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5. **Objectives:**

The purpose of this lab was to design a voltage regulator. This is used to maintain constant voltage for a part of the circuit. The load regulator properties will be investigated in order to determine the effects of the voltage regulator on various load values.

1. **Schematics/simulation results:**

**E1.**

The load portion of the circuit is designed. It can be seen in **Figure 1** below.

**E2.**

**Figure 1** below demonstrates the first circuit to be designed during the lab. 2 VCC sources are implemented. One is attached to the voltage regulator and the other with the load.

Diagram, schematic

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**Figure 1. The circuit to be designed in multisim. The voltage regulator is attached to the load.**

Diagram

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**Figure 2. The circuit from Figure 1 created in multisim.**

When the above circuit was run, we adjusted the potentiometer to achieve the desired load currents stated in **Table E2**. For each specified load current, the voltage was also taken and noted in **Table E2** as well.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| iL (mA)  (Vx (V)) | 0  (0) | 1  (0.1) | 2  (0.2) | 3  (0.3) | 4  (0.4) | 5  (0.5) | 6  (0.6) | 7  (0.7) | 8  (0.8) |
| Vo (V) | 6.08 | 5.85 | 5.52 | 5.17 | 4.81 | 4.48 | 4.22 | 3.79 | 3.42 |

**Table E2. iL was set using the potentiometer and the associated Vo was found using probes.**

Chart, line chart

Description automatically generated

**Graph E2. Plots the values of Table E2, with iL on the x-axis and Vo on the y-axis.**

**E3.**

**Figure 3** below is a slight variation of **Figure 2**. It includes a Zener diode, which replaces the R2.

Diagram

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**Figure 3. Now includes a Zener diode in place of a resistor. Probes are places to measure and graph voltages if necessary.**

The same experiment was conducted as in **E2**. The same values were to be found.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| iL (mA)  (Vx (V)) | 0  (0) | 1  (0.1) | 2  (0.2) | 3  (0.3) | 4  (0.4) | 5  (0.5) | 6  (0.6) | 7  (0.7) | 8  (0.8) |
| Vo (V) | 5.12 | 5.12 | 5.11 | 5.11 | 5.10 | 5.10 | 5.09 | 5.08 | 5.06 |

**Table E3. iL values were specified, while corresponding Vo values were found using the simulation.**

Chart, line chart

Description automatically generated

**Graph E3. Created using the values from Table E3.**

**E4.**

A picture containing chart

Description automatically generated

**Figure 4. Circuit similar to Figure 3. The difference now is that the Zener diode has been replaces with 9 diodes.**

Similar procedural step taken as **E2** and **E3** to conduct **E4**. All required values were noted in **Table E4.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| iL (mA)  (Vx (V)) | 0  (0) | 1  (0.1) | 2  (0.2) | 3  (0.3) | 4  (0.4) | 5  (0.5) | 6  (0.6) | 7  (0.7) | 8  (0.8) |
| Vo (V) | 9.81 | 9.45 | 8.91 | 8.34 | 7.75 | 7.22 | 6.64 | 6.11 | 5.52 |

**Table E4. Values of Vo were noted for specific iL values achieved.**

Chart, line chart

Description automatically generated

**Graph E4. Created using values from Table E4.**

1. **Conclusions and Remarks**

**C1.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| iL [mA] | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Vo [V] (Table P1) | 6.19 | 5.84 | 5.50 | 5.15 | 4.81 | 4.46 | 4.11 | 3.77 | 3.42 |
| RL [kΩ] | ∞ | 5.84 | 2.75 | 1.72 | 1.20 | 0.82 | 0.69 | 0.54 | 0.43 |

**Table C1. Equivalent load resistance for voltage divider of Figure P1 (In Appendix/Prelab).**

RL was calculated using:

EQUATION 1 - RL = Vo/iL

**C3.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| iL [mA] | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Vo [V] (Table P2) | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.64 | 6.08 | 5.58 |
| Vo [V] (Table E3) | 5.12 | 5.12 | 5.11 | 5.11 | 5.10 | 5.10 | 5.09 | 5.08 | 5.06 |
| e% | 21.09 | 21.09 | 21.33 | 21.33 | 21.57 | 21.57 | 30.45 | 19.69 | 10.28 |

**Table C3. Percent error between the calculated and measured output voltages of the voltage divider of Figure P1.**

EQUATION 2 – e% = (calculated – measured)/measured \* 100

**C4.**

Chart, line chart

Description automatically generated

**Graph C4. V-I graphs from Graph E2, Graph E3 and Graph E4 all into one.**

From **Graph C4**, we can see that the red line (**E3** – Zener-diode-based) is the best at maintaining its output voltage as the load current rises. It maintains a nearly constant value for the entire graph, unlike the other two.

**C5.**

When comparing the two options, aside from the voltage regulation performance, we must remember that the Zener diode has a low ripple effect when compared to the diode-based voltage regulator. This again makes the Zener diode the better choice.

1. **Appendix/Prelab**

Diagram

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Diagram

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Chart

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