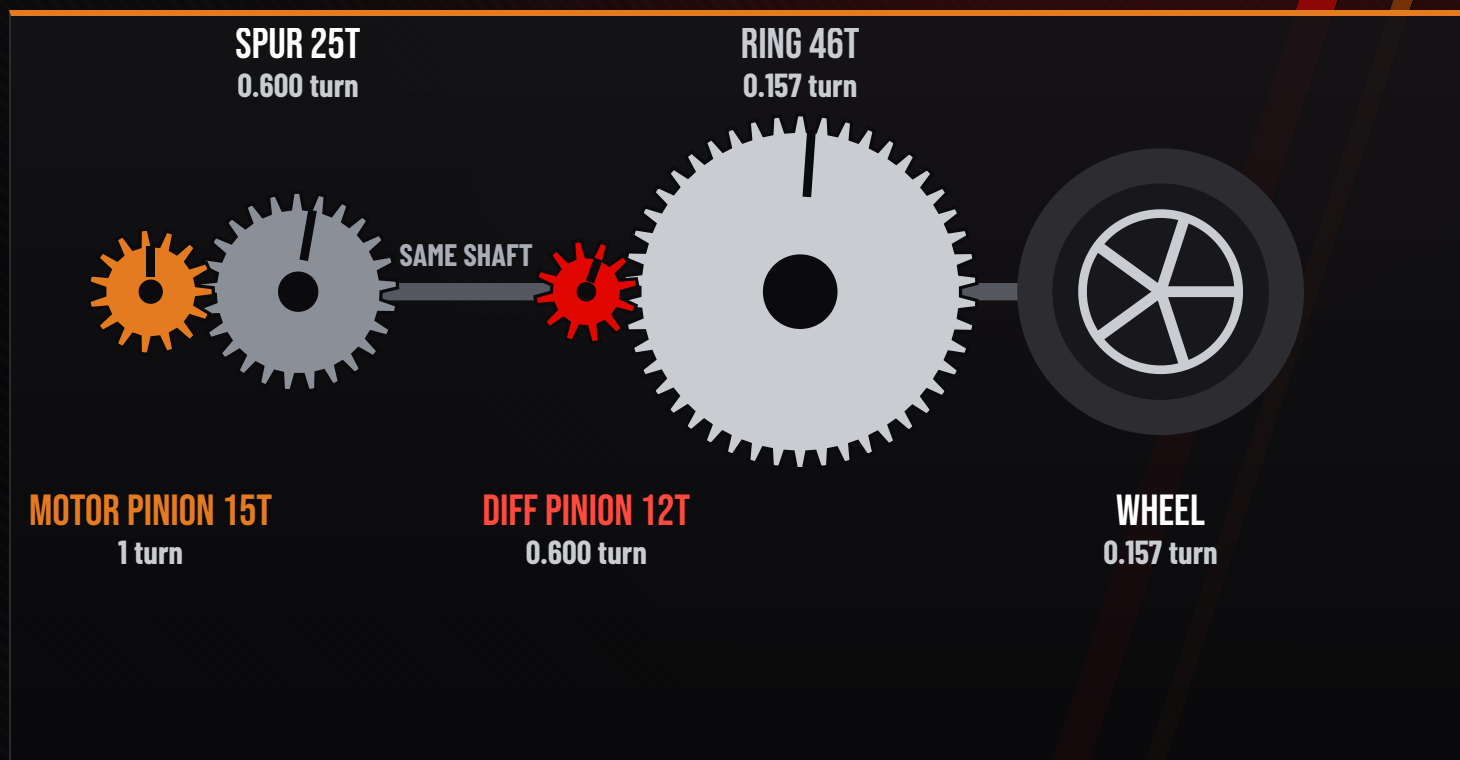




EVUL EMPIRE RACING · TECH GUIDE

YOUR GEARS MULTIPLY

Motor pinion → spur → diff pinion → ring → wheel. Two steps, one number.



$$\frac{\text{SPUR} \div \text{PINION}}{25/15} = 1.667$$

×

$$\frac{\text{RING} \div \text{DIFF PINION}}{46/12} = 3.833$$

=

$$\text{FINAL DRIVE} = 6.39:1$$

MOTOR TURNS PER WHEEL TURN

Mike's example gearing. Tire, motor and speed numbers in this guide are clearly labeled example assumptions, not measured EVUL results. The EVUL Gearing Calculator (HTML) does all of this live.

WHAT EACH GEAR DOES

Small gear drives big gear = slower, stronger. Big drives small = faster, weaker.



MOTOR PINION 15T

On the motor shaft.
Small. Spins the
fastest.



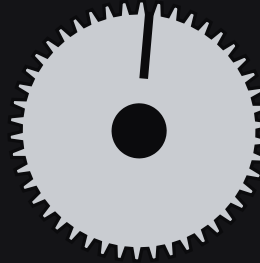
SPUR 25T

Driven by the motor
pinion. Bigger = slows
it down, adds push.



DIFF PINION 12T

Inside the diff, on the
spur's shaft. Turns with
the spur.



RING GEAR 46T

Big gear on the diff.
Turns the axles and the
wheels.

MOTOR

PINION

SPUR

DIFF PINION

RING

WHEEL

STAGE 1 = pinion → spur · STAGE 2 = diff pinion → ring (inside the diff)

STAGE 1

STAGE 2

THE RULE FOR EVERY PAIR

Driven ÷ driver = that stage's ratio. $25 \div 15 = 1.667$ means the motor turns 1.667 times for each spur turn.

TWO STAGES MULTIPLY

Each ring = one full motor turn. Count the rings.

STAGE 1

motor turns per spur turn



1.67

STAGE 2

spur turns per ring turn



3.83

TOTAL

motor turns per WHEEL turn



6.39

$1.667 \times 3.833 = 6.39$ · the stages **MULTIPLY**, they do not add

STAGE 1

1.667

$25 \div 15$

×

STAGE 2

3.833

$46 \div 12$

=

FINAL DRIVE

6.39

: 1

NOT $1.667 + 3.833$

Adding gives 5.5, which is **wrong**. Every spur turn already took 1.667 motor turns, and the ring needs 3.833 spur turns. So $3.833 \times 1.667 = 6.39$ motor turns.

EXTRA STAGE? MULTIPLY AGAIN

A transmission or extra gear pair is one more ratio in the chain: final = stage 1 $\times$ stage 2 $\times$ extra. No extra stage = 1.

MIKE'S WORKED EXAMPLE

15T pinion · 25T spur · 12T diff pinion · 46T ring

1 **STAGE 1**
spur ÷ motor pinion $25 \div 15$ **1.667 : 1**

2 **DIFF**
ring ÷ diff pinion $46 \div 12$ **3.833 : 1**

3 **FINAL DRIVE**
stage 1 × diff 1.667×3.833 **6.39 : 1**

4 **ROLLOUT**
tire circumference ÷ final drive $199.5 \text{ mm} \div 6.389$ **31.2 MM**

5 **TOP SPEED (NO LOAD)**
kV × volts × rollout $5800 \times 12.6 \text{ V} \times 31.2 \text{ mm}$ **85 MPH**

6 **TOP SPEED (LOADED, EST.)**
× sag and 90% loaded kV $\text{loaded volts} \cdot 90\%$ **74 MPH**

FINAL DRIVE
6.39:1

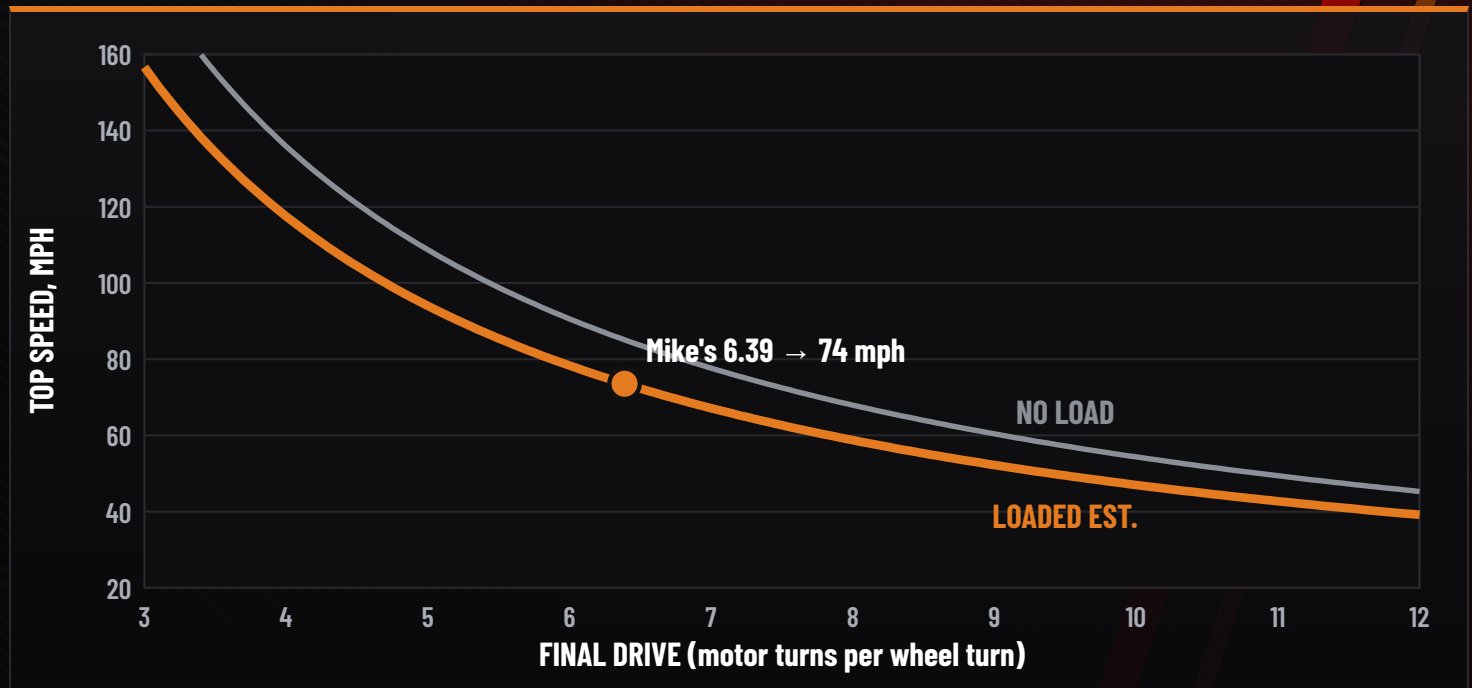
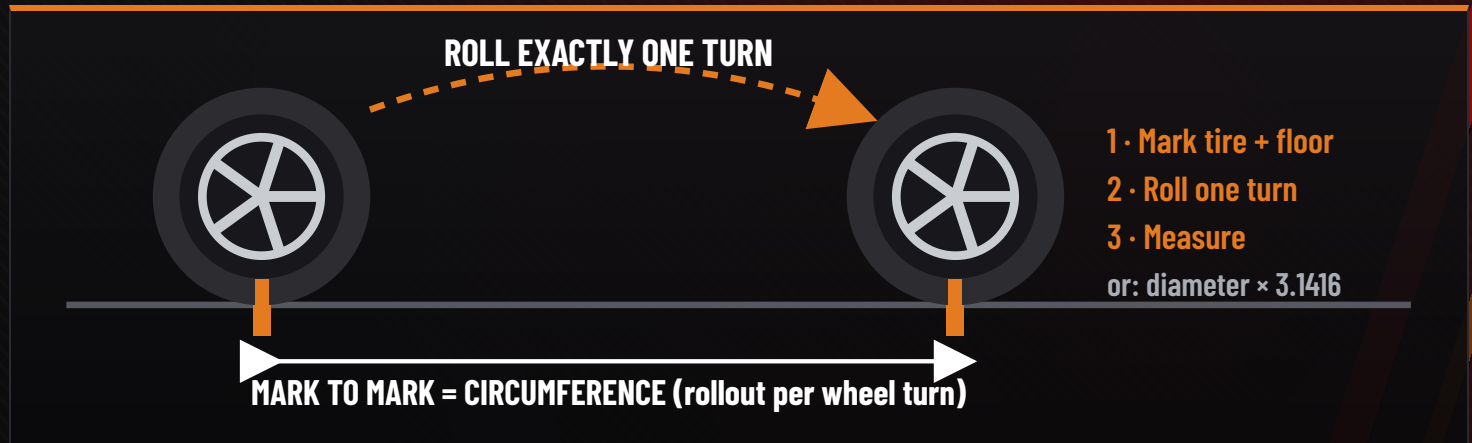
ROLLOUT / MOTOR REV
31.2 MM

WHEEL TORQUE ×
5.75

Example assumptions for steps 4-6: 2.5 in (63.5 mm) tire, no growth; Tenshock EVO2240HS 5800 kV (factory chart); 3S at 4.20 V per cell = 12.6 V; loaded speed uses the battery-guide sag model (2 lb car, 4 mΩ per cell) and 90% loaded kV. Wheel torque × = final drive × 90% drivetrain efficiency. Not measured EVUL data.

ROLLOUT + TOP SPEED

Rollout = how far the car moves for one motor turn. Bigger rollout = taller gear = more speed, more load.



+0% GROWTH
73.6 mph

+3% GROWTH
75.8 mph

+6% GROWTH
78.0 mph

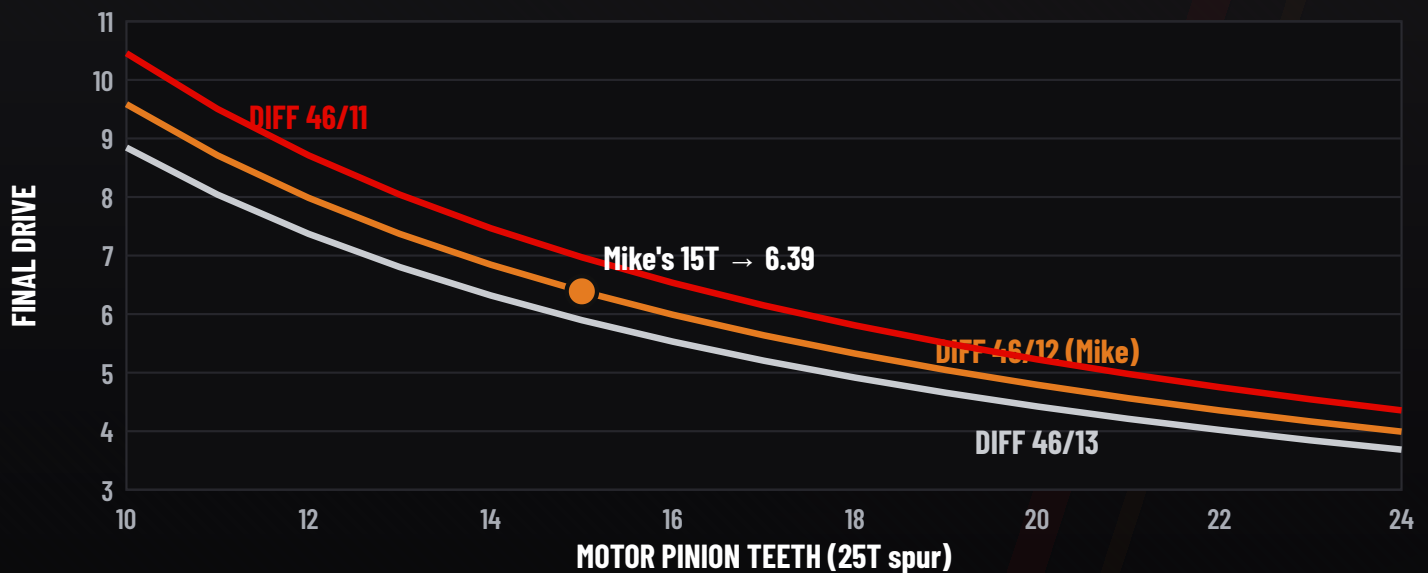
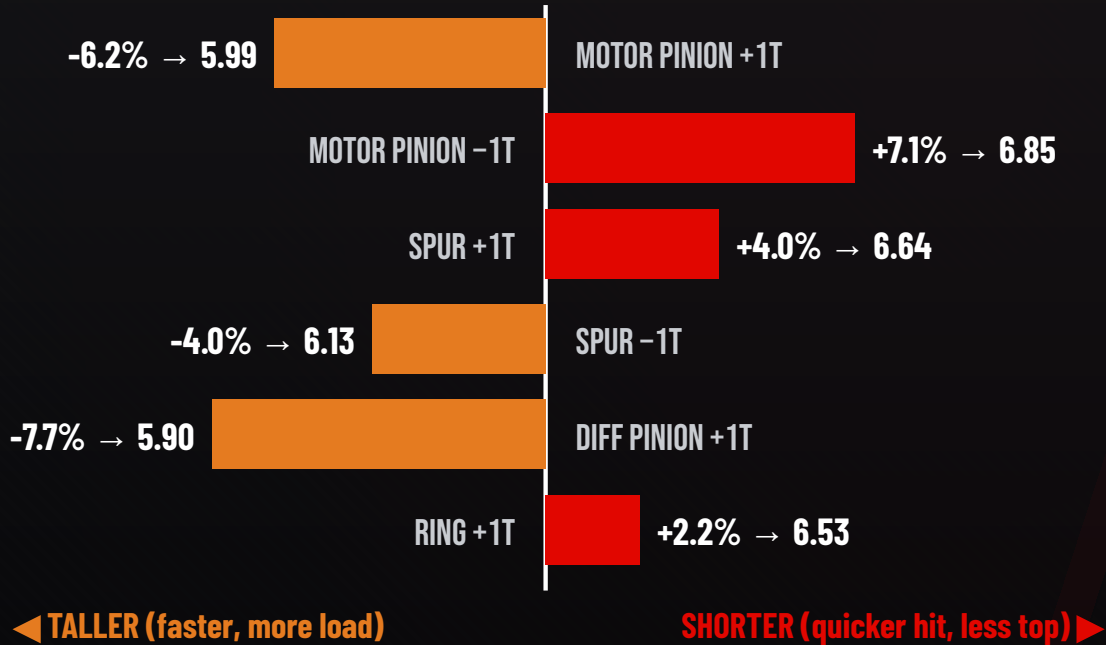
+10% GROWTH
80.9 mph

Drag tires can **grow** at speed. Growth makes the tire act taller: same gears, more top speed, more load. Growth % values are **examples**; measure yours. In Mike's example, **+1 mm of circumference ≈ +0.37 mph**.

PINION VS SPUR VS DIFF

Small gears make big jumps. Big gears make fine steps.

% CHANGE IN FINAL DRIVE FROM ONE TOOTH (Mike's 6.39:1)



FINE TUNE = SPUR

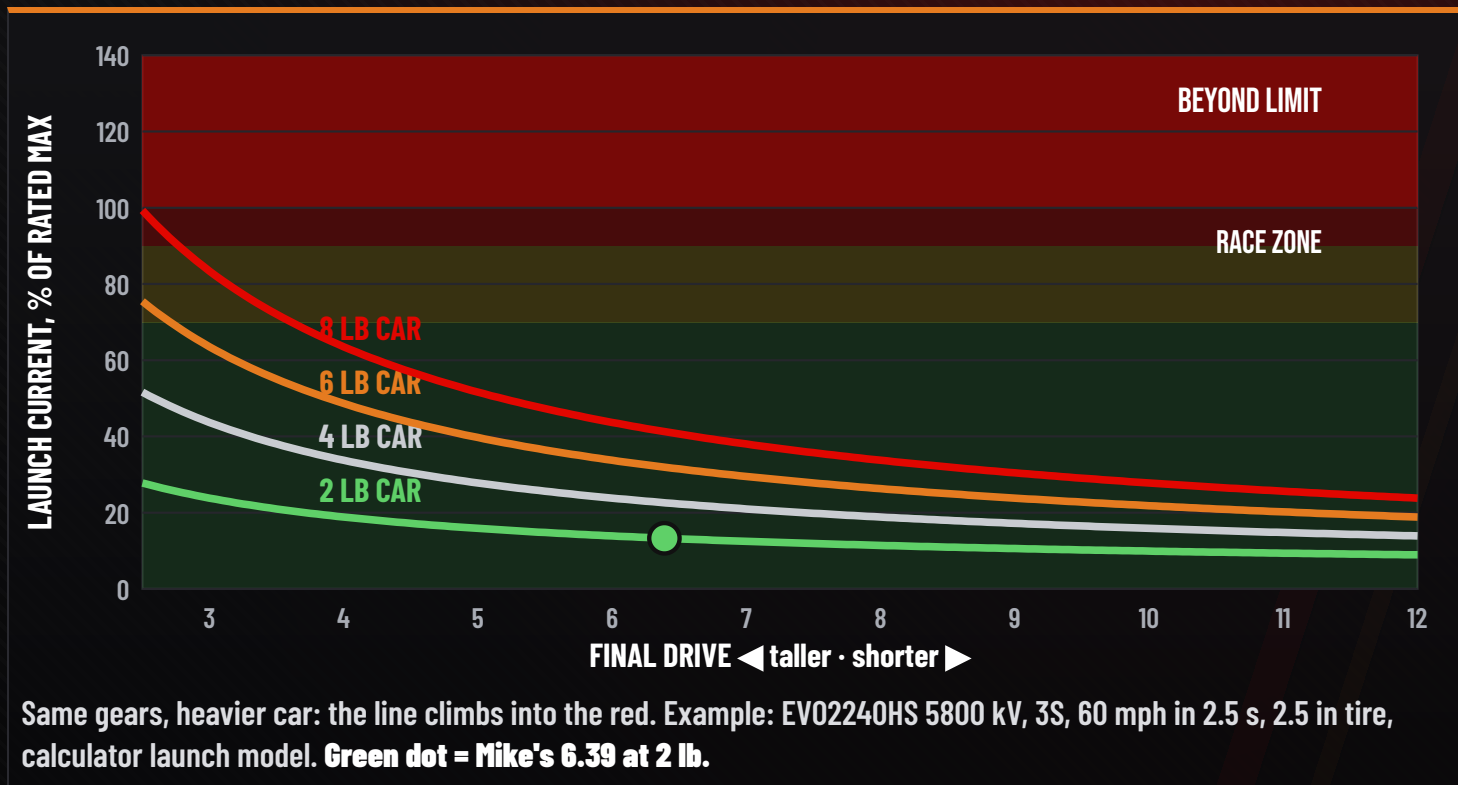
One spur tooth ≈ 4% here. Use the spur (or tire) to fine tune.

BIG JUMP = PINION / DIFF

One pinion tooth ≈ 6%; one diff-pinion tooth ≈ 8%. Change these for big moves.

132 FT GEARING TIPS

Taller gear (lower number) = more load. Heavier car = more load.



GOOD

under 70% of rating

CAUTION

70-90%

RACE ZONE

90-100%: at the limit, on purpose

BEYOND LIMIT

past the published rating



TALLER = MORE TOP, MORE LOAD

Lower final drive = more rollout and top speed, but the motor works harder off the line. In 132 ft you rarely need all the top speed.



SHORTER = HARDER HIT, LESS TOP

Higher final drive launches harder but runs out of RPM sooner. If top speed is under your trap speed, it's too short.



THE PACK PAYS FOR IT

More load = more amps = more sag. Put this final drive into the **EVUL Battery Sizing Calculator** as its gear ratio and check sag against your floor.



TINY PINIONS

Very small pinions (under about 12T) have weak teeth and mesh poorly. Under about 9T is flagged as unworkable in the calculator (example thresholds).

APPENDIX · THE MATH

Stage 1 = spur ÷ motor pinion

$$25 \div 15 = 1.6667$$

Diff ratio = ring ÷ diff pinion

$$46 \div 12 = 3.8333$$

Final drive = stage 1 × diff × extra stage = motor turns per wheel turn

$$1.6667 \times 3.8333 \times 1 = 6.3889$$

Circumference = π × diameter · at speed = circumference × (1 + growth)

$$\pi \times 63.5 \text{ mm} = 199.49 \text{ mm}$$

Rollout per motor rev = circumference ÷ final drive

$$199.49 \div 6.3889 = 31.23 \text{ mm (1.229 in)}$$

Top speed (mph) = kV × volts × rollout(in) × 60 ÷ 63,360

$$5800 \times 12.6 \times 1.2293 \times 60 \div 63,360 = 85.1 \text{ mph no load} \cdot \text{km/h} = \text{mph} \times 1.609$$

Wheel torque = motor torque × final drive × drivetrain eff. · tractive force = wheel torque ÷ tire radius

$$\text{torque multiplier} = 6.3889 \times 0.90 = 5.75 \cdot \text{lbf} = \text{N} \times 0.2248$$

EST. $K_t \approx 9.549 \div kV$ (N·m per amp) · est. max torque = $K_t \times \text{rated max amps}$

$$9.549 \div 5800 \times 350 \text{ A} = 0.576 \text{ N·m} \cdot \text{cross-check: rated watts} \div \omega \text{ at loaded RPM}$$

Launch torque needed = mass × (trap ÷ ET) × tire radius ÷ (final drive × eff.)

$$2 \text{ lb car, 60 mph in 2.5 s: } 0.0537 \text{ N·m at the motor} \cdot \text{launch amps} \approx \text{torque} \div K_t + \text{no-load amps}$$

% of rating = demand ÷ rated (or est.) max × 100

$$\text{Good under 70} \cdot \text{Caution 70-90} \cdot \text{Race zone 90-100} \cdot \text{Beyond limit over 100 (example thresholds, adjustable in the calculator)}$$

Ratings: Tenshock factory chart (max current, power, voltage; torque figure shown for reference). No max RPM is published in that chart, so the calculator shows "no rating on file". Pack sag and peak power use the same formulas as the EVUL Battery Sizing Guide. All results are estimates.