Document status

Published status	Confidentiality status
☐ Draft	☐ Internal
☒ Released	☐ NDA
☐ Canceled	☒ Public

Version control

Ver.	Date	Summary of changes
1.00	2017-01-10	Initial version

Scope and summary

This Application Note explains technical requirements for installing FLARM antennas. The Application Note is supplemental to the Installation Manual and MCA Installation Instructions. Also refer to the Installation Manual and MCA Installation Instructions for information on GPS and SSR antenna installation.

The Application Note is generic in nature and does not provide detailed instructions for a specific aircraft type. The radiation pattern and range is heavily influenced by material and location of other parts of the aircraft.

Installation of antennas, as well as installation of the complete FLARM system, can be done only under an EASA Minor Change Approval (MCA), as a Standard Change, or the national equivalent. The installation must be released by Part-66 certifying staff. It is not permitted to install FLARM and/or antennas under pilot-owner maintenance.

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1 Abbreviations and definitions

Term	Meaning/Explanation
external antenna	Antenna installed on top of or below the aircraft fuselage
internal antenna	Antenna installed inside the fuselage or vertical stabilizer, normally only in fiberglass gliders
kt	knots (1.852 km/h)
MCA	Minor Change Approval
nm	nautical miles (1.852 km)
SSR	Secondary Surveillance Radar
SWR	Standing Wave Ratio
UAV	Unmanned Aerial Vehicle

2 Introduction

FLARM systems are today being installed in a variety of aircraft types: light airplanes, helicopters, gliders, UAVs, etc. The specific requirements for each type of aircraft, as well as individual differences between aircraft, make it difficult to produce comprehensive guidelines. This Application Note nevertheless aims to explain the most common installation types, best practice, and don'ts.

Light airplanes and helicopters will normally be required to use external antennas, of which the placement and installation is normally straightforward. UAVs will require antennas and installation thereof that is very specific to the type of UAV. The most challenging antenna installations are instead in gliders when using internal antennas. These guidelines therefore focus on internal antennas installed in gliders.

Before making a permanent installation of internal antennas, it's recommended **not to make the first installation permanent**. Read the section "How to build a temporary dipole antenna mount" and follow the guidelines for a first try. This will most probably yield an acceptable range or at least give you a good starting point for further optimization. Keep in mind that for safety purposes, you only need a range of about 2 nm forward (less to the sides). See the FAQ section for explanation. Once you are happy with the achieved range, make the installation permanent.

An online range analysis tool is available at:
http://flarm.com/support/tools-software/flarm-range-analyzer/

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The EASA Minor Change Approval (MCA) valid for ELA1 and ELA2 airplanes can be purchased under the following link:

http://flarm.com/shop/easa-minor-change-approval-mca/

The documents received as part of the EASA approved MCA are also required for a Standard Change installation.

3 Antenna Installation Guidelines

3.1 PowerFLARM Antenna types

PowerFLARM external antenna AV-75 ▪ Requires a ground plane[1] (the aircraft skin) ▪ Highest performance ▪ Normally, antenna diversity is required, just like the SSR antennas (one antenna on top of the aircraft and one below)	
PowerFLARM Portable device antenna (rubber ducky antenna) ▪ Does not need a ground plane[1] ▪ Medium performance	
PowerFLARM Core internal antenna (center fed dipole antenna) ▪ Does not need a ground plane[1] ▪ High performance	
Classic FLARM device antenna (¼ wave whip antenna) ▪ Requires a ground plane[1] of at least 80 mm (3 inch) radius ▪ Medium performance ▪ Blind spots below the ground plane[1]	

[1] A ground plane is a plane of highly conductive material (e.g. metal) orthogonal to the antenna axis and electrically connected to the antenna ground. If you are unsure about the meaning of the term “ground plane”, just use the bundled antennas and keep any conductive material (e.g. aluminum, carbon fiber) away from the antennas.

3.2 Do's and Don'ts

3.2.1 Before connecting, always check type and polarity of antenna connectors carefully

Version E devices

FLARM antenna connectors on PowerFLARM Core and PowerFLARM Portable are SMA Female.

Version A devices

On PowerFLARM Core, both FLARM antenna connectors are RP-SMA (Reversed Polarity SMA) Female. Of PowerFLARM Portable, the FLARM A antenna connector is RP-SMA Female and the FLARM B antenna connector is SMA Female.

Note: The AV-75 external antennas are BNC Female.

Attaching incompatible antennas to the connectors will cause loss of performance, permanent damage to the device, and void the warranty.

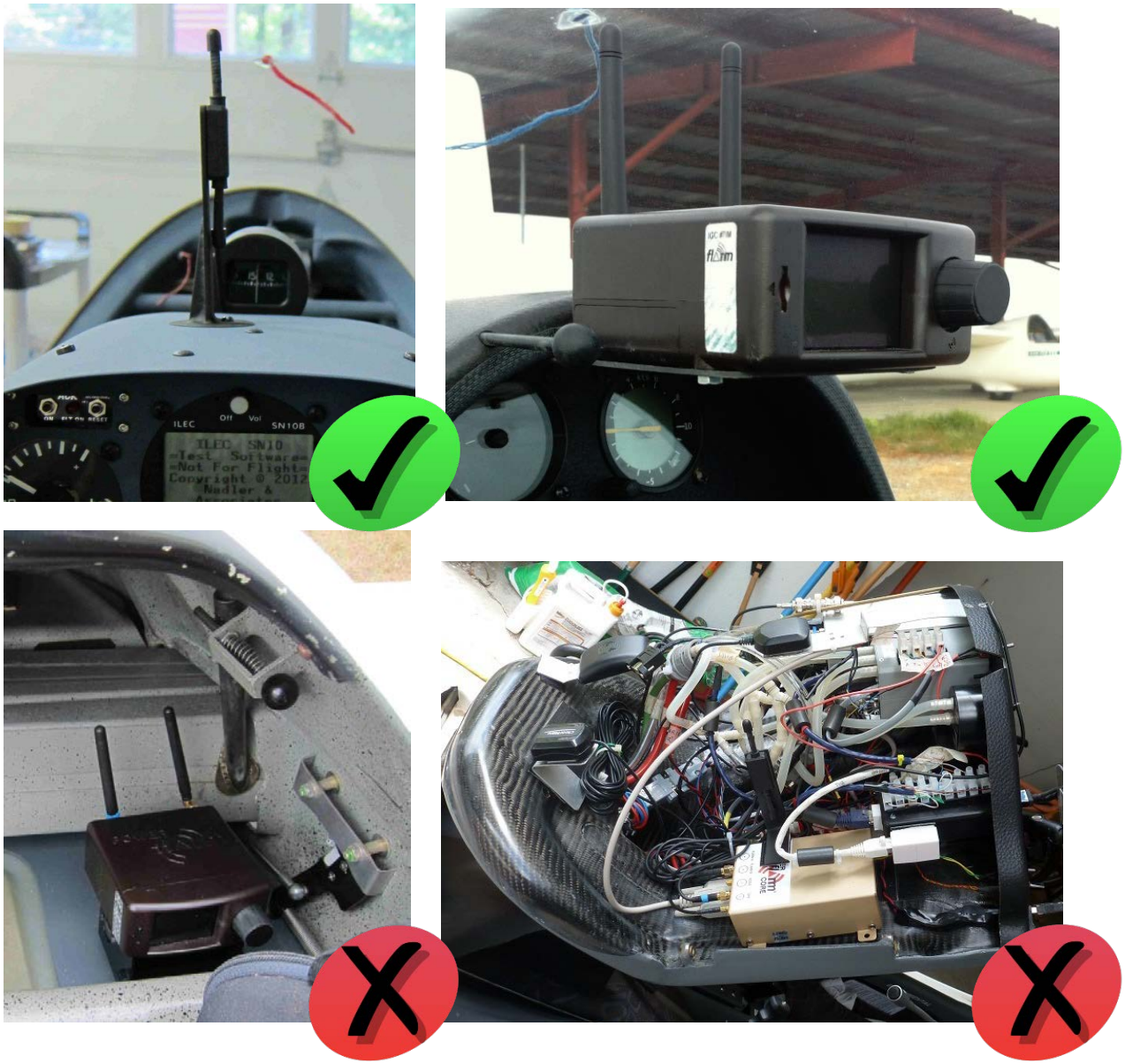
Note: Version E and Version A devices are intended for different parts of the world (different frequency bands) and require different antennas.

3.2.2 Mount antenna clear of any object

Give the antenna as much free room as possible.

Don't let it touch anything!

Keep in mind that not just conductive material but also humans attenuate signals. Glass fiber and Kevlar barely attenuates signals.



3.2.3 Always connect an antenna to the FLARM A port

If you only use one antenna, connect it to the FLARM A port. If you feel that your airplane attenuates signals strongly in one direction, you can connect a second antenna to the FLARM B port. The best solution however is to find a place where the antenna on FLARM A port can freely radiate in every direction.

It is forbidden to connect more than one antenna to one RF Port (e.g. via a splitter). Doing so will severely decrease range, possibly to zero.

3.2.4 Ensure that the installation does not conflict with any operation of the aircraft, e.g. canopy emergency release

The coaxial antenna cable will not rip!

3.2.5 Mount antennas vertically

Do not tilt the antennas more than max +/- 15°.

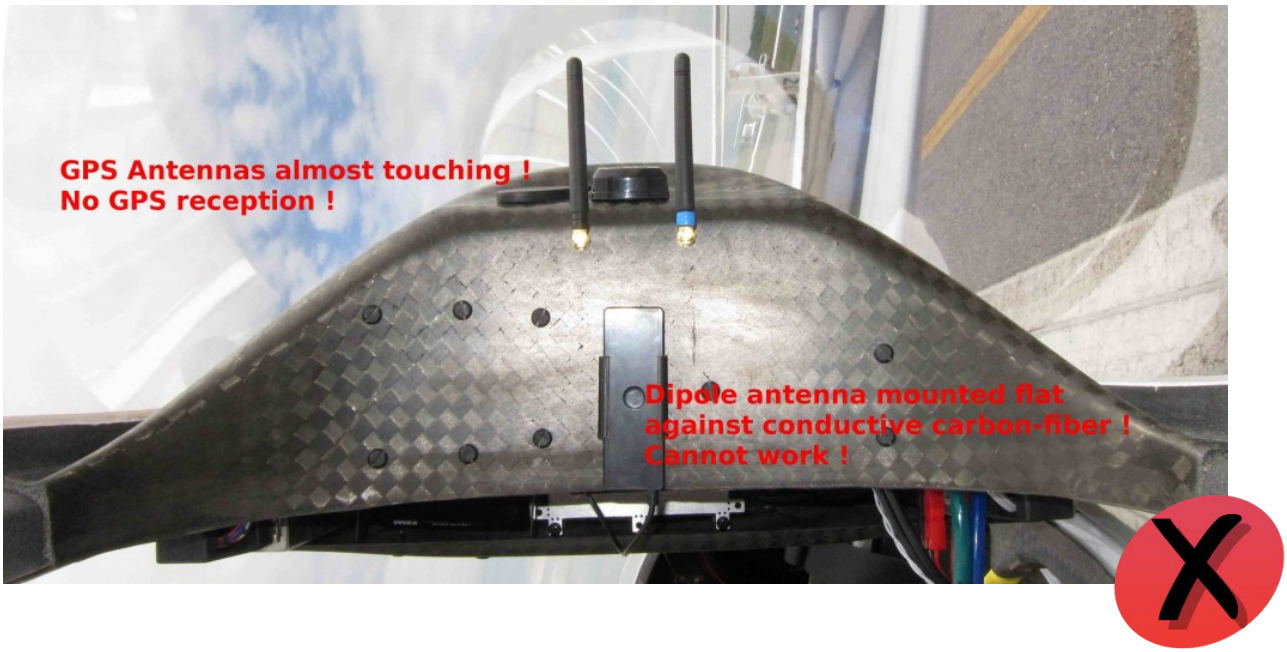
3.2.6 Mount PowerFLARM Portable device horizontally on a level surface.

Tilting will cause the antennas to get too close together

3.2.7 Keep antennas separated as far as possible

Min. distance between antenna on FLARM A and FLARM B port: 30 cm (1 ft)
Min. distance between antenna on FLARM A port and GPS antenna: 30 cm (1 ft)
Min. distance between antenna on FLARM B port and GPS antenna: 10 cm (4”)
Min. distance between ADS-B / SSR antenna and GPS antenna: 10 cm (4”)

3.2.8 Do not mount rubber ducky or dipole antennas on conductive material (e.g. any type of metal or carbon fiber)



3.2.9 Guide cable horizontally away from the PowerFLARM remote antenna

Do not tie the cable to one arm of the dipole, since it will distort the signal.

3.3 Alternative antenna types and placements

PowerFLARM is delivered with universal antennas that work well for most glider installations.

However, some alternative antenna types or placement locations may be beneficial.

Contact your local PowerFLARM dealer for alternative antennas.

3.3.1 On top of the glare shield

A simple ¼ wave whip antenna with ground plane of at least 80 mm (3 inch) radius works very well, if installed properly.

Some gliders can be ordered with this type of FLARM antenna pre-installed; talk to your supplier.

Figure 1 Example of factory installed glare shield antennas; required ground plane is hidden under the cover. ADS-B/SSR antenna on the left, FLARM antenna on the right.

Possible supplier: Mobile Mark PSTG0-925SE

http://www.tessco.com/products/displayProductInfo.do?sku=384213&eventPage=1

Note: The length and picture on the Tessco site are incorrect. Actual length is 2 7/8.

You will also need an extension cable with suitable connectors (RP-SMA to SMA) and a ground plane.

Note: This is not a product that FLARM has tested, supplies, or officially endorses. It will require the installation of a suitable ground plane and cables to work properly. We do not supply support for this type of installation.

3.3.2 External AV-75 antenna

The external AV-75 antennas are normally required for light aircraft (other than fiberglass gliders) and helicopters. Typically, one antenna is mounted on top of the aircraft and one antenna on the bottom of the aircraft, similar to the SSR antennas.

The following antenna cables are approved: 50 Ω RG58, RG142B, RG142B/U, RG400, or equivalent.

3.3.3 Antenna in tail

Some carbon fiber gliders have dedicated glass only areas in their tails for VHF and other antennas.

It may be possible to place the FLARM antenna there.

The following antenna cables are approved: 50 Ω RG58, RG142B, RG142B/U, RG400, or equivalent.

3.3.4 Antenna in gear box

This location is NOT recommended for the Port A antenna.

In carbon fiber gliders, the Port B antenna may be placed in or near the gear box to improve range below, if the gear doors are not made of carbon.

3.4 FAQ

Q: What is the minimum required range for a timely warning?

A: When flying at or below 250 kt, a range of 2 nm (3 704 m) forward and 1 nm to the side and behind will give the pilots a warning at least 15 seconds before closest convergence.
Any range beyond that may be useful for tactical purposes but it adds very little to safety.

Calculation:
Worst case below 10 000 ft is normally two aircraft converging at 250 kt each -> 500 kt closing speed -> 257 m/s
For a 15 second warning -> 3 858 m -> 2.08 nm
The profile of a glider when seen from straight ahead at 2 nm distance is about as thick as a human hair held at arm's length; almost impossible to see...

Q: Can you tell me if my antenna installation will perform well?

A: No, we will not be able to predict how your particular installation will perform. You have better knowledge of the material used in your airplane than we do. Stick to the guidelines in this document and your installation should be OK for collision avoidance. If you want to get extended range, you will have to do some testing.

Q: I found this antenna datasheet on the Internet, can I use it for PowerFLARM?

A: Maybe. It is often difficult to determine real world antenna performance from datasheets. Some antennas tested by FLARM Technology do not meet their published specifications. If you like experimenting, make sure the connectors, operating frequency, and impedance (50 Ohm) match! A generic rule: The larger the antenna, the better it works.

Q: May I use an extension cable for the antennas?

A: Yes, but total attenuation must remain < 1.5 dB. Do not use RG-174 or similar poor coaxial cables. Also, keep in mind that every connector introduces signal losses. The following antenna cables are approved: 50 Ω RG58, RG142B, RG142B/U, RG400, or equivalent

Q: Does the human body attenuate the FLARM signal?

A: Yes

Q: Does the FLARM signal harm the human body?

A: PowerFLARM devices meet or exceed all relevant CE and FCC requirements. In addition, the signal is up to 100 times weaker than a cell phone signal, while using similar frequencies.

Q: May I use an antenna splitter to attach two FLARM antennas to one antenna port?

A: No, this will most likely result in signals cancelling themselves out completely.

Q: May I use an antenna splitter to share the GPS antenna with another device?

A: Yes, if you know what you are doing (probably not if you have to ask…)
Hint: most GPS antennas are active and need to be powered…

Q: Do the FLARM antennas really have to be within 15 degrees of vertical?

A: Yes, really. A 90 degrees tilted antenna will have near zero range.

Q: Why does PowerFLARM Version A have Reversed Polarity SMA connectors for the FLARM antenna?

A: Because of illogical FCC requirements.

Q: What about the SSR/ADS-B antennas?

A: Placement of the SSR/ADS-B antenna is not as crucial as the signals it receives are many times stronger than the FLARM signals. Observe the same fundamental rules as for the FLARM antennas but don't lose sleep over its placement.

Q: Can I fully test an antenna with an SWR meter?

A: No, even 50 ohm resistors look **great** on SWR meters... (Don't worry if you don't know what an SWR meter is)

4 How to build a temporary dipole antenna mount

We highly recommend starting with a temporary antenna installation to verify proper operation and range of PowerFLARM. In particular, we do not recommend making the installation permanent before it has been checked with the online range analysis tool.

4.1 Materials needed

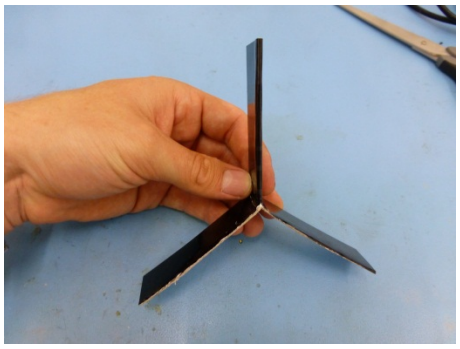
- Black, fat sharpie
- Thin cardboard 2 x 6 inch
- Double sided tape
- Scissors
- 5 minutes

4.2 Instructions

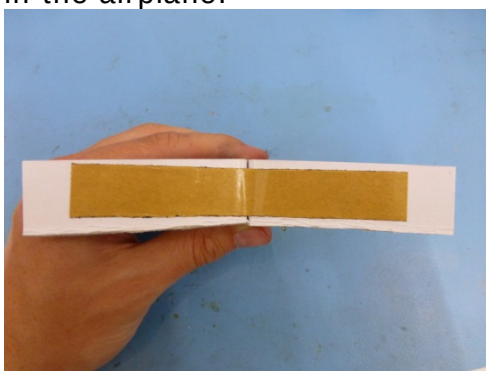
1. Paint one side of the carbon completely black to avoid reflections on the canopy.

2. Fold cardboard in the middle.

3. Cut bottom halves and fold out bottoms.



4. Apply double sided tape to the folded-out bottoms for subsequent installation in the airplane.



5. Attach antenna and cable with its double-sided sticker.