

PTEN

PROFESSIONAL **TOOL & EQUIPMENT** NEWS

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Volume 33, Number 10

ENDEAVOR
BUSINESS MEDIA

PPTAMP & PPTPWM ADAPTERS

MEASURING CURRENT &
PULSE WIDTH MODULATION
BY POWER PROBE



SEMA/AAPEX
EDITOR'S
TOP PICKS
FROM VEGAS
PAGE 32

TOP 100
OUR MOST
REQUESTED
PRODUCTS
OF 2022
PAGE 34



FIND THE
**DIAGNOSTIC
PROCESS
SUPPLEMENT**
INCLUDED
AFTER THE
REGULAR ISSUE

DETAILS ON THE COVER PRODUCTS
AND OTHER NEW TOOLS **PAGE 8**

VehicleServicePros.com, official website of PTEN



▲ Allows for left or
right-handed use



▲ Quickly removes
and installs the
fan clutch



▲ Has a duty
cycle of 175 at
30 percent

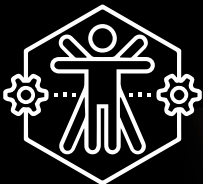
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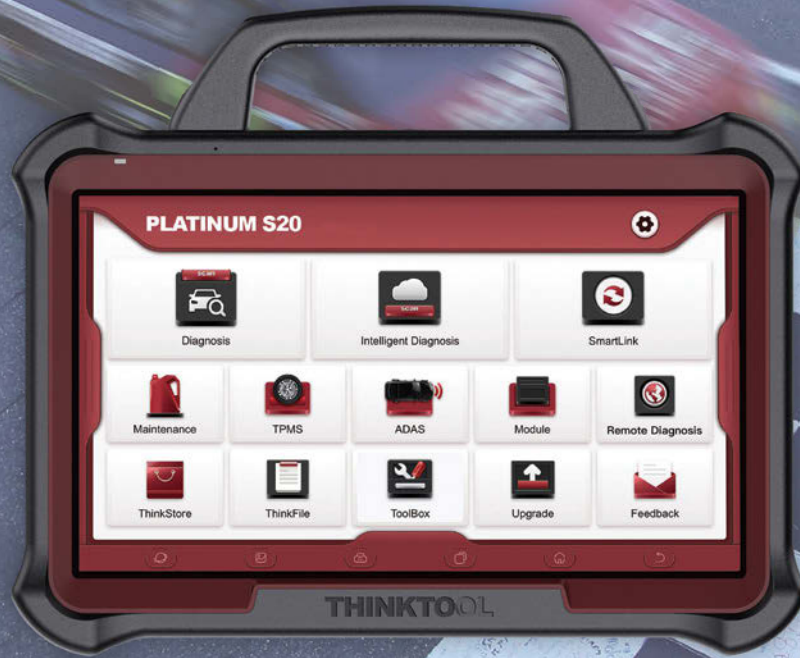
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PLATINUM HD



PLATINUM S20



PLATINUM S10 PRO

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STEP 1



Connect to the Vehicle OBDII Port with OBDII Cable

STEP 2



MaxiFLASH VCI or VCMI is Connected Via USB to a Tablet

STEP 3



Diagnostic Tool: Can Be MS909, MS919 or Ultra

STEP 4



Hard-wired Internet Connection Via Cat 5 Cable (Ethernet)

STEP 5



Experts Use OEM Hardware & Software Connected to a Programming Converter Box

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TOP 100



We reveal the most sought-after tools and equipment from 2022. Check out the first 25 in this issue (on page 34) and visit the link below to download the complete list.

VehicleServicePros.com/2022-top-100-products

KEYNOTE SPEAKER



During AAPEX's opening session, Bill Hanvey, president and CEO of the Auto Care Association (ACA), told the packed room that Right to Repair was delayed again for the seventh time.

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CERTIFICATION



The National Institute for Automotive Service Excellence (ASE) announced its new ADAS Specialist Certification test (L4) to identify technicians who possess knowledge of the skills required to diagnose, service, and calibrate ADAS on late model automobiles, SUVs, and light duty trucks.

VehicleServicePros.com/21285039

TECHNICIAN PROFILE



We talked to Josh Whiteman of George's Shell in Fontana, Calif., about his rise through the ranks in the automotive industry. Josh was the runner-up in this year's Best Young Tech awards.

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TECHNICAL TRAINING



The complete ACCELERATE training event (all eight hours!) is now available On-Demand. Shop professionals, educators, and automotive repair students interested in upping their game when it comes to diagnostics, solving electrical issues and dealing with hybrid/EV repairs should visit:

accelerate-conference.com

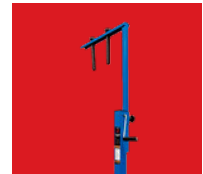
FEATURED PRODUCTS



Makita

18V LXT Variable Temperature Heat Gun, No. XGH02ZK

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ATD

Vehicle Door Jack Lift, No. 6557

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Lubegard

RUSTGARD Rust and Corrosion Preventive Oil

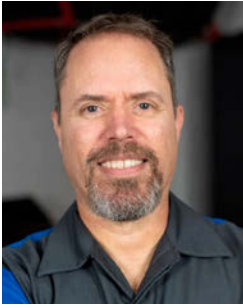
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Killer Tools

Bumper Perfect Hole Punch Extension Kit, No. ART251EX

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The technician shortage is getting real

By **Brendan Baker**, Editor
BBaker@EndeavorB2B.com

Even before the pandemic, there was a technician shortage. Some estimates say the industry, which includes every segment from automotive to aviation, will need more technicians in the next four years than we have available in the pipeline.

What does that mean?

According to the TechForce Foundation, a non-profit group helping replenish the supply of technicians to shops that desperately need them, the industry may require almost one million new technicians by 2026.

TechForce recently released its 2022 Transportation Technician Supply & Demand Report that shows program graduates (completions) slipped 2.6 percent and 0.4 percent in the diesel and collision repair segments but have fallen by a combined 17 percent over the past five years.

Even with a solid year-over-year rebound in employment for automotive (+4.2 percent) and diesel (+6.5 percent) repair segments, the overall picture shows a drop in combined graduates, going from 48,208 in 2020 to 44,052 in 2021. Collision repair techs have also dropped 0.7 percent, continuing a six-year decline.

At the heart of the issue, TechForce estimates demand for new automotive/

diesel/collision repair technicians (new and replacements from prior years) will reach 232,000 in 2022 and balloon to 900,000 through 2026. That big number will need to be filled in just four years.

A recent article in *WIRED* magazine highlighted the issue of fewer shops to repair high-tech cars and fewer independent shops capable of working on these vehicles. The article states that U.S. repair shops fixed 246 vehicles per bay in 2022, compared to 225 in 2016.

The problem growing under our noses is the amount of expert, specialized knowledge, and expensive tools required to do the job. And in many cases, independent shops can't get all the necessary repair information to do the job. Without expert techs who know how to use high-tech tools and think like engineers, some shops are reluctant to work on a vehicle if they know they can't do it right. So they send the job to the dealership. But even dealerships need help hiring techs.

The issue of repairing vehicles in a timely and affordable manner has also worsened. According to *WIRED*, it took an average of 2.1 days longer to fix a car in 2021 than in 2019; and nearly 11 days overall on average. Some experts suggest that getting a vehicle repaired in the future (10 years from now) will require the vehicle owner to travel

significantly farther to find a shop to do the work (especially for late-model cars).

The state of the repair industry should matter to everyone involved, not just to the repair shops.

"The solution to this crisis lies in industry, non-profit, education, and government partners working together to build awareness, curiosity, and interest in these careers among our youth," said TechForce CEO Jennifer Maher. "This year's report underscores the challenges we face in attracting, training, and retaining technicians and the boundless opportunities available for these technology-intensive industries." ❌

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FEATURED NEW PRODUCTS



ALLOWS FOR LEFT OR RIGHT-HANDED USE

The **Dynabrade 1-1/4" Diameter Mini-Dynorbital Extreme**, No.

X125TR, is a random orbital sander ideal for small-scale sanding applications.

Its integrated speed control allows for fine adjustment of rpm for artistic results, sensitive workpieces, or when sanding/repairing a coated surface. Weighing just over 1 lb, the X125TR reduces fatigue and the likelihood of repetitive motion injuries during extended use.

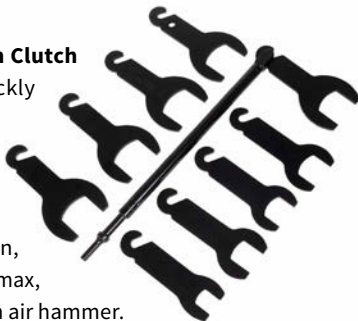
The tool is also compact, and has an ambidextrous design to fit naturally in most hands. Includes tool hanger bracket for easy storage and a vinyl-face, locking-type pad (No. 54037) for quick and easy pad changes.

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FOR USE WITH AN AIR HAMMER

The **Lisle Corporation 10-pc Pneumatic Fan Clutch Wrench Set**, No. 43350, is designed to quickly

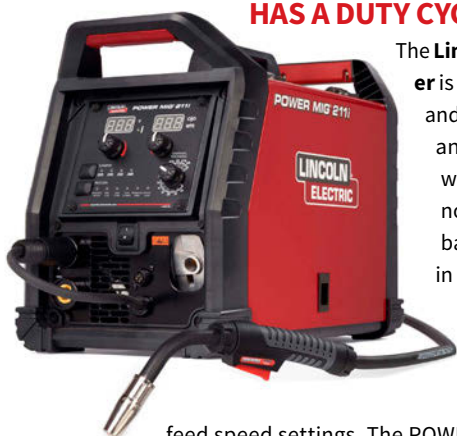
remove and install the fan clutch when repairing the water pump or fan clutch. The set includes nine driving wrenches that fit Ford, GM, VW, BMW, Chrysler, and International. Driving wrench sizes include: 7/8", 32mm, 36mm, 40mm thin, 47mm, 1-7/8", 2", 52mm for 2019 and newer Duramax, and 2-1/8" for newer International. Use with an air hammer.



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HAS A DUTY CYCLE OF 175 AT 30 PERCENT

The **Lincoln Electric POWER MIG 211i MIG welder** is a 200A machine ideal for MIG, flux-cored, and spool gun welding. The unit weighs 41 lbs and is portable thanks to its sleek design with multiple lift points and inverter technology. With its seven-segment display and basic knob controls, users can weld quickly in a simple three-step process: Select welding process, select wire diameter, and select material thickness. The machine then takes it from there, automatically providing the optimal voltage and wire



feed speed settings. The POWER MIG 211i has a duty cycle of 175 at 30 percent and can operate on 120V or 230V input voltage. Various accessories included.

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FOR MORE INFORMATION ON THESE PRODUCTS, CLICK ON "PTEN E-INQUIRY" at VehicleServicePros.com OR CIRCLE THE NUMBER ON THE CARD.

Kicking off the New Products section each month, our Featured New Products page includes brand new products showcased on the cover that are available to the automotive market.



MEASURE CURRENT OR APPLY PWM SIGNALS

Power Probe is proud to announce two new test adapters. The **PPTAMP** allows your Power Probe circuit tester to read applied current. When powering up a circuit, you can monitor current to determine the health of components, from one milliamp to 20 amps. The **PPTPWM** allows any Power Probe circuit tester to apply a pulse width modulated output, a feature used to control new vehicle components with an adjustable duty cycle. These new adapters work with any current Power Probe model to help you cut your diagnostic times and increase your diagnostic accuracy.

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REMOVES A WIDE VARIETY OF HOSE CLAMPS

The **CTA Manufacturing Locking Hose Clamp Pliers with Offset**, No. 1224, is designed for removing a wide variety of hose clamps. The head of the pliers has a dimension of 32mm by 19mm and features a multi-directional slotted pattern for wide application range, including tank ventilation line clamps, radiator hose clamps, and transmission cooler lines. The spring-loaded locking mechanism can open up to 65mm. The pliers have an extra-long reach of 10-1/2" and cushion grips for comfort.

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HAS THE POWER TO PERFORM IN HEAVY APPLICATIONS

The **Milwaukee Tool M12 FUEL 16 Gauge Variable Speed Nibbler**, No. 2476-20, is a compact, lightweight tool that is designed to deliver fast clean cuts in 16-gauge mild steel and is also rated for 18-gauge stainless steel and 12-gauge aluminum. The cordless tool has a variable speed dial, tool-free die holder orientation change, and an LED worklight. It also features M12 Redlithium battery technology and includes a chip collection bag for easy clean up.

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HAS A MAGNETIC HOOK BASE

The **Matco Tools 1,500 Lumen High Tech Sensor Activated Flood and Spotlight**, No. MWLZFG, features a human body detection system that automatically turns the light off if the user goes 6' away for more than 30 seconds to save battery power. A 360-degree axis enables users to reposition the lamp head to any position desired, while the magnetic hook base allows for multiple mounting configurations. The floodlight pivots 90 degrees, enabling it to shine directly down or up at an angle. The unit is waterproof and comes with a 5200 mAh lithium battery.

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FEATURES A 360-DEGREE SWIVEL TOP

The **Tire Mechanics Resource Manual Tire Spreader** features a 360-degree swivel top and a wide base for added stability. It's adjustable in six stages and the platform can rotate horizontally 180-degrees for all types of tire repairs. The manual tire spreader offers an incline of 60 degrees, maximum enlargement of 13.8", and includes an attached tool pan. It's an economical tire spreader ideal for all types of tires from cars to light trucks and for all types of tire repair work, including tire inspection, cutting, buffing, cleaning, patching, and more.

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DESIGNED TO REDUCE RESISTANCE

The **Snap-on Creeper Seat**, No. JCW80AO, features a caster profile designed to reduce resistance and roll through any job. The seat contains a storage drawer and parts tray tucked under the plywood core seat that's padded with high-density foam and surrounded by a durable, heavy duty vinyl cover, plus a 16-gauge 1" steel frame.

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FOR FORD 3.5L AND 3.7L ECOBOOST ENGINES

The **ProMAXX Intake Manifold Repair (IMR) ProKit** allows technicians to easily remove broken fasteners on Ford 3.5L and 3.7L EcoBoost engines. The kit includes signature machine-shop tooling and precision components to make an on-the-truck repair. The EcoBoost IMR ProKit quickly bolts right onto the cylinder head and uses the company's trademarked Extractorless repair application to speed up repair times and eliminate broken extractors. All accessories to complete an on-the-truck repair are included.

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FEATURES A REVERSIBLE HEAD

The **Titan Professional Tools 1/4" Drive Aluminum Swivel Head Micro Ratchet**, No. 11320, features a 90-tooth, reversible head, a 4-degree sweep, knurled grip, and an anodized aluminum handle. The detent ball holds sockets securely in place. The ratchet has an overall length of 4".

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DESIGNED FOR DURABILITY IN ALL-WEATHER CONDITIONS



The **Enel X Way JuiceStand Pro** is designed for durability in all-weather conditions. The JuiceStand Pro allows users to charge their electric vehicle in open areas where wall mounting isn't an option. The product is ideal for workplaces and small businesses that expect light to medium EV traffic. JuiceStand Pro's small footprint is suited for locations with limited parking space and can support one or two JuiceBox Pro chargers, which are compatible with all electric vehicles. The products dimensions are 3.5" width by 12" depth by 59.3" height, and it weighs 32 lbs.

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INCLUDES A HIGH-POWER WHITE LED

The **Streamlight Dualie 3AA Color-Rite** provides the option of bright, white light, or high CRI light with Streamlight's Color-Rite Technology. The dual beam light offers three output modes: a spot beam for distance illumination; a soft, wide flood beam to illuminate work areas and to aid in true color recognition; and a combined spot and flood beam. The compact, rugged light measures 7" in length and is IP67-rated for dust-tight and waterproof operation. The spot beam emits 225 lm while the flood beam emits 175 lm. When combined, the light offers 320 lm. It's powered by three AA alkaline or lithium batteries, and includes an integrated, snag-free clip.

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OVERALL LENGTH OF 5"

The **Lang Tools 2-pc Mini Pocket Pry Bar Set**, No. 853-06-2ST, is designed for prying/separating small items apart. The blades are made from 3/16" diameter hardened alloy steel, and the angled blade gives greater access to tight areas. Featuring an acetate handle with a pocket clip, the overall length of the pry bars are 5". Each pry bar is available individually as well.

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STOPS AND SEALS COOLANT LEAKS

Bar's Leaks Radiator Stop Leak Concentrate, No.1196, is designed to stop minor cooling system leaks and drips caused by normal cooling system wear and age. The formula works with all types and colors of antifreeze, coolant, and/or water. It stops and seals coolant leaks, in addition to sealing leaks in radiators, gaskets, heater cores, and freeze plugs.

One bottle covers the cooling system of most 6- and 8-cylinder passenger vehicles and light trucks, while half a bottle can be used for 4-cylinder engines.

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FEATURES SIX 1/4" OUTLETS

The **Ascot Supply 6-in-1 Air Line Manifold Kit** features six 1/4" outlets and comes with three 1/4" aluminum plugs. The aluminum plugs can be inserted into the manifold when the additional outlets are not in use. The kit is made from lightweight aluminum and acts as a manifold for 1/4" hoses to split the line.

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2022 GREAT PRIZE GIVEAWAY 

Congratulation to our 2022 Winners!

And thanks to our vendors for supplying the winners with over \$25,000 worth of tools!

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Bryan Strecker Lang Tools Made In USA Specialty Tools Valued at \$550	Joe Kwiecien AUTEL US Inc. ITS600 Sensor Kit Valued at \$965	Raymond Ochsner OEMTOOLS Oil Service Prize Pack Valued at \$650	Ralph Schissler Opus IVS Mongoose-Plus J2534 Device Valued at \$495	Charles Finley COAST Bright Light Bundle Valued at \$715
Todd Ragatz AirCat Valued at \$500	Joe Palacios XtoolUSA Nitro LT & Auto Keys Valued at \$2,250	Jeffery Flippo Oasis Scientific, Inc. ME-610i Boroscope Valued at \$900	Mark Kroening THINKCAR Platinum S8 Valued at \$1,249	Perri DeBernardi K-Tool Deluxe Mechanics Tool Set Valued at \$3,600
James Burkins Streamlight, Inc. 2022 Worklights Prize Valued at \$750	Sean McCall TEXA Nano S, IDC5 Car and Tablet Valued at \$4,495	Anthony Harlin LaunchTech Millennium MAX Scan Tool Valued at \$799	Marty Baker Induction Innovations, Inc. Mini-Ductor Venom HP + Coil Kit Valued at \$737	Al Daum Gray Manufacturing 7-THF Vehicle Support Stands Valued at \$500
Agustin Sanchez S&G Tool Aid Corp. Electrical Diagnostic and Repair Pack Valued at \$615	Gerald Barber OTC Ball Joint Connected Adapter Professional Kit by Bosch Automotive Service Solutions Valued at \$2,140	Kevin Mack ProMAXX Tool Ford 3.5L Exhaust Manifold Repair Kit Valued at \$613	Toby Gillespie Bosch SMT 500 Smoke Machine Leak Tester with built-in Air Compressor Valued at \$1,972	

Parasitic battery drain is a bandit

The procedures to diagnose a battery drain can be time-consuming and tedious, especially when an electronic module offers no clues to the events that occurred the night before.

By Roy Ripple, Contributing Editor

A parasitic battery drain is a bandit that creeps in during the night and kills your battery, sometimes leaving behind no evidence of the crime. The procedures to diagnose a battery drain can be time-consuming and tedious, especially when an electronic module offers no clues to the events that occurred the night before. Effectively utilizing the proper diagnostic equipment and a little ingenuity should lead to a proper diagnosis.

With the doors closed and the key removed, all modules in the vehicle should enter sleep mode within seventy-five minutes of shutting down. The current drain on a battery should not exceed .050A once the modules have turned off. Battery drains are typically caused by a module that remains awake or continues to wake up, sometimes turning on other modules in the network.

The amount of time it takes a current draw to kill a battery depends on the battery's condition and the magnitude of the draw. In most cases, a small drain under 1A will take a couple of days to discharge a battery. A parasitic drain close to an amp or higher will cause a quick overnight death.

DEAD FORD BATTERY

A 2015 Ford Fusion was towed to our shop with a dead battery. The customer stated that the battery died overnight. The first thing we did was charge and test the battery. It's essential that the battery is in good condition and fully charged before testing for a battery drain. I like to use an easy-to-carry portable battery charger. I hooked up my Dewalt DXAEC801B bat-



▲ An easy-to-carry battery charger is a great tool to have. This battery is at a 77 percent state of charge, suitable for diagnosing a current draw.

tery charger and let the battery charge for about two hours. My Midtronics EXP-890 battery load tester verified that the battery was fully charged and in good condition.

After checking for aftermarket additions, a common cause of a battery drain, we took the vehicle on a road test. The vehicle should be driven over 30 mph for at least five minutes before testing for a current draw. The idea is to turn things on and wake things up. So, we activated everything from the sunroof to the power seats.

MODULE TEST

After the road test, we checked all the modules for Diagnostic Trouble Codes (DTC). A faulty module or a module receiving a bogus input can drain a battery, so DTCs should be addressed before continuing with battery drain diagnosis. I use the OBD

Auto Doctor App on my phone when I need to see what DTCs are in which modules. It works fast and saves a lot of time. If there's an issue, I use my OTC 3896 Evolve full-function scan tool for diagnosis.

After we determined that there were no DTCs in any modules, we needed to ensure that nothing remained on once the vehicle was shut down. We turned off the ignition and exited the vehicle with the key, locking the doors with the windows down. We opened the hood and the trunk, engaging the latches and disengaging the pin switches so we could see the cargo lights go out.

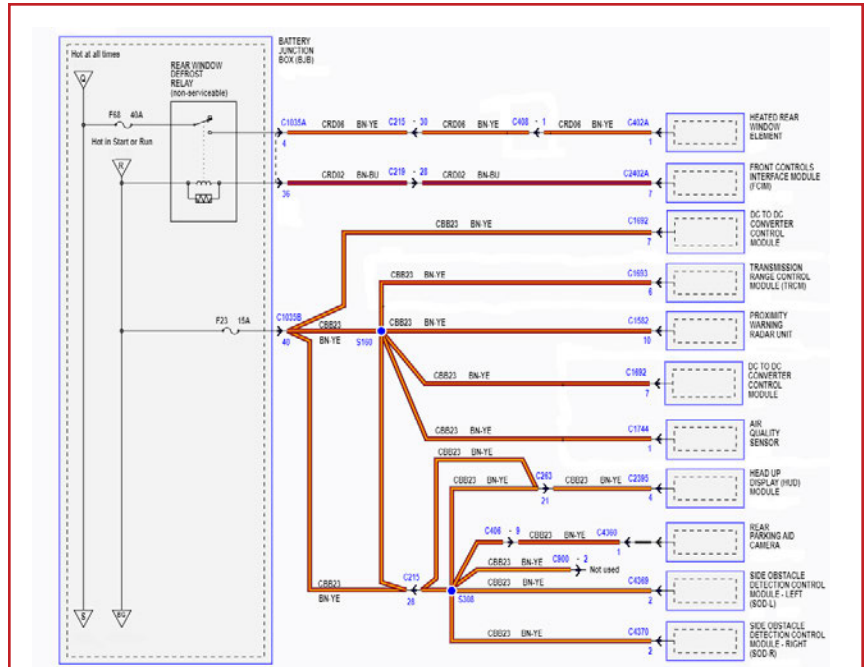
We waited a couple of minutes until everything shut off, looking closely at all dash and instrument illumination. The slightest glow in a touchscreen, a radio knob, or a shift indicator is all it takes to kill a battery overnight. Once we determined

that nothing was staying on, we opened all the doors and engaged the latches in case we needed to access the vehicle's interior during diagnosis. The modules won't sleep with an open door.

DMM TESTING

We hooked up my Fluke Digital Multi Meter (DMM) between the negative battery post and the negative cable terminal. Using the positive side is okay if the negative terminal is difficult to access. I like to install a jumper wire between the post and the terminal before attaching the DMM. A current surge capable of blowing the fuse in your meter occurs when completing the circuit between the battery post and the terminal. The jumper is there to take the hit. Don't use cheap test leads.

You need to be confident that the test lead you're using will provide a low-resistance connection while carrying a reasonable amount of current. I use a set



▲ Figure 1 - The current draw was on circuit CBB23, powered by fuse F23. You can see how many components on this circuit could have been the causal part.

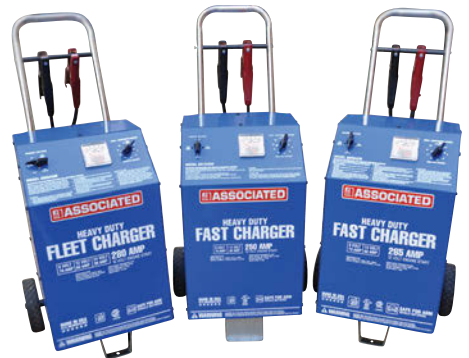
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TOOLS USED:

- DEWALT DXAEC801B BATTERY CHARGER
- MIDTRONICS EXP-890 BATTERY ANALYZER
- OBD AUTO DOCTOR APP
- OTC 3896 EVOLVE SCAN TOOL
- FLUKE DIGITAL MULTIMETER
- SNAP-ON EETH311 DIAGNOSTIC THERMAL LASER
- JASLEEN INDUCTIVE AMMETER
- WELLER WEP70 SOLDERING IRON

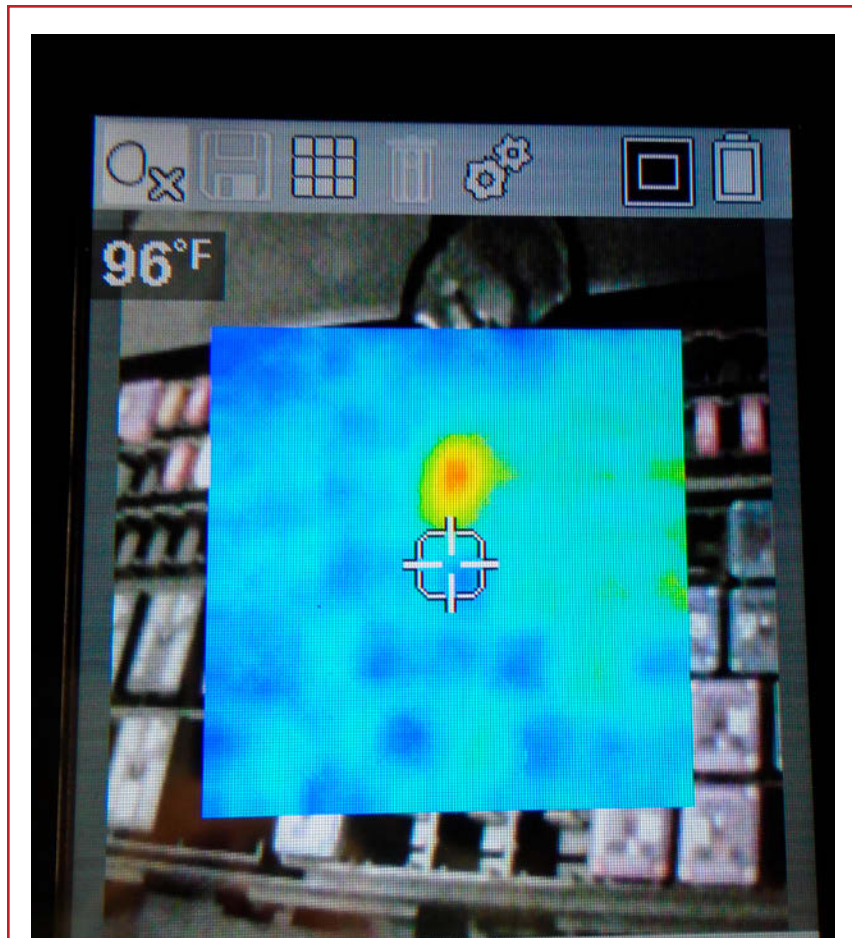
of Klein Tools test leads that I fully trust to maintain a good solid connection. With the DMM on the amps setting, we attached the like polarity lead to the post and the other lead to the battery terminal then removed the jumper wire. We then had to wait about seventy-five minutes for the modules to deactivate.

During this time and for the remainder of testing, we had to be careful not to touch the outside door handles or the keyless entry keypad. This will send an entry signal that will wake up the entire network, which means waiting another seventy-five minutes.

THERMAL IMAGING TOOL

After the waiting period, we verified a 1.12 amp drain on the battery, so we broke out the Snap-on model EETH311 Thermal Imaging Tool. Since electrons moving through a circuit create heat, it's safe to assume that whatever circuit is pulling, the amperage is warmer than the rest. Sure enough, fuse F23 in the battery junction box (BJB) glowed red in the thermal image (Figure 2). Pulling fuse F23 dropped the battery drain to an acceptable .026A. Looking at the wiring diagram in Figure 1, we can see that fuse F23 supplies power to six modules and three sensors.

This is where it gets tricky. The obvious next move is to start disconnecting modules one by one. This can involve a lot of tear-down time. The diagram shows that the current passing through fuse F23



▲ Figure 2 - The Snap-on Thermal Imaging tool shows that fuse F23 in the battery junction box is moving current.

exits the BJB at pin 40. Circuit CBB23 then splits into three directions. I use an inexpensive Jasleen inductive ammeter to determine the current flow direction.

INDUCTIVE AMMETER

Pulling the three circuit CBB23 wires from the harness, I used the inductive ammeter to test each wire for current. Once I found the wire carrying the load, I needed to determine which wire it was (Figure 3). As you can see, all three wires are the same color. So, I snipped the wire and hooked up my OTC 3896 scanner. The DC-to-DC module was off the network, the drain was gone with the fuse installed, and the wire snipped. The DC-to-DC module was the cause of the battery drain.

I soldered the snipped wire and covered it with shrink tube. It's essential to use a good

quality soldering iron. There's nothing worse for an electrical connection than a cold solder. I use a Weller WEP70 because it's small, easy to handle in tight places, and gets really hot.

Replacing the DC-to-DC module fixed the battery drain.

RECORDING CURRENT FLOW

The most difficult current draw to diagnose is the one that sticks around just long enough to kill the battery, then leaves. Most Fluke digital multimeters can record current flow over many hours, showing you what the lowest and highest reading was during that time period. Setting up a recording will verify that there is a draw, but not where it originates. An inductive ammeter with the ability to record allows recording individual harnesses, narrowing the current draw down to specific circuits. Even then, be pre-



▲ Figure 3 - We had a 129 mA current draw narrowed down to two harnesses. We found the right one using the inductive ammeter.

pared for a long diagnostic journey when diagnosing an intermittent battery drain.

Diagnosing a battery current drain requires time and patience. Chances are that you'll have to sit out the seventy-five-minute wait period more than once, and attempting to take shortcuts can only lead to a misdiagnosis. A diligent technician, a patient customer, and the right tools and equipment should produce an accurate diagnosis. ❌



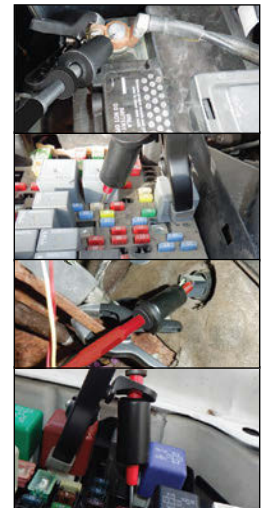
ROY "DENNIS" RIPPLE

is a technical contributor to *Motor Age/PTEN*. He is the son of Roy Ripple Sr., who passed away in September 2021 at the age of 84. Ripple Sr. was a technician his entire life and ran his own shop before venturing into automotive journalism with *Motor Age* magazine. In his youth, he was an avid drag racer and a good friend of Don Garlits. He raised four children, rode motorcycles, hunted deer, and loved to shoot trap. Now, Roy Dennis Ripple is carrying on his father's legacy.



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Using digital tools to reduce the friction of running a shop

A shop management system is an eclectic mix of tools, processes, and procedures used to help a service business realize success.

By **Scott Brown**, Technical Editor

A shop management system is more than just a software application used to manage your daily operations, it's a system consisting of an eclectic mix of tools, processes, and procedures used to help a service business realize success.

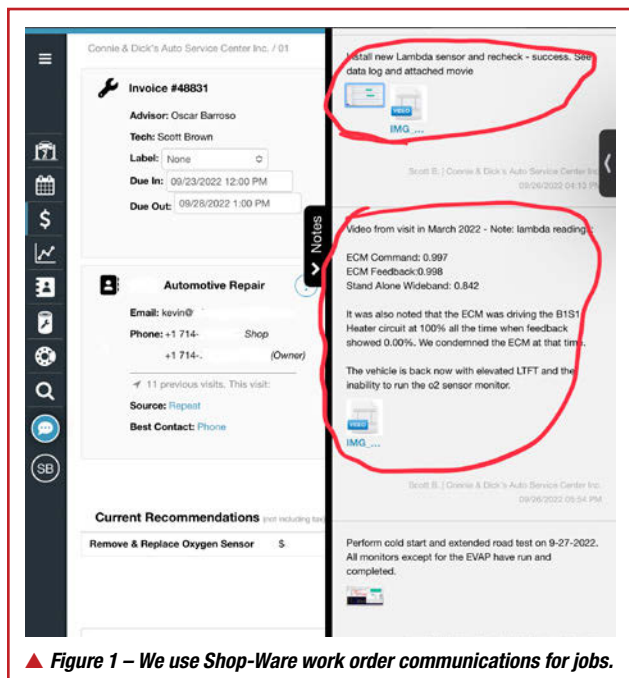
Success for an automotive service dealer is not always easy to achieve, but with the right tools, equipment, drive, and mindset, one can more easily manage challenges standing in the way. In my opinion, success means more than just the financial bottom line, as it resonates back to the core values as to why we are in business.

We are an important factor in the transportation segment where we help people maintain their mobility and independence. And with the automobile being one of the most complex devices a human will interact with during their lifetime, it is our duty to always stay competently proficient and professional. That means managing staff so that they are maintaining the assets required to bring forward success. Managing workflow, indeed, is extremely challenging, and there may be several tangents encountered during a repair process.

For instance, a vehicle arrives with a complaint of X. The vehicle is one that fits well with one of your technicians. However, they may be away at training or may be off because of sick leave, etc. Wouldn't it be great if you could leverage some of the knowledge that your out of commission technician has and have them share that knowledge with another technician in the shop remotely?

We've had situations where some preliminary analysis was performed on a vehicle before it even reached our facility. Some of that research may include technical service bulletins, industry knowledge, etc. When we find something relevant to the vehicle in question, we can easily attach it to the invoice (digital in this case) where it can be used as a reference for any technicians interacting with this vehicle and complaint.

Now, keep in mind that these documents can also serve a purpose later down the road. There may be conditions where you're unable to duplicate a specific complaint on a vehicle resulting in the shop placing the vehicle back into service. If the vehicle returns a new work order can be generated with a link back to that original ticket containing all the research assets that were used previously. This is a huge time saver, especially if relevant diagnostic and research data was attached. What I'm referring to here is things like a full vehicle



▲ **Figure 1 – We use Shop-Ware work order communications for jobs.**

diagnostic scan, relevant wiring diagrams and other complementary items such as photos and/or video.

We had a situation recently where we were tasked with performing an analysis on a vehicle for another shop. The vehicle arrived with documentation showing the issues they faced and what had been performed thus far. This vehicle had some strange issues that we were able to research and reach a conclusion. The wide-band fuel control sensor was reporting Lambda 1 where an independent measurement reported 0.84. Further, we determined that the ECU was commanding the B1S1 wide-band sensor's heater at 100 percent all the time, regardless of what the ECM data stream command was. We advised the shop of our findings (replace ECM and front lambda sensor) and returned the vehicle to them. A few months later, the vehicle returned to us after the repair stating that the O2 sensor monitor will not complete.

We began our analysis by verifying that our previous recommendations were performed. A new ECM had been installed and properly commissioned, and it appeared to have a new B1S1, but

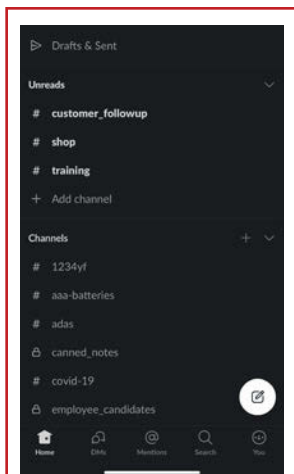
that had also been replaced before the vehicle visited us on the first trip. We began analysis and immediately noticed that LTFT was running at about +24 percent, but there were no codes. We then proceeded to connect our MoTeC LSU4 to the vehicle to sample the exhaust. What we found was that while the ECM was indicating Lambda 1, we were measuring 0.94.

We found that the B1S1 sensor was defective. We were able to pull the video showing the previous results from the first visit and share them with the shop (Figure 1). We found that they had not replaced the B1S1 along with the ECU, as recommended, which led to this problem.

Having the hard evidence backed up our findings and went a long way toward smoothing out our relationship. In our shop, we use *shop-ware.com* for work order communications such as this.

TRAINING DAY

We subscribe to many services out there that provide us with training opportunities and the ability to keep staff up to date. We use Google Calendar, which has a tie-in to Slack (an internal messaging application all our staff members subscribe to, and I'll cover more on this subject next) that brings these notifications to the forefront for all to see. For example, if we sign up for a webinar, we add it to the training and education calendar in Google. As soon as this hits, the Slack API pulls in the notice and lets everyone subscribed to that channel know. Then on training day, the system delivers another reminder ping so everyone has easy access to log in and view. Another training solution we're subscribed to is called Today's Class Technician (*todayclasstechnician.com*). Primarily, it's a smartphone app that feeds a few questions a day to subscribed staff members. To explain how it works in the simplest terms, the app is focused on reinforcing current knowledge and eliminating knowledge deficiencies. The company calls it micro-learning, and I really like that.



▲ Figure 2 – Slack is a tool we use for back office communications.

CUT SOME SLACK

Slack (*slack.com*) is a versatile application that allows us to manage back-shop operations (Figure 2). For example, we have the “Front Office” channel to discuss office issues. Another example is our “Special Tools” channel, where technicians can post requests for tools that may be needed to perform a certain task or any other topics that are appropriate. A final example is our “Social” channel, which we use for any social media posts that tag our company

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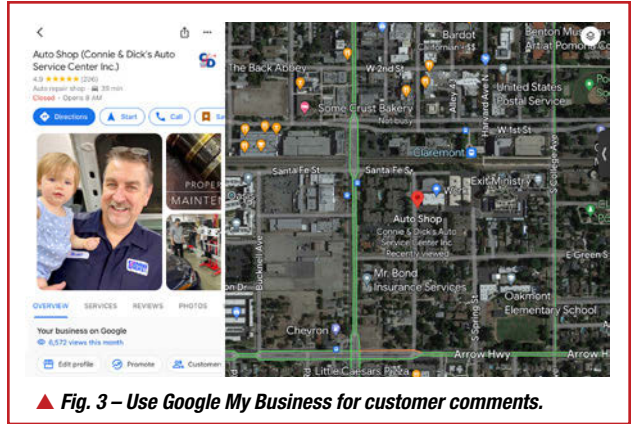


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▲ Fig. 3 – Use Google My Business for customer comments.

name. Another use case is how we use our “Uniform Channel.” Employees report any deficiencies with their uniforms in this channel by snapping an image and a short description of the issue right into the channel.

CUSTOMER RELATIONS

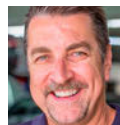
Our shop uses a program called Broadly to manage reviews, send appointment reminders, and operate a chatbot right on our website to capture leads. Since 2017, this program has returned to us a wealth of value. Looking through our Google reviews helps to reinforce this fact. We also use a program called Full Slate for appointment scheduling, which allows us to embed a self-serve scheduler on our website. Then, we use a program called MechanicNet to send our marketing materials, find lost customers, encourage scheduling deferred maintenance, and more. Lastly, we use Google My Business, which is now part of Google Maps (Figure 3). If you’re not leveraging this free service, I highly encourage you to do so immediately.

FINAL THOUGHT

Managing a shop can be a daunting task, but there are many options out there in the way of SaaS (Software as a Service) that help reduce the everyday friction we all experience. Check out some of the related SMS links in the sidebar when you can. ❌

Related Links

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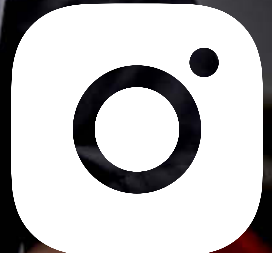


SCOTT BROWN is an ASE Master Certified L1 Technician and has over 37 years of professional service industry experience. He is an independent shop owner in Southern California and is engaged at various levels within the industry. He has a deep understanding of the challenges technicians experience at the service level and is continuously striving to move the industry forward through education and networking. Brown founded Diagnostic Network (diag.net) after 22 years of service at iATN, where he retired as company president in 2018.

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TOPDON Phoenix Max Scan Tool

Reviewed by Phil Fournier, owner of
Phil's Auto Clinic in Hemet, Calif.



PRODUCT DESCRIPTION

The **TOPDON Phoenix Max Diagnostic Scan Tool** is an OE-level scanner with a 13.3" screen, housed in a worksite-ready exterior. It's capable of configurations on vehicles ranging from 9V to 24V batteries and features FCA Gateway access, topology mapping, and is ADAS compatible. The scan tool includes a four-channel oscilloscope to visualize signals from multiple data sources and an updated MDCl (modular diagnostics and communication interface) that allows users to run CAN FD, DoIP, D-PDU, RP1210, and J2534 programs. The Phoenix Max provides dealer-level capabilities, two years of automotive updates, and one year of enhanced heavy duty coverage.

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Q: How did the tool function as far as saving you time?

A: I love the scan-all-modules function up front that identifies modules communicating and which ones have codes. Jumping from that screen directly into the module is also a powerful feature that saves time. Most other scanners also have the scan-all-modules function, but few have the graphical interface available on this scanner.

Q: What features did you like?

A: The PID search function is flat-out amazing. On a late model Ford vehicle where you can search every PID on the engine module and there are over 250 PIDs, the search window is invaluable. That feature alone is enough to influence me to use this tool over others for

a Ford product. It also has an option for ALL PIDs on a Nissan, something that other scan tools do not offer, so you cannot always combine the PIDs you want in a single data list, whereas this one will let you do that.

Q: What kind of setup was involved before using the product?

A: There is some setup required and the instruction book is not very good. I had to get help from product support to get the tool in operation. The scope setup was instantaneous; I plugged it in, and it opened the scope app automatically.

Q: How easy was it to use?

A: I am an experienced scan tool user, having used a wide variety of factory and aftermarket scanners. I'd put this one somewhere in the middle. I did have to make a few phone calls to tech support when I found the tool failed to record several long data captures I made. But they resolved the issue.

Q: Is there any way you could think to improve or add to this tool?

A: Open up a proactive pipeline with techs working with the tool, so missing PIDs or functions are very easy to report and make sure that they get fixed quickly.

Q: On a scale of 1 to 10, how would you rate this tool overall? Why?

A: I give it an eight for having the search function and the network topology smart scan. It would be great if the network topology could help identify a module that was supposed to be on the car that was not communicating. I don't think any aftermarket scan tool has this functionality at the moment. ❌



PHIL FOURNIER has been the owner/technician at Phil's Auto Clinic for 32 years and a working auto technician for 45 years. Fournier received his ASE Master Certification in 1982 and his AAM

from the Automotive Management Institute in 1994. Currently, he works as a consultant doing diagnosis, reprogramming, and virtual instruction. Fournier currently holds 17 ASE certifications including ASE Master Auto and Master truck plus L1, L2, and L3.

This product was given to the reviewer free of charge from the manufacturer.



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Clore Automotive SOLAR 12V 100A Flashing Power Supply and 100/40/10A Battery Charger

Reviewed by Eric Moore, fleet manager at Griffin Pavement Striping in Columbus, Ohio.

Q: How did the tool function as far as saving you time?

A: This power supply is fantastic for ensuring that voltage is maintained at a constant level while performing critical updates, or flash programming. Without the variations in voltage to interrupt the process, things proceed smoothly and quickly. The capability of recovering and charging batteries is also extremely convenient, especially the 100A option.

Q: What features did you like?

A: Being able to recover discharged bat-



PRODUCT DESCRIPTION

The **Clore Automotive SOLAR 12V 100A Flashing Power Supply and 100/40/10A Battery Charger**, No. PL6800, is designed to provide stable power, on-demand up to 100A, to a vehicle electrical system to support module reprogramming. It's also designed specifically for fleet service battery charging with a maximum charge rate of 100A to quickly bring 4- and 8-battery Group 31 packs back to full charge. In power supply mode, the unit provides power to maintain vehicle electrical system voltage at a preset level, increasing its output in response to system load increases to maintain a stable power environment for successful reprogramming. It features a voltage output range of 13.1 to 14.9V, adjustable in 0.1V increments allowing the operator to dial the output in.

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teries is a great feature, it saved us a few dollars by not replacing batteries that we considered unusable. The smart features on the unit allowed our techs to set it up and walk away while it was either charging or providing power. Previous tools or chargers always needed babysitting to ensure they hadn't timed out or weren't set up incorrectly. Not to mention the fluctuating voltages when trying to use a battery charger as a power supply.

Q: What kind of setup was involved before using the product?

A: The power supply comes with a special AC cord that your typical outlets may not accept. We decided to outfit a 24", 12-gauge extension cord with the correct end to accept the plug. We also keep the extension cord in a secure location. This way the power supply is less likely to be used incorrectly by staff not instructed in its proper use.

Q: Is there any way you could think to improve or add to this tool?

A: My only "complaint" is that the clamps could have stiffer springs. They are actually

very good, but I just prefer a more robust clamp when it comes to connecting to batteries. We will likely upgrade the unit with the heavy duty style clamps we use on our jumper cables in the shop.

Q: On a scale of 1 to 10, how would you rate this tool overall? Why?

A: With today's vehicles being electronically focused and reliant, the need for clean, constant power when diagnosing or updating them is critical. I have a hard time not recommending that this be an essential tool for any shop. That makes it a 10 in our book. ☒



ERIC MOORE began his career working on cars at several franchise dealerships. Initially, he leaned towards smaller vehicles, settling into Powersports vehicles, where he stayed for over 20 years. Then, Moore went the total opposite direction, landing at a medium and heavy duty truck dealership. Eventually, he moved into management and has performed most roles at the dealership level except for owning his own franchise. Currently, he is the fleet manager at Griffin Pavement Striping, belonging to the Frontline Road Safety group of companies.

This product was given to the reviewer free of charge from the manufacturer.

Vessel

Impact Ball, No. IB31P02U

Reviewed by Mario Rojas, lead diagnostics tech at Autobahn Performance in Oakland Park, Fla.



Q: How did the tool function as far as saving you time?

A: It saves me time by not breaking, unlike many of its competitors.

PRODUCT DESCRIPTION

The **Vessel IMPACT BALL Torsion Bit 30+1-pc Set**, No. IB31P02U, comes in a slide case. The product includes +1, +2, +3, SL4, SL6, SL8, SQ1, SQ2, SQ3, T10, T15, T20, T25, T27, T30, T40, PZ1, PZ2, PZ3, H3, H4, H5, H6, H3/32, H7/64, H1/8, H9/64, H3/16, H7/32, H1/4, and 1/4" hex bit holders with C-ring retainers. The set also features magnetized tips, high wear-resistance, durable bits made from VoHA material, and the highest hardness (62 HRC) created by in-house optimum heat treatment.

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Q: How easy was it to use?

A: About as easy as any tool, ever. Truly impossible to mess up.

Q: What kind of setup was involved before using the product?

A: No real setup. Ready to use as soon as tools are removed from packaging.

Q: How was its packaging? Did it come with any accessories?

A: The packaging is great. All of the bits are held thanks to the packaging retention, and it came with a 60mm extension.

Q: Is there any way you could think to improve or add to this tool?

A: A 1/4" ratchet would make this kit great!

Q: What features did you like?


A: The quality of the bits and the strength they have. I tried everything I could to break a bit, to no avail. I also love the con-

tainer that it comes in; they are all labeled and easy to keep track of.

Q: What types of jobs/repairs did you use this tool for?

A: I used this under the dash for blower motor installations and other interior repairs under the seats and center console removal, cluster removal, etc.

Q: On a scale of 1 to 10, how would you rate this tool overall? Why?

A: Ten, easily. Great build quality, packaging, storage, ease of use, and simplicity. 



MARIO ROJAS is an L1 ASE Master certified Diagnostic Technician from Miami, Florida. He works at Autobahn Performance, a shop that specializes in European vehicles. Rojas also shares some

of his work on his YouTube channel, Super Mario Diagnostics, to show what it takes to troubleshoot and repair the modern automobile, and to steer everyone into continued training.

This product was given to the reviewer free of charge from the manufacturer.



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Matco Tools

1/2" Drive Dual-Flex Angle Pneumatic Impact Wrench

Reviewed by Brin Kline, shop owner/technician at Assured Auto Works in Melbourne, Fla.

Q: How did the tool function as far as saving you time?

A: This flex head, low-profile impact wrench is a game changer. Being able to use the power of an impact wrench in areas where a traditional or even low-profile impact will not fit was a huge time saver.

Q: How has using this tool impacted your shop's profitability?

A: As far as I'm aware, there's nothing like this on the market. Before this tool, we were forced to remove a lot more parts just so our tools would fit where we need them. In some scenarios, we would have one person hold a device with one tool



Q: How easy was it to use?

A: Anyone who has used air tools or pneumatic impact wrenches can use this tool without referencing the manual.

Q: What features did you like?

A: I love how low profile the head is and that it swivels. The trigger/switch is on the handle and the handle turns. I love that as well. In some situations, it's easier when the trigger is facing the same direction as the wrench so you can simply press the trigger with your fingers. In other situations, it might be easier to turn the handle so you can press the trigger with your thumb or the palm of your hand.

Q: Is there any way you could think to improve or add to this tool?

A: No, I like it just the way it is.

Q: On a scale of 1 to 10, how would you rate this tool overall? Why?

A: I give this tool a 10. It's powerful considering its low-profile shape, and it's more versatile than anything else on the market right now. This tool is a problem solver for problem solvers. ✖



BRIN KLINE is the owner of Assured Auto Works in Melbourne, Florida, an automotive general repair business with a mobile diagnostic and module programming division. He has been in the automotive industry for 27 years. Kline also teaches for Carquest Technical Institute and Trained by Techs, is a member of the Automotive Service Association's Mechanical Operations Committee, and president of the Automotive Service Association of Florida.

while the other individual tries to loosen a fastener. With this tool, we are saving time because we're not having to do as much disassembly, and we are not having to rely on help from others to get the job done. Both situations mean more efficiency and more opportunity to make money.

Q: What kind of setup was involved before using the product?

A: Just add an air nipple, a drop or two of air tool oil, and get to work.

PRODUCT DESCRIPTION

The **Matco Tools 1/2" Drive Dual-Flex Angle Pneumatic Impact Wrench**, No. MT2612, features an adjustable head angle that works like a flex-head ratchet, plus a swivel position handle and throttle. Its ultra-slim head with 3-5/16" long paired with adjustable angle allows users to use an impact tool where previously only hand tools would fit, the company says. The MT2612 offers a twin-hammer reactionless mechanism that delivers up to 400 ft-lbs of break-away torque as well as a front head exit exhaust to reduce noise and air consumption. Head angle is tension adjustable based on preference and job, included with wrench to adjust.

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This product was given to the reviewer free of charge from the manufacturer.

CATEGORY SPOTLIGHT

DIAGNOSTIC TEST EQUIPMENT

To diagnose a vehicle quickly and efficiently, technicians are no longer able to get away with just having one or two tools in their arsenal. As vehicles continue to advance and are now considered computers on wheels, it's now a matter of which tools to use. Whether testing EVAP systems, evaluating a battery's state of health, inspecting brake calipers for sticking, or checking for electrical faults, here's some diagnostic test equipment worth checking out to make your job a little easier.

OFFERS PRE-INSTALLED EXTENDED FUNCTIONS

The **Launch Tech X-431 Torque Link** is designed to assist technicians and repair shops with productivity and accuracy. The Android 10-based scan tool has added features, including X-431 FIX repair database (Driven by Motor), SmartLink VCI, upgraded 4G/128GB storage, optional HD add-on subscription, J2534 Pass-Thru programming, FCA/SGW compliance, and more. Additionally, X-431 Torque Link offers pre-installed extended functions, such as an ADAS calibration system, battery and starting system, oscilloscope, video scope, TPMS, and immobilizer diagnostics.

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BUILT-IN INTERNAL COMPRESSOR FOR MOBILE REPAIRS

The **Mastercool Dual EVAP/High Pressure Diagnostic Smoke Machine with Truck Adapter Accessory Kit**, No. 43070, is designed for EVAP, turbo/intake, and heavy duty truck testing, offering a complete automotive smoke detection testing in a single unit. With an internal compressor, mobile repairs are made possible. The unit doesn't need the use of shop air, but has the ability to utilize shop air and inert gases if and when needed. The smoke machine kit includes all the adapters for EVAP, high pressure, and heavy duty truck testing.

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Beta Tools USA is a subsidiary of BETA UTENSILI S.P.A. Sovico (MB) - Italy

Beta
Italian design. European quality.

NICKEL PLATED PROTECTION. RESILIENT STRENGTH.

Produced in Northern Italy, the 42-combination wrench is one of the most remarkable and well known tools made by Beta. Newly improved, the 42 has features that make it the ideal solution to your everyday challenges:

ERGONOMIC: Designed with your hand in mind, the improved 42 features reduced thickness for better accessibility and an offset ring on a fifteen-degree angle for protection.

RESILIENT: Made from high-quality material that allows the 42 wrenches not to break under extreme load.

POWERFUL: Offers Torque value more than double ISO 1711 requirements.

PROTECTED: Nickel-chrome plating provides lasting resistance against some of the most corrosive agents on earth.

WHAT ARE YOU WAITING FOR? **THE 42 IS MEANT FOR YOU.**

Beta 42

BETATOOLSUSA.COM

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PROVIDES LIVE ACCESS TO EXTENDED VEHICLE DIAGNOSTIC DATA

The **Continental Autodiagnos Drive** is a remote vehicle data solution designed to deliver advanced diagnostic information that service providers, fleet managers, and repair facilities can use to maximize their data-driven services. The easy-to-install, plug-and-play technology provides users with live access to extended vehicle diagnostic data for all popular makes and models of passenger cars, light trucks, and commercial vehicles. It also provides vehicle owners with up-to-date information on their vehicle's health.

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THREE KITS TO CHOOSE FROM

The **Off-Highway Automotive Kits** from **Pico Technology** are designed for fault diagnosis on trucks, tractors, forklifts, boats, combine harvesters, excavators, and more. The kits contain a modified PS4425A PicoScope having additional protection to withstand off-highway conditions. The included accessories help users quickly connect and easily carry out non-intrusive and non-invasive measurements on a wide variety of systems and components found in these vehicles. There are three kits to choose from: Entry (No. PQ324), Expert (No. PQ331), and Elite (No. PQ332).

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OFFERS BLUETOOTH AND WI-FI CONNECTIVITY

The **USB-Link 3: Wireless**, No. 121052, from **NEXIQ Technologies** is designed for flexibility as it can connect to a PC, tablet, or smartphone via Bluetooth and Wi-Fi. In addition, the USB cable gives technicians the option to directly connect to a PC when working in the field or during signal interruptions. Built to support the latest protocols (CAN FD, DoIP), and with the compatibility for a wide range of OEM diagnostics software, the USB-Link 3 is the company's most advanced VCI to date. A USB-Link 3: Wired Edition, No. 121054, is also available.

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E-Z-Hook's Deluxe Automotive Test Lead Kit

(part # 3604)



E-Z-HOOK

MANUFACTURER OF ELECTRONIC TEST ACCESSORIES

info@e-z-hook.com

www.e-z-hook.com

- Reliable and secure diagnostic connections
- Made in the U.S.A
- High quality materials
- Family owned and operated since 1956

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2-PIECE POCKET PRY BAR SET



853-06-2ST

Also available individually.



3/16" DIAMETER STEEL WITH
HIGH FATIGUE AND
TORSIONAL STRENGTH

SET CONTAINS STRAIGHT AND
27° OFFSET PRY BARS

OVERALL LENGTH OF 5"

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TOOLS
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CATEGORY SPOTLIGHT

Diagnostic Test Equipment



INCLUDES THREE ADAPTERS

The **Electronic Specialties Super Relay Buddy Pro Kit**, No. 195, includes the Super Relay Buddy tester, plus three different adapters, which increases the test coverage to ten different 12V relays. The Super Relay Buddy incorporates a full 7A load into the automated test sequence, making it capable of finding more heat/load caused failing relays. It also has a third test result (green for good, red for fail, and yellow for caution) and can test seven different 12V relays. To test, simply remove the relay from the vehicle, plug it into the relay buddy, and then press the "test" button until the test cycle is completed.

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OFFERS LOCAL AND REMOTE CAPABILITIES

The **asTech All-in-One** is a comprehensive tablet-based solution with both local and remote capabilities, allowing for OEM and OEM-compatible diagnostics, ADAS calibrations, and programming on a vehicle. The All-in-One features asTech's capabilities and OEM vehicle coverage, including those utilizing the DOIP, CAN-FD, and secure gateway protocols. With the All-in-One, users can scan using 1,000+ remote OEM and local OEM-compatible diagnostic tools; conduct remote and local calibrations, initializations, and parts programming; access 400+ certified remote technicians; and access local OEM-compatible pre- and post-scan reports.

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ABLE TO MEASURE, RECORD, AND PLAYBACK COMPRESSION READINGS

The **OTC Deluxe Digital Compression Tester Kit**, No. 5605-DG, is designed to help determine the mechanical condition of the engines' cylinders. The digital gauge is easy to read and can display pressures in psi, kPA, bar, and kg/c. It also can measure, record, and playback compression readings on up to 12 cylinders, for quicker testing and diagnosis. Specialized adapters work on both flat and tapered seat plugs. The kit includes standard and specialty adapters, including the deep well connector used on recessed plug well style heads and the Ford Triton engine adapter using 16mm thread plugs.

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LATEST UPDATE TO THE G-SCAN SCAN TOOL DATABASE

The latest **G-scan Software Update** from **CAS** has three dozen different car lines being added or updated to the G-scan scan tool database, including the majority of 2022 models for Chrysler/Jeep/Dodge. The software also includes new Volkswagen, Audi, and Subaru coverage, as well as 30+ other car lines. Expansion areas include diagnostics, maintenance functions, and ADAS calibrations. Current customers can update their G-scan to get the latest add-ons.

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CATEGORY SPOTLIGHT



Diagnostic Test Equipment

INCLUDES IVSMAP VEHICLE BLUEPRINT

The latest **Opus IVS DriveSafe Software Update** includes key productivity enhancements such as the IVSMap Vehicle Blueprint and related invoicing automatically transferring to the CCC work file. The new functionality presents ADAS calibration requirements both on-screen in the diagnostic tool and uploads the results into the CCC work file for the vehicle. An on-screen diagnostic tool checklist also provides guidance and documentation that critical calibrations are completed before the post-scan runs.

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DETECTS INVISIBLE PROBLEMS QUICKLY

The **Innova Electronics Multi-Purpose Infrared Inspection Camera**, No. 3360, uses thermal sensors to target and record temperatures, detecting invisible problems quickly. Users can turn thermal images into a photo that can be stored and viewed at a later date as well as download images to the computer to edit, share, or print. Automotive applications include checking the radiator and hoses for hot/cold spots to identify potential blockages or failed components, inspecting brake calipers for sticking, and measuring HVAC lines and condensers to confirm temperature uniformity or restrictions. The Innova 3360 features a 2" color screen, IP54 rating, and a measuring range of -4 to 1,112 degrees F.

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INCLUDES ENHANCED DIAGRAM NAVIGATION

The **Mitchell 1 ProDemand Advanced Interactive Wiring Diagrams Update** further integrates diagrams with related information assets provided in ProDemand repair information software, making it faster and easier to diagnose complex electronic systems in today's modern vehicles. Users won't need to exit wiring diagrams to find crucial information like component location, pin configurations, connectors, grounds and splices, because they are now linked inside the diagrams. Additionally, "diagram to diagram" navigation is now

available so if a technician is researching a diagram that references another, they can jump directly to the other diagram without multiple steps. The new diagram history feature also provides instant recall.

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**▶ Watch this product in action here:
VehicleServicePros.com/21287017**



EVERY JOB IS A GO.

The **OEMTOOLS® 68922 Battery Service Kit** has all the tools you need to jump, test, service and replace batteries on most vehicles.

Kit Includes: Battery Terminal Puller, 4-Way Post Cleaner, 5/16" and 10 mm Battery Terminal Wrench, Battery Nut Pliers, Extended 5/16" Battery Terminal Wrench and a Side Terminal Brush.



Shop **OEMTOOLS®** huge selection of professional tools and equipment online to give your jobs the green light.

Scan for special promotions or follow this link: BIT.LY/BATTERY1225



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GENERATES DIAGNOSTIC REPORTS IN LITTLE TIME

The **TOPDON Phoenix Lite 2** generates diagnostic reports in a short amount of time in order to assist shops in completing jobs faster and more efficiently. The diagnostic tool is best utilized for basic functions, including ECU lookup, reading and clearing fault codes, and reading data streams. The product offers OE-level full system diagnostics for 200+ vehicle makes and comes equipped with upgraded hardware, a larger screen with higher resolution, and an improved battery life, as well as a wireless Bluetooth diagnosis connector. The scanner offers 28 different maintenance services for major vehicle brands, including oil resets, EBP resets, suspension resets, and more.

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**▶ Watch this product in action here:
VehicleServicePros.com/21287011**



RUNS PROFESSIONAL-GRADE FULL SYSTEM SCANS

The **OTOFIX D1 Diagnostic Tablet** is a professional-grade all-in-one handheld tool to read, analyze, and clear diagnostic trouble codes; reset steering angle sensors, service mileage, and service intervals; relearn parking brake-pad positioning; test and register a battery, and more. Powered by the OTOFIX cloud services app, users have access to data backups, past diagnostics history, and online solutions backed by OTOFIX Support. The OTOFIX D1 is built on an Android tablet featuring a 7" touchscreen, a built-in microphone and loudspeaker, onboard camera and flash, USB OTG/charging port, and a microSD card slot for unlimited data storage.

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FEATURES A FULLY DETACHED WIRELESS FOUR CHANNEL SCOPE

The **Snap-on ZEUS+** provides the information needed to diagnose, repair, and manage any issue, simplifying the workflow and increasing efficiency on every job. Features a streamlined design with a fully detached wireless four channel scope for mobility, ample storage for capturing intermittent glitches, a 12" optically bonded color touchscreen display, an eight megapixel camera, and an integrated stylus with a flashlight built in. The software includes advanced graphing features to help technicians easily navigate through data, a guided component test meter for verifying component failure, and fast boot up and one-touch code scan and clear.

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Lisle NEW TOOLS



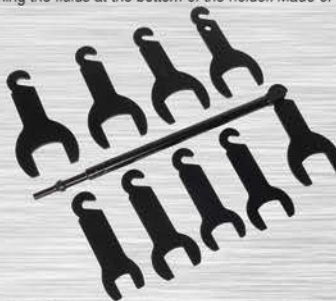
50240 MAGNETIC FUNNEL HOLDER

Translucent funnel holder accommodates various style and size funnels and stores the funnel without a mess. Two strong neodymium magnets hold the funnel on ferrous metal surfaces without slipping. Holder collects residual fluids as they drain into the 12 oz. reservoir. Funnel sits slightly angled so it will clear any mounting surface. Interior ribs prevent the funnel from touching the fluids at the bottom of the holder. Made of polypropylene for durability.



43350 PNEUMATIC FAN CLUTCH WRENCH SET, 10 PC.

Does the job much faster than conventional fan clutch wrenches. Set includes nine driving wrenches that fit Ford, GM, VW, BMW, Chrysler and International. Driving wrench sizes include: 7/8", 32mm, 36mm, 40mm Thin, 47mm, 1-7/8", 2", new 52mm for 2019 and newer Duramax, and 2-1/8" for newer International.



64180 ACTUATOR MOTOR WRENCH SET, 5 PC.

Toothless, infinite ratchet and hinged handle design make it easier to remove and replace fasteners on small, electric HVAC motors. These motors commonly found in confined areas under the vehicle dash. The ratchet can be flipped to switch from clockwise to counterclockwise drive. Set includes 5.5mm socket (new), 7mm socket (new), 8mm socket and 1/4" Square Drive Adapter for use with 1/4" sockets and bit holders. Can also be used in other hard-to-reach applications. Vinyl holder for sockets and adapter.



28800 DIGITAL TEST LIGHT WITH LOAD TESTER

3-30 Volts DC dual polarity digital test light that can also apply load to get an instant voltage drop reading. Works as a regular test light and when you push the button on the tool it applies an 800mA load at 12V DC to easily check for voltage drop on circuits. The display will indicate the voltage drop when the button is pushed. Displays voltage under load to tell if circuit has problems like corrosion, resistance, or faulty connections.



40740 DIESEL INJECTOR PULLER KIT

Injector puller handles a variety of injectors found in Cummins and Duramax engines. The kit comes with three application specific attachments. Remove the shoulder bolt to switch between the attachments. Two-jaw design firmly grips the injector while it is being removed by the slide hammer. Applications: Duramax 2001-2010, LB7, LLY, LBZ and LMM. 2011 and newer LML engines. Cummins 2003 to 2018 5.9L and 6.7L.



59350 STRETCH BELT INSTALLER-DOUBLE PULLEYS

Used to install the main stretch belt on extra deep double pulleys. Inside of the tool is designed to fit securely on the front side of pulley. The tool holds the belt on the pulley as the engine is rotated clockwise to install the belt. Helps prevent damage to the belt or pulley during installation. Works on 2011 and newer Ford 3.5L EcoBoost and 3.7L engines, as well as 2019 and newer GM 5.3L and 6.2L engines.

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PTEN TOP 100 PRODUCTS 2022



WHEN IT COMES TO SHOWCASING new tools there's a reason why we have tools and equipment within the title of our publication and why we fill majority of our pages with

products. *PTEN* understands the value of having the right tools for the job as well as staying informed on new tooling.

Our annual Top 100 Products is a way for us to share the top most sought-after products this year that were requested from other technicians and shop owners like yourself.

At the end of every year, the editors of *PTEN* compile all print and online product inquiries that were submitted from our readers through the reader service cards found in every issue and through our online e-inquiry system.

The next few pages feature the top 25 products. For the full list, visit: VehicleServicePros.com/2022-top-100-products

—Kayla Oschmann, Associate Editor



THERMALLY STABLE IN EXTREME TEMPERATURES

Dana Incorporated

Victor Reinz Reinzosil RTV Silicone

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SIZES RANGE FROM 20MM TO 46MM

Platinum Tech

17-pc Metric 1/2" Drive Jumbo Crowfoot Wrench Set, No. PLT-99380

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ALLOWS FOR PINPOINT ACCURACY

FedPro

Free All Deep Penetrating Oil with Precision Straw

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STREAMLINED ALUMINUM SAFETY TOES

Keen Utility

Sparta 2 Athletic Work Sneaker

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AUTOMATICALLY SHUTS OFF TO PREVENT OVERINFLATION

Milwaukee Tool

M18 Inflator

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IDEAL FOR EXHAUST WORK, BODY WORK, AND DASHBOARDS

EZRED

8" S-Shaped Quarter Stick, No. 4SS8

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For the full list of the 2022 TOP 100 PRODUCTS, visit:
[VehicleServicePros.com/2022-top-100-products](https://www.VehicleServicePros.com/2022-top-100-products)



**FOR REMOVING GASKETS,
SEALS, RUST, AND MORE**

VIM Tools

2-pc Carbide Scraper Set,
No. CS100

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**OFFERS A WIDE RANGE
OF SIZES**

CTA Manufacturing

15-pc Torx Plus Socket Set,
No. 5420

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**BONDS METALS, HARD
PLASTICS, GLASS, RUBBERS,
AND MORE**

Permatex

500° High Heat Epoxy

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**FEATURES SKIN SENSITIVE
TECHNOLOGY**

Adenna

Optify Nitrile Disposable Gloves

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EXTENDABLE TOP DECK

Stan Design

Engine and Transmission
Lift Table, No. TA2600

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**ABLE TO DRILL OUT
BROKEN BOLTS**

Mueller-Kueps

Carbide Milling and Grinding Burrs
Set, No. 297 001/KIT5

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[VehicleServicePros.com](https://www.VehicleServicePros.com)



**FOR USE IN MINIMAL
ACCESS SPACES**

Tekton

3/8" Drive Folding Ratchets

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USES LED CURING

ITW Evercoat
Light Speed System

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We saw a number of products introduced at the AAPEX and SEMA shows again this year. Here are some new tools and equipment selected by our editorial staff that piqued our interest.



asTech asTech Mini

The **asTech Mini** is a compact and comprehensive Bluetooth-enabled OBD-II scanning solution for OEM and OEM-compatible diagnostics. Paired with the asTech mobile app, the asTech Mini delivers the functionality of thousands of OEM scan tools in a pocket-sized device. With the asTech Mini, users can access asTech's patented remote OEM diagnostics and 400+ certified technicians, perform local OEM-compatible quick scans, read and clear codes, access all scan reports in the asTech mobile app, and be assured that scans are backed by the company's warranty. The asTech Mini will be available to automotive and collision repair centers and multi-shop operators for order in 2023.

Editor's Note: This device is a diagnostic scanning solution that fits in the palm of the user's hand and gives technicians the same capabilities they would have in multiple OEM diagnostic scanners in one small package.

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FOR MORE INFORMATION ON THESE PRODUCTS, CLICK ON "PTEN E-INQUIRY" at VehicleServicePros.com OR CIRCLE THE NUMBER ON THE CARD.

Milwaukee Tool

M12 FUEL Bandfiles, Nos. 2482-20 and 2483-20

The **Milwaukee Tool M12 FUEL Bandfiles**, Nos. 2482-20 and 2483-20, are available in both 18" and 13" sizes and are designed to deliver fast spot removal. The bandfiles feature two speed adjustment settings (high 3,600 sfm and low 1,800 sfm), a lock-on button, a variable speed trigger, forward and reverse functionality, and are resistant to belt slip. Both are also equipped with a 360-degree tool-free arm rotation to improve access in hard-to-reach applications. When equipped with an M12 Redlithium XC 4.0 battery, users can remove up to 50 spot welds using the 18" bandfile and up to 40 spot welds with the 13" bandfile on a single charge.

Editor's Note: After demoing this tool, one of our editors had this to say, "What's great about it is it's the first cordless version of a bandfile. Most use air and are more difficult to maneuver with the airline." It comes in two sizes, and the batteries can be swapped with other M12 devices.

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TOPDON

TC003 Infrared Thermal Imager



The **TOPDON TC003 Infrared Thermal Imager** is an open-system Android tablet infrared thermal imager. The TC003 offers the user-friendly interface and detail of the TC001, with the added benefit of a built-in smartphone-sized

touchscreen. The imaging tool features an IP55 water- and dust-resistant rating, Bluetooth connectivity, and two lenses for dual optical fusion.

Editor's Note: An update from TOPDON's TC001, which turned user's smartphones/tablets into thermal imagers, this new device comes with a touchscreen the size of your typical smartphone, meaning mobility isn't an issue as technicians take the device from job to job.

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Bosch Diagnostics

EV3000 30kW DC Fast Charger

The **Bosch EV3000 30kW DC Fast Charger** is ideal for commercial, workplace, fleet, and public charging. Compact and wall mountable, the charger is also weatherproof and suitable for indoor or outdoor installation. With its simple two button interface, users can plug in and begin to charge, just like a standard Level 2 charging station. The EV3000 Series is also capable of being a connected charging station, following OCPP network protocol, allowing owners to select a private charging network or open the station publicly. Compatible with vehicles using the SAE J1772 Combo connector found on most electric vehicles in North America.

Editor's Note: "Fast Charger" isn't just a name for this new EV charger from Bosch. It can charge up to four times faster than Level 2 AC chargers. For a typical passenger vehicle, the EV3000 can charge from 20-80 percent in about an hour.

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TEXA USA

Konfort 780 Dual Gas Touch A/C Recovery Machine

The **TEXA Konfort 780 Dual Gas Touch A/C Recovery Machine** is designed to allow users to alternate services on vehicles equipped with refrigerants R-134a and R-123yf, since it has two tanks and two separate circuits for recovery, recycling, and recharging. The service process is automated. Other notable features include airtight oil bottles, a scale locking/unlocking device, a refrigerant weight accuracy check system, and an automatic cleaning device for all the hydraulic ducts. The Konfort 780 Bi-Gas Touch also sports a 10" color multi-touchscreen display, Wi-Fi connectivity, and a Bluetooth module which allows users to connect the station with several accessories such as an A/C efficiency kit, built in thermal printer, dedicated phone app for remote access, and more.

Editor's Note: This A/C recovery machine is a game changer because it houses two tanks – one for R-134a and one for R-123yf, and the software will automatically detect which gas is used and switch to that.

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Hunter Engineering Company

Maverick Tire Changer

The **Maverick Tire Changer from Hunter Engineering** is a center-clamp tire changer that shares many features with Hunter's standard-setting Revolution tire changer, but gives technicians a more hands-on approach and freedom to adapt the process to their own precise needs. With its four-joystick layout, the Maverick provides tactile feedback with one-handed control. Its leverless head utilizes a Revolution-style tool and hook mechanism for maximum wheel protection, while automatically articulating to maintain ideal wheel alignment. A lifting ledge in the pusher foot saves additional time and effort. Additionally, it features HunterNet 2 connectivity, a compact size, and hydraulic cylinders that deliver force and precision over air cylinders.

Editor's Note: Hunter has updated this tire changer to include features that protect the wheel, tire, and technician such as customization of travel and rotate speeds, ramp rate, and more, as well as monitors for the roller and hook positions to prevent unintended wheel contact.

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H&S Autoshot

Pull-Pro Portable Dent Pulling Tower, No. UNI-1096

The **H&S Autoshot Pull-Pro Portable Dent Pulling Tower**, No. UNI-1096, is designed to quickly setup and pull aluminum or steel dents with over 1,300 lbs of pulling force. The adjustable height tower and belt driven manual hoist allows for precise and progressive pulls. A metal base plate with vacuum seal allows for ultimate portability. The wheels mounted on the tower make for quick setup and storage. Optional accessories include the lower pull base plate (UNI-1097) and high pull extension kit (UNI-1098).

Editor's Note: H & S Autoshot's Dent Pulling Tower is easy for technicians to maneuver and goes wherever the job is. Its portable nature also means it won't unnecessarily take up shop space.

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Wiha Tools

26-pc Insulated EV Essential Tool Kit

The **Wiha Tools 26-pc Insulated EV Essential Tool Kit** includes individually tested, 1,000V AC rated, insulated VDE screwdrivers, sockets, ratchets, extension bars, wrenches, pliers, a cutters, a cable stripping knife, and tweezers. The tools feature a SoftFinish cushion grip handle with a slip guard design, exact fit precision machined tips for reduced cam-out, and induction hardened cutting edges and jaws for ideal sharpness and longevity. They also endure a rigorous heat-treatment process for maximum strength. The tools come in a sturdy plastic shell case with dedicated tool compartments for secure storage and organization as well as custom-fit trays with finger-recesses for easy tool retrieval.

Editor's Note: This insulated tool kit will cover all your hand tool needs when it comes to any EV, HEV, or BEV repairs. With tools individually tested to 10,000V and rated to 1,000V AC, technicians can be sure of their safety while using these tools.

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Milwaukee Tool wins Innovation Award for M12 Underbody Light

This light has been a huge hit with technicians since its introduction late last year.



We spoke with Milwaukee Tool's Jason Isaacs about their M12 Underbody Light and how it was developed. The light has been a hit with technicians since its introduction and received a 2022 Innovation Award from **PTEN** magazine. It features a magnetic base for easy mounting and a 12" magnetic extended arm to hold loose nuts and bolts. This light adapts to the tech's needs with a rotating arm and light head to provide complete undercarriage lighting coverage. Dual joints allow the light head to swivel 300-degrees horizontally and up to 180-degrees vertically for maneuverability. The M12 Underbody Light delivers 1,200 lm of TRUEVIEW high-definition output for full visibility. To watch the full interview, visit: vehicleservicepros.com/21287963

PTEN is the only publication to feature the prestigious "Innovation Awards." Every year since 1999, the Innovation Awards highlight the newest and most innovative products introduced to the automotive aftermarket. For 2022, *PTEN* received 121 submitted product entries in 23 categories. We will be featuring each category winner in a monthly video on our YouTube channel *PTEN (Professional Tool & Equipment News)*. To view a full list of winners online, visit: VehicleServicePros.com/2022IAWinners.



The Innovation Awards honor companies that take their products to another level and offer unique features that make a technician's job easier. If you would like to submit a product to be considered for the 2023 Innovation Awards, entries will be accepted starting in February. Visit: VehicleServicePros.com for more information.

Getting our tradeshow legs

For the editors of *PTEN*, we finally got our tradeshow legs back after attending three shows in two cities.

By **Brendan Baker**, Editor

We finally got our tradeshow legs back after attending three shows in two cities. With light attendance for in-person events last year, 2022 marked a turning point of going back to normal (at least a new normal).

SEMA and AAPEX got the lion's share of attention in early November, with "Automotive

IndustryWeek" running from Nov. 1 - 4. While attendance was not quite up to pre-pandemic levels, organizers estimated that it was more than 90 percent back to what it was before 2020.

SEMA is the biggest draw as it's the grandfather of automotive tradeshow, but AAPEX was also solid, with attendance being much better than the previous year. The addition of a garage atmosphere on the first floor was an improvement to the overall

experience for showgoers who were there to see tool/equipment demos and learn from industry experts.

The prevailing theme of both shows was new technology, with ADAS getting a lot of attention and a dedicated area at SEMA, and plenty of demonstration and explanation in the garage at AAPEX. EVs were also a hot topic at both shows. SEMA expanded their EV area, and AAPEX also had highly-visible EV displays at exhibitor's booths. Notably, tools for new technology vehicles were front and center in new product displays.

The final show we attended was a new one for us. The Electrify Expo in Austin, Texas, held an Industry Day where we spoke about the challenges and opportunities for shops gearing up for servicing EVs.

It certainly seemed like the industry was back to normal this year. And our legs and feet confirmed it. ❌

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Top Left- At the opening reception at AAPEX, political strategists Karl Rove and James Carville got the audience revved up about the election and how it might affect business. Top Right- Autel dedicated almost half of their booth to EV tools and chargers. Lower Left- The upper South Hall was dedicated to Tools and Equipment such as lifts, welding, hand tools, and more. Lower Right- Austin Matney accepted his Best Young Tech award and uniform patch on Tuesday morning at the PTEN booth.

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WRAP UP



Left - PTEN/PD Tech Editor Scott Brown stands next to his likeness pasted all over the show. He didn't mind that people walked all over him this time. Middle Top - We gave away some heavy hardware (Innovation Awards) at our booth on Tuesday morning. Middle Bottom - Power Probe demonstrates their new PPTAMP/PPTPWM adapters. Right - Hunter Engineering introduced a new tire machine at SEMA called the Maverick. It has many of the same features as the Revolution, but it is completely manual for shops who want that control.

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A tribute to years served

This service technician's setup features a half hutch with a custom wrap to showcase his Veteran status.

By Kayla Oschmann, Associate Editor

Before making his big purchase of a new toolbox, Tom Smith, an automotive service technician at Boucher Buick GMC in Waukesha, Wis., made sure to do his homework. And it wasn't just a few quick online searches, Smith took his time to research – a couple of months in fact.

It wasn't until watching toolbox drop test videos - one specifically where toolboxes were lifted by a hoist and then dropped on an I-beam - Smith decided to go with Matco Tools, seeing that they tend to have thicker metal.

Smith purchased his custom Matco 6S double-bay toolbox in 2015. His requirements were simple. It had to have a power

OWNER

Tom Smith
 Shop: Boucher Buick GMC
 Location: Waukesha, Wis.

accessory drawer, power receptacles on the front, and it had to have silver vein paint.

He also wanted green chrome handles to go with the silver vein paint – a not-so-common color combination.

“I've only seen that combo one other time on a Matco Revel series, which is a completely different line,” Smith says.

Nearly three years after his purchase, Smith decided to expand his box by adding a half hutch. Keeping with the technician's need for power, the hutch features a power strip and light.

However, above all, when Smith ordered the half hutch, his Matco tool dealer was able to get a custom wrap on the hutch door – an honorable and unique wrap to show the technician's Veteran status.

Then last year, Smith decided to trade in his previous tool cart for a matching Jamestown service cart to complete his set.

KEEPING THE TOOLS ORGANIZED

Working in the reconditioning area of the dealership, Smith comes across all types of cars and in all types of conditions. Vehicles that enter his bay are pre-owned cars that were either taken in from a trade or from auctions. Although they are primarily GM vehicles, he does see many others including Audi R8s and Porsches.

Never knowing what's going to come in, he understands the importance of keeping your tools organized and knowing which ones to keep close by.

For this reason, he keeps his commonly used tools and electronic diagnostic tools (for example his multimeter and leads) in his service cart. Tools that he doesn't use as often, such as specialty sockets and tire pressure monitor tools, he keeps in his toolbox.

The tool that he uses daily and is considered his favorite tool, would be his Launch Tech X-431 Pad II scan tool.

“It can scan pretty much all makes and models, bidirectional control sensors, and relearn values, and things of that nature,” Smith notes. “It helps get to the root of the cause.”

THE NEED FOR MORE STORAGE

Like most technicians in the auto industry, Smith shares the common issue of running out of room for his tools. He plans to add a matching side cabinet. Just one for now, but eventually he would like to have one on each side. ☒

Want to see more photos of Smith's box? Visit: [VehicleServicePros.com/21286614](https://www.VehicleServicePros.com/21286614)



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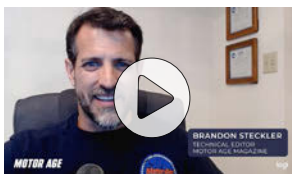
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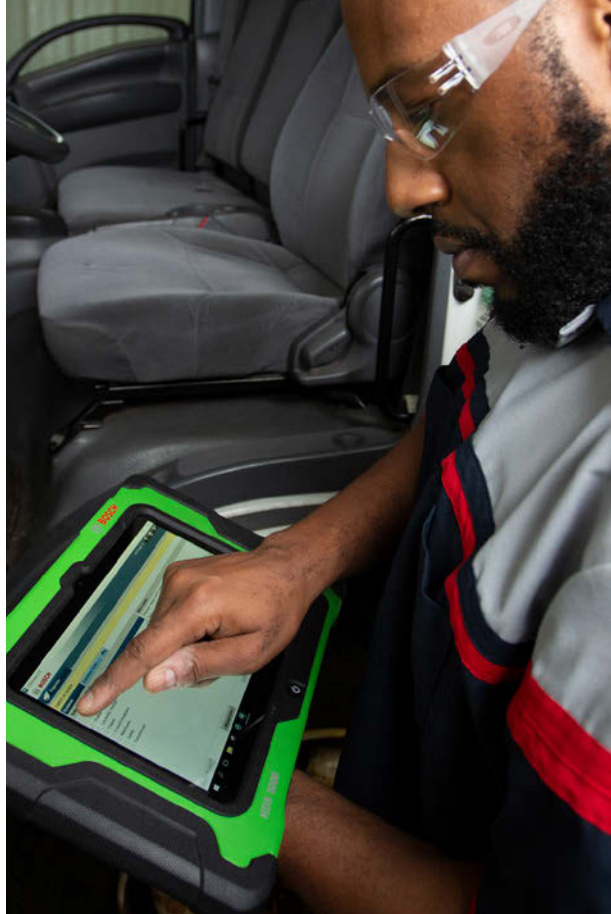
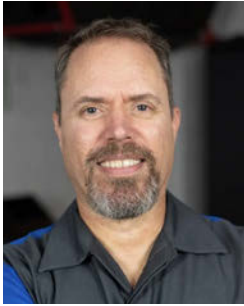


Photo from Bosch

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Diagnosing Progress

We are at the cusp of a new era in diagnostics and computer control.

By Brendan Baker, Editor
BBaker@EndeavorB2B.com

In the early days of EFI, and OBD-I, there were no real standards for getting data from the ECU. My brother and I raced a Honda Prelude in the IMSA Firehawk Series for showroom-stock cars that were modified for safety and that's about it. You weren't allowed to make performance modifications outside of the stock specs. But some teams figured out how to skirt the rules and modified the baseline ECU maps by having them reflashed to specific parameters such as removing the rev limiter or advancing the timing for a certain rpm range.

The GM cars that raced in the series had a distinct advantage because they were equipped to connect to a laptop through the ALDL port (the DLC before OBD-II). This allowed teams to make adjustments at the racetrack with a few taps on the keyboard; it was mind-boggling at the time. Honda teams banded together to swap ECUs as some were reflashed and worked better than others. However, we weren't able to change anything on the fly like GM teams.

My dad, who began racing in the mid-'60s before I was born, was from a different era. In his day, all of the adjustments were mechanical. Need more fuel? Change the jetting and read the weather to get the right air/fuel ratio. You can feel it in your hands. You'd give it a tune-up, as they do in drag racing. But my dad thought that the new electronic



Baker Motorsports - IMSA Firehawk

code readers and scan tools were like a genie in a box that fixed everything. Not quite. At that time, scan tools were in their infancy and mostly just to read the emissions codes and little else.

Today, the idea of connecting a bi-directional scan tool to diagnose a vehicle and make the repair is the norm. Nearly every shop has a diagnostician on staff to troubleshoot and decode all of the data that is available to technicians. As we move further into what is ostensibly OBD-III, technicians, shop owners, and service advisors are going to be dealing with more data than ever. But data is only good when you know how to use it.

Next-level diagnostic tools and even connected machines like tire changers, inspection tools and brake lathes can help shop owners deliver higher profits and ROI. Techs can connect remotely to customers' vehicles to do an initial diagnosis before it arrives in the shop. And EVs are starting to creep into service bays across the country. It's as exciting as it is trepidatious.

There is a lot of opportunity for technicians and shop owners alike, but there are many challenges ahead. The technician shortage is real and appears to be getting worse. There are more cars and fewer shops doing the work. We are also seeing a changing of the guard in shops as many owners are at or near retirement.

Yes, the tools today are amazing and complex and require more training. ADAS is going to be mandated on all new cars soon. So, shops must be prepared to invest in the next level of equipment and tooling, but not everyone will make that leap of faith.

When you need \$30,000 worth of ADAS equipment to change a windshield or repair a bumper, that tells you what is ahead for the industry. ADAS is somewhat a precursor to EVs and autonomous vehicles. There are far more sensors in vehicles today than a decade ago, and it's only going to increase in the years ahead.

My dad had the right idea about what a scan tool should do, but he was a little ahead of his time. We've certainly come a long way since the '90s. ♦

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Common diagnostics and trends in hybrid and electric vehicles

Attendees of ASE's "NAPA - Hybrid and Electric Vehicle Update" webinar learned about high-voltage tools, trends, and common diagnostic issues.

By Kayla Oschmann

What we will see in vehicles 14 to 20 years from now will be completely different than what we are seeing now. That is what technicians and shop owners heard during a National Institute for Automotive Service Excellence (ASE) webinar.

"Technicians need to be up to date and onboard to work on electric vehicles (EVs)," said Jason Gloria, ASE Master Technician and NAPA Autotech Instructor. "Electric vehicles are our future, and they're not going away."

Gloria hosted ASE's webinar entitled "NAPA - Hybrid and Electric Vehicle Update" and identified several key topics for techs and shop owners to beware of when working on hybrid and electric vehicles.

SAFETY FIRST

Although manufacturers have built-in safety features within the high-voltage system, technicians still need to take the right steps to remain safe.

First and foremost is using the right tools. Special tools include a CAT III meter and leads as well as high-voltage rubber gloves and protective outer leather gloves. It's important to self-check the rubber gloves before every use. To do so, Gloria recommends filling the gloves with air, then roll up the cuffs to check for leaks.

Secondly, when working on EVs, one must first disable the high-voltage system. Every EV will have service disconnects. When a battery service disconnect is pulled out, a sensor will shut down the relays that connect the battery to the



Photo Courtesy of NAPA

vehicle, disconnecting the power from the battery. Since there's still power in the battery, technicians still need to be careful when working.

It's only safe to probe the high-voltage circuits after the service disconnect is opened, the capacitors have bled down, and DMM confirms 0V in the system, Gloria notes. Once confirmed, it's then safe to continue working with high-voltage gloves. Gloves are always needed when working inside the battery assembly until voltage levels are safe (12V or less).

THE FUTURE OF EVS

Tesla may not have come out with the first electric vehicle, but they are the ones who "made electric vehicles fun."

"It's the whole reason we are where we are," Gloria noted. "Without Tesla, all these manufacturers wouldn't be making electric vehicles."

The original Tesla, the Model S, was the one that made an impact (not the Roadster). The Model S consisted of 16

battery modules with each module holding 444 Panasonic 18,650 battery cells, similar to those found in flashlights.

Now, Tesla's Model Y is fitted with 4680 battery cells. They also created a tab-less design to reduce electron flow distance – making it very efficient and eliminating thermal issues.

When it comes to Ford, the manufacturer took the No. 1 selling vehicle in the U.S. – the F-150 truck – and made it an all-electric truck. By going electric, they are taking people to the next step to adopting electric vehicles, Gloria said. It can do everything the gasoline-powered truck can do, plus it can power a house for three days from a full charge.

Most vehicle manufacturers have plans in effect to eliminate ICE vehicles as soon as 2035, if not earlier.

Same with state and federal legislation. There are already 12 states that have signed legislation in place to ban the sale of new ICE vehicles by 2035.

COMMON DIAGNOSTICS

Gloria shared three common EV diagnostic-related issues that he's come across.

For one, the warning lights on the dashboard of EVs are different. Gloria pointed out two: a wrench that means non-emissions fault and an orange triangle with an exclamation point, an ISO symbol for "master warning", that will appear when there's something going on with the high voltage system.

The high voltage battery is another common issue. Gloria said to check the battery by simply using a scan tool and looking to see which block's value is under. It's easy to do, yet many technicians don't do it at first.

The third most common issue are isolation faults where there's high voltage leaking somewhere in the system such as

Cooling High-Voltage Batteries

High-voltage batteries run best between 65 degrees F and 105 degrees F.

There are three ways to cool high voltage batteries –

1. Air cooled
2. Liquid cooled
3. Refrigerant cooled

If air cooled, the cabin filter must be clean to ensure proper operation (prevent overheating of battery), Gloria noted.

Some manufacturers are using the AC system to cool the vehicle batteries. If this is the case, then AC is no longer an option, Gloria noted. He adds that in many scenarios at a shop, customers will decide not to spend \$3,000 to fix an AC issue and will just "roll the windows down" instead. Now, technicians are going to have to explain to customers to rethink their decision because that \$3,000 fix is now needed to cool a \$10,000 battery.



the battery, wiring, inverter, etc. Using an insulation tester, technicians can induce high voltage at very low amperage (once the battery is disconnected and verified to be at 0V). This allows hyper-accurate readings on all high-voltage circuit isolation conditions.

In conclusion, as obvious as it may seem, understanding the system you are working on and diagnosing is key. If you don't fully comprehend it all, simply ask or use your resources.

"Plot your diagnostic strategy," Gloria said. "Plan your work, work your plan." ♦

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Diagnosing faults on modern vehicles

The complexity of today's vehicles means technicians are flooded with additional data when diagnosing vehicle faults. Here are ways and tools to help diagnose these faults.

By Damien Coleman



Albertshakirov | Dreamstime.com

Motor vehicles have become increasingly more complex over the last two decades to meet ever-tightening emissions regulations, increased fuel economy requirements, and passenger comfort and safety.

This added complexity means technicians are flooded with additional data when diagnosing vehicle faults. Below is a table outlining the difference between a modern vehicle and a vehicle from 20 years ago; this is only a high-level example to illustrate the differences.

FAULT CODES

However, with all the additional fault codes and data parameters, the technician is given more information that can help quickly and accurately diagnose any

faults. For most fault codes, there are several possible sub-codes. These sub-codes give the technician an indication of the condition which caused the fault code to be stored. An example of this is shown below for turbocharger system fault codes:

- Turbocharger boost pressure – Negative deviation (under-boost)
- Turbocharger boost pressure – Positive deviation (over-boost)
- Turbocharger boost control circuit – Voltage high
- Turbocharger boost control circuit – Voltage low

If a fault code won't clear with the ignition on and engine off, or the fault returns immediately once the ignition is switched on, the issue is most likely not mechanical in nature. An over-boost or

	VEHICLE PRE-2002	2022 VEHICLE
Number of Systems	≈6	25 - 40*
Engine Fault Codes	<50	>2000
Engine Data Parameters	<30	>100
Engine Special Functions	<3	>20

**Depending on options and trim level.*

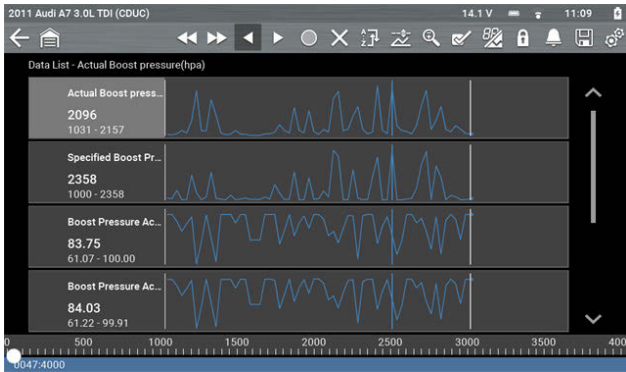
under-boost fault will only be set after a test drive.

LIVE DATA

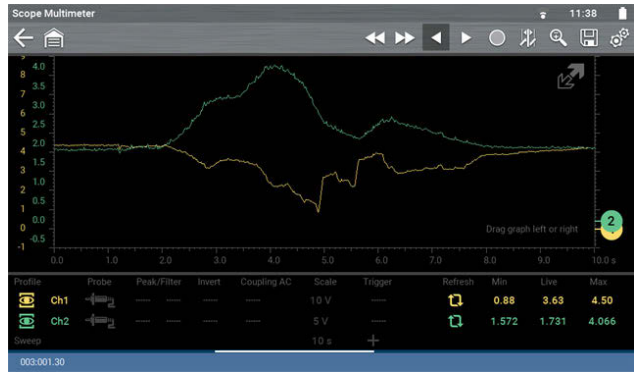
Many data lists will have two parameters for specific components or sub-systems. In the screenshot (on page 9) we have 'actual' and 'specific' boost pressure. Comparing these data parameters is important to ensure the vehicle is operating under the conditions expected by the management system. There will be a certain amount of latency between these parameters, but the returned values should be similar.

Command and feedback are also evident here with the data parameters for the boost pressure actuator, activation value (%), boost pressure actuator, and feedback value (%). This shows the control from the engine control module acting on the turbocharger vane position actuator and the feedback from the turbocharger position sensor, which is inferred as a percentage.

- Parameter 1 – Actual boost pressure
- Parameter 2 – Specific boost pressure
- Parameter 3 – Boost pressure actuator, activation value (%)



Actual and specific boost pressures.



Yellow channel - turbocharger vane position sensor. Green channel - boost pressure sensor.

- Parameter 4 - Boost pressure actuator, feedback value (%)

SPECIAL FUNCTIONS

Many engine components must be "adapted" to the vehicle when replaced. Previously, components like turbocharger actuators were "plug and play." Now, these components must be matched to the system. This is a way of setting the

base position for the actuator and position sensor and is used to detect possible faults or incorrect operation.

OSCILLOSCOPE TESTING

Another option to investigate the operation of a system is to use an oscilloscope. A scope provides a graphical representation of voltage over a particular time duration. The waveform below shows the

output from the boost pressure sensor and the feedback from the turbocharger vane position sensor under wide open throttle operation on a road test.

Not only is the scope good for diagnosing faults and validating repairs, but it can also be used to give the technician an in-depth understanding of the operation of a complicated system.

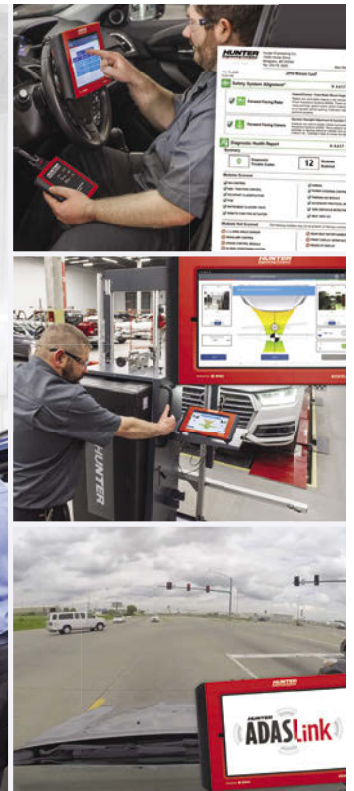
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The real cause of P0420/P0430 DTCs

The 'Catalytic Converter Efficiency' codes might imply a failed converter, but odds are the ultimate fault lies somewhere else.

By Pete Meier



Common sources of air leaks into the exhaust system that can skew the ECM's tests include damaged flex pipes and stripped or damaged sensor threads.

The "Catalytic Converter Efficiency" Diagnostic Trouble Codes (DTCs) P0420 and P0430, are among the top 10 DTCs technicians face. And while the description might imply a failed converter, odds are the ultimate fault lies somewhere else.

The catalytic converter is the last stop for the exhaust gasses generated by the engine during operation. It is here that the last remaining pollutants are cleaned up before finally exiting the tailpipe.

There are three ways a converter can fail:

Overheated, melted, or a broken substrate in the converter. This is usually caused by any factor that affects the engine's air/fuel mixture and the resulting feed gasses being sent to the converter. Even slight variations

will cause the converter temperature to rise significantly.

Converter poisoning: Converter poisoning means that the substrate has been coated by a foreign substance and is no longer exposed to the exhaust stream. Excessive oil consumption and coolant leaks past the intake or head gaskets are common contaminants, as is the improper use of certain sealants.

Structural damage: Structural damage can be physical damage like dents caused by road debris striking the housing, stripped oxygen sensor threads, thermal shock to the converter, and metal fatigue at mounting points or welds.

HOW TO TACKLE THESE DTCs

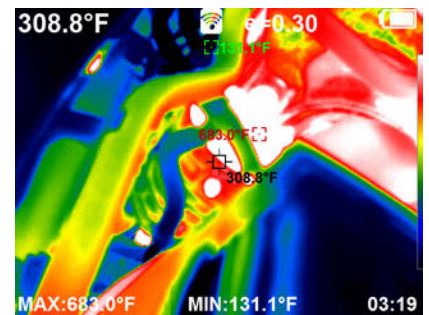
When tackling these DTCs, you must first determine if the converter has truly failed or not. You'll be surprised at how

many P0420/P0430 codes are corrected without replacing the cat!

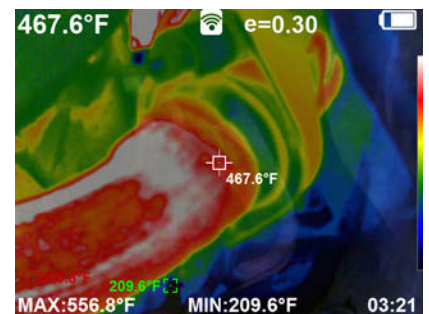
If the converter has failed, you also need to identify what caused the converter to fail. Sure, age is a factor – but there are other factors that can result in premature failure and if left uncorrected, the new replacement won't last long.

And if it the converter hasn't failed, you need to determine what caused the ECM to set the code(s) anyway. False catalytic converter codes are not uncommon and in many instances, a reflash is all that is required to correct the concern.

Start by taking the vehicle for a test drive. Is there any indication of sluggish response or low power that might indicate



After a quick visual, you can use a thermal imaging camera to "see" the converter in action.



Allow the engine to reach operating temp, and then check the temp of the converter's front weld ring.

an exhaust restriction resulting from a melted or broken substrate? Do you hear any rattling noises coming from the area of the converter?

Next, a scan tool check. First to verify the presence of the P0420 and/or P0430 DTCs but to also check for any others that might be recorded in the ECM. Any DTC or condition that increases emissions or affects sensor readings can cause a converter to fail the ECM tests even if the converter is good. Correct all other DTCs first and allow the Catalytic Converter monitor to run again before proceeding.

While the scan tool is connected, review the fuel trim data PIDs. Do they indicate a system lean or rich condition? If the vehicle is equipped with dual exhaust and dual converters, is one bank skewed lean while the other is skewed rich?

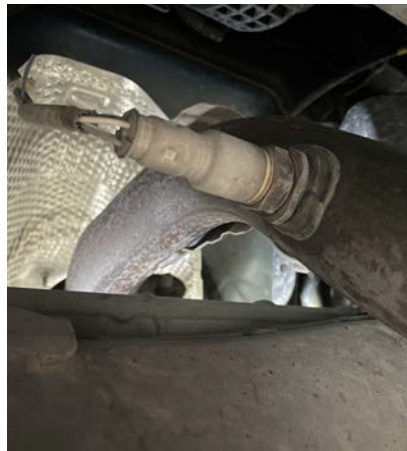
If the vehicle uses a conventional oxygen sensor upstream of the converter, graph and compare the signals from the upstream and downstream sensors. Most ECMs rely on this data to assess the condition of the converter. The front sensor should switch normally while the rear sensor should remain relatively steady. If it, too, fluctuates the same as the front sensor, it is an indication that the converter has failed OR the converter has not started working, also known as “lighting off”, because of an emissions problem with the engine.

Vehicles using Wide Band Air Fuel Sensors use a different diagnostic strategy so take advantage of what the data Mode \$06 has to offer to help in your diagnosis.

Next, put the vehicle up in the air and inspect the exhaust system and converters for damage or obvious leaks. Common sources of air leaks into the exhaust that can skew the ECM’s tests are damaged flex pipes and stripped or damaged sensor threads.

A smoke machine, especially one that can adjust the amount of pressure delivered, is one way to find elusive leaks. The use of an ultrasound tool like this

is another way to locate leaks that you can’t visually see. Another simple way to check the exhaust is to connect your shop vacuum cleaner to the exhaust, moving the hose to the outlet side and turning it on. Seal the hose to the exhaust and use a soapy water solution to check for leaks.



Graph and compare the signals from the upstream and downstream O2 sensors.



Even slight variations in the air/fuel mixture will cause the converter temperature to rise significantly.



Low HC and CO levels with high NOx emissions are typically not caused by a defective converter.

After a quick visual, you can use a thermal imaging camera to “see” the converter in action.

Start the engine and allow it to reach operating temperature and check the temperature of the converter’s front weld ring.

When using a five-gas analyzer, keep in mind that:

- High HC emissions indicate unburned fuel.
- High CO levels indicate partially burnt fuel or oil.
- High NOx levels are normally caused by high combustion temperatures and pressures, slightly lean air/fuel mixture, and excessively advanced ignition timing.

Tailpipe emissions readings low in HC and CO levels with high NOx emissions are typically not caused by a defective converter. The low HC and CO readings indicate that the converter is functioning. The root cause of the problem is an engine that is emitting excessively high NOx emissions, which in turn are caused by excessive combustion chamber temperatures.

Any cylinder that is not working as hard as the others is the most likely cause of emissions issues. Most professional scan tools can accurately perform a cylinder balance test by dropping one cylinder at a time.

You can also use the thermal imager to check cylinder power balance. Look for cylinders that are running hotter or colder than the others. Once identified, you can focus your attention on the odd man out.

Remember, diagnosing Catalytic Converter Efficiency Below Threshold DTCs requires you to do two things. First, determine the actual condition of your customer’s converter, and second, determine what caused it to go bad in the first place, OR if the converter is good, determine what caused the ECM test to fail.

If you don’t take the time to correct the true cause, you’ll only set yourself up for a dissatisfied customer and an expensive comeback. ❁

How diagnostic tools cut through the ADAS confusion

Technicians must overcome differences in ADAS technology with calibration tools and new industry standards.

By Mindy Long



Photo Courtesy of Precision Diagnostics

Not all shops have the tools to perform static calibrations, which can cause them to lose income.

Advanced driver assistance systems (ADAS) rely on a combination of cameras, radar, lidar, ultrasonic sensors, and other technologies to improve safety, but where those technologies are located, and how they interact with the vehicle, vary. The differences in these systems can make a technician's life difficult.

"There is a lot of confusion out there exactly how ADAS works, how to calibrate it, what can be calibrated, and what can't be calibrated," said Chris Freeman, director of sales and training for Autel North America. "We're getting a lot of different feedback from the dealers. No one puts these sensors in the same places. They're different from make-to-make and model-to-model."

Diagnostic tool providers such as Autel are equipping the industry with calibration tools to help close the gap as techs strive to ensure systems are working correctly.

"We're trying to clarify the information," Freeman said. "That way, we can give a clear picture of what needs to be programmed and what doesn't."

There are various elements to vehicle ADAS, including adaptive cruise control, around-view monitoring, blind-spot detection, lane departure warnings, light imaging detection and ranging, night vision systems, and rear collision warnings.

"Each of these has a different function and uses different sensors or a combination of sensors to function," said Brandon Alexander, marketing manager for Thinkcar.

Adding to the confusion, there aren't consistent expectations of ADAS capabilities for any given fleet or consumer vehicle.

"Because of that inconsistency, technicians don't know if a vehicle has the same capacity as the vehicle before it. I'm finding, too, that some technicians are even confused about what it means to perform a calibration and have it pass," said Jordan

Krebs, worldwide alignment product manager at Snap-on Equipment.

Tom McGuire, chief operating officer of Precision Diagnostics said the industry hasn't even figured out how to standardize terminology in the U.S.

"With emergency assist braking across 35 different manufacturers, there are literally 35 to 40 acronyms they use to describe their systems," he said. "There is a tremendous challenge of having both access and the current level of service information to really support that technician in not only where the sensors and the components of the ADAS are, but also what is required to program or calibrate it correctly."

Scott McKinney, senior product manager at Bosch Automotive Aftermarket, said a lack of standardization, and the fact that ADAS technology is new, puts the responsibility squarely on the shoulders of the shop to ensure a calibration is completed properly.

"There are thresholds and tolerances that each system allows, which means there are instances where it may pass but not prevent an accident or perform as it should have in a real-world scenario, Krebs said. "The problem that many techs face is they don't know what may or may not be on the vehicle. Even the same vehicle built in a different time period may not have the same system they were just working on," he explained.

Alexander said that manufacturers establish the specific functionality within their vehicles and the calibration process. The general function of the ADAS components is similar between brands, but the ADAS calibration process will differ.

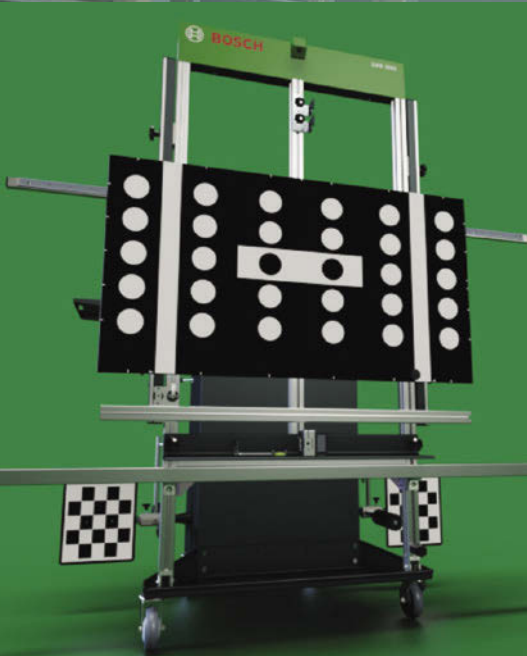
Fortunately, Fred Andersky, director of government and industry affairs for Bendix, said most OEMs make collision mitigation technology standard on their highway vehicles. "Each system has its own set of maintenance rules that are published by the manufacturer just like with any other system on the vehicle," he said. ➡

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The safety benefits of ADAS is understood, but the lack of regulation has slowed adoption.

UNDERSTANDING THE IMPORTANCE OF TOOLS

Marcos Obispo, director of sales for Cojali USA, said everybody seems to understand the safety benefits of ADAS, however, the lack of regulation has slowed adoption, and therefore the need for shops to invest in calibration equipment and training for technicians.

Calibration tools are helping to provide all necessary information to technicians, so they can prepare for the calibration and better estimate the time to repair, Krebs said.

Alexander said advanced scan tools will include detailed steps on how to set up the targets and framework, providing technicians greater confidence.

McGuire said his technicians utilize OEM information as well as calibration tools. “We like to have both. For a technician to work on it without a tool, they become almost a liability rather than an asset,” he said. “You can have a great technician, but without accurate, up-to-date service information, you’re chasing things you shouldn’t have to chase.”

Completing an ADAS calibration using the standard OE process can take up to an hour, McKinney said, but with Bosch’s DAS 3000, that exact calibration can be completed in under 10 minutes.

Obispo said calibrations could be either dynamic or static, which are not interchangeable. Some systems can be calibrated by driving the vehicle while using a handheld or diagnostics device connected to the ADAS, which is the dynamic calibration. According to the manufacturer, the tool will tell the technician how to drive during the calibration. Static calibrations are performed with the vehicle stopped. “In this case, we would need specific, sensitive calibration equipment to calibrate and test the ADAS modules to ensure their correct functioning,” he explained.

Not all shops have the right tools needed to perform static calibrations, which can cause them to lose income. If repairers want to continue being competitive, they will have to seriously consider this new market demand, Obispo explained.

MEETING TECHNICIANS’ CHALLENGES

The most common obstacle techs face is familiarity with the calibration process. “As with any newer technology, it is taking time for technicians to become comfortable with ADAS and gain the knowledge specific to calibrations,” Alexander said. “Until that time, a limited number of technicians will be willing and trained

to perform the calibrations, resulting in labor shortages.”

Brian Sreeton, supervisor of technical service training at Bendix, said radar alignment tends to be one of the top issues technicians encounter. “While radars today do a great job in adjusting their alignment, it can still happen that a radar needs to be aligned by the technician,” he said. “The other issues typically tie to the braking system. If the ABS goes out, then both stability and collision mitigation are deactivated. If stability goes out, then collision mitigation is deactivated.”

Often, issues with ABS are tied to wheel speed sensors, with the gap between sensor and tone ring being too great because the sensor was pushed back in the clip during a previous wheel end repair or a worn spring clip, Sreeton said. Another area often overlooked is some type of wiring harness issue, such as a wire casing that may be cut.

One of the stumbling blocks for technicians when repairing ADAS is not looking beyond it. ADAS relies on information from many other parts of the vehicle, including the ABS and stability systems. “Other systems, mainly the drivetrain, supply information that ADAS requires to function correctly,” Sreeton said. For example, an ‘Adaptive Cruise Fault’ could be activated by ADAS, and the root cause of the fault could stem from an engine issue.

A somewhat common situation that can cause lost repair time is not paying attention to J1939 communication errors first, especially ones that are being reported by multiple systems, Sreeton said. “We recommend that technicians resolve those diagnostic troubleshooting codes first, then rerun the Bendix ACom PRO diagnostic software to see what remaining DTCs may remain,” he said.

Systems have unique ways that they are calibrated and require different tools and procedures to perform calibration and

alignment, Screeton said. Having the correct tools and service information for the ADAS the technician is repairing is crucial.

“We recommend that all technicians troubleshooting Bendix electronic systems, including ADAS, use Bendix ACom PRO or Noregon’s JPRO software,” he said. “Those PC-based, subscription-based diagnostic tools are comprehensive to cover all Bendix electronic systems and offer a complete suite of diagnostics, troubleshooting, advanced troubleshooting, and reporting capabilities for both tractor and trailer systems.”

A second element that can present an issue is the space and environment required for calibrations. The area needs to be level, free of obstructions, and have ample lighting.

“Technicians have to know how to prepare the shop environment before starting the calibration. The OEM may provide the information in the service manual, but then the technician has to go through that service manual, and it adds to the time,” Krebs said. “There is a lot out there and a lot of confusion on what it takes to have a clean environment.”

ADAS calibration tools consist of the targets, framework to position the targets, and diagnostic tablets to access the CAN, Alexander explained. “High-quality targets are key to providing an accurate reference point for digitally calibrating the vehicle sensors,” he said. “The targets must be at the exact height, angle, and distance relative to the vehicle, and a solid framework with alignment accessories is critical to hold the targets in the precise position. Professional-level diagnostic tablets are essential to accessing the vehicle onboard network to initiate and confirm the calibration process.”

ADAS technology changes frequently, so regular software updates for calibration tools are critical. “For our technicians, whether they’re in one of our brick-and-mortars or are mobile, there are constant updates being sent to tools.

If you don’t update it, you’re looking at the front end of a car looking for a sensor that should be at point A, but at the mid-year model change, they moved it,” McGuire said, adding that he does a lot of work with Autel. “They do a nice job of providing you with auto-updates as long as you use them. You waste a lot of time without updates.”

EDUCATING BUYERS

Technicians are undergoing a learning curve related to ADAS, but buyers also have to gain a new understanding of the technology. For vehicle owners, there are things they can no longer do. “For instance, a lot of truck owners would buy a truck and replace the plastic bumper with a chrome bumper. With ADAS, you have to have one that works with it. There are things like that you have to think about now,” Freeman said.

McGuire explained that ADAS technology is a living, breathing component of the vehicle. “You have to be aware that once you modify as built, you could have changed how it works,” he said.

Every time a windshield gets replaced, it has to be recalibrated, and even an aftermarket windshield rather than an OE windshield could create challenges. “Some aftermarket windshields have more wave to them, or the tint level could be off in some cases,” Krebs said.

Autel’s Freeman explained that even a small bump, such as hitting a curb or a small animal, can cause problems if the system isn’t recalibrated. “The slightest bend can take a sensor from reading straight to reading at an angle,” he said.

MONITORING MANDATES

In the U.S., there is not a mandate for ADAS like there is in Europe. “In Europe, everyone has to have it, and it is a done deal,” Freeman said.

Bendix’s Andersky said mandates may be coming to the U.S. “In the

Infrastructure Investment and Jobs Act, the recently passed ‘infrastructure bill,’ there is a requirement that NHTSA promulgate a rulemaking for autonomous emergency braking on Class 7 and 8 tractors and motorcoaches within two years,” he said. “There is also a study requested for eventually mandating on Classes 3–6 trucks.”

Additionally, the U.S. government’s new car assessment program is getting a major update, which is moving the country closer to an ADAS mandate, Obispo said.

There has also been work to standardize terminology. While there are numerous marketing and brand names for ADAS, SAE and AAA have recommended a classification for naming 20 different types of ADAS, McKinney said.

Creating standardization is not an easy task because of the dynamic and changing nature of ADAS development, Obispo said. “Traditionally, there have been a lot of acronyms and naming given to these systems,” he said. “Manufacturers used to put their own names to similar technologies, which of course did not help much to the comprehension of the systems.”

GOING FORWARD

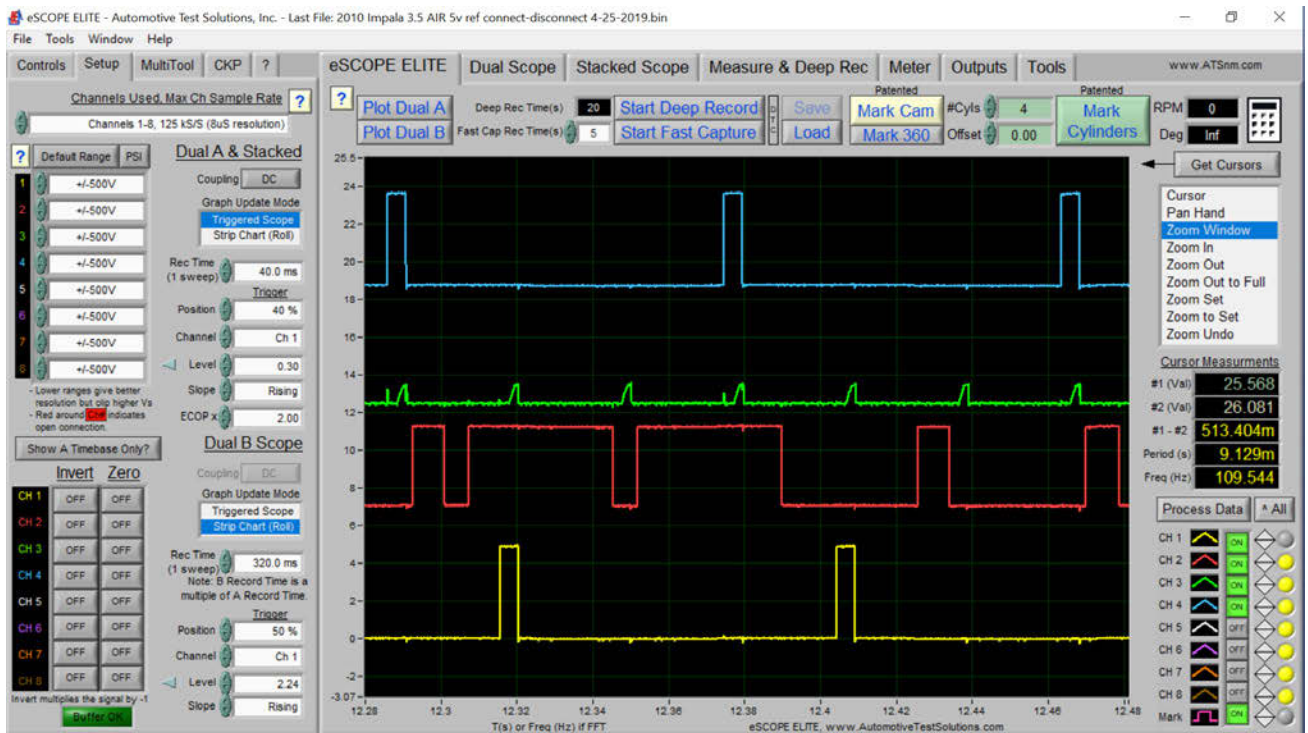
Because there are so many variables and the technology is continuing to emerge at a lightning pace, it’s going to become more challenging in the near- to mid-term for technicians to perform the tasks they’re required to perform, McGuire said. “As technologies and systems are advancing and more are being added, the lack of standardization really drives an incredible wedge between time and efficiency,” he emphasized.

In the future, equipment and technology providers can expect more systems to address the safety features. “Bosch is planning for these changes with upgradeable technologies to integrate in the shop now and grow with the technicians’ skill and expertise as the industry moves toward digitalization,” McKinney said. ●

When the tools become the tutor

Becoming a valuable technician takes time and comprehension. But using your tools to help conduct the lessons is a priceless commodity.

By Brandon Steckler



The DSO offers a visual representation of electricity and action/reaction comparative measure of different circuits simultaneously.

Any experienced automotive technician will tell you that most diagnosticians develop their skillset over time, they aren't necessarily born with it; I couldn't agree more. My rate of learning and comprehension drastically increased as I began to implement tools used for diagnostics.

VISUALIZING ELECTRICITY

I'll begin by describing one of the most valuable tools at a diagnostician's disposal, the DSO (Digital Storage Oscilloscope). This tool is highly coveted because it performs all the duties of

most DVOMs but also offers a visual representation of what is occurring in the circuit. More importantly, most scopes today support this functionality for multiple channels. It's common to see four channels but some even support eight channels. Seeing multiple circuits operate before your eyes has many benefits. Here are a few of my favorites:

- History of electrical activity (not just what occurs at a single moment in time)
- Action/Reaction view (how these multiple signals interact with one another; **example: Input vs Output**)

- Information stored in a buffer (no need to babysit the scope, it will capture and save the fault)

MEASURING DEVICES

Another brilliant technology is the ability to plot measuring cursors and rulers. Many scopes will allow for two cursors to be placed vertically (to allow for measuring a single point in time or the delta time between the two cursors). This becomes particularly handy when calculating events like the dwell of an ignition coil or the duration of a spark event. The waveform view itself may ➔

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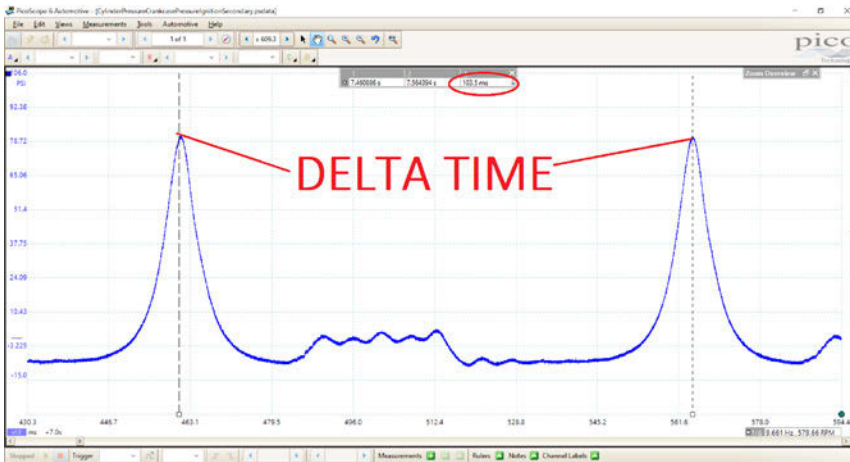
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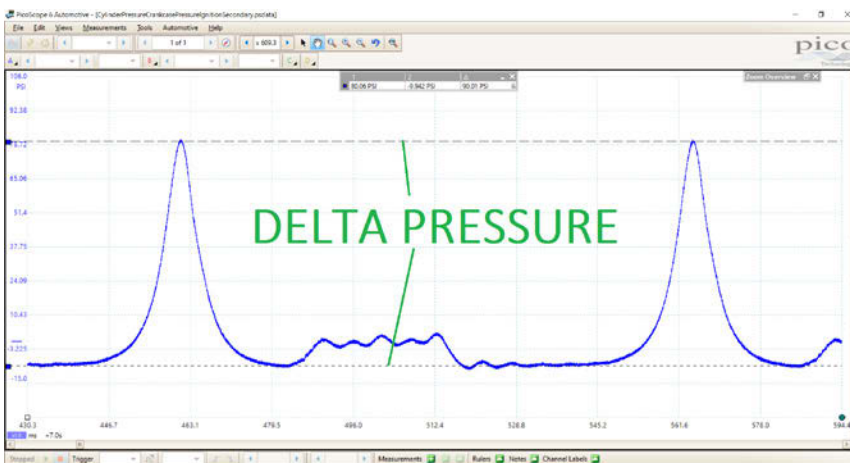
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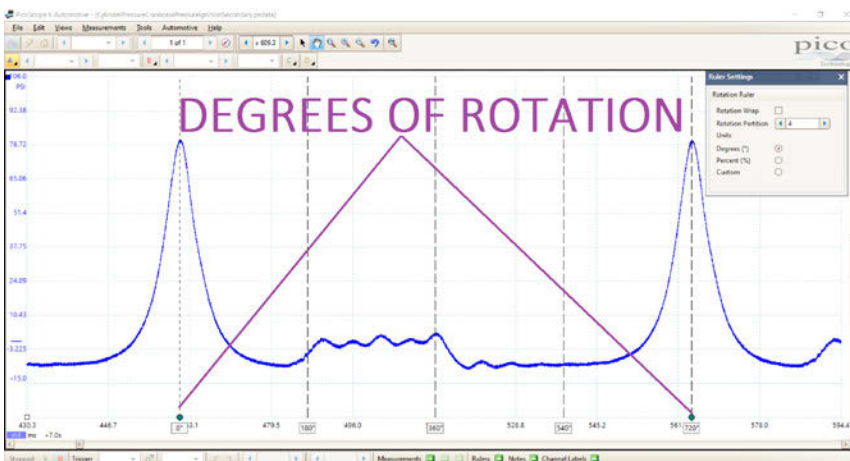
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Vertical cursors are handy when calculating events like the dwell of an ignition coil or the duration of a spark event. The image above displays the duration of a 720-degree engine cycle.



The horizontal cursors measure the amplitude or value of a signal when used singularly or the difference value between two measuring-points when used in tandem.



The rulers use the scope's software to associate elapsed time with either "percentage" or "degrees of rotation." A truly valuable tool, especially when it comes to engine mechanical analysis.

display a subtle fault that is not apparent to the naked eye. The vertical cursors can offer a more scientific approach to waveform analysis.

Like the vertical cursors, the scope may also offer two horizontal cursors to display a signal amplitude measurement, regardless of the domain you are measuring in (voltage, amperage, duty-cycle, pressure, temperature, etc.). For the same valuable reasons, the horizontal cursors can display minor variations that are not easily visible.

Rulers are another hot commodity. The rulers use the scope software to associate elapsed time with either percentage or degrees of rotation. A truly valuable tool, especially when it comes to engine mechanical analysis. Although this type of calculation can be easily performed using only the vertical cursors and a calculator, implementing the rulers allows the information to be displayed directly and instantaneously on the scope screen. The measuring cursors can then be used to determine delta degrees (indicating the duration of an event, like the open time of a cylinder's intake or exhaust valve).

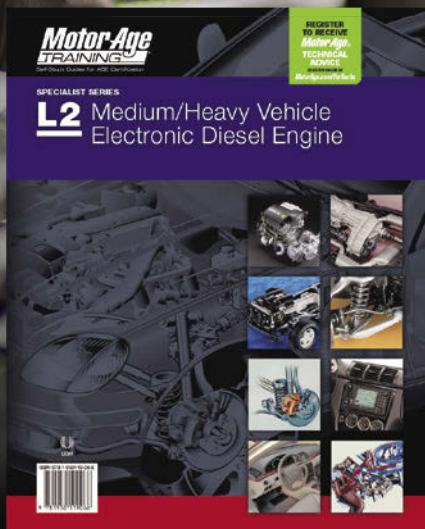
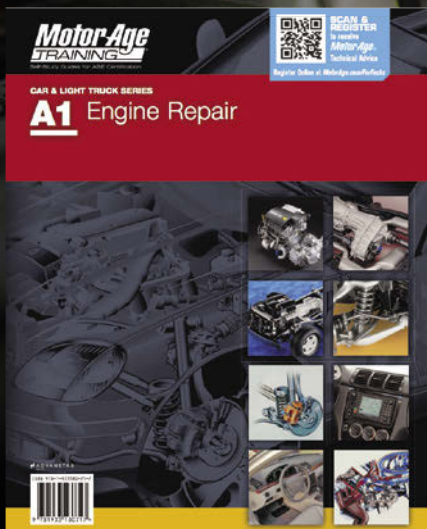
OVERLAY SOFTWARE

One of the most important tools I own besides the DSO is what is known as overlay chart software. The software offers many different configurations to allow for the accomplishment of multiple tasks. However, the one feature I'm most fond of is known as a piston chart.

I frequently perform many engine-mechanical analyses, and a common issue I face is explaining my findings to my customers (or fellow technicians wanting to learn). The Piston chart offers me the ability to point out what it is I'm seeing in the capture. In other words, to tell the story as it unfolds.

The piston chart is handy because it references all cylinder activity simultaneously, anywhere within the entire

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720-degree engine cycle. Here are just a few of the benefits:

- Comparison of piston position and direction of travel, from cylinder to cylinder
- The firing order is always displayed
- Valve overlap periods
- Top Dead-Center points/ignition events

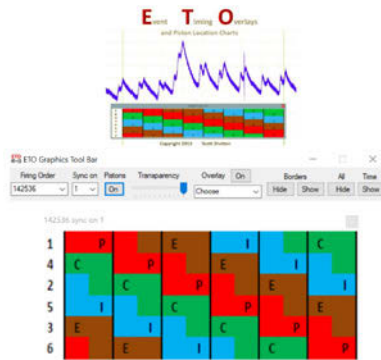
The piston chart is plotted either superimposed on the existing waveform or above/below the existing waveform. Implementing it is as simple as opening a new window on your PC. Regarding the return on investment, the tool typically pays for itself the very first time it is implemented.

SERVICE INFORMATION

Many technicians and shops in general take service information for granted. There is a lot more to it than simply referencing removal and installation instructions, labor time guides, or diagnostic flow charts. Adequate service information can yield a diagnostician a boatload of know-how without ever leaving the workbench. The following are some of the search criteria I frequently reference:

1. System description/operation- We all know that each vehicle may be configured differently. This means there are multiple ways to accomplish the same intended goal and multiple options for system configuration. Having access to this piece of the diagnostic puzzle is priceless. Establishing a game plan before approaching the vehicle is what it takes to stay efficient and accurate. Avoid the pitfalls that so many encounter when they don't take the time to research this important piece of information. Approaching the vehicle without anticipation of what is supposed to occur (under certain operating conditions) is a recipe for misdiagnosis and/or expensive and embarrassing comebacks.

2. Wiring diagrams- Like what was just stated above, each vehicle has the



Overlay software like the ETO by "The Driveability Guys" offers an easy-to-view piston chart to help identify engine-mechanical faults without disassembly.



The need for relevant service information is always present as it gives the technician information required for a proper analysis.

potential to be configured differently. For instance, depressing a horn pad may energize a relay to allow for a horn to sound. However, that same horn pad on a different vehicle may provide a ground path (but not for the relay) for a signal circuit to an electronic control unit (ECU). That ECU may send that horn request to another ECU on the network. It is the job of that second ECU to energize the horn relay. After all, the horn sounds the same in either configuration. Having access to and choosing to reference that system wiring diagram, in combination with the system description and operation will allow you a few benefits:

- Identify system configuration and functionality
- Develop anticipation of the test results before approaching the vehicle
- Determine the best testing locations with the least amount of invested time

3. Flowcharts- I use diagnostic flowcharts like many of us technicians do. However, I implement them differently. I choose not to follow the flowcharts, word for word. In fact, if I encounter a step in the diagnostic flow chart procedure that does not make sense to me, I do not proceed with that test. It's simply because I wouldn't know how to anticipate the results. I use flow charts for bits of data that only the manufacturer's engineers would know (they designed the systems). I will reference the flow charts to understand the thresholds or when the ECU determines there is a fault present. Understanding what the ECU desires is part of the diagnostic process.

Other pieces of data like resistance specifications or rate of pressure leak-down (and such) are desirable to be aware of as you will then know how to interpret the test results. Not having access to this information will leave you guessing and either have you replacing components for no reason or allowing a failing component or system to slip right past you.

THE DIAGNOSTIC PUZZLE

Being able to provide solutions to diagnostic challenges is something most of us will have to face at some point in our careers. Solving these diagnostic dilemmas is only one part of the equation. Doing so in a timely fashion is the other.

We can choose to have diagnostics as a hobby or a career. The main difference between the two options is efficiency. The examples above are just a few of the tricks I have up my sleeve. Be creative in the way you choose to implement your tools. They will likely serve you well and give you a more solid understanding of what is truly occurring in the systems and components you are forced to address each day. 🍷



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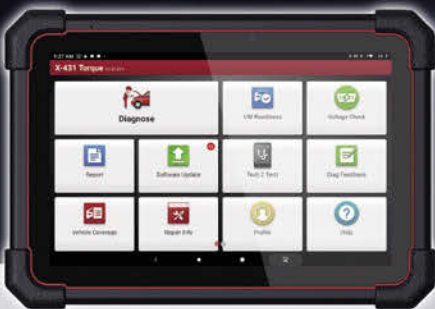
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