MPXV2050G

50 kPa Temperature Compensated Pressure Sensors

Rev. 2 — 22 April 2021 **Product data sheet**

1 General Description

The MPXV2050G device is a silicon piezoresistive pressure sensor providing 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
- Temperature Compensated over 0 °C to 85 °C
- Gauge Ported

3 Applications

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

4 Ordering Information

Table 1. Ordering options

Device name	Package options	Case number	Number of ports			Pressure type			Device marking
			None	Single	Dual	Gauge	Differential	Absolute	
MPXV2050GP	Tray	1369		•		•			MPXV2050GP

Small Outline Package

MPXV2050GP
CASE 1369

5 Block Diagram

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

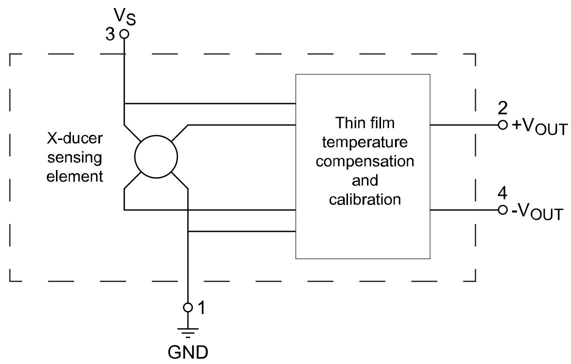


Figure 1. Temperature compensated pressure sensor schematic

6 Pin Information

6.1 MPXV2050GP

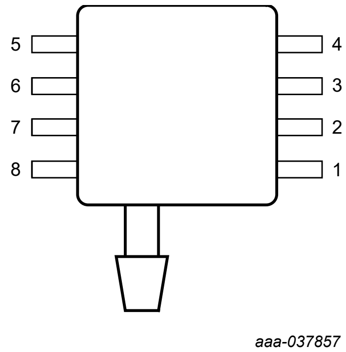


Figure 2. Case 1369-01

Table 2. Pin definitions – MPXV2050GP

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	—

7 Maximum Ratings

Table 3. Maximum ratings [1]

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

[1] Exposure beyond the specified limits may cause permanent damage or degradation to the device

8 Operating Characteristics

Table 4. Operating Characteristics (V_S = 10 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]	—	–0.3	—	0.3	$\%V_{FSS}$
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}	–1.0	—	1.0	$\%V_{FSS}$
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 3 shows the typical output characteristics of the MPXV2050G 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.

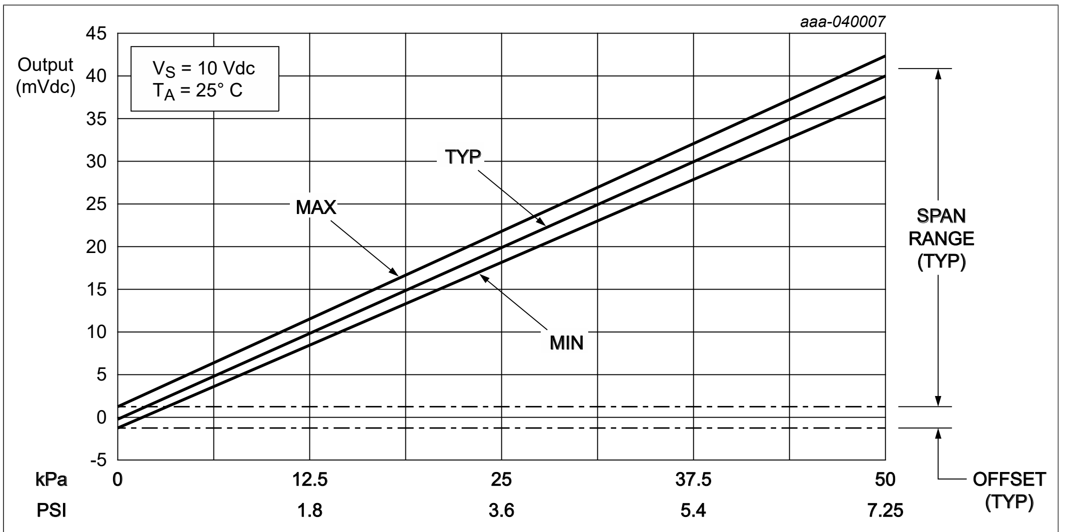


Figure 3. Output vs. pressure differential

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 4). 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.

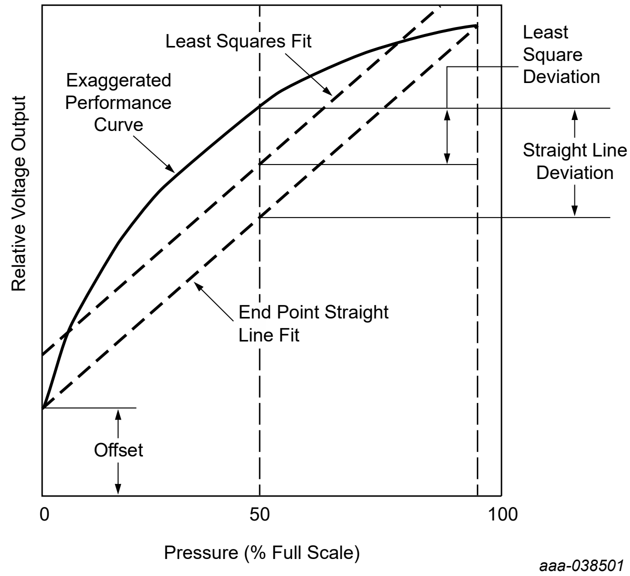


Figure 4. Linearity specification comparison

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 5.

Table 5. Pressure (P1) side delineation table

Part Number	Case Type	Pressure (P1) Side Identifier
MPXV2050GP	1369	side with port attached

9.5 Media compatibility

Figure 5 illustrates the 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 MPXV2050G 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.

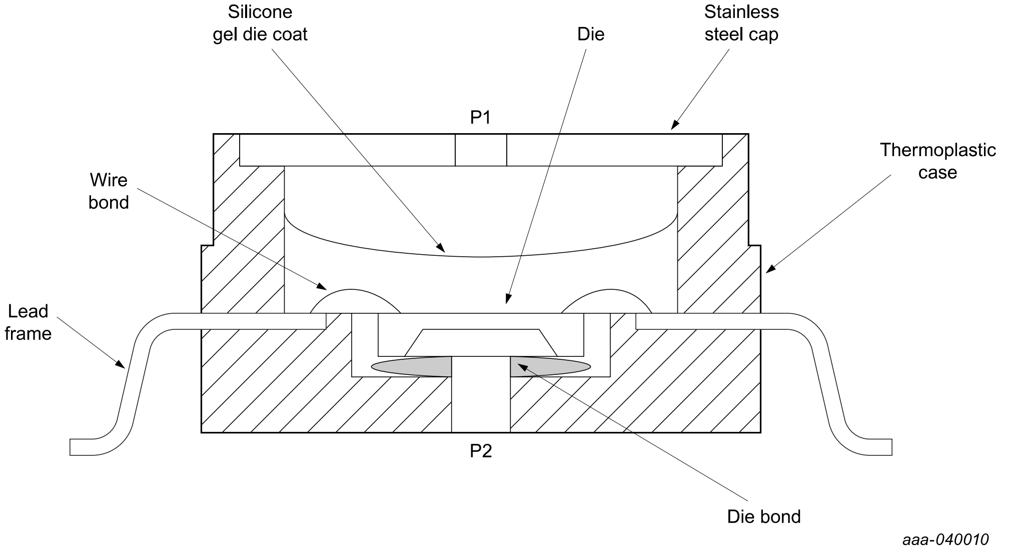
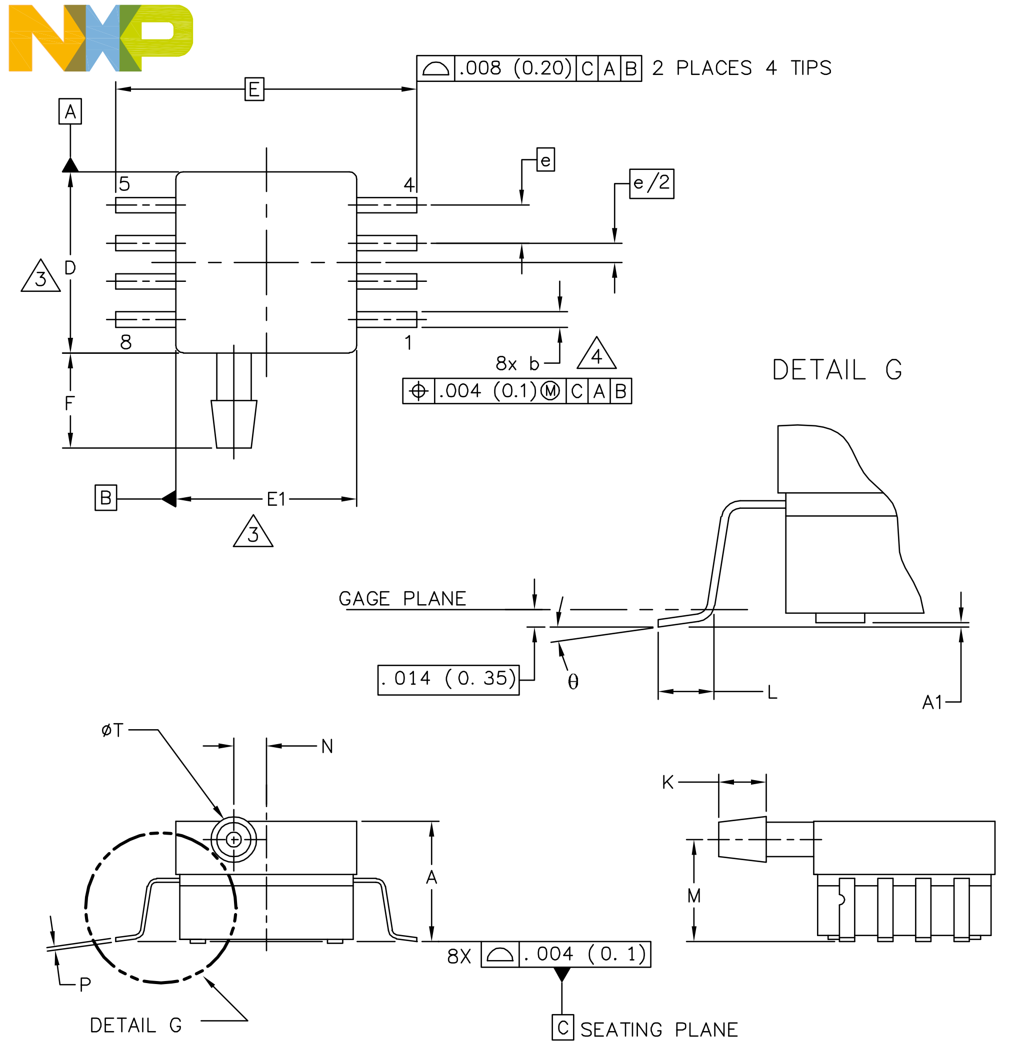


Figure 5. Small outline package — cross-sectional diagram (not to scale)

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



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	STANDARD: NON-JEDEC	
	SOT1693-3 14 MAR 2016	

Figure 6. SOT1693-3 (Case 1369-01) – 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 (0.152) PER SIDE.
4. DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE .008 (0.203) MAXIMUM.

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	.300	.330	7.62	8.38	θ	0°	7°	0°	7°
A1	.002	.010	0.05	0.25	–	---	---	---	---
b	.038	.042	0.96	1.07	–	---	---	---	---
D	.465	.485	11.81	12.32	–	---	---	---	---
E	.717 BSC		18.21 BSC		–	---	---	---	---
E1	.465	.485	11.81	12.32	–	---	---	---	---
e	.100 BSC		2.54 BSC		–	---	---	---	---
F	.245	.255	6.22	6.47	–	---	---	---	---
K	.120	.130	3.05	3.30	–	---	---	---	---
L	.061	.071	1.55	1.80	–	---	---	---	---
M	.270	.290	6.86	7.36	–	---	---	---	---
N	.080	.090	2.03	2.28	–	---	---	---	---
P	.009	.011	0.23	0.28	–	---	---	---	---
T	.115	.125	2.92	3.17	–	---	---	---	---

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	STANDARD: NON-JEDEC	
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Figure 7. SOT1693-3 (Case 1369-01) – 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 6. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
MPXV2050 v.2	20210422	Product data sheet	—	MPXV2050 v.1
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.			
MPXV2050 v.1	202006	Product data sheet	—	MPXV2050 v.0
Modifications	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • • Updated the package image on the first page. • Operating Characteristics: 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. • Updated images for package dimensions			
MPXV2050 v.0	201511	Product data sheet	—	—
Modifications	Initial release			

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".
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Contents

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