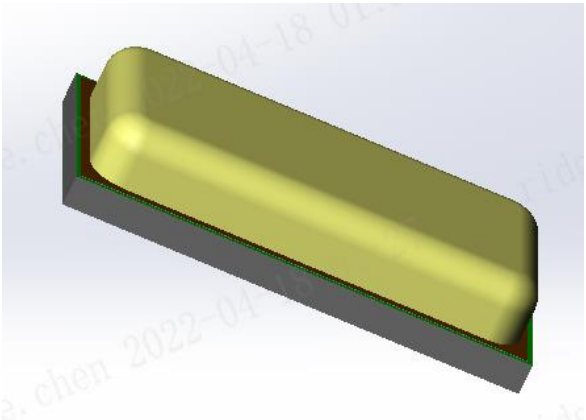
Products Datasheet

CDPB22-002

Integrated Environment Sensor Unit



Restricted

1. Security warning

2. Publication history

Version	Date	Description	Author	Approved
1.0	2022.04.18	New Design	Ridge	Wiming

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Introduction

The CDPB22-002 is an integrated environmental sensor unit. The unit combines digital high accuracy pressure sensor and high SNR digital microphone.
The pressure module highlights a capacitive sensing element, 32-bit results and FIFO output, which bring in high accuracy, ultra high precision during temperature changes and very low power consumption. Its I2C interface allows for easy system integration with microcontroller.
The microphone module features high sensitivity and high SNR with very low power consumption. It's PDM (pulse density modulated) output allows for two microphones to be time multiplexed on a single data line using a single clock.

Key Features

- Package dimensions: 10-pin LGA, 4.0 mm x 2.0 mm x 0.95 mm.
- Pb-free, halogen-free and RoHS compliant
- MSL 1

Pressure sensor

- Supply voltage: P-VDD: 1.7 – 3.6 V
- Operation range: Pressure: 300 … 1100 hPa
- Temperature: -40 … +85 °C
- Pressure sensor accuracy: type. ± 0.06 hPa (or ±0.5 m) (relative), ±1 hPa (absolute)
- Temperature accuracy: type.± 0.5°C（@25°C）
- Pressure temperature sensitivity: type.± 0.5Pa/K
- Measurement time: Typical: 27.6 ms. Minimum: 3.6 ms
- Average current consumption: High precision: 40 µA, Low power: 3 µA, Standby: <1 µA
- I2C interface (up to 3.4 MHz), Embedded 24-bit ADC
- FIFO: Stores latest 32 pressure or temperature measurements

Microphone

- Supply voltage: 1.6...3.6V (M-VDD)
- Low power: 230µA Current @ low power mode
- High sensitivity: -26dBFS
- High SNR : 65dB
- PDM Digital Interface

Typical Applications

- Enhancement of GPS navigation (dead-reckoning, slope detection, etc.)
- In- and out-door navigation
- Vertical velocity indication (rise/sink speed)
- Digital Audio output

1. Test Condition

Table 1: Pressure Sensor Test condition

Standard Conditions	Temperature	Humidity	Air pressure
Environment conditions	-40℃...+85℃	25%RH...75%RH	300hPa...1100hPa
Basic test conditions	+25℃	60%RH...70%RH	300hPa...1100hPa

Table 2: Microphone Test condition

Standard Conditions	Temperature	Humidity	Air pressure
Environment conditions	+20℃...+70℃	30%RH...70%RH	860hPa...1060hPa
Basic test conditions	+23℃	30%RH...70%RH	860hPa...1060hPa

2. Absolute Maximum Ratings

Table 3: Absolute maximum ratings

Parameter	Condition	Min	Max	Units
Storage temperature		-40	+70	°C
Supply Voltage	All pins		+3.6	V
ESD rating	HBM,R=1.5kohm,C=100pF	-2	+ 2	kV
Overpressure			10000	hPa

3. Electrical characteristics

3.1 Pressure Sensor Characteristics

If not stated otherwise, the given values are ±3-Sigma values over temperature/voltage range in the given operation mode. All values represent the new parts specification; additional solder drift is shown separately.

Table 4: Characteristics of pressure sensor

Parameter	Symbol	Condition		Min	Type	Max	Units
Operating Temperature	TA	Operational		-40	+25	+85	°C
		Full accuracy		0	+25	+65	°C
Operating Pressure	P			300		1100	hPa
Supply voltage	P-VDD			1.7		3.6	V
Supply current (1)	Idd	1 Hz	Low Power		3	5	uA
			Standard		11	15	uA
			High precision		40	50	uA
Peak current	Ipeak	During conversion			400	500	uA
standby current	Iddsbm	@25°C				1	uA
Relative accuracy pressure		700…900hPa			±6		Pa
		+25…+40°C			±0.5		m
Absolute accuracy pressure		300...1100hPa 0…+65℃		-3	±1	+3	hPa
Resolution of output data		Pressure			0.06		Pa
		Temperature			0.01		°C
Noise in pressure (2)	P_Noise	Low Power mode			5		PaRMS
		Standard mode			1.2		
		High precision mode			0.6		
Offset temperature coefficient	TCO	1000hPa		-1	±0.5	+1	Pa/°C
		+25…+40°C		-8.4	±4.2	+8.4	cm/°C
Absolute accuracy temperature		0…+65℃		-3	±1	+ 3	°C
Pressure / Temperature measurement rate	f			1		128	Hz
Pressure measurement time(3)	t	Low Power mode			5	8	ms
		Standard mode			28	35	

		High precision mode		105	115	
Power supply rejection	Ap_psr	Measured with 217Hz square wave and broad band noise, 100mVpp			0.063	PaRMS
Supply voltage ramp-up time	tvddup	Time for supply voltage to reach 90% of final value.	0.001		5	ms
Time to sensor ready	TSensor_rdy	The SENSOR_RDY bit in the Measurement Configuration register will be set when the sensor is ready.			12	ms
Time to coefficients are available.	TCoef_rdy	The COEF_RDY bit in the Measurement Configuration register will be set when the coefficients can be read out.			40	ms
Serial data clock		For I2C			3.4	MHz
Solder drifts				±0.5		hPa
Long term stability		12month		±1		hPa

Note 1： *The current consumption depends on both pressure measurement precision and rate. Please refer to the* ***Pressure Configuration (PRS_CFG)*** *register description for an overview of the current consumption in different combinations of measurement precision and rate.*

Note 2： *Pressure noise is measured as the average standard deviation. Please refer to the* ***Pressure Configuration (PRS_CFG)*** *register description for all precision mode options.*

Note 3： *The pressure measurement time (and thus the maximum rate) depends on the pressure measurement precision. Please refer to the* ***Pressure Configuration (PRS_CFG)*** *register description for an overview of the possible combinations of measurement precision and rate.*

3.2 Microphone Characteristics

Table 5: Characteristics of microphone

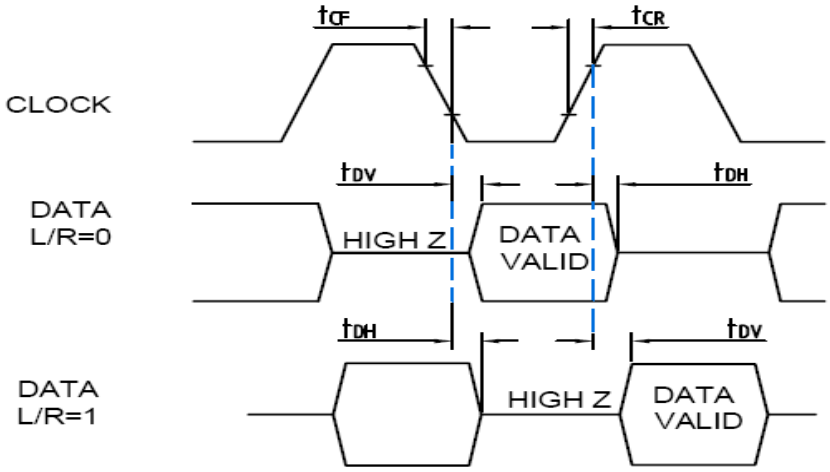
Parameter	Symbol	Condition	Min	Type	Max	Units
Directivity	Omni directional					
Supply voltage	M-Vdd		1.6	1.8	3.6	V
Operating Mode	fclk	Normal Mode, at 2.4MHz	2.9	3.072	3.3	MHz
			2.1	2.4	2.6	
			1.38	1.536	1.7	
		Low power Mode, at 800kHz	0.792	0.8	0.808	
			0.45	0.768	0.85	
Current Consumption (1)	M-Idd	VDD =1.8V, CLK=2.4MHz, output load <5pF		560	650	μA
		VDD =1.8V, CLK=800KHz, output load <5pF		230	300	μA
Sleep current	M-Isleep	CLK=off or CLK<1kHz			10	uA
Sensitivity	S	Normal Mode，1KHz @ 94dB SPL	-27	-26	-25	dBFS (2)
		Low Power Mode，1KHz @ 94dB SPL	-27	-26	-25	dBFS(2)
S/N ratio	S/N	Normal Mode，20 Hz – 20 kHz, CLK = 2.4MHz		65		
		Low Power Mode，20 Hz – 8 kHz, CLK = 800kHz		64		
Distortion	THD	1KHz @ 94dB SPL			1	
Acoustic overload point	AOP	10%THD@1kHZ S=typ		121		dBSPL
Power supply rejection	PSR	VDD=1.8V+100mVpp sine wave		-88		dBFS
Interface Digital Input/ Output Characteristics (3)	V_{OL}	Output Voltage Low			0.3×VDD	
	V_{OH}	Output Voltage High	0.7×VDD			
	VIH	Input Voltage High	0.65×VDD			
	VIL	Input Voltage Low			0.35×VDD	
		Output Load Capacitance			200	pF
		CLK Input Capacitance			10	pF
	f_{DC}	Fclk ≤ 3.072MHz	40		60	%
		Fclk > 3.072MHz	48		52	%

	t_{CR}	Clock rise time			13	ns
	t_{CF}	Clock fall time			13	ns
	tDH	DATA Output Logic Low Level	5		30	ns
	tDV	DATA Output Logic High Level	40		80	ns
DC Offset		Percent of full scale, t≥10 seconds after mode switch/start up	47	50	53	%
Mode switching time		Mic shall switch between any operating modes (CLK OFF, Low Power, and Normal Mode) with given clock frequency. VDD is always present during the mode switching. Time after stable clock until sensitivity accuracy ±0.5dB			35	ms
Power on behavior		Time until PDM idle data pattern. After VDD and CLK are applied and before a valid microphone signal is available, the PDM output shall emit an idle data pattern. This idle data pattern shall be either a pattern representing zero (for example, alternating 0s and 1s) or the output of the ADC with its electrical input held at 0V.			4	ms

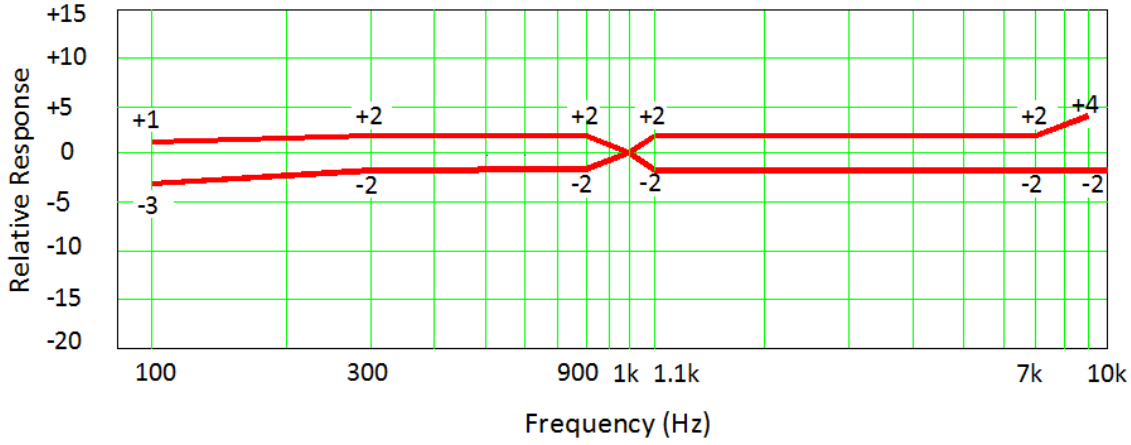
Note 1. The current consumption depends on the applied Clock Frequency and the load on the DATA output.

Note 2. dBFS = 20xlog (A/B) where A is the level of the signal, B is the level that corresponds to Full-scale level.

Note 3. Timing：



Free Field Frequency Response Limits



4. Operation of Pressure Module

4.1 General Description

The pressure module is both a pressure and a temperature sensor. The pressure sensor element is based on a capacitive sensing principle.
The internal signal processor in pressure module converts the output from the pressure and temperature elements to 24-bit results. Each sensor has been calibrated individually and contains calibration coefficients. The coefficients are used in the application to convert the measurement results to true pressure and temperature values.
The pressure module has a FIFO that can store the latest 32 measurements. By using the FIFO, the host processor can remain in a sleep mode for a longer period of time between readouts. Measurements and calibration coefficients are available through the serial I2C interface.

4.2 Application Schematics

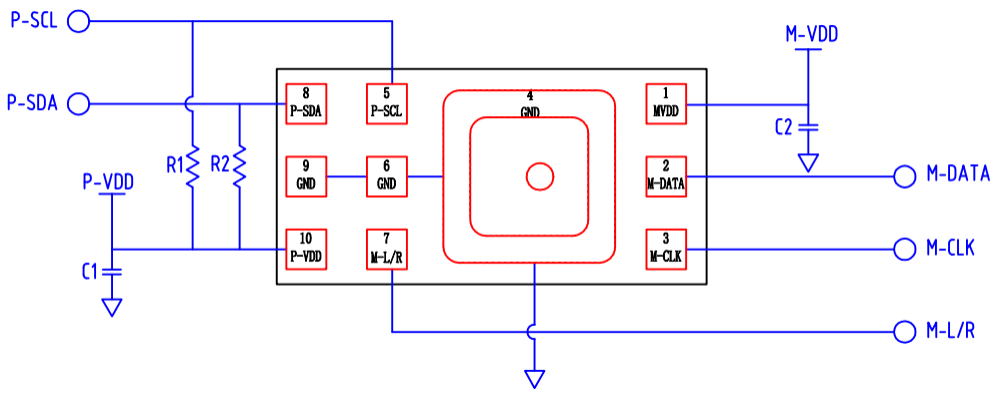


Figure 1: Typical application circuit
（Top View, PAD not visible）

Table 6 Component Values

Component	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Pull-up/down Resistor	R1,R2	2	4.7	100	KΩ	
Supply Blocking Capacitor	C1,C2	100	100		nF	The blocking capacitors should be placed as close to the package pins as possible.

4.3 Sensor Interface

The CDPB22-002 can be accessed as a slave device through I2C serial interface.

- The sensor's default interface.
- The sensor's address is 0x77 (default)

I2C write

Writing is done by sending the slave address in write mode (RW='0'), resulting in slave address 111011X0 ('X' is determined by state of SDO pin. Then the master sends pairs of register addresses and register data. The transaction is ended by a stop condition.

									Control byte									Date byte														
Start	Slave Address							RW	ACKS	Register address(06h)								ACKS	Register data - address 06h								ACKS					
S	1	1	1	0	1	1	X	0		0	0	0	0	0	1	1	0		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0		...				

									Control byte									Date byte														
									Register address(07h)								ACKS	Register data - address 07h								ACKS	STOP					
...	0	0	0	0	0	1	1	1		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0			P												

I2C read

To be able to read registers, first the register address must be sent in write mode (slave address 111011X0). Then either a stop or a repeated start condition must be generated. After this the slave is addressed in read mode (RW='1') at address 111011X1, after which the salve sends out data from auto-incremented register addresses until a NOACKM and stop condition occurs.

									Control byte																							
Start	Slave Address							RW	ACKS	Register address(10h)								ACKS														
S	1	1	1	0	1	1	X	0		0	0	0	1	0	0	0	0															

									Date byte									Date byte														
Start	Slave Address							RW	ACKS	Register data - address 10h								ACKS	Register data - address 11h								NOACKM	STOP				
S	1	1	1	0	1	1	X	1		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0		bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0		P				

4.4 Operating Modes

The CDPB22-002 supports 3 different modes of operation: Standby, Command, and Background mode.

- Standby Mode
  - Default mode after power on or reset. No measurements are performed.
  - All registers and compensation coefficients are accessible.
- Command Mode
  - One temperature or pressure measurement is performed according to the selected precision.
  - The sensor will return to Standby Mode when the measurement is finished, and the measurement result will be available in the data registers.
- Background Mode
  - Pressure and/or temperature measurements are performed continuously according to the selected measurement precision and rate. The temperature measurement is performed immediately after the pressure measurement.
  - The FIFO can be used to store 32 measurement results and minimize the number of times the sensor must be accessed to read out the results.

Note: Operation mode and measurement type are set in the ***Sensor Operating Mode and Status(MEAS_CFG)*** register.

4.5 Measurement Precision and Rate

Different applications require different measurement precision and measurement rates. Some applications, like weather stations, require lower precision and measurement rates than for instance indoor navigation and sports applications.

The CDPB22-002's measurement precision and rate (in background mode) can be configured to match the requirements of the application in which it is being used. This reduces current consumption of the sensor and the system.

In order to achieve a higher precision, the CDPB22-002 will read the sensor multiple times (oversampling), and combine the readings into one result. This increases the current consumption and the measurement time, which again reduces the maximum measurement rate.

The measurement precision, rate and time is set in the ***Pressure Configuration (PRS_CFG)*** and ***Temperature Configuration (TMP_CFG)*** registers. The register descriptions contain information about the current consumption and the possible combinations of measurement precision, time, and rate.

Please note that the pressure sensor is temperature dependent. Temperature measurements must be made together with the pressure measurements in order to compensate for the temperature dependency.

This reduces the maximum pressure measurement rate, since: $Rate_{temperature} * Time_{temperature} + Rate_{pressure} * Time_{pressure} < 1$ second. ***Measurement Settings and Use Case Examples*** contains a table with examples of combinations of pressure and temperature precision and rates for different use cases.

4.6 Interrupt

The CDPB22-002 can generate an interrupt when a new measurement result is available and/or when the FIFO is full. The sensor uses the SDO pin for the interrupt signal.

The interrupt is enabled and configured in the ***Interrupt and FIFO configuration(CFG_REG)*** register. The SDO pin serves as both interrupt and as the least significant bit in the device address. If the SDO pin is pulled low the interrupt polarity must be set to active high and vice versa.

The interrupt status can be read from the ***Interrupt Status (INT_STS)*** register.

4.7 FIFO Operation

The CDPB22-002 FIFO can store the last 32 measurements of pressure or temperature. This reduces the overall system power consumption when the host processor does not need to continuously poll data from the sensor but can go into standby mode for longer periods of time.

The FIFO will store any combination of temperature and pressure measurements since the measurement rate of temperature and pressure can be set up independently in Background Mode. The pressure rate can for instance be set 4 times higher than the temperature rate and thus only every fifth result will be a temperature result. The measurement type can be seen in the result data. The sensor will set the least significant bit to:

- '1' if the result is a pressure measurement.
- '0' if it is a temperature measurement.
  - The sensor uses 24 bits to store the measurement result. Because this is more bits than is needed to cover the full dynamic range of the pressure sensor, using the least significant bit to label the measurement type will not affect the precision of the result.

The FIFO can be enabled in the ***Interrupt and FIFO configuration (CFG_REG)*** register. The data from the FIFO is read out from the ***Pressure Data (PRS_Bn)*** registers regardless of the next result in the FIFO is a temperature or a pressure measurement.

When a measurement has been read out, the FIFO will auto increment and place the next result in the data register. A flag will be set in the ***FIFO Status (FIFO_STS)*** register when the FIFO is empty and all following reads will return 0x800000.

If the FIFO runs full a flag will be set in the ***FIFO Status (FIFO_STS)*** register and the sensor will generate an interrupt if this has been enabled in the ***Interrupt and FIFO configuration (CFG_REG)*** register.

4.8 Calibration and Measurement Compensation

The CDPB22-002 is a calibrated sensor and contains calibration coefficients. These are used in the application (for instance by the host processor) to compensate the measurement results for sensor non-linearity's.

The sections that follow, describe how to calculate the compensated results and convert them into Pa and °C values.

4.8.1 How to Calculate Compensated Pressure Values

Step 1. Read the calibration coefficients (c00, c10, c20, c30, c01, c11, and c21) from the ***Calibration Coefficients(COEF)*** register.

Note: The coefficients read from the coefficient register are 16 bit 2´s complement numbers, which need to be converted before using.

Step 2. Choose scaling factors kT (for temperature) and kP (for pressure) based on the chosen precision rate. The scaling factors are listed in ***Table7***.

Step 3. Read the pressure and temperature result from the registers or FIFO.

Note: The measurement data read from the result registers(or FIFO) are 24 bit´s complement numbers, which need to be converted before using.

Note: Depending on the chosen measurement rates, the temperature may not have been measured since the last pressure measurement, and the temperature result remain the same as the last one.

Step 4. Calculate scaled measurement results.

Traw_sc= Traw/kT
Praw_sc= Praw/kP

Step 5. Calculate compensated measurement results.

Pcomp(Pa)= c00 +Praw_sc(c10+ Praw_sc*(c20+ Praw_sc*c30)) + Traw_sc*c01 + Traw_sc*Praw_sc*(c11+Praw_sc*c21)*

4.8.2 How to Calculate Compensated Temperature Values

Step 1. Read the calibration coefficients (c0 and c1) from the ***Calibration Coefficients (COEF)*** register.

Note: The coefficients read from the coefficient register are 12 bit´s complement numbers, which need to be converted before using.

Step 2. Choose scaling factor kT(for temperature) based on the chosen precision rate. The scaling factors are listed in ***Table7***.

Step 3. Read the temperature result from the temperature register or FIFO.

Note: The temperature measurements read from the temperature result register (or

FIFO) are 24 bit´s complement numbers.

Step 4. Calculate scaled measurement results.

Traw_sc= Traw/kT

Step 5. Calculate compensated measurement results

*Tcomp(°C) = c0*0.5 + c1*Traw_sc*

4.8.3 Compensation Scale Factors

Table 7 Compensation Scale Factors

Oversampling Rate	**Scale Factor (kP or kT)**
1 (single)	524288
2 times (Low Power)	1572864
4 times	3670016
8 times	7864320
16 times (Standard)	253952
32 times	516096
64 times (High Precision)	1040384
128 times	2088960

4.9 Measurement Settings and Use Case Examples

Table 8 Measurement Settings and Use Case Examples (TBD)

Use Case	**Performance**	**Pressure Register Configuration Address: 0x06**	**Temperature Register Configuration Address: 0x07**	**Other**
Weather Station (Low power, Background mode)	5 Pa precision. 1 pr sec. 6 uA	0x01	0x80	Start background measurements (addr 0x08)
Indoor navigation (Standard precision, Background mode)	10 cm precision. 2 pr sec. 30 uA	0x14	0x80	Enable P shift (addr 0x09) Start background measurements (addr 0x08)

Sports (High precision, high rate, background mode)	5 cm precision 4 pr sec. 200 uA	0x26	0xA0	Enable P shift (addr 0x09) Start background measurements (addr 0x08)

4.10 Calculating Absolute Altitude and Pressure at sea level

With the measured pressure P and the pressure at sea level P_0=1013.25hPa, the altitude in meters can be calculated with the international barometric formula:

$$\text{altitude} = 44330 * \left(1 - \left(\frac{P}{P_0}\right)^{\frac{1}{5.255}}\right)$$

Thus, a pressure change of Δ*p* = 1hPa corresponds to 8.43m at sea level.

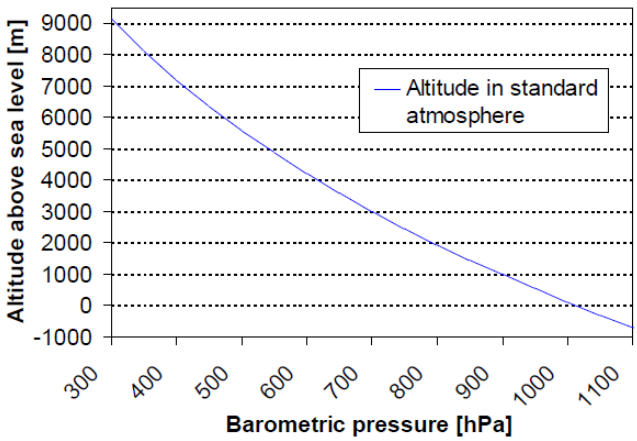


Figure 2: Transfer function: Altitude over sea level – Barometric pressure

With the measured pressure *p* and the absolute altitude the pressure at sea level can be calculated: $p_0 = \frac{p}{\left(1 - \frac{attitude}{44330}\right)^{5.255}}$

Thus, a difference in altitude of Δaltitude = 10m corresponds to 1.2hPa pressure change at sea level.

5. Register Map

Table 9 Register Map

Register Name	Addr.	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Reset State
PSR_B2	0x00	PSR[23:16] (r)								00_h
PSR_B1	0x01	PSR[15:8](r)								00_h
PSR_B0	0x02	PSR[7:0](r)								00_h
TMP_B2	0x03	TMP[23:16] (r)								00_h
TMP_B1	0x04	TMP[15:8] (r)								00_h
TMP_B0	0x05	TMP[7:0] (r)								00_h
PRS_CFG	0x06	-	PM_RATE [2:0] (rw)			PM_PRC [3:0] (rw)				00_h
TMP_CFG	0x07	TMP_ EXT (rw)	TMP_RATE [2:0] (rw)			TM_PRC [3:0] (rw)				00_h
MEAS_CFG	0x08	COEF_ RDY (r)	SENSOR _ RDY (r)	TMP_ RDY (r)	PRS_ RDY (r)	-	MEAS_CRTL [2:0] (rw)			00_h
CFG_REG	0x09	INT_ HL (rw)	INT_ SEL [2:0] (rw)			TMP_ SHIFT_ EN (rw)	PRS_ SHIFT_ EN (rw)	FIFO_ EN (rw)	SPI_ MODE (rw)	00_h
INT_STS	0x0A	-	-	-	-	-	INT_ FIFO_ FULL (r)	INT_ TMP(r)	INT_ PRS(r)	00_h
FIFO_STS	0x0B	-	-	-	-	-	-	FIFO_ FULL(r)	FIFO_ EMPTY(r)	00_h
RESET	0x0C	FIFO_ FLUSH (w)	-	-	-	SOFT_RST [3:0] (w)				00_h
ID	0x0D	PROD_ID [3:0] (r)				REV_ID [3:0] (r)				XX_h
COEF	0x10-0x21	< see register description >								XX_h
Reserved	0x22-0x28	Reserved								XX_h

6. Register Description

6.1 Pressure Data (PRS_Bn)

The Pressure Data registers contains the 24 bit (3 bytes) 2's complement pressure measurement value.

If the FIFO is enabled, the register will contain the FIFO pressure and/or temperature results (please see ***FIFO Operation***). Otherwise, the register contains the pressure measurement results and will not be cleared after read.

6.1.1 PRS_B2

The highest byte of the three bytes measured pressure value.

PRS_B2	**Address:**	00_H
Pressure (MSB data)	**Reset value:**	00_H

7	6	5	4	3	2	1	0
PRS23	PRS22	PRS21	PRS20	PRS19	PRS18	PRS17	PRS16
r							

Field	Bits	Type	Description
PRS[23:16]	7:0	r	MSB of 24 bit 2´s complement pressure data.

6.1.2 PRS_B1

The middle byte of the three bytes measured pressure value.

PRS_B1	**Address:**	01_H
Pressure (LSB data)	**Reset value:**	00_H

7	6	5	4	3	2	1	0
PRS15	PRS14	PRS13	PRS12	PRS11	PRS10	PRS9	PRS8-
r							

Field	Bits	Type	Description
PRS[15:8]	7:0	r	LSB of 24 bit 2´s complement pressure data.

6.1.3 PRS_B0

The lowest byte of the three bytes measured pressure value.

PRS_B0	**Address:**	02_H
Pressure (XLSB data)	**Reset value:**	00_H

7	6	5	4	3	2	1	0
PRS7	PRS6	PRS5	PRS4	PRS3	PRS2	PRS1	PRS0
r							

Field	Bits	Type	Description
PRS[7:0]	7:0	r	XLSB of 24 bit 2´s complement pressure data.

6.2 Temperature Data (TMP_Tn)

The Temperature Data registers contain the 24 bit (3 bytes) 2's complement temperature measurement value (unless the FIFO is enabled, please see ***FIFO Operation***) and will not be cleared after the read.

6.2.1 TMP_B2

The highest byte of the three bytes measured temperature value.

TMP_B2	**Address:**	03_H
Temperature (MSB data)	**Reset value:**	00_H

7	6	5	4	3	2	1	0
TMP23	TMP22	TMP21	TMP20	TMP19	TMP18	TMP17	TMP16
r							

Field	Bits	Type	Description
TMP[23:16]	7:0	r	MSB of 24 bit 2´s complement temperature data.

6.2.2 TMP_B1

The middle byte of the three bytes measured temperature value.

TMP_B1				**Address:**			04_H
Temperature (LSB data)				**Reset value:**			00_H
7	6	5	4	3	2	1	0
TMP15	TMP14	TMP13	TMP12	TMP11	TMP10	TMP9	TMP8
r							

Field	Bits	Type	Description
TMP[15:8]	7:0	r	LSB of 24 bit 2´s complement temperature data.

6.2.3 TMP_B0

The lowest part of the three bytes measured temperature value.

TMP_B0				**Address:**			05_H
Temperature (XLSB data)				**Reset value:**			00_H
7	6	5	4	3	2	1	0
TMP7	TMP6	TMP5	TMP4	TMP3	TMP2	TMP1	TMP0
r							

Field	Bits	Type	Description
TMP[7:0]	7:0	r	XLSB of 24 bit 2´s complement temperature data.

6.3 Pressure Configuration (PRS_CFG)

Configuration of pressure measurement rate (PM_RATE) and resolution (PM_PRC)

PRS_CFG				**Address:**			06_H
Pressure measurement configuration				**Reset value:**			00_H
7	6	5	4	3	2	1	0
-	PM_RATE[2:0]			PM_PRC[3:0]			
-	rw			rw			

Field	Bits	Type	Description
-	7	-	Reserved.
PM_RATE[2:0]	6:4	rw	Pressure measurement rate: 000 - 1 measurements pr..sec. 001 - 2 measurements pr.. sec. 011 - 4 measurements pr. sec. 100 - 8 measurements pr. sec. 100 - 16 measurements pr. sec. 101 - 32 measurements pr. sec. 110 - 64 measurements pr. sec. 111 - 128 measurements pr. sec. Applicable for measurements in Background mode only
PM_PRC[3:0]	3:0	rw	Pressure oversampling rate: 0000 - Single. 0001 - 2 times (Low Power). 0010 - 4 times. 0011 - 8 times. 0100 *)- 16 times (Standard). 0101 *) - 32 times. 0110 *) - 64 times (High Precision). 0111 *) - 128 times. 1xxx - TBD

*) Note: Use in combination with a bit shift. See ***Interrupt and FIFO configuration (CFG_REG)*** register

Table 10 Pressure measurement time (ms) and precision (PaRMS)

Oversampling (PRC[3:0])	Single (0000)	2 times (0001)	4 times (0010)	8 times (0011)	16 times (0100)	32 times (0101)	64 times (0110)	128 times (0111)
Measurement time (ms)	3.6	5.2	8.4	14.8	27.6	53.2	104.4	206.8
Precision (Pa_{RMS})	5		2.5		1.2	0.9	0.5	

Table 11 Estimated current consumption (uA)

Oversampling (PRC[3:0]) Measurements pr sec. (PM_RATE([2:0])	Single (0000)	2 times (0001)	4 times (0010)	8 times (0011)	16 times (0100)	32 times (0101)	64 times (0110)	128 times (0111)
1 (000)	2.1	2.7	3.8	6.1	11	20	38	75
2 (001)								

4 (010)								
8 (011)	*Note: The current consumption can be calculated as the Measurement Rate * Current Consumption of 1 measurement per. sec.*							n.a.
16 (100)							n.a.	n.a.
32 (101)						n.a.	n.a.	n.a.
64 (110)					n.a.	n.a.	n.a.	n.a.
128 (111)			n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: The table shows the possible combinations of Pressure Measurement Rate and oversampling when no temperature measurements are performed. When temperature measurements are performed the possible combinations are limited to $Rate_{temperature}$ *x Measurement* $Time_{temperature}$ *+* $Rate_{pressure}$ *x Measurement* $Time_{pressure}$ *< 1 second.*

6.4 Temperature Configuration(TMP_CFG)

Configuration of temperature measurement rate (TMP_RATE) and resolution (TMP_PRC)

TMP_CFG	**Address:**	07_H
Temperature measurement configuration	**Reset value:**	00_H

7	6	5	4	3	2	1	0
TMP_EXT	TMP_RATE[2:0]			-	TMP_PRC[2:0]		
rw		**rw**		**-**	**rw**		

Field	**Bits**	**Type**	**Description**
TMP_EXT	7	rw	Temperature measurement 0 - Internal sensor (in ASIC) 1 - External sensor (in pressure sensor MEMS element) Note: It is set to use the temperature sensor on MEMS element (value=1), which should not be changed.
TMP_RATE[2:0]	6:4	rw	Temperature measurement rate: 000 - 1 measurement pr. sec. 001 - 2 measurements pr.. sec. 010 - 4 measurements pr. sec. 011 – 8 measurements pr. sec. 100 – 16 measurements pr. sec. 101 – 32 measurements pr. sec. 110 – 64 measurements pr. sec. 111 – 128 measurements pr. sec.. Applicable for measurements in Background mode only

TMP_PRC[2:0]	2:0	rw	Temperature oversampling (precision): 000 - single. (Default) - Measurement time 3.6 ms. Note: Following are optional, and may not be relevant: 001 - 2 times. 010 - 4 times. 011 - 8 times. 100 - 16 times. 101 - 32 times. 110 - 64 times.. 111 - 128 times. 1xxx - TBD.

6.5 Sensor Operating Mode and Status (MEAS_CFG)

Setup measurement mode

MEAS_CFG	**Address:**	08_H
Measurement configuration	**Reset value:**	00_H

7	6	5	4	3	2	1	0
COEF_RDY	SENSOR_RDY	TMP_RDY	PRS_RDY	-	MEAS_CTRL		
r	**r**	**r**	**r**	**-**	**rw**		

Field	**Bits**	**Type**	**Description**
COEF_RDY	7	r	Coefficients will be read to the Coefficents Registers after start-up: 0 - Coefficients are not available yet. 1 - Coefficients are available.
SENSOR_RDY	6	r	The pressure sensor is running through self-initialization after start-up.. 0 - Sensor initialization not complete 1 - Sensor initialization complete It is recommend not to start measurements until the sensor has completed the self-initialization.
TMP_RDY	5	r	Temperature measurement ready 1 - New temperature measurement is ready.. Cleared when temperature measurement is read.
PRS_RDY	4	r	Pressure measurement ready 1 - New pressure measurement is ready.. Cleared when pressure measurement is read.
-	3	-	Reserved.

MEAS_CTRL	2:0	rw	*Set measurement mode and type:* *Standby Mode* *000- Idle / Stop background measurement* *Command Mode* *001- Pressure measurement* *010 - Temperature measurement* *011 - na.* *Background Mode* *100- Continous pressure measurement* *101- Continous temperature measurement* *111- Continous pressure and temperature measurement*

6.6 Interrupt and FIFO configuration (CFG_REG) Measurement Configuration

Configuration of interrupts, measurement data shift, and FIFO enable

CFG_REG	**Address:**	09_H
Configuration register	**Reset value:**	00_H

7	6	5	4	3	2	1	0
INT_HL	INT_FIFO	INT_PRS	INT_TMP	T_SHIFT	P_SHIFT	FIFO_EN	SPI_MODE
rw	**rw**	**rw**	**rw**	**rw**	**rw**	**rw**	**rw**

Field	**Bits**	**Type**	**Description**
INT_HL	7	rw	Interupt (on SDO pin) active level: 0 - Active low.. 1 - Active high.
INT_FIFO	6	rw	Generate interupt when the FIFO is full: 0 - Disable. 1 - Enable.
INT_PRS	5	rw	Generate interupt when a pressure measurement is ready: 0 - Disable. 1 - Enable.
INT_TMP	4	rw	Generate interupt when a temperature measurement is ready: 0 - Disable. 1 - Enable.
T_SHIFT	3	rw	Temperature result bit-shift 0 - no shift. 1 - shift result right in data register. *Note: Must be set to '1' when the oversampling rate is >8 times.*

P_SHIFT	2	rw	Pressure result bit-shift 0 - no shift. 1 - shift result right in data register. *Note: Must be set to '1' when the oversampling rate is >8 times.*
FIFO_EN	1	rw	Enable the FIFO: 0 - Disable. 1 - Enable.
SPI_MODE	0	rw	Set SPI mode: 0 - 4-wire interface. 1 - 3-wire interface.

6.7 Interrupt Status (INT_STS) Configuration register

Interrupt status register. The register is cleared on read

INT_STS	**Address:**	$0A_H$
Interrupt status	**Reset value:**	00_H

7	6	5	4	3	2	1	0
-					INT_FIFO_FULL	INT_TMP	INT_PRS
-					r	r	r

Field	Bits	Type	Description
-	7:3	-	Reserved.
INT_FIFO_FULL	2	r	*Status of FIFO interrupt* *0 - Interrupt not active* *1 - Interrupt active*
INT_TMP	1	r	*Status of temperature measurement interrupt* *0 - Interrupt not active* *1 - Interrupt active*
INT_PRS	0	r	*Status of pressure measurement interrupt* *0 - Interrupt not active* *1 - Interrupt active*

6.8 FIFO Status (FIFO_STS)

FIFO status register

FIFO_STS	**Address:**	$0B_H$
FIFO status register	**Reset value:**	00_H

7	6	5	4	3	2	1	0
-						FIFO_FULL	FIFO_EMPTY
-						**Rr**	**r**

Field	Bits	Type	Description
-	7:2	-	Reserved.
FIFO_FULL	1	r	*0 - The FIFO is not full* *1 - The FIFO is full*
FIFO_EMPTY	0	r	*0 - The FIFO is not empty* *1 - The FIFO is empty*

6.9 Soft Reset and FIFO flush (RESET)

Flush FIFO or generate soft reset.

RESET	**Address:**	$0C_H$
FIFO flush and softreset	**Reset value:**	00_H

7	6	5	4	3	2	1	0
FIFO_FLUSH	-			SOFT_RST			
w	**-**			**w**			

Field	Bits	Type	Description
FIFO_FLUSH	7	w	FIFO flush 1 - Empty FIFO After reading out all data from the FIFO, write '1' to clear all old data.
-	6:4	-	Reserved.
SOFT_RST	3:0	w	Write '1001' to generate a soft reset. A soft reset will run though the same sequences as in power-on reset.

6.10 Product and Revision ID (ID)FIFO flush and soft reset

Product and Revision ID

ID	**Address:**	$0D_H$
Product and revision ID	**Reset value:**	00_H

7	6	5	4	3	2	1	0
PROD_ID				REV_ID			
r				**r**			

Field	**Bits**	**Type**	**Description**
PROD_ID	7:4	r	Product ID
REV_ID	3:0	r	Revision ID

Note: Unless declared, ID content in register $0D_H$ is 0x10.

6.11 Calibration Coefficients (COEF)

The Calibration Coefficients register contains the 2´s complement coefficients that are used to calculate the compensated pressure and temperature values.

Table 12 Calibration Coefficients

Coefficient	**Addr.**	**bit7**	**bit6**	**bit5**	**bit4**	**bit3**	**bit2**	**bit1**	**bit0**
c0	0x10	c0 [11:4]							
c0/c1	0x11	c0 [3:0]				c1 [11:8]			
c1	0x12	c1[7:0]							
c00	0x13	c00 [19:12]							
c00	0x14	c00 [11:4]							
c00/c10	0x15	c00 [3:0]				c10 [19:16]			
c10	0x16	c10 [15:8]							
c10	0x17	c10 [7:0]							
c01	0x18	c01 [15:8]							
c01	0x19	c01 [7:0]							
c11	0x1A	c11 [15:8]							
c11	0x1B	c11 [7:0]							
c20	0x1C	c20 [15:8]							
c20	0x1D	c20 [7:0]							
c21	0x1E	c21 [15:8]							
c21	0x1F	c21 [7:0]							

c30	0x20	c30 [15:8]
c30	0x21	c30 [7:0]

7. Mechanical Characteristics

7.1 Pin Configuration

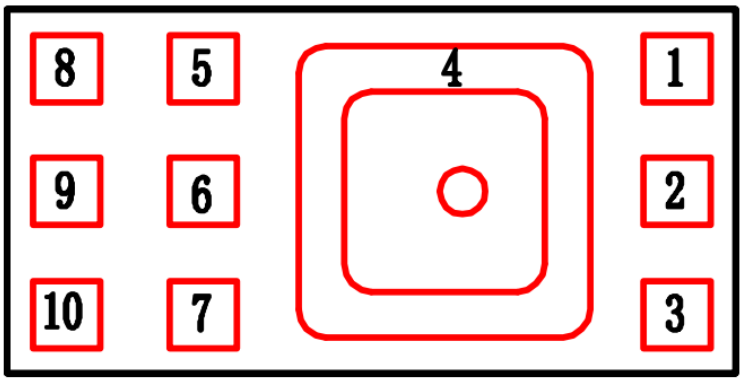


Figure 3: Layout pin configuration CDPB22-002
（Top View, PAD not visible）

Table 13: Pin configuration of CDPB22-002

Pin No.	Name	Function
1	M-VDD	Microphone Power
2	M-DATA	Microphone DATA Input
3	M-CLK	Microphone CLK Input
4	GND	Ground
5	P-SCL	Pressure Serial Clock
6	GND	Ground
7	M-L/R	Microphone L/R
8	P-SDA	Pressure Serial data in/out
9	GND	Ground
10	P-VDD	Pressure Power

7.2 Outline Dimensions

The sensor housing is an 10 Pin LGA package with metal lid. Its dimensions are 4.0mm (±0.1 mm)

x 2.0mm (±0.1 mm) x0.95mm (±0.1mm) , ***undeclared tolerance (±0.1mm)***.

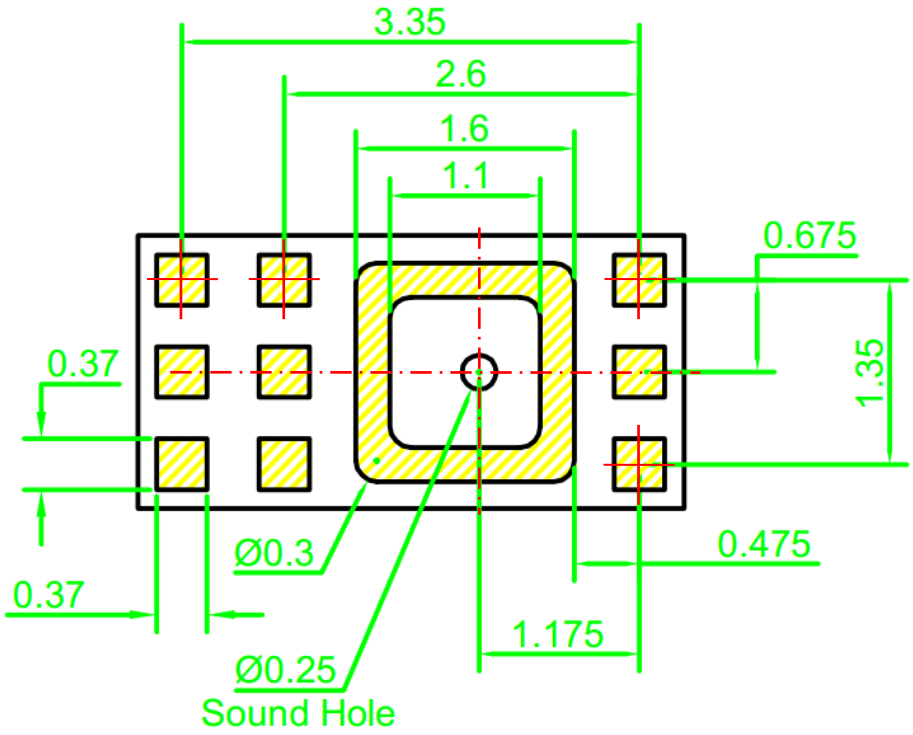


Figure 4: Bottom view of CDPB22-002

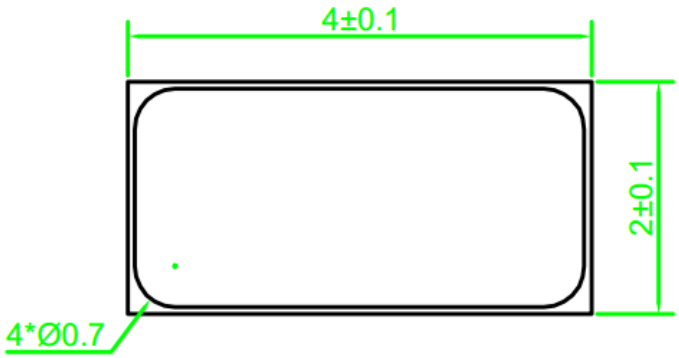


Figure 5: Top view of CDPB22-002

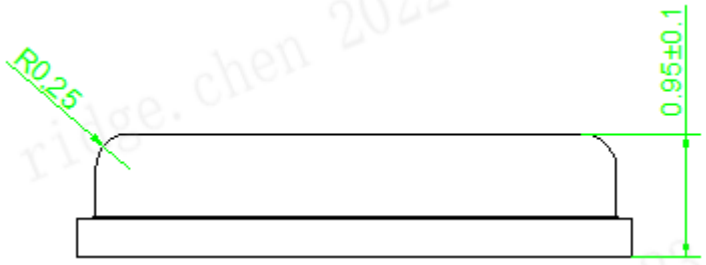


Figure 6: Side view of CDPB22-002

8. Storage and Transportation

- Keep in warehouse with less than 75% humidity and without sudden temperature change, acid air, any other harmful air or strong magnetic field; Recommend storage period no more than 1 year and floor life (out of bag) at factory no more than 4 weeks.
- The MEMS pressure sensor with normal pack can be transported by ordinary conveyances. Please protect products against moist, shock, sunburn and pressure during transportation.
- Storage Temperature Range：-40℃～+125℃
- Operating Temperature Range：-40℃～+70℃

9. Soldering Recommendation

Recommended Solder Reflow

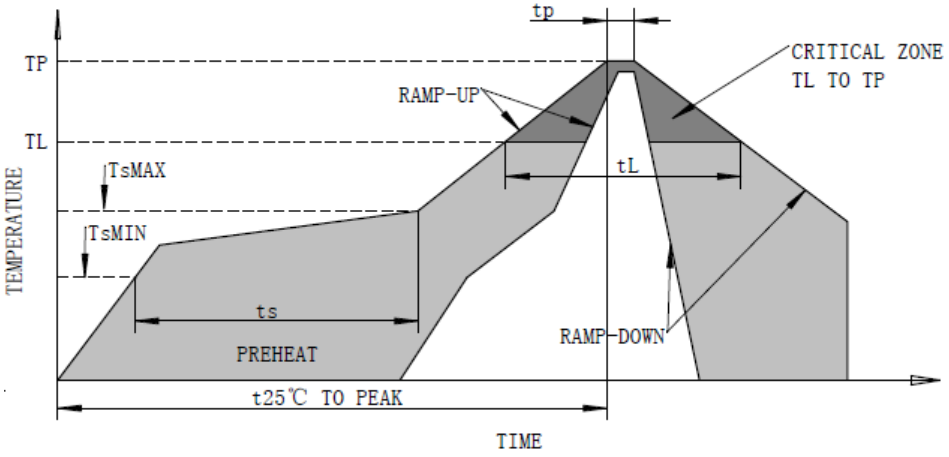


Table 14: Reflow parameter

Profile Feature	Pb-Free Assembly
Average ramp-up rate(TsMAX to TP)	3℃/seconds max.
Preheat -Temperature Min.(TsMIN) -Temperature Max.(TsMAX) -Time(TsMIN to TsMAX)(Ts)	 150℃ 200℃ 60～80seconds
Time maintained above: -Temperature(TL) -Time(tL)	 217℃ 60～150seconds
Peak temperature(TP)	260℃
Time within 5℃ of actual peak temperature(TP)2	20～40seconds
Ramp-down rate	5℃/seconds.
Time 25℃ to peak temperature	8 minutes max.

10. Package Specifications

Carrier Tape Information [Unit: mm]
Quantity per reel: 6k PCS.

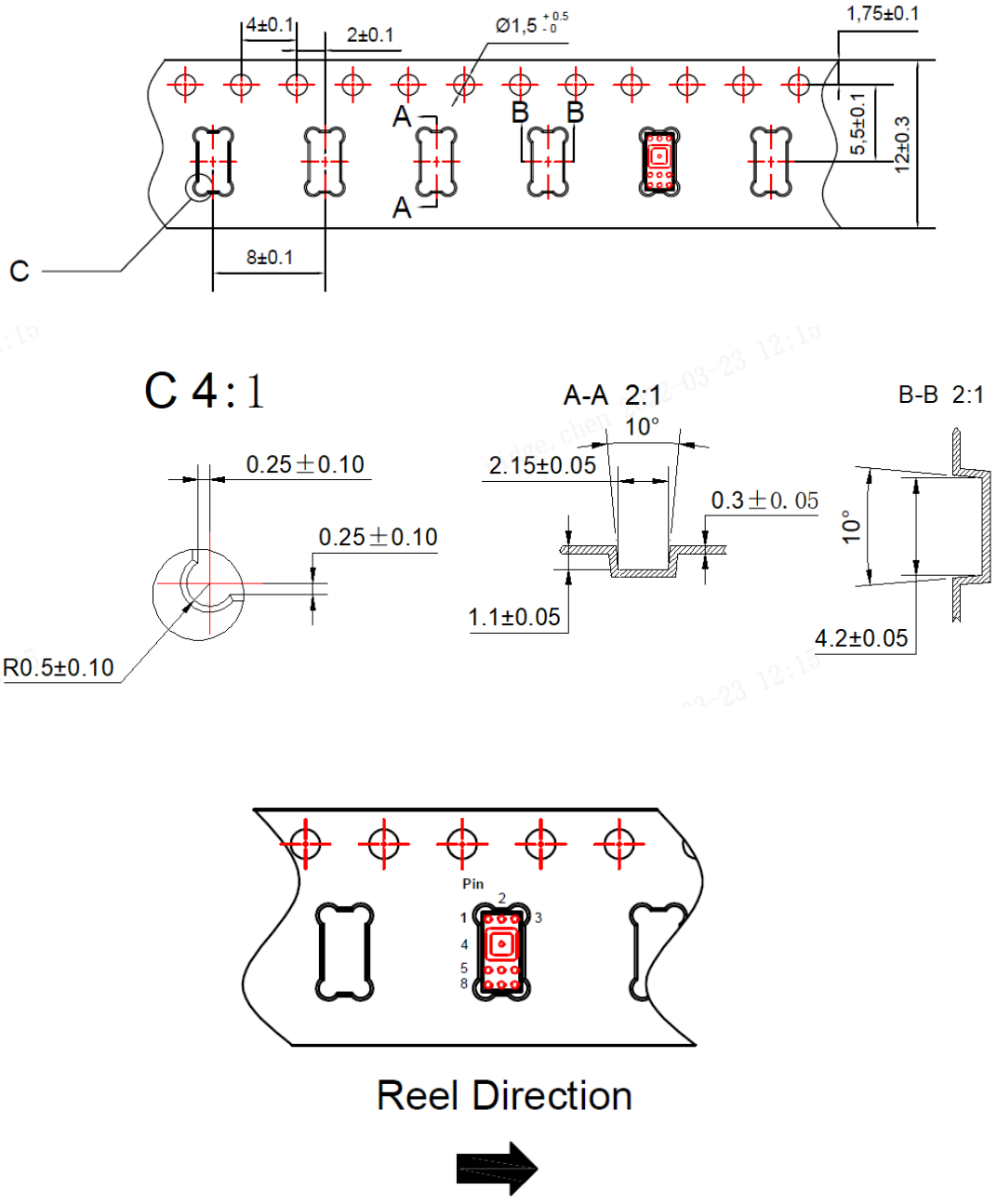


Figure 7: Carrier Tape

11. Cautions When Using Sensor Unit

- Board Wash Restrictions
  It is very important not be subjected to any liquid or gaseous cleaning methods, otherwise this may damage the sensor.
- Strong airflow(such as nozzle) Restrictions
  It is very important not to be pull a nozzle over the acoustic port of the microphone module or blow the acoustic port, otherwise this may damage the microphone.
- *Away from dust or particle*
  It is very important to protect the sensor from dust or particle, otherwise this may pollute the membrane of microphone module, and lower the performance of sensor.
- *Away from Mechanical stress*
  It is very important to set the sensor away from mechanical stress from assembling process or mechanical structure, otherwise this may make the pressure module swift from calibration value.
- Ultrasonic Restrictions
  It is very important not to use ultrasonic procedures, otherwise this may damage the microphone module.
- Adaption to Wire Width
  It is needed to adjust the dumping resistance according to the wire length and wire load etc. when using microphone module.
  It is also necessary to insert dumping resistance in the M-Data line located adjacent to the microphone according to circuit condition.

Please refer to Design Guide of CDPB22-002 for detailed information.

12. land pattern and stencil design

12.1 land pattern

The following figure shows the design recommendations for the client PCB pad.

- The sound hole of the product is designed at the bottom to prevent too much solder paste from remaining around the sound hole, which hinders the acoustic channel.
- PCB sound hole size design needs to meet acoustic requirements to ensure better MIC frequency response. At the same time, it is necessary to ensure that there is a wide enough welding ring pad around the sound hole, so that the welding between microphone and PCB pad is completely sealed to avoid sound leakage.

- PCB sound hole should be non-metallic through-hole to avoid solder paste flowing into the sound hole, resulting in sound hole blockage.

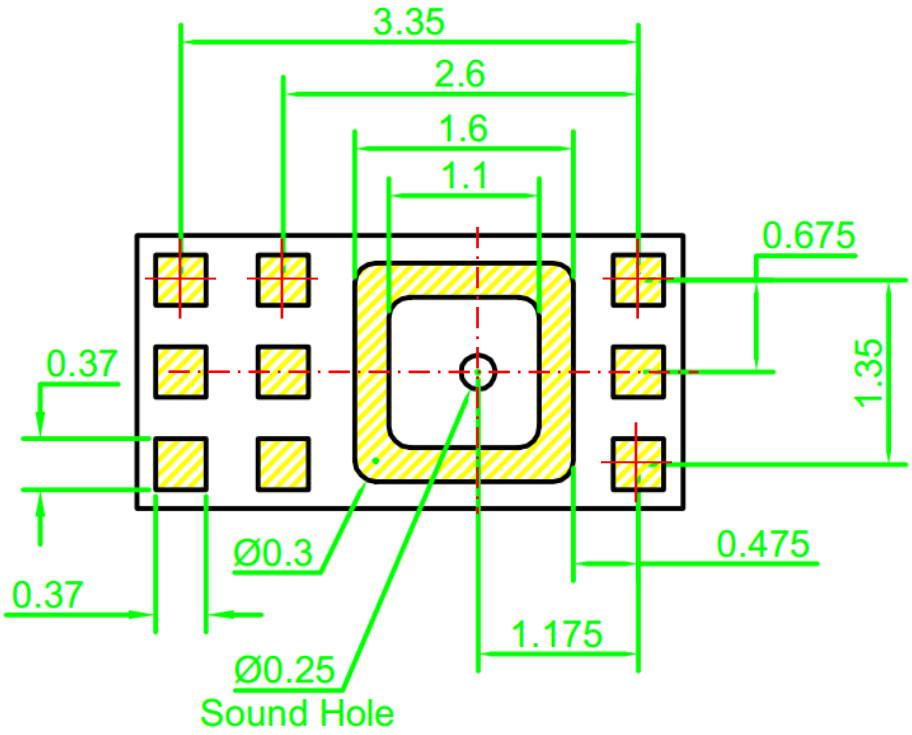


Figure 8: Land pattern

Note: the yellow area is PCB pad (1:1 window opening)
It is recommended to open the window 1:1 for solder paste screen

12.2 stencil design

- When applying solder paste, stainless steel template is recommended;
- The recommended stencil for silk screen printing is 90-150 μ m (3.5-6 mil);
- The stencil opening of signal pad should account for 70-90% of PCB pad area;
- In order to release the solder paste better, the hole wall should be trapezoidal and the corners should be rounded.
- Tight IC lead arrangement requires accurate alignment of stencil and PCB. Before using solder paste, the assembly accuracy of stencil and printed circuit should be within 25 μ m (1 mil).

13 Reliability Specfications

NO.	Testing Item	Test Condition
1	High Temperature Storage	125℃,1000h（JESD22-A103）
2	High Temperature & Humidity Test	85℃, 85%R.H., 1000h, V=Vcc max（JESD22-A101）
3	Thermal Shock Test	-40℃/0.5 hours ~125℃/0.5 hours, 500 cycles（JESD22-A106）
4	Mechanical Shock Test	3000g,0.3ms,6axes*3 times（JESD22-B110）
5	Vibration Test	From 20 to 2000Hz peak acceleration 20g,16min/axis(4 cycles),X,Y and Z axis total 48 minutes（JESD22-B103）
6	HBM	±2KV,3 times for each pad（JESD22-A114）