Electric Go-Kart

Mechanical and Aerospace Engineering
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Abstract

The project consisted of designing, analyzing, and modifying an electrical go-kart for the Top Kart EV Grand Prix competition. Students were challenged to build off last year's team's kart and improve it to compete in the 2022 Grand Prix in Indianapolis, Indiana. The team traveled to the 2021 competition in West Lafayette in September to compete against other schools across the county and finished 5th. Teams competed to be the fastest kart while also expending the least amount of energy. The EV Grand Prix uses its position to increase awareness of electrical vehicles and their future to the auto industry. The project consisted of the engineering design process which the team used to design and build improvements to the kart including battery packs utilizing 21700 Lithium-Ion batteries. It also included the calculating and validating of losses throughout the kart through theoretical modeling and testing of the kart.

Customer Needs and Requirements

- Improve last year's kart design and achieve a competitive level of vehicle performance
- Explore battery options
- Achieve 35 mph speed
- Work within $2,000 budget
    - Spent: $1986.31
- Pass all racing and technical inspections
- Mechanical and electrical components safe for operation
- EV Grand Prix rulebook is followed for all components

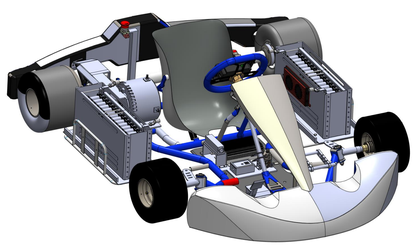
evGRANDPRIX

Concept Selection

- Motor: Motenergy ME0708
- Batteries: 21700 Lithium Ion
- Data Acquisition: Raspberry Pi 4
- Battery Box: Polycarbonate
- BMS: DALY Programmable Configurable Smart BMS with UART 16S 48V 250A LiFePO4 Battery Protection Module
- Throttle: JEENDA Throttle Foot EFP-005 0-5K Electric Accelerator for EV Curtis Throttle Pedal
- 2 AWG and 4 AWG Marine-grade cable

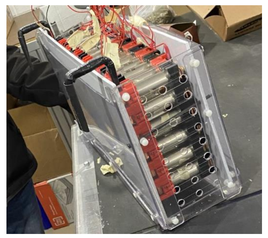
Design Solution

To power the kart, 84 Lithium-Ion Battery Cells are connected in series and parallel to a programmable controller, where the throttle potentiometer signal is used to vary the speed of an electric permanent magnet motor. The motor transmits power through a chain-sprocket system fixed to the rear axle – when the motor turns, so does the axle, which moves the kart forward.



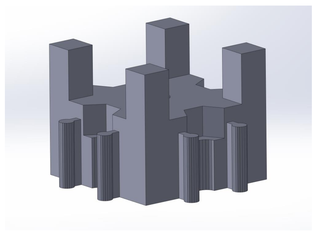
Manufacturing

Battery Box



- Clear, removable box
- Air vents
- Inside – 2 ABS plates to provide support

Cap Design

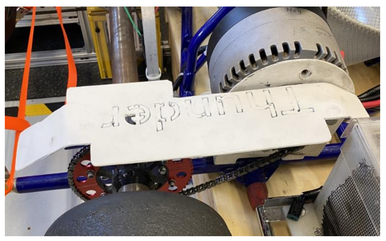


- Holds 21700 Battery Cells
- Connect Together
- Easy removability

Raspberry Pi

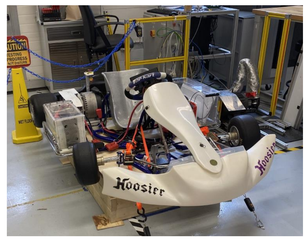
- 7" display screen on steering wheel
- Displays speed, top speed, duration, and battery temperature
- Stores data for further processing

Chain Guard



- Painted white 12-gauge steel
- Plasma cut
- Used Iron Worker

Dyno Set Up



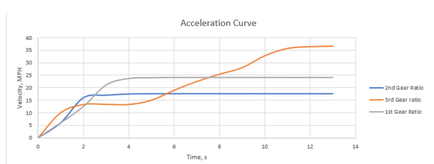
- Dyno used for testing and validation
- Energy loss calculations
- Gear ratio data

Testing and Validation

Test 1: Speed/Acceleration

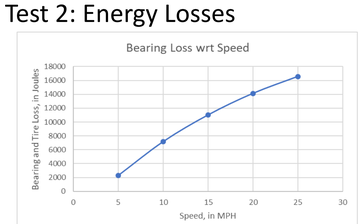
- GR 1 (2.46): 27 MPH
- GR 2 (3.2) 21.2 MPH
- GR 3 (2.11): 36.7 MPH

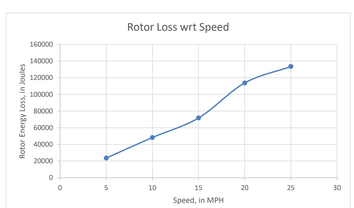
Acceleration Curve:

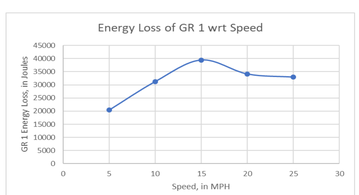


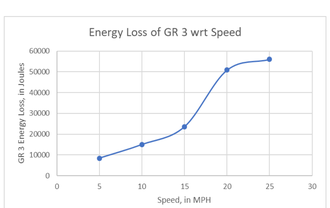
Based on this plot the most desirable gear ratio for the team to use would be the first gear ratio that was tested, 2.46. This gives the best balance of top speed and acceleration.

Test 2: Energy Losses









These plots depict the energy losses from the EV go-kart. As the plots illustrate, the energy loss from the kart is a function of the speed where, in general, the loss increases as the speed of the kart increases. Additional losses from the motor are included below:
5mph: 43507.67 J
10mph: 80249.69 J

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