MOTOR AGE

MARCH 2022
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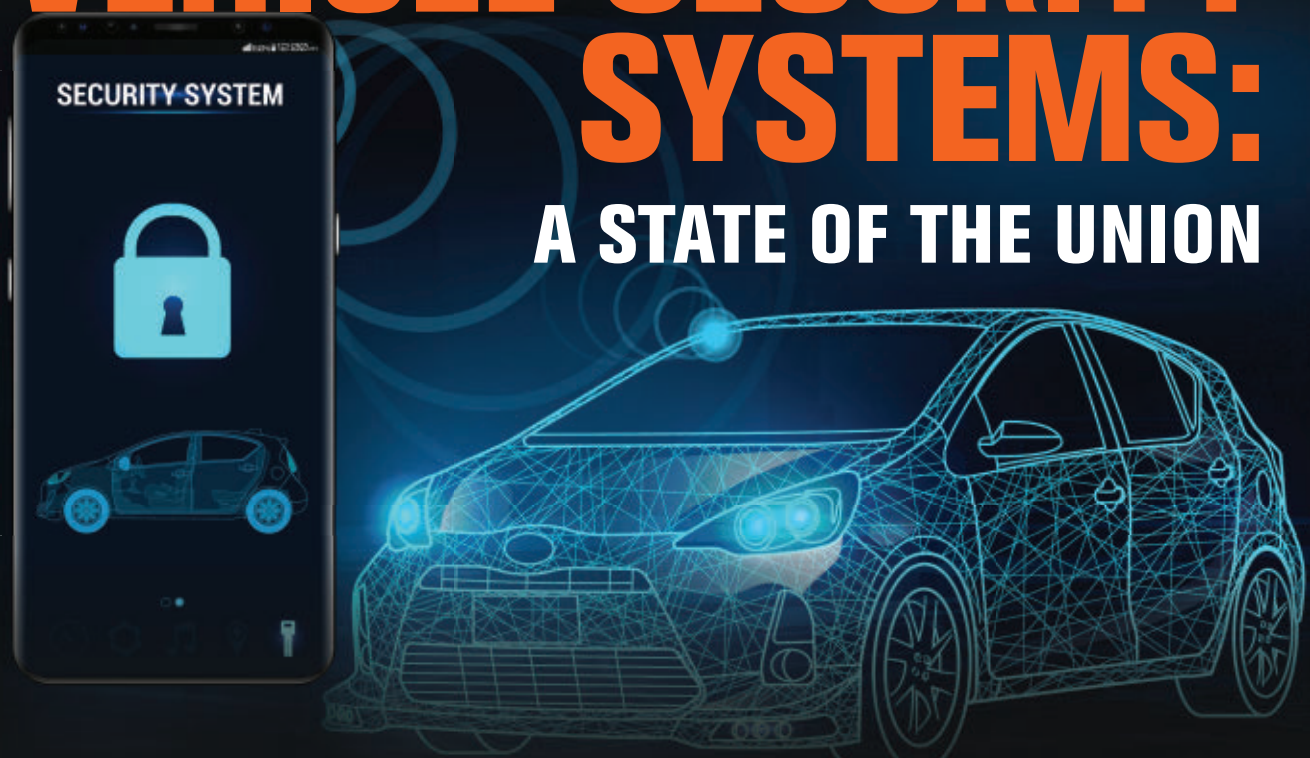

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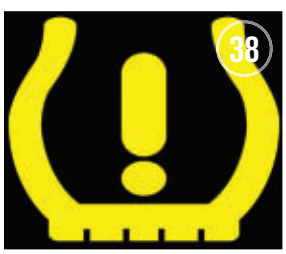

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But how do you know which to choose?

This article will guide you through the qualities of a top-notch trade school.

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LEGISLATION

REPAIR ACT INTRODUCED

IF PASSED, THIS FEDERAL LEGISLATION WOULD GIVE CONSUMERS RIGHTS TO THEIR VEHICLE'S DATA AND ENSURE A FREE AND FAIR REPAIR MARKET.

WIRE REPORT //

Editor's note: Independent repair facilities throughout the nation likely relish the thought of increased repair opportunities and corresponding revenue the REPAIR Act promises to bring (and not to mention, the convenience provided to their customers). This is an exciting time and a breath of fresh air to independent technicians and shop owners everywhere, for sure. Having access to the appropriate tooling, necessary vehicle data, and service/repair information would be a game-changer in the aftermarket.

United States Rep. Bobby Rush has introduced the Right to Equitable and Professional Auto Industry Repair (REPAIR) Act. The Automotive Aftermarket Suppliers Association (AASA), Auto Care Association, CAR (Consumer Access to Repair) Coalition, and Specialty Equipment Market Association (SEMA) issued a statement supporting this action. The legislation, H.R. 6570, is meant to ensure the preservation of consumer choice, a fair marketplace, and the continued safe operation of the nation's 288 million registered motor vehicles, 70 percent of which are serviced by independent repair shops.

"Today is one of the most memorable and important days in the history of the aftermarket. The REPAIR Act will help guarantee consumers' rights and the ability of the industry to ensure their vehicles operate safely," commented Paul McCarthy, president and CEO of AASA. "From the repair shop to the board room, this effort has been fueled by the people of the aftermarket, and we couldn't be prouder of that alignment behind this important legislation. This effort supports principles of competition, consumer choice, and safety that we believe will benefit the whole automotive industry in the long run."

To accomplish this, the REPAIR Act will:

- **Preserve consumer access to high-quality and affordable vehicle repair** by ensuring that vehicle owners and their repairers of choice have access to necessary repair and maintenance tools and data as vehicles continue to become more advanced.
- **Ensure access to critical repair tools and information.** All tools and equipment; wireless transmission of repair and diagnostic data; and access to on-board diagnostic and telematic systems needed to repair a vehicle must be made available to the independent repair industry.

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- **Ensure cybersecurity** by allowing vehicle manufacturers to secure vehicle-generated data and require the National Highway Traffic Safety Administration (NHTSA) to develop standards for how vehicle-generated data necessary for repair can be accessed securely.
- **Provide transparency for consumers** by requiring vehicle owners to be informed that they can choose where and how to get their vehicle repaired.
- **Create a stakeholder advisory committee** and provide them with the statutory **authority to provide recommendations to the FTC on how to address emerging barriers** to vehicle repair and maintenance.
- Provide **ongoing enforcement** by establishing a process for consumers and independent repair facilities to file complaints with the FTC regarding alleged violations of the requirements in the bill and a requirement that the FTC act within five months of a claim.

As advancements in vehicle technology continue, more barriers are being created for a competitive auto repair market. These barriers not only raise prices for vehicle repair and maintenance but also limit the consumer's choice in where they take their vehicle for those services. The REPAIR Act will limit these barriers, putting consumers' interests first.

According to a recent YouGov poll, 93 percent of respondents agreed that they should have the right to choose where and by whom their vehicle is repaired.

"The REPAIR Act will ensure consumers will have more, not fewer choices when they need a repair shop," said the CAR Coalition executive director Justin Rzepka. "They will also have access to the data they need to make sure the repair is done safely. This is important, consumer-first legislation and we look forward to working with lawmakers and industry partners to pass it."

The REPAIR Act follows three other significant moments for consumer choice in repair. In November 2020, Massachusetts voters voiced their support for Ballot Question 1 (also known as Right to Repair) with 75 percent of the vote, which preserves their right as vehicle owners to have access to and control of their vehicle's mechanical data necessary for service and repair at the shops of their choice. In May 2021, the FTC released their Nixing the Fix report which highlighted barriers that vehicle manufacturers have instituted to squash a consumer's right to repair. The FTC strongly supports expanding consumer repair options and found "scant evidence" for repair restrictions imposed by original equipment manufacturers. And in July 2021, President Biden issued the "Promoting Competition in the American Economy" executive order which encouraged the FTC to address anti-competitive repair restrictions.

"Americans should not be forced to bring their cars to more costly and inconvenient dealerships for repairs when independent auto repair shops are often cheaper and far more accessible," said Rush. "But as cars become more advanced, manufacturers are getting sole access to important vehicle data while independent repair shops are increasingly locked out. The status quo for auto repair is not tenable, and it is getting worse. If the monopoly on vehicle repair data continues, it would affect nearly 860,000 blue-collar workers and 274,000 service facilities."

STAFF ANNOUNCEMENT

ENDEAVOR BUSINESS MEDIA WELCOMES BRANDON STECKLER AS FULL-TIME MOTOR AGE TECHNICAL EDITOR

Endeavor Business Media's Vehicle Repair Group welcomes Brandon Steckler to his new full-time role as technical editor of Motor Age magazine. He had been part-time technical editor since January 2019, in addition to what was his "day job" of running Steckler Automotive Technical Services, a diagnostic specialist and technical training/support company serving technicians across the globe, as well as serving as a training instructor with CARQUEST Technical Institute.

"I'm extremely excited for the opportunity to devote more time to Motor Age," Steckler said. "This will allow me to weave myself more tightly into the fabric of the automotive community that I love so much, and to give back more than I ever could in the past. Great things to come, I promise."

Steckler began his automotive career at Northampton County Community College in Bethlehem, Pennsylvania, where he was a student of GM's Automotive Service Educational program. In 2001, he graduated top of his class and earned the GM Leadership award for his efforts. He still instructs classes on evenings and weekends and also provides private training, telephone and live technical support for technicians around the world. He holds ASE certifications A1-A9 as well as C1 (Service Consultant) and is certified as an Advanced Level Specialist in L1 (Adv. Engine Performance), L2 (Advanced Diesel Engine Performance) and L3 (Hybrid/EV Specialist).

"We are thrilled to welcome Brandon to the Vehicle Repair Group," said Group Publisher Kylie Hirko. "His role as Technical Editor brings a depth of technical expertise to ensure our portfolio of flagship brands continues to deliver expert insights and technical content to address the biggest challenges impacting automotive service professionals today. Brandon is recognized as one of the top aftermarket trainers in the industry, and we're so excited he has joined our team to help us in our mission of advancing the automotive service professional."

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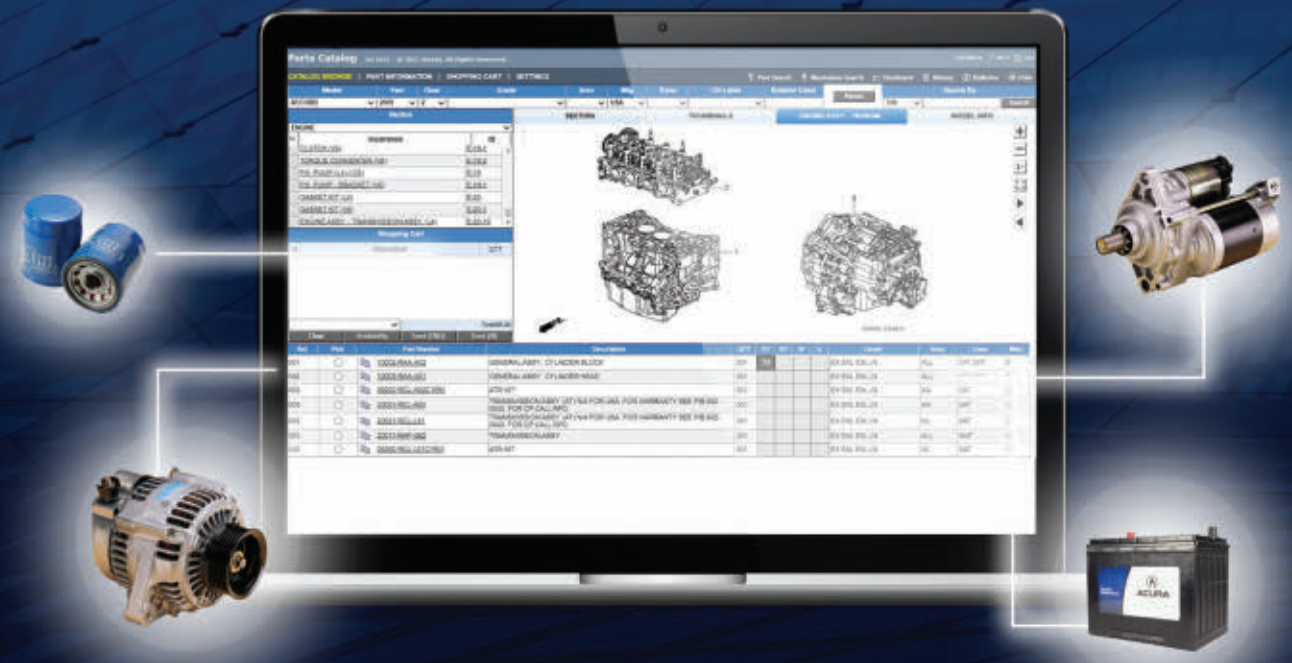

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Why it's important to track your shop's conversion rate

BY MIKE HALEY // Contributing Editor

We have all been told that tracking sales and key performance indicators (KPIs) is the best way to determine how well our business is doing. While that statement is true, I've found that the most common KPIs tracked rarely include conversion rate. The problem with excluding conversion rate is that this KPI plays a key role in gauging sales performance. Keep reading to discover why you should track conversion rate and its role in tracking sales performance.

The goal of courtesy checks

Let's go back a decade or so. Do you remember when courtesy checks were introduced as a process that would help grow our business? Back then, it was a paper checklist of safety and maintenance items that a technician should inspect while the vehicle was in for service. It has evolved into a picture/video inspection, but the original intent remains intact. So, what was the reason for introducing the courtesy inspection? There are a few. First, vehicles were becoming more complex, and the "do-it-yourselfers" could not work under the hood like they used to. Second, checking the engine when the light came on required a scan tool to pull the code to help diagnose the problem. Third, the tune-up went away along with other parts that required adjusting or replacing. All these changes put auto repair professionals at the forefront, making it our responsibility to inspect vehicles for the convenience and safety of our customers.

There was also a business reason for courtesy checks. Back in the day, car count was not an issue. The car manufacturers were not building the highest quality product. Between breakdowns, tune-ups, brake replacements, and rebuilt carburetors, shops had no shortage of vehicles to work on. Then things started to change. Car manufacturers began to put in technology and improve reliability to compete with the Japanese manufacturers. As vehicles became more reliable, the number of yearly service visits was reduced. With fewer visits per year on each vehicle, we had limited opportunities to sell. The cour-

IF YOU REALLY WANT TO MEASURE THE TOTAL SUCCESS OF YOUR SHOP'S PERFORMANCE, YOU ALSO NEED TO TRACK CONVERSION RATE

tesy check helped ensure we inspected the correct items and systems on a vehicle to avoid missing a sales opportunity.

To that end, we worked hard to do a great job inspecting the vehicles' safety items and systems that required maintenance. Many of us have also become proficient in tracking related KPIs to gauge performance, including car count, sales, and average repair order. But, if we really want to measure the total success of our business, we also need to track the missed opportunities.

Why missed opportunities are important

Why track the missed opportunities, you ask? As we know, we very rarely sell everything we recommend to the customer. Taking our recommended total versus what we actually sell is the conversion rate. Sales companies measure this KPI to determine their sales team's performance. I like to use a baseball analogy to help explain this. Baseball tracks players' performance by taking their at- bats versus their actual hits to determine their batting average. No baseball players get a hit at every at bat; most professionals average around .300. A .300 batting average means a player earned three hits for every ten times at bat and missed seven opportunities to make a hit.

How do we apply this to our industry? Hopefully, you have a courtesy check program in your shop, and your technicians are doing a great job inspecting vehicles so your service writers can have more opportunities to sell estimates. This now becomes a measurable KPI.

Let's use simple numbers as an example. Let's say our technicians are averaging $1,000 estimates. The service writers are averaging $300 work orders. Our conversion rate is 30%. We can also help diagnose our business by measuring our technicians on the average estimate they turn in versus the other technicians. We can do the same for the service writers by measuring what each one is averaging. This can become a quick way to determine if you have a training, process, or another type of issue with a technician or service writer. It may also lead you to work on sales skills at the counter and possibly product knowledge for the technicians.

A strong conversion rate

So, what is a good conversion rate? The national average fluctuates between 33% and 36%. Being an optimist and wanting to be the best, I see these numbers as big opportunities. What if you work with your technicians to improve the courtesy checklist to help build taller estimates? What if you help the service writers sell features and benefits along with value? How much could you move the conversion rate?

A strong conversion rate will help you increase sales even if car count is off. Looking at your business from the perspective of "What could I have done versus what I actually did?" can help you diagnose opportunities you have.

To measure your service writer's conversion rate and your shop's rate overall, get ATI's Conversion Rate Tracker at http://www.ationlinetraining.com/2022-02 for a limited time.

MIKE HALEY started in the auto industry in 1985 at a four-bay shop while also attending college. He joined Pep Boys in 1987, climbing to District Operations Manager, and then was operations manager for CarMax Toyota, the second largest Toyota dealership in the country. Mike uses his experience and certifications to help shop owners become successful. ATI's 34 full-time, certified coaches, including Mike, have helped ATI's members earn over TWO BILLION DOLLARS in return on their coaching investment since ATI was founded.

Work faster, not harder… with technology

BY DAVID ROGERS // Contributing Editor

These are incredible times to be a shop owner.

Techs have never had more information closer at hand for fixing vehicles. Service advisors have never had more access to parts sourcing solutions. There have never been this many software applications or diagnostic tools or online forums literally at the fingertips of everyone in the shop.

Despite unprecedented access to tools and training and systems and processes and help, there's no efficiency revolution taking place in the auto repair industry. The average shop is paying for a half-dozen subscriptions each month, all explicitly promising the same undelivered thing. All the while, the hours billed by technicians stay steady, the effectiveness of the service advisors remains flat, and the amount of money spent by the owner keeps increasing.

We live in a golden age of technology, and we're wasting it.

It doesn't have to be this way. Shops CAN use technology to work faster not harder. But the only way to get the efficiency revolution we all want in this industry is to see technology as a means, not an end…and that using technology is an activity, not a result.

The telltale signs are everywhere.

For some shops, it's multiple monitors sitting on the front desk in front of each service advisor. For others, it's the flicker of the technician's computer screens as they toggle between multiple website subscriptions trying to dig for what they need. It's unnecessary personnel. It's unneeded hardware.

In shop after shop, owners have been sold a vision that technology can solve problems, but that's not really the truth. What they mean is "technology can solve this problem," with "this" being the one thing solved by the software or hardware a company is selling.

Which makes sense, of course. It's natural to want to solve one problem at a time, preferably the one that you're dealing with right now. If technology can make it easier to handle part and core returns, and all it takes is a new machine to do the work, then why not?

Of course, seven "solutions" later, and your shop needs a dedicated AP clerk to run the parts and core return technology, a dedicated AR clerk to operate the billing technology, and a dedicated parts manager to control the new inventory technology, and suddenly it's technology that is running your shop instead of the other way around.

This kind of thing happens everywhere in a shop. It happens to the numbers and reports that shop owners use to manage the shop every day. It happens to the hardware we have to upkeep to run all of the new systems and processes. And it happens to the technology we use to try to make our jobs easier.

We've fought this kind of bloat in our own shop! Technology gave us an unprecedented understanding of our metrics and allowed us to crunch the shop and team's performances into dozens of numbers. We then tried to use all of these numbers in our daily decision-making. You can imagine how poorly this went!

Rather than being empowered by all of the new insight created by technology, we created paralysis. We let unimportant data hinder our ability to make good decisions, and worse, we inflicted that same paralysis on our managers. Ultimately, despite all of its promise, technology created far more problems than it alleviated.

Does that mean I'm anti-technology? Of course not!

Technology has empowered my shop to maximize efficiency and bill more hours on every car. And it's allowed all my technicians to earn more than $100,000, putting

my shop in great shape during this worsening tech shortage.

The problem is technology without process.

Simply buying a second monitor for a service advisor doesn't allow them to get more done. Simply buying a subscription to a new labor guide doesn't make techs complete better inspections or writeups.

In fact, in both cases, investing in these technologies and neglecting processes can make the employee less efficient. If the service advisor is constantly hunting for a window, or the tech is constantly toggling between programs, then technology is a hindrance, not a help.

In the case of technology leading to too many numbers and decision-making paralysis, the solution was refining the process: these are the numbers our shop needs to pull, who is responsible for pulling them, and how we're going to use them as a team. Once the process was in place, technology allowed the process to be executed smarter and faster.

It's the same way for new hardware and software for service advisors and technicians. Is the process clear about how they complete inspections, estimates, and advisements? Do they clearly understand what they need to monitor, how often, and what actions to take? Answering these questions will definitively lead to eliminating unnecessary systems and combining processes, all of which improves productivity.

If the need for the new hardware or software exists after the process is refined, there's a good chance that adding the technology will lead to working smarter, not harder.

The next time you consider adding additional infrastructure – whether hardware, software, or even personnel – **start with the process**. Is everyone trained on their clear expectations? Have you eliminated unnecessary steps, extra data, bottlenecks, and hurdles?

Remember, every unnecessary system and step and process you eliminate will lead to your techs billing more hours and your advisors growing sales.

In spite of everything, I'm a huge believer in the power of technology. My own shop is proof of that. The technology emerging today has the potential to transform how repair shops operate.

But nothing replaces the need for good processes. It's the secret to eliminating stress, increasing productivity, and working smarter – not harder – with technology.

DAVID ROGERS is the COO of Keller Bros., an award-winning repair shop in Littleton, Colorado. 25 years after David took over management of the shop, it continues to set sales and profit records because of perfected processes and systems. These same systems and processes are at the core of Auto Profit Masters, which David founded in 1999 to help fellow shop owners eliminate inefficiencies and maximize profits. Learn more at https://autoprofitmasters.com/solutions

Right to Repair:

Views from the Biden Administration, the Federal Trade Commission, and the agriculture industry

Independent shops must retain access to the vehicle data, tools, and equipment necessary for repairs

Right to Repair" is currently a prevalent issue across industries—from small electronics and home appliances to agricultural equipment and automobiles. In many cases, the advent of new technology has prompted some original equipment manufacturers to restrict access to the tools and information necessary for repairs.

In July of 2021, President Joe Biden signed the "Executive Order on Promoting Competition in the American Economy" that directed the Federal Trade Commission (FTC) to craft rules enforcing the consumer right to repair. In the months since this order was signed, President Biden has spoken on right to repair on multiple other occasions. At the American Farm Bureau Conference in January, the President reiterated his support, saying that family farmers and ranchers deserve the right to repair the equipment they own, either themselves or at an independent shop.

President Biden also spoke before a meeting of the White House Competition Council, saying, "Too many areas, if you own a product... you don't have the freedom to choose how or where to repair the item that you purchased. Denying the right to repair raises prices for consumers and means independent repair shops can't compete for your business." The White House Competition Council was created as part of the Executive Order and is chaired by the head of the White House National Economic Council.

IT IS ESSENTIAL THAT INDEPENDENT REPAIR SHOPS RETAIN ACCESS TO THE VEHICLE DATA, TOOLS, AND EQUIPMENT NECESSARY TO REPAIR CARS THAT CONSUMERS BRING TO THEIR SHOPS.

There are currently two lawsuits filed against agriculture equipment manufacturer John Deere alleging that the company's proprietary tractor software is creating a monopoly that unfairly disadvantages small farmers. In these cases, farmers were given only one option for repair of their malfunctioning agricultural equipment—the John Deere technician. Historically, farmers have had the option to repair their equipment themselves or take the equipment to an independent repairer. However, according to these suits, John Deere has restricted access to the software and tools necessary to repair this equipment, often resulting in more costly repairs for the consumer.

These cases allege that John Deere has violated the Sherman Antitrust Act by creating a monopoly—stifling competition in the tractor repair market, driving up prices, and forcing small independent repairers out of business. John Deere committed to making their software and equipment available by January 2021, but to date, these suits allege, has not followed through on this commitment. This month, U.S. Senator Jon Tester introduced the "Agriculture Right to Repair Act" which, if passed, would guarantee farmers the right to repair their own equipment and work to end current restrictions on the repair market.

Prior to the Executive Order on Promoting Competition, the Federal Trade Commission (FTC) released a report entitled "Nixing the Fix."

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This report provided a comprehensive review of "how manufacturers may limit repairs by consumers and repair shops, and how those limitations may increase costs, limit choice, and impact consumers' rights." In July, the FTC unanimously adopted a policy statement on repair restrictions. The statement affirmed that the commission would devote more enforcement resources to combat practices by manufacturers that impede third-party and self-repair.

On Capitol Hill, industry groups such as the American Alliance for Vehicle Owners' Rights (AAVOR), whose members include the Automotive Service Association (ASA) and the American Car Rental Association (ACRA), among others, are working for a legislative solution to the issue of vehicle data access. This month, AAVOR submitted a statement before the U.S. House Transportation and Infrastructure Committee's hearing on "The Road Ahead for Autonomous Vehicles" reaffirming the importance of vehicle data access not only for the autonomous vehicles of the future, but for all vehicles on the road today.

In November 2020, The Massachusetts Right to Repair Law Vehicle Data Access Requirement Initiative passed in a 75-25 percent popular vote through a public referendum. This ballot initiative required manufacturers to make telematics data wirelessly accessible by vehicle owners and independent repairers, beginning with model year 2022 vehicles. The referendum has been challenged in federal court by the Alliance for Automotive Innovation, where it remains in litigation.

The judge was initially expected to issue a verdict last November. However, in response to the legislation, Subaru disabled the telematics in all their 2022 vehicles in Massachusetts, raising questions on the enforceability of the ruling. Since then, automaker Kia has disabled their telematics system as well. To date, the case in Massachusetts remains open.

It is essential that independent repair shops retain access to the vehicle data, tools, and equipment necessary to repair cars that consumers bring to their shops. However, the correct pathway forward, whether it be state legislation, federal legislation, FTC regulation, or industry agreement, remains to be seen.

MADI HAWKINS works as a Washington D.C. representative of the Automotive Service Association. She has a B.A. of Public Policy Studies from Vanderbilt University. *mhawkins@reddingfirm.com*

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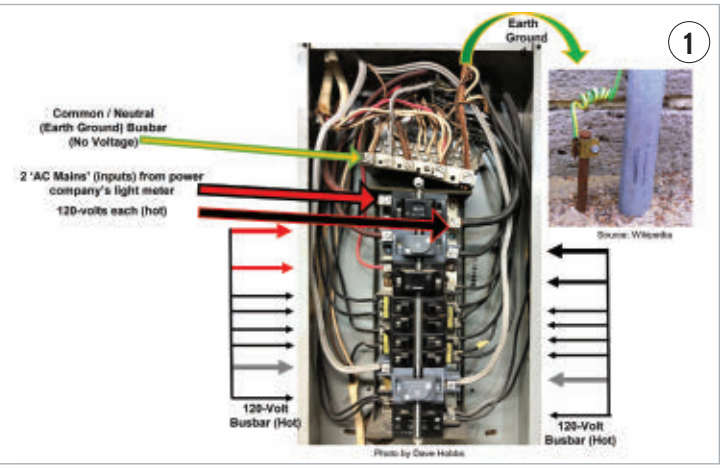
WITH AC CURRENT, WHAT YOU DON'T KNOW CAN HURT YOU, DAMAGE YOUR TEST EQUIPMENT AND FOOL YOUR DIAGNOSTICS.

BY DAVE HOBBS // Contributing Editor

If you know who (or what) "ELI the ICE Man" is, you're probably a commercial electrician or electrical engineer. If that applies, you might even consider skipping this article! Otherwise, what you don't know can hurt you, damage your test equipment and fool your diagnostics. AC (Alternating Current) is found inside alternators, coming out of sensors, and totally rules the worlds of HEVs, PHEVs, and BEVs. In spite of AC's varied uses in today's cars and trucks, most of us in the wrenching world are far more comfortable with our knowledge level of DC compared to AC.

What exactly is AC, and why should you care?

We've all been focusing on DC (Direct Current) for most of our automotive service careers, and rightfully so. DC is the flow of electrons in one direction. The direction of flow displayed in schematics (conventional flow theory of positive to negative) or the scientifically proven theory of electron flow (negative to positive) is mainly trivial for those of us in the automotive service world. AC is electricity that moves in both directions. The speed (frequency) at which it switches back and forth for household AC electrical power is 60 Hz in North America and 50 Hz in certain other parts of the world. Residential and light commercial AC voltage levels (**Figure 1**) are 120v and 240v (+/- 10 volts), depending on whether the circuit is used for lower wattage appliances (i.e., lighting, televisions, etc.) or higher wattage appliances (i.e., electric water heaters, clothes dryers, etc.). But wait . . . this is "Motor Age Magazine" and not "Electrical Contractor Magazine," right? Right . . . but the automotive world is taking a VERY fast turn to vehicle electrification. Knowledge of 3-phase AC power inverters, AC induction motors and off-board charging equipment for PHEVs (Plug-in Hybrid Electric Vehicles) and BEVs (Battery Electric Vehicles) needs to become yet another area of expertise for the professional automotive repair technician! Bluntly put . . . if you shy away from learning some of the same concepts your buddies in the electrical contracting world already know, you're going to fall behind in your ever-changing automotive world!



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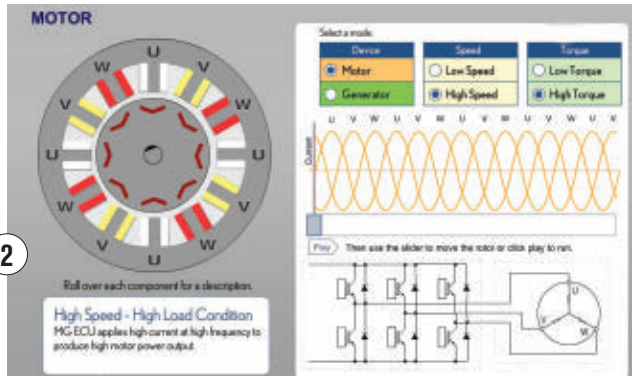
LESSONS FROM A RESIDENTIAL BREAKER BOX: Diagnosing BEV battery charging complaints will involve (at least) a cursory level of knowledge of AC residential/commercial power. The black breaker marked "MAIN" is where the two 120-volt AC power lines (large red wire on left, large black wire on right) come in (power inputs) from the power company to provide a total of 240-volts of AC power. These two gray-colored breakers (40 amps 2nd from top and 30 amps 2nd from bottom) also have a pair of power outputs (one red and one black hot wire each) to provide 240-volts of power leading to an electric range and an electric drier. Each of the smaller 15-amp (black) breakers have a single black (hot) wire feeding other circuits throughout the home. Notice the wires with white insulation and the wires without insulation all converging at a block of bus connections at the top? These are the neutral (white) and earth grounds (bare) that literally are connected into the earth outside this residence.



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ELECTRIFIED VEHICLE INVERTERS are involved in the rectification (from the MG in Generator mode) to charge the high voltage battery pack. They also provide the high voltage AC current to run the MG as a motor. Whether it's a 3-phase BLDC low voltage in tank fuel pump or a 480-volt 3-phase industrial motor, or a Prius MG, the same circuit labels apply (U-V-W) with the same phasing of a wave every 120-degrees. Avoiding equipment damage while multi-channel scoping of high voltage may require differential probes depending on the model of scope you're using.

Where will you encounter AC circuits on today's vehicles?

They've been all over the place, and you may not have thought much about them. But with vehicle electrification, they're growing by leaps and bounds! Here are just a few examples:

Examples of Traditional Automotive Low Voltage AC Circuits with Easier to Understand Concepts:

Sensors

- Electronic ignition distributor pick-up coils
- 2-wire reluctance-style (older) wheel speed sensors
- 2-wire CKP Sensors
- Vehicle Speed Sensors
- Knock Sensors

Audio

- Amplifier outputs to speakers
- Low level inputs from head units, microphones, and playback devices

Composite video

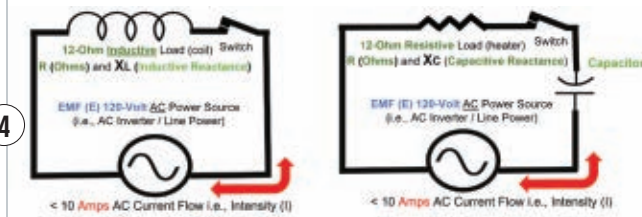
- Infotainment
- Video game connections
- Simple analog back up cameras.

Examples of Newer Automotive AC Circuits with High Voltage / More Challenging Concepts:

- Low-voltage 3-phase BLDC in-tank modular fuel pumps
- Electric motor resolvers (complicated position sensors)

3

THIS PICO 4423 (fig. 3) uses a common ground between each channel's BNC jack, so a set of differential probes was used. These probes feature attenuators to prevent damaging the scope's max input level, 100-volts.



4

ON THE LEFT SIDE OF FIG. 4 IS AN INDUCTIVE (COIL) CIRCUIT that has additional resistance beyond what can be measured by an ohmmeter (inductive reactance) when AC current flows. On the right side is a capacitive circuit that has additional resistance beyond what can be measured by an ohmmeter (capacitive reactance) when AC current flows.

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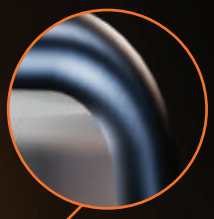

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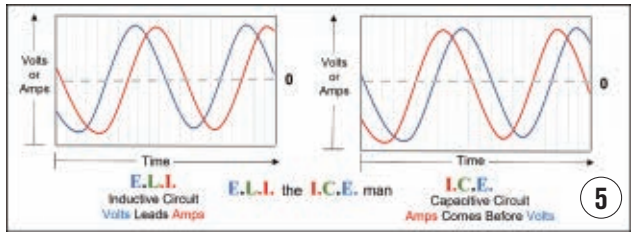
- 3-Phase High Voltage AC Motor Generators (MGs on HEVs, PHEVs and BEVs)
- EVSE (Electric Vehicle Supply Equipment)
- Level 1 Charging Cable (120-volt cable that comes with every PHEV and BEV)
- Level 2 Charging Cable (optional 240-volt cable that must be installed in customer's garage by a qualified electrician)
- Level 3 (technically level 2 "DC Fast Charge") charging station for 1-hour BEV charges

Testing AC Power Circuits? Use Caution! Basic Rules for Test Equipment and AC Powered DUTs (Devices Under Test):

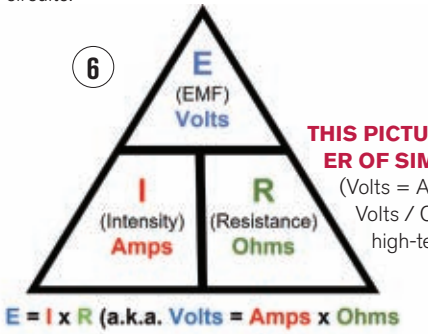
RULE # 1

ALWAYS use a differential probe and/or isolation transformer to "electrically separate" your equipment from what you're testing to prevent damage and/or injury!

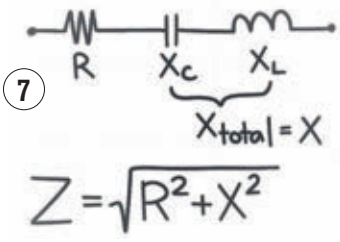
Reason: Vehicle grounds, equipment grounds, earth grounds and ground loops can be confusing. Electrical isolation can be your best friend.



DISPLAYED ARE SCOPE PATTERNS that illustrate how volts leads the amps in an AC powered circuit that's mostly inductive (L) and the opposite when the AC powered circuit is mostly capacitive (C). "ELI the ICE man" is a simple mnemonic to help remember the differences in "phasing" between volts and amps in the two different types of AC circuits.



THIS PICTURE IS A REMINDER OF SIMPLE OHM'S LAW (Volts = Amps x Ohms, Amps = Volts / Ohms, etc.) to perform high-tech math.



THIS EQUATION IS USED to calculate TOTAL resistance referred to as impedance (Z). Ohms (measured with an ohmmeter) along with capacitive reactance (Xc) and inductive reactance (XL) factor in.

RULE # 2

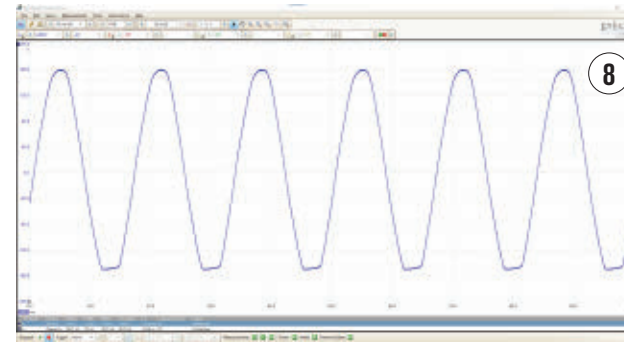
ALWAYS treat circuits as if they have potentially hazardous levels of voltage until proven otherwise.

Reason: OSHA rules designate any voltage (AC or DC) over 50-volts as potentially injurious or lethal. I've seen Fluke Instruments documents that put the number at 30 volts for AC power and 60 volts for DC. Using a Live/Dead/Live test is a good way to apply this safety rule. LIVE: First use your equipment to measure something you know is live (to make sure your connections and meter/scope set up is good. DEAD: Next move to the component/circuit you're wanting to make sure has been powered down. LIVE: Finally, move back to the circuit that you originally used in the 1st "LIVE" test to make sure you're not having a "stupid" moment!

RULE # 3

ALWAYS Follow OEM Recommended Safety Practices.

Reason: Auto and truck manufacturers have teams of engineers making sure their dealership service technicians stay safe. Safety is always a priority with vehicle manufacturers. When in doubt – read the manual! If you are prompted by a service manual to test Live AC voltage, (or opt to go beyond the manufacturer's published



GETTING A NICE AC sinewave pattern like this one from a 120-volt wall socket can be hazardous to your scope (or you) if you don't use the correct adapters and equipment.

EVEN THOUGH THE PICO 4425A featured high resistance between the BNC ground and USB ground and had a max input rating of 200-volts, I used a differential probe with a built-in attenuator set to 20:1 and only connected the red lead to the hot terminal in the power strip (just to be safe). The meter is a true RMS meter, showing 119.6-volts. The peak voltage of the scope shows 160-volts.

diagnostics and scope an inverter output – **Figure 2**) make sure you protect your equipment (**Figure 3**) and yourself (with Class 0/1,000-volt safety gloves). If you're dealing with residential/commercial 120-volt and 240-volt AC power and are in doubt, consult a professional electrician!

RULE # 4

Ohm's Law Still Applies to AC Circuits (Kind of!)

Reason: Subtle differences between DC and AC can change the math!

When DC travels through an inductor (i.e., a coil winding) there are some strange things (current inrush, voltage spikes, etc.) but they typically only occur for an instant. When AC travels through the same inductor, the frequency of the AC (moving back and forth within that coil) causes some additional resistance depending on the inductance (measured in Henries) and the frequency of the AC. (**Figure 4**) When DC travels in a circuit with a capacitor involved, it simply charges the capacitor and stops flowing. The capacitor acts like a diode to stop the current flow. When AC is involved in a similar "capacitive-natured" circuit, the AC will charge and discharge the capacitor. AC current (for all practical purposes) flows through the capacitor if the frequency of the AC and the capacitance (measured in Farads) allow. That's where we can get the crazy differences in a scope pattern illustrated in **Figure 5**. Ohm's Law still applies, (**Figure 6**) but with some variations thanks to inductive and capacitive reactance. The math to total circuit Impedance (Z) is complicated, (**Figure 7**) compared to simple math with Ohm's Law. The good news is, there is NO need to memorize ANY of this to diagnose vehicles. Just understand why AC behaves differently (compared to DC) depending on the nature of the circuit!

Testing AC power the RIGHT way!

Some concepts of AC power using a meter are simple – use a meter that says "True RMS" on it. RMS stands for "Root Mean Square." It's simply 0.707 multiplied by the peak AC voltage. (**Figure 8**) When looking at an AC power (wall socket) waveform on a scope, you'll see a VERY tall waveform with peak-to-peak voltage. Peak voltage is the highest voltage measured from the 0-volts level on the AC waveform. A battery-powered multimeter has no issues with plugging into line power because it's isolated from the power source. A scope, however, may need extra adapters and procedures (**Figure 9**) in order to capture accurate waveforms without damaging the scope or you!

Tips on EVSE – Electric vehicle supply equipment

Regarding EVSE, you might ask "why not let the customer deal with their local electrician on the matters of charging cables / stations?" Take a long pause and think about that question for a moment. Ask yourself "how many electricians do you know who are knowledgeable on PHEVs and BEVs?" I think we'll all agree the answer to this question will be "few to none!" Similarly, "how many automotive techs know the difference between Level 1 EVSE charging cable NEMA 15 and NEMA 20 plugs and wall outlets?" (**Figure 10**) The same answer applies . . . few to none! This will be an area where cooperation between those who manufacture and install EVSE will need to work closely with you, the professional auto tech. Otherwise, PHEV and BEV high voltage battery pack charging issues will become a game

NEMA (National Electrical Manufacturers Association) **HAS STANDARDS** for AC power plugs and sockets/receptacles. Make sure you know the difference between NEMA 15 (right) and NEMA 20 (left). Don't try to install a NEMA 20 GFI receptacle in your repair shop unless you know that circuit's wiring is rated for 20 amps. If in doubt – consult a qualified electrician!

CHECKING OUT YOUR CUSTOMER'S PHEV OR BEV destination charger? They should have an OEM-supplied Level 1 / 120-volt charging cable that comes with the vehicle. However, they may have purchased an aftermarket unit. You probably will end up purchasing a J1772 level 1 and possibly level 2 (240-volts) charger for your shop's diagnostic purposes. Look not only a reputable brand, but also make sure there's a "UL Listed" and CUS label (Canada and United States testing standardization). Note the charge cable's amperage draw spec and match to a suitable circuit in your shop. This Level 1 Charging cable from Delphi Technologies by BorgWarner has multicolored LEDs on the front to give charging status and outlet condition.

NOT SURE IF YOUR CUSTOMER'S PHEV OR BEV has a faulty Onboard Charging Module or a problem with their mobile Level 1 or optional (home) Level 2 equipment? For the serious "electrified repair shop" test equipment to test EVSE (off-board chargers and charging stations) like this FEV100 from Fluke can make the difference between the "blame game" and getting to the bottom of a customer's vehicle problem.

of "finger pointing" between the electricians/charging station providers and the auto techs. Not all EVSE components are created the same. The PHEV/BEV Level-1/120-volt charging cable in **Figure 11** is has a composite body and rubberized cord that is rated to survive vehicle runovers and operate in extreme cold temperatures. Some cheaper and/or fancier (Bluetooth Controlled) charging cables entering the aftermarket may not last as long or have the same protection compared to more robust (and expensive) charging equipment. I like to compare the lesser quality PHEV / BEV charging equipment to the Brand-X inexpensive power supplies for laptop computers. I've always avoided using them out of the reasonable concern they might damage my laptop. An electrical incident in your shop and/or expensive 'thermal incident' with your customer's PHEV/BEV would be an even greater concern compared to a damaged laptop. For the AC power-savvy shop of tomorrow, continued education and well researched tool and equipment choices (**Figure 12**) will be the key to success diagnosing and repairing vehicles that interact with AC power!

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He has extensive OEM service and field engineering expertise, with more than 30 years of experience in troubleshooting vehicle systems electronics, with 15 of those years in the independent aftermarket repair business. He has 20 years of experience in training engineers (worldwide) and service technicians in both the OEM and aftermarket arenas, as well as experience in working with postsecondary vocational / community college students as an adjunct instructor.

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WHO DOESN'T REMEMBER THEIR FIRST CAR? A 1970 VW Beetle.

VEHICLE SECURITY SYSTEMS: A STATE OF THE UNION

MODERN ALARMS ARE EFFECTIVE. BUT THE MORE COMPLEX THE SYSTEM, THE MORE SIGNIFICANT THE CHALLENGE IS FOR THE DIAGNOSTIC AND REPAIR TECHNICIAN.

BY MICHEAL SMYTH // Contributing Editor

I remember my first car just like it was still sitting in my driveway. It was a $50 1970 VW Beetle that had caught fire, burning most of the harness in the front trunk. I re-wired it with spools of cheap stranded wire purchased from Murphy Mart, and it was a great learning experience for this 14-year-old. I spent the next year "polishing" this pile, but boy was I proud of it. Once running, I installed a radio, 14" tires (taken from a Buick, that rubbed the fenders if anyone rode in the back seat), and white seat covers from J.C. Whitney. I loved that car. There wasn't a weekend that I didn't fix, break, or add something to it, so eventually, I ran out of common-sense things to do and decided I needed to have an alarm system. (**FIG 2**)

For those of us who cut our automotive teeth in the early '80s, you'll remember these systems. They came in a box full of wire and an installation manual that couldn't be more confusing if the sellers wanted it to be. I spent months trying to get at least the basic functionality operational but spent more time repairing the damage the installation was creating, rather than enjoying what the system could provide for me. My friends nicknamed the beetle "Kraco." (**FIG 1**)

That was then, this is now

Aftermarket alarm systems have improved immensely since those early days, and they are still a part of the automotive upgrade pathway. But most are now installed by professionals that have an understanding of modern vehicle electronic systems and how to integrate a third-party alarm correctly. However, the market for "aftermarket alarms" has significantly decreased for one simple reason: new vehicles (more often than not) have integrated security mechanisms from the OEM.

Even the most basic cars and trucks produced today have

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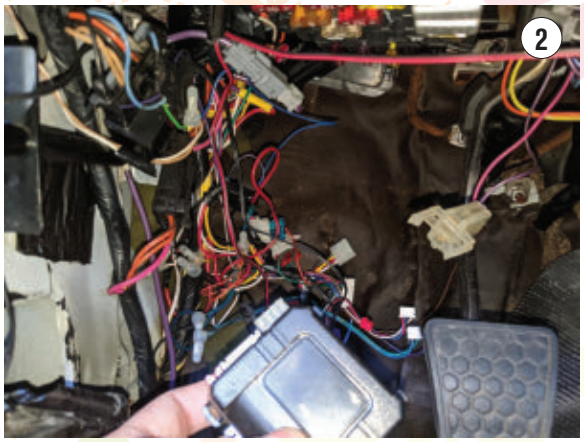

PHOTO COURTESY OF THIRDGEN

EARLY ALARM SYSTEMS were always a bit of a wiring challenge.

THE TESLA ADAS and alarm system are in many ways leading the push into advanced vehicle security systems.

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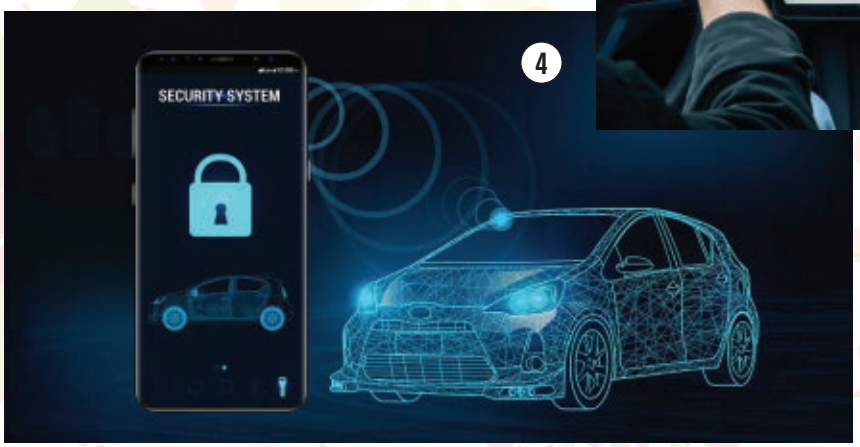

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SMARTPHONES ARE BECOMING an integral part of today's vehicle alarm systems.

immobilization and tamper sensors to protect them from content-theft or vandalism, and these OEM offerings have gotten very complex. If you haven't stumbled across it yet, check out the YouTube videos on Tesla cameras, capturing vandals and parking mishaps being automatically recorded with its industry-leading security and autonomous systems. Of course, the more complex the system, the more significant the viability for a service opportunity.

Alarms available from the aftermarket continue to evolve to keep up with OEM development. Integrated with autonomous (ADAS) systems, vehicle security will continue progression into a viable but complex network of sensors, cameras and controls, reporting data locally and into cloud-based computing options.

The modern OE alarm system had an extensive development phase, with incremental steps along the way to improve the offering. For example, GM vehicles have had five different vehicle deterrent systems, each requiring its own set of procedures to be followed for diagnostics and repairs. Take that number and multiply it by the number of vehicle manufacturers, and you'll get an idea of the variety of systems out there, increasing the challenges faced by the technician.

Keyless entry…but does it have an alarmed security system?

It is also surprising how many consumers have no idea of the capabilities of their vehicle's advanced factory systems and are often challenged to know whether they have a security system at all. Confusion can begin with a misunderstanding of the key fob. Just because a vehicle has a fob with a "Lock and Unlock" function, it does not guarantee that an alarm system exists. The owner's manual in the glove box with all the important operating procedures is a resource that could determine a vehicle's alarm existence and capabilities very easily. Most likely, the manual is unopened or possibly missing altogether.

Many incorrectly assume that their vehicle also has an alarm because they have a keyless entry system. If the fob has only two buttons (lock and unlock), chances are the car does not have a system. An easy way to test this is to roll down the window, turn the car off, get out, and lock the doors. After a minute or two (to assure any alarm has been activated) reach in the open window and attempt to open the door. Then, if the vehicle is equipped with an alarm, you'll know it.

Another way to determine this would be to look for a flashing light on top of or on the face of the dashboard of a locked vehicle. This flashing light shows you that your vehicle's alarm system is armed and should be somewhat of a deterrent to thieves (as they most likely recognize what that beacon represents). This light can also be

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helpful to show the status of your alarm system, as most will illuminate a solid light when the vehicle is in operation to show an error in the system (as opposed to a flashing light).

Of course, the most common-sense thing to do would be to allow a repair professional to examine the vehicle and determine its alarm capabilities. If necessary, the vehicle owner can then decide if installing an aftermarket system is right for them.

The different flavors of security

OE and aftermarket systems both can offer similar functionality. It can be difficult to remain one step ahead of well-heeled thieves, but a modern alarm system can give you a fighting chance. Of course, the more complex the system, the more significant challenge for the diagnostic and repair technician. Let's start the discussion by listing the most popular alarm system features that can be present on an alarm-enabled vehicle. (**FIG 3**)

Keyless remote: The remote is pretty self-explanatory, whether integrated into a key or as a stand-alone fob.

Immobilizer: Don't you love a system whose name states precisely what it does? The immobilizer… immobilizes. Tied directly into the vehicle's ECU, the immobilizer signal (which originates from the key fob) prevents the car from starting if the fob is not within range or the correct one for the vehicle.

Vehicle tracking system: Modern alarm systems can feature strategies that help recover a stolen vehicle through satellite GPS tracking.

Cameras: OEMs are integrating cameras into their vehicle networks. Not just for ADAS but also security. Tesla, the General Motors Surround Video Recording System, and others are pioneering video systems that perform multiple duties. These include driver situational awareness, safety systems, and vehicle security. Designed to start recording when there is vehicle movement or, in some cases, exterior activity is detected by proximity sensors, these cameras can record and stream live video to the vehicle owner's smartphone.

Anti-snatch mode: A relatively new system, anti-snatch functionality takes advantage of the ability to pair your smartphone with your vehicle **(FIG 4).** This connectivity allows for a host of consumer-friendly tasks such as proximity lock/unlock and shared data service, but anti-snatch is perhaps one of the most intriguing. With anti-snatch enabled, a running vehicle will automatically shut down after a user-defined period once the connection between the phone and vehicle are out of range of each other. This helpful feature is attractive in today's concerns over carjacking and "I only left the car running while I ran into the store for a minute" scenarios.

Anti-theft mode: A close relative of Anti-snatch, Anti-theft works the same way. With the vehicle security system activated, the car or truck will not start unless the connection between the phone and the vehicle is active.

Repairing a faulty alarm system (whether OE or aftermarket) can be a challenging docket. We all recognize that systems are integrated rather than stand-alone, building challenges for diagnostics. A good example happened to a friend who has a successful independent shop. He was asked why a client's Adaptive Cruise Control didn't work correctly. In addition, the OE alarm occasionally gave a false warning.

His scan showed many calibration errors of vehicle sensors, and a visual exam showed signs of a recent front-end collision repair. He queried the client, who informed him the front bumper cover had been replaced due to a parking incident a month before.

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THE KEY FOB. What did we ever do without them?

A call to the collision shop that performed the repair showed that no recalibration of sensors had taken place after straightening a grille brace and the replacement of the bumper cover.

Diagnostic steps for OE alarm systems always start with your scan tool. Factory service data and TSBs are also essential resources for system repair. But, of course, if the issue is rooted in an aftermarket system, all bets are off. The best recommendation I read was with a well-known automotive instructor that said, "Figuring out what is wrong with a stereo-shop alarm system has to start with disabling the entire system, then reactivate/install each system and sensor individually till the problem shows up." He has over 40 years in the industry, and I trust what he says.

Remember the basics

Another great place to begin when dealing with an alarm system error is the basics, such as issues originating with the fob **(FIG 5)**. Is the consumer accidentally creating a problem by having the vehicle's fob bouncing around in the bottom of a purse or briefcase? Perhaps the fob's battery is low or loose in its socket, creating an intermittent issue.

Another common but easily diagnosed root cause could be door, trunk, and hatch sensors. These latches get heavy use, are exposed to the elements, and can create alarm issues. A savvy tech should check for door/latch alignment, clean and lubricate, and verify the functionality of the sensor contact points. Perhaps the fob or the alarm system is looking for a reset. Fobs

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[1]Based on Independent Repair Facility's purchases from your local authorized dealership. IRF must be enrolled In the Parts Rewards program to be eligible. Available to one qualified repair facility employee per Independent Repair Facility. For official program rules and eligibility, see "Terms and Conditions" at NissanUSAPartsRewards.com. Program rules are subject to change without notice. [2]Participating Parts Rewards Enrollees may be eligible to earn an additional 10% in Parts Rewards for each qualifying part during quarterly promotional periods, product categories and rules will vary.[3]Remanufactured Genuine Nissan Part.

generally require a scan tool for reset, but you may get good results by disconnecting the vehicle's 12-volt battery for a minute or so. Oh, and don't forget to check the alarm fuse.

For aftermarket systems, the next step would be with the wiring. If the original installation manual is not available (it likely won't be), use the web as a resource for the documents that came with the system. And don't forget to check any warranty that may exist from an aftermarket installer. Some shops offer attractive warranty periods, and even if it is out of their service window, they can still be a helpful resource.

OE anti-theft system failures can be highly troublesome to diagnose without dealer software. However, it is not impossible. When analyzing the issue, a technician will use a computerized scan tool to observe conditions within the anti-theft system, identify where the miscommunication originates, and service that portion of the system.

For instance, if the body control module receives correct information to signal the engine control module to start the vehicle, the engine should start. However, consider if it does not signal the engine control module to start the car. In this case, the circuit, body control module, and engine control module will be tested/isolated to find which component is failing to interpret data. This can be a long and challenging process when intermittent issues are present. In some cases, an independent shop without factory scan tools may need to reach out to the dealership for assistance.

PHOTO COURTESY OF NASTF

NASTF IS THE INDUSTRY SOURCE for key programming and cutting credentials. This is a screenshot of the NASTF website (www.nastf.org) showing OEM information links.

Keys and Key Fobs

Another service opportunity for techs and shop owners is vehicle keys. Keys get lost, preowned cars arrive with only one key, keys stop working, and only the savviest user will attempt to rectify a key issue on their own. Due to the structure of today's keys and fobs, it takes a trained technician with certifications and the right tools to assist the customer with this problem, but offering this service isn't as expensive or complex as you would think (**FIG6**).

Key programming and cutting are viable ways an automotive shop can create a new revenue stream. For those in the market, there are surprisingly complex yet reliable equipment that allows independent shops to cut and program keys for all makes of vehicles, and for OEM establishments to offer the same services for cars outside of the makes they sell. However, a few steps need to be followed for those new to this service.

First, the ability to access key, immobilizer, and vehicle PIN codes aren't just handed out to everyone, for obvious reasons. To start down the key and fob programming path, a shop needs to acquire Secure Data Release Model (SDRM) credentials through an organization called the National Automotive Service Task Force, or NASTF (**FIG 7**).

The folks at NASTF provide credentials for locksmiths and auto repair technicians who need access to vehicle security information (generally key codes and or immobilizer codes). Techs can apply for a 2-year Vehicle Security Professional credential by undergoing a background check and providing documentation that establishes their identity and business in

PHOTO COURTESY OF ILCO

AN EXAMPLE OF a modern digital key production machine.

CARQUEST **PROFESSIONAL PLATINUM**

NEW updated HEX Shim Technology™ with aramid fibers to reduce noise and prevent shim wear

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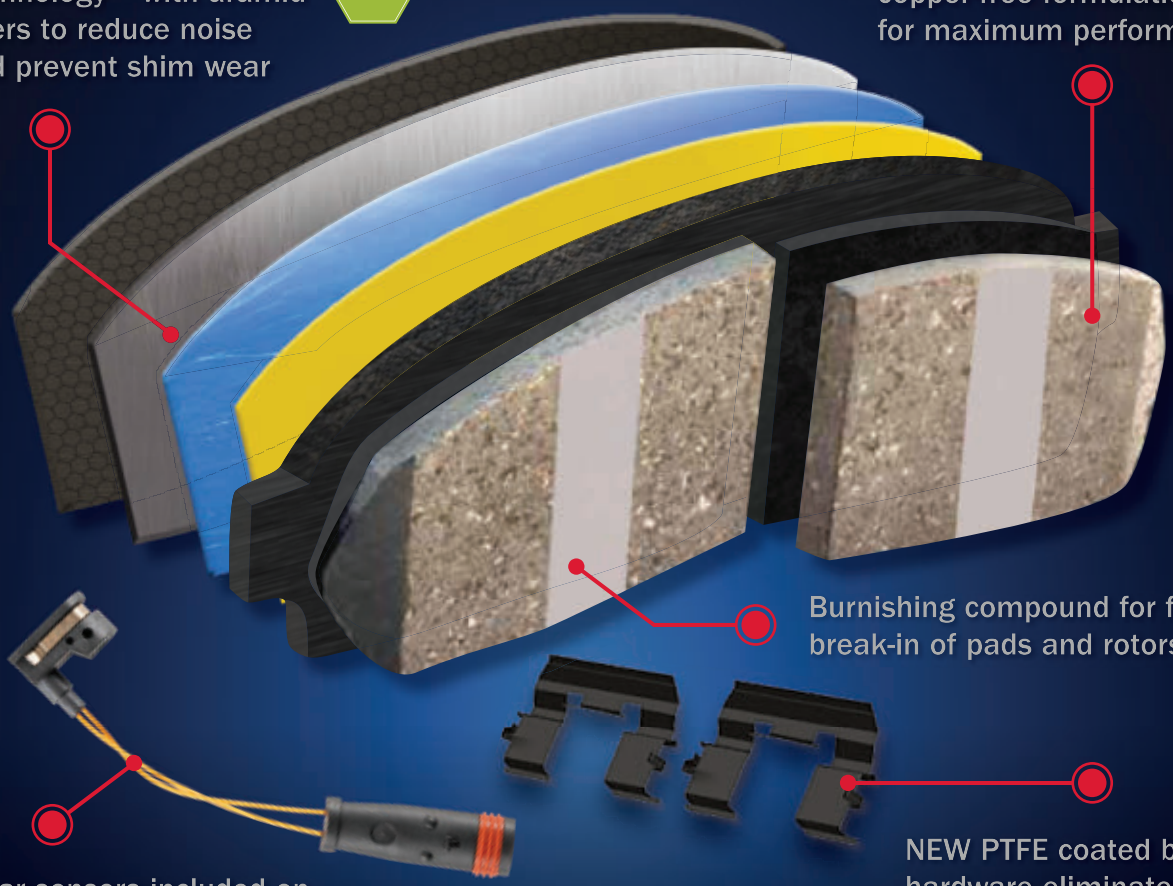

Burnishing compound for faster break-in of pads and rotors

NEW PTFE coated brake hardware eliminates rust and corrosion buildup

Wear sensors included on most European applications that require replacement

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their community. All the details can be found at nastf.org. It is free to become a member of NASTF. It is a relatively quick and painless process, and Donny Seyfer and the folks at NASTF are top-notch and will assist with the process. Once the certification is completed, the remaining key and fob service steps to get you up and running are purchasing and training on key cutting equipment and unprogrammed keys and fobs.

I did a study at a previous place of employment on the estimated cost to get into this field, and the return on investment was surprisingly attractive. Based on investment in tools, machines, and key fobs (of around $8,000) as well as the average industry charge to the consumer of $200 per key, the payback on the investment would be about 40 clients. Compare that with how many alignments are needed to pay for that new rack you installed last year. I recently saw a Google ad that my local ACE Hardware franchise offered vehicle key cutting and programming. If your local hardware store thinks it is a good move to provide this service, it makes sense that it would work for you, too.

So, what is the future of alarm systems? A study by Future Market Insights predicts the car security system market will surpass $33.8 billion by 2031 to coincide with the predicted rise in car theft cases. They further note that there was an almost 10% rise in auto thefts from 2019 to 2020 and expect an even more significant jump once the data from 2021 is compiled.

For the automotive technician, security systems are much like the growth of ADAS: technology and the need to understand how to diagnose, repair, and calibrate will become a necessity, rather than an option, in the tech's toolbox of skills. Jumping on board this train is no longer an option but rather a means of survival. Seeking training on automotive networks and integrated security systems will soon be a "must-have" rather than a "nice to have" skill. MA

MICHEAL SMYTH is a founding partner and Director of Training for AFV Educate, a not-for-profit 401(c)(3) training organization specializing in alternative fuel curriculum development and educational presentation for first and second responders and automotive technicians. His previous positions included Director of West Virginia University's National Alternative Fuels Training Consortium and Director of Training at Automotive Video Innovations. Mike has over 12 years of experience working with and presenting information on AFVs. Connect with him at LinkedIn.

2022 SPRING TRAINING ISSUE

X-431 IMMO PAD Immobilizer Diag and Programming

Launch continues to innovate and release diagnostic product solutions that support the Independent Automotive Repair segment. The latest product offering is the Launch X-431 IMMO PAD, a comprehensive Key and Module Programming Device that supports Asian, Domestic and Euro vehicle applications for OBD II diagnostics, bi-directional controls and Module Replacement and Reprogramming.

"In the past, due to the limited technologies available for programming, module/key replacement and the transfer/cloning of EPROM/chip data, it was a challenge for independent auto repair shops and technicians to support these functions," says Launch Tech USA Product Manager Haresh Gobin. "They had to resort to piggyback/work-around processes such as soldering chips off motherboard circuits for the extraction and transfer of the OE-encrypted data protocols."

In addition to ECM, TCM and other module replacement, the IMMO PAD supports the replacement of a common request that automotive repair shops encounter, such as replacement copies of key fobs.

ASE Master Tech Tony Shelton from John's Automotive in San Diego, California, frequently uses the X-431 IMMO PAD. "Prior to the IMMO PAD, I would have to refer key fob duplicates requests to mobile locksmiths," he says. "But with this product, I am able to perform Immobilizer Diagnostics / Configuration resets and key transponder/transmitter duplications and additions in an accurate /reliable and timely in-house process."

Current Launch X-431 Professional Line Scan Tool Users (Turbo, Torque III , Throttle ,Throttle III) are also able to perform IMMO Diagnostics and Programming with the acquisition of the XPROG 3 Device on a standalone basis.

For more information on the X-431 IMMO PAD, visit www.launchtechusa.com

Autolite spark plugs meet the needs of today's high-performing engines

Vehicle engine manufacturers are constantly striving to create models that improve efficiency, capacity, horsepower and overall performance, meaning that the manufacturers of the spark plugs that outfit them must keep pace with these innovations.

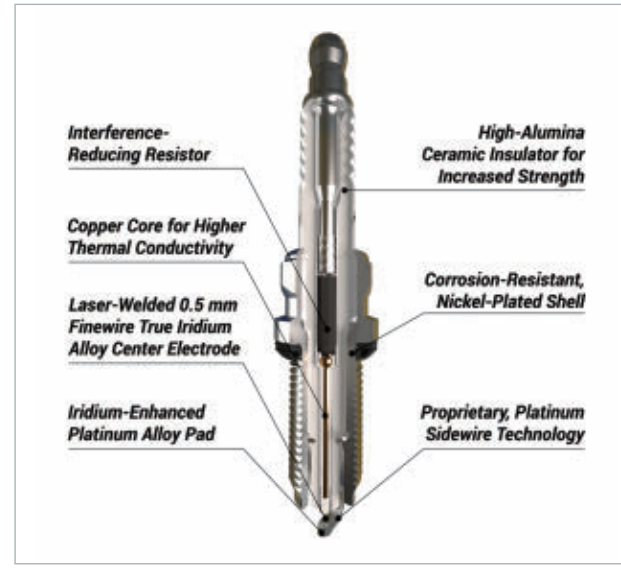
Autolite® satisfies this need with its Iridium Ultra® and Iridium XP lines of spark plugs, which combine to provide coverage for up to 94 percent of the nearly 84 million domestic and import vehicles in operation (VIO) in the United States today.

Iridium Ultra spark plugs have been designed to be a practical, cost-effective competitive alternative to late-model double-platinum or iridium original equipment (OE) spark plugs, which were included in 98 percent of the new cars sold in 2018. They feature a laser-welded 0.5-mm iridium finewire electrode that creates optimal fuel efficiency, acceleration and focused ignitability, and are backed by a limited lifetime warranty. Other differentiating features of Iridium Ultra spark plugs include a nickel-plated, corrosion-resistant shell; a high-alumina ceramic insulator that increases strength and reliability; and Autolite's proprietary platinum-sidewire technology.

In side-by-side tests against competitive brands that were conducted by an independent lab, the Iridium Ultra spark plug was shown to burn – at maximum brake torque (MBT) of minus 4 degrees of timing – the first 10 percent of the fuel mixture in just more than 38 degrees of crank rotation, while the competitors' plugs required more than 40 degrees of crank rotation to achieve 10 percent Mass Fraction Burn (MFB). The ability of the Iridium Ultra flame kernel to burn faster during the first 10 percent of MFB means that more of the fuel gets converted into operational energy quicker, resulting in improved fuel economy and reduced emissions.

All of these design and performance enhancements combine to make Iridium Ultra spark plugs the best alternative to premium OE iridium laser-welded plugs, but at a lower price point for repair-shop owners, technicians and do-it-yourselfers.

For the drivers of older vehicles, with the average age of VIOs in the United States having recently reached an all-time high of 11.8 years, Autolite offers the Iridium XP spark plug. These plugs, which can be used on vehicles from model year 1967 and up, have been designed to be a high-performance entry-level iridium plug for older engines.



They achieve OE-level performance in older engines through a construction process that features a balanced blend of iridium, platinum and palladium, resulting in a plug that precisely focuses its spark energy at the optimum ignition point to deliver high power, long life and exceptional value. Like the Iridium Ultra, the Iridium XP plugs have an iridium-enhanced finewire center electrode, nickel-plated shell, high-alumina ceramic insulator and platinum-sidewire technology, and are backed by Autolite's unmatched limited lifetime warranty.

Autolite, a division of First Brands Group, is the No. 1 manufacturer of ignition products in North America. Autolite manufactures and markets ignition products, including spark plugs and glow plugs, for U.S., Japanese, European and Korean cars, as well as plugs for Lawn & Garden and Powersports that meet or exceed OE fit and function requirements. For more information, please visit autolite.com.

Autolite
IGNITING YOUR PASSION™

2022 SPRING TRAINING ISSUE

Don't Strike Out When Choosing a Tire Changer

Whether you're buying a tire changer for the first time or are replacing existing equipment, it's important to do some work upfront to make sure you get a shop MVP instead of one that will get sent down to the minors.

There are three common mistakes people make when choosing a tire changer. Take some tips from the pros and avoid these three strikes when you step into the … buyer's box.

1. Buying based purely on price. You might think we're going to warn against buying the cheapest tire changer you can find — and you're right — but we're also warning against choosing the most expensive model "just because." Some tire changers, especially those that cost a little more, are made exclusively for high-performance wheels and tires. There are often features on these machines that sound cool, but that will actually hold you back if you're not in that high-performance market. Before you click "buy" or write that check, be sure to talk with a product expert about important business details like the vehicles you service and how much space you have in your shop.
2. Not understanding the numbers. For a tire changer to work properly, the tire/wheel size must be smaller than the maximum extendable range of the turntable. For example, if the specs say the turntable clamps extend to a 30-inch diameter, that doesn't mean the machine can service a 30-inch tire, because the clamps must be able to retract further to grab the tire. When choosing a tire changer, make sure the turntable extends to the right diameter for the wheels you'll be servicing. Also consider whether you will clamp internally or externally — that makes a big difference in which piece of equipment is best for you.
3. Wasting time by not using an assist arm. While a swing/assist arm adds a little to the cost of a tire changer, it's a massive time saver for most shops. And in shops that traditionally have two mechanics work on changing a single tire, it can provide a significant increase in productivity and profitability. The assist arm is pneumatically powered, locks in place and applies a lot of pressure without damaging the tire. A specially designed clamp lets the tire rotate slowly with the movement of the turntable and helps efficiently unseat the bead.

So, there you have it. Spend wisely on the right player, study the stats, and take the assist to get a tire changer that just might be a game changer, too.

Brake Pedal Pulsation 2,000-4,000 Miles After Brake Service

Manufacturers and the aftermarket brake industry have created many bulletins concerning rotor runout and how to correct it. However, we still receive calls daily on our technical help line concerning brake pedal pulsation and supposedly "warped" rotors. This typically takes place 2,000-4,000 miles after brake service. We will explain the reasons why checking rotor runout is so important when servicing brakes.

Most vehicles since 1999 have a rotor runout spec of .002". In prior years, .007-.010 was typical. Brake pad composition was one reason all manufacturers tightened up the specs. The pads used in the 80s and 90s were primarily made of soft materials, including asbestos. These pads were very forgiving, with very little noise and usually didn't wear the rotors.

Today's pads are typically semi-met or ceramic. If the rotor runout is more than spec, the constant pad to rotor contact at one small area will cause a thickness variation. This occurs without touching the brake pedal; just rolling down road.

If the pads are semi-met, the rotor will wear thinner in one spot from an abrasive action. The pulsation comes from rotor thickness variation. If ceramic pads are used, they can leave an uneven buildup of material, causing a slip-stick condition.

FIG 1

FIG 2

Ceramic pads leave material on the rotor every time you apply the brakes, so as you slow down, the pad is transferring material to the rotor. If the rotor is within runout specs, the material will transfer evenly. (**fig 1**) If too much runout, material will be spotty and cause the pads to grip, then slip, then grip again. This causes pedal to pulsate. (**fig 2**)

There have been numerous factory bulletins on this subject explaining the need to check runout. Many shops are investing in hub cleaners, dial indicators and even on-the-car brake lathes to help prevent comebacks.

To limit your brake pulsation issues, start performing the extra two to four minutes per wheel step of checking runout. In our experience, only two to three out of 10 rotors need correction. Usually, just rotating the rotor on the hub to index will get most in spec. Be sure to note runout specs on the repair order and educate your customer. Also, torque lug nuts correctly to minimize runout when rotors expand from heating.

The extra time spent will not only prevent you from doing the job over, but it will also save your customer the headache of returning to repair their vehicle again.

2022 SPRING TRAINING ISSUE

When dealing with electrical issues, make sure you perform a proper diagnosis to locate the underlying cause

Application: 2005 - 2006 Ford Expedition (with a computer-controlled alternator)

When you run into a no-charge issue on an '05-'06 Ford Expedition, the problem may be with the alternator's regulator connector. The alternator sends a signal through the wiring harness to the PCM so the PCM can determine the vehicle's electrical load to maintain the proper voltage set point. The PCM also uses this signal to determine the load placed on the engine by the charging system. If there is an issue with the wiring harness, the alternator's signal cannot reach the PCM and could cause a no-charge issue.

The PCM controls the alternator regulator through the Regulator Connector terminal/wire. The PCM sends a command signal to the regulator, indicating the desired voltage setpoint needed.

This fault often illuminates the No Charge/No Charge Warning light.

To test this system, first, disconnect the three-terminal connector. Use a wiring schematic to identify the AS =SENSE, RC =GEN-COM, and LI = GEN-MON circuits. With the ignition key on, engine off, and the alternator connector disconnected, your SENSE wire should have battery voltage at the connector. Next, the GEN-COM wire should have zero volts, and the GEN-MON wire should have approximately 9 - 12 volts at the connector. If there is not, suspect a bad regulator connector at the alternator, and repair or replace the connector.

Need more help? Call TECHNICAL SUPPORT 800-228-9672. ASE Certified Technicians are Standing by 7 days a week.

2005-06 ALTERNATOR HARNESS CONNECTOR

2005-06 FORD EXPEDITION ALTERNATOR

2005 FORD EXPEDITION PCM

Reduce Circuit Diagnostic Times

Cars and trucks continue to have increasingly complex electrical systems and diagnosing circuit problems on modern vehicles can be intimidating. But it really doesn't need to be.

Power Probe has always been dedicated to providing technicians with electrical testing tools to simplify circuit diagnosing and fault finding.

When teaching circuit testing, I try to keep things simple. One of the things I teach is that in most circuits, you will have no more than 5 different parts -

1. Source – Where the power comes from (battery, generator, solar, etc.)
2. Load - the device being activated (lamp, motor, solenoid, etc.)
3. Conductors – used to transfer power from the source to the load and back (wires, cables, chassis, etc.)
4. Control – breaks circuit for on/off control (switch, relay, transistor.)
5. Protection – protects circuit from overload (fuse, circuit breaker, etc.)

The beauty of this is, no matter how complicated the electrical system, you can break it down into circuit segments with no more than these 5 parts. So… when things go wrong and something isn't working, it must be a fault with one of those parts. Makes sense, right?

Most circuit parts are relatively easy to test and repair – checking fuses, testing batteries, etc., but conductor (wiring) problems can be the most difficult to diagnose and locate, and in my experience, more often than not, it will be a wiring problem. They are very common.

The good news is that there are really only 3 things that go wrong with wiring –

1. Opens – breaks or disconnects in the wire (infinite resistance.)
2. Shorts – any unwanted connection. Typically, is short to ground (blows fuses) but can be short to power, etc. (lo-resistance.)
3. Hi-Resistance – restriction of current usually due to – loose connections, damaged or corroded wiring or connectors.

With proper testing you can usually identify which condition is causing your problem (open, short, hi-res), the difficulty is physically locating the problem in what could be a vast wiring loom in the vehicle. Where is it? It can be a challenging task, but Power Probe has a tool that can help.

The Power Probe ECT3000 Circuit Tracer and Short Finder is a tool specifically designed to help locate shorts and opens in vehicle wiring quickly and easily.

The ECT3000 is a 2-piece tool – The ECT Transmitter connects to the vehicle's battery and injects a signal into the wiring and The ECT Handheld Receiver can pick up and follow the transmitter signal down the wiring. It even has directional arrows that points the direction to the Short no matter how the receiver is held.

The ECT3000 signal can be tracked through most paneling, carpeting, etc. with adjustable sensitivity up to 6 inches deep. This allows technicians to locate wiring faults without removing pieces or panels saving hours of valuable time when locating Shorts and Opens.

Comparing Different Types of Brake Fluid

The four main types of brake fluid are DOT 3, DOT 4, DOT 5 and DOT 5.1.

DOT 3, DOT 4 and DOT 5.1 are glycol-based fluids and are hygroscopic, meaning they absorb water over time. As moisture gets into the brake system, the boiling point of glycol-based fluid lowers. DOT 5 is a silicone-based fluid and is hydrophobic, meaning it repels water. Moisture introduced into a brake system with DOT 5 fluid doesn't mix with the brake fluid, causing the moisture to freeze or boil, leading to brake fade.

Glycol and silicone-based fluids are NOT compatible and should never be mixed. Use DOT 5 in a completely dry system or in a vehicle that already has DOT 5 in the system. DOT 3, DOT 4 and DOT 5.1 are all interchangeable.

As moisture enters the brake system, the boiling point of the brake fluid lowers. As the car is driven and the brakes are applied, the brake system heats up. If the fluid heats up to the point of boiling, it vaporizes and air bubbles form in the brake lines, causing brake fade or a loss of pedal completely.

Boiling Points

The dry boiling point of the brake fluid is measured with zero percent water by volume, while the wet boiling point is measured with 3.7 percent moisture by volume. Testing for moisture on a regular basis is important. As the moisture content of the fluid increases, the boiling point decreases.

Color

Glycol-based fluid is translucent yellow and looks clear when poured from the bottle. DOT 5 brake fluid is purple, making it easy to distinguish between glycol-based and silicone-based fluid.

Brake fluid darkens over time as rubber components in the hydraulic system break down due to moisture in the brake system and general wear.

Brown or black fluid needs replacing.

Corrosion Prevention

Moisture in the hydraulic system causes the metal parts to rust, including the master cylinder, wheel cylinder and ABS components, leading to leaks in the hydraulic system.

Brake fluid includes additives to prevent corrosion; however, additives break down over time.

Changing the Brake Fluid

Check the vehicle's service manual to see when to change the brake fluid. Some manufacturers recommend every two years or 24,000 miles.

If the service manual doesn't include this information, check the color and moisture content of the brake fluid once a year.

What to Use

Use whatever fluid is on the cap of the master cylinder reservoir. For older models that don't have this information on the cap, use DOT 3.

Remember, glycol-based fluids are interchangeable. DOT 3, DOT 4 and DOT 5.1 can be mixed and won't affect the vehicle's performance. Don't mix silicone-based fluid (DOT 5) with glycol-based fluid. They aren't compatible.

CAN-FD protocol:
Can your diagnostic tools keep up?

It's a well known fact modern vehicles have become increasingly complex with an ever increasing number of sensors and control modules. As the number of sensors has increased, so has the amount of data flowing between modules. In addition, Advanced Driver Assistance Systems (ADAS) which are common in many vehicles require very fast communication between sensors and modules to prevent collisions.

To be able to keep the existing two wire hardware of the vehicle Controller Area Network (CAN) and improve communication, the CAN FD communication protocol was released in 2012. This upgraded communication protocol has been slowly adopted by vehicle manufacturers over the last decade and is currently common with new passenger cars & light trucks. The main advantages of the CAN FD protocol are data transmission rates of up to 5 times faster compared to standard CAN and larger amounts of data to be transmitted on the same vehicle wiring. This is achieved by increasing the message size from 11 bits with standard CAN to 29 bits. The message payload is also increased from 8 to 64 bytes allowing more data to be communicated. To maximize the speed and amount of data, moving across the CAN, the CAN FD protocol can rapidly switch between high & low data rates depending on demand. To maintain data integrity and detect errors, the CAN FD protocol includes 5 different elements.

Data transmitted using CAN FD is in a different configuration than standard CAN and therefore diagnostic tools need to be able to read this new protocol. To complicate matters, diagnostic tools must be able to determine if the data is in either standard or CAN FD and interpret both protocols. Diagnostic tools manufacturers spend considerable time & resources on keeping pace with new data protocols. Higher quality scan tools will be able to communicate with hundreds of vehicle brands from all over the world ranging from model year 1996 and newer.

To ensure its tools keep pace with new diagnostic protocols, THINKCAR employs over 300 engineers to develop new tool software & communication devices. "Tool hardware such as screen size, amount of memory & processor speed are all important aspects of a tool's capacity," Eric Wang, Technology Director notes. "However, the software makes the difference between being able to communicate with a vehicle or not," says Wang. "We are currently working on technology and

software which will not be released for 6 to 12 months after extensive field testing on hundreds of live vehicles. A recent example of this is our new Platinum S10TVCI which was specifically developed to support CAN FD and is available via Cornwell Quality Tool dealers and Advance Auto Parts. The tool was under development for 9 months plus months of field testing to ensure the software and upgraded Vehicle Communication Interface (VCI) unit would accurately and efficiently communicate with a wide variety of vehicles. "

The VCI is equally important as the tool software as it provides the physical connection between the diagnostic tablet & the vehicle using the OBDII port. The VCI must be able to precisely interpret data from various protocols and relay them back to the tablet.

As modules to accommodate electric powertrains and battery packs are introduced the need for even faster protocols will continue to grow. When selecting a new diagnostic scan tool, it's important to select a model which can support new diagnostic protocols.

TPMS
CASTING A WIDE NET

WHEN IT COMES TO TECHNICIANS DRIVING THEMSELVES AND A BUSINESS FORWARD PROFITABLY, GETTING IT 'DONE CORRECTLY' ISN'T THE ONLY FACTOR IN THE EQUATION.

BY BRANDON STECKLER // Technical Editor

When discussing the subject of tire pressure monitoring systems, (TPMS) it's something many technicians (or shops for that matter) don't typically put too much thought into. They treat it as one of those necessary evils that just come with the territory of running a service and repair business. It's not typically thought of as being profitable as much as it is a task that just must be dealt with when, say, replacing tires. The truth of the matter is being adequately prepared to deal with TPMS systems can truly be a profitable venture.

A step back in time

We likely know that TPMS came to be popular around 2007, when the TREAD Act (which was introduced in 2000 to address issues of severe tire failures from inadequate tire pressure) required TPMS to be installed on all new model vehicles under 10,000lbs GVW. Now that they are no longer an option, these systems must now be faced head-on by techs and shop owners.

Early systems (known as "indirect TPMS") capitalized on the antilock brake system (ABS) to calculate tire pressure. The pressure in the tires was simply inferred (not measured). As a tire loses pressure, the outer circumference of the tire lessens as well. As a result, a complete rotation of that tire occurs over less of a distance, meaning the tire will rotate faster than one that is pressurized appropriately. A system like this can be found on some vehicles dating back to the 1980s! The wheel speed sensors of the ABS system will report this data to the ABS control module. That same data is used (by comparing the pressures of tires diagonally from one another) to trigger the TPMS warning indicator if a threshold is exceeded.

The point is this data was extrapolated from an existing system. There was not much needed as far as tooling goes to service, diagnose, and repair these early indirect TPMS systems. Simply driving vehicles under certain operating condi-

GETTY IMAGES

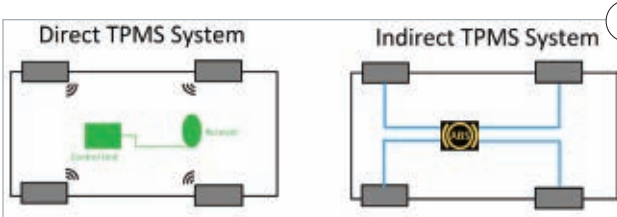
tions was all that was necessary to relearn the system. Again, the point is anybody could do it. This information was simply for a means to illuminate a warning light, alerting the driver to a tire with low pressure (25% lower than placard specification). Although these systems could detect the underinflation of a few tires, they were unable to calculate the underinflation of all four tires. It's for this reason the game had to change.

A shift in technology

Later systems utilized sensors that would output TPMS data. This information was not inferred but rather was being measured by the sensor. The sensors not only reported pressure but also included temperature, battery life, and individual sensor identification. Data was broadcast as a wireless signal from the sensor at a frequency of either 315 or 433 MHz (in the United States), and these two radio frequencies were not interchangeable. Because this data was no longer inferred, it was far more accurate. We refer to this method of reporting as "direct TPMS" (**FIG 1**).

The sensor could be found as one that attaches to the wheel rim (just as conventional tire valves do) or could be tethered to the wheel with a clamp or tension band. Depending on the configuration of the system, one or more transmitter/receivers (transceivers) would receive and process the TPMS data from the sensors and possibly relay it to an

1



THIS DIAGRAM DEPICTS the two basic designs of TPMS systems used. The indirect system inferred tire pressure data by way of an ECU using an algorithm to calculate a loss in tire pressure. The direct systems use sensors to measure and report information directly (pressure, temperature, battery life, and sensor identification).

2

PICTURED HERE IS just a handful of TPMS sensors that are available in the aftermarket. Many more are available but not all sensors are compatible with every vehicle make and model. Finding a sensor that functions with most of the vehicles is ideal.

ECU (if it were not integral to the ECU). Again, all the system was required to do was report if a tire were underinflated; however, some of these systems could also identify a specific tire. There are many sensors available in the aftermarket (**FIG 2**).

Later systems evolved again and went back to the indirect system, however, with far more accurate algorithms used to detect tire pressure differential. As interesting as a topic that is in and of itself, it is not what I am going to focus on here.

When it came to service and repair, a simple rotation of the tires could call for a relearn of the TPMS system. ECUs (electronic control units) are not smart; they are just programmed to process data swiftly and perform specific functions as a result. We would have to indicate to the ECU that the ID numbers for each sensor would now be in a new location. That is exactly what the relearn procedure provided. Many times, that procedure was carried out by a simple button push (located somewhere in the cabin or under the hood). Later systems incorporated initiators that would "ping" the sensors and allow them to self-identify their location to the TPMS system ECU.

The goal of the TPMS is system is to alert the driver of an underinflated tire. When detected, it would cause the system to illuminate the TPMS warning indicator steadily (**FIG 3**). Now, during a malfunction of the TPMS system, a different indication was given to the driver. This could be a separate warning indicator or the same indicator (now "flashing" instead of being illuminated steadily). This would require further diagnosis to determine not only the issue, but also which tire was related to the fault. As sensors begin to age, so do the batteries that power them, and they are non-serviceable. When it comes to replacement (to preserve battery life), the sensors, shipped as replacement parts, were dormant, or in an "off mode." These sensors had to be initialized to begin outputting data. Some sensors simply had to see a change in pressure to be initialized. Others required a TPMS activation tool that was used to ping the sensor (typically at a low frequency, 125kHz frequency) so they would function (**FIG 4**). In some situations, a magnetic device could be used to perform this same task (**FIG 5**). This is where tooling started to come into play.

3

THIS TPMS LOW TIRE PRESSURE ICON is a familiar warning, alerting both driver and technician of an underinflated tire. This indicator can be used in two ways. When illuminated solidly, it indicates a tire is underinflated. However, when this indicator flashes, it indicates a malfunction in the system. Proper tooling is required to pinpoint the root cause of the fault. Not all tools function with all vehicles. Tooling can become expensive. A solution is to utilize a tool that is designed to overcome the issues of tool application and coverage.

Time to invest-Getting the most bang for your buck

TPMS diagnosis is no different than any other system being analyzed on a vehicle. It requires an understanding of the components and how they interact with one another but equally as important as having the tools to do the job to completion.

4

FIG 4- DISPLAYED HERE IS JUST A HANDFUL of TPMS activation tools available. Each tool functions well on certain vehicles but many don't function on all vehicles. When choosing a tool, it's best to maximize your return on investment. Focusing on a tool with a vast range of vehicle coverage will do just that.

- Scanning for DTCs
- Verifying the sensors' function (can output data accurately)
- Making sure the tires are inflated to proper pressure (specification on tire placard)
- Finding the root cause of the fault being detected by the ECU
- Performing the repairs necessary to correct the fault
- Clearing the DTCs
- Relearning the TPMS system
- Verifying the proper operation before returning the vehicle to the customer

Again, it is just like any other diagnosis/repair procedure we perform. But we must have the tools to do the job to completion. There are many tools on the market today that can handle those above tasks. However, keep in mind that not every vehicle is configured the same. Therefore, not every tool will work on all vehicles. As I wrote in the beginning, having the ability to complete the job is just part of the equation. Being able to do so profitably is the other factor.

5

THIS MAGNETIC DONUT looking device can be used to initiate a TPMS sensor. The magnetic field it creates, when surrounding the sensor will excite (or "ping") the sensor, forcing it to "wake-up" from its dormant state and begin functioning.

Choosing tools that can tackle those above tasks on a large variety of vehicles is what I am interested in as a technician in today's ever-evolving world. I need the tools to overcome the challenges I face today, but what about the ones I face tomorrow? Selecting a tool that will be functional on only a few vehicle lines, or whose software updates cost a small fortune is something I try to avoid like the plague.

I want the tools that can do the job today, tomorrow, and efficiently. I do not think that is too much to ask. Rather than spending time researching service information,

COURTESY OF SCHRADER TPMS SOLUTIONS

consider a tool that has guided step-by-step instructions on the vehicle you are addressing. I would much rather be fishing with a net instead of a hook; it's simply more efficient. Consider a tool that could perhaps scan a VIN. Everything you would need to know about that TPMS system for that vehicle could arrive at your fingertips instantaneously. That would certainly save some time.

Consider the list of bullet points above. To complete that full list of tasks is necessary, but how easily doable is it when we are addressing multiple vehicle makes and models? Think of the investment in tooling required to tackle them all (and the software, as mentioned earlier), not to mention the time required to familiarize yourself with all the different tools and how to navigate them. Having one tool that would cover all (or at least almost all) makes and models is definitely attractive to me. But what if you had a tool that would also carry out that entire process on all makes and models (say, 99% of them)? That would be a game-changer, for sure!

The next challenge that comes to mind is sensor replacement. As mentioned earlier, vehicles are looking for a certain frequency to recognize the data being output from the sensors. Think of the inventory selection you would need on hand to cover the multiple makes/models you would be servicing. If possible, I would choose the sensor that functions for "most applications." For an inventory, this would be a safe bet to make. Having a sensor that functions with "almost all" vehicles would certainly limit downtime, boost efficiency, and maximize inventory storage space.

The hunt is on

When it comes to choosing the right tool, it's not just about if the tool functions. It's not only about cost, either. It must make sense from many angles for it to be a rapid return on investment. Choosing the tool that I'm going to use often and on most applications is the right tool for me. Do your due diligence and don't just select a "good tool." Select the "right tool." It must be "right" from all angles. This is how I remain efficient and profitable, but most importantly, confident that I can get the job done right on the customer's first visit.

BRANDON STECKLER is Technical Editor of Motor Age Magazine. He holds multiple ASE certifications. He is an active instructor and provides telephone and live technical support, as well as private training, for technicians all across the world.

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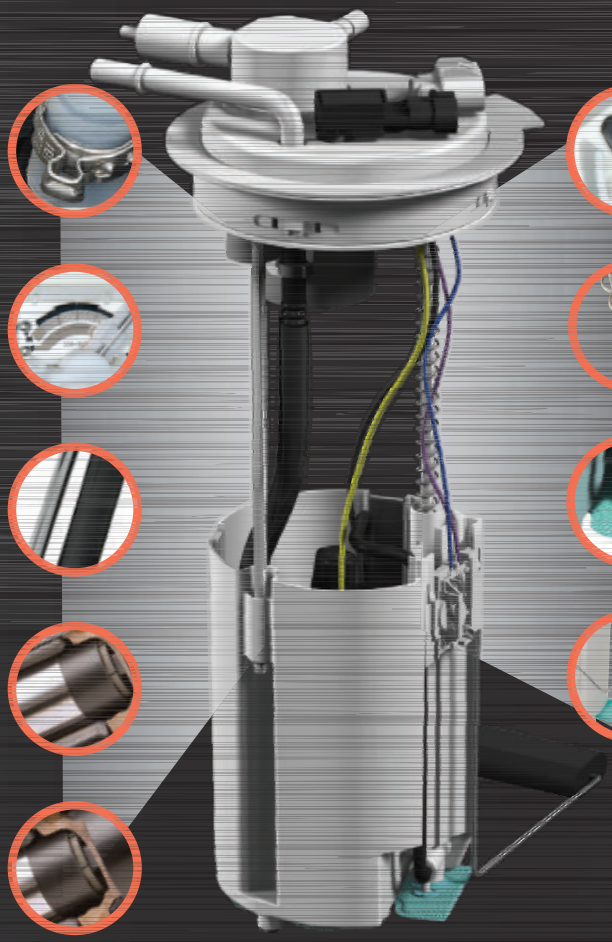

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A CASE OF PENNY-WISE & DOLLAR-FOOLISH

FAILURE TO GAIN A SENSE OF DIRECTION CAN FORCE US OUT OF NOT ONLY OUR COMFORT ZONE, BUT ALSO OUR NORMAL DIAGNOSTIC APPROACH.

BY ROSS COLKET // Contributing Editor

There are times we all encounter that one vehicle that simply drives us nuts. Failure to gain a sense of direction can force us out of our comfort zone as well as our normal diagnostic approach. But sometimes it's necessary to travel the uncharted path.

We were familiar with the customer's vehicle being a simple cargo van, so we knew this wasn't a complex vehicle to deal with. So, this should be a quick in-and-out diagnosis, or so we thought. In the end, we put 60 miles on the customer's vehicle, fixed the problem, and scheduled his next vehicle for a service appointment .

When the customer first called us on this vehicle, we viewed it as a chance to gain a new customer. We get many referrals on electrical and driveability concerns because of our reputation. We take pride in fixing these vehicles and always look at them as potential long-term customers.

In this case, it was the business owner (not the driver) who brought the vehicle in. He only knew that the warning indicators would come on every time the vehicle was driven. Specifically, the red brake warning lamp, ABS lamp, traction control light and traction control off lamps lit up when driving. No other specific information was given at the time. We did place a call to the driver, but he had little information to aid in duplicating the problem, just that every time he drove it, the lights would come on.

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THE FORD TRANSIT CONNECT (file photo shown) lit up the red brake warning lamp, ABS lamp, traction control light and traction control off lamps. The fix for a seemingly simple problem proved to be elusive.

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Flushing the fault to the surface

I am a big believer in making sure you can duplicate the customer's concern. If you can't, you have nothing to test for. If I can't duplicate the problem, I will ask for the customer to give me as much information as possible for the conditions in which the problem occurs. I will ask them to go for a test drive with me to try to duplicate the problem. We have all had that customer who doesn't believe us when we tell them the vehicle isn't acting up. The solution is simple; take them for a ride! There are two possible outcomes:

1) The customer will duplicate the problem for you

2) The customer will see the vehicle isn't acting up and realize you are not trying to ignore their problem

If the problem is not duplicated send the customer out till the problem becomes more frequent or until they know the conditions to duplicate the problem. On this Transit, it happened every time it was driven, although sometimes it would take longer than others.

My technician, Jason Oltmann (one of the best diagnostic technicians I have worked with), was tasked with this vehicle. I had every bit of confidence he would knock this one right out of the park. He was leaving for vacation in two days, and I never thought that would be a factor on this one. But in the end, both of us worked together to get this one fixed.

He was given this vehicle to look at and began with a test drive, as usual. It did take a longer test drive than normal to finally duplicate the problem. He initially only noticed that the indicator lights would come on and stay on. He then began gathering the codes, checking TSBs, and Identifix. The trouble codes indicated no clear direction. He went back out on several test drives to try and find what the specific trigger was for the problem to happen. As the test drives continued, he found he could duplicate the concern only on left-hand turns.

Code Scan: Relatively simple vehicle, only has 8 modules. There are only a total of 6 codes in the vehicle:

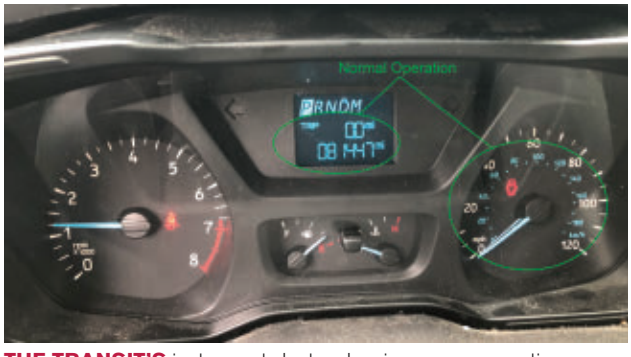
- ABS Module: U0100:00-08 Lost comm with the ECM
- U0100:87-48: Lost comm with the ECM
- U0100:00-08: Lost comm with the TCM
- U0100:87.08 Lost comm with the TCM
- U0126:00-08 Lost comm with the steering angle sensor
- BCM U0001:00-08 High Speed CAN comm bus

CODE DESCRIPTIONS:

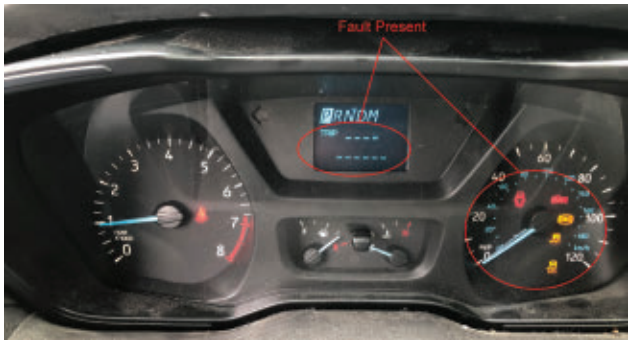
- **ABS U0100:00** Lost communication with ECM/PCM 'A'
  Sets when the ABS module does not receive any messages from the PCM
- **ABS U0100:87** Lost communication with ECM/PCM 'A': Missing message
  Sets when the ABS module any of the following messages are missing, accelerator pedal position, brake on-off switch, cruise control status, or engine RPM
- **ABS U0126:00** Lost communication with the steering angle sensor module
  Sets when the ABS module does not receive any messages from the SASM
- **BCM U0001:00** High-Speed CAN Communication Bus
  An HS-CAN fault was present at a point in time. The fault is not currently present since the module is communicating with the diagnostic scan tool.

POSSIBLE CAUSES:

- **ABS U100:00-08** (Applies for both the ECM & TCM)
  Possible causes: *Network communication concern*
  Stop lamp switch
  PCM
  ABS Module



THE TRANSIT'S instrument cluster showing proper operation



THE TRANSIT'S instrument cluster when the problem was occurring with the wiring

THE TRANSIT'S instrument cluster with the fuse pulled duplicates the problem we were diagnosing

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ABS U0126:00 Possible causes:
Network communication concern
Stop lamp switch
PCM
ABS Module

BCM U0001:00 Possible causes:
Network communication concern

The problem always lasted just a split second. But once the lights came on, the ignition had to be cycled to turn the lights out. As we gathered more information, we were finally able to make the problem last longer than just a split second. We would lose the tachometer, speedometer, odometer, and trip odometer when this would happen. Yet we had no codes for the instrument cluster. He also found that the vehicle would continue to run and would not lose power to the engine. We were making progress, back to the drawing board to look at the symptoms, trouble codes, and wiring diagrams.

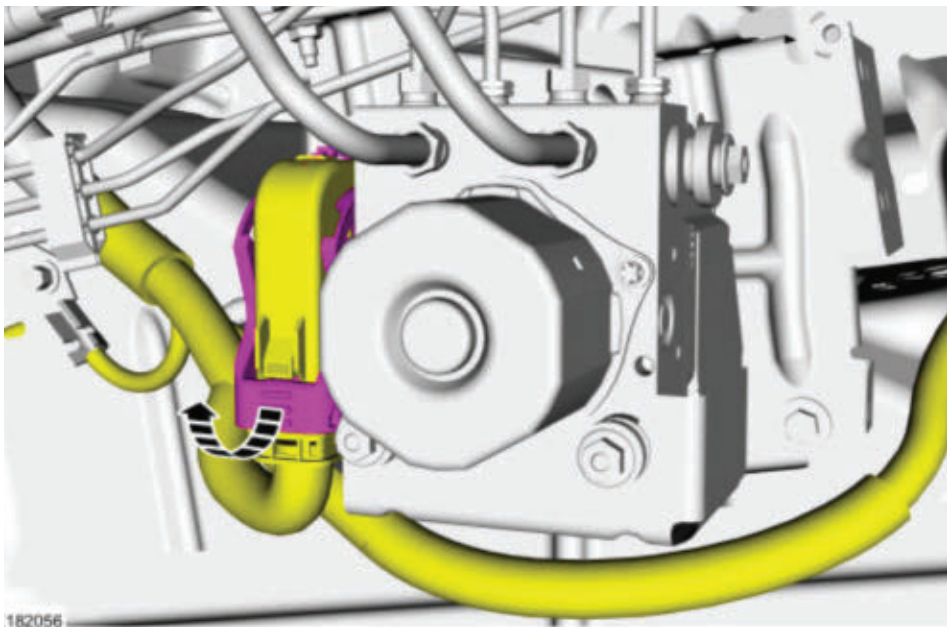
Developing a gameplan

Jason was diligently working on this vehicle to gather as much information as possible. He and I would then bounce theories off each other to formulate a test plan. I will not begin just testing a vehicle at random. If you are testing a vehicle without having a clear idea of what is wrong with the vehicle, you are wasting your time. When you test a vehicle, you are testing to confirm the problem you suspect. We knew from the trouble codes that we should be looking at the network, PCM, and ABS module, but what about the instrument cluster? The lights on the instrument cluster could be explained by the ABS module. The speedometer could be explained also by the ABS module. But, what about the tachometer, trip indicator, and odometer? Also, why only left-hand turns?

Jason placed the van on his lift, and we began to do a simple wiggle test of the engine bay wire harnesses. The symptom was not present. All the harnesses were routed properly and in their proper retaining clips, and a visual inspection also not indicate any type of damage to the harness. Again, where do we begin to test when we can't duplicate the problem consistently or for more than a few seconds?

Let's look at the network from a logical standpoint. The ABS module was the one reporting lost communication codes with the other modules, but the other modules were not reporting lost communication codes with the ABS module. The body control module was reporting high-speed CAN message codes. Looking at the network topology, we could see that the only modules on this vehicle on the High-Speed CAN bus were the BCM, PCM, ABS, Parking Assist module, and the Restraint control module. Why were there no communication codes from the other modules? Again, no direction. We checked the wiring diagrams for common grounds and power supplies, and none were found. We checked the easily accessible grounds, and they were all good. We simply could not gain any direction.

By this point, Jason and I were both getting frustrated. Both of us are very good diagnostic technicians, and our pride was being seriously challenged. We had spent the afternoon in a parking lot driving in circles for 6 miles. We had the scanner with us scanning modules, looking at live data, but again, we couldn't get the problem to happen consistently, or for more than 20 or 30 seconds to gather enough data for a theory as to the problem.



MITCHELL 1

ABS MODULE electrical connector.

At this point, with one last test drive with the scanner, both of us had our stomachs in our throats from driving in circles. Jason began to get the problem to occur more frequently, and I was able to find out that the ABS module and BCM would go offline when the problem occurred. Some direction, but still not enough.

With the countdown to vacation, I knew Jason wanted to finish this job and have a fix for peace of mind. The push was on! I also knew in the back of my mind we should have been on the problematic system within an hour of starting to work on

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this vehicle to begin pinpoint testing. We weren't even close.

Jason began the day knowing we had a problem with the ABS module going offline when the problem occurred. He started testing the ABS fuses for loss of power (when he could duplicate the problem); no problems were found. I even went as far as to place an amp clamp at the ABS module fuses. Nothing at all was found. I was getting very frustrated with myself by this point. I had begun doing what you shouldn't do, test without direction.

As the day continued, we took the van for a ride. And after 10 minutes, we got it to act up. Back to the bay we went. We had been very careful to take note of what was and wasn't working and also the specific lights that were on. Jason and I were both stumped; we still did not know if it was a power, ground, module, or network communication issue we should be chasing.

I had Jason pull the ABS module's electrical connector for a visual inspection, and no visual problems were found. When the connector was apart, Jason had tightened the terminals (just out of habit) and we continued on with another test drive. FINALLY, some direction! The problem could no longer be duplicated on left-hand turns, no matter what we did. Time for a different approach, we headed to a local parking lot that had a few crater-sized potholes, and we began hitting them. We knew we had changed something, but the problem was still there.

Third time is the charm

It was now 4:45 Friday afternoon and we decided we needed to come at this problem from a repeatable (but different) angle. We took what I deemed a time-consuming approach and started pulling fuses until we duplicated the problem. We pulled fuse #2, and we got the lights to come on after four seconds. But when we hit the bumps, the problem was immediate. Pulled Fuse #13… GOTCHA! We pulled the fuse and the exact symptoms happened immediately!

Fuse #13 is listed as powering the ABS module valves (HUH?) How would the power to the ABS control valves affect the network, the odometer, the tachometer? We called it a day (defeated, frustrated, and mentally exhausted). It was time for Jason to leave for vacation.

Monday 9 a.m., I grab one of my other technicians, Austin Gehman, to go pull the ABS module connector and check the terminal tightness with the proper terminals. WE GOT IT! The terminal was loose enough to lose connection from time to time. The terminal was tightened and after another test drive in the parking lot of craters, it was deemed FIXED!

HOW AND WHY!

Why did the warning indicator lights come on?

The ABS module was losing power on fuse #13. Let's examine the fuses for the ABS module:

Fuse # 22: 40 Amp	Hot at all times	Goes to the brake vacuum pump
Fuse # 17: 40 Amp	Hot at all times	Goes to the ABS Pump Motor
Fuse # 13: 25 Amp	Hot at all times	Goes to the ABS module
Fuse # 2: 4 Amp	Switched	Goes to the Traction control switch & VPWR for the ABS module

We can rule out Fuse #22 (that is the vac pump only), fuse #17 (for the ABS pump motor)

Fuse #2 (the power to wake up the module), and finally, fuse #13 is for the ABS valves and computer.

4 Amps is most likely not enough to power the computer by itself.

Why did the tachometer, speedometer, odometer, and trip stop?

The ABS module relays the information from the PCM to the BCM. The BCM then sends the information to the instrument cluster on a low-speed CAN network. I believe the mileage is logged in the PCM (therefore the loss of the odometer). I believe the trip odometer missing was simply a byproduct of the odometer information missing from the network message.

Why did it only happen on left-hand turns?

The best we can figure, it was a combination of body flex and movement of the harness.

Why did the amp clamp not work to pick up the loss of power to the ABS module?

I had the amp clamp set on a higher scale and did not see anything. But also remember, the ABS module did not reinitialize either after regaining power. We still had a switched power supply to stay active.

We had debated doing a voltage drop test across the circuit, but because the terminal was loose in the ABS module connector, we would have never seen a change. Our test point voltages wouldn't have changed.

Conclusion:

Looking back throughout events, the very thing that I didn't want to do was exactly what we needed to get the vehicle properly diagnosed. I was concerned that removing the fuses might mask the problem and also be very time-consuming. However, that simple step would have saved hours of driving. Yes, I was being penny-wise and dollar foolish. We had a very intermittent issue that we were able to force-duplicate. No, it didn't give us a specific fix, but it gave us the direction we needed to start our pinpoint tests and come to a conclusion within 30 minutes after that.

ROSS COLKET is the owner of Colket Automotive Technical Services in Lansdale, Pennsylvania. He is an ASE Certified Master Technician with over 30 years of experience as both a technician and educator.

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STREAMLINING ELECTRONIC DIAGNOSIS

WHEN AN ECM MAKES A BAD CALL, IT'S GENERALLY BECAUSE THE MODULE RECEIVED WRONG INFORMATION FROM AN INPUT.

BY ROY DENNIS RIPPLE // Contributing Editor

Electronics use devices to manipulate the flow of electricity. Most of the actions performed by today's vehicles are commanded by an Electronic Control Module (ECM) using inputs from numerous sensors and switches. An ECM is only as dependable as the information it receives. When an ECM makes a bad call, it's generally because the module received wrong information from an input or attempted to command a faulty output. In some cases, an ECM will recognize an erroneous input and report it to the user in the form of a malfunction indicator lamp and a Diagnostic Trouble Code (DTC). Other times it will believe the inaccurate input and continue to output invalid commands.

This article will offer tips and pointers that will be helpful when diagnosing an ECM-controlled system. This isn't about the inner workings of transistors, diodes, and thermistors. There will be no in-depth discussion about the movement of electrons between atoms, nor will we dive into electrical theory formulas. The purpose of this column is to help you diagnose the vehicle that's sitting in your shop. It's always crucial that theory, description, and operation are studied and understood for the system you're servicing before the onset of diagnosis.

ECMs are not smart

Every decision an ECM makes is based on its programming; it will never think out of the box. However many times you can try to type the word "train" (on a keyboard with an inoperative 'T'), it will type "rain." The computer doesn't know what your intentions were, and it doesn't care. It will do what it's programmed to do. So, the man at the station will board the "rain" every time. Computers really aren't smart. They are obedient, reactive, and quick to process, but they're not smart.

Look before you leap

Before proceeding with diagnosis, perform a thorough visual inspection. The visual inspection process is the most crucial step of all automotive diagnoses. Eliminating the obvious should be the first step when diagnosing an electrical concern.

Look under the hood, under the vehicle, and the dash for poorly installed aftermarket devices. Inspect harnesses for wire rub-through or critter chew-through. Check the area under the battery for a harness that might be corroded due to past battery leakage. Was the vehicle sunk in a puddle, causing water intrusion in connectors, or was it in a crash pinching a harness between bent metal? Spare yourself the frustration

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WE DECIDED TO RAISE this Ford Focus on the lift and perform a visual inspection before proceeding with check engine light diagnosis. Good thing we did. That's the PCM wired up under the vehicle. We had to replace the PCM, both harness connectors and the module box.

THIS HOOKUP IS LOAD-TESTING the ground circuit for the LF headlamp. The red test lead is supplying power to the load. The green test lead is using the tested ground circuit to supply ground to the load (for a clearer photo, the bulbs aren't lit).

of locating the issue following a prolonged diagnosis when you could have found it at the beginning during a competent visual inspection.

Hands-on testing

Electronic diagnosis starts with pulling DTCs. Even if you know which module the concern originates from, it's best to start by pulling DTCs from all modules. The operation of a module can be affected by false information transmitted over the network by another module. Pulling all DTCs allows you to determine if there's a network issue and if other modules are reporting a concern related to the issue you're diagnosing.

Pinpoint tests (PPT), also called diagnostic flow charts, take you step-by-step through a well-thought-out series of tests that should eventually lead to a diagnosis. Unfortunately, the final result of a PPT isn't always the correct diagnosis. The problem with the PPT is that the author of the test isn't in the service bay diagnosing that particular vehicle. This means that you are the eyes, ears, and hands of the test.

Don't get caught in the trap

Pinpoint tests procedures make many assumptions when they calculate results. It's up to the technician to recognize the discrepancies between what the PPT says and what he or she sees. It's not unusual for a PPT to display a wrong wire color or show a connector cavity to be empty when it's occupied by wire. Don't perform a PPT like you're putting together a piece of furniture from Ikea. Tab "A" doesn't always fit into slot "B", and the result is never predetermined. When directed by a PPT to check a circuit, it's essential to understand why you're testing it, what it does, and how to interpret the results.

For instance, when pursuing an Ambient Air Temperature Sensor (AAT) issue: Pinpoint test step A5 may direct you to check for voltage at pin 1 of connector C714 at the AAT. It may then it ask, "Is any voltage present?" The result of this step determines whether you're repairing a circuit or moving to the next step of the PPT.

If you're simply following directions, since no voltage measured at pin 1, you answer "no" and move on to step A6. The problem with this robotic approach to testing is that the test doesn't always tell you why you performed this step, and what you eliminated as a possible cause of the concern.

This is why you should be following every PPT step with an open wiring diagram. This allows you to see what is being tested and why. In the scenario above, pin 1 is the ATT signal wire to the Powertrain Control Module (PCM), and it should not be powered up. The wiring diagram shows that only the AAT would be affected if there's a short to power on this circuit. It also reveals an inline connector between the PCM and the AAT, which is a possible source of an intermittent issue. By viewing the schematic, you understand the test you performed and the system you're diagnosing.

Be careful not to change the state of anything between PPT steps unless the test directs it. The PPT step above could have tripped you up if you didn't carefully read the steps leading up to it. Step A2 requires disconnecting the connector at the PCM and does not reconnect it. The test asks if "any" voltage is present. There could be less than a volt creeping down that circuit with the PCM connected. Reconnecting the PCM after performing step A2 could cause a false result, leading you down entirely the wrong path.

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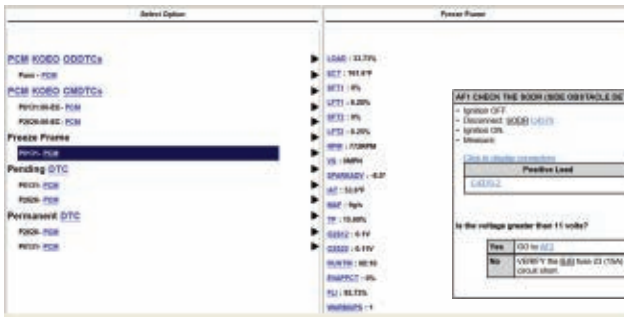
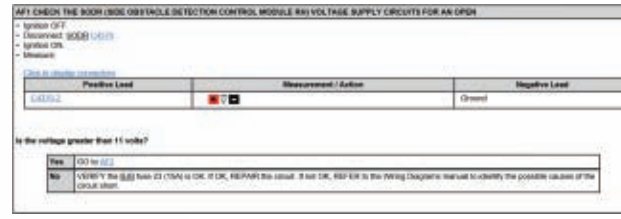


A SCANNER SNAPSHOT of DTC P0131 (O2 Circuit Low Voltage Bank 1, Sensor 1). Freeze-frame data shows that the engine coolant temperature was 161.6 deg F when the DTC was stored. Testing the circuit at this temperature revealed high resistance in the wire harness that is routed behind the engine.



FIRST STEP OF THE PINPOINT TEST for no network communication with the Side Obstacle Detection Module on a 2015 Lincoln MKZ. The test suggests checking the fuse after removing the rear bumper cover and verifying no power to the module. We checked the fuse first. The fuse was blown, saved a lot of time.

The outlined procedure isn't necessarily the most efficient

The main rule of performing a PPT is to carry out the steps without skipping an operation. The problem is that these tests usually make minimal effort to streamline the diagnosis. It's not uncommon for a test to require access to a module to check for power, just to find out that you have a blown fuse in the next step. Sometimes ripping through interior trim panels to access a module takes more time than the actual testing. Unfortunately, the test doesn't mention the fuse until you've removed the center console and discovered that there's no power to the module connector. This is why you need to be proactive.

When a PPT requires checking power feed at a hard-to-access module, reference the wiring diagram and back your way into the module connector. If the fuse has power and isn't open, check for power at an easy-to-access inline connector between the fuse and the module. This way, you're eliminating easy to access components and connectors. If all tests well, you'll have to gain access to and check power at the module.

If the module has no power, you've already eliminated the circuit section between the fuse and the inline connector as being the problem. If the module is powered up, you are right where you need to be for the next step of the pinpoint test.

The same goes for grounds. Reference the schematic and put your hands on all easily accessible grounds that pertain to the module you're pursuing. Finding a loose or corroded ground during a visual inspection is a "touchdown".

A logical approach will be a time-saver

You can also save time by performing numerous tests at once. Pinpoint tests will have you check the circuits in a connector for an open, then go back and check those circuits for a short to ground, then the test will send you back to the same connector pins to check for a short to power and a short to each other. For the sake of streamlined diagnosis, let's bang out all these tests at once.

After using an ohmmeter to verify that the circuit is closed, move the probe to the other wires in the connector, checking for continuity between circuits. Then move one probe and check for continuity to ground. With the probe still connected to ground, turn on the ignition, switch the meter to DCV, and check for a short to power. You've completed four tests on the single circuit with virtually one hookup.

In an ECM-controlled system, the amount of load that a wire carry can vary significantly between circuits. The wire that commands the HVAC module to move the temperature blend door carries only a fraction of the wire's current that moves the blend door actuator, yet the PPT has you check both circuits with an ohmmeter. Ohmmeters send minimal current through a wire. Circuits that fail under a heavy load during operation can easily pass with flying colors when tested with an ohmmeter. Load testing a circuit uses the tested wire to operate a load, forcing it to carry a current similar to what it endures during regular operation. We like to use one or two brake lamp bulbs for the load when testing a suspect wire. Again, it's recommended to use a load similar to the intended load.

One way I suggest to load-test a wire is to attach one end of the suspect wire to the positive battery terminal and the other side to the bulbs using jumper leads. Connecting the alternate side of the bulbs to the negative battery terminal should illuminate the bulbs. The suspect wire is now supplying current for the bulbs; therefore, it's assuming the load. Compare voltage at the bulbs with battery source voltage. Due to resistance in the jumper leads and the suspect wire, you could see about a 1V difference or voltage-drop. Much more than that means that there's a problem. If the voltage drop is over a volt, substitute a known good jumper lead for the suspect wire. If the drop decreases, the suspect wire isn't handling the load. Test the ground side the same way by using the suspect ground circuit to power up the bulbs.

Real-life application

We were diagnosing inoperative heated seats on a newer model Ford Taurus. The PPT directed us to check power at

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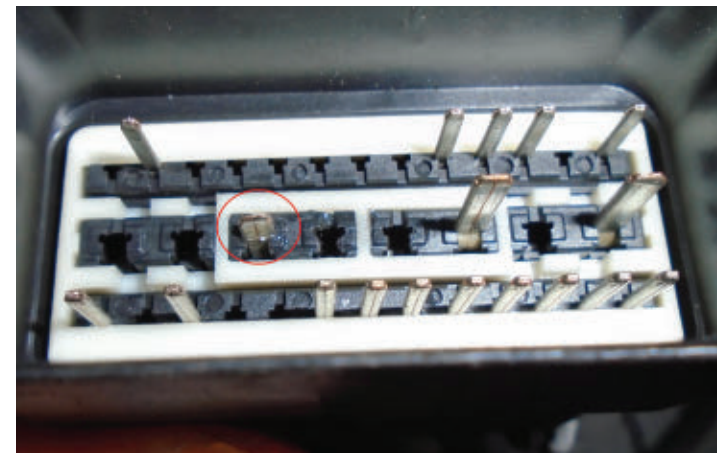
the Seat Control Module (SCM), which is integral to the Driver's Seat Module (DSM).

First, we verified the integrity of the fuse that powers the SCM. Then we checked power at the SCM with a voltmeter. The voltage at the connector was 12.5V; battery voltage was 12.6V, so it's good. We load-tested the power circuit using one brake lamp bulb. The bulb lit up brightly, and the voltage drop at the bulb was only .6V.

We replaced the DSM, per the PPT. Still no heated seat operation. We went through the PPT again. This time we load-tested the power circuit using two brake lamp bulbs. The bulbs did not illuminate. When we pulled one bulb from the circuit, the other lit up. When we added the second bulb, they both went out. The power circuit to the SCM was able to handle the load of one bulb but failed under the load of two bulbs and failed under the load of the heated seat elements. The cause was a burnt connector at the Battery Junction Box.

Circuits that are burdened with a heavy load, like heating elements or electric motors, should be tested using two bulbs. A circuit that uses a small gauge wire can be load tested using only one bulb. A brake lamp draws about 2 amps, so be careful; the 4-amps load of two bulbs could fry a low current circuit.



WHILE DIAGNOSING an illuminated ABS malfunction indicator lamp on a Ford F-150, I referenced the wire diagram, and checked all easily accessible inline connectors. I found a pin push-through condition at pin 16. This visual inspection saved me a lot of time.

Follow the clues

Heat increases the resistance of a metal conductor. This standard of electrophysics can cause chaos when diagnosing a concern in an ECM-controlled system. Resistance is the foundation for most module inputs, so any changes in resistance can cause values to go out of range.

When diagnosing an intermittent concern, especially if it's a circuit issue, it's beneficial to know the ambient temperature and the engine temperature at the time of the malfunction. The high passenger compartment temperatures of a vehicle sitting in the sun and the even higher engine compartment temperatures can impact a circuit's resistance, changing a sensor input to the ECM.

Obtaining this information starts with the customer's description of the concern. A good service writer will ask the customer if the concern occurs during the first start-up or when the engine is warmed up. Is it worse in the afternoon than it is in the morning? These clues can help you determine the best conditions to test the suspect circuits.

Freeze Frame Data accompany most electronic engine control DTCs. Freeze frame data is a snapshot of predetermined PIDs when the DTC is set. Included in this data are engine temperature and ambient temperature. This is excellent information to have.

We diagnosed a Ford F-150 that was intermittently turning on the check engine light with a stored P0190 (Fuel Rail Pressure (FRP) Sensor Circuit Malfunction). When the technician performed the PPT with the engine cold, no values were out of range. Freeze frame data showed that the DTC set when Engine Coolant Temperature (ECT) was 211

deg-F. We monitored the ECT PID until the engine reached the target temperature, then rechecked. Circuit 1289 from the FRP to the PCM had 22 ohms resistance when hot. We found that the wire harness broke loose from its retainer and was lying on a heater hose. Repositioning the harness is all it took to fix the concern. You have a good argument if you say that we should have found this during the initial visual inspection.

In-car temperature can play a big role when diagnosing an airbag malfunction indicator lamp concern. It takes very little change in circuit resistance for the Restraints Control Module to turn on the warning indicator. It's not uncommon for an airbag circuit to test out of range only after a long soak in the sun.

Network concerns add a whole new dimension to automotive electronic diagnosis. When a module perceives an issue within the network, it will store a U code, but not all U codes mean an issue with the network. Bad information coming over the network will also set a U code.

Let's say the Anti-lock Brake (ABS) module is sending an incorrect vehicle speed value to the PCM. The PCM might store DTC U0415 - (Invalid Data Received from ABS Control Module). This DTC tells us that communication between the PCM and the ABS module is good, but the PCM doesn't believe what the ABS module is reporting. The most likely cause of this DTC is an invalid input to the ABS module. This is why it's important to pull DTCs from all modules.

It's easy to lose track of the fact that automotive electronic diagnosis is electrical diagnosis — the proper amount of current needs to move along the designated wire at the correct time for everything to work smoothly. Understanding the strategies of the module you are diagnosing is critical when diagnosing an ECM-controlled system. Take the time to read Description and Operation before tackling the pinpoint test. Understand the reason for each step of the PPT and the consequences of the results. Don't be a robot. Modules are relatively stupid, and automotive technicians are brilliant. It's no contest.

ROY DENNIS RIPPLE is a Ford Senior Master Technician and an ASE Master Technician with more than 30 years experience in the automotive industry. As an automotive journalist, he is the recipient of a 2020 Azbees Award and a 2020 Tabbies Award. Ripple is currently working full-time as the shop foreman at a Ford dealership. He lives in New Jersey with his wife, three dogs, and two motorcycles. He can be reached at ripkrypton@gmail.com. .

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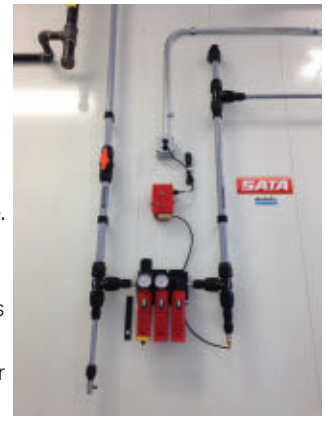

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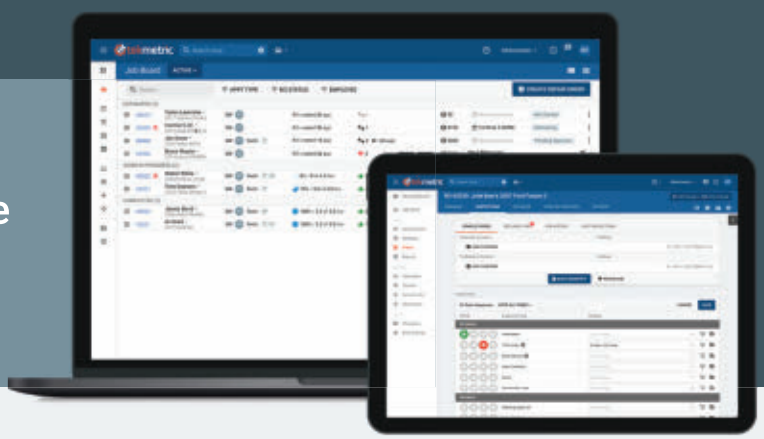

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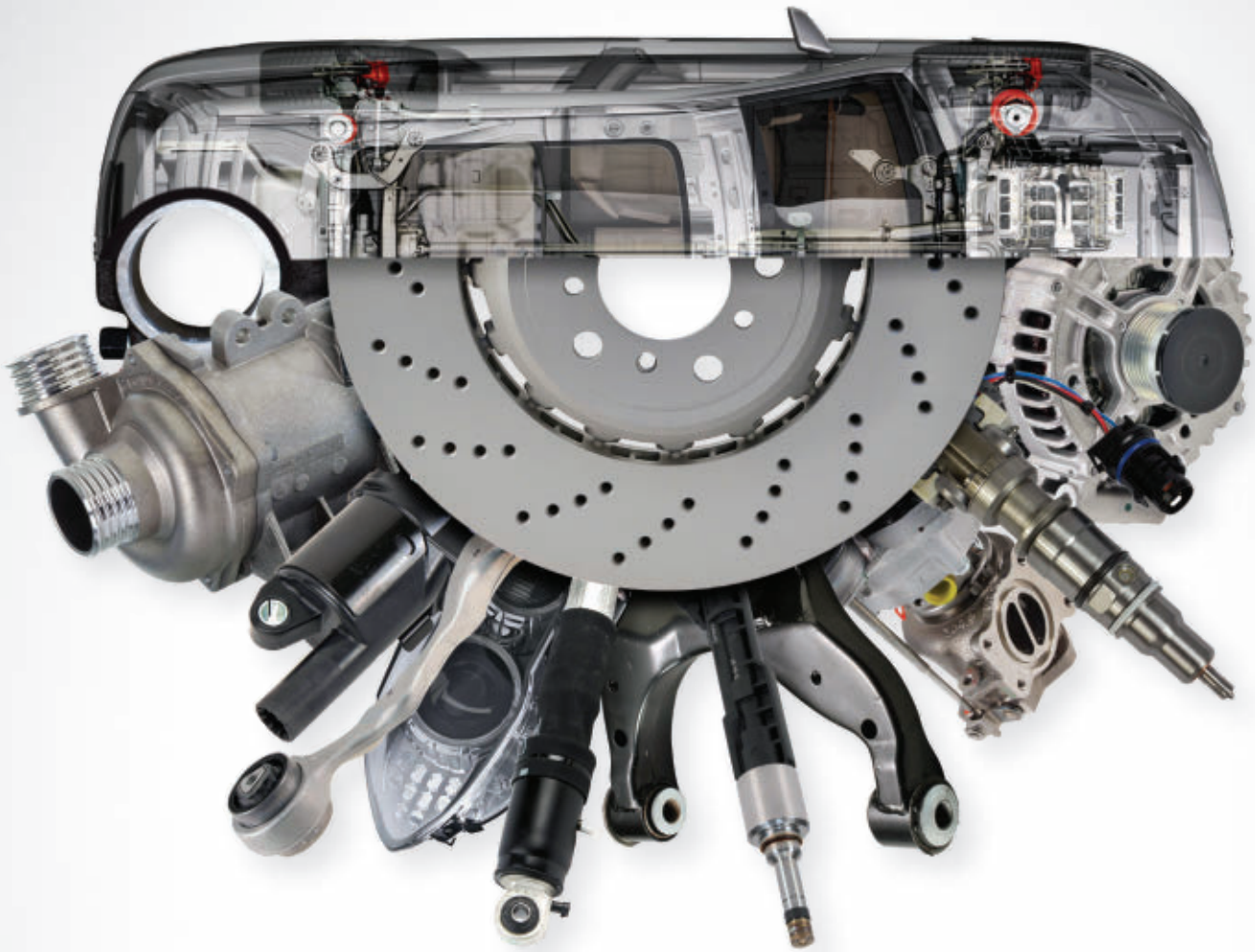

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