DEPLOYING ARDUPILOT

1.1 INSTALLING ARDUPILOT

The TS40 TRAINER can be equipped and controlled also using ArduPilot. ArduPilot is the most common Open Source robotics controller. It is widely used for surface robotics (car, tank etc), plane and also copter (quadcopter, hexacopter etc) model surveillance. Since it is open source, users are allowed to develop (and recompile) by themselves the controller software suited to their needs.

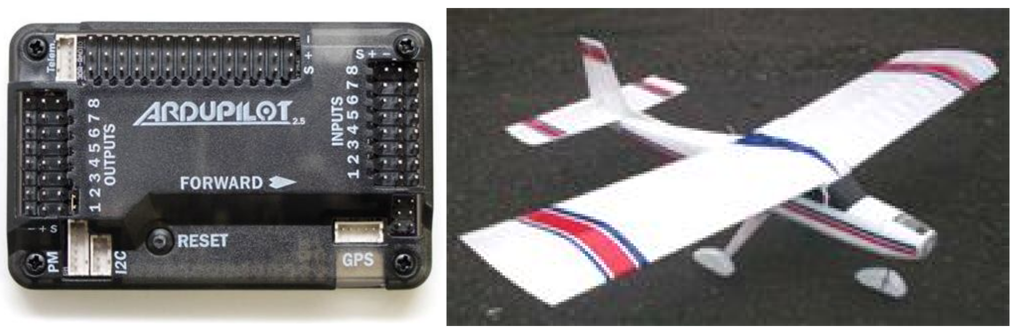

Figure 1 – 1 Deploying ArduPilot APM 2.5 Board to TS40 TRAINER

The heart of ArduPilot is the APM Board. With Processor, Memory and IO Ports, APM Board can be configured specifically to control land robotics, plane or copters using firmware uploaded to APM Board. APM Board will senses all command from Radio, check current position / status and give command to servo output to control devices. APM Board can be configured also to send status to ground control via radio or OSD Video.

1.1.1 ArduPilot Configuration

Euqipped with GPS Module (external) and onboard compass module, actually APM Board has all required parameters / sensors to know the status of the plane i.e. location (coordinates), X, Y, Z axis status and plane speed, hence ArduPilot may send command to servo motor. In case user requires precision parameter sensing, APM Board may be configured with IMU Shield to allow APM Board has input from Air Speed sensors (such as pitot) and external compass (Magnetometer).

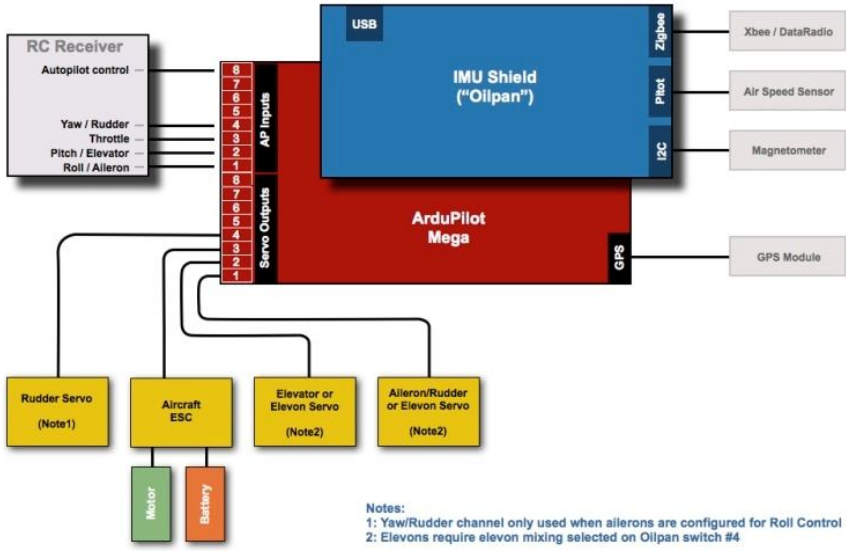

Figure 1 – 2 ArduPilot General Configuration

In practical, user mostly requires telemetry radio to send the status of the plane during the flight or connected to the ground control station or to assign mission or a task or remotely control to the plane.

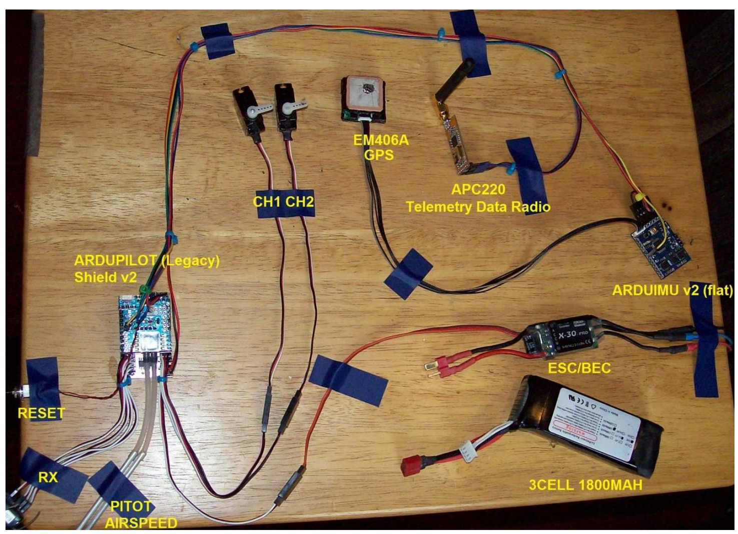

Figure 1 – 3 ArduPilot Sub Module required

1.1.2 Initializing APM Board

Before installing APM Board on the plane, it is important to setting the APM Board to match the plane or device we have. This can be done by uploading firmware to our APM Board. Uploading firmware should be done on the ground by computer, to prevent any unwanted error in data link.

To Seeting APM Board do the following step by step:

1. Download ArduPilot Mission Planner and APM Board USB Port driver.
2. Download USB Port driver according to APM Board you have (eg. Arduino Mega 2560).
3. Connect APM Board to Computer and install it's driver

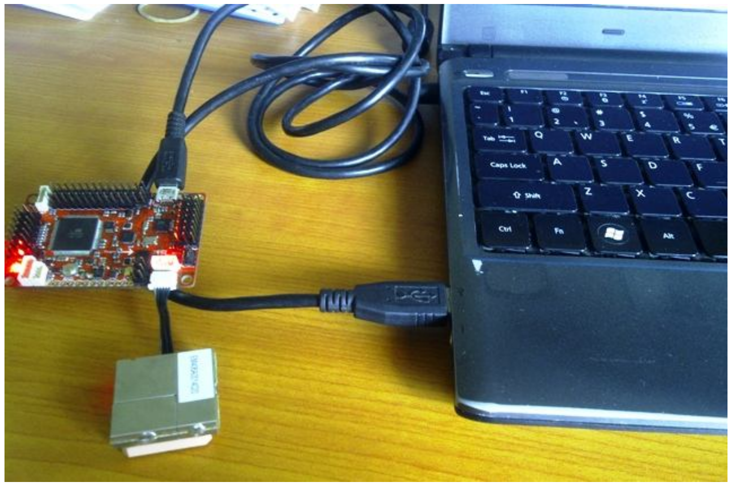

Figure 1 – 4 Connect APM Board and install driver

4. Run ArduPilot Mission Planner and select Port connected to APM Bord and click **Connect**

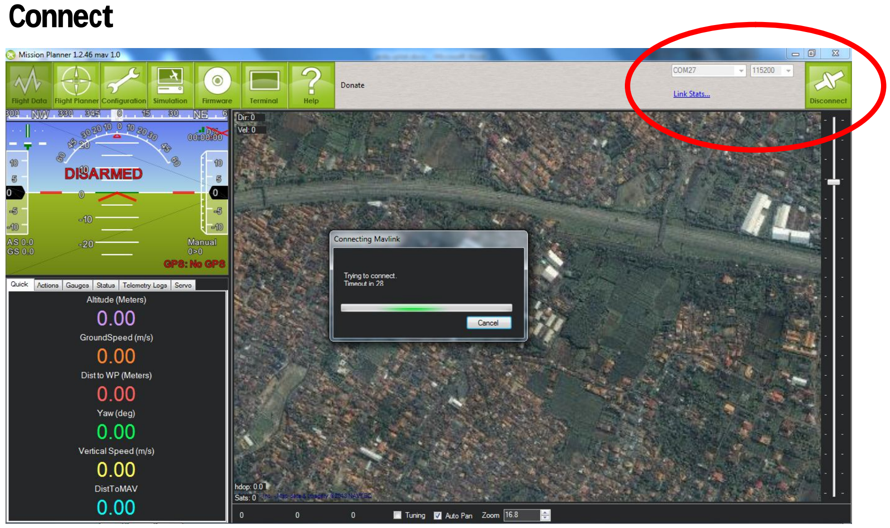

Figure 1 – 5 Connect Mission Planner to APM Board

5. Select menu Firmware. Select device i.e. ArduPlane and APM Setup button to upload selected Firmware to APM Board.

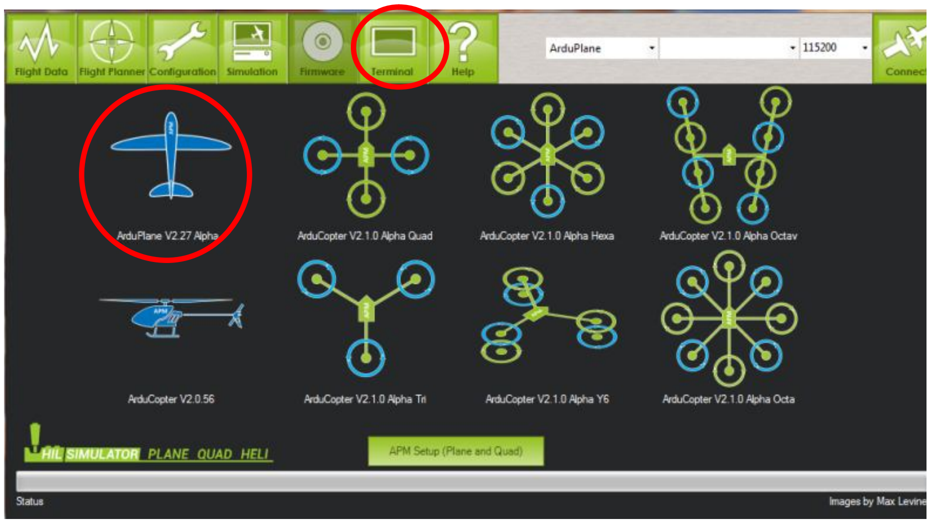

Figure 1 – 6 Upload Firmware

6. Your APM Board has been initialized as ArduPlane

1.1.3 Installing APM Board (IMU) on plane

As the heart of the ArduPilot, installing the APM Board and make it work is the first most important things to have before operate and assign a flight mission to the ArduPilot.

As the APM Board (IMU) provided with internal compass, it is needed to install it correctly, i.e:

1. The GPS connector should face forward, and the servo cables face back.
2. The board must also be right side up, with the IMU shield at the top.

Figure 1 – 7 APM Board should be installed correctly

Either using APM Board (IMU) with box or just the IMU card, it is provided with arrow. Ensure this arrow point the front side of the plane.

Kindly take notes that APM Board should be installed securely. No movement are allowed to prevent wrong plane status reading from internal compass.

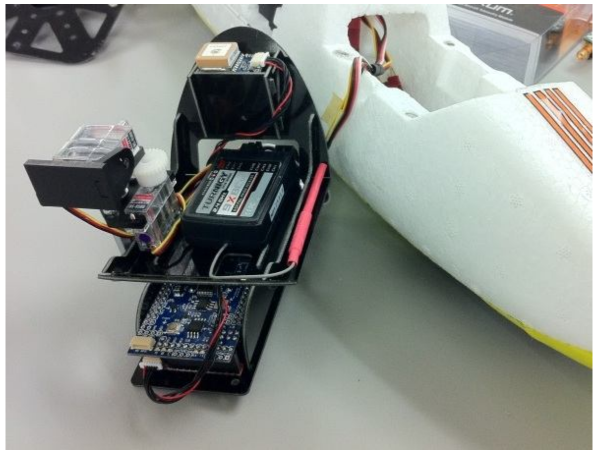

Figure 1 – 8 APM Board should securely installed and has no movement

1.1.4 Connecting APM Board

After APM Board installed securely on plane, now it is time to connect it to radio receiver, servo and others installed on board.

To connect APM Board to RC Receiver, you need:
1. At least a 5-channel RC unit. 7 channels or more is highly recommended.
2. Female-to female cables for each channel you'll be using.
3. A power source. For electric aircraft, this is usually the ESC. For gas/nitro powered planes, your servos will need its own battery/BEC.
4. If you're using APM 2.5, we recommend that it (and its accessories, such as GPS and 3DR radios), be powered by the included Power Module. You'll still need an ESC plugged into the usual Output 3 pins or BEC plugged into any spare Output pins to power your servos, however; the Power Module is only designed to power APM itself.

To Connect APM Board to RC Receiver, do the following:
1. Connect Inputs sections of APM Board to the corresponding RC Receiver

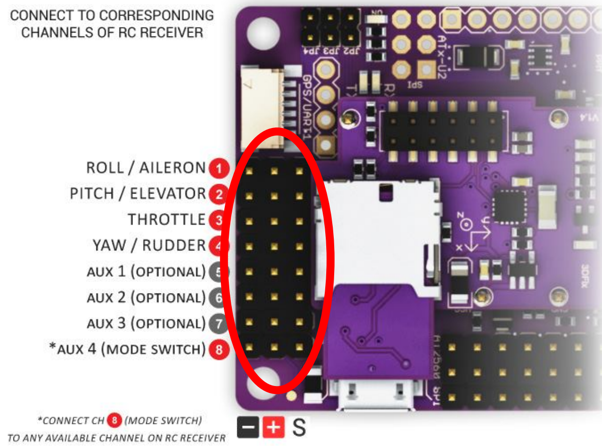

Figure 1 – 9 APM Board Input ports

Figure 1 – 9 Connect APM Board Input ports to RC Receiver

2. Connect Output APM Board to corresponding servos
3. Connect GPS Module and put GPS module to face the sky.
4. Connect Battery to available slots (To power the servos)
5. Connect Telemetry radio (if any) to APM Board

1.1.5 Setting and calibrate APM Board

As the APM Board connected to the RC and plane servos, it is important to have them set and calibrated. Setting and calibrate APM Board can be done using PC run Mission Planner application which is connected to the APM Board.

To do setting and calibrating APM Board, proceed the following:

1. If you're using a standard airframe, load a pre-made configuration file.
   For common airframes such as the Bixler, Skyfun and Skywalker, we have supplied configuration files which are tuned for those aircraft. You can

download theme here and use the Mission Planner to write them to APM. You'll still need to configure them for your own hardware,

2. Calibrate your RC input
   Your transmitter must be on. Ideally, you have already flown your airplane in manual RC mode and adjusted any trim values necessary, so the RC outputs reflect these trim settings; if you haven't already flown your aircraft in RC mode and trimmed it out, you may need to do the RC calibration again later, after you have flown the aircraft (this is easy to do at the field).

   Channel assignments are as shown above. When you move the RC sticks, the relevant bars will move. Click on "Calibrate Radio" to set the radio limits. Red bars will appear, and you should move them to their limits for each channel you have connected.

   On this screen you can also reverse servos if necessary and set up elevon mode if desired.

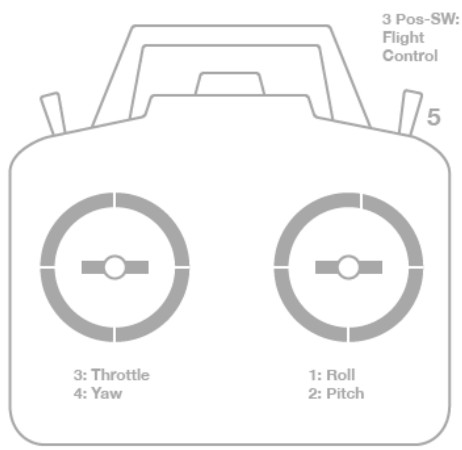

Figure 1 – 10 APM Board calibrated to Radio

Press save when you're done.

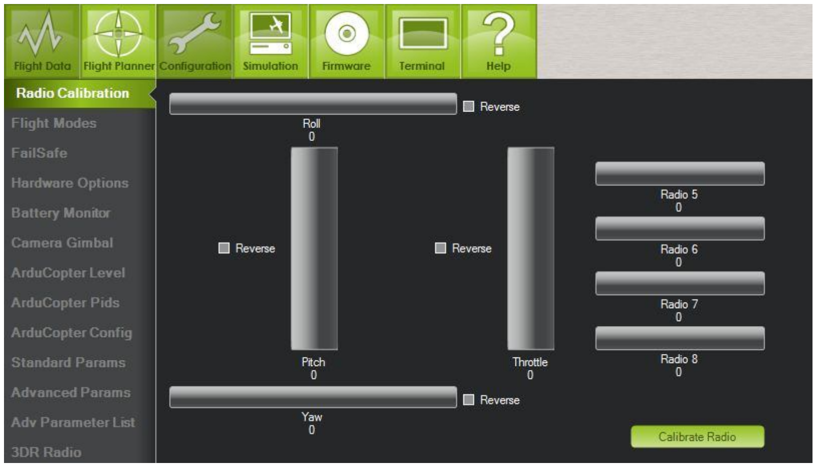

Figure 1 – 11 Calibrating RC Input into Mission Planner

3. Set your flight modes

   You can choose different flight modes in the air with your RC transmitter's toggle switch, which you should have connected to APM input 1. When you move the toggle switch, you will see the green highlight change to a different line. You can use the drop-down menu on each line to assign that mode to a function. Note that Flight Mode 6 cannot be changed from Manual. It's "hardware manual", which means that it's controlled by the failsafe circuit on the APM board to always be able to return you to RC control as a safety measure.

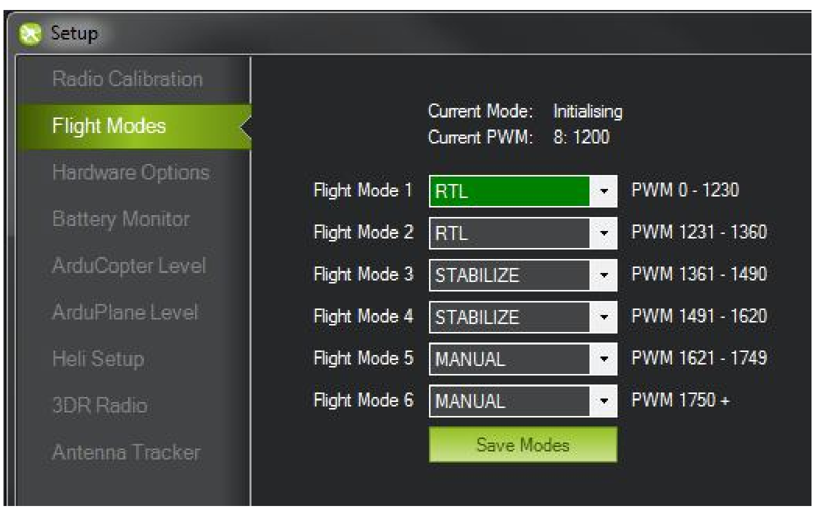

Figure 1 – 12 Setting Flight Mode on Mission Planner

4. Configure your hardware

In this tab, you can tell APM what optional sensors you have connected. Just click the check box for any sensor you're using. (Sonar is not currently supported with APM; it's primarily used for ArduCopter)

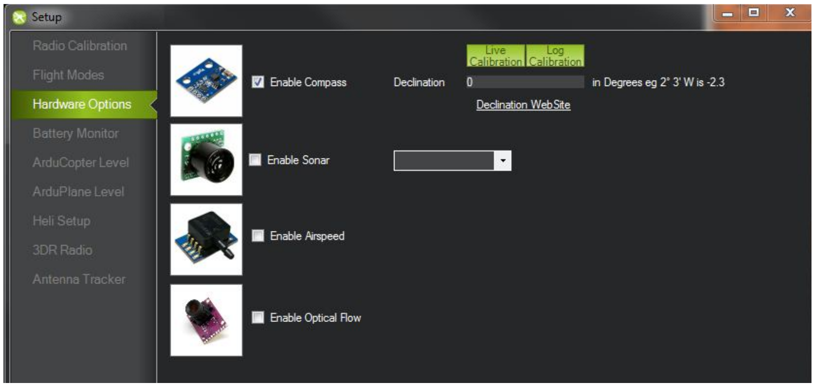

Figure 1 – 13 Setting Hardware Options on Mission Planner

For the magnetometer (compass), you have a choice of calibration options once you enable the sensor:

1. You can do nothing, and the code will try to figure out all the offsets and declination by comparing the compass readings with the GPS and IMU readings over time in flight. Pro: No user effort. Con: It takes a few minutes of flying to get right, so the compass is inaccurate at first launch.

2. Manual calibration in the Mission Planner (above). You can enter your Declination as instructed below and then press the "Live Calibration" button and move and rotate your aircraft around for 30 seconds while it records the data and does some math to calibrate the sensor. Pro: It works. Con: it's a little awkward, especially for big aircraft. Also it doesn't reflect the magnetic interference that can occur when the motors are going in flight.

3. Replay a flight log. This is a very cool option, shown above as Log Calibration, where you can just replay a previously recorded flight log (.tlog) and the code will compare the GPS and IMU readings with the compass reading and make the necessary corrections. Pro: Works great. Con: You must have already flown, if you load a .tlog file where you didn't actually fly you'll mess up your calibration and will have to do it again or risk poor flight performance.

To manually enter a declination for your geographic location, you can find the correct value by clicking on the link to open a web browser. Enter your location and it will give you a declination.

5. Now if you switch to the Flight Data tab with MAVLink connected, you will see the artificial horizon moving with the board. Remember to leave the board stationary for 15-20 seconds when you switch into this tab, since the IMU must calibrate first. Once it's done, the HUD will start moving.

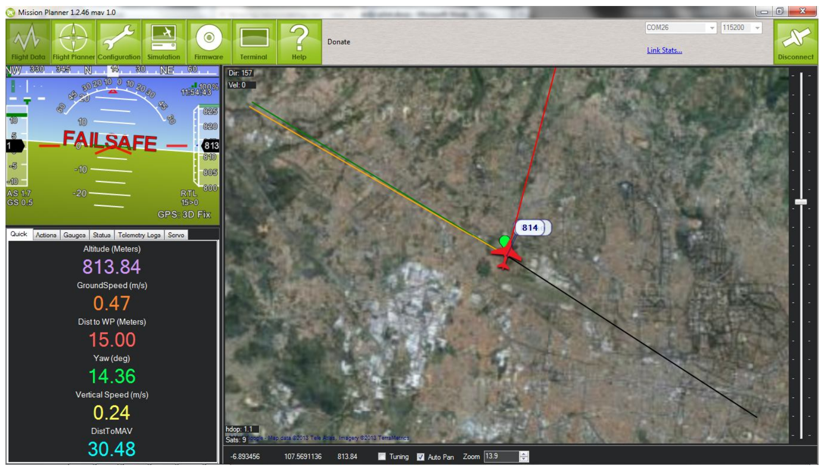

Figure 1 – 14 Mission Planner should receive and command Correctly

1.2 USING MISSION PLANNER TO CONTROL YOUR PLANE

The Mission Planner, created by Michael Oborne, does a lot more than its name. Here are some of the features:

- Point-and-click waypoint entry, using Google Maps.
- Select mission commands from drop-down menus
- Download mission log files and analyze them
- Configure APM settings for your airframe
- Interface with a PC flight simulator to create a full hardware-in-the-loop UAV simulator.
- See the output from APM's serial terminal

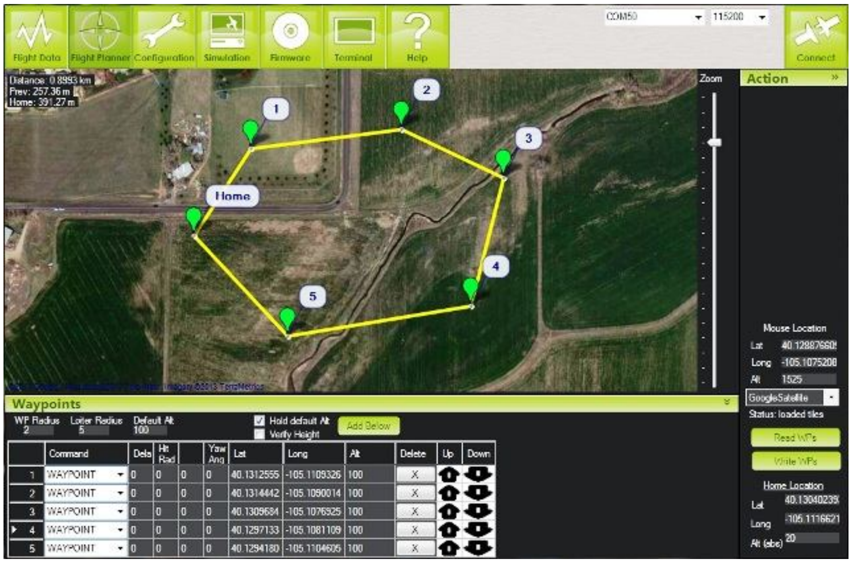

Figure 1 – 15 Mission Planner to control the Plane

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1.2.1 Flight Mode

Ardupilot has a range of built in flight modes, and will have more as development progresses. Ardupilot can act as a simple flight stabilization system or a sophisticated autopilot. Flight modes are controlled through the radio or through logic, using the events.pde file.

To setup your radio to control Ardupilot's Flight Modes, use the Mission Planner setup process or the interactive CLI: Setup/Modes. Note that the modes names may not show up as exactly the below in your Ground Station, due to the limitations of the MAVLink communications protocol. The modes display area as follows:

1. **MANUAL**
   Regular RC control, no stabilization.

2. **STABILIZE**
   RC control with stabilization; let go of the sticks and it will level.

3. **FLY BY WIRE_A**
   The autopilot will hold the roll and pitch specified by the control sticks. Throttle is manually controlled, but is constrained by the THR_MIN and THR_MAX settings. Note that THR_MIN is 0 by default, but if you raise it in the parameter settings, the throttle will rise to at least that value when FBA-A is invoked, even on the ground (so be careful!). The plane will not roll past the limits set in the configuration of the autopilot. Great for new pilots learning to fly.

4. **FLY BY WIRE_B**
   Requires airspeed sensor. The autopilot will hold the roll specified by the control sticks. Pitch input from the radio is converted to altitude error, which the autopilot will try and adjust to. Throttle is controlled by autopilot. This is the perfect mode to test your autopilot as your radio inout is substituted for the navigation controls. If no airpseed sensor is present, this will default to FBW-A.

5. **TRAINING**
   This mode is like training wheels on a bicycle and is ideal for teaching students manual R/C control. If the roll is less the the LIM_ROLL_CD parameter than the pilot has manual roll control. If the plane tries to roll past that limit then the roll will be held at that limit. The plane will not automatically roll back to level flight, but it will prevent the pilot from rolling past the limit. The same applies to pitch - the pilot has manual pitch control until the LIM_PITCH_MIN or LIM_PITCH_MAX limits are reached, at which point the plane won't allow the pitch to go past those limits.

6. **AUTO**
   Aircraft will follow GPS waypoints set by configuration utility. (You can also "nudge" the aircraft manuallyin this mode - see below*.)

7. **RTL**
   Aircraft will return to launch point and circle there until manual control is regained. You can also "nudge" the aircraft manually in this mode.

1. **LOITER**
   Aircraft will circle in current position. (You can also "nudge" the aircraft manuallyin this mode - see below*.)

(*"Nudging": Assume a model plane is flying in Stabilize mode and it's heading north, if you "nudge" it by moving the control stick (roll) a small and brief amount you "nudge" the plane off it's northerly course and now perhaps it will be flying north-west, all the time still having the autopilot in control. i.e All "nudging" means is that you can override the control that the autopilot has over the plane at any time and then have the autopilot resume it's control when you let the sticks go.)

Advanced modes

9. **TAKEOFF**
   Auto Takeoff is set by the mission control scripting only. Throttle is manual (it respects the limits of the autopilot settings so if you have 65% throttle

as the max, it will not go above 65%.) Once the plane is moving faster than a few m/s it will lock onto a heading and hold that heading until the desired altitude is reached.

10. **LAND**
Auto Land is set by the mission control scripting only. Throttle is controlled by the autopilot. After getting closer than 30 meters, the course will lock to the current heading. Flare, throttle, flaps, gear, and other events can be scripted based on distance to landing point.

1.2.2 Stabilize Mode

When in Stabilize Mode, Ardupilot will stabilize your plane during RC control. It smooths out your aircraft's movement and when you release the sticks, it will return to level flight.

Figure 1 – 16 AutoPilot Mode

This is a great mode for all users (it makes landing easy--you'll look like a pro), but is especially useful for beginners. If you get in trouble, just release the sticks and it will recover by itself, regardless of what crazy position it was in.

On the ground (or in the air also), We may check if the plane is in Stabilize Mode i.e. if we move the the plane to an axis, Mission Planner will counter it by commanding corresponding surface control to move to other direction in order to normalized the plane. For example we move (by hand on the ground) the plane to a climb direction, elevator will move to down, we turn the plane to left, Mission Control will turn rudder to right.

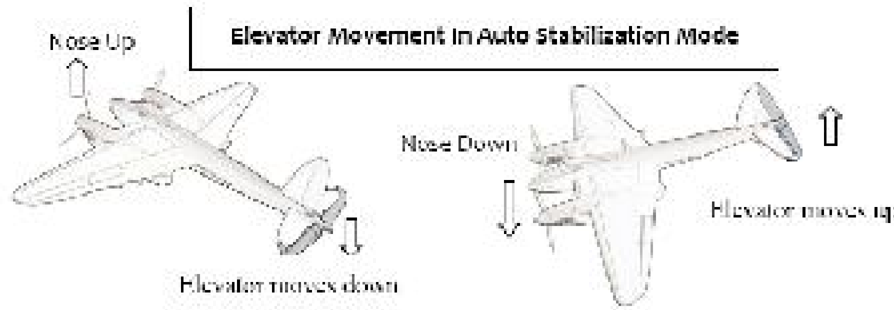

Figure 1 – 17 Elevator Auto Stabilization Mode

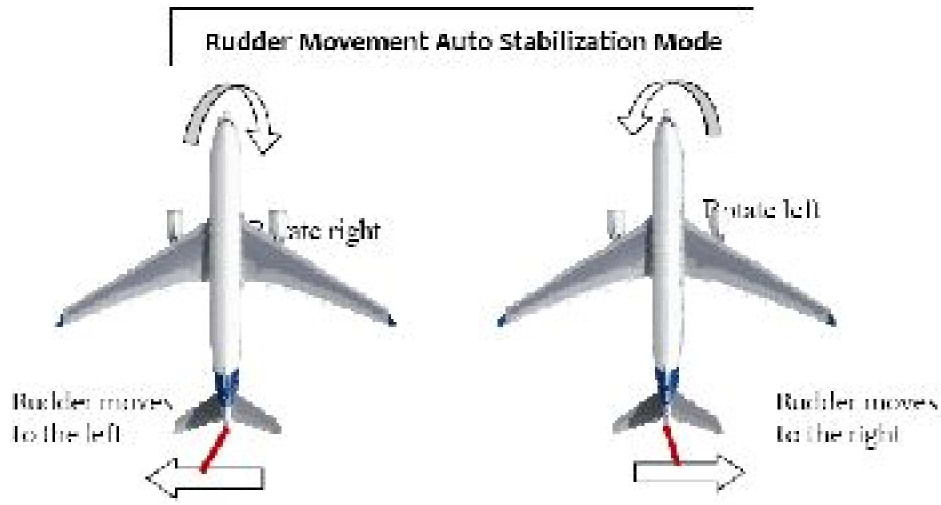

Figure 1 – 18 Rudder Auto Stabilization Mode

1.2.3 Autopilot Mode

In this mode, the aircraft travels to pre-programmed GPS waypoints. The waypoints are set before flight with the configuration utility.

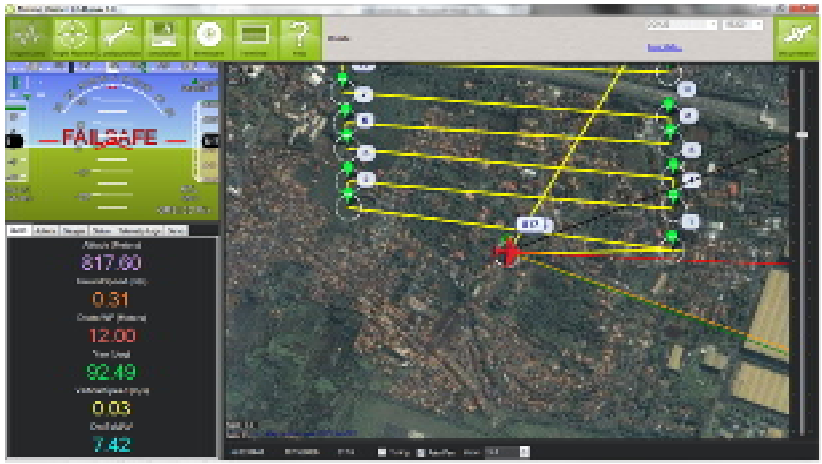

Figure 1 – 16 AutoPilot Mode

You can also "nudge" the aircraft manually in this mode. Throttle "nudging" occurs if the throttle stick is in the top 1/2 of the range and moves the airspeed or throttle setpoint up towards the upper limit proportional to the stick's position in the top 1/2 of the range. Normally you should have the throttle stick in the lower 1/2 of its range when using any "auto" mode.

G LAUNCH (Arduplane 2.71 and greater)

WARNING: BE AWARE OF 100% THROTTLE INPUT USING THIS MODE!!!!!)

G Launch is good for bungee or hand launched aircraft and may only be enabled in auto mode assuming a pre-programmed waypoint profile has been written to the autopilot to include a takeoff waypoint and at least one additional waypoint after the takeoff waypoint. The takeoff waypoint requires a lat/lon, takeoff pitch, and takeoff transition altitude..

1.2.4 Guided Mode

One of the most commonly-used features in pro UAVs is point-and-click mission control in real time. Rather than just pre-planned missions or manually flying the UAV, operators can just click on a map and say "go here now".

Figure 1 – 17 Guided Mode

That's now implemented in the Mission Planner. On the GCS map, you can right-click on the map and just select "Fly To Here". The UAV will fly there and loiter until you give it another command. We call this "Guided Mode". There are more commands coming in this mode soon, but the functionality is now built-in.

Note: Guided is a separate flight mode. If you enter it you will remain in it until you do something to change modes. So if you tell it to "go here now", once it arrives there it will loiter at the Guided waypoint till you tell it to do something else. Something else could either be going to another Guided waypoint (staying in Guided mode) or changing to some other flight mode. If you change to Auto your mission will resume where it left off.

1.2.5 Automatic Takeoff

ArduPilot Mega can automatically launch and land an aircraft, as part of a mission plan. Auto takeoff instructions:

The basic idea of automatic takeoff is for the APM to set the throttle to maximum and climb until a designated altitude is reached. To cause the plane to execute a takeoff, add a NAV_TAKEOFF command to your mission, probably as the first command. This goal is handled slightly differently depending on what sensors are attached, but the altitude parameter always specifies the altitude that must be attained before the APM will consider its takeoff complete and load the next Must command.

The APM will initially hold the wings level on takeoff, but as soon as a takeoff heading is established, the APM will adjust roll to maintain that heading.

If you do not have a magnetometer:

As soon as the ground speed, as measured by the GPS, exceeds 3 m/s, the takeoff heading will be set to the GPS ground course. This means that, in a crosswind, the APM may turn downwind somewhat during takeoff. Sometimes, the takeoff heading is accidentally set too early and this will cause the APM to turn the plane to an undesired heading during takeoff. To minimize this problem, try not to move the plane after Auto has been engaged except to throw it in the direction of takeoff. Try not to "wind up" by moving the plane backwards before throwing it. As much as possible, try to duplicate the behavior of a catapult launcher.

If you have a magnetometer:
As soon as the ground speed, as measured by the GPS, exceeds 3 m/s, the takeoff heading will be set to the magnetometer's yaw sensor.

If you do not have an airspeed sensor:
The first parameter of the NAV_TAKEOFF command will specify the maximum pitch the APM will target on takeoff. The minimum pitch is automatically set to 5 degrees positive pitch. As the plane increases in speed (as measured by the GPS), its pitch will increase. The exact formula is:

target pitch = (GPS speed / cruise speed) x maximum pitch / 2

If you have an airspeed sensor:
The first parameter of the NAV_TAKEOFF command will specify the minimum pitch the APM will target on takeoff. The APM will adjust pitch to achieve airspeed_cruise (pitch up if airspeed is above cruise, pitch down if airspeed is below cruise), but it will not pitch below the minimum pitch set by NAV_TAKEOFF.

1.2.6 Automatic Landing

To land the plane, simply add a NAV_LAND command to the end of your mission indicating the latitude, longitude and altitude of your desired touchdown point. In most cases, the altitude should be set to 0. During landing, the APM will shut down the throttle and hold the current heading as soon as the plane is within 2 seconds of the touchdown point horizontally, or as soon as the plane is lower than 3 meters above the touchdown point, whichever occurs first. On approach, the APM will fly normally if you have an airspeed sensor. If you do not have an airspeed sensor, the APM will hold 0 pitch.

Here is an example mission around the Sparkfun building that autotakeoffs, goes around the building and then sets up a landing pattern for an autoland. Note that the waypoints kick in once the plane has reached 30m altitude after autotakeoff, and that it lands at 0m altitude (altitude is given relative to home/launch altitude).

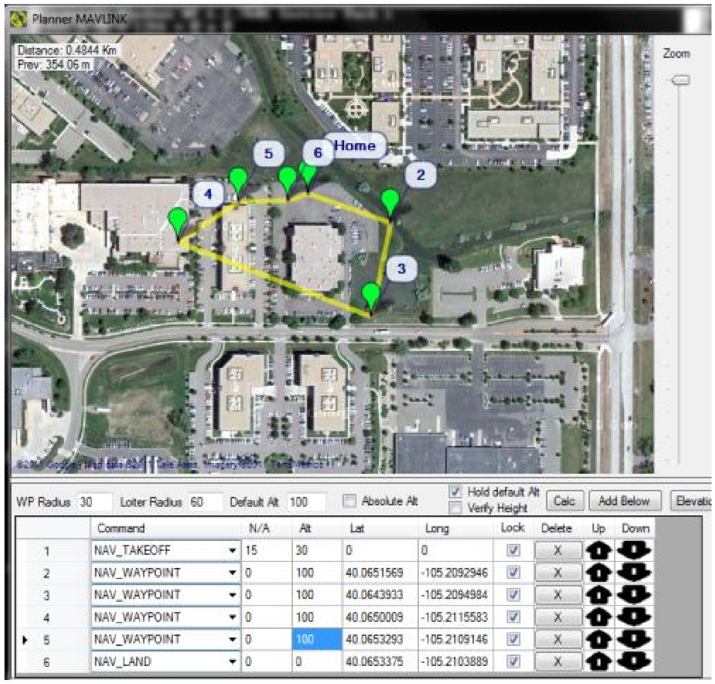

Figure 1 – 18 Auto Land

Note that in reality the above flight plan probably won't result in a successful landing in the desired area. Waypoint 5 is set with an altitude of 100 meters, and waypoint 6, which is the landing waypoint, is only a short distance away. Unless the particular airplane used has a very fast descent rate when gliding with the motor off, it will not be able to come down from 100 meters in the short distance planned here. It is more appropriate to step the altitude down over a few waypoints and make sure that the distance between the waypoint before the landing point and the landing point is sufficiently large for the altitude which must be lost. Use of automatic flap deployment can be helpful here if your airplane has a relatively flat glide angle - look under "Optional Additions".

1.3 CREATING A FLIGHT MISSION

Now we have a full understanding that ArduPilot using Mission Planner allow us to automate flying of our TS40 TRAINERby uploading waypoint and flight mode to APM Board installed. The question right now is How to create a flight mission which is consist of several waypoints and upload it to the APM Board. We can create a flight Mission using Mission Planner application on **Flight Planner** Menu.

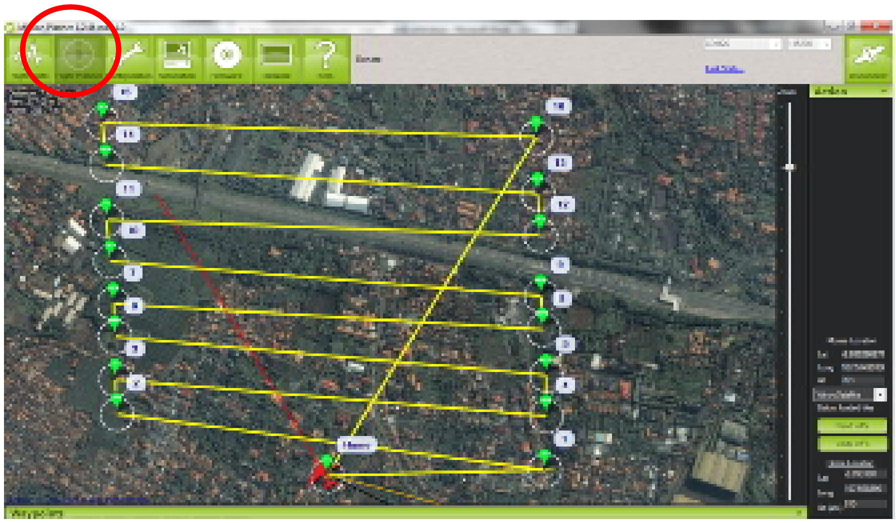

Figure 1 – 19 Flight Planner

You can enter waypoints and other commands (see below for the full list). In the dropdown menus on each row, select the command you want. The column heading will change to show you what data that command requires. Lat and Lon can be entered by clicking on the map. Altitude is relative to your launch altitude, so if you set 100m, for example, it will fly 100m above you.

1.3.1 Setting Home

You can set a home position by clicking on the Home lat or lon and then clicking on the map. Or, if the map is not already centered on the field you're going to be flying at, you can search for it by clicking on the "Zoom To" button and entering your location in the search box, as shown:

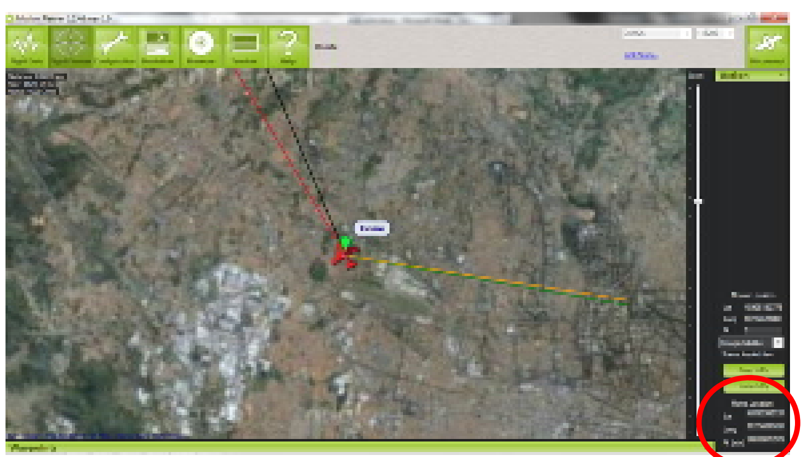

Figure 1 – 20 Setting Home

1.3.2 Creating Waypoint

You can create a waypoint using:

1. Manually set the waypoint one by one. This will create a precise Lat/Long/height waypoint location but time consummed.
2. Using Autogrid facility in the Mission Planner will be faster solution. Of course you can edit each waypoint later before upload it to your plane.

Manually Add WayPoints

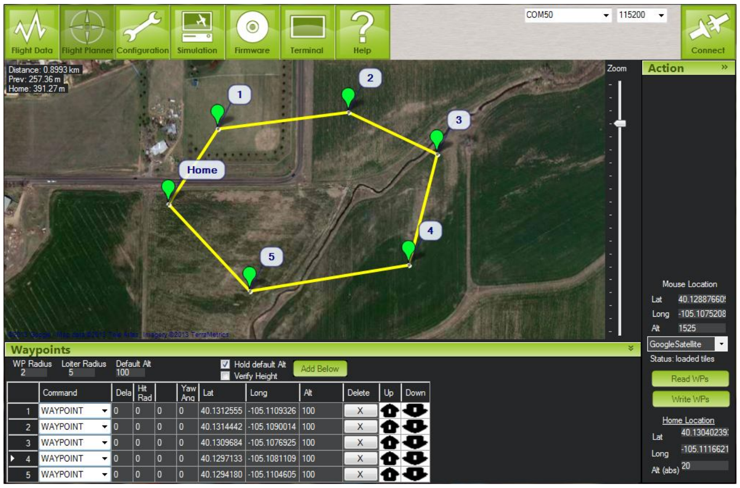

Figure 1 – 21 Add a WayPoint

Creating a WP is an easy task. You need just enter the Lat/Log/Height or just click on the Map to create a new waypoint.

Note that if the "Absolute Alt" box is checked, the altitude used will be altitude above sea level, NOT altitude above your launch position. If that box is unchecked, ALT will be relative altitude, so 100m will be 100m above your "home" altitude, or where you're probably standing.

Default Alt is the default altitude when entering new waypoints. It's also the altitude RTL (return to launch) mode will fly at if you have "Hold Default ALT" checked; if you don't have that checked, your aircraft will try to maintain the altitude it was at when you switched on RTL.

Verify height means that the Mission Planner will use Google Earth topology data to adjust your desired altitude at each waypoint to reflect the height of the ground beneath. So if your waypoint is on a hill, if this option is selected the Mission Planner will increase your ALT setting by the height of the hill. This is a good way to make sure you don't crash into mountains!

Auto WayPoints

If you're making aerial surveys and need to take lots of pictures that you will later stitch together to make a photo mosaic, a handy Mission Planner feature can help. It's called AutoWP, and it automatically creates waypoints that will take your UAV on a "lawnmower" pattern over an area, with trigger points at regular points to instruct your camera to take picture.

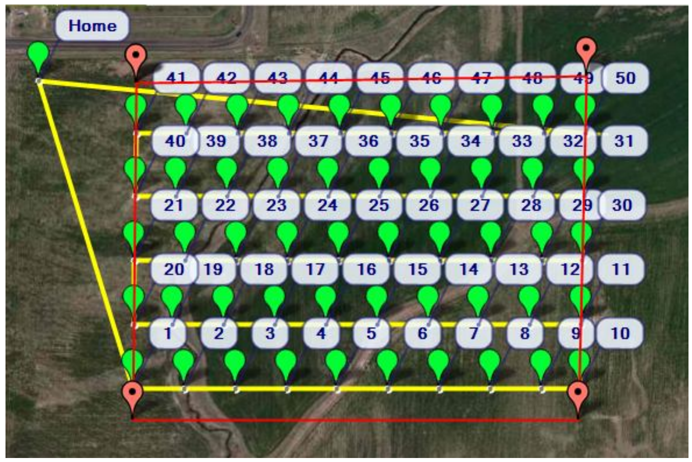

Figure 1 – 22 Automatic Waypoint

If you're making aerial surveys and need to take lots of pictures that you will later stitch together to make a photo mosaic, a handy Mission Planner feature can help. It's called AutoWP, and it automatically creates waypoints that will take your UAV on a "lawnmower" pattern over an area, with trigger points at regular points to instruct your camera to take picture.

1. **Draw a Polygon**
   To use this, go into the Flight Planner screen and right-click, selecting "Draw Polygon".

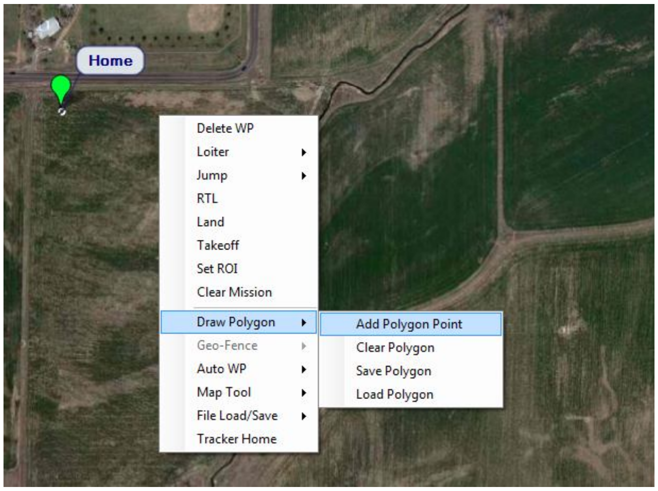

Figure 1 – 23 Draw Polygon

2. **Draw a Grid Waypoints**

   Once you've drawn a polygon around the area you want to cover, select "Auto WP" then either Grid or Grid V2 (the first starts at the bottom of your area, and the second starts at the top).

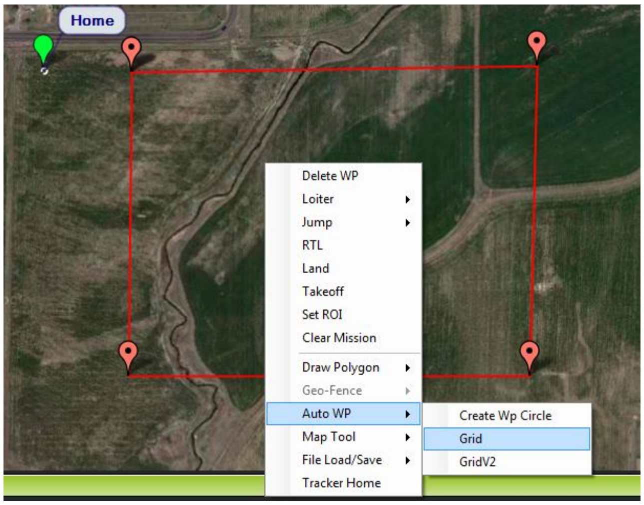

Figure 1 – 24 Draw a grid of waypoints

It will ask you to choose some other parameters for the mission, such as at what altitude to fly and how far apart the lines and waypoints should be. Choose these based on the characteristics of the camera you're using; in general you should have at least 20% overlap between pictures so the feature-matching algorithms of your photo stitching software have enough common features between photos to work with.

When you're done, it will automatically create a mission like the one shown at top.

1.3.3 Upload / Save Waypoint

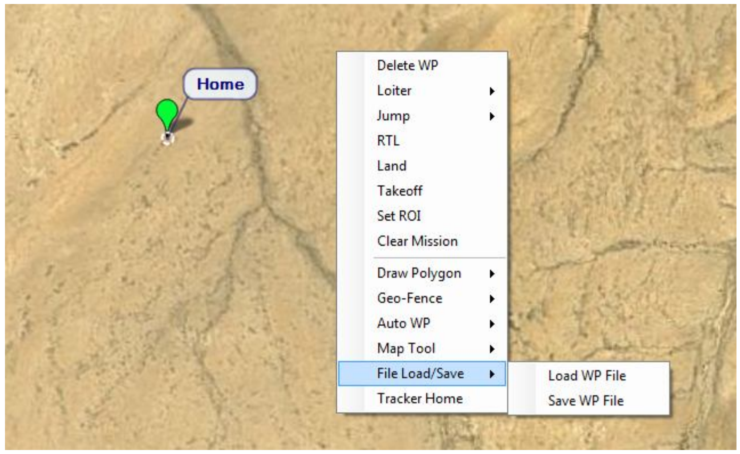

Figure 1 – 25 Saving Waypoint

Once you are done with your mission, select "Write" and it will be sent to APM and saved in EEPROM. You can confirm that it's as you wanted by selecting "Read"

You can save multiple mission files to your local hard drive by selecting "Save WP File" or read in files with "Load WP File" in the right-click menu:

1.3.3 Basic Waypoint Commands

A mission file is a little intimidating to the human eye, but is a powerful scripting language for the autopilot. (Again, remember that the GCS will soon take care of all of this for you. You shouldn't have to see it yourself for long!).

You can have as many commands as you want, ranging from pre-programmed ones to ones that you can create. Here are some common ones:

{NAV_WAYPOINT n/a, alt, lat, lon}
{NAV_TAKEOFF pitch, target altitude}
{NAV_LAND n/a, alt, lat, lon}
{DO_JUMP waypoint, n/a, repeat count, n/a} Goes to that waypoint and resumes mission there. Set repeat count to any number greater than 1 to do it that many times. or to -1 to do it forever. Good for looping missions.

(Note: DO_xxx commands currently need a dummy waypoint placed after the command
eg:

WAYPOINT_1
DO_SET_HOME
WAYPOINT_2

Home will be set at WAYPOINT_1 but will not work if WAYPOINT_2 is not there.)

In the screenshot above, I've planned a mission that starts with an autotakeoff to 20m attitude, the three waypoints at 100m, ending with one that sets up a landing pattern. Finally an autoland finishes the mission at 0m altitude.

Tips

- Prefetch: You can cache map data so you don't need Internet access at the field. Click the Prefetch button, and hold down Alt to draw a box to download the selected imagery of a location.
- Grid: This allows you to draw a polygon (right click) and automatically create waypoints over the selected area. Note that it does not do "island detection", which means if you have a big polygon and a little one inside of that, the little one will not be excluded from the big one (see this for more). Also, in the case of any polygon that partialy doubles backs on itself (like the letter U), the open area in the center will be included as part of the flyover.
- Setting your home location to the current location is easy, just click "Home Location" above where you enter your home location, and it will set your home location to the current coordinates.
- You can measure the distance between waypoints by right-clicking at one end and selecting Measure Distance. Then right-click on the other end and select Measure Distance again. A dialog box will open with the distance between the two points.

1.4 OSD & RADIO LINK OPTIONS

1.4.1 Using OSD

MinimOSD is a super-tiny board designed by 3DRobotics. It's all you need to get OSD telemetry data from ArduPilot Mega. Just connect your FPV camera and a video link and you're ready to fly with instruments on screen.

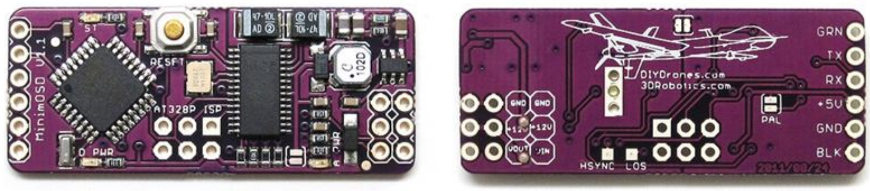

Figure 1 – 26 MinimOSD

The concept is to read data from APM board inputs. At the same time, read from Video Output. MinimOSD then merge them by putting data formatted to be displayed with Video Output. The result the transmitted so it can be received and displayed real time using PAL or NTSC TV.

It's intended to be a dedicated APM telemetry video output. So, it reads MAVLink messages from its RX and request rates from APM if you connect its TX to ArduPilot "telem" port.

Important note: You cannot connect the OSD when your APM 2 is also connected via USB (they share the same port). Make sure you disconnect your USB cable from the APM 2 board before attempting to use the OSD.

Details

It has the Max7456 chip powered by two stages to avoid noises from servos attached to ArduPilot Mega board.
It provides an extra clean power line to feed the FPV camera and video link.

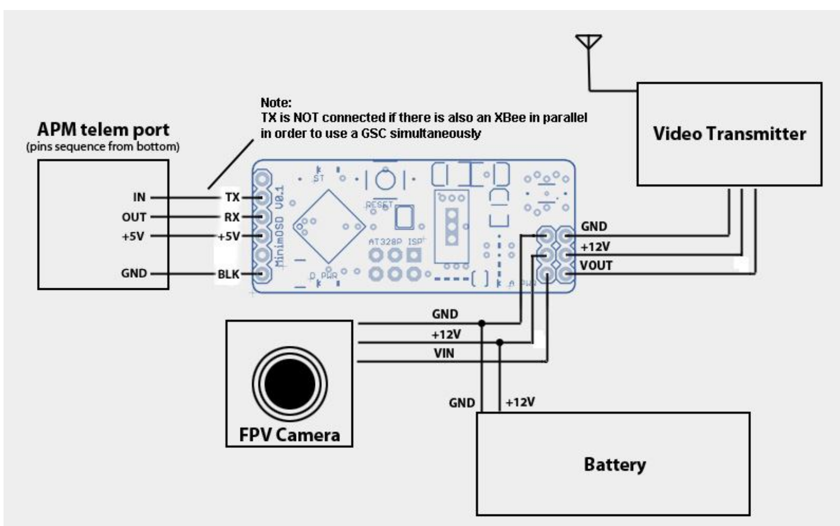

Figure 1 – 27 MinimOSD Configuration

The approach is to use two external power sources: 12V from a Lipo Battery and 5V from APM:

Raw 12V from Lipo Battery

- Feeds directly FPV camera and video transmitter.
- It also feeds Max7456's analog line (AVDD and AGND) by a 5V voltage regulator (avoiding noises from servos attached to APM).

5V from APM telem port

- Feeds the ATmega 328P and Max7456's digital line (DVDD and DGND)

MinimOSD has no extra pins exposed, because the concept is "capturing all the needed data from MAVLink". E.g.: to show RSSI from RC receiver, that info needs to be on msgs #35 and #36 (RC_CHANNELS "RAW" and "SCALED").
So, the analog reading of RSSI output from receiver needs to be done on APM analog ports and treated inside the APM code.

Figure 1 – 28 Using MinimOSD

PAL vs NTSC

The format of the video does have an impact on how many characters the OSD can fit on the video feed. The MimimOSD can be configured by the ArduCAM OSD Config Tool to work at PAL or NTSC. The "PAL" solder jumper underneath the board is not used anymore (Firmware 2.0 or above).

1.4.2 Using Radio Link

The 3DRobotics 3DR Radio is the ideal way to setup a telemetry connection between your APM and a ground station. Small, inexpensive and with great range, the 3DR radio uses an open source firmware which allows us to do things that cannot be done with other radios.

Figure 1 – 29 3DR Radio Link

Connecting your 3DR Radios

You will need two 3DR radios, one for your aircraft, and the other for your ground station. Important note: You cannot connect via the radios when your APM 2.x is also connected via USB (they share the same port). Make sure you disconnect your USB cable from the APM 2 board before attempting a wireless connection.

Looking at the above picture you will see that typically the "ground" radio module has a USB connector, making it easy to connect them to your ground station. It uses a D2XX FTDI driver that you can get here. This driver is built into Windows 7 and above, so it is only necessary if you are using Windows XP or below.

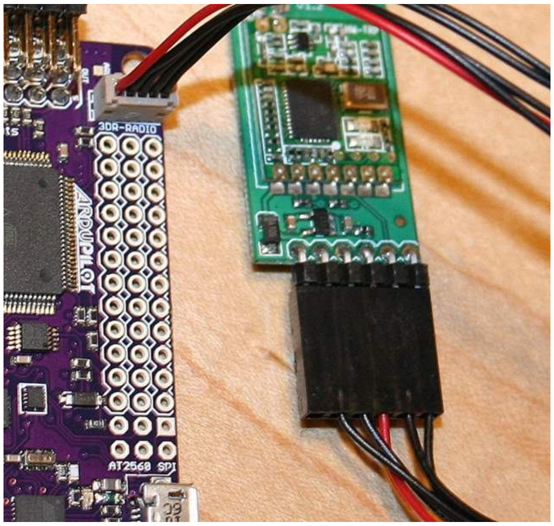

Figure 1 – 30 Connecting 3DR Radio Link

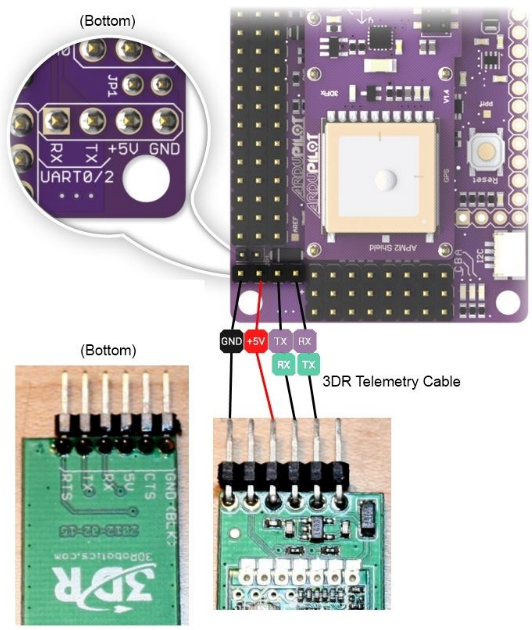

Figure 1 – 31 Connecting 3DR Radio Link

The 'aircraft' model has a FTDI six pin header, allowing it to be directly connected to your APM telemetry port.

The radios come pre-configured for a serial rate of 57600, which is the default rate that APM uses for telemetry, but you can change this to any rate you like, either using the AT command set, the APM Mission Planner radio setup interface, or the 3DR Radio Configuration Utility.

Status LEDs

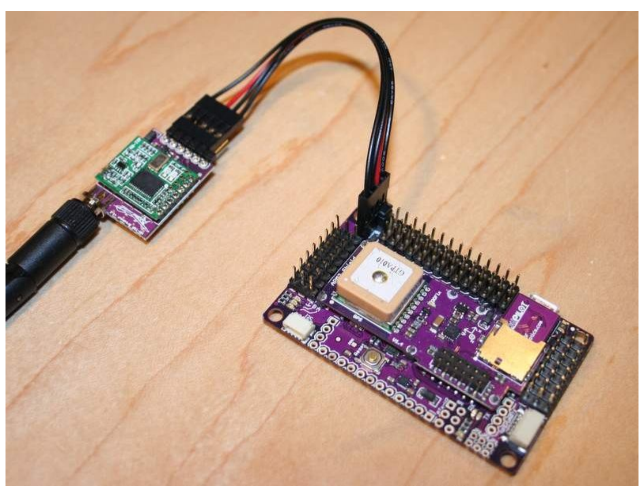

Figure 1 – 32 Connecting 3DR Radio Link

The 3DR Radios have 2 status LEDs, one red and one green. The meaning of the different LED states is as follows:

- green LED blinking - searching for another radio
- green LED solid - link is established with another radio
- red LED flashing - transmitting data
- red LED solid - in firmware update mode

Configuring using the Mission Planner

The latest versions of the APM Mission Planner support configuring your 3DR radios using a simple GUI interface. In the Mission Planner (top right) select the Com port that your "ground" 3DR radio is connected to and 57k as the baud rate.

Then switch to the Configuration screen. Choose the 3DR radio tab in the list at left, and click on "Load Settings" and it will populate it with data similar to that shown (the remote radio's settings will only show if it is also powered on and connected to APM running current ArduPlane or ArduCopter code).

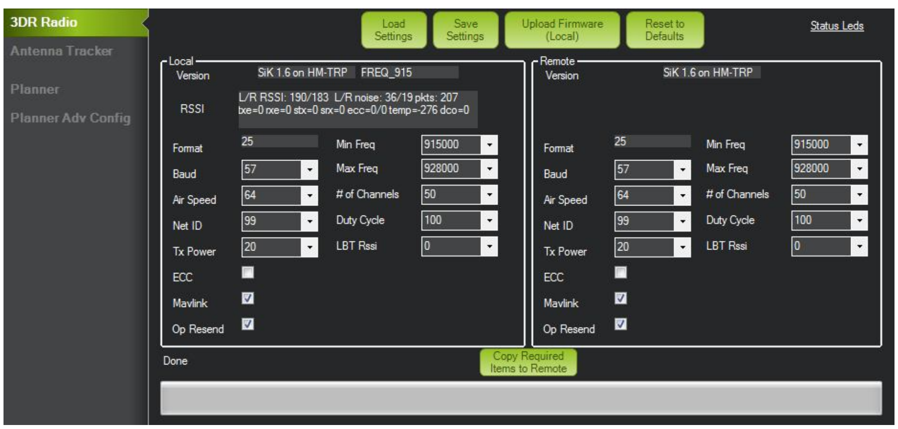

Figure 1 – 33 Configuring Mission Planner

This is the recommended configuration method for most users.