



FLARM Technology Ltd  
Hinterbergstrasse 15  
CH-6330 Cham

# POWERFLARM FUSION USER AND MAINTENANCE MANUAL

Date: 2021-05-10

Version: 1.3

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**FTD-078**



# FUSION

## PowerFLARM

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## Version Control

Ver.	Date	Summary of changes
<b>1.0</b>	2020-11-10	Initial version
<b>1.1</b>	2020-11-27	Moved Conformity Declarations to Installation Manual
<b>1.2</b>	2021-01-21	Added Binary Communication LED indication
<b>1.3</b>	2021-05-10	Added Oudie to supported apps Added Bluetooth instructions for XC Soar Added new Hub ver. 1.20 features

## Scope and Summary

This manual serves as the maintenance manual for the PowerFLARM Fusion installation, as well as the Instructions for Continued Airworthiness (ICA), unless replaced by an ICA as part of the Minor Change Approval or STC in applicable parts.

This manual also describes the user interfaces of PowerFLARM Fusion, for both pilots and maintenance personnel. This includes the FLARM Hub web app, Wi-Fi and Bluetooth interfaces, LEDs, and the USB port.

In addition, this manual contains general advice on operation of FLARM for pilots. For specific instructions for operating the FLARM displays, see the relevant display manual.

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## 1 General Overview

FLARM is the collision avoidance system and traffic awareness/electronic conspicuity technology used by General Aviation, light aircraft, and UAVs. It has been designed to support self-separation for both VFR and IFR in applicable airspace classes. Aircraft with a FLARM system alert the pilots when on a collision course with another aircraft. Similar to TCAS/TAS, visual and aural warnings indicate that a collision is imminent, requiring the pilots to take action. However, unlike TCAS, FLARM does not issue Resolution Advisories (RA), so pilots need to select the appropriate course of action themselves.

FLARM works by calculating and broadcasting its own predicted future 3D flight path to nearby aircraft. At the same time, it receives the future flight path from surrounding aircraft. An intelligent motion prediction algorithm calculates a collision risk for each aircraft based on an integrated risk model.

The system determines its position, altitude, and movement with a sensitive GNSS/GPS receiver. Based on those and other parameters, a precise projected flight path can be calculated. The flight path, together with additional information such as an identification number, is encoded before being broadcast over an encrypted radio channel twice per second. Flight models are available for most aircraft types, including piston-engine airplanes, jets, helicopters, gliders, hang gliders, paragliders, UAVs, etc.

PowerFLARM Fusion also incorporates an ADS-B and transponder (SSR) Mode-S receiver. This enables aircraft that are not yet equipped with FLARM to also be detected and included in the collision prediction algorithm.

FLARM was invented in 2004 following an increasing number of mid-air collisions. Research and accident investigations had shown that the see-and-avoid principle was insufficient to reliably detect approaching aircraft in time. It initially spread in the domain of non-powered aircraft but was soon followed by rapid expansion in powered airplanes and helicopters. Over 50,000 manned aircraft and many more UAVs already have a FLARM-system installed. In Europe, more than 50% of all General Aviation aircraft have FLARM (including nearly 100% of gliders). The technology has additionally spread to other parts of the world and is today also used most prominently in North and South America, Australia, New Zealand, South Africa, Israel, and some Asian countries.

In addition to annunciating collision warnings, many FLARM systems can also show nearby aircraft on a radar-like screen (CDTI). Similar to the use of weather radar to avoid thunderstorms, this can be helpful for short to medium term strategic planning in high traffic density situations.

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FLARM can also warn about fixed obstacles like masts and power lines. Obstacle collision warnings are based on an optionally installed database, which needs to be kept up to date.

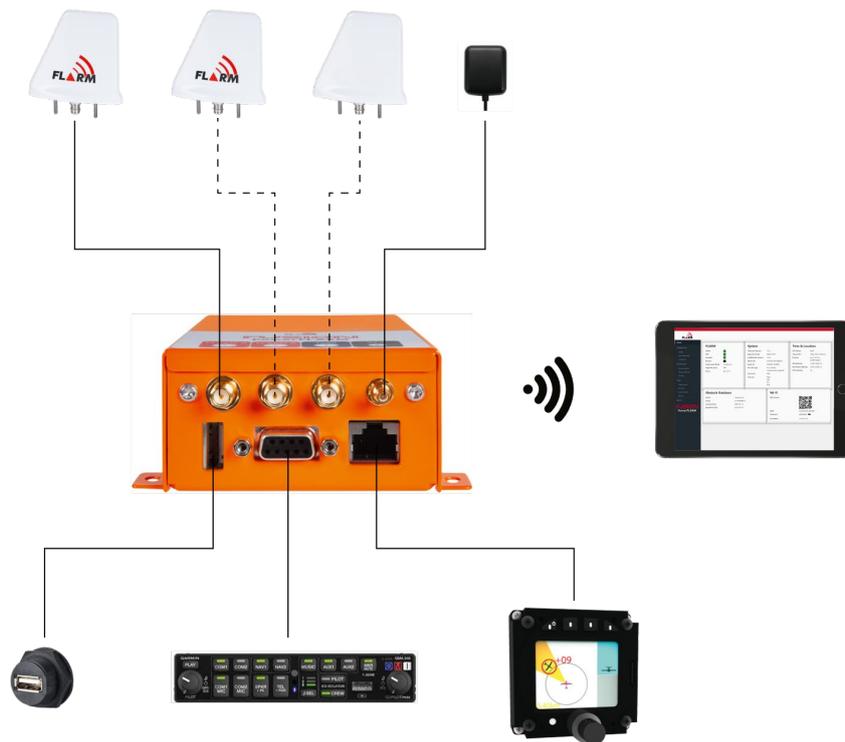
FLARM systems are available from many different manufacturers under different product names. A system normally consists of a remotely installed FLARM device, a panel-mounted *FLARM Compatible* display, one or two externally mounted FLARM antennas, and internally mounted GNSS and ADS-B/SSR antennas. There are also portable FLARM devices available (usually with an integrated display), as well as FLARM systems integrated into other avionics (e.g. EFIS-systems).

FLARM is approved by EASA and others for installation in certified aircraft and is recommended by many aviation authorities and organizations. The installation is normally a minor change and can be done by any competent maintenance organization. Several General Aviation airports have started requiring FLARM for all aircraft. FLARM is also mandatory in France for gliders and a similar requirement for light powered aircraft is under investigation.

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## 1.1 System Description

PowerFLARM Fusion is a modern FLARM device for installation in General Aviation aircraft. It is based on the latest PowerFLARM technology and features a novel web app called FLARM Hub. PowerFLARM Fusion has been designed for worldwide use and connects to a range of displays, including tablet apps via Wi-Fi or Bluetooth.



A FLARM system consists of several parts. PowerFLARM Fusion, or Fusion for short, contains the collision computer, radio circuitry, and peripheral communication subsystems. It is powered from the aircraft electrical system and connects to the following equipment and parts:

- One or two FLARM antennas. Installed antennas can be either external or internal. The choice depends on the antenna function and aircraft type. External antennas are mounted outside the aircraft fuselage (normally on top and below the aircraft). Internal antennas are mounted inside the aircraft fuselage (e.g. in the cockpit or in gliders also in the vertical stabilizer). The use of two antennas (antenna diversity) allows for an improved coverage.
- A 1090 ADS-B/SSR antenna (optional) for receiving Mode-S and ADS-B signals.
- A GPS antenna used by Fusion to determine its trajectory.



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- A panel mount USB socket with extension cord for a USB flash drive.
- At least one FLARM Compatible display. These displays have been certified or validated to have implemented all essential functions.
- A number of complementary displays or accessories, parsing the FLARM data stream.
- An audio panel for feeding aural warnings into the aircraft's audio system (optional).
- An Electronic Flight Bag (EFB) or navigation app running on a mobile device (tablet or phone), connected through Wi-Fi or Bluetooth.
- A web browser running FLARM Hub on a computer or mobile device.

## 1.2 Definitions

### 1.2.1 Abbreviations

Abbreviation	Meaning/Explanation
<b>ADC</b>	Analog-to-Digital Converter
<b>ADS-B</b>	Automatic Dependent Surveillance — Broadcast
<b>AIRAC</b>	Aeronautical Information Regulation And Control
<b>AMP</b>	Aircraft Maintenance Program
<b>CARP</b>	Continuous Analyzer of Radio Performance
<b>CDTI</b>	Cockpit Display of Traffic Information
<b>EEPROM</b>	Electrically Erasable Programmable Read-Only Memory
<b>EFB</b>	Electronic Flight Bag
<b>EFIS</b>	Electronic Flight Instrument System
<b>GNSS</b>	Global Navigation Satellite System
<b>GPIO</b>	General-Purpose Input/Output
<b>GPS</b>	Global Positioning System (NAVSTAR)
<b>ICA</b>	Instructions for Continued Airworthiness
<b>ICD</b>	Interface Control Document
<b>IFR</b>	Instrument Flight Rules
<b>ISM</b>	The ISM radio band ( $\approx 915$ MHz)
<b>PIC</b>	Pilot In Command
<b>RF</b>	Radio Frequency/Radio
<b>SRD860</b>	The SRD860 radio band ( $\approx 868$ MHz)
<b>SSID</b>	Service Set Identifier, (Wi-Fi network name)
<b>SSR</b>	Secondary Surveillance Radar
<b>TAS</b>	Traffic Advisory System
<b>TCAS</b>	Traffic alert and Collision Avoidance System
<b>UAV</b>	Unmanned Aerial Vehicle
<b>UI</b>	User Interface
<b>VFR</b>	Visual Flight Rules
<b>VMC</b>	Visual meteorological conditions



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## 1.2.2 Terminology

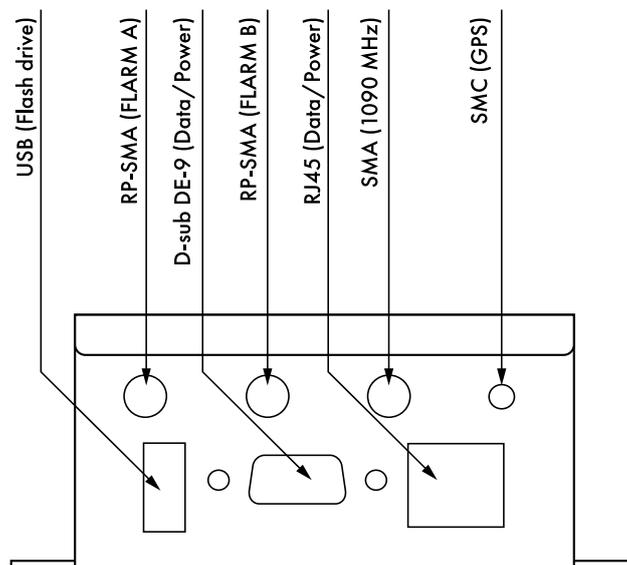
The words **shall** and **must** are used to indicate a mandatory requirement.

The word **should** is used to indicate a recommendation, meaning that there may exist valid reasons in particular circumstances not to follow a specific item, but the full implications must be understood and carefully weighed before choosing a different course.

The word **may** is used to indicate that an item is truly optional.

## 1.3 Housing

### 1.3.1 Connections and Cabling



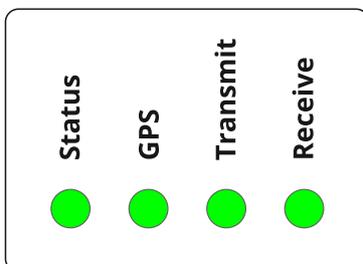
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PowerFLARM Fusion has the following connectors:

- USB 2.0: Accepts USB flash drive for flight log readout, device update<sup>1</sup>, and configuration.
- FLARM antennas A and B: When using a single antenna, connect to FLARM A. The internal FLARM antennas supplied with the device have a RED marking.
- 1090 MHz: For receiving SSR transponder and ADS-B 1090ES signals. The internal antenna supplied with the device has a BLUE marking. This antenna is optional; however, without it, no traffic will be received on 1090 MHz.
- GPS antenna: Must be connected for operation.
- RJ45 (Data Port #1) and D-sub DE-9 (Data Port #2): For connecting up to two independent *FLARM Compatible* displays and power. Power must only be supplied on one of the connectors.

For any type of modification, including connected displays, antennas, and other accessories, see the Installation Manual.

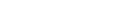
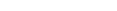
### 1.3.2 Status LEDs and Startup



PowerFLARM Fusion has 4 LED lights. These lights are normally not visible during flight. Each LED can be either **GREEN**, **AMBER**, **RED**, or **OFF**. The different states have the following meaning, depending on whether the device is in bootloader mode or if the application has booted, indicated by four amber LEDs:

---

<sup>1</sup> The FLARM Hub Firmware cannot be updated using USB.

	Status	GPS	Transmit	Receive
<b>BOOTLOADER</b>				
Initialization				
Serial port recovery update				
Safe update				
Firmware check error				
Firmware check successful, booting application				
<b>FIRMWARE</b>				
Initialization				
Non-fatal error				
Fatal error				
Operation in progress (obstacle database installation, IGC readout, etc.)				
Binary communication	(any)			
Nominal state, no GPS fix				
Nominal state, 3D GPS fix, transmitting				
Nominal state, 3D GPS fix, transmitting and receiving at least one aircraft				

The LED lights are also visualized in FLARM Hub on the Status page (see Section 3.3).

### 1.3.3 Factory Reset

PowerFLARM Fusion can be reset to factory defaults if required. The following items are reverted to factory default:

- FLARM configuration
- FLARM Hub configuration
- Wi-Fi SSID and password
- Bluetooth name

The following items are removed/deleted:

- IGC flight recordings



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- FLARM Hub device lock
- Bluetooth pairings
- Obstacle database
- CARP range analyzer data
- Diagnostic log files

The firmware versions (PowerFLARM and Hub) do not change.

A factory reset should be applied under the following circumstances:

- Installation in another aircraft and/or change of ownership
- The Wi-Fi or device lock passwords have been lost

The device can be reset either via FLARM Hub (on the Tools / Support page) or by using the hardware reset pin. To reset using the pin, push a paperclip or similar into the hole next to the LED lights (see picture below) with the device OFF, until the reset pin is pushed in. Hold the pin pushed in while powering on the device. Hold the pin pushed in for at least 2 seconds and then withdraw the paperclip. The device will revert to factory configuration during startup.



## 1.4 Displays

PowerFLARM Fusion must be connected to a FLARM display. Displays originate from third party manufacturers implementing the FLARM ICD protocol, an extension of NMEA 0183. To ensure that collision warnings and traffic information work correctly and that critical status and error conditions are correctly annunciated to the pilots, Fusion should be connected to at least one *FLARM Compatible* display. The display should be installed in the primary field of view of the pilots. In aircraft with tandem seating, each pilot should have a display in its primary field of view.

Fusion also supports connections to supplementary displays and navigation systems over Wi-Fi and Bluetooth.

For detailed requirements for FLARM displays, see the Installation Manual.

## 1.5 Radio Communication and Antennas

The FLARM system uses a radio communication frequency in the SRD860 band ( $\approx 868$  MHz) or an ISM band ( $\approx 915$  MHz) in different parts of the world. PowerFLARM Fusion will automatically select the applicable frequency based on the GNSS position.

The following frequencies are used within the specified areas.

Area	Frequency
<b>Africa</b>	868.2 – 868.4 MHz
<b>Australia</b>	917.0 – 926.6 MHz
<b>Europe</b>	868.2 – 868.4 MHz
<b>Israel</b>	916.2 MHz
<b>New Zealand</b>	869.2 MHz
<b>North America</b>	902.2 – 927.8 MHz
<b>South America</b>	917.0 – 926.2 MHz

The antennas should be designed for the frequency band applicable in the geographic area where the aircraft is being operated. Internal antennas, including the antennas that are shipped with Fusion, are normally designed for only one of the frequency bands. The external AV-75 antenna is designed for worldwide use. Only antennas supplied or approved by FLARM Technology should be used. Inappropriate antennas, especially antennas without complete insulation, can damage devices and should not be used.

**Note:** Fusion will not detect inappropriate antennas, including antennas for the wrong frequency band.

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PowerFLARM Fusion can use two antennas concurrently for better coverage (antenna diversity). Normally, one antenna is placed on top of the aircraft and one below. In especially fiberglass gliders, they can also be placed inside the aircraft fuselage in a way that ensures 360° coverage. Antenna diversity is recommended for all aircraft and is strongly recommended for aircraft fuselages containing a lot of metal or carbon fiber.

**Note:** Communication between FLARM devices employs a proprietary, encrypted, and copyright protected protocol. The design is patent protected. Any unlicensed use, copying, distribution, conversion, replication, access, interception, de-compiling, reverse engineering, or further transmission of knowledge so acquired relating to the system components or software/firmware, in whole or in part, is forbidden and will result in legal enforcement action.

For detailed requirements for antennas and their installation, see the Installation Manual.

## 1.6 Additional Documents

The PowerFLARM Fusion Installation Manual (FTD-077) is an integral part of the maintenance documentation and must be used for maintenance where referenced. The Installation Manual, together with additional documents for installation, maintenance, operation, and support can be found under the following link:

<https://flarm.com/support/manuals-documents/>

For questions, first consult the FAQ:

<https://support.flarm.com/hc/en-us>

For questions not answered in the FAQ, contact FLARM Technology:

[support@flarm.com](mailto:support@flarm.com)

## 1.7 Document Revisions

This document will occasionally be updated. The latest version can be found under the link to additional documents above. Always make sure that you are using the latest document. Updates will be communicated to official FLARM dealers, in the FLARM blog, and the official FLARM newsletter. Sign up to the newsletter from the FLARM website to ensure that important communication is not missed:

<https://flarm.com/blog/>

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## 2 Limitations

PowerFLARM Fusion has been designed as a non-essential situation awareness only device, whose task is solely to support the pilot; it is not always in a position to provide a reliable warning. In particular, Fusion does not provide any resolution advisories. Under no circumstances does Fusion facilitate a change in flight tactics or pilot conduct. Operation of Fusion is solely at the discretion of the PIC. The system may only be used after completing familiarization training.

A display attached to Fusion can only alert of the presence of other moving aircraft if the other aircraft is equipped either with a FLARM system, an ADS-B Out 1090ES device, or an interrogated Mode-S transponder. Fusion does neither interrogate transponders nor operate as a transponder and is thus not detected by TCAS or ATC.

FLARM firmware development was conducted in accordance with industry best practice for industrial electronics products. The use of public access license-free radio bands in the air is subject to a number of limitations, with some national differences. The PIC is solely responsible that Fusion is operated in accordance with applicable regulations.

The use of Fusion is limited to flights in VMC (both VFR and IFR). Fusion may not be used for navigation.

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### 3 FLARM Hub

FLARM Hub is the web app that makes configuring and maintaining FLARM easier than ever before. It runs directly on the Wi-Fi network of Fusion and can be used from any smartphone, tablet, or computer.

The following main features are available in FLARM Hub:

- Device status
- Firmware updates
- Interactive configuration
- Obstacle database update
- IGC file download
- Traffic Monitor
- Interactive Data Port
- Integrated CARP Range Analyzer
- Simulated scenarios to test connected equipment
- IGC task declaration
- Diagnostics

FLARM Hub pages can be printed to paper or PDF for documentation purposes, using the browser's print function.

#### 3.1 Connection

Connecting to FLARM Hub is done over Wi-Fi. Fusion presents its own Access Point (AP) to which a client device can connect. The Wi-Fi is identified via its name (SSID). When accessing it, the user is prompted to enter the password. SSID and password can be set in the configuration to restrict access.

Fusion comes with a default SSID and password programmed. Both values are printed on the black serial number sticker on the device. The sticker also contains a QR code which can be used to easily connect, provided the SSID and password have not been changed. For this, simply scan the QR code with the phone's camera app. An additional device sticker is included with the device and can preferably be attached to maintenance documentation to facilitate future connections.

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**Note:** A phone or computer can usually be connected to only one Wi-Fi network at a time. When connecting to Fusion, you may thus lose Wi-Fi connectivity to the internet. Phones with a data plan can use the internet while connected to Fusion.

Next, open a web browser and enter the address <http://10.10.10.10/>. This will bring up the Status Page.

<b>FLARM Hub web address (URL):</b>  <a href="http://10.10.10.10/">http://10.10.10.10/</a>
--

The status page contains another QR code which can be used to connect additional devices by scanning it (see Section 3.3.5). This QR code always contains the current settings for Wi-Fi network name and password.

**Note:** Internet is not available over the Wi-Fi connection. If asked when connecting, select to use the connection even if no internet is available.

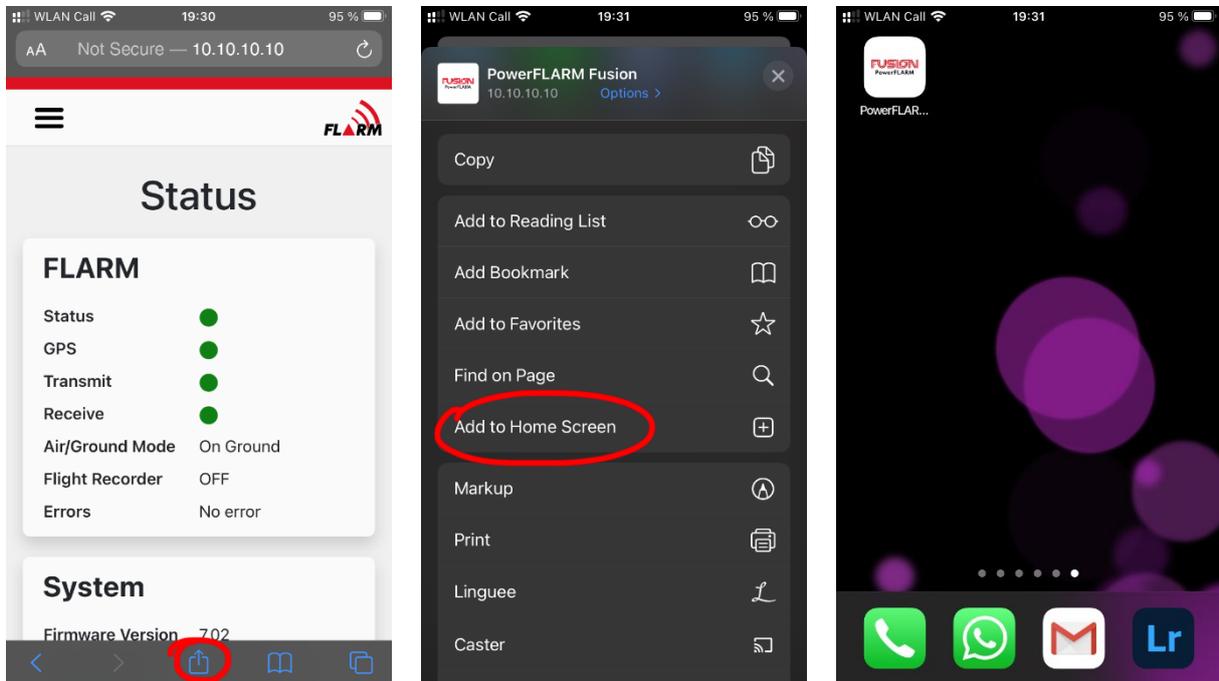
**Note:** FLARM Hub is not available over TLS/SSL (https).

On mobile devices, it is recommended to create a bookmark for FLARM Hub on the springboard (home screen):

**On iOS:**

1. Open FLARM Hub in Safari (visit <http://10.10.10.10/> and make sure you are on the Status page)
2. Click the Share button at the bottom of the screen
3. Select "Add to Home Screen"

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### On Android:

On Android, the procedure depends on the flavor of the OS and the browser. In general:

1. Open FLARM Hub in e.g. Chrome (visit <http://10.10.10.10/> and make sure you are on the Status page)
2. Click the Menu button to the right of the address bar
3. Select "Add to Home screen"

## 3.2 General Web Interface Guidance

FLARM Hub has been designed following modern user interface principles and is easy and intuitive to use. It uses a responsive design and is accessible on both desktop and mobile. Each page also prints nicely to PDF or paper (great for documentation purposes).

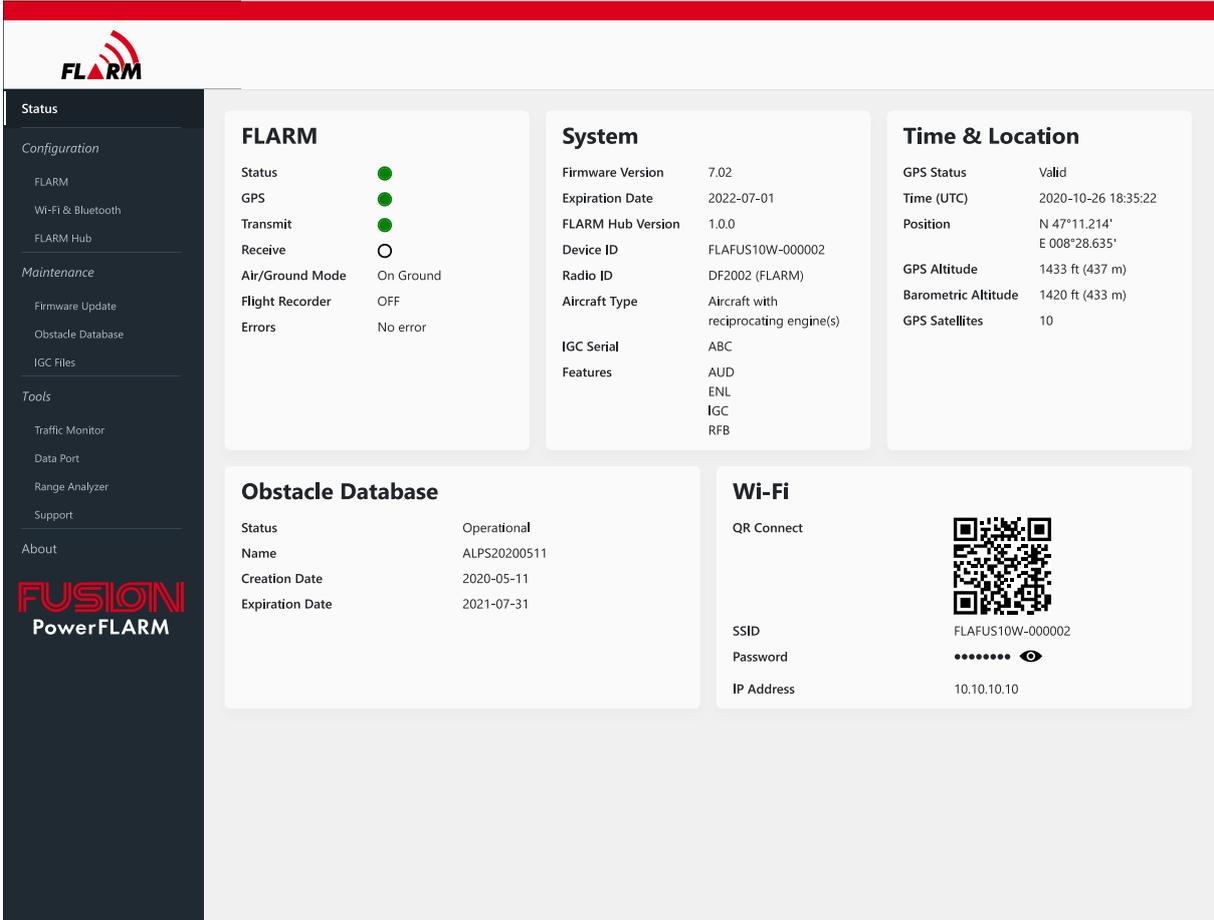
All dynamic information in FLARM Hub is "live", i.e. it is updated automatically when the underlying data changes. Thus, there is normally no need to refresh the page or to push a button to commit changed settings to the device. If there is a connection problem, this will be indicated at the top of the page.

The language of the interface can be changed on the Configuration / FLARM Hub page (see Section 3.4.3.2). Independently of the selected language, all dates are shown in the international standard format (YYYY-MM-DD).

**Note:** Some features (e.g. file downloads) do not work on Chrome for iOS because of how Chrome has been implemented on iOS. Please use Safari instead.

**Note:** While we strive to ensure compatibility with a broad range of devices, some platforms and browsers, especially older ones, might only be partially supported or not at all. In case of issues, ensure that you are using a newer device running the latest OS version.

### 3.3 Status Page



The screenshot shows the FLARM Hub Status Page. On the left is a navigation menu with categories: Status, Configuration (FLARM, Wi-Fi & Bluetooth, FLARM Hub), Maintenance (Firmware Update, Obstacle Database, IGC Files), Tools (Traffic Monitor, Data Port, Range Analyzer, Support), and About (FUSION PowerFLARM). The main content area contains several panels:

- FLARM:** Status (green dot), GPS (green dot), Transmit (green dot), Receive (white circle), Air/Ground Mode (On Ground), Flight Recorder (OFF), Errors (No error).
- System:** Firmware Version (7.02), Expiration Date (2022-07-01), FLARM Hub Version (1.0.0), Device ID (FLAFUS10W-000002), Radio ID (DF2002 (FLARM)), Aircraft Type (Aircraft with reciprocating engine(s)), IGC Serial (ABC), Features (AUD, ENL, IGC, RFB).
- Time & Location:** GPS Status (Valid), Time (UTC) (2020-10-26 18:35:22), Position (N 47°11.214', E 008°28.635'), GPS Altitude (1433 ft (437 m)), Barometric Altitude (1420 ft (433 m)), GPS Satellites (10).
- Obstacle Database:** Status (Operational), Name (ALPS20200511), Creation Date (2020-05-11), Expiration Date (2021-07-31).
- Wi-Fi:** QR Connect (QR code), SSID (FLAFUS10W-000002), Password (••••••••), IP Address (10.10.10.10).

The Status Page is the first page shown when accessing FLARM Hub and can always be accessed by clicking on "Status" (first item) in the navigation menu. The Status Page shows information about FLARM. It also shows connection information to connect additional mobile devices to FLARM Hub.

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The different sections on the Status page are explained below.

### 3.3.1 FLARM

This section depicts the physical device LEDs and shows their corresponding status (color). See Section 1.3.2 for details. An LED that is OFF is indicated by a white LED with a black border. If using a mouse, hover over the Receive LED to see the number of aircraft being received.

#### Air/Ground Mode

Indicates if FLARM considers the aircraft to be in flight or on the ground. This depends on ground speed and the configured aircraft type. When on the ground:

- No collision warnings will be issued
- FLARM systems in other aircraft will not issue collision warnings about you
- All aircraft may not be shown, e.g. when *no track* or *stealth mode* are active

#### Flight Recorder

Indicates if IGC flight logs are currently being recorded (IGC files). This is based on FAI/IGC rules and independent of the FLARM Air/Ground mode.

#### Errors

Shows the errors, if any, generated by FLARM. The error codes (Hex, see Appendix B) and error messages are shown. See example below.

Error	Message
11	Firmware expired
82	Obstacle database expired.
71	Pressure sensor

The severity level is indicated by the color and has the following meaning:

Severity	Meaning
<b>1 (gray)</b>	Information only, normal operation.
<b>2 (amber)</b>	Functionality may be reduced.
<b>3 (red)</b>	Fatal error; FLARM will not work.

If an error occurs (usually during startup), it will be shown until the device is restarted.

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### 3.3.2 System

Shows relevant information about the FLARM hardware and firmware, Hub version, and FLARM configuration. It also shows activated features.

This section can be checked to quickly ensure that the correct device/aircraft is being configured, that the essential configuration items are correct, and that the FLARM firmware is not expired.

### 3.3.3 Time & Location

Shows current data received from the GNSS and barometric sensors.

**Note:** The Barometric Altitude shown is from the barometric sensor in the device and not from the Mode-S transponder.

### 3.3.4 Obstacle Database

Shows information about the installed obstacle database and appurtenant license. If no database is installed, or the current one is expired, see Section 5.2 for details.

### 3.3.5 Wi-Fi

Shows Wi-Fi connection information (SSID and password) to connect additional devices to FLARM Hub. When delivered or after being reset to factory default, the connection information is the same as printed on the device sticker. The QR code and connection information shown takes changes to the SSID and Wi-Fi password into account.

Click on the eye icon to reveal/hide the password.

## 3.4 Configuration

The different configuration pages can be used to configure FLARM, the Wi-Fi and Bluetooth interfaces, and FLARM Hub. FLARM can also be configured by uploading a configuration file.

### 3.4.1 FLARM

FLARM can be configured using either the configuration page in FLARM Hub or by using a configuration file created e.g. by the [online configuration tool](#). The configuration file can be uploaded at the bottom of the FLARM Hub configuration page. When the upload has finished, the number of configuration items applied, and if there were any errors, will be indicated.

**Note:** When using a configuration file, the configuration should be verified in FLARM Hub after uploading the file.

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Explanations for each field are available as a tooltip by hovering over or clicking on the question mark next to each field. Check the box "Show advanced configuration items" to show additional customization options.

When a configuration item is changed (selecting a dropdown item, radio button, or moving focus away from a text field), the configuration is automatically applied to FLARM. No additional step is necessary to apply the value. A successful change of the configuration item is indicated as a green border around, and a green checkmark inside, the field. An incorrect value is indicated as a red border around, and a red exclamation mark inside, the field.

Items that must be configured before use are listed in Section 5.1.

### 3.4.2 Wi-Fi and Bluetooth

Wi-Fi and Bluetooth settings and network names can optionally be changed, e.g. to make it easier to identify a particular device by using the aircraft tail number. The default password is secure in the sense that it is generated randomly for every Fusion, i.e. it cannot be found out without access to the device or the sticker. It can be changed (e.g. to have the same password for the entire fleet) or even removed.

Wireless connectivity (Wi-Fi and Bluetooth) can be disabled under configurable conditions (in-flight, with valid GPS, or after specific elapsed time since power-on).

**Note:** If SSID or password are changed, it will not be possible to access the Wi-Fi interface using the QR code on the device sticker. The QR code on the *Status* page will be updated and hence can still be used, e.g. when printed.

**Note:** To recover from a lost password (Wi-Fi or device lock), the device needs to be reset to factory defaults.

### 3.4.3 FLARM Hub Settings

#### 3.4.3.1 Device Lock

To prevent unauthorized persons from modifying the configuration, the configuration can be locked by a password. Set a password that is different from the Wi-Fi password. Users will still be able to access FLARM Hub but will not be able to change the locked configuration items.

**Note:** Users with physical access to Fusion will be able to change the configuration by using a USB flash drive as well as reset the device, including all passwords, by using the hardware reset pin (see Section 1.3.3).

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### **3.4.3.2 Language Selection**

FLARM Hub can be used in different languages. To change the language, click on the desired language. The language in the user interface is updated immediately without having to refresh the page. The setting is saved in the browser for each user. The currently support languages are French, German, and English.

## **3.5 Firmware and Obstacle Updates**

The PowerFLARM firmware, obstacle database, and FLARM Hub firmware can be updated under the Maintenance menu section.

The PowerFLARM firmware must be updated at least every 12 months as part of the annual maintenance. See Section 9 for details.

Download the latest PowerFLARM firmware file (.fw) and FLARM Hub firmware file (.bin) under the following link:

<https://flarm.com/support/firmware-updates/>

Obstacle database updates with license can be purchased under the following link:

<https://flarm.com/product-category/obstacle-databases/>

## **3.6 IGC file download**

IGC files can be downloaded from the IGC Files page under the Maintenance menu section. Click the button at the top to populate the table with all IGC files that are available on the device. The list is sorted in reverse chronological order (newest first). Click on a file to download it.

## **3.7 Traffic Monitor**

The traffic monitor displays traffic received by Fusion, using symbology similar to TCAS. It does not issue collision warnings. Obstacles and alert zones are not displayed.

The traffic monitor can be used e.g. to troubleshoot display connectivity and configuration issues. It should not be used for collision avoidance purposes. When on the ground, aircraft with Stealth or No Track mode enabled will not be shown.

When using the traffic monitor, note the zoom level and vertical axis reference (North Up or Track Up).

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### 3.8 Interactive Data Port

An interactive bi-directional data port is available with the same functionality as the physical data ports. This can be used e.g. for troubleshooting when instructed by support.

### 3.9 Range Analyzer

The CARP (Continuous Analyzer of Radio Performance) Range Analyzer always runs in the background during flight and continuously integrates the receive range over time. The range is based on receive range of other FLARM-equipped aircraft and calculated separately for 20 sectors, 18° each.

A range analysis should be done after installation and then as part of the annual maintenance (see Section 9).

The range should be at least the minimum recommended range as indicated by the range plot.

CARP data should be reset after annual or system maintenance, after having documented the previous range. Resetting CARP removes all recorded CARP data and starts a new continuous range analysis.

A description of the working principle of CARP is available here:

<https://flarm.com/introducing-carp-range-analyzer/>

### 3.10 Scenario Simulator

The Scenario Simulator can be used to simulate a predefined scenario on connected displays and other equipment. This can be used to verify the installation and to test displays. The different scenarios simulate traffic, collision warnings, as well as other alerts. Visual and aural warnings should be generated by the connected equipment as in a real situation. Ownship position will also be simulated for the duration of the scenario.

**Note:** The simulations do not provide information about the quality of the antenna installation; see the Range Analyzer for that.

### 3.11 IGC Task Declaration

Manage an IGC task on the device. Task declaration files created by an external tool can be uploaded as well. It is also possible to view, edit, or delete the existing task, as well as creating new ones.

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### 3.12 Support Package Download

When asked by 3rd party support, FLARM Hub can create a zip file containing configuration and debug data. The button to create the zip file can be found on the Tools / Support page. The zip file is saved on the connected computer or mobile device.

**Note:** The package creation and download takes approximately 10 minutes to complete, during which the device will be inoperable.

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## 4 USB Flash Drive Operation

PowerFLARM Fusion has a built-in USB A 2.0 connector for a USB flash drive. It can be used for device updates, configuration, and readout of device information and flight logs (IGC). A USB extension cable with connector is normally installed in the instrument panel for easy access.

**Note:** The FLARM Hub firmware can only be updated via FLARM Hub.

**Note:** The USB flash drive must not be connected during flight.

USB flash drive transactions take place automatically when Fusion is switched ON with a USB flash drive connected. In addition, transactions can take place when triggered by a FLARM display or flight computer (e.g. readout of flight logs).

Transactions when switching Fusion ON are executed in the following sequence:

- Apply device configuration (FLARMCFG.TXT)
- Write device information (FLARMDEV.CSV)
- Updates: PowerFLARM firmware, obstacle database, licenses. Fusion restarts if any update is done (Status LED OFF for three seconds); this is to allow expedited updating of multiple updates.
- Flight logs readout

USB flash drives properties:

- Formatted as FAT16, FAT32, or exFAT (NTFS will not work)
- Capacity <= 128 GB
- USB 2.0 connector (not USB 3.0)

Recommendations and additional information for USB flash drive usage:

- Use a dedicated USB flash drive for PowerFLARM Fusion (Exception: Updates of multiple Fusion devices to the same firmware version).
- Leave flight logs (IGC files) on the USB flash drive, space permitting. This will reduce the time needed for readout since files already on the flash drive are skipped.
- IGC files will have the correct timestamp, corresponding to when the flight took place. This allows to sort by date on a PC.
- Do not have multiple obstacle database files on the USB flash drive.
- Fusion will skip firmware, license, and obstacle database files which are already installed.

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## 5 Configuration

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

The following means of configuration are available:

1. Interactively via FLARM Hub (see Section 3.4.1)
2. Interactively through a connected display that supports it
3. Using a configuration file and the USB flash drive (see Section 4)

If configuring using a USB flash drive, the configuration should be verified using FLARM Hub or by other means. The essential settings should also be verified after a firmware update.

### 5.1 Essential Settings

The following settings must be configured:

#### **Aircraft type**

FLARM uses collision algorithms specific to the aircraft type in which it is installed. If the wrong aircraft type is configured, this will have negative effects both for the own system as well as FLARM systems in other aircraft, e.g. when calculating the collision risk with the own aircraft.

#### **Transponder type**

The type of transponder installed must be configured, so FLARM knows how to interpret the data from the own transponder.

#### **ICAO 24-bit aircraft address**

If the aircraft has a Mode-S transponder or separate ADS-B Out 1090ES equipment, the 24-bit aircraft address must be configured. This ensures that receiving devices can correctly correlate the FLARM and transponder signals. Furthermore, this allows to use the pressure altitude received from the own transponder instead of from the integrated barometric sensor. This produces more accurate altitude readings.

#### **Protocol Version and Baud Rate**

Configure the highest protocol version and baud rate that the connected display(s) support, on each data port, respectively. This information is available from the

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display manufacturer. Higher protocol versions support additional features. Higher baud rates support a higher number of concurrent aircraft shown on the display.

**Note:** Some displays automatically set the required baud rate and/or protocol version during startup. Other displays may adapt to the already configured baud rate.

**Note:** Newer protocol versions transport more information than older versions. It is thus recommended to use the highest protocol version supported by the connected display. Similarly, it is recommended to use the highest supported baud rate to prevent loss of information due to an overwhelmed serial connection.

## 5.2 Obstacle Databases

The Obstacle Warning System in FLARM is an integral, but optional, part of the system. It requires a valid obstacle database with license to work. There are different databases covering various geographical areas and use cases. An installed obstacle database should be renewed as part of the annual maintenance and before it expires. They can be purchased under the following link:

<https://flarm.com/product-category/obstacle-databases/>

Obstacle databases are also available per the AIRAC cycle on an individual basis.

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## 6 FLARM Operations

This section describes general flight operations with a FLARM system installed. The specific handling of the pilot user interface is described in the display Operating Manual.

General information about how the FLARM system works is described in Section 1.

### 6.1 FLARM Displays

PowerFLARM Fusion is normally connected to a *FLARM Compatible* display as a primary means of collision avoidance (see PowerFLARM Fusion Installation Manual). The display is normally installed in each pilots' primary field of view.

**Note:** Displays certified as *FLARM Compatible* (normally carry the "FLARM Compatible" logo) have shown to have implemented all required systemic functions. This includes collision warnings, status information, error conditions, and obstacle warnings. Other displays may not be conformal.

The display serves as the primary pilot user interface. In addition to annunciating collision warnings and visualizing traffic information, it also shows status and error conditions of Fusion.

#### 6.1.1 Status and Error Conditions

The display will indicate status conditions and error codes. A list of error codes is available in Appendix B.

Error codes are accompanied by a severity 1-3. Severity 3 implies a fatal error and FLARM is not operational. Severity 2 in most cases implies that functionality is reduced. Severity 1 is for information purposes only.

**Note:** An error condition is also indicated on the Hub *Status* page and via the status LEDs.

### 6.2 Traffic Collision Warnings

Traffic collision warnings are issued based on the time remaining to the predicted collision (i.e. not the geometric distance between the aircraft). There are three levels of warnings with different types of annunciations — visual and/or aural depending on the installation. The warning consists of the distance, relative bearing, and altitude difference to the intruder.

The first warning is issued around 18 seconds before impact. The second warning is issued around 12 seconds before impact and the third warning around 8 seconds

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before impact. The warning is active as long as the collision risk remains. Depending on changes in the predicted flight paths, the warning level may be downgraded or cease. The collision risk algorithms are sensitive; warnings are only issued if there is a high probability of a collision within the next 18 seconds. The margin used depends on several factors, including but not limited to aircraft type (size), speed, vertical speed, turn radius, and position accuracy.

### **6.2.1 ADS-B and Mode-S Traffic**

PowerFLARM Fusion incorporates a complementary 1090 MHz ADS-B and transponder (SSR) Mode-S receiver.

The positions of aircraft with ADS-B Out 1090ES will be received and processed independently of the received integrity and accuracy values (SIL/SDA). For aircraft with both FLARM and ADS-B Out, Fusion will automatically choose the better signal. Because of the inherent limitations of the ADS-B system, ADS-B aircraft will have larger margins than FLARM-equipped aircraft. Collision warnings for ADS-B Out aircraft will be issued similar to FLARM-equipped aircraft.

Aircraft with a Mode-S transponder will be received when the aircraft is interrogated by a Secondary Surveillance Radar (SSR) or TCAS/TAS. Since the transponder signal received is non-directional, the intruder will only be indicated with approximate distance (e.g. a range ring on the display) and relative altitude, but without bearing. The approximate distance is based on the signal strength of the transmission from the other aircraft. Collision warnings will be issued based on the altitude difference and approximate distance.

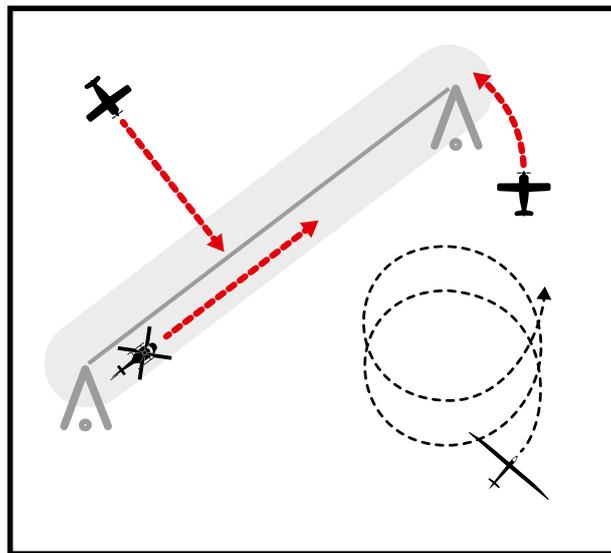
The altitude difference to the intruder is calculated using the altitude received from the own Mode-S transponder, if installed. In other cases, the pressure sensor inside PowerFLARM Fusion is used, which may deviate from true static pressure.

## **6.3 Obstacle Collision Warnings**

When an obstacle database and license is installed, collision warnings are issued for static obstacles in the database, such as cable railways, powerlines, and antenna masts. The annunciation is different from traffic collision warnings; see the display Operating Manual for details.

The first warning is issued around 18 seconds before impact. The alarm level increases at 12 and 8 seconds before impact, respectively. The warning is active as long as the collision risk remains. Depending on changes in the predicted flight paths, the warning level may be downgraded or cease. The collision risk algorithms are sensitive; warnings are only issued if there is a high probability of a collision within the next 18 seconds.

In addition to predicted impacts, obstacle collision warnings are also issued when a sudden change of flight path could lead to an obstacle collision. This includes flying parallel to a line obstacle or turning around the end of a line obstacle. At the same time, obstacle collision warnings are not issued when circling (e.g. gliders thermalling) close to a line obstacle. The effect is visualized in the graphic below, the red dashed line illustrating where collision warnings are issued.



For obstacle collision warnings, no relative bearing or altitude difference is indicated since this is always along the own predicted flight path.

## 6.4 Alert Zones

Skydiver drop zones and UAV operations areas may be equipped with FLARM Alert Zone generators. These consist of FLARM-based ground stations that broadcast a cylinder-formed airspace around the affected area. Both the ground station operator and pilots flying in the cylinder are alerted when an aircraft enters the airspace.

The FLARM system onboard the aircraft will issue a warning for 4 seconds every 12 seconds while flying inside the zone. After the first 3 warnings, while still inside the zone, the warning will be repeated only every 60 seconds.

*FLARM Compatible* displays using FLARM protocol version 7 or higher will indicate the Alert Zone warning in a unique way. Other displays will indicate the warning as an obstacle collision warning, but with the timing of the warning still according to the schedule described above.

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## 6.5 Traffic Information

In addition to collision warnings, FLARM sends the following information about proximate aircraft to connected displays:

- Position (relative)
- ICAO 24-bit address or FLARM radio ID
- True Track
- Turn rate
- Ground speed
- Vertical speed
- Aircraft type

Additionally, supplemental information can be sent for later data port protocol versions.

## 6.6 Radio Range

Other aircraft must be within radio range (line-of-sight) for FLARM to be able to provide collision warnings. The effective range depends on the type and position of installed antennas as well as a proper installation. External FLARM antennas are recommended in general, since they typically achieve better range than an internal setup. Under optimal conditions, the system can give a range of well over 10 km. For speeds up to 250 kt head-on, a range of 5 km is required (and sufficient) for FLARM to be able to warn in time.

If there is only one FLARM antenna installed (e.g. on top of the aircraft), the range in some directions (e.g. directly below the aircraft) may be limited due to aircraft parts or the human body attenuating the signal. It is thus recommended to install two antennas (antenna diversity).

**Note:** It is not allowed to use antenna splitters.

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## 7 IGC Flight Recorder

PowerFLARM Fusion operates as an IGC-approved flight recorder (level 3, badges up to diamonds). It also has Engine Noise Level recording (ENL).

**Note:** The pressure sensor is precalibrated when shipped. If calibration is required for FAI/IGC purposes (e.g. record flights), this should be done by an appropriate entity.

PowerFLARM Fusion has an internal memory for approximately 50 hours of flight recording at a 4 s interval. Flight recording automatically starts when the aircraft starts moving and ends when Fusion is switched OFF or after more than 10 minutes on the ground. When the memory is full, the oldest flights are overwritten first.

To read out the flights, use FLARM Hub (see Section 3.6). It is also possible to read out all IGC files to a USB flash drive:

1. Switch PowerFLARM Fusion OFF after flight (allow at least 2 minutes after landing to avoid losing data)
2. Connect a USB flash drive (see Section 4 for usage of USB flash drives)
3. Switch Fusion ON
4. Observe Status LED or progress indication on display to verify that flights are being copied
5. Wait until the system has started up normally after copying the flights
6. Disconnect the USB flash drive

Some displays and flight computers allow reading out flights without switching Fusion OFF after the flight. Refer to the display documentation for details.

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## 8 Wi-Fi and Bluetooth Data Usage

PowerFLARM Fusion can be connected to EFBs and mobile devices (tablets, smart phones) to stream traffic data. The connection can be made over either Wi-Fi or Bluetooth. The following modes are available:

- FLARM ICD on Bluetooth (serial port profile, Android only)
- FLARM ICD on Wi-Fi (TCP, socket 2000)
- FLARM ICD on Wi-Fi (WebSocket)
- GDL 90 on Wi-Fi (UDP)

To use one of the Wi-Fi modes, the mobile device must be connected to Fusion's Wi-Fi as described in Section 3.1. The host IP address is 10.10.10.10.

**Note:** Some apps have an option to connect to FLARM via third party interface modules (e.g. AIR Connect). These modules, however, use different connection settings (e.g. IP number) and the associated connection option may not be compatible with PowerFLARM Fusion.

### 8.1 ICD on Wi-Fi, TCP

Fusion accepts incoming connections on the socket 2000. Streaming starts immediately when the client connects. Communication is bidirectional, NMEA commands can be issued to FLARM. Only one TCP connection is accepted at a time.

### 8.2 ICD on Wi-Fi, WebSocket

The WebSocket stream is available at <http://10.10.10.10/api/flarm/dataport>. Only one WebSocket can be open at a time.

### 8.3 ICD on Bluetooth

To use Bluetooth, the mobile device first has to be paired with PowerFLARM Fusion. This can be done on the Configuration / Wi-Fi & Bluetooth page in FLARM Hub. To pair a new device, click on the button "Start pairing". Within 1 minute, pair the mobile device using the Android system settings. Once paired, the data stream can be selected as virtual serial port in the app.

**Note:** Fusion uses a single radio module for Bluetooth and Wi-Fi. Thus, Wi-Fi is not available while Bluetooth streaming is active. To re-enable Wi-Fi, simply stop the Bluetooth data stream, e.g. by closing the app.

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## 8.4 GDL 90

Fusion automatically streams the GDL 90 protocol to connected mobile devices. This protocol is based on datagrams (UDP) and connectionless. The destination port is 4000, unless when the auto-discovery mechanism is used (e.g. ForeFlight).

GLD 90 transports traffic and position data, but many other aspects of FLARM ICD are missing. Usually, in the app this is called "GDL 90 Compatible device" or similar, and it can be added via the settings in the normal way.

## 8.5 Apps

The settings for some common apps are listed below. For other apps, use the generic connection settings as specified above.

### **Air Navigation Pro**

Select "FLARM [...]" as Traffic Source. Manually configure the following settings (no "Pin code" is needed):

IP Address: 10.10.10.10

Port number: 2000

### **Airmate**

Select "ADS-B Device" (GDL 90).

### **EasyVFR**

Select "GDL90 Stratux [...]".

### **ForeFlight**

Connects via auto-discovery (GDL 90). No settings are necessary. The auto-discovery mechanism allows to use a non-standard destination port (4000).

### **Helios Horizon**

Select "Stratux or Compatible GDL90 Device".

### **Oudie**

Uses ICD over Bluetooth. The PIN code is 1234.

### **Sky-Map**

Use the following settings under WLAN Interface configuration:

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IP: 10.10.10.10  
Port: 2000  
Password: (none)

### **SkyDemon**

Select "GDL90 Compatible Device" as Wi-Fi GPS/Traffic source under Third-Party Devices.

### **XCSoar**

Port: TCP client  
IP Address: 10.10.10.10  
TCP Port: 2000  
Driver: FLARM

or connect to FLARM Hub using Bluetooth:

Port: Hub device name (e.g. Hub-c04d84)  
Driver: FLARM  
K6Bt: Off

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## 9 Annual Maintenance

Each FLARM system must be inspected and updated every 12 calendar months. For installations in certified aircraft, the annual maintenance must be part of the Aircraft Maintenance Program (AMP) or equivalent. For other installations, the owner must set up an individual reminder 12 months after the previous maintenance.

A checklist for the annual maintenance is available in Appendix A.

### 9.1 Mandatory Firmware Update

In order to allow global and synchronized changes to the FLARM ecosystem, every FLARM device needs to be updated with the latest PowerFLARM firmware version at least once per year (every 12 calendar months) as part of the annual maintenance. Firmware updates typically contain algorithm and protocol improvements and new features.

In addition, each firmware also has a fixed expiry date to avoid that devices that have not been updated are broadcasting obsolete data. If the expiry date is reached, the device will issue an error. If the firmware update scheme is followed, the expiry date will never be reached. The expiry date shall not be relied upon for scheduling updates.



**If the annual firmware update is not applied, the device may no longer be interoperable with other FLARM devices and will stop to operate! If a *FLARM Compatible* display is not used, information about firmware expiration or non-operating status may not be annunciated.**

Download the latest PowerFLARM firmware file (.fw) under the following link:

<https://flarm.com/support/firmware-updates/>

To stay up to date with additional unscheduled updates and other important information, sign up to the newsletter from the FLARM website to ensure that important communication is not missed:

<https://flarm.com/blog/>

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## 9.2 Obstacle Database Update

If an obstacle database is installed, the database and the associated license is valid for one year and needs to be updated as part of the annual maintenance. See Section 5.2 for details.

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## 10 Pre-flight Inspection

Inspect the external and accessible internal antennas to verify that they are clean and not damaged. Power on FLARM and verify that no error occurs during the boot sequence. If an error occurs, check the severity and type of error (error code) to determine if the system can be operated for the flight. Error codes are listed in Appendix B. After power-on, the system should indicate GPS and TX (Transmit).

**Note:** The system will not indicate GPS and TX if the GPS does not have a clear view of the sky (e.g. if inside a hangar).

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## 11 Troubleshooting and Servicing Information

Many problems and issues can be related to one of the following causes:

- Improper antennas or antenna cables used
- Incorrect antenna or antenna cable installation
- Incorrect configuration
- Aging or breaking of components under normal or abnormal wear (device, cables, antennas, connectors, connector pins)
- Not using a *FLARM Compatible* display (no, incorrect, or incomplete collision warnings, operation with error conditions, expired obstacle database, etc.)
- No valid GNSS position (e.g. aircraft is inside a hangar)

Make sure all instructions have been followed. This includes the installation instructions as well as other instructions.

A list of approved antennas and cables is available in the Installation Manual.

Configure the system using FLARM Hub (see Section 3.4 as well as Section 5).

Pay special attention to the 24-bit aircraft address, aircraft type, and FLARM/ADS-B/SSR ranges and target processing settings.

A list of certified *FLARM Compatible* displays can be found in the Installation Manual, as well as in the [Product Selector](#) under the category "Primary Displays".

If an error is indicated, a list of error codes can be found in Appendix B. Many issues can also be resolved by consulting the FAQ:

<https://support.flarm.com/>

PowerFLARM Fusion may only be repaired by FLARM Technology Ltd or its authorized service partners.

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## 12 Removal, Replacement, and Addition of components

System components may be removed and replaced following the instructions from the respective manufacturer (e.g. Installation Manual). If removing or disconnecting any component required for the operation of FLARM, the display (or the location where the display was located if removing the display) must be placarded with "FLARM INOP".

If the PowerFLARM Fusion is replaced, it must be updated to the latest firmware version, or it must be ensured that a current firmware version is installed. Configure the device as required during reinstallation. Always save the configuration for documentation and future use. If not updating to the latest firmware version, it must be ensured that the next annual maintenance is completed before the firmware expires.

If the display is replaced, it must be configured e.g. for the correct baud rate. If the display is replaced with a different model, PowerFLARM Fusion might have to be reconfigured as well. If any replaced or newly installed display was/is able to configure Fusion (e.g. as part of the start-up), ensure that all connected components are configured and operate as required.

If any part of the system is modified (i.e. change, addition, or removal of components), the Installation Verification Checklist in the Installation Manual must be completed after the change, even if the modification is formally not a change to the type certificate of the aircraft.

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## **13 Additional Information**

### **13.1 Warranty Information and Terms of Use**

Any warranty is immediately void should the device be opened, misused, or installed incorrectly. EULA including Terms of use is applicable. The latest version available when this manual was published can be found in Appendix C.

### **13.2 Installation of Mode-S Transponder or ADS-B Out Equipment**

If a Mode-S transponder or separate ADS-B Out equipment is installed in the aircraft, it must be ensured that both the transponder/ADS-B Out equipment and the FLARM system is configured to the correct (identical) 24-bit ICAO aircraft address. Otherwise, FLARM may indicate ownship as another aircraft and/or systems in other aircraft may show duplicate aircraft.

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## Appendix A – Annual Maintenance Checklist

The following checklist shall be completed during annual maintenance, i.e. every 12 calendar months (see Section 9).

This checklist may be performed as pilot-owner maintenance if otherwise allowed by the AMP, where applicable.

#	Item	Description
<b>1</b>	Mechanical Attachment	Verify proper installation and secure mounting of installed parts.
<b>2</b>	Antenna status and placement	Verify that all antennas are correctly installed/placed. In particular, verify that antennas are vertical (FLARM RF is vertically polarized), do not touch other objects, and are not close to or shielded by metal or carbon parts. Verify that the antennas and their insulation are undamaged (see the appendix on Acceptable Antennas and Cables in the Installation Manual for details).
<b>3</b>	Cables & wiring	Perform a visual check in order to verify that all antenna cables and wiring, including connectors, are undamaged, unbent, have no corrosion or signs of water, and are correctly installed.
<b>4</b>	Range analysis	<p>Verify acceptable range by using the CARP Range Analyzer (see Section 3.9). Alternatively, download all IGC logs from the device (see Section 7) and upload the most recent file(s) to the online FLARM Range Analyzer:</p> <p><a href="https://flarm.com/support/tools-software/flarm-range-analyzer/">https://flarm.com/support/tools-software/flarm-range-analyzer/</a></p> <p>Only upload flights completed after the last maintenance or modification, as applicable.</p> <p><b>Note:</b> For a CARP analysis, only upload the single most recent file.</p> <p>Check the range to verify the functioning of the system. Omnidirectional range with external antennas should normally be at least 10 km, and with internal antennas &gt; 5 km. Recommended minimum range is indicated by the range analyzer result graph.</p> <p>Retain the range analysis for future comparison.</p>



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<b>5</b>	Reset CARP	Reset the Continuous Analyzer of Radio Performance (CARP) using FLARM Hub (see Section 3.9).
<b>6</b>	Firmware update	Update the PowerFLARM firmware and FLARM Hub firmware to the latest version. See Section 3.5 and Section 9.1 for details.
<b>7</b>	Display update	Install the latest display firmware, if applicable. It can be acquired from the display manufacturer.
<b>8</b>	Configuration	If the PowerFLARM firmware release notes indicate that configuration settings have been added or changed, reconfigure the device as required. See Section 3.4.1 and Section 5 for details.
<b>9</b>	Obstacle database update	If an obstacle database is installed, update the database to the latest version. See Section 5.2 for details.
<b>10</b>	Status/Error conditions	<p>Power on Fusion and verify that no error occurs during the boot sequence. If an error occurs, check the severity and type of error (error code) to determine the proper remedy. Error codes are listed in Appendix B.</p> <p>Verify that Fusion has GNSS reception at the latest 15 minutes after power-on. The aircraft/device must be outside with a clear view of the sky. The system should indicate GPS and TX (Transmit). In addition, RX (Receive) should be indicated if other transmitting FLARM-equipped aircraft are within range.</p> <p>Verify that connected displays are showing normal indications. See the display manual for details.</p>



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## Appendix B – List of Error Codes

The table below lists the error codes that can be indicated and their meaning. The hexadecimal value of the error code is shown. Some displays may instead indicate the decimal value and/or a text description. The possible error code range is from 0 to FFF.

Error Code (Hex)	Meaning
<b>11</b>	Firmware expired (requires valid GNSS information, i.e. will not be available during the first minutes after power-on)
<b>12</b>	Firmware update error
<b>21</b>	Power (e.g. voltage below minimum)
<b>22</b>	UI error
<b>23</b>	Audio error
<b>24</b>	ADC error
<b>25</b>	SD card error
<b>26</b>	USB error
<b>27</b>	LED error
<b>28</b>	EEPROM error
<b>29</b>	General hardware error
<b>2A</b>	Transponder receiver Mode-C/S/ADS-B unserviceable
<b>2B</b>	EEPROM error
<b>2C</b>	GPIO error
<b>31</b>	GNSS communication
<b>32</b>	Configuration of GNSS module
<b>33</b>	GNSS antenna
<b>41</b>	RF communication
<b>42</b>	Another FLARM device with the same Radio ID is being received. Alarms are suppressed for the relevant device.
<b>43</b>	Wrong ICAO 24-bit address or radio ID
<b>51</b>	Communication
<b>61</b>	Flash memory
<b>71</b>	Pressure sensor
<b>81</b>	Obstacle database (e.g. incorrect file type)
<b>82</b>	Obstacle database expired
<b>91</b>	Flight recorder
<b>93</b>	Engine-noise recording not possible
<b>94</b>	Range analyzer
<b>A1</b>	Configuration error, e.g. while reading flarmcfg.txt from SD/USB
<b>B1</b>	Invalid obstacle database license (e.g. wrong serial number)
<b>B2</b>	Invalid IGC feature license
<b>B3</b>	Invalid AUD feature license
<b>B4</b>	Invalid ENL feature license



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<b>B5</b>	Invalid RFB feature license
<b>B6</b>	Invalid TIS feature license
<b>100</b>	Generic error
<b>101</b>	Flash File System error
<b>110</b>	Failure updating firmware of external display
<b>120</b>	Device is operated outside the designated region; the device does not work
<b>F1</b>	Other

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## Appendix C – End User License Agreement (EULA)

By purchasing or using a FLARM device or by downloading, installing, copying, accessing, or using any FLARM Technology Ltd, Cham, Switzerland (hereafter "FLARM Technology") software, firmware, license key, or data, you agree to the following terms and conditions. If you do not agree with the terms and conditions do not purchase or use the FLARM device and do not download, install, copy, access, or use the software, firmware, license key, or data. If you are accepting these terms and conditions on behalf of another person, company, or other legal entity, you represent and warrant that you have full authority to bind that person, company, or legal entity to these terms and conditions.

If you are purchasing or using a FLARM device, the terms "firmware", "license key", and "data" refer to such items installed or available in the FLARM device at time of purchase or use, as applicable.

### 1. License and Limitation of use

- 1.1. **License.** Subject to the terms and conditions of this Agreement, FLARM Technology hereby grants to you a non-exclusive, non-transferable right to download, install, copy, access, and use the software, firmware, license key, or data in binary executable form solely for your own personal or internal business operations. You acknowledge that the software, firmware, algorithms, license key, or data and all related information are proprietary to FLARM Technology and its suppliers.
- 1.2. **Limitation of use.** Firmware, license keys, and data may only be used as embedded in and for execution on devices manufactured by or under license from FLARM Technology. License keys and data may only be used in the specific devices, by serial number, for which they were sold or intended. Software, firmware, license keys, and data with an expiration date may not be used after the expiration date. Right to download, install, copy, access, or use software, firmware, license key, or data with an expiration date does not imply right to upgrade or extension of the license beyond the expiration date. No other licenses are granted by implication, estoppel or otherwise.

### 2. Terms of use of FLARM

- 2.1. Every FLARM installation must be approved by licensed Part-66 certifying staff or the national equivalent. A FLARM installation requires an EASA Minor Change Approval or the national equivalent.
- 2.2. FLARM must be installed according to the Installation Instructions and the EASA Minor Change Approval, or the national equivalent.
- 2.3. FLARM cannot warn in all situations. In particular warnings may be incorrect, late, missing, not being issued at all, show other threats than the most dangerous or distract the pilot's attention. FLARM does not issue resolution advisories. FLARM can only warn of aircraft that are equipped with FLARM, SSR transponders (in specific FLARM devices), or of up-to-date obstacles stored in its database. The use of FLARM does not allow a change of flight tactics or pilot behavior. It is the sole responsibility of the pilot in command to decide upon the use of FLARM.
- 2.4. FLARM may not be used for navigation, separation, or under IMC.
- 2.5. FLARM does not work if GPS is inoperative, degraded, or unavailable for any reason.
- 2.6. The most recent Operating Manual must be read, understood and followed at all times.

- 2.7. The firmware must be replaced once per year (every 12 months). The firmware must also be replaced earlier if a Service Bulletin or other information is published with such instruction. Failure to replace the firmware may render the device inoperable or incompatible with other devices, with or without warning or notice thereof.
- 2.8. Service Bulletins are published as a Newsletter by FLARM Technology. You are required to sign up for the Newsletter on [www.flarm.com](http://www.flarm.com) to ensure that you are informed of published Service Bulletins. If you are entering into this agreement in a form where your email address is available (e.g. online shop) you may be automatically signed up for the Newsletter.
- 2.9. After power-up, FLARM performs a self-test which must be monitored by the pilots. If a malfunction or defect is observed or suspected, FLARM must be disconnected from the aircraft by maintenance before the next flight and the device inspected and repaired, as applicable.
- 2.10. The pilot in command is solely responsible to operate FLARM according to applicable national regulations. Regulations might include, but are not limited to, airborne usage of radio frequencies, aircraft installation, safety regulations, or regulations for sports competitions.
3. **Intellectual Property.** No part of the software, firmware, license keys, data (including obstacle databases), the FLARM radio protocol and messages, and the FLARM hardware and design may be copied, altered, reverse engineered, decompiled or disassembled without an explicit and written approval by FLARM Technology. Software, firmware, license keys, data (including obstacle databases), the FLARM radio protocol and messages, the FLARM hardware and design, and the FLARM logos and name are protected by copyright, trademark and patent laws.
4. **Manipulation.** It is forbidden to intentionally feed artificially generated signals to the FLARM device, its GPS antenna or the external/internal GPS antenna connections, unless agreed with FLARM Technology in writing for limited R&D activities.
5. **FLARM Data and Privacy**
  - 5.1. FLARM devices receive, collect, store, use, send, and broadcast data to enable the system to work, improve the system, and to enable troubleshooting. This data may include, but is not limited to, configuration items, aircraft identification, own positions, and such data of other aircraft. FLARM Technology may receive, collect, store, and use this data for said or other purposes including Search and Rescue (SAR).
  - 5.2. FLARM Technology may share data with its partners for aforementioned or other purposes. FLARM Technology may in addition publicly make available data from a FLARM device (Flight Tracking). If a FLARM device has been configured to limit tracking, SAR and other services may not be available.
  - 5.3. Data sent or broadcast by FLARM devices may only be used at own risk and under the same conditions as the FLARM device itself, and is encrypted partially to ensure message integrity, system safety and provide protection for the relevant content against eavesdropping, namely by article 3 of the Budapest Convention on Cybercrime as signed and ratified by most countries respectively its national implementations. FLARM Technology is not responsible for any third party device, software, or service receiving, collecting, storing, using, sending, broadcasting, or making publicly available data regardless of whether legally or illegally.



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## 6. **Warranty, Limitation of Liability, and Indemnification**

- 6.1. **Warranty.** FLARM devices, software, firmware, license keys, and data are provided on an "as is" basis without warranty of any kind — either expressed or implied — including, without limitation, any implied warranties of merchantability or fitness for a particular purpose. FLARM Technology does not warrant the performance of the device, software, firmware, license key, or data or that the device, software, firmware, license key, or data will meet your requirements or operate error free.
- 6.2. **Limitation of Liability.** In no event shall FLARM Technology be liable to you or any party related to you for any indirect, incidental, consequential, special, exemplary, or punitive damages (including, without limitation, damages for loss of business profits, business interruption, loss of business information, loss of data or other such pecuniary loss), whether under a theory of contract, warranty, tort (including negligence), products liability, or otherwise, even if FLARM Technology has been advised of the possibility of such damages. In no event will FLARM Technology's total aggregate and cumulative liability to you for any and all claims of any kind arising hereunder exceed the amount of fees actually paid by you for the device, license keys or data giving rise to the claim in the twelve months preceding the claim. The foregoing limitations will apply even if the above stated remedy fails of its essential purpose.
- 6.3. **Indemnification.** You will, at your own expense, indemnify and hold FLARM Technology, and all officers, directors, and employees thereof, harmless from and against any and all claims, actions, liabilities, losses, damages, judgments, grants, costs, and expenses, including reasonable attorneys' fees (collectively, "Claims"), arising out of any use of a FLARM device, software, firmware, license key, or data by you, any party related to you, or any party acting upon your authorization.

## 7. **General terms**

- 7.1. **Governing Law.** This Agreement shall be governed by and construed in accordance with the internal law of Switzerland (to the exclusion of Swiss Private International Law and of international treaties, in particular the Vienna Convention on the International Sale of Goods dated April 11, 1980).
- 7.2. **Severability.** If any term or provision of this Agreement is declared void or unenforceable in a particular situation, by any judicial or administrative authority, this declaration shall not affect the validity or enforceability of the remaining terms and provisions hereof or the validity or enforceability of the offending term or provision in any other situation. To the extent possible the provision will be interpreted and enforced to the greatest extent legally permissible in order to effectuate the original intent, and if no such interpretation or enforcement is legally permissible, shall be deemed severed from the Agreement.
- 7.3. **No Waiver.** The failure of either party to enforce any rights granted hereunder or to take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights or subsequent actions in the event of future breaches.

- 7.4. **Amendments.** FLARM Technology reserves the right, in its sole discretion, to amend this Agreement from time to time by posting an updated version of the Agreement on [www.flarm.com](http://www.flarm.com), provided that disputes arising hereunder will be resolved in accordance with the terms of the Agreement in effect at the time the dispute arose. We encourage you to review the published Agreement from time to time to make yourself aware of changes. Material changes to these terms will be effective upon the earlier of (i) your first use of the FLARM device, software, firmware, license key, or data with actual knowledge of such change, or (ii) 30 days from publishing the amended Agreement on [www.flarm.com](http://www.flarm.com). If there is a conflict between this Agreement and the most current version of this Agreement, posted at [www.flarm.com](http://www.flarm.com), the most current version will prevail. Your use of the FLARM device, software, firmware, license key, or data after the amended Agreement becomes effective constitutes your acceptance of the amended Agreement. If you do not accept amendments made to this Agreement, then it is your responsibility to stop using the FLARM device, software, firmware, license key, and data.
- 7.5. **Governing Language.** Any translation of this Agreement is done for local requirements and in the event of a dispute between the English and any non-English versions, the English version of this Agreement shall govern.