Volume 22, Issue 12

December 2025

Technicians Service Training

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Editor

"G" Jerry Truglia

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"Real World Computers Diag"

Today's vehicles are heavily computerized with some having over 100 modules on board. However, the computer we deal with the most is the PCM (Powertrain Control Module). The PCM improves vehicle performance, efficiency, emissions and reliability. Computerized vehicles are here to stay and with huge advances in computers and electronics (i.e. the Caddy Optiq or the Chevy Volt, **Figures 1 & 2**) this is not the future of auto repair—it's the present! The 2025 Optiq is a full EV while the 2011 Volt is an Extended Range/ Plug in Hybrid vehicle. Both of theses technologizes are hear to stay and if you have not work on one of the yet you will in the future.

Figure 1

Figure 2

Vehicles today break less, last longer, emit less pollution, and use less fuel. The computers on these new marvels are always adjusting to make the engine perform as good as possible, sometimes putting off the need for major service past 100,000 miles (160,000 km).

(Con't on page 4)

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TST is a group of dedicated technicians and instructors committed to the continuing education of our fellow technicians. We provide training seminars to technicians at a reasonable price. TST brings our members nationally known instructors and state of the art training.

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- *Deliver information that the technician can use now.*
- *Keep technicians informed of information affecting our industry.*
- *Increase consumer awareness of what a good technician is.*

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"Real World Computers Diag" (con't from p. 1)

Figure 3

Nonetheless, remind the vehicle owner that they still need to maintain their vehicle on a regular basis. USA EPA tests have shown even high mileage (150K plus) vehicles still perform well, emitting very low emission levels if the vehicle has been maintained.

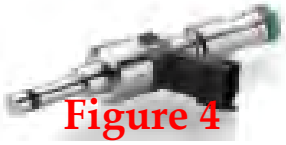


Figure 4

In this article we are going to give you a crash course on how computers work on today's vehicles. We'll also look at multiple controllers and using your scan tool on PIDS, DTC, Freeze Frame, Bi-directional, etc. and reprogramming. But, before we cover that we first need to explain the relationship of sensors and actuators **(Figures 3, 4 & 5)** with the computers.

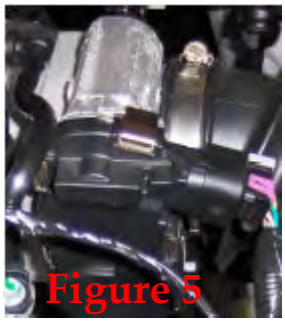


Figure 5

How Vehicle Computer Work

A Module (let's stick with the PCM) is the brain of the vehicle comparing engine data to what it would like things to be. Sensors in a vehicle are the eyes, ears, nose, and hands that God gave you to know what's going on. The PCM knowing **(Figure 6)** what is going on might want to do something, like firing the fuel injectors for a certain period of time, uses actuators to get this done.

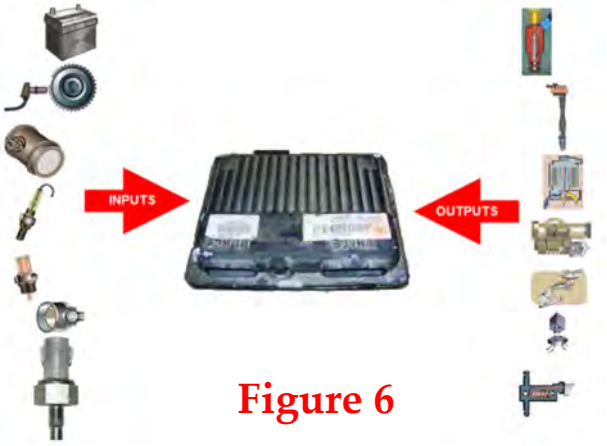


Figure 6

Sensors tell the PCM what is going on by transferring voltage signals that reflect what is going on in the engine such as load, throttle position, temperature, and more. So, to summarize, what vehicle computers do **(Figure 7)** is Sense, Compare and Adjust.

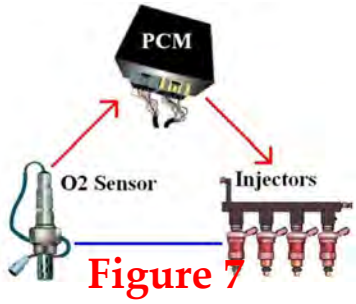


Figure 7

(Con't on page 5)

"Real World Computers Diag" (con't from p. 4)

The waveform to the right shows an O2 sensor reading a low voltage (lean condition). This information is sent to the PCM where it is compared to a good O2 reading (voltage signals moving up and down from at least 150 mV to 850 mV in 100 milliseconds or less). So, the PCM decides to send a voltage signal command to the fuel injector to spray fuel longer. This enriches the fuel mixture sending 02 sensor V up, and the process repeats. Channel A is fuel injector & Channel B is the O2 sensor. As O2 voltage line goes down (lower voltage - Lean Condition) the fuel injector on time will widen (adding more fuel – more pulse width - Rich Command).

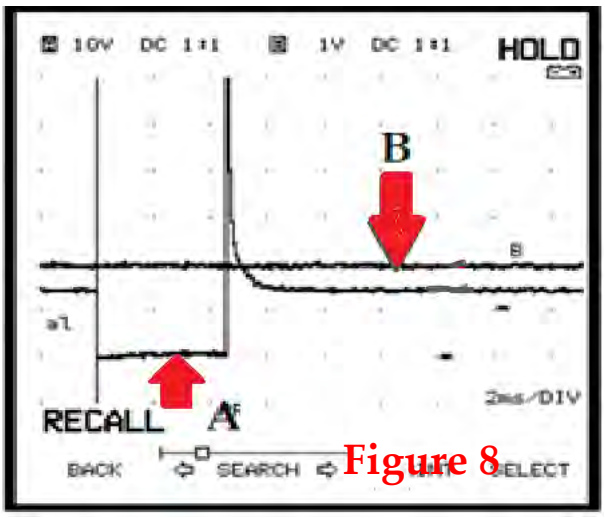
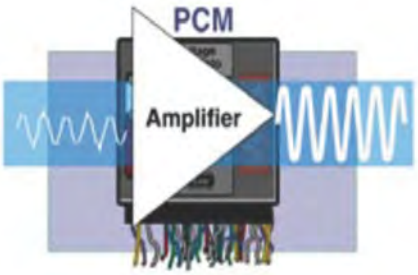


Figure 8

Sensor Signal Conversion

Sensors send signals in as an analog version to the PCM. If you want to get really technical the signal needs to be converted to digital voltage pulses. For example, some Mass Air Flow sensors require no conversion. To be honest, the PCM automatically converts analog sensors, so knowledge of this really has no effect on diagnosing any modern vehicle.

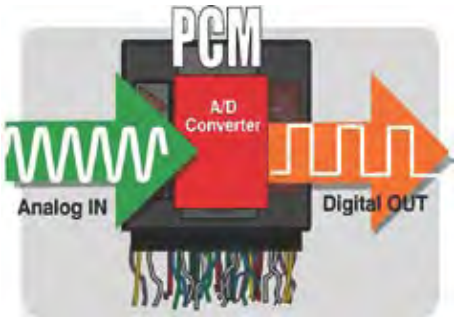
Analog sensors send variable voltage signals to controllers to indicate changes in component speed, signals position, and temperature. Analog signals are filtered to remove voltage spikes or other irregularities and amplified to increase signal strength.



(Con't on page 6)

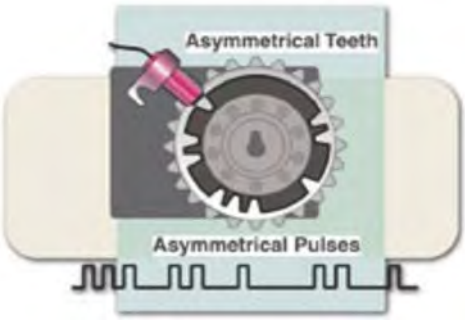
"Real World Computers Diag" (con't from p. 5)

Next, analog voltage signals are converted to digital voltage pulses by computer components known as analog-to-digital (A/D) converters.



An example is the speed signal from an AC (Alternating Current) crankshaft sensor that is converted to a digital rpm signal by an ignition module.

Some sensors generate a digital signal that needs no A/D conversion. Hall Effect and Photo-Optic sensors create digital voltage pulses whose frequencies indicate the speed of a rotating part, such as a flywheel, crankshaft, camshaft, or ignition distributor (in vehicles that still have them).



The engine speed, or rpm signal, is the single most important signal received by the PCM. Without it, the PCM has no idea how often to trigger an ignition spark or turn on the fuel injectors. The engine will not run without an rpm signal.

Computer Memory

Computer's need memory in order to do everything from remembering the radio presets to complicated timing calculations. Memory comes in three flavors: ROM, RAM, and KAM.

(Con't on page 11)

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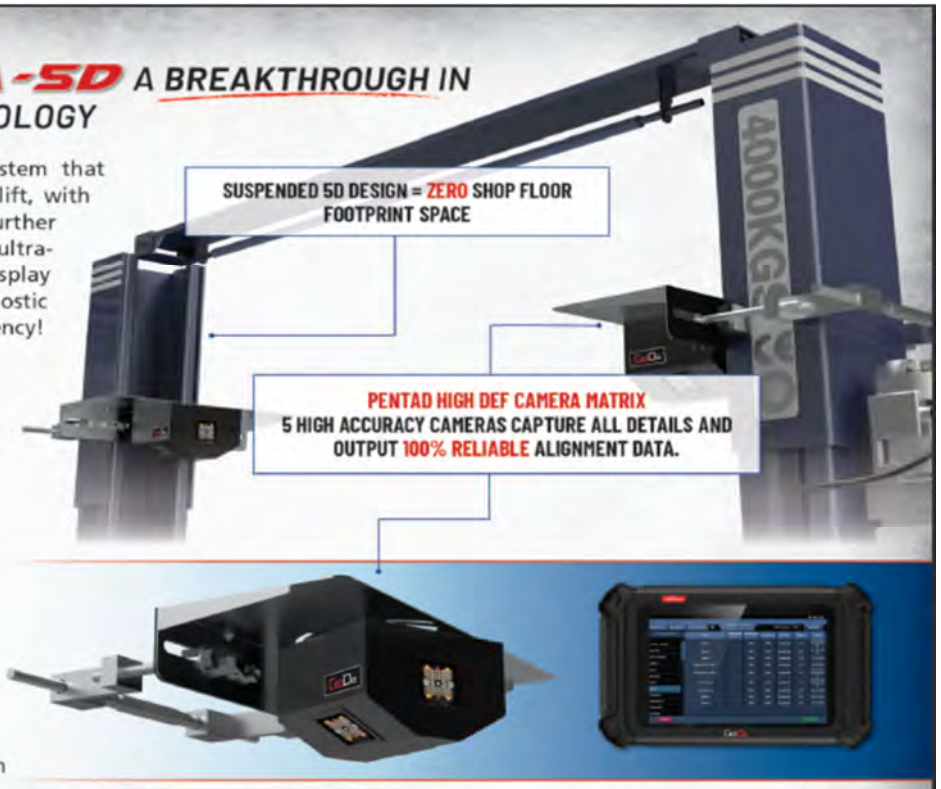

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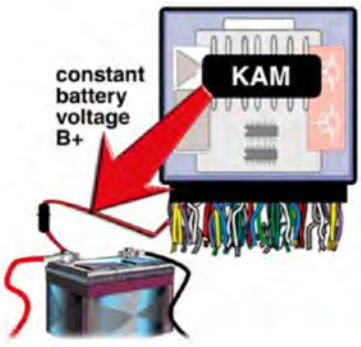
"Real World Computers Diag" (con't from p. 6)

ROM (Read Only Memory) is permanent memory that stores computer operating software and reference data. ROM is not erased when the ignition is switched off, and is changed only by reprogramming.

RAM (Random Access Memory) is volatile memory used by the computer for operational calculations. Think of it as an electronic scratch pad. RAM is erased each time the vehicle ignition is switched off.

KAM (Keep Alive Memory) stores driver preferences such as clock time, radio presets, seat position, etc. KAM also stores computer learned values. **Learned values** are adaptive corrections to default factory settings based on: personal driving habits; shifts in component performance caused by changes in operating conditions and different fuels; and normal vehicle wear and tear. KAM is maintained by **constant battery voltage**, even at key-off. It is erased only by a direct scan tool command or by removing power from the computer.



Computers need stable voltage as much as engines need fuel. They require stable DC operating voltage in a specified range (normally 10.5 to 15+ volts). The PCM also contains small voltage regulators that create reference voltages (Vref) used in sensor circuits.

Throughout the remainder of this article, it should be understood that correct vehicle system voltage is essential to proper computer operation. Repair battery and charging system problems first!

(Con't on page 12)

"Real World Computers Diag" (con't from p. 5)

The Evolution of Auto Computers

- Computers are faster and more precise than ever before. Slow responding, inefficient mixture control carburetors have all been replaced by rapid acting fuel injectors, soon all to be direct injection.

- Unreliable thermal/vacuum controls have been replaced by solenoids. Lightning fast transistors allow almost instantaneous control of actuators. Control valves can be modulated to precisely regulate the flow of liquids and gases. Computer controls keep a tight rein on overall vehicle performance, providing us with new standards of performance, reliability, and economy.

- Component wear is reduced, and vehicle hardware lasts longer. Cooling fan operation is a good example. For decades, the cooling fan was driven by an accessory belt connected to the engine crankshaft, placing a constant drag on the engine. The fan is now spun by an electric motor and activated only when needed.

- Maintenance intervals are longer than ever before. Improved lubricants and coolants and tighter control over cooling system operating temperatures and more precise fuel metering help extend oil and coolant life while reducing engine wear.

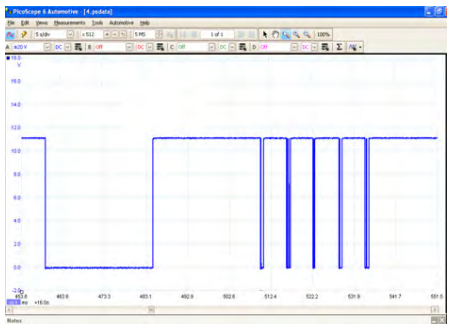
• Onboard diagnostic systems are more comprehensive and effective. As self diagnostics improve, new diagnostic trouble codes are added. Detailed code definitions specify the exact nature of vehicle faults. Increasingly sophisticated fault detection software allows the current generation of onboard diagnostic systems to actually anticipate many in harmful vehicle emissions.

(Con't on page 13)

"Real World Computers Diag" (con't from p. 6)

How Computers "Think"

Computers speak in 1s & 0s. I don't know that language and neither do you! If we want to talk directly to one computer or listen in on conversations between several interconnected computers in the same vehicle, we need an interpreter to convert all those 1s & 0s into words and messages we can understand.

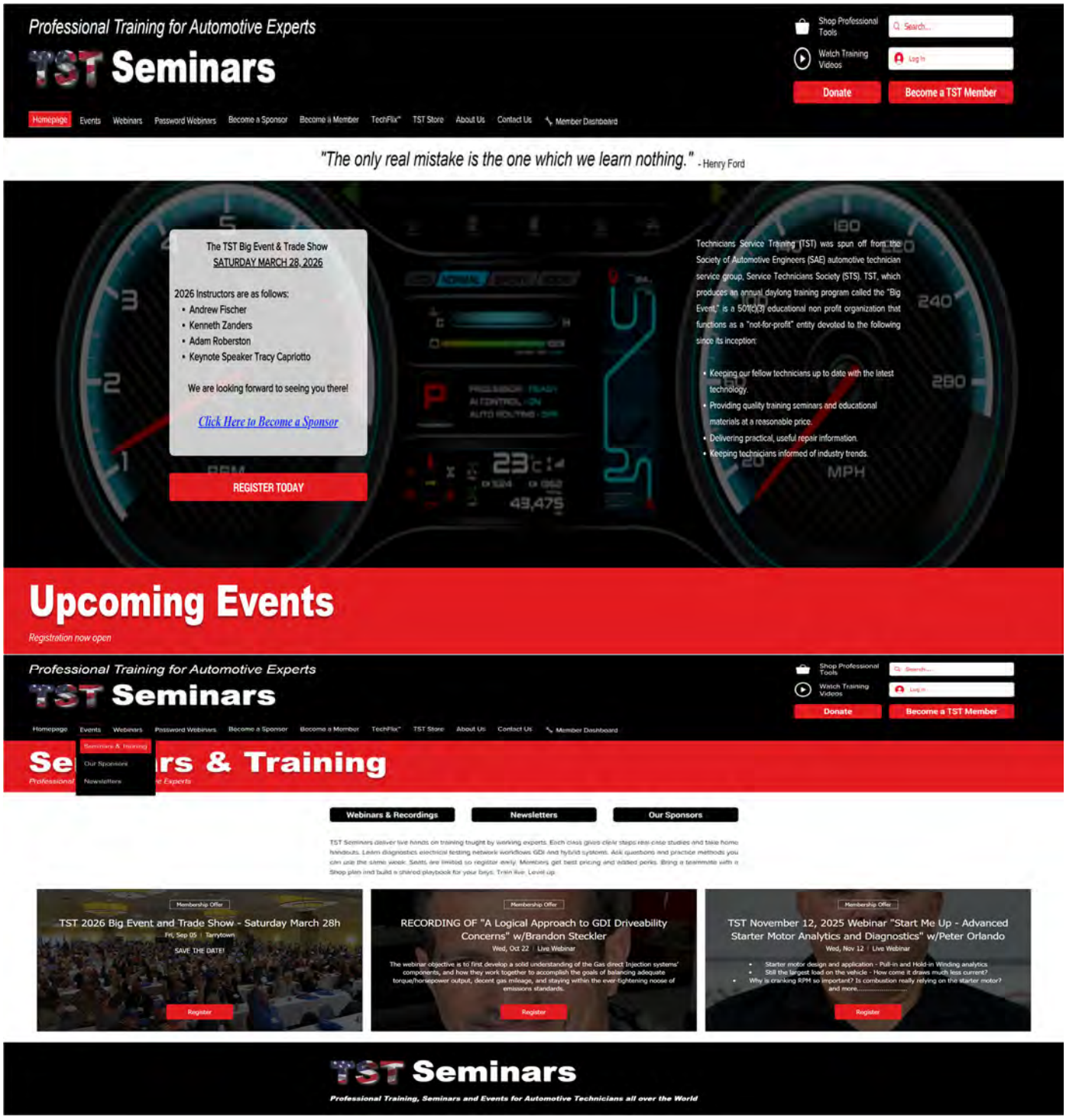


To give you a visual idea of what the computer speak looks like, we have to the right a screen shot of a PICO 6 labscope waveform capture.

The Scan Tool as Interpreter

Our dialog with the vehicle computer begins when we use the scan tool to enter a request for data. We may ask for information about fault codes, or about the current state of engine sensors. The computer responds to our request and sends back a string of coded voltage pulses representing data. The scan tool converts data from the vehicle computer into words and measurements and displays them on the scan tool display screen. The scan tool is the middleman-the interpreter-in our communication with the computer.

Article by "G" Jerry Truglia
TST Founder- President - ASE Master Technician



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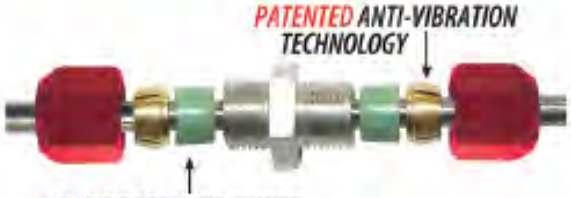

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