University of Washington

BEE331 Lab 1.1

2301991
Jason Truong

1900585
Henry Haight

supervised by
Prof. Joseph Decuir

July 15, 2024

Characterising Diodes; I-V Curve

Design Objective

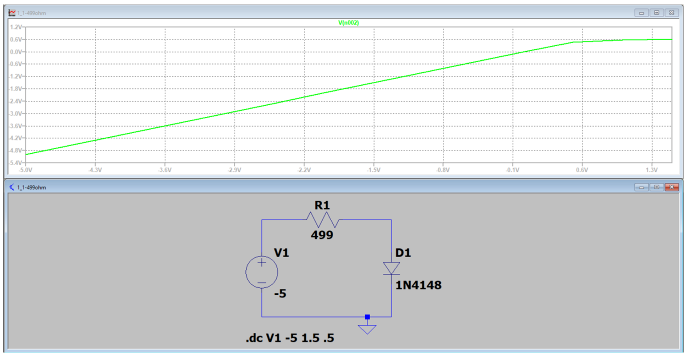
In this lab, we introduce ourselves to the diode, we characterise its function by the I-V curve.

Circuit Design Outline

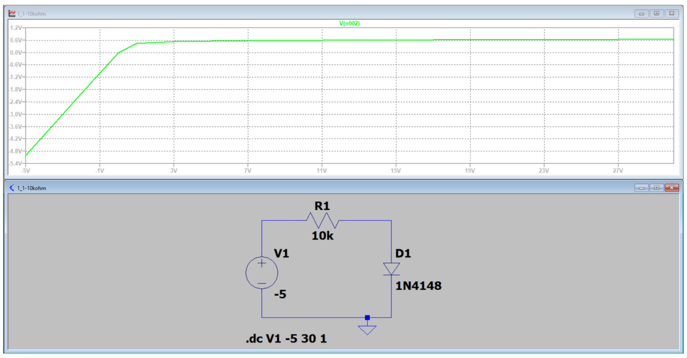
With a resistor of an arbitrary impedance greater than 100Ω ($R \geq 100\Omega$), and the natural impedance of the Function Generator in series ($R_{TOT} = R_{FG} + R \geq 150\Omega$), the (1N4148 silicon) diode is set in series to forward-bias from the function generator. Set the function generator @ f=1kHz and $V_P = 5V$.

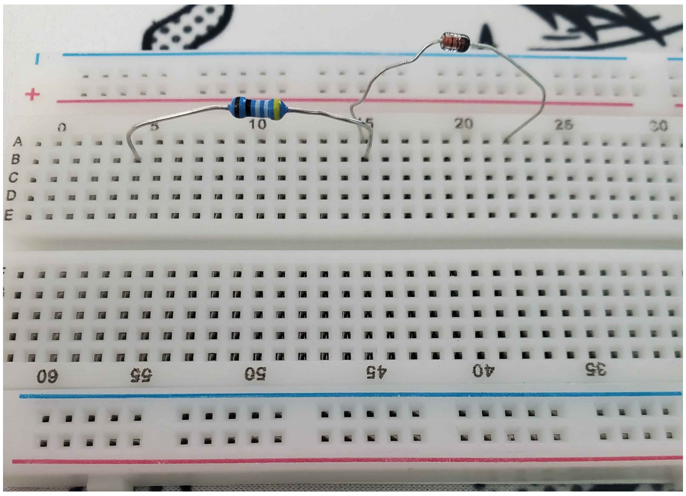
Figure 1: Series R + Diode

(a) LTSpice + Rudimentary Schematic Seris RD (499Ω) Circuit

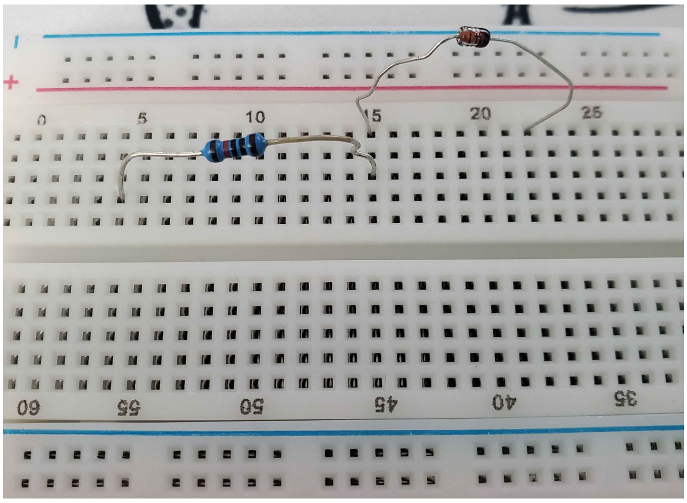


(b) LTSpice + Rudimentary Schematic Seris RD (100Ω) Circuit





(c) Series RD Circuit 499Ω



(d) Series RD Circuit 100Ω

Descriptions of Measurements & Calculations

Analysis

- **i. Describe how you measured I_D and V_D?**

  At the node where R; ($R > 100\Omega$) and the Diode; (D) meet, we denote this junction as V_{out}. We attach our Multimetre's positive lead (Red) to V_{out}, and attached our ground lead to the opposing node of the Diode; (D) - which should be grounded.

- **ii. In this experiment how would you determine the value of $I_{D,max}$**

  $I_D = I_S(e^{\frac{V_D}{V_T}} - 1)$; reference Figure 1b.

- **iii. In the circuit, what limits I_D?**

  The characteristics of the I-V curve of a diode has current I_D exponentially rise towards a cut-off at the threshold, towards the C.V.D @ V_D.

- **iv. Explain why V_D does not change much while I_D can change a lot.**

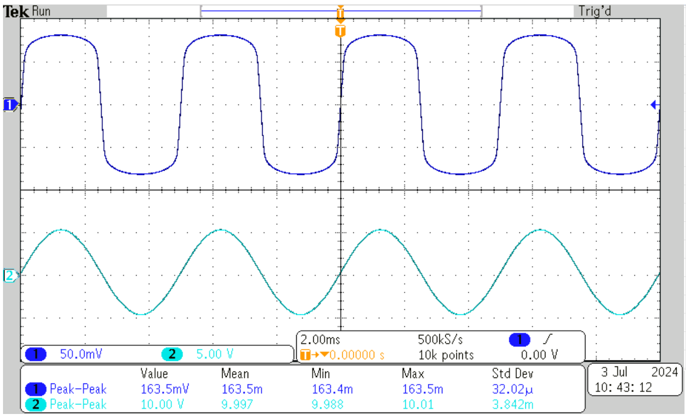
  Given the equation of a Diode's characteristics of $I_D = I_S(e^{\frac{V_D}{V_T}} - 1)$. Putting the equation in reference to I_D is an exponential function, while V_D is a logarithmic function with a very slow rise time.

Summary & Conclusions

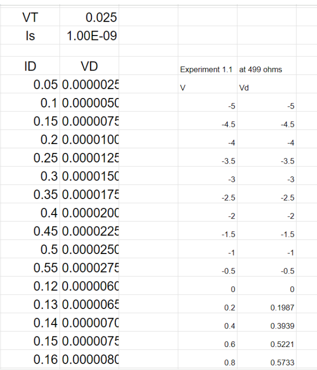
Revealed in Figure RD-Circuit 1A & 1B, the generated oscilloscope readings of the two periodic function match the characteristics of the transfer function found in 1b (RD Circuit). So the measurements do infact closely align.

Figure 1: RD Circuit

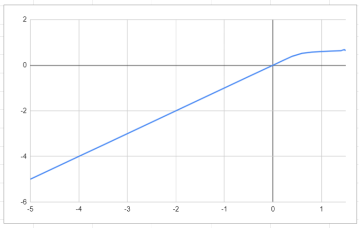
(a) RD Circuit Measurement



(b) Sample Measurement



VT	0.025			
Is	1.00E-09			
ID	VD		Experiment 1.1	at 499 ohms
0.05	0.0000025		V	Vd
0.1	0.0000050		-5	-5
0.15	0.0000075		-4.5	-4.5
0.2	0.0000100		-4	-4
0.25	0.0000125		-3.5	-3.5
0.3	0.0000150		-3	-3
0.35	0.0000175		-2.5	-2.5
0.4	0.0000200		-2	-2
0.45	0.0000225		-1.5	-1.5
0.5	0.0000250		-1	-1
0.55	0.0000275		-0.5	-0.5
0.12	0.0000060		0	0
0.13	0.0000065		0.2	0.1987
0.14	0.0000070		0.4	0.3939
0.15	0.0000075		0.6	0.5221
0.16	0.0000080		0.8	0.5733



Addendum Pages

Figure 2: Jason Truong Addendum

(a) Lab Design Calculations

$$I_D = I_S(e^{qV_D / NkT} - 1)$$

Where,

I_D = Diode current in amps

I_S = Saturation current in amps (typically 1×10^{-12} amps)

e = Euler's constant (~ 2.718281828)

q = charge of election (1.6×10^{-19} coulombs)

V_D = Voltage applied across diode in volts

N = "Nonideality" or "Emission" coefficient (typically between 1 and 2)

k = Boltzmann's constant (1.38×10^{-23})

T = Junction Temperature in Kelvins

Bibliography

Cited:

- Lab 1 Manual
- Sedra, Adel, and Kenneth Smith. Microelectronic Circuits. S.L., Oxford Univ Press Us, 2019.
- “How Do You Calculate, a Silicon Junction Diode with N = 1 Has v = 0.7 v al I = 1 MA. What Is the Voltage Drop at I=0.1 MA and I=10 MA.?” Quora, 2024, appliedmathematics.quora.com/How-to-calculate-A-silicon-junction-diode-with-n-1-has-v-0-7-V-al-I-1-mA-What-is-the-voltage-drop-at-I-0-1-mA-an?top_ans=223007030. Accessed 15 July 2024.

(a) Look at her, she’s perfect.