

INSTRUCTION MANUAL



AL200 ALERT2 Encoder, Modulator, and Sensor Interface

Revision: 7/17



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- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

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AL200 ALERT2 Encoder, Modulator, and Sensor Interface

1. Introduction

The AL200 is an encoder, modulator, and sensor interface designed for use both as a stand-alone device and as a peripheral to a Campbell Scientific datalogger or third party Data Collection Platform (DCP). Portions of embedded code were developed and copyrighted by Blue Water Design LLC and are used under license.

This device uses the Automated Local Evaluation Real Time Protocol version 2 (ALERT2) and can operate as both a remote ALERT2 transmitter and as an ALERT to ALERT2 concentrator and repeater.

For more information on the ALERT2 protocol, refer to the National Hydrologic Warning Council's ALERT2 Technical Working Group website: http://www.hydrologicwarning.org/content.aspx?page_id=22&club_id=617218&module_id=83216.

2. Precautions

- GPS input gain, antenna gain less conductor losses, should not exceed 25 dBm.
- If protecting GPS input with coaxial surge protector, ensure that the protector does NOT block DC voltages.
- Ensure maximum protection against electrical transients/surges. Install coaxial surge protection on all antenna runs. Keep RS-232 and CS I/O connections short.
- The AL200 is NOT powered over CS I/O.
- When powered over USB, the AL200 will not power up either the radio or attached sensors.
- The device driver for the AL200 must be installed on your computer before you can connect to the AL200 via USB. See Appendix E, *AL200 USB Driver Installation Instructions (p. E-1)*, for instructions on installing the device driver.
- Device Configuration Utility 2.05 or higher is required to configure the AL200. The latest Device Configuration Utility can be downloaded from our website, www.campbellsci.com/downloads.

3. Initial Inspection

Inspect the AL200 for any obvious signs of damage upon receipt. For each AL200, the following items should be accounted for:

- QTY 1, AL200
- QTY 1, 2-pin mating screw terminal connector (pn 7843)
- QTY 2, 5-pin mating screw terminal connectors (pn 28750)
- QTY 4, mounting grommets (pn 6044)
- QTY 4, mounting screws (pn 505)
- QTY 1, Micro-B USB cable (pn 27555)

4. QuickStart

There are two basic modes of operation for the AL200. For simplicity, these will be referred to as stand-alone and datalogger peripheral modes.

4.1 Stand-Alone Mode

4.1.1 Physical Setup

- Attach a GPS antenna to the GPS SMA connector located on the side of the AL200.
- Attach the desired sensors to the appropriate channels on the sensor input connector.

4.1.2 Configuring the AL200

NOTE

The device driver for the AL200 must be installed on your computer before you can connect to the AL200 via USB. See Appendix E, *AL200 USB Driver Installation Instructions (p. E-1)*, for instructions on installing the device driver.

1. Connect the supplied USB cable between a USB port on your computer and the USB port on the AL200. The AL200 will be powered over the USB for configuration only. The AL200 will not turn on an attached radio and transmit while powered over the USB port.
2. Open *Device Configuration Utility*.
3. Under **Device Type**, select **AL200**.
4. Click the browse button next to **Communication Port** and select the port associated with the AL200.
5. Click **OK**.
6. Click **Connect**.

7. Specify the settings on each tab as described below.

- **Main**

Set **Operation Mode** to **Sensor Input Enabled (CS I/O Disabled)**, **ALERT Concentration on RS-232**.

- **ComPort**

Leave all settings as defaults.

- **ALERT2**

Configure settings to match your ALERT2 network.

- **Radio Settings**

Default settings will work for Campbell Scientific's RF320 series radios. (Campbell Scientific's RF320 series is the Ritron DTX-L series. For other radios, check with the manufacturer for the necessary radio settings.)

- **GPS Settings**

Leave all settings as defaults.

- **Sensor Input Settings**

Configure settings to enable or disable the inputs you wish to use with the AL200.

8. Click the **Apply** button located at the bottom of the window. It is a good idea to save the configuration file for later reference.

NOTE

The AL200 will suppress event-triggered transmissions while connected to Device Configuration Utility. During this time the Test Button may be used to trigger a data transmission.

4.2 Datalogger Peripheral Mode

Out of the box, the AL200 is configured for **ALERT2 on CS I/O, ALERT Concentration on RS-232** (datalogger peripheral mode). In this mode, the AL200 will receive ALERT protocol packets on the RS-232 port from an external device and retransmit them as ALERT2 packets using the ALERT concentration protocol. The AL200 will also receive ALERT2 IND layer packets on the CS I/O port and retransmit them as ALERT2 packets.

4.2.1 Physical Setup

Attach a GPS antenna to the GPS SMA connector located on the side of the AL200.

4.2.2 Configuring the AL200

NOTE

The device driver for the AL200 must be installed on your computer before you can connect to the AL200 via USB. See Appendix E, *AL200 USB Driver Installation Instructions (p. E-1)*, for instructions on installing the device driver.

1. Connect the supplied USB cable between a USB port on your computer and the USB port on the AL200. The AL200 will be powered over the USB for configuration only. The AL200 will not turn on an attached radio and transmit while powered over the USB port.
2. Open *Device Configuration Utility*.
3. Under **Device Type**, select **AL200**.
4. Click the browse button next to **Communication Port** and select the port associated with the AL200.
5. Click **OK**.
6. Click **Connect**.
7. Specify the settings on each tab as described below.

- **Main**

Set the **Operation Mode** to **ALERT2 on CS I/O, ALERT Concentration on RS-232**.

- **ComPort**

Leave all settings as defaults.

- **ALERT2**

Configure settings to match your ALERT2 network.

- **Radio Settings**

Default settings will work for Campbell Scientific's RF320 series radios. (Campbell Scientific's RF320 series uses the Ritron DTX-L series.) For other radios, check with the manufacturer for necessary radio settings.

- **GPS Settings**

Leave all settings as defaults.

- **Sensor Input Settings**

Leave all settings as defaults.

5. Overview

The AL200 ALERT2 Encoder, Modulator, and Sensor Interface is designed for use in radio networks using the ALERT2 protocol. The AL200 can be configured to operate as a stand-alone device or as a datalogger peripheral. In stand-alone mode, the AL200 will measure sensors, perform calculations, and if appropriate, transmit the data during a designated time slot. In datalogger peripheral mode, the AL200 will receive data from a datalogger, such as the CR800 or CR1000, or other device and transmit this data during a designated time slot. In both modes, the AL200 will receive ALERT data on one of the serial ports, then concentrate and retransmit the data via the ALERT2 protocol.



FIGURE 5-1. AL200

The AL200 includes a CS I/O port and an RS-232 port for serial communications. A USB device port is used for configuring the AL200, viewing real time sensor data, and diagnostics. An SMA female connector is provided for connecting a GPS antenna, and a removable screw terminal allows for the easy connection of an analog radio. Removable screw terminals are also used for supplying power to the AL200 and connecting sensors. Lastly, there is a copper ground lug for attaching an earth ground.

6. Specifications

Operating Temperature

Standard -40° to $+60^{\circ}\text{C}$

Power

9-18 Vdc

Current Drain @ 12 Vdc

Idle: 1.5 mA

GPS Fix: 40 mA

Transmit: 35 mA (not including radio or attached sensors)

Reverse polarity protected

Removable screw terminal connector, 0.15" pitch

Weight

206 g (7.3oz)

Dimensions

159.385 x 76.683 x 25.857 mm (6.275 x 3.019 x 1.018 in)

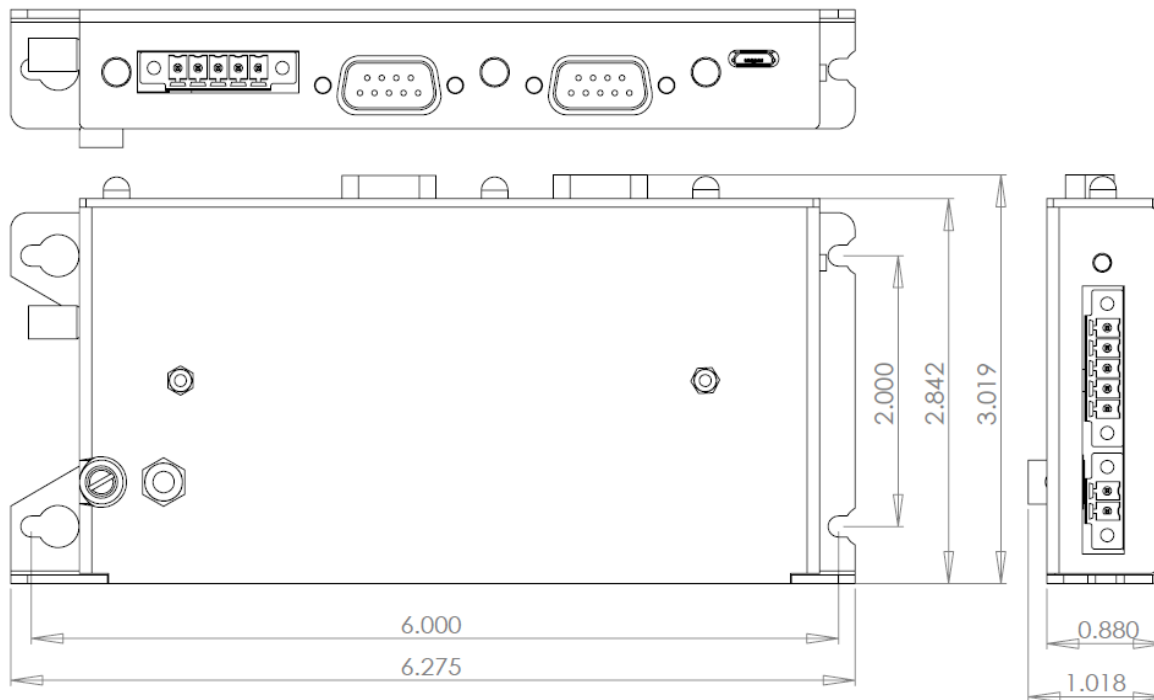


FIGURE 6-1. AL200 dimensions

Configuration

This device is designed to easily be configured through the graphical interface, Device Configuration Utility. When used as a stand-alone device, no programming is required.

NOTE

The device driver for the AL200 must be installed on your computer before you can connect to the AL200 via USB. See Appendix E, *AL200 USB Driver Installation Instructions (p. E-1)*, for instructions on installing the device driver.

When used as a datalogger peripheral, the same Device Configuration Utility software is used to configure the AL200. Additional steps will be required to program the datalogger to interface with the AL200.

USB

Micro-B receptacle
Can power AL200 during configuration; not suitable for operational current draws
Requires FTDI Virtual COM Port (VCP) driver installation

CS I/O Port

SDC 7, 8, 10, 11
ALERT2 or ALERT-concentration
AL200 is NOT powered over CS I/O
Multiplexed with integrated sensor I/O

RS-232 Port

DCE
Configurable baud rates, parity, stop bits, and timeout
EIA/TIA-232 and V.28/V.24 Signaling
 $\pm 15\text{kV}$ ESD protection

Test Button

The test button located in the lower left hand corner of the AL200 serves two functions. Pressing it for three to six seconds will trigger a test transmission containing the latest data available to the AL200. Pressing the button for longer than 6 seconds will cause the AL200 to generate a test tone and sustain it for 5 seconds. If the AL200 has been configured as a datalogger peripheral, only the test tone functionality is active.

Analog Radio Interface

Removable screw terminal connector, 0.15" pitch
Transmit only
Transmit Audio (Tx), 100 – 1000 mV peak-to-peak, software adjustable
Switched Voltage (SW12V), switched supply voltage, 1.8 A at +70°C

Sensor I/O

Removable screw terminal connector, 0.15" pitch

Switch closure (P1)

Internally pulled up to 5 V
16-bit counter
3.3 ms time constant for debounce
5 ms minimum closed time, 6 ms minimum open time

Single-ended analog (SE1)

16-bit A/dc
0-5 Vdc
 $\pm 12\text{ mV}$ accuracy
80 μV resolution
50 dB rejection at 60 Hz
Software configurable as millivolt or milliamp input

Precision 100 Ω current sense resistor when configured for milliamp input

Digital I/O (C1)

Software configurable as status (high/low) or SDI-12 input

Status Low 0 to 1.4 Vdc, High 3.5 to 5.0 Vdc

SDI-12 limited to 1 address, 1 value

Transient voltage surge (TVS) and gas discharge tube (GDT) protected

Switched Voltage (SW12V)

Voltage supply switched on prior to operational sensor scan

Thermal fuse hold current = 900 mA @ 20°C, 630 mA @ 50°C,

450 mA @ 70°C

GPS

SMA Female

50 Ω input impedance

Active antenna design, 3.3 Vdc

25 dBm maximum input

Integrated SAW filtering and jam resistance

1 second time-to-fix during normal operation

35 second time-to-fix on power up or reboot

13 min for leap second, once per day auto

PPS \pm 1 usec to full UTC second

Receive sensitivity -161 dBm

Timekeeping

GPS disciplined to \pm 1 μ S

Drift \pm 170 ms per day with 40°C temperature change (w/o GPS sync)

Compliance

RoHs

CE

IEC61000-4 ESD

7. Installation

7.1 Configuring the AL200

The AL200 is configured via the USB port using the Device Configuration Utility.

It is important to have an understanding of the network that the AL200 will be used in. There are many settings that are used to configure when and how the AL200 will report data in the time division multiple access (TDMA) scheme. Incorrect settings can cause channel contention and may result in lost data.

NOTE

The device driver for the AL200 must be installed on your computer before you can connect to the AL200 via USB. See Appendix E, *AL200 USB Driver Installation Instructions (p. E-1)*, for instructions on installing the device driver.

1. Connect the supplied USB cable between a USB port on your computer and the USB port on the AL200. The AL200 will be powered over the USB for configuration only. The AL200 will not turn on an attached radio and transmit while powered over the USB port.
2. Open *Device Configuration Utility*.
3. Under **Device Type**, select **AL200**.
4. Click the browse button next to **Communication Port** and select the port associated with the AL200.
5. Click **OK**.
6. Click **Connect**.
7. Specify the settings on each tab as described below for the desired mode.

NOTE

When a value is shown in parentheses next to a setting, it is the default values that should work in most cases. Do not change these values, unless you are certain a change is required.

7.1.1 Stand-alone Device

Main

- Set the **Operation Mode** to **Sensor Input Enabled (CS I/O Disabled), ALERT Concentration on RS-232**.

ComPort

These settings have no effect in stand-alone mode.

ALERT2

These settings will be unique to a particular station and to your network.

- Set the **Station Source Address** – This is a station ID number that must be unique within the network. This is an integer between 0 and 65,501. A database of source addresses can be found at www.alert2.org.
- Set the **Frame Length** – This is the total amount of time that all of the stations in the network will report in. This is an integer with a resolution of 500 ms between 5,000 and 3,600,000.

- Set the **Slot Length** – This is the maximum amount of time within the frame that the station can report. It is an integer value between 500 and a maximum of the **Frame Length**.
- Set the **Slot Offset** – This is the amount of time into the frame that the slot will occupy. For example, if your frame is 120,000 ms (2 minutes) and your slot offset is 60,000 ms, the slot time will begin 1 minute after the beginning of the frame.
- Set the **Hop Limit** – (None) – This is the maximum number of times a remote transmission can be retransmitted by repeaters.
- Set the **Path Service Enabled** – (No) – When enabled, each device that repeats a remote transmission will add its source address to the packet. This makes it possible to trace the path that a packet took from its beginning to its destination.

Radio Settings

The default radio settings have been chosen to work well with Campbell Scientific's RF320 series (Ritron DTX-L series) radios. If using a different type of radio, consult the manufacturer and apply the changes to the following settings.

- Set the **Radio Power Up Mode** – (On Only With Data to TX) – This determines when the radio will be powered on.
- Set the **Radio Warm Up** – (750) – This is the amount of time, in milliseconds, that power will be applied to the external radio prior to data transmission.
- Set the **Carrier Only Time** – (10) – This is the amount of time, in milliseconds, that radio will be fed an unmodulated carrier.
- Set the **AGC Time** – (25) – This is the amount of time, in milliseconds, that the radio will be fed a tone-modulated carrier.
- Set the **Tail Time** – (5) – This is the amount of time, in milliseconds, an unmodulated carrier will be transmitted following data transmission.
- Set the **Modulation Voltage** – (390) – This is the peak-to-peak voltage level of the modulated signal that will be fed to the radio. Value is expressed in millivolts.
- Set the **Modulation Polarity** – (Normal) – This is the polarity of the modulated signal fed to the radio.

GPS Settings

- **Last GPS Fix** – This is the data and time of the last successful GPS fix obtained by the AL200.

- Set the **GPS Power On Interval** – (30) – This is how often the GPS receiver will be powered on and an attempt to get a GPS fix will be made. Value is expressed in minutes.
- Set the **GPS On Max** – (5) – This is the maximum amount of time, in minutes, that the GPS receiver will be powered on without a GPS fix being obtained.

Sensor Input Settings

- Set the **Self Report Interval** – (43,200,000 (12 hours)) – This is how often the AL200 will transmit non-event triggered data. Value is expressed in seconds.
- Set the **Sensor Scan Interval** – This is how often the AL200 will power up and measure attached and enabled sensors. Value is expressed in seconds.
- Set the **SW12 Warm Up Time** – This is the amount of time in seconds that the AL200 will wait after powering up attached sensors before making a measurement.
- Set the **P1 Mode** – Enable or disable the pulse count channel depending on whether or not it is being used.
- Set the **SE1 Mode** – Set to **Millivolt** if using a sensor that has a single ended voltage output. Set to **Milliamp** if sensor has a single ended current output or 4-20 mA loop output.
- Set the **SE1 ALERT2 Sensor ID** – This is the sensor ID of the sensor connected to the SE1 channel. See Appendix G, *List of Recommended Sensor IDs* (p. G-1), for a list of recommended sensor ID values.
- Set the **SE1 Multiplier** – This is a sensor specific value that along with the SE1 Offset will be used to convert the analog output of a sensor to an engineering unit. See Appendix H, *Calculating Multipliers and Offsets* (p. H-1), for how to calculate multipliers and offsets.
- Set the **SE1 Offset** – This is a sensor specific value that along with the SE1 Multiplier will be used to convert the analog output of a sensor to an engineering unit. See Appendix H, *Calculating Multipliers and Offsets* (p. H-1), for how to calculate multipliers and offsets.
- Set the **SE1 Tx Change** – This is the threshold which a calculated value for the SE1 measurement must exceed in order to trigger a data transmission.
- Set the **C1 Mode** – Set to **Status** to configure C1 to read a dry contact (commonly a float switch). Set to **SDI-12** to configure for use with an SDI-12 type sensor.

- Set the **C1 ALERT2 Sensor ID** – This is the sensor ID of the sensor connected to the C1 channel. See Appendix G, *List of Recommended Sensor IDs (p. G-1)*, for a list of recommended sensor ID values.
- Set the **SDI-12 Command** – This is the measurement command that will be sent to the attached SDI-12 sensor. The format is xM!, where x is the SDI-12 address.
- Set the **SDI-12 Value to Send** – If the attached SDI-12 sensor returns more than one value, select which value will be used.
- Set the **SDI-12 Multiplier** – (1) – This is a sensor specific value that along with the SDI-12 Offset will be used to convert the analog output of a sensor to an engineering unit. See Appendix H, *Calculating Multipliers and Offsets (p. H-1)*, for how to calculate multipliers and offsets. (Note that most SDI-12 sensors do not require a multiplier or offset except for unit conversion.)
- Set the **SDI-12 Offset** – (0) – This is a sensor specific value that along with the SE1 Multiplier will be used to convert the analog output of a sensor to an engineering unit. See Appendix H, *Calculating Multipliers and Offsets (p. H-1)*, for how to calculate multipliers and offsets. (Note that most SDI-12 sensors do not require a multiplier or offset except to convert units of measure.)
- Set the **SDI-12 Tx Change** – This is the threshold which a calculated value for the SDI-12 measurement must exceed in order to trigger a data transmission.

Sensor Data Monitoring

- Set the **Configuration Sensor Scan Interval** – This is the interval on which sensors will be read only while you are connected to the AL200 with the Device Configuration Utility software.

After configuring the AL200 settings, click the **Apply** button at the bottom of the screen to send the changes to the device. It is a good idea to save the configuration file for later reference.

7.1.2 Datalogger Peripheral

Main

- Set the **Operation Mode** to either **ALERT2 on CS I/O**, **ALERT Concentration on RS-232** or **ALERT Concentration on CS I/O**, **ALERT2 on RS-232** depending on what type of device the AL200 will be connected to.

ComPort

- If the AL200 is connected to a Campbell Scientific datalogger, select the appropriate SDC address. When using the CS I/O port, it is not necessary to configure the RS-232 related settings.

- If the AL200 is connected to an RS-232 device, configure the **RS-232 Baud Rate**, **RS-232 Parity**, and **RS-232 Stop Bits** to match the device.

ALERT2

These settings will be unique to a particular station and to your network.

- Set the **Station Source Address** – This is a station ID number that must be unique within the network. This is an integer between 0 and 65,501. A database of source addresses can be found at www.alert2.org.
- Set the **Frame Length** – This is the total amount of time that all of the stations in the network will report in. This is an integer with a resolution of 500 ms between 500 and 43,200,000 (12 hours).
- Set the **Slot Length** – This is the maximum amount of time within the frame that the station can report during. It is an integer value between 500 and a maximum of the **Frame Length**.
- Set the **Slot Offset** – This is the amount of time into the frame that the slot will occupy. For example, if your frame is 120,000 ms (2 minutes) and your slot offset is 60,000 ms, the slot time will begin 1 minute after the beginning of the frame.
- Set the **Hop Limit** – (None) – This is the maximum number of times a remote transmission can be retransmitted by repeaters.
- Set the **Path Service Enabled** – (No) – When enabled each device that repeats a remote transmission will add its source address to the packet. This makes it possible to trace the path that a packet took from its beginning to its destination.

Radio Settings

The default radio settings have been chosen to work well with Campbell Scientific's RF320 series (Ritron DTX-L series) radios. If using a different type of radio, consult the manufacturer and apply the changes to the following settings.

- Set the **Radio Power Up Mode** – (On Only With Data to TX) – This determines when the radio will be powered on.
- Set the **Radio Warm Up** – (750) – This is the amount of time, in milliseconds, that power will be applied to the external radio prior to data transmission.
- Set the **Carrier Only Time** – (10) – This is the amount of time, in milliseconds, that radio will be fed an unmodulated carrier.
- Set the **AGC Time** – (25) – This is the amount of time, in milliseconds, that the radio will be fed a tone-modulated carrier.

- Set the **Tail Time** – (5) – This is the amount of time, in milliseconds, an unmodulated carrier will be transmitted following data transmission.
- Set the **Modulation Voltage** – (390) – This is the peak-to-peak voltage level of the modulated signal that will be fed to the radio. Value is expressed in millivolts.
- Set the **Modulation Polarity** – (Normal) – This is the polarity of the modulated signal fed to the radio.

GPS Settings

- **Last GPS Fix** – This is the data and time of the last successful GPS fix obtained by the AL200.
- Set the **GPS Power On Interval** – (30) – This is how often the GPS receiver will be powered on and an attempt to get a GPS fix will be made. Value is expressed in minutes.
- Set the **GPS On Max** – (5) – This is the maximum amount of time, in minutes, that the GPS receiver will be powered on without a GPS fix being obtained.

Sensor Input Settings

These settings have no effect in datalogger peripheral mode.

Sensor Data Monitoring

These values are not updated when the AL200 is configured as a datalogger peripheral.

After configuring the AL200 settings, click the **Apply** button at the bottom of the screen to send the changes to the device. It is a good idea to save the configuration file for later reference.

7.2 Mounting in an Enclosure

When used in outdoor applications, the AL200 should be installed in a desiccated, weatherproof enclosure. The AL200 can either be flat- or edge-mounted to a panel using the supplied plastic grommets and 6-32 screws.

7.3 Grounding

The ground lug should be connected to a good earth ground using 12 AWG stranded wire. This will help protect the AL200 from electrical surges and provide a good reference for analog measurements.

7.4 Wiring

Connect the transmit, power, and ground lines (Push to Talk and Frequency Select lines are optional) from your analog radio to the SW12V, Tx and G terminals of the radio connector. The AL200 should be mounted as close as possible to the radio in order to avoid long cable runs between the two devices.

Connect the sensor leads to the appropriate sensor inputs. Depending on site conditions, additional surge protection for the sensor cables may be required.

If using the AL200 as a datalogger peripheral, connect either the CS I/O or RS-232 port to the datalogger using the supplied SC12 cable.

8. Operation

The AL200 uses the ALERT2 protocol as developed by the ALERT2 Technical Working Group (TWG) and is designed for use as an ALERT2 transmitter or ALERT to ALERT2 concentrator and repeater. For more information on the ALERT2 protocol, visit the National Hydrologic Warning Council's website: www.hydrologicwarning.org.

Under normal operation, the AL200 will obtain a GPS fix and measure sensors based on its configuration. When the sensors are measured and an event threshold has been exceeded, the AL200 will wait until its designated time slot and then power up the radio and transmit the data to a repeater or base receiver.

- Concentrated ALERT data is retransmitted using the ALERT concentration protocol.
- Event-driven rainfall data is transmitted as a tipping bucket rain gauge report with a sensor ID of zero (0).
- Other event-driven sensor data is transmitted as a general sensor report. If events for multiple sensors are detected in the same frame, then multiple general sensors reports will be transmitted.
- A scheduled self-report is transmitted as a multi-sensor report.

If a GPS fix cannot be obtained and the AL200's internal clock cannot be disciplined, the device will transmit data during random slot times throughout the frame interval in an attempt to not continuously interfere with adjacent time slots.

When connected to the AL200 with the Device Configuration Utility, the AL200 will power up and measure the attached sensors on the **Configuration Sensor Scan Interval** located on the Sensor Data Monitoring tab, but transmissions will be suppressed.

9. Maintenance

It is a good idea to periodically check the sensor inputs against known values to ensure that the device is still within the specified accuracy ranges. Connecting to the AL200 with a USB cable will force the AL200 to measure the attached sensors on the **Configuration Sensor Scan Interval**. This will allow the user to quickly see how sensors respond to changes. Upon disconnecting from the device, the AL200 will resume its **Sensor Scan Interval**.

Pressing the test button for three to six seconds will trigger a test transmission containing the latest data available to the AL200. Pressing the button for longer than six seconds will cause the AL200 to generate a test tone and sustain it for

five seconds. This test tone can be used to check the forward and reflected power of the radio.

Consult your sensor and radio manufacturer’s manuals for recommended maintenance of these devices.

10. Troubleshooting

Problem	Possible Causes
The AL200 will not transmit event-triggered data.	<ul style="list-style-type: none"> • The AL200 is currently connected to Device Configuration Utility and data transmissions are being suppressed. • The event threshold is not properly set. • The AL200 is not currently measuring a level that exceeds the event threshold. • The AL200 has not obtained an initial GPS fix.
The Test Button is not initiating a data transmission.	<ul style="list-style-type: none"> • The AL200 has not obtained an initial GPS fix. • The AL200 has been configured as a datalogger peripheral and the test button functionality has been disabled.
The AL200 is reporting incorrect values.	<ul style="list-style-type: none"> • The applied multipliers and offsets are not correct. • There is an issue with the attached sensor or sensor wiring.
The radio LED is always red.	<ul style="list-style-type: none"> • The AL200 has been configured to keep the radio always on.
The GPS LED is on longer than the maximum allowed on time.	<ul style="list-style-type: none"> • The GPS module is attempting to obtain leap second information and may be on for up to 13 minutes.

11. Repair

The AL200 is designed to give years of trouble-free service with reasonable care. However, if factory repair is needed, first contact a Campbell Scientific application engineer to obtain an RMA (Return Materials Authorization) number. An RMA number and product-safety documents are required prior to any repair shipments being accepted at Campbell Scientific. See the Assistance statement at the beginning of this manual for more information.

12. Acknowledgements

Portions of embedded code were developed and copyrighted by Blue Water Design LLC and are used under license.

Appendix A. Glossary

ALERT

Automated Local Evaluation in Real Time. A communication protocol developed in the early 1970's for the efficient reporting of real-time rainfall data over radio telemetry networks.

ALERT2

Successor of the ALERT communication protocol. A layered protocol suite designed for the primary purpose of real-time and coordinated communication of data over a radio telemetry network.

IND

Intelligent Network Device. A device that implements the AirLink and MANT protocols for the transmission, repeating, or receipt of ALERT2 data.

MANT

ALERT2 Network and Transport layer providing the required services to transport application and network control data.

PDU

Protocol Data Unit. Data payload with control header used for exchange between protocol layers. Sometimes generalized as "packet".

SDC

Synchronous Device Communications. A Campbell Scientific addressable, synchronous communications protocol. The protocol allows multiple peripherals to be connected to the same communication bus as long as each peripheral has a unique SDC address.

Appendix B. Cables and Connector Pin Descriptions

B.1 CS I/O

CS I/O is an interface unique to Campbell Scientific products. CS I/O uses TTL signaling. CS I/O devices are connected using a 9-pin, straight-through, male to female cable with all 9 pins connected. Use of the supplied SC12 cable (pn 16675) is recommended.

TABLE B-1. CS I/O Pin Description		
Pin	Datalogger Function, DB9 Female	AL200 Function, DB9 Male
1	5 VDC	N/C
2	SIGNAL GND	SIGNAL GND
3	RING	RING
4	RXD	TXD
5	ME	ME
6	SDE	SDE
7	CLK/HS	CLK/HS
8	12 VDC	N/C
9	TXD	RXD

B.2 RS-232

RS-232 is used for asynchronous serial communication. It is a standard EIA/TIA-232 DB9 socket female DCE interface. A DB9 male to male null modem cable (pn 18663) is used to connect the AL200 to a Campbell Scientific datalogger's RS-232 port.

TABLE B-2. RS-232 Pin Description	
Pin	AL200 Function, DCE, DB9 Female
1	N/C
2	TXD
3	RXD
4	N/C
5	SIGNAL GND
6	N/C
7	CTS
8	RTS
9	N/C

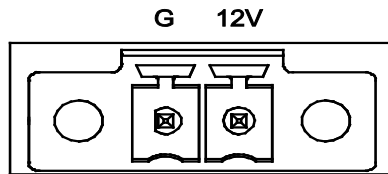
B.3 USB

The USB interface is a standard Micro-B configuration. A USB A to Micro-B cable is supplied (pn 27555). Connection to a PC requires installation of the FTDI Virtual COM Port (VCP) device driver.

Pin	Function
1	VBUS, 5 Vdc
2	Data -
3	Data +
4	Not used, Grounded Internally
5	GND

B.4 Power

Input power is supplied via a 2-pin screw terminal. A mating connector is supplied (pn 7843).



Pin	Function
G	Supply Ground
12V	Supply Voltage

B.5 Analog Radio Interface

The analog radio interface is a 5-pin screw terminal. A mating connector is supplied (pn 28750).

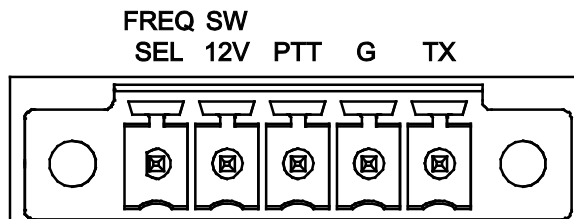


TABLE B-5. Radio Interface Pin Description	
Pin	Function
Freq. Select	Frequency Select. Accommodate frequency selection during operation by grounding selected pin on radio interface.
SW12V	Switchable radio power supply
PTT	Push-to-talk. Grounded during transmission.
G	Ground
TX	Transmit audio output

B.5.1 Connecting a Maxon SD-125 or SD-225 Series Radio

A Maxon SD-125 or SD-225 Series Radio can be connected to the AL200 using Campbell Scientific pn 31924 as shown in TABLE B-6.

TABLE B-6. Maxon SD-125/225 Radio Connections		
Color	AL200 Terminal	DB9 Pin
Black	G	4
Red	SW12V	5
White	PTT	3
Green	TX	1

B.6 Sensor I/O Interface

The sensor I/O interface is a 5-pin screw terminal. A mating connector is supplied (pn 28750).

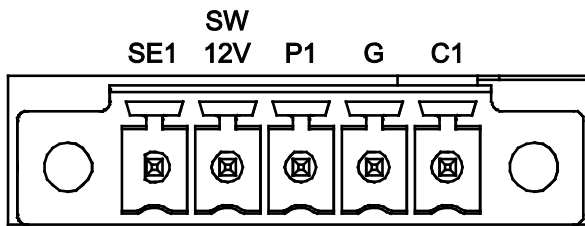


TABLE B-7. Sensor I/O Pin Description	
Pin	Function
SE1	Analog voltage / current input
SW12V	Switchable sensor power supply
P1	Switch closure input. Internally tied high to 5V.
G	Ground
C1	Digital I/O for high/low status or SDI-12

B.7 GPS Input

The GPS input is a threaded SMA female connector.

TABLE B-8. GPS Input Pin Description	
Pin	Function
Center Conductor Socket	RF Input, biased by 3.3 V for use with active antennas
Shield	RF ground

Appendix C. LED Indicators

The GPS LED is next to the GPS antenna connection. It can be used for monitoring GPS power up and acquisition of a good satellite lock / fix.

TABLE C-1. GPS LED State Descriptions	
State	Description
Off	GPS module in “hibernate state”
Green	GPS lock acquired (will only flash momentarily before turning off)
Red	GPS module on, No GPS Lock (or downloading almanac/leap second information)

The Serial LED is located between the RS-232 and CS I/O interfaces. It can be used for monitoring communication events on those ports.

TABLE C-2. Serial LED State Descriptions	
State	Description
Off	Neither interface is currently transferring data
Green	RS-232 activity, Internal U0 activity
Red	CS I/O activity, Internal U1 activity

The Radio LED is located between the CS I/O and USB interfaces. It can be used for monitoring the power and communication state of the radio interface.

TABLE C-3. Radio LED State Descriptions	
State	Description
Off	Radio interface not currently in use
Green	PTT applied, Transmitting
Red	Power applied to radio, SW12V high
*When the radio is both powered on and transmitting, the red and green LEDs will appear orange.	

Under normal operation, the LED sequence should be as follows from powering up the device through a data transmission:

- a. GPS LED is red immediately after power, then flashes green indicating that the AL200 has a GPS fix.

- b. The GPS light remains red for up 13 minutes as the AL200 downloads leap second information from the satellite.
- c. The Serial LED flashes green or red indicating that the AL200 has been sent data from a datalogger, or data is being internally transferred from the sensor inputs to memory.
- d. The Radio LED is red briefly while the radio is powered up and allowed to warm up. If the radio is set to always on, this LED will constantly be red.
- e. The Radio LED flashes orange (actually green and red lights, but is orange in appearance) indicating that the AL200 is transmitting data.

Appendix D. AL200 Settings

Operation Mode	<p>The AL200 supports ALERT2 and ALERT-concentration processing. Each process can service one physical connection on the AL200 at a time. Those connections are the CS I/O, RS-232, and direct-sensor inputs. The CS I/O port and sensor inputs are multiplexed, so their use is mutually exclusive.</p> <ul style="list-style-type: none"> • ALERT2 on CS I/O, ALERT Concentration on RS-232 In this mode, the AL200 will accept ALERT2 on the CS I/O port and ALERT packets on the RS-232 port. • Sensor Input Enabled (CS I/O Disabled), ALERT Concentration on RS-232 In this mode, the AL200 will measure attached sensors and receive serial ALERT packets on the RS-232 port. • ALERT Concentration on CS I/O, ALERT2 on RS-232 In this mode, the AL200 will accept ALERT on the CS I/O port and ALERT2 on the RS-232 port.
OS Version	The version of the operating system currently running on this device. Updates can be found on Campbell Scientific's website, www.campbellsci.com/downloads .
CS I/O SDC Address	Synchronous Device for Communication (SDC) address that this device should use while communicating over CS I/O. Communication speed (bit rate) is controlled by the datalogger.
RS-232 Baud Rate	The baud rate used for communication over RS-232.
RS-232 Parity	Parity bit usage during communication over RS-232.
RS-232 Stop Bits	The number of stop bits sent after each character during communication over RS-232.
Time To Next Slot	Time (seconds) until the next transmission slot.
Station Source Address	ALERT2 station source address. Each station in an ALERT2 network should have a unique source address.
Destination Address	The source address of device that packets are directed to.
Add Destination Address	Controls if Destination Address will be added to the packet header. A setting of No will disable the Destination Address settings control.
Frame Length	The total amount of time that all of the stations in the network will report within. The value is expressed in milliseconds with a resolution of 500 ms. It is an integer between 500 and 43,200,000 (12 hours). The value must be evenly divisible into 12 hours, that is $(43200000 / \text{Frame Length} = \text{Whole Number})$ or $(43200000 \text{ MOD } \text{Frame Length} = 0)$.
Slot Length	The maximum amount of time this device can transmit within a single frame. The value is expressed in milliseconds with a resolution of 500 ms. It is an integer value between 500 and a maximum of the Frame Length .
Slot Offset	The offset, from the beginning of the frame, for the transmission slot. The value is expressed in milliseconds with a resolution of 500 ms. The value cannot exceed (Frame Length - 500 ms) .

Hop Limit	The maximum number of times a packet, originating from this device, will be repeated (hop) before being discarded. None (7) disables the limiting of hops. Example: if this station requires 1 repeater hop to reach the base station receiver, the hop limit should be set to a minimum of 1.
Path Service Enabled	Request that each device that forwards data originating from this station add its source address to the packet header. Enabling this option allows a receiver to know the path that the packet took through the network.
Radio Power Up Mode	The setting controls when the attached radio is powered up. The radio can be powered up every frame, continuously, or only when data is available for transmission. For maximum power savings, set to On Only With Data to Tx . The radio will only power up if the AL200 has data to be transmitted. For maximum responsiveness, set to On Every Frame or On Continuously . If On Every Frame , the radio will be turned on for a minimum of Radio Warm Up milliseconds every frame.
Radio Warm Up	The amount of time power should be applied to the radio prior to the start of the transmission slot. Power will be applied according to the Radio Power Up Mode . The value is expressed in milliseconds with a resolution of 10 ms.
Carrier Only Time	Amount of unmodulated carrier used in Airlink preamble. The value is expressed in milliseconds.
AGC Time	Amount of tone-modulated carrier used in Airlink preamble. The value is expressed in milliseconds.
Tail Time	Amount of unmodulated carrier to follow transmitted frame. The value is expressed in milliseconds.
Modulation Voltage	This setting controls the modulation voltage. The value is expressed in millivolts, peak-to-peak. Settings do not take effect until applied.
Modulation Polarity	Depending on the radio used the audio AirLink modulation signal may need to be inverted. For Midland and Ritron radios, set this to Normal.
Last GPS Fix	The last time that the device successfully acquired a GPS fix. The time is shown in UTC. Remember that you may need to correct for your time zone offset when trying to understand this value in context of the local time.
GPS Power On Interval	Time between GPS fix attempts. The value is expressed in minutes.
GPS On Max	The maximum time the GPS will remain on while trying to obtain a fix. The value is expressed in minutes.
Self Report Interval	Controls the frequency at which sensor data should be reported, without being triggered by an event. Value is expressed in seconds.
Sensor Scan Interval	Controls the interval at which sensors, with the exception of P1, will be read during normal operation. Value is expressed in seconds.
SW12 Warm Up Time	Controls the amount of time SW12V should be on before reading sensor inputs, with the exception of P1. A setting of -1 means SW12V will be left on continuously. A setting of 0 means SW12V will not be enabled before measurement. Value is expressed in seconds.
P1 Mode	Enables the P1 terminal input. The P1 input is most commonly used for measuring switch closures, like those commonly produced by a tipping bucket rain gage. An ALERT2 sensor ID of 0 will be used for tipping bucket and general sensor reports for this input.

SE1 Mode	Sets the operation mode for the SE1 terminal input. SE1 is used for measuring millivolt or milliamp input signals, like those commonly produced by a pressure transducing level sensor.
SE1 ALERT2 Sensor ID	The ALERT2 sensor ID that will be used to identify a SE1 general sensor report. The ID cannot be set to 0 or 8. 0 is reserved for reporting P1 input. 8 is reserved for reporting battery.
SE1 Multiplier	Multiplier to apply to SE1 measurement before evaluation and transmission. Example: Water Level = SE1 measurement • SE1 Multiplier + SE1 Offset .
SE1 Offset	Offset to apply to SE1 measurement before evaluation and transmission. Example: Water Level = SE1 measurement • SE1 Multiplier + SE1 Offset .
SE1 Tx Change	Amount of change in reading required to trigger Tx of reading. Reading = SE1 measurement • SE1 Multiplier + SE1 Offset .
C1 Mode	Sets the operation mode for the C1 terminal input. C1 is used for measuring status (high/low) or SDI-12 inputs, like those produced by a float switch or pressure transducing level sensor, respectively.
C1 ALERT2 Sensor ID	The ALERT2 sensor ID that will be used to identify a C1 general sensor report. The ID cannot be set to 0 or 8. 0 is reserved for reporting P1 input. 8 is reserved for reporting battery.
SDI-12 Command	SDI-12 command to be sent to the attached sensor.
SDI-12 Value to Send	Selects which value returned by the SDI-12 sensor to use for evaluation and transmission. For example, if the sensor returned 4 values, and the 3rd value needs to be used, this setting should be 3.
SDI-12 Multiplier	Multiplier to apply to the SDI-12 measurement before evaluation. Example: Water Level = SDI-12 measurement • SDI-12 Multiplier + SDI-12 Offset .
SDI-12 Offset	Offset to apply to the SDI-12 measurement before evaluation. Example: Water Level = SDI-12 measurement • SDI-12 Multiplier + SDI-12 Offset .
SDI-12 Tx Change	Amount of change in the reading required to trigger Tx of reading. Reading = SDI-12 measurement • SDI-12 Multiplier + SDI-12 Offset .
Configuration Sensor Scan Interval	Controls the interval at which sensors, with the exception of P1, will be read while connected with Device Configuration Utility. Value is expressed in seconds. This setting does not take effect until settings are applied.
Battery	Battery / supply voltage (volts). While connected via Device Configuration Utility, the battery voltage will be measured every Configuration Sensor Scan Interval . The measured value will be queried and displayed here at a regular refresh interval.
P1 Total	If the P1 input is enabled, the total number of counts since the device was last powered up or reset will be displayed here. The measured value will be queried and displayed here at a regular refresh interval.
SE1 Raw Reading	If SE1 is enabled, the SE1 reading without SE1 Multiplier and SE1 Offset applied. While connected via Device Configuration Utility, SE1 will be measured every Configuration Sensor Scan Interval . The measured value will be queried and displayed here at a regular refresh interval.
SE1 Scaled Reading	If SE1 is enabled, the SE1 reading, with SE1 Multiplier and SE1 Offset applied. While connected via Device Configuration Utility, SE1 will be measured every Configuration Sensor Scan Interval . The measured value will be queried and displayed here at a regular refresh interval.

SE1 Transmitted	Last three transmitted readings for SE1 (T0, T1, T2). The list will be queried and displayed here at a regular refresh interval. While connected via Device Configuration Utility, automated reporting/transmission is disabled. Press and hold the test button for 3 to 5 seconds to force a transmission while connected.
C1 Raw Reading	If C1 input is enabled, this will be either a) the control port state or b) the value for SDI-12 without SDI-12 Multiplier and SDI-12 Offset applied, during the last sensor scan. While connected via Device Configuration Utility, C1 will be measured every Configuration Sensor Scan Interval . The measured value will be queried and displayed here at a regular refresh interval.
C1 Scaled Reading	If C1 input is enabled, this will be either a) the control port state or b) the value for SDI-12 with SDI-12 Multiplier and SDI-12 Offset applied, during the last sensor scan. While connected via Device Configuration Utility, C1 will be measured every Configuration Sensor Scan Interval . The measured value will be queried and displayed here at a regular refresh interval.
C1 Transmitted	If C1 input is enabled, this will be either a) the control port state or b) the value for SDI-12 for the last three transmitted readings of C1 (T0, T1, T2). The list will be queried and displayed here at a regular refresh interval. While connected via Device Configuration Utility, automated reporting/transmission is disabled. Press and hold the test button for 3 to 5 seconds to force a transmission while connected.

Appendix E. AL200 USB Driver Installation Instructions

When plugging the AL200 into your Windows XP or Vista PC for the first time, it may be necessary to install the FTDI Virtual COM Port (VCP) driver. This is not required when using Windows 7 or 8.

Visit www.ftdichip.com/Drivers/VCP and select the appropriate file based on your computer's operating system. Download the zip file to your PC and extract the files to a directory of your choosing. Select and open the executable file and proceed through the install wizard. After the drivers finish installing, you should see a confirmation screen indicating that the drivers were installed or updated successfully. You will then need to restart your computer to apply the changes.

Appendix F. Updating the Operating System of the AL200

Whenever a new operating system is released for the AL200, it will be available from our website, www.campbellsci.com/downloads.

Follow these steps to send the new OS to the AL200:

1. Connect a USB cable between one of your computer's USB ports and the USB port on the AL200.
2. Open *DevConfig*.
3. Select the **AL200** under Device Type.
4. Select the appropriate **Communication Port**.
5. Go to the Send OS tab.
6. Press the **Start** button.
7. In the resulting dialog box, select the file that should be sent to the device as an operating system (this file should have a .hex extension) and press the **OK** button.
8. The operating system will be sent to the AL200.
9. Do not remove power while an OS download is in process.

Appendix G. List of Recommended Sensor IDs

TABLE G-1. Recommended Sensor IDs	
ID	Sensor Type
0	Rain
1	Air Temperature
2	Relative Humidity
3	Barometric Pressure
4	Wind Speed
5	Wind Direction
6	Peak Wind Speed
7	Stage
8	Battery Voltage

*As recommended in the ALERT2 Application Layer Protocol Specification document, Version 1.2.

Appendix H. Calculating Multipliers and Offsets

Unlike ALERT which could only represent measurement values between 0 and 2047, ALERT2 has the ability to represent a much larger range of floating point numbers. It is no longer necessary to scale a reading to a unit-less number less than 2047. Instead, with ALERT2, you can transmit values in engineering units with a high degree of resolution. The simplified example below demonstrates how to calculate the multiplier and offset that are needed to convert a pressure transducer's output, 0-5 volts, to feet of water.

For this example we will use a pressure transducer that has a 0 to 30 psi range and a 0 to 5 volts output. From the manufacturer supplied calibration report it is known that the sensor outputs 0.0123 volts at 0 psi and 4.987 volts at 30 psi (12.3 and 4987 millivolts respectively).

The relationship between the sensor's output in millivolts and pressure is defined by the equation of a line (assuming linearity), $Y = mX + b$, where Y is pressure, m is the calculated multiplier, X is the sensor's output in millivolts, and b is the calculated offset.

$$Y = mX + b$$

OR

$$\text{Pressure} = \text{Multiplier} \cdot \text{Sensor Output} + \text{Offset}$$

The multiplier is determined by dividing the sensor's measurement ranges by the sensor's range of output. For this example the multiplier will be:

$$\text{Multiplier} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

OR

$$\text{Multiplier} = \frac{30 - 0}{(4987 - 12.3)} = \frac{30}{(4974.7)} = 0.0060 \text{ psi per mV}$$

The offset is determined by entering the multiplier into the pressure equation and solving for the offset using a known pressure and sensor output.

$$\text{Offset} = \text{Pressure} - (\text{Multiplier} \cdot \text{Sensor Output})$$

OR

$$\text{Offset} = 0 - (0.0060 \cdot 12.3) = -0.074 \text{ psi per mV}$$

Now, we can calculate pressure based on the reading we get from the sensor. For example, you measure the sensor's output as 2543.210 mV. Pressure would be determined by:

$$\text{Pressure} = (0.0060 \cdot 2543.210) + (-0.074) = 15.263 \text{ psi}$$

To determine water depth, simply multiply the pressure value by the appropriate conversion factor.

For fresh water this is:

$$1 \text{ psi} = 2.308 \text{ ft.}$$

For salt water this is:

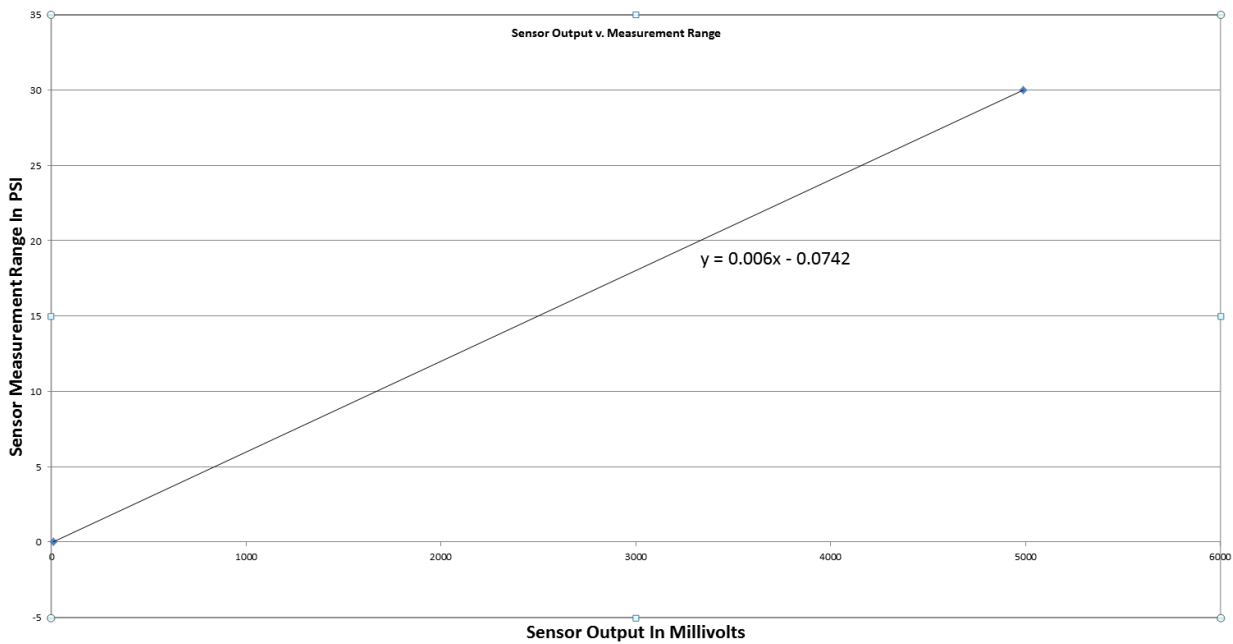
$$1 \text{ psi} = 2.250 \text{ ft.}$$

For the above example (assuming fresh water):

$$\text{Depth of Water} = \text{Pressure} \cdot 2.308$$

$$\text{Depth of Water} = 15.263 \cdot 2.308 = 35.226 \text{ ft.}$$

These calculations can easily be performed using many spreadsheet programs by plotting the sensor's measurement range versus the sensor's output range. The equation of the trendline contains the multiplier and offset.



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