Motor Age

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DECEMBER 2018

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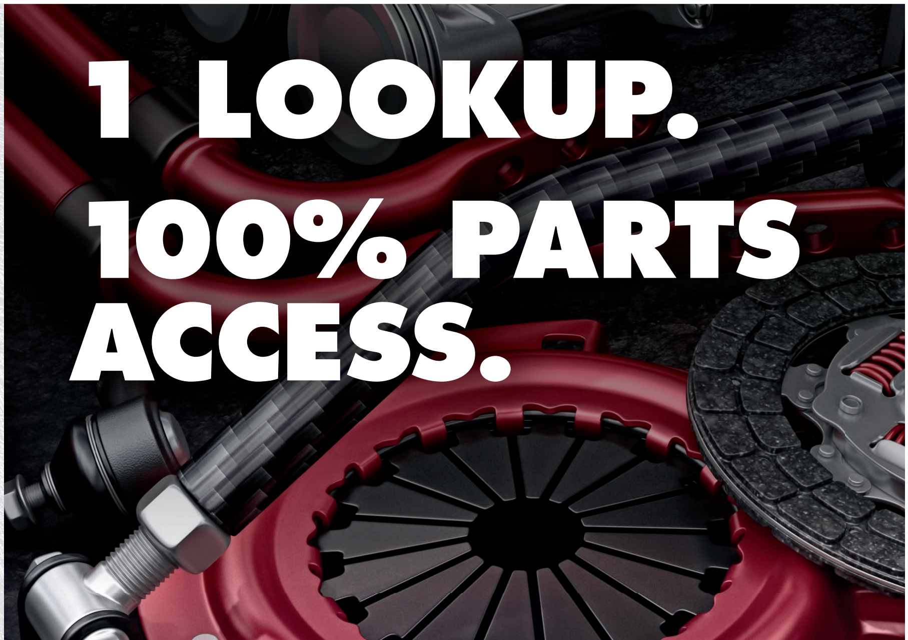

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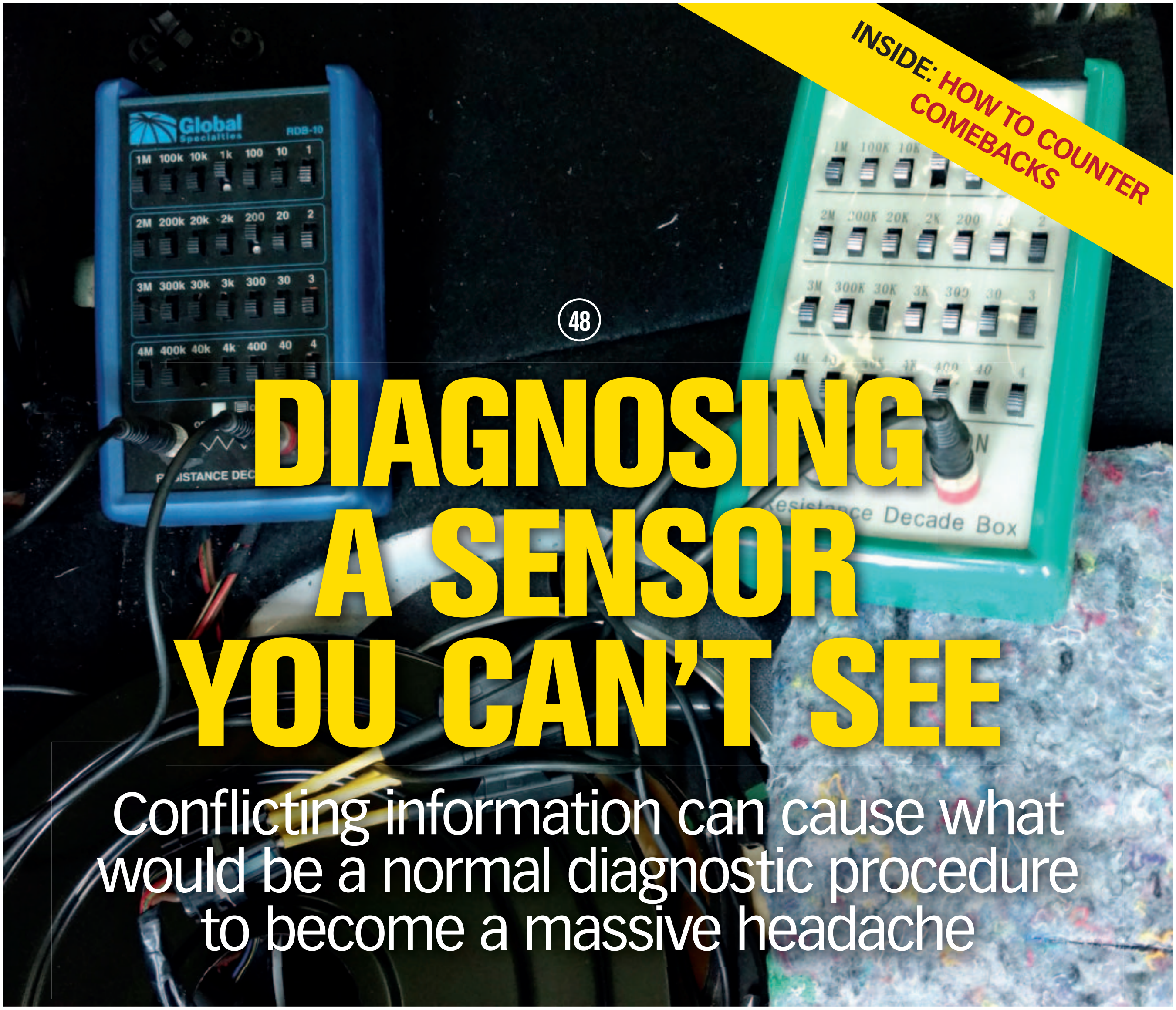

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Talk Shop Anytime

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IN EVERY ISSUE

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WEB EXCLUSIVES // MOTORAGE.COM

USING REAL-WORLD INFORMATION FOR AN EFFICIENT DIAGNOSIS

Repair information does not exclusively mean OEM repair information. Real-world information is as much of a part of the diagnostic process. Gary Hixson with Mitchell 1 leads a webinar centered on an easy-to-implement diagnostic process any tech — from beginner to advanced – can use.
MOTORAGE.COM/USEREALWORLD

STRIKE MARKETING GOLD

Learn about ways you can market your shop, even when you feel like you want to cut this important part of your budget. Featuring shop owner Paul Marquardt, owner of Northwoods Auto Techs in Rhinelander, Wis., and NAPA's Emily Beetler, Program Brand Specialist, the pair has the real-world lessons you can relate to.
MOTORAGE.COM/STRIKEGOLD

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MATTHEW WOLFE, second from left, receives the 2018 Mitchell 1/ASE Technician of the Future award.

TECHNICIAN HONORED

MITCHELL 1, ASE PRESENT TECH OF THE FUTURE AWARD

MOTOR AGE WIRE REPORTS //

Matthew Wolfe of Rebersburg, Pa., was named the 2018 Mitchell 1/Automotive Service Excellence (ASE) Technician of the Future during the ASE Fall Board of Governors Meeting and Annual Technician Awards, held recently in Ft. Lauderdale, Fla. Wolfe received a $1,000 cash prize, a one-year subscription to ProDemand® auto repair software from Mitchell 1, along with airfare and hotel accommodations to attend the event to receive his award.

"We congratulate Matthew on being named the 2018 Technician of the Future," said Nick DiVerde, senior marketing director, Mitchell 1. "His accomplishments have demonstrated his commitment to excelling in his chosen field, and we know he will be successful

>> TECH CONTINUES ON PAGE 6

BREAKING NEWS

CERTIFICATION

NAPA LAUNCHES CERTIFICATION PROGRAM FOR SHOPS

Each marketing plan for repair shops is different from the next. A new program from NAPA AutoCare is taking what makes each shop unique and backing it up with the power of a national brand through a new national certification program.

The NAPA Gold Certification Program launched this fall, merging local and national marketing ideas. Emily Beetler, program brand specialist with NAPA, explains how the NAPA AutoCare Council created the program to create a consistent consumer experience.

"We have a network of over 17,000 NAPA AutoCare Centers, and really with that large of a network, what you get is a mixed bag. You have some shops that participate in three to four of our programs, but you also have a handful of shops

>> NAPA CONTINUES ON PAGE 6

TRENDING

ROLE PLAYING WITH SERVICE ADVISORS

In this latest Remarkable Results podcast, Carm Capriotto digs deep with a panel to help aftermarket professionals learn more about the service advisor position and how to make it effective in your shop.
MOTORAGE.COM/ADVISOR

$1 MILLION AWARDED TO TOP SKILLED TRADES TEACHERS

Three public high school skilled trades teachers have been named the first-place winners of the 2018 Harbor Freight Tools for School Prize for Teaching Excellence.
MOTORAGE.COM/HARBOR

PEP BOYS EXPANDS TIRE INSTALLATION FOR AMAZON CUSTOMERS

Pep Boys will take its Amazon.com Ship-to-Store tire installation national. At nearly 1,000 locations, Pep Boys is one of the largest service networks to collaborate with Amazon.
MOTORAGE.COM/AMAZON

ARE AUTO PARTS NEXT FOR DRIVERLESS DELIVERY?

Over the past year, a number of companies have announced autonomous vehicle delivery projects, and the automotive parts space is no exception.
MOTORAGE.COM/DELIVERY

NATIONAL AUTO PARTS LAUNCHES NEW ONLINE WARRANTY PORTAL

Clutch and brake specialist National Auto Parts, based in the UK, launched its new electronic Warranty Portal, aimed at streamlining returns for customers.
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>> TECH CONTINUED FROM PAGE 4

in his future endeavors."

Wolfe studied automotive technology at Central Pennsylvania Institute of Science and Technology in Pleasant Gap, Pa., and diesel industrial technology at Universal Technical Institute (UTI) in Exton, Pa.

His accomplishments include being named Automotive Student of the Year 2017 by Central Pennsylvania Institute of Science and Technology; earning fifth place in 2016 and second place in 2017 in the Universal Technical Institute Top Tech Challenge; receiving a full scholarship to Universal Technical Institute; and being named top of the class student speaker at the UTI graduation.

Wolfe decided he wanted to become an automotive technician because he has always loved figuring out how things work. In his free time he enjoys collecting older garden tractors and riding classic motorcycles. He sees the value of his ASE certification, as it allows him to have confidence in his automotive knowledge, and it's a way to let customers know that their cars are in good hands.

To qualify to win the Mitchell 1/ASE Technician of the Future award, the winner must be ASE Certified, must have registered as a student and have the highest cumulative test scores on the A4, A5, A6 and A8 tests.

>> NAPA CONTINUED FROM PAGE 4

that participate in all of our programs," she said. "Over the last several years, shops have wanted to take the next step in partnering with us. They wanted a program that would build more trust and more loyalty, while also filling their bays more, selling more vehicle repairs and services."

And with that, the NAPA Gold Certification Program was born. The program created a package of benefits that the top NAPA AutoCare Centers can utilize to combine the local knowledge with a national brand power.

Paul Marquardt, owner of Northwoods Auto Techs in Rhinelander, Wis., is one of the first shops to earn the NAPA Gold Certification. He and Beetler shared their experiences with the program and marketing overall in a free webinar, "Marketing Gold," available for download at MotorAge.com/MarketingGold.

"What really piqued my interest is that NAPA is recognizing the AutoCare Centers that are really taking advantage of the programs we have to offer and utilizing those programs to best benefit the customers as well as the shops," he says. "Sometimes we as shop owners get so caught up in the day-to-day operations of our business that we don't sit down and review what programs we are using and are we utilizing programs to the best of our advantage? Are there some things that have changed in the programs that we have not caught up on?"

What's in it for the shop? First, referrals — something every shop wants and needs. According to NAPA AutoCare, Gold Certified members will receive priority on all referral programs, on NAPA online locators and from NAPA stores. They will show up as a top choice when someone searches for an AutoCare Center in their area.

There also is the benefit of co-op marketing dollars to spend on pre-approved, co-branded messaging in the local market. This piece, according to NAPA AutoCare, helps both the local shop and NAPA achieve national brand marketing while celebrating the uniqueness of each independent shop and owner.

Other features of the NAPA Gold Certification program include local labor and Peace of Mind® Warranty, Autotech Training, NAPA EasyPay consumer financing, Sales Driver promotions, NAPA TRACS, digital menu board and more.

"I can be confident that I am offering the best programs for my shop and for my customers, giving them the best experience they could have," Marquardt said.

Shops interested in the program must have an ASE Master Tech on staff or be an ASE Blue Seal shop, use the NAPA PROImage co-branding, participate in a digital vehicle inspection (DVI) platform, offer consumer financing, have an average monthly parts purchase spend, participate in a Business Development Group and a few other criteria.

To learn more about the program or to see new tips on marketing for your shop, watch the free webinar at MotorAge.com/MarketingGold.

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HOW TO COUNTER A COMEBACK

Minimize these and their negative effects on your business, customers

JOHN BURKHAUSER // Contributing Editor

Having comebacks and repeat repairs is inevitable. However, some steps and processes can minimize them and their negative effects on your business and customers.

When it comes to repeat repairs, we need to keep the customer in mind and limit their inconveniences and hassles. Keeping them informed and fixing the issue as quickly as possible will hopefully gain their trust back and give some understanding of the situation.

Comebacks are the result of several varying issues: miscommunication between the customer and advisor, advisor and tech, part failures, misdiagnosis, and so on. Many are preventable; some are not. It's in the handling of the situation that will make the difference, though it is best to prevent comebacks from happening in the first place.

Understanding the customer's exact concerns and preventing them

This requires spending time with the customer and their vehicle to understand the issue fully. Many times, the customer's expectations can be the cause of the issue, not you. Other times, it is just the customer's inability to explain their problem.

These types of comebacks are the easiest to prevent. Go out to the car with the customer and verify their exact concern. Road testing is a great first step. This will take time and effort, but in the long run, it will save you time, money and customers.

This is especially important when customers have noise issues because what bothers one person, another person may not hear. I had a customer come in about a noise in their car. I started the car, and the whole lower dash assembly began to vibrate and make a noise loud enough that I had to raise my voice to be heard over it. "Do you hear the noise now?" I asked. She responds, "No. You have to drive for it to happen." I wondered to myself if the car was even safe to drive.

I put it into drive and, as the RPM fluctuated, I heard a "zing" noise from under the car. "There it is! That's it!" she exclaimed

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over the dashboard noise. I put the car into park, re-engaged drive, and the zing noise repeated itself. I recognized the noise as the catalytic converter shield vibrating loosely due to some rusted welds.

Any tech given this car would have immediately blamed and fixed the lower dash assembly. Imagine giving the vehicle back to the customer with the dash noise fixed but not the converter shield. She would not have been very happy!

A failed part

Comebacks that result from a replaced part failure will happen. The easiest way to avoid this is to use quality parts, which are not only better but often come with warranties that cover some of the replacement cost in the event of premature failure. Have all your documentation in place so if an issue does occur you have a minimum delay in getting the needed parts and reimbursement.

Shop and industry failures

There are the repeat repairs and comebacks that are the result of misdiagnosis, improperly performed work, accidents, and so on. No matter the cause, the No. 1 priority is to keep the customer happy and back on the road. Investigate the root cause during and after the repair without delaying the completion and return of the vehicle.

The following are what I see as the biggest reasons for comebacks.

Training

Today's vehicles have ever increasing technology built into them. Training to keep up with these advancements is, without question, necessary. Technicians would also benefit from training on just the basics of each system in a vehicle. With electrical diagnosis, for example, the cause is often something basic like an unwanted voltage drop in the circuit. Many technicians do not understand voltage drop and depend on measuring the resistance of the circuit, which is not as effective a way to diagnose most electrical issues.

Technical information

You cannot work on any modern vehicle without having the proper technical information of the systems. Not knowing can result in costly damage or worse, injury to a tech. Having access to at least one technical resource should be a minimum requirement for every shop.

All vehicles should be checked for TSBs, recalls or other information available that may provide a fix even before diagnosis. Even with this information, a tech should still go through the diagnostic procedures required to verify the issue.

Proper tools

Using the proper tools to perform diagnosis and procedures seems like a no-brainer, yet shops still attempt to address issues without the proper tools or information. Why put yourself in this position where the odds are against you from the start?

Negligence

Comebacks related to sloppiness, negligence or other tech-centric behaviors are an employee issue and need to be dealt with immediately since they can lead to liability problems. Some comebacks are just the result of the tech not verifying the "fix" with a road test. Each one of these comebacks should be documented and followed by a discussion on how to prevent it from happening again.

Process

Your shop should have a system in place for dealing with comebacks, keeping in mind to minimize inconvenience to the customer as much as possible. The better each situation is handled, the more it will help rebuild trust with your customers.

There are negative emotions related to each comeback, but it is best to take emotion out of the situation and deal with the facts. Find out what the issue is, get it fixed, then talk about it.

Then sit down with the tech and determine the cause of the comeback and whether the tech gets paid or not. Do not delay this discussion. Have it as soon as possible once the customer's issue is fixed. Make sure the tech understands the outcome of your discussion.

An example

A vehicle returns, the issue is verified with the customer and is possibly related to previous work. The original paperwork is provided along with a new repair order for today's return visit, and the job is returned to the original tech to determine the cause.

The tech finds and corrects the concern and documents each step on the repair order. At this point, the vehicle should be road tested by a manager to completely verify that the repair has been successful. Finally, the customer is contacted, and the vehicle is released to them.

The tech and manager should sit down and discuss the situation and make a final determination as to whether it was a chargeable comeback or not.

Comebacks will always be a part of the service process. Prevention is easier than dealing with them. The ideas above work. Use them, and when a comeback does occur, take care of the customer, get the vehicle fixed, discuss the situation and how to prevent it in the future with the tech, then move on to the next job.

JOHN BURKHAUSER is an auto repair specialist with more than 30 years of experience. As the Director of Education at BOLT ON TECHNOLOGY, John coaches independent and franchise repair facilities on how to grow their business using simple best practices and everyday technology, resulting in increased car count, repair order revenue and customer trust.
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Are your misguided beliefs causing misguided results?

Examine the why in your behavior and it may lead to a change in the how

Have you ever thought that many things you do every day are because of a misguided or unexamined belief? I heard longtime ATI Coach and 20 Group Facilitator, Rick Johnson, tell a story about how this can happen to the best of us. Let me repeat a story that has been told many times. Here is my favorite version:

A husband and wife were in the kitchen preparing ham for dinner. The husband watched the wife cut off one inch from either end of the ham. He asked why she cut the end off, proclaiming, "That's a waste of good ham!" She said, "That's the way my mother prepared the ham." The husband asked, "Why did your mom cut the ends off?" The wife didn't know.

Later, the wife called her mom to find out why she cut the ends of the ham off. Her mom said, "Because that was the way my mom prepared the ham." The wife's grandma had passed away several years earlier, but her grandpa was still living. She called her grandpa and asked, "Grandpa, why did Grandma cut the ends off the ham?"

He thought for a while and then said, "So that the ham would fit in her pan!"

Seems silly, doesn't it? Just think of all the good ham cut off and wasted all those years. But does it not get you to thinking — what about me? How many things do I do every day that, if examined, go back to some misguided belief system?

THE OLD SAYING THAT KNOWLEDGE IS POWER IS WRONG. IMPLEMENTING THE THINGS YOU HAVE LEARNED AND MAKING CHANGE IS POWER!

All my life I have asked why and questioned everything. And I can't tell you how many times when I asked, "Why do you do it that way?" I was told, "Because that's the way we always have done it!" Let me tell you — that answer never satisfied me.

I one time came across a book titled, *If It Ain't Broke…Break It.* It challenges everything we do in business, and it was like it was written for a person like me. Now don't get me wrong, there are very good reasons why we do a lot of things and follow procedure. So let's examine just a few things that came to my mind and see if this challenges you to maybe "break it." First, let's examine the things you do every day that could be causing you to not get the results out of your business that you really want.

Knowledge is not power!

How many of you read books, magazines like *Motor Age* and so on to get tips and ideas on how to make your business better? Well of course all of you reading this article, right? Anyway, here is a great challenge to that habit from me. STOP READING these things! If you really want to make a difference in your business, how many more books and articles do you think you need to read? For goodness sake put the book down and start implementing the things you have already learned! There are only so many ways to do time management, only so many ways to learn how to be more productive. The old saying that knowledge is power is WRONG! Implementing the things you have learned and making change is power!

How about this one — I hear it all the time. "I can't charge that much or set my labor rate that high because I am in a small town" or "We are in a poor area and people around here can't/won't pay that much." My question to this has always been: So, when you pay your power bill in this small town, do you tell the power company, "I need the small-town price" or when you go to buy a truck or a new TV, do you tell them "I need the small-town price?" Because you know the folks that drive new vehicles and have nice houses in your town pay everyone else's normal price. How is it that they just won't pay your price?

It is amazing when we finally have a breakthrough on these misguided beliefs, and the shop owner finally starts charging the correct prices. Prices based on his actual costs. Then the shop finds out that the customers will in fact pay the correct amount even in a small town. What a great thing that the shop owner can now afford to take a vacation. Maybe they can cash a few weeks' worth of their own paychecks they have been writing but have in their desk drawer. And it could have been this way all along, but someone a generation or maybe two or three back got the idea that it couldn't be done in a small town and the following generations just fell in line without ever questioning it or examining it.

Here is another one that again we hear all the time: "I just can't pay like the dealer does, and I certainly can't provide benefits!" Holy cow! What? Why? Really? The only way dealers are paying more and offering benefits is because they have sat down and figured out what they needed to charge to be able to provide these things. I am sure they add those costs into their business plan and make it work.

So, do you think maybe you should challenge this idea that you cannot provide top pay and benefits? I would hope so. I would start doing some checking into health insurance group plans and some IRA or 401k plans and see what the true cost is. Then sit down and break it out by the hour and adjust your labor rates to reflect this; you will be amazed at how you can compete with the dealer for techs once again.

Implementation is power!

Belief systems — we all have them. We all go throughout our day guided by them, and as true as that is, you must realize that so are your results in your business! Henry Ford said, "Whether you think you can, or you think you can't, you're right!" That's great insight from a man with an eighth-grade education. Think about that for a minute or two. An eighth-grade education. How many times have we heard or said, "If you want to be successful in life, you must have a college education." Pretty good thing ol' Henry challenged and, most importantly, proved that to not always be 100 percent true! Again, I am not disrespecting education, not at all, but Mr. Ford did not let that belief prevent him from researching and inventing and changing the world.

So today, start looking around and noticing all the things going on in your business. Are you cutting the ends off a ham in any area or department? I hope not, but if you are, I hope you start making changes and start getting the results you need from all you have learned.

A great place to check to see if you are charging what you should is ATI's Parts Matrix. Learn what shops all around the country are asking for and getting. Every shop has to make the right profit. Any shop business model will work if you have the cars to feed it and the staff to deliver it. If you want to run the Bring Your Own Parts Model you'll need two times the cars or labor rate to make the same money you used too. If you want great technicians and loyal customers, work on selling the value you're bringing to your customers. History has taught us that companies trying to be everything to everybody die a slow death! Simply decide what model you want to be recognized for! Go to *www.ationlinetraining.com/2018-12* for a limited time and see how your parts pricing matches up.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 130 full-time associates train and coach more than 1,500 shop owners every week across North America to drive profits and dreams home to their families. Our full-time coaches have helped our members earn over 1 BILLION DOLLARS in a return on their coaching investment since ATI was founded. This month's article was written with the help of ATI Coach Rick Johnson.
chubby@autotraining.net

Get focused if you want to move forward

Management must be willing to change with the market to be successful

There is no doubt about the confusion in our economy. The high technology sector is under siege on its up-and-down market capitalization value; the various automobile manufacturers are trying to redefine growth strategies to deal with various emission regulations, market and globalization realities; the fishing and forestry industry is quite distraught; and the oil and gas sector has to rethink their strategies with shortages and "all over the place" global economics. Things have changed in four to six months and, in some cases, four to six weeks. It seems there is no more constant in the world we once knew.

These are the facts of today's life, yet I see too many independent shop owners and managers burying their heads in the sand and not changing their business style to the times we are in — and it is dramatically affecting their bottom line. Some of it, I'm sure, has to do with technicians in our industry believing it is fine to do it the way they've always done, which can create a stagnation mindset within the shop. Too many people see change as "for other people, not me." This attitude can put, and hold, management in a rut. We must agree — the only constant now is change. Now we must deal with it. We must be prepared to reinvent our business every three years now and that reality demands good management skills to be in place on a daily basis moving forward.

Management must take charge of the business. That's your function within the business. Your decisions affect everyone who is working with you. That is a huge weight on your shoulders and it must be taken seriously.

Clearly explain to all employees where the business must go over the next three years in terms of why and how. Lay out your vision in written form so they can read, see and understand where the future lies. Explain to them the difference between a customer and a client. You want to build a client-strategic business where you get all your work by building strong, trusting relationships. Clearly tell the staff that they are an important and key part in getting the shop to the next level, and if they are not interested in moving forward, this is not the shop for them. This may sound harsh to you with such a shortage of competent technicians in our industry, but if you have a team member who does not want to grasp reality, challenge themselves and move forward to be the very best they can be, where does that leave your future and the balance of the team's future?

One issue that we must agree to is that we must pay our people better if we are going to get the best available workers, otherwise, from an employee's perspective, what is the incentive to challenge oneself? To achieve this, you must manage your business to increase bottom-line profitability. This includes changing your mindset on what to measure in the business. Watching sales is just measuring activity. Sales can increase, but that is absolutely no guarantee that net profit increases. It will take more net income to be available to reinvest in the team's financial standard of living.

Now we must watch billed hours, which is productivity. Measuring and increasing productivity on an individual basis must become a culture within the shop that everyone clearly understands. Invest and train your staff thoroughly! If they are in the shop for 8 hours a day, find out clearly why they are not billing out 8 hours a day. Is it an internal process problem affecting the efficiency of the operation or is more individual training required?

IF YOU HAVE A TEAM MEMBER WHO DOES NOT WANT TO GRASP REALITY, CHALLENGE THEMSELVES AND MOVE FORWARD TO BE THE VERY BEST THEY CAN BE, WHERE DOES THAT LEAVE YOUR FUTURE AND THE BALANCE OF THE TEAM'S FUTURE?

Measure the average hours produced per R/O. Strive to average 2.5 billed hours per R/O for basic consumer vehicles. Strive for 4 to 6 billed hours for one-ton vehicles such as cube vans and if you do any heavy-duty vehicles the objective is 8 to 10 billed hours per R/O. Look at your vehicle mix and determine what you should be averaging in billed hours per R/O if you have a blend of vehicles. Measure your total labor hours billed for each month for true comparison purposes. Measure your parts percentage sales

AVOID SHOP OWNER BURNOUT!

If this sounds like you, here's the guaranteed cure: reevaluate the goals of your company. If you look to the future and set some worthy long-term and mid-term growth goals for your company, not only will those goals get you excited, but they will give you a better sense of purpose. Add to that, your day-to-day decisions will be that much easier to make, and your new-found goals will put that spark back in you that will be seen by all of your employees. Continue at MotorAge.com/burnout.

mix between aftermarket and dealer domestic and dealer foreign name plates. This measurement can help define your client base and the talent and ongoing training required to do the job right the first time. Charge out maintenance work at 85 percent of your total cost per billed hour, and charge out diagnostic at 125 percent of your total cost per billed hour. Now you are truly looking at shop efficiencies to be market competitive with your labor rates.

Review your detailed system as to how the vehicle is inspected when it enters the shop. Are you completing at least one comprehensive inspection per year for your basic clients and two per year for commercial clients? It's all about having a complete file on each vehicle for safety, reliability and efficiency so you can counsel the client effectively based on their realities.

Put your report into print for the client. Discuss with them how to obtain the best return on their investment with their vehicle, based on their driving habits. Print the upcoming maintenance schedules for the client and schedule accordingly. Develop trust through educating, then deliver true value to your clients.

Finally, acknowledge the truth: business is so hard when I have to, and yet so easy when I want to. MA

BOB GREENWOOD, AMAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), which provides business management resources for the automotive aftermarket. Bob has more than 36 years of business management experience and is one of 150 worldwide AMi-approved instructors. *greenwood@aaec.ca*

Policy differences may be ahead with 116th Congress

The path to data access remains unclear

The recent elections moving Democrats to control the U.S. House of Representatives could lead to policy changes the automotive repair industry will see in the new 116th Congress. Committee changes will also produce new players for automotive policy in the U.S. Senate.

With 435 seats in the U.S. House of Representatives, 218 seats are necessary for party control. As of this writing, 225 Democrats and 200 Republicans will serve in 2019 with 10 seats yet to be decided. In the Senate, Republicans will still be in control with 51 seats and 46 Democratic seats; 3 seats are yet to be determined.

What does all this mean for automotive repairers? The most obvious issue impacted could be data access and related cybersecurity issues. Despite earlier House passage of autonomous vehicle (AV) legislation and passage of companion legislation in the U.S. Senate Commerce Committee, the Senate has yet to schedule their version, S.1885, the AV START Act, for the floor.

Recently the Automotive Service Association (ASA) and other AV Coalition members sent a letter to Senate leadership asking to move the AV START Act during the Lame Duck session of Congress. If the bill is not considered by adjournment, the process will begin again in 2019. Without passage, states and the auto industry will be provided little direction on AV policy including data access and cybersecurity.

The new House Democratic leadership has not been decided, but leaders are already discussing priorities. Democratic Minority Leader Nancy Pelosi (D-CA) is likely the next Speaker of the House. She recently highlighted her top priorities as health care, infrastructure and to clean up corruption.

New vehicle technology policy is just one example of areas that could change in the new Congress. With new chairs for key committees, considerable differences in policy initiatives could happen.

Judiciary Committee — Congressman Jerrold Nadler (D-NY) will chair next year. Although the Committee is anticipated to spend much time on oversight, immigration reform is another possible concentration.

Financial Services Committee — Congresswoman Maxine Waters (D-CA) will chair and have jurisdiction for most insurance matters including Dodd-Frank oversight. Former Chairman Jeb Hensarling (R-TX) was tireless in his efforts to dismantle the Federal Insurance Office (FIO) housed at the U.S. Department of Treasury. Under Congresswoman Waters' chairmanship, FIO is not considered to be a target.

Energy and Commerce Committee — Congressman Frank Pallone (D-NJ) is predicted to chair. This is the most important House committee relative to data access and cybersecurity. If the Senate fails to move AV legislation, the Committee will begin again. It is unlikely the new 2019 AV legislation will mirror the current House-passed AV bill.

Transportation Committee — This committee will be critically important to the industry with both the House Democratic Leadership and the Trump Administration emphasizing the need for a new transportation infrastructure initiative.

In the Senate, Senate Commerce Committee Chairman John Thune (R-SD) is expected to move up in leadership and Senator Roger Wicker (R-MS) will likely replace him as Chairman. Senate Judiciary Committee Chairman Chuck Grassley (R-IA) has not decided whether to take the chairmanship of the Senate Finance Committee or stay put. If Grassley moves, this could create movement on the Senate Banking Committee.

Prior to adjournment, House and Senate will settle leadership elections, committee chairs and memberships. Repairers will see differences with issues of importance in the 116th Congress when compared to the current 115th Congress.

ROBERT REDDING is the Automotive Service Association's Washington, D.C. representative. He has served as a member of several federal and state advisory committees involved in the automotive industry. *rlredding@reddingfirm.com*

Successful ADAS service requires active reading

NOT FOLLOWING THE SERVICE INFORMATION PROPERLY CAN PUT DRIVERS AT RISK

CHRIS CHESNEY // Contributing Editor

With the onslaught of new vehicle technologies, it is important for us to get our tool box in order so that we are successful in servicing these new systems. Advanced Driver Assist Systems, or ADAS, are a series of advanced technologies that not only provide incredible levels of protection for motorists, but also challenge us as shop owners and technicians in a way that hasn't been seen since OBD (on-board diagnostics) was introduced in the mid 1990s.

When OBD was first applied in 1996 to newer gas-powered vehicles, there was anxiety around how these systems worked, as well as how to go about diagnosing and repairing them. Each manufacturer took a different approach to the application of the OBD standard. I started my training company during those times and remember emphasizing the need to read service information in a way that most had not done in the past. Code set criteria and blocking conditions were two elements that needed to be understood in order to successfully solve many of these system's issues. It was not difficult to find the information, yet, I would receive call after call asking about how this system worked or where to go with that vehicle. I was always thinking to myself, "Can you read?"

Since that time the modern automobile has become ever more complex, and the need to read has remained. But during that time society changed the way we communicate with the introduction of cell phones, texting, email, smart phones and social media. Today we get information via small bite-sized communications, emojis or acronyms that have eroded our ability to read and comprehend effectively. Couple this degradation of reading skills with the advancement of technology that requires us to fully understand before we can be successful and you can quickly see the cause of some of our failings in diagnosing and repairing these complex machines. So many technicians gravitated toward experienced-based information systems that could provide a quick fix without having to invest as much time in reading. We got by, and we continue to seek that path.

If you've made it this far in the article then please slow down and focus on this: ADAS is not like OBD. It is completely safety oriented, and as such carries a litigation potential that we as automotive professionals have never had to deal with. If you don't follow service information and OE process properly there is a risk that the system you serviced will fail to work properly and someone may get hurt.

Because of this risk, there are lawyers waiting in the bushes to take your business and livelihood. Sure, you've worked on brakes and steering systems and you didn't need to read service information to repair them. But if you are of the mind that "I've done brakes for 20 years. I don't need to read service information," then you are at risk and don't recognize it. With today's technology you can't assume you know how any system works without reading and training. Training prepares you to know what critical information is available and required, but discipline is required to research and read on every technology-based job.

So to put this back in context with ADAS, you must be a good technical reader. That is a learned activity and there are many articles on the web to assist. You must also have access to OEM service information, and you must use it in the context that the OEM intended. You must read and fully understand what the OEM is asking you to do for each service or calibration, and you need to know why it is asking you to follow these steps; training is available for the latter. Finally, you need to follow each step. Don't misinterpret this to mean you need to buy an OEM scan tool when it references it; it means you need to place the targets in the right spot and the targets need to represent the OEM intent perfectly. This isn't difficult; however, it is critically important. ADAS presents you with a tremendous opportunity to differentiate yourself in your market, and it is worth the investment and effort. Also, it isn't just ADAS that requires this level of reading detail. Everything on the vehicle requires it, and your customers deserve it. MA

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MECHANICAL MOMENT

SERVICE REPAIR PROBLEMS AND SOLUTIONS THAT JUST MIGHT BENEFIT YOUR SHOP TECHNICIANS

MITSUBISHI BODY PROBLEMS AFTER BODY REPAIRS

VEHICLE: 2004 Mitsubishi Lancer, L4-2.4L SOHC, Automatic Transmission

MILEAGE: 149,009

PROBLEM: The car was a sublet from a body shop after they did repairs because the radio, turn signals, low beams and the low-speed wipers were inoperative. The steering column switches and front ECU had already been replaced.

DETAILS: The tech first inspected all of the fuses – all of which checked out – so he called ALLDATA Tech-Assist for some guidance. Based on the wiring diagram, the Tech-Assist consultant suggested that the tech verify voltage to the ETACS-ECU left turn signal and light relay.

Using a digital multi-meter, the tech found no voltage on the orange wire at connector C-129 / pin 14, which was located behind the left kick panel. He jumped power to the orange wire at C-129 and the turn signals began working. Upon further inspection, the tech found several wires in the harness going to connector C129 were damaged in the collision.

CONFIRMED REPAIR: After repairing the left-hand instrument panel wiring harness, everything worked normally again.

This tech tip and others come from ALLDATA Tech-Assist, a diagnostics hotline of ASE-certified Master Technicians.

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Anaheim, California

FEBRUARY 28-MARCH 3
VISION Hi-Tech Training and Expo
Overland Park Convention Center
Overland Park, Kansas

MARCH 20-23
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JW Marriott San Antonio
Hill Country Resort
San Antonio, Texas

MARCH 22-24
Automotive Training Expo (ATE)
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DIESEL TANDEM CURVEBALL

DIESEL CHARGING SYSTEMS CAN BE A LITTLE TRICKIER THAN THEIR GASOLINE COUNTERPARTS

JOHN ANELLO // Contributing Editor

I had a shop call me for advice on a 2002 Dodge Ram Truck with a 5.9L diesel engine that had a charging system issue (**Figure 1**). I probably field at least 50-70 calls a day, and there are many times that I will provide my shops with free tech advice over the phone. This issue seemed simple to me, because Chrysler, for many years, has used a strategy to control their alternators externally. In the early days, they mounted voltage regulators on the firewall, but once onboard computers came into play, the regulator worked its way into the circuit board of the Engine Control Module. The alternator field circuit was usually fed an ignition feed and controlled by a ground feed on the opposing side of the field circuit.

The owner of the vehicle was a do-it-yourselfer and had changed the alternator with an aftermarket one, but it did not resolve his problem. The truck was then shipped to the shop where they checked all the wiring and decided to opt for an OEM alternator to see if that would resolve the charging system issue (**Figure 2**). When this didn't work, the shop gave me the call.

1

Before I make the drive

I ran through all the steps with the shop technician and educated him on how the system should work. He mentioned that there was no power feed coming out of the PCM to feed the one side of the alternator field circuit. I explained to him that it was possible that the PCM was bad or that the PCM was sensing a partial short to ground in the feed line and was possibly turning off an internal driver to protect itself.

The next day the shop tech called me back to explain that he temporarily ran dedicated wires for both the power feed and triggering lines of the field control circuits between the alternator and PCM. The alternator still would not charge, but if he supplied the 12 volts into the power feed circuit the alterna-

tor was charging fine so he decided that he was going to order up a rebuilt PCM unit from the dealer. I told him that once he purchased the PCM and installed it, to call me so that I could swing by and program it for him.

Later in the week I received the call that all was ready to go, so I ventured out to his shop at the end of my day to program the PCM. Once I arrived there I set up my old Chrysler DRB III scan tool as a pass thru device with an interface cable to my laptop. I configured the PCM with the vehicle VIN number and then downloaded the necessary software into the PCM. The truck started up, but guess what? We were back to square one. We both sat there scratching our heads and then I offered to perform a full diagnostic on the vehicle in order to retrace ALL the steps that had been taken; he agreed.

2

Diving in a little deeper

I hooked up my scan tool and pulled codes from the PCM. One code was P1765 that indicated a loss of ignition feed to the transmission relay, and the other code was a P0622 indicating that the generator field was not switching properly (**Figure 3**). These codes both had a common power feed issue because the PCM was still not sending the 12-volt output required to satisfy their circuits. There had to be a reason why the PCM was not doing its job, and I decided to look at some data PIDs, hoping to find a piece of the puzzle that could guide me in the right direction.

When I was viewing the data I saw something that raised my eyebrows. There was no RPM signal getting to the PCM, and the desired charging voltage was 0 volts (**Figure 4**). The PCM was not performing its task of charging the alternator, because as far as it was concerned, the vehicle was not running. So then how was this vehicle running without an RPM signal? Why didn't the PCM set a code for loss of RPM signal input? I now have to pull some diagrams to do some onsite strategy research, because at this point I had no answers.

This vehicle was a diesel and was a horse of a different color, because it used a separate Engine Control Module that was specifically used to run the Diesel engine. The crank sensor fed a direct RPM signal to the ECM and there was a cam sensor signal that was also supplied to the ECM coming from the engine-driven injection pump. The ECM in turn would output an RPM signal to the PCM so that it could properly control the transmission and the alternator. So I now had to

3

CodeType	Fault Codes
P1765	Transmission Volt Relay Circuit - open or short
P0622	Generator Field Not Switching Properly

4

FUEL LEVEL(V)	
RPM	0
BATTERY VOLTS	11.8
DES CHARGE(V)	0.0
BATT TEMP(V)	2.6
BATT TEMP (°F)	73
GENERATOR LAMP	OFF
IGNITION SW	HIGH
FUEL LEVEL(V)	2.96

5

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CodeType	Fault Codes
P1693	MIL Fault In Companion Module

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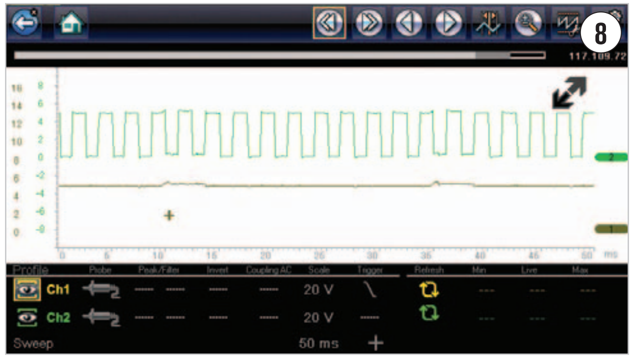

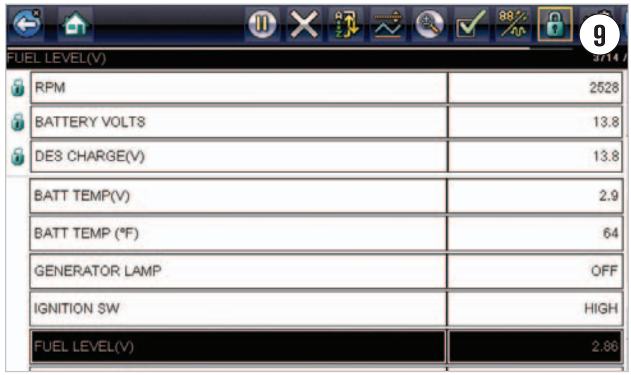

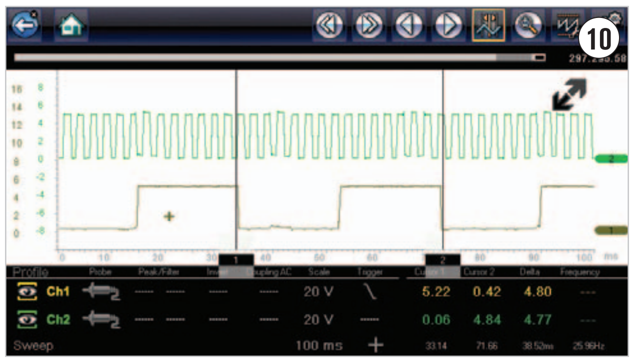

run some tests on the ECM to determine what was going on.

I scanned the ECM and found a code P1693, which indicated a fault in the PCM, so I kind of ignored this code because the ECM was playing the blame game (**Figure 5**). I next looked at some ECM PIDs and found that it was receiving the RPM signal from the crank sensor and an RPM signal from the cam sensor (**Figure 6**). The ECM inputs did not seem to be an issue, so now I was leaning towards an output signal issue with the circuit going back to the PCM. At this point I needed access to the ECM so I could put my scope on the signal lines.

I had the shop pull the fuel filter housing on the left side of the engine block to gain access to the ECM that was mounted to the side of the block (**Figure 7**). I placed my scope lead on the RPM output signal to the PCM on channel 1 and placed my other scope lead on the crank sensor RPM Input signal to the ECM on channel 2. I started the vehicle and you could see that the crank sensor RPM signal to the ECM was fine with good triggering transitions from 0-5 volts, but the RPM output signal to the PCM was flat lined at 5 volts (**Figure 8**). The PCM signal line was not shorted because it was elevated at about 5 volts.

I next decided to think out of the box by opening the RPM signal line at the PCM and sending the RPM signal from the crank sensor into the PCM to simulate that the engine was running to test PCM system strategy. My results were as expected, because the alternator started to charge immediately. I went back to view the PCM data, and you could now see that the desired voltage was 13.8 volts and the charging voltage was also 13.8 volts. It would have been nice to just leave it at that just to get the truck out the shop door, but the issue now was that the PCM was seeing the vehicle running


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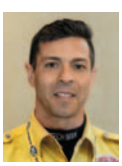
at 2528 RPMs when actually the truck was idling at 700 RPMs (**Figure 9**).

In the end

The ECM on this truck most likely took the crank sensor signal input and internally reduced the frequency of the signal delivered to the PCM for some type of strategy reason. There was an internal circuit board failure, and the only choice was to have the ECM sent out for repair because there was not one available from the dealer or aftermarket due to the age of the vehicle. I just feel bad for the owner of the vehicle because this was a work truck and the shop owner never knew what a nightmare it would turn out to be and how long he would have it in his possession.

About another week goes by and the rebuilt ECM finally showed up and the shop installed the ECM, which was a plug-and-play unit. The vehicle started up and the good news is that everything worked like a charm. I had to go back to just get a scope pattern out of this diesel monster and to validate the repairs before the shop buttoned it all up. I quickly hooked my scope up again to view the patterns, and you could now see the input and output RPM signals were working as designed with different frequencies (**Figure 10**).

This vehicle really proves that a trouble code does not always lead you down the right path. It is vitally important to know how to read data PIDs. The code in the PCM only validated that the alternator field circuits had a power feed or switching ground issue that was pointing you to a wiring fault or a possible bad PCM with an internal alternator field driver failure. There was no cam signal reference to the PCM like there would be in a gas engine, so there was no way for the PCM to fail the crank sensor for a lack of input. The strategy of this system would be for the PCM to provide a voltage output and field circuit toggling once a specific RPM threshold was met, but this never took place. In the end, it took some out-of-the-box thinking to unmask the true culprit. My only hopes are that this story will enhance what you know or don't know about Chrysler diesel controllers working in tandem. MA



JOHN ANELLO owns Auto Tech on Wheels in northern New Jersey, which is a mobile diagnostic service for 1,700 shops, providing technical assistance and remote programming. He is also a nationally known trainer.
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THE WHYS GUY

SOMETIMES WE GET LUCKY AND THE CAUSE OF THE CUSTOMER'S CONCERN IS READILY APPARENT AFTER A TEST DRIVE AND A REVIEW OF SOME FUNDAMENTAL PIDS. AND THEN OTHER TIMES — WELL, YOU KNOW!

BRANDON STECKLER // Contributing Editor

I live near the Philly area, born and raised. True, my mom is from Jersey City and my dad is from Brooklyn. My friends across the country poke fun at the way I talk but hey, let's face it, I am a "WHYs GUY," through and through (yep, I spelled that correctly). It's not what you think, though. When it comes to troubleshooting drivability faults, sometimes we got it made. We simply drive the vehicle and analyze the data we capture, looking for the root cause of the fault presented at the time. We invest time learning how to understand the relationships between the PIDs and how they reflect underlying faults. We all know it ain't that easy all the time.

Why ask why (or when or how)?

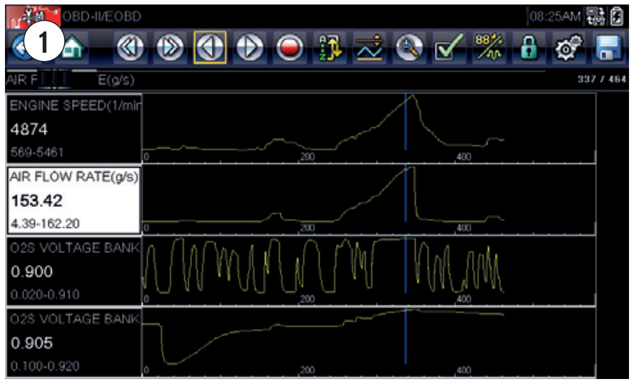
Sometimes, it's a bit more involved than that. Sometimes we get that vehicle that requires us to dig way deeper than we are accustomed to. Because I spend a lot of my day troubleshooting drivability faults, to remain efficient I had to devise a plan of attack, a strategy. This strategy involves analyzing preliminary data (the low-hanging fruit). I use this data to ask questions of the vehicle, like:

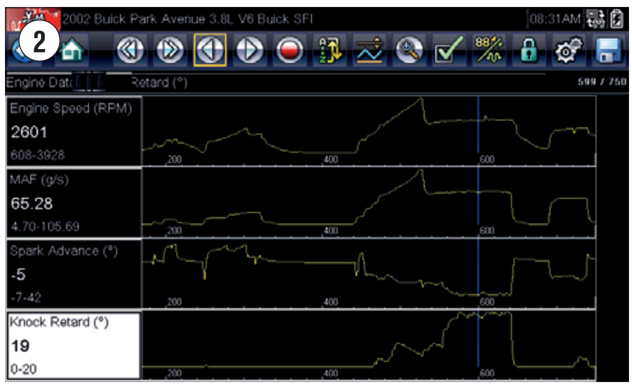
- Why are you performing poorly? (Are you lacking sufficient fuel supply, can you breathe?)
- When do you perform poorly? (Is it when you are idling, or when I force you to work hard?)
- How can I get you to reveal your fault to me? (Are there certain weather conditions you don't like?)

Questions like the ones above help me decide which road I will head down. More importantly, it gives me a sense of direction and justifies the next test I will perform. Otherwise, we'd just be shooting from the hip. I do get lucky every now and then, and diagnosis falls in my lap, but I'd take a rock-solid game plan over luck any day of the week.

The bum

The subject vehicle of today's topic is a 2002 Buick Park Avenue with a 3.8L (K) engine that's just shy of 130k miles on the odometer. The customer is concerned with the vehicle's lack of





power and a "knocking" noise from underneath the hood. The vehicle was in the shop in the recent past for replacement of spark plugs and ignition cables and had been without fault for at least a few months.

I began the analysis with a scan for DTCs and, to my surprise, none had been stored. I drove the vehicle, monitoring some basic PIDs and within a very short distance, the vehicle began to ping hard and lacked power. This is where the questioning began. If you refer to **Figure 1**, you will see that I had placed the vehicle under heavy acceleration. Now at this point, the vehicle wasn't pinging but the goal was to see if the vehicle had adequate fuel supply. Ruling out what is "good" with the vehicle is equally as valuable as discovering what is faulty. As you can see, both the pre- and post-CAT H_2O sensors reflected high voltage output, indicating a lack of O_2 (or otherwise stated, plenty of fuel). The demand for

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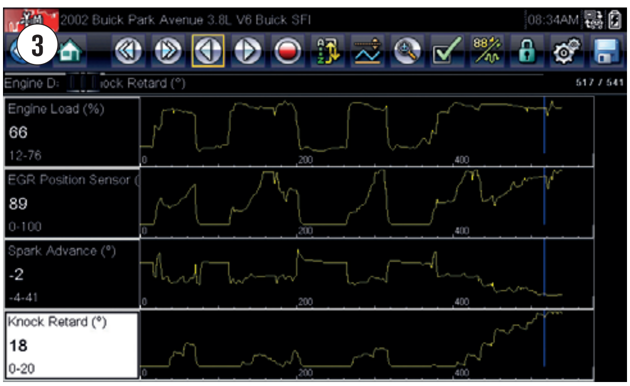
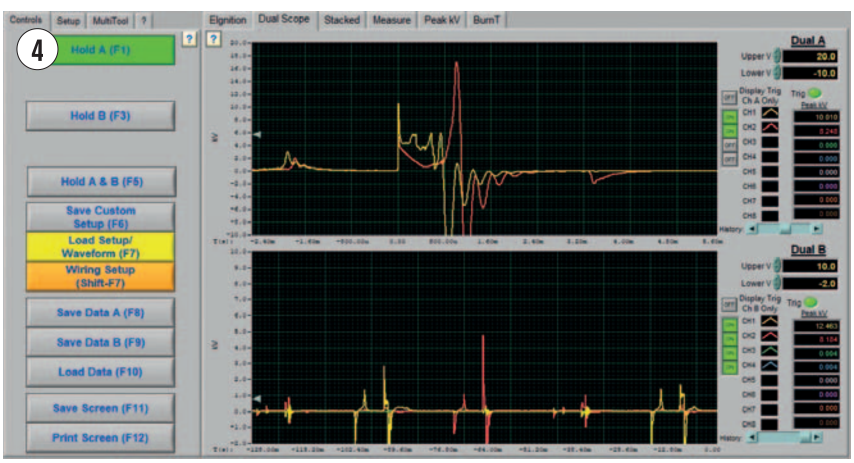
fuel is much greater under heavy load than it is under less of a load. So, the fault doesn't appear to be related to a lack of fuel delivery. But why the lack of power output?

The next screen capture answers that question — see **Figure 2**. It's clear to see that as this vehicle begins to ping, the PCM compensates (through the ears of the knock sensor) and generates a command to retard spark. You are all likely aware that a spark occurring too early initiates a combustion process that hinders the piston's ascent towards top dead center of the compression stroke. This, in turn, places a tremendous force on the piston and can damage the internal engine components, due to the violent collision. So, the question then becomes why is the engine pinging?

To battle the production of the harmful gas, NOx, an EGR valve is utilized in this application. NOx is produced in abundance in temperatures exceeding 2500 deg F. The EGR valve is set to reintroduce exhaust gas back to the cylinder. The idea is to fill the cylinder with the inert gas to make the cylinder's effective area smaller, reducing the intensity of the combustion event. This in turn cools the combustion chamber and reduces the potential for NOx production. My thought process is if the EGR valve doesn't open or fails to deliver EGR, it may be the root cause of the "ping" the engine is suffering from. Let's have a look. If you refer to **Figure 3**, it shows the PCM's intent to introduce EGR at the expected engine load levels. The EGR position feedback is reporting about 90 percent open, indicating that the PCM is hearing what I'm hearing and commanding a spark-retard of 20 degrees. So now the question is why is the engine still pinging, if the EGR is opening as intended? Is there a restriction of some sort, within the EGR system? A stroll through the bi-directional control function of my scan tool can answer that question right from the driver's seat. I simply commanded the EGR valve open at idle and the engine struggled to maintain idle. Its clear to me that the EGR ports were not restricted…time to roll up my sleeves and dig in deep.





Brought in for questioning

As I mentioned earlier, sometimes we get lucky and we can get the vehicle to tell us everything we want to know with little effort. Other times, we must push to get the answers we need. In situations like this, maintaining a structured game plan is even more crucial to prevent going down a rabbit hole. Rather than trying to find out what is broken, I chase the symptom. I do this because I know what the symptom is. I've felt it and I can easily recreate it. I want to see the ping. I want to see inside the combustion chamber while the engine is running to determine the health of that combustion event. I can't think of an easier way to do this than to view it through the eyes of an ignition scope.

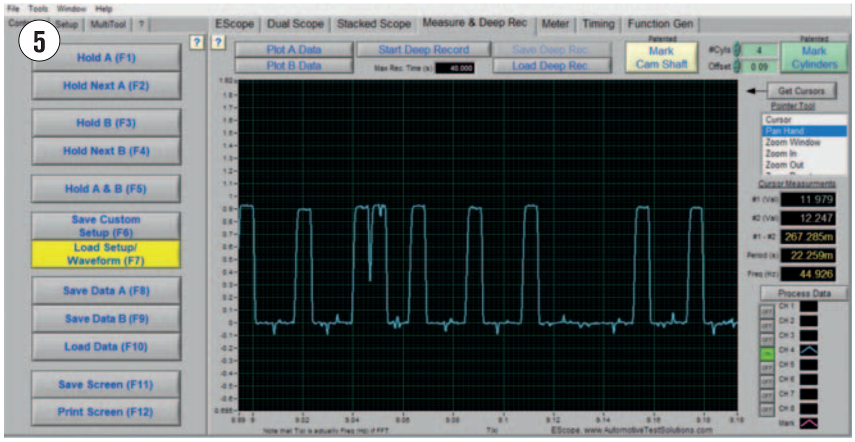
This vehicle utilizes a waste-spark system, using three coils to provide the energy to initiate combustion for six cylinders. This system tethers the coils to the spark plugs with ignition cables. The good news is that I can (unobtrusively) acquire the waveforms capacitively, right from under the hood in seconds. With the help of an assistant in the driver's seat (to place the vehicle under the fault conditions), the testing was carried out for all cylinders under heavy brake-torque conditions. **Figure 4** displays a Bank #1 ignition event in yellow and a Bank #2 ignition event in red. The waveform displayed (indicated by the red trace) demonstrates an increase in cylinder resistance as the duration of the spark burn line carries on. We can see this because the waveform slopes upward very sharply. A cylinder that is adequately fueled has less resistance

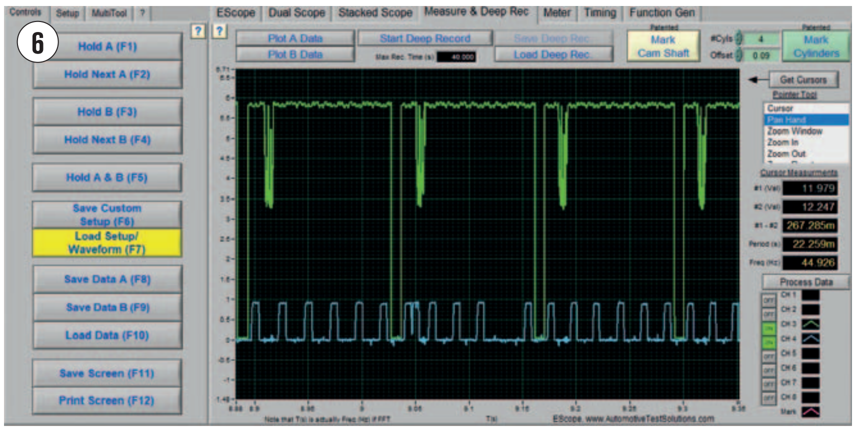
and less energy is expended, trying to maintain the plasma channel (as displayed in yellow). The significance of this event tells me that the bank #2 cylinder is indeed under-fueled. All the cylinders were tested, and each shared this similar characteristic.

I now understand why the engine was pinging. But I must now ask why is the cylinder under-fueled? A quick test of injector current (using an amp probe and lab scope) ruled out any differences between the injectors' ability to flow amperage. An injector balance test was also carried out and showed the ability to deliver fuel was equal among all six injectors. Gaining the answers to these tests justified my need to dig even further. I'm not dealing with a flow issue; I'm dealing with a control issue.

Being in control of fuel delivery also means being in control of the fuel injectors on-time. I will have to monitor the suspect bank's injectors on-time during the fault and compare it to the known good — dynamically! To gather all that data is as simple as sampling current from a single common point in the underhood fuse box. I positioned my amp probe to acquire the current flow from fuse #12 of the underhood fuse block. This fuse's only purpose is to supply current to all six injectors (this was very convenient, as there were no other circuits that could skew my results).

The results of the test exhibit all six injectors yielding the same 1-amp current ramp. Hmmm...the ignition waveform clearly exhibited a lean condition on the rear bank of cylinders yet the injector flow test and amperage waveforms yielded no difference between Bank #1 and Bank #2? My mistake was that the acquisition was not acquired during the fault conditions. I assumed the fault would be present because I assumed the injectors were restricted or lacked enough current flow. It goes to prove that we learn something new every day, and knowledge will continue to beget new knowledge.





Just the facts

After a few moments to gather my thoughts, I had another idea. I would place the vehicle under fault conditions while capturing the injector current. The current is the result. It represents the work performed. I know the bank #2 cylinders are under-fueled, so I'm confident I will see the fault reflected in the current waveform. After recreating the fault conditions, the symptom was exhibited, and the injector current trace revealed the cause. If you refer to **Figure 5**, it's clear to see the that one injector ramp dropped out and another mis-triggered. This created a lack of injector on-time, which explains the lack of fuel delivery exhibited in the ignition trace, as well as the ping. This only proves that the injector failed to open properly. We have yet to decipher the cause.

Remember, current is the output generated by the PCM's reaction (or processing) of an input. This vehicle uses a sequential fuel injection strategy. It uses a CKP 18x signal and sync signal referenced from the crankshaft balancer's reluctor. It also monitors a CMP pulse referenced from the nose of the camshaft. These same inputs affect ignition timing as well. The ignition events were also being affected, but I'm just chasing the symptom. Regarding injector control only, these signals are processed by the PCM to determine injector timing and TDC of the number one cylinder so that it may synchronize the correct injector to #1 cylinder. A PCM just does what it is programmed to do. In this case, it will drive an injector when it sees the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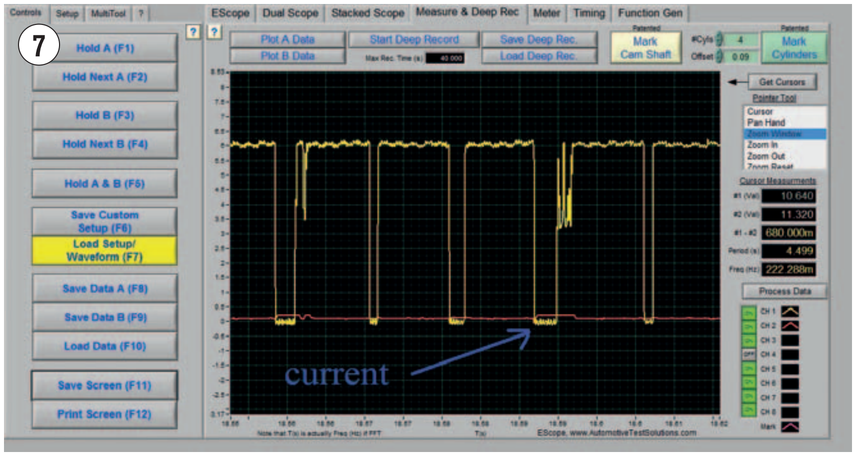
CKP 18x, sync pulse and CMP correlate in a certain manner. Because the failure was reflecting a fault pertaining to injector control, if the PCM receives a bad input, it's going to create a bad output (unless the bad input is recognized as such). Shortly, you can see exactly what my next plan of attack is. The strategy was to capture the fault occurring and use that as my point of reference for the other correlating signals. Here, I monitored the fault (injector current), and I will correlate that to the responsible inputs that the PCM relies upon for fuel injection calculation (CKP 18x, sync, CMP). I will simply see if, when the fault occurred, did my inputs to the PCM show any kind of deficiencies?

Keep in mind each test I perform is justified by the previous test. No time is being wasted. The beauty in approaching drivability faults from this angle is that logic prevents a step from being missed. Every test performed will almost always yield a diagnostic clue. Referring to **Figure 6**, it displays the fault quite clearly as my blue injector current ramp is once again deficient. More importantly, there is an anomaly visible within the CMP pattern and the 18x pattern as well (only CMP signal visible for better clarity). So, let's take a moment to ask why again. Why is the voltage CMP signal dropping low? There could be a few possible causes for a failure of this kind:

- faulty CMP sensor
- damaged CMP reluctor
- poor connection or voltage drop within the signal circuit or the reference voltage circuit
- shorted/ loaded sensor signal circuit or the reference voltage circuit

This simply requires another test. In this next step, I studied the wiring diagram and saw that the CKP 18x, sync and CMP signals all shared the same reference voltage source. I will



monitor the fault as carried out in the previous step but add some new data to the equation. We must now view sensor reference voltage feed, the common feed to all three suspect inputs. Viewing this piece of data will explain whether the reference voltage has a fault. It allows us the ability to divide the circuit up and determine on which side of the input the fault lays. Now, I want to mention something that I feel is a valuable point to make. I'm asked regularly if it is necessary to own an 8-trace lab scope like the one I'm using in this case study. It certainly isn't a necessity, but you will see how having one allows me to save a ton of time. As John Anello (the Auto Tech on Wheels) says, "It's like fishing with a net instead of a hook." Having the capturing capability of an 8-trace lab scope allows me to see relationships between multiple inputs, the ECUs response and the actions carried out, all simultaneously. You will see how this characteristic works to my advantage in this next step. There is one more tool

that I will utilize in tandem with the scope, to further nail down the fault to a pinpoint. I will implement the use of a microamp clamp. The microamp clamp is a very sensitive device designed to accurately measure very miniscule amounts of current flow.

The final showdown

The final test will be to monitor the CMP sensor signal under the fault conditions (all inputs reflected the fault, so I just chose to monitor the CMP only). At the same time, I will be monitoring the reference voltage feeding the sensor. The third piece of the puzzle is to monitor current flow through that sensor reference voltage circuit. My thought process is simple.

When the sensor signal is deficient, I will immediately be able to see whether it is due to a deficiency in the reference voltage circuit feeding the sensor. At the same time, the current flow will tell me a story, too. If a poor reference voltage feed is due to a voltage drop, the current flow through the sensor will diminish. On the other hand, if the reference voltage circuit is being loaded/partially shorted to ground, the current flow through the reference voltage circuit will INCREASE!

Figure 7 tells the whole story. When the vehicle was operated under fault-conditions, the engine began to "ping" hard. This occurred while the injector current ramps showed a deficiency. The inputs responsible for the injector commands were deficient as well. They were fed a reference voltage that was common among all three inputs (CKP 18x, sync and CMP). With the microamp probe surrounding the reference voltage feed wire, it was quite clear to see the amperage increasing as the fault presented in the CMP, CKP 18x and sync signals. This tells me that I must pursue a short circuit. So now, the hunt is on for a rubbed-through harness. After a quick visual inspection, a suspect area was located. Just below the power steering pulley, but above the crankshaft balancer, the CMP sensor harness was unsecured and intermittently touching the crankshaft balancer (**Figure 8**). This exposed some copper and the wire suffering the damage was the sensor reference voltage circuit, common to all the sensors discussed previously.

If you take the time to ask yourself "WHY?" at least five times, you typically find yourself face to face with the root-cause of the fault and coworkers looking at you like you are a wizard. So, to sum it all up, let's revisit the chain of events through the questions I asked to lead me down the path to beat the system:

- Why is the engine "pinging"? (Lean condition)
- Why is the engine running in a lean state? (Not a fuel delivery issue, but a fuel injector control issue)
- Why is the PCM failing to drive the injectors correctly? (The PCM operating with skewed inputs)
- Why are the CKP 18x, CMP and sync signals skewed? (A loaded common reference voltage circuit)
- Why is the reference voltage circuit loaded? (Ref. voltage wire feeding CMP is shorting to ground)

As mentioned before, the steps taken were not achieved in record time, but not a step was missed, and this led to an accurate and efficient diagnosis without any parts replaced unnecessarily. Taking the time to question the vehicle will yield you some valuable diagnostic clues that will save you time in the long run. A great side effect is developing the understanding of PCM strategy and how different inputs are used in different applications.

So, in the end, being a "WHYs GUY" can really make you a Wise Guy.

Author's note: I'd like to say that this was a fast and simple find, but that wouldn't be correct. True, it was not difficult, but did require some thought. Logic, studying of circuit topology, system strategy and lots of practice with the tools I have were a huge part of drawing an accurate diagnosis, but my process would've been random without inquiring "why."

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DO I REALLY NEED A LAB SCOPE?

TECHS LIKE TOOLS, AND OFTEN OUR TOOLBOXES ARE LITTERED WITH TOOLS THAT HAVEN'T SEEN THE LIGHT OF DAY IN MONTHS. NOT TRUE FOR MY DSO!

ERIC OBROCHTA // Contributing Editor

I think we can agree on the fact that we like to buy new tools that can make our job more efficient or even easier. Sometimes we have to buy them out of necessity to be able to handle the tasks at hand or to keep up with technology. However, it often happens that some of these tools end up in the bottom of drawers or tucked away on shelves collecting dust years later, only to be dragged out when we try to stump our friends with a game of name that tool.

One tool I have never regretted getting my hands on and learning how to use is a lab scope (better known as the digital storage oscilloscope aka DSO, **Figure 1**). Anyone who has been in the shop long enough knows this is not a new invention and variations of them have been around since I was a kid growing up in my dad's shop. I remember the day my father bought the Snap-On Counselor II and the hours he spent learning to look at secondary ignition waveforms, figuring out what's good, what's bad, practicing on known good vehicles to get the feel for it. As a young boy in the shop I was hooked watching the waveforms parade across the flickering green screen. For once I could see the electricity, as opposed to feeling it rush through your body as you learned not to touch old plug wires!

Just as the scope was an important part of a growing shop in the 70s and 80s, I feel it's just as important today to make the call. After all, test — don't guess!

Here's why

I recently had a 2006 Honda Odyssey with a 3.5 Liter engine and 188,000 on the odometer in the shop that had a complaint of a Check Engine light on

with a DTC P0389: Crankshaft Position (CKP) Sensor B Intermittent Interruption. Now this vehicle had been dragged around to several other shops before landing in my lap. It has had the timing belt replaced several times including all the components that go with it — water pump, timing belt idlers, tensioner, several crank sensors and a cam sensor. It was determined that the vehicle needed a new PCM because that was the only item left that hadn't been replaced. Before installing and programming the

PHOTOS: ERIC OBROCHTA

customer's used PCM, I had asked him if he would like me to have a look at it first. He was hesitant, but I assured him if I determined it was the PCM I would not charge him for the diagnostic time. He agreed, so I proceeded with the diag.

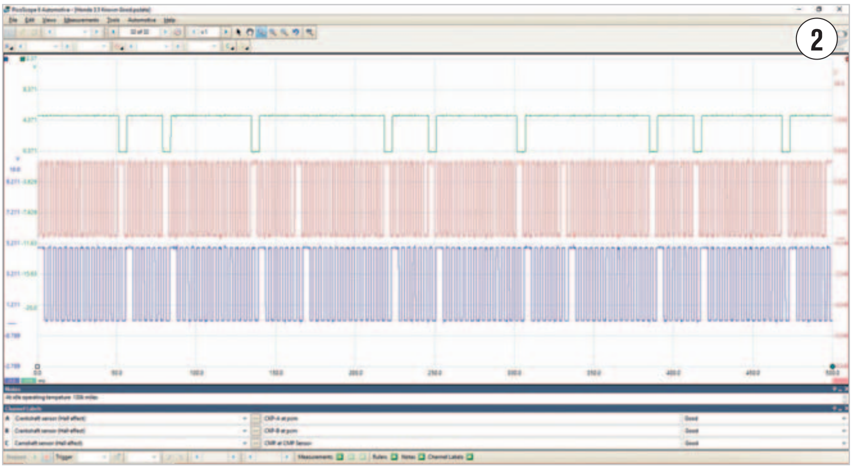
My practice is always to look at service information to get the code setting criteria and any related TSBs. I know what the code number is, and I also knew it is a hard fault that sets immediately when cleared. So, what is the PCM looking at? Why is it unhappy?

According to Honda service info (located on Identifix), this is the criteria to generate the P0389:

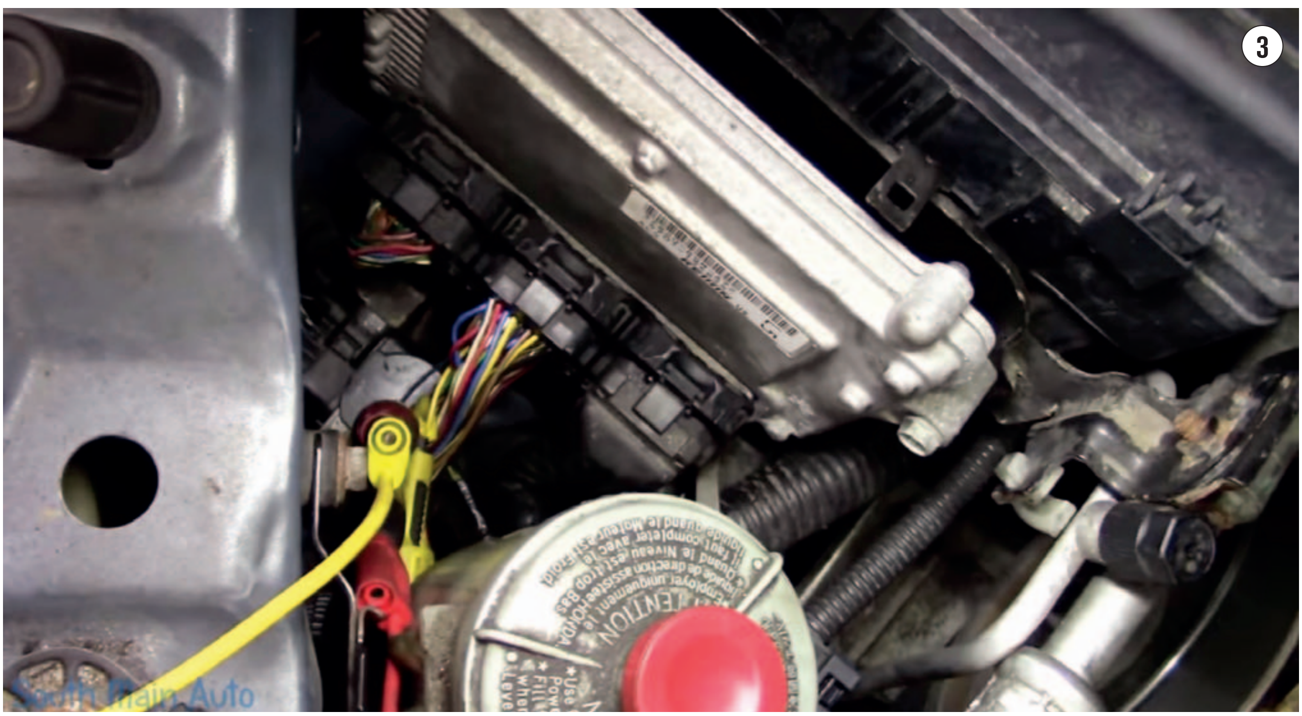
Crankshaft position (CKP) sensor B consists of a rotor and a semiconductor that detects rotor position. When the engine starts, the rotor turns and the magnetic flux in the semiconductor changes. The changes of magnetic flux are converted into pulsing signals to the powertrain control module (PCM). CKP sensor B detects injection/ignition timing for each cylinder and engine speed. If an abnormal amount of pulsing signals are detected from CKP sensor B, a malfunction is detected and a DTC is stored.

Malfunction threshold

Other than 22 pulses are detected during intervals between reference pulses for each crankshaft revolution. This condition has been detected at least 30 times.



Now that I was armed with the information and the insight as to what the PCM was looking for, I decided to grab my Pico scope and have a look myself. In my opinion, this is the only way to see what the ECM is seeing. If I determine the signal is good, then the other shop was on the right track and the PCM moves higher up the list as a possible suspect. However, before I can make that determination, I have to know what good or bad is, and the only way to do that is to refer to a "known good" example specific to the car I'm testing today. Fortunately, I had a known good CMP/CKP correlation waveform saved from one of these engines **(Figure 2)**.

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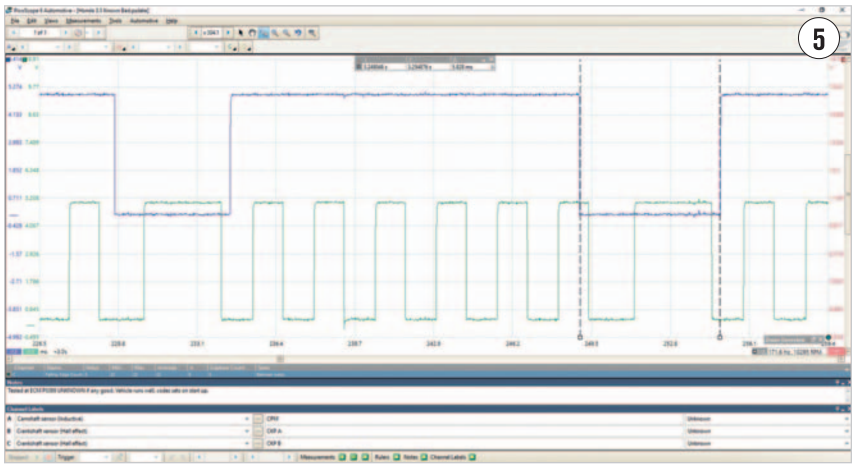
I tapped into the wires at the PCM for CKP A and B, as well as the CMP sensor (located on the front cylinder head, **Figure 3**). Now that that was done, I started the vehicle and gathered a few screens of data on the Pico and shut the vehicle off. I knew the amount of time it ran was long enough to set the code, so if the problem is present, we should be able to see it. At first glance it did not jump off the screen to me (**Figure 4**). I could see the crank timing was slightly more retarded compared to my known good, but when I zoomed in a little closer the problem stood right off the page. Aha! I found it (**Figure 5**)!



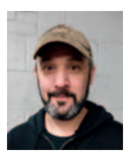
What's wrong with this picture?

I could see there was an anomaly in the CMP waveform and it was very consistent. One of the cam pulses was noticeably wider than the rest. It seemed to be triggering off at the correct time but for some reason it was turning on sooner. Why? Heck if I knew, but I knew it was likely causing the problem and triggering this code.

Now that the data was gathered, it was time to do some investigative work, so I removed the timing covers to have a look. I knew if the air gap on the cam sensor or trigger was changing, it could cause an issue like this. I inspected the cam gear for runout on the engine because it retains the raised bosses that trigger the cam sensor. I figured if it had gotten bent somehow it could cause this issue. Maybe someone used a puller on it servicing the cam seals? I knew it was a long shot and needless to say it ran true as could be.

Scratching my head for a moment I knew I had to go with the data. It never lies. I removed the timing belt and front cam pulley to have a look at the raised portion of the cam gear thinking, "Well heck, I really wasn't sure what I would see. Was it physically damaged? Was it magnetized? Was there something stuck to it causing this to trigger early?" Come to find out it looked perfect (**Figure 6**)! I even dug out the digital calipers and could find no difference between any of the three raised sections. I went with my gut (and the data) and made the call on the cam pulley. After getting approval from the customer, I replaced the front cam pulley and installed an OEM timing belt to correct the correlation being slightly off. Needless to say, I was 100 percent correct. After installing the new parts, relearning the CKP pattern in the PCM using a scan tool, the light was finally off. I also grabbed the waveform from the vehicle to stash in my library of known goods. A full drive cycle was performed and the vehicle returned to the customer after months of being out of service.

Could this problem have been found without guessing and without a scope? I honestly do not believe that it could have. The scope is a powerful tool, and I believe it is a necessity in any shop today. What better way to "see" electricity, gather data and make the right call the first time? MA



ERIC OBROCHTA is the owner of South Main Auto Repair LLC, a Napa Auto Care Center, in Avoca, NY since 2005. In addition to taking care of customer cars, Eric also provides mobile diagnostics and programming to other area shops. Born to shop-owning parents in 1980, Eric now shares his experiences with others as the owner of the popular South Main Auto YouTube channel.
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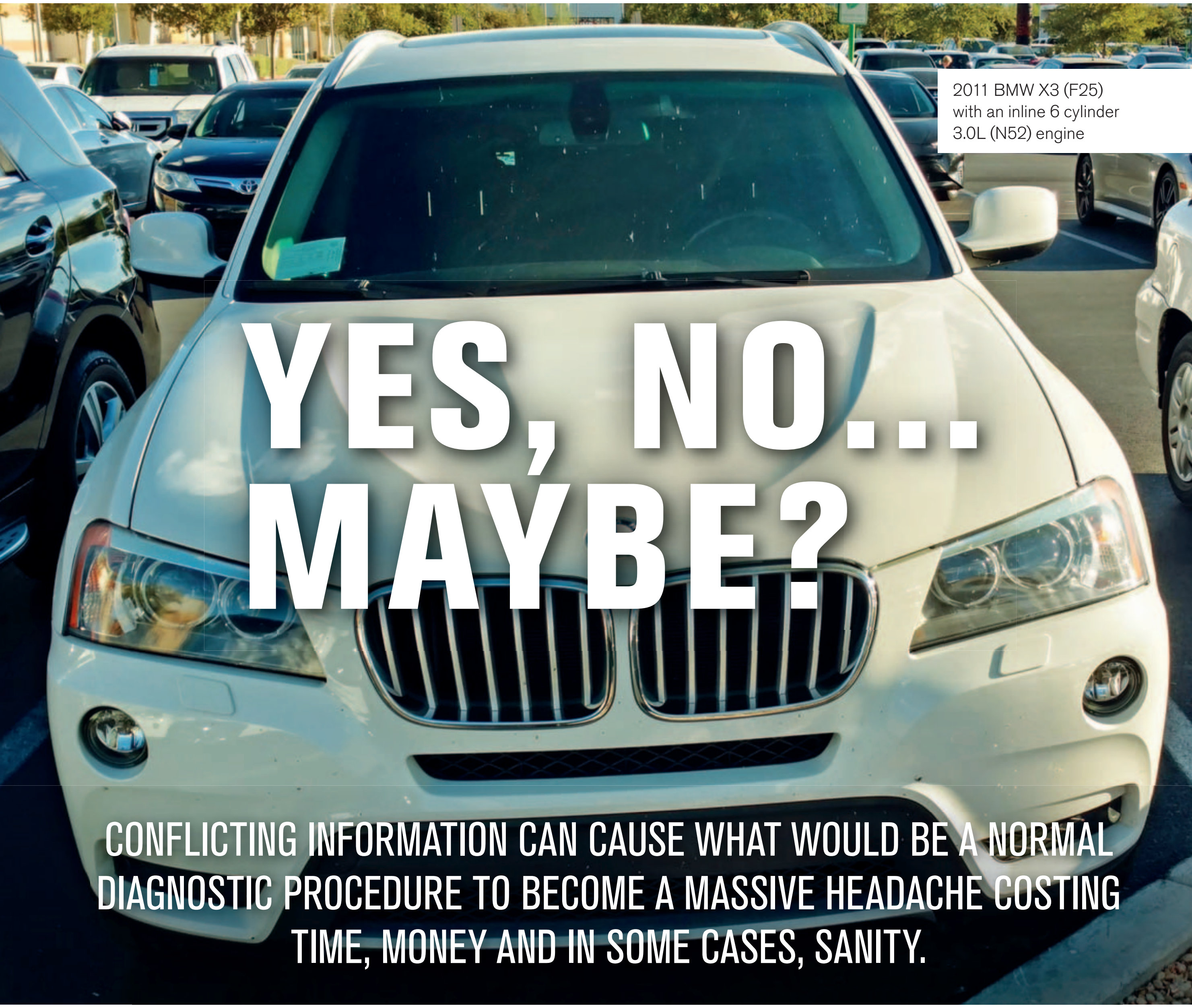


2011 BMW X3 (F25) with an inline 6 cylinder 3.0L (N52) engine

YES, NO... MAYBE?

CONFLICTING INFORMATION CAN CAUSE WHAT WOULD BE A NORMAL DIAGNOSTIC PROCEDURE TO BECOME A MASSIVE HEADACHE COSTING TIME, MONEY AND IN SOME CASES, SANITY.

MICHAEL MILLER // Contributing Editor

The vehicle that caused this is a 2011 BMW X3 2.8i (F25 Chassis) with a 3.0L (N52T) turbocharged engine. It was towed into the shop for stalling while driving and would not restart. I did not physically look at this vehicle on its original diagnosis but did offer the tech assigned to it some direction to find the problem. However, I was asked to get more involved and assist with the diagnosis when a problem still existed after the original repair.

The vehicle was initially dropped off with the concern that while driving, the engine sputtered and stalled. The engine cranked over fine but would not restart. Once at the shop the technician put the vehicle on a set of GoJaks Car Dollies to get it inside. Normally a couple of people would have just pushed the vehicle inside so they don't have to work out in the 115-degree Las Vegas summer heat, but this vehicle, like many other modern BMWs, will not shift into neutral if the engine is not running, making it very difficult to move.

No fuel or no fuel pressure?

Once inside the shop, the technician did his basic checks and

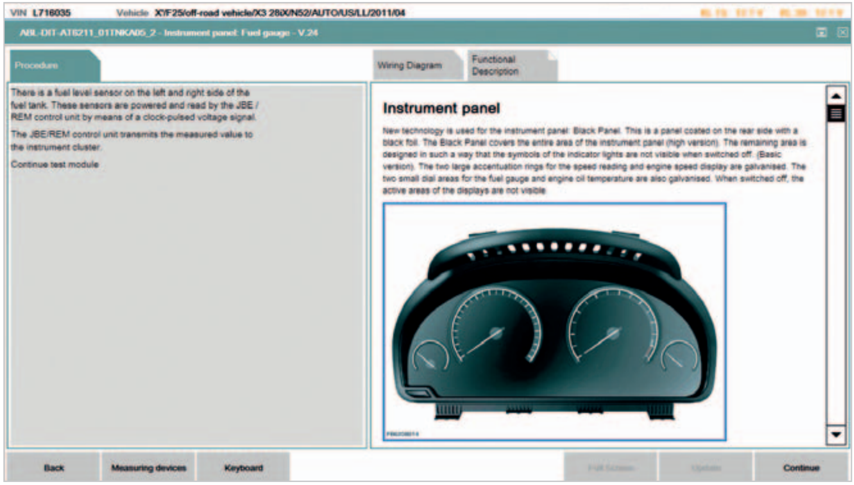
PHOTOS: MICHAEL MILLER

decided that fuel was the cause of the crank, no start. He stated that he had no fuel pressure with the engine cranking. I asked, "Is there fuel in the tank?" to which he replied that there had to be since the fuel gauge was reading at half a tank. Based on my experience, and probably anyone who has dropped a gas tank to replace a fuel pump only to find the tank completely empty, I recommended that he add a couple of gallons of gasoline before condemning the fuel pump just to be on the safe side. He did and the engine started within a couple seconds of cranking.

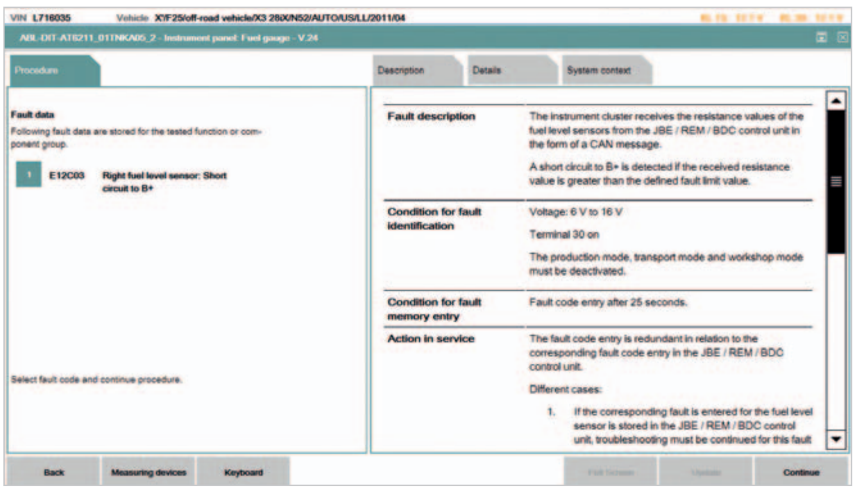
So the fuel pump was working but the fuel level was not being read correctly. The fuel gauge still read at half a tank, which cannot be correct for only having a couple of gallons of fuel in the tank. He came back to me later after some further diagnostic work and said that he had ordered the fuel pump assembly that came with the fuel level sensor. Well, OK running the pump with no fuel didn't do it any favors so I agreed with his conclusion. On a side note, I later found out that the fuel level sender is available separately without purchasing an entire fuel pump. The dealer did tell the tech that the fuel level sensor was part of the pump assembly when ordered.

New part, same problem

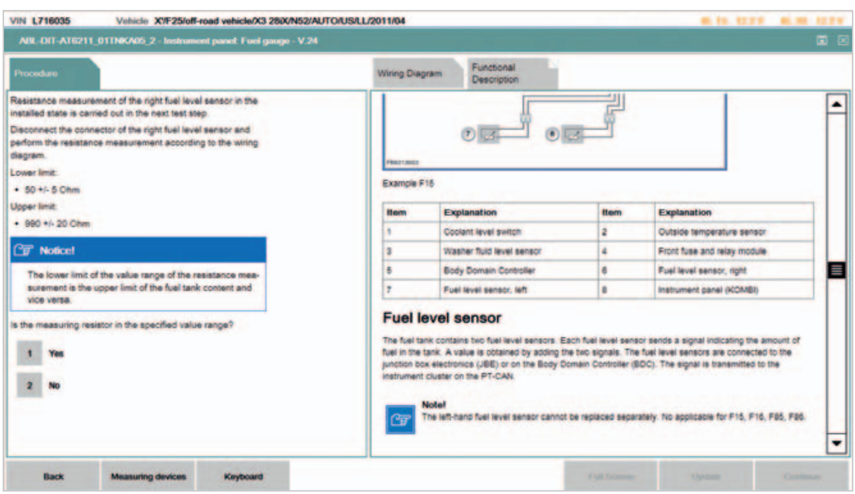
The new fuel pump assembly was installed and the technician noticed that the fuel gauge still read a little under half a tank. He then added more fuel to the tank and test drove the vehicle. The needle still remained at almost the halfway point. A call to the dealer parts department was made and the parts person stated that this model only has one fuel level sensor on the right side and no left-side fuel level sender was listed. He stated he also checked for TSBs and any matches in Identifix but came up empty handed.



USING THE TEST PLAN IN THE FACTORY SCAN TOOL gave me information on how the fuel level sensor circuit functioned. Most importantly, it contradicted what the dealer had stated and verified the vehicle does, in fact, have two fuel level sensors.



THE CODE POINTED TO THE RIGHT FUEL LEVEL SENSOR being shorted to battery positive; however, that sensor was already replaced with an OE unit.



THE TEST PLAN INSTRUCTS ME TO TEST THE RESISTANCE of the right-side fuel level sensor in the installed state, which agrees with the nearly empty fuel tank level.

At this point the tech had hit a wall since he replaced the only part responsible to indicate the fuel level — in his mind — but the same problem remained. Frustrated and out of ideas, he asked if I could assist with the diagnosis.

Noting that the vehicle has a saddle tank, I find it odd that it does not have a sensor on both sides. The rear seat is still removed and it is easy to see that there is an access hole on the passenger side for the fuel pump, but there is no cut out on the body on the left side for an additional fuel pump sender or jet pump. Next I look up the fuel level sensor theory of operation. I do find that (depending on the series) one or two fuel level sensors are installed in the vehicle. So at this point, it looks like the dealer parts person very well could be correct. As I read on, I find that voltage is supplied by either the Junction Box Electronics module (JBE) or the Rear Electronics Module (REM) or Body Domain Controller (BDC) or the Hybrid pressure refueling electronic control unit (TFE). We can rule out the last one since this is not a hybrid vehicle, but reading that there are three possible modules that supply voltage doesn't make this diagnosis any easier.

One of these control modules then measures the voltage drop across the potentiometer(s). From this a resistance value is added and it is transmitted to the instrument cluster (KOMBI) in a PT-CAN message.

Where is the information?

My first step is to hook up BMW ISTA, which is the factory scan tool for the vehicle. While the system is gathering its preliminary information, I also print out a wiring diagram to get an understanding of how the circuit is designed.

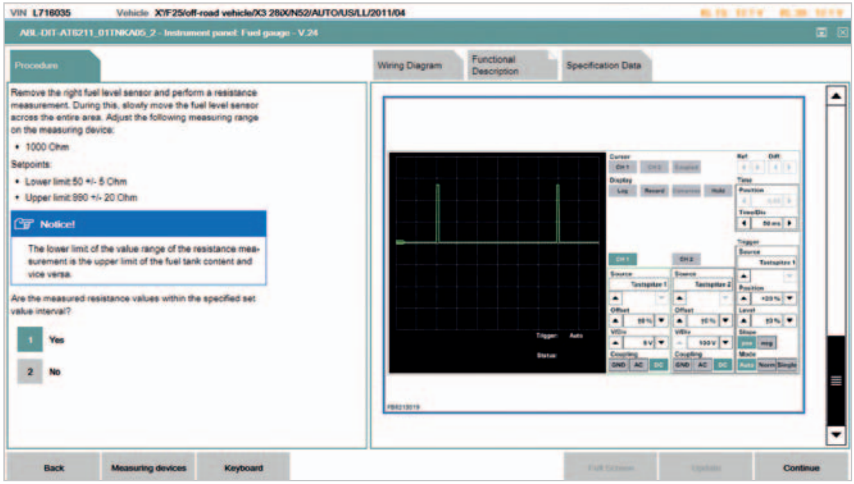
Something interesting occurs during both. First, I have a code in the Junction Box Module (JBE) and the Instrument Cluster (KOMBI) for the right fuel level sensor: Short circuit to B+. Several times codes may not be stored in the powertrain module but other modules may have codes that give clues to the fault being experienced. It is always a good practice to check for codes in all modules. This is something that is commonly done on vehicles, especially ones with Guided Fault Finding (GFF). Since all modules communicate over multiple Controller Area Networks (CAN), they all need to be included when performing a scan to help see problems in all system circuits. Second, according to the wiring diagram and ISTA's circuit description, the fuel level sensor signals go directly to the Junction Box Module (JBE). This knocks out the other ones listed in the circuit description I had referenced earlier. Most importantly, the circuit diagram shows two fuel level sensors, not just a right-side level sensor like the dealer showed on their system. This is later verified by the same information in ISTA.

With that information I proceed with the GFF in ISTA. I am instructed to disconnect the 6-pin connector to the right-side pump/fuel level assembly and measure the resistance of the right-side fuel level sensor. I am looking for a range between 50 and 990 ohms, and it passes. Next, I am instructed to remove the right-side pump and sensor assembly to test the range of the fuel level sensor while I physically move the float arm. Note that the lower limit of 50 ohms actually corresponds to the high fuel level of the tank and the high limit of 990 ohms would indicate the tank is almost empty. The range indicated by the ohmmeter as I was moving the float from empty to full shows that the right-side fuel level sensor is working correctly. When asked by the GFF section of ISTA if the measured resistance values were within the listed specifications I clicked "Yes." The response I received was disheartening: "The right fuel level sensor is OK. No fault can be currently found in the component group tested."

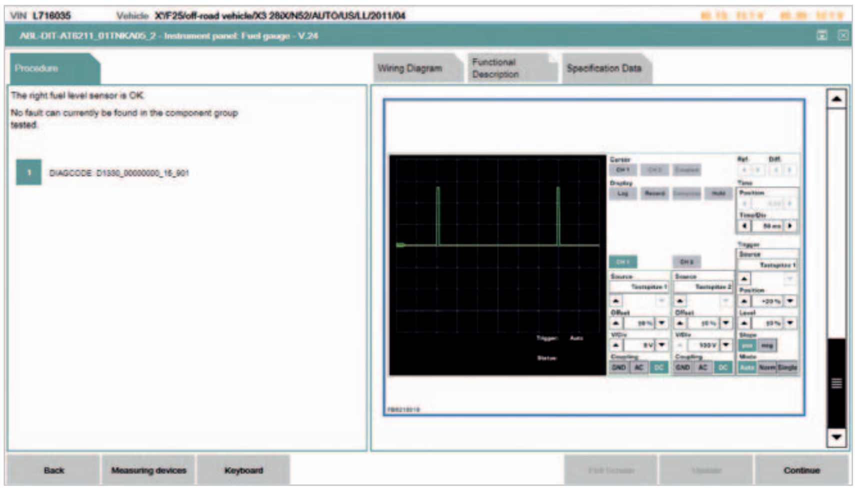
What's next?

Next, I clear the code and see if any changes occur in the fuel level on the gauge, thinking that if there is a code in the system, it may substitute a default value until the fault is rectified. There is no change on the fuel gauge (still stuck at a little below half full) and the same code for a shorted right-side fuel level sensor signal returns on the next key cycle. Knowing that the GFF in ISTA already did some circuit tests in the background during the beginning of the test plan, I'm fairly confident that the Junction Box Electronics (JBE) module is working correctly and the Instrument Cluster (KOMBI) is simply displaying the information it received from the PT-CAN.

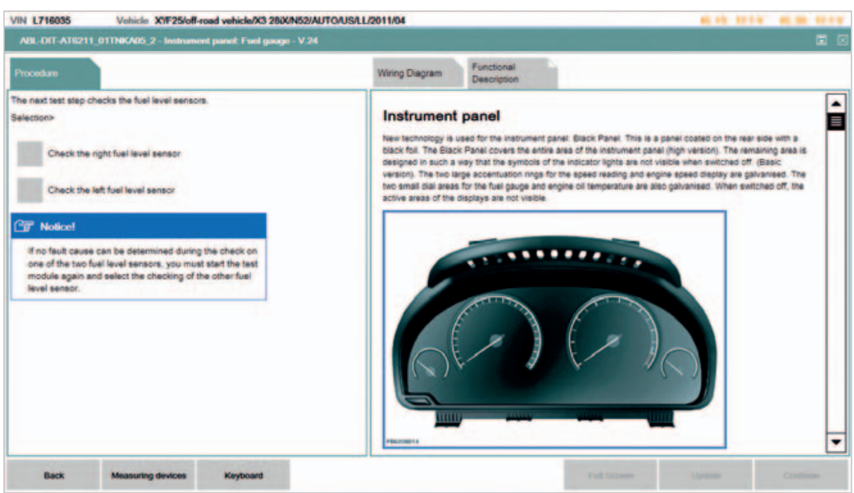
So now what?Run the test plan again? Replace the JBE? Replace the KOMBI? Since all test procedures are contained within the factory scan tool



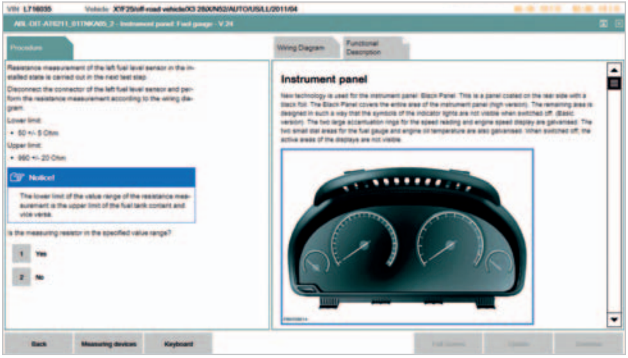
THE TEST PLAN INSTRUCTS ME TO REMOVE THE FUEL LEVEL SENSOR and use an ohmmeter to verify the resistance at full and empty levels while physically moving the float arm.



AFTER PERFORMING THE TEST WITH SATISFACTORY RESULTS, ISTA informs me that no fault can be found with the right-side fuel level circuit. However, the same code returns shortly after it is cleared.



AFTER INDUCING A FAULT CODE for both sensors by disconnecting the connector at the fuel tank, I am given an option to choose the test plan for the left fuel level sensor.



THE LEFT FUEL LEVEL SENSOR can only be tested in its installed state since there is no way to remove the sensor for testing like we did for the right-side fuel level sensor.

and there are no other test procedures that I can find, I created a fault with both fuel level sensors by unplugging them and causing the module to code for the left-side fuel sensor as well. Just a reminder that the left-side fuel sensor is not accessible from under the back seat like the right side; there is no access to it even when the tank is removed from the vehicle.

THIS CONNECTOR IS ALL THAT IS VISIBLE of the left-side fuel level sensor. Due to the saddle-style fuel tank, the float for the left side cannot be seen even while looking into the opening of the right-side level sensor/fuel pump assembly.

I now have an option to pick the test plan for either the right or left fuel level sensor. Something interesting that I noticed when given that option was a note in ISTA: "If no fault cause can be determined during the check on one of the two fuel level sensors, you must start the test module again and select the checking of the other fuel level sensor."

The test plan of the left-side fuel level sensor is similar to the right for the first part, but I cannot physically remove the sensor to move the float through its full travel while observing the ohmmeter. When measuring the resistance of the left fuel level sensor I notice a strange value of 577 ohms. The fuel level sensor has a range of 50-990 ohms corresponding from full to empty, and this fuel tank has less than two gallons of fuel in it. From that observation, I selected "No" when the test plan asked if the measured resistance was in the specified range.

Based on that response, the next screen in ISTA stated there was a fault in the left-side fuel level sensor. The repair was to replace the fuel tank. Using a mirror, I looked into the opening for the right-side fuel pump/level sensor assembly hoping to see the float on the left side of the tank so that I might be able to move the arm with a long screwdriver to see if the resistance on the sensor changes, but I only found the transfer tube and wiring disappearing into the darkness.

Pulling the trigger on the tank

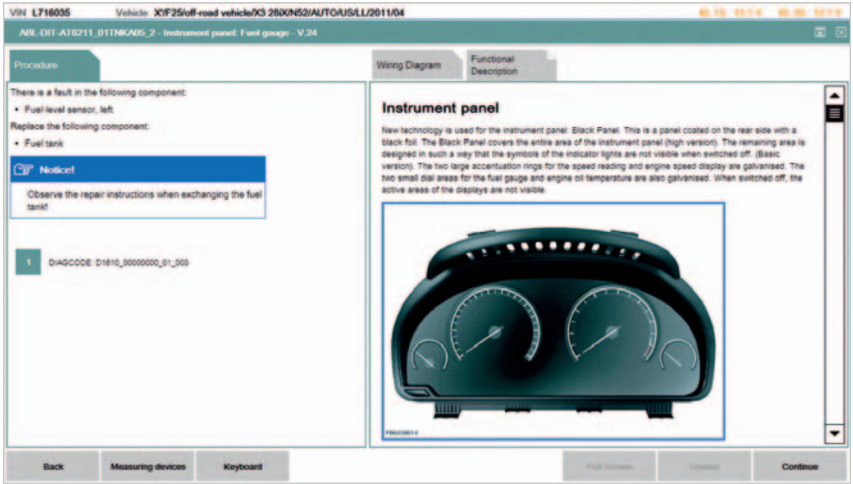
The cost of a new fuel tank (which includes the left-side fuel level sensor) is over $1,000, not to mention the 5.7 hours of labor it calls for to replace it. I'm sure all of us have felt that doubt when asked, "Are you absolutely sure that will fix it?"

With that large amount of parts and labor, I wanted to be sure that the rest of the circuit and components were working as designed for myself — but how? There was no way to test the sweep of the left-side sensor. Even if we filled the fuel tank, I could not see the left-side float to tell if it was actually moving. So, I decided to simulate the fuel level sensors with a pair of resistance decade boxes.

A resistance decade box is a device that will create a specific resistance using a combination of switches. With it I can create any resistance from 1 ohm to over 11 megaohms (11 million ohms) in 1-ohm increments.

I replace each fuel level sensor with a decade box attached at the 6-pin connector at the right-side fuel pump assembly. Each box was wired to the specific pins of its substituted fuel level sensor. Setting each box to 50 ohms and then changing each to 990 ohms, I was able to see the corresponding change on the fuel gauge from full all the way to empty. In fact, changing to various resistances, I could place the fuel gauge anywhere I wanted to.

This proved that the Junction Box Module (JBE), the Instrument Cluster



AFTER DETERMINING THE LEFT FUEL LEVEL SENSOR is not reading correctly, I am instructed to replace the entire fuel tank assembly, which is the only way to replace the defective level sensor.

SINCE THE FUEL TANK AND LABOR REQUIRED to replace it was very expensive, I installed a resistance decade box in place of each fuel level sensor and verified that the fuel gauge responded correctly to changing the resistances throughout the ranges specified in the test plan.

(KOMBI) and all wiring were all OK and I could confidently make the call to have the fuel tank and labor authorized, as this would fix the concern.

I do not know why the right-side fuel level sensor having a short to battery + was indicated when the left-side sensor was at fault. Looking at the wiring diagram, each sensor's value was determined by individual circuits to the Junction Box Module (JBE) and they were then added together. The sensor's circuits appear to be completely isolated from each other, so the left sensor should have been the one that coded, and I also don't understand why it was a short to battery positive fault. Perhaps it is just a software error, but it definitely caused a lot of frustration and confusion to something that if coded correctly to identify the fault component would have made the diagnosis fairly straightforward. MA

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PATTERN FAILURES THAT ARE ANYTHING BUT

HANDLING SURPRISE AND ANNOYANCE WHEN SEEMINGLY SIMPLE JOBS TAKE UNEXPECTED TURNS

RICHARD MCCUISTIAN //
Contributing Editor

One local service manager of a GM dealer told me that he has seen multiple technician applicants who managed to fiddle around with a small block Chevy in their backyard until they finally got it to start — and believed that one wrench-and-steel conquest and a couple of brake pad swaps on friends' cars qualified them for an A-tech slot in the dealer service bay. He doesn't hire them.

By far, we all know the best skill gained comes from performing lots of real repairs on vehicles people will be driving, day after day, one after another. And no matter how many vehicles we troubleshoot and repair, we're going to encounter some that we will remember for many a year. For me, well, I can think of dozens. But in those moments when we think we know what to expect when we draw a work order but get blindsided, it's downright annoying.

And then it gets personal — you against the machine — usually one-on-one, slugging it out, sometimes over several days. That kind of meat grinder works well for any skill level from my automotive students to full-blown techs. We never stop learning, and the tough ones put iron in our souls. And for those who are just getting started in this business or are reading these words as a consumer, this, ladies and gentlemen, is what we do.

THESE ARE NICE RIDES, BUT THIS ONE WOULDN'T MOVE

THE ONLY DIFFERENCE BETWEEN the noisy bearing and the non-noisy one was the color of the grease; there was no visible wear on the balls or the race.

The Durango

This one came in with a simple "Check Engine" light. And the initial annoyance was that this Durango started out by refusing to talk to us on the enhanced line, and while we did agree to have a look at the MIL issue, we aren't doing network/comm stuff this semester, so I had my

PHOTOS: RICHARD MCCUISTIAN

guys back out of the enhanced screen on and dive into the generic OBDII side, which is always a good idea anyway, because what doesn't show up in the enhanced room might appear in the generic one.

And on the generic comm line we found a P0520 code — that familiar Chrysler oil pressure sensor circuit failure. That's the one the PCM monitors even if the cluster doesn't have a gauge. We've done these on the V8 Chargers— a few of them, anyway. So I told the owner of the vehicle we could handle it — no problem. And we did. But we were surprisingly annoyed at just how involved that job turned out to be. And there were pitfalls.

This one was a 3.6L, and the upper and lower intakes had to be removed to access the rear of the oil cooler, where two different sensors are nestled. We packed the intake ports full of rags on the heads at this point for obvious reasons while the sensor swap was under way.

The oil temperature sensor was directly above the oil pressure sensor and also directly in the way, so it had to be disconnected and removed, and then the oil pressure sensor connector had to be disconnected, which turned out to be aggravating because the connector trigger was facing down and inaccessible. So, we'd need to turn the sensor to access the connector trigger. Piece of cake, right? Well, a thick, heat-stiffened wire harness was passing right next to the sensor and that harness was unyielding. Remember, we couldn't disconnect the sensor wire connector, so a socket was a no-go. And a 1-1/16 wrench is nice and beefy for turning big, tight fasteners, but it doesn't fit in a tight spot worth a toot. This sensor wasn't all that tight (1/8 pipe thread), but it was tight enough that even if you managed to shove the open end onto the sensor flats, we couldn't turn the sensor even a little without that heat-tempered 1.5-inch-thick wire harness forcing the fat wrench off the sensor flats. This was an annoying surprise.

I did some bench grinder work on one side of an old chopped-up 1-1/16 wrench I had already modified for something else, and we used that modified wrench to work the sensor around, getting it indexed so we could finger the trigger and remove the connector. We continued to use that same wrench to worry the sensor out, because even with the connector disconnected, the harness prevented the use of the sensor socket. We finger-started the new sensor and worried it back in until it was good and tight, then we reinstalled the previously removed oil temp sensor and reconnected all the wires. Then we went back together with it using new intake gaskets and whatnot.

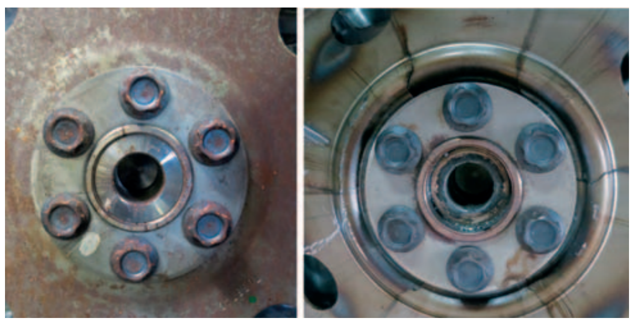
The job was a victory, but it took a couple of dedicated students just about an entire day to make it happen. That surprisingly annoying task was behind us, and so was the Durango and its MIL light.

The 2005 S10

THIS STOPLIGHT SWITCH ON THE 98 F-150 wasn't giving a problem until we replaced the booster. I ground some flashing off the molded-and-cast booster pushrod on the rebuilt booster to fix this one.

This 4-cylinder S10 was a beat-up little farm truck that came to us with the owner complaining of a hesitation, and sure enough it stumbled on takeoff. But even after acceleration, this dog was anemic at best. We applied the fuel pressure gauge to determine that the pressure was always steady and strong. We got a P0300 code, and on the scan tool misfire screen, cylinders 1 and 4 had recorded LOTS of misfires — thousands of them. Initially, I'd have believed there was a coil pack issue, since coil packs fire companions and 1 and 4 share the same coil on those. But this one is fitted

THIS BUSHING WAS NEVER INTENDED to contain a spinning torque converter snout. Subsequently, when the flywheel failed while driving, that's exactly what it did for probably 2 hours — and the results are plain to see.



ON THE LEFT IS A GOOD BUSHING IN PLACE (this was the 2004 engine). On the right is the cavity the destroyed bushing came out of when the flywheel was pried off. Note the cracked and overheated flywheel.

with COP coils. What else could cause multiple misfires on companion cylinders? Was the valve timing skewed?

Just for grins I had the students check compression, and they found that the firing cylinders actually had less compression (175 psi) than the ones that were reporting misfires (210). The two rear spark plug wells were awash with oil, so we did the valve cover while we were there. Those higher compression readings might have been due to surface quenching from unburned fuel, but it was strange, and we couldn't see a lot of difference in the spark plugs on the misfiring cylinders and the plugs on the ones that weren't reporting misfires. Just to be sure there wasn't a cam/crank issue, we PICO scoped the cam and crank traces to check for a timing situation, but everything lined up perfectly so we moved on.

After the valve cover gasket was in place, we tossed a couple of coils in the reportedly misfiring holes along with a full set of plugs, but nothing changed. Misfires were still being recorded on 1 and 4, but it honestly didn't feel like it was misfiring; it only seemed sluggish and a holding a rag in hand by the exhaust didn't show any puffing. And the ACE Misfire Detective was confusing enough as to be no help at all on this one.

At this point, I decided to focus on the MAF sensor because, according to my professional eye, the airflow readings didn't seem to reflect reality, even when MAF was the only PID being traced. Interestingly, when we unplugged the MAF and did a test drive, the truck ran like brand new, and as I peered through the sensor with my streamlight, the hot and cold wires seemed dirty — but cleaning the sensor only helped a little. This one needed a new MAF, but when we showed the farmer how good it ran with the sensor disconnected, he opted to drive it that way and ignore the MIL, since most of the time he's using this truck to herd cows. His call, I guess. But the surprisingly annoying part of this job was that the misfire counter pointed us in the wrong direction initially.

The Edge

One of my colleagues drives a Ford Edge. A while back we had to replace the brake booster, which was dreadfully annoying. Speaking of brake boosters, for a short (annoying) side story we had to replace the booster on a 1998 F-150, and after we changed the booster, the brake lights were always on because the booster pushrod had some flashing on it that had to be ground off so it wouldn't keep the switch closed all the time. Didn't see that coming!

On the Edge this time around she was having issues with her A/C. She reported that it'd run for about 30 minutes and then get hot on one side (dual zone), so, after we duplicated that and saw erroneous readings coming from the blend door actuator on the driver side, we replaced that actuator with a Dorman unit and let her try that, but after a few days, the Edge returned with the complaint that the A/C that would totally stop cooling after about 30 miles of driving.

In addition to that issue, her radio would always begin to search wildly for no reason after a few minutes — obviously an APIM problem (the 2012s are problematic this way), which we figured might have something to do with the A/C issue, but it didn't. We did that wacky Ford PTS software update/reflash with the IDS (with some guidance from Joey Henrich's AE tools guy), but the APIM radio function still wasn't fixed, so on her orders, we ordered a rebuilt replacement APIM from

THIS FLYWHEEL FAILED IN SUCH A WAY that the engine was able to spin the bolt circle very nicely. This was the perfect storm for the torque converter and its bushing, since the flywheel was stationary all this time — as was the converter.

Ford. The core charge is $500 on one of those, by the way, and replacing that unit fixed the radio — but by the time the APIM came in, we had already figured out the A/C problem.

After letting the A/C run in the service bay with the recycler connected so we could watch the pressures, we noticed that when the register got warm, the low side had drifted into the negative and the high side was hung at just over 150 psi — much lower than it had been when the A/C was cooling. That was our smoking gun.

An expansion valve took care of that one. As an aside, the owner had, on a previous day, dropped by a dealer shop when she was in another town for a quick check of the A/C and they told her she'd need a $1,500 evaporator case replacement to take care of the no-cooling issue because, in their words, "the actuators aren't communicating." I'm not sure what pocket to put that in, but she was glad she had opted against letting them do that!

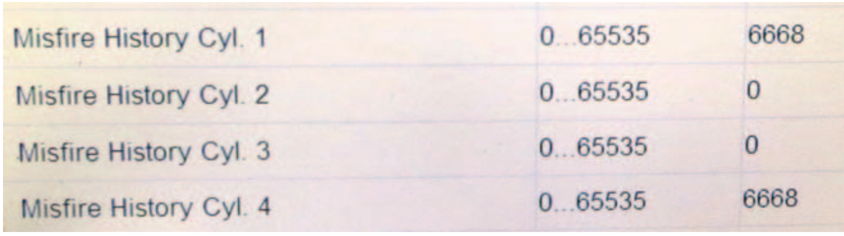
Mysterious bearings

Another one of my colleagues drives an old Sentra that had developed a nasty noise, and after we determined it was a bearing noise by doing some tire-swapping, we went out of our way to make sure we got the right bearing — these can be really tricky sometimes (can I get a witness?), and this one was no exception.

ON TOP IS THE BUSHING IN ITS BOSS — we used a high-speed cutter to surgically remove it. The middle is the bushing; the bottom is the bushing being driven into the rear of the crank on the Altima.

I told the owner that we might wind up having to replace both bearings and he gave us his blessing. Using the Chassis Ear® we thought we had it pinpointed as the one on the left front (swerving seemed to point to that bearing too), but when we broke it down I could have a good look at those shiny balls and race. I could tell that we had misfired on that — Mr. Murphy is alive and well, you see. But we were at the point of no return, so we installed that bearing and drove it again — no change.

With that, we attacked the other bearing, which still didn't show any brinelling or wear as we had supposed, but we did



Misfire History Cyl. 1	0...65535	6668
Misfire History Cyl. 2	0...65535	0
Misfire History Cyl. 3	0...65535	0
Misfire History Cyl. 4	0...65535	6668

THIS MISFIRE COUNTER LED US IN THE WRONG DIRECTION on the S10. At the end of the day, the farmer drove it home with the MAF connector swinging free. The truck ran good enough to chase cows that way.

THESE WERE THE READINGS WE GOT ON THE EDGE after it stopped cooling (with the A/C running, no less). After the expansion valve was replaced, it was good to go with limitless cold air.

notice that the grease in that bearing was discolored. Instead of a healthy cream color it was kind of brown, and even though the balls and races looked good, replacing that bearing eliminated the noise. We had no smoking gun, but we had a solid fix. That always bugs me, because I like visual verification of that kind of thing. Granted, you don't always get that with transmission or ring and pinion gears, but with bearings you usually see something. This time, not so much.

The Altima – A perfect storm

This one came to us with the story that a guy at a shop in another town had replaced the transaxle, but that after only two hours of driving around, the transaxle had started slipping and then stopped pulling and now the guy who had changed the transaxle was telling them it needed a flywheel. So they brought the car to us with a used flywheel they wanted installed. How tough or annoying could this one be?

We worried that CVT out of there to find that, although we had unbolted the torque converter, it stayed attached to the engine when the CVT was removed. Furthermore, it didn't want to come off at all. But it was rattling around loose. After using a big prybar and a hammer and whatever else it took, I managed to get the torque converter on the floor. It was at that point that I discovered a very serious issue.

The flywheel had broken smoothly enough that the engine was spinning the now-separate center of it. The outside of the flywheel and the torque converter were both sitting still while the engine was spinning to beat the band, and the pilot bushing those Nissans have in the back of the crankshaft had been whirling on the pilot of that converter until the pilot had become red hot and had swelled to the point that the pilot bushing came out of the crankshaft when we pried the converter out of there. This was surprisingly annoying, and that wasn't all.

This was ultra-nasty, because all the information I found was that the bushing in question is not obtainable apart from buying a replacement crankshaft. Granted, with the right dimensions, a machine shop could have made us one on a lathe, but machine shops are hard to find these days.

As it was, this customer got lucky. It just so happened that I had a defunct 2004 Altima powerplant sitting in the engine shop that had been swapped out because it was knocking, and I got the bushing out of that one. It was an annoying process, but with a high-speed cutter, we made it happen. The bushing was a perfect fit, and with a replacement torque converter and the CVT back in place, the Altima was good to go.

The customer asked if the previous tech had done anything wrong to cause this. My answer was that he hadn't, and that was that. I told them about a transmission we had replaced in a four-wheel drive Expedition that came back a month later with a busted flywheel it's always annoying but sometimes it happens. MA

RICHARD MCCUISTIAN is an ASE-certified Master Auto Technician and was a professional mechanic for more than 25 years. Richard is now an auto mechanics instructor at LBW Community College/MacArthur Campus in Opp, Ala. *rwm19@mail.com*

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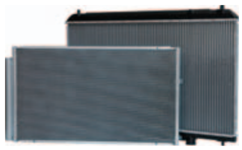

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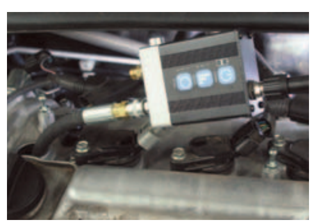

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AD INDEX

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TRAINING

UNDERSTANDING GROUND-SIDE VOLTAGE DROP

PROBABLY THE MOST CONFUSING METER READING YOU'LL EVER SEE IS A POSITIVE VOLTAGE WHEN YOUR METER IS CONNECTED TO A GROUND AT BOTH ENDS.

PETE MEIER // Technical Editor

I'll never forget my visit to Wells Vehicle Electronics, made early in my career here at the magazine. I was invited by Mark Hicks, Wells' Technical Service Manager. Mark was an early adopter of YouTube as a means to communicate with his customers, and the channel that he started back in 2008 is still going strong today.

The company headquarters was, at the time, still located in the same building they had started in back in 1903. Interestingly, their primary business then was the manufacture of wiring harnesses for electric vehicles! In the early days of the automobile, only the affluent could afford such a luxury, and the blue bloods of the era hated the idea of having to get all dirty cranking over a gasoline-powered "horseless carriage," let alone having to deal with all the noise and fumes.

In one nearly-forgotten part of the building, Mark and I stumbled across an old Chrysler training display — a flip chart that explained voltage drop as a testing method for locating parasitic drains on the battery. Flip charts, in case you didn't know, were the early versions of the PowerPoint presentations instructors use today. This one was developed to help techs back in the early '60s!

I bring all this up to get to this point. Voltage drop testing and electrical issues have been around as long as the car has. It confused techs then, and it still does today. And nothing seems to confuse us more than seeing a positive voltage reading on our DVOM when both of the meter leads are attached to a ground.

But the reality is that many of the electrical problems our customers experience are due to problems on the ground side of the circuit. Without a clean and unrestricted way back to the battery, no load device (from a turn signal bulb to an ECU) can function the way it is supposed to. And voltage drop is the most effective way to find them.

So, in this month's episode of The Trainer, we're going to revisit the topic of voltage drop with an emphasis on the ground path. Together, let's take out the confusion of understanding what your meter is telling you and help each other become more effective at electrical troubleshooting! MA


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