MPX12 Series

10 kPa Uncompensated Pressure Sensors

Rev. 12 — 22 April 2021 **Product data sheet**

1 General Description

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 compensation and signal conditioning networks. Compensation techniques are simplified because of the predictability of NXP's single element strain gauge design.

2 Features and Benefits

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

3 Applications

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

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	
MPAK Package (MPXM12 Series)									
MPXM12GS	Rail	1320A-02		•		•			MPXM12GS
MPXM12GST1	Tape & Reel	1320A-02		•		•			MPXM12GS

MPAK package

MPXM12GS/GST1
Case 1320A-02

5 Block Diagram

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

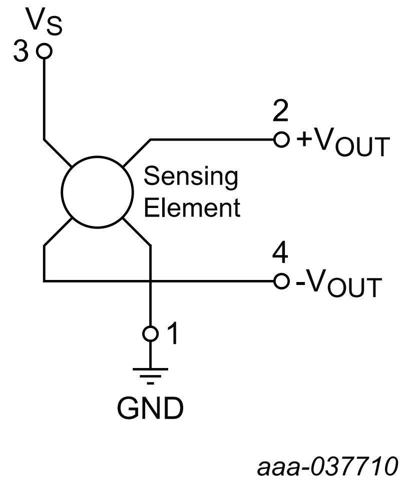

Figure 1. Uncompensated pressure sensor schematic

6 Pin Information

6.1 MPXM12GS/GST1

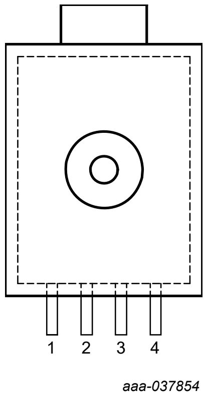

Figure 2. Case 1320A-02

Table 2. Pin definitions - MPXM12GS/GST1

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 3. 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	—	—	75	kPa
P_{burst}	Burst Pressure	P1 > P2	—	—	100	kPa
T_{stg}	Storage Temperature		−40	—	+125	°C
T_A	Operating Temperature		−40	—	+125	°C

8 Operating Characteristics

Table 4. Operating Characteristics (V_S = 3.0 Vdc, T_A = 25 °C unless otherwise noted, P1 > P2)

Characteristic	Symbol	Min	Typ	Max	Unit
Operating 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 (0 kPa to 10 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}	−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 (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 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.
- 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] 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 Temperature compensation

Figure 3 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 MPX2010 series sensor.

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

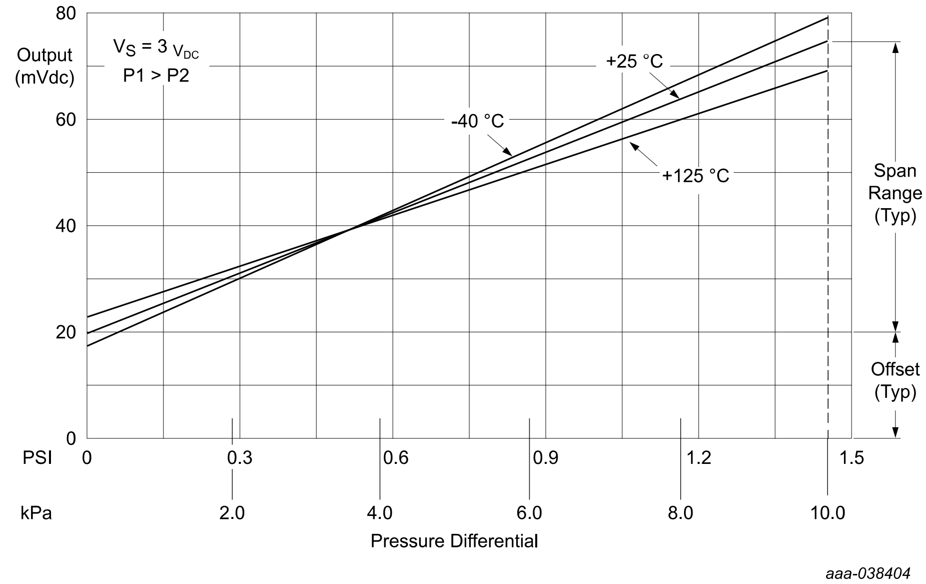

Figure 3. Output vs. pressure differential

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.

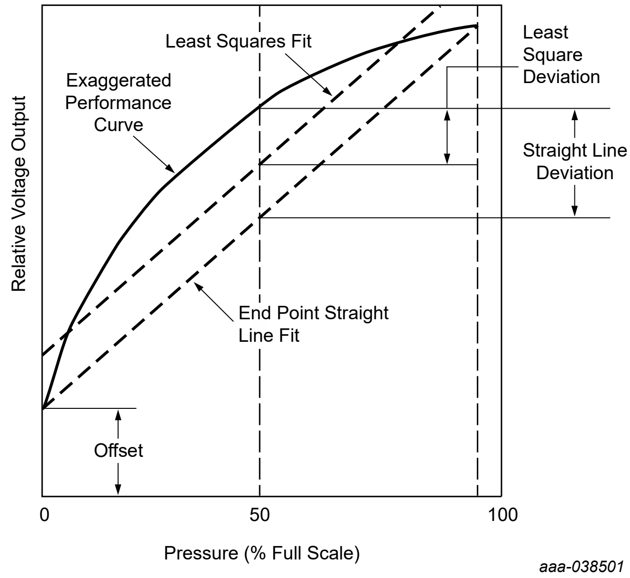

Figure 4. Linearity specification comparison

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
MPXM12GS/GST1	1320A	Side with port attached

9.5 Media compatibility

Figure 5 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 MPX12 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.

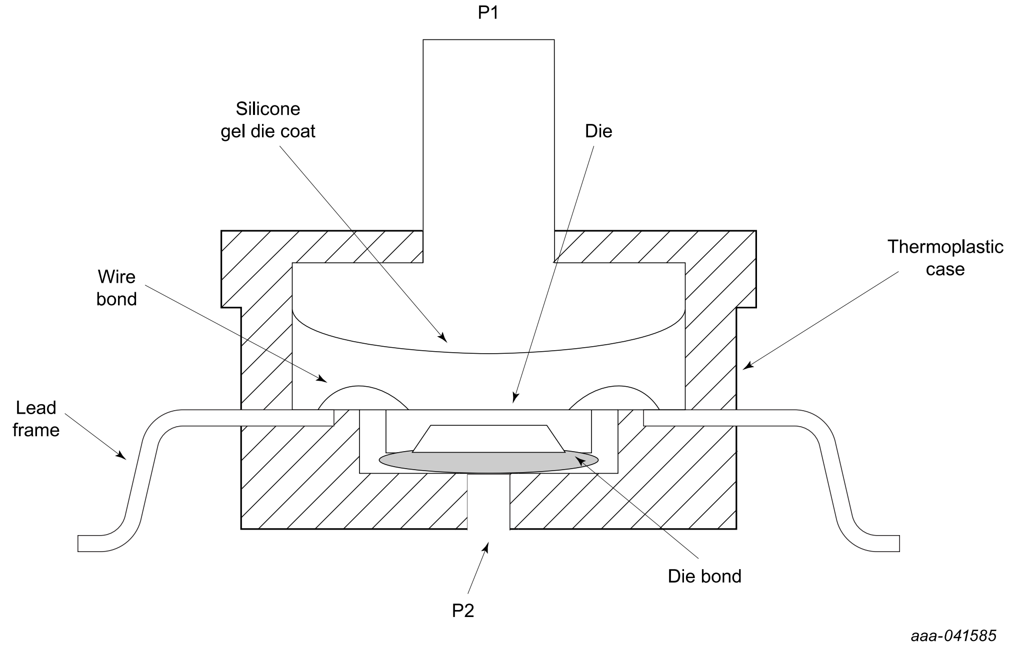

Figure 5. MPAK package — cross-sectional diagram (not to scale)

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 MPAK packages

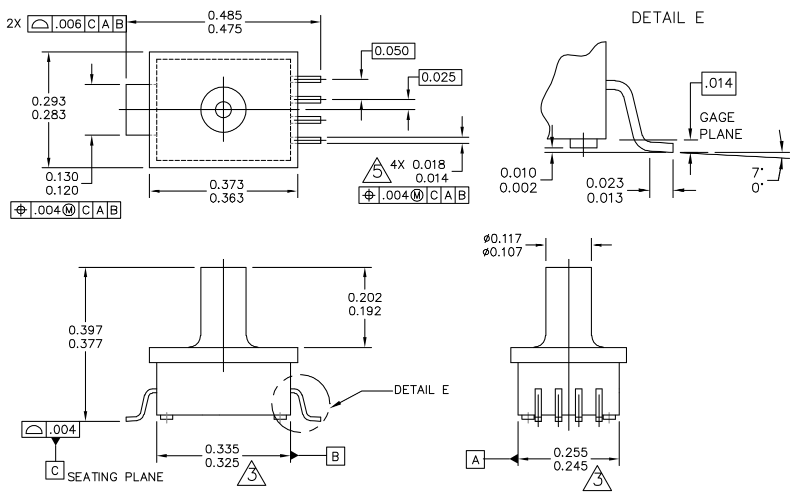

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Figure 6. SOT1673-1 (1320A-02) – Page 1

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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Figure 7. SOT1673-1 (1320A-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 6. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
MPX12 v.12	20210422	Product data sheet	—	MPX12 v.11
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. • Removed the following discontinued part numbers throughout: MPXV12GP, MPXV12GW6U, MPXV12D, MPX12GP,MPXV12GW7U			
MPX12 v.11	200907	Product data sheet	—	—

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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