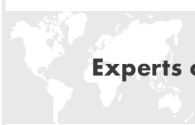


Operating manual

**Angst+Pfister Sensors and Power
oxygen sensor modules**

**FCX-MP1000-Extern-FH-030-A-CH
OEM module platform**



The items mentioned in this manual are trademarks and might be used for identification purpose.

Output protocol

Issue	Month / Year	Change management overview
1.1	February 2015	
1.2	October 2016	New, improved PCB layout
1.3	January 2020	New product code

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Angst+Pfister Sensors and Power AG

Thurgauerstrasse 66
8050 Zurich
Switzerland

Tel: +41 (0)44 877 35 00

sensorsandpower.de@angst-pfister.com
<https://sensorsandpower.angst-pfister.com>

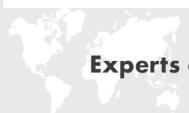
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Issue 1.3

Release 01.2020

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2 Customer Service

We at Angst+Pfister Sensors and Power AG would like to offer the best possible customer service. Should you have any questions, problems or comments regarding your FCX-MP1000-Extern-FH-030-A-CH, we would appreciate if you get in touch with us.

We recommend that all services, including repairs of the device, will only be taken care of by either our customer service or by specially trained staff.

You can reach us the following address:

Headquarter:

Angst+Pfister Sensors and Power AG

Thurgauerstrasse 66
8050 Zurich
Switzerland

Tel +41 (0)44 877 35 00

sensorsandpower.de@angst-pfister.com

<https://sensorsandpower.angst-pfister.com>

Before returning anything, please ask for an RMA-No.

Please send return goods to our Logistic Center:

Angst+Pfister Sensors and Power AG

Logistic Center
Hardhofstrasse 31
8424 Embrach/ZH
Switzerland

3 Security Information

Safety hazards that can endanger humans or do damage to the devices are specially mentioned in the user manual.

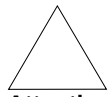
Before installing the device you should read the instructions carefully. Please take note of all paragraphs that point out possible hazards.

Warnings and instructions are expressed as followed:



Warning

Means that ignoring this instruction can endanger humans



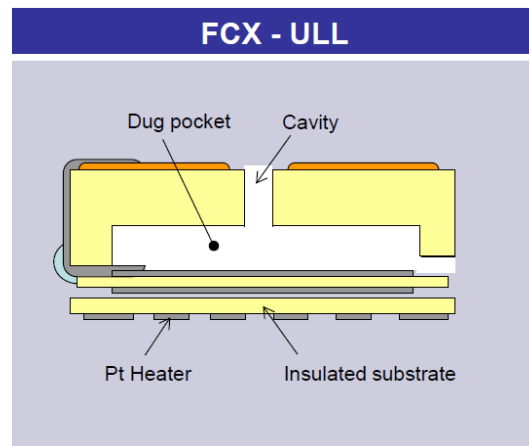
Attention

Means that this instruction has to be followed in order to prevent damage to the device

4 Measuring Principle

The sensor module is a complete solution for measuring oxygen within the range of 0...1000 ppmO₂. The sensor and the electronics are connected via board. The sensor is encapsulated in a pressure tight flow housing. The electronics amplify the sensor signal and transform it into a linear current output signal 4...20mA (according to IEC 60381)

In the picture below the schematics of zirconia sensing elements are shown.



Zirconium oxide, heated to about 450 °C, is penetrable for oxygen ions. A voltage applied to the sensor therefore pumps the oxygen out of the inner chamber. At a constant gas pressure, the quantity of oxygen pumped out is equal to the quantity of oxygen molecules diffusing in through the capillary, and within a certain range it is independent of the voltage applied between the electrodes. The measurement current is proportional to the quantity of oxygen molecules pumped away. The relationship between the oxygen partial pressure and sensor current is

$$I_L = ([A]/1000) \times [O_2\text{ppm}],$$

where

I_L = sensor current

A = sensor output current in 1000ppm O₂ (μA)

pO₂ = oxygen concentration (vol ppmO₂)

The sensor module performs four tasks:

- Regulation of the heating power of the sensor
- Amplification of the microampere signal from the sensor
- Conversion of the amplified signal into a standardised current output signal

The sensor and module are calibrated to one another at the factory. The heating voltage must be custom-adjusted for each sensor to bring the temperature to exactly 450 °C. The sensor is not directly replaceable, and cannot be used with other modules.

5. Operation Start

5.1 Mechanical Installation

The PCB has dimensions 75 x 40 x 15 mm (including the electrical connector) (Fig.1 & 2).

The total height (18 mm) of the module is composed of the thickness of the board (2 mm), the height of the electrical connector (11 mm) on the front side of the board and the maximum height (5 mm) of the components on the back side of the board.

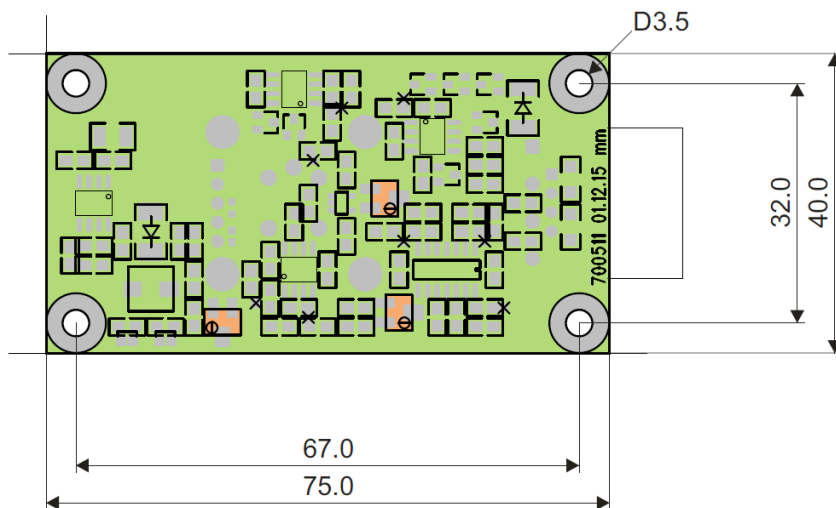


Fig. 1 PCB electronic layout for FCX-MP1000-Extern-CH (back side of the board)

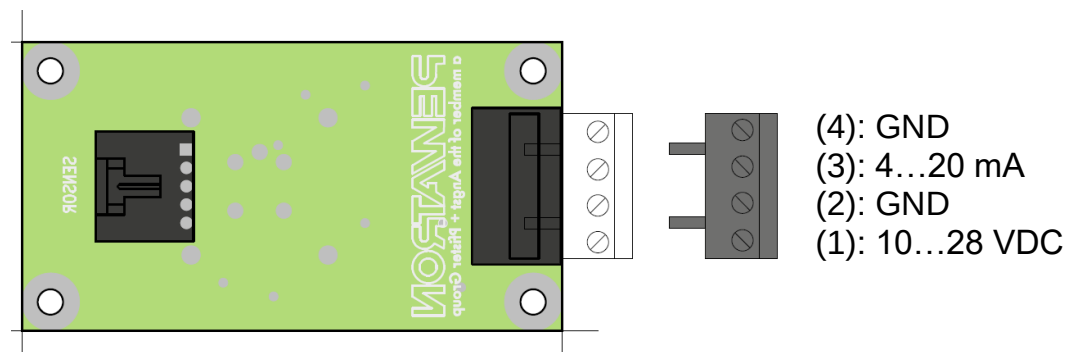


Fig. 2 PCB side with plug cable electrical connector; FCX-MP1000-Extern-CH (front side of the board) with solder paths for the soldering of the cable.

In each corner of the PCB, there are mounting holes with a diameter of 3.5 mm. The distance between the centre of mounting holes are 67 and 32 mm, respectively.



Caution

The PCB has highly sensitive circuitry. During installation, be careful that none of the components are damaged mechanically.

The sensor FCX-ULL is mounted in a flow house construction (Fig. 3) that ensure no leaks from outside during the measurement. The sensor and flow housing is connected to the PCB with a 30 cm cable. Other configurations of the sensor integration are available upon request.

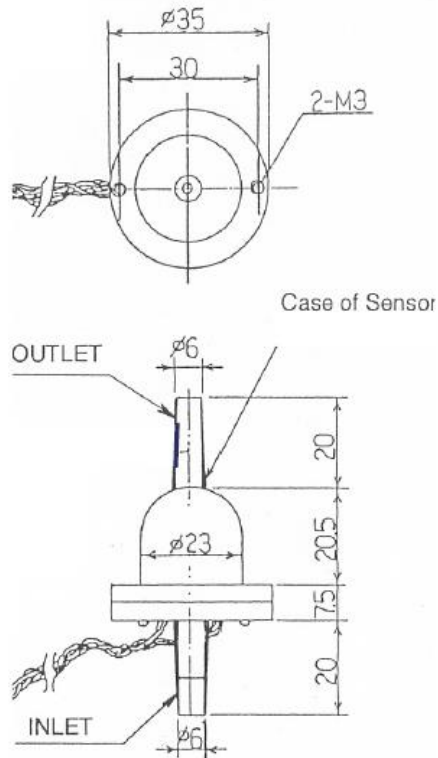
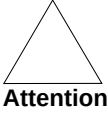


Fig. 3 Drawing of Flow house for the FCX-ULL sensor.

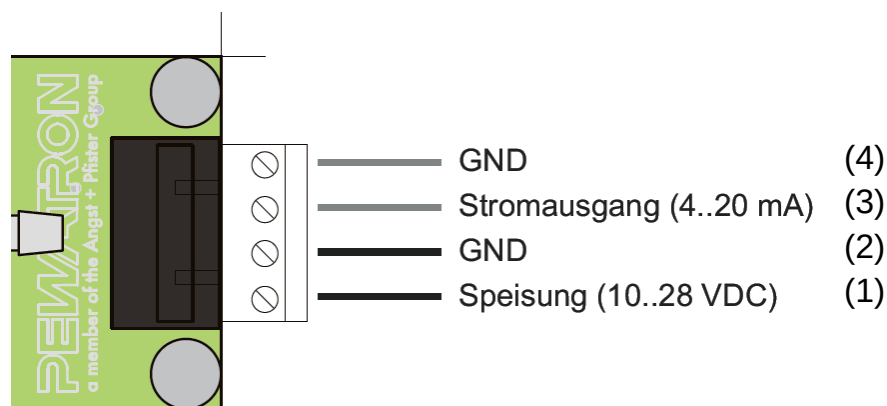
5.2 Pneumatical Connections

The flow housing has two pressure ports with 6 mm diameter. The flow direction is from the top part (with the bulb-form appearance) to the bottom part where the sensor connecting wires comes out.



Do not use silicone hoses.

5.3 Electrical Connections



The 10–28 VDC power for the module is supplied through terminals 1 (+) and 2 (GND), at about 250 mA (24 VDC). For the lower limit of the power supply voltage, please take into account the resistance between the current output terminals. As an example; using a 500 Ohm resistance between the output terminals will cause of 10 V voltage drop at an output current of 20 mA. If the supply voltage is only slightly above this voltage drop, the required current for operating the module may be too low, which will then cause erroneous measurement output values.

For the output signal (4-20 mA) the clamps 3 (+) and 4 (-) is to be used.

6 Environment Condition

Also see item 11 in our specifications, especially for the temperature and humidity range (non-condensing).

- Not to be operated outdoors without proper protection of the electronics.
- Protect the module against humidity
- The sensor is best operated in oxygen concentrations below 1000 ppmO₂, but can see short periods of atmospheric oxygen (20.9 vol%O₂). Continuous exposure of the sensor with oxygen concentrations above 1 vol%O₂ may slow the sensor response time and it limits the lifetime of the sensor.

The temperature of the sensor is 450°C. Be aware of possible dangers while handling sensitive gas mixtures.

	Potentially explosive Atmosphere The device must not be operated in a potentially explosive atmosphere.
Warning	

7 Warm Up Time

The modules need a warm up time of approx. 5 minutes

8 Gas Flow

The following points should be noted:

- The flow should not be less than 0.1 l/min and no greater than 1.0 l/min; ideally, it should be 0.5 l/min.
- We recommend placing an appropriate filter upstream of the module, since contaminants brought in by the flow can significantly shorten the service life of the sensor.
- Avoid condensation (H₂O) in the sensor housing.

9 Calibration

All necessary adjustments and calibrations are being done at the production site.
The output signal is to be read as followed:

$$pO_2 \text{ (ppm)} = 1000 \text{ (ppm)} (I_{out} [mA] - 4 [mA]) / 16 [mA]$$

means:

pO_2 : oxygen partial pressure in ppm of the total pressure

I_{out} : output current in mA

9.1 Calibration Adjustments and Periodical Check-ups

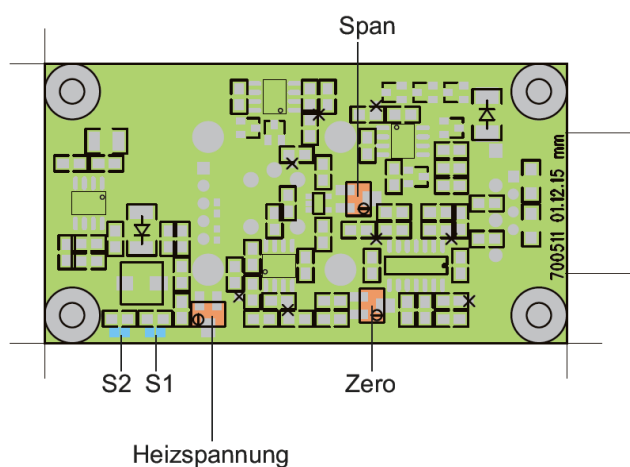
It is recommended to check the device periodically by running it under regular lab conditions and flush the sensor with pure nitrogen (6N) to check the zero-point. After flushing the sensor for 1 minute the output current should be 4.005 +/-0.005 mA.

9.2 Adjustment Span and Zero

The modules are calibrated and each module is supplied with a calibration sheet. The result of the measuring at an environmental temperature of 25°C and in pure nitrogen should be 0+/-50 ppm. Should there be higher differences as expected try following procedure.

- 1 Attach the module to the supply
- 2 Expose the sensor with a gas with known concentration and in the range 1000+/-10 ppm.
- 3 After 10min. adjust the output signal using the span potentiometer. In a clean environment the amplifier should have an output signal of 20,00 mA ($\pm 0,05$ mA).
- 4 Flow pure N₂ (6N).
- 5 After approx. ca. 10min. adjust the output signal to 4,050 mA $\pm 0,05$ mA using the zero potentiometer.

This completes the calibration.



10 Important Advice

10.1 Restrictions

- 1 Don't change the length of the lead wires.
- 2 Do not continuously operate the sensor in a high oxygen concentration ($> 0.1\% \text{ O}_2$)
If the sensor is exposed to such high oxygen concentration, limited output over 20mA will be observed. Should this happen, please turn off the power source.
- 4 Please use regulated DC power source with current capacity over 1 ampere/pc. If current capacity is not sufficient, the sensor module will not operate correctly.
- 5 This sensor module was adjusted for $\text{O}_2\text{-N}_2$ system, so abnormal output maybe observed if there are other gases present.
- 6 Don't use in a gas that contains the halogen atoms (F, Cl, Br). The sensor can be damaged by the gas.
- 7 SO_x , NO_x und H_2S will damage the performance of the sensor. Therefore, please do not use sensor module in the atmosphere that contains these gases.

11 Specifications

Measurement Ranges	: 0...1000 ppmO ₂
Supply	: 24 VDC nominally (10...28 VDC)
Current supply	: typ. 200 mA (24 VDC). Turn off peak approx. 0.7 A
Power Consumption	: < 3 W
Output	: 4...20 mA, linear
Accuracy	: ±50 ppmO ₂ (single measurement), < ± 5 ppmO ₂ (Continuous measurement cycles or fast repetitive measurements)
Repeatability	: ±5% Reading (single measurement)
Temperature Influence	: < 0.02 %relative/°K (-10 °C... +50 °C)
Response Time	: < 20 sec. T ₉₀
Gas Temperature	: -10 °C... +50 °C
Environmental temperature	: -20 °C... +70 °C
Humidity	: 85 %RH non-condensing
Dimensions L x W x H	: 75 x 40 mm (PCB)
Weight	: 100 g

We are here for you. Addresses and Contacts.

Headquarter Switzerland:

Angst+Pfister Sensors and Power AG
Thurgauerstrasse 66
CH-8050 Zurich
Phone +41 44 877 35 00
sensorsandpower@angst-pfister.com

Office Germany:

Angst+Pfister Sensors and Power Deutschland GmbH
Edisonstraße 16
D-85716 Unterschleißheim
Phone +49 89 374 288 87 00
sensorsandpower.de@angst-pfister.com

Office North America:

Angst+Pfister North America Inc.
10391 Brecksville Rd.
US-Brecksville, OH 44141
Phone +1 440 375-5212
info.apus@angst-pfister.com

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