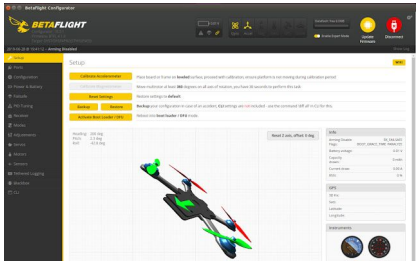
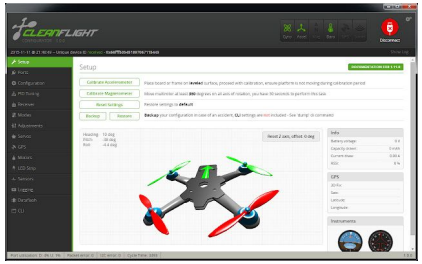
Ground Control Station (GCS)

- Ground Control Stations (GCS) are **ground-based** hardware and software that allow UAV operators to communicate, control, and configure a drone
- **Configuration** parameters are set for normal drone operation or autonomous operation

BETAFLIGHT



CLEANFLIGHT



INAV

Proprietary - DJI, Naza, etc.

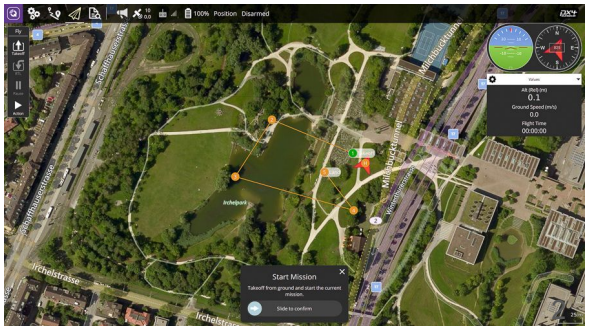
LibrePilot

MP

ARDUPILOT

Versatile, Trusted, Open

QGroundControl

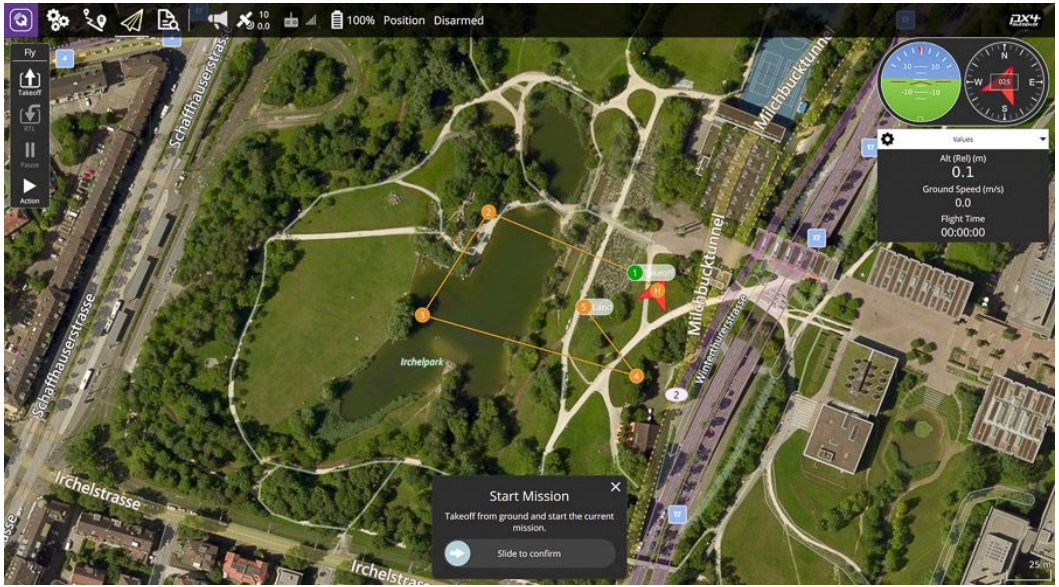


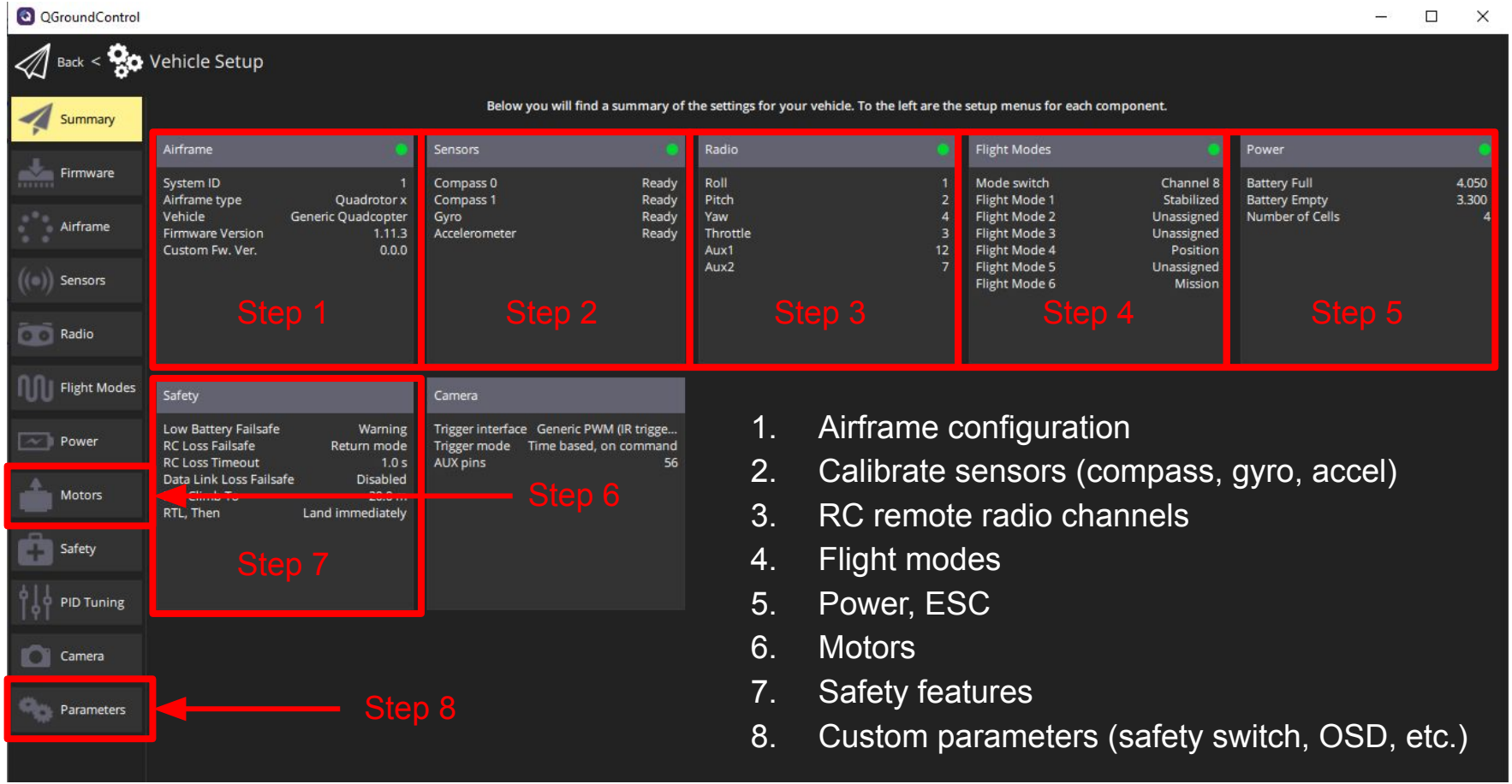
QGroundControl

http://qgroundcontrol.com/

Key features:

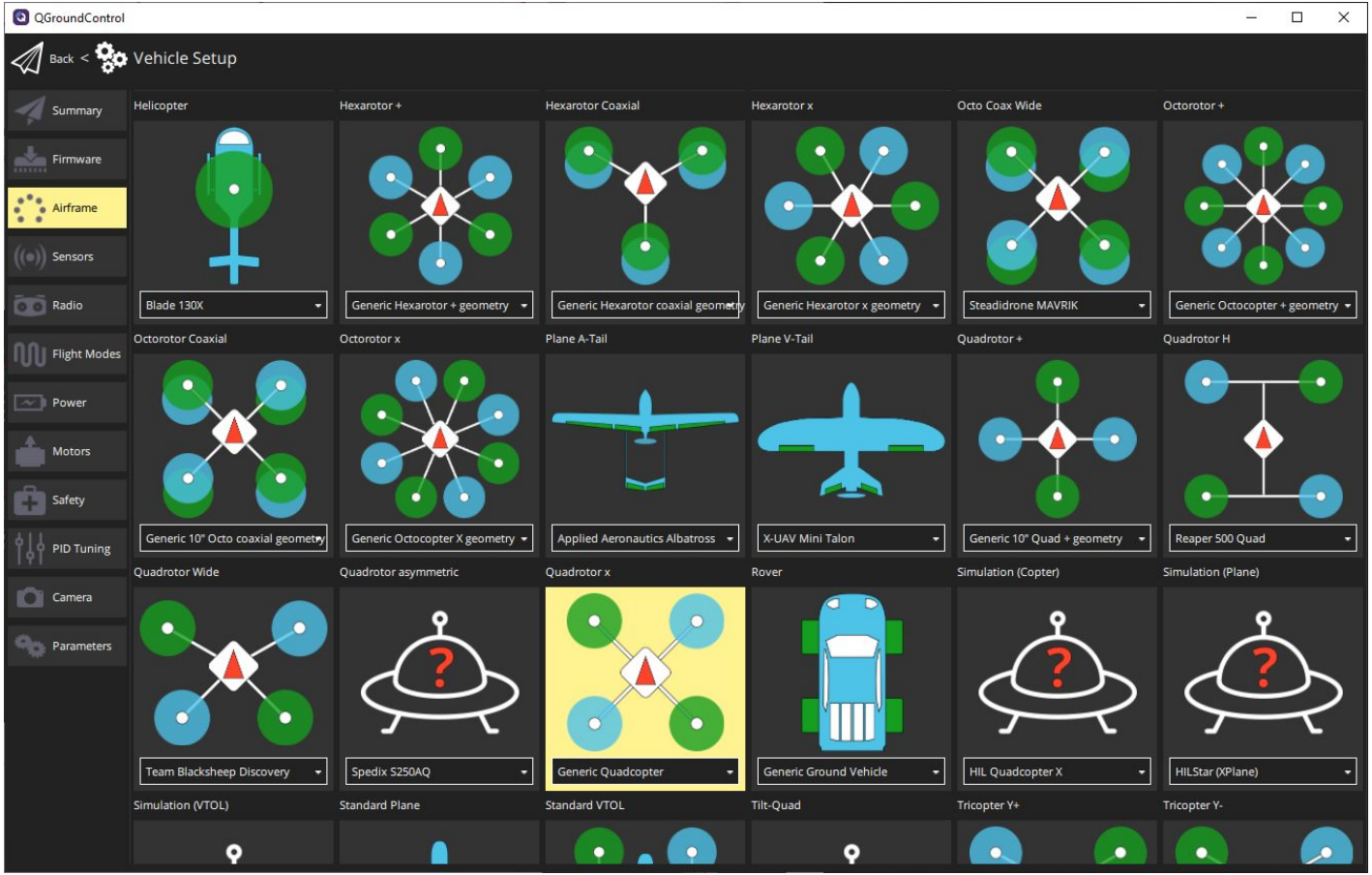
- Open Source Software
- PX4 and ArduPilot firmware
- Multirotor, fixed wing
- Windows, Mac, Linux, Android



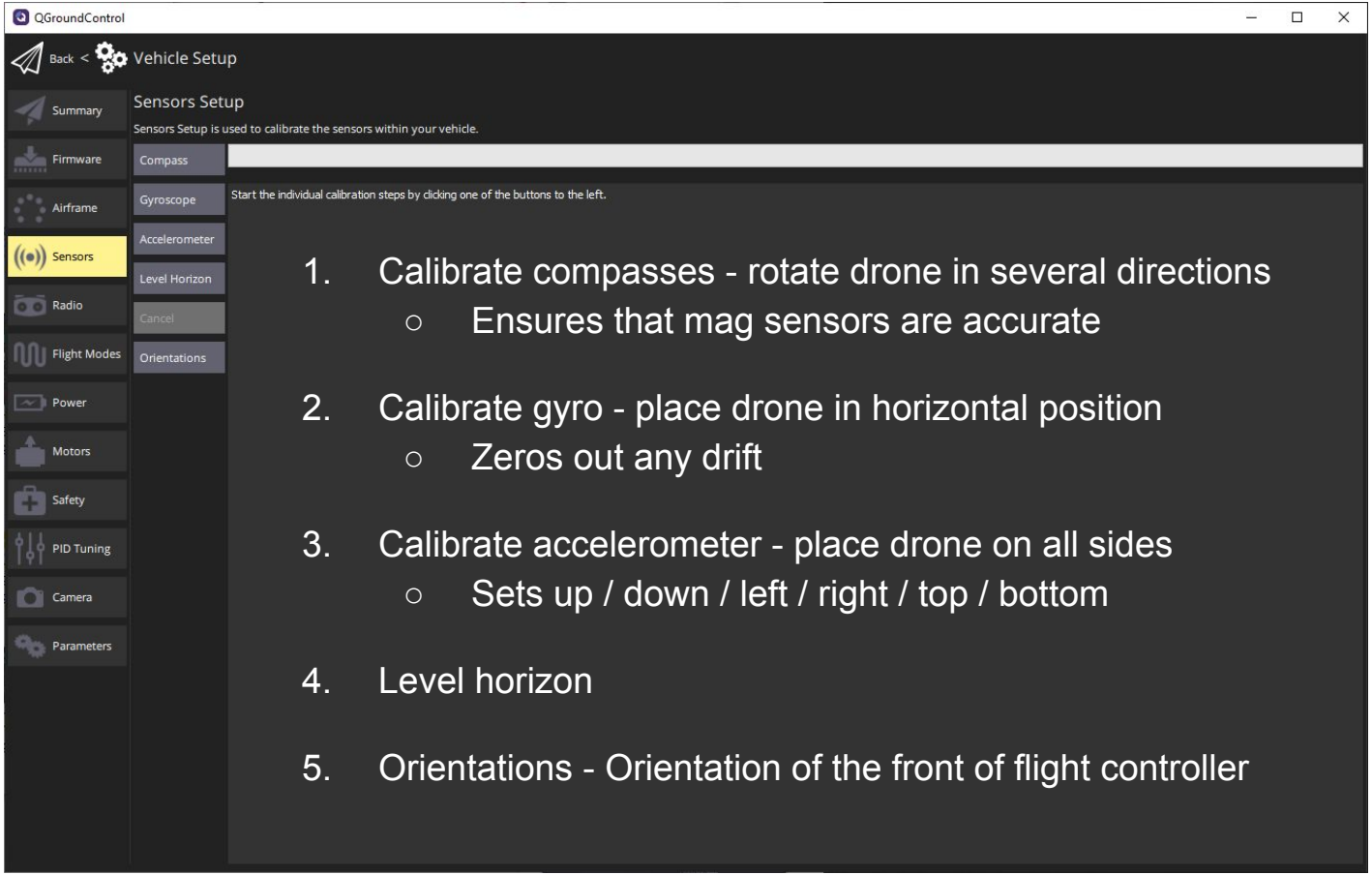


1. Airframe configuration
2. Calibrate sensors (compass, gyro, accel)
3. RC remote radio channels
4. Flight modes
5. Power, ESC
6. Motors
7. Safety features
8. Custom parameters (safety switch, OSD, etc.)

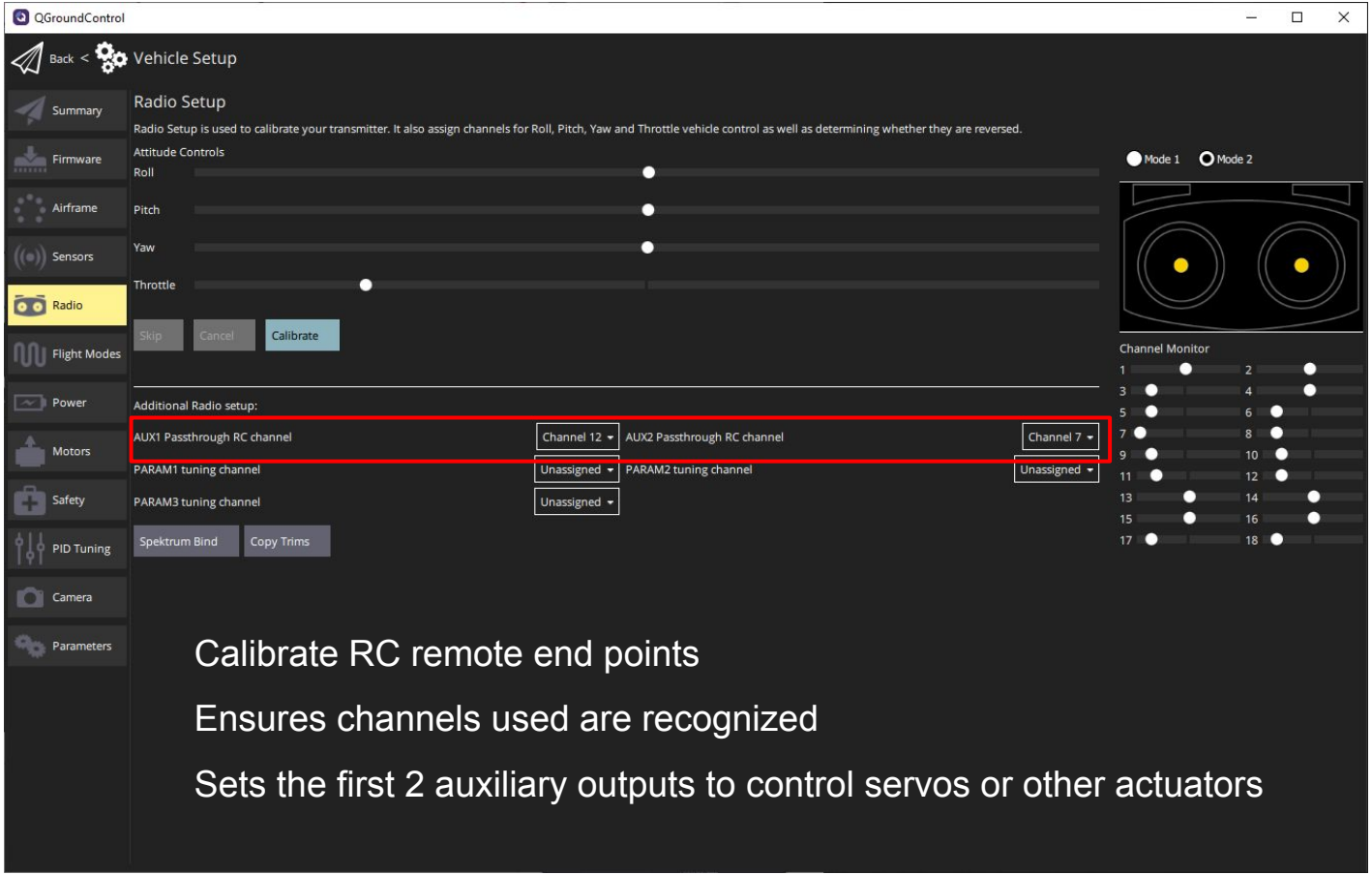
Step 1 - Airframe



Step 2 - Sensors



Step 3 - Radio

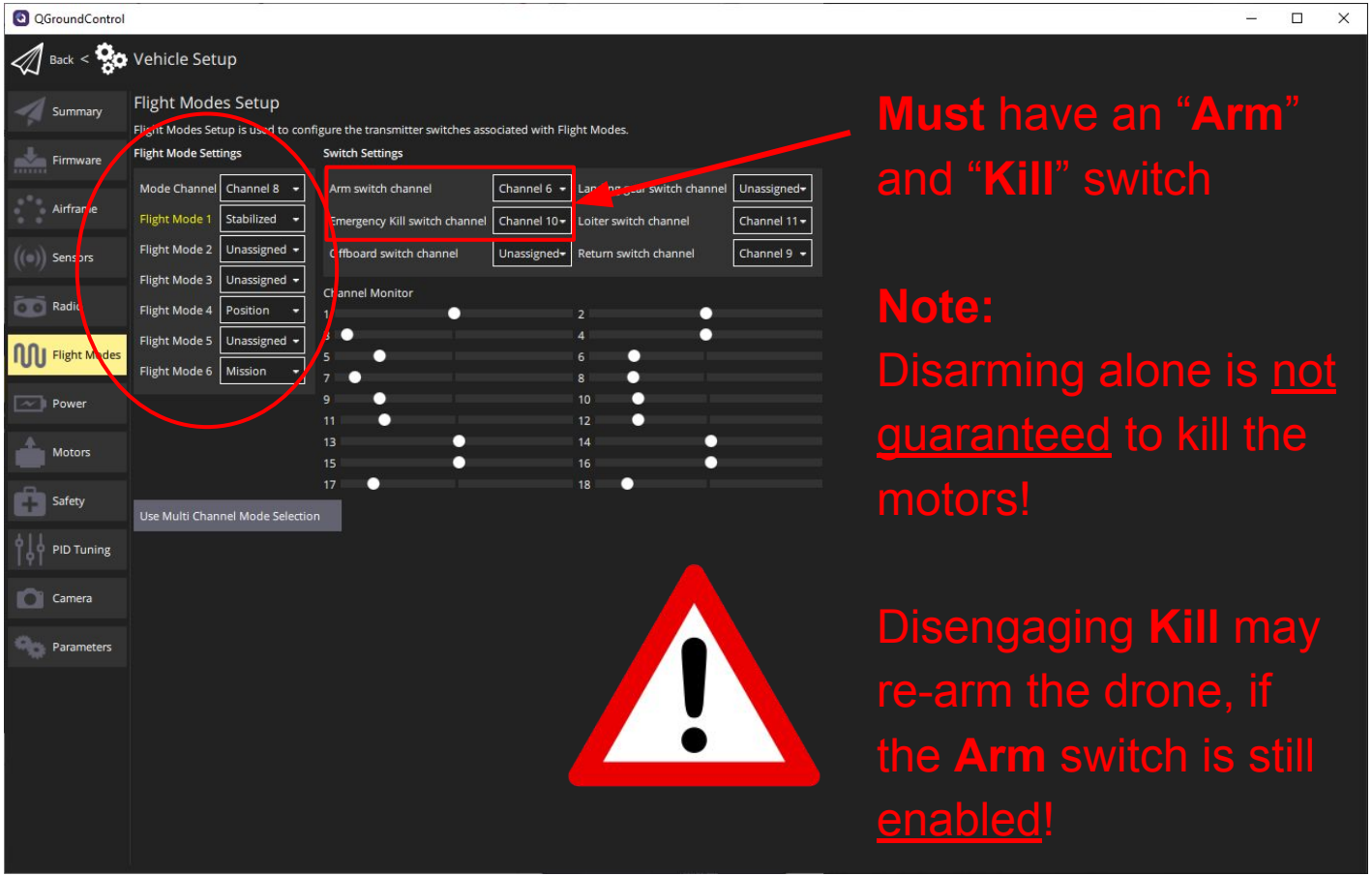


Calibrate RC remote end points

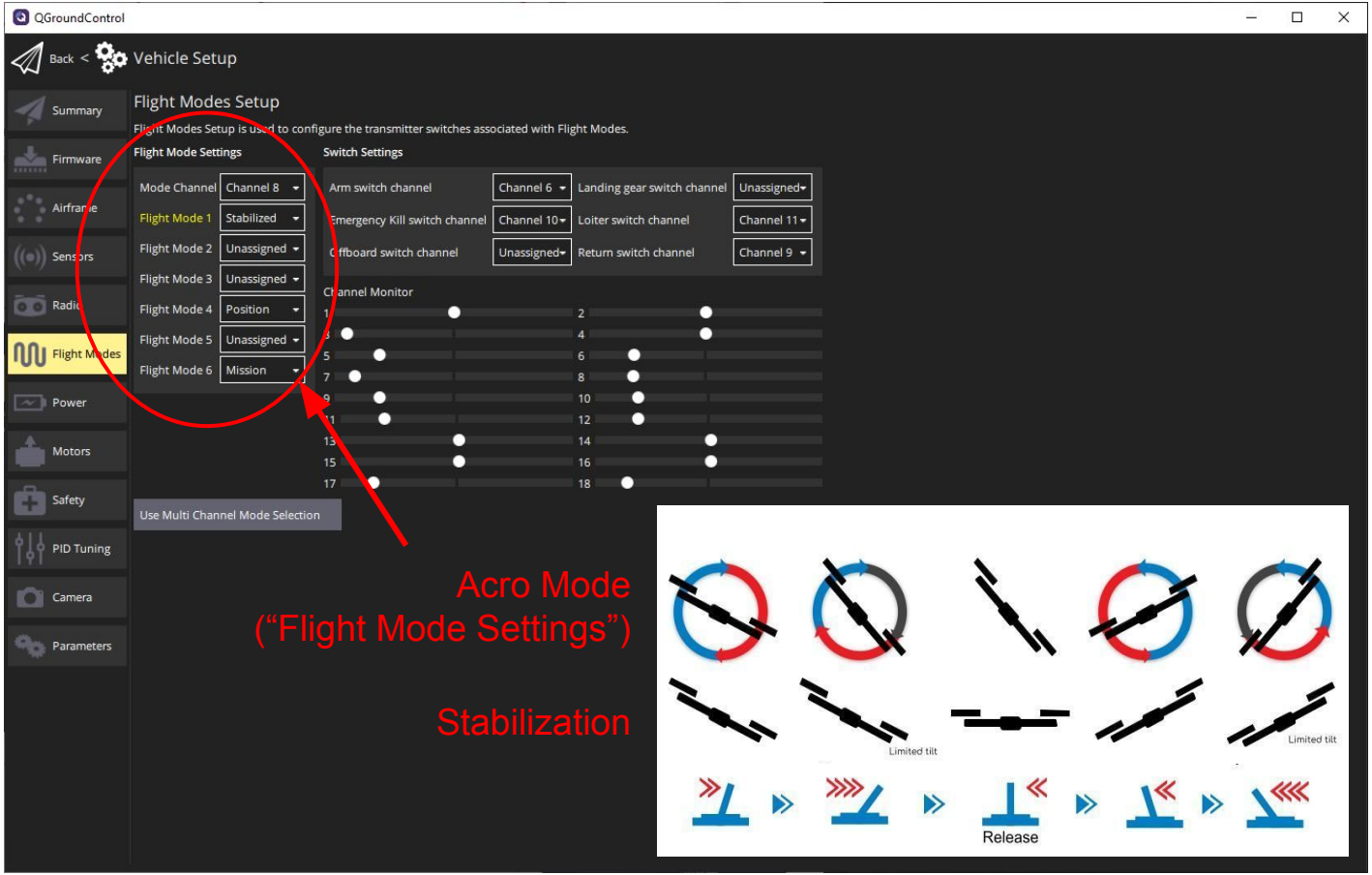
Ensures channels used are recognized

Sets the first 2 auxiliary outputs to control servos or other actuators

Step 4 - Flight Modes



Step 4 - Flight Modes



Step 4 - Flight Modes

QGroundControl

Back < Vehicle Setup

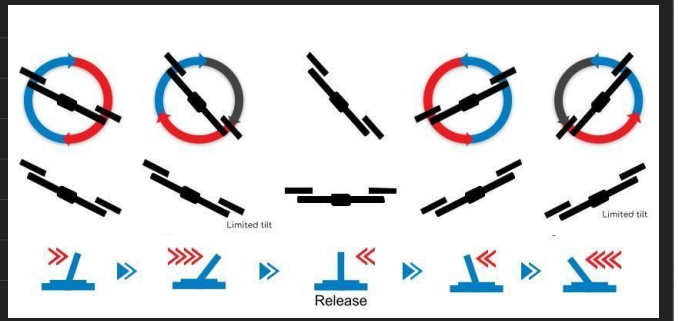
- Summary
- Firmware
- Airframe
- Sensors
- Radio
- Flight Modes
- Power
- Actuators
- Safety
- PID Tuning
- Flight Behavior
- Camera
- Parameters

Search: acro Clear Show modified only

COM_LKDOWN_TKO	3.000 s	Timeout for detecting a failure after takeoff
MC_ACRO_EXPO	0.69	Acro mode Expo factor for Roll and Pitch
MC_ACRO_EXPO_Y	0.69	Acro mode Expo factor for Yaw
MC_ACRO_P_MAX	720.0 deg/s	Max acro pitch rate
MC_ACRO_R_MAX	720.0 deg/s	Max acro roll rate
MC_ACRO_SUPEXPO	0.70	Acro mode SuperExpo factor for Roll and Pitch
MC_ACRO_SUPEXPOY	0.70	Acro mode SuperExpo factor for Yaw
MC_ACRO_Y_MAX	540.0 deg/s	Max acro yaw rate
MC_BAT_SCALE_EN	Disabled	Battery power level scaler
MC_PITCHRATE_MAX	220.0 deg/s	Max pitch rate
MC_ROLLRATE_MAX	220.0 deg/s	Max roll rate
RC_MAP_ACRO_SW	Unassigned	Acro switch channel (deprecated)

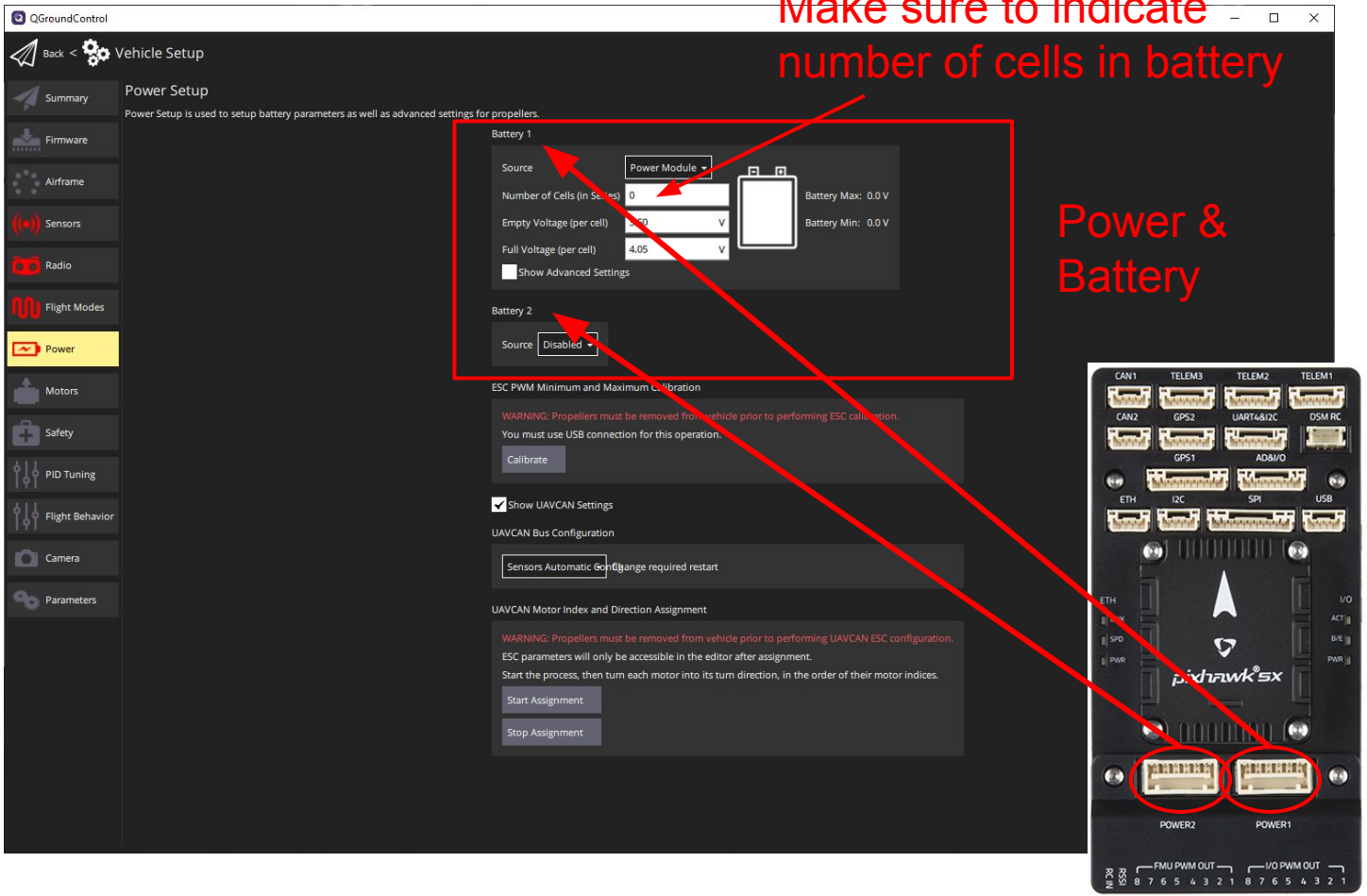
Acro Mode

Stabilization

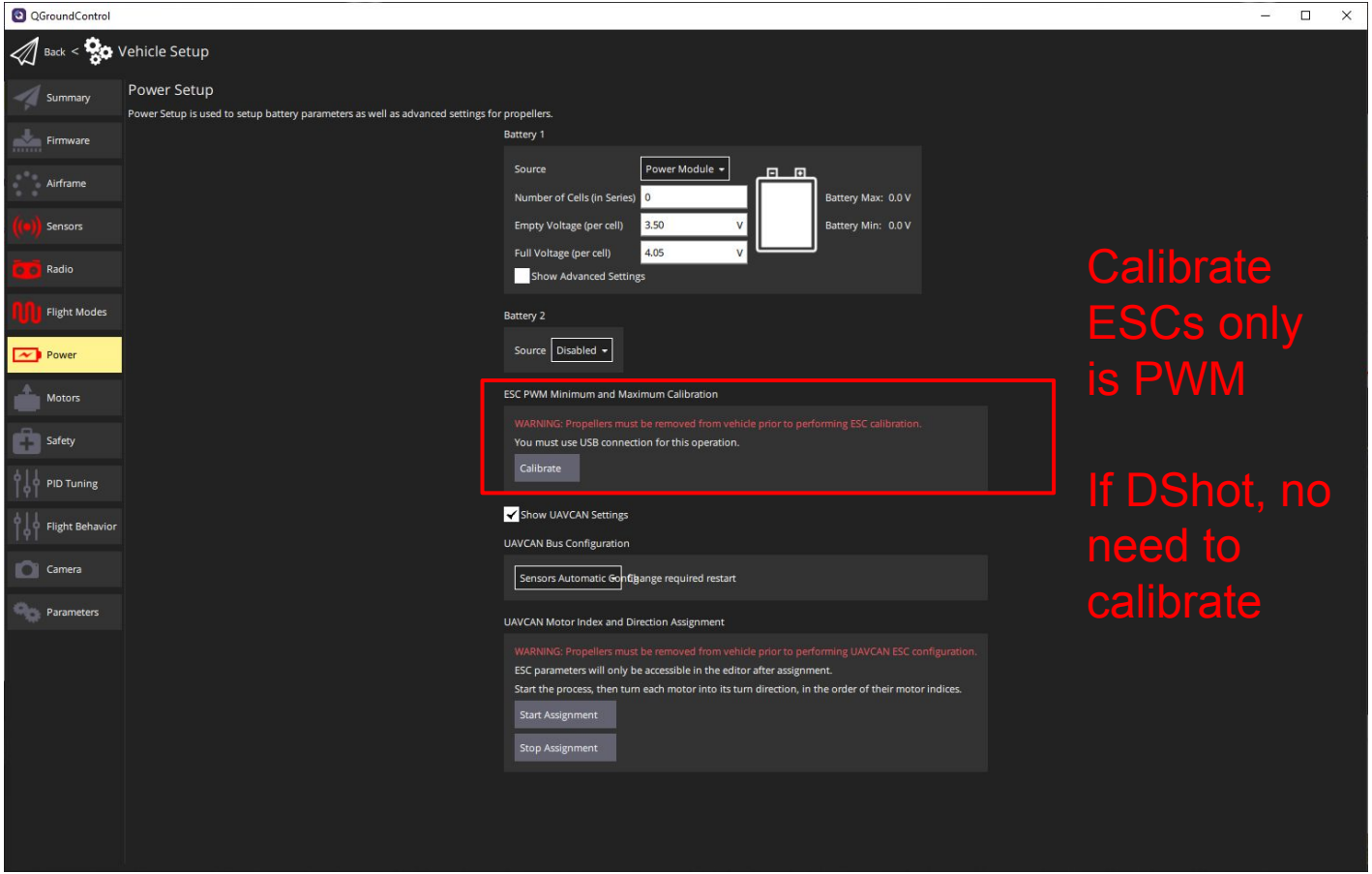


Setting “Acro” mode in Parameters is deprecated in versions 4.3.x

Step 5 - Power, and ESCs



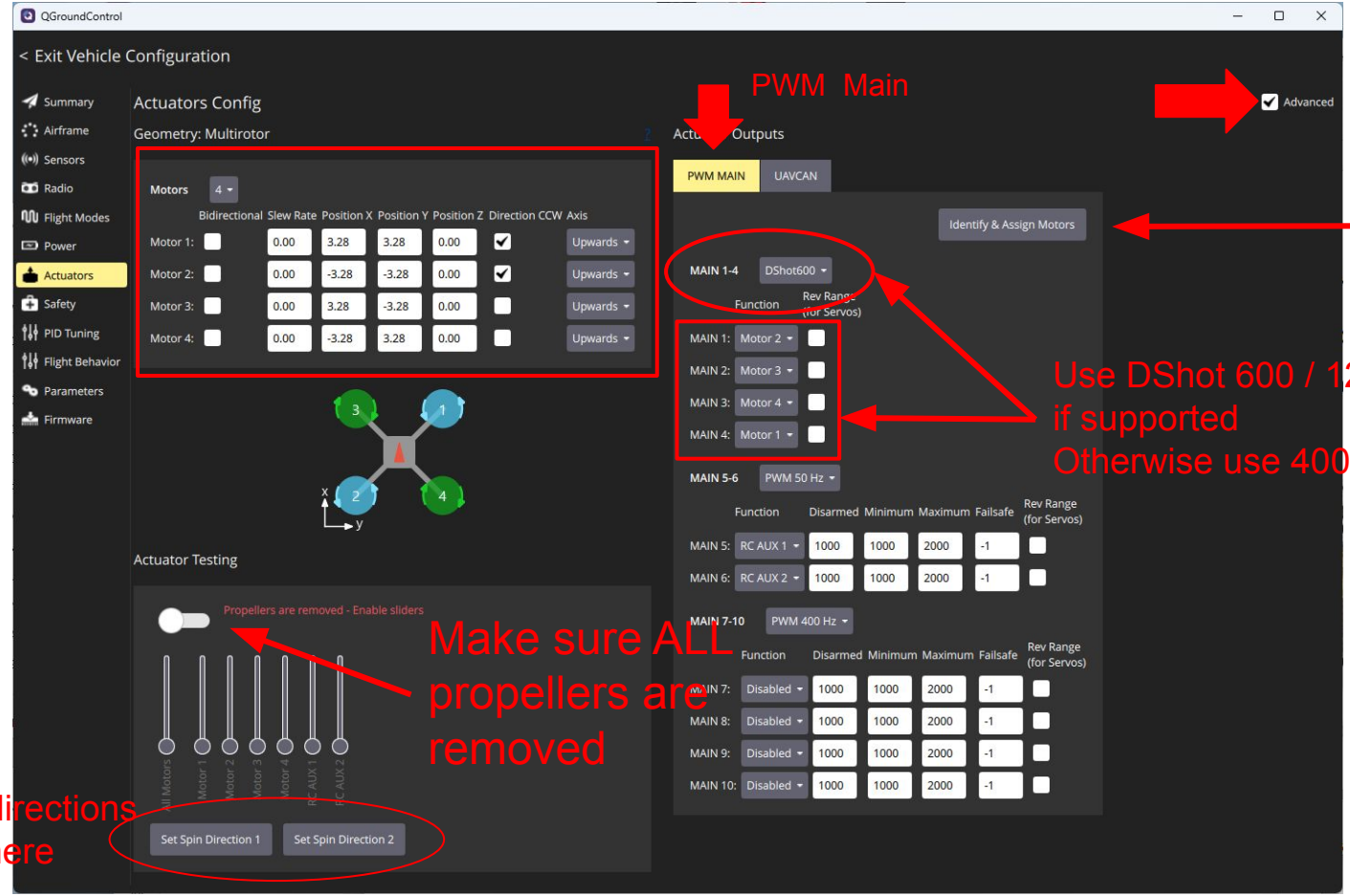
Step 5 - Power, and ESCs



Calibrate ESCs only is PWM

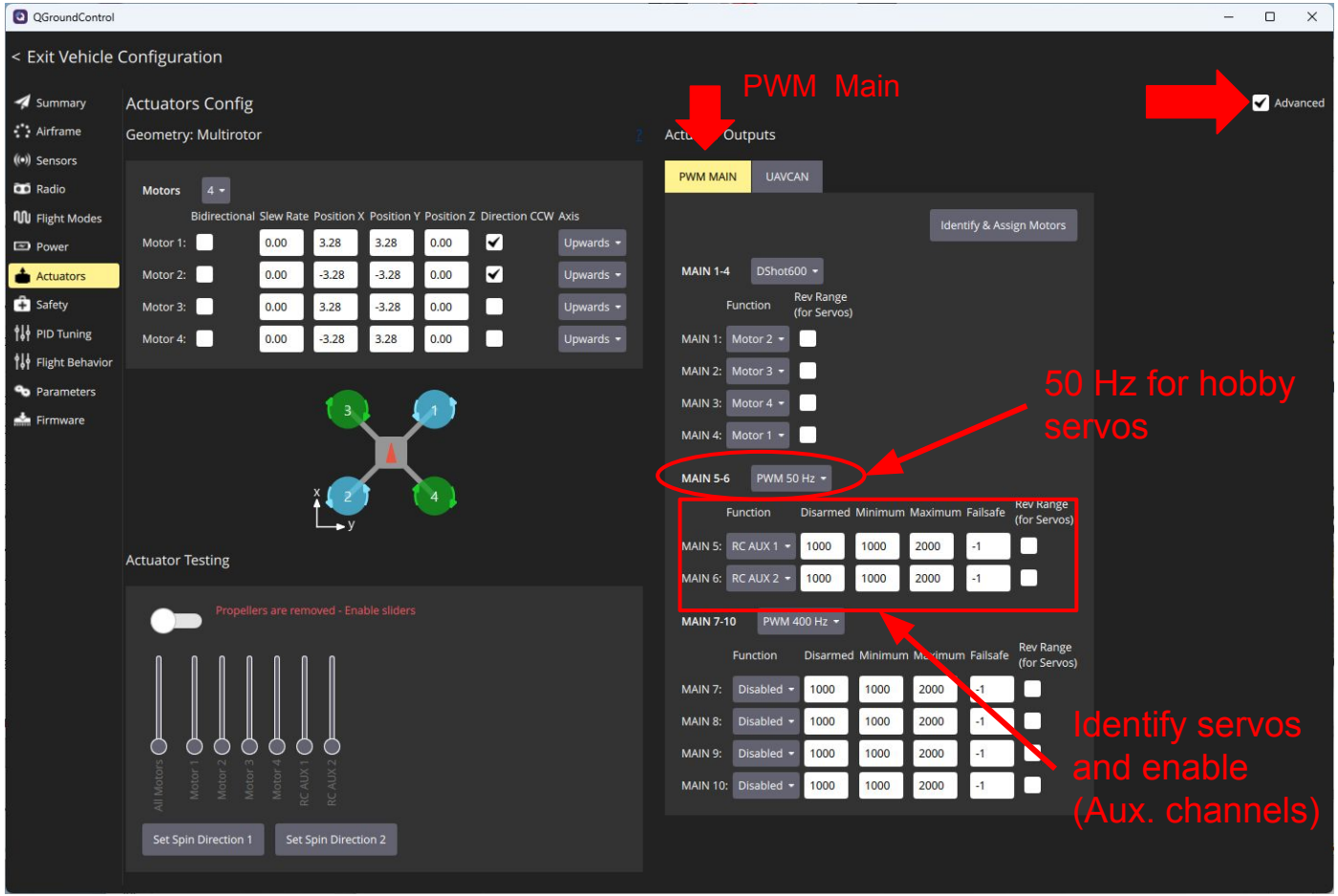
If DShot, no need to calibrate

Step 6 - Motors (and Other Actuators)

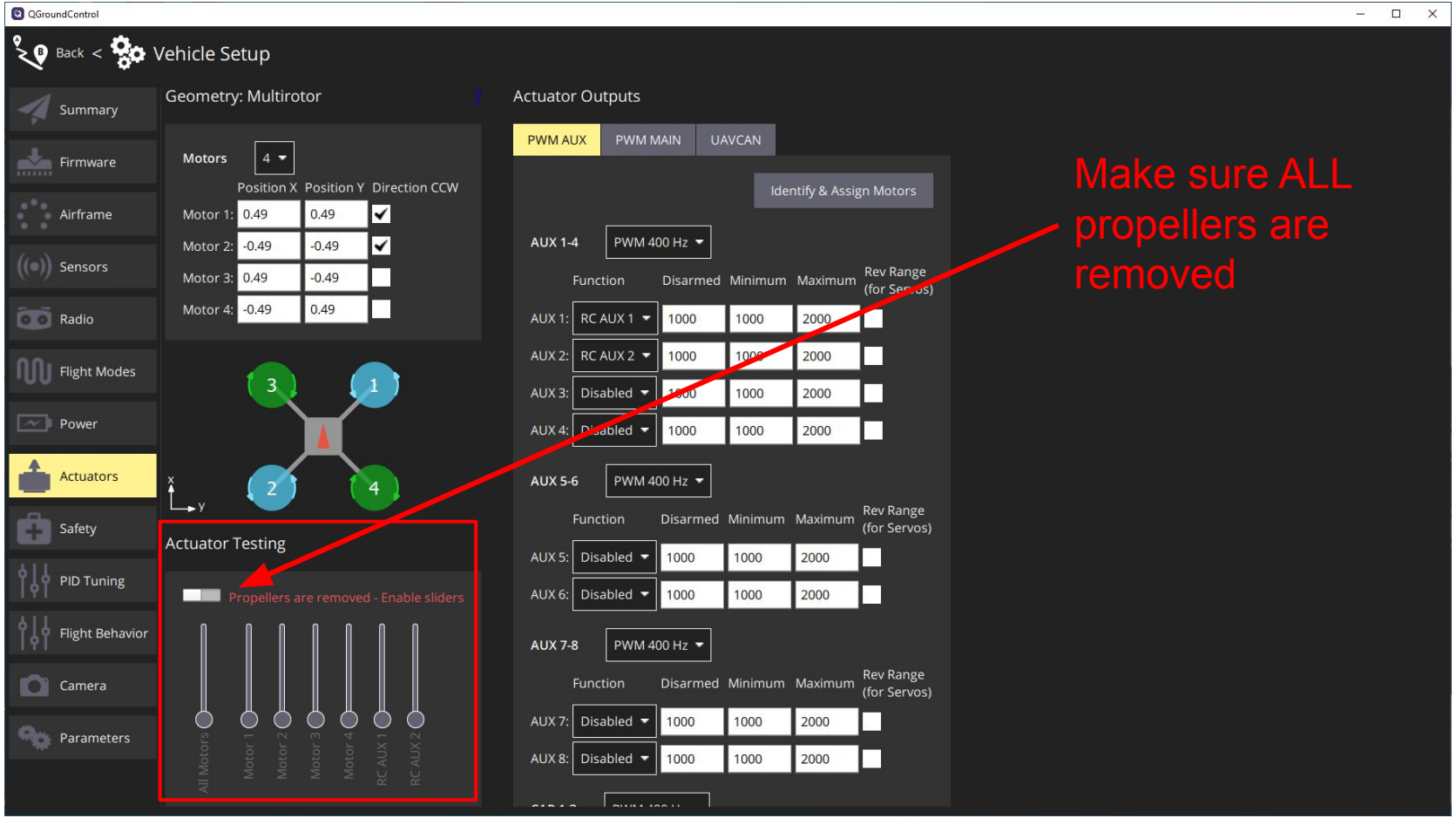


Optional:
Motor spin directions can be set here

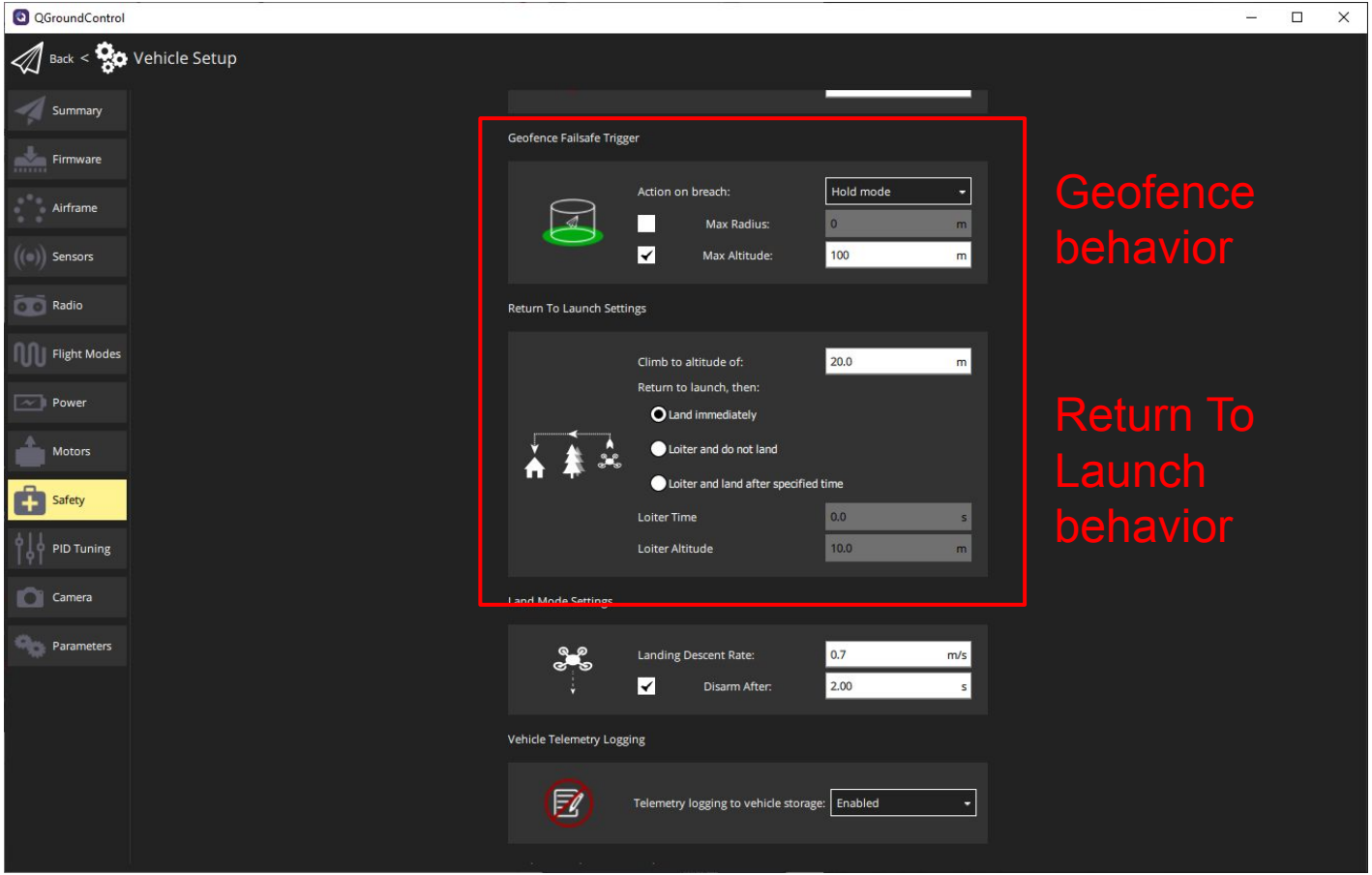
Step 6 - Motors (and Other Actuators)



Step 6 - Motors (and Other Actuators)



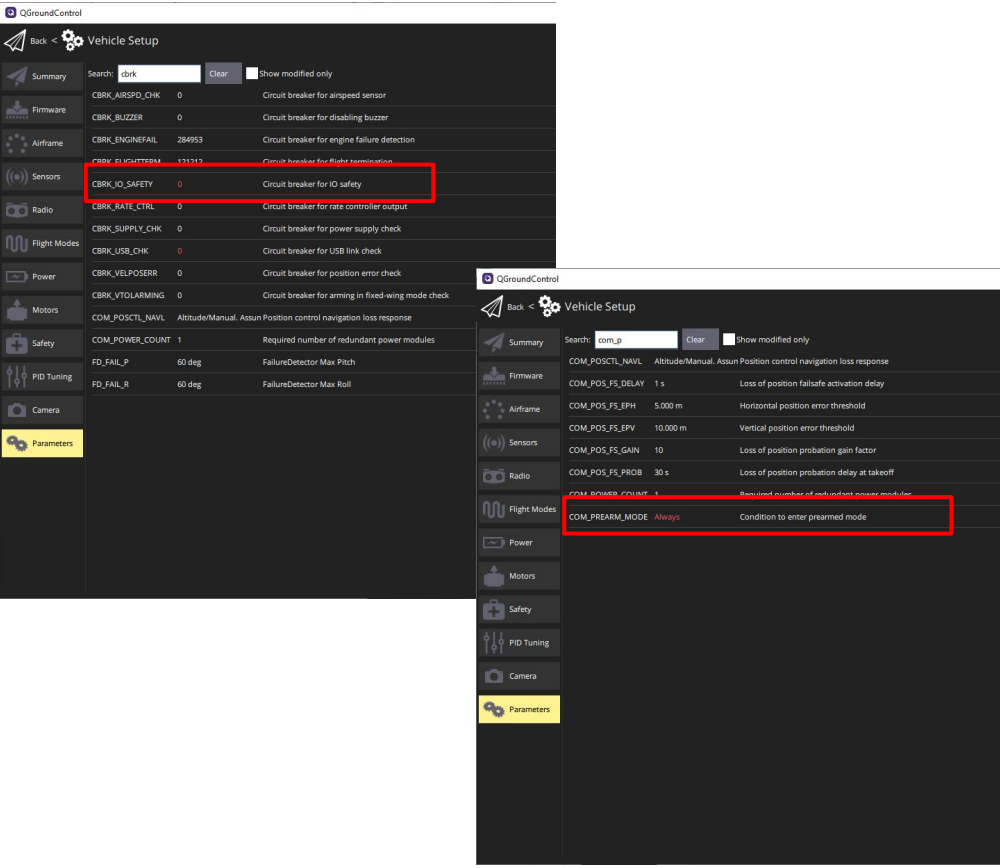
Step 7 - Safety



Geofence behavior

Return To Launch behavior

Step 8 - Safety Switch, Pre-Arm



CBRK_IO_SAFETY = 0
COM_PREARM_MODE = ALWAYS

Safety switch ACTIVE
Servos / RC_MAP_AUX channels always active

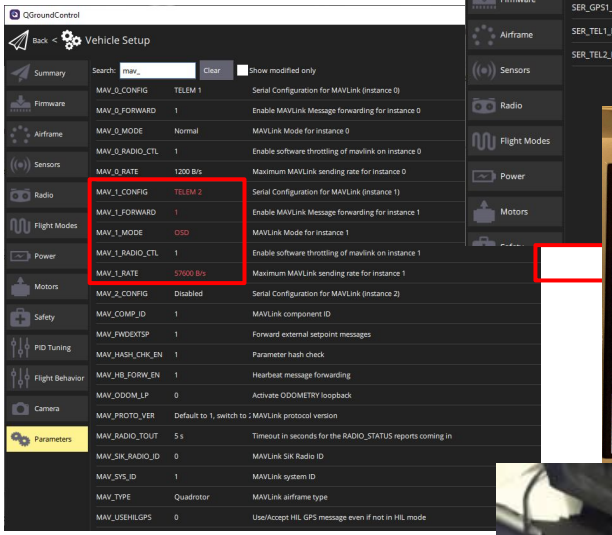
CBRK_IO_SAFETY = 0
COM_PREARM_MODE = Safety Button

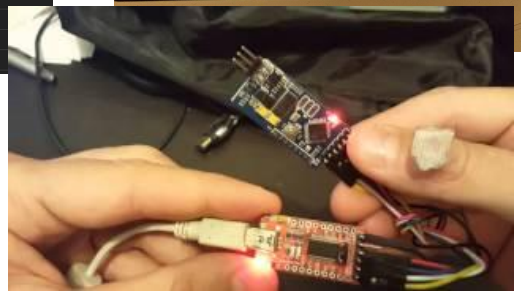
Safety switch ACTIVE
Servos / RC_MAP_AUX channels active only after Safety switch is pressed

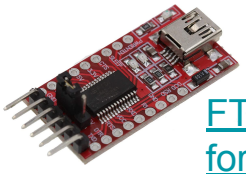
CBRK_IO_SAFETY = 22027
COM_PREARM_MODE = ALWAYS / DISABLED

No Safety Switch
Servos / RC_MAP_AUX channels always active

Step 8 - OSD







[FTDI to USB for config]

[MiniOSD]

[MicroOSD]

OSD

Configuration App
https://code.google.com/archive/p/arducam-osd/downloads

Configure Telemetry port 2

- MAV_1_CONFIG = TELEM 2
- MAV_1_FORWARD = 1
- MAV_1_MODE = OSD
- MAV_1_RATE = 57600 B/s

Reboot vehicle to access next parameter

- SER_TEL2_BAUD = 57600 8N1

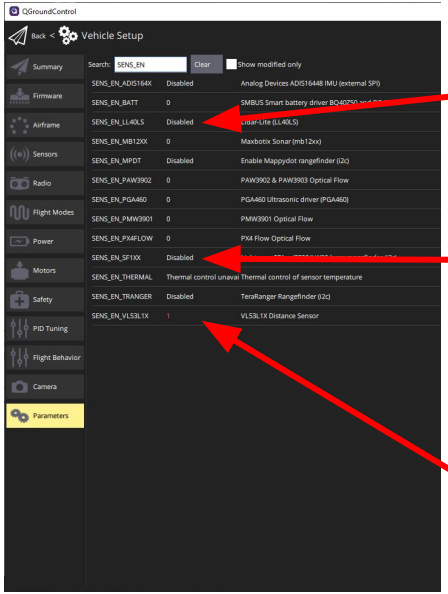
Configure Telemetry port 3

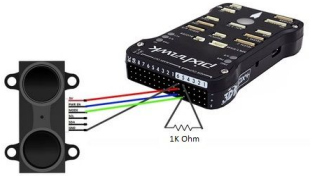
- MAV_2_CONFIG = TELEM 3
- MAV_2_FORWARD = 1
- MAV_2_MODE = OSD
- MAV_2_RATE = 57600 B/s

Reboot vehicle to access next parameter

- SER_TEL3_BAUD = 57600 8N1

Step 8 - Parameters (Range finders, Optical flow)





Lidar Lite

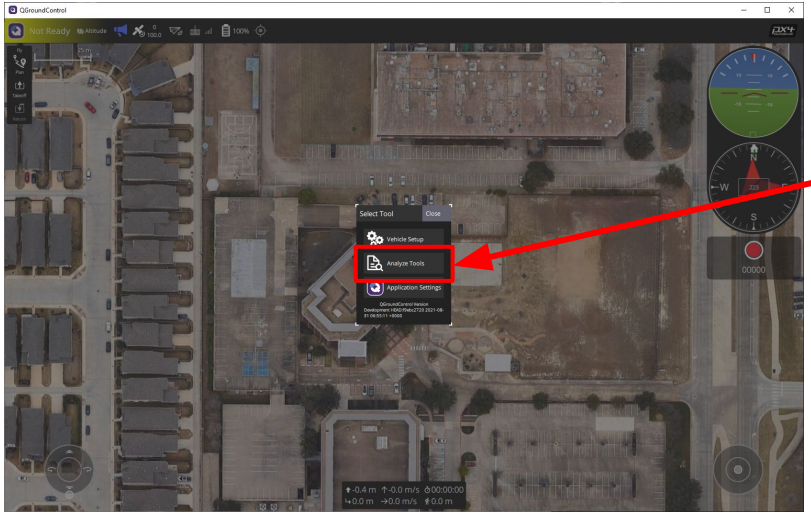
LightWare SF1X/SF02/LW20 Lidar

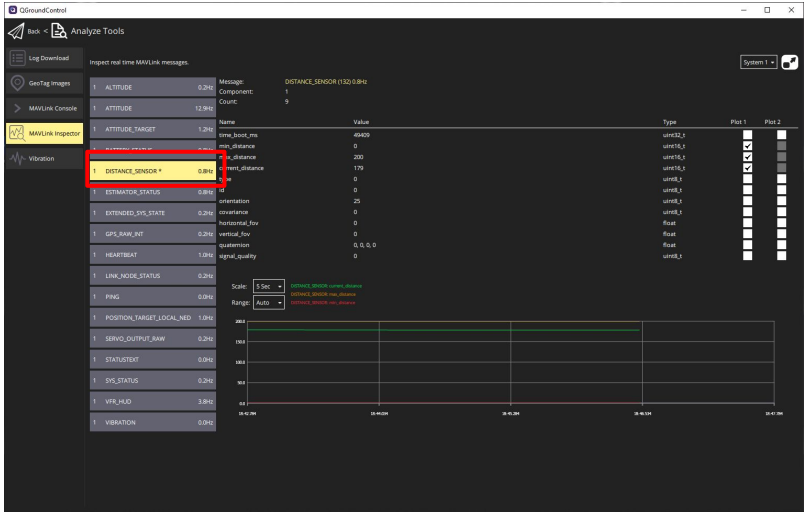
VL53L1X Lidar

SENS_EN_XXXXX set to “1”

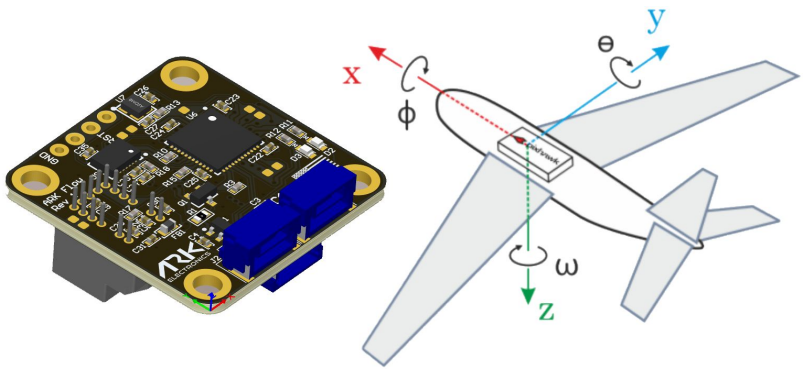
- SENS_EN_VL53L1X
- SENS_EN_LL40LS
- SENS_EN_SF1XX
- …and others

Step 8 - Parameters (**Range finders**, Optical Flow)





Step 8 - Parameters (Range finder, **Optical flow**)

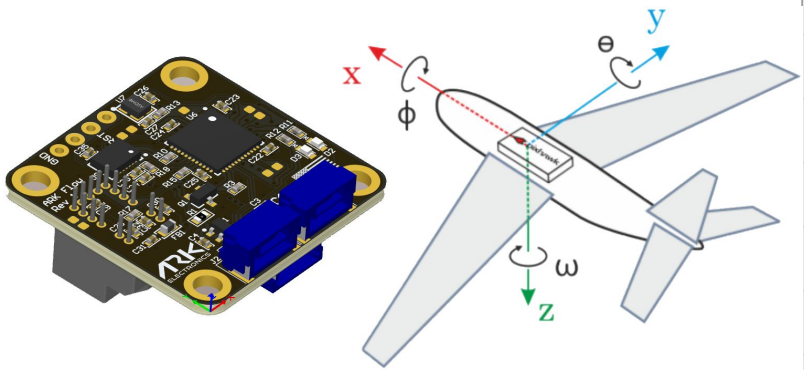


[ARK Flow - ARK Electronics]

Step 8 - Distance Sensors (Range finder, **Optical flow**)

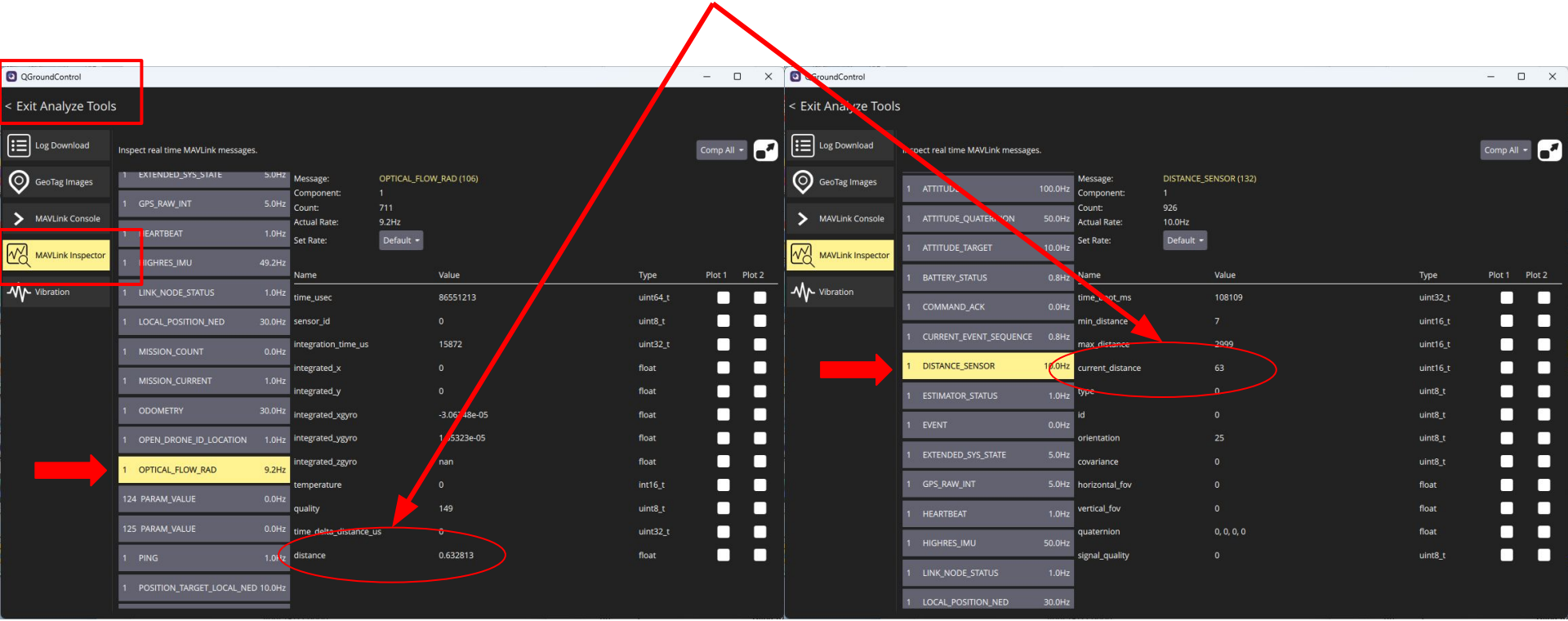
QGroundControl [parameters for the ARK Flow]

UAVCAN_ENABLE	2 (reboot required to detect CAN sensors)
EKF2_OF_CTRL	enable
EKF2_GPS_CTRL	0
UAVCAN_SUB_FLOW	enable
UAVCAN_SUB_RNG	enable
EKF2_RNG_A_HMAX	10 m (32.8 ft)
EKF2_RNG_QLTY_T	0.2 s
UAVCAN_RNG_MIN	0.08 m (0.26 ft)
UAVCAN_RNG_MAX	30 m (98.4 ft)
SENS_FLOW_MINHGT	0.08 ft (0.26 ft)
SENS_FLOW_MAXHGT	25 m (82 ft)
SENS_FLOW_MAXR	7.4
EKF2_OF_POS_X, EKF2_OF_POS_Y, EKF2_OF_POS_Z	Set X, Y, Z positions of the optical flow focal point in the body frame (refer to diagram for +/-)



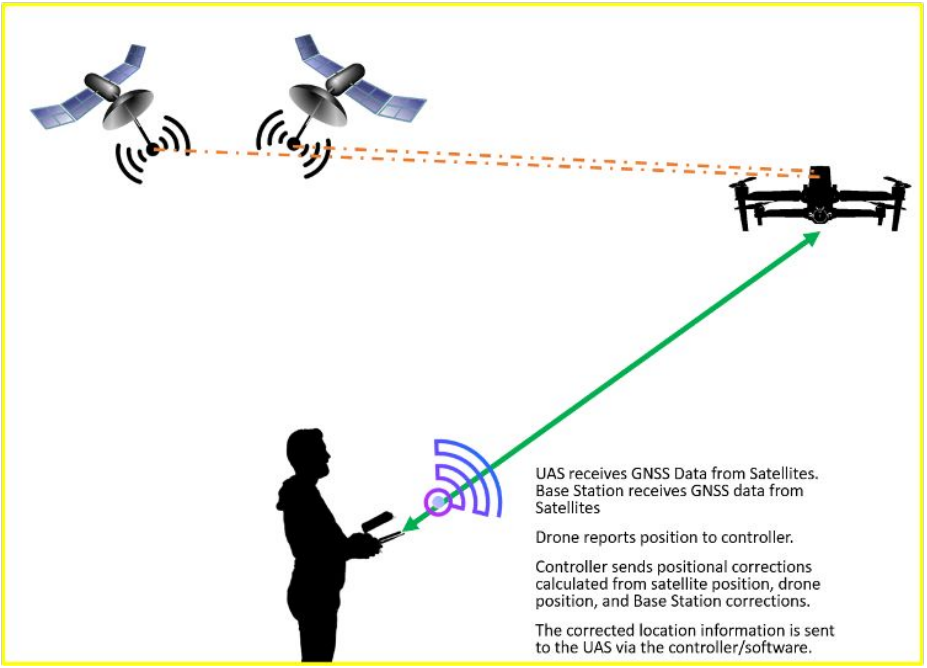
Step 8 - Distance Sensors (Range finder, **Optical flow**)

Check the distances to make sure the optical flow sensor is functioning correctly. Values *may* be in meters or centimeters.

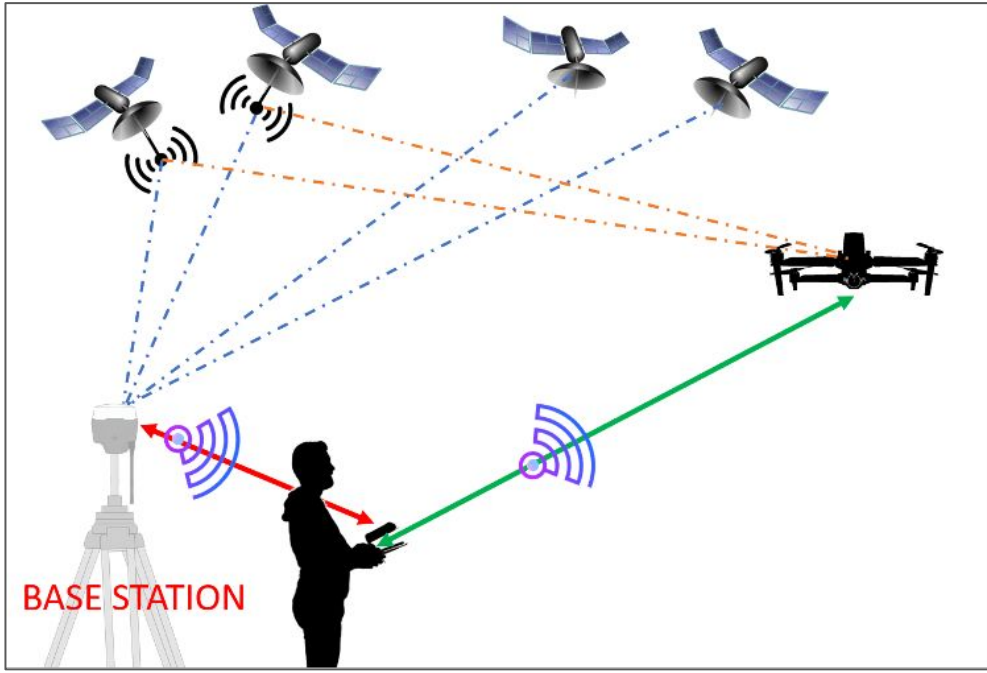


GPS & TELEMETRY

HOW A NON-RTK AIRCRAFT CAPTURES AERIAL POSITION
(2 - 3 m accuracy)

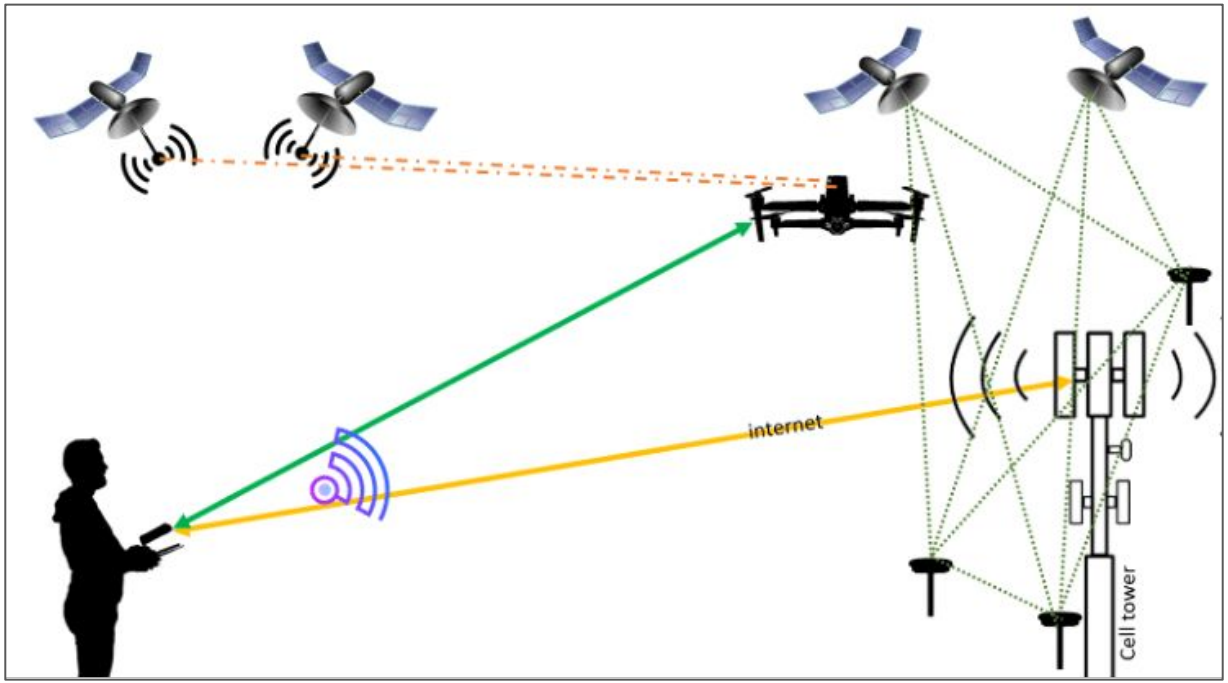


HOW AN RTK-CAPABLE AIRCRAFT CAPTURES POSITION with a BASE STATION
(cm accuracy)



Reference: https://dronelife.com/2022/03/20/rtk-and-drone-mapping-do-you-need-it-is-it-worth-it/

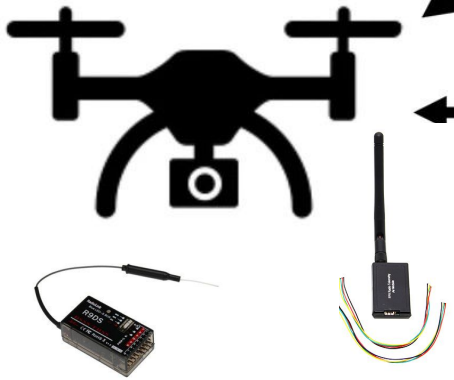
HOW AN RTK AIRCRAFT DETERMINES
POSITION with NTRIP



Reference: https://dronelife.com/2022/03/20/rtk-and-drone-mapping-do-you-need-it-is-it-worth-it/

GPS satellites

RC Transmitter



Telemetry link

RC Receiver

Internet, optional

GPS & TELEMETRY

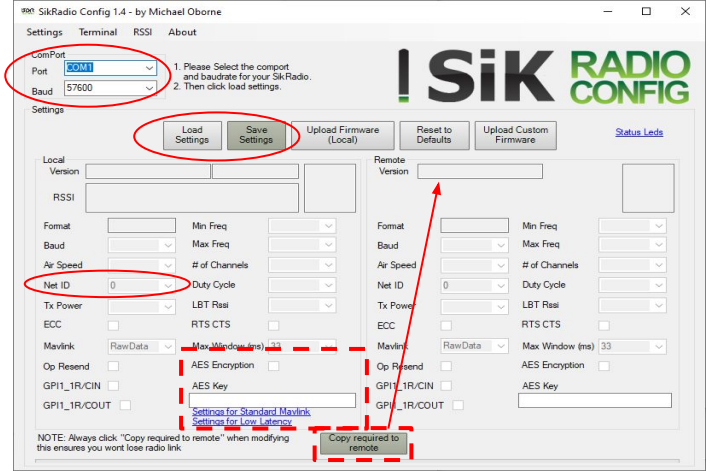
Telemetry frequency

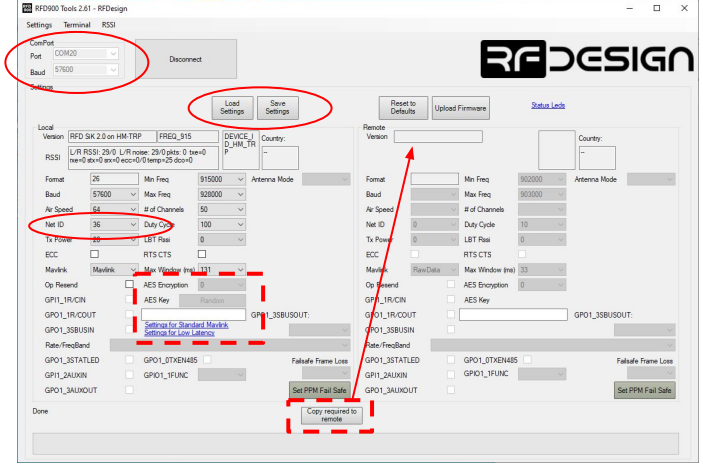
- 915 Mhz (US)
- 433 Mhz (Europe)

Configure **Net ID** for your telemetry module

- Use modem AT commands
  - https://docs.px4.io/main/en/data_links/sik_radio.html

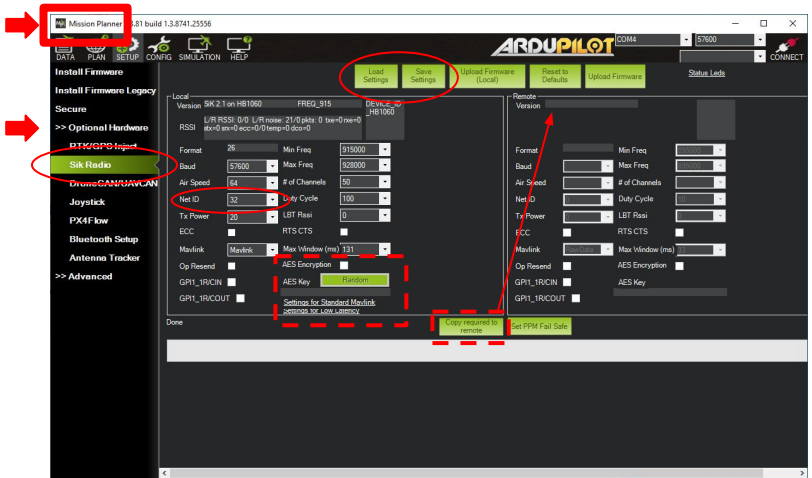
- Use the Radio Configuration tool
  - ~~http://vps.oborne.me/3drradioconfig.zip~~
  - https://files.rfdesign.com.au/
    - https://files.rfdesign.com.au/Files/tools/RFDTools-V2.61.zip
  - Mission Planner GCS (https://ardupilot.org/planner/)





http://vps.oborne.me/3drradioconfig.zip

https://files.rfdesign.com.au/Files/tools/RFDTools-V2.61.zip

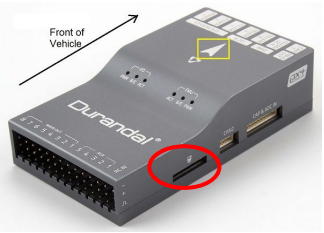


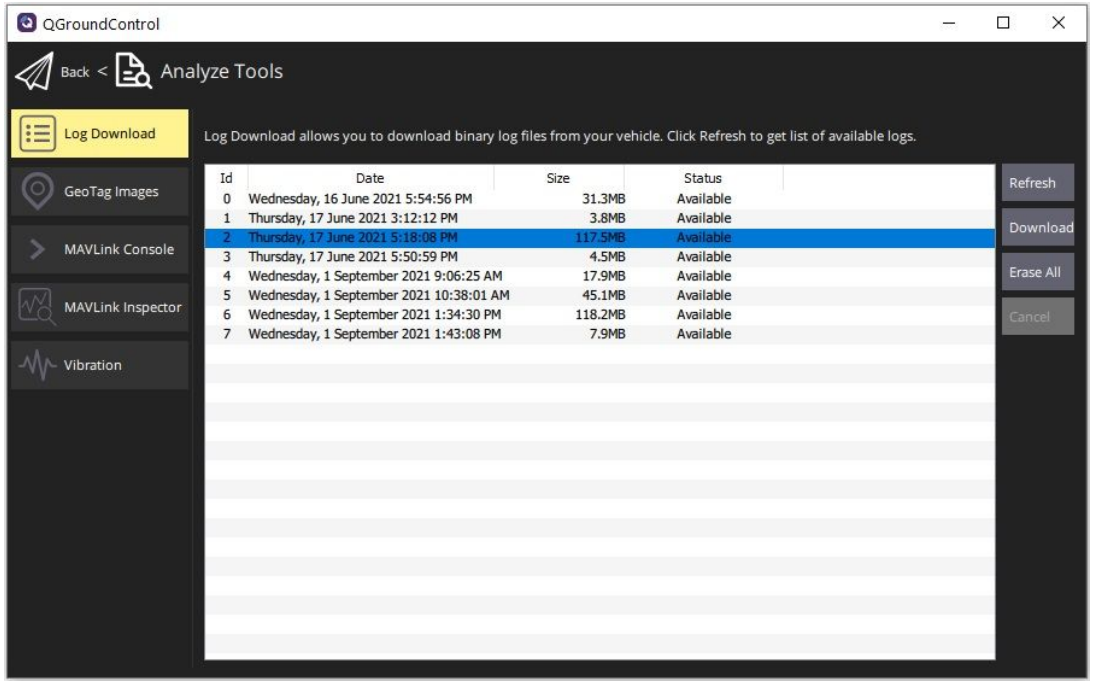
https://ardupilot.org/planner/

OPTIONAL - Telemetry Logs & Post Flight Analysis

Telemetry Logging (The Black Box)

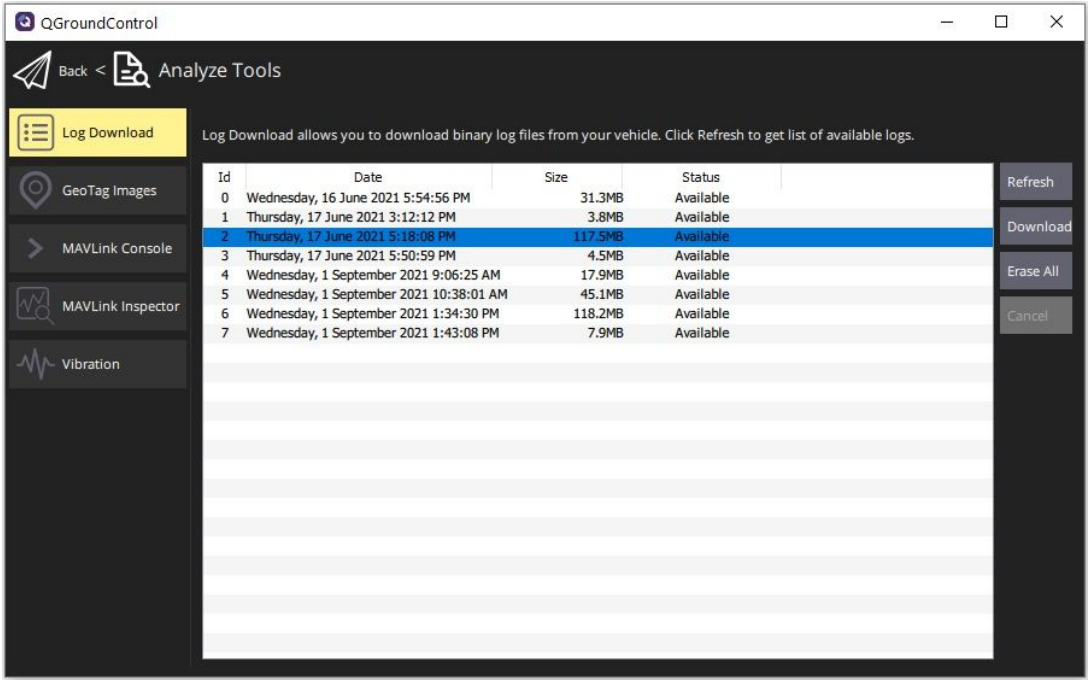
- Flight control logs are stored on the SD Card of the Pixhawk FC, or
- Logs can be downloaded using QGroundControl: Analyze View > Log Download.





Analysing The Logs

- Upload the log file to the online Flight Review tool (http://logs.px4.io)
- After upload you'll emailed a link to the analysis page for the log



- Flight control logs are stored on the SD Card of the Pixhawk FC, or
- Logs can be downloaded using QGroundControl: Analyze View > Log Download
- Telemetry, flight path to analyze performance, flight mishaps, or other incidents