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A2X User Manual

Version 1.0.3
2018-09-20

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About the A2X

The A2X from Blue Water Design is a two-way capable ALERT2 Intelligent Network Device (IND), which can act in any of the traditional ALERT2 roles: base station, repeater, or gauging site.

ALERT2 Information

ALERT2 is a low-bandwidth, high-reliability protocol designed for the transport of real-time data over radio telemetry networks.

A Description of the ALERT2 Protocol[1], a white paper summarizing the protocol, opens with the following description:

> ALERT2 is a new protocol optimized for the transport of real-time data over radio telemetry networks. It is the intended successor to the ALERT (Automated Local Evaluation in Real Time) protocol introduced in the 1970s. It offers a 7- to 10-fold increase in net data rate (or channel capacity), detects all errors introduced in transmission and corrects the great majority of them. The new protocol comprises multiple sub-protocols, with the flexibility to add new ones as needs emerge. It provides greater "data space" that expands the range of sensor identifiers and data resolution. It can be used in either ALOHA or TDMA environments, the latter providing the opportunity to eliminate data contention altogether.

The protocol specification documents are linked from Blue Water Design's support page, here.

A2X Firmware Types

The A2X is available with two different firmware types (IND or RPT), specified at the time of purchase. The IND firmware is suitable for a gauging site or base station, but is not able to repeat messages. The Repeater firmware adds repeater and address listing functionality.

The second set of letters in the A2X model number indicates the firmware (e.g., A2X-**IND**-BP).

Power

An external DC power source is required. The A2X can accept inputs ranging from 9 to 17 volts, and includes reverse-polarity protection. Typical installations will provide power using 12V lead-acid batteries. The A2X will monitor the input voltage level and include it in its regular status reports.

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[1] *A Descirption of the ALERT2 Protocol*, Don Van Wie, October, 2011, http://bluewaterdesign.us/docs/ALERT2_Description_102511.pdf

Configuration and Control Software

Blue Water Design provides configuration and control software called **A2Control** as a companion to the A2X. A2Control allows users to view received message, configure the A2X, and transmit messages.

The software is available for download from the Blue Water Design website at:
http://bluewaterdesign.us/downloads/a2control

Connecting to the A2X with A2Control

- Connect your computer to the console port on the A2X using a MicroUSB cable.
- Launch A2Control.
- If there is only one attached serial port, A2Control will select it by default. Otherwise, select the appropriate serial port from the dropdown in the top right of the window and click the "Connect" button.

Image: The connect button and serial port selection drop-down

- If A2Control is able to communicate with the A2X, the firmware type and version of the A2X will be shown in the toolbar along the top of the A2Control window as well as the device's IP address, if it is connected to the network.
- A2Control is also able to connect to the A2X remotely via TCP/IP by choosing network connection in the serial port drop down instead of a port number. See "Remote Configuration via IP Network" below.

Device Configuration

Device configuration is most easily performed using A2Control.

Connect to the device using A2Control as above, then select the gear icon in the toolbar to bring up the configuration pane.

See the "Initial Configuration" section below for commonly used configuration settings.

When changes are complete, click the "Write To Device" button to save them. Settings may also be loaded or saved to a local file.

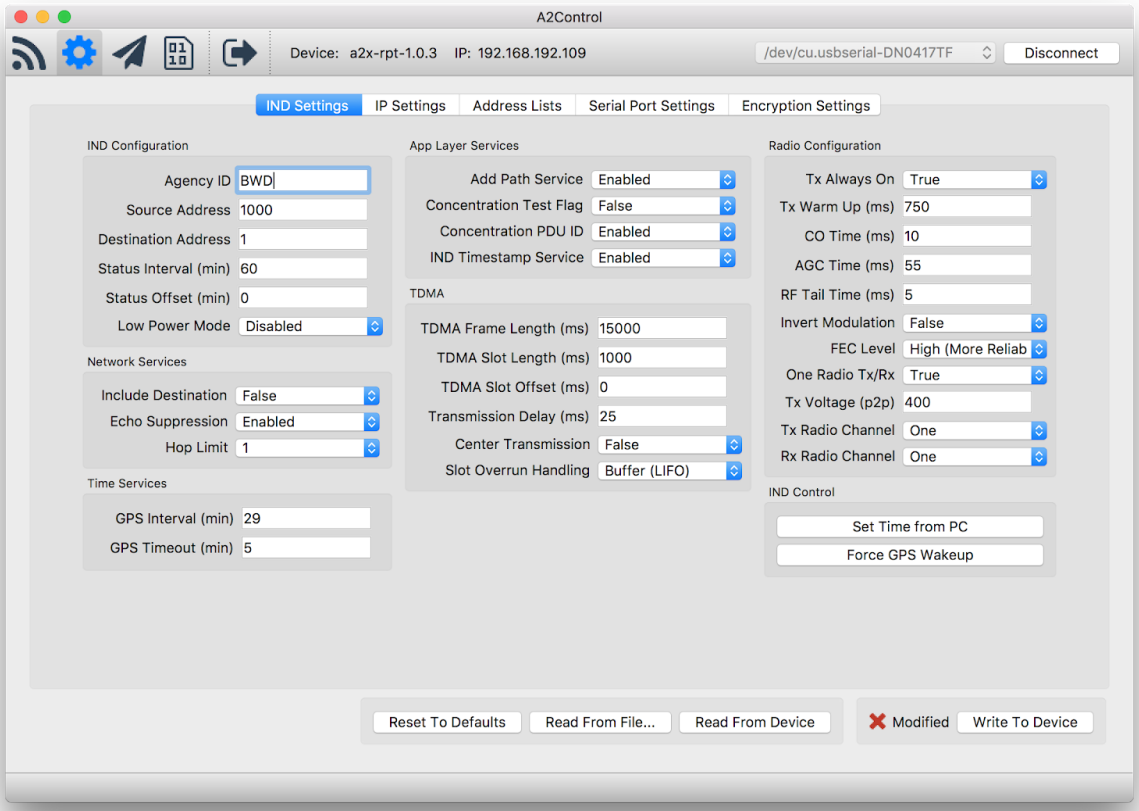

Image: The IND Settings page of A2Control

Device configuration can also be performed using the ALERT2 IND API to communicate with the A2X over any of the available serial ports. The ALERT2 IND API specification is an open standard published by the National Hydrologic Warning Council. More information is available from the support page on the Blue Water Design website:
http://bluewaterdesign.us/support/

Receiving Data

The A2X will receive and decode ALERT2 data as long as it is powered on. When the A2X finds a valid Bit Sync pattern in the incoming audio, it turns on the Bit Sync LED and begins listening for a valid Frame Sync pattern (which should immediately follow the Bit Sync). If a valid Frame Sync pattern is found, the Frame Sync LED is turned on as well, and both LEDs will remain illuminated for the duration of the incoming message. If no valid frame sync is found, the Bit Sync LED is turned off.

The A2X is a full-duplex modem, and will continue to decode ALERT2 messages while the transmitter is active. (Note, however, that this requires a full-duplex radio configuration.)

To view incoming messages, connect to the device using A2Control, then select the “View Messages” icon in the toolbar. Messages will appear as they are received.

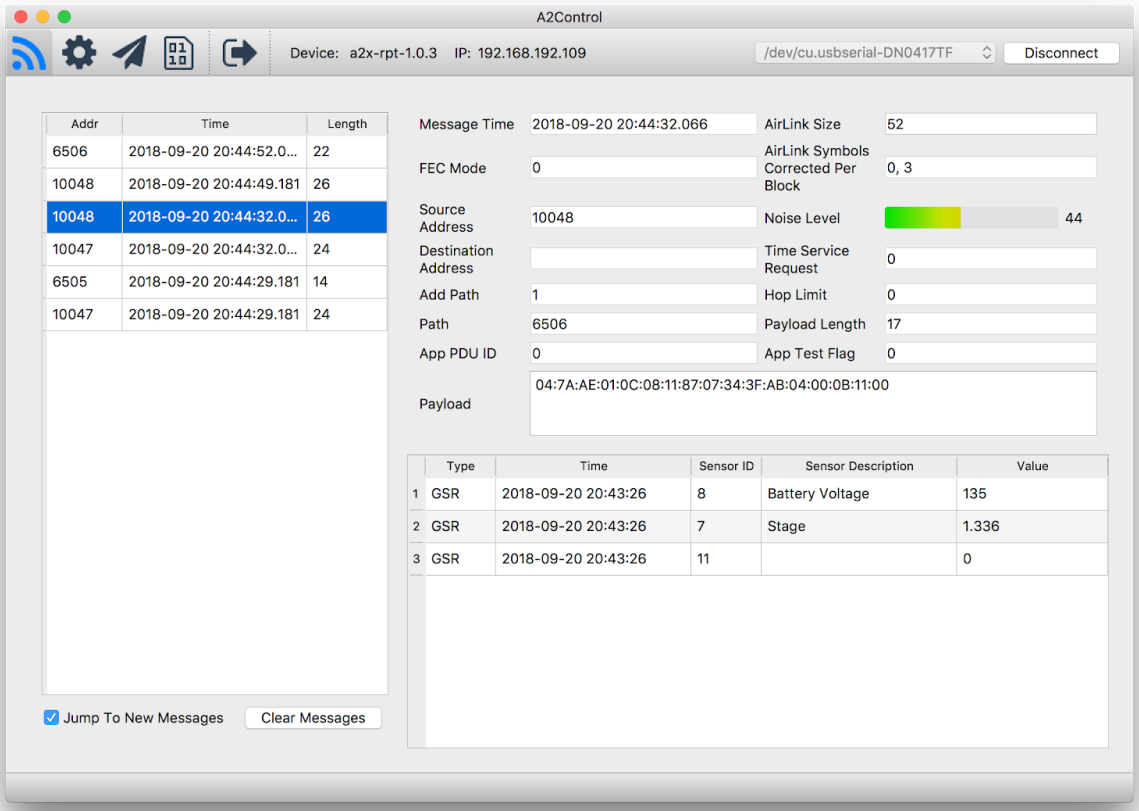

Image: The Messages page of A2Control

Transmitting Data

The A2X is a fully-functional ALERT2 transmitter. Provided that it is configured with the GPS as its clock source and that it has a good GPS signal, the A2X will use the assigned TDMA (time-division multiple access) slot for transmission.

ALERT2 data can be submitted to the A2X for transmission using the ALERT2 IND API over any of the serial ports, or transmissions can be initiated using A2Control on the “Transmit Data” page. Additionally, the A2X will send status messages at user-configurable intervals and upon acquisition and loss of the GPS clock sync.

Status LEDs

LEDs are visible on the front of the A2X case or may be brought to other locations via headers on the board.

Name	Functional Description
TX Radio On	Power is being supplied to the TX radio.
Transmit	The A2X is transmitting an ALERT2 message.
GPS On	The GPS is currently powered up. The GPS may require several minutes to initially get a fix, but after that will only require turning on for a brief time to maintain accurate time.
Clock Sync	A solid light indicates that the A2X has a reliable clock source, and will transmit in TDMA mode. The clock is able to maintain synchronization for up to 4 hours without the GPS being on. A slowly flashing light indicates that the the A2X is configured to use NTP as its clock source and it has obtained an appropriate time from an NTP server. The A2X will not transmit using TDMA with an NTP time source.
Serial 1-3	This LED will flash as serial data is input or output from the corresponding port.
Bit Sync	The Bit Sync light is illuminated when a valid ALERT2 Bit Sync pattern has been found in the data stream from the RX radio. The light will remain illuminated until a message is fully received or until it has been determined that no message was present.
Frame Sync	The Frame Sync light is illuminated when a valid ALERT2 frame sync has been found, and remains lit while the A2X attempts to decode the message.
Power	The device has power and is running.

Port Descriptions

Name	Functional Description
Ethernet	Enables TCP/IP connections to the A2X. Possible uses include: remote configuration of the A2X using the A2Control GUI, pulling logs of collected ALERT2 data, streaming ALERT2 data to other endpoints, and firmware updates.
SD Card	Stores logs of all received ALERT2 traffic and decoder operation.

Console	micro USB port. Intended for use with the A2Control GUI, but is available an ALERT2 Binary API port. This port will appear a serial port when plugged into a PC. Serial port settings are fixed at 115200 8,N,1. When the device is booting, some diagnostic information may be displayed.
USB	USB Host port, Supports plugging in a USB flash drive for copying logs from the A2X, as well as firmware updates. If you want to copy the ALERT2 logs from the device, create a folder called decoder_output on the USB flash drive. If, and only if, the device finds this folder, ALERT2 output will be synchronized to the folder. The USB flash drive is also used to install a firmware update.
GPS	A GPS antenna must be connected for proper time sync.
Serial 1	First serial port
RX Radio	4 pin connection for receive radio
TX Radio	5 pin connection for transmit radio
Serial 2	Second serial port
Serial 3	Third serial port

Common Tasks

Initial Configuration

The ALERT2 specification defines a wide range of configurable settings that can apply to an IND. These configuration settings are divided into three categories: mandatory, recommended, and optional. The A2X implements all mandatory and recommended settings, and many of the optional configuration items as well.

Because there are some many configuration options, initial setup of an ALERT2 device can be intimidating. In most cases, however, the default values are reasonable and need not be changed. This section highlights values that users should consider changing.

All Units		
Setting	*Tab*	*Description*
Agency ID	IND Settings	A unique string describing your agency. (e.g., UDFCD

		or BWD)
Source Address	IND Settings	The unique address of this device. Addresses may be managed through the Source Address Management System (SAMS) at alert2.org
Network Password	IP Settings	A password that can be used to connect to this device remotely
Serial Port Input / Output Mode	Serial Port Settings	Configure serial ports for API or Concentration input, ASCII/Binary/No output
Receivers		
Setting	*Tab*	*Description*
ASCII IP Forward	IP Settings	Comma separated list of hosts to which received ALERT2 messages, in ASCII format, will be streamed
Binary IP Forward	IP Settings	Comma separated list of hosts to which received ALERT2 messages, in Binary format, will be streamed
Transmitters		
Setting	*Tab*	*Description*
TDMA Frame Length	IND Settings	TDMA Configuration
TDMA Slot Length	IND Settings	TDMA Configuration
TDMA Slot Offset	IND Settings	TDMA Configuration
Transmission Delay	IND Settings	Delay into TDMA slot (set to 12 ms for 250ms slot)
Tx Voltage (p2p)	IND Settings	Set to 400 (Ritron) or 425 (Maxon) depending on the transmit radio being used

Upgrading Device Firmware

Firmware images are available for download from the Blue Water Design here:
http://bluewaterdesign.us/downloads/firmware/

The update file must match the firmware of the device you wish to upgrade (e.g., an A2X-**RPT**-C must use the **a2x-rpt-update-...** series of updates).

Please Note: The A2X firmware images end in a double extension (.tar.gpg); when downloading, some browsers (Internet Explorer) may rename the files with only one extension (.tar). In this case, you must rename the file to restore both extensions or the A2X will not find the update file.

Local Upgrade

To perform a firmware upgrade when you have physical access to the A2X, place the firmware upgrade file in the root folder of a USB flash drive and insert that drive into the USB port on the front of the A2X. The A2X must be powered on for at least two minutes for it to register the USB flash drive.

Initially, you will see the "Bit Sync" LED flash rapidly while system logs are copied from the A2X onto the flash drive (see Downloading ALERT2 Logs). When that is complete, the A2X will search the drive for firmware updates. If one is found, the status LEDs -- starting with "Clock Sync" -- will begin flashing slowing to display update progress. When the upgrade is complete, the lights will remain solid for a few seconds and then the device will reboot.

If the Serial 1 light blinks quickly, the update has failed. You may attempt installing the update again. If you continue having problems, please contact Blue Water Design for further instructions.

Please Note: Some manufacturers ship USB flash drives with a default "exFAT" filesystem. The A2X does not support exFAT, so you will need to reformat any such cards with the regular "FAT" filesystem before using them with the A2X.

Remote Upgrade

The A2X can be upgraded remotely over a TCP/IP network using the SFTP protocol. Remote access to the A2X is disabled by default, and must be enabled by setting a network password in A2Control. Blue Water Design recommends the free and Open Source FileZilla as an SFTP client (https://filezilla-project.org).

Connect to the A2X with the following parameters:

IP: [Configured / visible in A2Control]
Port: 4422
Username: alert2
Password: [specified in A2Control]

Once connected, simply upload the firmware update file to the default folder of the A2X to be upgraded. When the upload completes, the A2X will automatically install the updated firmware and reboot.

Downloading ALERT2 Data and A2X System Logs

The A2X ships with a microSD card which stores all received ALERT2 traffic. The microSD card is intended to be left in the device during normal operation. It is not necessary to remove the microSD card to obtain logs from the A2X; however, if you do remove the microSD card, power down the A2X before doing so.

ALERT2 data can be retrieved from the A2X in three different ways: remotely, via SFTP; locally, using a USB flash drive, or by removing the microSD card and copying data off of it directly.

Remote Download: SFTP

Remote access to the A2X is disabled by default, and must be enabled by setting a network password in A2Control. Blue Water Design recommends the free and Open Source FileZilla (https://filezilla-project.org) as an SFTP client.

Connect to the A2X with the following parameters:

IP: [Configured / visible in A2Control]
Port: 4422
Username: alert2
Password: [specified in A2Control]

Received ALERT2 data is stored in the **decoder_output** folder. Files are named [AGENCY_ID]_[DATE].gz and are compressed with gzip.

System logs are stored in the **logs** folder. Each subsystem has its own folder with the most recent logs stored in it. These logs are not intended to contain useful information for day-to-day use of the system, but may be helpful for troubleshooting.

Local Download: USB flash drive or microSD card

When a USB flash drive is inserted, the A2X's system logs are copied to the USB flash drive and placed in a folder named [AGENCY_ID]-[SOURCE_ADDRESS]-[DATE]. To copy the received ALERT2 data from the device, create a folder called decoder_output in the root folder of the USB flash drive. If the A2X finds this folder, ALERT2 output files will be copied to the folder. The A2X must be powered on for at least two minutes for it to register the USB flash drive.

Please Note: Some manufacturers ship USB flash drives with a default "exFAT" filesystem. The A2X does not support exFAT, so you will need to reformat any such cards with the regular "FAT" filesystem.

If, instead, you want to copy data directly from the microSD card, simply power off the A2X and remove the card from the device. Reinsert the card after copying the data, before powering it on again.

Please Note: The A2X will reformat the microSD if it does not understand the partition scheme or filesystem, completely erasing the device. Some manufacturers ship microSD cards with a default "exFAT" filesystem, which the A2X does not support. If you are worried about losing data on a micro SD card, and are unsure of the filesystem type, DO NOT insert it into the A2X.

Clock Source Selection: GPS or NTP

In TDMA mode, an ALERT2 transmitter requires a 3D GPS fix in order to acquire accurate time. For a receive-only site, it is optional, and the A2X will also support time synchronization using the NTP protocol via the Ethernet port.

Remote Configuration via IP Network

It is possible to connect to a remote A2X over a TCP/IP network using A2Control.

Before you can connect to the remote device, you must first set a network password in the IP Settings tab of the configuration pane in A2Control. The A2X ships with remote connections disabled as a security precaution, so you must set this password locally the first time.

To connect to a remote A2X, select “Network Connection” in the dropdown to the left of the “Connect” button, then enter the IP address or hostname of the device. When you click “Connect”, you will be prompted to enter the network password.

Pass and Reject Lists

The A2X repeater firmware supports up to two different Pass or Reject lists for determining which messages to repeat. Before a message is repeated, it is checked against all active address lists.

Lists can be either a “Pass” list, where only listed entries are repeated, or a “Reject” list where messages are repeated by default, but dropped if they are in the list. Messages can be filtered by Source Address, Destination Address, or the path list added by other repeaters.

Messages can either be reported locally in the ALERT2 logs or dropped silently.

This lists can be configured on the Address Lists tab of the configuration pane in A2Control, or they can be configured via the ALERT2 IND API.

Connectors, Cabling, and Pinouts

Serial ports

Three serial ports are available for use, and their function is configurable. The serial ports operate at RS232 line levels.

Serial port Pinout (from left, facing the A2X):

Pin Number	Pin Function
1	TX (data output from A2X)
2	RX (data input to A2X)
3	Ground

The serial port connector is made by Harting Elektronik, part number 14310410301000.

The default serial port settings for all ports are:

Setting Name	Setting Value
Input Mode	API
Output Mode	ASCII
Baud Rate	9600
Parity	None
Stop Bits	1
Flow Control	None
Timeout	250ms
Independent Addressing	False/Off
Address	9000 (see above, not enabled by default)

Serial port settings can be configured using the ALERT2 IND API or via the “Serial Port Settings” tab in the configuration pane of A2Control.

The A2X implements version 1.0 of the ALERT2 IND API. The specification document is linked from the Blue Water Design website, here: http://bluewaterdesign.us/support/

Describing the details of the API is beyond the scope of this document, however at a very high level:

- Sending messages with the A2X requires feeding it properly formatted API messages.
- If a serial port is configured for ASCII mode, messages may be inspected from any serial terminal program (for example, Tera Term).
- If a serial port is configured for binary mode, software will be needed to properly decode messages from the API binary format

- For a list of specific API commands implemented by the A2X, see the Blue Water Design ALERT2 IND API Overview document, also available on our support page.

Radio ports

RX Pinout (from left, facing the A2X):

Pin Number	Pin Function
1	12V power (provided by A2X)
2	Ground
3	RF Data (input to A2X)
4	Channel Select

The RX radio connector is made by Harting Elektronik, part number 14310413101000.

TX Pinout (from left, facing the A2X):

Pin Number	Pin Function
1	RF Data (output from A2X)
2	Ground
3	Push to Talk
4	12V power (provided by A2X)
5	Channel Select

The TX radio connector is made by Harting Elektronik, part number 14310513101000.

Please Note: The RX Radio power path is designed to handle a maximum of 1.5 amps of continuous current. The TX Radio power path is designed to handle up to 2.5 amps of continuous current. Half-duplex repeater configurations, with a single radio, should favor using the TX power path to power the radio.