Basic Electronics Part 3
by
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Let's look at a circuit that contains resistors in parallel. A circuit node is any point in a circuit where two or more conductors connect. A node is the point where two resistors connect. The point where a wire connects to a battery is also a node. Most of the time we look for nodes that are branch points in the circuit. At least three conductors connect at that point. In Fig. 1 we have identified two nodes, node A and node B.

node A

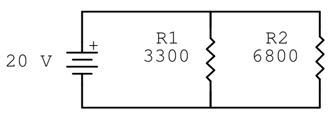


Fig. 1

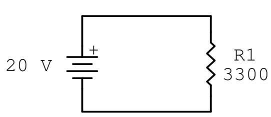
node B

If we think of the current, I_T, flowing from the + side of the 20 volt battery into node A, then we realize that the current splits into current I_1 flowing through R1 and current I_2 flowing through R2. We now observe that **all currents flowing into a circuit node must equal all currents flowing out of that node**. If we express the above statement in symbols we have

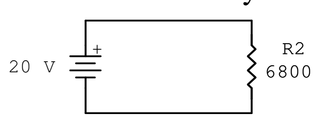
$I_T = I_1 + I_2$.

This equation represents the three quantities we want to find. The question is, how do we find them?

To calculate the currents in this circuit we go back to Part 2 and use the Voltage Law. We can identify two voltage loops in the circuit of Fig. 1. One loop includes the battery and R1 and the other loop includes the battery and R2.



Loop 1



Loop 2

The current in loop 1 is I_1 = 20 v / R1 = 20 / 3300 = 0.00606 A = 6.06 mA.
The current in loop 2 is I_2 = 20 v / R2 = 20 / 6800 = 0.00294 A = 2.94 mA.
Therefore, the total current in the circuit of Fig. 1 is I_T = 6.06 + 2.94 = 9 mA.

We now know the total current in the circuit of Fig. 1 (I_T = 9mA) and we know the voltage (E = 20 volts). We now ask what resistor, R, would be equivalent to the resistors R1 and R2 in the circuit? In other words, what resistance R would produce a current of 9 mA when a voltage of 20 volts is placed across it? Ohm's law comes back into the picture. In this case

$$R = \frac{E}{I_T} = \frac{20}{0.009} = 2222 \text{ ohms.}$$

Another way of looking at this situation is as follows. Since we have the relationship

I_T = I1 + I2,

We may use Ohm's law in the form

$$I = \frac{E}{R}$$

to write

$$I_T = \frac{E}{R} = \frac{E}{R1} + \frac{E}{R2}.$$

Since the voltage, E, is common in this equation, we may divide through by E to get the relationship

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2}$$

This is the way to combine two resistors in parallel.

The statement that THE SUM OF ALL CURRENTS FLOWING INTO A CIRCUIT NODE EQUALS THE SUM OF ALL CURRENTS FLOWING OUT OF THAT NODE is called Kirchhoff's Current Law. We have combined this with Kirchhoff's Voltage Law to solve the unknowns in the parallel circuit of Fig. 1. This process can be used to solve more complicated circuits. To practice what we have discussed before, consider the circuit in Fig. 2.

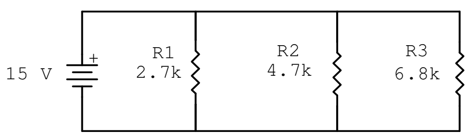


Fig. 2

Now try using Ohm's Law to determine the value of a single resistor that would be equivalent to the circuit in Fig. 2. The result of this exercise should suggest how you can combine three resistors in parallel. That is

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}.$$

You should get an answer of around 1400 ohms for the equivalent resistor.