

## INAV Setup for X Tailed NEPTUNE

Control architecture for the X Tailed Neptune.

My reasons for using a frsky R9mm ota 900 mHz receiver paired to a SpeedyBee F405 flight controller using INAV:

My objective is to optimize the receiver antenna location in order to maximize reception.

I am not qualified to go down the “antenna theory” rabbit hole, so suffice it to say: don’t mess with the antenna and mount it vertically with a minimum of surrounding obstructions.

First, the frsky R9mm ota.

1. Long Range: according to Frsky, it has an operating range of 10 km.
2. Compact form factor: 10 x 16 mm
3. 16 channels available via F. Port.

The SpeedyBee F405 Wing APP

1. Low cost, great value
2. 12 pwm outputs
3. Stability control
4. Telemetry

INAV:

Admittedly, using a flight controller is overkill. However, its value is in allowing optimal locations for the receiver antenna and stability hardware (accelerometers and gyros). I also prefer a computer user interface to that of a Transmitter for setup.

Also, having all those channels allows for customization by using INAV programming and transmitter switches. One example is three bow plane operation modes: independent, synchronized and opposed to the x tail. The left slider on the Frsky Tx operates the bow planes independently. Switch SA low works the bow plane and x tail in tandem. This would raise or lower the boat with minimum pitching. Switch SA high operates the bow planes opposed to the x tail. This would provide maximum pitch control.

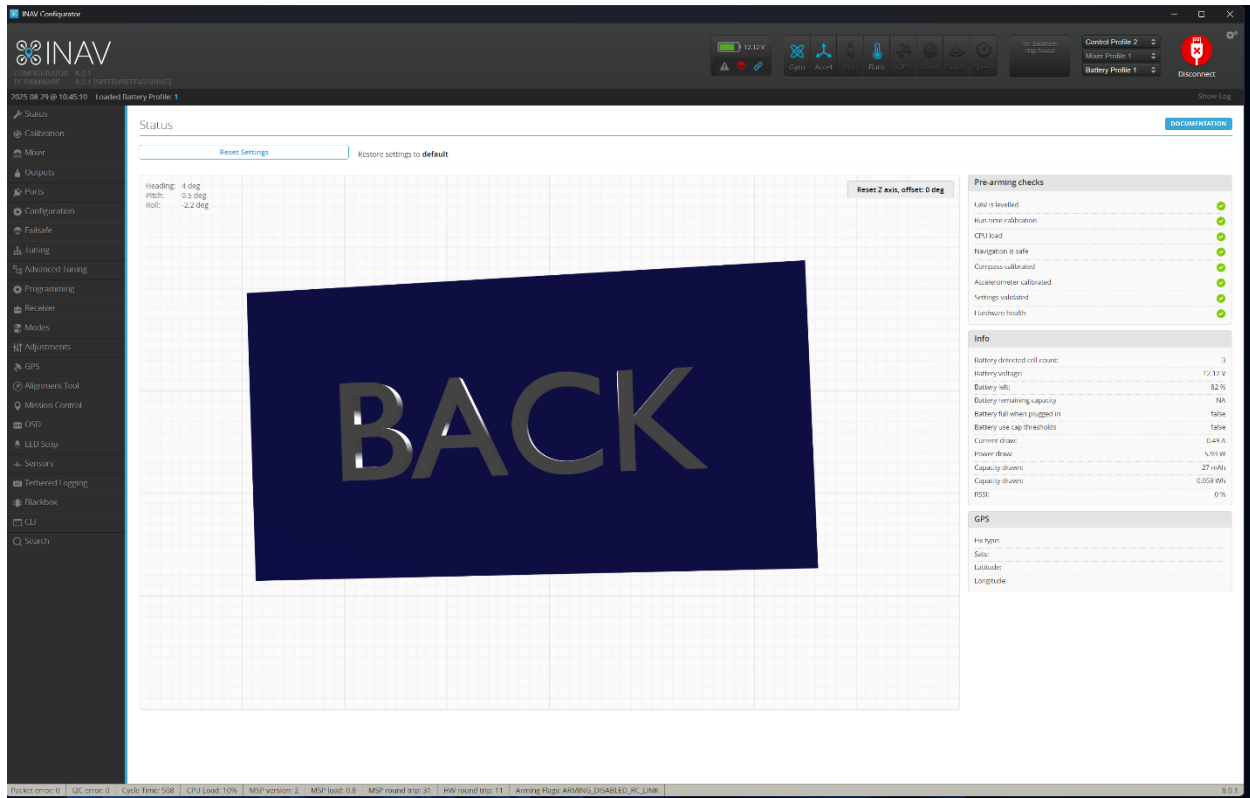
More details on “how to”...

- Update Frsky Tx and Rx to Ethos 1.6.3
- Install INAV 8.0 on WINDOWS OS.
- Install SpeedyBee Driver on WINDOWS OS using ZADIG.
- R9MM: solder wire leads to V\_in, GND & Inverted S.Port.
- SpeedyBee: Rx power and ground go to respective SBUS pins. The Rx ‘Inverted S.Port’ connects to a Tx pad on any free UART. I used “Tx5” on UART5.
- Follow the SpeedyBee manual to connect ESC and servos. Make sure to NOT connect the ESC power wire.
- The Rx must be paired to the Tx while connected to the SpeedyBee. Otherwise, Fport won’t work.
- INAV values to follow (probably a word doc)

## INAV Setup for X Tailed NEPTUNE

- Useful references: GitHub, You Tube channels: Painless360, Joshua Bardwell, FPV University, FrSky Rc and Mr.D – Falling with style.

### INAV Setting:



This is the “Settings” Page. The BACK picture represents the orientation of the flight controller. I changed the orientation in the “Adjustments” view to match the physical orientation in the boat.

Pre-arming checks	
UAV is levelled	✓
Run-time calibration	✓
CPU load	✓
Navigation is safe	✓
Compass calibrated	✓
Accelerometer calibrated	✓
Settings validated	✓
Hardware health	✓

Info	
Battery detected cell count:	3
Battery voltage:	12.12 V
Battery left:	82 %
Battery remaining capacity	NA
Battery full when plugged in	false
Battery use cap thresholds	false
Current draw:	0.49 A
Power draw:	5.93 W
Capacity drawn:	27 mAh
Capacity drawn:	0.059 Wh
RSSI:	0 %

GPS	
Fix type:	
Sats:	
Latitude:	
Longitude:	

Here you see that all pre-arming checks are green meaning that the FC can be armed.

## INAV Setup for X Tailed NEPTUNE

### MIXER PAGE:

Mixer

DOCUMENTATION

Platform Configuration

Boat Platform type  
Motor direction  
☒ Normal motor direction / Props in configuration  
☐ Control Profile will use same index as Mixer Profile index

Timer Outputs

AUTO Timer 1

AUTO Timer 2

AUTO Timer 3

AUTO Timer 4

AUTO Timer 5

AUTO Timer 12

Output Mapping

Output (timer)	S1 (Timer 4)	S2 (Timer 4)	S3 (Timer 3)	S4 (Timer 3)	S5 (Timer 8)	S6 (Timer 8)	S7 (Timer 8)	S8 (Timer 2)	S9 (Timer 2)	S10 (Timer 2)	S11 (Timer 12)	S12/LED (Timer 1)
Function	Motor 1	-	Servo 3	Servo 4	Servo 5	Servo 6	-	-	-	-	-	-

Motor Mixer

Motor	Throttle [T]	Roll [A]	Pitch [E]	Yaw [R]	
1	1	0	0	0	Delete

Add new mixer rule

Mixer preset

Boat

Custom Mixer

Load and apply Load mixer

Servo Mixer

Servo	Input	Weight (%)	Speed (10µs/°)	Active	
3	RC Channel 5	55	0	Logic Condition 0	Delete
4	Stabilized Yaw	80	0	Always	Delete
5	Stabilized Yaw	80	0	Always	Delete
4	Stabilized Pitch	-100	0	Always	Delete
5	Stabilized Pitch	100	0	Always	Delete
6	RC Roll	100	0	Always	Delete
3	RC Pitch	35	0	Logic Condition 1	Delete
3	RC Pitch	-35	0	Logic Condition 2	Delete

Logic conditions

Add new mixer rule

Servos 4 & 5 are used to control the “X” tail. They are used for both PITCH and YAW and are stabilized. The weighted values were derived empirically. Servo 3 is matched to “RC Channel 5” conditionally set by Logic condition 0 (defined in Programming). Servo 3 is also matched to “RC Pitch” in order to work with the X Tail Pitch movements. Servo 6 controls the Ballast Pump.

## INAV Setup for X Tailed NEPTUNE

### OUTPUTS PAGE:

Outputs

DOCUMENTATION

Configuration

☒

Enable motor and servo output

STANDARD

ESC protocol

50Hz

Servo refresh rate

☒

Stop motors on low throttle

0.0

Motors IDLE power (%)

1.00

Throttle scale

14

Number of motor poles (number of magnets)

When Reversible Motors are used, set Motors IDLE power to 0%

☒

Reversible motors mode (for use with reversible ESCs)

1425

Reversible Motors Deadband Low

1575

Reversible Motors Deadband High

1500

Reversible Motors Neutral

Motors

1

1000

Master

Acc. noise RMS

0.0004

Current [A]

0.50

Voltage [V]

12.10

Motor Test Mode Notice:

Moving the sliders will cause the motors to **spin up**.  
In order to prevent injury **remove ALL propellers** before using this feature.

☒ I understand the risks, propellers are removed - Enable motor control.

Servos

0

1500

1

1500

2

1500

3

1500

4

1500

5

1500

6

1500

7

1500

8

1500

9

1500

10

1500

11

1500

12

1500

13

1500

14

1500

15

1500

Save and Reboot

Save

Here are the motor configuration values for the brushed ESC. I won't go into set up detail here, but there are You Tube Video tutorials (see references on page 2) for ESC testing. Servo 6 controls the Peristaltic pump.

## INAV Setup for X Tailed NEPTUNE

### PORTS PAGE:

Ports DOCUMENTATION

Note: not all combinations are valid. When the flight controller firmware detects this the serial port configuration will be reset.  
Note: Do NOT disable MSP on the first serial port unless you know what you are doing. You may have to refresh and erase your configuration if you do.

Identifier	Data	Telemetry	RX	Sensors	Peripherals
UART1	<input type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input type="checkbox"/> Serial RX	Disabled ▾   115200 ▾	Disabled ▾   115200 ▾
UART2	<input type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input type="checkbox"/> Serial RX	Disabled ▾   115200 ▾	Disabled ▾   115200 ▾
UART3	<input type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input type="checkbox"/> Serial RX	GPS ▾   115200 ▾	Disabled ▾   115200 ▾
UART4	<input type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input type="checkbox"/> Serial RX	Disabled ▾   115200 ▾	Disabled ▾   115200 ▾
UART5	<input type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input checked="" type="checkbox"/> Serial RX	Disabled ▾   115200 ▾	Disabled ▾   115200 ▾
UART6	<input checked="" type="checkbox"/> MSP   115200 ▾	Disabled ▾   AUTO ▾	<input type="checkbox"/> Serial RX	Disabled ▾   115200 ▾	Disabled ▾   115200 ▾

This is where you program the FrSky inverted S.Bus connection to the SpeedyBee UART. As mentioned in the beginning, you must connect the inverted S.Bus output of the Rx to an unused UART Tx pad. I used UART 5 so Serial Rx is turned on at UART 5.

### CONFIGURATION PAGE:

Configuration DOCUMENTATION

Note: Not all combinations of features are valid. When the flight controller firmware detects invalid feature combinations conflicting features will be disabled.  
Note: Configure serial ports **before** enabling the features that will use the ports.

**Sensors & Buses**

ICM42005 ▾ Accelerometer

None ▾ Magnetometer

SPL06 ▾ Barometer

None ▾ Pitot tube

None ▾ Rangefinder

None ▾ Optical flow

Please switch to 800kHz if connected hardware allows for it

400KHZ ▾ I2C Speed

**Other Features**

☐ Enable CPU based serial ports

☐ GPS for navigation and telemetry

☒ Telemetry output

☒ Reversible motors mode (for use with reversible ESCs)

☐ Analog I2S input

☐ Multi color RGB LED strip support

☐ OLED Screen Display

☐ Blackbox flight data recorder

☒ Enable motor and servo output

☐ CPU based SPI

☒ OSD

☐ Permanently enable AIRMODE

☐ Permanently enable Launch Mode for Fixed Wing

☒ Profile selection with TX stick command

☐ Throttle voltage compensation

☐ Automatic battery profile selection

☐ Continuously trim servos on Fixed Wing

☐ Geoplane

**Voltage & Current Sensors**

☒ Battery voltage monitoring

ADC ▾ Voltage Meter Type

Raw ▾ Voltage source to use for alarms and telemetry

1100 ▾ Voltage Scale

12.09 ▾ Battery Voltage

☒ Battery current monitoring

ADC ▾ Current Meter Type

195 ▾ Current Meter Scale

0 ▾ Offset in millivolt steps

0.49 ▾ Battery Current

**Battery Settings**

0 ▾ Number of cells (0 - auto)

4.25 ▾ Maximum cell voltage for cell count detection

3.3 ▾ Minimum Cell Voltage

4.2 ▾ Maximum Cell Voltage

3.5 ▾ Warning Cell Voltage

mAh ▾ Battery Capacity Unit

0 ▾ Capacity

▾ Warning Capacity (remaining %)

▾ Critical Capacity (remaining %)

**Serial Gimbal**

0 ▾ Gimbal sensitivity

0 ▾ Pan channel (yaw)

0 ▾ Tilt channel (pitch)

0 ▾ Roll channel

**Headtracker**

None ▾ Head tracker type

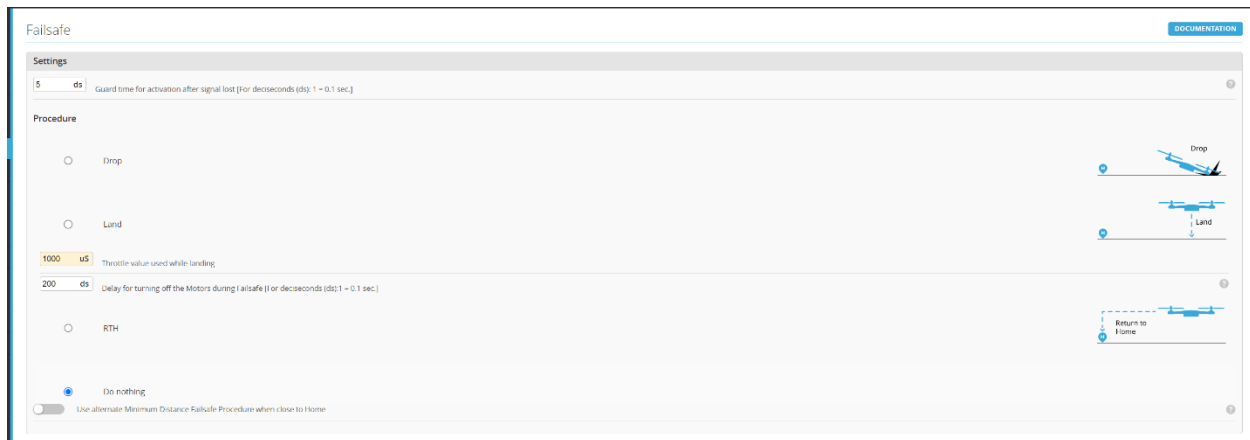
1.00 ▾ Head tracker pan movement ratio

Save and Reboot

To keep it simple, just match the switch settings displayed here. Battery Setup is self-explanatory.

## INAV Setup for X Tailed NEPTUNE

### FAILSAFE PAGE:



I had to peel back the onion here. I don't use the INAV FAILSAFE feature. I set the Failsafe in the FrSky Tx to no output. That way the native Neptune board acts as the failsafe.

### TUNING PAGE (PID):



Here are the preliminary PID values set on the bench. Fine tuning will occur when the boat is launched. There is a SpeedyBee Android APP and Bluetooth connection for WiFi interface but I have yet to play with it.

## INAV Setup for X Tailed NEPTUNE

### PROGRAMMING PAGE:

#	Enabled	Operation	Operand A	Operand B	Active	Flags	Status
0	<input checked="" type="checkbox"/>	Mid	Get RC Channel	6	Always		<input checked="" type="radio"/>
1	<input checked="" type="checkbox"/>	High	Get RC Channel	6	Always		<input type="radio"/>
2	<input checked="" type="checkbox"/>	Low	Get RC Channel	6	Always		<input type="radio"/>
3	<input type="checkbox"/>	True					<input type="radio"/>
4	<input type="checkbox"/>	True					<input type="radio"/>
5	<input type="checkbox"/>	True					<input type="radio"/>
6	<input type="checkbox"/>	True					<input type="radio"/>
7	<input type="checkbox"/>	True					<input type="radio"/>

This is the set up for Dive Plane Mode. **Note:** Nomenclature is everything. Things can get confusing.

Servo numbers are the domain of INAV and channel numbers are the domain of the Tx.

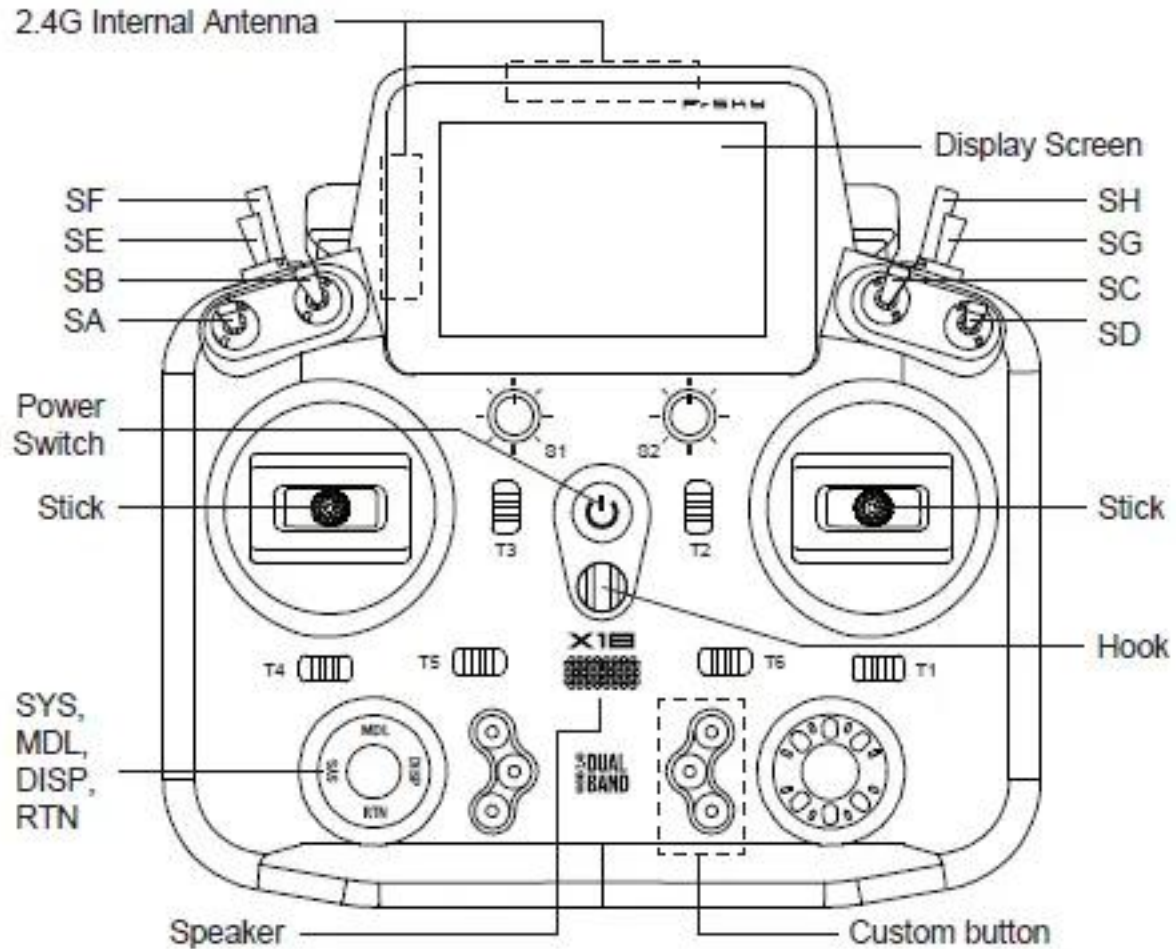
For example: the INAV Servo 6 is matched to channel 1 in the Tx which is used for Ballast control. INAV names the Tx channel 1, "RC Roll".

So RC Channel 6 in INAV is not the Ballast control. Channel 6 in the Tx is matched to switch SA.



## INAV Setup for X Tailed NEPTUNE

Here is a layout of the Tx:



SD HIGH (down) = ARM FLIGHT CONTROLLER

SA MID = ENABLE LEFT SLIDER [INDEPENDENT BOW PLANE]

SA LOW = SYNCED BOW AND STERN PLANES

SA HIGH = OPPOSED BOW AND STERN PLANES

SE LOW = EMPTY BALLAST BLADDER

SE HIGH = FILL BALLAST BLADDER

VERTICAL RIGHT STICK = PITCH

HORIZONTAL RIGHT STICK = YAW

VERTICAL LEFT STICK = THROTTLE

HORIZONTAL LEFT STICK = N/A

## INAV Setup for X Tailed NEPTUNE

## RECEIVER PAGE:

Receiver

DOCUMENTATION

Please read receiver chapter of the documentation. Configure serial port (if required), receiver mode (serial/gsm/psm), provider (for serial receivers), bind receiver, set channel map, configure channel midpoint/range on TX so that all channels go from -1000 to +2000. Set midpoint (default 1500), trim channels to 1500, configure stick deadband, verify behaviour when TX is off or out of range. Make sure that the channel values all increase when you push the sticks up and to the right. If not, reverse the channel in the TX. Do not apply any other mixing in the TX. **(IMPORTANT)** before flying read failsafe chapter of documentation and configure failsafe.

Channel Map

AEIR

RSSI Source

AUTO

RSSI Channel

Disabled

Roll [A]

1500

Pitch [I]

1500

Yaw [R]

1500

Throttle [T]

1500

CH 5

1500

CH 6

1500

CH 7

1500

CH 8

1500

CH 9

1175

CH 10

1500

CH 11

1500

CH 12

1500

CH 13

1500

CH 14

1500

CH 15

1500

CH 16

2011

CH 17

988

CH 18

988

CH 19

1500

CH 20

1500

CH 21

1500

CH 22

1500

CH 23

1500

CH 24

1500

CH 25

1500

CH 26

1500

CH 27

1500

CH 28

1500

CH 29

1500

CH 30

1500

CH 31

1500

CH 32

1500

CH 33

1500

CH 34

1500

Receiver Mode

SERIAL

Receiver type

Note: Remember to configure a Serial Port (via Ports tab) for the serial receiver

FPORT

Serial receiver Provider

OFF

Serial Port Inverted (comparing to protocol default)

AUTO

Serial receiver half duplex

RC Smoothing

30

Auto Smoothing Factor

Throttle MID

0.50

Throttle EXPO

0.00

BE Deadband

2

Yaw Deadband

2

Save and Reboot

This page graphically displays the output values of the Tx. This is very useful for setup and debugging.

## INAV Setup for X Tailed NEPTUNE

### MODES PAGE:

Modes DOCUMENTATION

Use ranges to define the switches on your transmitter and corresponding mode assignments. A receiver channel that gives a reading between a range minimum will activate the mode. Remember to save your settings using the Save button.

☐ Hide unused modes

**Arming**

ARM CH 7 Min: 1525 Max: 2075 900 1000 1200 1400 1600 1800 2000 2100

**PREARM**

**Flight Modes**

MANUAL Add Range

**Flight Mode Modifiers**

HEADING HOLD Add Range

**OSD Modes**

OSD OFF Add Range

OSD ALT 1 Add Range

OSD ALT 2 Add Range

OSD ALT 3 Add Range

**FPV Camera Modes**

CAMSTAB

ACRO Save

Cycle Time: 508 CPU Load: 10% MSP version: 2 MSP load: 0.7 MSP round trip: 30 HW round trip: 12 Arming Flaps: - 8.0.1

This page sets the Arming switch. This is a Quadcopter and airplane safety feature. I couldn't figure out a work around. The problems with arming were caused by a glitchy Tx switch. I now have a bit more confidence in this feature.

I will cover the Tx set up in a future document. It isn't complicated, all the work is performed by the Flight Controller. Just remember to have the Rx actively connected to the SpeedyBee before binding the Rx to the Tx. This is the only way F.Port will work.