Oxygen Sensor

Owners Manual

Model: O2S
-D or -F
-S or -FR
-TM or -TC

apogee instruments inc.

model O2S-F-S-TC

Oxygen Sensor

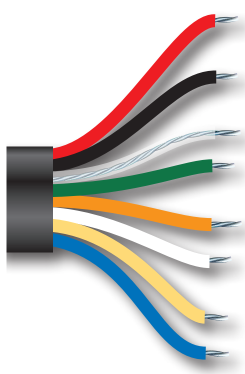
This sensor is a galvanic cell type oxygen sensor that measure oxygen gas (O_2) in air. It has a lead anode, a gold cathode, an acid electrolyte, and a Teflon membrane. The current flow between the electrodes is proportional to the oxygen concentration being measured. An internal bridge resistor is used to provide a mV output. Unlike polargraphic oxygen sensors, they do not require a power supply. The accompanying temperature sensor and resistance heater (inside the same housing) do require power as listed on page 8. The internal micro-heater serves to prevent condensation on the sensing membrane in high humidity applications.

The mV output responds to the partial pressure of oxygen in air. The standard units for partial pressure are kPa. However, gas sensors that respond to partial pressure are typically calibrated to read out in mole fraction of the gas in air, or units of moles of oxygen per mole of air. These units can be directly converted to % O_2 in air, or ppm O_2 in air. The concentration of oxygen in our atmosphere is 20.9476 %, and this precise percentage has not changed for decades. It is also constant across changing temperatures or pressures. This allows for precise calibration of the instrument.

Additional information and a sample datalogger program for Campbell Scientific Dataloggers can be found at our website at:

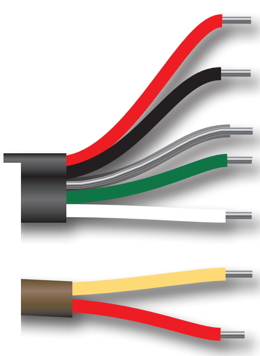
http://www.apogee-inst.com/oxygen_sensor.htm

Wiring for O_2 sensor with thermistor (-TM)



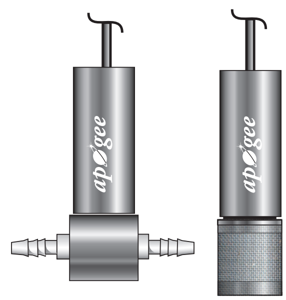
red	High side of differential channel (positive lead for sensor)
black	Low side of differential channel (negative lead for sensor)
clear	Analog ground (for sensor)
green	Single-ended channel (Positive lead for thermistor)
orange	Analog ground (negative lead for thermistor)
white	Excitation channel (excitation for thermistor)
Yellow	12V port (positive lead for heater)
Blue	Ground (negative lead for heater)

Wiring for O_2 sensor with thermocouple (-TC)



red	High side of differential channel (positive lead for sensor)
black	Low side of differential channel (negative lead for sensor)
clear	Analog ground (for sensor)
green	12V port (positive lead for heater)
white	Ground (negative lead for heater)
Yellow	High side of differential channel (positive lead for thermocouple)
red	Low side of differential channel (negative lead for thermocouple)

Using the Sensor



For the most stable reading, the sensor should be used with the sensor opening facing down. This facilitates the best contact of the electrolyte with the O_2 sensing elements.

1. Connect the O_2 lead wires to a good quality volt meter or a datalogger. See page 3 for wiring instructions.

2. To calibrate, measure the millivolt output of the sensor in a well ventilated area. The O_2 concentration in the atmosphere is 20.95 %. Do not breathe on the sensor as exhaled breath is much lower. The output signal of the sensor is approximately 50 mV for the soil sensor and 12 mV for the fast response sensor in ambient air at sea level. Calibration establishes the exact multiplier to convert the mV reading to % O_2 .

3. Divide 20.95 by the mV output value. If the output was exactly 12.0 mV the multiplier would be 1.746 (20.95 / 12.0). This is the multiplier to convert mV to % O_2. This multiplier will be correct for your elevation, current barometric pressure, current humidity, and current temperature.

4. Install the multiplier value in your datalogger program.

5. Recalibrate as needed when changes in pressure, temperature, or humidity occur.

Effects on Output

Influence From Various Gases

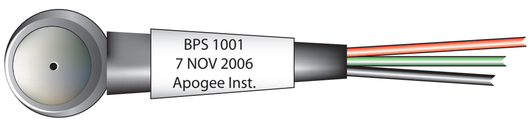
The sensor is unaffected by CO, H_2, and various acidic gases such as CO_2, H_2S, NO_X, SO_X. However, the Teflon membrane used in the sensor may be damaged by ozone.

Temperature Sensitivity

By itself, the uncorrected mV output of the galvanic cell would follow changes of the absolute temperature. A 3 °C change at room temperature (about 25 °C), would change the output by approximately 1 %. The internal thermistor or thermocouple provides data on the current temperature so its effect can be corrected according to the ideal gas law ($PV = nRT$).

Pressure Changes

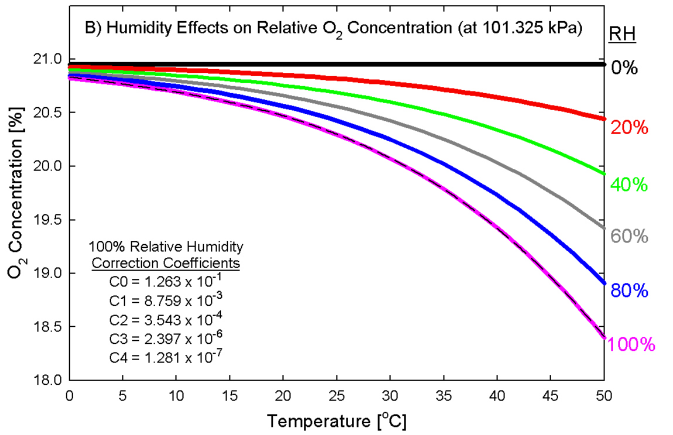
A change in barometric pressure changes the amount of oxygen available to the sensor and therefore changes what mV output correlates to oxygen's atmospheric constant of 20.95 %. To eliminate this possible error, simply re-calibrate or incorporate Apogee's barometric pressure sensor, model BPS.



Model BPS

Humidity Changes

The graph below shows an example of humidity dependency. The sensor chemistry is not influenced by humidity, but its output decreases because O_2 is displaced by water vapor molecules in the air. The effect of humidity is larger at warmer temperatures because there is more water vapor in the air.



For use in high humidity, such as in soil, remove the head and take the calibration measurement over water in a sealed container as shown at right.

Zero Offset

The mV output in ultra-pure nitrogen gas (0.000 % oxygen) is typically ± 0.05%. Precise measurements of hypoxic and anaerobic conditions can be made by making a periodic zero calibration of the sensor with ultra-pure nitrogen gas. The zero offset for each sensor is highly reproducible and should be entered into the programming after a zero- test.

Life Expectancy

The life expectancy of the sensor is expressed in %-hours as follows:

[Oxygen Concentration (%) x Exposure Time (hours)]

Accordingly, the life of the Apogee Fast Response Oxygen Sensor (-FR) is 900,000 %-hours or approximately 5 years of continuous use (at 21% oxygen at 20 ˚C). Life expectancy for the Apogee Soil Sensor (-STD) is 1,800,00 %-hours, or approximately 10 years.

Storage Temperature

The life of the sensor can be extended by storage at a lower temperature. For example a sensor stored at 0 ˚C will have a life expectancy approximately twice that of a sensor stored at 20 ˚C. The absolute minimum storage temperature is -20 ˚C. Below that temperature the electrolyte will freeze. Maximum storage temperature is 60 ˚C.

Shock And Vibration

The sensor is resistant to 2.7 G of shock. However, vibration may influence the sensitivity of the sensor and should be minimized.

Specifications

Sensor dimensions	3.15 dia. by 6.85 cm long. 1/2" X 20 threaded end
Mass	175 g
Range	0 to 100% O_2
Accuracy	< 0.01% O_2 drift per day
Repeatability	±0.001% O_2 (10 ppm)
Input power	12V power for heater, 5V excitation for thermistor
Operating environment	0 to 50 °C
Cable	3 meters of shielded, twisted 6-conductor cable with Santoprene casing, ending in pigtail leads;
Warranty	1 year parts and labor

O2S	***D or F***	***S or FR***	***TM or TC***
	Diffusion Head (D) 1.375" tall, 1.375" dia., 125 mesh screen creates air pocket	**Soil (S)** Output: ~50 mV at 20.95% O_2 Signal Decrease: <0.2% annually Life Expectancy: 10 years continuous use Response time: 60 seconds	**Thermistor (TM)** Datalogger Channels: 1 differential and 1 single-ended (Recommended for best accuracy.)
	Flow Through (F) 3.5 long by 3.5 cm dia. 1/8" Barbed adapters for hose connections	**Fast (FR)** Output: ~12 mV at 20.95% O_2 Signal Decrease: 4% annually Life Expectancy: 5 years continuous use Response time: 12 seconds	**Thermocouple (TC)** Datalogger Channels: 2 differential (Requires a thermocouple reference.)

apogee instruments inc.

435-792-4700
www.apogeeinstruments.com
techsupport@apogee-inst.com