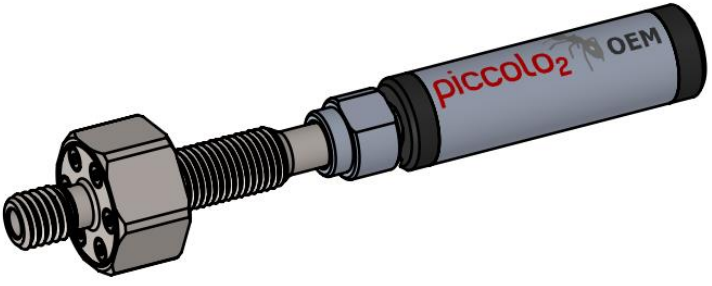
pyroscience
sensor technology

PICO2-SUBPORT

UNDWERATER
OEM-MODULE WITH UART-INTERFACE

MANUAL



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1 Introduction

The *PICO2- SUBPORT* is an OEM solution for fiber-optic oxygen measurements under water. It is designed for integration into custom-made underwater housings. The *PICO2-SUBPORT* consists of two parts. A special version of the *PICO2* oxygen meter, and a pressure stable optical connector. It can be used for many different applications like water column and sediment profiling, eddy covariance studies, etc.

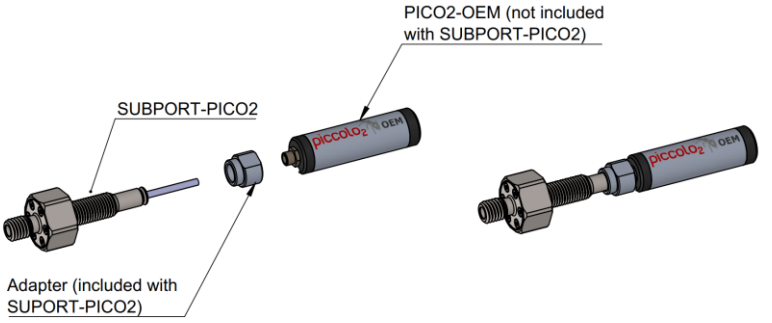


Figure 1 Overview of PICO2-SUBPORT

The *PICO2-SUBPORT* is a high precision optical oxygen meter for liquid samples, which is based on the optoelectronics of the proven USB-device *PICO2*. Most features of the *PICO2-SUBPORT* are identical to the *PICO2*.

The *PICO2- SUBPORT* is easy to mount and can also be used to retrofit existing underwater equipment since its thread is compatible to some of the most popular deep-sea connectors. The titanium connector is open face pressure stable up to 4000 m water depth (400 bars). It is typically mounted in the lid of pressure cylinders (Fig. 2).

A serial interface allows to control the instrument and to retrieve data. An optional USB-interface-cable (item ***PICO2-USB***) allows easy configuration, calibration and prototype testing of the module with the comfortable logger software ***Pyro Oxygen Logger***.

Download the correct software and Manual in the downloads tab of your purchased device on www.pyroscience.com

2 Safety Guidelines

Before using the *PICO2-OEM* and its sensors, read carefully the instructions and user manuals.

In case of problems or damage, disconnect the instrument and mark it to prevent any further use! Consult *PyroScience* for advice! There are no serviceable parts inside the device. Please note that opening the housing will void the warranty!

The *PICO2-OEM* is not watertight. The *PICO2-OEM* should be kept under dry and clean conditions, avoiding moisture, dust, corrosive conditions and excessive heating of the instrument (e.g. direct sun light).

Calibration and application of the sensors is on the user's authority, as well as data acquisition, treatment and publication!

The sensors and the *PICO2-OEM* are not intended for medical or military purposes or any safety-critical applications.

The sensors should be used in the laboratory by qualified personnel only, following the user instructions and the safety guidelines of the manual, as well as the appropriate laws and guidelines for safety in the laboratory!

Keep the sensors and the *PICO2-OEM* out of reach of children!

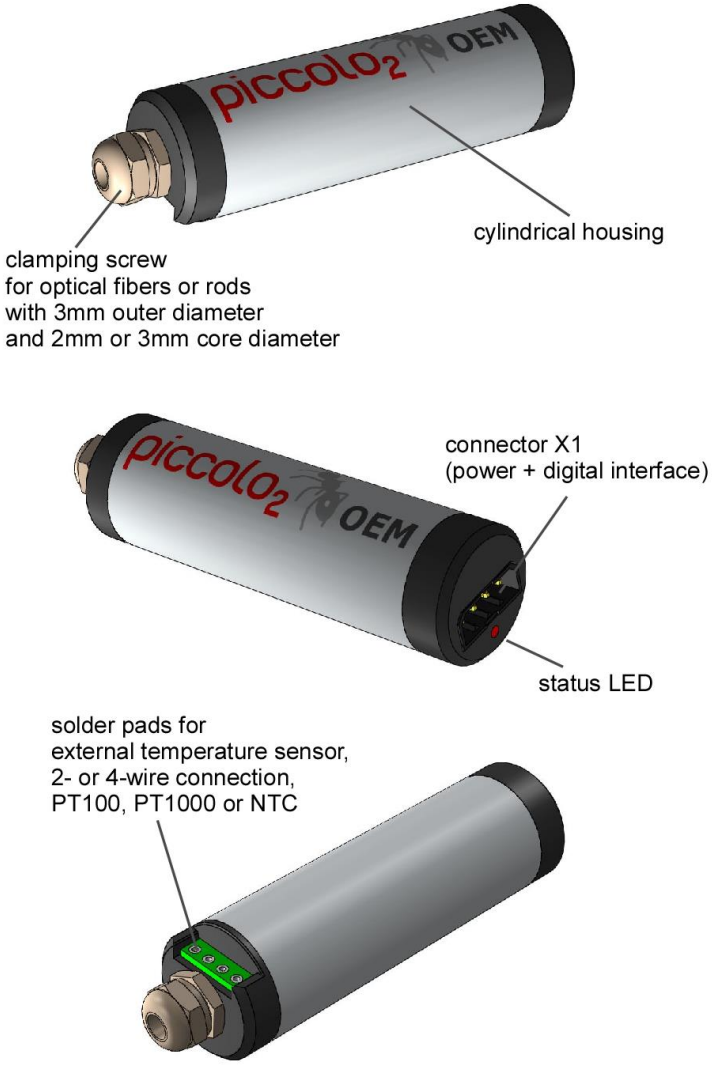


Figure 2: Overview PICO2-OEM

3 Overview

Figure 2 provides an overview of the ***PICO2-OEM***. The front provides the port for connecting fiber-optic oxygen sensors, as well as solder pads for an external temperature sensor (not included) enabling automatic temperature compensation of the oxygen measurement. The backside of the module provides the connector for the power supply and the digital communication interface, as well as a red status LED.

3.1 Fiber Connector

The ***PICO2-SUBPORT*** is compatible with special ***Pyro Science*** fiber-optic sensors for underwater applications designated by the appendix "-SUB" in the item number. A broad range of compatible sensor heads are available with tip diameters ranging from ca. 50-70 µm up to 430 µm (microsensors and minisensors). Refer to the ***PyroScience*** webpage for further details. The sensors can be easily installed and exchanged in the field without any tools.

3.2 External Temperature Sensor

The oxygen measurement is generally temperature dependent. To obtain accurate oxygen readings, the water temperature needs to be measured at the same time. The ***PICO2-SUBPORT*** provides built-in temperature compensation using an internal temperature sensor or an attached external sensor. Although the internal temperature sensor can be used for compensation under certain circumstances, the first choice should always be an external sensor placed close to the oxygen sensor.

Temperature compensation can also be performed in data post-processing using independent temperature measurements. Please contact ***PyroScience*** for details.

The oxygen measurement is generally temperature dependent. Therefore, the ***PICO2-OEM*** offers automatic temperature compensation of the oxygen measurement, which typically should be activated if the temperature changes during measurements are more than ca. 1ºC. The module offers for this a high-precision sensor interface which can be directly connected to a resistive temperature sensor (PT100, PT1000, or NTC; not included) which has to be placed within the sample where the oxygen is measured.

The firmware of the module offers special configuration registers which can be adapted to any PT100, PT1000 and NTC temperature sensor. A PT100- and PT1000-solution should be generally preferred, as they for most applications do not need any calibration, or in the worst case a simple offset calibration is sufficient. An NTC sensor is generally more difficult to calibrate due to its non-linear temperature characteristics and its typ. large production tolerances.

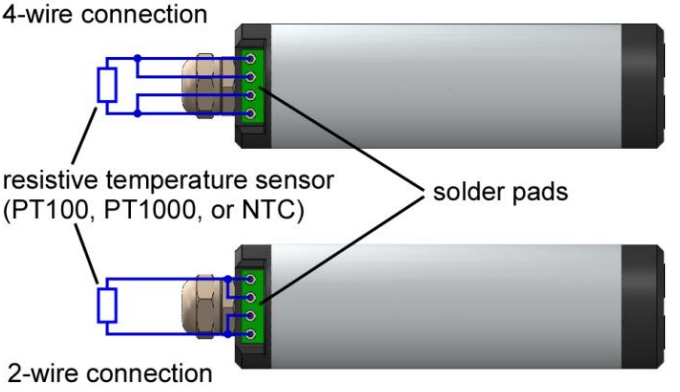


Figure 3: Connecting a resistive temperature sensor to the module

The resistive temperature sensor has to be soldered to the 4 solder pads at the front of the module (3). For short distances (e.g. 10 cm) a simple 2-wire connection might be sufficient. For this it is important to shortcut the outer with the inner solder pads as

indicated in Figure 3. For longer distances and/or for high precision measurements a 4-wire connection should be preferred (Figure 3).

NOTE: In order to minimize potential electrical noise coupling into the external temperature sensor, the cables should be twisted and as short as possible.

3.3 Supplementary Internal Sensors

Besides the very oxygen sensor, the ***PICO2-SUBPORT*** provides three other built-in high precision sensors:

(1) internal **atmospheric pressure sensor** for measuring the ambient air pressure
(2) internal sensor for measuring the **relative humidity** of the ambient air
(3) **internal temperature sensor** measuring the temperature of the ambient air

In typical applications, these three sensors will not be used since they are inside the pressure housing and thus provide no information about the environment. They are present because the ***PICO2-SUBPORT*** is a special version of the more generic ***PICO2*** module. The pressure and the humidity sensors will give reliable data about the ambient air of the module. The readings of the internal temperature sensor should be interpreted more carefully. Internal heating by the electronics typically increases the internal temperature by about 1°C, depending on operation conditions.

4 Installation

4.1 Mounting of Fiber Connector in the housing

The fiber connector can be installed in two ways, depending on the housing. In thick-walled housings, the connector can be screwed directly into a threaded hole. For thinner walls, fixing of the connector with the supplied hex nut is possible (Fig. 4). In both cases, the tightening force should not exceed 12 Nm. Note that the sealing surface must be smooth to ensure a good sealing. The O-ring should be lubricated with a thin layer of silicone grease before installation. The screw joint can be secured with bold adhesive, e.g. Loctite™243. Recommendations for the mounting hole can be found in Fig. 4.

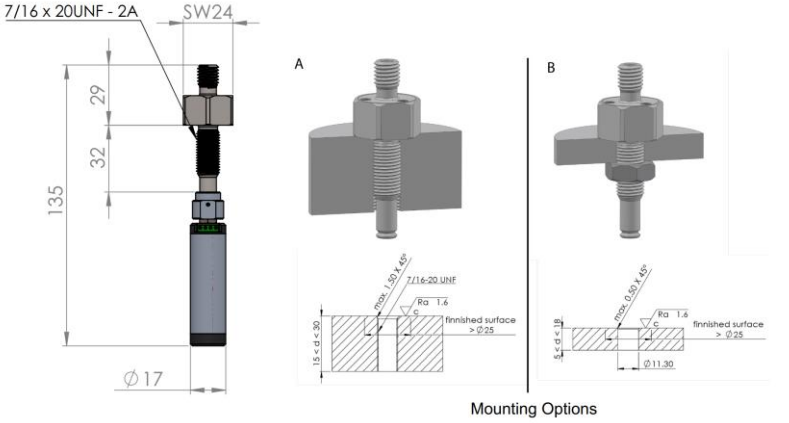


Fig. 4 Mounting options

Pressure tests of the whole assembly prior to deployment are strongly advised.

4.2 Status LED

The behavior of the status LED is given in Table 1.

Action/Status	Description	Behavior of status LED

Power-Up	The power supply is switched on.	A correct startup of the module is indicated by 4 flashes within 1-2 seconds, after this the LED remains lit.
Active	The module is either in idle mode waiting for a new command, or it is executing a command.	The LED is constantly lit.
Enter deep sleep	While the power supply is still enabled, the module can be put into deep sleep mode by the #STOP command.	The LED is switched off.
Exit deep sleep mode	The module reverts to active mode.	The LED is switched on.
#LOGO-command	The #LOGO-command is send to the communication interface	The LED flashes 4 times within 1-2 seconds, after this the LED remains lit.

Table 1: Behavior of the status LED

5 Electrical Interface

5.1 Connector

The electrical interface of the *PICO2-OEM* consists of the connector X1 (Figure 4). The package includes the fitting connector plug S1 (manufacturer: ***Phoenix Contact***, type: ***PTSM0,5/4-P-2,5***, item no.: ***1778858***). Stripped cable ends can be connected to S1 without any soldering or crimping. When inserting or removing a stripped cable end (stripping length 6 mm, max. core diameter 0.5 mm²) into one of the connector holes of the connector S1, an internal spring mechanism has to be unlocked by pushing relatively strong with a small screw-driver (flat-bladed 2 mm in width) into

the adjacent rectangular hole (Figure 4). The same manufacturer offers also fitting connector plugs for PCB mounting (details on request).

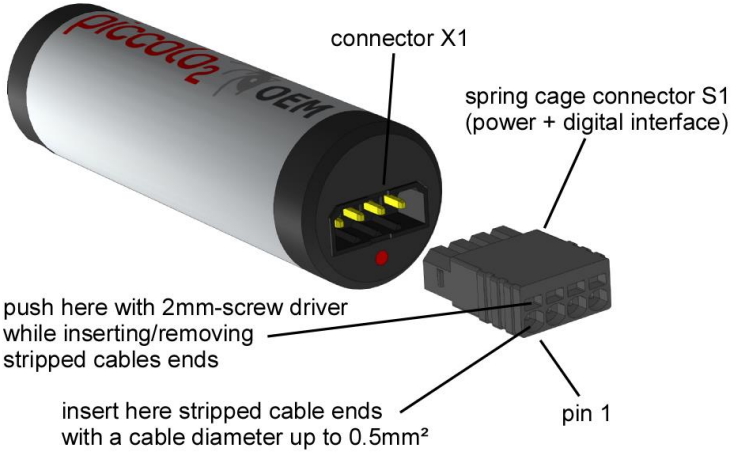


Figure 4: Electrical connectors of the PICO2-OEM

The pin configuration of the connector X1 is given in Table 2.

Pin	Name	Function	Description
1	VCC	Power	Power supply min. 3.3 VDC max. 5.0 VDC
2	RXD	Digital input 3.0 V levels (3.3 V & 5 V tolerant)	Data receive line of the UART interface
3	TXD	Digital output 3.0 V levels	Data transmission line of the UART interface
4	GND	Power	Ground

Table 2: Pin configuration of the connector X1

5.2 Operation via the UART-Interface

The ***PICO2-OEM*** is operated via a standard UART interface at 3.0 V levels (3.3 V and 5 V tolerant) consisting of a receive and a transmit line. The configuration of the UART-interface is as follows:

19200 baud, 8 data bit, 1 stop bit, no parity, no handshake

The baud rate can be changed by a special command of the communication protocol (refer to the communication protocol for further information). However, after power cycling the module always reverts to the standard baud rate of 19200.

Each action of the module is triggered by transmitting a text-command via the UART interface. For further details please refer to the communication protocol (available on request).

6 Software and USB interface cable

For the operation of the *PICO2-OEM* with a usual Windows PC, a coded USB interface cable (item *PICO2-USB*) is available from *PyroScience*. It includes a license for the comfortable oxygen logger software *Pyro Oxygen Logger*. Especially for initial testing purposes this logger software can speed up OEM-developments significantly. Additionally, the USB-interface cable *PICO2-USB* provides a virtual COM-port. Custom Windows-software can use this virtual COM-port for communicating directly with the module based on the communication protocol (available on request).

6.1 Software Installation

System requirements: PC with Windows 7/8/10 and min. 700 MB free disk space.

IMPORTANT: Do not connect the USB-interface cable *PICO2-USB* to your PC before the *Pyro Oxygen Logger* software has been installed. The software will install automatically the appropriate USB-drivers.

Installation steps:

- Download the correct software and manual in the downloads tab of your device on www.pyroscience.com
- unzip and start the installer and follow the instructions
- after the successful installation a new program group "Pyro Oxygen Logger" is added to the start menu, and a short-cut named "Oxygen Logger" can be found on the desktop
- connect one end of the USB-interface cable *PICO2-USB* to the connector X1 of the *PICO2-OEM*
- connect the other end to an USB-port of the PC. The status LED of the *PICO2-OEM* should flash shortly and remain lit, indicating the correct startup of the module.
- Start the *Pyro Oxygen Logger* software.

6.2 Using the Pyro Oxygen Logger software

The ***Pyro Oxygen Logger*** software with the USB interface cable ***PICO2-USB*** can be used for convenient configuration and calibration of the device. All device settings and calibration data are stored in non-volatile memory in the ***PICO2-OEM*** when the logger software is closed. Only minimal programming effort is necessary to trigger and read measurements from a device that is pre-configured this way. Thus, it is not necessary to implement any settings and calibrations routines in the custom software / firmware.

Please refer to the ***PICO2***-manual for general operation instructions for the oxygen logger software.

7 Connecting Oxygen Sensors

The ***FireStingO2-SubPort*** is compatible with special fiber-optic oxygen sensors for underwater applications designated by the appendix "***-SUB***" in the item number. A broad range of compatible sensor heads are available with tip diameters ranging from ca.50-70 µm, 430 µm, to 3mm (microsensors, minisensors, robust probes). Refer to the ***PyroScience*** webpage for further details.

An index matching liquid inside the connector enhances the sensor signals. Before connecting a sensor, insert a syringe needle to the bottom of the connector and fill it completely with deionized water. Alternatively, a drop of silicone oil on the face of the sensor plug can be used. The sensor is inserted and secured with the cap nut (Fig. 5). Do not use a wrench. It is sufficient to tighten the nut by hand.

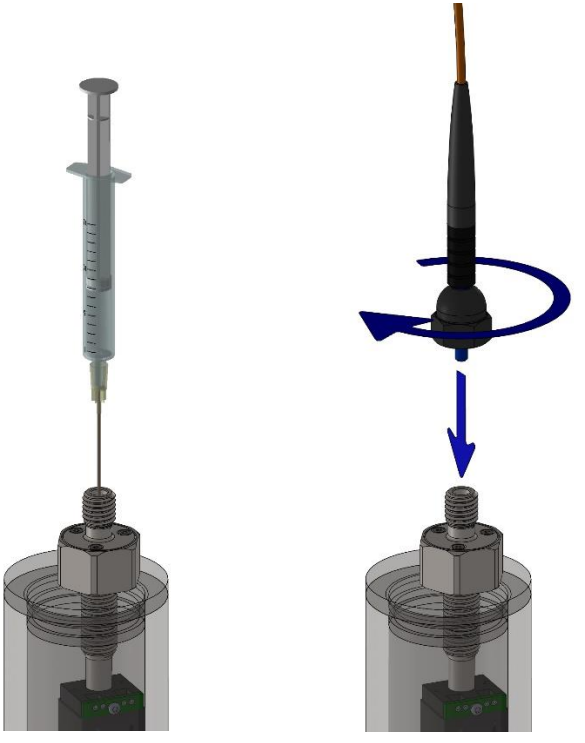
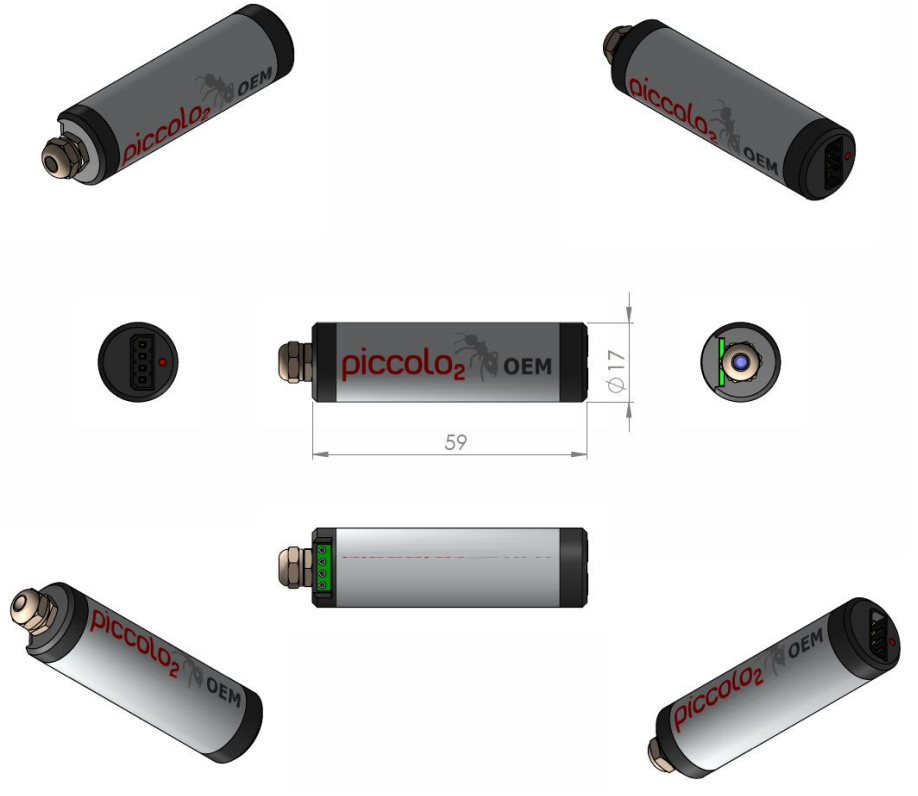


Fig. 5 Connection of sensors

8 Technical Drawing



The solder pads have 2.54mm pitch.

9 Specifications

General Specifications	
Dimensions	L=59 mm, Ø 17mm (without the optical port)
Maximum hydrostatic pressure	400 bar
Material fiber optic connector	Titanium (3.7035)
Power supply	min. 3.3 VDC max. 5.0 VDC
Power consumption	
-while acquiring a new oxygen data point	typ. 5-10 mA (typ. duration <100 ms)
-during idle time	typ. 2-3 mA
-during deep sleep mode	typ. 10 µA
Start-up time	
-from power off	1-2 s
-from deep sleep	ca. 200 ms
Interface	UART (3.0V levels, 5V tolerant), 19200 baud, 8 data bit, 1 stop bit, no parity, no handshake
Max. sample rate[1]	
-only with oxygen measurement	ca. 20 samples/s
-with oxygen and temperature measurement	ca. 5 samples/s
Operating temperature	0 to 50 °C
Storage temperature	-20 to 70 °C
Max. relative humidity	Non-condensing conditions

[1] Note: This max. sample rate refers only to the limits of the UART communication. It does not consider the actual response time of the connected optical oxygen sensor or of the temperature sensor.

Oxygen Sensor	
Oxygen measuring principle	lifetime detection of oxygen dependent REDFLASH indicator luminescence
Oxygen sensor connector	clamping screw for connecting optical fibers with an outer diameter of 3mm
Excitation wavelength	620 nm (orange-red)
Detection wavelength	760 nm (near infrared)
For further specifications of the oxygen sensors refer to the separately available specifications for the connected oxygen sensor.	
Port for External Temperature Sensors	
Compatible sensor types	PT100, PT1000, NTC (not included)
Measurement principle	2-wire or 4-wire resistance measurement via 24bit ADC
Resolution	<0.02 °C (typ. for PT100)
Accuracy	<+-0.2 °C (typ. PT100)
Range	-30 to 150 °C (typ. for PT100)
Internal Temperature Sensor	(located on internal PCB)
Resolution	0.02 °C
Accuracy	+-0.3 °C
Range	-40 to 125 °C