Buck Converter Alt. Designs

1. Design Req:

Vin: 5V

Vout: 3.3V

Power out: 0.4389 W

Efficiency > 85%

f_s = 250 kHz

current output = $\frac{0.4389}{3.3} = 0.133A$

max duty cycle $\frac{V_{out}}{V_{in}} = \frac{3.3}{5} = 0.66$

Efficiency:

$P_{loss} < P_o\left(\frac{1}{\eta} - 1\right)$

$< 0.4389\left(\frac{1}{0.84} - 1\right)$

$P_{loss\ total} < 83.6$ mW

Inductor sizing

use 20% to be more conservative

$\frac{\Delta I}{I_o} < 40\%$: $\Delta I = (0.2)(0.133) = 0.0266A$

$L = \frac{V_o(1-D)}{f_s \cdot \Delta I} = \frac{3.3(0.34)}{(250\cdot10^3)(0.0266)} = 168.72\ \mu H$

Inductor Efficiency

L = 168.72 uH 20% tolerance

R_{DCR} = 40 mΩ

$P_L = I_o^2 R_{DCR} = (0.133)^2(40\times10^{-3}) = 0.70756$ mW

Capacitor sizing

3.3V ± 0.01V

$\Delta V_o = 0.02V$

$C = \frac{\Delta I_o}{8 \cdot f_s \cdot \Delta V_o} = \frac{0.0226}{8\cdot(250\cdot10^3)(0.02)} = .565\ \mu F$ or 565 nF

Diode sizing - Shottky diode - V_f must be low

Diode Efficiency V_f = 340 mV

$(0.133)(1-D) = A = 0.04522$ I_f

$P_o = (0.133)(340\cdot10^{-3})(0.34) = 15.3748$ mW

max reverse V has to exceed 5V

MOSFET sizing

$I_o \cdot D = 0.0886667$ A

$V_{DS} > 5$

MOSFET Efficiency

$P_{cond} = I_o^2 R_{DSON}(0.133)^2(3.0)(0.4) = 42$ mW

$P_{SW} = \frac{1}{2} V_{loss} I_o (t_{on} + t_{off}) f_s =$

$\frac{1}{2}(80)(0.133)(40.5\times10^{-9})(250\cdot10^3) = 20.199$ mW

$P_{loss\ total} = 0.70756 + 15.3748 + 42.029064 + 20.199 = 78.310$ mW

84% efficiency 78.310 < 83.6