



# What Do Solid State Devices Actually Do?

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## Table of Contents

1. Introduction.....	4
2. Wires.....	4
3. Solid State Diodes Used as Rectifiers.....	9
4. Zener Diodes.....	16
5. Varistors.....	19
6. Solar Cells.....	23
7. Three Terminal Devices.....	25
8. Operational Amplifiers.....	37
9. Conclusions.....	42
10. References.....	43

## List of Illustrations

<b>Figure Title</b>	<b>Pages</b>
2.1 Model for a Piece of Wire	4
2.2 Drawing Showing How to Think about Circular Mills	5
2.3 Chart of the Resistivity and Temperature Coefficient of Resistance of Some Materials at 20 Degrees Centigrade	6
2.4 Drawing Showing How a Piece of Wire Can Be Modeled	7
2.5 One Resistor Direct Current Circuit and Its VIPeR Chart	9
3.1 Two Symbols and Allowed Direction of Current Flow for a Solid State Diode	10
3.2 A Diode Circuit with an AC Input Voltage	10
3.3 Waveform of the AC Input Voltage of Figure 3.2	11
3.4 Waveform of the Output Voltage for the Circuit of Figure 3.2	12
3.5 Model for a Diode for Forward and Reverse Biasing	12
3.6 Pictures of Various Diodes	13
3.7 Schematics of a Half Wave Rectifier Circuit and a Full Wave Rectifier Circuit	14
3.8 Output Voltage for the Full Wave Rectifier Circuit of Figure 3.7	15
3.9 Transformer Coupled Full Wave Rectifier Circuit	15
4.1 Symbol for a Zener Diode	16
4.2 Voltage – Current Curve for a Typical Zener Diode	17
4.3 Typical Voltage Regulator Circuit Using a Zener Diode	18
4.4 Forward and Reverse Models of a Zener Diode	19
5.1 Varistor or MOV Symbols	19
5.2 Pictures of Some Typical Varistors	20
5.3 Typical MOV Characteristic Voltage-Current Curve	21
5.4 Circuit Showing a Typical Application for a Varistor (MOV)	21
5.5 Waveforms Showing What Happens When a MOV Is Added to a Circuit	22
5.6 Two Ways to Connect Two Zener Diodes to Mimic the Operation of a MOV	23
6.1 Sketch Showing What a Solar Cell Does	24
6.2 Typical Current, Voltage, and Power Curve for a Solar Cell	24
7.1 Pictures of Some Common Bipolar Junction Transistors	25
7.2 Schematic Representations of NPN and PNP Bipolar Junction Transistors	25
7.3 Diagram Showing BJT Transistors and How They Function as Current Amplifiers	26

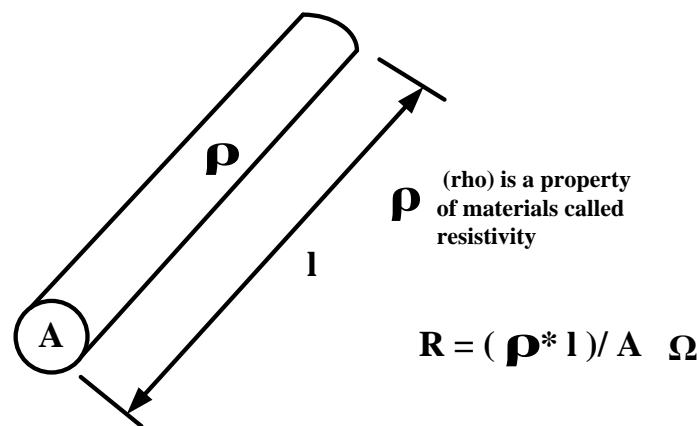
<b>7.4</b>	<b>Pictures of Typical Field Effect Transistors</b>	<b>27</b>
<b>7.5</b>	<b>Symbols for Four Types of Field Effect Transistors</b>	<b>28</b>
<b>7.6</b>	<b>Curve showing Drain Source Current Versus Gate Source Voltage</b>	<b>28</b>
<b>7.7</b>	<b>Pictures of Several Insulated Gate Bipolar Transistors</b>	<b>29</b>
<b>7.8</b>	<b>Simplified Equivalent Circuit and Circuit Symbol for an IGBT</b>	<b>30</b>
<b>7.9</b>	<b>Typical IGBT Circuit</b>	<b>31</b>
<b>7.10</b>	<b>Pictures of Some Common Silicon Controlled Rectifiers</b>	<b>32</b>
<b>7.11</b>	<b>Electronic Symbol for a Silicon Controlled Rectifier</b>	<b>32</b>
<b>7.12</b>	<b>Single Phase Silicon Controlled Rectifier Circuit</b>	<b>33</b>
<b>7.13</b>	<b>Input and Output Waveforms for the Circuit of Figure 7.12 with a Turn on Or Firing Angle of 45 degrees</b>	<b>34</b>
<b>7.14</b>	<b>Schematic of a Full Wave Six SCR Circuit</b>	<b>34</b>
<b>7.15</b>	<b>Typical V-I Characteristic of a SCR</b>	<b>35</b>
<b>7.16</b>	<b>Schematic Symbol for a Triac</b>	<b>36</b>
<b>7.17</b>	<b>Triac Operating Characteristic</b>	<b>36</b>
<b>7.18</b>	<b>Triac Circuit</b>	<b>37</b>
<b>8.1</b>	<b>Schematic Representation of an Op Amp</b>	<b>38</b>
<b>8.2</b>	<b>Pin Designation for a 741 Op Amp</b>	<b>38</b>
<b>8.3</b>	<b>Schematic of a Voltage Follower Op Amp circuit</b>	<b>39</b>
<b>8.4</b>	<b>Schematic of an Inverting Amplifier Using an Op Amp</b>	<b>40</b>
<b>8.5</b>	<b>Schematic of a Non-Inverting Amplifier Using an Op Amp</b>	<b>41</b>

## 1. Introduction

In our modern world, there are many Solid State devices that work for us on a daily basis. To help us navigate this modern Solid State world, I believe that it would be useful to know what these devices actually do. We do not need to know or understand, solid state physics to know what devices actually do. This course is written so that anyone can see and feel what these devices do. With that in mind, let's look at some solid state devices and start to see how easy it is to understand what the devices of our modern world actually do.

## 2. Wires

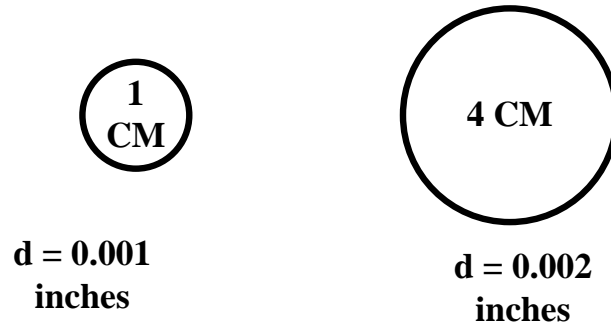
This might be a strange place to start on Solid State Devices. But we start with wires because they are actual devices. They are solid, have some resistance, and for alternating current, they may have some inductance and/or capacitance. A simple model of a piece of wire for direct current flow is shown in Figure 2.1.



**Figure 2.1 Model for a Piece of Wire**

The drawing shows that the resistance ( $R$ ) of the wire depends on its cross-section area ( $A$ ), its length ( $l$ ), and its resistivity ( $\rho$ ). The unit of resistance is Ohms ( $\Omega$ ). In the English System,  $\rho$  has the units of Ohm-Circular Mills per foot, Area has the units of Circular Mills (CM), and length has the units of feet. A Circular Mill is the area of a circle with a diameter of 0.001 inches. Admittedly, this is odd, but the English System developed this way and did have some

odd features. Figure 2.2 gives an idea of a way to look at the area in Circular Mills of two circles with diameters of 0.001 inches and 0.002 inches.



**Figure 2.2 Drawing Showing How to Think about Circular Mills**

The Area in CM of a circle is found by the following formulas:

$$\text{Area in CM} = d^2 \text{ (in inches)} / 0.001^2 \text{ (in inches)} \text{ or}$$

$$\text{Area in CM} = d \text{ (in mils)}^2 \text{ where 1 mil is 0.001 inch}$$

In the Metric System, the Area is usually given in square meters. Sometimes, square millimeters are used. To keep things simple, for our work here, we will only use square meters.

The resistivity ( $\rho$ ) is a property of materials. It is low for conductors like copper and other metals, and high for insulators like most plastics and Teflon. As mentioned earlier, in the English system of units,  $\rho$  has the units of Ohm-CM per foot. In the Metric System,  $\rho$  has units of Ohm meters<sup>2</sup> per meter. Sometimes this is shortened to Ohmmeters. This could lead to confusion, so we will always use Ohm-meters<sup>2</sup> per meter. Figure 2.3 is a chart showing the resistivity of some materials at 20 degrees centigrade (68 degrees Fahrenheit). The Temperature Coefficient of Resistance is also given in the chart. We need to know this because resistance actually changes with temperature and depends on the Temperature Coefficient ( $\alpha$ ) of the material.

