SERIES AND PARALLEL RESISTORS

Resistors are paired together all the time in electronics, usually in either a series or parallel circuit. When resistors are combined in series or parallel, they create a **total resistance**, which can be calculated using one of two equations. Knowing how resistor values combine comes in handy if you need to create a specific resistor value.

Series resistors

When connected in series resistor values simply add up.

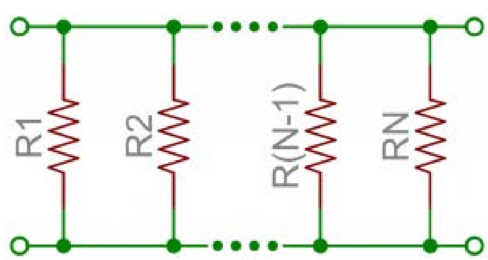
$$R_{tot} = R_1 + R_2 + ... + R_{N-1} + R_N$$

N resistors in series. The total resistance is the sum of all series resistors.

So, for example, if you just *have to have* a 12.33kΩ resistor, seek out some of the more common resistor values of 12kΩ and 330Ω, and butt them up together in series.

Parallel resistors

Finding the resistance of resistors in parallel isn't quite so easy. The total resistance of *N* resistors in parallel is the inverse of the sum of all inverse resistances. This equation might make more sense than that last sentence:



$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_{N-1}} + \frac{1}{R_N}$$

N resistors in parallel. To find the total resistance, invert each resistance value, add them up, and then invert that.

(The inverse of resistance is actually called **conductance**, so put more succinctly: the *conductance* of parallel resistors is the sum of each of their conductances).

As a special case of this equation: if you have **just two** resistors in parallel, their total resistance can be calculated with this slightly-less-inverted equation:

$$R_{tot} = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

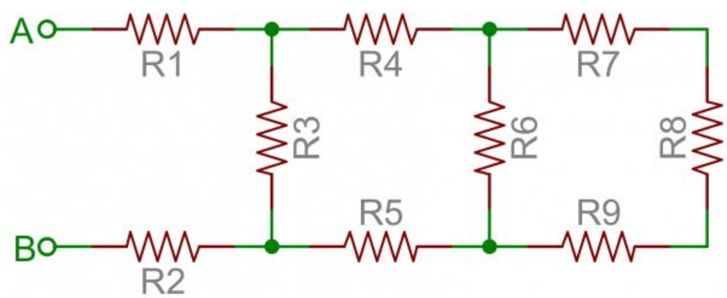
As an even *more special* case of that equation, if you have two parallel resistors of **equal value** the total resistance is half of their value. For example, if two 10kΩ resistors are in parallel, their total resistance is 5kΩ.

A shorthand way of saying two resistors are in parallel is by using the parallel operator: **||**. For example, if R_1 is in parallel with R_2, the conceptual equation could be written as $R_1||R_2$. Much cleaner, and hides all those nasty fractions!

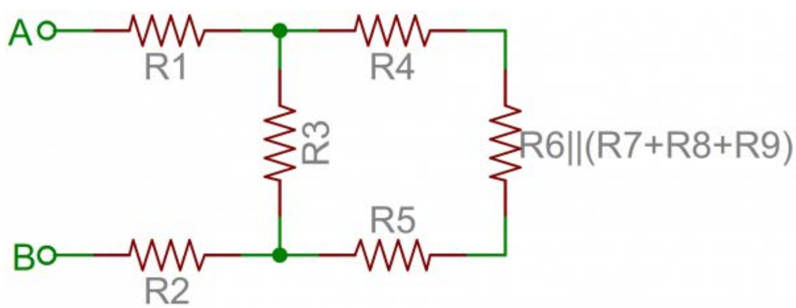
Resistor networks

As a special introduction to calculating total resistances, electronics teachers just *love* to subject their students to finding that of crazy, convoluted resistor networks.

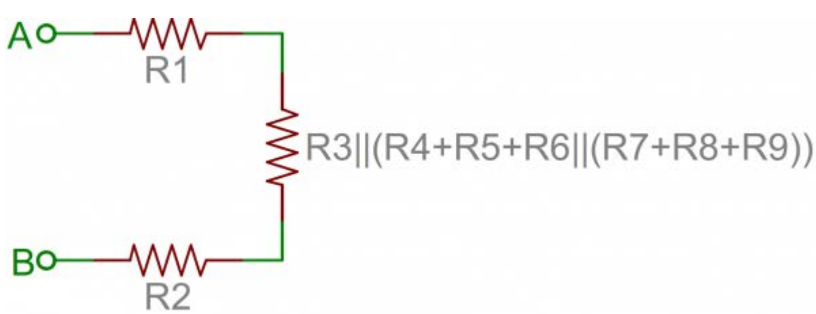
A tame resistor network question might be something like: “what’s the resistance from terminals *A* to *B* in this circuit?”



To solve such a problem, start at the back-end of the circuit and simplify towards the two terminals. In this case R_7, $R_8$and R_9 are all in series and can be added together. Those three resistors are in parallel with R_6, so those four resistors could be turned into one with a resistance of $R_6||(R_7+R_8+R_9)$. Making our circuit:



Now the four right-most resistors can be simplified even further. R_4, R_5 and our conglomeration of R_6 - R_9 are all in series and can be added. Then those series resistors are all in parallel with R_3.



And that's just three series resistors between the *A* and *B* terminals. Add 'em on up! So the total resistance of that circuit is: $R_1+R_2+R_3||(R_4+R_5+R_6||(R_7+R_8+R_9))$.

Source : https://learn.sparkfun.com/tutorials/resistors#series-and-parallel-resistors