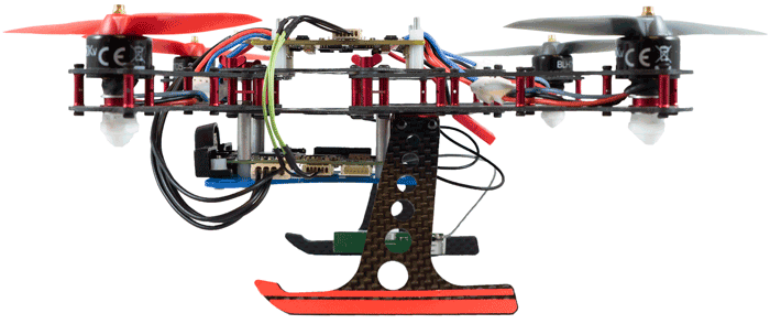

Build your drone and fly it! Walkthrough instructions

[Document: ITC-01IMP1209-WI-001 Version: 1.6]

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IDENTIFICATION

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1. INTRODUCTION

1.1 Purpose

The purpose of this user guide is to provide instructions on how to assemble the Qualcomm® Snapdragon™ Flight Kit, program it and fly it!

In a nutshell, there are three flight configurations:

1) **Spektrum™ or similar remote control connected to a PC with control over Wi-Fi**
   A PC or laptop can be used to fly the drone, but it requires the following:
   - AeroSIM ™ simulator with Trainer link USB adapter.
   - QGroundControl™
   - Spektrum™ RC transmitter or similar.

   To fly the drone with a PC, the Spektrum ™ RC transmitter must be connected to the PC via the USB trainer interface, this allows data to be passed to the PC for use with QGroundControl. QGroundControl, when configured appropriately will relay the data to the drone over Wi-Fi. It is important to understand the RF transmitter on the remote controller is not active in this configuration.

2) **Tablet running Android APK over Wi-Fi**
   An APK file to control the drone from an Android table or phone, is provided as part of the build process.
   When the drone is powered up, the drone will act as a server and provide an IP address over Wi-Fi.
   The tablet or phone needs to connect to it, then the application needs to be started. From there, if configured properly, the app will allow control of the drone.
   Streaming onto the tablet or phone is also possible.

3) **Spektrum™ or similar remote control connected to RC RF receiver**
   The Spektrum™ remote controller can be used to fly the drone without the need of a PC. For this configuration to work, the Spektrum™ Remote Controller must be paired with a compatible RC receiver. The model number of the RC receiver is specific.
   The 2.4GHz RC receiver is directly connected to the Flight board over a UART interface. Each channel of the Spektrum™ RC controller is sent and received over the 2.4GHz band and once processed by the receiver is carried out to the UART which the Flight board can then process.
   Note: When the Spektrum™ RC controller controls the drone; the Wi-Fi interface is not used.
   It should be possible however to stream video to a tablet or phone as indicated in configuration 1.
   This configuration has not been validated by Intrinsyc at this point.

After you purchase a Qualcomm® Snapdragon™ Flight Kit and agree to the end user agreement (required by Qualcomm®) you can access the complete Flight Kit documentation suite here:
http://support.intrinsyc.com/projects/snapdragon-flight

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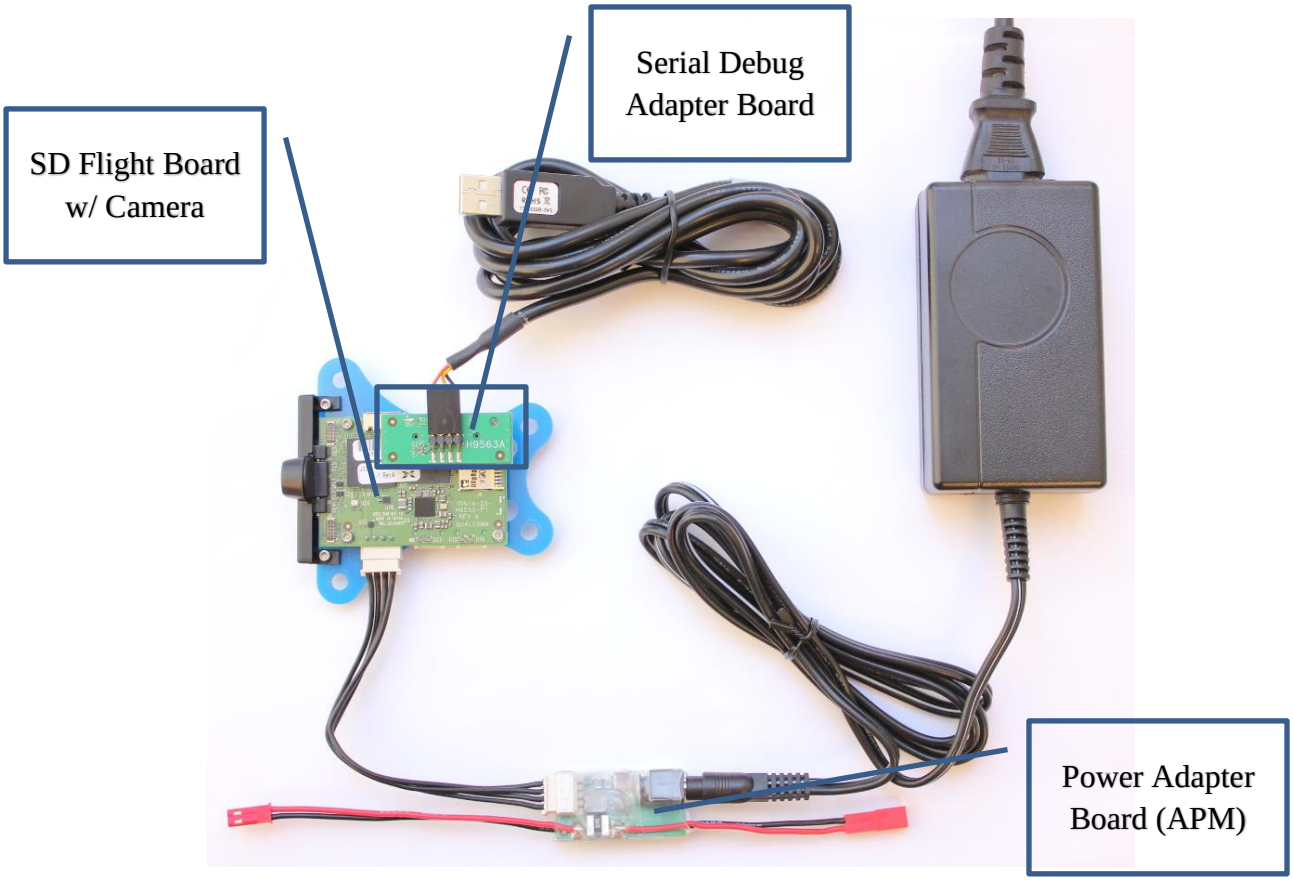
2. COMPONENTS

2.1 Content of the Qualcomm Snapdragon™ Flight Kit

- A Snapdragon Flight board with 4K and Optic Flow cameras
- A Power Adapter Cable (a.k.a. APM)
- A serial Debug Adapter Board



2.2 Additional off the shelf components

The following are the additional components needed to build a quadcopter flying platform around the Snapdragon Flight:

- BLADE 200 QX frame kit; aluminum/carbon fiber: Red (MHE20QX105QK) or Blue(MHE20QX005QK)
- Qualcomm 4-in-1 Electronic Speed Controller (ESC) with ESC serial communication cable: available from http://shop.intrinsyc.com
    - See Appendix A for details of the ESC serial communication cable
- 2x Brushless motors: Blade 200 QX (BLH7705) CW Rotation
- 2x Brushless motors: Blade 200 QX (BLH7706) CCW Rotation

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- Gray propellers: Blade 200 QX (BLH7707). Package includes a pair of blades for CW and CCW rotation, plus 1 CCW nut and 1 CW nut
- Red propellers: Blade 200 QX (BLH7708). Package includes a pair of blades for CW and CCW rotation, plus 1 CCW nut and 1 CW nut
- Battery 800 mAh 2S 7.4 V 20C LiPo 20 AWG JST (EFLB8002SJ)
- 1 x Wi-Fi antenna (Taoglas-Limited FXP522.A.07.A.001)

2.3 Optional components

- PX4 User Guide for the Snapdragon Flight available from http://support.intrinsyc.com/projects/snapdragon-flight (requires Flight Kit purchase)
- Li-Po Battery charger - Any 2S Li-Po charger with balancing would do, such as the Celectra 2S 7.4V DC Li-Po charger (EFLUC1007) and AC to 12 VDC, 1.5-amp power supply (EFLC4000)
- Remote Controller – Spektrum™ Dx6i transmitter with SPM9645 Receiver
- AeroSIM RC dongle http://www.aerosimrc.com/en/home.htm

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3. ASSEMBLING

3.1 Frame Instructions

The instructions for the BLADE 200 QX QUADCOPTER CNC Aluminum/Carbon Fiber Quadcopter Frame Kit are included with the frame but some changes are necessary to mount the Flight board, see instructions in sections below.

3.2 Tools

3.2.1 Necessary tools

- Small Phillips head screwdriver
- Precision tweezers
- 2 mm hex key

3.2.2 Recommended tools

- 5.0 mm nut driver (for Snapdragon Flight mounting nuts)
- 5.5 mm nut driver (for M3 nuts)
- 7 mm nut driver or small pliers (for M4 nuts)
- Curved tweezers

3.2.3 Recommended parts

- 3x standoffs (male-female, #2-56 thread size, ¾" height)
    - **Nylon standoff is preferred to avoid shorts**

3.3 Step 0 – Unpacking the 200QX

Figure 1 What comes with the 200 QX frame kit

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3.4 Step 1 – Adding Standoffs to the Snapdragon® Flight

Before building the 200QX frame, the Snapdragon Flight must be modified to attach to the bottom plate of the quadcopter.

Warning: Do not remove all the screws at once. Trying to reinstall them can be difficult with the bottom camera.

Note: Only 3 standoffs are installed. A 4th standoff would interfere with the insertion of the Serial Debug Board. User is recommended to add the 4th standoff should his/her frame allows to do so. See figure below for standoffs install location

1. Unscrew one nut.
2. Remove screw from top and reinstall from bottom. Try to prevent the spacer from moving, otherwise there is extra work to realign.
3. Screw on ¾" standoffs. Make sure to not damage PCB and components when installing the standoffs.
4. Repeat for the other two screws.

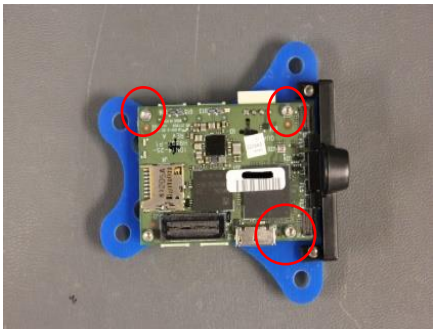

Figure 3 Where to add standoffs

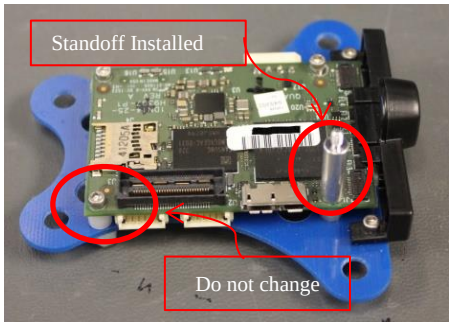

Figure 2 Alter one screw at a time

Figure 4 Snapdragon Flight with standoffs

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3.5 Step 2 – Attaching the arms to the bottom plate

Attaching the arms to the bottom plate requires the bottom screws near the attachment point (the 3 near the wingnut) to be removed. After the bottom screws are removed, line up each arm such that the wingnut is on the corner most through-hole. Re-attach the screws through both the arm and bottom plate, such that the arms are at the end of the slide-hole. Repeat for each arm.

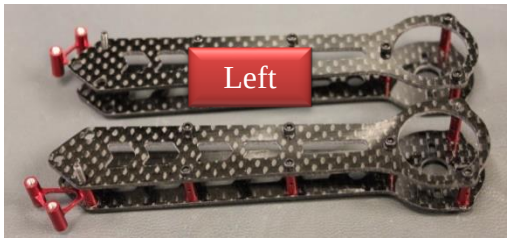

Figure 5 Right and Left Arm assemblies

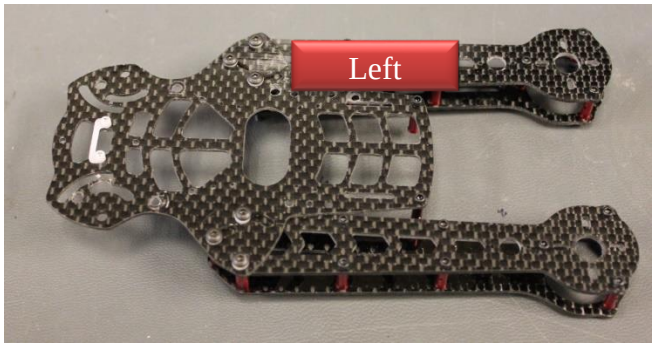

Figure 6 Attach each arm to the bottom plate

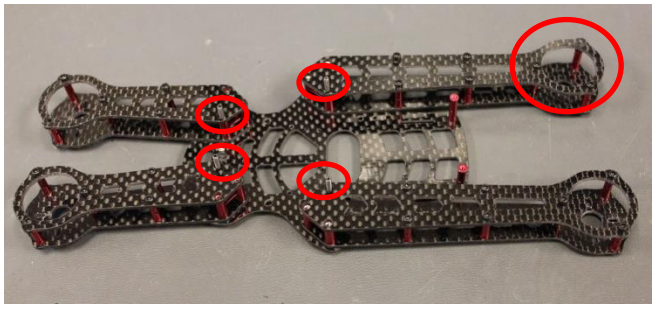

Figure 7 All Arms attached. Note location of the long screw for the wing nut and motor mount orientation.

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3.6 Step 2 – Attaching Snapdragon Flight to bottom plate

The 200QX frame must be modified to accommodate the Snapdragon Flight. This involves drilling three holes through the bottom frame and arms to accommodate the modified Flight board.

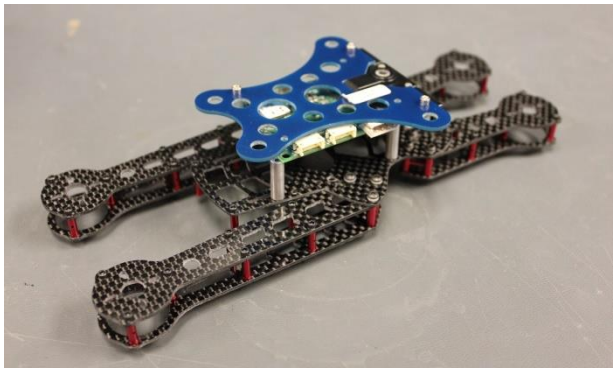

Figure 8 Approximate mounting arrangement

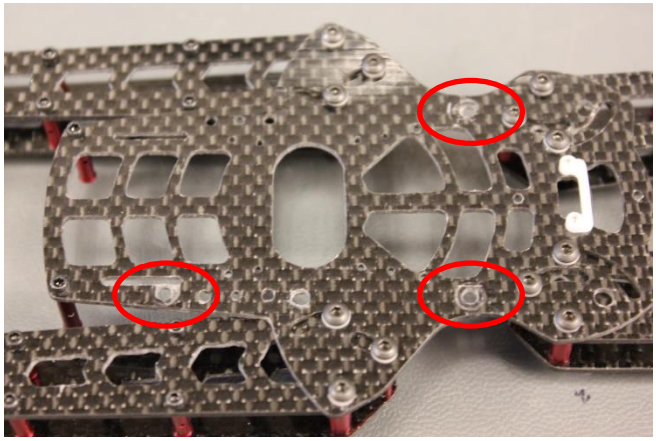

Figure 9 The 200QX bottom plate must be drilled to accommodate the Flight board. Note the suggested location for drilling through-holes

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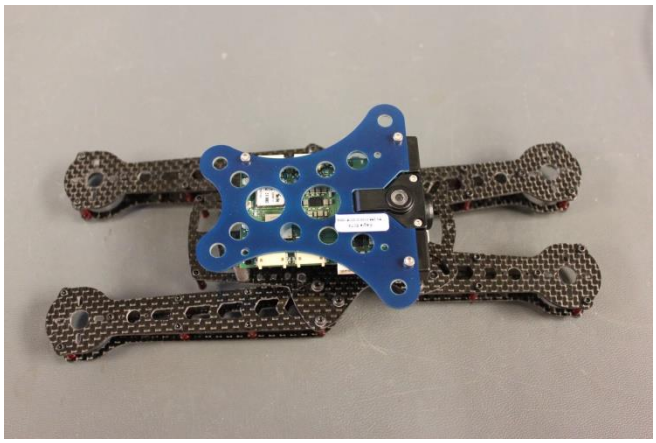

Figure 10 Attach the flight board to the bottom plate. Ensure the standoff threads pass through the newly drilled holes.

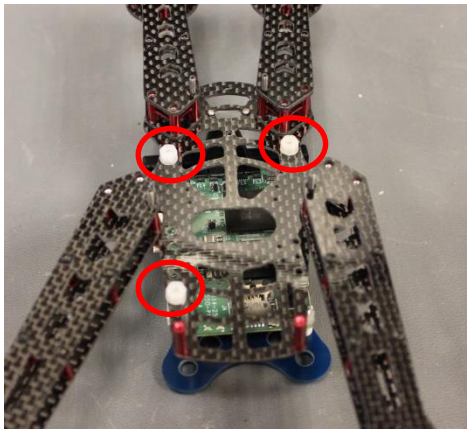

Figure 11 Be sure to attach a nut to lock the flight in place

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3.7 Step 4 – Attaching the legs

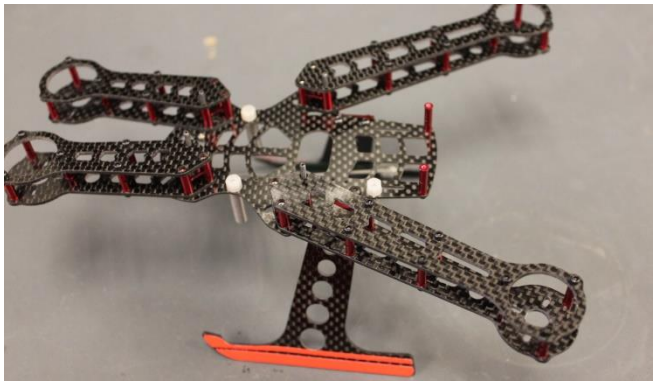

Figure 12 Attach Legs to Frame.

3.8 Step 5- The Top plate

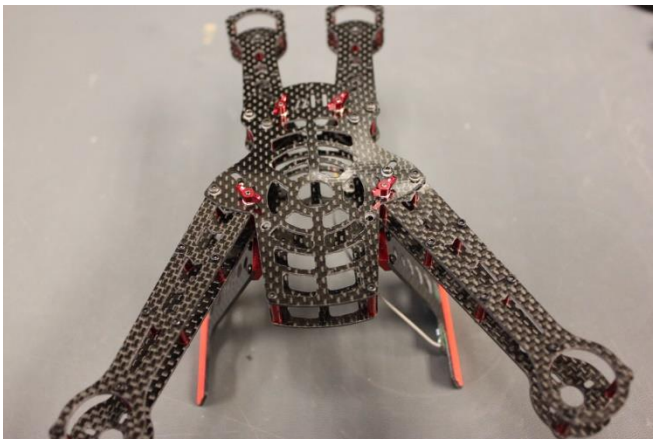

Figure 13 Top Plate Assembly.

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3.9 Qualcomm ESC mounting

Mount the ESC to the top plate, drilling holes that clear the arms. Two holes at the back of the ESC are sufficient to hold the board in place. In this example, we have J10 mounted at the head of the drone.

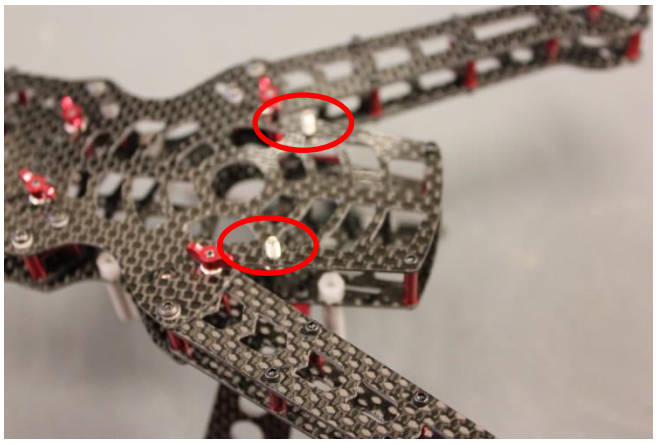

Figure 14 Approximate location of mounting holes

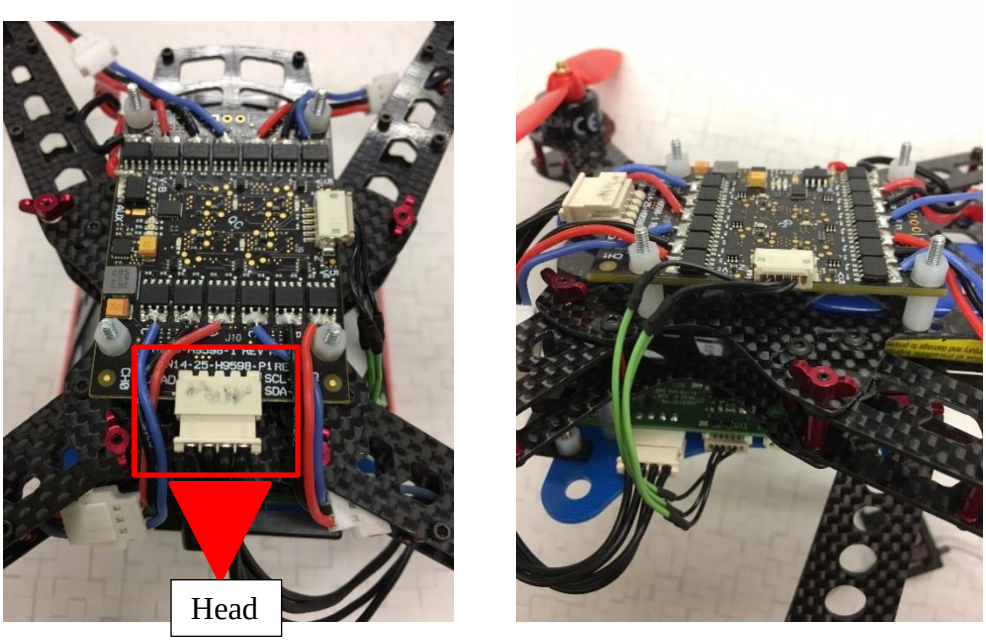

Figure 15 Approximate mounting location of ESC boards

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3.10 Prepare the motors

The connector original motor cable can be mated with a 3-pins header made by Hirose (Model #: DF3-3P-2DSA(01) , Digi-Key PN: H3922-ND). User can remove the connector on the motor and solder this connector on the wire to mate with the ESC. The three different phases input on the 200QX motor are color coded. The ESC board has a three-phase output for each motor. Each phase is labelled as A, B, or C on the ESC board. (See picture below) The connection to the motor are:

- Phase A on ESC → Red cable on 200QX
- Phase B on ESC → Black cable on 200QX
- Phase Con ESC → Blue cable on 200QX

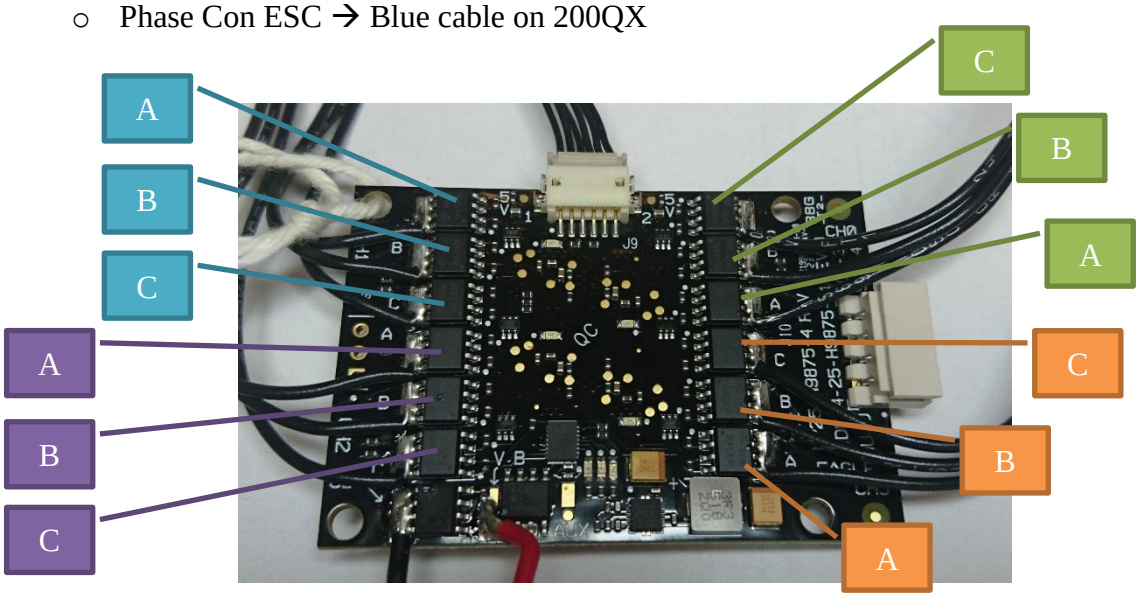

Figure 16 Motor output on ESC Board

3.11 Mounting the Wi-Fi Antenna

The Wi-Fi Antenna connects to the connector shown in below. After connected, it can be affixed to either to the frame or the bottom plate of the SnapDragon Flight. See figure below for the COAX connector location.

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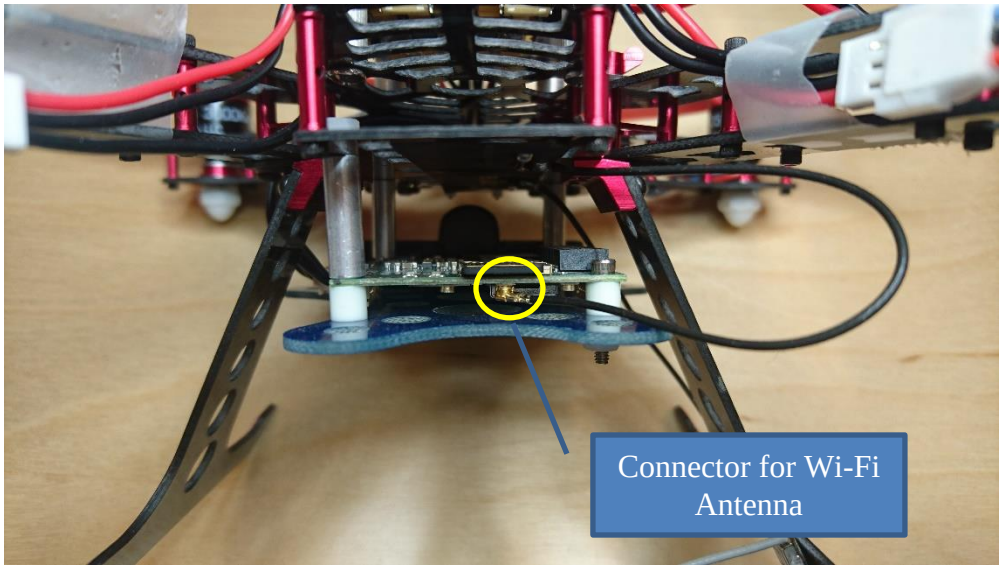

Figure 17 Wi-Fi Antenna Connection

3.12 Finished Drone

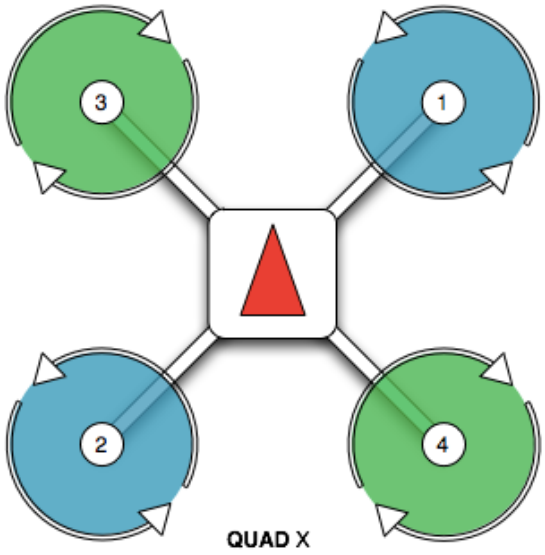

Figure 18 PX4 motor configuration, from http://dev.px4.io/airframes-motor-map.html

Mount the motors into each arm of the quadcopter. If using CW and CCW motors, the motors are mounted on opposite arms. The CW and CCW motors have right- and left- handed threads. User should pay attention when installing the blade.

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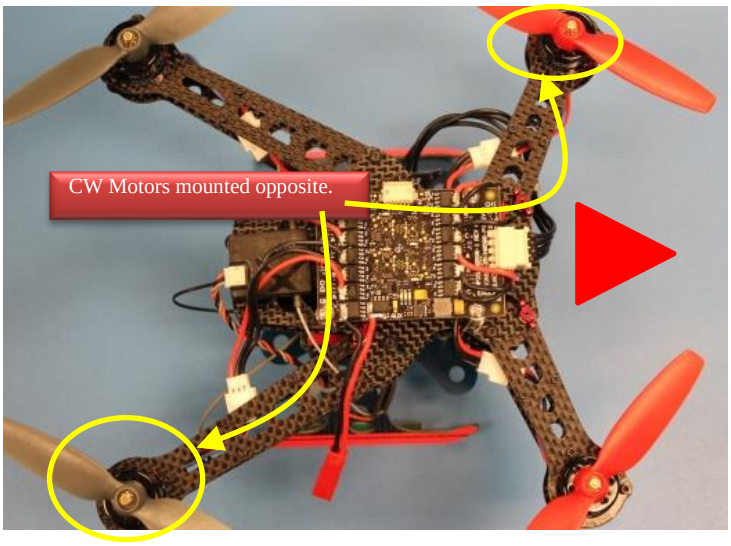

Figure 19 Motor arrangement when using CW and CCW motors.

The propellers are configured for CW and CCW rotation. As the CW and CCW motors are opposite, so should be the propellers. Observe the orientation of the blades in Figure 20.

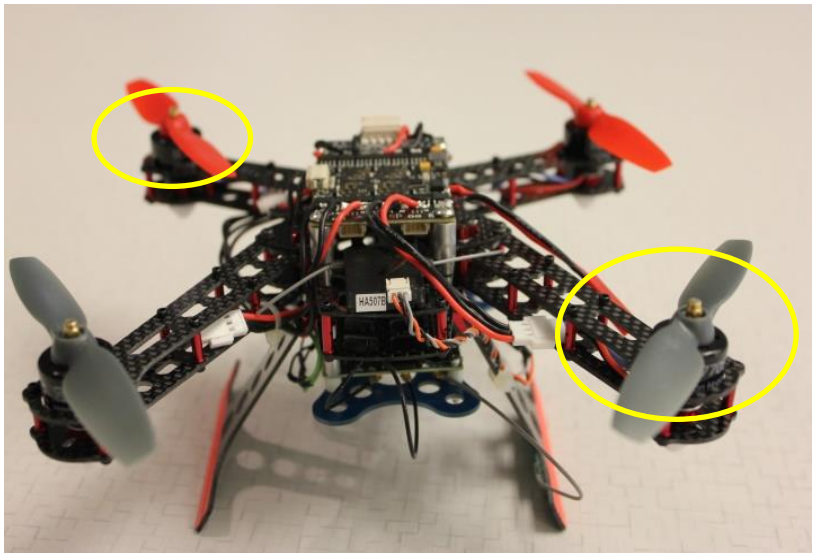

Figure 20 Matching Propellers.

See Figure 21 for connection of the power cable from the ESC board to the Flight board, J14. Also, the ESC communication connector to J13 of Flight.

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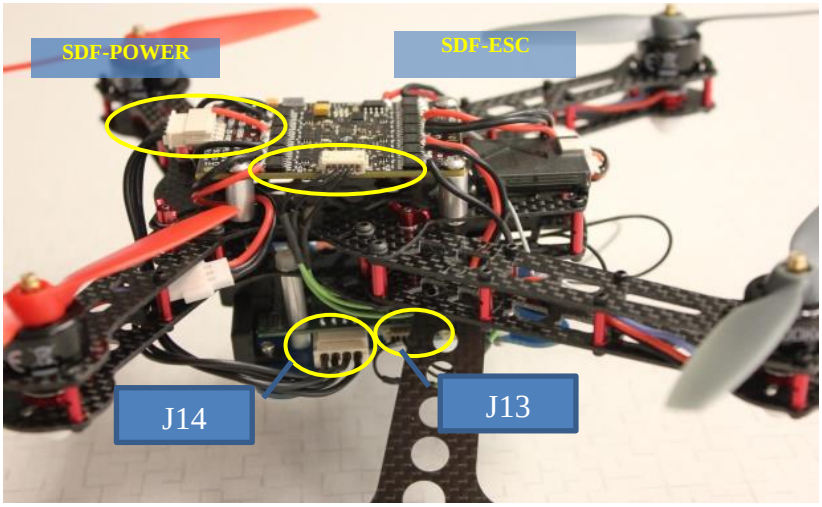

Figure 21 Cable Connection View

Note the wiring from the ESC board to each propeller in the figures below. Orienting the ESC board in a different manner would cause the motor configuration to change.

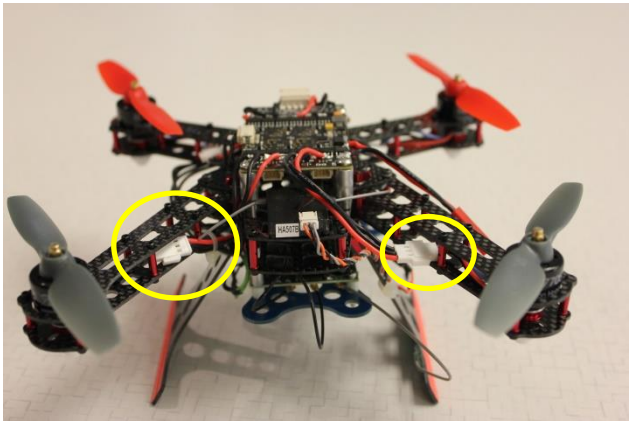

Figure 22 Connection of Motors to ESC Board

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The completed drone is shown in below.

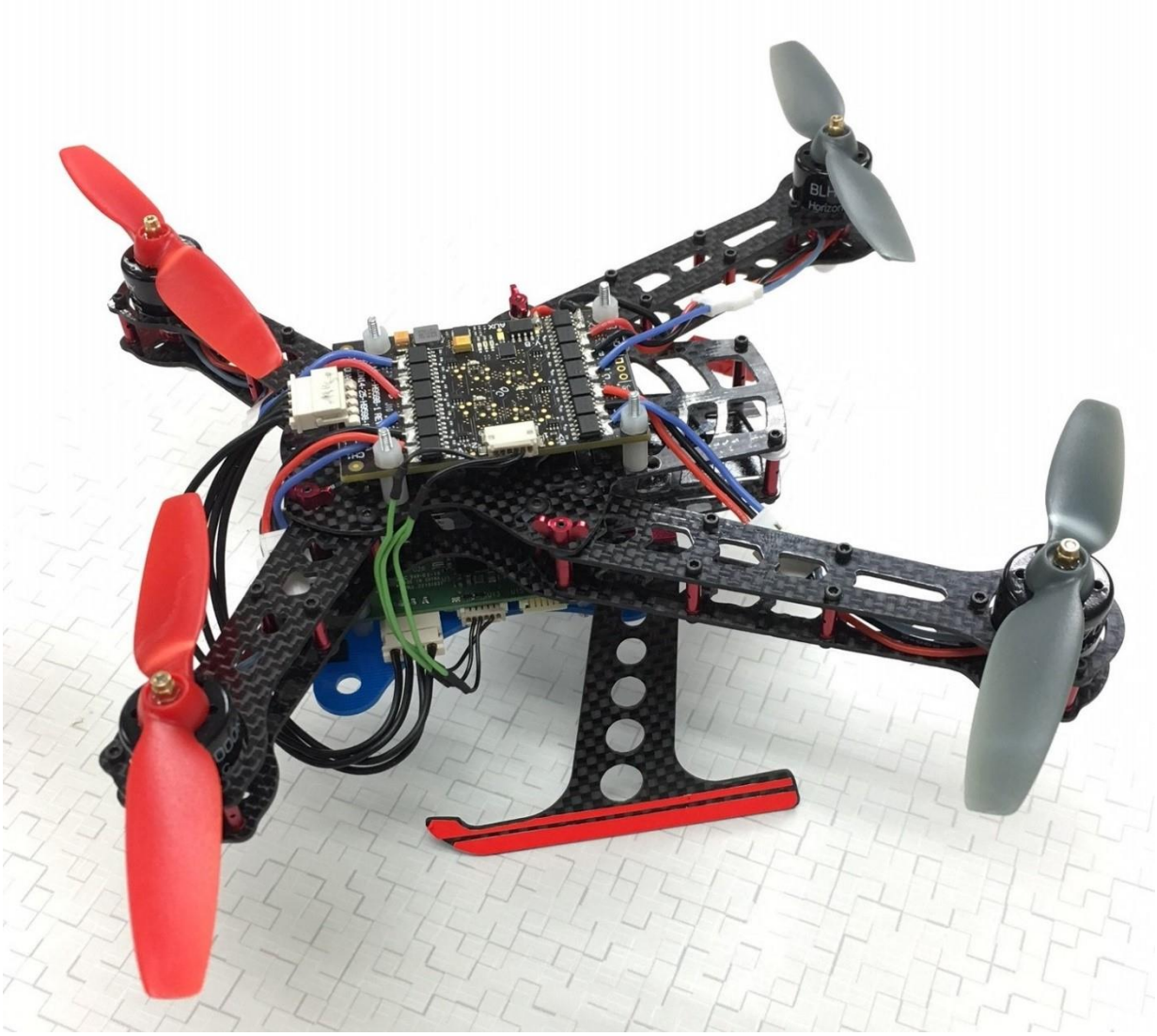

Figure 23 Completed Drone

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4. PROGRAMMING

To re-program the Flight board, download and extract
"**Flight_BSP_X.Y_apq8074-le-V.W_rxxxxx.zip**" from
http://support.intrinsyc.com/projects/snapdragon-flight (requires purchasing a Flight Kit)

The download includes the binary image for the board, the compiled PX4 flight stack and the Android tablet app that can be used to control the drone. For more information, see README files in **Flight_BSP_X.Y_apq8074-le-V.W_rxxxxx**.

Detailed instructions to re-flash the BSP (base operating system, no flight stack) can be found in the README in **Flight_BSP_X.Y_apq8074-le-V.W_rxxxxx/binaries**

Instructions to install the PX4 flight stack onto the device for flight or HIL simulation can be found in the *PX4 User Guide for Qualcomm Flight*.
Instructions on how to create programs that run on the device using the ARM applications processor, aDSP, IMU and system update, refer to the *Qualcomm Snapdragon Flight Developer Guide*.

The SDK for the ARM applications processor is **Flight_X.Y_qrlSDK.zip** and the SDK for the aDSP can be found on Qualcomm's website: https://developer.qualcomm.com/software/hexagon-dsp-sdk/tools and also the **Flight_X.Y_qcom_flight_controller_hexagon_sdk_add_on.zip**

Instructions on how to use the camera API can be found in *Snapdragon Linux Camera Interface Specification*.

Instructions on how to perform the IMU calibration and set up the DroneController app can be found in the *Qualcomm Snapdragon Flight Reference Platform User Guide*.

Instructions on how to set up the Wi-Fi hotspot and use the camera to make a video recording can be found in the *Qualcomm Snapdragon Flight User Guide*.

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5. FLYING

5.1 Motor Configuration

The configuration files in Flight_3.0_apq8074-le-1-0_ap_standard_oem_r00015 contain code for the orientation of the mounted Flight board.

5.2 Starting the PX4 Flight Stack

Pre-requisite:

To allow the drone to become flight ready, PX4 Flight Stack must be running.
PX4 Flight Stack is running and communicating with the ESC whenever the 4 blue LED's on the ESC board are blinking steadily. (LEDs flash when ESC is receiving UART commands from flight stack)

The best approach to handle flight readiness of the drone in the field is to establish a SSH connection over Wi-Fi.
Shortly after a fully charged battery is plugged-in, the Flight will act as a server and will broadcast its SSID in the form of Atlanticus_XXXXX.
While on the PC or laptop, the SSID should be made available shortly after power up.
The PC or laptop must establish a connection to the drone.

Connecting to Atlanticus_XXXXX will require a password. The password is "password" (excluding the quotes).
Connection should now have been allowed. There is going to be a warning message indicating the lack of Internet connection. This is normal and expected as the drone is not providing such service.

It is now time to access the drone over SSH.
To do so you need either PUTTY (http://www.putty.org/) or Bitvise installed for which a profile can be created and called anytime as necessary.

Use the following credentials:

Host: 192.168.1.1 (This is the address advertised by the drone).
Port: 22
Username: linaro
Password: linaro

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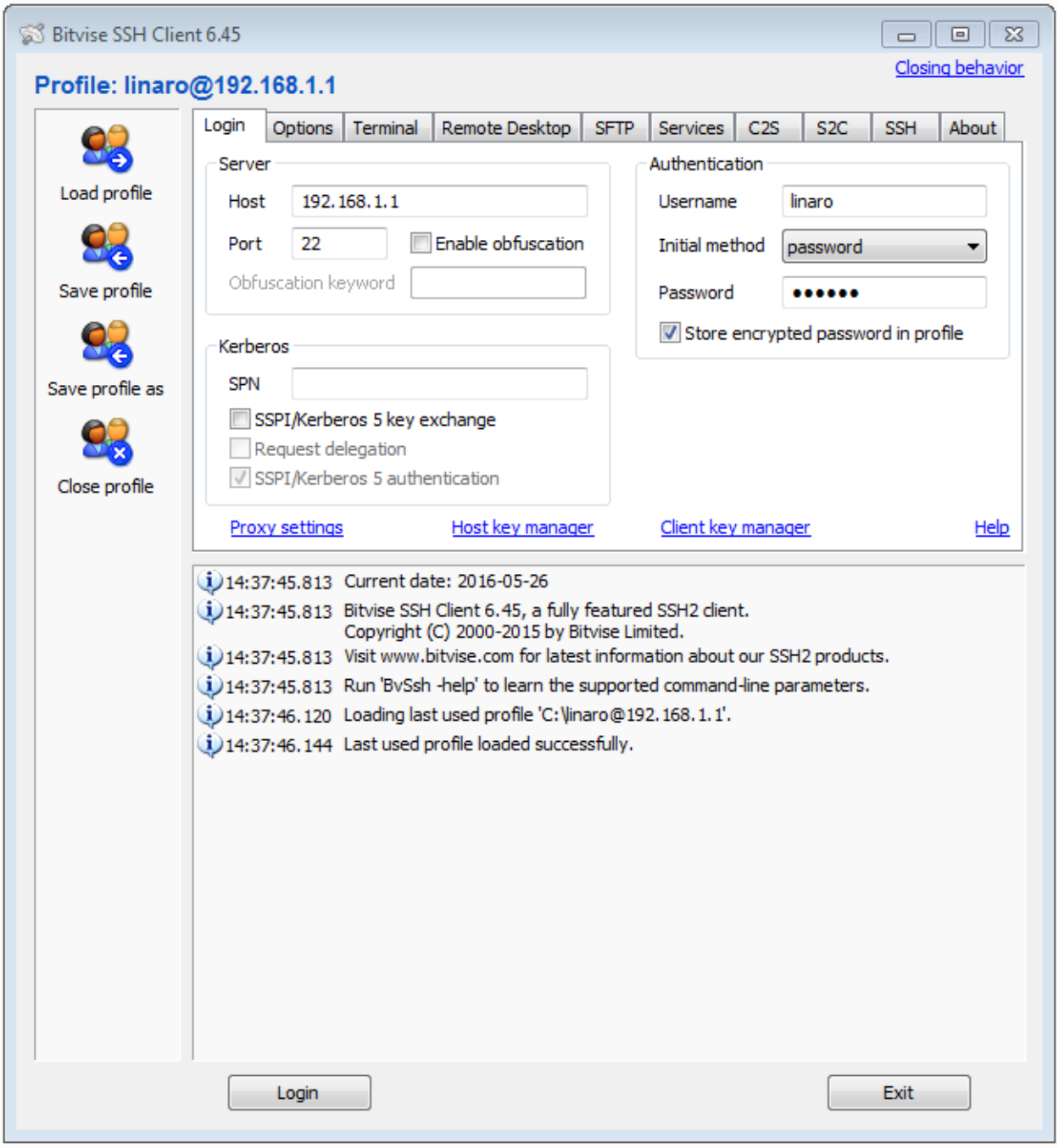

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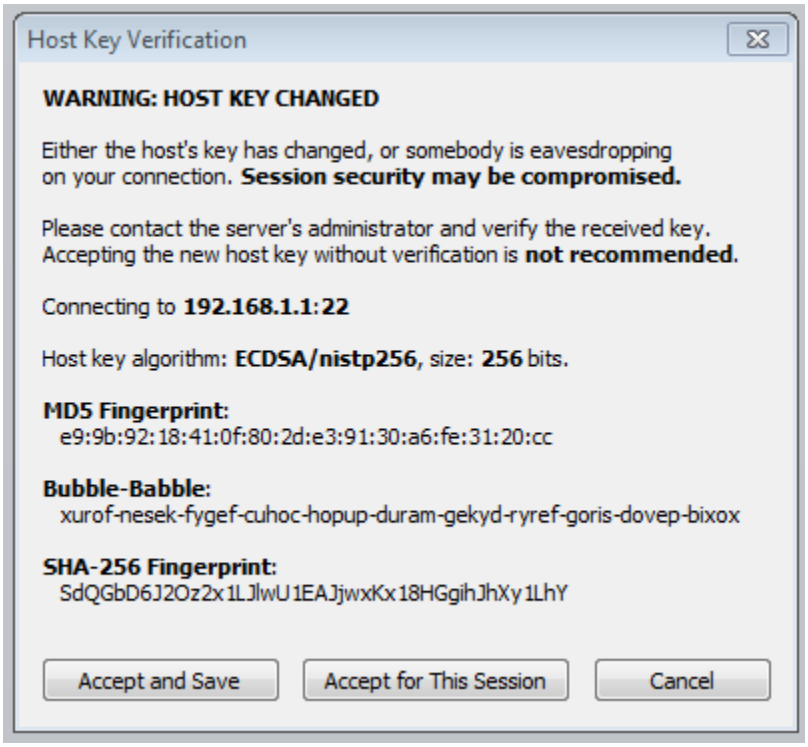
Pressing the “Login” button will initiate connection over SSH.
If it is the first time the drone is being accessed from this PC, a Host Key Verification window will pop-up such as below:



Press “Accept and Save” to proceed ahead.

A new terminal console needs to be opened from Bitvise in order to be able to enter commands.
Upon successful connection, login should be similar to the following screen:

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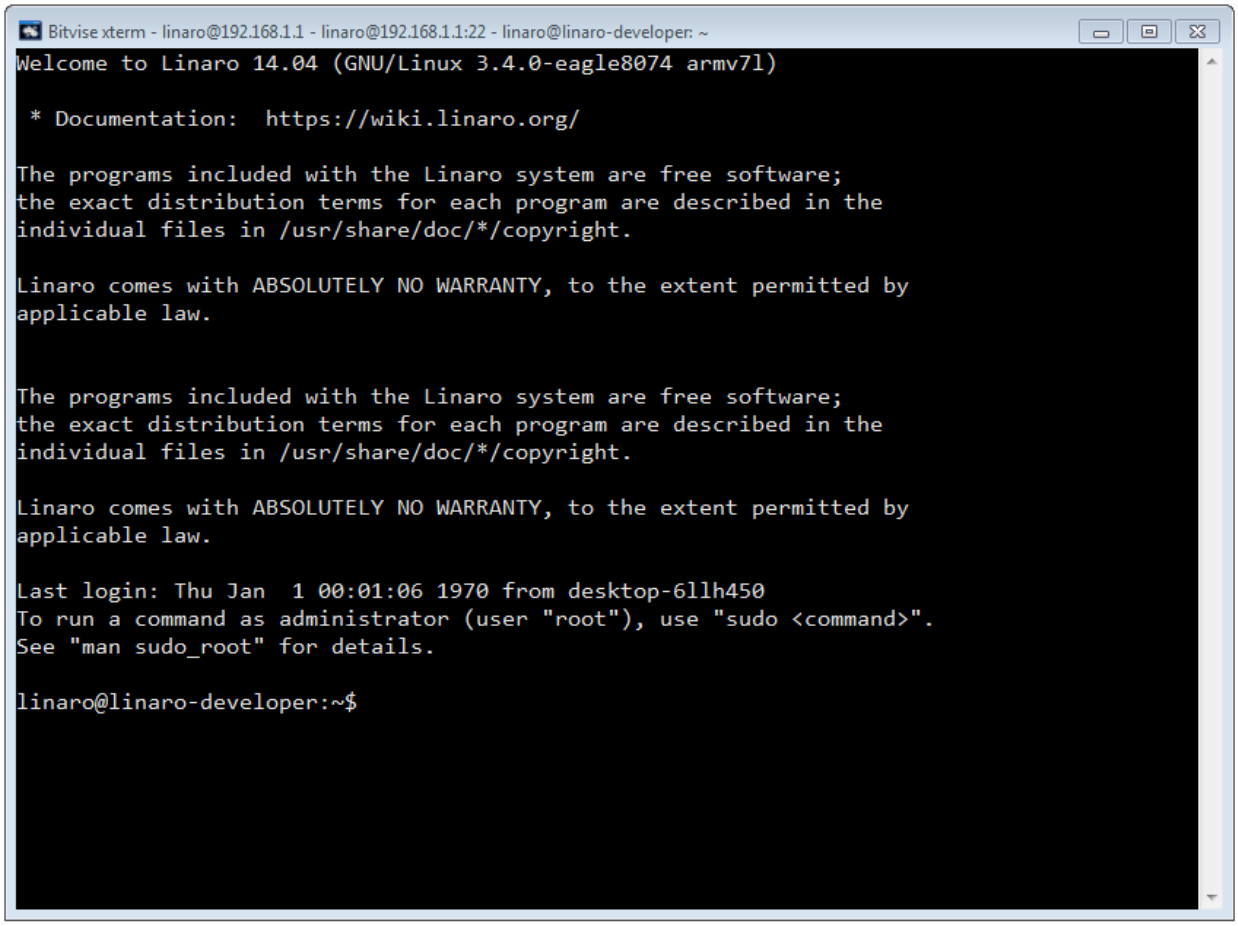

While the drone has been connected over SSH, the 4 ESC LED's should still be OFF.
To place the drone in flight ready status, the following commands need to be executed:

cd /home
sudo ./mainapp mainapp.config &

Upon proper start of the drone application, the 4 ESC LED 's should now be toggling.
The drone is now in "flight ready" status.

NOTE: It is important to not forget the ampersand character at the end of the sudo command. If ampersand character "&" has been omitted, closing the terminal window, pressing "Ctl+C" or terminating the connection over SSH will cause the mainapp application to be terminated.

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5.3 Using Spektrum Remote Control and QGroundControl

Flying the drone with Spektrum Remote Control and QGroundControl.

See PX4_User_Guide_for_Qualcomm_Snapdragon_Flight.pdf for more details on PX4, QGroundControl and other configurations.

5.4 Starting the PX4 Flight Stack and using an Android device

Start the PX4 flight stack by following instructions in 5.2

To start streaming video, run the following command:
sudo qcamvid –t 600

From an Android tablet running the drone controller APK, connect to the Snapdragon flight.
Go to Settings->Background and ensure that FPV Stream is selected. Back out of the app and re-enter. The DroneController application should be streaming video.

5.5 Flying with Spektrum™ remote controller

To use the Spektrum™ Dx6i transmitter to control the drone, user will need to connect the data port on Spektrum™ SPM9645 receiver to the Snapdragon Flight J15. Below is the wiring instruction

Spketrum SPM9645 Data port	Snapdragon Flight J15
Pin 1 (VDD)	Pin 1 (VDD)
Pin 2 (GND)	Pin 5 (GND)
Pin 3 (Data)	Pin 3 (RX)

User can use the following part to mate to the respective connector

Snapdragon Flight [J15]: Hirose DF13-6S-1.25C (Housing) with the Hirose DF13-2630SCF crimp terminal

Spektrum™ SPM9645 [Data Port]: JST ZHR-3 (Housing) with the JST SZH-002T-P0.5 crimp terminal

Further details of the Spektrum™ SPM9645 can be found at:
https://www.spektrumrc.com/ProdInfo/Files/Remote%20Receiver%20Interfacing%20Rev%20A.pdf

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5.6 Basic Flight Control with the Spektrum™ remote controller

See DX6i Instruction Manual (http://www.spektrumrc.com/ProdInfo/Files/DX6i-Manual_EN.pdf) for additional transmitter details.

5.6.1 Arm / Disarm for flight

Once the system has powered up, the drone can be armed for flight mode using the transmitter.

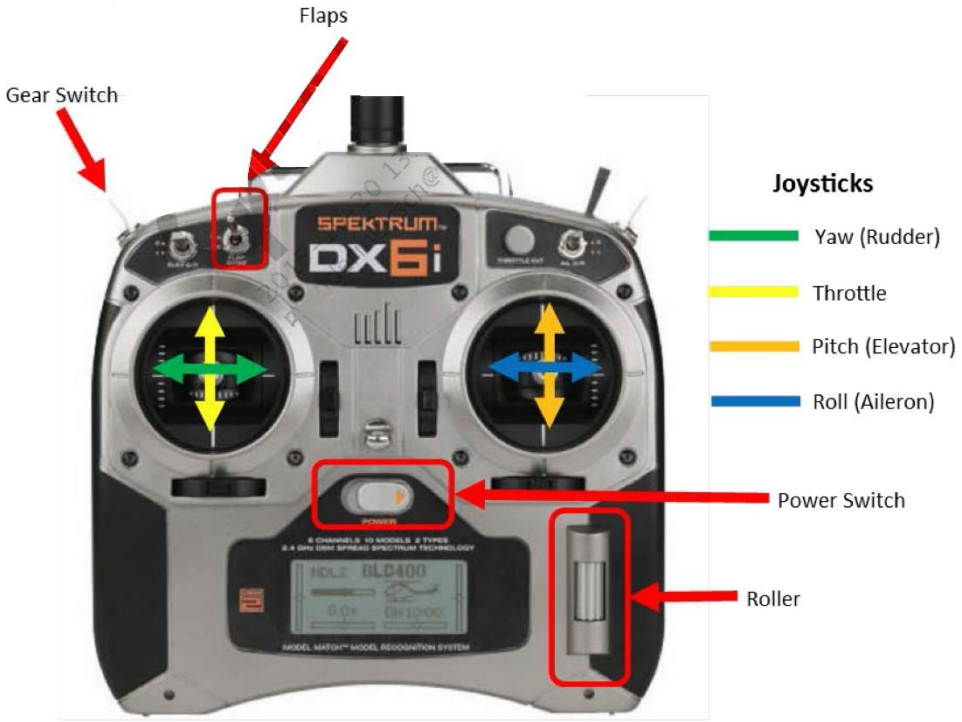

Figure 24 Spektrum™ DX6i Remote Controller

5.6.1.1 Arm Flight

To arm a flight, pull the throttle lever down to the lower right corner and hold it for 3 sec.

5.6.1.2 Disarm Flight

To disarm a flight, pull the throttle lever down to the lower left corner and hold it for 3 sec.

5.6.1.3 Transmitter Operation

Transmitter joysticks operate the UAV.
The left stick controls the throttle and yaw. The right stick controls the pitch and roll.

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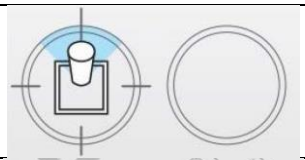
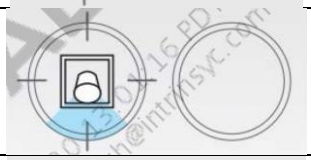
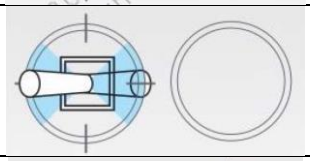
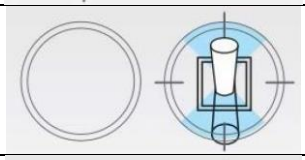
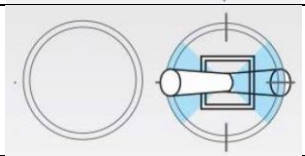
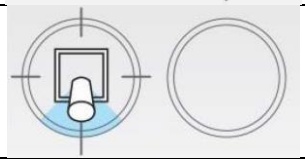
Motion	Control	Illustration
To takeoff and gain altitude	Raise left stick above centre	
To maintain altitude	Set left stick to centre	
To rotate	Move left stick left and right	
To fly forward and backward	Move right stick forward and backward	
To fly left and right	Move right stick left and right	
To land or lower altitude	Set left stick below centre	

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6. APPENDIX

6.1 Appendix A

Electronic Speed Controller (ESC) serial communication cable details:

Connector on SD Flight Dev. Board	Connector MFG	MFG Part Number	Pin Configuration	Mating Connectors and Cables	Notes
J13	Hirose	DF13-6P-1.25H(50)	Pin 1: 5V Pin 2: UART6_TXO Pin 3: UART6_RXI Pin 4: APQ_GPIO_29 Pin 5: GND Pin 6: APQ_GPIO_30	**Connector Housing**: Hirose DF13-6S-1.25C **Pre-Crimped wire**: Hirose H4BBT-10103-B6	UART and GPIOs are at 5V CMOS levels. Connect TXO to target device's RXI, and vice-versa. GPIO's are not set for I2C (no pull-ups, push-pull driver).

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