WITESPY RTF QUADCOPTER USERS MANUAL

Quad built by: Witespy
Cover photo by: Earl Douglas
http://photosbydouglas.smugmug.com/Electronics/Quad/16463246_CSshU#1238756576_WXPMF
This documentation prepared by: Tony Roberts – fastpilot2@sbcglobal.net
Additional photos by: Warren

Thanks to the many others that assisted in the review of this information to help others.

BACKGROUND

The information contained in this document is to help you get up and flying with your Witespy Quadcopter. It is best to have experience with RC planes and/or helicopters before flying and working on a quadcopter. There is a wealth of information on the internet and RCGROUPS to help you learn the basics of RC and quadcopters.

Understand that quadcopters are not a toy and is not totally a “turn-key” flying machine. Even if you purchase a RTF quadcopter it will take “some” tweaking initially and at times to get the quad flying to your liking.

Here are some resources you can visit for assistance:
wiki : http://www.multiwii.com/?page_id=103
forum : http://www.rcgroups.com/forums/showpost.php?p=15334307
http://www.rcgroups.com/forums/showthread.php?t=1416168

Witespy does a great job on his quadcopters. It is recommended when you order your quadcopter to specify if you would like the following options:

- Autolevel
- Type of battery connectors (XT60, Deans Ultra, etc.)
- Cover plate
- Extra propellers
- Extra battery

Before we begin, read this information from MULTIWIICOPTER.com below about the different modes and fail safes. Note how you arm and disarm your quadcopter. This will be VERY IMPORTANT in the setup of your quad.

Set your Tx to ACRO (basic Airplane) mode - set PPM (not PCM), Activate Ch5 (Gear-Mode)
Read your Tx/Rx product manuals - You as the Pilot are responsible for safety.

Set the Throttle to OFF - After connecting the LiPo - the green CPU LED will flash for 5 seconds then go OUT If the LED blinks green (fast) but won't stop blinking - then the Rx is not powered; or not connected to the correct THRO pin correctly. The ESCs cannot calibrate as a group because the default state of the CPU->ESC is Disarmed. If the ESC's beep non-stop then they are not connected to the board.

If your copter goes out of radio-range it may cause harm - if still powered - Take the precaution to program in the FAILSAFE condition to protect people/property. Do not skip this step. Bind your failsafe (Read your Radio manual - FAILSAFE) on the Tx with power/Throttle set to OFF For Example

on FrSky - set sticks as above - then Press the Rx button - 2 green flashes on the Rx itself - done. Failsafe can also be set in Software (for ultra-basic or legacy Tx's)

Arming - Learn to recognize that your WiiCopter is ARMED.
Hold right Yaw for 1 sec - you will see the Green LED come on - stays on. If LED does not come on GREEN - then increase YAW travel - Check the THRO is not actually reversed by mistake - and trim down a few clicks on the THRO trim If it still won't arm connect FTDI and use the JAVA-Config (see below) to make sure the Throttle PWM is below 1100 (normal THRO range is 1100-1900) - In order to arm - the Wii CPU is looking for THRO <1100 and YAW ~1900 - The GUI shows actual values from Rx and is a valuable guide to trouble-shoot a CPU which won't arm.

Disarming - Learn to DISARM the ESC's before touching or approaching the Copter ESC's/Motors can start suddenly and the props can cut - fingers and eyes - permanent injuries With THRO OFF ; Hold the YAW stick LEFT for 1 sec ; then the CPU GREEN LED will go OUT and stay out

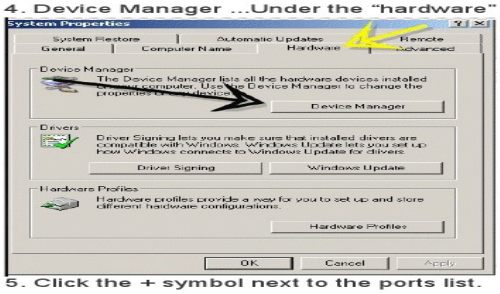
Gyro Calibration - Disarm the copter (see above) ; Place the Copter on a perfectly LEVEL LZ - it must be completely static - Set Trims to neutral - Stand back - With THRO off, Hold the YAW LEFT and the Cyclic stick Back & Right for 1 Sec ; release - you will see the GREEN LED blinking fast for a few seconds then go out - The Gyro is now calibrated for drift (at this ambient temperature) - The Gyro on a PARIS/warthox board is the WiiMP+ Do this every time you fly - preferably about 2mins after Powering up - in the outside air temps where you will fly.

Accelerometer (ACC) Calibration - Fly the Copter in ACRO mode - Trim the copter using the Transmitter stick sub-Trims so it hovers still on STILL air (no wind) - Land - Disarm the copter (see above) ; ensure the Copter is on a perfectly LEVEL LZ - it must be completely static - Confirm the DISARMED LED is OFF - Hold Full THRO/YAW LEFT and the Cyclic stick Back & Right for 1 Sec ; release - you will see the GREEN LED blinking fast for a few seconds then go out - The ACC is now calibrated for LEVEL mode(at this ambient temperature) - The ACC on a PARIS/warthox board is the Nunchuk®. Switch to LEVEL mode (Gear Switch) -Take off and mentally note the way the copter wants to drift - DO NOT TRIM THE TX - Land - final trimming procedure is now required to be completed for the ACC.

INITIAL SETUP

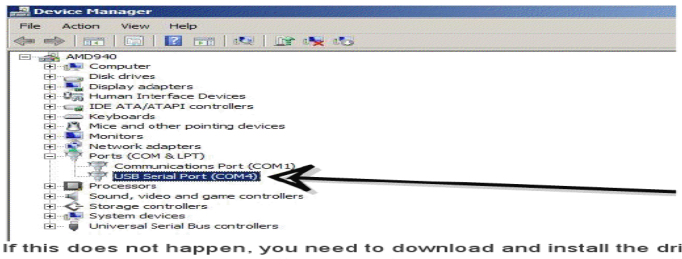
1. Remove and inspect your quadcopter from the box and packing materials. Make sure it did not become damaged in shipping. Make sure all your parts are accounted for “BEFORE” disposing of the packing material and box.
2. 
3. Bind your transmitter to your quad. Follow the directions for your user’s manual of you transmitter. Move the plug that is in the BATT position on the receiver to the AUX position. Plug in your bind plug to the BATT port. Plug in your quad to the LiPo battery. With the throttle in the down position, hold your bind switch on the transmitter and turn on the power to the transmitter to bind the transmitter to the receiver. The amber light on the receiver will stop blinking and remain on steady when bound. After it is bound, unplug the LIPO battery, remove the bind plug, move the plug from AUX back to the BATT position.
4. Set up your computer to use the FTDI programming card included with your quad. Go to your control panel – System – Device Manager

4. Device Manager …Under the "hardware" Tab

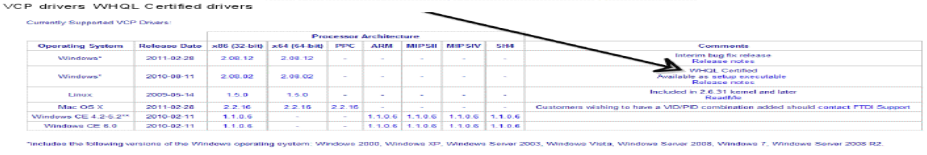


5. Click the + symbol next to the ports list.

5. Plug in the programming card to the computer.
6. Under Ports, look for the Communications Port of the FTDI card you just plugged in. This is your COM Port of the new FTDI card. REMEMBER THIS PORT NUMBER for a later step.



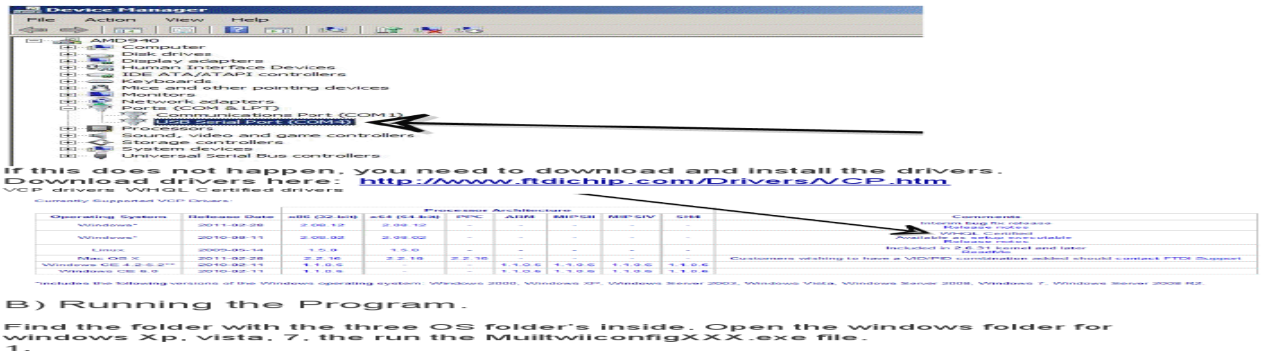
If this does not happen, you need to download and install the drivers.
Download drivers here: http://www.ftdichip.com/Drivers/VCP.htm



B) Running the Program.

Find the folder with the three OS folder's inside. Open the windows folder for windows Xp, vista, 7, the run the MuiltwiiconfigXXX.exe file.
1.

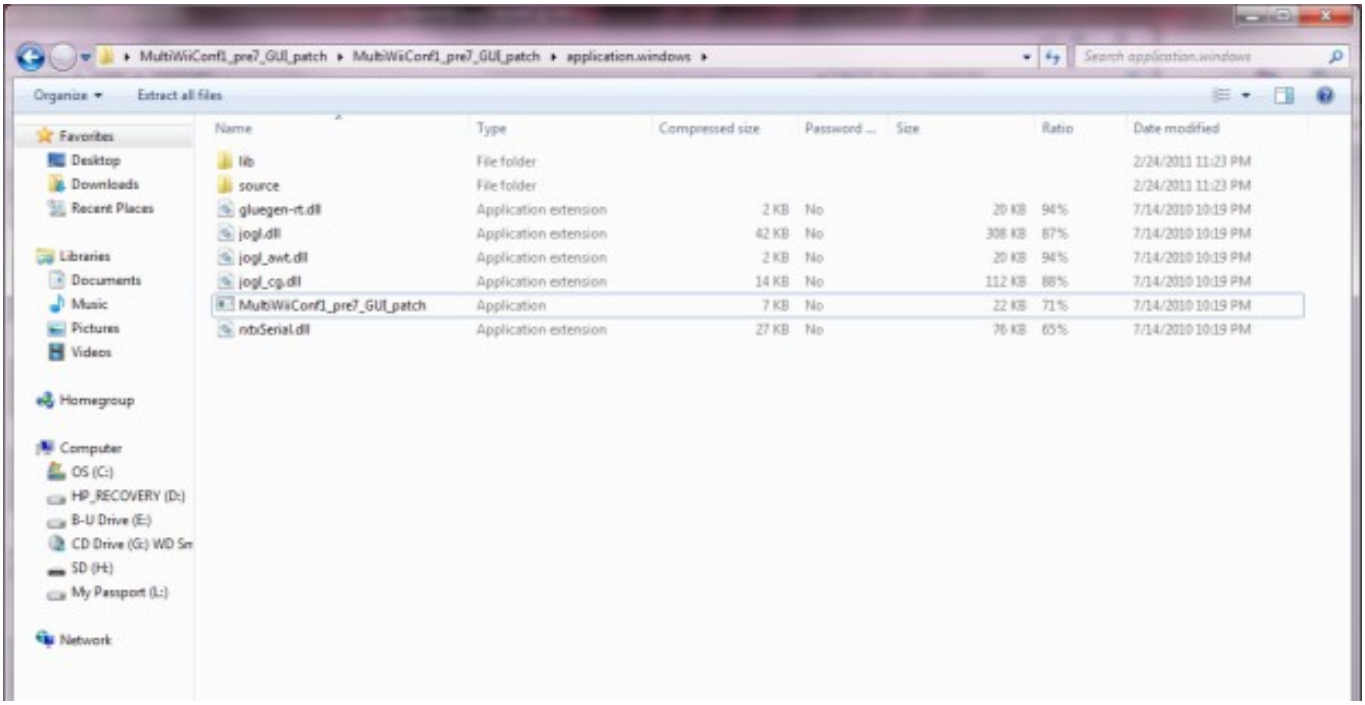
7. If the drivers are not found and you get a yellow exclamation point for the port, download the drivers here: http://www.ftdichip.com/Drivers/VCP.htm



B) Running the Program.

Find the folder with the three OS folder's inside. Open the windows folder for windows Xp, vista, 7, the run the MuiltwiiconfigXXX.exe file.
1.

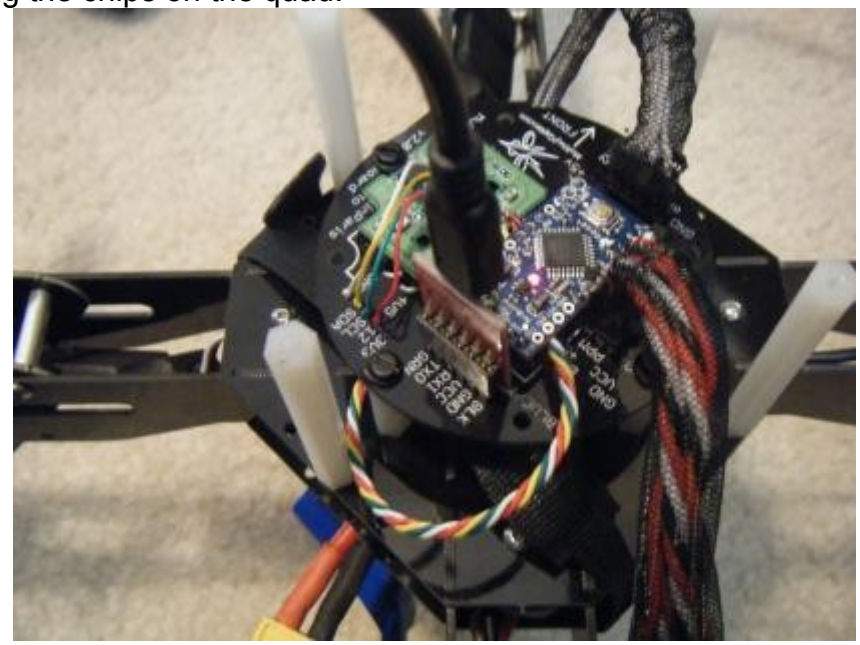
8. Now run the multiwiiconfig.exe file



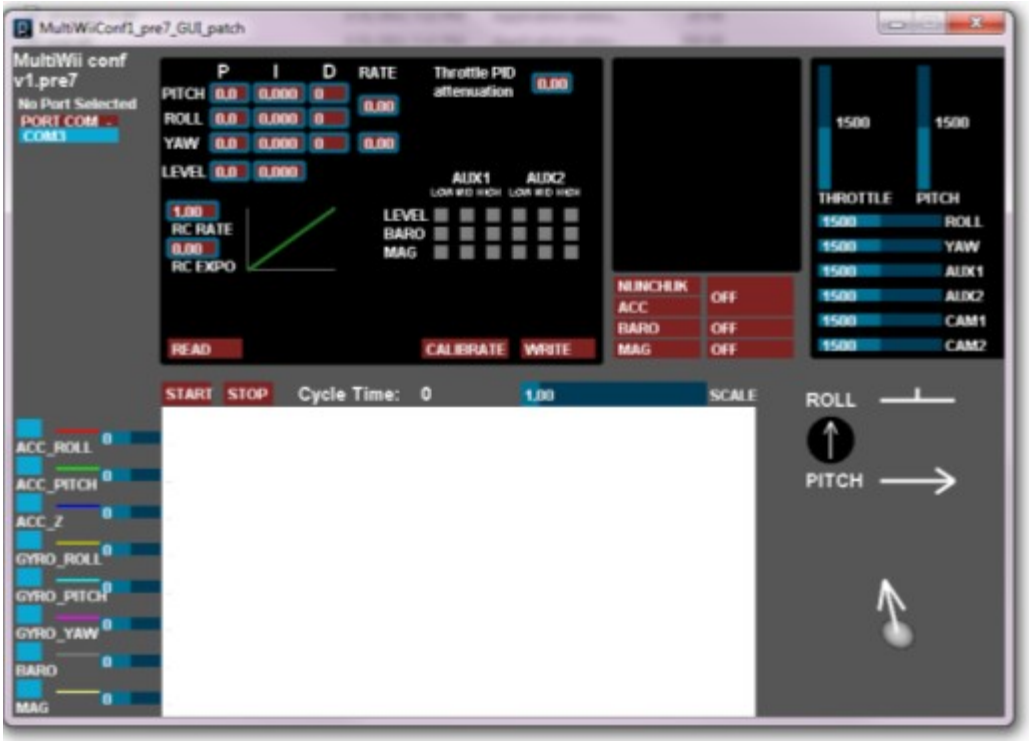
9. Once unzipped you will see three folders. Open the application.windows folder.
10. Double-click the file named Multiwiiconf1_pre7_GUI_patch.exe

11. You should then see this screen:

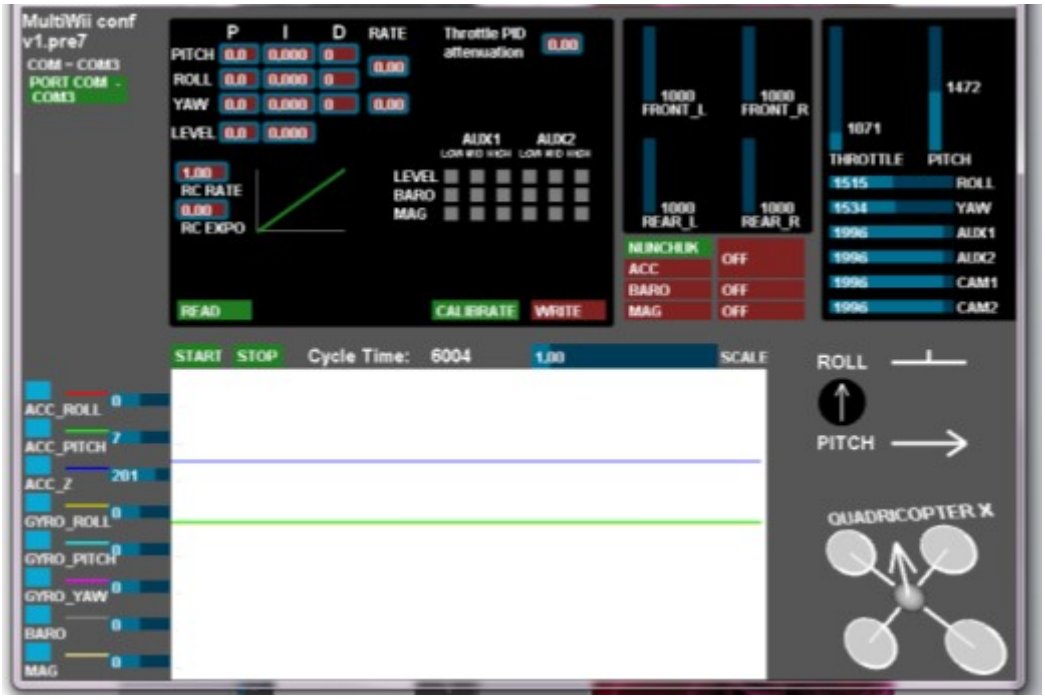
12. Plug in your LIPO battery to the quad. DO NOT ARM your quad by going left stick full right and down. Leave the quad in disarm mode.
13. Plug in the FTDI card to your quad. Plug it in “chip-to-chip” meaning the chip side of the card should be facing the chips on the quad.

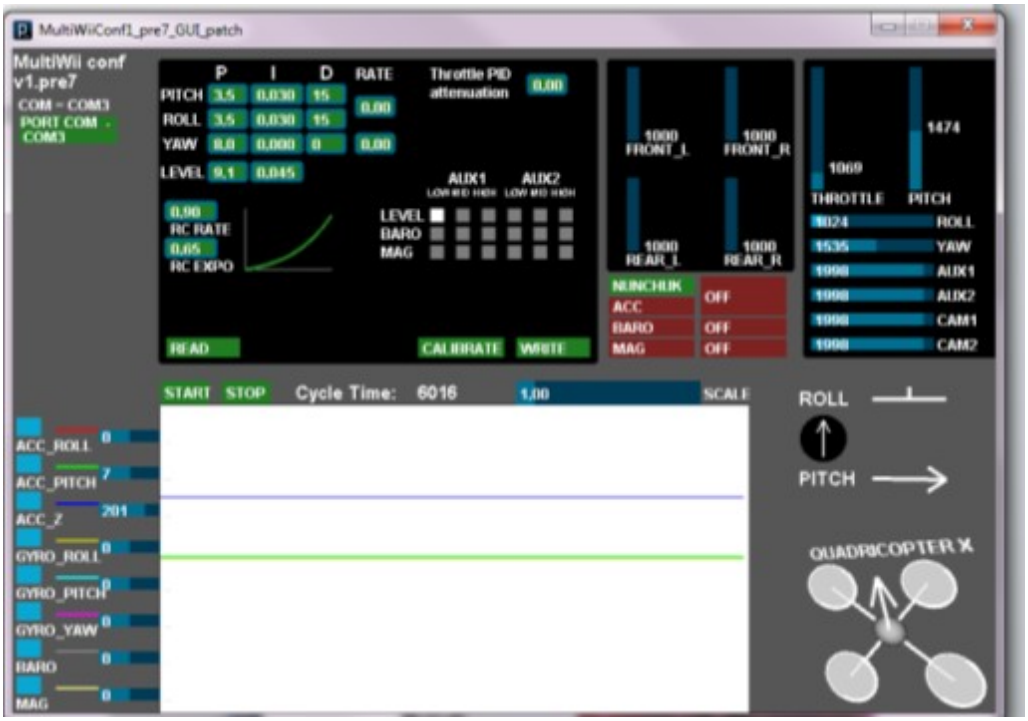


14. Select your com port by clicking on it. Recall your com port number from when you installed the FTDI card in device manager.

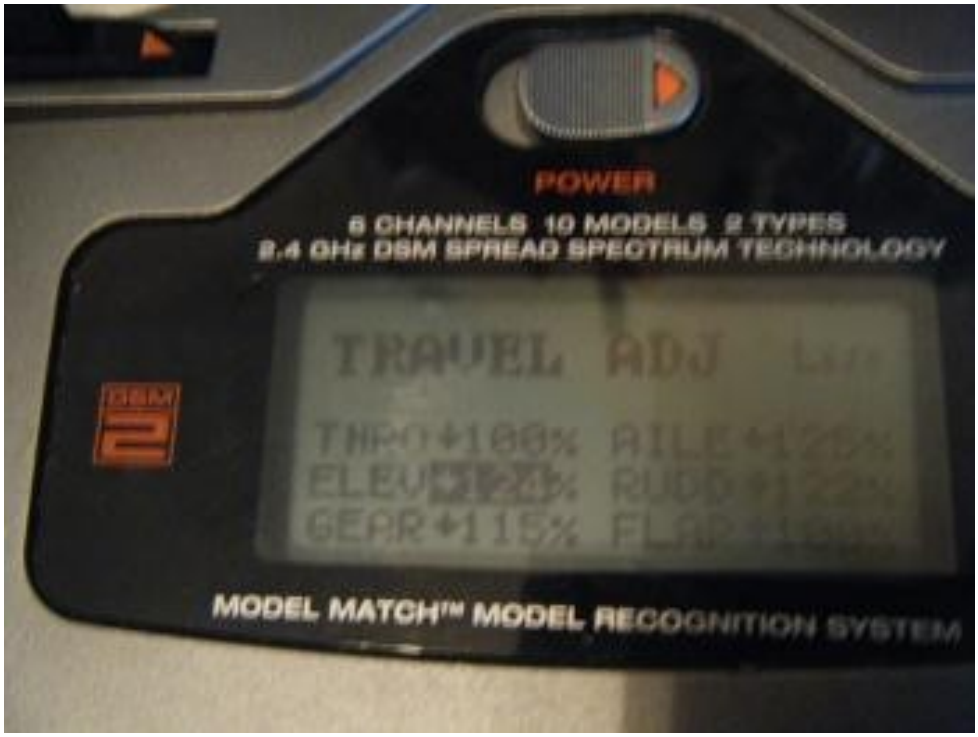


15. Click START to start monitoring your sensors.
16. Click READ to read your quads settings. You will then see data coming from your quad.





17. Make sure your transmitter channels (elevator, aileron, and rudder) are set for the correct direction. To do this, move your right stick up “nose down” and make sure the PITCH bar moves up towards the top of the screen. If it is backwards, reverse that channel (elevator) in your transmitter menu. Pull back on the right stick, bar should go down. Move right stick to the right, bar should go right. If it doesn’t, reverse that channel (aileron). Move the stick left, bar should go left.
18. Adjust your travel end points on your transmitter to match up to 1000 minimum and 2000 maximum. Do this for pitch, roll and yaw. To do this, pull up your ATV menu on your transmitter.

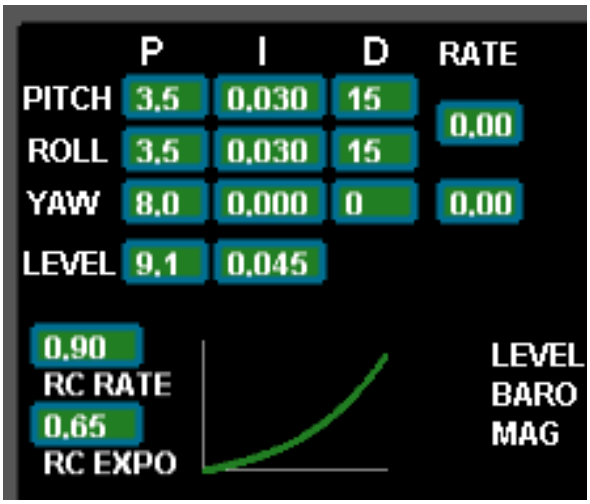


19. Move the right stick full up. Adjust your ATV to get as close as possible to 2000. You don't have to have it perfect, get as close as you can.
20. Move the right stick full down. Adjust ATV to get as close to 1000 as you can.
21. Move the right stick full right. Adjust ATV to get as close to 2000 as you can.
22. Move the right stick full left. Adjust ATV to get as close to 1000 as you can.
23. Move the left stick full right. NOTE – you may notice the motors spin up briefly because you just armed the quad. DON'T move the throttle stick up! Adjust ATV to get as close to 2000 as you can.
24. Move the left stick full left. NOTE – this will disarm the quad. Adjust ATV to get as close to 1000 as you can.
25. Leave the throttle channel as defaults.
26. Make sure your GEAR switch turns ON and OFF your AUTOLEVEL mode. You may need to reverse this channel if necessary. Adjust this channel to 1000 and 2000 as well.

27. It may be necessary to trim the throttle down a few clicks to get the quad's board to arm. You will know the board is armed when you see a steady green light on the board. Remember – left stick down and right arms the board. Down and left disarms the board. If you do this and the board does not arm, bump the throttle trim down a few clicks and retry.

28. Now calibrate the gyros and AUTOLEVEL. Make sure the quad is sitting on a LEVEL surface.
29. Hold both sticks full down and full left. You should see the green light start to flash.
30. Press the calibrate button on the screen. You don't have to do this while holding the sticks.
31. ACC (AUTOLEVEL or STABLE MODE) Calibration – Left stick full throttle and full left. Right stick full backward.

32. Leave the P I D settings the way they are. They can be adjusted later to your liking. Read on the forum about what settings to try “after” you fly your quad a bit.



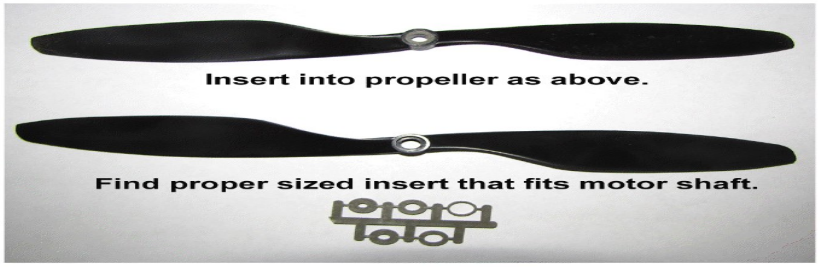
33. Disconnect your card from the quad.
34. Disconnect LIPO battery power.
35. It is recommended to balance your propellers. You can get by without balancing your propellers however you may notice some vibration that may cause some issue as far as screws coming loose, poor video recording quality of your onboard camera, etc. You can research this online however it is quite simple. It is best to have a good prop balancer. You can purchase them online or at your local RC hobby shop. Here is an example on what they are: http://www3.towerhobbies.com/cgi-bin/wti0095p?FVPROFIL=+ +&FVSEARCH=prop+balancer&search=Go
36. Balancing your props is easy. Basically you just add a bit of tape to the lighter blade to make both blades equal. Any kind of scotch or clear vinyl tape works great. Add as much that is needed to get the prop balanced.

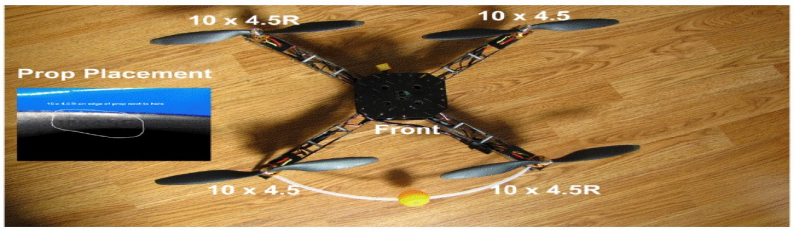
Notice the heavy blade is on the bottom

Put a small piece of tape on inside of lighter blade and recheck

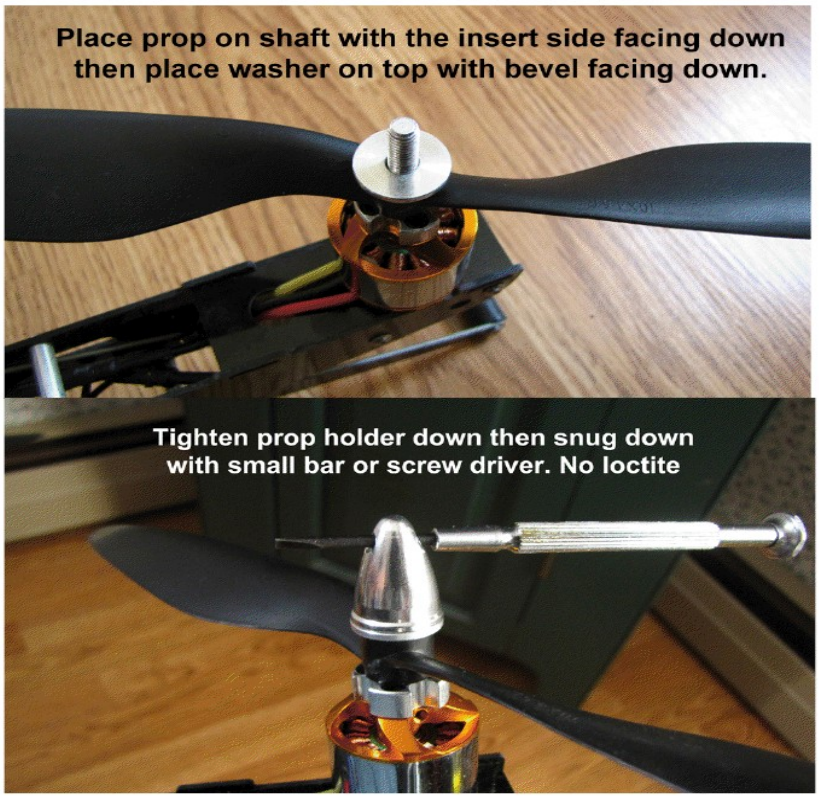
Prop blades even = balanced prop

37. Now install the propellers on your quad. The inserts may already be inserted in your propellers. If not, find the proper size for your motor shaft. Note the location of where to place the propellers. The counter-rotating propellers go on the front left and back right.





The prop information is located near the prop hub on the blade.
Ensure the prop info can be seen (facing up).



38. Make sure your propellers are snug.
39. Install your reference ball and tube on the front of the quad. The front is marked on the main board with an arrow and the text “FRONT”. The tube and ball just press in the holes under the motors.

40. You can also adjust the landing gear if you would like. If you plan on carrying a camera, you can extend the gear to make the quad sit taller. Remove the lower screws and threaded tube in the leg and move the legs to the desired height. Install the screws and threaded tube.

41. You are now ready to go flying!!!! Read the FLYING section over before attempting to fly.

Flying

It is recommended to **NOT** fly the quad in winds above 10 mph until your quad has been properly trimmed and you have some practice flying the quad.
The following directions assume you have set your quad up using the setup directions listed earlier. Ensure you have calibrated your gyro and ACC before you fly for the first time. Refer back to steps 27-30 under the INITIAL SETUP SECTION.

1. Turn on your transmitter.
2. Place your quad on LEVEL surface. DO NOT TURN YOUR QUAD UPSIDE DOWN TO PLUG IN THE LIPO BATTERY.
3. Plug in your battery to the quad. You will hear the speed controllers chime.
4. Arm the quad - left stick full down and right. You may see props twitch.
5. Make sure you are taking off in normal mode (also called ACRO mode). This was set up on your gear switch earlier.
6. Throttle up slow but steady, if the quad starts to flip on one direction, cut the throttle and start up again.
7. At approximately ½ left stick (throttle) the quad should hover.
8. Hold the quad steady approximately 4-5' above the ground. This will keep it out of ground effect and give you a better feel for what input the quad requires to trim it out. Trim the quad using your trims on the transmitter. No need to land to adjust your transmitter trims, do it while flying. Trim it until the quad flies pretty much hands-off.
9. Once satisfied with your trim settings, switch to AUTOLEVEL mode (also called ACC mode) while in a hover. It is best to do this while in a hover to compensate while flying in case your quad isn't trimmed properly for ACC mode. You may notice the quad jump to a level position. The quad will want to be level. It will feel and fly like a helicopter with the gyro gain turned way up. You will still have to correct for drift but the quad will want to stay level.
10. Note if the quad needs to be trimmed or sticks held in a certain stick position to keep it level. Note the required right stick input you are needing to keep the quad level. DO NOT USE THE TRANSMITTER TRIMS TO COMPENSATE OR LEVEL THE QUAD. HAND FLY THE QUAD.
11. Switch back to NORMAL mode and land. It is easier to land in NORMAL mode vice ACC mode.
12. After you have landed, DISARM MOTORS by holding the left stick down and full left. Release the left stick input and slowly increase the left stick to ensure the motors truly are disarmed.
13. With the right stick you will be able to trim the quad in the ACC mode.
14. If the quad was drifting back and left in ACC mode, you can trim that out. Move the right stick full forward and back to neutral about 4-5 times. You will see the LED blink on the board. You would correct for the left drift by moving the right stick full right then back to center 4-5 times. You will see the LED blink on the board.
15. Now you are ready to check the result of your trims.
16. Arm the motors – left stick full down and right.
17. Take off in the NORMAL mode and switch to ACC (STABLE) mode. Again, make sure you are about 4-5' above the ground to prevent ground effect from giving you false feeling of how the quad is flying. If you find you still have to give a lot of right stick position to keep the quad level, repeat steps 11-17. If you need to reset the ACC trims and start over, land and place the quad on level ground. Disarm the motors – full throttle up – right stick full back – left stick full left.
18. Your quad should now be trimmed and calibrated to fly in both the NORMAL (ACRO) mode and STABLE (ACC) mode.

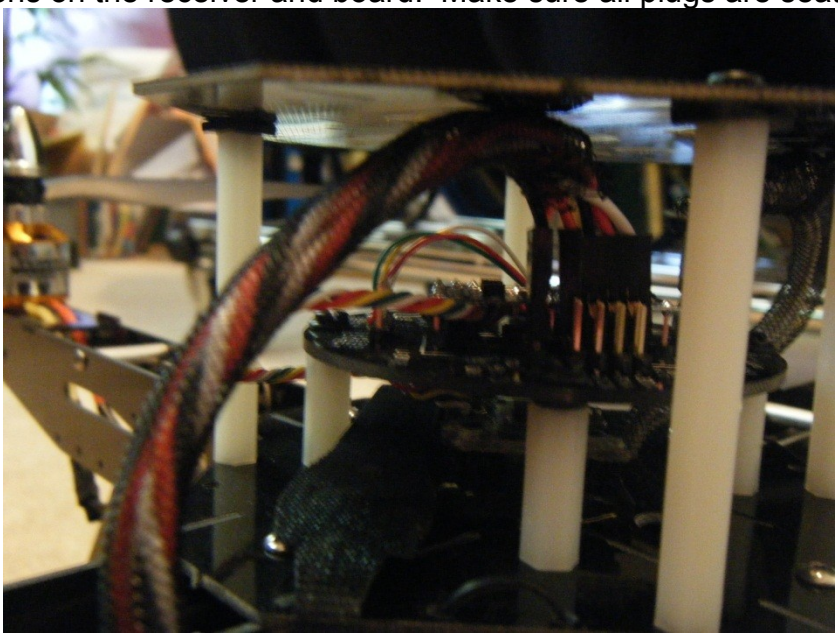
FLYING NOTES

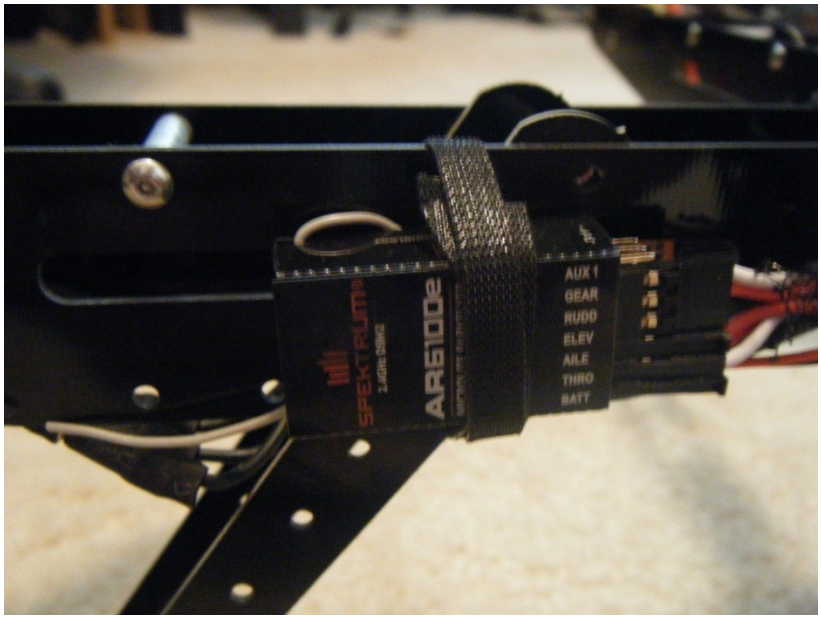
- Always turn on your transmitter first before you plug in your LiPo battery. Always unplug your LiPo battery before turning off your transmitter when you are done flying your quad. Never leave the LiPo battery plugged in when not flying the quad.
- Never charge LiPo batteries unattended.
- Use LiPo battery chargers to charge your LiPo batteries.
- Do not fly in close proximity to people, vehicles, buildings, trees, etc. until you are a proficient flyer.
- Keep an eye on your flight times to ensure you do not run your LiPo pack down too low. It harms the battery if you go below a certain voltage per cell. You may want to purchase a LiPo low voltage alarm that can be installed on the quad and plugged into the balance plug on the battery to continuously monitor the cells and sound an audible alarm once the cell voltage gets to a predetermined voltage. Depending on how you fly, a 2200 mah pack should only last 6-7 minutes to be safe.
- It is recommended to always fly with the tail towards you. It takes a lot of practice to fly "nose-in". Hover with the tail towards you for a while until you are comfortable to start to drift around a bit. Once you get better at drifting.
- Try to make figure-eight flights coordinating yaw (left stick) with your flights to keep the quad facing in the direction of flight but not allowing the quad to be facing "nose in" towards you. Do this until you feel comfortable. Once you feel comfortable flying figure-eights in front of you, try to make left-hand and right-hand racetrack patterns.
- Continue to keep up on RC GROUPS for updated tips, software, notes, etc.
- Remember that this and all quadcopters can require more research, tweaking, etc. to get them to fly as you desire. The information contained in these directions is to get you going. There are a lot of people on RC GROUPS that are willing to answer questions if you have them.

PREFLIGHT CHECKS

1. Periodically, tighten the motor mount screws and check all hardware, connections, etc. on the quad.

2. Check connections on the receiver and board. Make sure all plugs are seated.





Ensure plugs seated on receiver

Periodically check props nuts for security

ADVANCED NOTES

PID tuning theory and configuration guide for MultiRotorCraft

PID - Proportional-Integral-Derivative
When the MultiRotor orientation is changed in any pitch/roll/yaw axis, the gyros indicate an angular change from its initial position. The MultiRotor controller records the original position and by utilizing a "PID" program loop, drives the motors to attempts to return the MultiRotor to its initial position. This is done by a combination of the measured angular deviation, sampling the change over time and predicting the future position. This provides enough information for the controller to drive the motors to return equilibrium.

P is the dominant part of PID and gets you in the ballpark for good flight characteristics.

Advanced Tuning - understanding impact of P, I and D

P - this is the amount of corrective force applied to return the MultiRotor back to its initial position.
The amount of force is proportional to a combination of the deviation from initial position minus any command to change direction from the controller input.
A higher P value will create a stronger force to resist any attempts to change its position.
If the P value is too high, on the return to initial position, it will overshoot and then opposite force is needed to compensate. This creates an oscillating effect until stability is eventually reached or in severe cases becomes completely destabilized.

Increasing value for P:
It will become more solid/stable until P is too high where it starts to oscillate and lose control
You will notice a very strong resistive force to any attempts to move the MultiRotor

Decreasing value for P:
It will start to drift in control until P is too low when it becomes very unstable.
Will be less resistive to any attempts to change orientation

Aerobatic flight: Requires a slightly higher P
Gentle smooth flight: requires a slightly lower P

I - this is the time period for which the angular change is sampled and averaged.
The amount of force applied to return to initial position gets is increased the longer the deviation exists until a maximum force value is reached
A higher I will increase the heading hold capability

Increasing value for I:
Increase the ability to hold overall initial position and reduce drift, but also increase the delay in returning to initial position
Will also decrease the importance of P.

Decreasing value for I:
Will improve reaction to changes, but increase drift and reduce ability to hold position
Will also increase the importance of P.
Aerobatic flight: Requires a slightly lower I
Gentle smooth flight: Requires a slightly higher I

D - this is the speed at which the MultiRotor is returned to its original position.
A higher D (as it is negative value this means a lower number - i.e. closer to zero) will mean the MultiRotor will snap back to its initial position very quickly
Increasing value for D: (remember, that means a LOWER number as it is a negative value)
Improves the speed at which deviations are recovered
With fast recovery speed comes a higher probability of overshooting and oscillations
Will also increase the effect of P

Decreasing value for D: (remember, that means a HIGHER number as it is a negative value - i.e. further from zero)
Reduces the oscillations when returning any deviations to their initial position
Recovery to initial position becomes slower

Will also decrease the effect of P

Aerobatic flight: Increase D (remember, that means a LOWER number as it is a negative value - i.e. closer to zero)
Gentle smooth flight: Decrease D (remember, that means a HIGHER number as it is a negative value - i.e. further from zero)

Advanced Tuning - practical implementation
For Aerobatic flying:
Increase value for P until oscillations start, then back of slightly
Change value for I until hover drift is unacceptable, then increase slightly
Increase value for D (remember, that means a LOWER number as it is a negative value - i.e. closer to zero) until recovery from dramatic control changes results in unacceptable recovery oscillations
P may now have to be reduced slightly

For stable flying (RC):
Increase value for P until oscillations start, then back of slightly
Change value for I until recovery from deviations is unacceptable, then increase slightly
Decrease value for D (remember, that means a HIGHER number as it is a negative value - i.e. further from zero) until recovery from dramatic control changes becomes too slow. Then Increase D slightly (remember - lower number!)
P may now have to be reduced slightly

For stable flying (AP / FPV):
Increase value for P until oscillations start, then back of slightly
Change value for I until recovery from deviations is unacceptable, then increase slightly
Decrease value for D (remember, that means a HIGHER number as it is a negative value - i.e. further from zero) until recovery from dramatic control changes becomes too slow. Then Increase D slightly (remember - lower number!)
P may now have to be reduced slightly

You will have to accept a compromise of optimal settings for stable hover and your typical mode of flying. Obviously factor it towards your most common style.
Other factors affecting PID
Taking known good PID values from an identical configuration will get you close, but bear in mind no two MultiRotors will have the same flying characteristics and the following items will have an impact on actual PID values:

Frame weight /size / material / stiffness
Motors - power / torque /momentum
Position - Motor-->motor distance
ESC / TX - power curves
Prop - diameter / pitch / material
BALANCING
Pilot skills

References
http://en.wikipedia.org/wiki/PID_controller
Don't be afraid to try high D and P values together. Some fly with D up to 40.

Try a D of 20-25 and P of about 8-10 10. Just out of interest.. The P creates the stability and D dampens it down to become controllable.
My sweet spot is P around 11 and AT 25

Problem is if you change any one value, almost certainly need to change another.
Also sometimes instability can be because value is too high or low. I should add that in the guide.
This needed to be done to match your transmitter. To get flying level in mode modes. You have "two" trims .