Freescale Semiconductor

MPL115A2
Rev 5, 08/2009

Miniature I²C Digital Barometer

The MPL115A2 is an absolute pressure sensor with digital output for low cost applications. A miniature 5 x 3 x 1.2 mm LGA package ideally suits it for portable electronics and space constrained applications. Low current consumptions of 5 μA during Active mode and 1 μA during Shutdown (Sleep) mode target battery and other low-power applications. A wide operating temperature range from -40°C to +105°C fits demanding environmental requirements.

MPL115A2 employs a MEMS pressure sensor with a conditioning IC to provide accurate pressure measurement from 50 to 115 kPa. An integrated ADC provides digitized temperature and pressure sensor outputs via an I²C port. Calibration Data is stored in internal ROM. Utilizing raw sensor output, the host microcontroller executes a compensation algorithm to render *Compensated Absolute Pressure* with 1 kPa accuracy.

The MPL115A2 pressure sensor's small form factor, low power capability, precision, and digital output optimize it for barometric measurement applications.

Features

- Digitized pressure and temperature information together with programmed calibration coefficients for host micro use.
- Factory Calibrated
- 50 kPa to 115 kPa Absolute Pressure
- 1 kPa Accuracy
- 2.375 V to 5.5 V Supply
- Integrated ADC
- I²C Interface
- Monotonic Pressure and Temperature Data Outputs
- Surface Mount RoHS Compliant Package

MPL115A2
50 to 115 kPa

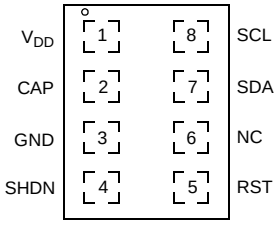
Application Examples

- Barometry (portable and desk-top)
- Altimeters
- Weather Stations
- Hard Disk-Drives (HDD)
- Industrial Equipment
- Health Monitoring
- Air Control Systems

ORDERING INFORMATION									
Device Name	Package Options	Case No.	# of Ports			Pressure Type			Digital Interface
			None	Single	Dual	Gauge	Differential	Absolute	
MPL115A2T1	Tape & Reel	2015	•					•	I²C

LGA PACKAGE

MPL115A2
5.0 mm X 3.0 mm X 1.2 mm MAX



PIN CONNECTIONS

Pin Description

PIN	NAME	FUNCTION
1	VDD	VDD Power Supply Connection.
2	CAP	External Capacitor
3	GND	Ground
4	SHDN	Shutdown (Sleep): Connect to GND to disable the device.
5	RST	Reset: Drive line low to disable I²C communications.
6	NC	NC: No connection.
7	SDA(1)	SDA: Serial data I/O line.
8	SCL(1)	I²C Serial Clock Input.

1. Use 4.7k pull-up resistors for I²C communication.

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Maximum Ratings

Voltage (with respect to GND unless otherwise noted)
V_{DD} ..... -0.3 V to +5.5 V
SCLK, $\overline{CS}$, D_{IN}, D_{OUT} ..... -0.3 V to V_{DD}+0.3 V
Operating Temperature Range ..... -40°C to +105°C
Storage Temperature Range..... -40°C to +125°C
Overpressure ..... 1000 kPa

Operating Characteristics

(V_{DD} = 2.375 V to 5.5 V, T_A = -40°C to +105°C, unless otherwise noted. Typical values are at V+ = 3.3 V, T_A = +25°C.

Ref	Parameters	Symbol	Conditions	Min	Typ	Max	Units
1	Operating Supply Voltage	V_{DD}		2.375	3.3	5.5	V
2	Supply Current	I_{DD}	Shutdown (SHDN = GND)	—	—	1	µA
			Standby	—	3.5	10	µA
			Average – at one measurement per second	—	5	6	µA
Pressure Sensor							
3	Range			50	—	115	kPa
4	Resolution			—	0.15	—	kPa
5	Accuracy		-20ºC to 85ºC	—	±1	—	kPa
6	Power Supply Rejection		Typical operating circuit at DC	—	0.1	—	kPa/V
			100 mV p-p 217 Hz square wave plus 100 mV pseudo random noise with 10 MHz bandwidth.	—	0.1	—	kPa
7	Conversion Time (*Start Pressure Convert*)	tcp	Time between start convert command and data available in the Pressure register	—	0.6	0.7	ms
Temperature Sensor							
8	Range			-40	—	105	ºC
9	Conversion Time *(Start Temperature Convert*)	tct	Time between start convert command and data available in the Temperature register	—	0.6	0.7	ms
10	Conversion Time *(Start Both Convert*)	tcb	Time between start convert command and data available in the Pressure and Temperature registers	—	0.8	1	ms
11	Resolution		Temperature ADC is 472 counts at 25ºC	—	-5.35	—	counts/ºC
I^2C I/O Stages: SCL, SDA							
12	SCL Clock Frequency	f_{SCL}		—	—	400	KHz
13	Low Level Input Voltage	VIL		—	—	$0.3V_{DD}$	V
14	High Level Input Voltage	VIH		$0.7V_{DD}$	—	—	V
I^2C Outputs: SDA							
15	Data Setup Time	t_{SU}	Setup time from command receipt to ready to transmit	100	—	—	ns
I^2C Addressing							
MPL115A2 uses 7-bit addressing, does not acknowledge the general call address 0000000. Slave address has been set to 0x60 or 1100000.							

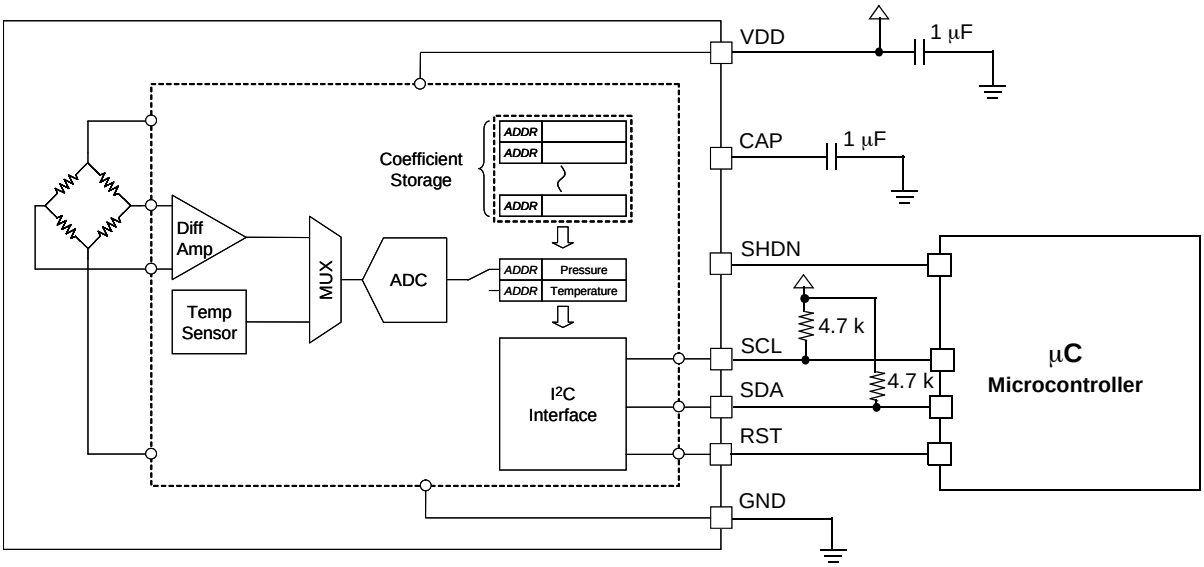


Figure 1. Block Diagram

Compensation

The pressure compensation for MPL115A2 is based on a 2-dimensional, second order polynomial.

The 10-bit compensated pressure output, Pcomp, is calculated as follows:

Pcomp = a0 + (b1 + c11*Padc + c12*Tadc) * Padc + (b2 + c22*Tadc) * Tadc

Where:

Padc is the 10-bit pressure output of the MPL115A2 ADC,

Tadc is the 10-bit temperature output of the MPL115A2 ADC,

a0 is the pressure offset coefficient,

b1 is the pressure sensitivity coefficient,

c11 is the pressure linearity (2nd order) coefficient,

c12 is the coefficient for temperature sensitivity coefficient (TCS),

b2 is the 1st order temperature offset coefficient (TCO),

c22 is the 2nd order temperature offset coefficient.

Ideally, Pcomp will produce a value of 0 with an input pressure of 50 kPa and will produce a full-scale value of 1023 with an input pressure of 115 kPa.

Coefficient Bit-Width Specs

The table below specifies the initial coefficient bit-width specs for the compensation algorithm.

10-bit Output: Compensation Coefficient Specs							Total Coeff. Bits
	a0	b1	b2	c12	c11*	c22*	
Total Bits	16	16	16	14	11	11	84
Sign Bits	1	1	1	1	1	1	
Integer Bits	12	2	1	0	0	0	
Fractional Bits	4	13	14	13	11	10	
dec pt zero pad	—	—	—	9	11	15	

* Factory reserves the option to make these values = 0.

Example Binary Format Definitions:

1. Sign = 0, Integer Bits = 8, Fractional Bits = 4 : Coeff = S I_7 I_6 I_5 I_4 I_3 I_2 I_1 I_0 . F_3 F_2 F_1 F_0
2. Sign = 1, Integer Bits = 4, Fractional Bits = 7 : Coeff = S I_3 I_2 I_1 I_0 . F_6 F_5 F_4 F_3 F_2 F_1 F_0
3. Sign = 0, Integer Bits = 0, Fractional Bits = 6, dec pt zero pad = 2 : Coeff = S 0 . 0 0 F_5 F_4 F_3 F_2 F_1 F_0
4. Sign = 0, Integer Bits = 0, Fractional Bits = 5, dec pt zero pad = 3 : Coeff = S 0 . 0 0 0 F_4 F_3 F_2 F_1 F_0

NOTE: Negative coefficients (Sign = 1) are coded in 2's complement notation.

Coefficient Address Map

Address	Coefficient
$04	a0 MS Byte
$05	a0 LS Byte
$06	b1 MS Byte
$07	b1 LS Byte
$08	b2 MS Byte
$09	b2 LS Byte
$0A	c12 MS Byte
$0B	c12 LS Byte
$0C	c11 MS Byte
$0D	c11 LS Byte
$0E	c22 MS Byte
$0F	c22 LS Byte

For coefficients with less than 16 bits, the lower lsbs are zero. For example, c11 is 11 bits and is stored into 2 bytes as follows:

c11 MS byte = c11[10:3] = [$c11_{b10}$, $c11_{b9}$, $c11_{b8}$, $c11_{b7}$, $c11_{b6}$, $c11_{b5}$, $c11_{b4}$, $c11_{b3}$]

c11 LS byte = c11[2:0] & "00000" = [$c11_{b2}$, $c11_{b1}$, $c11_{b0}$, 0 , 0 , 0 , 0 , 0]

Solder Recommendations

1. Use SAC solder alloy (i.e., Sn-Ag-Cu) with a melting point of about 217°C. It is recommended to use SAC305 (i.e., Sn-3.0 wt.% Ag-0.5 wt.% Cu).
2. Reflow
   - Ramp up rate: 2 to 3 C/s.
   - Preheat flat (soak): 110 to 130s.
   - Reflow peak temperature: 250°C to 260°C (depends on exact SAC alloy composition).
   - Time above 217°C: 40 to 90s (depends on board type, thermal mass of the board/quantities in the reflow).
   - Ramp down: 5 to 6 C/s.
   - Using an inert reflow environment (with O2 level about 5 to 15 ppm).

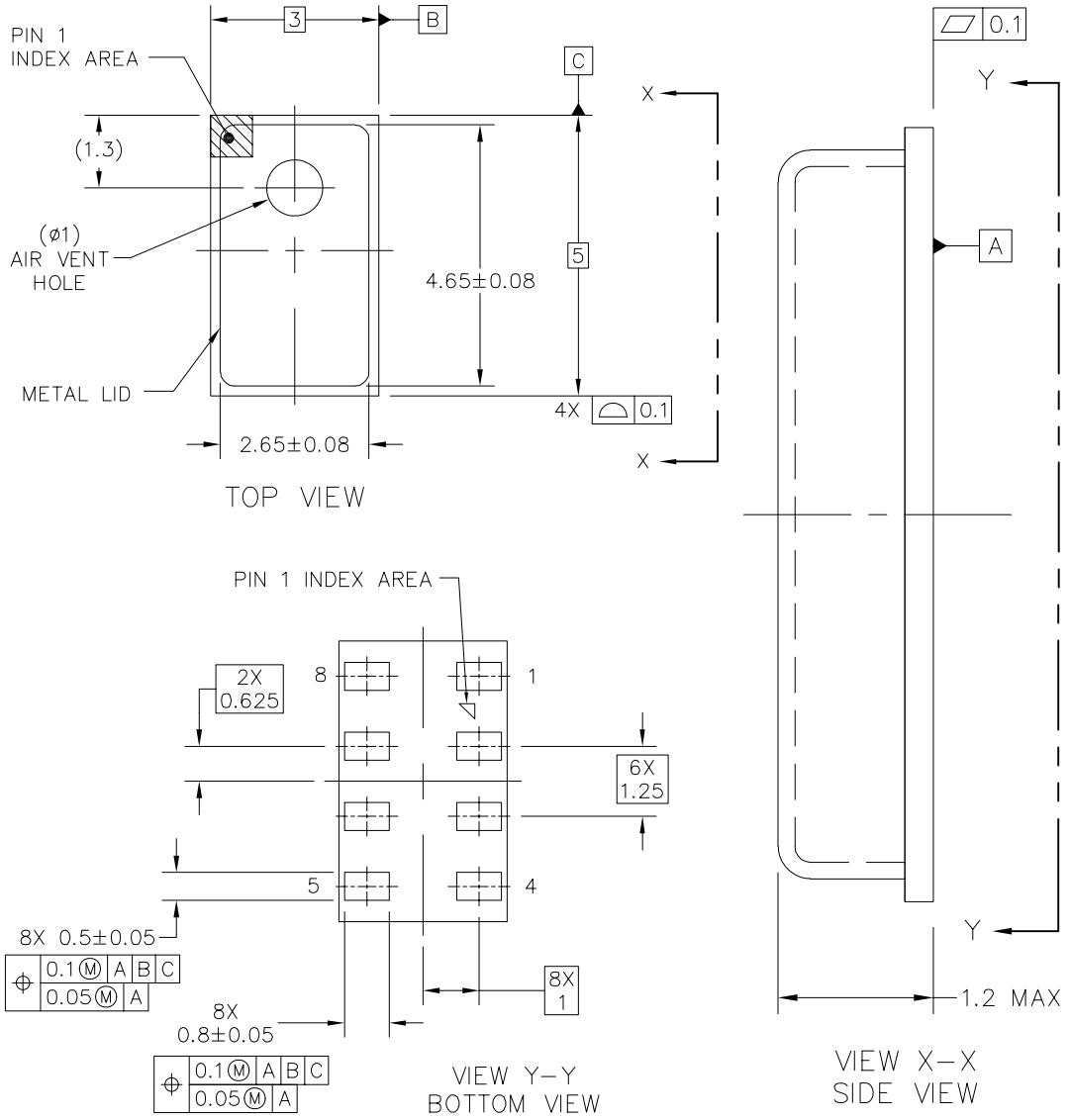
NOTE: The stress level and signal offset of the device also depends on the board type, board core material, board thickness and metal finishing of the board.

Handling Recommendations

It is recommended to handle the MPL115A Pressure Sensor with a vacuum pick and place tool. Sharp objects utilized to move the MPL115A Pressure Sensor increase the possibility of damage via a foreign object/tool into the small exposed port.

The sensor die is sensitive to light exposure. Direct light exposure through the port hole can lead to varied accuracy of pressure measurement. Avoid such exposure to the port during normal operation.

PACKAGE DIMENSIONS



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	CASE NUMBER: 2015–02	15 APR 2009
	STANDARD: NON–JEDEC	

CASE 2015-02
ISSUE O
LGA PACKAGE

PACKAGE DIMENSIONS

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS.

2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

3. STYLE:
   PIN 1: VDD PIN 5: CS
   PIN 2: CAP PIN 6: DOUT
   PIN 3: GND PIN 7: DIN
   PIN 4: SHDN PIN 8: SCLK

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LGA PACKAGE

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