



8 PROFIT MOTIVE

WHAT STAYS AND WHAT GOES WHEN THE PANDEMIC IS OVER?

A close-up photograph of a mechanic wearing blue overalls. The mechanic is kneeling and using a handheld TPMS scan tool on a silver alloy wheel. The scan tool has a small screen displaying data. The mechanic's hands are visible, with one hand pointing at the tool and the other holding it. The background is dark, suggesting an indoor garage setting.

SERVICING TPMS CAN ADD TO A SHOP'S BOTTOM LINE

Investing in the tools and training for TPMS service has big payoffs for independent repair shops — Don't be left behind!

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Learn how to make a quick and smart choice for your shop

36 A TALE OF THREE SUBARUS

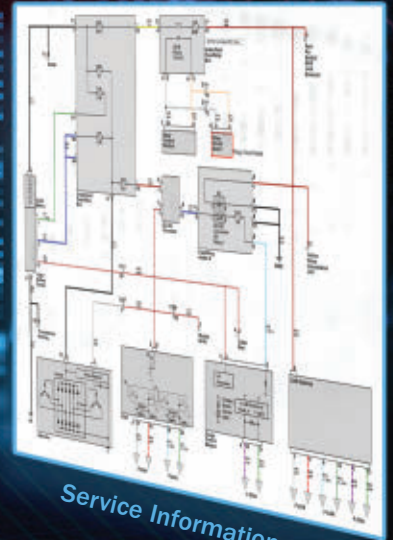
Understanding vehicle brand challenges and how to work through a proper diagnosis



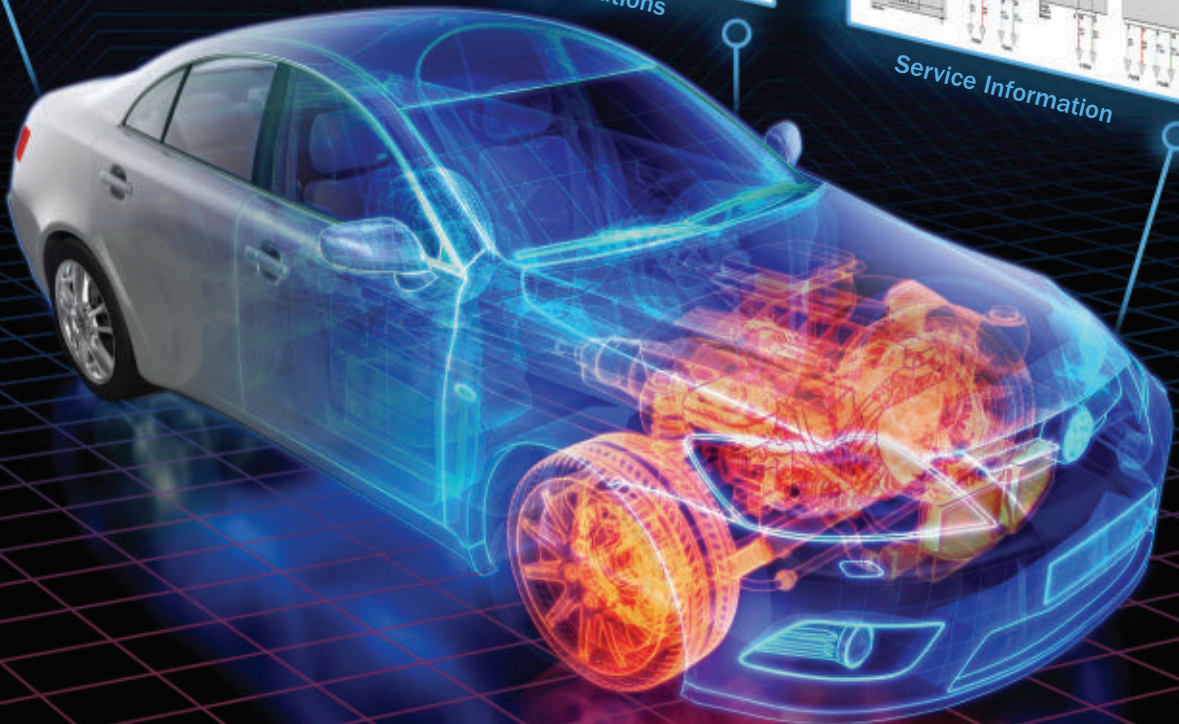
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OPERATIONS

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ONLINE EXCLUSIVE

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WEB EXCLUSIVES

WEBINAR: KEYS AND IMMOBILIZER SYSTEMS

Join Technicians Service Training (TST) for a webinar on vehicle security systems on November 17 from 6:45-10:30 p.m. EST. Vehicle security systems are considered by most technicians to be overly complex and difficult to repair. Keith Perkins, the webinar instructor, will explore some solid foundations of how vehicle security works, how each OE implements the systems, and how to effectively approach diagnosis, key production and cutting, copying, and key registering/programming.

The webinar will cover PINs, EEPROM, NASTF, tools and current industry challenges.

The cost for the webinar is \$40, and it will be available to view for 30 days after editing.

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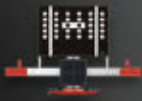
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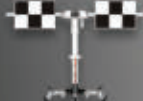
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EV IMPACT ON TECHNICIAN DEMAND

BY GREG SETTLE // Contributing Editor



The shortage of transportation technicians available to fill open industry positions has been well documented in the past few years. More recently, however, an additional factor has entered the equation. And that is the degree to which the entry of electric vehicles (EVs), autonomous vehicles, and other bleeding-edge technology into the market will impact the technician demand.

The question arises as to whether the unfilled demand that we see now will continue into the future, in a world where it is clear that electric vehicles and potentially other zero-emission power plants are the wave of the future.

When examining the future technician shortage question, there are many factors that need to be considered. One of the most important facts we must be aware of is that the entry of this new technology will take place gradually over many years. The internal combustion engine (ICE) has had a long and very successful history in passenger vehicles, and it will not be replaced by electric power overnight. To put it into perspective, it is forecast that by 2030, battery electric vehicles (BEVs) will still only comprise 25 percent to 30 percent of new light vehicles sold annually.¹

Another key factor to consider is the huge number of ICE vehicles already in operation in the market. The quantity of those existing vehicles dwarfs the number of new vehicles coming onboard each year. It is projected that nearly 290 million vehicles will be in operation on the roads and highways of America by the end of 2021. By comparison, looking ahead to 2030, even assuming sales of BEVs reach 30 percent of new light vehicles sold, that number will only be approximately 6.2 million vehicles.

Additionally, in evaluating the future technician shortage, it should also be remembered that the reality is that just because a vehicle is electric-powered, it does not mean that the need for all maintenance and repair suddenly goes away. It is true that electric vehicles require less service. The largest study to quantify these savings was recently released by the U.S. Department of Energy, Vehicle Technologies Office. That study evaluated vehicle maintenance costs for the General Services Administration U.S. government fleet, the largest fleet in the world. Detailed analysis showed that BEVs had a reduced maintenance cost of about 40 percent, compared to conventional ICE vehicles.²

But, is the reduced demand for technician hours for these vehicles significant? Yes, it might be when looked at in isolation. However, with the relatively small number of electric vehicles that are projected to be in use in relation to the overall vehicle population, we are talking about a gradual change over many years.

This being the case, a concern for both new entry-level technicians and current working technicians is how this changeover to electric vehicles and the introduction of other new technologies will affect the knowledge and skills they will need as technicians. The good news is that manufacturers, as well as many schools offering technical training programs, recognized this need early on and have worked aggressively to develop and implement related curricula. For passenger vehicles, this first began with the introduction of hybrid electric vehicles.

High voltage electrical systems entered the picture, and understanding how to safely disable and work on these systems became the No.1 training priority to prevent serious injury or even death through electrocution.

New training courses moved onto an array of other subjects, including battery technologies, power inverter systems, regenerative braking systems, and motor and motor drive systems, just to name a very few. However, electric vehicles by definition are a broad category, and within that sphere there are four subtypes: battery electric vehicles (BEV), hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), and fuel cell electric vehicles (FCEV). As one might expect, due to different systems within these subtypes, you will find training topics specific to each.

The last subtype mentioned, fuel cell electric vehicles (FCEV) are arriving later to market than the other EV types, and certainly in much smaller quantities. But they are expected to have a bright future down the road. Training for these vehicles will differ from all other EVs, as hydrogen is used as the fuel, bringing to the table the understanding of fuel cell technology, hydrogen storage system safety and refueling procedures.

Natural gas-powered vehicles (NGV) continue to grow in popularity as another clean, cost-efficient alternative, both with compressed natural gas (CNG) and liquefied natural gas (LNG). These systems are primarily found on commercial vehicles, particularly with refuse, transit and heavy-duty fleets. Some key training topics for these vehicles are safety procedures in working with natural gas, fuel system testing and inspection, and learning diagnostic skills specific to natural gas.

So, when it comes to looking at the knowledge and skills needed for the future as a transportation technician, there are two key topics that stand out.

The first priority must be on safety. Safety is always No. 1, and most of these new technologies come with very specific requirements that need to be understood and followed, with severe repercussions for those that fail to do so. You can expect that there will be a heavy emphasis on that topic in related training courses.

The second key consideration is not a new one, by any means. But with advancing technology and the complexities of new systems, its importance is growing. That topic is the understanding of electrical and electronics fundamentals. Whether you are speaking with management at OEMs, dealerships or independent service providers, there is unqualified agreement that the biggest shortfall in knowledge and skills we face as an industry is an in-depth understanding of electric and electronic fundamentals, both in theory and application. You can expect that the complexity of vehicle electrical systems will only continue to multiply exponentially in the future.

It is clear that with the shortage of technicians we are currently facing, and the low number of new entry-level technicians entering the workforce every year, we are still going to be facing a shortage, even as alternative fuel vehicles gradually enter the mainstream and eventually replace the internal combustion engine. The bottom line is new technicians entering the transportation workforce can be assured of job security for many years to come. Proper training and the development of new knowledge and skills for new technician entrants, as well as for technicians already in the workplace, will ensure they are prepared for the challenges and rewards of their future transportation technical career.

1 IHS Markit article May 3rd, 2021; <https://ihsmarkit.com/research-analysis/global-electric-vehicle-sales-grew-41-in-2020-more-growth-comi.html>

2 U.S. Department of Energy, Vehicle Technologies Office: FOTW #1 190, June 14, 2021

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INDUSTRY NEWS

ADDRESSING THE SKILLS GAP

ASE EDUCATION FOUNDATION LAUNCHES APPRENTICESHIP PILOT PROGRAM



MOTOR AGE WIRE REPORTS //



George Arrants, vice president of the ASE Education Foundation,

presented a new apprenticeship pilot program during the recent ASE Training Managers Council (ATMC) conference.

Intended for high school and college automotive students, the apprenticeship pilot program puts students to work in an actual repair shop while still in school and pairs them with a trained mentor who follows a structured development plan for the student. The program was created to address the skills gap by allowing students to learn the workplace culture, build competence, and increase productivity before graduation.

During the ATMC conference, several presentations were also made by ASE industry partners and the United States Air Force, highlighting the importance of training and retention of service technicians in the automotive industry.

During the conference, ATMC released the results from its annual survey on training benchmarks within the auto and heavy-vehicle service and repair industry. The survey is conducted to establish a series of metrics to help the industry recognize trends, provide a comparison standard, and align the offerings of training providers with the needs of training consumers.

“In light of the trends we’re seeing when it comes to recruiting and retention within the industry, we really appreciate the opportunity to present our apprenticeship pilot program to the ATMC conference attendees,” said Mike Coley, ASE Education Foundation president. “We had some productive discussions and received feedback and ideas that will assist us as we develop and implement programs that help prepare the next generation of the automotive service workforce.”



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WHAT STAYS AND GOES

Evaluating what business practices developed in response to COVID-19 are worth keeping long-term

BY MIKE HALEY // Contributing Editor

As we continue to move beyond the pandemic, I'm sure there are certain practices you can't wait to get rid of, along with eye-opening opportunities you prefer to keep. Personally, I really enjoy ordering curbside pickup at my local grocery store; I hope this service never goes away. Of course, curbside pickup is something my grocery store could have offered all along, but it took a pandemic to bring about this value-added service offering.

It got me thinking about shop owners. When COVID isn't an issue anymore, how would they evaluate which services should go, which should stay, and which should possibly improve? I have used a coaching method with my members to help them make such decisions. I ask them three questions that each require the answer "YES"; they are:

1. Is it good for the car?
2. Is it good for the customer?
3. Is it good for us?

Disinfecting and sanitizing

When the pandemic first hit, sanitizing everything was important for reducing the spread of COVID. Auto shop owners should keep and promote their infection control practices and offer disinfecting services during cold and flu season: disinfect interior surfaces, along with the ventilation system; replace the cabin filter; and ozonate the vehicle. This disinfection service would be valuable to customers who have a new definition of "clean" and understand the importance of killing germs to protect themselves and others.

Touchless transactions

Other practices worth keeping are touchless transactions. Now, everyone has lock boxes on the side of the building for customers to drop off and pick up keys to their vehicles. They also added the touchless payment process, making text-to-pay service popular overnight. Customers can pay without touching

your credit card machine or the service advisor's pen during the process.

Shop owners quickly learned that they could do business with their customers virtually 24 hours a day, seven days a week. Customers became comfortable dropping off, paying, and picking up their vehicles without ever stepping into the shop. Many shops added a second shift to keep some of their team isolated if there was an outbreak on another shift. They also found many productivity benefits resulting from scheduling this way.

Concierge services

The onset of COVID forced many to expand their version of concierge services to include drop-off and pickup. Staff now can go to the customer's home or work to pick up their vehicle, perform repair services at the shop, and return the vehicle to the customer.

Social media usage

Another challenge addressed was how to keep in touch with customers when they're not leaving the house. Social media usage became more popular as shop owners sought cost-effective ways to keep customers informed about when they were open for business and changes in service delivery. Being transparent and sharing availability and service wait times on social media made surviving this challenge easier for both shop owners and customers.

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Community marketing

Marketing had to be adapted to be more community-focused and empathetic. I was so proud of the shops offering specials for first responders and asking parts vendors to come along for the ride. We should continue to acknowledge them and always strive to take care of these special people.

Cross-promotion marketing was also revitalized. Many shop owners partnered with other businesses in the community to cross-promote and support each other's services. For example, giving your customer a gift card for a local restaurant and that same restaurant giving a gift card for the shop helped promote and expose your business to new customers. Cross-promotion was an effective way to keep vehicles coming in.

Workplace communication

In addition to communicating with customers, shop owners had to step up their game with their employees. They had to increase communications with their team to keep them informed on how the pandemic impacted their community, shop policy and procedures, and their job. For many shop owners, keeping the business open, keeping their employees safe, and being respectful of their employees' beliefs was daunting. But they did a good job sharing information, explaining their new processes, and keeping employees safe. Now, their



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 33 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.

employees are more loyal and grateful. Owners should continue this level of engagement with their staff. In ATI's Hiring and Staffing class, I always say that it is harder to steal a happy employee.

So, what will you keep?

There are new opportunities in front of us, and we can identify them by doing a

SWOT analysis — an evaluation of your shop's Strengths, Weaknesses, Opportunities, and Threats. This method helps shop owners think outside the box and break out of their comfort zone when evaluating change. To access ATI's SWOT Analysis Tool, go to www.ationlinetraining.com/2021-11 for a limited time. **TL**




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DIAGNOSING THREE-PHASE BRUSHLESS DC FUEL PUMPS

GET A BETTER UNDERSTANDING OF THE COMPLEX CONTROL CIRCUITS AND THE TRAINING YOU NEED FOR REPAIR

BY DAVE HOBBS // Contributing Editor

You might consider a multimeter to be your best tool for diagnosing electrical circuits that power in-tank electric fuel pumps. Those pumps are powered with two wires – 12-volt ignition and ground...right? Not necessarily! If you miss reading this article, you might just experience a misdiagnosis of the growing number of newly designed electric fuel pumps. We'll give you a close look at three-phase brushless DC (BLDC) fuel pumps and pass along the knowledge required to diagnose their complex control circuits.

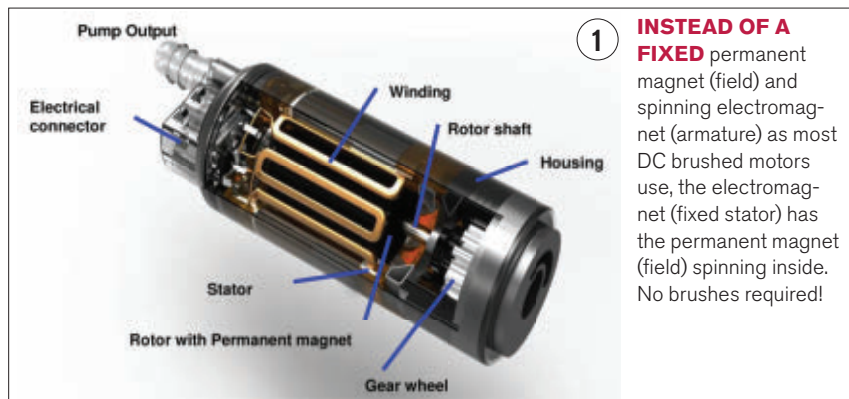
Three-phase BLDC?

We've all heard or used that phrase "two's company, three's a crowd." Traditional low-voltage DC (12-volt) electric motors use two wires to power them. One wire carries the 12 volts (positive), and the other wire (or metal bracket) carries the

ground (negative) side of the circuit. Today, that technology is on a road to obsolescence. The requirement for increased fuel efficiency is the primary reason behind the shift to these more expensive (and complicated) three-phase brushless (BLDC) fuel pumps. Side benefits are longevity, with no brushes to wear out, and robustness to corrosive fuels (E85), thanks to no armature commutator for brushes to ride on (**Figure 1**).

Starting around 2011, select European vehicles began using three-phase BLDC fuel pumps in place of traditional

(and simpler to diagnose) two-wire fuel pumps. By 2018, some Asian OEMs followed suit. North American car and LD truck manufacturers joined the three-phase BLDC fuel pump club on select models in 2019. Even some newer LD truck diesel applications are going with the three-phase BLDC for in-tank lift pumps, as well. Before we go on to the newer design, let's make sure we fully understand the "lower tech" fuel pumps that are controlled with "high tech" modules.



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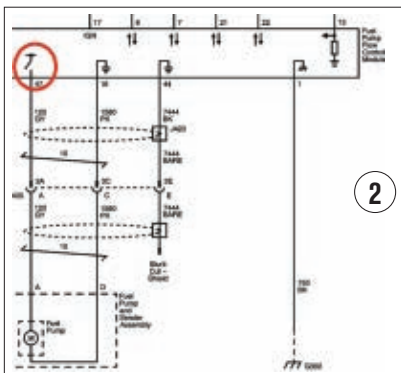
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Understanding fuel pump duty cycle, frequency, and the mysterious world of EMI

I've always had better luck diagnosing and repairing things that I can understand (at least partially). If I don't understand it, I either have to have a photographic memory to keep track of all the possible fixes for every vehicle or rely on factory diagnostic trouble trees. My memory isn't perfect, and trouble trees certainly aren't perfect either! So let's explain some established



THIS FPCM IS CONTROLLED BY the PCM via HS CAN lines to Pins 6,7,21 & 22. Note the shield wire (circuit 7444) is "bare." This may be bare stranded wire or take the form of reinforced aluminum foil. The important thing to remember is the notation "Blunt Cut – Shield". That means the shield is grounded at the FPCM's terminal 44 but NOT grounded at the tank or pump assembly. Some applications its grounded on both ends, but most of the time only at one end. Generally, you want the shield wire to be a "RFI interference catcher" not a path for the fuel pump's current demand to follow. Never try to re-engineer it unless there is an EMI issue. If it's not broke...don't fix it!

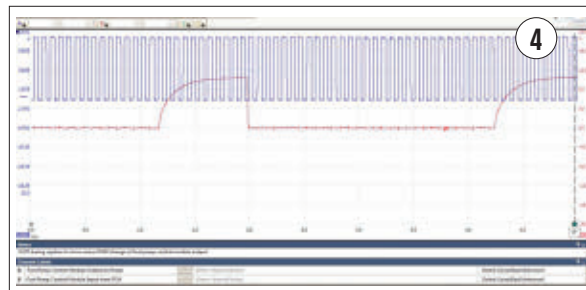
electronic theories used before the new three-phase BLDC pump controls.

Even before the adaptation of Gasoline Direct Injection (GDI), vehicle manufacturers began moving away from simple relay-powered in-tank fuel pumps. Removing the mechanical/vacuum adjusted fuel pressure regulator from the rail in favor of a returnless fuel system did not eliminate the need to vary the fuel pressure applied to SFI injectors. Most fuel pump control modules (FPCMs) use either a data bus like CAN or LIN, or digital pulse width modulation (PWM) input from the PCM to request the proper average voltage output to the fuel pump (Figure 2). Varying the pump's input voltage varies its speed. Pump speed creates the correct fuel pressure. A mechanical pressure regulator built into the modular electric fuel pump assembly keeps the fuel pressure from exceeding a safe limit and allows the fuel to recirculate within the pump assembly/fuel tank. The FPCM's output is a varying duty cycle to control the speed of the in-tank electric pump. This

allows for more precise fuel pressure control. A variable duty cycle is a much more efficient means of controlling the speed of anything (lights, solenoids, motors) compared to dropping the voltage to where you need it via power resistors. Resistors that drop voltage can also suffer from heat damage and eventually drop dead! Solid-state controlled PWM is the way to go!

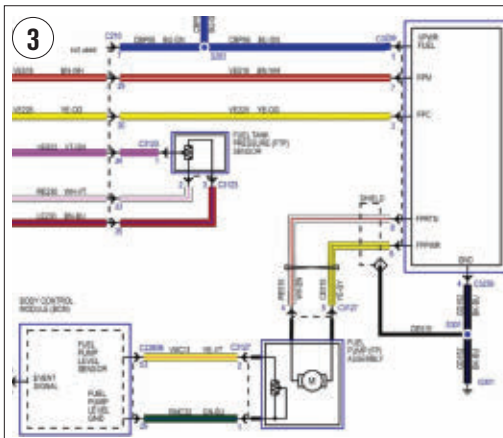
V-8 vs. V-6 engines help explain the PWM high-frequency mystery

Ford has been varying fuel pump speed with their FPCM outputs on SFI models for several years (Figure 3). Ford FPCMs use a varying duty cycle on a fixed frequency signal wire from the PCM to the FPCM. The FPCM then sends an output with a different varying duty cycle to the fuel pump's power feed. Variable PWM in/variable PWM out; simple, right? The FPCM's fuel pump power output has a much higher frequency compared to its input from the PCM (Figure 4). Why? Technically, it's all about calculating the



THE FPCM'S OUTPUT

to the fuel pump (Channel A - blue trace) is on longer (higher duty cycle) compared to the FPCM's input duty cycle from the PCM (Channel B - red trace). Additionally, the frequency of the PWM output of the PCM to the tank is several time higher (around 330 Hz compared to over 14 kHz). Notice the ramping of the FPCM's input (FPC) on the red trace? This is often referring to as "wave shaping." The module does this to reduce EMI. A "perfect" square wave can be a 'perfect' electrical interference emitter!



THIS FORD SCHEMATIC SHOWS conventional (unshielded) wiring between the PCM and the FPCM (Fuel Pump Control Module). The FPC (Fuel Pump Control) is the yellow wire and FPM (Fuel Pump Monitor) is the red wire. Notice the FPCM's output circuits leading to the pump assembly using twisted pair/shielded wiring on FPPWR (yellow-grey) and ground (FPRTN white-brown)? Why twisted pair/shielded wiring? FPC and FPM are lower frequency circuits. Fuel Pump Power and Fuel Pump Return are higher frequency signals more prone to create EMI. When you see the shield terminate on both ends of the circuit – leave it that way. Conversely, if you see the shield NOT terminate at each end of the circuit, leave it that way. In other words, don't try to fix what's not broken! EMC (Electromechanical Compatibility) engineers use both methods – depending on a vast number of variables for each vehicle model and system involved.

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PWM frequency based on the electric motor's time constant, inductance, and low-pass filter effect. The correct PWM frequency can help the motor to benefit mainly from the DC element of the PWM signal. If that bit of techno-babble is hurting your head, let's apply an engine analogy that will help make the point much clearer.

Eight-cylinder engines typically run smoother than 6-cylinder engines (of like designs) due to the higher frequency of power contributions afforded by their extra two cylinders (more combustion events per cycle). Also, a lower idle RPM (a.k.a. frequency) on any engine will result in fewer power contributions per second and therefore make the engine idle rougher. With electric motor PWM outputs, the higher frequency smooths out those motor speeds, too (**Figure 5**)! As with any rough-running motor (en-

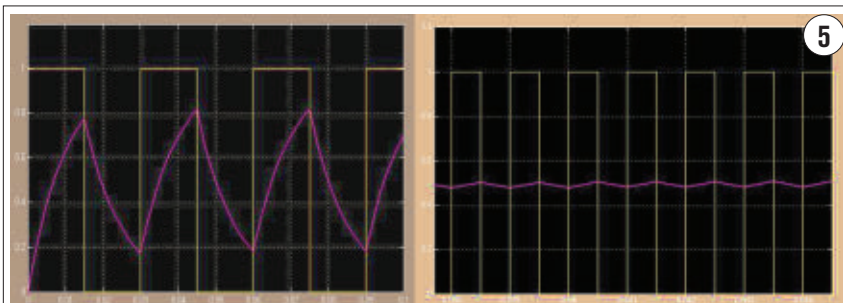
gine or electric fuel pump), if the noise goes up the reliability goes down.

What's the big deal about three wires going to a fuel pump?

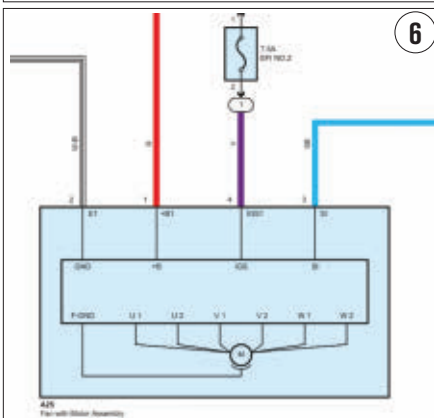
All the fuel pumps we've covered to this point have been two-wire models. Even though modular pump assemblies may add to that number of wires with a float sending unit and fuel vapor pressure sensor circuits, the actual fuel pump motors themselves have been simply two wires – positive and negative (ground). If you've worked in the hybrid/EV world of high voltage electric motors, you know they are three-phase AC-powered motors. The three wires to these motors receive high voltage AC (Alternating Current) from the vehicle's inverter (which changes high voltage DC into high voltage three-phase AC). These motors can also

create three-phase AC power when the vehicle is coasting or braking (called regenerative braking). Similar (but smaller) three-phase AC motors are used in most hybrids (and all EVs) to run the air conditioning compressors. That's old news to most techs, but did you know there may be numerous other "low" voltage DC applications of three-phase motors in many of the vehicles you work on? Probably not!

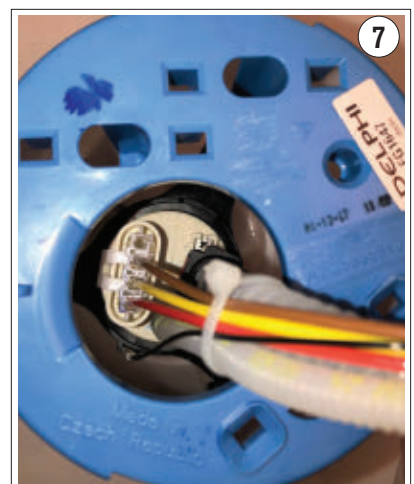
I say that because most of the time, these motors have their control modules built onto the 12-volt three-phase BLDC motor assemblies. Many vehicles with electric water pumps, advanced electric radiator cooling fans, and HVAC blower motors have been using these three-wire/three-phase BLDC 12-volt motors for years (**Figure 6**). If the schematic shows a single non-serviceable assembly containing the motor and the motor's control module, you don't need to know



THE PURPLE TRACES REPRESENT fuel pump motor speed on both scope captures. The yellow traces represent the frequency of the PWM feed powering the motor. Notice the PWM percentage (on vs. off) is the same (50%) for both captures? The electric motor speed (left capture) is changing rapidly (like a rough running engine) when the frequency of the PWM is lower. Notice how much steadier the electric motor speed is (like a smooth-running engine) when the PWM operates at a higher frequency as displayed in the capture on the right.



6 HERE'S AN EXAMPLE OF A THREE-PHASE BLDC you don't need to know anything special about. The fan and control module assembly are not separately serviceable. Just check the power, ground, signal/control circuits per schematic/trouble tree as you would any other electronic component. The clue that this motor is a three-phase motor is in Toyota's labeling of the phases: "U, V and W." This radiator cooling fan motor uses two sets of three-phase connections but works much the same as true three-wire/three-phase BLDC motors.



IN ADDITION to the vehicle schematics indicating you're working on a three-phase BLDC fuel pump, the actual wires leading to the fuel pump motor are equally helpful in establishing what you are encountering. Note the red, yellow and brown wires. A much smaller gauge black wire (RFI shield) terminates on a metal clip fastened to the side of the fuel pump motor's body. NEVER try "jumping" power and ground across any of the three-phases in your testing. The motor will be damaged! These motors require a three-phase BLDC FPCM to pulse each phase (every 120 degrees at a high frequency) to work.

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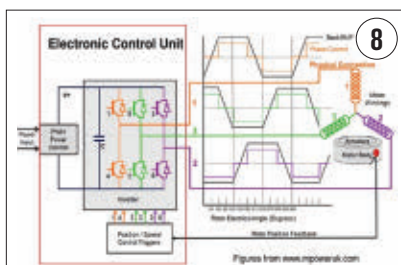
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anything about these motors. They run or they don't. Their control modules either have the correct power, ground, and signal circuits (bussed or PWM) or they don't. Diagnosis is business as usual.

Diagnosing three-phase BLDC fuel pumps

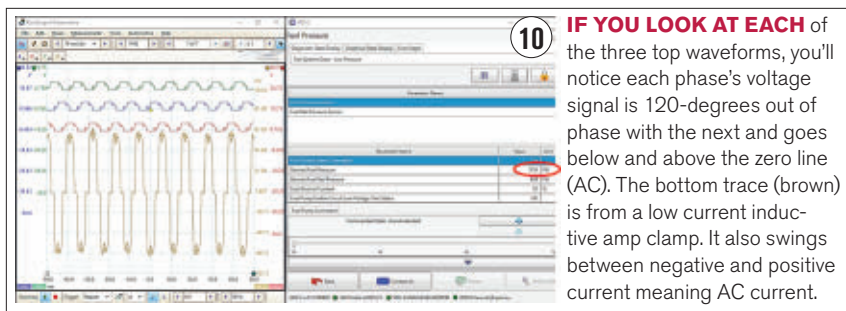
A minority of three-phase BLDC fuel pump applications include an integrated FPCM. On those, just diagnose as you would with any other module with power, ground, and signal circuits. If the FPCM is remote from the modular pump assembly, as are the majority of three-



MOST THREE-PHASE BLDC fuel pump stator windings are wired like this diagram. Note the three motor windings are tied together in a "Wye" connection similar to an alternator's stator. These motors work like an alternator in reverse. Another commonality between an alternator and a three-phase BLDC is the resistance between each end of each winding/phase being "almost" a dead short. That's why you never use power and ground jumper wires to try to run one of these motors. A micro-ohmmeter (like used in checking three-phase high voltage AC motors windings) can be used on these fuel pumps.



TOP: This is a known good vehicle (2020 Chevy Equinox) idling. There is only 2-volts of DC. (left) The PWM's frequency 5.97 kHz (center) The PWM's duty cycle is 21.9% (right) **BOTTOM:** This is a known good vehicle (2020 Chevy Equinox) idling. There is 4-volts of AC. (left) The PWM's frequency of AC is 746 Hz (center) The PWM's frequency of AC goes UP to 820 Hz (right) when the factory scan tool requested a higher fuel pressure output from this GDI vehicle's low-pressure pump in the tank. These three-phase BLDC fuel pumps are speed controlled by the PWM's frequency shifts!



IF YOU LOOK AT EACH of the three top waveforms, you'll notice each phase's voltage signal is 120-degrees out of phase with the next and goes below and above the zero line (AC). The bottom trace (brown) is from a low current inductive amp clamp. It also swings between negative and positive current meaning AC current.

phase BLDC pumps, you'll have three wires carrying the three phases along with an RFI shield wire (**Figure 7**).

The three-phase BLDC harness between the FPCM and the in-tank module fuel pump assembly may only be a couple of feet (Chevy Equinox), or the harness may be several feet in length, as with the newer Toyota Sienna (hybrid) minivan. The longer the harness, the more things can go wrong electrically. The resistance between each phase is very low, so don't even think about employing a PowerProbe between a pair of the three-phase connections (**Figure 8**). When diagnosing no starts/no fuel pressure, most FPCMs will set a DTC to help give you a clue, but that's never guaranteed. Checking for voltage supply to the pump/doing voltage drop testing becomes a whole new world on these three-phase BLDC fuel pumps. The typical multimeter will be almost useless unless it can show frequency/duty cycle (**Figure 9**).

What goes wrong with BLDC fuel pumps?

The root causes of failures vary. Fuel contamination (any pump's enemy), along with mixed-up phases (wiring repair induced), faulty FPCMs, and probing (jumping) with power and ground can cause no-starts, DTCs, and pump failures. These pumps are unlikely to wear out (no brushes) and they use less current (their main advantage). Misdiagnosis due to lack of training will inevitably be the main enemy of these fuel pumps. On Toyota and Lexus models using three-phase BLDC fuel pumps, the factory scan tool (Toyota Techstream) works well with a laptop, factory subscription, and J2534 pass-through device. That factory tool allows for bidirectional-requested pump speed control (so you can watch the results of the fuel pressure PID/gauge reading). That tool can request a single-phase activation, enabling you to monitor with a meter or scope as each phase is activated with a pulse. Overall analysis with a multi-channel lab scope will show strange and new voltage and current ramping patterns we'll be comparing notes on in various technician forums for many years to come (**Figure 10**).



DAVE HOBBS is a field trainer and training product developer for Delphi Product & Service Solutions. He holds ASE CMAT/L1 and EPA 609 certifications and is an experienced hybrid instructor. Dave has been featured as an instructor in more than 15 automotive training videos.

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FOLLOW A PROCESS FOR ADAS REPAIRS

UNDERSTANDING THE STEPS NEEDED FOR PROPER CALIBRATION

BY DEVIN PURCELL //
Contributing Editor

ADAS systems have been around in some form since the 1950s with the invention of anti-lock braking systems. However, the current generation systems that are starting to be more common in our service bays are starting to create a challenge for the industry. Even the most experienced technicians are finding it difficult to stay abreast of the changing technology as we make our way from Level 1 ADAS systems all the way to what most see as the future of the automobile, the Level 5 fully autonomous vehicle. While most of us argue until our faces turn red that this isn't going to happen until we are retired in some sunny spot down south, the truth is, that may not be true. If there has ever been a time that keeping up with industry changes is ever important, it is now.

Rear cross traffic alert, lane departure, forward collision braking, adaptive cruise control, and blind spot monitoring are all terms that we need to keep at the front of

our thoughts as we progress a vehicle from the estimation to completion stage in our shops. We need to know what areas of the vehicle the sensors and modules for these items live in. We are all aware at this point that if a customer has a run-in with a raccoon, it may cause significant front-end damage to the vehicle, and most likely the radar assembly has been damaged as well. But what about the things we cannot see? What if we replace steering components during a repair and the vehicle needs an alignment completed; is a calibration required then? It will be, if you have altered the vehicles thrust line during those repairs.

One of these items that lives a covered-up life is the blind spot monitor. These monitors can be used for blind spot monitoring as well as rear cross traffic alerts, and they are sometimes hidden in precarious locations. Have you looked under the rear fascia lately...or perhaps behind a tail lamp? Yes, it is true, some of these sensors have

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PHOTO: LAUNCH TECH USA

THE LAUNCH TECH X-431 ADAS MOBILE is a portable ADAS calibration tool for calibrating ADAS system and ideal for repair business to target new revenue stream.

found a home as part of a tail lamp assembly. Making a mental note of the location of these components will help us as we complete the repairs on the vehicle and come to the last stage of any successful repair order, the post-repair scan and repair calibrations.

Importance of the post scan

The post scan is an important part of the repair procedure because we can identify any calibrations that may be needed on the vehicle that we may have not been aware of. This is important, as there are some ADAS systems that do not have an approved test procedure, such as forward collision. Checking codes and ensuring there are none present is sometimes the only way to verify these systems are OK. After all, how can we verify operation of a system that will only work if we are in a near collision/collision with another automobile on the road?

So, we have identified a code that states an ADAS system needs calibration on our vehicle; what's next? This is one of the reasons why ADAS systems are causing many technicians to prematurely start to go gray. There is no simple answer. We need to have a standard process in our shops that all technicians can follow to allow them to find the information quickly and efficiently. Whether your shop uses Mitchell Pro Demand, ALLDATA, or possibly has access to dealer-level information, thorough research should always begin by accessing service information.

Another source of information may be directly through the scan tool you are using to scan the vehi-

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THE NEW BODY STYLE Ram's adaptive cruise control module is placed underneath the rear-view camera and is known as the Driver Assistance System Module.

cle. If your shop is equipped with an ADAS-capable scan tool or repair system, you may be able to simply search through the available calibrations that are listed for the vehicle to find the correct calibrations needed for the specific vehicle you are working on. This is completely dependent on the equipment that you have on hand in your shop.

We all know that service information can be lacking,

so what else can we do to know what calibrations are needed? Attending ongoing service training is as important as it has ever been to keep technicians updated with the latest information. Ensuring that your technicians are educated does not always mean sending them off-site for an all-day training event. If there are off times during the week when a technician can sneak in an hour or two of training, check online for great informational sources. One leading provider of ADAS equipment, Autel, has an amazing two-part video that goes through a live demonstration of ADAS calibrations.

Now that we know what we need to do, we need to ask ourselves, "Can we do it?" There are many companies producing ADAS solutions — Launch X431 ADAS Pro and the Autel ADAS ADVANCED are packages that have numerous adapters, lasers, etc. to allow you to complete multiple calibrations on many different vehicles. What is needed to complete the calibration can range from vehicle to vehicle and even from year to year. Let's take a quick look at two vehicles and see the differences.

One of the most common luxury vehicles on the road today is the BMW sedan. When an active cruise control repair is completed, we must recalibrate the forward radar assembly. To complete this calibration, we need to bring out our large ADAS calibration assembly and position it correctly with exacting measurements, ensuring that radar reflectors are placed in the correct area. Then through the scan tool, the calibration can be completed. Sound complicated?

Let us look at another vehicle common on the road, the new body style Ram (DT). The adaptive cruise control module on this vehicle is placed underneath the rear-view camera and is known as the Driver Assistance System Module. If we perform a repair where we need to reca-



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This new designation requires multiple categories of training, including shop management basics; coaching, mentoring, team building, and five new courses focused on the shop foreman role.

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WHEN AN ACTIVE CRUISE CONTROL repair is completed, the forward radar assembly must be recalibrated.

librate this unit, for, say, a simple windshield remove/replace, it can be done with tools that may be on hand. First, there is a measurement with a digital inclinometer that is completed on the Driver Assistance System Module. Once this is completed, an auto alignment procedure is completed with an approved scan tool and short test drive.

As you can see, it's important to follow a standardized procedure for your shop when completing ADAS related repairs. We need to know the capabilities of our shop and our technicians. Maybe your shop has not yet invested in something like the Autel ADAS solution. You can see in the above scenario that with some simple tools we already have in our tool arsenal and some well-trained technicians, we may be able to complete some ADAS calibrations in-house instead of having to sublet them. This will help expedite the repair for the customer and have them on the road much faster, mostly because we now do not have to deal with the headache of having to schedule a time at the local dealership for the repair.

Remember, ADAS calibrations do not have to be a headache. However, there needs to be a process in place. If you have yet to create a standardized process to help your technicians, maybe the time is now. No matter how much we wish it away, this technology is here to stay for the foreseeable future. **VZ**



DEVIN PURCELL is an automotive technician with more than 20 years of experience in the industry. Currently he is guiding future technicians in their educational experience as a professor at Fanshawe College in Ontario, Canada.
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HOW TO CHOOSE THE RIGHT SCAN TOOL

LEARN HOW TO MAKE A QUICK AND SMART CHOICE FOR YOU AND YOUR SHOP, AS WELL AS THE IMPORTANCE OF DOING SO



BY TIM MILLER//Contributing Editor

Many technicians find it hard to choose from the many options of scan tools available to them in the market. Are you one of them?

If so, you can use our enlightening guide to make a quick but smart choice. You'll not only know how to choose the right scan tool for you and your shop, but also **WHY** you should.

Who knows? You could discover an important aspect of the diagnostic tool industry that was overlooked in your earlier thought process.

The importance of choosing the correct scan tools

Several aftermarket scan tools can perform most of the functions of factory scan tools. Nonetheless, even top-rated products can't offer all the functionality needed. This has made many independent shops obtain more than one scanner for certain purposes. The execution of some tasks may only be possible with the utilization of factory scanners.

Factory diagnostic tools have been undergoing constant development over the years, just as have aftermarket scan tools. Several vehicle makers are offering subscription-based models of their scanners with J2534 Pass-Thru device compatibility.

Technicians in independent garages can now utilize the same generic J2534 device that's being employed in the reprogramming of modules to also access factory level scanners. You'll find several of them obtainable through short-term subscriptions.

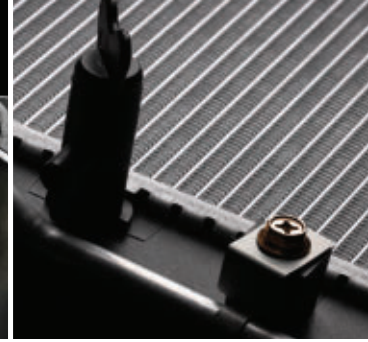
Some vehicle makers have switched from the provision of software applications that can be downloaded on a mobile device or PC to cloud-based technology that requires internet connectivity. You'd have to subscribe to the service to benefit from it, of course. This has become especially common for manufacturers of EVs (electric vehicles).

The security of on-vehicle data (crucial onboard systems) is a matter of increasing importance. Concerned automotive manufacturers have started taking innovative steps to implement solutions. They're doing this by transforming technologies that could be utilized in accessing vehicle networks. The introduction of upgraded cloud-based diagnostic tools is one of the results of their efforts.

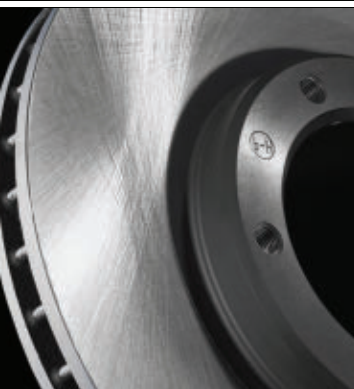
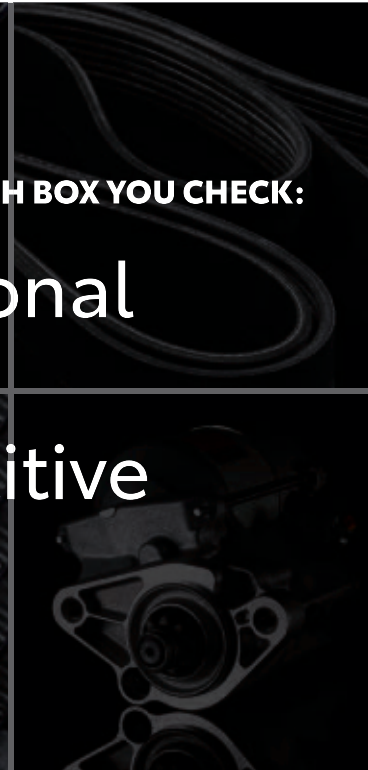
Choose the right scan tools for your shop to ensure that customers' vehicles (especially the most recent models) are effectively repaired. Modern vehicles have a great number of reflashing and diagnostic requirements. You can expect producers to keep adding more of them to newer models. With this in mind, it's only right that you seek to upgrade your scan tools regularly or get more suitable ones to meet up with the latest standards.



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Some products work only for certain vehicles. Be sure about what you're getting so you can choose the best diagnostic tool or combination of diagnostic tools for your garage.

As Donny Seyfer, former co-chair of the tool and equipment committee for the National Automotive Service Task Force advised, shops will need scan tools for contrasting reasons. This is why you should have a complete knowledge of the functionalities your shop would require from the product(s). See the steps in selecting the most suitable scanner for your garage below.



What vehicles do you service?

Make a list of the vehicle makes, models, and years you work on. Your decision-making process will be easier if your scope is narrow or if you specialize in one type or few types of vehicles.

What vehicles don't you service?

This second criterion can be thought of in place of the first. However, there's another approach you can take in answering the question...

Knowing which vehicles you don't repair (and why you don't repair them) can aid you in discovering which vehicle could incorporate into your service range. After all, you're always trying to have more ways to generate revenue, right? You could decide to get a scan tool that lets you service additional vehicle makes.

Do your research on various shopping criteria

Your research will be based on the following factors:

Product Types/Categories: Find out the advantages and disadvantages of the type or category of scanner you need:

- Code readers
- OBD I
- OBD II generic
- OBD II generic with enhanced data
- Factory tools

Hardware: Seek information about diagnostic tools that are compatible with PDAs (personal digital assistants), smartphones, and PCs— and don't forget those that come with their dedicated hardware.

Vehicle coverage: It's important to know the range of vehicle makes and models that the tool is compatible with. What's the extent of its functionality and what type of data can it produce?

Guidance/Usage: Will it be easy to learn how to use the product? What kind of training is required, and how long will it take? You should also research what's needed to make the scanner work.

Software compatibility: Details about software compatibility is important, whether for PDAs, PCs, tablets, or smartphones. Operating systems such as Windows, Mac, Android, iOS, and so on will come to mind.

Ongoing support: Find out if the manufacturer of the diagnostic tool has a technical support hotline that technicians can call. Such a feature might be useful when you encounter difficulties in using the scanner or want to make inquiries.

Regular updates/upgrades: Tool makers that offer constant updates and upgrades should be on your checklist. Their products will keep getting better and better over time.

Cost-effectiveness: Think of affordability in terms of purchase price and regular updates/upgrades.

What value can the scan tool offer to you and your shop?

In other words, what will be the ROI (return on investment) for buying the diagnostic tool? Compare the purchase price plus subscription and upgrade fees to the revenue you may get from charging customers for scans. This will give you a minimum estimate.

Test the product

Testing the diagnostic tool is the best way to be sure that it's the one for you and your shop. You'll be able to see the complete functionality the brand is offering and compare it to the range of vehicles you service. It will be great to see a manufacturer or seller that lets you demo before making a purchase.

Utilize the tool appropriately and strategically

This should be done after buying the scanner to make the best use of it. Follow the instructions in the manual, undergo training, seek advice from experts and on forums, etc. The next thing would be to market your shop's diagnostic know-how to potential customers effectively.

Final thoughts

When it comes to recommending a scan tool, diagnostics expert George Lesniak says that there's no one answer for any workshop. He advises technicians to make the decision-making process as easy as they can for themselves by researching and testing the products before making a purchase. Don't just go for the flashy, pricey, or cheap scanners—but the most suitable ones. *TM*



TIM MILLER is a technician and also editor-in-chief at obdadvisor.com. timmillergp.0781@gmail.com



SERVICING TPMS CAN ADD TO A SHOP'S BOTTOM LINE

INVESTING IN THE TOOLS AND TRAINING FOR TPMS SERVICE HAS BIG PAYOFFS FOR INDEPENDENT REPAIR SHOPS — DON'T BE LEFT BEHIND!

BY TRACY MARTIN//Contributing Editor

One of man's greatest ideas is the wheel, invented about 3,500 years ago. First used for wheelbarrows, chariots, and eventually carts and wagons, early examples were made of stone or wood and were improved upon by first adding leather, iron, and steel bands to wooden spoked wheels.

Solid rubber tires appeared in the mid-1800s (the first run-flat tires) and were excessively heavy and did not provide a smooth ride. Although not invented by him, John Dunlop is credited with creating air-filled (pneumatic) tires in 1888. In that same year, the first gasoline car (patented by Carl Benz in 1886) was fitted with metal tires covered with air-filled rubber. The tire tread was added in 1905 to protect the tire's car-

case from direct contact with the road and improve traction.

The air-filled tire was also the start of "flat tire anxiety" experienced by drivers worldwide, worrying about their tires losing air. The fear and inconvenience of tires going flat and having to mount a spare tire has led to tire pressure monitoring systems, or TPMS.

TPMS history

It is estimated that around 25 percent of U.S. vehicles operate with underinflated tires, and fuel economy, tire longevity, handling, and safety all pay the price for low tire pressure. Auto manufacturers addressed this in 1986, when Porsche was the first car to feature a factory TPMS system and Renault was the first manufacturer to produce high-volume vehicles (2000 model year) that came standard with TPMS. The 1997 C5 Corvette was the first U.S. production vehicle to have TPMS as standard equipment, and because it lacked room for a spare tire, it was equipped with Goodyear run-flat tires.

In 2000, Firestone Tires and the Ford Motor Company recalled 14.4 million tires because of vehicle rollovers, caused by tire tread separation. These tire failures were linked to more than 250 deaths starting in the early 1990s and put pressure on the U.S. Congress to pass the Transportation Recall, Enhancement, Accountability, and Documentation (TREAD) Act. The TREAD Act mandated TPMS technology for all light motor vehicles under 10,000 lbs. from September of 2007 on. The European Union adopted the same regulations in 2012.

TPMS alerts drivers when tire pressure falls below more



THIS 112-YEAR-OLD TIRE GAUGE operates using a sliding scale under spring tension to measure tire pressure. The Schrader-Universal tire gauge was patented in 1909 and manufactured by A. Schrader Son's Inc. in Brooklyn, New York.

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TECHNICAL

than 25 percent of recommended inflation pressure. Early TPMS did not display actual tire pressure, and many drivers assumed that if the warning light was off, tire pressure must be good—this is not true. For example, if tire pressure in a passenger car is supposed to be 32 psi, the TPMS light will not come on until pressure has dropped to 24 psi. If light truck tire pressure is recommended at 80 psi, the driver will not be warned until the pressure drops to 60 psi. In either case, load capacity is significantly reduced before the driver is warned, and depending on driving conditions, it could cause severe tire damage or an accident.

Two flavors of TPMS

Direct TPMS (dTPMS) uses a sensor to measure tire pressure (**Figure 2**). Indirect (iTPMS) use input from ABS wheel speed sensors to approximate low tire pressure. This works because when air pressure is low, the tire's diameter is decreased, which affects wheel speed (**Figure 3**).

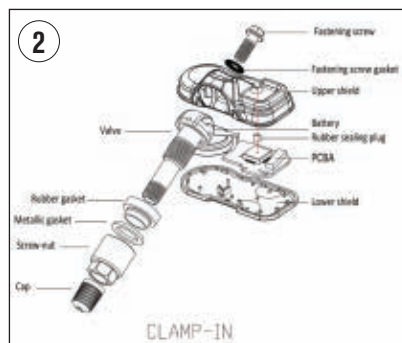
Early iTPMS was not reliable, because if overall tire pressures were low, the system would not set an alert; tire size and road conditions could mislead

iTPMS, causing a false alert or no alert. Current and future iTPMS are and will be more reliable because of advanced data analysis (software). Some iTPMS requires tire size to be entered via a diagnostic tool to accurately calculate tire pressure. After adding air to a low tire, changing/servicing tires, or tire rotation most iTPMS has a RESET button and driving procedure to recalibrate the system.

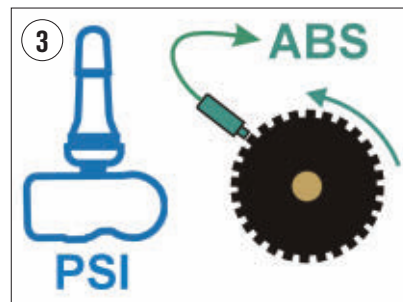
The vast majority of vehicles use dTPMS systems rather than iTPMS. In general, dTPMS is found on domestic, and some European or Asian vehicles, while iTPMS is used on some Asian and European vehicles. Professional TPMS tools, like the Autel MaxiTPMS TS508, or Continental's Autodiagnos TPMS SE, will have a database listing which vehicles use what type of TPMS.

Aftermarket sensors

Introduced in 2007, TPMS-equipped vehicles in the U.S. are estimated at around 205 million in 2021. Early replacement tire pressure sensors were often only available at OEM dealers at a cost of around \$100. In the past 14 years, the aftermarket has responded with universal, programmable sensors and pre-programmed sensors that can replace numerous OEM sensors with only a few part numbers and at about half the cost.



THE DRAWING SHOWS what's inside the Autel Sensor-1 TPMS sensor. The clamp-in, metal valve stem is held in the sensor with a fastening screw. Inside the upper/lower shields are the battery and printed circuit board assembly (PCBA). TPMS sensors cannot be disassembled, as they are encased in epoxy to protect them from moisture, corrosion, and vibration.

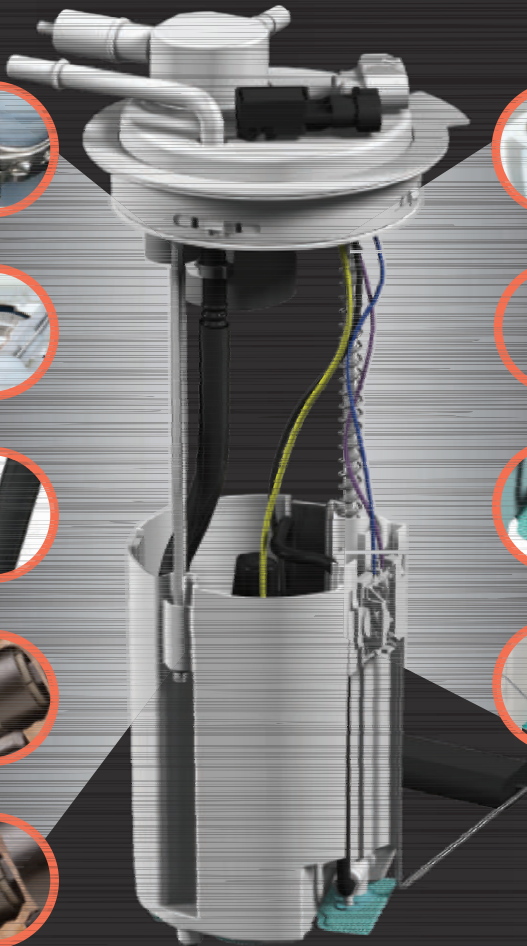


THERE ARE TWO TYPES OF TPMS SENSORS, direct and indirect. Direct TPMS uses pressure sensors to monitor tire pressure. Indirect systems use wheel speed to approximate low tire pressure because the tire's diameter changes slightly with a loss of air.



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This sensor technology has reduced independent repair shops' sensor inventory, making TPMS service more efficient. Sensors are available as "clamp-in" (retaining nut at the base of a metal valve stem) and "snap-in" (rubber) valve stems. On some applications, they can even be used as a replacement for older "band" style TPMS sensors.

One example of new sensor technology is the MX 1-Sensor by Autel. The company provides full-function TPMS diagnostic tools, sensors, and professional scan tools. The universal, programmable 1-Sensor combines both 315MHz and 433MHz frequencies into one TPMS sensor that provides coverage for 98% of vehicles. The patented



THIS MX 1-SENSOR by Autel has both 315MHz and 433 MHz frequencies; is 100% ID cloneable with no relearn required, and can be programmed and updated with Autel wireless programming tools. The PRESS release valve stem allows rubber and metal valve stems to be interchanged by hand.



THE CONTINENTAL REDI-SENSOR is available in snap-in and clamp-on type styles that are direct replacements for 280 OE sensors covering over 138 million vehicles. They are pre-programmed for an entire range of vehicles and come ready to use out of the box.

PRESS release valve stem design allows rubber and metal valve stems to be interchanged using no tools (**Figure 4**).

The MX 1-Sensor can be programmed wirelessly, even when sensors have already been mounted to the wheel. Sensors are 100 percent cloneable, with no relearn required when cloned with the original sensor ID and mounted in the same position on the vehicle. Using Autel's latest TPMS tools, up to 16 sensors can be programmed at one time, and sensors can be updated for new vehicles applications via the tool.

The MX 1-Sensor is certified to meet SAE standards and is guaranteed for 24 months or 24,000 miles. For quality control tracking of a series, the number is imprinted on the sensor and can be read with Autel TPMS tools. A single sensor retails for around \$43, and wholesale costs are \$39.95 per sensor. In some markets, Autel has a promotion for 20 sensors and their TS508 TPMS tool for \$895.

The Continental REDI-Sensor is another example of aftermarket TPMS sensors. The company offers both snap-in and clamp-on type sensors that are direct replacements for 280 OE sensors covering over 138 million vehicles. They are pre-programmed for an entire range of vehicles and come ready to use out of the box. Labor time for installation is saved because no sensor programming is required (**Figure 5**).

REDI-Sensor works with all major

TPMS scan tools, including ATEQ, Bartec, and Snap-on. REDI-Sensor is designed to follow existing OEM vehicle relearn procedures with no added steps. The REDI-Sensor pivoting metal clamp-in valve stem makes installation easier and accommodates a wide range of wheel rim profiles. REDI-Sensor replacement parts and service kits are available and include seals, washers, valve cores, hex nuts, and caps. Replacements are also available for the sensor's metal valve stem.

Continental Commercial Vehicles & Aftermarket has a warranty registration website for REDI-Sensor Multi-Application TPMS Sensors. The website allows shops to register REDI-Sensors installed on customers' vehicles. Technicians can use the information to alert customers of their warranty status and to file a warranty claim. The site stores customer names and addresses, as well as their vehicle's year, make, model, date of sensor installation, serial number, and part number.

TPMS service

TPMS sensors don't broadcast a continuous signal but only transmit when the vehicle is in motion, and even then, the signal is intermittent to conserve battery



CLAMP-IN SENSORS are subject to galvanic corrosion when exposed to road salt and moisture. Corrosion can weaken the valve stem, leading to a possible sudden loss of tire pressure. Courtesy of Autel.

life. How long a vehicle is parked vs. how much it's driven will affect battery life. Batteries inside TPMS sensors last anywhere from five to 10 years, with five to six years representing a more typical lifespan. Some scan tools can read battery data, but there is no industry standard regarding what battery information (if any) will be displayed (**Figure 6**).

Economically, it makes sense to replace sensors when new tires are installed. The dilemma is that after operating long enough for the tires to wear out, the batteries may not last through another set of tires. It's a tough sell to customers: change the sensors with a new set of tires (adding \$200 to the bill) or wait until the sensor batteries go dead, then having to pay for mounting/balancing plus the new sensors. An effective approach to upselling customers TPMS sensors with a new set of tires is to stress safety. In addition to warning drivers of an underinflated tire, TPMS reduces risks of accidents due to tire failure; increases fuel economy and tire life. If a single sensor has reached the end of its lifespan, replacing all sensors at the same time is recommended—once one sensor's battery dies, the rest are likely to be close behind.

One cause of TPMS sensor failure is galvanic corrosion. This affects the clamp-in type of sensor that uses a metal valve stem with a nut at its base to mount the sensor to the wheel. Exposure to road salt and moisture can weaken metal valve stems that could lead to a sudden loss of tire pressure. TPMS sensor service kits for metal stems include hex nut, grommet/seal, valve core, and cap. Rubber stem valve kits include a new stem, valve core, and cap. These parts should be replaced when repairing a flat tire and mounting new tires. Do not replace a TPMS stainless steel valve stem core with one made of brass (**Figure 7**).

Always check the spare tire to deter-

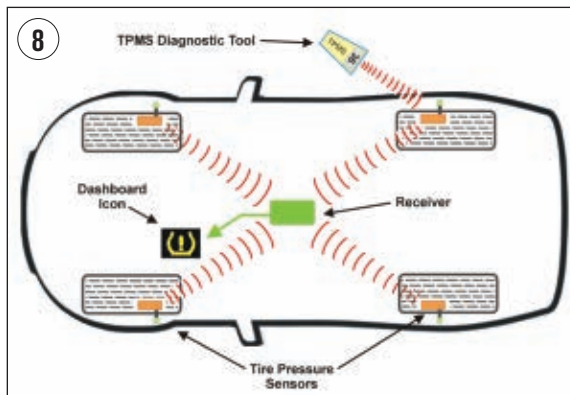


ALWAYS USE A SERVICE KIT when repairing a tire with a metal TPMS valve stem. These parts can become damaged due to corrosion, causing a leak. Rubber TPMS valve stems do not corrode.

mine if it's TPMS-equipped and working properly.

If the spare tire sensor is not relearned or serviced, it typically results in a comeback. Replacement TPMS sensors must be relearned to the vehicle, plus a relearn may also be required after performing a tire rotation (**Figure 8**).

When a vehicle is in for service check the TPMS alert light and document the presence of any illuminated or blinking light before performing any work. A steady light usually means that one or more of the tires has low air pressure and needs to be inflated. A warning light that flashes for 60 seconds (then stays on) can indicate a variety of issues, including incorrect sensor installed, missing sensor, damaged sensor, or dead sensor battery.



THE TPMS CENTRAL RECEIVER communicates with the sensors and controls the operation of the dashboard warning light. Aftermarket TPMS sensors come in two varieties: pre-programmed for specific vehicles or universal sensors that must be programmed using a TPMS tool. When tires are rotated or replaced a TPMS tool is used to trigger the sensors, updating their location to the receiver.

TPMS tools

The Autel TS508 is a new generation TPMS diagnostic/service tool that will: activate TPMS sensors, read sensor status, check TPMS system health, program MX-sensors and conduct TPMS relearn. The TS508 is a minimum-level, professional tool for individuals, or as a second TPMS tool for a busy shop. The tool costs \$270 (wholesale). The TS508K kit (\$329.95) comes with the tool and eight sensors and is a good starting point to experience Autel's TPMS products (**Figure 9**).

The TS508 has two modes: TPMS Quick Mode: basic TPMS functions to check sensors and program MX-Sensors quickly and, TPMS Advanced Mode: TPMS sensor check, TPMS diagnostics, and sensor position relearn.

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Programming Autel MX 1-Sensors with the TS508 is easy, and up to 16 sensors can be programmed at one time. Because the sensors are programmable, any programming mistakes are easily fixed using the tool. TPMS relearn procedures are stored in the tool for U.S., Asian and European vehicles. The tool can be updated online at no cost after product registration.

Continental's Autodiagnos TPMS SE tool is designed for shops with multiple bays and the need for more than one tool. It provides coverage for all passenger vehicle OE sensors and the most popular aftermarket sensors. TPMS and tire service functions can be accessed from the main screen without requiring vehicle-specific configurations where applicable. The tool can read and clear TPMS codes and has a VIN scanner for faster make/model/year lookups. The TPMS SE tool offers a graphical user interface that allows it to be used in a variety of lighting conditions including direct sunlight (**Figure 10**).

The SE professional-grade tool triggers and reads data from all OE vehicle sensors and has relearn-coverage for 99 percent of domestic, Asian, and European passenger vehicles. It provides direct (OBD, auto, manual) and indirect TPMS relearn procedures and

CONTINENTAL'S AUTODIAGNOS TPMS SE

professional-grade tool can trigger and read data from all OE vehicle sensors and has relearned coverage for 99 percent of domestic, Asian, and European passenger vehicles. The tool can read and clear TPMS codes and has a built-in VIN scanner for quick make/model/year lookups.



performs OBD-II mode relearning via a cable connection. The SE tool displays data including sensor ID, tire pressure/temperature, and sensor battery status.

The future of TPMS

Between 2007 and 2021 more than 205 million vehicles were sold in the U.S. All of these cars and light trucks were required to have TPMS. Multiplying that number times four tires per vehicle results in 822 million TPMS sensors — that's a lot of potential dollars for the automotive repair industry.

The future of TPMS technology is ever-changing as onboard systems become more dependent upon each

other for efficiency and performance. Lindsay Smith, Continental REDI-Sensor Product Manager recently said, "Several TPMS innovations will be introduced to mass vehicle production over the coming years, most notably Continental's Electronic-Tire Information System (eTIS) that can be integrated into the inner liner of the tire, allowing for installation on any tire regardless of type or rim size. This solution also has scalable features, such as load and tread depth monitoring and possible integration with the chassis network processing."

TPMS sensors are constantly draining their batteries, becoming damaged during tire repairs, replacements, rotations, and from corrosion. This represents a huge opportunity for repair dollars to flow into a repair shop—don't send your customers to the dealership for TPMS service. Invest in the tools, training, and parts inventory to service TPMS. **TM**



THE AUTEL MAX-TPMS TS508

diagnostic tool comes with a USB cable/charger and OBD-II Cable. It can read ECU sensor ID, check sensor and ECU ID matching, and read/erase TPMS DTCs. The tool can program sensors by a copy-by-activation, copy-by-manual input, auto-create up to 16 sensors at one time, and copy-by-OBD.

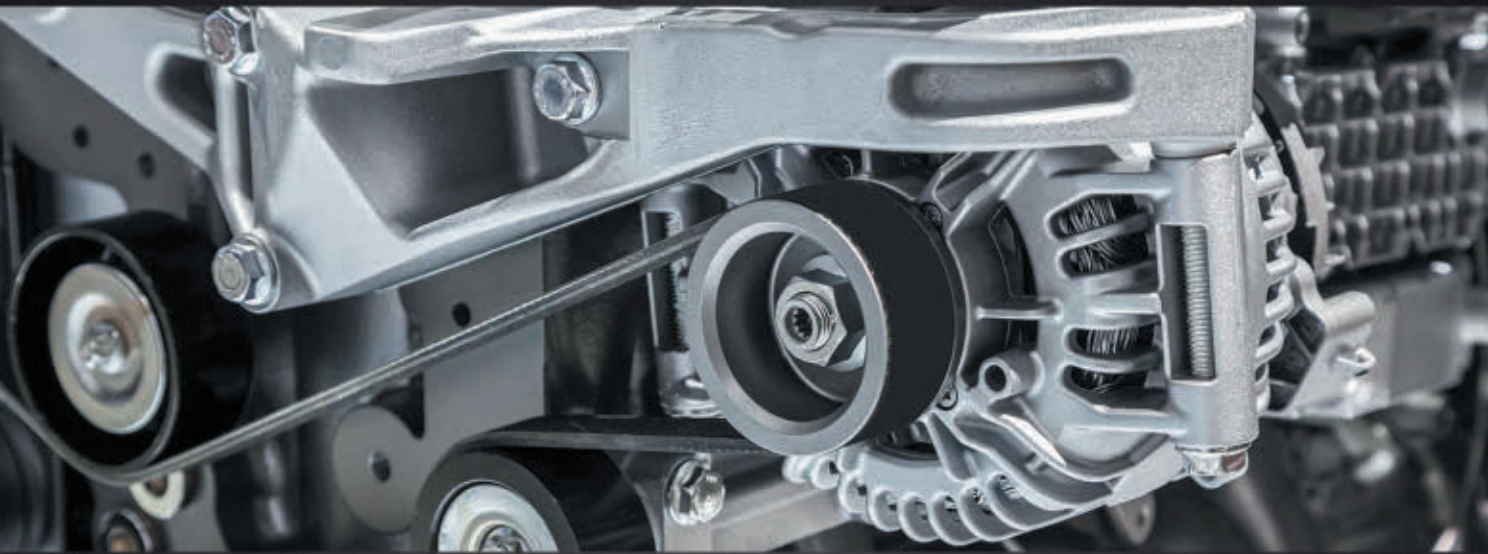


TRACY MARTIN has covered the powersports industries since 1998. He is also the author of six Motorbooks Workshop Series books published

by the Quarto Publishing Group and is a regular contributor for *Motor Age*.

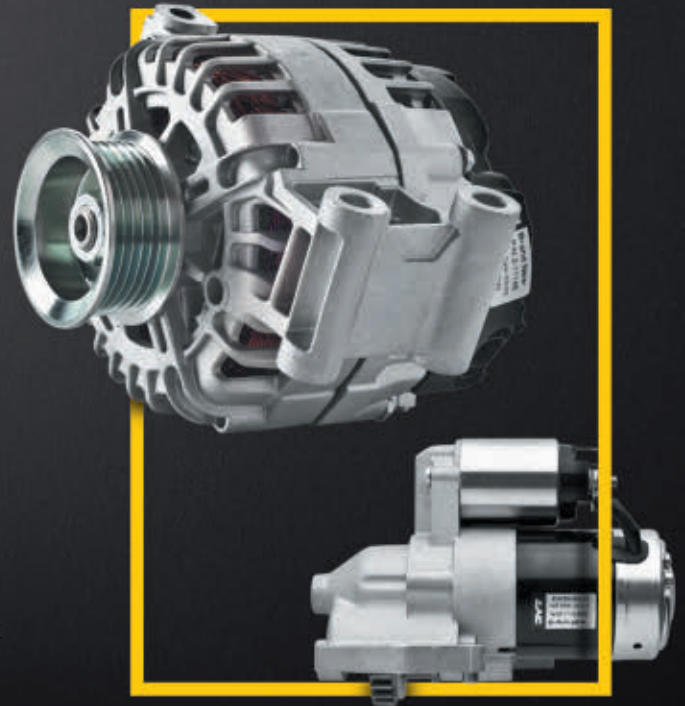
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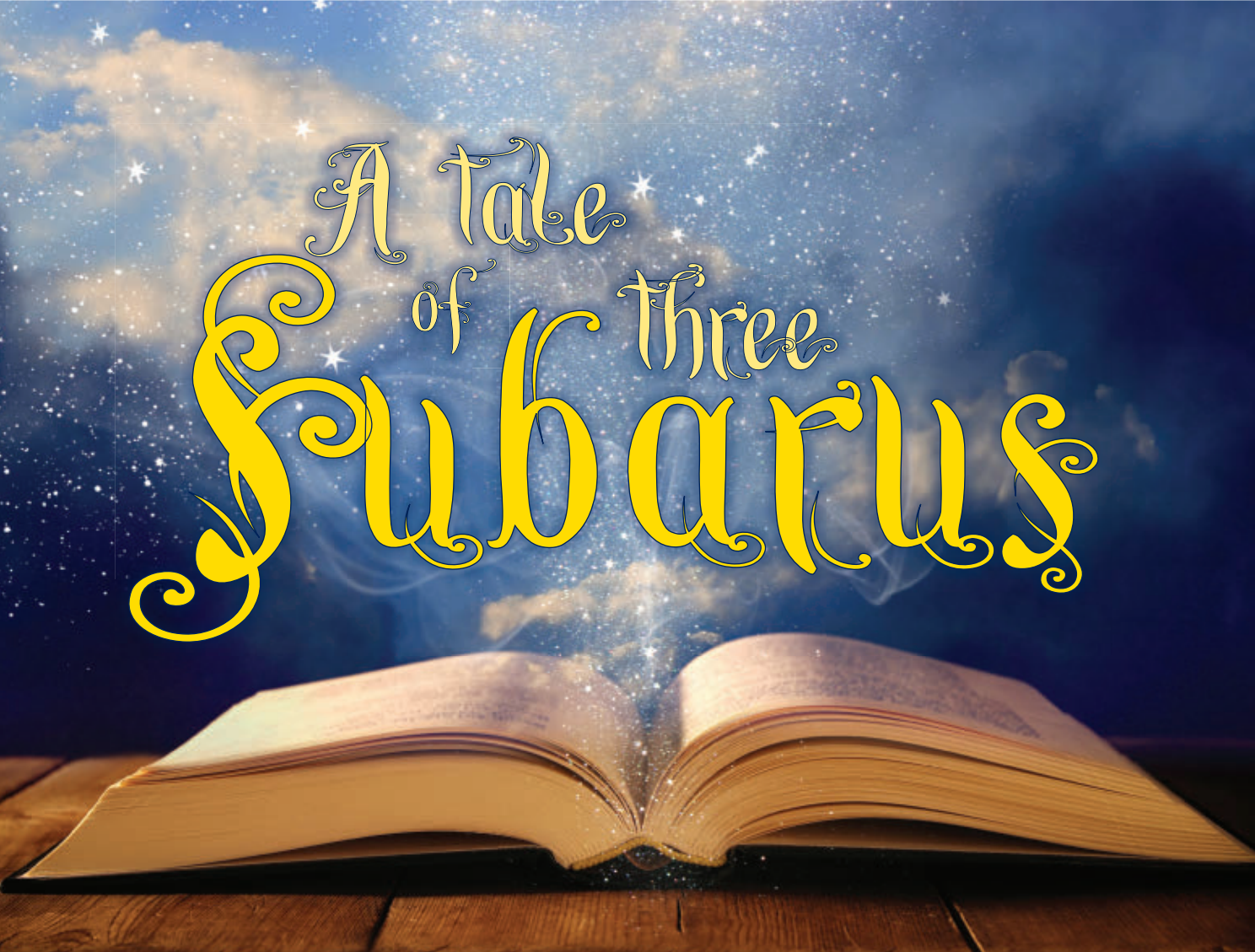
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A Tale of Three Subarus

UNDERSTANDING VEHICLE BRAND CHALLENGES AND HOW TO WORK THROUGH A PROPER DIAGNOSIS

BY SCOTT SHOTTON // Contributing Editor

Some of you may know I am an industry technical trainer and a mobile technician. I work on almost all makes of vehicles, but there are a few makes I do not see very often. Historically, in my day-to-day work, I have not seen Subaru vehicles regularly. Recently, Subaru's market share has been growing and more Subaru vehicles may be coming through your door. I have personally been seeing more Subaru vehicles in the last year or so, and this has forced me to sharpen

up on my Subaru knowledge and skills. Additionally, I have decided this may be worthy of a class. To do justice to such a class, I had to network with individuals who know more about Subarus than I do. My choice of Subaru contacts was Leo Gilmore. Between the two of us and many broken vehicles, we put together a class. In the process, I learned a lot.

Our class intends to cover many issues, such as differences between other makes, common failures, differences in scan tool data, and diagnostics for said vehicles. As a

result, we intend to teach this class at Vision 2022! Here are a few case studies that we have gathered on Subaru vehicles that may or may not be used in our class at Vision. Here we go.

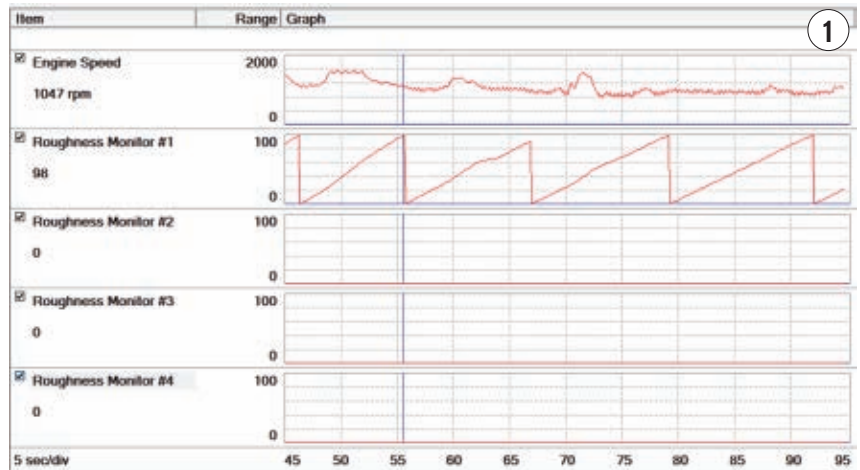
2012 Outback 2.5L “P0301”

This vehicle presented itself with an illuminated MIL and a rough-running concern that any of us could feel was a single-cylinder misfire. If we were to look at scan data, we would see some differences if we were used to other makes of vehicles. What I mean is that there is not a data PID named “Misfire Counter,” like in the case of a General Motors vehicle. In Subaru’s world, the data PID we would be looking for is called a “Roughness Counter.” In this case, we can see that we are counting misfires on cylinder number one (**Figure 1**). This data was recorded with a Subaru Select Monitor (SSM), which is the factory tool for Subaru. Most quality aftermarket scan tools should be able to see this data.

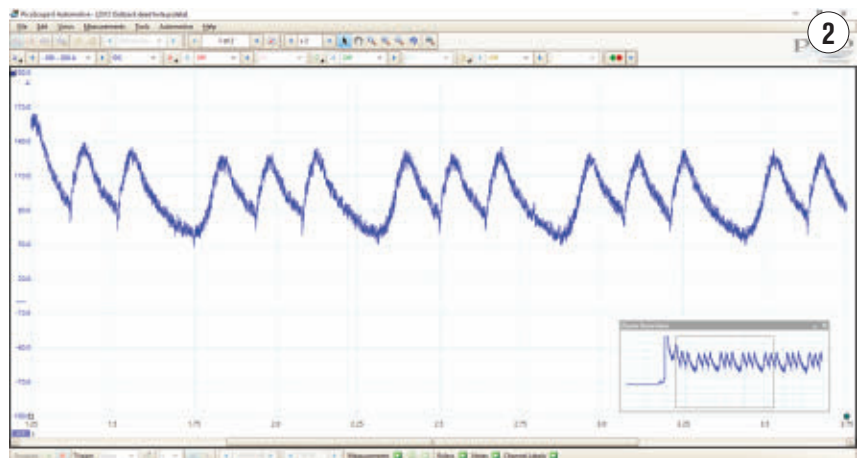
Fuel trim numbers were checked next and were close to normal when the vehicle was in closed loop. Fuel trim diagnosis is extremely valuable when the vehicle is in closed loop. Incorrect fuel trim numbers could point us in the direction of a fuel delivery-related issue. However, if the fuel trim numbers are close to normal, we may need to head in another direction.

The next option was to investigate the potential for a mechanical or ignition failure. For the sake of efficiency, the throttle was held wide open and the engine was cranked over. I know it is old school, but this test still gives us direction. The result is a rhythmic engine RPM fluctuation that can be heard. I think it is time to investigate a mechanical issue.

A high current probe was connected around the battery cable, the throttle was held to the floor, and the engine



MISFIRES ON CYLINDER ONE are obvious when observing the “roughness” PIDS.



RELATIVE COMPRESSION shows a single cylinder issue on this 4-cylinder engine.

was cranked over. The scope capture confirmed that there was a compression issue in a single cylinder of this engine (**Figure 2**). For you scope individuals out there (I am one of them), I realize there was not a sync present to identify the cylinder with low compression, but we knew which cylinder it was because of the DTC.

Now we had quickly determined the issue was mechanical. We could use vacuum transducers to narrow down the cause. In this case, the tool choice was conventional. Either way, we came to the same result. Cylinder number one was confirmed to be near the top dead center of the compression stroke and a cylinder leakage test was

performed. I was pretty sure that the results confirmed an issue (**Figure 3**).

While snooping around to find where the leakage was, a rubber glove was taped over the tailpipe, and it immediately inflated (**Figure 4**). I think it was safe to say that the loss of compression was related to the exhaust valve.

The relatively simple task of removing the exhaust manifold was performed. It became visible that the exhaust valve guide had broken loose and dropped from its bore in the cylinder head, hindering the exhaust valve from closing fully (**Figure 5**). It should be noted that this is a common issue on some Subaru engine platforms.

2008 Impreza WRX 2.5 L Turbo P0011 and P0021

This vehicle came in for an MIL complaint with “A-Camshaft Position System Performance (Bank 1)” and “A-Camshaft Position System Performance (Bank 2)” DTCs stored in the ECM. In Subaru speak, “A-Camshaft” means the intake

camshaft is the issue. This particular engine application only phases the intake camshafts. With the scan tool connected and viewing the AVCS (Active Valve Control System) data while varying engine RPM, it was noted that bank 1 did not vary at all, while bank 2 changed only a couple of degrees.

Not ignoring the basics, the next step was to check the oil level. Lo and behold, the crankcase was more than one quart low. The oil level was corrected, the DTCs were cleared, and the vehicle was taken on a test drive. AVCS data was observed again. Now the bank 2 (left) camshaft was moving, but the bank 1 (right) camshaft still did not phase, even though it was being commanded (**Figure 6**). During the test drive, the P0011 returned but the P0021 did not.

Current flow through the oil control valves (OCVs) can be seen in the data, so it was a safe bet that there was circuit integrity and the poten-

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CYLINDER LEAKAGE results for cylinder one.



OLD SCHOOL BUT effective! There is a compression leak through the exhaust valve.

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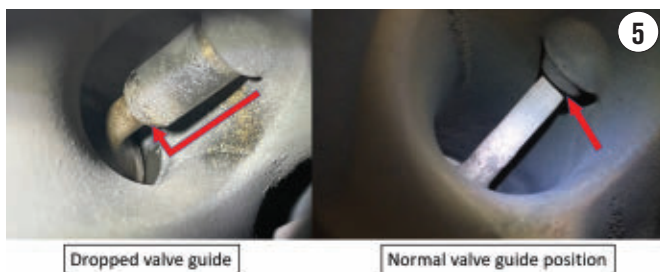


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DROPPED VALVE guide versus normal valve guide.

Item	Value	Unit	Minimum	Maximum
Oil Pressure	2.0	bar	1.0	3.0
VVT Adv. Ang. Amount R	0	deg	7	0
VVT Adv. Ang. Amount L	15	deg	23	0
OCV Duty R	52.8	%	5.78	92.4
OCV Duty L	28.7	%	8.73	92.4
OCV Current R	758	mA	736	0
OCV Current L	418	mA	578	0

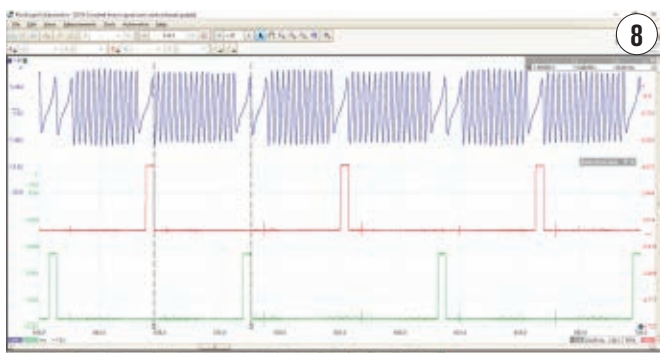
response ←
command ←

6

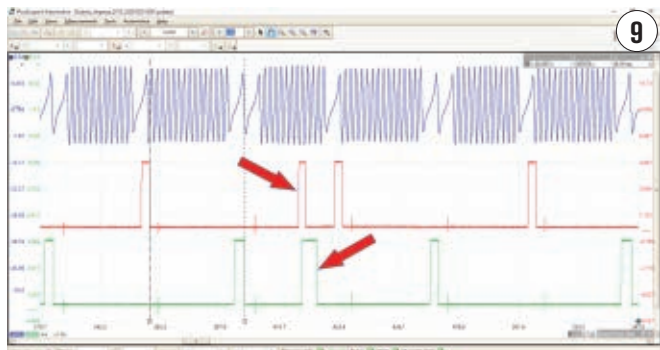
BOTH BANKS are being commanded to phase. Bank 1 does not move while bank 2 does.



THE PLUGGED SCREEN was not allowing oil to make it to the camshaft phaser.



A KNOWN GOOD CKP/CMP capture taken from another vehicle with the identical engine.



BOTH CMP SENSORS show additional pulses that should not be present.

tial for an electrical-related fault was minimal. The next step was to investigate the possibility of a mechanical or oiling issue that affects bank 1 only. The right bank OCV was removed and inspected. The oil screen was removed and was found to be plugged solid with debris (**Figure 7**).

The screen was replaced and everything was reassembled. The next test drive confirmed that the issue was resolved for now. Most likely the cause of the restricted screen was a lack of normal maintenance, as noted by the initial low oil level, and the issue could reoccur over time.

2013 Impreza 2.0 L Engine replaced and MIL illuminated

This particular vehicle had an engine replaced with a used unit. After the engine was replaced, DTCs were cleared, and the engine was started. The MIL illuminated immediately. A DTC scan was performed, and P0366 “Camshaft Position Sensor — B Circuit Range/Performance Bank 1” and a P0391 “Camshaft Position Sensor — B Circuit Range/Performance Bank 2” were both stored. If you remember from our previous case, camshaft A was the intake camshaft. A DTC that calls out “B” is referring to the exhaust camshafts. Unlike the last case study, this engine application phases all four camshafts.

The Subaru diagnostic information was pretty limited for these DTCs. The trouble chart would have had us go through a series of circuit tests, much like other manufacturers do, that may be time-consuming and inefficient. However, a description of the code-set criteria was found that could aid in our diagnostics. In a nutshell, the ECM will store these DTCs if there are irregular pulses detected from the camshaft position sensors during a relatively low number of crankshaft revolutions. The information also showed a poorly

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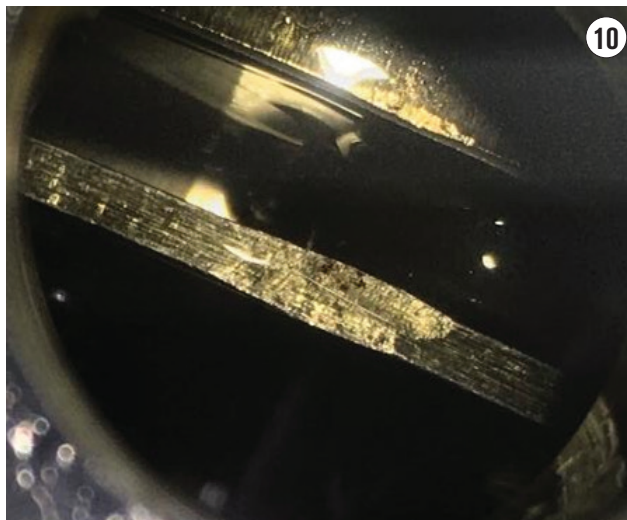
drawn CKP/CMP capture. Although this may not be completely valuable, at least it pointed us in a direction. Time to break out our scope!

First, we needed a known good capture to compare to. It does not matter what we gather with a scope if we do not know what “good” is. In this case, a known good CKP/CMP scope capture was found for a 2014 Crosstrek with the same 2.0 L engine (**Figure 8**).

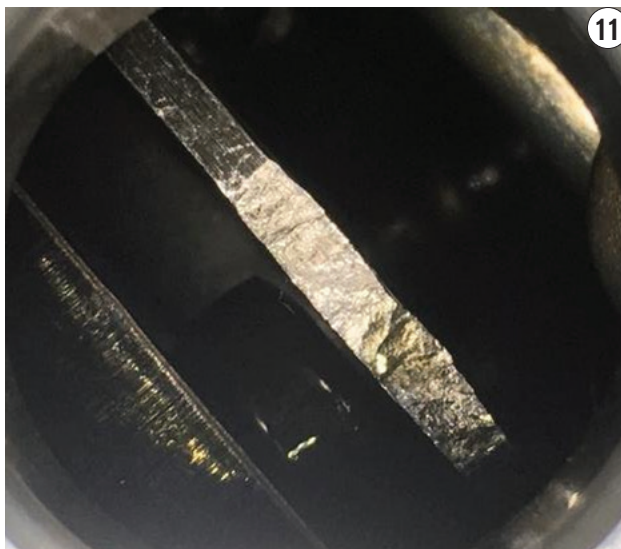
For reference, the top trace (blue) is the CKP. The bottom two traces (red and green) are the exhaust CMPs for both banks. Cursors were also pulled up on the screen to analyze timing. Again, this was a known good vehicle. The next step was to scope our subject vehicle. Making the same connections with our scope we obtained a capture that did not match the known good. The capture obtained from the subject vehicle showed some anomalies in both CMP signals that should not have been there (**Figure 9**).

I think it was safe to say that the CMP sensors were good. They both pulled down to a clean ground, the voltage transition was instant, and both sensors hit a full 5 volts. Now it was time to investigate the camshaft reluctors. The CMP sensors were removed and the engine was turned over by hand to inspect the condition of the camshaft reluctors. Looking through the CMP mounting bore for Bank 1 exhaust camshaft showed an obvious problem (**Figure 10**). Repeating the process on Bank 2 yielded similar results (**Figure 11**).

The cause of the issue was damaged exhaust camshaft reluctors. If we were to play “Automotive CSI,” I would have guessed that the used engine had been apart in the past to repair camshaft carrier oil leakage. Head gasket issues were common on older Subaru engine platforms. Although that problem seems to have been fixed, a common oil leak concern



BANK 2 INTAKE RELUCTOR did not look much different.




DAMAGE TO BANK 1 intake camshaft reluctor was causing the DTC.

on newer engines is the seal between the camshaft carrier and the cylinder head. My guess, in this case, was that during a previous repair, the reluctors were damaged by the technician during an unrelated repair. I cannot swear to that, but regardless, the cause of the DTCs had been identified and the engine had to come back out again.

Conclusion

These three Subaru case studies illustrated a few points. Some show similarities with other manufacturers and others do not. If you are not used to working on Subarus then I hope this information has helped. A misfire is a misfire, but the data PIDs may be different. Mechanical engine testing is still the same, even though spark plug access may be tougher than some other vehicles. Acronyms may be different, such as “AVCS,” but the systems still work on the same concepts and our diagnostics are no different once we know the terminology.

Assuming that COVID is not going to shut down Vision 2022, and you have an interest in sharpening your Subaru skills, please feel free to attend, and Leo and I will do our best to provide many more case studies and answer your questions to the best of our ability. 



SCOTT SHOTTON is owner of The Driveability Guys, and he performs mobile diagnostics, reprogramming, industry training and has been a college instructor for the past 14 years. With a degree in Automotive Service Technology, Scott holds more than 21 ASE certifications. scott@driveabilityguys.com

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Protect Your Customers from Winter Wiper Woes

With winter on its way, it's never too early to get ahead of the snow, slush, ice and all conditions that aren't nice for drivers. Preparing customers before winter rolls in means they have the best chance for safe travels ahead, especially during peak periods. While new tires, a full battery and a fresh oil change will keep drivers on course, they won't be ready to take to the road without a clear view ahead.

Safe winter driving starts with wiper maintenance. After all, the only place for drivers to go when visibility is compromised is right back inside. When it comes to wipers, ANCO has the answers. Here are a few tips to pass along to your customers to identify and prevent wiper mishaps this winter.

Spot the Three S's

Next time your customers turn on their wipers, have them look out for any streaking, skipping or splitting. Wipers that are in good shape will clear the full field of view across the windshield with ease. If smears are left behind or sections of the windshield are missed by the wipers, there's a strong chance that the blade is being obstructed or has sustained damage.

Take a Closer Look

Customers don't have to be pros to catch wiper damage, but yours can be if they know what to look for. The rubber blade should be secure and fully intact



against the frame. If any cracks, tears or abrasions are visible, it's time to find replacements. Wipers designed for snow and ice resistance can give your customers extra protection in harsh conditions.

Fend Off the Freeze

Frozen wipers simply can't provide a clear field of view in any conditions. Luckily, drivers do have a few options to prevent wipers from sticking to the windshield or collecting ice. Lifting the blades up is a simple and effective solution if the vehicle allows for it. Covering the wipers up or wiping them down with rubbing alcohol are also efficient solutions.

Remove Salt and Sand

It can be a major relief to drivers to see salted and sanded roads in winter. The same can't be said for wipers. The tiny granules that land on the windshield can dry out and scratch wipers, eventually leading to damage. Drivers should

make a habit of cleaning off their windshield when gassing up in addition to using a warm, wet cloth to wipe down the blades.

Clear Off Nozzles

After a heavy snowfall or deep freeze, drivers should make sure that their washer fluid nozzles haven't been blocked. If no snow is covering up the nozzles and the fluid doesn't come out, the nozzles are likely frozen. Giving the vehicle a couple of extra minutes to heat up should solve the problem. If not, a pin can be used to dislodge the clog.

Unlike other critical components, your customers don't have to look under the hood to check out their wipers. Sparing a moment to ensure their wipers are road ready means they won't be sacrificing their safety later on. When your customers stop by for winterization, make sure their wipers are a part of the conversation.



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How Often Is Lift Maintenance Needed?

Even the most rugged, low-maintenance lifts need attention from time-to-time.

Give your lift a onceover every day before you use it, check the safety devices, operating controls, lift arms and all moving parts to make sure everything is functioning properly. Look for breakage, excessive wear or other conditions that may affect its performance. Be sure to check your adapters — it's critical to your safety that they're not damaged, missing their rubber pads or excessively worn.

Keep an eye and an ear out for any unusual sounds or issues when using your lift. If something doesn't seem right, stop using the lift until you can get it checked out. Never use a lift if any component is broken or damaged or if you see signs of an oil leak. Call a lift service professional.

Your owner's manual should lay out the specific maintenance requirements for your lift, but for an overview, here's the minimum you should do monthly for most two-post and four-post lifts.

Monthly Checklist

- Visually inspect all moving parts and all cables for signs of excessive wear.
- Check all arm adjusting locks to make sure they're operating properly.
- Check all cable connections, bolts and pins to ensure proper mounting and torque.
- Visually inspect safety locks for proper operation.
- Lubricate posts with grease if required.
- Lubricate locking latch shafts. Push the latch handle/release arm several times for oil to penetrate the pivot points.
- Inspect all anchor bolts and tighten if necessary.
- Check all posts to make sure they are square and plumb.
- Inspect all pivot arm pins to ensure they are properly secure.
- Check cable tension and adjust if necessary.
- If the lift is equipped with an overhead micro-switch, make sure it is operating correctly.
- Check the equalizer cable tension and adjust per the owner's manual if needed.
- Replace any missing or damaged caution, warning or safety-related decals. You can order new ones from your lift manufacturer.

If cement anchor bolts are loose or any lift component is found to be defective, **do not use the lift**. Call a qualified lift service professional to repair it. Never put a lift back into operation until all faulty parts have been replaced with genuine OEM replacement parts.

Finally, always keep your lift and its components clean.



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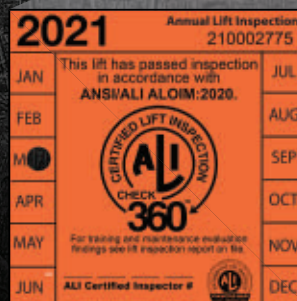


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Digital Inspections for Technicians

We are always talking about digital courtesy inspections that we send to drivers, so they see exactly what we recommend in repairs and maintenance for their vehicles—and more importantly, why. Shops that use technology like digital inspections will tell you that educating drivers on their vehicle's needs builds the trust between your shop and customers.

But did you know that technicians benefit from using digital inspections too? Especially if the digital inspection software gives the technicians the ability to create their own inspections that will make their jobs easier and more efficient.

A very basic inspection is created just for documenting a finding or repair—or even recording a procedure so that it is shown to be done correctly. Digital inspections give technicians three ways to document using detailed notes, pictures, and video. Most of the time, pictures get the job done, but having the opportunity to use other options is always a good backup.

A digital inspection also opens the door for techs to document the step-by-step disassembly of a major component—documenting exactly what was found. The pictures taken during the process are now valuable assets allowing techs to:

- Document any repairs made
- Reference the images through the reassembly of the unit

On vehicles missing the “map” for how the serpentine belt winds around the multitude of pulleys, techs simply capture several pictures with a tablet to ensure proper reinstallation.

Replacing drum brake shoes may not be something techs perform on a regular basis, so it's very possible to get out of practice in knowing how to exactly put the spring hardware back in—in the right order and places. Taking pictures before disassembly assists techs during reassembly when the time comes.

I know that some of you are thinking this is silly. Is the utilization of a digital inspection for these purposes easier and simpler than a trusty smart phone taking pictures? I hear you. But consider the fact that these inspections are time stamped and connected to the vehicle being worked on and is easily accessible anytime in the future. Whereas, on a phone, it is likely that pictures are deleted from the device after the vehicle is complete and out of the shop.



Digital inspections offer more valuable capabilities—especially to more-involved technicians. Building diagnostic routines is easy as 1-2-3—simply create a digital inspection for that specific action. For example, an AC Performance Test Inspection doubles as a step-by-step guide for techs performing this on a vehicle. The first step or point might be identifying the refrigerant, checking to be sure it is not contaminated. Next step, hooking up the gauges and recording the readings. Finally, recording the findings of the diagnosis.

This digital inspection is then sent to the customer, validating the value of your diagnostic fees. Even more, it educates customers that there is more to diagnostics than just reading a code. Even though customers will presumably not understand details like what the pressure gauges are indicating, it's more than likely they have never received such a comprehensive report summarizing the process.

Built the right way, these diagnostic inspections guide younger techs through the process—requiring them to document each step and its findings, proving all important actions were taken.

Digital inspections are not only for courtesy inspections and customers. Digital inspections are the new tool each technician's wants in their toolbox.



JOHN 'JB' BURKHAUSER is an Auto Repair Specialist with over 35 years of experience—with expertise ranging from A Level & ASE Certified Master Tech, Shop Advisor/Manager, to Automotive Trade School Instructor, and Technical Writer. He is a highly sought-after industry thought leader who has been published in both the US and Europe. JB currently serves as Director of Education at BOLT ON TECHNOLOGY, the leading provider of automotive software solutions that solve the most common struggles facing the Automotive Repair & Maintenance Industry. For more information or to get in touch with JB, please visit www.Boltontechology.com



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Why Full Synthetic Media is Important

It's no secret that oil filters maintain proper engine lubrication while removing solid particle debris that could otherwise wreak havoc. After all, changing out the filter during an oil change is one of the major vehicle service needs that every driver must regularly maintain.

While most customers have a basic understanding of filters and their role, many are unaware the advantages of full synthetic media oil filters and what those benefits can mean for their vehicle. Purolator is here to pass you some tips to share with your customers so they can make a more informed decision for their vehicle.

Study, compact formulation

Oil filters are designed with consideration for particulate removal efficiency and dirt-holding capacity. Compact synthetic fiber media filters offer robustness through improved mechanical strength and excellent water, chemical and temperature resistance. Full synthetic media oil filters not only catch and remove even the smallest particulates, but also better withstand complex chemical reactions between fuel components, combustion products and oil that cause filter aging.

The compact synthetic filter media structure also helps to decrease differential pressure. Lowering that pressure greatly reduces that amount of time the filter bypass valve needs to be open. During cold start situations, the bypass



MAXIMUM ENGINE PROTECTION

valve decreases pressure to allow oil to flow freely – though unfiltered – to the engine oil galleries.

Water resistant and stable

Water in engine oil is a common, often unavoidable occurrence. Compressed natural gas, ethanol, short driving distances, start-stop systems, water injection and environmental factors all contribute towards water content. In instances where the engine isn't heated up enough to vaporize water, the water content in oil can reach up to five percent. Combining with contaminants and combustion byproducts, this residual water creates a sludge that coats filter fibers and raises differential pressure. This process increases the total acid number of the oil, which begins to at-

tack filter media. However, these affects are much less severe on hydrophobic synthetic media filters and their supporting grids.

Purolator has developed laboratory tests to specifically examine the influence of water and critical temperature ranges on oil filter media. In coordination with customers, cold chamber, cold climate and short-haul operation tests are conducted to measure the direct influence of temperature, water, contaminants and pressure on oil filter media. Through these tests, Purolator has determined that 100 percent synthetic PET oil filter media offers significant mechanical strength and chemical resistance for greater filtration performance.



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Save Time When Building a Diagnostic Strategy

When a vehicle enters the bay, the first step to a successful repair is a diagnostic test.

But don't stop there. Having a diagnostic testing strategy saves time and increases accuracy by allowing technicians to pinpoint the root cause of the issue. It also avoids throwing parts at the problem, which is costly to both the consumer and the shop via comebacks and lost shop credibility – something you never want to see happen.

Auto repair information systems, like ProDemand from Mitchell 1, give you a prioritized list of components based on the code or symptom that you are experiencing. As a technician, you could read the top result and swap the most popular part. However, that is not recommended. Instead, it's best to follow the whole diagnostic process, including isolating the fault through testing to be sure that you have properly identified the component at fault.

Using symptom-to-component information helps you build your prioritized diagnostic strategy. Once you have a diagnostic plan in place, you can then execute your plan by following through with diagnostic testing.

Electrical Diagnosis

Using a combination of OEM and real-world information can provide the most efficient way to diagnose electrical problems. When looking into a symptom like a code or customer complaint, you are going to first want to review OEM information like technical service bulletins to see if the OEM has already released information for this issue to their technicians.



In ProDemand, interactivity connects wiring diagrams to full component information without a secondary lookup.

Then you can jump to real-world information to learn if other technicians have addressed this same issue before and have a solution.

From there you may want to go back to OEM information – like set conditions and OEM test procedures – as you diagnose the issue. ProDemand makes this easy with its 1Search Plus search engine and SureTrack real-world Real Fixes and Community content.

Wiring Diagrams

Wiring diagrams give the technician a simplified and schematic representation of the electrical components and systems on the vehicle. Just like having a map of a city to know the layout and where you are going, a wiring diagram provides a high-level view of an entire electrical system. This view helps you understand how the components interact with each other, what might occur upstream or downstream from your suspect component, and the effects of a current flow through the entire system.

One of the biggest difficulties today is finding the correct diagram to begin with.

Today's vehicles have dozens of electrical systems, each with multiple pages of diagrams. Some engine performance system diagrams can span 16 pages. Then there is difficulty in finding the specific component you are interested in and then also tracing the wires to understand connection points within the large diagrams.

The latest enhancements to the advanced wiring diagrams in ProDemand include exclusive interactive features to help you quickly find the specific information you want, including components, connectors, grounds and splices. Navigating within a diagram set, or navigating from one diagram set to a completely different diagram set, is as simple as clicking a mouse. The component links are all clickable so you can view related content right from the diagram. When you open that diagram the component, connector, ground or splice will be in focus with all the traces already highlighted.

For diagnosing complex electrical systems, it's vital to have a repair information system that supports your diagnostic strategy, helping you to properly diagnose from start to finish.

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Inspecting the Brake Fluid

Brake fluid plays a critical role in the brake system. It's responsible for the transfer of hydraulic pressure into mechanical movement, allowing the brake pads to make contact with the rotor.

If the fluid levels are too low or if the fluid is too old, there is the risk of greatly reduced braking power or a loss of braking completely. Check the brake fluid on an annual basis.

Checking fluid levels

First, check the level of the brake fluid in the master cylinder. Almost every master cylinder will have a maximum and minimum line on the side of the reservoir. Check that the fluid is at the proper level. Low fluid levels are caused by worn down brake pads or leakage in the hydraulic system.

Checking moisture content

Checking the moisture content of the brake fluid is a vital part of any fluid inspection. Most vehicles use glycol-based brake fluid (DOT 3, DOT 4, DOT 5.1). This type of brake fluid is hygroscopic, which means it is always absorbing moisture.

As fluid absorbs moisture, it lowers the boiling point of the fluid. If the fluid boils, air bubbles form in the hydraulic system. Since air is compressible, this can greatly reduce the effectiveness of the brake system and even lead to a complete loss of brake pedal.

To check the moisture content, a moisture content tester is needed. Take a sample of the brake fluid and use the tester to measure the moisture content. As a rule, if the moisture content is above three percent, it's a good indication that the brake fluid needs to be replaced.



Low fluid levels

Low fluid levels are caused by either worn down brake pads or leakage in the hydraulic system.

As the brake pads wear down, the pistons must come further out of the caliper so that the pads can make contact with the rotor. When the pistons come further out, the void is then filled with brake fluid. This causes the fluid levels to drop. To fix the problem, the brake pads will need to be replaced.

If the brake pads are not worn down, check the hydraulic system for leaks, including the master cylinder, brake hoses and lines, calipers and wheel cylinder (if the vehicle has drum brakes). If there is a leak in any of these components, it will have to be repaired or replaced.

High moisture content

If the moisture content of the fluid is too high, the old fluid will have to be replaced with fresh fluid. To do this, bleed the old fluid out of the hydraulic system. Always check the cap of the master cylinder to see what brake fluid to use. If the cap does not specify, check the vehicle's service manual.

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Introducing the NAPA Exclusive Coated Brake Products that deliver guaranteed customer satisfaction

No matter where you live or what you drive, your vehicle is subjected to extreme weather from time to time. And the more your ride is exposed to the elements, the more it deteriorates. Over time, rust can build up in places that aren't visible: inside the rotor's vanes, caliper brackets, and brake pad backing plates. These hidden areas can progressively corrode and deteriorate your brake system's performance, leading to brake noise, premature wear, pulsation, and overall dissatisfaction when braking.

Adaptive One is the go-to brand with the latest aftermarket braking technology from NAPA AUTO PARTS. They are designed to deliver exceptional brake performance and guaranteed customer satisfaction.

Adaptive One Pads

Adaptive One Brake Pads offer the best formulations and technology for your vehicle. An exclusive friction lineup for passenger car, SUV/CUV and light truck coverage; featuring advanced noise reduction and CleanCoat™ technology for the best protection available. And Adaptive One Pad & Rotor KITS offer the best coated value including a limited lifetime warranty.

Adaptive One Coated Rotors & Adaptive One Performance Rotors

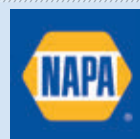
Adaptive One Coated Rotors provide the best defense against rust and corrosion. With original equipment matched designs and robotically applied full corrosion-resistant coating, Adaptive One Coated Rotors are recommended as the first replacement for newer vehicles. They're guaranteed quiet, certified



safe, and when paired with Adaptive One Brake Pads, they deliver on performance and the clean look favored by today's drivers.

Adaptive One Calipers

Adaptive One Calipers or Eclipse Calipers bring the same level of quality and protection. The coating provides a uniform layer of corrosion protection for housing and bracket on both iron and aluminum calipers, including inside the piston bores to help prevent pistons from sticking. Everything needed for installation is in the box: banjo bolts, cable mounting brackets, levers, springs, and pre-lubed components.



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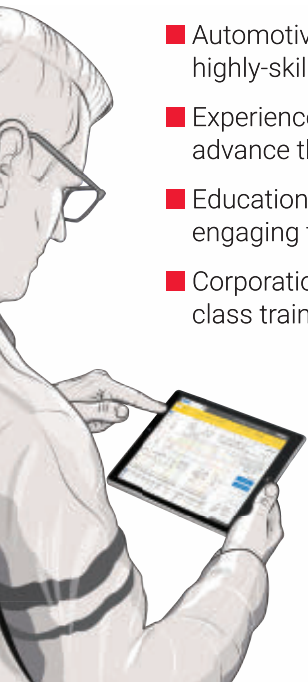


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FEATURES A WIRE STRIPPER, FOLDING SCREWDRIVER

The Milwaukee Tool FASTBACK 6-i-1 Folding Utility Knife, No. 48-22-



1505, features a wire stripper, folding screwdriver, fold-out 1/4" bit holder, and a reversible Phillips #2 and slotted 1/4" bit. The knife features a press and flip mechanism for one-handed opening and quick-change for easy tool free blade changes. It has a durable wire belt clip that reduces pocket tearing. The blade holder features a metal extension to prevent accidental blade removal and is designed for scoring.

WWW.MILWAUKEETOOL.COM

FEATURES A SELF-CENTERING DESIGN

The OEMTOOLS Hub and Wheel Bearing Replacement Set, No. 37342, is used for removal and installation of front wheel hub and bearings on Asian, Domestic, and German Vehicles where the hub and/or bearing is pressed, along with rear wheel hubs and bearings on European vehicles. The heavy duty thrust bearing reduces effort and extends the life of the pressure screw. The set includes adapter shoes, pusher washers, receiver sleeves, a nut bolt, and a heavy duty bearing.



OEMTOOLS.COM

COMES WITH AN UPDATED WIRELESS VCI

The TOPDON Phoenix Elite Diagnostic Scan Tool supports online programming for nine vehicle brands, online coding for three different makes, and comes with an updated wireless VCI. The Phoenix Elite features topology mapping, allowing technicians to quickly find communication issues or to identify and fix trouble codes by showing a clear picture of the vehicle's systems in a tree diagram.



WWW.TOPDON.COM

FEATURES A TWO-WAY PIVOTING 5.5MM PROBE CAMERA

The Oasis Scientific Vividia VA-455i USB Flexible Smartphone Two-Way Articulating Inspection Camera Borescope features a 5.5mm diameter, 1m long flexible probe that is covered with a durable and waterproof polymer tube. The VA-455i has bright LEDs, two-way pivoting 5.5mm probe camera, and can be directly connected to an iPhone iPad or Android phone or tablet.



WWW.OASISSCIENTIFIC.COM

EXTENDS FROM 49.5" TO 79.75"

The BendPak LITESTIX is a bright, versatile LED worklight powered by a rechargeable lithium battery. It uses dual 90-degree swivel handles equipped with magnetic ends to mount on any flat or off-angle metallic surface. The lamp's all-steel telescoping cradle frame can extend from 49.5" to 79.75" in length and can secure to the underside of a vehicle hood with the help of grabbing hooks attached at both ends of the frame. Designed for a long life of heavy duty use, LITESTIX features an impact-resistant polycarbonate housing.



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Carquest Starters and Alternators are available as new or remanufactured units utilizing premium, upgraded components to ensure a long-lasting assembly with industry-leading warranties. With a high level of proven performance, these parts are 100% tested to ensure they meet or exceed OE specifications.



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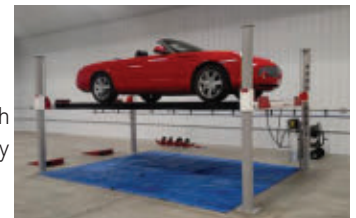
The DeWalt 20V Max Powerstack Compact Battery has 50 percent more power with a 25 percent smaller footprint than DeWalt's 20V Max Compact Lithium Ion Battery Pack. It's compatible with all 20V Max tools and chargers. The battery features an impact-resistant, over-molded base with non-marring material to resist wear and tear. The battery weighs .7 lbs.



WWW.DEWALT.COM

OFFERS 6' OF CLEARANCE UNDER THE PLATFORM

The Service Four-Post Lift by Backyard Buddy features an overall length of 14' 5", height of 7' 5-1/8", and width of 8' 6". The lift is powered by a 120V power supply (also available in 220V). The unit offers a full 6' of clearance under the platform with extra clearance to accommodate taller vehicles. The lift is ideal for those with an extra tall ceiling.



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Ranger RST-500ES Engine Support
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Ranger RP-20FC Oil Filter Crusher with Stand
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APG // AUTOMOTIVE PRODUCT GUIDE

FEATURES A BUILT-IN OVERPRESSURE SETTING FUNCTION

The Ascot Supply Automatic Inflator offers all the features of a wall-mounted inflator in a portable handheld unit. The multi-scale inflator features a built-in overpressure setting function that allows the tire to be inflated to a certain pressure then deflated automatically to a normal pressure while setting tires to rims. The auto on/off operation allows for maximum inflation to 174 psi. A backlight digital display gives clear, easy-to-read images and boasts two programmable preset buttons.

WWW.ASCOTSUPPLY.COM



JUMP-STARTS A VEHICLE UP TO 20 TIMES ON A SINGLE CHARGE

The AutoMeter E-POWER 800 Emergency Power/Jump Starter is designed to jump start a vehicle, as well as charge personal electronics and supply an emergency LED flashlight with SOS and strobe modes. The E-POWER 800 doesn't require jumper cables or another vehicle. On a single charge, it can jump-start the vehicle up to 20 times.

WWW.AUTOMETER.COM



COMPACT AND LIGHTWEIGHT

The Ledlenser P5R Core Flashlight is compact and lightweight to fit comfortably in a jacket or pants pocket. Its light functions can be customized with Smart Light technology. Additionally, its magnetic charge system provides easy charging of the battery and with Flex Sealing technology the lamp can easily handle submersion in water.

WWW.LEDLENSERUSA.COM



OFFERS VARIABLE SPEED CONTROL

The R1200 Leverless Pro Tire Changer from Rotary Lift features a quick-locking and adjustable center post that offers three different height options to work from, giving operators added flexibility. The changer can handle wheel diameters from 10 to 30", tire widths of up to 19", and a maximum tire diameter of 47".

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The KNIPEX Pneumatic Hose Pipe Cutter, No. 90 10 185, is ideal for all liquid, multilayer, and pneumatic hoses 3/16" to 3/4" in diameter. A wide hose support base keeps the hose at a right angle in relation to the blade for clean and even cuts. The Pipe Cutter measures 7-1/4" in length and features an opening spring and locking device for repetitive cutting, as well as handles made from fiberglass-reinforced plastic.



WWW.KNIPEX-TOOLS.COM

DETECTS HIGH-LEVEL FAULTS ON VARIOUS ELECTRICAL COMPONENTS

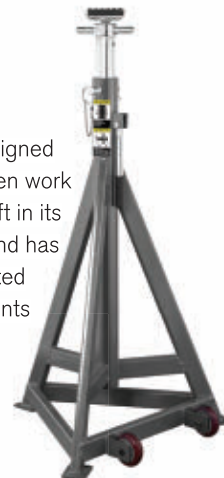
The Launch Tech O2-1 Scopebox is an automotive oscilloscope that detects high-level faults on various electrical components such as sensors, actuators and various circuits. The O2-1 is able to deliver accurate and conclusive diagnostic findings through waveform analysis, leading to efficient and precise repairs for the shop and technician.



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IDEAL FOR HEAVY DUTY VEHICLE WORK

The BendPak MLS-18 Mobile Jack Stand is designed to provide added support and peace of mind when work on a heavy duty vehicle on a lift may cause a shift in its center of gravity. Each MLS-18 Mobile Jack Stand has a rated capacity of 18,000 lbs and can be adjusted from 48.75" to 74.5" in height to reach lifting points more than 6' in the air. Additionally, it features a tripod design, foldaway transport handle, and 3" diameter wheels. It's ideal for use in sets of four, six, or eight.



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THERMOPLASTIC HANDLE RESISTS MOST CHEMICALS

The AFF Slack Adjuster Release Tool and Wrench Set, No. 45010, includes an automatic slack adjuster release tool and wrench for adjusting automatic slack adjusters on Meritor brake systems. The fork-end tool is able to fit securely under the pull pawl, allowing hands-free operation to release the tension button. The 5/16" double square, offset reversible wrench adjusts the brake and is capable of releasing the anti-reverse mechanism without prying.



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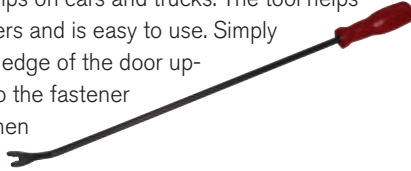
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ELIMINATES BROKEN FASTENERS

The Lisle Corporation Long Door Panel Tool, No. 35600, measures 19.75" in length, making it ideal to reach upholstery clips in the middle of a door panel. Its square notch design removes both plastic and metal clips on cars and trucks. The tool helps eliminate broken fasteners and is easy to use. Simply place the tool under the edge of the door upholstery panel, insert into the fastener as far as possible, and then simply pry up. It's heat treated for durability.

WWW.LISLECORP.COM



SIZES RANGE FROM 20MM TO 46MM

The Platinum Tech 17-pc Metric 1/2" Drive Jumbo Crowfoot Wrench Set, No. PLT-99380, includes wrench sizes from 20mm to 46mm designed to work in tight spaces where ordinary sockets and wrenches may not be able to reach. The set meets or exceeds ANSI standards and has a limited lifetime warranty against defects in workmanship and materials.

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The Clore Automotive Updated Pro-Logix 12V 1.5A Underhood Battery Charger/Maintainer, No. 1002, from Solar combines a fully automatic operation, a permanent mount design, and the ability to properly charge virtually any lead acid battery type, including conventional, AGM, gel cell, spiral wound, deep cycle, and marine batteries. Advanced microprocessor-controlled logic delivers a fully automatic, precisely controlled charging routine to optimally charge and maintain each battery serviced.

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FEATURES AN LED WORKLIGHT

The Marson BT-5 Battery Powered Riveter from Howmet Fastening Systems is designed to deliver reliable performance at a valuable price point. The BT-5 is lightweight and offers an ergonomic grip. It also features an LED worklight and has a stroke length of .866". The Marson BT-5 kit includes nose tips for 1/8", 5/32" and 3/16" rivet diameters. An optional nosepiece allows users to install 3/32" rivets, as well.

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The Ingersoll Rand Truck-Mounted Two-Stage Diesel Driven Reciprocating Air Compressor is designed to provide fuel-efficient compressed air where electric power is not readily available. It's ideal for field service and remote pneumatic applications and for the automotive and vehicle service, farm and agriculture, and oil and gas markets. The reciprocating air compressor pump features a solid cast iron design with an overhung, precision-balanced crankshaft to reduce noise and vibration.

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SERVICING BATTERIES IN “START/STOP” VEHICLES

ON INITIAL GLANCE, THE BATTERY IN A VEHICLE EQUIPPED WITH “START/STOP” FUNCTIONALITY MAY LOOK THE SAME AS ANY OTHER.

PETE MEIER // Director of Training

Every battery today has to deal with the increasing demands placed on it. In addition to starting the engine, the battery is the supply for every electrical device on the vehicle—from the ECUs needed to operate the car to the creature comfort systems such as heated seats and refrigerated cup holders.

But starting the engine is the largest single demand we make of our batteries. Then consider the load placed on the battery when we ask it to start the engine after every stop we make - a red light, a stop sign, or in a parking lot!

Sure, the charging system replaces the charge we took out. This is referred to as a discharge/charge “cycle,” and conventional flooded cell batteries just can’t handle the high-cycle-rate “Start/Stop” systems go through. Instead, AGM (absorbent glass mat) and EFB (enhanced flooded) batteries are used, as they’re better suited to the challenge.

In addition to special battery designs, most “Start/Stop” vehicles are also equipped with some form of battery management system.

This system continuously records parameters such as voltage, current and temperature via a battery sensor. Based on this data, important parameters such as the battery’s SOC (state of charge), the battery’s ability to start the engine, or SOF (state of function) and its overall SOH (state of health) is determined.

The ECM then decides on the energy balance in the vehicle and, if necessary, restricts the use of comfort systems such as seat heating or air conditioning, switches off the start/stop function, and signals this to the driver with appropriate information on the display. If the alternator then recharges the battery sufficiently, the ECM automatically reactivates all functions.

The top priority is to ensure that the engine starts when it’s supposed to. When the ECM determines the battery is



no longer up to the job, a warning of a “defective battery” is stored in the system.

When it comes time to replace the battery, the process is a bit more involved than “remove and replace”. Depending on the make of car and the functionality of the respective system, modern vehicles with battery energy management (BEM) may or may not require or recommend that the ECM be told of the swap — or “registered”.

If the new battery is not registered, DTCs may occur, and convenience systems may not work or may only work to a limited extent. In some instances, even the “start/stop” functionality can be lost for a time.

Want to know more? Then watch the November edition of The Trainer! **ZZ**

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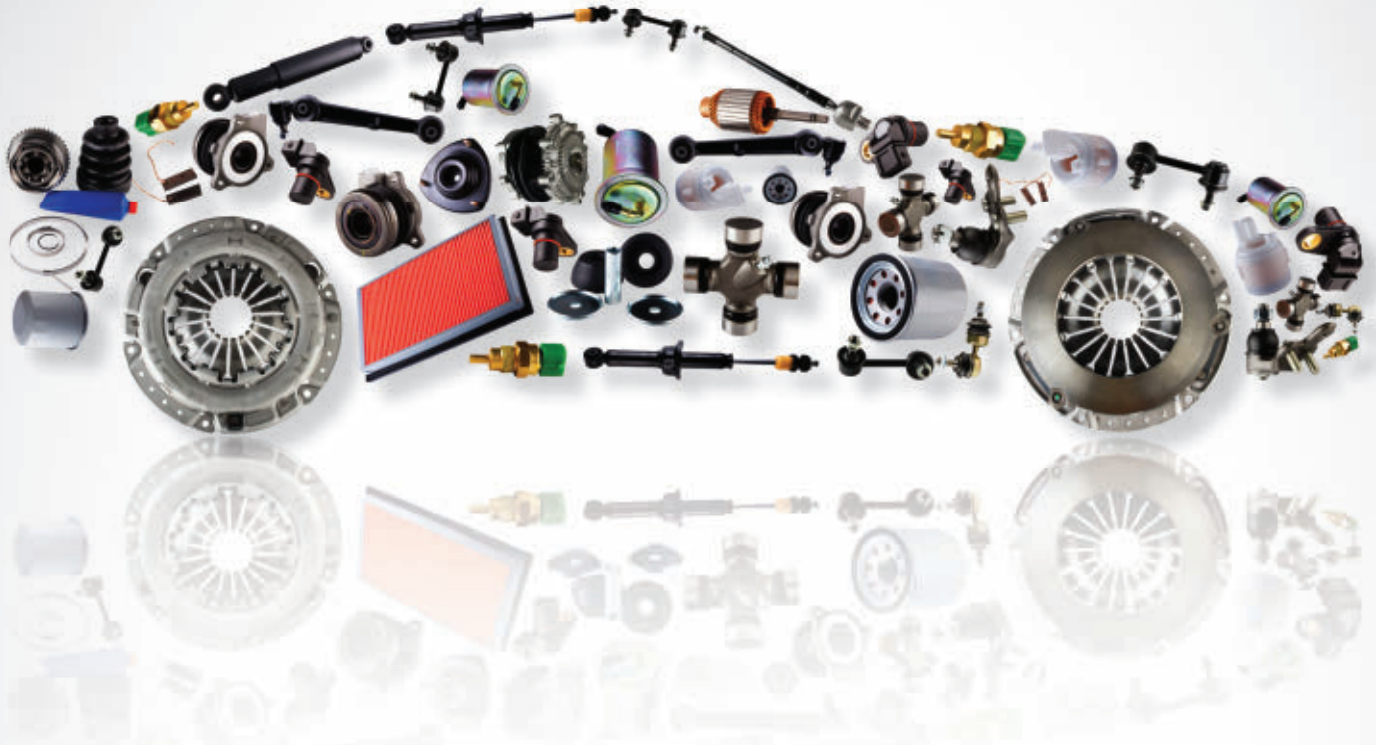
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