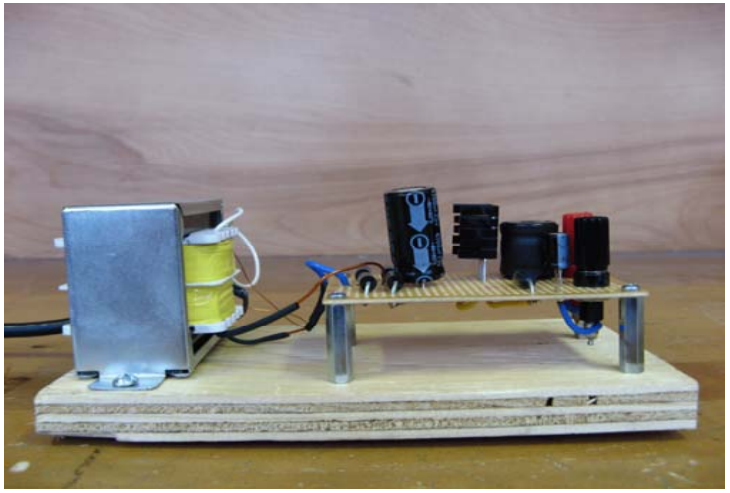
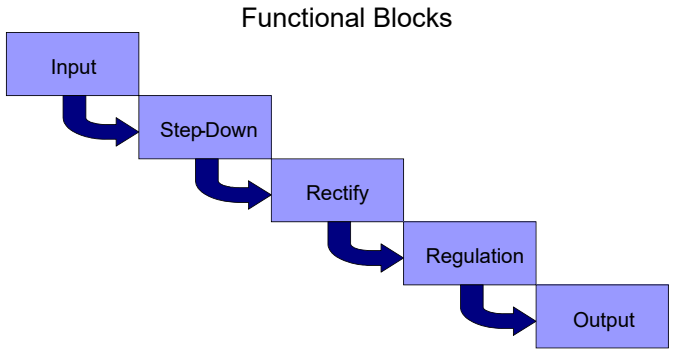
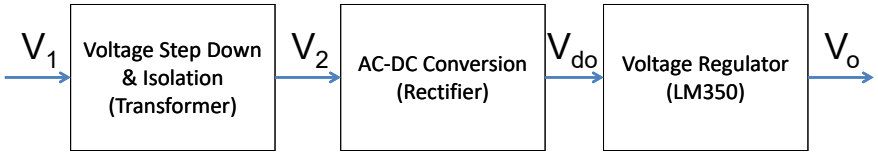
A Previous Design Project
- A Working Power Supply



A Previous Power Supply Project



Detailed Design
- Rectifier + Linear Regulator



V_{1RMS} = 108V ~ 126V, 60Hz

V_o = 15V, DC I_o = 2A

Ambient Temperature = 40 °C

Detailed Design

1. Linear Regulator Selection

V_o = 15V, DC I_o = 2A

$V_{dropout}$ = 2.2V from curve

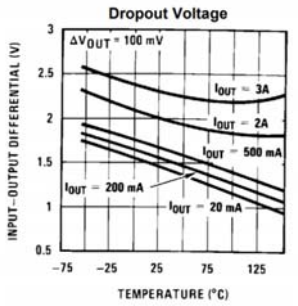
V_{do_min} = 15 + 2.2 = 17.2 @ V_{in} = 108V

V_{do_max} = 20.1 @ V_{in} = 126V

LM350
Max 3A

Note:
Higher V_{do} → **Lower** Efficiency

P_{loss_max} = (20.1-15)x2 = 10.2 W



Detailed Design

2. Thermal Design

Maximum Operating Temperature $T_j = 125\ ^oC$

Ambient Temperature $T_a = 40\ ^oC$

Maximum Temperature Rise $\Delta T = 85\ ^oC$

If no heatsink is used:

Thermal Resistance $R_\theta = 50\ ^oC/W$ Junction to Ambient

Then:

$\Delta T = P_{loss} \times R_\theta = 510\ ^oC$

Detailed Design

3. Thermal Design

Maximum Operating Temperature $T_j = 125\ ^oC$

Ambient Temperature $T_a = 40\ ^oC$

Maximum Temperature Rise $\Delta T = 85\ ^oC$

A heatsink is required:

$R_{\theta total} = R_{\theta jc} + R_{\theta ins} + R_{\theta paste} + R_{\theta sink} < \Delta T / P_{loss\_max}$

TO-3	1.5	0.2	0.1	8.3
TO-220	4.0			

$R_{\theta sink} <$ 6.5 TO-3, 4.0 TO-220

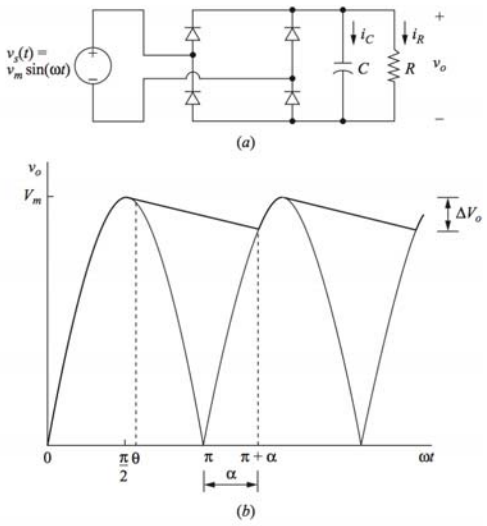
Detailed Design

4. Rectifier Design

$$V_{do} \approx \sqrt{2}\, V_{2rms}\left(1 - \frac{1}{4fRC}\right)$$

$$V_{2rms} = \frac{V_{do}}{\sqrt{2}\,(1 - \frac{1}{4fRC})}$$

$$\Delta V_{do} = \frac{I_{do}}{2fC}$$



$V_{do} = 17.2 \sim 20.1V$

$I_{do} = 2A$

$R = V_{do} / I_{do} = 8.6 \sim 10\ \Omega$

Detailed Design

5. Rectifier Filter Capacitor

$$\Delta V_{do} = \frac{I_{do}}{2fC}$$

Let peak-to-peak ripple

$\Delta V_{do} = 4\ V$

$C = I_{do}/(2f\,\Delta V_{do})$

$= 2/(2x60x4) = 4166\ uF$

Select 4700 uF

OR

Rule of Thumb:

$$C \geq \frac{3\sim5}{f_{ripple} \cdot R}$$

$f_{ripple}=120$

$R = 8.6$ worst case

$C >=$ 2904 ~ 4840 uF

6. Transformer Output Voltage

$$V_{2rms} = \frac{V_{do}}{\sqrt{2}\left(1-\frac{1}{4fRC}\right)}$$

V_{1rms} = 108V ~ 126V

V_{do} = 17.2 ~ 20.1V

C = 4700 uF R = V_{do} / I_{do} = 8.6 ~ 10 Ω

V_{2rms_min} = 13.6V @ V_{in} = 108V

V_{2rms_max} = 15.6V @ V_{in} = 126V

7. Diodes Selection

Peak reverse voltage:

$V_{RRM} = \sqrt{2}\, V_{2rms} = \sqrt{2}$ x 15.6 = 22.1 V worst case

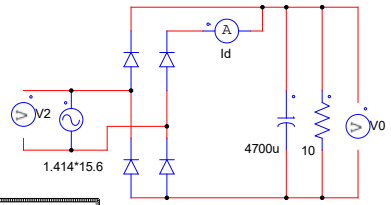
Average current:

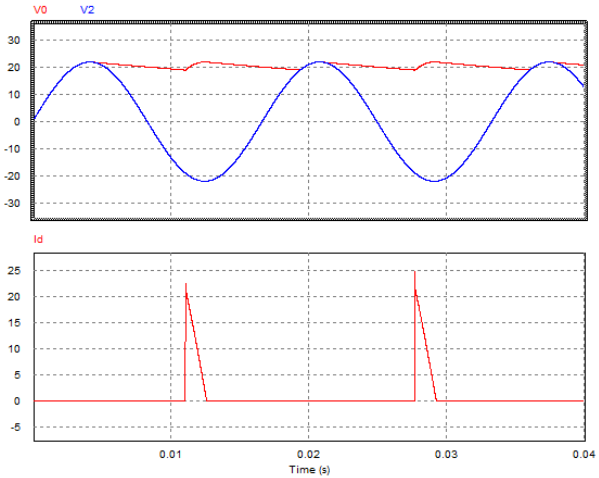
$I_{AVG} = I_{do} / 2$ = 1 A

Safety factors for diodes:

voltage 1.5~2.0 current 1.5~2.5

Simulation Results in PSIM





Average Value

Time From	2.0000000e-006
Time To	3.3334000e-002
V0	1.9868287e+001
V2	-2.5535227e-006
Id	1.0287826e+000

RMS Value

Time From	2.0000000e-006
Time To	3.3334000e-002
V0	2.0149843e+001
V2	1.5597484e+001
Id	3.8791166e+000