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

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Application Example

Target Devices Example

Packaging Information

Structure	Packaging	Model	Miminum Packing Unit
LGA 9pin	Tape and Reel	QMP6988	3500

Table of Contents

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

1.2 Absolute Maximum Ratings

Item	Symbol	Rating	Unit
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	
Storage Humidity	Hstr	10~95	%RH
ESD(HBM)	Vhbm	±2000	V
ESD(MM)	Vmm	±200	V
ESD(CDM)	Vcdm	±500	V

1.3 Operating Ratings

Item	Symbol	Min	Typ
Operating Voltage	Vopr	1.71	1.8
	Vio	1.2	1.8
Operating Temperature	Topr	-40	

1.4 Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
		1sample/s force-mode				
Average Current *	Ihp	Ultra High Accuracy	-	21.4	-	μA
	Iddp	Pressure mode	-	640	800	μA
	Iddt	Temperature mode	-	410	520	μA
Sleep Mode Current Consumption	Isleep		-	1.1	2.3	μA
Measureable Pressure Range	Popr		30	-	110	kPa
Absolute Pressure Accuracy	Pabs1	30-110kPa, -20 - 65	-100	-	100	Pa
Relative Pressure Accuracy *	Prel1	Ultra High Accuracy	-	±3.9	-	Pa
rms Noise *	Pnois	Ultra High Accuracy	-	1.3	-	Pa
Absolute Temperature Accuracy	Tabs	30-110kPa, -20 - 65	ol			
*Pressure Aes]olurer0*rel z¸			2...V-			μa
A¸ l p]l sa						
ropæppNurPe~t þ		l È l ¥ ionN~a gn*				
*Aa]ᵀu A H						

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 Hysterisis	Vidhys		Vio*0.1	-	-	V
Digital Output Low Voltage(I2C)	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	-	-	V
Leakage Current at Output OFF	Ioff	SDI, SDO	-10	-	10	µA
Internal Pullup Resistor	Rpullup	CSB	70	120	190	kohm
I2C Load Capacitor	Cb	SDI, SCK	-	-	400	pF
Load Capacitance of Reset Terminal	Crst		-	-	20	pF
Pulse Width of Asynchronous Reset	Trst		100	-	-	usec
Power On Startup Time	Tstart		-	-	10	msec

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	µA	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	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

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

1.8 Bandwidth by IIR Filter Selection

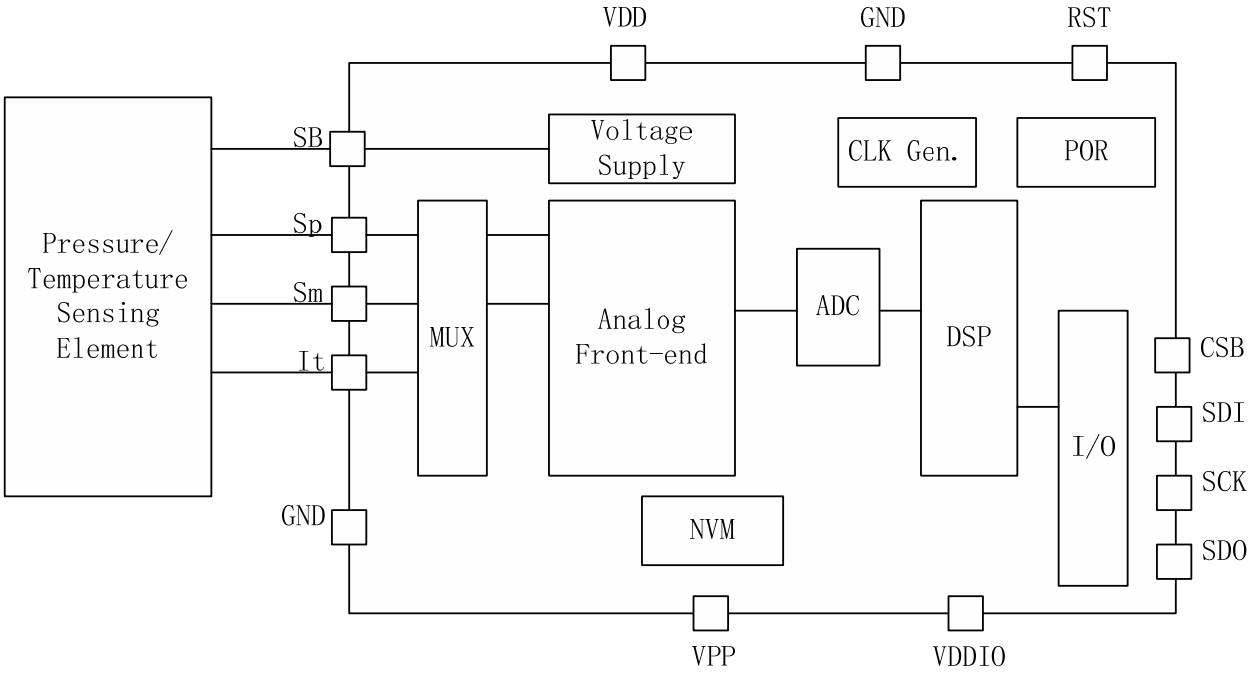
Oversampling setting	Typical Bandwidth [Hz] IIR filter coefficient					
	off	2	4	8	16	32
High speed	133	30.7	12.8	5.9	2.9	1.4
Low power	108	24.9	10.4	4.8	2.3	1.1
Standard	79	18.2	7.6	3.5	1.7	0.8
High accuracy	49	11.3	4.7	2.2	1.1	0.5
Ultra High accuracy	28	6.5	2.7	1.2	0.6	0.3

1.9 Filter selection based on use cases

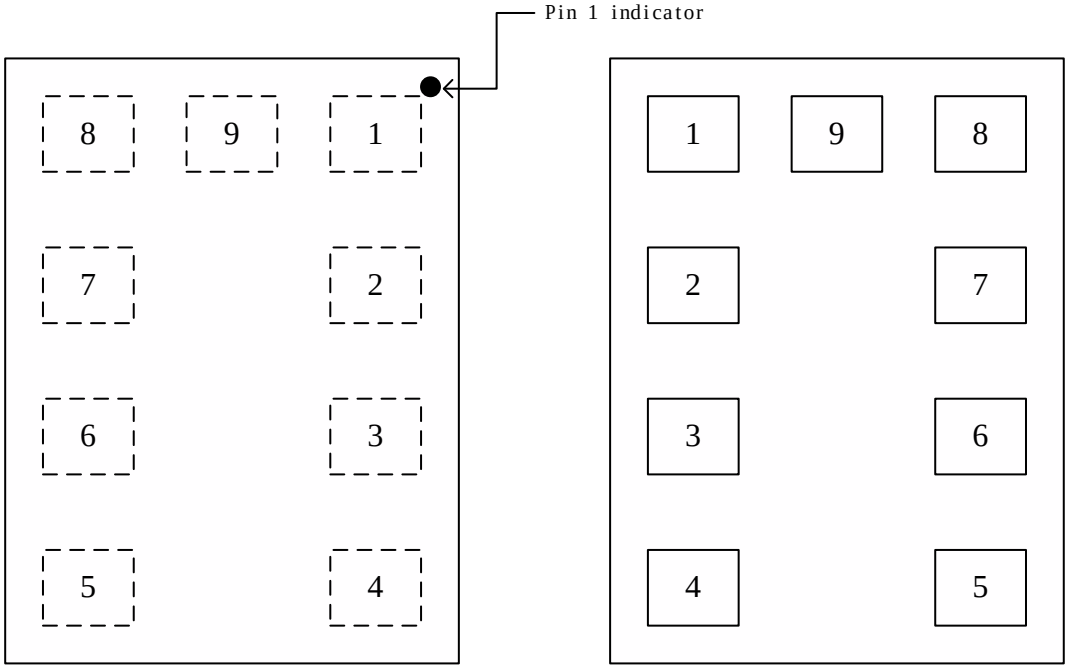
Example use case	Oversampling Setting	Pressure oversampling times	Temp oversampling times	Specification (Typ.) IIR filter coefficient	Current consumption [uA]	ODR [Hz] (Example)	rms Noise [Pa]
Weather monitoring	High speed	2	1	off	1.2	0.05	5.2
Drop detection	Low power	4	1	off	407	100	3.7
Elevator detection	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

2. Connection

2.1 Block Diagram



2.2 Pin Description and Layout



Top View　　Bottom View

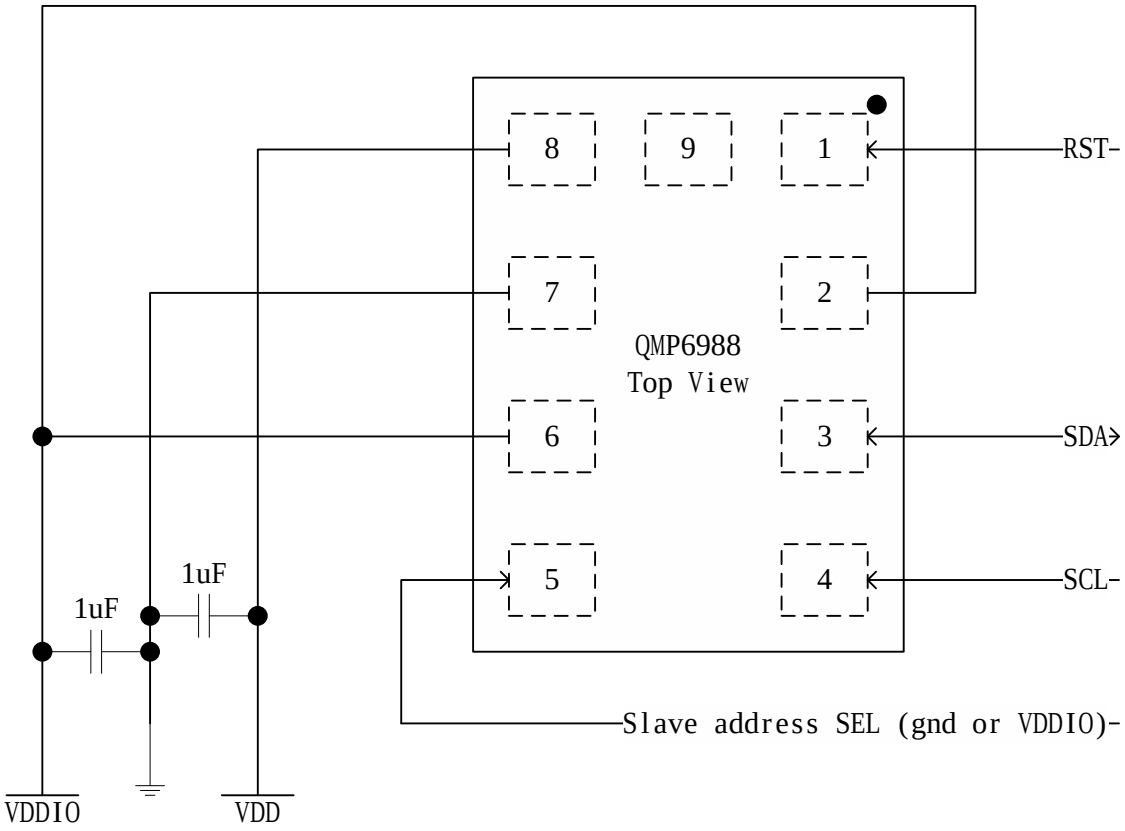
Pin Description

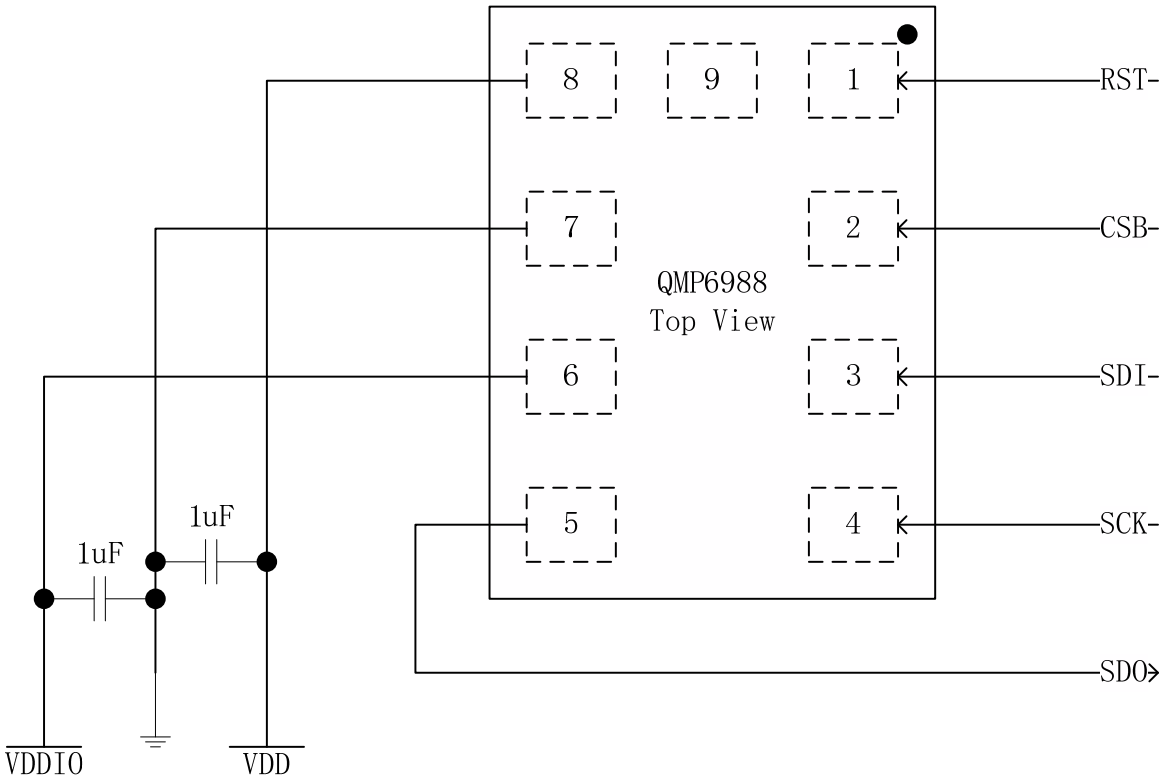
No.	Symbol	Description	
		SPI	I2C
1	RST	Asynchronous Reset *1)	
2	CSB	CSB	VDDIO
3	SDI	SDI/SDO	SDA
4	SCK	SCK	SCL
5	SDO	SDO	ADDR
6	VDDIO	Power Supply to Digital IO	
7	GND	Ground	
8	VDDIO	Power Supply	
9	VPP	Power Supply to NVM Programing *2)	

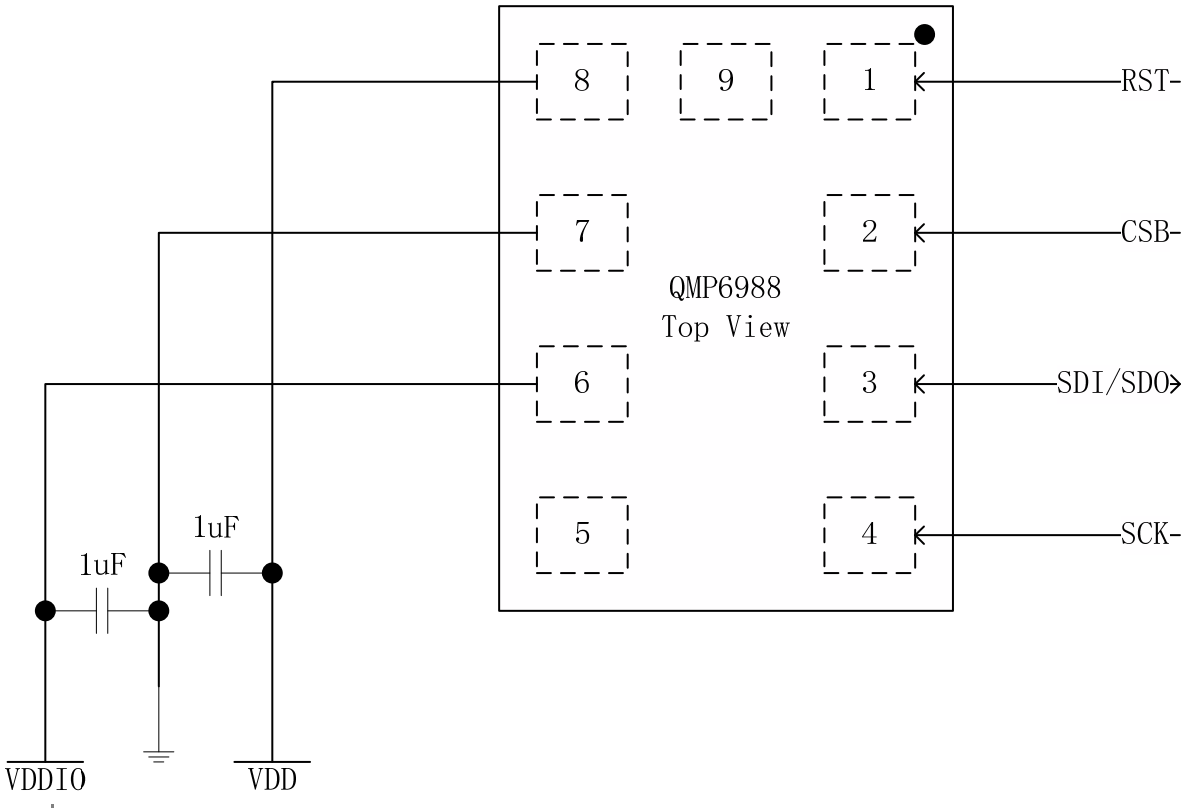
Note. *1) If you do not need the reset function, please just have the layout design of PCB of connecting both No.1 (RST) pin and No.7 (GND) pin into the ground of PCB.

*2) Pin 9 is only used internally Please leave this pin disconnected. If Pin 9 is connected with any other Pin electrically, the sensor will not work properly.

2.3 Typical Connection Diagram

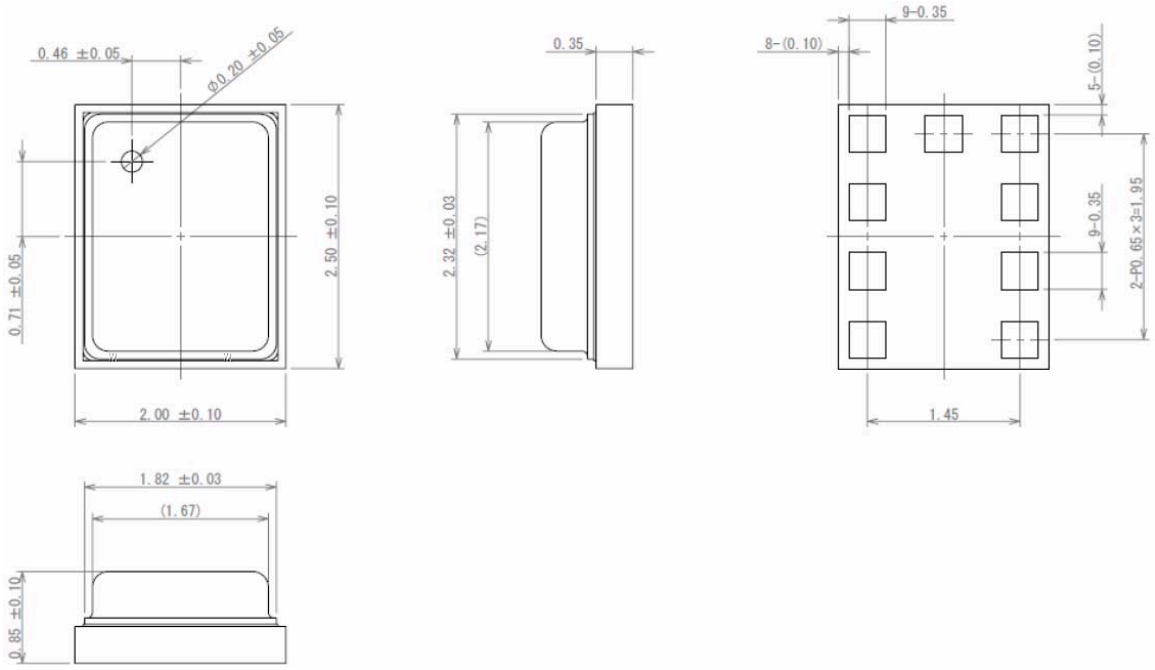




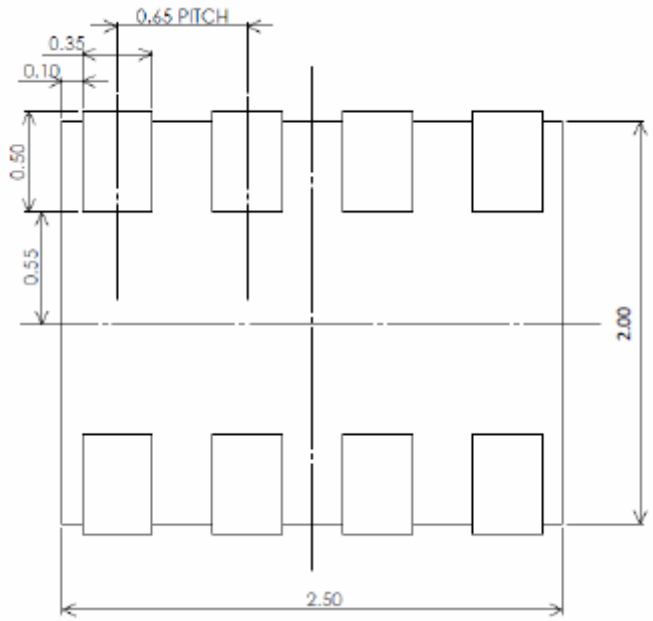


3. Dimensions

3.1 Package

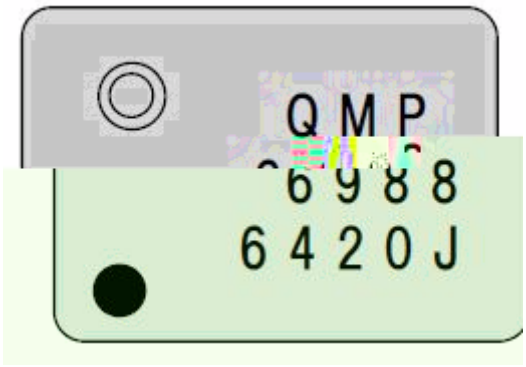


3.2 Mounting PAD Dimensions



(Top View) : Recommended

3.3 Marking structure



4. Operations

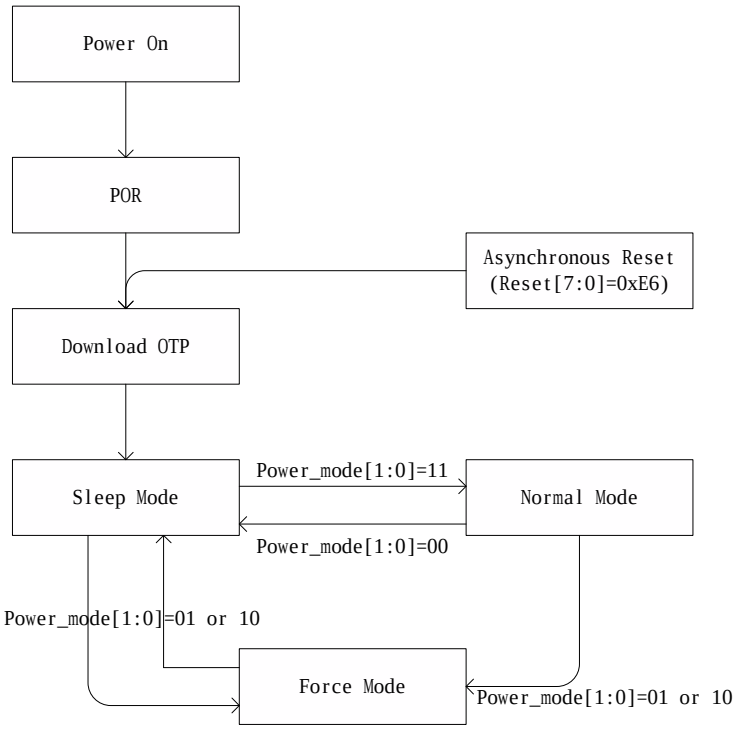
4.1 Communication Mode

Communication Mode	CSB	SDI	SCK	SDO	Remark
I2C	VDDIO	SDA	SCL	0/1	SDO=0→70h, SDO=1→56h
SPI 3 wires	CSB	SDI/SDO	SCK	-	spi3w register = 1
SPI 4 wires	CSB	SDI	SCK	SDO	spi3w register = 0

1)
2)
3)

4)

4.2 Power Mode



1) Sleep Mode (Power Reduction Mode)

2) Forced Mode

3) Normal Mode

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

- **How to get compensation coefficients**

K	Conversion factor		OTP		
	A	S	23-16bit	15-8bit	7-0bit
a1	-6.30E-03	4.30E-04	-	COE_a1_1	COE_a1_0
a2	-1.90E-11	1.20E-10	-	COE_a2_2	COE_a2_0
bt1	1.00E-01	9.10E-02	-	COE_bt1_1	COE_bt1_0
bt2	1.20E-08	1.20E-06	-	COE_bt2_1	COE_bt2_0
bp1	3.30E-02	1.90E-02	-	COE_bp1_1	COE_bp1_0
b11	2.10E-07	1.40E-07	-	COE_b11_1	COE_b11_0
bp2	-6.30E-10	3.50E-10	-	COE_bp2_1	COE_bp2_0
b12	2.90E-13	7.60E-13	-	COE_bp12_1	COE_bp12_0
b21	2.10E-15	1.20E-14	-	COE_bp21_1	COE_bp21_0
bp3	1.30E-16	7.90E-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**

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

$$Dt = ((TEMP\_TXD2) << 16) + ((TEMP\_TXD1) << 8) + (TEMP\_TXD0) - pow(2,23)$$
$$Dp = ((PRESS\_TXD2) << 16) + ((PRESS\_TXD1) << 8) + (PRESS\_TXD0) - pow(2,23)$$

IO_SETUP : IO SETUP Register

Register Name	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

Bit7~5 t_standby[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[2]: select output type of SDI terminal
0: Lo / Hiz output
1: Lo / Hi output
Bit1 Reserved: keep this bit at 0
Bit0 spi3w[0]: 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	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

Bit7~5 temp_average[2:0] Average 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

Bit4~2 press_average[2:0] Average 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: force mode
11: normal mode

DEVICE_STAT : Device Status Register

Register Name	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

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

I²C_SET : Master code setting

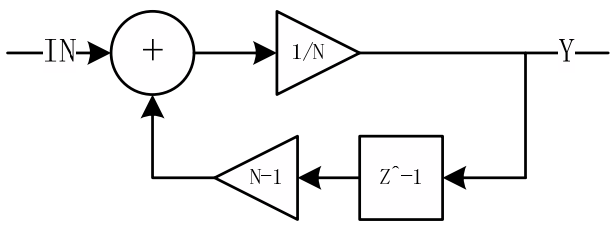
Register Name	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

bit7~3 Reserved: Keep these bits at 0
bit2,1,0 master_code[2:0] Master code setting at I2C high-speed mode.

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

IIR: IIR filter co-efficient setting Register

Register Name	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial



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	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

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

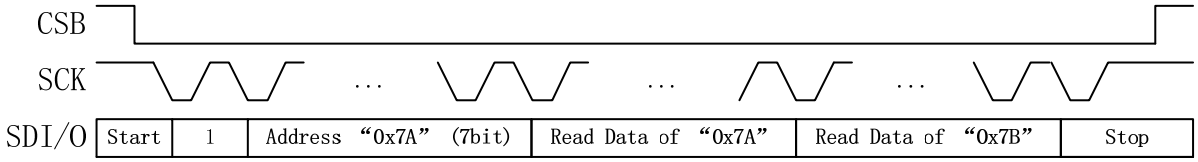
Register Name	I²C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

Bit7~0 chip_id[7:0] 5C

4.5 I2C Protocol

(1) I²C Slave Address

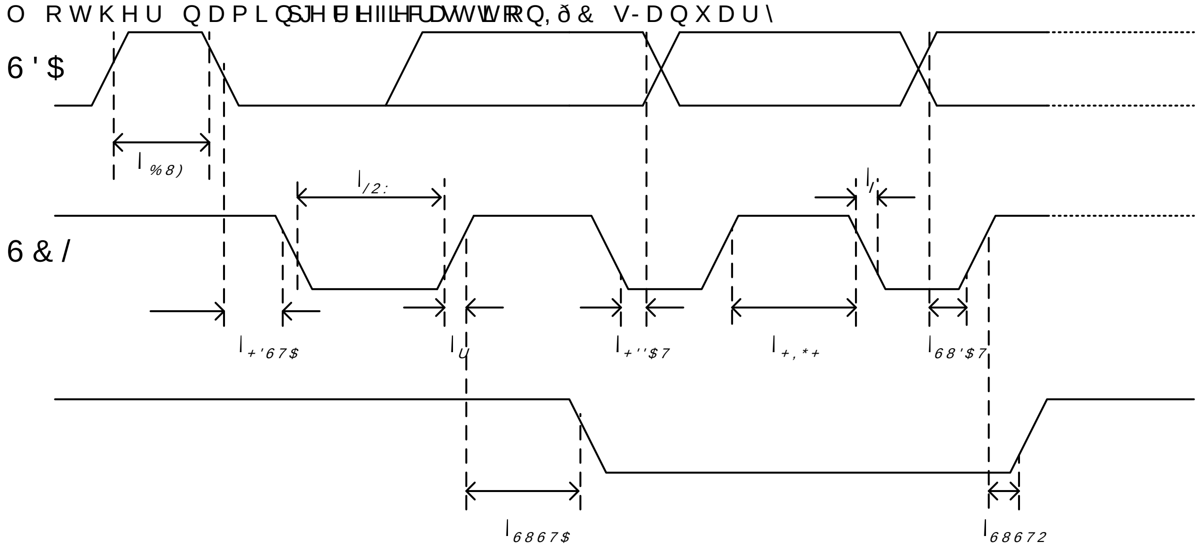
SDO	I2C Slave Address (7bits)	bit	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
			Add[6]	Add[5]	Add[4]	Add[3]	Add[2]	Add[1]	Add[0]	R/W
High(1)	56h + R/W	Value	1	0	1	0	1	1	0	1/0
Low(0)	70h + R/W	Value	1	1	1	0	0	0	0	1/0



,QWHUIDFH VSHFLILFDWLRQV

,ð& WLPLQJV

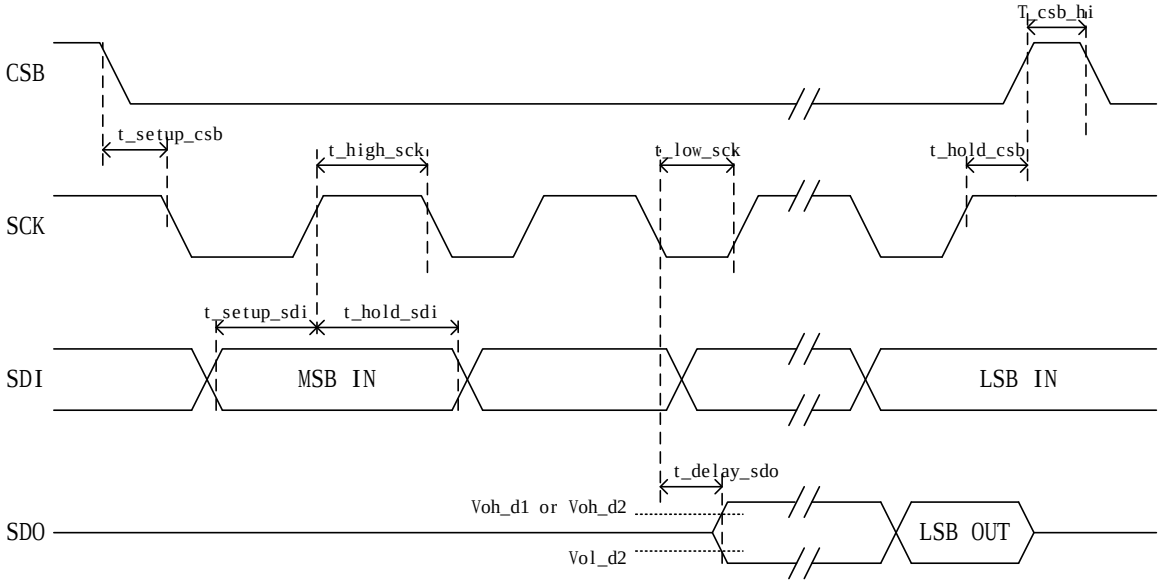
$OO WLPLQJV DSSO\ WR ERWK 6WDQGDUG PRGH DQG)DVW 0RGH DQG +LJK 6SHHG 0RGH ,ð& WLPLQJV WKH IROORZLQJ DEEUHYLDWLRQV DUH XVHG
6) 0RGH VWDQGDUG DQG IDVW PRGH
&E EXV FDSDFLWDQFH RQ 6', OLQH
$OO RWKHU QDPLQJ UHIHU WR ,ð& VSHFLILFDWLRQ ,ð& V-DQXDU\



8QGHVFULEHG LWHPV DQG V\PEROV DUH GHILQHG LQ ,ð& VSHFL

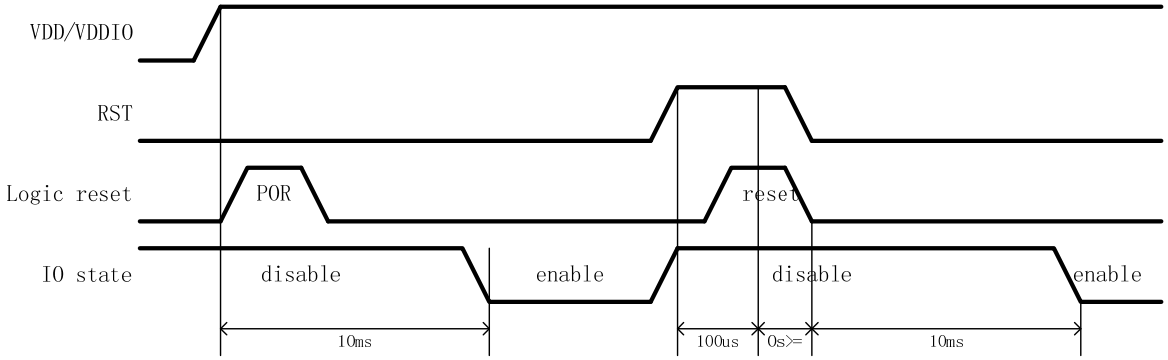
,WHPV	6\PERO	&RQGLWLRQ		PLQ	W\S	PD[	8QLWV	5HPDUN
6', 6HWXS WLPH	W+'67$	6) 0RGH					QV	
		+6 0RGH	YLR	9			QV	
		+6 0RGH	9LR	9			QV	
6', KROG WLPH	W+''$7	6) 0RGH &E S)					QV	
		6) 0RGH &E S)					QV	
		+6 0RGH &E	9LR	9			QV	
			9LR S)	9			QV	
		+6 0RGH &E	9LR	9			QV	
			9LR S)	9			QV	
6&. ORZ SXOVH	W/2:	+6 0RGH &E S)	9LR	9			QV	
			9LR	9			QV	

(2) SPI timings

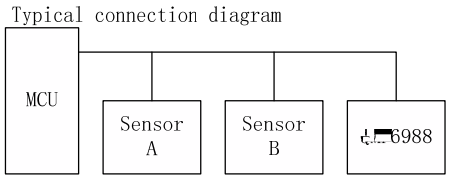


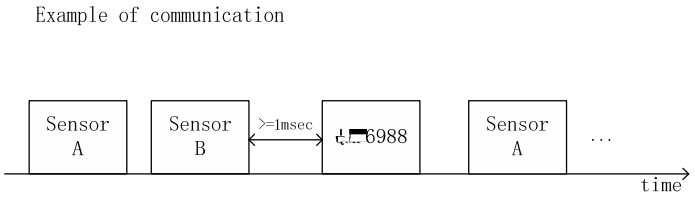
Items	Symbol	Condition	min	typ	max	Units	Remark
SCK frequency	f_spi		-	-	10	MHz	
SCK low pulse	t_low_sck		40	-	-	ns	
SCK high pulse	t_high_sck		40	-	-	ns	
SDI setupt time	t_setup_sdi		20	-	-	ns	
SDI hold time	t_hold_sdi		20	-	-	ns	
SDO output delay	t_delay_sdo	Cb=25pF, Vio=1.62V min	-	-	30	ns	
		Cb=25pF, 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



4.9 Recommended conditions of communication

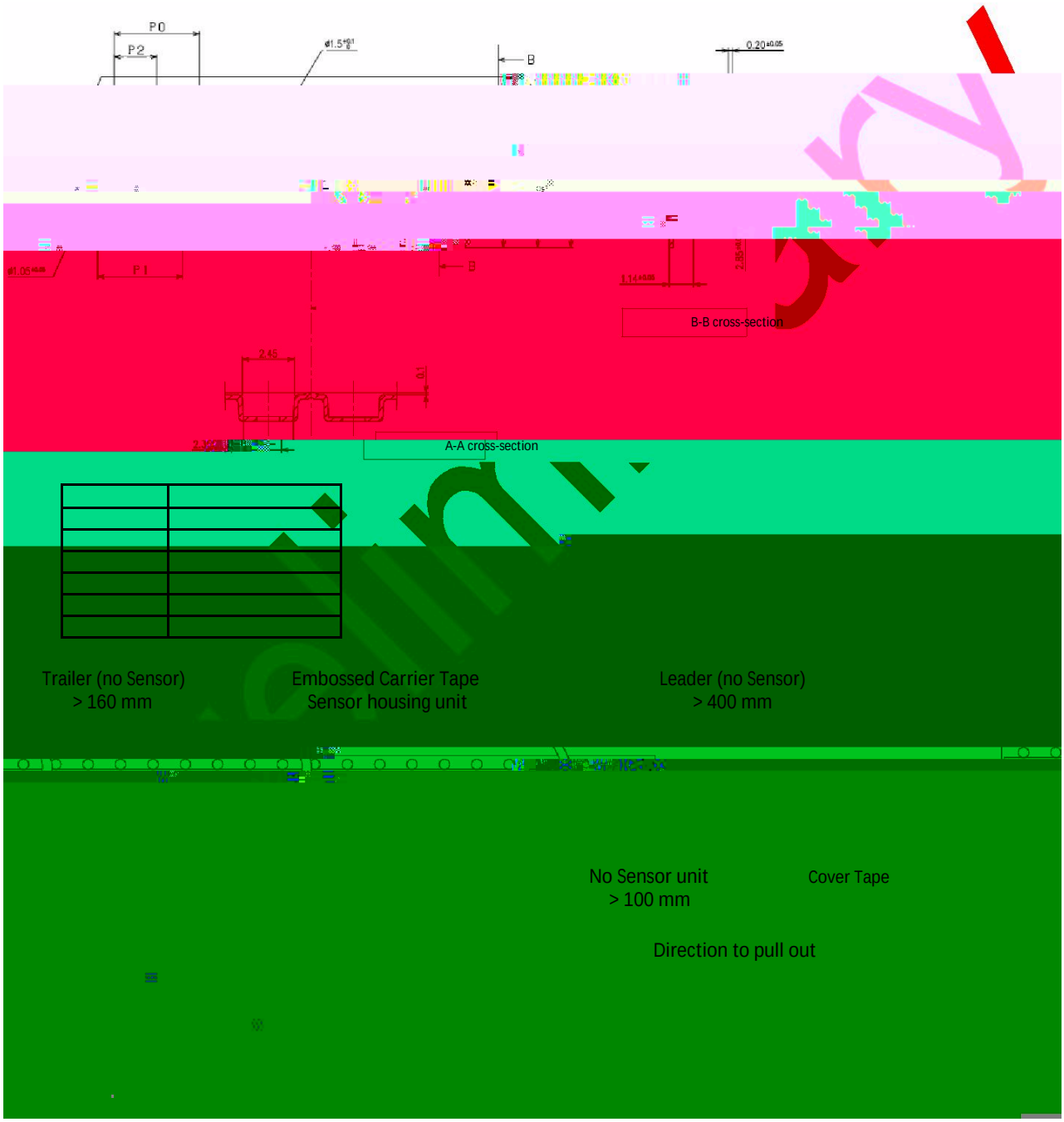




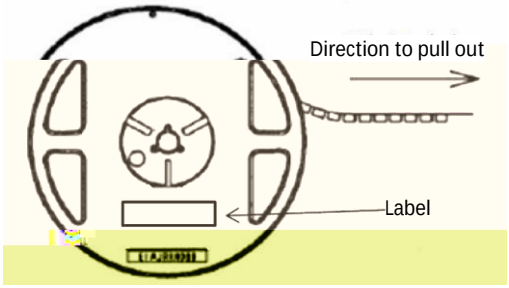
5. Packaging

5.1 Configuration of shipment

5.2 Taping



5.3 Reel

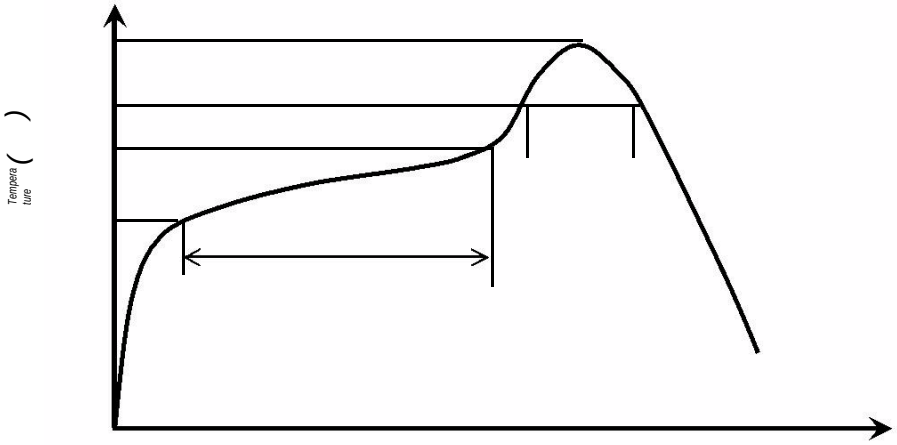


Reel 180 mm dia.
comply with JIS C 0806-3 requirements

5.4 Individual packaging

6. Recommended Soldering Method

Soldering method
Condition of Temperature
Recommended Soldering Method



7. Precautions

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