



EVUL EMPIRE RACING · TECH GUIDE

HOW MUCH BATTERY DOES A 132 FT PASS NEED?

Weight, gearing, kV and cell count in plain words, with formulas you can run yourself

01 A PASS SIPS CAPACITY

A 132 ft run is over in a few seconds. In our 2 lb example, a 3S car uses about **12.5 mAh** per pass, under 1% of a 3,000 mAh pack.

02 BUT IT GULPS CURRENT

What runs out first is not mAh. It is **voltage**: how far the pack sags when the car hooks and pulls. Sag is set by the pack's **internal resistance (IR)**.

03 LABEL C IS A MARKETING NUMBER

No pack really delivers 100C-200C. Size your pack by **measured IR and sag**, then work out its real, **effective C**.

04 WEIGHT IS THE MULTIPLIER

Same ET and trap speed with double the weight takes about **double the energy and current**. Every ounce you add, the battery pays for.

Every example in this guide uses clearly labeled example assumptions (ET, trap speed, tire, gearing, efficiency, IR). They are not measured EVUL results. Plug in your own numbers and verify with a logged pass.

FROM CAR WEIGHT TO PACK CURRENT

Follow the 2 lb example car down the chain: the car asks, the pack pays



THE CAR

2 lb · 60 mph at the stripe

Weight × speed² sets the job

326 J

of moving energy



TIRES + GEARING

2.5 in tire · 5.5:1 · rollout 1.43 in

Tire spin, rolling drag and air

424 J

at the tires (+30% losses)



MOTOR + ESC

EV02240HS 5800 kV · XC E6 series

90% drivetrain × 85% motor/ESC

555 J

from the pack



POWER

Spread over a 2.5 s pass

Average ≈ 222 W

444 W

peak (≈2× the average)



THE PACK

3S · 3,000 mAh · 13.5 mΩ

12.5 mAh used · 4.04 V/cell at peak

37 A

peak current

Example assumptions, not measured EVUL data: ET 2.5 s, trap 60 mph, 2.5 in tire, 5.5:1, 3S 3,000 mAh at 4 mΩ per cell + 1.5 mΩ wiring. Full math in the appendix.

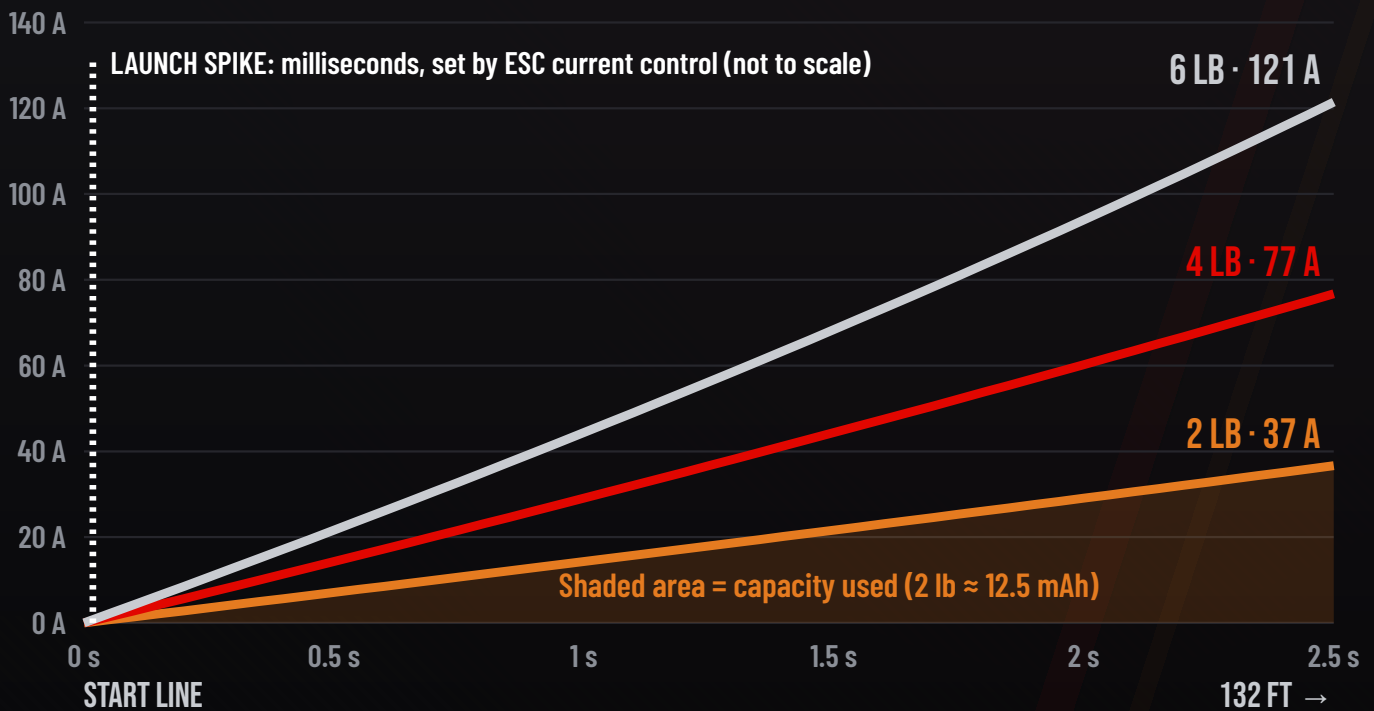
A PASS SIPS CAPACITY, BUT GULPS CURRENT

3,000 MAH PACK

One 132 ft pass, 2 lb car: 12.5 mAh (0.4%) · 6 lb car: 39.0 mAh (1.3%)

The fuel tank barely moves: $\text{mAh used} = \text{average amps} \times \text{seconds} \div 3.6$.

ESTIMATED PACK CURRENT DURING A 132 FT PASS



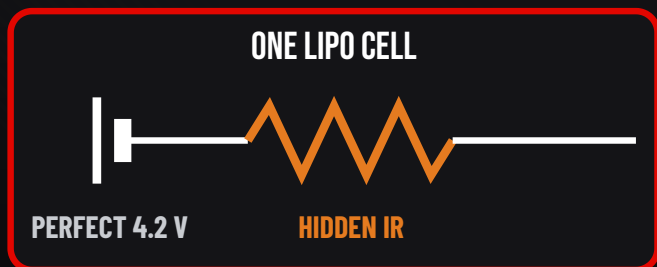
Current climbs all the way down the track and peaks near the stripe. The pack has to deliver that **peak** without sagging too far. That is the real sizing job.

MIKE'S QUESTION · 2 LB CAR ON A 3,000 MAH 3S?

Plenty of capacity: about **12.5 mAh** a pass, peak about **37 A**. Choose the pack by **sag at peak current** and **weight**, not mAh. Bigger cells usually sag less but weigh more. Even an example 1,000 mAh pack at 8 mΩ per cell keeps up here (38 A peak vs about 118 A deliverable).

Example model, not measured EVUL data: steady push, power rising to 2× the average at the stripe; ET 2.5 s, trap 60 mph, 3S 3,000 mAh at 4 mΩ per cell. Your X.BUS Data Lab log shows the real curve.

SAG IS WHAT RUNS OUT FIRST

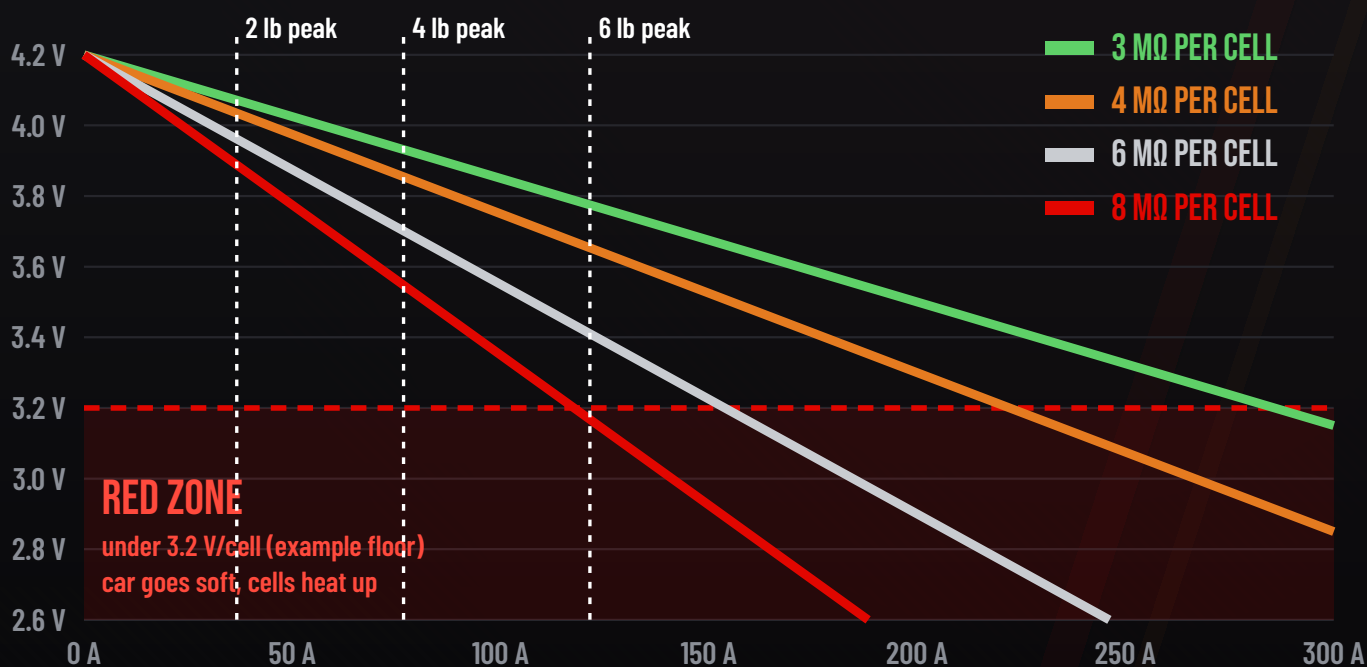


$$\text{AMPS} \times \text{IR} = \text{VOLTS LOST}$$

More amps or more IR = more sag.

Sag makes the car pull even more amps.

VOLTS PER CELL VS CURRENT · 3S PACKS WITH DIFFERENT IR



Lower IR lines stay flat longer. **Your peak amps must land above the red zone** on your pack's line, with room to spare.

MARKETING

LABEL C

A sticker number. Brands don't test it the same way, and no pack truly delivers 100C-200C. **Don't size by it.**

MEASURED

EFFECTIVE C

Deliverable amps ÷ Ah. Example 4 mΩ/cell 3S, 3.2 V floor:
222 A ÷ 3.0 Ah ≈ **74C**.

Lines: pack R = per-cell IR × 3 + 1.5 mΩ wiring (example values). Peak markers use the 4 mΩ example.

2, 4 AND 6 LB CARS ON 3S

Tenshock EV02240HS 5800 kV (rated 13 V, so 3S) · same example ET and trap speed, so only weight changes

12.5 MAH

2 LB · USED PER PASS

37 A

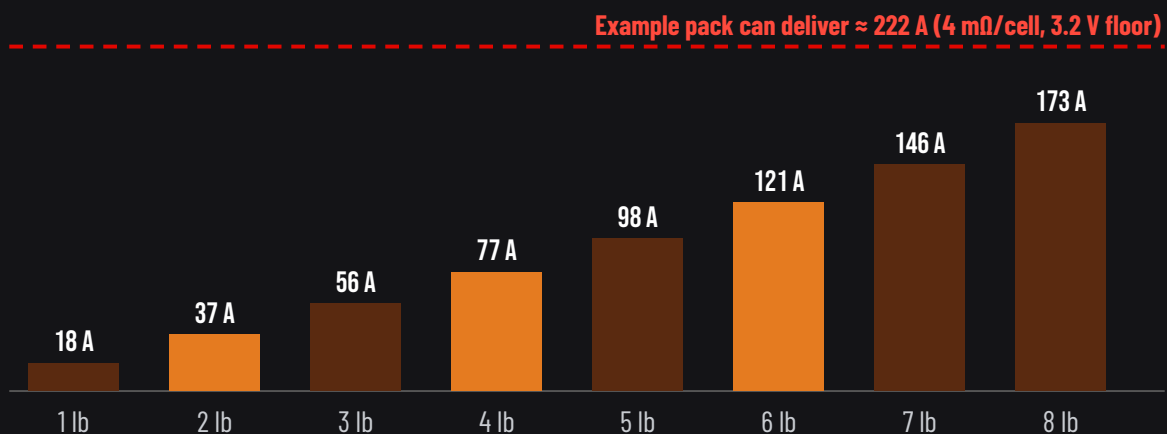
2 LB · EST. PEAK

12C

2 LB · NEEDED FROM 3,000 MAH

Result (example assumptions)	2 lb	4 lb	6 lb
Moving energy at the stripe (J)	326	653	979
Energy from the pack (J)	555	1,109	1,664
Average power (W)	222	444	665
Peak power, 2× average (W)	444	887	1,331
Average current (A)	18	37	56
Estimated peak current (A)	37	77	121
Capacity used per pass (mAh)	12.5	25.5	39.0
Share of a 3,000 mAh pack (%)	0.4	0.8	1.3
Volts per cell at peak	4.04	3.85	3.65
C needed from 3,000 mAh (peak ÷ Ah)	12	26	40
Geared top speed at peak sag (mph)	85	82	77

ESTIMATED PEAK AMPS BY WEIGHT



Example assumptions, not measured EVUL data: ET 2.5 s, trap 60 mph, 2.5 in tire, 5.5:1 gear, 3S 3,000 mAh at 4 mΩ per cell + 1.5 mΩ wiring, +30% losses, 90% drivetrain, 85% motor/ESC, peak = 2× average. A heavier car at the same gearing would really run slower; holding ET and trap fixed shows what weight alone costs.

MEASURE IR, THEN PROVE IT

ROUGH · CHARGER IR READOUT

Many chargers show per-cell IR. A **quick, rough** number that shifts with charger, temperature and charge level. Great for tracking a pack over time and spotting a bad cell.

BETTER · PULSE LOAD TEST

Hit the pack with a known high-current pulse and read the voltage **during** it.

PULSE TEST · WHAT THE METER SEES

VOLTS 12.50



IR = voltage drop ÷ current step

Example: 12.50 V resting → 11.15 V at a 100 A step: $1.35 \div 100 = 13.5 \text{ m}\Omega$ for the pack

Test warm and fully charged, the way you race. Measure each cell on the balance lead if you can.

THE LAUNCH SPIKE · LOCKED ROTOR

At the instant of launch the motor is not turning yet, so it makes no back-voltage. Only resistance limits the current, like a locked rotor:

launch amps = V open ÷ (R pack + motor Ri)

$12.6 \text{ V} \div (13.5 + 1.0 \text{ m}\Omega) \approx 869 \text{ A}$ in theory; the pack would sag to about 0.9 V

In practice the ESC's current control and throttle punch settings cap this, and the spike lasts only milliseconds. The E6 MAX is rated 550 A continuous. It is still why packs, plugs and wires need to be built for far more than the average amps.

VERIFY WITH THE X.BUS DATA LAB

The EVUL X.BUS Data Lab reads the XC ESC's live telemetry, including **bus current, voltage, motor and ESC temperature, rpm and fault flags**. Compare your logged peak amps and minimum voltage with this guide's estimate, then update your inputs.

IN DEVELOPMENT

THE EVUL IMPULSE TESTER

Mike is developing an EVUL impulse tester to answer one question: **what does this pack really deliver at launch?** It applies a short **2-3 millisecond high-current pulse** to the pack to simulate locked-rotor launch draw, then measures the current the pack actually delivers and how far it sags.

- Real deliverable amps and sag, in place of a label C rating
- A measured basis for **effective C** and pack-to-pack comparisons

The tester is in development. Specs and availability will be announced by EVUL.

YOUR CAR, YOUR NUMBERS

Fill in the boxes, or use the EVUL spreadsheet / calculator that comes with this guide

1 · YOUR INPUTS

CAR WEIGHT lb scale, pack installed	CELLS S / P S / P 3S = 3 in series	PACK SIZE mAh on the label	IR PER CELL mΩ charger or pulse test
MOTOR KV rpm/V 5800 = EV02240HS	GEAR · TIRE ratio · in measure the tire	ET s timer or target	TRAP SPEED mph timer or target

2 · WORK IT OUT (APPENDIX HAS THE DETAIL)

① ROLLOUT in $\pi \times \text{tire} \div \text{gear}$	② MOVING ENERGY J $\frac{1}{2} \times \text{kg} \times (\text{m/s})^2$	③ PACK ENERGY J $\text{②} \times 1.3 \div 0.765$	④ PEAK WATTS W $\text{③} \div \text{ET} \times 2$
⑤ PACK R mΩ $\text{IR} \times \text{S} \div \text{P} + 1.5$	⑥ PEAK AMPS A $\text{④} \div \text{loaded volts}$	⑦ V/CELL AT PEAK V $4.2 - \text{⑥} \times \text{⑤} \div 1000 \div \text{S}$	⑧ MAH USED mAh $\text{avg A} (\text{⑥} \div 2) \times \text{ET} \div 3.6$

3 · CHECK

☐ ⑦ above your floor (3.2 V example)?	☐ ⑥ under the pack's deliverable amps?
☐ Geared top speed above trap speed?	☐ ⑥ inside the motor and ESC ratings?

PUSHING PAST 3S AND STAYING SAFE

NOT RATED · TESTING ONLY

4S ON A 3S MOTOR

The EV02240HS 5800 kV is rated by Tenshock to **13 V**. A full 3S pack is 12.6 V; a full 4S pack is **16.8 V**, over the rating. The EV02260HS 4450 kV (16 V) is in the same spot. Running these motors on 4S is **not rated: testing only, at your own risk**. EVUL combos are competition equipment sold **without warranty**.

If you test anyway: 4S adds about a third more rpm, so gear down, make short pulls, log every hit, and talk to EVUL first.

SAFETY IN PLAIN WORDS

- **Peak current makes heat:** twice the amps, four times the heat in pack, plugs, wires and ESC.
- **Size plugs and wire for the peak, not the average.** A warm plug is resistance you pay for in sag.
- **Respect your sag floor** under load (3.2 V per cell is this guide's example).
- **Feel the pack after each pass.** Hot, puffed or damaged packs get retired, not raced.
- **Charge and store LiPos in a fire-safe bag or box**, never unattended, and balance-charge every time.
- **Launch spikes are real.** Set the ESC's current control and punch sensibly, and check your logs.

THE WHOLE GUIDE IN ONE LINE

peak amps $\approx 2 \times [\frac{1}{2} \times \text{kg} \times (\text{m/s})^2 \times 1.3 \div 0.765] \div \text{ET} \div \text{loaded volts} - \text{and it must stay under } (\text{V open} - \text{V min}) \div \text{R pack}$

mAh used = average amps $\times \text{ET} \div 3.6$. 1.3, 0.765 and 2 are example loss, efficiency and peak factors: replace them with your logged numbers.

TENSHOCK EVO · RATED CELL WINDOW

Motor	kV	Max V*	Max A*	Ri	Rated window
EV02240HS	5800	13 V	350 A	1.0 mΩ	3S only
EV02260HS	4450	16 V	465 A	0.9 mΩ	3S only
EV02260HS	3350	24 V	310 A	2.1 mΩ	3-5S
EV02270HS	3800	21 V	398 A	1.1 mΩ	3-5S
EV02250HP	3150	22 V	290 A	1.5 mΩ	3-5S
EV02280HP	2050	30 V	310 A	2.2 mΩ	3-7S
EV02290HP	1850	32 V	320 A	2.1 mΩ	3-7S

* Tenshock factory chart. Window = cells whose full charge (4.2 V each) stays at or below max voltage, from 3S (XC E6-series low end).

This guide gives physics-based estimates, not guarantees. Real results depend on traction, track, setup and parts. Verify every setup with a logged pass.

APPENDIX A · THE MATH, STEP BY STEP

Five steps from car weight to amps. Worked for the 2 lb example car on 3S.

01 ROLLOUT AND GEARED TOP SPEED

Rollout is how far the car moves for one turn of the motor. **Top speed** is how fast the gearing lets the car go before the motor runs out of rpm. Make sure your geared top speed is comfortably above your trap speed, or the car hits a wall before the stripe.

$$\text{rollout (in)} = \pi \times \text{tire diameter (in)} \div \text{gear ratio}$$

$$\pi \times 2.5 \div 5.5 = 1.43 \text{ in per motor turn}$$

$$\text{top mph} = \text{kV} \times \text{loaded volts} \times 0.90 \times \text{rollout} \times 60 \div 63,360$$

$$5800 \times 12.11 \text{ V} \times 0.90 \times 1.43 \times 60 \div 63,360 \approx 85 \text{ mph (0.90 = example loaded-kV efficiency; 63,360 in per mile)}$$

02 ENERGY THE CAR CARRIES AT THE STRIPE

This is where **weight** enters. Moving energy grows with weight and with speed **squared**: 10% more trap speed costs 21% more energy.

$$\text{energy (J)} = \frac{1}{2} \times \text{mass (kg)} \times \text{speed (m/s)}^2$$

$$\frac{1}{2} \times 0.91 \text{ kg} \times (60 \times 0.447)^2 \approx 326 \text{ J}$$

03 ADD LOSSES, DIVIDE BY EFFICIENCY

Tire spin, rolling drag and air add to the job (example +30%). The drivetrain (example 90%) and motor+ESC (example 85%) waste some of what the pack sends.

$$\text{pack energy} = \text{energy} \times (1 + \text{losses}) \div (\text{drivetrain eff} \times \text{motor/ESC eff})$$

$$326 \times 1.30 \div (0.90 \times 0.85) \approx 555 \text{ J (0.15 Wh)}$$

04 AVERAGE AND PEAK POWER

Spread that energy over the run. If the car pulls with a steady push, power climbs from zero at the line to its maximum near the stripe, so the peak is about **2× the average**. Wheelspin and launch spikes can push it higher; your log tells the truth.

$$\text{average watts} = \text{pack energy} \div \text{ET} \cdot \text{peak watts} \approx 2 \times \text{average}$$

$$555 \div 2.5 \approx 222 \text{ W average} \cdot \approx 444 \text{ W peak}$$

05 AMPS AND MAH

Watts ÷ volts = amps, but the volts drop as the amps rise (sag, next page). The quick version uses loaded volts; the calculator solves it exactly.

$$\text{amps} \approx \text{watts} \div \text{loaded pack volts} \cdot \text{mAh} = \text{avg amps} \times \text{ET} \div 3.6$$

$$\approx 18 \text{ A average, } \approx 37 \text{ A peak, } \approx 12.5 \text{ mAh used}$$

APPENDIX B · IR AND SAG MATH

Every pack acts like a perfect battery with a small resistor inside it: the **internal resistance (IR)**. Push current through it and you lose volts. That lost voltage is **sag**. Too much sag and the car goes soft, the ESC can hit low-voltage cutoff, and the cells heat up.

06 PACK RESISTANCE

$R_{\text{pack}} (\text{m}\Omega) = \text{per-cell IR} \times \text{cells in series} \div \text{packs in parallel} + \text{wiring}$

Example: $4 \text{ m}\Omega \times 3 \div 1 + 1.5 \text{ m}\Omega$ for wires, connectors and ESC path = $13.5 \text{ m}\Omega$

07 SAG AT YOUR PEAK CURRENT

$\text{loaded volts} = \text{full-charge volts} - \text{peak amps} \times R_{\text{pack}}$

6 lb example: $12.6 \text{ V} - 121 \text{ A} \times 0.0135 \Omega \approx 10.96 \text{ V}$ (3.65 V per cell)

08 WHAT THE PACK CAN REALLY DELIVER

$\text{deliverable amps} = (\text{V open} - \text{V min under load}) \div R_{\text{pack}} \cdot \text{effective C} = \text{deliverable amps} \div \text{Ah}$

3S, 3.2 V per cell floor (example): $(12.6 - 9.6) \div 0.0135 \approx 222 \text{ A} \rightarrow \div 3.0 \text{ Ah} \approx 74\text{C}$, whatever the label says

Rule: your **peak amps must stay below the deliverable amps**, with room to spare.

SAME 6 LB CAR, FOUR PACKS (EXAMPLE IR VALUES)

Per-cell IR	R pack mΩ	Peak A	V/cell at peak	Deliverable A	Effective C
3 mΩ	10.5	117	3.79	286	95C
4 mΩ	13.5	121	3.65	222	74C
6 mΩ	19.5	133	3.34	154	51C
8 mΩ	25.5	153	2.90	118	39C

Higher IR means more sag, so the car pulls **more** amps for the same power, and that sags it further. At 8 mΩ per cell and above, the pack drops below the 3.2 V floor: wrong pack for this car, whatever C is printed on it.

UNITS CHEAT SHEET

lb $\times 0.4536$ = kg

ft $\times 0.3048$ = m · 132 ft =
40.23 m

mph $\times 0.447$ = m/s

J $\div 3,600$ = Wh

mΩ $\div 1,000$ = Ω