Date: 1-28-2017

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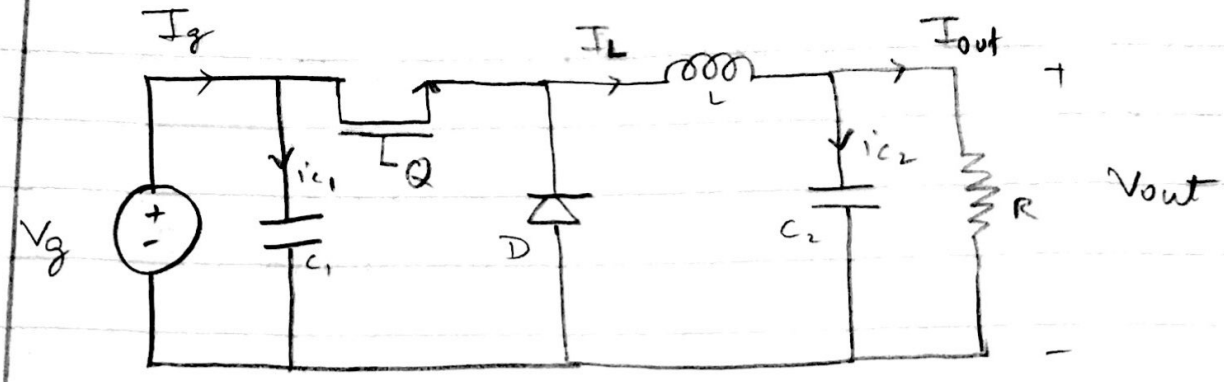
Prelab - Exp - 3-1

Converter operating point for design



$V_g = 17.2\,V$

$V_{out} = 13\,V$

$D_{max} = 0.755$

$P_{out} = 85\,W \Rightarrow I_{out} = 6.538\,A = I_L$

$I_g = D I_L$

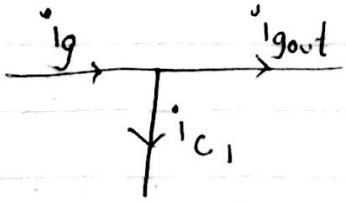
$= 4.936\,A$

Assuming 12% ripple and $f_s = 25\,kHz$

$\Delta I = 0.7845\,A$

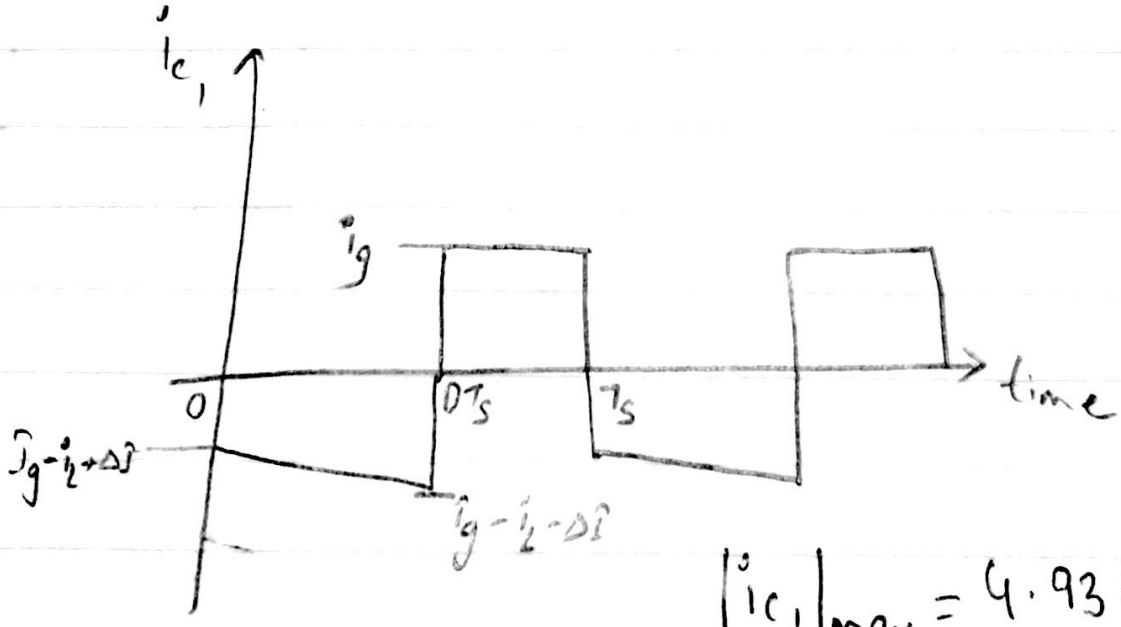
1. Current waveforms of Power components

Input filter capacitor C_1



Switch on $\quad i_{C_1} = I_g - i_{gout}$

Switch OFF $\quad i_{C_1} = I_g$



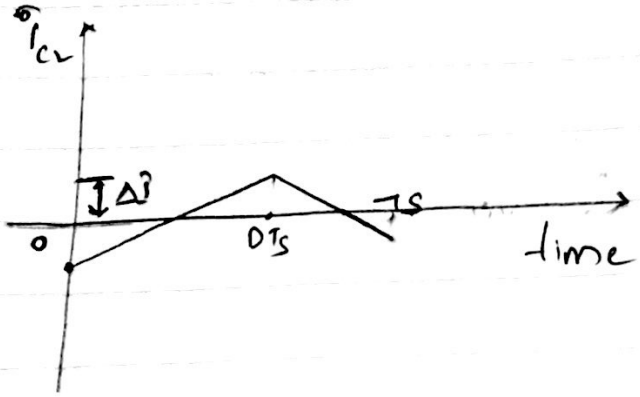
$|i_{C_1}|_{max} = 4.936\ A$

$i_{C_1 min} = -2.3925\ A$

$i_{C_1 rms} = 0.2.808\ A$

Output capacitor filter C_2

- The current in output capacitor will be ripple of inductor

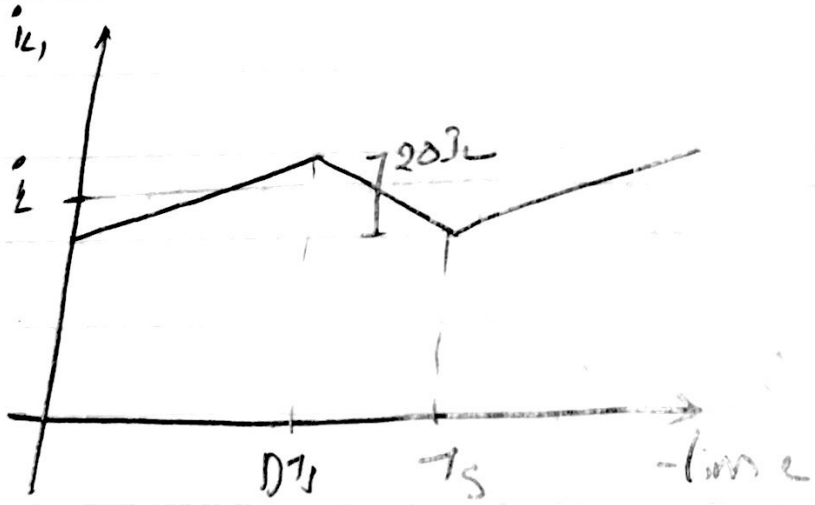


$i_{C2\,max} = 0.7845\ A$

$i_{C2\,min} = -0.7845\ A$

$i_{C2\,rms} = 0.4529\ A$

Inductor L_1

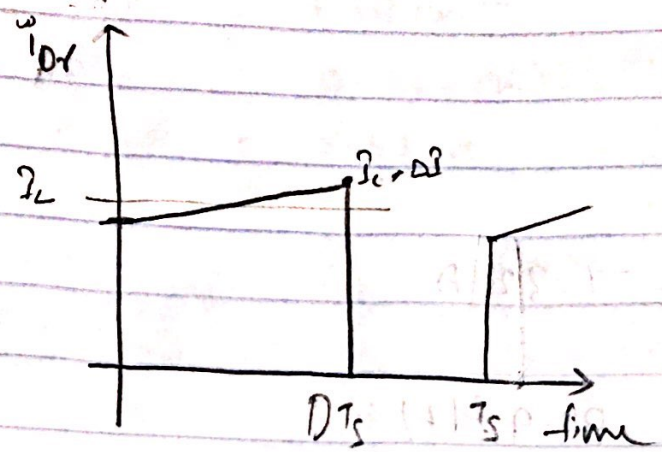


$i_{L1\,max} = 7.322\ A$

$i_{L1\,min} = 5.753\ A$

$i_{L1\,rms} = 6.5\ A$

Mosfet Drain current

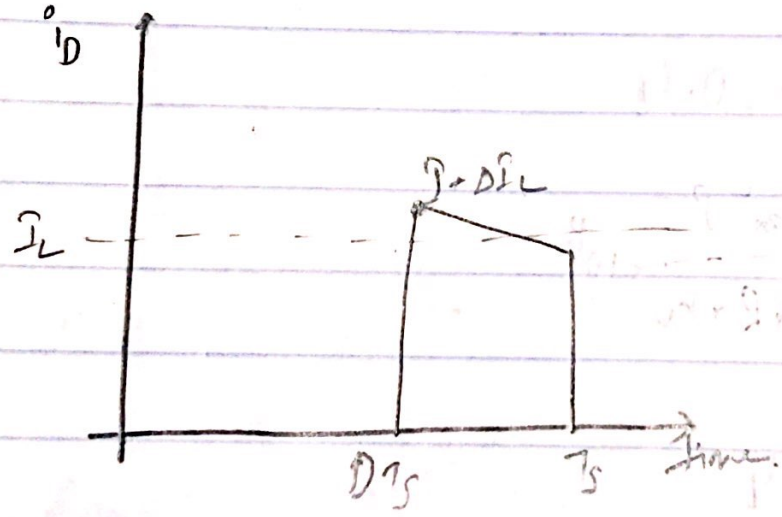


$i_{D_{max}} = 7.322A$

$i_{D_{min}} = 0A$

$i_{D_{rms}} = 5.694A$

Diode Current



$i_{D_{max}} = 7.322A$

$i_{D_{min}} = 0$

$i_{D_{rms}} = 3.24A$

2. Inductor design

$f_s = 25\ kHz$

$D = 0.755$

$\Delta I = 12\%$

$I_{max} = I_L + \Delta I = 7.32\ A$

$$L_b = \frac{V_{out} D' T_s}{2 \Delta I} = 80.9\ \mu H$$

$P_{loss} = 1\ W \Rightarrow R = 23.4\ m\Omega$

$B_{max} = 0.25\ T$

fill factor $k_u = 0.4$

$$k_g \geq \frac{L^2 I_{max}^2 \rho}{B_{max}^2 \times R \times k_u} \times 10^8$$

$$k_g \geq 0.104$$

a Ferrite PQ 26/25 with $k_g = 0.125\ cm^5$ is selected

from PQ 2612S data sheet

$A_c = 1.18\ cm^2$

$W_A = 0.503\ cm^2$

$MLT = 5.62\ cm$

air gap $l_g = \dfrac{\mu_0 \times L \times I_{max}^2}{B_{max}^2 \times A_c} \times 10^4$

$$\boxed{l_g = 0.739\ mm}$$

Number of turns : $N = \dfrac{L \times I_{max} \times 10^4}{B_{max} \times A_c}$

$$\boxed{N = 20.1}$$

$A_w \leq \dfrac{k_u W_A}{N_1}$ $\Rightarrow$ [illegible]

$A_w \leq 10 \times 10^{-3}\ cm^2$

Use $\boxed{\text{AWG \#18}}$

3. Balance of converter

MOSFET : HUF75321

rated : 55V, 35A

Voltage and Current stress expected = 20.5V, 7.32A

well within specs.

Diode : MBR1645

rated : 45V, 16A

Voltage and Current stress expected = 14.4V, 7.32A

well within specs.

Capacitor C_1 = 3300 μF

rating : 35V, 4.22A rms

Voltage and current stress expected : 20V, 2.8A

well within spec

Capacitor C_2 = 730 μF

rating : 25V, 0.865 rms

Voltage and current stress expected : 14.4V, 0.42A

well within specs