Technical Training Tip of the Month

"Ohm's Law?"
and
"Why do I have to know this stuff?"

By Grant Wolter

Ohm's Law states that "one Volt of electromotive force will push one Amp of current through one Ohm of resistance. If you massage that statement a little bit, you come up with the three famous (or infamous) equations used for calculating the different Volts, Amps and Ohms in an electrical circuit. The math equations come out looking like this:

E = I x **R**
I = E ÷ R
R = E ÷ I

(Where **E** = Electromotive Force = Volts, **I** = Intensity = Amps, and **R** = Resistance in Ohms)

Ohm's Law is a subject that often strikes fear into the hearts of technicians learning automotive electrical diagnosis. As soon as that formula comes out, E = I x R, or some other incantation of it, so do the groans and moans from students. If you wander over to the coffee pot a little later during break, you'll usually hear the question "What do I need to know that stuff for?", or "When am I ever going to use that?", usually with a few expletives attached. To be sure, you don't see many automotive technicians whipping out their calculators to calculate how much that mystery resistance might be.

Leaving the math aside, Ohm's Law describes how voltage, current, and resistance relate to each other in an electrical circuit. Without a firm grasp of the relationship between Volts, Amps, and Ohms, described by Ohms Law, electrical system diagnosis is a crapshoot and not really diagnosis at all. Successful diagnosis of electrical systems cannot be accomplished without a working knowledge of Ohm's Law. That being said, many technicians who are successful at electrical diagnosis, use Ohm's Law without knowing how to "do the math". Some call their knowledge of electrical diagnosis "common sense", but like most other "common sense" knowledge, they actually *learned* it somewhere, and just can't remember where they picked it up.

Here's a couple of practical examples of using Ohm's Law, some of which may not be recognized as such:

1) A technician is walking through the yard in the early morning as drivers are starting up their buses. He notices that a bus with its headlights on, cranks over slowly, but still starts up and runs. He also notices that the headlights did not get brighter when the bus was running. The

tech tells the driver to leave the bus for service, and has a repair order written up to check the charging system.

- Why not start with a check of the starting system or battery for the slow cranking problem? The tech has correctly surmised that the charging system didn't bring up the supply voltage when the engine was running, as he didn't see the headlights get brighter. The charging system problem is most likely the root cause of the problem. As the circuit supply voltage increases, the current through the load increases; an Ohm's Law relationship between voltage and current.

2) A technician gets a repair order for a complaint about the taillights not working. He checks the fuses for the taillight circuit at the fuse panel and finds that they are OK. After checking for blown bulbs, he proceeds to check the light sockets and harness connections for corrosion and broken connections. He finds a connector in the harness along the frame rail with corroded terminals. After cleaning the connections and rechecking, the taillights work properly.
    - Why didn't the tech check for short circuits from pinched or chafed wires first? The tech correctly surmised that, since the fuse wasn't blown, the problem is a high resistance or open in the circuit. I short circuit is a low resistance problem causing the current to go up, and blow the fuse from overload. A high resistance or open causes the current to go down and not allow enough flow for the load to work. As the resistance in a circuit goes up, the current through the circuit goes down; an Ohm's law relationship between resistance and current.

Would you, or the tech's you know, have made the same straightforward diagnosis, or would both vehicles still be in the shop with all manner of new parts installed, and still not repaired? The techs in the examples were performing diagnosis using Ohm's Law, but neither was using a calculator. Do you wish that you, or the techs you know, had that kind of "common sense"?

The big picture of Ohm's Law is a necessary part of a technician's education. "Doing the math" is often a piece of an electrical course that is used as a tool to help gain a deeper understanding of Ohm's Law. To be a successful automotive electrical system diagnostician, get over the fear, and make an understanding of the relationships between Volts, Ohms, and Amps in a circuit *your* "common sense".