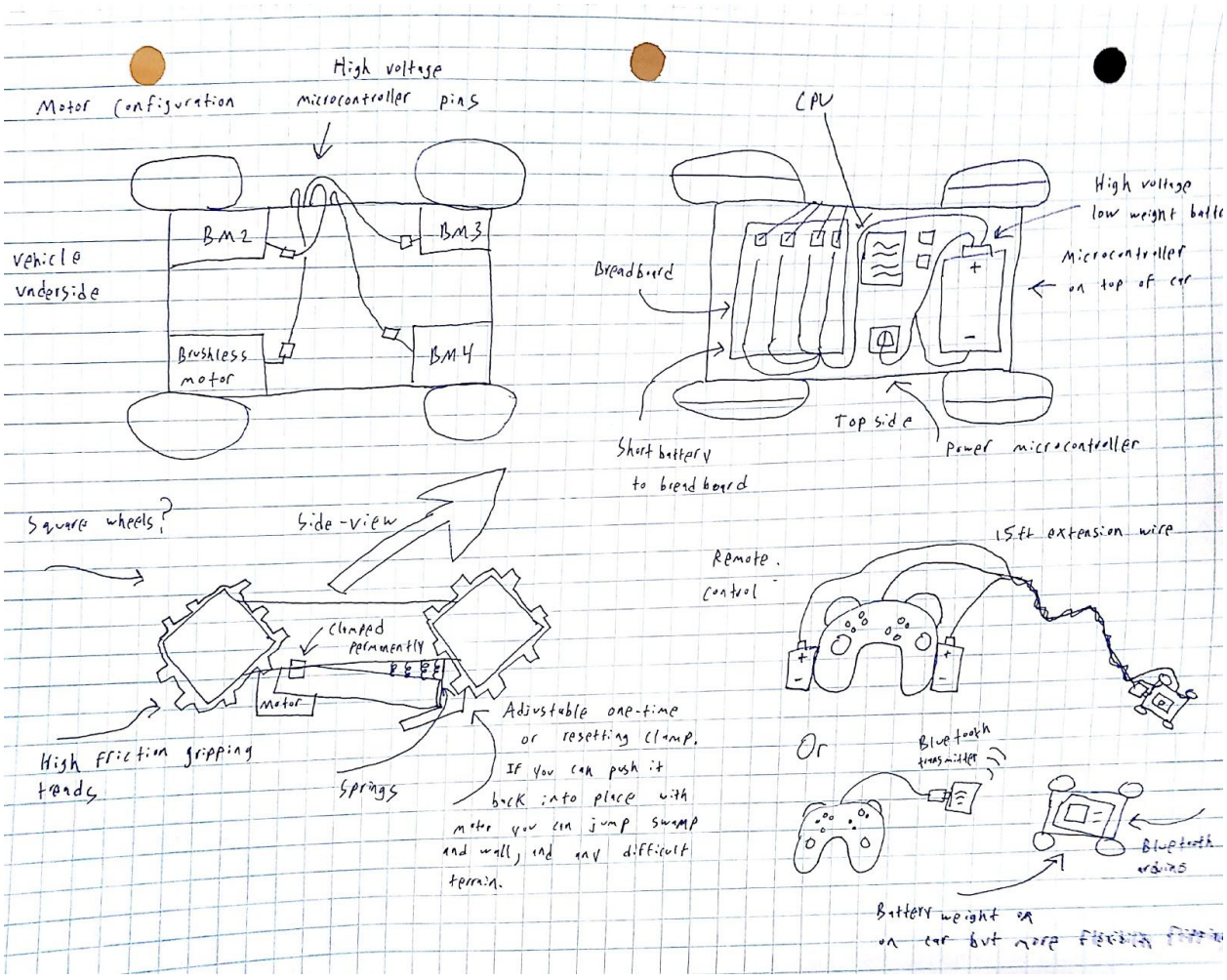
Discovery Progress Report
Anthony Louis Rosenblum, CompE, Team E7
1/23/2019

Design Theory



Preliminary Design Sketch, Louis Rosenblum 2019

What is design?

- Structure
- Design
    - Useful
    - Effective
    - Functional

    - Reliable
    - Maintainable
    - Aesthetics
    - Easy
- Process
    - Systematic intelligent process
    - Generate evaluate and specify concepts
    - Achieve clients objectives
    - Satisfying specific set of constraints
- Dym's Design Process
    - Client Statements (Need, problem definition)
    - Conceptual design
    - Preliminary design
    - Detailed design
    - Design communication
    - Final Design
    - Product
- Use designers sensibility and methods to match people's need with what is technologically feasible and also a viable business strategy
- Browns design thinking process
    - Inspiration Ideation Implementation
- Qualities of a good designer
    - Tolerate ambiguity
    - Big picture in mind
    - Handle uncertainty
    - Make decisions
    - Function well in team
    - Communicate in several languages of design
    - Empathy, people first approach
    - Observant
    - Practice integrative thinking, see all aspects of problem solving
    - Optimism
    - Experimentalism
    - Collaboration, interdisciplinary
- Design is not a single moment of genius inspiration
    - "Opportunity is missed by most people because it is dressed in overalls and looks like work" - Thomas Edison
- Design Process Steps
    - Discover

        - Define
        - Ideate
        - Prototype
        - Test
        - Communicate

Cats Conundrum Introduction

- Obstacle course for remote control vehicles
- Course has many 2x2 elements
    - Visit tiles in NAH 220
- Everyone has to do the tunnel
- Having a chemE, you have to do the swamp
- Odd number teams run A tiles, Even run B
- Design and construct circuitry for remote control vehicle
- Having a CompE
    - No Commercial Receiver
    - No commercial transmitted
    - No electronic speed control
    - The vehicle must be remotely controlled
- Computer science
    - Create a control app through which the driver controls the vehicle

Managing design activities

- Scope
    - Complexity
    - Uncertainty
    - Identify all physical and digital resources
    - Understand full scope of what your team must provide
- Spending
- Schedule

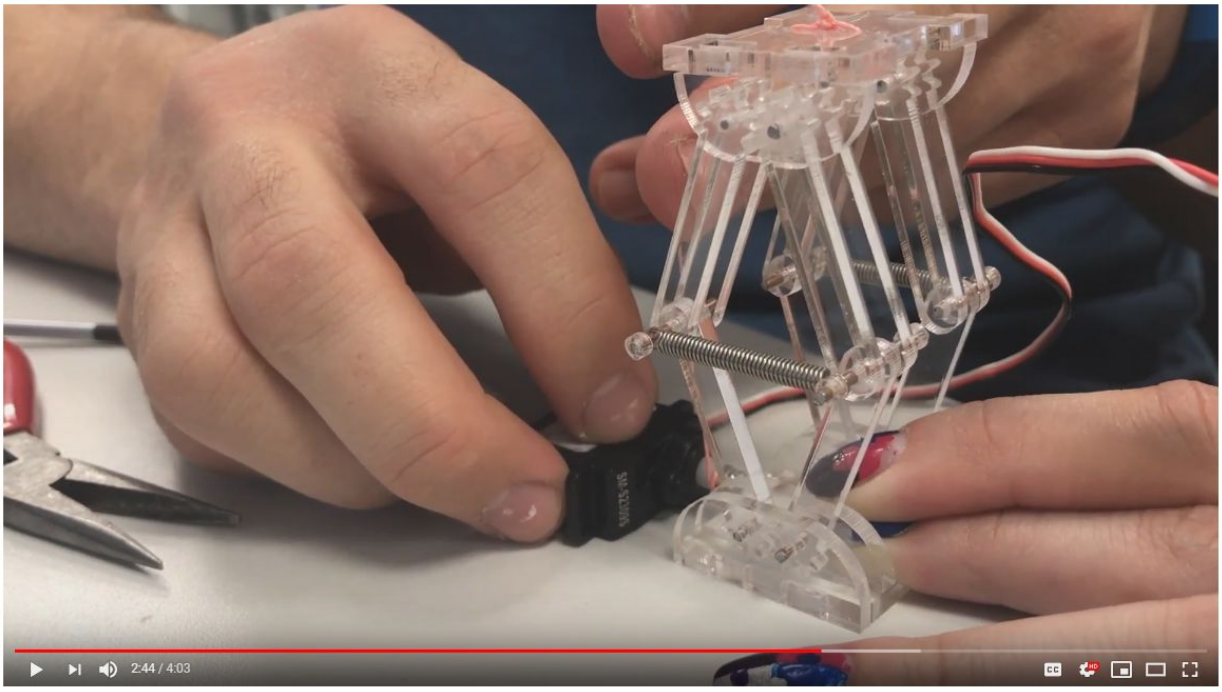
Team Values:

- Curiosity
- Trust
- Wisdom
- Productivity
- Risk-taking

Background Research

[Sand Flea Jumping Robot (Boston Dynamics)]

[Flea Inspired Jumping Robot (University of Southhampton)]



Flea Inspired Jumping Robot

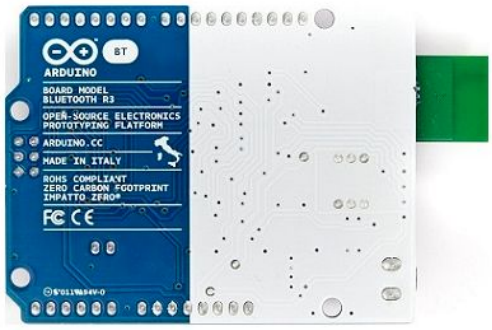
10,020 views

116 4 SHARE SAVE

[Arduino Bluetooth]

Arduino BT (Bluetooth)

Arduino BT Front



Arduino BT Back

[Raspberry Pi 3 Model A+]

← RETURN TO PRODUCTS

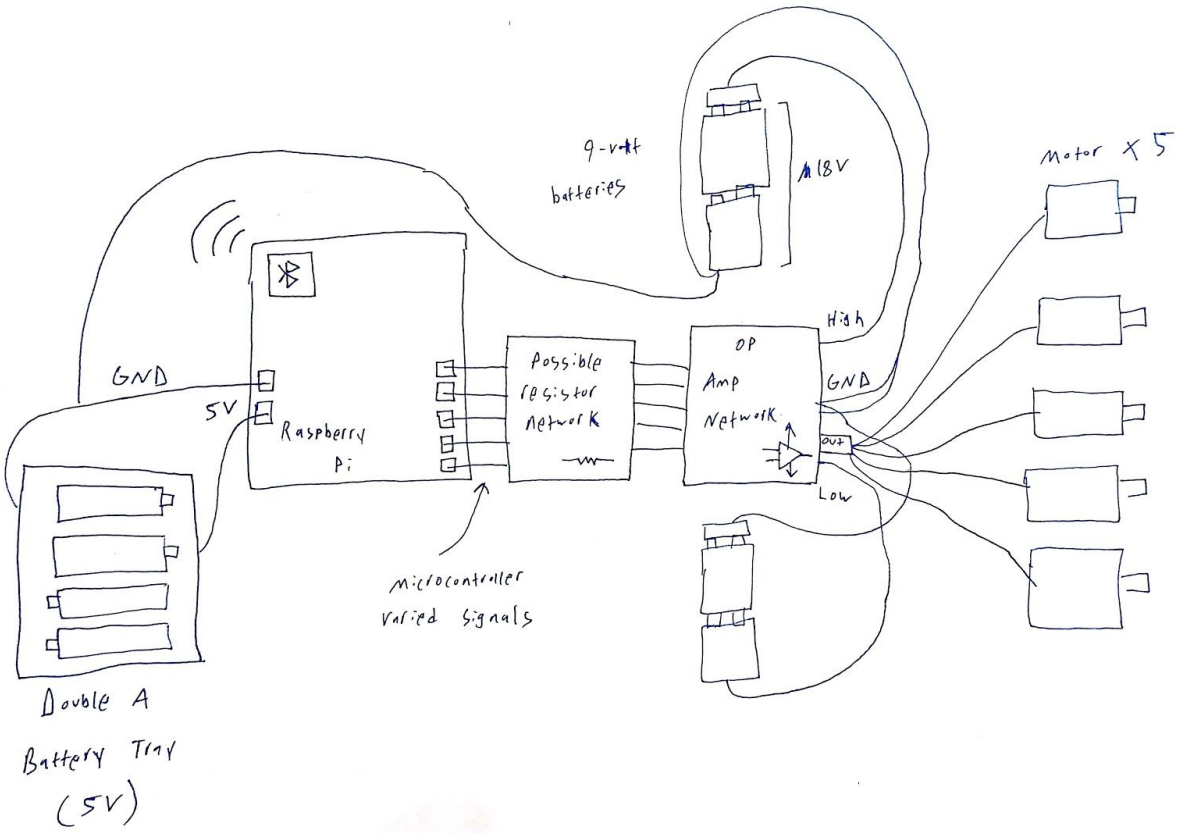
Raspberry Pi 3 Model A+

1.4GHz 64-bit quad-core processor, dual-band wireless LAN, Bluetooth 4.2/BLE in the same mechanical format as the Raspberry Pi 1 Model A+

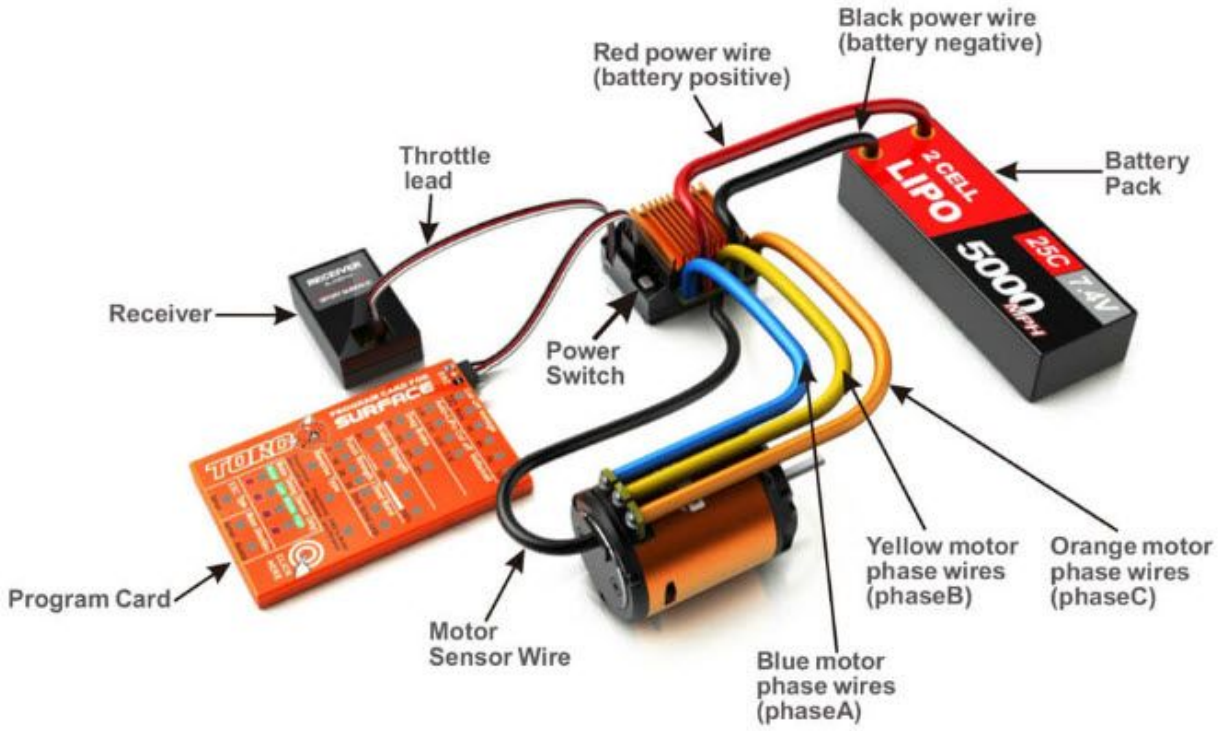
BUY NOW >

GETTING STARTED | SPECIFICATIONS | SOFTWARE & OS | COMPLIANCE

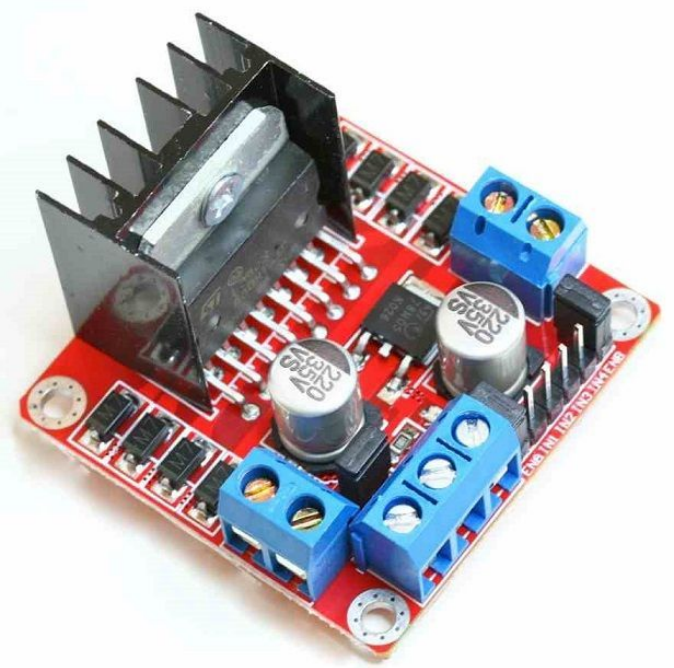
1. Block Diagram



2. Electronic Speed Control



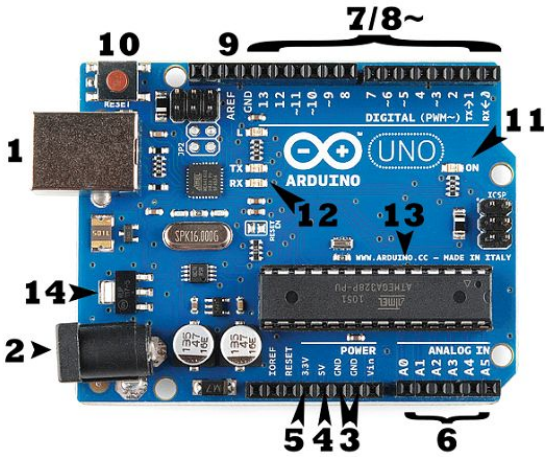
Motor Driver



3. What is a BEC?

A BEC is a Battery Eliminator Circuit. This circuit acts as a step down voltage regulator. Functioning as a transformer the BEC steps down the voltage from the main power source in order to power RC servos and transceivers. This eliminates the need for additional battery packs.

4. Arduino Uno Pinout



1. Serial USB port. Used for powering device from USB and programming the board.
2. DC power connecter. Used for powering the device.
3. Ground. Used as the reference point for all voltages in the circuit.
4. 5 V. Used to supply power to external components in the circuit.
5. 3.3 V. Used to supply power to external components in the circuit.
6. Analog inputs. Used to input analog information to the device.
7. Digital pins. Can be configured as inputs or outputs to transmit data around the circuit.
8. Pulse width-modulation pins. Digital pins that can be used as outputs to transmit pulse wave signals.
9. Analogue reference pin. Allows users to treat a voltage from an external power supply as ground.
10. Reset button. Used to restart the program, power cycle, or interrupt code.
11. Power LED. Shows the user that the arduino is on and receiving power.
12. Serial Rx/Tx LEDs. Used to display information about serial communication.
13. Arduino Microcontroller (Plastic Dual In-Line Package). A device that can be moved onto a breadboard to create a new system instead of using the demo board.
14. Voltage regulator. Used to transform voltages up and down.

a. Programming Language:

The arduino uno can be programmed in C or C#. Team E7 does not have a computer scientist.

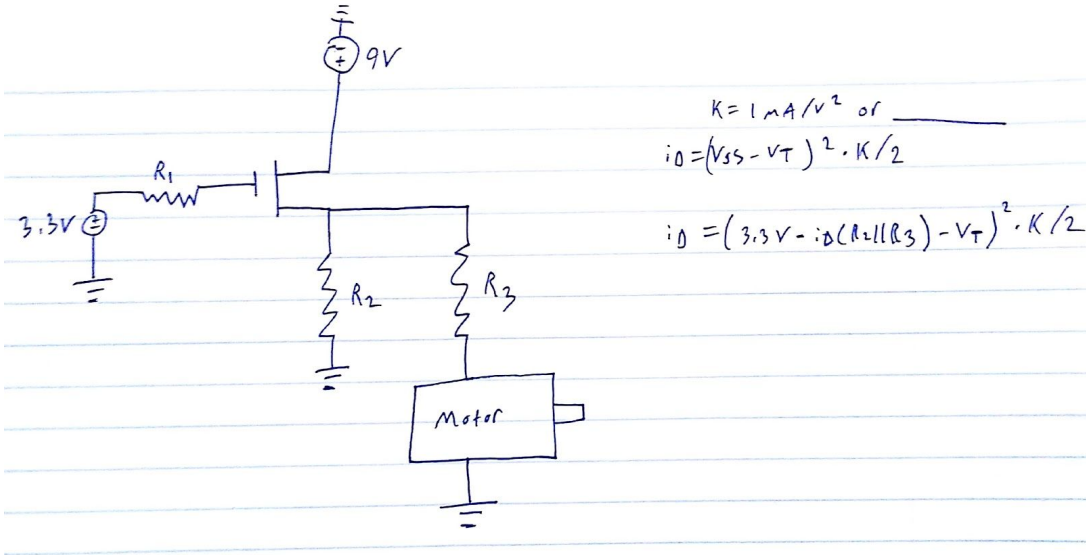
5. No-load current draw of 0.10 A, stall current of 1.5 A, motor?

Each GPIO pin on the Arduino Uno can output a maximum of 40 mA. If you hooked up the specified motor to one of these pins you would not be able to overcome the no-load current draw of 100 mA. The motor would never run.

6. What is an H-bridge? How could it be used to drive a motor?

An H-bridge is a device that can invert the polarity of a voltage in order to apply it to a load. A H-bridge could be used to create a polar version of a voltage in order to drive both the plus and minus power rails for an op amp in order to create high enough voltages or currents to drive a motor based on signals from a microcontroller.

Single Transistor Motor Circuit



Mathematical Models

1. 6 V Motor

Pololu Metal Gearmotors » 20D mm Metal Gearmotors » 6V Carbon Brush (CB) 20D Gearmotors »
63:1 Metal Gearmotor 20Dx43L mm 6V CB

Pololu item #: 3702 — 24 in stock
Brand: Pololu
Status: Active and Preferred
Free shipping in USA

Price break	Unit price (US$)
1	21.95
10	18.66
50	16.46
100	15.36

Quantity: 1 — Add to cart
backorders allowed — Add to wish list

These small brushed DC gearmotors can deliver a lot of power for their size. This version has a **6V** brushed DC motor with **long-life carbon brushes** combined with a **62.5:1** metal spur gearbox. The gearmotor is cylindrical with a diameter of 20 mm, and the D-shaped output shaft is 4 mm in diameter and extends 18 mm from the face plate of the gearbox.

Key specs at 6 V: 230 RPM and 170 mA at no load, 54 oz-in (3.9 kg-cm) and 2.9 A at stall.

No-load current: 170mA
Stall current: 2.9A
Max Efficiency Output Power: 6V * 2.9 A = 17.4 W
Cost: $22.95

6V Servo

Mechanical Components » Servos » RC Servos »
Power HD Mini Digital Servo HD-1810MG

Pololu item #: 1047 — 2 in stock
Brand: Power HD

Price break	Unit price (US$)
1	19.95
10	18.95

Quantity: 1 — Add to cart
backorders allowed — Add to wish list

The HD-1810MG digital servo from Power HD is a miniature servo with digital control electronics for increased performance. The output shaft is supported by a ball bearing, and the gear train and part of the case are metal for increased durability. Servo horns and associated hardware are included.

Key specs at 6 V: 0.13 sec/60°, 54 oz-in (3.9 kg-cm), 16 g.

No-load current: 240mA
Stall current: 1.4A
Max Efficiency Output Power: 6V * 1.4 A = 8.4 W
Cost: $19.95

2. How long will a 350 mAH 35C 2S LiPo last if you drove your car and servo at full current draw continuously?

```
p1 = 17.4 % watts
p2 = 8.4 % watts

p3 = p1+p2 % watts = joules/second

bat = 350 * 1e-3 % amp hours

coul_sec = bat * (60*60) % amp seconds, coulombs

joules = 6 * coul_sec % joules

time = joules/((p1+p2)) % time = joules / (joules/second) = seconds
```

```
1/25/19 5:34 PM     MATLAB Command Window                    1 of 1

p1 =

   17.4000

p2 =

    8.4000

p3 =

   25.8000

bat =

    0.3500

coul_sec =

   1.2600e+03

joules =

   7.5600e+03

time =

  293.0233

>>
```

293 seconds = 4.88 minutes

LiPo and NiMH equivalents:

Venom Power LiPo 2S 7.4V 300mAh 30C JST/E-Flite PH (2)

Check Store Availability

Venom Power
VNR25147X2

Be the first to write a review!

Low Price: **$14.99**

Quantity: 1

Add To Cart | + | Add to Wish List

Usually ships in 3 to 4 days

This item earns up to **15** VIP Reward Points Learn More

Note: Manufacturer does not allow using discount coupons

Radient 6-Cell NiMH Flat Superpax Battery Pack w/EC2 Connector (7.2V/260mAh)

Check Store Availability

Please be aware that pricing and product availability in-store may vary from what's available online because each store is independently owned and operated.

Radient
RDNA0346

Be the first to write a review!

Low Price: **$13.99**

Quantity: 1

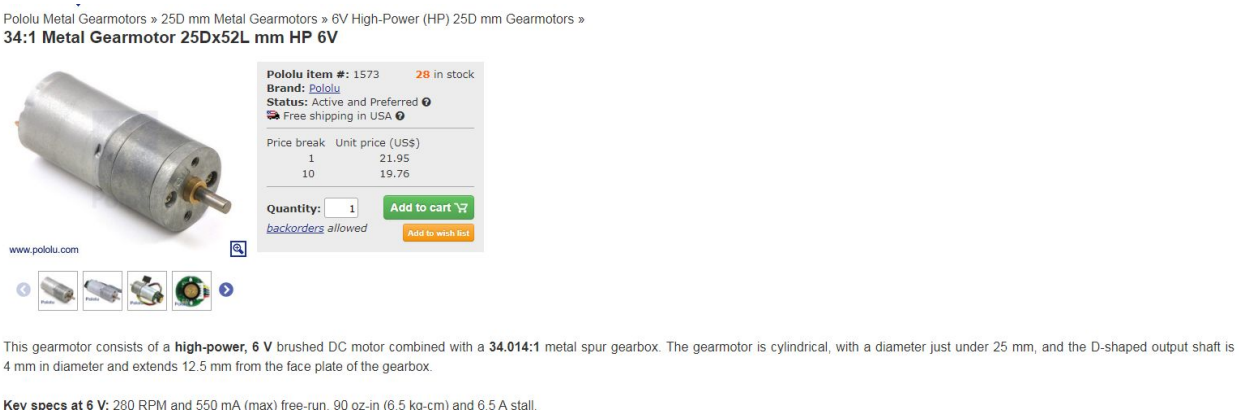
Add To Cart | + | Add to Wish List

Usually ships in 5 to 6 days

Truly negligible current draw?

While the other components in the system are still going to require current that amount will pale in comparison to the current needed for the motors and the servos. Thus for most intensive purposes the power life of the car can be calculated based solely on the current draw for the motors and servos.

3. **Given**: Your ME changes his/her mind and now wants a motor with at least 250 rpms and 90 oz in with the same servo.



Find: Use your Excel tool to find your new battery needs and determine if the battery size will be physically too large to fit in your design? How much weight do this battery add to your design? Does it change the size/form factor of the motor?

```
%p1 = 17.4 % watts
p1 = 6 * 6.5; %watts
p2 = 8.4 % watts

p3 = p1+p2 % watts = joules/second

bat = 350 * 1e-3 % amp hours

coul_sec = bat * (60*60) % amp seconds, coulombs

joules = 6 * coul_sec % joules

time = joules/((p1+p2)) % time = joules / (joules/second) = seconds

need = 10/(time/60) * bat % Amp hours
```

```
p2 =

    8.4000

p3 =

   47.4000

bat =

    0.3500

coul_sec =

   1.2600e+03

joules =

   7.5600e+03

time =

  159.4937

need =

    1.3167
```

In order to run the new motor with the previous servo for about ten minutes a battery with 1300 mA hours will be necessary.

Venom Power 3S 30C LiPo Battery w/Uni 2.0 Connectors (11.1V/1300mAh) (Two Pack)

Check Store Availability

Venom Power
VNR25028X2

Be the first to write a review!

Low Price: **$33.99**

Quantity: 1

Add To Cart | + Add to Wish List

In Stock Online!
Usually ships in 24 hours
This item earns up to **34** VIP Reward Points Learn More

These LiPos weight 3.6 oz each and have dimensions 66.5 x 34 x 21.5 mm. These would be able to fit in the design without the need for a different form factor and the additional weight would be negligible given the more powerful motor being installed.

Other questions

Resources Identified

Identify at least one resource locally where you could procure parts for your vehicle.	Batteries Plus Bulbs 502 Professional Dr, Bozeman, MT 59718
Identify at least two sources online where you could parts for your circuit (beyond the sites mentioned in this document). Identify shipping time and cost.	Amazon (Fast shipping , high cost) Ebay (Slow shipping, low cost)
List of resources in Makerspace and Light Build room that will be of use as you build your design.	Hand Tools ○ Hand Saws ○ Hand Drills ○ Utility/Craft Knives ○ Drivers ○ Socket Sets ○ Jig Saw

	3D Printers ○ Ultimaker 2+ ○ Formlabs Form 2 CNC Machines ○ PocketNC ○ Shopbot Bench Tools ○ Miter Saw ○ Band Saw ○ Drill Press ○ Hot Wire Cutter Electronics ○ Soldering Station ○ Oscilloscope ○ Wave Function Generator ○ Digital Multimeter ○ Parts Inventory ■ Adafruit/Arduino ■ Raspberry Pi Textiles ○ Sewing Machine

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“Venom Power LiPo 2S 7.4V 300mAh 30C JST/E-Flite PH (2) [VNR25147X2] | Cars & Trucks.” [MKS-HV777] | Airplanes - AMain Hobbies