

QDrone 2

User Manual – System Hardware

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This equipment is designed to be used for educational and research purposes and is not intended for use by the public. The user is responsible for ensuring that the equipment will be used by technically qualified personnel only.
NOTE: While the GPIO, and USB ports provides connections for external user devices, users are responsible for certifying any modifications or additions they make to the default configuration.

FCC Notice This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Contains FCC ID: SQG-6oSIPT

Industry Canada Notice This Class A digital apparatus complies with CAN ICES-3 (A). Cet appareil numérique de la classe A est conforme à la norme NMB-3 (A) du Canada.

Contains IC: 3147A-602230C

Waste Electrical and Electronic Equipment (WEEE)



This symbol indicates that waste products must be disposed of separately from municipal household waste, according to Directive 2012/19/EU of the European Parliament and the Council on waste electrical and electronic equipment (WEEE). All products at the end of their life cycle must be sent to a WEEE collection and recycling center. Proper WEEE disposal reduces the environmental impact and the risk to human health due to potentially hazardous substances used in such equipment. Your cooperation in proper WEEE disposal will contribute to the effective usage of natural resources.



This product meets the essential requirements of applicable European Directives as follows:

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 2014/53/EU; Radio Equipment Directive (RED)

Warning: This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.



During flight QDrone 2 sound pressure level has been measured at 92 dBA at 1m away from the QDrone 2 and it is considered hazardous. Users shall ensure that they are not exposed to a sound level greater than the hazardous level as defined by the local authority. Use protective earpieces during operation.



The Intel RealSense D435 RGB-D camera is classified as a Class 1 Laser Product under the IEC 60825-1, Edition 3 (2014) internationally and EN 60825-1:2014+A11:2021 in Europe. The camera complies with FDA performance standards for laser products except for conformance with IEC 60825-1 Ed. 3 as described in Laser Notice No. 56, dated May 8, 2019.

Do not power on the product if any external damage is observed. Do not open or modify any portion of any laser product as it may cause the emissions to exceed Class 1. Invisible laser radiation when opened. Do not look directly at the transmitting laser through optical instruments such as a magnifying glass or microscope. Do not update laser product firmware unless instructed by Quanser.

Regular maintenance of QDrone 2:

- Inspect the propellers before flight to confirm they are not damaged or loose (able to move while the motor is not moving).
- Prior to using the QDrone 2, visually inspect the LiPo battery for damage (e.g., bloating). **DO NOT USE** the battery if damaged.
- Ensure that the battery and its cables are secured using the provided straps to avoid movement or damage during flight.
- Inspect the QDrone 2 frame before and after each flight to confirm that no major structural damage exists. Repair if needed.

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A. Hardware Components

The main components for the QDrone 2 are listed in Table 1.

ID	Component	ID	Component
1	Intel RealSense D435	12	LCD display
2	Right CSI camera	13	ESC Enable
3	Rear CSI camera	14	Programable LEDs
4	Left CSI camera	15	USB3 Port
5	Downward Greyscale camera OV9281	16	Micro USB2 Port
6	WiFi 802.11 a/b/g/n/ac with dual antennas	17	NVIDIA Jetson Xavier NX
7	Expandable I/O	18	Brother Hobby Brushless motors
8	Micro-HDMI Port	19	Optical Flow Camera
9	Power Button	20	Height Sensor
10	XT-60 battery connector	21	15x1mm FPC RPi Connector
11	LiPo battery compartment		

Table 1. QDrone2 Components

i. Nvidia Jetson Xavier NX

The QDrone2 is powered by a NVIDIA Jetson Xavier NX with 384CUDA® Cores and an NVIDIA Volta™ GPU architecture with 48 Tensor Cores. It also features a 6-Core NVIDIA Carmel ARM® 64-Bit CPU. More information on this board can be found [here](#).

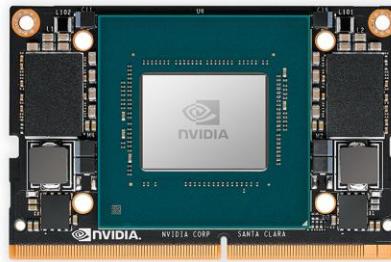


Figure 1. NIVIDIA Jetson Xavier NX Processor

The board includes 16 GB of storage via an eMMC and 8 GB of 128-bit LPDDR4X 1866 MHz 59.7 GB/s memory. Ubuntu 18.04LTS is installed in the 128GB SD card provided.

ii. Intel RealSense D435 Camera

The QDrone2 comes equipped with an Intel RealSense D435 RGB-D camera. It includes an IR projector and two IR imagers, making this unit a stereo tracking solution. The camera can provide RGB, Infrared (left and right) and depth streams of data at frame rates and resolutions summarized in Table 2, as well as at fields of view in Table 3. More information can be found [here](#).



Figure 2. Intel RealSense D435 RGBD camera

RGB		Infrared		Depth	
Resolution	Max. FPS	Resolution	Max. FPS	Resolution	Max. FPS
1920 x 1080	30	1280 x 800	30	1280 x 720	30
1280 x 720	30	1280 x 720	30	848 x 480	90
960 x 540	60	848 x 480	90	848 x 100	100
848 x 480	60	848 x 100	100	640 x 480	90
640 x 480	60	640 x 480	90	640 x 360	90
640 x 360	60	640 x 360	90	480 x 270	90
424 x 240	60	480 x 270	90	424 x 240	90
320 x 240	60	424 x 240	90	256 x 144	90
320 x 180	60	256 x 144	90		

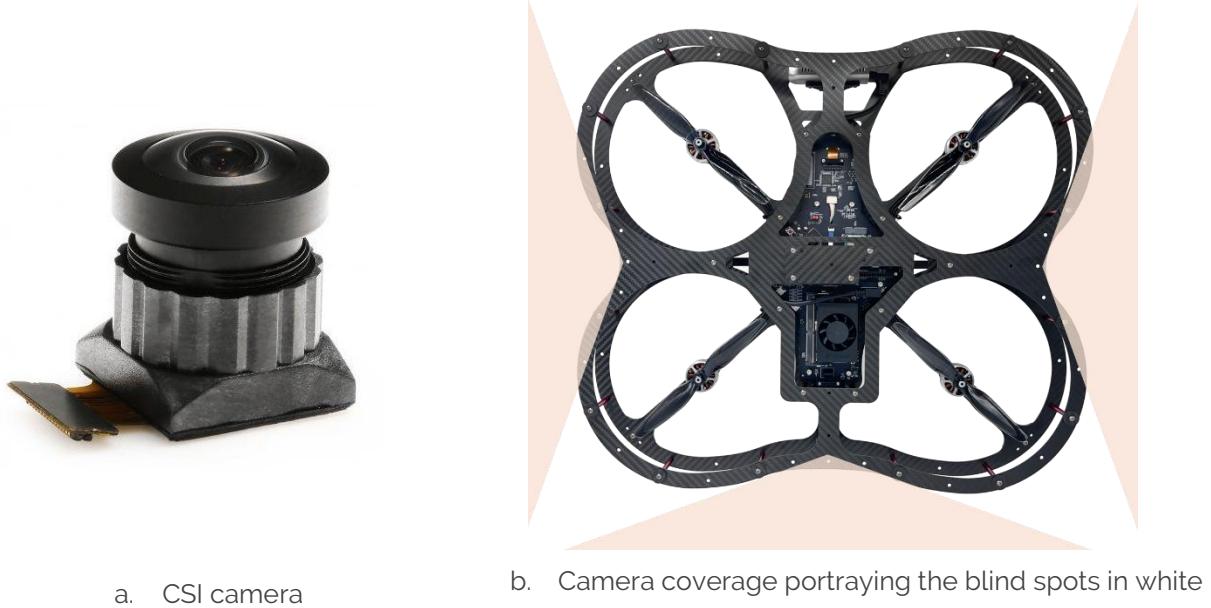
Table 2: Intel RealSense resolutions and frame rates

Camera	Horizontal	Vertical	Diagonal
RGB	69.4° ± 3°	42.5° ± 3°	77° ± 3°
Depth	87° ± 3°	58° ± 1°	95° ± 3°

Table 3. Intel RealSense D435 field of view

iii. CSI Camera Suite

The QDrone2 provides 3 CSI cameras along with the Intel RealSense to give a complete 360° view (Figure 3a). Each camera has a wide-angle lens providing up to 160° Horizontal-FOV (field of view) and 120° Vertical-FOV. The corresponding blind-spots are shown below in Figure 3b.



a. CSI camera

b. Camera coverage portraying the blind spots in white

Figure 3. CSI cameras with wide angle lenses and field of view via their placement.

These cameras are indexed in Simulink, Python and C/C++ using the camera IDs as presented in Table 3. The frame resolutions, frame rates and corresponding FOV are documented in Table 4.

Camera	ID
Right	0
Rear	1
Left	2

Table 3. Camera indexing IDs

Resolution	Max Frame Rate (FPS)	Horizontal FOV	Vertical FOV
3280 x 2464	21 Hz	160°	120°
1640 x 1232	80 Hz	160°	120°
820 x 616	80 Hz	160°	120°
1640 x 820	120 Hz	160°	80°
820 x 410	120 Hz	160	80°

Table 4. Achievable frame rates for CSI cameras

iv. Brother Hobby Motors

The QDrone2 comes equipped with 4 Brother Hobby 2806.5-1300Kv brushless motors. Onboard motor command modulation is done from the microcontroller to prevent overheating from damaging the ESC or the onboard PCB.

When sending a 100% duty cycle command the onboard modulation will send a command signal with the following characteristics:

- A 1s burst at 80% duty cycle followed by a 5s continuous signal at 70%

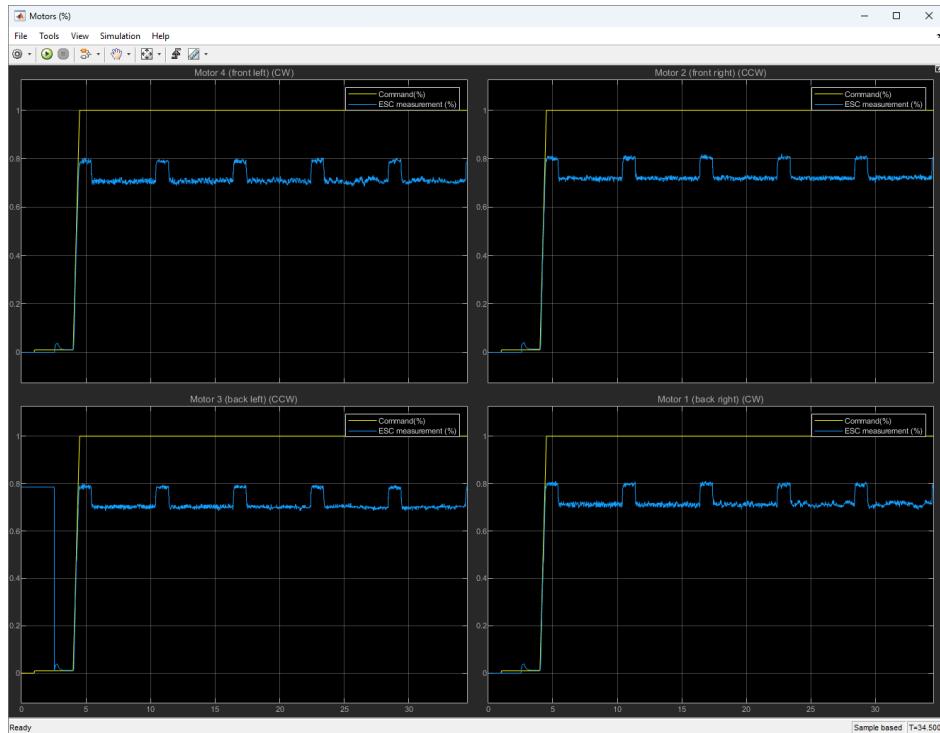


Figure 4. Firmware throttle limits applied to a continuous 100% duty cycle command.

Symbol	Description	Value
K_V	Motor speed constant	1300 RPM/V

Table 5: Brother Hobby motor thrust constant.

v. Height Sensor

The QDrone2 comes with a VL53L1X Time of Flight optical distance sensor for measuring the distance of a surface to the underside of the QDrone2. Distance measurements can be performed in the three following modes:

Description	Value	Max Sampling Rate
Short	1.3 m	50Hz
Medium	3.0m	30Hz
Long	4.0m	30Hz

Table 6: VL53L1x max distance parameters.

For more information on the VL53L1x module you can click [here](#).

vi. Battery

QDrone2 uses a 4S (4-cell 15.6 Volts) 3700 mAh capacity lithium polymer (LiPo) battery (Figure 5a) with a female XT-60 connector. More information on the provided battery is summarized in Table 7. The battery can be charged using the provided EV-Peak E4 charger (Figure 5b). Under-voltage protection ensures that the QDrone 2 automatically shuts down when the battery voltage drops below 14V. For more information, see the [User Manual - Power](#) document.



Caution: A battery voltage below 13.3V increases the risk of uneven charge between the three cells. If you experience issues charging a battery that is consistently below 13.3V, discard it in accordance with your country's relevant recycling and disposal laws.



- a. LiPo 4s 3700mAh with balancer cable (5 wire connector) and XT60 female connector b. EV-Peak E4 charger

Figure 5. LiPo battery and charger provided with the QDrone

#	Item	Value
1	Cells	4S (4 cells in series)
2	Battery capacity	3700 mAh
3	Minimum continuous discharge rating	45 C
4	Connector on battery side	XT60 (Female)
5	Maximum voltage per cell	4.2 V
6	Nominal voltage per cell	3.7 V
7	Minimum voltage per cell	3.5 V
8	Battery weight	372 grams
9	Battery dimensions (LxWxH)	136 mm x 41 mm x 27 mm

Table 7. LiPo battery characteristic

a. LiPo Battery Safety



Caution: Before using any batteries, chargers/balancers, or power supplies, users must first read the manuals packaged with their equipment. Quanser supplies these guidelines for charging batteries, but it is the users' responsibility to ensure they are operating their equipment safely and correctly. Quanser is not responsible for any damages resulting from use of batteries, power supplies, chargers, or balancers.



Caution: Prior to using the QDrone 2, visually check the battery for bloating or damage. If the battery exhibits bloating **DO NOT USE** it. Visual bloating of the battery is dangerous - discard it in accordance with your country's relevant recycling and disposal laws.

Note: Use and store batteries in a dry environment.



Caution: Do not charge the battery under direct sunlight.



Caution: Do not charge the battery when the battery feels hot.



Caution: Always be present when charging batteries and **do not leave batteries connected to the chargers or the QDrone 2 overnight.**



Caution: Charge and store LiPo batteries in a location where a battery fire or explosion (including smoke hazard) will not endanger life or property.



Caution: Keep LiPo batteries away from children and animals.



Caution: Never charge a LiPo battery that has ballooned or swollen due to overcharging, undercharging or from a crash.



Caution: Never charge a LiPo battery that has been punctured or damaged in a crash. After a crash, inspect the battery pack for signs of damage.



Caution: Never charge the LiPo battery in a moving vehicle.



Caution: Never overcharge the LiPo battery.



Caution: Never leave the LiPo battery unattended during recharging.



Caution: Do not charge LiPo batteries near flammable materials, liquids or objects.



Caution: Ensure that charging leads are connected correctly. Reversing polarity charging can lead to battery damage, fire or explosion.



Caution: A LiPo battery fire is a chemical fire. Have a suitable fire extinguisher (class D/for electrical fires) or a large bucket of dry sand near the charging area. Do not try to extinguish electrical battery fires with water.



Caution: Reduce risks from fire/explosion by storing and charging LiPo batteries inside a suitable container: a LiPo storage sack/bag or metal/ceramic container is advised.



Caution: Protect your LiPo batteries from accidental damage during storage and transportation. Do not put battery packs in pockets or bags where they can short circuit or come into contact with sharp or metallic objects.



Caution: If your LiPo battery is subjected to a shock (such as a crash) you should place it in a metal container and observe signs of swelling or heating for at least 30 minutes.

Ensure that the metal container doesn't short the leads of the battery, which may cause a fire!



Caution: Do NOT attempt to disassemble, modify, or repair the LiPo battery.



Caution: Never use a battery that is warm from charging or charge a battery that is warm from usage.

Note: Consider how you would deal with a LiPo battery fire/explosion as part of your normal fire safety and evacuation planning.

Note: When discarding a LiPo battery, discard it in accordance with your country's relevant recycling and disposal laws.

Note: Monitor charging LiPo batteries for signs of overheating.

The battery's performance has been summarized in Table 8 below.

Condition	Battery Life
Hover Flight (no payload)	8 min 30 s

Table 8. Battery performance at hover

vii. IMU

The platform includes 2 6-axis IMU. The specifications are summarized in Table 9 below.

Sensor	Description
Accelerometer	16-bit with configuration range $\pm 2g$ to $\pm 16g$
Gyroscope	Configurable range from $\pm 125 \text{ } ^\circ/\text{s}$ to $\pm 2000 \text{ } ^\circ/\text{s}$

Table 9. IMU specifications for QDrone2

vii. Dimensions

The QDrone 2 has the following dimensions:

Item	Value
Length	442.58mm
Width	490.8mm
Height	135.53mm
Weight	1180 \pm 25 g

Table 10. QDrone2 dimensions

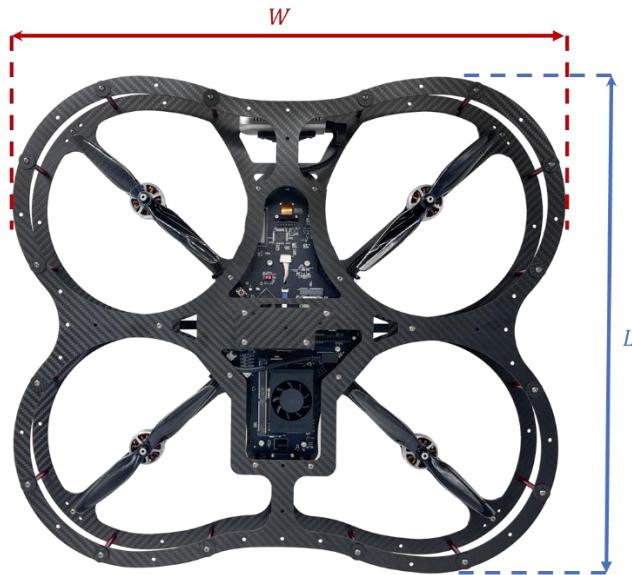


Figure 6. QDrone2 dimensions top view

ix. PCB and integrated Data Acquisition (DAQ)

The QDrone2 PCB is equipped with a wide array of components to support expanded I/O capabilities. These components are summarized in Table 11 and displayed in Figure 7. These I/O include:

1. 6 3.3V PWM output channels: Four PWM output channel to command the Brother Hobby motor plus two additional PWM outputs for ESCs or servos. Standard PWM, OneShot, Multishot and DShot are all supported.*
2. One unipolar user analog input channels, 12-bit, +3.3V*
3. 6 reconfigurable 1.8V digital I/O*
4. 2 LEDs (intensity cannot be controlled)
5. 2 6-axis IMU
6. 2 5V-tolerant encoder inputs. Supports two quadrature encoder inputs with 16-bit count values.
7. 2 general purpose 1.8V high-speed serial ports (up to 4 Mbaud)*
8. 1 high-speed 1.8V SPI port with 2 chip selects (up to 25 MHz)*
9. 1 high-speed 1.8V SPI port with 1 chip select (up to 25 MHz)*
10. 2 3.3V I2C ports (up to 1 MHz)*

* See figure 10 for pin diagram

ID	Description	ID	Description
1	User LEDs*	8	Nvidia Jetson Xavier NX*
2	J3 (User analog, digital, PWM and encoders)*	9	Programmable LCD*
3	ESC PWM Connector*	10	ESC Enable Switch*
4	WiFi Module*	11	Power Button*
5	J12 (User digital, I2C, SPI and UART)*	12	RPi camera connector*
6	USB3 Port*	13	Micro USB2 debug port*
7	J15 Power Connector*	14	Micro-HDMI Port*

Table 12. QCar PCB components (* See Figure 10 for pin diagram)

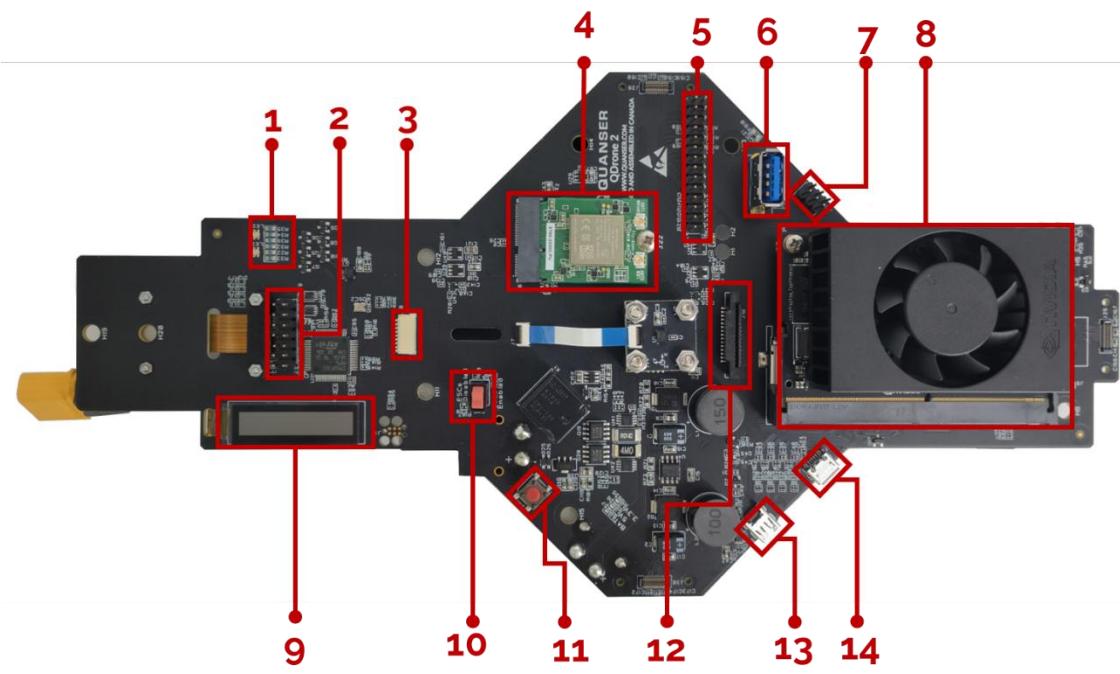


Figure 7. QDrone2 PCB components

The QDrone board has a number of connectors for expansion I/O. These connectors and their pinouts are listed below. Note that all pins are either 1.8V or 3.3V and are *not* 5V tolerant unless marked otherwise. Nor are the 1.8V pins 3.3V tolerant. The analog inputs only support 0 to +3.3V. *Exceeding these voltages may damage the board!*

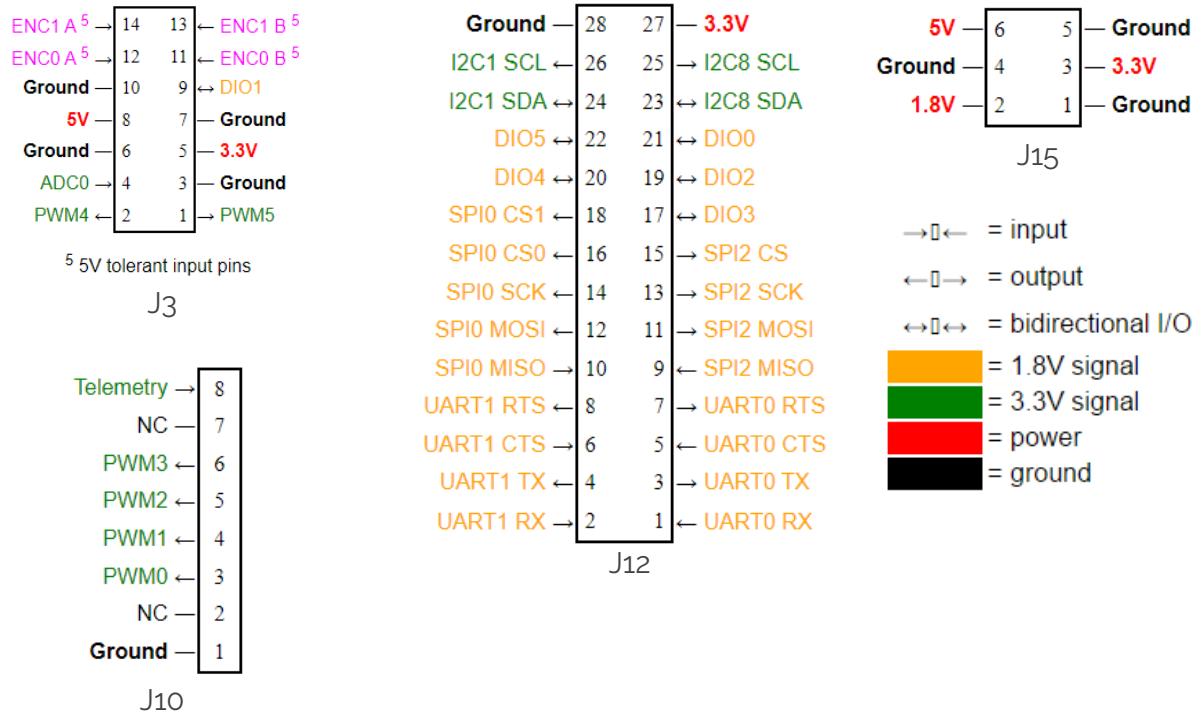


Figure 10. Pin I/O diagram (max current - 5A for 5V pins, 5A for 3.3 V pins, 0.2A for 1.8V pins)

B. Environmental

The QCar is designed to function under the following environmental conditions:

- Standard rating
- Indoor use only
- Temperature 5°C to 40°C
- Altitude up to 2000 m
- Maximum relative humidity of 80% up to 31°C decreasing linearly to 50% relative humidity at 40°C
- Pollution Degree 2
- Mains supply voltage fluctuations up to 10% of nominal voltage
- Maximum transient overvoltage 2500 V
- Marked degree of protection to IEC 60529: Ordinary Equipment (IPX0)

C. Electrical Considerations



ESD warning

The QDrone 2 internal components are sensitive to electrostatic discharge. Before handling the QDrone 2, ensure that you have been properly grounded.



Caution

Maximum recommended total current draw from the power pins on user headers is

- 5 Amps for 5V
- 5 Amps for 3.3V
- 0.2 Amps for 1.8V



Caution

Do not have conductive material touch either the top or bottom surface of the PCB as it can short the LiPo battery, cause sparks and damage the electronics.



Caution

Do not remove the NVIDIA Jetson Xavier NX fan connector or obstruct the fan as it may cause overheating and damage the Xavier NX.



Caution

The QDrone 2 is not waterproof.

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