Chart, funnel chart

Description automatically generated

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| Report Title | Voltage Regulator |

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# Introduction

This report is for lab 2 “Voltage Regulator”. The lab took place on 2 Feb 2022. The prelab is placed at the end of the report as an Appendix.

# Objectives

The objective of this lab was to examine the three types of voltage regulators based on resistors, diodes and Zener diodes and the load regulation properties by each respective type of voltage regulator.

# Circuit Under Test

Diagram, schematic

Description automatically generated

Figure 1

The circuit above shows a 2N3904 transistor with its base connected to a potentiometer which is connected to two other resistors, one connecting it to the source Vcc, and the other is connected to ground. The transistor’s emitter connected to a 100-ohm resistor which is also connected to ground.

Diagram, schematic

Description automatically generated

Figure 2

The Circuit above shows circuit from Figure 1 connected the voltage regulator circuit (on the left hand-side). R­­2 is the variable component that will be replaced with a diode and a zener diode to examine the difference between them.

# Experimental and Results

The simulated circuit for E2:Diagram

Description automatically generated

The table for this circuit:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E2 | | | | | | | | | |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Vo/V | 6.08 | 5.85 | 5.52 | 5.17 | 4.81 | 4.44 | 4.15 | 3.79 | 3.42 |

The simulated circuit for E3:Diagram

Description automatically generated

The table for this circuit:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E3 | | | | | | | | | |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Vo/V | 6.11 | 6.11 | 6.11 | 6.10 | 6.09 | 6.08 | 6.07 | 6.02 | 5.52 |

The simulated circuit for E4:Diagram

Description automatically generated with medium confidence

The table for this circuit:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E4 | | | | | | | | | |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Vo/V | 5.91 | 5.88 | 5.84 | 5.78 | 5.71 | 5.63 | 5.56 | 5.42 | 5.25 |

# Conclusions and Remarks

Table

Description automatically generated

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| V0/V | 6.190 | 5.844 | 5.497 | 5.150 | 4.804 | 4.457 | 4.110 | 3.764 | 3.417 |
| RL/kΩ | **∞** | 5.844 | 2.749 | 1.717 | 1.201 | 0.891 | 0.685 | 0.538 | 0.427 |

RL=Vo/IL

When RL is equal to 0 there is no load therefore the potential difference is 0 because the Thevenin voltage is equal to the output voltage and when RL is infinity it is equivalent to an open so the voltage drop across RL=0 is the same as the source voltage.

A screenshot of a computer

Description automatically generated with low confidence

Voltage decreases as current increases in the voltage divider regulator. As the current increases, the voltage in the Zener-diode regulator remains constant till before the current reaches 7mA then it starts to decrease. However, voltage in the regular diode-based regulator decreases steadily as the current increases.



The Zener diode voltage regulator is better at maintaining a constant output as the load increases since it allows current to pass in both directions unlike the normal diode voltage regulator. The Zener diode is much more doped than a regular diode causing the difference in their behavior.

# Appendix – Prelab

Part 1:

Derivation:

Nodal analysis at Vo:

Rearrange to make Vo the subject:

Table:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Part 1 | | | | | | | | | |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| V0/V | 6.190 | 5.844 | 5.497 | 5.150 | 4.804 | 4.457 | 4.110 | 3.764 | 3.417 |

Graph:

Part 2:

Derivation:

Vz=Vzo + Iz \*Rz

The potential difference across both the source and the Zener diode (Vz) is equal to the sum of the built-in voltage of the diode (Iz \*Rz) and the voltage supplied by the source (Vzo).

Vz = 6.2V Iz = 41mA Rz = 2ohms

Vzo= Vz - Iz \*Rz

Vzo=6.118

Nodal analysis at Vo:

Rearrange to make Vo the subject:

Eq 1

Equation 1 is only valid for

Izk=1mA

So, Vo6.12V and

Thus

Rearrange to make Vo the subject:

Equation 2 is valid for values of IL greater than or equal to 6.93 mA

Eq 2

Applying both equations for their respective values of IL in the table gives these results:

Table:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Part 2 | | | | | | | | | |
| IL/mA | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| V0/V | 6.132 | 6.130 | 6.128 | 6.126 | 6.124 | 6.122 | 6.120 | 6.08 | 5.52 |

Graph: