Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Second Assignment for Basic Electronics

Student: Lucas Mateus Gonçalves
Teacher Advisor: Walter Antonio Gontijo

August
2021

Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Second Assignment for Basic Electronics

Second Assignment for Basic Electronics presented for the class of Thirteenth of August, 2021.

Student: Lucas Mateus Gonçalves

Teacher Advisor: Walter Antonio Gontijo

August
2021

Conteúdo

1 Objective

The analysis of multiple electrical circuits containing ideal and non-ideal diodes.

2 Introduction

This paper has the purpose of describing how diodes work in electrical circuits using simulations and arithmetic.

2.1 Diodes

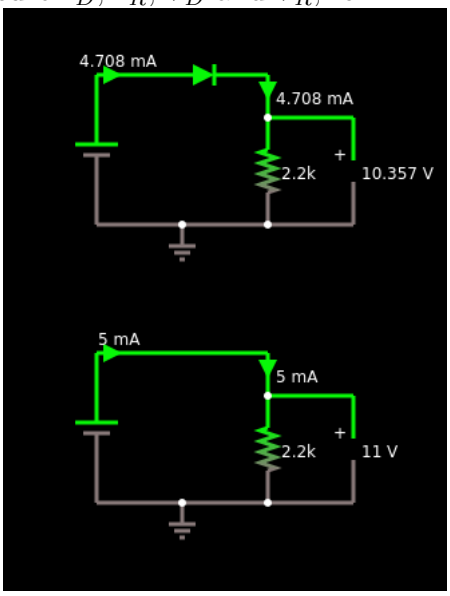
Diodes are simple ´check-valve´ components for current, ideally it allows current to flow in one direction only. However, no diode is capable of limiting the flow of current completely, allowing for some small leakage current to flow against it, having noticeable effect upon the circuit as will be shown in the simulations.

These components have uses from power rectification, to signal processing in radios.

3 Development

3.1 First Circuit

Measure I_D, I_R, V_D and V_R, for $E = 11V$.



Simulation with a real (1N4004) and ideal diode.

The following arithmetic will consider only the ideal diode.

$$I_D = TotalCurrent = \frac{11}{2.2 \times 1000} = 0.005A \quad (1)$$

$$V_D = DiodeVoltage = 0V \quad (2)$$

$$I_R = ResistorCurrent = 0.005A \quad (3)$$

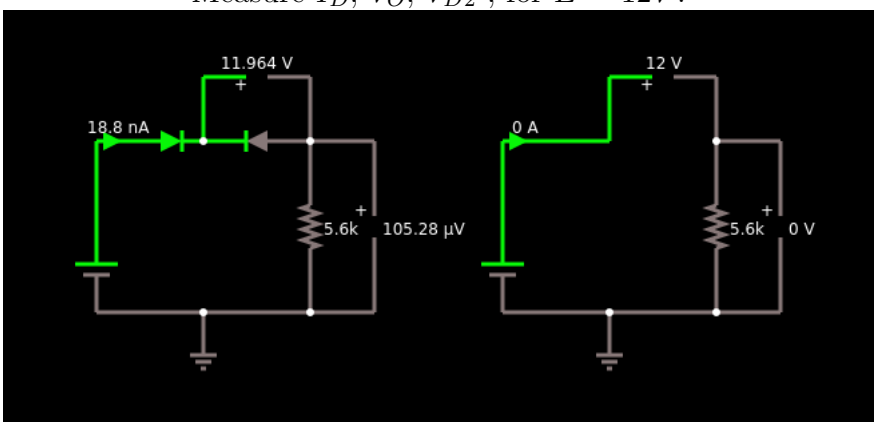
$$V_R = ResistorVoltage = 11V \quad (4)$$

	Calculated	Simulated
I_D	$0.005A$	$0.004708A$
V_D	$0V$	$0.643182V$
I_R	$0.005A$	$0.004708A$
V_R	$11V$	$10.357V$

The table indicates that there is some resistance between the diode, as it has it's own voltage and the resistor is affected by it. That is caused by a voltage drop between its points, acting like a resistor.

3.2 Second Circuit

Measure I_D, V_O, V_{D2} , for $E = 12V$.



Simulation with two real (1N4004) and ideal (current direction known) diodes.

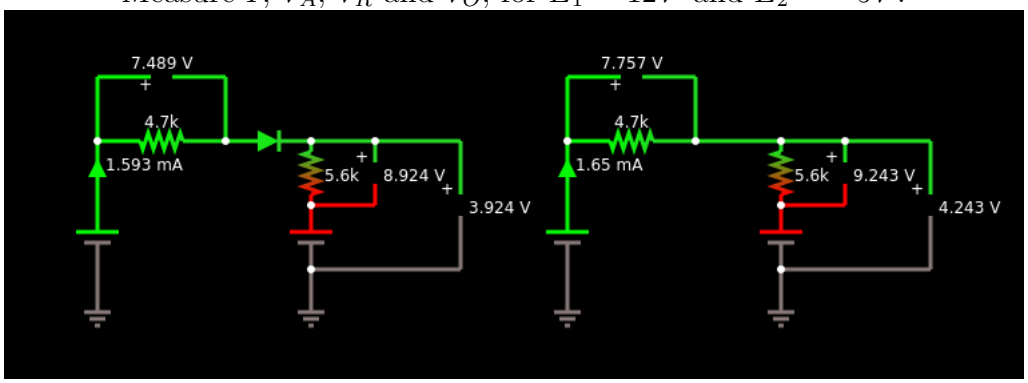
Ideally the circuit doesn't actually complete at any point due to the fact that the circuit opens at nodes that pass a current against the diode polarity, so there is no arithmetic to implement, only interpretation.

However due to the fact that in reality the diodes allow some *leakage current*, there is some, although small, current and voltage measurable in some nodes.

	Calculated	Simulated
I_D	$0A$	$18.8nA$
V_D2	$12V$	$11.964V$
V_O	$0V$	$105.20\mu V$

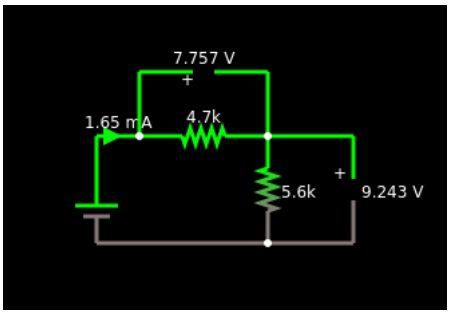
3.3 Third Circuit

Measure I, V_A, V_R and V_O, for $E_1 = 12V$ and $E_2 = -5V$.



Simulation with a real (1N4004) and ideal (current direction known) diode.

The ideal circuit can be further simplified to the following.



$E = 17V$

The parameters can be calculated simply by knowing the total current of the circuit, then extrapolating to the resistors.

$$I = \frac{17}{4.7k|5.6k} = \frac{17}{10.3 \times 1000} = 0.00165A \quad (5)$$

$$V_A = VoltageinTopResistor = (4.7 \times 1000) \times 0.00165 = 7.757V \quad (6)$$

$$V_R = VoltageinBottomResistor = (5.6 \times 1000) \times 0.00165 = 9.24V \quad (7)$$

$$V_O = VoltageinForwardDiodeNode = -5V * V_R = 4.24V \quad (8)$$

	Calculated	Simulated
I	$0.00165A$	$0.00159A$
V_A	$7.757V$	$7.489V$
V_R	$9.24V$	$8.924V$
V_O	$4.24V$	$3.924V$

The discrepancy between the ideal and real measurements are due to the previously mentioned effects of the *voltage drop* of the diode.

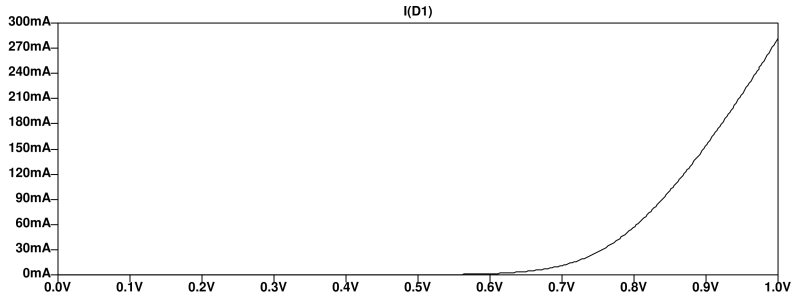
3.4 Diode DC Sweeps

Sometimes you need specific parameters for you circuit, or need to know how the circuit is behaving with the component you chose.

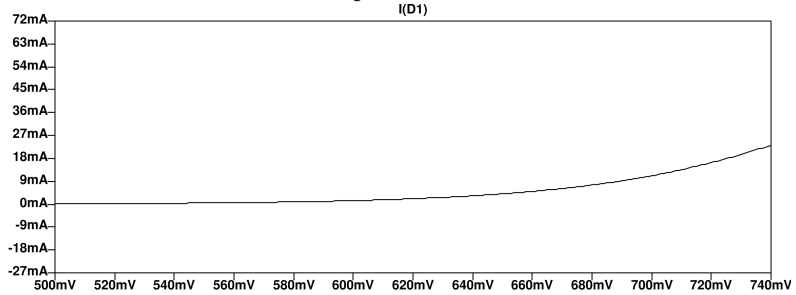
Sweeps are used to plot the behaviour of parameters of circuit nodes, Here are some sweeps of the two nodes of two real diodes.

Note that the circuit therein is simply a voltage source connected to the diodes, there is no current limiting resistor associated with the circuit.

3.4.1 1N914



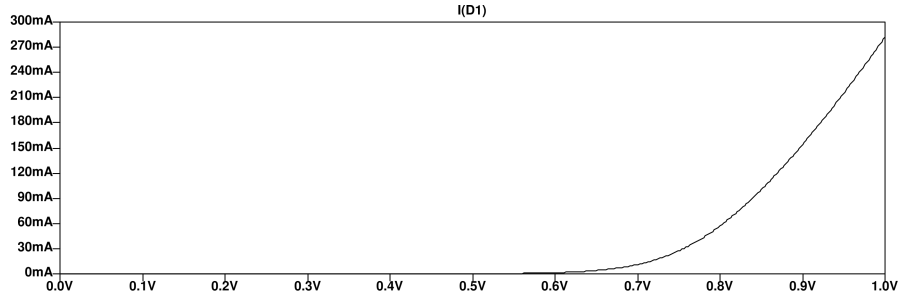
DC Sweep from $0V$ to $1V$



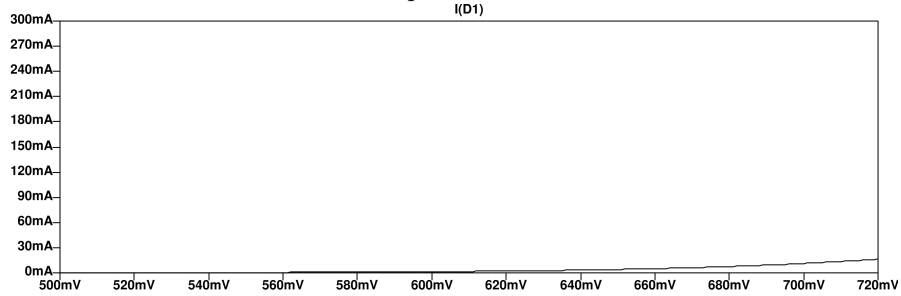
Close up in range of $500mV$ to $740mV$

The diode begins to conduct at around $540mV$, allowing some current through.

3.4.2 1N4148



DC Sweep from $0V$ to $1V$



Close up in range of $500V$ to $720V$

Here the diode seems less sensitive, allowing current only past $560mV$.

4 Conclusion

In conclusion, although they simplify the arithmetic considerably by opening circuit loops, ideal diodes cannot be trusted in real circuits as the simulation proves that although small, the can be some current flow, even reverse current flow in areas of the circuit.

In turn, some caution must be exercised when dealing with sensitive circuitry to account for diode imperfections.