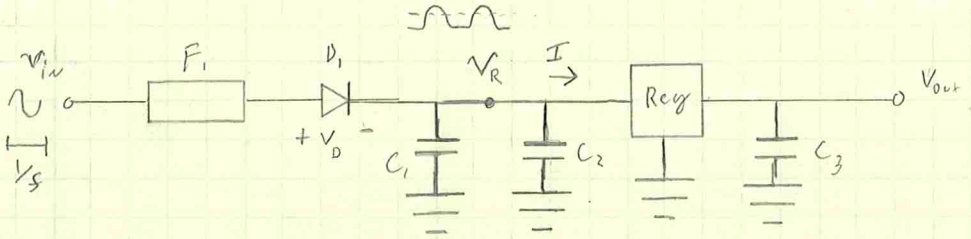
Rectifier Design | Project Palmer | Bobby Schulz | 10/11/2019

Circuit



Analysis

$V_R = V_R \pm \Delta V_R$ $\quad V_R = \frac{V_{in,peak}}{\pi}$ $\quad \Delta V_R = \frac{I}{f C_1}$ ← negate Parallel effect of C_2 since $C_2 \ll C_1$

Force $V_R > V_{out} + V_{Dropout}$ ← Dropout voltage of Regulator

$V_R \pm \Delta V_R > V_{out} + V_{Dropout}$ Worst case, $V_R = V_R - \Delta V_R$

$V_R - \Delta V_R > V_{out} + V_{Dropout}$

$\Delta V_R < V_R - V_{out} - V_{Dropout}$

$\frac{I}{f C_1} < \frac{V_{in,peak}}{\pi} - V_{out} - V_{Dropout}$

Component selection

$V_{in,Rms} = 24V \rightarrow V_{in,peak} = \sqrt{2} \cdot 24 \simeq \underline{34V}$, $\underline{f = 60\,Hz}$

Assume max $I = 150mA$

Reg → MA78M05, $V_{out} = 5V$, $V_{Dropout} = 2V$

$\frac{I_{max}}{f \cdot C_1} < \frac{V_{in,peak}}{\pi} - V_{out} - V_{Dropout}$

$C_1 > \frac{I_{max}}{f\left(\frac{V_{in,peak}}{\pi} - V_{out} - V_{Dropout}\right)} = \frac{0.150\,A}{60\left(\frac{34}{\pi} - 5 - 2\right)} = 654\,\mu F$

we choose to increase by at least 50% for margin of safety and error (tolerance)

Note: $V_{C_1} > V_R + \Delta V_R = \frac{V_{in,peak}}{\pi} + \frac{I_{max}}{f C_1}$

$= 13.32V \rightarrow +25\%$ Factor of safety

$V_{C_1} > 16.65V$ Practically we choose $\underline{V_{C_1} \geq 25V}$

$\boxed{C_1 \simeq 1000\,\mu F}$

Component selection, (cont.)

Bel Fuse
0ZCJ0005FF2E

$F_1 \rightarrow$ $i_{Trip} = 150\,mA$ ($\frac{1}{2}$ Sprinkler Load MAX)

$i_{Hold} = 50\,mA$

$P_{Hold} = i_{Hold} \cdot V_{in,\,Rms} = 0.05 \cdot 24 = \underline{1.2\,W}$

↑ Uncertified Power delivered

Schottky Desired to Reduce dissipation

$D_1 \rightarrow$ $I_{Rectified,\,Avg} > 2 \cdot I_{max} = 300\,mA$ (overspec for thermal consideration and lack of counter motivation)

$V_r = -V_D$

↑ Reverse Voltage

$V_{r,max} = -V_{D,max} = V_R - \Delta V_R - V_{in,min} = \underline{\doteq 25.67\,V}$

Desire at least 25% factor of safety, Results in

$\underline{V_{r,max} \geq 40V}$ → do not desire to go higher than this value due to a corresponding increase in forward voltage drop

Recommend $\underline{1N5819\ HW}$

↓ Derating Factor

$\underline{C_2 = 0.33\,\mu F}$ $V_{C_2} \geq 2(V_R + \Delta V_R) = 26.64V \rightarrow \underline{50V}$ (next practical value)

$\underline{C_3 = 0.1\,\mu F}$, $\underline{16V} \geq 2.5V$

Recommended By Reg data sheet