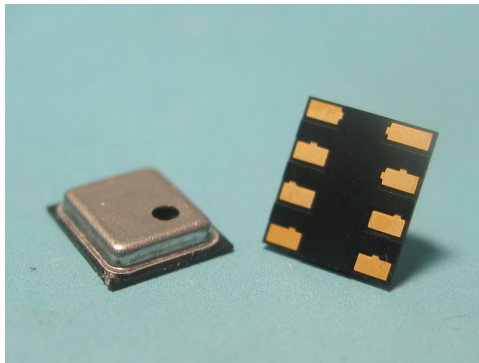


IPPS-015 series Intelligent Pressure Sensor

■ Features

- Supply Voltage 2.0 to 3.6V
- 300 to 1100 hPa pressure range
- Low standby current: <math>< 0.1\mu\text{A}</math>
- Factory calibrated and temperature compensated
- SPI and I2C digital signal output



The IPPS-015 is an intelligent pressure sensor which consists of a MEMS piezoresistive pressure sensor and a signal conditioning ASIC. The sensor is formed in an ultra-thin 8-pin LGA package. The package dimension is 4.5x4x1.1mm. The signal conditioning ASIC is a

■ Applications

- Digital barometer and altimeter
- Weather forecast station
- Mobile phones
- Personal navigation devices (PND)

16-bit AD converter with embedded 512 bits OTP memory. The sensor was calibrated and temperature compensated in factory. The factors for temperature compensation were stored in OTP memory. Users can implement temperature compensation via an external microprocessor. The external microprocessor reads the raw output data from IPPS-015 and does simple calculation according to the factors stored in OTP memory. Therefore, using IPPS-015 series is easy to get rid of bothersome calibrations and temperature compensations. IPPS-015 provides SPI or I2C digital serial output interfaces to communicate with microprocessors. IPPS-015 series is specially designed for low voltage and low power consumption concerned applications.

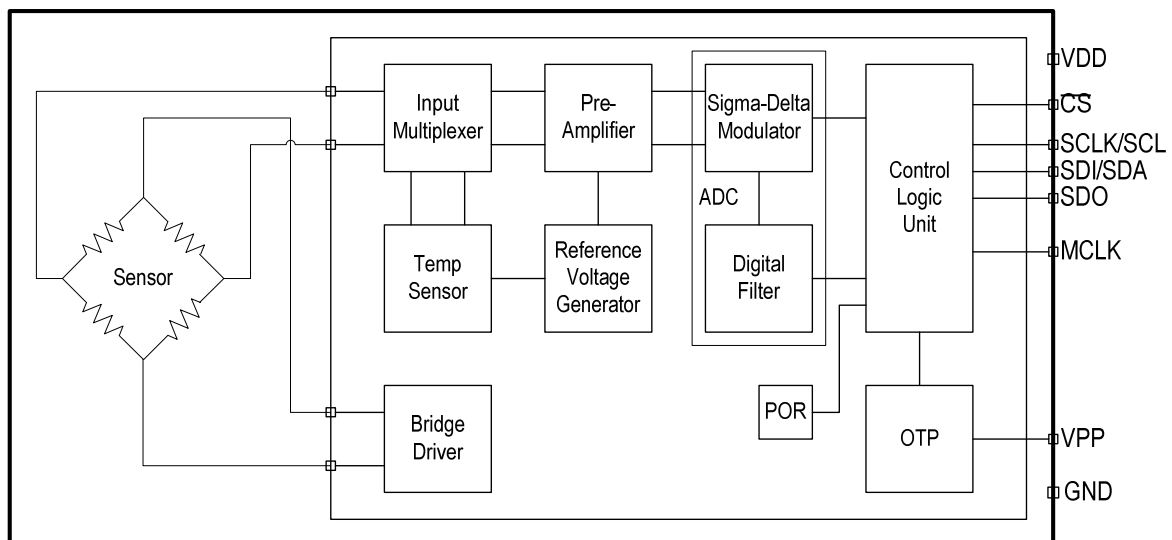


Fig. 1 Functional Block Diagram of IPPS-015

■ Specifications

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
1. Absolute Maximum Ratings							
Supply Voltage	VDD		-0.3		4	V	
Inputs voltage to VSS			-0.3		VDD+0.3	V	
Storage Temperature Range			-40		125	°C	
Maximum Overpressure					2X	Rated pressure	
ESD Rating							
HBM			4000			V	
MM			400				
2. Recommended Operating Conditions							
Pressure Range			300		1100	hPa	mbar
Operating Temperature Range			-40		85	°C	
Humidity			0		95	%RH	
Supply Voltage	VDD		2.0	3	3.6	V	
Supply Current		VDD=3V					
Peak Current During Conversion	I_{sc}			600		μA	
Standby	I_{ss}			0.1	0.5	μA	
Average	I_{avg}	1 conversion/s		21.6	30.5	μA	
Conversion Time	t_{conv}	MCLK=32.768kHz		34.5		ms	
External clock signal	MCLK		30000	32768	35000	Hz	
Duty cycle of MCLK			40	50	60	%	
Serial data clock	SCLK				500	kHz	
3. Electrical Parameters							
Analog to Digital Converter							
Resolution				16		Bits	
Output Code Range			2048		63487		
Integral Nonlinearity			-4		+4	LSB	TBD
Differential Nonlinearity			-1		+1	LSB	TBD
Digital Interface							
Digital Inputs							
Serial data clock					500	kHz	
Input High Voltage	V_{IH}	$I_{IH} < 5\mu A$	80%VDD		VDD		
Input low Voltage	V_{IL}	$I_{IL} < 5\mu A$	0		20%VDD		
Input leakage current					0.1	μA	
Rise time	t_r				200	nS	
Fall time	t_f				200	nS	
Digital Outputs							
Output High Voltage	V_{OH}	SDO, $I_{source}=0.6mA$	80%VDD				
Output low Voltage	V_{OL}	SDO, $I_{sink}=0.6mA$			20%VDD		
Output low Voltage	V_{OL}	SDI, $I_{sink}=1.0mA$			20%VDD		
Rise time	t_r	$C_{load}=50pf$			200	nS	
Fall time	t_f	$C_{load}=50pf$			200	nS	
Pressure Output Characteristics							
Resolution				0.045		hPa	
Absolute Pressure Accuracy		$p = 700 \sim 1100$ hPa $T_a = 0 \sim 65^\circ C$	-2.5		2.5	hPa	2
		$p = 300 \sim 1100$ hPa $T_a = 0 \sim 65^\circ C$	-3		3	hPa	
Relative Pressure Accuracy		$p = 700 \sim 1100$ hPa $T_a = 25^\circ C$	-0.5		0.5	hPa	3
Noise in pressure				0.035		hPa	RMS noise ⁴
Soldering drift		After solder reflow	-2		2	hPa	

Rev. 1.0 2013/3/26

2



Long term stability		12 months	-1		1	hPa	
Recovery time after reflow				7		days	5
Temperature Output Characteristics							
Resolution				0.1		°C	
Accuracy		-40 to 85 °C	-2		2	°C	
Notes :							
1. Unless otherwise specified, measurements were taken with a supply voltage of 3 Vdc at a temperature of 25 ±3°C and humidity ranging from 0 ~95% RH. 2. Maximum error of pressure reading over the pressure range. 3. Maximum error of pressure reading over the pressure range after offset adjustment at one pressure point. 4. The noise data was calculated as standard deviation of 25 data points. 5. Time to recovering >66% impact of solder reflow							

■ Pin Configuration and Function Descriptions

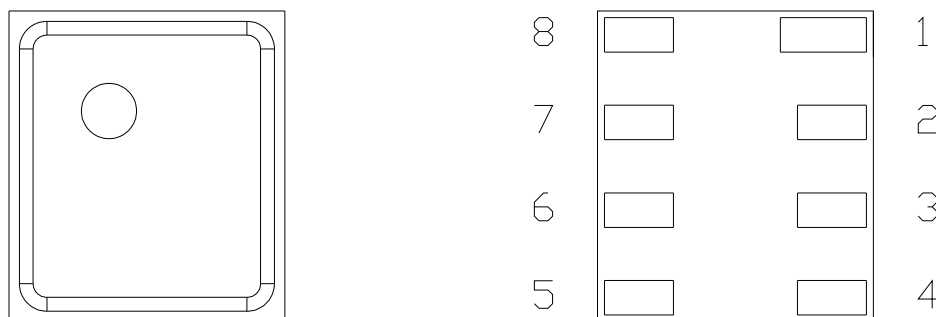
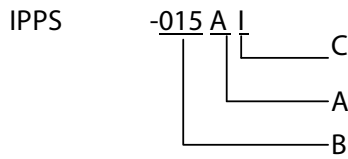


Fig. 2 Pin configuration of IPSS-015

Pin No.	Pin Name	Description
1	SCLK/SCL	External Clock Input. This clock synchronizes serial data I/O.
2	GND	Ground.
3	\overline{CS}	Chip Select Input. Control data conversion timing and enables the serial input/output register.
4	VPP	OTP Programming Voltage.
5	VDD	Power Supply.
6	MCLK	External Clock Input. This clock runs the A/D conversion process.
7	SDI/SDA	SPI Serial Data Input I2C data I/O
8	SDO	SPI Serial Data Output. Data is shifted on the RISING edge of SCLK. This output is high impedance when CS_ is HIGH.
Note! Pin4 was used only for calibration by the manufacturer and should not be connected.		

■ Ordering information



A	Pressure type	B	Pressure range
A	Absolute	015	300-1100hPa
C	Interface		
I	I2C		
S	SPI		

Part No.	Pressure type	Pressure range	Digital interface	Note
IPPS-015AI	Absolute	300-1100hPa	I2C	
IPPS-015AS	Absolute	300-1100hPa	SPI	

■ Application Information

General

The IPPS-015 is SIP device consisted of a MEMS pressure sensor and a signal conditioning ASIC. A 16-bits ADC is used to convert analog pressure and temperature signal to a 16-bits digital data. Due to the strong temperature coefficient of sensor output voltage, it is necessary to be compensated for practical applications. By a dedicated program running at an external microcontroller, this compensation will be performed.

Factory calibration

Each sensor was individually calibrated in the factory. There are several coefficients stored in OTP memory for compensation. Resulted from process variation and temperature variation of sensor, the coefficients are read by microcontroller and calculated by software to correct temperature drift of sensor.

Pressure and Temperature Measurement

The sequence of reading pressure and temperature as well as software compensation is shown as fig. 3.

First the coefficients C1 to C10 have to be read from OTP memory via serial interface. This can be done once reset the IPPS-015. The data format of coefficient is unsigned 16-bit. In order to measure pressure, the microcontroller have to read the 16 bit data for pressure (D1) and temperature (D2). Then, the microcontroller calculate the compensated pressure by D1, D2, and coefficients C1 to C10. The general flow for temperature compensation calculation was listed as fig. 3.

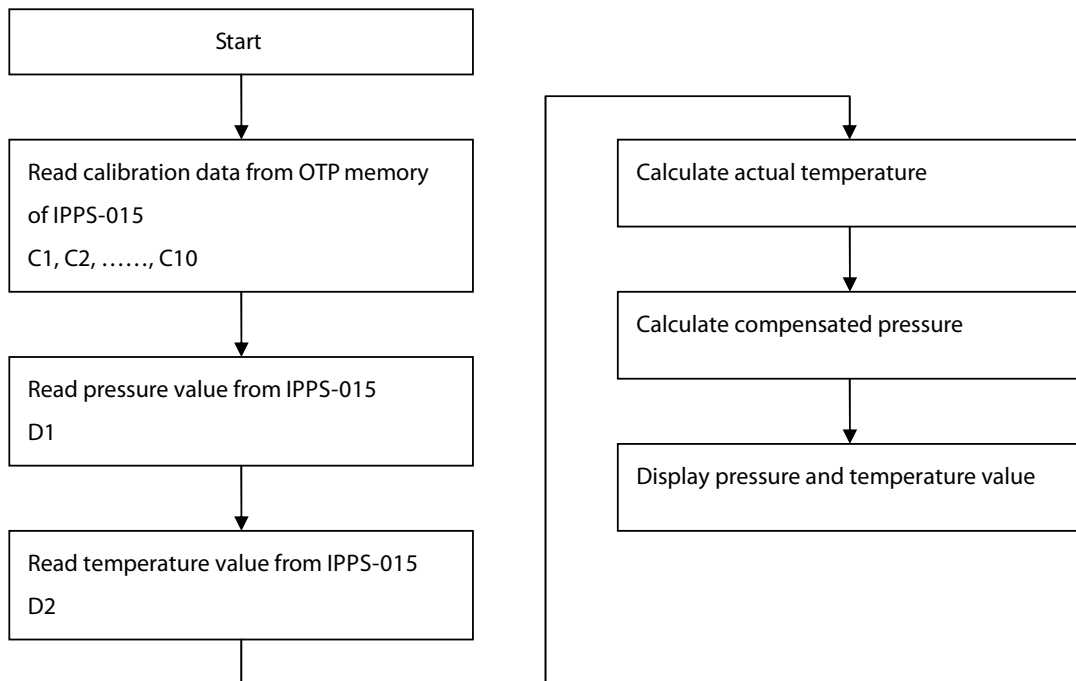


Fig. 3

Decoupling Capacitor

The decoupling capacitors, 0.1µF ceramic plus 1µF tantalum capacitor, have to be placed as close as possible to the IPSS-015 VDD and GND pin. This capacitor will stabilize the power supply during data conversion and thus, provide the highest possible accuracy.

Application Circuit example

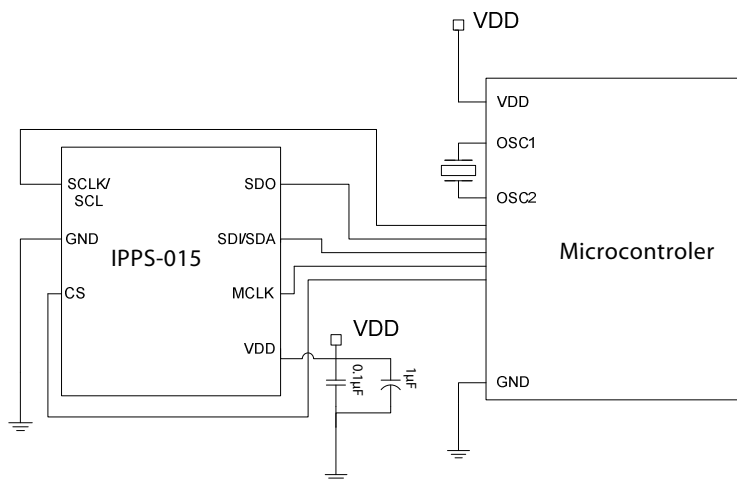


Fig. 4 Typical application circuit of IPSS-015 in SPI mode

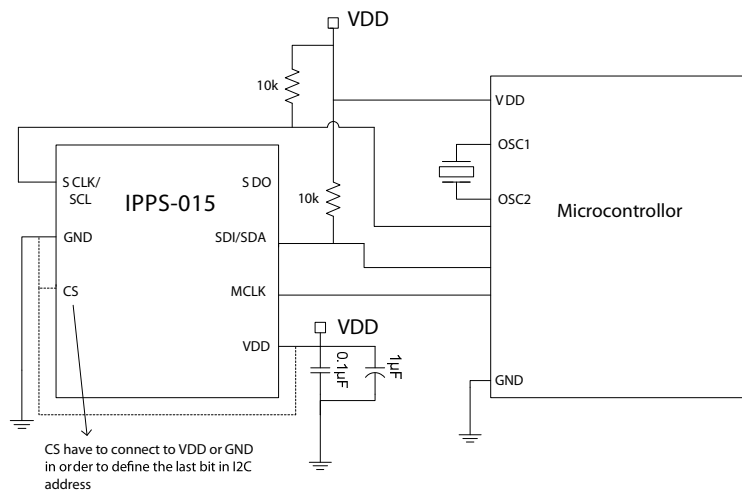


Fig. 5 Typical application circuit of IPPS-015 in I2C mode

■ Serial Interface

The IPPS-015 can provide two types of serial interfaces as SPI or I2C. The type of serial interface is defined as the device manufactured. The user can't choose the type of serial interface by hardware wiring. So the user has to decide the type of serial interface as ordering the device.

■ SPI Interface

The IPPS-015 has a SPI (Serial Peripheral Interface) bus to communicate with the microprocessor and other digital systems. The functional block diagram of MIS-7300 was shown as fig.1. The SPI bus consists of four wires as SCLK, SDI, SDO, CS.

Serial Clock Input

The SCLK is the serial clock input for the device, and all data transfers (either on SDI or SDO) occur with respect to the SCLK signal. Each bit is shifted out of the SDO pin on the falling edge of SCLK and data is shifted into the SDI pin on the rising edge of SCLK. The SCLK-signal is generated by the microprocessor's system.

Chip Select Input

The CS (Chip Select Input) is an active low logic input used to select the IPPS-015. The CS can be used to select the IPPS-015 in systems with more than one device on the serial bus or as a frame synchronization signal in communicating with the device. CS can be hardwired low, allowing the IPPS-015 to operate in 3-wire mode with SCLK, SDI, and SDO used to interface with the device.

Serial Data Output (SDO)

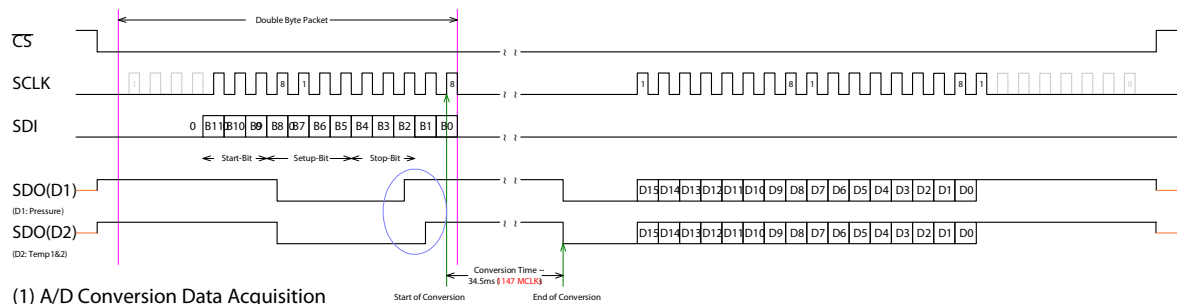
The SDO pin provides the result of the last conversion as a serial bit stream during the data output state. In addition, the SDO pin is used as an end of conversion indicator during the conversion. When CS is HIGH, the SDO driver is switched to a high impedance state in order to share the data output line with other devices. If CS is brought LOW during the conversion phase, the SDO pin will be driven HIGH. Once the conversion is complete, if CS is brought

LOW, SDO pin will be driven LOW indicating the conversion is complete and the result is ready to be shifted out of the device. The digital data sent by IPPS-015 SDO pin is either the conversion results or the calibration data stored in OTP. The selection of the output data is done by sending the corresponding instruction on the SDI pin.

Serial Data Input (SDI)

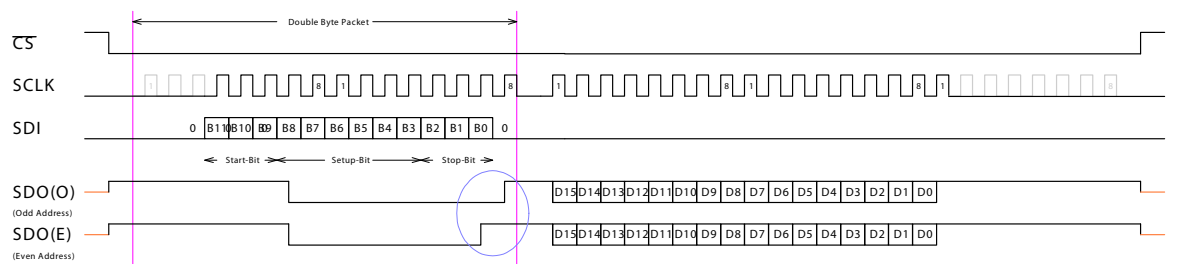
The SDI pin is used to select the input channel (Pressure or Temperature) and to access the OTP memory. Data is shifted into the device during the data output/input state on the rising edge of SCLK while CS is low.

Timing Waveform Diagrams



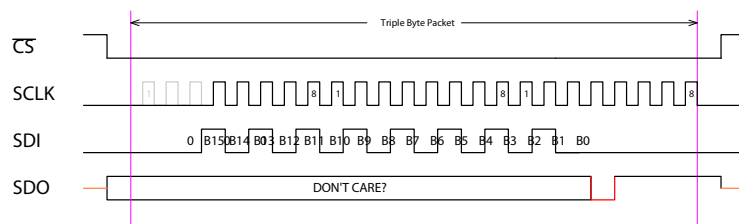
(1) A/D Conversion Data Acquisition

Fig.6



(2) OTP Data Acquisition

Fig.7



(3) RESET Sequence

Fig. 8

■ **I2C Interface**

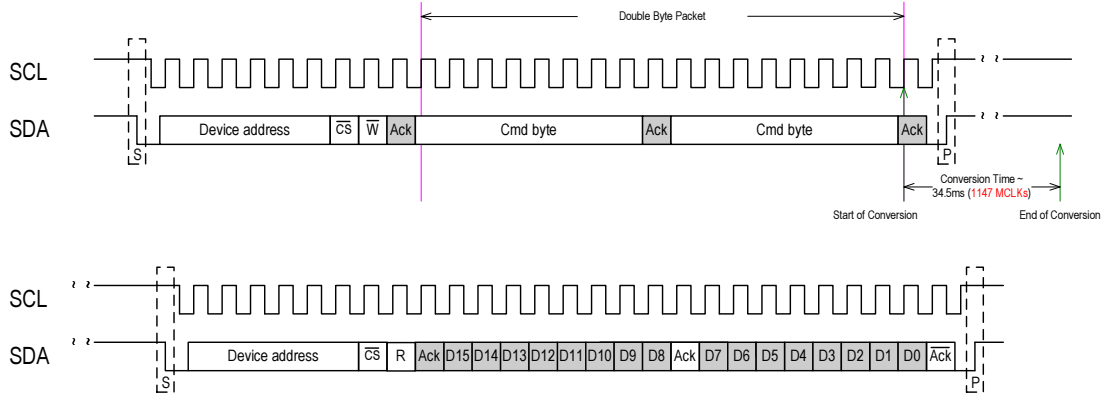
Typical I2C communication starts with the start condition and is ended with the stop condition. The device address consisted of six pre-defined bits plus a pin defined bit. The device address is 111011C. The value of C is determined by the CS pin connected with VDD or GND.

\overline{CS} connected to	Device address
------------------------------	----------------



VDD	1110111
GND	1110110

A/D conversion data acquisition

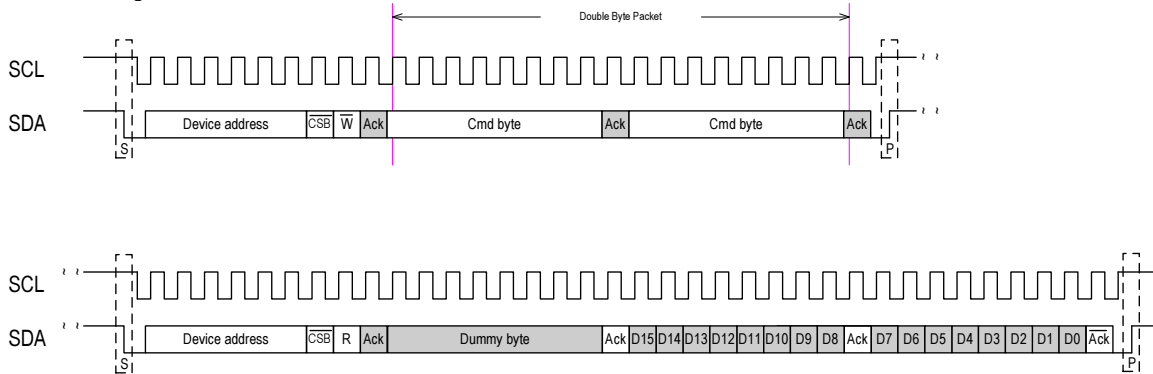


From master to slave S: Start condition \bar{W} : Write=0 ACK: Acknowledge
 From slave to master P: Stop condition R: Read=1 \bar{ACK} : Not acknowledge
 \bar{CS} : 1=CS connects to Vdd
 0=CS connects to Gnd

(1) A/D Conversion Data Acquisition

Fig. 9

OTP data acquisition



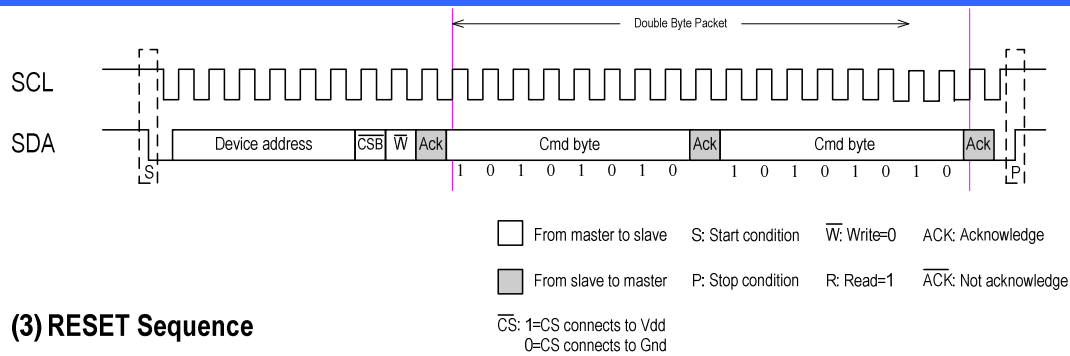
From master to slave S: Start condition \bar{W} : Write=0 ACK: Acknowledge
 From slave to master P: Stop condition R: Read=1 \bar{ACK} : Not acknowledge
 \bar{CS} : 1=CS connects to Vdd
 0=CS connects to Gnd

(2) OTP Data Acquisition

Fig. 10

Reset sequence





(3) RESET Sequence

Fig. 11

■ Pressure and temperature reading instructions

Here we will give several examples to introduce reading pressure, temperature and calibration coefficients. All the commands for pressure, temperature and coefficients reading is listed as following table.

Action	Instruction	
	SPI mode	I2C mode
Conversion start for pressure measurement (D1)	0Fh & 51h	0Fh & 51h
Conversion start for temperature measurement(D2)	0Fh & 21h	0Fh & 21h
Reset	0Ah & AAh & A0h	AAh & AAh
Reading coefficient C1	1Ch & 40h	0Eh & 20h
Reading coefficient C2	1Ch & 50h	0Eh & 28h
Reading coefficient C3	1Ch & 60h	0Eh & 30h
Reading coefficient C4	1Ch & 70h	0Eh & 38h
Reading coefficient C5	1Ch & 80h	0Eh & 40h
Reading coefficient C6	1Ch & 90h	0Eh & 48h
Reading coefficient C7	1Ch & A0h	0Eh & 50h
Reading coefficient C8	1Ch & B0h	0Eh & 58h
Reading coefficient C9	1Ch & C0h	0Eh & 60h
Reading coefficient C10	1Ch & D0h	0Eh & 68h

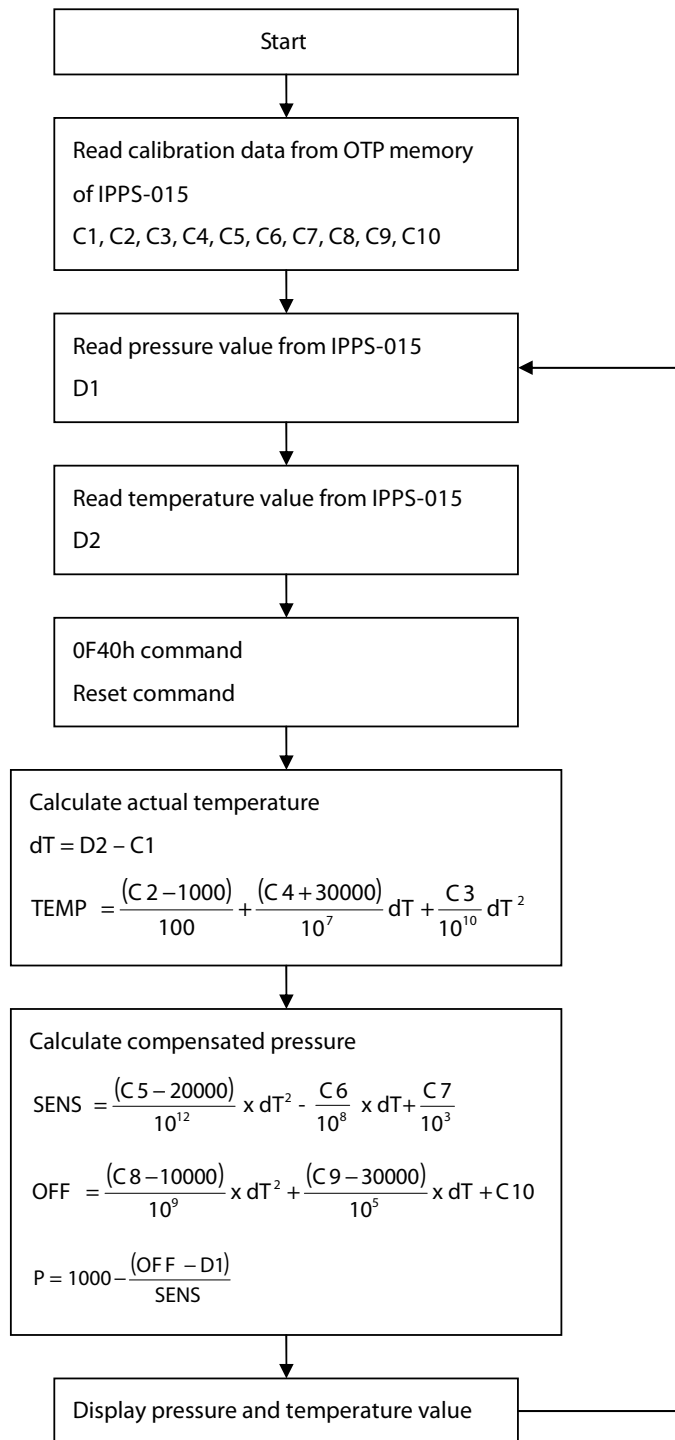
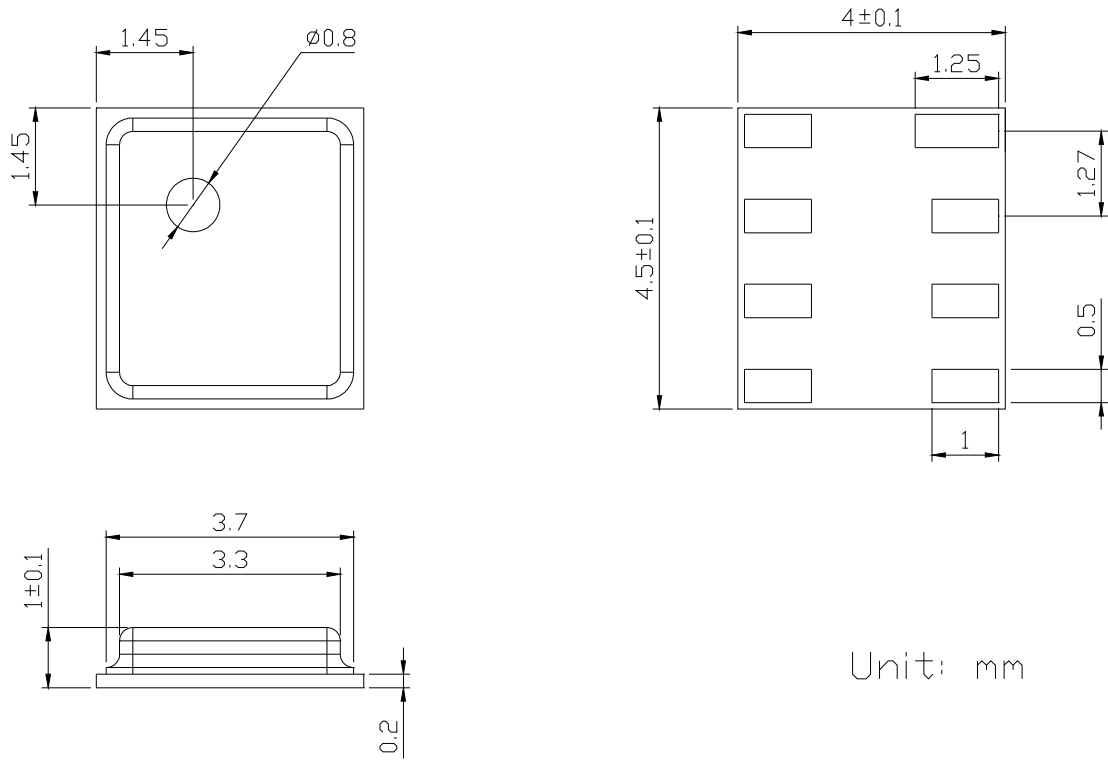


Fig. 12

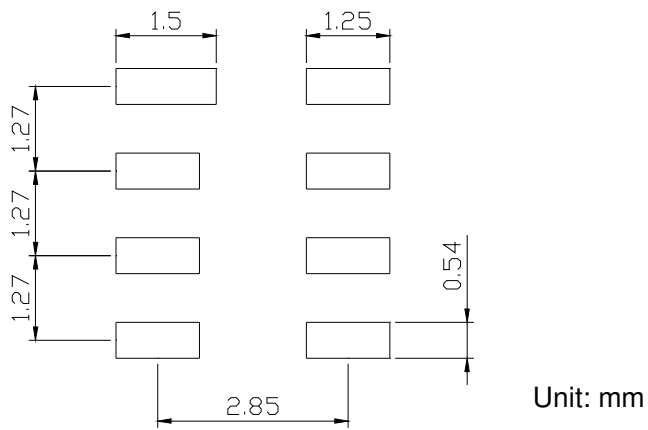
■ **Package Outlines**



Unit: mm

Fig. 13

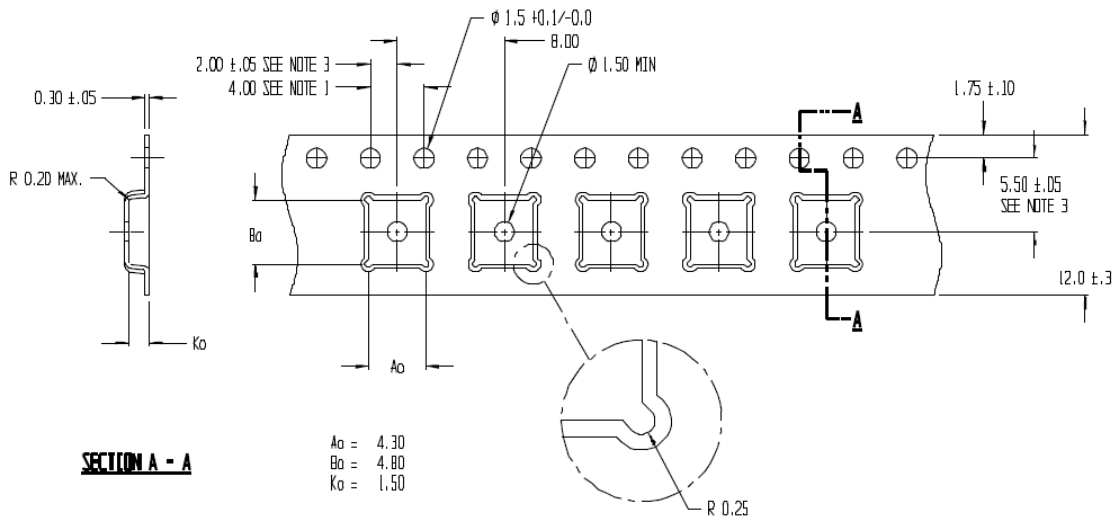
■ **Recommended footprint**



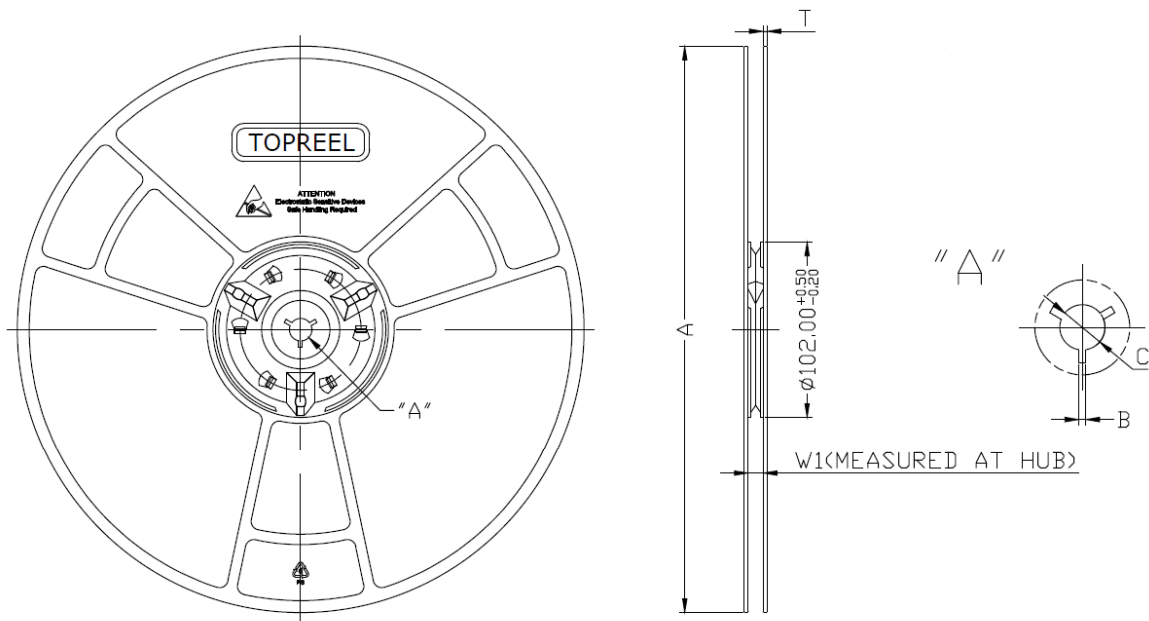
Unit: mm

Fig. 14

■ **Tape specification**



■ **Reel specification**



XX is for RB/SW/BK/BL/RC

Part Number	Nominal Hub Width	+0.5mm		+0.5mm		+0.5mm	
		A -0.2mm	T -0.2mm	C -0.2mm	B -0.2mm	W1 +0.6mm	-0.4mm
XX13412-A	12.0mm						12.8mm
		330.0mm	2.30mm	13.1mm	2.0mm		



We are here for you. Addresses and Contacts

Sales Switzerland & Liechtenstein

Matthias Rüegg
Ruhbergstrasse 32
CH-9230 Flawil

Phone +41 44 877 35 18
Mobile+41 76 491 66 66
Fax +41 44 877 35 19

matthias.rueegg@pewatron.com

Sales International Key Accounts

Peter Felder
Thurgauerstrasse 66
CH-8052 Zürich

Phone +41 44 877 35 05
Mobile+41 79 406 49 83
Fax +41 44 877 35 25

peter.felder@pewatron.com

Sales Germany

Postcode 60000–79999

Dieter Hirthe
Mühlweg 23
D-71554 Weissach i.T.

Phone +49 719 149 60 58
Mobile+49 163 762 74 30
Fax +49 719 193 31 88

dieter.hirthe@pewatron.com

Postcode 10000–59999
Postcode 80000–99999

Kurt Stritzelberger
Neumarkter Str. 86a
D-81673 Munich

Phone +49 89 260 38 47
Mobile+49 171 803 41 35
Fax +49 89 43 10 91 91

kurt.stritzelberger@pewatron.com

Key Accounts
Aerospace and Defence

Claus Wübbena
Vogelkamp 26
D-26655 Westerstede

Phone +49 4488 5204 614
Mobile+49 173 9700 691
Fax +49 4488 5204 616

claus.wuebbena@pewatron.com

Sales Austria

Kurt Stritzelberger
Neumarkter Str. 86a
D-81673 Munich

Phone +49 89 260 38 47
Mobile+49 17 18 03 41 35
Fax +49 89 43 10 91 91

kurt.stritzelberger@pewatron.com

Sales Other Countries / Product Management

Sensors

Physical Sensors
Data Acquisition

Thomas Clausen
Phone +41 44 877 35 13
thomas.clausen@pewatron.com

Geometrical Sensors

Eric Letsch
Phone +41 44 877 35 14
eric.letsch@pewatron.com

Power Supplies

DC-DC Converters
Switching Power Supplies
DC-AC Inverters

Sebastiano Leggio
Phone +41 44 877 35 06
sebastiano.leggio@pewatron.com

E-Components

Current Sensors
Man Machine Interface
Measurement Probes

Sebastiano Leggio
Phone +41 44 877 35 06
sebastiano.leggio@pewatron.com

PEWATRON AG
Thurgauerstrasse 66
CH-8052 Zurich

Phone +41 44 877 35 00
Fax +41 44 877 35 25

www.pewatron.com
info@pewatron.com