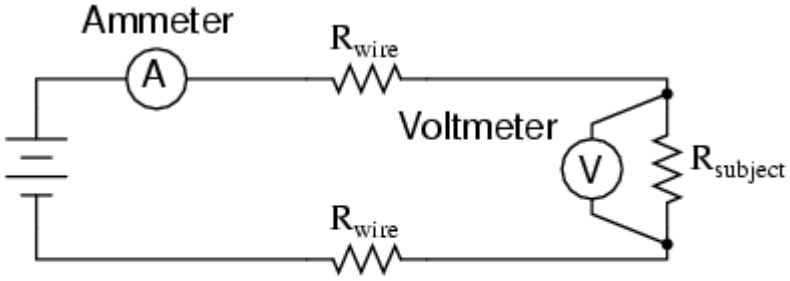
What is a Kelvin connection and when should it be used?

A Kelvin connection is a means of making precision electrical potential contact with a current carrying component or reference point in such a way that eliminates or greatly reduces the effect of contact resistance. This is especially important when dealing with low milli-volt reference voltages with relatively heavy loads where contact resistance is a significant and unknown variable. The best means is to use a (4) terminal device in which two terminals conduct the high current, while the other two are used expressly for sensing and correcting for error voltage. When working with two terminal devices, clip leads are sometimes connected as close as possible to the reference element to compensate for voltage error induced in test leads. —these are referred to as “Kelvin clips.” In this case, clip leads are used for inducing an accurate voltage where you want it at the end of your tests leads at the reference point, but a two lead device may be converted to a (4) lead device simply by replacing the clips with soldered leads.

Usually, wire resistance is very small (only a few ohms per hundreds of feet, depending primarily on the gauge (size) of the wire), but if the connecting wires are very long, and/or the reference point has a very low resistance anyway, the voltage errors introduced by wire resistance will be substantial.

An ingenious method of measuring the subject resistance in a situation like this involves the use of both an ammeter and a voltmeter. We know from Ohm's Law that resistance is equal to voltage divided by current (R = E/I). Thus, we should be able to determine the resistance of the subject component if we measure the current going through it and the voltage dropped across it:

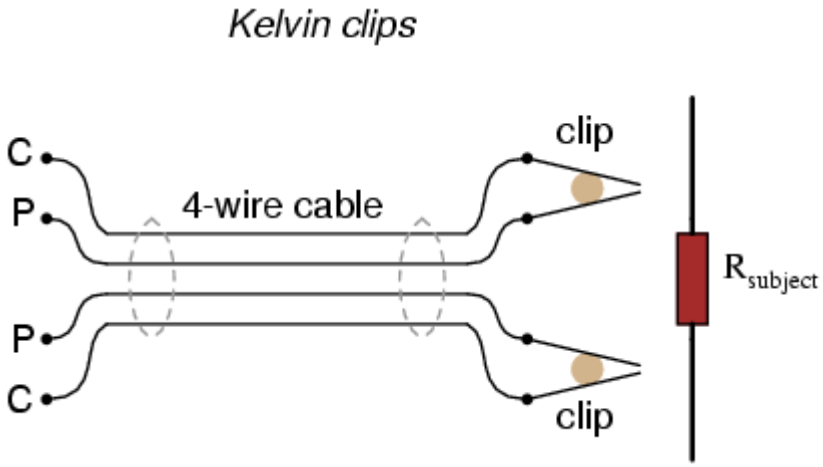


$$R_{subject} = \frac{\text{Voltmeter indication}}{\text{Ammeter indication}}$$

Current is the same at all points in the circuit, because it is a series loop. Because we're only measuring voltage dropped across the subject resistance (and not the wires' resistances), though, the calculated resistance is indicative of the subject component's resistance ($R_{subject}$) alone.

Our goal, though, is to eliminate any errors caused by wire resistance or by a heavy subject load that would cause and error in the reference voltage impressed on the subject load.

A method of impressing a precise voltage across the subject reference load which avoids errors caused by wire resistance is called the *Kelvin*, or *4-wire* method. Special connecting clips called *Kelvin clips* are made to facilitate this kind of connection across a subject resistance: They are available through Calibrator Inc.



In regular, "alligator" style clips, both halves of the jaw are electrically common to each other, usually joined at the hinge point. In Kelvin clips, the jaw halves are insulated from each other at the hinge point, only contacting at the tips where they clasp the wire or terminal of the subject voltage reference point. Thus, current through the "C" ("current") jaw halves does not go through the "P" ("potential," or *voltage*) jaw halves, and will not create any error-inducing voltage drop along their length: