EEE - 313 Electronic Circuit Design Lab - 2

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Section - 2
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PRELIMINARY

1) Introduction

In this lab, we are asked to design the Differential Temperature Sensor circuit in LTspice and integrate it into DipSpace as a schematic.

2) Simulations and Calculations

2.1) Calculation of β

In order to calculate β of pnp BJT, it should in active region which means:

$$V_{EC} > V_{TH} \text{ and } V_{EB} > V_{TH}$$

The circuit below has been set up accordingly.

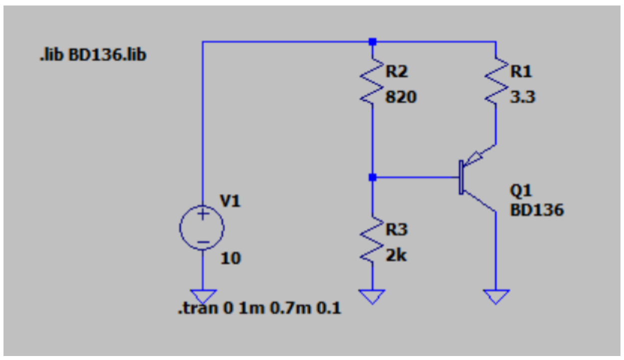

Fig. 1: Circuit of β Calculation Method

Component list:

- 3 resistor $(2K, 3.3, 820)$
- pnp BJT (BD136)
- voltage supply

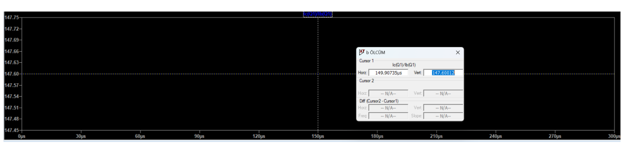

Fig. 2: Graph Of β Calculation Method

In order to calculate β, we need to use following formula with the circuit component values;

$$\beta = \frac{I_c}{I_b}$$
$$I_c = 287.9mA,\ I_b = 1.94mA$$
$$\beta \cong 147.6$$

2.2) Low-Dropout Voltage Regulator

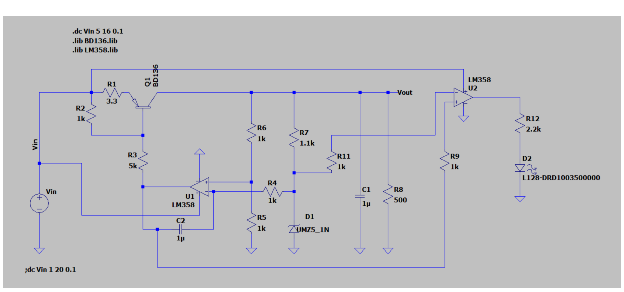

Fig. 3: Low-Dropout Voltage Regulator Circuit

Component list:

- 10 resistor $(1\ 3.3\Omega, 5\ 1K\Omega, 1\ 5K\Omega, 1\ 1.1K\Omega, 1\ 2.2K\Omega, 1\ 500\Omega)$
- 2 Opamp (LM358)
- Zener diode (with 5.1 Breakdown Voltage)
- Led (L128-DRD1003500000)
- 2 capacitor $(1\mu C)$
- voltage supply

2.3) Line regulation

I choose 10V output voltage. Zener diode is chosen 5.1V(which is exist in lab) in order to use it in implementation.

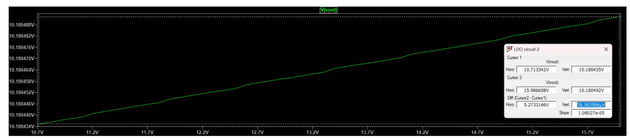

Fig. 4: V_{out} When V_{in} Is Between 10.7V And 16V

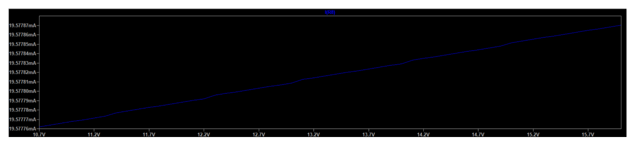

Fig. 5: V_{out} Current When V_{in} Is Between 10.7V And 16V

It can be seen that, V_{out} change is less then $10mV$ and output current is around 20mA. It is not exactly $20mA$ because of usage of ideal resistor values which can be seen as acceptable error rate.

2.4) Load regulation

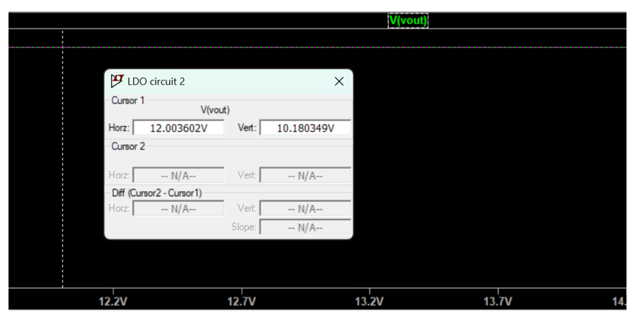

Fig. 6: V_{out} Voltage When V_{in} Is 12V with 100Ω R_L

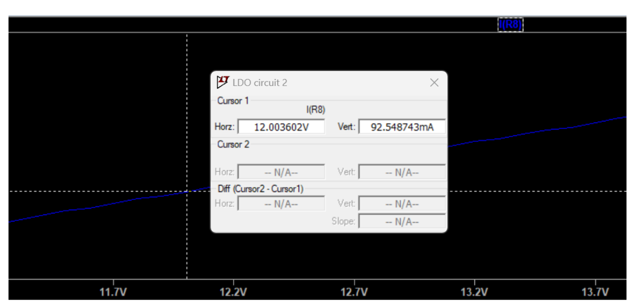

Fig. 7: V_{out} Current When V_{in} Is 12V with 100Ω R_L

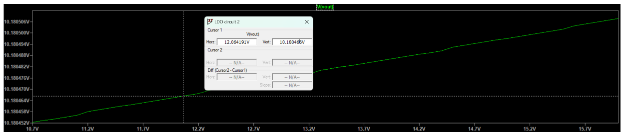

Fig. 8: V_{out} Voltage When V_{in} Is 12V with 2kΩ R_L

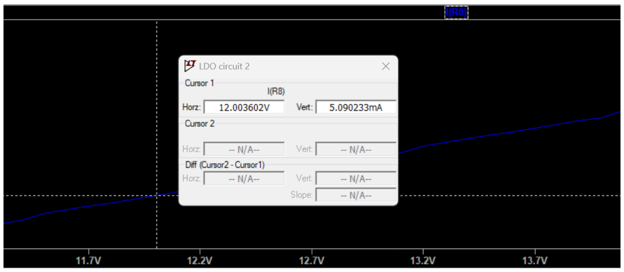

Fig. 9: V_{out} Current When V_{in} Is 12V with 2kΩ R_L

all values are in the correct ranges.

2.5) Output Short Circuit

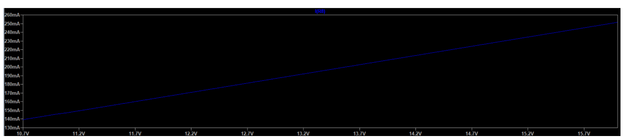

Fig. 10: V_{out} Output Short Current

It is seen that the output short current is lower than 250mA.

2.6) Power Dissipation

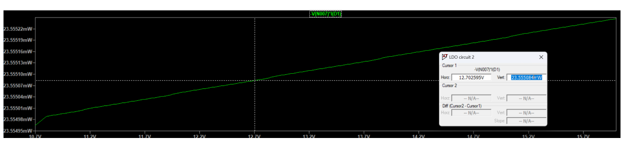

Fig. 11: V_{out} Zener Diode Power Dissipation

Zener diode Power Dissipation is less then 100mW.

Fig. 12: V_{out} Load Resistor Power Dissipation

Zener Power Dissipation is less then250mW.

2.7) green LED Voltage

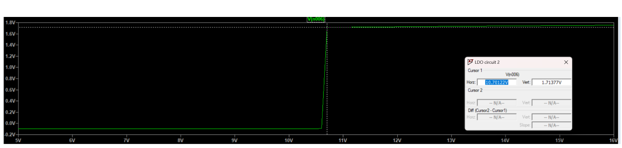

Fig. 13: V_{out} Output Short Current

As can be seen, when the input voltage is greater than 10.7V, the current through to the LED turns positive, and at lower values, it is zero.

2.8) Estimation of The Junction Temperature

When I look into the BD136 datasheet:

$$\text{Junction Ambient thermal resistance: } R_{\theta JA} = 100°C/W$$
$$\text{Junction case thermal resistance: } R_{\theta JC} = 10°C/W$$
$$\text{maximum junction temperature:} T_{Jmax} = 150°C$$
$$p_{diss} = Vin - Vout = 3 * 80 = 240mW$$
$$\Delta T = P_{diss} * R_{\theta JA} = 24°C$$
$$\Delta T_c = P_{diss} * R_{\theta JC} = 2.4°C$$
$$T_C = T_J + \Delta T_c = 51.4°C$$

2.8) DipTrace circuit

The diptrace circuit has been drawn to take up minimum space. Optimized to avoid overlapping cables. Components were brought to the appropriate places and the cable was bypassed.

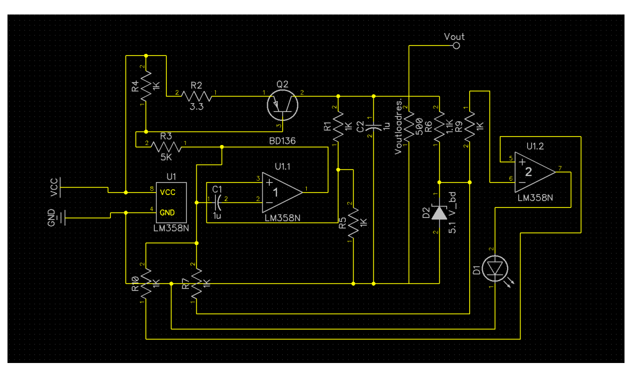

Fig. 14: DipTrace circuit

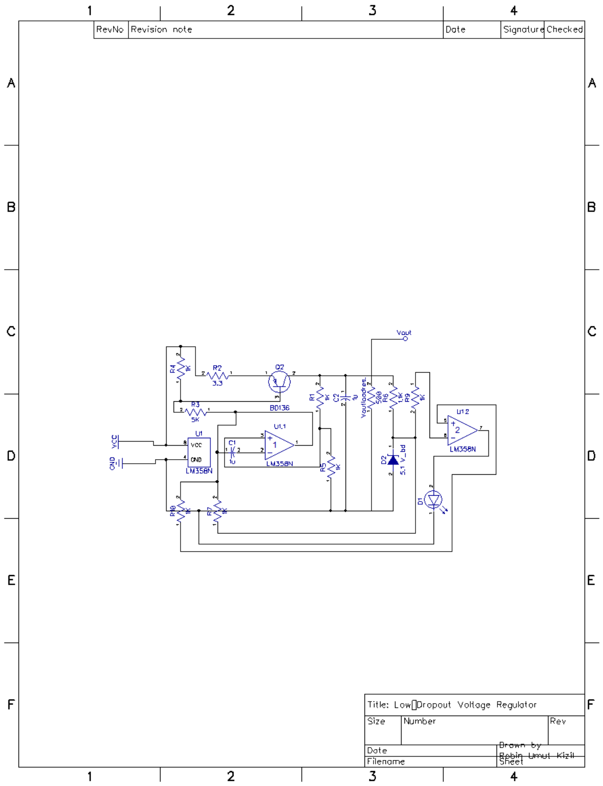

Fig. 15: DipTrace circuit on A4