University of Washington

BEE331 Lab 1.2

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Characterising Diodes; I-V Curve

Design Objective

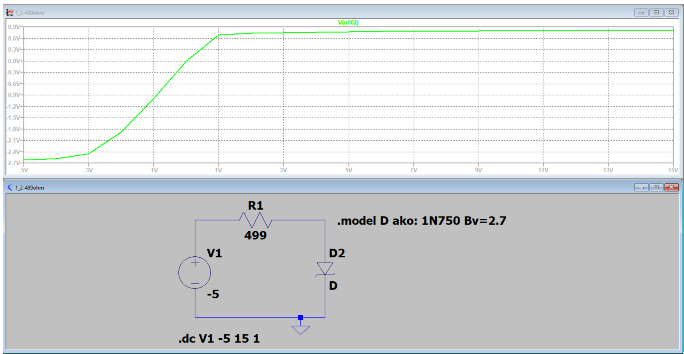
In this lab, we introduce ourselves to the *Zener* diode, we characterise its function by the I-V curve.

Circuit Design Outline

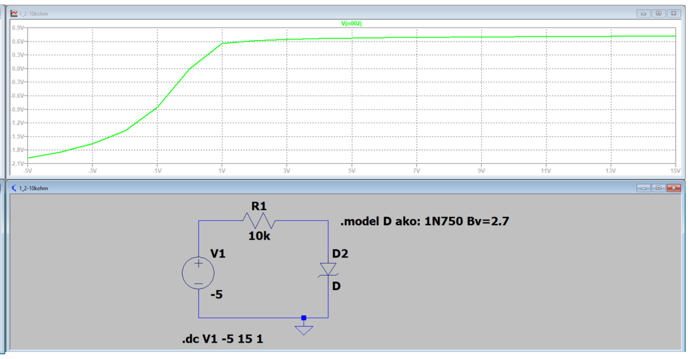
With a resistor of an arbitrary impedance greater than 100Ω ($R \geq 100\Omega$), and the natural impedance of the Function Generator in series ($R_{TOT} = R_{FG} + R \geq 150\Omega$), the (1N4732 or 1n5223) Zener diode is set in series set in reverse-polarity to procate reverse-breakdown from the diode; through the function generator. Set the function generator @ f=1kHz and $V_P = 5V$ (We'll be focusing on the negative portion of V_P).

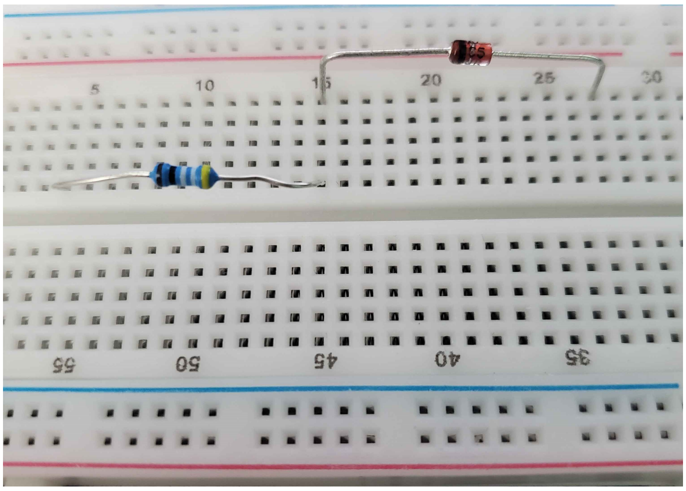
Figure 1: Series R + Diode D_Z

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

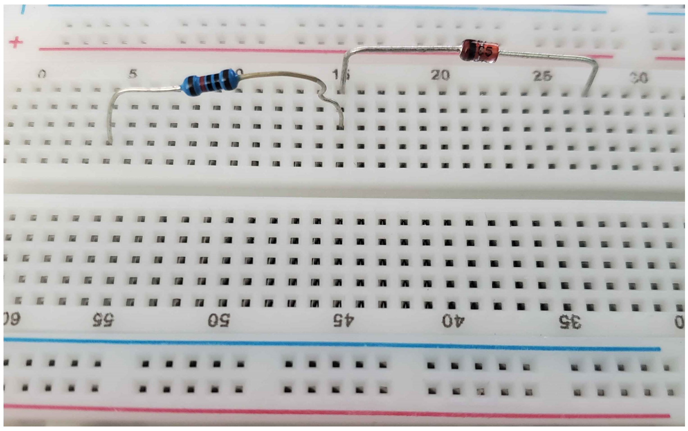


(b) LTSpice + Rudimentary Schematic Seris RD ($10k\Omega$) Circuit





(c) Series RD Circuit 499Ω



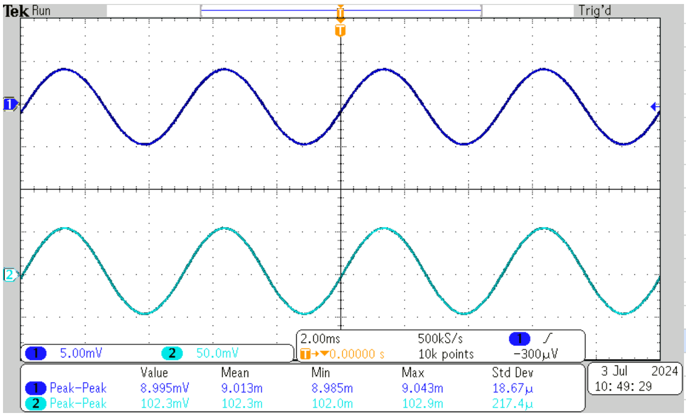
(d) Series RD Circuit $10k\Omega$

Descriptions of Measurements & Calculations

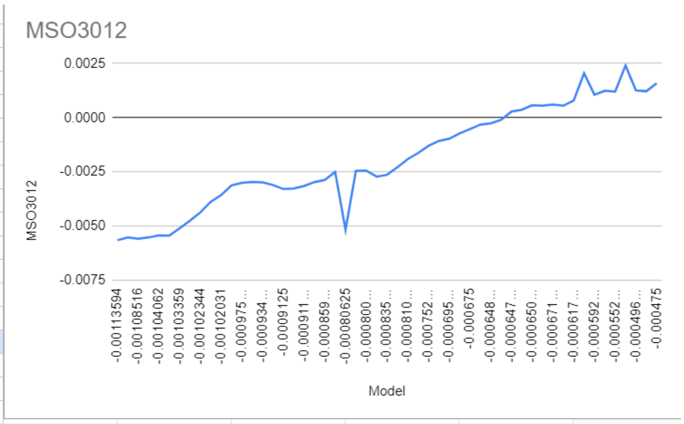
Given the default theoretical calculation for a Diode in forward-bias: $I_D = I_S(e^{\frac{V_D}{V_T}} - 1)$; the dataset is similar in-nature - not exact because the characteristics of this diode differs - from section 1.1 of the lab.
The characteristic of a *Zener* Diode is its relationship to $-V_D$, as I_D enters **Reverse-Breakdown** @ $-V_{Z0}$; the point of breakdown.

Figure 1: RD_Z Circuit

(a) RD Circuit Measurement



(b) Sample Measurement



-1.00E-02	-0.00118672	-0.0056875
-1.00E-02	-0.00113594	-0.00564844
-1.00E-02	-0.00112969	-0.00552344
-9.99E-03	-0.00108516	-0.00557813
-9.99E-03	-0.00105469	-0.00552344
-9.99E-03	-0.00104062	-0.00542187
-9.99E-03	-0.00101172	-0.0054375
-9.99E-03	-0.00103359	-0.00510156

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_Z Circuit). So the measurements do infact closely align.

Discussion

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

  At the node where R; ($R > 100\Omega$) and the Zener Diode; (D_Z) 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 Zener Diode; (D_Z) - which should be grounded.

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

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

  Reverse-Breakdown: The functioning range when $V_D < V_{D_{BR}}$; the output voltage of a reverse-breakdown Zener diode is $V_o = V_i - R_i{*}_i$ (the subscript of i meaning input of the function generator.)

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

  Forward-Bias: 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.

  Reverse-Breakdown: Similarly to how the Forward-Bias meets an exponential curve towards its threshold; V_D, the Reverse-Breakdown meets and meets a sharp declination of V_o towards $-V_{D_{BR}}$.

- **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. This goes for both Forward-Bias and Reverse-Breakdown, only the output voltage nature changes.

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.