

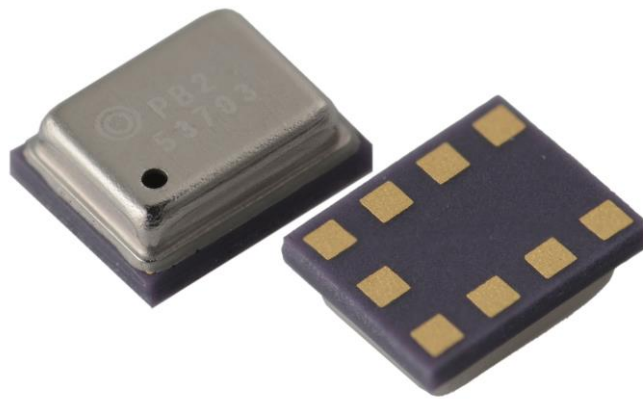
# 2SMPB-02E

## Digital Barometric Pressure Sensor

***High accuracy and small size barometric pressure sensor with low current consumption***

- Measure barometric pressure and temperature with high accuracy
- Built in low noise 24bit ADC
- Digital control and output via I<sup>2</sup>C/SPI interface
- Automatically power down non-working circuit to minimize power consumption
- Individual calibration parameters stored in OTP\*  
(\*One Time Programmable - ROM)

**RoHS compliant**



### Application Example

- Indoor navigation (floor detection)
- Car navigation (to distinguish highway and frontage road)
- Altimeter
- Activity monitor (to detect up and down of stairs)
- Life log
- Weather forecast

### Target Devices Example

- Smart Phones / Tablet PCs
- Wearable devices, such as watch type, band type, clip type or glasses type
- GPS devices
- Healthcare devices such as pedometer

### Packaging Information

- Standard Models with Surface Mounting Terminals

| Structure | Packaging     | Model     | Minimum Packing Unit |
|-----------|---------------|-----------|----------------------|
| LGA 9pin  | Tape and Reel | 2SMPB-02E | 3,500                |

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## 1. Ratings, Specifications and Functions

### 1.1 Use conditions and recommended operating conditions

|                          |                   |
|--------------------------|-------------------|
| Type of Pressure         | Absolute pressure |
| Medium                   | Air (*1)          |
| Operating Pressure Range | 30kPa to 110kPa   |

Note. \*1: Never use corrosive gases.

### 1.2 Absolute Maximum Ratings

| Item                             | Symbol | Rating        | Unit | Remark                        |
|----------------------------------|--------|---------------|------|-------------------------------|
| Power Supply Voltage             | Vddmax | 4.0           | V    |                               |
| Input Voltage (other than power) | Vmax   | -0.2~Vopr+0.2 | V    |                               |
| Maximum Pressure                 | Pmax   | 800           | kPa  |                               |
| Storage Temperature              | Tstr   | -40~85        | degC | with no condensation or icing |
| Storage Humidity                 | Hstr   | 10~95         | %RH  | with no condensation or icing |
| ESD (HBM)                        | Vhbm   | ±2000         | V    |                               |
| ESD (MM)                         | Vmm    | ±200          | V    |                               |
| ESD (CDM)                        | Vcdm   | ±500          | V    |                               |

### 1.3 Operating Ratings

| Item                  | Symbol | Min  | Typ | Max | Unit | Remark |
|-----------------------|--------|------|-----|-----|------|--------|
| Operating Voltage     | Vopr   | 1.71 | 1.8 | 3.6 | V    | VDD    |
|                       | Vio    | 1.20 | 1.8 | 3.6 | V    | VDDIO  |
| Operating Temperature | Topr   | -40  | -   | 85  | degC |        |

### 1.4 Electrical Characteristics

| Item                              | Symbol | Condition                                         | Min  | Typ    | Max | Unit |
|-----------------------------------|--------|---------------------------------------------------|------|--------|-----|------|
| Average Current                   | Ihp    | 1sample/s force-mode<br>Ultra High Accuracy       | -    | 21.4   | -   | uA   |
| Operating Current Consumption     | Iddp   | Pressure mode                                     | -    | 640    | 800 | uA   |
|                                   | Iddt   | Temperature mode                                  | -    | 410    | 520 | uA   |
| Sleep Mode Current Consumption    | Isleep |                                                   | -    | 1.1    | 2.3 | uA   |
| Measureable Pressure Range        | Popr   |                                                   | 30   | -      | 110 | kPa  |
| Absolute Pressure Accuracy        | Pabs1  | 30-110kPa,<br>0-65°C                              | -    | ±50    | -   | Pa   |
|                                   | Pabs2  | 30-110kPa,-20-0°C                                 |      | ±80    |     |      |
| Relative Pressure Accuracy        | Pre1   | Ultra High Accuracy                               | -    | ±3.9   | -   | Pa   |
| rms Noise                         | Pnois  | Ultra High Accuracy                               | -    | 1.3    | -   | Pa   |
| Absolute Temperature Accuracy     | Tab    | 30-110kPa,-20-65°C                                | -2   | -      | 2   | degC |
| Pressure Resolution               | Pres   |                                                   | -    | 0.06   | -   | Pa   |
| Temperature Resolution            | Tres   |                                                   | -    | 0.0002 | -   | degC |
| Power Supply Rejection Ratio (DC) | Ppsrr  | 101.3kPa,0-40°C,<br>1.71-3.6V<br>Base on VDD=1.8V | -9.4 | -      | 9.4 | Pa   |

(At Ta=25 degC, VDD=1.8V, unless otherwise noted)

Note : Typical specifications are not guaranteed

**1.5 Digital Interface Characteristics**

| Item                                            | Symbol  | Condition            | MIN     | TYP | MAX     | Unit |
|-------------------------------------------------|---------|----------------------|---------|-----|---------|------|
| Digital Input Low Voltage                       | Vil_d   |                      | -       | -   | Vio*0.2 | V    |
| Digital Input High Voltage                      | Vih_d   |                      | Vio*0.8 | -   | -       | V    |
| Digital Input Hysteresis Voltage                | Vidhys  |                      | Vio*0.1 | -   | -       | V    |
| Digital Output Low Voltage(I <sup>2</sup> C)    | Vol_d1  | Io=3mA (SDI) *1)     | 0       | -   | Vio*0.2 | V    |
| Digital Output Low Voltage(SPI)                 | Vol_d2  | Io=1mA (SDI,SDO) *1) | 0       | -   | Vio*0.2 | V    |
| Digital Output High Voltage1 (SPI) (Vio>=1.62V) | Voh_d1  | Io=1mA (SDI,SDO) *1) | Vio*0.8 | -   | -       | V    |
| Digital Output High Voltage2 (SPI) (Vio>=1.2V)  | Voh_d2  | Io=1mA (SDI,SDO) *1) | Vio*0.6 |     |         |      |
| Leakage Current at Output OFF                   | Ioff    | SDI,SDO              | -10     | -   | 10      | uA   |
| Internal Pullup Resistor                        | Rpullup | CSB                  | 70      | 120 | 190     | kohm |
| I <sup>2</sup> C Load Capacitance               | Cb      | SDI,SCK              | -       | -   | 400     | pF   |
| Load Capacitance of Reset Terminal              | Crst    |                      | -       | -   | 20      | pF   |
| Pulse Width of Asynchronous Reset               | Trst    |                      | 100     | -   | -       | μsec |
| Power On Startup Time                           | Tstart  |                      | -       | -   | 10      | msec |

Note. \*1) "Io" is the load current of the output terminal.

\*2) Undescribed items are compliant with the I<sup>2</sup>C specification.

About detailed I<sup>2</sup>C bus information, please refer to the I<sup>2</sup>C bus specification and user manual presented by NXP.

**1.6 Characteristics by Oversampling setting (Force mode)**

| Oversampling setting | Pressure oversampling | Temperature oversampling | Measurement time Typ. | ODR @standby 1ms Typ. | Average Current Typ. @1sample/sec force-mode | rms Noise Typ. |
|----------------------|-----------------------|--------------------------|-----------------------|-----------------------|----------------------------------------------|----------------|
| unit                 | -                     | -                        | msec                  | Hz                    | uA                                           | Pa             |
| High speed           | 2                     | 1                        | 5.5                   | 153                   | 4.1                                          | 5.2            |
| Low power            | 4                     | 1                        | 7.2                   | 121                   | 5.2                                          | 3.7            |
| Standard             | 8                     | 1                        | 10.6                  | 86                    | 7.3                                          | 2.6            |
| High accuracy        | 16                    | 2                        | 18.3                  | 51                    | 12.0                                         | 1.8            |
| Ultra High accuracy  | 32                    | 4                        | 33.7                  | 28                    | 21.4                                         | 1.3            |

(At Ta=25 degC, VDD=1.8V, CPU Clock Frequency=300kHz, unless otherwise noted)

Note. \*1) These characteristics are guaranteed by design.

\*2) ODR is defined as Output data rate at standby time 1msec.

**1.7 rms Noise by IIR Filter Selection**

| Oversampling setting | Typical rms Noise in Pressure [Pa] |     |     |     |     |     |
|----------------------|------------------------------------|-----|-----|-----|-----|-----|
|                      | IIR filter coefficient             |     |     |     |     |     |
|                      | off                                | 2   | 4   | 8   | 16  | 32  |
| High speed           | 5.2                                | 2.5 | 1.6 | 1.1 | 0.8 | 0.5 |
| Low power            | 3.7                                | 1.8 | 1.1 | 0.8 | 0.5 | 0.4 |
| Standard             | 2.6                                | 1.3 | 0.8 | 0.5 | 0.4 | 0.3 |
| High accuracy        | 1.8                                | 0.9 | 0.6 | 0.4 | 0.3 | 0.3 |
| Ultra High accuracy  | 1.3                                | 0.6 | 0.4 | 0.3 | 0.3 | 0.2 |

(At Ta=25 degC, VDD=1.8V, unless otherwise noted)

Note. \*1) IIR : Infinite Impulse Response.

\*2) These characteristics are guaranteed by design.

\*3) Initial setting of the IIR filter coefficient is "off".

**1.8 Bandwidth by IIR Filter Selection**

| Oversampling setting | Typical Bandwidth [Hz] |      |      |     |     |     |
|----------------------|------------------------|------|------|-----|-----|-----|
|                      | IIR filter coefficient |      |      |     |     |     |
|                      | off                    | 2    | 4    | 8   | 16  | 32  |
| High speed           | 153.0                  | 35.3 | 14.7 | 6.8 | 3.3 | 1.6 |
| Low power            | 121.0                  | 28.0 | 11.6 | 5.4 | 2.6 | 1.3 |
| Standard             | 86.0                   | 19.9 | 8.3  | 3.8 | 1.8 | 0.9 |
| High accuracy        | 51.0                   | 11.8 | 4.9  | 2.3 | 1.1 | 0.5 |
| Ultra High accuracy  | 28.0                   | 6.5  | 2.7  | 1.2 | 0.6 | 0.3 |

(At Ta=25 degC, VDD=1.8V, unless otherwise noted)

Note. \*1) These characteristics are guaranteed by design.

\*2) Initial setting of the IIR filter coefficient is "off".

**1.9 Filter selection based on use cases**

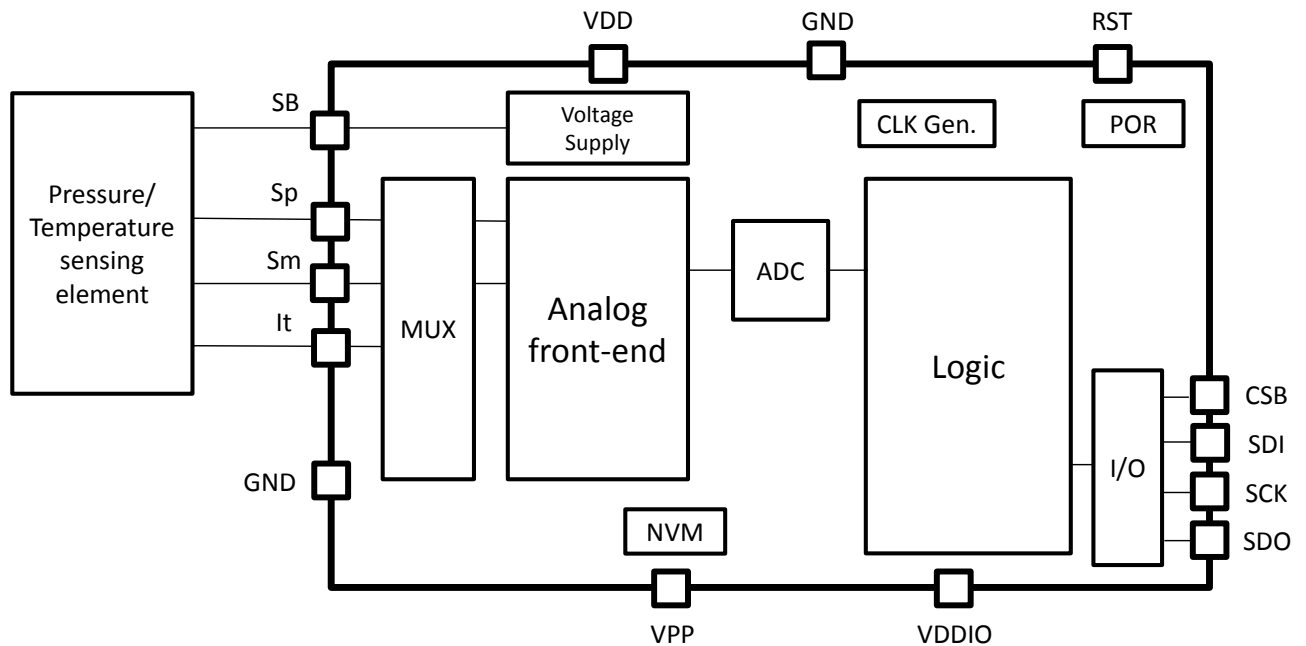
| Example use case   | Oversampling setting | Pressure over sampling times | Temp. over sampling times | Specification (Typ.)   |                          |                    |                |
|--------------------|----------------------|------------------------------|---------------------------|------------------------|--------------------------|--------------------|----------------|
|                    |                      |                              |                           | IIR filter coefficient | Current consumption [uA] | ODR [Hz] (Example) | rms Noise [Pa] |
| Weather monitoring | High speed           | ×2                           | ×1                        | off                    | 1.2                      | 0.05               | 5.2            |
| Drop detection     | Low power            | ×4                           | ×1                        | off                    | 407                      | 100                | 3.7            |
| Elevator detection | Standard             | ×8                           | ×1                        | 4                      | 63.4                     | 10                 | 0.8            |
| Stair detection    | High accuracy        | ×16                          | ×2                        | 8                      | 219                      | 20                 | 0.4            |
| Indoor navigation  | Ultra high accuracy  | ×32                          | ×4                        | 32                     | 570                      | 28                 | 0.2            |

(At Ta=25 degC, VDD=1.8V, unless otherwise noted)

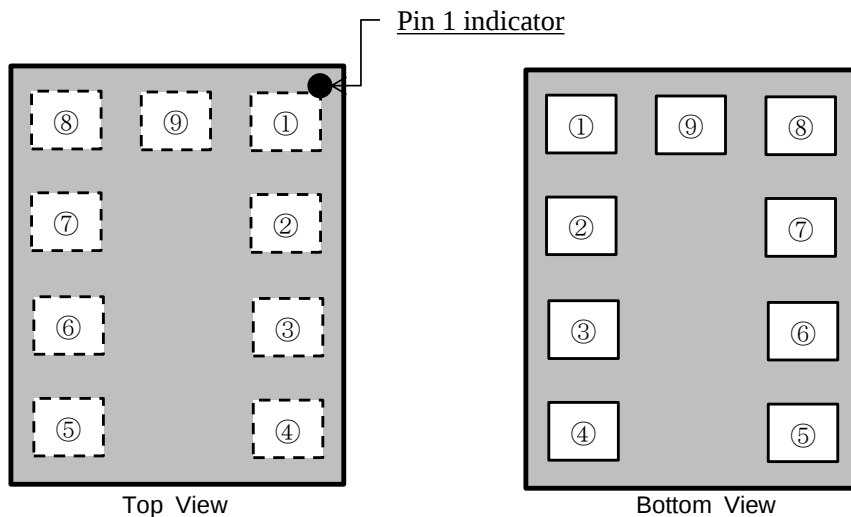
Note. These characteristics are guaranteed by design.

## 2. Connection

### 2.1 Block Diagram



### 2.2 Pin Description and Layout



Pin Description

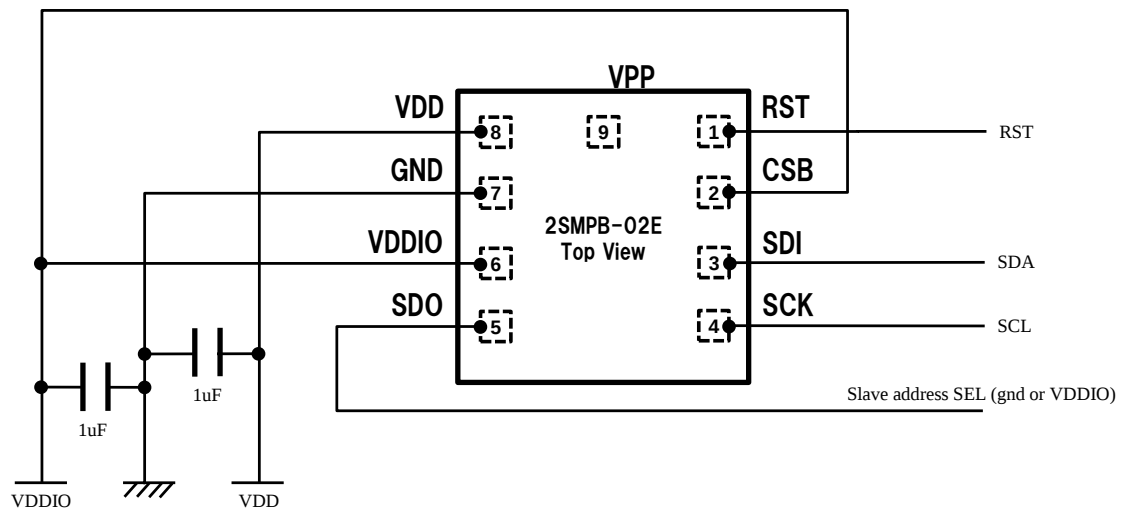
| No. | Symbol | Description                   |                  |
|-----|--------|-------------------------------|------------------|
|     |        | SPI                           | I <sup>2</sup> C |
| 1   | RST    | Asynchronous Reset *1)        |                  |
| 2   | CSB    | CSB                           | VDDIO            |
| 3   | SDI    | SDI/SDO                       | SDA              |
| 4   | SCK    | SCK                           | SCL              |
| 5   | SDO    | SDO                           | ADDR             |
| 6   | VDDIO  | Power Terminal for Digital IO |                  |
| 7   | GND    | Ground Terminal               |                  |
| 8   | VDD    | Power Terminal                |                  |
| 9   | VPP    | NVM Writing Terminal *2)      |                  |

- Note. \*1) If you do not need the reset function, please just have the layout design of PCB of connecting both No. 1 (RST) pin and No. 7 (GND) pin into the ground of PCB. Please refer "4.8 Reset Function" for the case of using the reset function.
- \*2) Pin 9 is only used internally in OMRON. Please leave the pin disconnected. If Pin 9 is connected with any other Pin electrically, the sensor will not work properly.

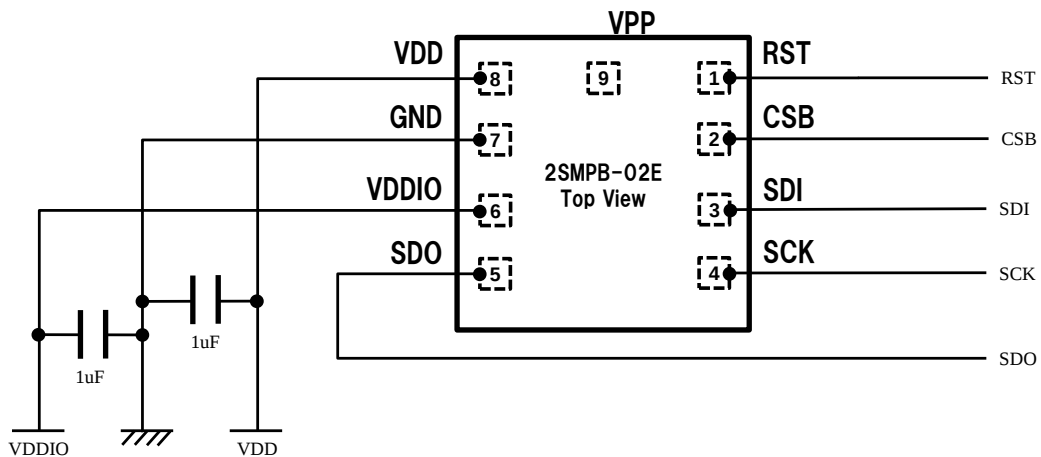
### 2.3 Typical Connection Diagram

(1) I<sup>2</sup>C mode

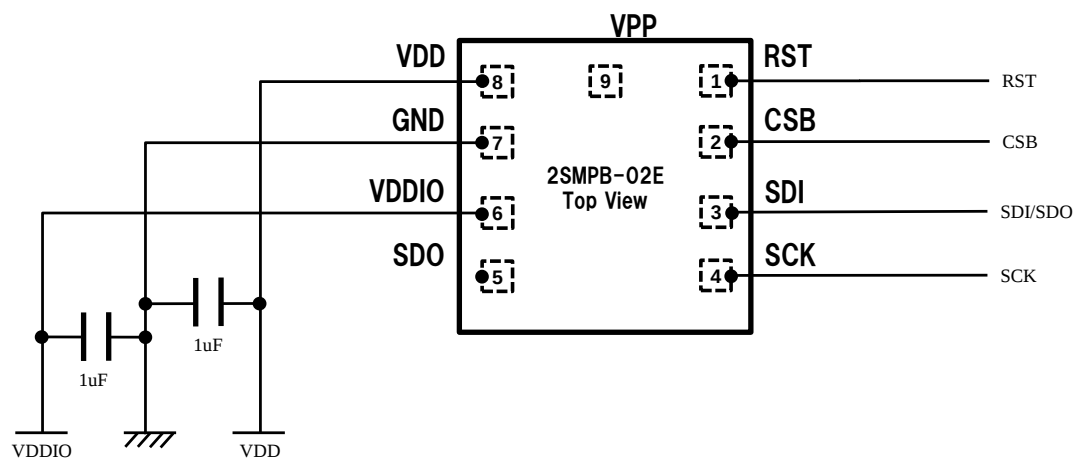
Corresponding to 100Kbit/s (at Standard Mode), 400Kbit/s (at Fast Mode) and 3.4Mbit/s (at High Speed Mode)



(2) 4-wire SPI mode (Corresponding to 10Mbit/s)



(3) 3-wire SPI mode (Corresponding to 10Mbit/s)



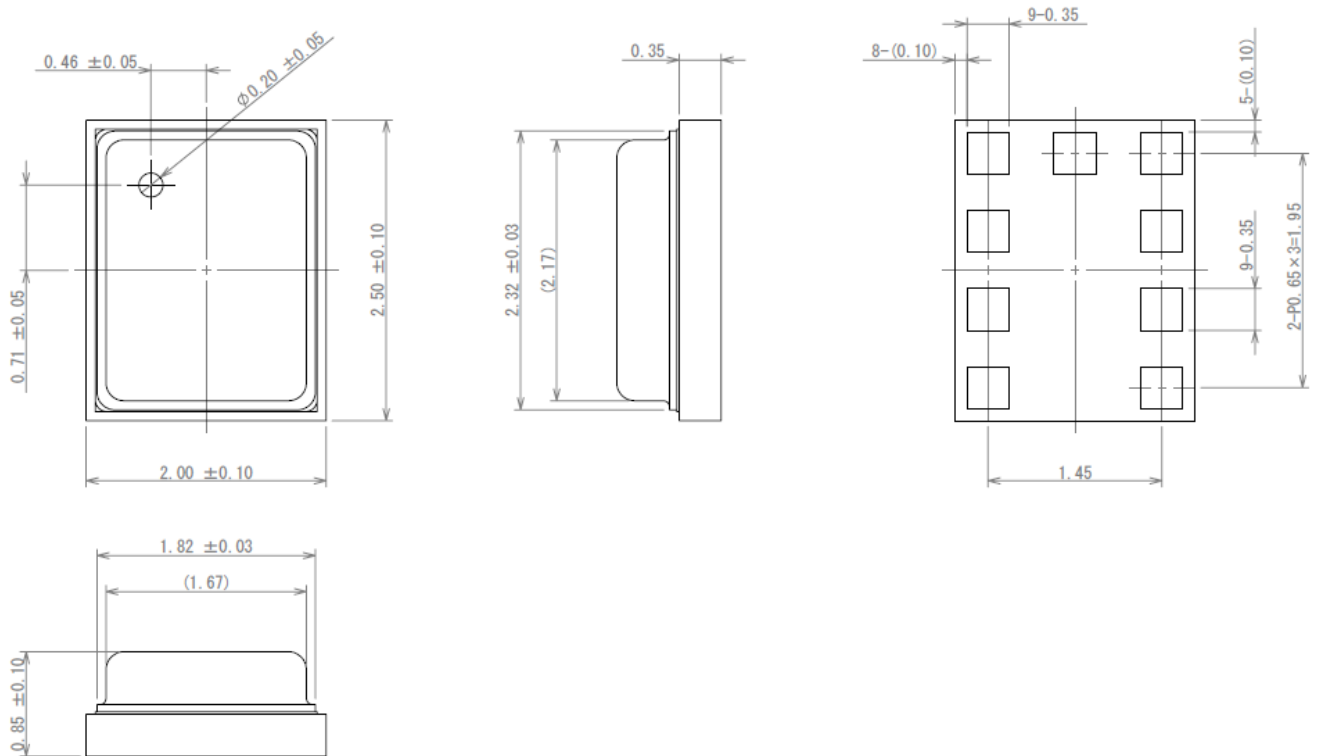
### 3. Dimensions

(unit: mm)

#### 3.1 Package

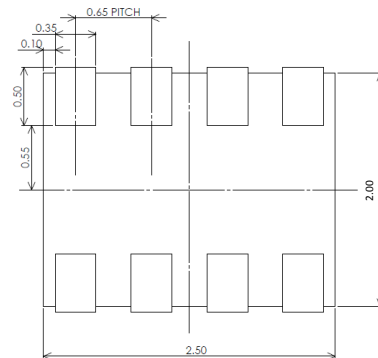
Package Type : LGA (Land Grid Array) 9pin

Package Size : 2.00×2.50×0.85 mm

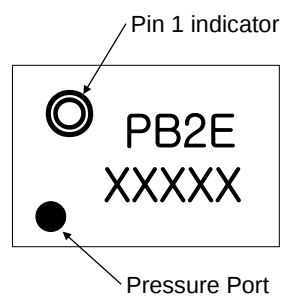


#### 3.2 Mounting PAD Dimensions

(Top View) : Recommended



#### 3.3 Marking structure



## 4. Operations

### 4.1 Communication Mode

This sensor is corresponding to I<sup>2</sup>C and SPI communication.

Digital interface terminal functions for each communication mode are as below.

| Communication mode | CSB   | SDI   | SCK | SDO       | Remark                     |
|--------------------|-------|-------|-----|-----------|----------------------------|
| I <sup>2</sup> C   | VDDIO | SDA   | SCL | GND/VDDIO | SDO=GND→70h, SDO=VDDIO→56h |
| SPI 3 Wires        | CSB   | SDI/O | SCK | -         | spi3w Register = 1         |
| SPI 4 Wires        | CSB   | SDI   | SCK | SDO       | spi3w Register = 0         |

When changing the communication mode, also see Typical Connection Diagram section.

- 1) I<sup>2</sup>C mode becomes effective by pulling CSB up to VDDIO.
- 2) SPI mode becomes effective by pulling CSB down to GND.
- 3) Once CSB is pulled down, SPI mode would not be changed unless otherwise Power on Reset (POR) or Asynchronous Reset. Switching between SPI 3-Wire mode and SPI 4-Wire mode can be configured with the register value of "spi3w". Refer to IO\_SETUP register section for more detail.
- 4) Default mode after POR or Asynchronous Reset will be I<sup>2</sup>C mode.

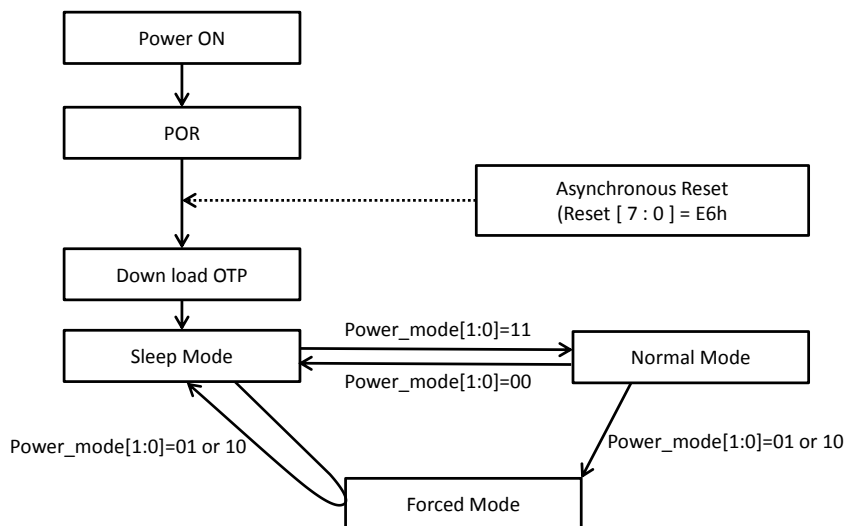
### 4.2 Power Mode

This sensor has three power modes and it can be switched by setting CTRL\_MEAS register.

Refer to the "CTRL\_MEAS" register section for more detail.

- Sleep mode
- Normal mode
- Forced mode

Transition diagram for each mode is as follows.



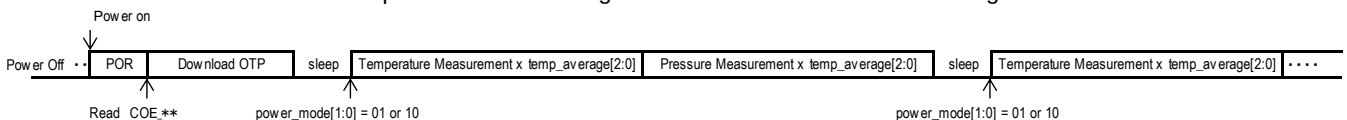
#### 1) Sleep Mode (Power Reduction Mode)

No measurements are performed.

I<sup>2</sup>C/SPI interface and each register can be accessed even if the sensor is in sleep mode.

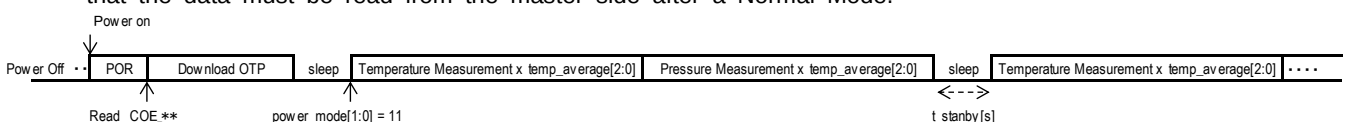
#### 2) Forced Mode

In case of Forced Mode, a single measurement is performed. When the set up measurement is finished, the sensor returns to Sleep Mode after storing the measurement data to the register.



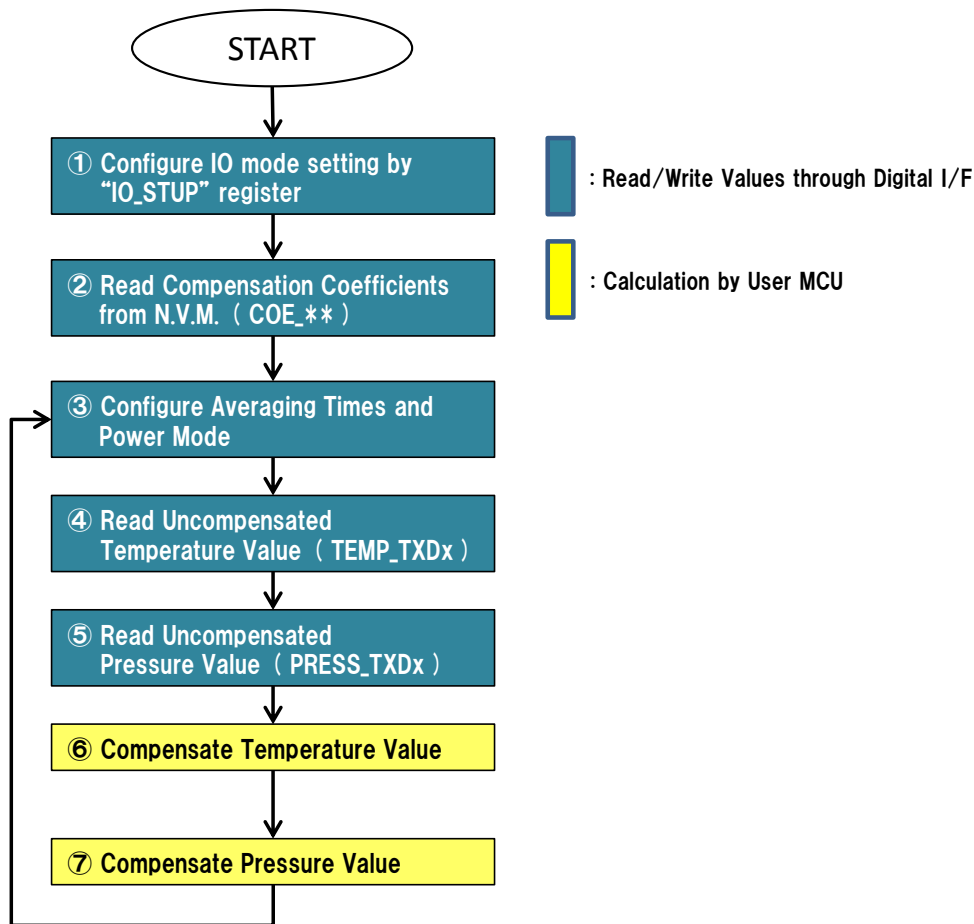
#### 3) Normal Mode

In case of Normal Mode, the measurements are performed repeatedly between a measurement period and a standby period. The standby time can be configured by "t\_stanby[1:0]" register. Be sure to consider that the data must be read from the master side after a Normal Mode.



### 4.3 Compensation of Pressure and Temperature

This section describes a typical measurement procedure and a calculation method after POR. This sensor has compensation coefficients in internal Non Volatile Memory (NVM). The compensated pressure can be calculated by using these values.



MSB of PRESS\_TXDx, TEMP\_TXDx and COE\_\*\* are sign bit.

- ① Configure IO mode setting. Refer to IO\_SETUP register section for more detail.
- ② Read compensation coefficients which are stored in NVM. This procedure is sufficient just once after POR. These values are used for a compensation calculation at the step ⑥ and ⑦.
- ③ Configure averaging times and power mode. Refer to CTRL\_MEAS register section for more detail.
- ④ Read raw temperature data which are stored in TEMP\_TXDx registers.
- ⑤ Read raw pressure data which are stored in PRESS\_TXDx registers.
- ⑥ Compensated temperature can be calculated by using the below formula and the values of the step ② and ④.

$$Tr = a0 + a1 \cdot Dt + a2 \cdot Dt^2$$

Tr Calculation Result of Temperature ( Tr/256 = Temperature [degreeC] )

e.g.) If Tr Value is 6400 LSB,

$$\text{Temperature (degreeC)} = \frac{\text{Tr Value (LSB)}}{\text{Scaling Factor}} = \frac{6400 \text{ LSB}}{256 \text{ LSB/degree C}} = 25.00 \text{ degreeC}$$

Dt Raw Temperature Data [digit] ( 20-24bits measurement value of TEMP\_TXDx Reg. )

a0 Compensation Coefficient of PTAT (NVM resister: COE\_a0\_ex, COE\_a0\_0, COE\_a0\_1 )

a1 Compensation Coefficient of PTAT (NVM resister: COE\_a1\_0, COE\_a1\_1 )

a2 Compensation Coefficient of PTAT (NVM resister: COE\_a2\_0, COE\_a2\_1 )

- ⑦ Correction pressure without temperature compensation can be calculated by using the below formula and the values of the step ② and ⑥.

$$Pr = b00 + bt1 \cdot Tr + bp1 \cdot Dp + b11 \cdot Dp \cdot Tr + bt2 \cdot Tr^2 + bp2 \cdot Dp^2 \\ + b12 \cdot Dp \cdot Tr^2 + b21 \cdot Dp^2 \cdot Tr + bp3 \cdot Dp^3$$

|     |                                                                                         |
|-----|-----------------------------------------------------------------------------------------|
| Pr  | Calculation Result of Pressure [Pa]                                                     |
| Tr  | Calculation Result of Temperature ( Tr/256 = Temperature [degreeC] )                    |
| Dp  | Raw Pressure Data [digit] ( 20-24bits measurement value of PRESS_TXDx Reg. )            |
| b00 | Compensation Coefficient of Pressure ( NVM resister: COE_b00_ex, COE_b00_0, COE_b00_1 ) |
| bt1 | Compensation Coefficient of Pressure ( NVM resister: COE_bt1_0, COE_bt1_1 )             |
| bp1 | Compensation Coefficient of Pressure ( NVM resister: COE_bp1_0, COE_bp1_1 )             |
| b11 | Compensation Coefficient of Pressure ( NVM resister: COE_b11_0, COE_b11_1 )             |
| bt2 | Compensation Coefficient of Pressure ( NVM resister: COE_bt2_0, COE_bt2_1 )             |
| bp2 | Compensation Coefficient of Pressure ( NVM resister: COE_bp2_0, COE_bp2_1 )             |
| b12 | Compensation Coefficient of Pressure ( NVM resister: COE_b12_0, COE_b12_1 )             |
| b21 | Compensation Coefficient of Pressure ( NVM resister: COE_b21_0, COE_b21_1 )             |
| bp3 | Compensation Coefficient of Pressure ( NVM resister: COE_bp3_0, COE_bp3_1 )             |

#### ● How to get compensation coefficients

Each compensation coefficients can be calculated by using the below formula and conversion factors.

$$K = A + \frac{S \times OTP}{32767} \cdots a1, a2, bt1, bt2, bp1, b11, bp2, b12, b21, bp3 \quad K = \frac{OTP}{16} \cdots a0, b00$$

| K   | Conversion factor |         | OTP      |            |            |
|-----|-------------------|---------|----------|------------|------------|
|     | A                 | S       | 23-16bit | 15-8bit    | 7-0bit     |
| a1  | -6.3E-03          | 4.3E-04 | -        | COE_a1_1   | COE_a1_0   |
| a2  | -1.9E-11          | 1.2E-10 | -        | COE_a2_2   | COE_a2_0   |
| bt1 | 1.0E-01           | 9.1E-02 | -        | COE_bt1_1  | COE_bt1_0  |
| bt2 | 1.2E-08           | 1.2E-06 | -        | COE_bt2_1  | COE_bt2_0  |
| bp1 | 3.3E-02           | 1.9E-02 | -        | COE_bp1_1  | COE_bp1_0  |
| b11 | 2.1E-07           | 1.4E-07 | -        | COE_b11_1  | COE_b11_0  |
| bp2 | -6.3E-10          | 3.5E-10 | -        | COE_bp2_1  | COE_bp2_0  |
| b12 | 2.9E-13           | 7.6E-13 | -        | COE_bp12_1 | COE_bp12_0 |
| b21 | 2.1E-15           | 1.2E-14 | -        | COE_bp21_1 | COE_bp21_0 |
| bp3 | 1.3E-16           | 7.9E-17 | -        | COE_bp3_1  | COE_bp3_0  |

| K   | Conversion factor    | OTP       |           |            |
|-----|----------------------|-----------|-----------|------------|
|     |                      | 19-12bit  | 11-4bit   | 3-0bit     |
| a0  | Offset value (20Q16) | COE_a0_1  | COE_a0_0  | COE_a0_ex  |
| b00 | Offset value (20Q16) | COE_b00_1 | COE_b00_0 | COE_b00_ex |

#### ● TEMP(PRESS)\_TXDx : Temperature and Pressure data : TXD0, TXD1 or TXD2

This sensor holds ADC data with 22 to 24 bits accuracy. It can be obtained as each 24 bits data. If there are redundant data, the low order positions will be filled by zero (0). The shaded regions as shown below are valid data area.

| bit           | 24  | 23  | 22  | ... | 5  | 4  | 3  | 2  | 1  | Note                   |
|---------------|-----|-----|-----|-----|----|----|----|----|----|------------------------|
| 22bits output | D21 | D20 | D19 | ... | D2 | D1 | D0 | 0  | 0  | Temp/Press_ave=001     |
| 23bits output | D22 | D21 | D20 | ... | D3 | D2 | D1 | D0 | 0  | Temp/Press_ave=010     |
| 24bits output | D23 | D22 | D21 | ... | D4 | D3 | D2 | D1 | D0 | Temp/Press_ave=011~111 |

※Dn(D23~D0) : Sensor Data ..... The value of n bit (1 or 0)

※The raw measurement values are unsigned 24bits values. The values need to do subtraction with  $2^{23}$  at 24bits output mode. Here is a programing example for Dt and Dp calculation.

$$Dt = ((TEMP\_TXD2) \ll 16) + ((TEMP\_TXD1) \ll 8) + (TEMP\_TXD0) - \text{pow}(2, 23)$$

$$Dp = ((PRESS\_TXD2) \ll 16) + ((PRESS\_TXD1) \ll 8) + (PRESS\_TXD0) - \text{pow}(2, 23)$$

#### 4.4 Implementing Register List

| Register Name | Address |      | Length | R/W | Data               |      |      |                    |         |           |                  |            | Discription                                                                                                                              | Initial |
|---------------|---------|------|--------|-----|--------------------|------|------|--------------------|---------|-----------|------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------|---------|
|               | I2C     | SPI  |        |     | bit7               | bit6 | bit5 | bit4               | bit3    | bit2      | bit1             | bit0       |                                                                                                                                          |         |
| TEMP_TXD0     | 0xFC    | 0x7C | 8bit   | R/- | t_tx0[7:0]         |      |      |                    |         |           |                  |            | Temperature DATA[8:1] in 24bit                                                                                                           | 00h     |
| TEMP_TXD1     | 0xFB    | 0x7B | 8bit   | R/- | t_tx1[7:0]         |      |      |                    |         |           |                  |            | Temperature DATA[16:9] in 24bit                                                                                                          | 00h     |
| TEMP_TXD2     | 0xFA    | 0x7A | 8bit   | R/- | t_tx2[7:0]         |      |      |                    |         |           |                  |            | Temperature DATA[24:17] in 24bit (*)                                                                                                     | 00h     |
| PRESS_TXD0    | 0xF9    | 0x79 | 8bit   | R/- | p_tx0[7:0]         |      |      |                    |         |           |                  |            | Pressure DATA[8:1] in 24bit                                                                                                              | 00h     |
| PRESS_TXD1    | 0xF8    | 0x78 | 8bit   | R/- | p_tx1[7:0]         |      |      |                    |         |           |                  |            | Pressure DATA[16:9] in 24bit                                                                                                             | 00h     |
| PRESS_TXD2    | 0xF7    | 0x77 | 8bit   | R/- | p_tx2[7:0]         |      |      |                    |         |           |                  |            | Pressure DATA[24:17] in 24bit (*)                                                                                                        | 00h     |
| IO_SETUP      | 0xF5    | 0x75 | 8bit   | R/W | t_stanby[2:0]      |      |      | -                  |         | spi3_sdim | -                | spi3w      | t_stanby[2:0] : Standby time setting<br>spi3w : SPI mode setting (4 or 3 wire)<br>spi3_sdim : Select output type of SDI terminal         | 00h     |
| CTRL_MEAS     | 0xF4    | 0x74 | 8bit   | R/W | temp_average[2:0]  |      |      | press_average[2:0] |         |           | power_mode[1:0]  |            | temp_average[2:0] : Temperature Averaging times<br>press_average[2:0] : Pressure Averaging times<br>power_mode[1:0] : Power mode setting | 00h     |
| DEVICE_STAT   | 0xF3    | 0x73 | 8bit   | R/- | -                  | -    | -    | -                  | measure | -         | -                | otp_update | measure : Status of measurement<br>otp_update : Status of OTP data access                                                                | 00h     |
| I2C_SET       | 0xF2    | 0x72 | 8bit   | R/W | -                  | -    | -    | -                  | -       |           | master_code[2:0] |            | Master code setting at I2C HS mode                                                                                                       | 01h     |
| IIR_CNT       | 0xF1    | 0x71 | 8bit   | R/W | -                  | -    | -    | -                  | -       |           | filter[2:0]      |            | IIR filter co-efficient setting                                                                                                          | 00h     |
| RESET         | 0xE0    | 0x60 | 8bit   | W   | reset[7:0]         |      |      |                    |         |           |                  |            | When inputting“E6h”,<br>a software reset will be occurred                                                                                | 00h     |
| CHIP_ID       | 0xD1    | 0x51 | 8bit   | R/- | chip_id[7:0]       |      |      |                    |         |           |                  |            | CHIP ID: 5Ch                                                                                                                             | 5Ch     |
| COE_b00_a0_ex | 0xB8    | 0x38 | 8bit   | R/- | b00[3:0] / a0[3:0] |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_a2_0      | 0xB7    | 0x37 | 8bit   | R/- | a2[7:0]            |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_a2_1      | 0xB6    | 0x36 | 8bit   | R/- | a2[15:8]           |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_a1_0      | 0xB5    | 0x35 | 8bit   | R/- | a1[7:0]            |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_a1_1      | 0xB4    | 0x34 | 8bit   | R/- | a1[15:8]           |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_a0_0      | 0xB3    | 0x33 | 8bit   | R/- | a0[11:4]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_a0_1      | 0xB2    | 0x32 | 8bit   | R/- | a0[19:12]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_bp3_0     | 0xB1    | 0x31 | 8bit   | R/- | bp3[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_bp3_1     | 0xB0    | 0x30 | 8bit   | R/- | bp3[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_b21_0     | 0xAF    | 0x2F | 8bit   | R/- | b21[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_b21_1     | 0xAE    | 0x2E | 8bit   | R/- | b21[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_b12_0     | 0xAD    | 0x2D | 8bit   | R/- | b12[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_b12_1     | 0xAC    | 0x2C | 8bit   | R/- | b12[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_bp2_0     | 0xAB    | 0x2B | 8bit   | R/- | bp2[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_bp2_1     | 0xAA    | 0x2A | 8bit   | R/- | bp2[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_b11_0     | 0xA9    | 0x29 | 8bit   | R/- | b11[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_b11_1     | 0xA8    | 0x28 | 8bit   | R/- | b11[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_bp1_0     | 0xA7    | 0x27 | 8bit   | R/- | bp1[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_bp1_1     | 0xA6    | 0x26 | 8bit   | R/- | bp1[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_bt2_0     | 0xA5    | 0x25 | 8bit   | R/- | bt2[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_bt2_1     | 0xA4    | 0x24 | 8bit   | R/- | bt2[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_bt1_0     | 0xA3    | 0x23 | 8bit   | R/- | bt1[7:0]           |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_bt1_1     | 0xA2    | 0x22 | 8bit   | R/- | bt1[15:8]          |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |
| COE_b00_0     | 0xA1    | 0x21 | 8bit   | R/- | b00[11:4]          |      |      |                    |         |           |                  |            | Compensation Coefficient                                                                                                                 | -       |
| COE_b00_1     | 0xA0    | 0x20 | 8bit   | R/- | b00[19:12]         |      |      |                    |         |           |                  |            | Compensation Coefficient (*)                                                                                                             | -       |

(\*) MSB of PRESS\_TXDx, TEMP\_TXDx and COE\_\*\* are sign bit.

**IO\_SETUP : IO SETUP Register**

| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7          | bit6 | bit5 | bit4 | bit3 | bit2      | bit1 | bit0  | initial |
|---------------|------------------------|-----------|--------|-----|---------------|------|------|------|------|-----------|------|-------|---------|
| IO_SETUP      | 0xF5                   | 0x75      | 8bits  | R/W | t_stanby[2:0] |      |      | -    | -    | spi3_sdim | -    | spi3w | 0x00    |

bit7~5 t\_stanby[2:0] : Standby time setting

|     |     |      |       |       |     |     |     |
|-----|-----|------|-------|-------|-----|-----|-----|
| 000 | 001 | 010  | 011   | 100   | 101 | 110 | 111 |
| 1ms | 5ms | 50ms | 250ms | 500ms | 1s  | 2s  | 4s  |

bit3~4 Reserved : keep these bits at 0

bit2 spi3\_sdim : Select output type of SDI terminal

0 : Lo / Hi-Z output

1 : Lo / Hi output

bit1 Reserved : keep this bit at 0

bit0 spi3w : Change mode between SPI 4-wire and SPI 3-wire

0 : 4-wire (Default)

1 : 3-wire

**CTRL\_MEAS : Measurement Condition Control Register**

| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7              | bit6 | bit5 | bit4               | bit3 | bit2 | bit1            | bit0 | initial |
|---------------|------------------------|-----------|--------|-----|-------------------|------|------|--------------------|------|------|-----------------|------|---------|
| CTRL_MEAS     | 0xF4                   | 0x74      | 8bits  | R/W | temp_average[2:0] |      |      | press_average[2:0] |      |      | power_mode[1:0] |      | 0x00    |

bit7,6,5 temp\_average[2:0] Averaging times setting for Temperature measurement (skip means no measurement.)

|      |     |     |     |     |     |     |     |
|------|-----|-----|-----|-----|-----|-----|-----|
| 000  | 001 | 010 | 011 | 100 | 101 | 110 | 111 |
| skip | 1   | 2   | 4   | 8   | 16  | 32  | 64  |

bit4,3,2 press\_average[2:0] Averaging times setting for Pressure measurement (skip means no measurement.)

|      |     |     |     |     |     |     |     |
|------|-----|-----|-----|-----|-----|-----|-----|
| 000  | 001 | 010 | 011 | 100 | 101 | 110 | 111 |
| skip | 1   | 2   | 4   | 8   | 16  | 32  | 64  |

bit1,0 power\_mode[1:0]

Operation mode setting

00 : Sleep mode

01,10 : Forced mode

11 : Normal mode

**DEVICE\_STAT : Device Status Register**

| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7 | bit6 | bit5 | bit4 | bit3    | bit2 | bit1 | bit0       | initial |
|---------------|------------------------|-----------|--------|-----|------|------|------|------|---------|------|------|------------|---------|
| DEVICE_STAT   | 0xF3                   | 0x73      | 8bits  | R   | -    | -    | -    | -    | measure | -    | -    | otp_update | 0x00    |

bit7~4 Reserved : keep these bits at 0

bit3 measure

Device operation status. This value automatically changes.

0: Finish a measurement -- waiting for next measurement

1: On a measurement -- waiting for finishing the data store

bit2,1 Reserved : keep these bits at 0

bit0 otp\_update

The status of OTP data access. This value automatically changes.

0: No accessing OTP data

1: While accessing OTP data

**I<sup>2</sup>C\_SET : Master code setting**

| Register Name        | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7 | bit6 | bit5 | bit4 | bit3 | bit2             | bit1 | bit0 | initial |
|----------------------|------------------------|-----------|--------|-----|------|------|------|------|------|------------------|------|------|---------|
| I <sup>2</sup> C_SET | 0xF2                   | 0x72      | 8bits  | R/W | -    | -    | -    | -    | -    | master_code[2:0] |      |      | 0x01    |

bit7~3 Reserved : keep these bits at 0

bit2,1,0 master code[2:0]

Master code setting at I<sup>2</sup>C high-speed mode.

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 000  | 001  | 010  | 011  | 100  | 101  | 110  | 111  |
| 0x08 | 0x09 | 0x0A | 0x0B | 0x0C | 0x0D | 0x0E | 0x0F |

**IIR\_CNT : IIR filter co-efficient setting Register**

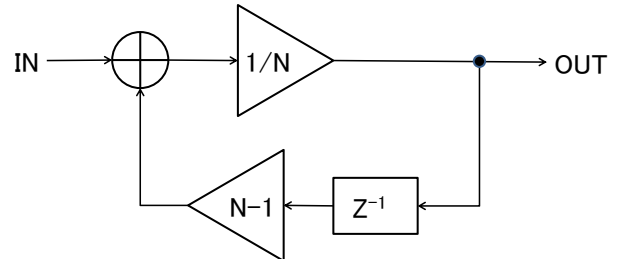
| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7 | bit6 | bit5 | bit4 | bit3 | bit2        | bit1 | bit0 | initial |
|---------------|------------------------|-----------|--------|-----|------|------|------|------|------|-------------|------|------|---------|
| IIR_CNT       | 0xF1                   | 0X71      | 8bits  | R/W | -    | -    | -    | -    | -    | filter[2:0] |      |      | 0x00    |

bit7~3 Reserved : keep these bits at 0

bit2,1,0 filter[2:0] IIR filter co-efficient setting

Write access to this register address, IIR filter will be initialized.

Note. Initial setting of the IIR filter coefficient is "OFF"



|     |     |     |     |      |      |      |      |
|-----|-----|-----|-----|------|------|------|------|
| 000 | 001 | 010 | 011 | 100  | 101  | 110  | 111  |
| OFF | N=2 | N=4 | N=8 | N=16 | N=32 | N=32 | N=32 |

**RESET : Reset Control Register**

| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7       | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 | initial |
|---------------|------------------------|-----------|--------|-----|------------|------|------|------|------|------|------|------|---------|
| RESET         | 0xE0                   | 0x60      | 8bits  | W   | reset[7:0] |      |      |      |      |      |      |      | 0x00    |

bit7~0 reset[7:0]

When input "E6h", the software reset will be effective.  
Except for that, nothing is to happen.

**CHIP\_ID : Chip ID Confirmation Register**

| Register Name | I <sup>2</sup> C Addr. | SPI Addr. | Length | R/W | bit7         | bit6 | bit5 | bit4 | bit3 | bit2 | bit1 | bit0 | initial |
|---------------|------------------------|-----------|--------|-----|--------------|------|------|------|------|------|------|------|---------|
| CHIP_ID       | 0xD1                   | 0x51      | 8bits  | R   | chip_id[7:0] |      |      |      |      |      |      |      | 0x5C    |

bit7~0 chip\_id[7:0]

5C

#### 4.5 I<sup>2</sup>C Protocol

##### (1) I<sup>2</sup>C Slave Address

The 2SMPB-02 module I<sup>2</sup>C slave address is shown below.

| SDO     | I <sup>2</sup> C Slave Address (7bits) | Bit   | bit7   | bit6   | bit5   | bit4   | bit3   | bit2   | bit1   | bit0 |
|---------|----------------------------------------|-------|--------|--------|--------|--------|--------|--------|--------|------|
|         |                                        |       | Add[6] | Add[5] | Add[4] | Add[3] | Add[2] | Add[1] | Add[0] | R/W  |
| High(1) | 56h+R/W                                | Value | 1      | 0      | 1      | 0      | 1      | 1      | 0      | 1/0  |
| Low(0)  | 70h+R/W                                | Value | 1      | 1      | 1      | 0      | 0      | 0      | 0      | 1/0  |

For example, in case of SDO=Low (0),

Write Access : Please set LSB of slave address as "0", then the address is E0h(1110\_0000b). ( $70h \ll 1 + WR(0)$ )

Read Access : Please set LSB of slave address as "1", then the address is E1h(1110\_0001b). ( $70h \ll 1 + RD(1)$ )

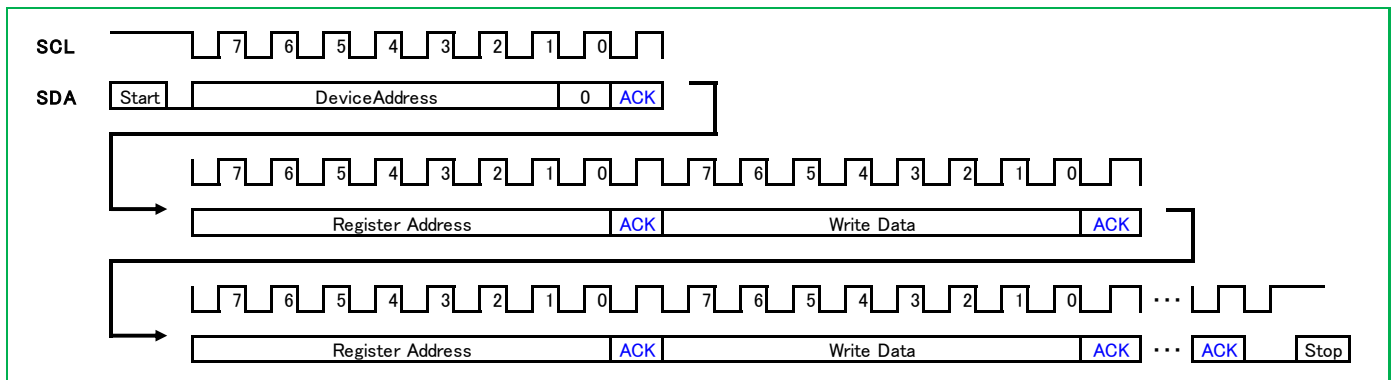
##### (2) I<sup>2</sup>C Access Protocol Examples

Symbol

- START : START condition
- STOP : STOP condition
- Re-START : Re-START condition for Read
- SACK : Acknowledge by Slave
- MACK : Acknowledge by Master
- MNACK: Not Acknowledge by Master

##### (3) Register Write Access Protocol

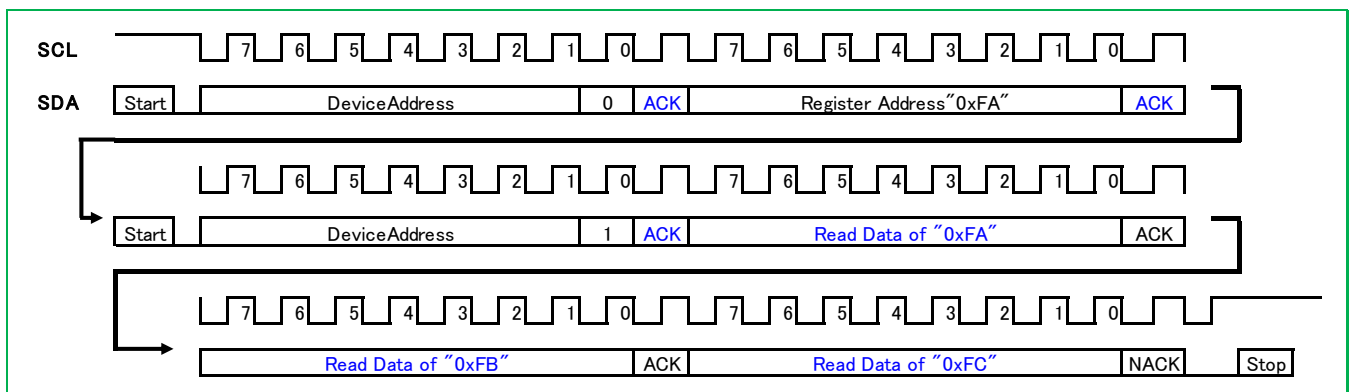
After the START condition, a Device Address is sent. This address is seven bits long followed by an eighth bit which is a data direction bit. A 'zero' indicates a transmission "WRITE". After that, the register address and the writing data shall be one set and it should be continuously transmitted until a STOP condition. A data transfer is always terminated by a STOP condition generated by the master.



※Black characters : Master → Slave / Blue characters : Slave → Master

##### (4) Register Read Access Protocol

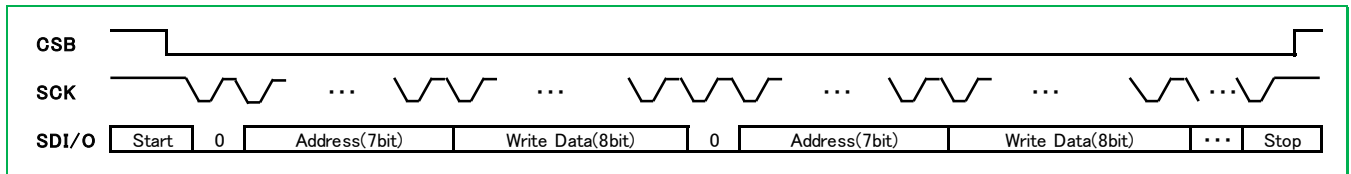
After a START condition, the Device Address with WRITE sign ("0") and Word Address intended to read a first data are transmitted. Next, "STOP-START" or "Re-START" condition are transmitted by the master. After that, Device Address with READ sign ("1") is transmitted by the master. Then, the slave will output the first data that is intended to read. In case of incrementing Register Address automatically, the slave will output the data repeatedly until NACK is input by the master. If Register Address becomes "0xFF", please continue to output "0xFF." Below example shows 3 bytes reading method from "0xFA" register.



#### 4.6 SPI Protocol

##### (1) SPI write

"SPI Write" needs to transmit the one set data of Register Address(Ctl.="0"+Address) and a writing data in the situation where CSB is "L". Two or more writing can be possible during CSB is "L". If CSB becomes "H", SPI communication will finish. (as well as I<sup>2</sup>C write)

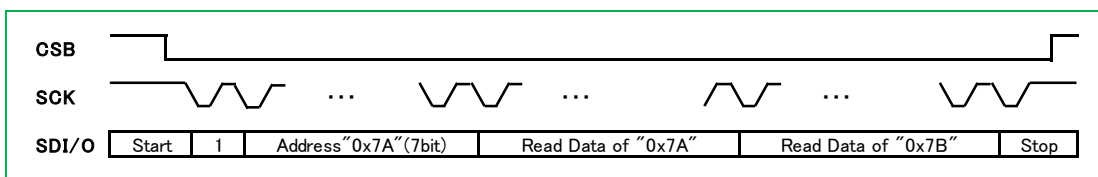


##### (2) SPI read

First, "SPI read" needs to transmit Register Address(Ctl.="1"+Address) in a situation where CSB is "L".

Next, the data of the requested register address will be output from SDO. (in case of 3-wire mode, the data will be output from SDI). After that, the register address is automatically incremented by one until CSB becomes "H", the device will output the data repeatedly. (as well as I<sup>2</sup>C read)

Below shows an example of the 2 bytes reading from "0xFA" register.



#### 4.7 Interface specifications

##### (1) I<sup>2</sup>C timings

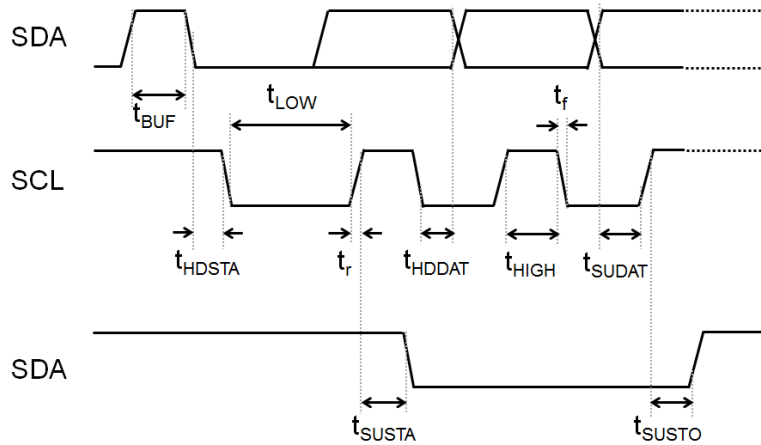
All timings apply to 100kbps(at Standard Mode) , 400kbps (at Fast Mode) and 3.4Mbps(at High Speed Mode).

For I<sup>2</sup>C timings, the following abbreviations are used :

\*1) S&F Mode = standard and fast mode

\*2) Cb = bus capacitance on SDI line

All other naming refers to I<sup>2</sup>C specification 2.1 (January 2000).



Undescribed items and symbols are compliant with the I<sup>2</sup>C specification.

| Items          | Symbol             | Condition                         | min                          | typ | max | Units | Remark |
|----------------|--------------------|-----------------------------------|------------------------------|-----|-----|-------|--------|
| SDI setup time | $t_{\text{SUDAT}}$ | S&F Mode *1)                      | 160                          | -   | -   | ns    |        |
|                |                    | HS Mode *2)                       | $V_{\text{IO}}=1.62\text{V}$ | 30  | -   | -     | ns     |
|                |                    | HS Mode                           | $V_{\text{IO}}=1.2\text{V}$  | 55  | -   | -     | ns     |
| SDI hold time  | $t_{\text{HDDAT}}$ | S&F Mode, $C_b \leq 100\text{pF}$ | 80                           | -   | -   | ns    |        |
|                |                    | S&F Mode, $C_b \leq 400\text{pF}$ | 90                           | -   | -   | ns    |        |
|                |                    | HS Mode, $C_b \leq 100\text{pF}$  | $V_{\text{IO}}=1.62\text{V}$ | 18  | -   | 115   | ns     |
|                |                    |                                   | $V_{\text{IO}}=1.2\text{V}$  | 25  | -   | 140   | ns     |
|                |                    | HS Mode, $C_b \leq 400\text{pF}$  | $V_{\text{IO}}=1.62\text{V}$ | 24  | -   | 150   | ns     |
|                |                    |                                   | $V_{\text{IO}}=1.2\text{V}$  | 45  | -   | 170   | ns     |
| SCK low pulse  | $t_{\text{LOW}}$   | HS Mode, $C_b \leq 100\text{pF}$  | $V_{\text{IO}}=1.62\text{V}$ | 160 | -   | -     | ns     |
|                |                    |                                   | $V_{\text{IO}}=1.2\text{V}$  | 210 | -   | -     | ns     |

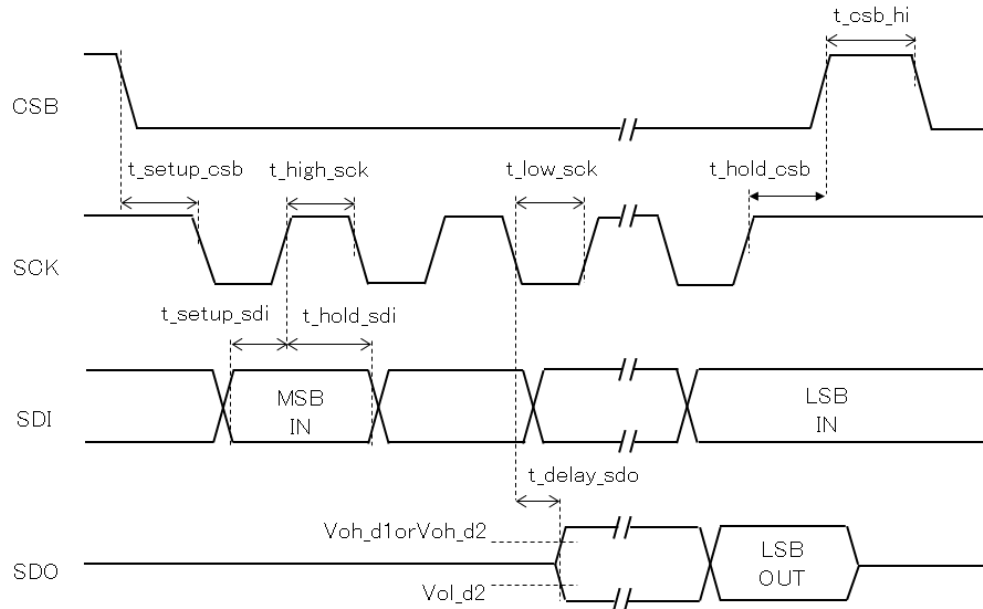
**(2) SPI timings**

All timings are applied both to 4- and 3-wire SPI.

To reduce external noise in High-Z state, we recommend the following;

- In 4-wire mode, SDO terminal is pulled up to Vio via the resistor.
- In 3-wire mode, SDI terminal is pulled up to Vio via the resistor.

e.g.) Rpullup = 3.6kΩ @Vio=1.8V.



| Items            | Symbol      | Condition              | min | typ | max | Units | Remark |
|------------------|-------------|------------------------|-----|-----|-----|-------|--------|
| SCK frequency    | f_spi       |                        | —   | —   | 10  | MHz   |        |
| SCK low pulse    | t_low_sck   |                        | 40  | —   | —   | ns    |        |
| SCK high pulse   | t_high_sck  |                        | 40  | —   | —   | ns    |        |
| SDI setup time   | t_setup_sdi |                        | 20  | —   | —   | ns    |        |
| SDI hold time    | t_hold_sdi  |                        | 20  | —   | —   | ns    |        |
| SDO output delay | t_delay_sdo | Cb=25pF, Vio=1.62V min | —   | —   | 30  | ns    |        |
|                  |             | Cb=25pF, Vio=1.2V min  | —   | —   | 40  | ns    |        |
| CSB setup time   | t_setup_csb |                        | 40  | —   | —   | ns    |        |
| CSB hold time    | t_hold_csb  |                        | 40  | —   | —   | ns    |        |
| CSB_HI time      | t_csb_hi    |                        | 100 | —   | —   | ns    |        |

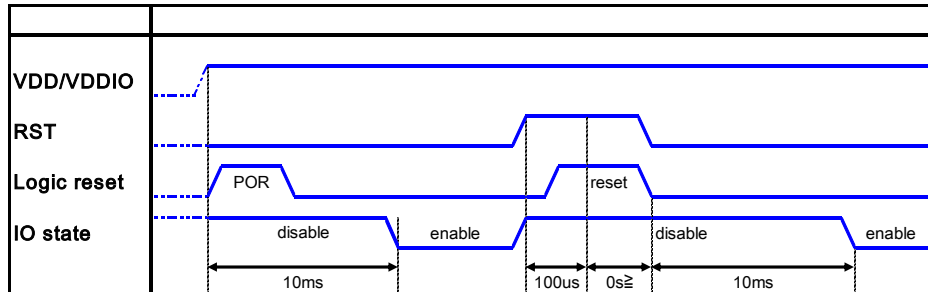
#### 4.8 Reset Function

The sensor is capable of resetting the operation with "Asynchronous Reset Terminal (RST pin)".

The procedure is as follows:

- ① Input high voltage to RST pin. ( $100\mu\text{s} \geq$ )
- ② Turn off (input low voltage) and wait 10ms.

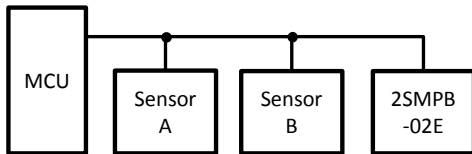
##### ◆Reset sequence



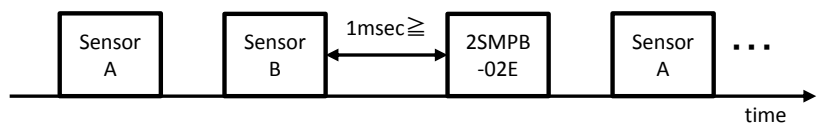
#### 4.9 Recommended conditions of communication

In case that this sensor and other sensors are connected with a common bus line, if you use this sensor at a communication speed more than 400kbit/s, after finishing the communication with other sensors, we recommend to provide 1 ms or more waiting time before starting the communication with this sensor in order to ensure a stable communication (see diagram below).

##### ◆Typical connection diagram



##### ◆Example of communication



## 5. Packaging

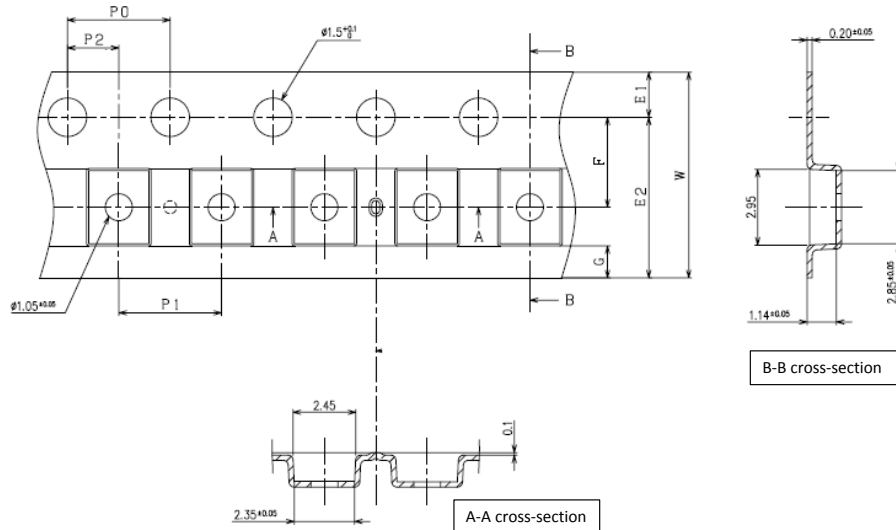
### 5.1 Configuration of shipment

|               |                                                                                          |
|---------------|------------------------------------------------------------------------------------------|
| Packaging     | Embossed Carrier Tape                                                                    |
| Quantity      | 3,500 pcs / 1 reel<br>1 reel / 1 Interior box<br>Max. 20 Interior boxes / 1 exterior box |
| Reel          | 180 mm dia.                                                                              |
| Insert method | see below                                                                                |

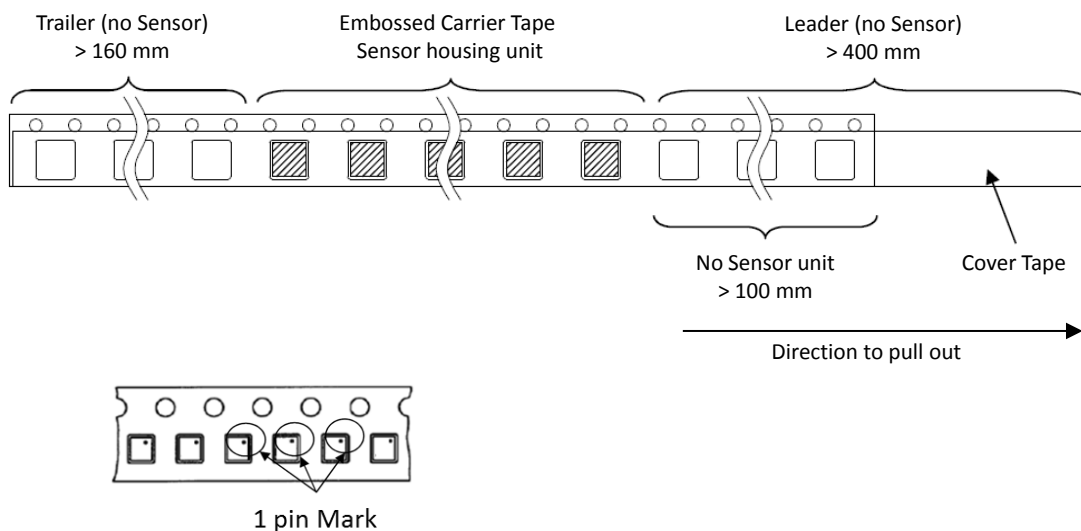
Specification of taping & reel comply with JIS C 0806-3 (IEC 60286-3).

### 5.2 Taping

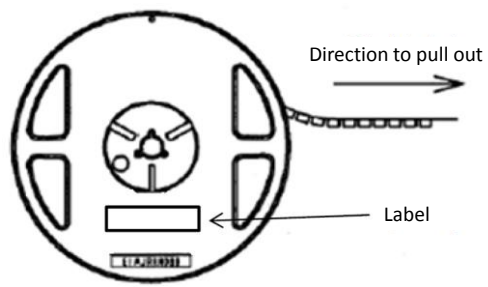
Emboss pitch 4 mm type & tape width 8 mm type.



| Symbol | Rating         |
|--------|----------------|
| W      | 8.0 +0.03/-0.1 |
| E1     | 1.75 +/- 0.1   |
| F      | 3.50 +/- 0.05  |
| P0     | 4.0 +/- 0.1    |
| P1     | 4.0 +/- 0.1    |
| P2     | 2.00 +/- 0.05  |

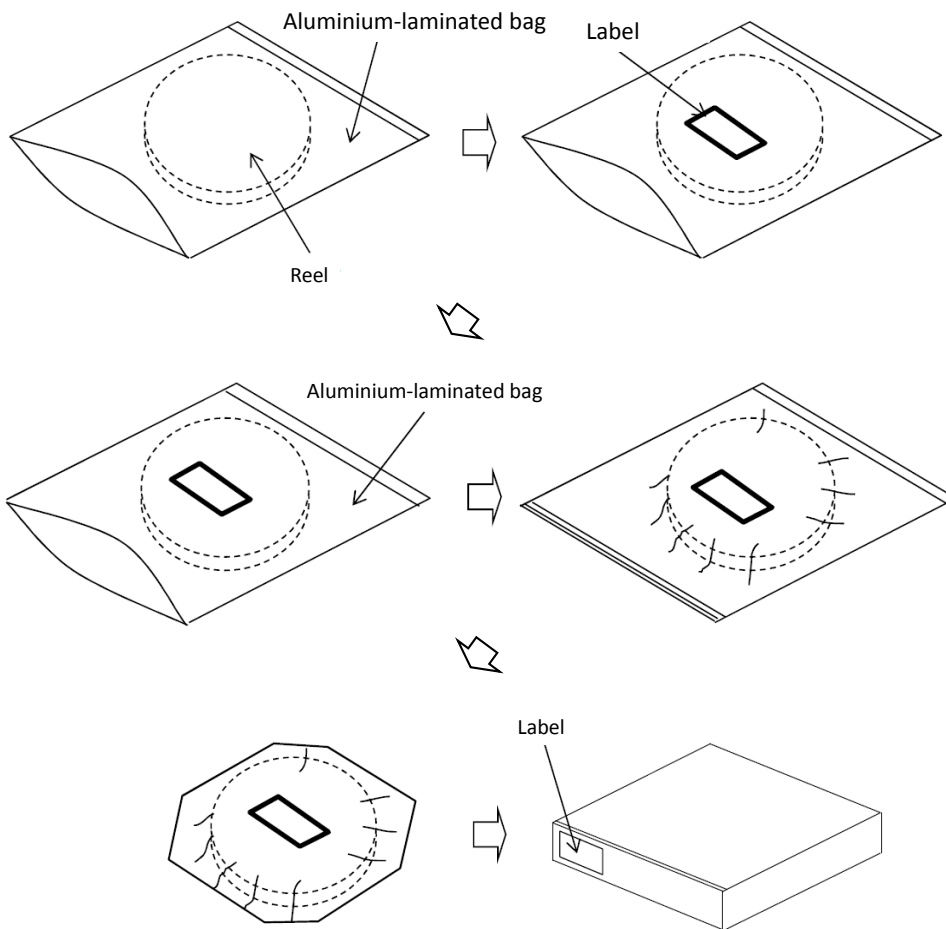


### 5.3 Reel



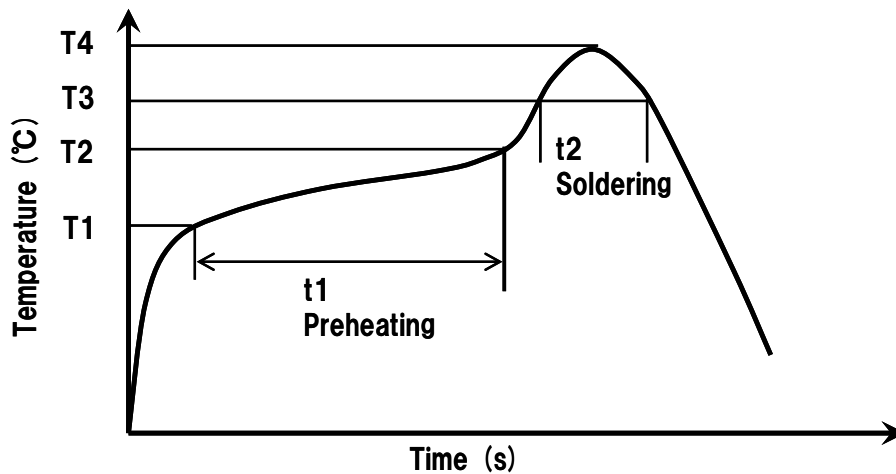
Reel 180 mm dia.  
comply with JIS C 0806-3 requirements

### 5.4 Individual packaging



## 6. Recommended Soldering Method

- Soldering method : Air Reflow ( Max 2 times )
- Condition of Temperature : Max.260 degreeC, within 40seconds
- Recommended Soldering Method :



Temperature profile conditions of reflow soldering should set the temperature condition as shown in the below table and then confirm that actual conditions are met them in the table.

| Item     | Preheating (T1 to T2, t1)                      | Soldering (T3, t2)                  | Peak Value (T4)                 |
|----------|------------------------------------------------|-------------------------------------|---------------------------------|
| Terminal | 150 degreeC to 200 degreeC<br>60sec to 180sec. | 217degreeC min.<br>60sec to 150sec. | 260 degreeC<br>20sec to 40sec.. |

- Since the pressure sensor chip is exposed to atmosphere, cleaning fluid shall not be allowed to enter inside the sensor's case.
- We recommend that it should be used the recommended mounting PAD dimensions for the land pattern.

## 7. Precautions

### (1) Handling

- 1) Only air can be used as pressure media on the product directly. It is prohibited to use pressure media including corrosive gases (e.g. organic solvents gases, sulfur dioxide and hydrogen sulfide gases), fluid and any other foreign materials.
- 2) The products are not water proof. The product shall be kept dry in use excluding the sensor port.
- 3) The product shall not be used under dew-condensing conditions. Frozen fluid on sensor chips may cause fluctuation of sensor output and other troubles.
- 4) The product shall be used within rated pressure. Usage at pressure out of the range may cause breakage.
- 5) The product may be damaged by static electricity. Charged materials (e.g. a workbench and a floor) and workers should provide measures against static electricity, including ground connection.
- 6) The product shall not be dropped and handled roughly.
- 7) The product shall not be used under dusty or damp condition.
- 8) Do not wash the print circuit board after the pressure sensor is mounted using solvent. It may cause a malfunction.
- 9) Please connect the sensor terminals according to the connection diagram.
- 10) The product shall not be used under high-frequency vibration including ultrasonic wave.
- 11) This product uses the elastic adhesive for bonding the lid, so do not add excessive stress to the lid.
- 12) If soldering is not fit, then this product may catch fire or get hot.
- 13) There is a possibility that the peripheral circuit board or some electronic part generates heat while driving this product. Please handle with care.
- 14) Do not tear down this product.
- 15) Please do not use the sensor after following case;
  - excessive shock added to the terminal of the sensor
  - the sensor lid decapped
  - the sensor dropped
- 16) If you use other conditions described in this document, please check yourself in advance.

- (2) Environmental conditions for transport and storage
  - 1) The product shall not be kept with corrosive gases (e.g. organic solvents gases, sulfur dioxide and hydrogen sulfide gases).
  - 2) The products are not water proof. The product shall be kept dry during storage.
  - 3) The outer box strength may be degraded depending on the storage conditions. Please use the product in order.
  - 4) For this product, please keep away from direct sunlight or ultraviolet rays.
  - 5) The product shall be kept in appropriate conditions of temperature and humidity.
  - 6) The product shall not be kept under dusty or damp condition.

## 8. Warranty and Limited Warranty

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### (1) Definition

The definition of terms used in these Terms and Conditions are as follows:

- 1) *Usage conditions*: Usage conditions, rating, performance, operating environment, handling instructions, cautions, prohibited use, etc. of *Omron products* described in specifications, documentations or manuals.
- 2) *Customer application*: Application of *Omron products* by customers which include embedding and/or using *Omron products* in their parts/components, electronic substrates, devices, equipment or systems manufactured by customers.
- 3) *Fitness*: (a) performance, (b) non-infringement of third-party intellectual property, (c) compliance with laws and regulations and (d) conformity to various standards.

### (2) Caution on Descriptions

Attention is required to the following points on descriptions in specifications.

- 1) Rated values and performance values are the product of tests performed for separate single conditions, including but not limited to temperature and humidity. It is not intended to warrant rated values and performance values for multiple combined conditions.
- 2) Reference data are provided for reference only. *Omron* does NOT warrant that *Omron products* work properly at all time in the range of reference data.
- 3) Application examples are provided for reference only. *Omron* does NOT warrant the *Fitness* of *Omron products* under such application.
- 4) *Omron* may discontinue the production of *Omron products* or change the specifications of them for the purpose of improving such products or other reasons entirely at its own discretion.

### (3) Precautions

Please be aware of and accept the following when you introduce or use *Omron products*:

- 1) Please use *Omron products* in compliance with *usage conditions* including rating and performance.
- 2) Please confirm *fitness* of *Omron products* in your application and use your own judgment to determine the appropriateness of using them in such application. *Omron* shall not warrant the *fitness* of *Omron products* in customer application.
- 3) Please confirm that *Omron products* are properly wired and installed for their intended use in your overall system.
- 4) When using *Omron products*, please make sure to (i) maintain a margin of safety vis-à-vis the published rated and performance values, (ii) design to minimize risks to customer application in case of failure of *Omron products*, such as introducing redundancy, (iii) introduce system-wide safety measures to notify risks to users, and (iv) conduct regular maintenance on *Omron products* and *customer application*.
- 5) *Omron products* are designed and manufactured as general-purpose products for use in general industrial products. They are not intended to be used in the following applications. If you are using *Omron products* in the following applications, *Omron* shall not provide any warranty for such *Omron products*.
  - (a) Applications with stringent safety requirements, including but not limited to nuclear power control equipment, combustion equipment, aerospace equipment, railway equipment, elevator/lift equipment, amusement park equipment, medical equipment, safety devices and other applications that could cause danger/harm to people's body and life.
  - (b) Applications that require high reliability, including but not limited to supply systems for gas, water and electricity, etc., 24 hour continuous operating systems, financial settlement systems and other applications that handle rights and property.
  - (c) Applications under severe condition or in severe environment, including but not limited to outdoor equipment, equipment exposed to chemical contamination, equipment exposed to electromagnetic interference and equipment exposed to vibration and shocks
  - (d) Applications under conditions and environment not described in specification

- 6) In addition to the applications listed from (a) to (d) above, *Omron products* are not intended for use in automotive applications (including two wheel vehicles). Please do NOT use *Omron products* for automotive applications. Please contact *Omron* sales staff for products for automotive use.
- (4) Warranty Terms and Conditions  
The terms and conditions for warranty of *Omron products* are as follows:
- 1) Warranty period: One year after the purchase.
  - 2) Coverage: *Omron* will provide free replacement of the malfunctioning *Omron products* with the same number of replacement/alternative products
  - 3) Exceptions: *Omron* will not cover *Omron products* under its warranty if the cause of the malfunction falls under any of the following.
    - (a) Usage in a manner other than the original intended use for the *Omron product*.
    - (b) Usage outside of the *usage conditions*.
    - (c) Cause which could not have been foreseen with the level of science and technology at the time of shipping from *Omron*.
    - (d) Causes originating from other than *Omron* or *Omron products* (including force majeure such as but not limited to natural disasters).
- (5) Limitation of Liability  
The warranty set out in these Terms and Conditions is the whole and sole liability for *Omron products*. There are no other warranties, expressed or implied. *Omron* and the distributors of *Omron products* are not liable for any damages which may arise from or be related to *Omron products*.
- (6) Export Controls  
Customers of *Omron products* shall comply with all applicable laws and regulations of other relevant countries with regard to security export control, when exporting *Omron products* and/or technical documents or providing such products and/or documents to a non-resident. *Omron* may not provide customers with *Omron products* and/or technical documents should they fail to comply with such laws and regulations.

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Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.

С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

Мы предлагаем:

- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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