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AUTOPRO WORKSHOP

DECEMBER 2017

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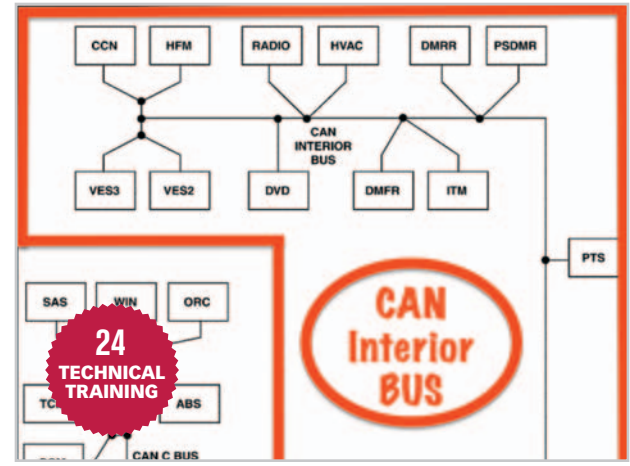

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Brian Bates, owner of Eagle Automotive Service, and Randy Pickering, owner of Pickering's Auto Service share insight in the latest podcast from NAPA AutoCare Experts and *Motor Age* to help you decide if offering customer and commercial financing is right for your shop.

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Every year, more than two billion Oetiker clamps and quick connectors are trusted by the world's OEMs. The Swiss company attributes its success, in part, to long-lasting partnerships. In March 2016, Oetiker announced its newest partnership — the acquisition of Jiffy-tite, another powerhouse in fluid connections.

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TRAINING RESOURCES

TECH BOLSTERS KNOWLEDGE WITH VIDEO TRAINING RESOURCE

CHELSEA FREY //
Senior Associate Editor

Motor Age aims to help readers stay up to date with the newest industry developments, and its latest training offering is making that mission even easier.

This summer, the UBM Automotive Group announced the launch of a new video-based training resource — *Motor Age Training* CONNECT, powered by AutoMate.

When Jonathan Lowen, a technician from Vancouver, British Columbia, Canada, saw a demonstration of *Motor Age Training* CONNECT this summer, he signed up for the service immediately.

>> CONTINUES ON PAGE 6

BREAKING NEWS

A/C CHANGES

MACS REMINDS INDUSTRY OF A/C CHANGES IN 2018

Technicians who service mobile A/C systems and distributors who sell refrigerant need to be aware of new regulations effective on January 1, 2018 concerning the requirement of technicians to be Section 609 certified.

- The final rule published November 2016 extends Section 608 requirements to HFCs. Starting Jan. 1, 2018, sale of most refrigerants of two pounds or larger will be restricted to 608 and 609-certified technicians; distributors must keep refrigerant sales records and verify purchasers are (or employ) 608 or 609-certified technicians.
- Small cans (2 pounds or less) of non-exempt refrigerants may continue to be manufactured or imported and sold after Jan. 1, 2018, if equipped with self-sealing valves.

>> CONTINUES ON PAGE 6

TRENDING

TENNECO VIDEOS TO HELP CUSTOMERS GROW BUSINESS

Tenneco will introduce the first of several installation videos and other resources to help shops grow their business with Monroe suspension conversion kits.

MOTORAGE.COM/GROW

NEW DANA WEBSITE TO IMPROVE CUSTOMER EXPERIENCE

Dana introduced a new website to provide "better" customer experience for the Victor Reinz® and Spicer® brands by offering improved parts searching capabilities.

MOTORAGE.COM/BETTER

WYOTECH LAUNCHES ALUMNI ASSOCIATION TO SUPPORT STUDENTS

WyoTech is launching its first alumni association to connect more than 64,000 graduates with ongoing career development opportunities, mentors and philanthropy.

MOTORAGE.COM/ALUMNI

NASCAR DRIVER TEAMS UP WITH TECHFORCE

NASCAR driver Julia Landauer has signed on as an official partner of TechForce Foundation and its FutureTech Success campaign, that aims to drive tomorrow's workforce to the industry.

MOTORAGE.COM/JULIA

INGERSOLL RAND DONATES $500,000 TO HIGH SCHOOL CLASSES

The Ingersoll Rand Foundation has awarded 50 high schools $500,000 in grants since 2015 to fund improvements to their automotive technology programs.

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>> CONTINUED FROM PAGE 4

Since then, Lowen has worked his way to the *Motor Age Training* CONNECT level 10 masterclass courses.

Motor Age Training CONNECT is designed to keep automotive professionals up-to-date on the latest vehicle technologies and repair techniques. Featuring more than 350 video training modules, the portal is the go-to online resource technicians need to maintain skills and find advanced solutions to consumer vehicle complaints.

Video training is an increasingly popular and convenient method of learning for today's technicians, and Lowen is a perfect example of someone who has benefited from this type of learn-at-your-own-pace education.

Lowen has been in the service repair industry for four years and is currently a level 3 apprentice working at an independent shop in Vancouver as the head technician. Due to a lack of in-class training opportunities in his region, Lowen often learns from online resources, textbooks and YouTube training videos.

Thus, *Motor Age Training* CONNECT was a perfect fit. Lowen expresses, "My experience with the *Motor Age Training* CONNECT video-based training courses has been wonderful. The instructors are engaging and don't put me to sleep. There's a wide variety of video subjects and topics ranging from basic suspension principles to advanced electrical component diagnostics. Sometimes there are even tech tips and tricks in the videos, which have helped with my diagnostics in the workplace."

The video training modules cover dozens of automotive subjects, including engine performance, driveline systems, steering and suspension, electrical systems, HVAC systems, technical information and tools and equipment, among others. In addition, the videos include industry news and resources such as tool specs, recalls and DTC information.

Lowen's favorite topics have been the electrical system operations and diagnostics. He explains, "My specialty is electrical diagnostics and repair and engine performance diagnostics and repair. The videos related to these topics have kept me up-to-date on new systems and have taught me so much about how the systems work. I believe that knowing how a sensor, switch, motor or module operates is essential to being a great technician. So many times I have seen a parts cannon loaded up and fired at a vehicle when a basic understanding of how the system operates would have saved the customer time and money."

The standard access package for *Motor Age Training* CONNECT is $24.99 per month, and the premium access package, which includes *Motor Age* original content and video training tools from Pete Meier, director of training, UBM Automotive Group, and other contributors, is $29.99 per month.

Lowen's dedication to training and keeping up on the latest vehicle technologies will lead to a bright future in the service repair industry—something *Motor Age Training* CONNECT has helped bolster. He expresses, "*Motor Age Training* CONNECT has been a huge benefit to my career. The more I know about a customer's vehicle and its systems' operations, the better I can serve the customer's needs. The videos teach me diagnostic strategies, shortening the amount of time needed to diagnose a vehicle's issues, which is money in both the business' and our customers' pockets. I have recommended *Motor Age Training* CONNECT to every single technician that I know. The service is fantastic and worth every penny."

Sign up for your subscription to *Motor Age Training* CONNECT today at connect.motoragetraining.com.

>> CONTINUED FROM PAGE 4

- To learn more about Section 609 certification visit the MACS website at www.macsw.org. To view the new regulations on the U.S. EPA website, visit www.epa.gov/section608/refrigerant-sales-restriction

There is no mandatory re-certification — Section 609 certification once obtained is good for life. Technicians who have lost their MACS or IMACA certification may replace their credentials for $10 by calling the MACS office at (215) 631-7020 x 0 or following the directions listed on the Section 609 page of the MACS website at https://goo.gl/PhRzEF.

"The MACS staff has been busy answering questions for technicians and distributors who are confused or have been given wrong information about the new requirements. MACS wants everyone to understand that if you are Section 609 certified, your credentials are good for life. If you have lost your credentials and are MACS or IMACA certified, MACS can issue a reprint of credentials for a $10 processing fee," explained Elvis L. Hoffpauir, MACS president and chief operating officer.

Technicians who are not certified can become certified by visiting the MACS website at www.macsw.org. The newest Section 609 certification program, which debuted in 2015, includes training on handling R-1234yf. Section 609 certification can be obtained through a written or online test for $20. Group classes can also be arranged by contacting their training department at (215) 631-7020 x 304 or emailing marion@macsw.org.

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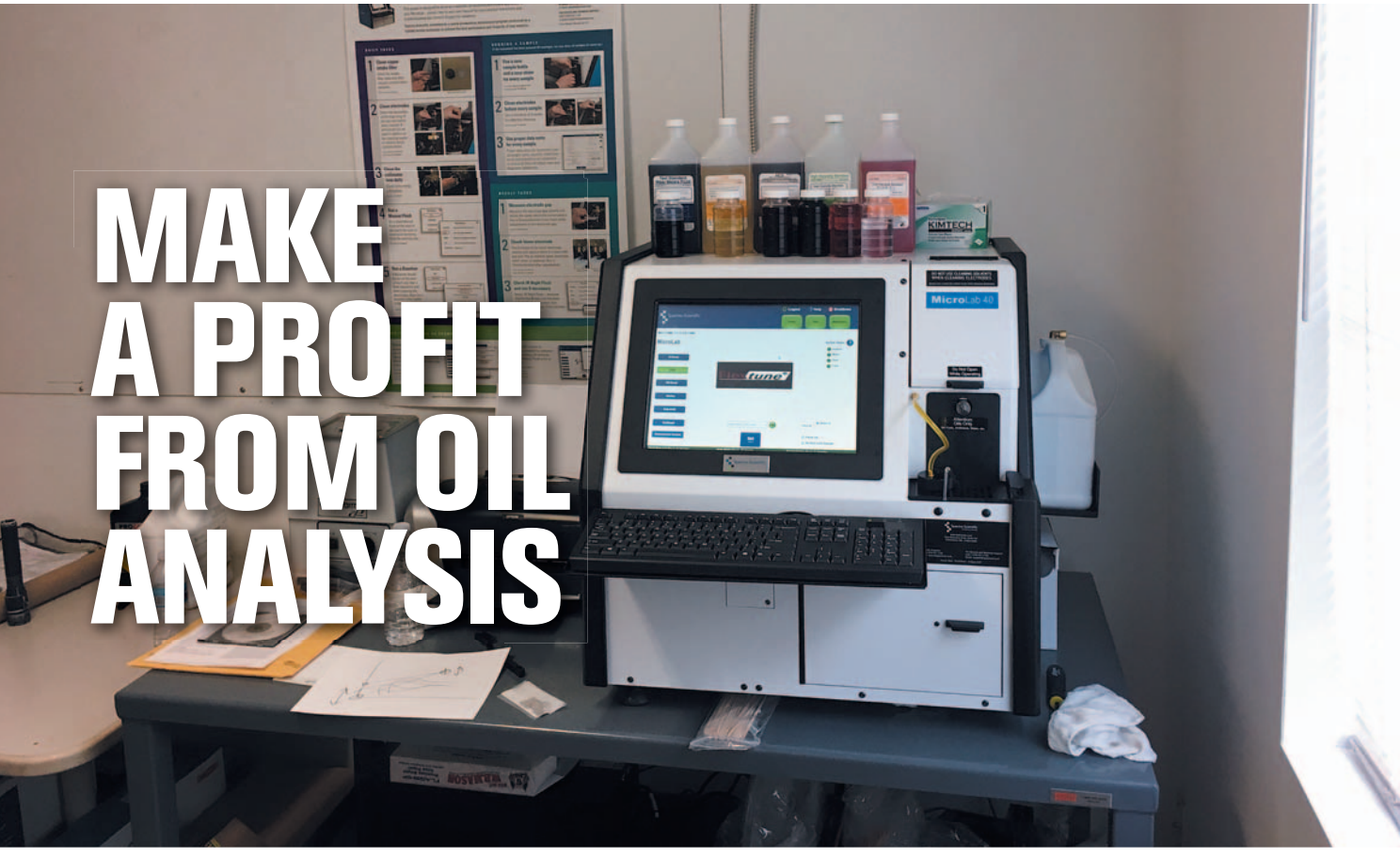

MAKE A PROFIT FROM OIL ANALYSIS

Five tips to get the most out of an oil analysis system

MICHAEL PHILLIPS //
Contributing Editor

I recently brought oil analysis to my automotive repair shop. I've learned quite a bit about applying oil analysis to my daily operations, and thought I would share my experience. Oil analysis is used by the vast majority of organizations operating fleets of vehicles, ships and equipment such as heavy- and light-duty trucks, police cars, tractors, cargo ships and naval vessels, construction and mining equipment, etc. Oil analysis enables these organizations to closely monitor the condition of engines and transmissions and their oil, making it possible to identify and correct issues before they cause catastrophic failures. But oil analysis instruments have long been too expensive, too complicated and too slow for the auto repair market. Today, new oil analysis instruments have been simplified and are much quicker — in some cases you can get a report in just 10 minutes with test data and diagnostic information. This is convincing many repair shop owners to take a second look. These instruments have the potential to create a new revenue stream while earning customers' goodwill by providing a more accurate diagnosis. Here are five tips that will help you get the most out of an oil analysis system.

1. Help your customers keep their older cars going

Most of our customers' vehicles are 5 to 15 years old and nearly all are daily drivers. Our customers depend on these vehicles to get them to work, to take their kids to school, to go to doctors' appointments, etc. Oil analysis makes it possible for us to do a better job of helping our customers keep these cars running by giving them the information they need to make informed decisions on whether or not to invest in their vehicles. As an example, one of my customers brought in a 2000 Ford Ranger with 175,000 miles. She loves the truck and wants to keep it. But the vehicle needed $2,500 worth of repairs and she was in a quandary as to whether or not to make the investment. She gladly paid $90 each for analysis of the engine and transmission oil. Both tests came back clean. The

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customer made the decision to have us do the work with confidence that the engine and transmission are sound. She is elated that she gets to keep her favorite truck running.

2. When oil analysis is justified, give the customer a reason to buy it

It would be overkill to recommend oil analysis to every customer who brings their vehicle in for an oil change. A better approach is to broach the subject when you see something that makes you suspect an engine or transmission problem or when the customer is faced with the decision of whether or not to invest in an older vehicle. For example, one customer brought in a Subaru with 120,000 miles on the odometer for an oil change because he was about to go on a long trip. When we checked, there was no oil on the dipstick. I recommended oil analysis and the customer said go ahead. The analysis showed an elevated level of iron in the oil which most likely came either from the rings or cylinder walls. We informed him that the car should survive the trip but that it was likely to burn oil, so he should check the oil level every time he filled the tank. When he got back from the trip he told us he had to add oil midway through the trip and said he understood that if he had not been checking, the car might not have made it. Soon after, he brought in his other car, his wife's car and referred a friend, all for oil analysis. An important point to note — the person who recommends oil analysis to the customer should be the owner of the shop, the shop foreman or the technician. This makes it clear to the customer that you are not merely looking to upsell him or her but rather that you have a good reason to suspect a problem. Under these circumstances, the customer says 'yes' to the recommended oil analysis 90 percent of the time.

3. Build customer loyalty by stopping them from putting money into a vehicle that's about to die

Overselling is the quickest way to lose a customer and get bad word-of-mouth. If I sell a steering and suspension overhaul and the engine blows up in a month, my customer may blame me even though I had no way of knowing the motor was about to go. Oil analysis enables me to give my customers the information they need to make a decision that they will be happy with over the long term. As a case in point, a customer brought in a 2001 Jeep Grand Cherokee with 4.7-liter engine. The engine was running hot and there was no oil on the dipstick. I suggested performing oil analysis to find out why the car was overheating. The results showed both wear metals and coolant in the oil, indicating the engine was nearing the end of its life. The car could have been sold or traded in its current condition for $4,000 to $5,000 but it would have only been worth about $500 to a junkyard after the engine died. The customer decided to get rid of the car immediately. Clearly, he was impressed that we were willing to give up immediate revenue for the customer's benefit. He later came back for a pre-purchase oil analysis on his new vehicle and he has continued to bring it to us for service.

4. Protect the customer and the shop

This is the first time I have been able to peer into the heart and soul of my customer's vehicle without the cost of a teardown. For example, one of my customers brought in a car with 168,000 miles and wanted it checked out before she left on a cross-country trip. The transmission oil analysis came back with high iron. We pulled the pan and discovered 14 teeth that had been shucked off a planetary gear. I warned the customer not to take this car on her trip. She decided to take it anyway but with the understanding that the transmission could break down at any time. Before she left, she spent around $1,100 on other repairs that were needed for the car with the intention that she was going to drive it until it quit and then buy a new vehicle. If I had not performed the oil analysis she would have been surprised when the transmission died and might have blamed it on me.

5. Turn an unprofitable $30 oil change into a profitable $100 to $200 value-added service

Oil analysis today can be a very profitable service for a repair shop because you don't have to buy the analyzer. Instead you can pay by the sample. For example, our total cost of performing each analysis is $27 per sample. Our only up-front investment was three months of prepaid fees and a bench for the small room just off the shop floor where we house the analyzer. We offer the service at $90 per engine or transmission, the equivalent of one hour of shop labor. So we make $63 on each sample. Our shop has been averaging over 50 oil analysis sales for the past six months. As a result, oil analysis is the product with the highest revenue and profit per square foot in my business. As sampling volume increases, it has the potential to generate additional profits both via direct sales and increased sales of repair services. Most important, oil analysis builds customer loyalty by enabling us to deliver superior service when our customers are facing difficult decisions about whether or not to invest in an older vehicle.

MICHAEL PHILLIPS is the owner of Flextune, Inc. an automotive repair shop located in Bloomington, Ind. He can be reached at *flextunetech@gmail.com*

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You need someone to fill the role of three managers wrapped into one

I get it. You started this business on your own and grew it all by yourself. Now, you want to have time off — some time for yourself and your family. But one important question remains: Who can you trust to run your baby?

It's an incredibly hard decision, and this won't make it any easier. Keep in mind that every coach we have at ATI never ran a shop with the owner present. It's just not the way we do things here. You pay us very good money to run your shop, and you shouldn't have to be there.

If you want time off but still want to have confidence in your shop running so effectively that you don't have to be there, then you need something very complicated to find: three managers, all wrapped into one, to give you the best results.

Let's listen to our Director of Client Fullfillment George Zeeks explain how you can accomplish this, which is one of the toughest challenges in any business owner's life.

The retail manager

This is the easiest and most routine type of manager you can have. They keep the bathroom clean, the coffee area running right and the magazines neat and orderly. There is not a lot of creativity needed here — just attention to detail and always keeping the basics in mind. The daily deposit is run and correct every day. The cash drawer is right and on the money.

The biggest issue that we see many shop owners facing is that many of you haven't trained your manager to do these things because you assume they are too basic and that the person you have hired in this role should just know what to do. However, nothing is too basic.

You wouldn't believe how many owners don't reconcile the cash drawer every single day. They don't even make a deposit every day. Communicating the expectations of these basic tasks is a huge first step in becoming an owner who is not in the business every day. This can be a challenge, but nothing compared to the next level.

RUNNING YOUR OWN BUSINESS IS HARD. YOU NEED TO FACE UP TO THE FACT THAT YOU HAVE TO GROW OTHERS IN ORDER TO BE SUCCESSFUL.

The sales manager

This is the manager who not only sells stuff but who can manage the overall sales of service advisors across many cases and scenarios.

The basic principle of every business is that you have a product or service and you sell these products or services or a combination of both to your customer. The sales manager must relate to your customers in the most basic way possible and relate to why the customer needs your goods or services.

Most owners do not do a great job of this due to fear. A lot of owners are afraid that people won't like them if they give the bad news. Customers don't want to hear bad news, and being the bearer of bad tidings is a difficult task. But I say suck it up. That's the job. We have to let people know what is wrong with their car. If it's a lot of money, then they really need to know. Maybe they would want a new car? Maybe they don't have the credit for the new car? We have a responsibility to tell them what is really going on, so they can make the right decision.

The key is to have someone who can explain what is going on in a way that the customer can understand. I have, personally, never believed in selling someone a repair on their car. I have always believed that we need to explain and cover everything that they need in a way they can understand, and then it becomes a logical choice as to whether a customer should do the repairs or not.

You need to build value in what you are going to do to a customer's vehicle and why you are going to do it. You have to clearly explain the pros and cons. You must cover, in detail, the features and benefits of what the repairs entail.

The customer needs to understand what is involved in your recommended repairs, what everything costs and why it is important that it be done now. Offer anything less than that and you are taking shortcuts that will always eventually cause pain to the customer or the business.

The sales manager also manages the promises made to the customer and the true end result that they receive and experience. Is the car done

when promised? Are we communicating with the customer along the way? Many shops have said that they receive way too many phone calls on a daily basis from customers. One reason for that may be because the shop isn't setting the proper expectations and then following up on them. The customer must be kept informed throughout the entire repair process so they always know what is going on. Anything else can turn into a disaster.

The sales manager also has the responsibility to secure the customer's next visit. A lot of people don't want to hear this, but this is the foundation of any business. Employees typically don't quit the overall business; they quit the manager. And this is often reflected in the behavior of the customers as well. The sales process doesn't end until the customer picks up the vehicle and is happy. Anything less than that will cost you your future.

So, let's say you have the first two covered and all is right with the world. That still doesn't mean that you are profitable; that doesn't mean that your shop is running anywhere near capacity. What you need now is the production manager.

The production manager

This is the next and most important step needed in order for you to have a shop that runs without you there. The manager that can drive production, in addition to all the other things, is crucial to a profitable shop.

This manager gets the most out of the crew and always gets the most out of the shop. Technicians love and can also hate a good production manager. That manager demands higher performance and expects more overall from the staff. The common phrase is that "you'll hate me today, but love me on payday." The manager gets the most out of each member of the crew.

The production manager is always concerned with the technical training and job skills improvement of every staff member so that the shop is always moving forward, improving and growing. They understand the time deadlines that everyone across the business is facing. They always have a hand in making sure that the right person is adequately assigned the right job. It doesn't help anyone to give the wrong job to the wrong person. In that scenario, everyone pays a penalty. Why would you want to set someone up to fail? It doesn't help the staff member or the shop and especially not the customer.

This is the hardest job in the shop and most owners have a hard time growing the manager into this role. I know that you can do it better than anyone else. I get it. If you want the time off, then you must put the quality time into the person who will replace you. This is the hardest thing to teach and to learn. This manager is constantly checking on the crew. Did you get the parts you needed? Have we gotten the approval for the repairs? Is there anything that you are having a problem with? If any of the above things are going on, then we take a step back and evaluate where we are. Do we need to call the customer and get more time? Do we have an issue where we must sell more time? These things are an ongoing process that the production manager must deal with. So you don't have to!

To some of you, this must sound like an impossible task. How can I find one person who can do all three things at one time, especially to do them the way I want them done? I will be honest. It can be hard. It takes time and patience. It takes commitment and an investment in the individual to help them reach the next level. It doesn't always work out, but every attempt makes you better prepared for the next one. Life isn't easy, and running your own business is even harder. You need to face up to the fact that you have to grow others in order to be successful. That's what makes it all worthwhile.

If you would like a checklist to help evaluate your shop to see if you are ready to reach that next level, you can go to *www.ationlinetraining.com/2017-12* for a limited time.

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 115 associates train and coach more than 1,400 shop owners every week across North America to drive profits and dreams home to their families. This month's article was written with the help of Coach George Zeeks. *chubby@autotraining.net*

Think about 2018 as the year for measured growth

You must progress your shop to the aftermarket's new service-on-need model

Let's take a look at your business, assuming you have made a lot of progress in 2017.

You have been working on relearning the business and are becoming more familiar with your shop numbers and realize the key ratios such as the total billed labor to wage package ratio, year-to-date average cost per billed hour and average billed hours per R/O in its various labor categories and how those kind of measurements are so critical to building net income.

You have developed many tools within your business that no other shop in your area has, and it's time to play that up as to how unique you are for the client and what you bring to the table that serves that client very well. Play the card on how you communicate with and educate prospective clients and what it does for them. Play up the internal processes as to how you book the vehicle service time and why you do it that way. Play up the follow-up procedures that are in place and how you manage the vehicle service intervals on behalf of the client based on how they use their vehicle.

OUR INDUSTRY IS CHANGING FASTER THAN EVER BEFORE; IT IS IMPORTANT THAT YOU HAVE AND EMBRACE A CONTINUOUS LEARNING CULTURE.

Get focused to go after and attract new retail and wholesale business starting on the first of the year. No need to wait. Have a staff meeting and discuss the key objectives in terms of how many new commercial accounts (for example) you want to attract in the first six months of 2018. Target one a month — you have what they need. Make sure the staff understands the importance of each visit by a new commercial account. You are in the business "not to let them down," so review the type of documentation that is critical on every vehicle. Review with the team the value a comprehensive inspection brings to the commercial and retail client.

Don't be afraid to ask current retail clients for referrals. If you obtain a new client from a referral, put in a little thank you reward for that referral, such as a complimentary oil change or even a nice gift card if you know what they enjoy.

2018 must be the year where you can let the imagination soar and be creative. You know you have the mechanisms in place on a monthly reporting basis to measure the results properly as to how you are doing. The monthly reporting is an important aspect on measuring your progress and recognizing your strengths and bringing attention to where improvement is required. Remember: If you can't measure it, you can't manage it.

So are you one of the shop owners who is reading this and asking, "What is he talking about?" That simply means you most likely have not been progressing the business to the new aftermarket model. You are still clinging to the old business model but expecting different results. The old model is totally broken, and it is very important to learn and embrace the new aftermarket service-on-need business model, which is the next level from the preventative maintenance model.

Our aftermarket is changing faster than ever before in its history, so it is important that you have and embrace a continuous learning culture throughout the business at every level from the back shop to the front counter to the business office.

The business opportunities that are approaching are exciting, and the shops that learn and embrace how to capture them will enjoy a beautiful career as their business grows.

Finally, as you know, this is a special time of year. I want to thank the readers. I am looking forward to a very successful 2018 for you.

Happy holidays and may 2018 bring you and your family great health, a lot of happiness and of course much business success — the success I know very well you are capable of achieving.

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*

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Old school's still cool

Shop has built business on trust and the value of a handshake

ROBERT BRAVENDER // Contributing Editor

There's something to be said for the old school way of doing things. For one, it still works — take Tune Master. This Pontiac, Mich. repair shop endures despite not having a website. Outside of Google and Facebook, Jeff Leonard's facility barely has any presence on the internet. "Nope, don't need it," he confides. "Never really had a use for it."

Call it hardened intuition, because Leonard has seen many things exit this Detroit community — the Lions pro football team in 2002, Pontiac's namesake GM division in 2010 — but he had the foresight to set a different course for his shop since he opened in 1995.

"I get a lot of walk-ins off the street," he notes, "but the mainstay of my business is wholesale. We're backed up for two weeks all the time. My dealer accounts come first, and I squeeze my [walk-in] clientele in when I can, but realistically I could take the sign off my building tomorrow and it wouldn't affect my business."

Leonard has built a reputation exclusively on a market most shops have only tapped into, namely because this kind of trust isn't something that happens overnight. It took years to cultivate contractual work from "dealers, car lots, things like that," he explains. "Word-of-mouth in the car business is pretty big here since Pontiac isn't a very big city. I've got to maintain a good reputation."

Today Leonard and his techs spend most of their time troubleshooting for other shops and doing extended service work for car lots. "I deal with (nearly every aftermarket) warranty company," he states, having established Tune Master as a preferred shop for many of the area's used car dealers.

"I've got a couple of them that are pretty substantial," Leonard continues. "We do the safety inspections and initial repairs on everything they get from auction or take in on trade. They've always got something ready to go — a car on the lot might have an engine light pop on, or a rusty frame."

The latter is a problem unique to the Midwest, especially Michigan, where both snow and salt are plentiful; certain models are prone to premature rust. "I've actually seen a subframe broken in half like a Saltine cracker right down the middle — it drove in like that with the wheels buckled in," laughs Leonard.

"To replace one is not as extensive as you might think; a typical frame cradle takes about 6-8 hours," he says without irony. "But we just finished up a 2010 Cadillac SRS SUV; we had to drop the frame cradle with the motor and trans so we could pull the motor apart and put in a timing chain. Now that's a pretty major job."

As a result of all this work, Leonard has an employee whose chief job is transporting vehicles back and forth to the dealers. "One thing I do with our wholesale customers is I acknowledge they don't have the time to leave their desks and be away from their customers to pick up and deliver cars," he explains.

"Everything is done by what I think is best for the car, because (the dealers) know I'm not going to overcharge," says Leonard. "I'm going to give my clients the best for what they need — when I build them a car, they make money on it. I care

TUNE MASTER, INC.
Pontiac, Michigan //

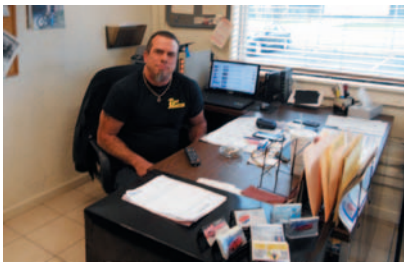
Jeffrey Leonard Owner	**3,500** Total square footage of shop
1 No. of shops	**3** No. of bays
22 Years in business	**30-40** No. of customer vehicles per week
4 No. of employees	**$500,000** Annual gross revenue

about their bottom line as much as I care about my own, or else I wouldn't be doing my job.

"If one of my accounts is a rush job," Leonard continues, "and it's life or death — meaning the deal's going to die if they don't get it done right then — then we stop what we're doing and take care of them. You'd be surprised how many people will refuse to do that, but that's what makes us click."

Since Tune Master primarily deals with cars that are three years old or older, Leonard has to stay on top of diagnostics. "I've got a new Snap-on scanner, and it's really thorough on all the different species of cars that I'm going to run into," he affirms. "Very seldom do I run into a problem where I can't use it for a certain system in a car. I also use ALLDATA as my invoicing and my research software. We're up to date on all the current things that we need to be."

Outside of that, Tune Master doesn't do diesel or hybrid work, or any retail sales like tires, although they occasionally sell a car or two. "We've got the technology to fix the cars, but a lot of stuff is still done on a handshake; I learned that from the Freemasons," says Leonard. "I've been a Freemason for 18 years. It's a good way to operate your life. Masonic Fellows usually are real word-holding, straightforward business people."



Take Leonard's relationship with his crew. While he keeps the shop open every Saturday till 1 p.m., he always treats his techs to lunch every Friday "wherever they want to go," he says. "I respect my guys; I never tell them to do anything, I've always asked them. I'm there for them if they need a loan; everybody takes care of everybody."

Even the shop's name is homage to Leonard's father. "Back in the '60s my dad used to road race cars, MGs and Jaguars," he relates. "To pay for his habit he started up this mobile car repair service out of a van, which he called Tune Master. But when my mom got pregnant with my brother, she told my dad to 'get a job — right now.'"

The race cars and van were quickly sold as his dad went 9 to 5, but years later Leonard would find an old box of Tune Master business cards in the basement. "I always remembered that name," he recalls. "When I went to incorporate, I was calling the company Superior Auto, but I changed it to Tune Master. My dad got a real big kick out of that."

ROBERT BRAVENDER graduated from the University of Memphis with a bachelor's degree in film and video production. He has edited magazines and produced shows for numerous channels, including "Motorhead Garage" with longtime how-to guys Sam Memmolo and Dave Bowman.
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Managing your high achievers

ENHANCE THEIR SKILL SET WHILE ENCOURAGING CONTINUED GROWTH

CHRIS CHESNEY // Contributing Editor

If you research the characteristics of high achievers, you will find a lot of information on their distinct behavior such as a competitive nature, persistence and innovative thinking. High achievers are never satisfied for long and are able to see and buy into the bigger picture. High achievers can implement new ideas and skills quickly and are very convincing and persuasive. They see problems as opportunity, and they love to win. Do these traits describe anyone on your team?

High achievers are likely to be found among the greener employees or as someone who is passionate about learning. They are the teammates who attempt to put what they've learned into action the day after a class or after reading about a new way of doing things. Often, they are the teammate who just does things differently, faster and more efficiently than anyone else.

If you have a high achiever on your team, it's important to recognize and ensure they are allowed to shine within your company. However, if you don't find the above traits in members of your team, you should consider if your business model and management standards are establishing a culture that attracts these crucial teammates.

Let's assume you have a high achiever on your team. How do you feed them in a way that benefits their growth and your success? If you keep the traits and behaviors listed above in mind as you interact with them, you'll find success.

There are risks with housing high achievers. If you don't have a process to guide their natural desire to win at almost any cost, you will see your profits erode. High achievers want to win, rarely give up and consider it counterintuitive to fail. For that reason, don't just put them on the line and expect them to fix all the tough jobs. Eventually they'll find that job that will kick them and they won't quit before it's too late to make a profit or to best serve your customer.

High achievers can also become idealist, and if not properly managed, they can forget that it's okay to live to fight another day.

Because they are able to grasp new ideas and apply them quickly and because they understand your goals and plan, they become a great asset when asked to lead a team in implementing new ideas.

Because the high achiever is able to bring knowledge learned from a training event back to the shop and implement it quickly, empower the high achiever to guide your team through the implementation of new skills and training knowledge.

High achievers can be very persuasive when attempting to influence others, which if not moderated appropriately can cause some risk. The high achiever needs to be on the same page as you or they could lead your team down their path, which may not be the right path for your business. Include high achievers on your strategic planning to ensure they are not formulating a different or their own path for the shop.

High achievers are also driven by achievement and think success is dependent on them. They will take the opportunity to grow their understanding and skills, attending every training event, with your support or even on their own dime. But don't let them go alone. I often see the high achiever in a shop as the only attendee in a training class using the excuse that he will take the training back to the others. All this does is turn your high achiever into a trainer, not a person who can implement positive change in your team.

Your high achiever should be given the opportunity to lead your training plan to success. Have the entire team attend the class so they can all discuss how to best implement what they have all learned. This will ensure successful growth in your team's skills while making sure you and the high achiever work together to create the learning plan for the entire team. This gives the high achiever ownership and will help ensure you get a high return on investment.

Finally, as you begin recognizing who your high achievers are, pause for a moment and take a look in the mirror and determine if you are one yourself. Honestly evaluate your traits and see if they match those discussed above. If you discover you are a high achiever, you've taken the best first step towards future success.

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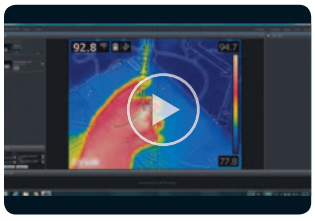
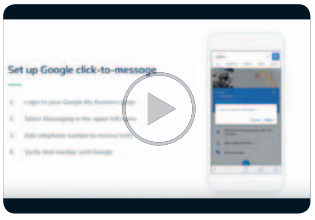


Testing the heater circuit of an oxygen sensor

MOTORAGE.COM/HeaterCircuit

Techs discuss technician pay, benefits and ADAS

MOTORAGE.COM/TechRoundtable



5 most effective ways to retain customers

MOTORAGE.COM/Retain

Understanding the role of the ECM

MOTORAGE.COM/ECM

MECHANICAL MOMENT

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

DODGE RAM AND BMW NO STARTS

VEHICLE: 1996 Dodge Ram 1500, 4×2, V8-360 5.9L Magnum, Automatic Transmission

MILEAGE: 228,995

PROBLEM: The engine will crank but not start. The MIL was not on and there were no DTCs.

DETAILS: The technician verified the engine will crank but not start. It had spark but no fuel pressure. He verified voltage on both sides of the fuel system fuses, swapped the fuel pump relay and tried replacing the fuel pump. Still, there was no fuel pressure. At this point, he called ALLDATA Tech-Assist. The ALLDATA Tech-Assist consultant suggested that he check for power and grounds at the pump. The technician found no voltage at the fuel pump (Circuit A61). He traced the circuit back to the fuel pump relay and found the circuit was open about 10 inches from the power distribution center.

CONFIRMED REPAIR: He repaired the wiring and the truck started and ran normally. He also rechecked the fuel pressure. It was at factory specifications.

VEHICLE: 2008 BMW 335xi, AWD (E90), L6-3.0L Turbo (N54), Automatic Transmission

MILEAGE: 118,669

PROBLEM: When trying to start the engine, the starter momentarily engaged then stopped.

DETAILS: The tech found that, while attempting to crank/start the engine, the starter solenoid was only powered for a split second. He connected a scan tool and retrieved an A0C1 (Output Terminal 50) diagnostic trouble code. The ALLDATA Tech-Assist consultant suggested he open the Car Access System (CAS) module to inspect for signs of burned spots on the circuit board.

CONFIRMED REPAIR: When the tech opened the CAS module, he found several burned circuits. He replaced the CAS module. After the repair, the engine started and ran normally.

This tech tip comes from ALLDATA Tech-Assist, a diagnostic hotline of ASE-Certified Master Technicians. Learn more at ALLDATA.com.

TRAINING EVENTS

DECEMBER 30
ATI Repair Shop Mastery
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Daytona Beach, Florida

JANUARY 31-FEBRUARY 1
Women in Auto Care Winter Conference
Scottsdale Plaza Resort
Scottsdale, Arizona

FEBRUARY 14-17
MACS 2018 Training Event and Trade Show
Caribe Royal
Orlando, Florida

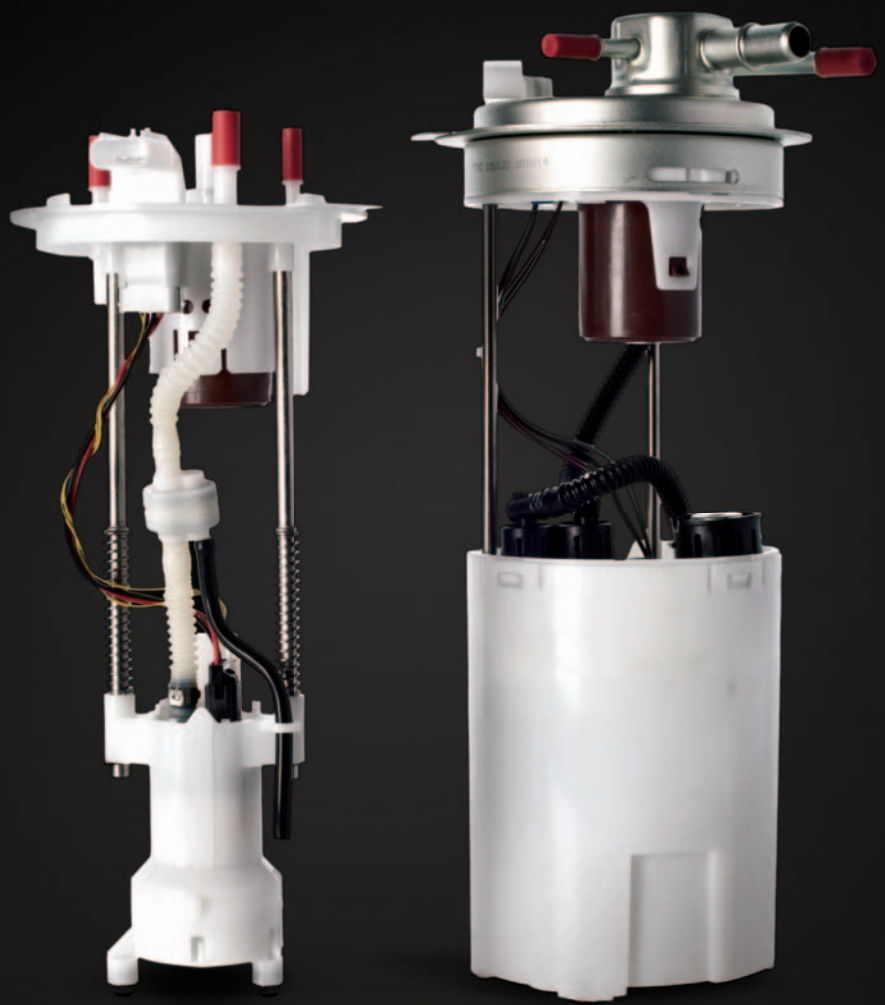
MARCH 1-4
2018 VISION Hi-Tech Training & Expo
Overland Park Convention Center
Overland Park, Kansas

MARCH 17
TST 2018 15th Annual Big Event
Westchester Marriott
Tarrytown, New York

MAY 2-6
ASA Annual Meeting and Conference
Walt Disney World Swan and Dolphin
Orlando, Florida

JULY 23-26
2018 ASE Instructor Conference
Embassy Suites
Frisco, Texas

AUGUST 8-10
NACE Automechanika 2018
Atlanta World Congress Center
Atlanta, Georgia



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UNTIL PROVEN INNOCENT

ON OCCASION, WHAT SEEMS TO BE AN OBVIOUS FIX TO A DIFFICULT ISSUE COMES BACK TO BITE US.

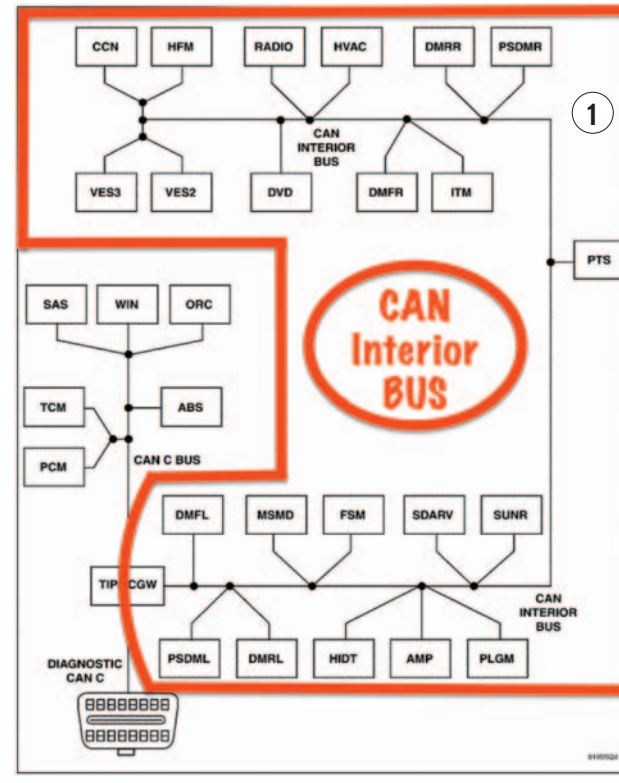
BRANDON STECKLER //
Contributing Editor

Pushing through a diagnosis with a plan of attack is the best course of action to keep you focused and making diagnostic decisions accurately and efficiently. These decisions should be based on your test results, whenever possible. Although, sometimes instinct and gut-based decisions can't be helped. Duplicating a customer's complaint, pinpointing the root cause of the symptom and verifying the fix is absolutely essential to a solid repair. So, what to do if a vehicle comes back with the same issue? You may recognize this subject vehicle — it had me eating crow when I saw it roll back into our parking lot last week! That is, of course, until I fixed it — again!

The saga begins

The 2008 Chrysler Town and Country came to the shop with the complaint of erratic gauge operation and cycling of the windshield wipers all while hearing an audible warning chime. As strange as this series of complaints sounds, I witnessed it myself. I began my diagnosis at the DLC. A scan of the entire vehicle and all of its nodes was carried out and without surprise, multiple Diagnostic Trouble Codes (DTCs) were stored in many of them. All of the DTCs were based on the CAN Interior Bus functionality and loss of communication between modules. There was quite a handful of DTCs, and attempting to follow them, hoping for a conclusion, would just lead a tech to confusion and drive him/her in circles. Lots of times modules like to tell on one another. Sometimes we get lucky and a bunch of modules will point a finger at a single module. I wasn't so lucky in this case. When faced with the challenge of erratic symptoms like this one, related to bus integrity, I find it best to print out a road map to help me navigate myself to the problem. The road map in this case is the wiring diagram for the CAN Interior Bus (Figure 1). With this topological diagram in hand, I can devise a plan to narrow down the shortest route to the problem.

The first order of business after printing out the roadmap is to sit back and regroup. Jumping into a diagnosis like this one



is very tempting, but let's think about this for a second. The CAN Interior Bus runs the entire length of the van. It's in every door, inside the dashboard, behind all the trim panels and even into the headliner, connecting 25 modules in a network. Do you really want to roll those diagnostic dice and hope for a "7"?

I start with the facts I do have. The wipers cycle, the gauges drop out, a chime sounds. This is what I know. I want to print wiring diagrams for these components (wipers/cluster, for starters) and look for common points between them. It seems all of the malfunctioning systems do share something in common — the Totally Integrated Power Module (TIPM). This device serves as the gateway in this vehicle's communication network. It also drives the wiper relay. I'm not one for silver bullets, but I will state that these devices have a high failure rate for all sorts of various malfunctions. A road test was con-

PHOTOS: BRANDON STECKLER

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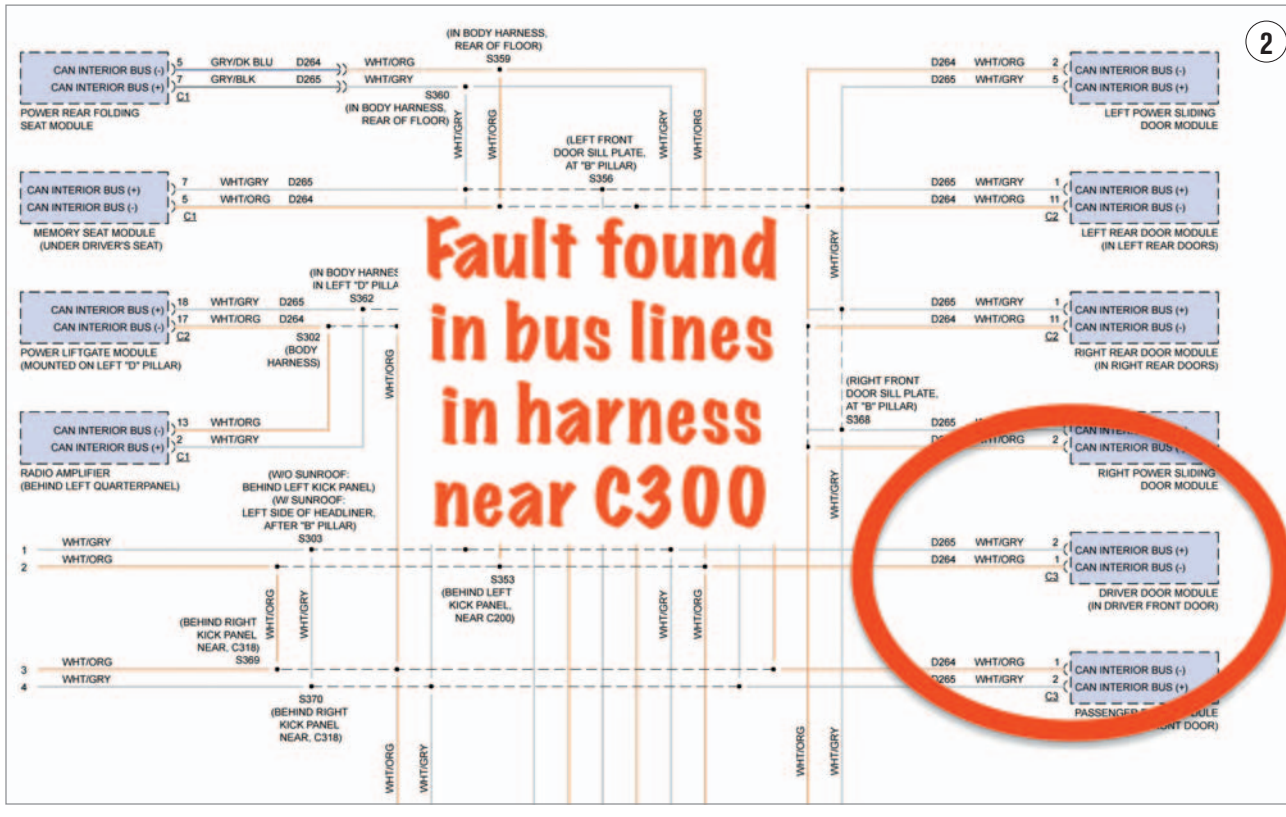
ducted with a scan tool interfaced at the DLC. Two objectives were in order; first, to determine the scenario required to reproduce the problem and second, to see if the scan tool lost communication when those symptoms were exhibited. The problem was very repeatable. Just driving the vehicle around the corner I was able to reproduce the concern multiple times, but I couldn't pinpoint a why or how as of that point. The fault wouldn't present itself sitting still, so the first thought was water intrusion or a short somewhere in the bus. I attempted to shake the vehicle and rock it back and forth, but to no avail.

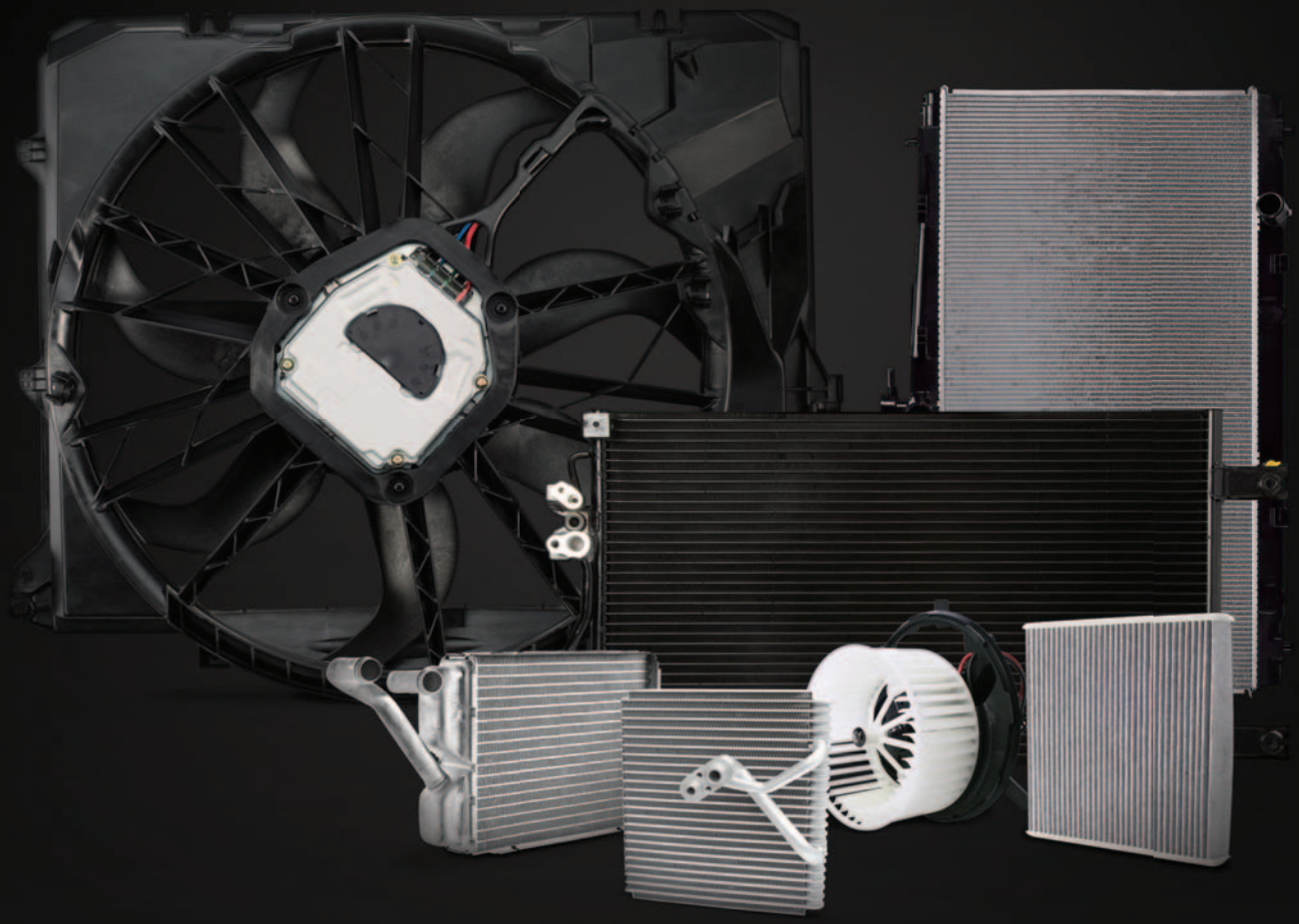
The leap of faith

I couldn't think of a way to temporarily eliminate or bypass the TIPM without disabling the vehicle. This is why I thought it best to replace the TIPM initially. The premature decision to replace the TIPM was made on my order and as you guessed it, the problem remains. Now, I'm married to this vehicle and I have to get this resolved. It's still as broken as it was and now so too, is my pride and conscience. This was very embarrassing for me. If I could take it back, I would, but I can't. Humbled with a belly-full of that yummy crow, I proceeded to find the cause and fix this van, now more determined than ever!

The language of Interior-CAN is spoken only between the nodes on that network. The TIPM, as the gateway (or interpreter) translates this language to me (and my scan tool) on the Diagnostic CAN-C bus (terminals #6 and # 14 of the DLC). My point is I can't just monitor the network with a scope from the DLC as you can with a break-out box (B.O.B). I will have to access the network from the harness itself. I figured the easiest point was at the driver's door module. Being that the issue only occurs while moving, I thought it best to access the harness at the hinge of the driver's door, where the harness passes through the door and the base of the A-Pillar. I carefully separated the conduit to access the harness.

Suddenly, the sun came out and all the little birdies began to chirp. That pretty White/Gray wire I was seeking as a scope test-point was broken in its insulation and exposed, rubbing on the body. It was grounding out intermittently, causing loss of communication on the CAN Interior Bus (Figure 2). I wiggled the wire and could generate the symptoms at will. I didn't understand why the wipers would cycle, though. Well, on top of my premature decision to replace the TIPM, I failed to educate myself properly, as well. After some minor research, according to the description and operation found in Identifix, the wipers and the audible warning will cycle if a loss of communication is experienced on the CAN Interior Bus. Had I taken the time to read just a little deeper and familiarize myself more with how the wipers function, I surely would've realized that the erratic wiper





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5 TIPS TO HIRING SUPERSTAR TECHS AND ADVISORS

BOB COOPER // Contributing Editor

One of the greatest challenges shop owners face today is finding and hiring the superstars. And in today's market of ever-increasingly complicated diagnostics and the need for customer retention, it is now more vital than ever to ensure the best and brightest are part of your team. Here are some tips that will help you hire the stars.

1. With rare exception, the stars you are looking for are already working and are reasonably satisfied. This doesn't mean that they won't be open to a conversation with you. It's your responsibility to identify those stars and then reach out to them. Even if there is little or no interest on their part after speaking with you, you have still started a relationship. Not only may the time come when they reach back out to you, but the stars know the stars, so they may be able to provide you with the names of some other good candidates who would be interested in your offer.

2. Never offer someone a job; instead, offer them an opportunity to join a company like yours. Beyond just a competitive wage, you will need to provide a compensation and incentive package that includes paid vacations and holidays, paid sick days, uniforms and ongoing training. In addition, you will need to provide the opportunity for growth and income advancement, security, rewards for tenure (such as retirement programs), and of course, leadership. Anyone can offer them a wage; what you need to offer is a package that shows that you really do care about the people who work with you. If you put out peanuts, you'll get monkeys. The stars produce profits; the monkeys produce debt.

3. When there is a shortage of skilled labor, you not only have to make the candidates an attractive offer, but you need to remove as many barriers as possible. Change is scary for most, so you need to be well aware of their fears. No matter how good a tech or an advisor is, one of the greatest concerns they'll have is that you'll be unable to deliver. A method I've used is providing a really attractive guarantee for a number of months. Most shop owners are hesitant to do so because they fear that if the employee doesn't produce, it will cost them a fortune. What they don't realize is that if they do a better job of qualifying candidates, and if they accept that they can always terminate an underperformer, their concerns should diminish dramatically. As business owners, we need to both set our fears aside and reduce the fears of the candidates.

4. We should never forget the rule that says, "When we hire Larry, we get Mary." Simply put, if the candidate has a significant other in their life, with rare exception, they will be involved in the decision-making process. This is why we strongly encourage you (whenever possible) to meet with the significate other as well as with the candidate. If Mary is sold on you and your company, then there is a really good chance that she will sell Larry on joining your team.

5. Let the candidates know about the culture of your company. The stars you are looking for may have well-paying jobs, but there is a good probability there is a vacuum when it comes to the culture of the company they are working for. If you let them know that you are committed to ethics, and that you and your entire team live by a principle that you will never put money ahead of people, you will discover you are able to hire the superstar you've been looking for.

cycling was not the problem, but the result of the problem, simply a normal response to the lost communication. Surely, I would've steered clear of TIPM replacement so early on.

A shot at redemption

I repaired the compromised wire and inspected for any other wires that may have been damaged due to the normal opening and closing of the driver's door. Surprisingly, all of the other wires seemed fine without a need for remedy. After repair of the severed CAN Interior Bus wire, the harness conduit was secured and a road test was performed. The erratic wiper operation and audible chime vanished as well as all of the bus-failure DTCs throughout the vehicle. The van has now been fixed and confirmed fixed — or so I thought!

The boomerang

As I stated in the beginning, the van returned weeks later with an angry and frustrated owner sitting behind the steering wheel, staring once again through erratically operating wiper blades! The vehicle was scanned with most of the same DTCs stored. A road test with the scan tool interfaced was repeated and all of the symptoms were exhibited, along with my scan tool laughing at me, screaming loss of communication right in my face. During my road test, I did take notice that the symptoms were more easily exhibited when the rear end of the van hit a bump in the road.

I have a nice parking lot nearby the shop that I use to reproduce noises/rattles. This parking lot has a handful of speedbumps that I can use to my advantage without disrupting traffic. Each time I drove the rear of the van over the bump, I could generate the symptoms. I drove the vehicle with the sliding doors open to change the position that the door harnesses were resting in. The idea was, if


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the fault vanished with the doors open, I likely had a fault in one of the respected door harnesses. It would just be a matter of eliminating one door at a time.

The fault remained, however; the only door left to check was the power lift gate. As I cycled the lift gate open switch from the driver's seat, the latch opened and the power lift gate motor began to drive the lift gate open. No sooner did it raise an inch or so, the symptoms were exhibited once again. With excitement, I attempted to open the lift gate again with the switch. I could reproduce the symptoms each and every time the lift gate opened. I made my way to the back of the vehicle and opened the lift gate manually. The symptoms were not exhibited this time. Thinking I may have disturbed something, I repeated opening the door both manually and with the switch. The symptoms were exhibited every time I used the switch, but never when the lift gate was opened manually. This tells me that the fault is not likely in the lift gate harness (not in the conduit, like we found in the previous repair).

I decided to start the digging process in the left rear of the vehicle (where the lift gate motor was located), palms sweaty with anticipation. Before doing so, I noticed that the actuator arm that linked the lift gate to the motor had a lot of movement when the lift gate operated electrically, when it was loaded. With the door opened manually and fully extended, I gently grabbed the arm and gave it a tug. The symptoms were once again exhibited! I removed the trim panels for inspection of the harness and there it was. Just behind where the lower portion of the motor assembly was secured to the body was the body harness. Upon closer inspection, the harness was rubbed through and there was some shiny, copper wire exposed.

The lift gate motor assembly is supposed to be secured from three different points to the body of the vehicle. This will prevent the lift gate motor from moving during electrical operation. The lowest bolt was missing, preventing the motor from being secured properly. This, in turn allowed the (metal) motor to rotate outward, ever so slightly and rub the body harness/CAN-Interior Bus circuit, providing an intermittent ground path and pulling the bus down momentarily. Of course, this is the root cause of our customer's symptoms (erratic wiper operation/gauges, audible warning chime). But here is the kicker — the same, exact failure symptoms exhibited were caused by the same circuit fault occurring on the same circuit as the one I had just repaired (#D265 wht/gry) but at two completely different locations more than 10 feet apart from each other! I accessed the harness, repaired the wire, and insulated the harness so it couldn't be harmed any longer. I then secured the lift gate motor assembly with a new fastener and reassembled the vehicle for a final successful road test, without fault.

I had to prove to myself beyond a shadow of a doubt that this vehicle was not misdiagnosed during the first repair. Vehicles like this one get you down in the dumps at times because no one likes comebacks. However, you have to appreciate learning experiences like this one. This is how we grow as technicians and how we get better and more efficient for the next challenge.

BRANDON STECKLER is a technician at Advanced Automotive Diagnostics and Repair in Whiteland, Ind. He holds ASE certifications A1-A9, X1, L1, L2 and L3. He is also a Honda factory certified master technician and specializes is drivability and diagnostics.
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NOTABLE NISSANS

I OFTEN SEE THE NISSAN MURANO, NOT BECAUSE IT IS PRONE TO PROBLEMS BUT BECAUSE IT IS A POPULAR AND RELIABLE VEHICLE. HERE ARE A FEW OF THE MORE INTERESTING ONES I'VE RUN INTO.

MIKE MILLER // Contributing Editor

The first one is a 2007 Nissan Murano with 73,443 miles on it. It has a V-6 3.5L (VQ35DE) engine, which is standard on this platform. This vehicle is a FWD model, but it is also available in an AWD version as well. It came to us after having work done at another shop. The customer stated it was taken to them to have some oil leaks repaired on the engine and (here it comes) ever since getting the vehicle back the check engine light has been on. The customer stated they thought it wasn't running the same since they got it back, but admitted it might be due to seeing the check engine light on and being overly sensitive because of that.

A quick visual under the hood didn't reveal much. It appears the other shop had done a decent job of repairing the oil leaks and putting everything back together correctly. While I was under the hood, I also made a check on the condition and level of the engine oil (we'll see why this is important in the next case study). Mostly I was looking for a connector that was unplugged, thinking it would be a simple repair, but it was not going to be that easy. A code scan was done and two codes were present — a P0021 Bank 2 "A" Cam Position Timing Performance and a P0174 Fuel System Too Lean Bank 2.

My first thought was a vacuum leak due to either a gasket that was not installed correctly or a disconnected vacuum hose, but since I already did an underhood visual inspection, I decided to observe scan data first. Banks 1 and 2 were both slightly lean with an Alpha of 105-107, which basically means the engine is 5 percent to 7 percent lean at idle. I wasn't going to go look for a vacuum leak on the engine because, had there been one, the number would have been much higher.

Thinking about the codes for a minute, I realized whatever was causing the problem, it was going to be isolated to Bank 2 since both codes pointed in that direction. Next, I decided to look at data relating to the Cam Position Timing code and was surprised to see the variance between banks. The Intake Valve Timing for Bank 1 was -3° and the Intake Valve Timing for Bank 2 was 45° (Figure 1). The command for both Intake Valve Solenoids were 0 percent at idle (which is correct), so it was not a stuck solenoid holding the cam in the advanced position. However, that very well could be the cause of the lean code for Bank 2.

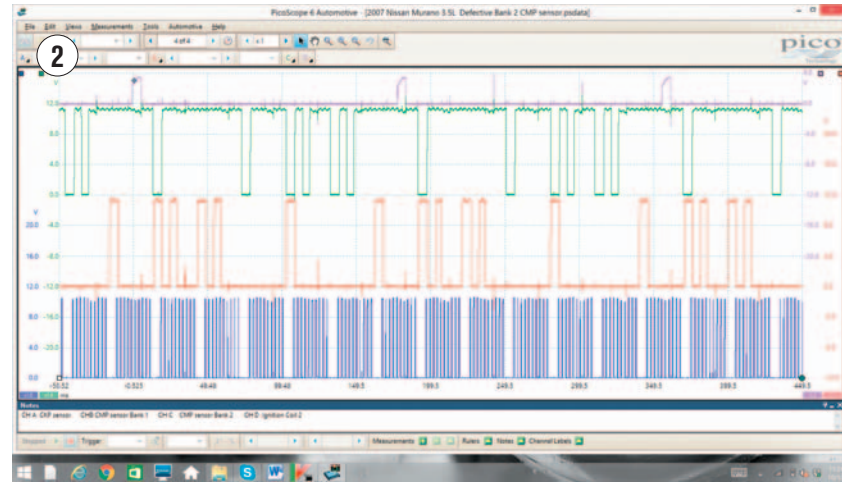
The last shop repaired oil leaks but the customer was not specific on exactly what they did. Was it an oil pan, valve covers, timing cover? Could they have removed a tensioner or the timing chain and the cam on Bank 2 jumped? Before going too much further and calling the customer for a list of exactly what was done, which should have been gathered by the service advisor when the vehicle was dropped off to us, I wanted to get a scope capture of the Crankshaft Position Sensor (CKP) and both Camshaft Position Sensors (CMP) to see if the data being displayed was really accurate.

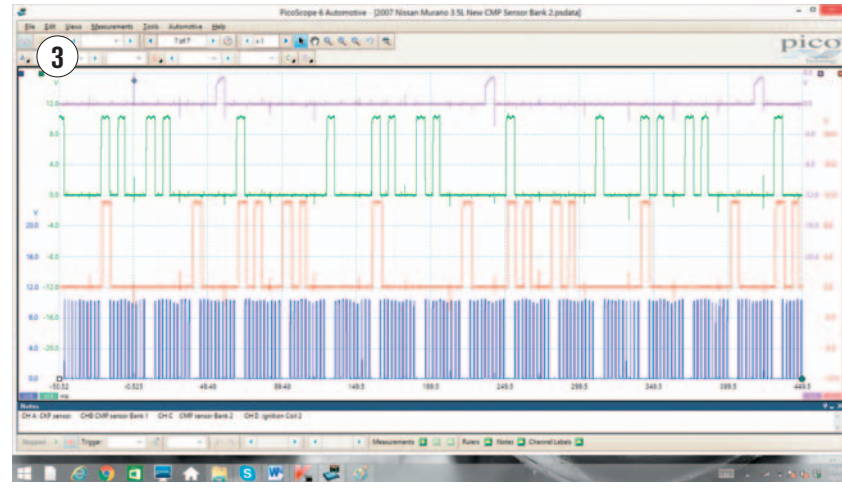
PHOTOS: MIKE MILLER

To tell the truth

While the camshaft sensors are fairly easy to access on the top left side of each bank, the CKP sensor is a different story. Even with the vehicle on a lift, the sensor is buried deep in the firewall side of the engine right where the bellhousing attaches to the engine. The best way to access the signal for testing is at the ECM itself, which is in the passenger compartment near the glove box. Similar to the sensors, the Bank 2 ignition coils are fairly easy to access while the Bank 1 coils are on the firewall side buried by the plenum. This is why the capture uses Cylinder #2 instead of Cylinder #1 as an ignition coil reference, but all signals could have easily been accessed at the ECM as well. A capture was taken and something did not look quite right with the Bank 2 CMP sensor (green trace on Figure 2). I compared this capture to a known good and it confirmed what the problem was. Both the CKP sensor and the Bank 1 CMP sensor were pulled from low to high, which is what the known good waveform showed; however, the Bank 2 CMP sensor was flipped. The pulses were occurring at the correct time, just in the opposite direction (Figure 2). This was confusing the ECM as to the correct position of the Bank 2 Camshaft position and causing the data for the Intake Valve Timing PID to be off.

Looking closely at the Bank 2 CMP sensor revealed that it had recently been replaced. Contacting the customer and inquiring about the new CMP sensor, their receipt did not show that it was replaced. What I believed happened was the tech who was performing the work noticed that one of the oil leaks that needed to be repaired was the seal of the Bank 2 CMP sensor. Anyone who has disconnected a Nissan CKP or CMP sensor connector knows what I am referring to. The connector locking tab is spring loaded and removal requires first pushing the locking tab until it clicks, which will also hold the lock in that position, then pulling back on the connector housing to release it from the sensor. During this process, I think the tech tried to remove the connector in the conventional way of pressing downwards on the tab and in doing so broke the CMP sensor. Since it was the fault of the shop, an aftermarket sensor was ordered and installed without the customer knowing about it.





I installed a new OEM Camshaft Sensor for Nissan and took another scope capture; now the pattern looks correct (Figure 3). Also, I noticed that the tech who installed the aftermarket camshaft sensor thought that the sealing the O-ring that came with the sensor wasn't good enough so they applied a healthy amount of silicone where it attaches to the cylinder head.

Clearing the codes and watching the data PIDs for the Intake Valve Timing and Fuel Trims confirmed that the new sensor resolved the concern.

On to Nissan No. 2

The next case study is on a 2006 Nissan Murano S with 109,625 miles on the odometer, but the same V-6 3.5L (VQ35DE) engine as the previous vehicle. This was also a FWD similar to the last case study. The customer's only complaint was a Service Engine Soon light illuminated with no drivability complaints. A code scan revealed two

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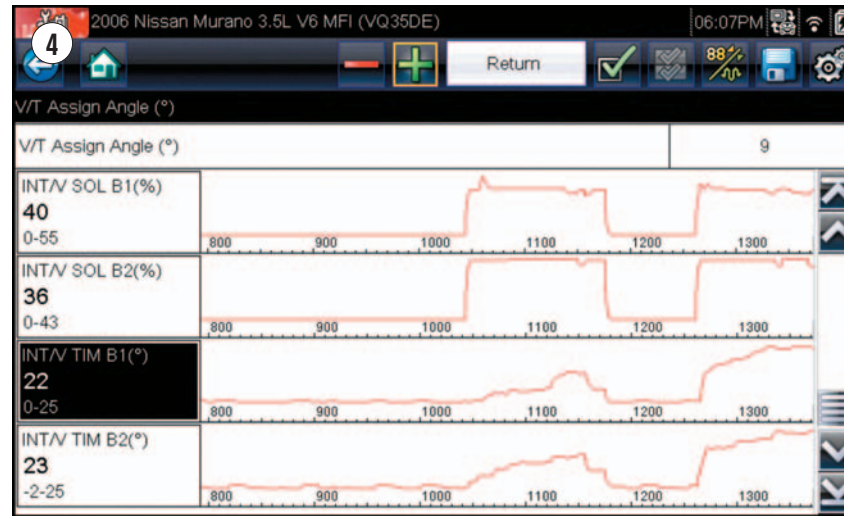
codes in the ECM — a P1800 VIAS Control Solenoid Valve Circuit Open and P0011 Bank 1 "A" Cam Position Timing Performance.

The P0011 Camshaft Position Timing Performance code is one that is familiar to most technicians and what the "performance" part of the code means is that it is not operating as expected by the PCM. As with almost all Camshaft Position Timing codes, the first step is to check the medium responsible for changing the camshaft timing — the engine oil. With insufficient oil supply, the actuators cannot move or hold the cams in the desired position. On several occasions I have seen techs replace solenoids, actuators, phasers and so on due to these types of codes without ever checking the level and condition of the engine oil. This Murano was no exception; the dipstick had only a trace of oil on it when removed from the port on the front cylinder head. It actually took 2.5 quarts of oil to bring it to the upper section of the crosshatch area and this is on a vehicle that during an oil and filter change specifies an initial fill of 4.2 quarts. Restarting the vehicle and using the bidirectional controls of the scan tool, I was able to control the position of the intake cams and saw that both banks were responding equally to the commanded percentage of solenoid activation (Figure 4). I didn't take a 'before' capture of the bidirectional controls for the simple reason that low engine oil level is such a common cause of this code that I would only start looking elsewhere if correcting the oil level did not repair the concern.

Now onto the second code, the P1800 VIAS Control Solenoid fault. This is actually my first time seeing this particular code. VIAS stands for Variable Intake Air System. Anyone who is into performance tuning can attest to the benefits of this type of



system. The Nissan Variable Intake System uses a solenoid, which either allows or blocks vacuum to a power valve, which in turn controls the effective length of the intake runners. At medium speed (around 1800 RPM), the ECM grounds the VIAS solenoid valve, which allows engine vacuum to reach the power valve actuator. The actuator then closes the power valve, increasing the distance the incoming air must travel between the throttle body and the intake valve. When the engine is at a very low or high speed, the ECM turns off the VIAS solenoid blocking engine vacuum to the power valve actuator. This allows the power valve to move to the normally open position, which shortens the incoming airflow's path to the intake valves.

The reasoning behind the variable intake length is to maintain power across a broader engine operating range. By having a longer runner length

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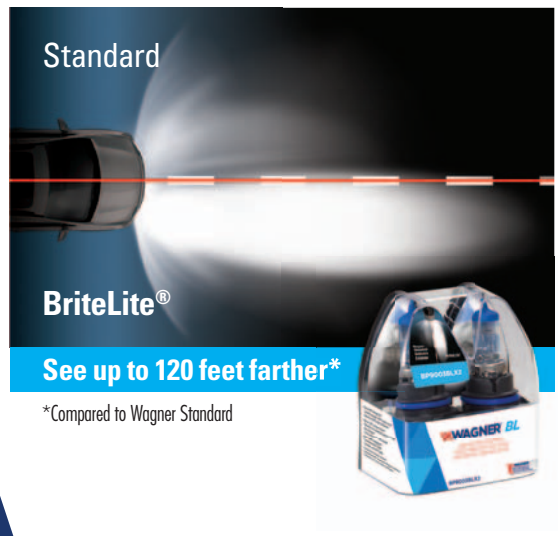

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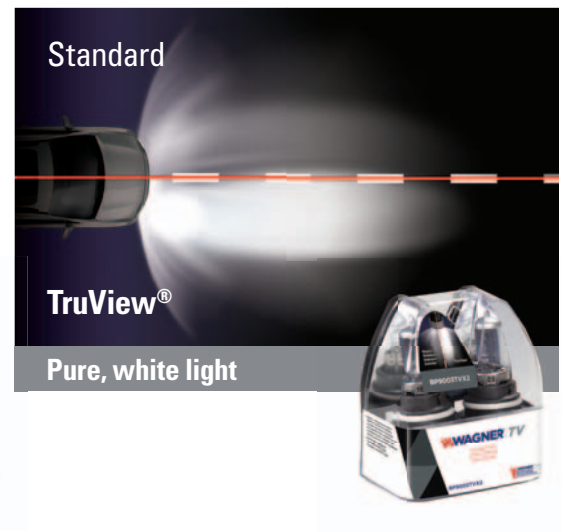

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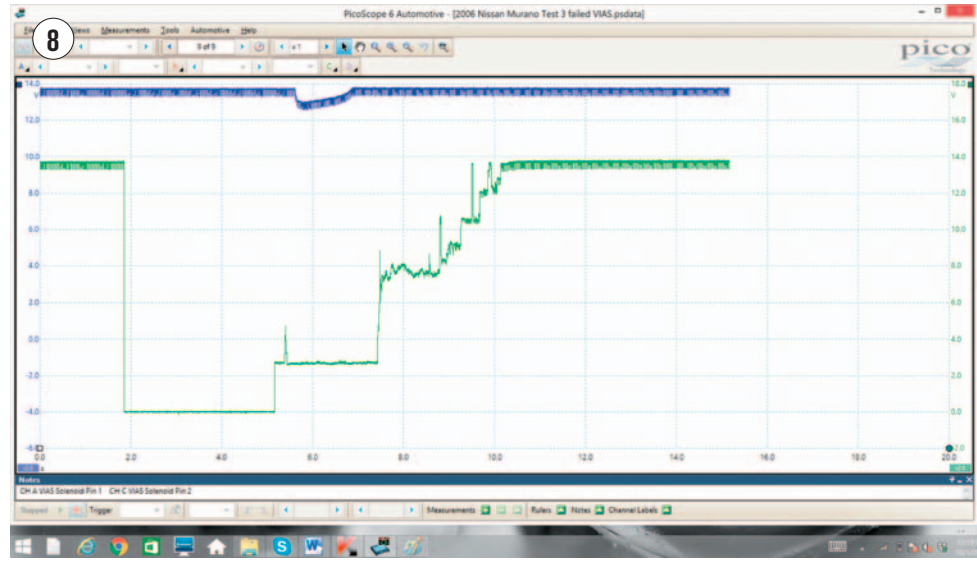
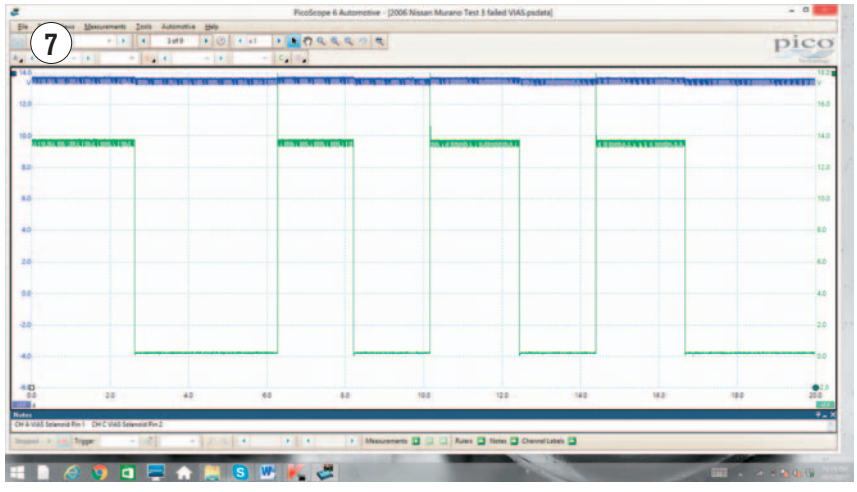


My first time

Since I am not familiar with this code, I used a popular automotive technical website to get some testing insight on the system. It stated that there is no actual resistance specification given by Nissan, but an expected resistance of the VIAS solenoid valve is 25-40 ohms. Alright, this is an easy test, so I ohmed out the solenoid. The meter showed 33 ohms (Figure 5), right in the middle of the specification, so the solenoid is OK, right? A popular saying of one of the smartest technicians I know is, "If you ohm a component and it tests bad, it's bad. However, if you ohm out a component and it tests good, it could still be bad." Bottom line — if you ohm test a component and it tests good, test it another way to confirm.

An easy connection of my PicoScope with the blue trace showing the voltage supplied by the ECM Relay and the green trace showing the ground command from the ECM was established and a vacuum gauge was installed (Figure 6) in place of the power valve actuator. Normally you would need to raise the RPM to get the ECM to activate the solenoid, but using the bidirectional controls of a scan tool, it can be accomplished with the vehicle running at idle. Activating the VIAS solenoid the first couple of times showed that the ECM was commanding the solenoid on and off (Figure 7), also the solenoid was responding correctly by applying and blocking vacuum respectively. However, about the fourth or fifth time of turning the solenoid on and off I noticed the vacuum gauge did not move. The scope showed that the ECM driver had supplied ground to the solenoid, but when deactivated, the solenoid did not have a clean turn off, but more of a stepped pattern back up to system voltage (Figure 8). I noticed this occurred each time that the solenoid was commanded on but did not allow vacuum to pass through it. The VIAS solenoid valve was sticking occasionally; however, this did not show up on an ohms test.



A new VIAS solenoid was installed and the codes cleared. After a long test drive, no codes were present or pending, and the Murano was returned to the customer along with a maintenance recommendation and a reminder to check their oil level routinely.

MICHAEL MILLER lives and works in Las Vegas. He is an ASE certified World Class Technician. He holds degrees in both Mechanical Engineering and Automotive Technology.
mmiller7290@gmail.com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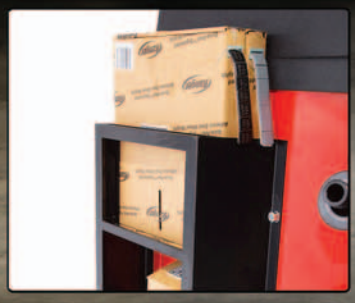

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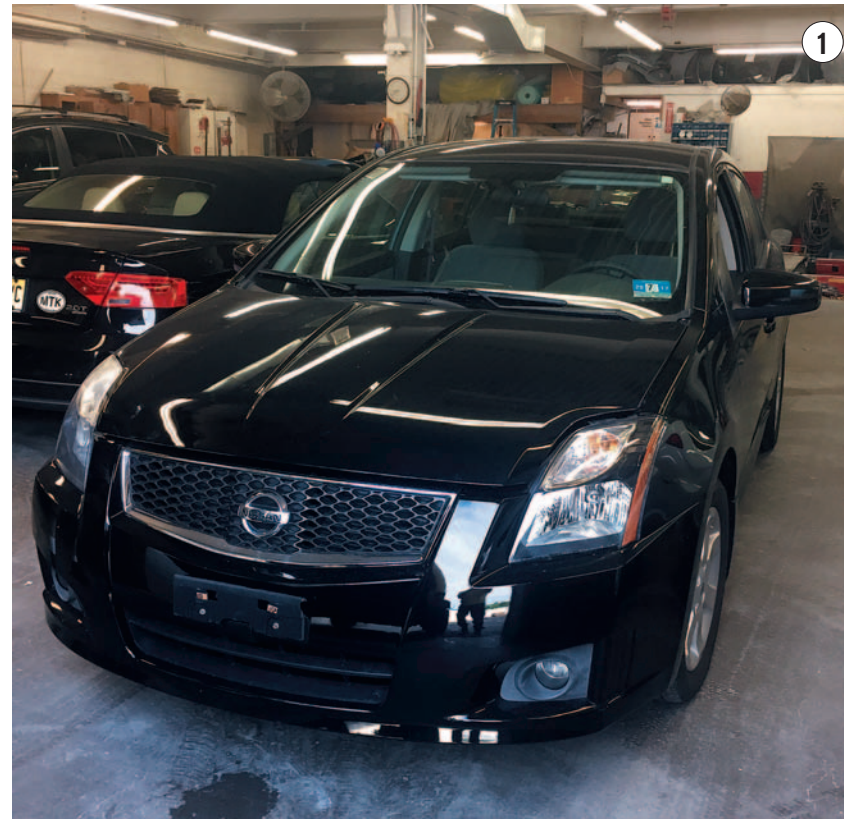
JOHN ANELLO // Contributing Editor



I was called to a shop early in the summer for a complaint of no air conditioning operation on a 2010 Nissan Sentra with a 2.0 Liter engine (Figure 1). The shop had done all the preliminary checks such as A/C pressure tests and scanning the A/C system for trouble codes. There were no blown fuses in the vehicle that would prohibit the operation of the compressor clutch coil, and everything electrically visible seemed okay, including the wiring at the A/C compressor. The shop needed a second opinion so they decided to give me a call.

Here in New Jersey, where it is very seasonal, you would not expect these calls most of the year because people are usually not testing the full ability of their climatic control system to blast cold air. Most of these vehicles may not even alert a driver with an indicator light if there is a fault in the system, so current problems may not be detected until the warmer weather moves in.

A/C systems pre-OBD II were less complex to diagnose and work on. Most of these systems were not electronically challenging unless you were working on the higher-end vehicles with the fancy climatic control systems of the '80s and '90s. The basic systems all had a compressor clutch relay that was ground controlled through a series circuit. The command would start from the A/C switch and work its way through high and low pressure switches and also through a compressor cycling switch. If it was climatically controlled within the cabin of the vehicle, then the bells and whistles would include an electronic controller with added ambient, interior and evaporator temperature sensors. It still was not hard to tackle for any reasonably competent technician.

The cars of today have gotten so complex that many control modules on board will interact to finalize a decision to apply the A/C clutch once a command has been directed from the vehicle driver. Most systems will use the Engine Control Module (ECM) to monitor Wide Open Throttle, coolant temperature, power steering effort and outside bussed data before the ECM will activate the A/C clutch relay. Bussed messages may come from a Body or A/C Control Module that will monitor high and low A/C pressure, sun load, ambient and interior temperatures as well as evaporator core temperature.

PHOTO: JOHN ANELLO

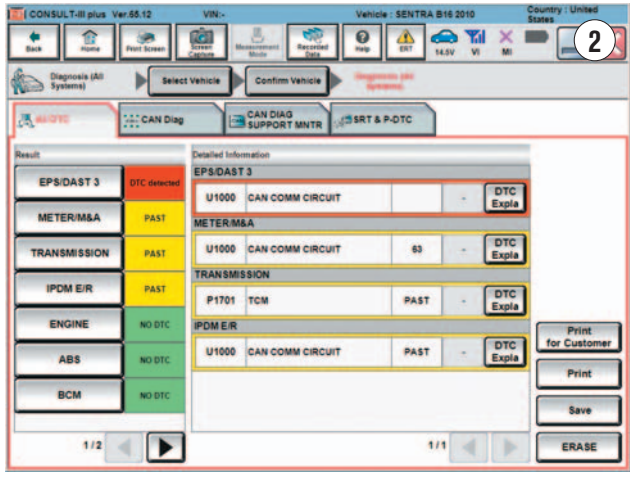
On to the Sentra

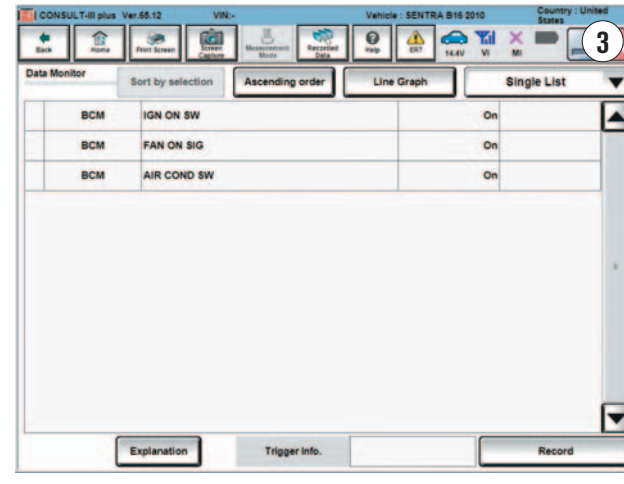
This particular vehicle used the Integrated Power Distribution Module to control the A/C clutch relay directly and relied on bussed data from the Body and Engine Control modules. There are many manufacturers now that are using a computerized fuse/relay panel to reduce the amount of wires needed to run from each controller to a common fuse/relay block. It would be much easier for each module to buss information into the computerized power panel to perform driver circuit tasks that are normally performed by each individual module. The only challenges are the expanded criteria list that each individual control module must meet before decisions are made by the Integrated Power Distribution Module (IPDM) to perform a requested task. It is very important to understand system strategy for all onboard control modules.

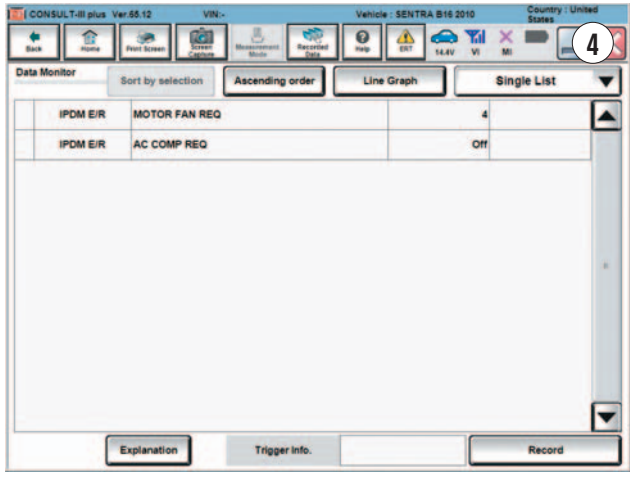
I scanned the network just as the shop had already done and did not see any trouble codes that would prevent the operation of the A/C clutch (Figure 2) so I decided to access controller PIDs to make sense of it all. My first place to start was at the A/C panel because this is where the command begins. I had to make sure the panel was initiating a command when the A/C button was selected. By viewing the Body Control Module (BCM) data PIDs (Figure 3) you can see that the "AIR COND SW" signal was sent from the A/C switch and the switch was actively working. The A/C panel in this vehicle had a dedicated line that directly went to the BCM to start the A/C command journey. The next guy on the journey was the IPDM. He would be the one to have the final say of applying the A/C clutch relay by grounding the relay coil.

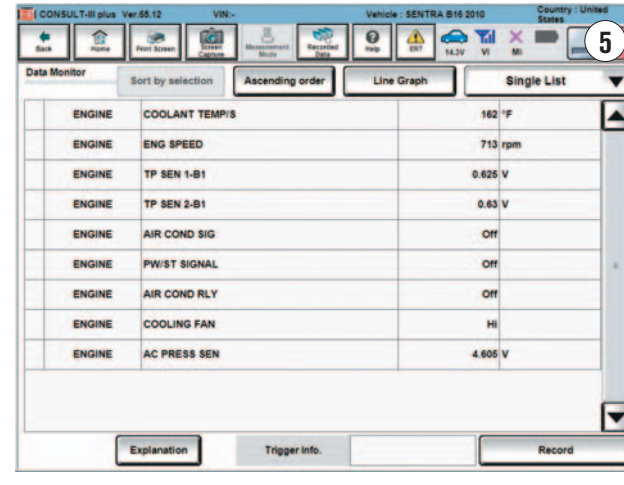
I selected the IPDM data (Figure 4) and viewed the data with the vehicle running. It was interesting to see that the IPDM parameter for the "A/C COMP REQ" was off. The command was sent by the BCM, but there was something in the network preventing the IPDM from making the final decision to apply the A/C compressor relay. It would have been nice if the manufacturer would have allowed you to activate the A/C Clutch relay through bidirectional control with the Nissan Consult 3+ scan tool, but this was not an option on this model.

There was another player involved in this strategy game and that was the ECM. There have been many vehicles I have









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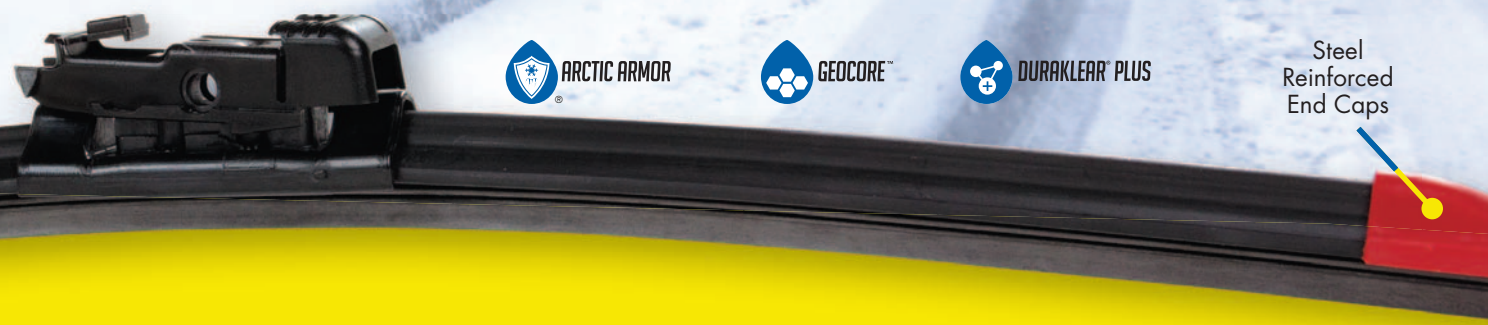

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diagnosed in the past that had residual codes left in the network from prior problems that placed the vehicle in a failsafe mode. This in turn would keep certain component drivers from functioning until codes were cleared. So by simply clearing residual codes from a prior problem it would enable the A/C compressor to function again. This was not the case here so now I had to closely look at all ECM PIDs that could affect normal operation of the A/C system.

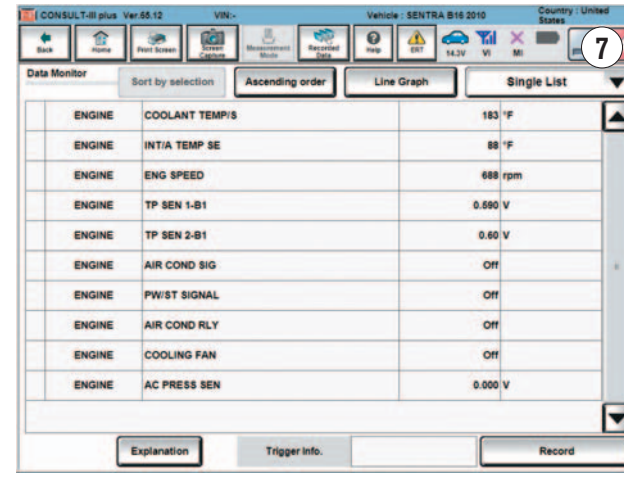
I selected some critical operating PIDs in the ECM, such as the coolant temperature, throttle position, power steering pressure switch and A/C pressure (Figure 5). I was viewing each one to see if they all met the criteria for A/C clutch operation. If the engine temperature were too hot, the throttle was at Wide Open position, power steering was being applied or the A/C pressure was too high or too low, the ECM could send a message to the IPDM to not allow the A/C clutch to apply. The data all seemed to be normal except for the A/C pressure sensor reading that showed about 4.6 Volts. This seemed a little high to me, but I was not certain where it was supposed to be or what pressure value it represented.

Information please

By looking up information in the resources I had at my disposal, I found that 0.1 Volts represented 10 psi. So doing the math, the reading on the A/C pressure switch with the compressor off was about 460 psi. There was no way there was that much pressure in the system and it made sense why the ECM would not OK IPDM A/C clutch operation. There were no codes in the ECM because the sensor value was not within the threshold of a short or open circuit. The engineer who designed the system did not write rationalization into sensor valve input. If the reading was abnormally high or low some manufacturers could set codes for this type of problem so you could at least have a sense of direction in what to address with an inoperable A/C clutch.

The most probable cause would be a bad A/C pressure transducer, but I had to rule out the wiring going to the sensor because a weak ground could elevate readings on most sensors that require a reference ground. I had the shop remove the front grille to gain access and I noticed that someone had repaired wiring at the A/C pressure sensor (Figure 6). I turned the ignition switch on and unplugged the connector and as soon as I did this, my A/C pressure input on the scan tool went to 0 Volts (Figure 7). This told me that the sensor input line back to the ECM was not an open circuit or partially shorted to voltage. It was a quick test to rule out one of the wires, so now I had two more circuits to check.

Looking at a wiring diagram to match wire color, pin numbers and seeing where the wires originate from doesn't always guarantee pin configuration. The harness connector was previously repaired and that changed the dynamics of my diagnostics, so I had to validate the wiring repair. The diagram shows the pin #2 to be blue and at the middle of the connector, and that was correct. The diagram also shows pin #1 to be red/green for the reference ground, and this wire checked OK with my logic probe at 0 Volts (Figure 8). Pin #3 was shown to be green/white for the 5 Volt reference, and this also checked okay with my logic probe (Figure 9). The problem here is that the diagram is not a direct visual of pin orientation, but only for a pin assignment.



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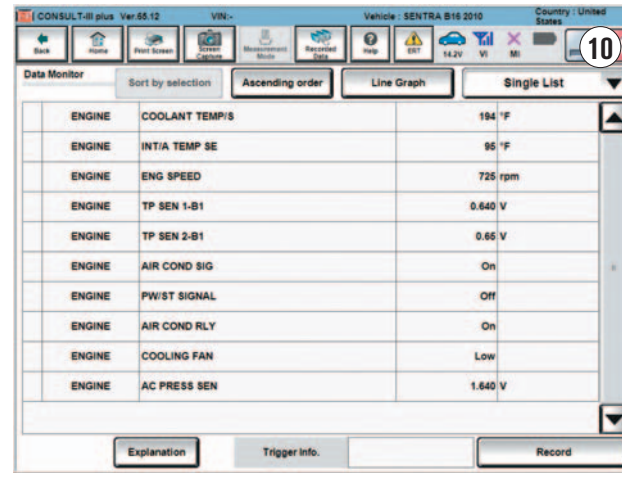
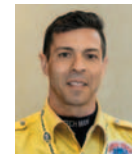


I went back to my information system to acquire a connector view for proper pin orientation (Figure 10). Looking at the connector from a back view with the lock on top, pin #1 was to the right and pin #3 was to the left. The 5V line and the Ref GRD were mistakenly crossed by whoever repaired the connector. I simply removed both outer wires from the connector and placed them in their proper cavities and plugged the connector back in. I now had a reading of 1.5 Volts that equated to about 150 PSI. I cleared any codes in the vehicle that might have been triggered during my diagnostics and started the vehicle. I pressed the A/C switch on the panel and I heard the A/C clutch kick in. The A/C was now blowing cold once again.

This diagnostic adventure was a true A/C curve ball that really tested a technician's ability to fully understand system operation and the strategies involved. This was not your normal run-of-the-mill component or wiring integrity failure. There was no direction to follow because there were no trouble codes, only a customer's complaint. When someone changes the dynamics of a vehicle with wrong parts or poor workmanship, it becomes a different ballgame on a different playing field. I could easily see a shop throwing many parts at this job such as an A/C pressure switch, A/C control head, BCM, ECM and even an IPDM, but the clues were hidden and masked by only the unknown values within the data stream. Engineers design these vehicles to work within certain parameters, and it is up to a good technician to figure out these diagnostic puzzles based on acquired knowledge and the will to keep learning.



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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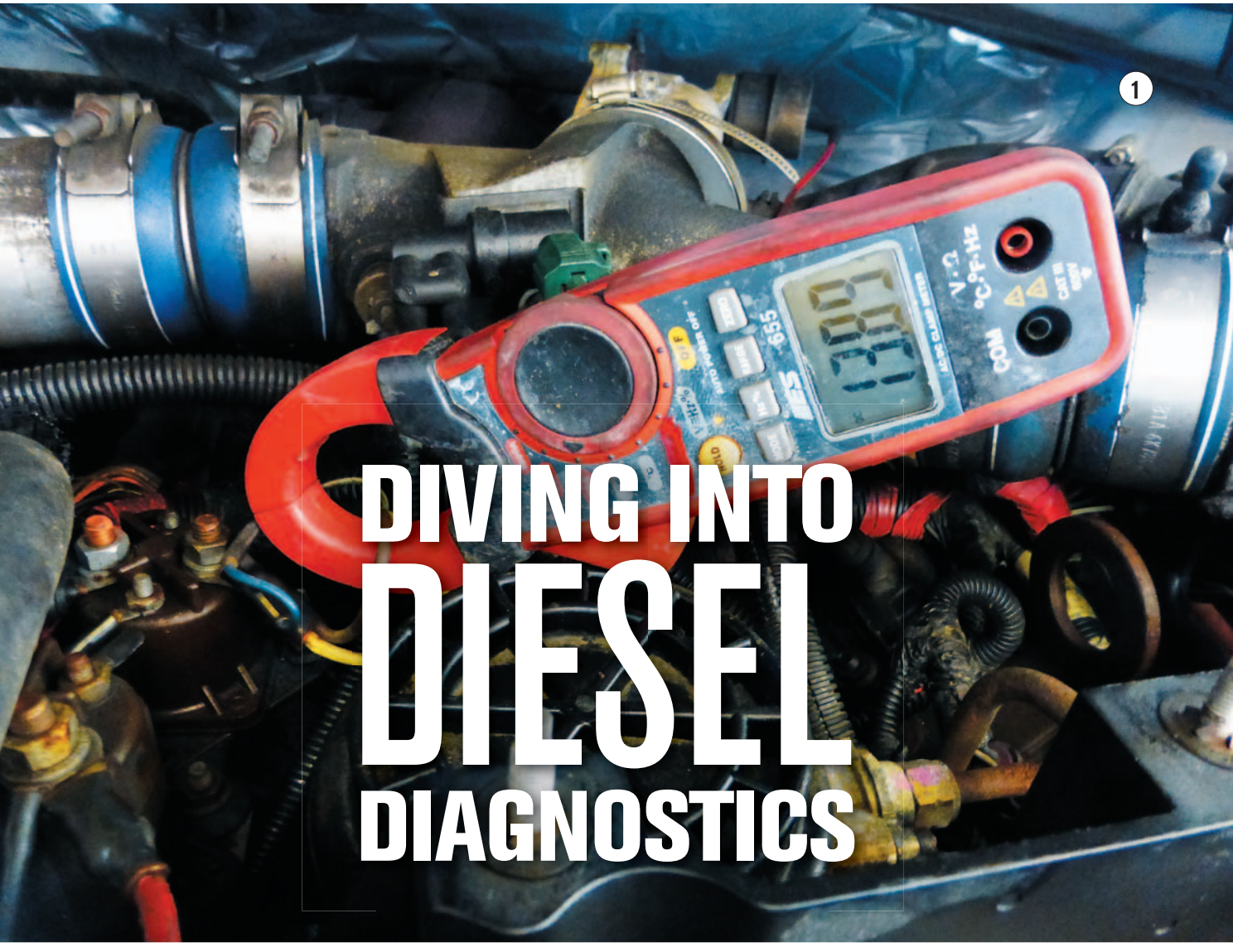

DIVING INTO DIESEL DIAGNOSTICS

A TALE OF AN AILING F-150 AS TOLD BY A GAS GUY. CAN YOU RELATE?

MIKE REYNOLDS // Contributing Editor

I hate working on diesels. A few years ago while working as a diagnostic tech for a mom-and-pop repair shop I was introduced to a landscaping company's fleet of not-so-well-cared-for 6.0 Powerstroke diesel trucks. I had little to no prior diesel experience. These trucks were all banged up and had at least 100K+ miles. Still to this day when I see a white Super Duty on the back of a flatbed I flashback to the horror of seeing one of these trucks being brought in on the hook knowing that my afternoon would be spent scrubbing diesel soot out of my armpits wondering why they couldn't make that coolant bottle hose a half an inch longer so that it could be easily moved out of the way.

At this point in my career, it has been a while since I've seen any diesel work and frankly, I wasn't mad after I saw this particular truck get towed in and the work order passed to another tech. But as my luck goes, the original tech had a "no communication" issue when he hooked up his scan tool, so it was passed on to me. I normally cringe at the thought of diesel work, let alone the term "Powerstroke," but I had recently purchased a truck with a 7.3 engine and I was excited to learn the differences between the 6.0 and the 7.3, as they have completely different reputations.

Initial investigation

I was told that this particular truck was running great and then abruptly died on

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the road. It would crank but not start and was towed in. I went out to the parking space where the flatbed dumped it and at first had no communication with the PCM or the hybrid electronic cluster. I ignored the hybrid electronic cluster because the cluster in this truck is analog and not listed as a module in the bus diagram. I disconnected the DLC connector, cycled the key a few times, and plugged the DLC connector back in and — voila — communication resumed! The previous technician had been using a different scan tool, and it was still a crank no start even with communication, so I knew I had some work to do.

The PCM had the following codes stored:

- P1280 ICP out of range low
- P0237 Turbo boost sensor A circuit low input
- P0340 CMP sensor circuit malfunction
- P1670 Electronic feedback signal not detected

I started out checking high-pressure oil. The injectors need about 800 PSI to start the engine, and this one was reading over 2000 PSI on the scan tool. The fuel injectors in this engine are controlled by an Injector Driver Module (IDM). When energized by the IDM, high-pressure oil from the high-pressure oil pump is sent to the top of an amplifier piston inside the injector that pushes fuel on the bottom of the piston out of the tip of the injector and directly into the combustion chamber at nearly 18,000 PSI. Without oil, this system cannot inject fuel and will not run. Oil level is an often overlooked cause of a crank no start concern by technicians like me who mainly diagnose gas engine no starts. The oil level in this truck was right where it should be.

Confused about the intermittent no communication, I started checking the 5V references KOEO (Key On Engine Off). Modules can fail and lose communication by having one of the 5v reference circuits shorted to ground by a failing sensor. This is common in 4.0 Liter Jeeps and my strategy is to disconnect the easiest sensor to access that on the shared 5V circuit and check for 5V at the connector. If it does have

5V, then I check to see if the module is communicating. If it is now communicating, chances are I just unplugged the shorted sensor. If there is no 5V reference at the connector, I will then go access the wiring diagram, find every sensor on that shared 5V circuit and disconnect each one by one to see if the 5V reference voltage returns. If it does not, then I start checking powers and grounds at the module. This can be tricky, as the 4.0L Jeep engine has two separate 5V reference circuits. If I pull one connector and find 5V but still no communication, I will plug it back in and check another sensor on that same 5V circuit to make sure that the first sensor I unplugged is not the one causing the short.

Even though I had communication, I decided to quickly check a few sensors and saw a clean 5V at more than one sensor. I figured if it was an intermittent issue with a sensor, I might catch it by checking the PIDs for all of the sensors and noticed that the Intake Air Temperature (IAT) sensor was reading -11°F. I unplugged what I thought was the IAT and the reading did not change. After a little research, I learned that this truck has two IAT sensors: one located in the airbox and another located in the intake manifold. The one in the manifold is called a manifold temperature sensor. Since that sensor had no effect on my no start, I decided to ignore that value for the time being.

Next, I looked into the cam sensor code, but my research indicated that a cam sensor failure would be accompanied by no rpm reading. After clearing the codes, none of them returned during cranking, including the cam sensor code, so I figured that was a dead end.

Next, I did a quick check at the glow plug solenoids. This solenoid looks and functions just like a starter solenoid. It gets a command from the PCM and then sends power to each bank of glow plugs on two wires connected to the output terminal of the solenoid. Each glow plug should draw about 20 amps when cold, and it is easy to test them right at the solenoid. There are two wires providing power to the glow plugs — one for each bank — so look for a reading near

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80 amps on each. In this instance I had only 15 amps on one bank (Figure 1) and almost nothing on the other. At this point it was getting late and both of the batteries in this truck were spent from cranking this engine, so I pulled one and threw it on the charger overnight.

Day 2 of the diesel dilemma

I came in the next morning expecting the amperages to change with a fully charged battery, but they didn't. From there I could assume almost all of the glow plugs are bad. Had I seen more amperage on those circuits, I could have traced the circuits down and measured the amperage on each individual glow plug to isolate the good and bad ones. Fortunately for me, I own a 7.3 and recently had most of my glow plugs fail, and I was able to still get mine started after an extended crank in colder temperatures (it was about 70 degrees this particular day) so I decided to take a different direction in diagnosing this no start, as I wasn't yet sure of the primary cause.

Next, I did the injector buzz test thinking I wasn't getting fuel. The buzz test gave me codes P1293 "High Side Open Bank 1" and P1294 "High Side Open Bank 2," indicating either all of the injectors or the IDM had failed. At this point, I needed to get the truck pushed in the shop, as I had still been working on it outside, as well as get the batteries fully charged. Once in the shop with fully charged batteries, I was back to no communication. One important thing to note is that most PCM failures on this engine will cause the "Wait To Start" light to not come on, but that never happened in this case. Another common issue with these is an aftermarket chip installed leading to a PCM failure. The PCM is firewall mounted and easily visible from under the dash. I removed the cover over it and checked for any aftermarket chips that would be plugged in the back where there is a factory access cover and there were none.

I started thinking about any other variables that could

cause no communication. I try to approach difficult diagnostics by making the main goal to eliminate any possible variables in the testing (things like a broken wire at the connector). I have even at times made lists to help me think through it. So in this case, I'm running through all of the things that could cause this truck not to communicate. Since the first tech had no communication with a different scanner, I could assume that it wasn't a scanner issue and it was unlikely that it had anything to do with spread pins at the DLC because that wouldn't cause a no start. Prior to this, I had never actually scoped communication lines, so I figured I would give it a shot. I backprobed the DLC and found the bus – stuck at 5V and the bus + stuck at 0V (Figure 2).

On to something

If you look back at the first set of codes, I had I noted a code P1670. I went back and looked this code up and it is a communication fault between the PCM and the IDM. Even if I had known this when I pulled the code the first time, I probably would have ignored it because communication codes often set due to low batteries and there really is no telling how long that code was stored in memory. It also never reset after being cleared, but it is important to mention at this point.

Assuming the IDM was causing the bus to be stuck this way, I decided to remove it from the bus and see if I could communicate with the PCM again. It is located inside of the driver's fender well (Figure 3) and is accessible by removing the inner fender liner. With the IDM disconnected, I still had 5V and 0V on the same bus wires. I have seen modules lock up, but even after disconnecting and reconnecting the PCM and cycling the key, I still had no communication. I figured since I had 5V on one bus wire that it was unlikely it was a circuit issue. It was also unlikely for a rat to chew through the one inch of a 10-foot long wire that I didn't test, so out came the sealed beam headlight as I checked all of the powers and grounds at the PCM (Figure 4). It is easy to forget to check the ignition switch inputs at the PCM during this test, as a mod-

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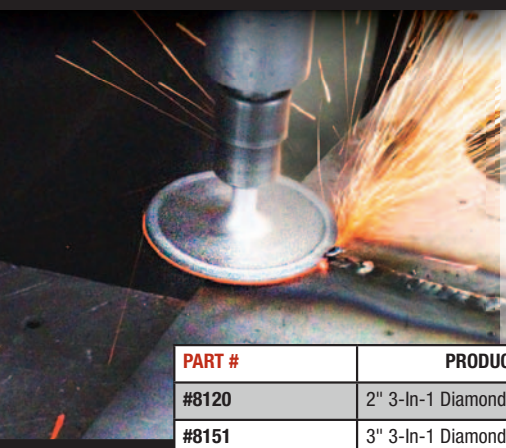

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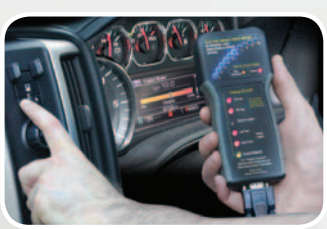

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ule will stay "asleep" until it is told to "wake up." Another thing to keep in mind when module testing is how the modules are told to "wake up." Some are commanded by other modules and some use power from the ignition switch. This PCM uses the ignition switch feed to "wake up," which tested good along with the powers and grounds so the module should have been functioning. The only other possible cause of this failure that I could come up with would be an issue in the bus wires. I quickly eliminated that as a concern by checking for continuity between the PCM and DLC as well as making sure I had no continuity to ground or B+. At this point I had eliminated any variables I could think of. Let's recap what I've learned so far.

- The IDM could not be shorting the BUS as it still won't communicate unplugged.
- None of the sensors were shorting the 5V reference, causing the PCM not to communicate.
- A blown fuse, bad ground or bad ignition switch couldn't be the cause.
- The BUS wires couldn't be broken or shorted to power or ground.

At this point I was comfortable recommending replacing and programming the PCM and then rechecking the IDM.

Are we done yet?

The next day I reconnected the IDM, installed the PCM, and performed the programming. The flash loaded perfectly and I had communication but the engine is still a crank no start. I still had the DLC backprobed so I hooked up the scope and saw good clean opposing square waves on the bus lines (Figure 5). I then tried to perform the injector buzz test and all of a sudden I lost communication! I went back to check the scope and the bus is stuck again at 5V and 0V. The next procedure I performed was a strategic banging of my head on the dash board hoping to shake the gremlins from this diesel nightmare…no luck.

However, I did find some luck that our service writer had first ordered an IDM rather than a PCM and we had one sitting on the "go back" shelf. Exhausted by testing, I slammed it in still dangling out of the driver's fender and wouldn't you know it the truck starts right up.

I still had the new IDM hanging out of the wheel well at this point and when I removed the old one and turned it upside down water came dribbling out of it (Figure 6)! It hadn't rained recently and we could not identify any area rain water drained into the unit. The customer is certain that the truck had never been in a flood or submerged. The unit is supposed to be RTV sealed but the RTV sealer at the top of the unit had failed.

I mount the IDM and get ready to test drive the truck and the service engine soon light is on. It had two codes:

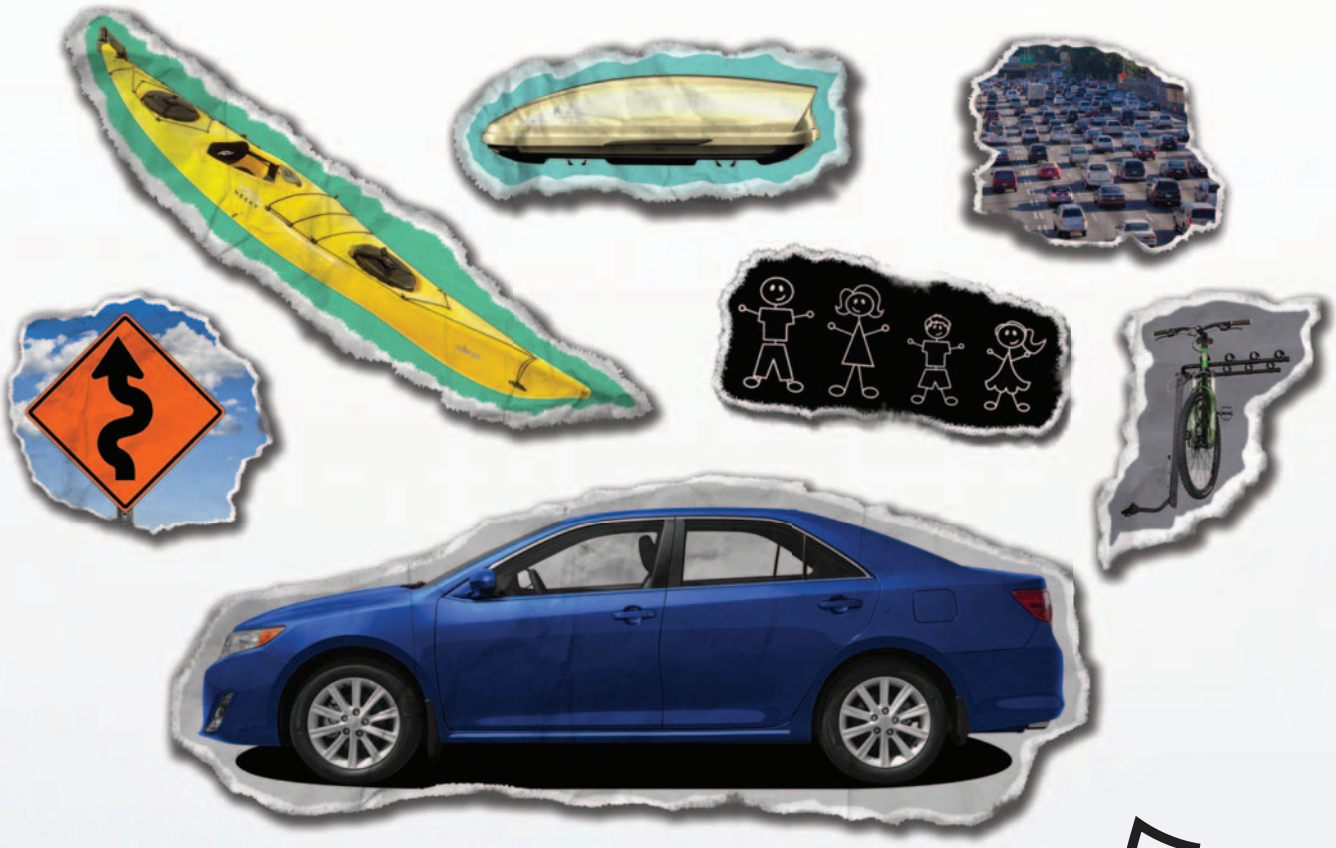
- P0603 PCM KAM test error
- P0122 Throttle position sensor circuit

I clear them assuming the P0603 is from the reprogramming. The P0122 immediately resets. I check Identifix and find the simple testing for the APP on this truck. The APP should have 0.5V at rest and ramp up to 4V at WOT. Testing at the APP connector everything looks good, but the scanner PIDs show the voltage starting at almost 0.0 V and ramping up to a just below 0.4V at WOT. I did not think that this was a scanner issue similar to what I had seen with the IAT sensor.

My next step would have been to test the signal voltage at the PCM, but since this is the first time I have seen this code and the original PCM was still on my toolbox, I decided to swap the old PCM in and see if it will communicate again to check the APP readings. Once back in the truck the engine fires right up with no codes. I check the APP sweep on the scanner and it matched what I saw on the connector.

We explained to the customer that the PCM had been "locking up" but we believed that it was due to the IDM failure. We explained that we were able to get the truck to run on the old PCM but the customer decided to replace it anyway so we ordered another unit, programmed it and it ran great with no codes. The customer did not want to follow up with the glow plugs and I was more than happy to see him drive this one off the lot.

MIKE REYNOLDS is the owner of Mobile Automotive Service Solutions in Charleston, SC, an ASE Master Technician and an automotive technology instructor at Trident Technical College.
mike@masscharleston.com



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BITTEN ON THE BACKSIDE

EVERY TECH HAS BEEN THERE — TUNNEL VISION SETS IN AND OFTEN MISTAKES ARE MADE. BUT IT'S ONLY A FAILURE IF YOU DON'T LEARN FROM THE EXPERIENCE

PETE MEIER // Technical Editor

In this month's Tech Corner, I would like to share an experience I had when still full-time as a technician. It's an experience I'm sure most of you have also enjoyed, or not, depending on your outlook on life. You know, the old "glass half full" kind of thing.

The car in question is an older Ford Mustang with the 3.8 liter V-6, with a hard misfire on cylinder #1. Follow along and see if how you would have tackled this difficult one would have been different from my approach!

THE ANSWER TO THE FORD MISFIRE is in this picture. Do you see it?

The first mistake

The customer had brought the Mustang in to the shop for a complaint of a rough idle and stumble on acceleration. After a short test drive, it was easy enough to tell that there was a serious misfire going on under the hood. I hooked up my scan tool and found code P0301 (cylinder #1 misfire) and P0316 (misfire detected on startup) stored in the Engine Control Module (ECM).

This vehicle uses a Direct Ignition System (DIS) that fires two plugs simultaneously. Upon opening the hood, I could hear the distinctive "tick" of a spark jumping to ground outside the cylinder. Looking a little more closely, I could see the spark jumping to the valve cover from the #1 wire. The wires looked like original equipment, and a closer inspection revealed signs of leakage in the others.

On this type of coil, one plug is "positive" and the other one is "negative." When the coil discharges, current first travels to ground through the negative plug, then back to the coil through the positive plug.

When the coil is stressed, the internal insulation can fail, reducing total coil output. In this low state, there is just not enough voltage left to jump the gap on the second plug, even though the first plug continues to run just fine. That's why it's possible to have a DIS coil with one dead plug.

Thinking that I had this one nailed down, I ordered a replacement coil and ignition wires and moved on to the next car on my list that day. Time is money after all when you're working flat rate!

PHOTOS: PETE MEIER

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The second mistake

When the parts at the shop arrived later in the day, I pulled the Mustang back into the bay. It is a simple installation and took no time at all. I cleared the codes and went to verify the repair. Have you guessed yet? The miss was still there, and the MIL light was back on.

You would think that after all the time I've had in this business I would remember my own personal rules regarding diagnostics — never take a shortcut, especially on a misfire code.

A misfire code can be set by any condition that doesn't allow for complete combustion in the cylinder. My normal procedure is to first do a relative compression test to ensure the engine is mechanically sound. Doing that test now indicated that the #1 cylinder had a problem.

If I see a low cylinder indication on this quick and dirty test, I then follow up with a normal compression test; 60 psi was all I got on the misfiring cylinder. What I found had me muttering a few very choice words under my breath. I was kicking myself for breaking my own set of rules, and now I had a major engine fault to explain to my customer.

Was the original repair even necessary? Replacing the ignition wires may have been; however, the coil was certainly a rushed diagnosis. The low firing line I had seen on my scope was a result of low compression, not low spark energy. Remember, the firing line is typically affected by pressure, gaps in the system and the amount of hydrocarbons available for conduction. The scope was trying to tell me something. I just wasn't listening, instead choosing to see what I wanted to see based on an assumption.

What's the fix?

The next step I took was to perform a cylinder leak-down test. This test uses a tool called a differential cylinder pressure tester and has two gauges on it. One indicates line pressure (supplied by shop air), and the other is the pressure being contained in the cylinder. When connected, and with the cylinder to be checked at TDC of its compression stroke, the tool pressurizes the cylinder and you compare the two pressure readings on the gauges.

When connected to the 3.8's #1 hole, the left side gauge displayed the line pressure of 90 psi. The right side gauge reads the pressure in the cylinder, showing 70 psi. That's a 20 psi difference, or a little more than 20 percent of line pressure. Not a lot, but standard specification is no more than 10 percent difference.

With the line still connected, I removed the oil fill cap, radiator cap and air filter housing. That 20 percent of air pressure is obvioulsy going somewhere, and using this method, you can actually hear it escaping. That's the nice thing about this tool. It allows you to hear if the loss of compression is from the valves (air escaping from the throttle body or exhaust pipe), the rings (air escaping from the oil fill) or from the head gasket (air escaping from the radiator).

This one, thankfully, was a no-brainer. Air was audibly rushing out of the throttle body with no evidence of air flowing through any of my other checkpoints. OK, now I've got it, I thought to myself. The intake valve is leaking. I got authorization to remove the head, confident that this was the problem.

With the head removed, I verified the valve was leaking by pouring solvent into the intake port and looking to see if any of it leaked past the valve on the combustion chamber side. It began to pour out as soon as the solvent got to the valve face. But because I had been burned on my first diagnosis, I needed to be extra thorough this time around.

I STILL DON'T KNOW how the #1 rod was bent, but it caused the piston to fall short of TDC and lowered the effective compression in that cylinder.

I also checked the installed valve height to see if there might be a problem with bent valves or recessed valve seats and found no problems there. I inspected the push rods for damage and the cam lobes for wear. While the head was off, I rotated all the cylinders to the bottom of their travel to look for damage to the cylinder walls.

Everything looked good — or so I thought to myself. But again, I was wrong.

I got the head back a few days later and reinstalled it on the Mustang. I turned the key, and you should have heard the expletives that immediately followed!

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What had I missed??

You've got to know that I am really upset with the repair process of this vehicle by now. I felt I had effectively done a thorough diagnosis, and I had definitely found a major flaw in the leaking intake valve. Thinking then that maybe the machine shop had done something wrong, I checked cylinder leakage with my tester. This time, the results showed no leakage.

But what about compression? Again, I got a low reading on the #1 cylinder. What is going to make a tight cylinder low on compression? The only answer I could come up with is that the cylinder couldn't breathe. However, I had checked the valve train and had found no problem there.

I pulled off the valve cover and rechecked the valve operation, measuring opening and closing heights of the valves on #1 and comparing them to #2 and #3. I could not find the problem.

There was only one answer left. It had to be in the bottom end.

Again, I removed the head on my way to the piston, and here I'll tease you with the photo in Figure 1. Do you see what I should have noticed the first time?

With the piston removed, the problem was obvious. Now take a close look at Figure 2 (page 60). Do you see what should have caught my eye? The interesting thing about this failure is that the rod bent almost perfectly along its axis, effectively shortening its length. Other than that, there were no other symptoms present in the vehicle — no noise, no vibration and no bearing damage.

Now look closely at the stain on the cylinder wall in Figure 1 (page 58) where the ring travel ends near the top. The cylinder in the foreground is #1; #2 is behind it. Notice how the stain is thicker on #1. This is showing that the piston wasn't reaching TDC. I should have caught this when I had the head off the first time. Would you have caught it if this vehicle came into your bay?

What would bend the rod? Perhaps it was hydraulic lock from a leaking head gasket and the failed rod went undetected, or ignored, during that repair. When I first performed my visual inspection, the oil level was correct with no sign of intermix. Coolant levels in both the reservoir and radiator were correct as well, and there was no air escaping through the radiator during the first leakdown test.

Learn from my mistakes

Hindsight is always 20/20, as they say. Looking back, I had made several missteps. My first mistake with this vehicle was not performing my normal diagnostic routine and checking engine integrity from the start.

My second mistake was not considering that a 20 percent leakage rate (a nominal amount) would result in a compression reading of only 60 psi. The two did not agree with one another — what the ECM would flag as a "rationality" error. Now, in my defense, who among you would have expected to find a bent rod or would have caught the visual signs that were present, especially considering that there was no other evidence present? Even if I would not have been alone, the visual cues were in fact there when I had the head off the first time, and I missed it.

When troubleshooting any kind of vehicle problem in the shop, always try to remember what Spock told Captain Kirk on *Star Trek* – "We must fall back upon the old axiom that when all other contingencies fail, whatever remains, however improbable, must be the truth."

PETE MEIER is an ASE certified Master Technician and sponsoring member of iATN. He has over 35 years practical experience as a technician and educator, covering a wide variety of makes and models. His primary goal is to bring working techs the information they need.
pete.meier@ubm.com

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NEEDFUL THINGS

DOING THINGS RIGHT REQUIRES A SHARP WIT AND QUITE A BIT OF GRIT

RICHARD MCCUISTIAN //
Contributing Editor

One day I got a very terse call from the vice president of the company where I was responsible for fleet maintenance back in the late '70s. It seemed that an almost new (1978) Dodge one-ton we had was pointed at the gate with a gooseneck trailer behind it and that truck and trailer needed to arrive at our offshore diving and salvaging dock 25 miles away within the next 30 minutes. I had no idea why that trip to the dock was so urgent, but someone had misplaced the key to the Dodge.

"Get that truck started and on the road within the next 10 minutes," he told me with his gravelly voice, "and I don't care what it takes. Just make it happen."

I must admit that I was in my element under pressure in those days, so I hung up the phone and grabbed a jumper wire with a couple of gator clips on each end out of my toolbox. I opened the hood on the Dodge and made a connection from the positive battery terminal to the ballast resistor to feed current to the ignition coil. Making sure the tranny was in neutral, I "pocket screwdrivered" the starter to fire the engine up. Ninety seconds had expired and the steering wheel was still locked, but I knew I could defeat the pewter collar around that silly spring-loaded steering wheel lock peg, and I slid into the seat and muscled the wheel hard to the right, and broke the lock. Mission accomplished in less than three minutes and the truck was headed out the gate.

THIS IS MY 2007 F-150 that was victim of a surgical strike by some toothy critter who was copper-hungry.

Then there was the time at that same job where I had to drive down Highway 87 toward Galveston and take a steamy ride on one marsh buggy through a swarm of mosquitoes and dragonflies to another marsh buggy that had jumped time, stranding a different vice president and his passengers a couple of miles off the road. Putting a timing belt on while standing in snake and alligator-infested water and swatting away mosquitoes wasn't my idea of a good time, but I was motivated enough that I got that job done in record time, too.

The point is that every job isn't interesting, but in our line of work, challenges are the spice of life, and it feels good to be a problem-solver. It feels even better to be appreciated, and usually we are, but that isn't always the case.

Critters

Dogs and squirrels chew wires, as do rats. Rats and squirrels build nests in engine compartments, and cats looking for a warm place to sleep can die under the hood and under the car in very gruesome ways sometimes. I've had to kill spiders and roaches, wasps, dirt daubers and all manner of other wildlife in my under-the-hood and under-the-vehicle odysseys. One morning I did a classroom presentation on critter damage, and a day or so later I walked out to where I park my own F-150, slid in behind the wheel, and thought I was going somewhere in my truck, but it wasn't to be. The battery was good and hot, but I had no starter operation and no scan tool communication. The red theft light was blinking, which can point to a few different problems, but it usually means a module (usually the PCM) isn't talking. With the key on, I checked for voltage at the EGR assembly and found 9 volts on the gray-red signal return wire, which should have been grounded through the PCM. What that meant to me was that the PCM had lost its own ground reference somehow.

PHOTOS: RICHARD MCCUISTIAN

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Next it was time to bust out my smart phone and dig into ALLDATA, where I found that PCM G103 is located behind the battery on the bulkhead. With my flashlight, I peered down there and saw that about eight inches of that wire had been removed by some sharp little teeth and my much larger main power feed cable to the inside fuse panel had been just as viciously attacked, but it had survived without being severed. Some chew-happy squirrel must have a nice piece of wire lining its nest and a belly full of copper as I type these words.

There was another ground wire in that same area that was compromised as well. While removing the battery and doing some solder and heat shrink work was almost enjoyable that Saturday morning, I found myself wondering if I was going to have this problem again. No other wires under the hood had been attacked. It was almost like the critter had pulled up a wiring schematic and did a surgical strike to prevent my truck from going anywhere. And it worked.

I prevailed in that fix and placed some rat poison in the general area. We'll see how that works out.

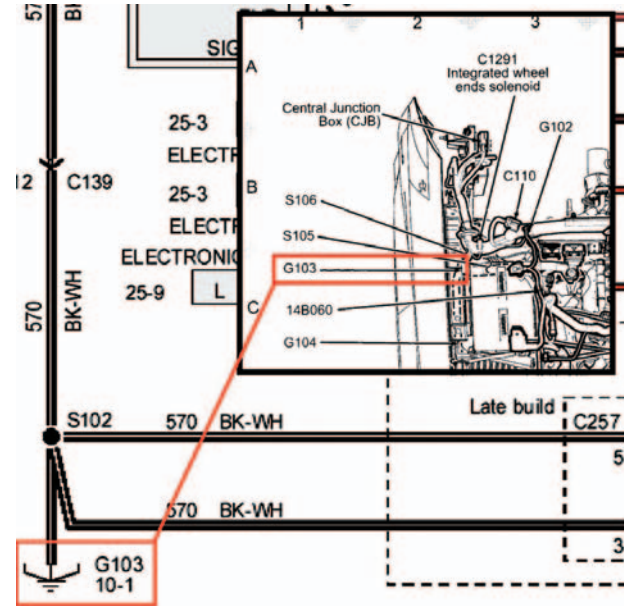
The 2004 Suburban

In a previous article, I mentioned a 2004 Suburban with a 5.3L that was misfiring on cylinder 4 with low compression and during the cylinder leakage test air was escaping into the exhaust, but the owner chose to drive it skipping for a while before having it fixed. Finally, the Suburban returned and we hashed out what needed doing.

This was one of those high-milers, so I talked them into a reman engine because of the better warranty, which we managed to stuff in there in pretty good time.

After the swap, I had Robbie jerk the head off so we could inspect the valves and the head of the piston on the offending cylinder, and we found a valve that had become mismatched with its seat and was leaking compression. With the new engine in place, the MIL was off, the monitors all cleared, O_2 sensors were switching handily, and fuel trims were bouncing around the zero line, so we put that one back on the road. There was a strange caveat, though. For some reason, the transmission wouldn't go into park well enough to not roll away on a slope.

This was a deal-breaker, to be sure. The shift cable was adjusted as far as it could go. I could disconnect the cable and put the transmission fully in park, so there was nothing wrong inside the case. Eventually I decided to try the shift lever off another transmission I had on the shelf and with that lever installed, it would go completely into park just fine even though it looked the same. I have yet to figure that one out, but it was safe when it left.



HAVING ALLDATA AVAILABLE ON A SMARTPHONE is pretty handy when you're under the gun to find out what's wrong and you're somewhere else besides the shop.

I SUPPOSE I SHOULD HAVE BEEN THANKFUL that these wires were the only ones the critter chewed — he could have done a lot more damage than he did. Fixing this took about 30 minutes.

THIS RUSTY BRAKE LINE SYNDROME is fairly common everywhere on trucks of all kinds, especially on trucks that do a lot of mudding, but salt did this one in. This Silverado had spent its early life in Panama City Florida, where the salt air took its toll.

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The Silverado, Fusion and the MKZ

While all this was going on, another instructor who drives a 2003 Silverado 2500 Duramax asked if we could replace his master cylinder. He's ordinarily pretty savvy, and since he brought us the master cylinder I had a guy pop it on there and begin the bleeding process. Well, the pedal felt like you were stepping on a plum, and there was fluid dripping from underneath the truck and we found that classic rusty brake line situation a lot of you guys have to fix every day. He didn't look under the truck, I don't guess. A careful exam of the whole system revealed that this line was a lot worse than any of the other lines, all of which looked pretty good, and so we got a roll of that dandy nickel-alloy rust-free stuff and built a replacement line from stem to stern (complete with new double flare fittings), and after the bleeding procedure, we got that one rolling again with a good firm pedal and a master cylinder he didn't need. I gave him the rest of that $60 roll of brake line just in case something else would be needed later.

The 2010 Fusion that came in around this time was making a bump noise underneath on the left side during parking lot maneuvers, and it was one of those cranky situations where you can't see anything but you know something is wrong. And every bolt was tightened to no avail. This one has that odd double-ball joint design with two lower control arms, and when we applied the Chassis Ear® we found that one of the control arms was the source of the bump, and when we got it out of there you could see the problem. The hidden rubber that is couched in the frame area had died, and that was allowing the sudden pressure of certain braking and steering maneuvers to give a metal-to-metal contact sound. The fix was easy enough.

THIS INNER CONTROL ARM BUSHING isn't visible on the Fusion until you remove the control arm. This was the rear of two control arms that car is blessed with on each side.

That Fusion reminded me of another vehicle, a 2012 MKZ that came in with an alternator you could hear whining from 100 feet away. She had been to a tire shop complaining about a noise, and the first guy who rode with her at that shop said he thought the noise was a hub bearing. The more experienced mechanic said, "no, that's the alternator," because it was making the noise when the car was sitting still and the pitch of it matched engine speed. When I heard it, I agreed with the older guy's prognosis. That alternator was making a LOT of noise that changed with throttle.

Getting the alternator off a 2012 MKZ isn't for wimps — the refrigerant has to be recovered and the A/C compressor has to be removed, and the alternator comes out the bottom. But my guy got it done. I knew this 17-year-old could handle it — he had just finished replacing the heater core in a 2010 Wrangler, and after that extremely difficult job, this one was a cake walk.

The new alternator didn't whine. The car sounded normal under the hood now, but it did have what sounded like a noisy hub bearing on the right front at road speed. It was one of those situations where the customer didn't believe she had needed the alternator to begin with, because she was still hearing a noise on the road and one noise was masking the other. She chose to drive the car for a few days but eventually came back and implied that it was our fault for replacing the alternator.

HERE'S THE SILVERADO'S WATER PUMP with the rear cover removed, but I couldn't see a problem, nor could I feel one manipulating the pulley and holding the impeller.

THIS WAS ONE OF THOSE EXHAUST BOLTS that had rust-melted from a 15mm down to something just a little larger than a 9/16, and it wasn't in an easy place to access. We air-hammered this wiggler onto the bolt to get it out. It was a needful thing, but getting the bolt separated from the socket was tough.

"I left it running outside," she said. "I had to jump it this morning, and then I drove here. It wasn't giving that problem before you replaced my alternator."

I had her pull it into the shop. I carefully explained that if the alternator wasn't charging, the engine would have died as soon as the jumper cables were removed. Then I switched the car off and tried to restart it, but the battery was too weak. When I jumped it off and connected the Snap-on tester, I showed her that the alternator was indeed charging and suggested that she find a cool place to rest while I did some more troubleshooting to figure out what was going on, but I told her I'd need the rest of the morning to be sure of what was going on.

I put a good stiff charge on the battery with a heavy-duty charger, then I got out the $1,700 Midtronics unit I bought from Joey Henrichs and ran through the entire routine, which records everything, including battery health and alternator ripple, printing it

out for the customer. The MKZ showed a clean bill of health all the way around except for the battery.

Taking it a step further, I did a parasitic drain test, connecting a meter in series with the battery and waiting until all the modules finished charging their stuff. End of story — there was no drain, only a weak battery.

When she came back I showed her the results and told her she'd need to get the hub bearing noise handled at the tire shop. Sometimes it's best to send some customers down the road, so that's what I did.

Another Silverado

This 2003 1500 5.3L came to us with an overheating complaint. It was overheating, but it was happening slowly, and there was no quick pressure buildup in the cooling system when the engine was started. The fan kicked on at 228, but the engine kept getting hotter until the fans kicked on high, and all that took a while, but I noticed that the radiator was still cool.

"Let's try a thermostat," I told my guy. Cheap and easy comes first. We put one of those in there and burped it out, but nothing changed. The radiator was cool, but the engine was getting hot. So I had him pull the water pump, and the borescope didn't show anything wrong down in the pump, so we reinstalled it. With the radiator removed (no external clogging seen) I bypassed the radiator using the long hose, and we also looped out the transmission cooler lines and took the guts out of the old thermostat to allow free flow. With the engine running we had to squeeze the hose in the middle to neutralize the natural kink so as to facilitate flow but even with that hose in place of the radiator, there was still no flow through the hose, which was only warm on the ends — not in the middle. And the engine continued to try and run hot. What madness was this? If coolant had been flowing, the hose would have been hot its entire length.

To make a long story short, a radiator and a water pump fixed that one, although I couldn't figure out what was at the root of this problem. One way or another, the truck never runs over 210 degrees now. Happy customer.

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

PRODUCTS // TOOL AND EQUIPMENT GUIDE

SHOP EQUIPMENT

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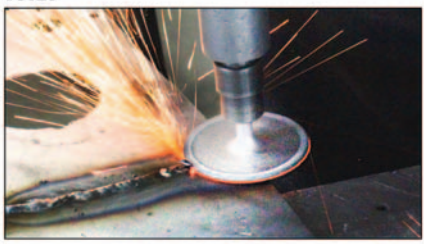

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DMM TIPS AND TRICKS

THE DMM, OR DIGITAL MULTIMETER, IS A POWERFUL STANDALONE DIAGNOSTIC TOOL. HERE ARE A FEW USES FOR THIS VERSATILE TOOL THAT YOU MAY NOT HAVE THOUGHT OF.

PETE MEIER // Technical Editor

What were the first tools you ever purchased? Of course, there was the selection of the basic hand tools and power tools, right? A basic tool box to store it all was also part of that initial investment, I'll bet. But what about diagnostic equipment? Was a high-end scan tool on your list? What about a scope? Odds are, neither were during the early part of your career.

I am willing to bet, though, that a Digital Multimeter was. It's a tool that is as vital to a technician as a hammer is to a carpenter. We use it to measure the resistance of electrical components, voltage potential in a battery, and some of us even use it to measure current flow in a working circuit. All are good uses, but there is so much more that the DMM can perform and so many ways it can be used to solve a variety of diagnostic dilemmas.

In this edition of The Trainer, we'll take a look at the features included with most DMMs you may or may not be familiar with, how to perform some of the more standard tests with the meter, and then share some testing techniques you may never have considered.

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