

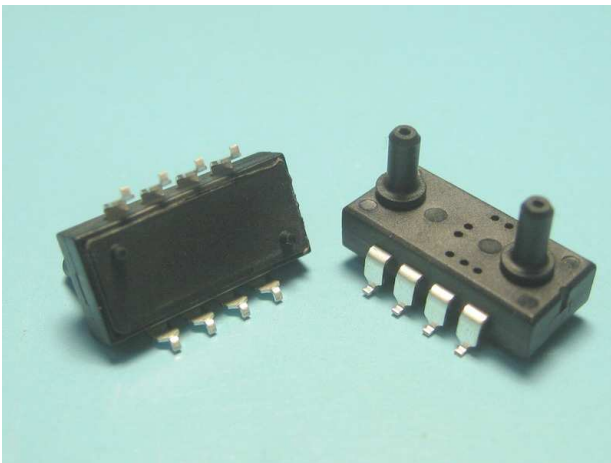
MIS-3600 series (Preliminary) Intelligent Pressure Sensor

■ Features

- Supply Voltage 2.0 to 3.6V
- 1, 5.8, 15 psi gauge pressure range
- Low standby current: <math><0.1\mu\text{A}</math>
- Factory calibrated and temperature compensated
- SPI and I2C digital signal output

■ Applications

- Airflow meter
- Ventilation and air flow monitors
- Sleep apnea monitoring and therapy equipment
- Pneumatic controls
- HVAC



The MIS-3600 is an intelligent pressure sensor which consists of a MEMS piezoresistive pressure sensor and a signal conditioning ASIC. The signal conditioning ASIC is a 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 micro processor. The external microprocessor reads the raw output data from MIS-3600 and does simple calculation according to the factors stored in OTP memory. Therefore using MIS-3600 series is easy to get rid of bothersome calibrations and temperature compensations. MIS-3600 provides SPI or I2C digital serial output interface to communicate with microprocessors. MIS-3600 series is specially designed for low voltage and low power consumption concerned applications.

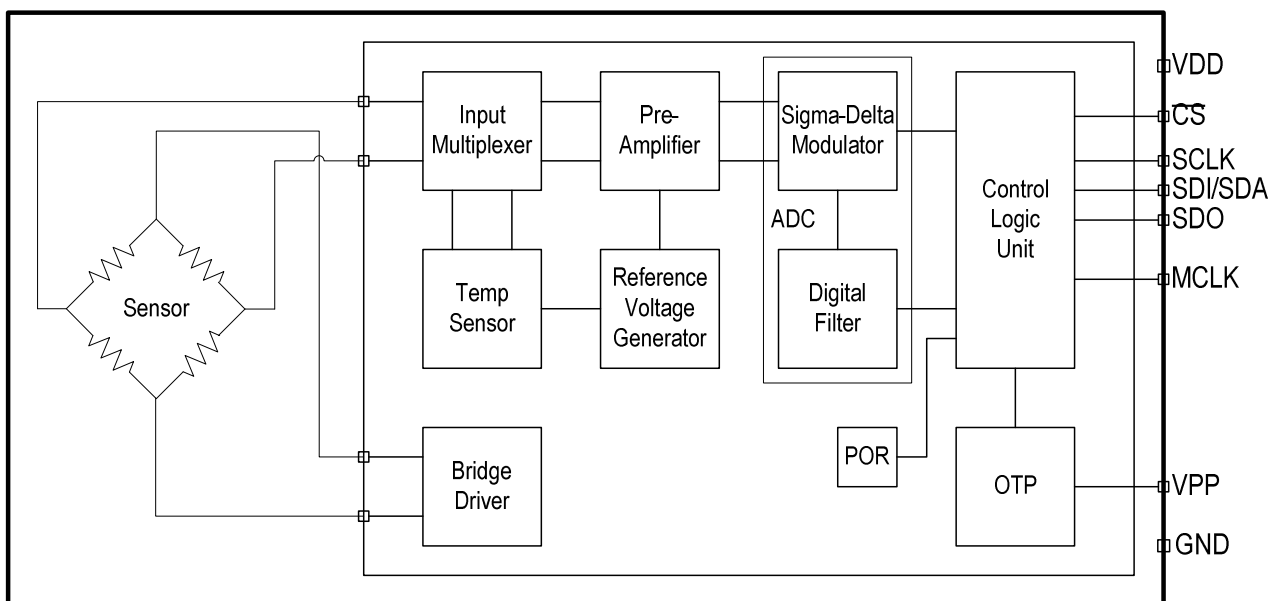


Fig. 1 Functional Block Diagram of MIS-3600

■ 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				1, 5.8, 15		psi	
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
SPI Interface							
Digital Inputs							
Input High Voltage	V _{IH}	I _{IH} < 5µA	70%VDD		VDD+0.3V		
Input low Voltage	V _{IL}	I _{IL} < 5µA	-0.3V		70%VDD		
Rise time	t _r				200	nS	
Fall time	t _f				200	nS	
Digital Outputs							
Output High Voltage	V _{OH}	I _{OH} = -1mA	80%VDD				
Output low Voltage	V _{OL}	I _{OL} = 1mA			20%VDD		
Rise time	t _r	C _{load} = 50pf			200	nS	
Fall time	t _f	C _{load} = 50pf			200	nS	
Pressure Output Characteristics							
Resolution							
1psi			11	11.6	12	bits	
5.8psi			12.7	12.9	13.1		
15psi			12.8	13.4	13.7		
Pressure Accuracy		T= 0~40°C		±1		%FS	2
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 compensated temperature range and pressure range. That include all errors resulted from offset, span, linearity, temp. drift of offset and temp. drift of span.							

Metrodyne Microsystem Corp. reserves the right to make changes to the product specification in this publication.

■ Pin Configuration and Function Descriptions

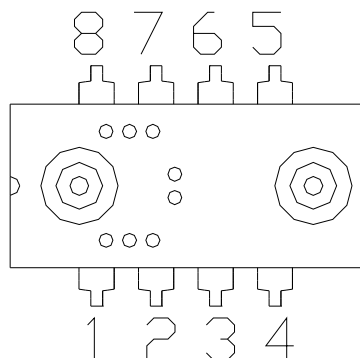
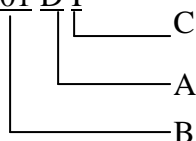


Fig. 2 Pin configuration of MIS-3600

Pin No.	Pin Name	Description
1	SDO	Serial Data Output. Data is shifted on the RISING edge of DCLK. This output is high impedance when CS_ is HIGH.
2	SDI	Serial Data Input. If CS_ is LOW, data is latched on RISING edge of DCLK.
3	MCLK	External Clock Input. This clock runs the A/D conversion process.
4	VDD	Power Supply.
5	VPP	OTP Programming Voltage.
6	CS	Chip Select Input. Control data conversion timing and enables the serial input/output register.
7	GND	Ground.
8	SCLK	External Clock Input. This clock synchronizes serial data I/O.
Note! Pin5 was used only for calibration by the manufacturer and should not be connected.		

■ Ordering information

MIS-3 6 0 0-001 D I



A	Pressure type	B	Pressure range
D	Differential	001	1 PSI
		006	5.8 PSI
		015	15 PSI
C	Interface		
I	I2C		
S	SPI		

Part No.	Pressure type	Pressure range	Digital interface	Note
MIS-3600-001DI	Differential	1 PSI	I2C	
MIS-3600-001DS	Differential	1 PSI	SPI	
MIS-3600-006DI	Differential	5.8 PSI	I2C	
MIS-3600-006DS	Differential	5.8 PSI	SPI	
MIS-3600-015DI	Differential	15 PSI	I2C	

MIS-3600-015DS	Differential	15 PSI	SPI	
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■ Application Information

General

The MIS-3600 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 10 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 MIS-3600. 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 algorithm for temperature compensation calculation was listed as fig. 3.

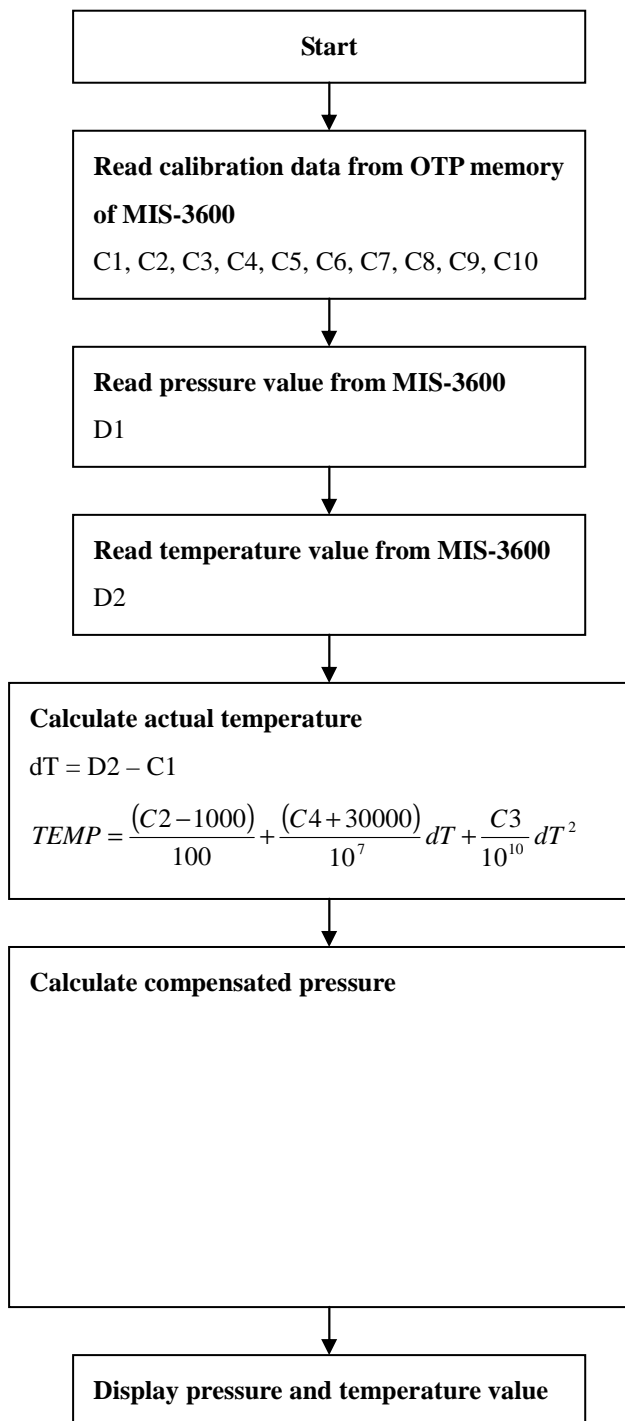


Fig. 3

Decoupling Capacitor

A decoupling capacitor, 1μF tantalum capacitor, have to be placed as close as possible to the MIS-3600 VDD and

GND pin. This capacitor will stabilize the power supply during data conversion and thus, provide the highest possible accuracy.

Application Circuit example

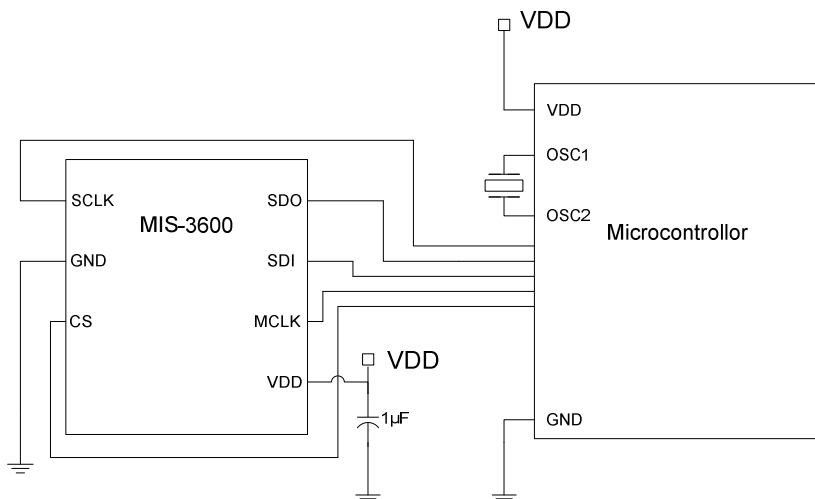


Fig. 4 Typical application circuit of MIS-3600 in SPI mode

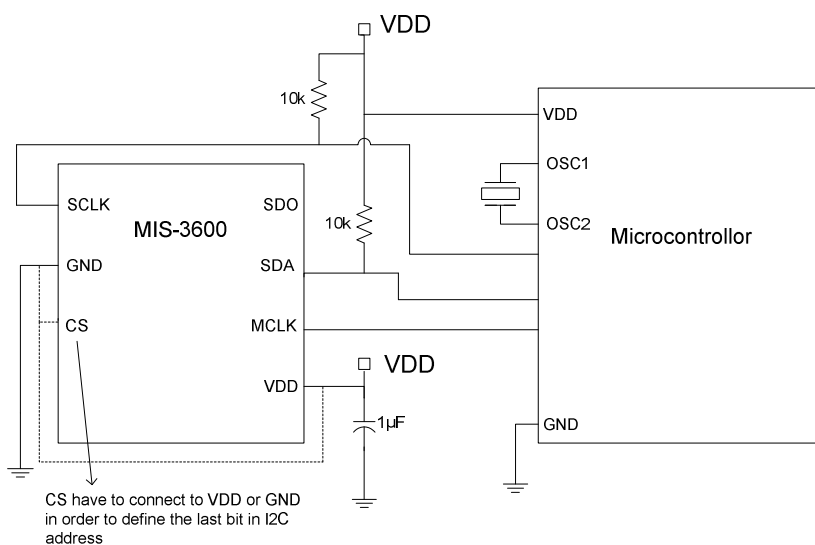


Fig. 5 Typical application circuit of MIS-3600 in I2C mode

■ Serial Interface

The MIS-3600 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 have to decide the type of serial interface as ordering the device.

■ SPI Interface

The MIS-3600 have a SPI (Serial Peripheral Interface) bus to communicate with the microprocessor and other digital systems. The functional block diagram of MIS-3600 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 MIS-3600. The CS can be used to select the MIS-3600 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 MIS-3600 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 MIS-3600 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

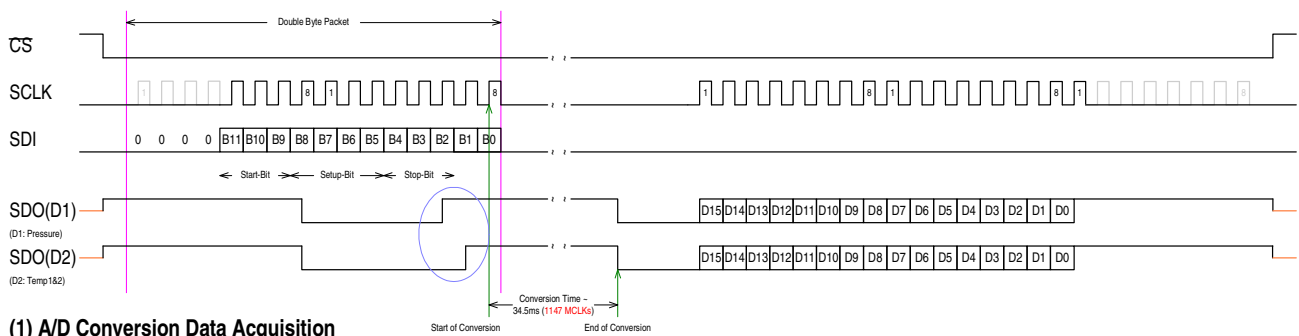
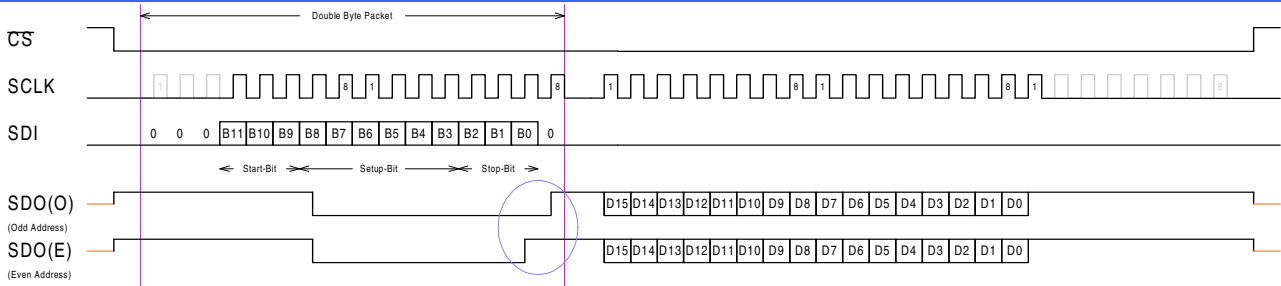
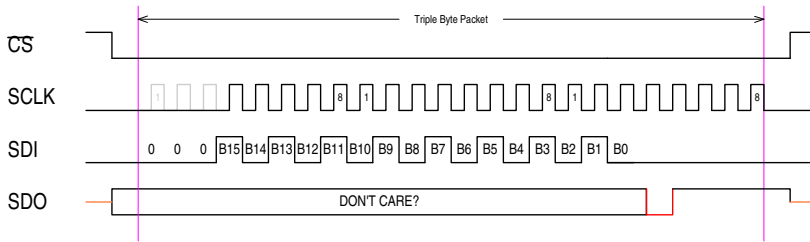


Fig.6



(2) OTP Data Acquisition

Fig. 7



(3) RESET Sequence

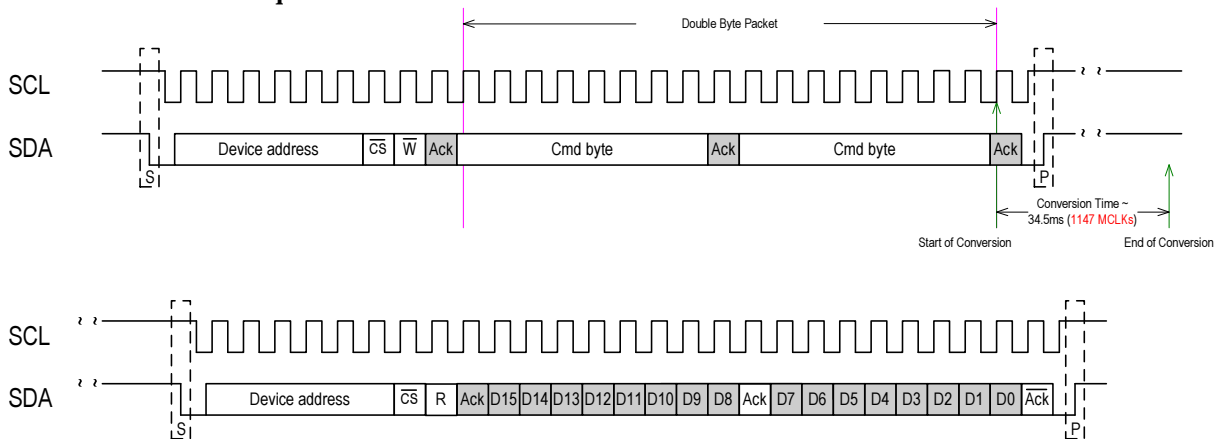
Fig. 8

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 \overline{CS} pin connected with VDD or GND.

\overline{CS} connected to	Device address
VDD	1110111
GND	1110110

A/D conversion data acquisition



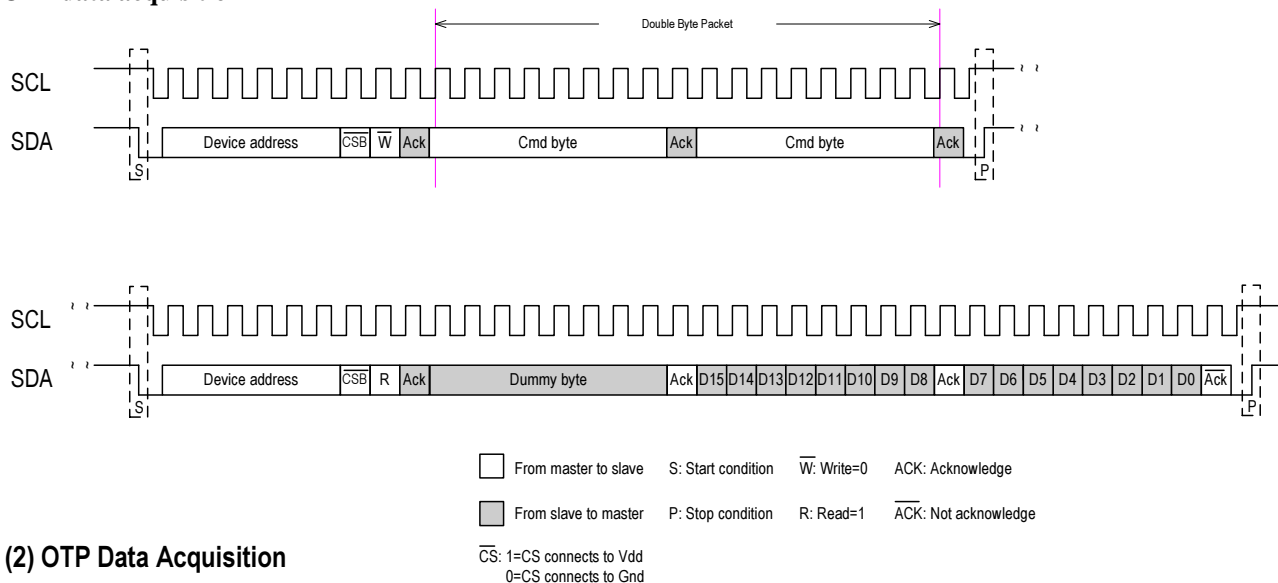
From master to slave S: Start condition \overline{W} : Write=0 ACK: Acknowledge
 From slave to master P: Stop condition R: Read=1 \overline{ACK} : Not acknowledge

\overline{CS} : 1=CS connects to Vdd
 0=CS connects to Gnd

(1) A/D Conversion Data Acquisition

Fig. 9

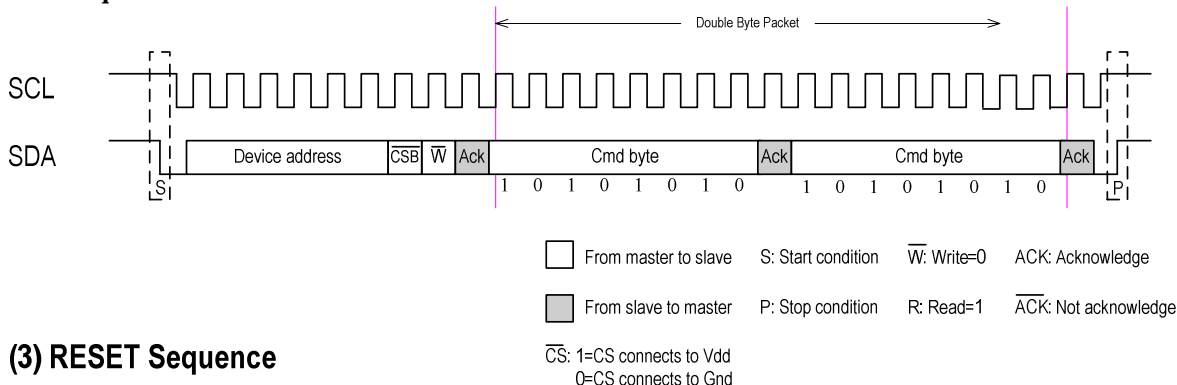
OTP data acquisition



(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. The fig.12 is the flow chart for reading coefficient C1. And The fig.13 is the flow chart for reading pressure value.

Action	Instruction
Conversion start for pressure measurement (D1)	0Fh & 48h
Conversion start for temperature measurement(D2)	0Fh & 20h
Reading coefficient C1	1Ch & 40h
Reading coefficient C2	1Ch & 50h
Reading coefficient C3	1Ch & 60h
Reading coefficient C4	1Ch & 70h
Reading coefficient C5	1Ch & 80h

Reading coefficient C6	1Ch & 90h
Reading coefficient C7	1Ch & A0h
Reading coefficient C8	1Ch & B0h
Reading coefficient C9	1Ch & C0h
Reading coefficient C10	1Ch & D0h

Reading coefficient C1 :

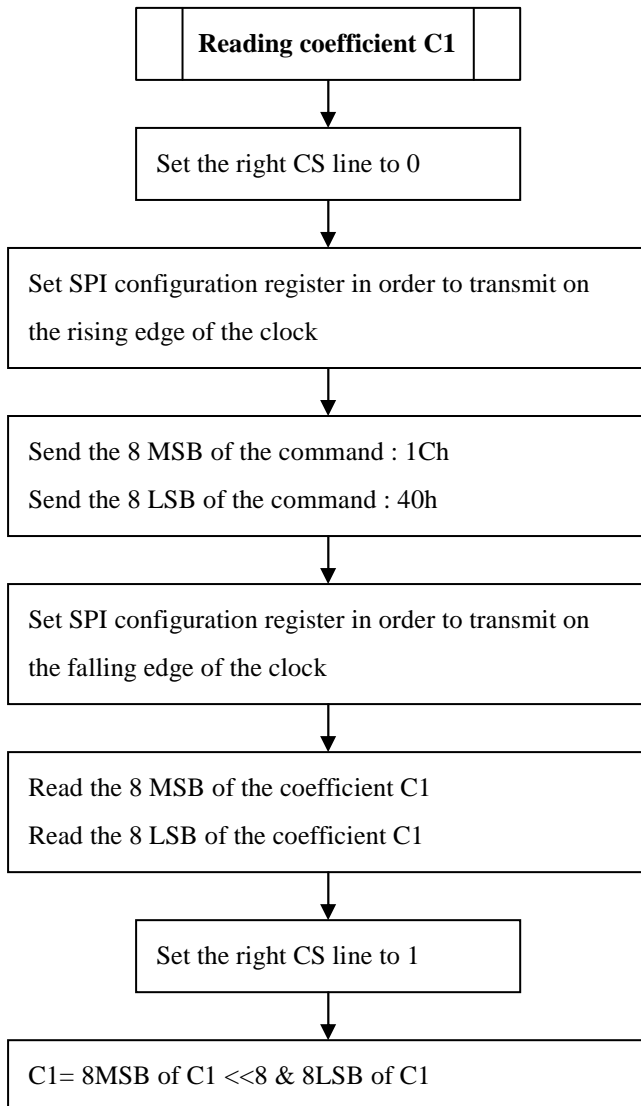


Fig. 12

Reading pressure value :

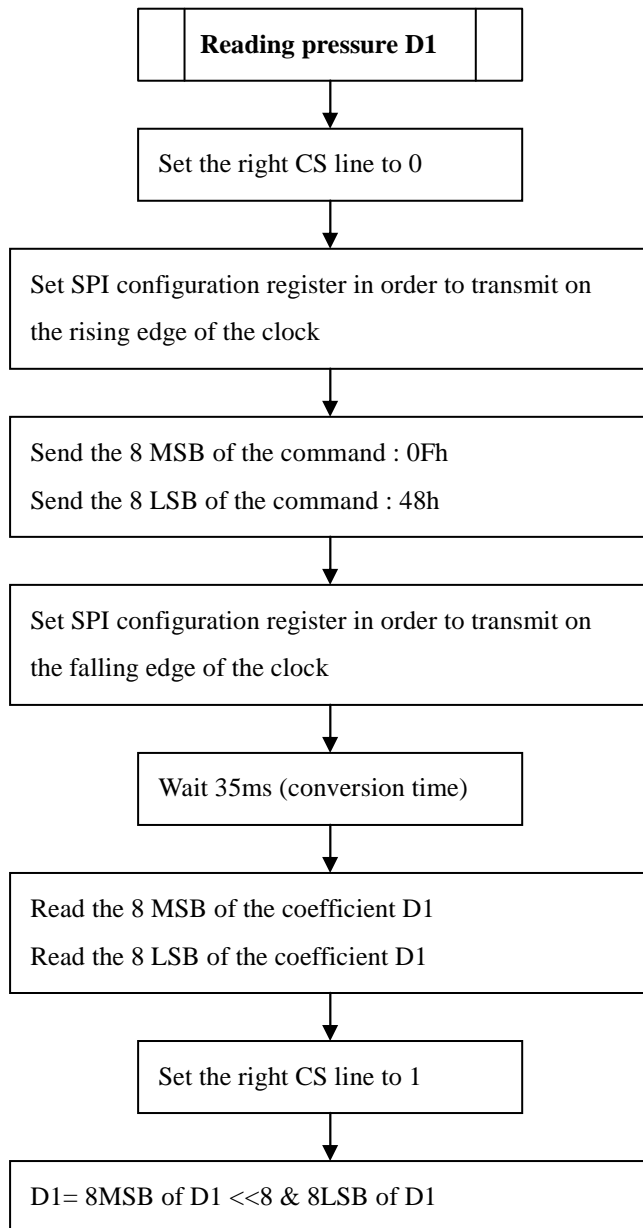


Fig. 13

■ Package Outlines

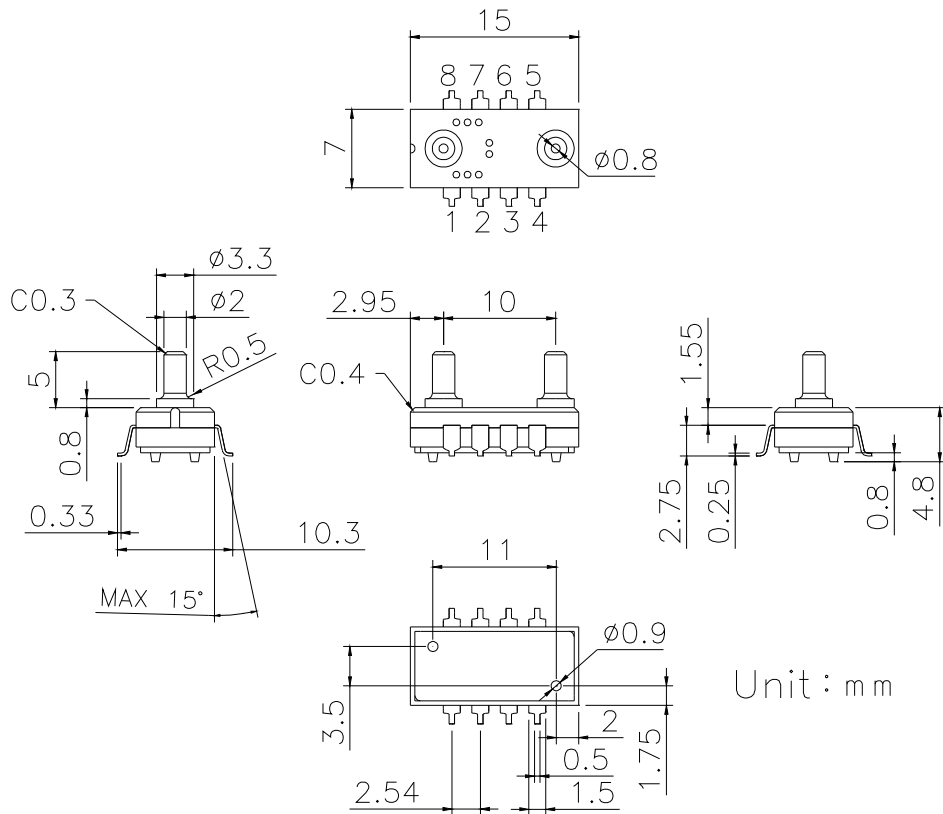


Fig. 14

■ Recommended footprint

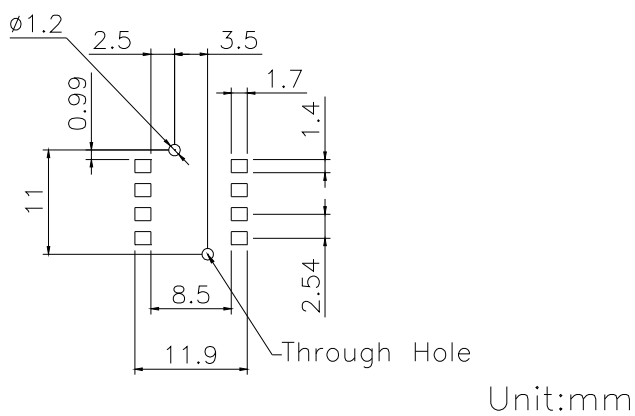


Fig. 15