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ECD LAB01

1. Introduction

In this labwork we were tasked with designing and applying a diode circuit in order to obtain I-V curve of the diode. I-V characteristic of a diode is expected to be like this:

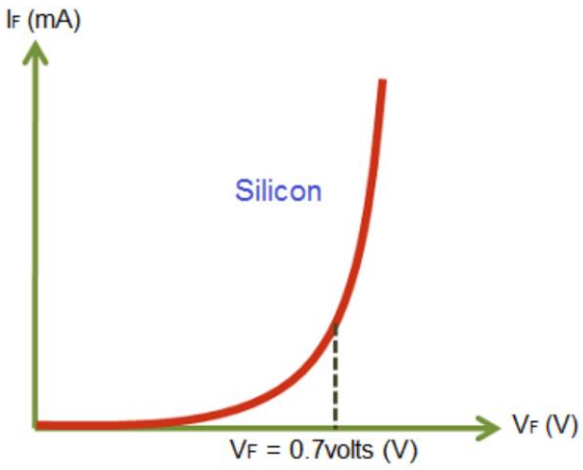

Figure 1(I-V curve of a diode)

In figure 1 we can observe that up until PN junction voltage barrier (generally between 0.6V and 0.7V) the current is close to zero. After the knee point on the forward curve the current increases drastically. This is the theoretical result, for the labwork I have designed a oscilloscope circuit to show these characteristics.

2. Design

For design purposes I have used the LTSpice software and tested my ircuit before going into lab implementing it. This is the design I came up with:

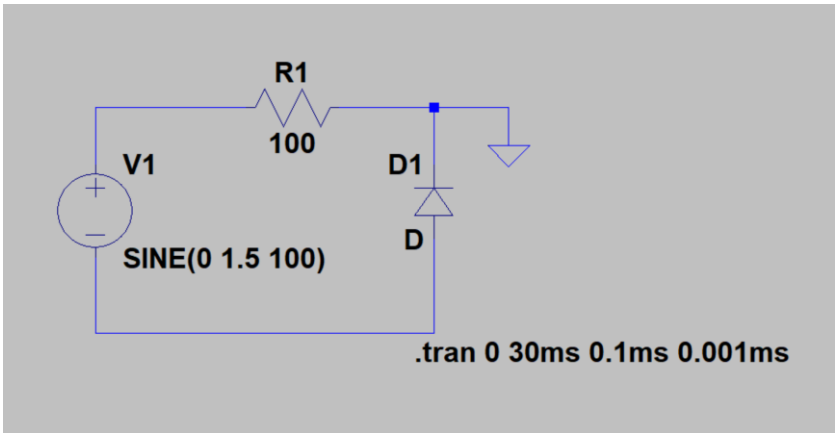

Figure 2 (LTSpice Design)

Important Note: I have designed my circuit to be easy for implementation with oscilloscope. As you can see the minus side of signal generator is not connected to ground since in the lab the real signal generator has floating output. The grounds of the two probes of oscilloscope have a ground. This design should show the I-V curve of the diode, not the black box (resistor + diode). It is easy to measure and plot the current in the software. However the oscilloscope can't measure the current. Because of that I have implemented my circuit in such a way that one channel shows diode voltage and the other shows the voltage on the resistor. Since resistor is just constant, we can easily see the I-V curve when we plot channel 1 against channel 2 in the oscilloscopes XY mode.

This is the simulation results in the LTSpice:

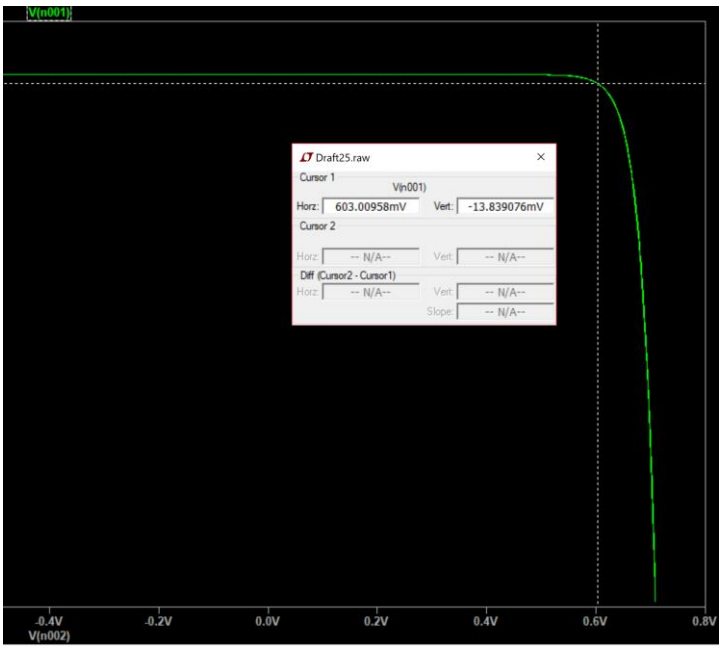

Figure 3 (Simulation Result of the proposed circuit)

As we can observe the simulation result is very similar to theoretical expectations. Beware that the diode is backwards in my design because that the curve grows downwards after knee point expectedly.

3. Implementation

After completing the design and software simulation of my circuit I have implemented my circuit in the lab.

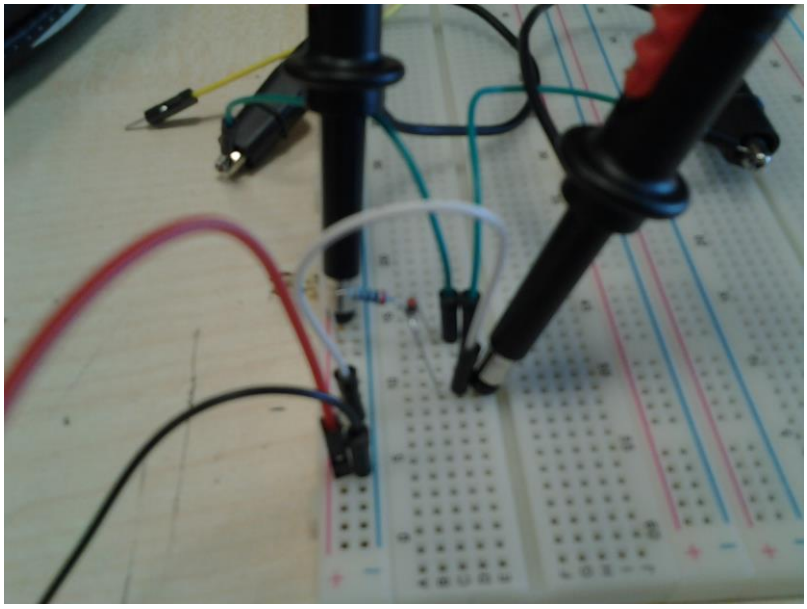

Figure 4 (Real world implementation of my circuit)

I have implemented my circuit just like the way I designed without changing any parameter. I have seen this screen in the oscilloscope as a result:

Figure 5 (CH1 is diode, CH2 is resistor voltage)

We can see expected diode behavior in this plot. Beware that the diode is connected backwards so the plot is mirrored by x axis. However this is not the plot we actually want. We

should observe the I-V curve. Because of that we should XY mode of the oscilloscope to see the curve. This is the plot in XY mode:

Figure 5 (CH1 is Voltage, CH2 is 100 (Constant resistor) times the Current)

In this plot we can clearly see the expected I-V curve of the diode. It is very close to the theoretical and simulation expectation though there is a slight noise. However we are not done just yet. This was the I-V curve in the small frequencies. This is the resulting plots of I-V curve of diode when input is high frequency:

Figure 6

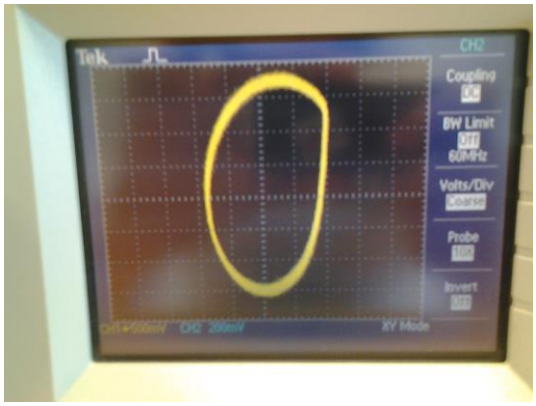

Figure 7

As you can see when we increased the frequency the I-V plot gradually lost its original shape. High frequency I-V plot of the diodes almost resembles a RC circuit. This is caused by the fact that the diode that we used naturally not ideal. Because of that at the higher frequencies the diode starts to behave like a capacitor caused by the pn junction. In higher frequencies this effect becomes more and more clear.

4. Conclusion

In this lab I have managed to design and implement successfully a diode circuit that shows the I-V characteristics of a diode. I pay attention to the fact that the signal generator in lab has floating outputs and oscilloscope probe's ground is the actual ground. Other than that the circuit was pretty simple I did not face any issues in the design and implementation process. In oscilloscope screen we were able to see forward knee voltage and I-V curve of the diode clearly in 100 Hz. However when we increased the frequency the I-V curve started to lose its shape and become more like a RC circuit rather than a diode. This is caused by the pn junctions inside the diode that behaves noticeably like a capacitor in high frequencies.