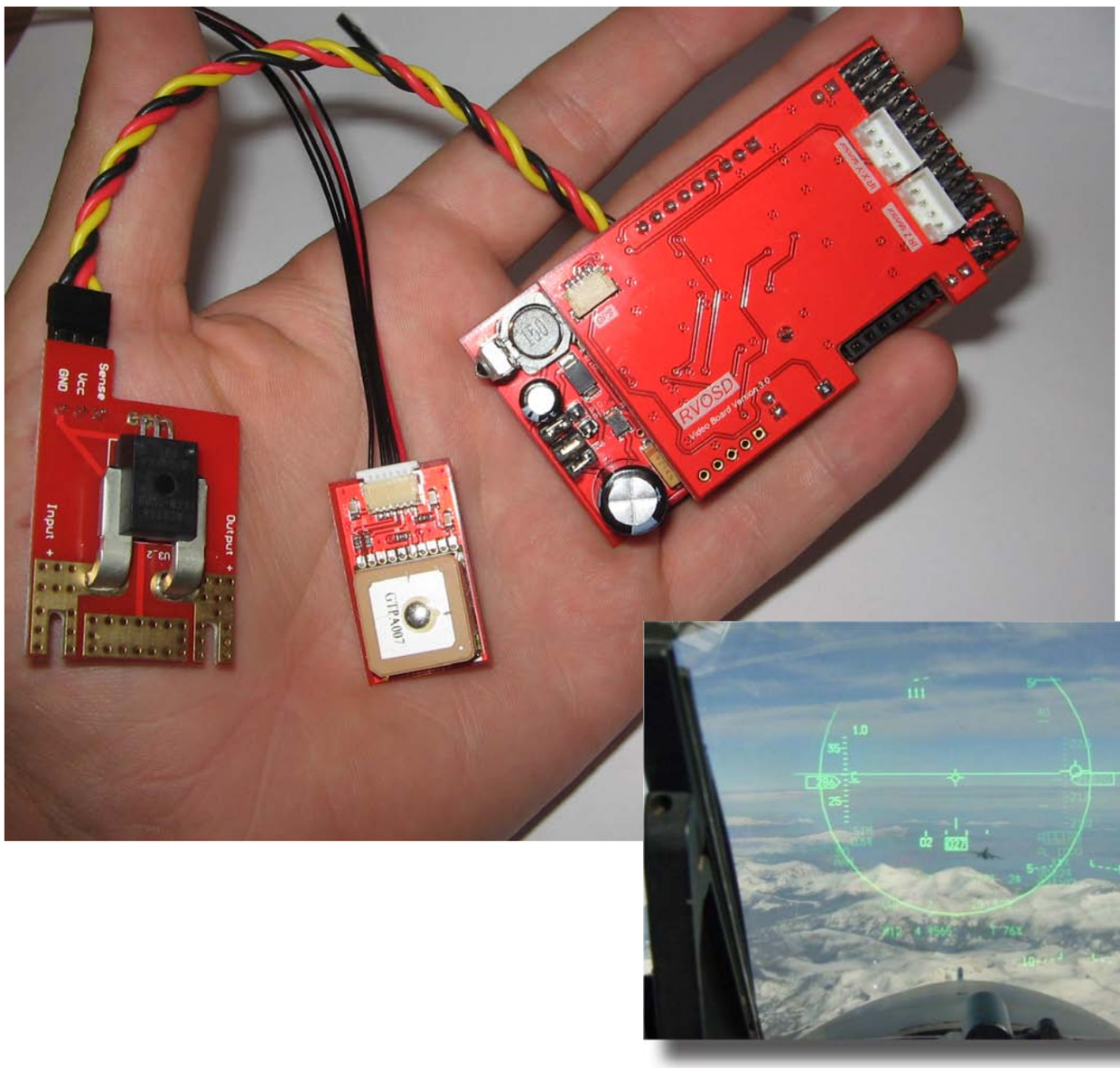
RVOSD Gen3

F16 HUD + autopilot for model airplanes.



User manual version 1	October 29th , 2009

RangeVideo
Wireless Video Solutions

Table of Contents

1 KIT CONTENTS

The RVOSD kit comes with:

(1) RVOSD

(1) GPS with extension cable

(1) PICkit 2 USB Software Updater and USB cable

(1) 100A Current sensor

(1) Temperature sensor

(1) IR remote

(3) 150mm male to male servo wires

(3) 300mm male to male servo wires

(1) KX131/KX191 camera to OSD connector

(1) KX171 camera to OSD connector

(1) DX201 camera to OSD connector

(1) 300mm male to bare lead servo cable

(1) T-plug pair

1.1 If a part is missing from your contents

Please take a photo of the box and its contents , and send an email to: rangevideo@yahoo.com

Include:

- Missing items
- Date of purchase and the dealer name.

1.2 DOA

Please note, each RVOSD + GPS is tested before shipment. Before blaming the equipment, please read this manual carefully. In most case, the problem is the lack of understanding how the RVOSD works. We have designed the RVOSD to withstand many user errors, like reverse battery connections, etc. But even so, it's possible to break something in the RVOSD. The most common warranty repair is when users short circuit their camera or video transmitter power supply. This happens because the tiny connectors on the camera/transmitter can tear in a crash, and cause a short circuit.

If the camera or transmitter is being powered though the RVOSD, and you short circuit the camera or transmitter power supply, RVOSD part L1 will blow. This part is actually a filter for RVOSD internal PSU, but functions as a fuse in this case. It saves your camera / transmitter during the short circuit. If pat L1 blows, you will need to route the power wires for the camera and transmitter separately (not through the RVOSD), repair your RVOSD ,or send the RVOSD for repair:

RangeVideo

1970 NE 124th St

Miami, Fl 33181

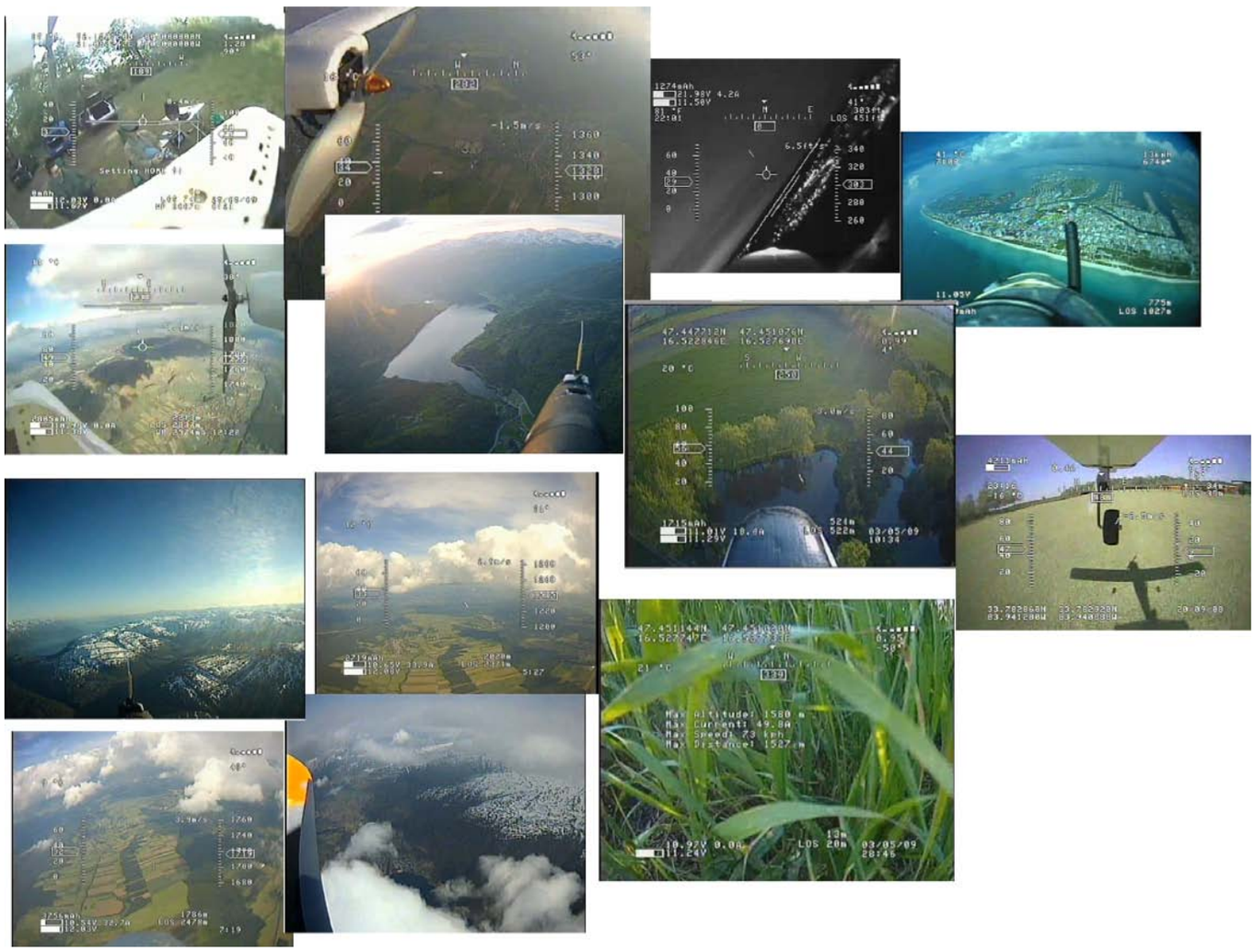
USA

Repair cost range from 10 USD – 30 USD, usually. Example: replacing L1, the cost is 10 USD.

Return shipping cost is 10 USD to USA/Canada, 25 USD international

Note: L1 manufacturer part number: NLCV32T-R68M-PFR
http://search.digikey.com/scripts/DkSearch/dksus.dll?Detail?name=445-3647-1-ND
INDUCTOR .68UH 1.90A 20% 121

2 About



2.1 What is FPV flying?

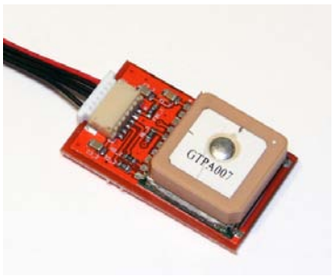
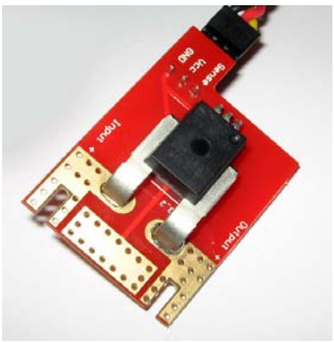
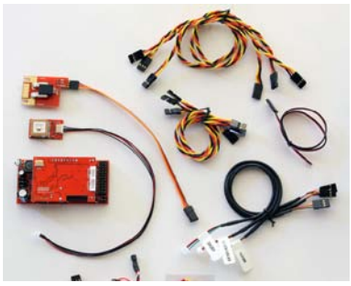
FPV is an exciting offshoot of a 60+ year old hobby, which enables a pilot of a radio-controlled plane to immerse themselves in flying by watching the video from an onboard camera.

Several recent technological advances have enabled this: small cameras, lightweight wireless video links and high-resolution head-mounted displays.

The RVOSD makes FPV safer and more fun. It features an on screen telemetry display, full autopilot and power management. The RVOSD also acts as a ‘motherboard’ for your FPV gear. Everything connects to the RVOSD: GPS, IR sensors, camera, video transmitter, main flight battery, auxiliary battery, R/C receiver and flight control servos.

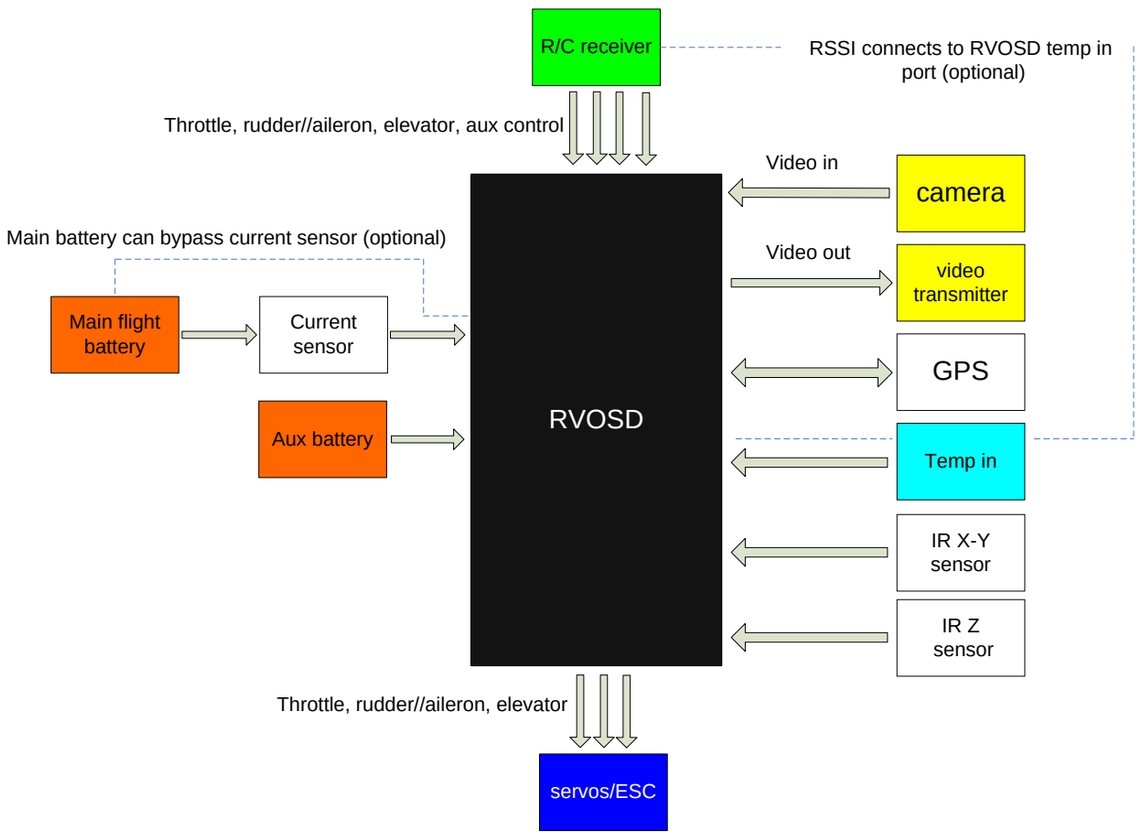
3 HIGHLIGHTS

This section highlights the main parts of the RVOSD kit.

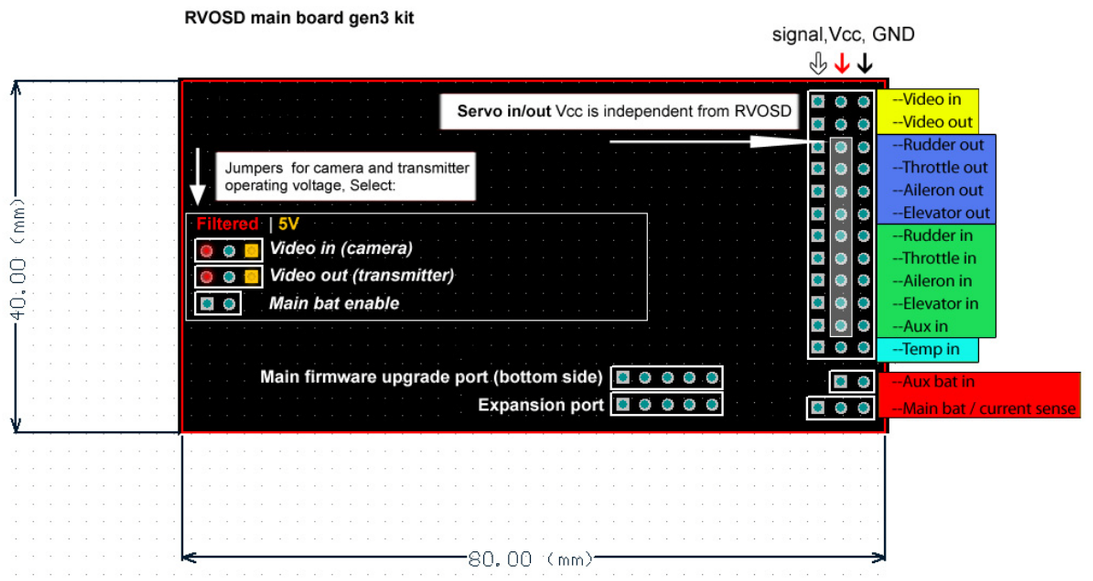
The RVOSD is the unit which does all of the navigation, autopilot control, text / graphic overlay, and power management. Custom graphics engine draws a flicker free overlay. Two microprocessors handle all of the processing.	
10Hz GPS with SAW filter. Immune to jamming and strong satellite lock. Altitude and climb rate is more accurate than most hobby grade barometric sensors. WAAS enabled, accuracy to < 2 m.	
The current sensor measures the current consumption of your electric motor system. 0-100A range	
The IR remote is used to navigate the RVOSD menus. Handy to take to the flying field. No need to lug a laptop with you or remove RVOSD from your model to change settings.	
Pickit2 USB firmware updater.	
Accessories. Cables to connect video in, video out, GPS, current sensor, R/C receiver, are all included.	

4 CONNECTING THE SYSTEM

This section describes all the connections which can be made to the RVOSD. Please read it carefully.



4.1 RVOSD pinout



Not shown: ***IR XY***, ***IR Z***, and ***GPS*** ports.

Name	Pin	Signal Type	Range	Notes
Video In	Signal	Composite video input	PAL/NTSC	Video input from camera
Video out	Signal	Composite video output	PAL/NTSC	Video output w/ OSD
Rudder out	Signal	Servo pulse output	1.0-2.0mS 5VDC	
Throttle out	Signal	Servo pulse output	1.0-2.0mS 5VDC	

Aileron out	Signal	Servo pulse output	1.0-2.0mS 5VDC	
Elevator out	Signal	Servo pulse output	1.0-2.0mS 5VDC	
Rudder in	Signal	Servo pulse input	1.0-2.0mS 5VDC	
Throttle in	Signal	Servo pulse input	1.0-2.0mS 5VDC	
Aileron in	Signal	Servo pulse input	1.0-2.0mS 5VDC	
Elevator in	Signal	Servo pulse input	1.0-2.0mS 5VDC	
Aux in	Signal	Servo pulse input	1.0-2.0mS 5VDC	Switch OSD screens in-flight
Temp in	Signal pin	Analog voltage input		Can be used for RSSI
Aux bat	Vcc	DC voltage input	6-30 VDC	Input is Reverse polarity protected
Main bat	Vcc	DC voltage input	6-30 VDC	Input is Reverse polarity protected
Main Bat Current sense	Signal	Reading from current senor		Current sensor reading
Current sensor input	Gold plated pads on the current sensor board	DC voltage input	6-35VDC 0-100 A	Connect main flight battery here
Current sensor output	Gold plated pads on the current sensor board	DC voltage output	6-35VDC 0-100 A	Connect ESC here
GPS input	Small white connector on the top left of RVOSD	Pin 1: Pin 2: Pin 3: Pin 4: Pin 5:		
IR XY input	White vertical connector on the RVOSD board.	Pin 1: Pin 2: Pin 3: Pin 4:		
IR Z input	White vertical connector on the RVOSD board.	Pin 1: Pin 2: Pin 3: Pin 4:		

4.2 Required connections

To use RVOSD in the most basic configuration you need to connect:

1. GPS
   Without the GPS, you will not have any interesting information on the display, except for battery voltages, temperature, RSSI, and timer.

2. Video in
The RVOSD will not provide a video output without a valid video input.
Use the included cables to connect your camera to the RVOSD. There are cables for the KX131/KX191, KX171, and DX201. Or you can make your own cable to connect any camera to RVOSD.

3. Video out
The video out is the video signal with the graphic /text data overlay. You can connect this directly to a TV monitor, DVR, or wireless video transmitter. Use the included male to male servo cable to connect the video out to a RangeVideo *Aerial Video System* transmitter. Or use the included bare servo lead to make a wiring harness for any video transmitter.

4. Main bat and or Aux Bat
Connect the battery here. If you connect your flight battery using the included current sensor, then you will have current measurement on the display. **Please see section 4.3** The input range is 6-30 VDC. You can power the video camera and video transmitter from the same battery as RVOSD. **Please see section 4.41**.

To switch OSD screens in-flight and to detect R/C link lost with a PPM receiver (R/C glitch detection), you need to connect :

5. Aux in
The RVOSD will monitor this channel for valid servo pulses. If it detects that the pulses are
Connect this port to a spare receiver channel using the included male to male servo cable.

To to detect R/C link lost with a failsafe equipped PCM receiver you need to connect :

6. Throttle in
In PCM mode, the RVOSD detects ***R/C link lost*** when the throttle channel goes past a preset failsafe position called ***PCM failsafe point***. This position can be set in the RVOSD main menu.
Connect this port to your throttle receiver channel using the included male to male servo cable.

7. Throttle out
During regular flight (not autopilot) , the RVOSD will be transparent to the R/C receiver and ESC.
Connect this port to your ESC using the included male to male servo cable.

To use autopilot you need to connect (in addition to all above)**:**

1. Rudder in
During regular flight (not autopilot) , the RVOSD will be transparent between the R/C receiver and servo.
In autopilot mode, RVOSD takes over this channel to stabilize roll and navigate the heading.
Connect this port to your receiver using the included male to male servo cable.

2. Rudder out
During regular flight (not autopilot) , the RVOSD will be transparent between the R/C receiver and servo.
In autopilot mode, RVOSD will use this channel to stabilize the plane and navigate.
Connect this port to your rudder or aileron servo using the included male to male servo cable

.

3. Elevator in
During regular flight (not autopilot) , the RVOSD will be transparent between the R/C receiver and servo.
In autopilot mode, RVOSD takes over this channel to stabilize roll and navigate the heading.
Connect this port to your receiver using the included male to male servo cable.

4. Elevator out
During regular flight (not autopilot) , the RVOSD will be transparent between the R/C receiver and servo.
In autopilot mode, RVOSD will use this channel to stabilize the plane and control altitude
Connect this port to your elevator servo using the included male to male servo cable.

To take advantage of full autopilot functions, you need to connect:

5. **IR XY sensor**
Connect to a X-Y IR thermal sensor using a 4 pin ribbon cable.

6. **IR Z sensor**
Connect to a Z IR thermal sensor using a 4 pin ribbon cable.

The function of **Aileron in** and **Aileron out** is as follows:

In case you are using a PPM receiver , which has no failsafes, and which glitches when the R/C link is lost. The Aileron in and Aileron out can be used to program a failsafe position when R/C link is lost. This is very useful. For example: the autopilot does take over the rudder and elevator when R/C link is lost, but you have an aileron servo which will keep glitching and make the plane unstable- even under autopilot control. The solution is to connect the aileron channel through the RVOSD and assign a neutral failsafe position. Of course, you can use this in/out port to set a failsafe position for any channel you want. And if you are using a radio with failsafes, you will likely not ever use the Aileron in and Aileron out ports.

4.3 GPS

The first time a GPS tries to get a satellite lock, it's called a cold start.

Cold start, approximate time to get satellite lock:

indoors: 5-10 minutes

outdoors: 3-5 minutes

Sequential satellite locks are called warm starts.

Warm start, approximate time to get satellite lock:

Indoors: 3-5 minutes

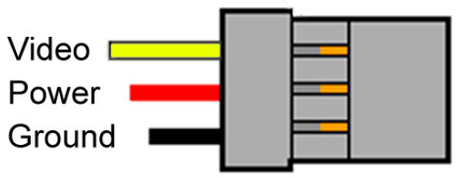
Outdoors: 30 seconds- 2 minutes

The coordinates and satellite antenna icon will blink if the GPS still does not have locked on the satellites properly. Also the satellite antenna icon will be oriented to the left if normal fix it's acquired, and oriented to the right if differential fix is acquired (WAAS enabled). Five bars can show the number of satellites locked. Each bar represents the number of satellites plus three, so five bars indicate 8 satellites acquired. GPS coordinates will be shown when the plane goes below the value in degrees set on the Low altitude angle menu item, or the R/C link is lost.

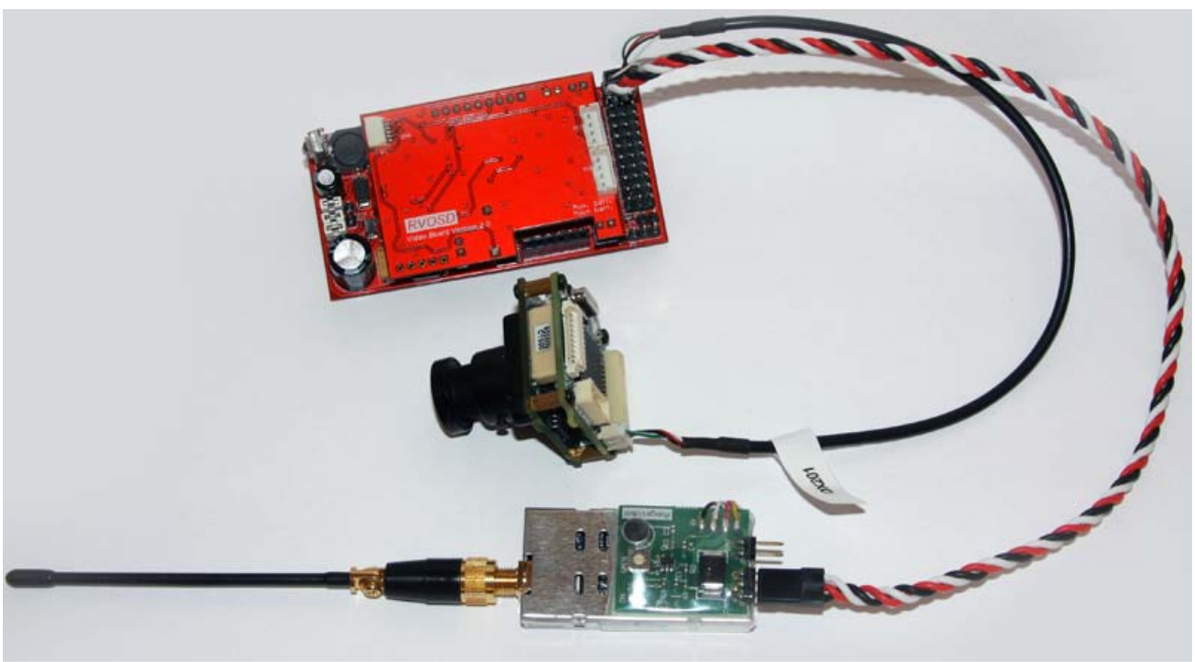
Note: If you disconnect the GPS from RVOSD, it will lose the almanac information and will go to cold start again.

4.4 Video in / video out

The RVOSD is compatible with all video cameras and video transmitters (PAL and NTSC),
Video in and Video out connection is as follows:



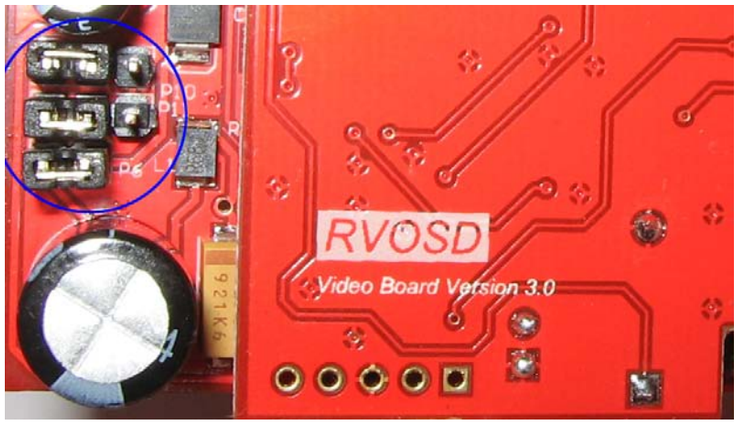
The power wire is in the center position, so an accidental reverse connection will not cause damage to the device.



4.4.1 Selecting camera and transmitter operating voltage

The RVOSD has a 5V 1.5A switch mode regulator, which can be used to supply 5V to cameras and transmitters , and a **filter** for powering cameras and from the main flight pack. Yes ! You can power everything from one battery, with no interference on the video from ESC//motor noise.

5V jumper: selects the 5V RVOSD power supply to power camera/transmitter
Filter jumper: selects the Main bat to power camera/transmitter.
Main battery enable jumper: enables Main bat to power the camera/transmitter when ***filter jumper*** is selected. Remove this jumper to let Aux bat power camera/transmitter when ***Filter jumper*** is selected.



Correct jumper positions for a 12V camera and 12V transmitter, using a 12V main flight battery.

Jumpers selected: ***Filter jumper*** *and* ***Main bat enable***

Warning: DO NOT connect a 5V device to the RVOSD before changing jumper position to ***5V.***
DO NOT connect a 12V device to the RVOSD before making sure that your main flight and or aux battery is no more than 3s 11.1V (12V).If your main battery is more than 3s 11.1V (12V) , then remove the ***main bat enable jumper***, and connect a 12V battery to **Aux bat in.**

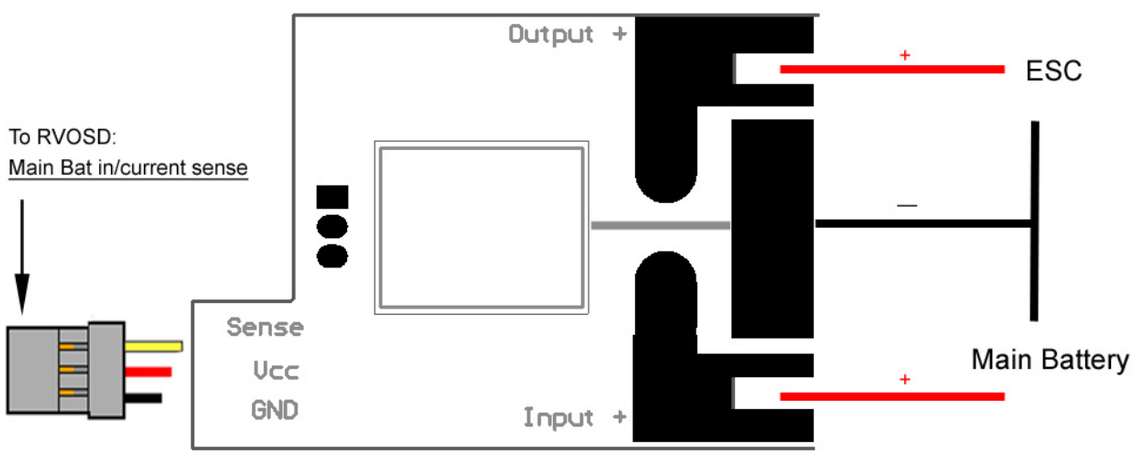
Note: It is wise to check the voltage and polarity being supplied to your camera // transmitter before connecting them. Just in case a camera cable was reversed at the factory or you made a mistake somewhere. This will save your camera / transmitter from magic smoke!

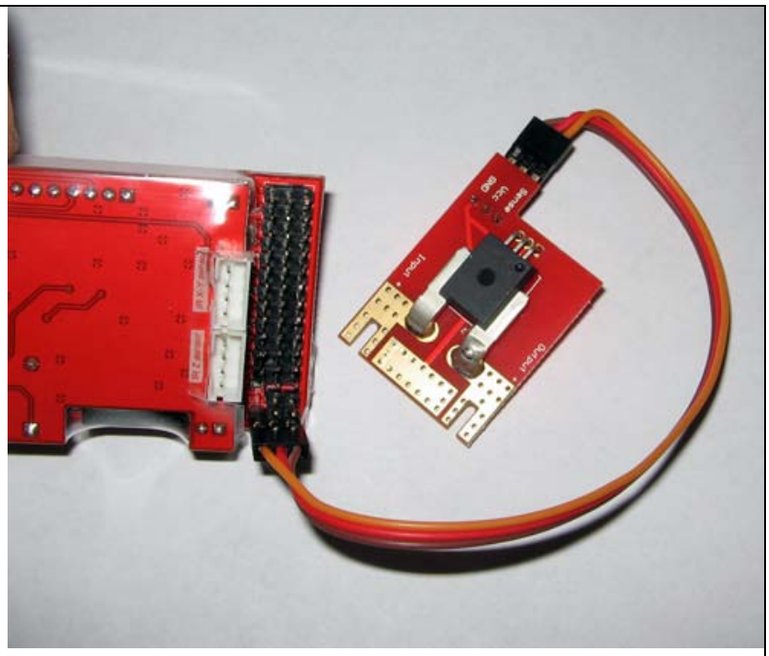
4.5 Main battery input

It's possible to connect the main battery directly to the RVOSD, without the current sensor. The RVOSD will display 0.0A current draw. In this case, it's better to connect the battery to Aux bat in , since this will hide the empty amperes display on RVOSD, and show just the battery voltage.

4.6 Current sensor

The current sensor is used to measure electric motor current. Connect it in between your flight battery and ESC, as follows:



The current sensor connects to RVOSD Main bat in/current sense port.	

You may use a standard servo extension wire to extend the wire between the RVOSD and current sensor board. Keep in mind the current used by the RVOSD + GPS (150mA) and other devices like the camera and transmitter. Do not use a very thin gauge extension wire.

The 100A model can measure from 0-100 amps. The voltage range is 6-30VDC.
It comes without shrink wrap installed, so you can solder your own battery /ESC plugs or wires
Slots are cut in the current sensor board for the T-plug connectors. Please be sure to shrink wrap the current sensor board afterwards, to prevent accidental short circuits, which will cause damage to RVOSD.

Note: The RVOSD is compatible with different current sensor models: 50A, 100A 130A 150A
The lower models have better resolution. 100A is the best compromise. Gen 2 came with the 50A version and gen 1 with the 130A.

4.6.1.1 Current sensor calibration

Every time RVOSD is turned on, the current sensor is calibrated. It takes 30 seconds to calibrate. You will see '***Calibrating current sensor…***" on the screen. During this time, it's important to not run the motor or move servos a lot. Doing so will skew calibration bias values and the current reading will be inaccurate- usually too high.
If you connect two batteries: a 3s 11.1V Main flight pack and a 3s 11.1V Aux bat, and connect the main bat enable jumper, the RVOSD will use the the higher voltage battery. This can be used as a safety feature. When your main flight battery dies, the RVOSD will use the auxiliary battery to power the video equipment.

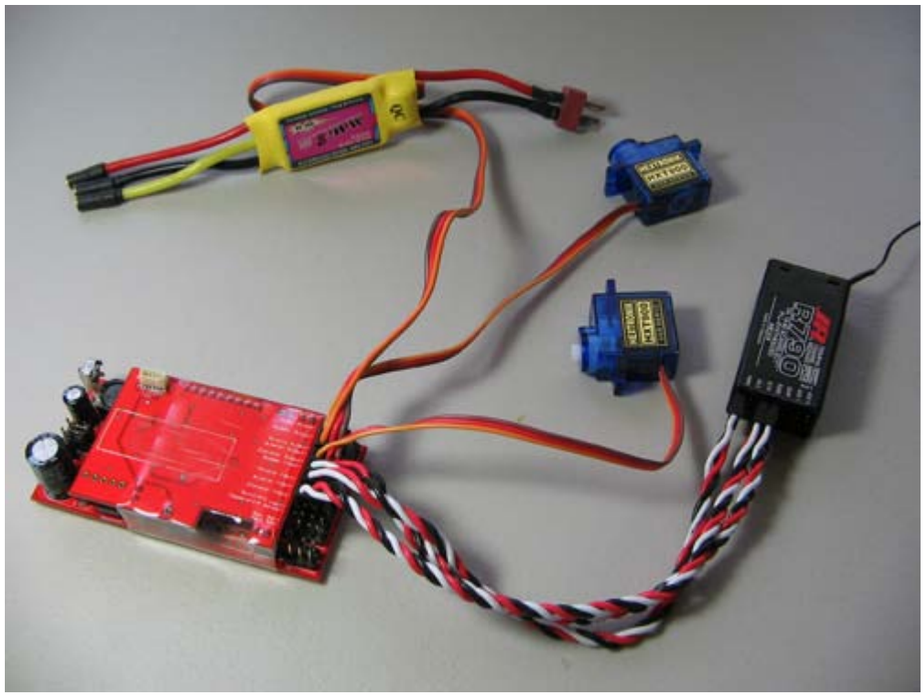
Warning: Secure the connection between the current sensor and RVOSD. If this connector comes loose in-flight, you will lose all power to the RVOSD-unless you have another battery connected to Aux bat in.

4.7 Aux battery input

It's possible to connect another battery to the Aux bat in. In this case, the RVOSD will choose between the two battery inputs and select the higher voltage battery to use. If you want the RVOSD to select the lower voltage battery instead, remove the ***Main bat enable jumper***, and connect that battery to Aux bat in.

4.8 Servo input/outputs

The RVOSD is installed between your R/C receiver and servos / ESC. In manual flight, the RVOSD is transparent, and simply passes through all servo and ESC inputs, to the outputs.



Gen 1 RVOSD shown. Gen 3 has the same type of input/output connections.

4.9 External temperature sensor

The external temperature sensor can be used to monitor engine, ESC, or battery temperature.

If the external temperature sensor is left disconnected, then RVOSD will display the onboard temperature sensor reading.

Operating range

external temp sensor LM34	-40 to +150 degrees Celsius
onboard temp sensor MCP9700	-40 to +150 degrees Celsius

4.10 RSSI measurement

Advanced users can connect RSSI voltages from your receiver to the temperature sensor input on RVOSD. This should be done thru a series resistor of 100 kilo ohms, so the OSD input will not load too much the RSSI circuit, and affect your radio range.

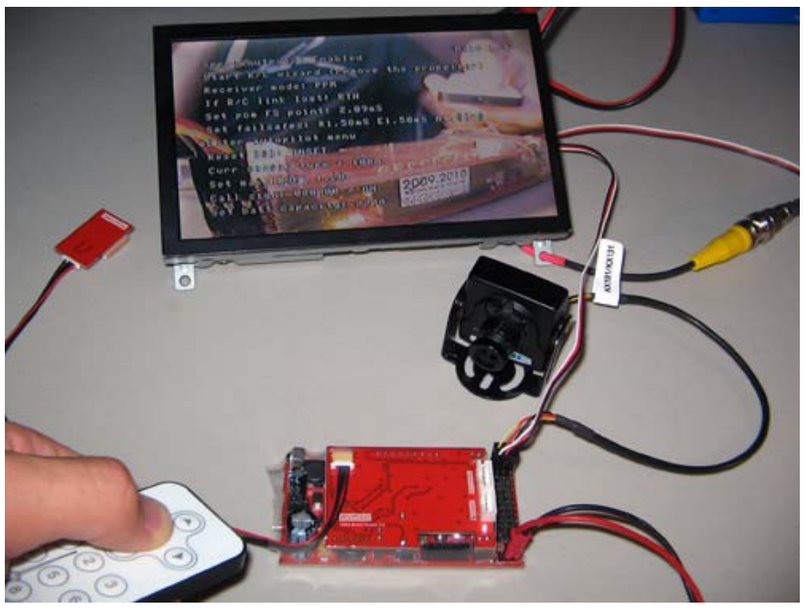
Operating range

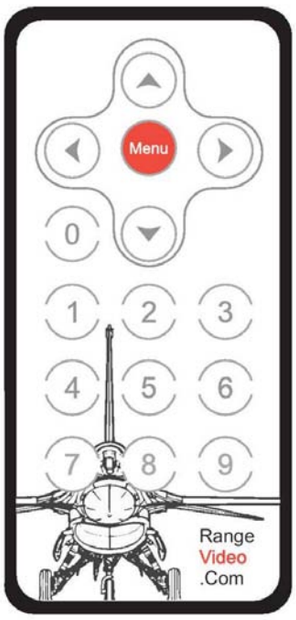
Temp in , signal pin	0V – 3.3V

5 CONFIGURING THE RVOSD SETTINGS

This section introduces the RVOSD menus.

5.1 Navigating the menus with the IR remote





Note: If you lose the remote, you can replace it with any universal TV remote. Just program the universal remote for Sony TV codes.

All configurations are done through on screen menus which can be navigated by IR remote. To enter the Main menu, press Menu until you see the main menu screen. Use buttons to select the menu option which you want to change . Use or to select an option or to change its value.

To use submenus:
To enter the Autopilot submenu: select 'Enter Autopilot Menu' option.

To return back to the Main menu: select 'Exit' option, or press Menu , until you get back to the Main menu screen.

All menu changes take effect immediately; but the settings are not saved to memory until you press 'Save' menu option. So if you turn off// reset the RVOSD before saving the changes, they will be lost.

Menu	Changes the OSD screens : **1.** Main Screen **2.** Navigation Screen **3.** Blank Screen **4.** Menu screen
	Selects the menu options.
	Changes the value
Numeric pad	For entering coordinates in the waypoint menu option.

5.2 Configuring servo inputs/outputs

Enabling and connecting servo inputs/outputs let you detect when R/C link is lost, use the safety options, and control the OSD in-flight.

If **Servo outputs: No** is selected, you can ignore this section, and continue to 5.1.

5.2.1 Run the wizard

1. To use the servo in/out functions of the RVOSD, please set the menu option: **Servo outputs: Yes** (default)

2. The next step is to select **Start R/C wizard**. Remove your propeller before running the wizard, because it will ask you to move your throttle stick and turn off you radio, which can cause the motor to spin.

This wizard will guide you step by step, and set the following menu options for you:

- **Receiver mode**: PPM or PCM
- **Set PCM FS point**: This is the throttle position which triggers RVOSD safety features (return to home or failsafes) to automatically take over in PCM mode. The wizard will set this point a little above 100% throttle position. To use it, program your R/C Radio throttle failsafe to 110% .If you lose R/C contact, the failsafe moves the throttle to 110%, and RVOSD takes over. The RVOSD will release control back, when the R/C system is out of failsafe.
- **Set neutrals**: this sets the neutral stick position for level flight. (for autopilot)

You can leave disconnected the channels which you don't use.
Additionally, you can edit these menu options directly, after you run the wizard.

5.2.2 Rx not detected

3. The RVOSD tries tries to detects the status of your R/C link by looking for valid servo pulses from the receiver, as follows:
PPM mode: RVOSD looks for pulses on the Aux input
PCM mode: RVOSD looks for pulses on the Throttle input.

If no valid pulses are detected by the RVOSD, it will display 'Rx not detected' on start up .
Servo outputs will be disabled until a receiver is detected and RVOSD becomes 'armed'.

Note: 'Rx not detected' can also be displayed on startup, if your throttle position is higher than **Set PCM FS point.**

5.2.3 If R/C link is lost

When the OSD is armed, it will automatically activate a safety option if R/C link is lost. There are two safety options: return to home autopilot or preset failsafe positions.
We highly recommended to select the latter, until you have tested the autopilot function.

5.3 Configuring warnings

You can set warnings for:
Low battery
Line of sight distance too far
Altitude too low

These settings are located on main menu page 2/4.

5.4 Configuring waypoints

RVOSD allow inputting up to 5 waypoints to be displayed on the “Radar screen”. The number of displayed waypoints will be up to the “Last waypoint” selected. Each time you change the value on the “Last waypoint” menu item the “Waypoint LAT” and “Waypoint LON” menu items will display the selected waypoint coordinates. You can change this coordinates with the remote control using up or down arrows or the numeric keypad. Remember that an RVOSD use decimal degree coordinates. “Waypoint altitude” item is not used for the RVOSD version without waypoint sequencer.

5.5 Configuring RSSI measurement

A new RSSI display option allows advanced users to connect RSSI voltages from your receiver to the temperature sensor input on RVOSD. This should be done thru a series resistor of 100 kilo ohms so the OSD input will not load to much the RSSI circuit and affect your radio range. After RSSI it’s connected you can go to the Main menu page 2 and with your transmitter turned ON nearby, store the maximum RSSI value. Then take the transmitter far from the receiver until you start to see glitching or your receiver goes in to failsafe. Then store the minimum RSSI. Finally you can select how to display RSSI analog or digital. If digital mode is selected the RSSI will be shown in a value from 0 to 100% that will match the signal received. If analog display it’s selected it will take place of the Satellite bars indicator showing 10 bars proportional to the signal strength. GPS satellite count will be shown digital instead.

5.6 Configuring OSD display

These settings are on Main menu pages 2, 3, and 4.
Some more display options can be found in Autopilot submenu page 1/3.

5.7 Configuring GPS

Be sure that the **GPS fix update**: is set to **10Hz** (default) , if you are using the included 10Hz GPS module.

RVOSD will display "Searching Sats" when there is not any satellite lock reported from GPS and will change to "Setting Home" as soon as it locks on the first satellite.

The RVOSD start the ‘Setting Home” timer after GPS HDOP value goes below **Set max HDOP**: value.

-This value sets the minimum GPS signal Horizontal Dilution of Position (HDOP). -Its recommended to set this value to the minimum possible (around 1.00) to have an accurate set of zero altitude and home GPS coordinates, however it can take too long to set home with this value to low. Setting it to 1.30 seems to be the best compromise between accuracy and lower time to set. Keep in mind that this must be done with clear open sky visibility.

5.8 Configuring current sensor

Curr sensor type: **100** is default. Don’t change it unless you use a different current sensor.
The **Bat capacity** option is used to calculate the scale of graphic mAh drawing.

5.9 Debug screen:

When the menu item “Debug screen” it’s set to enable. The screen that is usually blank (no overlay) will display useful information.
-The first parameters: Elevator, Aileron, Throttle and rudder. Display the servo pulse width for every channel input. Those values are in milliseconds, and should change if you move the matching stick in your R/C remote control.
-Pitch, Roll and Abs thermal should display the RAW value of the three matching pair of sensors. This value is

scaled down to be from 0 to 256. Every pair of sensors should give the maximum or minimum values when one sensor is pointed to earth and the other to the Zenith. By reversing the sensor orientation you should see the other extreme value. Middle value ((max+min)/2) should be around 125-130, and all sensors should have similar maximums and minimums. Make sure to keep your body away from the sensors view when you do this test.
-The other useful values are GGA, RMC and VTG. Those values should be 10 for all of them. And the “Buffer” values should be more than 30. This will help to know if your GPS digital communications are working (GPS is not dead or GPS cabling faulty).
-The values “Fix” and “mode” will provide information about the GPS lock status. When Fix is 1 or 2, and mode is autonomous or differential. The GPS is working properly.

5.10 Saving settings

Changes will be lost on a power reset or OSD reset, unless you **Save configuration**.

6 CONFIGURING / TUNING THE RVOSD AUTOPILOT

6.1 How to turn on autopilot and automatic RTH in-flight..

If the IR sensors are installed, and the AHI properly working, RVOSD autopilot can be used for more tasks than return home on R/C link lost condition. This is done by toggling down the switch on the transmitter assigned to the auxiliary channel, then the selected autopilot mode on the menu item “Autopilot mode”, will be activated.

The available autopilot modes are:
RTH, Return to home, same mode that will be set if the failsafe condition is detected.
Level flight, the autopilot will keep the attitude of the model leveled on the pitch and roll axis.
Heading hold, the autopilot will keep the heading of the plane at the moment it was activated, also will try to keep the actual altitude.
Position hold, the plane will start making figure eight patterns around the GPS coordinates at the moment of activation, it will also try to keep the actual altitude.
Fly by wire, the control of the plane is give up to the OSD computer, it will check for user stick movements and will translate to model desired attitudes. Control sticks are interpreted from 0 to full as 0-60° on each axis.

Important things to remember are that if the system detects R/C link lost when any of the “autopilot mode” are activated, it will cancel the actual mode and set the model to RTH. After R/C link is restored the user will have manual control back, but the “autopilot mode” will be cancelled.

If any of the autopilot modes is selected while the user enter the autopilot menu, the mode will be temporally set to Level flight, and some menu items will not be available to be changed.

Note that the autopilot mode “level flight” allow you to make an independent test of the stabilization part of the autopilot; “Stabilization pitch gain” and “Stabilization roll gain” can be tweaked on this mode.

On all modes every time any mode is activated it will be displayed on the screen, and will remain ON until it is deactivated, but the mode “Fly by wire” will only remain in the screen around 5 seconds then will blink and disappear, instead you will notice 4 dots blinking every 5 seconds around the Flight path marker.

6.2 Tuning autopilot without IR sensors

Please refer to the the menu items on Autopilot sub menu page 3/3. Also read the first paragraphs of 6.3.

6.3 Tuning autopilot with IR sensors

The most important thing to get the autopilot to work properly is to have an AHI indication that it is also accurate. Within +-40° on the roll axis the AHI should not have an error of more than 5°. So make sure to properly set it with “Set neutral AHI” and “IR sensors equalization”.
RVOSD autopilot works in two stages. One stage is stabilization control which function is to set the desired attitudes for pitch and roll axis. On this stage you can only change proportional gain, and this is done with the menu items “Stabilization pitch gain” and “Stabilization roll gain”. If the plane attitude control is weak, the autopilot attitude corrections will be slow and you should increase the values for the appropriate axis. If the plane attitude control is too much strong, the autopilot will start to do roll or pitch oscillations, and you should reduce the gain for the offender axis.
This should be all the adjust you need to do to get a working autopilot. Because the second stage (navigation) should work good enough with the default values for almost all the models.

The other stage is navigation control.
For heading, it output a request for the stabilization control to set the appropriate bank angle to correct the

heading toward the desired target. It is used a PID control that includes the gains:
• Bank limit
• Bank proportional gain
• Bank derivative gain
• Bank integral gain
For altitude, it outputs a request for the stabilization control to set the appropriate pitch angle to correct altitude towards the desired cruise altitude. It is used a PID control that includes the gains:
• Altitude limit
• Altitude proportional gain
• Altitude derivative gain
• Altitude integral gain
Some models, will not correct heading fast enough by just banking, for those you can use “Turn rate gain” the function of turn rate gain is to cancel any pitch request proportionally to the actual bank angle so the plane will not try to pitch down while it is banking, if the gain is increased it will also try to pitch the plane up proportionally to the bank angle.

Throttle control on the autopilot it’s fixed to two values, when the model is above “altitude limit”+”cruise altitude” the throttle control is fixed to the value on the “Set throttle failsafe” menu item, This value should be set so the airplane can gently glide at optimum battery consumption.
Bellow “altitude limit”+”cruise altitude” the throttle control is fixed to the value on the “Set cruise throttle” menu item, this value should be set to allow the airplane to dive and climb using the pitch control.

RVOSD return to home system and autopilot control, works on a separated microcontroller than the OSD display, so if the video signal it’s lost, and you have your autopilot configured. Forcing RTH by turning off your transmitter or any other means will make the system to take the plane back to home. Any problem on the video signal will not affect the autopilot

6.3.1 IR sensors equalization:

This option should help when you have XY and Z sensors from different sources, and there is a mismatch. You can check this on the debug screen. Before starting it, make sure that you are in a location with unobstructed view to the sky.
When this option is initialized, the OSD will display the steps and actions you need to do.
First it will ask to get the plane leveled, during this stage the system it’s checking the Z sensors values and storing the biggest value detected.
Second it will ask for keep the plane nose down, during this stage the system is checking the pitch aligned sensors maximum (if value is greater than 127) or minimum (if value is less than 127) and storing it to make the appropriate XY to Z sensor equalization.
After this the system should improve if you had sensors mismatch. If you are not satisfied with this correction and the AHI is working worst after the calibration (make sure to test this while flying). You can go to the menu “IR XY head position” and try to change it with your transmitter, It will not change because it is not allowed to be changed by the transmitter, but still will eliminate any change done by the AHI equalization.

6.4 First time setup with a flying wing

-RVOSD will make the elevon mixing, so set your R/C controller for normal outputs. Connect Rx elevator output to RVOSD elevator input, and Rx rudder output to RVOSD rudder input. Connect RVOSD rudder output to one elevon and elevator output to the second elevon.
-Change the “Airplane type” menu item set to “flying wing”, and make sure rudder and elevator transmitter trims are to 0%.
-Go to the menu “Set neutrals” and set it.
-Go out of the autopilot menu. Now mechanically adjust the elevons to neutral positions.

-Make sure that the elevons move both up//down, when you move elevator sticks. If not change the menu item “Flying wing CH1 reverse”.
-Adjust with the transmitter the correct rudder and elevator channel direction, so climb//dive and bank left/right are properly executed. At this stage the OSD has strong software limits to the servo throws, so don’t increase those on the transmitter. One way to check the real servo throws is by changing “airplane type” back to “normal”, each elevon will become rudder and elevator but, you can check the throws for every channel.
-Make sure the “airplane type” is back to “Flying wing”. Remove the propeller! And run the “Start R/C wizard” menu item on, main menu page 1/4..

6.5 Safety

- Remember that the Aux input channel can change autopilot modes. If you are flying by watching the video with OSD, this won’t be problem. But please pay attention , if you are flying in third person mode and accidentally toggle an autopilot mode. You have to think fast ! Better disable autopilot modes when flying third person.

The Auxiliary input is used to control the OSD in flight. It works by measuring the period of the pulse input (servo pulses). On a change from less to more than 1.85mS it cycles screens. On a change from more to less than 1.35mS it cycles autopilot mode

- Do not try to adjust the autopilot at a low altitude. You will have no chance to recover from a bad autopilot response.

7 ALL MENU OPTIONS – REFERENCE

7.1 Main Menu page 1/4

Servo outputs:

-Enable//disable servo outputs.

Start R/C wizard:

-Start the OSD configuration for RC link lost detection, Servo neutral positions, Maximum servo throws, Control surfaces directions and maximum//minimum throttle positions.

Receiver mode:

-Selects PCM or PPM receivers. (This should be properly configured in the R/C wizard)

If R/C link lost:

-Select OSD action when R/C link is lost. Failsafe, RTH, test in the air, test in the ground. The last two modes are only available when the “IR sensors installed” menu item is set to No.

Set PCM FS point:

-In PCM mode this parameter set the throttle point at which RVOSD will interpret receiver went to Fail Safe mode. Adjust this to be over your 100 % normal throttle position and under the FS setting on your throttle channel. (This should be properly configured in the R/C wizard)

Set Failsafes:

- If "Fail safe" mode its set in the menu item “If R/C link lost”, RVOSD will send the values set here to rudder, elevator and aileron outputs when R/C link is lost.

Enter autopilot menu:

-Door to the autopilot submenu

Reset OSD:

-Restart main microprocessor unit, the conditions to set home will be required again.

Curr sensor type:

-Adjust gains for different current sensor type. Five types of sensors will be available, 50-100-130-150-200.

Set max HDOP:

-This value sets the minimum GPS signal Horizontal Dilution of Position (HDOP) RVOSD will accept to start setting home. RVOSD will display "Searching Sats" when there is not any satellite lock reported from GPS and will change to "Setting Home" as soon as it locks on the first satellite.

-Its recommended to set this value to the minimum possible (around 1.00) to have an accurate set of zero altitude and home GPS coordinates, however it can take too long to set home with this value to low. Setting it to 1.30 seems to be the best compromise between accuracy and lower time to set. Keep in mind that this must be done with clear open sky visibility.

Call Sign:

-You can set your call sign here and also turn it ON or OFF.

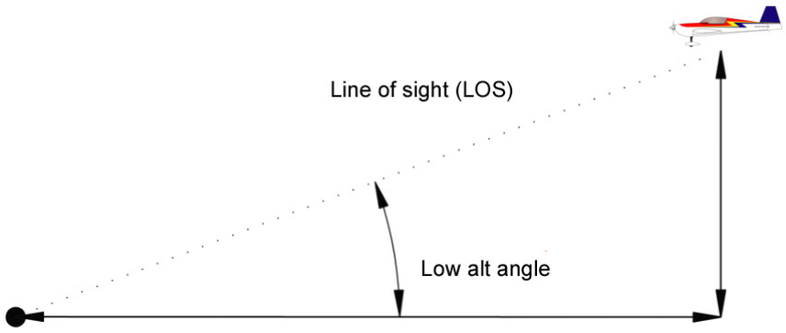
Set Batt capacity:

-Sets the maximum battery capacity of your pack. RVOSD only measures motor consumption, thus you need to calculate your static consumption (video Tx, camera, receiver). A typical value for 500mW Tx, KX191 camera and usual EzStar Rx and micro servos, its 500mAh. If your battery has a capacity of 2200mAh, a good practice is to set 2200-500=1700mAh as battery capacity for 1 hr flight time. The current indicator will start to blink when mAh consumed go over 80% of the value set.

7.2 Main Menu page 2/4

Low altitude angle:

-If the plane has an angle in the horizon less than this value, GPS coordinates and date will be shown. If "Warnings screen" is selected "Low altitude" warning is displayed.



Batt warning:

-The Main Battery voltage indicator will start to blink when it goes under the value set.

-The Video Battery voltage indicator will start to blink when it goes under 10.6V. This value is fixed. Note that video battery input can be connected to your 5 Volt servo – Rx rail if you don't want to use a video battery, this way you can monitor also the BEC voltage.

Dist warning:

-Distance indicator will start to blink when it goes over the value set.

Display RSSI:

-The temperature input port can be connected to the RSSI voltage in your receiver thru a 100Kohm resistor, when this is done the OSD can display this information as a digital value from 0-100% or analog display using the space of the GPS sats indicator, if this is done then the sats are displayed as a number in the upper left screen.

Minimum RSSI:

-Take the R/C transmitter away from the receiver until glitching starts, and then store this value. The OSD will take this value as the minimum RSSI.

Maximum RSSI:

-With the R/C transmitter close to the receiver, store this value. The OSD will take this value as the maximum RSSI.

Last Waypoint:

-This will be the last waypoint displayed on the radar screen, notice that the next three menu items will display the waypoint latitude, longitude and… altitude (only useful for waypoint navigation, USA-Canada only)

Waypoint LAT:

-Latitude of the current waypoint selected on "Last Waypoint" menu.

Waypoint LON:

-Longitude of the current waypoint selected on "Last Waypoint" menu.

Waypoint altitude:

-Altitude of the current waypoint selected on "Last Waypoint" menu.

Virtual fence:

-Limits the maximum distance from home for any waypoint to be selected as target for the waypoint navigation (USA-Canada). IF the model reaches this distance from home all waypoints will be cancelled and the model will go back to home.

Display waypoint indicator:

-Enable or disable the waypoints directions and distance display on the OSD.

7.3 Main Menu page 3/4

Display units:

-Allows the use of metric or imperial units

Display Vario:

-Select the type of display for the variometer information. disabled, digital or analog.

Display clear ground:

-When this parameter is ON, most of the OSD information is displayed in the upper side of the screen.

Display FPM:

- Enable/Disable Flight Path Marker (FPM).

FPM position adjust:

-This setting allows adjustment of the vertical position of the Flight Path Marker (FPM) as well as the center of the rotating Home and Waypoint indicators.

AHI Size:

- Adjust the Size of the of the Artificial horizon indicator, while this parameter its being adjusted you will see the main screen, with AHI displayed, Vol+ and Vol- keys will make the AHI line bigger or smaller respectively.

Display speed ladder:

- Enable/Disable the speed ladder on the F16 screen.

AHI Width:

- Adjust the OSD display to wider or narrower positions.

Display compass:

- Enable/Disable the compass on simple and F16 screens.

Hide ground distance:

-Maximum distance to display Ground Distance, if this value set to zero Ground Distance is always displayed.

Display home arrow:

- Change the type of home arrow to be displayed on the Simple screen.

Display turn rate:

- Enable/Disable the turn rate indicator to be displayed on the F16 screen

7.4 Main Menu page 4/4

Blank screen warnings:

- Enable/Disable the warnings to be displayed on the blank screen (No OSD screen)

GPS fix update:

- Select the GPS module type to be 5Hz or 10Hz if available.

Debug screen:

- Enable/Disable debug information to be displayed on the blank screen. Useful if you have any problem with GPS signal/connection, Thermal sensors, or servo inputs.

Save configuration:

-Saves all settings to permanent memory so when you cycle power to the OSD its parameters will be kept in memory. (You will see a very fast "Done" blink to confirm this action). After that, no further save is needed unless you want to modify something else. Be conservative because this option its limited to 800-1800 cycles only.

7.5 Autopilot Submenu page 1/3

Set neutrals:

-Sets the neutral trims for the airplane Yaw/roll, pitch controls. And aileron output while the system is on autopilot mode.

Set cruise throttle:

-Sets the engine throttle position when the autopilot is trying to correct altitude (less than "Cruise altitude" + "Altitude limit")

Set throttle failsafe:

-In "Fail safe" autopilot mode, RVOSD will output this value to throttle if RC link lost is detected. In "RTH" autopilot mode, RVOSD also will output this value if the plane altitude is more than "Cruise Altitude" + "Altitude Bearing Limit" so you must set it to neutral(engine off), or to a low value to keep altitude if possible.

Set neutral AHI:

-When this menu is activated, the system will get out of the autopilot menu, to the main screen (F16 or simple) and a long line will be displayed in the center of the screen, after this the system will give you 4 seconds to align the line with the real horizon. And the actual attitude of the plane will be assumed to be the AHI position when the

plane is flying leveled in both pitch and roll.

Stabilization pitch gain:

-This parameter will set how much the autopilot will deflect the controlled flight surfaces to set the plane pitch requested by the navigation module.

Stabilization roll gain:

-This parameter will set how much the autopilot will deflect the controlled flight surfaces to set the plane roll requested by the navigation module.

Max pitch angle:

-Maximum angle the autopilot will allow the plane to pitch while correcting altitude.

Max roll angle:

-Maximum angle the autopilot will allow the plane to roll while correcting heading.

Autopilot mode:

-Select the autopilot mode to be activated when toggling auxiliary channel down.

- RTH
- Level flight
- Heading hold
- Position hold
- Fly by wire

Main screen selection:

-Choose the main flight screen; it can be F16 or Simple screen

Radar screen selection:

-Enable or disable the altitude and speed ladders on the radar screen.

AHI display:

-Sets how the AHI will be displayed, ON = always, Autopilot = on autopilot activation, OFF = never.

7.6 Autopilot Submenu page 2/3

IR sensors installed:

-Enable/disable the thermal sensors for autopilot attitude control.

-If this menu its set to “disable”. All menus related to the IR heads will be set to “n/a”

IR XY head position:

-Sets the XY thermal head orientation. Heads aligned or 45° with roll and pitch axis.

AHI pitch direction:

-Correct the AHI pitch movement if the pitch sensors need to be placed reversed on the plane. If it is noticed that the AHI pitch is working backwards, change this parameter.

AHI roll direction:

-Correct the AHI roll movement if the roll sensors need to be placed reversed on the plane. If it is noticed that the AHI roll is working backwards, change this parameter.

Airplane type:

-Select the type of autopilot control; Normal, or flying wing (Elevon mixing is done inside RVOSD).

Flying wing CH1 reverse:

-On flying wing mode this reverse just one servo so elevator move both elevons to the same side (pitch), and rudder move both to different sides (roll)

7.7 Autopilot Submenu page 3/3

Cruise altitude:

-Sets desired altitude for autopilot corrections on the Pitch control (meters or feet depending on units setting on main menu).

Bank limit:

-When using the autopilot without the IR heads, this parameter can be used to limit the maximum servo deflection

allowing more authoritative response of the autopilot while avoiding too much bank angle when the plane is going completely away from home (maximum autopilot output)
-With the IR heads active, this parameter will limit the heading error to avoid excessive angles requested by the navigation module.

Bank proportional gain:
-This option adjusts the proportional gain on the Yaw/Roll PID control. Autopilot output is proportional to the heading error (Plane heading – home direction). This parameter determines how much this error will deflect the rudder of the plane.
-If the IR sensors are connected, then this parameter will set the desired bank angle instead of direct rudder/aileron deflection.

Bank derivative gain:
-This option adjusts the derivative gain on the Yaw/Roll PID control. This parameter will act as a damper making the planes rate of turn softer.
- If the IR sensors are connected, this parameter will make the same action on the correction of the heading changes (smoother changes of heading).

Bank Integral gain:
-This option adjusts the integral gain on the Yaw/Roll PID control. This parameter will make corrections to the set point of the PID control. When the neutral rudder position is not adjusted properly or there is some wind, an additional correction is needed to make the heading to home more accurate.
- If the IR sensors are connected, this parameter will make additional corrections if the heading keeps unchanged because autopilot correction is not enough to roll the plane due to AHI errors.

Turn rate gain:
-IF these gain it’s set to anything but zero, the amount of Roll angle will proportionally cancel any pitch correction, allowing better heading control. Gains higher than 1, will add a proportionally related to roll, pitch up command.

Yaw/roll servo direction:
-Corrects the sign of the Autopilot action on the YAW servo.
- If the IR sensors are connected, this parameter sets the direction of correction for the autopilot angles. Change this if you notice that the plane banks away from home while on autopilot mode.
-This parameter should be automatically set if the R/C wizard is properly executed.

Altitude limit:
-Limits PID action over and under Cruise altitude. Also, if actual altitude is greater than "Cruise altitude" + "Altitude limit" autopilot will set throttle to "throttle failsafe" and pitch control will be annulated, leaving to the "set neutral elevator" the pitch adjust of the plane. Pitch attitude to zero degrees angle with the IR sensors connected.

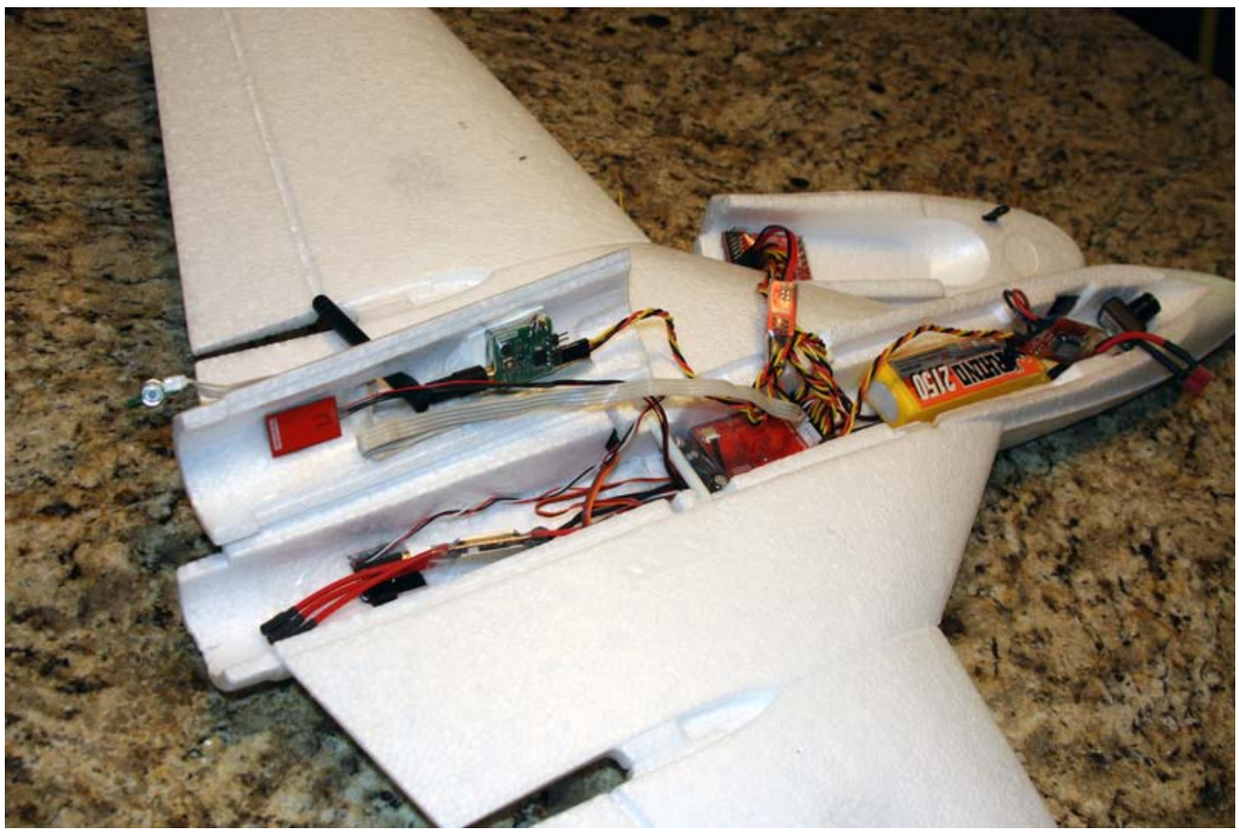
Altitude proportional gain:
-This option adjusts the proportional gain on the PITCH PID control. Autopilot outputs its proportional to the altitude error (Plane altitude – cruise altitude), this parameter determines how much this error will deflect the elevator of the plane.
-If the IR sensors are connected, this parameter will set the desired pitch angle instead of elevator deflection.

Altitude derivative gain:
-This option adjusts the derivative gain on the PITCH PID control. This parameter will act as a damper, making the rate of climb of the plane softer.
- If the IR sensors are connected, this parameter will make the same action on the correction of the altitude (smoother changes of altitude)

Altitude integral gain:
-This option adjusts the gain of the rudder to elevator mix available if you want to compensate pitch down due to rudder action.
-If the IR sensors are connected, this parameter will add additional corrections if the altitude is not changing towards cruise altitude.

Pitch servo direction:
-Corrects the sign of the Autopilot action on the Pitch control servo.
- If the IR sensors are connected, this parameter sets the direction of correction for the autopilot altitude. Change this if you notice that the plane pitches away from the desired cruise altitude while on autopilot mode.
-This parameter should be automatically set if the R/C wizard is properly execute

8 MOUNTING IN MODEL



Before making any explanations I will make some suggestions that will save some planes out there. The radio control receiver is very sensitive to electromagnetic fields generated all over the electronics on the plane. Placing your receiver as far as possible from the rest of the electronics (at least 20 cm) is a very good practice. I think the sources of interference can be organized following this order from more to less interfering.

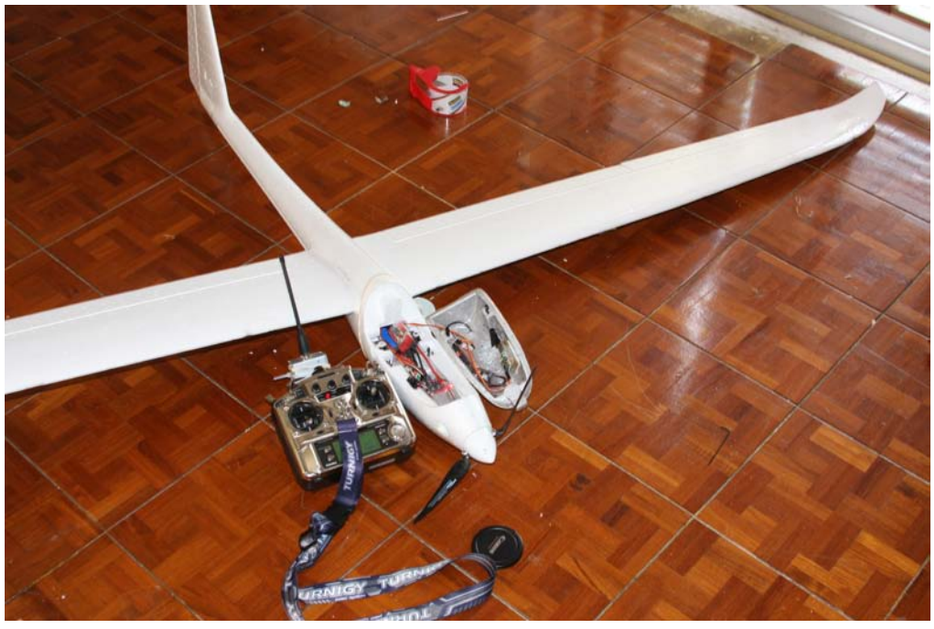
-Video transmitter. A lot of harmonics can be generated inside the transmitter. They are radiated thru the antenna and the worst part of it escapes thru the video and power cabling. Wiring those cables together around a toroid and twisting the rest of the cable length will give you a lot of improvement.
-GPS module. This unit can be affected by the video transmitter, but also can be the source of interference affecting your receiver. The cabling that goes to the OSD transports high speed data communications that can be radiated if they pass near the receiver or antenna.
-ESC. Speed controllers have a microprocessor that uses an internal crystal that can generate harmonics on the RC link band. Also, the PWM output to the motor can be radiated.
-BEC. A switching regulator operating on the KHz bands can generate harmonics.
-The OSD. The OSD contains two microprocessors running at 120 Mhz with crystal oscillators at 10 Mhz which can cause interference on its harmonics. Also, high speed data flows all over the unit. Low pass filters were added to all the inputs and outputs but it is still suggested you use a separation of 10 cm or more between the OSD and the receiver and antenna.

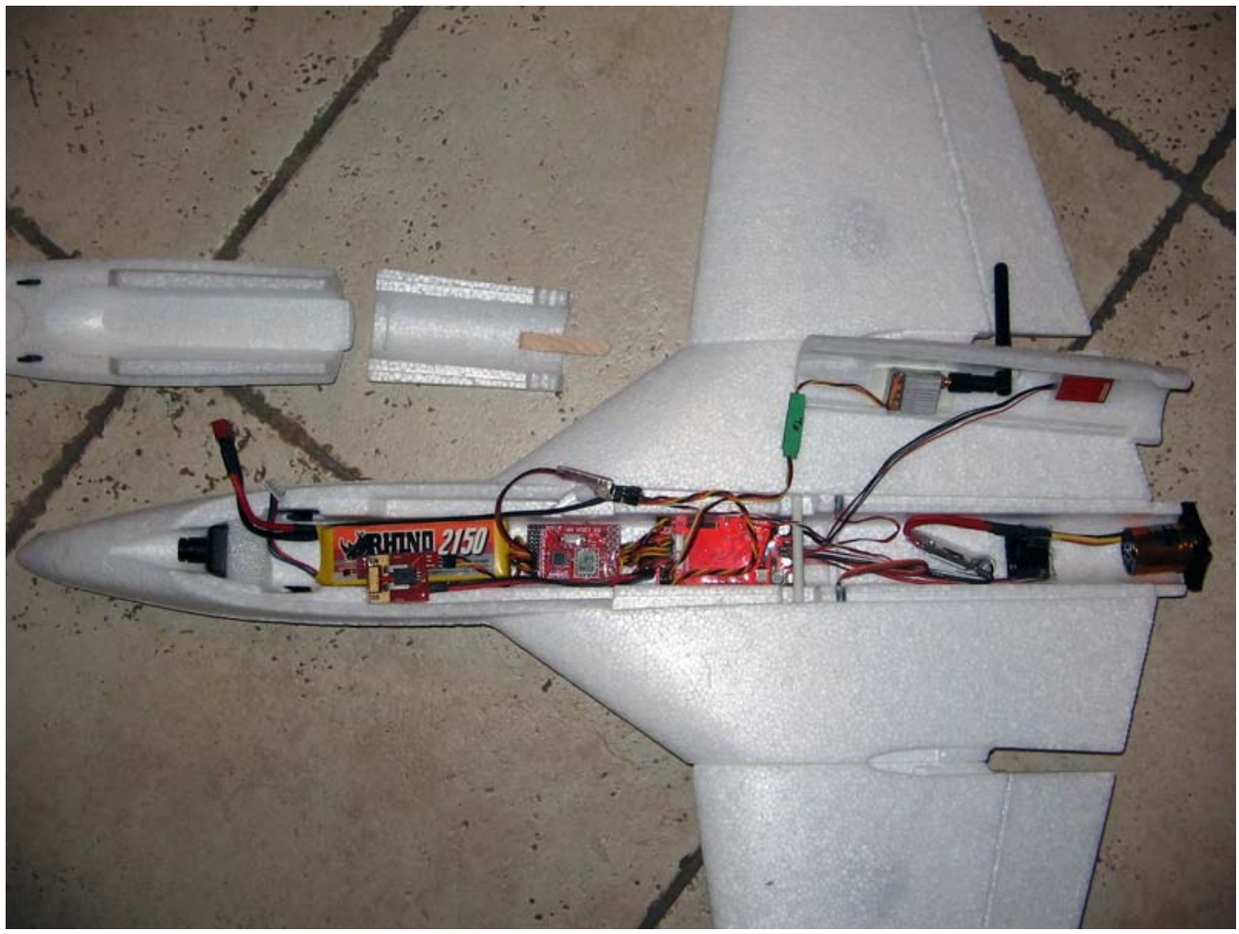
Check the function of the RVOSD and your video equipment before installing it in your model.
Remember …

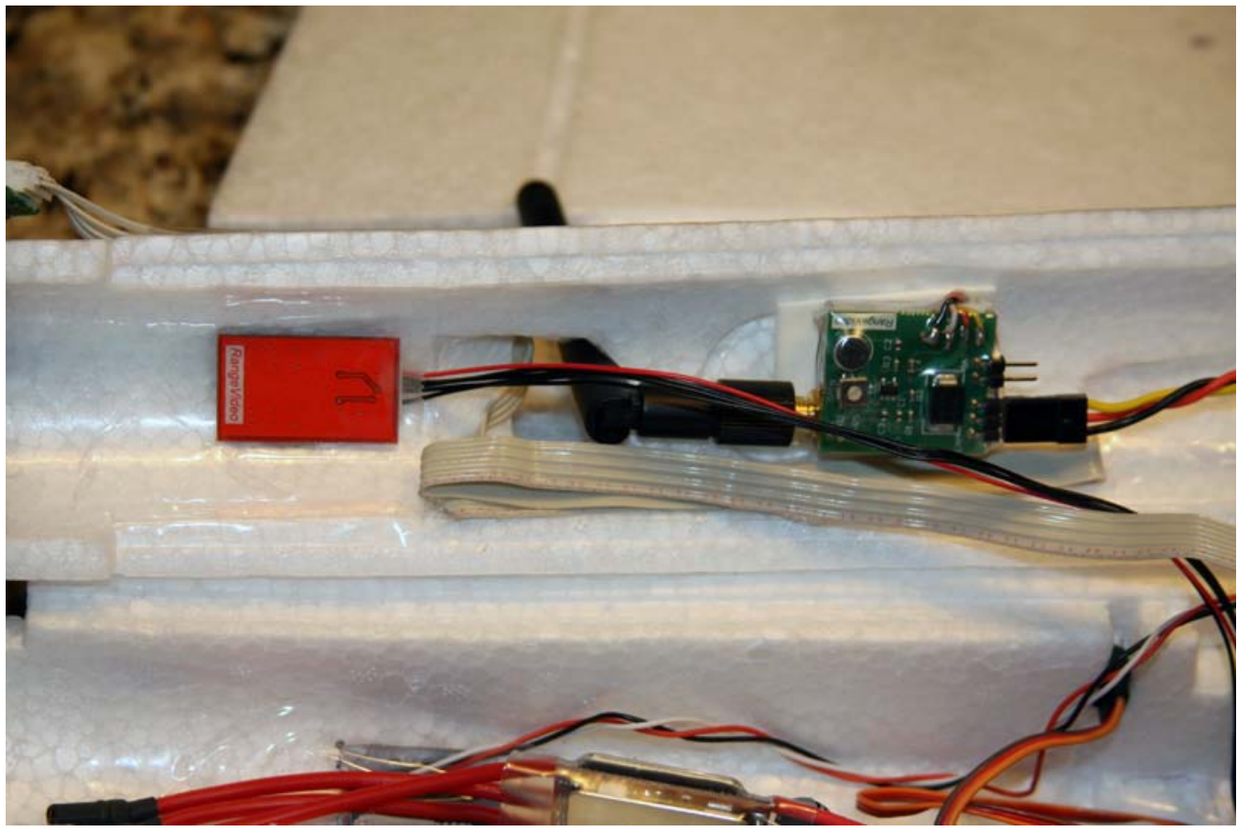
You will need access to the RVOSD board to perform firmware updates.
An update might come every 6 months, or the next day (if we discover a bug in existing code)! So it's better to have the RVOSD in an easily accessible spot.

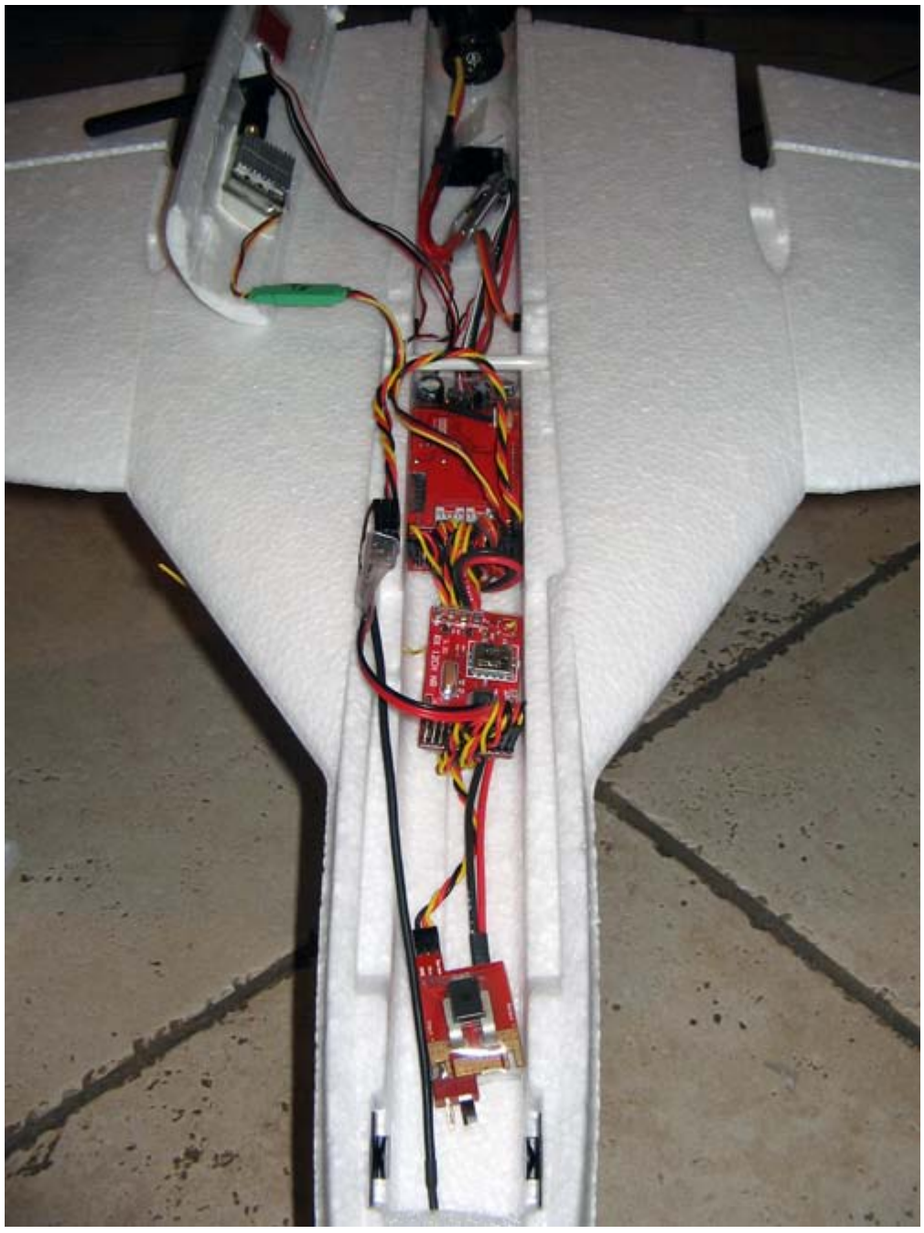
The RVOSD main menu is navigated by an IR remote. You will constantly be using this menu to adjust settings. The IR remote is powerful enough to penetrate foam. Test the IR remote before you bury your RVOSD deep inside your airframe

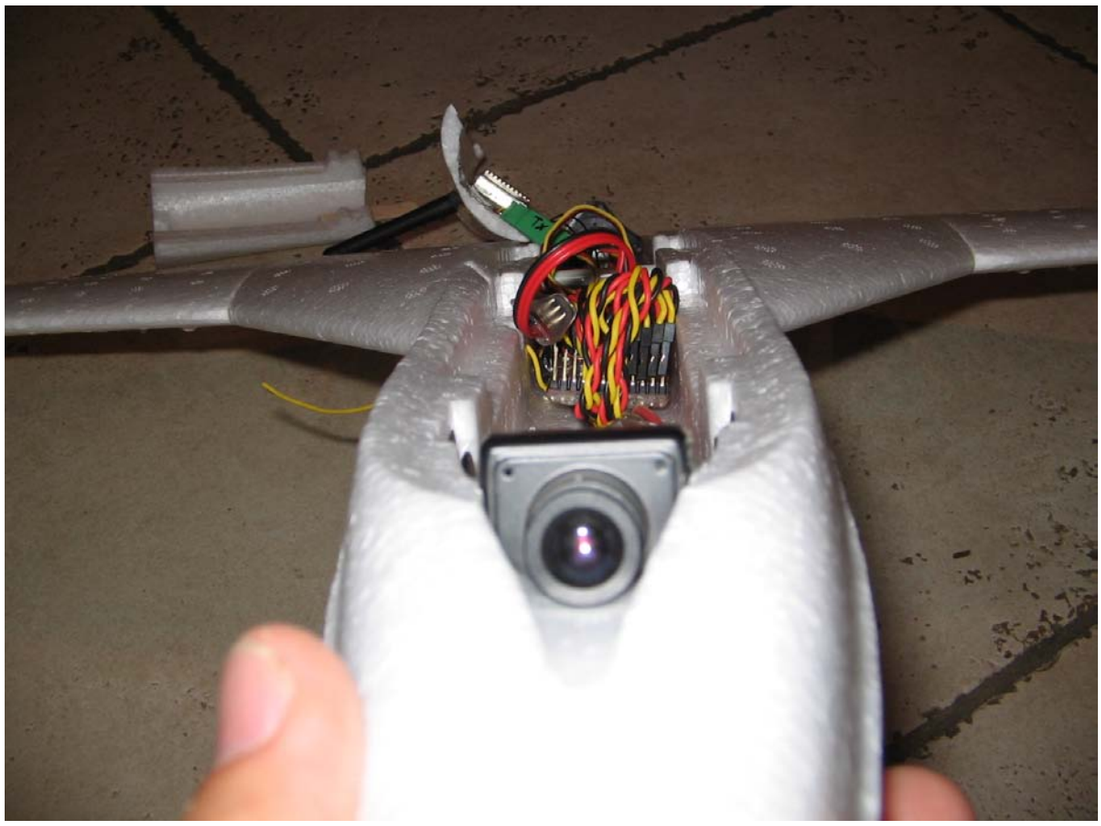
Multiplex Cularis

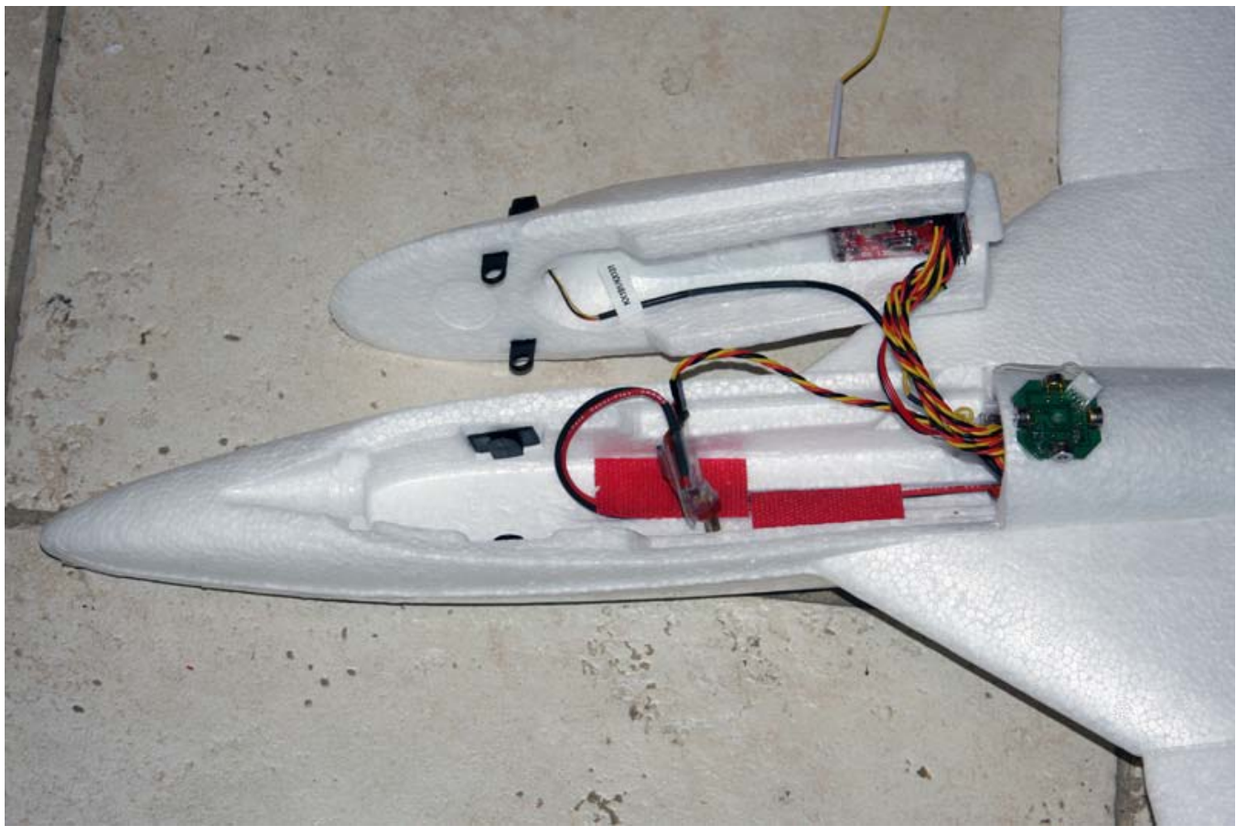


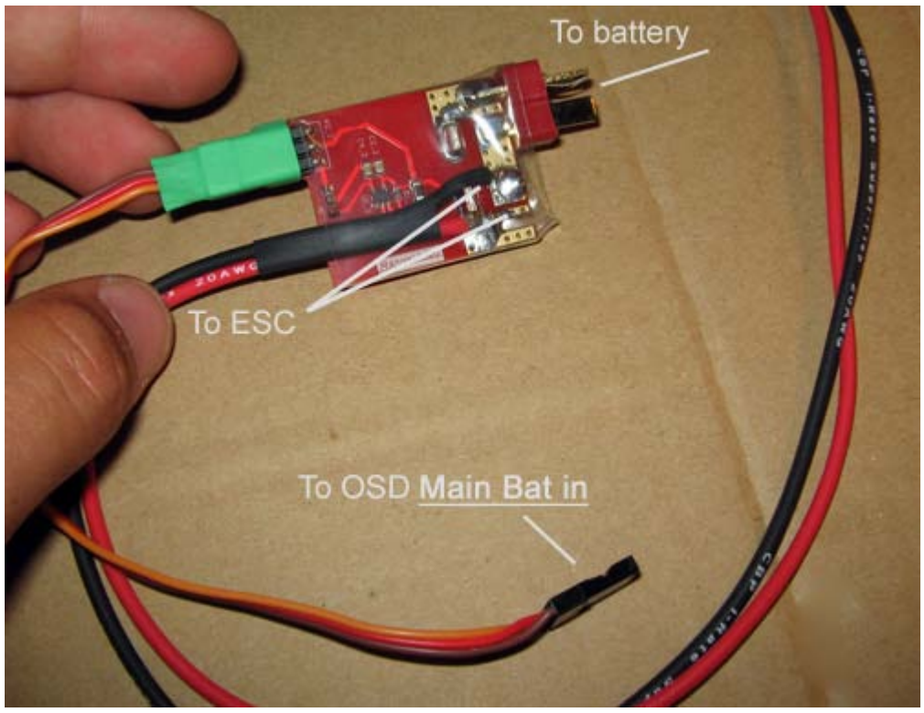

RHINO 2150





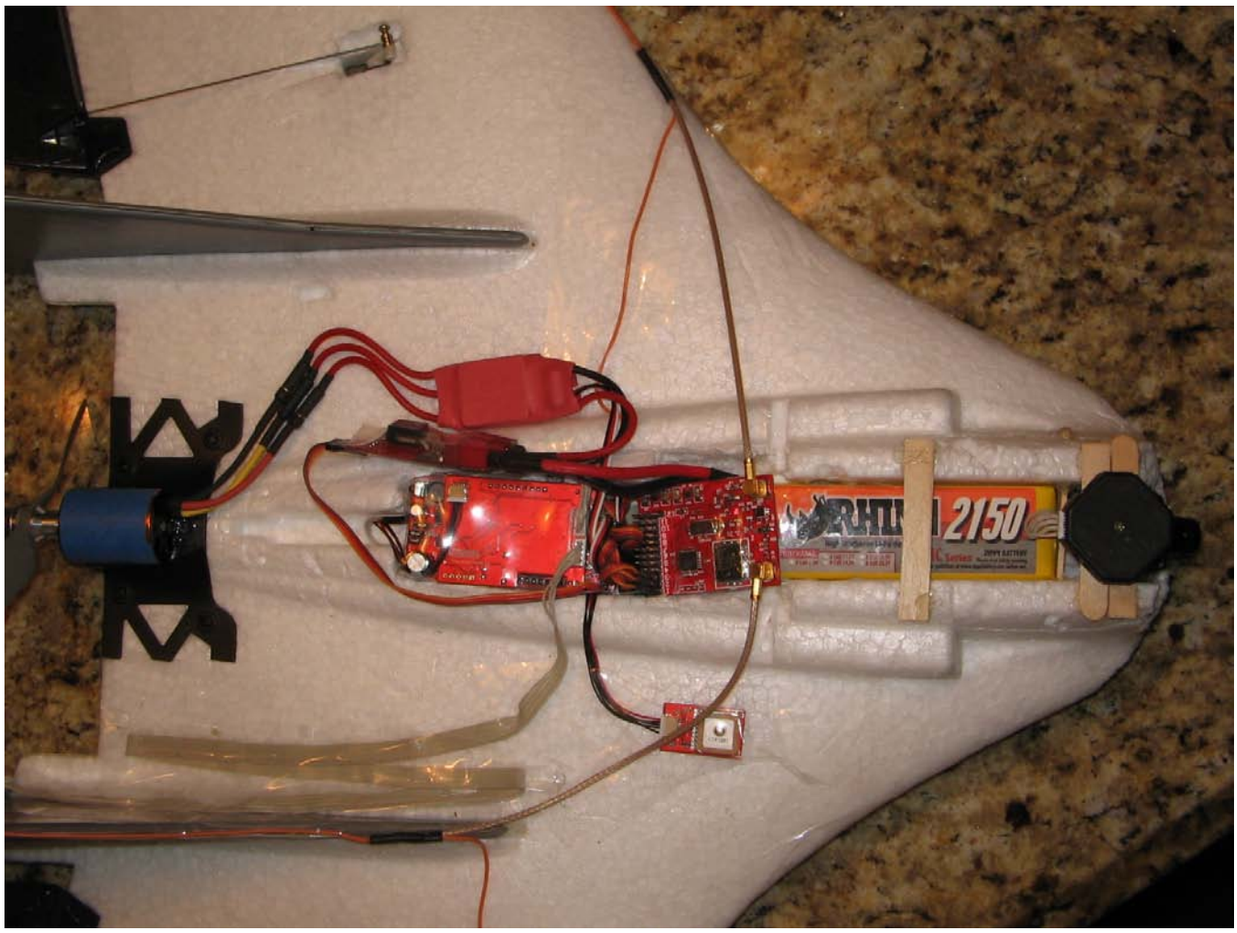




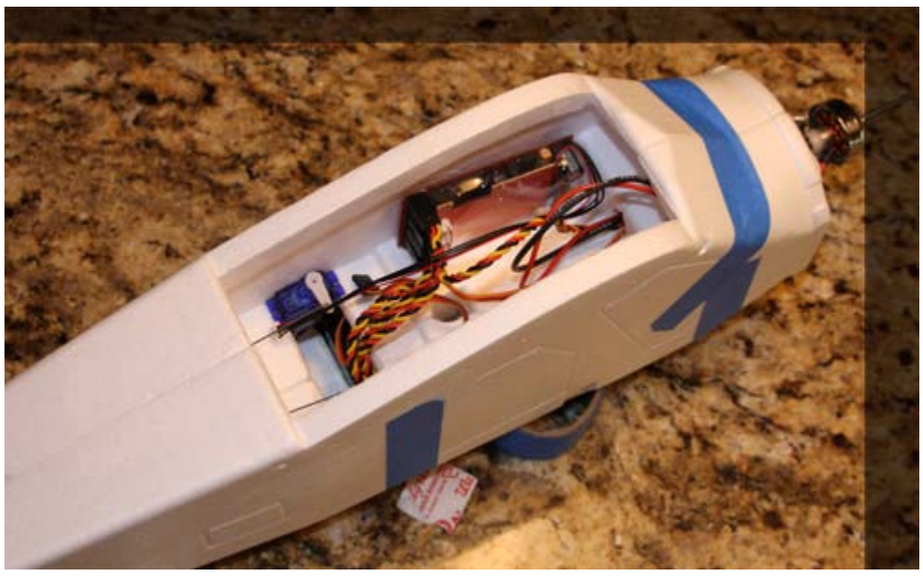


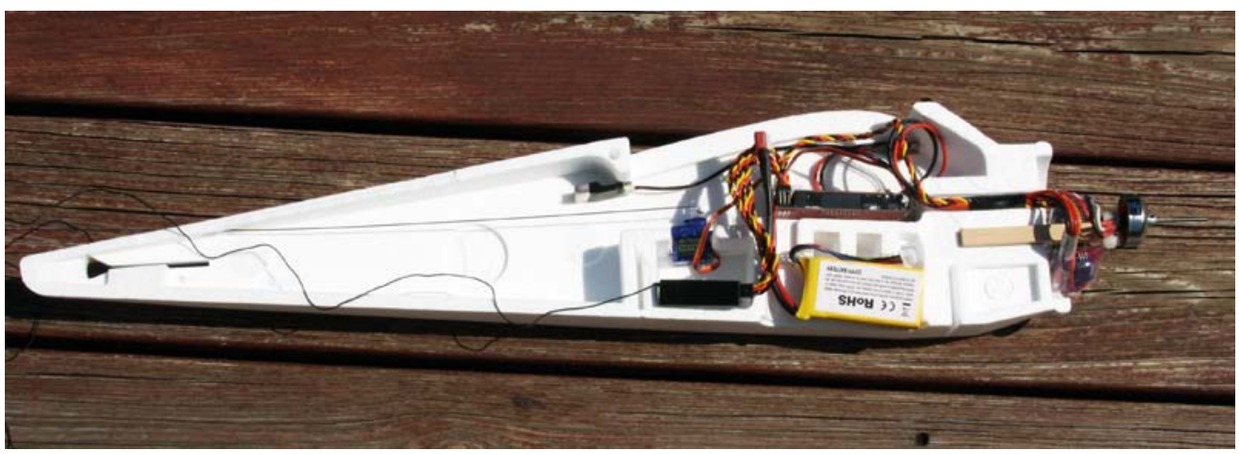
In this example, I soldered the ESC wire directly to the current sensor board. More reliable and some weight savings.

Parkzone F-27 Sryker



GWS Beaver





9 UPDATING THE FIRMWARE

The RVOSD is has two microprocessors, and each one has its own firmware.
The main board processor handles the calculations and the graphic board processor does the video overlay.
Small bugs are usually addressed with a main board patch. Big updates, like a new generation update, requires updates to the graphic board + main board.
Download FW updates on www.rvosd.rangevideo.com or www.rangevideo.com

How to update main board FW :
You will need the PICkit 2 programmer to perform the update.

1. Install PICkit 2 software from microchip:
   http://ww1.microchip.com/downloads/en/DeviceDoc/PICkit%202%20v2.61.00%20Setup%20A.zip
2. Connect the PICkit 2 to a USB port.

3. Remove power from your RVOSD and connect the PICkit 2 programmer as shown below.

The white arrow on the PICkit 2 indicates pin 1. This pin matches the square on the RVOSD:

3. Open the PICkit 2 PC software and choose device family > dsPIC33

4. Go to File > import HEX file , (find the hex file you downloaded)
Click > Write

5. Keep the RVOSD connected to the PICkit 2. After the programmer is finished you will see this screen:

You are finished. You may disconnect the PICkit 2 from the RVOSD.

Note: Updating the main board will reset all settings back to defaults.

Appendix	