1421 Research Park Dr
Lawrence, KS 66049

Radar Altimeter

US-D1

User Manual

D00.02.05
04/03/2023

1421 Research Park Dr
Lawrence, KS 66049

Revision History

Version Number	Date	Authors	Notes
D00.00.01	Mar 2, 2018	Jin Cheng, Sheen Xiao	Draft based on engineering spec and customer requirements
D00.00.02	April 10, 2018	Jin Cheng, Sheen Xiao	Put customer requirements in development phases
D00.00.03	September 10, 2018	Zhenyu Hu	Update specs and features. Add data format and communication protocol
D00.01.01	October 5, 2018	Andrew Megaris	Technical Revision
D00.02.00	June 24, 2019	Zhenyu Hu	Revision for FCC certificate
D00.02.01	October 23, 2019	Andrew Megaris	Final FCC Edit
D00.02.02	October 14, 2020	Zhenyu Hu	Add Firmware version information
D00.02.03	January 8, 2021	Zhenyu Hu	Update the Specs
D00.02.04	November 1, 2021	Camron Myers	Installation Instructions, Operational Requirements, Product Description
D00.02.05	April 3, 2023	Camron Myers	Updated Firmware Instructions

1421 Research Park Dr
Lawrence, KS 66049

Copyright 2019 © Ainstein AI, Inc. All rights reserved. No part of this work may be reproduced, published, or distributed in any form or by any means (electronically, mechanically, photocopying, recording, or otherwise), or stored in a database retrieval system, without the prior written permission of Ainstein AI, Inc. in each instance.

Warning!

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

- **This document and other information from Ainstein AI Inc, its subsidiaries and authorized distributors provide product and/or system options for further investigation by users having technical expertise.**
- **The user, through its own analysis and testing, is solely responsible for making the final selection of the system and components and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application, follow applicable industry standards, and follow the information concerning the product in the current product catalog and in any other materials provided from Ainstein or its subsidiaries or authorized distributors.**
- **To the extent that Ainstein or its subsidiaries or authorized distributors provide component or system options based upon data or specifications provided by the user, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the components or systems.**
- **The Buyer and/or end-user will be solely responsible for final disposal of all products.**

1421 Research Park Dr
Lawrence, KS 66049

Table of Contents

Title Page **1**
Table of Contents **4**
1. Product Description **6**
1.1. US-D1 6
1.2. Compliances 6
2. Installation Guidelines **7**
2.1. Mounting Angle 7
2.2 Mounting to an Aircraft 7
2.3. Line of Sight Clearance 8
2.4. Integration Requirements 8
3. Operational Requirements **10**
3.1 Obstruction to the US-D1 Field of View 10
3.2 Excessive Pitch/Roll 10
3.3 Terrain 10
3.4 Power Source 10
3.5 Orientation of US-D1 10
3.6 Minimum and Maximum Operating Altitude 11
4. Technical Specifications **12**
5. Data Protocol For US-D1 **14**
5.1 UART Data Protocol Specifications 14
5.2 CAN Data Protocol Specifications 15
6. Mechanical Specifications **17**
7. Radiated Emissions **19**
8. Hardware Interface **19**
9. Customizations **20**
10. Firmware Update Kit **20**
10.1 Hardware Connection and Software Installation 20
10.2 Software --Firmware Binary Files 22
10.3 Software --Ainstein US-D1 Firmware Update Tool 25
10.4 Firmware Update Procedure 27
10.4.1 Connecting the Firmware Update Kit (Auxiliary Board) 27
10.4.2 Connecting the US-D1 28
10.4.3 Configuring the US-D1 Parameters 30
10.4.4 Updating the Firmware 32
10.4.5 Changing the CAN BAUD Rate 35
10.4.6 Changing the CAN ID 36
11. Application Notes **37**

12. Hardware & Firmware Version **40**
13. Firmware Changelog **41**
14. Contact Us **43**

1. Product Description

1.1. US-D1

The US-D1 Radar Altimeter uses the principles of radio detection and ranging to determine the altitude of the aircraft. A microwave signal is transmitted out of the sensor, reflects off the target and is received by the sensor. Distance from the sensor to the terrain (altitude) is derived by the difference in time from when the signal is sent from the sensor to when the signal is received by the sensor

The US-D1 is enclosed in a black plastic case, the radome, which is conducive to radar telemetry. The US-D1 has a short cable terminated with a connector.

Custom units with different cable lengths and connector types may be configured for OEM customers. Contact Ainstein for more information.

1.2. Compliances

FCC ID: 2ATMB-USD1AZ

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B device (commercial or industrial use), pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communication. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his/her own expense.

CE Compliance
This device complies with Directive 2014/53/EU of the EU declaration of conformity.

2. Installation Guidelines

Warning! Follow the manufacturer's regulations when mounting, modifying, repairing, and maintaining equipment. The manufacturer assumes no responsibility for any accidents caused by incorrectly mounted or incorrectly maintained equipment. The manufacturer assumes no responsibility for the system being incorrectly applied, or the system being programmed in a manner that jeopardizes safety.

The following instructions are critical to the proper operation of the US-D1 device. Failure to install the unit according to the given instructions can result in malfunction of the device.

2.1. Mounting Angle

When mounting the device, the front face of the US-D1 must be **perpendicular** to the ground below the aircraft. There should not be any angle of inclination in any direction while the device is fastened to the aircraft.

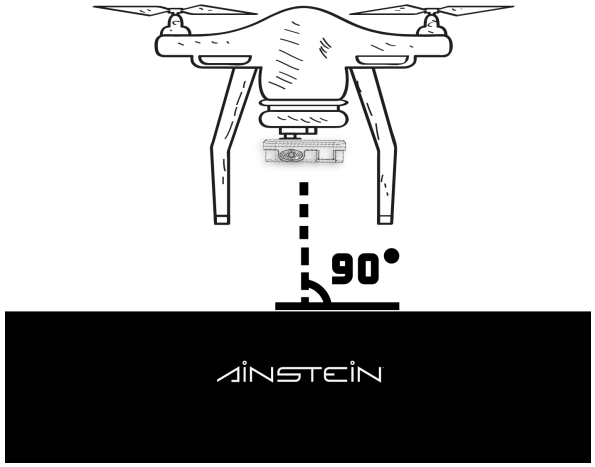


Figure 1

2.2 Mounting to an Aircraft

The device should be secured to the aircraft, where it is not free to move in any direction.

2.3. Line of Sight Clearance

Keep the face of the radar clean, and do not cover it with any additional materials. Any coatings, coverings, and modifications to the radome can degrade the performance of the radar device.
Additionally, keep any unexpected objects out of the radar's FoV (Field of View). Obstructions to the US-D1's field of view will cause a decrease in the performance of the radar. It is highly recommended that the US-D1 be mounted on the underside of the aircraft far away from the landing gear, other aircraft structures, or other equipment.

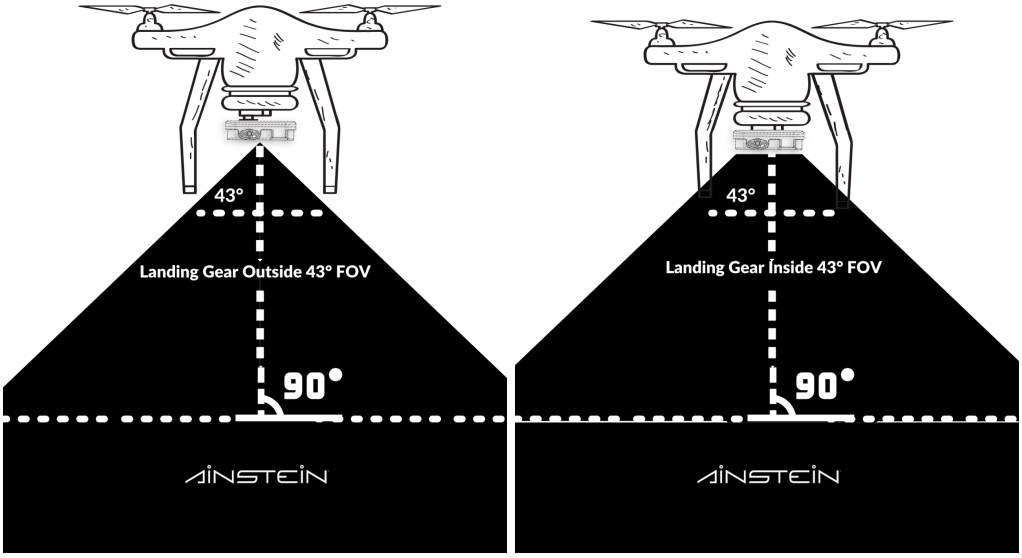


Figure 2

2.4. Integration Requirements

The US-D1 outputs altitude measurements and signal-to-noise ratio (SNR) measurements when operational. When integrating the US-D1 radar altimeter, it is necessary to use both altitude and SNR measurements to properly filter out erroneous altitude values.

Caution! Altitude measurements associated with a SNR value of 13dB or lower are considered erroneous.

The altitude measurements should not in any circumstances be used as true measurements independently of the corresponding SNR values.

A filtering algorithm should be used to estimate vehicle position, velocity and angular orientation based on rate gyroscopes, accelerometer, compass, GPS, airspeed and barometric pressure measurements in addition to the recorded US-D1 measurements. Sensor redundancy is heavily advised for the US-D1.

3. Operational Requirements

The US-D1 will perform optimally if the operational requirements below are fully satisfied. Failure to meet the operational requirements may cause a decrease in performance, accuracy, or reliability of the US-D1 altimeter and is not advised.

3.1 Obstruction to the US-D1 Field of View

Objects or aircraft structures that are located within the US-D1's conical field of view which obstruct the radar's view of the ground may cause multipath reflections or other degrative phenomena to occur. The US-D1 should be mounted a safe distance away from the landing gear and any other components of the aircraft below it.

3.2 Excessive Pitch/Roll

Pitch and roll angles that exceed 21.5° and 15° respectively may also cause the performance of the US-D1 to worsen. This sensitivity increases with altitude.

3.3 Terrain

Terrain with poor reflectivity may cause the performance of the US-D1 to worsen. Flying at the limit of the US-D1's range over dry, loose soil, such as tilled farmland, or sand is not recommended.

3.4 Power Source

Any power source used to operate the US-D1 that does not provide the minimum power and voltage can worsen the performance of the device or cause it's operation to stop altogether.

3.5 Orientation of US-D1

The US-D1 must be mounted upon the aircraft in such a manner as to be fully horizontal, it's radome directly facing the ground. Any angle of inclination may degrade performance.

3.6 Minimum and Maximum Operating Altitude

Operating the US-D1 at altitudes below 0.5 meters and above 50 meters will result in a degradation of performance and potentially erroneous measurements.

4. Technical Specifications

Table 1: Specifications

Frequency Band	24 GHz
Bandwidth	190 MHz
Minimum Operating Altitude	0.5 meters
Maximum Operating Altitude	50 meters
Altitude Precision	6.0cm (< 1m), 4.0cm (> 1m)
Field of View	43 ° x 30 °
Interface	UART, CAN
Update Rate	100 Hz
Supply Voltage	5V~13V DC (5.5V recommended)
Power Consumption	2W(at 5 Volts DC input)
Operational Temperature Range	-20 °C ~ 65 °C*
Size	108 x 79 x 20 millimeters
Weight	110 grams
Environmental Conditions	IP67(with sealant)

Notes:

- All specs above are measured under the environment of 35 °C temperature, standard atmospheric pressure and humidity, without any Electromagnetic Interference (EMI).
- Operational Temperature Range indicates radar works properly in this range. If operating temperature goes beyond this range, radar might not be accurate and can suffer mechanical damage.
- The radar unit can be shipped with either CAN or UART for it's output data protocol.

- * Operational Temperature Range is based on the hardware's subcomponent specifications. Actual operational testing is still pending.

5. Data Protocol For US-D1

5.1 UART Data Protocol Specifications

- Baud Rate: 115200 b/s
- Data bit: 8
- Parity bit: N
- Stop bit: 1
- Voltage Level: 3.3V

A single data packet consists of six(6) bytes. Table 2 defines the packet structure.

Table 2: UART Data Packet Definition

From	**US-D1 Altimeter**	**To**	**Receiver**
Byte	**Data**	**Note**	
1	0xFE	Packet Head	
2	0x02	Version ID	
3	0x**	Altitude (Least Significant 8 Bits)	
4	0x**	Altitude (Most Significant 8 Bits)	
5	0x**	SNR	
6	0x**	Checksum (see formula below)	

Notes:

- '*' refers to a variable bit containing dynamic data.
- Altitude: The altitude bytes can be combined (total 16 bits) to represent the altitude information in centimeters. The structure would be: 0x[MSB][LSB], where MSB and LSB are each two hexadecimal numbers (8 bits).
- Checksum: The Checksum Byte could be used in the following:
    - checksum = (Version_ID + Altitude_H + Altitude_L + SNR) & 0xFF
    - If checksum = 1, check passed
    - if checksum = 0, check failed

5.2 CAN Data Protocol Specifications

- Baud Rate: 1 Mb/s
- Frame ID: customized (Standard Frame, Extended Frame)
- Standard: CAN Protocol 2.0 section A and B, ISO 11898-1:2015,-4

A single data packet uses four bytes of either a Standard or Extended CAN frame. The type of CAN frame used and CAN ID of the device can be customized. The CAN frame is defined in table 3.

Table 3: CAN Frame Data Packet Definition

From	**US-D1 Altimeter**	**To**	**Receiver**
Byte	**Data**	**Note**	
StdID	0x***	Standard ID frame	
EtdID	0x********	Extended ID frame (Default 0x00090002)	
1	0x**	Altitude (Most Significant 8 Bits)	
2	0x**	Altitude (Least Significant 8 Bits)	
3	0x**	SNR(Most Significant 8 Bits)	
4	0x**	SNR(Least Significant 8 Bits)	
5	0x00	(Reserved)	
6	0x00	(Reserved)	
7	0x00	(Reserved)	
8	0x00	(Reserved)	

6. Mechanical Specifications

Figure 3: Dimensions of US-D1 (Units: mm)

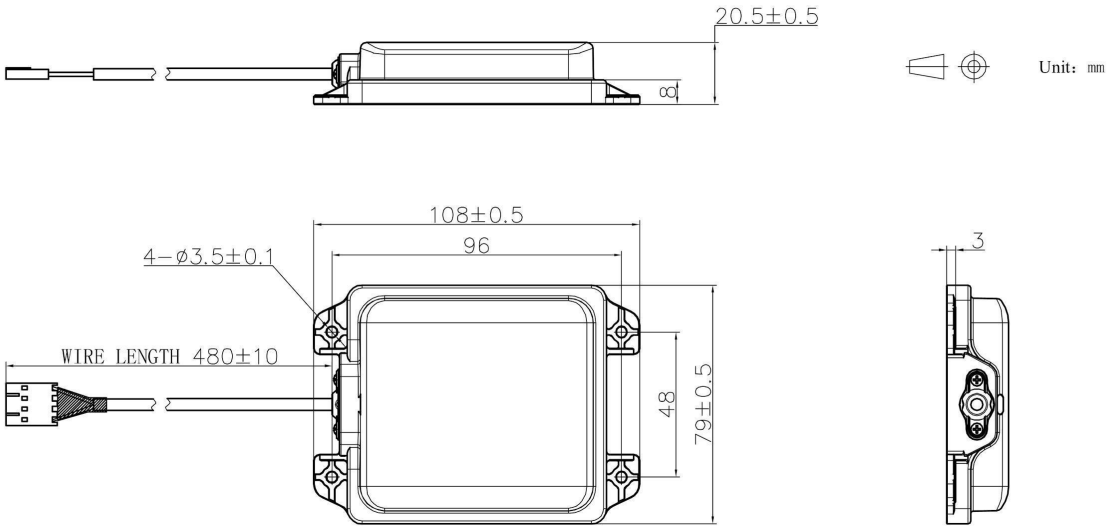
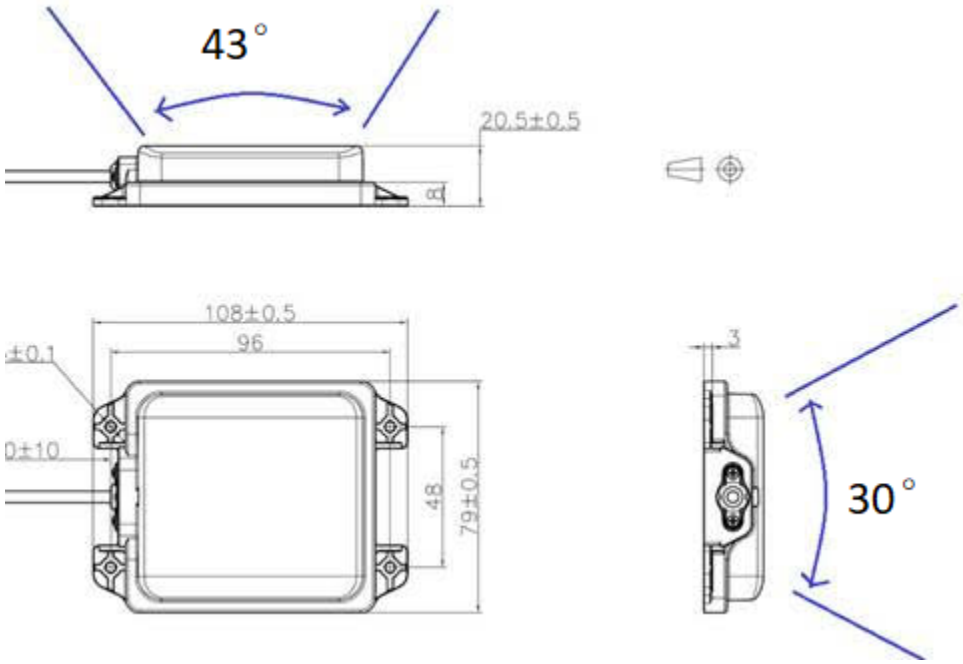


Figure 4: Field of View Orientation of US-D1



7. Radiated Emissions

The output field strength generated by the US-D1 is within the acceptable range set by the FCC and CE.

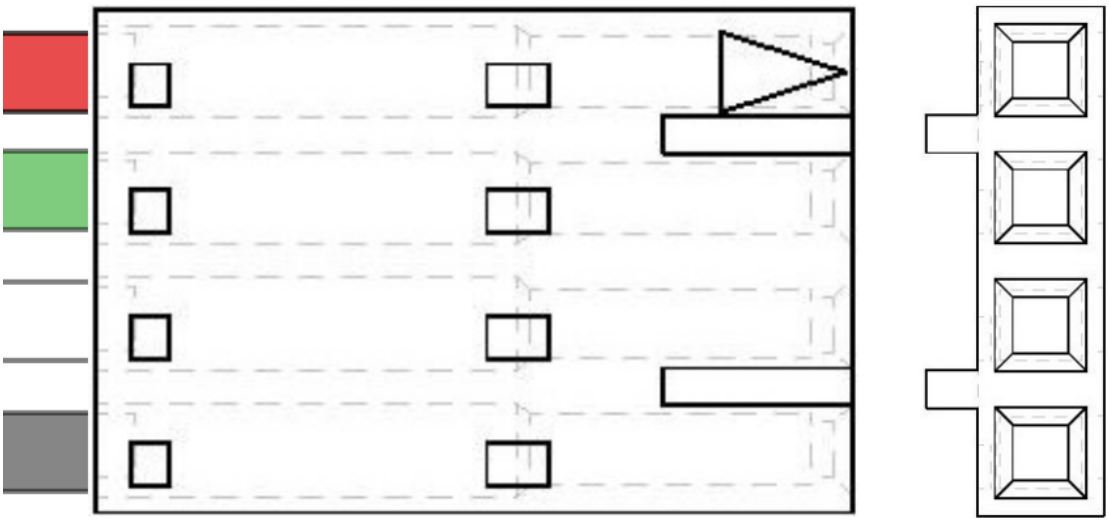
Maximum Transmit Power (EIRP)	25 dBm

8. Hardware Interface

Table 4: Data Packet Definition

Wire Color	UART	CAN
Black	Ground	Ground
White	RX [Radar] (Connect to Controller TX)	CAN_LOW
Green	TX [Radar] (Connect to Controller RX)	CAN_HI
Red	Voltage(5~13V)	Voltage(5~13V)

Figure 5: US-D1 Cabling Interface



9. Customizations

The US-D1 Radar Altimeter has several hardware and firmware customization options. All customizations can be requested by contacting Ainstein directly.

The following US-D1 hardware customizations can be requested prior to purchasing.

- US-D1 PCB (no enclosure)
- Interface Protocol (CAN, UART)
- Modified connector (JST, bare wire)
- Extended Cable (1 meter).
- BAUD Rate (38400, 57600, 115200, 250 Kbps, 500 Kbps, 1Mbps)

10. Firmware Update Kit

The US-D1 Firmware Update Kit is an external device that can update the firmware of the US-D1 radar altimeter. The Firmware Update Kit contains an update tool, a USB connector, and power cable. The Kit connects the US-D1 to the Firmware Update Tool via a USB port, which allows the user to load and flash new firmware versions onto the device. The Kit can be purchased directly from Ainstein.

The US-D1 Firmware Update Kit was designed to update the existing US-D1 firmware via the serial port on a PC. The update tool hardware is required to connect to all US-D1 units regardless of UART/CAN interface and baud rate to be recognized, configured, and flashed. Once the US-D1 unit is connected to the PC through the Auxiliary Board, the US-D1's information can be queried, including the hardware version, firmware version, interface type, and baud rate.

10.1 Hardware Connection and Software Installation

[Installation Overview]

NOTE: *This hardware connection guide is based on installation/collaboration with a Windows PC. If you are running this on any other OS, Linux, or MAC, please use the OS-specific method to make the necessary connections. Please contact support@ainstein.ai for help with Linux or MAC setup.*

a. Install 'CDM21228_Setup.exe' as <UART to USB> driver on Windows.
    i. **Note:** Depending on your OS, this step may not be required. If the Auxiliary Board is not recognized automatically, please perform this step.
b. Install 'Ainstein US-D1 Firmware Update Tool Installer.exe' on Windows. This can be downloaded from the US-D1 product page under the "Downloads" tab.
c. Connect the US-D1 firmware update board to the PC through a micro-USB cable. Using Windows Device Manager, select the "Ports" dropdown. When connected to the Auxiliary Board, there are a total of four sequential USB Serial Ports listed. Of these four ports, the **third** one is the port number of the Auxiliary Board.
    i. *The port numbers are different for each computer. In this case, it is port COM13. This might not be the case in all instances.*

In this instance, 'USB Serial Port (COM13)' is the port that is connected to the Auxiliary Board that we will use the software tool to connect to.

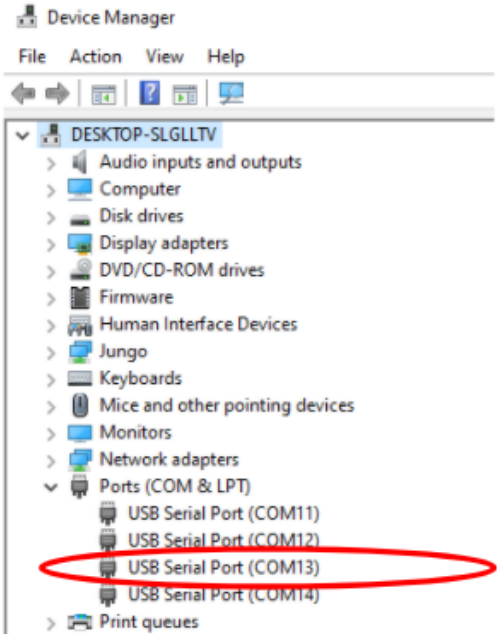


Figure 5: Windows Device Manager - USB Serial Ports

d. After establishing the power and USB connection as instructed above, launch the *'US-D1 Firmware Update Tool'* App.

10.2 Software --Firmware Binary Files

Caution! Before performing any firmware update, please consult the firmware installation guide to understand how to determine which generation your device is (1 or 2)! **Failure to upload the correct firmware file can cause damage to the US-D1 unit.**

Two hardware generations of the US-D1 exist. Generation 1 applies to all units purchased prior to December 1, 2020. If you are using a US-D1 that was purchased prior to December 1, you must flash your units with Generation 1 firmware. If you have a unit that was purchased after December 1, 2020, please flash your unit with Generation 2 firmware. The latest version of Generation 1 firmware is version 1.8.2, and the latest version for Generation 2 firmware is version 1.8.3. A table detailing the distinction can be found below.

Table 5: US-D1 Hardware Generation Changelog

US-D1 Generation 1 **Purchase Date Prior to Dec 1, 2020** **Firmware Changelog**				**US-D1 Generation 2** **Purchase Date After Dec 1, 2020** **Firmware Changelog**		
Firmware Version	Features	Firmware Release Date		Firmware Version	Features	Firmware Release Date
v1.0.6	Initial released version	3/24/2019		v1.5.3	Add support for new MCU model.*	11/20/2020
v1.3.1	Update data format	7/17/2019		v1.5.3N	1. Optimize FM bandwidth to comply with FCC certificate 2. Fix for minor offset bug.	3/13/2021
v1.4.0	Improve performance at low temperatures	12/20/2019		v1.8.3	Optimize boot sequence to fix an altitude hang issue	8/16/2021
v1.4.1	New customized data format for US customers	2/26/2020				
v1.4.2	Continued improvements to performance at low temperatures	3/15/2020				
v1.4.3	Optimize FM bandwidth to comply with FCC certificate	4/9/2020				
v1.43Y	Optimize calibration range coefficient to	7/10/2020				

	comply with FCC certificate					
v1.5.2	1. Optimize FM bandwidth to comply with FCC certificate 2. Fix for minor offset bug.	11/20/2020				
v1.5.2N	Fix for out-of-range aliasing	3/13/2021				
v1.8.2	Optimize boot sequence to fix an altitude hang issue	8/16/2021				

Table 6: US-D1 Firmware and Parameter Definitions

File Name	File Type	Description
USTD_StdUART.json	Data Format Configuration File	Data Format file for Standard UART protocol
MNKJ_StdCAN.json	Data Format Configuration File	Data Format file for Standard CAN protocol
US-D1_v143Y.bin	Firmware File	Original firmware of FCC version for Model Y MCU
US-D1_v152.bin	Firmware File	Revised firmware of FCC version for Model Y MCU
US-D1_v152N.bin	Firmware File	The latest firmware for Model Y MCU
US-D1_v153.bin	Firmware File	Revised firmware of FCC version for Model V MCU
US-D1_v153N.bin	Firmware File	The latest firmware for Model V MCU
US-D1_v182.bin	Firmware File	Fixed the issue of occasional reading stuck after booting for Model Y MCU
US-D1_v183.bin	Firmware File	Fixed the issue of occasional reading stuck after booting for Model V MCU

10.3 Software --Ainstein US-D1 Firmware Update Tool

The software tool titled 'Ainstein US-D1 Firmware Update Tool' is designed for updating firmware and configuring the parameters of the US-D1 via a PC.

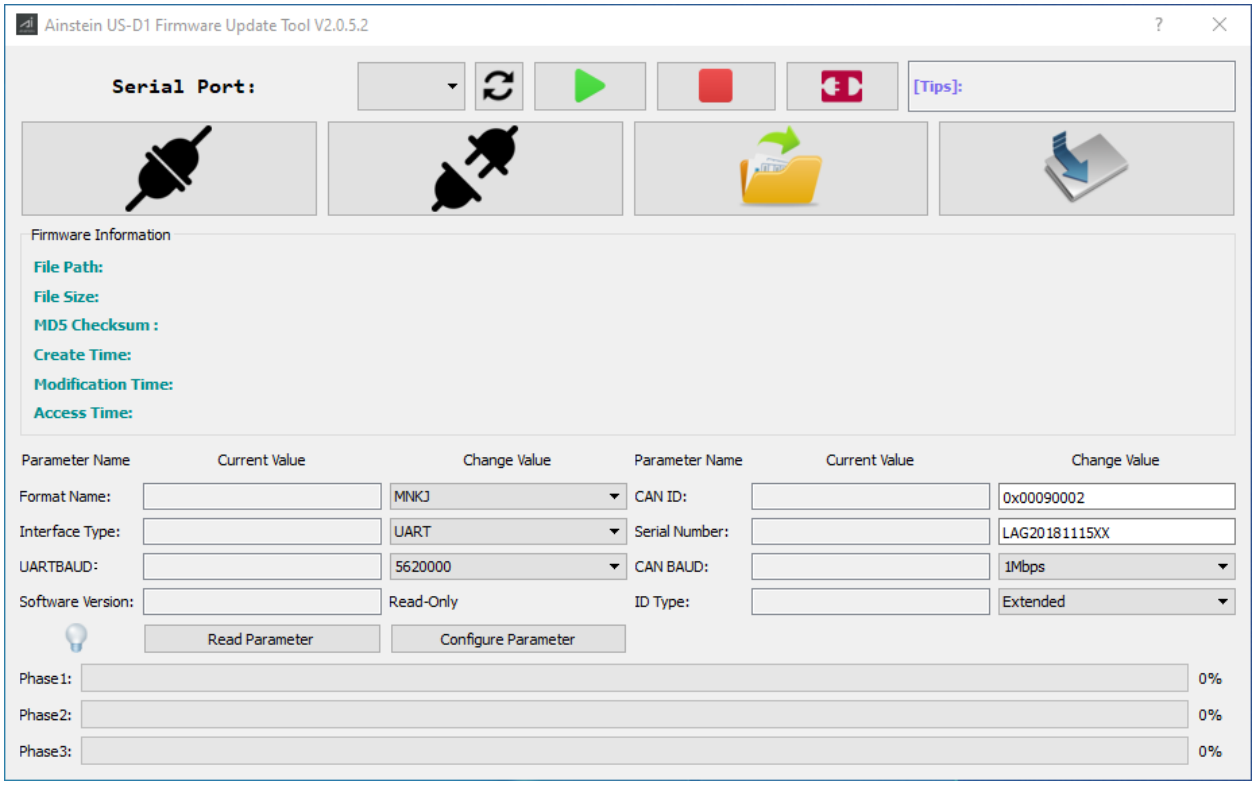


Figure 6: Main Window of the US-D1 Firmware Update Tool

Table 7: Software Tool Button Labels - First Row

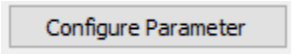
Serial Port selection (COM).	
Refresh the Serial port.	
Open the Serial Port.	
Close the Serial Port.	

Connect/Disconnect to the Auxiliary Board via the Serial Port.	

Table 8: Software Tool Button Labels - Second Row

Connect the US-D1 to the firmware update board.	
Disconnect the US-D1 from the firmware update board.	
Select the flash file (.bin) or configuration file (.json).	
Upload the flash file (.bin) from the PC to US-D1. This begins the firmware update process.	

Table 9: Software Tool Button Labels - US-D1 Parameter Selection

Read the current values of each parameter on the US-D1 device. Once clicked, the current values will display in the “Current Value” columns.	
Writes the selected parameters in the “Change Value” column onto the US-D1.	

Caution: Ensure that the values selected are compatible with the hardware version of the US-D1 device. If a UART US-D1 is selected, the format must be USTD and the interface must be UART. For a CAN US-D1, the format must be MNKJ and the interface must be CAN.

10.4 Firmware Update Procedure

Caution: Please confirm the hardware interface of the US-D1 unit, then follow the instructions accordingly. Some steps differ for UART and CAN units.

10.4.1 Connecting the Firmware Update Kit (Auxiliary Board)

1. Power on the firmware update kit and connect it to the host PC via a micro-USB cable.
2. Select the serial port (COM) that corresponds to the 3rd serial port in **Windows Device Manager** and click the "Open Port" icon (green play button) to connect to the serial port, then click the "Connect" icon to connect the firmware update kit.

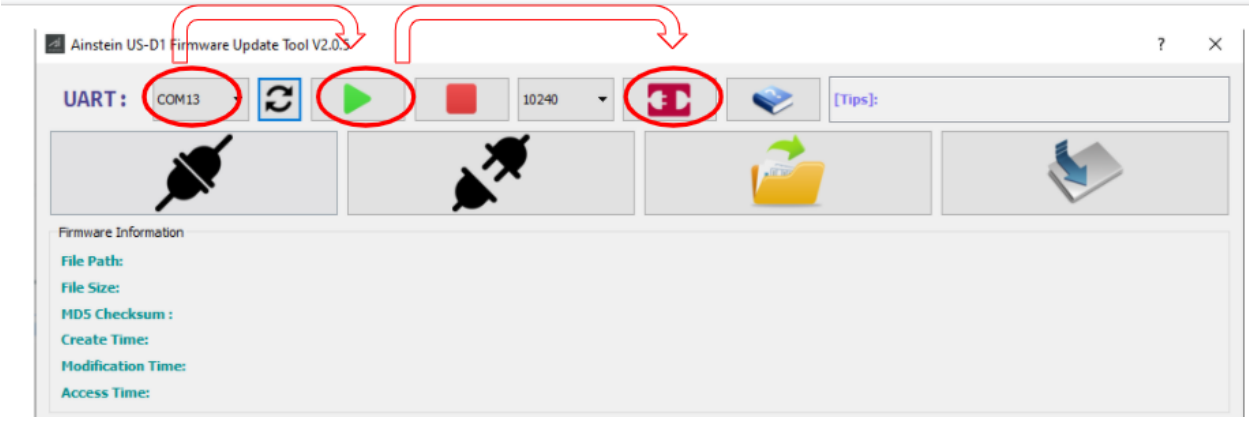


Figure 7: How to Connect the Auxiliary Board over the Serial Port

If the operation is performed successfully, the following pop-up window will be displayed.

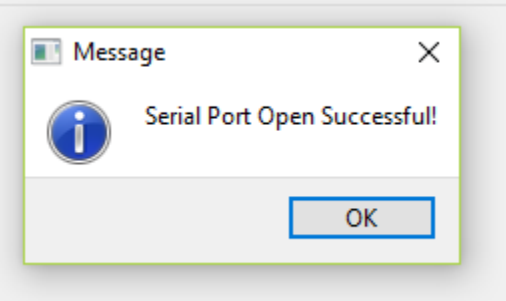


Figure 8: Serial Port Connection

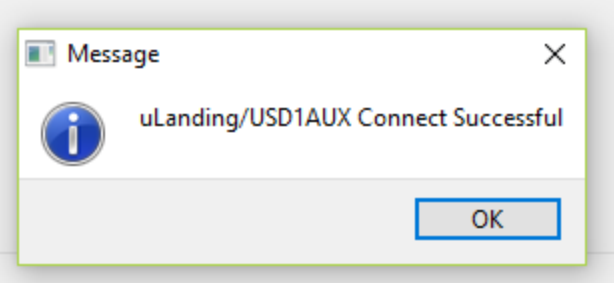


Figure 9: Firmware Update board Connection

After successfully connecting the firmware update board, the "Connect" button will turn green.

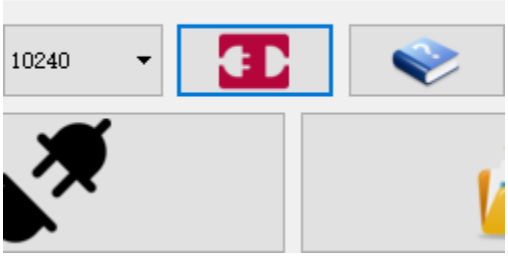


Figure 10: "Connect" Button Before Connection

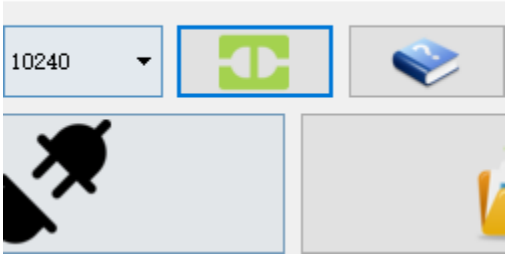


Figure 11: "Connect" Button After Connection

10.4.2 Connecting the US-D1

1. Plug the US-D1 into the firmware update board with the standard 4-Pin Molex connector, then press the circular, green power button to power on the US-D1 radar from the firmware update board.

Figure 12: US-D1 Firmware Update Board Connection

2. When the US-D1 hardware is connected to the programming tool port, press the "Connect Radar" button as shown in Figure 13 below.

Note: The "Connect Radar" button must be pressed within 6 seconds of pressing the green power button on the programming board, otherwise the US-D1 connection will fail. When the US-D1 is connected, the current displayed on the firmware update board should read ~170 mA. When the US-D1 is fully powered and cannot connect to the firmware update board, the current will be ~300 mA.

Figure 13: "Connect Radar" Button

If the connection is successful, the following window will pop up with a message showing the current US-D1 interface type and baud rate. Any other parameters will be displayed on the main window.

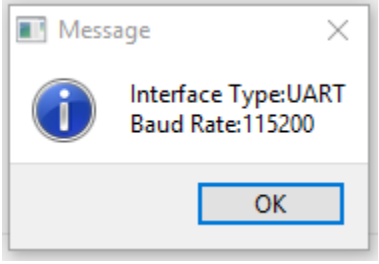


Figure 14: Current US-D1 Interface Type and Baud Rate

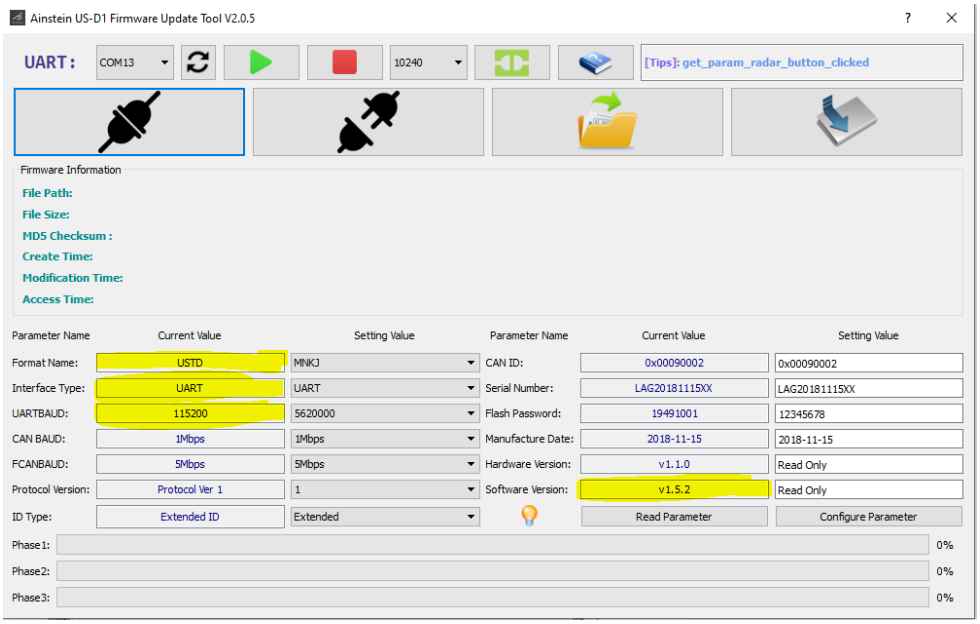


Figure 15: Current US-D1 Parameters

3. Check the Software Version.

Note: Two hardware generations of the US-D1 exist. Generation 1 units would have been purchased prior to December 1, 2020. If you are using a US-D1 that was purchased prior to December 1, you must flash your units with Generation 1 firmware. If you have a unit that was purchased after December 1, 2020, please flash your unit with Generation 2 firmware. The latest version of Generation 1 firmware is version 1.8.2, and the latest version for Generation 2 firmware is version 1.8.3. Therefore, follow the instructions below to update the US-D1 to the correct firmware version depending on the existing firmware version on the unit.

a. If the "Software Version Current Value" displays "V1.5.2" or earlier, please update to V1.8.2.
b. If the "Software Version Current Value" displays "V1.5.3" or later, please update to V1.8.3.

10.4.3 Configuring the US-D1 Parameters

1. Press the "Select File" button and choose a ".json" file.

Figure 16: "Select File" Button

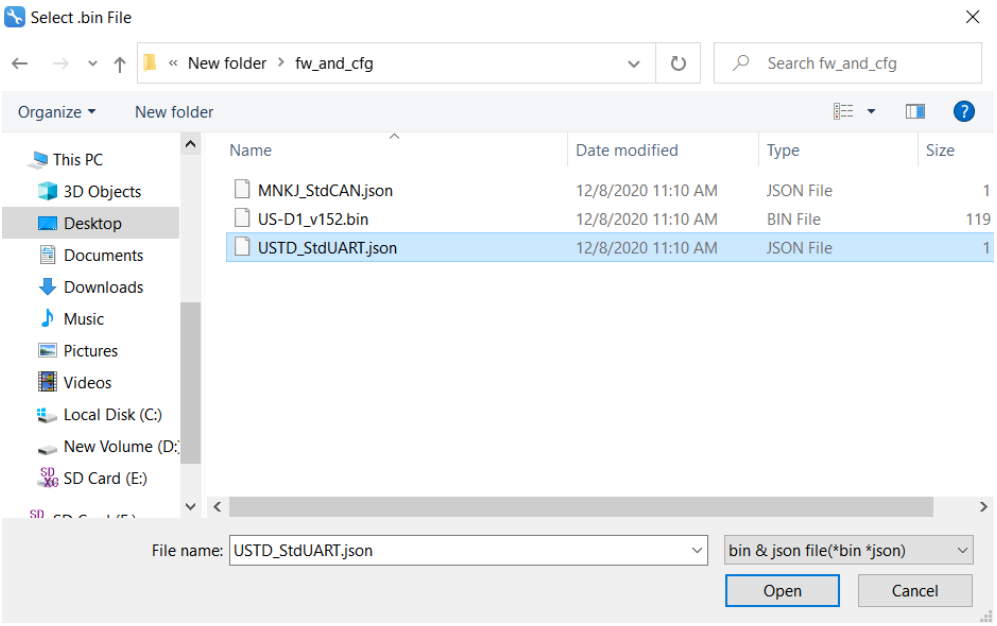


Figure 17: Selecting the ".json" File

2. Select the .json file and click "Open". The selected parameter values will be updated on the main window under the "Setting Value" column.

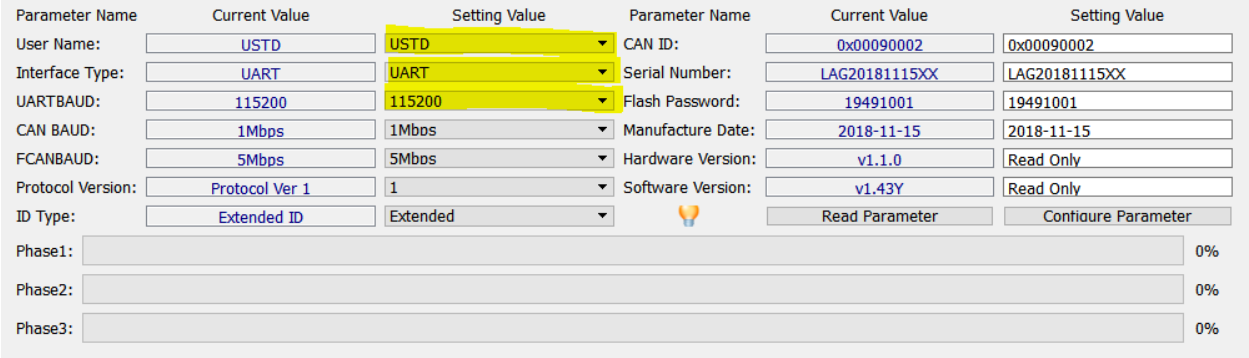


Figure 18: "Setting Value" Parameters

3. Confirm that the desired parameters are selected and displayed in the "Setting Value" column, particularly the Format Type, Interface Type, Baud Rate, and CAN ID.
4. Click the "Configure Parameter" button. If the operation is successful, the following message will be displayed. Select "OK".

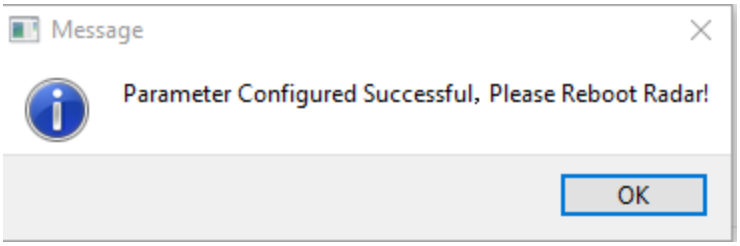


Figure 19: Successful Parameter Configuration Pop-Up Window

5. **For UART devices, proceed directly to updating the firmware if desired and do not power cycle US-D1. For CAN US-D1 units, the US-D1 must be power cycled to allow the parameter information to be written on the flash memory**. Perform the following steps for CAN US-D1 units only.
   a. Power off the US-D1 by pressing the green button on the firmware update kit.
   b. Power on the US-D1 by pressing the green button again, and DO NOT click the "Connect Radar" button. Let the US-D1 run without interaction for 10 seconds. Ensure that the radar is operating at a current of 300 mA for at least 10 seconds before proceeding to the next step.
   c. Power off the US-D1 by pressing the green button on the firmware update kit.
   d. Power on the US-D1 by pressing the green button and then connect the US-D1 to the software tool. The updated parameters can be read in the software tool upon connecting the device.
6. **Verify that the parameters and software version are correct after performing the parameter configuration.**

10.4.4 Updating the Firmware

1. Press the "Select File" button and choose a ".bin" file. The selected firmware information will be displayed in the main window.

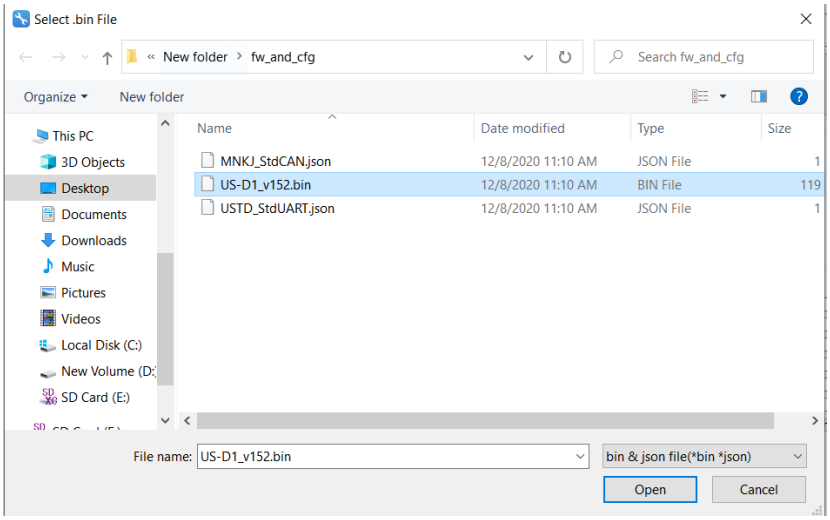


Figure 20: Select the ".bin" Firmware File

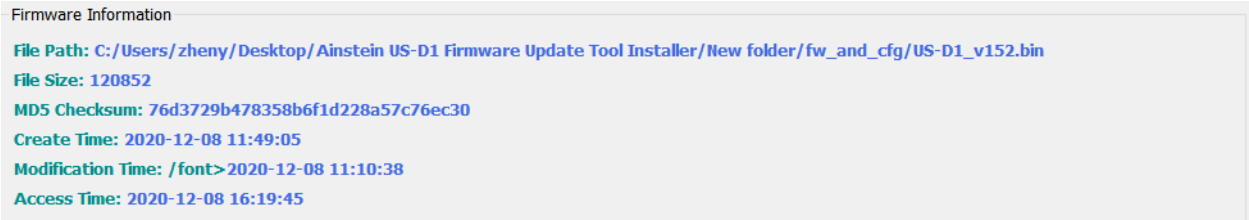


Figure 21: Firmware Information

2. Click the "Upload" button. The software tool will begin to update the US-D1 firmware. Once completed, a pop-up message will be displayed, indicating that the process was successful.

Figure 22: "Upload" Button

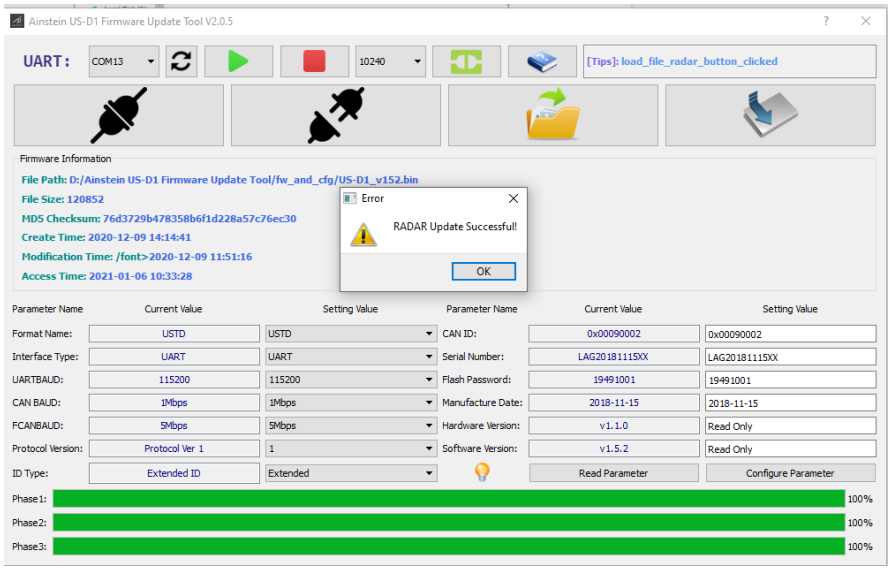


Figure 23: Successful Firmware Update Pop-Up Message

3. Power cycle the US-D1 by pressing the green button on the programming board twice. The current displayed on the programming board should decrease to 0 mA, and back up to 300 mA when the US-D1 is fully booted. Ensure that the radar is operating at a current of 300 mA for at least 5 seconds before proceeding to the next step.
   a. Alternatively, you can unplug the 4-pin connector and plug it back into the firmware update board.
4. Connect the US-D1 and verify that the parameters and software version are correct after power cycling the US-D1. If successful, the "Software Version""Parameter Name" will be updated.

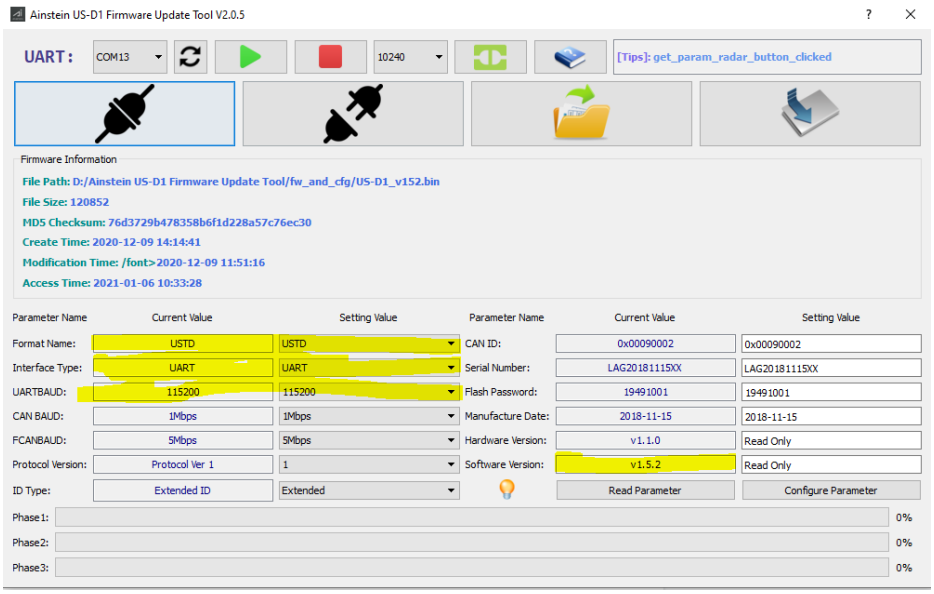


Figure 24: Updated Software Version and Parameters

10.4.5 Changing the CAN BAUD Rate

CAUTION: These instructions are for CAN US-D1 units. DO NOT Change the "Interface Type" to UART in any cases, as it may cause damage to the US-D1.

1. Connect the US-D1 through the software tool. Ensure that all the info in the "Current Value" and "Change Value" tabs are properly displayed.
   a. The current values for the software version and the CAN BAUD rate should be V1.83, 1Mbps, respectively.
2. Select the MNKJ_StdCAN.json file, click "Open", and then change the"CAN BAUD" value to 250 or 500 Kbps in the drop-down menu. After this, click the "Configure Parameter" button. **Caution**: DO NOT click the "Upload Firmware" button.
3. Upon seeing the pop-up window, wait for 2 seconds and then close by clicking "OK".

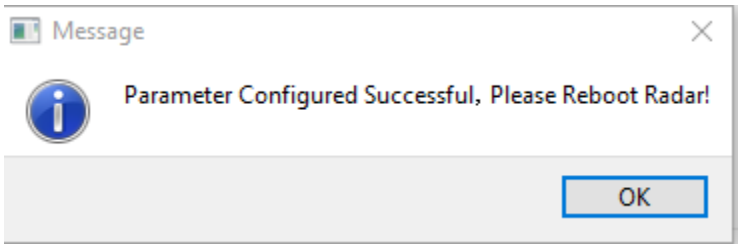


Figure 25: Successful Parameter Configuration

4. **Power cycle the US-D1 by hitting the green button. DO NOT click anything on the software tool during this step. Keep the radar on for at least 10 seconds. Make sure the current doesn't stay at 120 mA, but reaches 300+ mA. Then turn the radar off by hitting the green button.**
5. Turn the radar on by hitting the green button again and connect US-D1 to the software tool in the same way as in step 1. You should see the updated information displayed.
   a. "Current Value" for the CAN BAUD rate should display either "250 Kbps" or "500 Kbps", and the software version should remain the same.
   Note: If the 'Software Version' displays 1.0.4, repeat the process and leave the US-D1 powered on in step 4. for a longer time. If you see the pop-up display, "Connection Failed", repeat steps 4 and 5.

10.4.6 Changing the CAN ID

CAUTION: These instructions are for CAN US-D1 units. DO NOT Change the "Interface Type" to UART in any cases, as it may cause damage to the US-D1.

1. Connect the US-D1 through the software tool. Ensure that all the info in the "Current Value" and "Change Value" tabs are properly displayed.
   a. The current values for the software version and the CAN ID should be V1.83 and 0x00090002, respectively.
2. Select the MNKJ_StdCAN.json file, click "Open", and then change the"CAN ID" value to the desired value. After this, click the "Configure Parameter" button. **Caution**: DO NOT click the "Upload Firmware" button.
3. Upon seeing the pop-up window, wait for 2 seconds and then close by clicking "OK".
4. **Power cycle the US-D1 by hitting the green button. DO NOT click anything on the software tool during this step. Keep the radar on for at least 10 seconds. Make sure the current doesn't stay at 120 mA, but reaches 300+ mA. Then turn the radar off by hitting the green button.**
5. Turn the radar on by hitting the green button again and connect US-D1 to the software tool in the same way as in step 1. You should see the updated information displayed.
   a. "Current Value" for the CAN ID rate should display the updated CAN ID and the software version should remain the same.
   Note: If the 'Software Version' displays 1.0.4, repeat the process and leave the US-D1 powered on in step 4. for a longer time. If you see the pop-up display, "Connection Failed", repeat steps 4 and 5.

11. Application Notes

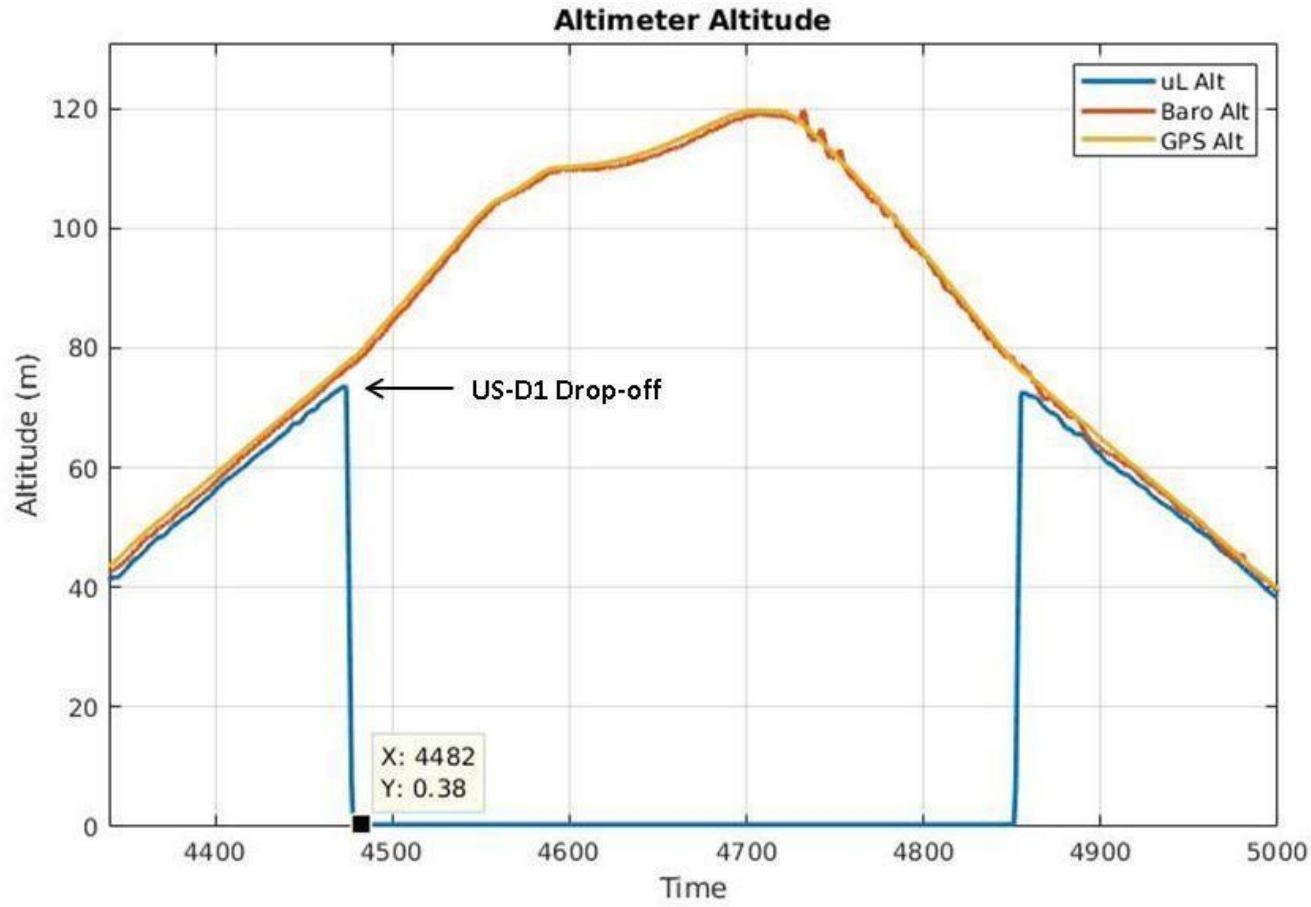
Table 5 lists the application notes that will be addressed in future revisions.

Table 10: US-D1 Application Notes

Issue ID	Description	Notes
1	If US-D1 is used outside of its Maximum Operational Altitude (Table 1), Inconsistent small readings of ~0.51m will be output, because 0.51m is the edge of the US-D1's blind zone. (See Figure 4 below).	• For full confidence, only consider US-D1's data when used within its operating range
2	Altitude data from US-D1 may have various step-size, since a post-processing algorithm is implemented after radar processing, e.g. averaging, filtering.	• No action needed
3	Altitude data from US-D1 may give unexpected or incorrect measurements under operation in an indoor environment. Multipath reflections of the sensor's radio waves are complicated in enclosed environments and may introduce errors in the radar's processing.	• DO NOT rely on US-D1 in an indoor, tightly enclosed environment
4	When the US-D1 is operated at altitudes of ~1m, there may be rare unstable readings potentially due to multipath reflections of reflective surroundings or inaccuracies due to nearness to the radar's blind zone.	
5	When transitioning from normal detection to out-of-range detection, the US-D1 will toggle between outputting correct measurements at the highest altitude of the operating range and reporting ~0.51m when out-of-range, instead of smoothly transitioning to out-of-range behavior.	
6	When the US-D1 is close to the blind zone (<1m) and a highly reflective object is placed in	

	between the US-D1 and the ground and then is removed, the US-D1 output may get stuck outputting erroneous values until another object enters the FOV.	
7	SNR may not be perfectly representative of the accuracy of the altitude measurement near the minimum operating range, because multipath reflections can have high SNR when operating close to the blind zone.	

Figure 26: US-D1 Altitude Drop-off Example



12. Hardware & Firmware Version

Table 11: US-D1 Current Hardware and Firmware Versions

Firmware	V1.8.2/V1.8.3
Bootloader	V1.0.7
Hardware	V2.1.0

13. Firmware Changelog

Table 12: US-D1 Generation 1 Firmware Changelog

Firmware Version	Change Reason	Date
v1.0.6	Initial released version	3/24/2019
v1.3.1	Update data format	7/17/2019
v1.4.0	Improve performance at low temperatures	12/20/2019
v1.4.1	New customized data format for US customers	2/26/2020
v1.4.2	Continued improvements to performance at low temperatures	3/15/2020
v1.4.3	Optimize FM bandwidth to comply with FCC certificate	4/9/2020
v1.43Y	Optimize calibration range coefficient to comply with FCC certificate	7/10/2020
v1.5.2	1. Optimize FM bandwidth to comply with FCC certificate 2. Fix for minor offset bug	11/20/2020

v1.5.2N	Fix for out of range aliasing	3/13/2021
v1.8.2	Optimize boot sequence to fix a altitude hang issue	8/16/2021

Table 13: US-D1 Generation 2 Firmware Changelog

Firmware Version	**Change Reason**	**Date**
v1.5.3	Add support for new MCU model*	11/20/2020
v1.5.3N	1. Optimize FM bandwidth to comply with FCC certificate 2. Fix for minor offset bug	3/13/2021
v1.8.3	Optimize boot sequence to fix a altitude hang issue	8/16/2021
	*v.1.5.3 is the 1st firmware release of the 2nd generation US-D1. The performance and functionality is equivalent to v1.5.2	

14. Contact Us

ADDRESS:
2029 Becker Drive,
Lawrence, KS 66047 USA

EMAIL:
hi@ainstein.ai

PHONE:
785-856-0460