AquaMetrix AM-LDO

Luminescent Dissolved Oxygen Sensor

(Hamilton VisiWater DO Arc 120 FC 10, P/N 238999-4314)

Installation and Operation Guide

AM-LDO Manual, Rev. 2, July, 2015

1 Introduction

The AM-LDO is one of the most compact, durable and easiest to use dissolved oxygen sensors on the market. It is made for AquaMetrix by Hamilton, a manufacturer with a long history of making premium sensors for the highly demanding medical field.

The AM-LDO is an optically based sensor. It emits a pulse of light that is absorbed by a rare metal compound. The compound re-emits light at a longer wavelength pulse of light (i.e. fluorescence) that is measured by a photo-detector in the sensor. The intensity and lifetime of the emitted pulse depends on the oxygen concentration (whether in air or water). Oxygen shortens the lifetime and decreases the intensity of the emitted light. The sensor's firmware measures the amount of this so-called "quenching" of the fluorescence and calculates the oxygen concentration.

The AM-LDO provides two electrical interfaces: standard analog (4–20 mA) and digital Modbus RTU over RS485. These are built into each sensor and are supported directly from the sensor head. The analog 4–20 mA and digital RS485 interfaces do not require any additional equipment such as amplifier or transmitter. The AM-LDO sensor also contains a temperature sensor (NTC 22 kΩ). This temperature sensor is only used for the compensation of temperature of the oxygen signal when it's in analog 4-20 mA mode

The AM-LDO is a standout from amongst optically based DO sensors for several reasons:

1. All electronics and firmware are housed in the compact sensor body.
2. The sensor's luminescent cap lasts an industry-leading 3 years or longer before needing replacement.
3. The sensor outputs both an analog 4-20 mA signal and digital Modbus signal.
4. The sensor comes ready to operate out of the box as an analog sensor without any configuration or calibration via the digital interface.
5. For making configuration or calibration changes all you need is the free HDM software, a USB-to-RS485 adapter and a PC.

The main application for the AM-LDO sensor is the in-line measurement of DO in clean and waste water. The main characteristic that makes the AM-LDO sensor ideal for his application is its remarkable long-term stability, even after prolonged use in wastewater.

The AM-LDO typically connects to either a PLC or to the AquaMetrix 2300 controller. This manual is not an exhaustive overview of all of the features of the AM-LDO. It is meant to get you started in the shortest amount of time and there are advanced features that it will not cover in detail. The HDM software has an excellent online guide that is searchable by topic.

Table of Contents

3 Specifications

POWER

Power Supply	7 to 30 VDC, Maximum 1 W, 0.6 W continuous

GENERAL

Functionality	Measurement, self-diagnosis, analog and digital output
Measurement Principle	Oxygen quenching of luminescence
Temperature Range	-10 to 85 ^{0}C
Pressure Range	0 to 12 bar (174 psi)
Measurement Range	0.05 to 300% air saturation
Measurement Units	%-saturation, %-volume, mg/l or ppm. ^{0C}.
Response Time	98% of measurement in <30 seconds @ 25^{0}C
Detection Limit	0.01 %-volume
Drift	Lower than 0.2%-volume oxygen per week in air at 30^{0}C
Cross sensitivities	Not sensitive to carbon dioxide, hydrogen sulfide, sulfur dioxide or ethylene oxide
Resistances	Resistant to ethanol, methanol, hydrogen peroxide. Not resistant to chlorine and organic solvents

Output

Analog Output	4-20 mA for DO or temperature
Digital Output	Modbus RTU over RS 485. Maximum 31 addresses

ENVIRONMENT

Temperature Range	-40˚F to +185˚F (-40˚C to +85˚C), process and storage areas
Pressure	7 psi (0.5 bar)

PHYSICAL

Wetted Materials	316 stainless steel
Replaceable Parts	Sensor cap with luminescent coating
Dimensions	12 mm diameter x 120 mm length
Mechanical Connector	PG 13.5 male connector
Electrical Connector	VP8 socket head
Weight	
Ingress Protection	NEMA 4X (IP66 to EN 60529)

4 Installation

4.1 Safety Precautions

The AM-LDO sensor must be used for its intended application, and in optimum safety and operational conditions. The specifications (such as temperature or pressure) defined in Section 3 (Technical Specifications) and must not be exceeded under any circumstances. Potential hazards can exist if the sensor is not operated correctly or appropriately.

Only trained personnel should perform assembly and maintenance. Make sure that the PG 13.5 thread and the O-ring are not damaged when screwing the sensor into the process. O-rings are consumable parts, which must be exchanged regularly (at least once per year).

Before removing the sensor from its measurement setup, always make sure that no process medium can be accidentally spilled.

The built-in temperature sensor can only be used for temperature correction, not for controlling the process temperature.

4.2 Sensor Installation

The AM-LDO has a PG13.5 compression fitting for mounting in a vessel or pipe. AquaMetrix sells a stainless steel adapter that converts this ISO standard male fitting into a more common 1" MNPT fitting.

4.3 Identification

The AM-LDO is equivalent to the Hamilton sensor, VisiWater DO Arc 120 FC10 Open End, P/N 238999-4314. There are several D.O. sensor models made by Hamilton. In particular one that was sold by Water Analytics in the past consists of an orange cable. **Please note that the color-coding of the conductors for this probe is different.** Table 1 lists the color code of the AM-LDO and also includes the appropriate color code for this earlier probe.

Table 1 - Color code for sensor conductors. The corresponding pin assignments for the Hamilton Visiferm with separate cable and sensor are in the third column.

Color	ID	Wire	Older Visiwater (orange cable)
N/A	A	N/A	N/A
White	B	4-20 mA	White
Brown	C	24 VDC	Red
Green	D	Ground	Blue
N/A	E	N/A	Brown
N/A	F	N/A	N/A
Yellow	G	RS 485- (B)	Pink
Gray	H	RS 485+ (A)	Gray
Yellow-Green	Housing	Shield	Yellow-Green

In normal operation only the white, green and brown wires that carry the 4-20 mA signal and power will be used. When connecting the sensor to a PC the gray and yellow conductors carry the Modbus signal.

4.4 Digital Configuration and Analog Operation

The operating parameters of the AM-LDO are configured using its Modbus digital output. However the probe is usually operated as an analog 4-20 mA output sensor. The next section explains the configuration of the sensor though the FDT interface with a PC. Section 6 explains the operation of the sensor in its analog mode.

5 The HDM Digital Interface

5.1 Downloading the HDM and DTM Software

The AM-LDO communicates to a Windows computer using the FDT/DTM framework. This open environment allows different devices using different protocols (Modbus, Profibus, DeviceNet, etc.) to communicate through a Windows based PC using an interface, called a Field Device Tool (FDT) frame. Each device has its Device Type Manager (DTM).

There are two software packages that must be installed to enable Modbus control of the sensor:

1. **HDM**. The Hamilton Device Manager is Hamilton's FDT frame application. You can use a third party FDT application.

2. **DTM**. The Device Type Manager, is the interface specific for the probe's Modbus output to the FDT.

Because the Hamilton website changes it's easier to locate the two software packages using the website search tool. Go to www.HamiltonCompany.com. The search box is located on the upper right.

5.1.1 Downloading the HDM and DTM Software

Typing in "HDM" brings up links to the HDM setup software and the HDM DTM Quick Guide. The search brings you to the two download links shown in Figure 5-1. The Quick Guide is helpful but not necessary since this manual covers the same material.

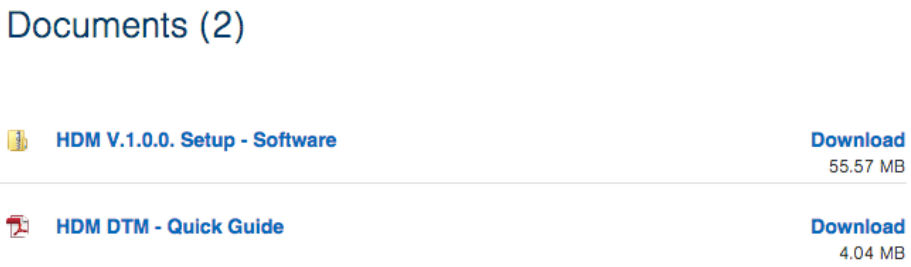


Figure 5-1 – Links to the HDM software and Quick Guide. The Quick Guide is optional as the information in it is included in this manual.

Clicking on the HDM Setup-Software folder will download a zip archive of the software. Use an unzip utility to decompress the archive.

5.1.2 Downloading the DTM Software

Type "DTM" in the search box of the www.HamiltonCompany.com web page. The search brings you to the three download links shown in Figure 5-2. The Quick Guide is the same as the Quick Guide downloaded along with the HDM software. Click on the Arc Sensors DTM 1.5.0 Setup Software to download the zip archive of the software. Extract the folder from the archive using your PC's unzip utility.

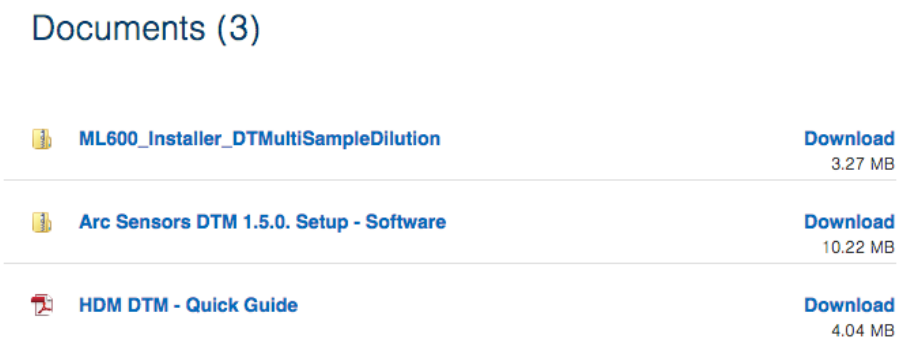


Figure 5-2 - Links to the DTM software and Quick Guide. The Quick Guide is optional as the information in it is included in this manual.

5.1.3 Installing the HDM and DTM Software

Installing the HDM software will automatically install the DTM software. Therefore there is no need to separately install the latter. Locate the setup.exe file in the HDM folder and click on it to start the installation process. The default location of the two software folders is C: > Program Files (x86) > Hamilton.

5.2 Installing USB-RS485 Converter and Powering the Probe

5.2.1 Configuring the USB-RS485 Converter

Hamilton supplies a USB-RS485 (Modbus) converter which we offer for resale. Other USB-RS485 converters should work and the driver software for them can be found on the manufacturer's website. In our testing of third party adapters some have not worked for reasons that we could not ascertain.

Connect the RS485 conductors from the probe (yellow and gray wires) to the converter. For the Hamilton branded converter the gray wire connects to the A terminal and the pink wire connects to the B terminal. Most converters use that use labels of "+" and "-", connect the gray wire to the RS485- terminal the yellow wire to the RS485+ terminal.

5.2.2 Powering the Sensor

Power the sensor with a 24 VDC power supply. Connect the 24 V (+) lead of the power supply to the brown wire of the probe and the ground (-) to the yellow wire.

Windows will detect the inserted converter, search the network for the corresponding driver software and download the software driver. After Windows downloads and installs the driver it sends get a pop-up message on the bottom right task bar stating that the device driver installed correctly.

5.2.3 Optional: Installing the Device Driver

To verify that the PC did indeed recognize and connect the converter, bring up the Device Manager. You will find the converter's presence in two places as shown in Figure 5-3. Keep in mind that the following instructions are based on Windows 7 and may differ for other Windows operating systems.

a. You will find an item in the Device Manager list, Ports (COM & LPT). If you click on that list to expand it you will find item, USB Serial Bus Controller (COM X), where X is a port number.

b. At the bottom of the Device Manager list you will find the item, Universal Serial Bus Controllers. If you click on that list to expand it you will find the item, USB Serial Converter (likely at the bottom of that list).

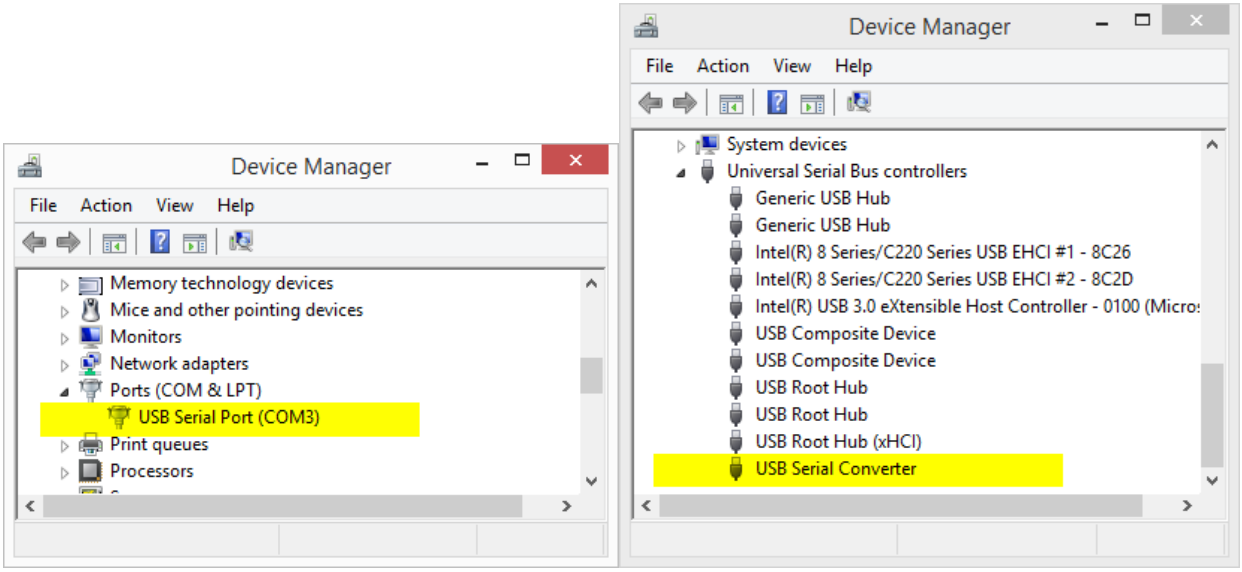


Figure 5-3 – The Device Manager window on the left confirms that a port (number 3) has been assigned to a USB Serial Port. The Device Manager window on the right confirms that the

6. Should it become necessary to remove the driver and free up the COM-port, bring up the Device Manager, right click on Ports (USB & LPT) > USB Serial Port (COM3) and click on Uninstall. If you wish to keep the driver installed and just release the COM port do not select the field, Delete the driver software for this device. This will enable the PC to recognize automatically any future USB-to-RS485 converter.

5.3 Operating the AM-LDO Through the PC Interface

After you have installed the HDM and DTM software, powered the probe and wired the converter to the probe you are ready to operate the probe through its PC interface.

Launch the Hamilton Device Manager (HDM) application. You will see one window in that lists the status of all devices that communicate through the FDT. In this particular case there will only be one AM-LDO sensor though more can be added. All sensors are shown as files in a folder in the left hand window, Network View.

You may see three additional windows. On the right side is the Device Catalogue and, on the bottom, are the FDT Monitor and the Error Log tabbed windows. Both of these are only useful for diagnosing a connection problem and can be closed in normal operation.

To close or open windows go to the View menu.

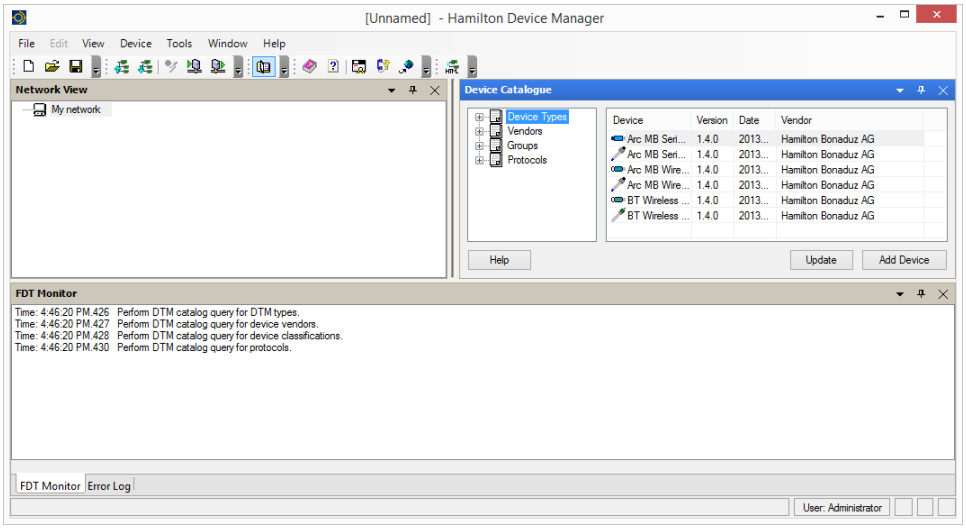


Figure 5-4 - Initial screen when first starting up the HDM application. The FDT Monitor, Error Log and Device Catalog windows are not needed except to diagnose a problem and are better

1. If the Device Catalogue, Error Log or FDT Monitor windows are open you can close them so that you can view the settings for the COM port that communicates with the sensor.

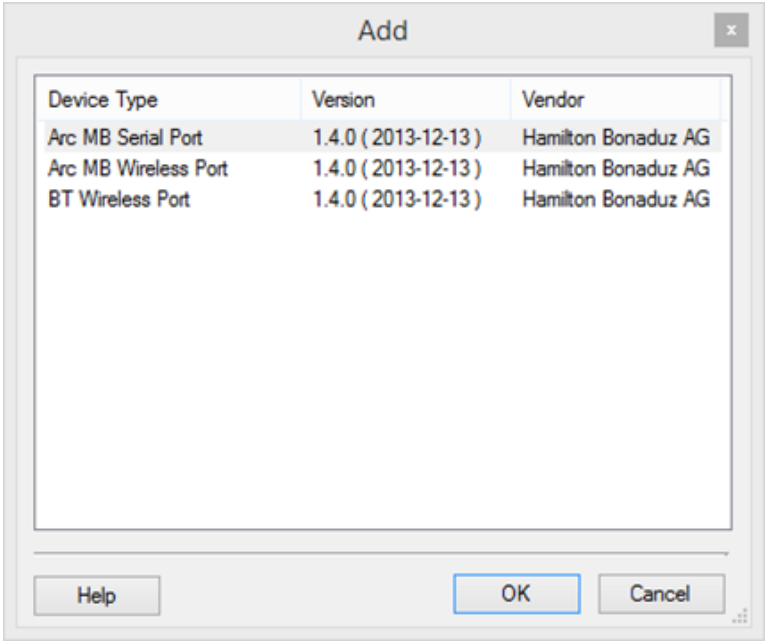


Figure 5-5, - The first line, Arc MB Serial Port, shows that the HDM frame found the AM-LDO sensor. Click on the OK button to add it.

2. You will then see a new window, shown in Figure 5-6. The Device Manager has added the ARC MB Serial Port to the HDM's FDT. The new window shows the communication parameters between the computer and the USB-RS485 Modbus adapter. You may change any of the communication parameters in this window. If the adapter does not appear in this window, make sure that the serial port number listed in the upper right corner of the Offline Parameter window matches the port number listed in the Device Manager's Ports setting. Clicking on the Scan for Device button at the bottom of the window will search for the USB device.

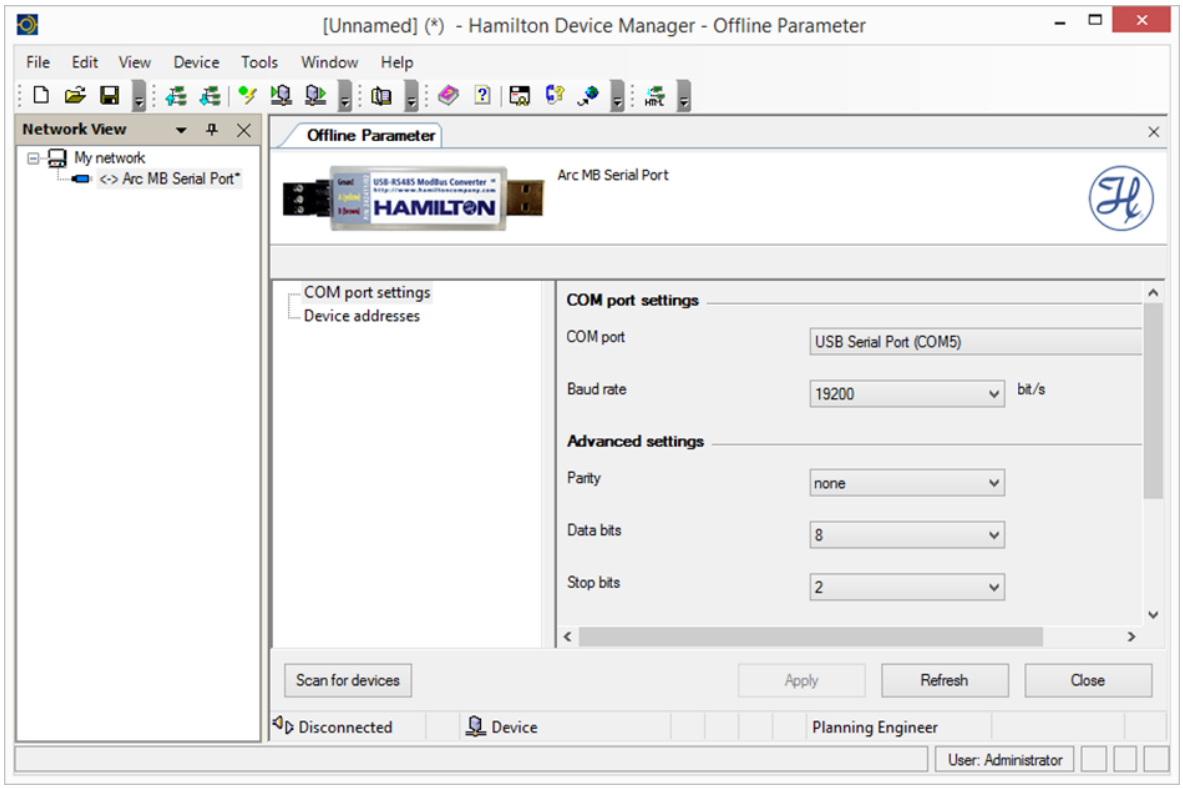
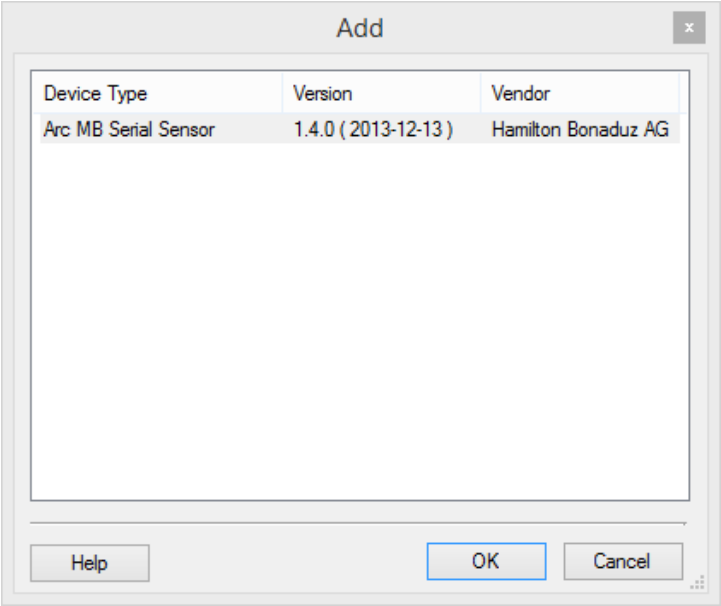


Figure 5-6 - The HDM sets up a connection to the AM-LDO through the serial port.

3. As the window tab name shows, the USB-Modbus converter is offline. You can only change the COM port communication settings or remove the converter when the device is offline. The visual cue that a device is offline is that its name is written in a non-bold font. If a device is online the text changes to a bold font.

4. The next step is to add the sensor to the serial port. You can either navigate to the Device Menu and click on Add… **or** right click on the Arc MB Serial Port icon in the Network View window. When you do you a new window will pop up as shown in Figure 5-7. Click OK to add the sensor to the FDT frame.

5. If you are using a wireless Bluetooth sensor the same instructions apply.



6. Figure 5-7 - Window showing the DO sensor connected to the serial port.
7. The Hamilton Device Manager window reappears and the sensor now appears in the Network View window under the ARC Serial Port listing, as shown in Figure 5-8. Note that the text for both the converter and the sensor are both in plain (not bold) text to indicate that they are offline.

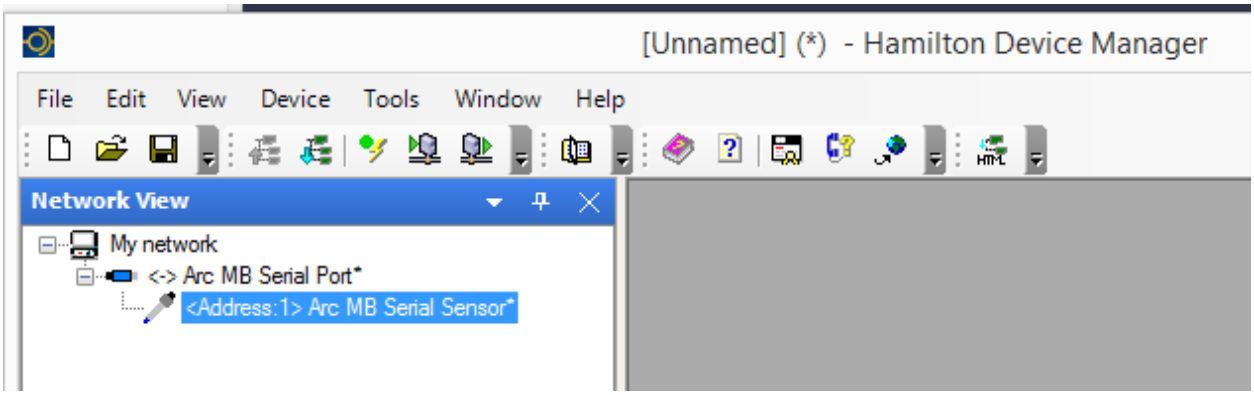


Figure 5-8- After clicking OK in the Add window the HDM adds the LDO sensor.

8. Now that the sensor is connected to the device manager you bring it online. Either navigate to the Device menu and click on Go Online or right-click on the sensor listing in the Network View window and select Go Online. If you make the sensor go online then the Serial Port also goes online. When the sensor and serial port go online the text in the Network View window becomes bold.
9. Double click on the <Address 1> Arc MB Serial Sensor and you will see the window shown in Figure 5-9.

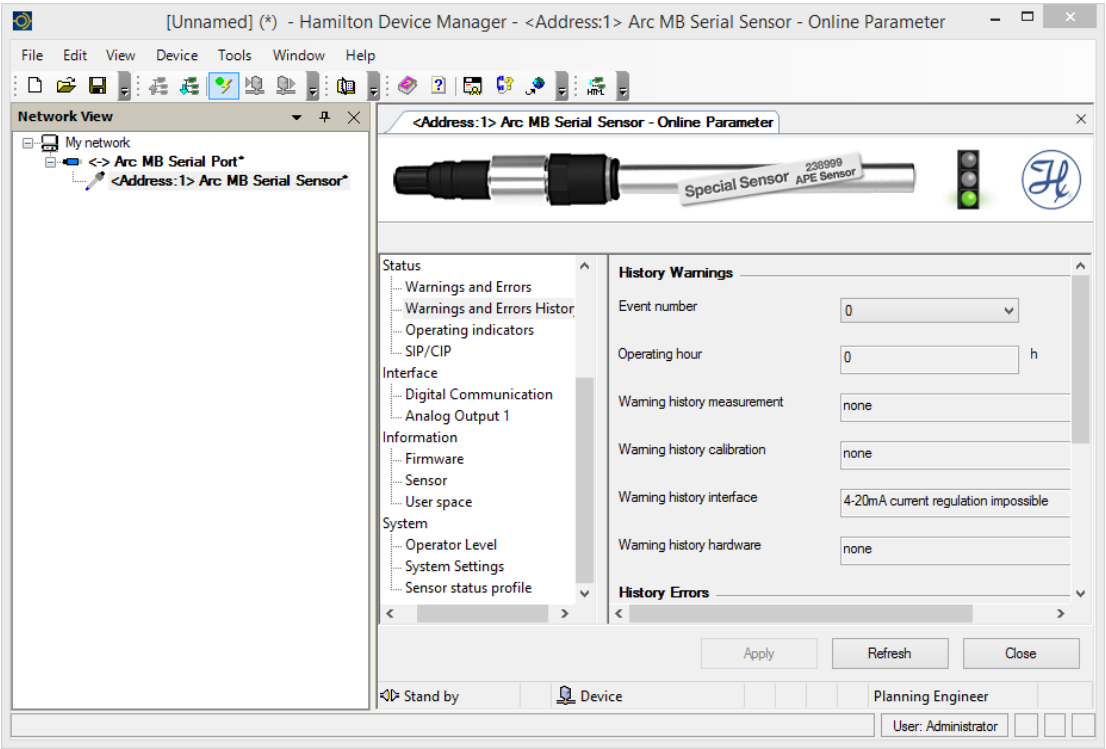


Figure 5-9 - HDM window showing the AM-LDO sensor. The sensor and the port are both live as indicated by the bold font in the list view on the left.

Note the traffic light in the upper right corner in Figure 5-9. The green light means everything is okay. A yellow light means that a sensor warning has been activated and a red light means that a sensor error has been activated.

If the HDM reports that a sensor was not found the most probably reason is that the USB-RS485 converter is not working properly.

5.4 The Device Manager Menu Bar

The options contained in the menu bar of the Device Manager are mostly self-explanatory. A searchable manual can be accessed at any point by clicking on the Help menu or the Question Mark icon. A few notes are in order for some of the more important menu items.

5.4.1 File Menu

The File > Save as command allows you to save the settings in the sensor configuration so that it can be recalled at a later time.

Info…. provides a space for recording notes that may be needed. For instance, if there are no errors or warnings during operation it makes sense to close the Error Log window.

5.4.2 Device

Several of the items in the Device menu, such as Go Offline / Go Online are also accessible through right clicks in the Network View window.

5.4.3 View Menu

The View Menu is a listing of the windows that comprise the Device Manager. You can click on any of these windows to customize the workspace.

5.4.4 Tools

The Tools menu contains two items: Customize and Options. The Customize menu has two daughter menus: Toolbars allows you to configure the menu of icon shortcuts in the row just below the top level menu.

Of greater importance is the Options menu which has several useful functions

- General Options > Language allows one to switch the language to German, Chinese or Japanese.

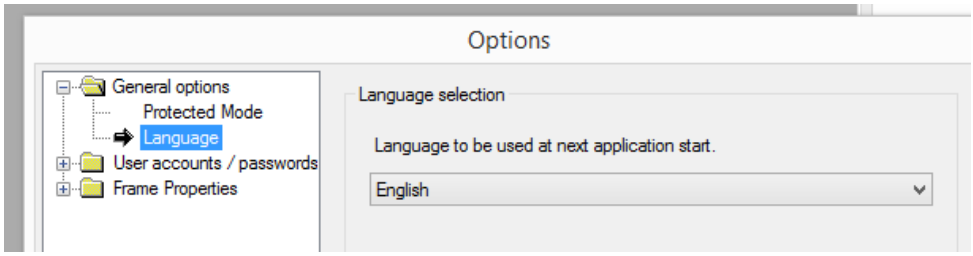


Figure 5-10 - To change the language select Tools > Options > Language. You may select English, German, Chinese or Japanese.

- The menu item, User accounts/passwords, enables one to restrict permission to four classes of user, which are, in order of authority level: Observer, Operator, Maintenance and Administrator. You can also change passwords for each of the four classes of users.

5.5 Configuring the Device Manager

The status window allows the user to view and change settings to the sensor. Most of the settings are self-explanatory. When changing a setting, one must click on the Apply button at the bottom of the window.

The following section highlights only the settings you are most likely to adjust:

5.5.1 Measurement:

a. Data log / Monitoring enables data logging. The Trace file path allows the user to change the location of the data file. The trace interval specifies the time between data points. Choosing On for Record Trace file turns on the data logging.

Clicking on the Refresh button gives an instantaneous measurement reading of the D.O. and temperature values. (So does Interface > Analog Output 1:Signal.)

b. Measurement Variables allows one to select between units for D.O temperature. The most commonly units for D.O. are mg/l (or ppm) and % saturation. Remember that mg/L values are only valid if you enter the correct values for ambient pressure and salinity.

c. Measurement Parameters includes all those factors that affect the D.O. reading. A D.O. sensor can only measure % saturation. It then calculates absolute concentration of oxygen, e.g. mg/l, using a known value of air pressure. The Air pressure setting should be changed when the sensor is not at sea level (or if a hurricane is imminent.) The other parameters control the reporting of data.

5.5.2 Calibration

a. Calibration Zero Point can only be used if the user can insert the probe in a zero D.O. environment. One can do this only by adding a sufficient amount of reducing agent, such as sodium bisulfite. In most cases, the user simply assumes that zero D.O. corresponds to a zero reading and skips this step.

b. Calibration Air is the most common, and easiest, way to calibrate. Simply select calibration option auto in air, hold the probe in air (preferably at or near 100% humidity) and click on Apply. You may take additional calibration readings by clicking on the Refresh button. Note that you will not see the actual probe reading; that can only be done as described in the previous section.

c. Product Calibration allows a sensor to be calibrated without removing it from a process. It uses a standard calibration curve and a reading from an independent sensor on a grab sample of the process. It is only rarely used.

Section 8.2 discusses calibration in greater depth.

5.5.3 Status

a. Warnings and Errors is perhaps the most important of all the Online Parameter options. If the traffic light in the upper right corner turns yellow (for warning) or red (for error) then the details of either will appear in this section. An example of a warning is that the probe has not been calibrated/ An example of an error is that the 4-20 mA output has exceeded 20 mA.

b. Warnings and Errors History is useful for looking back at previous errors or warnings.

c. SIP/CIP (sterilization-in-place and clean-in-place) defines the temperature and duration that the sensor encounters to enable it to recognize these maintenance procedures. They are not very pertinent to the water and wastewater industries.

5.5.4 Interface

a. Analog Output: Setting maps the usual 4 mA and 20 mA output signal to D.O. measurements. The default mapping is 4 mA to 0% D.O. and 20 mA to 300% D.O. For maximum accuracy choose 20 mA for the highest measureable D.O. value, which is likely to be 100%.

b. Analog output: Signal gives an instantaneous probe reading upon clicking on the Refresh button.

c. Analog Output: Warnings/Errors allows the user to trigger an alarm and/or error condition based on the 4-20 mA signal.

5.5.5 Information

a. Firmware does not contain any user configurable parameters. Firmware updates are available on the Hamilton website.

b. Sensor contains only parameters that are set at the factory. They are not configurable.

c. User space enables one to set up user-defined fields. (MORE)

5.5.6 System

a. Operator Level defines levels of permissions. There are four levels:

   i. Users (U) can read basic data from the sensor. No password is required.

   ii. Administrators (A) can calibrate sensors. A password is required.

   iii. Specialists (S) have full access to all of the editable parameters accessed in the HDM. A password is required.

b. Change Password allows an Administrator or Specialist to change his/her password. The HDM comes with the following default passwords:

   Administrator – 18111978

   Specialist – 16021966

c. Factory Setting allows the user to restore all parameters to their factory settings.

d. Sensor Status Profile writes all of the sensor parameters into a text document that can be found in C: > Hamilton > DocuSensor.

6 Using the AM-LDO in 4-20 mA Operation

In most environments the AM-LDO is used in analog mode as a 3-wire 4-20 mA output probe. Digital communication via the Modbus output and FDT framework is only necessary for configuring the sensor as described in the above sections. While the AM-LDO can be simultaneously wired to a PC and a PLC or 2300 the connection to the PC is normally not necessary.

As a 4-20 mA 3-wire sensor, the AM-LDO is powered by an external 24 VDC power supply. Figure 6-1 shows the connections between a power supply, the AM-LDO and the AquaMetrix 2300 controller. The connections to the 2300 are the same as those to any PLC. Note that these connections differ from a traditional 3-wire sensor.

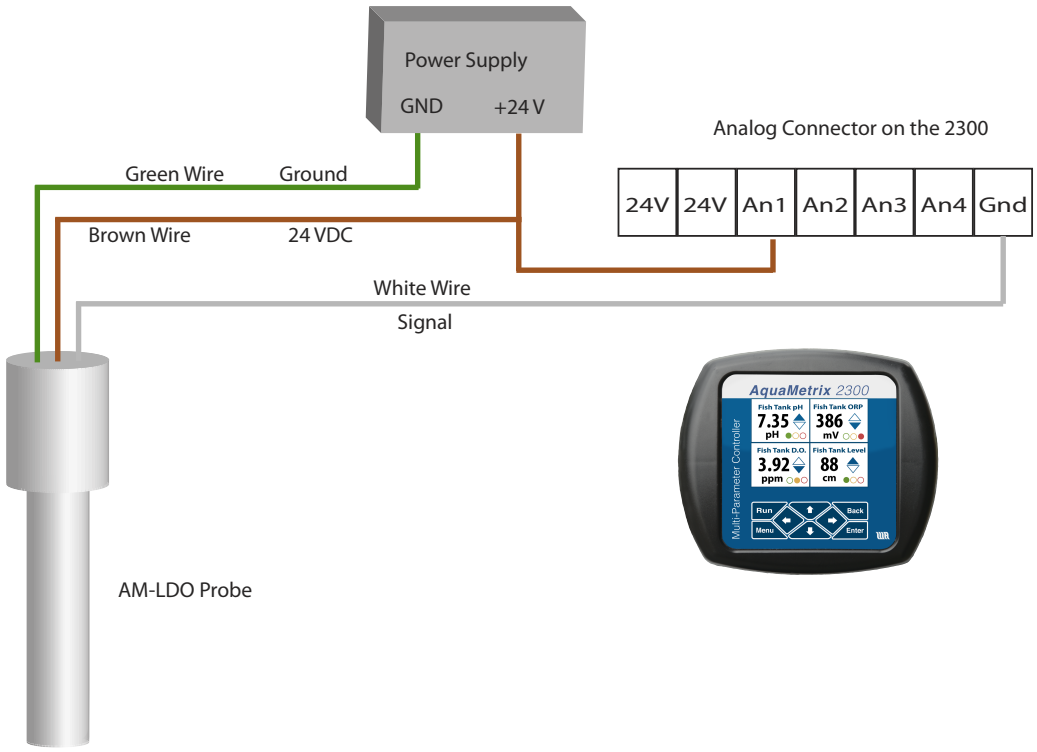


Figure 6-1 –Electrical Connections to the AM-LDO (Hamilton VisiWater DO Arc 120 P/N 238999-4314). The 3-wire probe is powered by a 24 VDC power supply. The connections are shown for the AquaMetrix 2300 but are the same for any PLC. If your probe has an orange cable contact us for the correct wiring.

If you have an older AM-LDO that has an orange cable the color-coding differs. Refer to Figure 12-1 for the correct wiring.

7 Multiplexing Multiple Sensors

The serial Modbus RS485 interface allows the user to gang multiple sensors through one RS485 connection. Figure 7-1 shows the connections. A 24 VDC power supply is still needed.

The Modbus connection between the RS485 port and the corresponding interfaces of the sensors has to be ensured according to the EIA/TIA RS485 standard. Only one sensor can communicate with the master at any time.

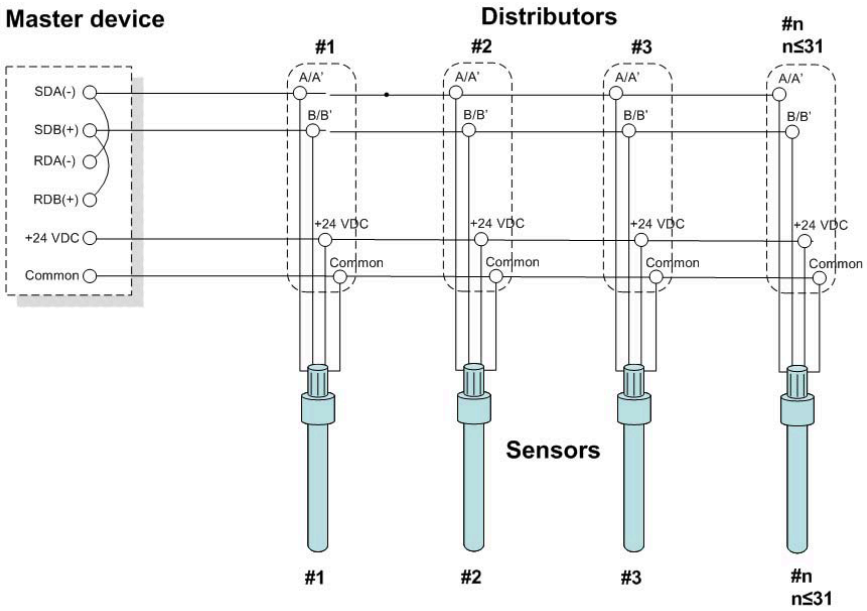


Figure 7-1 - Multi-drop bus wiring for the Modbus two-wire mode. Each sensor functions as a Modbus slave.

8 Calibration

The optical technique of measuring D.O. is based on the measurement of luminescence of a Ruthenium compound in the absence of oxygen and in its presence. The probe accomplishes the former by irradiating the Ruthenium compound with a long wavelength source that is not absorbed by the compound. This optical technique is therefore inherently self-referencing. For most applications, calibration need only be done several times per year.

8.1 Understanding D.O. Calibration

It is important to understand that a D.O. sensor does NOT measure absolute concentrations of D.O., i.e. mg/l or ppm. (Values of D.O. expressed as mg/l and ppm are identical.) It measures the partial pressure the dissolved oxygen, which is proportional to the %-saturation. The probe will always measure %-saturation correctly but, to display mg/l or ppm values, it must account for changes in atmospheric pressure, salinity and temperature. Compensation is done via the firmware in the probe.

All 4-20 mA sensors can be calibrated at two different interfaces:

1. **Calibrate at the probe**. For the AM-LDO this means calibrating using the HDM interface. In this case the user enters values for atmospheric pressure and salinity. There is no need to enter the temperature since the probe measures it. The firmware converts the partial pressure or %-saturation into a mg/l value using these parameters. The HDM software allows you to customize the 4-20 mA output over any D.O. range. (Interface > Analog Output). In particular the total measurement range of the sensor is 300% or saturation

so, in most cases, you will want the 20 mA value to correspond to 100% saturation (or one third of the total possible range).

The so-called calibration at the PLC then becomes a simple matter of mapping the 4-20 mA input to D.O. concentration as already determined in the HDM interface.

2. **Calibrate at the PLC or 2300**. In this method no configuration at the sensor interface is necessary. The PLC becomes the point at which calibration takes place. For optimizing accuracy you should still set the 4-20 mA output to correspond to the D.O. range your probe will encounter. Without proper knowledge of the pressure and salinity you should calibrate in units of %-saturation. In order to calibrate in units of mg/l you must know the pressure and salinity so that you can perform the correct conversion.

If it is important to express D.O. measurements in units of mg/l then the first method is preferable. If units of %-saturation are acceptable, then either method works.

The following sections only apply to calibration using the HDM probe interface.

8.2 Warm-up

The sensor requires a preheating period of 10 to 15 minutes after it is switched on. Although measurements are possible during this time, you must wait until preheating is complete to be able to calibrate the sensor optimally.

The concept behind the AM-LDO sensor enables calibration and configuration in the lab before use in the process control. Another calibration for the installation in the process setup is not required

8.3 Calibration Procedure

The HDM provides two kinds of sensor calibration: automatic standard calibration and product calibration. Both procedures are found in the Calibration section of the Hamilton Device Manager.

8.3.1 Automatic Standard Calibration

D.O. sensors are calibrated at the 100% saturation value either by immersing the probe in air-saturated water or exposing the probe to the atmosphere. To do the former involves adding an air pump-driven air stone to a bucket of water. The latter is less accurate but requires no additional equipment and is therefore done more frequently. Calibration is always a two-point procedure with one point being 100% saturation and the second point being 0% saturation. However the difficulty of preparing a 0% saturation standard leads most users to simply assume that 0% D.O. is associated with zero output.

During calibration, the sensor monitors the stability of the oxygen and temperature signals.

Calibration at Point 1 (0% D.O.)

(As just stated, the zero point calibration step is not necessary as one can assume zero output at 0% D.O.)

1. Set an appropriate operator level (Administrator or Specialist).
2. Immerse the sensor into an oxygen-free environment.
3. Let the system equilibrate. This usually requires at least three minutes. For greater measurement accuracy insure that temperature difference between calibration medium and process medium is minimal.

4. Take the calibration at point 1 by clicking on the Apply button.
5. The device manager confirms the calibration immediately.

Calibration at Point 2 (100% D.O.)

1. Set an appropriate operator level (Administrator or Specialist).
2. Leave the sensor for at least three minutes under stable conditions in ambient air or in oxygen saturated medium. An air pump with a diffuser that can be found in any aquarium store works fine.
3. Take the calibration at point 2 by clicking on the Apply button.
4. The device manager sensor confirms the calibration immediately. The calibration curve of the sensor is now defined by the recent calibration at both points: 1 and 2.

If you experience measurement value shifts as small as a few percent within a period of a few days, suspect damage to the lumiphore caused by the measurement or cleaning medium. Should this occur, consider whether more frequent exchange of the sensor cap is acceptable, or whether the sensor should be placed in a different part of the process.

8.3.2 Product Calibration

The product calibration is an in-process calibration procedure in order to adjust the measurement to specific process conditions, or in case the sensor cannot be removed for the standard calibration.

Product calibration is an additional calibration procedure to a standard calibration. Product calibration corrects the standard calibration curve to the process conditions in force at the time of product calibration. If product calibration is activated, the AM-LDO's calibration curve is calculated from the data of last calibration at point 1 and from the data of the product calibration.

In order to restore the original standard calibration curve, the product calibration can be cancelled at any time. A new standard calibration cancels a product calibration as well.

1. Set an appropriate operator level (Administrator or Specialist).
2. Perform an initial measurement while taking a sample from the process. The data of the initial measurement are stored in the sensor.
3. Perform a measurement with an independent (laboratory) sensor of the sample at the same temperature as it was measured in the process.
4. Assign the laboratory value to the value of the Initial measurement.

This new DO value is accepted and instantaneous active, if the difference between initial measurement and laboratory values is not greater than 20%-sat units.

9 Maintenance

9.1 Changing the Sensor Cap

Changing the sensor cap is easy: Unscrew the old sensor cap from the shaft.

HINT: If the sensor cap is mounted very firmly on the shaft, and if you cannot obtain a good grip on the stainless steel with your fingers, a silicone tube between your fingers and metal may supply a better grip. Examine the small O-ring that seals the sensor cap to the sensor shaft.

Exchange the O-ring, if any traces of wear are seen. A replacement O-ring is included with each replacement sensor cap.

Screw the new sensor cap onto the sensor shaft again. Make sure that the gap between the shaft and cap is closed, and that the sealing effect of the O-ring under it is therefore guaranteed. In order to enable traceability note the serial number of the new sensor cap.

Examine the measurement values of the sensor in air, and if necessary, in an oxygen-free medium. If the measurement values deviate significantly from operated value, perform a calibration.

10 Errors and Warnings

The AM-LDO can diagnose most common problems through the HDM interface. The Status section of the Online Parameter window in lists warning errors. The following types of messages are provided by the self-diagnosis function:

- Warning (alarm):
  - DO readings upper/lower range, unstable.
  - Temperature readings upper/lower, unstable.
  - Calibration recommended.
  - Calibration upper/lower, out of range, or unstable.
  - Replace sensor cap.
  - 4–20 mA output out of range, unstable
  - Supply voltage upper/lower range.
- Error (failure):
  - Sensor cap missing (reading failure).
  - Temperature out of range.
  - Temperature sensor defect (reading failure).
  - Supply voltage out of range.

11 Products and Accessories

AM-LDO	Optical DO sensor with direct output to 4-20 mA or Modbus RTU
RS485-USB	Converts Modbus over RS485 to USB (model subject to change)

12 Appendix

12.1 Wiring for earlier AM-LDO Probes (with orange cable)

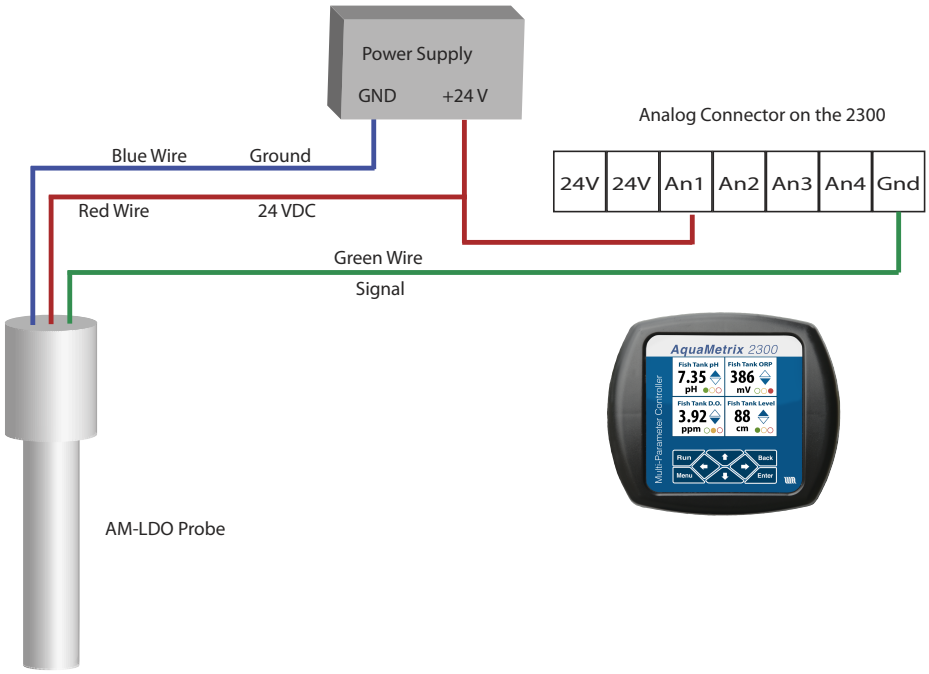


Figure 12-1 - If you have an older AM-LDO with an orange cable then the color-coding of the wiring is different. Use this wiring diagram.

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