ATech - AIPC AutoTeacher News

February 2007

Ohm's Law Busted?

Is Ohm's Law busted?" That was the question posed to ATech by an automotive instructor who had downloaded our Virtual SET demo. After building and measuring the demo circuit, he sent an email, "Mr. Ohm must be turning over in his grave with the circuit in your demo. (Ha Ha) The measured resistance value of the lamp does not match the voltage - current values! Is the actual product more accurate?"

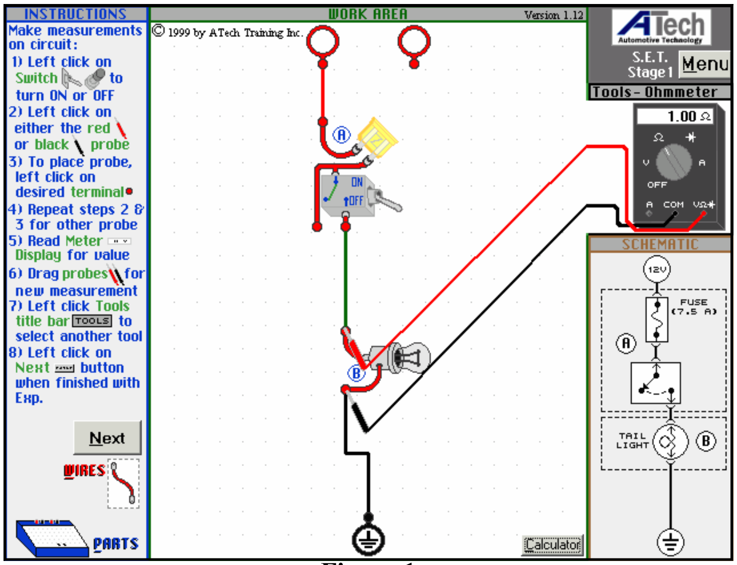


Figure 1

We have had many instructors who have asked for assistance with this apparent disparity. At ATech we attempt to build all simulation and demonstration products as realistic as possible. The simulation circuit is modeled from the values that would be measured on the actual General Mo-

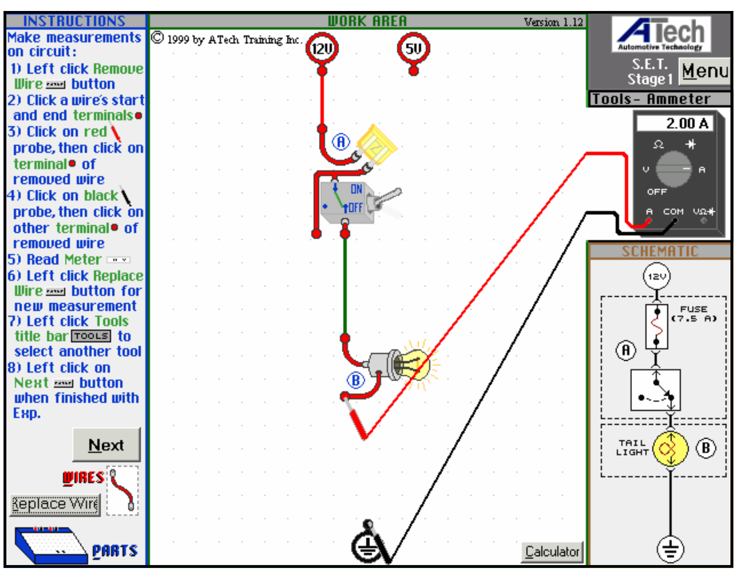


Figure 2

tor's SET hardware breadboard system.

In figure 1, the resistance of the lamp is measured as 1 ohm. When voltage is applied to the circuit and current measured, the current value is 2 amps. The current measurement on the virtual breadboard is shown in figure 2 and on the hardware SET board in figure 3. Using Ohm's Law, I = E / R, the current value should be 12 volts / 1 ohm = 12 amps. But, the current value measured is only 2 amps. To have 2 amps of current flow with 12 volts applied, the lamp

Figure 3

resistance would need to be R= E / I, 12 volts / 2 amps = 6 ohms!

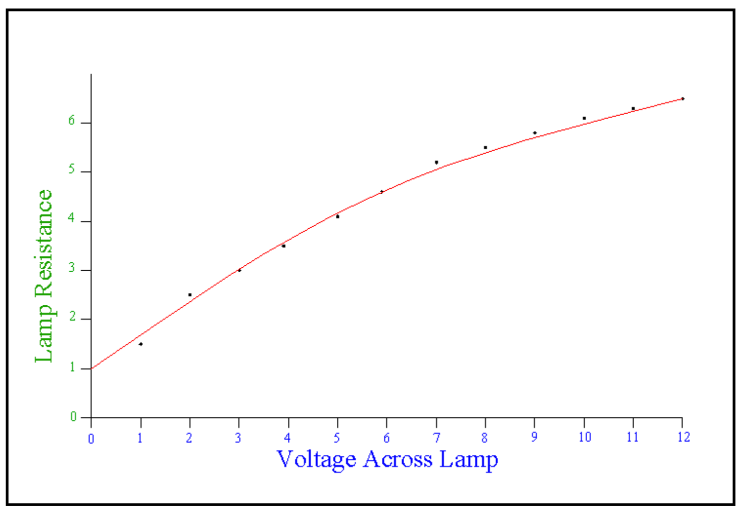


Figure 4

The graph in figure 4 compares voltage dropped across the lamp to resistance of the lamp. As can be seen on the graph, the relationship is non-linear. This means the resistance does not increase the same amount for a given increase in voltage. In this case, each voltage step is 1 volt. If you continued applying voltage to the lamp, you will find the lamp resistance flattens out. The rate of change becomes smaller and smaller until the lamp filament overheats and destructs.

The answer is in the properties of the material that is used for the lamp filament. The filament temperature goes from the ambient temperature when no current is flowing to several hundred degrees when current is flowing. Most material used for lamp filaments has a positive temperature coefficient. This means as its temperature increases, so does

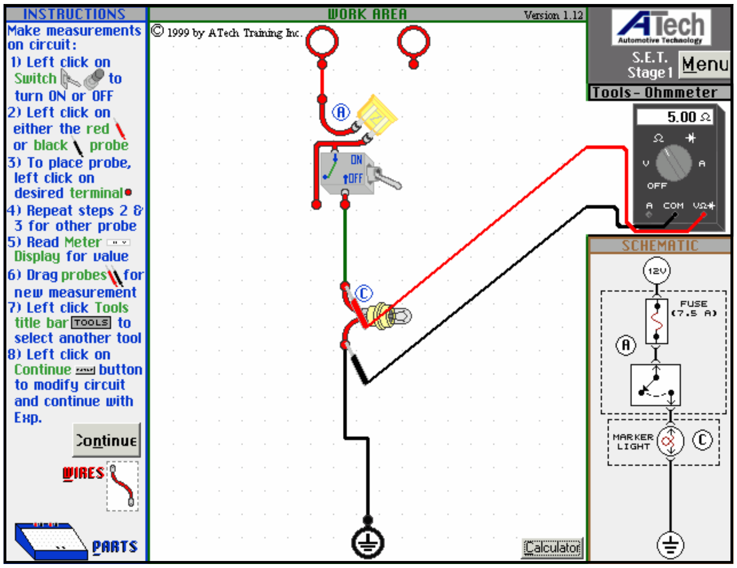


Figure 5

its resistance. Conversely, as its temperature decreases, its resistance goes down. If you place an ohmmeter across the lamp immediately after the voltage is removed, you can watch the resistance decrease as the filament cools down.

Let's take another lamp used for experiments in the SET program, module c, and investigate its properties. The lamp on module c is a marker light as opposed to module b which is a tail light. Figure 5 shows the resistance measure-

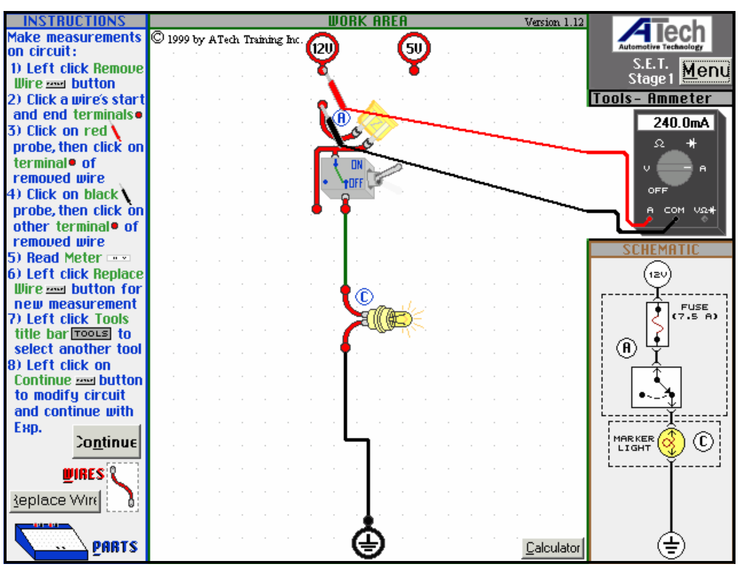


Figure 6

ment of lamp c to be 5 ohms. When 12 volts is applied to the lamp, a current flow of 240 milliamps results as shown in figure 6. The hot resistance of lamp c is R = E / I, 12 volts / .240 amps = 50 ohms. This lamp has a larger resistance change from cold state to hot state than the lamp used on module b.

Figure 7 shows a scope trace of the voltage (top, 10v/div) and current (bottom, .5 amp/div) of a typical c module lamp for the first 450 milliseconds after voltage is applied. Voltage is ~13.8 and the initial current surge is 2.7

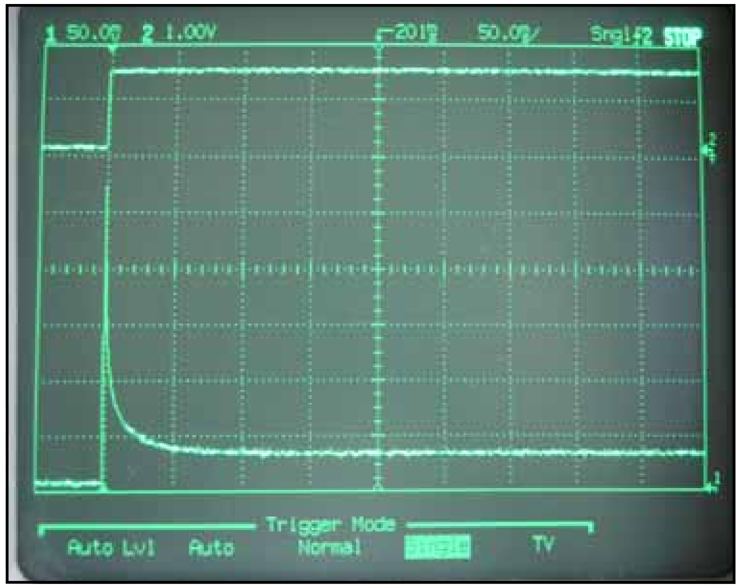


Figure 7

amps. Lamp resistance is ~ 5 ohms. After 100 milliseconds, the current is ~.35 amps. Resistance is 40 ohms. Figure 8 shows the first 40 milliseconds in more detail.

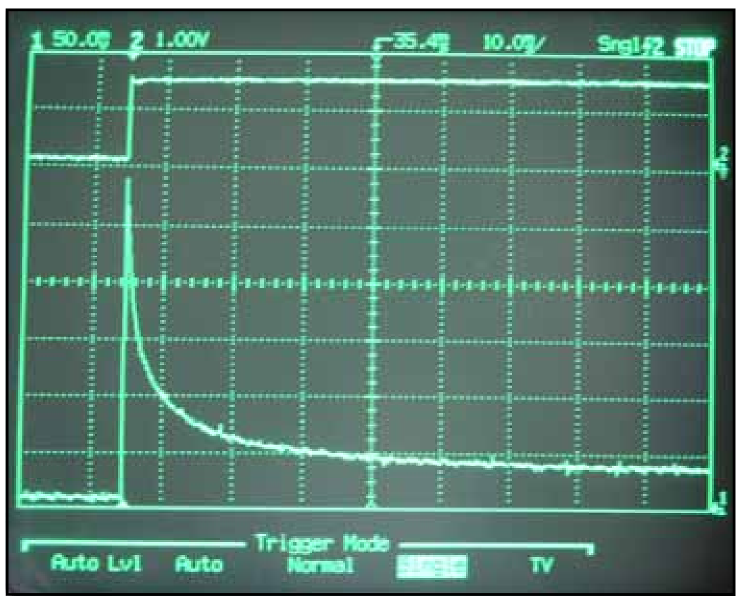


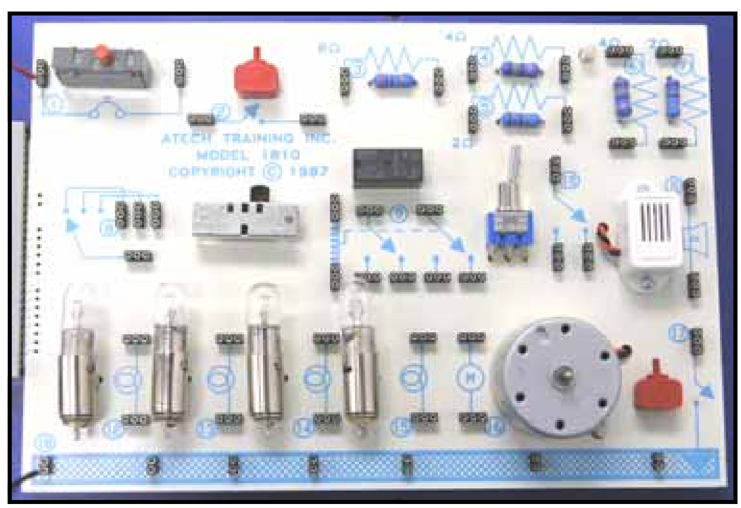
Figure 8

If you want to demonstrate a scope trace of the dynamic resistance of an incandescent lamp, you will need a current probe and a storage scope that can produce a single trace from one trigger. You will also need to build a switch debouncing circuit. Most switches will bounce longer than the initial surge time in the lamp. All mechanical switches on closing or opening, make and break the contact many times before finally settling in the desired position. Radio Shack has the necessary components to make a suitable switch debouncing circuit.

1800 Electricity/Electronics

The ATech 1800 series Automotive Electrical/ Electronic training system was initially designed in 1987. It has received many upgrades, additions, and revisions in the last 14 years. Many of the additions came at the request of OEMs. For example, Ford asked ATech to develop the 1830 - Automotive Sensors and Actuators, the 1840 Automotive Computer Concepts programs, and the 1841 - MAP/BARO and TPS. These three boards / programs added activities directly related to the engine control functions needed for OBDII. This one electrical / electronics training system now takes a student from beginning electricity up through automotive computer concepts.

The first two programs, 1810 - Automotive Electricity and 1820 - Automotive Electronics, have the capability of computer controlled fault insertion. If the 1802 keypad /1800FB fault board is added to the base unit, random or selected faults can be inserted into the circuits by an internal microprocessor. Fault insertion can also be controlled through a standard network utilizing ATech's network interface system. With network control, individual stations can be faulted with single or chained multiple faults and selected stations can all be faulted identically for classroom troubleshooting technique instruction. In addition, the 1810 and 1820 programs are available as computer based instruction (CBI) with individualized student record keeping.



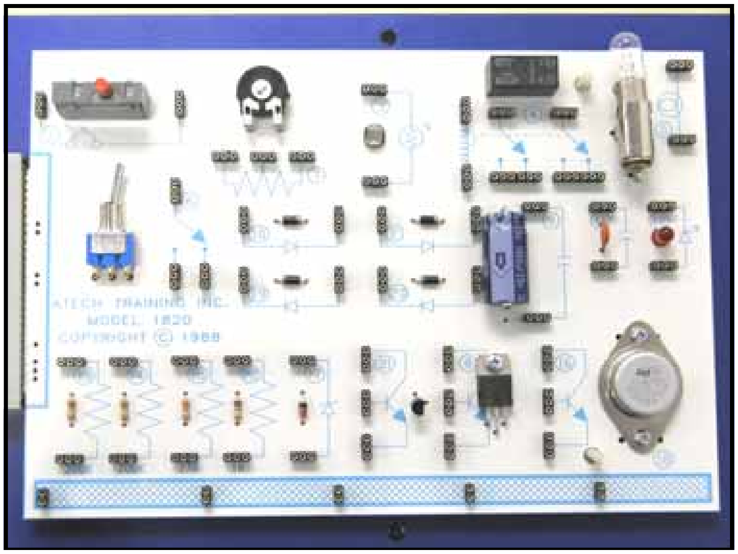
1810 Board

The 1810 activities include:

- Volt, Ohm, Amp Meter Use
- Series Cicuits
- Parallel Circuits

1800 Electricity/Electronics cont'd

• Series - Parallel Cicuits
• Troubleshooting Automotive Circuits
• Automotive Schematics



1820 Board

The 1820 Activities Include:

• Unit I – Introduction to Electronics
• Unit II – Introduction to Semi-Conductors/Diodes
• Unit III – Transistor Circuits
• Unit IV – More Electronics

The 1830, 1840, and 1841 boards are the experiment platforms for Automotive Sensors and Computers programs.

1830 Activities Include:

1. Temperature Sensor Circuit
2. Position Sensor Circuit
3. Ground Side Switch
4. Power Side Switch
5. Magnetic Pick-Up Sensor Circuit
6. Frequency Generator Circuit
7. Hall Effect Sensor Circuit
8. Optical Sensor Circuit
9. Climate Control (with 1840)
10. Injector Pulse Width Control (with 1840)

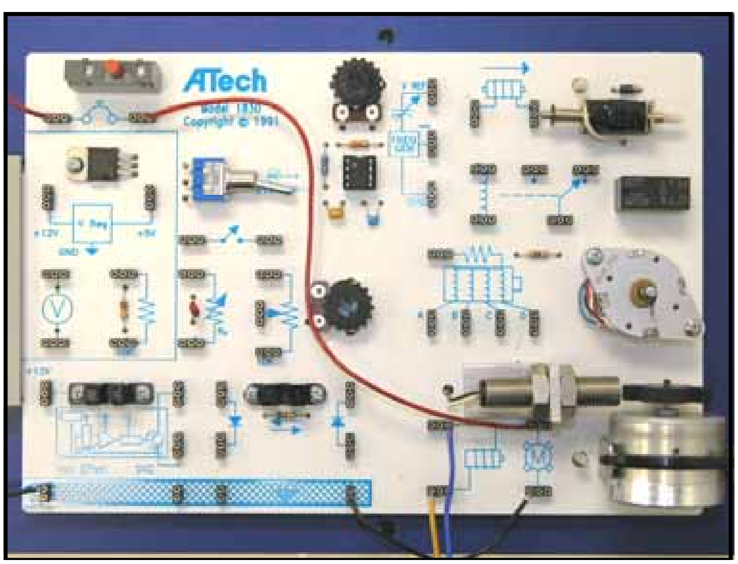


Figure 1

A wired experiment for the magnetic pickup and motor driven reluctor wheel circuit is shown in figure 1. The actual oscilloscope output signal is shown in figure 2. The reluctor wheel has four notches representative of a four cylinder engine. Student tasks for this simple circuit include:

1. Determine RPM from pattern
2. Distance effect on signal amplitude
3. Wave shape discussion
4. Runout and amplitude variation
5. RPM and amplitude variation

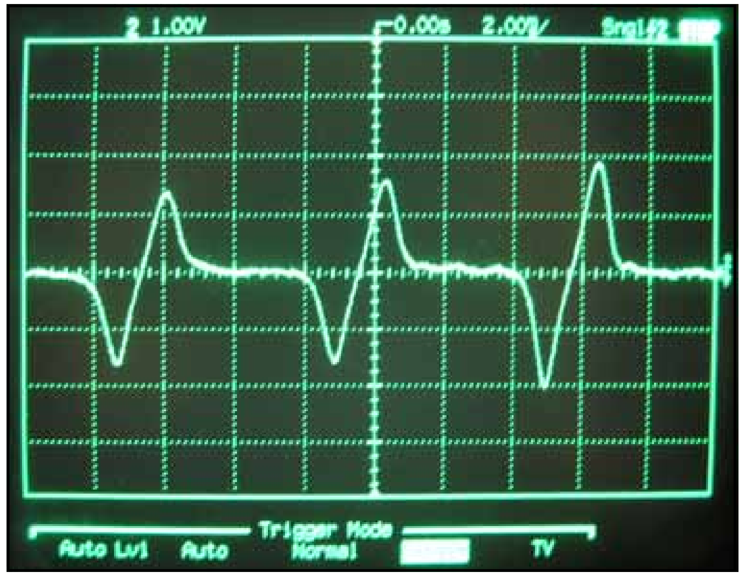


Figure 2

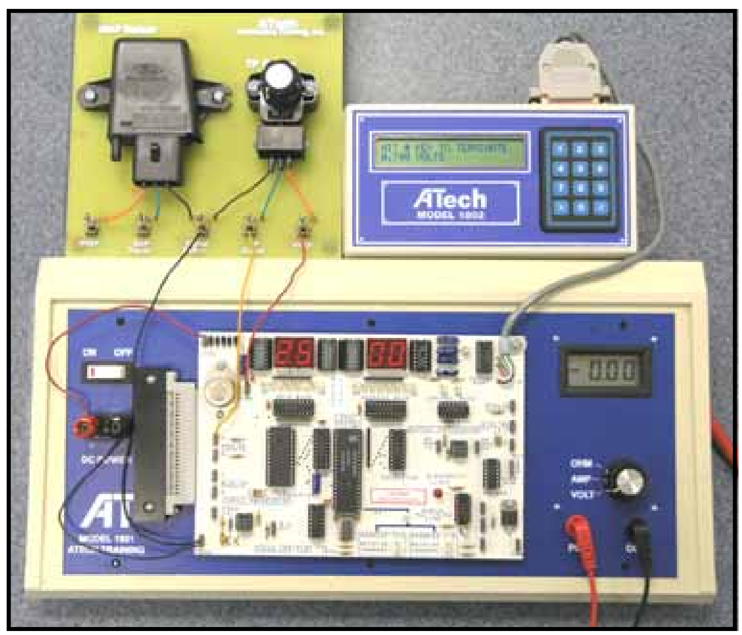
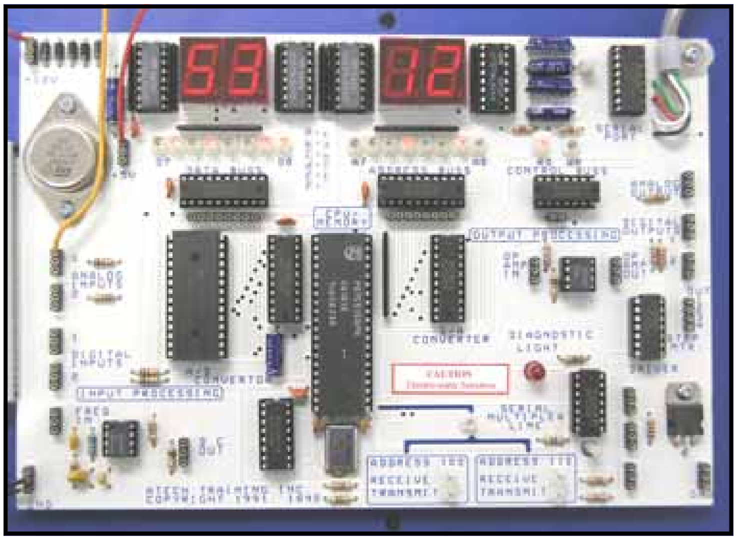


Figure 3

A typical setup for PCM operation investigation, figure 3, is the 1841 board supplying a throttle position analog signal to the 1840 board. The 1840 computer is converting the analog signal to digital using an A/D Convertor and displaying the value on the binary LED display, the Hexadecimal Seven Segment display, and the 1802 Keypad LCD. The 1841 board also has a MAP/BARO frequency output sensor.

1800 Electronics cont'd



1840 Components Include:

Regulated 5 Volt Supply:
- •Voltage Regulator

Input Signal Processing:
- •Analog to Digital Converter
- •Frequency to Voltage Converter

Computer:
- •Microprocessor (CPU)/Memory Chip
- •Data Buss w/8 LED - (8-Bit Binary)
- •Data Buss 2 Digit Display - (Hex)
- •Address Buss w/8 LEDS - (8-Bit Binary)
- •Address Buss - 2 Digit Display - (Hex)
- •Control Buss w/2 LEDS
- •Serial Port (interface with Model 1802 Keypad)
- •Serial Multiplex Line (Single LED)
- •Digital to Analog Converter
- •Op-Amp
- •Stepper Motor Drive Chip
- •Drive Transistor

1840 Activities Include:
- •Analog to Digital Conversion
- • Frequency to Voltage Conversion
- • Computer Addition
- • Digital to Analog Conversion
- • Op-Amp Voltage Gain
- • Pulse Width Modulation (PWM)
- • System Self-Test
- • Computer Sampling Time
- • Serial Multiplex
- • Climate Control
- • Injector Pulse Width Control
- • Threshold Detection – A/C Cutout
- • Frequency vs. PWM

Both the 1810 Automotive Electricity program and the 1820 Automotive Electronics program are available in Computer Based Instruction format (CBI). Computer controlled fault insertion provides troubleshooting practice and competency testing.

College Credits for ASE Certs.

NJC
NORTHEASTERN
JUNIOR COLLEGE

AAS in Automotive Technology

Northeastern Junior College (NJC) offers an Associate of Applied Science (AAS) degree in Automotive Technology. This two year degree offering allows a Master ASE + L1 technician in the field, to use "Credit for Prior Learning" towards the required core competencies and after completion of the required general education requirements they hopefully apply for an instructor's position. **This can be done, all on-line!**

Steps needed for this process:
- • Register for and pass 6 credits from NJC (all on-line)
- • Have ASE send their transcript to NJC Records office for evaluation.
- • Submit a Petition for Credit form and $10.00 per semester credit to the Business Office. Then send that form on to the Prior Learning Assessment Coordinator.
- •Register for and pass the additional 9 credits for a total of 15 credits from NJC. (all on-line).

The student can graduate from NJC with an Automotive degree once he/she has the CPL awarded and has taken a total of 15 credits to finish off the degree. Six of those credits need to be taken and passed PRIOR to the CPL being awarded.

Many states require a degree of some level to instruct in the automotive arena and this may very well, be the ticket needed to get their foot in the door to fill the instructor openings that we will be faced with in the future. Different states have different requirements but many do offer a higher starting salary depending on years of education. This is not the fix, but is a step in the right direction to help fill the void that we will all be faced with when instructors retire.

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Training Automotive Students Is My Passion

I am Margie Zamorski. I teach the Ford ASSET program at Milwaukee Area Technical College. This passion of the automotive industry started when I was a young girl. My father worked at an automotive shop and raced cars on the weekends. When most girls were playing with Barbie dolls I was outside in the garage helping my father. I knew what a wrench was and how to use it at a very early age.

Margie Zamorski, Milwaukee Area Technical College, Ford ASSET
Gene Pierce, Automotive Industry Planning Council

In high school, even though my counselor strongly advised me against it, I took two years of automotive shop classes. That is when I realized that I wanted to work on cars for a living, but my parents wanted me to go to college. The Ford Automotive Student Service Educational Training (ASSET) associate degree program at MATC allowed me to follow my dream and make my parents happy.

I graduated MATC in the early 90's and worked at a dealership for nine years. I found great satisfaction knowing that I was doing what I wanted to do. Having a car come in on the back of a tow truck and having a customer drive it away after I was done working on it gave me a sense of pride for myself and for my work. During that time, I also mentored the new technicians coming into the dealership. I had just as much fun teaching the new technicians as I did working on cars. So I got a job teaching automotive at night.

A full time position became available at MATC teaching at a local high school. I had a difficult decision to make. Do I stay working as an automotive technician or do I apply for the position? Being a mother and having the same schedule as my daughter would definitely have its bonuses. I took the job teaching. One of the requirements of the job was to go back to school and receive a bachelor's degree. I took classes at night and on weekends to achieve that goal. At the time, a typical day for me started early in the morning getting my daughter ready for school, teaching during the day, coming home to make dinner, help my daughter with her homework, grade my student's homework and then do my own homework. I have to give special thanks to my husband for his support during the three years I was taking classes.

After teaching a year at the high school, a position in the Ford ASSET program became available. Now I teach in the very program that I was a student in. Out of the 39 schools that teach the Ford ASSET program I am the only female instructor. I enjoy going to work and now have the chance to give students the same opportunity that I had entering into the automotive industry.

I am an evaluation team leader for NATEF and team contest manager for the Ford AAA state competition. I also enjoy hunting, fishing and riding ATV's with my family.

Bill Kersten, NATEF President; Margie Zamorski, Ford ASSET Instructor and Coordinator; Scott Schiefe, Instructor/Dept. Chair; Gene Pierce, AIPC

If you are or know a female who is interested in going into the automotive industry, I say go for it! The road was not always easy, but I wake up every day knowing that I made the right choice.

Margie Zamorski

Margie's Ford ASSET program was a National Runner Up in the Post Secondary Manufacturer Affiliated category in 2006. Women endure many more hardships in automotive service than men, but the opportunities are tremendous. Margie is the model of success. Thanks for sharing your experiences with us. What a great story!

Fred Hines

What's Wrong With This?

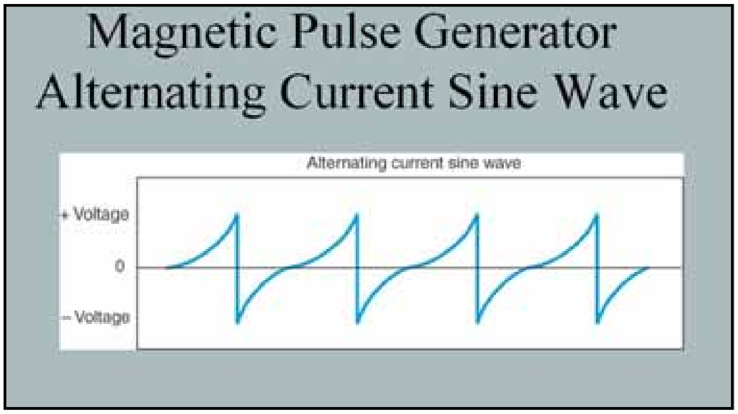

Figure 1

We received many interesting answers as to the problem with this waveform depiction. The major problem is the waveform is not a sine wave. It seems that many people in automotive training think that all AC waveforms are sine waves. A sine wave gets its name from the fact that its voltage at any point in time is determined by the sine of the rotational angle. An easy illustration is to consider the waveform as being produced by a mechanical alternator. As the alternator's rotor turns through the various rotation angles, the output it produces is related to the sine of that angle. The typical 60 Hz house current is a perfect example.

One answer that was received many times referred to the speed of the transition from positive to negative. It was stated that it was impossible for the voltage to change that fast. When viewing waveforms, it is important to know the sweep time of the display. For example, in figure 2, the sweep time is 1 millisecond per division. The transition time appears to be zero. But the same waveform shown at a 100 nanoseconds per division in figure 3 makes the transition time appear very slow.

Waveforms are viewed based on points of interest. In figure 1, the area of interest is the overall shape, not the time of the positive to negative transition.

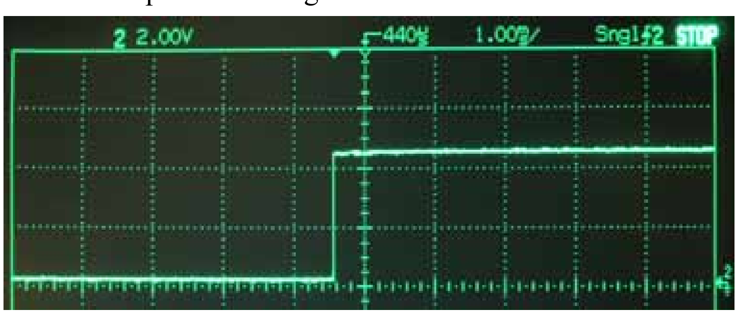

Figure 2

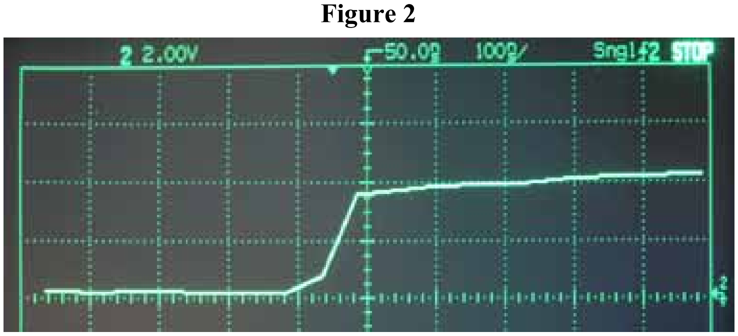

Figure 3

Figure 4 illustrates both a sine wave and a cosine wave. The wave shapes are unique and are instantly recognizable. It should **not** be drawn as half circles which has been done in a major OEM training program for the last fifteen years. Why is it important? Sine waves have some ex-

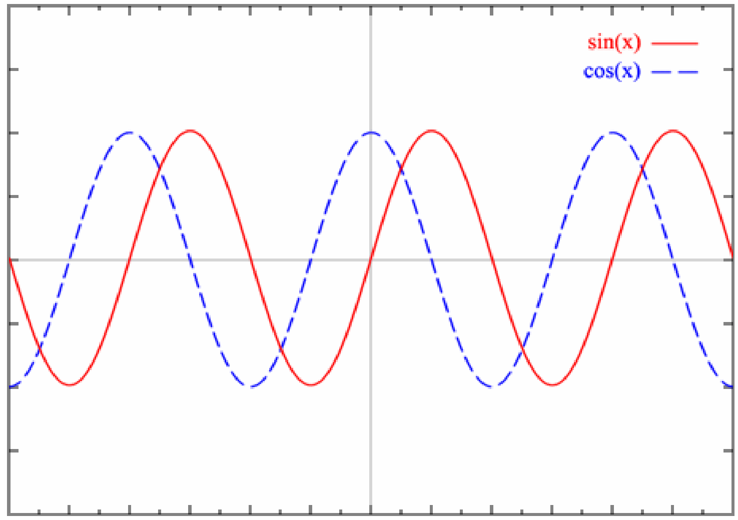

Figure 4

clusive properties. For example, the wave shape in figure 1 is actually composed of sine waves. Sine waves of varying amplitudes and different frequencies are combined to form the particular wave shape seen. Sounds strange, but filter circuits can actually remove the various frequencies from the wave shown in figure 1. Those frequencies are called harmonics and will all be some multiple of the basic frequency

Current flow without voltage ?

I illustrated both the sine and the cosine in figure 4 because it shows another unique property. That is phase angle. The angle shown in the figure is 90° with the cosine wave leading the sine wave. You have probably heard of phase angle as related to electrical power. Normally the voltage and current arriving at your house should be in-phase; current at maximum when voltage is maximum. But if someone has a large reactive load on the line, it can cause the two to become out of phase by a slight amount. If the phase angle becomes too large, it will cause over heating and damage to other electrical devices on the line.

In automotive electronics, there are three types of devices; passive, active, and reactive. An example of passive devices is the resistor - the phase angle is 0° and the amount of current is set by I=E/R. The transistor is an active device where a small base current can control a large emitter-collector current. Reactive devices are inductors (coils) and capacitors. They are reactive because they store and return (react) energy to the circuit that includes them. Another reactive device property is the current and voltage have a 90° phase angle. Voltage leads current in an inductor by 90° and current leads voltage in a capacitor by 90°. **Therefore, a capacitor has current flow without a voltage.**

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Others talk about great product quality and service… ATech delivers them. Ask our customers.

ATech Training is a member of:

Automotive Industry Planning Council

Spring 2007 CAT Conference, WyoTech, Sacramento

California Auto Teachers (CAT) Spring Conference at the new WyoTech location in Sacramento, April 27-28. CAT promotes the interests of secondary and post-secondary auto teachers, and hosts professional teaching and technological skills development, collegial networking opportunities and features vendors, such as ATech, who support the work of auto instructors. All interested are invited to become members of CAT, and attend our twice-yearly conferences. For more info visit our website: www.calautoteachers.com

Drew Carlson, CAT President

In this Issue:

Flash! Flash! Flash!

The Automotive Industry Planning Council (AIPC) Awards 2007 Program is accepting applications for both NATEF certified and non certified programs. Visit www.autoipc.org to download the applications. Get started now! Entry deadline is July 16, 2007