Ultra-low power, 4 bar, absolute digital output pressure and temperature transmitter with water-resistant package

Features

- Current consumption down to 1.7 µA
- Absolute pressure accuracy: 0.5 mbar
- Low pressure sensor noise: 0.32 µBar
- Embedded temperature compensation
- 24-bit pressure data output
- ODR from 1 Hz to 200 Hz
- I^2C
- No external components
- Hermetic packaging for underwater/outdoor devices
- Supply voltage: 1.7 to 3.6 V

Applications

- Underwater devices
- Wearables
- industrial control pressure
- GPS applications
- Weather station equipment
- Water depth monitoring

1. Pin description

Cable color	Name	Function
Green	SDA	I^2C / MIPI I3CSM serial data (SDA)
White	SA0	I^2C least significant bit of the device address (SA0)
Blue	SCL	I^2C / MIPI I3CSM serial clock (SCL)
Black	GND	0 V supply
Red	VDD	VDD Power supply

2. Electrical characteristics

VDD = 1.8 V, T = 25 °C, unless otherwise noted.

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
VDD	Supply voltage		1.7		3.6	V
Idd	Supply current		1.7		32.5	µA
IddPdn	Supply current in power-down mode			0.9		µA
Vil	Low-Level input voltage				0.3-VDD	V
Vih	High-Level input voltage		0.7*VDD			V
Vol	Low-Level output voltage				0.2	V
Voh	High-Level output voltage		VDD-0.2			V

(1)

3. Absolute maximum ratings

Stress above those listed as "Absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Symbol	Ratings	Maximum Value	Unit
VDD	Sypply voltage	-0.3 to 4.8	V
Vin	Input voltage on any control pin	0.3 to VDD +0.3	V
Pressure	Overpressure	10	Bar
Temp	Storage temperature rage	-40 to +125	°C
ESD	Electrostatic discharge protection	2	kV

4. Functionality

Le device is a high-resolution, digital output pressure sensor packaged in a plastic package. The complete device includes a sensing element based on a piezoresistive Wheatstone bridge approach and an IC interface which communicates a digital signal from the sensing element to the application.

4.1.Sensing element

This device is using a silicon membrane for MEMS pressure sensors technology. When pressure is applied, the membrane deflection induces an imbalance in the Wheatstone bridge piezoresistances whose output signal is converted by the IC interface.

4.2.IC interface

The complete measurement chain is composed of a low-noise amplifier which converts the resistance unbalance of the MEMS sensors (pressure and temperature) into an analog voltage using an analog-to-digital converter. The pressure and temperature data may be accessed through an I^2C/MIPI I3CSM interface thus making the device particularly suitable for direct interfacing with a microcontroller.

4.3.Factory calibration

The trimming values are stored inside the device in a non-volatile structure. When the device is turned on, the trimming parameters are downloaded into the registers to be employed

during the normal operation which allows the device to be used without requiring any further calibration.

4.4.Interpreting pressure readings

The pressure data are stored in 3 registers:

PRESS_OUT_H (2Ah)

PRESS_OUT_L (29h)

PRESS_OUT_XL (28h)

The value is expressed as a 24-bit signed number (in 2's complement).

To obtain the pressure in hPa, take the complete 24-bit word and then divide by the sensitivity 2096 LSB/hPa when the FS_MODE bit is 1 (full scale is up to 4060 hPa).

This same interpretation is applied to pressure readings when FIFO is enabled and the pressure data are stored in 3 registers:

FIFO_DATA_OUT_PRESS_XL (78h)

FIFO_DATA_OUT_PRESS_L (79h)

FIFO_DATA_OUT_PRESS_H (7Ah)

Pressure Value = PRESS_OUT_H 2Ah & PRESS_OUT_L 29h & PRESS_OUT_XL 28h

= 3FF58Dh = 4191629 LSB signed decimal

FS_MODE bit = 1, (CTRL_REG2 (11h)) for full scale up to 4060 hPa:

$$\text{Pressure } (hPA) = \left(\frac{\text{Pressure value } (LSB)}{\text{Sensitivity}}\right) = \frac{4191629\ (LSB)}{2048\ (\frac{LSB}{hPA})} = 2046.7\ hPA$$

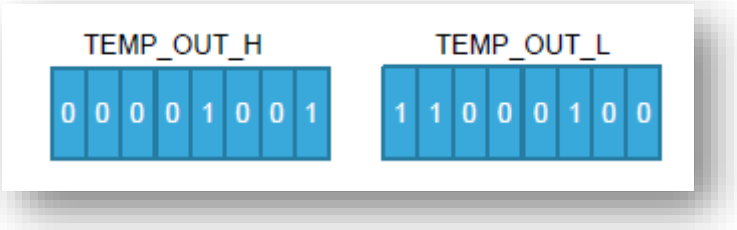
4.5.Interpreting temperature readings

The pressure data are stored in 3 registers:

TEMP_OUT_H (2Ch)

TEMP_OUT_L (2Bh)

The value is expressed as 2's complement. To obtain the temperature in °C,, take the two's complement of the complete 16-bit word and then divide by the sensitivity 100 LSB/°C.



Temperature Value = TEMP_OUT_H (2Ch) & TEMP_OUT_L (2Bh)

= 09C4 = 2500 LSB (decimal signed)

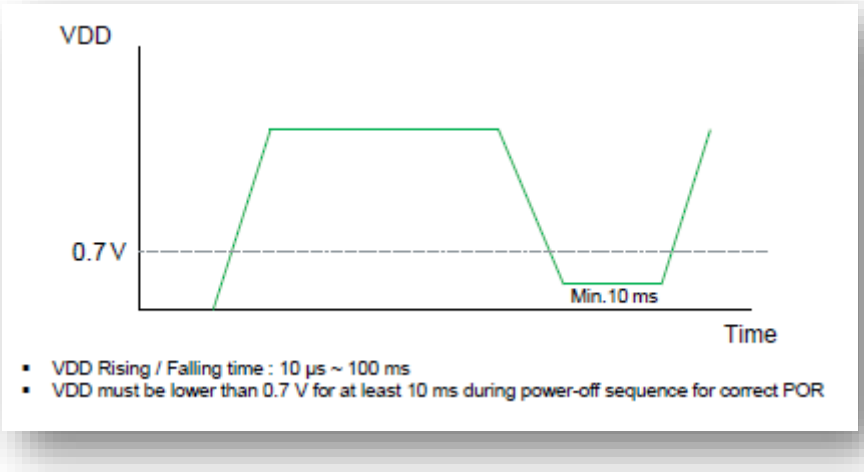
$$\text{Temperature } (°C) = \left(\frac{\text{Pressure value } (LSB)}{\text{Sensitivity}}\right) = \frac{2500\ (LSB)}{100\ (\frac{LSB}{°C})} = 25.0\ °C$$

5. Application

The device power supply must be provided through the VDD line. Depending on the application, an additional capacitor of 4.7 µF could be placed on the VDD line.

The functionality of the device and the measured data outputs are selectable and accessible through the I^2C interface.

To guarantee proper power-off of the device, it is recommended to maintain the duration of the VDD line to GND for at least 10 ms.



6. I²C serial interface

The device I²C is a bus slave. The I²C is employed to write data into registers whose content can also be read back.

Transmitter → The device which sends data to the bus
Receiver → The device which receives data from the bus
Master → The device which initiates a transfer, generates clock signals and terminates a transfer
Slave → The device addressed by the master

There are two signals associated with the I²C bus: the serial clock line (SCL) and the serial data line (SDA). The latter is a bidirectional line used for sending and receiving the data to/from the interface. Both lines must be connected to VDD through pull-up resistors.
The I²C interface is compliant with fast mode+ (1 MHz) I²C standards as well as with the normal mode.

6.1. I²C operation

The transaction on the bus is started through a start (ST) signal. A start condition is defined as a high to low transition on the data line while the SCL line is held high. After the master has transmitted this, the bus is considered busy. The next data byte transmitted after the start condition contains the address of the slave in the first 7 bits and the eighth bit tells whether the master is receiving data from the slave or transmitting data to the slave. When an address is sent, each device in the system compares the first seven bits after a start condition with its address. If they match, the device considers itself addressed by the master.
The 7-bit slave address (SAD) associated to the product is 101110xb. The SA0 (pin #2) pin can be used to modify the less significant bit of the device address. If the SA0 pin is connected to the voltage supply, LSB is "1" (7-bit address 1011101b = 5Dh), otherwise if the SA0 pin is connected to GND, the LSB value is "0" (7-bit address 1011100b = 5Ch). This solution permits connecting and addressing two different devices to the same I²C lines.
Data transfer with acknowledge is mandatory. The transmitter must release the SDA line during the acknowledge pulse. The receiver must then pull the data line low so that it remains stable low during the high period of the acknowledge clock pulse. A receiver which has been addressed is obliged to generate an acknowledge after each byte of data received.
The I²C embedded inside the ASIC behaves like a slave device and the following protocol must be adhered to. After the start condition (ST) a slave address is sent, once a slave acknowledge has been returned (SAK), an 8-bit subaddress is transmitted (SUB). The IF_ADD_INC bit in CTRL_REG2 (11h) enables subaddress auto increment (IF_ADD_INC is '1' by default), so if IF_ADD_INC = '1' the SUB (subaddress) is automatically increased to allow multiple data read/write.
The slave address is completed with a read/write bit. If the bit is '1' (read), a repeated start (SR) condition must be issued after the two subaddress bytes; if the bit is '0' (write), the master transmits to the slave with direction unchanged. The following table explains how the SAD + read/write bit pattern is composed, listing all the possible configurations.

Command	SAD[6:1]	SAD[0] = SA0	R/W	SAD + R/W
Read	101110	0	1	10111001 (B9h)
Write	101110	0	0	10111000 (B8h)
Read	101110	1	1	10111011 (BBh)
Write	101110	1	0	10111010 (BAh)

SAD + Read / Write patterns

6.2.STATUS (27h)

Status register (read only)

7	6	5	4	3	2	1	0
-	-	T_OR	P_OR	-	-	T_DA	P_DA

T_OR	Temperature data overrun. (0: no overrun has occurred; 1: new data for temperature has overwritten the previous data)
P_OR	Pressure data overrun. (0: no overrun has occurred; 1: new data for pressure has overwritten the previous data)
T_DA	Temperature data available. (0: new data for temperature is not yet available; 1: new temperature data is generated)
P_DA	Pressure data available. (0: new data for pressure is not yet available; 1: new pressure data is generated)

This register is updated every ODR cycle.

6.3.PRESS_OUT_XL (28h)

Pressure output value LSB data (read only)

7	6	5	4	3	2	1	0
POUT7	POUT6	POUT5	POUT4	POUT3	POUT2	POUT1	POUT0

POUT[7:0]	This register contains the low part of the pressure output value.

The pressure output value is a 24-bit data that contains the measured pressure. It is composed of

PRESS_OUT_H (2Ah), PRESS_OUT_L (29h) and PRESS_OUT_XL (28h). The value is expressed as 2's

complement. The output pressure register PRESS_OUT is provided as the difference between the measured pressure and the content of the register RPDS (18h, 19h).

This register contains the pressure value and the resolution is: 1 LSB = 1/4096 hPa (when FS_MODE = 0), otherwise 1 LSB = 1/2048 hPa (when FS_MODE = 1).

6.4.PRESS_OUT_L (29h)

Pressure output value middle data (read only)

7	6	5	4	3	2	1	0
POUT15	POUT14	POUT13	POUT12	POUT11	POUT10	POUT9	POUT8

POUT[15:8]	This register contains the mid part of the pressure output value. Refer to PRESS_OUT_XL (28h)

6.5.PRESS_OUT_H (2Ah)

Pressure output value MSB data (read only)

7	6	5	4	3	2	1	0
POUT23	POUT22	POUT21	POUT20	POUT19	POUT18	POUT17	POUT16

POUT[23:16]	This register contains the high part of the pressure output value. Refer to PRESS_OUT_XL (28h)

6.6.TEMP_OUT_L (2Bh)

Temperature output value LSB data (read only)

7	6	5	4	3	2	1	0
TOUT7	TOUT6	TOUT5	TOUT4	TOUT3	TOUT2	TOUT1	TOUT0

TOUT[7:0]	This register contains the low part of the temperature output value.

The temperature output value is 16-bit data that contains the measured temperature. It is composed of TEMP_OUT_H (2Ch), and TEMP_OUT_L (2Bh). The value is expressed as 2's complement.

This register contains the temperature value and the resolution is: 1LSB = 0.01 °C.

6.7.TEMP_OUT_H (2Ch)

Temperature output value MSB data (read only)

7	6	5	4	3	2	1	0
TOUT15	TOUT14	TOUT13	TOUT12	TOUT11	TOUT10	TOUT9	TOUT8

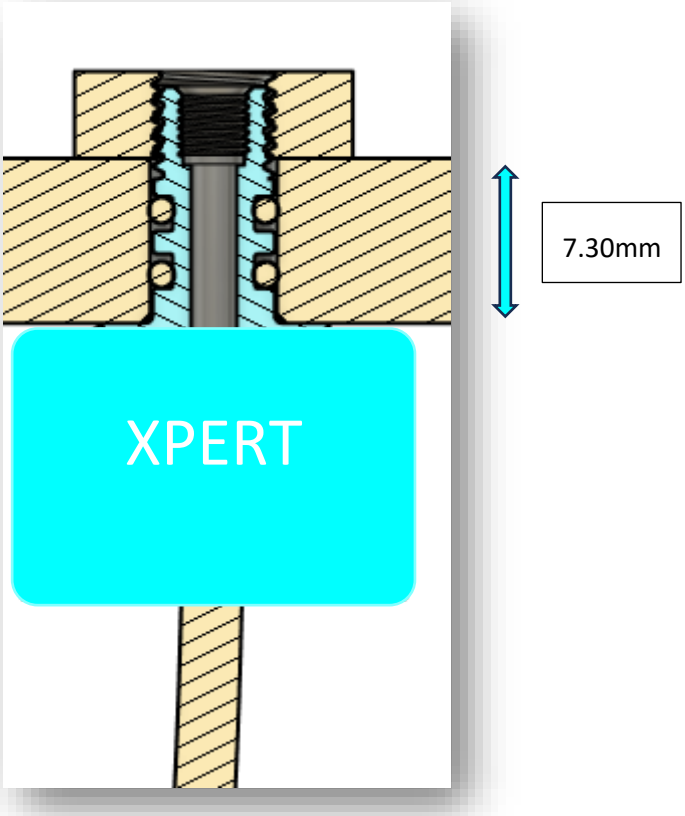
TOUT[15:8]	This register contains the high part of the temperature output value.

7. Installation

This product can provide 3 possible connections:

7.1.Thin wall

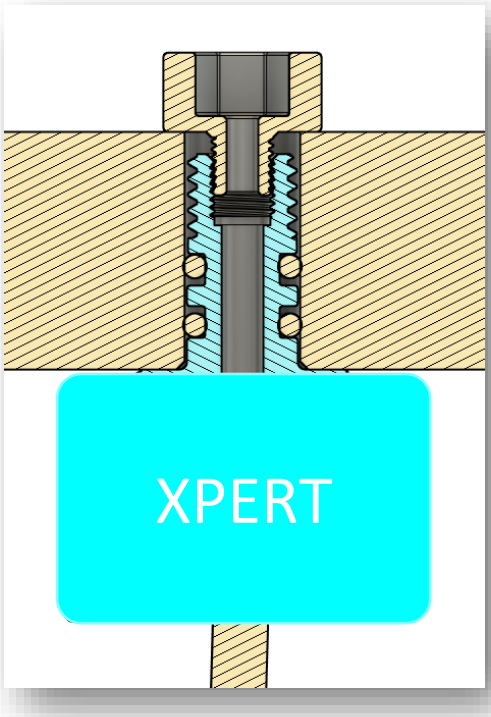
To reach the perfect watertightness trough a thin wall, the minimum thickness has to be 7.30mm.



The nut can fix and tight the sensor in position by using the external thread ISO M7x1mm

7.2.Large wall

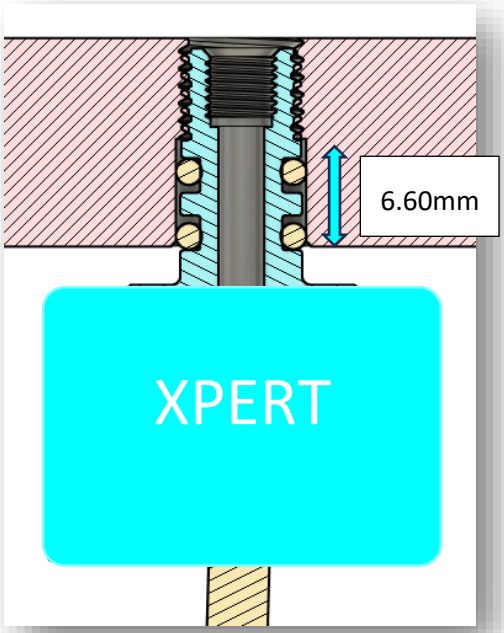
To reach the perfect watertightness trough a large wall, the minimum thickness has to be 15mm. in that case, it is recommended to use and external throughout scew that can be fix on the internal thread ISO M4x07.



Depending on the application the external screw has to be adjusted according to the thickness.

7.3.screw wall

To reach the perfect installation by using external thread ISO M7x1mm directly into the wall. The minimum recommended size has to be:



7.4.Used materials

As the component will be install in very long time in harsh environment, The mechanical sensors part as to be compliant with :

- Nature of the environment (salt water, chlorin water, waste water, oil, gas)
- hydrostatic pressure
- Temperature variation
- long immersion period

PEEK is a unique semi crystalline, engineering thermoplastic that also offers excellent chemical compatibility.

Some PEEK feature :

Plastic	Tensile strength	Impact strength	Heat resistant
Peek	1000 - 4000 Mpa	20 - 100 KJ/m2	260 - 300°C

7.5.Mechanical dimensions

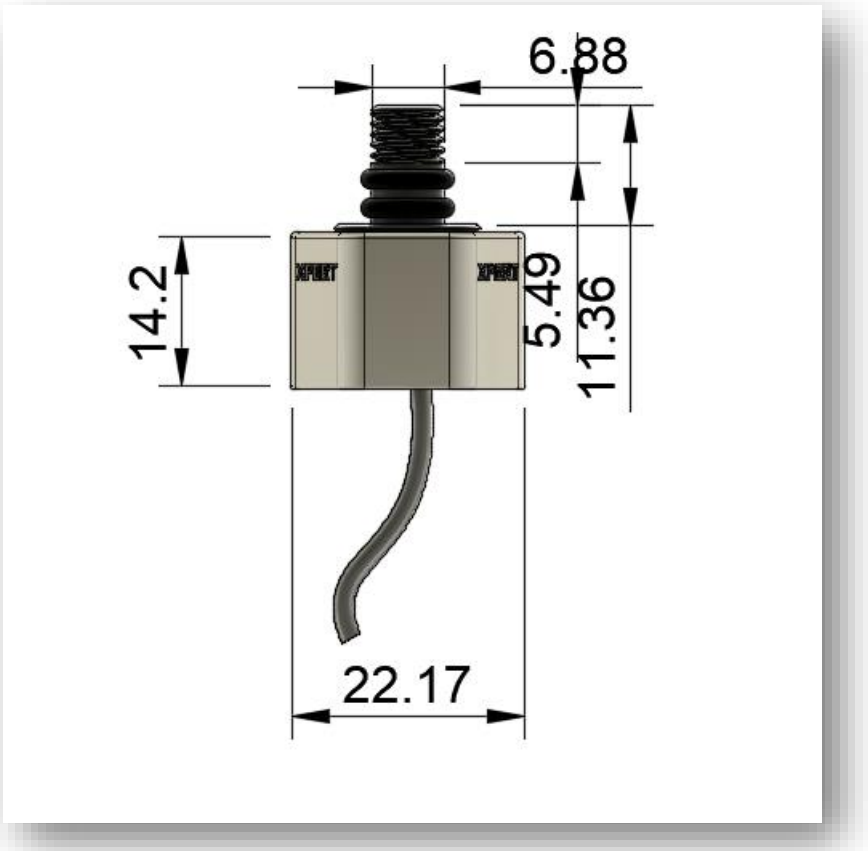


Figure 1 : side view

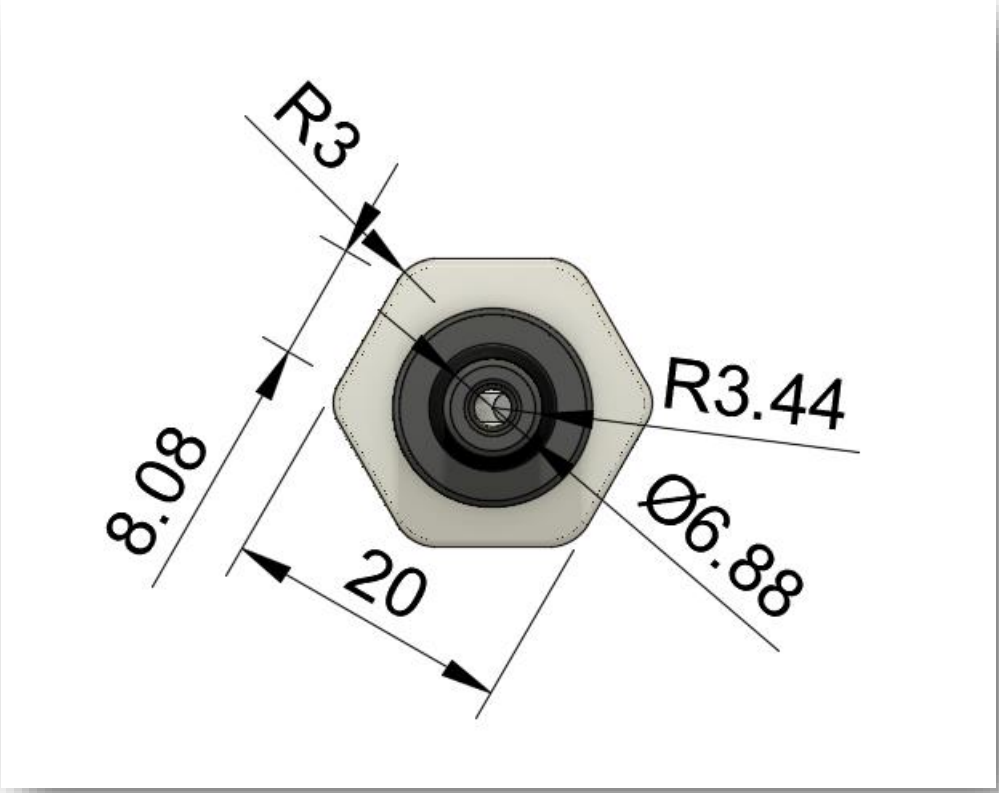


Figure 2 : top view

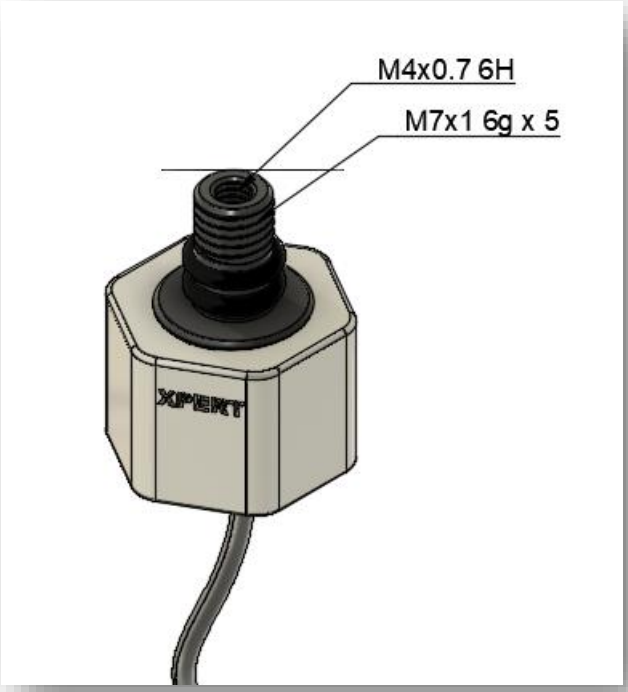


Figure 3 : 3D view

7.6.Ordering information

Part number	Description	Quantity
Supion100018	Supion 0-4bar water package	1
JT100046	Orin nitrile	2