NFPA Fluid Power Vehicle Challenge

NFPA
Education and
Technology
Foundation

FINAL PRESENTATION &
DESIGN REVIEW
Cal Poly San Luis Obispo
Jim Widmann
May 1st

CAL POLY

Team Introductions

Tristan Crawford

Karan Hothi

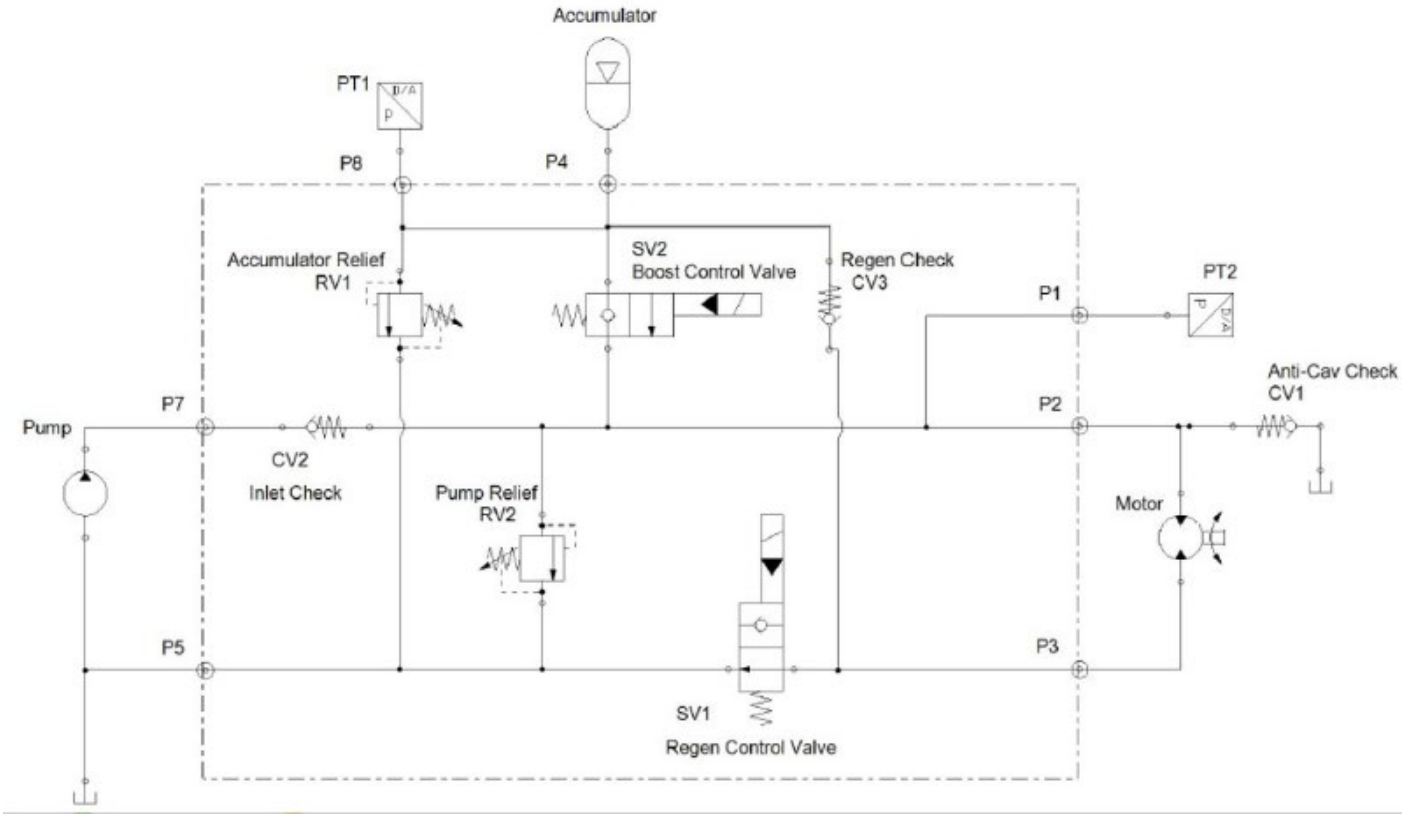
Justin Lesko

Diego Velazquez

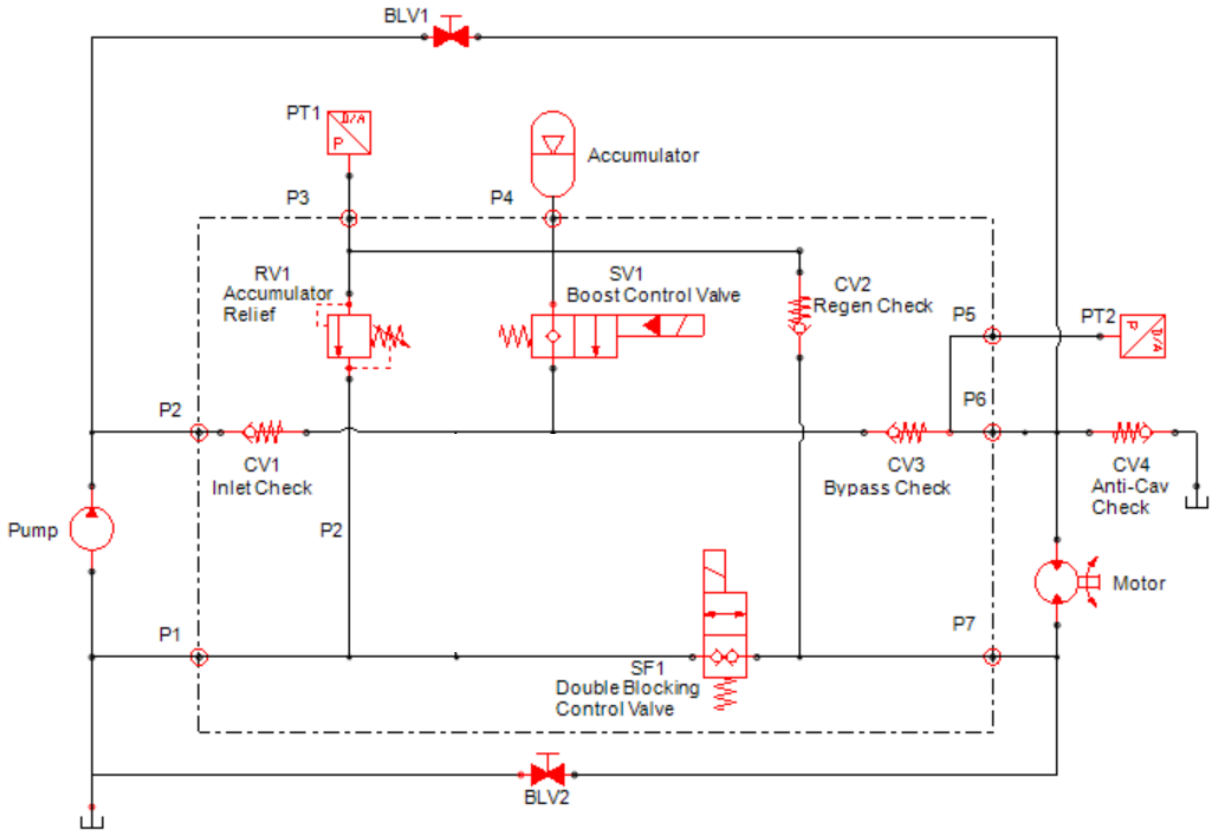
Lucas Erickson

Hydraulic System-Circuit

2024 Cal Poly FPVC Team Hydraulic Circuit Schematic



Hydraulic System-Circuit



System changes:

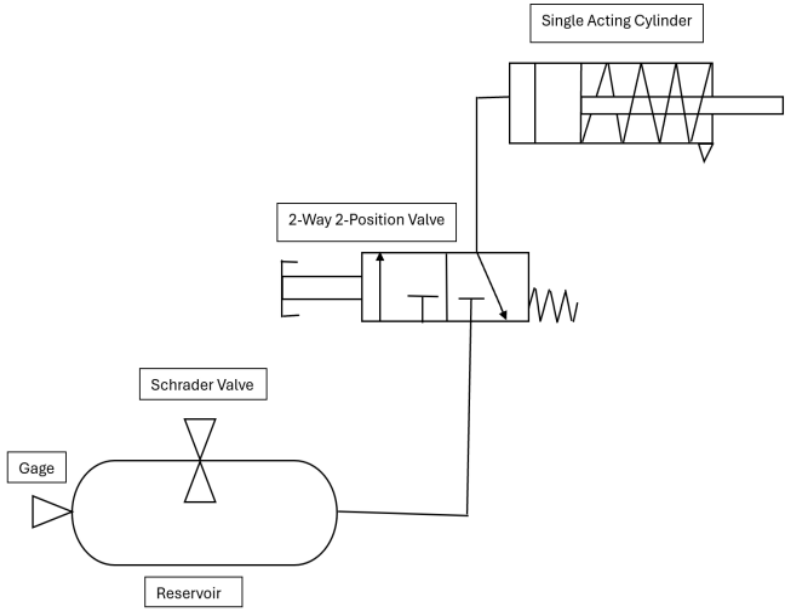
- Parker F11-5cc motor/pump
- Bypass line with rigid lines
- Bypass check valve
- Replaced SV1 with SF1 (double blocking valve)

Hydraulic Construction

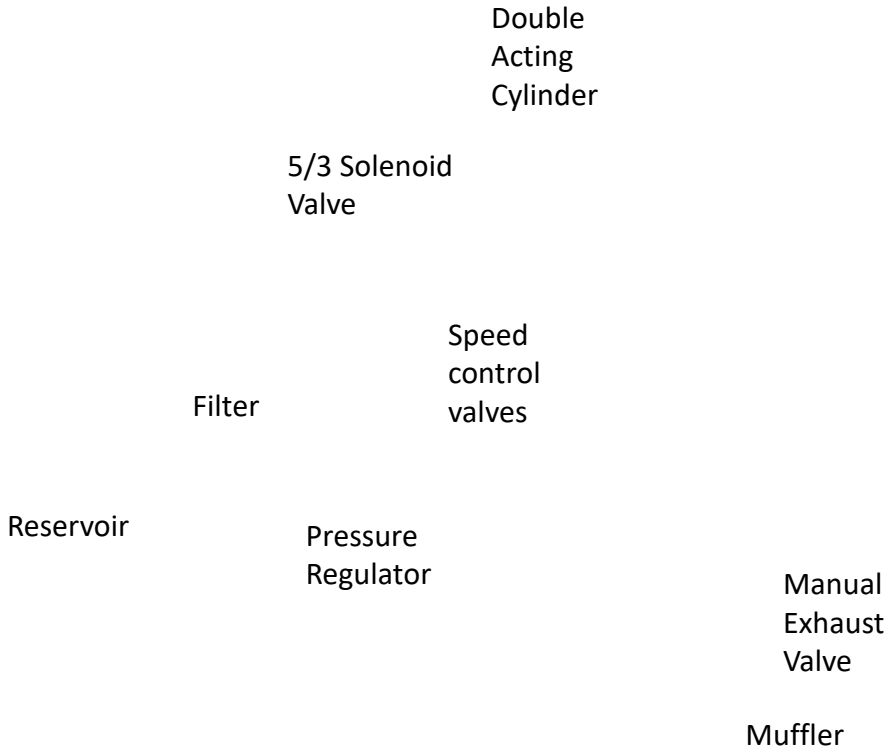
- Routed hydraulic lines 3 different times to avoid putting stress on the mounts(caused a leak with the old motors)
- Motor was switched due to a leak, which necessitated fabrication of sprockets to fit the new spline shaft
- Used hydraulic hoses instead of solid lines to facilitate installation with newer motors
- Removed dials and gauges used for calibrating sensors

Pneumatic Circuit

- Switched to meter out – flow control valves moved to exit of solenoid valve
- Added manual valve before muffler as extra mechanical failsafe



FPVC 2024 Pneumatic Schematic



FPVC 2025 Schematic (Note – manual valve should not have spring).

Construction: Manufacturing Processes

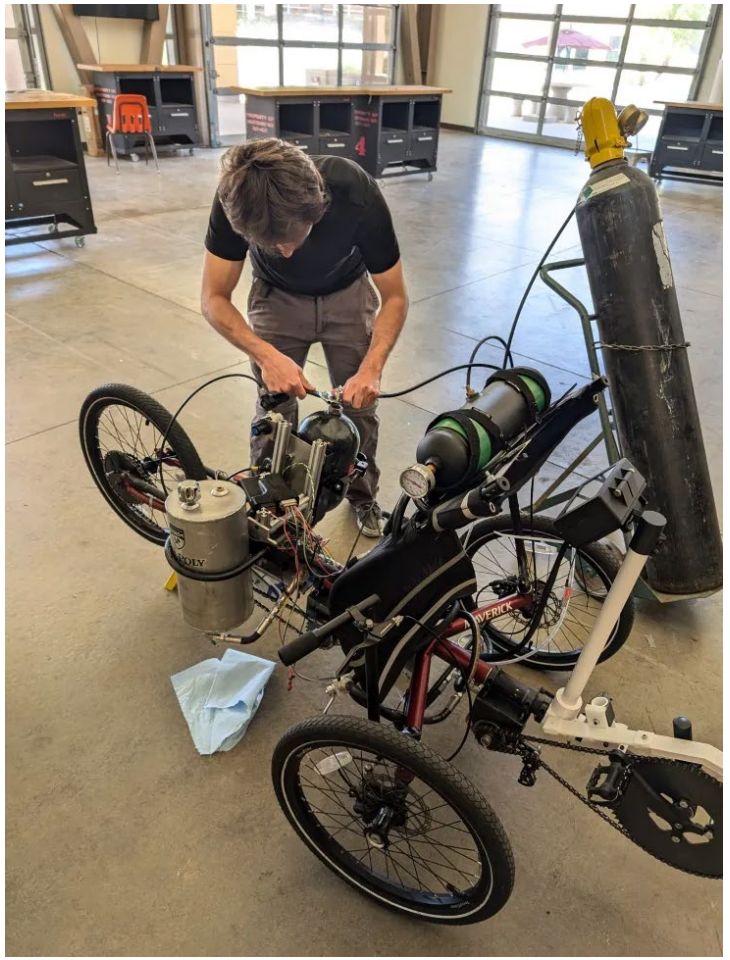
- Waterjet
  - Jack stand, hydraulic mounts, sprockets
- Drilling and sanding
  - All metal mounts
- 3D printing
  - Screen mount, chainguard, analog controls mount
- Soldering
  - Mechatronics PCB

Construction: Assembly

- Manifold, motors, and jack stand mounted to central frame
- Custom sprockets attached to splined motor shafts and secured with spacers
- New chains and tensioners aligned with front and rear drivetrains
- Mechatronics screen mounted in front of seat. Battery and additional circuitry attached to reservoir mount
- Chainguard attached to front drivetrain
- Hoses and wires routed around the bike

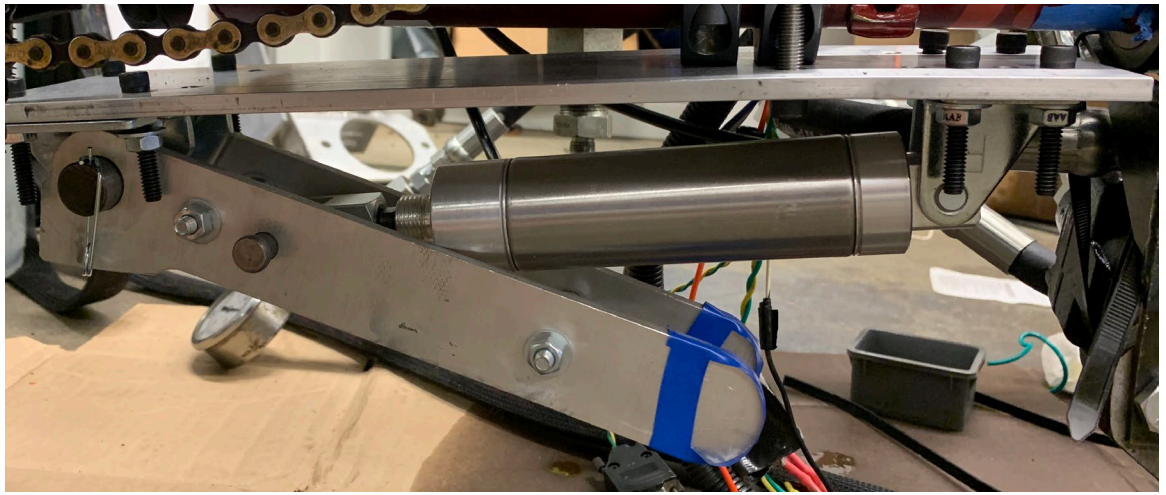
Testing

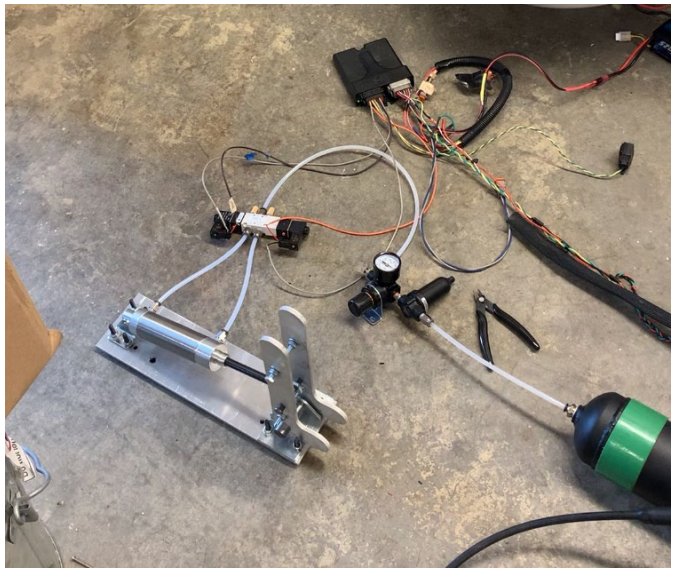
- Hydraulics
  - Averaged direct drive pressure to find optimal pre-charge pressure
  - Tested optimal fluid capacity
  - Stand can only lift bike 4 times, not 7 times as calculated



Testing

- Pneumatics
  - Initial testing performed off of bike to confirm range of motion
  - Intermediate testing performed with manual valve before mechatronics added
  - Stand can only lift bike 4 times, not 7 times as calculated



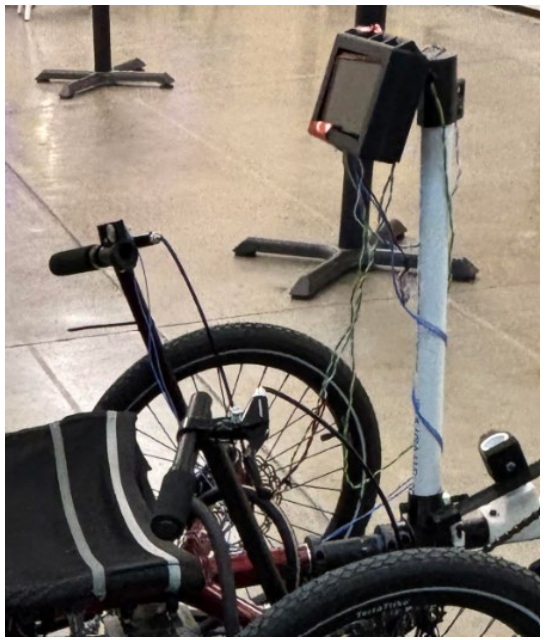


Testing

- Drivetrain
  - Rear tensioner mounted underneath frame due to high force on chain and chain alignment
  - Due to reliability issues during testing, variable gearing system was removed

Testing

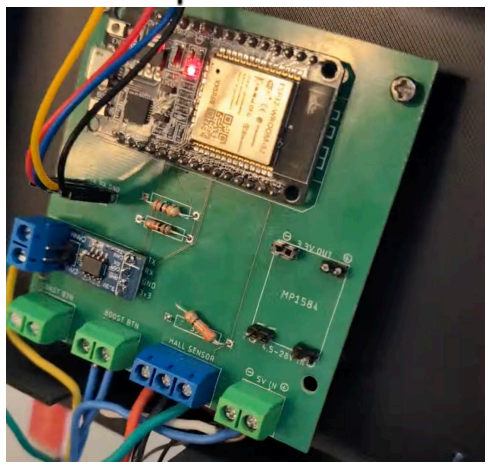
- Mounting:
  - Due to manufacturing delays, new motor mounts were scrapped in favor of repurposing old mounts
    - Adjusted to align with drivetrain and manifold positioning
  - 3D printed mounts were strength tested, revealed failure points
    - New mounts include higher density and fillets



Testing

- Mechatronics
  - Tested mechatronics to ensure reliable message exchange between microcontroller and valve driver, preventing the bike from getting stuck in boost mode.
  - Calibrated hall effect sensor and pressure transducer for accurate speed and pressure readings

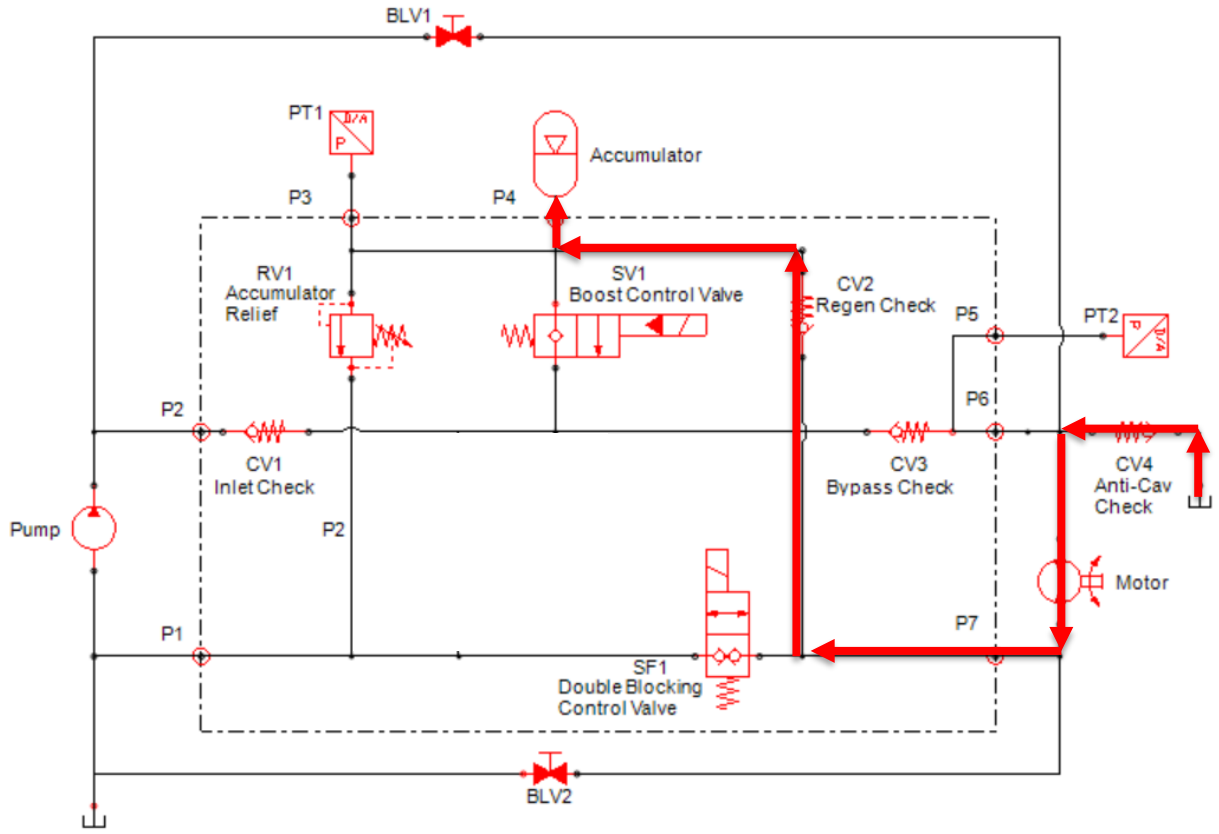
```
signal: 621
psi: 108.75
signal: 624
psi: 112.5
signal: 629
psi: 118.75
signal: 633
psi: 123.75
signal: 637
psi: 128.75
signal: 642
psi: 135.0
```



```
✅ CAN Bus Initialized
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
🔴 Button Pressed → acc_dump
✅ Executed Command: acc_dump
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
----acknowledged on 0x184----
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
🟢 Button Released → direct
✅ Executed Command: direct
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
----acknowledged on 0x184----
Wheel Speed (RPM): 0.00
Wheel Speed (mph): 0.00
```

Regenerative Braking

- Circuit was developed for regenerative braking
- However tire has a ratcheting mechanism that does not allow for proper regenerative braking



Lessons Learned

- Nothing works the first time (or second)
- Start manufacturing early, anticipate delays
- Design for manufacturing – splined shaft