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Version control

Ver.	Date	Summary of changes
0.1	2020-11-09	Initial version
0.2	2021-09-19	Hardware Rev.2.0 images, web maintenance, oem variant
0.3	2021-05-31	Added JSON protocol, forced flight state and protocol configuration.
0.4	2021-07-08	Added radio diversity configuration
0.5	2021-07-13	Added Conformity Declarations
0.6	2021-07-26	Added Packing List
0.7	2021-08-31	Updated Conformity Declarations
0.8	2021-09-30	Amend Conformity Declaration

Scope and summary

This document explains how to get started with the Atom UAV (product code FLATMUAV)

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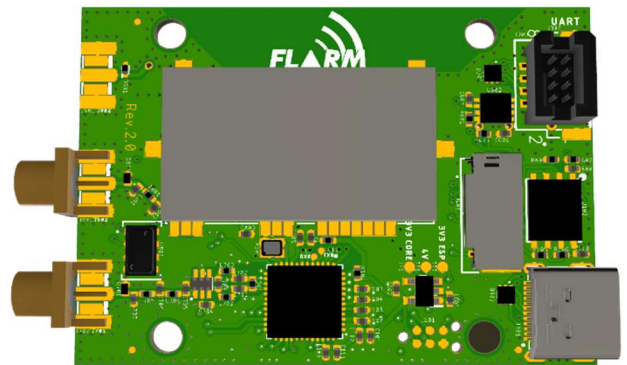
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1 Introduction

Atom UAV is a FLARM developed specifically for drones. Leveraging the Atom SoC platform, it is a miniature, feature-packed device that can be used standalone ("hook-on", retrofit) or integrated into own designs.

Highlights:

- Atom System-on-Chip platform
- Full, worldwide FLARM interoperability
- V2X communication payloads
- Cortex-M4F processing core
- Integrated Wi-Fi and Bluetooth module
- 72-channel u-blox GNSS engine
- Webapp for configuration and diagnostics
- 1090MHz receiver for ADS-B and rebroadcast (TIS-B/ADS-R)
- Sensor for pressure altitude
- Consolidated, unified traffic stream
- Direct broadcast remote ID, compliant with ASTM F3411-19, EC 2019/945, EC 2020/1058



Atom UAV is available in two variants:

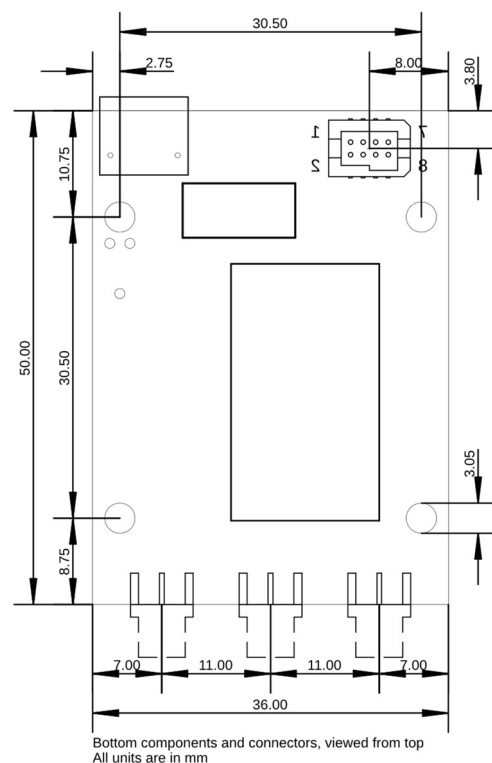
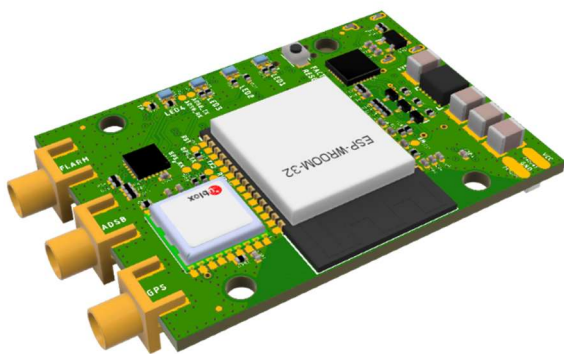
- For embedded use with a board to board data connector
- For standalone use in an enclosure with a JST data connector and an integrated Wi-Fi antenna

This documents describes the functionality of the device at the time of writing. As more features will be added and other functionality will be simplified, the description thereof will certainly change. Be sure to check for updates to this manual as new firmware is released.

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1.1.1 Specs

Dimensions:	57x36x10 mm (50x36x8 mm without connectors)
Mounting:	4xM3 holes, 30.5mm grid
Platform:	FLARM Atom System-on-Chip (SoC)
Navigation:	u-blox 8th generation multi-GNSS receiver
Storage:	32 MB NOR FLASH, microSD card slot
Connectors:	MCX or u.FL (FLARM radio) MCX or u.FL (ADS-B Receiver) MCX or u.FL (GNSS) u.FL (Wi-Fi, optional) USB-C (power, virtual serial) JST GH 6-pin or TFM 8-pin B2B (power, UART)
Protocols:	JSON, MAVLink, GDL90
UI:	4 status bicolour LED
Power supply:	5-28 VDC on JST GH 5 VDC on USB
Power consumption:	200 mW typical



1.1.2 Description

The Atom UAV is equipped with two microcontrollers and thus needs two firmwares to operate. The Atom SoC runs the FLARM radio protocol. The Espressif-based peripheral processor runs FLARM Hub and provides connectivity via WiFi, USB and the JST/TFM connector.

1.1.3 RF Connectors

There are three MCX connectors, documented as GNSS, ADSB and FLARM on the PCB, next to the connectors. The Flarm RF antenna must be pointed vertically (perpendicular to sea level) in the final installation.

1.1.4 Factory Reset

A factory reset can be triggered by holding the button pressed while powering up the device (hold for at least 1s). This will restore all settings to factory default.

1.1.5 USB Connector

The board comprises an CP2102 chip for converting serial data to USB. The Virtual COM Port (VCP) drivers¹ need to be installed on the host computer to use this feature. In Windows, use the 'Device Manager'² to see what COM-port is used.

The unit may be powered through the USB connector. Due to vibration, this is however not recommended in flight in any type of aircraft.

1.1.6 JST GH

The GH connector from JST³ is used on the Atom UAV standalone variant over the DF-13 for its improved mechanical properties and ease of handling. It exposes a 3.3 V UART and may be used to supply power. The pinout is identical to what is used in Pixhawk-based flight controllers:

1.1.7 JST-GH Pinout

Pin	Function	Function Alt
1	Vin 5–28 V	
2	TXD UART (Out)	
3	RXD UART (In)	
4	CANbus TX (Out)	GPIO
5	CANbus RX (In)	GPIO
6	GND	

1.1.8 TFM Connector

The TFM-104-02 is a board-to-board connector used on the OEM variant instead of the JST connector.

1.1.9 TFM-104-02-L-D Pinout

Pin	Function	Function Alt
1	Vin 5–28 V	
2	TXD UART (Out)	
3	DO NOT CONNECT	External ADS-B TXD (Out)
4	RXD UART (In)	
5	DO NOT CONNECT	External ADS-B RXD (In)
6	CANbus TX (Out)	GPIO

¹ Download from: <https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers>

² In Windows, press the "Windows" key and X together, then M

³ <https://jst.de/product-family/show/89/gh>

7	GND	
8	CANbus RX (In)	GPIO



When connecting to a Pixhawk or similar flight controller, the RX and TX lines must be crossed, i.e. TX of the flight controller must be connected to RX of the Atom UAV, etc.



The JST GH receptacle is surface-mounted to the board, thus the mechanical stability is limited. When pushing in the connector, secure the receptacle firmly, e.g. by putting a thumb on it. Do not put force on the solder connections!

1.1.10 Status LEDs

The LEDs are numbered from LED1 to LED4 on the PCB.

- LED1: GNSS reception
- LED2: Flarm transmitting
- LED3: Flarm receiving
- LED4: Power

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2 Interfaces

The Atom UAV can provide traffic information on both the USB connector and JST/TFM connector and provides different protocols.

Please note that currently the external GNSS source is activated by enabling the EXG license. In order to use the internal GNSS source, the EXG license needs to be disabled. A description on how this is done is provided in Sections 3.3 and 3.4 of this document. In future releases, this will be simplified.

2.1 MAVLink Interface

MAVLink⁴ is a protocol used by many popular flight control systems for drones, e.g. PX4, ArduPilot and more. MAVLink connectivity is available on the JST GH UART connector only, if enabled in the HUB firmware. The messages HEARTBEAT and ADSB_VEHICLE are published to output traffic information. Baud rate is set to 115200 (8N1).

The system ID (sysid) is adapted from the MAVLink master (usually the autopilot). The compid is fixed to MAV_COMP_ID_FLARM (160).

2.1.1 Integration with PX4

Wire up the JST/TFM MAVLink connector to the TELEM2 port on the pixhawk (RX and TX lines need to be crossed).

Configure the following parameters with a Ground control software (Tested with QGroundControl):

- MAV_1_CONFIG: TELEM 2
- MAV_1_FORWARD: 1
- MAV_1_MODE: OSD
- SER_TEL2_BAUD: 115200 8N1

Atom UAV will consume HEARTBEAT messages. The MAV mode "MAV_1_MODE: OSD" also provides SYSTEM_TIME and GPS_RAW_INT messages, needed for 2.1.2, while sending minimal other messages.

Atom UAV will emit ADSB_VEHICLE messages for each received target from either FLARM or ADS-B.

The interface functionality has been verified on PX4 v1.11.1.

⁴ <https://mavlink.io/en/>

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With "MAV_1_FORWARD: 1", Atom UAVs Heartbeat will be forwarded to the Ground Control Station and can be seen in its MAVlink Inspector with the component id 160.

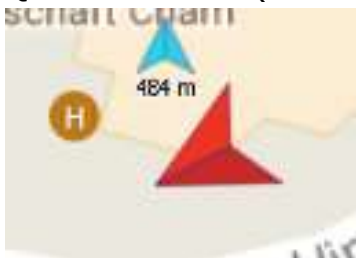
2.1.2 Using Navigation Solution from PX4

Instead of using the integrated GNSS module for positioning, Atom UAV can use the navigation solution from PX4. This requires installing an EXG license on Atom (see Sections 3.2 and 3.4). If EXG is installed, Atom uses the Navigation solution from Mavlink instead of that from the own GNSS module. For this, it consumes the GPS_RAW_INT and SYSTEM_TIME messages and issues the TIMESYNC message for time synchronization. Because the Flarm RF protocol is very time-sensitive, the provided mavlink time needs to be accurate. To reduce jitter, a Mavlink mode like OSD that emits SYSTEM_TIME and GPS_RAW_INT, but as few as possible other messages should be used. A static time offset will be configurable to compensate for systematic latency. The methodology will be described in detail once available.

2.1.3 Compatible GCS Software

GCS software which supports display of ADSB_VEHICLE packets:

- QGroundControl (verified on v4.1.1)



Other GCS may offer support, too.

2.2 JSON

A JSON message stream providing a user friendly to interface with Atom UAV is available on the JST port. A detailed interface description can be found in document FTD-092.

The protocol sends out unsolicited heartbeat and traffic information. Furthermore, currently a simple JSON command is used to encapsulate NMEA configuration sentences to enforce the flight state.

2.2.1 Examples of unsolicited JSON messages

```
{"heartbeat":{"protocol":{"version":1},"system":{"id":"FLAFUS10W-000051"}}}\r\n
```

```
{"navigation":{"pos":{"lat":47.18686,"lon":8.477258,"alt":482,"baro":352},"mov":{"speed":0.01,"gnd":true},"time":1622118506}}\r\n
```

```
{"traffic":{"id":{"flarm":14622722},"src":{"flarm":{}},"type":1,"pos":{"lat":47.1868486,"lon":8.4772844,"alt":488},"mov":{"gnd":true,"climb":-0.1},"time":1622118506}}\r\n
```

```
{"traffic":{"id":{"flarm":14622761},"src":{"flarm":{}},"type":1,"pos":{"lat":47.1867496,"lon":8.4766621,"alt":497},"mov":{"gnd":true,"climb":-0.1},"time":1622118506}}\r\n
```

2.2.2 Forced flight state

The flight state is automatically determined from the horizontal and vertical speed. When the speed is too low to be considered flying, for example in stationary flight, it is possible to issue a command on the JST port to force the flight state.

The syntax is as following:

```
{"bridge":{"flarm":"$pflac,s,ffs,<forced_flight_state>"}}\r\n
```

<forced_flight_state> can take the following values:

Value	Meaning
0	Invalidate any force flight state, resume normal operation.
1	Forces the device to be on the ground. Expires after 20 seconds.
2	Forces the device to be in flight. Expires after 20 seconds.

A forced flight state expires after 20 seconds, so it must be repeatedly applied to maintain it.

An answer to the command is inserted into the JSON message stream. The syntax is as following:

```
{"bridge":{"flarm":"$PFLAC,A,FFS,<forced_flight_state>*XY"}}\r\n
```

More details can be found in FTD-014.

The configuration method is described in the next section.

Please note that the syntax of the command is likely to change in the future and should be considered as an experimental feature.

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3 Maintenance via Web Interface

Most configuration can be done via the HUB web interface. First connect to the Wifi Hotspot with the name like FLATMUAVW-xxxxxx (.e. FLATMUAVW-000042 when the serial number is 42) and the given password. The default password is "password". Please make sure to change when configuring the device.

On the OEM variant with a U.FL connector instead of an PCB antenna, a WiFi antenna needs to be connected. If not, the range might be insufficient for proper operation of the Web Interface.

Open the address <http://10.10.10.10> in a browser of the device that is connected to the Hotspot. The Web Interface should now load. On the Status page, the connectivity, system information and GNSS fix are shown.

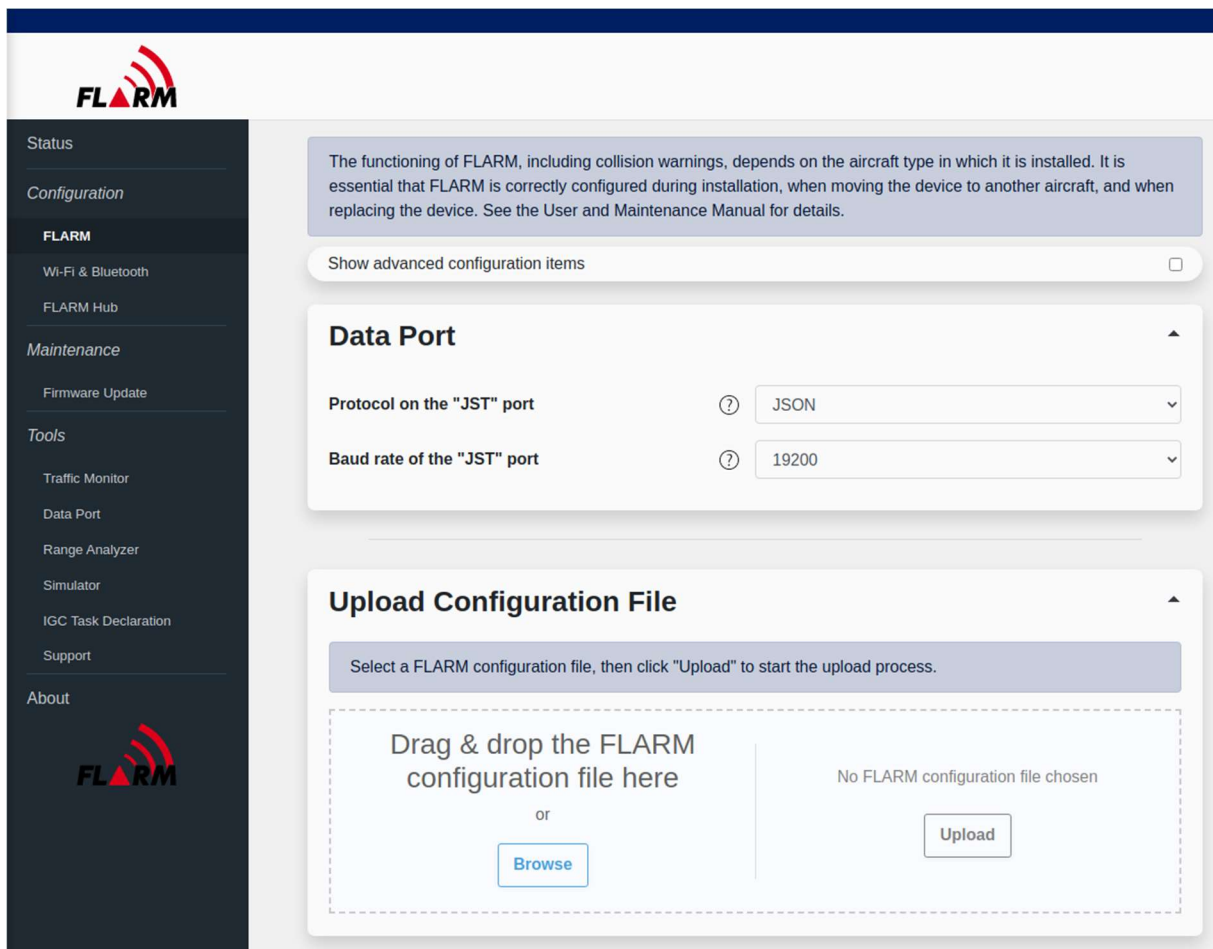
3.1 Updating the Firmware

On the navigation bar of the page, go to "Maintenance", "Firmware Update". To update the Atom with a new PowerFLARM Firmware, a .fw file is needed. To update FLARM HUB, a .bin file is needed.

3.2 Port Configuration

The protocol and baudrate on the JST port can be configured on the Web Interface in "Configuration", "FLARM", "Data Port".

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The screenshot shows the FLARM web interface. On the left is a dark sidebar with a navigation menu. The main content area is white with a light blue header. The 'Data Port' section is expanded, showing configuration options for the 'JST' port. Below it is the 'Upload Configuration File' section with a drag-and-drop area and an 'Upload' button.

FLARM TECHNOLOGY

FLARM

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The functioning of FLARM, including collision warnings, depends on the aircraft type in which it is installed. It is essential that FLARM is correctly configured during installation, when moving the device to another aircraft, and when replacing the device. See the User and Maintenance Manual for details.

Show advanced configuration items ☐

Data Port

Protocol on the "JST" port

Baud rate of the "JST" port

Upload Configuration File

Select a FLARM configuration file, then click "Upload" to start the upload process.

Drag & drop the FLARM configuration file here

or


No FLARM configuration file chosen

Please note that currently, the default on both output ports is the MAVlink protocol.

3.3 Enable/ Disable EXG Licence

The selection of either an external or internal GNSS source is done through the EXG license. If the EXG license is enabled, it forces the device to use an external source provided through MAVlink. Otherwise the internal GNSS receiver is used. An active GNSS antenna needs to be connected to the device for proper operation of the device.

If the device has the EXG licence installed, it can be enabled and disabled by renaming the licence file on Atom. To do this, go to "Tools", "Data Port" on the navigation bar of the page and click "Connect". If there is a continuous output in the text field, disable it by typing "\$pflac,s,nmeaout,0" in the input text field below and clicking "Send". The text output can be re-enabled by typing "\$pflac,s,nmeaout,91" and clicking "Send".



Data Port

FLARM Data Port

Disconnect
Clear
Save

flight13.log	01.01.1970	00:00:06	1753 bytes (6)
lic-EXG.bin	18.03.2021	17:08:22	168 bytes (7)
flight17.log	16.03.2021	17:21:20	29311 bytes (8)
flight19.log	01.01.1970	00:00:06	9086 bytes (9)
flight22.log	18.03.2021	18:08:45	34456 bytes (10)
flight20.log	18.03.2021	16:58:09	17108 bytes (11)
flight21.log	18.03.2021	17:22:55	49616 bytes (12)
flight24.log	01.01.1970	00:00:06	12522 bytes (13)
flight23.log	01.01.1970	00:00:06	3729 bytes (14)
curr25.log	19.03.2021	12:27:53	20049 bytes (15)
range.bin	18.03.2021	18:17:55	344 bytes (17)

Total 17 Files, Total 31984512 bytes Free 31436832 bytes

Send

The license is disabled by sending "\$file,mv,lic-EXG.bin,lic-EXG.tmp". It can be enabled again by sending "\$file,mv,lic-EXG.tmp,lic-EXG.bin". In the output field, a response should be listed. The files can be listed with "\$file,ls", but not all files may be shown if there are too many.

3.4 Installing the EXG Licence

To install the EXG licence, if not already, the windows command line has to be used while connected to the Wifi Hotspot.

If the licence is in the user home directory with the name "EXG.lic", type the following in the command line:

```
curl -X PUT --data-binary "@EXG.lic" http://10.10.10.10/api/flarm/lics
```

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3.5 Radio diversity

Atom UAV can only be connected to one antenna. However, multiple antennas might sometimes be required to ensure sufficient radio coverage. With Atom UAV, it is possible to use two devices to provide this radio diversity. Both devices will emit the same ID (and thus be seen as one aircraft by other receivers) and ignore each other.

When using multiple devices, one will be the primary radio and the other one the secondary radio. The secondary radio, once configured, will emit the ID of the primary device.


This can be configured on the Web Interface under "Configuration", "FLARM", "Radio Diversity".

To use the device standalone, that is not as part of a primary/secondary setup, choose the "No diversity" option. This is the default.

Both the primary and secondary device need to be configured. The primary device is to be configured as "Primary". This is important, otherwise the secondary device will NOT be ignored, which will lead the primary device to switch its ID to avoid duplicate IDs, resulting in multiple targets for other aircraft.

The secondary device need to be configured as "Secondary" and to have the reference to the primary device set, to allow emitting the correct ID. This reference is the serial number of the primary device, as can be found on the sticker on the device or in the Web Interface, on the "Status" page, under "System", "Device ID". Make sure not to use the "Radio ID". For instance, for the device "FLATMUAWW-000042", the serial number to use is "000042" or simply "42".

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FLARM


Status	●
GPS	●
Transmit	●
Receive	●
Air/Ground Mode	On Ground
Flight Recorder	OFF
Errors	No error

System

Firmware Version	7.04
Expiration Date	2023-02-01
FLARM Hub Version	1.20
Device ID	FLATMUAWW-000042
Radio ID	18002A (FLARM)
Aircraft Type	Unmanned Aerial Vehicle (UAV/drone)
IGC Serial	424
Features	---

How to find the serial number of the primary device

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The functioning of FLARM, including collision warnings, depends on the aircraft type in which it is installed. It is essential that FLARM is correctly configured during installation, when moving the device to another aircraft, and when replacing the device. See the User and Maintenance Manual for details.

Show advanced configuration items ☐

Data Port

Protocol on the "JST" port ? Mavlink ▼

Baud rate of the "JST" port ? 115200 ▼

Radio diversity

Radio diversity role ? Secondary ▼

Radio diversity reference ? 000042

Setting the radio diversity role, here of the secondary device

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4 Packing List

There are two variants available for Atom UAV: standalone and OEM. The standalone variant is complete with a plastic enclosure, and comes with all the antennas and cables required to use the product right away. The OEM variant is only shipped with a fully tested and certified board that can be integrated in a more complex system.

The Atom UAV standalone is shipped with the following items:

- Atom UAV device
- 2x FLARM/ADSB antenna
- 1x GNSS antenna
- 1x JST cable ready to use in MAVlink-based system
- 1x USB-C cable

The Atom UAV OEM is shipped with the board module. The following components are recommended for system integration:

- FLARM/ADSB antenna: JIAXING BEYONDOOR ELECTRONICS CO.,LTD BY-868-915-PCB(62X15) with MCX connector (2x)
- GNSS antenna: u-blox ANN-MS with MCX connector
- WiFi antenna: Inventek W24P-U with U.FL connector
- JST cable: any JST-GH 6 crossover cable (with RX/TX pin 2/3 crossed) is suitable

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5 Current Limitations

- A simple configuration method of the GNSS source not available yet. Use the EXG licence instead to switch between internal and Mavlink GNSS source.
- With MAVlink GNSS source selected, no ADSB_VEHICLE messages are generated for received targets. They are shown however on the Traffic Monitor page in the Web Interface. With internal GNSS source, all received traffic output is generated as ADSB_VEHICLE message.
- With MAVlink GNSS source selected, internal communication of GNSS might not be in sync or the GNSS time might not be accurate enough. This can cause the receive and transmit LEDs turning off intermittently.
- The time offset of the Mavlink GNSS source due to communication latencies can not be measured and configured yet. This may result in package loss in the FLARM radio.
- Configuration of baudrates and inflight speed threshold not possible in Web Interface.
- Mavlink connection and time synchronization state not shown in Web Interface.

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6 Conformity Declarations

6.1 FCC Compliance Statement

Contains FCC ID: 2AC7Z-ESP32WROOM32E

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.

CAUTION: The manufacturer is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

RF exposure statement

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Professional Installation Statement

This equipment is intended for professional installation only.

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6.2 ISED Compliance Statement

Contains IC: 21098-ESPWROOM32E

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada license-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) L'appareil ne doit pas produire de brouillage;
- (2) L'appareil doit accepter tout brouillage radio électrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RF exposure statement

This equipment meets the exemption from the routine evaluation limits in section 2.5 of RSS-102. It should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Cet équipement est conforme à l'exemption des limites d'évaluation habituelle de la section 2.5 de la norme RSS-102. Il doit être installé et utilisé à une distance minimale de 20 cm entre le radiateur et toute partie de votre corps.

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6.3 Supplier's Declaration of Conformity

47 CFR § 2.1077 Compliance Information

Product Name: Atom UAV standalone, OEM

Product Model: FLATMUAVW, FLATMUAOW

Manufacturer:

Flarm Technology AG
Hinterbergstrasse 15
6330 Cham, Zug, Switzerland
info@flarm.com
www.flarm.com

Modular Components Used:

NAME: Wi-Fi & Bluetooth Internet of Things Module

MODEL: ESP32-WROOM-32E

FCC ID: 2AC7Z-ESP32WROOM32E

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.