INAV FIXED WING SETUP GUIDE

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New: If you're experiencing technical problems please refer to the 'INAV Trouble-Shooting Guide.'

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INTRODUCTION

This is a setup guide for the firmware on your INAV Flight Controller (FC). It is meant to be used after your aircraft is built and mechanically set up. If you are not there yet, don't worry! There is a "Getting Started with INAV" document that covers things you need to know about getting your aircraft ready for INAV, before you dive in to setting up the firmware. This is near the bottom of this document in Appendix C. There are things you should know before working with your flight controller.

This setup guide started from notes that Georgios Ntanas (a group member) made from watching Pawel Spychalski's YouTube videos on INAV. Pawel is an INAV developer and a group member. Thank you also to Leslie Wr (another group member) for bringing this document to our attention. Steve Schlesinger also modified the guide a bit, to highlight the sections people seem to struggle with the most.

This guide will take you through each menu item found on the left side of the INAV Configurator in the order they appear - top to bottom. This is the best way to approach setting up INAV. Since this guide is based on Pawel's video, in each section we have put a link to the exact moment in the video where he discussed the specific tab. This will save you time searching for the right spot. In his video he set up a flying wing, which is a good first plane to build with INAV. His video was published on Oct 15, 2018 and is based on INAV 2.0 which is now out of date. Regardless, most of the information is still relevant.

INAV changes from time to time. Please notify Steve Schlesinger (INAV Fixed Wing Facebook Group admin) if you know of any changes or things that need to be updated or addressed. Our goal is to get you up and running with INAV as quickly and painlessly as possible.

While following this guide and using the INAV Configurator, be aware of one common mistake we have all made: Whenever you are finished with one tab and about to move to another, don't forget to click "Save and Reboot", or else your changes WILL NOT be saved!

CONFIGURATOR SECTIONS

SETUP TAB

Pawel's video link to this topic: https://youtu.be/lkn9t7WBHNY?t=42
Importance: Medium
Difficulty: Easy

When you plug your flight controller into the USB lights will start flashing and hopefully you'll get the USB sound notification. We're going to assume you've flashed the board and you can log in. If you can't do either, try using a port other than Com1. If you are still struggling, drop a message in the group and folks will walk you through it.

As you move the flight controller the graphic on the setup should show your flight controller moving in the same direction. The arrow on the board should point forward. If it doesn't, don't worry! Calibrating will take care of that. (We'll fix that in the next tab) The indicators on the right all need to be green before the plane will arm. If your plane refuses to arm, this screen is a valuable resource in helping to tell you what's wrong.

CALIBRATION TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=46
Importance: High
Difficulty: Easy

This tab is where you teach your flight controller all the different axis's. You don't need to have the board in the plane to perform this step. It's actually easier to do it when not in the plane. The arrow on the board points forward and should correspond to the direction on the screen. You can set the board on a table or other flat surface to help improve the experience. Don't forget to save and reboot.

NOTE: A common problem for planes is that true level flight will have the tendency to push the nose down. Most planes can benefit from up trim of a few degrees. When you get to your first flight and notice that the plane tends to nose down in the gyro modes (Horizon, Angle, Acro), this is normal. A common 'cheat' is to place the plane on a table for step one and put batteries or something to take the nose up few degrees. This will fool the flight controller into thinking that level flight is actually with slight up trim. Another spot to do this will be in the configuration tab.

MIXER TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=138
Importance: High
Difficulty: Easy

This is the portion where you tell INAV what type of plane it's going into. The flight controller will do the mixing for you. Simply select the right plane type from the pulldown menu and click save and reboot. Most of the heavy lifting has been done for you with this move.

Important - If you have a delta, v-tail or some other custom setups in your radio, you need to **turn them off**. Kill your trim, kill your expo. **THIS IS HIGHLY IMPORTANT!**

PRESETS TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=221
Importance: High
Difficulty: Easy

Chances are you won't find an exact preset for your plane. Find something close.   After you select it, you have to load the model and then click save and reboot. You can continue on to the manual process in step 9 if you want to do this manually (Not suggested).

PORTS TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=243
Importance: High
Difficulty: Medium (People do get stuck here from time to time)

This tab is where you tell INAV what type of receiver you are using and where it is connected on your FC. The video does not spend much time here, because the settings will vary depending on your particular setup. If this is new to you, you'll need to see Appendix 2 for instructions on setting up a receiver (RX) with your flight controller. As complex as this may sound, it's as simple as finding where you physically connected your receiver to your flight controller (i.e. which UART you chose), enabling the corresponding INAV serial port for that UART on this screen, and clicking save and rebooting. Don't let the word "UART" scare you. The USB ports you work with all the time are UART ports. The pins or pads you attach to dictate which UART ports you are to use.

This is also where you will learn if you need to buy a new TX/RX system. If you're going to fly with a flight controller, you should have a system that takes advantage of serial-based receivers. Before you buy anything, watch videos and ask questions. FrSky uses OpenTX which has its own learning curve. There are other options in the market. Pick people's minds in the group. Take your time and research your options. From this point on we'll assume you have the radio system installed and working.

CONFIGURATION TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=284
Importance: High
Difficulty: Medium/Hard (Pilots don't always set up this tab as well as they could)

At this point, it is assumed your flight controller is working and is installed in your plane.

Go into the configuration tab and change the receiver (RX) mode to match your receiver's protocol (ppm, sbus, ibus, crossfire, etc.). Click save. After it restarts, go into the receiver tab and verify all controls are working correctly! You can do this by moving your TX sticks and verifying the corresponding movements on the various channels. If they are not working properly, you may need to change the Channel Map in your radio to AETR. The default on FrSky for some reason is RETA (Rudder, Elevator, Throttle, Ailerons). You will need to change this in your radio to AETR.

Side note: This is also a good time to check to see if you can calibrate your radio's gimbals. My brand new FrSky radio wasn't remotely close to calibrated. This is when doing a Google search is useful. Five minutes with YouTube and it was PERFECT.

Back in the configuration tab: change board and sensor alignment depending on how you have set it up in your aircraft. You want the model to be moving correctly when in setup tab, according to how you move it on the bench. Normally the arrow on the FC should point straight forward, but let's say that your FC board won't allow access to your USB plug with the arrow pointing toward the direction of flight. But if you turn it 90 degrees you have clear access to the USB plug. This is an example where you would tell INAV you have your flight controller facing 90 degrees one way or the other (this is the Yaw Degrees setting, and in this example it would be set to either 90 or 270 degrees depending on which way you turned your FC board). Performance won't suffer because of this. You can even mount it upside down.

Under Esc/Motor Features, enable the motor and servo output and select corresponding esc protocol (standard etc…) and refresh rate. In the new INAV configurator the configurator will start to give you unsubtle suggestions if you go off track here.

Under Esc/Motor Features, the Servo refresh rate should be left at 50hz (99% of people use standard 50hz servos).

Under Esc/Motor Features, enable "Don't spin motors when armed" (you want to be able to glide with no power). Also, select "0 seconds until disarm due to low throttle". Leave min and max throttle at default settings if you want.

Under System configuration, select 256 Hz for your Gyroscope LPF cutoff frequency. It's the best possible option for a flying wing. Asynchronous mode should be disabled. Select flight controller loop time at 1Khz (doesn't really matter, but 1 kHz is a good value).

NOTE: (continuation of the note from the calibration tab) After setup, if when flying your plane you notice the nose pitching down during Acro, Horizon, and angle modes (and assuming you've gone through a normal level calibration in step 2), instead of recalibrating the gyro again, you can change the pitch in "Board and sensor alignment" section. There is no exact number to put in here to make your plane fly perfect. A good starting point may be 3 degrees. If it's still nosing down during gyro modes, take it up a little at a time. You may need to repeat this process this a couple of times before you find the sweet spot. If the plane starts to stall at slow speeds, you may want to take it down.

Under Current Sensor and Voltage Sensor Battery Capacity, these are optional. Use them if you want and/or if your board supports it.

Under Other Features, permanently enable Airmode. Click Save and Reboot to save this step and all the changes you just made in the configuration tab. Don't forget to click Save and Reboot!!!!

We'll be coming back to the configuration tab when working with the GPS.

SERVOS TAB

(We're now going out of order when it comes to tabs. Some we won't cover).

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=498
Importance: Medium
Difficulty: Medium

You will need to go to YouTube and learn how to perform a 'High Five" test. You need to make certain all your control surfaces are going in the right direction.   Often one or more servos is going in the wrong direction. This tab is where you reverse it. You can also tone down the rates here, but it will be across the board. This is more crucial for smaller planes that may not like full servo travel.

FAILSAFE TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=594
Importance: Medium
Difficulty: Easy

If your plane doesn't have GPS, just leave failsafe set to "Land".   The lack of a GPS unit means your plane has no idea where it is, so return to home (RTH) isn't even an option. This is why GPS units are highly suggested. In "Land" mode, the plane is going down where it lost signal. Make sure to set guard time for activation after signal loss too!!

If your plane has a GPS unit, select RTH (Return to home) if you want it to come home. Click Save and Reboot.

TESTING

Please remove your prop! During testing the motor will spin up and the servos will activate. If you turn off the radio, the red parachute at the top of the page should light up indicating Failsafe has activated! If it doesn't light up, you may need to read your receiver/radio manuals on how to set failsafe, and then go and set it up manually so it will trigger correctly. If not able to do so, set it to trigger the "failsafe" mode under the "Modes" tab. Very important, don't skip this step,

MAKE SURE you get the red parachute when turning off your transmitter! If it doesn't light up, Failsafe has not activated and whatever action you selected for failsafe (i.e., RTH) WILL NOT WORK!!!

What you are doing is testing failsafe with this test. By shutting off the transmitter you are cutting the signal between transmitter and receiver. This mimics a real-world flight situation where you fly out of your transmitter's range. In reality, you never want to shut off your transmitter when your plane is in the air. We're teaching your flight controller what do if your plane loses signal.

Another scenario that pilots experience is when you lose video signal, but you still have a good control connection and can still fly the plane? This is where having a "NAV RTH" switch is important. (You will not see this option until your GPS unit is installed and working) If you lose video, you can flip on "Nav RTH" which is "return to home". The video signal hopefully will come back as the plane comes back toward you, and then you can flip off the switch and fly normally.

PID TUNING TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=658
Importance: Low
Difficulty: Medium/High (You really need to have some time with INAV under your belt before messing with the PIDS on your own).

This tab is where you go to fine tune your plane after your maiden flight. You don't need to do this if you have selected a preset in step 4, but it's a good idea to go over the settings of your preset just to learn what they are.

These are instructions for manually setting up your plane, if a preset from #4 isn't used. If you've used the preset, you can look around a bit but you're not required to change anything.

Leave all PIDs at default values for the maiden. If you want, you might slightly increase the pitch I (Integral) to 12 and roll I (Integral) to 9.

ROLL rate for flying wings up to one meter wingspan should be around 300 - 400. PITCH rate for same wingspan should be around 120-200 (select 120).

Select the ROLL and PITCH angle, they should be around 40 for ROLL and 30 for PITCH.

Gyro LPF cutoff frequency should be around 30-40, that makes it smoother when it gets hit by winds/gusts and tries to self-right itself or fly in automated modes such as PosHold and RTH.

Leave all the rest (D-Term, D-Term Notch, etc. and everything in Miscellaneous) at default values. However, TPA should be around 0 for maiden, you can tune this after the maiden.

Don't forget to click Save and Reboot!!!

ADVANCED TUNING TAB

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=952
Importance: Low
Difficulty: Medium/High (Some values are safe to change, but use cautiously).

If you don't use GPS and automated functions, leave everything AS IS.

Note: There are different sections in this guide dealing with Advanced Tuning. This one is for non-GPS users. We will be dealing with the **Advanced Tuning Tab** later.

Pawel's video link to this topic https://youtu.be/lkn9t7WBHNY?t=977
Importance: High
Difficulty: Low/Medium (Don't setup modes you don't understand).

Frankly, this is a subject that is too broad to cover in this document. We're working on a second set of documents to cover all of these modes. The most important thing is to understand what each mode does before you assign a switch to it. It's really in your best interest to start with the basics and then add more modes over time.

Another important point: If you don't have a working GPS, some modes won't appear. This isn't very well documented. For example, if you want to see NAV RTH and NAV Cruise modes, you'll need to have your GPS setup.

The key modes you'll want to get started with are:
Arm, Angle, Horizon, Nav RTH

NOTE: LOOK IN THE FILE SECTION IF YOU HAVE A FRSKY TARANIS SYSTEM. WE HAVE A COMPLETE BUILD WITH MODES ACTIVATED. YOU CAN IGNORE THIS SECTION.

Other modes like Autotune and Servo AutoTrim can make a huge difference with your plane. Servo AutoTrim will get the plane flying remarkably better if used properly.

Just as important as learning the modes is how you position them on your switches. After setting up your first INAV plane you'll have more modes to remember. If your switches are in different locations for each plane, you'll be asking for trouble. The French have a culinary term "Mise en place." It means "everything in place." When a chef is busy, they need to grab for something, and it needs to be in the same spot every time. So, everything is set exactly in the same place, all the time. It has to be something that is logical to you, and that you can memorize. Over time you can add new modes to unused switches.

The first time you work with your radio, your switches won't work. Even with the most basic FlySky transmitters you'll need to assign a channel to a switch. Once again, there are great videos on YouTube to teach you this.

Pro Tip: Perhaps you have a transmitter with a limited amount of switches and channels, but it has a couple of knobs. And let's say you only have a six-channel receiver, with 3 channels going toward your delta wing. The FlySky/Turnigy for example only has one 3-way switch. You can assign a lot of modes on the knobs. You can have the three-way switch work the Arm and Nav RTH. If you use the knobs and watch the modes on your OSD you can scroll through perhaps five modes per knob. For example: One knob could have manual, angle, horizon, and Nav Cruise, while the other knob could have your 3 OSD screens, Servo AutoTrim and Autotune. In this example you would have 11 modes on 3 channels.

OSD TAB

Importance: Medium
Difficulty: Low/Medium

As you can tell, there are many things you can put on your OSD screen, but how much do you really need? It's easy to flip on everything, but the screens do get crowded. Thankfully you can now have 4 different OSD screens! You need to go back to the "Modes" tab to set up changing screens with switches or knobs. If you have no use for a knob (such as a flying wing) here's a chance to set up the four screens plus "OSD Off" on a knob. Here are some ideas that experienced INAV member Marc Hoffman came up with.

Examples:
Main screen (Default screen) - If you have nothing else on switches/knobs this will be your only screen. Mark uses this screen to display any and all relevant information.

1st screen (Standard flight screen) - Marc removes the GPS coordinates and throttle views, and adds a map view.

2nd screen (Freestyle flight screen) - Marc's uses only minimal information such as RSSI and battery voltage.

3rd Screen (Tuning screen) - Marc turns everything off on this screen for temporary use of auto-tune and activating PID values in the OSD.

You can also use the "OSD off" switch if you have a need for no OSD whatsoever. The OSD on a knob works great, you should try it.

LED TAB

Importance: Medium
Difficulty: Low/Medium

If you are using an LED strip, you first need to enable that function from the configuration tab and Save and Reboot. Then go to the LED tab and set up your programmable LED strip according to your liking. Click Save and Reboot.

LED's are something that we picked up from our drone brothers. They find it helpful to see the quad, and to know what their orientation is. If you do a lot of flying at dusk or dawn this may be useful. There are LED's with beepers that are inexpensive and not too difficult to install. This is something you can check into as you get deeper into INAV.

One idea from our moderator Jason is to set the LED to come on when the plane is armed. Many LED's are sold with beepers. You can also set the beeper on a switch, which comes in handy when you lose your plane. Provided you are close enough, you can simply turn it on to hear where your plane is.

CLI TAB

Pawel's video link https://youtu.be/lkn9t7WBHNY?t=1082
Importance: Medium

Difficulty: Medium/High

If you have really bad CG and/or Servo throw problems, you can change the I-term servo throw limit to 300. The new 300 I-term throw limit will help with the Auto-tune process.

Here's how to change it to 300: In the CLI Tab, type "get iterm" and press enter. Note what the I-term Servo throw limit is (default is 165). Now type "set fw_iterm_throw_limit=300" and press Enter. Now type "get fw_iterm_throw_limit" and press Enter to check if it correctly changed to 300. Finally, type "save" and press enter.

After performing a Servo Auto trim and Autotune correctly as suggested above in step 11, come back here and set the I-term Throw limit back to the default 165.

Keep reading below this point if you want to use GPS, Automated Flight Modes, etc

A few notes about GPS, Barometer and Compass (Magnetometer)

For automated modes, if you have a barometer on your flight controller, leave it enabled (blue icon should be lit up on top) and USE IT since GPS altitude accuracy is not very accurate. Also, new to INAV 2.1, you can use a magnetometer on fixed wing airplanes. This is a compass. Up until this release we didn't use it. You are not required to have a magnetometer to use flight navigation on INAV. GPS units without a magnetometer are often less expensive.

GPS TAB

Pawel's video link https://youtu.be/kSs3JYT5Zns?t=177
Importance: Medium

Difficulty: Medium (People get stuck here from time to time)

GPS setup can be tricky the first time around, but the newer GPS pucks and latest firmware releases have made it easier. It's actually quite simple in theory. There are four wires if you're using a GPS. Power, ground, TX and RX. The RX wire goes to the TX port on your flight controller. The TX from your GPS goes to the RX port on your flight controller. The little clue that they will give you is that the board will say something like TX3 and RX3. The "3" means you are using UART 3. In the Ports tab you simply enable the GPS peripheral for the GPS on UART 3, then click Save and reboot.

And yet, it's rarely that easy. See Appendix 3 (Getting your GPS Working)

Here are the notes from Pawel's video on GPS:

M8N series GPS are highly recommended. He suggests the BN-880 or the BN-220 (My favorite GPS) and the Matek GPS.

For GPS setup, first go to the Ports tab and enable GPS on the corresponding UART and also select the correct baud rate (if you know it) or select Auto-Baud. In most cases Auto-Baud will work. Click save and reboot.

Now, go into configuration tab, select "Enable GPS for navigation and telemetry" and select the correct protocol for the GPS you are using. Select "Ground assistance autodetect" or depending on where you live, select the appropriate setting. The declination is not needed if you are not going to be using the magnetometer. Again, click save and reboot.

To see if GPS is working properly. Check for the blue icon on the top of the page, then go to the GPS tab and check to see that there are no errors and time outs and that communication is normal by looking at the message count (it should be rising).

ADDING GALILEO

Pawel's video link https://youtu.be/kSs3JYT5Zns?t=528

Adding Galileo can greatly increase the number of satellites you have, and the more the better! More satellites mean more accuracy, and hopefully less time waiting for a 3D lock in order for INAV to arm.

Note: Pawel explains that Galileo is only for Europe and that you will not have good results in North America, however many INAV and Betaflight users are using Galileo in North America with great results. It's simple to change this setting to on using the CLI tab, so why not try?

Go into the CLI tab and type "get gali" and press enter to see if it is off or on. Type "set gps_ublox_use_galileo=ON" press enter, and then type "get gps_ublox_use_galileo" and press enter to see if it saved to "ON". Now type save and press Enter.

ADVANCED TUNING TAB

Pawel's video link https://youtu.be/kSs3JYT5Zns?t=577
Importance: Medium

Difficulty: Medium/High

- Leave Position Estimator as is
- Ignore Multirotor Navigation Settings

Under Fixed Wing Navigation Settings:

- Cruise throttle, min and max throttle settings will depend on your aircraft, you should know how much you need to cruise and not stall, etc.
- Max bank angle (used in all automated flight modes) is set to 20. That will make for very wide turns. You should increase it to 30-40.
- Dive angle - leave as is
- Climb angle - leave as is or change only if you know your craft is not underpowered and can climb on a steeper angle.

- Pitch to throttle ratio is how INAV uses the throttle when in automated modes, lower it if you see the craft is applying too much throttle when climbing, increase if it doesn't apply enough throttle while climbing, causing a stall. Consider tailwinds and headwinds for this setting. Usually, leaving this as-is will be ok for most planes that aren't severely underpowered.
- Loiter radius is preset to 50m radius circles. You can change this if you want a tighter radius but remember your wing might or might not be able to make a tight radius. Change the bank angle to be able to achieve a tighter radius.

RTH AND LANDING SETTINGS:

- Select "at least" for RTH altitude mode - The plane will climb to that altitude.
- Change the RTH Altitude as you like: Default is 10m (1000cm), it is recommended to increase it since you are flying a fixed wing. 30-40m is good (3000-4000cm).
- Climb before RTH should be off for fixed wings, because if you leave it on, it will first climb and only after it reaches your RTH altitude it will turn around to go home! If you leave off as recommended it will turn around right away when RTH is called (we want that) and then start gaining altitude as it flies home.
- Climb regardless of position sensor should be disabled.
- Tail first should be disabled.
- Land after RTH depends on what you want:
  o "always" will descend slowly in circles with intent to land, every time you go into RTH. Make sure where you are flying there is enough space to do so. The plane will land (crash gently) into the ground.
  o "only on failsafe" will do the above, but only when there is a failsafe state. For example, if you fly out of transmitter range or your transmitter runs out of battery or you have a radio problem. In this mode the plane will not land if you enabled failsafe on a switch.
  o "Never" will never try to land the craft after it comes home. It will fly in circles above until the battery dies.
  o "Only on failsafe" is recommended and has saved many planes when people had radio problems.
  o If you decide to use "only on failsafe" - Leave vertical landing speed at 200. Change min vertical landing speed at altitude to 1500cm or 1000cm (15m or 10m). This is the height at which the plane will cut the motor and try to land softly.
  o Leave all other numbers below as is.

Now you are done with the advanced tuning tab. Click save and reboot.

NAVIGATION MODES

Pawel's Video Link - https://youtu.be/kSs3JYT5Zns?t=1109
Importance: Medium
Difficulty: Medium/High

Now we return to the modes tab to set up the navigation modes. You will not see these modes if you don't have a GPS unit enabled.

The most important automated flight modes are "nav althold" and "nav poshold" - these two modes should be used simultaneously and together on the same switch. "Nav RTH" – use this mode instead of the "failsafe" mode. It is also recommended to use "nav launch" as mentioned before, to assist with launching! After you are done don't forget to click save and reboot.

For more info on all the modes, go to the iNav website
https://github.com/iNavFlight/inav/wiki/Flight-modes

SIDE NOTES

ASKING FOR HELP

Please feel free to address questions in the discussion portion of the INAV Fixed Wing Group. When you do, please be specific as to what plane you have, which flight controller, which version of INAV you're running and describe the issue in detail.

GAUGING SUCCESS

This is a journey. Deciding to put INAV on your plane is the first step.   Next will be flashing your flight controller for the first time. Then getting the receiver working. What will be exciting is the first flight. It may not be as smooth as you hope. You'll probably need to do some tuning. When the plane is auto trimmed, you'll be better off.   Then you can start investigating how to fine tune the PIDs.

The INAV developers have taken a lot of the guesswork away. Still, there will be more refinements along the way. This is an exciting time for INAV, and each new version is something to celebrate. It's looking like INAV will be able to do some fairly advanced calculations in real time with a large number of variables. What this means is that INAV will be able to give a better flying experience than anything you've ever experienced before. Hopefully soon the setups will be even easier, and the learning curves won't be as steep.

INAV isn't perfect. It's an emerging technology. You are now a part of it during its rapid development phase, prior to going mainstream. It doesn't get much more exciting than this!

HOW OFTEN SHOULD YOU UPDATE INAV?

Even when you get good at flashing your board and going through the steps, you're still looking at least an hour to get back to where you were. Sometimes compelling new features are added and that hour or so is a small investment compared to the benefits you will get out of it.

When you flash your board, INAV will give you the option of the most current stable release by default. You can click on the "show unstable releases" and get to see the optional release candidates. In the INAV Fixed Wing Group we often discuss these release candidates. The trade-off for being the first to get a sneak peek at what's next is that sometimes, some of the new features aren't fully baked.   You can go to the Github INAV site to see known support issues prior to installing the INAV release candidate firmware on your flight controller.

A good rule of thumb is your plane should be updated with the most current stable version of INAV that your fight controller will accept about once a year if you don't fly it often, and about twice a year if you do fly it often.

As you work with your settings and learn more about INAV, you'll need to connect your FC to your computer from time to time. Whenever you build, make it a priority to allow access to your USB plug on your flight controller. Be careful when installing your USB cable to your USB plug. These plugs are known to break off easily (another reason to make access easy, to avoid forcing things).

APPENDICES

Appendix 1 – Flashing INAV on your FC

This video covers how to not only flash a flight controller, but how to set up INAV. He's showing it on version 1.9, so some things have changed since it was made. It is also a review of how to setup a Matek F411-Wing, which is a great FC board.

https://www.youtube.com/watch?v=7J8o88opTDs

There are better videos but some of them are getting too old to share.

Appendix 2   Setting up the receiver to flight controller

This video explains the different receiver protocol types. You really should watch this, especially before you buy a new receiver. Also, since it is from 2015, it doesn't mention Crossfire, which is a very popular transmitter / receiver system, especially for mid-range or long-range flyers.

https://www.youtube.com/watch?v=GbUMC8h2uhU&t=197s

This video moves slowly, explaining how to hook up your receiver to your flight controller.

https://www.youtube.com/watch?v=wSdX758qfpM&t=68s

Appendix 3 - Getting your GPS Working.

So. let me guess, your GPS isn't working? We can help you figure your problem out 98% of the time. The most common problems are:

1. Power - The GPS works from 5V and the vast majority have an indicator light of some kind.   No light means no power.   So, what are the common issues that cause a lack of power?
   a. Your flight battery isn't plugged in - Many FC's need a flight battery plugged in to provide power to the GPS unit. If you are still powering the FC from your USB port it may not be powering the GPS. So if you're setting up your flight controller prior to install and the GPS isn't powered, you'll have to wait until you've got full VCC power before setting up the GPS.
   b. You've plugged into 12V - Your GPS unit is fried. This isn't all bad. The place that will sell you a new GPS unit will also sell you a 5v BEC and a multi-tester. Time to move on.
   c. You got a dead unit from a friend or took it from a crashed plane - You're not the first guy to salvage parts from a dearly departed plane. Sometimes the crashes are a bit too much for the GPS units. They are often resilient, but they have been known to break due to a bad crash. Sometimes your buddies will unknowingly give you their dead gear. GPS units aren't that expensive, so just buy a new one that works.

2. Wiring/Connection - GPS units have simple enough wiring, so taking a few minutes to check out wiring diagrams will save you problem in the end.   Wiring and connections are often problems for GPS units.
    a. Red goes to +5V, black goes to ground - We're just focused on these two wires. You need to be certain that you look at the diagram of your GPS unit. Sometimes it says VCC, and other times it says +5. The red and black wires don't always sit next to each other on these units. On the BN-220 for example, the red and black wires are on the ends with two other wires between them.
    b. JST Cable is backwards - Speaking of the BN-220, it comes with a micro JST cable. Look carefully – on one end the red and black wires are next to each other, this plugs into your flight controller if you have the right plug. The other end (where the red and black wires are on the opposite ends) goes into the GPS.
    c. Poor connection - Someone in our group wrote recently about losing a Bixler due to a faulty GPS connection. He used pins instead of soldering in wires. Some pins are better than others. I find the right-angle pins to be a bit beefier and less likely to break. I have broken cheap straight pins before. If you really want to be certain of a good connection, get some good 20AWG silicone wire, and connect those wires directly to your board. Then run +5 from your BEC. Make certain to check to see that your connection has solder on the wires and flows down to the base where it goes in the hole. If you are running your GPS further out on your plane's wing and have run a long wire that you have soldered, check to make certain the connection is good. You will need high powered magnification to check this out.
    d. Wrong wires / backwards wires for TX and RX. Not all the GPS units tell you what the wires do. On the older hockey puck style GPS units, you'll need to open the case and look for the wiring diagram. They have the compass as well. You need to write down the TX and RX wire colors. The GPS TX wire goes to the FC's RX pin. And the GPS RX wire goes to the FC's TX pin. The other two wires (if you have them) are for the compass.
    e. Wiring too close to power fields – Power distribution boards, BEC's, FC's and Video transmitters create small magnetic fields around them (especially high powered video transmitters). GPS units and especially compasses (magnetometers) are sensitive to these fields. If your GPS unit, compass, and/or wiring are too close to these components, it can disrupt the signals enough to prevent the GPS or compass from working properly. When building your plane, try to locate the GPS unit, compass, and wiring with some clearance around these components.

We are now assuming you've got lights working on your GPS, and that they stay on.

3. Ports - Wherever you connect the GPS wiring on your FC board, there is a UART assigned to that port. You need to assign the GPS to that UART. Go into the Ports tab and click on the correct UART for your GPS unit. Often you'll find wiring diagrams that show which set of pins is suggested for the GPS Unit. Make sure the GPS RX and TX wires are connected to these pins. There should be a number like TX6 which means in the Ports tab you click on the GPS in "sensor" section for UART 6. You don't need to hook up any other wiring. Check your GPS unit specs to see the maximum baud rate for your GPS. In the Ports tab, set the baud rate to that, or lower (a lower number). Click save and reboot.

4. Protocol - This is after you get the lights on the GPS working. After you have configured the port correctly, you need to enable GPS in the Configuration tab. Make sure "GPS for navigation and telemetry" is turned on. Under protocol, make sure you have selected the correct protocol for your GPS unit. This can be tricky. The best place to get this information is from the manual for your unit, but sometimes you need to go to the website you bought the GPS from or search the internet for more information. For "Ground Assistance Type", pick the one that best works for where you live or is closest to where you live. For "Magnetometer Declination (deg)".

5. INAV Flash Problems

   Still not working? On rare occasions, a board flash isn't as successful as it could be. It seems to work fine, but certain things don't work. Sometimes GPS is one of those things that just doesn't work no matter what you do. When you re-flash your board again, this time do a cold reboot of your PC, make sure you are using a quality cable, and plug your USB cable directly into the computer (not into a hub). Don't have other programs running, and don't open other screens while flashing. This all may seem a bit extreme, but the idea is to eliminate all potential sources of an unsuccessful flash. Experience has shown these steps really do work.

   Another time you may experience issues with GPS is at the field. If you get your GPS unit working but your plane isn't arming, try this: Unplug your flight battery, make certain your radio is on, but the ARM switch is off. Then, plug in your flight battery and stand at least 10 meters back from your plane with your radio in hand. Give it around 90 seconds and try and arm again. You may also want to double check that your plane is level.

   After all of this you should get a blue GPS Icon. If it's red, that means the GPS isn't talking to the flight controller. If it's red then blue then red again, don't worry.

   a. Take the plane outside, plug it in and let it spend a few minutes finding GPS for the first time. If you came back inside and hook the plane up quickly. You may need to use a laptop to check and see it's seeing the satellites.
   b. The GPS unit should be on your wing pointed the right way up toward the sky.

YES, YOU CAN DO INAV.

INAV has a steep learning curve. If your current RC building experience is with multi-rotors, you have an advantage, because you know about flight controllers and flight control firmware. If you're experience is with line-of-sight fixed wing aircraft, you already know about airframes and will need to learn some electronics and how to work with INAV. Regardless, if you have the will, the INAV Fixed Wing Group on Facebook is a community that is behind you. So yes, you're not alone.

Our advice for learning INAV is to not force things. Take your time, lurk around on the group page, read the discussions. Watch the videos. The "Units" section is loaded with past discussions we've highlighted to help bring certain things to your attention. The Candy Shoppe is full of cool things that people have done with INAV, including builds, mods, and great flights. We hope it will be an inspiration to you!

When you build your first plane, resign yourself to the notion that it won't be a fast build. Enjoy the journey because you're only new once.   The next build gets easier. The more you invest up front the more rewards you'll recoup over time.

YOU WILL NEED TO BUY STUFF

You will need to buy flight controllers, video transmitters, FPV cameras, goggles (or monitor) GPS units, soldering supplies and perhaps a whole new transmitter radio and receiver if you don't have them. This will be an investment upfront. But, once you're past it, the money outflow drops considerably. Once you get your first INAV plane dialed in, you'll be excited for your second and third builds.

First, a few words of advice about buying flight controllers (FC's). Not all FCs are supported by INAV. More importantly, there are a lot of clone knockoffs out there. It is crucial to follow this document (https://github.com/iNavFlight/inav/wiki/Supported-boards) which contains the current list of supported FCs. Using this link to purchase your FC will ensure your FC isn't a clone, plus INAV gets a small part of the sale which helps to fund INAV development. Why not buy a clone? One example is a common problem with the 5v supply. One of our members lost a $400 (US) plane with a clone of a Matek F405-Wing FC. There are lots of other good reasons as well. When it comes to flight controllers, Matek seems to be the leader, followed by Omnibus and the Furious FPV line. HGLRC recently came out with their first FC for wings.

Electronic components typically have many options in different price ranges. Generally, you get what you pay for. When it comes to radio systems, don't be cheap. Buy something that will meet your needs, and maybe a little more. Don't be impulsive. Study the guides in this Facebook Group. Read and listen to the advice of others who have paved the way. A lot of us fly with FrSky, FlySky, Spektrum, TBS Crossfire, RadioLink, Dragonlink, EZ UHF, Futaba, TX and RX.

IS YOUR PLANE REALLY FLIGHT WORTHY?

If you don't know how to fly line-of-sight, it's best to reach out to someone who understands how to do this and have them help you. Ask them to inspect your airframe. If they are knowledgeable, they will check the CG and make certain your servos are mechanically centered with the proper amount of deflection with zero trim. There is a difference between a plane that just flies, and one the flies well. A flight controller won't completely compensate for a poorly built plane. Thankfully there are many great build videos online. Get your plane's CG properly balanced and make sure that your flight controller is positioned as close to the CG as possible.

We are also assuming you have secure electrical connections. If you're new to soldering please triple check your solder joints under high power magnification. Troubleshooting electronics can be challenging and having confidence in your connections makes it much easier. More importantly, poor solder joints have been known to cause crashes. A good solder connection should touch the pins and board without touching other pins. Start with a good quality soldering iron and good quality solder. Spend a little time studying soldering techniques, how much heat to use, etc. This is a skill you get better at over time and having good quality tools will make this process much easier! 100% secure electrical connections are mandatory for your success. Take your time and do this right. You have a lot counting on this.

FLASHING INAV TO YOUR BOARD

When you build your plane keep in mind, you'll need access to the USB port on your flight controller. Why? Well, because, sooner or later you'll need to flash INAV to your board. The question becomes how often do you plan to update INAV and how easy is it for you to get your USB port hooked up to your computer? Some boards come pre-loaded with Betaflight, or you may get a board with an older version of INAV, and you may want something a bit more current. Also, INAV will undoubtedly be updated in the future, and you may want to take advantage of new features.

The best time to flash the board is when you first pull it out of the package, before you install it into the plane. One advantage to this is if there are any defects in your new board, you will know before you spend a lot of time installing and soldering. Not only can you flash the board before it is installed, but you can run the first few steps of the board setup without it being powered by a flight pack. The USB connection will power the board. See Appendix 1 for flashing INAV.

Assuming you have everything built, ready and connected correctly to corresponding ports, you can now follow the steps in this Study Guide to get your plane flying amazingly!