What Are Characteristic Curves?

Solid State Electronics – Unit 9: Transistors

What Are Characteristic Curves

In your studies, you have learned about voltage, current and resistance. You have learned the basic fundamentals of electricity. You have learned that if a circuit has a given resistance, and if the voltage across the resistor goes up, the current through the resistor will also go up. You have learned that if the same circuit has the same given resistance, and if the voltage across the resistor goes down, the current through the resistor will also go down. This is because of the relationship between voltage, current and resistance. Ohm's Law tells us this will happen.

If we were to graph this concept the graph would show the following:

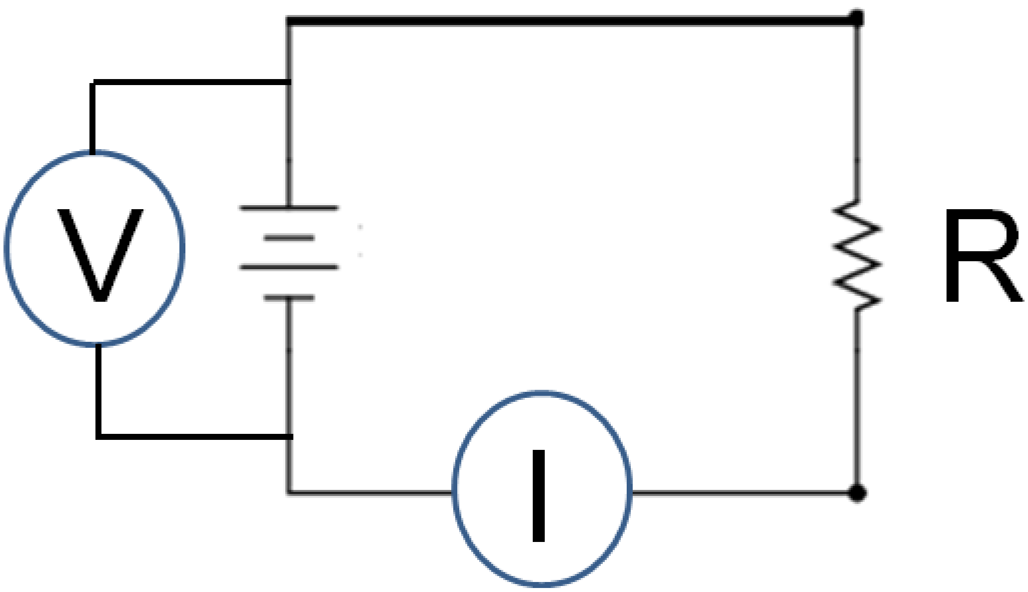

Figure 1

Look at Figure1. For this example V=1 volt. I=1 amp. Using Ohm's Law to find R, we see, R = 1 Ω. Ohm's Law states R=V/I. For our example we will say V=I. This means for every value of V we choose, R will be equal to 1 Ω.

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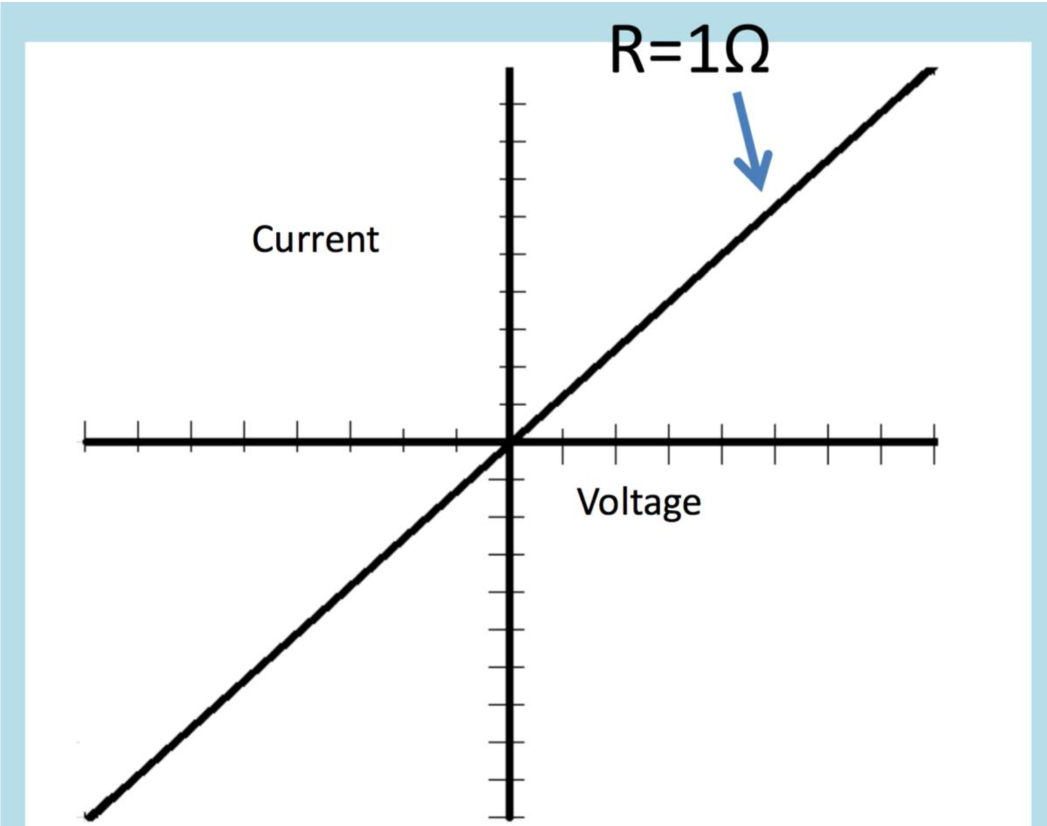

Figure 2.

If we were to graph these results the graph would look like Figure 2. The linear line would be a representation of the resistance of Figure 1. We could go a step further and say the line represents the characteristics of the resistance of Figure 1.

We have examined how the diode functions. We have seen that it does not behave like a resistor in a circuit. The resistor does not care if it is flipped around. It functions the same if connected in either direction. We have seen the behavior of the diode in a circuit is much different than a resistor. The diode has its own unique characteristics. The diode does care which direction it is connected in the circuit.

We placed a diode in series with a resistor. The diode was connected in forward bias (Figure 3a) and in reverse bias (Figure 3b).

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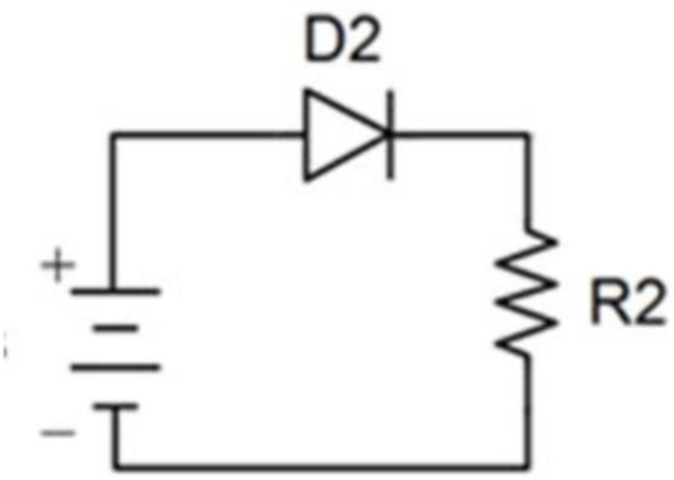

Figure 3a

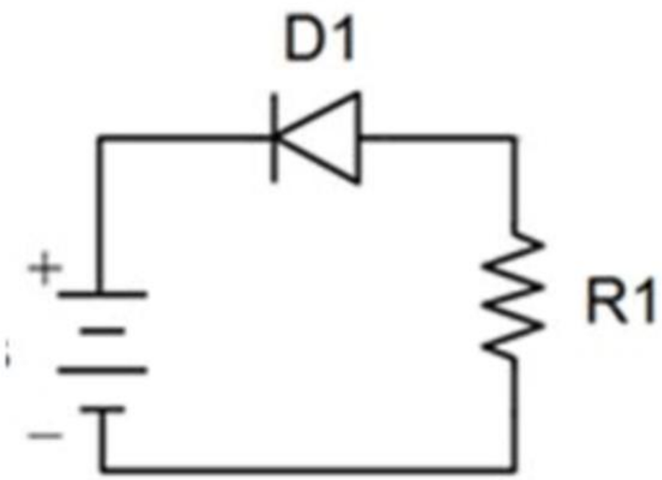

Figure 3b

Current did flow in the forward bias circuit and was only limited by the resistor value in the circuit. The voltage across the diode in this circuit was about .7 volts. The remaining voltage (Vtotal - .7 v) was across the resistor. Current did not flow through the circuit with the diode connected in reverse bias. Since there was no current flow in the circuit, there was no current flow through the resistor. Since there was no resistor current according to Ohm's Law, V = (I)(R).

= (0)(R)
= 0 volts

This meant the voltage across the diode was:
VD = Vtotal – VR

= Vtotal – 0v

= Vtotal

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Let's examine what the graph (characteristics) of a forward biased diode would look like.

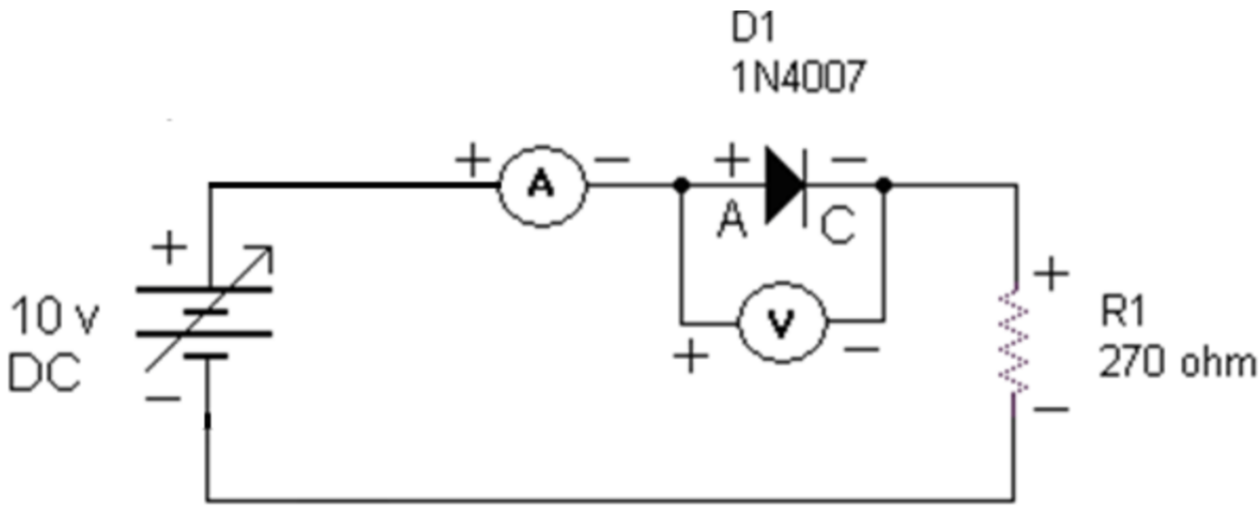

Figure 4

If voltage and current measurements were made using the above circuit a graph could be produced that would look like the graph in Figure 5.

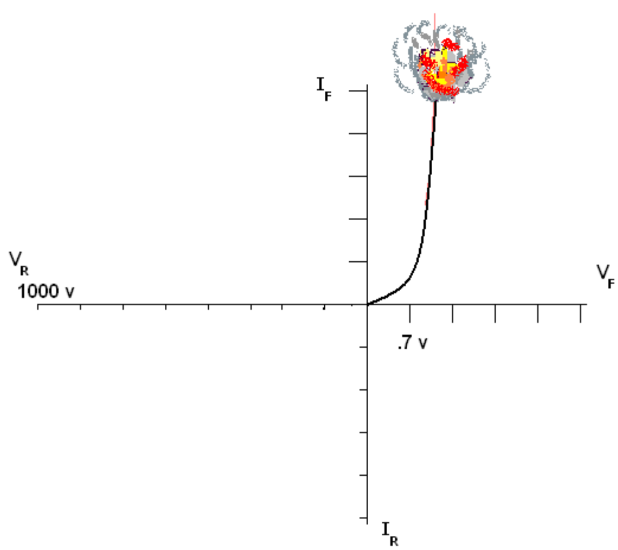

Figure 5

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The characteristics of the forward bias diode are as follows:

When the voltage across the diode is 0 volts, no current flows. The diode has very high resistance. As the voltage across the diode increases past .7 volts, current begins to flow. In fact, the current flows through the diode just like it was a piece of wire. There is very little resistance from the diode. We need to put a resistor in series with the diode to limit the flow of current through the diode. The amount of current through the diode depends on the specification of the diode. Please see the specification sheet to see what the Average Rectified Output Current is for the 1N4007 diode.

The Average Rectified Output Current is for the 1N4007 diode is 1 amp. This means if more than 1 amp of current flows through the diode it will be destroyed.

Let's examine what the graph (characteristics) of a reverse biased diode would look like.

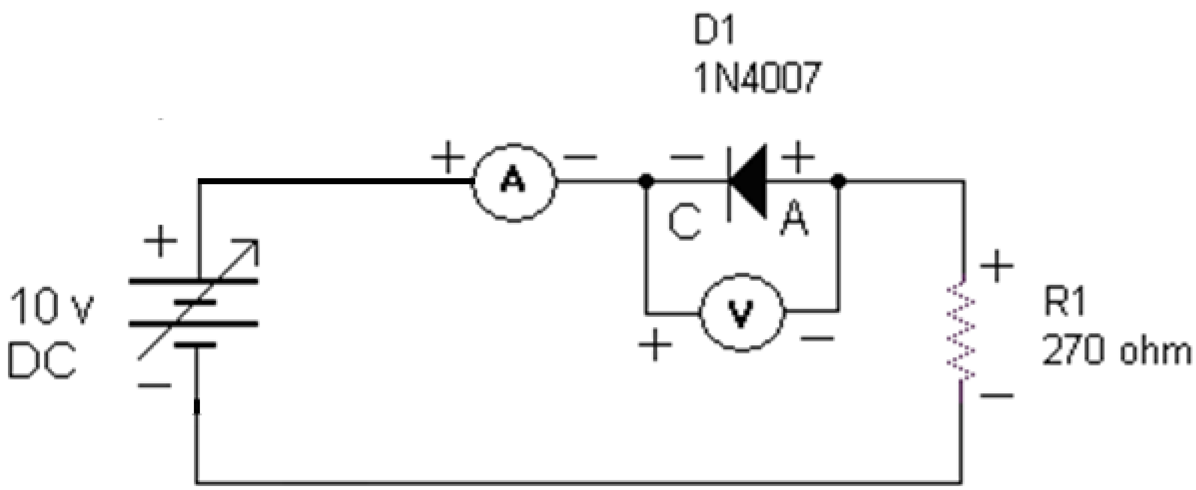

Figure 6

If voltage and current measurements were made using the above circuit a graph could be produced that would look like the graph in Figure 7.

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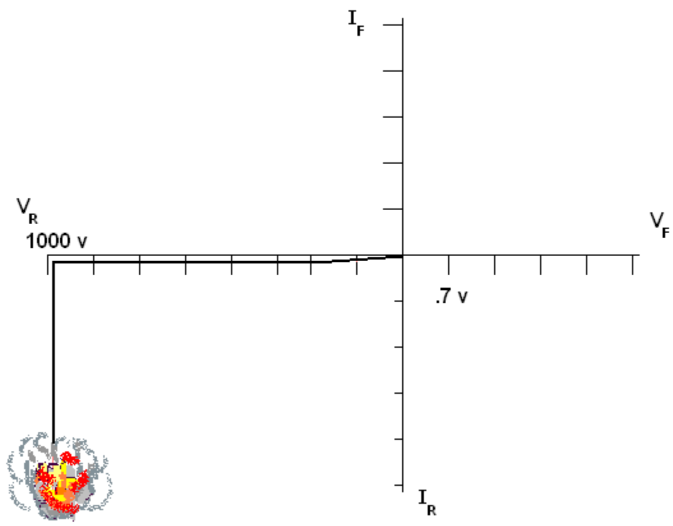

Figure 7

In the reverse biased diode very small current flows in the circuit. Looking at the specification sheet, once again, it shows the Maximum full load reverse current, full cycle average 0.375" (9.5 mm) lead length TL = 75 °C is 30 µA. In the reverse bias connected diode it is clearly not the current that destroys the diode. Looking at the graph it shows the diode is destroyed at 1000 volts. This is also given in the specification sheet as: Maximum repetitive peak reverse voltage = 1000 volts.

The complete characteristics of a diode shown graphically are shown below in Figure 8.

All semiconductors have a unique set of characteristics and those characteristics can be shown graphically.

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Diode Characteristics Displayed Graphically

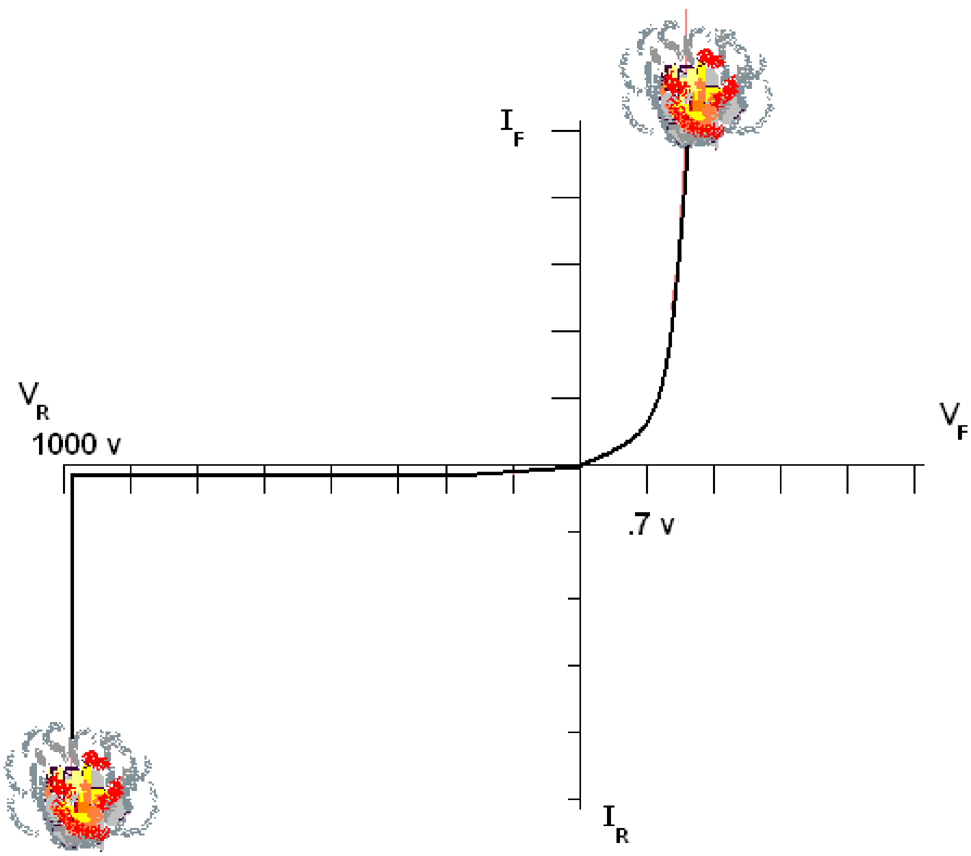

Figure 8

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What Are Characteristic Curves

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