DATA SHEET
HSPPAD143C

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This specification is subject to change without notice.

History of Revision

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1. OVERVIEW

HSPPAD143C is the 3.1x3.1mm footprint and 2.6mm height digital interface pressure sensor designed as gas meter system. Barometric pressure is detected by MEMS sensor element using piezo resistive bridge circuit formed on the silicon diaphragm. The sensor element is connected to ASIC for signal conditioning. ASIC has 17-bit ADC and temperature compensation capability. The ASIC output compensated pressure values. In addition to the compensation, this product supports averaging and filtering for lower noise, and FIFO function. I2C interface is prepared for communication.

2. FEATURES

- Pressure Range 300 to 2000 hPa
- Supply Voltage 1.7 to 3.6 V (Typical 3.0V)
- Operating Temperature -40 to +85 °C
- Package Small LGA Package: 3.1mm x 3.1mm x 2.6mm
- Digital interface I2C
- Current Consumption 1.8uA (Low power setting)
- Noise RMS 0.026hPa (High resolution setting)
- Sampling rate 200Hz max (Continuous mode)
- Lead free, RoHS instruction, Halogen free conforming

3. ABSOLUTE MAXIMUM RATINGS

Table 1 : Absolute maximum ratings

Item	Symbol	Unit.	Specification			Notes
			min.	Typ.	max.	
Max supply voltage	VDD	[V]	-0.5	-	4.0	-
Max load pressure	Pmax	[hPa]	-	-	30000	-
Storage temperature	Tstg	[°C]	-40	-	+125	-
ESD		[V]	-2000	-	+2000	HBM

4. ELECTRICAL CHARACTERISTICS

Table 2 : Electrical Characteristics

Item	Symbol	Unit	Specification			Notes
			min.	Typ.	max.	
Operating temperature	Topr	[°C]	-40		+85	
Pressure range	Popr	[hPa]	300		2000	
Supply voltage	VDD	[V]	1.7	3.0	3.6	
Current consumption	IDD	[uA]		1.8		@1Hz sampling, Low power setting, 25°C
Standby current		[uA]		0.1		T=25°C
Pressure RMS noise		[hPa]		0.060		Low power setting
		[hPa]		0.026		High resolution setting
Maximum measurement rate		[Hz]		200		Continuous mode
Pressure resolution		[LSB/hPa]		50		
Pressure absolute accuracy *1		[hPa]	-2.0		+2.0	800 to 1200hPa 25°C
Temperature accuracy *1		[°C]	-1.0		+1.0	1000hPa 25°C

Table 2.1: Typical accuracy

Item	Symbol	Unit	Typ.	Notes
Pressure absolute accuracy *1	---	[hPa]	±2.0	800 to 1200hPa,-25 to 65°C
		[hPa]	±4.0	800 to 1200hPa,-40 to -25°C
Temperature accuracy *1	---	[°C]	±2.0	-40 to -25℃
			±1.0	-25 to 65°C
Solder drift *1	---	[hPa]	±2.0	
Long term drift *1	---	[hPa]	±1.0	12 months

*1: VDD=3.0V

5. POWER UP AND DOWN SEQUENCE

Power up and down sequence must be followed the specification in the table 3.

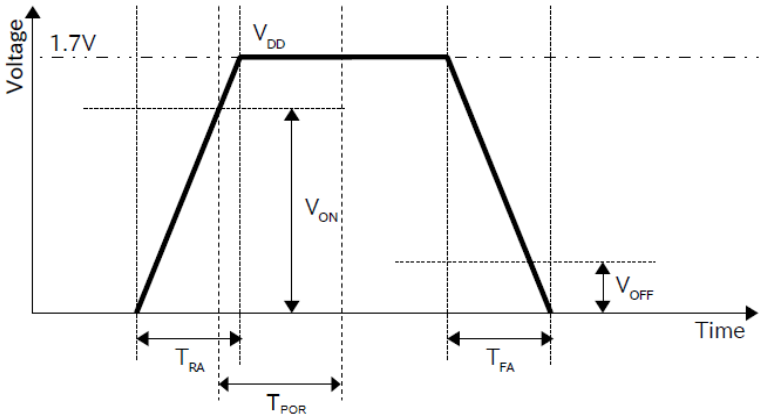


Fig. 1 : Power up and down sequence

Table 3 : Power up and down specification

Items	Symbol	Min	Typ	Max	Unit
ON voltage	V_{ON}	-	-	1.6	V
OFF voltage	V_{OFF}	0.5	-	-	V
Rise time	T_{RA}	0.1	-	2.0	mS
Fall time	T_{FA}	0.1	-	2.0	mS
POR time	T_{POR}	-	-	2.2	mS
OFF time	T_{OFF}	100	-	-	mS

Until POR is done, register access from host device is ignored. POR will take 2.2msec after VDD reaches ON voltage. Consecutive power on after VDD sink below V_{OFF}, must wait T_{OFF} to perform POR correctly.

6. BLOCK DIAGRAM

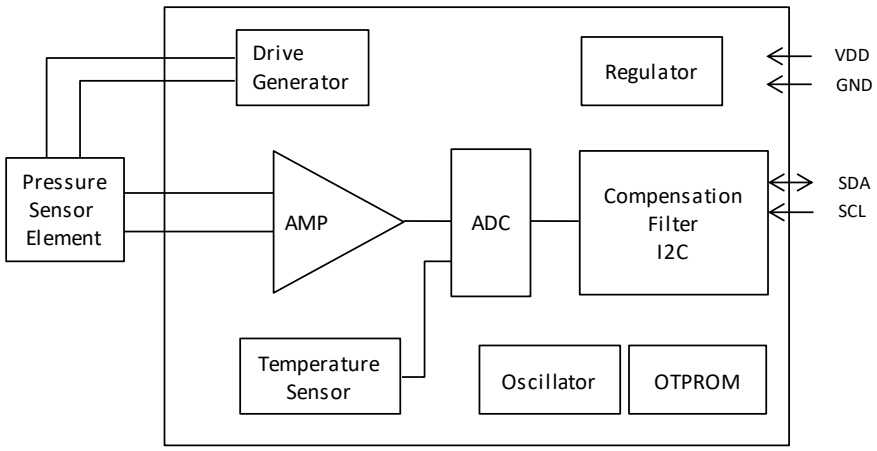


Fig. 2 : Block Diagram

7. MODES

Mode transition diagram is shown below. Mode can be set by CTL1.MODE[1:0] in Register 0x0F. After POR or Software reset, mode is set to Register Action Mode.

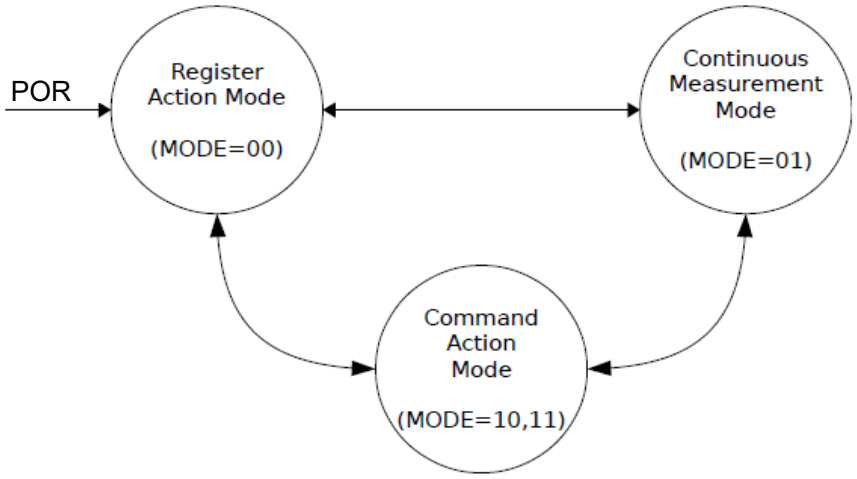


Fig. 3 : Mode transition

Table 4 : Mode setting

CTL2.MODE	Measurement Mode	Notes
00	Register Action Mode	Execute measurement by accessing Register ACTL1.
01	Continuous Measurement Mode	Automatically repeat measurement by specified frequency
10 or 11	Command Action Mode	Execute measurement by receiving Action Commands

7.1 Register Action Mode

Register Action Mode allows access to ACTL1 and execute each functions by setting "1" for each bit. Temperature measurement and Pressure measurement is performed by setting TDET and PDET to 1, respectively. When TDET and PDET are set to "1" at the same time, Temperature measurement is done, followed by Pressure measurement. If the PDET is performed independently, the latest temperature data is used for pressure data compensation. Temperature data is stored into register address 0x09 and 0x0A, and compensated pressure data is in 0x04 to 0x06. After data store, TRDY and PDRY in STAT register is changed to "1", and TDET and PDET back to "0". TDET and PDET are accessible during measurement, but they will be effective after the measurement. Only PDRP is effective right away. After measurement, device goes to stand-by state and minimizes current consumption, then waiting for next command.

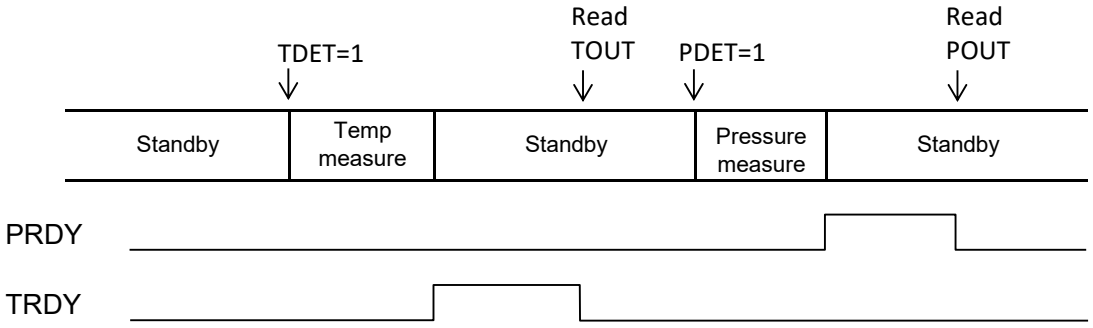


Fig. 4 : Timing chart in Register Action Mode (PDET and TDET are executed individually)

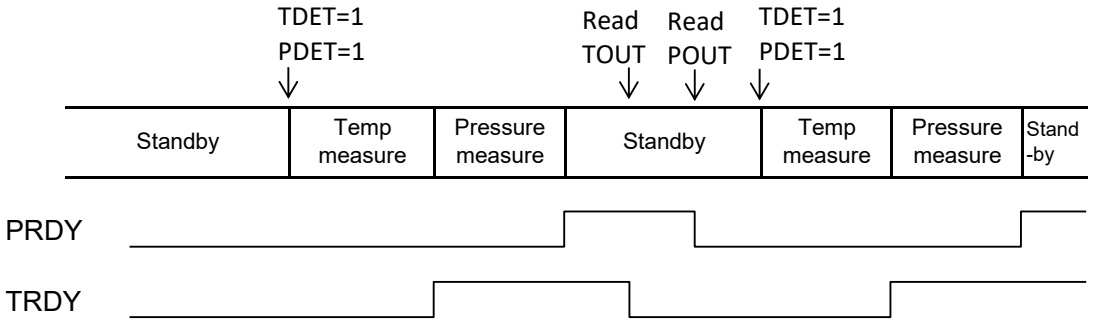


Fig. 5 : Timing chart in Register Action Mode (PDET and TDET are executed at same time)

7.2 Continuous Measurement Mode

Continuous Measurement Mode executes measurement with specified frequency by CTL2.ODR. In order to move into this mode, CTL2.PMES must be set "1". Measurement is started immediately after mode transition and following measurement is repeated. In this mode, regulator will not be inactive in standby period and keeps consuming current. If ODR is changed in this mode, new measurement will be performed immediately and repeat following measurement. However, ODR change is done in measurement period, new measurement will start right after the measurement finished.

Table 5 : ODR and Sampling frequency

ODR	Sampling Frequency	Sampling Period
00	1Hz	1000ms
01	10Hz	100ms
10	100Hz	10ms
11	200Hz	5ms

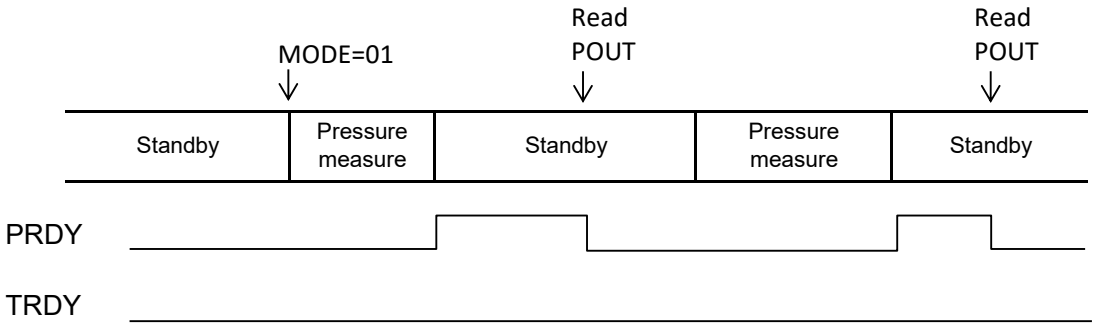


Fig. 6 :Timing chart in Continuous Measurement Mode (PMES=1, TMES=0)

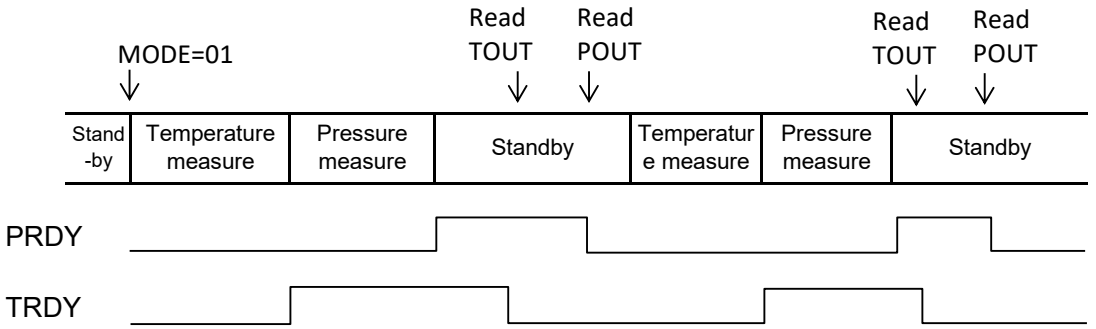


Fig. 7 :Timing chart in Continuous Measurement Mode (PMES=1, TMES=1)

7.3 Command Action Mode

In Command Action Mode, several functions are performed by write access the register address. Each actions are the same with setting "1" at same bit name in ACTL1 and ACTL2 in Register Action Mode.

Table 6 : Action Commands

Address	Name	Function
20h	PDET	Perform pressure measurement
22h	TDET	Perform temperature measurement
26h	SRST	Perform software reset
29h	PTDET	Perform pressure and temperature measurement

8. FUNCTIONS

8.1 FIFO

There are 16 steps FIFO for Pressure read data. FIFO function can be enabled by setting FCTL.FFEN=1.

Table 7 : FCTL.FFEN setting

FCTL.FFEN	Description
0	FIFO disabled
1	FIFO enabled

Write pointer is incremented when the sensor data is stored into FIFO memory, and next data is stored to next register. Read Pointer is incremented when the sensor data is read.
Number of stored data is indicated by FFST.FP, if the FP (FIFO Pointer) is greater or equal to WMT (Water Mark Pointer) then FFST.FFEV becomes "1". All 16 steps FIFO memory are filled by the sensor data, the most oldest data is discarded and Read Pointer is incremented. All data in FIFO memory is discarded when FFEN is set to "0".

Increment every data storage

Write Pointer	FIFO Memory			Read Pointer
	POUT L	POUT M	POUT H	
W0	POUT_L0	POUTM_0	POUT_H0	R0
W1	POUT_L1	POUTM_1	POUT_H1	R1
W2	POUT_L2	POUTM_2	POUT_H2	R2
W3	POUT_L3	POUTM_3	POUT_H3	R3
W4	POUT_L4	POUTM_4	POUT_H4	R4
W5	POUT_L5	POUTM_5	POUT_H5	R5
W6	POUT_L6	POUTM_6	POUT_H6	R6
W7	POUT_L7	POUTM_7	POUT_H7	R7
W8	POUT_L8	POUTM_8	POUT_H8	R8
W9	POUT_L9	POUTM_9	POUT_H9	R9
W10	POUT_L10	POUTM_10	POUT_H10	R10
W11	POUT_L11	POUTM_11	POUT_H11	R11
W12	POUT_L12	POUTM_12	POUT_H12	R12
W13	POUT_L13	POUTM_13	POUT_H13	R13
W14	POUT_L14	POUTM_14	POUT_H14	R14
W15	POUT_L15	POUTM_15	POUT_H15	R15

Increment every data read or data discard

8.2 Averaging

Table 8 : AVCL.AVG setting

AVCL.AVG	Number of data to average	
	Register Action and Command Action Mode	Continuous Mode
000	no average	no average
001	x 2	x 2
010	x 4	x 4
011	x 8	x 8
100	x 16	x 16
101	x 32	x 16
110	x 64	x 16
111	x 128	x 16

Table 9 : AVCL.TFRQ setting

000	Once before first pressure measurement
001	Once every 64 pressure measurement
010	Once every 32 pressure measurement
011	Once every 16 pressure measurement
100	Once every 8 pressure measurement
101	Once every 4 pressure measurement
110	Once every 2 pressure measurement
111	Every time

8.2.1 In Register Action Mode and Command Action Mode

Averaging function can be activated by setting AVCL.AVG. In Register Action Mode and Command Action mode, simple average is calculated. Measurement is performed after the command PDET is issued . Temperature is measured by specified frequency by AVCL.TFRQ. The measurement repeats until specified number of data is collected. Each data are temperature compensated with the latest temperature data. Then, average is calculated and the result is stored into POUT.

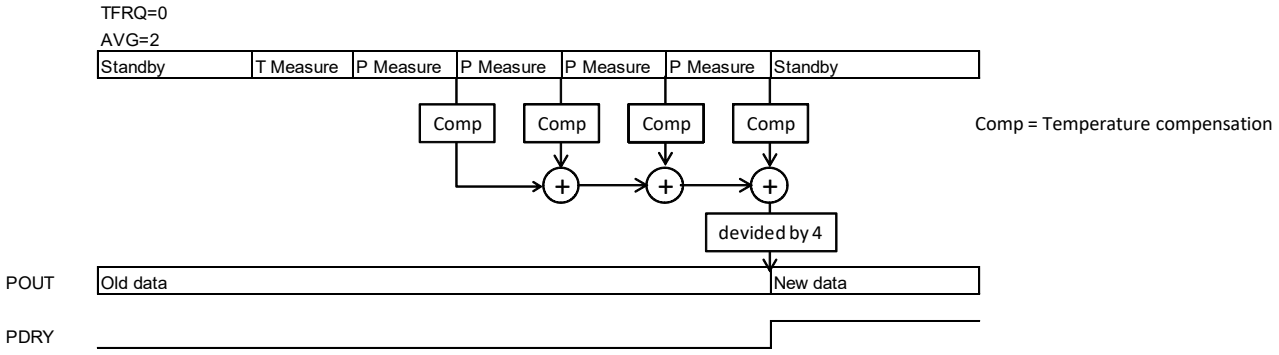


Fig. 8 Average calculation (TFRQ=0, AVG=2)

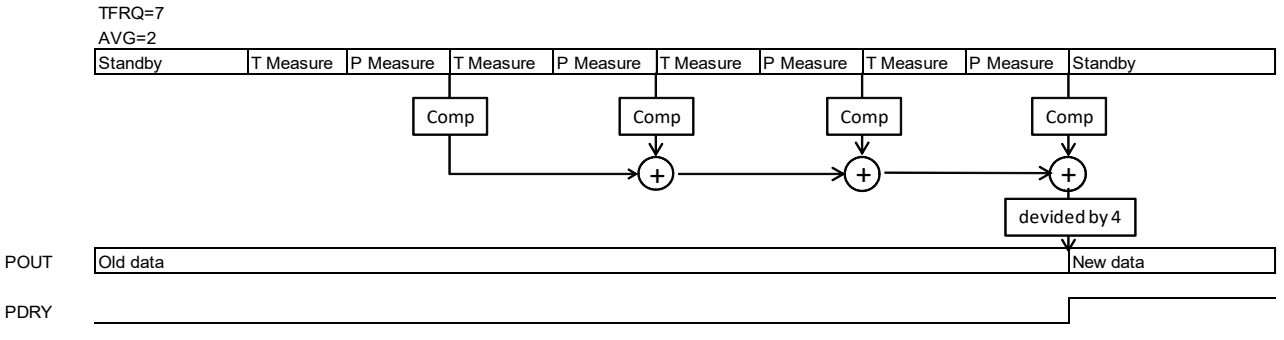


Fig. 9 Average calculation (TFRQ=07 AVG=2)

8.2.2 In Continuous Mode

In Continuous Mode, moving average is calculated. Set CTL2.MODE=01 with AVCL.AVG>0, periodical measurement is started. Average is calculated when every measurement is done and the result is stored into POUT. Moving average can update averaged data at every measurement, so sampling rate won't be compromised. When first few measurement, number of data is not sufficient to specified average number, in this case necessary data is supplemented by initial data.

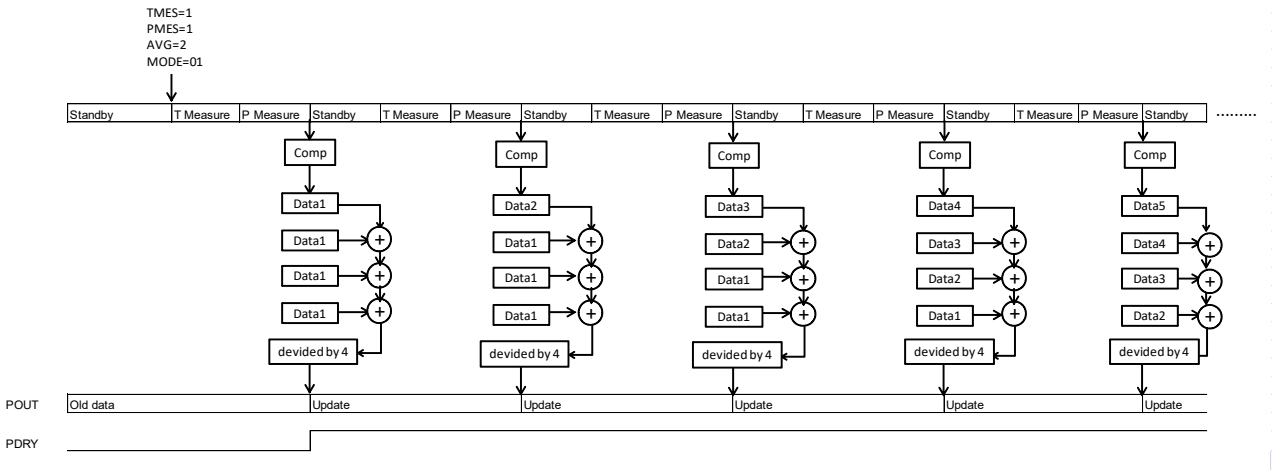


Fig. 10 Moving Average calculation

8.3 CIC Filter

Digital output data from ΔΣADC is processed at CIC filter in the digital block. Number of TAP can be specified at CTL1.PTAP. Output data accuracy is increased by larger number of TAP, however, current consumption is increased too. This TAP setting is effective to pressure reading only and fixed for temperature.

Table 10 : CTL1,PTAP setting

PTAP	Name	Tap count	Pressure Measurement time
00	Ultra Low Power	32	260 uS
01	Low Power	64	356 uS
10	High Accuracy	128	548 uS
11	Ultra Accuracy	256	932 uS

Measurement time is typical value and not guaranteed. Temperature measurement time (416uS) is not included.

8.4 Software Reset

Software reset is performed by setting ACTL2.SRST to "1" or send action command SRST. Once software reset command is detected, digital regulator is disabled and all register values are reset. Then transfer to Register Action Mode and Standby state. After Software reset command, command can not be received for 2.2msec to complete POR.

8.5 Flag Function

Following flag function can be used. The status is checked by reading FFST or STAT register.

8.5.1 STAT and FFST Register

STAT register indicates following status.

Table 11 : STAT and FFST Register function

Register	Name	Flag	Condition to be "1"	Condition to be "0"
STAT	BUSY	Busy flag	Pressure or Temperature sensor is in measurement.	In standby state.
	TRDY	Temperature measurement completion flag	TDET was executed and temperature measurement is completed.	TOUT is read. FFEN is changed.
	PDOR	Pressure data over run flag	a) FIFO is disabled Old data is discarded and updated by new data in POUT. b) FIFO is enabled The most oldest data is discarded with FFEN=1 and FP=16.	a) FIFO is disabled POUT is read. b) FIFO is enabled POUT is read. FFEN is changed.
	PRDY	Pressure measurement completion flag	a) FIFO is disabled Pressure measurement is competed. b) FIFO is enabled FP>=1	a) FIFO is disabled POUT is read. B) FIFO is enabled FP=0. FFEN is changed.
FFST	FFEV	FIFO event flag	FP>=WMT	FP<WMT Change FFEV

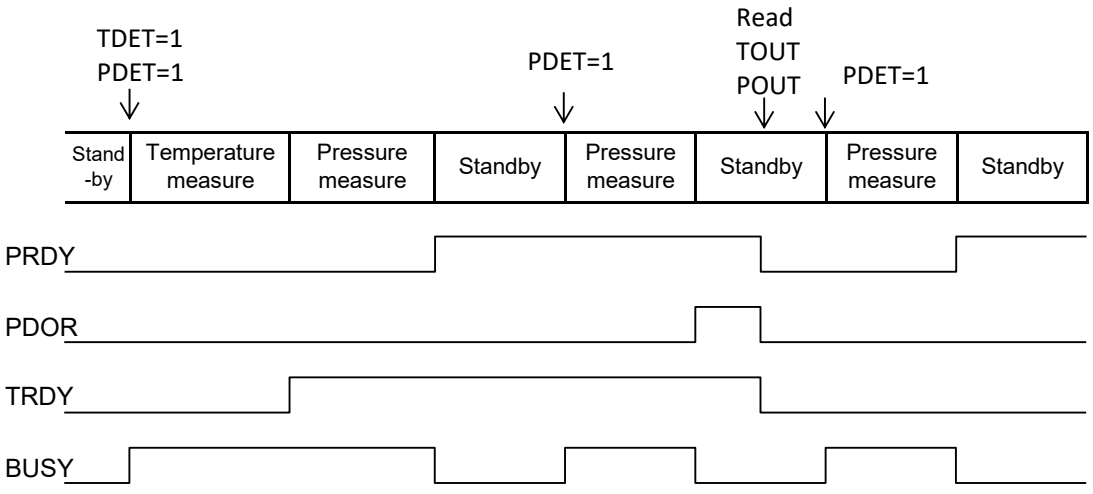


Fig. 11 :STAT register during measurement.

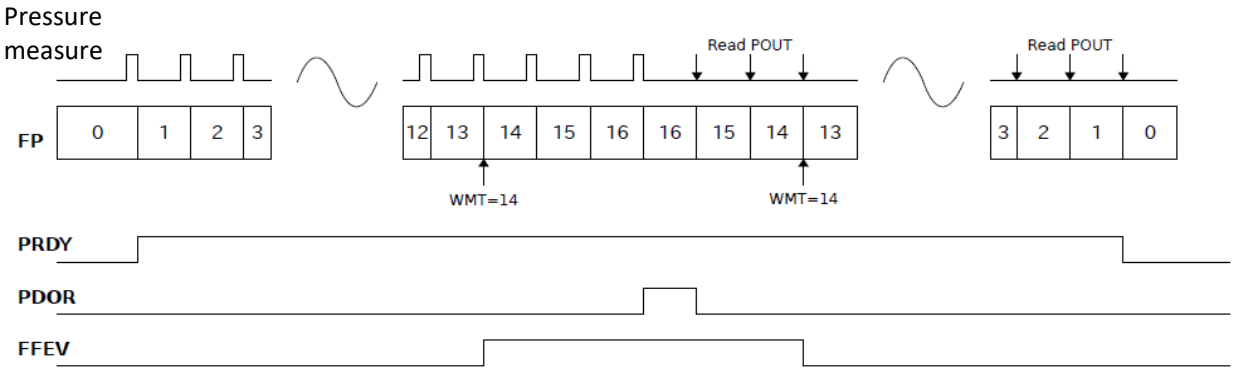
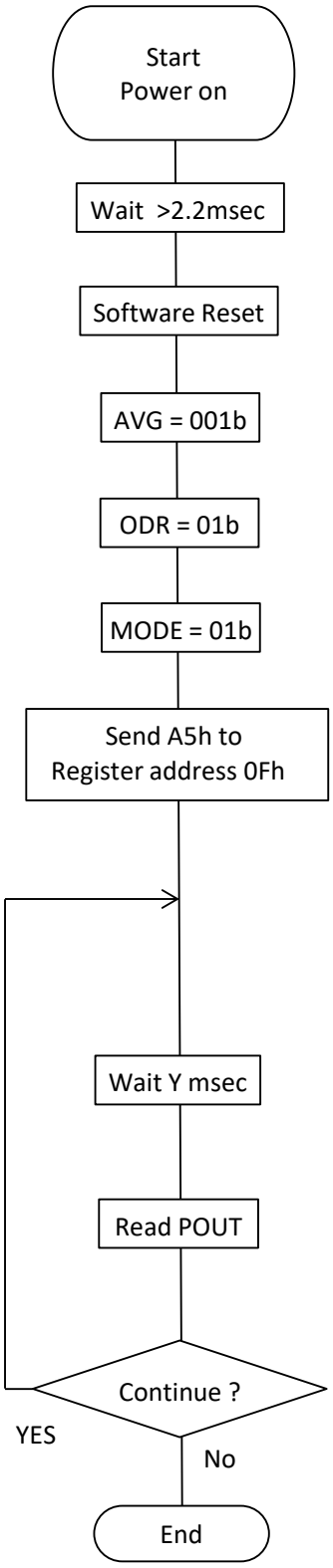


Fig. 12 :Timing chart in FIFO mode

9. SAMPLE FLOW CHART

9.1 Continuous mode

This flow chart is showing from power on to pressure measurement in continuous mode.



Comments

Wait for POR (Power On Reset) time.

To perform software reset, send 80h to register address 11h

To average measured data of 2 times, AVG=001b. Send 39h to register address 13h.

To perform continuous measurement at 10Hz , ODR=01b.

To set mode to continuous mode, MODE=01b.

Write A5h to register address 0Fh, start continuous measurement. Measurement data is updated by Time X [msec].

ODR setting (binary)	ODR [Hz]	Time X [msec]
00	1	1000
01	10	100
10	100	10
11	200	5

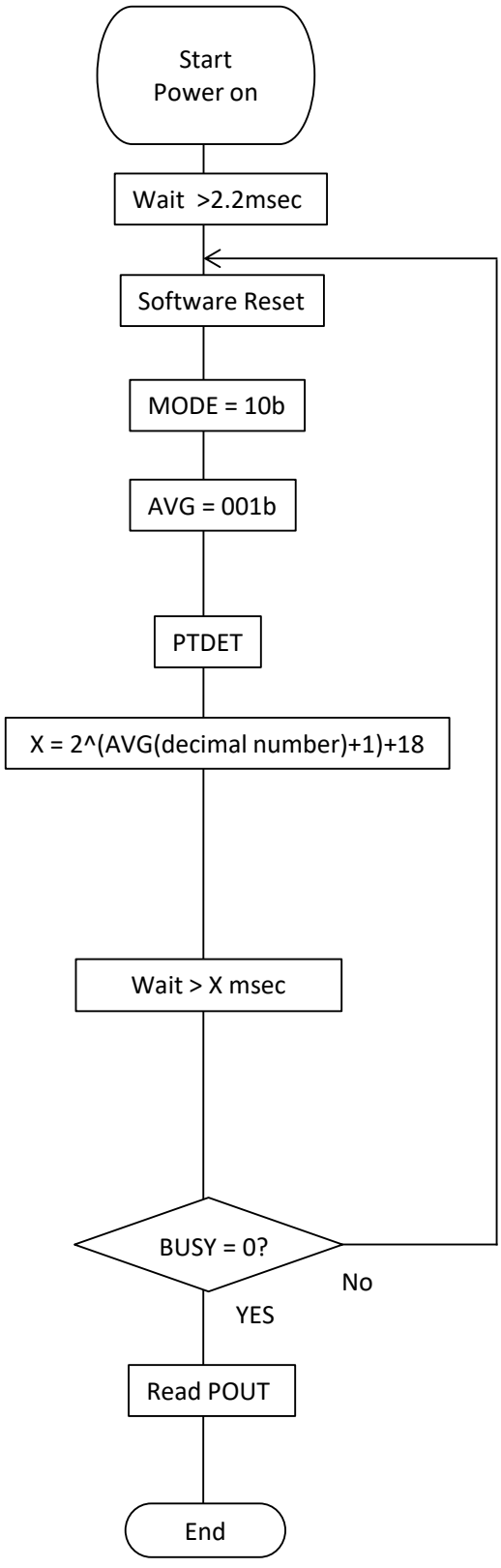
The waiting time Y is set to the user's arbitrary value.

Read out pressure data
(Read POUT Register address 04h to 06h)

Fig. 13 : Sample flow chart (Continuous mode)

9.2 Command Action mode

This flow chart is showing from power on to pressure measurement in command action mode.



Comments

Wait for POR (Power On Reset) time.

To perform software reset, send 80h to register address 11h

To set mode to command action mode, MODE=10b. (Send A2h to Register address 0Fh)

To average measured data of 2 times, AVG=001b. Send 39h to register address 13h.

To perform pressure and temperature measurements, send action command to 29h, Send PTDET

Check wait time. Time X depends on AVG settings.
Time X (msec) = 2^(AVG(decimal)+1)+18

AVG setting (binary)	AVG (decimal number)	Time X [msec]
000	0	20
001	1	22
010	2	26
011	3	34
100	4	50
101	5	82
110	6	146
111	7	274

(ex:AVG=001, X = 2^(1+1)+18 = 22 msec)

Check measurement is done
(Read BUSY in Register address 03h, bit 7)

Read out Pressure data
(Read POUT Register address 04h to 06h)

Fig. 14 : Sample flow chart (Command Action mode)

10. TYPICAL REGISTER SETTING

Table 12 : Typical settings

Setting	Application	MODE	PTAP	AVG	TFRQ	ODR [Hz]	Measurement Period [mS] (*1)	Current [uA]	Noise [Pa]	Noise [cm]
Fastest Dynamic motion detection	Game or fast move handheld device	Continuous	11	x 16	NA	200	NA	356	1.2	10
Dynamic motion detection	Handheld device	Continuous	11	x 16	NA	100	NA	181	1.2	10
Indoor navigation	Floor detection	Continuous	11	x 16	NA	10	NA	23.6	1.2	10
1Hz Single shot High resolution	On demand altitude detection	Register Action or Command Action	11	x 8	0	1 (*2)	8	11.2	2.6	22
1Hz Single shot Low power	High frequency weather station	Register Action or Command Action	11	x 1	0	1 (*2)	1.5	1.8	6	51
1/60Hz Single shot Low power	Low frequency weather station	Register Action or Command Action	11	x 1	0	1/60 (*2)	1.5	0.03	6	51

*1 : Measurement period in msec. In other words, necessary time period after receiving command.
Not applicable for Continuous mode.
*2 : Sampling frequency must be controlled by command from host device.

11. INTERFACE SPECIFICATIONS

11.1 I2C Slave Interface

I2C interface specification conforms Philips I2C-BUS Specification version 2.1 and NXP UM10204 I2C-BUS Specification and user manual Rev.03-19 June 2007. The slave address is 1001000x (x= Write:0, Read:1). Standard mode (100kHz), Fast mode (400kHz), Fast mode plus (1MHz) and High-speed mode (3.4MHz) are supported. Multiple read and write is supported and register address is automatically incremented every read or write.
High-speed mode is selected when master code (00001xxx) is received instead of slave address. Once master code is received, the product return NAK.
The device works in Fast mode plus and High-speed mode with power supply less than 2.5V. Please contact us, if the device needs to be operated in those mode with or higher power supply. Different factory calibration will be done before shipment.

Bus protocol definitions

S: Start condition
SAD+W: Slave Address + write bit
SAD+R: Slave Address + read bit
SAD+R/W: Slave Address + read or write bit
SAK: Slave Acknoledge
REG: Register Address (2nd byte)
Sr: Repeat Start condition
A: (Master) Acknowledge
/A: (Master) Non-Acknowledge
DATA: Data (load)
P: Stop condition
M-code: Master code (00001XXX)

Read Formats

One byte read flow

master	S	SAD+W		REG		SR	SAD+R			/A	P
slave			SAK		SAK			SAK	DATA		

Multiple byte reads flow

master	S	SAD+W		REG		SR	SAD+R			A		/A	P
slave			SAK		SAK			SAK	DATA		DATA		

Write Format

One byte wirte flow

master	S	SAD+W		REG		DATA		P
slave			SAK		SAK		SAK	

Multiple byte writes flow

master	S	SAD+W		REG		DATA		DATA		P
slave			SAK		SAK		SAK		SAK	

HS mode data trasfer

HS mode is enable after writing Mcode.

speed	F/S-mode			Hs-mode						FS-
master	S	Mcode	/A	SR	SAD +R/W		DATA	/A	P	
slave						A	DATA	A		
									Hs- continue	
master									SR	SAD +R/W

12. REGISTER MAP

Reg add	Name	Cust. R/W/A	Test R/W/A	Full Name	Bit assignment								Init. Value
					bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	
00	WIA	R	R	Who I am	0	1	0	0	1	0	0	1	49
01	INFO	R	R	Information	0	0	1	1	0	0	0	1	31
02	FFST	R	R	FIFO Status	FFEV	-	-	FP[4:0]					00
03	STAT	R	R	Status	BUSY	-	-	TRDY	-	PDOR	-	PRDY	00
04	POUTL	R	R	Pressure Output Low	POUT[7:0]								00
05	POUTM	R	R	Pressure Output Middle	POUT[15:8]								00
06	POUTH	R	R	Pressure Output High	-	-	-	-	-	-	-	POUT[16]	00
09	TOUTL	R	R	Temperature Output Low	TOUT[7:0]								00
0A	TOUTH	R	R	Temperature Output High	TOUT[15:8]								19
0E	CTL1	RW	RW	Control 1	-	-	-	-	-	-	PTAP[1:0]		13
0F	CTL2	RW	RW	Control 2	TMES	-	PMES	-	ODR[1:0]		MODE[1:0]		A0
10	ACTL1	RW	RW	Action Control 1	-	-	-	-	TDET	-	PDET	-	00
11	ACTL2	RW	RW	Action Control 2	SRST	-	-	-	-	-	-	-	00
12	FCTL	RW	RW	FIFO Control	FFEN	-	-	WMT[4:0]					10
13	AVCL	RW	RW	Average Control	-	-	TFRQ[2:0]			AVG[2:0]			38
1C	PNUM	R	R	Product Number	0	1	1	0	0	0	0	1	61
20	PDET	AC	AC	Pressure Detection Command	-	-	-	-	-	-	-	-	-
22	TDET	AC	AC	Temperature Detection Command	-	-	-	-	-	-	-	-	-
26	SRST	AC	AC	Software Reset Command	-	-	-	-	-	-	-	-	-
29	PTDET	AC	AC	P&T Detection Command	-	-	-	-	-	-	-	-	-

Registers marked "-" must not be changed.

13. REGISTER DESCRIPTION

WIA (Who I am) Address:00h (Read only)

bit	Name	Initial	Description
7:0	WIA	49h	Fixed value

INFO (Information) Address:01h (Read only)

bit	Name	Initial	Description
7:0	INFO	31h	Fixed value

FFST (FIFO Status) Address:02h (Read only)

bit	Name	Initial	Description
7	FFEV	0b	FIFO event flag. 0: FP<WMT 1: FP>=WMT
6:5	-	-	-
4:0	FP	00000b	Number of data stored in FIFO memory. 5bit = 0~16.

STAT (Status) Address:03h (Read only)

bit	Name	Initial	Description
7	BUSY	0b	Busy state flag. 0: Standby state 1: In Busy state
6	-	-	-
5	-	-	-
4	TRDY	0b	Temperature measurement completion flag 0: No data update or data was read 1: New data is ready
3	-	-	-
2	PDOR	0b	Data over run flag 0: No data update or data was read 1: Old data is discarded
1	-	-	-
0	PRDY	0b	Pressure measurement completion flag 0: No data update or data was read 1: New data is ready

POUT (Pressure Output) Address:04h~06h (Read only)

bit	Name	Initial	Description
23:17	-	-	-
16:0	POUT	00000h	17bit Pressure output 0~131071 Pressure [Pa] = POUT[LSB] x 2

TOUT (Temperature Output) Address:09h~A0h (Read only)

bit	Name	Initial	Description
15:0	TOUT	1900h	16bit temperature data -32768~32767 (Two's complement) Temperature [°C] = TOUT[LSB] / 256

CTL1 (Control 1) Address:0Eh (Read/Write)

bit	Name	Initial	Description
7:5	-	-	-
4	-	-	-
3:2	-	-	-
1:0	PTAP	11b	sinc filter Tap count 00: 32-tap, Ultra low power 01: 64-tap, Low power 10: 128-tap, High accuracy 11: 256-tap, Ultra accuracy

CTL2 (Control 2) Address:0Fh (Read/Write)

bit	Name	Initial	Description
7	TMES	1b	Temperature measurement 0: Disable temperature measurement in Continuous mode. 1: Enable temperature measurement in Continuous mode.
6	-	-	-
5	PMES	1b	Pressure measurement 0: Disable pressure measurement in Continuous mode. 1: Enable pressure measurement in Continuous mode.
4	-	-	-
3:2	ODR	00b	Sampling rate 00: 1Hz 01: 10Hz 10: 100Hz 11: 200Hz
1:0	MODE	00b	Mode setting 00: Register Action Mode 01: Continuous Measurement Mode 10: Command Action Mode 11: Command Action Mode

ACTL1 (Action Control 1) Address:10h (Read/Write)

bit	Name	Initial	Description
7:4	-	-	-
3	TDET	0b	Temperature measurement in Register Action Mode 0: Not measure 1: Measure
2	-	-	-
1	PDET	0b	Pressure measurement in Register Action Mode 0: Not measure 1: Measure
0	-	-	-

ACTL2 (Action Control 2) Address:11h (Read/Write)

bit	Name	Initial	Description
7	SRST	0b	Software Reset 0: None 1: Execute Software Reset
6:0	-	-	-

FCTL (FIFO Control) Address:12h (Read/Write)

bit	Name	Initial	Description
7	FFEN	0b	FIFO enabler 0: Disable 1: Enable
6:5	-	-	-
4:0	WMT	10000b	FIFO threshold 5bit 0~16.

AVCL (Average Control) Address:13h (Read/Write)

bit	Name	Initial	Description
7:6	-	-	-
5:3	TFRQ	111b	Frequency of temperature measurement 000: Only first time 001: Once every 64 times 010: Once every 32 times 011: Once every 16 times 100: Once every 8 times 101: Once every 4 times 110: Once every 2 times 111: Every time
2:0	AVG	000b	Number of data to average (In Continuous Mode) 000: No average 001: x 2 (x 2) 010: x 4 (x 4) 011: x 8 (x 8) 100: x 16 (x 16) 101: x 32 (x 16) 110: x 64 (x 16) 111: x 128 (x 16)

PNUM (Product Number) Address:1Ch (Read only)

bit	Name	Initial	Description
7:0	PNUM	61h	Fixed value for HSPPAD143C

14. MECHANICAL INFORMATION

14.1 Pin Layout

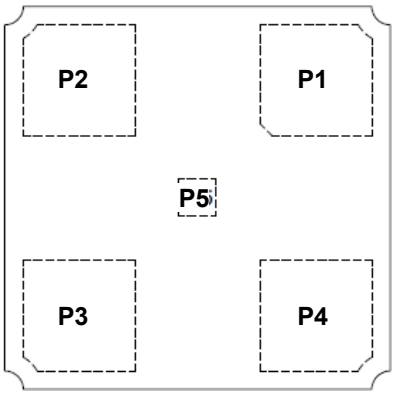
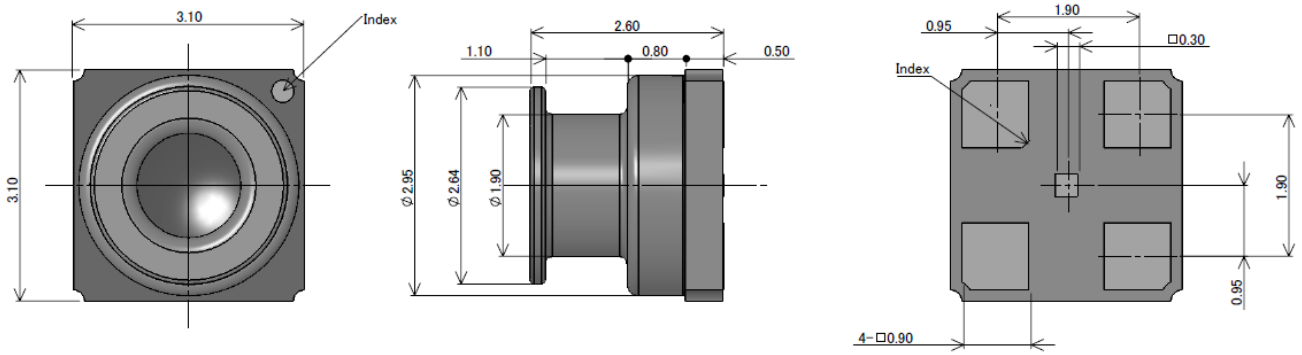


Fig.15 : Pin layout (Top view)

Table13 : Pin assign

P#	Name	Description
P1	GND	Ground
P2	VDD	Voltage supply
P3	SCL	Serial clock
P4	SDA	Serial data input/output
P5	NC	-

14.2 Package Dimension



Top view **Side view** **Bottom view**

Fig. 16 : Mechanical Dimension

14.3 Recommended Land Pattern

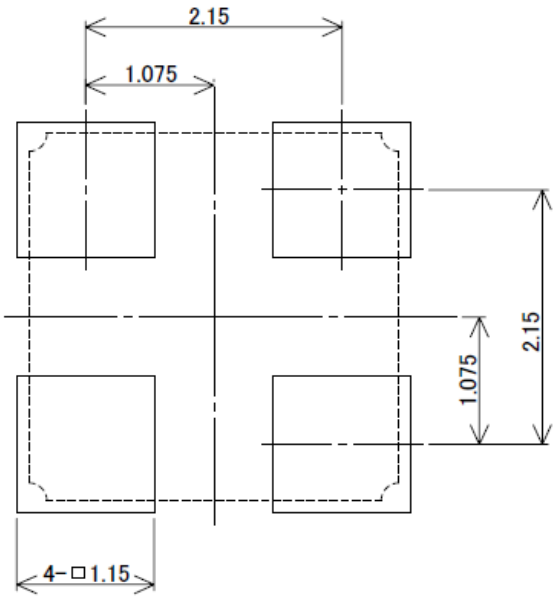


Fig. 17 : Land Pattern

14.4 Tape and Reel drawing

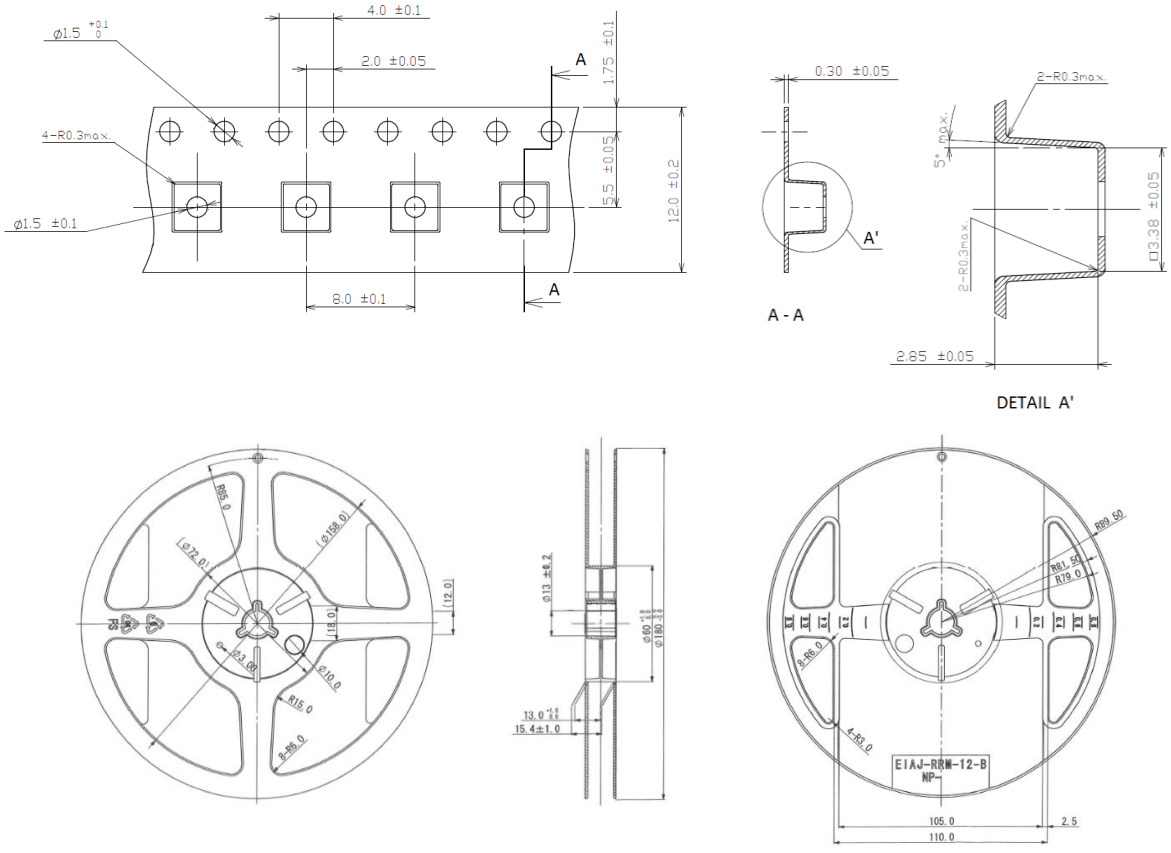


Fig. 18 : Tape and Reel dimension

Quantity per reel : 500pcs

15. I2C CONNECTION EXAMPLE

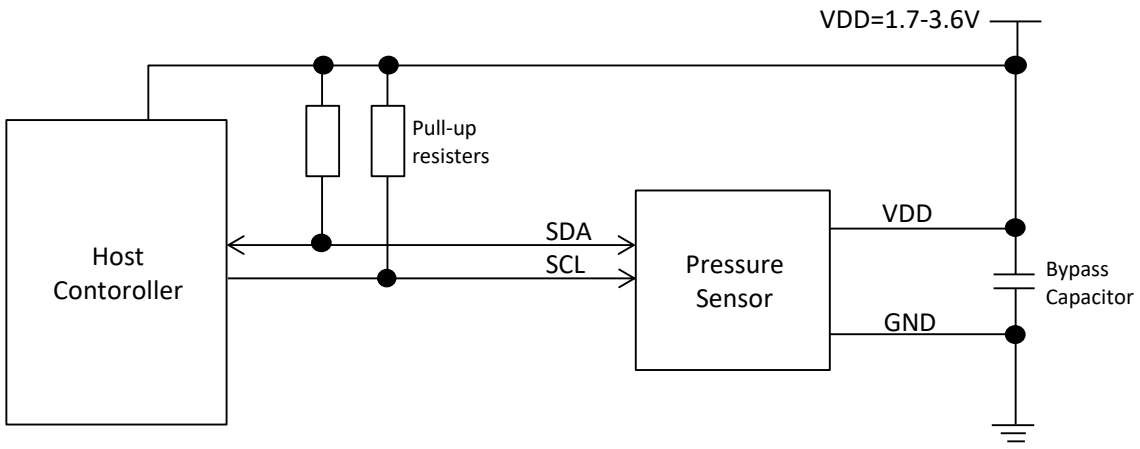


Fig.19 : I2C connection diagram

3.3kohm Pull-up resister is recommended
0.1uF Bypass capacitor is recommended

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https://www.P65Warnings.ca.gov

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