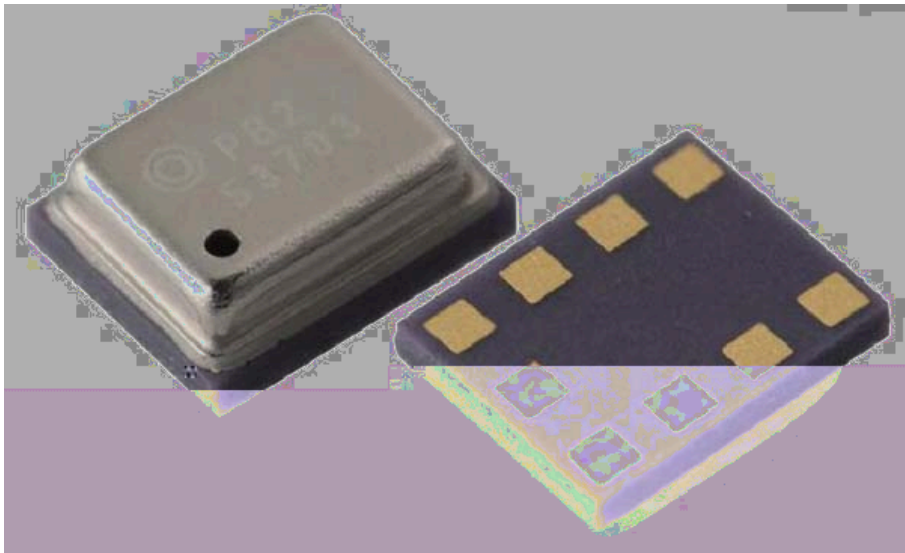


High accuracy and small size barometric pressure sensor with low current consumption

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

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

Item	Symbol	Rating	Unit
Power Supply Voltage	Vddmax	4.0	V
Input Voltage (other than power)	Vinax	-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

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

Item	Symbol	Condition	Min	Typ	Max	Unit
Average Current *	Ihp	1sample/s force mode 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
Measurable 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						
PresPt	tr					

ihp Iddp Iddt Isleep Ihp Iddp Iddt Isleep

Item	Symbol	Condition	Min	Typ	Max	Unit
Digital Input Low Voltage	Vl_d		-	-	V _{IO} *0.2	V
Digital Input High Voltage	Vh_d		V _{IO} *0.8	-	-	V
Digital Input Hysteresis	Vdhys		V _{IO} *0.1	-	-	V
Digital Output Low Voltage(I _{2C})	Vol_d1	I _O =3mA (SDI) *1)	0	-	V _{IO} *0.2	V
Digital Output Low Voltage(SPI)	Vol_d2	I _O =1mA (SDI, SDO) *1)	0	-	V _{IO} *0.2	V
Digital Output High Voltage1 (SPI) (V _{IO} >=1.6V)	Voh_d1	I _O =1mA (SDI, SDO) *1)	V _{IO} *0.8	-	-	V
Digital Output High Voltage2 (SPI) (V _{IO} >=1.2V)	Voh_d2	I _O =1mA (SDI, SDO) *1)	V _{IO} *0.6	-	-	V
Leakage Current at Output OFF	Ioff	SDI, SDO	-10	-	10	μA
Internal Pull up Resistor	Rpull up	CSB	70	120	190	kohm
I _{2C} Load Capacitor	Cb	SDI, SCK	-	-	400	pF
Load Capacitance of Reset Terminal	Crst		-	-	20	pF
Pulse Width of Asynchronous Reset	Trst		100	-	-	μsec
Power On Startup Time	Tstart		-	-	10	msec

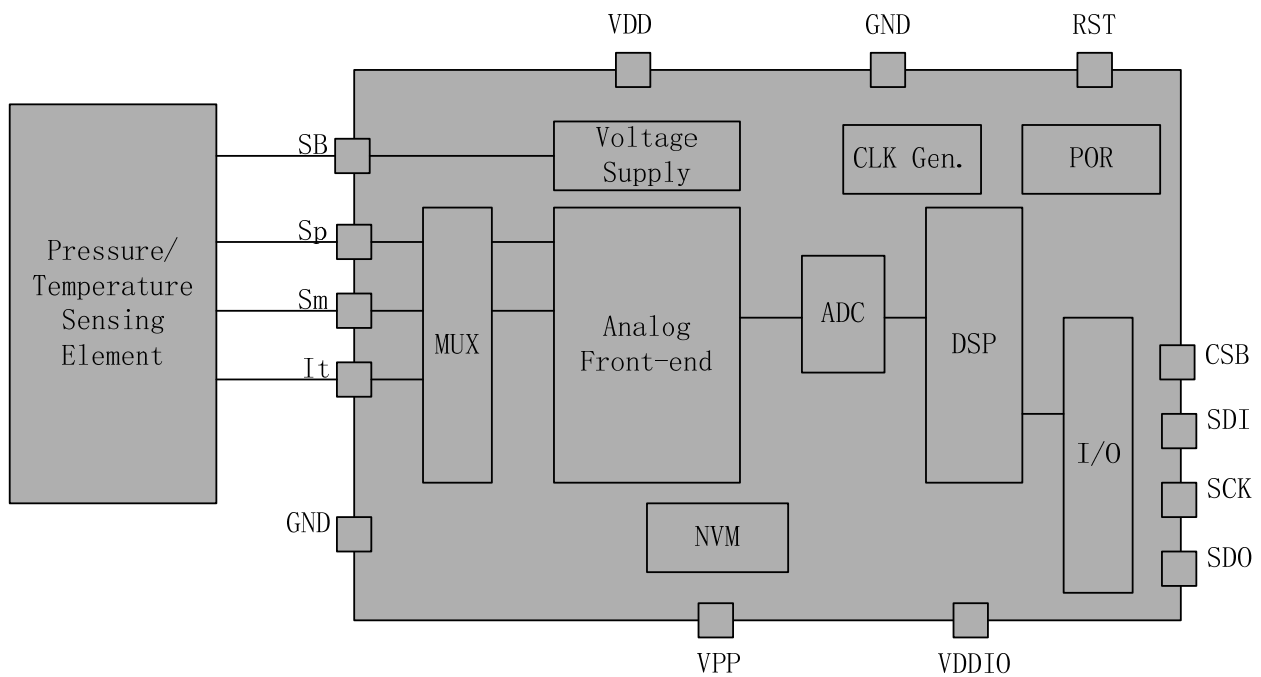
Oversampling setting	Pressure Oversampling	Temperature Oversampling	Measurement time Typ	OIR @standby Ins Typ	Average Current Typ @sample/sec force-node	r _{rms} Noise Typ
Unit	-	-	nsec	Hz	μA	Pa
High speed	2	1	5.5	153	4.1	5.2
Low power	4	1	7.2	121	5.2	3.7
Standard	8	1	10.6	86	7.3	2.6
High accuracy	16	2	18.3	51	12	1.8
Ultra High accuracy	32	4	33.7	28	21.4	1.3

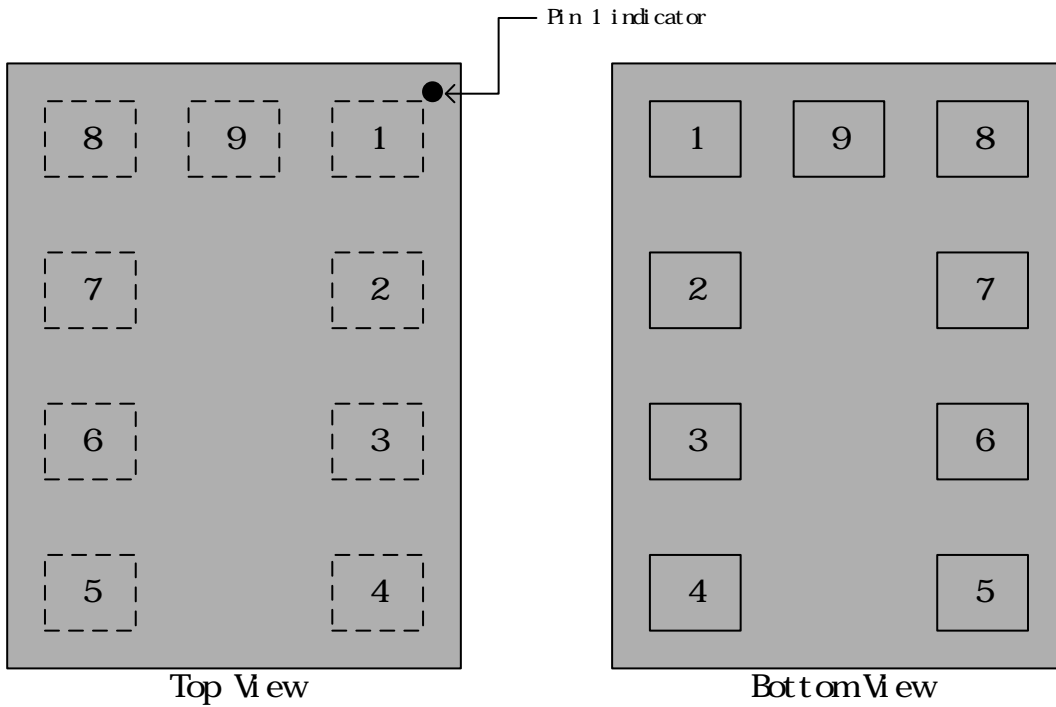
At Ta=25 degC, VDD=1.8V, CPU Clock Frequency=300kHz, unless otherwise noted

Oversampling setting	Typical r _{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

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

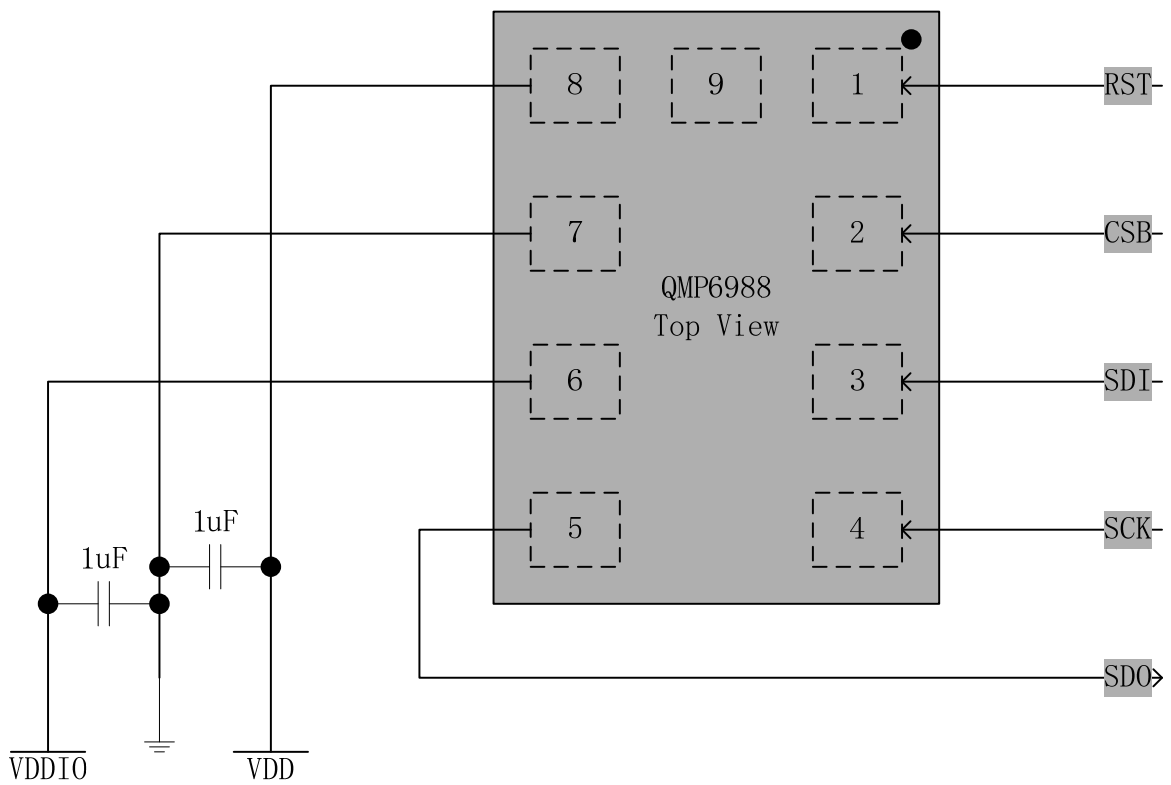
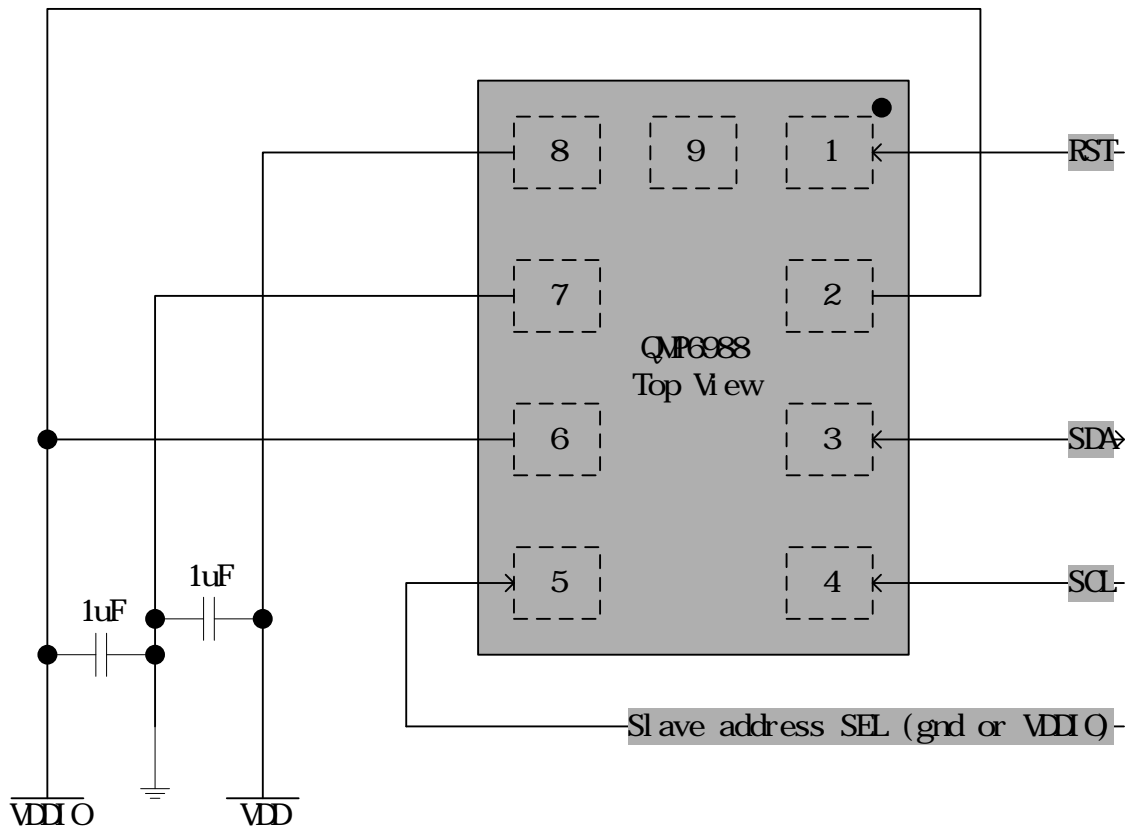
Example use case	Oversampling Setting	Pressure oversampling times	Temp oversampling times	Specification (Typ.)			
				IIR filter coefficient	Current consumption [uA]	CDR [Hz] (Example)	rms Noise [Pa]
Water monitoring	High speed	2	1	off	1.2	0.05	5.2
Drop detection	Low power	4	1	off	407	100	3.7
Elevator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

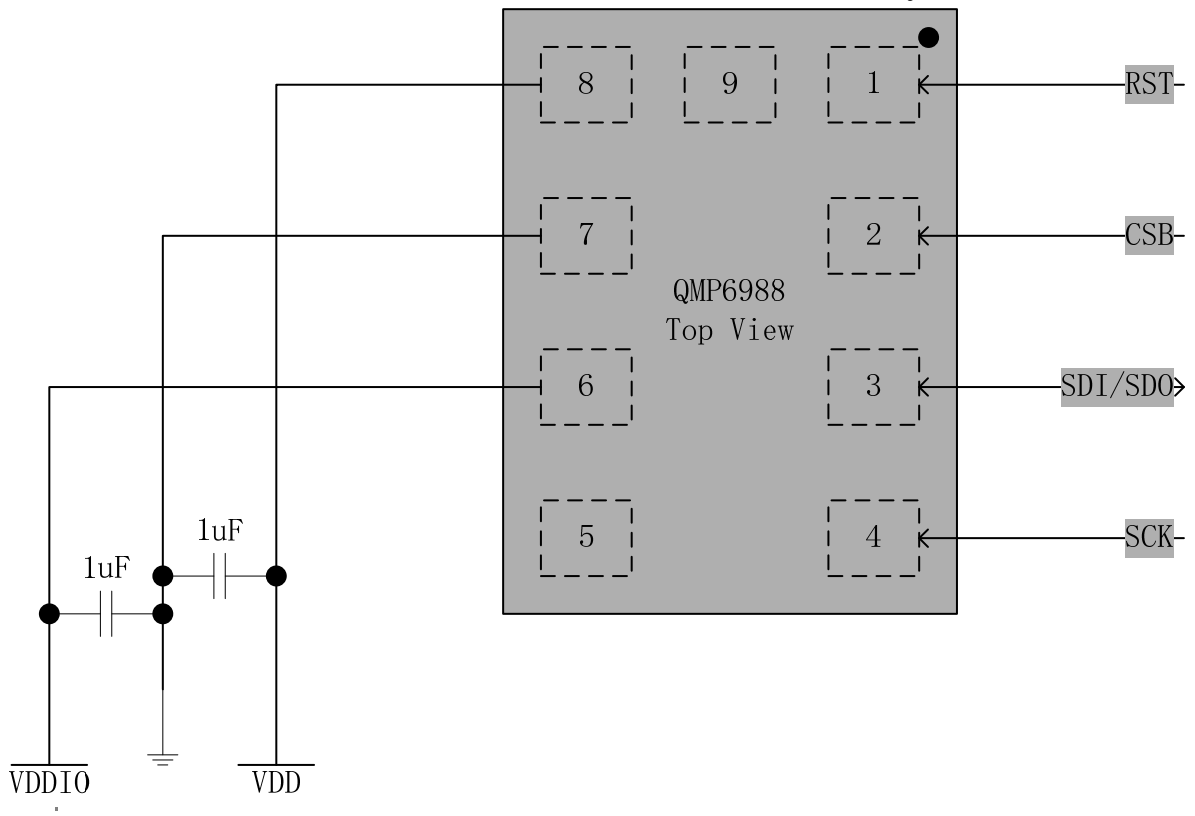


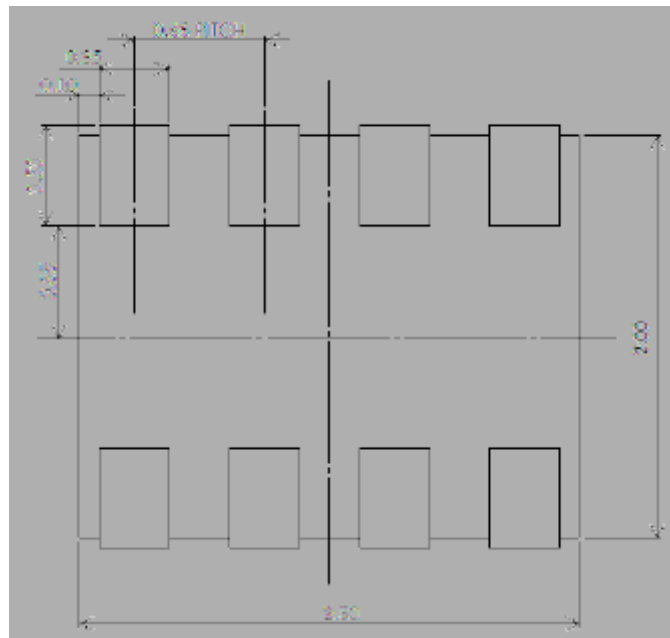


Pin Description

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)	







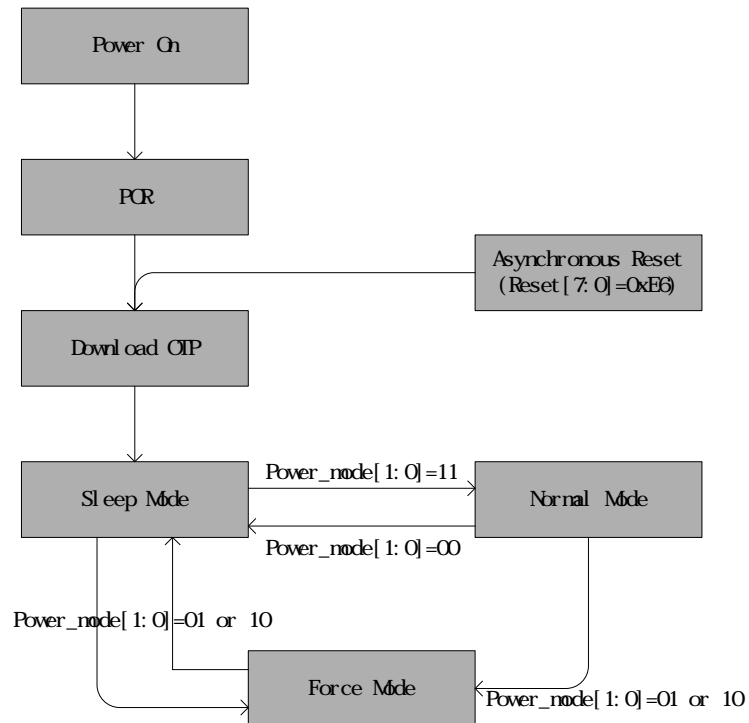
(Top View) : Recommended



Communication Mode	CSB	SDI	SCK	SDO	Remark
I2C	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)



- 1)
- 2)
- 3)

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

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

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

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

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

Register Name	I ² C 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

Register Name	I ² C 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

Register Name	I ² C 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

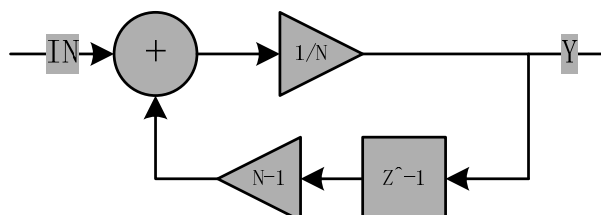
Register Name	I ² C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial

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

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



000	001	010	011	100	101	110	111
0f	N=2	N=4	N=8	N=16	N=32	N=32	N=32

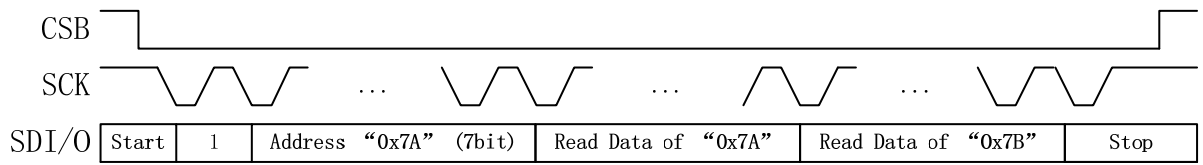
Register Name	I ² C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial
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Bit7~0 reset[7:0] When input “E6h”, the software reset will be effective.
 Except for that, nothing is to happen.

Register Name	I ² C Addr.	SPI Addr.	Length	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	initial
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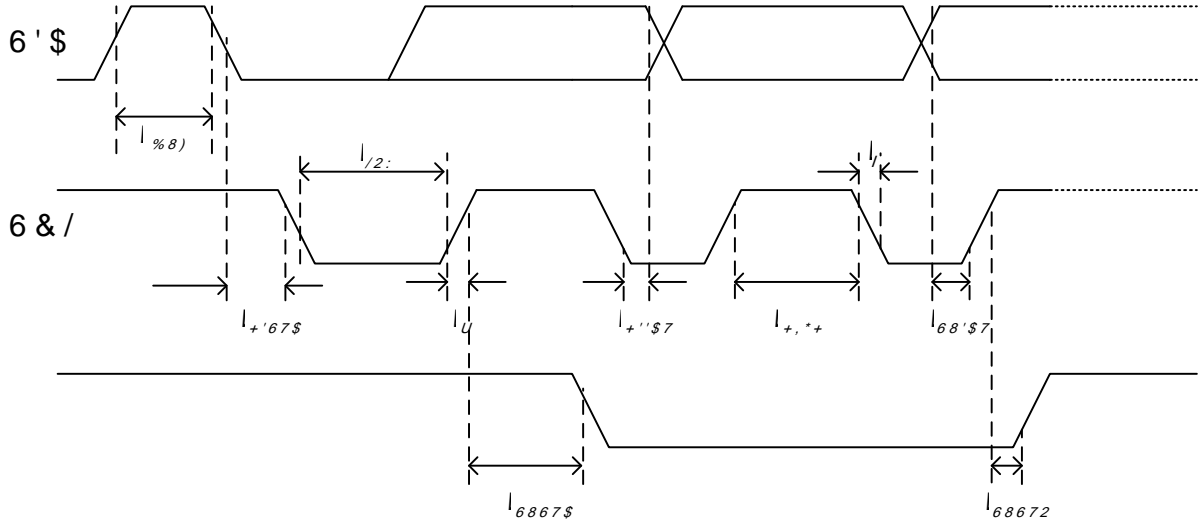
Bit7~0 chip_id[7:0] 5C

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



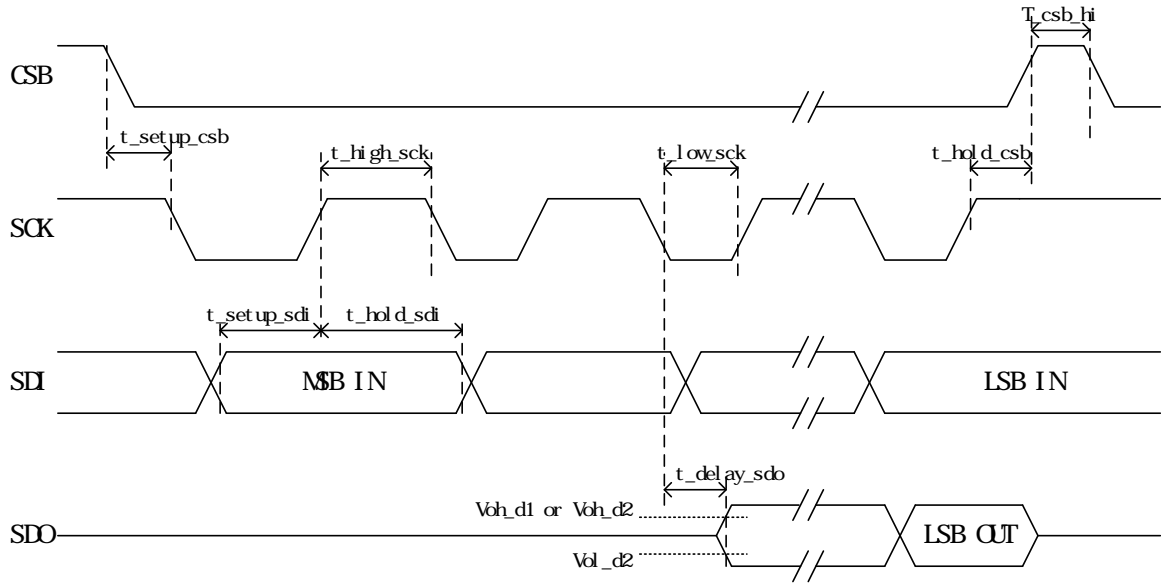
,QWHUIDFH VSHFLILFDWLRQV

,ø & WLPLQJV
 \$OO WLPLQJV DSDW 6WRDQGHESV ORGH DW)DVW ORS/HDWQ:GLJK 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\

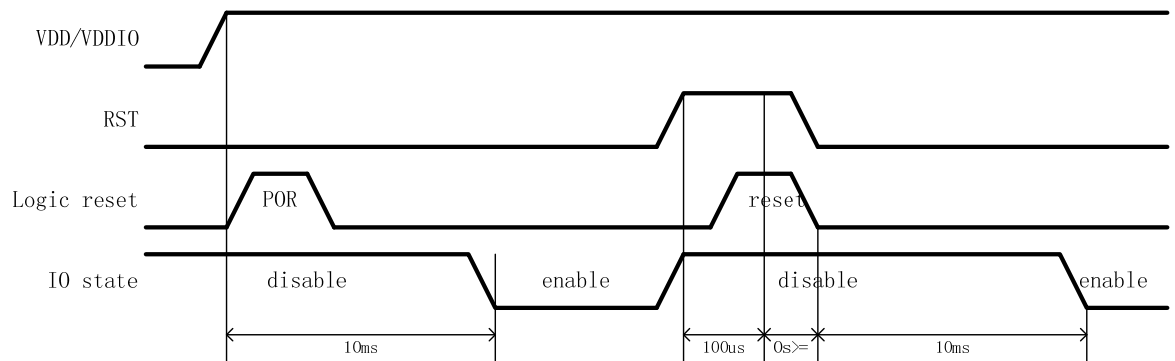


8QGHVFULEHG LWHPV FROPS VLDROZLDKFDWLRQ & VSHFLI

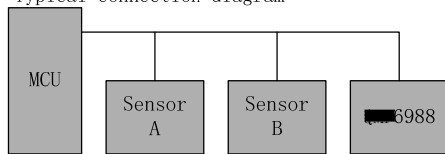
,WHPV	6	PERO &RQGLWLRQ	PLQ	W\S	PDI	8QLWV 5HPDU
6', 6HWXS	WLP	6) ORGH				QV
		+6 ORGH	YLR	9		QV
		+6 ORGH	9LR	9		QV
6', KROG	WLP	6) ORGH &E S)				QV
		6) ORGH &E S)				QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
		+6 ORGH &E	9LR	9		QV
6&. ORZ SXOVH	W/2:	+6 ORGH &E	9LR	9	S)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



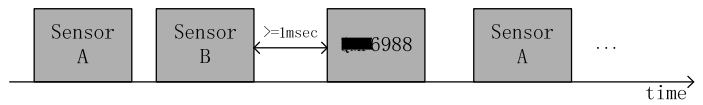
Items	Symbol	Condition	min	typ	max	Units	Remark
SCK frequency	f_spi		-	-	10	MHz	
SCK low pulse	t_low_sck		40	-	-	ns	
SCK high pulse	t_high_sck		40	-	-	ns	
SDI setup time	t_setup_sdi		20	-	-	ns	
SDI hold time	t_hold_sdi		20	-	-	ns	
SDO output delay	t_delay_sdo	Cl=25pF, Vio=1.62V min	-	-	30	ns	
		Cl=25pF,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

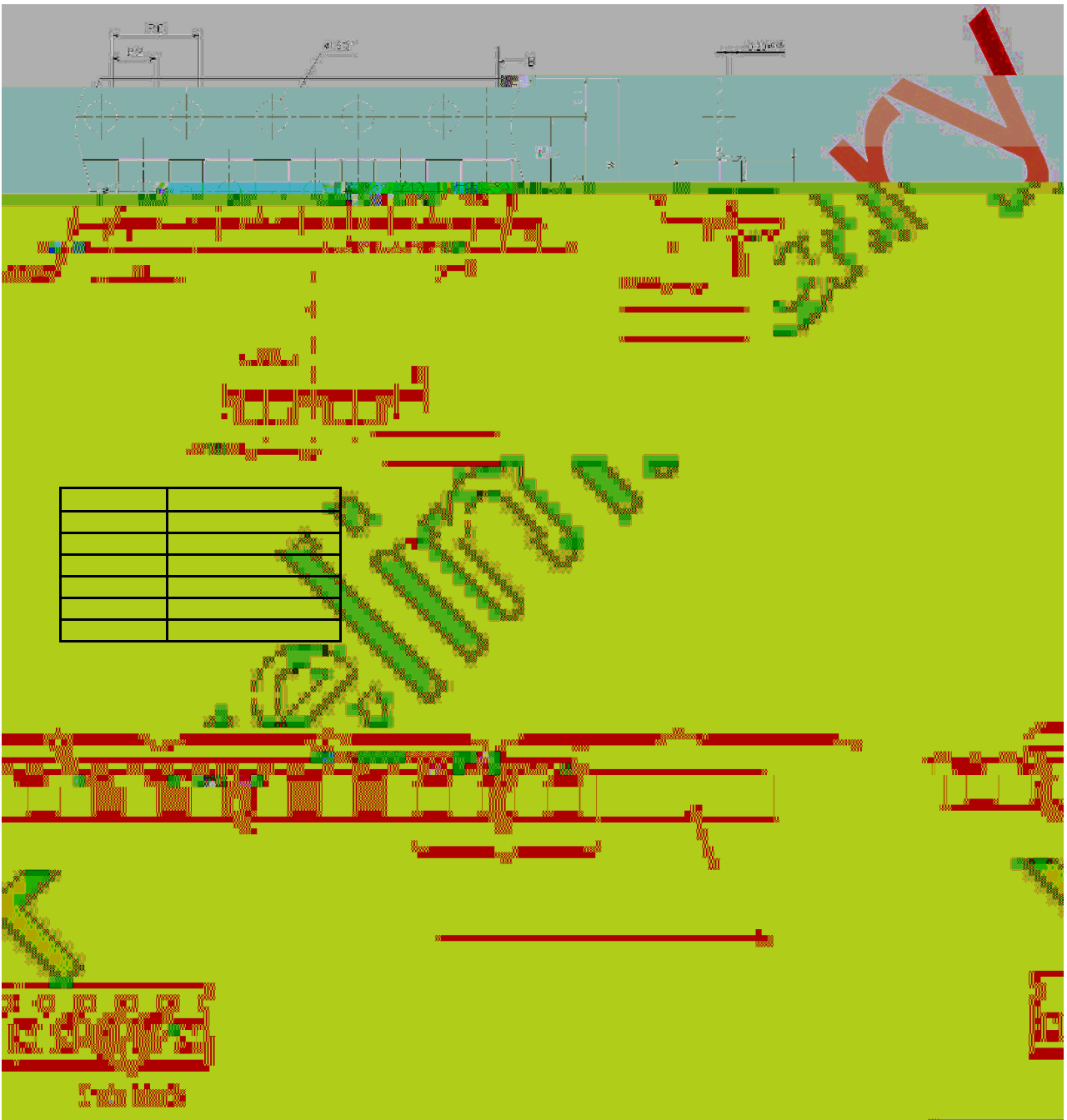


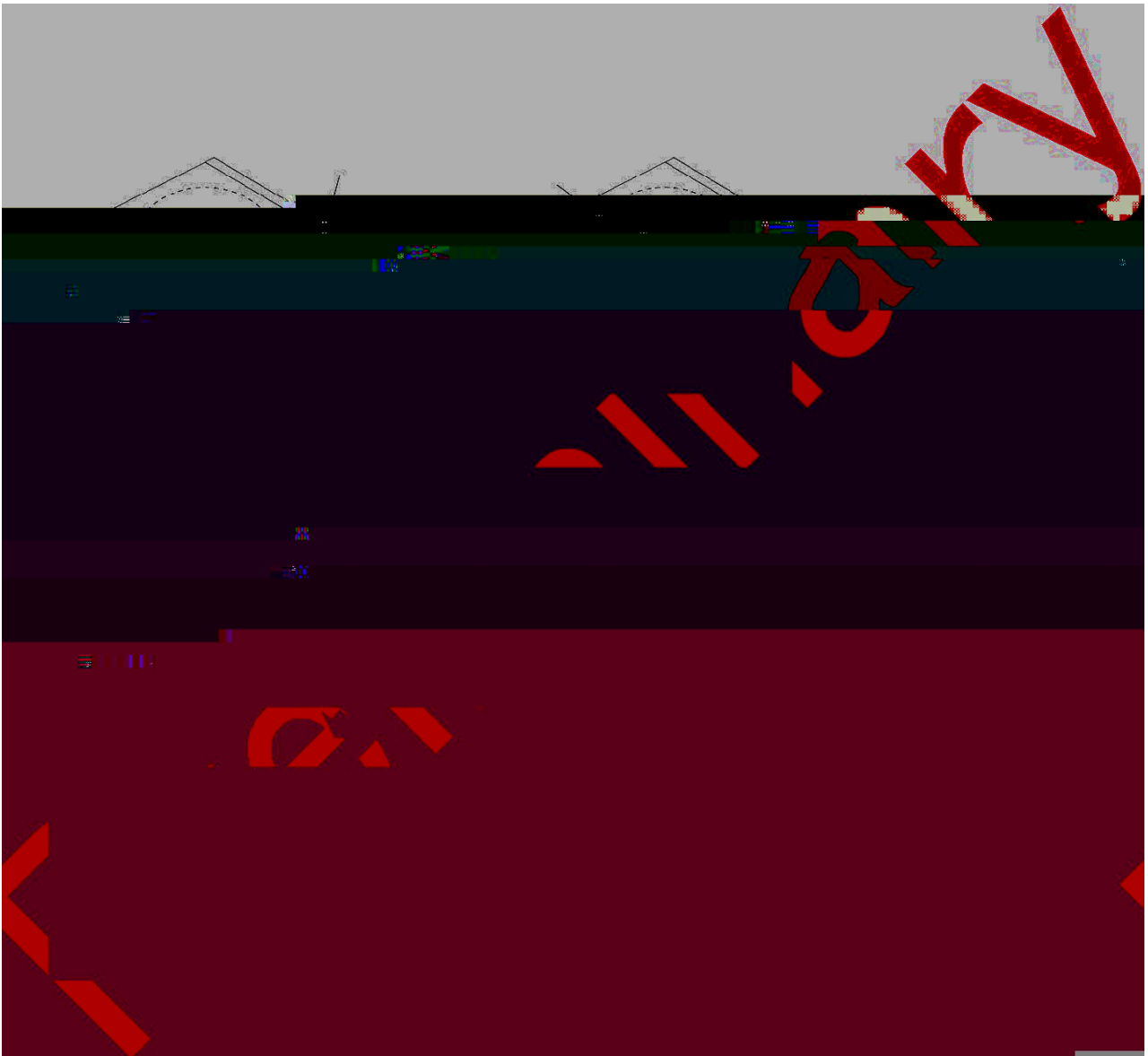
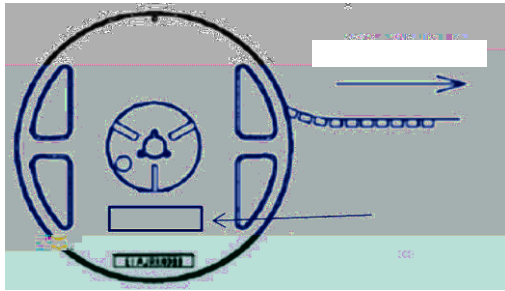
Typical connection diagram

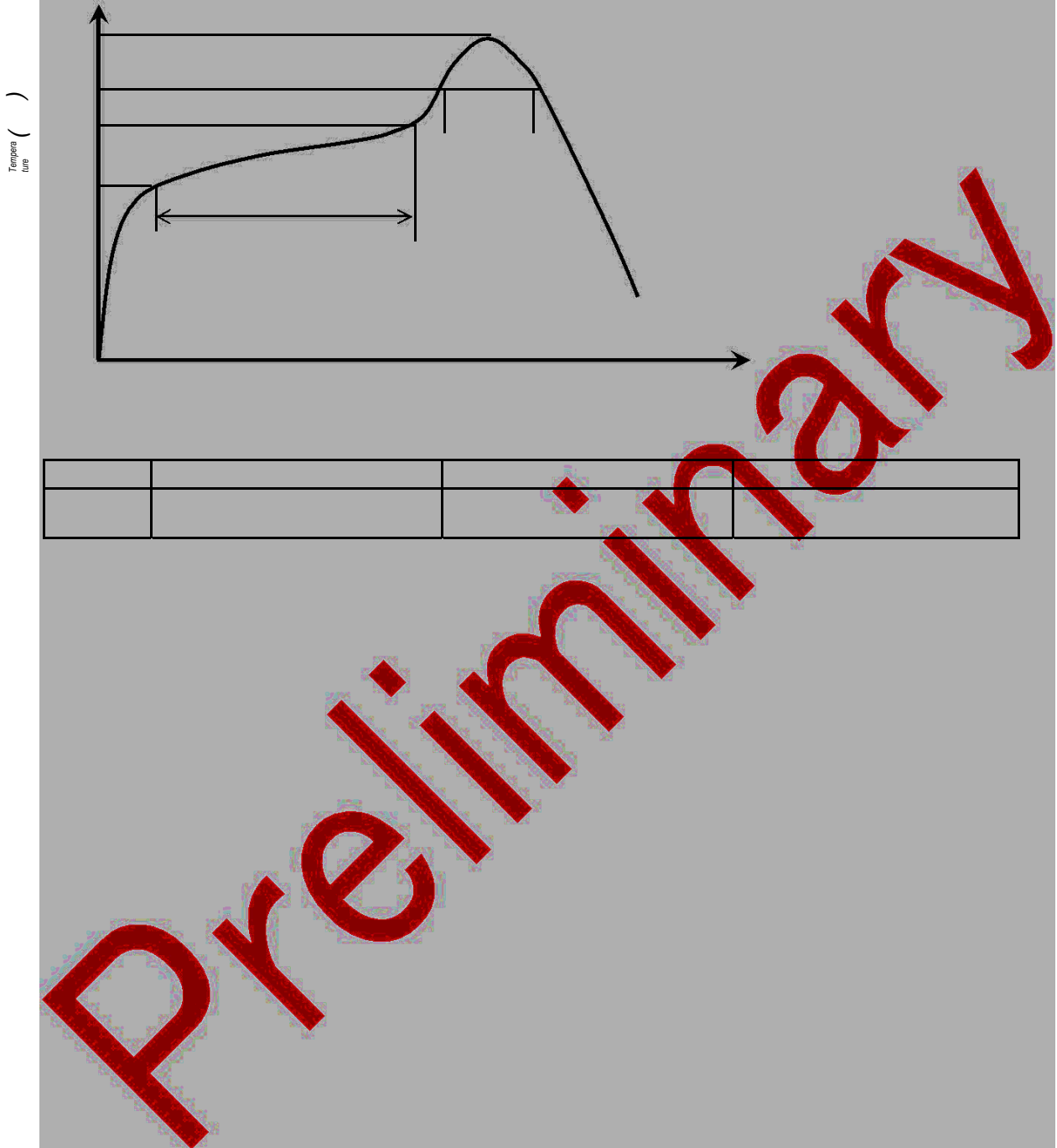


Example of communication









Preliminary

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5)

6)

(2)

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- 9)
- 10)
- 11)
- 12)
- 13)

- 14)
- 15)

16)

(3)

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- 2)
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- 6)

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