Those of you who have been reading my newsletters since I began distributing them may remember that I predicted, roughly a decade ago, that cars and light trucks would soon have 42-volt electrical systems; I guess I need to put lots of salt and pepper on that document, because I now have to eat those words. ☺ Back then, few people, if anyone, anticipated the current proliferation of hybrid and all-electric highway vehicles.

The reason for higher voltages has to do with the relationship between power, voltage, and amperage. Power is the time rate of doing work. Power provided by engines is often expressed in terms of horsepower, while power provided electrically is usually expressed in watts, or kilowatts (KW--one thousand watts). Consumed direct-current (DC) electrical power is simply the product of the voltage times the amperage. Electrical conductors are sized for the intended amps; the insulation on the conductors is sized for voltage; it is very much easier to insulate for high voltage than it is to build a conductor to carry large amperage. As an example, a 16-gauge wire can safely carry 10 amps; a 14-gauge wire can safely carry 15 amps; a 12-gauge wire can safely carry 20 amps; a 10-gauge wire can safely carry 30 amps.

Before the days of electrically driven or hybrid vehicles, most electrical loads in cars and light trucks were no more than 20 amperes, and many were quite a bit less. Alternators rated at 12 VDC (nominal) output with a maximum charging capability of 80 amperes or less were common in those vehicles. The only heavy electrical load was the starter, which could draw 100 amperes or more while turning an engine to start it; that's why battery cables are so large.

Propelling a motor vehicle to highway speeds requires many kilowatts of power, provided either electrically or mechanically or as a combination. To deliver 1.2 KW at 12 volts requires a current of 100 amperes, which would require a conductor similar to the size of conductors used to supply power to some homes. At 120 volts, however, only 10 amps are required to deliver 1.2 KW of power; the conductor size to safely carry 10 amps is very much smaller, lighter, and less expensive than the conductor size to safely carry 100 amps. There's the reason and justification for the higher voltages. So hybrid and all-electric highway vehicles have battery banks which deliver much higher voltage than the 12 VDC we are accustomed to in our cars, but those vehicles still need 12 VDC for standard automotive accessories. Some of them still maintain a separate 12-volt battery, while others have a 12-volt tap off the primary batteries. But all of them run on higher voltage. For instance, the GM eAssist system has a belt-driven, 11 KW (15 horsepower) motor-generator in place of the alternator and a 115-volt battery pack. Each manufacturer develops or uses its own system for charging and driving their hybrid and/or all-electric vehicles. All-electrics, of course, must be plugged into an external source of electrical power after some pre-defined period of operation.

An interesting side effect of electric motors is the difference in torque characteristics. A gasoline or diesel-fueled engine has zero torque at zero rpm; the torque increases with increasing engine speed to some maximum value at some engine speed. Motors, on the other hand, have maximum torque at zero speed; i.e., their maximum value of torque is available immediately upon application of voltage. Torque is what causes or allows a vehicle to accelerate; electrically driven vehicles, therefore, accelerate quickly from a stop. Except for those few which have extremely powerful motors, however, the top speed of an electrically powered vehicle is limited by the total power delivered by the motor(s), which is less than the total power delivered by most automotive engines at their peak output levels, resulting in a lower top speed for the electric car.

Perhaps an explanation regarding particulars of terminology is appropriate here. Although many people call the gasoline-fueled engine in a vehicle a "motor," technically a motor does not use a moving fluid; i.e., a device with windings which provides mechanical activity to produce work upon the application of voltage (resulting in current flow) is a motor. Devices which produce mechanical activity to produce work as a result of a flow of a fluid are called engines. The primary fluid involved in internal-combustion engines is air; the purpose of the fuel is to provide a source of heat to increase the volume and pressure of the air, enabling it to do work as it expands by pushing a piston. Some large, industrial air compressors are very similar to internal-combustion engines, but they function in reverse: instead of using pressurized air to create the ability to do work at the output shaft, work is applied at an input shaft, and pressured air comes out of the compressor. So, to be technically correct, an all-electric vehicle has only one or more motors, a hybrid vehicle has motor(s) and an engine, and a conventional highway vehicle has an engine. But no one will complain if you call the engine in your car a motor; it's relatively common usage, although not exactly correct. Even engine builders may call them motors!

The two photographs below show phases of the third staged collision conducted at the 2011 SCARS conference held in July of last year. The first photograph was taken shortly after the Ford Crown Victoria bullet car made contact with the Mercury target car. The second photograph was taken as the front of the left side of the Mercury made contact with the left rear door of the Ford in a secondary "sideslap." This collision was designed to provide for secondary contact, to demonstrate that conservation of momentum principles and procedures can be used to reconstruct a collision when there has been a sideslap after the primary impact. There are some who have proposed that a secondary impact prevents a reconstructionist from using conservation of momentum to reconstruct the crash. When asked what part of the laws of physics are invalidated by a secondary impact, however, those people are unable to provide a reasonable answer.

As the date on which all manufacturers of cars and light trucks will have to provide access to crash data contained in their airbag control modules (ACMs) if they store any crash data at all draws ever nearer, it will be interesting to see who gets on the Bosch CDR "bandwagon." Bosch provided access to ACM data in many Toyotas because of cooperation by Toyota; in subsequent releases of software, access to crash data in all Toyota vehicles which stored such data is planned to be provided. The process is not as simple as one might suspect, because the automakers do not manufacture their own ACMs—at least, not any which are currently accessible through the Bosch CDR Toolkit. Automakers also use different ACMs in some different lines of vehicles; they will also use the same ACM in other different lines of vehicles, but not with the same calibration. You wouldn't want the ACM in a Chevrolet Malibu to have the same calibration as the ACM in a Chevrolet Suburban (relatively soft in the front versus relatively hard in the front). So the automakers, the manufacturers of the ACMs, and Bosch all must get together to develop the hardware (primarily cables, which are usually different for each class of ACM) and the software to properly access and interpret the stored data. In other words, the software has to know that it's downloading an ACM from a Suburban, not a Malibu, and it has to properly decode the binary data stored in the module, converting it to the understandable results we see on the pages of the Crash Data Retrieval Report. There are dozens of modules in use in hundreds of vehicles; a 1998 Suburban is not the same as a 2007 Suburban, and a 2000 Impala is not the same as a 2010 Impala. The software has to know what vehicle is involved, in terms of year, brand, and model, and sometimes in terms of when in the production year the vehicle was manufactured, what engine was in the vehicle, and perhaps some other data bits. That's why the vehicle's VIN is one of the first inputs in the Bosch CDR software. If the user inserts an invalid VIN, the program will not allow him to progress to the next screen of inputs. But some people will "spoof" the software by putting in a valid VIN for some other vehicle which uses the same module, like inputting the VIN for a 2007 Chevrolet Impala to download a module in or from a 2007 Cadillac DTS. They both use the same ACM model, but they are not the same vehicle; the software usually won't know that it's being spoofed if the VIN is from a supported vehicle and is consistent with the specific ACM being interrogated. But, how do you know that the spoofed binary data has been properly and accurately "translated" to the numbers and other elements of the CDR Report? You don't! That's why a user is never supposed to spoof the software for an interrogation. And that's just one of the many details one learns at training seminars, an essential component of proper use of the Bosch CDR Toolkit. One interesting aspect of ACMs in Chrysler-corporation vehicles is that they "learn" and store the VIN of the vehicle in which they are installed, and that number will appear in the CDR Report after an interrogation. This characteristic of the Chrysler ACMs will provide additional documentation to verify that the data shown in the CDR Report was taken from the vehicle in question. It reportedly takes 10 to 20 ignition cycles for the ACM to acquire the VIN from the vehicle, so a very new car or truck may not have that piece of data inside the ACM, but it should be present in all other situations.

I hope all of you had a safe and happy holiday season. Last year was financially difficult for many people, including me. Let's make 2012 a better year! Please call whenever you have a question concerning my services.

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