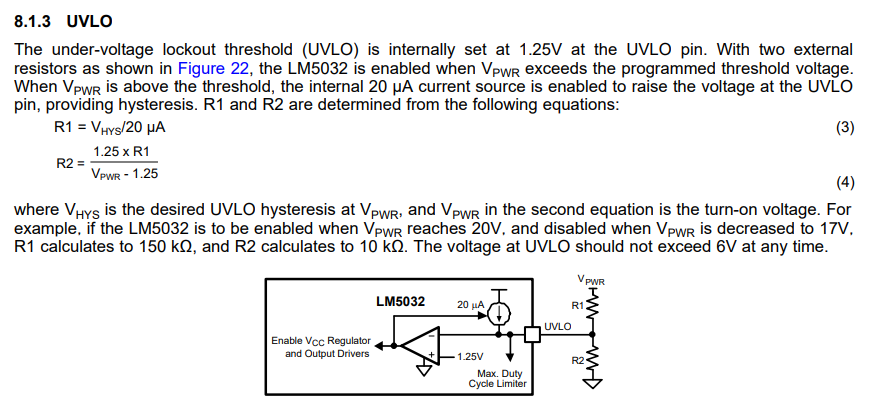
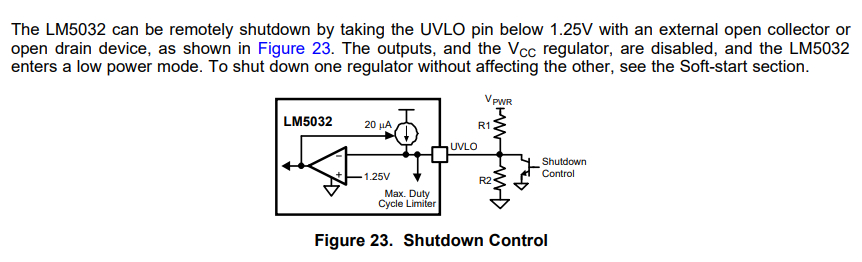
**Power Stage Calculations**

The battery voltage range is 2.5V to 3.65V per cell, 37.5V to 54.75V total (absolute max is 3.7V x 15S = 55.5V), and the capacitor voltage will charge up to a bit less than that. To avoid extreme duty cycles, the converter should only be capable of 3:1 voltage step up, which still removes 86% of the capacitor’s stored energy. The output current is up to 190A.



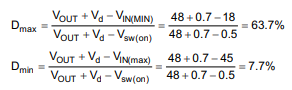


A diagram of a voltage

Description automatically generated

Output current up to 190A with up to 3:1 voltage step-up, IIN = 190A \* 3 = 570A. Input voltage as low as 18V. Vout as high as 55V.

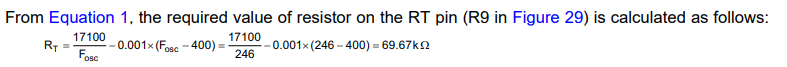
Switching frequency of 500kHz, interleaved to make it effectively 1MHz for the capacitors RLoad = VOut/IOut = 3.2\*15/190 = 0.25 ohms

A black text with black letters

Description automatically generated

DMin = 0

DMax = 1 – [(18 \* 0.85) / 52] = 70.6%



Peak IOut = 95\*2 = 190A

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Description automatically generated  

IL(avg) = (0.5 \* 190A) / (1 - 0.706) = 323.1A \*\*\*note this is per phase

△IL = (18V \* 0.722) / (500000 \* 470 \* 10-9) = 55.3A

I(Peak) = 341.7 + (55.3 / 2) = 369.4A

LMin = (18V \* 0.722) / (500000Hz \* 55.3A) = 470 nH

△IL = (18V \* 0.722) / (250000 \* 470 \* 10-9) = 110.6A

I(Peak) = 341.7 + (110.6 / 2) = 397A

LMin = (18V \* 0.722) / (250000Hz \* 110.3A) = 940 nH

△IL = (18V \* 0.706) / (200000Hz \* 1100 \* 10-9) = 57.8A

I(Peak) = 323.1 + (57.8 / 2) = 352A \*\*\*this is the peak current in the inductor

LMin = (18V \* 0.706) / (200000Hz \* 57.8A) = 1099 nH

A diagram of a duty cycle

Description automatically generated

ICap-RMS = 0.7\*190A = 133A

A diagram of a complex

Description automatically generated

Use 4 x 10uF capacitors, X7R loses 10% of capacitance at 1 MHz, DF = 2.5%

ESR = DF/(2π\*f\*C) = 0.025 / (2 \* 3.14 \* 1000000Hz \* (10 \* 10-6F)) = 0.0004 Ω

\*\*\*per capacitor

PCap = (133/4)2\*0.0004Ω = 0.489 W



ΔVOUT = [(190A \* 1) / (8 \* 10 \* 10-6 \* 2 \* 200000)] + [(352A \* 0.03 Ω) / 2] ≈ 2.41V

Additional ΔVOUTdue to ESR:

A close up of a symbol

Description automatically generated

ΔVOUT(ESR) = (0.0004 Ω) \* [(190A / (1 – 0.717)) + (48.8A / 2)] = 0.28V

A diagram of a duty cycle

Description automatically generated

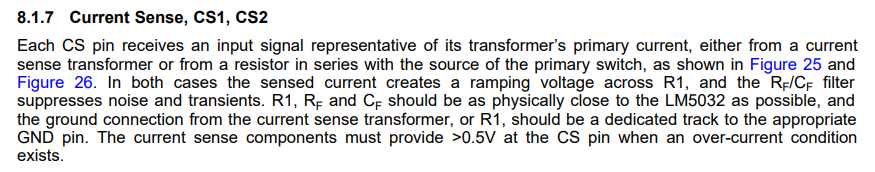
IN = 54 / (0.47 \* 0.5) = 230A

IRipple = 0.35 \* IN = 0.35 \* 230A = 80.5A

Again, use 4 x 10uF

PCap = (80.5A / 4)^2 \* 0.000442Ω = 0.179 W

PFET = 190A / (2 \* (1 - 0.673)) \* 0.0011 \* 0.717 \* 1.3 + 12 \* 0.178 \* 0.5 = 1.35 W



Calculating necessary current-sensing resistor value:

V = I\*R = 369.4A \* 0.0001Ω = 0.037

P = I\*I\*R = 369.4A \* 369.4A \* 0.0001Ω = 13.65W

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Description automatically generated

Heat Transfer from PCB through silicon thermal pad to cooling block

Q(t) = (kAΔT) / L

Q = [(0.9W/m-k) \* (0.108m \* 0.1143m) \* (30°C)] / 0.000178m = 1872W