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Linear Power Supply

Group 29

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EN2111 - Electronic Circuit Design

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1 Objective

We have been tasked with the design of a linear power supply incorporating a maximum current limitation. The objective is to develop a power supply that can consistently deliver a stable output voltage, even when faced with fluctuating input line voltage conditions.

2 Design Parameters

- Mid input voltage : 20 V
- Input voltage range : 18 - 22 V
- Mid output voltage : 12 V
- Output voltage range : 9 - 15 V - given
- Maximum output current : 100 mA

3 Component selection and Calculations

3.1 Calculations

$$V = \left(1 + \frac{R_1}{R_2}\right)(V_Z + V_{BE}) \tag{1}$$

$V_Z = 4.5V$ and $V_{BE} = 0.6V$. Then,

$$V = \left(1 + \frac{R_1}{R_2}\right)(5.1)$$

$$15 < \left(1 + \frac{R_x + R_v}{R_y}\right)(5.1) \tag{2}$$

$$9 > \left(1 + \frac{R_x}{R_v + R_y}\right)(5.1) \tag{3}$$

From 2 and 3 respectively we get,

$$1.94 < \frac{R_x + R_v}{R_y}$$

$$0.76 > \frac{R_x}{R_v + R_y}$$

We have selected $R_v = 9.7\,k\Omega$ variable resistor.

$$1.94 < \frac{R_z + 9700}{R_y} \tag{4}$$

$$0.76 > \frac{R_x}{9700 + R_y} \tag{5}$$

We have selected $R_x = 10\,k\Omega$ variable resistor.

$$1.94\,R_y < 19700 \Rightarrow R_y < 10154$$

$$7372 + 0.76\,R_y > 10000 \Rightarrow R_y > 3458$$

We have selected $R_y = 10\,k\Omega$

$$I_{R_{min}} = \frac{V_{i_{min}} - V_{x_{max}}}{R}\,A \tag{6}$$

$$I_{R_{min}} = \frac{18 - 15.6}{R}\,A$$

$$I_{R_{min}} = \frac{2.362}{R}\,A$$

$$I_{R_{min}} > \frac{I_{L_{max}}}{\beta} + I_{Z_{knee}} \tag{7}$$

$$10 \leq \beta < 50$$

$$\frac{2362}{R} > \left(\frac{100}{50} + 2\right)$$

$$\frac{2362}{4} > R$$

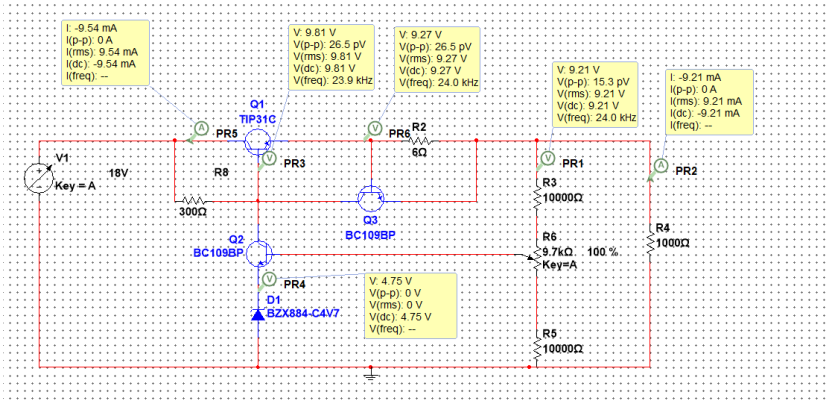
$$R < 590\,\Omega$$

We have selected $R = 300\,\Omega$

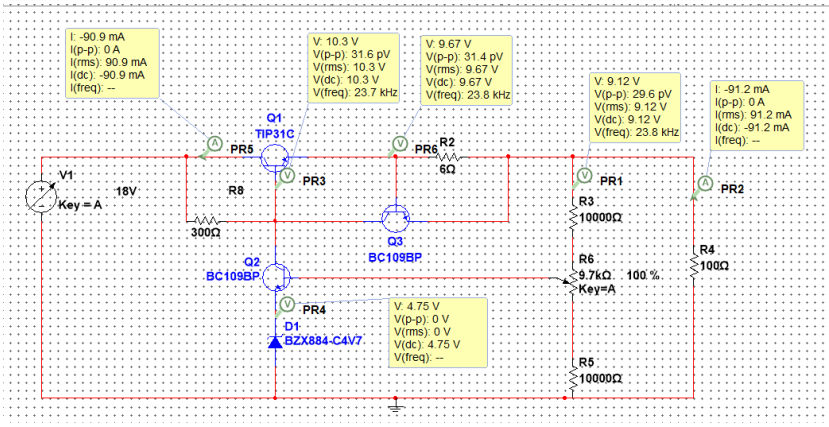
3.2 Component selection

- Transistors
  - BC109B : General NPN
  - TIP31C : Power transistor
- Resistors
  - $10\,k\Omega$ - Qty 2
  - $300\,\Omega$
  - $5\,\Omega$
  - Variable resistor : $10\,k\Omega$
  - Light load : $100\,\Omega$
  - Heavy load : $1\,k\Omega$

4 Simulation Results

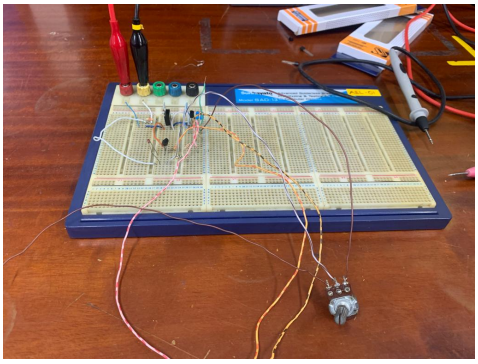


Working level with $1\,k\Omega$

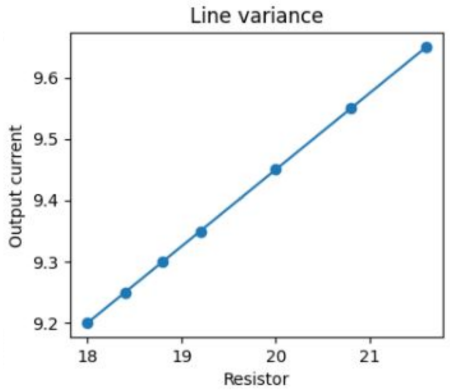


Current limiting feature

5 Measurements



5.1 Line Variance



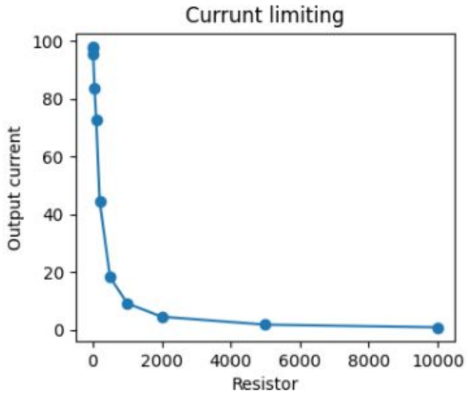
5.2 Current Limiting Value

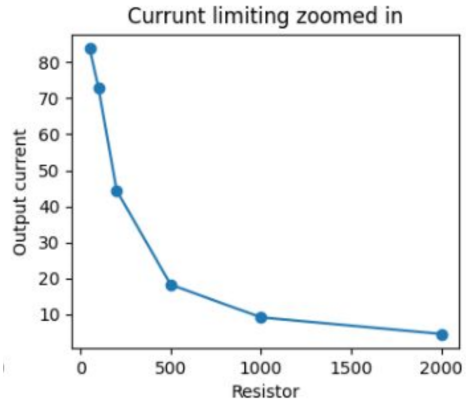
$$I_L \cdot r = 0.6$$

$$(0.1) \cdot r = 0.6$$

$$r = 6\,\Omega$$

We obtained a current of 130 mA during the current limiting process, which should be duly noted. The reason for this was the unavailability of a $1\,\Omega$ resistor, compelling us to utilize a 5-ohm resistor instead.





5.3 Load Regulation