Analytical Calculation

We are going to use 3phase diode rectifier and buck converter

3 Φ Diode Rectifier

$$V_{dc} = \frac{3\sqrt{2}}{\pi} V_{ll} - \frac{3}{\pi} \omega L_s I_d$$

Min

$V_{ll} = 15\, V_{ll}$

$$V_{dc} = \frac{3\sqrt{2} \times 15}{\pi} - \frac{3}{\pi} \omega L_s I_d$$

Assume no commutation

$V_{dc} = 20.25\ V$

Max

$V_{ll} = 25 V_{ll}$

$$\frac{3\sqrt{2} \times 25}{\pi} - \frac{3}{\pi} \omega L_s I_d$$

With Commutation

$V_{dc} = 33.76$

Buck Converter

$V_o = 12V$

$V_o = D\, V_d$

$$I_{L_{peak}} = \frac{1}{L}(V_d - V_o) D T_s$$

$$L_{min} = \frac{R(1-D)}{2 f_s}$$

$V_{DC} = 34 \rightarrow D_{max} = 0.35$

$$I_{L_{peak}} = \frac{1}{L}(22).0,35.T_s$$

$$L_{min} = R\,\frac{0.65}{2} \times T_s$$

$$I_{L_{peak}} \times L = \frac{7.7}{f_s}$$

If I want to use $L = 220\mu H$ with %20 tolerance

$L_{min} = 200\mu H$

$$L_{min} = \frac{R.0.325}{f_s}$$

$I_{Lpeak} \times f_s = 35000$

SRI1204 %20 tolerans

$f_s = 50\,kHz \rightarrow I_{Lpeak} = 0.7A$ Exist and lots of options

$f_s = 80\,kHz \rightarrow I_{Lpeak} = 0.44\,A$

to small current all inductors have higher current capability

if $f_s = 70\,kHz$, $I_{Lpeak} = 2A$ > 220μH/2A inductor exist in dirençnet but I need to put safety margin

So → $f_s = 50Hz$, $L = 220\mu H$ > $I_{c\,peak} = 0.7A$

$L_{min} = 200\mu H$

$L_{min} = R \cdot \frac{0.325}{f_s}$ $\quad R = 30.76\Omega$

Check Does this values valid for small V_{DC}:

$V_{DC} = 20 \rightarrow D_{max} = 0.6$

$I_{c\,peak} = \frac{1}{L} 8 \cdot 0.35 \cdot T_s$

$L_{min} = \frac{R \cdot 0.4\ T_s}{2}$

$I_{c\,peak} = \frac{1}{220\mu H} \times 8 \times 035 \times \frac{1}{50kHz} = 0,25\,A$ ✓

$L_{min} = \frac{31 \times 0.4}{2 \times 50kHz}$ $\quad R \geq 45\Omega$

We need to change R. For putting safety margin

Lets make $\boxed{R = 100\Omega}$

$$\frac{\Delta V_o}{V_o} = \frac{(1-D)\,T_s^2}{32\,\pi^2 f_c^2}$$

$$0 < \frac{\Delta V_o}{V_o} < \frac{(T_s)^2}{8LC}$$

$$\frac{(T_s)^2}{8 \times 220 \times 10^{-6} \times C} = \frac{2.2727 \times 10^{7}}{C}$$

We need to find a capacitor that has small ESR and choose C as big as possible

MOSFET

Maximum voltage in the circuit = 34V. Our mosfet has at least 45V voltage rating.