

# Bolt & BigQuad deck workshop

**BAM days**  
19 October 2021



bitcraze Awesome Meetup Days

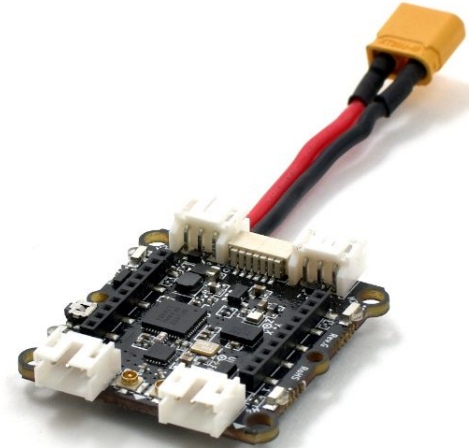
# Agenda

- Introduction
- Design & limitations
- Building an example setup
- Configuration & tuning
- Future work
- Q&A



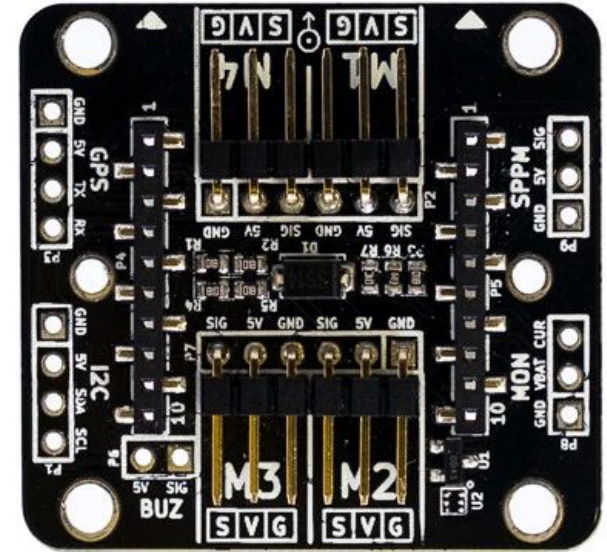
# Introduction

- BigQuad deck is a cost efficient way to build a bigger drone using the Crazyflie 2.X as a flight controller.
- Crazyflie Bolt is a Crazyflie 2.X compatible flight controller for brushless builds, all in one board.

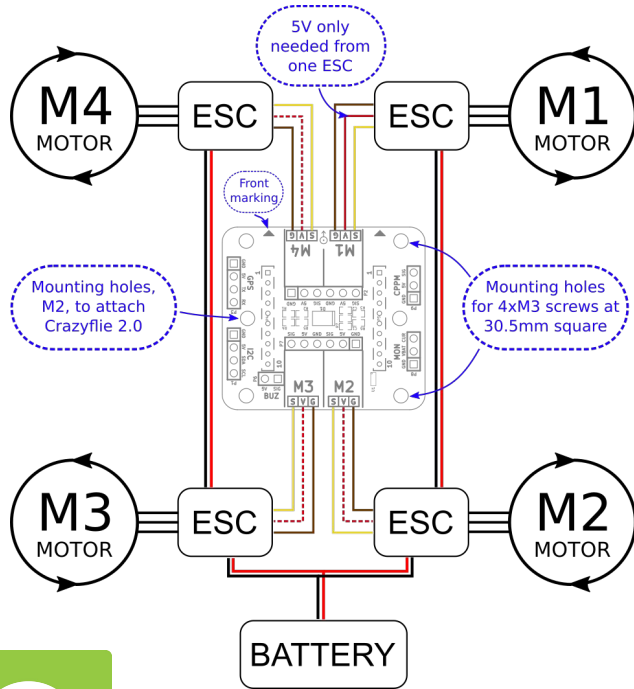


# Introduction - BigQuad deck

- Breaks out the deck expansion port pins for easier access
  - 4 x ESC (Electronic Speed Controller) connectors
  - Radio receiver input (SPPM/CPPM) (3 pin)
  - GPS input (4 pin)
  - I2C expansion (4 pin)
  - Battery and current monitoring input (3 pin)
  - Buzzer output (2 pin)
- “Standard” M3 mounting holes placed 30.5mm square to fit many different frames.

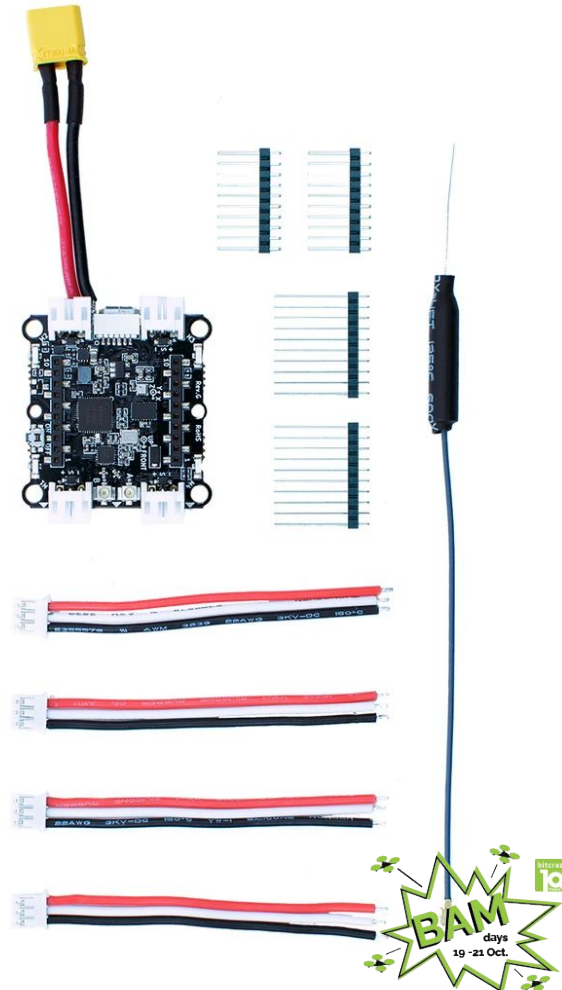


# Introduction - BigQuad deck



# Introduction - Bolt kit

- Does not “hog” any deck pins
- Fully compatible with the CF2 firmware, expansion decks as well as radio.
- Connectors to attach motor controllers (also possible to solder though) so it is easy to build and repair.
- Power distributions built into controller board. (Max ~8A per motor controller) with XT30 connector.
- Motor controllers can be switched off by the system (MOSFET) so the system can go into deep sleep and only consume around 50uA.
- Voltage input 1S-4S (3V to 17V).
- Standard mounting (M3 mounting holes spaced 30.5mm in a square).
- External antenna for increased range.
- SPI connected IMU (BMI088) for minimum latency.



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# Design - Bolt

MOSFET to control power to ESC or drive brushed motor.

Power distribution inside board with XT30 connector

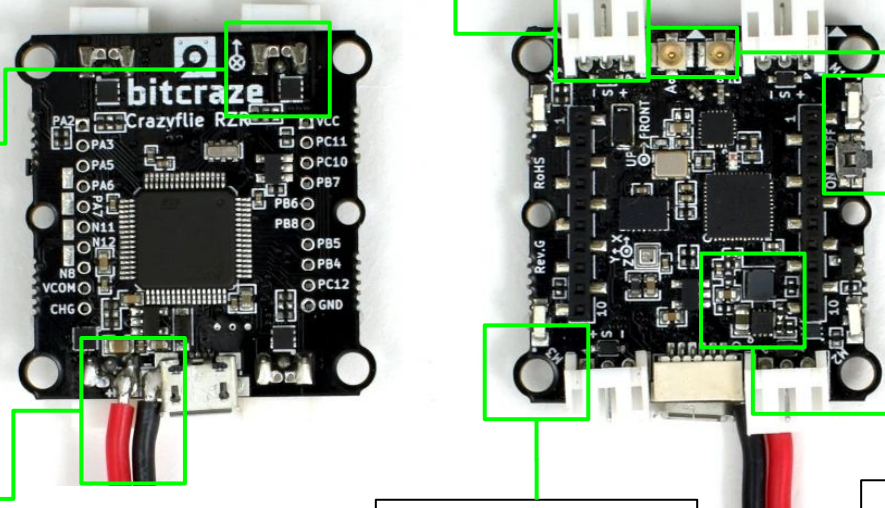
JST-PH connectors for ESCs

External antenna output, u.FL connector

Power button and LEDs now mounted on the side

4 x M3 - 30.5mm squared mounting holes added

3-17V DC/DC converter replacing 1-cell charger. 500mA max





# Limitations - Bolt

- The ESC on/off MOSFET together with the connector limits the peak current to around 8A per ESC.
- The battery DC/DC converter limits the 5V (VCOM) to 500mA and the base system consumes around 100mA of those. Decks will add more.
- 1-Cell (3.0 - 4.2V) issues
  - The off current is higher than expected and around 1mA. Unplug battery when not used
  - USB is leaking current and charging the battery unintentionally if both are connected. This potentially damages the battery. Don't have them both connector more then for a short while.



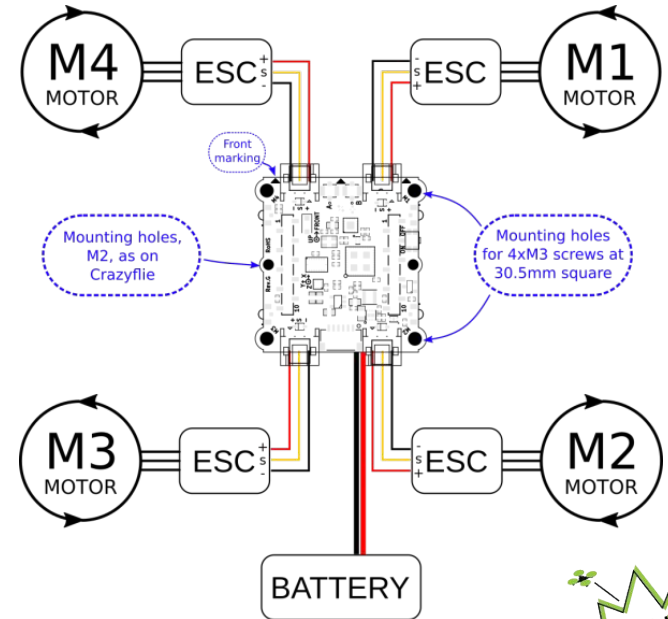
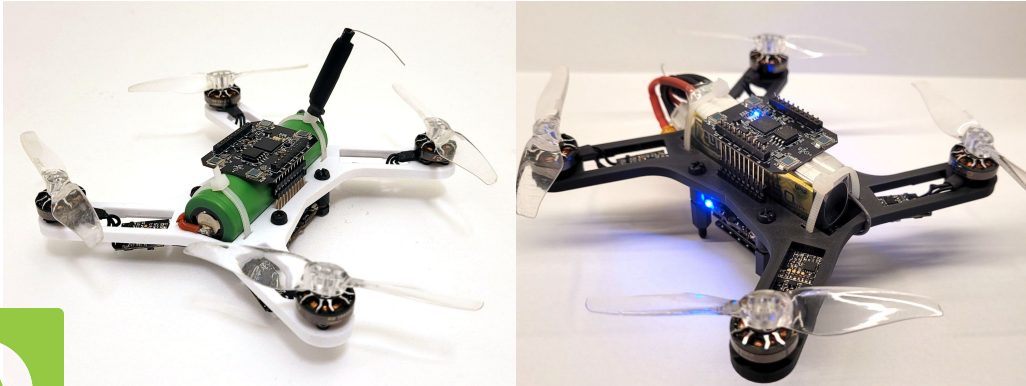
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# Bolt suitable setup examples

- Weight: ~100g
- Lift: 200g - 300g
- Flight time: 10-20 min
- Deck boards above or under



# Bolt 2-cell example setup, 10min hover, 3:1 thrust.

- 1 x Custom designed 130mm 3D printed frame (latest v5)
  - <https://github.com/bitcraze/bitcraze-mechanics/tree/master/models>
- 1 x Crazyflie Bolt flight controller
  - <https://store.bitcraze.io/collections/kits/products/crazyflie-bolt>
- 2 x pin-header and long pin-header soldered together
  - <https://store.bitcraze.io/collections/spare-parts/products/male-long-deck-connector>
  - <https://store.bitcraze.io/collections/spare-parts/products/male-deck-connector>
- 4 x Gemfan Hurricane 3018 (2xCW + 2xCCW)
  - Match prop hole size to motor shaft size (1.5mm or 2mm)
- 4 x Flywoo ROBO RB 1202.5 5500 Kv motors
- 1 x Tattu R-Line 550 mAh 2S 95C LiPo with XT30
- 4 x Flash hobby 7A 1-2S ESC
- 2 x Zip-ties to fasten battery
- 4 x 7mm M3 Anti-vibration fixed screw spacers
- M3 Nylon screws, nuts and standoffs



# Bolt Li-Ion example setup, 17 min hover, 2:1 thrust

- 1 x Custom designed 130mm 3D printed frame (latest v5)
  - <https://github.com/bitcraze/bitcraze-mechanics/tree/master/models>
- 1 x Crazyflie Bolt flight controller
  - <https://store.bitcraze.io/collections/kits/products/crazyflie-bolt>
- 2 x pin-header and long pin-header soldered together
  - <https://store.bitcraze.io/collections/spare-parts/products/male-long-deck-connector>
  - <https://store.bitcraze.io/collections/spare-parts/products/male-deck-connector>
- 4 x Gemfan Hurricane 3018 (2xCW + 2xCCW)
  - Match prop hole size to motor shaft size (1.5mm or 2mm)
- 4 x Flywoo ROBO RB 1202.5 11500 Kv motors
- 1 x Li-Ion Sony 18650 VTC6 3000mAh 30A
- 1 x XT30 Female with 20AWG cables to solder to the battery
- 4 x Flash hobby 7A 1-2S ESC
- 2 x Zip-ties to fasten battery
- 4 x 7mm M3 Anti-vibration fixed screw spacers
- M3 Nylon screws, nuts and standoffs



# Bolt example setup pointers

## Soldering the ESCs

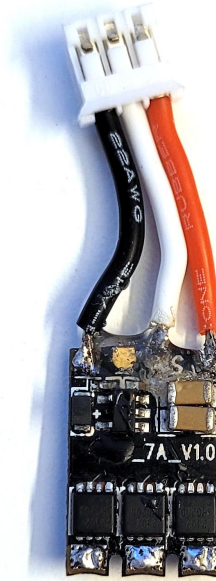
The ESC cables included with the Bolt are quite stiff and the signal pad on the Flash hobby 7A ESC is quite brittle. After soldering the wires apply hot glue to fixate the wires at the ESC to prevent the signal pad from being ripped off.

## Solder pin-headers together

Even the long pin-header is not long enough to reach from the bolt, thought the frame, to above the battery. By soldering pin-headers together longer pins can be created. Match e.g long and short pin-headers to get the wanted length. The picture below is the short and medium length headers. For this setup the short and long headers are probably needed.

## Shorten the Bolt battery wires if needed

The bolt battery wires can be unsoldered, cut and soldered back.



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# Configuration

- Early access products and firmware should be built with compile flags enabled in config.mk to get desired behavior. We recommend:

Applicable	BQ	BQ/Bolt	BQ/Bolt	BQ/Bolt
Flag	ENABLE_BQ_DECK	START_DISARMED	DEFAULT_IDLE_THRUST	ENABLE_ONESHOT125
Description	Needed to build BigQuad deck driver	Parameter system.forceArm must be 1 to enable flight	Brushless motors should not stop unwantedly as they take time to start. Set this so they spin slowly when armed, 5000-7000 is usually good.	Standard motor signal protocol is PWM at 400Hz. Set this to get a newer one-shot protocol with less latency. Supported by most ESCs.





# Tuning - PID

- Rate and Attitude parameters in PID.h
- Position in position\_controller\_pid.c
- Possibly ESC input range should be calibrated which currently requires ESC programming adapter. Most ESC works well out of the box.
- Other controllers are not discussed here



# Tuning - PID rate demo

- Brushless setup is most likely more powerful than the stock Crazyflie 2.1 PID settings.
- Connect using the cfclient and open parameter tab.
- Locate pid\_rate and pid\_attitude parameter group
- Set rate\_pid: roll\_kp, roll\_kd roll\_ki values to half.
- Do flight test and check for ringing/wobbling when doing short and quick roll/pitch movement.
- Increase roll/pitch \_kp if none, decrease if some, until only little ringing is visible.
- Increase roll/pitch \_kd and ki until ringing is gone.

Note values and save in PID.h



# Tuning - PID position demo

- Setup a log variable with `stabilizer.thrust` in `cfclient`
- When hovering using the `cfclient` note the thrust value
- Set `thrustBase` to the hovering value in `position_controller_pid.c`
- Build firmware and flash



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## Future work

- Goal is to bring BigQuad deck and Bolt out of early access during 2021-Q4
- Make configuration and setup easier
  - Persistent parameters so that building new firmware isn't necessary
  - Documentation and getting started guide
- BLHeli passthrough interface to easily configure ESCs
- Simplified arming



Thanks!

# Questions & Answers

