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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	V _{ddmax}	4.0	V
Input Voltage (other than power)	V _{max}	-0.2~V _{opr} +0.2	V
Maximum Pressure	P _{max}	800	kPa
Storage Temperature	T _{str}	-40~85	
Storage Humidity	H _{str}	10~95	%RH
ESD(HBM)	V _{hbm}	± 2000	V
ESD(MM)	V _{mm}	± 200	V
ESD(CDM)	V _{cdm}	± 500	V

1.3 Operating Ratings

Item	Symbol	Min	Typ
Operating Voltage	V _{opr}	1.71	1.8
	V _{io}	1.2	1.8
Operating Temperature	T _{opr}	-40	

1.4 Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Average Current *	I _{hp}	1sample/s force mode Ultra High Accuracy	-	21.4	-	μA
	I _{ddp}	Pressure mode	-	640	800	μA
	I _{ddt}	Temperature mode	-	410	520	μA
Sleep Mode Current Consumption	I _{sleep}		-	1.1	2.3	μA
Measurable Pressure Range	P _{opr}		30	-	110	kPa
Absolute Pressure Accuracy	P _{abs1}	30~110kPa, -20 ~ 65	-100	-	100	Pa
Relative Pressure Accuracy *	P _{rel1}	Ultra High Accuracy	-	± 3.9	-	Pa
rms Noise *	P _{nois}	Ultra High Accuracy	-	1.3	-	Pa
Absolute Temperature Accuracy	T _{abs}	30~110kPa, -20 ~ 65				
Atmosphere						

1.5 Digital Interface Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Digital Input Low Voltage	V _{l_d}		-	-	V _{io} *0.2	V
Digital Input High Voltage	V _{h_d}		V _{io} *0.8	-	-	V
Digital Input Hysteresis	V _{dhys}		V _{io} *0.1	-	-	V
Digital Output Low Voltage(I _{2C})	V _{ol_d1}	I _o =3mA (SDI *1)	0	-	V _{io} *0.2	V
Digital Output Low Voltage(SPI)	V _{ol_d2}	I _o =1mA (SDI, SDO *1)	0	-	V _{io} *0.2	V
Digital Output High Voltage1 (SPI) (V _{io} >=1.62V)	V _{oh_d1}	I _o =1mA (SDI, SDO *1)	V _{io} *0.8	-	-	V
Digital Output High Voltage2 (SPI) (V _{io} >=1.2V)	V _{oh_d2}	I _o =1mA (SDI, SDO *1)	V _{io} *0.6	-	-	V
Leakage Current at Output OFF	I _{off}	SDI, SDO	-10	-	10	μA
Internal Pull up Resistor	R _{pull up}	CSB	70	120	190	kohm
I _{2C} Load Capacitor	C _b	SDI, SCK	-	-	400	pF
Load Capacitance of Reset Terminal	C _{rst}		-	-	20	pF
Pulse Width of Asynchronous Reset	T _{rst}		100	-	-	μsec
Power On Startup Time	T _{start}		-	-	10	msec

1.6 Characteristics by Oversampling setting (force mode)

Oversampling setting	Pressure Oversampling	Temperature Oversampling	Measurement time Typ	OR @standby Ins Typ	Average Current Typ @sample/sec force-mode	rms Noise Typ
Unit	-	-	nsec	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

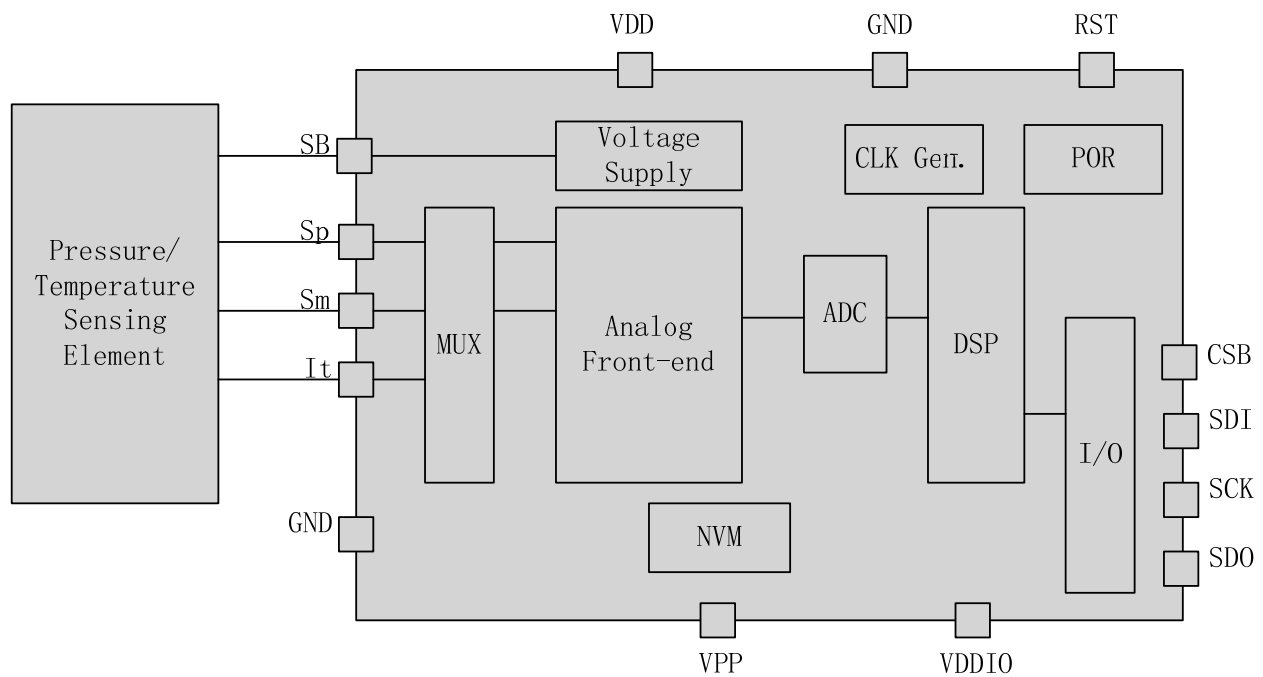
Oversampling setting	Typical Bandwidth [Hz]					
	IIR filter coefficient					
	off	2	4	8	16	32
High speed	133	30.7	12.8	5.9	2.9	1.4
Low power	108	24.9	10.4	4.8	2.3	1.1
Standard	79	18.2	7.6	3.5	1.7	0.8
High accuracy	49	11.3	4.7	2.2	1.1	0.5
Ultra High accuracy	28	6.5	2.7	1.2	0.6	0.3

1.9 Filter selection based on use cases

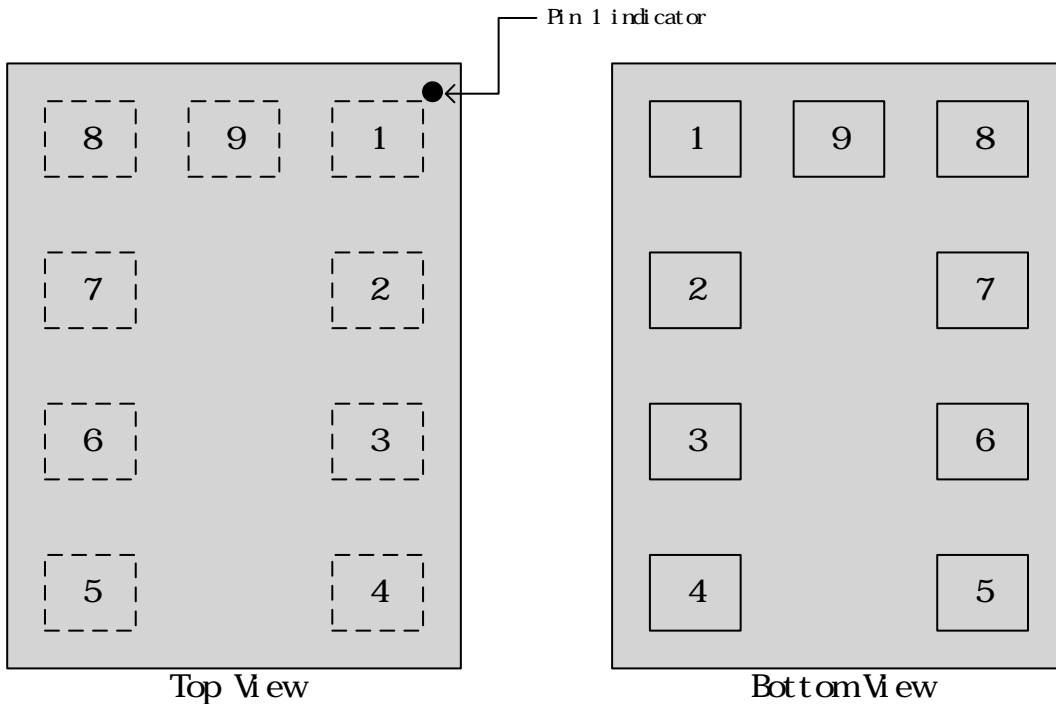
Example use case	Oversampling Setting	Pressure oversampling times	Temp oversampling times	Specification (Typ.)			
				IIR filter coefficient	Current consumption [uA]	ODR [Hz] (Example)	rms Noise [Pa]
Water monitoring	High speed	2	1	off	1.2	0.05	5.2
Drop detection	Low power	4	1	off	407	100	3.7
Elevator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



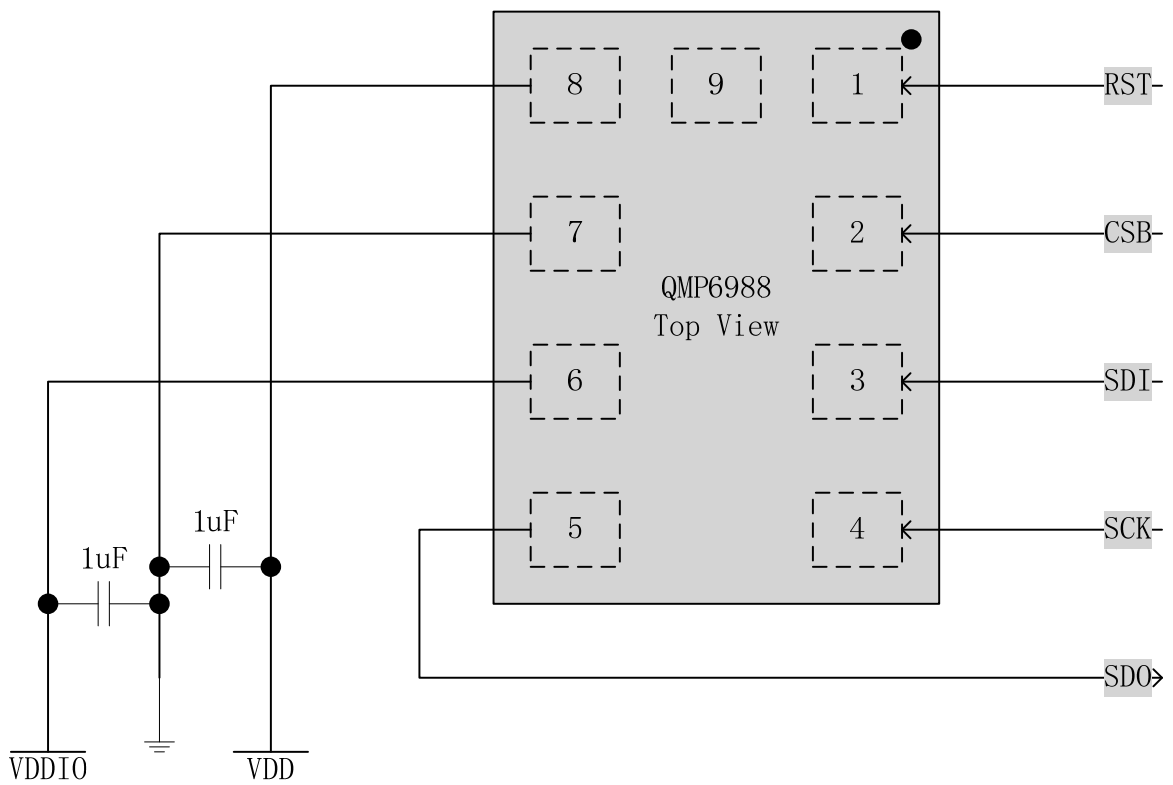
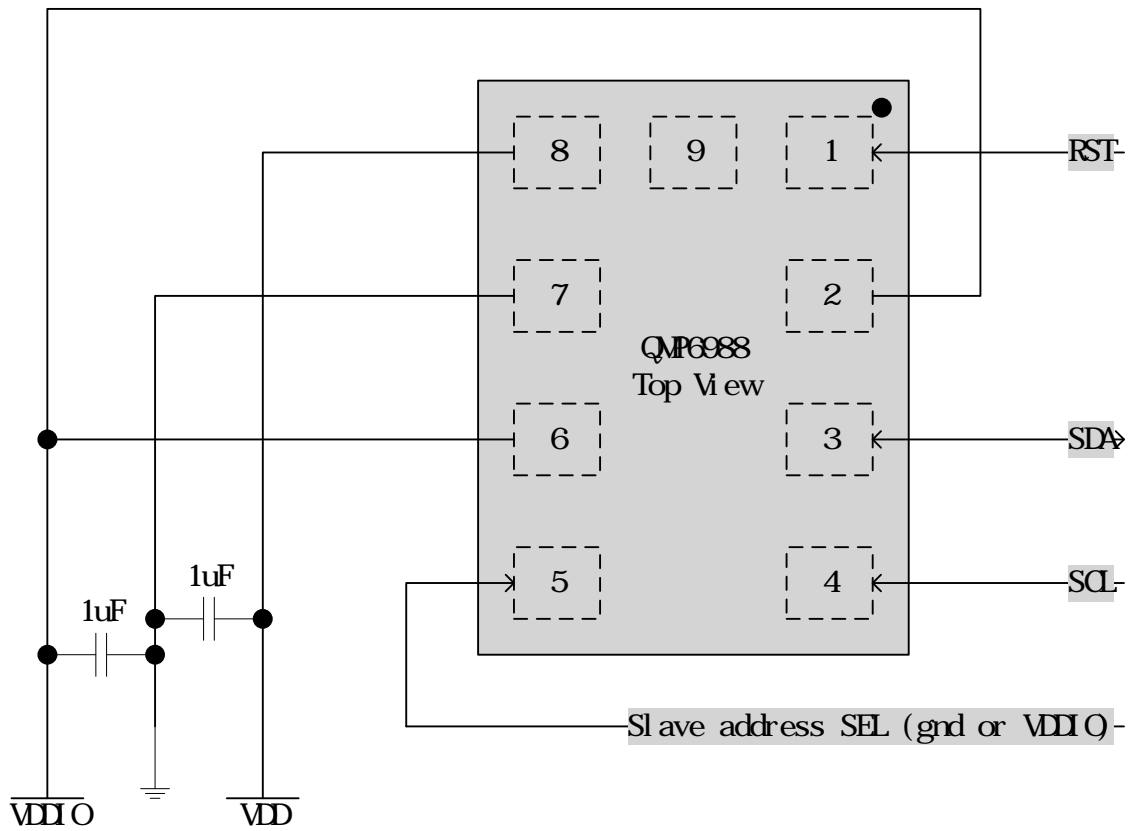
Pin Description

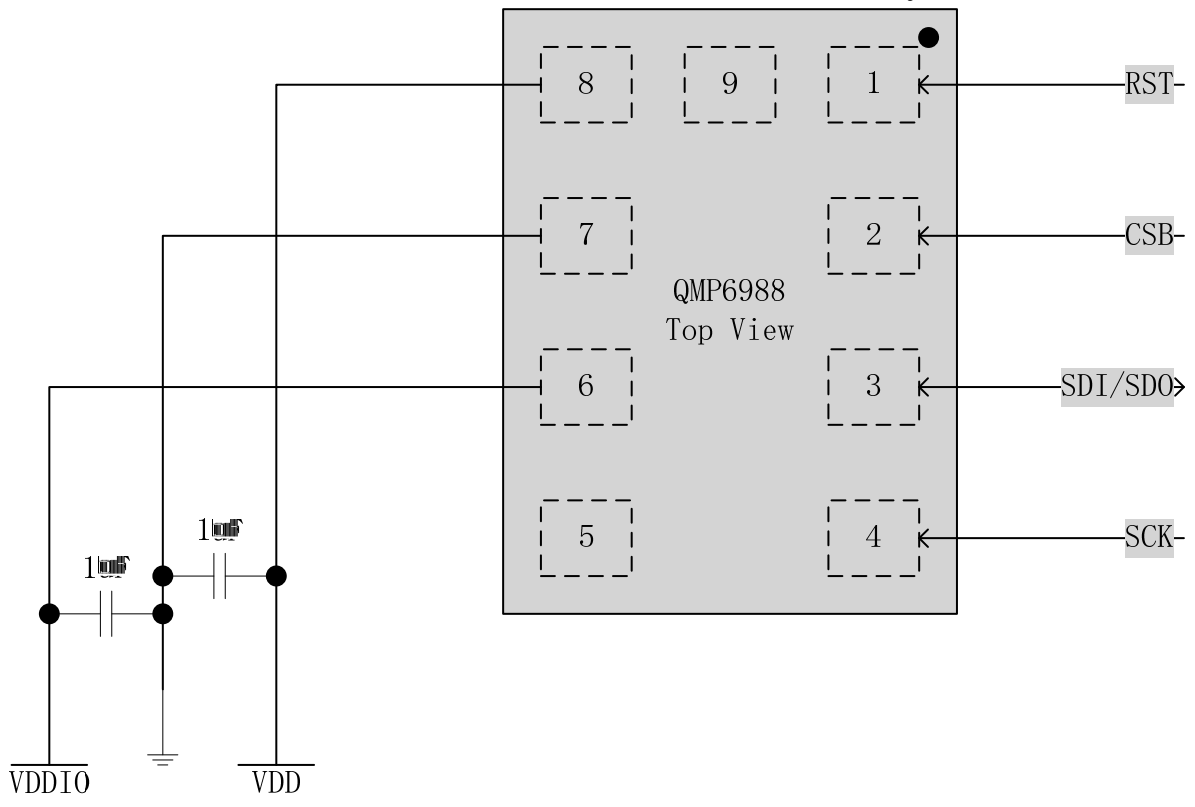
No.	Symbol	Description	
		SPI	I2C
1	RST	Asynchronous Reset *1)	
2	CSB	CSB	VDDIO
3	SDI	SDI/SDO	SDA
4	SCK	SCK	SCL
5	SDO	SDO	ADDR
6	VDDIO	Power Supply to Digital IO	
7	GND	Ground	
8	VDDIO	Power Supply	
9	VPP	Power Supply to NVM Programming *2)	

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.

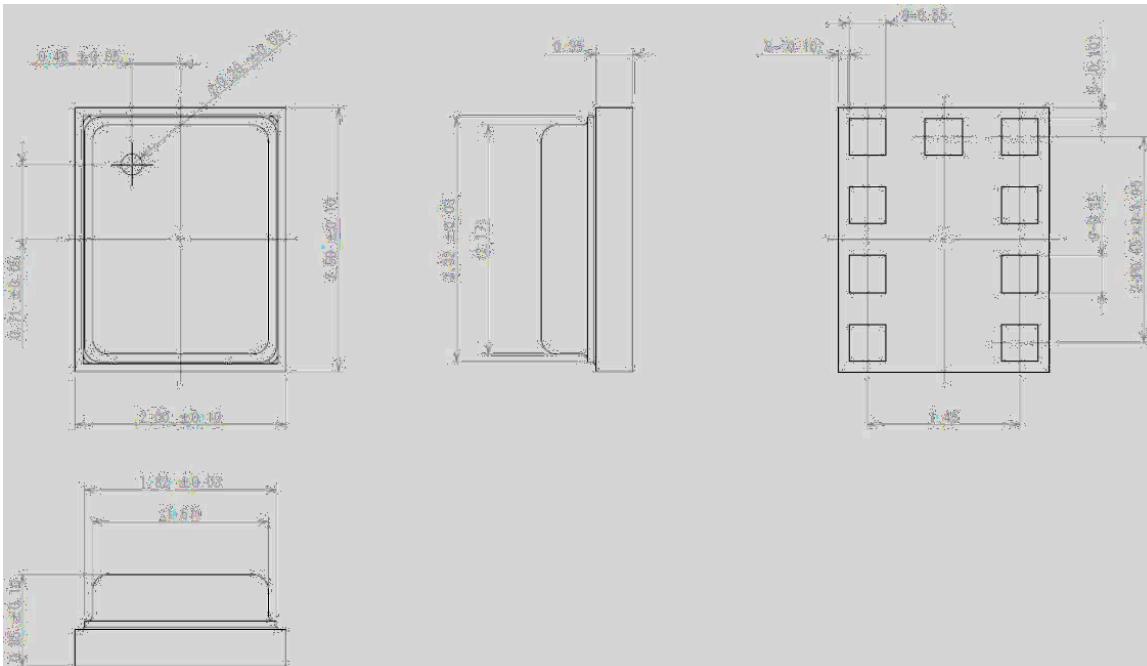
2.3 Typical Connection Diagram



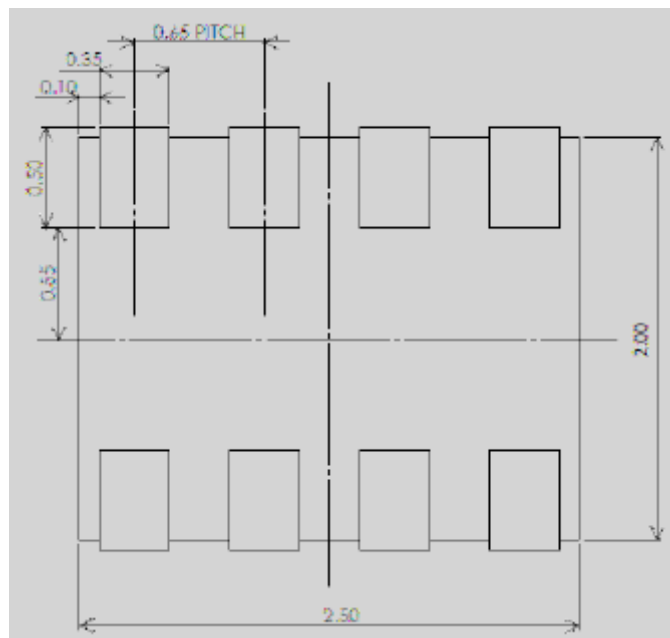


3. Dimensions

3.1 Package



3.2 Mounting PAD Dimensions



(Top View) : Recommended

3.3 Marking structure



4. Operations

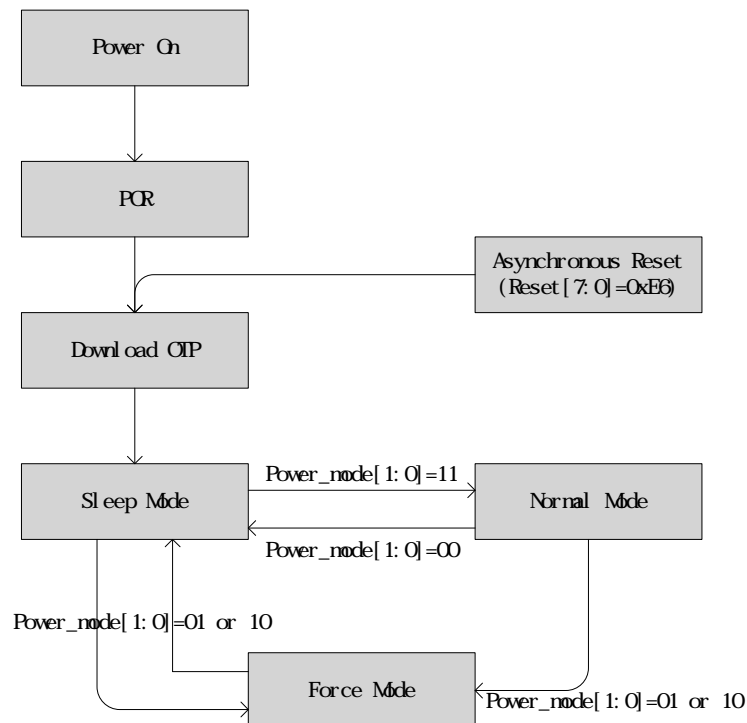
4.1 Communication Mode

Communication Mode	CSB	SDI	SCK	SDO	Remark
I ² C	VDDIO	SDA	SCL	0/1	SDG=0 70h, SDG=1 56h
SPI 3 wires	CSB	SDI/SDO	SCK	-	spi3wregister = 1
SPI 4 wires	CSB	SDI	SCK	SDO	spi3wregister = 0

- 1)
- 2)
- 3)

- 4)

4.2 Power Mode



- 1) **Sleep Mode (Power Reduction Mode)**

- 2) **Forced Mode**

- 3) **Normal Mode**

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

How to get compensation coefficients

K	Conversion factor		OIP		
	A	S	23-16bit	15-8bit	7-0bit
a1	-6.30E-03	4.30E-04	-	CCE a1 1	CCE a1 0
a2	-1.90E-11	1.20E-10	-	CCE a2 2	CCE a2 0
bt1	1.00E-01	9.10E-02	-	CCE bt1 1	CCE bt1 0
bt2	1.20E-08	1.20E-06	-	CCE bt2 1	CCE bt2 0
bp1	3.30E-02	1.90E-02	-	CCE bp1 1	CCE bp1 0
b11	2.10E-07	1.40E-07	-	CCE b11 1	CCE b11 0
bp2	-6.30E-10	3.50E-10	-	CCE bp2 1	CCE bp2 0
b12	2.90E-13	7.60E-13	-	CCE bp12 1	CCE bp12 0
b21	2.10E-15	1.20E-14	-	CCE bp21 1	CCE bp21 0
bp3	1.30E-16	7.90E-17	-	CCE bp3 1	CCE bp3 0

K	Conversion factor	OIP		
		19-12bit	11-4bit	3-0bit
a0	Offset value (20Q16)	CCE a0 1	CCE a0 0	CCE a0 ex
b00	Offset value (20Q16)	CCE b00 1	CCE b00 0	CCE 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

$$Dt = ((TEMP_TXD2) \ll 16) + ((TEMP_TXD1) \ll 8) + (TEMP_TXD0) - pow(2,23)$$

$$Dp = ((PRESS_TXD2) \ll 16) + ((PRESS_TXD1) \ll 8) + (PRESS_TXD0) - pow(2,23)$$

IO_SETUP : IO SETUP Register

Register Name	PC 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 PC Addr. SPI Addr. Length R/W bit7 bit6 bit5



RESET: Reset Control Register

Register Name	I ² C 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

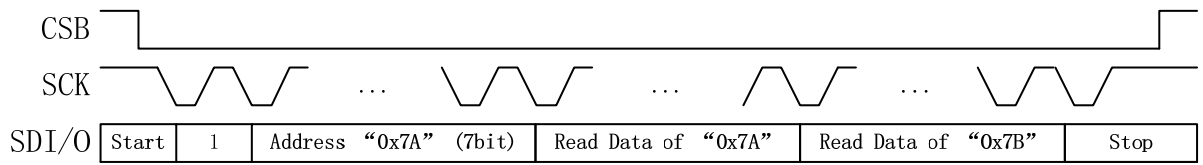
Register Name	I ² C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

Bit7~0 chip_id[7:0] 5C

4.5 I2C Protocol

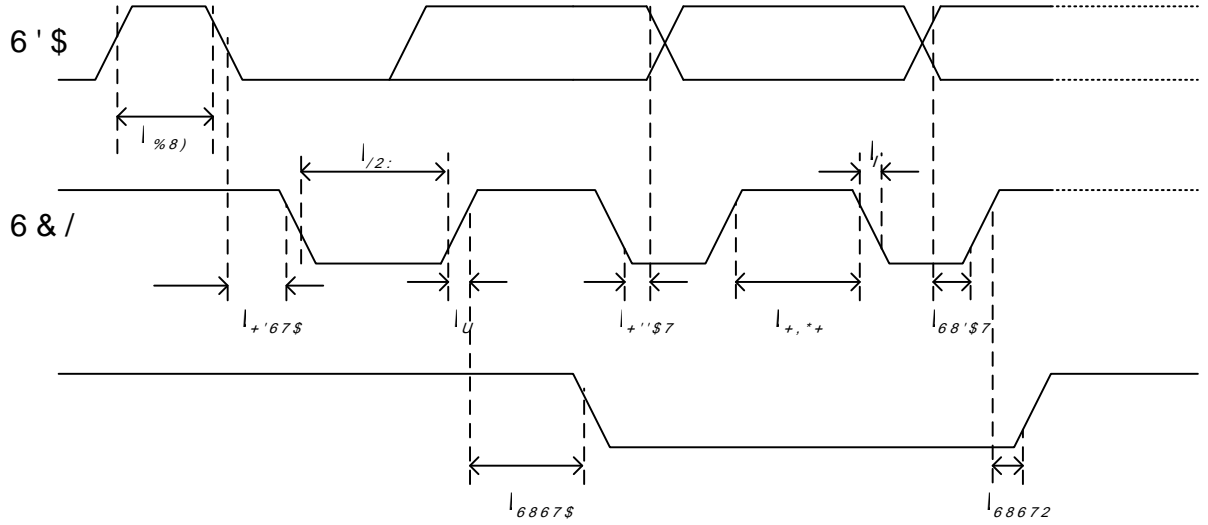
(1) I2C Slave Address

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

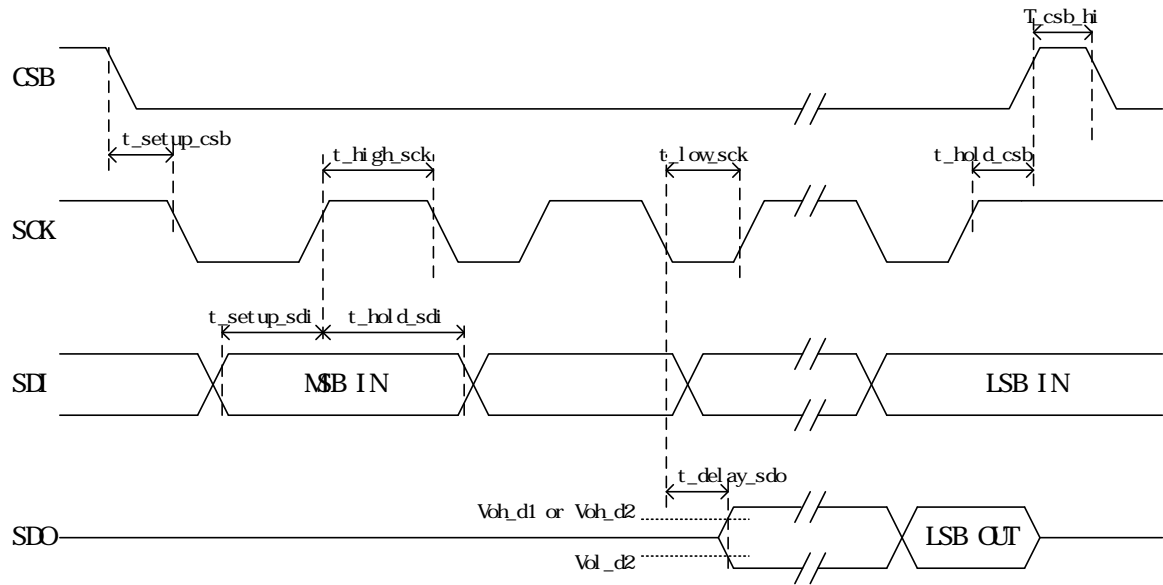
,ø & WLPLQJV
 \$OO WLPLQJV DSDW 6WRDQGHESV ORGHW DW)DVW ORSGHDWQGLJK 6SHH,6ORGH
 WLPLQJV WKH IROORZLQJ DEEUHYLDWLRQV DUH XVHG
 6) ORGH VWDQGDUG DQG IDVW PRGH
 &E EXV FSDFLWDQFH RQ 6', OLQH
 \$OO RWKHU QDPLQJH HHHHFDWLRQ,ø & V-DQXDU\



8QGHVFULEHG LWHPV FROPS VLDORZLDKFDWLRQ & VSHFLI

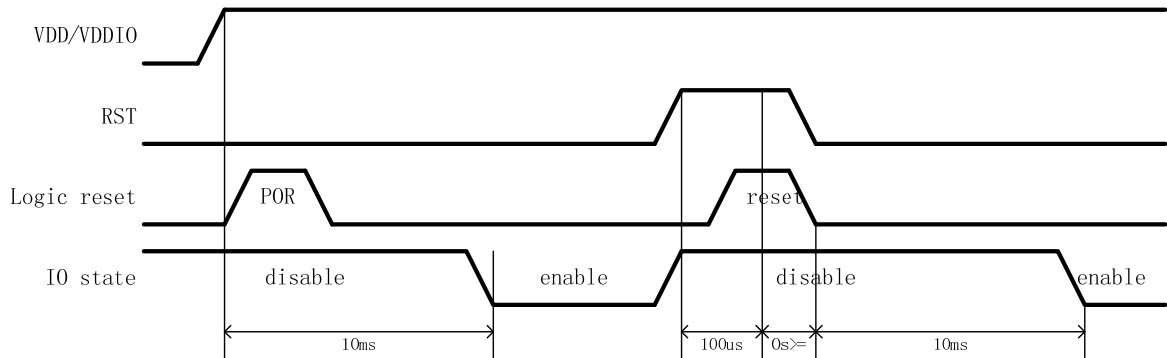
,WHPV	6	PERO &RQGLWLRQ	PLQ	W\S	PDI	8QLWV 5HPDU
6', 6HWXS	WLP	6) ORGH				QV
		+6 ORGH	YLR	9		QV
		+6 ORGH	9LR	9		QV
6', KROG	WLP	6) ORGH &E S)				QV
		6) ORGH &E S)				QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
6&. ORZ SXOVH	W/2:	+6 ORGH &E	9LR	9	S)	QV
		+6 ORGH &E	9LR	9	S)	QV

(2) SPI timings



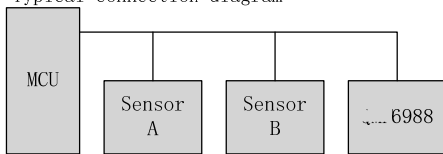
Items	Symbol	Condition	min	typ	max	Units	Remark
SCK frequency	f_spi		-	-	10	MHz	
SCK low pulse	t_low_sck		40	-	-	ns	
SCK high pulse	t_high_sck		40	-	-	ns	
SDI setup time	t_setup_sdi		20	-	-	ns	
SDI hold time	t_hold_sdi		20	-	-	ns	
SDO output delay	t_delay_sdo	Cb=25pF, Vio=1.62V min	-	-	30	ns	
		Cb=25pF,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

4.8 Reset Function



4.9 Recommended conditions of communication

Typical connection diagram



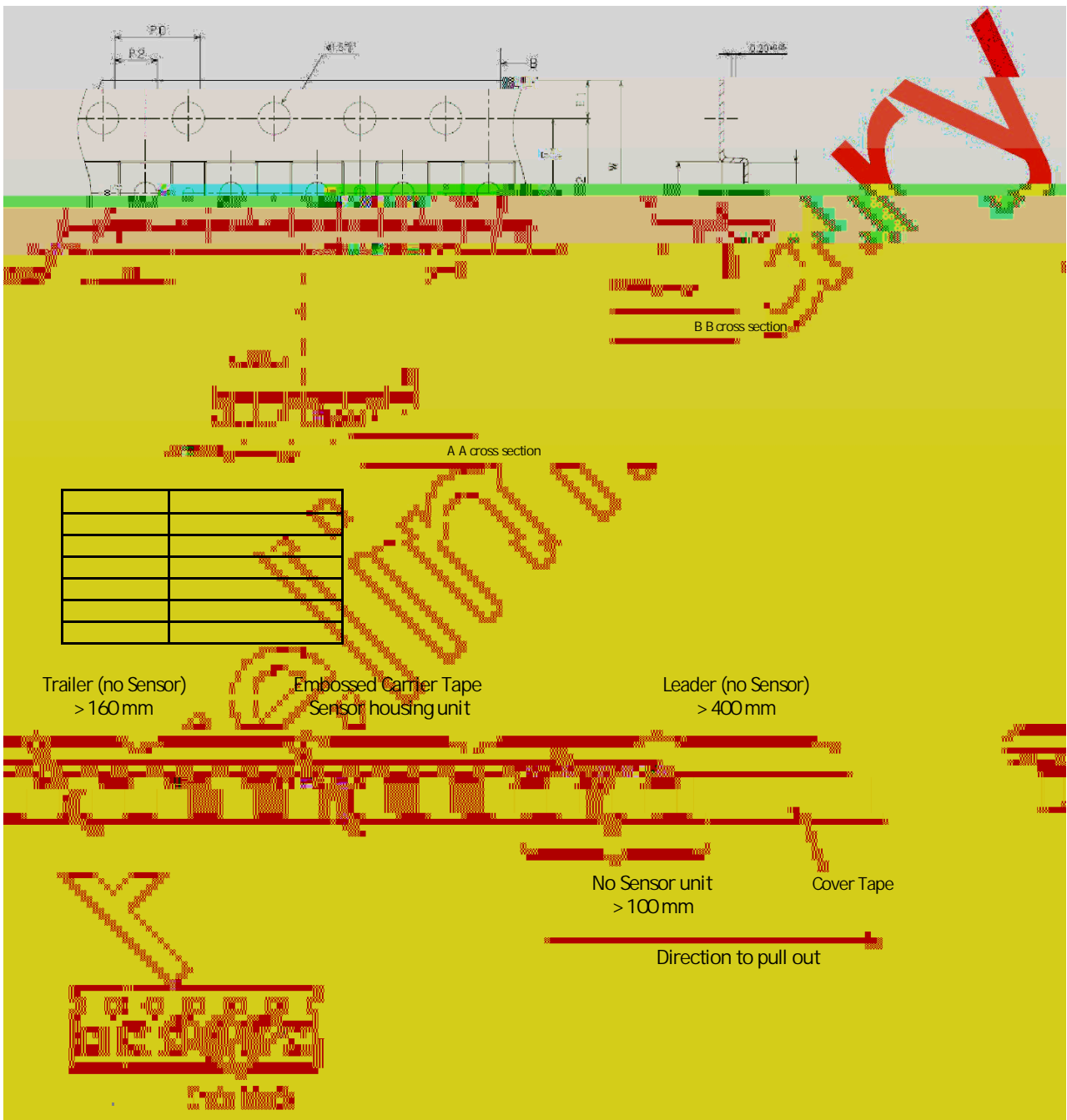
Example of communication



5. Packaging

5.1 Configuration of shipment

5.2 Taping

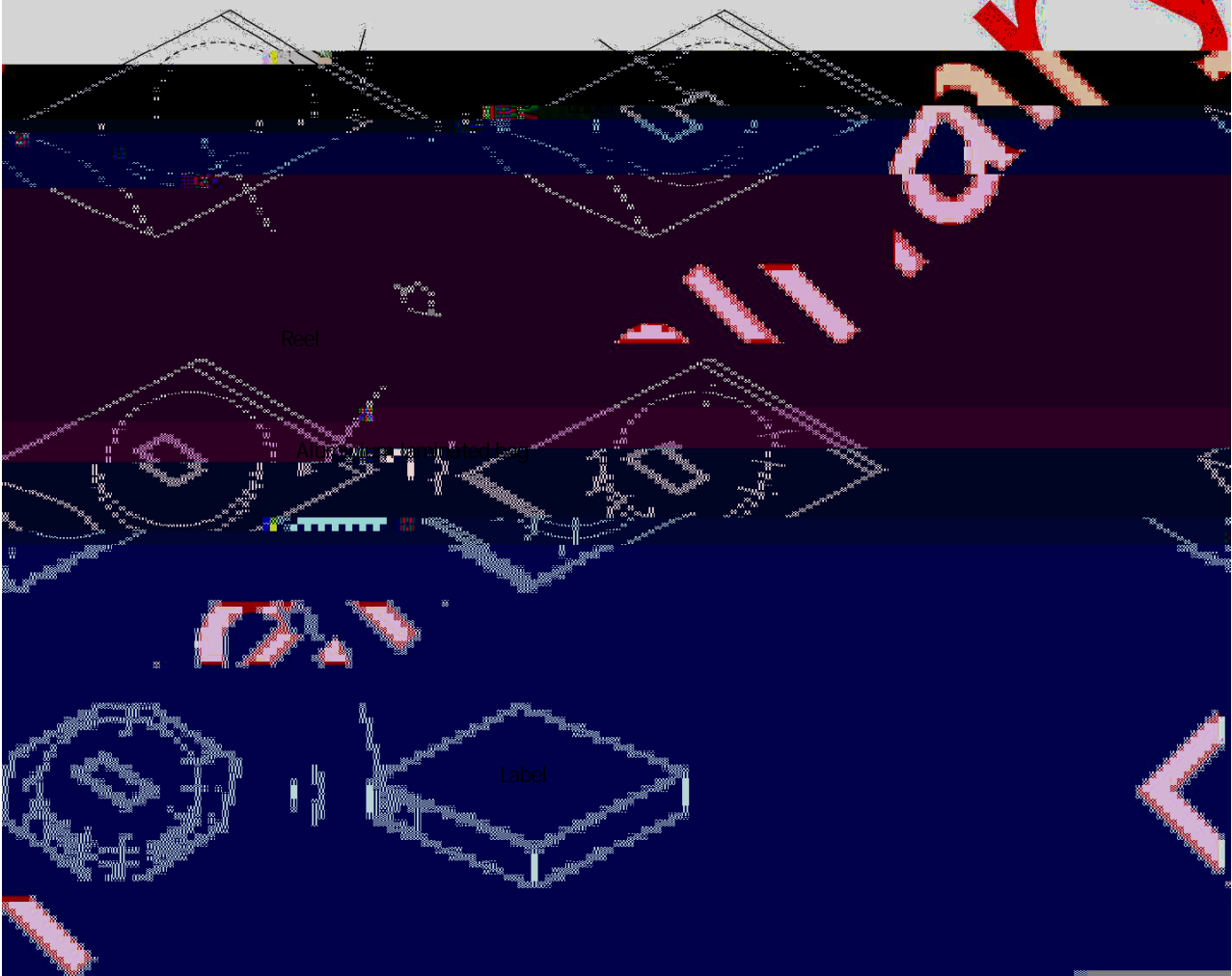


5.3 Reel



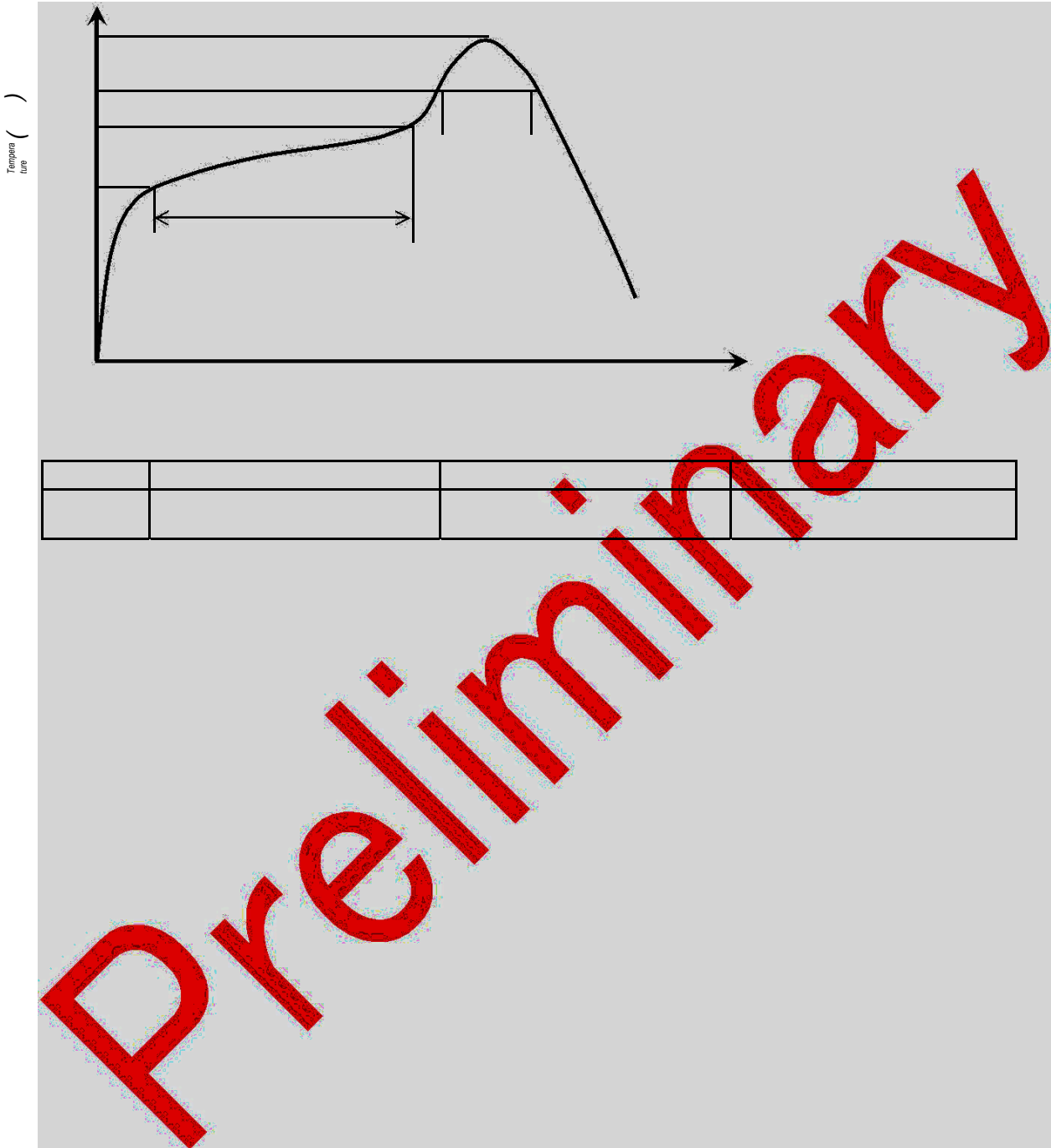
Reel 180 mm dia.
comply with JIS C 0806 3 requirements

5.4 Individual packaging



6. Recommended Soldering Method

Soldering method
Condition of Temperature
Recommended Soldering Method



Preliminary

7. Precautions

(1)

- 1)
- 2)

3)

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