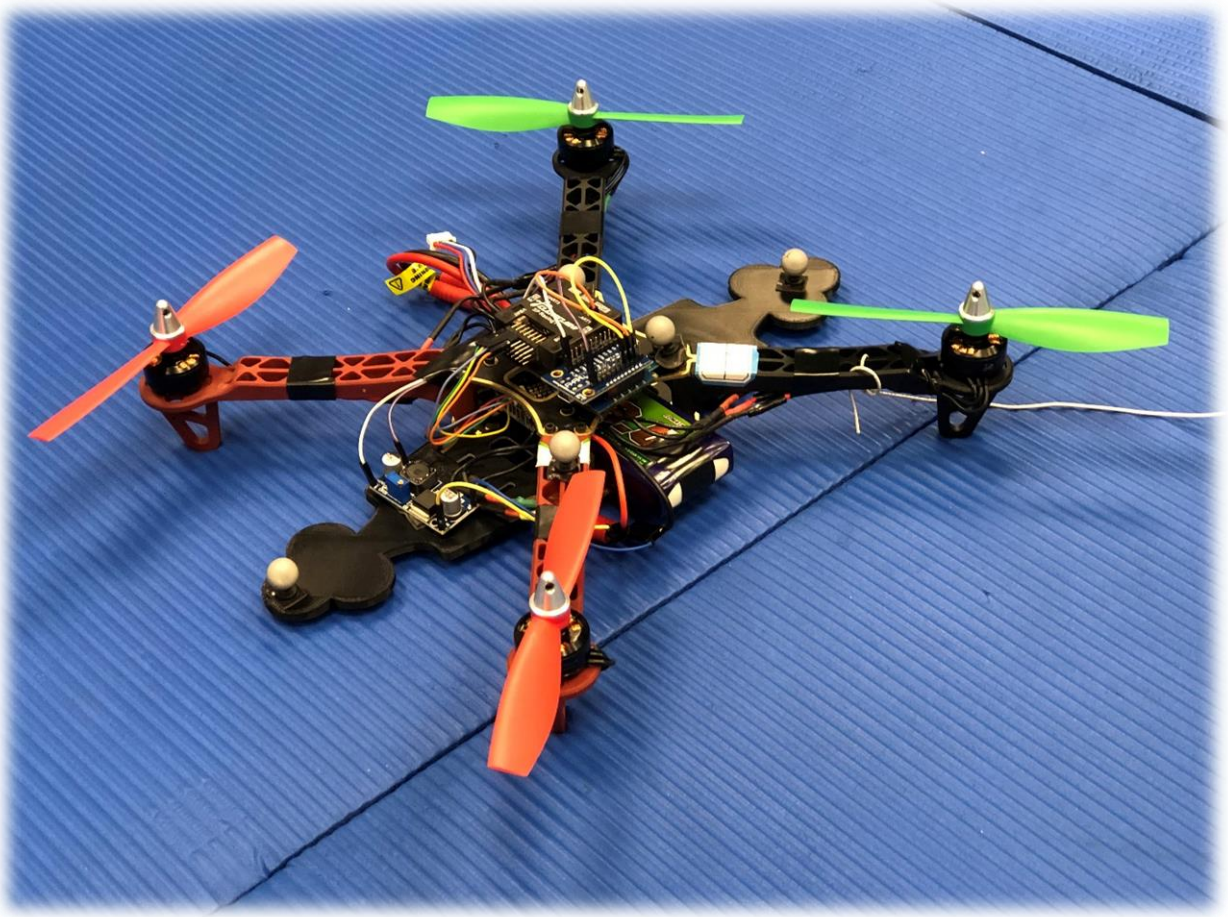
Building a Quadcopter for Research: Essential Parts



Contents

1. Frame

1.1. Description

Model: Flame Wheel 330

Weight: 156g

Diagonal Wheelbase: 330mm

Color: White, Red and Black

Quantity: 1 of whole package (i.e. 4 legs, 1 top board and 1 bottom board)

1.2. Features

- Frame Arms adopt PA66+30GF ultra strength material design, provide better crashworthiness. Using high strength compound
- PCB frame board, which makes wiring of ESCs and battery more safe and easier. Optimized frame design, which provides
- Abundant assemble space for autopilot systems.
- Provide different color frame arms: red, white, black, which makes your flight more colorful.

1.3. Related Links

Shopping link: https://www.banggood.com/DJI-F330-4-Axis-RC-Quadcopter-Frame-Kit-Support-KK-MK-MWC-p-943370.html?ID=49335&cur_warehouse=CN

User Manual:
http://dl.djicdn.com/downloads/flamewheel/en/F330_User_Manual_v1.6_en.pdf

YouTube Video:
https://www.youtube.com/watch?v=jNE7FkHBug8

2. Battery

2.1. Description

Model**: Turnigy nano-tech 3000mah 3S 25~50C Lipo Pack w/XT-60**
Capacity: **3000mAh**
Voltage: **3S1P / 3 Cell / 11.1V**
Discharge: **25C Constant / 50C Burst**
Weight: **231g (including wire, plug & case)**
Dimensions: **150x43x17mm**
Balance Plug: **JST-XH**
Discharge Plug: **XT-60**
Quantity: **1**

2.2. Related Links

Shopping link:
https://hobbyking.com/en_us/turnigy-battery-nano-tech-3000mah-3s-25-50c-lipo-pack-xt-60.html

3. Motors

3.1. Description

Cobra CM-2206/30 Motor Specifications	
Stator Diameter	22.0 mm (0.866 in)
Stator Thickness	6.0 mm (0.236 in)
Number of Stator Slots	12
Number of Magnet Poles	14
Motor Wind	30 Turn Delta
Motor Kv Value	1400 RPM per Volt
No Load Current (Io)	0.52 Amps @ 12 Volts
Motor Resistance (Rm) per Phase	0.185 Ohms
Motor Resistance (Rm) Phase to Phase	0.123 Ohms
Maximum Continuous Current	17 Amps
Max Continuous Power (3-cell Li-Po)	190 Watts
Max Continuous Power (4-cell Li-Po)	250 Watts
Motor Weight	36.5 grams (1.29 oz.)
Outside Diameter	27.0 mm (1.063 in.)
Motor Shaft Diameter	3.00 mm (0.118 in.)
Prop Shaft Diameter	5.00 mm (0.197 in.)
Motor Body Length	16.5 mm (0.650 in.)
Overall Shaft Length	35.3 mm (1.390 in.)
Motor Timing	5-10 degrees
PWM Frequency	8-20 KHz

Quantity: **4**

Included with every Cobra CM-2206 Series Motor is a complete accessory package which contains the following items:

- Four M3x5mm Motor Mount Screws
- Four M3 Flat Washers
- Machined Aluminum Prop Washer
- Locking Prop Nut with Nylon Insert

3.2. Related Links:

More data and performance graphs:
http://www.cobramotorsusa.com/multirotor-2206-30.html

4. Electronic Speed Controller (ESC)

4.1. Description

Model: **Turnigy Multistar BLheli_32 ARM 4-in-1 32bit 21A 11g Race Spec ESC 2~4S (OPTO)**

Constant Current: **4 x 21A**
Cells: **2~4S**
Input Voltage: **8.4v ~ 16.8v**
BEC: **None (opto only)**
MCU: **Arm Cortex-M0**
Timing: **Auto**
Frequency: **48Mhz**
Programmable: **Yes (with Multistar program card)**
PCB Size: **36 x 36 x 5mm**
Weight: **11g**
Quantity: **1**

4.2. Features

- Lightweight (11g)
- 4 x 21A ESC's in one unit
- Very compact
- Smooth and linear throttle control
- Fast response to throttle input
- Arm Cortex-M0 MCU
- Stalled motor protection
- Throttle signal loss protection
- Safe power-on (throttle lockout)
- Supports 480Hz high refresh rates
- Programmable

4.3. Related Links

Shopping link:
https://hobbyking.com/en_us/turnigy-multistar-blheli-32-4-in-1-32bit-21a-11g-race-spec-esc-2-4s-opto.html?___store=en_us

Useful information:
https://oscarliang.com/choose-esc-racing-drones/

5. Flight Controller

5.1. Description

Model: **SP-Racing-F3 (Acro)**

• 36x36mm board with 30.5mm mounting holes.

• ~5 grams.

• STM32F303 CPU with FPU 256kB flash.

• 8MB (64Mbit) High-Capacity Flash (Acro and Deluxe).

• MPU6050 accelerometer/gyro.

• MS5611 barometer (Deluxe only).

• HMC5883 magnetometer (Compass Sensor, Deluxe only).

• Micro USB socket. • 4x 4pin JST-SH sockets (I2C, SWD, 2xUART).

• 2x 8pin JST-SH sockets (PPM, PWM, SERIAL RX, GPIO, ADC, 3V, 5V, GND).

• 8x 3pin though-holes for pin headers for ESC/Servo connections.

• 2x 4pin though-holes for pin headers for 2x serial ports.

• 2x 2pin though-holes for pin headers for battery voltage and buzzer.

• The size of this module(including the box): length and width:39.15mm, height: 14.3mm

• Quantity: **1**

5.2. Related Links

Shopping Link:
https://shop.seriouslypro.com/sp-racing-f3-acro

Data Sheet:
http://seriouslypro.com/files/SPRacingF3-Manual-latest.pdf

6. Propellers

6.1. Description

Size: **6*4.5 inch**

Material: **ABS**

Weight: **5g/pcs**

Quantity: **2 Pairs**

7. Wireless Communication Module

7.1. Description

Model: **Laird RM024-P125-M-30**

Current – Receiving: **36 mA**

Current – Transmitting: **136 mA**

Data Rate: **500 kbps**

Frequency: **2.4 GHz**

Interface: **UART**

Max Operating Temperature: **85 °C**

Min Operating Temperature: **-40 °C**

Sensitivity (dBm): **-95 dBm**

Quantity: **1 Pair (Receiver and Sender)**

7.2. Related Links

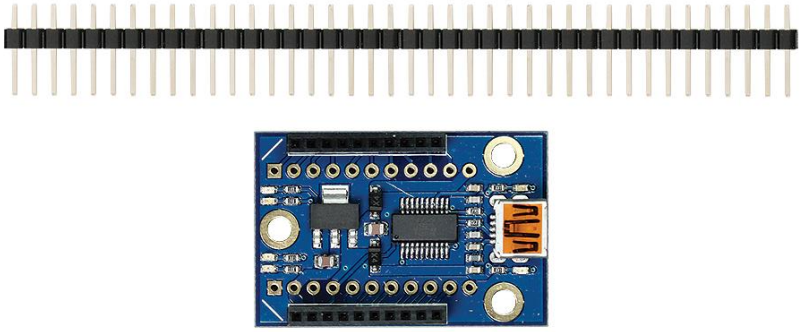
Data Sheet:
https://connectivity-staging.s3.us-east-2.amazonaws.com/2019-02/CS-DS-RM024%20v3_10_0.pdf

User Guide:
https://connectivity-staging.s3.us-east-2.amazonaws.com/2019-02/CS-GUIDE-RM024_v3_6.pdf

Shopping Link:
https://www.digikey.com/product-detail/en/laird-wireless-thermal-systems/RM024-P125-M-30/RM024-P125-M-30-ND/4863729

8. USB Adapter Board

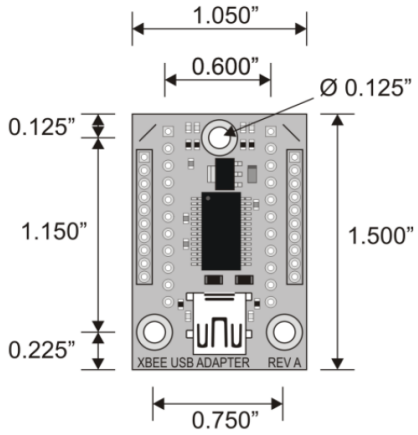
8.1. Description



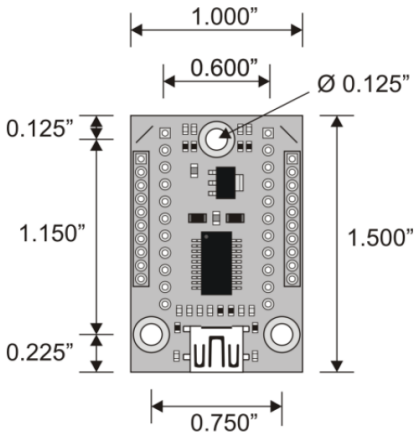
Model: **XBee USB Adapter Board | 32400 | Parallax**

Voltage requirements: **5.0V from USB or VDD pin, 3.3V generated on-board**
Current requirements: **Varies with XBee Model**
Communication: **Serial pass-through to XBee module/USB to Host PC**
PCB Dimensions: **1.5 x 1.0 in (38.1 x 25.4 mm)**
Operating temp range: **-40 to +158°F (-40 to +70°C)**
Quantity: **2 (Receiver and Sender)**

Rev A and B



Rev C



This module is mounted on the wireless module and provides the input voltage. To mount this module, proper sockets are needed to be soldered on the board (See XBee USB Adapter Documentation Link).

8.2. Related Links

XBee USB Adapter Documentation:
https://www.parallax.com/sites/default/files/downloads/32400-XBee-USB-Adapter-Documentation-v2.0.pdf

XBee USB Adapter Schematic:
https://www.parallax.com/sites/default/files/downloads/32400-XBee-USB-Adapter-Schematic_C.PDF

Shopping Link:
https://www.parallax.com/product/32400

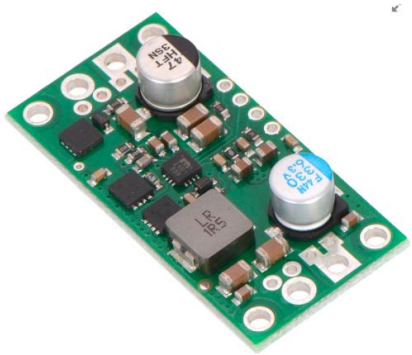
9. Voltage Regulator

During the experiments, it was found that providing a reliable and constant 5 voltage input is necessary for the mounted USB adapter on the wireless module. There was the fact that our tests had shown that the output voltage from UART pin of the flight controller is not reliable and it was decided to connect the USB adapter directly to the battery. However, the output voltage of the battery is too high and needs to be regulated and that is where this voltage regulator plays its role.

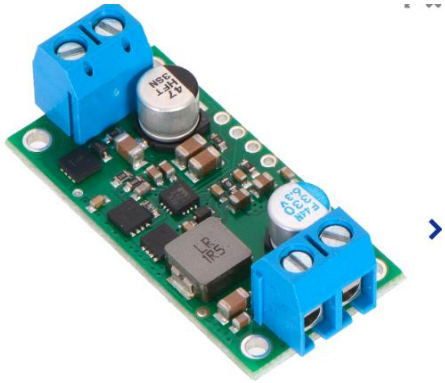
There are three different types which were used in our setup as following:

9.1. Pololu 5V, 9A Step-Down Voltage Regulator D24V90F5

9.1.1. Description



Pololu 5V, 9A Step-Down Voltage Regulator D24V90F5.



Pololu 5V, 9A Step-Down Voltage Regulator D24V90F5, assembled with included terminal blocks

- Input voltage: **5 to 38 V** (see below for more details on the regulator's dropout voltage, which affects the low end of the operating range)
- Output Voltage: **Fixed 5 V output** (with 4% accuracy); this can be lowered by adding an external resistor between FB and VOUT
- Output Current: **Typical maximum continuous output current between 4 A and 8 A**

- Integrated reverse-voltage protection, over-current protection, over-temperature shutoff, soft-start, and under-voltage lockout
- Typical efficiency of 80% to 95%, depending on input voltage and load; the switching frequency automatically changes at light loads to maintain high efficiencies
- 800 µA typical no-load quiescent current; can be reduced to 10 µA to 20 µA per volt on VIN by disabling the board
- "Power good" output indicates when the regulator cannot maintain its set output voltage
- Compact size: **1.6″ × 0.8″ × 0.3″ (40.6 × 20.3 × 7.6 mm)**
- Four 0.086″ mounting holes for #2 or M2 screws
- Smaller holes for 0.1″ header pins and larger holes for terminal blocks offer several options for connecting to the board
- Quantity: **1**

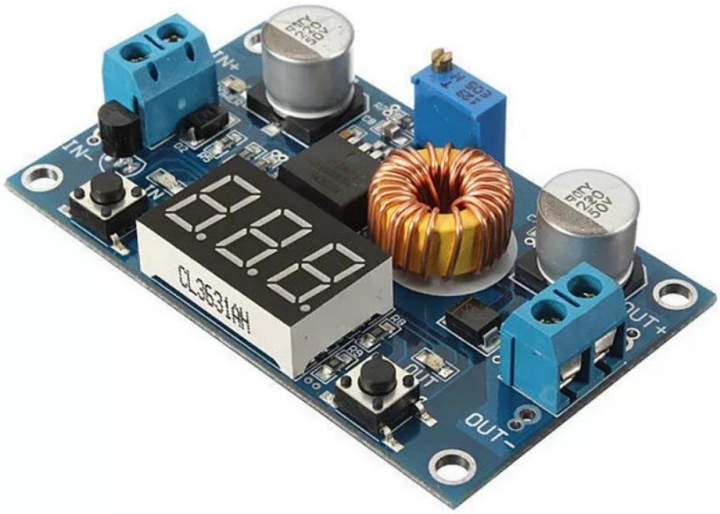
9.1.2. Related Links

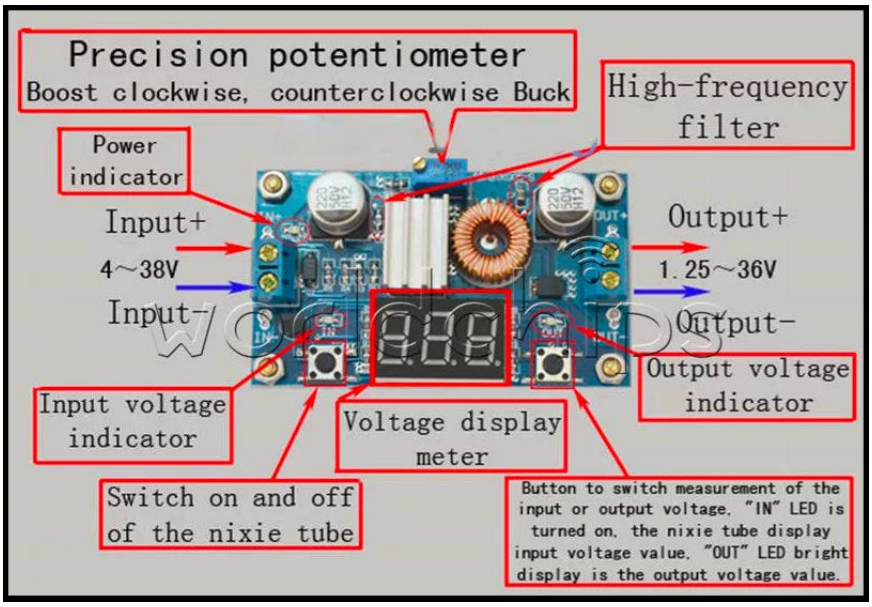
Shopping and Producer Link: https://www.pololu.com/product/2866

Technical Dimensions: https://www.pololu.com/file/0J1581/step-down-voltage-regulator-d24vxf5-dimensions.pdf

9.2. XL4015 LM2596 5A DC-DC Adjustable Voltage Step Down

9.2.1. Description





Performance parameters:

- Input voltage range：4～38VDC (Note: input voltage not exceeding 38V)
- Output voltage range：1.25-36VDC adjustable
- Output current: 0-5A
- Output power: 75W
- voltmeter range: 4 to 40V, error ±0.1V
- Operating frequency: 180KHz
- High efficiency up to 96%
- Built in thermal shutdown function

- Built in current limit function
- Built in output short protection function
- Input reverse polarity protection: None (if required, high current diode in series with the input).
- L x W x H =6.6*3.9*1.8CM
- Quantity: **1**

9.2.2. Related Links

Shopping link (module A is what we used):
https://arduinotech.dk/shop/xl4015-lm2596-5a-dc-dc-adjustable-voltage-step-down/

9.3. LM2596 DC-DC 4V-35V to 1.23V-30V Step Down Power Module Voltage Regulator 3A

9.3.1. Description

- Input voltage: **4-35V**
- Output Voltage: **1.5-35V (adjustable)**
- Output current: **rated current 2A, maximum 3A** (heat sink required)
- Conversion efficiency: **Up to 92%** (the higher the voltage, the higher the efficiency)
- Switching Frequency: **150KHz**
- Rectifier: **Non-Synchronous Rectification**
- Module Properties: **Non-isolated step-down module** (buck)
- Short circuit protection: **current limiting**
- Operating temperature: **Industrial grade** (-40 ℃ to +85 ℃) (output power 10W or less)
- Full load temperature rise: **40 ℃**
- Load regulation: **± 0.5%**
- Voltage regulation: **± 0.5%**

- Dynamic response speed: **5% 200uS**
- Dimensions: **L4.3cm x W2cm x H1.4cm**
- Quantity: **1**

9.3.2. Related Links

Shopping Link:
https://hobbycomponents.com/power/215-lm2596-dc-dc-3-35v-adjustable-step-down-power-supply-module