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# pyroscience Optical Temperature Sensors User Manual

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Temperature Sensors User Manual

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## pyroscience Optical Temperature Sensors



### INTRODUCTION

PyroScience offers fiber-based and contactless optical temperature sensors, as well as a number of combined sensors like flow-through cells respiration vials and sensor vials for simultaneous measurements of temperature, oxygen and pH. These sensors can be read-out with the following fiber-optic meters from PyroScience

- the multi-channel PC-operated FireSting-O2 (FSO2-Cx (firmware 4 devices) with Pyro Workbench and FSO2-x (firmware 3 devices) with Pyro Oxygen Logger software) for optical O2 and temperature sensors and
- the multi-analyte & multi-channel PC-operated FireSting-PRO (with Pyro Workbench) for optical pH, O2 and temperature sensors
- the underwater AquapHOx Loggers and Transmitters (with Pyro Workbench) for optical pH, O2 and temperature sensors with underwater connector (option -SUB). All software versions are available for free download from the PyroScience website and must be installed on a Windows PC/laptop before connecting the respective meter for the first time. For details on the read-out devices and their software, please see their respective manuals and handling guidelines. This manual is intended to provide all necessary information on standard application of optical temperature sensors from PyroScience. For more information concerning advanced applications, please get in touch with us at [info@pyroscience.com](mailto:info@pyroscience.com). Your PyroScience Team

### QUICK START

Step 1: Please download the correct software in the downloads tab of your purchased device on [www.pyroscience.com](http://www.pyroscience.com), unzip and start the installer, and follow the instructions.

Step 2: After successful installation, connect the PyroScience read-out device to the Windows PC/laptop with the micro-USB cable.

Step 3: Carefully remove the protective caps from the sensor tip, from the fiber plug and from the optical connector(s) at the FireSting read-out device.

Step 4: Connect the PyroScience temperature sensor(s) to the optical channel connector(s) of the device.

Step 5: For calibration of optical temperature sensors, connect an appropriate Pt100 temperature sensor to the temperature port. Alternatively, a fixed temperature can be entered (needs to be measured and kept constant).

Step 6: Start the PyroScience software by clicking on the short-cut on your desktop.

Step 7: Enter all required Sensor Settings for each connected sensor, including the sensor code, sample interval, measuring mode and, for contactless sensors, also the fiber length (m).

Step 8: Perform a 1-point Calibration of the optical temperature sensor. As reference temperature, select either the connected Pt100 temperature sensor (needs to be calibrated first, see chapter 8.4) or enter a fixed temperature at constant temperature conditions (e.g. in a water bath).

Step 9: Start measurements and activate Data Logging.

## SENSOR SETTINGS

Each optical temperature sensor comes with an individual Sensor Code, containing important information for optimal sensor settings and for calibration. The first letter of the sensor code defines the sensor type. Therefore, it is important to enter the Sensor Code of the connected sensor into the Sensor Settings of the respective software. The number of the channel tab must correspond with the channel number at the FireSting read-out device. Important: Enter the correct Sensor Code for sensors connected to a channel at a FireSting read-out device. The sensor code can be found on the label attached to the cable (fiber-based sensors) or on the bag of contactless sensors (see



example below).

Next the Measuring Mode needs to be entered (refer to the Pyro Workbench or FireSting-O2 (firmware 3) manual for further information). This can be adjusted gradually between low drift and low noise of the sensor signal by moving the arrow with the mouse along the scale. An intermediate mode is default. The Unit of the temperature readings is °C (centigrade).

## SENSOR CALIBRATION

Ensure that the correct Sensor Code has been entered in the settings (refer to chapter 3). The 1-point calibration of optical temperature sensors can be performed against two different reference temperatures:

- the temperature measured by the external Pt100 Temperature Sensor (item TDIP15 or TSUB21)
- a Fixed Temperature that needs to be determined and entered in the software (must be kept constant)Note: For precise optical temperature sensor calibration using the External Temperature Sensor, it needs to be determined manually if the external (Pt100) temperature sensor has an offset. In case of an offset, the Pt100 temperature sensor needs to be calibrated first (see Appendix 8.4) before calibrating the optical sensor. If a Manual Temperature was selected, the temperature in the sample/calibration standard must be measured, adjusted and kept constant (needs to be controlled)! Ensure constant and defined conditions!
- Gas measurements (only in combination with oxygen sensors): the sensor should be calibrated in ambient air at defined temperature
- Measurements in aqueous/water samples: the sensor has to be calibrated in water at defined temperatureNote: It is strongly recommended to perform the calibration at conditions close to the environmental temperature during measurements. Ensure constant temperature during calibration.

### Calibration procedure

NOTE: Calibration of the optical temperature sensor is only possible if the correct Sensor Code has been entered in the Settings. Calibration should be performed following the instructions of the software (Pyro Workbench) or read-out device manual. It is generally recommended to perform a 1-point calibration in gas (water) for gas (water) measurements. Important: The device and sensors must be placed for >30 min. under constant temperature conditions before the calibration is performed. For a calibration with the external temperature sensor (item no. TDIP15 or TSUB21), ensure that the external temperature sensor is placed close to and exactly at the same temperature conditions as the optical temperature sensor. For calibration against a fixed/manual temperature (°C), use a calibrated incubator (for measurements in the gas phase) or water bath of constant and known temperature (for measurements in water/aqueous samples). When the sensor is placed into the calibration medium (air or water), wait until the sensor reading is stable by observing the graph and the numerical display of the temperature sensor reading. If all readings have reached their steady-state, calibrate the optical temperature sensor accordingly. A completed calibration is indicated by the green indicator.

## SENSOR APPLICATION

PyroScience optical temperature sensors can be applied in gas phases and aqueous solutions, and are typically used for two different purposes:

- for precise and fast temperature measurements in water
- for true temperature compensation of PyroScience optical oxygen and pH sensor readings

Specific application and calibration instructions for different sensors are listed in the following table.

### Fiber-based Sensors

- Sensor item Sensor-specific application instructions
- TPR430 Application: water & gas & semi-solid samples Calibration: 1-point calibration Note: Handle with care to avoid injuries! Extend sensor tip for calibration and measurements.
- TPF1100 Application: water & gas and semi-solid samples (only in combination with item OXF1100) Note: Handle with care! Unprotected fragile sensor tip.
- TPB430 Application: water & gas & custom application Calibration: 1-point calibration Note: Handle with care, especially during custom integration! Unprotected fragile sensor tip. Avoid breakage!

### Contactless and combined sensors

- Sensor item Sensor-specific application instructions
- TPSP5 Application: water & gas (gas only with item OXSP5) Calibration: 1-point calibration Features: optical isolation Sterilization: 70% ethanol (EtOH), 70% isopropanol (ISPP), can be autoclaved (details on request) Note: Mind air bubbles! Glue carefully with silicone glue and let dry for 24h.
- TOVIAL... Application: water & gas Calibration: 1-point calibration for temperature sensor, 1- or 2-point calibration for oxygen sensor (see oxygen sensor manual) Features: optical isolation Sterilization: 70% ethanol (EtOH), 70% isopropanol (ISPP) Note: Remove air bubbles! Determine specific volume before measurements. Ensure stable temperature conditions.
- PHTOVIAL ... Application: water Calibration: 1-point calibration for temperature sensor, 1- or 2-point calibration in specified buffers/oxygen calibration standards (see oxygen and pH sensor manual) Features: optical isolation Note: Remove air bubbles! Determine specific volume before measurements. Ensure stable temperature conditions.
- TOFTC2 Application: water & gas Calibration: 1-point calibration for temperature sensor, 1- or 2-point calibration for oxygen sensor (see oxygen sensor manual) Sterilization: 70% ethanol (EtOH), 70% isopropanol (ISPP) Note: Liquid flow rate of 20-500 mL/min recommended. Remove air bubbles! Clean regularly.

## STERILIZATION, CLEANING AND STORAGE

### Sterilization

Refer to the specifications on the respective PyroScience website. The temperature sensor spots (item no. TPSP5) can be autoclaved. More details on request. The temperature sensor spots and the combined sensors can be treated with 70% ethanol and 70% isopropanol. Important: Do not use bleach, acetone or any solvent/agent not approved by PyroScience!

### Cleaning and Storage

After the measurements, the sensor tip of the needle-type and bare fiber sensors should be rinsed carefully with demineralized water. The sensors can further be cleaned with 3% H<sub>2</sub>O<sub>2</sub> and soap solution, followed by thorough rinsing with demineralized water. After cleaning, let dry and put on the protective cap/tubing for storage in a dry, dark and secure place at room temperature. Put the black caps on the plug of the fiber to prevent that light is entering the fiber possibly causing photo-bleaching of the indicator. For retractable sensors and application in samples with dissolved salts (e.g. seawater), the sensor must be cleaned thoroughly with demineralized water to prevent salt crystallization in the needle which can cause breaking of the sensor tip. After drying, retract the sensor tip into the needle and put on the protective cap onto the needle to protect the sensor tip and to avoid injuries. Store the sensor in a dry, dark and secure place at room temperature.

## RELATED DOCUMENTS

Related documents for more detailed instructions on fiber-optic read-out devices, software and optical sensors are available:

- manual for logger software “Pyro Workbench” (Windows)
- manual for multi-analyte meter FireSting-PRO
- manual for oxygen meter FireSting-O2 (FSO2-Cx, firmware 4)
- manual for oxygen meter FireSting-O2 (FSO2-x, firmware 3 with Oxygen Logger software)
- manual for the AquaphOX Loggers or Transmitters
- manual for optical pH sensors
- manual for optical temperature sensors

## APPENDIX

### Temperature Measuring Principle

Optical temperature sensors rely on thermal quenching of photoluminescence. In this physical process, luminescent properties of the material are reversibly affected by temperature. The sensor response times are only limited by the dimensions of the sensor and are ultra-fast (<0.1 s in water), like in case of fiber-optic minisensors. The utilized temperature-sensitive material is specially optimized to be fully compatible with the innovative REDFLASH technology from PyroScience, being excitable with orange red light (610-630 nm) and showing emission in the near infrared part of the spectrum. Importantly, the optical temperature sensors are characterized by extreme photo-stability, which enables virtually unlimited number of measurements, and does not show interferences with gases (such as oxygen) and ionic species.

### Explanation of the Sensor Code

The temperature sensors are delivered with an attached sensor code which must be entered into the Settings (refer to chapter 3). The following figure gives a short explanation of the information given in the sensor code.

Example Code: **DG6-310-479**

**Sensor Type**

**LED Intensity**

**Amplification**

**C0**

**C100**

- Optical Temperature Minisensor (Thermoblue) Optical
- Temperature Sensor Spot/FTC (Thermogreen)

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LED Intensity

- 10%
- 40%
- 15% F 60%
- 20%
- 80%
- 30%
- 100%

### OPTICAL TEMPERATURE SENSORS

C0 and C100 values needed for calibration

### Available sensors and read-out devices

Sensor Type	Compatible read-out devices		
	FSO2-Cx/FSO2-x	FSGO2	FSPRO
TPR430	✓	✗	✓
TPF1100	✓	✗	✓
TPB430	✓	✗	✓
TPSP5	✓	✗	✓
TOFTC2	✓	✗	✓
TOVIAL4 TOVIAL20	✓	✗	✓
PHTOVIAL20	✓ with SPFIB-BARE / SPFIB-LNS	✗	✓

### FireSting devices

### PICO devices

Sensor Type    Compatible read-out devices PICO-T

TPSP5            with PICFIB2 / PICROD2

TOFTC2        x

### SUB-connector Devices

Compatible read-out devices		
Sensor Type	FSO2-SUBPORT APHOX-x	PICO-T-SUB
TPR430-SUB	x	
TPF1100-SUB	x	
TPB430-SUB	x	
TPSP5	with SPFIB-BARE-SUB	
TOFTC2	x	
TOVIAL4		
TOVIAL20	x	
PHTOVIAL20	x	

## Pt100 Temperature Sensor Calibration

For precise absolute temperature readings and precise calibration of optical temperature sensors, an optional 1-point calibration of the external temperature sensor Pt100 is recommended (except for AquapHOx devices). For this, check the reading of the external temperature Pt100 probe periodically in stirred water / water bath / incubator of known temperature at steady state. It is also possible to prepare a water-ice-mixture giving 0°C, where at least 50 mm of the Pt100 temperature probe tip is submerged. IMPORTANT: After calibration of the Pt100 temperature sensor, a new optical sensor calibration must be performed.

## WARNINGS AND SAFETY GUIDELINES

Before using PyroScience oxygen sensors, carefully read the instructions and user manuals for the respective PyroScience read-out device. The manuals are available for download on [www.pyroscience.com](http://www.pyroscience.com) Prevent mechanical stress (e.g. scratching) to the sensing surface at the tip of the temperature sensor! Avoid strong bending of the fiber-optic cables. They might break!

Ensure that the complete sensing surface at the tip is always covered by the sample and is free of air bubbles, and that liquid samples are stirred. Calibration and application of the temperature sensors is on the user's authority, as well as data acquisition, treatment and publication! PyroScience temperature sensors and read-out devices are not intended for medical or military purposes or any other safety-critical applications. They must not be used for applications in humans; not for in vivo examination on humans, not for human-diagnostic or therapeutic purposes. The sensors must not be brought in direct contact with foods intended for consumption by humans. The sensors must 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 PyroScience temperature sensors and read-out devices out of reach of children! Store the temperature sensors in a secure, dry and dark place at room temperature.

## Documents / Resources



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Optical Temperature Sensors, Temperature Sensors

## References

- [Sensor technology - PyroScience GmbH](#)
- [Sensor technology - PyroScience GmbH](#)

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