BLOG 1: DO 'RESPONSES' OF ALL RESISTORS TO APPLIED VOLTAGE, FOLLOW SAME RELATION?

"A blog by: Funky Scientists"

I am a Ph.D. in polymer science and did my graduation in engineering. I learnt a lot in university through books, but when I grew up and started learning science in the jobs, I started having feel of materials. So, one day I decided to freshen up my Mechatronics subject and started from basics, i.e., voltage, resistor, and amperes. I learnt Ohm's Law, Kirchhoff's Law and lots of Laws but never took a resistor in hand and I learnt in life that *courses without projects is a waste of time*.

Materials: Few resistors, batteries, wires, breadboard and a multimeter.

Goal: Our goal was to start with resistors in series and parallel and measure the response to applied voltage through various batteries, i.e., approximately 9V, 12V and 16V. The responses were flow of current as Ampere, Resistance as Ohm and voltage as Volt, measured by an HTC multimeter.

Project: Before starting project, we were confused, what is measured first by an instrument: Voltage, Ampere or Ohm. We had the instrument in mind and started thinking like "Chicken and Egg Problem". Although we learnt that it was an Egg which was first...............ummm we meant bacterial cell as an Egg!

On waking up whole night and walking through our room we realized that none of them was first, but it was a needle of a magnetic compass, which led to all the findings. If there was no magnet the Scientists wouldn't be able to give us the precious relations and formulas.

Thus, voila we came up with the idea of naming few new Funky parameters. Don't worry they are not so difficult to learn or forget...... i.e., *Intrinsic Parameters and Relational Parameters*.

Intrinsic: are like Free Energy and Entropy, whereas,

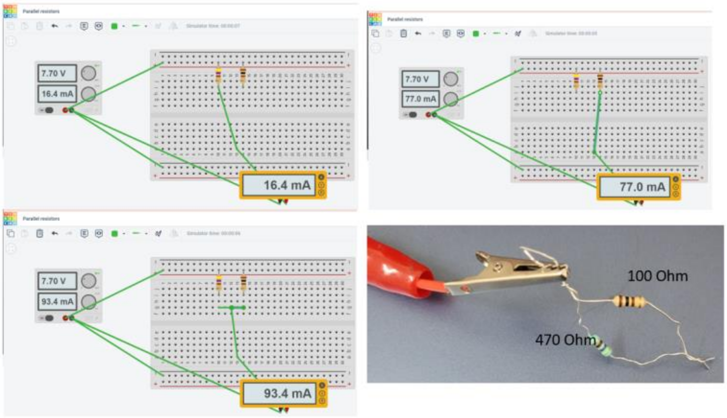
Relational Parameters: are invented, obviously, to find relationship between intrinsic parameters.

So out of these 3 parameters, we think Voltage and Resistance are Intrinsic Parameters and Ampere is a relational parameter. So, scientists took some magnets and measured the response to some unknown parameter which was later called as Ohm and relation as Ampere.

In a way, we can say that there is only one parameter, called as Voltage-drop-part and Voltage-drop-whole. Let us call them $V_{component}$ (V_c) and $V_{assembly}$ (V_a), respectively. Therefore,

{$I = V/R$} can be written as {$I = (V_a)/(V_a - V_c)$ } both the voltages are Standard Fluctuation of Standard Magnetic Field called as Voltage!

The following pictures show schematic diagrams of our connections:



We measured all 3 parameters using multimeter separately and parallel. Also, we used formulae to simulate the current flowing through parallel resistance. Below is the graphical summary of findings:

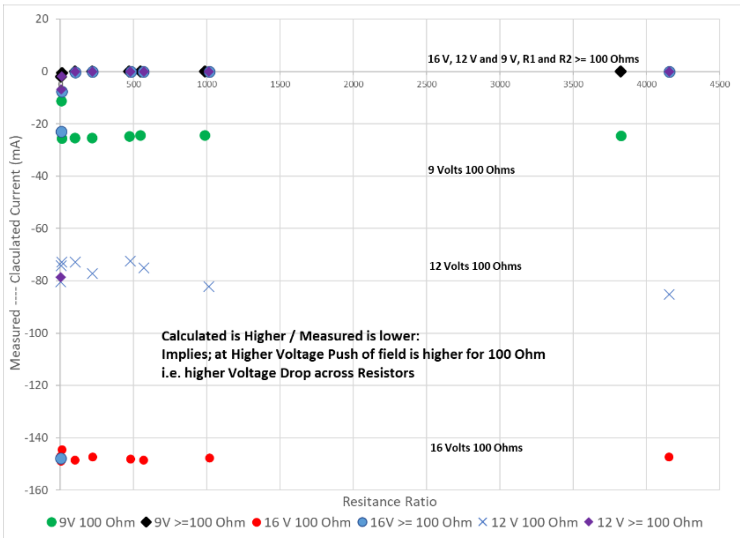


Figure 1: The above graph shows the difference between measured and calculated (by Ohm Law) current (mA) for individual resistors.

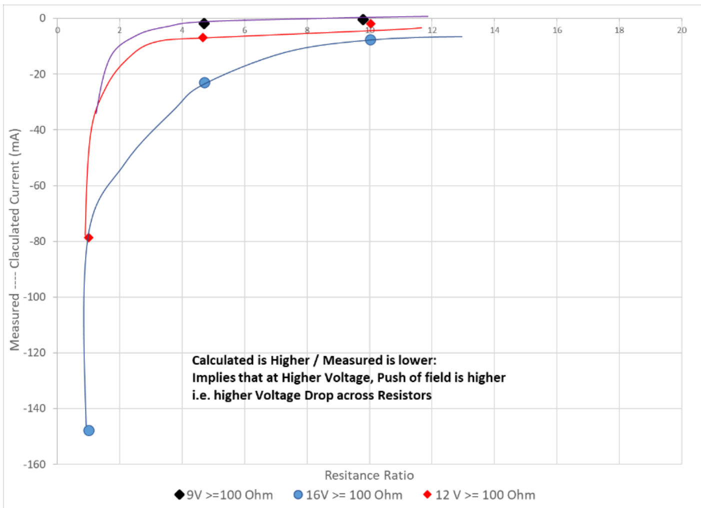


Figure 2: The above graph shows the (zoomed) difference between measured and calculated (by Ohm's Law) current (mA) for individual resistors >= 100 Ohms.

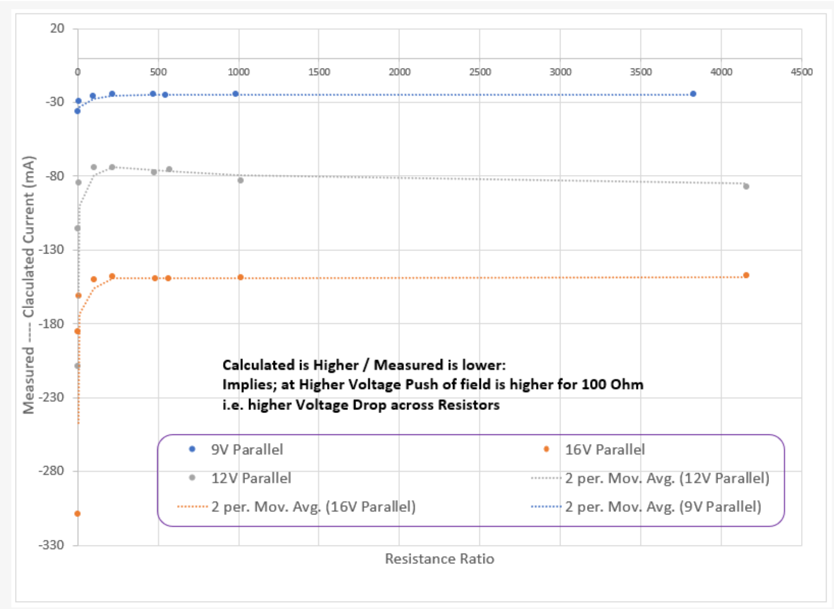


Figure 3: Similarly, the above graph shows the difference between measured and calculated current (mA) for parallel resistors (Kirchhoff's Law).

As the above graphs show, the resistors act as piston where the flow of current is impeded by magnetic flux around resistors. This can be denoted as Voltage drop across component (Vc) and the battery voltages can be denoted as voltage across assembly (Va).

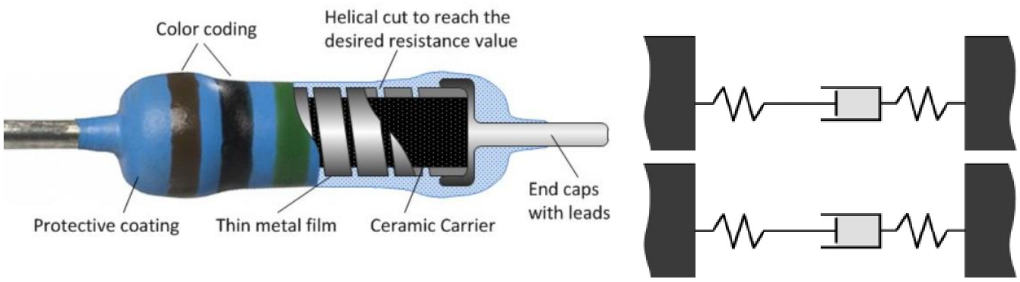


Figure 4: The above illustrations are taken from internet and give an idea about the impedance and voltage drop. **<u>The lower the voltage applied (Va) the lower is the impedance.</u>**

The purpose of this introspection is to visualize the intrinsic and extremely simplified nature of electron and magnetic field flow, starting with a very basic and simple circuit. Now, keeping this in mind, if we express everything in just voltage (potential energy and kinetic energy). Since, we know the principle of conservation of energy and using this principle we tried to find relation between flow of energy (I_i) intrinsic or in other words (I_m) measured, and (I_c) conventional.

The following table shows V_c, V_a, I_m and I_c. Using these values, we propose the following relations.

S. No.	Resistance Ratio	$V_{component}$	$V_{assembly}$	$I_{calculated}$	$I_{measured}$
1.	9.79		7.7	85	55.5
2.	10.04	4	11.99	133	48.6
3.	10.02	1.5	16	180	18.44

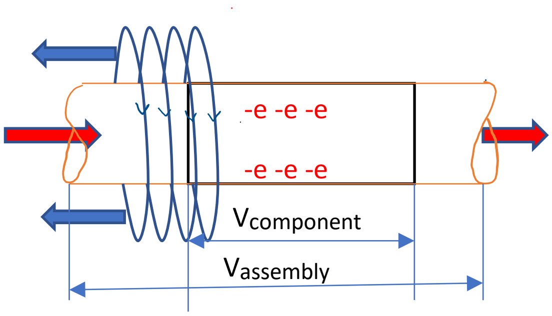
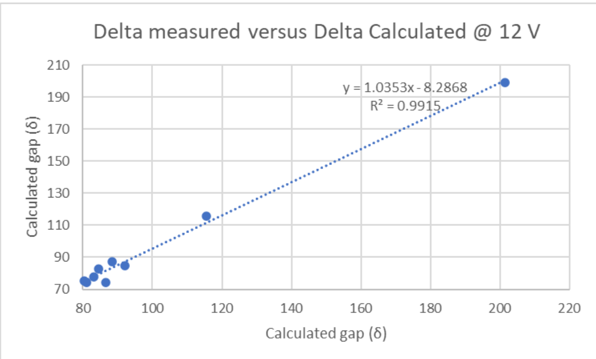


Figure 5: The figure above shows a schematic diagram of electron current flow and magnetic flux impedance in the opposite direction.

If δ is the difference between measured and calculated current of the parallel assembly, and ΔV is the resultant voltage (V_a-V_c); in a physical sense δ is related to flux impedance, i.e.:

Va-Vc = δ / (1/R1 + 1/R2) [Using Ohm's Law Principle of V=IR].

The following figures show that both the measured and calculated **gaps** between the Actual current and Calculated current (δ) are approximately same.



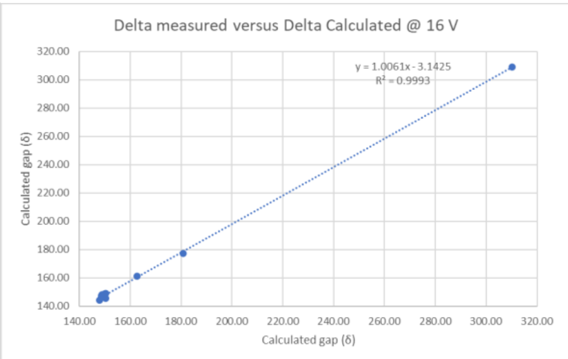


Figure 6: The 'measured and calculated gaps' between the Actual current and Calculated current (δ) are approximately same.

Conclusions:

1. The gap in the calculated current flow (Kirchhoff's Law) and measured flow (Multimeter) is explained and predictable by the principle like Ohm's Law but using the concept of flux impedance. Thus, there are two types of resistances in a resistor, i.e., **flux impedance and internal impedance** which is due to internal bonding/atomic forces.
2. At **Higher applied Voltage**, negative push of flux impedance is higher for 100 Ohm, i.e., higher Voltage Drop across Resistors. Lower applied voltage gives lower flux impedance and hence higher voltage drop in each component. Note: "This drop is different than the total potential energy of battery (voltage applied)".
3. At **higher resistance** the Ohm's Law and Kirchhoff's law are more applicable. So this shows the **design space** issue.
4. Voltage drop across component is different than assembly, i.e., the **relative points of measurement**.

Practical Use of the Study:

We can use this study, e.g., when several components are connected in parallel, and we want to design a circuit we would like to know the applied voltage and current flow through each component as well as the voltage drop in each component. This helps in selecting the size of the components for the projects. We shall take examples of the projects in future to see if these findings help and shall report it in future blogs. Till later.... by the way, your comments are welcome!