

Freescale Semiconductor
Data Sheet: Technical Data

MPXV4115V Rev 4, 10/2012

# Integrated Silicon Pressure Sensor On-Chip Signal Conditioned, Temperature Compensated, and Calibrated

The MPXV4115V series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, particularly those employing a microcontroller with A/D inputs. This transducer combines advanced micromachining techniques, thin-film metallization and bipolar processing to provide an accurate, high-level analog output signal that is proportional to the applied pressure/vacuum. The small form factor and high reliability of on-chip integration make the sensor a logical and economical choice for the automotive system designer. Figure 1 shows a block diagram of the internal circuitry integrated on a pressure sensor chip.

# MPXV4115V Series

INTEGRATED
PRESSURE SENSOR
-115 to 0 kPa (-16.7 to 0 psi)
0.2 to 4.6 V Output

### **Application Examples**

- Vacuum Pump Monitoring
- · Brake Booster Monitoring

#### **Features**

- 1.5% Maximum error over 0° to 85°C
- Temperature Compensated from -40° + 125°C
- Ideally Suited for Microprocessor or Microcontroller-Based Systems
- Durable Thermoplastic (PPS) Surface Mount Package

			ORDEF	RING INF	ORMAT	ION			
Device Name Package C			se # of Ports		Pressure Type			Device	
Device Name	Options	No.	None	Single	Dual	Gauge	Differential	Absolute	Marking
Small Outline Packa	Small Outline Package (MPXV4115V Series)								
MPXV4115V6U	Rails	482	•			<ul> <li>Vacuum/ Gauge</li> </ul>			MPXV4115V
MPXV4115VC6U	Rails	482A		•			Vacuum/ Differential		MPXV4115V

#### **SMALL OUTLINE PACKAGES**







MPXV4115VC6U CASE 482A-01





# **Operating Characteristics**

**Table 1. Operating Characteristics** ( $V_S = 5.0 \text{ Vdc}$ ,  $T_A = 25^{\circ}\text{C}$  unless otherwise noted. Decoupling circuit shown in Figure 3 required to meet electrical specifications.)

	Characteristic	Symbol	Min	Тур	Max	Unit
Pressure Range (Differential m	node, Vacuum on metal cap side, Atmospheric	P <sub>OP</sub>	-115	_	0	kPa
Supply Voltage <sup>(1)</sup>		V <sub>S</sub>	4.75	5.0	5.25	Vdc
Supply Current		Io	_	6.0	10	mAdc
Full Scale Output <sup>(2)</sup> (Pdiff = 0 kPa) <sup>2</sup>	(0 to 85°C)	V <sub>FSO</sub>	4.535	4.6	4.665	Vdc
Full Scale Span <sup>(3)</sup> @ V <sub>S</sub> = 5.0 V	(0 to 85°C)	V <sub>FSS</sub>	_	4.4	_	Vdc
Accuracy <sup>(4)</sup>	(0 to 85°C)	_	_	_	1.5%	%V <sub>FSS</sub>
Sensitivity		V/P	_	38.26	_	mV/kPa
Response Time <sup>(5)</sup>		t <sub>R</sub>	_	1.0	_	ms
Output Source Current at Full	Scale Output	Io	_	0.1	_	mAdc
Warm-Up Time <sup>(6)</sup>		_	_	20	_	ms
Offset Stability <sup>(7)</sup>		_	_	±0.5	_	%V <sub>FSS</sub>

- 1. Device is ratiometric within this specified excitation range.
- 2. Full Scale Output is defined as the output voltage at the maximum or full-rated pressure.
- 3. Full Scale Span is defined as the algebraic difference between the output voltage at full-rated pressure and the output voltage at the minimum-rated pressure.
- 4. Accuracy is the deviation in actual output from nominal output over the entire pressure range and temperature range as a percent of span at 25°C due to all sources of errors, including the following:

Linearity: Output deviation from a straight line relationship with pressure 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 minimum

or maximum rated pressure at 25°C.

TcSpan: Output deviation over the temperature range of 0° to 85°C, relative to 25°C.

TcOffset: Output deviation with minimum pressure applied, over the temperature range of 0° to 85°C, relative to 25°C.

- 5. 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.
- 6. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the Pressure has been 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	P <sub>max</sub>	400	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.

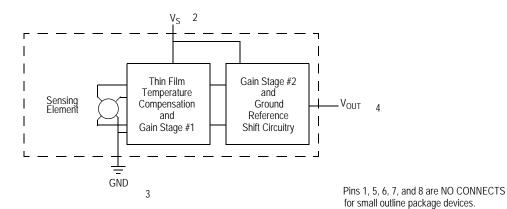


Figure 1. Fully Integrated Pressure Sensor Schematic for Small Outline Package



## On-chip Temperature Compensation, Calibration, and Signal Conditioning

The performance over temperature is achieved by integrating the shear-stress strain gauge, temperature compensation, calibration and signal conditioning circuitry onto a single monolithic chip.

Figure 2 illustrates the gauge configuration in the basic chip carrier (Case 482). A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPXV4115V series sensor operating characteristics are based on use of dry air as pressure media. Media, other than dry air, may have adverse effects on sensor performance and long-term reliability. Internal reliability and qualification test for dry air, and other media, are available

from the factory. Contact the factory for information regarding media tolerance in your application.

Figure 3 shows the recommended decoupling circuit for interfacing the output of the integrated sensor to the A/D input of a microprocessor or microcontroller. Proper decoupling of the power supply is recommended.

Figure 4 shows the sensor output signal relative to differential pressure input. Typical, minimum and maximum output curves are shown for operation over a temperature range of 0°C to 85°C using the decoupling circuit shown in Figure 3. The output will saturate outside of the specified pressure range.

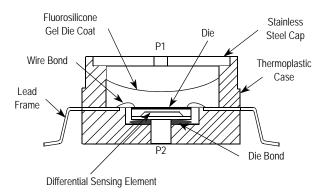


Figure 2. Cross-Sectional Diagram (not to scale)

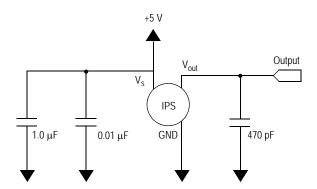


Figure 3. Recommended Power Supply Decoupling and Output Filtering (For output filtering recommendations, refer to Application Note AN1646.)





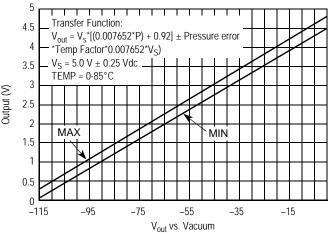


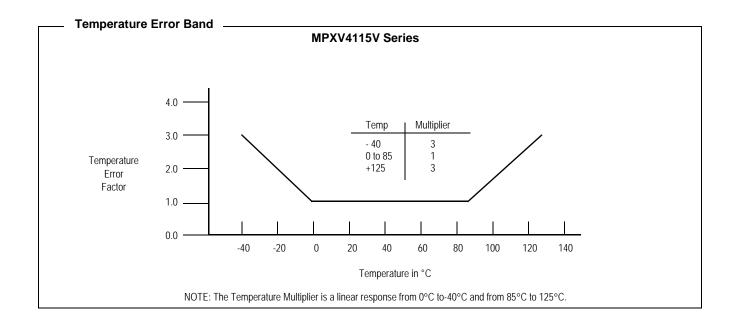
Figure 4. Applied Vacuum in kPa (below atmospheric pressure)

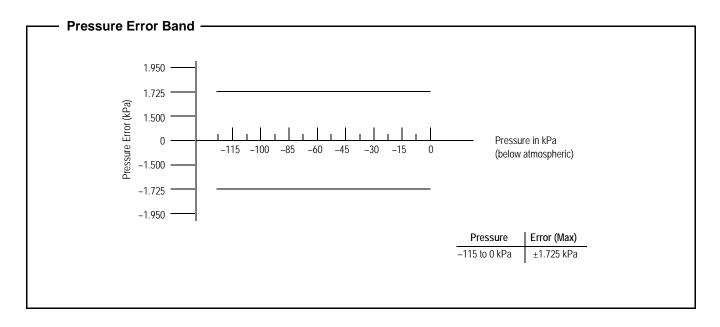
Transfer Function (MPXV4115V) -

Nominal Transfer Value:  $V_{out} = V_S (P \times 0.007652 + 0.92)$ 

 $\pm$  (Pressure Error x Temp. Factor x 0.007652 x  $V_S$ )

 $V_S = 5 V \pm 0.25 Vdc$ 







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

The two sides of the pressure sensor are designated as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing fluorosilicone gel, which protects the die from harsh media. The MPX pressure sensor 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
MPXV4115V6U	482	Side with Part Marking
MPXV4115VC6U	482A	Side with Port Attached

### INFORMATION FOR USING THE SMALL OUTLINE PACKAGE (CASE 482)

#### MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the surface mount packages must be the correct size to ensure proper solder connection interface between the board and the package. With the correct

footprint, the packages will self align when subjected to a solder reflow process. It is always recommended to design boards with a solder mask layer to avoid bridging and shorting between solder pads.

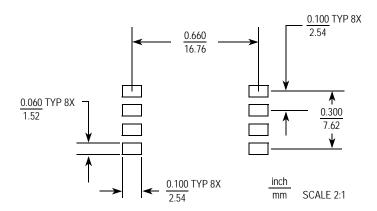
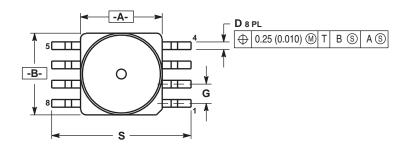
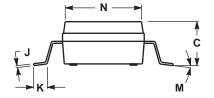


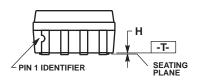
Figure 5. SOP Footprint (Case 482)



#### **PACKAGE DIMENSIONS**



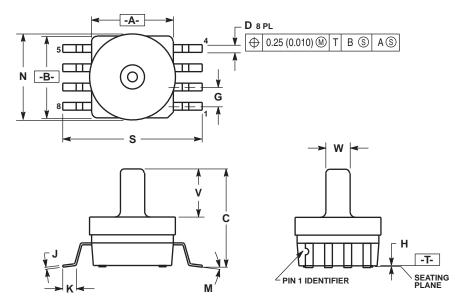




- NOTES:
  1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006).
  5. ALL VERTICAL SURFACES 5' TYPICAL DRAFT.

	INC	HES	MILLIM	ETERS
DIM	MIN	MAX	MIN	MAX
Α	0.415	0.425	10.54	10.79
В	0.415	0.425	10.54	10.79
С	0.212	0.230	5.38	5.84
D	0.038	0.042	0.96	1.07
G	0.100	BSC	2.54	BSC
Н	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0°	7°	0°	7°
N	0.405	0.415	10.29	10.54
S	0.709	0.725	18.01	18 41

#### **CASE 482-01 ISSUE 0 SMALL OUTLINE PACKAGE**



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DIM	MIN	MAX	MIN	MAX
Α	0.415	0.425	10.54	10.79
В	0.415	0.425	10.54	10.79
С	0.500	0.520	12.70	13.21
D	0.038	0.042	0.96	1.07
G	0.100 BSC		2.54 BSC	
Н	0.002	0.010	0.05	0.25
J	0.009	0.011	0.23	0.28
K	0.061	0.071	1.55	1.80
M	0°	7°	0°	7°
N	0.444	0.448	11.28	11.38
S	0.709	0.725	18.01	18.41
٧	0.245	0.255	6.22	6.48
W	0.115	0.125	2.92	3.17

**CASE 482A-01 ISSUE A SMALL OUTLINE PACKAGE** 





## **Table 3. Revision History**

Revision number	Revision date	Description of changes	
4	10/2012	Deleted references to device number MPXV4115V6T1 throughout the document	



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Тел: +7 (812) 336 43 04 (многоканальный) Email: org@lifeelectronics.ru