DIAGNOSTIC PROCESS

DECEMBER **2022**

GUIDE TO

DIAGNOSTIC PROCESS AND TOOLS

ADAS, FAULT CODES, HYBRID/EV, EDUCATION, AND PRODUCTS

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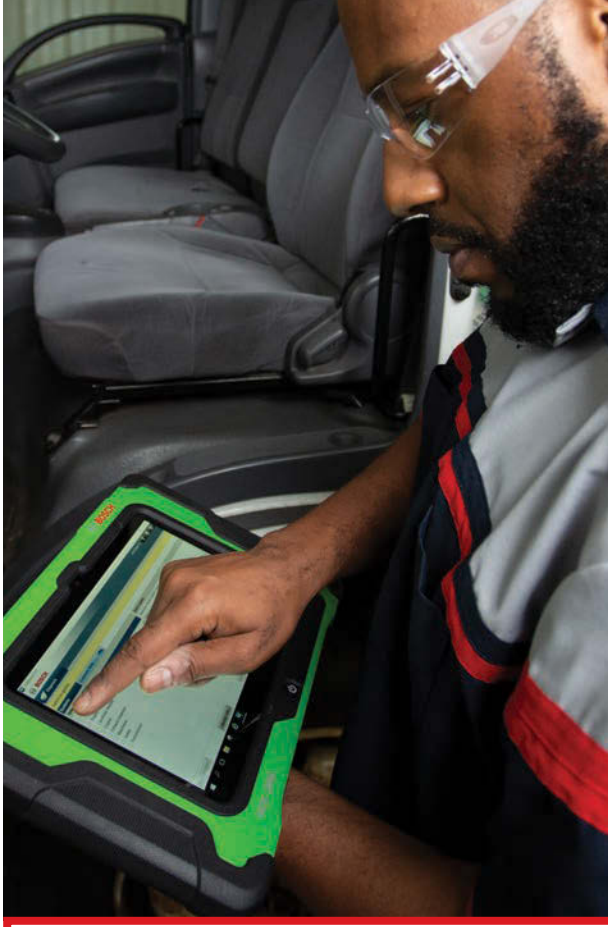

Photo from Bosch

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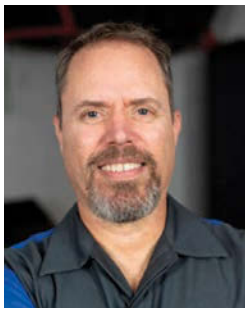

Diagnosing Progress

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.

Baker Motorsports - IMSA Firehawk

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 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.

LEVEL UP

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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.

Photo Courtesy of NAPA

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 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 tabless 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 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."

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.

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.

	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.*

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

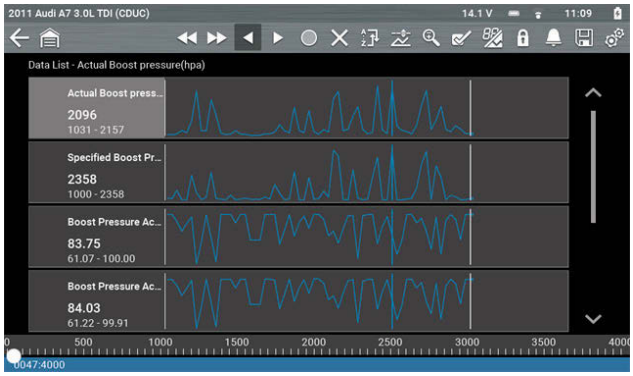
If a fault code won't clear with the ignition on and engine off, or the fault returns immediately once the ignition is switched on, the issue is most likely not mechanical in nature. An over-boost or under-boost fault will only be set after a test drive.

LIVE DATA

Many data lists will have two parameters for specific components or subsystems. 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.

Article provided by Snap-on Diagnostics

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 contaminates, 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.

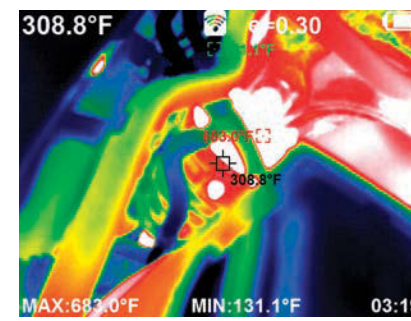
HOW TO TACKLE THESE DTCS

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!

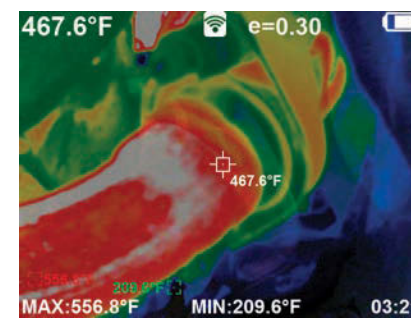
If the converter has failed, you also need to identify what caused the converter to fail. Sure, age is a factor – but there are other factors that can result in premature failure and if left uncorrected, the new replacement won't last long.

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.

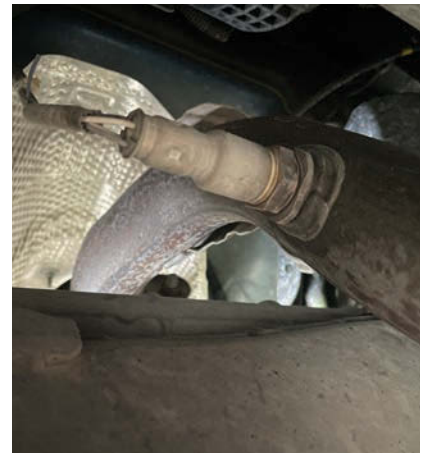
While the scan tool is connected, review the fuel trim data PIDs. Do they indicate a system lean or rich condition? If the vehicle is equipped with dual exhaust and dual converters, is one bank skewed lean while the other is skewed rich?

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 Screeton, 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, Screeton 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," Screeton 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, Screeton 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

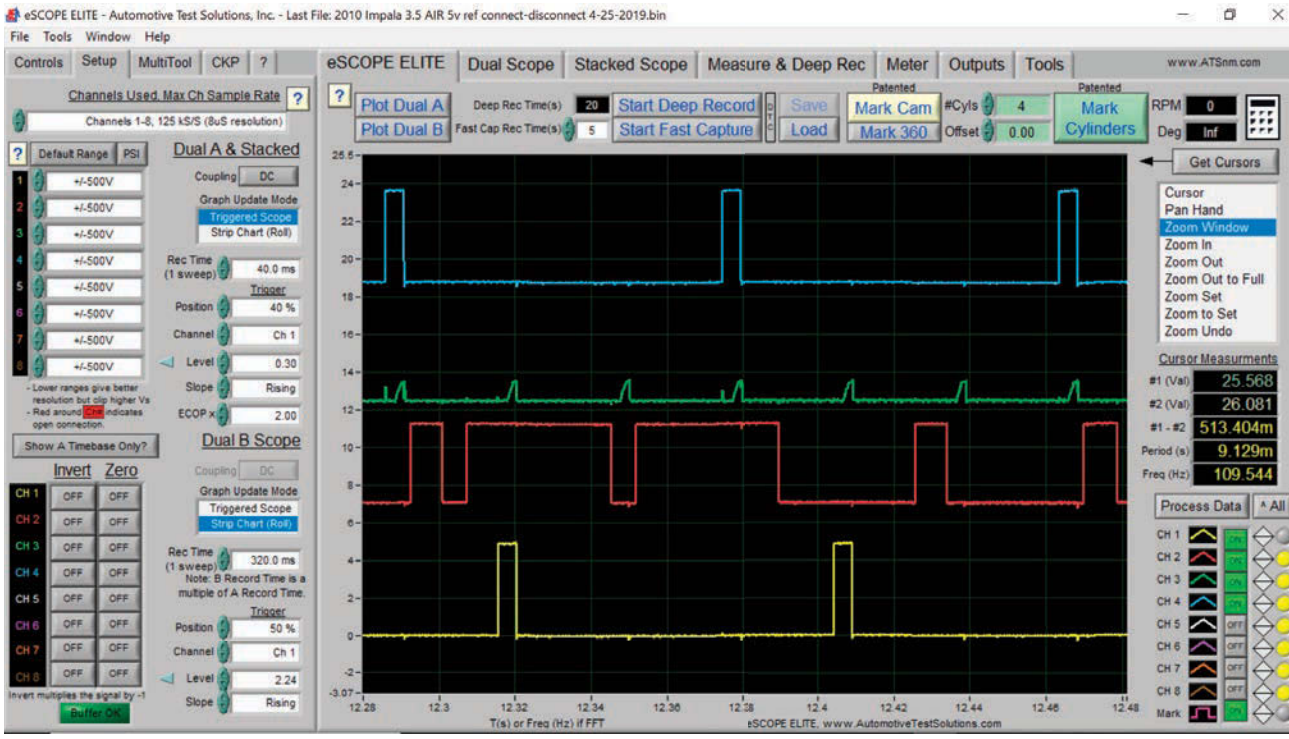
Because there are so many variables and the technology is continuing to emerge at a lightning pace, it's going to become more challenging in the near- to mid-term for technicians to perform the tasks they're required to perform, McGuire said. "As technologies and systems are advancing and more are being 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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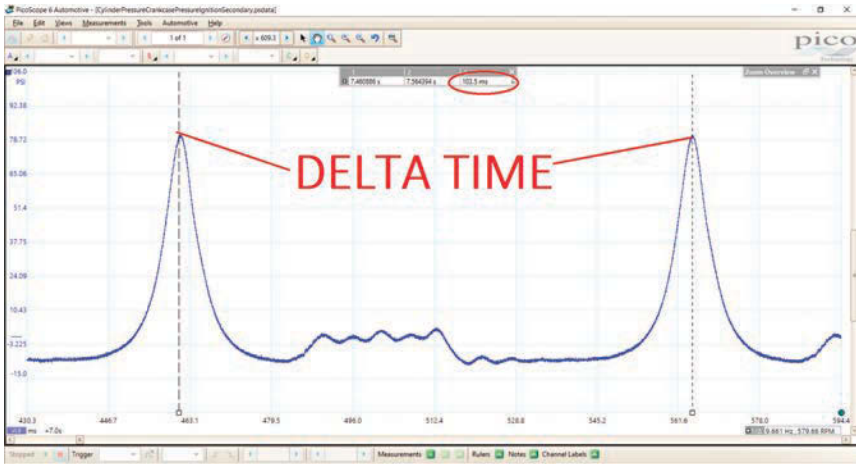
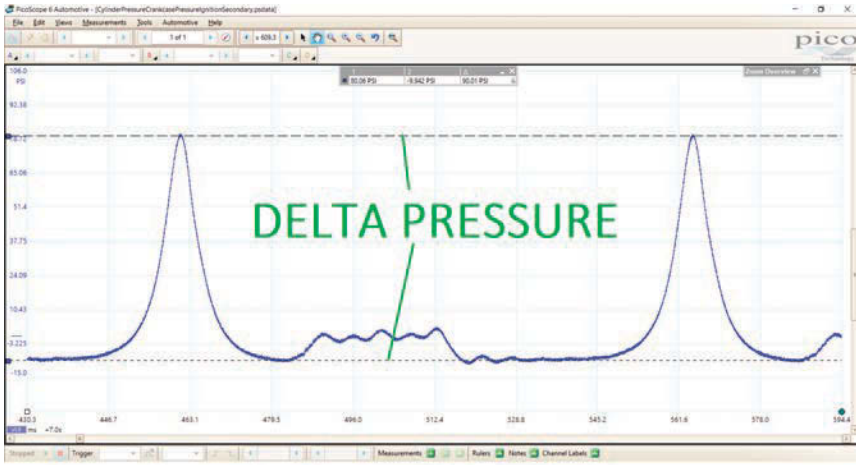
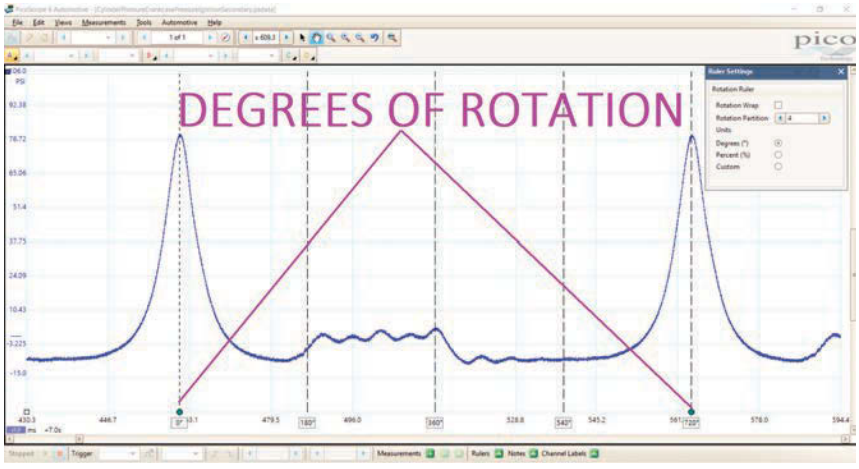


Vertical cursors are handy when calculating events like the dwell of an ignition coil or the duration of a spark event. The image above displays the duration of a 720-degree engine cycle.



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.

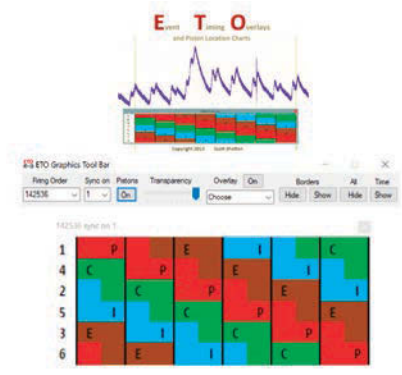
SERVICE INFORMATION

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 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



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.

3. Flowcharts– I use diagnostic flowcharts like many of us technicians do. However, I implement them differently. I choose not the 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 leakdown (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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The Android-based **Millennium MAX** from **Launch Tech** can perform 29 advanced service functions and support CANFD and DoIP protocols, making it a professional level diagnostic tablet. Featuring a 7" touchscreen and intuitive interface, the tablet is easy to operate. It also supports full system diagnosis to read and clear trouble codes as well as offers auto detect VIN, Wi-Fi software updates, generates and shares diagnostic reports, and more.

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The **Matco Tools Maximus Flex Pro Diagnostic Scan Tool** is an Android-based tablet with 10.1" high resolution touchscreen designed to be flexible to let users choose the level of coverage that works for them, from fully-loaded coverage, monthly subscriptions, or a basic version with enhanced code reader. The scan tool comes with a rugged case for durability and is IP65 rated. It also fully supports the security gateway module with special access to select 2018 and newer FCA US vehicles with Auto Auth subscription (purchased separately).

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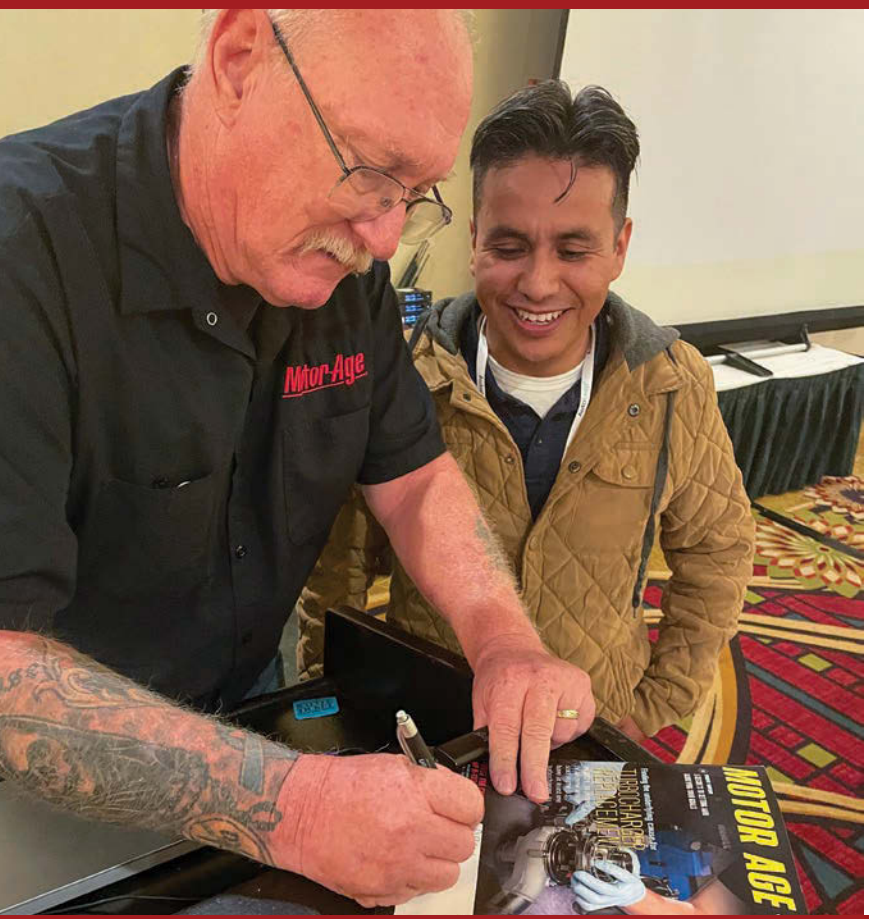

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