Interim Design

Lunar Regolith Excavator Student Competition
Hexcavator

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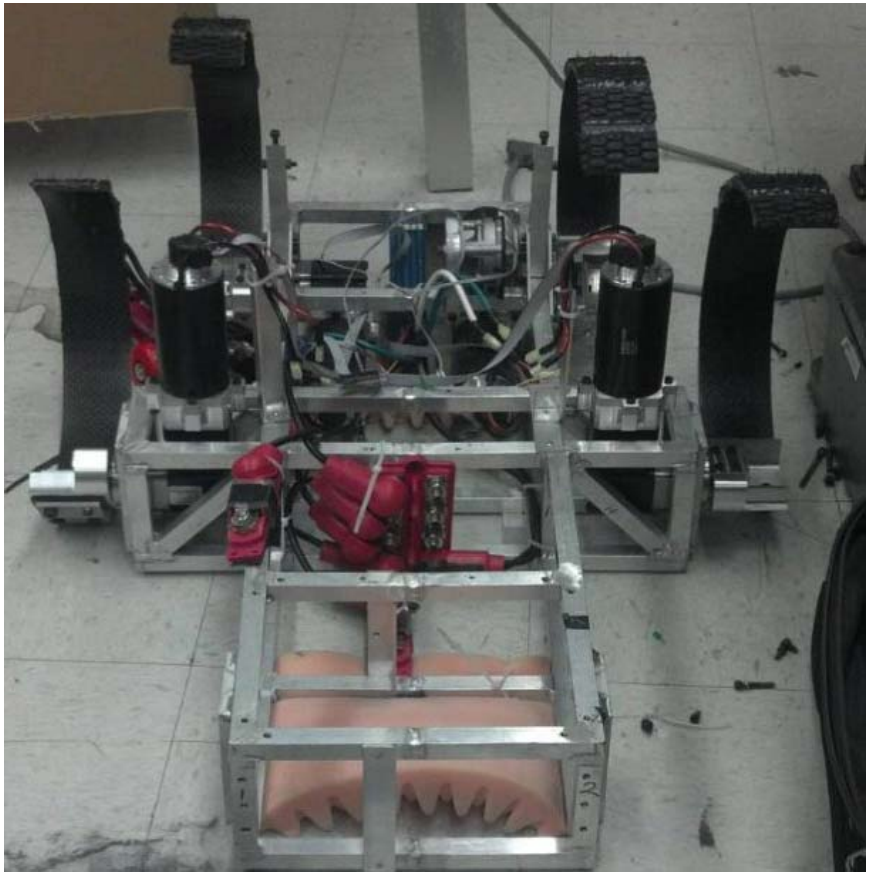
Previous Hexcavator Efforts

Complete:

- Frame
- Legs
- Motors
- Batteries
- Stop Button

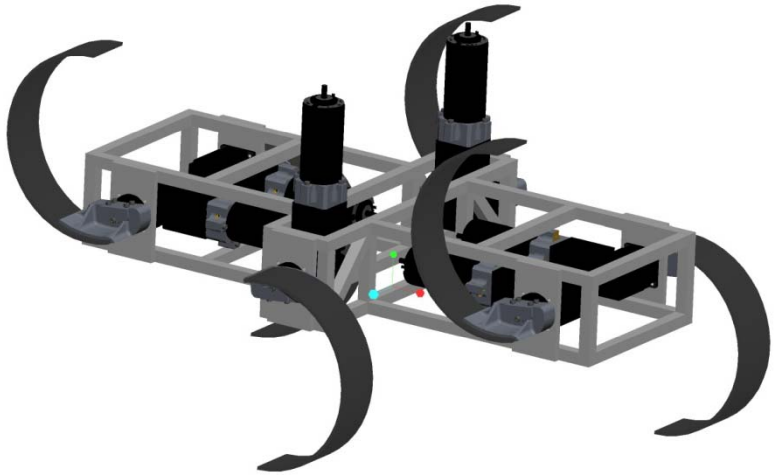
Needs:

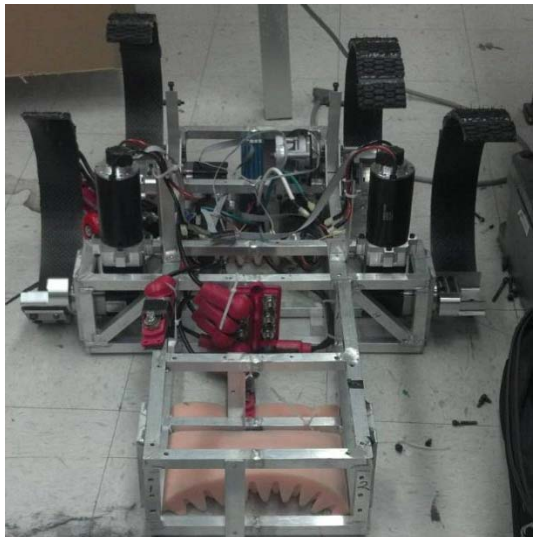
- Excavation
- Controls



Approach

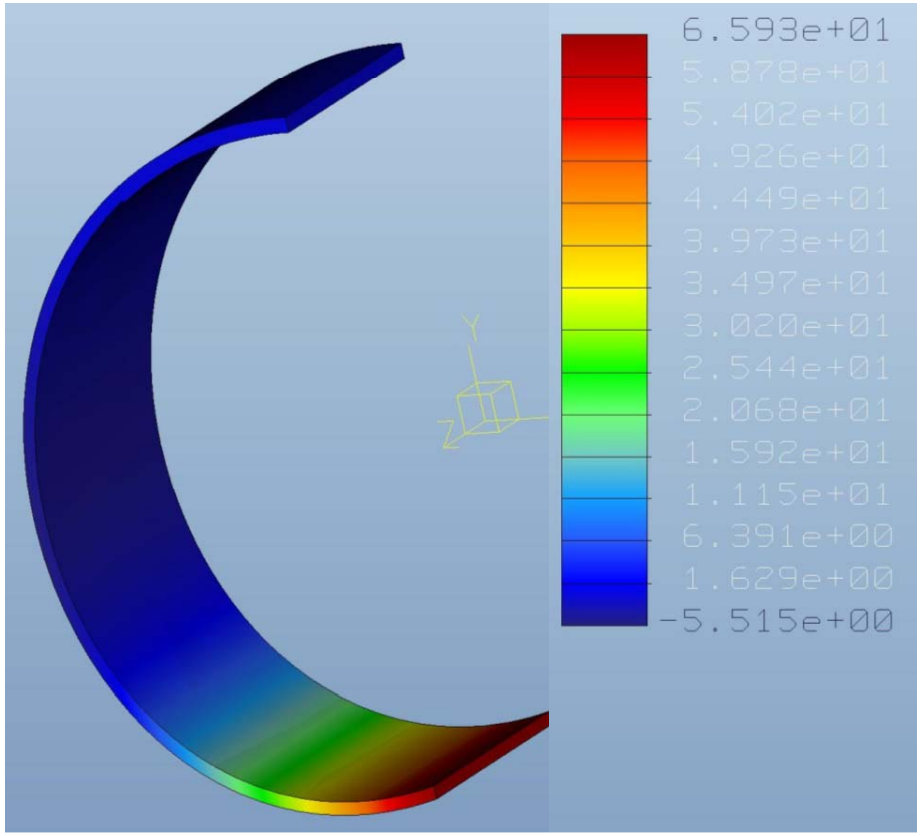
- Excavation Design
- Locomotion Scheme
  - Buehler Clock
- Microcontroller Selection
- Communication System
  - Inter-robot
  - Robot to user interface
- Power System





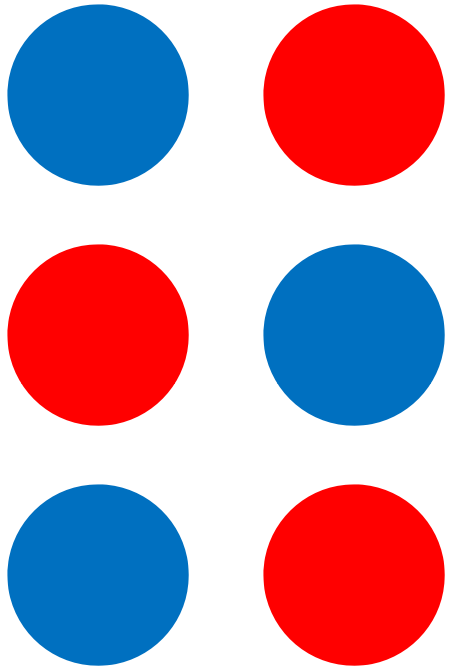
FEA Simulation

- Stiffness = 15,167 N/m
- For a 1 kN load
  - Vertical tip Deflection: 65.93mm



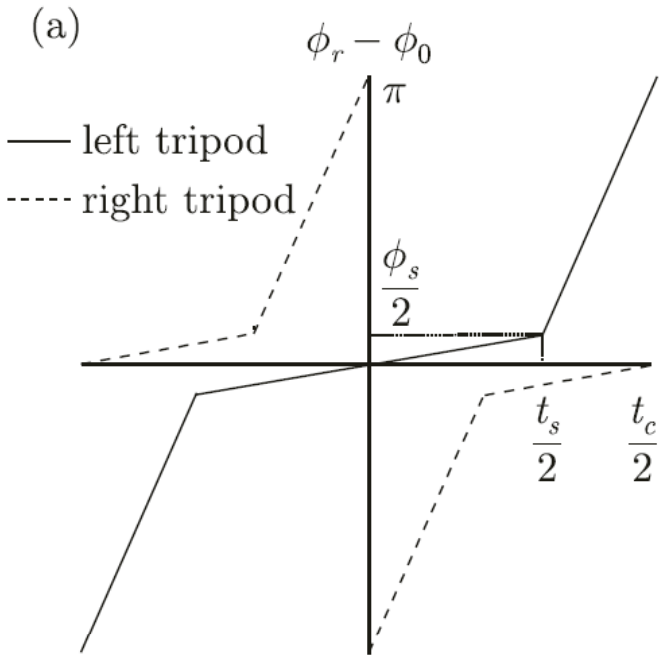
Locomotion

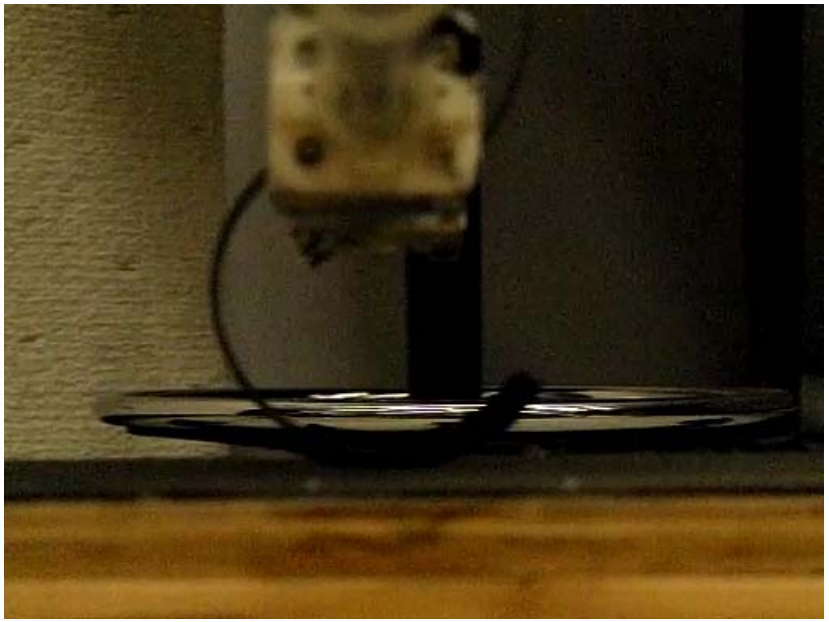
- Hexapedal walker
- Alternating tri-pod gait
- Uses Buehler Clock



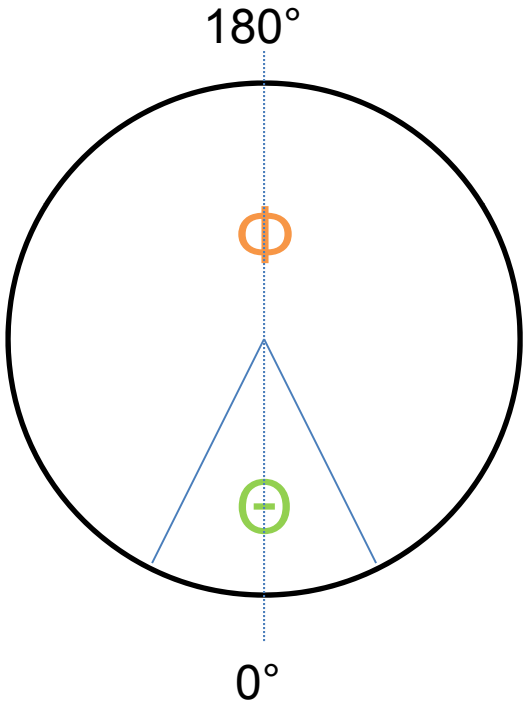
Buehler Clock

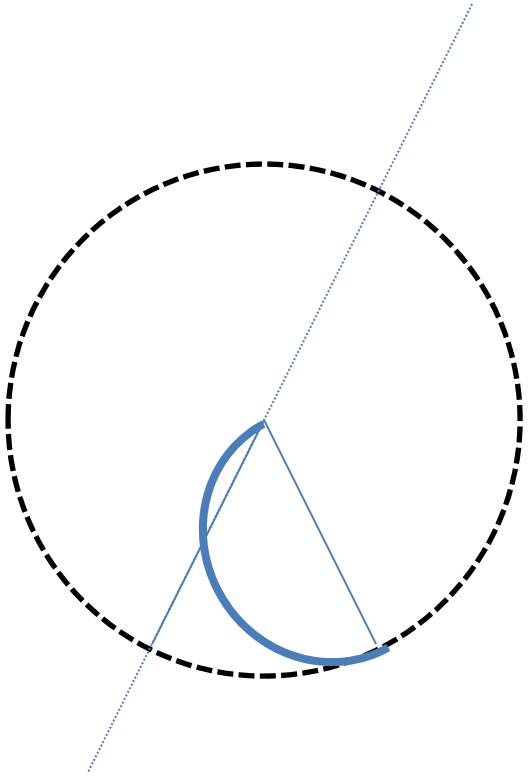
- Faster during aerial period
- Slower during touchdown



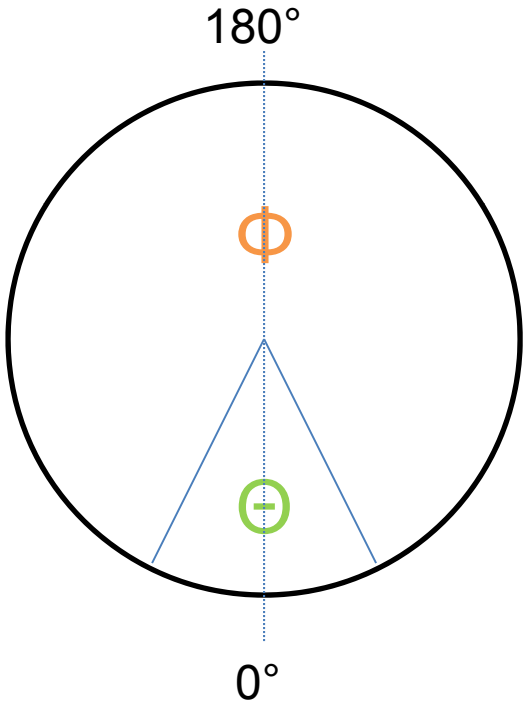


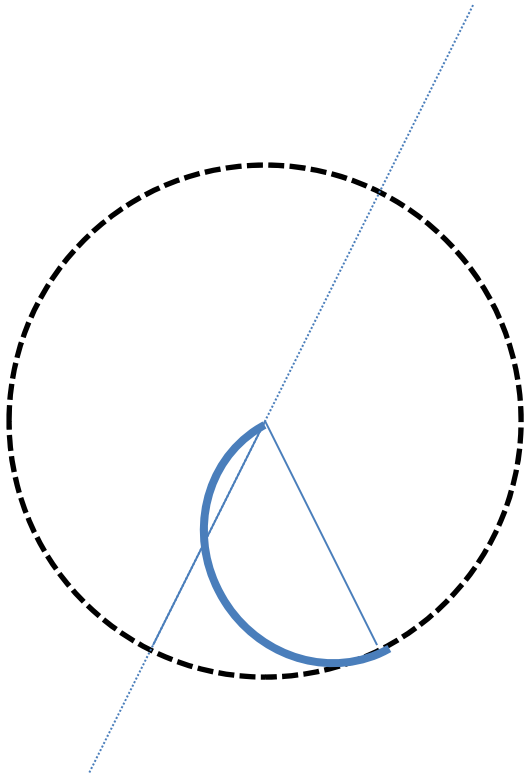
Buehler Clock



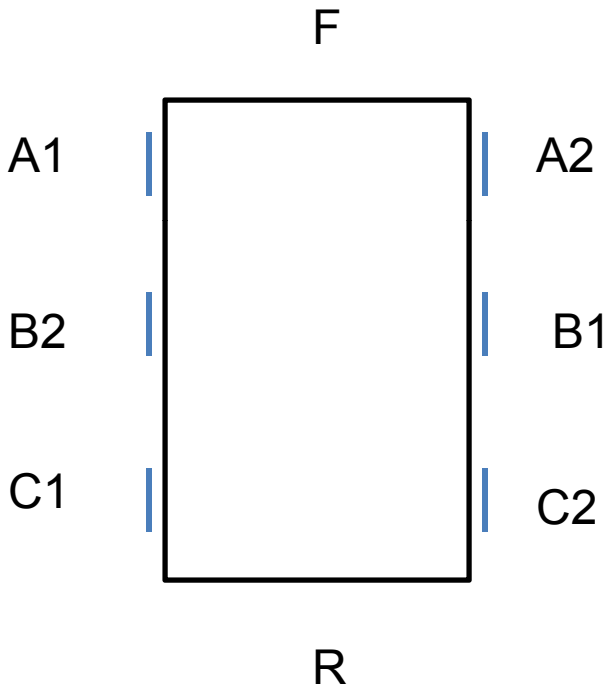


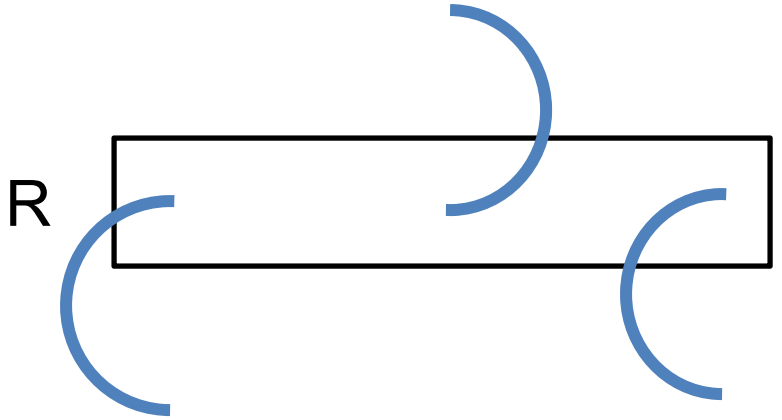
Buehler Clock





Buehler Clock for Multiple Legs





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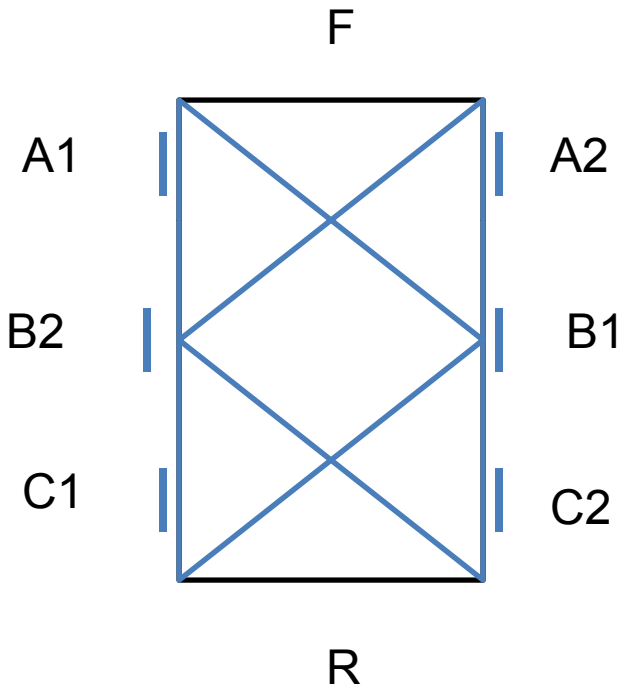
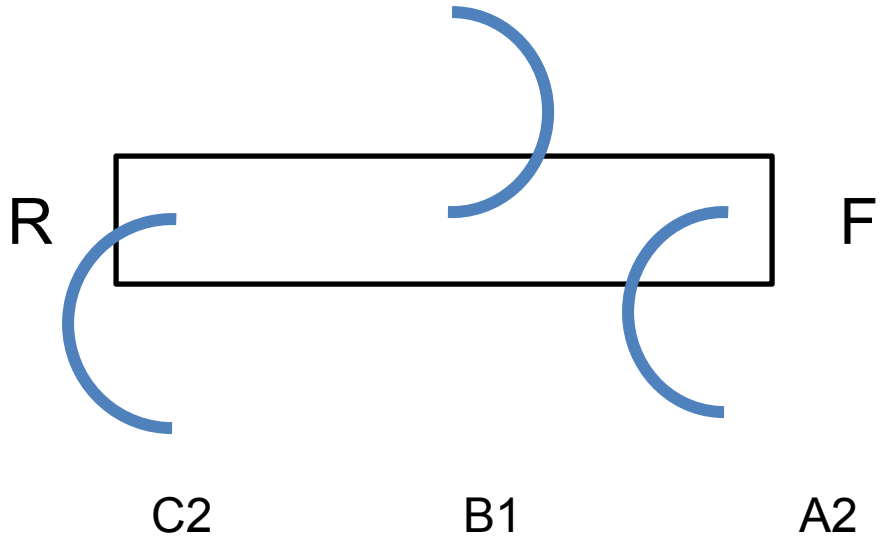
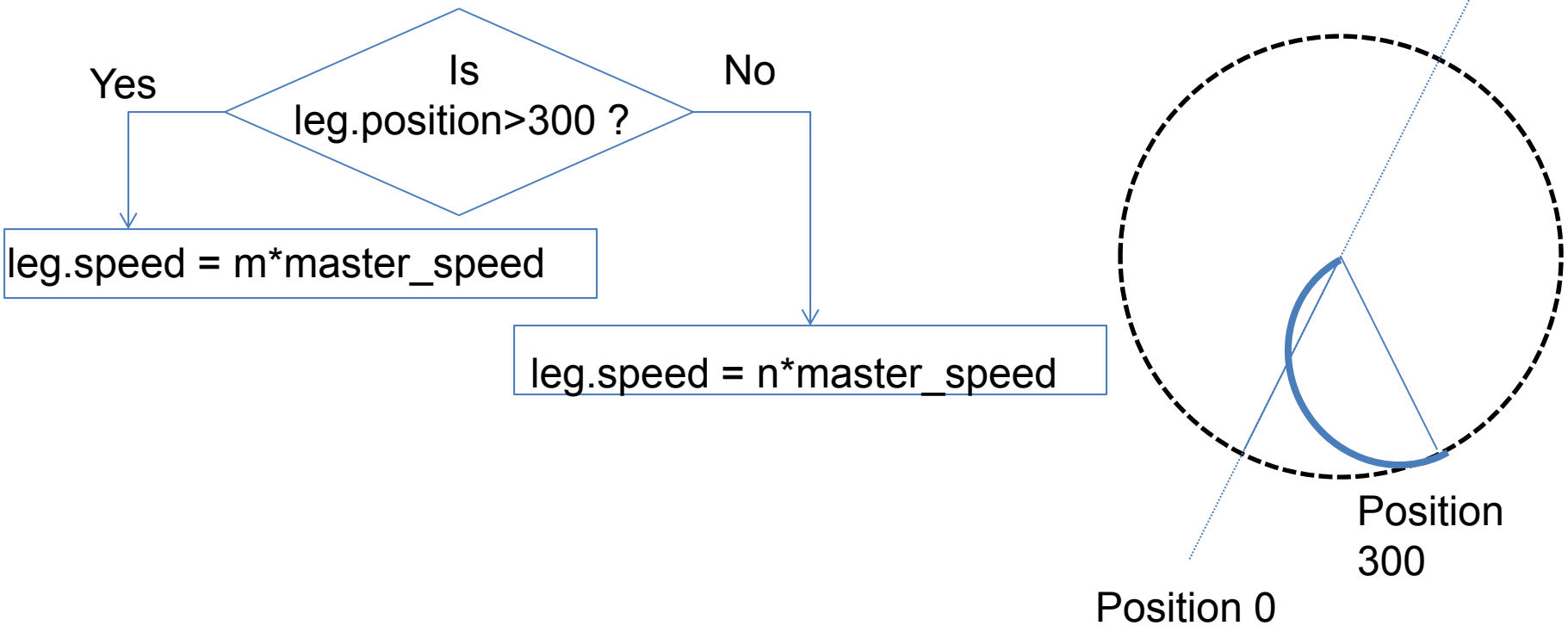
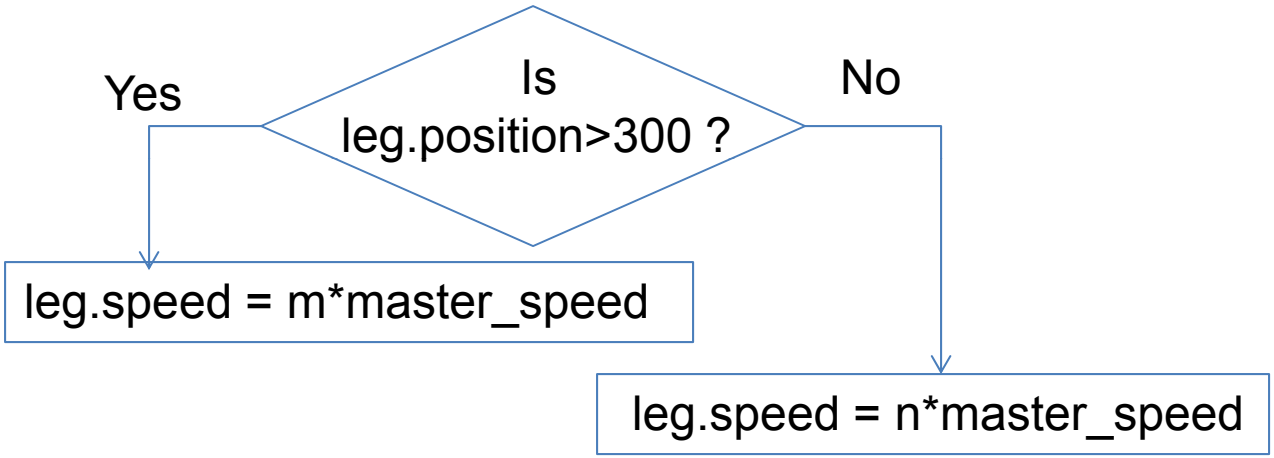


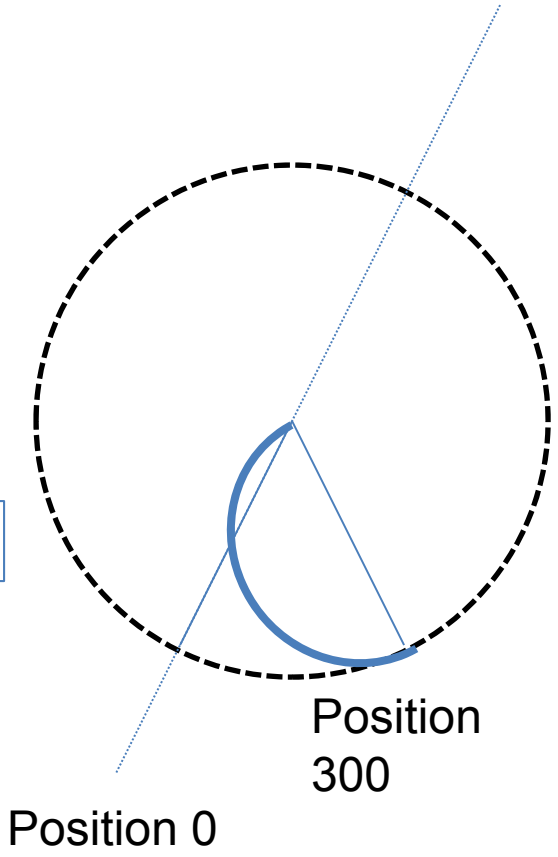


Buehler Clock for Multiple Legs



Buehler Clock for Multiple Legs





Prototyping Buehler Clock

- Learn from last year
- Implement code on DC motor
  - Incorporate encoders and decoders
  - Get single motor moving
  - Get multiple motors moving

Netbook

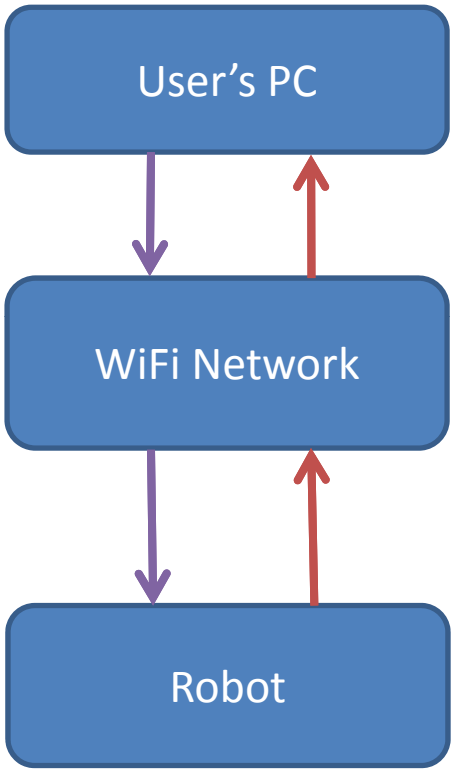
- Pros:
  - Components included
  - Physically small
- Cons
  - High bandwidth usage
  - Superfluous ports
  - Limited low level customization

Microcontroller (PC/104)

- Pros
  - Very customizable
  - Limited bandwidth usage
- Cons
  - Dimensions
  - In-house developed drivers

Communications

- Robot to User
  - WiFi
  - PC Interface
- Inter-Robot
  - Serial
  - Analog

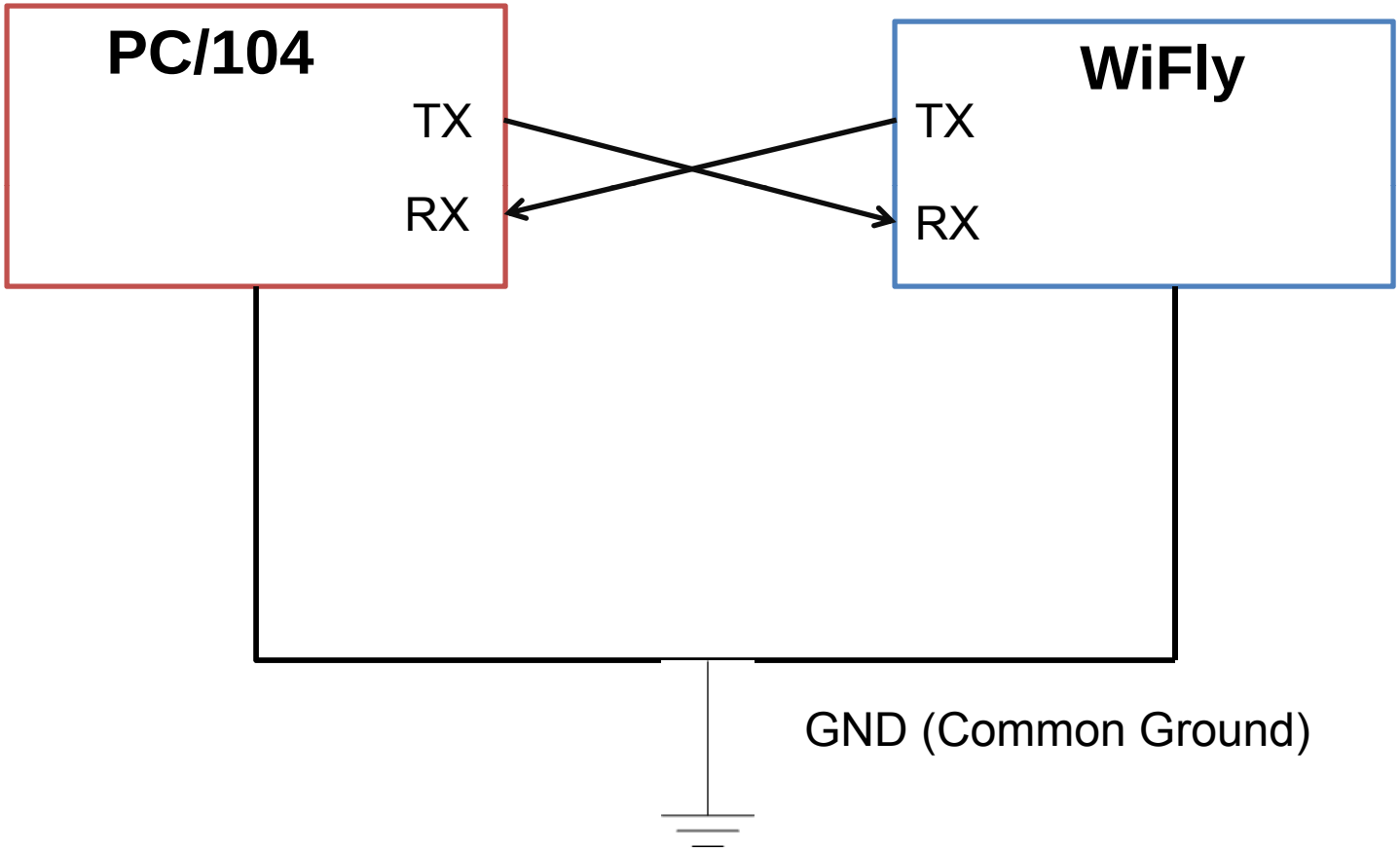


What is the WiFly?

- Wireless LAN access device
- UART
- Data rate up to 4Mbps
- Automatic RS-485 support

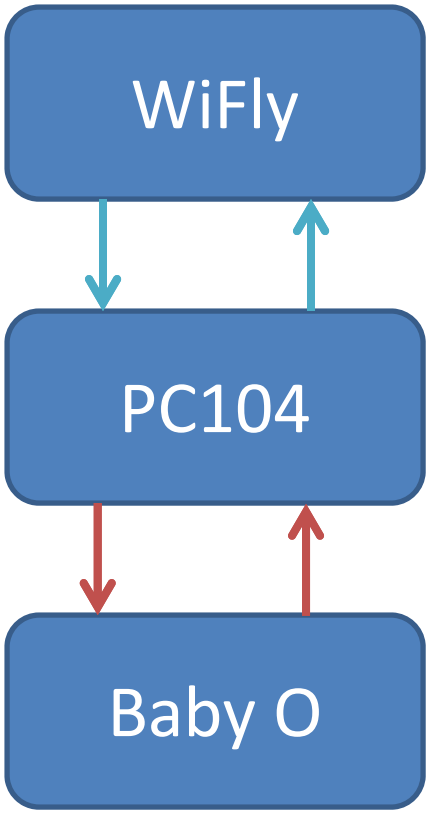
Circuit Block Diagram

Connect WiFly to PC/104



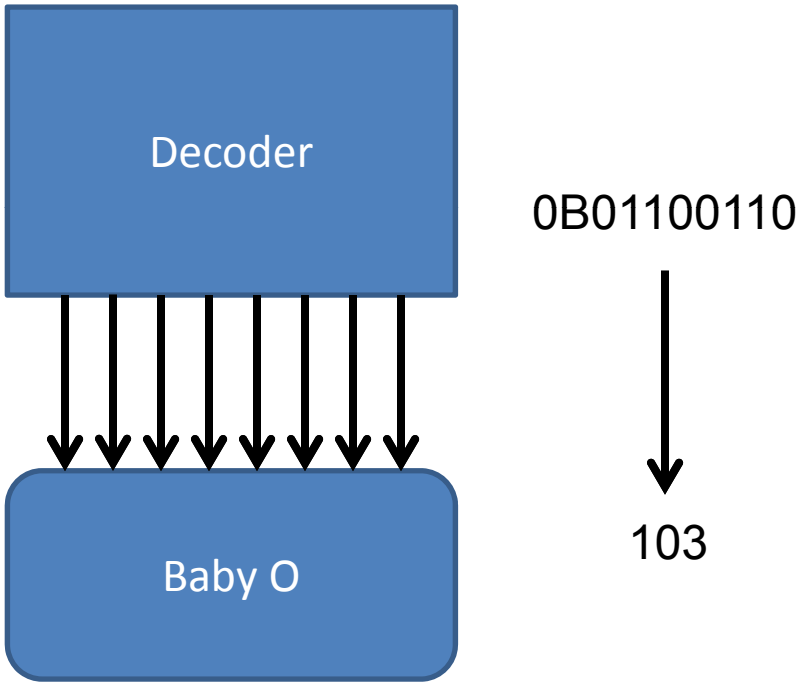
Serial Commination

- WiFly to pc104
  - Rs485 →
  - Separate Commands
- Baby Orangutan (Baby O)
  - Rs232 →
  - Single character



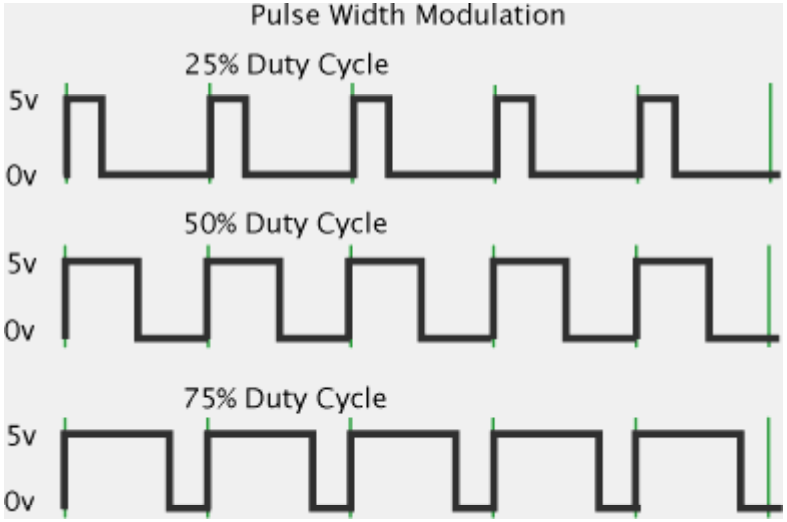
Analog Communication

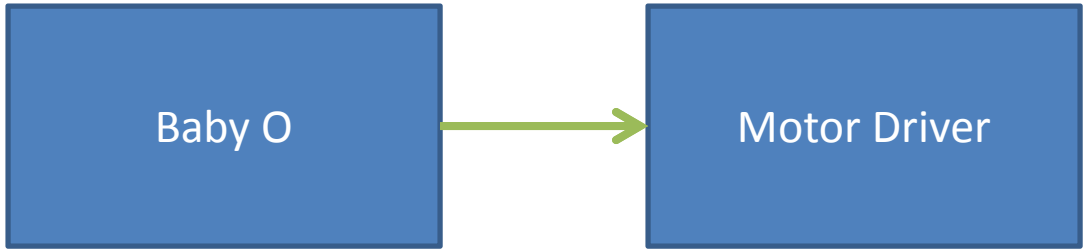
- 8 Bit Binary Communication
  - Decoder to Baby O
  - Max 255
  - One Direction
- Prototype Design



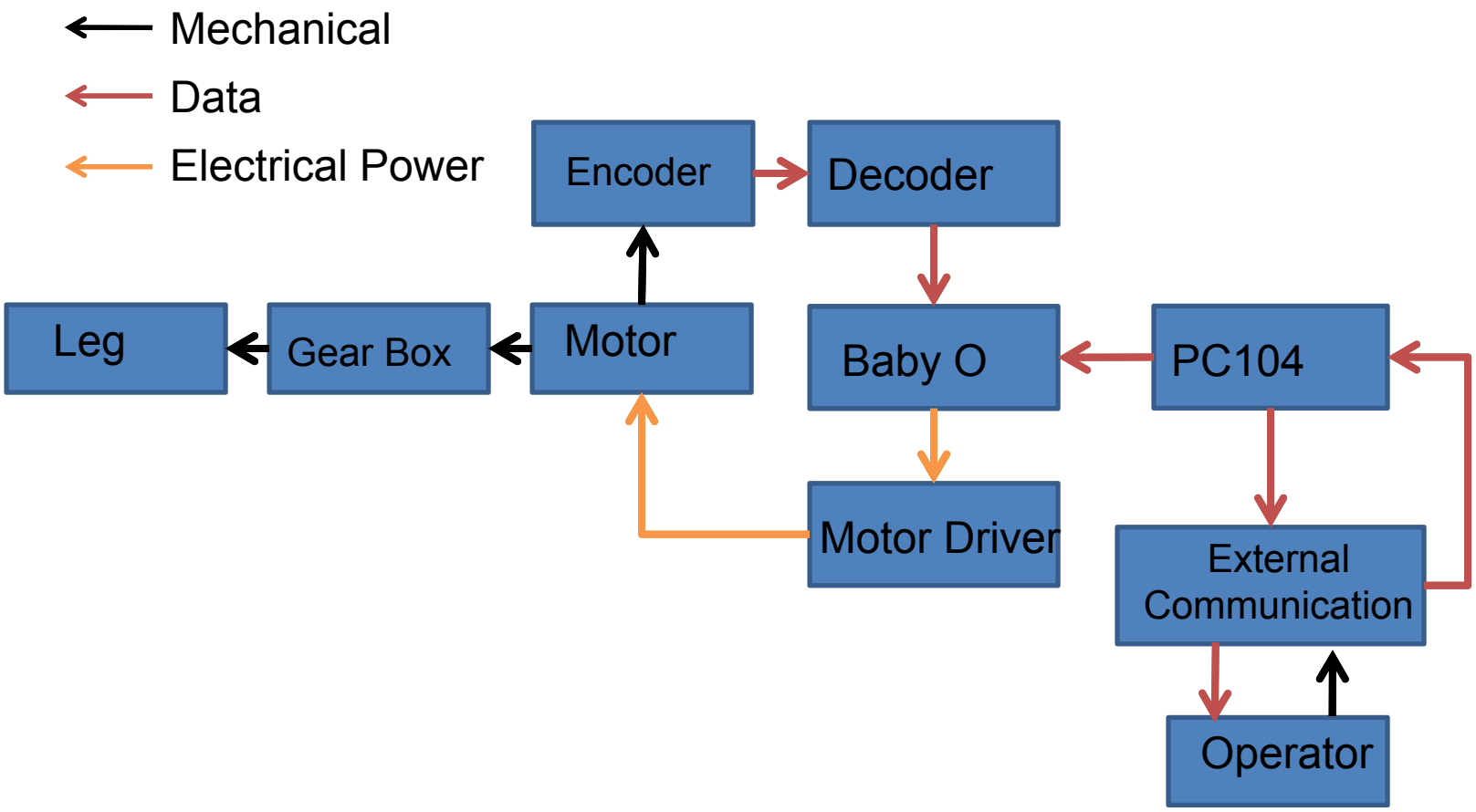
Analog Communication

- PWM
  - Baby O to Motor Driver
  - 5 Volt Max
  - One direction

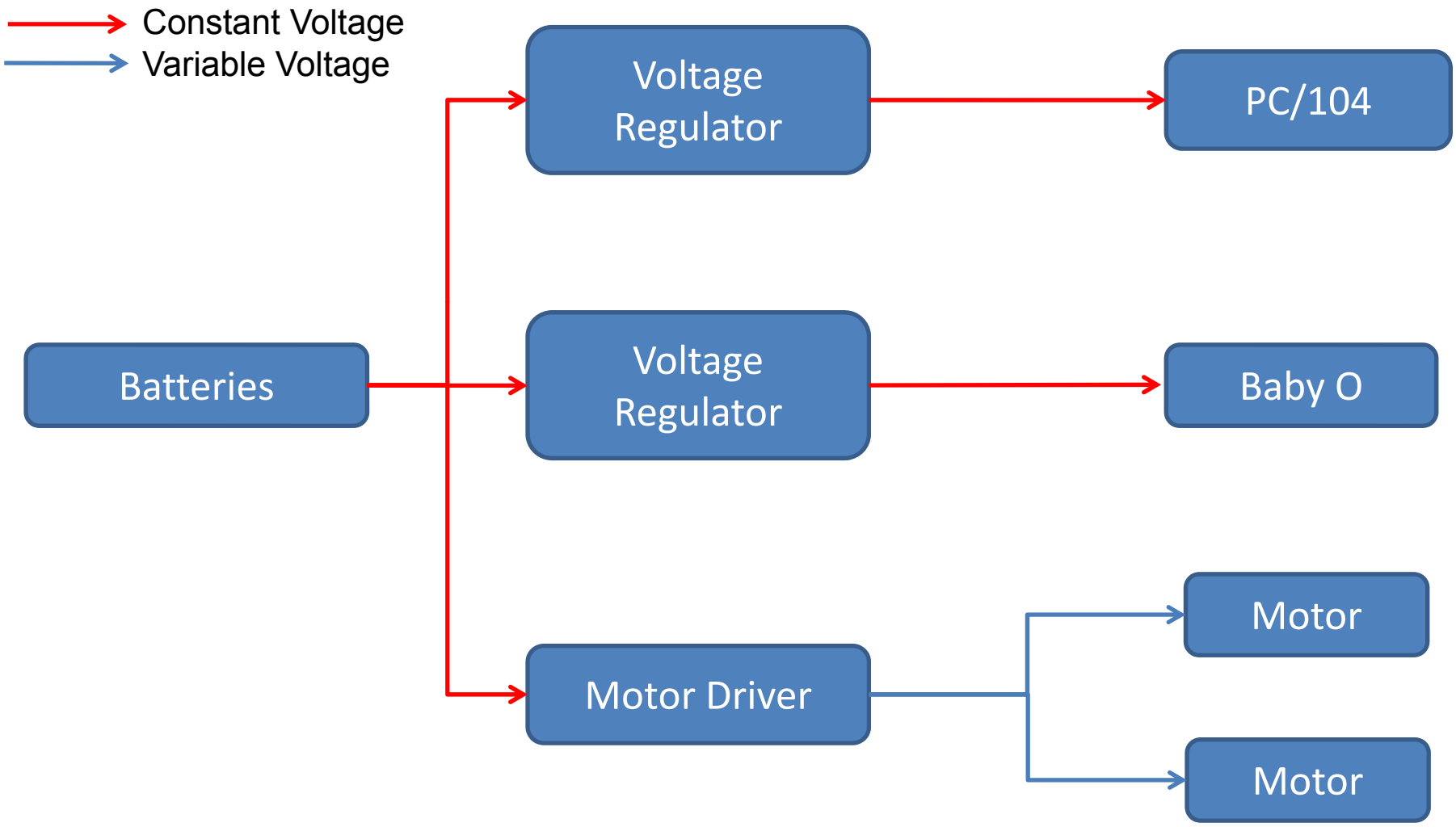




Communication Flow Chart



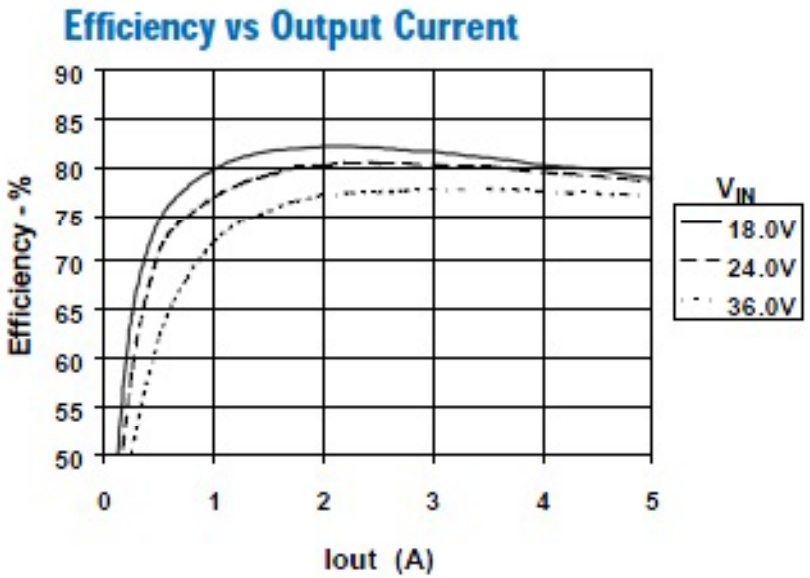
Power Flow Chart

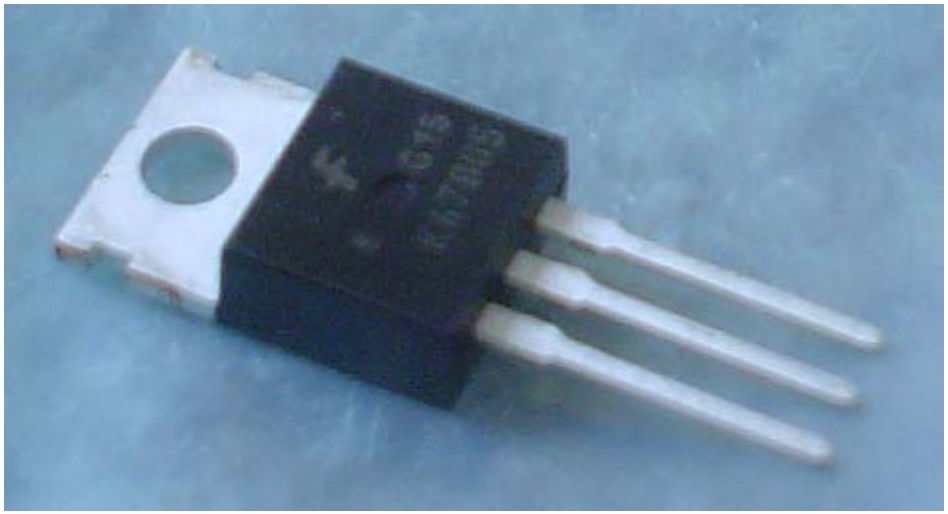


Voltage Regulator

Part No: TI PT6683

I_o = 0.1 to 5.0 A
V_{in} = 18V to 36V
V_o = 5V

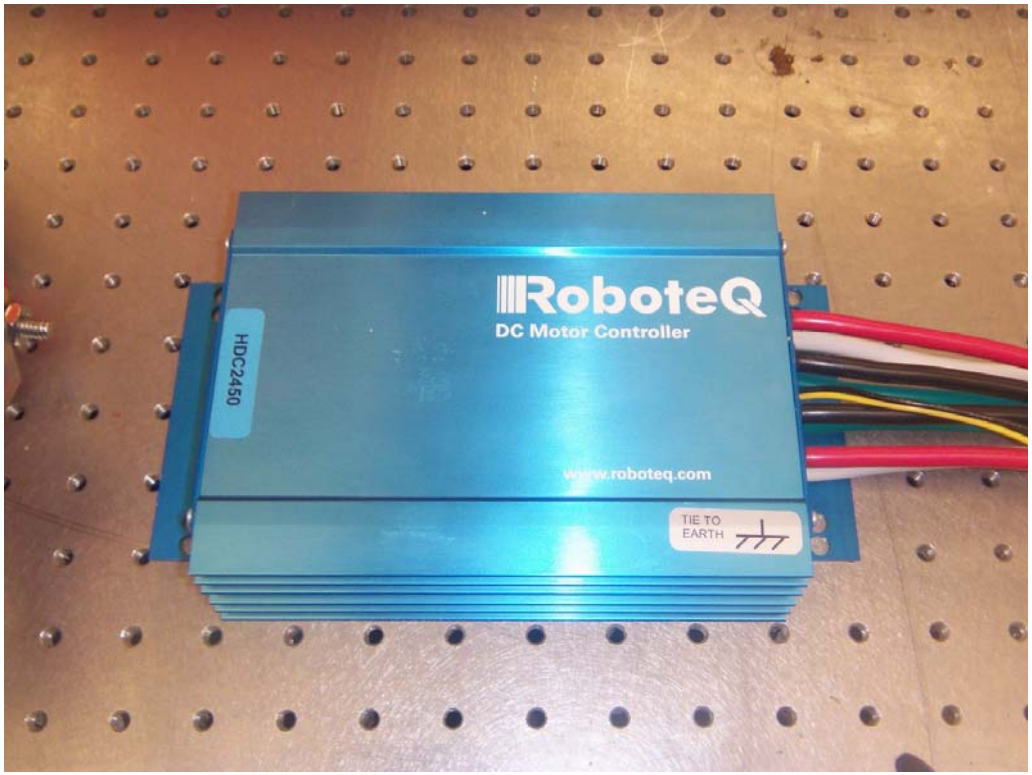




Motor Driver

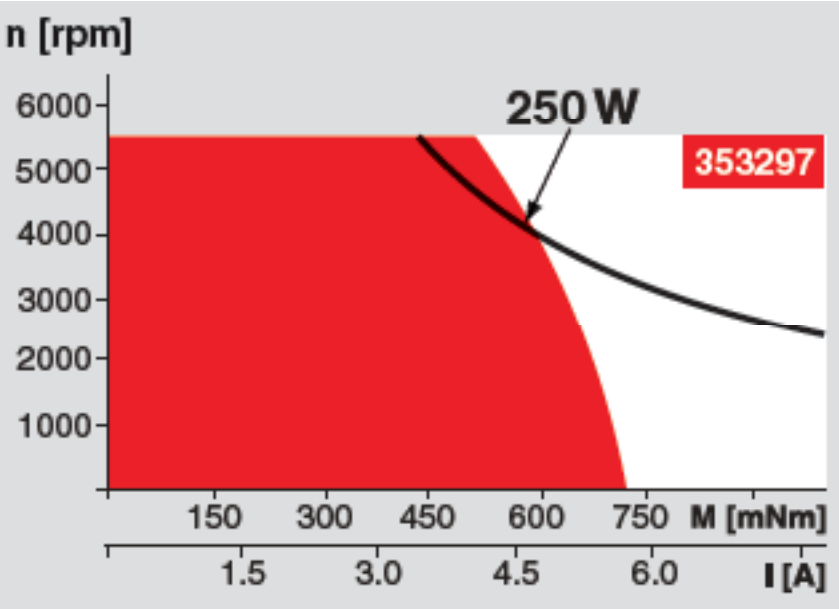
Part: Roboteq HDC2450

Battery Leads: 50 V
Motor Leads: 50 V
Stall Current: 300 A



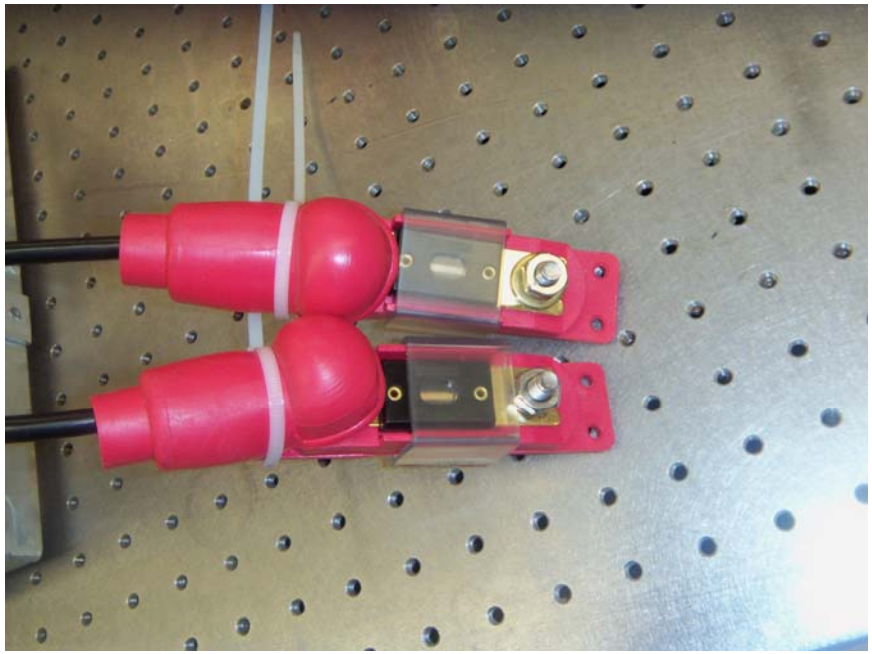
Motor

Nominal voltage = 18V
Nominal torque = 442mNm
Nominal current = 10A
Stall torque = 14 Nm
Starting current = 296A
Nominal speed = 3,150rpm



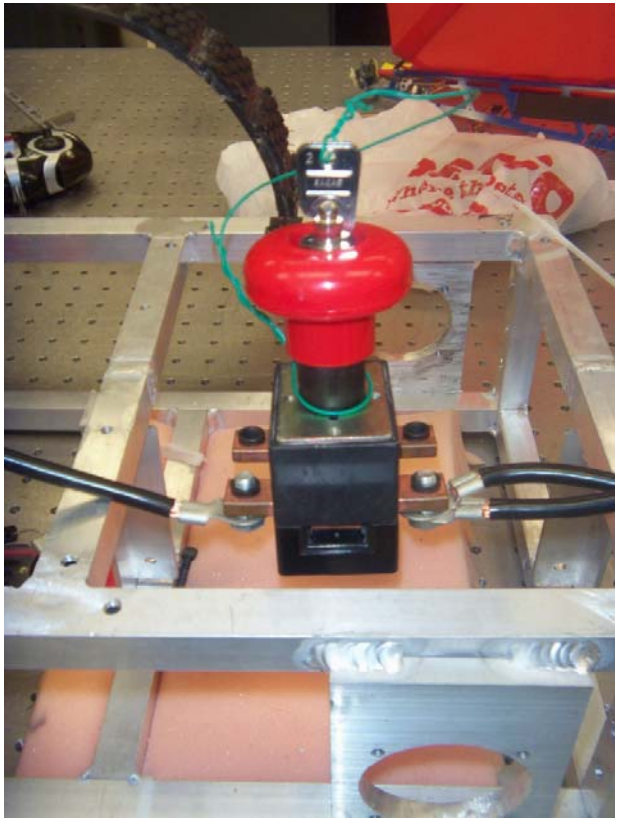
Fuses and Safety Switch

100A Fuse Rating

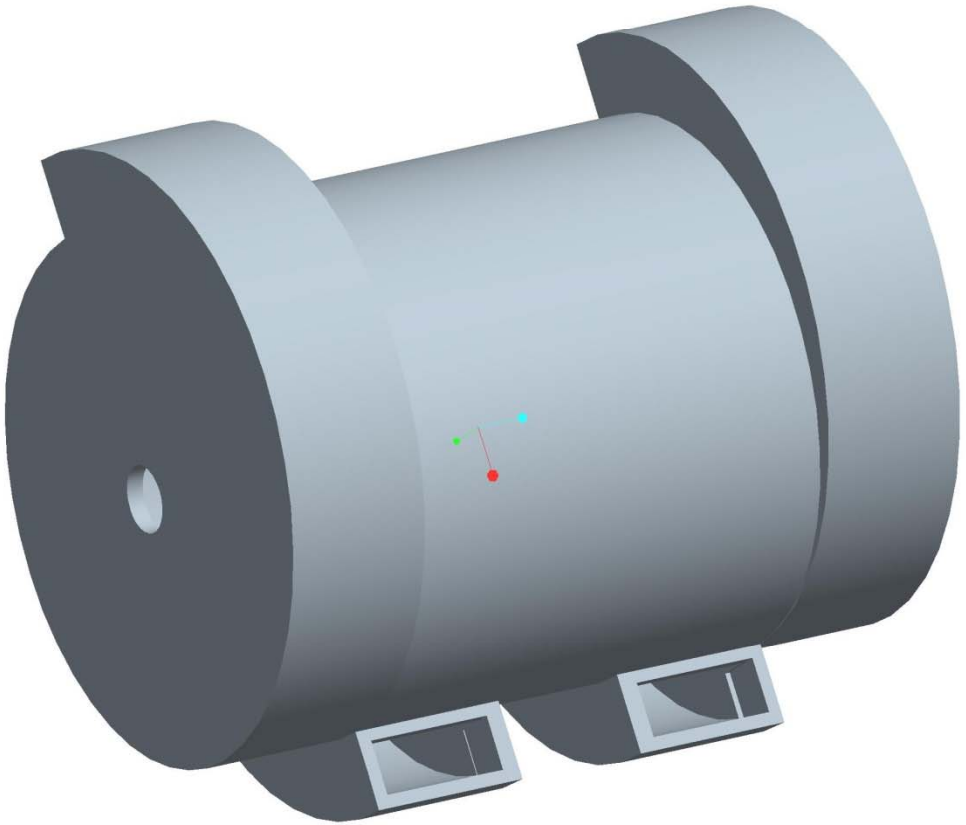


ED252L Locking safety switch

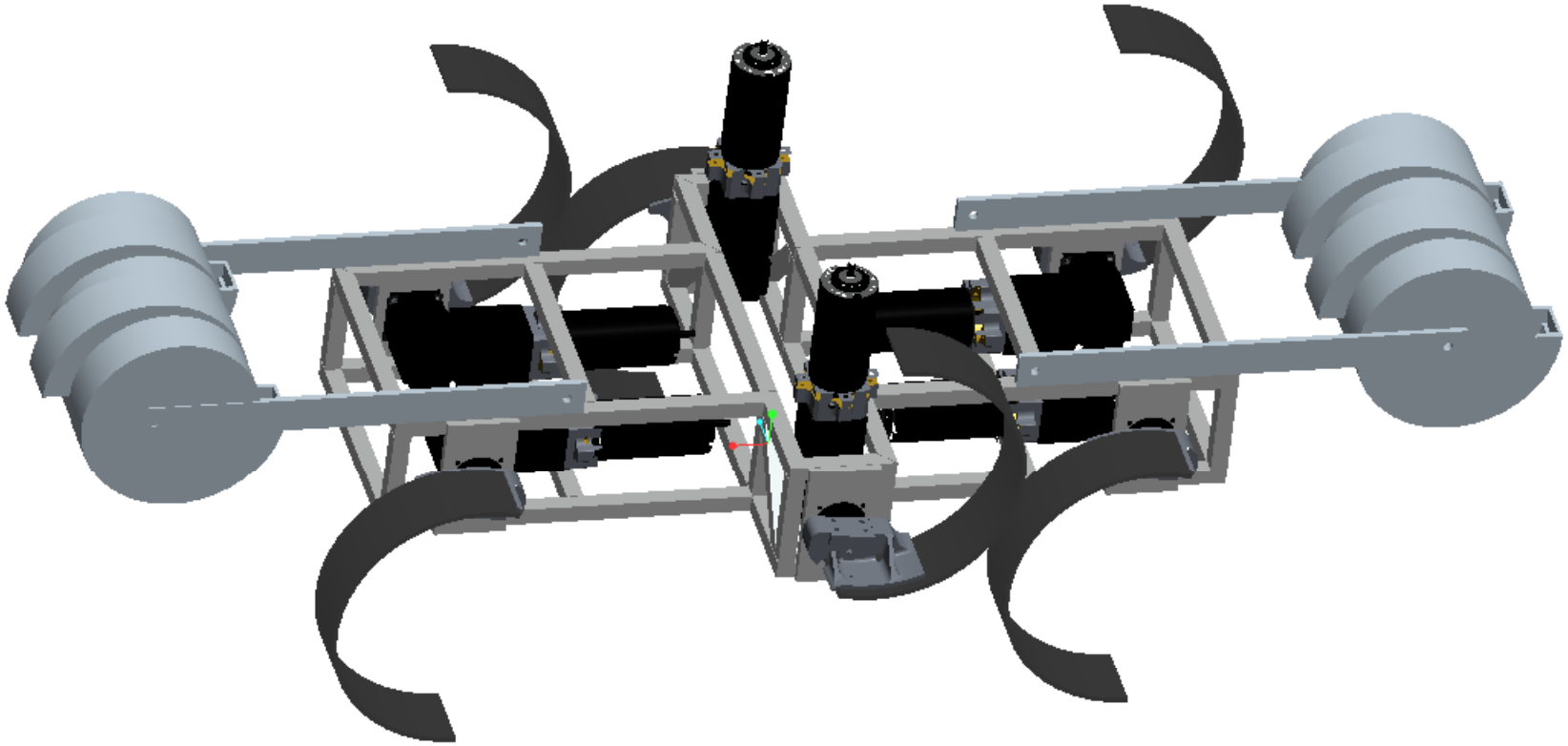
Maximum Voltage: 96V
Maximum Current: 250A



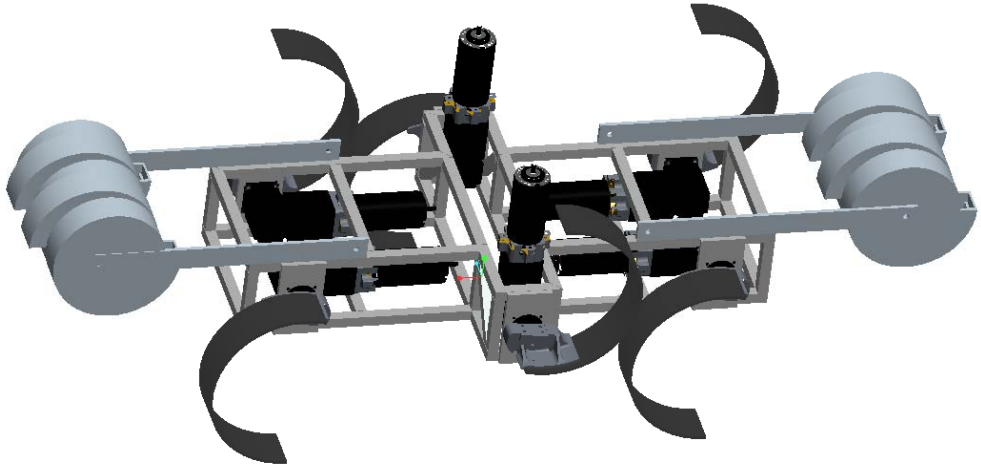
Rotating Drum



Double Rotating Drums



Pros/Cons Drummer



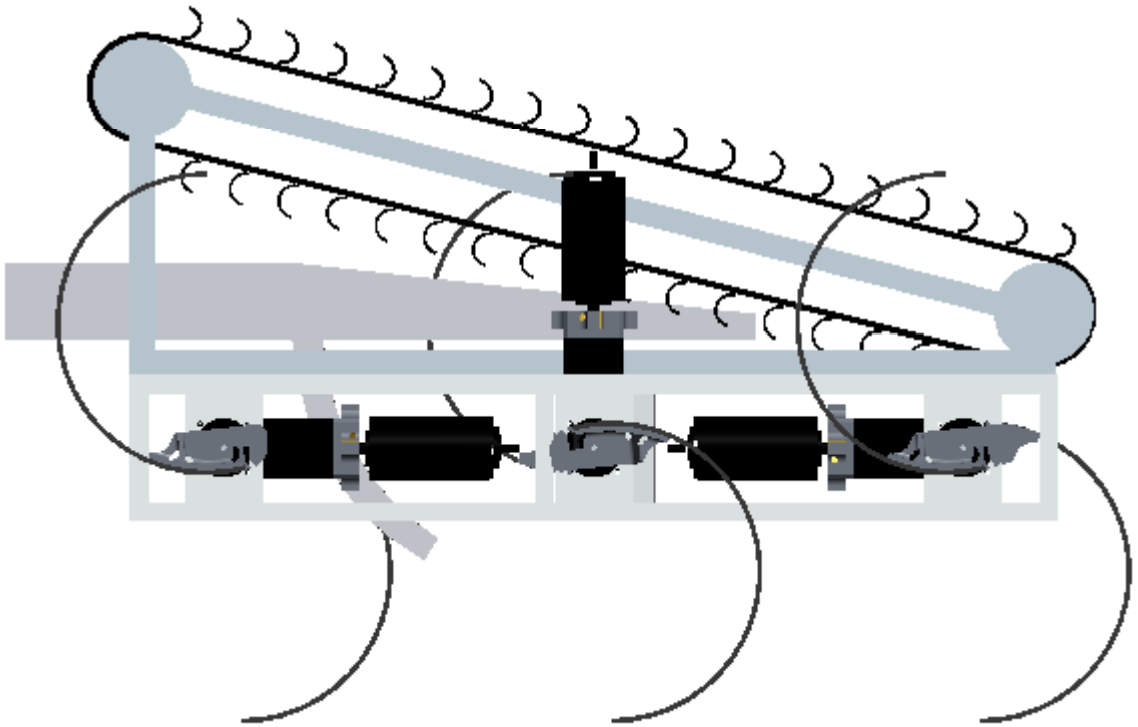
Advantages

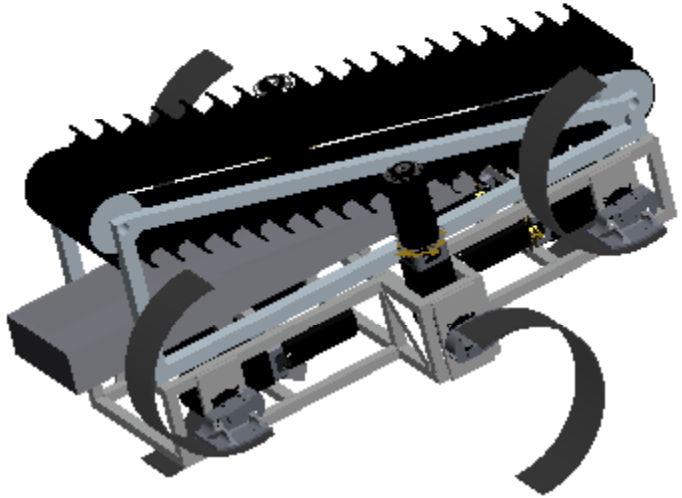
- Significant payload
- Cost effective
- Proven to work
- Balanced Center of Mass

Disadvantages

- Difficult to manufacture

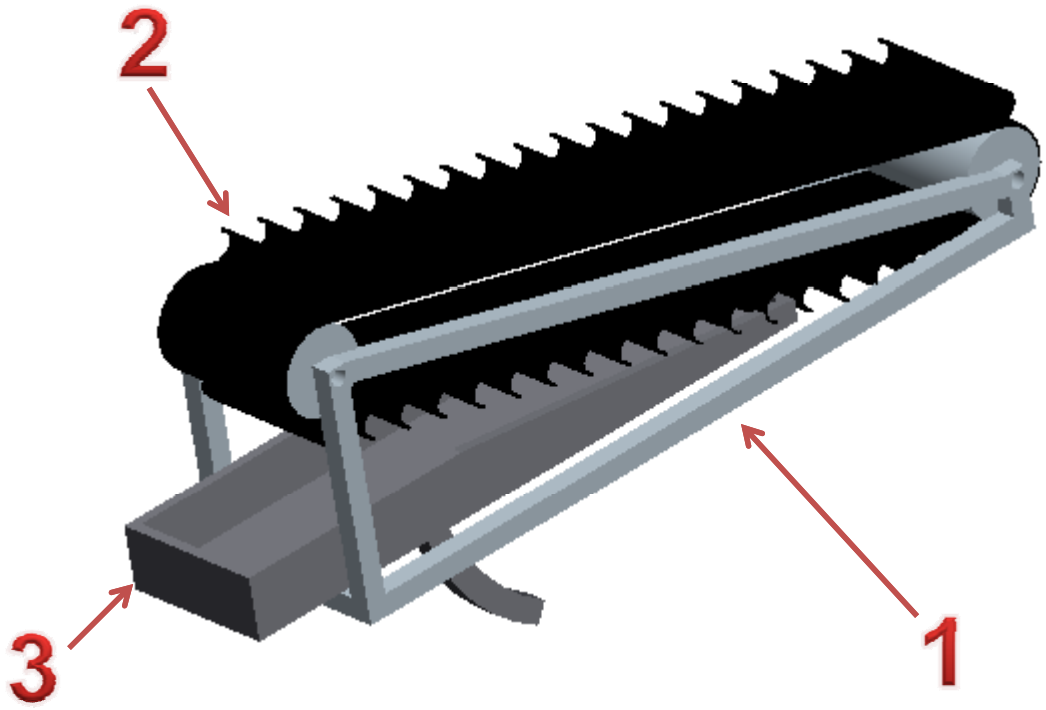
Excavation Design: Rotating Belt





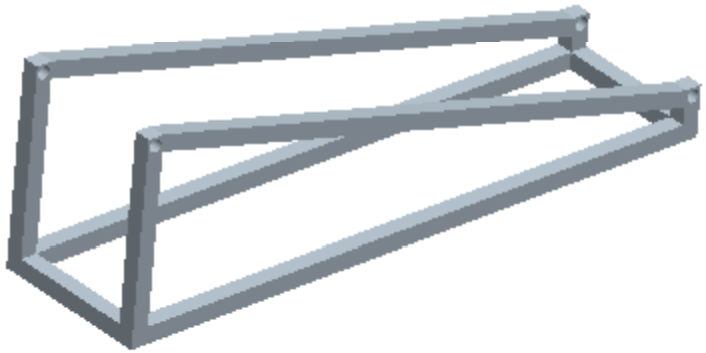
Overview

1. Frame
2. Rotating belt
3. Catch Pan
4. Center of Mass considerations



Frame

- Four post design
- Hollow to allow regolith drop
- Angled to accommodate belt and pan



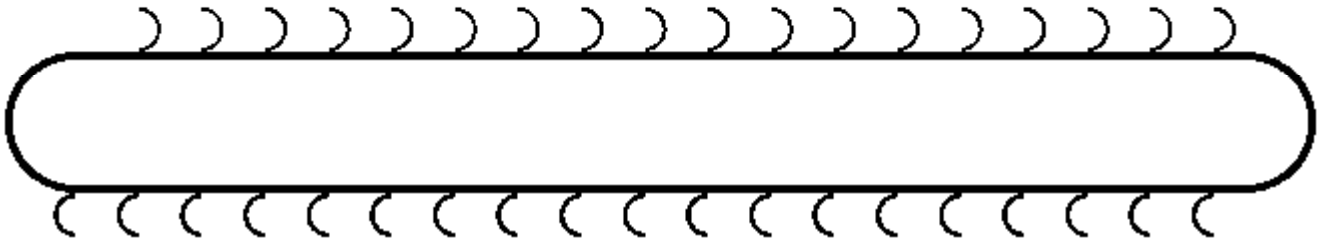
Rotating Belt

Specs

- Urethane or Neoprene material
- Teeth on inside
- “Clawed” Exterior
- Cut-outs for regolith drop

Possible Complications

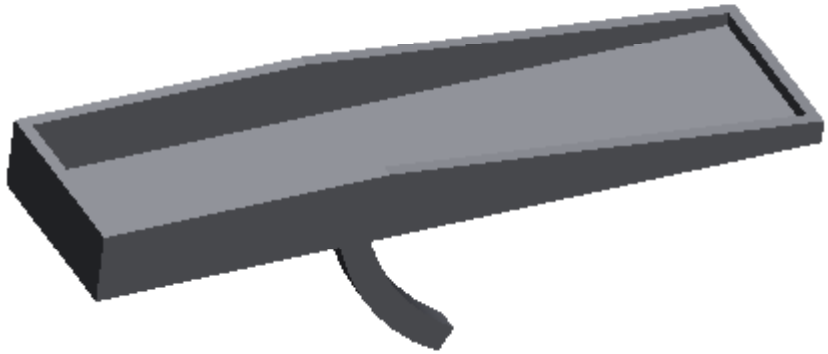
- Belt deviation
- Regolith build up
- Slippage

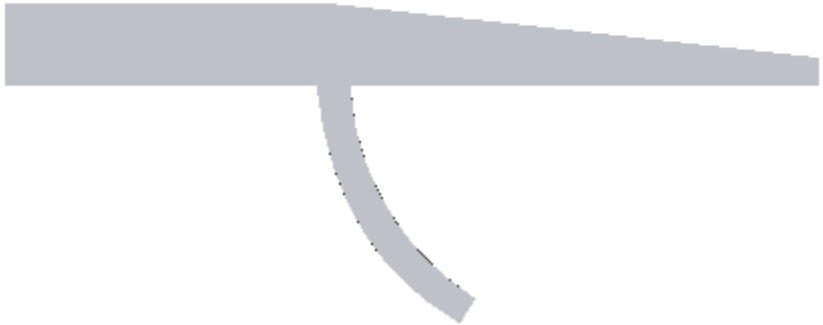


Catch Pan

Specs

- Regolith catcher
- Tapered rear design
- Motor actuation for lift
  - 30-45° lift





Considerations

- Taper
- Actuation
- Degree of lift
- Regolith translation

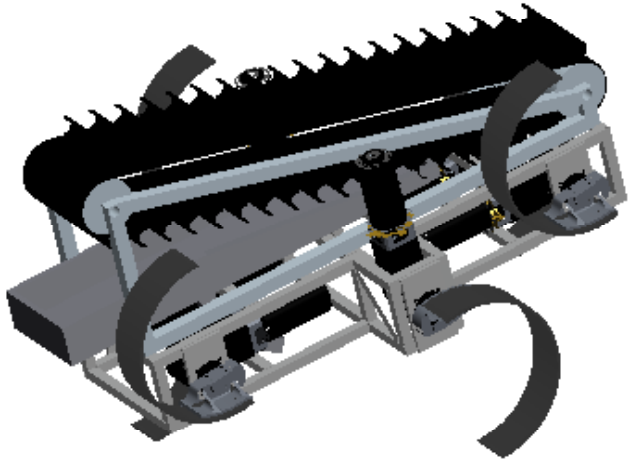
Center of Mass Consideration

Potential Problems

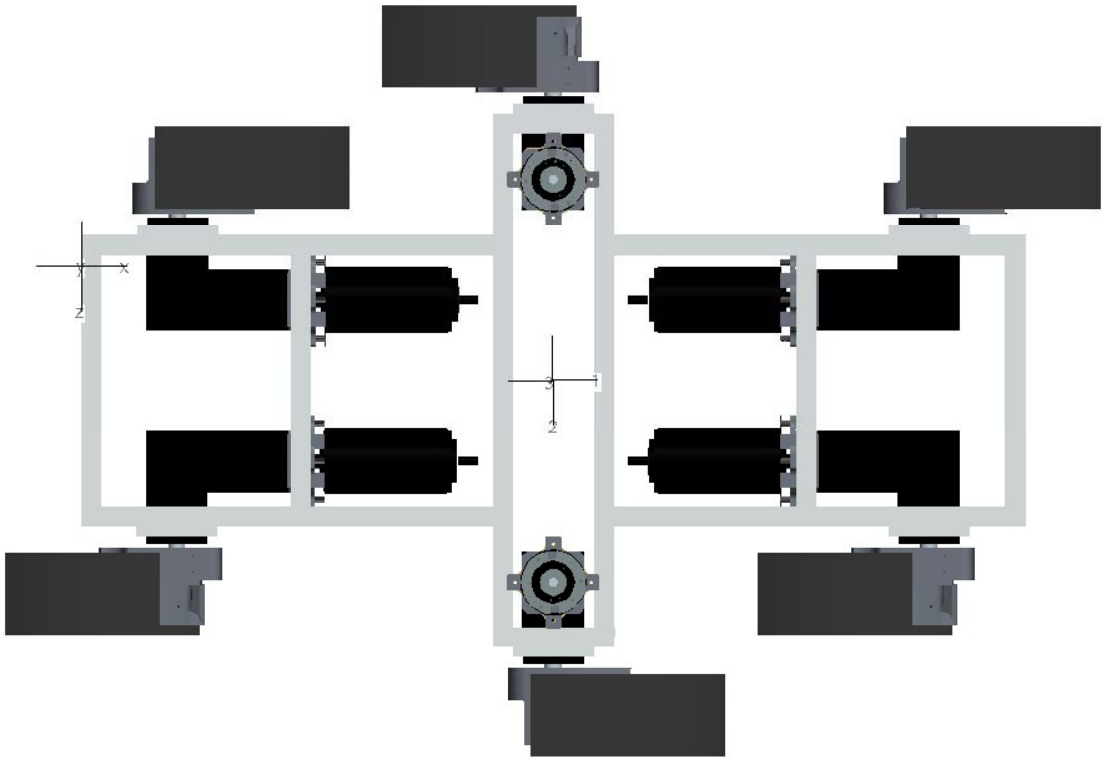
- Possible center of mass deviation
- Unsteady locomotion
- Control complications
- Loss of regolith

Solutions

- ProE and MatLab simulation
- Center mounted design
  - Belt and pan
- Pan lift toward center

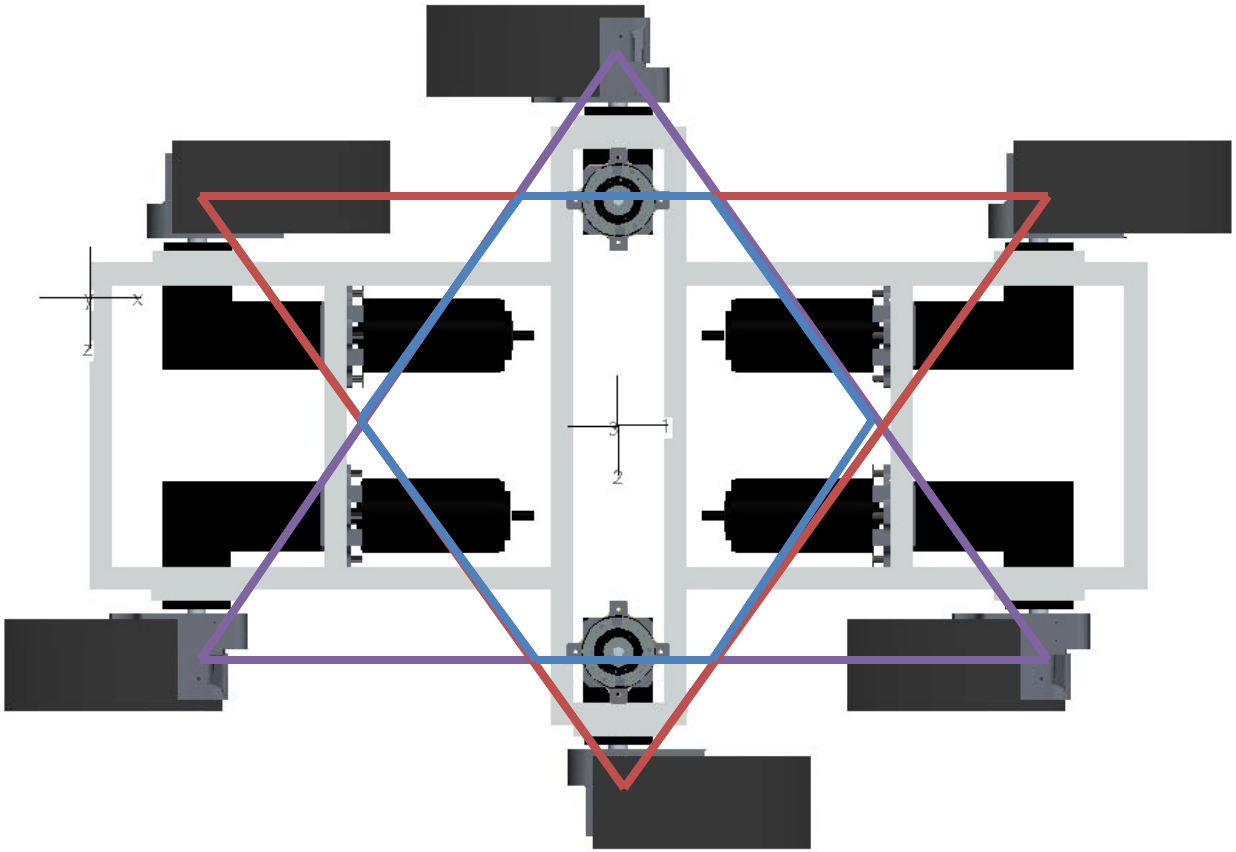


Current Center of Mass



Direction	(mm)
X	470.8
Y	102.6
Z	114.2

Center of Mass



Questions?

References

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- Roboteq. *Hdc2450_datasheet*. 20 July 2010. PDF.
- Maxon Motors. *RE-65-353294_11_EN_084*. May 2011. PDF.

Extra Slides

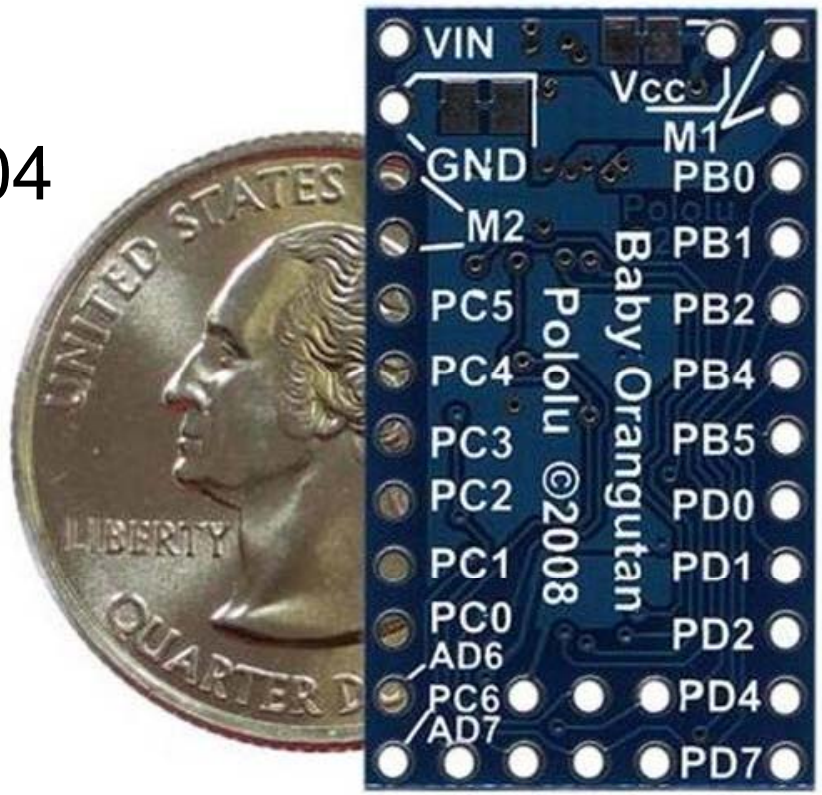
Here are extra slides…

Why Decentralize?

- Difficult to close loop on 6 motors
  - Baby Os can handle 2 motors
- PC/104 can handle communication
  - Inter-robot
  - User

Baby O

- Operates Buehler Clock
- Manages two motors
- Reads decoders
- Communicates with PC/104



AMD LX800

- 500MHz Processor
- Onboard 512 MB DDR Memory
- Supports up to three RS-232 ports
- Temperature Range: -20 to 80 ° C