S123

Data Sheet

Digital Barometer

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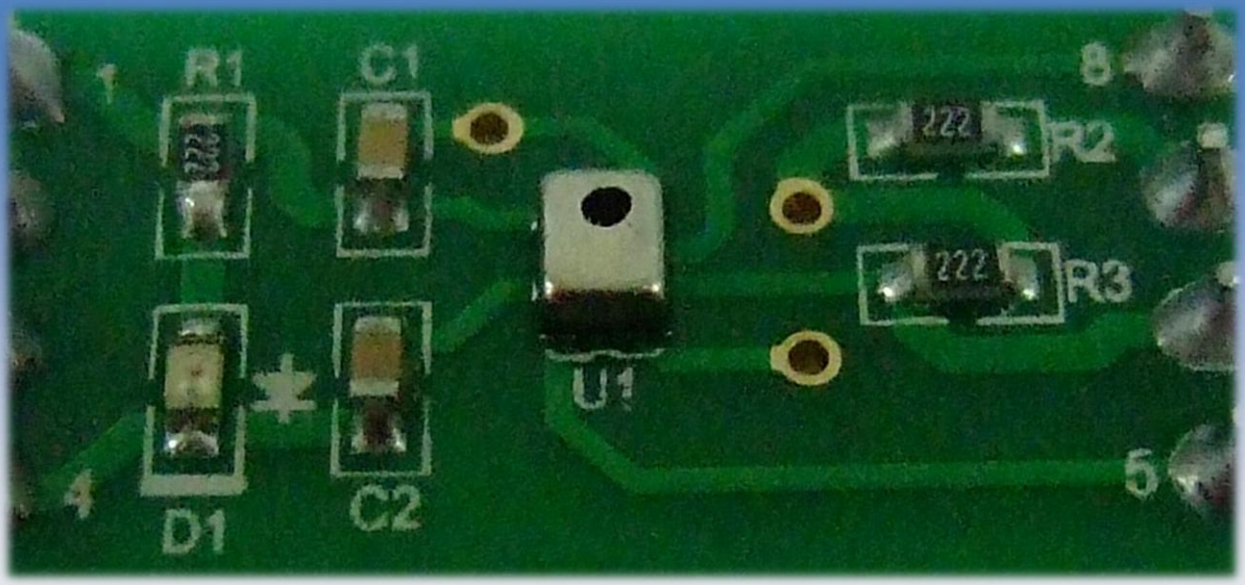
DAT-0016



S123

Digital Barometer

Overview

The S123 SIP (System-in-a-Package) solution comprises of a resistive bridge type pressure sensor and a 24-bit ADC for high resolution and accurate pressure measurements. The fully calibrated pressure and temperature compensated digital output makes the S123 solution simple to use. The ADC comprise of an internal calibration logic that provides accurate pressure and temperature measurements to the application via the SPI or I²C interface. There is no need to separately download internal calibration coefficients and have the host micro-controller conduct complicated compensation calculations.

Applications

- Altimeters
- Portable and Stationary Barometers
- Weather Stations
- GPS Applications
- Hard Disk Drives(HDD)
- Industrial Equipment
- Air Control Systems
- Vacuum Systems

Benefits

- Low Power Consumption. Excellent for Battery and Other Low-Power Applications
- External Clock not Required
- High Resistance to Sensing Media

Features

- Factory Calibrated Pressure and Temperature Sensor
- Supply Voltage: 2V to 5.5V
- Current Consumption: <5uA
- Sleep State Current: <200nA (25°C)
- Operating Temperature Range: -40°C to +85°C
- Pressure Accuracy: <±0.4kPa (<±4.0mbar) @ 25°C
- Temperature Accuracy: ±1.0°C
- Altitude Resolution Better Than 1.0 meter (50cm) in Active Mode

Interfaces

- I²C™ * Compatible (≤400kHz)
- SPI (≤ 10MHz)

Physical Characteristics

- Small Form Factor, 2.5 x 2 x 1mm (w x l x h)
- LGA Package, 8 Lead
- Top Side Sensing Port

*I²C™ is a registered trademark of NXP

S123 BLOCK DIAGRAM

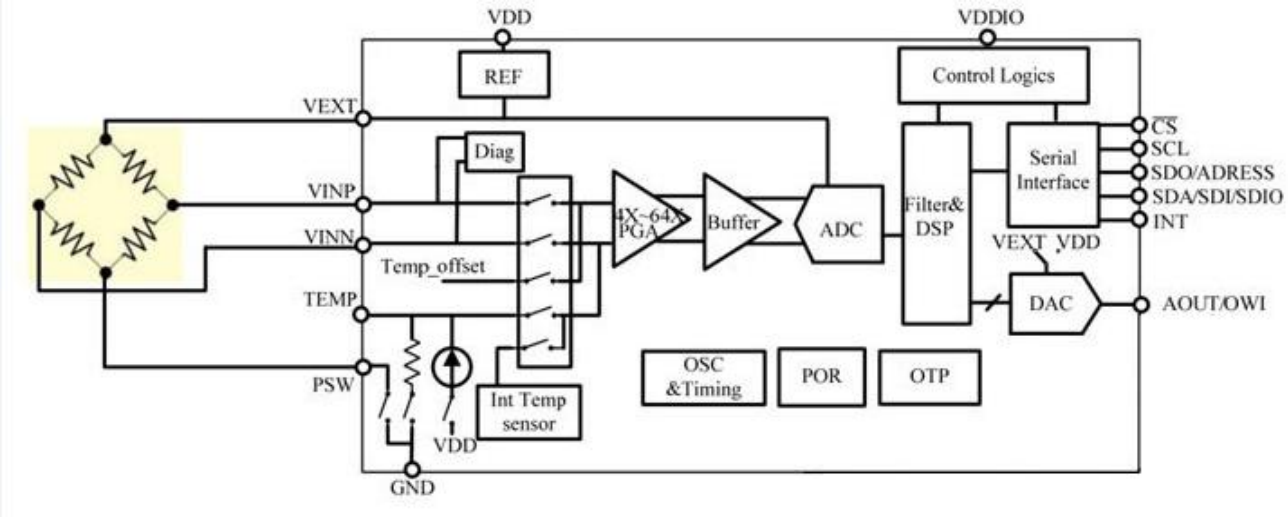


TABLE 1: ORDERING INFORMATION

PART NUMBER	OUTPUT MODE	OPERATION MODE	PACKAGE
S123	I²C and SPI	Sleep	8-Lead LGA
SALES and CONTACT INFORMATION			
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1 OPERATING CHARACTERISTICS

1.1 ABSOLUTE RATINGS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Over Pressure					2X FS	kPa (bar)
Supply Voltage (with respect to GND)	V_{DD}		-0.3		6.5	V
Voltages at Analog and Digital I/O Pins	V_{A_IO} V_{D_IO}		-0.3		V_{DD} +0.3	V
Storage Temperature	T_{STOR}		-60		150	°C

1.2 OPERATING CONDITIONS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
PRESSURE SENSOR						
Range			30 (300)		130 (1300)	kPa (mbar)
Resolution				0.001 (0.01)		kPa (mbar)
Accuracy		70 to 115kPa @25°C	-0.4 (-4.0)	±0.30 (±3.0)	+0.4 (+4.0)	kPa (mbar)
		70 to 115kPa (0°C to 50°C Verified)	-0.6 (-6.0)	±0.50 (±5.0)	+0.6 (+6.0)	kPa (mbar)
Range			-40		85	°C
Resolution				0.003		°C
Accuracy		-40°C to 85°C	-1	±0.75	+1	°C
Supply Voltage to GND[1]	V_{SUPPLY}		2	3.0	5.5	V
Operating Temperature Range[2]			-40		85	°C
I²C Pull-Up Resistors	R_{PU}		1	2.2		kΩ

[1] Factory calibrated for Pressure and Temperature at 3.0V±10%. Output accuracy will be affected if used outside this range. Other ranges available upon request.

1.3 ELECTRICAL PARAMETERS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SUPPLY CURRENT						
Supply Current, average(1) during conversion(2) standby(no conversion)	 Iavg Isc Iss	VDD=3V		 3.95 1.5	 0.2	 µA mA uA
ANALOG TO DIGITAL CONVERTER						
Resolution	r_{ADC}				24	Bit
SPI Clock Frequency	$F_{C,SPI}$				10	MHz
I²C Clock Frequency	$F_{C,I2C}$				400	kHz

Notes

1) Under the assumption of one conversion every second. Conversion means either a pressure or a temperature measurement
2) During conversion, the sensor will be switched on to VDD, and after conversion ended, the sensor will automatically be switched off from VDD.

2 OPERATION MODES

The S123 is factory programmed in Sleep Mode. In Sleep Mode, the S123 waits for commands from the master before taking measurements. After it receives a MR command, it runs a full measurement, and then turns into sleep mode again.

3 OUTPUT MODES

3.1 I²C AND SPI

Two-wire I²C and SPI are available for reading data from the S123. The interface is selectable by the voltage level on the CSB pin:

- CSB = 0 → SPI Mode
- CSB = 1 or float→ I²C Mode

When CSB=0, SPI mode is selected. When CSB = 1 or not connected (IC internal pull-up at CSB pin).

The factory setting for the I²C slave address is 0x6D and the communication is restricted to this address only.

3.1.1 I²C AND SPI COMMANDS

Table 2 details the commands to interface with the device in the I²C and SPI modes.

TABLE 2: I²C AND SPI COMMANDS

TYPE	DESCRIPTION	SUPPORT
Get Data (GD)	Used to Get Data in Active Mode, and Automatically Turns into Sleep Mode Again	I²C and SPI
Measurement Request (MR)	Used to Enter Active Mode from Sleep Mode, and Take a Measurement	I²C and SPI

The Get Data (GD) command is used to get data in Active mode. With the start of communication (for I²C after reading the slave address; for SPI at the falling-edge of CSB) the entire output packet will be loaded in a serial output register. The register will be updated after the communication is finished. The output is always scaled to 24-bits.

The ordering of the bits is “big-endian”.

3.1.1.1 I²C GET DATA

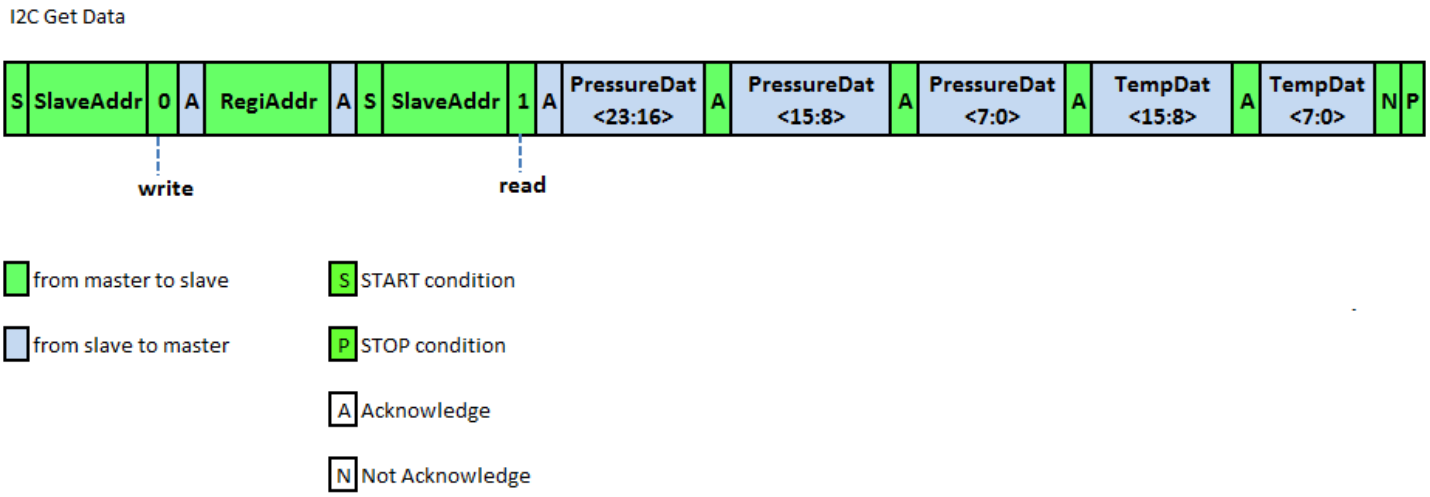
An I²C Get Data command starts with the 7-bit slave address and the 8th bit = 1 (READ). The device as the slave sends and acknowledges (ACK) indicating success. The number of data bytes returned by the device is determined by when the master sends the NACK and stop condition.

Figure 1 shows examples of receiving a total of 8 bytes. The first byte contains the I²C address followed by internal register address(0x06), and then restart again, with I²C address, three pressure bytes and two temperature bytes then output.

In Figure 1, the last five bytes returns 3 bytes of pressure data followed by 2 bytes of temperature data.

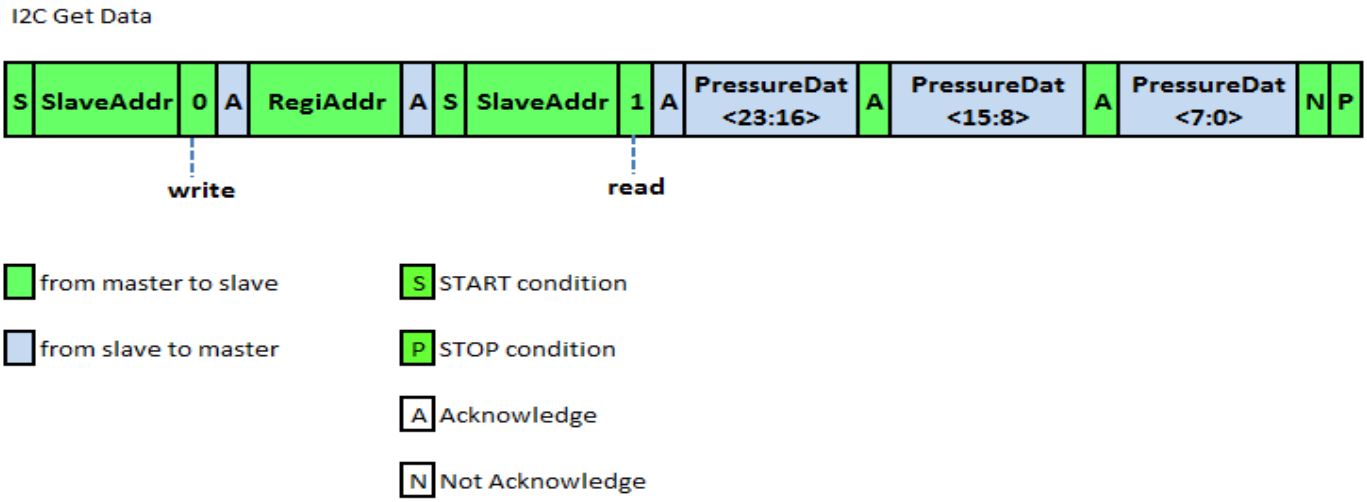
After executing the MR command, use the GD command to retrieve the Pressure and Temperature raw output counts.

2 bytes temperature counts are in 2’s complement code.



For Pressure data only, the data stream can be terminated after the sixth pressure byte. See Figure 2 below.

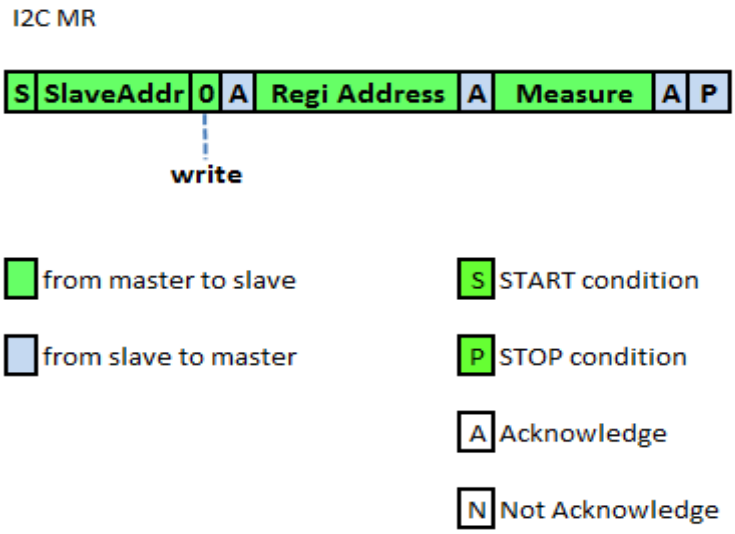
FIGURE 2: 7-BIT SLAVE ADDRESS FOLLOWED BY THREE PRESSURE BYTES



3.1.1.2 I²C MEASUREMENT REQUEST

The I²C MR is used to wake up the device in Sleep Mode and start a complete cycle starting with the Pressure measurement, followed by the Temperature measurements; after the DSP calculations. The results are then written to the digital output register. As shown in Figure 6, the communication contains firstly the slave address and the WRITE bit (0), and then the Register Address of 0x30, finally 0xA for measurement, sent by the master. After the IC responds with the slave ACK, the master creates a stop condition.

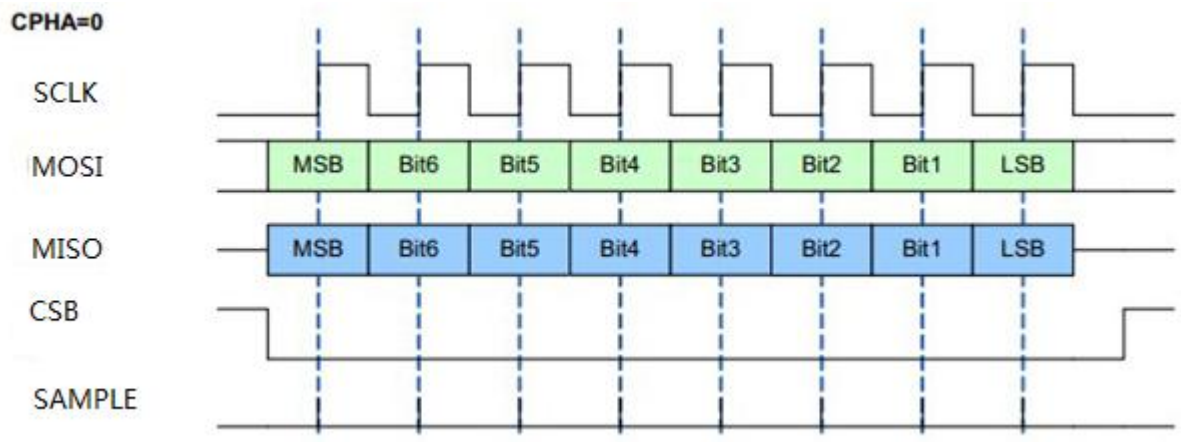
FIGURE 3: I²C MEASUREMENT REQUEST COMMAND (0xA)



3.1.1.3 SPI GET DATA

The SPI Mode is available when the CSB pin =0. The default is set for Data latch on rising edge and data output on the falling edge of SCLK.

FIGURE 4: DEFAULT SPI INTERFACE MODE



As seen in Figure 5, the entire output packet is 15 bytes. Command 0x80 means 'Read only' and 0x06 to 0x0A are for the address of pressure and temperature values stored. If the user only requires the corrected Pressure value, the read can be terminated after the 9th byte

FIGURE 5: SPI GET DATA AFTER MEASUREMENT REQUEST

MOSI	Command = 0x80	Command = 0x06	00_{HEX}	Command = 0x80	Command = 0x07	00_{HEX}	Command = 0x80	Command = 0x08	00_{HEX}	Command = 0x80	Command = 0x09	00_{HEX}	Command = 0x80	Command = 0x0A	00_{HEX}
MISO	00_{HEX}	00_{HEX}	PressDat <23:16>	00_{HEX}	00_{HEX}	PressDat <15:8>	00_{HEX}	00_{HEX}	PressDat <7:0>	00_{HEX}	00_{HEX}	TempDat <15:8>	00_{HEX}	00_{HEX}	TempDat 7:0>

3.1.1.4 SPI MEASUREMENT REQUEST

The SPI MR is used to wake up the device in Sleep mode and start a complete Pressure measurement and Temperature measurement cycle. The SPI command request always consists of 3 bytes. The 1st byte is 0x00 means 'Write only', and the 2nd byte 0x30 means register address, 0xA is for the value need to be written into 0x30.

FIGURE 6: SPI MEASUREMENT REQUEST COMMAND

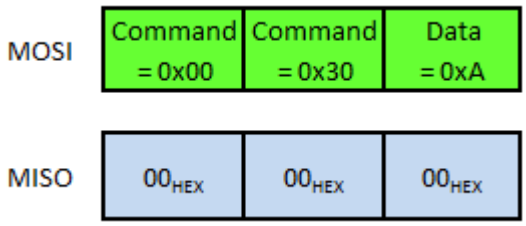
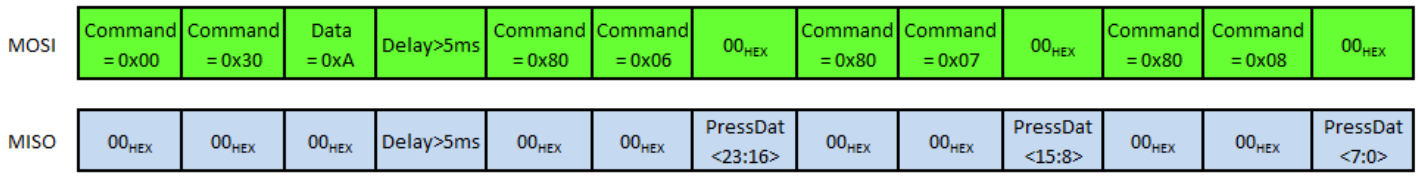


FIGURE 7: SPI MEASUREMENT REQUEST FOLLOWED BY GET PRESSURE DATA COMMAND



4 CALCULATING OUTPUT

After retrieving the data, the compensated output can be calculated by following the equations below.

4.1 PRESSURE OUTPUT

An example of the 24-bit compensated pressure with a full scale range of 30 to 130kPa can be calculated as follows:

Pressure [kPa] = (Pressure 3rd Byte [23:16] x 65536 + Pressure 2nd Byte [15:8] x 256 + Pressure 1st Byte [7:0]) / 2^6 /1000

4.2 TEMPERATURE OUTPUT

The 16-bit compensated temperature can be calculated as follows:

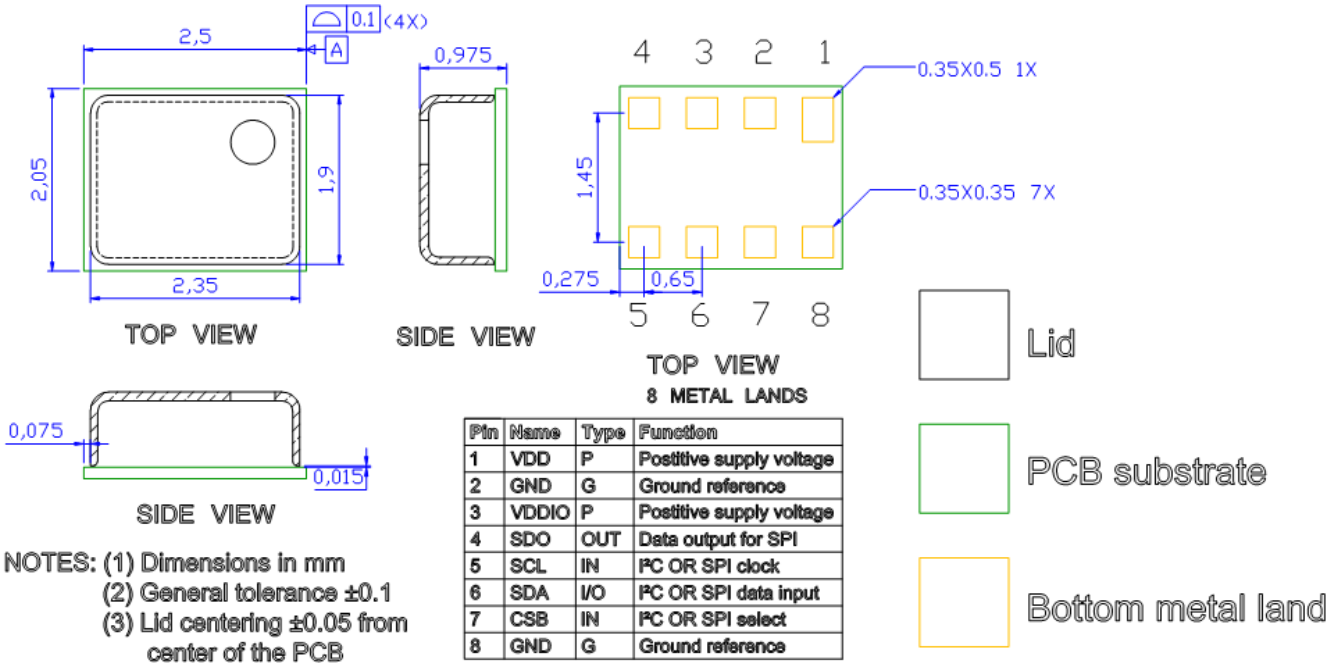
Positive Temperature [°C] = (Temperature High Byte [15:8] x 256 + Temperature Low Byte [7:0]) / 2^8

Negative Temperature [°C] = (Temperature High Byte [15:8] x 256 + Temperature Low Byte [7:0]-65536) / 2^8

5 PACKAGE AND ASSEMBLY

The S123 is available in a LGA package.

5.1 PIN ASSEMBLY AND MECHANICAL DRAWING



Pin	Name	Type	Function
1	VDD	P	Positive supply voltage
2	GND	G	Ground reference
3	VDDIO	P	Positive supply voltage
4	SDO	OUT	Data output for SPI
5	SCL	IN	I²C OR SPI clock
6	SDA	I/O	I²C OR SPI data input
7	CSB	IN	I²C OR SPI select
8	GND	G	Ground reference

5.2 SOLDERING CONDITIONS

TABLE 4: PACKAGE REFLOW TEMPERATURE

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Soldering Peak Temperature	Less than 30 seconds (JEDEC-STD-020 Standard)			260	°C

6 DOCUMENT HISTORY

REVISION	DATE	DESCRIPTION
0	24-Nov-2014	Initial Release

7 DISCLAIMER

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