

## TPS5420 5V Supply Design

### Design Parameters

$$V_{in\_min} := 10 \text{ V}$$

$$V_{in\_max} := 35 \text{ V}$$

$$V_{out\_nom} := 5 \text{ V}$$

$$K_{ind} := 0.2$$

$$V_{in\_ripple} := 300 \text{ mV}$$

$$V_{out\_ripple} := 50 \text{ mV}$$

$$I_{out\_max} := 2 \text{ A}$$

$$F_{sw} := 500 \text{ kHz}$$

Fsw fixed by TPS5420

### Input Capacitors

$$C_{bulk} := 10 \cdot 10^{-6} \text{ F}$$

$$ESR_{max} := 0.002086 \text{ } \Omega$$

$$ESL_{max} := 1200 \cdot 10^{-9} \text{ H}$$

$$V_{in\_ripple\_calc} := I_{out\_max} \cdot \frac{0.25}{C_{bulk} \cdot F_{sw}} + (I_{out\_max} \cdot ESR_{max}) = 0.104 \text{ V}$$

$$I_{cin} := \frac{I_{out\_max}}{2} = 1 \text{ A}$$

Choose input capacitors rated for at least 50V with a ripple current capacity for each at 3A at 500kHz

### Output Filter Components

#### Inductor Selection

$$L_{min} := V_{out\_nom} \cdot \frac{(V_{in\_max} - V_{out\_nom})}{(V_{in\_max}) \cdot K_{ind} \cdot I_{out\_max} \cdot F_{sw} \cdot 0.8} = (2.679 \cdot 10^{-5}) \text{ H}$$

$$L_{nom} := 33 \cdot 10^{-6} \text{ H}$$

$$I_{L\_rms} := \left( I_{out\_max} \cdot I_{out\_max} + \frac{1}{12} \left( \frac{(V_{out\_nom} \cdot (V_{in\_max} - V_{out\_nom}))^2}{(V_{in\_max} \cdot L_{nom} \cdot F_{sw} \cdot 0.8)} \right)^{0.5} \right)^{0.5} = 2.002 \text{ A}$$

$$I_{L\_peak} := \left( I_{out\_max} + \frac{V_{out\_nom} \cdot (V_{in\_max} - V_{out\_nom})}{1.6 \cdot V_{in\_max} \cdot L_{nom} \cdot F_{sw}} \right) = 2.162 \text{ A}$$

Choose an inductor with at least 2.5A rms and 3A saturation current

## Output Capacitor Selection

$F_{co} := 10 \text{ kHz}$  Target Crossover frequency

$$C_{out} := \frac{1}{(3357 \cdot L_{nom} \cdot F_{co} \cdot V_{out\_nom})} = (1.805 \cdot 10^{-4}) \frac{s^6 \cdot A^3}{kg^2 \cdot m^4}$$

~100uF

$N_c := 5$  Select 5x 22uF capacitors to approximate 100uF

$$C_{out\_esr\_max} := \frac{1}{(2 \cdot \pi \cdot C_{out} \cdot F_{co})} = 0.088 \frac{kg^2 \cdot m^4}{s^5 \cdot A^3}$$

~88mOhms

$$V_{pp\_max} := C_{out\_esr\_max} \cdot V_{out\_nom} \cdot \frac{(V_{in\_max} - V_{out\_nom})}{N_c \cdot V_{in\_max} \cdot L_{nom} \cdot F_{sw} \cdot 0.8} = 0.006 \frac{kg^2 \cdot m^4}{s^5 \cdot A^2}$$

6mV pk-pk ripple

Ensure output cap is rated for  $V_{out} + 1/2$  ripple voltage + derating, ~  
 $5.006 \cdot 1.3 = 6.5V$ , round up to 25V

Estimate ripple current max at 150mA

## Output Voltage Set

$R1 := 10 \text{ k}\Omega$   $R1_{min} := R1 \cdot .999$   $R1_{max} := R1 \cdot 1.001$

$$R2 := \frac{R1 \cdot 1.221}{(V_{out\_nom} - 1.221 \text{ V})} = (3.231 \cdot 10^3) \frac{1}{A} \quad 3.24KOhms \text{ +/-0.1\%}$$

$R2_{min} := R2 \cdot .999$   $R2_{max} := R2 \cdot 1.001$

$$V_{out\_min} := R1_{min} \cdot \frac{1.221}{R2_{max}} + 1.221 \text{ V} = 4.992 \text{ V}$$

$$V_{out\_max} := R1_{max} \cdot \frac{1.221}{R2_{min}} + 1.221 \text{ V} = 5.008 \text{ V}$$

## Boot Cap

Datasheet gives 0.01uF for the boot capacitor. NP0/COG preferred

## Catch Diode

$$D_{reverse\_voltage\_min} := V_{in\_max} + 0.5 \text{ V} = 35.5 \text{ V}$$

$$D_{iout\_max} := I_{out\_max} + 0.5 \cdot I_{L\_rms} = 3.001 \text{ A}$$

Diodes, Inc B340A has a reverse voltage of 40V, forward current of 3A and forward voltage drop of 0.5V