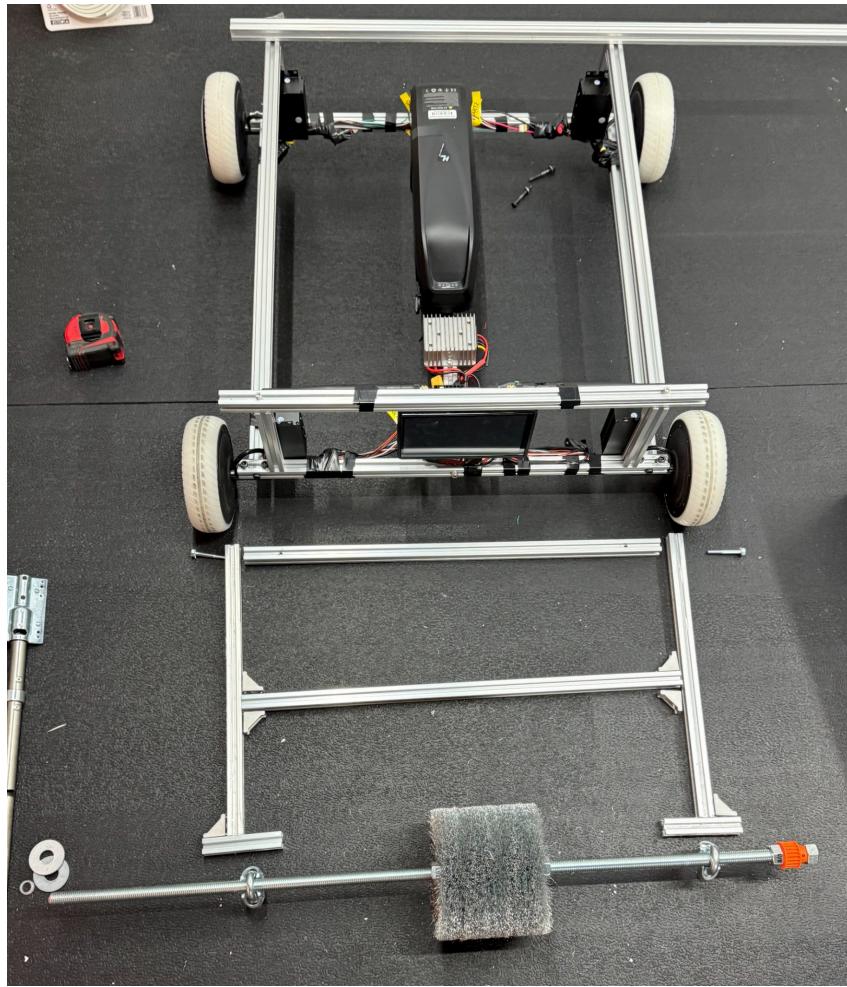


Technical Manual

BVR0

Base Vectoring Rover



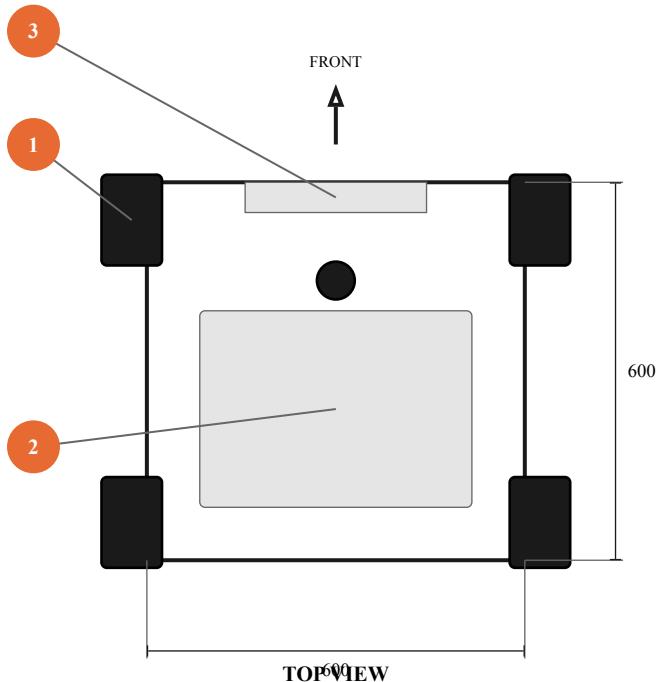
Revision 0.1 December 2025

Municipal Robotics
Cleveland, Ohio
muni.works

Contents

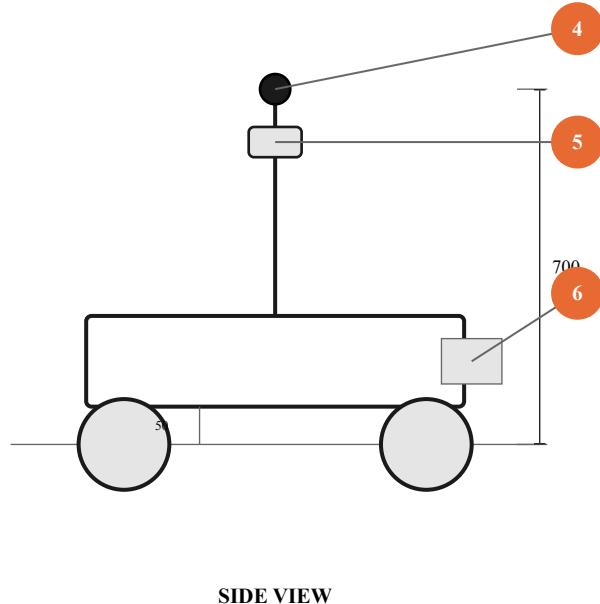
1 Overview	4
2 Bill of Materials	5
3 Assembly	6
3.1 Phase 1: Chassis Frame	6
3.2 Phase 2: Motor Mounting	7
3.3 Phase 3: Electronics Mounting	7
3.4 Phase 4: Wiring	8
3.5 Phase 5: Testing	8
4 Electrical System	9
4.1 Power Distribution	9
4.2 CAN Bus	9
4.3 Connectors	9
4.4 VESC Configuration	10
5 Operation	11
5.1 Startup	11
5.2 Controls	11
5.3 Shutdown	12
5.4 Tool Attachment	12
6 Safety	13
6.1 Hazard Zones	13
6.2 Battery Safety	13
6.3 Emergency Stop	14
7 Maintenance	15
7.1 Pre-Operation Inspection	15
7.2 Maintenance Schedule	15
7.3 Storage	16
7.4 Troubleshooting	16

1 Overview



Components

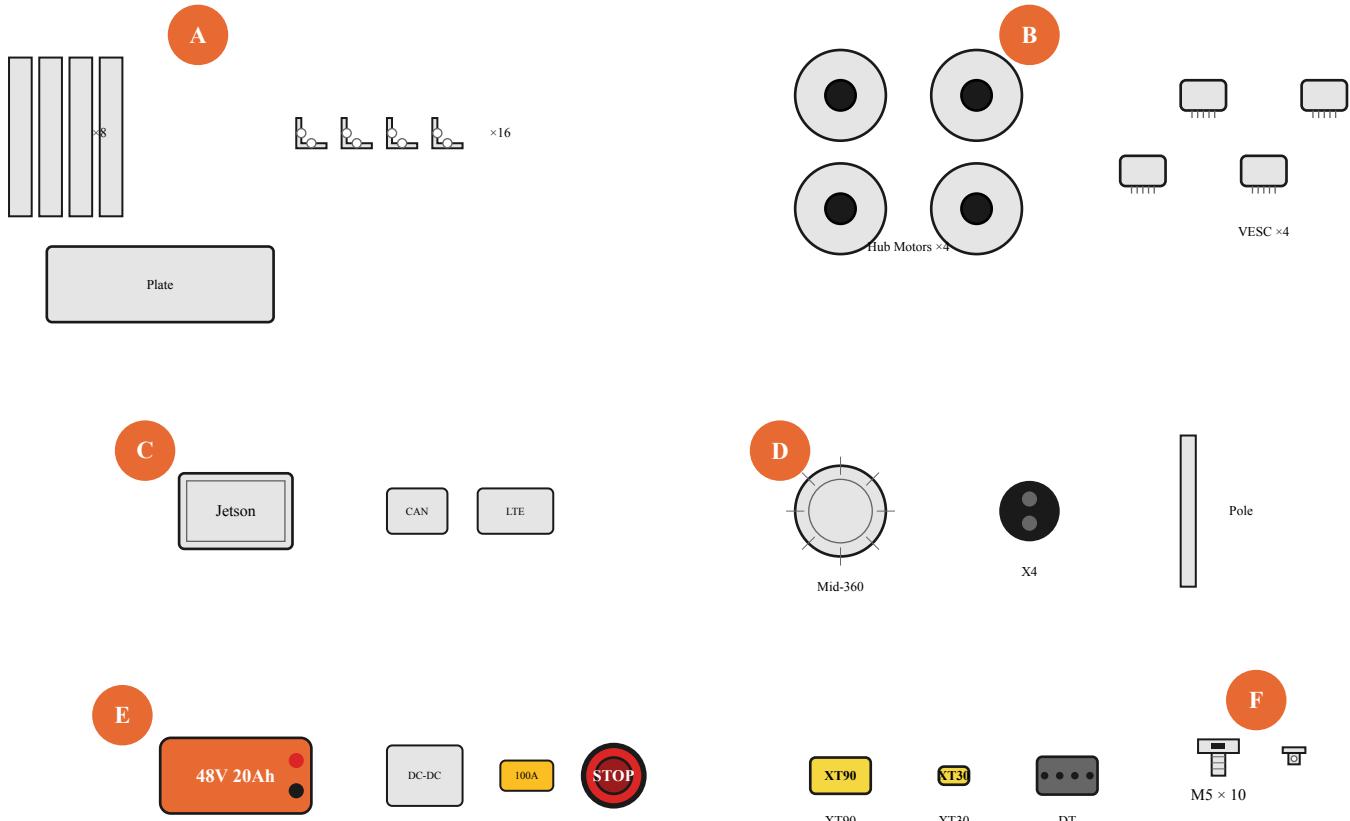
- 1** Hub motor wheels ($\times 4$) — 350W each
- 2** Electronics bay — Jetson, VESCs, power
- 3** Tool mount — quick-attach interface
- 4** 360° camera — Insta360 X4
- 5** LiDAR — Livox Mid-360
- 6** Tool attachment point



Specifications

Dimensions	600 \times 600 \times 700 mm
Weight	30 kg with battery
Battery	48V 20Ah (960 Wh)
Motors	4 \times 350W hub motors
Speed	1.0–2.5 m/s
Runtime	4 hours
Temp range	-20°C to +40°C

2 Bill of Materials



Parts Key

A	Chassis: extrusions, brackets, plate	\$150
B	Drivetrain: motors, VESCs, mounts	\$800
C	Electronics: Jetson, CAN, LTE	\$900
D	Perception: LiDAR, camera, pole	\$1,800
E	Power: battery, DC-DC, fuse, E-stop	\$400
F	Hardware: bolts, T-nuts, wire, connectors	\$100

Cost Summary

Chassis	\$150
Drivetrain	\$800
Electronics	\$900
Perception	\$1,800
Power	\$400
Hardware/Wiring	\$100
Total	\$4,150

All parts commercially available. Custom fab limited to plate cutting.

3 Assembly

Required Tools



Hex Keys

2.5, 3, 4, 5mm



Screwdriver

Phillips 2



Wrenches

8, 10, 13mm



Multimeter

V / Ω / Cont.

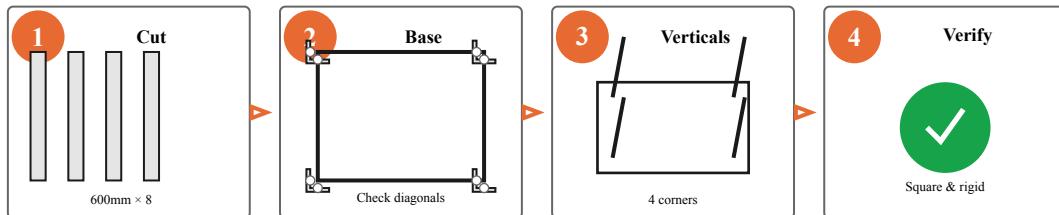


Torque

All M5 bolts

4 Nm

3.1 Phase 1: Chassis Frame



3.2 Phase 2: Motor Mounting

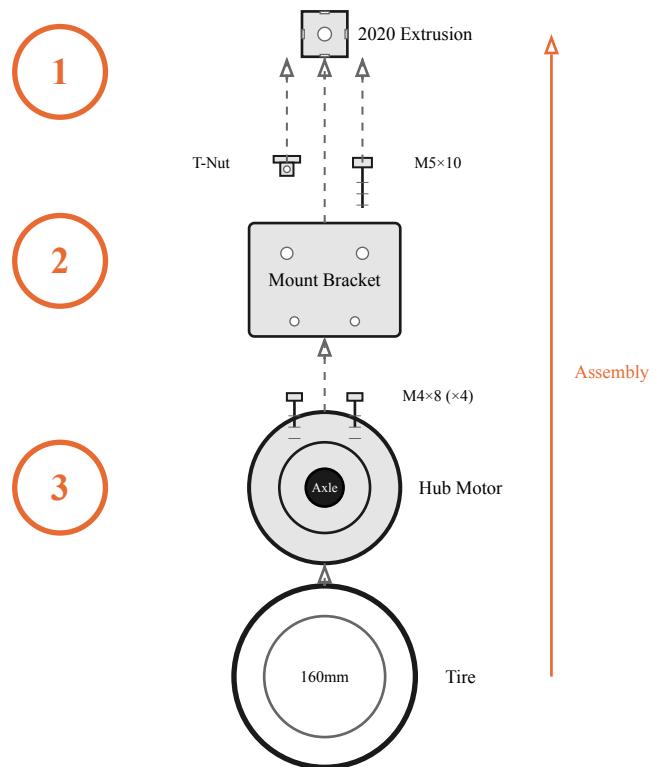


Figure 5: Exploded view: (1) Insert T-nuts into extrusion, (2) Bolt bracket to frame, (3) Attach motor and tire

3.3 Phase 3: Electronics Mounting

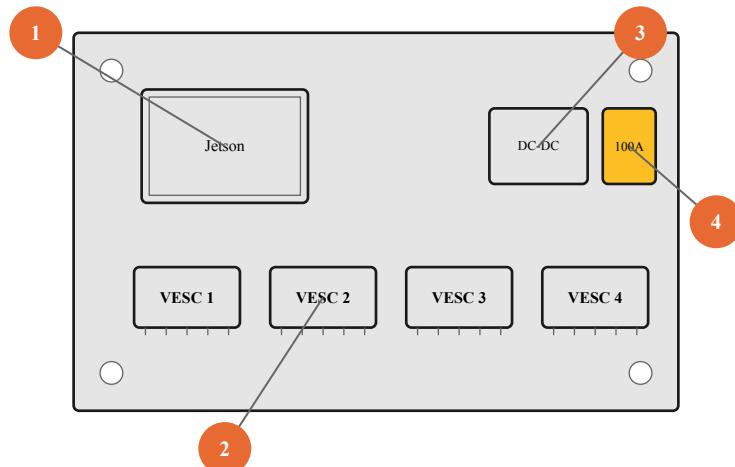


Figure 6: Electronics plate: (1) Jetson Orin NX, (2) VESC motor controllers, (3) DC-DC converter, (4) Main fuse

3.4 Phase 4: Wiring

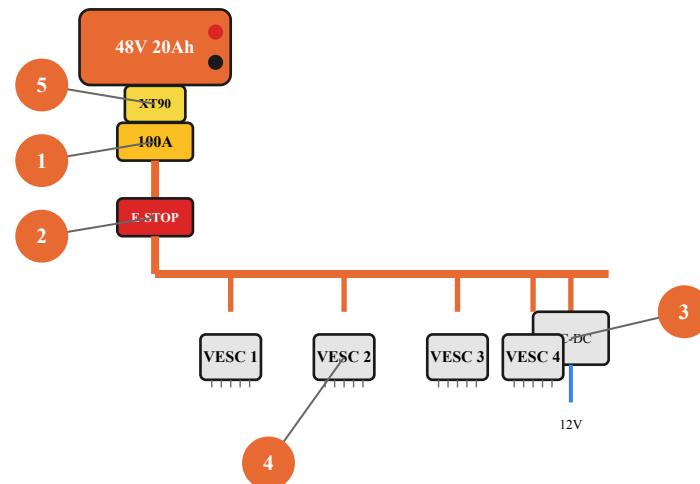


Figure 7: Power distribution: (1) Main fuse, (2) E-Stop relay, (3) DC-DC converter, (4) VESCs, (5) XT90 disconnect

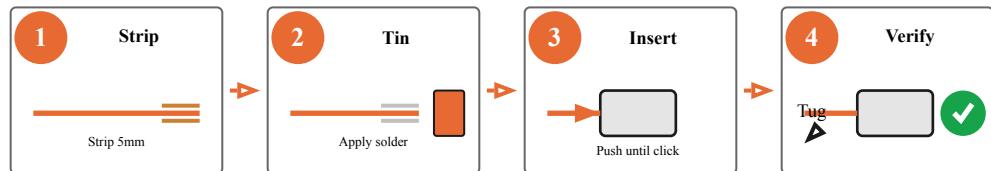
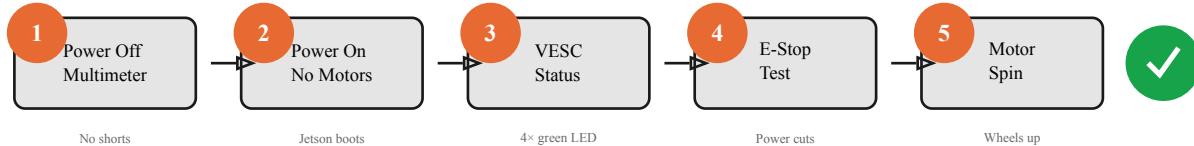


Figure 8: CAN wiring sequence: (1) Strip 5mm insulation, (2) Tin exposed wire, (3) Insert into JST connector, (4) Verify with gentle tug test

3.5 Phase 5: Testing



Quality Checklist

- | | |
|---|---|
| <input type="checkbox"/> All bolts torqued to 4 Nm | <input type="checkbox"/> All wheels spin freely |
| <input type="checkbox"/> No exposed wiring | <input type="checkbox"/> Battery secure |
| <input type="checkbox"/> CAN bus termination verified | <input type="checkbox"/> All connectors clicked |
| <input type="checkbox"/> E-Stop cuts power in 100ms | <input type="checkbox"/> Thermal management OK |

4 Electrical System

4.1 Power Distribution

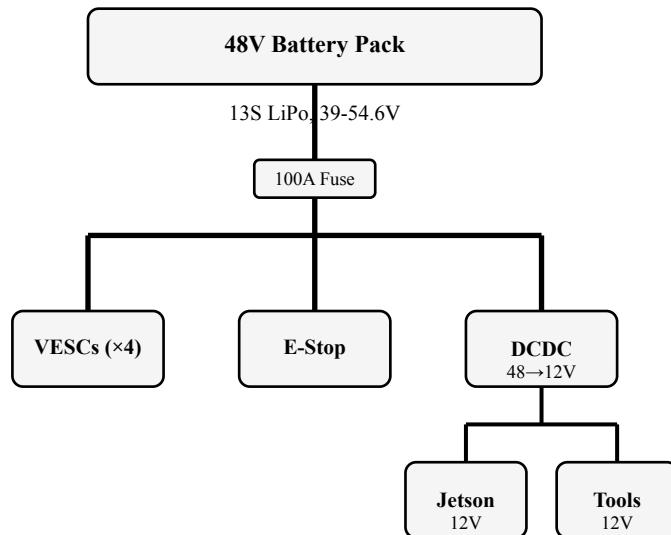


Figure 10: Power distribution from 48V battery to all subsystems

4.2 CAN Bus

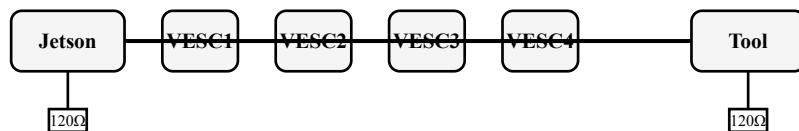


Figure 11: CAN bus daisy chain with 120Ω termination at each end

4.3 Connectors

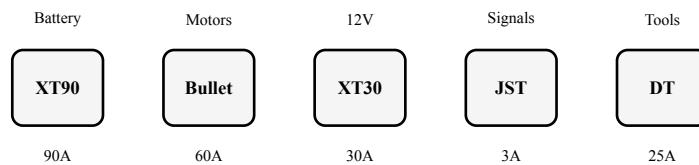


Figure 12: Connector types used throughout the rover

4.4 VESC Configuration

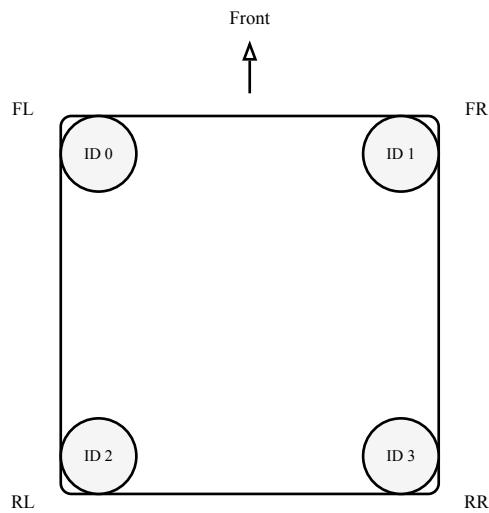


Figure 13: CAN ID assignment by wheel position

Setting	Value
Controller ID	0-3 (unique per VESC)
CAN Mode	VESC
CAN Baud Rate	CAN_500K
Send CAN Status	Enabled
CAN Status Rate	50 Hz

5 Operation

5.1 Startup

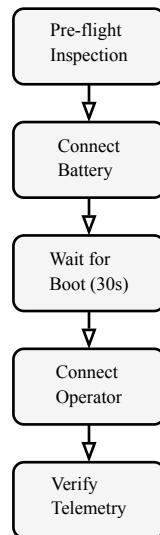


Figure 14: Startup sequence from inspection to operation

5.2 Controls

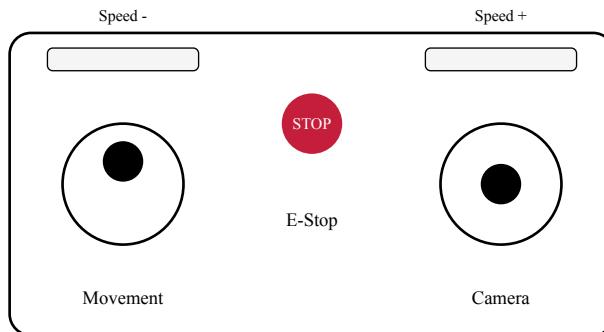


Figure 15: Gamepad control layout for teleoperation

5.3 Shutdown

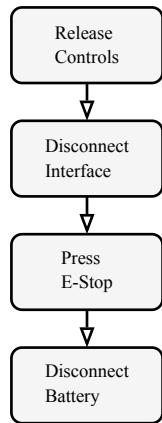


Figure 16: Shutdown sequence

5.4 Tool Attachment

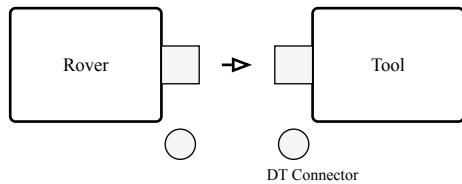
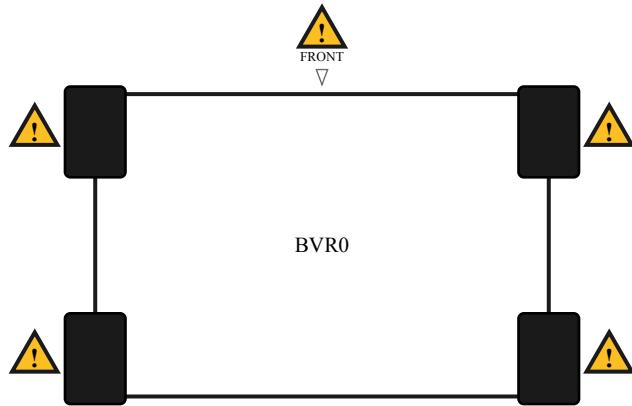


Figure 17: Tool attachment via quick-release mount and DT connector

6 Safety

⚠ DANGER Heavy powered machine. Can cause serious injury. Maintain situational awareness.

6.1 Hazard Zones



Pinch/Crush Hazard Zone

Figure 18: Hazard zones: wheel areas and tool mount require clearance during operation

6.2 Battery Safety

⚠ WARNING Li-ion batteries can catch fire if damaged or short-circuited.



Figure 19: Battery handling requirements

6.3 Emergency Stop

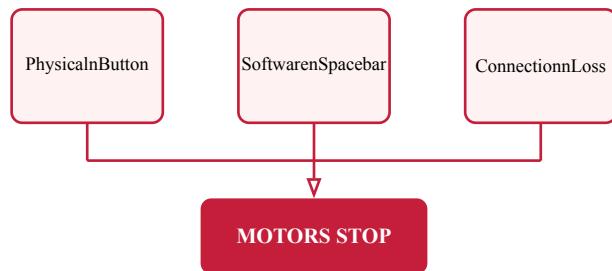


Figure 20: Three independent paths to emergency stop

i NOTE To reset: resolve cause, release button, reconnect, verify dashboard.

7 Maintenance

7.1 Pre-Operation Inspection

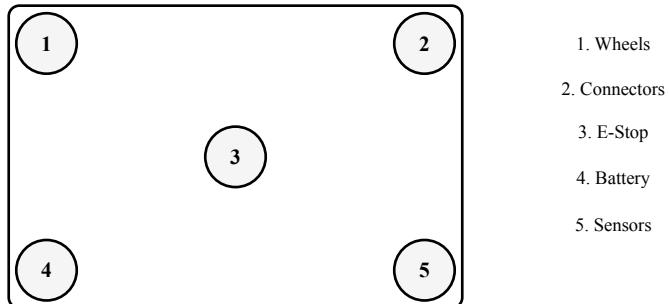


Figure 21: Pre-operation inspection points

- Battery voltage > 40V
- No visible damage to chassis or wheels
- All connectors secure
- Wheels spin freely
- E-Stop button functions
- Sensors clean and unobstructed

7.2 Maintenance Schedule

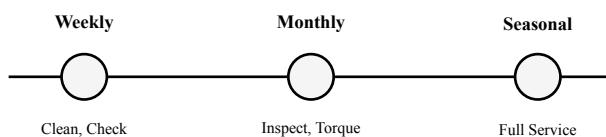


Figure 22: Maintenance schedule intervals

Weekly

- Clean wheels/chassis
- Wipe lenses
- Check connections

Monthly

- Inspect wiring
- Verify bolt torque
- Clean contacts

Seasonal

- Full electrical check
- Check bearings
- Replace worn parts

7.3 Storage

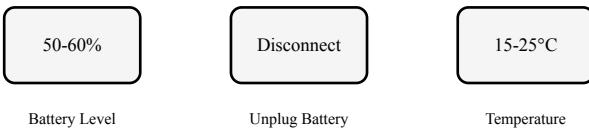


Figure 23: Storage preparation requirements

7.4 Troubleshooting

Symptom	Solution
Rover won't power on	Check battery connection, verify fuse
No video feed	Check LTE connection, verify camera USB
Motor not responding	Check CAN wiring, verify VESC ID
E-Stop won't release	Check relay wiring, verify button not stuck
Poor LTE signal	Relocate antenna, check SIM data plan
Erratic movement	Verify VESC IDs match wheel positions

Municipal Robotics

Cleveland, Ohio
muni.works