

ELECTRIC GO-KART POWERTRAIN & REGENERATIVE BRAKING REBUILD

Building and rebuilding a battery-powered go-kart platform: custom 13S5P lithium-ion pack, VEVOR BLDC drivetrain, full wiring integration, and an Arduino-based regenerative braking circuit currently in development.

KART STATUS	BATTERY	DRIVETRAIN	REGEN BRAKING
Active Rebuild	13S5P / 48V	Operational	Breadboarded

Battery Integration	BLDC Motor Systems	Arduino Controls	Wiring Harnesses	Mechanical Packaging	Regen Braking
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48 V	2000 W	13S5P	Samsung 30Q
Powertrain platform	BLDC motor system	Cell configuration	18650 cells

ORIGIN

How it started — high school build

This project started in my final year of high school. Two classmates — Reyab Saluja and David Danilluc — and I set out to design and build a fully electric go-kart from scratch. The goal was a functional prototype that taught us real power systems, battery architecture, mechanical integration, and embedded control. Before committing to a lithium-ion EV configuration, we worked through a fuel viability study comparing combustion blends, hydrogen production, and magnesium-air fuel cells on theoretical energy density, electrochemical viability, and material sourcing. We concluded that the operational risks and integration challenges of the alternatives outweighed the gains at our scale, and went with a battery-electric drivetrain.

The original build produced a running kart — no regenerative braking, but it drove under its own power. The current phase is a structured rebuild: cleaner wiring, better packaging, a new cell configuration, and the addition of an Arduino-based regenerative braking circuit.

BATTERY PACK

13S5P lithium-ion architecture

The battery pack uses Samsung 30Q 18650 cells — 3000 mAh, 15A continuous discharge rating each. The configuration is 13 cells in series and 5 in parallel, giving a nominal pack voltage of approximately 48V with a total capacity of around 15 Ah. The series count was chosen to match the VEVOR motor controller's operating voltage range; the parallel count sets the total energy storage and continuous current delivery.

Cells are arranged into submodules in a series-parallel configuration that balances voltage targets with manageable pack assembly. The assembled pack sits in a custom-fabricated compartment on the rear platform of the kart, outfitted with aluminum heat sinks and designed for passive airflow to handle thermal dissipation under load. Rudimentary BMS safeguards cover overcurrent and undervoltage protection to maintain basic cell health and safety during charge and discharge cycles.

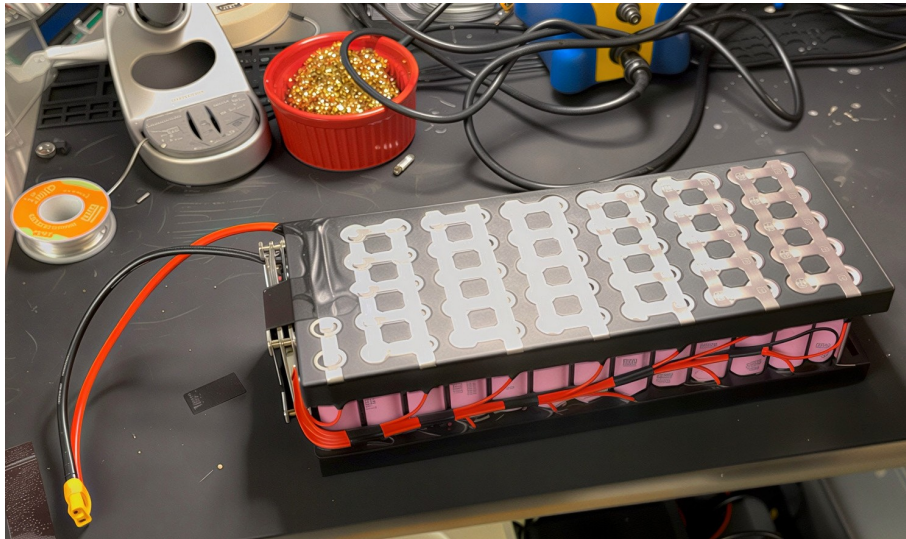


Fig. 2 — Custom-assembled 13S5P lithium-ion battery pack on the workbench, showing Samsung 30Q 18650 cells in their holders with nickel strip interconnects, series wiring, and XT60 output connector. Soldering station and flux visible in background.

DRIVETRAIN

VEVOR BLDC motor and controller

The drivetrain centers on a VEVOR 2000W brushless DC motor paired with its matching motor controller. The controller handles three-phase commutation and interfaces with throttle and brake signals from the driver controls. Power delivery from the 48V pack through the controller to the motor gives the kart enough torque for track use at the current weight and gear ratio.

The wiring harness routes high-current lines from the battery through an inline fuse to the controller, with signal lines — Hall effect throttle, brake input, phase wires — kept separated from power runs to minimize interference. The mechanical packaging positions the controller and battery within the frame envelope with clearance checked against the sprocket path and moving components.

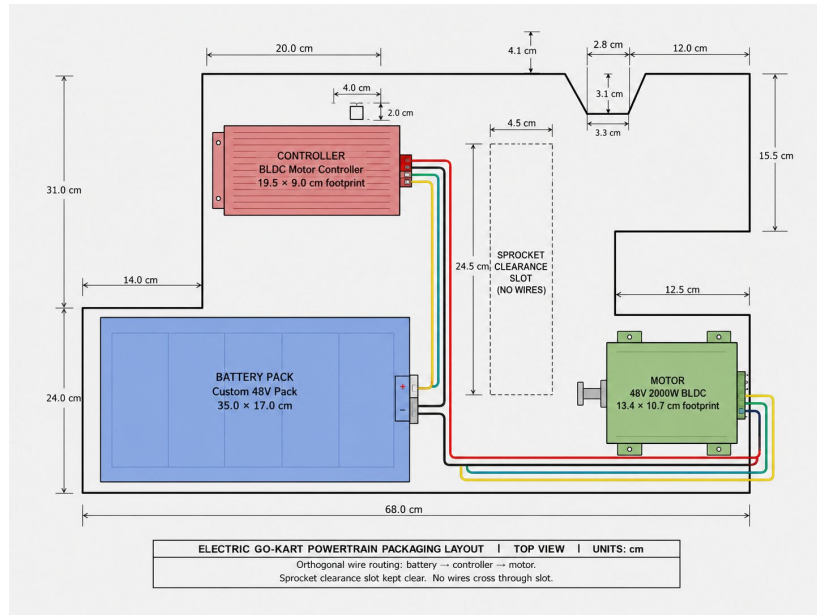


Fig. 3 — Electric go-kart powertrain packaging layout (top view). BLDC motor controller (19.5 x 9.0 cm) top-left, custom 48V battery pack (35.0 x 17.0 cm) bottom-left, 48V 2000W BLDC motor (13.4 x 10.7 cm) bottom-right. Orthogonal wire routing from battery to controller to motor; sprocket clearance slot maintained wire-free.

EMBEDDED CONTROL

Arduino and signal processing

An Arduino Uno interprets analog throttle and brake inputs from the pedal assembly and translates them into PWM signals sent to the ESC. Signal filtering is applied to minimize jitter and smooth the torque response — a noticeable improvement over the unfiltered input behavior. The Arduino handles the control layer; the VEVOR controller handles the motor power stage directly.

Build videos — electronics and wiring:

<https://www.youtube.com/watch?v=qjUDvdYy5ck>

Kart build documentation: <https://www.youtube.com/watch?v=6hj4AJ4eZII>

CURRENT DEVELOPMENT

Regenerative braking circuit

The current rebuild phase is focused on adding regenerative braking. The goal is a circuit that captures kinetic energy during braking events and routes it back into the battery pack, reducing energy waste and extending run time. This work is being done with Mani Adhami, a 2B Mechanical Engineering student at the University of Waterloo.

Current state — breadboard prototype

The regenerative braking circuit is currently prototyped on a breadboard. The basic topology uses the BLDC motor in generator mode during braking — the motor's back-EMF is harvested rather than dissipated. The Arduino monitors braking input and switches the control logic between drive mode and regeneration mode. The circuit is not yet integrated into the kart; the breadboard stage is for validating the logic and component behavior before committing to the wiring harness.

Next steps — integration and validation

Once the breadboard circuit is validated, the plan is to integrate it into the rebuilt wiring harness alongside a cleaner electrical layout. The rebuild also includes refining the battery and controller packaging, routing wiring more cleanly through the frame, and validating how the braking circuit behaves under real load while keeping drivetrain behavior predictable and safe.

This phase of the project represents a meaningful step up in system complexity — moving from a working single-direction powertrain to a bidirectional energy flow system where the motor acts as both a drive actuator and a generator. Getting it right requires understanding both the electrical behavior of the BLDC system and the mechanical constraints of the kart under braking.

PRE-BUILD STUDY

Fuel viability modeling

Before the build started we ran a comparative analysis of alternative powertrains. Combustion blends were modeled using stoichiometric air-fuel ratios, lower heating values, and flame speed estimates. Hydrogen production via water electrolysis was explored across acidic and alkaline methods, including Faraday efficiency calculations and pressurized storage risks. Magnesium-air fuel cells were investigated for their theoretical energy density (~13 kWh/kg) and evaluated for electrochemical viability and magnesium corrosion behavior.

The comparison emphasized energy density, chemical stability, storage infrastructure, and material sourcing. Despite promising figures for hydrogen and magnesium-air, operational risks and integration challenges at our scale outweighed the gains. Lithium-ion was the clear practical choice for a student-built platform.

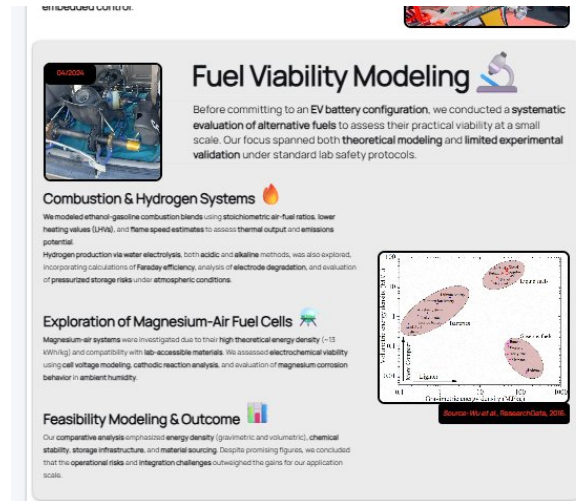


Fig. 5 — Fuel viability modeling section from early project documentation, covering combustion systems, hydrogen production, and magnesium-air fuel cell analysis used to justify the lithium-ion EV configuration.

RETROSPECTIVE

What I'd do differently

01 Add a proper BMS from the start

The rudimentary overcurrent and undervoltage protection we implemented works but leaves gaps — no cell balancing, no state-of-charge estimation, no temperature monitoring. A proper BMS from day one would have made the pack safer, given better visibility into cell health over time, and made the regenerative braking integration cleaner since the BMS could manage the charge-back logic directly.

02 Separate the signal and power wiring harnesses from the beginning

In the original build, signal lines and power runs shared routing paths in several places, which caused interference issues with the throttle signal. The rebuild is fixing this, but doing it right at the start would have avoided a full rewiring. The lesson was that wiring architecture decisions are much harder to change later than they are to get right at the design stage.

03 Validate the regen braking topology on a bench motor before the kart

Moving from breadboard to kart integration is a significant jump. Running the regenerative braking circuit on a bench-mounted motor under controlled load before touching the kart would reduce the risk of damaging the controller or battery during integration and give cleaner data on the circuit's actual energy recovery performance.

REFERENCE

Technical specifications

Project type Personal build — ongoing since 2024

Collaborators	Reyab Saluja, David Danilluc (original build); Mani Adhami, UWaterloo 2B MechE (rebuild)
Motor	VEVOR 2000W brushless DC (BLDC)
Controller	VEVOR matching BLDC motor controller, 19.5 x 9.0 cm footprint
Battery config	13S5P — 13 cells in series, 5 in parallel
Cells	Samsung 30Q 18650 — 3000 mAh, 15A continuous per cell
Pack voltage	~48V nominal
Pack capacity	~15 Ah (13S5P x 3000 mAh)
BMS	Rudimentary overcurrent and undervoltage protection
Thermal mgmt	Aluminum heat sinks, passive airflow, custom-fabricated compartment
Control system	Arduino Uno — analog throttle/brake input, PWM output to ESC, signal filtering
Regen braking	Arduino-based circuit, breadboard prototype stage — BLDC in generator mode during braking
Wiring	Inline fuse on battery positive, separated signal/power routing (rebuild)
Status	Kart drives operationally; regenerative braking circuit in active development
Build videos	youtube.com/watch?v=qjUDvdYy5ck youtube.com/watch?v=6hj4AJ4eZII