Pressure Sensor Module
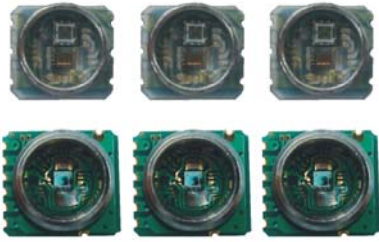
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. Integrated pressure sensor
. 300-1100hpa absolute Pressure Range
. 16 Bit $\Sigma-\Delta$ ADC
. 11 coefficients for software compensation
  stored on chip
. I^2C Serial Interface
. One system clock line (32768Hz)
. One hardware controlled reset line
. Low voltage, low power consumption

Description

The Sensor103pressure module includes a piezo-resistive pressure sensor and an ADC interface. It provides 16 bit word data for pressure and temperature related voltage. With the help of a highly accurate calibration of the senor, 11 unique coefficients were stored on the chip, thus accurate pressure and temperature reading can be realized. HM03 is a low power, low voltage device with automatic power down switching. I^2C Serial Interface is used for communications with a microprocessor. Sensor packaging options are DIP or SMD (with metal cap)
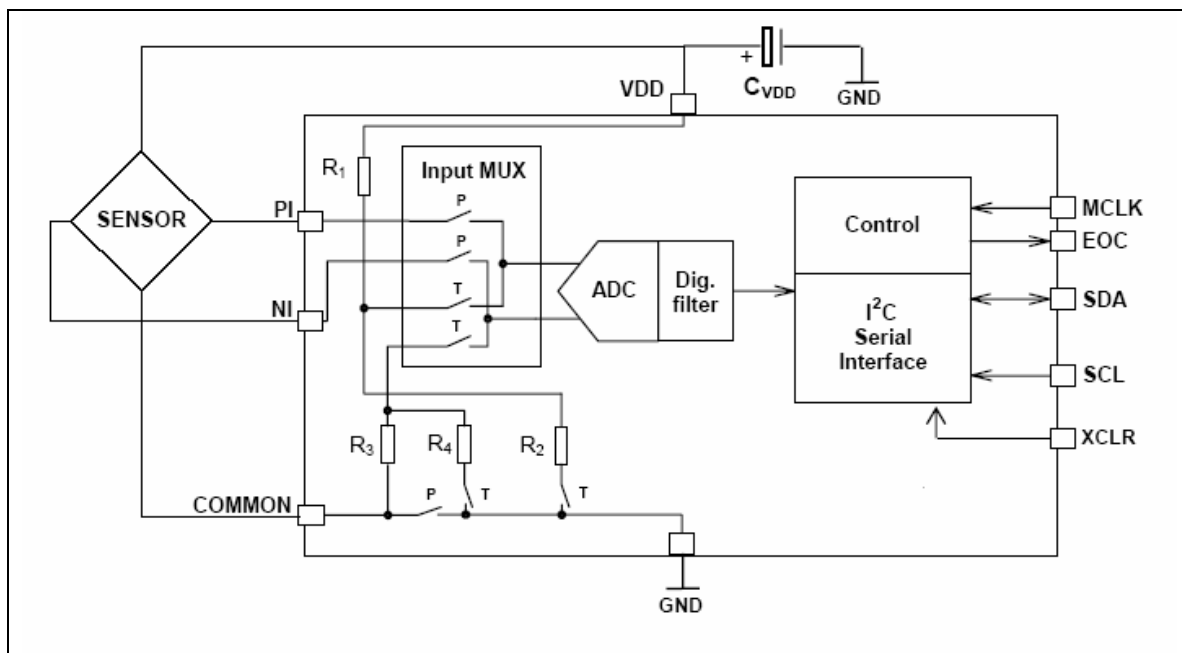
Features

. 15 Bit ADC resolution
. Supply voltage 2.2v-3.6v
. -20°C to + 60°C operating range
. No external components required

Applications

. Pressure measurement and control systems
. Mobile altimeter/barometer systems
. Weather forecast products
. Adventure or multi-mode watches
. GPS receivers

Block Diagram

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PIN Description

Pin Name	Pin Number	Type	Function
VSS	1	G	power ground
VDD	2	P	power VCC
MCLK	3	I	master clock(32k) input
XCLR	4	I	ADC reset input (keep low when system is in idle state)
SDA	5	I/O	. I^{2}C data input and output
SCL	6	I	I^{2}C clock input

* XCLR is to reset the AD converter (active low). XCLR should be set to high only during AD conversion phase(reading D1,D2), at all other states, such as reading calibration factors, this pin should be kept low.

* The quality of the MCLK signal can significantly influence the current consumption of the pressure module. To obtain minimum current, remember to supply good quality MCLK signal

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Supply Voltage	VDD	-0.3	4	V
Over pressure	P		15	Bar(abs)
Storage Temperature	Tstg	-30	90	°C

Recommended Operating Conditions

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	VDD		2.2	3	3.6	V
Supply Current	I	VDD=3V				V
during conversion				500		μA
Stand by				1		μA
Operating Pressure Range	P		300		1100	hpa (abs)
Operating Temperature Range	T	HP03D/S	-20	25	60	°C
		HP03M/C	TBD		60	°C
Conversion Time	T	MCLK=32k	30		35	KHz
Duty Cycle of MCLK			40%	50%	60%	%
Serial Date Rate	SCL				500	KHz

Pressure and Temperature Output Characteristics

With the calibration data provided by the Sensor103 system, it should be able to reach the following characteristics:

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Resolution			0.1			hpa
Relative Pressure Accuracy		750-1100	-1		1	hpa
Absolute Pressure Accuracy		750-1100	-2		2	hpa
Maximum Error Over Temperature		-30~+79	-3		3	hpa
Long Term Stability		12 month		2		hpa
VDD Dependency		2.4~3.6	-1.5	0	1.5	hpa
Temperature Accuracy			-0.8		0.8	°C

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Pressure and Temperature Measurement

The main function of Sensor103 system is to convert the uncompensated pressure and temperature signal from a pressure sensor. After the conversion, the following two values can be obtained:

. measured temperature   "D2"
. measured pressure   "D1"

As the sensor is strongly temperature dependent, it is necessary to compensate for these effects. Therefore 10 sensor-specific coefficients are stored on the Sensor103 at our manufacturing facility, and they allow an accurate software compensation in the application.

The 7 coefficients are:

. Sensitivity coefficient   "C1"
. Offset coefficient   "C2"
. Temperature Coefficient of Sensitivity   "C3"
. Temperature Coefficient of Offset   "C4"
. Reference Temperature   "C5"
. Temperature Coefficient of Temperature   "C6"
. Offset Fine Tuning   "C7"

4 sensor parameter

. Sensor Specific Parameter   "A,B,C,D"

Parameter Range(Hex:Dec)		
C1	0x100 -- 0x7FFF :	256 -- 32767
C2	0x00 -- 0x1FFF ;	0 -- 8191
C3	0x00 -- 0x400 ;	0 -- 3000
C4	0x00 -- 0x1000 ;	0 -- 4096
C5	0x1000 -- 0x8000 ;	4096 -- 32768
C6	0x00 -- 0x4000 ;	0 -- 16384
C7	0x960 -- 0xA28 ;	2400 -- 2600
C,D	0x01 -- 0x0F ;	1 -- 15
A,B	0x01 -- 0x3F ;	1 -- 63
D1	0x00 -- 0xFFFF ;	0 -- 65535
D2	0x00 -- 0xFFFF ;	0 -- 65535

Pressure and Temperature Calculation:

Step 1: (get temperature value)

$$D2 \geq C5 \quad dUT = D2-C5 - ((D2-C5)/2^7) * ((D2-C5)/2^7) * A / 2^C$$
$$D2 < C5 \quad dUT = D2-C5 - ((D2-C5)/2^7) * ((D2-C5)/2^7) * B / 2^C$$

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Step 2: (calculate offset, sensitivity and final pressure value)

OFF=(C2+(C4-1024)*dUT/2^14)*4
SENS = C1+ C3*dUT/2^10
X= SENS * (D1-7168)/2^14 - OFF
P=X*10/2^5+C7

- For altitude measurement system, recommend to use P=X*100/2^5+C7*10
- So that better altitude resolution can be achieved

Step 3: (calculate temperature)

T = 250 + dUT * C6 / 2 ^ 16-dUT/2^D

Example:

C1=29908
C2=3724
C3=312
C4=441
C5=9191
C6=3990
C7=2500
A=1
B=4
C=4
D=9

D1=30036
D2=4107

dUT = (4107-9191) - ((4107-9191)*(4107-9191)/128^2) * 4 / 2^4 = -5478

OFF = (3724 + (441-1024) * (-5478) / 2^14) * 4 =15675

SENS= 29908 + 312 * (-5478) / 2^10 = 28238

X= 28238 * (30036-7168) / 2^14 – 15675 = 23738

P= 23738 * 10 /2^5 + 2500 = 9918 = 991.8hpa

T= 250 + (-5478) * 3990 /2^16- (-5478/2^9) =-72 = -7.2°C

Serial Interface

The I^{2}C interface is used for accessing calibration data as well as reading measurement result from AD conversion.

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The EEPROM and ADC is sharing the same I^{2}C bus but with different chip address assigned. The EEPROM chip address is set to 0xA1(in the case of read), write operation is not allowed. For AD part, the chip address is set to 0xEE. So this module used two different addresses for calibration data and AD converting data accessing. Calibration EEPROM data read operation is fully compatible to 24C02. Bus drive timing should be referred to the specification of this part as well.

Coefficient	EEPROM ADDRESS
C1(MSB:LSB)	(16:17)
C2(MSB:LSB)	(18:19)
C3(MSB:LSB)	(20:21)
C4(MSB:LSB)	(22:23)
C5(MSB:LSB)	(24:25)
C6(MSB:LSB)	(26:27)
C7(MSB:LSB)	(28:29)
A	(30)
B	(31)
C	(32)
D	(33)

AD chip address is set to 0xEE(device write address), 0xEF(device read address). In order to get the AD value D1 and D2, you have to follow the following timing sequence:

Pressure Measure:

S	11101110	**A**	11111111	**A**	11110000	**A**	P	D	S	11101110	**A**	11111101	**A**	S	11101111	**A**	**MSB**	A	**LSB**	N	P

Temperature Measure:

S	11101110	**A**	11111111	**A**	11101000	**A**	P	D	S	11101110	**A**	11111101	**A**	S	11101111	**A**	**MSB**	A	**LSB**	N	P

S: start condition
P: stop condition
A (bold) : acknowledge from slave
A : acknowledge from master
N: no acknowledge from master (send out bit 1 instead)
D : delay for 40ms minimum
MSB: conversion result MSB
LSB: conversion result LSB.

Remark:
Before start an AD conversion cycle, remember to pull high for XCLR pin so that the system is no longer in the reset state.
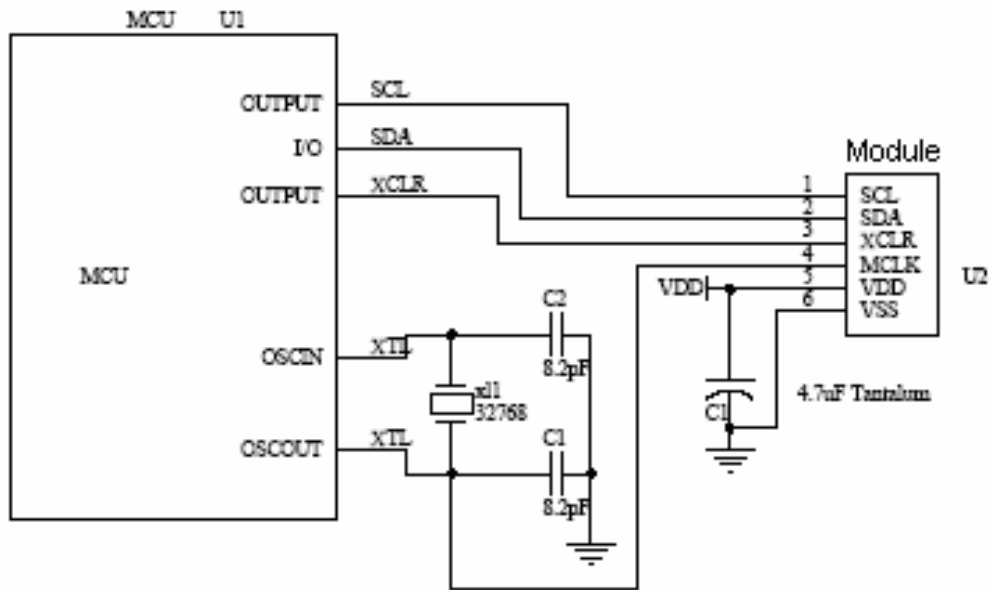All data read from the module is in hex format.

After first power on, the first read data should be disregarded, and only the second value should be used. This can assure that any unstable data after reset can be filtered out.
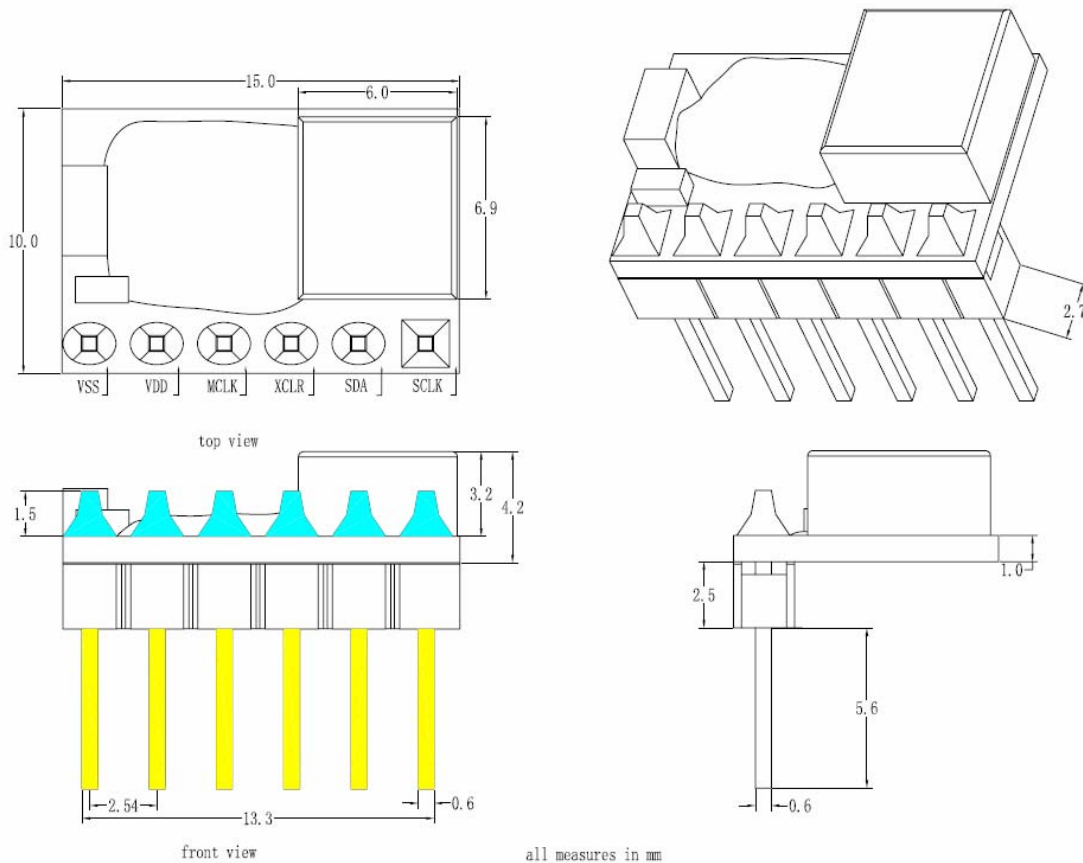
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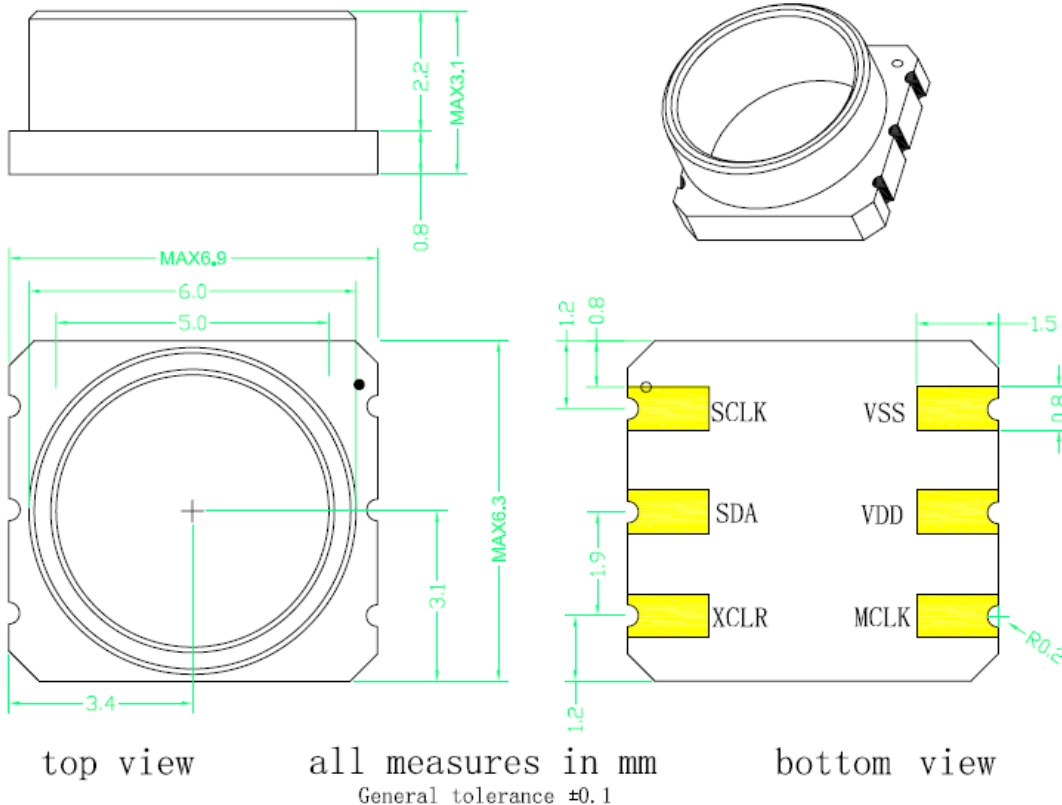
Typical Application Circuit Diagram:
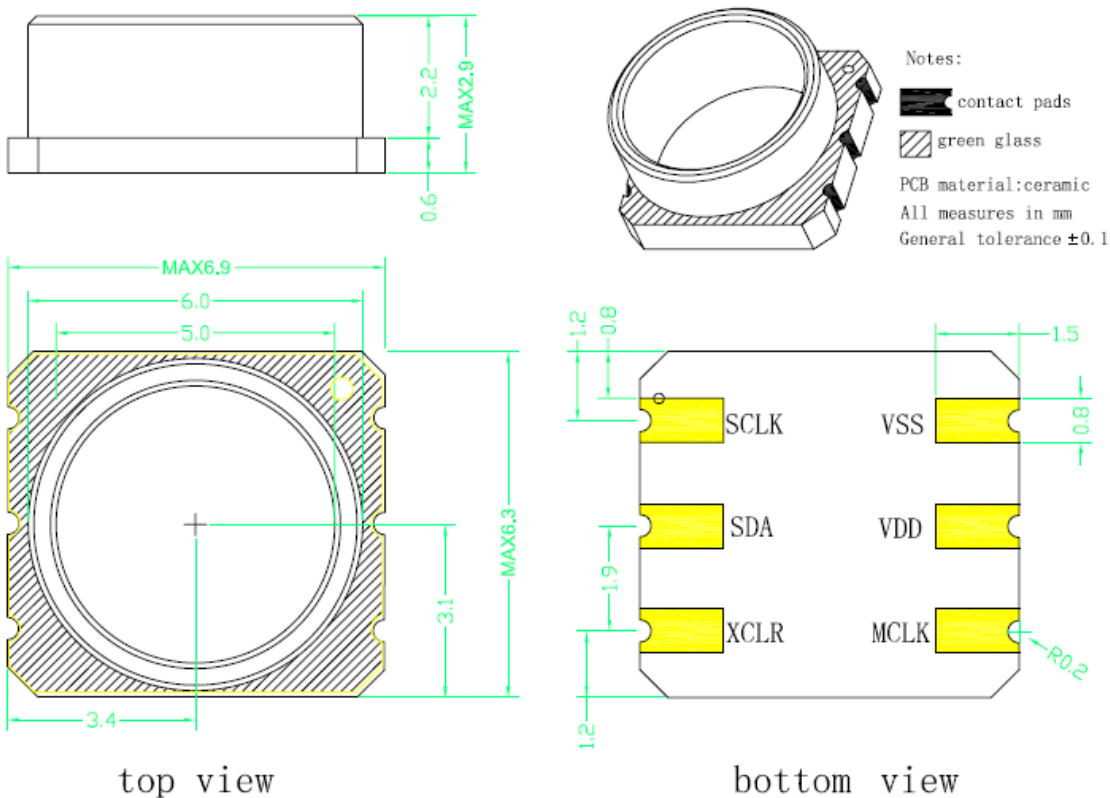

HM03D Mechanical Dimension

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Sensor103M Mechanical Dimension

MAX6.9
6.0
5.0
MAX6.3
3.1
3.4

top view   all measures in mm   bottom view
General tolerance ±0.1

SCLK   VSS
SDA   VDD
XCLR   MCLK

Sensor103C Mechanical Dimension

Notes:
▬ contact pads
▨ green glass

PCB material:ceramic
All measures in mm
General tolerance ±0.1

MAX6.9
6.0
5.0
MAX6.3
3.1
3.4

top view   bottom view

SCLK   VSS
SDA   VDD
XCLR   MCLK

Pressure Sensor Module

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Sensor103S Mechanical Dimension

top view   all measures in mm   bottom view

Pins (top view): VSS, VDD, MCLK, XCLR, SDA, SCLK