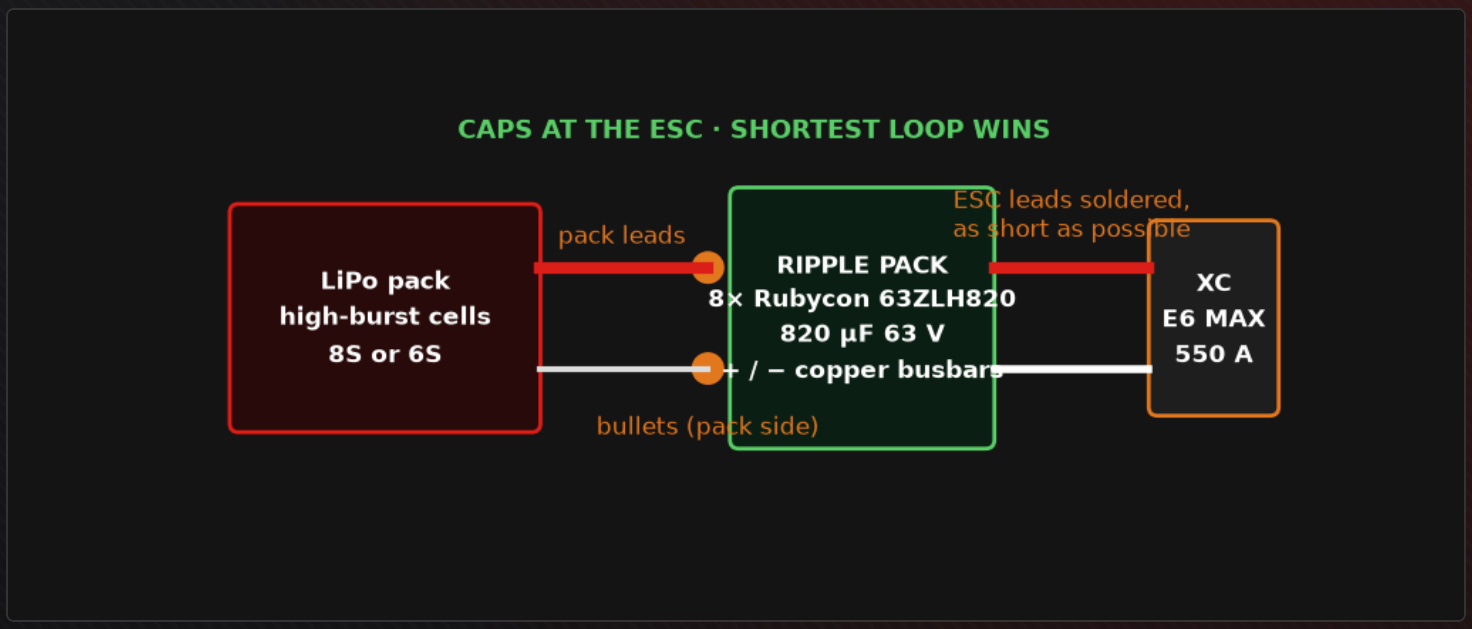
RIPPLE PACK GUIDE

How many caps the ESC really needs, worked out over a real pass, and why each piece of the math matters. 8S · XC E6 MAX 550 A.



8 CAPS

Rubycon 63ZLH820, 820 µF 63 V RATED. Minimum 5, recommended 9 EST

5.3%

sustained ripple, 1.77 V p-p on 33.6 V. Launch spike 7.3% for ~50 ms EST

+2.5 °C

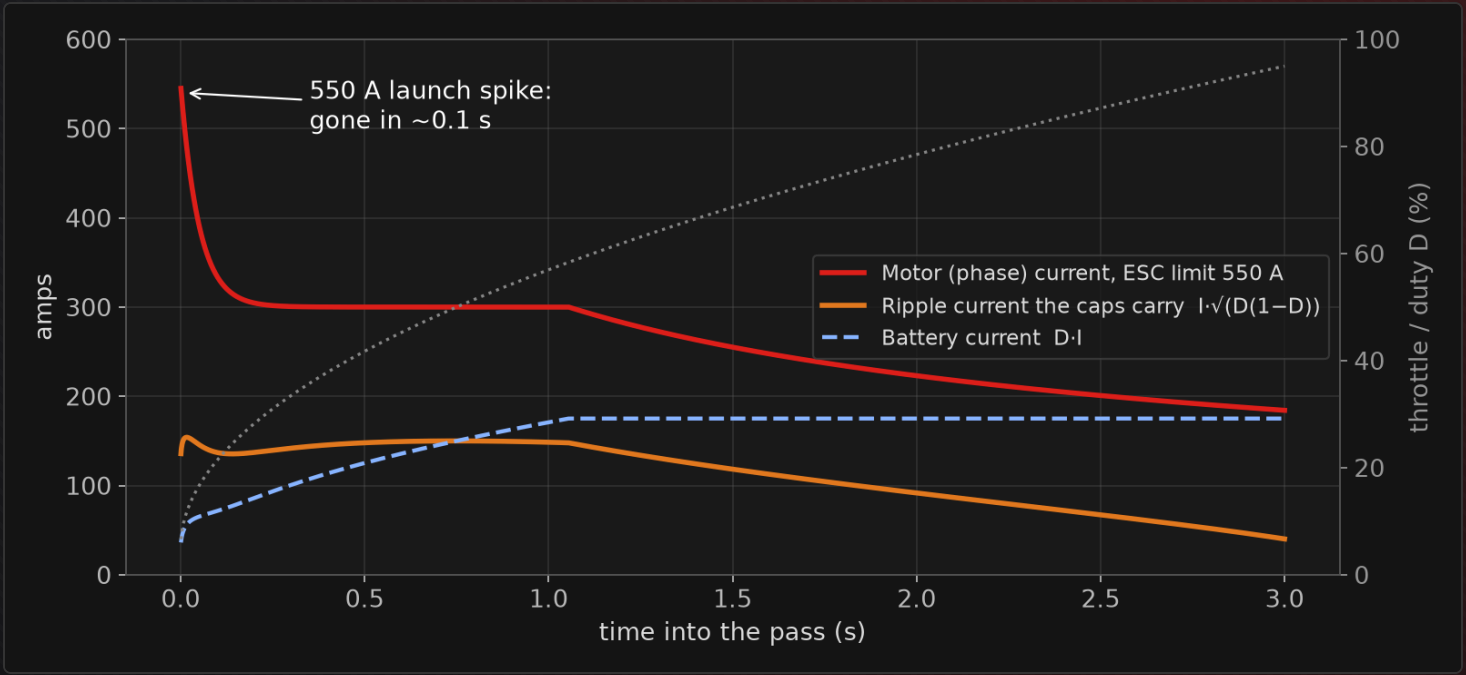
cap warm-up over a 3 s pass, 64 g of caps EST

WHAT IT DOES: the ESC switches the battery on and off thousands of times a second. The ripple pack sits right at the ESC and feeds those pulses so the pack wiring doesn't have to. It does **not** fix sag; that's the battery's job (see Sag: Battery First).

Assumptions EST: 8S at 4.20 V/cell, 20 kHz switching, launch spike 550 A decaying over τ = 50 ms to ~300 A traction-limited, 5000 W pack power cap, throttle ramp over a 3 s pass. The E6 MAX doesn't publish its switching frequency or onboard caps; those are not counted, so the result is on the safe side.

THE 550 A IS A SPIKE

The ESC's 550 A limit is motor (phase) amps, and it only lasts milliseconds. Sizing caps as if it lasted the whole pass is how you end up with 79 caps.

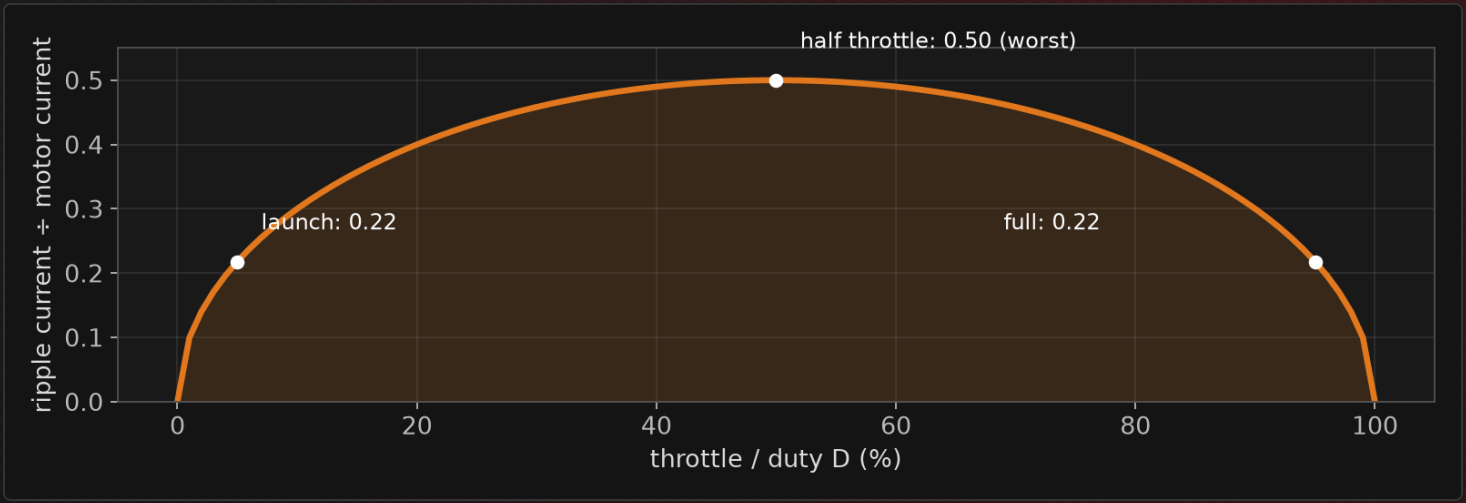


WHY IT MATTERS: the launch hits the 550 A limit RATED, but the tires can't put that down. Current falls to about 300 A EST within ~0.1 s, then the pack's power limit takes over as speed and throttle rise. The caps see a short spike, not a 3-second wall.

BATTERY AMPS ≠ MOTOR AMPS. Battery current = duty × motor current. At 20% throttle, 550 A in the motor is only ~110 A out of the pack EST. The ESC turns low volts × high amps into the motor's current, the same way a gear does.

RIPPLE CURRENT: I·√(D(1−D))

This is the current the caps carry back and forth every switching cycle. It's what heats them.



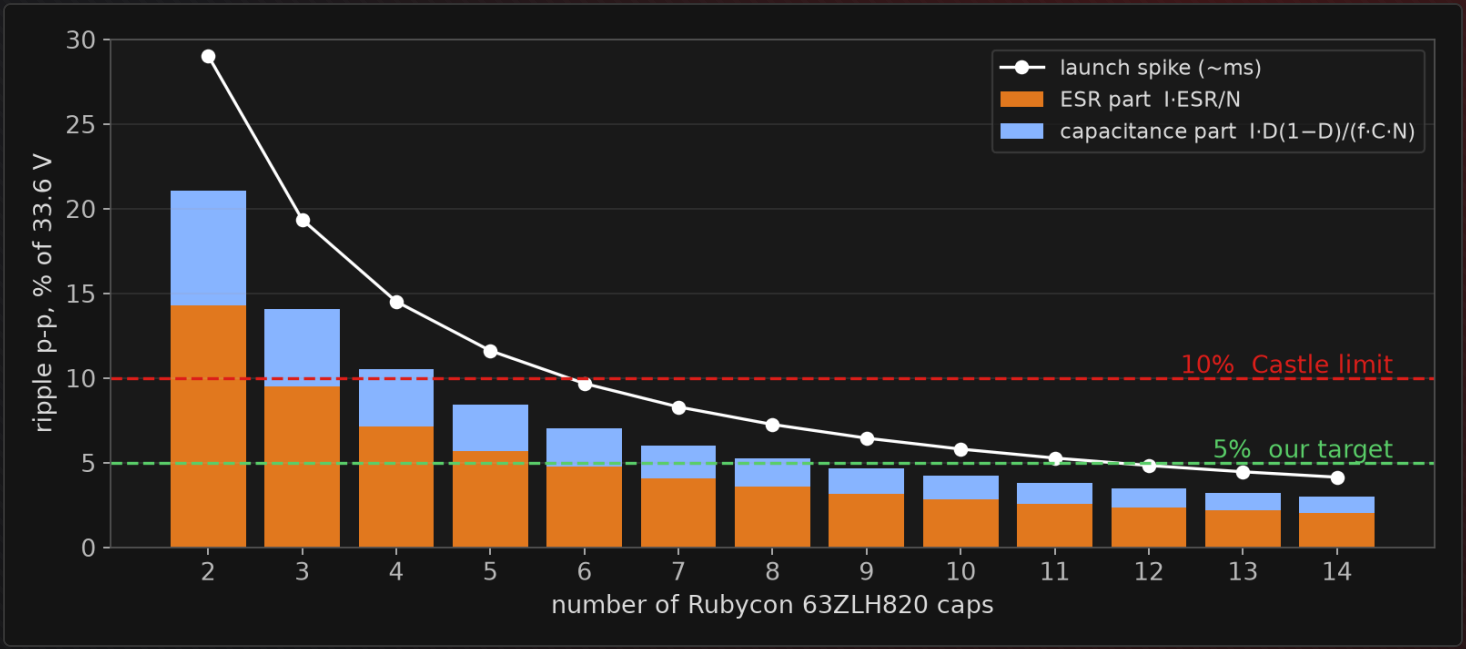
WHY IT MATTERS: at the launch (low duty) and at full throttle the factor is small, about 0.22. The worst case is half throttle, factor 0.50, and by then the motor current has already fallen to the traction/power-limited level. The worst moments for current and for ripple don't line up.

THE OLD MISTAKE: multiplying 550 A by the worst factor 0.50 for the full 3 s. That's 275 A rms of ripple for a whole pass. The sweep gives about 116 A rms over the pass EST.

I = motor current, D = duty (throttle). Same formula as the Burst Physics guide. Over the pass: ripple rms = √(average of $(I\cdot\sqrt{D(1-D)})^2$).

ESR SETS THE RIPPLE VOLTS

Ripple p-p ≈ I·D(1−D) / (f·C·N) + I·ESR / N. Count caps until the line is under the target.



WHY IT MATTERS: for these caps about 68% of the ripple is ESR (resistance), not microfarads EST. Buying bigger µF barely helps; more caps in parallel or lower-ESR caps does. N caps in parallel divide the ESR by N.

THE TARGETS: Castle Creations says keep ripple under 10% of pack voltage. Minimum: sustained ≤10% → **5 caps**. Recommended: sustained ≤5% and the launch spike ≤10% → **9 caps**. The 8-cap default sits at 5.3% EST.

63ZLH820MEFC16X25: 820 µF, 32 mΩ impedance, 2.73 A ripple rating RATED. "Sustained" = the worst point after the first 0.2 s, so the ms spike is checked but doesn't size the bank.

HEAT OVER A REAL PASS

The ripple rating is a continuous, hours-long figure. A pass is 3 seconds. What matters is how warm the cap gets.

63ZLH820 CAPS	SUSTAINED	SPIKE	AMPS / CAP	WARM-UP / PASS	WEIGHT
4	10.5%	14.5%	29.1 A	+10.1 °C	32 g
5	8.4%	11.6%	23.2 A	+6.5 °C	40 g
6	7.0%	9.7%	19.4 A	+4.5 °C	48 g
8	**5.3%**	**7.3%**	**14.5 A**	**+2.5 °C**	**64 g**
9	4.7%	6.5%	12.9 A	+2.0 °C	72 g
12	3.5%	4.8%	9.7 A	+1.1 °C	96 g

WHY IT MATTERS: heat rise = amps^2 × ESR × time ÷ (mass × heat capacity). 14.5 A per cap is 5× the continuous rating EST, but for 3 s the 8 g cap only warms ~2.5 °C. Holding every cap inside its continuous rating would take **43 caps**, sized for a load that never lasts.

WHAT'S OUT THERE: Castle's 8S cap pack is 4 × 220 µF 50 V; Team Brood's 12S bank is 5 × 2400 µF 63 V RATED. Real race packs run 4–10 caps. 79 was never practical; it came from two bad assumptions: 550 A held for the whole pass, and a 3% ripple limit.

Heat capacity ~1 J/g·K EST, no cooling, starting cool. Let caps cool between passes; replace any cap with a bulged or discoloured case.

BUILD IT

8 × Rubycon 63ZLH820MEFC16X25 between two copper busbars, as close to the ESC as it fits.

1. Pack unplugged, ESC disconnected from everything.
2. Stand the 8 caps in a row, all minus legs to one busbar, all plus legs to the other. Check the stripe (−) on every can.
3. Solder each leg to its busbar; keep legs short. Every extra mm adds loop inductance.
4. Cut the ESC's plugs and solder its leads straight onto the busbar pads, as short as the layout allows. Heat-shrink and tie down so the joint can't flex.
5. Pack leads to the busbars through the bullets on the pack side.
6. Insulate the busbars. Check polarity: ESC + to the + busbar, − to −, before the pack goes on.

CHECK IT

- Joints shiny, solder flowed into the strands
- Tug test every lead
- Feel the caps after a pass: warm is fine, hot means too few caps or a bad joint
- Check your numbers at **evulempire.com/ripple/**

SAFETY

- 63 V caps on 8S (33.6 V) RATED: good margin. Don't go below 50 V caps.
- Plug the pack in last, unplug it first.
- Charge LiPo in a LiPo bag, never unattended.
- Cutting ESC plugs may affect the ESC maker's warranty.

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