

## 1 Introduction

In this lab, we were tasked with experimenting with the idea of a diode—specifically a light-emitting diode, or LED—and seeing how applying different voltages to it affected how much current ran through the diode, and how bright the LED lit up. A diode’s main purpose is to only allow current to run in one direction; LEDs also happen to emit light while current runs through them. All diodes have a forward voltage ( $V_f$ ), which is the voltage that must be applied to it in order for it to act as a wire with very low resistance. Our LED also had a maximum current ( $I_f$ ), which is the maximum amount of current that can safely go through it.

## 2 Lab Setup

Our red LED came with a data sheet: on this data sheet, it noted the forward voltage  $V_f$  as between 1.8 V and 2.2 V. It also listed the maximum current  $I_f$  as 30 mA. Our circuit consisted of the LED connected in series with a 330  $\Omega$  resistor. We were tasked with applying voltages from 0 V–5 V in increments of 0.25 V, and taking measurements of the current going through the circuit ( $I$ ), the voltage across the LED ( $V_D$ ), and the voltage across the resistor ( $V_R$ ), along with a short description of the amount of light that the LED is emitting. The results are listed below.

$V_{\text{applied}}$ (V)	$I$ (mA)	$V_D$ (V)	$V_R$ (V)	Comments
0.50	1.6	0.018	0.500	Off
0.75	2.1	0.024	0.682	Off
1.00	3.0	0.035	1.00	Off
1.25	3.8	0.043	1.24	Off
1.50	4.5	0.13	1.49	Off
1.75	5.1	0.06	1.68	Slight glow
2.00	5.9	0.067	1.94	Bright glow
2.25	6.3	0.071	2.06	Very bright glow
2.50	7.2	0.078	2.37	Very bright glow
2.75	7.6	0.086	2.50	Very bright glow
3.00	8.8	0.10	2.92	Very bright glow
3.50	10.5	0.12	3.47	Intense glow
4.00	11.6	0.13	3.82	Max glow
4.50	13.0	0.14	4.30	Max glow
5.00	14.6	0.15	4.83	Max glow

### 3 Conclusions

It is uncertain just from looking at the data whether LEDs are either voltage- or current-driven devices. This is because both the voltage measured across the LED and the current going through the LED are increasing as the LED gets brighter. One might be inclined to think that the more voltage applied to the LED, the more light is given off, but this idea fails to acknowledge Ohm's Law: voltage and current are directly proportional, so as voltage increases, current increases as well, assuming that the resistance of the resistor stays constant.

In one sentence, if an LED is either current- or voltage- driven, that means that as either current or voltage increases, the LED gives off more light.

$V_f$  (forward voltage) according to the datasheet falls into the range of 1.8 V–2.2 V, and the first sign of light we observed in the lab was at 1.75 V, so it's pretty close to the expected result. According to the datasheet, the maximum current that is safe for the LED is 30 mA. We found that at around 6 mA the LED is bright enough to be an indication light, therefore the usable brightness is achieved at 6 mA.

Lastly, it is never acceptable to use an LED without having some resistance to limit the current. When the voltage applied reaches the forward voltage, the resistance of the diode falls to zero, and the current increases hyperbolically. This is dangerous for the engineer messing with the current, as well as for the equipment used to generate it.