

Ai1

All-in-one, rugged, remote monitoring

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Quick Start Guide

March 2020 Revision

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Warranty

Ai1 products are warranted for twelve (12) months subject to this limited warranty

Limited Warranty: Ai1 products are warranted to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified. Batteries, desiccant, and other consumables have no warranty. The Manufacturers obligation under this warranty is limited to repairing or replacing (at the Manufacturers option) defective Products, which shall be the sole and exclusive remedy under this warranty. Products may not be returned without prior authorization. The Customer assumes all costs of removing, reinstalling, and shipping Products to The Manufacturer. For all returns, The Customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The Manufacturer reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns. The Manufacturer will return such Products by surface carrier prepaid within Australia. To all other locations, The Manufacturer will return such Products best way CIP (port of entry) per Incoterms[®] 2010. This warranty shall not apply to any Products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for services performed by The Manufacturer such as programming to Customer specifications or product specific training, is part of The Manufacturers product warranty. Ai1 products are intended to be part of a well maintained and comprehensive monitoring system. Reliable operation depends on suitable site selection, correct installation, real time monitoring of data, adequate maintenance and investigation of alarm and diagnostic information. Stations are designed to be mounted above water, submersion may result in damage. All ownership and risk transfers to the purchaser at the time of shipment. The Manufacturer does not accept any liability or consequential damages for any failure of systems supplied. Repair or service of the system is only to be handled by factory trained technicians. No service by The Customer is allowed. Refer to terms and conditions of sale for full details. THE MANUFACTURER EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. The Manufacturer hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.

Precautions

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR NEAR ROADS, RIVERS, WATER BODIES, ELEVATED PLATFORMS, REMOTE LOCATIONS AND OTHER SIMILAR HAZARDS. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of sites. Installation sites should be evaluated and approved by a qualified engineer. Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing permits and use only qualified personnel. The use of licensed and qualified contractors is highly recommended. Read all applicable instructions carefully and understand procedures thoroughly before beginning work. Wear all relevant personal protective equipment, including a hardhat and eye protection, and take other appropriate safety precautions while working. You can be killed or sustain serious bodily injury if the system you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines. 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. Protect all equipment from over-voltage, water and electrostatic discharge. Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc. Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose clamps, fastener tightness, electrical ground connections, etc. and take necessary corrective actions. While every attempt is made to embody the highest degree of safety in all Measurement Science products, the customer assumes all risk from any injury resulting from improper installation, use or maintenance of these products. The Manufacturer recommends a level of calibration appropriate to the application, and recommends, at a minimum, recalibration every three years

Measurement Science products including the Ai1 and SDI12 sensors are distributed globally by Xylem Analytics. Please contact your local distributor for support services.

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This guide is constantly updated, the current version is available here: measci.com/ai1/doc/ai1_quickstart.pdf

2. Configuring your Ai1

The base Ai1 model includes the measurement and control module and weatherproof housing. The system is enhanced by adding power, communications and integrated sensors and output modules.

2.1 Power options

The most versatile package is the **Ai1-18W** which has integrated solar panels, however other options are available:

1. **Ai1-EXT.** Externally powered system (no internal battery or integrated solar modules). The power source can be configured to be 12V (default) or 24V. This must be specified at the time of order.
2. **Ai1-9W.** Single 9W solar panel for mounting to a pole or the Ai1 body
3. **Ai1-18W.** Dual 9W solar panels with 7Ah lithium battery. Specify **Vertical (18WV)** or **45° Angle (18WA)**
4. **Ai1-17W.** Single 17W solar panel for mounting to a pole or the Ai1 body

EXT. External Power

Uses external power typically 12V (default) or 24V (option). The full range of operation for each power source is:

- 12V. 10 to 18Vdc
- 24V. 16 to 32Vdc

By default no internal battery is supplied with the EXT power option, however the 7Ah/12.8V battery can be supplied for internal battery backup.



18WV. Dual Vertical 9W solar panels

Suits buoy platforms where the platform is free to move and rotate. Suits higher latitudes where sun angles are lower.

Uses 2 x 9W panels and 7Ah/12.8V Lithium battery



18WA. Dual 45° Angle 9W solar panels

Suits pole mounting with fixed orientation, recommended East-West orientation for optimum charging. Also suitable for buoys for lower latitudes where the sun is commonly high in the sky.

Uses 2 x 9W panels and 7Ah/12.8V Lithium battery



9W or 17W. Single 45°. Towards equator orientation

Suits fixed mounting locations. Can mount on the body of the Ai1, or with a variety of mounting options using the versatile bracket

Uses 1 x 9W or 1 x 17W panels and 7Ah/12.8V Lithium battery



Single 9W panel option



Horizontal pole mount



Wall mount



Vertical pole mount

2.2 Communications options

The Ai1 can be fitted with any of the following primary communications options.

- 3G** Global 3G cellular communications (with 2G fallback)
- 4G** Region specific 4G (US/EU/AU/Asia) cellular communications
- RADIO** Region specific 900MHz (US/EU/AU) radio communications
- WIFI** Wi-Fi communications
- IRID** Iridium transmitter using Short Burst Data (SBD)



Figure 1 – External Iridium option

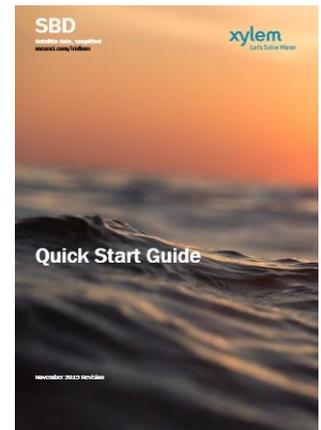
Along with the primary communication, a local network or local control can also be used

- REMOTE** Two button remote control for nearby operations (<200m) such as turning on or off a pump
- LORA** A LoRa radio network (master & remotes) for distances up to 15km or further with repeaters.

For these methods, specify the number of remote controls or remote stations to be supplied.

All communications modules have internal antennas although an external antenna may also be specified at the time of order for fitting high gain antennas. The Iridium module is a separate component designed to mount on top of the Ai1. Refer to the Iridium quick start guide for further details about the Iridium integration and operation.

Figure 2 – Iridium Quick Start guide



Throughout this guide the Ai1-3G model connected to Eagle.io will be used for most examples. Similar concepts apply to all models

2.3 Enhancements

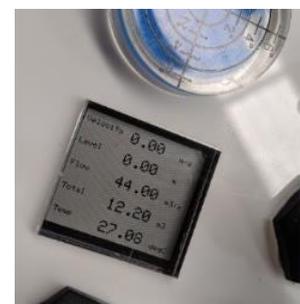
Many integrated enhancements may be included at the time of order. These enhancements may be combined within the limit of the Ai1 I/O. A configurator spreadsheet is available which describes the I/O utilization for each option and confirms that the Ai1 has capacity.

-GPS. Global Positioning System

The internal GPS is a special SDI12 version to reduce the need for serial ports, being able to be read on the same port as other SDI12 sensors. This enhancement is highly recommended on moving platforms (such as buoys) or for use in high risk locations where theft may be a problem.

-DISPLAY. Integrated display

An SDI12 based display option is integrated into the top of the Ai1 for real-time monitoring of measured data. The display operates on the same SDI12 data bus as other sensors, eliminating the need for additional serial ports. No additional software is required to configure the display, using SDI12 commands to configure the parameters displayed, the names, the units and to update the values. The values update instantaneously. Using a memory screen, the display only requires power when updating values, operating at near zero power when always on. Being mounted in the top of the Ai1, the display may not be combined with some other top mounted accessories (i.e. lantern)



-BYPASS. USB serial port bypass to talk to smart sensors

An additional top mounted USB port may be supplied with stations using smart sensors (such as the Sontek IQ flow meter, or Radar velocity sensor) allowing direct communications to the sensor for site specific configuration. An integrated bypass switch is used to allow direct connection for configuration, then returned to the normal position for sensor measurement by the datalogger.



-SWITCH. High power switched outputs

Dual 5V power outputs used for controlling external devices, up to 1A each. While the standard Ai1 allows for many digital outputs these are often current limited to less than 50mA. The SWITCH option includes additional circuitry to allow higher power switching.

-RELAY. High power switched relay outputs

While the SWITCH option may be used for 5V outputs, the relay option provides dual switch outputs (each with Common and Normally Open connections) to allow high power switching (up to 5A / 240Vac). Each output is isolated and independently controlled. This option is typically used for controlling external pumps or high-powered devices. It is recommended that externally wiring is performed by a suitably skilled professional, especially for applications using AC power.

-LATCH. Latching relay

The latching relay may be used to provide high power switching that does not consume power to hold in either the ON or OFF position. The -RELAY option requires constant power while the relay is held ON, whereas the -LATCH option only briefly requires power when switching from ON to OFF or vice versa. The -LATCH option can switch up to 2A of resistive current at 30VDC, 0.5A at 120VAC, and 0.3A at 250VAC.

-RS485. RS485 serial interface

The default RS232 port may be converted to an RS485 port instead. The RS485 port uses the 4 "Custom" terminals. Two RS485 ports are provided (1+/1- and 2+/2-) suitable for 2-wire half duplex instruments.

-STROBE. High visibility alarming

Integrated into the top of the Ai1 the strobe provides visual indication of alarm conditions. Powered from the internal SW12 output or using the -SWITCH, -RELAY or -LATCH power switching options.



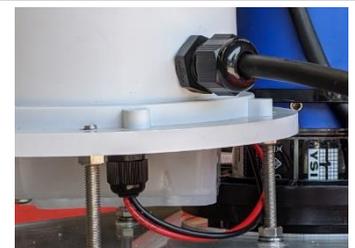
-SIREN. Audible alarming

Integrated into the bottom of the Ai1 the siren provides a strong 120dB audible alarm under program control. Powered from the internal SW12 output or using the -SWITCH, -RELAY or -LATCH power switching options. The siren is able to mounted in a variety of fixed orientations



-PUMP. Peristaltic pump

Integrated into the bottom of the Ai1 the peristaltic pump may be used for a variety of applications, including the collection of a water sample through program control. Powered from the internal SW12 output or using the -SWITCH, -RELAY or -LATCH power switching options. The pump operates at up to 500mL/min flow rates



-6F. Bulkhead 6-pin Micro Wet-CON connector

Integrated into the bottom plate of the Ai1 the bulkhead connector allows for quick connection of a wide variety of water quality sensors including the YSI EXO2 and EXO3, without opening the protective housing.



-SOA. EXO Signal Output Adapter (SOA)

Integrated inside the Ai1 with 4 wire connection using the "Custom" terminals. Often combined with the -6F bulkhead connector supplied prewired into the SOA ports. The SOA is wired to allow both the EXO2 and EXO3 sondes to be used. Uses SDI12 interface configurable to either C1 or C2 port.

-COMPASS. Internal compass

Useful for rotating platforms such as buoys to provide orientation correction for wind and current instruments. Uses SDI12 interface

-ACCEL. Internal accelerometer for tilt measurement

Dual X-Y analog measurements for tilt or movement detection. Uses two internal analog ports.

-LIGHT. Daylight sensor

Integrated top mounted daylight sensor for determining day and night conditions or periods of low light. May be useful for checking other sensor operation.

-BARO. Internal barometer

Integrated into the terminal area with a vent tube through the bottom plate. The internal analog barometer provides barometric pressure corrections for calculating level from absolute pressure sensors

-2MP. Integrated camera

Integrated onto the bottom terminal plate with adjust mounting option, the camera saves 2MP images to the internal storage, for transmission over the integrated communications. The camera may be triggered based on program control



Along with the integrated enhancements, a variety of sensor options are available for integrated sensor systems, such as the integrated Surface Velocity Radar / Laser Level combination station in Figure 3.



Figure 3 – Non-contact flow sensors

3. Unpacking

When unpacking, take care to keep the packet of parts supplied with the station, which includes:

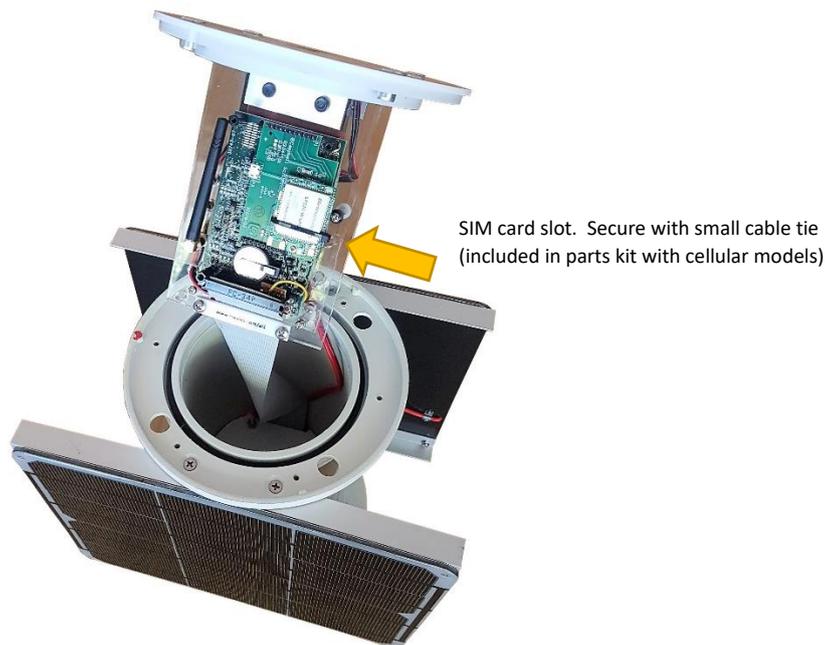
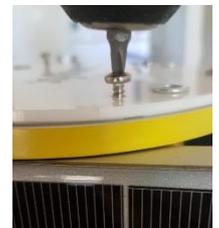
1. The fuse and fuse cap
2. Gland options
3. Mounting kit options (if applicable)
4. Charging cable (if applicable)
5. Cable tie for SIM card



4. Overview

4.1 Opening Electronics Housing

Both the top and bottom plates may be opened to access in internal components. Fully unscrew the 6 screws holding the lid in position to open. Both top and bottom plates have an o-ring seal and may experience suction when trying to remove the plates. A suction cup may be used to pull out the plate, or a screw driver can be used to push the plate out from underside. When the top plate is removed, the top electronics can be lifted out. This is typical performed when installing or changing a SIM card



For easy alignment of the top or bottom plates, a red dot has been included on both the body and the plate itself. Ensure that the red dots are aligned before installing fully.



Figure 4 – Align red dots on the plate and the body



Figure 5 - Correct alignment is when the red dot is visible through the hole

When closing the top plate, take care to not overtighten the 6 screws or the plate may be damaged.



Figure 6 - Too much gap between plate and body

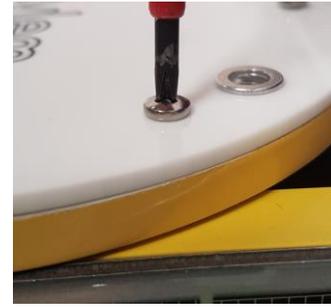


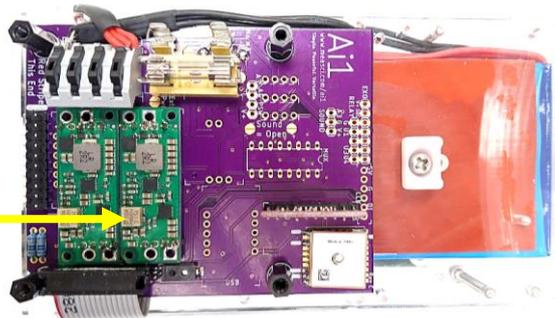
Figure 7 - Correctly tightened

4.1.1 Internal Regulators

The datalogger has a dedicated regulator (a step-up regulator to increase the voltage from the 3.7V lithium-ion battery) to operate from 12V. The normal range for the regulator voltage is $12V \pm 0.5V$ while the normal voltage for the lithium battery is 3.2V to 4.2V. Care should be taken to minimize voltage draw below 3.4V and prevent discharging below 3.2V.

A second regulator is provided to power external sensors. The regulator is able to be adjusted using a 20-turn trim pot to optimise power to the sensor. For conservation of power, the voltage should be as low as possible, however some sensors may require a specific voltage. The factory default is 12.0V. The trimpot may be adjusted as shown below.

Adjust trimpot here,
in this direction

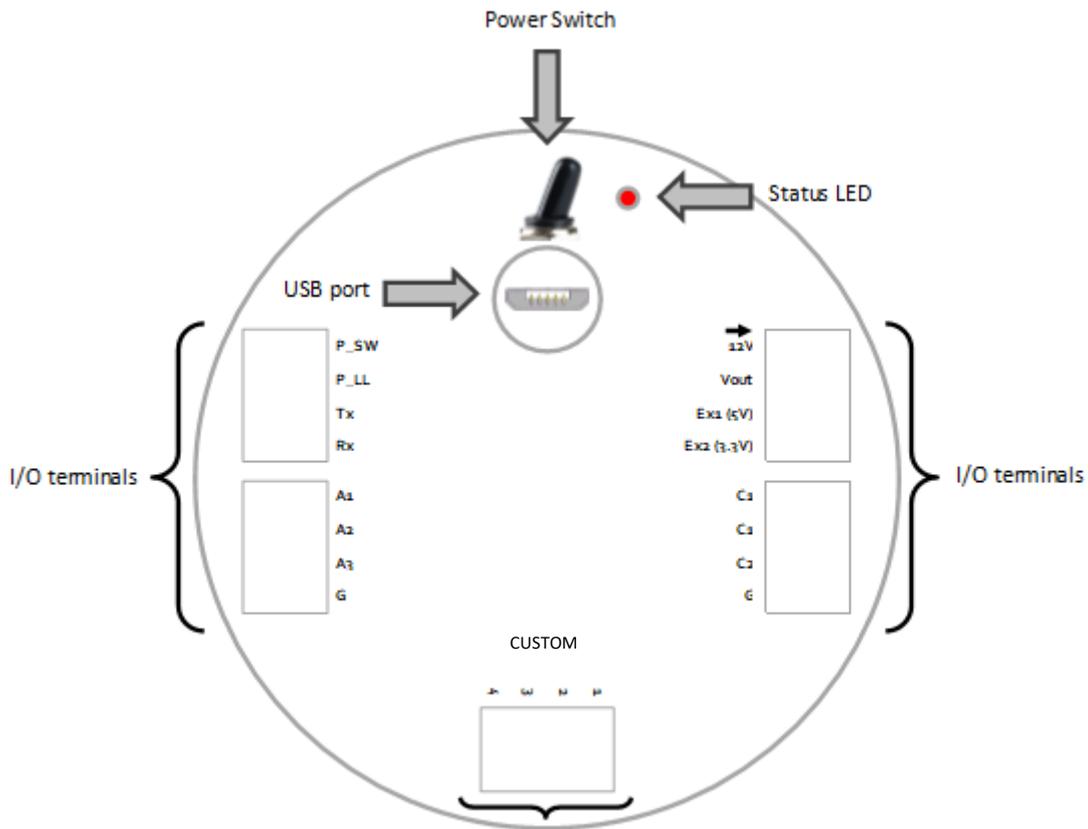


4.2 Bottom Terminal Plate

The main wiring and control of the Ai1 is via the terminal plate at the bottom of the system, protected behind a clear acrylic plate with an o-ring seal. Cable entry can be via the clear plate or via glands inside the side of the housing (as shown in the image to the right), depending on the application. It is recommended to use the clear acrylic plate if practical as these are available as replacement spare parts should the wiring and cable entry need to be changed.



The schematic of the terminal plate is as shown below.



CUSTOM port used for expansion options such as EXO Signal Output Adapter

Figure 8 - Terminal Plate Schematic

4.2.1 USB Port

It is possible to power the Ai1 using the USB port to allow easy configuration, program and firmware uploads and basic operation. While powered from the USB port alone, some functionality may be limited. USB power does not power the communications system, or the Vout port, and voltage from Ex1 and Ex2 are limited to 2.5V approximately. On models with internal batteries, these do not charge from USB power. The free application “Device Configuration Utility” (hereafter called DevConfig) is used for configuring the station and is available for download from here: <http://measci.com/devconfig>

Refer to DevConfig help for connection instructions, following the steps shown below to establish a connection.

1. The Ai1 is compatible with the CR300 series. Select this datalogger



3. When plugging in a USB cable use the **Direct** type. If connecting through Eagle.io, use the **IP** type



5. Use the connect button to connect



CR300 Series Datalogger



Connecting with USB

Install USB Driver

1. Power should be supplied to the datalogger by
2. Connect the datalogger's USB port to your computer using
3. Select the correct Communication Port in the left panel
4. By default, PakBus Encryption Key is not required. How
5. Select the Connect button.

Connecting with RS-232

1. Power should be supplied to the datalogger by connecti
2. Connect the datalogger RS-232 port to your computer us
3. Select the correct Communication Port in the left par
4. By default, PakBus Encryption Key is not required. How
5. Select the Connect button.

Connecting with IP

If the datalogger has an IP connection, it may be possible to co

1. Check the IP Connection in the left panel
2. Enter the Communicat
3. Select the default
4. By default
5. Select the

Connecting with WiFi

Note: The CR300/CR310 WiFi default configuration is to ho

1. Power should be supplied to the datalogger by connecti
2. The CR300/CR310/WiFi will power up and either create a
3. If the device is configured to create a network, the connect

2. On first use, you may need to install a USB driver. Click this button and follow these steps



4. Once the USB driver is installed, use the pull-down option to find the right COM port, it will appear as the CR300 datalogger type



You will most likely need to install USB drivers on the first connection to the station. See Step 2 in the image above for more instructions.

If this is your first time using a Campbell Scientific datalogger system, a quick start video series may be useful to introduce basic concepts. Refer to the Training section for more information (section 6, page 24).

4.2.2 Power Switch

The switch controls power to the Ai1 depending on the model:

Model	Power
Externally Powered (EXT PWR)	The switch connects/disconnects the external 12V or 24V input
Battery Powered	The switch connects/disconnects the internal battery and external charging port. For models with a battery, an external charging cable plugs into the barrel connector through a hole in the bottom plate, as shown here. The charging port accepts 5 to 6V with the center pin +. 
Solar Powered	The switch connects/disconnects the solar and battery power sources

If the Ai1 is powered through the USB port, the Ai1 will remain operational, although communications will stop.

The switch is inline with an internal fuse that is accessed by opening the Ai1 electronics housing as described in 4.1. By default, stations are shipped with a 3A fuse which may be replaced to alternative sizes if required. A battery measurement (if fitted) will only be available when the switch is on and the fuse is installed.

4.2.3 LEDs

Power status LED's are mounted on the top of the Ai1 and on the terminal plate, with a flash sequence indicating the power and program modes:

Table 1 – Red power LED functions

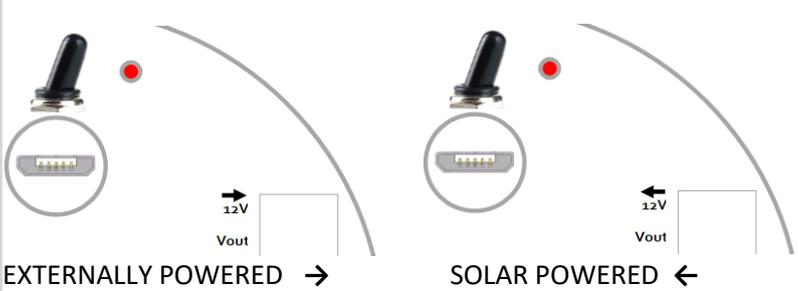
Off	No power
Double flash every 15 seconds	Operating on USB power. Restricted functionality. When running on USB power everything except the following operates as normal: <ul style="list-style-type: none"> - The internal modem will be off

	<ul style="list-style-type: none">- Excitation ports limited to 2.5V rather than 5V- Switched 12V will not operate
Single flash every 15 seconds	Operating on battery/solar power. Full system functionality
Always on	Program stopped or no program

4.2.4 I/O Terminals

All models have 20 terminals as described below. Some terminal functionality depends on the model selected. The terminals are 5mm spaced with a spring loaded levers, allowing wire gauges from 14 to 28 AWG.

Table 2 - Internal terminal functionality

Terminal	Description																								
12V or 24V	<p>The function of this port is Model Dependent, and may be externally or solar powered as shown below</p>  <p>EXT PWR. For externally powered models (designated by EXT PWR markings on the terminal plate, external power is to be applied into this port. Ensure that the arrow is indicating in (as show in the left image above). For external power, this may be 12V or 24V, which must be selected at the time of order. The model is as noted by the 12V or 24V next to the terminal. The full voltage range for each model is: 12V: 10 to 18V acceptable range 24V: 16 to 32V acceptable range SOLAR POWERED. For solar powered models,</p>																								
Vout	<p>Adjustable Switched Power under program control, capable of 2A or more depending on voltage. The maximum continuous output current at various battery voltages is described in the table below</p> <table border="1" data-bbox="287 1142 1484 1523"> <thead> <tr> <th>Vout setting (Output Voltage)</th> <th>Battery Voltage</th> <th>Maximum Output Current</th> </tr> </thead> <tbody> <tr> <td rowspan="3">5V</td> <td>4.2V (100% charged)</td> <td>4.3A</td> </tr> <tr> <td>3.7V (50% charged)</td> <td>3.5A</td> </tr> <tr> <td>3.2V (0% charged)</td> <td>3.1A</td> </tr> <tr> <td rowspan="3">9V</td> <td>4.2V (100% charged)</td> <td>2.6A</td> </tr> <tr> <td>3.7V (50% charged)</td> <td>2.1A</td> </tr> <tr> <td>3.2V (0% charged)</td> <td>1.7A</td> </tr> <tr> <td rowspan="3">12V</td> <td>4.2V (100% charged)</td> <td>1.8A</td> </tr> <tr> <td>3.7V (50% charged)</td> <td>1.5A</td> </tr> <tr> <td>3.2V (0% charged)</td> <td>1.3A</td> </tr> </tbody> </table> <p>Vout is adjustable from 5 to 20V output by opening the electronics housing and using the multi-turn trim pot. Vout does not provide any power if the system is only powered from the USB port. Note that Vout uses a “Step-up” regulator meaning that it can only provide voltages higher than the input voltage. For solar powered systems running from a 3.7V Lithium Ion battery, this provides the full 5 to 20V range of regulation. For externally powered systems running from 12V, this reduces the range to approximately 12.5 to 20V. The output voltage must be at least 0.5V higher than the input voltage or the regulator will emit high pitched “hum”.</p>	Vout setting (Output Voltage)	Battery Voltage	Maximum Output Current	5V	4.2V (100% charged)	4.3A	3.7V (50% charged)	3.5A	3.2V (0% charged)	3.1A	9V	4.2V (100% charged)	2.6A	3.7V (50% charged)	2.1A	3.2V (0% charged)	1.7A	12V	4.2V (100% charged)	1.8A	3.7V (50% charged)	1.5A	3.2V (0% charged)	1.3A
Vout setting (Output Voltage)	Battery Voltage	Maximum Output Current																							
5V	4.2V (100% charged)	4.3A																							
	3.7V (50% charged)	3.5A																							
	3.2V (0% charged)	3.1A																							
9V	4.2V (100% charged)	2.6A																							
	3.7V (50% charged)	2.1A																							
	3.2V (0% charged)	1.7A																							
12V	4.2V (100% charged)	1.8A																							
	3.7V (50% charged)	1.5A																							
	3.2V (0% charged)	1.3A																							
Ex1 (5V)	<p>Switched 5V excitation power under program control, limited to 50mA (current shared between both Ex1 and Ex2 ports). This port is limited to 2.5V when powered from USB. The voltage of the excitation port is controlled with a 12-bit DAC (from +150mV to 5000mV). While other output voltages are programmable, consideration needs to be given to impacts on other internally powered monitoring systems</p>																								

Ex2 (3.3V)	Switched 3.3V excitation power under program control, limited to 50mA (current shared between both Ex1 and Ex2 excitation ports). This port is also used to provide power to the internal GPS and other system peripherals. All specifications are the same as the 5V excitation port.
C1	Control Port 1 , typically used for SDI12 sensors. If SDI12 sensors are not used this may be used for other control functions, include RS232 Tx or Rx, a digital output with limited digital drive capacity (10mA at 3.3V), or a digital input (inputs -10V to +15V). May be used for interrupt triggering in program control.
C1	Control Port 1 , another terminal for additional SDI12 sensors. Functions the same as the other C1 port
C1	Control Port 1 , another terminal for additional SDI12 sensors. Functions the same as the other C1 port
G	System ground , used for power ground or analog reference
P_SW	Pulse Input, switch counting. Counts switch closures such as on tipping bucket rain gauges, security switches, relay contacts or wind sensors. Allows $\pm 17.5V$ input voltage, 3mS pulse counting up to 150Hz for switch closures or up to 35kHz high frequency signals. May be used as digital output with extremely limited drive (0.1mA @ 3V)
P_LL	Pulse Input, Low Level AC.
Tx	RS232 serial port, Tx. Suitable for $\pm 13V$ RS232 signals.
Rx	RS232 serial port, Rx. As per Tx port
A1	Analog Input 1. 24-bit high precision analog inputs, -100mV to +2500mV input measurement range, with up to -6V to +9V sustained input voltage without damage. Accuracy over 0 to 40 °C operating range is $\pm(0.04\%$ of measurement + offset). Over full -40 to 70 °C operating range $\pm(0.1\%$ of measurement+ offset). May be used as single ended measurements or with A2 for differential voltage measurements. May also be used to measure 4-20mA current signals, resistance measurements, period averaging measurements, high frequency pulse counting (up to 35kHz) or PWM output. 5G Ω typical input resistance. >120dB DC common mode rejection with input reversal. Can be configured with A2 for quadrature input and for thermocouple measurement. May also be used with interrupt triggers for immediate program reaction. May be used as digital output with extremely limited drive (0.1mA @ 3V).
A2	Analog Input 2. As with A1.
A3	Analog Input 3. As with A1 and A2 but cannot be used for current or quadrature measurements but may sustain $\pm 17V$ input voltage without damage.
G	System ground , used for power ground or analog reference

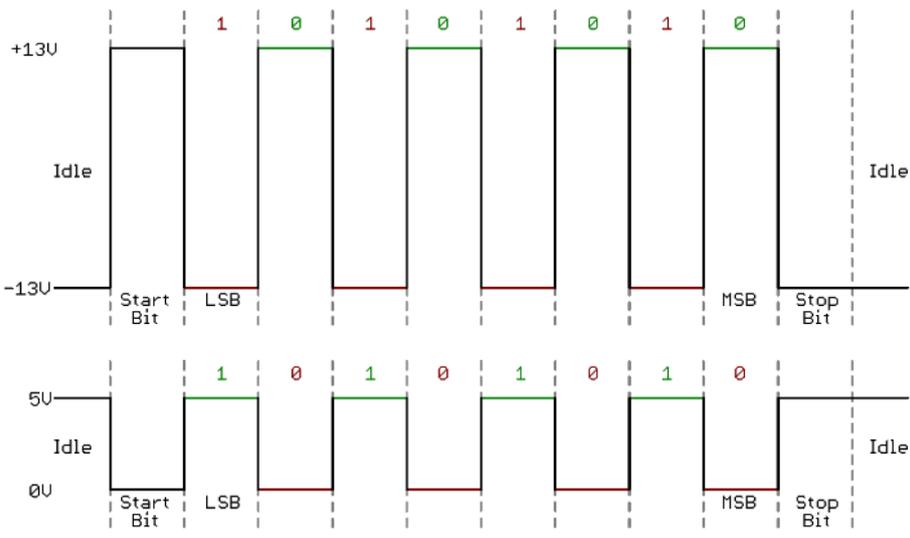
4.2.5 Custom Expansion Port

The custom expansion port is specified at the time of order. Each Ai1 may be fitted with one of the following expansion options

Table 3 – Custom Expansion Port Options

Option	Description	Labels
Custom	Universal Inputs. Provides a set of 4 terminals that may be rewired internally to suit customer specific applications, such as providing access to additional analog inputs, terminals in parallel to an already available terminal (such as additional Vout, G or C1 connections), or for use with a customer supplied component. Two terminals U1 and U2 are provided, with 2 additional G terminals	U1 U2 G G

Com Port Interfaces

RS485	Converts normal RS232 port into a RS485 serial port for use with 2-wire half duplex instruments. Two RS485 ports are provided, wired in parallel. 1+/1- and 2+/2-.	1+ 1- 2+ 2-
UART	<p>Converts normal RS232 port into a UART serial port for use with instruments that require UART voltage levels. RS232 voltages are normally $\pm 13V$, while UART voltages are normally 0-5V and inverted. The four terminal provided are Tx, Rx, Vout and G.</p> 	Tx Rx Vout G
I2C	An additional slave board is provided which allows for I2C sensors to be added (such as laser level sensor, barometric pressure sensor, compass, etc). This port provides two I2C signal wires (SDA and SCL) as well as two power connections (Vout and G). The I2C slave board must be programmed by the factory only. Refer to the instrument manual for instructions for use.	SDA SCL Vout G

Power Output Peripherals

Power Switch	The power switch provides 3 high current outputs from the normally low power outputs A3, A4 and PSW. Inside the electronics housing are 3 x 5V regulators with an output current up to 800mA. 4 terminals are provided, one each for the boosted A3, A4 and PSW outputs and an additional Ground (G)	A3 A4 PSW G
Relay Output	The relay output peripheral provides two independently controlled dry contact switch outputs from the A3 and A4 outputs. Each relay output is a separate pair of Common (C) and Normally Open outputs. I.e. Relay connected to A3 input has the common terminal wired to A3+ and the normally open terminal wired to A3-. Similarly, the relay connected to A4 has its own common terminal wired to A4+ and the normally open terminal to A4+. While the relay is rated to 8A, the contacts should only be used for up to 2A due to the wire sizes used internally.	A3+ A3- A4+ A4-

Multiplexers

Analog	The analog multiplexer allows the A4 analog input line to be switched between up to 4 inputs. The analog measurement is made by controlling P_SW and Ex1 outputs as per the logic table below		A4_1 A4_2 A4_3 A4_4
	P_SW State	Ex1 State	A4 connected to
	Off (0V)	Off (0V)	A4_1 terminal
	On (5V)	Off (0V)	A4_2 terminal
	Off (0V)	On (5V)	A4_3 terminal
	On (5V)	On (5V)	A4_4 terminal

	The multiplexer is bidirectional meaning that A4 can still be used as an analog input or a digital output.										
Digital	As with the analog multiplexer except the C1 digital input line is switched between up to 4 inputs. Typically this is used in one of two applications: <ul style="list-style-type: none"> - To read the state of up to 4 digital inputs (on/off) - To read the serial output of up to 4 serial output sensors (0-5V RS232) The input is controlled by using P_SW and Ex1 as described in the row above	C1_1 C1_2 C1_3 C1_4									
Serial	The ports C1 and C2 are switched in a pair controlled by P_SW as per the logic table below <table border="1" data-bbox="231 481 1236 593"> <thead> <tr> <th>P_SW State</th> <th>C1 connected to</th> <th>C2 connected to</th> </tr> </thead> <tbody> <tr> <td>Off (0V)</td> <td>Tx_2</td> <td>Rx_2</td> </tr> <tr> <td>On (5V)</td> <td>Tx_3</td> <td>Rx_3</td> </tr> </tbody> </table> These are commonly used to increase the C1/C2 pair from one serial port (0-5V RS232) to two. The numbering is TX2/RX2 and TX3/RX3 so as to not be confused with TX/RX already included by default. Within CRBasic these ports are connected to Com1 depending on the P_SW state.	P_SW State	C1 connected to	C2 connected to	Off (0V)	Tx_2	Rx_2	On (5V)	Tx_3	Rx_3	TX_2 RX_2 TX_3 RX_3
P_SW State	C1 connected to	C2 connected to									
Off (0V)	Tx_2	Rx_2									
On (5V)	Tx_3	Rx_3									
Miscellaneous											
EXO SOA	The electronics housing may include an EXO Signal Output Adapter (SOA) to convert the proprietary EXO signal to an SDI12 output. This port connects to the same labelled ports on the SOA. Refer to the EXO section in 4.2.6.1 (YSI EXO Sonde section) or the EXO SOA documentation for further details. <div data-bbox="461 958 1002 1337" data-label="Image"> </div> <p data-bbox="384 1361 1078 1391"><i>Figure 9 - The battery plate fitted with a YSI EXO Signal output adapter</i></p>	YEL WHY RED BLK									

Refer to the [CR300 product manual](#) for more detailed specifications on the I/O and program functionality.

4.2.6 Sensor Specific Wiring

The sensor specific wiring depends on the program requirements. The primary reference should always be the header of the program where a wiring reference is typically used, such as the example below

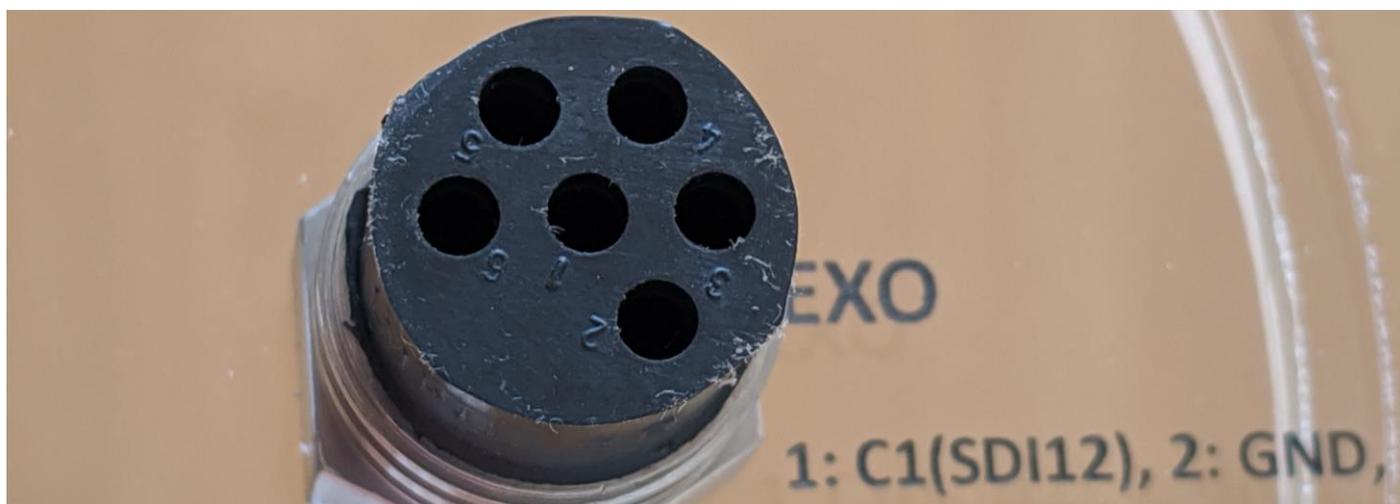
```
' SENSOR CABLE WIRING (SUBCON MCBH6M PINOUTS, ALL SENSORS HAVE SAME CABLE, DIFFERENT PINOUTS)
' YSI EXO2/EXO3          1=Orange,          2=Black,          3=Red,          4=Shield,
' Insitu Marine pinouts 1=Ground,          2=RS232 CR300 Tx, 3=N/C,          4=V+,
' Insitu Marine PAR Short Black 1=Black(Black extn), 2=White (White extn), 3=Red(x), 4=Green(Red extn),
' Insitu Marine DL3 Blue 1=Blue (Black extn), 2=Green+White (White extn), 3=none(x), 4=Brown (Red extn),
' Insitu Marine DL3 15m EXO 1=Orange(Black ext), 2=Black (White extn), 3=Red(x), 4=Shield(Red extn),
' Observator NEP5000.    1=Green(GROUND), 2=White(SDI12), 3=Brown(10-30V), 4=Blue(4-20mA/100ohm),
' Global Water WL400. Red = Power, Black = 4-20mA signal (http://www.globalw.com/downloads/WL400/WL400manual.pdf
```

4.2.6.1 YSI EXO Sonde

The YSI EXO sonde depends on the model used (EXO2/EXO3), if a Signal Output Adapter (SOA) is used, if bulkhead connectors are used, and the specific ports allocated in the program.

Connector Pin	1	2	3	4	5	6
Function	SDI12	Ground	Power In	Shield	RS485	RS485
Wire Color	Orange	Black	Red	Bare	Yellow	White
Ai1 Wiring						
EXO2 (RS232 with SOA)	-	Custom BLACK	Custom RED	-	Custom YELLOW	Custom WHITE
EXO2 (SDI12 with SOA)	-	Custom BLACK	Custom RED	-	Custom YELLOW	Custom WHITE
EXO3 (SDI12 natively)	C2	G	12V or Vout	-	-	-

The red wire may be left disconnected for sensors using internal batteries, connected to 12V if continuously powered, or connected to Vout if power is controlled by the program. For EXO2 models the wiring uses the 4 terminal custom expansion port with color codes matching the wire colors. The internal wiring for the SOA is typically **C1** when using SOA in SDI12 mode, and ComRS232 when using SOA in RS232 mode. If an EXO3 is used with an SOA, which also supports SDI12 the orange wire should be wired into C2. The EXO3 will be available via the SOA on C1, or using native SDI12 on C2. When supplied with a bulkhead connector the wiring may be engraved on the acrylic plate, as shown in the image below. The image also shows the numbering of the connector pins.



Bulkhead connectors are normally supplied with white wires numbered 1 to 6. The connector pin reference should be used (i.e. 1 is SDI12, 2 is Power, 3 is Ground). In some circumstances, a bulkhead connector with color coded wires may also be used. These color codes do not match the table above. The Black wire is pin 1 (SDI12), White is pin 2 (Ground/Black), Red is pin 3 (Power/Red), Green is pin 4 (Shield/G), Orange is pin 5 (RS485/Yellow), Blue is pin 6 (RS485/White).

5. Mounting

The Ai1 supports top mounted options, bottom mounted sensors, magnetic mounting feet, or various pole mounting kit options. An overview of these options is provided here.

5.1 Top mounted options

An example of the top mounted options is the navigation lantern (Figure 10), Iridium communications option (Figure 1), or top mounted instruments such as wind speed and direction. These devices are designed to mount directly to the 4 x M6 threaded holes on the top of the unit. The M6 threaded holes are arranged on a 100mm x 100mm square as shown in Figure 12.



Figure 10 - Navigation light using top mounting bolts

Some configurations with bottom mounted sensors have easy access top mounted systems, such as the USB port and integrated bubble level (for stations requiring levelling). Incorrect level may significantly degrade instrument range and measurement accuracy for non-contact sensors. All installations should be confirmed to be within the inner 1° circle. For non-contact sensors mounted well above the water level, the USB port is mounted on the top plate for easy access, and protected with a rain cap. Ensure the rain cap is fitted at all times. The top mounted position is preferred to keep any potential obstructions away from the field of view of the non-contact sensors.



Figure 11 – Top mounted USB and bubble level

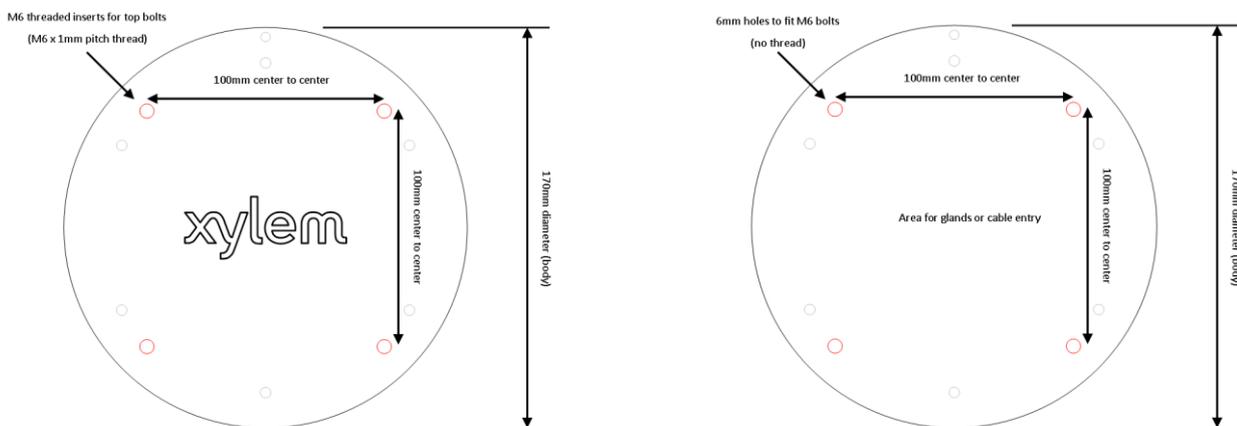


Figure 12 - Detailed drawing for top and bottom mounting



Figure 13 – M6 threaded inserts for top mounting devices such as navigation lantern

For installation locations that may be prone to bird damage, an optional bird spike kit is available. This may only be used where no other top mounted options use the mounting holes

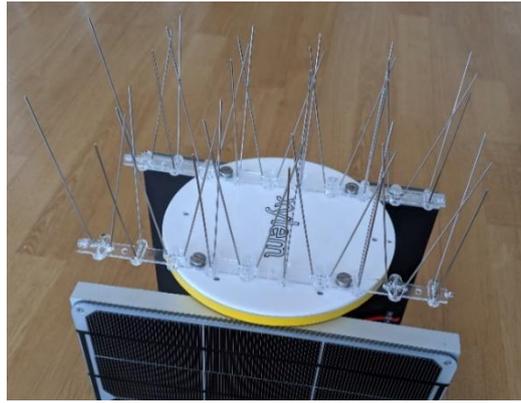


Figure 14 - Bird Spike Kit

5.2 Bottom mounted sensors

The bottom 6mm clear acrylic plate can be supplied customized for bottom mounted sensors or solid for customization to suit the project. The bottom plate includes 4 x 6mm holes to suit M6 bolts on the same 100 x 100mm square as the top mounting plate.



Figure 15 – 6mm holes for M6 bolts. The 100mm square neatly fits M6 nut or bolt heads beside the Ai1 body

5.2.1 Sensor plate

Customized sensor plate for direct support of relevant sensors. Several examples are provided below, such as a surface velocity radar and laser level sensor are mounted on the plate with glands for cable entry, and an ultrasonic level sensor station



The sensor plate can be drilled and customised to suit a wide variety of sensors depending on the application, as shown in Figure 16. The acrylic plate is 6mm thick and can take threads from M3 to M20. Care should be taken for fine threads or threads with excessive force. When drilling and tapping, use a lubricant such as WD40 and take care when finishing the hole or the acrylic may crack from the edges. It is best to use progressively larger drills and using a light force when pushing down on the drill

5.2.2 Panel mounted connectors

For easy servicing of water quality sensors, panel mounted connectors may be used for easy connect and disconnect. This is particularly attractive on buoy mounted systems for easy sensor cleaning and calibration, without opening the bottom plate in the field. As shown in Figure 16, the Ai1 is mounted on a bracket that allows the easy tilting of the station to expose the instrument tube through the centre of the buoy. The sensor is connected with a Subcon panel mount connector to allow quick disconnect without allowing water ingress or having small loose parts easily dropped in the water

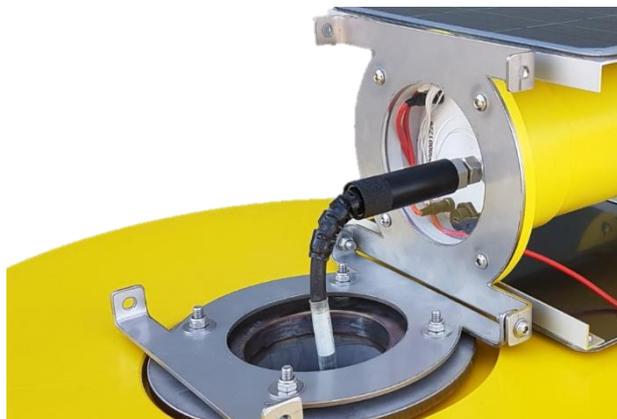


Figure 16 – Buoy mounted Ai1 with panel mount connector

5.2.3 Customizable Gland Plate

The 6mm acrylic is easily drilled and threaded to suit various gland sizes, with a selection of glands included in the Ai1 kit. The plate has been marked with 3 laser engraved pilot marks for the ideal gland locations, although any location may be used. Replacement gland plates are available as a spare part.



Figure 17 - Bottom plate fitted with M12 and M16 glands for waterproof cable entry

5.2.4 Magnetic mounting feet

4 x 20mm high strength magnetic feet may be provided for quick mounting of the Ai1 to steel structures, without drilling. On suitable surfaces, the magnetic feet have a holding force > 10kg.



Figure 18 - Ai1 with magnetic feet to a mobile pump system, for temporary monitoring of pump operation. No drilling, easy relocation.

5.2.5 Side Cable Entry

For bottom mounted locations, such as the pump monitoring in Figure 18, side cable entry may be preferred to bottom cable entry. In situations like this, a side gland may be fitted



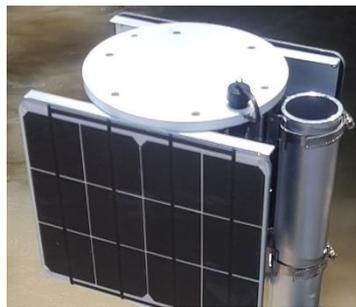
Figure 19 - Side gland cable entry



Figure 20 - Internal wiring for side gland entry

5.3 Pole Mounting Kit

A pole mounting kit suits a wide variety of vertical poles, up to 110mm in diameter. The kit includes two stainless steel clamps on the body of the Ai1, a pair of brackets and a pair of suitably sized stainless-steel clamps for the pole. Specify the approximate size of the pole clamp at the time of order



The pole mounting kit can also be rotated 90 degrees (and shifted up and down the Ai1 body) for mounting on two horizontal pipes. This image here shows the brackets rotated to allow for horizontal poles



6. Training

The Ai1 is designed to be as simple as possible while remaining versatile to a variety of applications. At the heart of the Ai1 is a Campbell Scientific CR300 datalogger. If you've never used an Ai1, or a Campbell Scientific datalogger, you will benefit from the watching video resources to introduce you to the concepts and techniques discussed in this guide.

CR300 Series. An introduction to the datalogger at the heart of the Ai1

- [Overview \(1:46\)](#)
 - CR300 [manual](#) section [0:42](#)
 - USB cable. [1:08](#)



- [Configure Software and Monitor Data \(5:18\)](#)

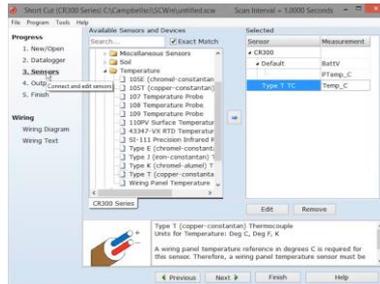
This series uses the licenced software LoggerNet. If you do not have LoggerNet, similar functionality is available with Device Config application as described in the instruction for the USB Port (section 4.2.1 on page 12). While the steps are not the same, DevConfig provides simpler steps.

- USB driver installation ([1:21](#))
- Plugging in the USB cable ([1:44](#))



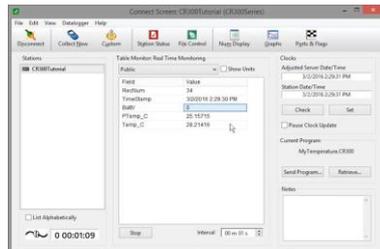
- [Create a program and connect sensors \(5:35\)](#)

In general, the Ai1 will be supplied with a program. You can probably skip to Public variables in the next video unless you want to write your own program



- [Send a program, collect and view data \(3:30\)](#)

- Connect ([0:17](#))
- Send a program ([0:41](#))
- Public variables ([1:32](#))
- Collect data ([2:17](#))
- Viewing data ([2:51](#))



A lot of the sensors used with the Ai1 support the SDI12 protocol, a digital serial protocol that allows remote diagnostics such as a terminal mode and a sniffer mode. These are powerful tools that often eliminate the need for a field visit

SDI12. The protocol often used with smart sensors

- [SDI12 Transparent Mode \(7:12\)](#)

```
CR1000>SDI12
Enter Cx Port 1,3,5 or 7
7
Entering SDI12 Terminal
?!
0
0A1_
```

Typical SDI-12 Commands:

?! Address Query
aAb! Change Address
a = current address
b = new address

- [SDI12 Watch or Sniffer Mode](#)

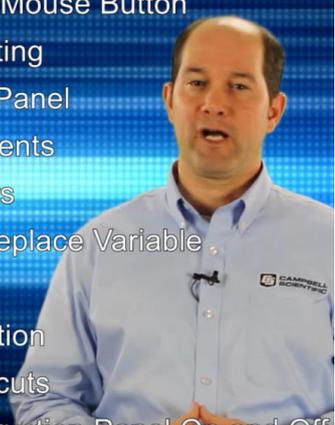
```
T 07:36:50.12 0M1
R 07:36:50.21 00012..
R 07:36:50.55 0..
T 07:36:50.56 0D01
R 07:36:50.75 0+22.698+22.060..
T 07:37:00.03 0M1
T 07:37:00.12 0M1
R 07:37:00.21 00012..
```

While the Ai1 is generally supplied with a program, you may want to write your own. Shortcut is a tool described in the CR300 series for writing programs, but most Ai1 programs will use CRBasic. This video series guides you through the use of CRBasic.

CRBasic. The language used to program the Ai1

1. [CRBasic Features \(11:09\)](#)

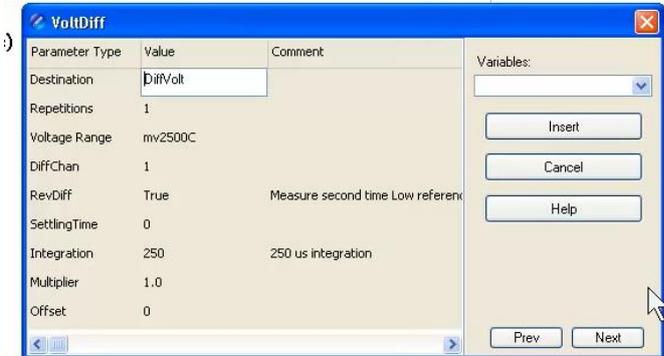
CRBasic is a licenced program supplied as part of LoggerNet. If you need to purchase a licence, contact support



- (1:35) Using the Right Mouse Button
- (3:00) Syntax Highlighting
- (4:00) The Instruction Panel
- (5:10) Inserting Comments
- (5:55) Correcting Errors
- (7:00) F9/F10 Insert/Replace Variable
- (8:10) Bookmarks
- (9:05) Rebuild Indentation
- (9:30) Keyboard Shortcuts
- 10:00) Turning the Instruction Panel On and Off

2. [CRBasic Help System \(3:33\)](#)

The interactive help and instruction menu system makes it very easy to program. Use the help system extensively.



3. [CRBasic Errors and How to Fix Them \(12:07\)](#)

- (1:20) An Undeclared Variable
- (3:10) Variable Out of Bounds
- (4:50) Illegal Float Destination Variable
- (5:50) Table Not Called AND Could Not Find Data Table
- (7:45) Invalid or Missing Parameter AND Too Many Parameters in an instruction
- (9:10) If Without EndIf
- (10:25) Data Interval Not Divisible by Scan

4. [Using Variable Arrays, Repetitions and Aliases \(6:50\)](#)

- Use Array notation when using repetitions
- Use **Alias** to assign unique names to array variables.



7. Sensor Specific Considerations

The Ai1 supports a variety of top and bottom mounted sensor options

7.1 LaserLEVEL or UltraLEVEL

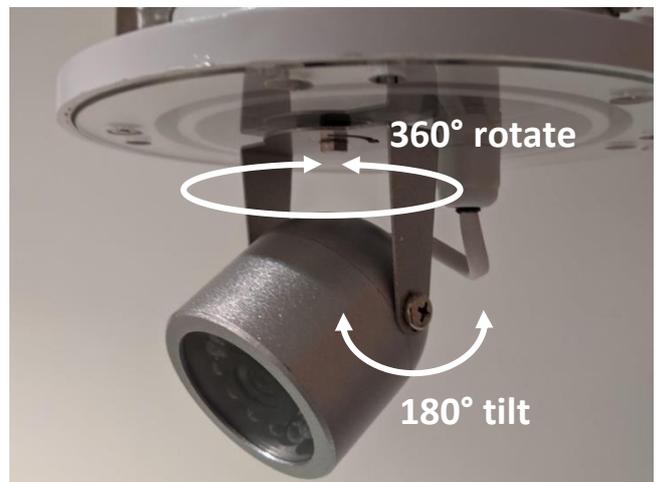
The LaserLEVEL and UltraLEVEL are both non-contact level monitoring solutions that need special consideration:

- The sensor must have a clear view of the water surface below. UltraLEVEL has a beam spread of 8° (half angle, or off-center) while the LaserLEVEL has a beam spread of less than 0.5°. While the UltraLEVEL has filtering to reduce readings from small objects within the beam, best results are obtained with a clear view to the water surface below.
- A bubble level has been included on the top of the Ai1 to ensure the sensor is aligned perpendicular to the surface for maximum reflection. Ensure the bubble level is within the center circle
- The sensor reports distance to the surface. To convert to level readings, the measurement needs to be subtracted from the installation level. i.e.:
 - o $\text{Level} = \text{Installation Level} - \text{Distance Reading}$
 - o For instance, if the installation level was 10.5m above sea level and the distance reading was 5.5m, the water surface would be 5m above sea level.



7.2 Camera

The camera includes the ability to rotate in any 360° direction as well as tilting through the full 180°. Adjust the rotate and tilt screws to set the desired fixed monitoring direction. It is recommended to make sure that the lens is pointing down to minimize fouling.



8. Power Budget

Solar powered stations are fitted with vertical mounted solar panels, with an air gap from the datalogger housing to minimize heating effects. Vertical integrated panels provide maximum self-cleaning and minimal installation size. Unlike traditional stations, these panels are intended to be faced typically East/West. The East/West orientation ensures maximum solar input in either the morning or afternoon sun and are suitable for rotating platforms. The 18W and 36W models each include an internal battery. The 18W model includes a 3.7V Lithium Ion (Li-Ion) battery rated at 25Ah, with a step-up regulator to run from 12V internally. The table below summarises the battery capacity at several example voltages:

Voltage	Battery Capacity (Equiv.)	Usage scenario
10V	9.25Ah	Maximum efficiency, recommended. Confirm that all sensors operate at 10V
12V	7.7Ah	Most common, most compatible with 12V nominal sensors
18V	5.1Ah	Only use for high power sensors that require higher voltages

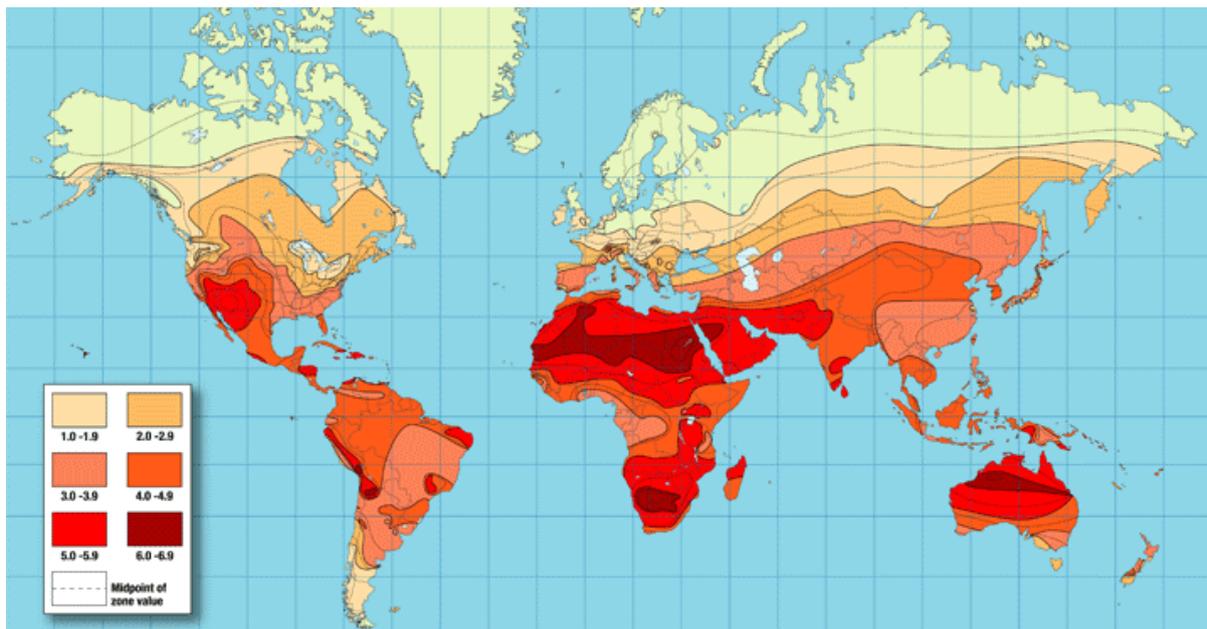
It is recommended to use 7Ah in all power supply calculations. For the 36W model, a 12Ah, 12V, Valve Regulated Sealed Lead Acid (VR-SLA) battery is used. The -EXT model is designed for external power for applications where an existing power supply is available on site, or more power than the standard models is required. In these applications the solar panel, regulator and batteries are all external to the system, provided separately.

When determining the power budget, it is recommended to perform detailed calculations including the duty cycle (on time / off time) for all subsystems and sensor power requirements, with safety factors to prevent deep battery discharge, and to allow for solar panel losses over time. A spreadsheet power budget calculator with example values for typical sensors, is available for download from:

www.measci.com/solar.xlsx

Approximate Sunshine Duration Method:

A significant factor in the power budget calculation is Sunshine Duration for the installation location. For initial calculations, the map below can be used to categorize locations.



Zone	Recommended Ai1 model	Measurement frequency and online state
<1.0	Ai1-EXT (External power)	Maximum power conservation
1.0-1.9	Ai1-36W (4x9W+12Ah VR SLA)	May require communications window, and slow measurement updates
2.0-2.9	Ai1-18W (2x9W+8Ah LiPo)	
3.0-3.9		
4.0-4.9		Ample power, full-time online, high frequency measurements
5.0-5.9		
6.0+		

Detailed Method:

Sunshine Duration is not the same as Equivalent Sunshine Hours which the spreadsheet uses. For detailed calculations, it is recommended to use the Apogee “Clear Sky Calculator” available from the Google Play store:

<https://play.google.com/store/apps/details?id=com.apogee.clearsky>

This app can be used to calculate the ESH for the worst day of the year (typically the winter solstice: 21st December in the Northern hemisphere, 21st June in the Southern hemisphere). If an Android phone is not available, a [web version](#) can be used although the setup data is more difficult. Select the size by Zipcode, by Map, or by entering the latitude and longitude, and configure the winter solstice day. The app will return the solar output at that time of day. Use a spreadsheet to record the output for each hour of the day and divide the total by 1,000 to calculate ESH.

Edit Parameters

Autofill by Zipcode

Autofill by Map

Latitude: 57.10345 °

Longitude: 344.0842 °

Elevation: 133.7198 m

Longitude TZ: 345 (GMT) °

Temperature: 15 C

Rel. Humidity: 75 %

Date: 10/9/19

Time of Day: 1:00 PM

Apply Changes

Clear Sky Calculator

Shortwave | PAR

Current Solar Output

416.14 W/m²

Daily Max

417.67 W/m² 12:43 PM

Verify Sensor Calibration

Calculation Details



Latitude: 57.10345
Longitude: 344.08423
Elevation: 133.71988

While the categorization based on Sunshine Duration or detailed calculation for ESH may be used, consideration should be given to localized shading and platform movement. Additional sensors may require the Ai1-36W model.

Vertical Panel Angle Considerations

The solar panels on the Ai1 are mounted vertically to allow top and bottom mounting options, to suit the widest variety of locations (including higher latitudes) and to maximise self-cleaning. Solar panel power generation is specified with incoming solar radiation at 1,000W/m² perpendicular to the panel face. The solar panel power generation must be de-rated to allow non-perpendicular incoming energy. With fixed installations, winter sunshine is maximised by orientating the panel South (in the Northern hemisphere, or North in the Southern hemisphere). For a station installation at a latitude of 27.5°N, the panel would point South, at an angle of 50° (27.5° + 23.5° for the optimum declination at the winter solstice). For vertical panels in a fixed location, the panels are to be orientated East / West for morning and afternoon charging. In this arrangement, the panels must be de-rated by approximately 24%. The 2x9W panel arrangement is as effective as an optimum mounting for a single 6.8W panel. The performance is demonstrated in Figure 4.

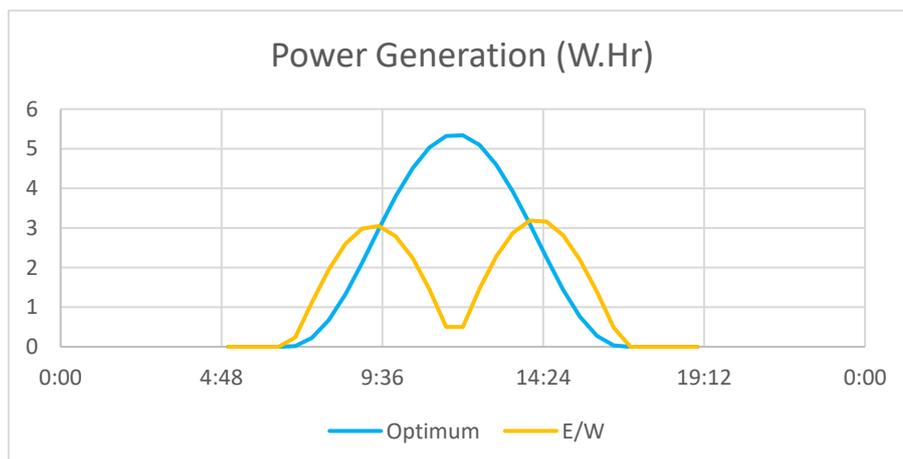


Figure 21 - Power generation from optimum angle panels and vertical East/West (E/W) panels

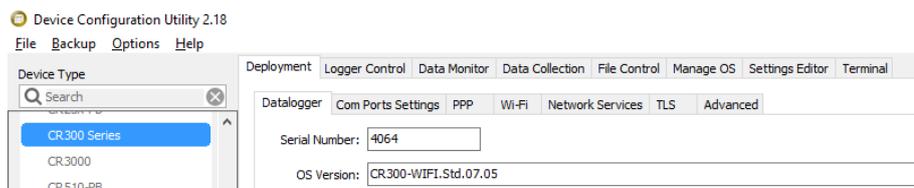
For moving platforms, with two panels (i.e. 2x9W), the panel output must be de-rated by a further 50% to allow for the rotation of the panels (as the panels cover only 180° of the possible 360° orientations). For moving platforms with four panels (i.e. 4x9W) no further de-rating is required. In all configurations, the non-optimum panels do receive some reflected energy resulting in the equivalent values shown in Table 4.

Model	Fixed Installation	Moving Installation
2 x 9W (18W total)	7W equivalent	3.5W equivalent
4 x 9W (36W total)	9W equivalent	9W equivalent

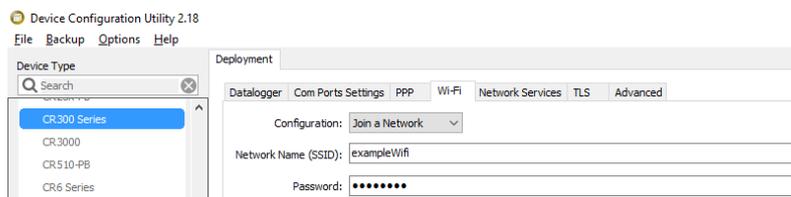
Table 4 – Recommended Panel Size Equivalents

9. Communications

Ai1 products come in WIFI, CELLULAR and RADIO options. If you are unsure of the model provided, connect using USB and DevConfig. Under Deployment -> Datalogger, the OS version will include a reference to the comms



Under Deployment -> Datalogger will be a tab referring to the communications provided, Wi-Fi, Radio, Cell.



The integrated antenna is possible to be replaced in the field if damaged. Replacement parts are available. External high gain or directional antennas may be fitted with modifications to the station housing. It is recommended to mount a higher gain antenna through the top plate

10. Software

All stations are pre-programmed with a user editable CRBasic program. CRBasic files may be edited in a basic text editor such as Notepad or using the feature rich CRBasic editor, available from

<https://www.campbellsci.com/crbasiceditor>

The Ai1 uses a custom operating system file called Ai1OS.cr300 that includes many of the internal functions. It is recommended to use this operating system to simplify the station operation, status monitoring, Eagle.io connection and alarming. Advanced users may prefer to write these functions themselves and not use the operating system. The latest Ai1OS.cr300 file is available for download from

<https://www.measci.com/ai1os.cr300>

The current datalogger program may be downloaded direct from the station and edited as required. If you do this, you will also need to download a copy of the Ai1OS library file to the same folder that you do your editing for the local compiler to work, either from the datalogger or the web page above. If you fail to do this, an error such as that below will be displayed by CRBasic:

```
[Version]C:\Campbellsci\Lib\Compilers\CR300Comp.exe VERSION:CR300.Std.07.05
FloodSONIC.CR300 -- Compile Failed!

line 19: Warning: Cannot open include file EnhancedOS_Enc.CR300.
line 24: Sub Initialization not defined.
Error(s) detected in the program. Double-click an error above to navigate to it.
```

CRBasic editing is an advanced topic and is not included in standard product support. Custom engineering may be performed with a support agreement. The top of the program provides the typical user configurable parameters

```
Const DESTINATION = "eagle"           ' Options: eagle, loggernet, scada
Dim AccessPointName As String * 20 = "telstra.internet" ' Telstra: telstra.extranet (publicly routable) telstra.i
Dim SmsDestinationPhone As String * 16 = ""
Const COMMS_DISABLED = False         ' Use this line if you need to turn the modem off for any
Const SCAN_INTERVAL = 2 's           ' INTERVALS. Interval to scan the system
Const MEASUREMENT_INTERVAL = 600 's ' Interval to perform sensor measurements
Const DATA_STORAGE_INTERVAL = 600 's ' Interval to store sensor data
Const INSITU_ON_TIME = 20 's         ' Total time for insitu sensor to take measurements
Const LOW_BATTERY_THRESHOLD = 3.2    ' THRESHOLDS. Internal lithium-polymer battery range 3.0
Const GPS_TIMER = 1                  ' TIMERS. Timer to keep track of how long the GPS has be
Const INSITU_SENSOR_TIMER = 2        ' Any other timers to be placed in sequence here
```

The key parameters to configure are described below

AccessPointName	This must be configured to match the APN for the SIM card provided. In the example above, a Telstra card is used so the APN is "telstra.internet"
SCAN_INTERVAL	The interval between system scans. A faster scan rate uses more power but is more responsive
MEASUREMENT_INTERVAL	How frequently measurements are made
DATA_STORAGE_INTERVAL	How frequently data is stored

Unless necessary, a SCAN_INTERVAL of 5 seconds or less is recommended. Any shorter than this and the current consumption is significantly higher, while any slower than this and the current consumption savings are smaller, as summarised in

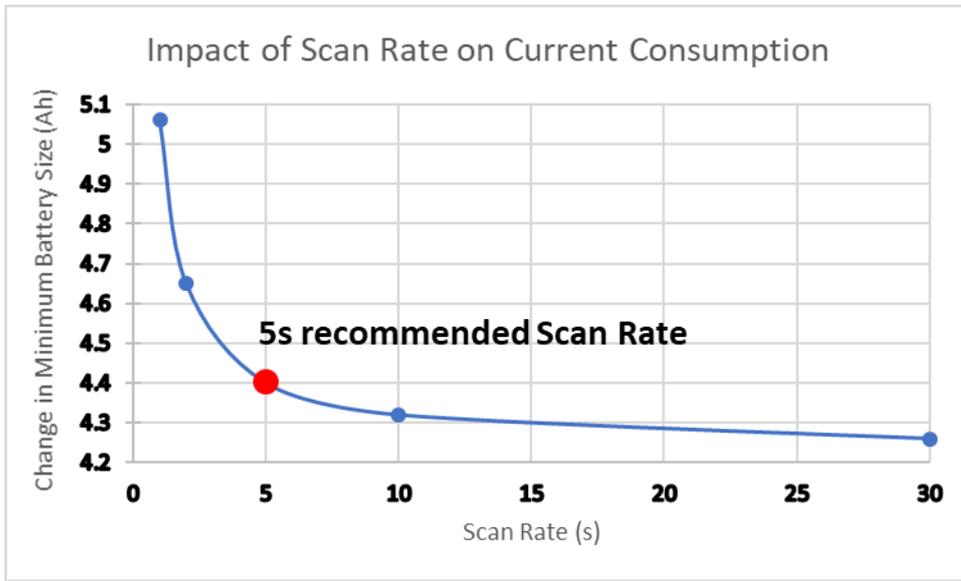


Figure 22 - 5s is the recommended scan rate for optimum balance of responsiveness and current efficiency

11. Data Destinations

The default option for data delivery is a 100% online connection to Eagle.io. The Ai1 supports all of the following data destinations:

6. Eagle.io
7. LoggerNet call-back¹ to a hosted LoggerNet system with a fixed IP address
8. DNP3 or Modbus² call-back to a SCADA or similar control system over the telemetry link
9. As a Modbus slave or SDI12 sensor over a local serial link
10. As an FTP client sending data to an FTP server
11. Email or SMS (on cellular models) data reports and alarms
12. HTTP web server or using HTTP API call-backs
13. Local display
14. Standalone datalogger for manual download

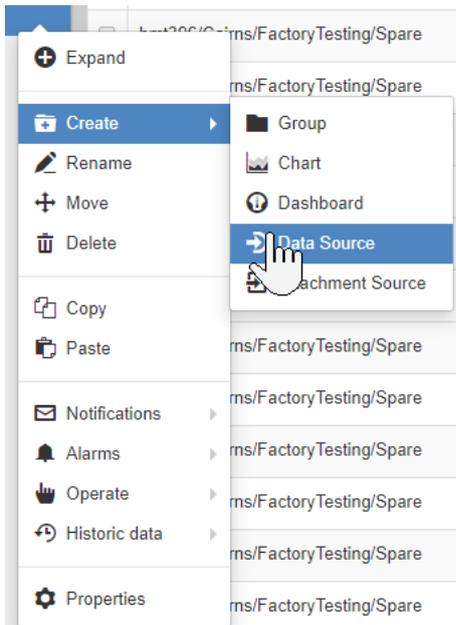
12. Eagle.io connection

12.1 Setup

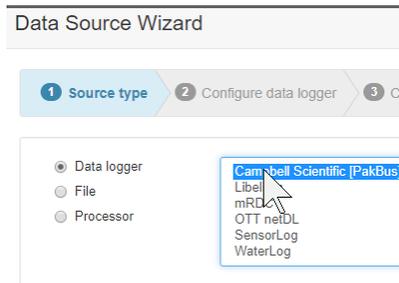
The Ai1 is optimised for automatic connection to Eagle.io. At the top of the CRBasic, include the definition of DESTINATION as shown below. The Ai1 will automatically establish the connection to Eagle and use the inbuilt cell modem IMEI as the unique identifier. For reference, the default connection method (renewing Eagle.io connection every 15 minutes) results in data usage of approximately 1MB/day. Higher frequency connection or higher frequency data storage may result in higher data transfer.

```
Const DESTINATION = "eagle"
```

```
Options: eagle, loggernet, scada
```



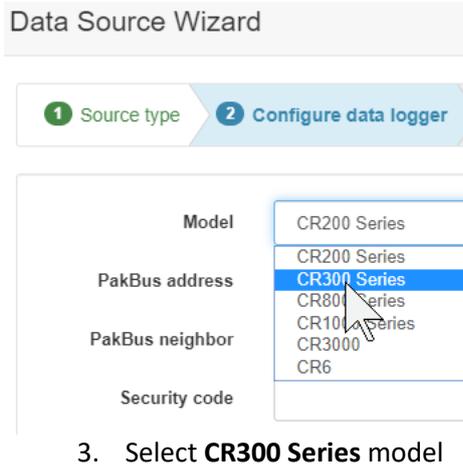
1. Create a new Data Source



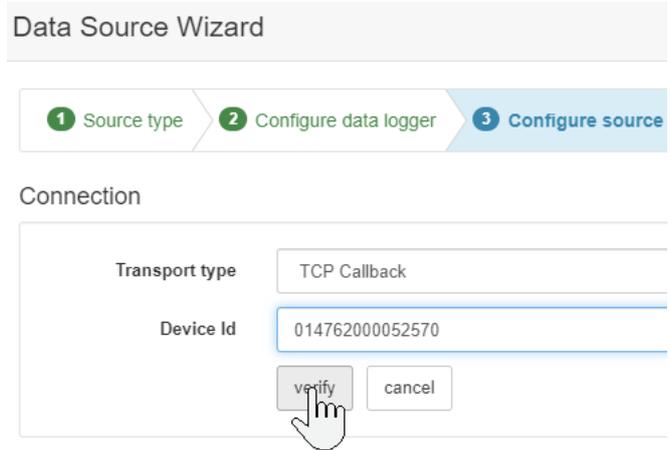
2. Select Campbell Scientific datalogger

¹ A call-back is where the Ai1 initiates a TCP/IP connection to a server on a specific port suitable for the proposed protocol. The server software would then manage the data transfer process

² Supports Modbus ASCII, Modbus RTU and/or Modbus TCP



3. Select **CR300 Series** model



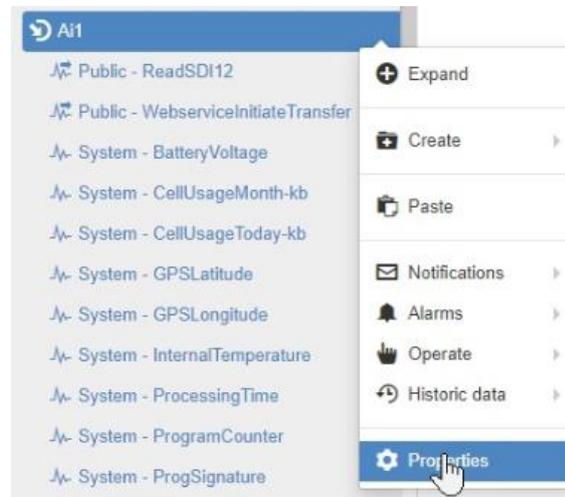
4. Set the connection to **TCP Callback**, use existing and use the **IMEI** number from the datalogger

The station will automatically configure the data tables and upload data to Eagle.io. For any other eagle.io functions, refer to the online documentation: <http://docs.eagle.io/en/latest/>. It is recommended to rename the Campbell Pakbus Datalogger to "Ai1" so it is easily identified

12.2 Swapping an Ai1 into an existing station

As Ai1's identify to Eagle.io by the IMEI of the modem, it is easy to swap out Ai1's and have the data continue seamlessly from the old to the new station. Once the new Ai1 is configured with the same program, the IMEI needs to be changed in Eagle.io. The two steps are:

1. Right click on the **Ai1** (as created in 12.1 above) and select properties



2. Switch to the connection tab, click “Use Existing” and enter the IMEI of the replacement unit. When it next connects to Eagle.io it will identify as the existing station and append to the existing data set.

Properties → tide63/HUTA/Taweelah/Ai1

General Connection Collection Configuration Series Historic Time Metadata Security

Transport type: TCP Callback

Device Id: 014762000051507
Change Use existing (selected) Last connected 5 days ago

Retry attempts: 3

Retry delay: 15 minutes

Remote access: Off

Session timeout: 1 hour

Allow access from: My current address

Communications Alarm

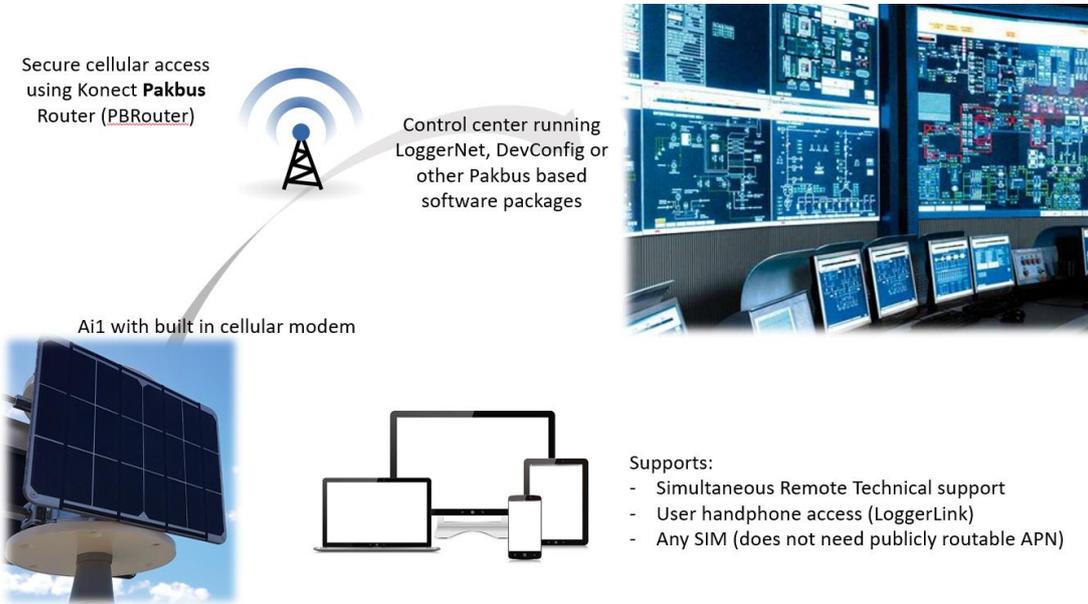
Category: Maintenance

Notifications: Failed or Restored

Node Id: 5d9adac6d8915d0cce407f87
@ - optional custom id - Save Cancel

13. Pakbus Router (PBRouter)

If Eagle.io isn't used, the most common solution for connecting to a station with a cellular or wifi modem is to use Pakbus Router. Most SIM cards, including the Global SIM option do not have static IP addresses and are private connections through the service provider (i.e. the cellular network blocks inbound connections). PBRouter enables the routing of Pakbus based connections, through a URL and port. This enables the remote station to function with [LoggerNet](#) (paid licence), [PC200W](#) (free) , [DevConfig](#) (free), [LoggerLink](#) (free, [for iOS](#) and [Android](#)) or a number of other software packages that support the Pakbus protocol. PBRouter is a lifetime subscription for the life of the Ai1 station. Multiple simultaneous Pakbus connections from various users to a single device can be used with PBRouter.



The following steps detail setting up the Ai1 with internal cellular or wifi modem. For other configurations, refer to the full PBRouter manual available here:

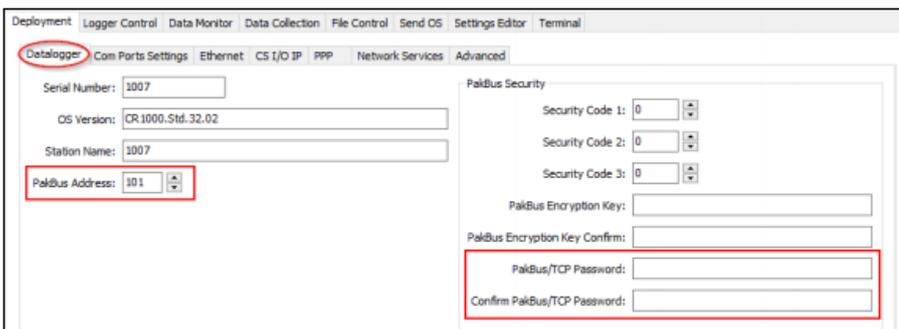
<https://s.campbellsci.com/documents/us/manuals/konect-pakbus-router-getting-started-guide.pdf>

13.1 Licence Details

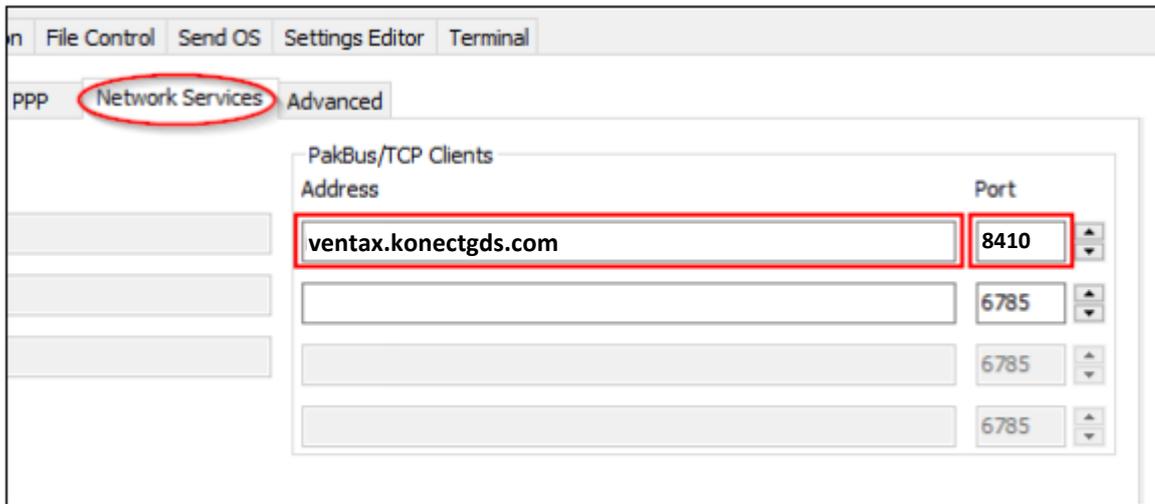
A PBRouter Lifetime licence is an add-on option when purchasing an Ai1. Refer to your supplier for pricing. When PBRouter lifetime licence is purchased, the Ai1 will be supplied with a specific URL and Pakbus Address that must be used. The URL is **ventax.konectgds.com** with the Pakbus port **8410**. The Pakbus address must exactly matched the specific address issued for the station or conflicts will occur. Refer to the documentation supplied with your Ai1 for your specific address.

13.2 Setting up Ai1

Using DevConfig, on the Datalogger Deployment screen. The Pakbus Address field must be matched to the address issued. If a password is required, this will also need to be entered



On the Network Services tab, enter the URL and port described in your licence. Click **Apply** to save.



13.3 Setting up Client software

The exact steps depend on the client software used, however they are illustrated using LoggerLink below. The TCP settings are the URL and port as described earlier. The Ai1 uses a CR300 internally so the CR300 datalogger type should be selected. The name is any name that you use to identify the site. The address is the Pakbus address issued in your licence. The key step to make this work is that the Neighbour address must be set to 4070 which is the Pakbus address of the server providing the networking.

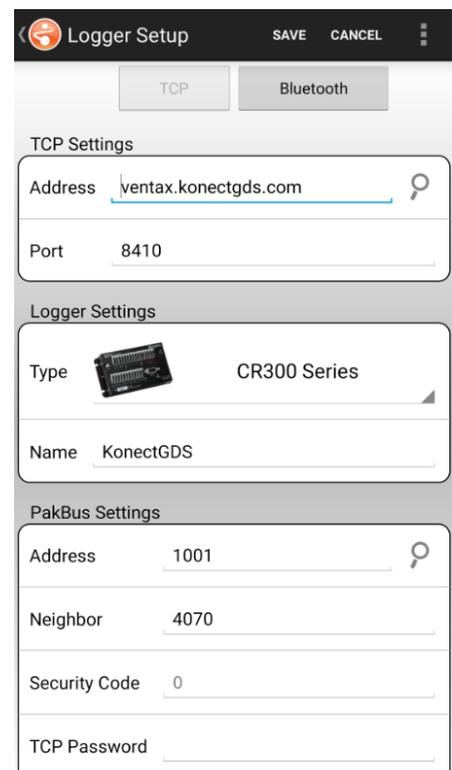


Figure 23- LoggerLink setup. Note that neighbour 4070 must be configured

14. Preparing for field deployment

Ensure that the following steps are performed prior to field deployment

15. Install the SIM card (if required). Make sure that AccessPointName in the program and default.cr300 match the required APN or cellular communications will fail.
16. Install the system fuse (supplied in the kit of parts). This is removed for shipping.
17. Confirm that the datalogger and the modem are both using the latest operating system and firmware (see Figure 26) and that the correct program is set to run.
18. Perform a full Factory Acceptance Test (FAT) with the sensors to be used at each location and confirm that correct data is received. It is recommended to run overnight at least.
19. Inspect both o-ring grooves, making sure they are clean and recently greased with o-ring grease such as Krytox GPL 205. Clean and apply new grease if required
20. Fit a fresh desiccant pack to prevent any condensation damage. The Ai1 is fitted with internal humidity monitoring. It is recommended to replace the desiccant if humidity is above 60%. The desiccant packs change color from blue (good) to pink (bad) when the drying capacity is exhausted. The packs may be recharged by heating in an oven at 150°C (300°F) for 3 hours or more.



Figure 24 – Fresh desiccant is blue (left). When orange (right) the desiccant must be replaced. Failure to use fresh desiccant will likely result in internal condensation and equipment failure.

21. When closing the bottom plate, ensure that cables are neatly twisted, remain connected in the terminals and do not get crimped in the o-ring seal.
22. Inspect cable entry points (including solar panel cable entries on the side) and ensure seals are intact.
23. Mount in position using suitable bolts or mounting kit
24. Ensure any port covers are in place
25. Verify station operation by viewing the red LED flash sequence (single flash every 15 seconds)
26. After site installation, complete the Site Acceptance Test (SAT) form. Print and complete one form for each station. Ensure Ai1 is online before departing

15. Site Acceptance Test (SAT) Form

Site Name

<i>Ai1 Serial Number</i>		
<i>Ai1OS Version Number</i>		(Refer to Ai1OSn.nn.cr300 filename)
<i>CR300 Operating System</i>		Check latest version here
<i>Program Running</i>	_____ .CR300	
<i>Communications Type</i>	<input type="checkbox"/> Cell <input type="checkbox"/> Radio <input type="checkbox"/> Wifi <input type="checkbox"/> Iridium <input type="checkbox"/> None <input type="checkbox"/> Other: _____	
<i>Communications IMEI</i>		(See ModemIMEI public variable)
<i>SIM card service provider</i>		
<i>SIM card APN</i>	<input type="checkbox"/> APN: _____	(See AccessPointName)
<i>Default.CR300 program loaded</i>	<input type="checkbox"/> default.cr300	Failsafe if program compile fails
<i>APN set in Default.CR300</i>	<input type="checkbox"/> APN: _____	
<i>Fuse installed</i>	<input type="checkbox"/> Main Fuse <input type="checkbox"/> Spare Fuse. Value: _____ Amp	
<i>O-rings inspected</i>	<input type="checkbox"/> Top inspected & greased <input type="checkbox"/> Bottom inspected & greased	
<i>Desiccant pack</i>	<input type="checkbox"/> 50g in main compartment <input type="checkbox"/> 10g in terminal area	
<i>Internal humidity</i>	__ %	<40% or desiccant to be changed
<i>Humidity sticker</i>	<input type="checkbox"/> Blue (good) <input type="checkbox"/> Pink (bad)	
<i>Battery Type</i>	<input type="checkbox"/> Lithium (12.8V) <input type="checkbox"/> Lithium (3.7V) <input type="checkbox"/> None	
<i>Regulator Voltage</i>		Only Lithium 3.7V stations use
<i>Low Battery Settings</i>	LowBatterySaver ____ V.	LowBatteryShutdown ____ V.
<i>GPS fitted</i>	<input type="checkbox"/> GPS <input type="checkbox"/> No GPS	
<i>Location</i>	Latitude: _____	Longitude: _____
<i>Reporting to</i>	<input type="checkbox"/> Eagle.io <input type="checkbox"/> Pakbus Router <input type="checkbox"/> Other: _____	
<i>Communications online</i>	<input type="checkbox"/> Yes	
<i>CellRSSI</i>	_____ dBm	Excellent: Less than -70dBm, Good: -70dBm to -85dBm, Fair: -85dBm to -100dBm, Poor: Worse than -100dBm
<i>Sensor fitted</i>	Type: _____	
<i>ReadNow test</i>	<input type="checkbox"/> Pass	
<i>Sensor notes</i>		

Test completed by: Name: _____ Position: _____ Signature: _____ Date: _____	Witness (if required): Name: _____ Position: _____ Signature: _____ Date: _____
---	---

16. Servicing

It is possible to perform some more advanced servicing tasks with the right tool

16.1.1 Battery replacement

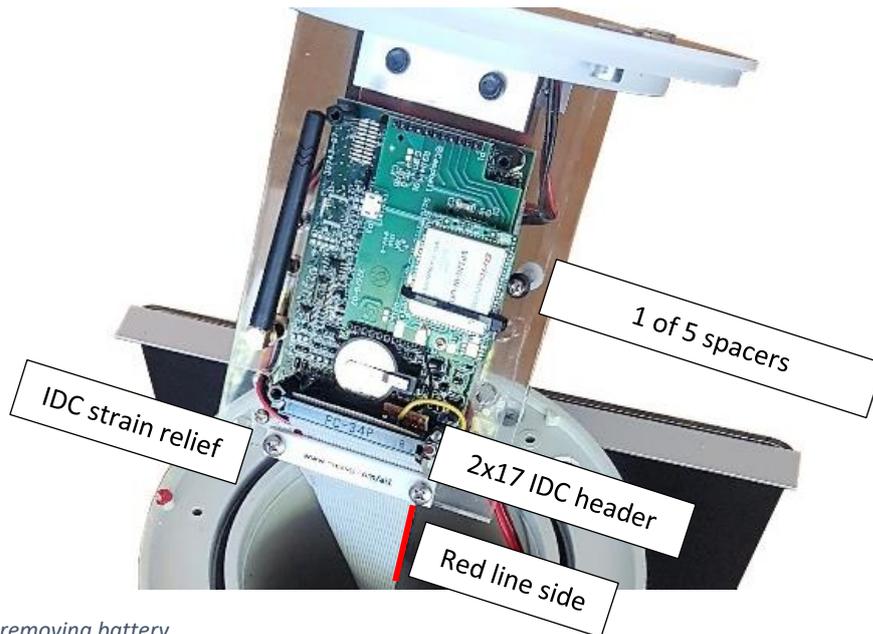


Figure 25 - Important parts when removing battery

On the 18W system the battery is replaced

- Open the housing as described in section 4.1.
- Unscrew black wire from terminal block, pull through the hole in the clear acrylic and use insulation tape to protect from short circuit on conductive materials
- Repeat with the red wire
- Remove the IDC header strain relief plate shown in Figure 25
- Note the orientation of the IDC cable as it will need to be returned in the same location. Consider a photo to refer to later. Remove the plate holding the IDC cable in position and carefully leverage off the IDC header. Remove evenly or the 2x17 header pins may be bent.
- Fully remove the middle spacer on the bottom of the center assembly. Unscrew both ends and completely remove
- Loosen slightly the remaining spacers to allow the battery to slide out from the end
- To replace the new battery, reverse the steps above. When returning the IDC cable take care to ensure correct alignment using the red line on one end to the red markings on the 2x17 pin headers

16.1.2 Battery Shipping

In almost all situations, the Ai1 is able to be shipped with the Lithium Ion battery inside, however many airline regulations prevent the shipping of the battery alone. The Ai1 battery comes in two sizes, 25Ah (which is 92Wh) or 34Ah (125Wh). Many airlines limit the size of the battery to either 160Wh or 100Wh. Confirm with your airline specifically³. An example of the Delta airline requirements, at the time of reference:

- Customers are permitted to travel with lithium ion batteries that contain a maximum of 160-watt hours per battery.
 - Any lithium ion battery containing more than 160-watt hours is prohibited on all passenger aircraft.
- Lithium ion batteries installed in a personal electronic device can be transported as checked or carry-on baggage.
- Lithium ion batteries not installed in a device (spares) **must be** in carry-on baggage and no more than two (2) spares between 100 and 160-watt hours are allowed.

<https://pro.delta.com/content/agency/us/en/policy-library/government-tsa/batteries.html>

³ Qantas: <https://www.qantas.com/au/en/travel-info/baggage/dangerous-goods/spare-batteries-and-powerbanks.html>

17. Recommended field tool kit

Review the recommended tools before performing field work

Recommended	Advanced	Spare parts
<ul style="list-style-type: none"> • Personal Protective Equipment PPE (depending on site requirements). Steel cap shoes, High visibility long clothing, Wide brim hat, sunscreen, insect repellent, safety glasses, Personal Flotation Device, etc • USB Micro-B cables • USB to serial RS23 adapter • 6mm socket & extension • ¼" socket • Drill set 1.0 to 6.0mm • Battery Drill • Multimeter • Heat shrink and heat shrink gun • Side cutters • Wire strippers • Soldering iron (gas recommended) and solder 	<ul style="list-style-type: none"> • M6 hand tap • M4 hand tap • M3 hand tap • Self-amalgamating tape • 2x Ratchet spanner for M6 nylock nuts 	<ul style="list-style-type: none"> • 5x20mm fuses • Clear bottom plate • O-rings • O-ring grease • 8G screws • M6 bolts and nylock nuts (for top and bottom mounting) • M4 screws • CR2012 lithium battery • Assorted glands (M12, M16, M25), hole saws and/or hand taps

18. GPS Options

Ai1 stations commonly include an internal GPS for location tracking (i.e. any model with the -GPS option). For stations fitted with an integrated GPS, the following parameters are reported:

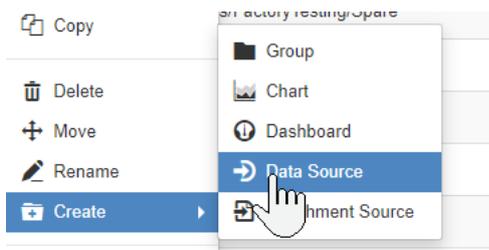
GPS_UTctime	UTC time in the format HHMMSS, where HH are hours, MM are minutes and SS are seconds
GPS_Latitude_dddmm	Latitude and Longitude are reported in dddmm.mmm format, where ddd are degrees and mm.mmm are fractional minutes
GPS_LatitudeHemisphere	The Latitude and Longitude hemisphere are reported as positive and negative numbers depending on the hemisphere. Northern latitudes are +1 while southern latitudes are -1. Eastern latitudes are +1 while Western latitudes are -1
GPS_Longitude_dddmm	As above
GPS_LongitudeHemisphere	As above
GPS_QualityIndicator	A quality indicator representing the quality of the GPS fix. 0=No Fix, 1=GPS Fix, 2=Differential Fix
GPS_HDOP	Horizontal dilution of precision, a representation of the measurement uncertainty. For a full definition: https://gisgeography.com/gps-accuracy-hdop-pdop-gdop-multipath/
GPS_Height	The estimated height of the location. Refer to HDOP for the uncertainty

For example, a buoy on the Columbia river near Portland Ohio (45°36'16.2"N, 122°38'44.9"W) <https://goo.gl/maps/dQhyfpNM9FKf2LEA7>, converted to decimal minutes would be:

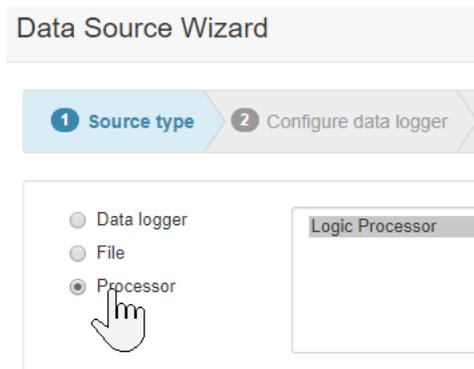
Convert latitude: $45 + (36 + (16.2/60))/60 = 45.6045$ (dd.mmmm)

Convert longitude: $122 + (38 + (44.9/60))/60 = 122.64581$ (dd.mmmm)

Applying hemisphere corrections and converting to dddmm.mmm (by multiplying x 100), the reported location is 4560.450, -12264.581. For use in displaying the station location in Eagle.io, or other platforms, the location needs to be converted back to dd.mmm and decoding the hemisphere information. This is performed in Eagle by using a Logic Processor with the following steps



1. Create a new **Data Source**



2. Create a **Logic Processor**

The parameters are decoded with the JavaScript described below. Both a screenshot (for seeing the location to enter the script) and the text (to copy and paste) are provided

Properties bmt396/Cairns/FactoryTesting/Spare/Location Processor

General Collection Processing Series Historic Time Metadata

Processing allows you to write JavaScript code to combine data from one or more input parameters to generate new output parameters as a result. [Read more...](#)

Run mode On input change

```

1 // Convert Lat/Long
2 var LatA = NODE('../Ail/GPS - GPS-Latitude-dddmm');
3 var LatB = NODE('../Ail/GPS - GPS-LatitudeHemisphere');
4 var LongA = NODE('../Ail/GPS - GPS-Longitude-dddmm');
5 var LongB = NODE('../Ail/GPS - GPS-LongitudeHemisphere');
6 var sign;
    
```

Copy the text below:

```

// Convert Lat/Long
var LatA = NODE('../Ail/GPS - GPS-Latitude-dddmm');
var LatB = NODE('../Ail/GPS - GPS-LatitudeHemisphere');
var LongA = NODE('../Ail/GPS - GPS-Longitude-dddmm');
var LongB = NODE('../Ail/GPS - GPS-LongitudeHemisphere');
var sign;
var degreesCalc;
var minutesCalc;

if (LatB < 0) {
    sign = -1;
} else {
    sign = 1;
}

degreesCalc = Math.floor(Number(LatA/100)); // Calculate the degrees part
minutesCalc = (LatA-(100*degreesCalc))/60; // Calculate the minutes part
NUMBER("lat").currentValue = (degreesCalc + minutesCalc)*sign; // Combine

if (LongB < 0) {
    sign = -1;
} else {
    sign = 1;
}

degreesCalc = Math.floor(Number(LongA/100));
minutesCalc = (LongA-(100*degreesCalc))/60; // Calculate the minutes part
NUMBER("long").currentValue = (degreesCalc + minutesCalc)*sign;
    
```

Series	Parameter assignment	Units
<input checked="" type="checkbox"/> Jp- lat	New Existing lat	
<input checked="" type="checkbox"/> Jp- long	New Existing long	

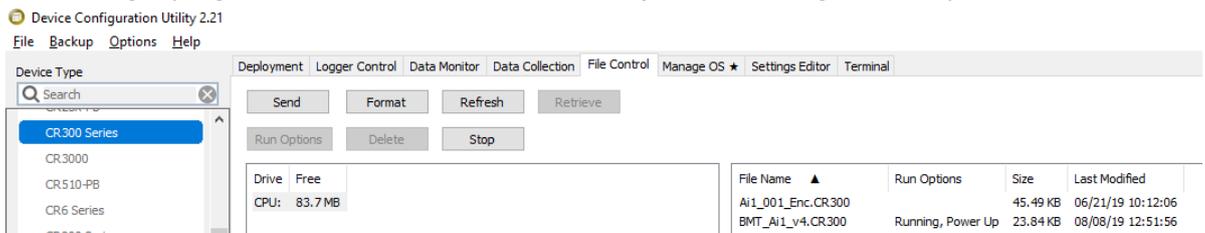
And set the location coordinates to the location processor

Once the script is created, use the new points (lat and long) as the location coordinates for the processor

19. Fault Finding Process

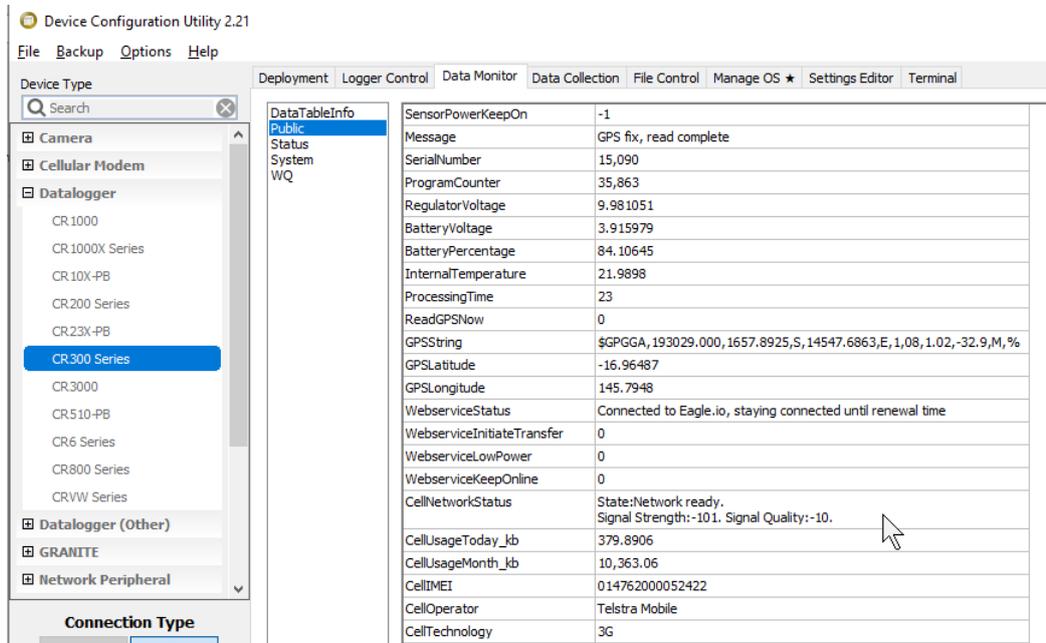
Use the sequence below to diagnose potential problems

- Power Check.** What is the power light flash sequence? Look at the **red** LED beside this symbol : 
 - **Off:** No power. Refer to step 2.
 - **1 flash every 10 seconds:** Ai1 is powered correctly, programming is running. Refer to step 3b
 - **2 or 3 flashes:** Ai1 is powered from the USB, not running from internal power. Refer to step 2
 - **Always On:** Powered correctly but no program is running. Refer to step 3a
- Power Fault Finding.** If the LED is not flashing correctly, the power has failed or needs to be switched on.
 - a. Check that the power switch is on
 - b. If externally powered, check the external power supply source. It must be between 10 and 18Vdc and correct polarity or damage will occur.
 - c. Make sure that the internal fuse is installed and not blown. A spare fuse is available inside the Ai1.
 - d. Remove the fuse and check that it is not blown (visual check and/or measure continuity).
 - e. If the Ai1 passes the steps above but the Power LED remains off, the Ai1 may be temporarily powered from USB for more detailed diagnosis. Connect a USB cable from the USB port to your computer and confirm the LED flashes.
 - f. For internally powered units, look at the variable "**BatteryVoltage**" which displays the internal lithium battery voltage (nominal 3.7V, normal range 3.2 to 4.2V). If the battery voltage is <3.2V the battery has been discharged too far and is likely damaged. Open the cannister and measure the battery voltage directly. If the voltage is low, request a replacement battery spare part, otherwise look for secure connections.
 - g. If all above steps fail, take a photo of the internal connections in the cannister and send to support for more detailed assistance.
 - h. If you hear a high pitched "hum" from a power supply, it indicates a device has high current draw and the supply voltage is dropping. Remove power device by device to isolate
- Program Fault Finding.** If the LED is on but the station is not doing what it was programmed to do, check the following steps. DevConfig is required for communication with the station, refer to the instructions in section 4.2.1.
 - a. If the LED is Always On, a program needs to be set to run. From the **File Control** option, make sure that the right program is selected with correct **Run Options**, Running, Power Up.



- b. For cellular models:
 - i. If the program is running, but a connection is not established to Eagle.io, make sure that the communication parameters are correct. Particularly the SIM card information. The **Access Point Name (APN)** must match the SIM card service provider. The settings vary depending on your service provider. For a global SIM card issued by Measurement Science, the APN is **globaldata**. Refer to your SIM card provider for further information. Find this line in your program to edit the APN:

```
Dim AccessPointName As String * 20 = "telstra.internet"
```
 - ii. The program provides extensive diagnostic information regarding the cellular service and internet connection. Use the **Data Monitor** to view **Public** variables such as and refer to the screenshot below for an example of a good connection. The connection to Eagle may be re-established every 15 minutes so keep watching the connection message.

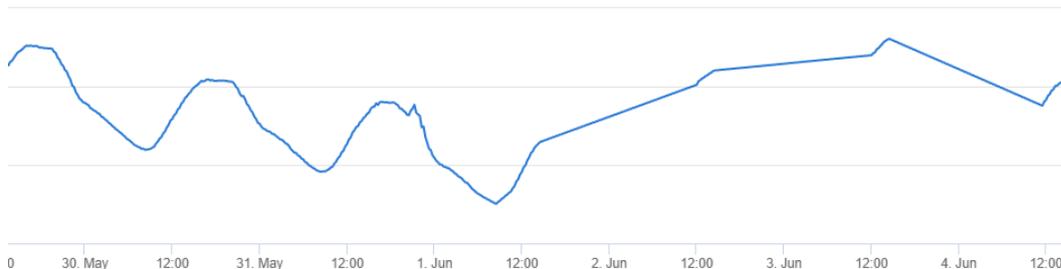


- iii. If the settings are correct but a cellular connection cannot be made, check the SIM card is correctly installed and secured, as shown in section 4.1
- iv. Connection problems are application specific and should be referred to your service provider.

20. Diagnostic Tips

20.1.1 Power related issues

1. If the station is only providing data in the middle of the day, it is possible that the fuse is not fully tightened, that the fuse has blown, or that the battery is disconnected internally. Solar power is sufficient to operate the station without the fuse or battery connected. The symptom is that big gaps in the data start to appear from afternoon through to morning, as demonstrated in the example below



20.1.1 Software and diagnostics

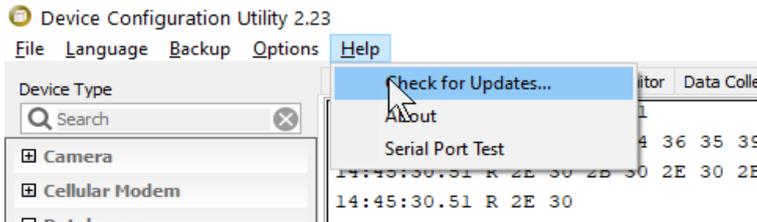
1. DevConfig is the recommended tool for general communications
2. Listen for Windows notifications when a USB device is connected or disconnected when connecting through USB. This may indicate power problems, datalogger resets or remote program changes
3. If the datalogger fails to connect, yet gives the USB connection sound when plugging in, it may be busy performing another process. For particularly difficult connections, consider using a terminal program and pressing enter to return the CR300> prompt. It is possible to connect to a good unit, switch to terminal screen in DevConfig and then plug into another unit. Press enter to see if the difficult unit returns the prompt
4. When sending a program remotely (i.e. through Eagle.io), the program will report as failed, even though it has most likely transferred. The reason is that the last step of sending a program is to wait for the restart confirmation, however the connection to Eagle.io is managed by the program. On starting up, the modem will re-establish the connection which causes a timeout to be diagnosed as a program failure. The sequence of events as shown below will be reported by Eagle.io

🕒	2019-06-06 12:25:43	➔ bmt396/SCA - SW Data/Real-time SPD2/Real-Time Station	📄 Program signature updated [45813 → 11917]	System
🕒	2019-06-06 12:25:37	➔ bmt396/SCA - SW Data/Real-time SPD2/Real-Time Station	🔦 Initiated acquisition [DEVICE]	System
⚙️	2019-06-06 12:25:21	➔ bmt396/SCA - SW Data/Real-time SPD2/Real-Time Station	🚫 Failed to apply configuration [BMT_Ai1.CR300: CampbellPakBusError.CLOCK_READ_ERROR]	System

The program can be confirmed as uploaded by observing that the program signatures updated. Confirm that the new signature matches the calculated signature from CRBasic. If DEBUGGING is enabled in the program, the System data table will store the program signature to know when changes have been made. When using Eagle’s “Manage Configuration” feature, it is recommended to cancel the program sending after this error, to prevent the program being sent again, unnecessarily.

5. Always make sure all software is up to date. The three main steps are DevConfig, CR300 Operating System and Cellular firmware.

- **DevConfig.** The latest version of DevConfig can be confirmed from the Help menu



- **CR300 Operating System.** The latest version for the CR300 operating system is confirmed from the Manage OS tab.



This should be enabled to check automatically each time the Ai1 is connected. At the bottom of the manage OS window is the Check Automatic tick box which should be enabled.



- **Cellular Update.** To check the current version, use the command SHOW CELLULAR INFO

```
CR300>SHOW CELLULAR INFO
State : Dialed.
PPP State : Down
PPP Error : User interrupt.
3G Cell network state: Registered.

Operator : Telstra Mobile
Technology : 3G
Bit error rate : 99
RSSI : -65
EcIo : -8.00
Manufacturer : Cinterion
Model : EHS6
Rev : 03.001
A-Rev : 00.000.49
Brio Ver : FW1.1.12
IMEI : 014762000053636
IMSI : 505013514462045
CCID : 8961018500224127063
Phone # :
```

Figure 26 - Checking cellular firmware information

As can be seen here, the reported firmware version is FW1.1.12. The latest version at the time of writing is FW1.1.12. To update, enter CELLULAR UPDATE in terminal mode, at the CR300 prompt. Answer Yes to the confirmation question.

```

CR300>CELLULAR UPDATE
Are you sure? (YES/NO)
CR300>YES
Restarting cellular modem please wait . . .
Restarting modem in firmware update mode . . .
Waiting for modem initialization . . .
Cellular module version:FW1.1.12
Radio status:1,0
APN command sent . . .
APN Set.
Waiting for modem registration . . .
Radio status:1,0
Connect status:2,2,61
Sending firmware update command . . .
Firmware update command sent . . .
Waiting for command reply . . .
Response received . . .
Failure code received. Code:13
Firmware update retry . . .
Firmware update command sent . . .
Waiting for command reply . . .
Response received . . .
Firmware update started. Please wait . . .
Firmware update command was successful. Please wait . . .
Firmware update time : 00:30
Firmware update time : 01:00
Firmware update time : 01:30
Firmware update time : 02:00
Cellular module version:FW1.1.12

```

Figure 27 - Updating cellular firmware

6. Remote diagnostic tools. Use the following commands to watch the status of various operations or interact with serial sensors, using terminal mode on the datalogger. It is recommended to use DevConfig instead of LoggerNet connect for datalogger terminal connections, as DevConfig can switch between terminal and other screens (such as “Data Monitor”) and have the processes run in parallel. LoggerNet terminal does not allow switching back to the main connect screen. From the CR300> prompt, use the following commands
 - **SET COMMS WATCH.** It is possible to watch the traffic on almost any port. Common options include 9 for SDI12 communications on port C1 and 12 for the status of the internal cellular connection. A shortcut for SET COMMS WATCH is W.

```

CR300>W
1: ComUSB
2: ComRS232
3: Com1
4: ComC1_Tx
5: ComC1_Rx
6: ComC2_Tx
7: ComC2_Rx
9: SDI_12 1
10: SDI_12 2
12: Cell Modem
13: DNP Trace
14: TCP/IP
15: Ethernet
16: IP Trace
Select: 12
Enter timeout (secs): 600
Comms watch started. Hit ESC to exit, any other key to renew timeout.
11:51:40.42 T 7E FF 03 C0 21 09 22 00 08 22 DC A6 B1 27 F9 7E ~...!.."."!±'..~
11:51:40.91 R 7E FF 03 C0 21 0A 22 00 08 7B 2D F7 6D A4 5F 7E ~...!.."!(-.mM_~

```

Figure 28 - SET COMMS WATCH for debugging

- **P. Serial talk-through and listen.** Similar to SET COMMS WATCH (with option 2 for ComRS232) it is possible to both watch traffic AND issue commands to talk to the serial instrument, however any datalogger commands the read the traffic will fail to read serial data while talk-through is active.

```

CR300>P
1: ComUSB
2: ComRS232
3: Com1
Select: 2
opening 2: press ESC ESC ESC ESC to close
In-situ Marine Optics - Copyright (c) 2018.
Multispectral Light Logger
MS9 (SN:0033)
SD CARD LOGGING = ON
LOGFILE: MS9_DATA.TXT
MS9,0033,05/06/2019,09:52:42.000,0,13.12,74.66,18.7500,0.619,0.005,0.015,0.035,0.042,0.040,0.060,0.061,0.070,0.071

```

Figure 29 - Serial talk through to communicate directly with serial sensors

- **SDI12.** Similar to serial talk-through but customised for SDI12 communications. The screenshot below shows a sample SDI12 session to confirm that an instrument is operating correctly.

```

Deployment | Logger Control | Data Monitor | Data Collection | File Control | Manage OS | Settings Editor | Terminal
CR300>
CR300>
CR300>
CR300>SDI12
1: C1
2: C2
Select SDI12 Port: 1
Entering SDI12 Terminal. Press ESC to exit
?!
0
OI!
013YSIIWQSGEXOSND100
OM!
00179
OD0!
0+093019+033147+0.00+0.00
OD1!
0+0.00+0.00+0.00+0.00
OD2!
0+0.00+0.12+0.082
█

```

Figure 30 – SDI12 interactive session confirming correct sensor operation

Type {enter} several times	A CR300> command prompt is returned
Type SDI12{enter}	The Ai1 asks which port to use C1 or C2. C1 is normally used for SDi12
Type 1{enter} for C1	The Ai1 enters SDI12 terminal mode
Type ?!{enter}	The ? asks for any sensors connected to the bus to respond. The ! must be at the end of all SDI12 commands to transmit the request. This only works if a single sensor is connected, otherwise all sensors may respond resulting in garbage. If multiple sensors are connected, disconnect some or advance to the next step
Type OI!	Assuming sensor address 0 responds, this asks for the sensor Identification . If a different address is used, substitute for this number in all subsequent commands. In this example, the instrument 013YSIIWQSGEXOSND100 responds, a YSI EXO sonde. The exact format of this response is manufacturer specific
Type OM!	This initiates a measurement. The response is of the format atttn where a is the address, ttt is the time in seconds for the measurement to be ready and n are the number of data points. In this example the instrument responds with 00179 meaning instrument address 0 will have 9 parameters ready in 017s.
Wait at least ttt seconds and type OD0!	This requests the first block of data. The response is of the format a+n.nnn+m.mmm+... where a is the address and n.nnn and m.mmm are measurements. If there are more measurements to return, request OD1! and OD2! for subsequent blocks of data until complete

SDI12 terminal mode can operate in parallel to datalogger issued SDI12 commands however SDI12 Failed or SDI12 Busy may be returned if the datalogger is performing another program operation.

```

CR300>SDI12
1: C1
2: C2
Select SDI12 Port: 1
Entering SDI12 Terminal. Press ESC to exit
?!
SDI12 Failed

```

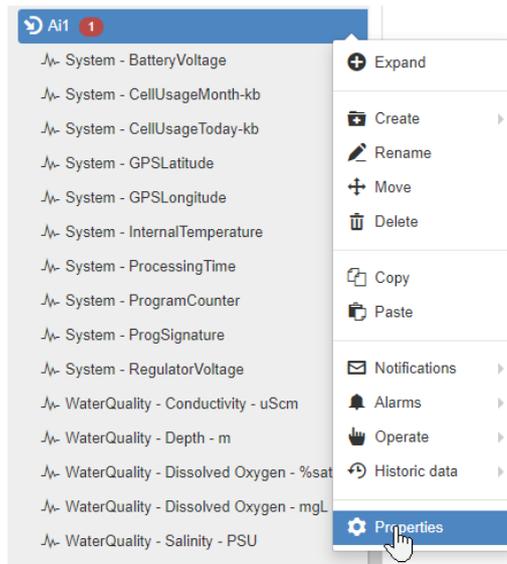
Figure 31 - SDI12 terminal mode without a sensor connected, powered up or configured correctly

- For advanced connections (such as FTP or email SMTP) it is possible to send filtered IP Trace information to a serial port, or to save these to a public variable. Refer to CRBasic help on **IPTrace** instruction for further details.
- For a full list of the available terminal commands, use both **HELP** and **H** for a list.

7. Unresponsive or slow datalogger. On power-up the datalogger will enable the modem and establish the connection to the destination. During this process the datalogger will be slow to respond to other services and may miss serial data or other commands. Use SET COMMS WATCH with option 12 to monitor the status of the modem and wait until a connection has been established.
8. If the GPS continuously responds with \$PGACK, \$PMTK011 and \$PMTK010 then it is most likely resetting due to power supply issues. Confirm that the voltage is a consistent 3.3V. Anything less than 3V and the GPS will reset.

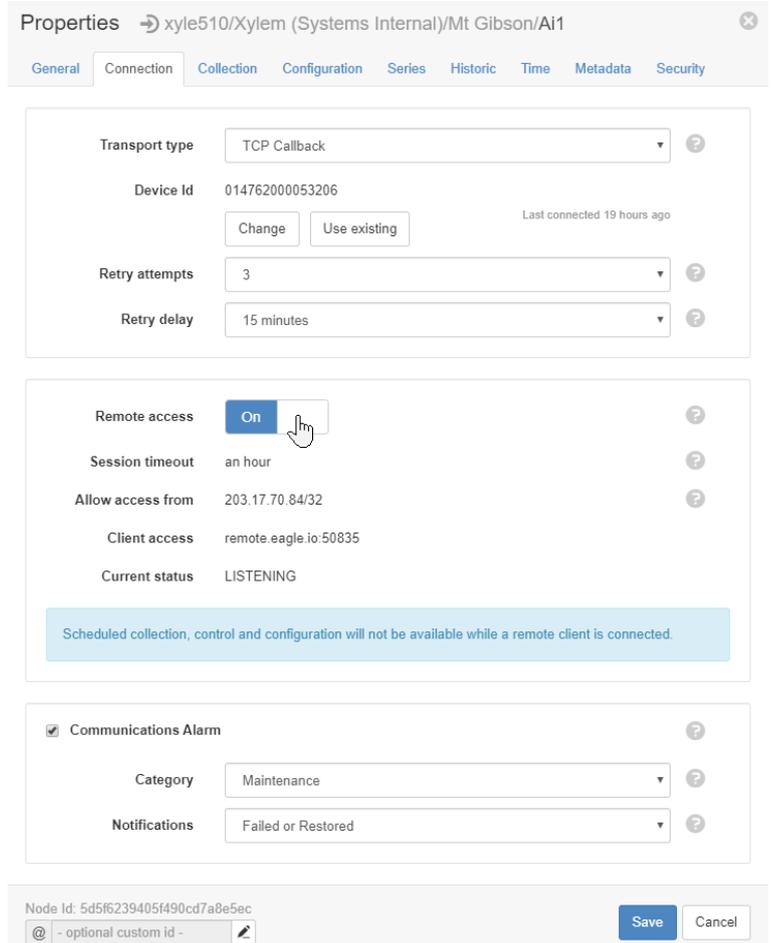
21. Sending a new program

Setup Eagle.io for remote access. Log in to Eagle.io and navigate to the station that you want to update the program on. Right click on the station and select "Properties"



Selection the **Connection** tab and click **Remote access** to enable remote access. By default, Eagle.io will allow access for 1 hour, limited to your specific IP address. If you want longer, or from other addresses, set these before enabling remote access.

Note the client access address, in this case **remote.eagle.io:50835**. Your address will be randomly assigned. Copy this address



Use DevConfig to connect. Using DevConfig (free download as described earlier), select the **CR300 Series** datalogger, and use an **IP** connection type, with the server address set to the address copied in the previous step. The screenshot here shows the correct settings. Click **Connect** when ready.

CR300 Series Datalogger

Connecting with USB

1. Power should be supplied to the datalogger by connecting +12VDC to supply enough power to the datalogger for configuration, but +12VDC
2. Connect the datalogger's USB port to your computer using the supplied
3. Select the correct **Communication Port** in the left panel. If using I
4. By default, PakBus Encryption Key is not required. However, if the de
5. Select the **Connect** button.

Connecting with RS-232

1. Power should be supplied to the datalogger by connecting +12VDC to
2. Connect the datalogger RS-232 port to your computer using a nine p
3. Select the correct **Communication Port** in the left panel. The defa

DevConfig will attempt to make a connection, which may take up to 60 seconds. If this step fails, follow fault finding methods to confirm the station is powered up and online.

Find Datalogger

Searching for PakBus neighbours on the link. While most loggers can respond very rapidly to the hello request that is being sent, some will fail to respond to our beacons for some time. You can abort this connection attempt by clicking the **Disconnect** button.

Find Datalogger

A PakBus neighbour with address, 1, has been found. We must now load the settings for that device. Please wait while this happens ...

Send the file. Once connected, select the **File Control** tab, and use the **Send** button to send the appropriate file. The file must be a unique name from the currently running file. Do not use the **Stop** button or the connection to Eagle may be lost and a site visit may be required to start the program.

Deployment | Logger Control | Data Monitor | Data Collection | **File Control** | Manage OS | Settings Editor | Terminal

Send | Format | Refresh | Retrieve

Run Options | Delete | Stop

Drive	Free	File Name	Run Options	Size	Last Modified
CPU:	83.73 MB	Ai1_002_Enc.CR300		45.66 KB	08/21/19 12:50:12
		BMT_Ai1_v5.CR300	Running, Power Up	24.89 KB	08/21/19 12:50:26
		default.cr300		11.21 KB	06/20/19 10:35:50
		StationConfiguration.cr300		446 B	05/31/19 10:26:10

Start the new program. Once sent, highlight the new program, and click the **Run Options** button. Select both **Run Now** and **Run on Power Up** and click **Ok**. The new program will now start. During this start, the program start will report as failed. This is normal as the old program is stopped, and therefore the internal modem is temporarily offline. Once the new program starts, a new connection will be made and a new DevConfig connection will need to be established, starting from "Use DevConfig to Connect".

Run Options

CPU:BMT_Ai1_v5.CR300

Run Now

Preserve existing data tables if possible
 Replace existing data tables

Run on Power Up

Ok | Cancel

22. Declarations

22.1 For models including LaserLEVEL

22.1.1 Warning

This device requires no regular maintenance. In the event that the device becomes damaged or is inoperable, repair or service must be handled by authorized, factory-trained technicians only. Attempting to repair or service the unit on your own can result in direct exposure to laser radiation and the risk of permanent eye damage. For repair or service, contact your dealer for more information. This device should not be modified or operated without its housing or optics. Operating this device without a housing and optics, or operating this device with a modified housing or optics that exposes the laser source, may result in direct exposure to laser radiation and the risk of permanent eye damage. Removal or modification of the diffuser in front of the laser optic may result in the risk of permanent eye damage.

22.1.2 Caution

This device emits laser radiation. This laser product is designated Class 1 during all procedures of operation. It is advisable to avoid looking into the beam when operating the device and to turn off the module when not in use.

Laser Notice

CLASS 1 LASER PRODUCT

Classified EN/IEC 60825-1 2014

This product is in conformity with performance standards for laser products under 21 CFR 1040, except with respect to those characteristics authorized by Variance Number FDA-2106-V-2943 effective September 27, 2016



Measurement Science products are distributed globally by Xylem Analytics. Contact Xylem for support information.
salesaus@xylem.com, +61 1300 995362

The Ai1 is intended to be part of a well maintained and comprehensive environmental monitoring system. Stations are provided for complete user customization and programming (programming services available). Reliable operation depends on suitable site selection, correct installation, real time monitoring of data, adequate maintenance and investigation of alarm and diagnostic information. Stations are designed to be mounted above maximum flood elevation, flooding may result in damage. In order to protect the design information, purchasers warrant to not reverse engineer the housing, components, software or supplier information. Refer to terms and conditions of sale for full details.

