Fluid Power Vehicle Challenge

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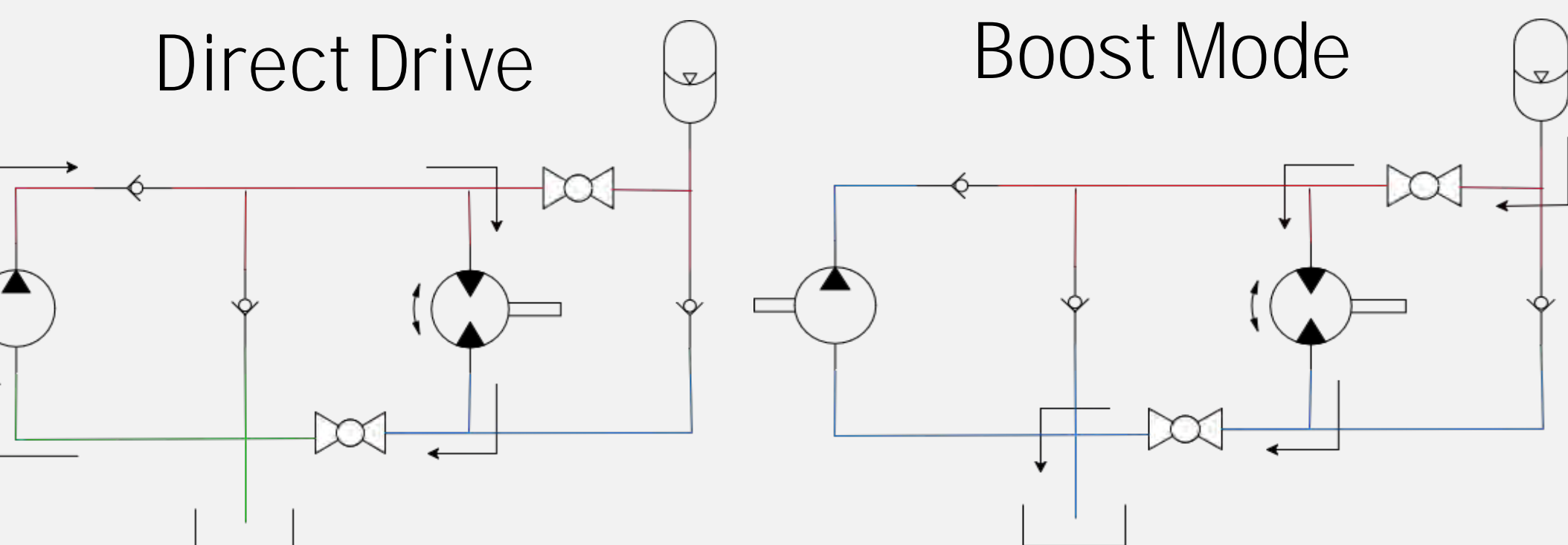**N F P A Fluid Power VEHICLE Challenge**

Hydraulic Circuit

The Hydraulic Circuit represents the paths that the fluid flow takes in the bike in a similar way to an electrical circuit. It has four different modes:

- Regenerative Braking: Fluid is pumped by the motor into the accumulator, slowing the vehicle and storing energy.
- Pedal Fill: Pedaling sends fluid to the accumulator to store energy.
- Boost Mode: Stored energy boosts the vehicle beyond pedaling speed
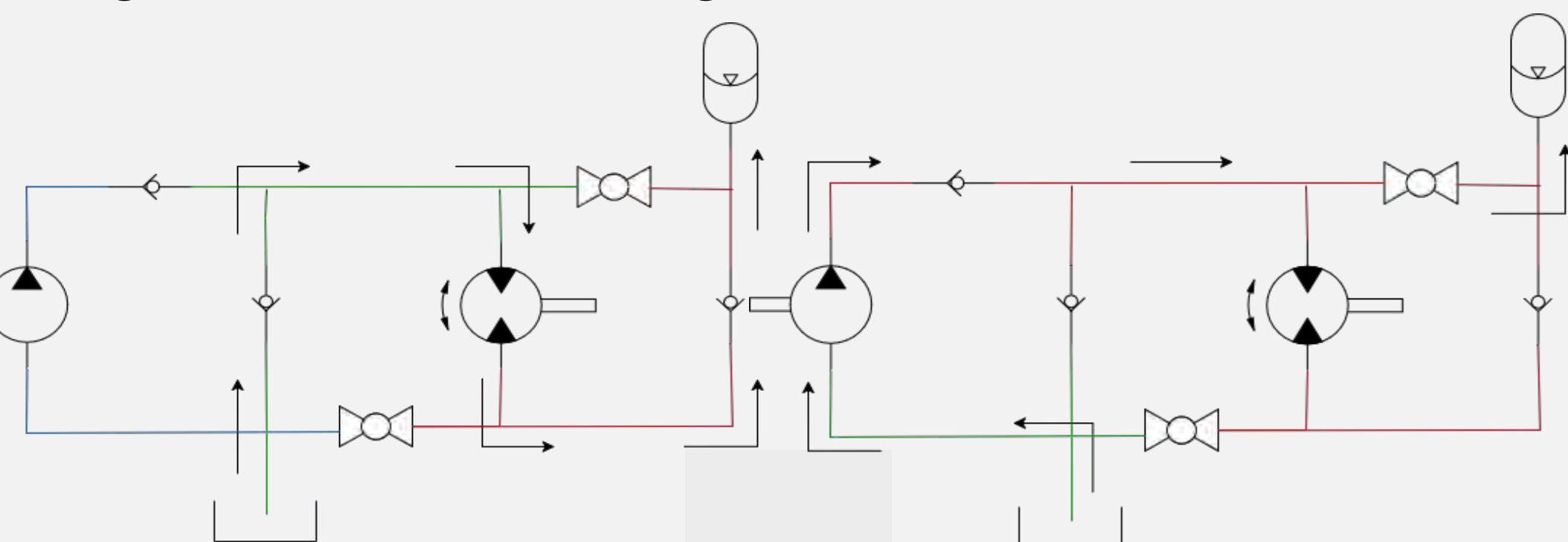- Direct Drive : Pump fluid powers the motor to move the vehicle.
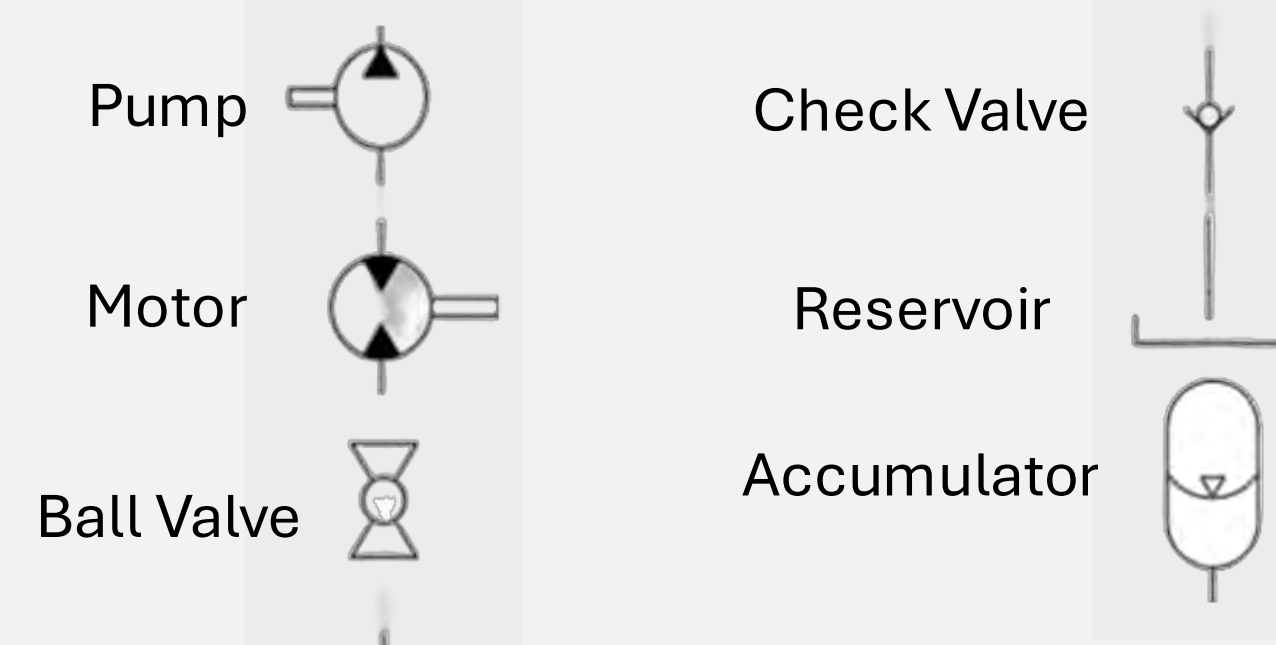
Direct Drive

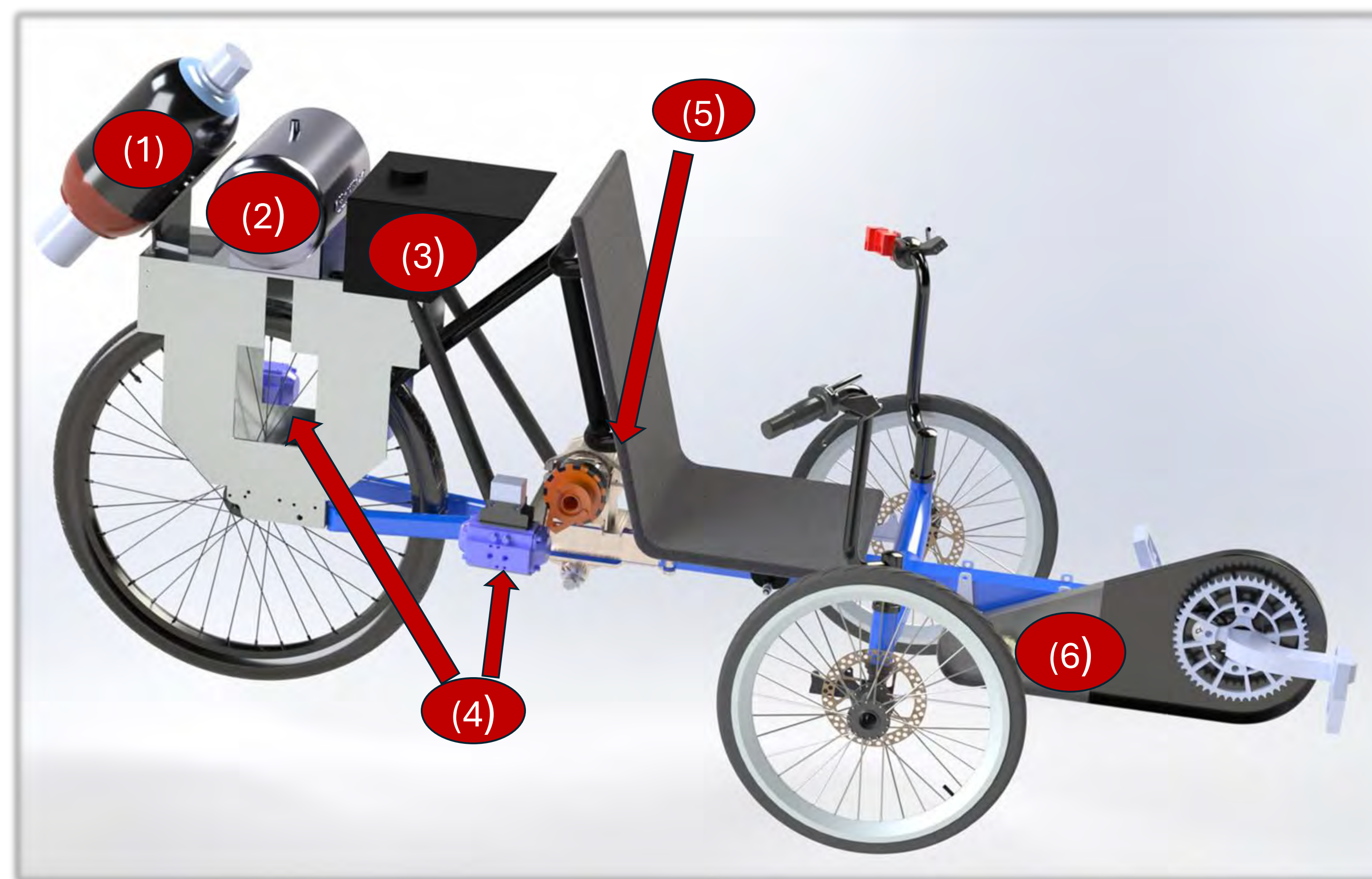Boost Mode

Regenerative Braking

Pedal Fill

Hydraulic Legend

Pump	Check Valve
Motor	Reservoir
Ball Valve	Accumulator

- High Pressure
- Low Pressure
- Inlet

System Components

(1) Accumulator

The accumulator stores and releases energy to ower our drive modes

(2) Air Tank

The air tank stores pressurized air used to operate the actuators and control the clutch

(3) Reservoir

The reservoir holds extra hydraulic fluid and supplies it to the system. Fluid from the motor's case drain also returns here
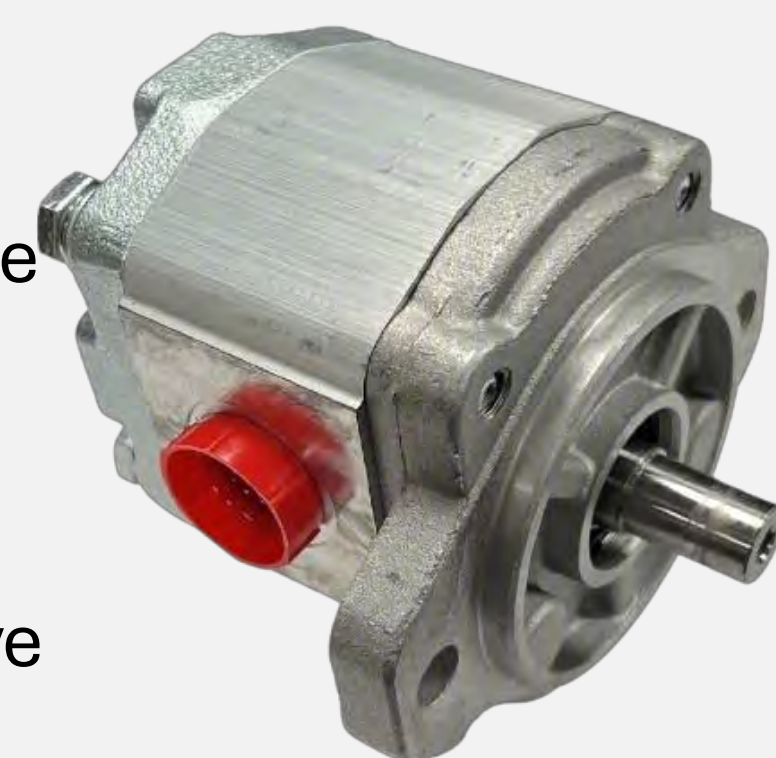
(4) Actuators

Two air-powered actuators control ball valves that direct fluid flow in our system-one for boost mode, the other for regenerative braking

(5) Motor/Clutch

We used a 1.025 cubic inch motor with a pneumatic clutch that lets the bike coast when disengaged. The motor drives the rear wheel to move the bike forward.

(6) Pump

Used a 0.39 cubic inch pump connected to the pedals, with a chain guard for rider safety. It's similar to the motor but has a smaller displacement to maximize bike power

Objective

Design and build a hydraulic-powered vehicle for the National Fluid Power Association's annual Fluid Power Vehicle Challenge. The vehicle will compete in 4 events: endurance, sprint, efficiency, and a regenerative braking demo. The vehicle must include multiple drive modes for pedaling, storing, and releasing fluid energy.

Design Decisions

- Ball valves were chosen to control flow in order to optimize flow efficiency by minimizing pressure drop.
- Pneumatic controls were selected over electronics in order to achieve fast actuations, and no electronics were used on the bike.
- A clutch between the motor and the drive wheel was used to allow for freewheeling to increase efficiency during coasting.
- A gearbox was installed at the pedals to allow the rider to output maximum power at a variety of speeds.

Pneumatic Circuit

Pneumatic circuit is used to control the actuators which switch to different modes on the hydraulic circuit and can disengage the clutch.

- Actuator mount (one side removed)
- Stem adapter
- Ball Valve
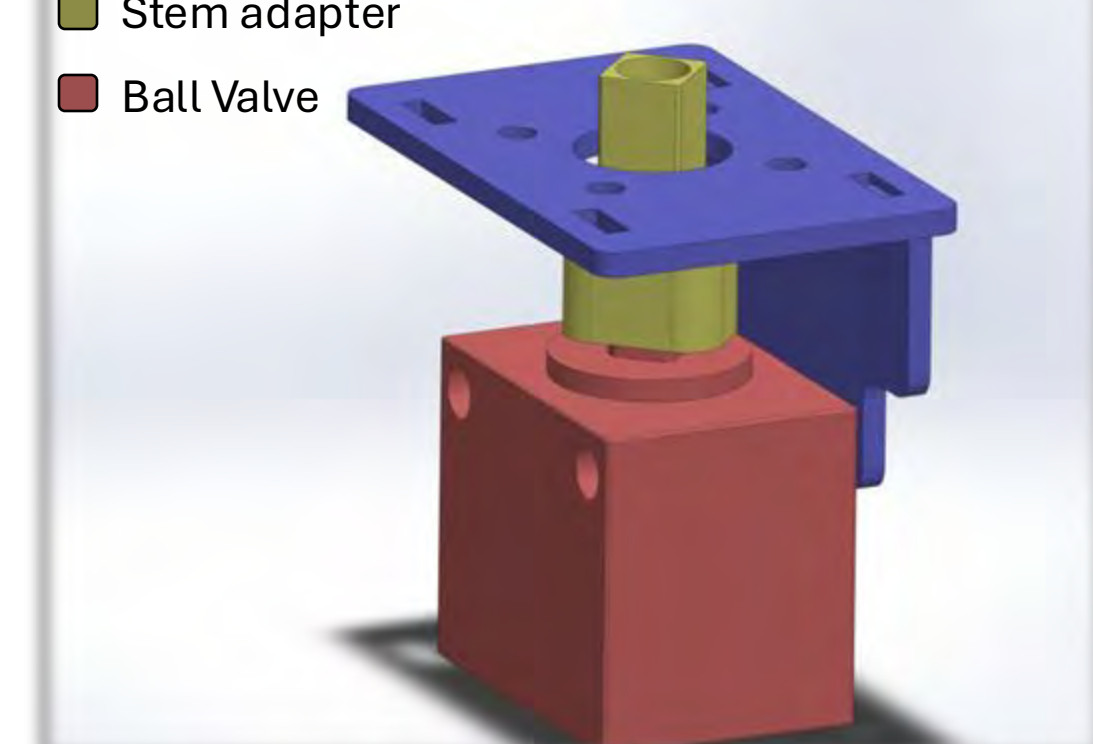
Performance

- Max direct drive Speed: 10.9 mph
- Max boost mode speed: 23.9 mph
- Max accumulator pressure: 3000 psi
- Max boost flow rate: 1.46 gal/min
- Regen race distance: 194 ft after regen to 1100psi
- Endurance race: 7,500 ft in 15 min
- Sprint race: 300ft in 12 sec
- Efficiency race: 1100 ft on one accumulator charge