Buck Converter Calculation

1^{st} Approach (More Practical Approach)

$$\Delta i_{L_{on}} = \frac{V_s - \bar{V_o}}{L} D.T$$

$$= \frac{V_s - \bar{V_o}}{L} \frac{D}{f_s}$$

$V_{s_{in}} = 15V_{ee} - 25V_{ee}$

$V_{s_{avg_{in}}} = 20V_{ee}$

$V_{s_{out}} = \frac{3\sqrt{2}}{\pi} . 20 = 27.009$

$\bar{V_o}$ assume $10V$

$\Delta i_{L_{on}}$ %20 $\quad i_{L_{on}} = 10A$

$\Delta i_{L_{on}} = 2$

$D = \frac{V_o}{V_s} = 0.3703$

$$2 = \frac{27 - 10}{L} \cdot \frac{D}{f_s}$$

$$2 = \frac{27 - 10}{L} \cdot \frac{0.3703}{f_s}$$

$$L = \frac{(27 - 10) . 0.3703}{2 . f_s}$$

$L \approx 63 \ \mu H$

2nd Approach

$$L_c = \frac{(1 - D_{max})\ R_{max}}{2f} = 0.30717$$

$V_o = D\ V_{in}$ $\qquad R_{max} = \frac{V_o}{I_{omin}} = \frac{10}{9} = 1.1111$

$10 = D_{max}\ 27\sqrt{2}$

$f = 50\,kHz$

$D_{max} = 0.6928$

$L_c = 3.413\ \mu H$

Calculation Based on Example Design @ Slayt 46 Taufik

$V_{s_{in}} = 15V_{pe} - 25V_{pe}$ $\qquad \bar{V}_o$ assume $10V$

$V_{savg_{in}} = 20V_{pe}$ $\qquad \Delta i_{L_{on}}$ %20 → try to make it %10 $\qquad i_{L_{on}} = 10A$

$V_{s_{out}} = \frac{3\sqrt{2}}{\pi} \cdot 20 = 27.009$ $\qquad \Delta i_{L_{on}} = 1$ → put phase margin

This calculation is held by assuming average values so that I take $D = 0.5$

$V_{sout_{rms}} = 25.40$ (simulink)

$f_s = 50\ kHz$

$D = \frac{\bar{V}_o}{V_s} = 0.37037$ $\qquad D = \frac{10}{25.40} = 0.3937$

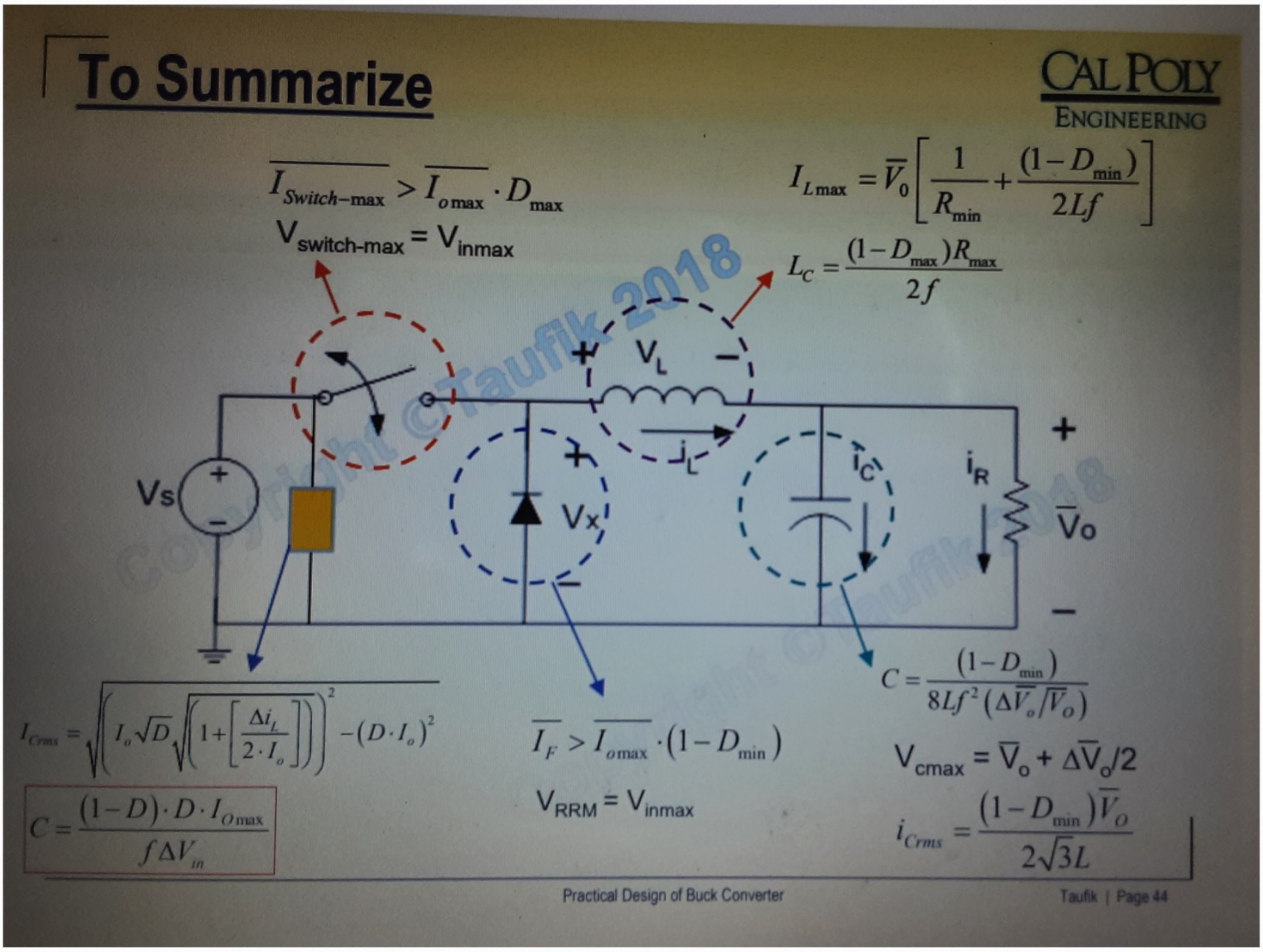
Inductor : $\frac{(1-D)}{2f} \frac{V_o}{\Delta i_o} = \frac{(1-0.37037)(10)}{2 \times 50 \times 10^3 \times 1} = 60.629\mu H$

$L_{crit} = 63\ \mu H$ $\qquad$ Let $L \approx 65\mu H$

Capacitor :

$$C = \frac{(1-D)}{8Lf^2}\cdot\frac{1}{\%V_o} = \frac{(1-0.37037)}{8\times 65\times 10^{-6}\times(50\times10^3)^2}\cdot\frac{1}{20}$$

$= 24.21\ nF$ $\qquad = 25\,nF$



From the calculations above, current = 1 A avg.

We may change Vout to charge battery

Now let assume $V_{out} = 14\,V$

$$D = \frac{V_o}{V_s} = \frac{14}{25.40} = 0.5511$$

$$\text{Inductor: } \frac{(1-D)}{2f} \frac{V_o}{\Delta i_o} = 62.83\,\mu H$$

$$L_{crit} = 63\,\mu H \qquad L_{crit} \approx 65\,\mu H$$

Capacitor:

$$C = \frac{(1-D)}{8Lf^2} \cdot \frac{1}{\%V_o} = 17{,}26\,nF$$

Not Working.

Theoretical calculations are useless.