Human Powered Hydraulic Vehicle Challenge: Pneumatic Clutch Control

Authors

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Introduction:

Our team has created a pneumatically actuated clutch system on a human powered hydraulic bicycle. In participation for a national challenge hosted by the NFPA we will be competing against other universities for the best use of pneumatics. Our design will engage a hydraulic pump to fill an accumulator with pressurized fluid to be used for the propulsion of the bike. (Pluta, 2023)

Objective:

Design and build a pneumatic clutch system that engages a regenerative brake.

Pneumatic Circuit Design

The pneumatic circuit will engage and disengage a friction clutch that is connected to a hydrualic regen pump. The regen pump will be used to store pressurized fluid in an accumulator to be used as a boost for the pilot.

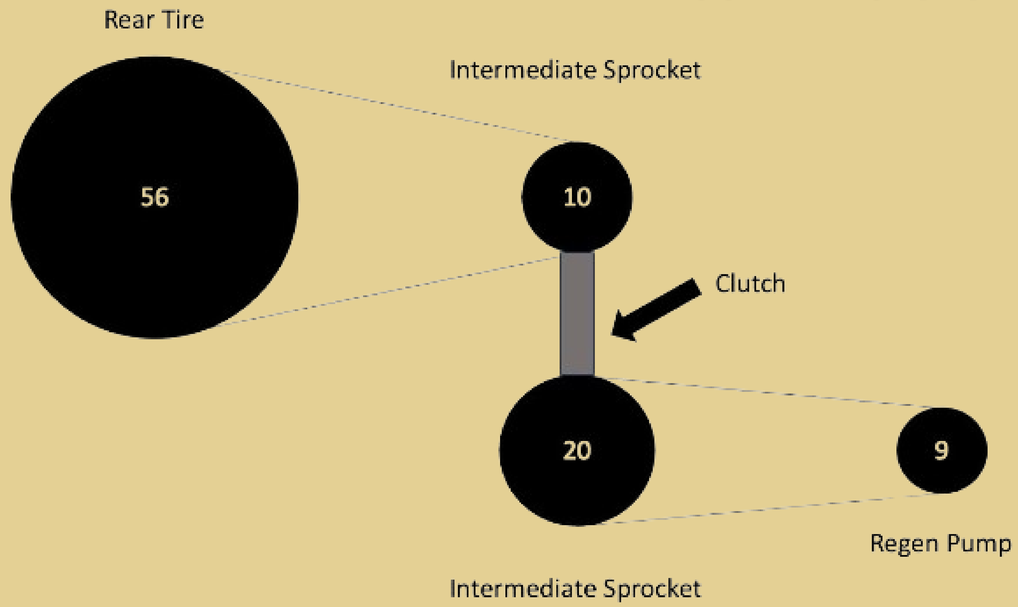
Nexen Air Engaged Shaft Mount Friction Clutch

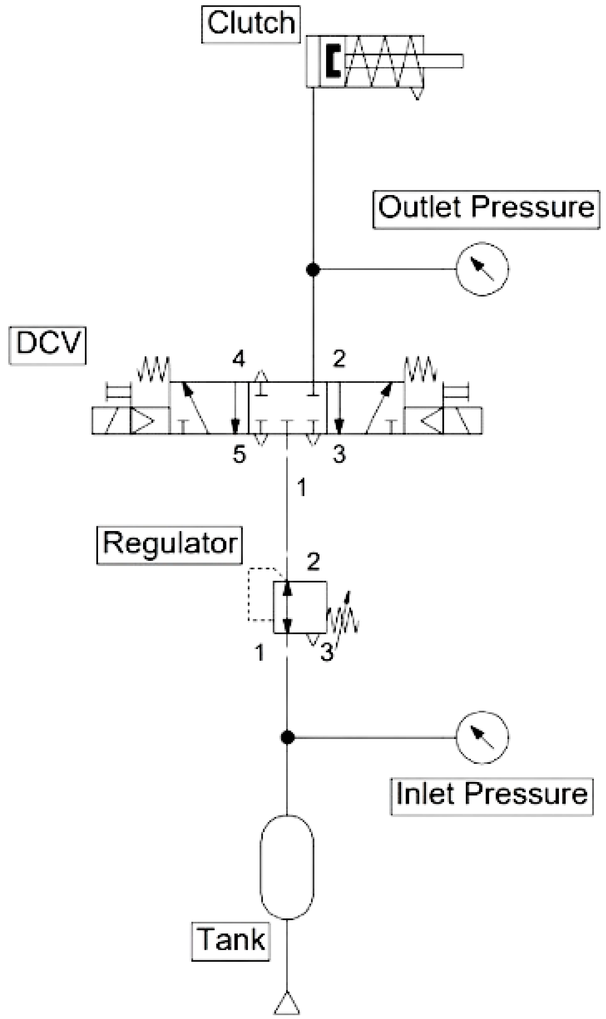
- Operates at 80 psi -> under safety limit of 150 psi set by NFPA
- Max dynamic torque of 85 lb-in -> will overcome regen pump minimum torque
- Max speed 3600 RPM -> within the operating speed of regen pump
- Total weight 4.03 lb -> lightweight to mount on the bicycle

(Nexengroup.com, 2024)

Gear System Design

Translating rotational motion from the back tire of the bike, across the clutch and when engaged to the regen pump.





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Human Powered Hydraulic Vehicle Challenge: Electrical System Design

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Introduction:

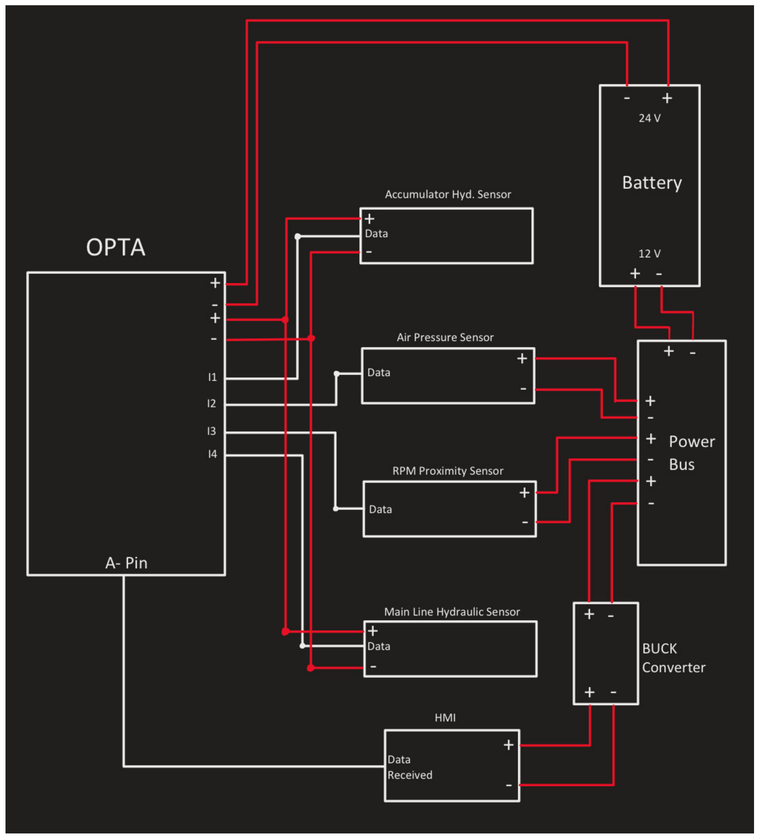
The electrical system combines mechanical and electronic components. With the use of the Arduino Opta PLC at its core, complemented with an onboard display, the system is designed for efficiency, accessibility, and advanced control. This setup is suited for applications demanding precise control over hydraulic, pneumatic, and rotational parameters, enhanced by the benefits of digital connectivity and real-time data access.

Objective:

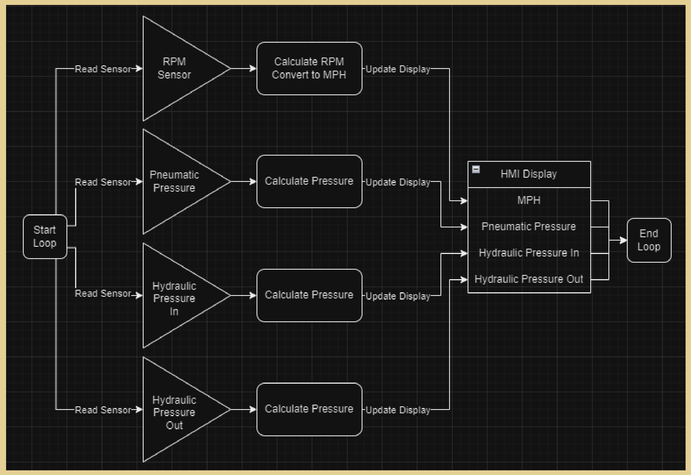
To read and display sensor data onto an HMI screen for the driver and team to interact with.

Electronic Circuit Design

- RPM Sensor
  - Proximity sensor attached to back wheel which gets triggered as the chain sprocket turns
- Pressure Sensors
  - In-line pressure sensors for both pneumatic and hydraulic systems
- Power
  - 24V battery with 12V output option
  - Power bus used to decrease wiring clutter
  - Buck converter used to step down 12V to 5V for the HMI
- HMI
  - Connected to OPTA through serial connection



Process Flowchart:



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