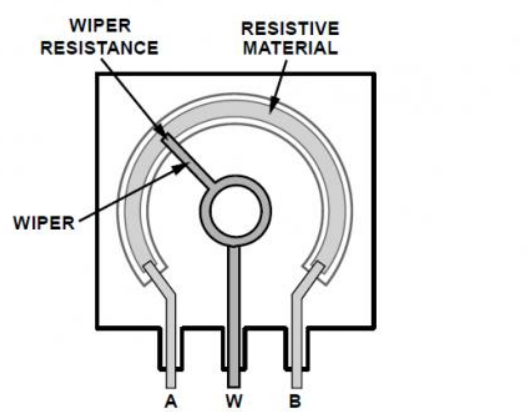
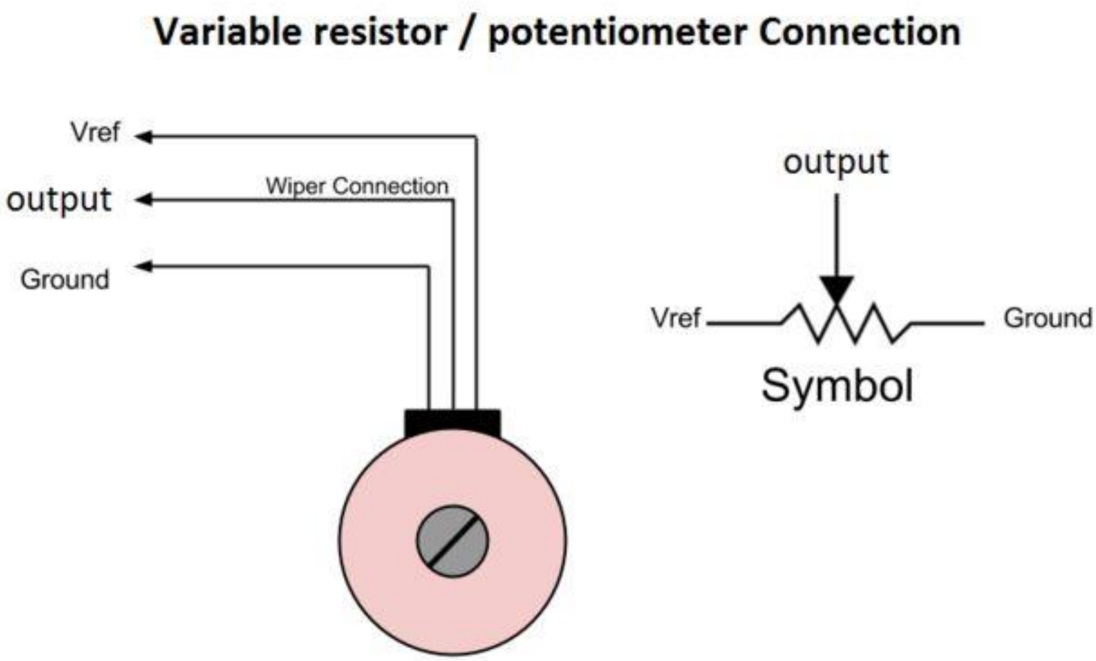
EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

We've talked about how to figure out what the voltage drop across a resistor is, how much current is flowing through it, and how much power it puts out. Let's turn our attention to why we're doing that. This can be a powerful tool if we can relate a physical parameter to an electrical property (e.g. angular displacement, light intensity, strain, or temperature to resistance) in a predictable and quantitative manner.

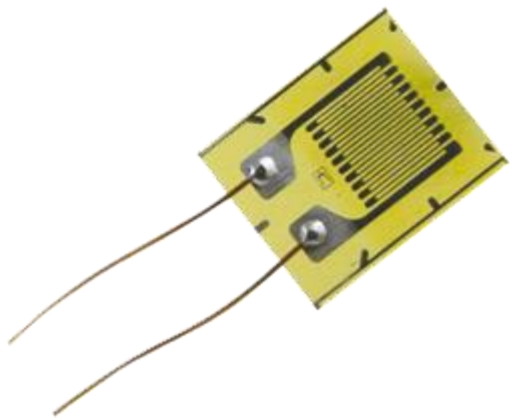


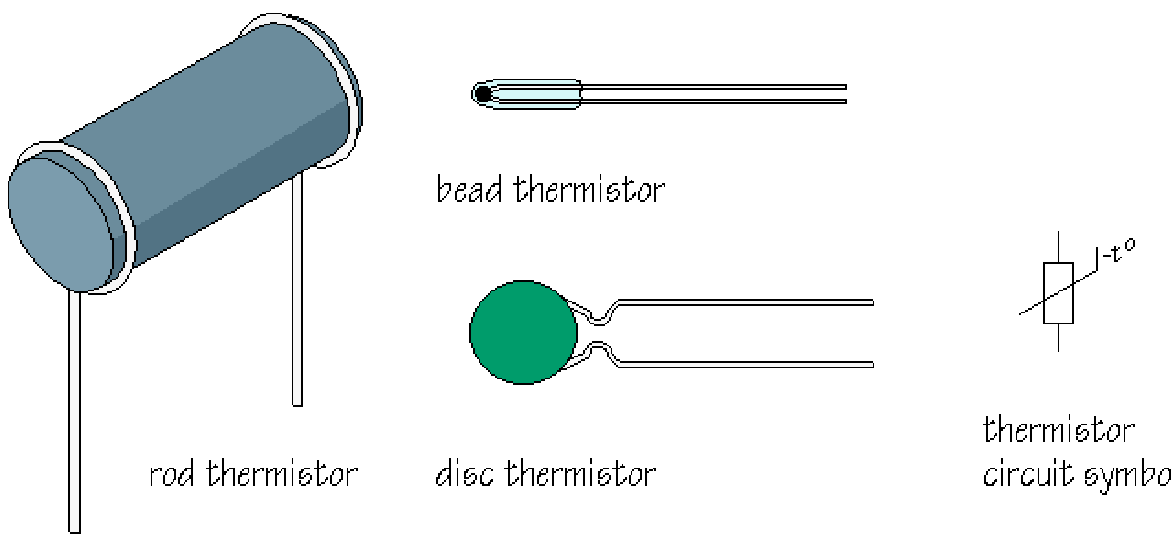


EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

Other types of resistors that relate a physical parameter to an electrical property in a predictable and quantitative manner.

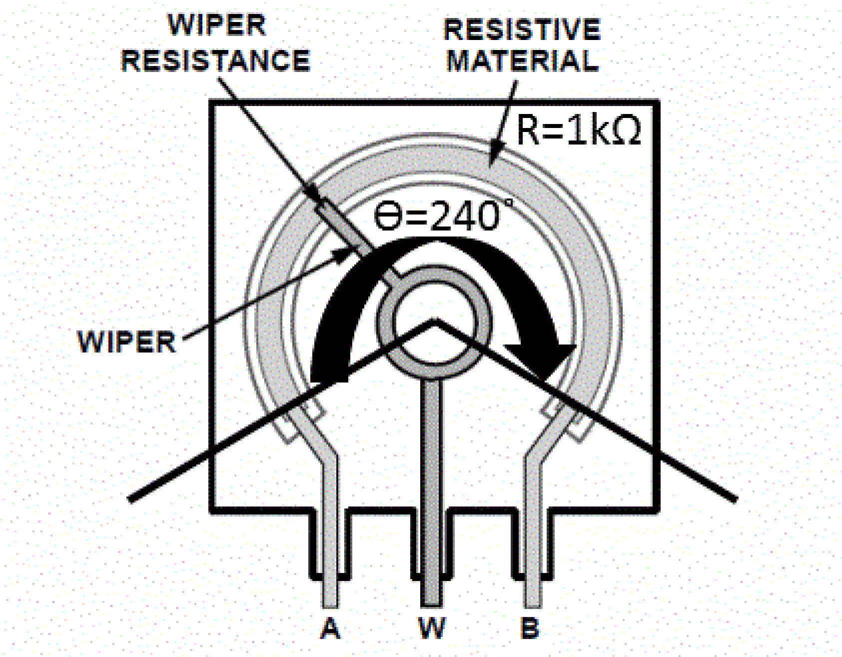




EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

Let's look at the example of the potentiometer. If we can quantitatively relate an angular position of a knob to the resistance of the device, we can use it to do some interesting things.

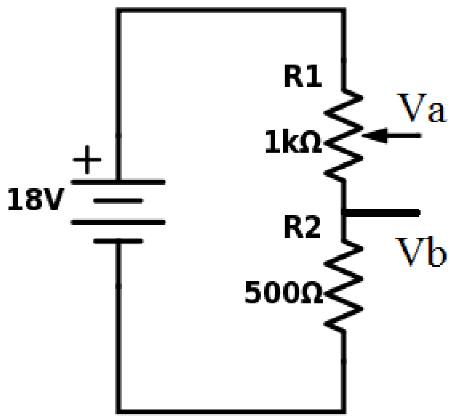


It should be clear that if we measure the resistance from A to W, it will be 0Ω when the potentiometer is at 0˚ and 1000Ω when the potentiometer to turned to 240˚. Here, it's safe to assume that the relationship between the resistance and the angular displacement is linear. So, from this information, we can build a transfer function. A transfer function does just what we said it would. It relates the resistance of the device to the angle of the knob. Follow along as we construct the transfer function.

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

Now, let’s put the potentiometer into a simple circuit.



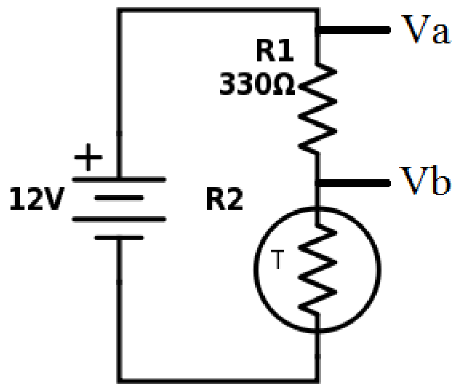
Find Vab when the potentiometer is turned to 135˚.

That potentiometer had a very simple transfer function. Let’s look at a resistance temperature detector (RTD). Don’t worry, that’s just a temperature dependent resistor. The relationship between temperature and resistance is usually linear with these devices. If the device has a resistance of 500Ω at 10˚ and a resistance of 515Ω at 100˚C, find the transfer function for the device.

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

If we place the RTD in the following circuit, find Vab when the temperature is 5˚.



Arguably, it's more important to be able to solve the following problem:

What is the temperature when Vab=4.65V?

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

For practice:

When the strain on a certain material is 0.001 (strain has no units), the resistance of the gauge is 1.5kΩ. When the strain is increased to 0.005, the resistance increases to 1.75kΩ.

Find:

a) The transfer function of the strain gauge.
b) The resistance of the strain gauge when the strain is 0.0036.
c) The strain when the resistance of the gauge is 1.64kΩ.

An RTD has a resistance of 438Ω at 15˚F.

Find

a) The transfer function if the resistance changes by 1.2Ω per ˚F.
b) The resistance of the device at 98.6 ˚F.
c) The temperature of the device when it’s resistance is 540Ω.

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

The resistance from one terminal of a potentiometer to the output terminal will be 0Ω when the potentiometer is at 0° and 500Ω when the potentiometer to turned 120°.

Find:

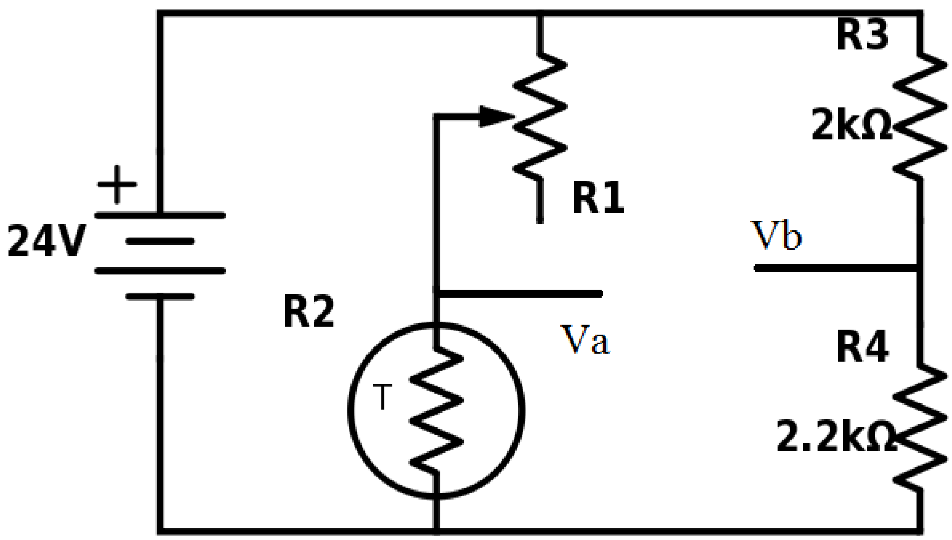
a) The transfer function for the potentiometer.
b) The resistance of the device when it is turned to 52°.
c) The angular displacement of the device when its resistance is 225Ω.

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

Now, let's really pull it all together!

Go get the transfer function from the last two problems (the RTD problem and the potentiometer problem) and put those two devices in the following Wheatstone bridge.



Find Vab if the temperature is 65˚F and the potentiometer is rotated to 93˚.

EN-3212 Electronics

Transfer Functions, The Wheatstone Bridge

If the temperature stayed at 65˚F, what angle would the potentiometer have to be rotated to in order to balance the bridge?

If the potentiometer stayed at 93˚ what would the temperature have to be in order to balance the bridge?

What did you just build?