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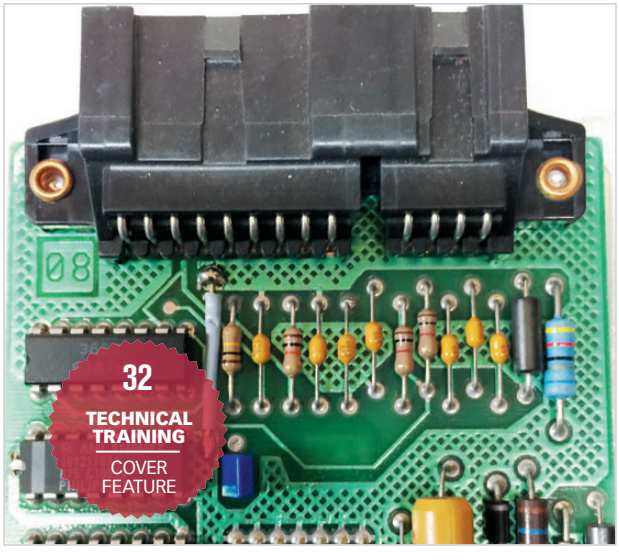

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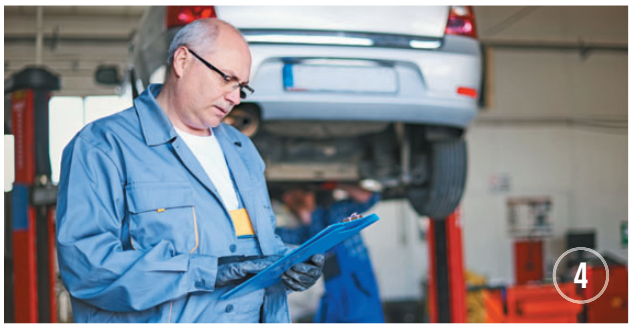

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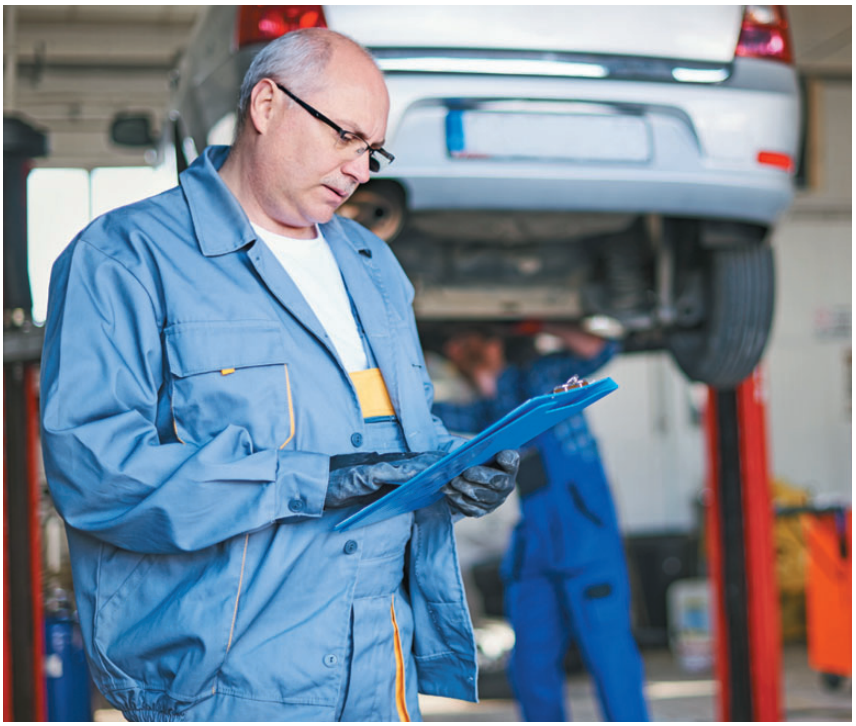

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INDUSTRY RESEARCH

AAA SURVEY: DRIVERS DON'T TRUST REPAIR SHOPS

BRIAN ALBRIGHT //
Contributing Editor

A survey released by AAA in December indicates that the majority of U.S. drivers don't trust repair shops because they believe they will overcharge them or recommend unnecessary service. However, 64 percent of respondents do have a favored auto repair shop that they trust.

The report is based on a telephone survey of more than 1,000 drivers.

According to the data, the top reasons that drivers don't trust repair shops are:

-Recommending unnecessary services (76 percent of respondents)

- Overcharging (73 percent)

- Negative past experiences (63 percent)

>> **STUDY** CONTINUES ON PAGE **6**

BREAKING NEWS

RECYCLING PROGRAM

HENKEL CORP INVOLVES SHOPS IN RECYCLING INITIATIVE

Henkel Corporation, the company that offers LOCTITE threadlocker products to suit the needs of the professional tech, is setting forth to reduce the ecologic footprint that the industry's day-to-day operations place on the environment. Henkel's new sustainability program gives shops the opportunity to recycle used bottles of LOCTITE threadlocker through TerraCycle, a company that makes consumer products from pre-consumer and post-consumer waste and by reusing other waste materials.

To participate in the program, shops must purchase a LOCTITE recycling box from their distributor or LOCTITE sales rep and place it on their shop floor. The boxes come with a pre-paid shipping label, so when the box is full, they simply seal the liner and ship it to TerraCycle for recycling.

>> **HENKEL** CONTINUES ON PAGE **6**

TRENDING

NHTSA TO ESTABLISH V2V COMMUNICATION RULES

The National Highway Transportation Safety Administration published a notice of proposed rulemaking on vehicle-to-vehicle (V2V) communications.

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ADVANCE AUTO PARTS SELECTED AS COMMUNITY PARTS PROVIDER

Advance Auto Parts has been selected as the exclusive parts supplier to the U.S. Communities Government Purchasing Alliance.

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ATMC ANNOUNCES NEW OFFICERS, DIRECTORS FOR 2017

The Automotive Training Managers Council announced its new officers and directors for 2017, with Chris Chesney of Advance Auto Parts as the new chair.

MOTORAGE.COM/ATMC

REGISTRATION OPEN FOR AASP/NJ'S NORTHEAST SHOW

Celebrating its 40th year, the Alliance of Automotive Service Providers of New Jersey presents its NORTHEAST Show, to be held March 17-19 in Secaucus, NJ.

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MITCHELL 1 SHOP MANAGEMENT WORKSHOP COMING TO SCOTTSDALE IN APRIL

Mitchell 1 will hold this year's first Shop Management Workshop April 27-29 in Scottsdale, Ariz., at the Scottsdale Plaza Resort.

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>> **STUDY** CONTINUED FROM PAGE 4

- Concerns that work will not be done correctly (49 percent)

"To minimize the stress associated with vehicle repair and maintenance, it is critical that drivers find an honest repair shop that they can trust with their vehicle," said John Nielsen, AAA's managing director of Automotive Engineering and Repair. "AAA found that one third of U.S. drivers — 75 million motorists in total — have yet to find a trusted repair facility, leaving them vulnerable when trouble strikes."

The level of trust varies by age group. Older drivers are generally more trusting than younger drivers, while Baby Boomers are twice as likely than younger car owners to fully trust auto repair facilities. One in five reported they "totally trust" the industry. Seventy-six percent of Boomers have a preferred shop, compared to 55 percent of Millennials and 56 percent of Gen-Xers.

With more connected cars on the road, drivers also want more control over how their vehicle data is used. The survey indicates that the majority of U.S. drivers want to be able to direct their vehicle's data to their favored repair shops.

AAA had a number of recommendations to help consumers in finding a trusted repair shop, including:

- Find a repair shop before you have car trouble. Ask around for recommendations.

- Research potential repair shops, including how long they've been in business. Check with the Better Business Bureau, State Department of Consumer Affairs or attorney general's office to see how they handle complaints.

- Visit the shop for a minor maintenance issue (like an oil change) in order to check out the shop's appearance, warranties, technician credentials and amenities.

Trust has been noted as a key factor in a number of industry studies, including research related to dealership service and body shop departments. A study earlier in 2016 by Cox Automotive found that many customers did not take their vehicles to dealerships because of costs, fears they would be overcharged and unreasonable labor or parts charges. In fact, 34 percent of respondents said they thought the dealer would overcharge them.

Both independent shops and dealers can benefit from having full price transparency — and listing prices for basic services on their websites and posted in the shop. Posting certifications and other information can also lend credibility to service recommendations.

>> **HENKEL** CONTINUED FROM PAGE 4

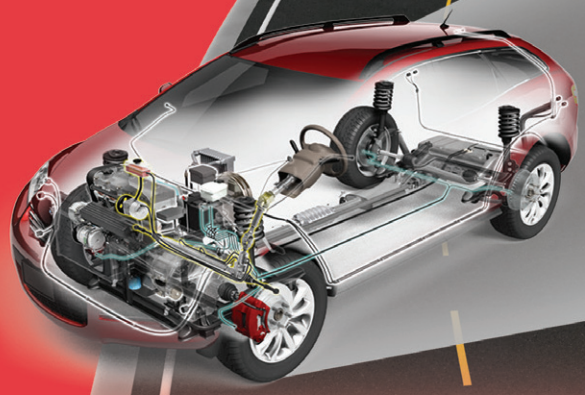
Kenneth Forlenza, Director of Vehicle Repair and Maintenance for North America, explains, "As sustainability goals become more important for industrial and manufacturing companies, many are trying to reduce the amount of waste they generate, and some have adopted 'zero waste' programs. Our program with TerraCycle gives customers a simple way to achieve their waste reduction goals by recycling their empty LOCTITE bottles."

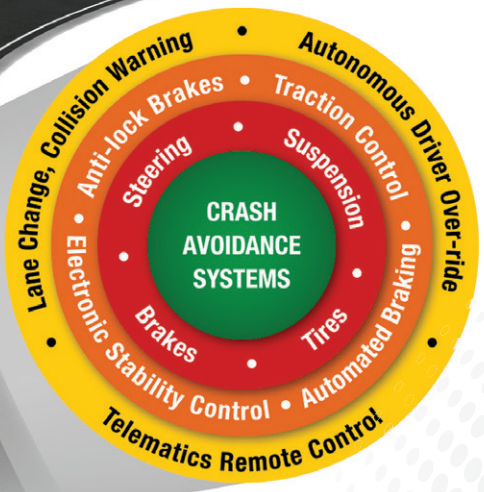
There are many reasons that the automotive aftermarket industry should be involved in sustainability initiatives — namely because it can help the industry improve its bottom line. "Reducing energy use, water and waste saves money in the long run. In addition, sustainability is becoming a bigger factor for customers in deciding which companies to do business with," Forlenza adds.

With this initiative, Henkel is reaching beyond the automotive aftermarket; the recycled threadlocker bottles will be repurposed for playgrounds, park benches and other community-centric fixtures. Forlenza explains, "Community involvement is part of Henkel's commitment to sustainability. We want to contribute to the quality of life in the places where we live and work. Our adhesive recycling program is going to keep LOCTITE bottles out of landfills, but it's also going to help our communities by providing playground equipment and other needed items."

For more information on the LOCTITE adhesive recycling program, visit www.na.henkel-adhesives.com/recycleloctite.

Designed Performance is Critical





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Get involved and try new recruitment tactics to fight against the tech shortage

You might not have yet had the pleasure of trying to hire a millennial technician, but someday you are going to have to. As the proud grandfather of 16 grandkids, I have had the privilege of watching a few of them thinking about careers. I was listening to a former shop owner and now ATI coach, Kim Hickey, tell a funny story, and I thought her suggestions might help you.

Here's Kim's story: I had the pleasure of being driven home from the airport by a man named Vinnie. Vinnie was a pleasant young man. He had been attending community college for quite a while (for much longer than it takes to get a degree) and working part-time. We were stuck in traffic for an hour and during that time the subject of politics came up.

Without getting too much into detail or getting on my political soapbox, I will just share with you that Vinnie thought Bernie Sanders was "the man." Vinnie thought all of Bernie's programs were the answer to everything, and it downright upset him that a "kid" should have to pay for his or her own education. Vinnie didn't know who or what would pay for these "free" programs, but he still thought it was a good idea. I asked him if he thought that people put as much commitment and care into things they did not work for as they did when it was something they earned. He didn't know. I asked him if any degree should be free, say for example Puppet Arts (yes, that really is a major). He said of course not — that would be stupid. I asked him who would get to pick what majors would be considered for "free" tuition. Again he didn't know, but still thought it was a good idea. I asked him what was taking him so long to get his degree, and he was quite honest with me. He said he is very lazy, gets bored and partied a lot.

I couldn't help myself but to point out to Vinnie that even without Bernie Sanders and his college program, there are opportunities right now that allow for students to go to college for "free" or at least get a portion of their tuition paid for. If you work hard and have great grades, there are many scholarships available. He said he knew that, but didn't want to put the work in during high school. I asked him if he knew that most colleges had programs where you could work there and that could help subsidize tuition. He said he did, but he didn't like that idea. I then brought up how there are companies out there that will pay for college for their employees, like Starbucks for example. He scoffed at that and said "Yeah, no way would I work in a Starbucks."

What does my conversation with Vinnie have to do with you and the automotive business? It reminded me of a song by 10 Years After. The chorus goes like this:

I'd love to change the world
But I don't know what to do
So I'll leave it up to you

Can't find technicians?

I often hear shop owners tell me they can't find good techs. That the number of available good techs is dwindling. I hear all sorts of reasons why this is occurring, and I agree with almost all of the ones I have heard. One popular school of thought is that the money involved in learning to be a tech scares potential techs away. With the major tech schools costing anywhere from $40,000 to more than $60,000 and then an investment right off the bat of more than $10,000 to start for tools, this is seen as an expensive trade to get into (we won't even get into that the tech schools don't give their students a realistic starting pay range).

And just where can kids go to get the automotive bug these days? I don't

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know about you, but where and when I grew up, somebody was always working on or "souping up" a car. Everyone had a dad, an uncle, a big brother or someone who was hunched over a car in their backyard during every family picnic and barbeque. If you wanted to speak with that person, you approached them knowing you would be handing them tools and would also be getting a lesson on what each tool did, and how to set timing, and what the points and plugs did and getting grease on both you and your hamburger bun.

We have known a shortage was coming for years. We have known it is getter harder and harder for years. We have had discussions about the cost of tech school, the cost of tools they must buy, the stigma that techs are still "grease monkeys," and so on. But guess what, no one that I know of (with the exception of a very limited few) is doing anything about it. Everyone talks about the problem, but few are willing to put in the work to create a solution. Many want to change their pay plans so they can offer a tech — that they say they can't find anyway — more money than they can afford.

If we want to change the world, the technician shortage or the perception of the automotive industry, we can't leave it up to everyone else. Guess what — everyone else is leaving it up to us. The tech shortage situation is not going to change until we do. I want to leave you with a few questions to think about.

Have you tried all these ideas?

How many shop owners who are desperate to find a good tech go by dealerships and other shops that are open in the evenings and weekends and give out their cards?

How many park outside the better shops and dealerships right before lunch hour and see where the techs head to for lunch and give out their cards?

How many have contacted their local community colleges and inquired about their automotive program and then:

- Volunteered to teach?
- Volunteered to be on the board?
- Asked if they could come in and talk to the class?
- Asked if they could offer a mentoring program where students can come to their shop X number of times and see what a real shop is like?
- Asked to speak to the students directly to find out what they are looking for in an employer when they graduate?
- Offered themselves and their shop for mock interviews for the students?

How many are sharing the idea of becoming a tech with kids at an early age?

What about contacting local preschools, grade schools and middle schools to come in and speak with the students about a career in the automotive industry?

What about going to the schools on a high school level for career days and setting up a booth to let students know just how much money techs can make today and how much computers are involved?

How about taking the time to visit the local community colleges nearby and finding out just how affordable it is for technician training? You would be shocked to know that you can attend a school like Glendale Community College and earn an associate degree via their General Automotive Degree Program for around $7,500.

What about contacting the schools nearby and offering to help pay for school for students that show mechanical aptitude?

What about having an apprentice or mentor program for someone wanting to be a tech?

How about contacting guidance counselors at the high schools and colleges and asking for any stats or demographic information on the kids that are considering becoming a tech so you know where to market to?

What can you do to change your ads and hiring approach to grab the attention of millennials?

Do you have an amazing shop with innovative systems and processes, benefits, the latest equipment and tools, great online reviews and strong leadership that will attract the best technicians?

There are many more questions I have, but I think I've made my point. People want the world to change, but they want someone else to do it. I have one client right now who is not waiting for someone else to do it. He is having air-conditioning installed in his shop for the techs. Do you think that might increase productivity during the summer and also attract technicians?

In case you were wondering, Vinnie is not going to get his degree any time soon. And his more than four years of community college tuition has been paid for by his dad. He thinks he may join the Coast Guard because he likes to swim. Vinnie would love the world to change, but he'll leave it up to you.

If you would like a training checklist to use for new entry-level employees, please visit the link below. Every shop is different, so feel free to add anything to the list that you feel is important. It will help you get a new millennial tech on board so he or she doesn't quit after you have found him or her. You can download the form at www.ationlinetraining.com/2017-02 for a limited time. So, you might want to get it before you need it!

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 Kim Hickey.
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Losing customers can help you make more money

Raise your labor rates to make more money with fewer customers

Everyone who knows this industry understands that things are changing very rapidly.

Everyone also understands that there is an extreme shortage of competent technicians. The problem with this is that the issues in our industry are creating increasing costs, and these costs must be dealt with.

Let's assume the shop owner goes through the processes and has examined the operation very carefully and eliminated any waste to keep costs down without affecting the service levels delivered. Management has also examined the level of productivity per person to ensure that this issue is addressed. Everything has been approached with thoroughness, but management comes to the only conclusion that increased costs are higher than expected, and they must be passed on through an increase in the shop's labor rates.

Now management's mind starts to play games. Management doesn't sleep too well at night. Management starts to think, "If I increase my labor rates, I will lose my customers and suffer financially."

Consider this: If you are competent and your clients trust you and you never let them down, why would they leave you over a labor rate increase?

Consider that it is time to slow down and do the math in your business. How many customers could you let go (or even fire) and send over to the competition? There is a formula for this that I will share — see the following example.

Shop assumption

- The shop labor dollars sold last year was $350,292
- The shop labor rate is $80
- The shop is averaging 1.48 labor hours billed per repair order
- The shop's gross profit earned from labor is 94.5 percent
  (Labor Dollar Sales - Sublet Labor = Labor Dollar Gross Profit
  Labor Dollar Gross Profit divided by Labor Dollar Sales = Labor Gross Profit percentage)
- The shop needs a 15 percent labor rate increase taking it up to $92 ($80 x 15 percent = $12)

WORK OUT YOUR NUMBERS TO ENSURE YOU ARE NOT THE ONE HOLDING YOUR SHOP BACK FROM MOVING TO THE NEXT LEVEL.

1. The first step is to take the labor dollars sold and divide it by the current labor rate: $350,292 divided by $80 = 4,378.6 hours billed for the year

2. Take the hours billed for the year and divide it by 12. This gives you the average billed hours per month: 4,378.6 divided by 12 = 364.88 average billed hours per month

3. Gross profit margin percent on labor divided by gross profit margin percent on labor plus 15 percent minus 1 = the percentage reduction allowed in billed hours, i.e: 94.5 percent divided by 94.5 percent + 15 percent = 94.5 percent divided by 109.5 percent = .8630; .8630 - 1.0 = .1369 percent (expressed as minus 13.69 percent)

4. Average labor hours billed per month multiplied by percentage reduction allowed in billed hours equals actual number of reduced labor hours allowed, i.e.: 364.88 X 13.69 percent = 49.95 hours

5. Average labor hours per month minus actual number of reduced labor hours allowed equals new average labor hours to be billed at new labor rate, i.e.: 364.88 – 49.95 = 314.93 average monthly hours

PROOF: 364.88 X $80 = $29,190.40

In other words, we can bill out less hours at the new labor rate and still retain the same labor dollars coming into the shop as we had at the old rate.

6. Now this is where the interesting part occurs. It is certainly not the intent to lose any customers, but there are some customers that management would probably prefer went somewhere else; therefore, how many customers could the business afford to lose (or fire) after management raises the labor rates, without affecting the total labor dollars brought into the shop?

Actual number of reduced labor hours allowed divided by average labor hours billed per repair order equals number of customers that can

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ADV 1114

be "fired," i.e.: 49.95 divided by 1.48 = 34 customers

It is most unlikely that the shop will lose 34 customers in a month over a $12 labor rate increase; however, if some are lost or fired, that can be good as well because it frees up valuable time that can be spent with "clients," not "customers" — time that allows you to slow down and get focused on the client's needs, which in turn allows the shop to service them very wel, and increase total revenue substantially beyond the old labor rate revenue. All costs are now covered and revenue growth begins, coupled with bottom line growth. With satisfied clients, the shop most likely gets "client" referrals, not "customer" referrals.

MANY SHOP OWNERS FEAR A LABOR RATE INCREASE. BUT IF THEY DO THE MATH, IT COULD MEAN THE DIFFERENCE BETWEEN BEING A FINANCIALLY STABLE SHOP PROVIDING GOOD SALARIES VERSUS TRYING TO RUN A STRESSED-OUT, CASH-STRAPPED SHOP.

Many shop owners fear a labor rate increase. But if they would do the math, it could mean the difference between being a financially stable shop providing good salaries for all versus trying to run a stressed out, cash-strapped shop. Too many times shop owners (management) can be the real enemy to a successful enterprise, not the technicians or the client, just the person in the mirror who writes the check. Work out your numbers to ensure you are not the one holding your shop back from moving to the next level that it must get to if it is going to succeed over the next five years.

BOB GREENWOOD, AAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), a company focused on providing business management resources and development for the independent sector of the automotive aftermarket industry utilizing the Internet environment. Bob has more than 36 years of business management experience within the independent aftermarket industry, consulting independent retail shops on all facets of their business operations. Bob is one of 150 worldwide AMI approved instructors.
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PERSEVERANCE, DETERMINATION WILL SOLVE MOST PROBLEMS IN THE END

MIKE JONES // Contributing Editor

Have you ever failed so badly at an outcome you set as a boss, employee, parent, significant other or a friend that the thought of doing it again made you feel sick?

Many of these failures had nothing to do with knowledge or preparation. Many failures were outside of the control of the people experiencing the failure. Here is one thing I have learned on my journey: there are a lot of pessimistic, smart people who have not had much success in their lives, and it has nothing to do with their IQ. In fact, there was a story shared with me about a 55-year-old gentleman who had an IQ of 120. When asked why he didn't start the business he dreamed about and often shared with others, or why he never got married, he cited the statistics of ALL the failed businesses and marriages that he read about during his research.

My question to you (and would have been to him) is how high is your PQ? I don't mean your pessimistic quotient. I mean your Persistence or Perseverance Quotient.

"Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men with talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent. The slogan 'Press On!' has solved and always will solve the problems of the human race," said Calvin Coolidge.

The conventional definition of persistence/perseverance is refusing to give up on your outcome in spite of difficulty or opposition.

In a study conducted in New York, researchers found that 95 percent of the people who set clear, specific, outcomes and had a High "PQ" were successful in reaching their outcomes.

Consider Beethoven, who composed most of his beloved works after losing his hearing. Ray Charles and Stevie Wonder produced incredible music while being blind. Helen Keller was deaf and blind from the age of 19 months yet wrote 12 books and was the first blind person to receive a Bachelor of Arts degree. Persistence/perseverance is what sets them apart from those with the same abilities, but little drive.

I have been asked many times, "How do you increase your "PQ"?" The answer is simple; however, it is not easy.

- Set specific outcomes that you are 100 percent committed to accomplish.
- Identify several benefits you will receive once you have reached the outcome.
- Take the first step.
- Now comes the toughest but most important ingredient to ultimate success: be in the moment.

There is NO way to prepare for some of the things that might get thrown at you. However, if you are truly committed, you will Just Do WIT (Whatever It Takes) in those moments to keep moving forward. You will never know the true character of a person when the sun is shining. It is in the moments when the storm is raging, those moments of adversity that you get to see what you and others are really made of.

So how high is your "PQ?" The opportunity to raise it begins with an outcome. Let's get started right now because we ALL occupy the largest room in the house, and that is the room for improvement. How will you create a better version of yourself in 2017?

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Anaheim, California

MARCH 2-5
VISION Hi-Tech Training & Expo; *Overland Park Convention Center*
Overland Park, Kansas

MARCH 25
TST 14th Annual Technician Training Big Event; *Westchester Marriott Hotel*
Tarrytown, New York

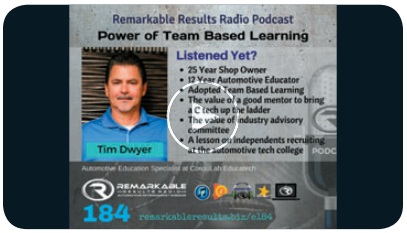
APRIL 18-24
Up your voltage! *Auto Career Development Center*
Wayside Automotive; Seekonk, Maine

APRIL 24
National Automotive Service Task Force spring meeting; *Bourbon Orleans Hotel*
New Orleans, Louisiana

APRIL 25-28
ToolTech 2017; *Bourbon Orleans Hotel*
New Orleans, Louisiana

JULY 26-29
NACE Automechanika Chicago; *McCormick Place West*
Chicago, Illinois

WATCH + LEARN

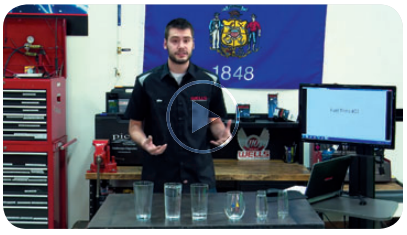


Former shop owner discusses career trajectory

MOTORAGE.COM/Trajectory

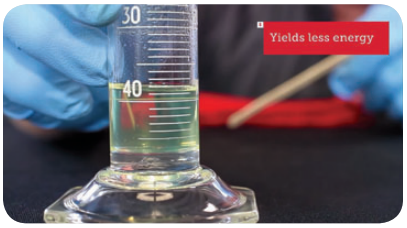
Using your scope's time and voltage settings

MOTORAGE.COM/ScopeSettings



Where to begin your diagnosis with fuel trims

MOTORAGE.COM/FTdiagnosis



How to identify flex fuel vehicles

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SOCIAL INSIGHTS

FIVE WAYS TO USE A SCOPE FOR DIAGNOSING VEHICLES

For years, Technical Editor Pete Meier was amazed at how few technicians he worked with had ever used a scope, let alone owned one of their own. But he'd been pleased to see that scope use is on the rise, as evidenced by the number of techs who raise their hands in the presentations he makes around the country and the growth of online support groups — even on Facebook! It is great that more techs are seeing just how valuable this diagnostic tool can be. Here are a few of his favorite uses for the scope.

MotorAge.com/scopeuses

MASTER VOLTAGE DROP BASICS TO IMPROVE YOUR DIAGNOSTIC ABILITY

Whether you are working on a spaceship or a modern vehicle, it will be necessary to understand basic electrical principles. Perhaps one of the most important principles in diagnosing electrical systems is the voltage drop. This is where voltage is consumed by resistance. Voltage is electric energy or electric pressure. This electric energy is the potential difference between two points with a charge present between them.

MotorAge.com/mastervoltage

MAKING SENSE OF STABILITY CONTROL SYSTEMS

Vehicle stability control was found on vehicles as far back as 1987 by Toyota and Mercedes-Benz in the form of traction control. Vehicle stability control is a combination of antilock brakes, traction control and an electronic stability program combining the two. If your vehicle has ESP or a VSC on board, it also provides you with two further safety systems: the Antilock Braking System (ABS) and the Traction Control System (TCS). ABS prevents the wheels from locking during braking; TCS prevents the wheels from spinning when starting off and accelerating.

MotorAge.com/stabilitycontrol

KEEP CURRENT CUSTOMERS TO BUILD CREDIBILITY, REFERRALS

You may think you can simply replace your departing customers with new ones, but the truth is, it's better to stop the flow of customers out the door. Keeping your current customer base is cheaper than acquiring new customers and helps build credibility and new referrals. Here are some strategies to help you turn the tide and inspire more allegiance from your current customers.

Motorage.com/keepcustomers

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HOW TO READ WIRING DIAGRAMS

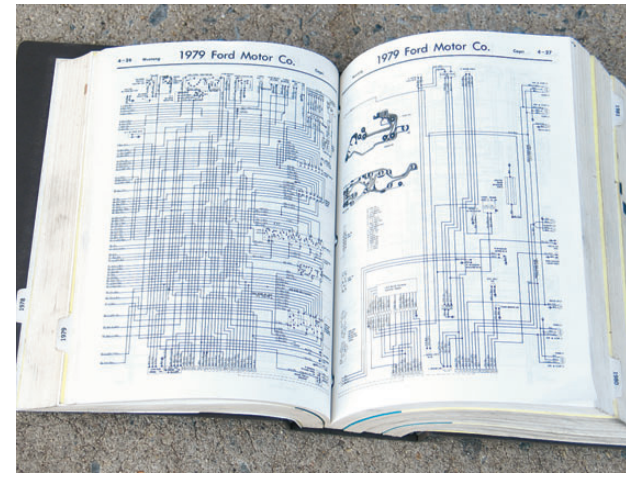
LEARNING HOW TO NAVIGATE THE ELECTRICAL CIRCUIT ROAD MAP

TRACY MARTIN // Contributing Editor

Wiring diagrams and road maps have much in common. Road maps illustrate how to get from point A to point B. However, instead of connecting interstates, highways and roads, a wiring diagram shows major electrical systems, sub-systems and individual circuits, all interconnected. Another feature they have in common are layers of detail. For example, if you look at a road map of California, you won't be able to locate a street address in Los Angeles. You might find a city or town, but you won't find a specific address. In order to find the exact location of a particular residence or building, you would need a detailed street map or go online and use Google Maps or the GPS feature on a smartphone.

The same is true (to a lesser extent) of wiring diagrams. Vehicles made before the 1970s usually had their wiring diagrams contained on one or two pages in a service manual. By the 1980s the complexity of automotive, on-board electronics changed, and most vehicle manuals had multiple pages of wiring diagrams to show all of a vehicle's electrical system. In the 1990s, printed service manuals started to disappear and now manuals and wiring diagrams are found on digital media or online. There is one aspect of wiring diagrams that has unfortunately remained constant: They lack directions regarding how to actually read them. Similar to a map, wiring diagrams will have a legend where symbols and naming conventions are spelled out but no "how-to" instructions.

While online automotive service manuals are written with the professional technician in mind, every technician had to learn to read and interpret wiring diagrams at some point in their career. The design and layout of wiring diagrams does not accommodate intermediate or entry-level technicians by starting with easy-to-understand circuits that become progressively more difficult to read and understand. This article will take a different approach and begin with simple circuits and wiring diagrams, then move on to diagrams with more complexity. This step-by-step process not only makes learning to read a wiring diagram less painful, but also promotes a greater understanding of how electrical circuits operate. Becoming more proficient at anything, including reading wiring diagrams, involves practice, and there are some challenging questions included for that purpose as well.



PHOTOS: TRACY MARTIN

WHILE THIS WIRING DIAGRAM for a 1979 Ford Mustang is dated, the skills required for using it to diagnose an electrical problem are no different than when viewing an online diagram from a late-model automobile. Unfortunately, there are no instructions as to how to actually read, and/or interpret most wiring diagrams whether in print, on a DVD or online.

Three things

The simplified wiring diagram of the battery, light bulb and wires is easy to understand. However, if this same circuit was more complicated and included several relays, multiple power sources and a computer controlling the entire circuit, the resulting wiring diagram would be far more challenging to read. A quick review of basic electrical circuits will make understanding how they are depicted in a wiring diagram easier to understand. Every electrical circuit on an automobile has

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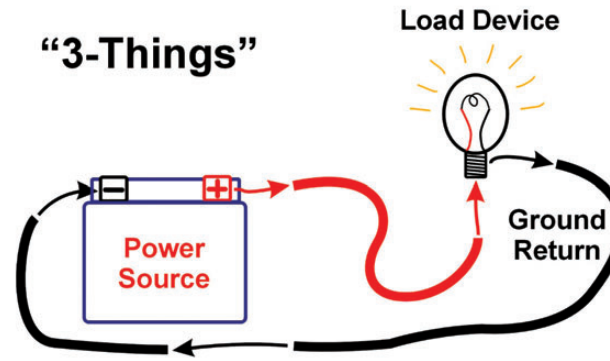
to have three things to operate: 1) a power source, 2) load device and 3) a ground return. The charging system and battery function as power sources and are extended throughout the entire car by way of numerous wires. Load devices are simply anything that does electrical work and can include lighting, starter motor, on-board computers, relays, power windows, keyless entry and many other components. The ground return completes the electrical path from the battery positive terminal to the load device and back to the battery negative terminal. If any of the three things are missing, the circuit won't operate. Wiring diagrams provide a "map" to assist in determining which of the three is not present.

In addition to the three things, load devices must be controlled. Some load devices are switched on or off by controlling their power source, while others are controlled by switching the ground returns on or off. The most common scenario is using a vehicle's electronic control unit, or ECU, to ground relays that in turn control load devices. The process of figuring out how a load device is controlled and its power and ground sources can be determined by using a wiring diagram. To learn a logical process for reading complex wiring diagrams, we'll start out with a simple fog light circuit.

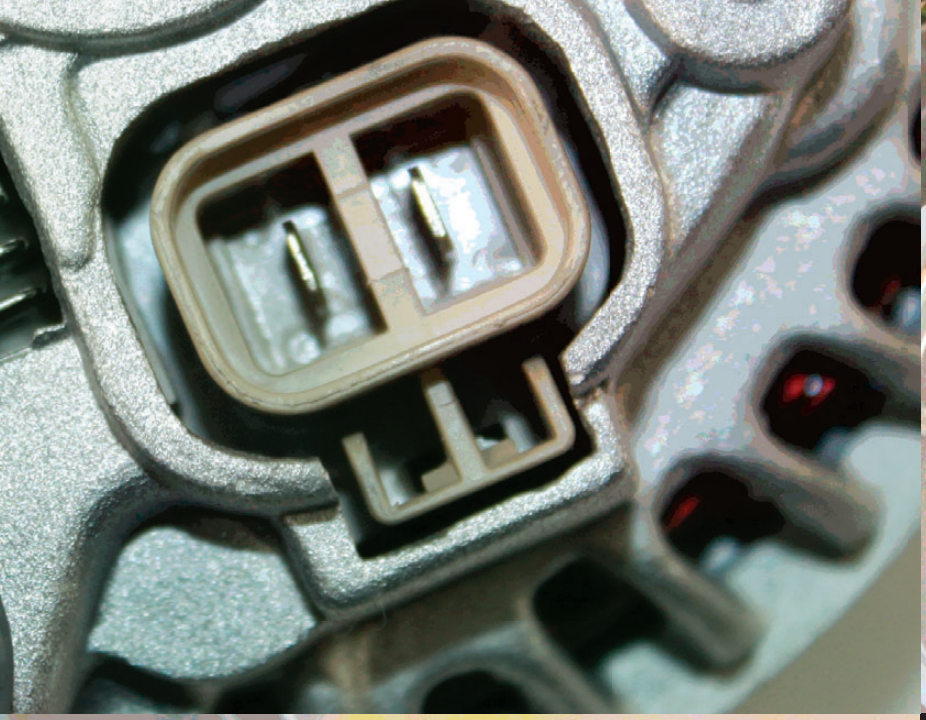
Figure 1 on page 26 is a simple wiring diagram showing a

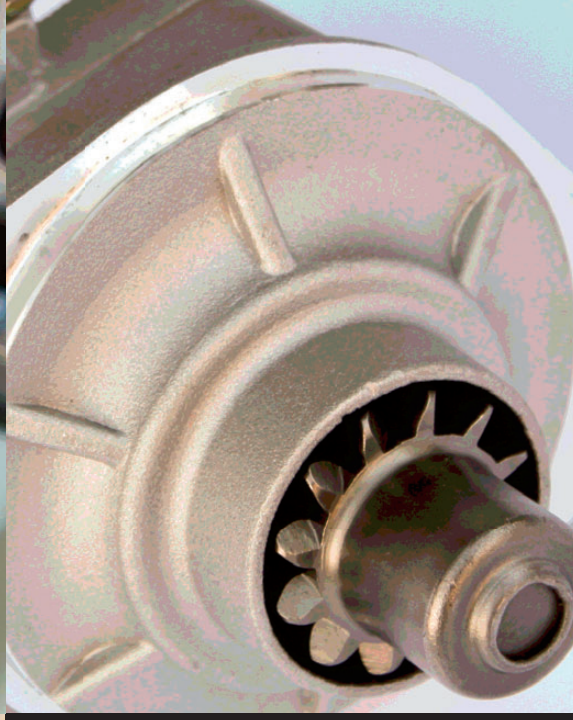


A LIGHT BULB powered by a battery illustrates the 3-Things that all 12-volt electrical circuits must have to operate—Power, a Load Device and Ground Return. While this may seem obvious, locating the 3-Things, plus whatever controls the circuit, on a wiring diagram that spans many pages is not a simple process.

fog lighting circuit. The circuit consists of a battery, 20-amp fuse (used to protect the circuit), a switch (located on a dash panel) and two fog lights. Ground returns are shown by the ground symbol of a vertical line with three horizontal lines. Not all wiring diagrams show ground wires, and it is assumed the ground symbols indicate wires that are connected to the negative battery terminal. This diagram is unusual in that the presence of 12 volts is illustrated with the circuit in both ON and OFF states. Red lines indicate the presence of 12 volts and black lines represent the ground side of the circuit that connects to the battery's negative terminal. In the circuit OFF part of the diagram, 12 volts is shown to be present from the battery, through the fuse and to the open dash switch. The lower part of the diagram shows the dash switch closed, connecting the battery to the lights and turning them on. It also illustrates one aspect of Kirschoff's Law that the load device(s) will use all the power (12 volts) in the circuit as the voltage at the negative battery terminal, and on the ground side of the fog lights is close to 0.0 volts. Unfortunately, actual wiring diagrams do not provide any of these advantages and late-model automobile diagrams may not isolate circuits to this extent — more likely they will be part of the overall lighting system. Color, if used at all in a wiring diagram, is for the purpose of identifying individual wire colors, not to indicate power and ground sides of a circuit. In addition, wiring diagrams always default to show a load device in its OFF state, and technicians have to imagine the presence of power throughout the circuit with the load turned on and operating.

There is an inherent problem with the design of the fog lights circuit as shown in Figure 1. These particular fog lights require high amperage (8 amps each, or 16 amps total) from the battery to operate, and this high electrical load has to travel through all the wires and dash panel switch to reach the lights. The wires, and especially the switch, would have to be heavy duty to handle the high current. A simple solution is the addition of a 12-volt





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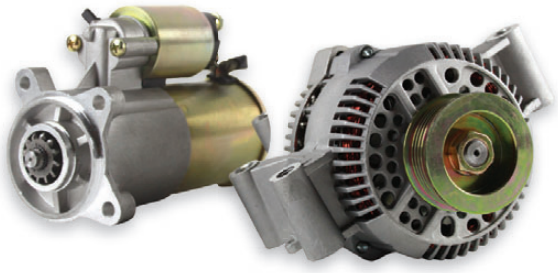

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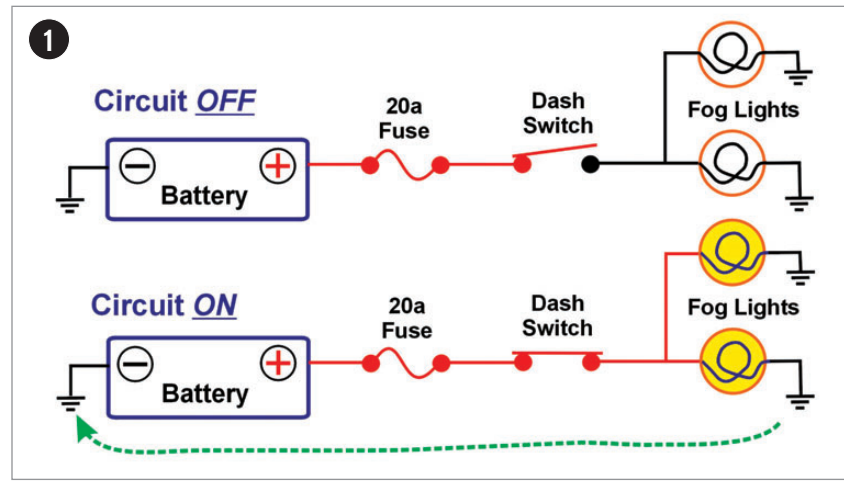

FIGURE 1 is not typical of wiring diagrams found in a service manual. The fog lights circuit is shown in both ON and OFF states and uses colored lines to illustrate the presence of power. The green dashed line shows how electricity travels back to the battery's negative terminal after providing power for the fog lights.

relay as shown in Figure 2 on page 28. The relay takes the place of the heavy-duty switch and provides the high-amperage connection between the fog lights and the battery. The dash panel switch is still a part of the overall circuit, but now it only has to switch the low-amperage relay control coil (0.3 amps) instead of the high-amperage fog lights. The dash panel switch, and the wires connecting it to the circuit, can be smaller because the relay is connecting the battery to the lights and not the switch.

The control coil inside the relay is an electro magnet, and when terminal 4 of the relay is connected to ground by the dash panel switch, the coil is energized and pulls down the high-amperage contacts within the relay connecting terminals 1 and 2. This diagram does show the circuit in the OFF position and is more typical of a real wiring diagram, as the technician has to visualize where power is present in the circuit when the lights are on.

While Figure 2 illustrates the basic layout of how a relay is used to operate a high-amperage circuit, it has relevance to modern electronics used in today's automobiles. Many automotive circuits are controlled by the vehicle's power control module (PCM) that cannot directly control high current loads. The use of multiple relays solve this problem, as the PCM only has to switch the low-amperage relays on and off.

The wiring diagram depicted in Figure 3 on page 29 shows how the addition of a second relay to the fog lights circuit improves its functionality. Relay #1 provides power to relay #2 — the same relay depicted in the previous diagram. Relay #1 is controlled by the ignition switch and only allows the fog lights to operate when the ignition switch is in the accessory or run positions. If the ignition key is in the lock or off positions or removed from the ignition switch completely, no power is available at Relay #2. This prevents the fog lights from being left on inadvertently, even if the dash panel switch is left on. This diagram is more typical of wiring diagrams found in a service manual. Wires are identified by their color, but there is no color indicating where power is present; the circuit is shown in its OFF state and the relay terminals are identified by number.

The most effective way to learn how to read and use wiring diagrams is to practice. With that in mind, the following three practice questions will test your knowledge and ability to read and interpret wiring diagrams. We'll go through the

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first two questions together and leave the third one for you to answer.

Wiring diagram questions

Question 1: This question refers to Figure 3. With the ignition switch in the "Acc" position, and the dash panel switch off, what terminal numbers on relays #1 and #2 will have 12 volts?

Figure 3 is typical of wiring diagrams found in a service manual. Relays and switches are shown in their "open" position and color is not used to indicate where power or grounds are present. When reading any wiring diagram, start where a known source of power (12 volts) is located — usually at the battery positive terminal. Relay #1, terminal 3, is directly connected to the battery via the 20-amp fuse. Terminal 1 goes to the ignition switch and in the "Accy" position will also have 12 volts (RED wire to the ignition switch and the ORN wire between the switch and relay). Terminal 2 is a constant ground for the relay's control coil. The relay is ON and terminal 3 is connected to 4 via the high-amperage contacts.

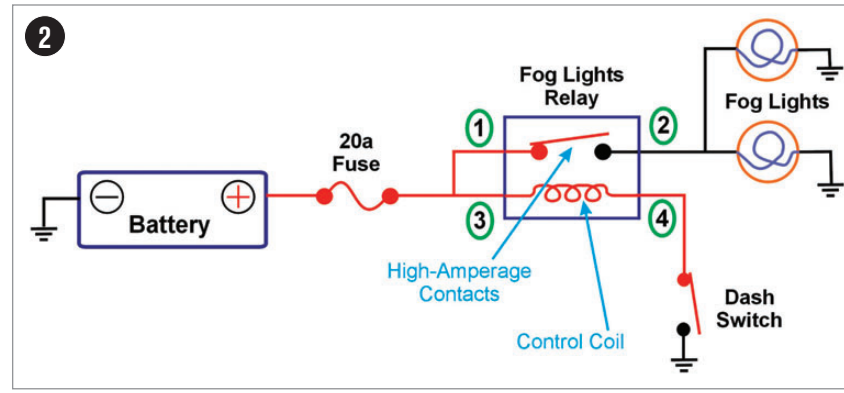


FIGURE 2 shows that a relay has been added to the fog lights circuit. Instead of using a switch as in Figure 1, a relay now controls the high-amperage current that the lights require in order to operate. The dash panel switch is used to energize the relay's control coil that connects power from the battery to the fog lights through the high-amperage contacts inside the relay.

Relay #2 terminals with 12 volts are: 1 (RED/WHT) and 3 (BRN) that receive power from terminal 4 on relay #1. Terminals 1 and 2 are connected via the relay's low amperage control coil; therefore, terminal 2 has power because the dash switch is open. If the dash switch was closed, terminal 2 would show 0 volts because it is connected to ground and the relay would be "On." Terminal 4 has no power because the relay is "Off."

Question 2: Trace the path that provides power and ground to each cooling fan in the high-speed mode.

Question 2 uses a wiring diagram that is more complex than the one used for the first question. Figure 4 on page 30 is a typical automotive wiring diagram that shows a radiator cooling fan circuit. Two fuses (40 and 10 amps) power the circuit and are directly connected to the vehicle's battery (Hot at All Times). There are three relays that connect power to the cooling fans and control low and high speeds. The relays are controlled by the vehicle's PCM. The diagram also contains notes regarding labeling of components, their physical location and information on which other wiring diagrams are part of the overall circuit. The relay control coils look a little different that those in Figure 3. A resister is shown (zagged line) and is used to prevent voltage spikes from reaching the PCM when the relay is operated. Otherwise, the relays work the same as those in Figure 3.

NOTE: This circuit operates on 12 volts. However, when the engine is running, the

operating voltage is 14 volts, or charging voltage provided by the alternator.

The three cooling fan relays determine the power and ground paths to the cooling fans. To run both cooling fans in the high-speed mode, the PCM grounds both terminals 42 and 33 (low and high-speed cooling fan relay controls). With PCM terminal number 33 grounded, the DK BLU wire becomes the ground for the cooling fan relay #3's control coil at terminal B4. This turns the relay on because terminal C6 has power all the time from the 10 am fuse. The RED wire at terminal C4 of the relay is connected to the 40-amp cooling fan fuse and with the relay on connects to terminal B6 within the relay. The WHT wire from the relay (terminal B6) is connected to the right cooling fan and provides power. The right cooling fan has a constant ground on the BLK wire. With 14 volts (engine running) on the WHT wire and a ground on the BLK wire, the right cooling fan runs at high speed.

The left cooling fan receives power from the 40a fuse on the RED wire at cooling fan relay #1 (terminal B3). The PCM low-speed cooling fan relay control (42) is grounded by the PCM providing a ground at terminal B1 (DK GRN) wire at cooling fan relay #1. On the same relay, terminal C3 gets power from the 10a fuse on the ORN wire. With power at C3 and a ground at B1, the relay operates and connects relay terminals B3 to C1, providing power to the left cooling fan on the LT BLU wire. The GRY wire from the left cooling fan is a ground, but only when cooling fan relay #2 is turned on by the PCM high-speed relay control ground at relay terminal C10 on the DK BLU wire. Relay #2 connects the GRY wire from the left cooling fan to the BLK wire (no terminal number listed). The BLK wire provides the ground for the left cooling fan, and it runs at high speed.

We have walked through the answers and analysis to questions 1 and 2. Finding the answer to question 3 is up to you. The answer and analysis to the question can be found on the next page. Be sure not to peak when looking at Figure 4!

Question 3: Trace the path that provides power to each cooling fan in the low-speed mode. Identify the wire colors, relays and relay terminals that are powered during fan operation. Trace the ground return path for the relays and cooling fans. Identify the wire colors and relay terminals used in the ground side of the circuit.

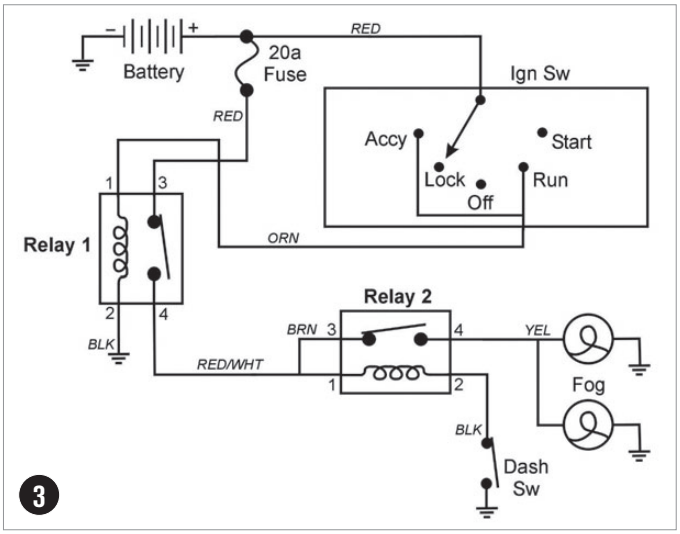
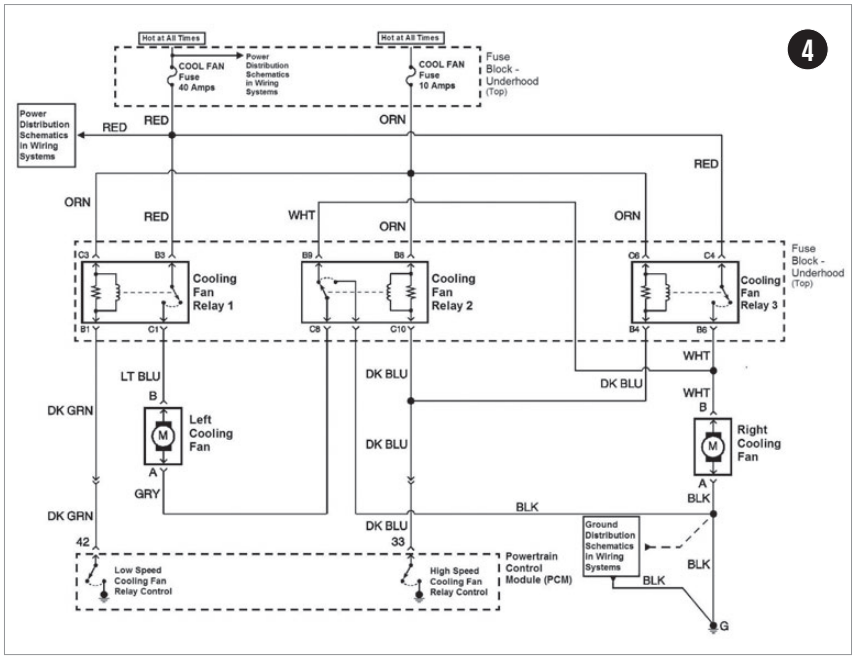


FIGURE 3 shows a more sophisticated fog lights circuit that has the addition of a second relay. The design of this circuit prevents the fog lights from being turned on if the ignition switch is not in the run or accessory positions, regardless of the dash panel switch being left on.



THIS WIRING DIAGRAM SHOWS the cooling fan circuit for a late-model automobile. The circuit has three relays, controlled by the vehicle's power control module (PCM), that operate the fans in low- or high-speed modes. Wires are identified by wire color. Cooling fan relay terminals are also identified with a letter and number.

Answer to Question 3

To understand the low-speed fan operation, a quick review of electrical theory will help. In a parallel circuit (the most common type used in automobiles) all load devices operate on system voltage. For example, when the cooling fans operate in the high-speed mode, each has 14v from the 40a fuse. A series circuit operates differently. With two load devices wired in series, they divide the available voltage between them. In the low-speed mode, the cooling fans are wired in series and each fan runs on 7 volts — one half of the system voltage of 14 volts.

During low-speed fan operation, the PCM low-speed relay control is grounded, turning on cooling fan relay #1. With a ground at relay terminal B1 (DK GRN wire) and power at C3, the relay's control coil connects the high-amperage contacts (terminals B3 and C1). This connects power (14 volts) from the 40a fuse (RED wire) to the LT BLU wire going to the left cooling fan. The GRY wire from the left cooling fan goes to terminal C8 of relay #2. Cooling fan relay #2 is not triggered by the PCM in the low-speed mode, and the C8 to B9 relay connection is normally closed. The WHT wire at cooling fan relay #2 (B9) goes to the right cooling fan, providing 7 volts (one half of 14 volts) to power the fan. Cooling fan relay #3 is not operated in low-speed fan operation. The BLK wire from the right fan provides the ground return for BOTH fans. Because the fans are wired in series, they divide system voltage (14 volts) equally between them and both operate on 7 volts, causing them to run at low speed.

TRACY MARTIN has covered the powersports industries since 1998. He is also the author of six Motorbooks Workshop Series books published by the Quarto Publishing Group and is a regular contributor for *Motor Age*.
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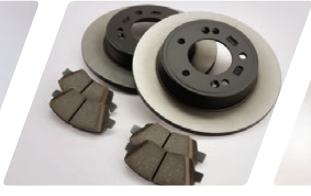

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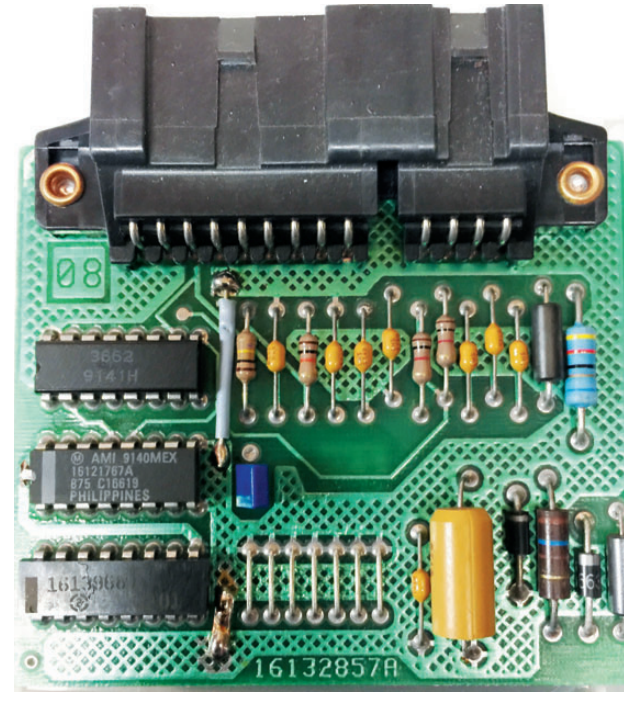
SHUTTING OUT INTERFERENCE

HOW TO DEAL WITH ELECTRICAL CONCERNS RELATED TO EMI

DAVE HOBBS // Contributing Editor

Electrical problems can be tough. Sometimes the most intermittent and hard-to-diagnose electrical problems aren't due to the classic faulty ground, computer glitch or software anomaly. Phantom electrical problems caused by EMI (electromagnetic Interference) while somewhat rare, can lead to a great deal of frustration, misdiagnosis and customer dissatisfaction. Examples vary tremendously; your road warrior customer drives past a busy airport each day and his cruise control kicks off. The 2-way radio in the local game warden's truck intermittently causes its transmission to downshift when the radio is used to transmit. Your customer's favorite FM radio station has static, but only when the engine is running. These are just a few of the problems that can occur in the world of electrical interference. It doesn't have to be a complete frustration for you as a technician, however. Here we'll give you practical information on grounding, shielding and proper wiring so you can put an end to high-tech menaces like electrical transients, magnetic fields and Radio Frequency Interference (RFI) on vehicles you encounter.



PHOTOS: DAVE HOBBS

THIS OLDIE BUT GOODIE GM speed buffer was a real RFI wrecker with broadband noise and harmonics of the clock. Notice the custom wiring added to the right of the ICs. They tied the ground planes of this module together to aid in reducing its excessive radiated emissions.

EMI/RFI/EMC – Meanings and examples

Starting out with a basic knowledge on this very tough topic is the first step. Electromagnetic compatibility (EMC) is the science of making sure every electronic component on a vehicle gets along with everything else, including the occupants and their favorite gadgets. A classic example of course is the use of resistor spark plugs/plug wires to combat AM radio noise and a diode across the A/C clutch coil to prevent the voltage spike induced when the compressor clutch coil is turned off from wreaking havoc on other electronics on the vehicle. EMC engineers even take into consideration the static electricity (ESD) customers can create. Opposite of EMC is EMI, which is the science behind fixing the lack of compatibility. A subsection of the entire electromagnetic spectrum is the slice of frequencies referred to as the radio spectrum. Any problem that involves any of these frequencies is referred to as radio-frequency interference (RFI). For the sake of simplicity, we'll just refer to it all as "electrical interference" and get right to diagnostics.

Electrical interference diagnostic essentials – modes of inference propagation

Two terms apply to all types of electronic component interference situations: radiated emissions and susceptibility. If a component on a vehicle is producing too high of a level of radiated emissions for another component on the vehicle to operate correctly, you can think of that component as the "culprit." The component not working correctly is referred to as being susceptible. In the 27 years I've worked for an OEM

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electronics supplier, there have been tremendous successes with EMC. However, nothing is perfect, and components do wear. Connections can begin to be affected by rust and corrosion or an ignition coil's primary winding's resistance can begin to break down. Wiring can get moved during repairs and aftermarket accessories are sometimes added. Some of the smallest changes can foul up the delicate balance of EMC.

As with any other diagnostic approach, duplicating the concern, performing a general inspection complete with an all-module vehicle DTC retrieval and searching for any applicable TSBs are the first steps. Subsequent steps would be:

1. Determining more about the "victim" component and "culprit" components by operating various switches and accessories, observing the problem in all modes of ignition switch positions and disconnecting known sources of EMI such as the alternator, fuel pump (fuel the vehicle with an alternate method such as propane via the intake/throttle body during this test) and blower motors.

ANTENNA COAX VARIES in center conductor diameter and distance from the braided shield. Always use the type the OEM used originally. The ground comes from the antenna's end and should be less than 0.1 ohms. Center conductors from end to end should be 0.1 ohms or 3-4 ohms with the type using a smaller conductor on long runs such as the radio to rear back glass-mounted antenna.

2. Adding grounds is a great method for combatting interference problems. In the case of problems of a radio frequency nature, braided ground straps are preferable due to their skin effect. The surface (or skin) of the braid is like fly paper for electrons in the air (radio waves) and brings them to ground. Many two-way radio installers play around with the right number and placement of braided ground straps, adding RF grounds to various body panels such as trunk decks and hoods so they will be tied to the chassis ground in a more effective manner. This is sometimes called "bonding."

Electrical interference from an "emitter" component can enter a susceptible component through one of three avenues — sideway noise, backway noise and frontway noise. We'll offer some examples and solutions for each.

Sideway noise/interference – move it, twist it or shield it!

Noises/interference can jump from one circuit to another just because of the proximity of the emitting device to the susceptible device. Think small-block Chevy motors and you recall 1-8-4-3-6-5-7-2. Remember running spark plug wires #5 and #7 next to each other? Since they were next to each other in the firing order, you didn't want those plug wires physically next to each other. Years ago I had a trooper with the Indiana State Police contact me with the complaint of an insufficient top speed on his Chevy LT1-equipped police cruiser. He thought he needed custom performance PCM software. The top speed problem was repaired with #5 and #7 plug wires being separated in the plug wire loom to prevent ignition cross firing at high speeds. Simple fix, right? Relocating other sensitive circuits such as sensors, serial busses and audio-related circuits (speaker, amplifier feeds and RF coax) are very helpful tactics to reduce or eliminate interference. If needed, you can create your own twisted pairs of wiring to replace existed circuits that seem at war with other circuits or purchase shielded cable with a sufficient wire gage to handle the current of your circuit. Remember to attach the shielded cable's braid or foil to a ground at one end only. Attaching the shield to ground at both ends only "sounds" like a good idea. In reality, we don't want regular DC ground current flowing through the shield. Slightly different from RF bonding, we want the shield's skin effect to attract radiated emissions near the cable and send them harmlessly to ground.

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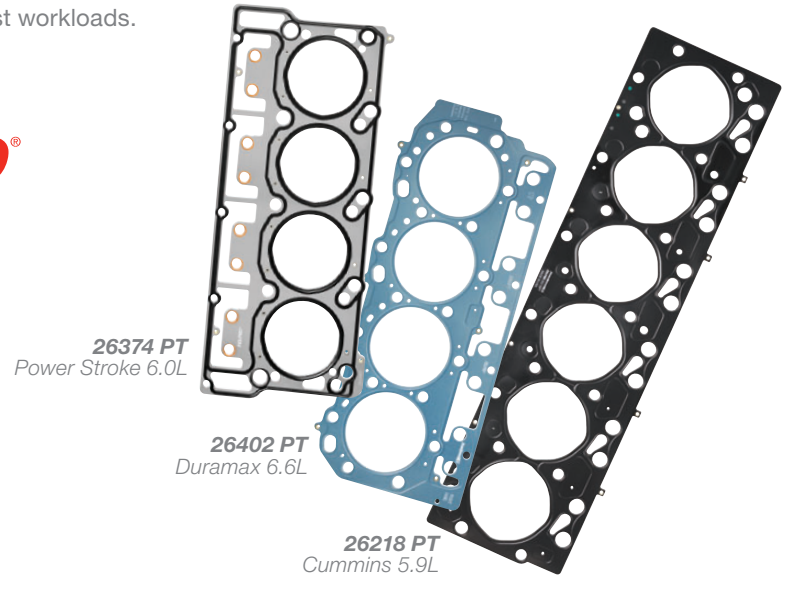

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Backway noises and transients – filter it or replace the emitter/susceptible module

Transients are basically voltage spikes. They can go above zero volts or be a negative (below zero) spike like when a compressor clutch, fuel injector or relay winding turns off. A self-inductive spike occurs when a magnetic field surrounding a coil winding collapses. The spike is normally suppressed with a diode connected in parallel across the coil. The suppression diode was historically located in the compressor clutch's coil connection (wrapped in black tape) and now located in the bussed electrical centers on more modern vehicles. Diodes block DC current from moving in one direction and allow for it to move in the other — so an open diode will result in a spike that can cause anything from a damaged module to a pop in a radio's speakers whenever the involved circuit is switched off. A shorted diode creates a similar condition as installing a diode backwards. The result will be a blown fuse or possible damage to the module that is controlling the output on to begin with. In relays, diodes have been losing out in favor of resistors. Resistors are cheaper, less prone to higher temperature failures (such as in a transmission valve body's shift solenoids) and do much the same job suppressing transients by applying a resistance with a higher ohms value than the coil (solenoid or relay) across that coil.

Good COPs and bad COPs – module resets and transients

Sometimes transients aren't created by the natural occurrences of a coil turning off. Sometimes the component is just plain noisy and back feeds lots of transients. A case study shared some time ago in a training class by fellow instructor John Thornton involved a Dodge Hemi's Coil On Plug that operated well enough to make the spark plug fire, but noisy enough to wreak havoc with the PCM that triggered it. It was a great case study that taught some very deep concepts. One concept that's not so deep is how limited on-board diagnostics can be. The PCM should have triggered a DTC for the root of the problem — repeated PCM resets. Module resets occur when an ECU internal to a module gets totally confused, for lack of better terms. This confused state is called COP loss (the acronym for Computer Operating Pulses, in this case) and results in the module simply rebooting over and over while the condition occurs. Partially shorted module outputs, poor power and ground connections, RFI, conducted transients (voltage spikes) and flaky solder connections on the module's circuit board all can lead to a COP loss/module reset. In John's case study, the PCM reset so rapidly that it cycled the Auto Shut Down (ASD) relay so fast that the relay buzzed! This in turn caused one of the ASD relay's out-

IN MOST CASES, the braid or foil grounds at one end only. Attaching the shield to ground at both ends only sounds like a good idea. In reality, we don't want regular DC ground current flowing through the shield. Slightly different from RF bonding, we want the shield's skin effect to attract radiated emissions near the cable and send them harmlessly to ground. In the case of this HID headlamp, we want the RFI produced from the bulb start up's high voltage to stay inside the shield!

MAKING TWISTED PAIR only requires a drill and a vice to twist the wire. If replacing existing twisted pair, such as with two-wire serial buss circuits, always duplicate the number of twists per inch.

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puts, the fuse to the Multiple Displacement System (MDS), to have rapid loss and reapply of ignition voltage. The final symptom in this chain reaction was the PCM flagging a DTC for one of the MDS solenoids having voltage status issues. This would be comparable to a man having a heart attack, but only complaining about a sore toe! A new Coil On Plug was installed on the vehicle to fix all the symptoms — computer resets and solenoid DTCs. In other cases, replacing components won't work to suppress transients, so you'll have to run alternative power supplies to them or filter them.

Filtering spikes/transients

The exact method for determining the proper type of filtering involves calculating a bunch of variables with pretty deep electrical math and even then trial and error often still needs to occur. So let's skip the math and cover some simple trial and error methods. DC current doesn't mind going through inductors such as coil windings. AC, on the other hand, sees an inductor (coil) as a resistance. Capacitors get charged by a DC circuit and then block any flow through them. If the transient's frequency is treated with just the right size capacitor, the transient behaving much like AC will, in effect, pass through a capacitor. Run the power supply to a victim module through a noise filter coil in series between the fuse and the module. Make sure you don't have too much current flow for the coil's rating or it will get hot/create a voltage drop to your victim module. Connect one end of a capacitor to the circuit you are trying to filter and the other end to ground. Observe and comply with any polarity symbols that might be printed on the capacitor. Experiment with different sized caps and coils. Generally speaking, the higher the frequency, the lower the cap's Farads (micro or pico) need to be rated at and the same with the coil in regards to henries of inductance (milli or micro).

THIS MODULE'S CRYSTAL performs the clock function required. The 8.390 is the speed in MHz. Noise from harmonics means any whole number multiplied by that frequency's value becomes another frequency where interference may occur.

AT FIRST GLANCE you might think these are diodes because of the arrows. They are both capacitors. The direction of the arrow points toward the end you connect to ground. The other end towards the circuit you are trying to filter noise (AC) off of. Getting an electrolytic capacitor like these shown wired in backwards will likely result in the capacitor getting hot and exploding with a pop!

Frontway noise – broadband

Frontway noise typically affects components that are wireless, such as the factory radio, telematics, collision avoidance (radar) or other wireless devices such as the keyless entry or bluetooth connection. A classic example of a frontway noise-susceptible device is the radio, and the emitter of noise is the vehicle's ignition system. The first 30 years of radio history saw the use of spark gap transmitters, so it's little wonder that the high voltage and high frequency from an ignition system have the ideal attributes to create interferences that can adversely affect a car radio. A coil or plug wire's connection to the spark plug may have corrosion that prevents the secondary ignition from conducting to the spark plug terminal. A good coil can produce more voltage than the spark plug requires, most of the time. As is the nature of secondary ignition, it jumps gaps. The normal spark air gaps tend to be manageable. The catch

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22 is when secondary connections get loose/are never snapped completely onto the spark plug terminal. The resulting arcing literally eats away the plating of the terminal on the coil/plug wire and now an additional "spark gap transmitter" is created. Frontway noise is now too great in amplitude for the susceptible device (the radio in this example) to ignore. The AM band is typically covered with unwanted noise that varies with engine RPMs, and the FM band may also have some engine noise on weaker stations. The solution is, of course, to replace any leaky ignition components even if they are not causing a misfire yet. After performing a visual inspection of all the secondary ignition system's components for signs of arcing, run the classic test of applying a salt water solution mist on the ignition system while loading the engine in the bay. Observe for any arcing around any secondary ignition component. If you have a lab scope with the ability to pick up either secondary or primary ignition waveforms, observe the patterns for uniformity among the cylinders. Also, keep in mind that while a light coating of dielectric grease (dielectrics are insulators) on plug wire/COP boots is great for preventing the boot from seizing to the spark plug's porcelain, too much grease can create a resistance problem. Conversely, the application of excessive amounts of conductive grease (never seize for the spark plug threads) can make its way to spark plug terminals and insulating porcelains and cause ignition leakage.

Occasionally, the source of the noise/interference is not excessive at all. The root of the problem lies with the susceptible device. In the case of the radio example, the antenna may have resistance on either its ground or within the lead's center conductor connections at either end. All coaxial cables are not the same, and interference and performance problems can occur if you use the wrong type of coax cable. Besides the quality of the shielding (braid/foil), the center conductor of any antenna lead is usually copper but varies in gauge/diameter between different types of antenna lead. Automotive RG-58U was a mainstay for the industry for years for antennas mounted on the front fenders. Those shorter antenna leads had almost no resistance from center conductor end to end when measured with an ohmmeter (usually around 0.1 ohms). Longer runs of antenna coax for rear-mounted antennas; however, have often been RG-62U, which has a smaller diameter center conductor to lessen the impedance and therefore can run as high as 3-4 ohms from center conductor end to end. Shields (grounded at each end) should, however, be tied to ground with ohmmeter measurements of less than 0.1 ohm. Use a wire brush/knife to clean away any paint or corrosion where the antenna gets its ground to ensure getting good performance and shielding from RFI that might enter a radio through its front end.

Frontway noise – narrow band a.k.a. the "black art" of harmonics

Other frontway noise sources besides the broadband noise from ignition systems and electric motors can occur due to harmonics. Harmonics are the echo of a frequency. Compare it to when a rock is thrown into a pond. The rock makes a ripple and subsequent ripples that form are distanced from one another in a mathematically predictable manner. The same is true with radio waves. Everything that oscillates (vibrates) makes a radio wave. Anything that computes (like your laptop or any module on a car) has a clock for the digital electronics to operate. Take a look inside most any module and you'll often see a component that looks like a crystal from an old CB radio. Let's say you see the numbers "8.375 MHz" on it. Now even though there is an oscillator (the module's crystal) vibrating along at that frequency, it's unlikely there is a radio frequency in the vehicle that would be the same as that module's clock. However, multiply 8.375 times any whole number and you have what is called a harmonic. If you are trying to listen to 100.5 Mhz. on your FM radio you might have some RFI to contend with. That interference's frequency could be calculated by multiplying 8.375 MHz (the module's clock) times 12 (the 12th harmonic), which of course would equal 100.5 MHz. If 100.5 on the FM radio is a strong signal due to the station's transmitter strength and the distance from the station, a

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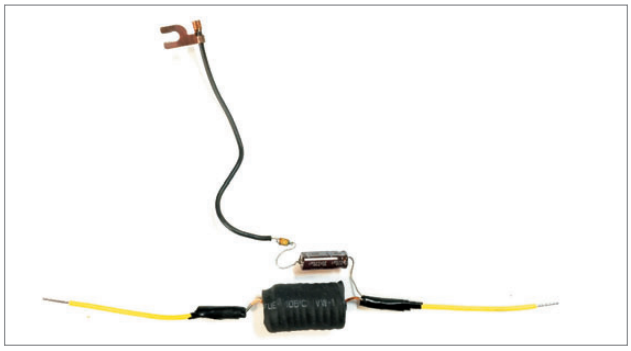

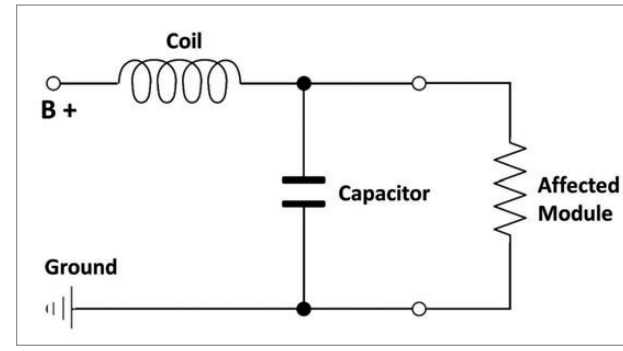

GM'S AGELESS NOISE FILTER KIT (p/n 1224205) has been filtering out noises from susceptible devices like radio power feeds for decades. Shown with the electrical tape removed, the capacitor can be arranged to be between the coil and the victim module (as shown) or before the coil. Experiment to see which order does the best job of keeping electrical noise in or out – whichever the case may be.

problem would be unlikely. On the other hand, if the station's signal is weaker/more distant and there are issues with resistance in the antenna lead connections or antenna ground, you may have a problem with your radio's reception when the noise-emitting module is powered up. That noise can sound like static, constant hissing or strange, almost space alien sounds. It will even sound like multipath in some situations. Multipath interference is when you get a clear signal from a weaker/distant radio station then hissing/static when the vehicle moves a few feet. This is due to receiving a signal from the radio station's transmitter directly to your vehicle's antenna in one spot, followed by receiving that same signal plus a reflected signal thanks to an obstruction like a building. The reflected signal is slightly delayed (out of phase) with the line of sight direct signal. The net result is a cancellation of at least part of the signal your radio is attempting to pull in. If you are moving at more than a crawl in traffic, you might hear a clear signal then "hissing" signal switching back and forth very rapidly. Modern high-end vehicles with diversity antennas (dual antenna elements) lessen this problem in many cases.

RFI emitters, however, can still affect the best radio and antenna arrangements. If antenna grounding/coax connection improvements are not helping, short of trying a new radio (an expensive guess when out of warranty), you must go after the culprit module emitting the harmonic.

Two-way radios are far more sensitive compared to FM entertainment radios and therefore more likely to suffer from frontway noise. In some rare cases, historically, there have been modules such as ECMs modified by the OEM or other electronic specialty company to radiate fewer emissions. Tying ground planes together with braided ground straps and attaching copper tape from the circuit board's ground plane to the module's case are just a few of the tricks done in the art of EMC. Even shifting the crystal's clock speed just ever so slightly by replacing it with a custom crystal a few KHz from stock has proven effective. If all goes well, the module still works, data bus messages are still received and transmitted correctly and those pesky RFI harmonics all shift a few KHz away from the customer's adversely affected frequency.

Frontway and sideway interference — compound headaches

In the case of the "key the two-way radio's mike and the transmission shifts" scenario mentioned at the beginning of this article, a little further questioning of the driver revealed exactly the information needed — the propagation mode. So how did the interference get into the game warden's PCM? Turns out the warden only noticed the problem occurring when he turned on the A/C at the HVAC head. If it was not hot enough for A/C operation, there was no problem with the automatic transmission when keying the two-way's mike. He actually learned to just shut off the A/C whenever he wanted to talk on his two-way radio. But not before the dealer and the local two-way radio company had replaced all associated components! Finally, at the direction of some very experienced EMC engineers working with yours truly, a shielded cable was used to replace the A/C request circuit between the HVAC head and the PCM on the vehicle with only one end of the shield grounded as recommended. The driver was very happy to be able to talk on his two-way radio all he wanted without having to turn off his A/C or put up with a transmission downshift! No more MacGyver tactics required by the driver, thanks to some MacGyver EMC tactics performed in the service bay!

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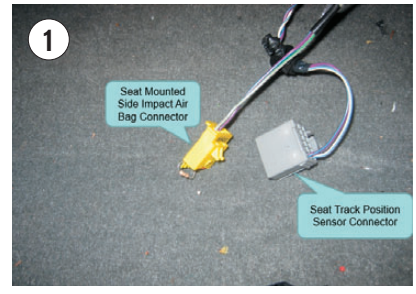
TIPS AND TECHNIQUES FOR AIRBAGS, PRETENSIONERS AND OCCUPANT DETECTION SYSTEMS

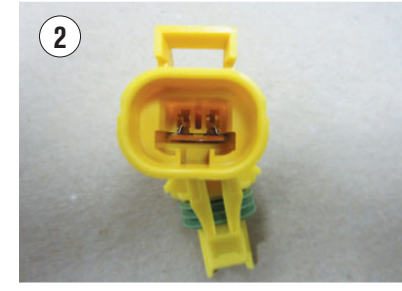
SCOT MANNA // Contributing Editor

Keeping vehicle occupants safe during a collision is a major concern for manufacturers and generates enormous costs for car companies in the area of crash worthiness testing and SRS system engineering. Vehicle collision restraint systems have undergone steady improvements over the last several decades since their introduction in the 1970s. All passenger vehicles built after Sept. 1, 1998 were required to have driver and passenger front airbags. As system improvements continued, the number and location of inflatable restraint bags has grown considerably and modern vehicles can have 10 or more pyrotechnic charges around the vehicle to inflate airbags or tension seat belts or even disconnect battery cables in the event of a collision. This article will focus on SRS system service, which can be somewhat intimidating to a service technician with little or no SRS experience or training. But fear not, SRS system repair can be done safely and profitably if basic caution and some common sense is followed.

A lot of letters

Let's start by mentioning that SRS will be used in this article as an all-encompassing acronym for airbags, seat belt pretensioners and occupant detection systems. There is no shortage of acronyms for SRS systems, and different manufacturers use different names for the same components. The airbag control module is called an SDM (Sensing and Diagnostic Module) by GM, an RCM (Restraint Control Module) by Ford, or an ORC (Occupant Restraint Controller) by Chrysler, so just deal with the issue and we'll move on. Most often a vehicle with an illuminated airbag light will have trouble codes stored to help identify the area of concern and point the technician in the right direction. Most of my SRS experience is in fixing codes in a vehicle or getting the warning light to go out after post-collision repairs are made by a body shop. I will not be discussing proper post-collision service procedures because this is usually done by the body shop. Oftentimes a body shop will bring in a vehicle after repairs are performed because the SRS warning light remains on, and they do not know how to clear the system or they do not have the necessary scan tool to perform code clearing or re-learn procedures that must be done.





PHOTOS: SCOT MANNA

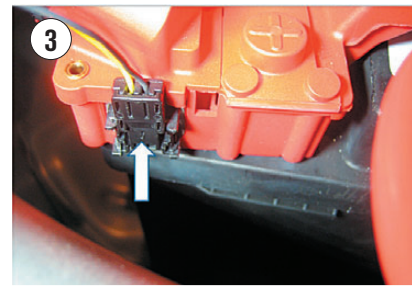
Let's discuss the issue of fixing a vehicle that develops a problem and illuminates the SRS warning light but has not been in an accident. Most of the problems I have seen are either inflator circuit issues or crash sensor problems. The good news is that the inflator circuits are just two wire circuits that either develop high- or low-resistance faults and are not too difficult to diagnose. The SRS module constantly monitors each airbag or seat belt pretensioner pyrotechnic circuit for the proper resistance to ensure the circuit will work if needed in the event of a collision. The normal resistance in these circuits is around 1-3 ohms. The scan tool capture from a 2007 Chrysler Sebring lists many codes that were set when the vehicle was in a collision.

There are many codes for open circuits in the various inflator circuits. Chrysler calls the airbag inflator charge or pyrotechnic a "squib," but it's just another variation in naming preferences. If an airbag inflates, the inflator becomes open, so the module now codes for an open circuit. Keep in mind that most SRS modules can only fire an airbag once, so if an airbag deploys, the SRS module must also be replaced. This should be covered in post-collision repair procedures, but many body shops do not

realize this and send the vehicle over to clear the warning light only to be told the SRS module must be replaced. If a vehicle comes in with a low- or high-resistance inflator circuit code, the technician's job is to determine if the fault is in the wiring or the inflator (airbag or seat belt pretensioner charge). This will require gaining access to the component connector, which may involve removing the airbag or any necessary interior trim to access seat belts or roof-mounted airbags. Once you access the connector, you can substitute the correct resistance into the circuit, clear the code and see if it returns after cycling the key. I have found it very helpful to keep handy in my toolbox ¼ watt resistors in 1, 2 and 3 ohm values to use as substitutes for inflator modules to test circuits. You can purchase SRS load tools to substitute the removed airbag inflator, but when you service many different makes this is way too large an investment to cover all models.

You only need to simulate the correct resistance in the circuit to see if the code clears or changes from an active code to a history code. If the same code returns, then the problem is in the wiring from the SRS module to your test point. If you are working on a driver's side airbag inflator, you can disconnect the wiring to the steering wheel clockspring and connect the resistor there. If the code does not return then the clockspring is defective, a pretty common problem on many vehicles. Figure 1 shows a picture of a resistor inserted into the connector of a seat-mounted side airbag to simulate the airbag inflator.

This type of circuit testing can be simplified even more when the inflator connector has a shorting bar in the connector. Many SRS system connectors have shorting bars that short the two harness wires together when the connector is disconnected. This



is done to prevent accidental airbag deployment. If there is a high resistance code set for the deployment circuit and you disconnect the inflator and a low-resistance code is set due to the shorting bars in the connector, then you know the circuit is good and the high resistance is the inflator module. The picture in Figure 2 shows a replacement SRS system wiring connector body before the wire terminals are inserted and the shorting bar is easy to see.

This leads to one of the more common problems I have seen when a body shop has done post-collision repairs. Many SRS deployment loop inflator connectors have small connector pin assurance (CPA) locks, which have to be unlocked to disconnect the connector. Often technicians lose or break these plastic locks and then a low-resistance or shorted circuit code sets because these locks also release the shorting bars in the connector. These may be difficult to find and are not available separately, so be careful when disconnecting inflator module or seat belt pretensioner connectors.

A 2013 BMW 528i was brought in by a body shop to have the replacement airbag module programmed. After successful programming, the SRS light remained on.

The code is for low resistance in the "Safety Battery Terminal." This BMW has a pyrotechnic charge at the positive battery cable clamp to open the battery cable in the event of a collision. The body shop has replaced the battery cable, but the technician left the connector lock out so the connector shorting bar has shorted the wires together and is causing the code. The shop found the connector lock and once re-installed, the problem was fixed. Shown in Figure 3 is the battery cable with the missing connector lock.

Real-world issues

These are all very common SRS service problems. During research for this article I spoke with Bob Heipp, a lead mobile diagnostic technician working at Mobile Auto Solutions located in Chicago, Ill. Mobile Auto Solutions has seven service techs and services body and repair shop clients throughout Chicago and the suburban area. Bob stated about 75 percent of their business is with body shops, so he has

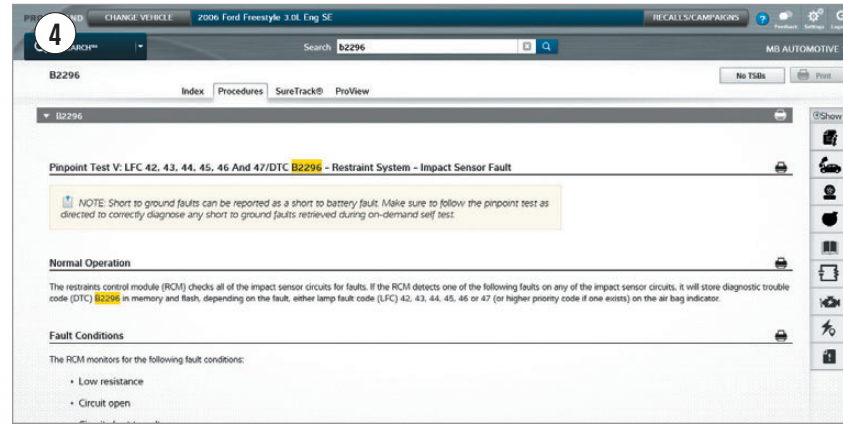


PHOTO: MITCHELL 1

seen it all when it comes to SRS system repairs. Mobile Auto Solutions services domestic, Asian and European vehicles so Bob has a wide range of experience. When asked what the most challenging SRS diagnostics are, Bob said without a doubt that man-made problems take the cake. Wrong parts installed, connectors crossed or poor wiring repairs can take the most time to sort out. His most common issues are connectors not mated properly or missing CPA locks causing airbag lights to stay on. Bob also pointed out the most important items to have for SRS service are the correct scan tool, usually a factory tool, and good service information. With these two items and some resistors, Bob can handle almost any SRS issue. Module programming, code clearing and Occupant Classification System seat weight calibrations are the most commonly performed jobs and constitute 40 percent to 50 percent of the jobs he performs each day. Bob felt a technician needs a good understanding of electrical system diagnostics and the ability to follow service procedures laid out in service manuals along with proper tooling to be successful servicing SRS systems.

The deployment loops are the output side of the SRS control module. The crash sensors are the input side of the SRS module, and they fail as well. Armed with a scope, it is possible to look at the signals, or data, that these crash sensors send out to determine if the sensors have failed. In my experience, when a crash sensor fails the module will properly code the offending sensor and the sensor itself is usually the bad component. Many frontal crash sensors are mounted in harm's way, and in the Midwest where my shop is located, there are always issues with corroded wiring and terminals. These failures are often found with a simple visual inspection. It is interesting to note here that some manufacturers such as Ford still use airbag warning light "flash" codes, which can be very helpful. A 2006 Ford Freestyle came in with the airbag light illuminated. A scan test with the factory Ford IDS scan tool revealed a code B2296, "Front Impact Sensor Circuit Failure" stored. Unfortunately, the code description does not reveal which crash sensor is at fault. The wiring diagram shows there are 6 impact sensors on this vehicle. Code B2296 covers multiple flash codes as seen in Figure 4.

When service information was accessed, the diagnostic test menu showed the LFC or "light flash code" table, which is seen in Figures 5 and 6. The table reveals that light flash code 42 is for the left front crash sensor mounted behind the grille; code 42 was the light flash code this Freestyle output.

This seemingly simple issue illustrates the need for following service information and using all the resources available. Much time can be wasted trying to determine which sensor is responsible for the code when all the while the blinking airbag light can point you in the right direction.

I captured waveforms from a 2005 Chevy Silverado with a stored SRS code for the left-hand front crash sensor. One waveform is the key on capture of the failed sensor, and another showed the right-hand sensor that is working properly — the difference was obvious. Also, a very low-voltage scale is needed to see this activity. I should mention here that correct terminal orientation is critical. The correct wire must go to the correct terminal to the crash sensors, and oftentimes the harness may have been repaired after a collision, so don't overlook wires being crossed if you are diagnosing crash sensor codes after collision repairs. Also, remember that incorrect parts can really make you chase your tail. These are man-made faults, so verify the vehicle you are working on and the correct part numbers of replacement parts. One last item is crash sensor mounting. Make sure the mounting location is clean and the bolts are properly torqued to prevent comebacks or codes resetting.

The second issue I want to mention is SRS module replacement and set up. This is a common procedure because most cars require the SRS module is replaced after airbag deployment. This is where the correct factory scan tool is really important. Some modules require only a configuration or setup procedure while some modules will require programming to be performed, so check service information before agreeing to take in a car so you are certain you have the capabilities to complete the repair. Most vehicles with a passenger front airbag will have some form of occupant classification system that can detect whether or not there is a person in the passenger seat during

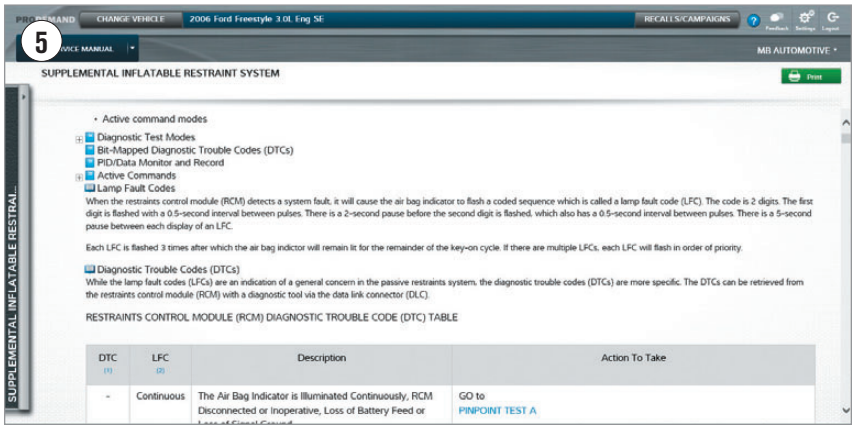
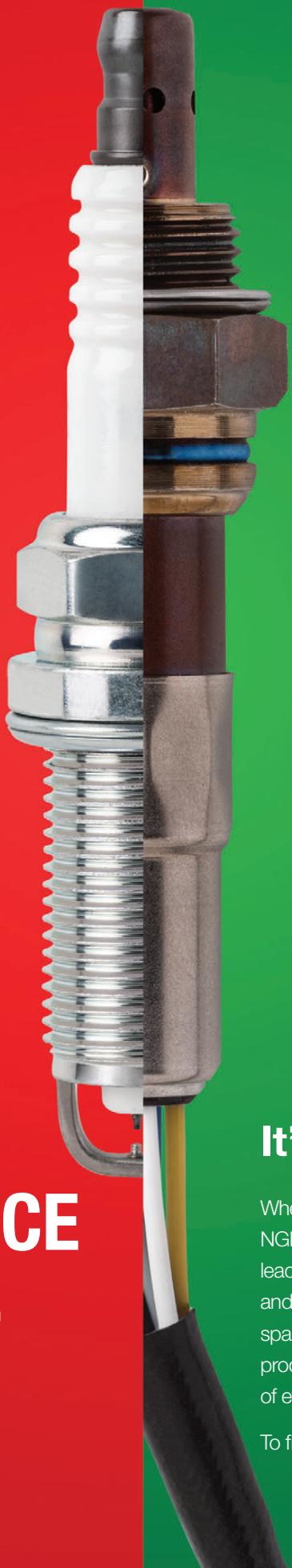


PHOTO: MITCHELL 1



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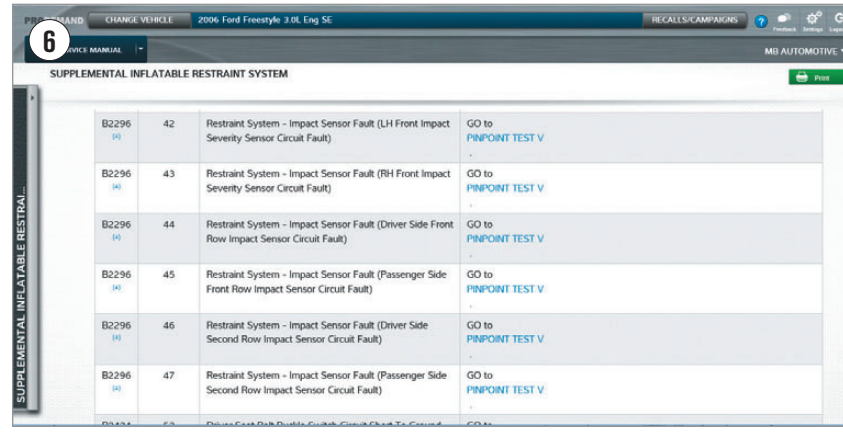
a collision event. This system will prevent passenger side airbag deployment if the passenger seat is unoccupied. This system can save a lot of money in post-collision repair costs. Oftentimes after a collision occurs, the passenger seat weight measuring system will need to be re-zeroed or calibrated. If this is not performed, a code will be set in the main SRS module and the dashboard airbag warning will remain on. Procedures to perform this function vary greatly among manufacturers, so consulting service information is necessary before beginning. There is a weight set needed to perform a calibration on many Chrysler vehicles. This three-piece assembly will simulate a rear-facing infant seat, (RFIS), 6-year-old child and a fifth percentile woman weight levels and are installed on the passenger seat one at a time while the scan tool performs the calibration. Without this special tool, you should not attempt to perform the calibration.

One issue that is somewhat common is SRS modules being replaced on Ford vehicles without following Ford's scan tool procedure called Programmable Module Installation (PMI). The PMI procedure, which should be performed when replacing most modules on a Ford product, involves having the factory IDS scan tool copy or "inhale" the module configuration files and reinstall or "exhale" the file in the replacement module. If this is not performed, you have two options: First, you could reinstall the original module and do the PMI or using the scan tool, write in the original "as-built" data for the module. The IDS scan tool may have the as-built data on the computer's hard drive or you can find it on the Ford service website at motorcraftservice.com/QuickGuides/QuickGuides.

Another problem I have seen is on Hyundai\Kia vehicles when a replacement SRS module is installed and there is still a failed component on the vehicle. Installing a new SRS module on these newer vehicles requires something called "variant coding," which tells the module which SRS components are installed on the vehicle. If there is a bad component, such as a deployed seat belt pretensioner, the variant coding will fail without any indication as to why. Because the replacement module is not coded, it cannot set fault codes, but with the factory GDS scan tool you can get a screen that helps detail the problem.



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In this case, the B1762 ACU coding error is due to a driver buckle pretensioner fault. Without the GDS scan tool, the old SRS module would need to be installed and codes pulled to find this issue, which is certainly a problem if the original SRS module has been disposed of already. One more point to ponder is that many SRS modules are mounted to the floor below a front seat. This is often the lowest point inside the interior of the car — a great spot for water to accumulate! Whenever diagnosing a module network communication problem, always verify the SRS module is not swimming under the carpet. Shorted out SRS modules have taken out many module networks and can cause all sorts of problems.

The area of SRS service is somewhat different for general repair shops versus collision repair shops. Collision shops will do mostly post-collision inspection and replacement of components, whereas general repair shops will perform more diagnostics as customers bring in their car with SRS warning lights on. Hopefully this article will better prepare the diagnostic technician in understanding the scope of SRS diagnostics and repair. Many problems require simple equipment and diagnostic procedures, while other problems may only be corrected with the proper factory scan tool.

It should be noted that proper service manual procedures should be followed at all times. Do not perform any test or jump any wires that are not covered in service information. Never remove or disconnect the SRS module with the battery connected and before letting the system deactivate to prevent accidental airbag deployment. Never measure airbag inflator modules for resistance with a meter that supplies a current for resistance measurements, and dispose of undeployed airbag inflators properly.

Use care and common sense when working on the SRS system and you will be able to repair these systems and keep your customers safe as well.

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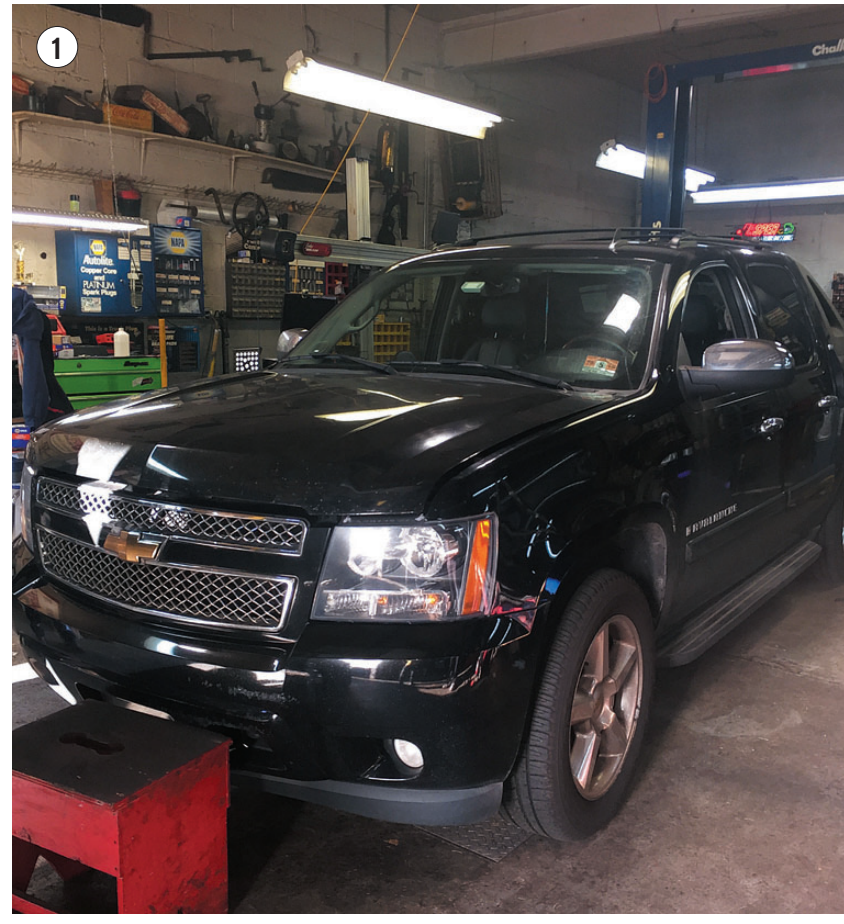
AUTOMOTIVE INTOXICATION

JUST WHEN I THOUGHT I'D SEEN EVERYTHING THERE IS TO SEE!

JOHN ANELLO // Contributing Editor

A 2008 Chevy Avalanche (Fig. 1) with a 5.3 liter automatic engine was setting codes P0172 and P0175 (System rich, banks 1 and 2). This vehicle, which had 94,000 on the odometer, had this problem for well over a year, according to the vehicle owner, and there were times the spark plugs would foul to a point where the engine would experience an engine misfire. The fix at that point was to pull the spark plugs, replace them, clear the codes and head down the road for another few months. The shop had already replaced the MAF sensor and a suspected #1 injector thinking the rich condition was being caused from a shift in MAF calculations or a leaky injector on the #1 cylinder. This, however, did not resolve the customer's ongoing issue.

The owner of the vehicle was very anxious to get the issue resolved, especially with an overdue inspection sticker on the windshield. The truck was not running well, and he thought he now had cylinder head problems because of all the carbon buildup from the prolonged rich operation, plus the fact that many people had told him that these trucks were known for bad valve guides. All the avenues had been exhausted trying to resolve his problem, so he convinced the garage to perform a valve job on his truck. The garage was against it, but the customer was persistent and willing to foot the bill, so the cylinder heads were pulled to have a valve job done. The heads were visually examined and the shop was able to see the carbon buildup on the #1 cylinder, but the other three cylinders on the same head did not seem bad (Fig. 2). The spark plugs that came out of the engine did have black carbon on them, but the #1 cylinder showed heavier deposits. The shop sent the cylinder heads out for repair and by later in the week, the truck was reassembled and released to the customer.



Well, that didn't work.

The valve job did not resolve the issue, and the customer was soon back within

a week with the CEL lamp on again. At this point, I was now thrown into the mix to unravel the shop's dilemma. When I arrived at the shop, I hooked up my scan tool to check the fuel trims with the engine fully warmed up. This would give me an indication of what the ECM was actually doing to control the fuel. The engine was not running smooth, and it had a slight rough idle. The long-term fuel trims were down around negative 26, and yet both the upper O_2 sensors were still seeing a rich operation (Fig. 3). The ECM was having a hard time in acheiving O_2 switching. The whole concept of fuel control is to achieve a constant high to low switching state above and below 500 mv. The short term fuel trim will constantly move inversely to the O_2 sensor. When the O_2 goes low, the short term will go positive. When the O_2 goes high, the short term will go negative. The short term will eventually drive the long term fuel trim slowly to a final acceptable value of plus/minus 5 percent to 10 percent. Once the long term trims exceeds plus/minus 15 percent, the ECM will usually set a code on most systems. I pulled the brake booster line to see if the O_2 sensors would respond to a major lean condition to rule out O_2 sensor failure, and their readings did go below 500 millivolts. At this point I was convinced that excess fuel was coming from somewhere or the truck had a sensor that was out of range.

Next, I viewed some basic raw data with the engine running — coolant and air temperature, Mass Air Flow, Throttle Position, Accelerator Position, Manifold and Barometric Pressures to see if everything was reading within reason (Fig. 4). At idle, I typically expect 1 gram per liter of engine displacement per second for the MAF reading. This was a 5.3L engine, so the 7 g/sec at idle was not too far off, and the other sensors all seemed to be within spec. I was looking for something that could really add some fuel, such as leaky injectors, high fuel pressure or a leaky purge valve. So I first disconnected the purge valve line at the left side of the engine just above the ignition coils (Fig. 5), but this did not have any effect on the rich operation. I even placed a fuel pressure gauge on the rail and measured the pressure, finding it within the spec of

3

Loop status	Closed		
HO2S bank 1 sensor 1	768	0...1200	mV
HO2S bank 2 sensor 1	846	0...1200	mV
Short term fuel trim bank 1	-2	-25...25	%
Short term fuel trim bank 2	0	-25...25	%
Long term fuel trim bank 1	-26	-25...25	%
Long term fuel trim bank 2	-27	-25...25	%
Fuel tank pressure sensor	0.11	-61...61	mmHg

4

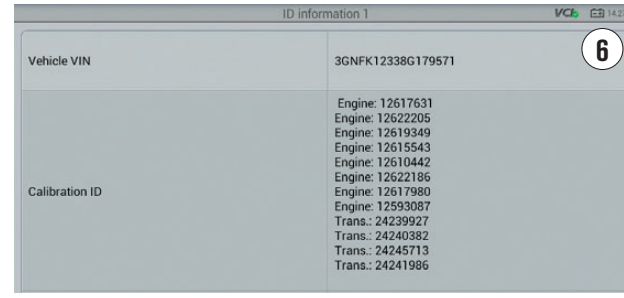
Engine speed	657	0...7000	rpm
Engine Coolant Temperature (ECT) sensor	40	-40...120	°C
IAT sensor	19	-40...120	°C
Ambient air temperature	19	-45...215	°C
Mass air flow sensor	7.28	0...300	g/s
Accelerator Pedal Position (APP) indicated an...	0	0...100	%
Throttle position indicated angle	16	0...100	%
MAP sensor	36	0...110	kPa
Barometric pressure	101	60...110	kPa

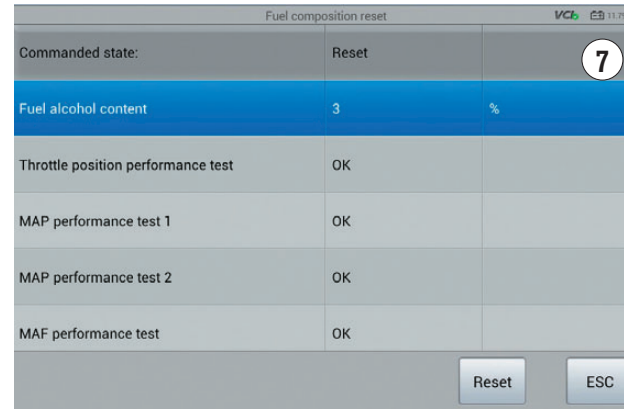
60P.S.I., and when I turned the engine off, the fuel pressure held without any signs of leakdown.

I was puzzled as to how this engine was getting more fuel than it could handle. I had to start thinking out of the box to find something out of the ordinary. I came across a vehicle a while back where a shop replaced a 5.3L ECM with a used 6.0L ECM. Both ECMs had the same hardware numbers but different software, and the engine ran but was being over fueled. I pulled up the ECM info on the scan tool (Fig. 6), but the VIN and software for this vehicle was correct. My next thought was to try to reset the fuel trims back to zero just in case the ECM was correcting for an old problem that was no longer there. Simply clearing codes or disconnecting a battery does not always guarantee resetting the fuel trims. Many learned adaptations can be stored in a non-volatile memory than can only be reset using a scan tool function. I proceeded to the fuel trim reset function in the scan tool and reset the learned fuel trims back to zero. I ran the vehicle, and the upper O_2 sensors were still seeing a rich condition, so the ECM began to ratchet down the trim values again. This car had something unusual going on, and it all pointed to a possible Engine Control Module issue, but I wasn't too quick to just go ahead and try one.

What was I facing?

I had to venture out on the internet, hoping that someone out there had a piece of the puzzle to this head-scratching issue. My diagnostic paths of approach kept hitting dead ends without





any reasonable clues to go on. We live in a cyber world where information is now at our fingertips, so I opted to Google my problem. I came across an issue about a flex fuel problem where you had to go in and reset the flex fuel alcohol counter if the ECM calculation was flawed somehow. I was unaware that this truck was flex fuel, so it was not something I would have even thought of in my diagnostic process. I went back into the scan tool to dig for the feature and there it was — "Fuel Compensation Reset." I proceeded to the function screen and was in shock to see a calculated fuel alcohol content of 73 percent! How was it that this vehicle was calculating 73 percent alcohol mixture? How was this abnormally high reading possible if the owner never used anything but straight-up gas? Did he accidentally pull up to an E85 station and fill up with the wrong stuff? Was this some type of driverless vehicle that went out on the town for for a night of drinking? There are many unanswered questions here, but by simply resetting the alcohol content back to 3 percent default (Fig. 7) and resetting the fuel trims again the vehicle was back in fuel control and ran like a champ (Fig. 8)! Now I needed answers as to how this counter had gotten so high in the first place.

The flex fuel vehicles have been around since the late 90s and are designed to handle the 85 percent alcohol to 15 percent gas mixture. The alcohol used is an ethanol made primarily from corn, but it can also be made from a variety of starch or sugary crops including potatoes, sugar cane, beets or even organic cabbage. Vehicles using E85 usually have specially lined gas tanks

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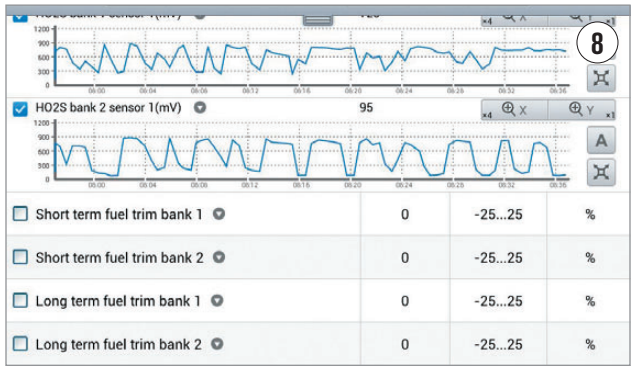
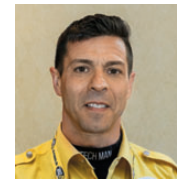
and have fuel system components that can handle the alcohol. The claim is you get a little more torque and horsepower and higher Octane ratings of up near 105. The alcohol does burn cooler and cleaner than gasoline. The downside is that you will need more of a gas mixture in a colder climate that can vary from 25 percent to 30 percent mix of gas to aid in cold weather starting. Also, alcohol has a lower BTU rating than gasoline, so the fuel-air ratio has to be bumped down from the norm of 14.7-1 to a low of 9.7-1. — thus, the reason why an onboard controller has to run a richer mixture and as a result your gas mileage is lower. Most cars since 1995 without flex fuel can handle 10 percent alcohol in their system because they are built to handle it, but put that amount of alcohol in an older car and you're asking for trouble that can lead to corroded components, damaged seals or severe fuel pump/engine damage. Today's non-flex fuel cars can handle up to 15 percent alcohol. This gives the gas companies more reason to "stretch the soup" just to meet their needs. Pulling up to a gas station today, be sure to read the warning of alcohol content in the gas you buy (Fig. 9). It would be nice if the fueling station would just offer you an option at the pumps to have a shot of alcohol to drink or just have you directly place it in your tank. There are some countries, such as Brazil, that will use a full concentration E100 alcohol for their specially designed vehicles where cold starting issues are not a factor. They will usually denature the mix with 2 percent of gas or Iso-propyl to keep people from trying to drink it!

This Avalanche does not use a direct flex fuel sensor to measure the alcohol content, but rather fuel trim algorithms to adjust the alcohol calculation. If this truck were ever to experience a lean condition, the ECM could easily mistake the lean condition for an increase of alcohol in the gas and miscalculate the mixture. When filling the tank with E85, you are supposed to do it on a warmed up engine ONLY, and after a fill up you are supposed to drive the vehicle a minimum of seven miles to recalculate the mixture. If you fill the tank and immediately park the car and let it sit for too long, the ECM with calculate the mixture on warmup the next key cycle and cause a higher-



than-normal alcohol mixture content value. I can tell you that the owner had this problem since the day he purchased the vehicle from a lot in Pennsylvania, and he lives in New Jersey. I did a Google search and there are about 2,758 E85 filling stations in the US and most are concentrated in the middle of the U.S.; there are only a few in Jersey.

The prior owner did leave a couple of clues behind, though. He left a ski rack on the roof of the truck and never deleted his trips in the navigation system that revealed some extensive driving in Colorado, North Dakota, Minnesota, Michigan and Nova Scotia, and he had access to many E85 stations because his travels were centralized in the "Corn Belt" states. It would be hard for me to believe that an ECM could calculate 73 percent alcohol from bad driving habits or prior lean conditions. I'm thinking the original owner was very fond of his flex fuel vehicle on his ski journeys across the US and possibly was the culprit to adapting his truck to be a compulsive alcoholic. It's beyond me how the vehicle was unable to adapt back to non-E85 gas. Just when you think your game plan is set in stone to resolve a simple rich condition that you may have conquered many times in the past, along comes a curveball of events that is just mind boggling. This is why I love this business. You just never stop learning. Hope this story hits home with you fellow technicians out there.



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.
atowscopeit@aol.com

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Centric Parts has released the latest addition to its award-winning library of catalogs: the updated Centric Parts 2017 Brake Systems Catalog (2010-2017). With over 5,100 newly applicated part listings, the 2017 Centric Brake Systems Catalog is the most comprehensive brake catalog available today for 2010-2017 model year vehicles.

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SOLVING DTCS WITH GLOBAL OBD II

THERE'S MORE IN THAT BASIC SCAN TOOL THAN YOU MAY KNOW!

PETE MEIER // Technical Editor

A common question I get is "what is the best scan tool to add to my toolbox?" To be honest, there is no one perfect answer to that. What I do share is that (in my opinion) many of the common drivability issues we face on a daily basis can be solved using even the most basic Global OBD II-capable tool. The key is in understanding what the tool is capable of doing, and that is the focus of this month's The Trainer installment.

In our last session, I shared that the primary role of the Engine Control Module (ECM) is to keep an eye on vehicle emissions. Every test it performs, every code it generates, every problem it finds is tied to an issue that will ultimately cause higher emissions to exit the tailpipe. Global OBD II provides us with a standardized set of Diagnostic Trouble Codes (DTCs) that all manufacturers have to incorporate and also requires the OEMs to provide access to the information we need to successfully diagnose those codes.

THE CHECK ENGINE LIGHT is the ECM's way of telling you something is wrong, and a Global OBD II-capable scan tool may be all you need to fix it.

You use most of the 10 "modes" offered in OBD II every day. Mode $01 to read live data or Mode $03 to access current DTCs are just two examples. But I'm willing to bet there are many of you who have no clue what most of the other modes are or what they have to offer in terms of diagnostic help.

While high-end aftermarket scan tools and factory scan tools have their distinct benefits, the majority of the common DTCs you face every day can be solved once you unlock the full power of Global OBD II. Take a look at this month's The Trainer to learn how.

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- R134A and R12 brass manifold set with 6' hoses
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