Low Pressure Sensor
16 Bit Digital I^{2}C Output

SM5238-BCP-S-060-000

FEATURES

- Pressure range from 0 to 60 cmH$_2$O
- 5 V operation (3.3 V available as an option)
- 16 bit digital I^{2}C output
- Compensated temperature range: -10 to 85°C
- Gage pressure configuration
- Insensitive to mounting orientation
- Pressurized from backside to protect topside electronics

DESCRIPTION

The SM5238-BCP-S-060-000 is a digital, low pressure MEMS sensor offering state-of-the-art pressure transducer technology and CMOS mixed signal processing technology to produce a digital, fully conditioned, pressure and temperature compensated sensor in an SO16 package with dual vertical porting. It is available in a gage pressure configuration.

Combining the pressure sensor with a signal-conditioning ASIC in a single package simplifies the use of advanced silicon micro-machined pressure sensors. The pressure sensor can be mounted directly on a standard printed circuit board and a high level, calibrated pressure signal can be acquired from the digital output. This eliminates the need for additional circuitry, such as a compensation network or microcontroller containing a custom correction algorithm.

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Absolute Maximum Ratings

All parameters are specified at Vdd = 5.0 V supply voltage at 25°C, unless otherwise noted.

No.	Characteristic	Symbol	Minimum	Typical	Maximum	Units
1	Supply Voltage	V_{DD}	0.0		6.0	V
2	Operating Temperature	T_{OP}	-20		+85	°C
3	Storage Temperature	T_{STG}	TBD	-	TBD	°C

No.	Product Number	Operating Pressure	Proof Pressure (P_{PROOF})[a, b]	Burst Pressure (P_{BURST})[a, c]
4	SM5238-BCP-S-060-000	$0 - 60$ cmH$_2$O	TBD	TBD

Notes:

a. Tested on a sample basis.

b. Proof pressure is defined as the maximum pressure to which the device can be taken and still perform within specifications after returning to the operating pressure range

c. Burst pressure is the pressure at which the device suffers catastrophic failure resulting in pressure loss through the device.

| No.	Characteristic	Symbol	Minimum	Typical	Maximum	Units
5	Supply Voltage [d]	V_{DD}	4.75	5.0	5.25	V
6	Supply Current	I_{VDD}		3.3		mA
7	Sleep Mode Current	I_{SLEEP}		<10		µA
8	Digital Output Resolution				16	Bits
9	Digital Pressure Output @ P_{MIN} (0 cmH$_2$O)	$DOUT_{MIN}$		-26214		Counts
10	Digital Pressure Output @ P_{MAX} (60 cmH$_2$O)	$DOUT_{MAX}$		+26214		Counts
11	Digital Full Scale Span	DFS		52428		Counts
12	Compensated Temperature Range	T_{COMP}	-10		+85	°C
13a	Accuracy – Mid Range [e, f]	ACC_{MID}	-0.67		+0.67	%FS
13b	Accuracy – Extended Range [e, g]	ACC_{EXT}	-1.33		+1.33	%FS
14	Update Rate			0.5		ms

Notes:

d. 3.3 V supply voltage is also available as an option.

e. The accuracy specification includes the combination of linearity, repeatability, and hysteresis errors over pressure and temperature .

f. The best case accuracy is achieved for pressures from 5 to 40 cmH$_2$O and temperatures from 0 to 40°C. See graphs on the next page.

g. The worst case accuracy is achieved for pressures from 0 to 5 cmH$_2$O and from 40 to 60 cmH$_2$O and temperatures from -10 to 0°C and from 40°C to 85°C. See graphs on the next page.

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Accuracy over Pressure and Temperature
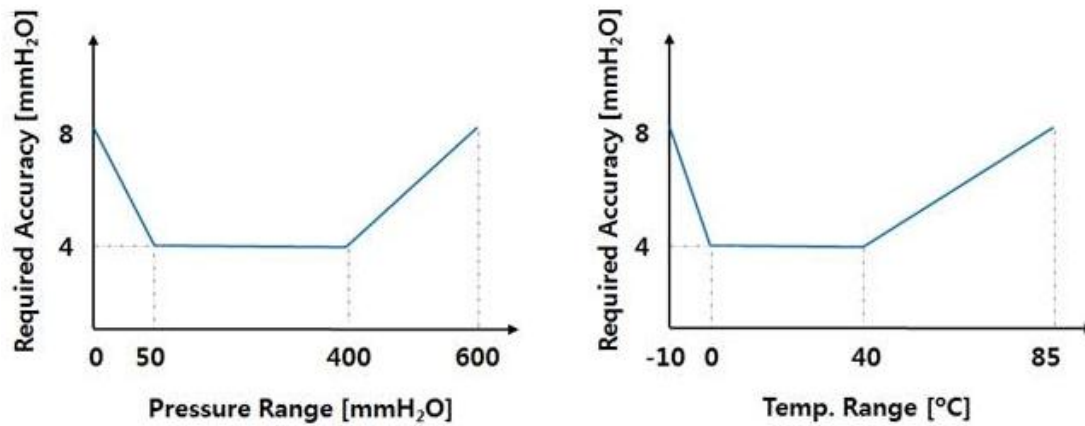

SO16 Dual Vertical Package Dimensions
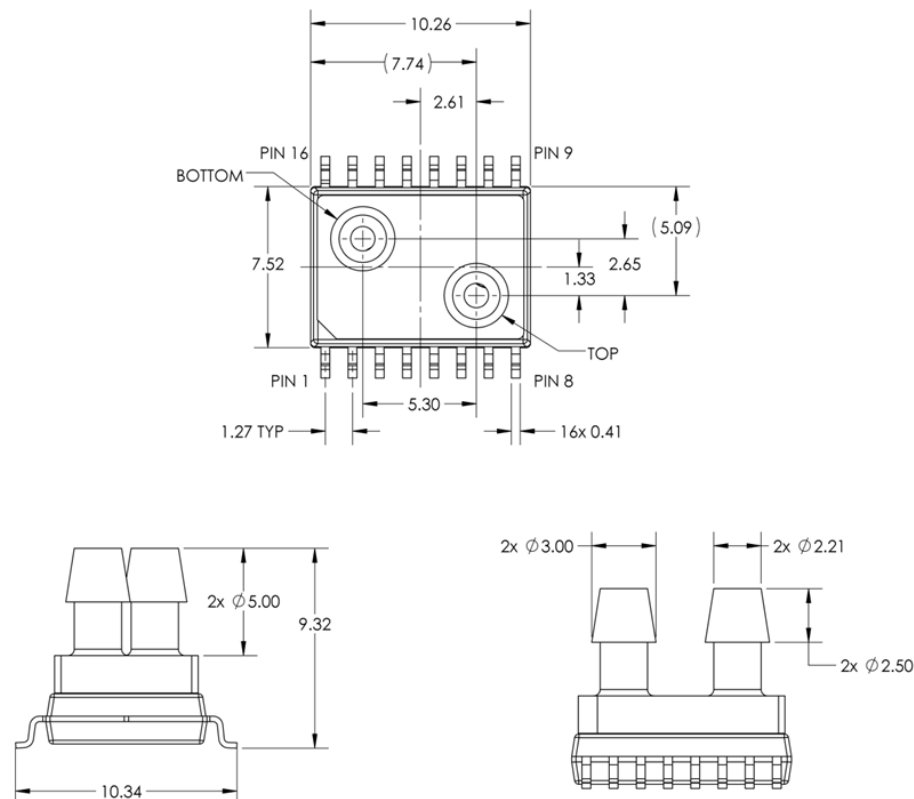
Notes:
- All dimensions in units of [mm]
- Moisture Sensitivity Level (MSL): Level 3
- Wetted materials: Silicon, glass, gold, aluminum, copper, stainless, epoxy, mold compound.
- [B] is tube connected to bottom side of sensor die. Bottom side pressure is positive pressure. An increase in bottom side pressure will result in an increase in sensor output.
- [T] is tube connected to top side of sensor die.

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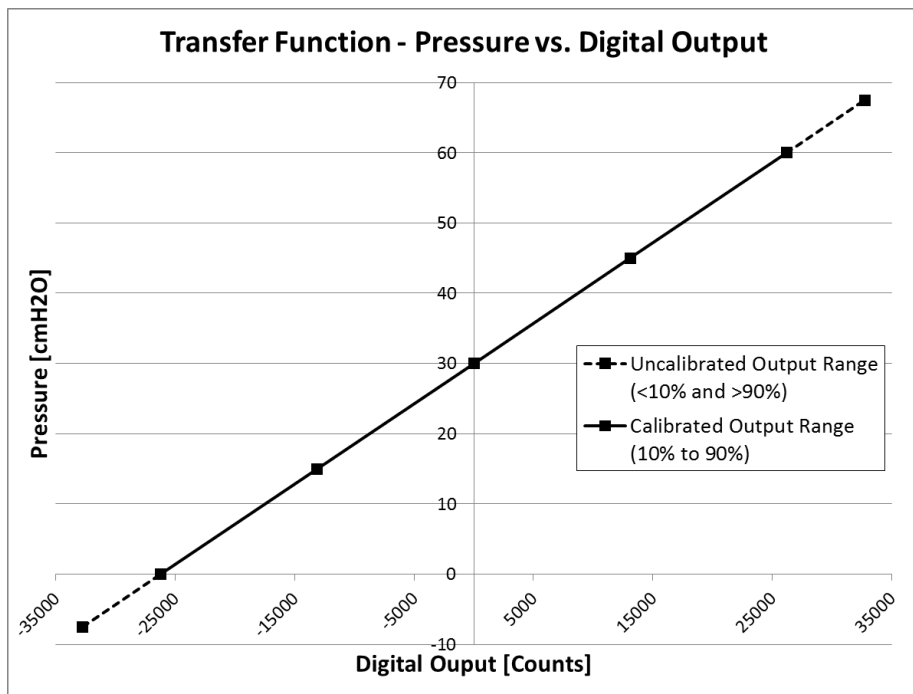
Applications Circuit & Pinout Table
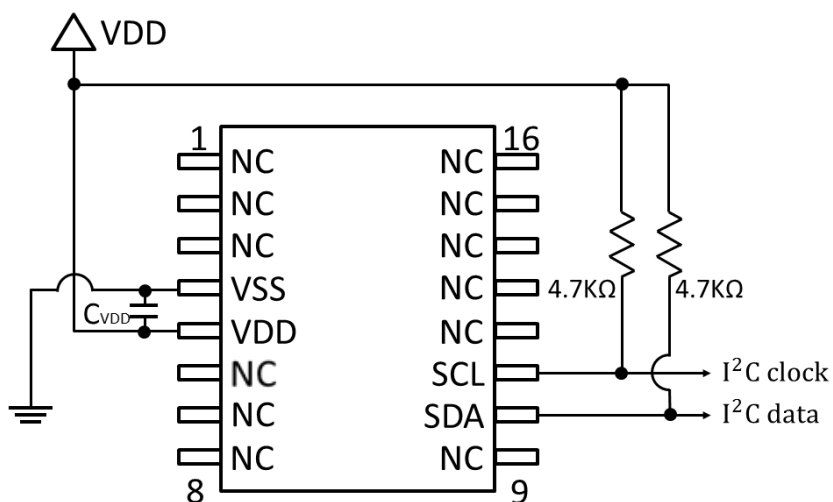
NOTES:
- Bypass capacitor C_{VDD} = 100 nF should be placed in close proximity to the device.

Pin No.	Pin function	Pin No.	Pin function
1	NC	9	NC
2	NC	10	SDA
3	NC	11	SCL
4	VSS	12	NC
5	VDD	13	NC
6	NC	14	NC
7	NC	15	NC
8	NC	16	NC

Transfer Function

Transfer Function - Pressure vs. Digital Output

Digital Output [Counts]	Pressure [cmH$_2$O]
-26214	0
-13107	15
0	30
13107	45
26214	60

Notes:
- The digital output of the sensor is **signed** 16 bit.
- The possible output range in counts is -32768 to 32767.

$$P_{read} = P_{min} + \frac{P\_DOUT_{read} - P\_DOUT_{min}}{P\_DOUT_{max} - P\_DOUT_{min}} * (P_{max} - P_{min})$$

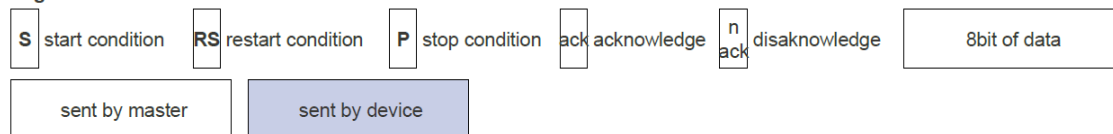$$= \frac{P\_DOUT_{read} + 26214}{52428} * 60 \; cmH_2O$$

- P_{min} and P_{max} are the minimum and maximum rating pressures in the specified pressure unit on the specification.
- P_DOUT_{min} and P_DOUT_{max} are the minimum and maximum digital counts on the specification.
- P_DOUT_{read} is the digital reading from the output and P_{read} is the converted pressure output based on P_DOUT_{read}.

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I²C

Random read

| S | slave address [6:1] | 0 | r̄w̄ 0 | ack | memory address A0[7:0] | ack | RS | slave address [6:1] | 0 | r̄w̄ 1 | ack | read data D[A0][7:0] | ack | ... | read data D[A0+N][15:8] | n ack | P |

Legend

| S | start condition | RS | restart condition | P | stop condition | ack | acknowledge | n ack | disaknowledge | | 8bit of data |

| sent by master | | sent by device |

- The default address of the sensor is **0x6C**. Other options are available upon request.
- The pressure, temperature and status data is stored in 2 bytes each in the following registers:
  - The address of the temperature register is 0x2E.
  - The address of the pressure register is 0x30.
  - The address of the status register is 0x32.
- The slave address byte is obtained as follows:
  - Bits[7:1] is the actual address (**0x6C**)
  - Bit[0] is set whether data is written (=0) or read (=1)
- The memory address field sets the byte address of the first memory location (see above) to be read.
  - Only word (16 bits / 2 bytes) long reads are supported.
- The read data is transferred MSB first, low byte before high byte.
- The two read bytes have to be concatenated with the 2nd read byte first.
  - This can be done by multiplying the 2nd read byte by 256 (2^8=256). This operation shifts the byte to the left by 8 bits. Then the 1st read byte can be added.
- The result is the pressure reading in counts:
  - $p[Counts]=256*byte2+byte1$
- The same conversion has to be used to convert the temperature and status bytes.
- Each of the 16 status bits indicates a certain event or status according to the following table:

0x3 2	STATUS _SYNC				
bits	name	default	rw	type	description
0	idle	0	rw	status	STATUS.idle
1	adc_ s_up	0	rw	event	copy STATUS.adc_s_up, when ADC_S is read
2	adc_ t_up	0	rw	event	copy STATUS.adc_t_up, when ADC_T is read
3	dsp_ s_up	0	rw	event	copy STATUS.dsp_s_up, when DSP_S is read
4	dsp_t _up	0	rw	event	copy STATUS.dsp_t_up, when DSP_T is read
5	dsp_al arm_lo	0	rw	status	STATUS.dsp_alarm_lo
6	dsp_alarm_hi	0	rw	status	STATUS.dsp_alarm_hi
7	bs_fail	0	rw	event	STATUS. bs_fail
8	bc_fail	0	rw	event	STATUS. bc_fail
9	acd_fail	0	rw	event	STATUS.acd_fail
10	dsp_sat	0	rw	status	STATUS.dsp_sat
11	com_crc_error	0	rw	event	STATUS.com_crc_error
12	aodo_lim it_lo	0	rw	status	STATUS. aodo_limit_lo
13	aodo_lim it _hi	0	rw	status	STATUS.aodo_lim it _hi
14	dsp_s_missed	0	rw	event	STATUS. dsp_s_missed
15	dsp_t_missed	0	rw	event	STATUS.dsp_t_missed

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Sleep Mode

Command register(CMD): 0x22

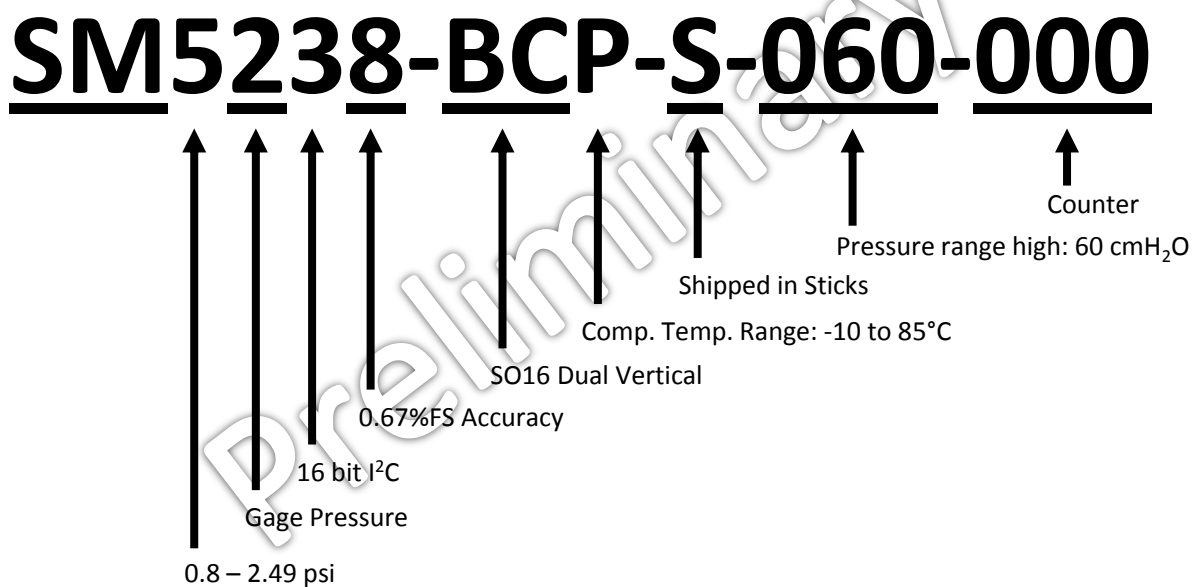| 0x22	CMD			
bits	name	default	rw	Description
15:0	cmd	0	w	Writing to this register controls the state of the SMI devices. 0x6C32: *SLEEP Mode* Initiate the power state *SLEEP*, powering down the ASIC

- Register Read or Write are performed via the digital communication interface. After power-up of the IC all registers except STATUS and CMD are write-protected.
- Power state sleep: The entire chip is powered down. All pins of the device are high impedance. Only wake up event monitoring is active.
- Current consumption in sleep mode is less than 10µA. (Typical values based on limited quantity of samples.)

- ***How to go to sleep mode?***
    - Write 0x6C32 into CMD register
    - Example code based on Arduino platform:
        - Wire.write(0x22); //Send CMD-register address
        - Wire.write(0x32); //Send sleep command low byte (low byte first)
        - Wire.write(0x6C); //Send sleep command high byte

- ***How to wake the device up?***
    - The following wake up condition is supported:
        - Rising edge on pin SCL.

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Ordering Information

Order Code	Part Marking	Minimum Pressure Range	Positive Pressure Range	Pressure Type	Port Configuration	Shipping Method
SM5238-BCP-S-060-000	95-006	0 cmH$_2$O	60 cmH$_2$O	Gage	Dual Vertical	Stick (T&R available)

Part Number Legend

SM5238-BCP-S-060-000

- 0.8 – 2.49 psi
- Gage Pressure
- 16 bit I^{2}C
- 0.67%FS Accuracy
- SO16 Dual Vertical
- Comp. Temp. Range: -10 to 85°C
- Shipped in Sticks
- Pressure range high: 60 cmH$_2$O
- Counter

Qualification Standards

REACH Compliant
RoHS Compliant
PFOS/PFOA Compliant
For qualification specifications, please contact Sales at sales@si-micro.com

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