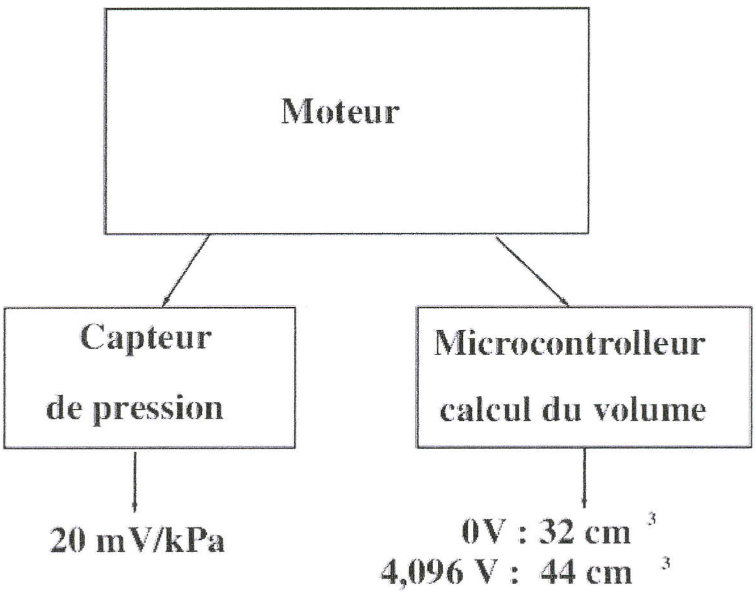
Moteur Stirling

5 juin 2014

1 Présentation

Cette maquette avec son interface permet d'obtenir l'image (tension analogique) de la pression et du volume interne au moteur Stirling, en temps réel.

2 Schéma de principe



2.1 Mesure du volume

- Le dispositif de base est un capteur incrémental de position solidaire de l'axe de rotation. Il fournit 256 impulsions par tour.
- Un micro calculateur permet d'évaluer la position angulaire dans un premier temps, par comptage, et de calculer le volume correspondant sous le piston.
- La détermination correcte du volume suppose de fixer initialement l'origine des angles (voir § 3.4).
- Le résultat de ce calcul est converti en une tension comprise entre 0 V et 4,096 V (voir § 3.4) .

2.2 Mesure de la pression

- Un capteur analogique de pression (MPX 4050A) de sensibilité 20mV/kPa donne une image électrique de la pression. Son temps de réponse est de 1 ms.

3 Utilisation mise en œuvre

1. Brancher le cordon de liaison entre le capteur de position incrémental (documentation PHYWE : sensor unit pVn ref 04371.00) et le boitier d'interface (cf.photo 1).

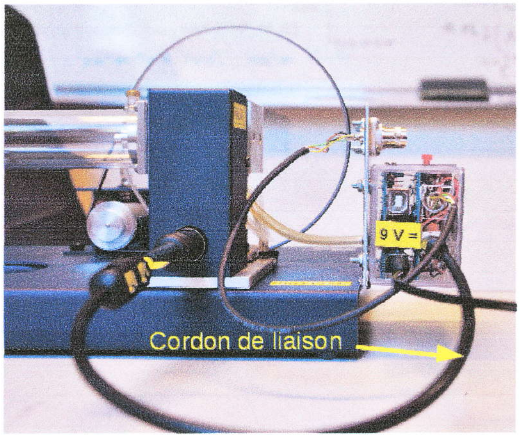
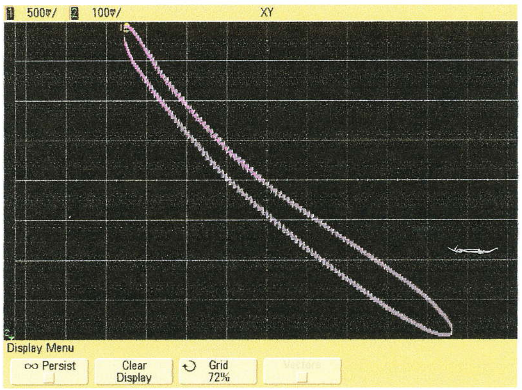


fig 1.

2. Brancher l'alimentation 9V continu du boîtier d'interface.
3. En réponse à cette mise sous tension, la LED rouge clignote.
4. Après s'être assuré que le moteur est susceptible de démarrer (par un lancement à la main), arrêter le moteur. Positionner le piston en position basse, confirmer l'initialisation en appuyant sur le poussoir : la sortie Volume est alors de 0 Volt pour un volume de 32 cm^3 et 4,096 V pour un volume de 44 cm^3 . En réponse la LED reste allumée.
5. Lancer le moteur dans le bon sens de rotation, sans inversion. En cas de retour en arrière, stopper le moteur, débrancher l'alimentation électrique du boitier d'interface, et reprendre la procédure en 2.
6. Les deux fiches BNC permettent de visualiser le volume "V" et la pression "P" à l'oscilloscope. A titre d'exemple, la figure suivante donne le diagramme (V,P) pour le moteur Stirling sans charge mécanique.



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

MPX4250A Series

20 to 250 kPa (2.9 to 36.3 psi)
0.2 to 4.9 V Output

The MPX4250A series Manifold Absolute Pressure (MAP) sensor for engine control is designed to sense absolute air pressure within the intake manifold. This measurement can be used to compute the amount of fuel required for each cylinder.

The MPX4250A 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 or microprocessor 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. The small form factor and high reliability of on-chip integration make the Freescale sensor a logical and economical choice for the automotive system engineer.

Application Examples

- Turbo Boost Engine Control
- Ideally Suited for Microprocessor or Microcontroller-Based Systems

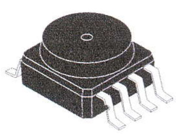
Features

- 1.5% Maximum Error Over 0° to 85°C
- Specifically Designed for Intake Manifold Absolute Pressure Sensing in Engine Control Systems
- Patented Silicon Shear Stress Strain Gauge
- Temperature Compensated Over -40° to +125°C
- Offers Reduction in Weight and Volume Compared to Existing Hybrid Modules
- Durable Epoxy Unibody Element or Thermoplastic Small Outline, Surface Mount Package
- Ideal for Non-Automotive Applications

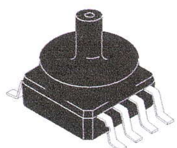
ORDERING INFORMATION

Device Name	Package Options	Case No.	# of Ports			Pressure Type			Device Marking
			None	Single	Dual	Gauge	Differential	Absolute	
Small Outline Package (MPXA4250A Series)									
MPXA4250A6U	Rail	482	•					•	MPXA4250A
MPXA4250AC6U	Rail	482A		•				•	MPXA4250A
MPXA4250AC6T1	Tape and Reel	482A		•				•	MPXA4250A
Unibody Package (MPX4250A Series)									
MPX4250A	Tray	867	•					•	MPX4250A
MPX4250AP	Tray	867B		•				•	MPX4250A

SMALL OUTLINE PACKAGES

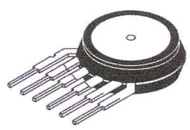


MPXA4250A6U
CASE 482-01

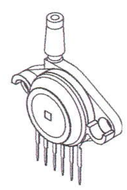


MPXA4250AC6U/C6T1
CASE 482A-01

UNIBODY PACKAGES



MPX4250A
CASE 867-08



MPX4250AP
CASE 867B-04

freescale™ semiconductor

P103.49

Operating Characteristics

Table 1. Operating Characteristics (V_S = 5.1 V_{DC}, T_A = 25°C unless otherwise noted, P1 > P2, Decoupling circuit shown in Figure 3 required to meet electrical specifications.)

Characteristic		Symbol	Min	Typ	Max	Units
Differential Pressure Range(1)		P_{OP}	20	—	250	kPa
Supply Voltage(2)		V_S	4.85	5.1	5.35	V_{DC}
Supply Current		I_O	—	7.0	10	mAdc
Minimum Pressure Offset(3) @ V_S = 5.1 Volts	(0 to 85°C)	V_{OFF}	0.133	0.204	0.274	V_{DC}
Full Scale Output(4) @ V_S = 5.1 Volts	(0 to 85°C)	V_{FSO}	4.826	4.896	4.966	V_{DC}
Full Scale Span(5) @ V_S = 5.1 Volts	(0 to 85°C)	V_{FSS}	—	4.692	—	V_{DC}
Accuracy(6)	(0 to 85°C)	—	—	—	±1.5	$\%V_{FSS}$
Sensitivity		$\Delta V/\Delta P$	—	20	—	mV/kPa
Response Time(7)		t_R	—	1.0	—	msec
Output Source Current at Full Scale Output		I_O+	—	0.1	—	mAdc
Warm-Up Time(8)		—	—	20	—	msec
Offset Stability(9)		—	—	±0.5	—	$\%V_{FSS}$

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range.
3. Offset (V_{OFF}) is defined as the output voltage at the minimum rated pressure.
4. Full Scale Output (V_{FSO}) is defined as the output voltage at the maximum or full rated pressure.
5. 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.
6. Accuracy (error budget) consists of the following:

   Linearity: Output deviation at any temperature 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 the 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 rated pressure applied, over the temperature range of 0° to 85°C, relative to 25°C.

   Variation from Nominal: The variation from nominal values, for Offset or Full Scale Span, as a percent of VFSS, at 25°C.
7. 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.
8. Warm-up Time is defined as the time required for the product to meet the specified output voltage after the pressure is stabilized.
9. 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[1]

Rating	Symbol	Value	Unit
Maximum Pressure[2] (P1 > P2)	P_{MAX}	1000	kPa
Storage Temperature	T_{STG}	-40 to +125	°C
Operating Temperature	T_A	-40 to +125	°C

1. TC = 25°C unless otherwise noted.
2. 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.

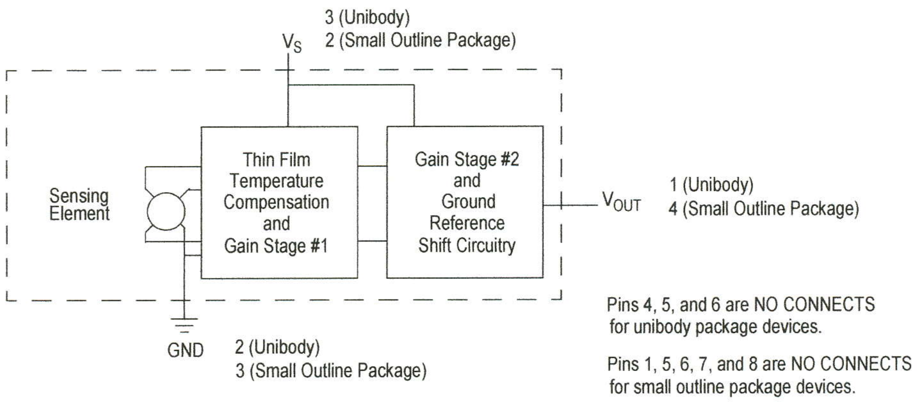


Figure 1. Fully Integrated Pressure Sensor Schematic for Unibody Package and Small Outline Package

On-chip Temperature Compensation and Calibration

Figure 2 illustrates the absolute pressure sensing chip in the basic chip carrier (Case 867). A fluorosilicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the sensor diaphragm.

The MPX4250A series pressure sensor operating characteristics and internal reliability and qualification tests are based on use of dry air as the pressure media. Media, other than dry air, may have adverse effects on sensor performance and long-term reliability.

Contact the factory for information regarding media compatibility 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.

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

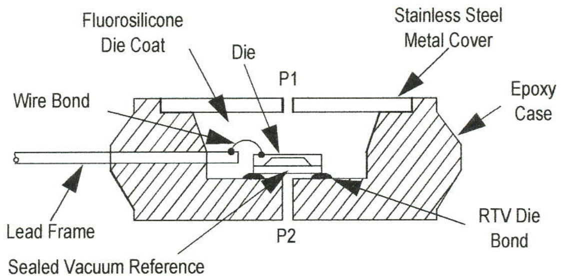


Figure 2. Cross Sectional Diagram (not to scale)

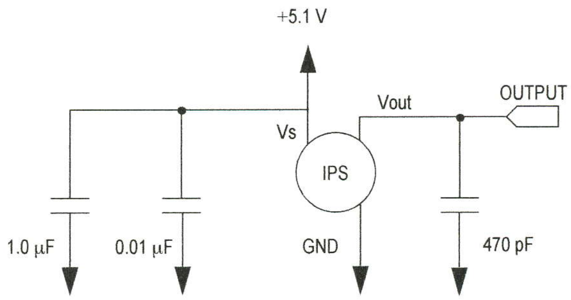


Figure 3. Recommended Power Supply Decoupling and Output Filtering
(For additional output filtering, please refer to Application Note AN1646)

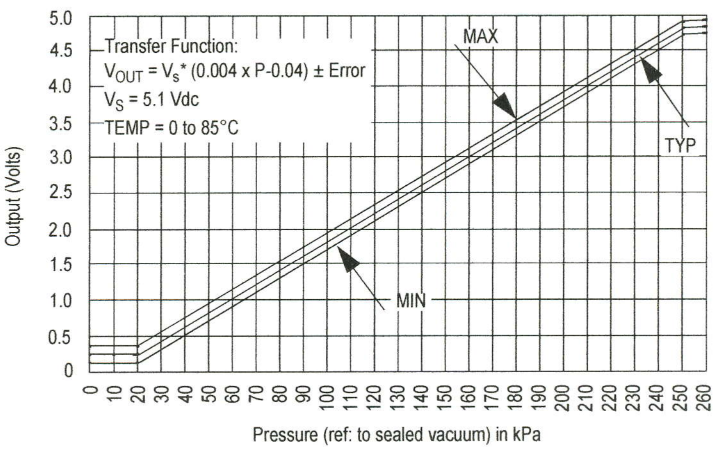
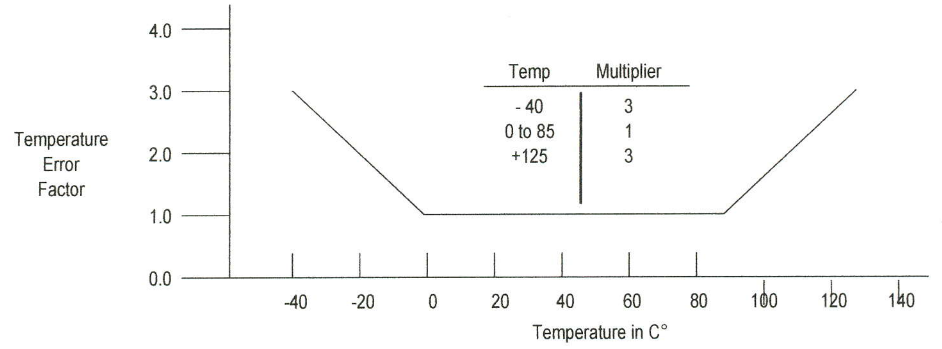


Figure 4. Output versus Absolute Pressure

Transfer Function

Nominal Transfer Value: $V_{OUT} = V_S (P \times 0.004 - 0.04)$
$\pm$ (Pressure Error $\times$ Temp. Factor $\times$ $0.004 \times V_S$)
$V_S = 5.1\ V \pm 0.25\ V_{DC}$

Temperature Error Band



NOTE: The Temperature Multiplier is a linear response from 0× to -40°C and from 85° to 125°C.

Pressure Error Band