2029 Becker Dr

Lawrence, KS 66047

User Manual

UAV Radar Altimeter US-D1

FCC Certificate Version

D00.02.01

6/24/2019

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

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IMPORTANT NOTICE

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.

NOTE:

- Only peripherals complying with FCC limits may be attached to this equipment. Operation with non-compliant peripherals or peripherals not recommended by Ainstein.
- Modification of this device may void the user's authority to operate the equipment
- Maintain 20cm of separation for the device during operation.

1. Technical Data

Table 1: Specifications

Starting Frequency	24 GHz
Bandwidth	0.25 GHz
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	UART: 82 Hz CAN : 86 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.
- Radar unit can be shipped with either CAN or UART for it's output data protocol.
- * Operational Temperature Range is based off of the hardware's subcomponent specifications. Actual operational testing is still pending.

2. Data Protocol For US-D1

2.1 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

2.2 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

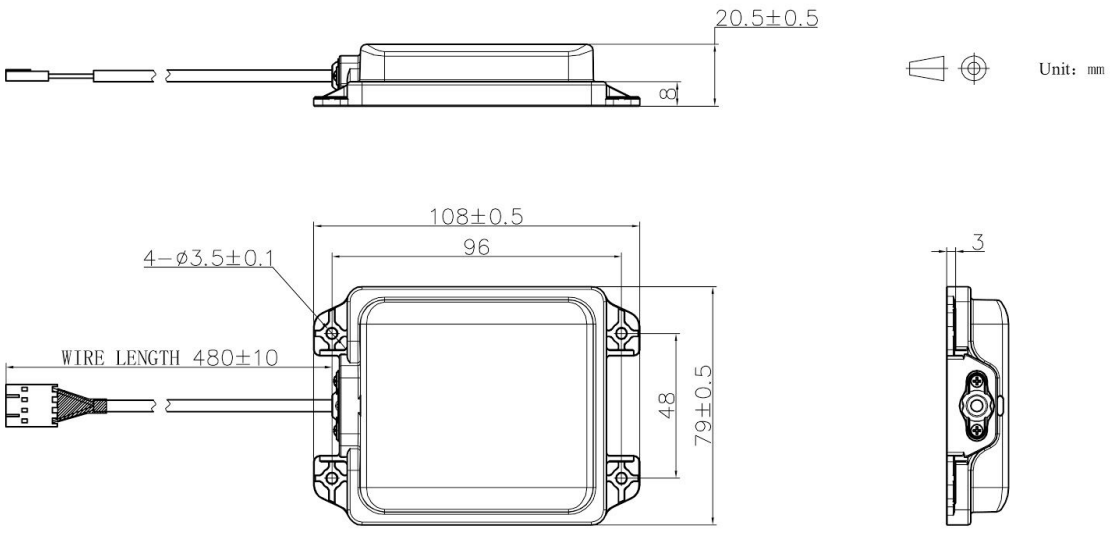
A single data packet uses four bytes of either, a Standard or Extended CAN frame. The type of CAN frame used and CAN ID of the device can be customized. The CAN frame is defined in table 3.

Table 3: CAN Frame Data Packet Definition

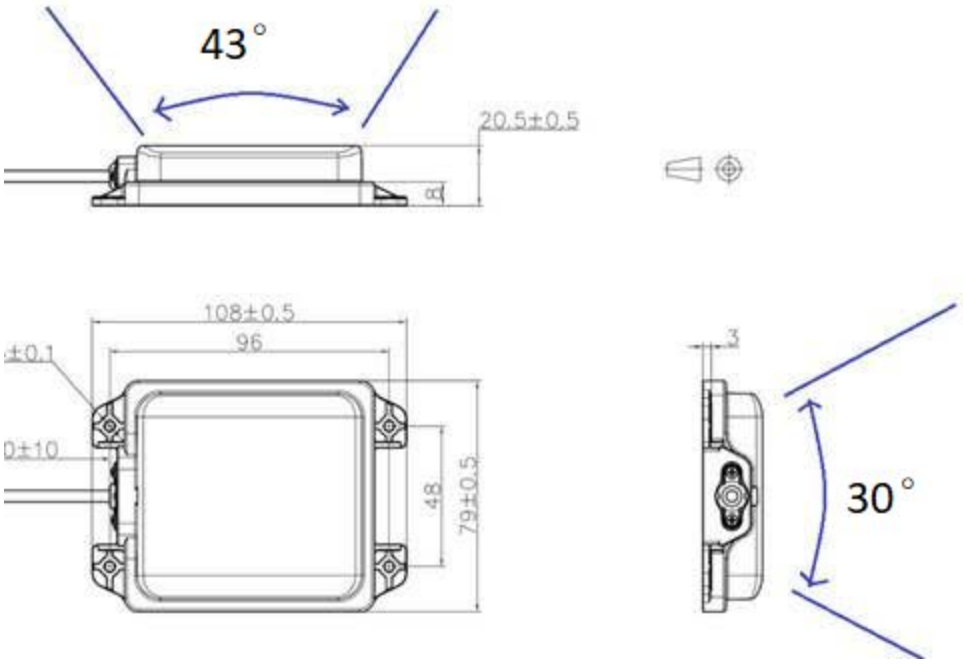
From	**US-D1 Altimeter**	**To**	**Receiver**
Byte	**Data**	**Note**	
StdID	0x***	Standard ID frame	
EtdID	0x********	Extended ID frame (Default 0x00090002)	
1	0x**	Altitude (Most Significant 8 Bits)	
2	0x**	Altitude (Least Significant 8 Bits)	
3	0x**	SNR(Most Significant 8 Bits)	
4	0x**	SNR(Least Significant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

3. Mechanical Drawing

Figure 1: Dimensions of US-D1 (Units: mm)



4. Field Of View Orientation

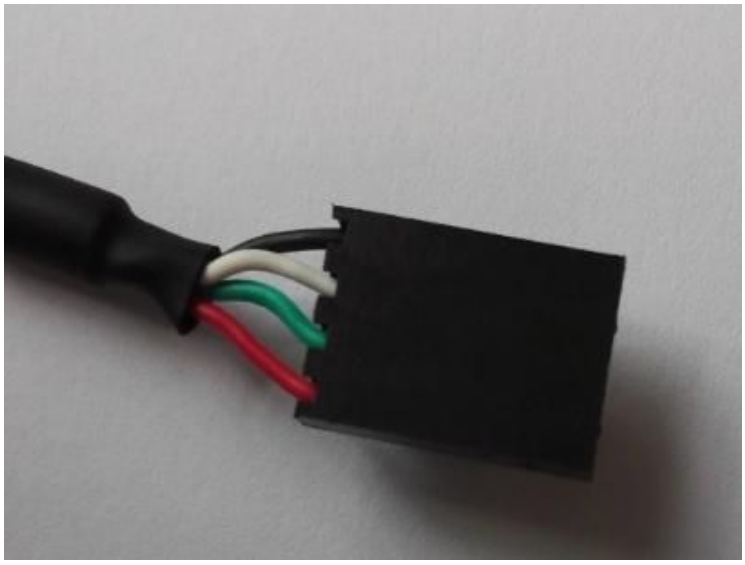


5. Hardware Interface

Table 4: Data Packet Definition

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

Figure 2: US-D1 Cabling Interface

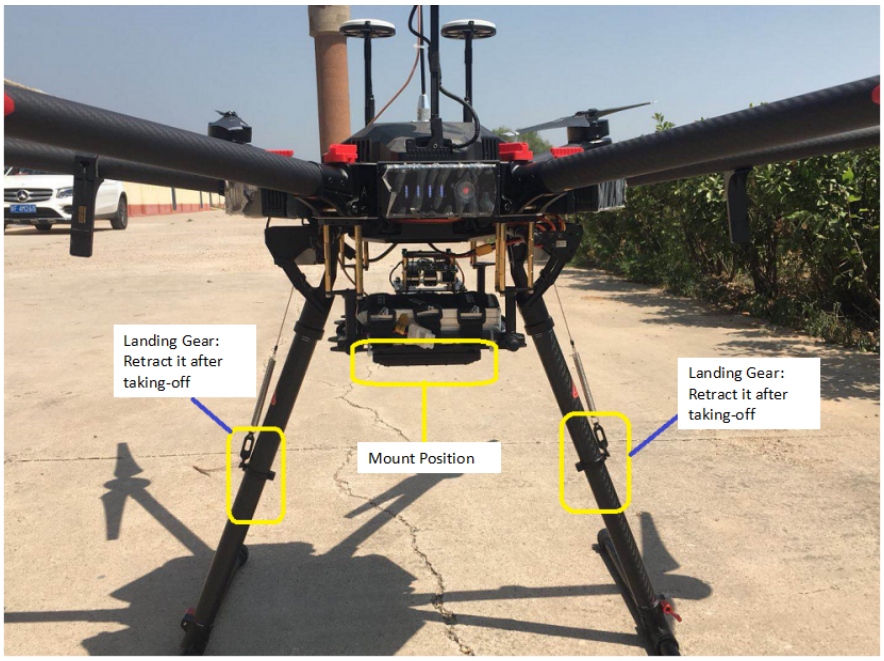


6. Installation Instructions

Mounting Requirements:

- Radar face should be perpendicular to the target that to be measured
- Keep radar face clean, and do not cover it.
- Keep any unexpected objects out of radar's FoV (Field of View), otherwise it might situate radar's signal
- No specific requirement for mounting orientation

Figure 3: Proper Mounting Example



Ensure altimeter will not be obstructed by mechanical landing gear!

7. Known Issues

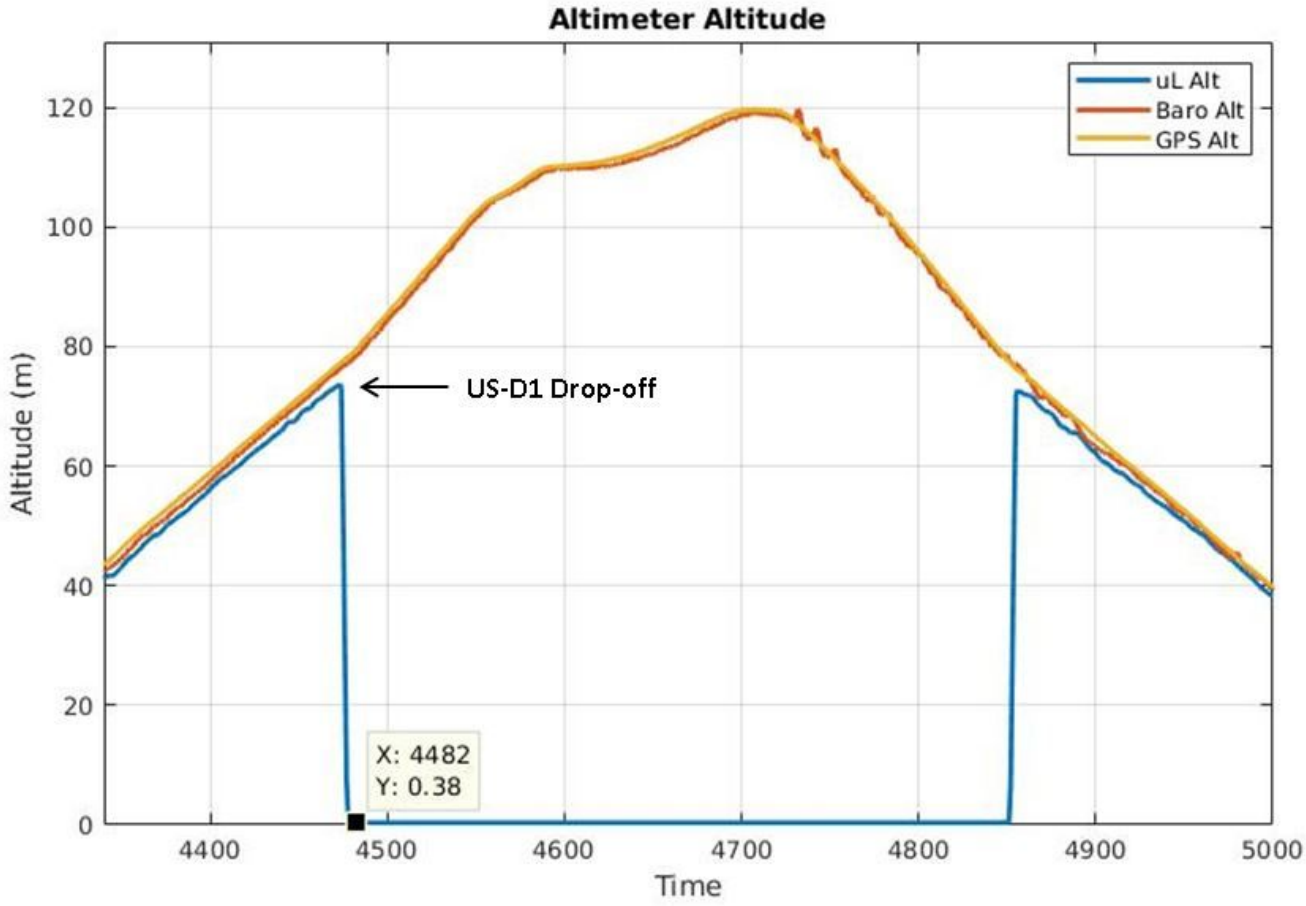
US-D1 is currently considered a 'B-Sample'. Table 5 lists the known issues that will be addressed in future revisions.

Table 5: US-D1 Known Issues

Issue ID	Description	Notes

1	If US-D1 is used outside of its Maximum Operational Altitude(Table 1). Inconsistent small readings will be output(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 some 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 therefore introduce errors in the radar's processing.	• DO NOT rely on US-D1 in an indoor, tightly enclosed environment

Figure 4: US-D1 Altitude Drop-off Example


Altimeter Altitude
uL Alt
Baro Alt
GPS Alt
US-D1 Drop-off
X: 4482
Y: 0.38
Altitude (m)
Time
0
20
40
60
80
100
120
4400
4500
4600
4700
4800
4900
5000

8. Contact Us

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