Imagine it. Build it. Control it.™

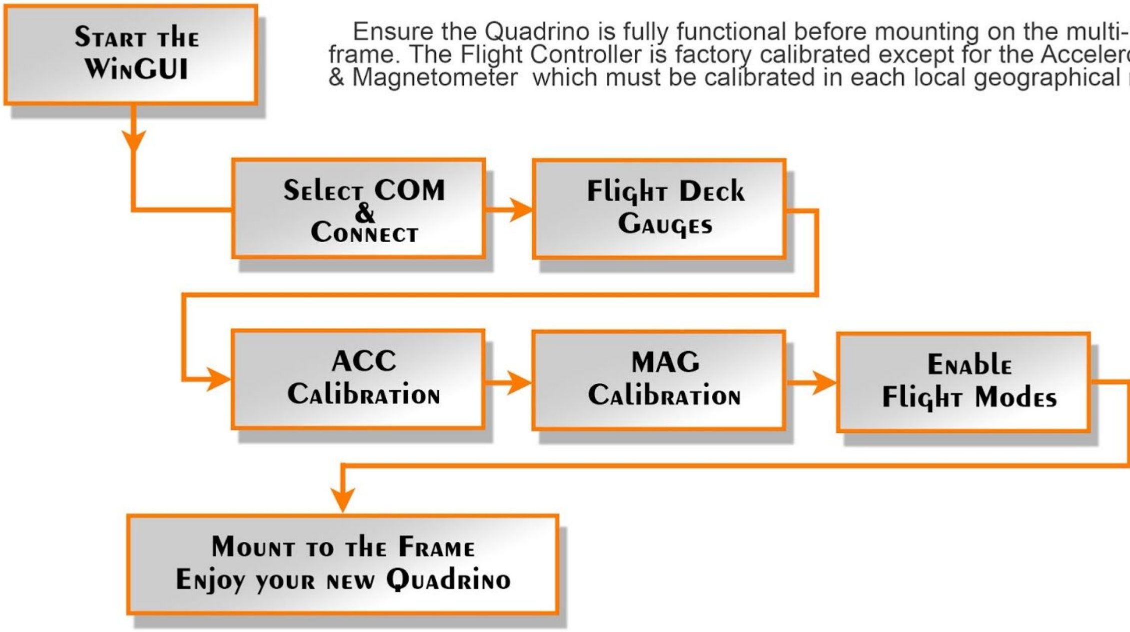
WinGUI Software Configuration

Revision 1.1, May 2015

1 - WinGui

MultiWii WinGUI is a .NET based configuration and GCS interface for the famous MultiWii multicopter controller software. It replaces MultiWiiConf software.

2 - Quick Start



WinGUI - Flow Diagram

1. Start the WinGUI:
   Start the WinGUI software either from the <Flash> page of the FCT or it can be found in the Windows start menu. Here is the default installation location: C:\Users\<your user>\AppData\Local\Quadrino Tools\applications\WinGUI-MultiWii_2_4
2. Select COM & Connect:
   Select the Quadrino COM port number and click on the <Connect> button to initiate the communication between the Quadrino and the WinGUI software.
3. Flight Deck Gauges:
   In the <Flight Deck> tab, you should now have the Horizon and other gauge moving together with the physical Quadrino.
4. ACC Calibration:
   To calibrate the Accelerometer, make sure your Quadrino is on a Level surface and click on the “Calibrate ACC” button.
5. MAG Calibration:
   To calibrate the Magnetometer:
   A. Click the “Calibrate MAG” button
   B. Rotate the Quadrino board a full 360deg on each axis. (Pitch / Roll / Yaw)
6. Enable Flight Modes:
   Open the “RC Control Settings” tab. Enable the needed “Flight Mode” and make sure to “Write” the settings to the Quadrino after making changes.
7. Mount to the Frame:
   Mount your Quadrino to the Copter frame.

3 - WinGUI Software Installation

3.1 - Installation with the FCT

In order to set up your Quadrino Nano, you will need to have either the official MultiWiiConf or WinGUI software installed on your PC. Either can be installed directly at the end of our Quadrino FCT (Firmware Config Tool) application. We suggest the use of WinGUI and will only support this version in our manuals.

In the last page (Flash page) you will find both links to install the WinGUI and MultiWiiConf. Just click on the “Install WinGUI Config” button and it will download and install the application.

WinGUI Install button in FCT

Once the WinGUI is installed, the button will now be a shortcut to start the application.

WinGUI Start button in FCT

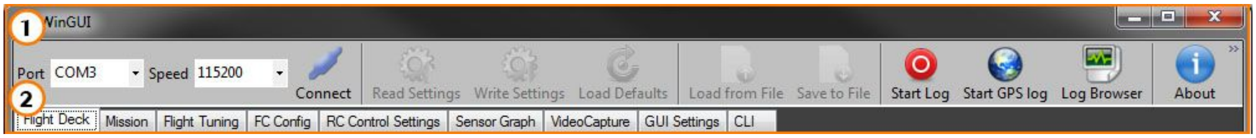
The installation will also create direct links in your “Start” menu of Windows. You can access them anytime without starting the FCT first. You can find them with all your other applications in the “Start | All Programs | Quadrino” program group.

WinGUI location in the Windows Start menu

3.2 - Stand Alone Installation

If you want to install WinGui separately (not recommended as there are changes made to the WinGUI by Lynxmotion / FlyingEinstein that are not done on the original version), you find the install files at:
https://code.google.com/p/mw-wingui/

4 - Navigation



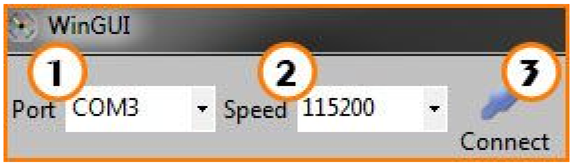
WinGUI - Navigation

1. The top portion of the WinGUI interface will always be visible and include tools that are not related to only one setting page.
2. A serie of Tabs will give you access to all the possible options and information pages present in the WinGui. Each of them will be explained in details in this manual.

5 - Using the WinGUI Software

5-1 - Connection

A serial connection between the Quadrino and WinGUI need to be initiated. They will share information and allow for setting up all the needed options. Before starting, make sure the Quadrino is connected with it's USB cable before starting the WinGUI application unless the COM port will not be available in the drop-down menu.



WinGUI - Connection

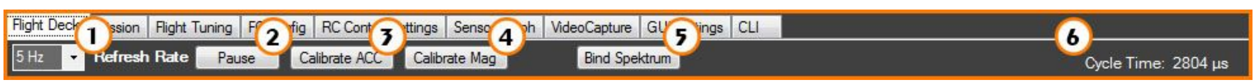
1. Select the COM port in the drop-down menu. This should be the same COM number that the FCT used for your Quadrino earlier.
2. If you have setup a different baud rate speed in the FCT, you can set the same here unless the default is 115500.
3. Click on the “Connect” button. This should start the connection and the Red and Green LED right next to the USB cable (on a Quadrino Nano) should start blinking rapidly.

5.2 - Flight Deck

WinGUI - Flight Deck

The Flight Deck is the main page of WinGUI and give you a lot of information about your MultiWii flight controller. We divided it in section for a better understanding.

5.2.1 - Flight Deck - Top



WinGUI - Flight Deck - Top

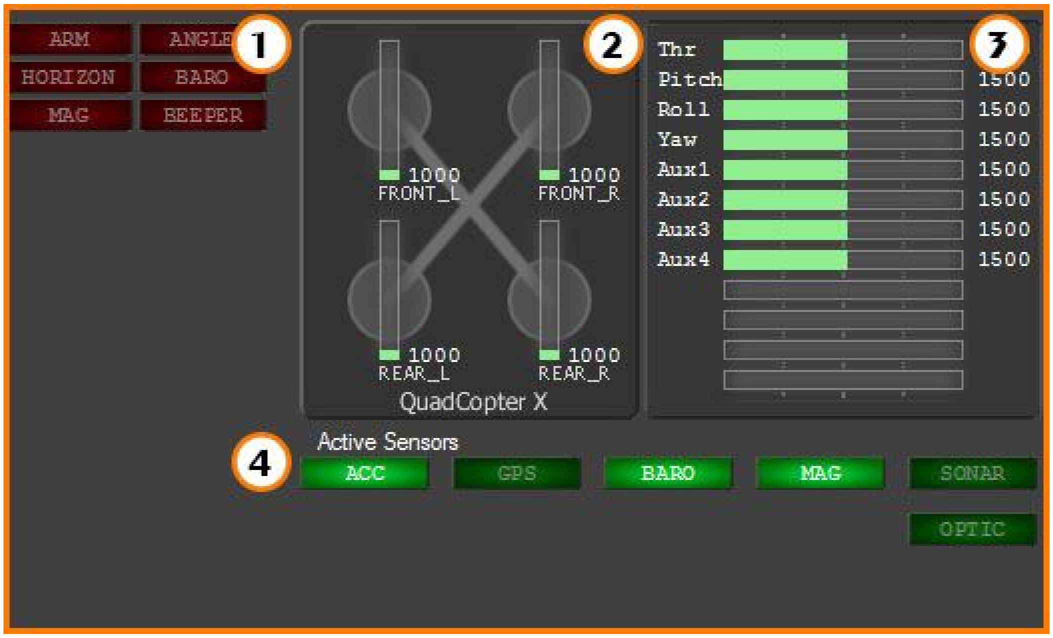
1. Refresh Rate:
   You have the choice at which the information on the page will be refreshed. You can lower the value if you want to lighten the serial communication between the WinGUI and the controller. (1Hz / 2Hz / 5Hz / 10Hz)
2. Pause:
   This option will pause the communication between your Quadrino and the WinGUI interface.
3. Calibrate ACC:
   Start the accelerometer calibration. This has to be done at least once on a level surface.
4. Calibrate MAG:
   Start the magnetometer (compass) calibration. If your Quadrino is equipped, you have to do this calibration at least once.
5. Bind Spektrum:
   Used only with Spektrum serial satellites receivers. This is not working at the moment so you have to bind your receiver and satellites the usual way before connecting to the Quadrino.
6. Cycle Time:
   Time needed to do a full MultiWii scan. Mostly used for troubleshooting the hardware.

5.2.2 - Flight Deck - Instruments

WinGui - Flight Deck - Instruments

1. Artificial Horizon show the Pitch and Roll movement. (with respect to the pilot)
2. Altitude based on the pressure sensor (meters)
3. Compass Heading
4. GPS / Home show direction and distance to HOME
5. Vertical Speed (meters per second)
6. Battery Voltage (in Volts, if equipped)

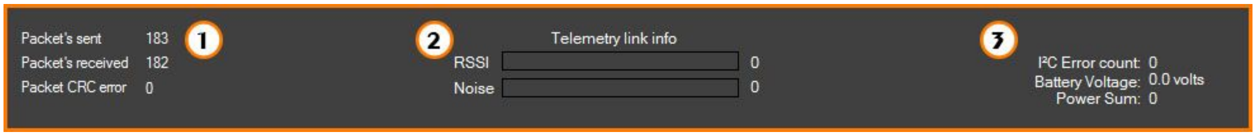
5.2.3 - Flight Deck - R/C & Status



WinGUI - Flight Deck - R/C and Status

1. Modes:
   Show the activated modes in real time
2. Motor Signal:
   Signals sent to the motor ESC's by the flight controller
3. Receiver Signal:
   Individual signals received by the flight controller
4. Active Sensors:
   Show which sensors been activated in the MultiWii firmware

4.2.4 - Flight Deck - Additional Information



WinGUI - Flight Deck - Additional Information

1. Serial Connection:
   Give you some information about the serial data sent and received by the flight controller
2. Telemetry:
   If equipped this will give you the RSSI (signal strength)
3. Other:
   I2C bus error count. Should be at Zero unless there is a major problem
   Battery Voltage, if setup and equipped
   Power Sum

Change to the “Flight Deck” Tab:

Take a few moments to watch how the displays react when you move the Quadrino Nano around. Note that the Artificial Horizon is with respect to the pilot as opposed to the craft; Imagine that you are sitting it a plane, if you roll left with the plane the horizon will tilt right. You can try it at home, tilt your head left and see how the horizon is tilting.

The fields marked 7, 8, 9 and 10 are also readouts:

R/C Control Settings (read only)
Copter type / Throttle values
Receiver values (see Trim below)
Active sensors

Additional information
Packets sent:
Packets received:
Packet CRC error:
Telemetry link info:
I2C Error count:
Battery Voltage: not native to the Quadrino Nano
Power Sum:
Transmitter End Point Calibration

-- WARNING --
The following setup should be done without the propellers installed on your copter. Moving the joysticks around could cause it to become “Armed” causing the motors to spin.

In order to work correctly, the MultiWii MPU6050 flight controller needs you to configure your transmitter’s “End Points”. End Points are the maximum and minimum signal values which your transmitter sends when the joystick(s) reach their mechanical limits. Unfortunately the min/max values on most controllers are not high enough to be used by the MultiWii MPU6050 controller and need to be set higher than the default settings. Note that not all flight controllers have the option to increase or decrease End Points; if you have chosen a remote control which does not allow these settings to be modified, you will need to refer to the MultiWii online guide. For flight controllers which allow the End Points to be reconfigured, follow the procedure below:

Power your handheld transmitter and turn it on
Connect your main battery (Should power up the Flight Controller and Receiver)
Connect your Flight Controller to the PC with the USB cable
Open the MultiWiiConf.exe application
Make sure your sub-trims are all centered and show values of 1500. If not, you can move them until you reach that number.
For each of your channels you have to set up the End Point so it shows 1000 as the minimum value and 2000 at maximum (usually 120% on the transmitter)

Trim

On most remote controls, there are trim switches around the joysticks; one vertical and another horizontal. These switches adjust the center position of the joysticks. Out of the box, the center position signal should be 1500 for the joysticks. You can see if any trim has been added via this interface by leaving the joysticks centered and seeing if the value on the screen is higher or lower than 1500.

5.3 - Mission

5.4 - Flight Tuning / PID Settings

Change to the “Flight Tuning” Tab.

The PID (“Proportional Integral Derivative”) settings affect the stability and responsiveness / manoeuvrability of the multirotor. This section is incredibly important and as such is explained in detail.

More information about PID settings can be found here: http://www.multiwii.com/wiki/index.php?title=PID
http://www.multiwii.com/wiki/index.php?title=Altitude_PID

If you are new to UAVs, the default PID settings should be used for the first flight. These are likely not optimal for your setup, and the stability and responsiveness may not be to your liking, but fortunately everything can be tuned and adjusted. RTF and ARF multirotors often have the advantage of only one configuration, and as such, the manufacturer can optimize the PID settings for that drone. With a more custom setup, it is important to take the time to set the PID settings to your liking. We also suggest not to change the values too much or instability may cause your UAV to crash.

To calibrate and PID settings, you will need to fly the UAV, which means it is important to have the propellers installed, oriented correctly, spinning in the right directions and connected to the correct output pins on the Quadrino. Failure to have all of these correct will make tuning PID settings impossible and frustrating.

5.4.1 - Controlled Environment

If you are worried about crashing and breaking parts of your copter, we have found the following “tie-down” procedure works well for testing the stability of a multi-rotor UAVs in confined spaces.

Clear out an area within a room of about two to three square meters (square)
Figure out some “anchor points” which may be the feet of very heavy objects in the room such as a sofa, chair, bookcase etc. The ideal is to have one anchor roughly at each corner of the open square
Put a fairly large (ideally level) cushioning / padding surface at the center of this square which is larger than the copter itself. This is best done with cushions from a sofa, a thick mat etc.
Place the UAV in the center of this square on the padding
Tie one end of a string to a landing gear and select one of the anchor points to which the other end will be connected (do not cut the string yet)
Move the copter around the square and determine the longest length of string possible so that the copter does not contact any objects on the opposite two sides of that anchor.
Cut the cord and connect the end to the anchor.
Repeat for all four anchor points

This will ensure that there is slack in the strong so that the UAV can take off and hover, but not enough to allow it to hit any of the objects in the room which surround it. Be sure to stand outside of this square when the UAV is armed.

5.4.2 - PID Settings

Roll: most important for steady flight.

Pitch: most important for steady flight.
Yaw: rarely need to be changed
Altitude: only P should be changed
PosHold:
PosHoldRate:
Navigation Rate:
Level:
Mag:

For the theory behind PID control
http://en.wikipedia.org/wiki/PID_controller

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 tries to correct the error calculated between a measured value at the controller output (measured by the gyros) and an input set point (position of the stick), and drives the motors to attempt to return the MultiRotor to its initial position. As such, PID is a type of “closed loop” control method.

Before changing any of the values, please read through the following sections on PID:

(P) - Proportional

“Proportional” is the first component of the PID loop and it focuses on correcting errors present in multirotor stabilization. The ‘P’ provides a proportional amount of corrective force based upon the angle of error from the desired position. The larger the deviation, the larger the corrective force. For example, if wind causes the drone to tilt in one direction, the gyro sensor will detect this change and adjust the motor thrust to correct. In reality, the correction is never perfect and the angle often overshoots and causes it to tilt in the opposite direction (to a smaller degree). The end effect is an oscillation about that axis, until it is once again balanced (or in severe cases, the overshoot becomes amplified and the multirotor becomes completely destabilised).

Higher value for (P):
Will create a stronger force to return to desired position. If the (P) value is too high, on the return to initial position, it will overshoot
UAV will become more solid/stable until (P) is too high where it starts to oscillate and loose control
You will notice a very strong resistive force to any attempts to move the MultiRotor
Aerobatic flight requires a slightly higher (P)

Lower 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
Gentle smooth flight requires a slightly lower (P)

(I) - Integral

Integral (I) is the second component of the PID loop and it focuses on correcting past errors in multirotor stabilization. Recall the original scenario when you had only a proportional (P) component in the PID loop and the multi rotor was indefinitely tilting back and forth between two opposite positions. This is where the integral (I) component comes into play.

When your UAV tilts, the controller will measure how many degrees it tilted and also how long the tilt lasted. The controller board will then integrate this tilt (in degrees) over the amount of time it measured for the tilt. The resulting integral (I) tells the controller board how much of an overshoot has been occurring in the past. Once the controller board knows this, it can then instruct the motors to compensate for the overshoot and help stabilize the multirotor.

The integral (I) component will bring the multirotor closer to equilibrium, however, there is one more issue. The integral (I) term uses the measurement of time to calculate errors made in the past. Due to this fact, there is a natural delay between when the controller board starts making measurements and when it finally implements a change. This delay can eventually result in the multirotor failing to reach equilibrium and this is where the derivative (D) component comes in to solve the problem.

(I) provides a variable amount of corrective force based upon the angle of error from desired position. The larger the deviation and / or the longer the deviation exists, the larger the corrective force. It is limited to prevent becoming excessively high.

Higher value for (I)
Increase the heading hold capability
Increase the ability to hold overall position
Reduce drift due to unbalanced frames etc
Aerobatic flight requires a slightly higher (I)

Lower value for (I):
Will improve reaction to changes, but increase drift and reduce ability to hold position
Gentler, smoother flight and minimise wobbles / jitter

(D) - Derivative

The derivative (D) component of the PID loop focuses on predicting future errors and uses the same measurements as (I), but instead of integrating the values and duration of the two terms, it takes their derivative. Once this derivative (D) is calculated, the controller knows the rate of change of the value (for example tilt), predict where the next overshoot will occur and take appropriate corrective action. Knowing where the next error will occur counteracts any issues that may occur with the integral (I) component of the loop.

This moderates the speed at which the MultiRotor is returned to its original position.
A lower (D) will mean the MultiRotor will snap back to its initial position very quickly

Higher value for D
Dampens changes. Slower to react to fast changes
Gentle smooth flight: Increase D

Lower value for D:
Less dampening to changes. Reacts faster to changes
Aerobatic flight: Lower D

5.4.3 - PID Tuning

A manual method to PID tuning (which is often not possible with drones) is as follows:
Set the (I) and (D) values to zero.

Increase (P) until the output of the loop oscillates, then the (P) should be set to significantly less than half of that value for a "quarter amplitude decay" type response.
Increase (I) until any offset is corrected in sufficient time for the process. However, too much (I) will cause instability.
Increase (D), if required, until the loop is acceptably quick to reach its reference after a load disturbance. However, too much (D) will cause excessive response and overshoot.

This will influence the flight characteristic with an accelerometer : this is “level mode”
P is the dominant part of autolevel mode.
I will tell how much force must be applied when the measured angle error persit
D is used to clamp the maximum correction for autolevel mode
Increase value for P will make the autolevel mode stronger
for smooth operation the sum of P axis + P level should stay near the default value : if you decrease P for Roll and pitch axis you can increase P Level

Default values provided by the program should be used as a starting point, this will help you to know the difference after changing some parameters. Those value are well suited for the average multirotor.
Ensure the center of gravity is in the middle of your copter, move battery to get it there.
Set motors running at approx 50% if you have props on be very careful, check GUI trace for an almost flat line from gyro and acc
if trace is dancing all over the place you have vibration issues and it needs to be sorted before proceeding.
Keep in mind that P is the dominant part of PID and gets you in the ballpark for good flight characteristics.

With props on:
Set PID to the their default value
Hold the MulitiRotor securely and safely in the air
Increase throttle to the hover point where it starts to feel light
Try to lean the MultiRotor down onto each motor axis
You should feel a reaction against your pressure for each axis.
Change P until it is difficult to move against the reaction.
Now try rocking the MultiRotor along the Pitch axis (front to back). Increase P until it starts to oscillate and then reduce a touch.
Repeat for Yaw Axis.
Without the autostabilisation mode engaged, you will feel it allow you to move over a period of time. That is OK. Your settings should now be suitable for flight.
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 until recovery from dramatic control changes results in unacceptable recovery oscillations. Lower D to make sharper movements
P may now have to be reduced slightly
For stable flying (RC)
Increase value for P until oscillations starts, then lower the value slightly
Change the value for I until recovery from deviations is unacceptable, then increase it slightly (lower I if you have slow “wobbles”)
Decrease the value for D until recovery from dramatic changes in control become too slow, then increase D slightly (which smooths these changes)
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 until recovery from dramatic control changes becomes too slow. Then Increase D slightly
P may now have to be reduced slightly
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

Increase PITCH and ROLL's P, the drone will be stronger, it holds better his angle/position.
For a 8″ or 10″ quadcopter, you can go up to 8 – 12.
If your drone starts to shake, you'd better reduce a little bit the P value. Or increase the D value.
The PITCH and ROLL's I value need to be feel. Increase it to maximum or middle and you will know what it changes.
By reducing the P value and increasing the D value a non-flyable drone can be flyable but you'd better reduce the vibration which comes from the motor, propeller and the frame. That will improve the IMU data reading. It helps a lot to get a better performing for GPS functions, gimbal stabilization, etc.

The LEVEL's P works for the auto stabilization. Higher value will make the drone more stable or get back to the stable/flat position quicker. A higher LEVEL's I value gives the drone more power to get back to the stable/flat position. It's you who decide how much P and I your drone needs. (higher I asks lower P)

RC Expo / Rate & Throttle MID / Expo

The RC and Throttle Exp Settings affect the user input (via joysticks) to the UAV. Sliders beneath have same effect as changing numbers.

RC Expo / Rate: Makes the UAV's response to joystick controls more or less sensitive to user input. The curve in the RC image shown gives you an idea of the response of the joystick in either direction. A high RC Expo number (1.00) means the UAV will only respond when the joystick is moved to an the extreme position (and it will respond very quickly), whereas a low number means the UAV will respond even to small motions of the joystick.
Steady: Higher RC expo; lower RC rate
Acrobatic: Lower RC expo; higher RC rate

Throttle Mid-point / Expo: Some transmitters provide the option to edit the throttle curve.

5.4.4 - Navigation Settings

Enable GPS filtering
Enable GPS forward prediction filter
Don't reset home position at arm
Nav control heading
Fly with tail first

Turn to takeoff heading at home: When the UAV returns home, it will orient itself in the same direction it was in during takeoff.
Wait for reach RTH alt:
Enable slow navigation
Ignore throttle during Nav and RTH:
Takeover BARO mode:

Rates / Expo
Roll / Pitch RATE
Yaw RATE
Throttle PID attenuation
Waypoint (WP) Navigation
WP Radius:
RTH Altitude (m): Sets the altitude at which the UAV will fly when returning to home (in a straight line). It is important to set this so that the UAV does not hit anything in its path
Crosstrack gain
Max Nav speed (cm/s)
Min Nav speed (cm/s)
Max Nav banking (degrees)
Land speed
Safe WP distance (m)
Max Nav Altitude (m)
Fence radius (m)

5.5 - FC Config

5.6 - RC Control Settings

If your transmitter has more than four channels, the RC Control Settings tab gives you control over which auxiliary channels on your transmitter control which flight modes. Notice how multiple boxes can be selected. This approach gives the most options possible, though be sure not to have conflicting information / settings.

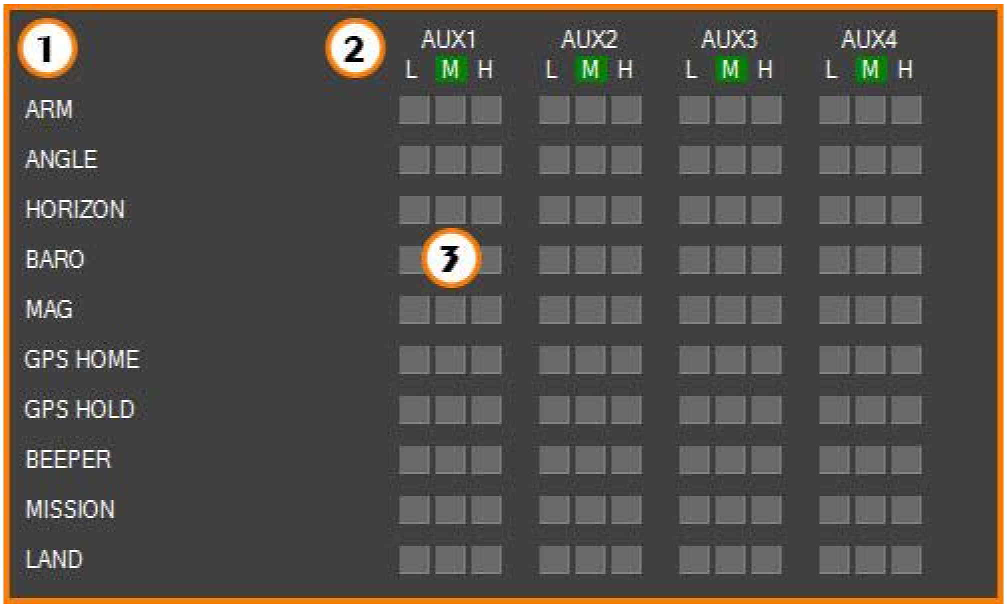
- Green boxes mean the field is selected
- No border means that the fields are being read from the board (already written)
- Orange border indicates that the field was changed but not written to the board

Auxiliary channels are associated with two or three-way switches or potentiometer inputs.

- L: Low, corresponding to a signal of 500 (switch down, or knob fully counter-clockwise)
- M: Medium, corresponds to 1500 (center position of a three-way switch, or mid-rotation on a knob. Does not apply to or work on a 2-way auxiliary switch)
- H: High, corresponds to 2500 (switch up or knob fully clockwise).

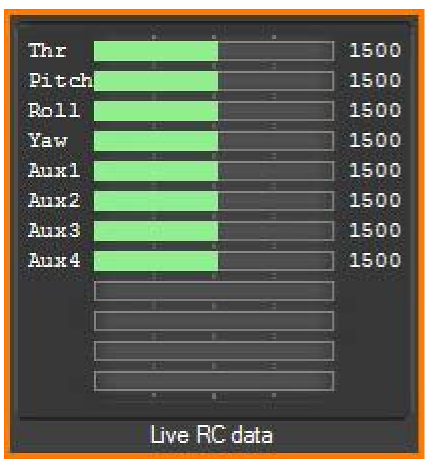
The same screen allows you to view input values from the transmitter, which can help in determining which switch or button is related to which AUX pin. A big advantage to this is to see your trim levels.

More information about flight modes, as well as which sensors are used, can be found here:
http://www.multiwii.com/wiki/?title=Flightmodes



WinGUI - RC Control Settings - Flight Modes

1. Available flight modes.
   This list will change based on the available sensors set on your Quadrino. If for example you do not have the GPS than the Modes related to GPS won't be shown here.
2. Receiver auxiliary channels.
   Here are four Auxiliary channels that can be used to set different modes. The current state of each channels is shown in green.
3. Checkboxes to set the Flight Modes



WinGUI - RC Control Settings - Live RC data

1. Live receiver values read by the Quadrino.

5.6.1 - Flight Modes

Here we have an explanation of each available Flight Modes on MultiWii.

- ACRO (Default mode and not in list)
  Made for Acrobatic flight and is the default setting (uses gyro only)This is the default mode when the HORIZON or ANGLE mode are not activated and is more “acrobatic” flight
- ARM
  Arming is a safety feature which is required in order for the motors to start spinning (at below takeoff speed) or stop spinning (after landing). If no aux channel is assigned, you arm the motors by positioning the left joystick to the bottom right, and the right joystick to the bottom left (at the same time)
- HORIZON
  This keeps the roll of the UAV level and is a mixture of ACRO and ANGLE modes. Stable with slow RC commands / acrobatics with fast RC commands. Will be in ANGLE MODE mode when PITCH / ROLL sticks are centered and in ACRO MODE mode when full PITCH or ROLL sticks are applied, allowing flips.
- ANGLE
  A stable mode (when the PID values are adjusted correctly and Gyro and ACC are calibrated and trimmed). It will try to keep the model level to the ground.
  Note: According to MultiWii developers, ANGLE MODE is virtually obsolete, HORIZON MODE is preferable in most cases.
- BARO
  The barometer is used in order to keep a certain (fixed) height when no other commands from the RC transmitter are received. If you activate BARO (ALT HOLD) and the GPS modes, they will use the same calculated altitude.
- MAG
  UAV will keep pointing in the same direction (compass / yaw) until there is yaw input from the transmitter. Can be activated in all flight stabilization modes. Without this mode, you will still have slight deviation (like a tail gyro in heli). Compared to no MAG, this mode offers a drift free tail
- GPS HOME
  Activates return to home (RTH) feature. Requires GPS lock before takeoff. Uses compass and GPS for the purpose of returning home to the starting point. Stabilisation is done in accordance with the flight mode (ANGLE / HORIZON). GPS altitude is not accurate and therefore not usable for holding the height.
- GPS HOLD
  Hold current position using GPS and baro (if available). GPS modes can be activated in ANGLE or HORIZON flight modes. will be ignored if there is no GPS lock at time of arming. are generally used along with ALT HOLD, but this is not mandatory. The mag sensor is mandatory for GPS control, but MAG mode is not. Activation of MAG MODE has no effect in GPS MODE. GPS altitude is never used in a control loop (only for display).
- BEEPER
  Not really a flight mode; if you have a beeper connected, useful for lost UAVs
- MISSION
- LAND

Flight Mode Sensor Summary

Mode	Gyroscope	Accelerometer	Barometer	Compass (Mag)	GPS
ACRO / Gyro Only	- X -				

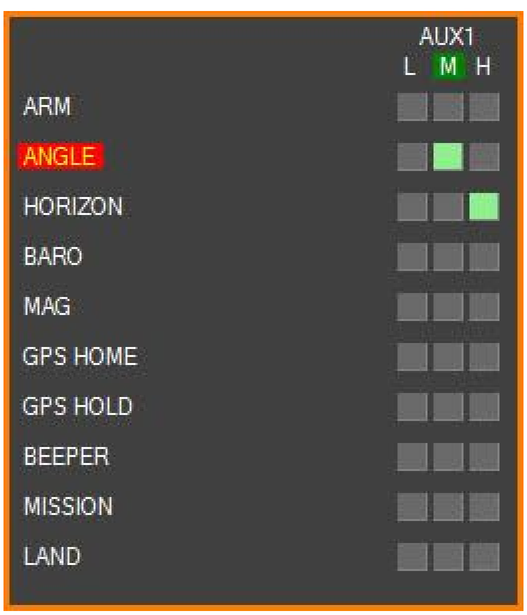
ANGLE (Stable/Level/Acc)	- X -	- X -			
HORIZON	- X -	- X -			
BARO (Altitude Hold)	- X -	- X -	- X -		
MAG (Heading Hold)	- X -	- X -		- X -	
HEADFREE (CareFree)	- X -	- X -		- X -	
GPS Return to Home	- X -	- X -		- X -	- X -
GPS Waypoint	- X -	- X -		- X -	- X -
GPS Position Hold	- X -	- X -		- X -	- X -
Failsafe	- X -				

Flight modes showing sensors required (X = Required Hardware for the Mode)

5.6.2 - Setting Flight Mode

To set the flight mode, you need to check the box according to the High - Mid - Low state of your auxiliary switch that you want the Mode to be activated. You need to click “Write Settings” after making changes for them to be loaded into your Quadrino.

For example, you can set AUX1 for:
ACRO - When the AUX1 is LOW (1000); when nothing is selected, the mode is ACRO
ANGLE - When the AUX1 is in MID (1500)
HORIZON - When the AUX1 in HIGH (2000)



5.7 - Sensor Graph

5.8 - Video Capture

5.9 - GUI Settings

5.10 - CLI