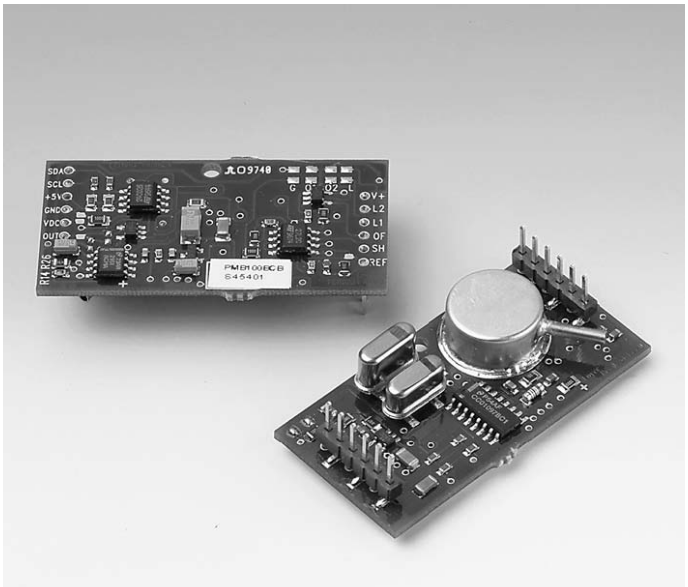
USER'S GUIDE

Vaisala BAROCAP® Barometer Module PMB100



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CHAPTER 1

GENERAL INFORMATION

Safety

Throughout the manual, important safety considerations are highlighted as follows:

WARNING Warning denotes a serious hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury to or death of personnel.

CAUTION Caution denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE Note highlights important information. It calls attention to an essential procedure, practice, condition or the like.

Warranty

Vaisala issues a guarantee for the material and workmanship of this product under normal operating conditions for one (1) year from the date of delivery. Exceptional operating conditions, damage due to careless handling and misapplication will void the guarantee.

CHAPTER 2

PRODUCT DESCRIPTION

The PMB100 for OEM applications is a new circuit board mountable barometric pressure transducer that is designed to interface with an AD converter and a microprocessor.

The PMB100 module is characterized over 800 to 1100 hPa (mbar) pressure range and over –5 to +45C temperature range. It ouputs pressure dependant voltage within 0 and 2.5 VDC along with a reference voltage of 2.5 VDC. All pressure and temperature related coefficients are given in a module specific certificate and also stored in an incorporated EEPROM, which uses the I^2C interface. All the user needs to do is to measure the temperature of the module and the two voltage outputs and then calculate the compensated pressure reading using the coefficients. A final offset correction against a high-class pressure standard is recommended as a final touch.

BAROCAP® pressure sensor

The PMB100 barometer modules use the BAROCAP® silicon capacitive absolute pressure sensor. The BAROCAP® sensor has excellent hysteresis and repeatability characteristics, low temperature dependence and a very good long-term stability. The ruggedness of the BAROCAP® sensor is outstanding and the sensor is resistant to mechanical and thermal shocks.

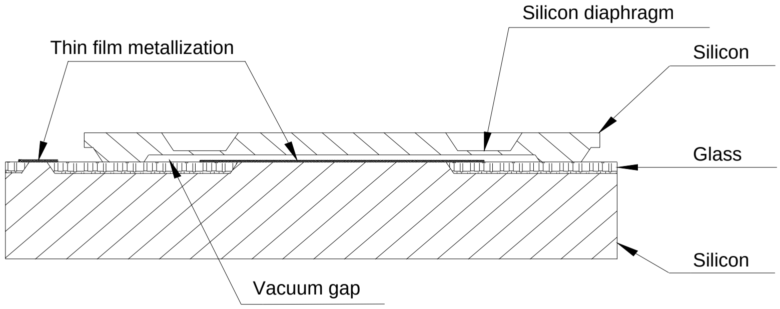


Figure 1 The BAROCAP® pressure sensor

The BAROCAP® pressure sensor consists of two layers of single crystal silicon having a layer of glass between them. The thinner silicon layer is etched on both sides to create an integrated vacuum reference chamber for the absolute pressure sensor and to form a pressure sensitive silicon diaphragm. The thicker silicon layer is the rigid base plate of the sensor and it is clad with a glass dielectric. The thinner piece of silicon is electrostatically bonded to the glass surface to form a strong and hermetic bond. Thin film metallization has been deposited to form a capacitor electrode inside the vacuum reference chamber; the other electrode is the pressure sensitive silicon diaphragm.

The coefficients of thermal expansion of silicon and glass materials used in the BAROCAP® pressure sensor are carefully matched together in order to minimize the temperature dependence and to maximize the long-term stability. The BAROCAP® pressure sensor is designed to achieve zero temperature dependence at 1000 hPa and its long-term stability has been maximized by thermal ageing at an elevated temperature.

The BAROCAP® capacitive pressure sensor features a wide dynamic range and no self-heating effect. The excellent hysteresis and repeatability characteristics are based on the ideal spring characteristics of single crystal silicon. In the BAROCAP® pressure sensor, the silicon material is exerted to only few percent of its whole elastic range.

CHAPTER 3

OPERATION

Connections

The pin assignments of the PMB100 module are according to Figure 2. Connect 8...16 VDC supply voltage (typically 2 mA) to the pin VDC and the ground plane directly to the pin GND. The output signal (0...2.5 VDC) is measured from the pin OUT and the reference signal (2.5 VDC ± 2%) from the pin REF.

If the coefficients are read from the EEPROM, the pin +5 V, SCL and SDA are also connected. The +5 V-pin is used for supply voltage of the EEPROM. The pins SCL and SDA are for data transfer between the EEPROM and a microprocessor.

Temperature of the module is measured with an external T sensor, which should be placed as close to the module as possible.

The module can also be switched to shut down mode by using a TTL level trigger on the pin SH. A signal 0.7 V or lower activates and a signal higher than 2 V switches the module off.

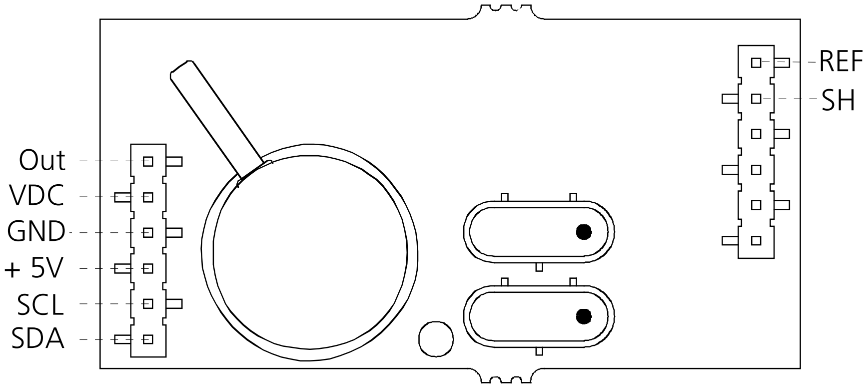


Figure 2 Pin assignments

In applications where adverse electromagnetic fields exist, an additional EMI protection may be necessary. In Figure 3, there is an example of an electromagnetic interference protection of the PMB100 module. The EMI filters should be placed as close to the pins as possible.

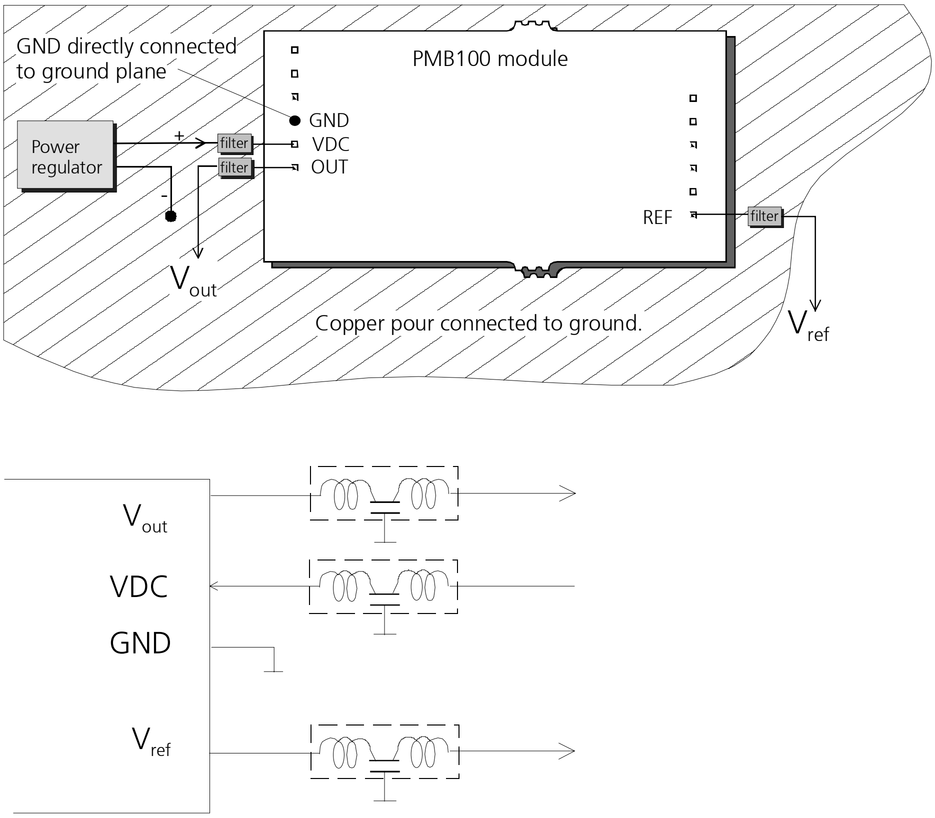
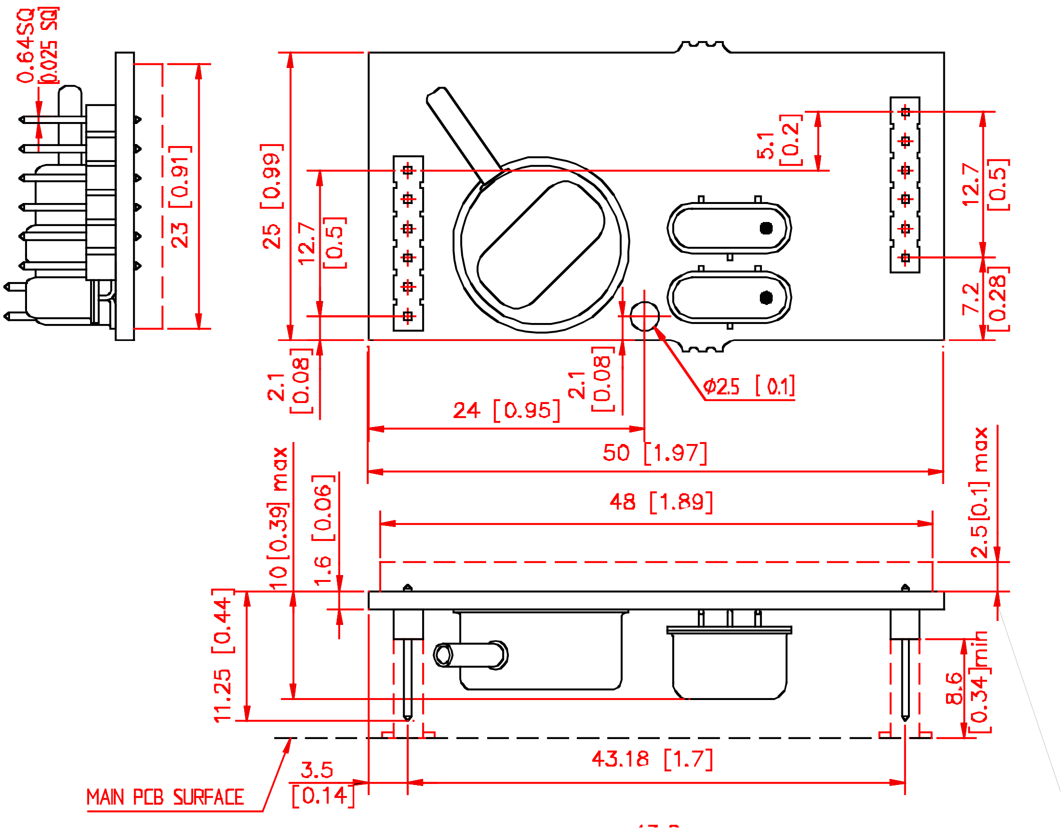


Figure 3 **Electromagnetic interference protection of the PMB100. Filters, for example, T-type EMI suppression filters with capacitance of 47pF (like Murata, DSS310-55Y5S470M100). This connection setup fulfills the RF field immunity standard EN61000-4-3.**

Dimensions in mm (in inches)



Pressure calculations

Measure the following parameters of the PMB100 barometer module:

- output voltage V_{out}
- reference voltage V_{ref}
- module temperature T_m (°C)

NOTE	External T-sensor is required for temperature compensation purpose with minimum ±1°C accuracy. 1°C error in temperature measurement causes 0.14 hPa error in pressure value.

In pressure calculation, normalized voltage (V_n) and temperature (T_n) are required. The normalization of the parameters is performed by using the equations 1 and 2.

$$V_n = \left(2 \cdot \frac{V_{out}}{V_{ref}}\right) - 1, \quad V_n \in [-1...1] \tag{1}$$

$$T_n = \frac{T_m}{128} - T_0, \quad T_n \in [-1...1] \tag{2}$$

Constant T_0 is found in the list of coefficient or in the EEPROM.

Normalized pressure P_n is calculated according to the equation 3. All the module specific coefficients are available in the list of coefficients supplied with each module or in the EEPROM.

$$P_n = k \cdot \left[\begin{array}{l} a_{00} + a_{10} \cdot V_n + a_{20} \cdot V_n{}^2 + a_{30} \cdot V_n{}^3 \\ + a_{01} \cdot T_n + a_{02} \cdot T_n{}^2 \\ + a_{11} \cdot V_n \cdot T_n + a_{12} \cdot V_n \cdot T_n{}^2 + a_{21} \cdot V_n{}^2 \cdot T_n + a_{31} \cdot V_n{}^3 \cdot T_n \end{array}\right], P_n \in [-1...1] \tag{3}$$

Compensated pressure P is then calculated by using the equation 4.

$$P = 150 \cdot P_n + 950 \text{ hPa} \tag{4}$$

Offset/Gain corrections

A final offset/gain correction against a high-class pressure standard is recommended as a final touch. The offset and gain adjustments are done after the pressure calculation by the user's host system.

CHAPTER 4

TECHNICAL DATA

Specifications

Operating range

Pressure range (1 hPa = 1 mbar)	800 ... 1100 hPa
Temperature range	-5°C ... +45°C
Humidity range	< 80%RH

Accuracy

Linearity	±0.25 hPa
Pressure hysteresis	±0.05 hPa
Repeatability	±0.05 hPa
Accuracy at +20°C	±0.3 hPa
Temperature hysteresis	±0.3 hPa
Accuracy (-5°C ... 45°C)	±0.5 hPa

Total accuracy after the OFFSET correction (+20 °C, 1000 hPa) performed by the user is obtained by using the following equation:

$$Total\ accuracy = \pm\sqrt{0.5^2 + n^2}\,hPa \qquad (5)$$

where n is the calibration uncertainty

Without the OFFSET correction performed by the user:

Total accuracy (-5 ... +45 °C)	±1.00 hPa
Long-term stability	±0.20 hPa/year (typical)
Effect of thermal or mechanical shocks	<0.20 hPa

An error of 1 °C in temperature measurement causes an error of 0.14 hPa in pressure.

General

Supply voltage range	9...16 VDC
Shutdown control with TTL level trigger	
<0.7 V	module ON
>2.0 V	module OFF
Supply voltage sensitivity	less than 0.1 hPa

Current consumption	
operation mode	2 mA (typical)
shutdown mode	150 µA (typical)
Output voltage	
output	0...2.5 V
reference	2.5 V ±2% (type LM4431M3)
Resolution	0.1 hPa
Load resistance	10 kΩ minimum
Load capacitance	100 nF maximun
Settling time at power-up	200 ms
Response time	100 ms
Warm-up shift	less than 0.05 hPa
Pressure hose	1/16" id 1/8" OD, vinyl hose 300mm
Maximum pressure limit	2000 hPa
Electrical connectors	two 6-pin pin headers, 2.54 mm grid
Weight	70 g

APPENDIX A

READING COEFFICIENTS FROM THE EEPROM

The PMB100 module has a Xicor's EEPROM memory, type X24C02, which uses the I^2C interface. All the pressure and temperature related coefficients are stored in the memory in form of 32 bit, and can be read by a microprocessor (see Table 1). The pin assignments are as shown in Figure 2 on page 7. Detailed instructions of the EEPROM are found on Xicor's web pages (http://www.xicor.com/).

NOTE EEPROM can not be read if the shut down is active (ON).

Table 1 EEPROM memory map

Name	Symbol	Type	Length [Bit]	Memory address [Byte]	Range
Product code	*PCode*	8-bit int	8	0	[0...256]
Serial number	*Sno*		32	1 - 4	
Calibration date	*Date*		24	5 - 7	
Scaling factor	k	8-bit int	8	8	[0...256]
Normalized room temperature	T_0	32-bit int	32	10 - 13	[-1...1]
Normalized coefficients	a_{00}	32-bit int	32	14 - 17	[-1...1]
	a_{10}	32-bit int	32	18 21	[-1...1]
	a_{20}	32-bit int	32	22 25	[-1...1]
	a_{30}	32-bit int	32	26 29	[-1...1]
	a_{01}	32-bit int	32	30 33	[-1...1]
	a_{02}	32-bit int	32	34 37	[-1...1]
	a_{11}	32-bit int	32	38 41	[-1...1]
	a_{21}	32-bit int	32	42 45	[-1...1]
	a_{31}	32-bit int	32	46 49	[-1...1]
	a_{12}	32-bit int	32	50 53	[-1...1]

The form of coefficients (32-bit signed integer) in the eeprom:

```
                 MSB  LSB        MSB  LSB        MSB  LSB        MSB  LSB
eeprom:   byte_0 xxxxxxxx byte_1 xxxxxxxx byte_2 xxxxxxxx byte_3 xxxxxxxx

long_int: bit_31 xxxxxxxx bit_23 xxxxxxxx bit_15 xxxxxxxx bit_7  xxxxxxxx bit_0
          MSB                                                             LSB
```

32-bit signed integer → FLOAT (1.0...-1.0)

float=signed_long_int/2^31

In following there is an example of C-program to convert the 32 bit coefficients to floating point numbers.

```
unsigned char read_eeprom(addr)
{
/* eeprom read routine */
return(read_data);
}

/*--------------------------------------------------------
-------------------- -------------------*/

void read_long_int( char addr, long int *coef )
{
unsigned char *pointer=(char*)coef;

*pointer++=read_eeprom(addr++);
*pointer++=read_eeprom(addr++);
*pointer++=read_eeprom(addr++);
*pointer=read_eeprom(addr);

}

/*--------------------------------------------------------
-------------------- -------------------*/

void main(void)
{

long int long_coef=0;            /* signed long integer
(32 bit) */
float float_coef=0.;

read_long_int(14,&long_coef);
float_coef=(float)long_coef/0x80000000;

printf("Float is %e\r\n",float_coef);

}
```

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