

rapidFIRE 5.8GHz Goggle Receiver

Operator's Manual

Rev 1.3 - 10 April 2019

Specifications

5.8GHz	
Frequency Range	5.3-6.0GHz
Sensitivity	Best In Class (stable image at close to -100dBm)
Bands	IRC/FatShark, RaceBand, LowRace, Band A, B, E, Favorites
Channels	All of the standard ones, plus favorites (custom frequencies)
Antenna Connectors	2x Standard SMA (not RP-SMA)
Mechanical	
Weight	80g
Power	
Voltage	5.0V nominal
Consumption	350mA @ 5V with both modules enabled, < 300mA in low-power mode
Cabling	Plug and Play for Attitude, Dom HDO. Included Aux Power cable for others
User Interface	
Display	0.96" Monochrome OLED
Input	5-way Joystick + Integration with FatShark Channel Buttons
Audible	Beeper to indicate marginal reception
Operation	
Modes	rapidFIRE #1, rapidFIRE #2, classic Diversity, power-saving single module modes
Compatibility	
Dominator	V1, V2, V3, SE, HD1, HD2, HD3, HDO*, HD2 T2 *
Attitude	V3, V4
USB	
Updates	Integrated USB port, Windows application for updates
Accessories Included	
Module Doors	Dominator and Attitude module doors (Gloss Ferrari™ Red)
Aux Power	Auxiliary (HT) power board + self-adhesive flat-flex cable
Sticker Set	Sticker set to cover the flat-flex cable



Introduction

The rapidFIRE 5.8GHz Goggle Module is a high performance receiver designed for the FPV market.

Unlike traditional diversity receivers, the rapidFIRE includes sophisticated hardware which 'fuses' together the image from two antennas, and digitally reconstructs the image, with no additional latency.

Designed to give the best possible video quality in indoor arenas where multipathing is a big issue, and also in outdoor environments where maximum video range is required.

Anatomy of a rapidFIRE Module

The rapidFIRE module follows the FatShark recommendations for an Rx module compatible with both Attitude, and Dominator goggle families.

Two SMA ports are provided, labelled in the User Interface as 'Upper' and 'Lower'.



Installation Background

Module Power (or lack of)

Back when FatShark placed the first Dominator V1 goggles on the market, many moons ago, Mr. Shark had the foresight to include an expansion bay to allow modules to be changed. This spawned a whole industry in 3rd party receiver modules, covering not only the 5.8GHz band, but also the 2.4 and 1.3GHz bands.

What wasn't foreseen was how power hungry 2017's receiver modules would be, and that the electronics in most of the goggles are not happy providing enough current to power these modules.

Depending upon the goggles used, the rapidFIRE may require an auxiliary power board in order to supply power to the module.

Installation Details

For Attitude v3, v4, Dominator HDOs, and Dominator HD2 T2s

For these goggles, installation is plug-and-play, no aux power board required.

- 1) Remove the goggle rx bay door
- 2) Insert the module carefully into the connector, ensuring that it is not offset, or slid into the gap between the connector and the goggle shell
- 3) Finish by attaching the appropriate goggle-bay door (noting of course that the Attitude and Dominator use different doors)
- 4) Go Fly



For Dominator v1, v2, v3, SE, HD1, HD2, HD3

There are three ways to install the module into these goggles.

- 1) Using the auxiliary power board
- 2) Sending the goggles to a repair center to modify the power supply
- 3) A DIY modification to the Goggle's power supply

Note that this includes the original HD2s, not the T2 edition of the HD2 which doesn't require extra power.

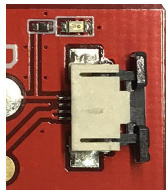
Option 1: Auxiliary Power Board

The first method is the easiest, and can be performed using just the accessories shipped with the rapidFIRE module. The Auxiliary power board is a replacement for the head-tracker board which is little used in the race/freestyle world.

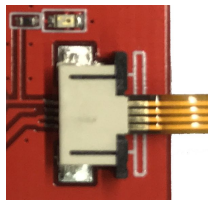


To install it, follow the procedure below:

- 1) Open the head-tracker bay door (opposite side of the goggle from the Rx bay).
- 2) Very carefully attach the end of the flat-flex cable to the auxiliary power board
 - a) First carefully slide the black part of the connector away from the body



- b) Insert one end of the cable with the metal pads facing up, and slide the black locking piece back to its original position



- 3) Install the aux power PCB very carefully into the head-tracker socket. Take great care to ensure that the pins are correctly aligned in the socket. Misalignment here can create damage to the goggles and/or rapidFIRE module.

- 4) Run the flat-flex cable across the front of the goggles, through the center of the FatShark logo.
- 5) Close the head-tracker bay door
- 6) Carefully attach the other end of the flat-flex cable to the rapidFIRE receiver using the same procedure described above.
- 7) Install the rapidFIRE receiver into the Rx bay
- 8) Close the Rx bay with the appropriate goggle-bay door
- 9) Apply the sticker (pick a color) to cover up the flatflex cable.
- 10) Go Fly

Note that to verify that the aux power modification worked, enter the main menu, and look in the bottom left corner of the OLED display. If a voltage is displayed, the mod did not work. If no voltage is displayed, then you are good to go.

*Note that with the cable installed you will notice that the playback mode of the DVR can no longer be accessed. To allow the DVR playback to function disable both receivers in the rapidFIRE **Antenna** menu (option 'Both Off').*

Option 2: Repair Center Modification

Included here for completeness, but we don't really expect pilots to give up their precious goggles for a few days.

If you do wish to eliminate the auxiliary power board a simple modification to the goggles may be performed by one of our repair centers, located in the USA, UK, and Australia.

To start the process, please send an email to repairs@immersionrc.com with the title 'HDO Power Modification'.

Option 3: DIY Goggle Modification (a.k.a the L1+L10 mod)

We do cringe a bit suggesting this, but given the fact that most pilots these days are fairly skilled with a soldering iron, and have successfully been adding power switches to their dominators we will suggest it anyway.

There is a fairly simple procedure to bridge one of the components that causes power issues for the older goggles. Basically, this component was a power filter that was included for good engineering practice, but was never really required.

Please be aware that any damage caused by opening your goggles to perform this operation is not covered by your warranty, however, our network of repair centers can always patch things up if the procedure goes horribly wrong (at your expense of course).



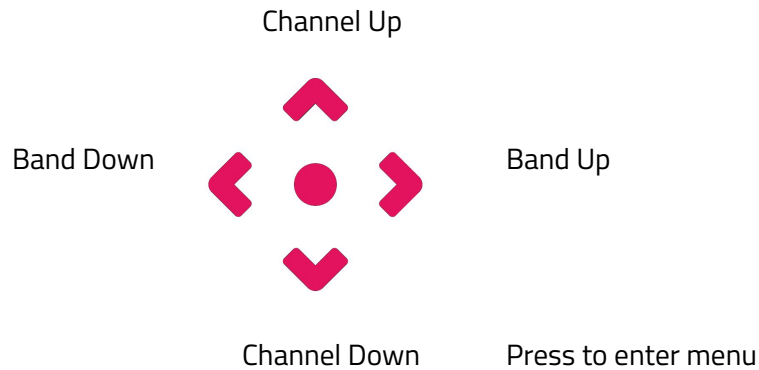
The procedure is documented in the User-Manuals section of our rapidFIRE product web page here: <https://www.immersionrc.com/fpv-products/rapidfire/>

Main Display

The main display shows the current frequency, band, and channel. Both band and channel may be changed directly from this display, using the joystick, without entering the menu.



Joystick Operation in the Main Display

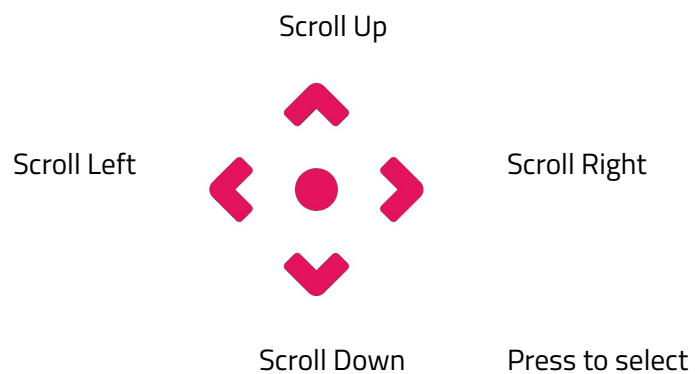


Main Menu






The main menu is navigated with the joystick, and is fairly self explanatory to use.



Joystick Operation in the Main Display



	<p>Exit Menu</p>
	<p>Channel Lock Use to lock the current rapidFIRE frequency so that an accidental touch of the goggle channel buttons, or the rapidFIRE joystick doesn't change channel.</p> <p>Turn off to restore normal functionality.</p>
	<p>Tools Menu Contains access to the Spectrum Analyzer, Band Scanner, Favorites setup, and Calibration</p>
	<p>.</p>
	<p>RF Mode Switch between rapidFIRE and Legacy diversity modes. rapidFIRE #2 is a compatibility mode that will function with all known cameras and OSD. It has the same multi-path rejection as rapidFIRE #1 mode.</p>
	<p>Antenna Selection Use both antennas for best performance in most situations. For long range with a very high gain antenna on one input, select the input here.</p> <p>Use the 'Both Off' option to allow DVR playback to function on goggles with the aux. Power cable.</p>

 <p>Off te. OSD Sta ● Lock RSSI</p>	<p>On-Screen-Display mode. Turn the rapidFIRE OSD Off, show only the 'lock' symbol, or show RSSI bars.</p> <p>PAL/NTSC mode shows the currently received TV standard, and is useful for ensuring the correct mode is selected for the major leagues that require one or the other.</p>
 <p>Safe OSD OSD P, St ● Top Left 3.3 Bottom Left</p>	<p>On-Screen-Display position. Position of the OSD text on the display.</p> <p>Modes are available for perfect alignment with the top edge of the LCD on several FatShark goggle modules.</p>
 <p>Off . Audio Sy ● On 3.3</p>	<p>Audio Enable/Disable For models with no microphone or telemetry, disable the audio to save goggle battery power, and to prevent static noise from appearing in DVR recordings.</p> <p><i>Note: Some noise does still leak through, but at a much lower level than if audio is enabled.</i></p>
 <p>io Sync St ● Default 3.3 Medium</p>	<p>Sync Lock Change the time that the module 'holds on' to a video sync before giving up.</p> <p>For camera/FC/OSD/vTx combinations which occasionally 'roll', use this setting to lower the sync lock time so that rapidFIRE drops out to mode 2 earlier. Useful in race situations where risk of video issues need to be minimized.</p>
 <p>OSD Statu: ● About 3.3</p>	<p>Status Contains the About menu, where firmware revisions, battery voltage, and low-power mode information may be found.</p>

Spectrum Analyzer

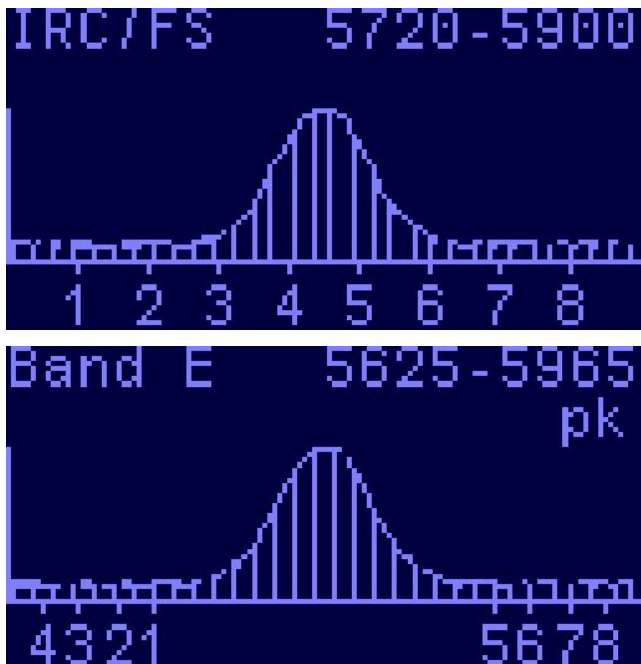
The Spectrum Analyzer scans the band with one receiver, while leaving the other receiver viewing the currently selected channel.

Note that while scanning, the upper SMA connector is fixed on the current channel, and the lower connector scans the band. This does cause some visible 'crosstalk' between the two modules, which is perfectly normal.

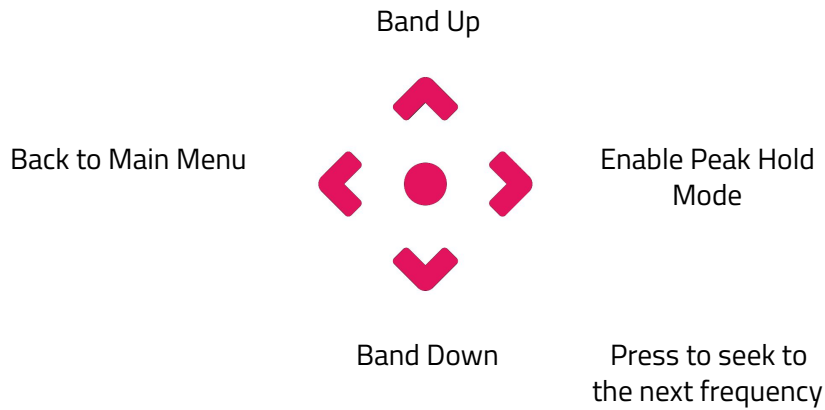
Access the Spectrum Analyzer from the Tools menu:



The default mode of the spectrum analyzer is to continuously update.



Joystick Operation in the Spectrum Analyzer Menu



Right-click on the joystick and the spectrum analyzer enters 'peak hold' mode, where the peak value of each frequency bin is stored. This mode is useful when arriving at a site, to scan the band for interference before starting to fly. Even interference that appears briefly will be detected and reflected in the spectrum display.



An interesting point to note in the Spectrum Analyzer is that the channels for each selected band are shown under the graph. For the rarely used bands E, B, and A, the rather odd frequency mapping is clearly visible when switching between the bands.

Band Scanner

A simpler form of the Spectrum Analyzer, the band scanner quickly scans the commonly used FPV frequencies and offers the ability to select quickly the active channels.



To enter into the band scanner you can either hold down the joystick on the main screen, or select 'Band Scan' from the tools menu.

Once in the menu, all channels with activity are shown, and can be selected using the joystick. Up/Down to change bands, Right to select the channel. Press the center button to select the channel.

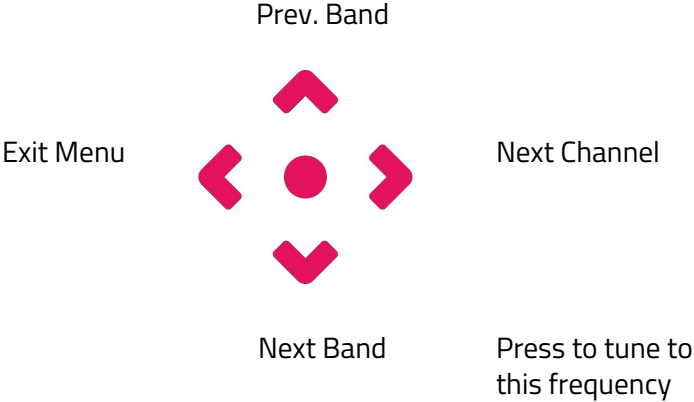
Note that while scanning, the upper SMA connector is fixed on the current channel, and the lower connector scans the band. This does cause some visible 'crosstalk' between the two modules, which is perfectly normal.

NOTE: The band scanner can be a very useful tool, but it is important to understand its limitations. The channels in the 5.8GHz band used for FPV overlap, and in some cases share the same frequency. This means that even though a single transmitter is turned on, it may appear in several of the bands. rapidFIRE currently has no way to identify which band was intended, so it helps to know which band the transmitter is on before using the scanner.

Be careful selecting a channel with the band scanner, on an incorrect band, and then flying far from the receiver. A frequency error of a few MHz may not be noticeable at close range, but when further out, it will become more of a problem.

All current band scanner implementations from all goggle receiver manufacturers have the same limitations, so this is not a rapidFIRE-specific issue.

Joystick Operation in the Band Scanner Menu



Band X/Favorites

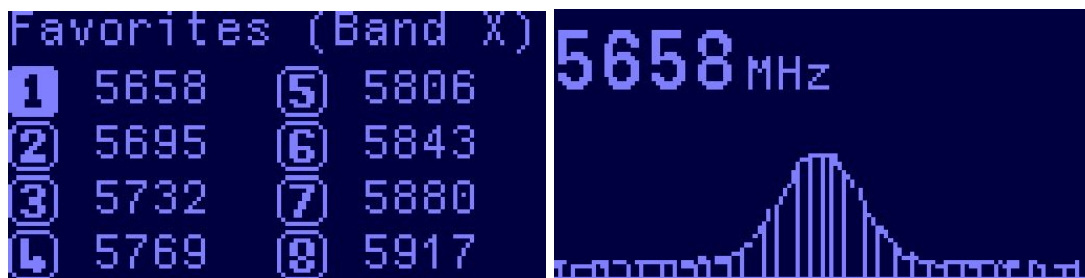
Band 'X' is a set of 8 channels for rebels. These channels do not need to fit any standard band plan.

During configuration of Band X, a mini-spectrum of the area around the channel is shown. This is an extremely useful tool to 'tune' the receiver to a transmitter before a long range flight.

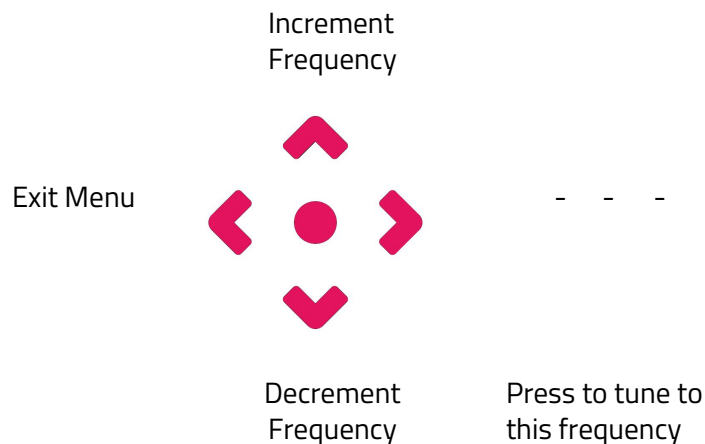
Both transmitters and receivers for 5.8GHz derive their master clock from a quartz crystal that does vary in frequency slightly from device to device. In addition, after smashing a quad around a track for a few months the Tx side is not always as precise as it was when shipped.

These slight variations may be tuned using the band-X mini-spectrum, and an optimal setup for long range flight may be created.

Band X is also very useful for event use. Enter the 8 frequencies used at the event and simply switch between them using the goggle channel buttons.



Joystick Operation in the BandX/Favorites Menu



Calibration

Even though the rapidFIRE is calibrated in the factory, it is possible that over time it will need recalibrating. This calibration removes any slight differences in RSSI reading between the two receiver modules.

After a firmware upgrade it is also advisable to perform a calibration.

1. Tune to RaceBand Channel 5 (or IRC channel 4, approx 5800MHz)
2. Enter the calibration menu from the Tools menu



3. Remove antennas, and ensure that you are not anywhere near a transmitting video transmitter.
4. Press the joystick center button when ready.



5. Wait for the progress bar to complete.



6. Now turn on a transmitter, on the same frequency selected above, and place it about 2 meters (6 feet) from the receiver
7. Press the joystick center button when ready
8. While the progress bar is moving, move the goggles around a bit
9. Once calibration is complete, a summary screen will show the calibration status (with success/fail).



If the calibration procedure fails, then it is likely due to one of two causes. The first is that the selected channel was not 'empty' when the first part of the calibration was attempted. The second is that the selected channel did not have a transmitting vTx when the second part of the calibration was attempted.

Note also that calibration will fail if the module is in low power mode, since both receiver modules need to be powered up to calibrate.

NOTE: Calibration DOES NOT need to be repeated for each quad used with the rapidFIRE. Calibration corrects for slight differences in the receivers used in the diversity pair, and has nothing to do with the vTx or Camera used on the quad.

Antenna Modes

Diversity receivers (those which use more than one receiver) are awesome, but are often misunderstood when flying long range.

To clarify; for long range flight, a diversity receiver is awesome if high-gain antennas are used on both antenna inputs. For long range flight with goggles though pilots generally use an omni, and a high gain antenna, the former being not of much use past a few km.

Because of this, the rapidFIRE module gives the user control over how the module operates. Single module modes (upper or lower SMA) with a single high gain antenna are available, which also have the advantage of lowering power consumption (and therefore fewer 'oops' moments 10km out when the goggles start playing that annoying low battery beep).

rapidFIRE #1 vs. rapidFIRE #2 Mode

rapidFIRE #1 mode pulls out all of the stops to eliminate multipathing, and repair the received analog video signal. It should be the preferred mode in which rapidFIRE is used.

In order to perform its magic, it requires an intimate knowledge of the video standards that it is repairing. Unfortunately the FPV world contains a few cameras and OSDs which violate various

aspects of the PAL/NTSC spec. Of course, this being a rather new spec, we shouldn't be surprised (that was a hint of sarcasm, the standard has been out since the early 1960s...).

rapidFIRE #2 mode was created to deal with the few cameras and OSDs which don't like to follow these well established standards. It still dramatically reduces multi-pathing, and in most cases will be indistinguishable from rapidFIRE #1 mode.

At present, rapidFIRE #1 mode supports the rapidFIRE OSD overlay, but mode #2, and legacy mode do not support it.

NOTE: For the technically inquisitive, the types of problems seen are cameras where the black pixels surrounding the OSD text are not 'black', but at the sync tip level! Others include the famous 2090 chipset which has a habit of confusing the most common text-based OSD chip on the market and causing it's blinking feature to fail to work.

Low Power Mode

When the rapidFIRE module detects a low headset voltage, it automatically turns off the receiver connected to the lower SMA connector, but continues to operate with the other receiver.

In this mode most of the rapidFIRE signal restoration features are still operational, and should provide a better FPV experience than most non-rapidFIRE diversity receivers.

Note that it is not recommended to run in this mode for long. A low module voltage normally indicates that power is being wasted internally to the goggles, and causing short battery life, and unnecessary heating of the goggle internals.

A few features are not available in Low Power mode such as:

- 1) Calibration mode is not available
- 2) Spectrum analyzer, and band scan modes can't show the current channel while scanning for the next channel.
- 3) The Audio amplifiers are disabled, and no audio will be generated by the module.

It is the Little Stuff...

One feature that most users will never notice is one of the things that drives us nuts with other modules.

We have a policy of always powering up the module in the state that it was last used in.

If the goggle channel buttons were used last to set the channel, then on power up, we respect that, and power up on that same channel.



If the UI on the module was used to set the channel, then on power up, the same rules apply, we remember, and respect that request.

The result is a user interface that works with you, instead of against you. No Surprises.

Support and Repairs

The first line of support for ImmersionRC products should be the retailer that supplied the product. If for any reason that channel does not result in problem resolution, one of our repair centers may be able to help.

ImmersionRC runs repair centers in the UK, and the USA. These centers are equipped with the knowledge to repair any of our products, whether or not the product is still covered under warranty.

A simple email to repairs@immersionrc.com starts the support/repair process.

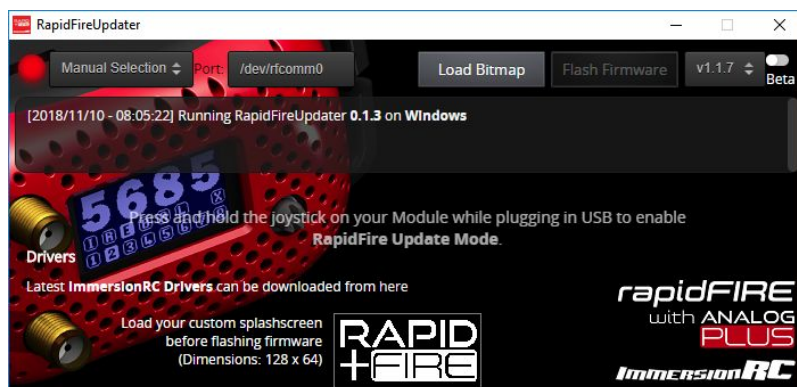
Our Facebook-based community hub is also a great place to ask for help.
[facebook.com/groups/immersionrchub](https://www.facebook.com/groups/immersionrchub)



Firmware Upgrade

Upgrading the firmware in your rapidfire is a simple process, thanks to an easy to use update tool, which may be downloaded from the ImmersionRC website (rapidFIRE product page).

This tool is provided in both a Windows, and Mac version.



Once the tool is installed, remove the rapidFIRE module from the goggles, hold down the center joystick button, and connect the rapidFIRE to the computer using a micro-USB cable .

If the module is correctly detected in firmware update mode, the 'Flash Firmware' button will be available. Select this, and the update process will automatically start.

No firmware files are required to perform the update. The necessary files are pulled from the ImmersionRC update server.

Do not remove the USB cable until a few seconds after the 'RapidFIRE Upgrade Completed' message appears.

```
[2018/11/11 - 07:30:46] Start flashing RapidFire v1.1.8  
[2018/11/11 - 07:31:00] RapidFire Upgrade Completed
```

NOTE: If the module is left plugged into the goggles during the firmware update, and the goggles are unpowered, it is normal that the goggles beep annoyingly indicating low voltage.

This will not affect the update, and as soon as the USB connector is unplugged the beeping will stop.

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Troubleshooting

Problem	Cause	Solution
Rapidfire takes a long time to lock, and unlocks during short-range flights. Video quality doesn't seem right.	Seen on a few Chinese flight controllers with OSDs (MAX7456) which use under-sized output capacitors, and result in distorted video syncs. Sunrise 30A 4-in-1 is known to have this problem (sold under several brand names)	Bypass the OSD, and hook the camera directly to the vTx in order to prove that this is the problem. Replace 'Cout + Csag' with 47uF ceramic capacitors as a permanent fix. <i>Contact your FC manufacturer and let them know that you are not happy!</i>
Calibration fails	rapidFIRE may be in low power mode.	Either install the aux power cable, or modify the goggles to resolve this before calibrating.
No audio is generated by the module via the 3.5mm headphone jack on the goggles	rapidFIRE may be in low power mode.	Either install the aux power cable, or modify the goggles to resolve this before calibrating.
Image is black and white	Usually caused by poor quality cameras and/or video transmitters which generate 'color burst' signals which are too weak.	Try with a different camera/vTx

Difference Between Batches

As with any product that ImmersionRC has ever made, we strive to improve it between production batches. rapidFIRE is no exception, and we continue to push the limits.

Batch 1

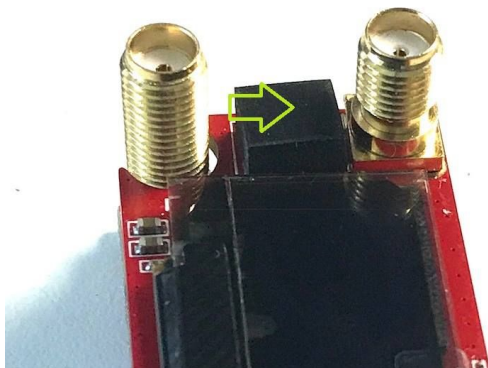
Initial batch, met all published specs, but struggled with certain cameras and OSDs which generated mal-formed PAL/NTSC signals.

Batch 2

Slightly better sensitivity, and tolerance for cameras and OSDs that Batch 1 had issues with.

Batch 2 can be identified by an additional foam block placed between the antenna connectors. *This protects the screen during the production process.*

Batch 2 modules reduced a bit the color oversaturation in RF Mode #1.



A Little History

Back in the early days of FPV, in May 2007, a passionate FPVer and aerial photographer was building electronics to support the fledgeling hobby in the basement of his home in Switzerland.

The equipment available for video downlinks wasn't great at the time, so a project was started to help clean up these rather poor video feeds. This project never saw the light of day as the sync restorer that was planned (embedded processors at the time weren't up to the very tight timing tolerances required), but instead turned into a 'pixel bit-banging' OSD, known as the 'AeroOSD', and sold under the 'AeroPix' brand.

In the decade that has passed since that project, and many gray hairs later, the ImmersionRC team has been researching ways to improve the FPV experience, especially for indoor flying where multipathing can really ruin a great FPV day. We have driven vans loaded with test equipment into metal-walled exhibition halls to capture the details of what happens as our video feeds experience multipathing. We developed test systems that created reproducible multipathing nulls, and then refined algorithms to eliminate them.

The rapidFIRE is the result of all of this work, and we are very proud to introduce this into the FPV market. We hope that it creates as much pleasure for our customers as we have had designing, testing it, and enjoying FPV flight with it.



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