

## **PowerFLARM Application Note RF ANTENNAS (North America)**

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## Introduction

This Application Note is concerned with the FLARM RF antenna installation. Refer to the PowerFLARM manual for information on GPS antenna placement and installation.





The following section “Antenna Installation Guidelines” gives you hints on how to properly install FLARM RF antennas. If you follow these guidelines you will most probably get a properly working installation for collision avoidance. However we cannot provide you with the optimal installation for an arbitrary aircraft type as the radiation depends on the type of the aircraft and the materials used.

Therefore, **do not make the first installation permanent**. Check the section “How to build a temporary dipole antenna mount” and follow the installation guidelines for a first try. This will most probably yield a good range or at least give you a good starting point for further optimization. Keep in mind that for safety purposes you require a range of only 1 NM forward, less to the sides (See “FAQ” section for explanation). Once you are happy with the achieved range, make the installation permanent.

My Q4 2012 a range analysis tool will become available for PowerFLARM, similar to what is available for ‘Classic’ FLARM at: [http://www.flarm.com/support/analyze/index\\_en.html](http://www.flarm.com/support/analyze/index_en.html)

## Antenna Installation Guidelines

### PowerFLARM Antenna types

PowerFLARM portable device antenna (rubber duckie antenna) <ul style="list-style-type: none"> <li>- Does not need a ground plane<sup>1</sup></li> <li>- Medium performance</li> </ul>	
PowerFLARM remote antenna (center fed dipole antenna) <ul style="list-style-type: none"> <li>- Does not need a ground plane<sup>1</sup></li> <li>- Highest performance</li> </ul>	
Secondary remote antenna (flat dipole antenna) <ul style="list-style-type: none"> <li>- Does not need a ground plane<sup>1</sup></li> <li>- Medium performance</li> <li>- Do not use this antenna as primary antenna!</li> </ul>	
Classic FLARM device antenna (¼ wave whip antenna) <ul style="list-style-type: none"> <li>- Requires a ground plane<sup>1</sup> of at least 80mm (3 inch) radius</li> <li>- Medium performance</li> <li>- May have blind spots below the ground plane<sup>1</sup></li> </ul>	

<sup>1</sup> 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 still unsure about the meaning of the term “ground plane” just use the bundled antennas and keep any conductive material (e.g. aluminium, carbon fibre) away from the antennas.

## The Do's and the Don'ts

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

***Have a very good look at the inside conductor, one side MUST be male, the other MUST be female.***

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



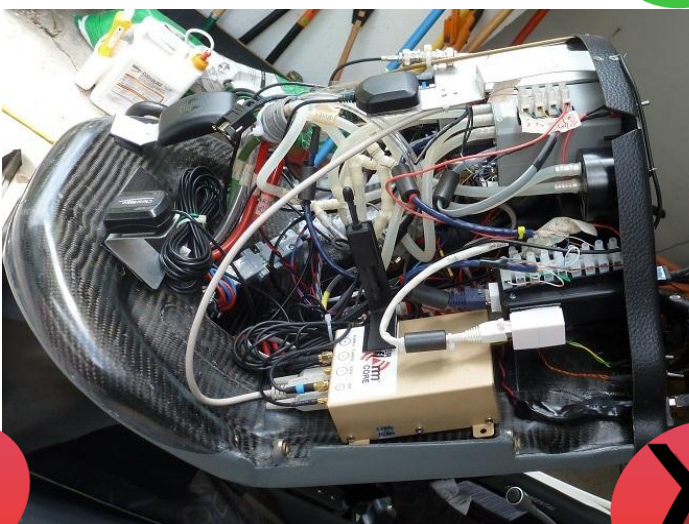
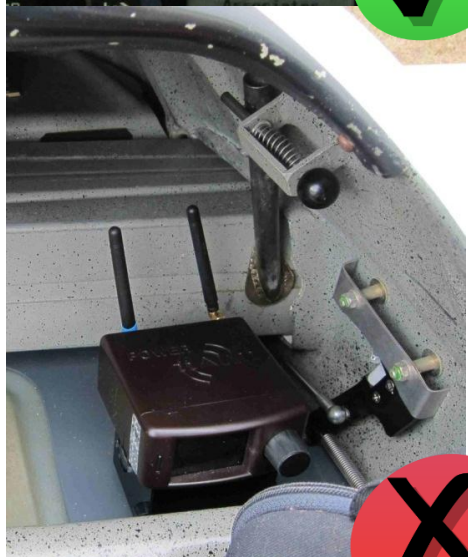
**Mount antenna clear of any object except for the parts intended for attachment by antenna designer!**

(e.g. adhesive patch on PowerFLARM remote antenna)

**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 fibre and Kevlar barely attenuates signals.



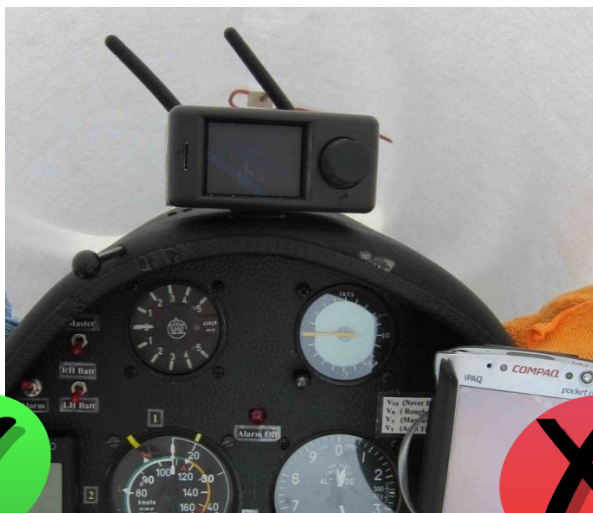


**Always connect an antenna to FLARM A port!**

If you only use one antenna, connect it to 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. Do not connect more than one antenna to one RF port (e.g. by splitter)!

**Ensure that the installation does not conflict with any operation of the aircraft e.g. Canopy emergency release**

No, the coaxial antenna cable will not 'just rip'...

**Mount antennas vertically. Do not bank (+/- 15° max.)!****Mount PowerFLARM PORTABLE device horizontally. Do not bank!**

banking will cause the antennas to get too close together



**Keep antennas separated as far as possible!**

Min. distance between RF antenna on FLARM A and FLARM B port: 1ft (0.3 m)

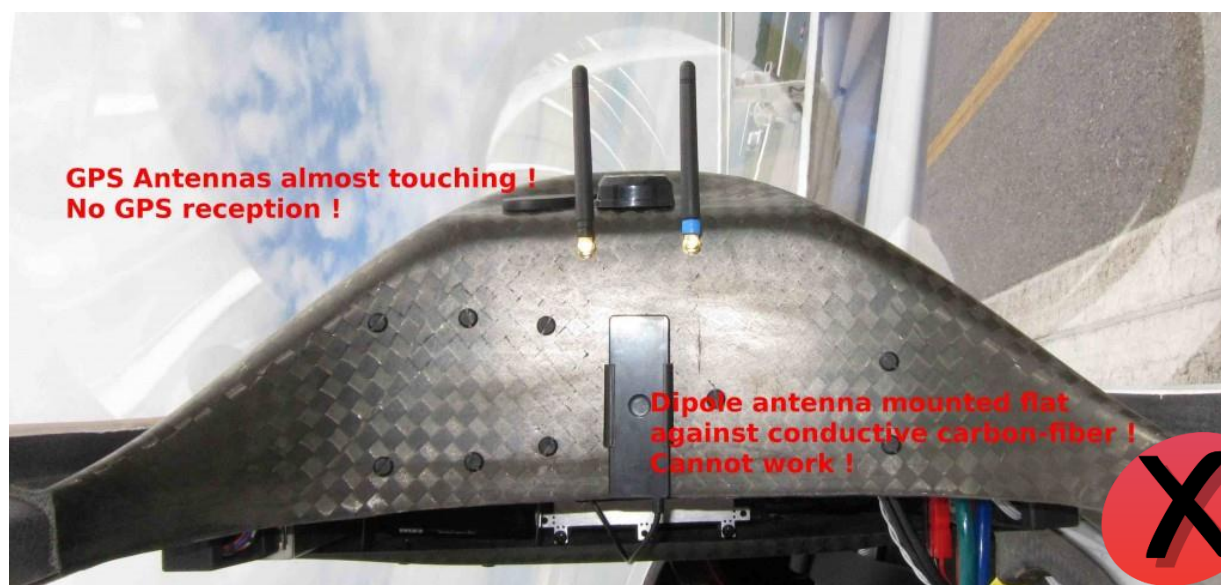
Min. distance between RF antenna on FLARM A port and GPS antenna: 1ft (0.3 m)

Min. distance between RF antenna on FLARM B port and GPS antenna: 4in (0.1 m)

Min. distance between ADS-B / XPDR antenna and GPS antenna: 4in (0.1 m)

**Do not mount antennas on conductive material (e.g. any type of metal, carbon fibre)!**

Exception: If you are using third party antennas which require a ground plane<sup>1</sup>.

**Guide cable horizontally away from the PowerFLARM remote antenna!**

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



## Alternative antenna types / placements

PowerFLARM is delivered with universal antennas that work well for most installations. However, some alternative antenna types or placement locations may be beneficial. Contact your favourite PowerFLARM dealer for alternative antennas.

### On top of the glare shield

A simple  $\frac{1}{4}$  wave whip antenna with ground plane of at least 80mm (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/PCAS antenna on left, FLARM antenna on right.**

Possible supplier: Mobile Mark PSTG0-925SE

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

Note that the length and picture on the Tesco site are incorrect. Actual length is 2 7/8. Datasheet is here:

<http://powerflarm.us/wp-content/uploads/2012/07/PSTG0-925SE.pdf>

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

**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. Please do not ask us for individual support on this type of installation.**

### Outside antenna

Some aviation antennas e.g. the ones used for transponders, will work very well, talk to the antenna supplier about performance in the 902-926MHz band used by FLARM in North America.

FLARM **cannot** share an antenna with a transponder.

### Antenna in tail

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

It may be possible to place the FLARM antenna there.

'Low loss' coaxial cables must be used with less than 1.5dB/10m attenuation at 900MHz, e.g. LMR-400

<http://www.timesmicrowave.com/products/lmr/downloads/22-25.pdf>

DO NOT use RG-174 coaxial cable for any extensions > 1m (3ft)

### Antenna in gear box

This location is NOT recommended for the 'A' port antenna.

In carbon gliders, the 'B' port antenna may be placed in or near the gear box to improve coverage from below, if the gear doors are not made out of carbon.



## FAQ

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

**A:** A range of 1 nautical mile (1852m) forward and 0.5 NM to the side and behind will give the pilot 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 for gliders is two aircraft converging at 110kn each -> 220kn closing speed -> 113m/s

For a 15 second warning -> 1697m -> 0.91 nautical miles

The profile of a glider when seen from straight ahead at 1 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 oftentimes difficult to determine real world antenna performance from datasheets. Some antennas, tested by FLARM 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:** I found this 'FLARM' antenna on the Internet, can I use it for PowerFLARM?

**A:** Maybe. Be careful with 'FLARM' antennas from non US sources, as for example FLARM in Europe uses other frequencies and therefore requires different antennas. Non US FLARM antennas may also have different polarity on the connector (RP-SMA vs. Std. SMA)

**Q:** May I use an 'extension' cable for the antennas.

**A:** Yes, but total attenuation at 915MHz must remain < 1.5dB. Do not use RG-174 or similar poor coaxial cables for extensions > 1m (3ft). Also, every connector introduces signal losses.

**Q:** Does the human body attenuate FLARM the signal?

**A:** Yes

**Q:** Does the FLARM signal harm the human body?

**A:** PowerFLARM USA devices meet or exceed all relevant FCC rules, 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 for the FLARM / PowerFLARM antennas

**A:** No

**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 (think Moiré pattern...)

**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.

**Q:** Why does PowerFLARM have 'Reverse Polarity' SMA connectors for the transmitting antenna?

**A:** Stupid FCC rule.

**Q:** May I use a 'remote' antenna, on the 'Portable' 'A' port?

**A:** Sure, just make sure you check the polarity of the connectors.

**Q:** What about the PCAS / ADS-B antenna?

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

**Q:** What about 'Port 'B' (PowerFLARM USA only)

**A:** Port 'A' is the primary FLARM antenna port and must **always** be equipped with an antenna.

If blind spots are observed or measured, a second antenna may be mounted on Port 'B'. Please purchase a suitable antenna from your favourite dealer.

**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)

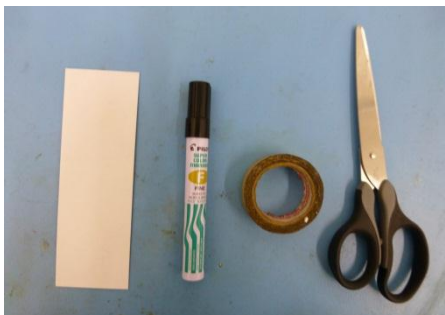


## How to build a temporary dipole antenna mount

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 by PowerFLARM's 'range analysis' tool (will become available online in Q4 2012).

### Materials needed

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



### Instructions

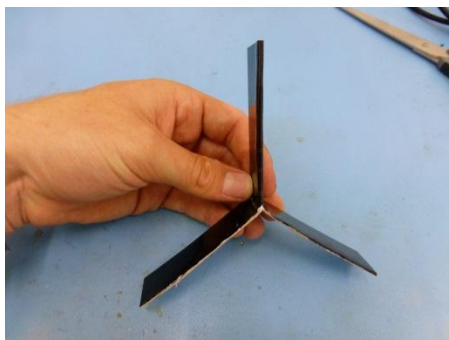
1. Paint one side of the cardboard completely in black to avoid reflections on the canopy.



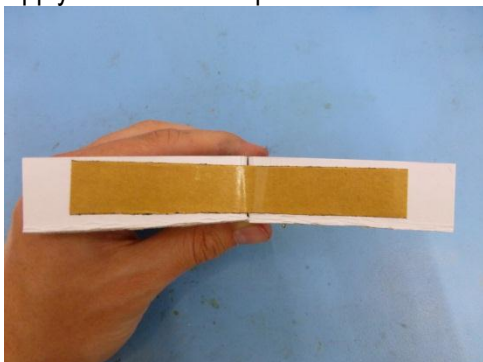
2. Fold cardboard in the middle.



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 the double sided sticker.

