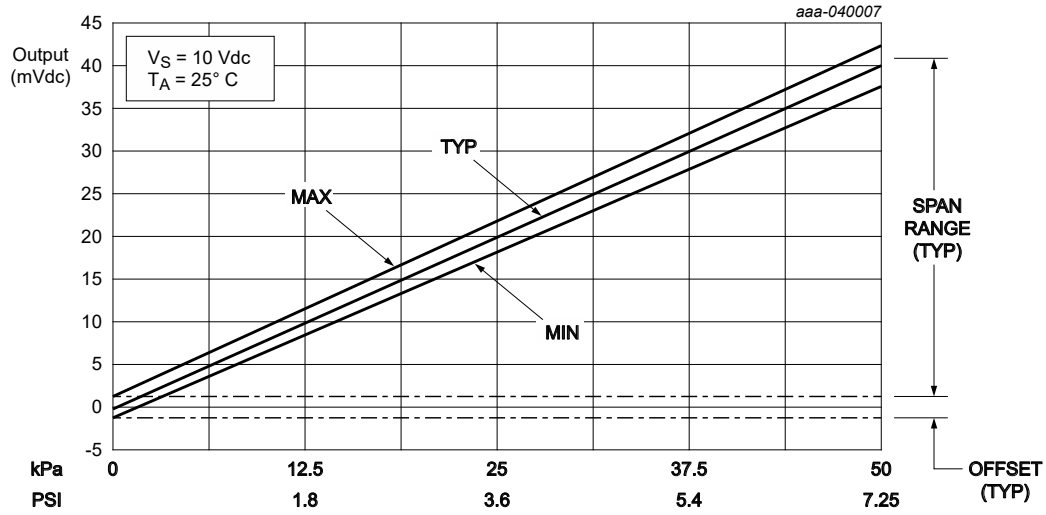


Figure 6. Output vs. pressure differential

9.3 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 7). There are two basic methods for calculating nonlinearity:

- End point straight line fit
- 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.

NXP's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

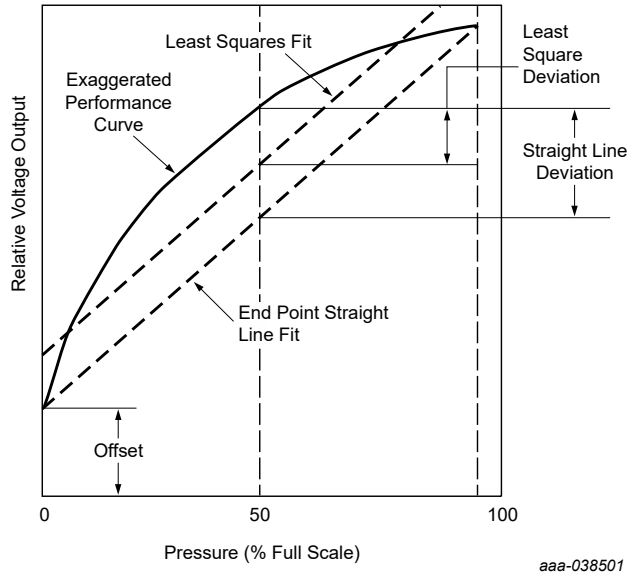


Figure 7. Linearity specification comparison

9.4 Pressure (P1) / Vacuum (P2) side identification

NXP 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 that isolates the die from the environment. The NXP MPX pressure sensor is designed to operate with positive differential pressure applied, P1 > P2.

The Pressure (P1) side may be identified by using Table 8.

Table 8. Pressure (P1) side delineation table

Part Number	Case Type	Pressure (P1) Side Identifier
MPX2053D	344	Stainless Steel Cap
MPXV2053DP	1351	Side with Part Marking
MPXM2053DT1	1320	Side with Part Marking
MPXM2053GS/GST1	1320A	Side with Port Attached

9.5 Media compatibility

Figure 8 illustrates the differential or gauge configuration in a typical chip carrier. 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 MPX2053 series pressure sensor operating characteristics, internal reliability and qualification tests are based on the use of dry clean air as the pressure medium. 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.

For more information, refer to application note AN3728.

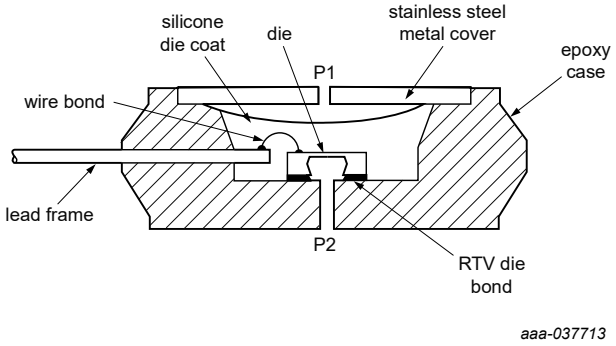


Figure 8. Unibody package — cross-sectional diagram (not to scale)

10 Package Outlines

Package dimensions are provided in package drawings. To find the most current package outline drawing, go to https://www.nxp.com/ and perform a keyword search for the drawing's document number.

10.1 Small outline packages

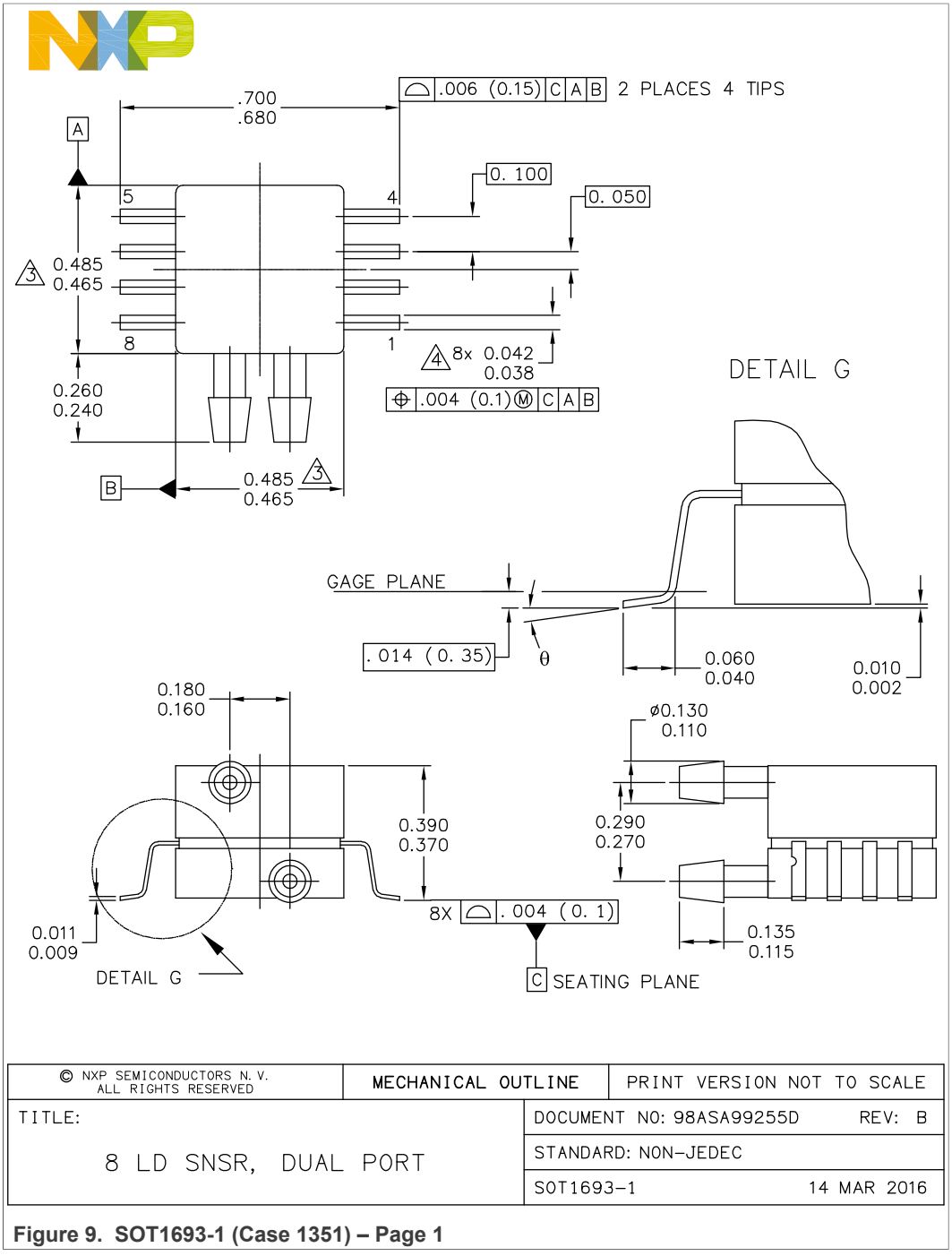
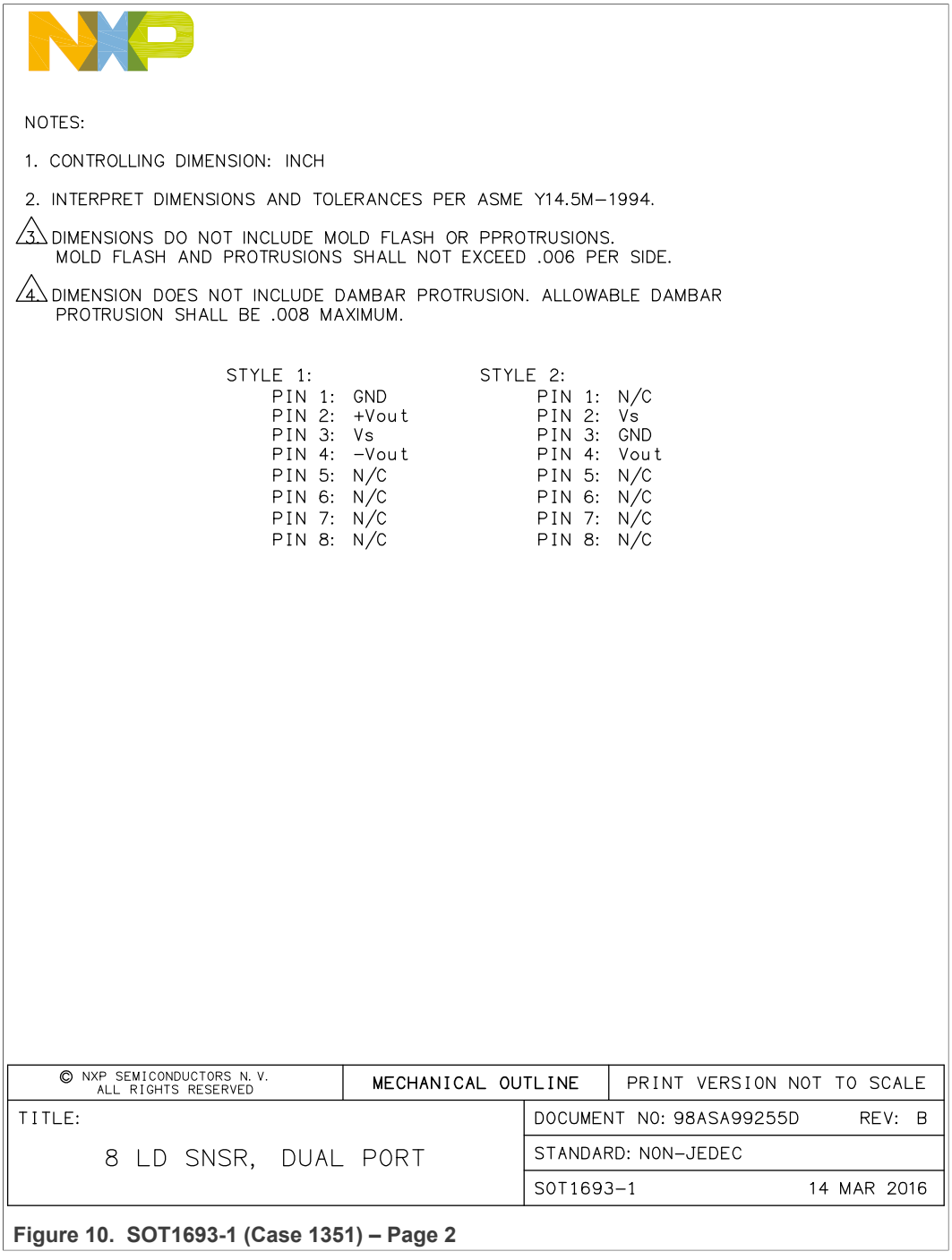


Figure 9. SOT1693-1 (Case 1351) – Page 1



NOTES:

1. CONTROLLING DIMENSION: INCH

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.

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

4. 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:	Vs
PIN 3:	Vs	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

MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

TITLE:

8 LD SNSR, DUAL PORT

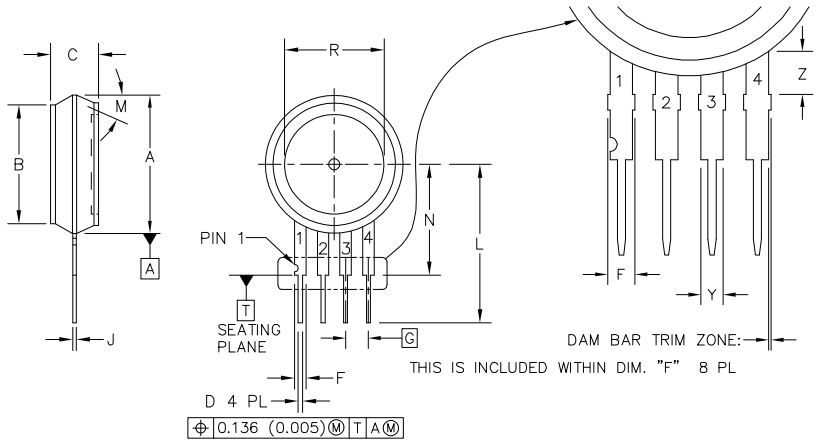
DOCUMENT NO: 98ASA99255D REV: B

STANDARD: NON–JEDEC

SOT1693–1 14 MAR 2016

Figure 10. SOT1693-1 (Case 1351) – Page 2

10.2 Unibody packages



DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	15.11	16.00	0.595	0.630
B	13.06	13.56	0.514	0.534
C	5.08	5.59	0.200	0.220
D	0.41	0.51	0.016	0.020
F	1.22	1.63	0.048	0.064
G	2.54 BSC		0.100 BSC	
J	0.36	0.40	0.014	0.016
L	17.65	18.42	0.695	0.725
M	30° NOM		30° NOM	
N	12.07	12.57	0.475	0.495
R	10.92	11.43	0.430	0.450
Y	1.22	1.32	0.048	0.052
Z	2.68	3.00	0.106	0.118

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION A IS INCLUSIVE OF THE MOLD STOP RING NOT TO EXCEED 16.00 (0.630)
4. 344–01 THRU –4 OBSOLETE.
5. 344–05 THRU –11 OBSOLETE, NEW STANDARD 344–15.

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

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

STYLE 3:
PIN 1. GROUND
2. – VOUT
3. VS
4. + VOUT

MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE

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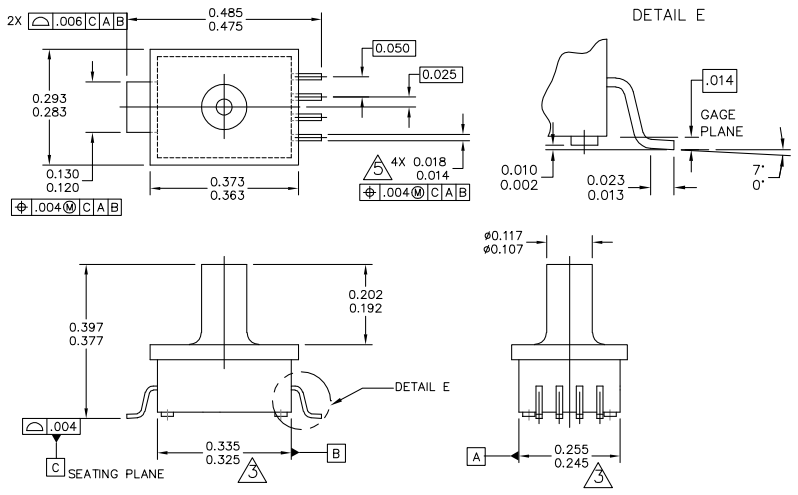
DOCUMENT NO: 98ASB42280B REV: AD

STANDARD: NON–JEDEC

SOT1772–1 02 FEB 2016

Figure 11. SOT1772-1 (Case 344-15)

10.3 MPAK packages



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	STANDARD: NON–JEDEC	
	SOT1673–1	29 FEB 2016

Figure 12. SOT1673-1 (1320A-02) – Page 1

NOTES:

1. DIMENSIONS ARE IN INCHES.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–1994.
3. 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.
5. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 MAXIMUM.

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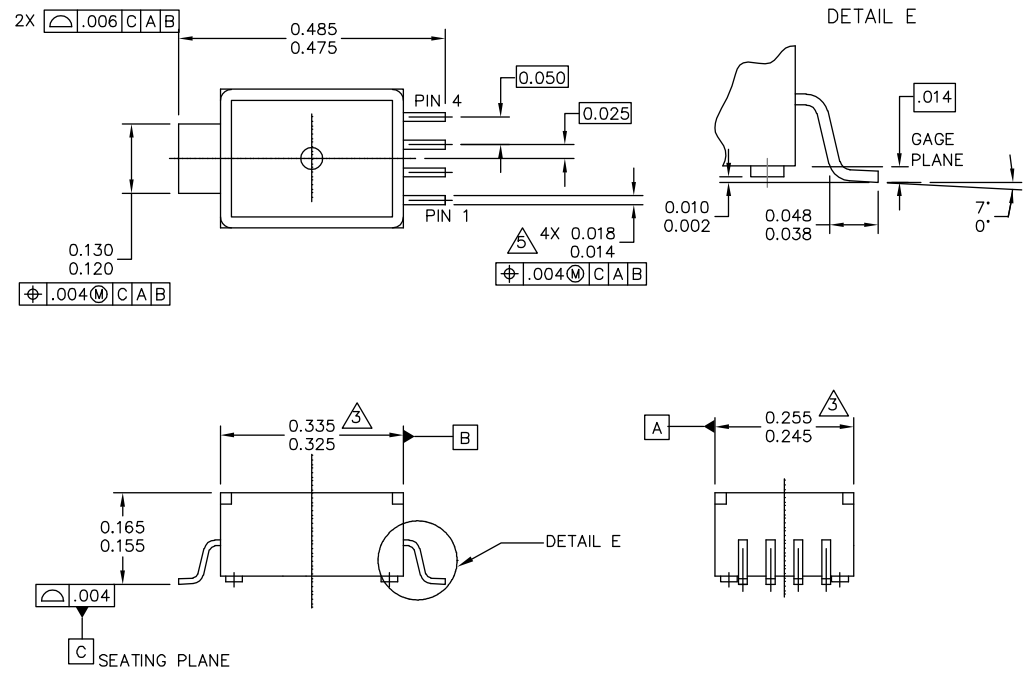
	STANDARD: NON–JEDEC	
	SOT1673–1	29 FEB 2016

Figure 13. SOT1673-1 (1320A-02) – Page 2



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TITLE: 5 LD M–PAC	DOCUMENT NO: 98ARH99088A	REV: D
	STANDARD: NON-JEDEC	
	SOT1674-1	29 FEB 2016

Figure 14. SOT1674-1 (Case 1320-02) – Page 1

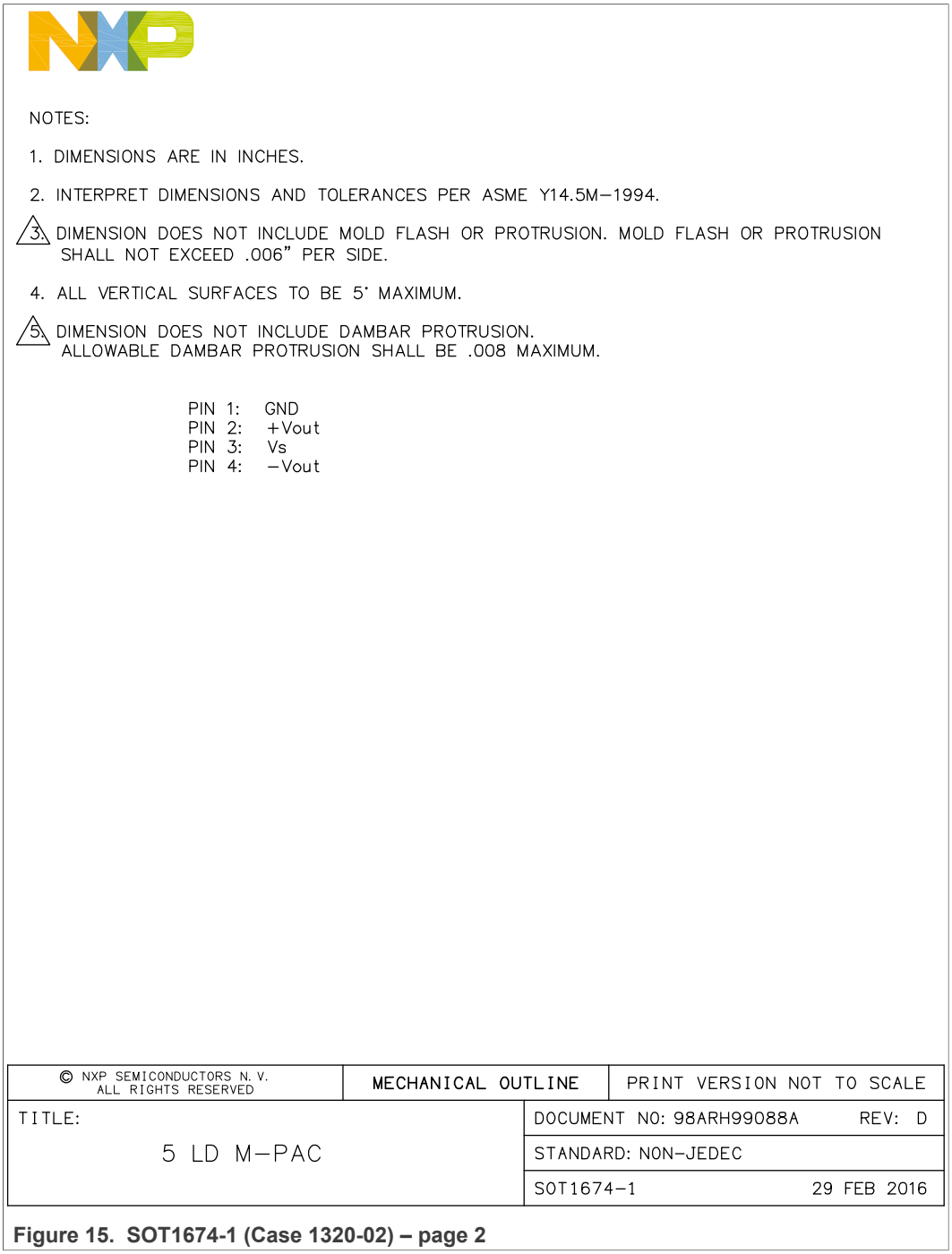

Figure 15. SOT1674-1 (Case 1320-02) – page 2

11 References

[1] AN840 – Temperature Compensation Methods For The Motorola X-ducer Pressure Sensor Element
https://www.nxp.com/docs/en/application-note/AN840.pdf

[2] AN1984 – Handling Freescale Pressure Sensors
https://www.nxp.com/docs/en/application-note/AN1984.pdf

[3] AN3150 – Soldering Recommendations for Pressure Sensor Devices
https://www.nxp.com/docs/en/application-note/AN3150.pdf

[4] AN1318 Interfacing Semiconductor Pressure Sensors to Microcomputers
https://www.nxp.com/docs/en/application-note/AN1318.pdf

[5] AN3728 Media Compatibility for IPS PRT Pressure Sensors
https://www.nxp.com/docs/en/application-note/AN3728.pdf

12 Revision history

Table 9. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
MPX2053 v.11	20210422	Product data sheet	-	MPX2053 v.10
Modifications	• Redesigned the data sheet to comply with the new identity guidelines of NXP Semiconductors. Adapted legal texts to the new company name where appropriate.			
MPX2053 v.10	200907	Product data sheet	-	MPX2053 v.10
Modifications	• This data sheet has been formatted to comply with the identity guidelines of NXP Semiconductors. • Ordering Information: Removed MPX2053DP, MPX2053GP and MPXV2053GP from the table. • Package images: Removed the package images for MPX2053DP, MPX2053GP and MPXV2053GP. Updated all other package images. • Section 8: Revised “Non-Linearity” to “Linearity” and added new footnote after Linearity, Pressure Hysteresis, Temperature Hysteresis, Temperature Coefficient of Full Scale, and Temperature Coefficient of Offset. • Package Dimensions: Removed package dimensions for Case 344B-01 Issue B, Unibody package, Case 344C-01 Issue B, Unibody package, and Case 1369-01, Issue D Small Outline package. Updated all other package dimension images.			
MPX2053 v.0	200907	Product data sheet	-	MPX2053 v.8
Modifications	• Deleted references to device number MPXV2053GVP throughout the document			

13 Legal information

13.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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