CALCULATIONS

LED Drive (LM3409HV)

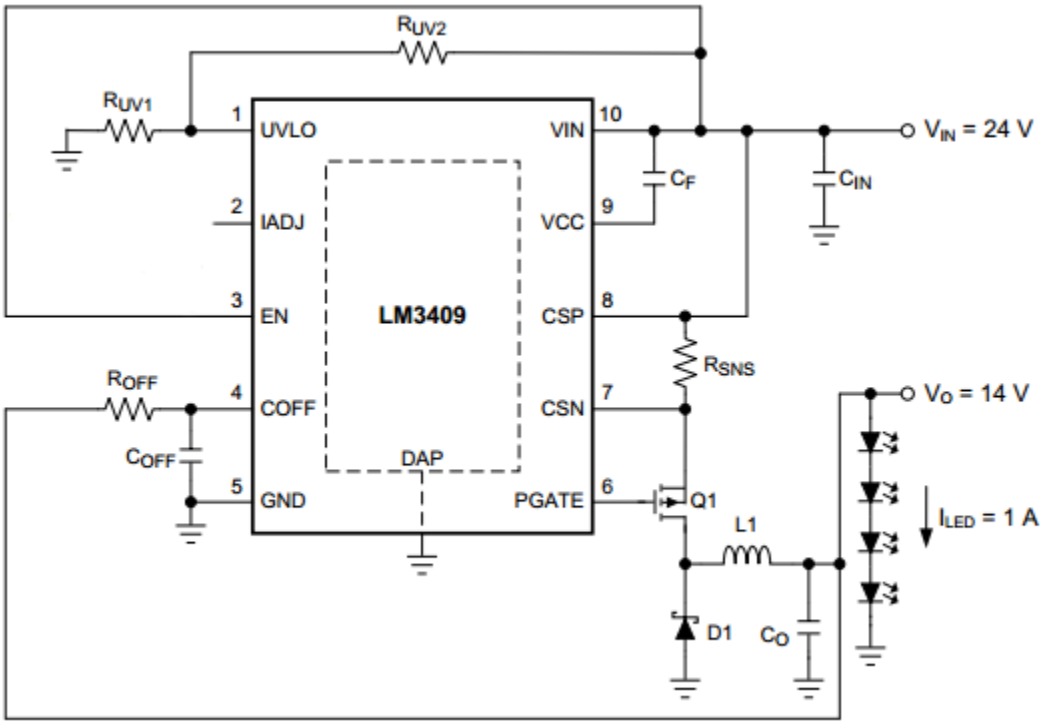

Figure 1 - LED Drive

Following data is used for the calculations:

1. Switching Frequency (f_{SW}) = 1MHz.
2. Input Voltage (V_{IN}) = 48V
3. Maximum Input Voltage (V_{IN-MAX}) = 64.8V
4. Output Voltage (V_O) = 33.5V
5. LED Rated Current (I_{LED}) = 250mA
6. Inductor PP Current Ripple (Δi_{L-PP}) = 75mA (30% of I_{LED})
7. LED PP Current Ripple (Δi_{LED-PP}) [Smaller the better] = 12.5mA (5% of I_{LED})
8. Input Voltage Ripple (ΔV_{IN-PP}) = 240mV
9. Voltage at which LED Drive is turned on ($V_{TURN-ON}$) = 30.5V
10. Hysteresis (V_{HYS}) = 1.1V
11. Efficiency (η) = 0.90

12. Maximum Voltage to IADJ Pin (V_{ADJ}) = 1.24V
13. r_D (Internal resistive component) = 0.2Ω

Nominal Switching Frequency (f_{SW})

Assuming C_{OFF} = 470p;

$$R_{OFF} = \frac{-\left(1-\frac{V_O}{\eta * V_{IN}}\right)}{(C_{OFF}+20pF) * f_{SW} * \ln\left(1-\frac{1.24V}{V_O}\right)} = 12.15k\Omega$$

Here the 20pF is a stray capacitance and it's generally present at this value in this circuit.

The closest 1% tolerance resistor for the calculated R_{OFF} is 12.1kΩ

Off time (t_{OFF});

$$t_{OFF} = -(C_{OFF}+20pF) * R_{OFF} * \ln\left(1-\frac{1.24V}{V_O}\right) = 224.5nS$$

$$f_{SW} = \frac{1-\left(\frac{V_O}{\eta * V_{IN}}\right)}{t_{OFF}} = 1MHz$$

Hence the selected components from this step are;

R_{OFF} = 12.1kΩ
C_{OFF} = 470pF

Inductor Ripple Current (ΔiL-PP)

Solve for L1;

$$L1 = \frac{V_O * t_{OFF}}{\Delta i_{L-PP}} = 100\mu H$$

Closest standard inductor value is as same as the calculated $\Delta i_{L\text{-}PP}$ value.

$$\Delta i_{L-PP} = \frac{V_O * t_{OFF}}{L1} = 75.2mA$$

Hence the selected component from this step is;

L1 = 100µH

Average LED Current (I_{LED})

Determine maximum current through the inductor ($I_{L\text{-}MAX}$);

$$I_{L\_MAX} = I_{LED} + \frac{\Delta i_{L\_PP}}{2} = 287.6mA$$

Hence;

$$R_{SNS} = \frac{V_{ADJ}}{5 * I_{L\_MAX}} = 0.8623\Omega$$

The closest 1% tolerance resistor is 0.866Ω

$$I_{LED} = \frac{V_{ADJ}}{5 * R_{SNS}} = 0.2488A$$

Hence the selected component from this step is;

R_{SNS} = 0.866Ω

Output Capacitance (C_O)

Calculation on Z_c (Internal impedance component);

$$Z_C = \frac{r_D * \Delta i_{LED\_PP}}{\Delta i_{L\_PP} - \Delta i_{LED\_PP}} = 0.3986\Omega$$

Minimum output capacitance ($C_{O\text{-}MIN}$);

$$C_{O\_MIN} = \frac{1}{2\Pi * f_{SW} * Z_c} = 399.26nF$$

Hence C_O;

$$C_O = C_{O\_MIN} * 1.75 = 0.68\mu F$$

Hence the selected standard capacitor is;

C_O = 0.68µF

Input Capacitance (C_{IN})

On time (t_{ON});

$$t_{ON} = \frac{1}{f_{SW}} - t_{OFF} = 775.46nS$$

Minimum input capacitance ($C_{IN\text{-}MIN}$);

$$C_{IN-MIN} = \frac{I_{LED} * t_{ON}}{\Delta V_{IN-PP}} = 803.79nF$$

Hence C_{In};

$$C_{IN} = C_{IN-MIN} * 2 = 1.6076\mu F$$

Hence the selected standard capacitor is;

C_{IN} = 1.5µF