



**AquaMetrix AM-ODO2**  
Optical Dissolved Oxygen Probe



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## 1. Introduction

The AM-ODO is one of the most compact, durable, and easiest to use dissolved oxygen sensors on the market. It is an optical sensor that utilizes fluorescence quenching technology. With this technology, the quenching of fluorophores by dissolved oxygen molecules decreases the fluorescence intensity and lifetime, the latter of which is detected by a photodetector and allows the dissolved oxygen (DO) concentration to be quantified accurately and consistently. Unlike polarographic and galvanic electrochemical technologies used for the measurement of dissolved oxygen, optical technology does not consume oxygen during measurement. Also, optical technology does not require electrolyte, a “warm-up” period, nor sample flow. The measured dissolved oxygen concentration is automatically compensated for by integrated data from the temperature and pressure sensors and sophisticated algorithms in the firmware.

The AM-ODO2-15 outputs 12 mA at 100% saturation so it covers a range of zero to 200% saturation (approximately 16 ppm). The AM-ODO2H measures concentrations up to 500% saturation (approximately 50 ppm). The %-saturation measurement is a function of atmospheric pressure while the concentration value is also a function of temperature and salinity. The magnet-activated switch eliminates the need of a software interface to perform necessary functions. Different sequences of magnet taps on the probe allow the user to set options such as calibration, salinity compensation and loading the response function of the membrane cap. For instance, tapping the magnet three times starts the process of calibration.

## 2. Application notes

1. A temperature sensor is built into the probe body, close to the sensor cap. It should be completely immersed in the sample when taking measurements.
2. For improved accuracy and quick response, when the probe is not in use, it is highly recommended to store the probe with its sensor cap installed and the calibration/storage bottle which was included in the original packaging, threaded onto the probe. A beaker of clean water or a moist/humid capping mechanism can also suffice if the calibration/storage bottle is not available. The sponge inside the calibration/storage bottle should be kept moist for best results.
3. Avoid sensor cap touching organic solvent, scratching, and abusive collisions to strengthen and lengthen the working life of the sensor cap. Special care should be taken to clean the coating of cap, to dip probe and cap in fresh water, and then to tap dry the surface with a tissue. Do not wipe the coating surface.
4. Replace the sensor cap if the cap coating is faded or stripped away. **DO NOT touch the clear window on the probe tip after unscrewing the old cap.** If any contaminants or residue are present on the window or inside the cap, carefully remove them with a powder free wipe. Then re-screw the new sensor cap onto the probe.

### 3. Installation

The AM-ODO2 can be connected to an AquaMetrix AM-2300 controller or any PLC. The probe can output either a single output (%-sat or ppm) or dual outputs (%-sat and ppm). An optional configuration outputs the temperature or pressure as a second parameter. The AM-2300 can connect up to 4 AM-ODO2 sensors without use of an external power supply.

An external power supply may be required if the PLC doesn't have a 5-36VDC voltage source. The power ground and signal grounds must be connected.

Refer to the instructions below, as well as the controller/analyzer manual for proper installation and operation instructions.

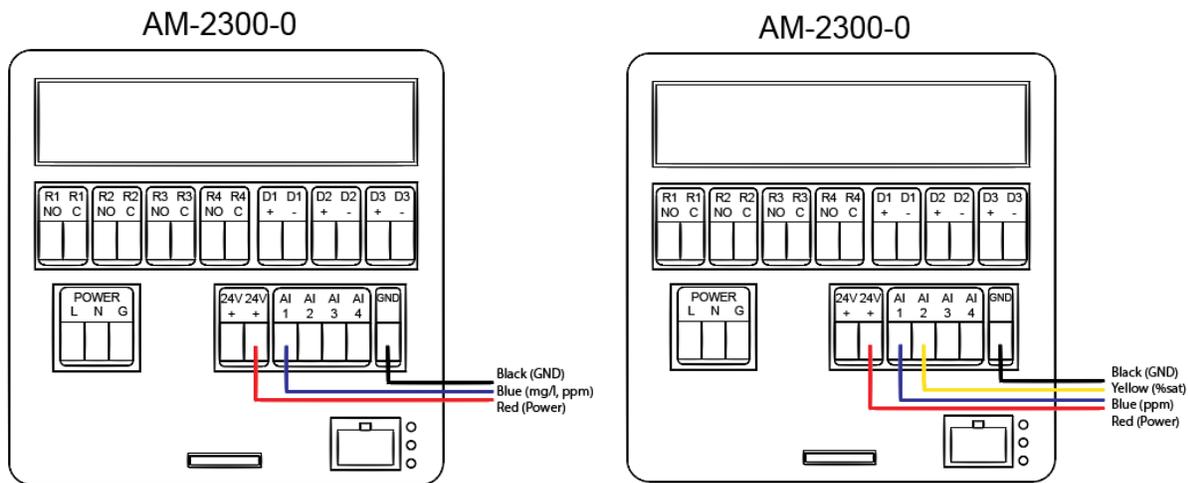


Figure 1- Wiring AM-ODO2 to an AM-2300 controller.

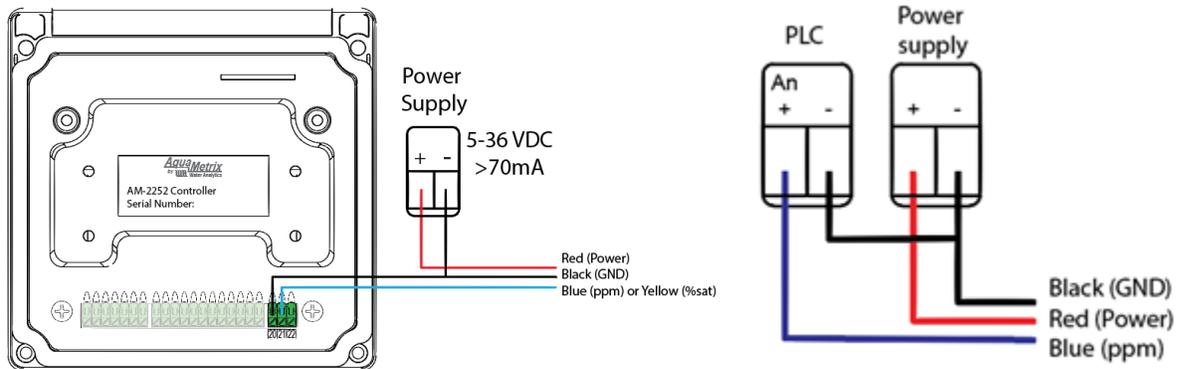


Figure 2- Wiring AM-ODO2 to an AM-2252 or a PLC with an external power supply

### 3.1. Dimensions and Schematics

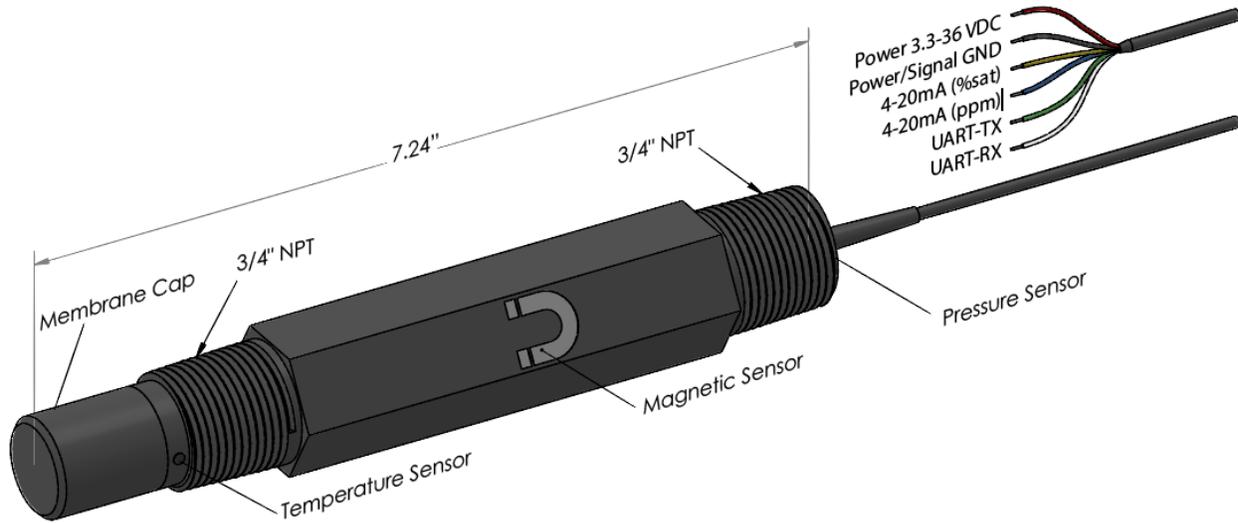


Figure 3- Dimensions and wiring information.

### 3.2. Connections to power supply and controller

Wire color	Description
Red	Power (5 ~ 36 VDC)
Black	GND (ground is shared between the power input and signal output, please make sure grounds are connected if external power supply is used)
Green	UART_RX (for upgrading or PC connection )
White	UART_TX (for upgrading or PC connection)
Yellow	DO (%) output and the red/mA test probe of multimeter
Blue	DO (mg/L or ppm) output and the red/mA test probe of multimeter

**Note:**

- 1) The two UART wires can be cut if the user does not need PC monitoring or firmware updates.
- 2) Outputting temperature or pressure (depth) is also optional based on the customer requirements.
- 3) Power supply: 5-36VDC. Make sure to follow the wiring instructions above and provide the proper power. Connecting the probe to any power outside the normal range may result in damage and may void the warranty.
- 4) Output: Dual Analog 4-20mA for the range 0-20mg/L and saturation 0-200%.
- 5) Pressure sensor operational range: 51-112 kPa (0.5-1.1atm).

### 3.3. Conversion Equations

**DO Concentration (mg/L)** =  $1.25 \times I - 5$      [ $I$  = current readings from blue to black wires]

**DO Sat.%** =  $(0.125 \times I' - 0.5) \times 100\%$      [ $I'$  = current readings from yellow to black wires]

### 3.4. Magnet-switched commands and LED indicator

Special commands can be performed using a magnetic switch controlled by a user's magnet. Tapping the magnetic marker of the probe is indicated with a bicolor red/blue LED. This LED is used to confirm the taps and the activation of the corresponding commands. The tap times, the related commands, and the LED conditions are all summarized in Table 1.

Table 1- Corresponding operations and commands of the LED indicator

Magnet taps = Red LED blinks	Commands	Blue LED confirming the command
1	Salinity off (0 ppt)	1 blink
2	Salinity on (35 ppt)	2 blinks
3	1-point calibration	3 blinks

#### Notes:

1. A successful magnet tap results in a red LED blink.
2. Magnet tapping is similar to “Morse code”, as an intended action for preventing the unexpected or accident magnetic trigger.
3. *The time between* taps must be less than 5 seconds for a single command.
4. Regardless of how long the magnet is held on the magnetic *area of* probe, its proximity is counted as one tap.
5. To avoid accidentally calibrating probes during measuring, the 1-point calibration is set as 3 taps.

## 4. Calibration

Connect the probe to an appropriate meter or controller and provide 3.3 - 36 V DC to power the probe. 1-pt calibration for the 100% saturation can be done by any of the following means:

### 4.1. Calibration in air-saturated water (standard method with error < 0.5%)

Air-saturated water can be obtained by either continuously purging water with air using an air bubbler or some type of aeration for 3 to 5 minutes, or stirring water with a magnetic stirrer at 800 rpm for 1 hour. The calibration procedure is as follows:

1. Immerse the sensor cap and temperature sensor of the probe (power needed) in the air-saturated water and wait until the reading becomes stable (usually 1 to 3 minutes).
2. Tap the magnetic area of the probe 3 times using the magnet head to start the calibration.
3. If calibration is successful the blue LED will blink 3 times. The current output will be 12 mA, corresponding to 100% saturation. If not, redo the steps above.

#### 4.2. Calibration in water-saturated air (convenient method and error < 2%)

Alternatively, calibration can be done in water-saturated air, but will result in an error of as much as 2%. The recommended procedures is:

1. Immerse the sensor cap and temperature sensor of the probe in fresh/tap water for 1 to 2 minutes (power needed).
2. Take the probe out and quickly tap dry the surface of sensor cap with a tissue.
3. Put the sensor end of the probe in the calibration/storage bottle containing a wet sponge. Avoid direct contact of the sensor cap with any water in the calibration/storage bottle during this calibration step.
4. Loosely screw the calibration/storage bottle onto the probe. Ensure that the distance between the sensor cap and the wet sponge is 1 to 2 cm. Be careful not to completely tighten the bottle on the probe to ensure the pressure inside the calibration/storage bottle is the same as ambient pressure.
5. Wait 3 to 5 minutes and then trigger the 1-pt calibration function using the magnet method mentioned above. A successful calibration will result in output of 12 mA, corresponding to 100% saturation and remain relatively constant for at least 1 minute. If not, redo the steps above.

### 5. Maintenance

Probe maintenance includes cleaning the sensor cap, as well as the proper conditioning, preparation, and storage of the test system. See Application Notes above.

#### 5.1. Salinity compensation

This ODO has a preset salinity compensation option to compensate for seawater and similar applications. It can be cancelled or selected by tapping the magnetic marker of the probe once and twice respectively. As shown in Table 1, two taps sets the salinity compensation to 35 ppt, which is a typical seawater salinity concentration.

The compensation of the concentration value for any salinity value can be calculated from the salinity compensation factor, S, as follows:

$$\text{DO (mg/L) (corrected)} = \text{DO "mg/L" (uncorrected)} \times S$$

The compensation factor can be calculated from:

$$S = e^x, \text{ where } x = (- [\text{ppt}] \times (0.017674 + (-10.754 + 2140.7/T)/T))$$

where salinity is in parts per thousand (ppt) and temperature is in Kelvin (K). In freshwater ("normal" mode) salinity is 0 ppt and S = 1, while in seawater mode (assuming the salinity level is 35 ppt), the factor is S = 0.816 (at 22°C).

The salinity value (ppt) can be estimated from the specific conductance (SC in  $\mu\text{S}/\text{cm}$ ):

$$\text{ppt} = 5.572 \times 10^{-4}(\text{SC}) + 2.02 \times 10^{-9} \times (\text{SC}) \times (\text{SC}).$$

#### 5.2. Coefficient change after sensor cap replacement

The probe has a preset database containing 10 groups of cap coefficients. The related group numbers are 0 - 9 for different sensor caps. The sensor cap manufacturing process is stable, and the given coefficient

database covers all potential sensor caps for the lifetime of the probe. Thus, no update the database is normally needed.

Each sensor cap has a 4-digit serial number on the side and the last digit is the coefficient group number. If the new sensor cap has a different last digit than the previous one the new coefficients needs to be loaded, otherwise no update is needed. This operation is:

1. Five magnet taps (confirmed by 5 corresponding red blinks by LED) for entering the coefficient selection mode.
2. Wait until blue LED starts to blink. The blue LED will blink 5 times, but Step 3 can be started before the 5 blinks have finished. The blue LED will stop blinking if Step 3 is started.
3. Tap the probe with the magnet several times equal to the last digit of cap SN. (A successful magnet tap will have a corresponding red LED blink, otherwise re-tap is needed).
4. Observe blue LED after tapping. If the blue LED blinks = the last digit of cap SN, suggesting operation success. Otherwise, repeat Steps 1-4.

To load coefficient group 0, only do Step 1 and allow the blue LED blink to five times for confirmation

## 6. Troubleshooting

To troubleshoot the AM-ODO2 connect it directly to the power supply avoiding, if possible, all interconnection, splices, and junction boxes. When the red and black wires are connected to the power supply (5-36 VDC), the two LED under the cap should start blinking (the ODO cap can be removed to observe the LED). If the LED's are not blinking – the sensor is not working.

The next testing level requires a multimeter in current mode. Without disconnecting the power connection add the black lead (COM) of the multimeter to the black wire and red wire (mA) to blue (ppm) or yellow (%-sat) wire. The expected reading in the air would be  $\approx 100\%$ sat (or  $\approx 8$ ppm) which would result 12mA on the yellow wire or  $\approx 10$ -11mA on the blue wire. If the output is stuck at 4mA or 20 mA – the sensor is not working.

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